ICDS 2013

The Seventh International Conference on Digital Society

CYBERLAWS 2013

The Fourth International Conference on Technical and Legal Aspects of the e-Society

February 24 - March 1, 2013

Nice, France

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Claus-Peter Rückemann, Leibniz Universität Hannover / Westfälische Wilhelms-Universität Münster / North-German Supercomputing Alliance (HLRN), Germany

ICDS 2013

Forward

The seventh edition of The International Conference on Digital Society (ICDS 2013) was held in Nice, France, February 24 - March 1, 2013.

Nowadays, most of the economic activities and business models are driven by the unprecedented evolution of theories and technologies. The impregnation of these achievements into our society is present everywhere, and it is only question of user education and business models optimization towards a digital society.

Progress in cognitive science, knowledge acquisition, representation, and processing helped to deal with imprecise, uncertain or incomplete information. Management of geographical and temporal information becomes a challenge, in terms of volume, speed, semantic, decision, and delivery.

Information technologies allow optimization in searching an interpreting data, yet special constraints imposed by the digital society require on-demand, ethics, and legal aspects, as well as user privacy and safety.

The event was very competitive in its selection process and very well perceived by the international scientific and industrial communities. As such, it is attracting excellent contributions and active participation from all over the world. We were very pleased to receive a large amount of top quality contributions.

The accepted papers covered a large spectrum of topics related to advanced networking, applications, social networking, and systems technologies in a digital society. It also includes articles originally submitted to CYBERLAWS 2013, due to extensive topic overlap. We believe that the ICDS 2013 contributions offered a large panel of solutions to key problems in all areas of digital needs of today's society.

We take here the opportunity to warmly thank all the members of the ICDS 2013 technical program committee as well as the numerous reviewers. The creation of such a broad and high quality conference program would not have been possible without their involvement. We also kindly thank all the authors that dedicated much of their time and efforts to contribute to the ICDS 2013. We truly believe that thanks to all these efforts, the final conference program consists of top quality contributions.

This event could also not have been a reality without the support of many individuals, organizations and sponsors. In addition, we also gratefully thank the members of the ICDS

20103 organizing committee for their help in handling the logistics and for their work that is making this professional meeting a success.

We hope the ICDS 2013 was a successful international forum for the exchange of ideas and results between academia and industry and to promote further progress on the topics of the conference.

We also hope that Côte d'Azur provided a pleasant environment during the conference and everyone saved some time for exploring the Mediterranean Coast.

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Testing the representative capacity of parties and coalitions
(with applications to German Bundestag)

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Abstract—**Five leading German parties and their coalitions are evaluated from the viewpoint of direct democracy. For this purpose, the positions of the parties on over 30 topical issues, as given for the last Bundestag (parliament) elections 2009, are compared with the outcomes of public opinion polls. The results are summarized in the party indices of universality (percentage of issues with majority representation). The same is done for party coalitions. A statistical test is developed to judge whether the index magnitudes are sufficiently high to confirm the representative capacity. It is shown that the representativeness of German parties and their coalitions is statistically insignificant.**

Keywords-**Mathematical theory of democracy; statistical test; parties; coalitions; representativeness; Bernoulli matrices; sums of random vectors.**

I. INTRODUCTION

The mathematical theory of democracy provides methods to evaluate single representatives (candidates for president, political parties) and representative bodies (parliament, cabinet of ministers) regarding their capacity to express opinions of the population. The evaluation is based on comparing the position of representatives on selected policy issues with the public opinion revealed in public polls, referenda, or plebiscites. However, any conclusion based on a data sample has a limited reliability. Therefore, the statistical significance of evaluation has to be estimated.

To illustrate what we are going to study, suppose that five political parties define their position on six issues like 'Introduce nation-wide minimum wage', 'Privatize railways', etc., and, according to public opinion polls, one party perfectly represents the public opinion, matching the majority opinion on all the issues. The party looks highly representative, nevertheless, the following questions emerge:

1) Does the outcome observed really indicate at the party's representative capacity, or it may be just a coincidence by chance? In other words, can a similar performance be expected on other policy issues, not yet considered or arising in future?
2) Are six policy issues sufficient to make any conclusion about the party's representative capacity? Or their number should be increased, say, to 10?

3) What can be said if the match of party positions to the public opinion is imperfect, for instance, is restricted to five out of six issues? Does the conclusion about the party's representativeness remain valid?

The same questions can be addressed to party coalitions.

The usual approach to this type of problems is developing a statistical test. Assuming that the parties meet the public opinion randomly, the probability of the actual outcome is found. If it is small then a coincidence by chance looks improbable and the actual observation is interpreted as a manifestation of the party's representative capacity. If the probability is not small then the outcome looks possible and no conclusion on the party capacity is made.

The match of party positions to public opinion can be represented by a table, in our example of six issues versus five parties, with 1s standing for match and 0s for no match. If the match is assumed random, the table elements turn into independent Bernoulli random variables, taking values 0 and 1 with equal probabilities 1/2.

If an alone-standing party is considered then the table consists of a single column. The match on six out of six issues has the probability $(1/2)^6 = 1/64 \approx 0.02$. Here, 0.02 is the significance level of the null hypothesis — that there is no representative capacity, i.e., the match and non-match of the party positions with the public opinion is unpredictable, and the responses to the questions are independent. In social sciences it is traditional to use the 5% significance threshold; therefore, 0.02 is considered too small, the null hypothesis is rejected and the alternative hypothesis about the existing representative capacity is accepted. Hence, the party is regarded representative.

For five parties, the situation is different. The probability that one party out of five expresses the majority opinion on all the six issues is $1 - \left[1 - (1/2)^6\right]^5 \approx 0.08$. It is not small enough to say that the actual outcome is little probable, so the party's representative capacity is in question. However, if the perfect match is observed for seven out of seven issues then the probability $1 - \left[1 - (1/2)^7\right]^5 \approx 0.04$ is sufficiently small, arguing for the party's representativeness.

Making conclusions about coalitions is similar, but random coincidences are more frequent than for single parties.

In our example of five parties, the occurrence of a three-party coalition which represents the public opinion on six out of six issues has the probability of about 0.10. Hence, the perfect coalition performance observed is not much promising for the future. The common probability threshold 0.05 (= 5%-significance level) can be surpassed with as many as eight hits out of eight. If the match is imperfect then the sample of issues should be extended further. For three-party coalitions, a single mismatch on $i = 1$ issue must be outbalanced by at least $m - i = 10$ hits, otherwise the 5%-significance is not attained.

Computing the probabilities required to statistically 'prove' the representative capacity of coalitions is not easy, and just this task is the subject of this paper.

II. PROBLEM FORMULATION

Perfect column pairs and column triplets: A *Bernoulli* ($m \times n$)-*matrix* $B = \{b_{ij}\}$ is a matrix whose elements b_{ij} are independent Bernoulli random variables, taking values 0 and 1 with equal probabilities 1/2. A k-tuple of its columns is called *perfect* if its sum along rows is a column m-vector with all m elements being $\geq k/2$.

Label every k-tuple of columns of Bernoulli matrix with the set of corresponding column numbers $J = [j_1, \ldots, j_k]$. Order these labels J and use them as scalar indices of column k-tuples.

By A_J denote the event that the J-th k-tuple is perfect. We are interested in the probability of union of these events, meaning that there occurs at least one perfect k-tuple of columns:

$$\Pr\left(\bigcup A_J\right) = ? \tag{1}$$

A table with random 0–1 codes of match of party positions to public opinion is nothing else but a Bernoulli matrix. Here, m rows are associated with m issues, and n columns are associated with n parties. If the majority opinion on the i-th issue is represented by the j-th party then the matrix element $b_{ij} = 1$, otherwise $b_{ij} = 0$.

A perfect k-tuple of columns corresponds to a coalition of k parties whose internal majority ($\geq k/2$ parties) shares the prevailing public opinion on every issue. The probability (1) characterizes the occurrence of such coalitions by chance and is needed to statistically test the representative capacity of coalitions with 100%-representativeness observed. That is, it is addressed to answer Questions 1–2.

i-imperfect column pairs and column triplets: To study Question 3 about imperfect match of party positions to public opinion, weaken the perfectness-condition. If it is violated in i or fewer rows, the k-tuple of columns is called *i-imperfect*, that is, its sum along rows is a column m-vector with at least $m - i$ elements being $\geq k/2$.

Obviously, perfect k-tuples of columns are 0-imperfect. A i-imperfect k-tuple of columns corresponds to a coalition which represents the majority opinion incompletely, failing

to do it on i or fewer issues. The events A_J and the probability (1) are respectively redefined for i-imperfect k-tuples of columns.

Existing literature: Besides the mathematical theory of democracy, the problem of estimating the probabilities mentioned arises in genetics, logistics, and some other applications like traffic control or finances [5], [6], [13], [14], [15]. Random matrices are considered in numerous publications; for a survey see [7], [8], [9], [10]. In particular, there are papers focused on sums of random vectors and their approximations; see [1], [2], [3], [5], [11].

These publications study trends in large random matrices or in large sums of random vectors rather than propose solutions for small and medium-sized practical applications where asymptotic properties are not salient. The given paper attempts to fill in this gap by developing approaches to the problem for column pairs and column triplets in small and medium-sized Bernoulli matrices, that is, for coalitions with two or three parties if the total number of parties and the number of reference policy issues are rather limited.

Meta-modeling approach: For Bernoulli matrices, three ways to find the probability (1) are developed. One method is geometric, another algebraic, and the third properly probabilistic. In theory, each of these methods solves the problem, but in practice every method has its computational limits. The geometric solution is computationally appropriate for Bernoulli matrices with a few columns, the algebraic — for Bernoulli matrices with a few rows, and the probabilistic — for Bernoulli matrices with twice more rows than columns. Therefore, the united computational solution is combined from the three methods. There are still non-computable probabilities, and their approximations are estimated from the known probabilities by five interpolation techniques.

The general approach is based on meta-modelling. Each meta-model builds a series of models with computational formulas for particular sizes of the Bernoulli matrix. These formulas are too complex to be derived 'manually' and have no visible regularity, so the meta-modeling approach is essential.

The complexity and lack of regularities may evoke suspects in the model errors. The doubts are resolved by equal output from different methods. In fact, the probabilities computed by alternative methods, say, geometric and algebraic, coincide with the precision better than $\epsilon = 2^{-25}$.

About this paper: This paper focuses on the application of the statistical test to estimate the statistical significance of the representativeness of five German parties currently in the Bundestag and their coalitions. The full account of mathematical methods which back up the statistical test is presented in [16]. A more broad overview of the mathematical theory of democracy is given in [14], [17], [18].

III. APPLICATION TO GERMAN PARTIES

Let us come back to the questions posed in Introduction. Apply the results obtained to evaluate the representative capacity of five eligible German parties and their possible coalitions at the time of Bundestag elections 2009; see Table I.

Figure 1 shows positions of the five parties on 32 topical policy issues; as well as outcomes of polls of public opinion on these issues. The party positions are taken from the Wahl-O-Mat — a German internet site developed after a similar Dutch site *StemWijzer* (Vote match) of the late 1990s [12], [19]. These sites were designed to stimulate political participation, primarily by young people. The user fills in a questionnaire on topical political issues with Yes/No answers, eventually with weights; then the answers are compared with the answers of the parties, and the user learns which party fits best to his political profile [4]. Before the elections, the governmental supervising committee — Bundeszentrale für politische Bildung — officially receives from the parties their Yes/No answers to the questions for the Wahl-O-Mat. Therefore, the information about party positions we refer to is *official*. The answers of the Wahl-O-Mat users are unavailable, because they are not saved even as cumulated statistics. The position of the electorate on the issues is taken from related public opinion polls; see [16], [17] for references to data sources.

To explain the figure, consider the top question: '2. Introduce nation-wide minimal wage'. The question number '2' is as in the 'official' *Wahl-O-Mat* table filled by the parties shortly before the Bundestag elections 2009. Each party is depicted by a rectangle, whose length is proportional to the number of the party seats in the Bundestag. The 'No/Yes' party opinion on the question is reflected by the location of the rectangle to the left side or to the right side from the central vertical axis, respectively. A Bundestag majority is attained if the cumulative length of party rectangles surpasses the 50%-threshold (marked with dotted lines). The balance of public opinion on each issue is shown by the blue bars with the length normalized to 100% (abstaining respondents are ignored). Their bias from the center indicates at the prevailing public opinion.

For every question, a given party represents either a majority, or a minority of the population (identified with the fraction in the opinion polls). For instance, the CDU-CSU (black rectangle) with the 'No' answer to the top question '2. Introduce nation-wide minimal wage' represents the opinion of 43% of the population against 52%. After normalization, we obtain that its *representativeness* for question 2 is

$$r_{\text{CDU-CSU,2}} = \frac{43}{43 + 52} \cdot 100\% \approx 45\% \ .$$

Similarly, with the 'No' answer to the next question '17. Relax protection against dismissals', the CDU-CSU expresses the opinion of 82% of the population against

Table I
RESULTS OF 2009 GERMAN PARLIAMENTARY ELECTIONS

	CDU-CSU	SPD	FDP	Left-Party	Greens	22 minor parties with < 5% of the votes
Percentage of votes	33.8	23.0	14.6	11.9	10.7	6.0
Bundestag seats, %	36.0	24.5	15.5	12.7	11.4	None

CDU-CSU Christian Democratic Union together with Bavaria's Christian Social Union (conservatives)
SPD Social Democratic Party
FDP Free Democratic Party (neoliberals) close to employer organizations
Left-Party fusion of the PDS (Party of Democratic Socialism—former East German communists) with the WASG (Voting Alternative for Employment and Social Justice—the separated left wing of the SPD)
Greens party of ecologists in a broad sense with a social-democratic background

17%. After normalization we obtain its representativeness for question 17

$$r_{\text{CDU-CSU,17}} = \frac{82}{82 + 17} \cdot 100\% \approx 83\% \ ,$$

and so on.

The frequency of representing a majority ($\geq 50\%$) is defined to be the *universality* of the party. As one can see, the CDU-CSU represents a majority on 15 questions from 32, having the degree of imperfectness $32 - 17 = 15$, or in %

$$\mathsf{U}_{\text{CDU-CSU}} = \frac{15}{32} \cdot 100\% \approx 47\% \ .$$

A higher universality means that a majority is represented more frequently. For instance the Left-Party represents a majority on 22 of 32 questions, having the degree of imperfectness $32 - 22 = 10$, or

$$\mathsf{U}_{\text{Left-Party}} = \frac{22}{32} \cdot 100\% \approx 69\% \ .$$

The universality indices and the degree of imperfectness of the parties are shown in Table II.

The representativeness indices for a coalition are computed with a probabilistic model. If the coalition member parties are unanimous on an issue, the coalition position on the issue is as that of the member parties. If the member parties are not unanimous, the index is computed for a lottery of two possible decisions on the issue, with the probability between 0.5 (absolute uncertainty) and the one which is proportional to the size of opposing factions within the coalition.

For the statistical test, however, a simplistic assumption is made: the position of a coalition on a given issue is defined by a simple majority of the member parties, for instance, if two parties out of three share the same opinion, this opinion is adopted by the coalition. In the case of a

Public opinion and its representation by party seats in the Bundestag 2009

CDU/CSU ■, SPD ▮, FDP ▮, Left–Party ▮, Greens ▮, Public opinion (polls) ▮

NO   YES

Labour market   2. Introduce nation–wide minimal wage
                            17. Relax protection against dismissals

Economy and taxes   24. Exclusive governmental owernship of railways
  10. Equity holding by government in private banks has to be temporary
                5. No state control over top–management salaries*
                                13. Decrease corporate taxes
                                28. Reintroduce a wealth tax*

Environment   1. Prolong the operation time of nuclear power plants
  19. Introduce a general speed limit on Autobahnen (German motorways)
                9. Unexceptionally ban experiments on animals
            26. Authorize production of genetically modified food*

Social policy 36. Increase significantly unemployment benefits (Hartz IV)*
                32. If wages decrease, pensions can be reduced*
            31. No Praxisgebuehr (quarterly fee for medical visits)
        15. Compensation to parents who use no public daycares

Education 29. Leave the education policy under the authority of the states
        34. Leave 3 types of schools with different access to further education
    16. Guarantee an apprenticeship training position for every adolescent*
                7. The first university degree should be free of tuition fees*

Gender   12. There should be a quota for women in leading positions
                    27. Full adoption rights for homosexual couples

Domestic policy 6. Prohibit secret online surveillance of private computers
                    25. Retain the compulsory military service
  37. Allow domestic use of German military forces against terrorism
                    14. Introduce referenda at the federal level
        23. German politics should follow Christian values*
        38. The German democracy is the best form of government
        35. Municipal voting rights for foreign permanent residents

Foreign policy 3. Immediate withdrawl of German troops from Afghanistan

European policy   4. Germany should leave the European Union
        18. Turkey should be a full member of the European Union
                            21. Reintriduce the D–Mark

100%   50%   0%   50%   100%

Percentage of **NO/YES** votes

* Adjustments based on party public statements, parliamentary voting, etc.

Figure 1.   Public opinion and party positions on 32 issues

Table II
UNIVERSALITY INDICES OF PARTIES AND COALITIONS AND STATISTICAL SIGNIFICANCE OF THEIR REPRESENTATIVE CAPACITY. INTERPOLATED
SIGNIFICANCE VALUES ARE **boldfaced**

Single party or coalition	Universality, in %	Ranks	Degree of i-imperfectness	Significance	Adjusted seats
CDU-CSU	46.9	13	17	.9976	17.0
SPD	56.3	10	14	.8299	20.5
FDP	43.8	14	18	.9998	15.9
Left-Party	68.8	7	10	.1191	25.0
Greens	59.4	9	13	.6482	21.6
CDU-CSU/SPD	81.3	4	6	**.7293**	37.5
CDU-CSU/FDP	62.5	8	12	**.9970**	33.0
CDU-CSU/Left-Party	100.0	1	0	.0010	42.0
CDU-CSU/Greens	93.8	2	2	.0587	38.6
SPD/FDP	75.0	6	8	**.9228**	36.4
SPD/Left-Party	75.0	6	8	**.9228**	45.5
SPD/Greens	68.8	7	10	**.9816**	42.0
FDP/Left-Party	87.5	3	4	.4072	40.9
FDP/Greens	78.1	5	7	**.8534**	37.5
Left-Party/Greens	68.8	7	10	**.9816**	46.6
CDU-CSU/SPD/FDP	50.0	12	16	**.8505**	53.4
CDU-CSU/SPD/Left-Party	56.3	10	14	**.6298**	62.5
CDU-CSU/SPD/Greens	56.3	10	14	**.6298**	59.1
CDU-CSU/FDP/Left-Party	50.0	12	16	**.8505**	58.0
CDU-CSU/FDP/Greens	46.9	13	17	**.9139**	54.5
CDU-CSU/Left-Party/Greens	62.5	8	12	**.3327**	63.6
SPD/FDP/Left-Party	56.3	10	14	**.6298**	61-4
SPD/FDP/Greens	53.1	11	15	**.7561**	58.0
SPD/Left-Party/Greens	62.5	8	12	**.3327**	67.0
FDP/Left-Party/Greens	59.4	9	13	**.4820**	62.5
Bundestag 2009	50.0	13	16	.5000	100.0
Bundestag 2009 with adjusted seats	56.3	10	14	.2983	100.0

tie opinion in a two-party coalition, the prevailing public opinion is assumed decisive, as if influencing the internal coalition debate. After the positions of coalitions have been determined, their universality and imperfectness indices are defined in the same way as for single parties. These indices for possible two- and three-party coalitions are also shown in Table II.

The statistical significance of the representative capacity of single parties and properly coalitions is shown in the last column of Table II. Here, the representative capacity of no party and of no three-party coalition is even 10%-statistically significant, to say nothing of the usual 5%-threshold. As for two-party coalitions, the only 5%-significant representative capacity is inherent in the 'politically impossible' coalition of the CDU-CSU with its extreme political opponent, the Left-Party. Its 100-% universality results from our assumption that in the case of tie vote the coalition position is determined by the public opinion. On four issues the CDU-CSU and the Left-Party share the prevailing public opinion. On the remaining 28 issues they are opposite, which, according to our assumption, makes the coalition's opinion the prevailing public opinion again. Thereby the coalition 'perfectly' expresses the public opinion, which is of course a strained conclusion.

Thus, the representative capacity of German parties is statistically insignificant. A relatively high degree of imperfectness of match of their positions to the prevailing public opinion leaves little hope that new surveys with additional policy issues can change this conclusion. The same holds for the party coalitions; however, with reservations caused by a simplistic assumption of the statistical test that the coalition member parties adopt the position on an issue by the majority rule.

IV. DISCUSSION: AN ALTERNATIVE ELECTION METHOD

In representative democracy, political participation by the people is realized through election of representatives. Therefore, representative democracy is *democratic* to the degree with which the elected *represent* the public interest.

To increase in the representativeness of a parliament, an election procedure with an alternative architecture is imagined. Electoral ballots are proposed to include questions about the voter's position on key issues in candidate manifestos (Introduce nationwide minimum wage? Yes/No, Relax protection against employee dismissals? Yes/No, etc.). The election method envisages processing the totality of the ballots and evaluating candidates by the degree to which their profiles match with that of the electorate as a single body. It differs from common elections in that candidates receive no votes. In contrast to voting based on individual choices, this procedure implements public determination. The embedded referenda on a sample of issues serve as a 'direct democracy test' of the candidates. In a sense, our proposal attempts to bridge direct and representative democracies, and to make election better meet democratic objectives.

Let us illustrate our proposal with redistributing the seats in the German Bundestag, referring the German public profile based on 32 polls of public opinion on 32 policy issues and the political profiles of the five leading German parties shown in Figure 1. The degree of match of the parties with the public profile is expressed by the universality indicator given in Table II.

Now we make the size of the Bundestag factions proportionally to the party universality indices. For instance,

$$\text{Adjusted seats of CDU-CSU} = \frac{\overbrace{47}^{\substack{\text{Universality} \\ \text{of CDU-CSU}}} \times 100\%}{\underbrace{47 + 56 + 44 + 69 + 59}_{\substack{\text{Sum of universality indices} \\ \text{of the five leading parties}}}}$$

$$= 17\% \ .$$

The adjusted seats for the five parties are shown in the last column of Table II. Note the increase in the Bundestag universality displlayed in the bottom row of the table.

Of course, this is only an illustration. The procedure can be modified arbitrarily and/or used in weighted combinations with traditional voting schemata. More generally, one can consider an optimization model to maximize the representativeness of the Bundestag (its universality index) by varying the size of Bundestag factions.

V. CONCLUSIONS

Thus, the representativeness of candidates (parties) can be accurately tested from the viewpoint of direct democracy. They are evaluated with regard to their match-up with the public opinion on the key issues from the candidate (party) manifestos, declarations in medias, etc. Next, statistical conclusions about their representative capacity can be made. The statistical test for individual candidates (parties) is accurate, whereas for coalitions it is simplified: It is assumed that, on each question at issue, the position of a coalition is made by the majority rule within the coalition, and in the case of a tied opinion, the prevailing public opinion is taken.

For illustration, five leading German parties and their coalitions are evaluated. For this purpose, the positions of the parties on over 30 topical issues, as given for the last Bundestag (parliament) elections 2009, are compared with results of public opinion polls. The outcomes are summarized in the party indices universality (percentage of issues with majority representation). The same is done for party coalitions. A statistical test is developed to judge whether the index magnitudes are sufficiently high to confirm the representative capacity. It is shown that the representativeness of German parties and their coalitions is statistically insignificant.

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IMPLEMENTATION E-GOVERNMENT INITIATIVES AMONG MALAYSIAN LOCAL AUTHORITIES

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Abstract— **This paper was to study the implementation of the eGovernment initiatives among the local authorities in Malaysia which are under the jurisdiction of the local governments by using the Web Presence Measurement Model. The findings showed that the City council came out top in terms of achievement for the five Stages of Web Presence while the District council came out last which means a good number of indicators are absent from the District council websites/portals The findings also showed that the local authorities operating in the State of Selangor were much more advanced in term of representation for their websites/portals compared to those found in the State of Sabah which is located at the bottom of the list. Lessons from this study indicate that local authorities operating in constituencies with high income per capita such as Selangor are able to integrate more facilities in their websites. However, social network facilities such as Facebook and Twitter are being provided by all the local authorities websites. It is expected that the evaluation of the local authorities websites will provide a clear indication as to the extent of e-government implementation among local authorities in Malaysia.**

Keywords- eGovernment, evaluation, Malaysia, local authorities, websites.

I. INTRODUCTION

The implementation of eGovernment in Malaysia witnesses the new beginning of reinventing the government by transforming the way it operates, modernises and improves its service delivery. This initiative by the government is in reality a product of the efforts under the Multimedia Super Corridor (MSC). It is designed to improve information flow and processes within the government, improve the speed and quality of policy development, and improve coordination and enforcement. This would enable the government to be more responsive to the needs of its citizens [1]
.
The MSC is a project created by the eGovernment to hasten the process of the nation to become first world status by the year 2020. For this purpose the government has embarked in various initiatives and investments related to information and communication technology (ICT). The MSC now known as MSC Malaysia was responsible for establishing the e-government flagship under its flagship applications programme. Under the e-Government flagship, seven main projects were identified to be the core of the e-government applications. The eGovernment projects are Project Monitoring System (PMS), Electronic Procurement (eP), Generic Office Environment (GOE), E-Syariah, Human Resource Management Information System (HRMIS Electronic Services Delivery (eServices)), and Electronic Labour Exchange (ELX).

The commitment of the government towards investments in the ICT sector has been enhanced recently. During the tabling of the 10th Malaysia Plan (10MP) 2011-2015 in parliament in June 2010, the prime minister outlined several investments in ICT sector.

The move by the Malaysian Government to enhance the ICT sector has resulted in the improvement of Malaysia's ranking in the eGovernment development index as reported in the United Nations E-Government Survey 2012 "It is somewhat noteworthy that the emerging leaders group includes some developing countries that have begun to catch up with higher-income countries, such as Kazakhstan with eGovernment development index at 0.6844 , Chile with eGovernment development index at 0.6769, and Malaysia with eGovernment development index at 0.6703." [2] Therefore, it is important to find out whether the improvement of Malaysia's ranking on the eGoverment development index is effecting changes at the local government level.

Several states announced ICT plans to complement the development of the MSC. For example, Selangor state government has set up the Selangor Networking and the Web homepage for its various agencies which would link the state

administration and all government departments and agencies with every business organisation, office, factory, school and home in the state. Johor state government announced the establishment of Johor Information Infrastructure (JII) costing RM30 million, the first state to set up such a system in order to provide the public with a more efficient information service. The rate of development of the ICT sector at the state government level would directly or indirectly influence the state of eGovernment implementation at the local government level. This is due to the fact that the local government authorities are under the jurisdiction of the state governments. This situation arises from the Malaysian government structure of having a three-tiered government administrative systems namely federal, state government and local authorities.

Generally, the local authorities are under the jurisdiction of the state governments. Three types of administrative councils are in existence. These are the City, Municipal, and District councils. A city council refers to a local authority in which the population of the jurisdiction area exceeds 500,000 people and the collection of the annual revenue is more than RM100 million. City councils are led by mayors. A local authority is known as the municipal council if the population of the jurisdiction area is not less than 150,000 and the annual revenue collection is more than RM20m. A municipal council is led by a president. On the other hand, a local authority is known as a district council if the population of the jurisdiction area is less than 150,000 and the collection of annual revenue is less than RM20m [3]. All these councils perform the same functions namely the provision of basic services which covers the maintenance of local community, including businesses as well as regulating land use and business activity within the administrative area.

A mayor or president will be appointed to head the local authorities. Currently the total number of local authorities in Malaysia is 145. The Malaysian local authorities (MLA) consists of 12 City Councils, 38 Municipal Councils and 95 District Councils. The executive powers lie with the mayors in city councils, and presidents in municipal and district councils. The state governments, elected every five years, appoint mayors, presidents and all councillors. These appointments are for a three-year renewable terms. The council decision-making process is through a committee structure determined by the local authority.

The eGovernment applications would not have succeeded had it not been for the strong support of the government in the information and communication technology (ICT) sectors. Governments of both developed and developing countries have embraced ICT to improve the quality of public service, increase public access to information and to energise more participation in civic affairs [4],[5]. The citizens also are accustomed to the developments of ICT through the high rate of utilization of Internet. In the case of

Malaysia Internet usage has increased at a remarkable rate. In 2000 the number of subscribers was only about 2 million [6]. In 2007 the number of Internet subscribers have reached 13.52 million [7]. At the end of 2010 it is estimated that the Internet penetration rate will be at 16.9 million [8]. The Internet is an important element in eGovernment as the term itself is defined as" exclusively an Internet-driven activity that improves citizen access to government information services and expertise to ensure citizen participation in, and satisfaction with the government process"[9].

One conduit of offering in the Internet services to the public and business clients is the creation of eGovernment websites or portals. The presence of eGovernment websites, however, might not change the status quo as they could just be displaying information in an attractive manner and nothing more to the public. [10] opined that " No longer can a website justify itself merely by being a website – the bottom line is apparently clear : web pages must reach concrete goals and prove their investment". In order to understand whether the creation of the eGovernment websites has benefited the public or not then the question of how usable these websites are to the public has to be evaluated. The evaluation of eGovernment websites and portals can be done at several levels of the government machinery. Some scholars have accessed for features such as information availability, service delivery, and public access at global level at national level and at municipality level [11].

The paper will cover the following components: purpose of study, methodology, data analysis and conclusion.

II. PURPOSE OF THE STUDY

The aim of the study is to determine the maturity level of implementation of eGovernment applications at the Local Government levels based on the evaluation of the eGovernment websites or portals at local authorities level. This approach is taken in order to understand more clearly the actual situation on the ground.

III.   METHODOLOGY

A Model called Web Presence Measurement Model WPMM) was employed to evaluate the current status of those local authorithy websites or portals in Malaysia selected for the study. The Web Presence Measurement Model (WPMM) was introduced in the UN eGovernment Survey 2003 as an assessment towards United Nations member countries specifically for their capability in providing services electronically via the Internet. The WPMM shows 5 progressively ascending stages of presence that consists of Emerging Presence, Enhanced Presence, Interactive Presence, Transactional Presence and Networked

Presence. WPMM quantification considers the development of maturity of E-Government presence on-line. Indicators are used to measure the presence or absence of specific electronic facilities or services available in the government agency websites or portals. The WPMM model is shown in Table 1 and some refinements or adjustments have been made to some indicators to ease the evaluation process.

TABLE 1 : WEB PRESENCE MEASUREMENT MODEL INDICATORS [12]

Stage 1 Emerging Presence
Existence of an Official Website or National portal
Archived information
Message from Head of organization
Link to Ministries or other organizations
Stage II: Enhanced Presence
Provide current and archived information
Policies, budgets, regulations and downloadable databases
Search enabled
Site map
Menu provided
Help features such as FAQ provided
Product, service details and downloadable brochures
Stage III: Interactive Presence
Downloadable forms for printing and to be mailed back
Audio and video capability
E-mail, fax, telephone and physical address provided for ease of participation from public
Updated regularly
Stage IV : Transactional Presence
Instruction to support any transaction
Online application of identity cards, birth certificate and license renewal
Able to make online payments via credit, bank or debit cards
E-procurement facilities provided
Online bidding via secure links for public contracts
Stage V: Networked Presence
Use of Web Comment forms
Other innovative dialog mechanism such as chat or forum facilities
Web rating

A weight scoring method to gauge the presence of the relevant indicators is adopted in analyzing the maturity of the respective websites or portals. The weighting is computed on the basis of 1 unit score is given to the presence of a particular indicator. Based on this procedure the scoring weight for the five stages of presence is shown in Table 2.

TABLE 2: SCORING WEIGHTING

Stages	**Weighting**
StageI ;Emerging Presence	4
StageII:Enhanced Presence	7
StageIII:Interactive Presence	4
StageIV:Transactional Presence	5
StageV:Networked Presence	3

IV.   DATA ANALYSIS

The data for this study were obtained from an assessment of the Malaysian local authorities websites or portals in 2012. The assessment was based on the official local government websites or portals covering all the 14 states in Malaysia . The scoring process was based on whether the indicators as stipulated in the WPMM are present or absent. In the case where indicators are present they will be provided with an appropriate weighting as stipulated above.

Table 3 shows the scores obtained from an assessment of the City councils websites/portals in Malaysia. Not all states in Malaysia have their own City councils. Only 9 states are represented with City councils. In cases where the City council operates it can be seen that all have passed Stage I : Emerging Presence, while in Stage II : Enhanced Presence two City councils operating in the states of Sabah and Sarawak have 70% and 80 % achievement respectively which means that there are certain indicators in the Stage II that are absent. All the City councils have passed Stage III : Interactive Presence while in Stage IV : Transactional Presence the City council of Selangor has the highest achievement of 100%. However for the Stage V : Networked Presence all the City councils achieved a high score of 100%. They have incorporated in their websites social network facilities such as Facebook, Twitter and blogs. Table 3 shows the data for the top three and bottom three of the City Councils.

It is important to note that in a study conducted by [13] on the implementation of eGovernment at the Federal, State and Local Government levels in 2010 the performance of agencies under the local government in respect of Stage V :

Networked Presence was very poor and low in percentages as they have not integrated in their websites the social network facilities. As such we find nowadays the trend among the local authorities websites is to include Facebook and/or Twitter in their websites.

TABLE 3 : SCORING WEIGHTING FOR CITY COUNCIL WEBSITES/PORTALS

Stages	Fed Ter	Slg	Kdah	Tgg	Sbah	Swak
Stage I	100%	100%	100%	100%	100%	100%
Stage II	100%	100%	100%	100%	70%	80%
Stage III	100%	100%	100%	100%	100%	100%
Stage IV	80%	100%	60%	40%	20%	40%
Stage V	100%	100%	100%	100%	100%	100%

Table 4 shows the scores obtained from an assessment of the Municipal council websites/portals in Malaysia All states in Malaysia except for the Federal Territory have their own Municipal councils. These Municipal councils usually operate in the main towns of the States. As expected their scope of operations are much smaller than the City councils and as such their achievements would be likely less than that of the City councils. As shown in Table 4 there are several Municipal councils websites/portals that have not passed Stage II especially in the States of Sabah and Sarawak where they manage to achieve 60% and 80% respectively. Table 4 shows the data for the top three and bottom three of the Municipal Councils

TABLE 4 : SCORING WEIGHTING FOR MUNICIPAL COUNCIL WEBSITES/PORTALS

Stages	Perak	Slg	Kdah	Tgg	Sbah	Swak
Stage I	100%	100%	100%	100%	100%	100%
Stage II	100%	100%	100%	100%	60%	80%
Stage III	100%	100%	100%	100%	80%	100%
Stage IV	60%	80%	60%	40%	60%	40%
Stage V	100%	100%	100%	80%	100%	80%

In the case of Stage IV, Table 4 shows that not a single Municipal Councils websites/portals obtained achievements

of 100 % which means that there are several indicators that are absent from their websites.

For stage V, the Municipal councils websites/portals achievement are almost similar to that of the City councils achievements at 100 %. They also used social network facilities to improve their standing.

Table 5 shows that even at Stage I the District Councils websites/portals have not obtained 100 % achievement. The State of Sarawak has obtained an achievement of only 80 % while all the Malaysian states that have City Councils and Municipal Councils have an achievement of 100% which means that all the indicators in Stage I are present in their websites.

Table 5 also shows for Stage III the District councils websites/portals of the State of Sabah and Sarawak, obtained the lowest achievement of 80%. In the case of Stage IV the achievement of the District councils websites/portals are relatively lower than the City councils and Municipal councils websites/portals and in the case of the District council of Sarawak websites they obtained merely 20 % achievement which means four out of the five indicators are absent from the websites. In respect of Stage V the number of indicators present in the District council websites/portals are almost similar to those exhibited by the City councils and Municipal councils .websites/portals except for the case of District Councils of Sabah and Terengganu.

TABLE 5 : SCORING WEIGHTING FOR DISTRICT COUNCIL WEBSITES/PORTALS

Stages	Joh	Slg	Kdah	Tgg	Sbah	Swak
Stage I	100%	100%	100%	100%	100%	80%
Stage II	100%	100%	100%	100%	100%	100%
Stage III	100%	100%	100%	100%	80%	80%
Stage IV	80%	80%	60%	40%	40%	20%
Stage V	100%	100%	100%	40%	40%	100%

V. CONCLUSION

Based on the findings we can infer that the success story in the case of Malaysia's eGovernment implementation for local authorities is up to the level of City councils

websites/portals. It is also shown that States with a high income capita such as Selangor are high achievers while poor States such as Sabah are low achievers. This sort of indicate that local authorities with money to spend can develop their websites/portals to a sophisticated level of maturity while other less fortunate States could only provide the barest minimum for their websites/portals as in the case of Sabah. The Web Presence Measurement Model is a useful tool in identifying the presence or absence of certain indicators which are related to the measures of sophistication or maturity of the websites as exemplified in this study. Having identified the shortcomings the relevant authorities especially MAMPU, the agency responsible for enforcing eGovernment initiatives, should take steps to improve the situation of the public sector websites especially related to local authorities operating at State level.

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Open Government Knowledge Base

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Abstract — **The paper describes the governmental knowledge base constructed from Brazilian laws, the events that surround them and authorities responsible for these. The knowledge base is built on RDF (Resource Description Framework) language through the Brazilian Official Gazette, which is the access for official information. This knowledge base is linked to other Brazilian Open Data and being one more effort in Open Government Partnership [10] to reflect the country's commitment to strengthen the transparency of government action, to prevent and combat corruption. The self-management characteristic in the knowledge base was obtained through an architecture that monitors the laws status in all Brazilian Open Data Providers and highlights the inconsistencies in a period of time. This system is used by the Secretary of Federal Treasury and presents a well-founded basis for checking the accuracy and validity of the decrees in a Federal Budget domain**.

Keywords-Knowledge Base; Self-Management; Linked Open Data.

I. INTRODUCTION

In the context of Open Data [10], Brazil has been actively participating and the last news was a federal law recently launched for the purpose of free access of federal information by Brazilian citizens [2], taking into account that some information is fundamental to the safety and operation of government public companies.

The main information source is the Federal Official Gazette, which is a PDF document and contains legislation, jurisprudence and administrative actions. Published by authority since 1808, the today's Brazilian Gazette is the Brazilian Government's Official Journal. It was set up to provide King Jonh with news while he and his court were in Brazil publishing Decree, Laws, Program and Internal Rules. With a new edition every day, today's Brazilian Gazette contains a huge amount of information and statutory notices about decisions and changes in a local and national level. The Brazilian Gazette is a natural candidate for the government semantically enables the potential reuse of information.

Our goal is making public sector's information available in a way that enables and maximizes its reuse for citizens, consumers and government adding maximum value. Furthermore, we notice that due to the complexity of managing a large number of documents within an organization, a mechanism for automating the documents annotation task has become essential in order to facilitate the retrieval of information.

Sacramento et al. [22] defines and relates ontology, knowledge base and data sources such as used within this research:

(a) An ontology is a pair O=(V,S) such that

(i) V is a finite alphabet, the vocabulary of O, whose atomic concepts and atomic roles are called the classes and properties of O, respectively, and

(ii) S is a finite set of inclusions in V, constraints of O.

(b) A knowledge base is a triple KB=(V,S,A) such that

(i) (V,S) is an ontology, and

(ii) A is a finite set of assertions in V.

(c) A data source is a pair DS=(V,A) such that

(i) V is a finite alphabet, and

(ii) A is a finite set of assertions in V.

Within this work, ontology, knowledge base and data sources are used with this caution. Similarly, RDF (Resource Description Framework) [7] is a triple subject-property-object, usually described as P (S, O), where a

given subject S has a property P that assumes the value O. Sacramento et al. [22] defines Linked Data as a set of best practices for publishing and connecting structured data on the Web [24]. From the user's perspective, the main goal of Linked Data is the provision of integrated access to data from a wide range of distributed and heterogeneous data sources [25].

The linked data is achieved through interaction with other Brazilian open knowledge bases developed independently, making use of technology patterns according to [17].

The self-management characteristic was incorporate in this work through an application that monitors the RDF (Resource Description Framework) triples and validates the integrating facts between several datasets. In this paper, self-management knowledge base is defined as a knowledge base that monitors and analyses the data linking between the data sources used to.

The aims of this project are two fold:

• Address the practical challenges of publishing public governmental information in a way that maximize its reuse and ensure valid and consistent information;

• Give to Brazilian Gazette a new role, as a vehicle of semantically enabled official information, ensuring publicly available.

II. RELATED WORKS

Our project is inserted in the Brazilian Initiative Linking Open Data for moving the Web from the idea of separated documents to wide information space of components easier to discover, more valuable and easier for people to reuse.

In the context of semantic web, applications can help to produce value-added content by simply treating resources information unstructured. There is a need for readers to know where to get new and pertinent information and how to consume it. The RDF (Resource Description Framework) provides a common framework that allows data to be shared and reused across application, enterprise and community boundaries. Also, it provides a simple data formalism for talking about things, their properties, inter-relationships and categories.

According to Berners-Lee [27], the raw data should be made available as soon as possible. Preferably, it should be put up as Linked Data. Also, it should be linked to other sources, which will allow any data communication to be composed of many mixed vocabularies.

Joshi et al. [30] proposes to querying linked data by using alignments for processing queries, whose constituent data come from heterogeneous sources. They treat alignment between datasets using similarities of ontology instances. This similarity is calculated by names with natural language processing and, the ontologies and datasets used for.

Heim et al. [29] define relationship discovery via the Semantic Web as a highly user-centered process. They identified semantic relation through user´s social bookmarks.

DBPedia [28] is a typical case of a large Linked Dataset, which essentially, makes the content of Wikipedia [31] available in RDF (Resource Description Framework). The importance of DBPedia is not only that it includes Wikipedia data, but also that it incorporates links to other datasets, e.g., to Geonames [33]. Providing links in terms of RDF triples, a user might exploit the knowledge from other datasets when developing an application through of integrating facts from several datasets.

Nevertheless, a large amount of unstructured textual information is supposed to be processed before annotating and validating information that are publicly available. Some definitions found in the literature define semantic annotation as a specific schema to create and use metadata, enabling new methods of access to information [12]. Eller [5] points out that the semantic annotation of documents describes its contents by the association of relevant resources through predicate, also described in the ontology. Eller [5] also developed a system for semantic annotation of documents related to lawsuits using the Smore tool with support of an ontology in RDF (Resource Description Framework) to facilitate the process of semantic annotation of documents for specific areas.

Many services available on the Internet offer generation of semantic information from textual information. We can highlight OpenCalais [15], Zemanta [16], Ontos [11] and TextWise [14]. All these are characterized by enrichment of web pages content with hints (notes) from knowledge bases as DBpedia, GeoNames, IMDB [34] and Musibrainz [35].

OpenCalais [15] is a service provided by Reuters [13], through which it is possible to create semantic content from unstructured source text. The OpenCalais performs natural language processing (English and French) and also use machine learning techniques to define entities in the text.

The entities are divided into three categories:

• Named entities - people, companies, organizations, books, albums, authors, geographic entities;

• Facts - categorized by position, political events, etc;

• Events - sports, change of command, etc;

According to [15], using these information it is possible to build maps (or graphs or networks) linking documents to people, companies, places, and various other entities. OpenCalais uses the microformat language [6] to express its annotations.

Since API proposed by Zemanta [16] provides functionality for generating semantic information from not semantics textual information, Zemanta Service Web returns a set of information (annotations) associated with the text submit for it, such as photos, magazine articles and links from Wikipedia articles, each corresponding to a resource in DBpedia ontology.

Brazilian LexML Project [19] aims to unify, organize and facilitate the access to legislative and legal information made available in digital form by all authorities of Executive, Legislative and Judiciary at the federal, state and municipal levels.

This project produce a controlled vocabulary that plays a key role for organization of legislative and legal information, allowing the integration of this vocabularies used by different governament houses. For example, the user may inform the prefix "urn:lex:br:lei" in the URN (Uniform Resource Name) of Supreme Court judgment. Thus, "urn:lex:br:federal:lei:2008-06-19;11705" is the standard name for the law nº11705 and internationally recognized unambiguously, which ensure a single URN for each piece of legislation. However, one of the major challenges for the legal domain is the retroactivity principle of the law to meet current regulations.

The vocabularies published by LexML use the W3C SKOS (Simple Knowledge Organization System) format [20] and organize the legislative and legal information, allowing, among other things, conducting process patterns of URN (Uniform Resource Name) and the integration of vocabularies used by different Houses. The Document Type Vocabulary available in (LexML 2011) was used in this work. However, another limitation of this project is the absence of Linked Data, for example, when a law cites another law, without use the identifier of this law. What results in nonexistence of Linked Data, not allow the complete reuse.

III. SIOP-LEGIS

SIOP-LEGIS is a Knowledge Organizational System that mines Brazilian Official Gazette daily generating metadata for each document related to Federal Treasury domain. Nowadays, SIOP-LEGIS repository has a collection of more than 80.000 indexed documents since 2008 and that number increases daily [32]. The goal of SIOP-LEGIS system is to use the most accurate official document set wherever possible to aggregate and interlink document that refer to the same resource (Decree, Laws, Program and Internal Rules). Thus, there is a clear need of applying temporal database concepts to RDF (Resource Description Framework) to allow metadata navigation across time.

Initially, a mining module was proposed to automate the indexing process of documents found in Federal Official Gazette that is a PDF document, which contains a domain documents set considered relevant [32]. As shown in Figure 1, despite being a PDF, there is no publicly available metadata or text format from the government press, which makes more difficult to automatically process of reading and indexing the Official Gazette. The technological challenge was to create a mining algorithm that is not tied to the current layout of the Gazette and not being vulnerable to small changes in the style of the Gazette, which is an unlikely situation.
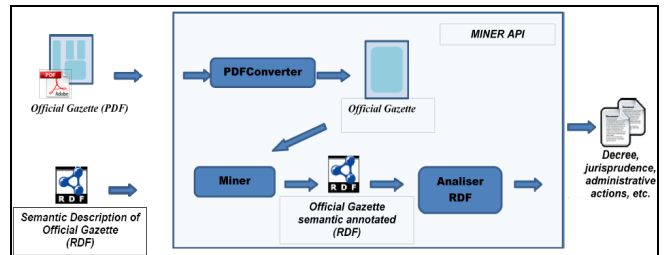
Figure 1. Process of conversion, mining and identification of documents in Federal Official Gazette

For each domain document identified, a metadata is automatically created as shown in Figure 2.

Figure 2. Metadata created automatically (in Portuguese language) for each domain document identified through Dublin Core metadata terms [26]

The mining module was created with the purpose of an API making the whole process transparent to the user, taking as input the Federal Official Gazette (in PDF format) and the RDF (Resource Description Framework) model that specify the structure of Official Gazette. After, the output is the documents list with their metadata. The Figure 3 summarizes the internal process of mining the Official Gazette.

Importantly, the Official Gazette has its text printed in several columns or combination of one, two to three columns.

A. Knowledge representation with RDF ontologies

Our proposal follows the LAG (List of Government Affairs) [9], whose approach is embedded in the e-Ping architecture - Standards of Interoperability for Electronic Government, whose goal is to define a minimum set of assumptions, policies and specifications that regulate the use of Information Technology in the Brazilian government

domain, establishing the conditions of interaction between federal houses and the society.

B. Resource Recognition

Resources are types of documents found in Official Gazette and already mapped by the Senate through the LexML project [19] within a controlled vocabulary: Decree, Laws, Program and Internal Rules.

The interested resource recognition occurs as drawn on Figure 4, when a resource is crawled on text and its unique identifier is recovered in the third-part LEXML knowledge base as shown in Figure 3, where we can see the URN present in the metadata of a law published by the government.
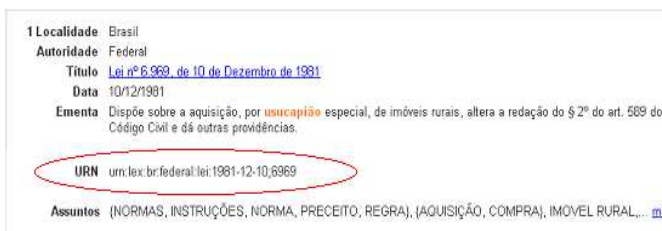
Figure 3. A result search for the law 'Lei nº6.969', which has an unique identifier 'urn:lex:br:federal:lei:1981-12-10-6969'.
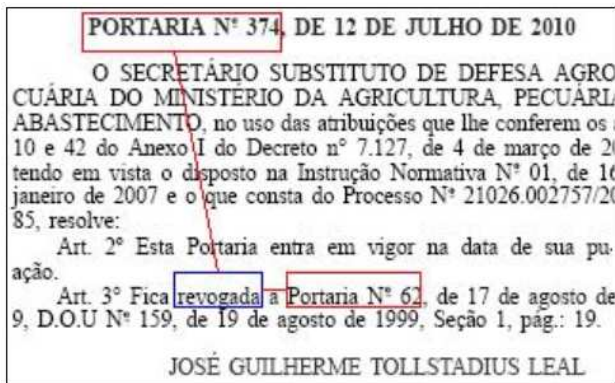
Figure 4. Government action ('revogada', in Portuguese language) identified between two resources: 'Portaria Nº374' repeal 'Portaria Nº62'.

The law cited in the Gazette is mapped in LEXML project to consolidate the Linked Open Data. Right now, the resource has a unique identity URN.

C. Event Recognition

The events between resources are present in the government acts that change the documents status over time: publication, grinding, re-publication, repeal and amendment. Thus, our goal was to process each document and find each governmental act between two resources and represents them on RDF (Resource Description Framework) language [7] to allow, among other things, control the events time.

TABLE 1. EVENTS MODELED BY THE PROPOSED PROCESS

Event	Description	Unique Identifiers
Initiative	Proposition legislative initiative	initiative
Signature	Signature normative documents.	signature
Judgment	Event that will result in a judgment or a decision monocratic.	judgment
Publication	Event official publication of document.	publication
Rectification	Event rectifying an official publication.	rectification
Re-publishing	Event re-publication of official document.	re-publishing
Annulment	Event cancellation of official document.	annulment
Modification	Changing a document on the other, creating a new version.	modification

Table 1 presents the events currently recognized and modeled with their respective unique identifiers. As shown in Figure 4, the events are identified between two resources, thus creating the RDF (Resource Description Framework) triple with the document date. This date will control the chronological order to know the resource status during its cycle life.

D. Authorities Recognition

The proposed governmental knowledge base is also monitoring the signing date, authority and role authority. Through the signing date, the chronological order of decree transformations over time is constructed.
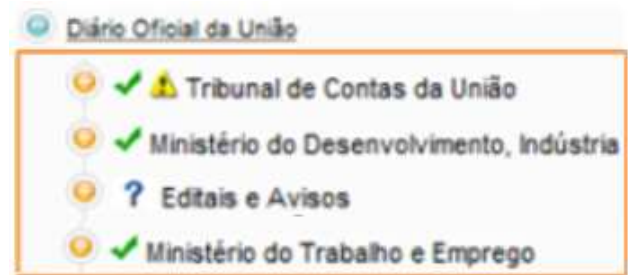
Figure 5. Shows the Brazilian authorities found in one Brazilian Official Gazette

With recognition is possible to identify the authority responsible for the promulgation of a decree. These authorities are in the third-party knowledge base maintend by the Planning Ministry, whose are reponsible for make this information public.

Figure 5 illustrates a document processing of Brazilian authorities identified. An exemple, Court of Auditors (Tribunal de Contas, in Portuguese). We can see three situations: the authority recognized successfully '✔', the authorities recognized with some difference in spelling '✔⚠' and; possible authority, but not recognized by the base '❓'.

E. Named Entities Recognition

Our governmental knowledge base performs the named entity recognition (NER) from other Brazilian open data. A major limitation here is this third-party dataset do not adopted open standard RDF (Resource Description Framework) technology. Even though this limitation, we are

motivated to computationally solve it in order to go forward in our project.

The solution thanks the Brazilian law that obliged all authorities of Executive, Legislative and Judiciary at the federal, state and municipal levels become available public servants with their occupation and function. From this information source, we have developed an algorithm to extract the names and performed the recognition of named entity on the *Corpus*.

Figure 6. An example of third-party official document with possible entities that can sign official decree.

Then, the official document issued by the Ministry, as Figure 6, is processed and used as input for the named entities recognition. In Figure 6, we have two employees with the Unique Personal Identifier (*CPF*, in Portuguese), Employee Name (*Nome do servidor*, in Portuguese) and their actual workplace (*Órgão*, in Portuguese), which are treated as authorities in this paper.

IV. CASE STUDY

Nowadays, our project is used by Federal Budget Secretary in order to audit federal publications within the domain of Federal Budget. The strength of the approach is the ability to audit documents through a user friendly interface that allows users to search for documents related to one of the available parameters as shows in the Figure 7:

• Authority (Autoridade, in Portuguese): grace the named entity identified in the processing;

• Date Signature (Data de Assinatura, in Portuguese) and Publication Date (Data de Publicação, in Portuguese) that used concomitantly with Revoked field (Revogado, in Portuguese) to identify the status of a Document Type on a specific period of time.

Figure 7. A user friendly interface that allows users to search for documents related to one of the available parameters

The processing result can be viewed in the search performed by the graphic user interface for documents or government actions available to the citizens in Portuguese language. Figure 8 shows a search result with RDF (Resource Description Framework) link and the URN of each document highlighted in red, listing with the differential:

• Shows the URN of each document, as present in this paper;

• Shows the possibility of export the RDF document representation, which allows a future automatic processing of documents returned in the search.

Figure 8. Search result with RDF link and the URN of each document highlighted in red

In Figure 9, we can see the RDF document that brings temporal processing of a federal document. From this point is possible to know the document status in a given month/year and the changes ocurrs so far. The temporal question is addressed by the knowledge base with information about each interesting event of selected document (resource).

Figure 9. RDF representation of the government act with the use of controlled vocabularies

The weakness remains the effective natural language processing to identify named entity of interest. Figure 10 shows the needed association between person's name (*Jose Guilherme Tollstadius Leal*, in Portuguese) with his title (in Portuguese, *Secretario Substituto de Defesa Agrope...*), which requires a high precision and recall.
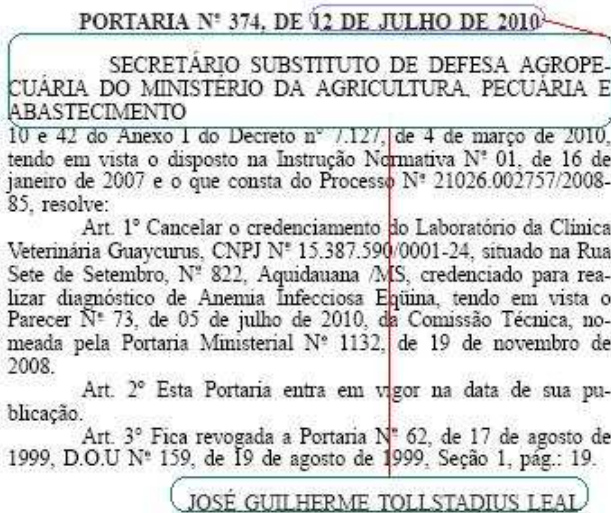
Figure 10. The desirable association between person's name (*JOSÉ...LEAL*, in Portuguese) with his title (in Portuguese, *SECRETÁRIO...ABASTECIMENTO*)

We could have this information in a relational database, but the goal here is the open access to government governamental linked knowledge base in a reuse form and understandable way. Besides creating the base interconnected with other databases that follow the open Brazilian international standard defined by [21].

V. CONCLUSION AND FUTURE WORK

The SIOP project [32] is part of Presidency initiative and Federal Budget Secretary for information provision for society. In addition to providing linked and interoperable open knowledge base, the proposal allows the development of tools to read the data provided by own government.

Note that this need arose for approval of government's public accounts. Moreover, there is a whole temporal control that lets us flag automatically when a rule is valid before causing inconsistency in the knowledge base.

The link between resources and third-party LEXML base, as well as government actions were done without problems because they are defined in a controlled vocabulary with a federal initiative. The big problem that remains is the named people recognition in the document. Despite being included as a future work, the first experiments showed an accuracy and recall of 64% and 61% respectively, which is still a unsatisfactory desire for the project.

Initially, we are working on fully automated process of documents selection in a domain of interest through the creation of rules that contain the terms of a domain ontology. The goal is to extend the application to other domains that has interest in other documents that would be selected automatically for processing.

Another work in parallel is to verify the person responsible for the decree, validating his authority for decree's promulgation in a period of time. The goal is to find inconsistencies in the knowledge base and indicates them for the domain specialist. With this, self-management characteristic will be added to the knowledge base.

Another ongoing future work is the creation of a unique identifier for authorities and people identified through recognition. However, this are suppose be provided by third-party governmental institution responsible for this information, with already happening with the project that provides a LEXML identifier to government actions promulgated, for example, the identifier '*urn: lex: br : ministerio.planejamento.orcamento.gestao: decree :2010-04-28, 777* ' for 'Decree No. 7778 of 04/28/2012', as Figure 7. The current recommended best practice for RDF identifiers is to distinguish between resource identifiers and document URLs. Resource identifiers are used as identifiers within RDF graphs, while document URLs are used on the web to retrieve documents [7].

Finally, a next work is become our Linked Open Government Knowledge Base available in web-service access to meet the information with capable of inference.

ACKNOWLEDGMENTS

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Assessing Open Government Budgetary Data in Brazil

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Abstract—**Budget transparency is an instrumental factor for better understanding the concept of budget within a democratic context. International codes for best governance practices in public management have appointed the internet as a communication media with the potential to provide this information in a timely and transparent manner to the several players in the society, and open government data has added important elements to this scenario. Currently, there is no structured framework to evaluate the quality of the budgetary information disclosed on the web. This paper takes this into consideration when proposing an assessment framework and analyzing data collected from two samples: one composed by 54 budgetary websites from different Brazilian executive power levels (national, state and municipal), complemented with another sample of 34 Brazilian audit court websites.**

Keywords-Budgetary web sites; budgetary disclosure assessment; open government data

I.   INTRODUCTION

Accessing public finance information is essential for transparency in government actions in order to increase its confidence and accountability. The movements New Public Management and New Public Financial Management [1, 2] state the importance of transparency as a prerequisite for accountability. According to OECD [3] "access to information, consultation and active participation in policy-making contributes to good governance by fostering greater transparency in policy-making; more accountability".

The use of Information and Communication Technologies (ICT) in Public Administration is linked to the New Public Management [4]. In this context, the publication of information on websites on public financing, can be observed in many countries since the early 2000s [5]. Usually, these portals publish budget laws, definitions and other technical supporting documents for the interpretation of published financial data. Regarding monitoring of budget execution afforded by websites, data is usually published both in regard to past years as well as to the current year. It is important to note that the websites have different refresh rates of information about income and expenses for the current year, which may occur monthly, weekly or daily. The level of detail, the formats used and the quality of accounting information are also very heterogeneous, usually

corresponding to the government's commitment to transparency [6].

Research on budgetary and financial information disclosure has been done since early 2000s; but, since 2009 Open Government initiatives [7, 8] have been adding new elements in the discussion. Open Government Data (OGD) initiatives emerged worldwide aiming to make public data freely available to everyone, without restrictions. However, despite its potential, there is currently a lack of roadmaps, guidelines and benchmarking frameworks to drive and measure OGD progress.

The publication of open government data on the web has great potential as pointed by [9]. However, the literature on governmental budgetary website evaluation does not provide a structured framework for assessing the quality of budgetary information disclosed to citizens. Therefore, the aim of this paper is of bridging this gap. In the pursuit of this goal, this paper proposes an assessment framework, which is based on the eight Open Government Data Principles [10]. The framework is then applied to assess 88 Brazilian open government data websites, a sample composed by different levels of the executive power (national, state and municipal), and complemented with all Brazilian audit courts.

The remainder of the paper is structured as follows. Section 2 makes a summary of the most relevant literature on governmental budgetary websites and also on the principles of open government data. Section 3 addresses the methodological issues, firstly presenting the aspects observed, including how they have been defined, then establishing the hypotheses, and finally, describing the sample, model and analysis procedures. Section 4 presents the main findings of the study, and Section 5 summarizes the conclusions.

II.   BACKGROUND

The international codes of good governance practices in public management, especially for the codes developed by the Organization for Economic Co-operation and Development (OECD) [3], International Monetary Fund (IMF) [11] and by International Federation of Accountants (IFAC) [12], as well as suggesting the actions that are translated into good practices, have also appointed the Internet as a communication media with the potential to

provide information in a timely and transparent manner to the several social players.

In Brazil, the legal recommendation [13, 14, 15] demands the public entities to disclose in real time, detailed information on the financial and budget execution, in accessible electronic media, with the objective of promoting the monitoring by the society of the usage of public resources and hold the managers who do not abide by the norms accountable.

In answer to the legal requirements, each member of the Federation sought its technological solutions, according to the principle of autonomy in the Federal Constitution, with different providers or creating its own technology teams. In this research, one can notice that even with structure and vocabulary defined by law, the information found in transparency pages from different members of the Federation bring different information, even if with a common budgetary legislation for all.

In this context, it is also important to place the existence of institutional controls on public accounts. The scrutiny of public accountancy in Brazil occurs similarly to other countries, where the creation of accountancy control institutions took place concomitantly to the modernization or monarchies or changes to the republican regimen [16]. Currently in Brazil, there are two financial control systems on the government accounts: internal control, performed by the own entities in the state apparatus, and an external control, performed by the Legislative Power, which has the aid of audit courts [17]. Thus, it is understood that by autonomy, the audit courts originate from a differentiation process in relation to the executive power - regarding the control of public finances - and legislative power - regarding the control of executive acts.

The external control is destined to prove: the probity of administrative acts; regularity of public expenditure and use of public goods, values and money; the faithful execution of budget. Also, as mentioned by [16], the external control should enable dialog channels with the civil society, with the objective of promoting social control on public administration so that any citizen, political party, association or sindicate - which are legitim parts, can inform irregularities or illegal acts.

In Brazil, the audit court system includes an audit court for the federal level (central government), 27 audit courts in states and Federal District. Most of them, that is, 23 state level audit courts, are responsible for auditing both the state and its municipalities accounts, and only 4 of them have the task of controlling exclusively state public accounts. Additionally, the audit court system has 6 audit courts: 2 for large municipalities (São Paulo and Rio de Janeiro cities), and 4 audit courts for municipalities, belonging to 4 states. All of these 34 audit courts have their own institutional websites on the internet, and the large majority publishes information for the society to follow, not only on public accountancy, but also on its audits.

A. Assessment of government portals

Many studies have been dedicated to the theme of quality in the disclosure of government information, especially budgetary, through internet portals. This section describes works that have contributed both with assessment methodologies and reflections about financial data disclosure in a particular locality.

Groff and Pitman [18] have studied 100 largest US Municipalities in order to establish a baseline against which to compare the growth of internet reporting. The items assessed were budgets and comprehensive annual financial reporting (full and summary statements).

Some aspects concerning content and design of the websites for financial reporting were evaluated in [19]. In this work, an index is proposed that comprises the type of financial information (including budgetary information and management indicators), quality of financial reporting contents, and user-friendly characteristics of website design (e.g. navigability and interaction conditions, easiness to manage and identify information). They have evaluated some Central Administrations of EU member-States. In another work, Rodríguez Bolívar [20] studied budgetary and financial position information disclosure as well as qualitative characteristics; performance indicators and the way the website is designed, tools it uses and the navigation system (e.g., easiness of interaction with potential users). Bolívar [21] propose an index which evaluates Internet-based financial information, based on the Spanish regional accounting standards. The index items embrace financial, budgetary and non-financial information for comparing accounts in hard-copy format with internet disclosure.

Similar concerns are observed to Caba et al. [22] who studied the disclosure at the municipal level (Spanish Municipalities) and proposed a disclosure index to compare paper-based financial reporting with internet financial reporting, considering information quality characteristics. Their index assesses three dimensions: financial information that websites should include, the characteristics of the contents included, and the website design to make information more accessible.

Transparency, interactivity, usability and website maturity are dimensions in the index proposed by Pina et al. [23]. A scoring system for the analysis of government financial disclosure in the internet assigns different weights to the dimensions, giving preponderance to transparency and interactivity. They have used the Web Site Attribute Evaluation System (WAES) methodology and surveyed some European regional and local government websites.

Pina et al. [24] have surveyed five local government web sites (the web site of the capital and the four subsequent largest cities) from 15 European web sites. Their survey has two groups of items of financial and non-financial information: items relating to financial accountability published through the Internet (economic and financial information performance, social and environmental information) and items relating to transparency, interactivity, usability and website maturity.

The municipal level is also studied by Jorge et al. [25]. This research combines items of budgetary and financial information to be disclosed with availability options, namely access/visibility, format and delivery mode and propose an disclosure index. They have evaluated a sample of 94

municipalities institutional websites, 49 from Italy and 45 from Portugal.

In the Brazilian context, Cruz et al.[26] has studied the transparency level of information in public administration published in the websites of 96 Brazilian municipalities included among the 100 most populous. They try to verify which characteristics and socioeconomic indicators of the municipalities can contribute to explain the level of transparency observed. The level of transparency in public administration was established from a research model called Transparency Index Municipal Public Management (ITGP-M) constructed with basis on international codes of good governance and transparency, the Brazilian legislation and the experiences of previous studies of similar nature conducted in Brazil and abroad. This index has 6 categories (general information on the municipality, municipal manager and councilors; municipal laws and municipal planning instruments; financial information, accountancy and fiscal reports; information on the interaction with citizens and society; analysis of the municipal portal; and quantitative and qualitative information on management).

Also within the Brazilian context, Ribeiro [27] evaluated two governmental portals under the transparency point of view. This evaluation had the investigation of the characteristics of the websites, and the implementation of WEAS evaluation methodology. The evaluated portals were the public purchase government portal (ComprasNet), and the Transparency Portal of the Federal Government. However, it is worth mentioning that the method applied presents limitations, such as not analyzing the quality and depth of published information, accessibility; specific problems in Brazil, such as digital exclusion; and the main issue: the model is not updated (its last version dates from 2001). Furthermore, it is important to note that none of the papers reviewed in this section explicitly addresses Open Government Data, which is the topic of the next section.

B. Open Government Data disclosure evaluation

As mentioned in Section 1, Open Government Data (OGD) introduces new possibilities to improve transparency, accountability and social participation, which are fundamental to financial information disclosure. Although there are some works that address the evaluation of OGD quality, these are not linked to the specific financial/budgetary domain. These works will be reviewed as specified below.

Braunschweig [28] presents a more technical evaluation on the state of open data portals, aiming to check not only if the data are available, but how and in which format this is made. The authors analyzed 49 existing open data portals from several countries and different organizational levels (municipal, state, federal and even international ones). Then, they crop this sample, and perform a deeper analysis in only 5 of these portals. Based on the observations made, the authors propose some standardizations, such as the presentation of data that can be re-used, which can be read by machines (and software). For the analysis of the 49 portals, which they named global view, the authors created ten indexes that were observed for each portal: Number of

published datasets (ND), Existence of standardized metadata attributes (SM), Standardized file formats (SF), Standardized domain categories (SC), Standardized spatial (SS)/temporal metadata (ST), Existence of an API (EA), API granularity: access to metadata or data (AG), Curation (CR) and Latest date of activity (DA). In the detailed view of the five portals, they created four indexes, namely: Downloadable Datasets (DD), Machine-readable Datasets (RD), Existence and number of tags (NT) and Existence and length of description (LD).

In this context of availability of government data, the term Open Government Data (OGD) was coined, which became popular at the beginning of 2008, after the publication of a set of OGD principles by lawyers in the USA, in December 2007 [10]. OGD is that any data produced by public sectors for anyone to use for any purpose [1] and the principles aiming to ensure the right to information are [10, 28]:

1) Complete: All public data is made available. Public data is data that is not subject to valid privacy, security or privilege limitations.
2) Primary: Data is as collected at the source, with the highest possible level of granularity, not in aggregate or modified forms.
3) Timely: Data is made available as quickly as necessary to preserve the value of the data.
4) Accessible: Data is available to the widest range of users for the widest range of purposes.
5) Machine processable: Data is reasonably structured to allow automated processing.
6) Non-discriminatory: Data is available to anyone, with no requirement of registration.
7) Non-proprietary: Data is available in a format over which no entity has exclusive control.
8) License-free: Data is not subject to any copyright, patent, trademark or trade secret regulation. Reasonable privacy, security and privilege restrictions may be allowed.

III. ASSESSMENT FRAMEWORK

The assessment framework proposed here encompasses the application of a survey to check the quality of budgetary data available in open government data portals. The framework is based on the eight open data principles [10], which are interpreted for the specific context of budgetary data based in good practice codes, regulations and applicable laws, namely:

- Manual on Fiscal Transparency (FMI, 2007);
- Brazilian Federal Republic Constitution;
- Complementary Law n.101/2000;
- Complementary Law n.131/2009;
- Law n. 4.320/1964;
- Technical budget manual 2012

This research was based on the eight open data principles mentioned in the previous section. Some explanations on their connection to this paper are given below.

In budget, there are two large information groups annually planned: revenues and expenses. In order to identify the compliance to the first principle - data must be complete - it was necessary that the portal presented these two groups in a temporal series.

The Brazilian budget, both for revenue and expenses, has a hierarchical classification in six levels. For example, in revenue, these levels are respectively economic (1), origin (2), species (3), approval (4), item (5), subitem (6). In this hierarchy, each sublevel is a detailing of the immediately prior level, that is, the total in origin (2) is the sum of all expenses in species (3). Thus, level 1 is the most aggregated and level 6 is the most primary.

For the third principle, data must be updated. Data from the last revenue or expense published were considered. On the access to data, forth principle, the attempts to download datasets through addresses provided in the transparency portals were checked. Also, the downloaded file should contain budget data to be considered accessible. If the data did not exist, it was not considered accessible.

The fifth principle, data must be processed by machine, was dealt in three issues since it depends on data being able to be accessed by machine, be downloaded and be in non-proprietary format in order to be read and processed. It also considered possible technologies that make difficult the access by machines, such as the use of CAPTCHA [29], a technology which depends on human intervention to access data. It can be observed that the eight principles have some intersection and/or dependency, such as in the two first ones. Data is not expected to be primary if they are not complete, nor that they can be processed if their format is not accessible.

For the sixth principle, non-discriminatory, it considered the need of some special access or enrollment. If there is no need to provide information for access the data were considered non-discriminatory. The seventh principle, data must be non-proprietary. It dealt on the observation of some options for known formats (PDF, CSV, XLS, XML) and an open field for unforeseen cases. The eighth principle, data must have free licenses, was also dealt as a single issue on the existence of usage licenses for data and if there is any restriction on them.

For this research, the parameters considered from [28] were: Standardized domain categories (SC), Standardized file formats (SF), Existence of an API (EA), API granularity: access to metadata or data (AG), Latest date of activity (DA), Downloadable Datasets (DD), Machine-readable Datasets (RD).

Number of published datasets (ND) is not part of our research since it is not about a data catalog, but only budget portals. The authors have not used the parameter Existence of standardized metadata attributes (SM) since there is no metadata standards in Brazil, even the well-know metadata standards such as Dublin Core [30] are not mentioned in the Brazilian documents like technical budget manual [31]. Also due to the absence of standards, the parameters Standardized spatial(SS)/temporal metadata (ST) were not considered. On Curation (CR), data from audit courts were considered curated data, but there is no equivalence of this parameter to

TABLE I. SUMMARY OF THE ASSESSMENT FRAMEWORK

Open Data principle	Our Framework
1 Complete	presence of information on revenues and expenses Standardized domain categories (SC)
2 Primary	observation of categories and phases in revenues and expenses Standardized domain categories (SC)
3 Timely	Date of the last update in 2012 must be of 48 hours. Latest date of activity (DA)
4 Accessible	publication on the web (valid links, not empty datasets) Downloadable Datasets (DD)
5 Machine processable	Existence of an API (EA), API granularity: access to metadata or data(AG), Machine-readable Datasets (RD)
6 Non-discriminatory	check the need of any special access or enrollment
7 Non-proprietary	Standardized file formats (SF)
8 License-free	existence of licenses for data usage and if there is any restriction to them

the eight open data principles. The parameter Existence and number of tags (NT) was not included since this parameter was considered, in the case of the Brazilian budget, equivalent to SC. Existence and length of description (LD) was not included since that for the data domains there are public budget manuals as well as legislation.

Table 1 summarizes the explanations on the framework.

IV. METHODOLOGY

Brazil has 5,565 municipalities, which belong to a federal district, and 26 states in the Brazilian federation. The study, as well as analyzing the federal government site, analyzed all portals from the 26 state governments and federal district, seeking to survey the reality of information offered in federal and state levels. At municipal level, at this point, the authors opted to investigate all capitals in the states and the federal district. In this manner, the criterion adopted was the cropping of 27 municipalities, which gather over 40% of the population in the country, rendering the study relevant, once it investigate information related to public management for a significant percentage of the Brazilian population, which answers for the largest part of all richness produced in the country.

The audit courts sites also compose another sample. All entities controlling the accountancies at municipal (6), state/municipal (4), state (23) and federal (1) levels were evaluated, with a total of 34 portals. From the collection of data in the 54 sites from the executive power and the 34 portals from control entities, we attempted to obtain 309 datasets theoretically offered, but it was only possible to download a total of 268 valid datasets, which were also evaluated. Craveiro et al. [32] made available all datasets collected and analyzed on the web.

Data collection, including the survey of municipalities and addresses of corresponding sites, data observation and analysis, information and services available on the portals, was performed between the months of August to October,
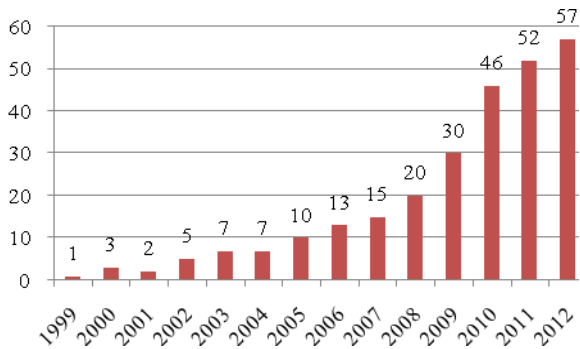
Figure 1. Datasets downloaded with data per year

Figure 3. Primary level of revenue datasets from 2009 to 2012

2012. In order to identify the websites of the municipalities, search machines were used, adopting as a standard expression "*Portal de transparencia* [*nome do município ou estado ou federal*]" (Transparency portal [name of the municipality or state or federal].

The collection of data from the portals, from the proposed assessment framework (Section 3) was performed following the procedure: when accessing the homepage, the content was accessed through the map of the site. When the homepage did not have a map of the site, the search was performed through the links existing on the main page; the information not found was sought through the search service, if it was available on the site.

V. RESULTS AND DISCUSSION

This section presents the results from the collection and analysis of data from the sample and discusses these results, organized according to the eight open data principles. In Figure 1, there is the distribution of datasets found with valid data, i. e., excluding download problems or absence of data in the files. It can be noticed that the most prominent increase is between 2009 and 2010.

In order to check the first principle of OGD, data was considered complete, at the budget domain, when both revenue and expense are published. Some portals provided more than one dataset for revenues or expenses, but for this analysis, only one dataset for each type per portal was considered. In this paper is presented only 2012 overview because there are more datasets offered. Figure 2 shows

information type disclosure: only revenue, only expense or both. Regarding the information provided in our budgetary websites sample, majority of executive power entities publish both expense and revenue, and audit courts mainly just expenses. It can be seen that 22 of 37 (59.46%) budgetary portals present both revenues and expenditures.

The assessment of the second principle was based on the classification of the Brazilian budget. From the 268 valid datasets downloaded from several years, 60 had revenues for 2012. In Figure 3, it is shown, between parenthesis, the number of datasets found for revenues between 2009 and 2012 using a scale corresponding to the classification of revenues: no classification (0), economic(1), origin(2), species(3), approval(4), item(5), subitem(6) category; a revenue dataset is only considered primary if it is classified as 6, otherwise, it only contains aggregated values. If a dataset is classified until species, it is accounted as 3. Therefore, six from the 60 datasets (10%) classified the expense only in economic, origin and species category. An increase from 31 datasets in 2009 to 60 in 2012 can be noticed. However, there is an increase in datasets that do not have the classification of the revenue.

Figure 4 presents the number of datasets found for expenses between 2009 and 2012, with the total of datasets between parenthesis, with a classification scale for expenses similar to Fig. 3: no classification(0), entity(1), budgetary unit(2), function(3), sub-function(4), program(5), action(6). In the same manner as the revenues, data are considered primary when classified as 6. Despite the smaller difference

Figure 2. Number of budgetary portals, 2012 overview
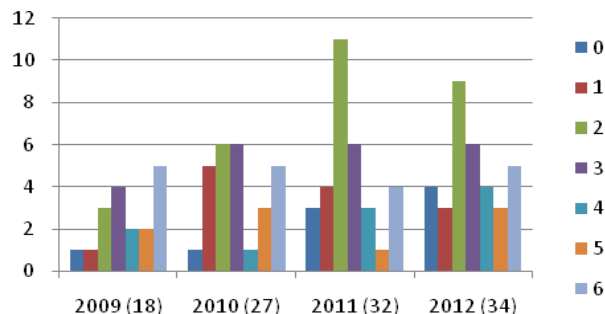
Figure 4. Primary level of expenses datasets from 2009 to 2012

between datasets classified as 0 and 6, the majority of data for expenses is not provided with detailed budgetary classification.

Among revenues and expenditures, 52 datasets were classified as primary, in total of 303 datasets from 2009 to 2012. Thus, in the considered period 17.16% of datasets are primary.

Considering the datasets for 2012 from executive entities, the average delay in publishing the budget was 1.4 months, being noticeable that for the State of Rio Grande do Sul, between the years 2006 and 2011, the last expense registered ranged from April and June, that is, for the previous years, there was a semester of information lacking on the expenses for this State. In the four audit courts presenting data for 2012, the average delay was of 5 months, which can be considered normal once the courts need to audit the public accounts. Since [14] also it demands budget data to be available in real time, in the Brazilian scenario we considered that the 'timely' principle is not met in the transparency portals, with only one dataset presenting a delay of one day and another one of two days, that is, 4.4% of the portals published the data in a satisfying time.

In order to assess the accessibility of data, forth principle, all attempts to download data were considered, being successful or not. From 309 attempts, 32 did not have files, from the 277 datasets downloaded, 9 did not contain data, remaining 268 datasets (86.73%). Even if the data can be accessed in most of the portals, over 10% access problems is significant, with a total of 41 datasets not found.

In order to analyze data that can be processed by machines, fifth principle, it could be seen that some technology would hinder the automatic downloading of data and format of the downloaded file. From the 88 portals visited, five redirected to a different address, which can impair the automatic access, and in one of them, human intervention was necessary due to the CAPTCHA technology. Most of the files were in PDF (50.72%), followed by CSV (30.07%) and XLS (19.20%). The greatest problem found was in the format of the downloaded file, where we only considered machine-processable those in CSV format. It is known that the format XLS/X despite being proprietary, has open specification [33], which makes the data accessible with the use of tools for the reading of this format, similar to a non-proprietary format. Even though XLS/X is similar to an open format, the majority of datasets are in PDF, which forbids reading by machines.

The majority of transparency portals (98.82%) meet the sixth principle - non-discriminatory access. Only the Audit Court from the State of Amapá requests enrollment for access to data.

Coincidently, as the analysis of the fifth principle resulted in the discussion of file formats, on the seventh principle, non-proprietary formats, it can be seen that only 30.07% datasets are in non-proprietary formats. Thus, in the Brazilian scenario, this principle is not met.

In no portal licenses for the data were found. This does not restrict the use, but it does not provide guarantees to the citizen. The Brazilian Freedom of Information Act establishes that information on government management is a
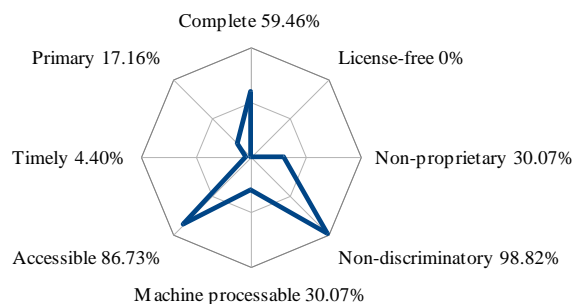
Figure 5. Compliance of sample with OGD principles

priori public. However, the absence of a license allows that in the future, the data be licensed in a restrictive manner.

Figure 5 summarizes the compliance of the sample in this article with the OGD principles. The authorsobserved that only the principles Complete, Acessible and Non-discriminatory are in compliance greater than 50%. On the other hand, only 4.4% of the analyzed sites provide timely information and only 17.16% comply with the principle of providing primary data.

As a result, it was noticed that adherence to the first two principles of open data - regarding complete and primary availability of data, respectively - is different in executive power portals, which normally provide both revenue and expenses, and in control entity portals, which focus on expenses. Regarding the quality of data available, it can be noticed that there is a tendency of growth in the amount of data available, but also that the majority of new data are not detailed (primary). This result might indicate that the Brazilian budgetary data portals are making efforts to meet the legal transparency requirements, but that the concern with the quality of data made public still needs to be reinforced.

Regarding the remaining principles, a weak adherence to the timeliness principle could be noticed, since only 4.4% of the portals visited published updated data in the two previous days. Thus, most Brazilian budgetary open data portals are yet to comply to the legal requirement of publishing in real time. Regarding the other principles, it can be noticed that many portals are already satisfactorily meeting the principle of non-discriminatory access. However, there is still the need of improving the accessibility of data (over 10% datasets analyzed could not be accessed) and the capacity of machine processing (over 50% data is still made available in PDF format, hindering its processing). Finally, the principle of free licensing of data is not followed by any of the portals analyzed, which must be object of consideration and action by public policy decision making entities in order to ensure the compliance to the legislation that indicates that government management information must be public.

VI. CONCLUSION AND FUTURE WORK

This article proposed an approach for the evaluation of budgetary government data portals in Brazil. A robust and thorough assessment framework was defined, considering the principles of open data, good practices in the disclosure

of governmental budgetary data and specific aspects in the Brazilian legislation. This framework was applied in the assessment of 88 Brazilian government budgetary data portals.

In this manner, this study makes three main contributions to the research on open budgetary government data. First, it proposes an assessment framework that integrates both open data quality and budgetary information disclosure, aiming at contributing to both research areas. On the one hand, our framework enables a more thorough examination of the format with which budgetary data is disclosed in open government data portals, what is not accomplished by previous work that analyzed transparency portals. On the other hand, our assessment framework includes specific requirements of the domain of budgetary data, thus making the evaluation of the adherence to the principles for open government data more tangible and precise.

Second, few studies hitherto have surveyed budgetary disclosure information in various levels, and in the case of Brazil, ours is the first one. Finally, as far as the authors know, there are no research results available that compare the information quality level disclosed by public entities that execute budget with entities that have the responsibility for supervising it. This work presents an assessment not only of the disclosure procedures of the entities responsible for making government data available (i.e. the executive power), but also from the institutions that must audit these data to detect irregularities and publicize them for the general public.

The authors expect this paper to bring new elements in order to improve transparency and accountability as a whole in the public budget matter. The intention is to extend this work by creating an index based on the assessment framework presented here, so as to enable a classification that indicates the quality of the disclosure procedures of public entities regarding open government budgetary data. Future work could also extend the proposed framework and perform empirical studies for establishing relationships for the impact of perceived usefulness and perceived ease of use of the websites. Additionally, the authors intend to expand the framework to consider further technical aspects of the data disclosure, such as the use of Application Programming Interfaces (APIs) and the availability of metadata.

Acknowledgements

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Assessing e-Government Service & Trust: Government to Citizen

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Abstract—Technological advancements have enabled governments across the globe to explore online facilities in offering a range of services to their citizens. One necessary element of offering quality online services is to understand citizens' views and perception towards using such services in contrast with the traditional service methods that they are accustomed to. Therefore, periodical performance assessment of online services is critical to any e-government. In this paper, the authors attempt to explore the underlying factors and various dimensions of e-government service delivery, and propose a performance assessment framework that will assess the quality and trust dimensions of the e-services from citizens' standpoint. A systematic study of the existing performance assessment models such as SERVQAUAL, E-S-Qual and D & M model, has been carried out in establishing the basis for conceptualising a new framework called e-GSQTA (e-government Service Quality and Trust Assessment Framework). The proposed framework will be validated by using the e-tax service offered by the Indian government in subsequent studies.

Keywords-e-government; performance assessment; e-services; quality; trust; e-tax; framework.

I. INTRODUCTION

E-government has been a popular topic and countries across the world are actively investing resources to improve public services. Despite the significant progress made in e-government services, research indicates that citizens as main customers are not fully taking the advantages of such e-services. This may be due to the poor quality of these services and /or lack of public trust in using them. In order to provide efficient and cost effective services and to retain citizens' confidence, governments should have better understanding of how its citizens perceive, use and evaluate the quality of the e-services offered to them. Literature review indicates lack of information in this area and also lack of effective measures to evaluate the quality of e-government services [1].

For governments, as the main service providers, it is important to know what constitutes a high quality e-service within the public domain and to have a clear and structured guidance on assessing its quality on a regular basis. Literature review also indicates the need for further research to interpret and synthesize the work done so far and to propose a comprehensive set of dimensions that determine the quality and effective use of e-services from citizens' perspective. This paper focuses on bridging this gap by proposing a new framework 'e-GSQTA' to conceptualise and assess the quality and trust aspects of the e-government

services.

The paper is divided into five sections. Section II presents previous work on existing e-government service assessment frameworks and trust measurement frameworks. Section III introduces the theoretical framework with associated assessment dimensions. Section IV discusses the methodological approach for the data collection and data analysis on a selected sample of e-government e-services in India. The final section ends up with discussion, conclusion and future research directions.

II. PREVIOUS WORK

Enormous amount of literature on e-service is available which focuses on e-commerce. Most of the studies show that many researchers speak on the e-service quality of e-commerce. Some of the known models for assessing e-service quality are SERVQAUAL [2], E-S-Qual [3], SITEQUAL [4], and E-GovQual [5], etc. Practitioners have been using these instruments for assessing e-service quality of retail and e-banking sectors. Similarly e-government is an area where citizens interact online for e-services; hence for determining the e-service quality, studies used many facets from the above mentioned models. Researchers compare e-commerce and e-government domain as identical since channel of service delivery is same. It is, therefore, necessary to do a comprehensive literature survey of e-service in e-government and e-commerce.

A. E-Service and Classification

E-services are defined by researchers in various ways. Papadomichelaki and Mentzas [5] state that e-service is web services which are delivered through the Internet. In e-service customer's interaction or contacts with service providers is through technology, such as their web sites. Customers have to rely entirely on information technology in an e-service encounter [5]. Zeithaml, Parasuraman, and Malhorta [6] conceptualize e-service as an information service or self-service since the primary value exchanged between the two parties (buyer and seller) is information. Services in e-government play a very important role by becoming the main conduit for a government in reaching out to citizens with specific, dynamic, explicit and implicit needs. In other words, digital government services encapsulate public administration functions by making information available through digital interfaces [7]. A common classification of services in e-government is related to the users: Government-to-Citizen (G2C) services provide full support to citizens, Government-to-Business (G2B)

services to firms, and Government-to-Government (G2G) services to the same or different administration, Government-to-Employee (G2E) [22].

B. Dimensions of e-Service Quality Measurements

As discussed before, most of the models introduced for measuring e-service quality are related to the online shopping, online retailing, and online banking. Now we will emphasize upon more studies related to the e-service quality measurements. Madu and Madu [9] developed a 15 dimensional scale of e-service quality based on better understanding of customer perspective and providing services to meet the needs and expectations of customers [9]. An 11 sub-dimensional scale developed based on the two dimensions of eservice quality [10]. Heim and Sinha [11] developed a process model for assessing and improving service quality by identifying eservice system entities and transactions between those entities and mapping key quality dimensions onto them [11]. Kim, Kim, and Lennon [12] suggested that the different dimensions of perceived service quality are influenced by different antecedents [12]. As mentioned earlier, [3] developed the dimensions for core service delivery and recovery services delivery in e-service quality [3]. Kim, Kim, and Lennon [12] extends the dimensions developed by [3] into a 9-dimensional scale in e-service quality in order to use them for content analysis and evaluation of web sites in the apparel retailing sector.

Agrawal [8] introduced a model EGOSQ for measuring online service quality from the users' perspective. Model suggests relationship between service quality and user's perception. DeLone and McLean [13] introduced the information success model which includes system quality, information quality and user satisfaction quality as main dimensions. Studies show that some researchers use the term "process quality" instead of "system quality". Wang and Liao [19] validated D&M IS success model in assessing systems success of G2C e-Government environment in Taiwan. They offer six dimensions: information quality; system quality; service quality; usage; user satisfaction; and perceived net benefit. With this validation it can be concluded that the quality of e-government services can be evaluated by user satisfaction and inclination of future use. Bhattacharya, Gulla, and Gupta [21] studied two main dimensions: system quality and information quality from D&M model. However process quality is not included. This model is good for e-government portal quality assessment. It does not show relationship between quality and trust.

C. The ISO/IEC 9126 Standards For Software Quality

The ISO/IEC 9126 [14] standard developed in 1991 by the International Organization for Standardization (ISO) provided the framework for evaluating software quality by providing the quality characteristics of the software throughout the development process. ISO/IEC 9126 [14] contains six quality characteristics: functionality, portability, maintainability, efficiency, usability, and reliability, which

are used for supporting the quality goals, quality assurance criteria, design review, verification and validation. These characteristics can be deployed for assessing e-government quality. The ISO/IEC 9126 [14] standard is used as a tool to identify the quality considered in each application. The ISO/IEC 9126 [14] standard describes an internal and external software quality. The internal software quality derives from the product itself. The external software quality derives from the behavior of the system of which it is a part, either direct or indirect. Both the internal and external software qualities are prescribed in a quantitative manner. ISO 9241 [15] is another standard for ergonomics of human system interaction. ISO 9241 [15] describes every aspect of usability including hardware usability, software usability, and usability processes. Furthermore, ISO 13407 [14] is the standard for human-centered design processes for interactive system (ISO 13407) [14].

III. THEORETICAL FRAMEWORK

An extensive literature survey and critical studies of the existing approaches on e-service quality, information quality, system quality, and various other e-service related dimensions identified for assessing e-service quality and trust in e-government services are in the proposed study. In this ongoing study we adopt the E-S-QUAL dimensions scale developed by Parasuraman, Zeithaml, and, Malhotra [3] as the measurement of customers' satisfaction on e-service quality in their online purchasing process. E-S-QUAL was developed for measuring e-service quality in business environment but its dimensions can be used for assessing citizen's satisfaction for measuring e-service quality. Similarly study follows another model e-GOVQUAL focusing on reliability and validity though this model includes important dimensions [4]. E-S-QUAL model involves 7-dimensional scale: four core dimensions and three recovery part of the e-service quality [3].

The four core dimensions of E-S-QUAL are: 1) System availability: the correct technical functioning of the site. 2) Efficiency: the ease and speed of accessing and using the site. 3) Fulfillment: the extent to which the site's promises about order delivery and item availability are fulfilled. 4). Privacy: The degree to which the site is safe and protects customer information. The ESQUAL has a recovery service quality scale (E_Rec_S-Qual) for problem resolution. It is only applied when customers have questions or run into problems in eservice process. The three dimension of E-Rec-S-Qual are:

1) Responsiveness: effective handling of problems and returns through the site.
2) Compensation: the degree to which the site compensates customers for problems.
3) Contact: the availability of assistance through telephone or online representatives.

Some of the dimensions like functionality, reliability, information appearance, interactivity, ease of use and trust are considered from e-GOVQUAL [4]. These dimensions are also suggested by ISO/IEC 9126 [14] for software product quality. D&M model [20] includes *system quality,*

information quality, use, user's satisfaction and *perceived net benefit* were used and validated by Wang and Liao [19]. From D&M we consider system quality, and information quality measures. To measure the performance of a system, "system quality" is the most important quality components. This is measured in terms of functionality, reliability, availability flexibility, data quality, portability, integration, and system efficiency [13][20]. Therefore, user satisfaction depends upon the system quality. Concerning the process quality, business processes should be defined, documented and streamlined to improve information flow within the organization [23].

Change in business process may affect the e-services. The information quality refers to the quality of information relating to government activities. It basically contains the measures like accuracy, timeliness, relevance, precision, and completeness. Information Quality is concerned with issues such as the relevance, timeliness, and accuracy of the information generated by an information system [13][20]. Trust element in e-service is based on overall e-service quality. Determination of trust is done by citizen's satisfaction in utilizing e-services, whereas citizen's satisfaction is based upon overall e-service quality.
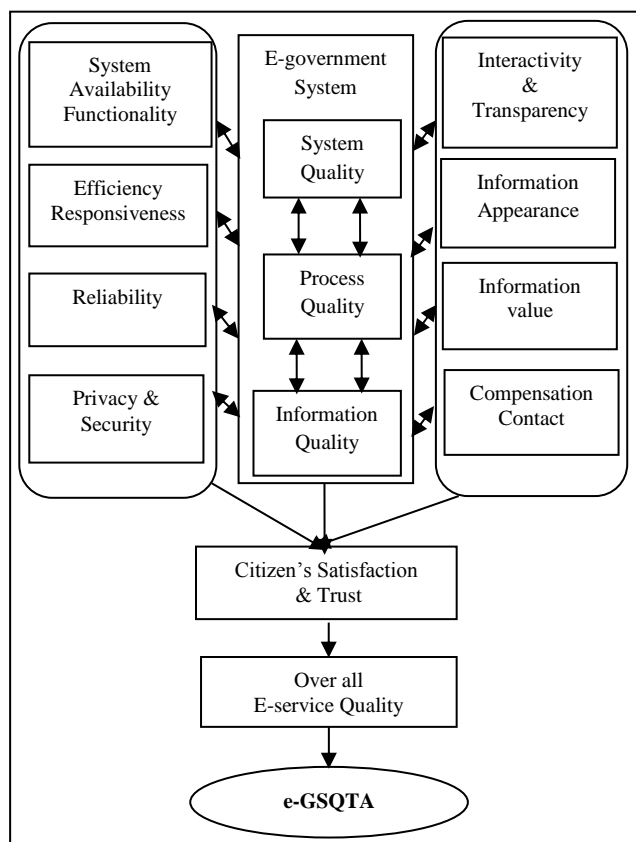
Figure 1. The proposed e-GSQTA framework

Number of hypotheses and studies has been considered for the development of e-GSQTA. Here, association among various dimensions is being presented and tried to show how e-government service quality and trust are assessed.

- Hypothesis (H1): While using online e-services the system quality in the government Web site affects the citizen's satisfaction. Hence it should be an essential part of e-GSQTA.
- Hypothesis (H2): Organizational processes should be included in an e-GSQTA assessment.
- Hypothesis (H3): While using online e-services the information quality in the government Web site affects the citizen's satisfaction. Hence it should be an essential part of e-GSQTA.
- Hypothesis (H4): E-service quality in the government Web site has a significant effect on citizen's satisfaction. Hence it should be an essential part of e-GSQTA.
- Hypothesis (H5): System quality, process quality, information quality, and e-service quality affects user's satisfaction in the G2C e-Government context.
- Hypothesis (H6): While using online e-services, interactivity, transparency, information value, and contacts are important measures and should be in the consideration since these all are related to e-government system quality dimensions. Hence it should be an essential part of e-GSQTA.
- Hypothesis (H7): Consolidation of e-service quality in e-government is done weighting all depicted measures and their dimensions of e-GSQTA framework. Hence it should be an essential part of e-GSQTA.
- Hypothesis (H8): Perceived usefulness of the government e-services has a positive effect on satisfaction and therefore it is positively related to e-service quality and becomes an important factor in assessing e-government performance.
- Hypothesis (H9): e-government "trust" is positively related to the use, and citizen's satisfaction which is based on the overall weight of e-service quality.

IV. RESEARCH METHODOLOGY

A. Data Collection

The target population includes citizens who had experience with browsing and searching for the information in e-government web portals. Research model is validated through conducting the surveys. Series of interviews took place in India from the users of e-Tax services. A set of questionnaires were distributed among the online e-tax users. Questionnaires were divided into 5- sections which included sib-questionnaires on information quality, e-service delivery, website quality, citizen's satisfaction and trust. This helped author in understanding the citizen's opinions about the existing offered e-service quality. In each section users are asked to rate from 1 to 5 each dimensions of online service quality.

B. Methodology

Collected set of questionnaires will be analyzed using partial least squares (PLS) method [24]. The PLS approach is superior to other structural equation modeling (SEM) approaches for this study because of its flexibility for distributional postulation, and its strength in handling complex predictive models [16]. Smart PLS version 3.0 or advance can be used for the analysis. SPSS 18.0 is used to store the collected data and produce descriptive statistics. PLS would be used to study the validity of the framework's main components and to determine the relationships among the constructs of framework. PLS as an analytical tool, is used in two sequential steps: these are assessments of validity of measurement model and of structural model [17].

V. DISCUSSION AND CONCLUSION

The proposed framework focuses on the main dimensions like system quality, process quality and information quality. There are measures like system availability, functionality, reliability, privacy, security, efficiency, interactivity, information value, compensation, and transparency associated with the framework which determines e-service quality. Various hypotheses introduced show the relationships among various dimensions. The introduced framework e-GSQTA will improve both practitioners and researchers understanding about the quality criteria. The purpose of this paper is to propose suitable framework and dimensions for measuring e-service quality and trust in e-government which will be beneficial for digital society. The proposed framework is based on revising the literature and adapting the E-S-Qual, E-GovQual and ISO/IEC 9126 [18] standards for the studies. The framework includes various dimensions like web site quality, design, reliability, responsiveness, security, privacy, effectiveness, ease of use and citizen's trust. A high quality e-government service is a determinant factor in building trust in the offered e-government services. The Objective of this study was to design a framework e-GSQTA which will help practitioners to assess e-government service quality and also citizen's trust. Next phase of this study will be the verification and validation. India's e-government is offering various e-services in different areas hence validation of the proposed framework is to be done using e-tax services. The objective of choosing this area is based on the idea that e-tax service is widely used by a majority of the citizens. Proposed framework may have some limitations. Cultural political, demographical and governmental issues always vary from country to country. These factors may impact the e-service quality assessment along with trust also. Second thing is, this framework focuses on G2C interaction, meaning that the assessment is done from a citizen's point of view. It does not include G2G interaction.

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Parametric Analysis of Speech Signals Based on Estimation of Joint Source-Filter Model Using Evolutionary Computation

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Abstract—This paper presents an analysis-by-synthesis algorithm based on joint estimation of speech parameters. The main advantage of the proposed algorithm is that both vocal tract and glottal source parameters are estimated simultaneously in an automatic way. The use of evolutionary algorithms is proposed to optimize these parameters. The results show that this strategy seems to be feasible for some applications such as compression of speech signals and voice conversion.

Keywords-Analysis-by-synthesis; *evolutionary algorithm*; *speech signal processing*; *source-filter model*.

I. INTRODUCTION

One of the approaches used to model the process of speech production is the so-called source-filter model [2]. In this model, the human vocal tract is separated into two distinct components: a linear filter, whose transfer function is related to the resonance frequencies of the supra-glottal cavities in the human vocal tract (mouth, throat, nasal tract), and a generating source that excites the filter with an input signal.

The type of signal emitted by the source depends on the characteristics of the speech signal to be analyzed. In voiced speech segments, whose typical example is vowels, the source signal is almost periodic, due to the vocal fold vibration. In unvoiced segments, such as the fricative consonants /s/ and /f/, the signal is treated as a white Gaussian noise. For hybrid segments, the source signal is seen as a sum of the two components described above.

On the basis of the source-filter model paradigm, speech signals are analyzed through the estimation of parameters for the excitation source and the vocal tract filter, by minimizing an error measure between the original signal and the one produced when the source signal is applied to the filter.

In this study, the representation of the voiced portions of speech signals is performed by means of a simplified source-filter model, proposing the use of evolutionary algorithms to jointly estimate the parameters of the source and the vocal tract filter [12]. The model is based on physical characteristics of the speaker: the vocal tract model is able to identify the formants of the speech signal, while the excitation model makes use of the glottal waveform, as well as of the aspiration and frication noises. To best fit the

latter, the use of the Transient Modeling Synthesis (TMS) algorithm is proposed.

The paper is structured as follows. Section II presents a state of the art. Section III introduces the proposed analysis-by-synthesis algorithm. In Section IV, experimental results are presented to illustrate the proposed method. Finally, Section V presents conclusions and perspectives for future study.

II. STATE OF THE ART IN JOINT SOURCE-FILTER ESTIMATION

Among the approaches used in joint source-filter estimation, the most common is based on the use of models for estimating the glottal waveform and the vocal tract, defining an error function and describing techniques for optimizing it. Next, some works addressing these points are presented.

In [3], the vocal tract is modeled by a filter with poles and zeros and the glottal waveform is obtained by the LF model [2]. All the parameters are estimated minimizing the least square error (LSE).

In [5], the glottal model is approximated by the Rosenberg-Klatt model (RK) [1], and the vocal tract is modeled by a Kalman filter. The Simulated Anealing algorithm was used to find the best set of parameters.

Lu and Smith [6] proposed a convex optimization method for estimating the parameters of the source and the vocal tract jointly. They used the RK model to estimate the glottal signal, and an all pole filter to vocal tract. The error criterion is the difference between estimated and original waveforms. Del Pozo and Young [10] use a similar method, but suggested certain improvements int the the glottal source model.

The method proposed in this paper presents some advantages, and the main ones are:

- The proposed vocal tract model automatically identify the resonance frequencies of the vocal tract, unlike the techniques presented. These frequencies carry information of the physical structure of the speaker's vocal tract. This information is important in voice morphing applications.
- In some studies (i. e., [6], [10]), the parameter that indicates the time of the glottal closure, GCI (glottal closure instant), is estimated a priori. The proposed

joint estimation method, based on evolutionary algorithms, enables the optimization of GCI together with the source and vocal tract parameters.

- The estimation method proposed in this paper, based on evolutionary algorithms, incorporates the spectral tilt coefficient in the joint optimization. Thus, this parameter can change over the time. In other papers, this parameter is usually a constant.

III. ANALYSIS BY SYNTHESIS BASED ON JOINT SOURCE-FILTER ESTIMATION

The speech production model proposed in this article is illustrated on Figure 1. The voiced and unvoiced portions of the speech signal are modeled in different ways. For the voiced segments, the derivative of the glottal waveform is modeled by means of the Liljencrants-Fant (LF) model [2]. The aspiration and frication noises are modeled using TMS and a white Gaussian noise with modulated amplitude. The vocal tract is modeled as a filter containing only poles, composed of two structures: one based on formant frequency and bandwidth, and an additional one representing the information not covered by the formant filter. For unvoiced frames, the turbulence noise is modeled as a white Gaussian noise, while the vocal tract is modeled as a filter containing only poles. The details of the proposed system are presented in the following subsections.

A. Joint Source-Filter Deconvolution Based on Evolutionary Algorithms

The method developed to estimate the parameters of the glottal source and vocal tract are based on a paradigm known as source-filter deconvolution. The proposed deconvolution algorithm is based on evolutionary computation [9]. The filter parameters of the vocal tract (modeled by a set of formants in cascade), the parameters of the excitation source (in this step, for simplicity, the Rosenberg-Klatt (RK) model is used to model the source) and the GCI are jointly estimated.

1) Glottal Source – RK Model: The RK model, parameterized in the time domain, models one phonatory period of the derivative of the glottal waveform, accounting for the glottal opening and closure instants. The RK model is described by 4 parameters: a, T_0 (the phonatory period), n_c
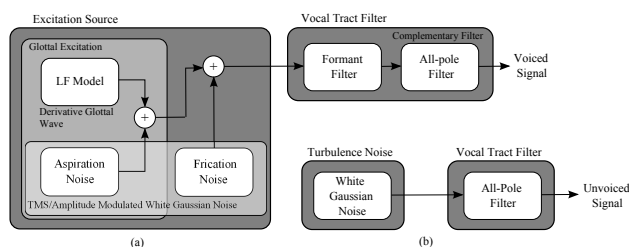
Figure 1. Source-filter model. a) Model for hybrid and voiced signals. b) Model for unvoiced signals.

Table I
SOURCE AND GCI PARAMETERS.

Parameter	Restriction	Enconding
n_c	$0.4 \times T_0 < n_c \leq 0.7 \times T_0$	Integer
a	$a \leq 0$	Real
μ	$0 < \mu < 0.99$	Real
GCI	$0 \leq GCI \leq T_0$	Integer

Table II
RESTRICTIONS ON FREQUENCY AND BANDWIDTH FOR THE CASCADE FORMANT FILTER.

Formants	Freq (Hz)		BW (Hz)	
	Min	Max	Min	Max
1	150	900	40	500
2	500	2,500	40	500
3	1,300	3,500	40	500
4	2,500	4,500	100	500
5	3,500	5,500	150	700

(duration of the closed phase) and μ (control the spectral tilt).

2) Vocal Tract Model – Formant Filter: The vocal tract filter consists of a set of resonators in cascade [1]. Each resonator is specified by two parameters: the resonance (formant) frequency F and resonance bandwidth BW.

3) Optimization Based on Evolutionary Algorithms: The method for the joint estimation of the glottal source and vocal tract filter parameters is based on evolutionary computation. To reduce the number of parameters to be optimized and limit their search space, reducing computational complexity, simplified models are used for the excitation source (Section III-A1) and the vocal tract filter (Section III-A2). A set of restrictions is also assumed, so that the models represent a valid physical structure; this provides an additional gain in computational cost and decreases the amount of local minima in the fitness surface. The RK model is used in this step with the restrictions shown in Table I.

The vocal tract is modeled through a filter with the restrictions listed in Table II [1].

An evolution strategy ($\mu + \lambda$) was used to simultaneously optimize model parameters. Both the source parameters (n_c, a, μ, GCI) and the filter (F_i, BW_i) were part of the chromosome, so that the models could be jointly evaluated.

The recombination pairs were selected based on a uniform probability. Thus, the probability of choosing an individual was the same for all the population. A discrete recombination operator, which generates the child genetic material selecting the genes of parents with equal probability, was used.

The chosen mutation operator acts on each gene of the entire population. The mutation consists of applying a gaussian mutation in all the parameters of the entire population of chromosomes. Each gene is mutated according to its variance, which is stored in the chromosome. After all the chromosomes of the population mutates, it is checked if they are still feasible. If one or more chromosomes become unfeasible, they have the value of its mutated gene restored

to the value used before the mutation.

The purpose of the evolutionary algorithm is to minimize the error between the original and the estimated signal. The equation for calculating the fitness of a solution is presented in equation 1. This function was constructed to obtain higher fitness values for solutions that present lower squared error between their samples and the original samples.

$$fitness = \frac{1}{1 + \sqrt{\sum\limits_{i=1}^{n}(s(i) - \hat{s}(i))^2}}, \qquad (1)$$

where $s(i)$ represents the original speech frame and $\hat{s}(i)$ the estimated speech frame.

More details of this implementation were presented in [11].

B. Adjustment of the Vocal Tract Using Adaptive Filters

To improve the vocal tract model, we propose the use of an adaptive filter that can estimate the parameters of an additional filter, which models the characteristics of the vocal tract that are not present in the formant filter. The adaptive filter is based on the Wiener filter, optimized with the Recursive Least Squares (RLS) algorithm. Figure 2 details this filtering model.

This method is based on the comparison between the output $g_o(n)$ of the Wiener filter and the estimate of the glottal source derivative $\hat{g}_{RK}(n)$, obtained in the process of joint estimation. When the Wiener filter coefficients are properly adjusted, the error signal $e(n)$ is minimized, which implies a filter output signal $g_o(n)$ as close as possible to the signal $\hat{g}_{RK}(n)$. The signal $g_o(n)$ is the derivative of the glottal waveform, obtained through the deconvolution of the original speech frame with the vocal tract filter (composed of the formant filter and the additional filter).

Due to inaccuracies caused by the simplification of the formant model used for the vocal tract, the joint estimation process does not produce a good estimate of the interval during which the glottis remains closed (parameter n_c).

To adjust n_c, we propose a linear search process during filter adaptation. The adaptive filtering algorithm is executed for values of n_c between 40% and 70% of the phonatory period [4], with step of 10%. The optimal solution is the one that leads to the lowest mean square error between the original frame and the temporal waveform of the signal synthesized from $\hat{g}_{RK}(n)$ and the vocal tract filter.
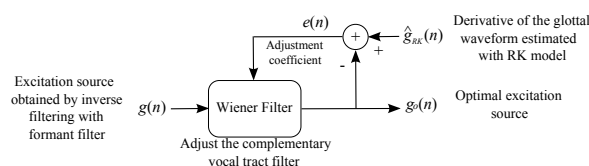
C. Adjustment of the Glottal Source - LF Model

The LF model [2] is able to describe the glottal waveform derivative with greater precision than the RK model.

The waveform produced by the LF model can be determined from the four temporal parameters $\{T_p, T_e, T_a, T_c\}$ and the magnitude of $\{E_e\}$.

The fit of the LF model is performed in two stages. Initially, the LF model parameters $(T_p, T_e, T_a, T_c, E_e)$ are estimated through direct methods [8]. This technique measures the parameters directly from the waveform obtained by means of the RK model.

The LF model parameters are then refined through an evolution strategy. The estimated T_c and T_e are considered reliable [8] and remain unchanged in the optimization process. The parameter T_a is confined between 0 and $T_c - T_e$; T_p can vary within $\pm 20\%$ of its initial estimate; and E_e can vary within $\pm 10\%$ of its initial estimate. The fitness function is based on the quadratic error between the derivative of the glottal waveform of the original frame and the waveform of the model adjusted through the LF model.

D. Modeling of the Residual Noise

The modeling techniques for the glottal source described in the previous sections do not account for the aspiration and frication noises. Due to this limitation, the difference between the source signal $\hat{g}_{LF}$ and the signal obtained through the inverse filtering of the original frame produces a residual noise. One way to interpret this noise is to consider it as a white Gaussian signal modulated in amplitude [10]; however, this approach does not always produce satisfactory results. In order to handle the residual noise, the use of the TMS algorithm [7] is proposed.

This technique exploits the time-frequency duality of sinusoids and impulses, and, as shown in [7], can be used to separate segments showing impulsive characteristics in the time domain. This process is illustrated in Figure III-D.

E. Modeling the Final Residue

The final residue model used in this article is based on the technique proposed in [10]. The method consists in treating the residue as a Gaussian noise synchronized with the phonatory period and modulated in amplitude by the LF model.

The final residue is parameterized as follows: first, a Gaussian noise with zero mean and unit variance is modulated by the glottal waveform obtained from the LF model. Then, the energy of this modulated noise is set to be equal to the energy of the final residue.
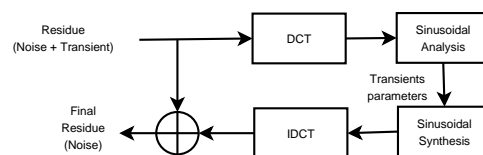

Figure 2.   Adaptive filter used to adjust the additional filter in the vocal tract model.

Figure 3.   Block diagram of the TMS operation.

IV. RESULTS AND ANALYSIS

For the evaluation of the proposed model, we present results for two signals: the first is a synthesized signal sampled at 8 kHz, generated by an LF source with a frequency of 120 Hz and a tract with four formants located at 500 Hz, 1.500 Hz, 2.500 Hz, and 3.500 Hz, with a bandwidth of 100 Hz; the second one is a frame of a stressed vowel /a/, extracted from a studio-quality recording of an utterance produced by a male speaker, encoded in linear PCM at a sampling rate of 8 kHz with 16 bits per sample.

For optimization, we set an evolution strategy to iterate through 100 generations, assuming a total of 200 individuals (μ) per generation. In each generation, 400 children (λ) were created, with a crossover rate of 1 and a mutation probability of 1 (these values were empirically adjusted).

Figure 4 shows the results for the synthesized signal. As can be seen in 4(a), the estimated tract is very close to the original one. There are small differences that are especially concentrated in high-order formants, which may be justified by the fact that the fitness of the evolutionary algorithm (section III-C) is based only on the square error of the glottal signal. Most of the glottal pulse energy is concentrated at low frequencies ($f < 2.000$ Hz); thus, an error in high order formants does not significantly affect the glottal signal, which in turn has no expressive effect on the fitness. Figures 4(b) and 4(c) show that the estimate of the derivative of the glottal waveform and the synthesized signal are close to their references. The differences may be explained by imprecisions in the optimization of the tract that reflect on the glottal signal. Nevertheless, the synthesized signal is close to the original one, as shown in Figure 4(c).

Figure 5 represents the optimization of a signal with source and tract identical to the previous ones (figure 4), except for the addition of aspiration noise to the glottal source. The aspiration noise was generated as a Gaussian noise of zero mean and unit variance, modulated by the glottal signal. Figure 5(a) displays the original time signal and the signal recovered by the algorithm (including the use of the TMS algorithm). It can be observed that, though the signals differ, they present similar contours.

Figure 5(b) shows the autocorrelation function of the noise in the signal (calculated as the difference between the LF model and the signal obtained by inverse filtering the original signal) with and without TMS. Unlike the autocorrelation function of the noise produced without TMS, the autocorrelation of the noise generated with TMS remains within the range of 95% (defined by the horizontal dotted lines present in the figure) for all delays greater than two samples, which means that the generated noise is whiter when TMS is used. It is important to state that the evaluation of the impact of TMS parameters on the presented results is not the focus of this study.

Figure 6 presents a preliminary result of optimization for a frame of a real signal of the vowel /a/. The waveform of the synthesized signal presents, notably at the beginning and end of the figure, large deviations from the original signal.

(a)

(b)

(c)
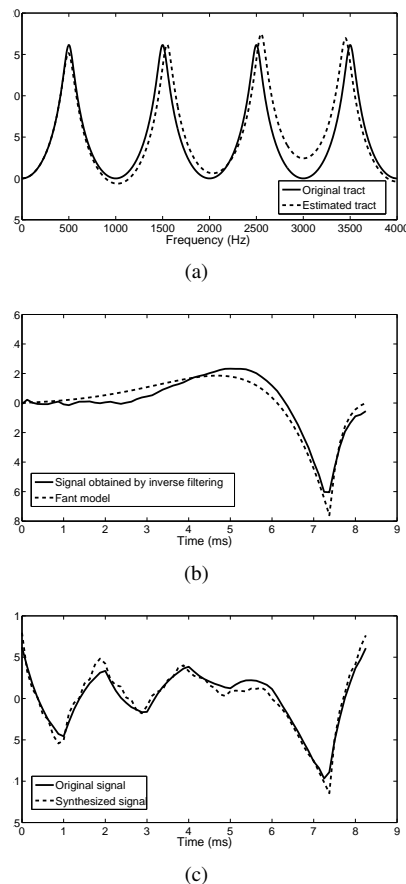
Figure 4. Optimization of a synthesized signal. a) Vocal tracts. b) Glottal signals. c) Temporal waveforms.

This probably happened because of limitations in the models used in this work. The precise identification of the reasons for this mismatch is a subject of future research.

V. CONCLUSIONS

This article presented a technique for the joint optimization of the sound source and vocal tract filter parameters for the production of voiced portions of speech signals. The LF model was employed to represent the source, while a strategy based on the TMS algorithm was used for modeling noise components. The filter was obtained by cascading four formants, defined by their bandwidths and center frequencies. The optimization was performed through an evolution strategy.

Evolutionary computation has the advantage of allowing the joint optimization of source and filter parameters, even if the fitness function implies a multimodal problem. In all simulations, the algorithms found solutions that were feasible and satisfying. The main disadvantage of this approach is related to computational cost for real time applications, requiring a significant amount of time for the convergence of the algorithms.

(a)

(b)
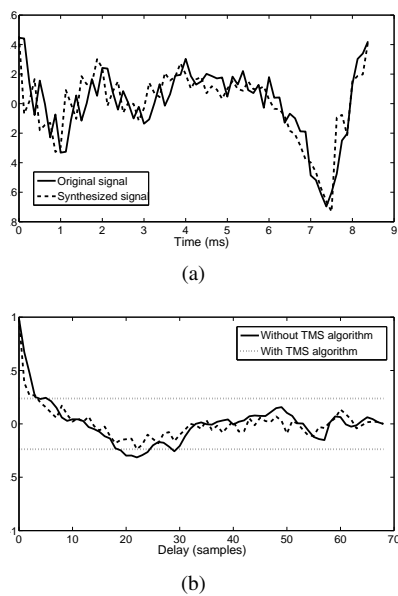
Figure 5. a) Original signal and recovered signal using the TMS algorithm. b) Autocorrelation function of the noise signal.
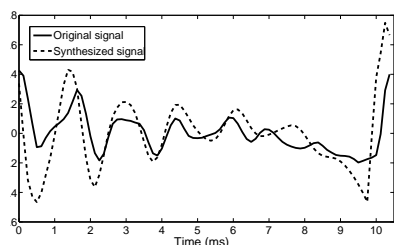
Figure 6. Temporal waveforms of the real and the synthesized signals (one frame of the vowel /a/).

One advantage of the optimization method presented in this article is its ability to efficiently determine the optimal spectral decay coefficient, as well as the instant of glottal closure; in other studies, as presented in [10], it is common to use specific algorithms for the obtainment of these parameters. Furthermore, the use of the TMS algorithm enables the whitening of the residual noise obtained as the difference between the derivative of the original glottal waveform and the one produced by the LF model, leading to a better adjustment of the noise.

The approach presented in this article for modeling the source and the filter allows the physical interpretation of the parameters obtained from the optimization, since the LF model expresses the derivative of the glottal pulse and the cascade formant filter represents the spectral envelope of speech frames. This technique seems to be feasible for applications such as compression of speech signals, voice conversion (as the parameters obtained from the optimization can be modified), and smoothing of frame boundaries prior to concatenation (for concatenative speech synthesis).

In the next steps of this research, the feasibility of applying the proposed technique in voice conversion systems will be analyzed.

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Low Complexity Estimation of Frequency Offset for OFDM Systems

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Abstract—**A frequency offset caused by the Doppler shift or the mismatch of the oscillators destroys orthogonality between the subcarriers in the orthogonal frequency division multiplexing (OFDM) signals. This paper proposes a frequency offset estimation scheme with low complexity for OFDM systems. Specifically, we use the coherence phase bandwidth to overcome the effect of timing offset and employ a threshold to estimate the frequency offset with low complexity. In addition, we also propose a timing offset estimation scheme as a next stage of the frequency offset estimation. Numerical results demonstrate that the proposed scheme can estimate frequency offset with lower computational complexity and does not require additional memory while maintaining the same level of estimation performance in terms of error variance.**

Keywords-OFDM; frequency offset estimation; threshold; coherence phase bandwidth; low complexity

I. INTRODUCTION

In orthogonal frequency division multiplexing (OFDM) modulation, the data is transmitted on the multiple orthogonal subcarriers. Due to its high spectral efficiency and immunity to multipath fading, OFDM has attracted much attention in the field of wireless communications [1], [2]. For example, OFDM has been adopted as the transmission method of many standards in wireless communications, including European digital video broadcasting (DVB) [3], IEEE 802.11a [4], IEEE 802.16 [5], and Long Term Evolution (LTE) [6]. However, the OFDM is very sensitive to the frequency offset caused by Doppler shift or the mismatch of the oscillators. To alleviate these problems, various techniques have been proposed [7]-[9]. Recently, estimation schemes for integer frequency offset have been proposed in [10] and [11]. However, the schemes in [10] and [11] are either sensitive to timing offset or complex to implement. [†]

In this paper, a novel frequency offset estimation scheme based on the coherence phase bandwidth (CPB) and a threshold is proposed for OFDM systems. The proposed scheme is robust to a symbol timing offset and has lower computational complexity when compared with Nogami's [10] and Bang's [11] schemes. We also propose a timing offset estimation scheme as the next stage of the frequency offset estimation.

The remainder of this paper is organized as follows. Section II introduces the related works on the frequency

offset estimation. In Section III, an OFDM signal model is influenced by the frequency and timing offsets is described. The effect of timing offset on conventional schemes is shown in Section IV. In Section V, a low complexity frequency offset estimation scheme is proposed, and then, a timing offset estimator is proposed as the next step of the frequency offset estimation. Section VI presents numerical results, and finally, Section VII concludes this paper.

II. RELATED WORKS

To estimate the frequency offset, several schemes have been proposed in [7]-[11]. The frequency offset estimation schemes can be classified into two categories: fractional frequency offset estimation schemes [7]-[9] and integer frequency offset estimation schemes [10], [11]. In [7], the fractional frequency offset was estimated by using the cyclic prefix of an OFDM symbol. The scheme in [8] provides an improved estimation performance over the scheme in [7] by using a training symbol with identical halves, yet, the estimation range was as large as the sub-carrier spacing only. In [9], a training symbol with several repeated parts is employed to provide the extended estimation range. On the other hand, for integer frequency offset estimation, an estimation scheme was proposed in [10] using the crosscorrelation between the received and locally generated training symbols. However, the scheme in [10] is very sensitive to the timing offset, thus, in [11], an estimation scheme robust to the timing offset was proposed considering CPB in its estimation process. However, the scheme in [11] has the problem that the complexity rapidly increases, as the frequency offset estimation range increases.

III. SIGNAL MODEL

An OFDM symbol is generated by inverse fast Fourier transform (IFFT) as

$$s_n = \frac{1}{\sqrt{N}} \sum_{l=0}^{N-1} S_l e^{j2\pi nl/N}, \qquad (1)$$

where S_l is a phase shift keying (PSK) or quadrature amplitude modulation (QAM) symbol in lth subcarrier and N is the size of IFFT.

In the presence of frequency and timing offsets, the received OFDM signal r_n can be expressed as

$$r_n = s_{n-n_0} e^{j2\pi f_0 (n-n_0)/N} + w_n, \qquad (2)$$

where f_0 and n_0 represent the frequency offset normalized to the subcarrier spacing $1/N$ and the timing offset,

respectively, and w_n is the zero-mean complex additive white Gaussian noise (AWGN).

A frequency offset f_0 can be divided into integer and fractional parts as

$$f_0 = \varepsilon + f_f, \tag{3}$$

where ε is the integer part of f_0 and $f_f \in [-0.5, 0.5)$ is the fractional part of f_0.

Since our focus in this paper is to estimate ε, we assume that the fractional part f_f is known and perfectly compensated. The received symbol is demodulated using FFT operation. The kth FFT output R_k can be expressed for $k = 0, 1, 2, \cdots, N-1$ as

$$R_k = S_{k-\varepsilon} e^{-j2\pi n_0(k-\varepsilon)/N} + W_k, \tag{4}$$

where W_k is the FFT output of w_n.

IV. THE EFFECT OF TIMING OFFSET ON FREQUENCY OFFSET ESTIMATION

A. Nogami's Scheme

To estimates the integer frequency offset, Nogami's scheme calculates the correlation between the known training symbol and the cyclically shifted version of the received training symbol, and then, obtain the integer frequency offset estimate $\hat{\varepsilon}_{\text{Nogami}}$ as

$$\hat{\varepsilon}_{\text{Nogami}} = \arg\max_d \left\{ \left| \sum_{k=0}^{N-1} Z_k^* R_{(k+d)_N} \right| \right\}, \tag{5}$$

where Z_k is the transmitted training symbol, R_k is the received training symbol, d is the amount of cyclic shift, and $(\cdot)_N$ is the modulo-N operator. The scheme was proposed assuming perfect timing synchronization, thus, its estimation performance degrades in the presence of timing offset.

Fig. 1 shows the correlation values of Nogami's scheme when $d = \varepsilon$ and $N = 1024$ in the absence and presence of timing offset (i.e., $\tau = 0$ and $\tau = 0.5, 1,$ and 2). In the absence of timing offset, the correlation value increases as the integration range increases, on the other hand, in the presence of timing offset, the correlation value oscillates.

Fig. 2 shows Nogami's correlation function as a function of timing offset. From the figure, we can see that the correlation value becomes smaller as the absolute value of timing offset increases. Especially, when the timing offset is an integer, the correlation becomes extremely small. Therefore, Nogami's scheme could be very sensitive to the timing offset since the estimate is determined by the maximum value of the correlation function.

B. Bang's scheme

The correlation functions of Bang's scheme are calculated individually within each CPB block, and then, summated. Here, CPB can be expressed as

Figure 1. Correlation values of Nogami's scheme in the absence and presence of timing offset when $d = \varepsilon$ and $N = 1024$.

Figure 2. Correlation values of Nogami's scheme as a function of timing offset n_0 when $d = \varepsilon$.

$$\text{CPB} = \frac{1}{2n_0^t} N, \tag{6}$$

where n_0^t is a maximum tolerable timing offset value.

Bang's scheme estimates the integer frequency offset as

$$\hat{\varepsilon}_{\text{Bang}} = \arg\max_d \left\{ \sum_{m=0}^{K-1} \left| \sum_{k=0}^{\text{CPB}-1} Z_{k+m\text{CPB}}^* R_{(k+m\text{CPB}+d)_N} \right| \right\}, \tag{7}$$

where $K = N/n_0^t$. As shown in Fig. 3, the correlation value of Bang's scheme increases monotonically as the value of integration range increases. Fig. 4 shows Bang's correlation function as a function of timing offset. From the figure, we can observe that the correlation function has no zero-crossing point unlike Nogami's correlation function. Thus, Bang's scheme would have the better estimation performance than Nogami's scheme in the presence of timing offset. However, Bang's scheme has high computational complexity since the correlation values are calculated for all possible values of d.
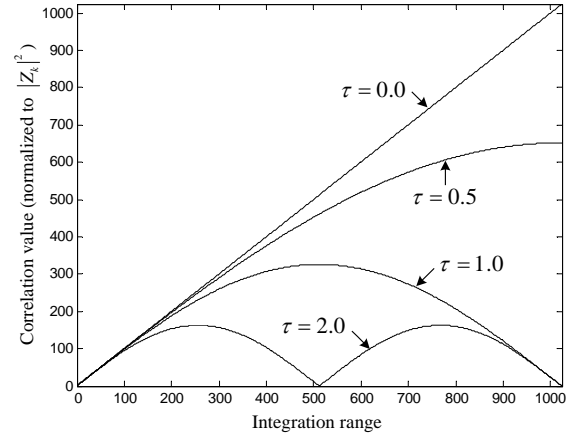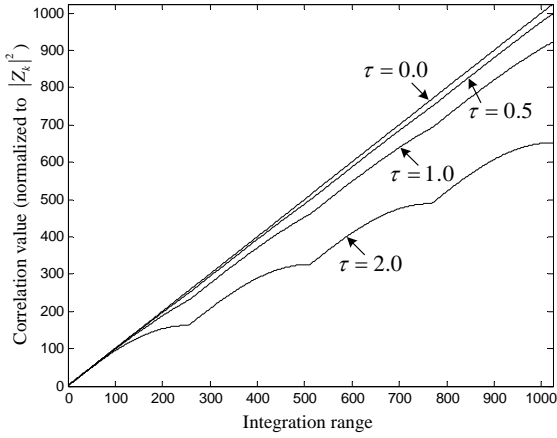
Figure 3. Correlation values of Bang's scheme in the absence and presence of timing offset when $d = \varepsilon$, $N = 1024$, and $CPB = 256$.

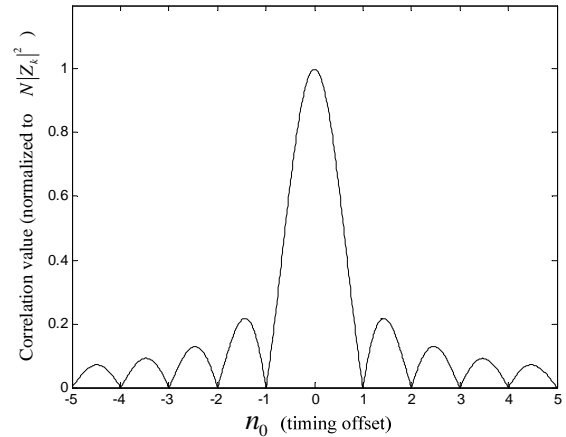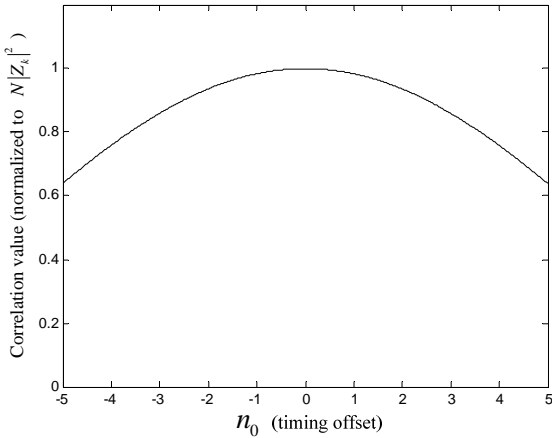
Figure 4. Correlation values of Bang's scheme as a function of timing offset n_0 when $d = \varepsilon$ and $CPB = N/10$.

V. PROPOSED SCHEME

A. Frequency offset estimation

When we calculate one CPB block in (7), correlation value C can be expressed as

$$C = \left| \sum_{k=0}^{CPB-1} Z_k^* R_{(k+d)_N} \right|. \qquad (8)$$

Assuming $d = \varepsilon$ and ignoring AWGN components in (8), the correlation value C can be expressed as

$$C = \left| Z_k \right|^2 \left| \sum_{k=0}^{CPB-1} e^{-j2\pi n_0 k/N} \right|. \qquad (9)$$

The value C in (9) is minimum when $n_0 = n_0^t$. Therefore, the minimum correlation value $C_{\min}$ can be expressed as

$$C_{\min} = \left| Z_k \right|^2 \left| 1 - j \cot\left(\frac{\pi n_0^t}{N} \right) \right|. \qquad (10)$$

We also express the minimum value of full correlation in a similar manner as

$$C_{\min}^{full} = 2 n_0^t \left| Z_k \right|^2 \left| 1 - j \cot\left(\frac{\pi n_0^t}{N} \right) \right|. \qquad (11)$$

In this paper, we use a threshold η as a half of $C_{\min}^{full}$

$$\eta = n_0^t \left| Z_k \right|^2 \left| 1 - j \cot\left(\frac{\pi n_0^t}{N} \right) \right|. \qquad (12)$$

The proposed scheme calculates the η and CPB as in (6) and (12). Then, the correlation value is acquired using the CPB as in (7). If the correlation value exceeds η, the d is decided to be the correct estimate of ε. Otherwise, the received signal is cyclically shifted by $d = d + 1$ and the above procedure is repeated. The operation of the proposed scheme is described in Fig. 5. When the frequency offset range is sufficiently large, the proposed scheme will generally have about a half computational complexity compared with Bang's scheme. It also should be noted that the proposed scheme does not require additional memory for correlation values unlike Nogami's and Bang's schemes.

B. Timing offset estimation

If we assume that frequency offset is completely recovered, the received symbol can be expressed in frequency domain as

$$R_k = H_k Z_k e^{j2\pi n_0 k/N}, \qquad (13)$$

where H_k is a frequency response of the channel. The argument of correlation between the transmitted and received training symbol can be expressed as

$$\Phi_k = \angle\left(Z_k^* R_k \right) = 2\pi n_0 \frac{k}{N} + \angle\left(H_k \right), \qquad (14)$$

where $\angle$ denotes the argument of a complex number.

Let us assume that the channel is time invariant during one OFDM symbol duration, then the difference between Φ_k and Φ_{k-1} can be re-written as

$$\Delta_k = \Phi_k - \Phi_{k-1} = 2\pi n_0 \frac{1}{N}. \qquad (15)$$

From (15), we can see that the effect of the channel (i.e., $\angle H_k$) is removed completely. Thus, the timing offset can be estimated as

$$\hat{n}_0 = \frac{N}{2\pi} \text{avg}\left(\Delta_k \right), \quad \text{for } k = 1, 2, \cdots, N-1, \qquad (16)$$

where $\left| \Delta_k \right| \leq 2\pi n_0^t / N$ and $\text{avg}(\cdot)$ denotes the average. The average value of Δ_k $\left(\left| \Delta_k \right| \leq 2\pi n_0^t / N \right)$ is used to improve the estimation performance, since the allowed range of $\angle$ operator is $[-\pi, \pi)$. Fig. 6 shows the block diagram of the proposed timing offset estimation scheme.

$$R_k \rightarrow \sum_{m=0}^{K-1}\left|\sum_{k=0}^{\text{CPB}-1} Z_{k+m\text{CPB}}^* R_{(k+m\text{CPB}+d)_N}\right|$$

$$\text{CPB} = \frac{1}{2n_0^t}N$$

$$\eta = n_0^t |Z_k|^2 \left|1 - j\cot\left(\frac{\pi n_0^t}{N}\right)\right|$$

Timing offset estimation

$> \eta$ yes / no

cyclic shift d
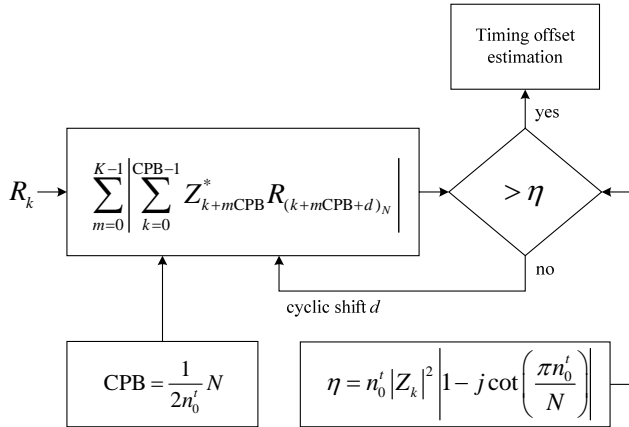
Figure 5. Block diagram of the proposed frequency offset estimation scheme.

$$\Phi_k = \angle\left(Z_k^* R_k\right)$$

$$\Delta_k = \Phi_k - \Phi_{k-1}$$

$$|\Delta_k| \le \frac{2\pi n_0^t}{N}$$

R_k

yes

$\hat{n}_0 \leftarrow \otimes \leftarrow \text{avg}\left(\Delta_k\right)$

$N/2\pi$
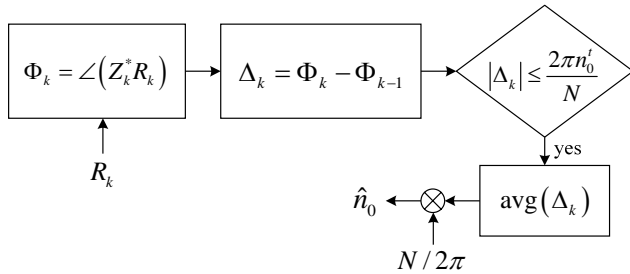
Figure 6. Block diagram of the proposed timing offset estimation scheme.

VI. NUMERICAL RESULTS

A. Frequency offset estimation

In this section, we first compare the computational complexity of the proposed and conventional schemes as shown in Table 1. We can see from Table 1, for $L \gg 1$, where L is the frequency offset range, the proposed scheme has approximately a half computational complexity compared with the Nogami's and Bang's schemes (computational complexity of proposed scheme is an averaged value).

In this paper, we use two channel models for performance comparisons: AWGN and multipath channel models. The signal-to-noise ratio (SNR) of AWGN channel model is 5 dB. The multipath channel model has four paths with 5, 10, and 15 sample delays from the first path, respectively, each path has 4, 8, and 12 dB attenuation in the amplitude and random phase jitter, and the SNR is 10 dB.

Tables 2 and 3 compare the accuracy of the proposed and conventional schemes over AWGN and multipath channels, respectively. The frequency offset used in this simulation is an integer value in [0, 500], $N = 1024$, and CPB $= N/32$. As we can see from tables, the proposed scheme exhibits significantly improved frequency offset estimation performance over Nogami's scheme in the presence of the timing offset. Specifically, Nogami's scheme can correctly estimate the integer frequency offset only when the value of the timing offset equals to zero, otherwise, the accuracy of the scheme severely decreases. On the other hand, Bang's scheme shows the same estimation performance as that of the proposed scheme, however, the computational complexity of Bang's scheme is almost twice the proposed scheme as shown in Table 1.

B. Timing offset estimation

Fig. 7 shows the error variance of the proposed scheme as a function of SNR over AWGN channel. The simulation performed 10,000 iterations at each SNR level. We can see that the error variance decreases as the value of SNR increases.

Fig. 8 shows the error variance as a function of SNR over multipath channel model. Since we assume that the channel is time-invariant during one symbol time, the error variance of proposed scheme on multipath channel is similar to that in Fig. 7.

VII. CONCLUSION AND FUTURE WORKS

In this paper, we have proposed a low complexity frequency offset estimation scheme using the CPB and employing a threshold. Moreover, we have proposed a timing offset estimation scheme as the next stage of the frequency offset estimation. From numerical results, we have shown that the proposed scheme exhibits much lower complexity than the conventional schemes while maintaining the same level of estimation performance.

The proposed scheme is designed to utilize a training symbol without assumption on its structure. However, we can further improve the performance of the scheme by considering the training symbol structure used in industrial applications, which is our future research topic. Moreover, since the scheme is derived in the absence of noise, we will evaluate the estimation performance of the scheme analytically in AWGN channel and numerically in practical channel environments.

TABLE I.   COMPUTATIONAL COMPLEXITY OF THE SCHEMES

Scheme	Number of complex multiplication	Number of comparison operation	Size of memory for correlation value
Nogami's scheme	LN	$L-1$	L
Bang's scheme	LN	$L-1$	L
Proposed scheme	$N(L+1)/2$	$(L+1)/2$	-

TABLE II.   ACCURACY COMPARISON OF THE FREQUENCY OFFSET ESTIMATION SCHEMES IN AWGN CHANNEL ENVIRONMENTS

Timing offset (samples)	Nogami's scheme	Bang's scheme	Proposed scheme
0	100	100	100
1	0	100	100
2	0	100	100
5	0	100	100

TABLE III. ACCURACY COMPARISON OF THE FREQUENCY OFFSET
ESTIMATION SCHEMES IN MULTIPATH CHANNEL ENVIRONMENTS

Timing offset (samples)	Nogami's scheme	Bang's scheme	Proposed scheme
0	100	100	100
1	0	100	100
2	0	100	100
5	0	100	100
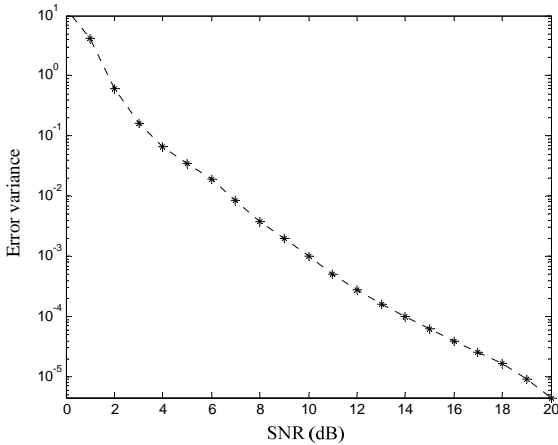
Figure 7. Error variance of the proposed timing offset estimation scheme in AWGN channel environments.
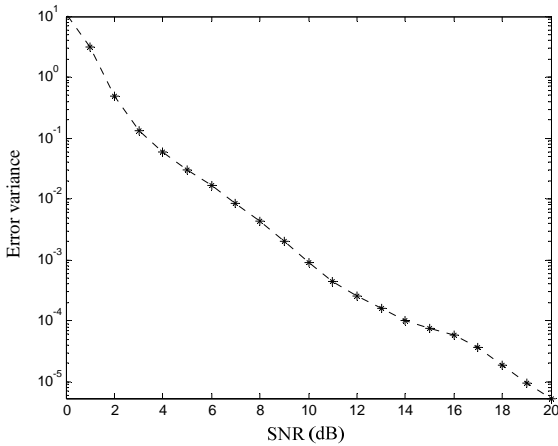
Figure 8. Error variance of the proposed timing offset estimation scheme in multipath channel environments.

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Predicting the Quality Level of a VoIP Communication through Intelligent Learning Techniques

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Abstract—**This paper presents a method for determining the quality of a VoIP communication using intelligent learning techniques. The proposed solution uses historical values of network parameters and communication quality in order to train the intelligent learning algorithms. After that, these algorithms are able to find the quality of the VoIP communication based on network parameters of a specific period of time. The intelligent learning algorithms take as input a baseline file that contains some values of network parameters and voice coding, associating an index quality for each scenario according to the ITU-T Recommendation G.107. The tests were performed in an emulated network environment, totally isolated and controlled with real traffic of voice and realistic IP network parameters. The quality ratings obtained for the learning algorithms in all scenarios were corroborated with the results of the algorithm of ITU-T Recommendation P.862. The results show the reliability of the three learning algorithms used on the tests: Decision Trees (J.48), Neural Networks (Multilayer Perceptron) and Bayesian Networks (Naives). The highest value of reliability in determining the quality of the VoIP communications was 0.98 with the use of Decision Trees Algorithm. These results demonstrate the validity of the method proposed.**

Keywords-**QoS; VoIP; Machine Learning; Decision Tree; E-Model; PESQ.**

I. INTRODUCTION

The quality of a VoIP (Voice over IP) communication does not have the quality levels of the conventional circuit-switched telephony, thus, users who do not have an acceptable user experience with VoIP calls continues using the traditional telephony. For this reason, the study of methods for evaluating quality of VoIP communication is very important because it allows that network resources can be reallocated to improve the communication quality.

Initially, determining the quality of a VoIP communication was done by subjective tests, resulting in a quality score called MOS (Mean Opinion Score), the ITU-T Recommendation P.800 [1] describes the requirements and methodology followed in these tests. After, some objective methods was performed: such as ITU-T Recommendation P.862 [2] or PESQ (Perceptual Evaluation of Speech Quality), which determines an index named MOS-LQO MOS-Listening Quality Objective which is the result of the comparison of the original voice or reference signal and the degraded speech signal. Also, nonintrusive methods were developed, such as the ITU-T P.563 [3], where the algorithms do not need a voice signal reference.

Other metrics of voice quality [4] - [6] do not consider the voice signal, for determining the quality index are employed models based on network parameters such as the E-Model [23], used in network planning and to configure the rate of communication VoIP MOS.

Machine Learning algorithms have been used to determine the quality of multimedia services, thus trying to ensure a better quality of service [7], [8]. For the case evaluation of voice quality in VoIP service, the works [9] - [12] show how neural networks are used for monitoring this service, but are not studied other learning techniques and do not detail how the training file used was built. The E-Model is not sufficient to predict the Quality Level, because sometimes a parameter is missing and it is not possible to measure the QoS with the E-Model, but with the machine learning if one parameter is missing it is possible to measure the QoS. This paper uses as a training file wich has been built based on ITU-T Recommendation G.107, more knowledge as E-Model, considering some network scenarios that have been extracted from real traffic and the results was achieved high levels of reliability.

Algorithms used in this study come from different approaches in sub-area of artificial intelligence, devoted to the study of learning by machines to predict the quality level of a service, these algorithms are: Decision Tree (J48 - C4.5 algorithm), Bayesian networks (Naive Bayes) and Neural Networks (Multilayer Perceptron) to determine the quality of a VoIP communication in a sample interval of 8 seconds; so, the reliability of the specified algorithms on this application was measured. Network training was performed using a file of 650 cases, which were prepared by the E-Model algorithm, each line of the file contains the network parameters: transmission rate, delay and probability of packet loss, and the value of quality (MOS), which is the result of the E-Model algorithm.

This work considers the encoding rates of 64 kbps for ITU-T G.711 [13] codec and rate of 8 kbps for ITU-T G.729 [14], respectively, and also consider the intrinsic values that these encoders have in the scenario with packet loss.

The tests were performed in a scenario of IP network emulation, where it is established a VoIP communication and is programmed different network parameters, in order to study the quality degradation of voice communication for each scenario tested. For purposes of network emulation, the

software named NETEM (Network Emulator) [20] was used, where the parameters of packet loss probability and delays point in an IP network can be changed. This article is divided as follows:

Section 2, where it is made a theoretical revision of machine learning algorithms used in this work; Section 3 deals with the E-Model algorithm; Section 4 presents briefly the PESQ algorithm, Section 5 presents the test scenario, the methodology followed on the tests and the parameters evaluated; Section 6 shows the results and discussions, and finally, Section 7 presents the conclusion and future work.

II. ALGORITHMS USED IN THE DETERMINATION OF COMUNICATION QUALITY

This section is presenting the different algorithms used in training of the network to determine the quality of VoIP communications.

A. Decision Tree Classification

Decision Trees [24] are tools that can be used for giving to the agent the ability for both learning and making decisions.

The decision tree takes as input a situation described by a set of attributes and returns a decision, which is predicted by the value of the input attribute. The input can be both discrete or continuous values. In this paper, only discrete values are used. The learning of discrete values is called classification.

B. Bayesian Classification

The Bayesian classification [25] algorithm has its name because it is based on probability of Bayes' Theorem. It is also known as Naïve Bayes classifier or only Bayes algorithm. The algorithm aims to calculate the probability that an unknown sample belongs to each of the known classes. This type of prediction is called the statistical classification; it is completely based on probabilities.

A feature of this algorithm is that it requires a data set that is already classified previously. Based on this preliminary data set, which is also called the training set, the algorithm takes as input a new unknown, i.e., this has no classification, and returns as output the most likely class for this sample according to probabilistic calculations.

C. Multilayer Perceptron

Rosenblatt [26] introduced the perceptron as the simpler architecture of neural network capable of classifying linearly separable patterns. The operation of a perceptron (artificial neuron) shows that:

- The neuron is responsible for calculating the combination of inputs and weights, and then applies an activation function that determines the effective output of the neuron.
- The training is done through the presentation of known inputs and outputs (supervised learning) and adjusting the weights with specific algorithms.

Multilayer Perceptron Networks (MLP) are computationally more powerful than networks without hidden layers. The MLP can handle data that are not linearly separable.

The processing performed by each neuron is defined by the combination of the processing performed by the previous layer of neurons that are connected to it. From the first hidden layer to output layer, implemented functions become increasingly complex. These functions define how the division is made of space-making.

There are several algorithms to train the MLP networks. Among these, the most popular learning algorithm for training these networks is the back propagation [27]. This is a supervised algorithm that uses the desired output for each input provided to adjust the parameters, called weights of the network. In addition, the adjustment weights use the method of backpropagation gradient to define the corrections to be applied.

III. ITU-T G.107 RECOMENDATION

This recommendation, better known as E-Model [23], is a computer model that measures the effects of the parameters of a transmission signal and the transmitted voice quality. The E-Model is defined by the following equation:

$$R = R_o - I_s - I_d - I_e + A \qquad (1)$$

where:

- R: determination factor of the transmission rate that has a correspondence with the MOS score ITU-T P.800.
- R_o: ratio - signal to noise.
- I_s: simultaneous degradation factor, which represents all the degradations that occur simultaneously with the speech signal.
- I_d: quality degradation due to the delay.
- I_e: degradation of the quality by effect of the device (encoder).
- A: improvement factor.

The default value of R_o is 93.2, which is obtained by putting all the inputs of the model with their default values, for example, the parameter of quality degradation due to delay (I_d), and the parameter corresponding to the degradation of equipment, i.e., for this calculation.

The parameter is not considered in the calculations of this work, since it describes conditions that are related to the signal, not depending on the transport network.

The factor A has the value 0 [15] for cable networks and is the scenario that matches the emulation of this work.

The delay factor I_d is defined by composition:

$$I_d = I_{dle} + I_{dte} + I_{dd} \qquad (2)$$

The parameters I_{dte} and I_{dle} correspond to delays due to echo, both the sender and receiver. These factors are not considered for the test scenario to assume perfect echo suppression.

The I_{dd} represents the delay (T_a) produced in the encoder and the network, including an echo cancellation. The network

delay is set according to the type of test on the network emulator.

The I_{dd} is defined as:

For $T_a \leq 100ms : I_{dd} = I_d = 0$

For $T_a > 100ms :$

$$I_{dd} = I_d = 0.024d + 0.11(d - 177, 3)P(d - 177, 3) \quad (3)$$

with: $P(k) = 0$, if $k < 0$, $P(k) = 1$, if $k \geq 0$

With these considerations, one can calculate the parameter R as a function of the parameters that correspond to the value of R_o, the delay (I_d) and the factor corresponding to the encoder (I_e).

$$R = R_o - I_d - I_e \quad (4)$$

The R factor is related to the MOS index, according to the following equation:

$$R = 3,026 \times M^3 - 25,314 \times M^2 + 87,06 \times M - 57,336 \quad (5)$$

IV. RECOMENDAÇÃO ITU-T P.862

The ITU-T Recommendation P.862 [16], known as PESQ (Perceptual Evaluation of Speech Quality) is an objective evaluation method that compares an original signal with a degraded signal, resulting from the passage of the signal through a communication system. The output is a PESQ predicting the perception of quality that would be felt by an individual in a subjective listening test. This prediction is related to a score, called an index MOS (Mean Opinion Score), and the methodology PESQ, this estimate is called LQO-MOS (MOS-Listening Quality Objective) and scores ranging from 1 (poor) to 4.5 (excellent).

PESQ only measures the effects of one-way speech distortion and noise on speech quality. The effects of delay, sidetone, echo, and other impairments related to two-way interaction are not reflected in the PESQ scores.

According to this recommendation, PESQ had demonstrated acceptable accuracy on the following scenarios:

- Speech input levels to a codec.
- Transmission channel errors.
- Packet loss and packet loss concealment with CELP codecs.
- Transcodings.
- Effect of varying delay in listening only tests.
- Short-term and long-term time warping of audio signal.
- Coding Technologies: Waveform codecs, e.g. G.711; G.726; G.727; CELP and hybrid codecs .4 kbit/s, e.g. G.728, G.729, G.723.1; Other codecs: GSM-FR, GSMHR, GSM-EFR, GSM-AMR, CDMA-EVRC, TD-MAACELP, TDMA-VSELP.

In the test scenario was used the codecs G.711 and G.729, and the network suffer degradation due packet loss and delay, the audio input was isolated to avoid voice impairments. Only

delay is not included on tested scenarios of recommendation P.862. To be possible include this factor on test scenarios were delay is present, it was converted the MOS index to R index value using equation (5); this way, we obtained the quality index in these type of scenarios.

V. SCENARIO AND TEST METHODOLOGY

The tests were conducted in emulation of IP network shown in Figure 1, which consists of three computers, two of them (PC-A and PC-C) establish VoIP communication point to point, and the third (PC-B) emulates the transmission channel, which are programmed different degradations of network such as: packet loss and delay. The audio inputs used belong to the set of validation tests that are included in ITU-T P.862, the algorithm of this same recommendation (PESQ) is used to assess the level of quality of voice signal in reception. The second quality index is determined by machine learning algorithm, these algorithms are: decision trees, neural networks and Bayesian networks.

The first step is to build the algorithm used in machine learning or training file, which has built considering 650 scenarios where QoS has been obtained using the E-model algorithm. Each test scenario is represented in the training file as a line, that will be presented later in more detail.

In the emulator network are programmed different scenarios, with different parameter values of probability of packet loss and delay inserted in the training file in order to better validate the reliability of results.

The sample period for assessing the quality of VoIP communications is 8 seconds, this time was chosen, in addition to the original size of the audio file, due to the number of packets sent by the transmitter (PC-A) during this time period thus considering an encoding rate of 64 kbps are sent 400 packets of 160 bytes, for a shorter time the number of packets sent is smaller and therefore the percentage of packet loss has a lower resolution.

The software and tools, in each PC, used to build the test scenario are the following:

- PC-A, PC-C: clients using softphone MyPhone 0.2b10 [17], packet analyser Wireshark [18] and software to record audio file of extension .wav - VRS Recording System [19].
- PC-B: router using the network emulator NETEM [20], to simulate packet loss, delay, jitter and bandwidth; the software ITU-T P.862 was used to find the MOS index for the voice quality.

The sound transmitted was generated by a player of file .wav that is connected to the microphone input of PC1 by an audio cable, and as mentioned previously, this file has a duration of 8 seconds and was sampled at 8 kHz and 16 bits.

The methodology followed in the tests to get the value using the tool PESQ MOS is as follows:

- Initially, it starts a communication between the PC-A and PC-C by softphones installed in the PCs, and lets you choose the voice coder used to each VoIP call, where it is made of computer to computer.
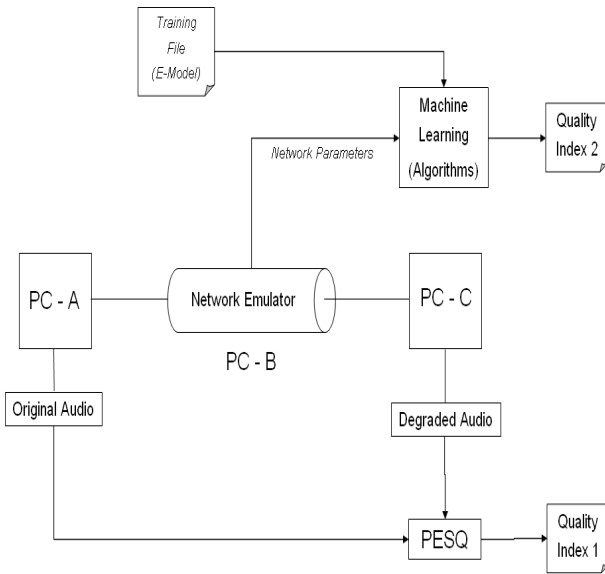
Fig. 1.   Test scenario.

- For each scenario the network emulator is configured with parameters required to perform the test.
- The player transmits the audio (arq-orig.wav) to PC-A where this sound is recorded (arq-orig2.wav), as the call is active, and the voice is transmitted to the PC-C through the PC-B.
- While data are transmitted, the program Wireshark that is running on the PC-A and PC-C, it is saved the network information such as: the signaling messages for establishing, maintaining and finalizing calls, messages from the RTP, the average size of the package (bytes), average number of packets transferred per second and average bandwidth.
- In the PC-C, the received audio is recorded in a file (arq-deg.wav). This file and the original file are compared by PESQ software, which runs on PC-B, resulting in a MOS-LQO score.

A. Implementation of the input file for training algorithms

As mentioned before, the preparation of an initial database of network parameters and the quality score for each scenario was performed considering the ITU-T Recommendation G.107. This mathematical model provides an R value of quality ranging from 0 to 93.2, where the highest value corresponds to a higher quality. The different scenarios were constructed leaving the default parameters fixed and varying the following parameters:

- The Mean One-Way Delay.
- The Packet-loss Probability.
- The type of encoder is related to the parameters: encoding rate, I_e (Equipment Impairment Factor) and Bpl (Packet-loss Robustness Factor).

The values of I_e and Bpl are dependent on the vocoder used, Table I represents values for the encoders have been

tested by the ITU-T G.107 and presented the recommendation. In the test scenario were employed coders G.711 and G.729.

TABLE I
VALUES OF I_e AND Bpl FOR VOICE CODERS

Codec	I_e	Bpl
G.723.1+VAD	15	16.12
G.729A+VAD	11	19
GSM-EFR	5	10.03
G.711	0	4.3
G.711+PLC	0	25.14

To obtain the value of quality index R were used the parameters described in Table II.

TABLE II
PARAMETERS OF THE E-MODEL ALGORITHM

Parameter	Default Value	Units
Noise Referred to at 0 dBr point - Nc	-70	dBm
Noise Floor - Nfor	-64	dBm
Room Noise (Send) - Ps	35	dB
Room Noise (Receive) - Pr	35	dB
Send Loudness Rating - SLR	8	dB
Receive Loudness Rating- RLR	2	dB
D-factor (Receive) - Dr	3	-
Listener's Sidetone Rating - LSTR	21	dB
D-factor (Send)	3	-
Mean One-Way Delay - T	100	ms
Absolute Delay from (S) to (R) - Ta	100	ms
Round-Trip Delay - Tr	200	ms
Talker Echo Loudness Rating - TELR	65	dB
Weighted Echo Path Loss - WEPL	110	dB
Quantizing Distortion Units - QDU	1	-
Equipment Impairment Factor - Ie	0	-
Packet-loss Robustness Factor - Bpl	1	-
Packet-loss Probability - Ppl	1	%
Expectation Factor - A	0	-

As a result it was obtained a file with 650 lines, for a better understanding Table III presents the 10 first cases or network scenarios:

In order to group ranges of R values and define categories of QoS, we took as reference model the classification drawn from ITU-T Recommendation G.107, which is presented in Figure 2, where it is presented the limit values for both R and MOS index.

The quality levels of classification used in this work only consider five categories, where the last two categories, Nearly All Users Dissatisfied and Not Recommended at Figure 2 were grouped into one.

These five categories are presented in Table IV:

With this categorization it is obtained the file that will works as training file to the algorithms that determines the quality of the communication. The sample lines from this file is presented on Table V.

TABLE III
VALUES OF I_e AND Bpl FOR VOICE CODERS

Rate (kbps)	Delay (ms)	Bpl (%)	Ie	R (Value)
64	0	4.3	0	93.2
64	50	4.3	0	91.8
64	100	4.3	0	90.7
64	150	4.3	0	89.5
64	200	4.3	0	85.8
64	250	4.3	0	79.2
64	300	4.3	0	72.5
64	350	4.3	0	67
64	400	4.3	0	62.2
64	450	4.3	0	58.2
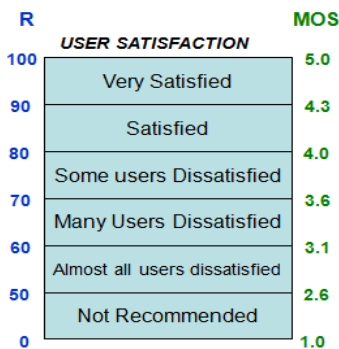
Fig. 2.   Levels of User Satisfaction of a VoIP communication.

TABLE IV
QoS LEVELS USED IN THE TEST SCENARIO

Categories	R (Min. value)	R (Max. Value)
Very Satisfied (QoS_1)	90	94
Satisfied (QoS_2)	80	90
Some Users dissatisfied (QoS_3)	70	80
Many Users dissatisfied (QoS_4)	60	70
Nearly all Users Dissatisfied and Not Recommended (QoS_5)	0	60

TABLE V
CODEC AND NETWORK PARAMETERS AND QoS

Rate (kbps)	Delay (ms)	Bpl (%)	QoS
64	0	0	QoS_1
64	50	0	QoS_1
64	100	0	QoS_1
64	150	0	QoS_1
64	200	0	QoS_2
64	250	0	QoS_2
64	300	0	QoS_3
64	350	0	QoS_4
64	400	0	QoS_4
64	450	0	QoS_5

B. Determination of QoS using the tool Weka

In order to determine the QoS using the learning algorithms, the software Weka-version 3.7.4 [21] was used as a tool for data analysis method. This tool supports several algorithms, based on related works, it was decided use the following three algorithms :

- Desicion Tree J48 - algorithm C4.5;
- Bayesian networks - Naive Bayes;
- Neural Networks - Multilayer Perceptron.

With the training file, it was analyzed the cross-validation and obtained the values of the factor 'F' (F-measure) for each algorithm tested, as shown in Table VI.

TABLE VI
VALUES OF FACTOR F FOR EACH ALGORITHM

Algorithm	F-measure
Trees J.48	0.98
Multilayer Perceptron	0.92
Bayes (Naives)	0.78

The values reached for the F factor were very high, whereas values greater than 0.7 are enough for network training. As the decision tree algorithm it was obtained the best results, having the same results determining the QoS for all tests.

VI. EXPERIMENTAL RESULTS

In this work, 300 tests were conducted following the methodology explained, where in each test was considered a scenario configured with different parameters on network emulator. The higher the number of tests in learning techniques greater the validity of the results.

The results obtained are presented in Figure 3, where it can be seen the highest value of successes in determining the quality of service of VoIP communication for each learning algorithm used, where the Decision Trees algorithm reach 294 test results concordant with the results obtained by PESQ.

Also, the Multilayer Perceptron and Naives-Bayes algorithms reached high values, these were 282 and 243 hits respectively.

It is important to note that these results were obtained considering the range of MOS values of each QoS category and not a single value of index MOS.

VII. CONCLUSION AND FUTURE WORK

The test results obtained show that machine learning is a valid method to determine the quality of a VoIP communication in several network conditions and using different voice codecs, for this work the codecs: G.711 and G.729. The good performance of the learning algorithms definitely depend of the initial file used to training these algorithms, in this work was used parameters values from a real IP network, and the test was performed in network with realistic parameters. Also, it was tested the confidence of the E-Model algorithm to determine the values of quality index for each scenario included in the training file. The best result was obtained

Fig. 3. Algorithms results

by the Decision Tree algorithm that reach 98% of accuracy, this is a very high degree of reliability to determine the quality category of VoIP communication in relation to other works. The Multilayer Perceptron algorithm had high number of success too, reaching 94% of accuracy. The Bayes Naives algorithm obtained a less number of success and reached 85%. The tests were performed in an emulated network and all the software used are free, for this reason the 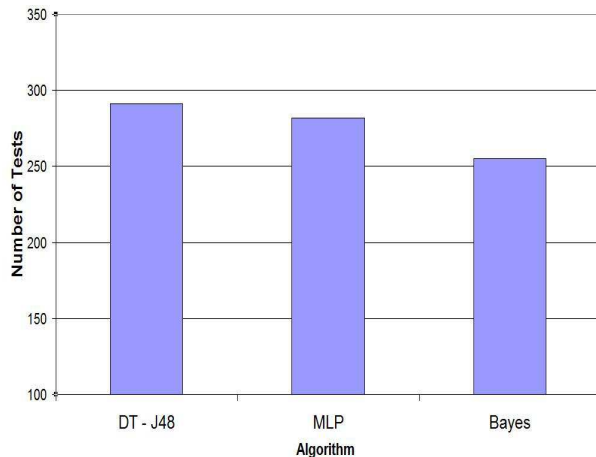implementation of the same scenario for other works is possible. As future work, we intend to evaluate the quality of video services, for example, streaming video, creating a training file based on ITU-T Recommendation P.930 [22]. Also, it will be studied different techniques of network resource allocation based on predictions of quality services of a future period of time, being the goal of this idea improving the quality of an specific service.

ACKNOWLEDGMENTS

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A Proposal for Implementing an IMS-based IPTV system over an IPv6/MPLS network Using Open Source Software

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Abstract—The continuous development of communication networks has allowed the emergence of IPTV has an innovative service which together with IMS, promises to change radically the TV experience for consumers. The main intention of this paper is to propose a design of an IMS-based IPTV system using completely open source software for its development and using an IPv6/MPLS core network to provide the transport of multimedia content. For this purpose, we first study the related work in the area, and then we present the proposed design describing the devices and software available for the implementation of the prototype. We have identified a lack of research in IPTV concerning IPv6 and we propose a prototypical implementation in order to answer the actual concerns about this subject and generate more research in the area. This work is a first approach on an IPTV framework and it is limited only to the design of an IPTV system, which is the starting point of several future work on IPTV traffic analysis.

Index Terms—Core Network, IMS, IPTV, NGN, Open Source.

I. INTRODUCTION

Nowadays, packet switching networks based on Internet Protocol are being deployed worldwide; this has enabled the emergence of a new kind of services, ready to be offered to clients. One popular service, which is still under continuous development, is the so called IP Television. IPTV represents a set of multimedia services that are transported over IP networks and are managed so as to guarantee (up to a certain extent) quality of service, security, interactivity and reliability [1].

IPTV has become a strong competitor against legacy television providers (like cable or satellite) in countries where this technology has been adopted, providing traditional Live TV service together with a set of supplementary services such as video on demand (VoD), private virtual record (PVR) and interactivity services, which have improved TV experiences for users.

Currently, there are several Telco providers who have implemented IPTV services over their already-deployed networks; normally IPv4-based networks. Given the increasing popularity of IPTV, the amount of users has rapidly grown, and Telco providers are now realizing that the IPv4 addressing scheme is falling short. IPv6 [2] is the latest version of protocol IP and unlike IPv4 [3], which has a 32 bit address space; IPv6 has an address space of 128 bits. Such an unimaginable amount of IP addresses permits getting rid of the NAT system; hence, it

is important to start the migration from the current IPv4 networks to the new IPv6 model so as to be able to cope with the increasing customer demand. An example of this is NTT, a Japanese Internet service provider that has deployed a next-generation-IPv6 network and has recently offered an IPTV service called Hikari TV, which runs completely over its own IPv6 infrastructure.

Convergence is another key point in the deployment of IPTV. Nowadays, there is the need to offer several services to users wherever they are regardless of the type of device they use (TV, smartphone, tablet, PC). The concept of ITU-T Next Generation Networks (NGN) [4] is intended to deal with this issue by providing a solid architecture to separate the Service Layer from the Transport Layer, allowing several services to be transported regardless of the network infrastructure. This will enable IPTV services to be delivered to several devices through different kinds of packet-based networks (fixed, wireless, mobile). NGN has adopted the IP Multimedia Subsystem (IMS) as a tool to provide a standard way of delivering signaling messages over networks, using Session Initiation Protocol (SIP) [5] in order to establish and control the multimedia session.

In this paper, we propose the implementation of an IMS-based IPTV system using Open Source Software. The main idea is to design an IPv6/MPLS core network to provide the transport of multimedia content using both QoS mechanisms and TE. Subsequently, the traffic generated by the IPTV system over such core network is evaluated.

The remainder of this paper is organized as follows: Related work is discussed in Section II. In Section III, our prototypical implementation is proposed. Section IV discusses the validity of the proposed implementation. Finally, conclusions are drawn in Section V.

II. RELATED WORK

Many studies on IMS-based IPTV systems have been conducted recently; some of these studies have dealt with the complete IMS architecture proposed by ETSI/TISPAN [6], as well as the standardization efforts made so far. Such studies were mainly intended to suggest a new architecture, specifically designed for IPTV systems and having the IMS Core component at its heart [7]. Additionally, the implementation of a prototype to evaluate such architecture has also been suggested [8]. Other authors have investigated the convergence capabilities of IMS-based IPTV systems,

proposing and/or deploying hybrid platforms that could provide services to both fixed and wireless networks [9-11]. It can be observed that in most of these proposals very few authors worked over IPv6 networks; their main focus was on the study of the IMS platform itself, rather than analyzing the effects of IPv6 on their implementations.

Other related works focused on the transport layer instead of the service layer. Murcia, et al., proposed and implemented a video transmission platform over IPv4 networks using MPLS-TE and other management mechanisms to guarantee some level of end-to-end QoS to video traffic [12]. Some researchers studied the re-convergence techniques on MPLS networks and analyzed ways of improving QoS, whereas others preferred to implement VPLS networks over IPv4 for a content-delivery network due to its capabilities in dealing with different classes of services and its fast restoration procedures [13, 14].

For the purposes of this paper, it is also interesting to study related works about IPTV traffic measurement. Young J. Won, et al., measured commercial IPTV traffic on four different residential broadband access networks and presented gathered traffic statistics of the IPTV service. These authors also provide a mathematical description of traffic behavior and bandwidth demand for IPTV VoD services [15]. Another particular study focused on measuring multicast traffic collected from an Italian IPTV service provider. Different kinds of IPTV flows were encountered, characterized, and measurements of QoS factors were made according to variables such as jitter, packet loss rate and delay [16]. Other authors explored several aspects that helped model IPTV services and presented a synthetic video trace generator that accurately resembles IPTV streaming itself [17].

As related work was being explored, we realized that there were very few IPTV implementations that cover the study of IPv6 networks over MPLS [18] and that implement the IMS architecture for controlling the service layer.

III. PROPOSED IMPLEMENTATION

In this section, we describe the devices, tools and design employed to implement a prototype of an IMS-based IPTV system at Universidad Distrital Francisco José de Caldas (U.D.F.J.C).

A. CECAD

CECAD is an acronym in Spanish that stands for High Performance Computer Center. It is a computing laboratory created by U.D.F.J.C to promote research and innovation in several areas, providing high performance computational tools for undergraduate, graduate and PhD students [19].

B. The Devices

- DELL HPCC Server: CECAD has a powerful Dell High-Performance Computing Cluster that is utilized to promote research in the campus. This platform will support different kinds of servers that are used in the IPTV prototype.
- Cisco 2911: The 2911 is an integrated-services router that offers voice-and-video-capable digital signal processor slots, embedded hardware encryption

acceleration, and other new characteristics that support a wide range of connectivity options and communication protocols; including IPv6, MPLS, OSPF, EIGRP, Multicast protocols, etc.
- Cisco 2821: The 2821 is an integrated-services router that has been optimized for the secure and wire-speed delivery of concurrent data, voice, video, and wireless services. The 2800 series provides IPv6 support as well as MPLS routing and multicast capabilities.
- Cisco 1841: The 1841 is an integrated-services router part of the 1800 series, it is a cheap and good choice for implementing a research laboratory for its price and its IPv6 and MPLS capabilities.
- Cisco 3750G: This is a Layer-3 Gigabit Ethernet switch, with smart multicast capabilities and IPv6 compatibility.
- Raspberry Pi: It is a credit card size computer powered by a 700 Mhz microprocessor and a 512 Mb RAM, this computer has a HDMI port and works using a Debian based distribution.

C. Open Source Software

- Open IMS Core: The Open IMS Core is an Open Source implementation (made by Fraunhofer FOKUS) of IMS Call Session Control Functions (CSCFs) together with a Home Subscriber Server (HSS). These two systems form the core elements of all IMS/NGN architectures, as currently specified by 3GPP and ETSI/TISPAN [20]. The IMS Core is the main component within the IMS architecture and it transports all the signaling traffic (SIP, SDP, Diameter) of the network.
- UCT Advanced IPTV: The UCT Advanced IPTV software is an attempt at a standards-compliant implementation of an IMS based IPTV service, created by the Communications Research Group at University of Cape Town. This software provides a SIP-based Application Server specifically designed for IPTV [21].
- VLC Server: VideoLAN is a complete software solution for video streaming and playback, developed by students at Ecole Centrale Paris under the GNU GPL. VLC can stream MPEG-2 and MPEG-4 files, DVDs, digital satellite channels, digital terrestrial television channels and live videos on the network in a unicast or multicast fashion and has full support for IPv6 [22].
- UCT IMS Client: The UCT IMS Client has been developed by the Communications Research Group at University of Cape Town in order to be used with the FOKUS Open IMS Core. The client supports AKA authentication and emulates IMS signaling. The current version supports voice and video calls as well as session-based instant messaging, Presence, IPTV viewers, and an XCAP client; however, it works with IPv4 only [23].

- myMONSTER TCS: The Telco Communicator Suite is a Java-based framework that delivers a unified communication experience for all forms of IP-based telecommunication, ranging from Multimedia Telephony to other types like rich Presence, Group List Management, and IPTV applications. It is extremely powerful, yet lightweight enough to run on both fixed and mobile devices; it also includes IPv6 support[24].

D. Design

Our intention is to design an IMS-based IPTV prototype by using the available devices and open source software tools described above. Our first attempt to design the IPTV system considers that, at present, few IPv6/MPLS-capable routing devices are available. Figure 1 depicts the physical layout (interconnection) of the devices that compose the IPTV prototype.

The Live TV and VoD Servers will be located on the content production side of this layout; both servers use VLC. There will also be a SIP Application Server using UCT Advanced IPTV, which may be located at the same server as the VoD service. Finally, there will be a server for implementing the IMS core (using Open IMS Core), which will be the key point in the IPTV platform session establishment. The HPCC Server, which will contain the servers already mentioned, is currently installed and interconnected through a Cisco 3750 layer-3-capable Switch, located at CECAD.

We have available three routing devices, namely a Cisco 2911 router, a Cisco 2821 router and a Cisco 18411 router. Our proposal is to construct a private network using this two devices and take advantage of their IPv6 and MPLS capabilities in order to design a robust core network for the IPTV prototype. Attached to the 2821and 1841 Routers, several LAN networks will be placed; these networks will serve the clients of the IPTV system.
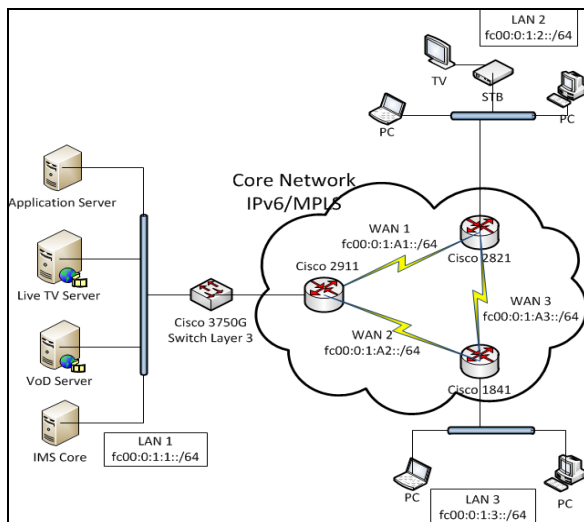
Fig. 1. Physical interconnection of the proposed IPTV prototype.

Figure 2 shows the logical connections between the components described above. The connection process for IMS clients is well known, namely the IMS clients send SIP-based messages to the IMS Core and request the IPTV service; the IMS Core authorizes and authenticates users and connects them to the Application Server (AS), which keeps all information about contents and the media servers.
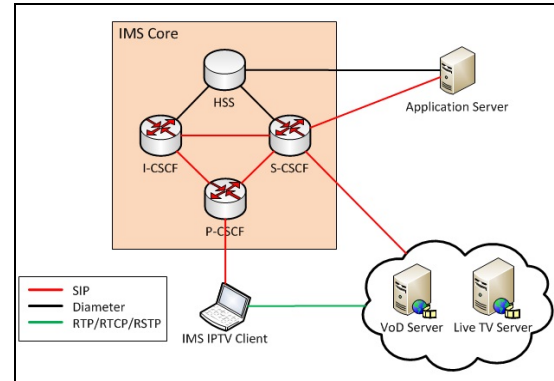
Fig. 2. Logical connections of the proposed IPTV prototype.

The AS communicates with the IMS Core's HSS to obtain information about the user profile; it also presents a personalized content guide to the client. From this content guide, the client choses a channel and sends a request to start receiving the channel's content. The IMS Core transfers this request to the AS, and then returns an appropriate multicast/unicast IPv6 address to the client so as to start listening to that specific address and receive the content as requested.

The clients will be implemented using several devices such as Personal Computers and Set Top Boxes in order to install on them the IMS client software. Our first intention was to use commercial Set Top Boxes in order to implement several clients, but such devices were incompatible with the current IMS Client software; so as to be able to emulate a STB we are going to use the Raspberry Pi to create our own STB IMS compatible which thanks to its capabilities is available to connect to any HD TV.

IV. DISCUSSION

In this paper, we have proposed a prototypical design for an IMS-based IPTV service over an IPv6/MPLS network. The main purpose is to implement such design with real equipment so as to assemble a first platform intended for researchers (U.D.F.J.C students and members) to work on subjects like IPTV6 and Next Generation Networks.

Nowadays, all communication systems converge on networking, and IP-based networks are the key in this new convergent architecture. NGN and IMS emerge as a potential solution that provides service-and-network convergence through the use of IP networks and SIP communication.

Through this investigation, we have realized that there is a lack of research on IPv6/MPLS core-networks implementation over IMS-based IPTV systems. In the IMS implementations mentioned, there was a marked trend towards IPv4, and few studies were intended to study the effects of IPv6. Moreover, most of such studies carried out their implementation avoiding the use of proper core networks, and focused their attention on the session establishment process rather than on the effects of the core network on the IMS system.

The main intention of our proposal is having implemented the framework presented in Figure 1, focusing in the core network so as to be optimized to work in an IMS IPTV environment; task that will be accomplished by using several tools such as MultiProtocol Label Switching (MPLS); diverse queuing techniques; and resource reservation techniques such as Resource ReSerVation Protocol (RSVP).

As we wrote this paper, the design was being implemented with the available equipment, but the ultimate goal is to obtain another IPv6/MPLS routing device so as to implement the design shown in Figure 3. By including another routing device, we can build a more complex network and study the effects of the IPTV multicast traffic on IPv6/MPLS core networks in a more precise way.

There are several advantages of using Open Source Software in this design; mainly the costs involved get reduced greatly and also the availability of the source code and the right to modify it brings flexibility working with the software.
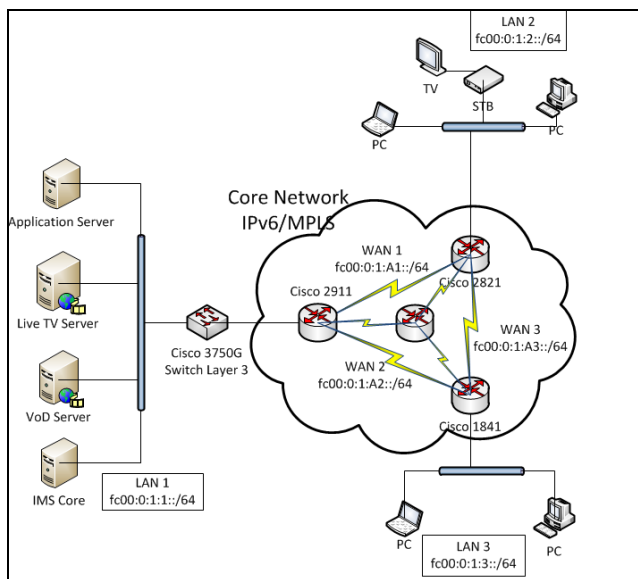
Fig. 3. Physical interconnection of the intended prototype.

V. CONCLUSION AND FUTURE WORK

IPTV has emerged as a novel technology that allows the transmission of Live and VoD contents over IP-based Networks, bringing additional interactive and personalized services to users, which renovates users' experience of television. The growing amount of users demanding IP-based

services is forcing providers to migrate towards IPv6 networks, allowing a major number of users to be accepted in a particular network. Additionally, with the implementation of NGN IMS, networks are converging to form a unique big network that can provide several services to several kinds of users and devices. During this investigation we realized that there is an important lack of research in IPTV concerning IPv6 and there is no much information in this subject available.

We have proposed an IMS-based IPTV service implementation, which represents the first step towards further extend research on IPTV platforms and networks. From this intended prototype there emerge comprehensive research studies on IPTV systems will be conducted. This paper claims to be a first approach in the implementation of an IPTV system; we currently are in a so early stage of our work so we only present the framework's design leaving the implementations results and the framework's optimization to future papers,

Future work will attempt to analyze traffic behavior on the IPTV system running over the IPv6/MPLS core network. A model for predicting the future IPTV traffic using ARIMA Time Series will be proposed. We are also considering future implementations of additional services (such as VoIP, Presence and IM) provided by the IMS system.

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A performance evaluation study for QoS-aware web services composition using heuristic algorithms

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Abstract—**In this paper five different algorithms are proposed to solve the QoS-aware Web Services Composition (QWSC) problem in ten different search-space sizes and a realistic deadline (a point not covered in many related works). Differently from some related works, statistical techniques are adopted in this paper to ensure more precise results from the algorithms. The results obtained showed that the design of experiments and the performance evaluation can be used to determine which algorithms have better performance according to the different search-space sizes and the estabilished deadline; it is also possible to determine which genetic operators are better suited for the QWSC problem.**

Keywords-**qos-aware web services composition; performance evaluation; heuristic algorithms; e-commerce;**

I. INTRODUCTION

Nowadays, QWSC is one of the most interesting research issues on Service-Oriented Architecture (SOA). Actually, it is not a new research issue and a Genetic Algorithm (GA) was proposed to solve this problem in 2005 by Canfora et. al. (2005) [1]. In that paper, an empirical study compared a GA with Integer Programming (IP) based algorithm. The results proved that GA was better suited for the QWSC problem. Other related works also compared IP-based algorithms with GAs concluding that a GA is a better alternative [2]. Furthermore, recent works also used GAs or hybrid algorithms (GA combined with another technique) to solve this problem [3] [4]. QWSC is a combinatorial NP-Hard problem so it is a complex problem to solve. The number of possible composition plans (the size of the search-space) grows exponentially according to the size of the composite plan. Thus, the use of Exhaustive Search (ES) algorithms or numerical method algorithms is limited to only very small search-space sizes. In addition, these algorithms become more and more obsolete when the growing proliferation of the use of Web Services (WS) is considered.

Another important characteristic of the QWSC is the fact that it is a soft real-time problem. However, many papers found in the open literature do not explicitly approach this characteristic. Only in some more recent papers this characteristic is mentioned [4] [5]. According to [5], due to this fact, it is necessary to obtain a good solution within the deadline, even if the solution found is only approximate to the optimal one.

E-commerce constitutes an important Internet application that is soft real-time and can benefit from the use of WS [6]. This happens because in complex e-commerce applications, different companies interact and, obviously, they could have different plataforms and languages for their systems. It is also important that e-commerce applications guarantee QoS, avoiding that dissatisfied customers leave the site and do not come back, that would generate monetary losses [7].

An issue related to the QWSC problem and not considered in most of the related papers is the use of statistical techniques to compare different algorithms. In [3] [8] they compared different algorithms using the average response times and the average QoS of them. According to [9] this is not enough and it is necessary to calculate the standard-deviation and confidence interval (in this paper a 95% confidence interval is adopted in all experiments performed).

In this paper, five QoS attributes were defined that are important to e-commerce applications: availability, cost, response time, reputation and confidentiality. Furthermore, five different algorithms were developed to deal with the QWSC problem. A deadline of 1,000 milliseconds to the algorithms was defined and ten different search-space sizes. Also a well-planned performance evaluation experiment was realized, to analyze how it contributes to the optimization of the algorithms for the QWSC problem.

This paper is organized as follows. In Section II the concepts related to WS and QoS are presented. Section III contains the developed algorithms. In Section IV, the testing environment where the experiments were executed is described. The experiment design, which includes fixed and variable factors during experiments, is also presented in this section. In Section V, the results are analyzed according to the response time and QoS obtained. Finally in Section VI, the conclusions are presented and possible future works are discussed.

II. WEB SERVICES AND QOS

According to the World-Wide Web Consortium (W3C), a WS is defined as: "*A WS is a software system designed to*

support interoperable machine-to-machine interaction over a network. It has an interface described in a machine-processable format (specifically WSDL). Other systems interact with the Web service in a manner prescribed by its description using SOAP messages, typically conveyed using HTTP with an XML serialization in conjunction with other Web-related standards" [10]. QoS could be referenced as a set of non-functional properties of Web services, such as performance, reliability, availability and security. With the increasing number of Web services with similar functionality, service quality measures are used to differentiate the existing services [11]. Some of the QoS attributes found in the related works are:

- **Availability**: it is an aspect of quality of service in which a Web service is present or ready for immediate use, represented as a percentage of time available for a service in an observation period and is related to its reliability.
- **Cost**: the amount of money charged by the service provider in order to access the service.
- **Response time**: it is the time spent between the time when the request is made and the time the client receives the response.
- **Reputation**: it is a measure of the client satisfaction by using the service.
- **Confidentiality**: determines that only the receiver and the sender must be able to understand the content of the transmitted message.

Given that each WS has its own QoS attributes, to calculate the QoS of the composition plan as a whole, it is necessary to use aggregate functions [2]. For example, Table I, adapted from [2], shows an example of aggregation of these attributes:

Table I
QUALITY OF SERVICE ATTRIBUTES

QoS Attributes	
Availability	$\prod_{i=1}^{i=n} availability(WSi)$
Cost	$\sum_{i=1}^{i=n} cost(WSi)$
Response Time	$\sum_{i=1}^{i=n} responseTime(WSi)$
Reputation	$\sum_{i=1}^{i=n} reputation(WSi) * 1/n$
Confidentiality	$\sum_{i=1}^{i=n} confidentiality(WSi) * 1/n$

The WS composition plan could be described as a sequence of tasks (abstract WS) with an initial and a final task. For any abstract WS, it could have some candidate services (concrete WS) with same or similar functionality but different QoS attributes. Thus, there are various composition plans for each execution path of composite service. For example, if there is one execution path, with 10 abstract WS and 15 concrete WS per abstract, then the number of composition plans should be about 15^{10} [12]. In [4] it was mentioned that QWSC could be divided into two aspects:

QoS-aware selection and orchestration creation. This paper is focused on QoS-aware selection and does not cover the use of Business Process Execution Language (BPEL) for the creation of the execution flow.

III. DEVELOPED ALGORITHMS

This section introduces five different algorithms: Exhaustive Search (ES), Utility Function (UF), Greedy Heuristic (GH), Random Search (RS) and Double Hybrid Genetic Algorithm (DHGA). The procedures of the algorithms and their possible advantages and/or disadvantages will also be discussed in this section.

A. Exhaustive Search (ES)

This algorithm, also known as "brute force", analyses all points in the search space. In the case of the QWSC problem, it compares the QoS obtained by all possible combinations of composite plans and returns the best one (with higher QoS). So the obviously advantage of this algorithm is that the global optima is always guaranteed. The disadvantage is related to their computational complexity, because it is exponential. Suppose a composite flow with ten abstract WS and one hundred concrete WS per abstract WS, the number of points in the search space will be 100^{10} which will probably take hundreds of years to be calculated. Because of that, this algorithm could be used only in small search space sizes, because of the soft real-time characteristic of the QWSC problem.

B. Utility Function (UF)

This algorithm was originally proposed by Yu et. al. (2007) [13] and uses a heuristic utility function to determine the best WS composite plan. It associates each concrete WS a unique QoS value that represents all the QoS attributes of that concrete WS. After that, it selects for each abstract WS the correspondent concrete WS with the higher QoS. Suppose j is the current WS to be evaluated, k is the number of QoS attributes, μ represents the average value of some QoS attribute, σ the standard-deviation and q represents the QoS attribute (i.e. cost, availability, and so on) the Equation 1 represents this algorithm adapted from [13]:

$$Fu(WSj) = \sum_{i=1}^{i=k} \frac{q_i - \mu_i}{\sigma_i} \tag{1}$$

This algorithm has the advantage that it does not need to analyze the entire search space. Another advantage is that its computational complexity is not exponential. For this reason, it could be used in any search space size (in this paper the biggest has 200^{12} points in the search space). The disadvantage of this algorithm is that it could not benefit from a larger deadline. For example, if the deadline was 1,000 milliseconds or one hundred seconds, the QoS obtained would be the same; because this is a deterministic algorithm. It does not guarantee the global optima either.

C. Greedy Heuristic (GH)

This algorithm was an original idea proposed by the authors in [14]. For each abstract WS in the composite flow, the algorithm evaluate all concrete WS available for that abstract WS and selects the one with higher aggregate QoS. Due to all QoS attributes are normalized between 0 and 1 (and the highest is always the best one) it is necessary to calculate the sum of all QoS attributes of all concrete WS. The one with higher aggregate QoS is selected to its respective abstract WS. Suppose j is the current WS to be evaluated, k is the number of QoS attributes and q is the current QoS attribute, the Equation 2 represents the algorithm:

$$GH(WSj) = \sum_{i=1}^{i=k} q_i \qquad (2)$$

The advantage of this algorithm is that it is very fast because it is directly related to the number of total concrete WS, i.e., suppose a composite flow with four abstract WS and one hundred concrete WS per abstract WS, the number of total concrete WS will be four hundred. So, the algorithm should calculate the aggregate QoS function of four hundred concrete WS; instead of calculating 100^4 composite plans like the ES algorithm does. The disadvantage of this algorithm is that it could not benefit from a larger deadline, because it is a deterministic algorithm.

D. Random Search (RS)

This algorithm is based on a technique denominated Random Walk. The algorithm randomly moves in the search space, while maintaining the best solution founded and then finishes its execution when the stop criterion is reached (in this case, the deadline). The only advantage of this algorithm is that could benefit from larger deadlines, using all available time to search for a proper solution.

E. Double Hybrid Genetic Algorithm (DHGA)

This algorithm is an original idea proposed by the authors in [14]. It combines a Genetic Algorithm (GA) with the two heuristics (UF and GH) mentioned before. First of all, it runs the UF algorithm and saves its results in a chromosome. After that, it does the same thing for the GH algorithm. So it initializes a random population of chromosomes and then includes the two chromosomes created before in this initial population. The genetic operators used in this algorithm is tournament with 16 players, one-point crossover and elitism operator activated.

The advantages of this algorithm is that it guarantees a solution at least as good as the best of the algorithms UF and GH (because of the elitism operator, that preservers the best solutions through the generations) and the possibilities of obtaining better results when the deadlines increase. The disadvantage is that it cannot guarantee the global optima and it is a slow algorithm for small search spaces.

IV. Performance evaluation

A. Environment Configuration

The main goal of this study is to evaluate different techniques to solve the QWSC problem. Thus, the test environment is composed of three machines: one representing a client, another a service provider and a third one executes a MySQL server with the data about the QoS attributes of the Web services. In the considered environment, the three machines are in the same network and are linked by a gigabit network switch. The machines used are heterogeneous and their configuration is presented in Table II.

The experiments were performed using the default configuration of all tools used. The interaction among the machines is as follows: the client requests a WS composition plan to the service provider, the service provider searches the MySQL server to get data about the QoS attributes of the WS and then executes one of the algorithms and responds to the client who was the WS composition plan selected and its Normalized Composition Aggregated QoS (NCAQ).

B. Experiment design

The experiments were conducted varying three factors in order to verify the performance of the algorithms in the defined deadline and different number of abstract WS and concrete WS per abstract WS. The parameterization of these factors can be observed in Table III.

Another key point to be analyzed in the experiment design is the definition of fixed parameters that should be considered in the application parameterization. Because of the fact that DHGA is a hybridization of a GA and it has to accomplish the established deadline it was defined a population size for all experiments and the number of generations was fixed in five. The populations used for the search-space sizes: 4_100, 4_200, 6_100 and 6_200 was 23,000; for the search-space sizes 12_100 and 12_000 the populations was 21,000.

Table I presents the aggregate functions of QoS attributes considered in this article. However, it is also necessary a way to assess the QoS of the composition as a whole, taking into account the QoS attributes defined. The function to be maximized in the experiments is shown in Equation 3, considering **A** (Availability), **C** (Cost), **RT** (ResponseTime), **R** (Reputation) and **Con** (Confidentiality).

$$F(x) = A + C + RT + R + Con \qquad (3)$$

Given that the QoS attributes were normalized in a way that 0 is the worst result and 1 is the best result possible, simply add up all the attributes of QoS, no matter whether they should be minimized or maximized. First, for each QoS attribute, the aggregated QoS is calculated using the formulas presented in Table I. Thereafter, the composition aggregated QoS is computed using the formula shown in Equation 3. Finally, this number is normalized between 0

Table II
ENVIRONMENT CONFIGURATION

Hardware Configuration				
Machine	**CPU**	**Clock**	**Cache**	**RAM**
Service provider	Intel® Core™2 Quad	2.66 GHz	3 MB	8 GB
MySQL server	Intel® Core™i3	3.10 GHz	3 MB	4 GB
Client	Intel® Core™2 Quad	2.4 GHz	4 MB	4 GB

Table III
EXPERIMENTS PARAMETERIZATION

Variable Parameters	
Algorithm	ES, UF, GH, RS and DHGA.
number of abstract WS	2, 4, 6 and 12.
number of concrete WS per abstract WS	100 and 200.
Fixed Parameters	
Deadline	1,000 ms.
Number of replications	10.
Confidence degree	95%

Table IV
GROUP OF EXPERIMENTS

Experiments		
#	**Search-space size**	**Algorithms**
1	2_100	ES, UF and GH.
2	2_200	ES, UF and GH.
3	3_100	ES, UF and GH.
4	3_200	ES, UF and GH.
5	4_100	ES, UF, GH, RS and DHGA.
6	4_200	ES, UF, GH, RS and DHGA.
7	6_100	ES, UF, GH, RS and DHGA.
8	6_200	UF, GH, RS and DHGA.
9	12_100	UF, GH, RS and DHGA.
10	12_200	UF, GH, RS and DHGA.

and 1 and called Normalized Composition Aggregated QoS (NCAQ).

V. RESULT ANALYSIS

In this section, the response times and NCAQ obtained of the five algorithms are analyzed. In Fig. 1 the horizontal axis represents the different search-space sizes evaluated, i.e. "4 - 100" means a composition with four abstract WS and one hundred concrete WS per abstract WS. The vertical axis represents the average NCAQ obtained (the higher the better). It is important to remember that the algorithm called Exhaustive Search (ES) always guarantees the global optima.

A. Time analysis

A deadline of 1,000 milliseconds was defined for the algorithms. The ES algorithm attended this deadline in the experiments groups one, two, three and four. In those cases, the ES was the best choice, because is the only one that guarantees the global optima. In experiments group two and four the three algorithms achieved the global optima, but the only one that can guarantee the global optima for any search-space is the ES. Table V shows the average response times of the experiments. For any search-space size, the three algorithms have accomplished the established deadline.

In the experiments groups five, six, seven, eight, nine and ten, the ES algorithm does not accomplish the deadline. Table VI shows the average response time of these groups of experiments. In experiment group five, the ES algorithm gets really close to the established deadline with an average response time of 1,768 milliseconds. In experiment group six, it takes about 171 seconds (an unacceptable response time) and in experiment group seven, it takes about forty hours, another unacceptable response time for the experiments. With these results, the conclusion is that even for medium search-space sizes, an ES algorithm does not comprise a good choice.

Table V
THE AVERAGE RESPONSE TIME OF ES, UF AND GH IN MILLISECONDS

Search-space size	ES	UF	GH
2_100	421	233	238
2_200	481	238	229
3_100	462	242	225
3_200	488	227	227

B. QoS analysis

Table VII and Fig. 1 show the average NCAQ obtained by the algorithms analyzed. In experiment groups one, two,

Table VI
THE AVERAGE RESPONSE TIME OF UF, GH, RS AND DHGA IN
MILLISECONDS

Search-space size	UF	GH	RS	DHGA
4_100	236	234	972	954
4_200	239	240	963	971
6_100	223	240	950	962
6_200	234	250	950	964
12_100	249	233	950	955
12_200	245	253	973	960

three and four the ES algorithm found the global optima within the established deadline, so it could be used in these search-space sizes. In the experiments groups five, six, seven, eight, nine and ten, the ES algorithm does not accomplish the deadline, so it cannot be used, but it was executed to find the global optima and compare it with the other algorithms.

Table VII
THE NCAQ OF ES, UF AND GH.

Algorithm	2_100	2_200	3_100	3_200
ES	0.804	0.846	0.789	0.881
UF	0.801	0.846	0.777	0.881
GH	0.801	0.846	0.777	0.881

In experiment group five the algorithms UF and GH have lower NCAQ than RS and DHGA. Experiment group six shows that UF and GH also have lower NCAQ than RS and DHGA. The RS algorithm has bad results in experiments groups seven, eight, nine and ten.

Finally, in experiments groups seven, eight, nine and ten, the DHGA was always equal or better than the other algorithms (except from ES, but ES could not accomplish the deadline). Because of those results, DHGA was the best algorithm for experiments groups five, six, seven, eight, nine and ten.

C. Influence of factors

The influence of factors was calculated for the algorithms UF and GH. The response variable was the difference between the global optima and the solution obtained by each algorithm. The factors and levels was: **A** - number of abstract WS, **B** - number of concrete WS per abstract WS and **AB** - interaction between A and B. This was done to discover which factors have higher influence on the degradation of the obtained solution. Table VIII shows the influences calculated.

Table VIII
INFLUENCE OF FACTORS

Algorithm	A	B	AB
UF	80%	9%	11%
GH	84%	7%	9%

VI. CONCLUSIONS AND FUTURE WORK

In this paper five different algorithms were presented and evaluated: ES, UF, GH, RS and DHGA. Such algorithms were evaluated considering the response time, the accomplishment of the established deadline and the NCAQ obtained. A testing environment was configured to enable the implementation of the experiments. As mentioned in Section 1, considering a deadline is important because e-commerce applications are soft real-time systems and it is necessary to find good solutions within the established deadline.

Another interesting result shows that is possible to use the design of experiments and performance evaluation to analyze algorithms focused on QWSC. Therefore, future works can consider a more complete performance evaluation including more GA operators for the DHGA algorithm, such as: crossover operator, mutation operator, mutation rate, crossover rate and so on.

In future works it is planned to analyze the influence of factors: number of abstract WS in the composition flow and number of concrete WS per abstract. By doing that, it could be possible to determine which algorithm is the best one for each search-space size; i.e. for a "2 - 100" search-space size the ES algorithm is probably the best choice, because it guarantees the global optima and comprises the deadline; for a "4 - 100" search-space size DHGA is the best choice. Combining the information of the influence of the deadline and the influence of the search-space size, it could be possible to dynamically determine which algorithm is the best (or at least, a good choice) for each requisition to a WS Composition Engine, that will execute the appropriate QWSC algorithm.

It is also planned in the next steps to use the design of experiments and performance evaluation to develop new hybrid algorithms that should probably have a better performance than some of the GAs present in the related works found in the literature.

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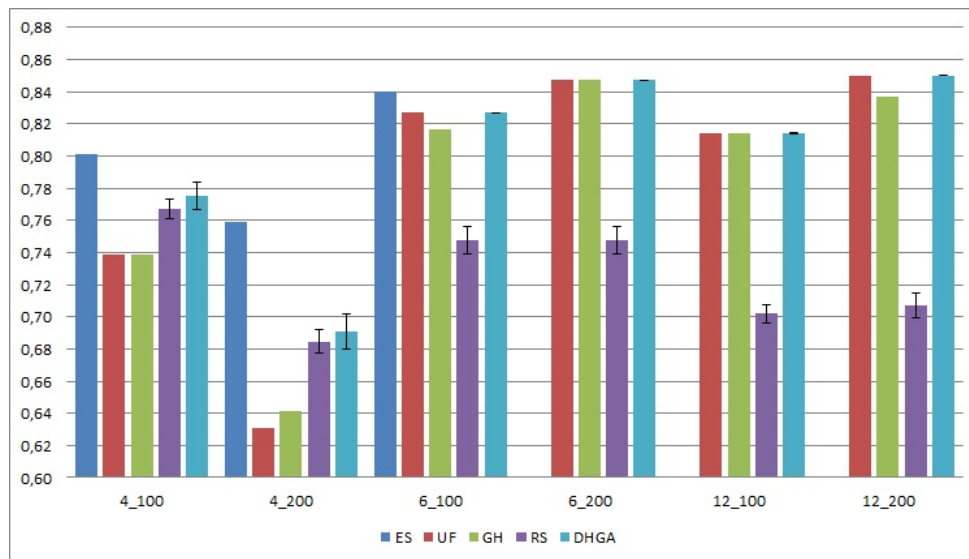
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On Information Exchange for Virtual Identities: Survey and Proposal

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Abstract—**The emerging concept of User Virtual Identity on the Web is inevitably related to information exchange between different entities. Therefore, we analyze the current solutions of an Identity-related information exchange, taking into consideration categories of the information being exchanged, parties involved in the exchange process as well as the exchange protocols. The analysis allows us to define an information exchange solution for the project Ego – Virtual Identity.**

Keywords-**virtual identity; information exchange;**

I. INTRODUCTION

Ever increasing amount of information is exchanged every day on the Internet. Users reveal bits of their interests and preferences while surfing the Web and using e-services. Building a Virtual Identity, which can comprehensively deal with the user representation in that environment, is inherently bound with information exchange [1].

We argue, that there is a need for a solution that will assure user-centricity in the field of Virtual Identity information management at the same time providing a level of anonymity. In this article we present an analysis of the state-of-the-art Identity-related solutions with the aim of finding the strengths and weaknesses of their information exchange implementations. Than we propose an information exchange model for the Ego – Virtual Identity system, that will preserve user anonymity, still enabling robust personalization, which potentially would allow building of a central Identity information store supplied with information from various sources. With this model the users can achieve a level of anonymity and tracking protection that can't be achieved in current solutions.

The article is structured in the following way. In Section II we consider personal information categories and accompanying solutions. Section III comprises analyzes of parties involved in the information exchange process. Details of the processes in different solutions are presented in Section IV. Then we present the information exchange model for the Ego project in Section V. The article concludes with the final remarks.

II. INFORMATION BEING EXCHANGED BY VIRTUAL IDENTITY

Type and amount of information being shared and acquired by a user's Virtual Identity is supposed to depend on the user's information needs and preferences regarding sharing this information with services. That brings us to a conclusion, that it is the user who is supposed to decide which information is to be exchanged. The user is the ultimate source of knowledge about the value of the information based on his or her needs and preferences.

A. Personal Information Sources

Personal information can be perceived as an information regarding a person and created by the person [2]. There are several types of personal information depending on the sources, from which such information is being acquired:

- *Volunteered information* — an information that is shared by a person freely and explicitly, usually by providing descriptive resources about oneself (e.g. filling a form with one's interests, publishing a CV) or personally generated content (documents, music etc.)
- *Observed information* — an information that is gathered by recording person's activities, while he interacts with various devices and applications (e.g. capturing Internet-browsing history, GPS location). This information is collected implicitly, with no additional user's actions.
- *Inferred information* — an information that is a result of reasoning process based on other personal information. It is often being performed by institutional bodies for widening the knowledge about a user, eg. client's financial history can be used to calculate credit scores by a bank.

B. Personal Information Categories

In the literature there are many attempts to enumerate types of personal information. The most popular approach is to categorize the information according to functional perspective, as it may be found in FIDIS deliverables [3], GUMO ontology [4] or in the Marc Davis' talk for the World Economic Forum [2], [5]. More user-oriented approach can be found in the work of Brusilovsky [6]. Additionally, Mitchel et al. [1] consider types of volunteered information being shared between enterprises and individuals.

We believe that, apart from personal information categories described by Nabeth [7], there is a more important perspective that describes a user — the *user's perspective*.

This perspective categorizes the information with respect to four essential characteristics of the users – who they *are*, what they *know*, what they *have* and what they *do* – as it was introduced by Anrig et al. [3].

Any superposition of pair of those characteristics can be perceived as a category of personal information. Thus the users can be characterized by the following types of information:

- *Attributes (are + has)* – any user's feature that can be directly described by an observer or can be extracted from any institutional records, including demographic data or biological features.
- *Acquisitions (have + know)* – all knowledge and possessions, including physical and virtual goods, both generated and consumed.
- *Roles (are + do)* – any relations that describe the user, inclusive of profession, citizenship or social affiliation and roles.
- *Abilities (know + do)* – any user's competences related to tacit knowledge the user has, as well as any user's activities that are indicators of those or any other user's features.

Additionally, we would like to propose two other categories as follows:

- *Context (do + have)* – information about user's relations to the external world and any objects of that relations, including people, locations or events.
- *Self (are + know)* – meaning reflective consciousness, any user's features that cannot be observed directly but rather can be deducted or frankly expressed by the user, as features of that category are strongly related to the user's state of mind, such as personality, preferences or interests.

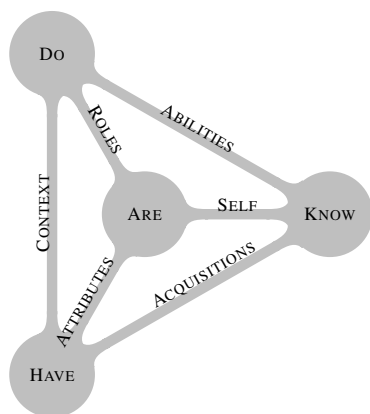The categories and corresponding essential characteristics are shown in the Figure 1.

Figure 1. Personal information categories from the user's perspective

III. Parties involved in the process of information exchange with the Identity

In this section, we will analyze different entities, that exchange the information with the Identity. Such exchange can be carried out in two directions; there can be an outbound flow of information (from the Identity to the outside entities) as well as an inbound transfer (external entities send information about the user to the Identity).

A. The consumers of information

The most important class of entites, that is mentioned in projects concerning the consumers of information stored in the user Identity, are Service Providers. In many situations, services need to learn attributes (permanent or temporary) characterizing their users.

The "Service Providers" term covers a wide range of entities with many different purposes for which they need the information. Probably, the most important of such purposes is authentication and authorization of users. For example, with prototype created in one of the STORK project's pilot programs, students can use foreign university services, proving their real Identity with eID cards, issued by their domestic government Identity providers [8].

Currently, there are more and more services, which need Identity information to fulfill other goals. Adaptive systems personalize their content and other features to users' needs. The simplest example are personalized Web portals, for example news sites. This domain is traditionally in interest of user modelling; based on user attributes representing her interest, the contents of a news site is adapted to match user's needs, as a result generating a personalized online magazine [9], [10]. Here, the consumer of information from an Identity is the provider of this web portal [11].

E-commerce services may use a so-called recommender systems, which, based on a user preferences, inform the user about products of the provider, which may best suit the user's needs [12]. These parties are consumers of Identity information also in ProjectVRM [13], where users can publish their needs (intents to buy specific items) on a so-called Personal Request for Proposals platform, and any vendors using the platform can thus learn users needs and respond with a personalized offer [1].

Mobile and location-based services can utilize user's location and attrbiutes in many ways, for example alerting the user when one of his friends is nearby [14].

Technically, it is possible to broaden described types of services to more real-world entities [15], [16]. For example in Ambient Intelligence vision, a temperature of water in the shower in the hotel room can be automatically adjusted to preferences of the roomguest, or music played in the restaurant may depend on average preferences of its guests. In these examples, service providers consuming the Identity information would be devices in such places as restaurants or hotels.

Another type of service providers are public institutions, such as hospitals. In scenario described in [16], a person's up-to-the-hour health information collected by a medical device attached to the person's wrist can be transferred to her hospital. Similarly, an information about user's location can be sent to the hospital during an emergency call [14].

The information about the users may be also transferred between two Identity Providers in order to merge user accounts or to reconcile differences between such identities. This is the case in Federated Identity scenarios [17].

Finally, consumers of Identity information are also user devices. The users may want to see their Identity information and in such situation it must be transmitted to his device. The information may be also transmitted to other users' devices and displayed there, if its owner agrees.

B. Information exchange – the inbound flow

The goal of inbound flow of information exchange is to update the Identity with additional information about its owner. Entities, that are sources of such information, can be the users (when they manually input some information to the Identity), a special sofware aiming to track the users' behavior to learn their attributes, or, theoretically, even Providers of services.

Editing information stored in the user model by it's owner is called *explicit user modelling* and was a traditional way of building user models in many adaptive systems in the past [18]. In this case, the information is transmitted from a user's device to the Identity.

The other method of feeding models with information about the users is *implicit user modelling*, in which users' behavior is analyzed (with or without their awareness and consent) in order to learn their attributes, without users' involvement [18]. This can be achieved in many different ways: by monitoring web log files, tracking pages visited by the users or queries their input to a search engine, etc. [9], [19]. An interesting example here is a mechanism of scrobblers used by Last.fm [20] portal, which maintains user music profiles. Information is sent from many such scrobblers installed on multiple devices used by the owner of Last.fm account to a single profile, stored on Last.fm servers.We believe, that such tracking mechanism can be extended to other user activities as well.

IV. INFORMATION EXCHANGE PROCESS

A. Front channel / Back channel

Identity-related information exchange involves passing some assertions about a user from an Identity Provider to a Service Provider and *vice-versa*. Most common approaches to that process are [21]:

- *Front channel* – information being exchanged by a redirection of a user's browser from one site to another with custom defined parameters. User can be informed in details about what is being exchanged.

- *Back channel* – direct information exchange between an Identity Provider and a Service Provider, after previously establishing an association, without a user participation. The user has no knowledge on what is being exchanged.

In subsequent sections we will analyze existing solutions in the implementation of Identity-related information exchange process. We will focus on the most popular projects.

B. Authentication-oriented solutions

Currently, two main authentication-oriented Identity solutions can be mentioned: popular and well-established OpenID [22] , and WebID [23], which is currently being developed.

The communication process, using authentication-oriented solutions, can be summarized as follows [22], [24]:

1) A user requests resources from a Service Provider and is asked to authenticate.
2) The user supplies the Service Provider with an identifier of a Virtual Identity.
3) The Service Provider verifies, if the user is the owner of the claimed Virtual Identity, eg.:
   - the OpenID redirects the user to the Identity Provider's website and verifies the response assertion, stating if the user has managed to login successfully,
   - the WebID compares user-provided certificate with the user public key published on the Virtual Identity website.
4) If the authentication succeeds, the user is provided with the requested resource.

C. Authorization-oriented solutions

Another group of the Identity-related solutions are those which allow for exchanging complex information for authorization purposes, eg. SAML and OAuth.

SAML [25]is an OASIS standard, defining a framework for describing and exchanging security information with the use of XML. While SAML can be used in different business scenarios, our interest is mainly focused on establishing Federated Identities and Multi-Domain Single Sign-On.

Another solution, OAuth, is a protocol allowing users to authorize third parties (here called clients or consumers) to access server resources, owned by the users, without revealing their credentials to the clients [26], [27].

D. The Identity Metasystem

The Identity Metasystem is based on Kim Cameron's identity laws and uses Information Cards for representation of Digital Identity [21], [28]. The exchange model is based on SOAP messages and uses a number of OASIS standards for Web services (WS-Trust, WS-SecurityPolicy and WS-MetadataExchange) [29].

The central elements of the metasystem from a user's point of view are Information Cards, that are visual representations of different digital Identities of the user. Such cards are presented to the user by a software component called Identity Selector, which allows users to easily choose from available cards [21].

Also, many other, smaller Identity-related projects exist. Example lists of such solutions can be found at: [30], [31]. Having analyzed the most popular solutions we developed an information exchange model for the purpose of the Ego project.

V. INFORMATION EXCHANGE MODEL FOR THE EGO PROJECT

A. The goal of the Ego information exchange model

The Ego project aims to research the possibilities of improvements in the area of instant personalization based on exchange of an Identity information during everyday tasks performed by the user during browsing the Web (for example visiting different portals in search for interesting articles or items). At the same time, we want to ensure, that the users can achieve a complete anonymity and complete control in terms of information, that service providers have about them.

Much research has been conducted on different aspects of users' privacy, anonymity, Identity management and global user modelling. Still, we have noticed a serious drawback in the current solutions. The Identity can store a lot of information about the user, but at the same time service providers store a lot of user-related information on their side, building user models for their own needs. Such information is treated by service providers as an important asset, giving them a competetive advantage on the market. This fact has two negative implications:

- users cannot easily learn, what Service Providers know about them, or update such information, if it is not accurate,
- users cannot reuse this information in another services.

In the following sections, we will describe our position on how this situation can be changed.

B. User session at Service Provider's website

The main goal, that we want to achieve with our information exchange model, is that the information used for personalization should be stored on the Identity Provider's side and not on Service Provider's servers. Thanks to that, users would be able to easily see and change any information, that different service providers may have about them.

To achieve that, the exchange model must be extended to foster an exchange of information in both ways (inbound and outbound). Service Providers must be encouraged or enforced to send information, that they have about the user, to the user's Identity. We came to a conclusion, that they would do that only in one situation: when using information

about the user gathered during a single session and stored on their side would be impossible in next sessions. To achieve that, Service Providers must not be able to link different sessions of the same user; such situation is called unlinkability [32].

We decided, that in our exchange scenario, the user will not provide the Service Provider with his identitfier, but only with URL to his Identity Provider. This can be thought as a next logical step in assigning different identifiers to a user based on a context, in which he is working (a so-called unidirectional Identity) [28], [32].

With such an exchange model, the Service Provider would have to send the information about the user, that he has gathered, back to the Identity. At this point, a question arises on what and how the Service Provider can store in the Identity. It must be restricted to some degree, otherwise the Service Provider would be able to put a user-specific identifier in the Identity (similarly as it is done in cookie files), and based on that to use profiles stored on his side, without sending it to the Identity. Some solutions that are possible here are:

- the storage can have a specified structure, which would restrict possible user characteristics to some predefined ones;
- user characteristics in the storage can be managed not by the Service Providers directly, but set by some Identity Provider modelling algorithms, which assign appropriate values based on user characteristics sent from the Service Provider,
- values sent to the Service Providers as responses to queries can be slightly changed. Such changes may be random or may be generated based on predictions of future user needs, at the same time helping users in finding new interesting items, similarly as in our paper [33].

C. Steps in information exchange model proposed

In this section, we will discuss the most important steps in our exchange model in greater detail.

1) Establishing a common user identifier between Identity Provider and Service Provider
   This is the first and basic step in our information exchange model. To enable exchange of information between the Identity and Service Providers about the user, an identifier must be assigned to the user. Such identifier must be randomly generated, if we want to force Service Providers to send information about the users to the Identity. This process is shown in the Figure 2.

2) Authentication of Service Provider request
   The identifier is now established and callable. It can be exposed in a form of URL, to which the Service Provider can send messages. Still, the identifier is dedicated to only one Service Provider. It must be there-
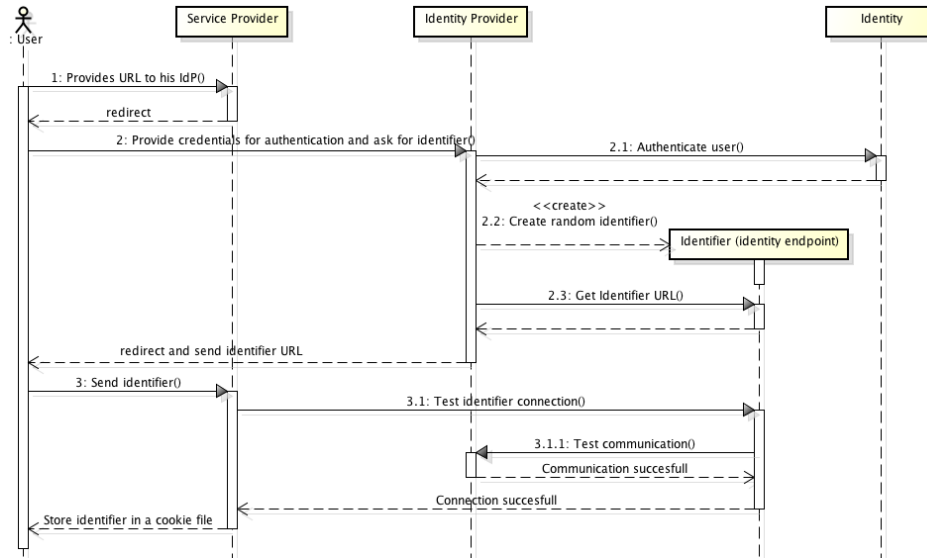
Figure 2. The process of information exchange to establish an identifier

fore ensured, that the messages, that are received at the identifier URL, are indeed sent from the intended Service Provider. A Service Provider authentication mechanism must be therefore established.

3) Service Provider's request for information from the Identity
One of two types of message exchange requests is a query for Identity information. The Service Provider needs this information to personalize its service. The requests are sent by the Service Provider via back channel when the user wants to access a certain resource and is received by Identity Provider at identifier URL. At this step it must be ensured, that the Service Provider is authorized to use the identifier and that the transmission is secure.

4) Request for an update of the Identity by the Service Provider
When the Service Provider has collected a new information about the user, the information may be sent to the Identity. This is a similar flow to one specified in previous step, but in the other direction. It's important to note, that the Service Provider must send it before the identifier expires.

5) Deletion of the identifier
As the identifier is tepmporary, at some point in time it must be deleted. After that, the Service Provider cannot get more information about the user or update the Identity with new information. Such deletion can be triggered by different events, such as:

- user can request deletetion of a specified identifier or all identifiers at Identity Provider's website;
- the identifier can be set for automatic expiration

trigger when a certain time passes since it was created.

User should also have an opportunity to configure a certain identifier to be persistent, so that it would not be deleted. Users may chose to do so for example, if they want to have a long-term and closer relationship with a certain Service Provider.

VI. CONCLUSIONS AND FUTURE WORK

In this paper, we have analyzed different issues related to exchange of user's personal information on the Web. The most important existing solutions were presented in terms of conceptual and technical means that they use to exchange the Identity-related information. Based on that, we have proposed our own information exchange model, which enables users to gain better control on information, that different entities may have about them. Our solution ensures, that all information, that Service Providers have about the user, will be stored in the user's identity and under the user's control.

Our further research directions focus on development of a reusable user model structure, which must be universal enough to be usable by many different adaptive systems, for example tech news portal, music recommender systems etc. Apart from that, we plan to develop a mechanism that would enable updating this model based on information sent from Service Providers. A comprehensive policies mechanism is also planned, that would allow users to clearly define conditions, under which their personal data may be exchanged with third parties.

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Extracting Occupational Therapy Concepts
to Develop Domain Ontology

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Abstract— **Recently, unstructured data on the World Wide Web has generated significant interest in the extraction of text, emails, web pages, reports and research papers in their raw form. Far more interestingly, extracting information from a specific domain using distributed corpora from the World Wide Web is a vital step towards creating corpus annotation. This paper describes a method of annotation, based on Occupational Therapy (OT) concepts, to build domain ontology using Natural Language Programming (NLP) technology. We used Java Annotation Patterns Engine (JAPE) grammar to support regular expression matching and thus annotate OT concepts using a GATE developer tool. This speeds up the time-consuming development of the ontology, which is important for experts in the domain facing time constraints and high workloads. The rules provide significant results: the pattern matching of OT concepts based on the lookup list produced 403 correct concepts and the accuracy was generally higher. Using NLP technique is a good approach to reducing the domain expert's work, and the results can be evaluated**.

Keywords-Ontology; Information extracting; Regular expression; Natural Language Programming.

I. INTRODUCTION

The semantic web offers semantic annotations that describe web resources explicitly. These annotations are based on ontologies that represent domain knowledge through defining concepts and the semantic relations between those concepts. It requires standards of machine-processable representations of ontology. The standards for this purpose, such as Resource Description Framework (RDF) [7], Web Ontology Language (OWL) [5], have been defined by the World Wide Web Consortium (W3C) [13]. Consequently, ontology is a foundation that is central to the growth of the semantic web that provides a common knowledge for correspondence and communication among heterogeneous systems. Furthermore, it is useful for different applications to share information among heterogeneous data resources [1].

Recently, Information Extracting (IE) has received significant interest due to the number of web pages emerging on the internet containing unstructured data. Because of the amount of information available on the internet, it is

necessary to have a tool for extracting it. Many specialists in the field of IE have worked to find suitable tools, such as Wrappers, that classify interesting data and map them onto appropriate formats such as XML or relational database. Furthermore, some HTML-aware tools are based on inheriting the structural features of documents so as to extract the data. Natural Language Programming (NLP) is a technique used by many tools to extract the data in natural language documents. Tools like GATE use techniques such as a part-of-speech tagging, filtering, or lexical semantic tagging to link relevant information, and identify relationships among phrases and sentence elements within text [4]. Each of these tools has advantages and disadvantages. A comparative analysis of the existing tools for data extraction is needed to assess their capabilities. This is done in the next section.

In this paper, first, we provide a brief background to IE tools to justify why we feel the NLP technique should be used to speed up the building of an Ontology of Occupational Therapy (OTO). To extract concepts in the field, we used CREOLE plug-ins from GATE in the IE system. We also show how the JAPE grammar has been implemented by detailing the rules we use to annotate IS concepts. The paper is structured as follows: In Section 2, we discuss the background of ontology and IE. In Section 3, we discuss the methods used to develop domain ontology of OT and extracting OT concepts, to show how they were constructed. In Section 4, is the implementation that shows how the domain knowledge is acquired for creating the corpus, Gazetteer, and how the JAPE rule [16] is implemented. Our discussion and evaluation is in Section 5. Finally, in Section 6, we draw conclusions and make suggestions for future work.

II. BACKGROUND

A. Domain ontology

It is a shared belief that ontology receives a lot of recognition from various research fields. Although there are some well-known domain ontologies, such as CYC, the Standardized Nomenclature for Medicine (SNOMED, a

clinical terminology) [8], Toronto Virtual Enterprise (TOVE) [10], and the GENE ontology (GO) [5], study of the ontology area is still immature and improvements are needed [9].

Occupational Therapy (OT) is a treatment using certain activities to improve physical, mental and social performance. The main objective of the treatment is development of the individual's personal autonomy, both social and professional. The therapist is one of a multi-disciplinary team to work with a stroke patient, for example.

OT has a big problem with a language; it needs a formal language to identify certain concepts in the field, to make communication easer between therapists and between people and machines. "Occupational therapists seem to have difficulty finding appropriate words with which to think about and express the nature and purpose of their practice" [10].

Although many attempts have been made to find a full agreement on specific concepts in the area, the problem still remains to identify the key concepts and their relationships. However, ontology in a specific domain provides concepts and the relationships between these concepts. Furthermore, it offers sharing vocabularies in a consistent mode. More crucially, in natural language, therapists use different meanings for one concept, for instance "occupation, function". If you looked at the Oxford dictionary you might find more than one definition.

Ontology specifies a formal definition to avoid vagueness and ambiguity, to decide the exact meaning. If you looked in the Oxford Dictionary for the meaning of occupation you will find many definitions; at the same time, many therapists, social and health staff, use different words and phrases to define occupation, such as daily activities, everyday life, persons of any age, individual and sociocultural value, leisure and so on; so ontology provides a single definition to make communication more effective.

B. Information Extracting IE

A number of studies have shown that applications of IE can be used to annotate documents that are written in natural language.

Certainly, the growing number of IE tools that can be used to annotate concepts, such as SHOE, Annota, Annozilla, MnM, Ontomat, COHSE, Melita, and GATE, makes it easy to process machine-readable text [14]. A comparison of these tools shows that they provide distinct methods of IE [1, 13], as illustrated in Table 1.

Table 1 shows that there are many tools such as SHOE, Annota Annozilla and KIM ontotext providing automatic annotation of extracted text from mark-up languages such as RDF OWL HTML, XHTML, written by different languages, e.g., Java and C. In comparing GATE developer with these tools, GATE provides semi-automatic and automatic annotations in easy to use ways, similar to the MnM ontology editor. GATE can extract text from different formats such as XML, HTML, XHTML, emails and PDF files, while MnM annotates HTML formats only.

Basically, the annotation of IS concepts is based on the GATE developer, which is an architecture tool for text engineering. It is a free open source tool developed by a team at the University of Sheffield, starting in the early 1990s [4]. The first version was released in 1995, the second one was in 2002, while the most recent in 2010.

GATE can run on any platform and supports JAVA 5.0. It has also been developed and tested on Linux, Windows and Mac OS X. It has a user interface to enable user editing and visualization and quick application development. Furthermore, it provides support for manual annotation, semi-automatic and semantic annotation as well as ontology management. Moreover, GATE uses CREOLE plug-ins as objects for language engineering. All of these are packaged as Java Archives and XML configuration data [4].

GATE is a tool used to take unseen texts and convert them into a fixed format such as XML or HTML. This data can then be displayed for users or stored in a database for analysis. Before talking about GATE in more detail, we should clarify the difference between Information Retrieval (IR) and IE [3]. IE helps the user to extract information from a huge amount of text for the purpose of fact analysis. IR is just pulling out documents containing relevant information according to a key word search. IE can identify queries in a structural way and provides knowledge at a deeper level, while IR uses a normal queries engine which makes it hard to gain accurate answers, and provides knowledge at the standard level.

Consider an enquiry such as 'which UK airports are currently closed due to severe weather conditions?' Or, where an event took place and who it involved, such as where was Gordon Brown's last visit as prime minister [2, 14].

IR would just provide a webpage containing the relevant information and the user would then need to search that webpage using various terms or concepts to analyse the information. IE, on the other hand, provides specific information about the enquiry; even if the information is not

TABLE 1. INFORMATION EXTRACTING TOOLS

Tools	Type	Degree of automation	Based on	Ease of use	Language written in	Advantages & Disadvantages
SHOE	Knowledge annotation	Automatic		+	Java	Allows users to mark up pages in SHOE, guided by ontologies or URL
Annota	Annotation schema W3C	Automatic	RDF mark-up XML,XHTML,CSS &Xpointer	+	C Available for Windows, Unix and MAC	Does not support IE; like an ontology server; makes annotation publicly available
Annozilla	Email annotation	Automatic	Mozilla	++		-
MnM	Ontology editor	Semi-automatic & automatic	HTML	+		Similar to Melita
Ontomat		Automatic	OWL	++		Used to create and maintain ontologies; uses OtoBroker as server
COHSE	Integration of text-processing components	Automatic	DAML+OIL	+	RDF	Uses ontology server to mark up pages in DAML+OIL and reuse as RDF
Melita	Annotation interface	Semi-automatic	Extensible mark-up language, Java, HTML	++		To retrieve structure and semi-structured annotations
KIM ontotext	Semantic annotation platform	Automatic	RDF	++		Semantic annotation, indexing, and retrieval of unstructured and semi-structured content.
GATE	Annotation tool	Semi-automatic & automatic	XML, HTML, XHTML, emails	+++	JAVA version 5	Comprises an architecture and framework. Based on NLP group

accurate, but you can only back up the correct information [11]. IE has been used for applications such as text mining, semantic annotation, question answering, opinion mining, decision support, rich information retrieval and exploration. GATE has a comprehensive set of plug-ins, including Alignment, ANNIE, Annotation_Merging, Copy_Annots_Between_Docs, Gazetteer_LKB, Gazetteer_Ontology_Based, Information_Retrieval, Keyphrase_Extraction_Algorithm, Language_Identification, Ontology_Tools, and WordNet.

GATE is based on ANNIE, which is a new IE system with core processing resources [4]. ANNIE relies on a finite state algorithm and JAPE grammar, and combines Tokenisor, which divide the text into simple tokens such as words, numbers, punctuation, Sentence Splitter, which splits the text into sentences, and abbreviations of gazetteer list helps distinguish between sentences. The POS tagger, Name entity tagger, and JAPE transducer uses JAPE grammar to produce entities, Orthomatcher (co-references),

to match rules to identify the relations between names already found by the POS tagger. The Gazetteer is a list presenting a set of names, terms, etc. to identify entities based on the list. Among these modules, we used Tokenisor, Sentence splitter, Gazetteer, and JAPE transducer [7].

GATE includes automatic and semi-automatic semantic annotation as well as manual annotation, which enables the user to create their own annotations. As a result, the GATE developer can be used to extract terms and concepts from a specific text effectively and efficiently. For this work, we annotate OT concepts from literature to be formalized into OTO ontology code.

III. METHODS EMPLOYED

Our method of creating OTO ontology is as follows:

A. *Specifications*

A. *A1 Identify goals, strategy and boundary of the ontology*. It is necessary to identify the domain interest and scope from the initial stage of the development process. It helps to construct the conceptualization of the domain. In

this stage there are many questions that need to be answered as recommended by Uschold and Grüninger, which are similar to the competency questions. These questions put together the resources that cover the ontology's objects, purposes, scope and granularity

- What are the general characteristics of OTO ontology? To answer this question we should describe the content of the ontology including: taxonomic organization, the kind of concepts it will cover at top-level division, internal structure of the concept.
- What is the scope of the domain - will it cover the general domain or be specific?
- What is the purpose of OTO ontology?
- Identify targeted users, applications and functional requirements.
- Choose knowledge acquisition method and tool
- Choose tool to create the ontology

A.A.2 Knowledge acquisition

Before creating the ontology, we had to collect the OT concepts for the domain model. Our approach consisted of annotating these concepts based on the JAPE grammar, using the GATE software. The annotation process began by:

- Creating a corpus of documents and a Gazetteer of OT, with JAPE rules used to extract OT concepts. GATE provides facilities for loading corpora for annotation from a URL or uploading from a file. The process generally started as follows:

We compiled OT knowledge from different resources and various publications.

- We analysed the data to ensure it covered the whole field.
- We transferred the information resources into an XML file to form the corpus.
- We uploaded the corpus into the GATE software so as to start running ANNIE.
- We annotated the concepts based on JAPE grammar, which is run within ANNIE.
- Testing and evaluation. As illustrated in Figure 1.
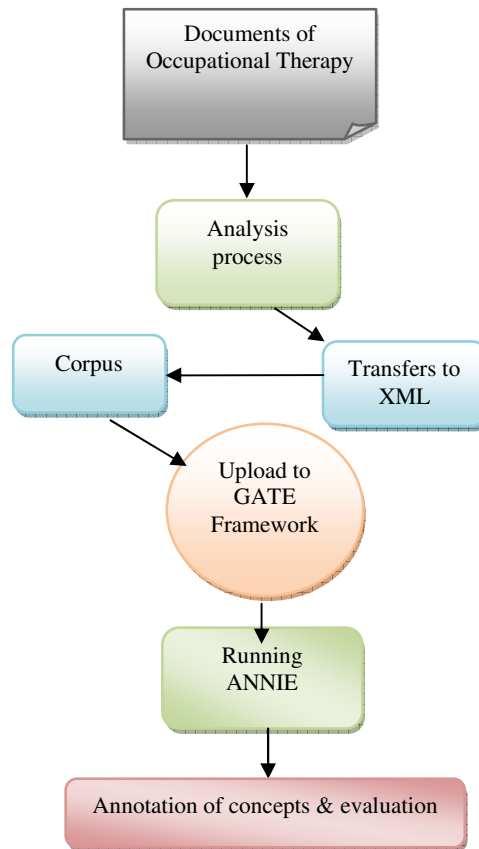
Figure 1. Annotation workflow

B. *Conceptualisation*

This stage starts by:

- Creating a glossary of terms to identify which terms need to be included in the ontology; the glossary includes the term names, synonyms, acronyms, and descriptions of each term.
- Building concept classification.
- Building the data dictionary to identify the concepts with their meaning, instance, class attributes, and their relations.
- In the data dictionary, the instances attributes should be described in more detail, and class attributes also need to be described.

C. *Formalisation:*

The ontology needs to be formalized by transferring the conceptual model into a formal model and to be

coded using the chosen knowledge representation languages and tools, such as OWL and Protégé [6].

D. *Evaluation:* ontology needs to be assessed, so its contents need to tested and verified to satisfy the real world that needs to be modeled.

E. *Documentation:* facilitates the reusability of the ontology design. Figure 2 depicts the method of OT developing the ontology.

Figure 2. Method of constructing OTO ontology

IV. IMPLEMENTATION

1. Identifies the main goal of the OTO ontology which is seeking for providing information for therapists that helps them to:
   - Provide valuable information about the patients.
   - Provide information on daily service and activities.
   - Enables effective occupational performance.

2. Knowledge acquisition started by:

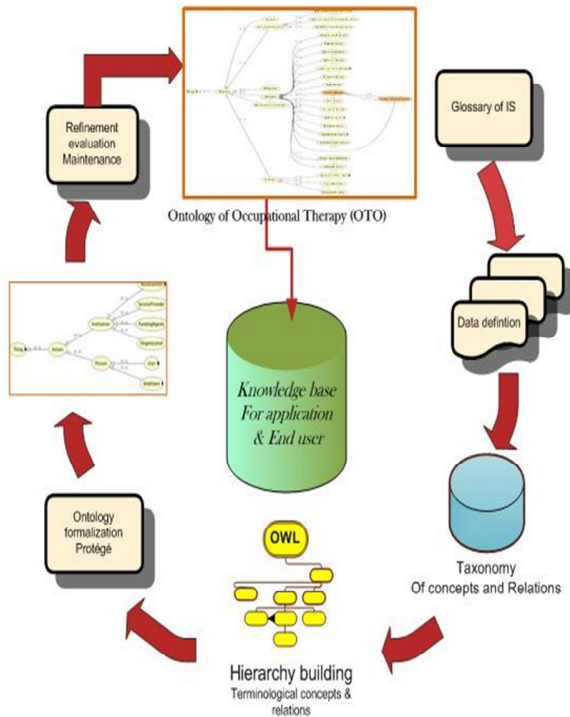   - Creating the corpus. It has 300 files in the XML format, containing text relevant to the IS field.

   - *Creating* the IS Gazetteer: This is a list of OT terms that have to be identified as Major Type, Minor Type, etc. For example:

     Productivity: major type= concept
     Personal Care: minor type= term
     Activities: major type= concept

   - *Next we use JAPE rules:*
     Using JAPE rules allows us to extract concepts and identify tokens that contain the concepts in the correct order, and then look up the concepts in the Gazetteer. JAPE rules create a phase based on Java for creating specific grammar. Each JAPE rule consists of Left-Hand-Side (LHS) that contains the pattern that must be matched and Right-Hand-Side (RHS) that details the annotations that are to be created [4].

   The JAPE grammar was used to support regular expression matching, as this is how annotation is achieved in GATE. Annotation can also be carried out using other CREOLE plug-ins such as Gazetteer, for which it is necessary to create a list of concepts to be annotated. By clicking on the ANNIE Gazetteer, all the lists appear, including the OT list, as shown in Figure 3. The sub-list presents the main concepts, such as Action, Task, Interactions, social role and Developmental.
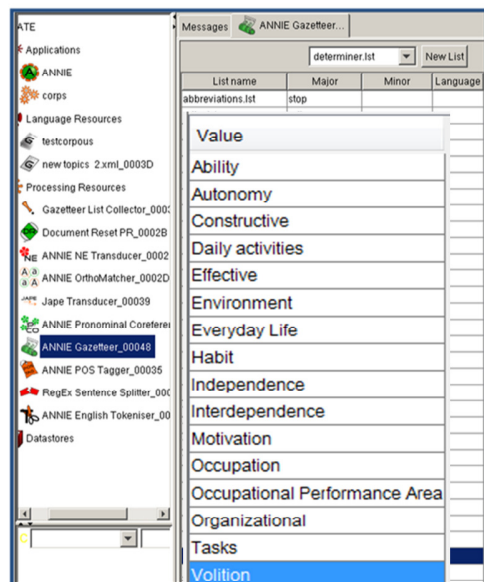

Figure 3. Screenshot of OT Gazetteer

- The next step was uploading the corpus to the application framework using the JAPE grammar and Gazetteer to match and annotate concepts from the corpus.

- *NLP technique used to extract OT concepts:*

We present an automatic extraction method based on ANNIE using a JAPE grammar that extracts concepts from XML files and HTML text. Our JAPE rule extracts concepts as follows: the first entity detected is Information service *{Type=Token, start=867, end=837, id=4210, majorType=concept}* labelled as *Occupational Therapy.concept.*

Phase: one

Input: Lookup Token
Options: control = applet

Rule: concept1
Priority: 20
(
({Token.string == "occupational"})
{Token.string == "therapy"}
({Lookup. major Type == "concept"})
) : occupational
-->
: occupational. concept = {Rule=concept1}

In these rules, we specify a string of text {Token.string == } that must be matched, specifying the attributes of the annotation by using operators such as "==", and then annotating the entities according to the correct labels. Furthermore, using a control field such as all, applet, brill gives the right results. The next example shows how regular expressions could be annotated as showing concepts related to (Therapy) metacharacter(dot, *, [ ], |), {Token.string == "therap (ies)"}.

3. Creating Glossary:

All terms were gathered along with the relevant information to be described in the glossary. We collect the terms from the point of view of occupational practice and therapists, see Table 2.

TABLE 2. GLOSSARY OF TERMS

Occupation	Role	Ability
Occupational mapping	Routine	Activity
Occupational performance	Setting	Assessment
Occupational components	Skills	Autonomy

4. Building concept classification:

In this stage, we followed the Top-down strategy to construct the high level of concepts of the ontology. The top- down method helps in creating the basic relations

between concepts. The ontogical hierarchy is developed based on the main components of the domain knowledge such as:

- Occupational Therapy Components
  - Therapist
  - Client= patient
    - Individuals
    - Groups
    - Organisation
  - Therapy
    - Therapy Action
      - Referral or reason for contact
      - Information gathering
      - Initial assessment
      - Problem Formulation
      - Goal setting
      - Action Planning
      - Treatment Implementation
      - Ongoing Assessment
      - Evaluation
      - Outcome Measurement
- Therapy Method
- Performance Area
  - Activities of Daily Living
  - Working and productive Activates
  - Play Activities
- Performance Components
  - Sensorimotor Component
  - Cognitive Integration
  - Psychosocial Skills and Psychosocial Components
- Performance Contexts
  - Temporal Aspects
  - Environmental Aspects
- Action
  - Internal influence
  - Philosophy
  - Beliefs
  - Values
  - Ethics
  - Goals
  - Key Concepts
  - Skills
  - Responsibilities
  - External Influence
  - Personal Experience
  - Education
  - Academic trends
  - Social and culture environment
  - Social context
  - Working Context
  - Historical

However, to attend to specific problems the relationships should be identified that provide more precise details; in OTO ontology, many taxonomic relationships

have been built, e.g., Is-A, hasA. Also, some relations among concepts are non-taxonomic relations used to present within the relation concept.

Therapists should have professional beliefs and values, about the nature of people, the nature of health, and beliefs about the nature and purpose of OT. OT ontology provides clear relationships between Clients, whether individual, group or organisation, each of which has to be influenced by internal and external factors.

Meanwhile, everyone has a history, experience, language, social and culture, physical, thoughts, beliefs, values, aspirations, needs, problems, interest, and abilities. More relationships are depicted in Figure 4.
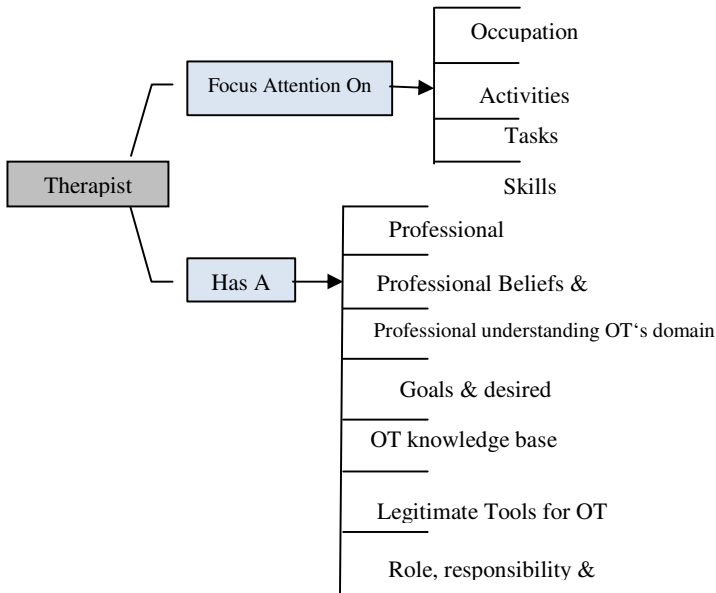
Figure 4. Relationships in OTO ontology

In the formal model of OTO ontology that covers the whole domain, the main classes are categorised based on fundamental considerations about the role concepts in the area. The Ontology is implemented by organising concepts according to is-A, part- of and hasA relations with axioms.

That gives specific definitions of these concepts. A fragment of the ontology is presented in Figures 5 and 6.
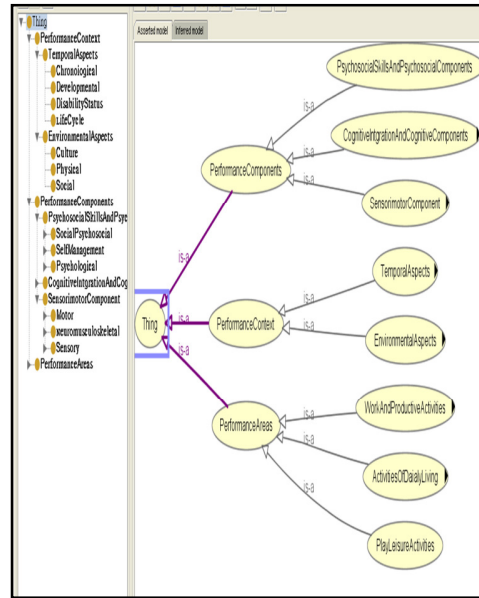
Figure 5. OTO ontology in Protégé
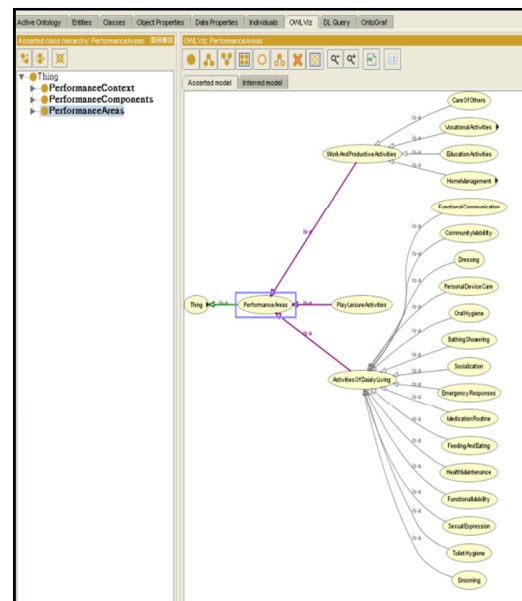
Figure 6. OTO ontology in Protégé

V.   DISCUSSION AND EVALUATION

The OTO ontology is based on IE techniques for extracting the main concepts in the domain. Our extraction of OT concepts using JAPE grammar and regular expression based on the GATE developer for automated IE provides significant results. The main idea behind using JAPE and regular expression is to identify OT terminology as tokens, for example Occupational Therapy, Activity and daily living, from a large text. The term identification relies on

looking up a list of OT terms from the Gazetteer. For example, we could look up collecting information, analysis of information, interpreting information or Social norms, social expectation, cultural norm, cultural expectation. These concepts can be collected to be the main component of the OT glossary and to structure in semi-formal hierarchy before creating the computational model of the OTO ontology.

We extracted the OT concepts from a corpus of 300 documents, obtained specifically for this purpose. We ran the ANNIE application, using document reset, Tokenisor, sentence Splitter, Gazetteer, POS tagger, JAPE transducer and Orthomatcher. The annotation set that appeared in the display panel, and the concepts are highlighted in the annotation default; each annotation has a different colour after running ANNIE and highlighting the matching concepts. The results show that our approach successfully annotates concepts. We recalled 541 of the *Occupation* concept, 275 of the *Therapy* concept and 35 of the *Habit* concept. Each annotation starts from a specific point and ends at a different point based on how many tokens it has. The *Occupation* concept starts at point (557) and ends at (566), while the *Therapy* concept starts at (624) and ends at (636), with its features {major Type=concept}.

In this study, the data were evaluated based on evaluation metrics for precision, recall and the F-measure, which is common metrics in IR field that defined as follows:

$$Precision = \frac{Correct + \frac{1}{2} Partial}{Correct + Spurious + Partial}$$

$$Recall = \frac{Correct + \frac{1}{2} Partial}{Correct + Missing + Partial}$$

$$F - Measure = \frac{(\beta 1 + 1)P * \mathcal{R}}{(\beta 2 \ P) + \mathcal{R}} \qquad (4)$$

The statistics of the corpus show that the pattern matching of OT concepts based on the lookup OT list was 403, correct concepts and accuracy were generally higher, and there were no partially correct results (0), or missing false positives, as illustrated in figure 7

Figure 7. The Accuracy results

The OTO ontology model represents OT therapist searching needs, and has potential to help social studies researchers find primary sources. The OTO ontology followed Methontology [17] ontology methodology

engineering as a general framework to construct the ontology model, and it was evaluated based on ontology quality criteria to ensure its clarity and completeness.

VI. CONCLUSION AND FUTUREWORK

A. Achievement

The development of OTO ontology is a stage towards creating a sharable and reusable OT system. Ontology is a formal model for therapists and social staff organising vision in the information hyperspace of the domain knowledge. This paper has described a method using NLP techniques to extract concepts for the purpose of developing OTO ontology. Furthermore, the development of the IE system should save time and effort in labelling the most common concepts. In total, we extracted 664 concepts that are classes of the OT, and 650 subclasses making up the main components of the ontology skeleton. The IE technique can be applied to many different formats, such as XML, HTML documents, URLs or emails.

B. Future work

Ontology is at the heart of the semantic web. It defines concepts and relations that make global interoperability possible. In future work, we plan to enhance more concepts to develop OTO, to be applied in specific applications to solve specific problems related to the OT domain.

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Expanding the Experience of Museum Visitors with a Social Application on Facebook

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Abstract— Since the early 20th century, museums and art galleries have been responding to a changing, increasingly diverse society, wherein a broader public is interested in culture and/ or arts. They are adjusting their products or adopting the existing technology to the needs of this changing society in order to serve a larger part of the population and gain revenues. With a burst of very popular social media, several museums have utilized the social media such as Facebook, Blog, Podcast, MySpace, and Flickr to communicate with their visitors or interesting group of people. Many visitors will learn new things and gain new experience for a single visit at museum. However, there are a number of silent barriers against the visitor experience, especially for art galleries. This paper proposes a methodology for expanding the visitor experience. Our methodology utilizes the existing social media such as Facebook. We introduce a new application with design decision. The preliminary results are its framework and the evaluation method. We also present a case study on the Southeast Asian Ceramics Museum (SEACM) at Bangkok University, Thailand. By the interview with experts, our application is a new channel to be able to enhance and expand the museum experience.

Keywords- social media; user networks; user experience; digital museums; virtual gallery; art museums.

I. INTRODUCTION

In the early 20th century museums have already experienced a shift from their historic mission of collecting, conservation, and research to a role of education and interpretation to serve a wider public. Museums are not longer purely seen as cultural attractions, but also as leisure places. Visitors are not even satisfied anymore with only products or services; they demand experiences, as addressed by Pine and Gilmore [1]. The focus of the visitors is thus not only directed on collections and exhibitions anymore, but also on sociable, recreational and participatory experiences [2]. Experiencing new things and learning new things are up to 65% and 56% of the motives for visiting the museum, respectively. But how do museums in practice deal with the visitor in his search for experiences?

In this paper, the focus is not only for searching a technique for expanding museum experience but also for managing the after-effects of disasters. Nowadays, a number of natural disasters have been slightly increasing year by year and these are also the main threats against museums. When facing with natural disasters, museums have had a policy for protecting their collections safely on the moment. Unfortunately, the damaged museums might be temporarily closed for restoration. The following question is "how can museums continue run their museum missions, mainly focused on developing the visitor experience, as well as keep in contact with their member without annoying them?"

In order to place our research in the current academic debate and to translate the findings into practice, the following objectives are met:

- Examine the application of experience development for art museums in literature,
- Investigate the need of art museums in aspect of developing the experience of visitors,
- Design our proposed application of experience development, and
- Develop, install, and evaluate the proposed application.

In the primary stage, the contribution of this paper is to serve the first and third objectives in order to understand (1) a changing of museum mission, (2) definition of museum experiences, and (3) the necessary of a new approach/application to meet the museum mission. We also proposed our application on social media as a solution to expand the museum experience, especially the dimension on social context.

II. MUSEUM EXPERIENCE

A. Types of Experience

As addressed by Falk and Dierking [3], combination among individual, group of people, places can develop the experience of each museum visit. Three dimensions are the personal context, the social context and the physical context. The interaction of these three dimensions constitutes the way in which a museum visit is perceived by every individual museum visitor.
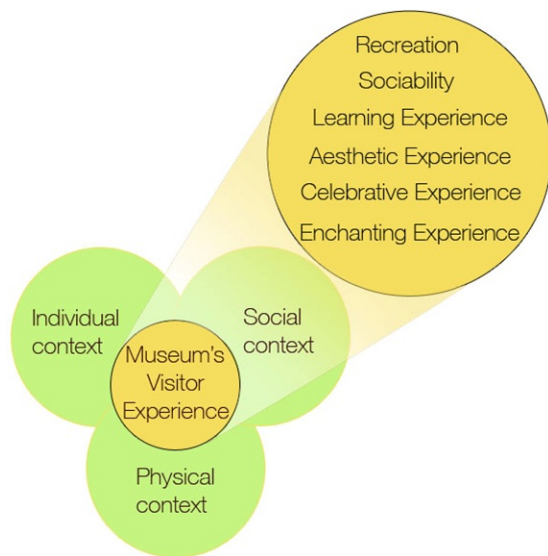
Figure 1. Concept of museum experience.

- Individual. The personal contexts involves a variety of experiences and knowledge, including varying degrees of experience and knowledge on the content and design of the museum, the visitors interests, and the visitors motivations and concerns. These factors together determine what an individual visitor appreciates, what he wants to do with the time available in the museum and what experiences he seeks for self-fulfilment. Every single museum visitor has different past experiences, related or not related to museum visits, which have an influence on the expectations and experiences in the museum [2].
- Group of people. The social context involves the interaction with other people in the museum. Most people visit museums in a group of friends or family and even people who go alone have interaction with other museum visitors or staff. The social interaction has a strong influence on the behaviour of people. Parents with little children show different behavioural pattern than a group of friends or an elderly couple. Also, the crowdedness of the museum is of great influence on the museum experience.
- Place. The physical context includes the architecture and feel of the museum as well as the objects and artefacts. Not only the placing of the artefacts, but also the size of the rooms, marble or carpeted floor, the sent, the presence of benches, a shop, a restaurant etcetera have a strong influence on the experience and behaviour of visitors.

From the aforementioned dimensions, the other experience types will be developed inside the visitors (as illustrated in Figure 1), but the formulation is depend on the intensity of each dimension. For example, the level of interaction among visitors that can develop a social network of special interest group for a particular museum. Increasing the degree of interaction will extend the size of social network. This is one of museum goals because the more shared knowledge and interest, the more experience will be perceived. The other types of experiences are listed below:

- Recreation; Visitors enjoy of free, relaxed, unstructured

time and activity playful and diversionary activity. They can try out interactive devices, sit down for a meal, shopping in a gift shop, etc.
- Sociability; Visitors meet with or participating with others, look at and spend time together with others, take part in shared, public activity.
- Learning Experience; Visitors gather and acquire information, perceive new things and new patterns, exercise curiosity and a sense of discovery.
- Aesthetic Experience; Visitors engage in sensory perceptions, especially visual and tactile, see objects with a view toward their beauty, rather than what is moral or useful, compare things and find patterns.
- Celebrative Experience; Visitors observe and honor a leader, event, group, or organization, share in historical achievements.
- Enchanting Experience; Visitors encounter things that uplift the mind, imagination, and spirit, find magic, delight, fascination, and rapture in things and places.

B. Barrier of Developing Experience from Art Museums

Although museums almost all offer tangible objects, there are enormous differences in collections and missions [2]. Most museums have their own collection like SEACM, but there are also museums that own no collection at all; these are often childrens museums, science and technology centers and history centers. The objects they posses have the function of demonstrating science and technology. These museums integrate on average more realistic of experience than museums that own collections comprising valuable objects of art, nature or history. The followings are reasons:

- Invaluable limited the visitor interaction. The value and delicacy of the objects does not allow people touching or coming close and often the objects can only be on exposition in highly cultivated spaces, with the right amount and sort of light, humidity and temperature. This restricts the contexts in which the artwork can be placed and the possibilities for interactivity.
- Individual preference. History and natural history museums, anthropological and ethnographic museums on the other hand suffer less from this perception of tourists, because they are seen as exhibiting parts of everyday life of normal human beings in the past or present. Art museums have therefore a more difficult job attracting audiences attracted by entertainment and experience such as the culture-peripheral tourist. In addition developing memorable experiences for arts museums is more complicated, since the visitor relates less to the objects because they are less obvious connected to everyday life.

Therefore, art museums therefore have an added role in education, which can undermine, if not being outbalanced, the total multifaceted experience.

III. Southeast Asian Ceramics Museum (SEACM)

A. Background

The Southeast Asian Ceramics Museum (SEACM) at Bangkok University houses and preserved valuable collections

Figure 2. the Southeast Asian Ceramics Museum (SEACM) at Bangkok University, Rangsit Campus, Thailand.

of ancient ceramics. SEACM established in 2002 is responsible for housing and preserving valuable collections of ancient ceramics covered in Southeast Asia. Most of them were made in Thailand or imported into Thailand in ancient times that were prehistoric Thai pottery, dating from 2500BC to 0AD years ago. The collection includes Khmer ceramics, mostly from old kiln sites in the province of Buriram, and also some from other countries such as Burma, China, and Vietnam.

B. Experiences Perceived from SEACM

The museum has even had the Shard archive and an extensive library available for use by researchers, but we observed that 70% of visitors often ask for interpretation of displayed objects. Comparing with science museums, they are developing their product in order to make it more attractive to the new type of museum visitor that seeks a leisure experience. Exhibition objects do not need interpretation. At most, they need explanation, but usually, the hands-on interaction with the object speaks for itself and increases participation of the visitor.

C. Impact of Severe Flooding in 2011

The 2011 Flood of the Makong and Chao Phraya Rivers spread through the provinces of Northern, Northeastern and Central Thailand killed hundreds of people and affected the lives of about three million people. Flooding persisted in some areas until mid-January 2012, and resulted in a total of 815 deaths (with 3 missing) and 13.6 million people affected. Sixty-five of Thailand's 77 provinces were declared flood disaster zones, and over 20,000 square kilometers (7,700 sq mi) of farmland was damaged.The disaster has been described as "the worst flooding yet in terms of the amount of water and people affected."

The impact of this disaster to SEACM is not as serious as happened to the World Heritage property like Ayuthaya. For Ayuthaya, because of the loss of evidence, it will result

Figure 3. SEACM was seriously affected from the worst flooding in Thailand 2011.

in incomplete integrity, and a restoration without sufficient budget and scientific support will certainly affect authenticity of the monuments and the sites. For SEACM, the collections are absolutely migrated to the safe place before the flood but the museum place itself was damaged of 100% as shown in Figure 3. At present, the museum has been underconstruction for renovation and the finishing takes many year.

IV. LITERATURE: APPLICATIONS FOR DEVELOPING EXPERIENCES

A. Museums and Web 1.0 Technologies

Web-based museums have been proposed to improve preservation of and access to cultural heritage [4]. Their examples are Australian National Maritime Museum in Sydney that aims at dynamic and innovative managing and exploring Australia's maritime heritage [5], Art gallery of Ontario that publishes the museum content on-line [6] to help new citizens learn more about their new home country through art. Another example worth mentioning is Smithsonian Institution that is the world's largest museum complex and research organization composed of 19 museums, 9 research centers, and the National Zoo.

All museums under Smithsonian Institution found in [7] have developed their digital museums where visitors of National Portrait Gallery can search more than 80,000 portrait records from the Catalog of American Portraits and new material is added regularly, and automatically published to the Website after being cataloged and validated.

Currently, the website is supposed to be developed for every museum. This is because of the following characteristics as mentioned in [4], [8]:

- Operation with reliability and availability
- Availability for anyone who can access through the Internet
- Convenience for users who are willing to be collaborative
- Reduction of cost for housing and exhibiting artifacts

Marty [9] concluded that as museum information resources become more technically complex, and the users of those resources become more information literate, the needs and expectations of visitors become increasingly sophisticated. Users of museum resources are no longer satisfied with limited access to information about museum collections, and many desire twenty-four hour access to museum data, no matter where these data are located, or how the data are organized. While the ability to manipulate and manage information resources has long been an important skill for museum professionals, meeting these changing expectations can pose new challenges for museum professionals. The coming of social media can be a solution.

B. Emerging Web 2.0 or Social Media

Emerging of Web 2.0 (social media) has dramatically changed the communication media of the world. With social media, all participant can be both sender and receiver of messages, which are news, information, knowledges, etc. It is a term that describes web-based applications on which users generate, share, and curate the content [10]. Over the last three years, the sites, from blogs to YouTube to Wikipedia, have transformed the ways that web users interact with content and with each other on the web.

Since museums have had a strong desire to be welcoming places, a use of social media can turn them into virtual community centers as their desire. Such as Facebook or Twitter, everyone has a voice, and a vote. Curators and online visitors can communicate, learning from one another. The engagement of the social media with a museum organization requires some protocols, applications, or systems to fulfill the museum needs. An example of health care, Kamel Boulos and Wheeler [11] offered a special-purposed application based on social media. Their design is very promising and potentially fit for purpose in many health care applications.

C. On-Site Applications

Games are a way to entertain visitors in museums and to support cooperation among museum visitors through games [12]–[14]. For example, Dini et al. [15] introduced a multi-players game in a museum. The game is to use the mobile devices for individual game play, and the situated displays for synchronized public views of shared game play; the individual game play contributes to the shared game. A number of applications with the same purpose are also addressed in [16], [17].

Unlike a game, another application is called *Artlinks* developed by [18]. Artlinks is classified as an information visualization tool with three goals: helping visitors make connections to exhibits and other visitors by highlighting those visitors who share their thoughts; encouraging visitors reflection on the social and aspects of museum-going.

V. The Proposed Application

We proposed an application for improving the social context for museum visitors. Our application has an idea of migrating the Artlinks [18] to social media as shown in Figure 4. This application will be developed on the social media; without loss of generalization, Facebook is chosen as a platform of our application. Facebook have been the highest popular used for social purpose since January 2009, and it had the registered users of 900 million in April 2012 as reported in [19]. The advantage of Facebook application is that we can exploit the user information in Facebook; however, the information have to be authorized by owners following the Facebook policy. The feasible post-processing modules are below:

- Identifying their preference/interest. To analyze the first-registered users, the explicit questionnaire has to be used, but it can burden user task and waste their time. Thus, Facebook will provide some useful information (such as their interest groups, member subscription, and previous joined applications) about users. The further analysis on these information can describe their preference.
- Supporting a reputation system. Essentially, the application in social media requires a protocol for tracking and scoring user activities. The more information about users, the more accurate assessment of users' comments/opinion we can design and develop.

A. Features of the Application

The features of our application are mainly listed below, and their graphic design and cross functions are shown in Figures 5-7.

- Virtual gallery. Displaying the selected objects (i.e. most of them are masterpieces) with their Flash format. That means the objects are built with the Flash technology containing of a series of photographs in several angle views (top, bottom, 4-Sides).
- Item description. Holding a mouse over a particular object will show its pop-up description (written by experts and curators).
- Annotation for user opinion. With adopting the Wiki concept, users can write their comments/opinions for each displayed object.
- Links to users' Facebook page. A social network of museums can be built by gathering a number of existing personal social networks.

Figure 4.   Our proposed application for linking the displayed objects to a group of people who have the same interest with the following features: virtual gallery, item description, user annotation, hyperlink to users' Facebook pages, souvenir shop, and information visualization.

TABLE I
INTERVIEW WITH THREE CURATORS ABOUT THE MUSEUM EXPERIENCE WHERE X MEANS NONE AGREED, △ MEANS SOME AGREED, AND O MEANS ALL AGREED.

Museum experience	Art museum	Our application	Artlinks [18]
Recreation	△	O	O
Sociability	△	O	X
Learning	O	O	O
Aesthetic	O	O	O
Celebrative	O	O	O
Enchanting	O	△	O

TABLE II
SUMMARIZATION OF THE RELATIONSHIP BETWEEN MUSEUM EXPERIENCE AND OUR APPLICATION FEATURES.

Museum experience	Application features
Recreation	Virtual gallery, and souvenir shop
Sociability	Annotation for user opinion, and Links to users' Facebook page
Learning	Virtual gallery, item description, and visualization
Aesthetic	Virtual gallery
Celebrative	Annotation for user opinion, and visualization
Enchanting	Virtual gallery and visualization

- Souvenir shop. Similar to many real museums, visitors are happy to have anything for their presence, memorization, and fun.
- Visualization. Visualizing a network of people who have the same opinions/comments can make an implicit link from objects to people.

B. Desirability in the Expert Domain

After we designed the application, we did a desirability research method for collecting visual design feedback from domain experts. We have had an interview with three curators about the museum experience that visitors are able to gain it during their spent time at a real gallery, our application, and Artlink. The interview results are summarized as shown in Table I where the curators summarized that our application features are able to develop the museum experience as shown in Table II.

VI. CONCLUSIONS AND FUTURE WORKS

Two main reasons of our proposed application on social media are as follows. First, everyone in anywhere can access whenever they are available. This feature of our application is an alternative way for museums temporarily closed because the museums must keep contact with their visitors. Also, the experience of visitors can be expanded without visiting the real place. Second, very-shy participants become less shy in social media. Thus, they would like to share their opinions with other people as well as to join museum activities in special events.

We can conclude that this paper has met the first and second objectives of our research project. First, we did the study of the application of experience development for art museums in the previous works. Second, we also finished the design of our proposed application of experience development. The remaining work is about the third objectives of the evaluation part. We are developing this application for SEACM during temporarily closing. Lastly, the evaluation will be conducted on the real visitors including university students and cultural tourists (excursion of school kids, foreigners).

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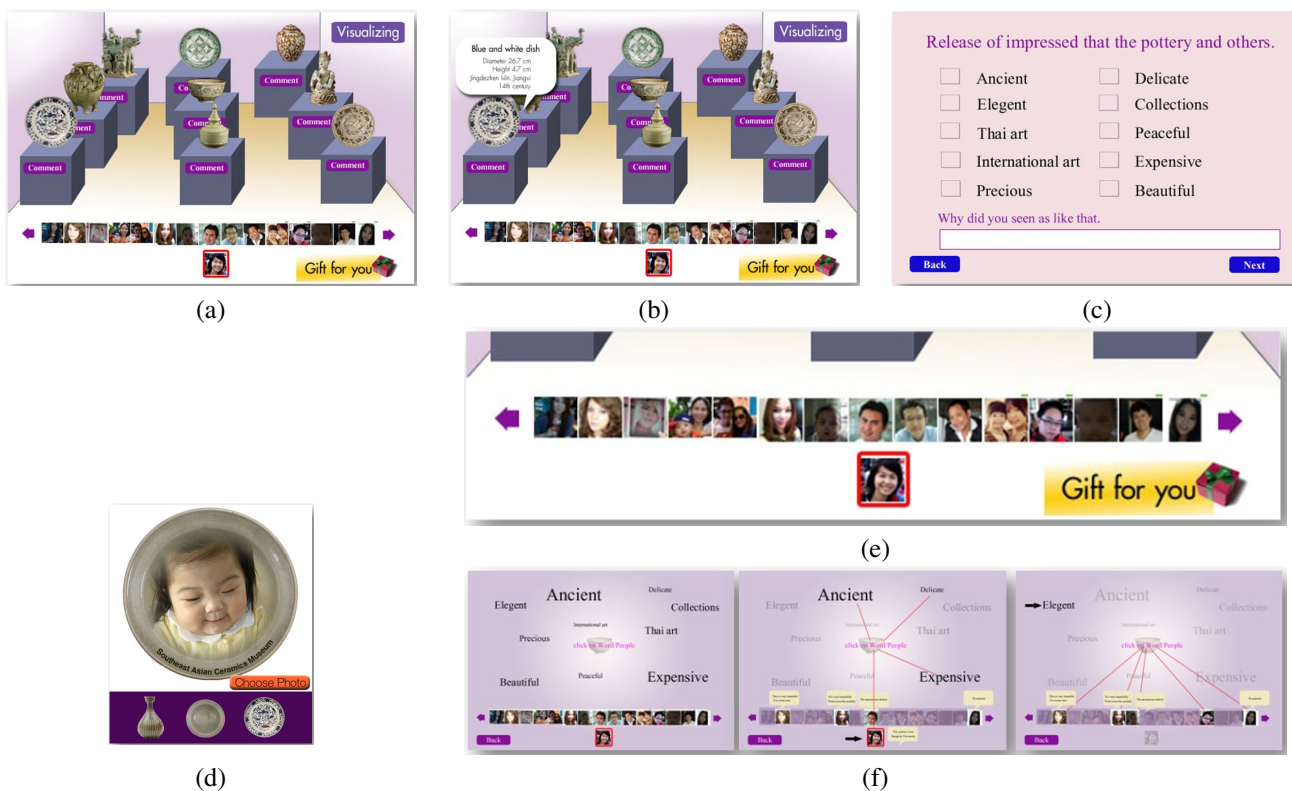
(a) (b) (c)

(e)

(d)

(f)

Figure 5.   Application features: (a) virtual gallery, (b) item description, (c) user annotation, (d) souvenir shop, (e) hyperlink to users' Facebook pages, and (f) information visualization.
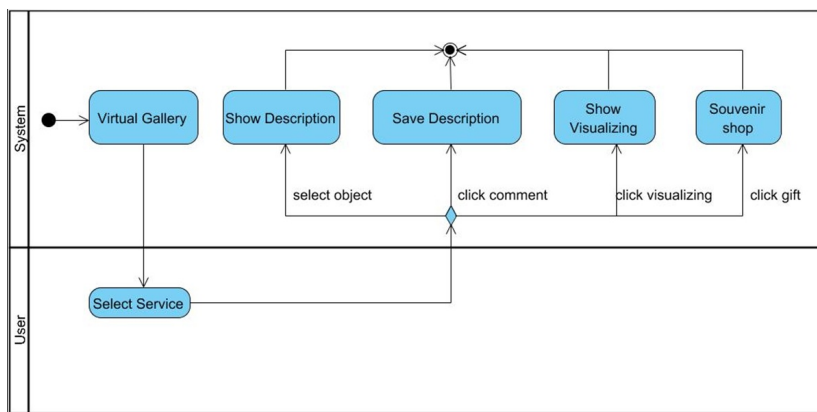

Figure 6.   Activity diagram between users and the application.

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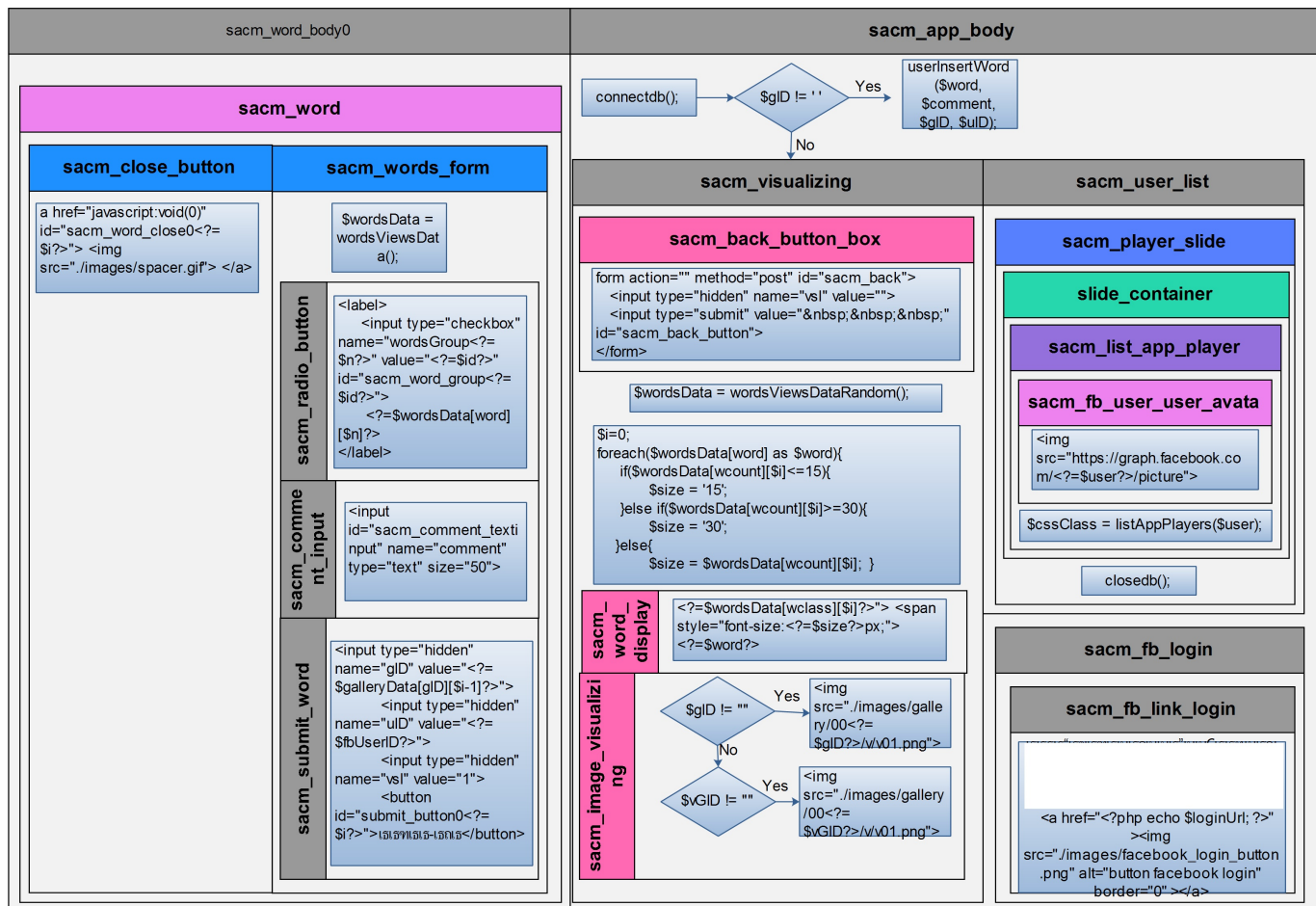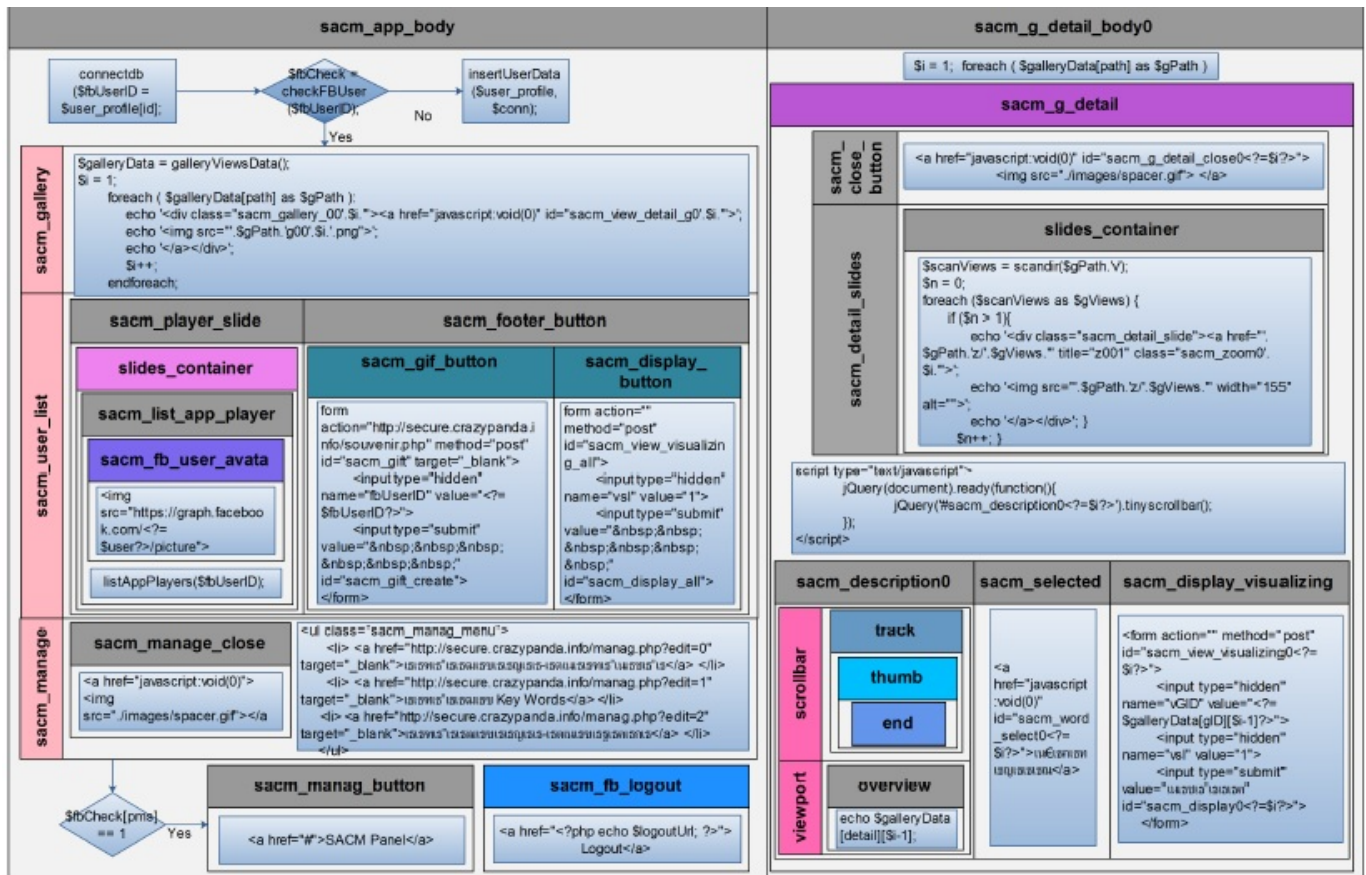
Figure 7.   Cross functional diagram of the application.

Understanding the cultural dimension on the Web homepage preferences and visual exploration

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Abstract— **In an experimental study conducted with thirty-two French and Japanese users, we investigated the impact of culture (*i.e.*, cultural cognitive style) on users' preferences and their visual exploration of homepages with two different designs: French-ness and Japan-ness design. Two main results have been obtained: (1) Even if homepages are culturally designed, preferences of the user is not related to this culture-centered design; (2) The visual exploration of homepages is subordinate to the culture of the user, *i.e.* is not really related to the design.**

Keywords- visual exploration; culture; consumer; preference; design

I.   INTRODUCTION

Since the early 1990s, many studies have focused on the influence of culture on the design of Websites and Webpages [1, 2, 25], giving rise to a current design focuses on culture [5, 6, 7, 8, 34]. In parallel, recent studies have focused on the impact of the culture of users and consumers about their perceptions and behaviours during online information searching [9] [10] [36]. All these studies emphasize the importance of the relationship between culture and usability in Web design and Web use, *i.e.* culturability (*culture + usability*; [1]).

In this paper, we focus on the two culturally determined cognitive styles (analytic style *vs*. holistic style) on preferences and visual explorations of homepages by users/consumers recruited from two different cultures (Japan *vs*. French).

II.   THE IMPORTANCE OF THE HOMEPAGE AND ITS CULTURE-CENTERED DESIGN

According to Nielsen [26], "Corporate homepages are the most valuable real estate in the world" because homepage determines the first impression at the consumer and then determines, in part, the future behavior of that consumer.

It is essentially the homepage of the Website where a user arrives prompting said user to enter or not in that site [7, 19, 20] (Figure 1), especially if it is an unknown site. This explains why the design and the design of homepages are of primary interest in e-commerce. Indeed, one of the issues for businesses is that the user remains long enough on the home page of their site to make them want to enter
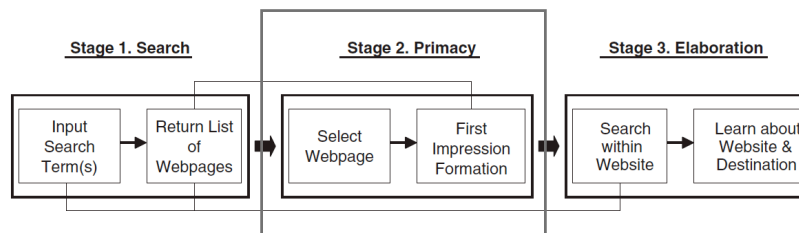
Figure 1.   The importance of first impression in the process of online information searching, according to Kim & Fesenmaier [19].

A research team at Microsoft Research has recently proposed a mathematical model explaining dropout behavior of users [21]. After analyzing the behavior of thousands of users over 200,000 websites, the team determined that the time spent by an individual on a Webpage followed the Weibull distribution. According to this Weibull distribution, the probability that an individual leaves a Webpage decreases as time increases that individual remains on said Webpage. And it appears that the first 10 seconds are crucial [20, 25].

In other words, if an individual stays longer than 10 seconds on the homepage of a Website, then the probability that the individual enters and explores this Website increase significantly because the user's attention has been captured and "hung". Then we understand the issues related to the homepages of Websites since these homepages, which will determine the behavior of the individual: to enter into the Website, or to leave immediately.

According to Nielsen [26], the average percentage of pixels used for each category on homepages is the following:

- Operating system and browser overhead: 19%
- Navigation: 20%
- Content of interest to users: 20%
- Advertisements: 2%
- Self-promotions (ads for the site's own stuff): 9%
- Welcome, logo, tagline, and other site identifications: 5%
- Filler (useless stock art, such as "smiling ladies"): 5%
- Unused: 20%

Nielsen [26, 27, 28] assumes that this distribution of these different types of information on homepages is universal. But it appears that, for a given company, homepages are very different among culture of designers and/or intended end-users. And some recent studies [7] [34] confirmed that the allocation of the different types of information is different among the version (French *vs*. Japan). In other words, homepages are culturally designed (Figure 2 shows an example).

But, what is the real impact of this culture-centered Web homepage design on users' preferences and their visual exploration among the culture of these users?

Figure 2.   The Japan (on the left) and the French (on the right) homepages of the Honda company©: An example of a culture-centered design.

III.   COGNITIVE STYLE AND INFORMATION BEHAVIOUR

The concept of "cognitive style" was developed in the late 1970s to explain the inter-individual differences in task selection, retention and retrieval of information [14, 15]. Cognitive style is defined as an individual adopts the approach to explore, analyze and organize their environment [32]. This cognitive style thus influences the individual strategies of analysis and exploration, including visual exploration.

Several studies have shown that cognitive style was essentially linked to the culture of the individual [3, 22, 23, 29, 30, 31, 32, 34]. Traditionally, the impact of culture is considered from the standpoint of theoretical work developed by Hofstede [17], considering only the behavioral level. But recently, Faiola and his collaborators [11, 12, 13] have suggested that culture could have an impact on cognitive processes on the one hand, designers of Websites and on the other hand, users and consumers of these Websites. In other words, culture does not express only in

terms of behavior: Culture would influence processes and cognitive strategies, creative Web design and use.

Indeed, Faiola & Matei [13] have confirmed that cognitive styles determined the conception and design Webpages. But these authors also showed that users within the same cognitive style that designers of Websites were most effective. In their study conducted with 171 American and Chinese individuals, participants were asked to find answers to factual questions in two versions of a Website: A site designed by Chinese developers and a site designed by U.S. developers. The results showed that the performance of individuals (*i.e.*, time taken to find the right answers) were directly related to the culture of the designer. More precisely, the performance was better when there was concordance between the culture of the user-participant (American *vs*. Chinese) and the culture of the developer-designer (U.S. *vs*. Chinese). This result was interpreted as evidence of the existence and impact of cognitive styles [13]: If a user of a given culture (and therefore, with a specific cognitive style) is "better" in a task involving a Website designed by a designer from the same culture, it is because the cognitive styles of these two individuals are identical.

As mentioned previously, cognitive style exploration of its environment depends directly on its culture, the analytic style and holistic style resulting in a large number of studies [23, 24, 29, 30, 31, 33]. The analytical style is characterized by a detachment of the object from its context, a tendency to focus on the attributes of the object, in order to assign it into categories, and production of inferences based in part on the contextualization of the content structure. The holistic style is characterized by orientation in the context or field as a whole, including attention to relations between the focal object and the field, a preference to explain or predict events based on these relationships, and an emphasis on the importance of change, recognition and identification, and the need for multiple perspectives. In other words, individuals with an analytical style tend to perceive an object regardless of the scene in which the object is and tend to assign objects to categories: they are more field independent. In contrast, individuals with a holistic style tend to perceive the scene as a whole, comes to perceive the context and scope as a whole. They tend to focus on the relationships between objects and the field: they are more field dependent. Studies show that the analytical style is mainly present in Western (USA, Western Europe) while the holistic style is mainly present in populations of the Far East (China, Japan, Korea) [23, 24, 29, 30, 31].

In an experiment, we investigated the impact of this holistic-analytic cognitive style on the Web homepage preferences and visual exploration for individuals recruited in two different cultures.

IV. EXPERIMENT

In an experimental study conducted with thirty-two French and Japanese users, we investigated the impact of culture (*i.e.*, cultural cognitive style) on their preferences and their visual exploration of different homepages issued and translated from the two cultures (France *vs*. Japan).

A. Participants

The sample consisted of seventeen French students (14 males and 3 females; mean age = 22.3 years) and fifteen Japanese students (12 males and 3 females; mean age = 22.3 years). All were students in Master degree in physics and mathematics. All of participating students self-reported that they, on average, used the Web more than 15 hours per week for academic and commercial purposes.

B. Independent variables

In our experiment, two independent variables were manipulated:
- The culture of the participants, with two modalities: French (FR) *vs*. Japanese (JP);
- The culture-centered design of homepages, with two modalities: French-ness (FR) *vs*. Japan-ness (JP).

C. Dependent variables (data collected)

In our experiment, the following data were collected:
- Preferences: After experiment, participants were asked to indicate their preferences between the two versions of homepages (French-ness *vs*. Japan-ness) for the two prototypes of Websites;

- Visual exploration: The viewing patterns were used to determine the way that participants read and scanned the homepages (Japan-ness *vs*. French-ness). According to Dong & Lee [9], five different viewing patterns can be distinguished:
  - "0" Shape: Eye movement is similar to drawing a "0" on the homepage;
  - "5" Shape: Eye movement is similar to drawing a "5" on the homepage;
  - "N" Shape: Eyes move down one column and then move over to another column;
  - "Z" Shape: Eyes pass over columns first and then move down the homepage;
  - "X" Shape: Eyes move diagonally across the homepage and scan it with random jumps.

D. Material

In this experiment, specific homepages and Websites have been created. More precisely, two versions of homepages (Japan-ness *vs*. French-ness) are designed for two prototypes of Websites (a Website to purchase computer equipment and a Website to find an internship). These two versions of homepage have been elaborated on the basis of data obtained with a previous ergonomics inspection (author, 2012). In other words, the average percentage of pixels used for each category on homepages is different between the two versions (Japan-ness *vs*. French-ness).

Moreover, participants viewed all these versions (presented in random order) on Tobii T120©. So, scanpaths and visual explorations of users were recorded in real time.

Finally, each participant was asked to complete two questionnaires before to search for information in the different Websites and to give their preferences:

- a questionnaire to collect socio-demographic data and the uses of the Web (frequency of use, nature of uses, *etc*.). The Web experience questionnaire was adapted from Thatcher and Greyling [35] and measures technical expertise with the Web based on the self-reported breadth and depth of exposure;

- the Analytic-Holistic Scale (AHS) elaborated by Choi, Koo & Choi [4] to determine the cognitive style of individuals. This questionnaire, a Likert-type scale (from 1 to 7), consists of 24 items assessing four dimensions related to cognitive style: causality, attitudes *vis-à-vis* the contradictions, change perception, and attentional focus.

E. Task and procedure

Each participant was individually asked to consult different prototypes of homepages (prototype A: a site to purchase computer equipment; Prototype B: a site to find an internship) before to give his/her opinion about these different versions. Consultation time was free. The order of presentation of the different prototypes and topics was counterbalanced.

Then, each participant was asked to complete a questionnaire to collect socio-demographic data and the uses of the Web [35] and the Analytic-Holistic Scale (AHS; [4]) to determine the cognitive style of individuals.

V. RESULTS

First, according to previous data obtained by a lot of researchers [3] [29] [30] [31] [32], our results obtained with the Analytic-Holistic Scale (AHS) confirmed that our French users hold an analytic approach whereas Japanese users hold a holistic approach (mean score for French users = 5.10 *vs*. mean score for Japanese users = 2.9; *p*<.005).

Second, as Table 1 shows, there is no impact of culture of users on their design preferences between the two versions of homepages (French-ness *vs*. Japan-ness). Whatever the Website (A and B), the number of French users preferring French-ness and Japan-ness homepages is substantially equivalent. In the same way, the number of Japanese users preferring French-ness and Japan-ness homepages is substantially equivalent, whatever the Website (A and B).

TABLE I. PREFERENCES OF FRENCH AND JAPANESE USERS FOR EACH PROTOTYPE (A AND B)
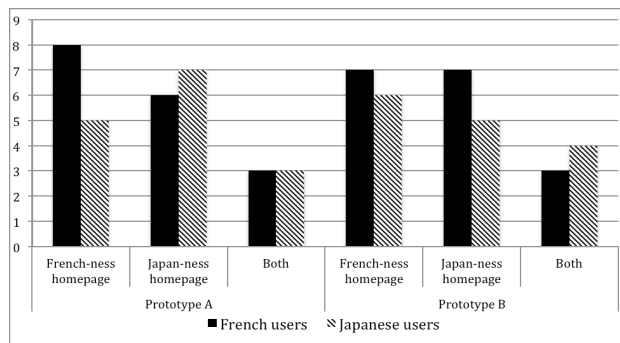
Third, visual exploration of homepage is essentially influenced by the culture of users, and is not really influenced by the design of the homepage. As Table 2 shows:

- The "0" shape (red dots in Figures 5 and 6) is the most frequent viewing pattern used by French users to explore the homepages whatever the design (64.7% for the French-ness design and 52.9% for the Japan-ness design);

- The "5" shape (black dots in Figures 5 and 6) is the most frequent viewing pattern used by Japanese users to explore the homepages whatever the structure (60% for the French-ness design and 66.6% for the Japan-ness design).
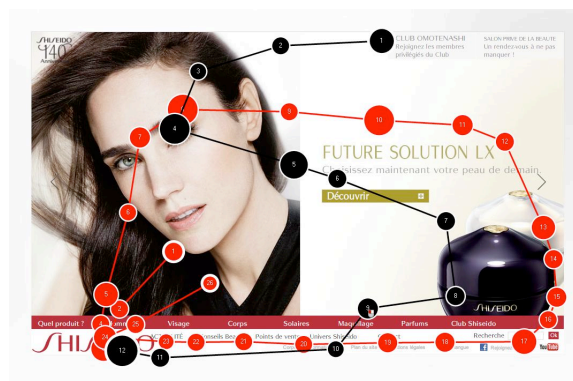

Figure 5. The "0" shape viewing pattern used by French users (red dots) and the "5" shape viewing pattern used by Japanese users (black dots) to scan the homepage a French-ness design.

Figure 6. The "0" shape viewing pattern used by French users (red dots) and the "5" shape viewing pattern used by Japanese users (black dots) to scan the homepage a Japan-ness design.

TABLE II.   VIEWING PATTERNS OF EXPLORATION OF HOMEPAGES ("0", "5", "N", "Z", "X") FOR FRENCH AND JAPANESE USERS FOR EACH DESIGN (FRENCH-NESS *VS*. JAPAN-NESS)
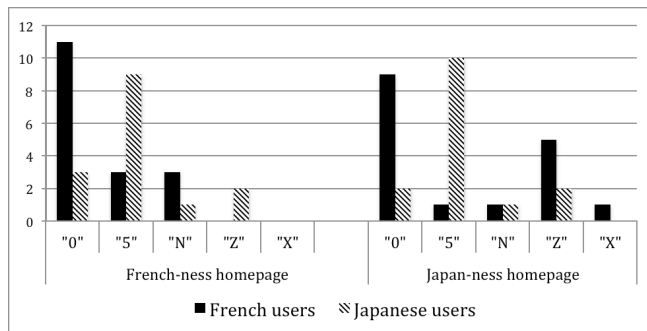
In other words, visual exploration used to read and to scan a Web homepage is culturally determined for our French and Japanese users. Thus, the visual exploration used by a user/consumer is dependent to his/her culture and is not dependent to the design of the Web homepage. More precisely, our experiment tends to show that the cognitive style (holistic vs. analytic) linked to the culture of the individual is a major factor to explain the visual exploration of homepages.

VI.   CONCLUSION AND FUTURE WORK

The two main results obtained in our study are the following:
- Even if homepages are culturally designed, preferences of the user is not necessary related to this culture-centered design;
- The visual exploration of homepages is subordinate to the culture of the user (and not related to the design).

From an ergonomics point of view, the results of our study have mainly shown that cognitive differences at the design level exist in the form of cultural styles that are perceptible to users/consumers. In accordance with other recent studies [13], although the purpose of our study was not to provide Web design recommendations *per se*, the results strongly suggest that awareness of cultural cognitive style is necessary for the improvement of online communication.

Building upon this research, we foresee future work that will better inform Website designers about how to respond to implicit thinking patterns of cross-cultural users. From a theoretical point of view, our experiment supports the view that culture is expressed and influences the cognitive processes of visual scanning, and not just behavior [11, 12, 13]. The growth of electronic commerce, in particular business-to-consumer, has been explosive during the last few years. Until recently, the Web community has been a dominated western-oriented society, with the design of Web sites reflecting that homogenous audience. But our results indicate that preferences and visual exploration of homepages differences exist between the cultural groups. So, if development of a "Universal" Website and homepages that appeals to all audiences and encourages increased visits and transactions is perhaps the "holy grail" of developers, creation of a single universally appealing global site does not appear feasible given the differences between some cultures/consumers, and that a preferable strategy might be to instead create culturally and consumer specific sites. In summary, the differences in culture plus the rapid expansion of the Web throughout the globe indicate that the current homogenous Website blueprint should change.

A user's preference and visual exploration with/of a homepage could affect the first impression, *i.e.* propensity to enter into that Website and ultimately initiate transactions with that business [20] [25]. So understanding culture-based perceptions of Internet users and their behaviors could serve to improve a Website to such an extent that it might also improve the competitive position of the business itself.

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Regional Information Platform and One-Segment Local Broadcast Service for Tourism Promotion and Disaster Prevention

An initial experiment and assessment

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Abstract—**Repeat tourists tend to gather information on their destination through mobile devices. For this reason, it is necessary to have a regional information platform that allows users to see all the information on an area in a unified format. One-segment local services in Japan are broadcasts targeted at mobile devices; however, these broadcasts are limited to a narrow area. We set out to use this service, which is currently in an experimental phase in Japan, for a large-scale event (the Lake Suwa fireworks show). Results of our experiment showed that the visitors found that this service is very useful, but also showed that it is necessary to provide the information that visitors really want. As the next step in this research, we intend implementing a regional information platform to find out the information that visitors want. And also disaster prevention information system will be implemented.**

Keywords-One-segment local broadcast service; mobile device; regional information platform; tourism; disaster prevention; data mining

I. INTRODUCTION

According to the Japan Tourism Agency, the ripple effect of production resulting from travel expenditure was 51.4 trillion yen (5.3% of the total in the "2005 Input-Output Table"[1]), equating to a value-added effect of 26.5 trillion yen. This is seen as having a large effect on employment and production. Furthermore, despite the problems caused by the earthquake and nuclear reactors, the agency has unveiled the "Visit Japan" project, which aims to attract 30 million foreign visitors to Japan. It is also seeking to expand tourism production. It is apparent that the needs of tourists are shifting away from travel with associated large-scale expenditure, which emphasizes groups, luxury, and well known tourist spots. Instead, this has given way to tourism that is "suited to individuals," which considers aspects such as individuals/small groups, day trips, and secluded destinations. Trips tend to be taken alone, with family, or with close friends. According to the Japanese Association of Travel Agents, the cost of tourism is advancing in two directions: one that emphasizes luxury, and the other that features low prices and includes such activities as day trips. It is thus necessary to devise a strategy that satisfies the changing needs of tourists.

However, with regard to tourism in Nagano Prefecture and the Suwa Region, while there has been a steady annual increase in visitors owing to large-scale events such as the Suwa Taisha Onbashira festival and the Lake Suwa fireworks show, the trend in the medium term has been decreasing.

As a new form of tourism, the Japanese Tourism Agency and other bodies have introduced "landing-type tourism" [2], which is a travel commodity produced by local areas. Volunteer guides from the areas' non-profit and other organizations lead tourists around the area, focusing on experiences, exchange, and education. In this way, it is possible to convey each area's unique charm, something that cannot be organized by large travel agencies.

The ability to send information directly to the visitor, which has been made possible by the spread of the Internet, is a key element in landing-type tourism. Alternative means of transportation have also played a significant part. Currently, travelers using their own cars comprise over 70% of tourists (Tourist Mobility Survey, 2008, Nagano Prefecture[3]). This means that tourists are now free to be selective about their trips, which are typically low cost. Furthermore, regarding the usage of information technology during landing-type tourist activities, the percentage of tourists who collect information while at their destination has risen to 46.5%. This figure has a high correlation with male IT users in their 40s and female IT users in their 30s (Survey Research Regarding the State of Landing-Type IT Tourism and Services for Attracting Visitors, 2007, Ministry of Economy, Trade, and Industry[4]). In particular, repeat visitors have a higher tendency to gather information at their destination. In terms of the IT medium for doing so, mobile devices have become the strong favorite. For this reason, it is necessary to have a regional information platform that allows users to see all the information on an area in a unified format, as well as an information distribution system that transmits information via the Internet and broadcasts aimed at mobile devices.

There is a also a wide range of disaster prevention information that can be covered, including weather information and river (flooding) information, which are transmitted by each area, and national earthquake information. As each type of information is transmitted through a different media and in different formats, it is necessary to consolidate everything. In addition, manual conversion of media and formats would prevent the information from being transmitted in real time. A system structure capable of immediate transmission is preferable.

Moreover, with Japan's terrestrial digital broadcasting format, one channel is split into 13 parts, called "segments."

A few of these segments are bundled together to send video, data, and audio, while one segment is dedicated to mobile devices; "1seg" uses this for broadcasts. One-segment local services in Japan are broadcasts destined for mobile devices; however, the broadcast is limited to a narrow area.

With regard to the discussion above, in the context of trial services for one-segment local services, many areas have been conducting experiments using the unused portion (white space) of television broadcast signals as a platform for research and development, as well as for demonstration experiments. These activities aim to utilize this white space to facilitate the initiation of new services and systems, as well as the development of business. The expectation of utilizing this for local tourism promotion and disaster prevention is particularly high.

II. RELATED WORK

There are no previous studies that address local area information and information distribution systems comprehensively, as this research aims to accomplish. However, the following are mentioned as examples of research on individual technological levels.

A. Transmission of Information using One-Segment Local Services

There are several reports in the literature on experiments that have been conducted to transmit information using one-segment local services, for example, those by Saito et al. [5] and Nishikawa [6].

B. Research on Data Mining Technology

Basic research on data mining technology is being addressed, and its effectiveness is expected to improve. Deguchi [7] suggested the possibility of content navigation through recommendation and data mining. Additionally, Haseyama and Hisamitsu [8] considered the use of video search technology to allow users to access videos they wish to view from amongst a great number of videos.

C. Regional Information Platform

An effort has been made to further standardize area information platforms from the viewpoint of municipalities [9]. Additionally, in [10] it is reported that through the optimal use of telecommunication and broadcasts, the satisfaction level of users can be maximized.

Thus, although there has been some research on individual technologies, to the best of our knowledge, no research has focused on a comprehensive area information platform and information distribution system.

III. AREA INFORMATION PLATFORM AND INFORMATION DISTRIBUTION SYSTEM

The Suwa Region has been designated as a white space specific district. In this study, for the purpose of tourism promotion and disaster prevention in the area, we conducted an experiment to determine the efficacy of a one-segment local service transmission service. In particular for this region, the timely transmission of weather, tourism, and disaster prevention information for the fireworks show (which attracts approximately 500,000 visitors) was a priority. But until now this kind of experiment was not yet conducted. To distribute tourist and disaster prevention information in a timely fashion to those who need it, the development of a regional information platform was required. Data mining and content understanding technology are also necessary on such a platform, to gather and analyze information, and then automatically generate and organize the information requested by the user.

In the current state, tourism information for large areas is scattered, and therefore, the desired information cannot be obtained instantly. In addition, accessing to individual hidden information is challenging. For these reasons, a regional information platform including social media information and the ability to find information on small areas through data mining is crucial.

In addition, a tourism and disaster prevention information (one-segment local service) distribution system will be developed on top of the regional information platform, as illustrated in Figure 1.
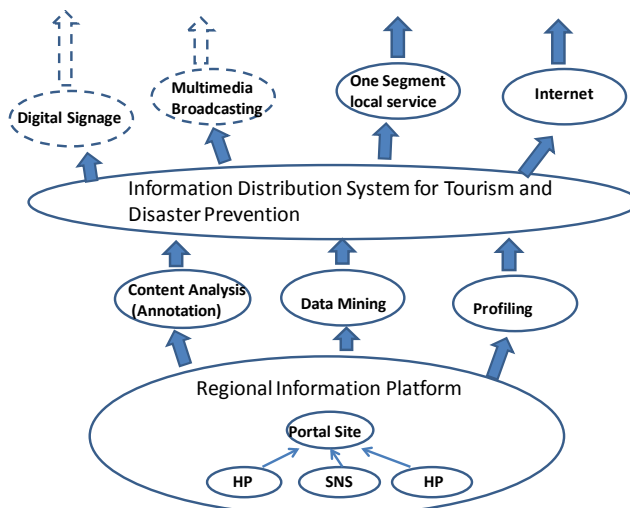
Figure 1. Regional information and distribution system.

In terms of the content transmission, the distribution system must be able to connect to broadcast and telecommunication units in a coordinated fashion. The aim of this system is to optimize the content in order to deliver programs better suited to the users' needs. Another aim of this system is to optimize the content distribution method suited to the users' environment. Finally, an autonomous disaster prevention information system, which has the ability of using broadcast and telecommunication units in the event of a disaster, is will be developed in next step.

IV. SYSTEM DESIGN

A. Regional Information Platform (corresponding to (1) in Figure 2)

First, by holding a workshop on the effective usage of social media, the utilization of social media transmissions by tourism officials was increased. In addition, as shown by the

area demarcated as (1) in Figure 2, the regional information platform can centrally manage not only official local area websites, but also personal sites, blogs, and social networking services. Through the realization of a one-stop portal site such as this, users (tourists) will be able to find the information they seek without having to search several sites. Moreover, by crawling websites for regional information, gathered knowledge about an area can be sampled, the information requested by users can be analyzed, and this can leveraged through broadcasts.
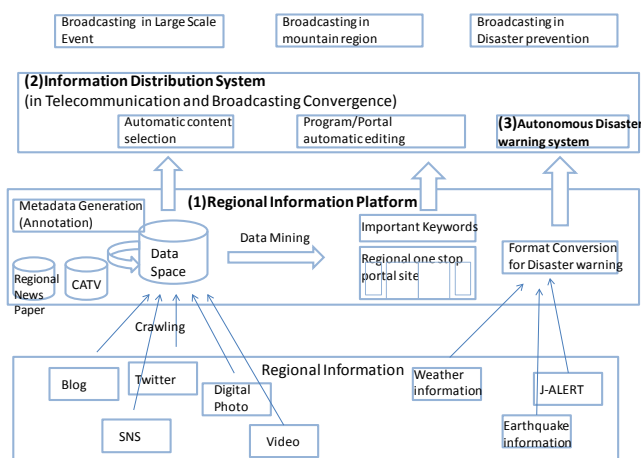
Figure 2. System configuration.

1) Workshop on the Effective Usage of Social Media

As depicted in Figure 3, workshops regarding portal sites and the effective use of social media will be held. Aimed at key individuals (from volunteer guide organizations and different tourism associations, tourism officials, and executive committees for special events) who are (or wish to be) involved in social media such as blogs, these workshops are intended to advance the utilization of such media.
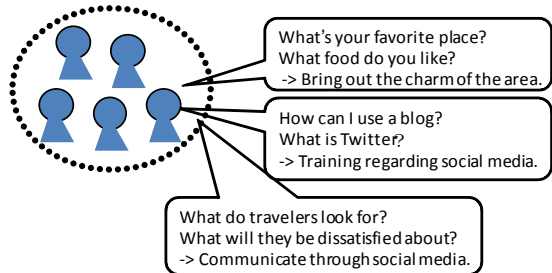
Figure 3. Social media workshop.

2) Construction of a Landing-Type Tourism Portal Site that Utilizes Social Media

a) Construction of a Functional Navigation Site

Using crawler programs employed by search engines, data regarding tourism websites including currently existing tourism organizations, hot spring associations, tourism project officials, and executive committees for special events will be collected. As shown in Figure 4, data from websites related to the Suwa Region will be imported, and using a clustering function, sorted by place, time (season),

keyword, target consumers, and so on. Displayed as a navigation site, these data will provide comprehensive information as a one-stop service for those planning trips.
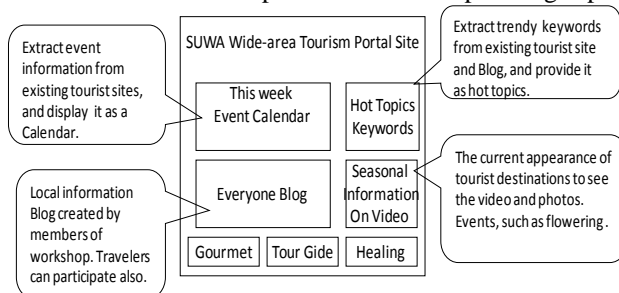
Figure 4. One-stop regional portal site.

b) Information Exchange for Volunteers and Tourists and Participation through Social Media, and System Structure

In addition, the website will include social media information from volunteer guides and others, created at the workshops discussed in 1) above.

Seasonal or rare events will be displayed on the main screen, and using mining functions such as the clustering described above. Analysis will be performed on customers (like what kinds of events certain customers are likely to participate in), and top-selling tourism commodities and so on. And also the cultivation of customers and information providers (the satisfaction level of customers and information providers, determining what is unsatisfactory for each, and raising their awareness of one another) will be performed. However, so as not to depend too much on mining technology, mined information will be used as a starting point to deepen the understanding and awareness between volunteer guides/tourism officials and tourists.

B. Construction of an Information Distribution System using Broadcast and Telecommunication Units (corresponding to (2) in Figure 2)

1) Incorporating Market Needs into Broadcasts

Through the use of data feature extraction (mining), for each time and place, the degree of interest and popularity can be extracted, and the program organization can be dynamically changed to match the users' interests. Also, through content selection (automatic annotation) technology, the necessary content can be searched for in an extensive archive and displayed. In this way, the program to be broadcast can be created with less manual intervention.

2) One-Segment Local Services Usability Trial

By experimenting with transmission of one-segment local services to 500,000 users, the usability of this type of product can be confirmed.

At the trailhead of the Yatsugatake Mountains, information about aspects such as weather conditions, changing leaves, snowfall, lodgings, transportation (buses, etc.) will be transmitted. This will confirm the quality of the radio reception and the effectiveness of the one-segment local service.

C. Development of an Autonomous Disaster Prevention System (corresponding to (3) in Figure 2)

1) Sharing of Local Area Disaster Prevention Information and Conversion Technology for Sharing Information

A disaster prevention information system will be developed as part of the regional information platform. Through the use of data mining and automatic annotation functions, this can be used to detect early disaster information in a timely manner and assist in evacuation guidance. Functionality to convert information regarding aspects such as weather, disaster prevention, and emergencies into a consolidated format will also be developed.

2) Emergency Information Transmission System

It is vital that residents in local areas become familiar with emergency information such as J-ALERT(The civil protection warning system in Japan) without delay. It is necessary to develop the automated technology that can transmit such information in real time. With linked together with various forms of media (networks, cable television, one-segment local services, and so on), the information transmission can be carried out in the most suitable manner.
For example, it is possible to make prompt reports using text superimposed over a television program that is being telecasted, and at the same time setting up a data broadcast using Broadcast Markup Language (BML) to report information on evacuation areas, and so on. Under these circumstances, any delay in sending such information is unacceptable, so it is necessary to generate and send such information from the regional information platform in as automated a way as possible.

V. TRANSMISSION EXPERIMENT AT LAKE SUWA FIREWORKS SHOW

Transmission using one-segment local services at large-scale events is one of the focus areas of this research. As such, a transmission experiment was carried out on August 15, 2012, at the Lake Suwa fireworks show.

On the day, the weather was mostly pleasant. Including the surrounding areas, 500,000 people participated in the event, with 40,000 fireworks being set off. As visitors who have come to see the fireworks tend to arrive in the early afternoon to secure good seats and have time to spare before the fireworks show begins, a survey was conducted between noon and 5 pm (before the fireworks show began).

A. One-Segment Local Broadcasting System

The upper portion of the diagram in Figure 5 shows the broadcasting system, which is in the media center in the main office. At this media center, archived videos of tourist information that had previously been collected and recorded, as well as live video captured on the spot, are encoded in real time using H.264, which is the video coding standard for one-segment local services. BML editing for the data broadcasting portion is also performed. Video information and data broadcasts, as well as schedule information, are

then sent to a remote broadcasting location over the Internet following IP (Internet Protocol) conversion.
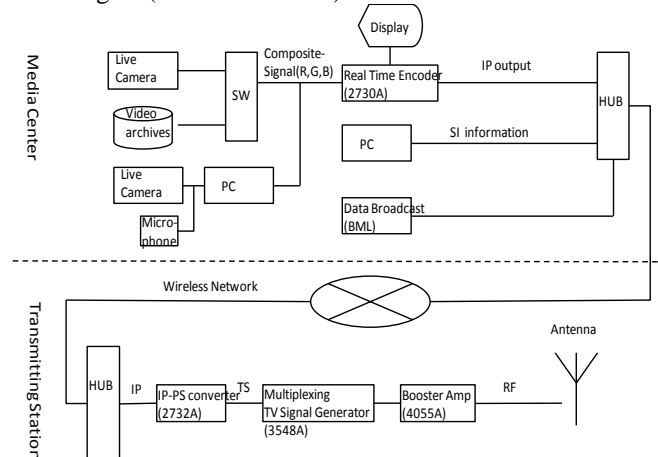
Figure 5. One-segment local broadcasting system.

Shown in the lower portion of Figure 5 is the system structure, which is in a broadcast location set up on the rooftop of a hotel. Here, after a TS (Transmission Stream) conversion of the video-type and broadcast-type data that have been received, the data are multiplexed and converted into a signal for program broadcast. They are then sent to an antenna and broadcast by orthogonal frequency division multiplexing.

Figure 6 shows the reception range of the signal, which was sent at 30mw for a full-segment and 2.3mw for a one-segment. The reception range covered an area with a maximum linear distance of approximately 500m from the antenna, although obstructions such as buildings within the range caused a deterioration in the reception conditions.

Figure 6. Broadcast service area.

B. Broadcast Program

The program that was broadcast is described below.
Followings are the program which was broadcasted at the Lake Suwa fireworks show.

Archived Video Content (basic content) compiled into a 15-minute broadcast:
- Welcome to the Suwa fireworks show
- Welcome message from the Mayor
- Fireworks photo digest

- How to enjoy the fireworks show
- Oguchi Enka (fireworks company)
- 1seg and lost child information
- Twitter
- Suwa area navigation information

Special Content compiled into a one-hour broadcast:
- Introduction to Suwa city by the Mayor
- Suwa city tourism

Live Content introduced by a master of ceremonies (MC):
- Fireworks show
- Information on congestion
- Toilet information
- Parking information
- Tourism information
- Explanation of Twitter and Facebook
- Address by the Mayor to open the show
- Fireworks stream

Live Content (output automatically by a PC):
- Clock detailing congestion times
  (during of the actual fireworks)
- Fireworks program and participating companies
- Messages for the fireworks
- Twitter content

Only lost child information was transmitted as Data broadcast content with using BML. This was because BML, the content language used for data broadcasting, was found to be too complicated to author content in timely fashion.

For example, in order to transmit Parking information, comparing to BML authoring, it was easier to create a PowerPoint presentation and transmit Power point Screen image. Therefore all the information except lost child information were transmitted as a screen image.

Figure 7. Display of the program on a Smartphone.

Figure 7 shows how the program is displayed on an actual Smartphone. In this example, the image in the upper portion of the display is the program promoting a tourism location in the local area. The text in the bottom portion of the display pertains to lost child information. When a lost child is reported, his/her name, age, and description are displayed.

C. Questionnaire Results and Observations

Prior to the start of the fireworks show, five university students carried out an interview-style survey.

As the survey also included an explanation of one-segment local services, the survey took about 20 minutes per person. Although fewer surveys were performed than anticipated, 71 completed questionnaires were collected from visitors. Figure 8 shows what kind of information visitors want. And it is evaluated on a scale from 1 to 5 (1 denotes the lowest score, while 5 denotes the highest).
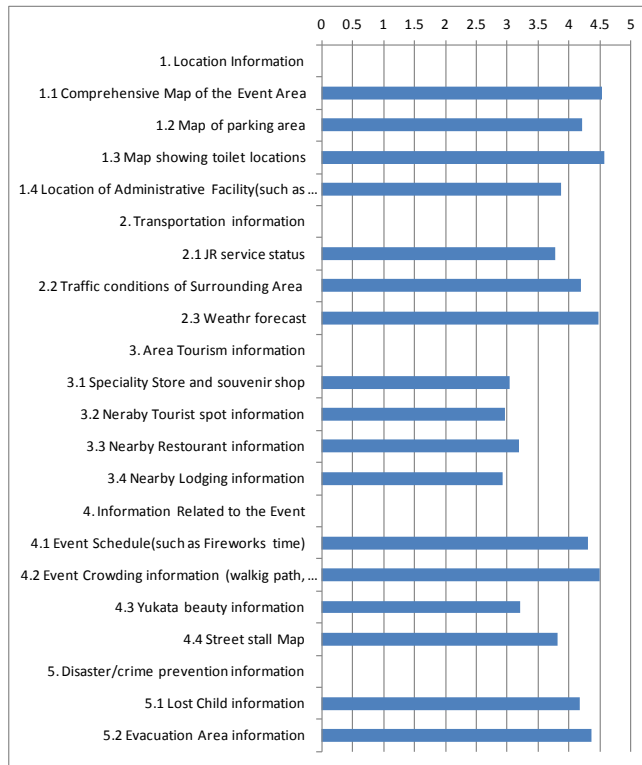
Figure 8. Evaluation of each item in the survey.

The top-ranked items were as follows: maps showing toilet locations (4.57), comprehensive map of the event area (4.53), event crowding information (4.49), and evacuation area information (4.37). It seems that visitors want a comprehensive view of the event area and would like information about their current location. It is also clear that they desire information on when toilets are expected to be overcrowded and on congestion.

The lowest-scoring items were nearby lodging information (2.93), nearby tourist spot information (2.96), and descriptions of souvenirs from nearby shops (3.04). A likely reason for this is that, as the majority of people attending the fireworks show were on day-trips. They were more interested in receiving real-time information about the fireworks show itself than about the surrounding area.

Figure 9 displays the average scores for each information category. According to this data, those attending the fireworks show were not particularly interested in tourism information about the surrounding area. However, location information related to the user's actual position within the area, as well as disaster and crime prevention information, attracted a high level of interest.

Figure 9. Average scores per category.

Finally, the question "Is the one-segment local service useful?" returned a score of 4.03. This confirms that visitors feel that this service is useful, but that it needs to be improved to be able to present the information that visitors want.

VI. CONCLUSION AND FUTURE WORK

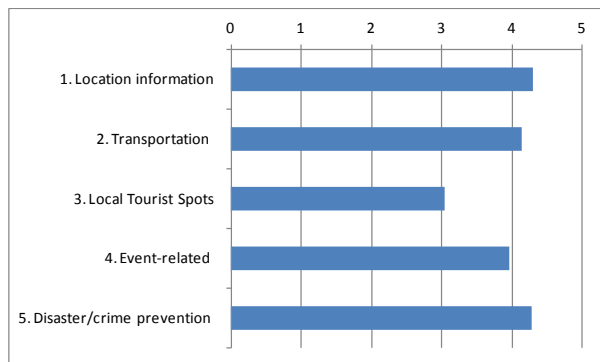In this study, we set up an experimental one-segment local transmission system (one of the themes of this research) and used it as a demonstration experiment at a large-scale event.

Based on the survey responses by visitors at the fireworks show, there is little interest in tourism information about the surrounding area. However, it seems that location information related to the user's position within the area, as well as disaster and crime prevention information are of high interest. This means that an optimal system should have broadcasts containing event area maps and real-time congestion information, in addition to a feature whereby the user can locate places relative to his/her location using a GPS. In particular, it would be desirable to be able to locate the nearest toilet or food/drink vendor. Also, as a form of disaster/crime prevention, there is a high demand for knowledge of the nearest exit in the event of an emergency, or the location of evacuation areas if a disaster were to strike.

Important lessons obtained in this experiment is that visitors felt that the one-segment local broadcast service was useful but that it should be improved to be able to present the information visitors want. These lessons gave us the several ideas regarding what kind of features to be developed in a regional information platform to fill the user's requirement. Especially, in terms of the promotion of tourism, it was found that it is necessary to push the local tourist information and event information to be involved with it.

During this one-segment local service transmission experiment, we found that creating programs for data broadcasts was complicated. The process involved taking BML files created with BML authoring tools, which are specialized and have professional specifications, and then performing a TS conversion on each before transmission. If there was a way to take content that has been entered and display it through broadcasts without carrying out the long-winded process, anyone would be able to use such technology.

It is also necessary to consider an optimal linking method for broadcast and telecommunication units.

At the time of the experiment, the regional information platform was not yet implemented, and so keyword detection technology through data mining was not available. However, the undeveloped parts of the system will be developed before the next transmission experiment is carried out.

By developing regional information platforms and one-segment local service broadcasting systems, we hope to facilitate the initiation of one-segment local broadcast services in many areas.

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Mapping Features of Smartphone on Consumer Behavior Model toward O2O2O

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Abstract—The smartphone has become a popular choice among mobile phones all over the world. Smartphones can provide more advanced services than feature phones can. They have also changed the way users perform information search and distribution. Consumers can access information and enterprises can distribute information via the Internet with smartphones anytime and anywhere. Thus, the spread of smartphones has caused revolutionary changes in consumer behavior and in enterprises' approach to consumers. Therefore, we have analyzed such changes based on actual services using smartphones and have systematized smartphone features with traditional consumer behavior theories. The mapping proposes a vision of what services using smartphones should be from the viewpoint of consumers.

Keywords-O2O; GPS; NFC; AR

I. Introduction

A smartphone is a mobile phone that offers an advanced operating system and compares favorably with a laptop computer. Modern smartphones have various functions; e.g., media player, digital camera, global positioning system (GPS) navigation unit, near field communication (NFC), and touch screen. The most important feature to be noted is a smartphone's ability to can display standard web pages as well as mobile-optimized sites. People can easily obtain information they are looking for via the Internet using a smartphone anywhere they go [9]. Therefore, users' behavior, especially in transactions, has changed drastically with the use of these devices [7].

A consumer can compare prices of a product in a real store using a smartphone. A consumer can also search the route map from the current location to the store which sells the product at the lowest price. On the other side of the commercial transaction, an enterprise can send advertising to a consumer according to his/her location. For instance, when a store holds a sale event, it can broadcast an advertisement announcing the event to the smartphones of consumers in proximity of the store. Thus, consumer behavior is changing through functions of smartphones.

Due to these changes, enterprises' approaches to consumers are also changing. Enterprises are trying to lead consumers to real stores to make purchases in their stores through various online services over the Internet using smartphones. One such service is called Online to Offline (O2O). O2O2O also denotes that consumers go back and forth between online and offline status.

It is not a premise that O2O is implemented by the use of smartphones. However, most O2O services are implemented through functions of a smartphone. The spread of smartphone use has triggered the expansion of O2O businesses. It has also broken down the borders between the real world and the Internet. The approach of consumers using smartphones is becoming more important for enterprises. Enterprises are being pressured to respond to changes in consumer behavior. That is, they must provide attractive and novel services using smartphones after obtaining understanding of modern consumer behavior.

Many studies and models of online consumer behavior have been performed [3][6][8]; however, there are no studies of consumer behavior of O2O-specialized smartphone features. Therefore, we attempt to examine the features/services of smartphones within the consumer behavior model. First, we have surveyed actual services using smartphones and analyzed changes in consumer behavior and the response from enterprises. Based on this survey, we have related the features to elements of the consumer behavior model and made a map of the relationships found. This map can help enterprises to capture with certainty a consumer's motivations within the O2O generation.

II. The Features of Smartphones

We herein enumerate and explain the major features of smartphones. Modern smartphones have the following devices in addition to telephone, e-mail, and Internet browsing.

NFC is a form of contactless communication between devices. Contactless communication enables a user to wave his or her smartphone over a NFC-compatible device to send information without physical contact between the devices or going through multiple steps to set up a connection. NFC is a set of short-range wireless technologies, typically requiring a distance of 1.6 inches or less. NFC-enabled devices can be used in contactless payment systems, similar to those currently used in credit cards and electronic money smartcards, and enable mobile payment to replace or supplement these systems.

Table I

THE MAP AMONG ELEMENTS OF THE CONSUMER BEHAVIOR MODEL, PURCHASING PROCESSES, AND SMARTPHONE FEATURES

Consumer behavior	Purchasing process	Smartphone services/applications	Smartphone features
Attention	Information contact	Market research/data analytics	All
Interest		Digital commerce	All
Desire			
Memory		Web browsing	App
Action	Funds access	Payments	NFC, App
	Store selection	Rewards/CLO (Card linked offers)	NFC, App
		Customer loyalty	All
		Digital coupons	All
	Store contact	In-store marketing	NFC, App
	Product contact	Bar code scanners	Camera
		Digital coupons	NFC
	Transaction	Payments	NFC, App
		Point of sale	NFC, App
		eReceipts	App
	Consumption and disposition	—	—
	Communication	Social media	App

GPS is one of the more frequently overlooked enhancements in consumer technology. GPS on smartphones is no longer an emerging trend; it's almost a must-have feature today, and more and more handsets offer it. With the embedded GPS receiver and a mapping service, we can get real-time position tracking, graphic-guided directions, and points of interest.

Most smartphones have a digital camera function that can capture both still photographs and video. Today, the technology on new smartphones has leapt forward enormously with better quality lenses, shooting modes, zoom functions, and even image enhancement built right in. There are many epoch-making applications with the camera; e.g., bar code scanner and Augmented Reality (AR). The bar code scanner application using the smartphone's camera can capture the UPC or EAN bar code on a product in any store. The user then relies on the application to search the Internet for reviews of the product, places to buy, and the best pricing available.

AR is a live, direct or indirect, view of a physical, real-world environment whose elements are augmented by computer-generated sensory input such as sound, video, graphics, or GPS data. For instance, Google Sky Map will appeal to stargazers and astronomers of all skill levels. The user simply points his or her phone at the sky and identifies a legion of constellations, stars, and planets. Upon moving the camera around, the information will change in accordance with the coordinates. AR can be used to display certain products in many other ways.

III. RELATIONSHIPS BETWEEN SMARTPHONE FEATURES AND CONSUMER BEHAVIOR

The consumer takes control of his or her in-store shopping experience through the use of smartphone applications.

Consumers are using these features to access highly targeted offers, decide when and where to shop, compare product pricing and features, and even make purchases.

Many consumer behavior models can be applied for the Internet, ubiquitous, and mobile society. However, the consumer behavior in the O2O generation can be explained using traditional (offline behavior) theories, because the purpose of O2O is making a consumer purchase within a physical store in the end. O2O does not make a clear distinction between online behavior and offline behavior. Thus, we systematize the major features and services of a smartphone using the AIDMA model [5] and the purchasing model of overt consumer behavior [2].

The 13 O2O key technologies have been listed by Gridley & Company LLC as follows [4]:

1) Market Research/Data Analytics
2) Payments
3) Point of Sale (POS)
4) In-Store Marketing
5) Integrated Systems
6) Bar Code Scanners
7) Digital Coupons
8) Rewards/CLO (Card Linked Offers)
9) Customer Loyalty
10) Traditional Coupons
11) Account Marketing
12) Digital Commerce
13) eReceipts

For the purposes of mapping, we have used only the technologies relevant to smartphone use. Table I shows the map of the relationships of O2O technologies with features of

smartphones and elements of consumer behavior.

The first step of the purchasing process, information contact, demonstrates the importance of shops and products publicizing themselves or making themselves known to the market. Consumers search information via the Internet using smartphones, and retailers provide applications focused on digital commerce and Internet marketing. In the second element, funds access, retailers provide various means of payment; e.g., e-money by NFC and applications for online payment with credit cards. In the third aspect, store selection, stores have to make themselves attractive in order to be selected, using such methods as online-distributed digital coupons, loyalty programs, and services of CLO (Card-Linked Offers).

In the fourth aspect, store contact, retailers can push their recommended information to the smartphones of consumers as a form of in-store marketing. The fifth step, product contact, involves consumers weighing the benefits of buying a product from one store against another store through web browsing or applications using bar code scanners. Consumers also seek lower prices and discount services, like in-store-distributed digital coupons by NFC.

In the sixth step, transaction, retailers focus on providing convenient payment methods. Moreover, retailers should develop the appropriate infrastructure, not only for collecting and processing payments, but also for storing customer payment information (e.g., customer's purchase history, POS data) to ensure pleasant shopping and the assortment of products. In the seventh and eighth steps, customers review products, thus providing valuable information for other shoppers. Customer reviews through avenues like social media are considered the most effective way of mobilizing consumers to "talk up" products online.

IV. DISCUSSION

As mentioned above, the O2O consumer behavior can be mapped with the features and services of smartphones. We have validated the map by the case study of actual smartphone services. For example, the map explains consumer behavior with a smartphone application AisleBuyer [1]. This application offers convenient in-store shopping with the use of the bar code scanner. With AisleBuyer, retailers enable consumers quickly and easily to access detailed product information and instantly make a purchase without waiting in line, all while standing in the store using a smartphone. By scanning product bar codes or browsing the store's product catalog, shoppers can instantly find the information they need to make the best purchasing decisions, resulting in a higher conversion rate and deeper customer satisfaction. AisleBuyer enables shoppers to skip checkout lines or even self-serve checkouts by paying with their credit card directly on their smartphones. Consumers can also search nearby member stores of AisleBuyer and access information about
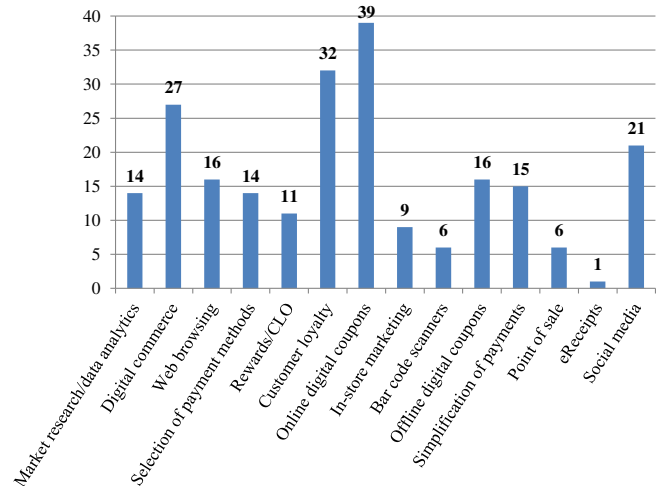

Figure 1.   The number of O2O cases using each smartphone application

their products with GPS. This application faithfully traces the process of the map.

Moreover, we have surveyed 73 cases of O2O with smartphones and gathered the statistics of the features on the map. Figure 1 shows the number of the cases using the smartphone services/applications on the map. In the graph, the online digital coupon is the most frequent service used by enterprises to activate the O2O actions of consumers. The majority of the enterprises have distributed online digital coupons (in the Internet) to potential offline customers (in the real store) via smartphones. This fact also backs up that store selection is the most important step in the purchasing process for O2O.

In contrast, the in-store services with smartphones after store selection have currently not been popular. The enterprises are quite free from care when potential customers come to the real store. However, in the near future, they will have to provide these in-store services in order to differentiate among the competing stores when O2O spread in a larger scale and removes the distinction between the real store and the Internet shopping site. To aim the real O2O, retailers should give customers incentives for visiting real stores. Moreover, the data which is gathered in the O2O process is not effectively used for marketing at the moment (see the bars of Market research/data analytics and Point of sale in Figure 1). The features of smartphones (e.g., GPS, NFC) in addition to the usual Internet technologies enable sellers to grasp detailed movement of customers both in online and in offline (e.g., the flow/traffic line or the behavior pattern of purchasers). Enterprises should utilize such "big data" which is obtained in the O2O process for the further O2O activities. This cycle can be an iterative management method used in business for the continuous improvement of the O2O processes. It follows from what has been said that eReceipts will be the particularly key service.

Figure 2. The virtual store of Tesco in the South Korea subway platform

V. CONCLUDING REMARKS

In this paper, we have proposed a consumer behavior model related to the use of smartphone features. Moreover, we have surveyed 73 cases of O2O and discussed the actual situation of O2O and the proposals for the future. The spread of smartphone use has changed consumer behavior and implemented practical O2O services. In order to achieve success, each enterprise must develop and provide a novel service according to purpose they aim to fulfill. For example, if improving name recognition is one company's purpose, the enterprise has only to develop an application focusing on offering users its contact information through GPS. Thus, the map supports changes in how retailers should behave during the O2O generation. Furthermore, enterprises can plan an unerring O2O strategy leading to O2O2O through consumers' smartphone use based on the map.

The ultimate goal of O2O2O is to establish competitive advantage. Nowadays retailers consider O2O2O services as advanced marketing strategies and aim to expand range of customers and business spheres by them. For example, the major British supermarket chain Tesco opened virtual stores in the South Korea subway platform (Figure 2). Tesco, as compared with the other supermarkets, is inferior in the number of the real stores, however, Tesco succeeds in an exploitative monopoly lock on commuters to provide novel customer experience of shopping with this service. We believe that the map help enterprises to create such innovative services with smartphones and their dissemination.

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Towards an Effective Distribution of Subsidized Food Using Mobile-based e-Government Solution

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Abstract —**Traditional means for the distribution of subsidized commodities suffer from many shortcomings such as unfair distribution, lengthy distribution process with many leakage opportunities along the way. This paper presents a mobile based solution as an emerging direction in e-Government to tackle this problem. The proposed solution provides transparency, visibility, and control over the distribution process. The solution and its operational process introduce a better mechanism for subsidies distributions. This mechanism improves the effectiveness and efficiency of the distribution process, and ensures high usability. Thus, the needs and competencies of the beneficiaries of the subsidies distribution system are met. The solution also improves the delivery of such an important government service to benefit citizens. Analysis, design, and implementation of such a solution are introduced too.**

Keywords - Mobile wallets; Subsidy distribution systems; Layered Architecture; Design using UML.

I. INTRODUCTION

Governments, everywhere, provide consumption subsidies in a number of ways: by providing use of government assets, property, or services at lower than the cost of provision, or by providing economic incentives to purchase or use such goods [1].

In Egypt, traditional means for the distribution of food subsidies suffer from many shortcomings such as: unfair distribution of goods, and lengthy distribution process with many leakage opportunities along the way. One of the conclusions in a recent report published by the World Bank [2] was "*If leakages are eliminated and coverage is narrowed, the government of Egypt could save up to 73 percent of the cost of food subsidies*".

Consequently, better mechanisms for subsidies distributions are needed in order to improve the effectiveness and efficiency of the distribution process and enhance the delivery of such a government service to beneficiary citizens.

The growing rate of subsidies beneficiary population in Egypt has made the development of a fair and efficient subsidies distribution system a real challenge [3]. Moreover, a major sector in the beneficiary population suffers from technology-illiteracy that renders some of the current technological solutions for subsidies management, e.g., smart cards inadequate to scale-up to the magnitude of the problem. Some of these inadequacies are reported in [4]

Currently two subsidy distribution systems are in place. In the first system (an old paper based) a family eligible for subsidized food is given a paper based registry book that carries the family and the monthly ration information. Food is distributed through merchants who are registered with the subsidizing entity to provide this service. A family must choose and register in its registry book one of those merchants based on geographic location.

Each registered merchant has a paper-registry that holds ration information for each family registered with her/him. At the beginning of each month the merchant receives amounts of food for registered families from the subsidizing entity. Families do not have to buy their full rations. At the end of the month cycle, the merchant provides the subsidizing entity with a report containing the amounts of distributed food and the collected money, in return of some percentage as a profit. Amounts of food for the new month are also replenished.

The paper-based system suffers greatly from embezzlement. Merchants may falsely claim larger amounts of food being distributed. This occurs when consumers do not claim their monthly rations and the merchants forge their signatures in the registry. This may also occur through an agreement between the merchant and the eligible family in which case the merchant pays a very low amount of money to this family in exchange of its entire ration.

In the second subsidy distribution system which is currently being deployed after an initial success in pilot regions, each eligible family is issued a smart card containing family and ration information. Each merchant is provided with a Point Of Sale device (POS) and a merchant smart card that contains the merchant ID, the list of families registered with this merchant and the transactions performed for those families. When a consumer acquires a ration, the POS reads both the cards of the merchant and the consumer, and registers the amount of food that the family has acquired on both cards. The rest of the process is similar to that of the paper based except the level of automation introduced. For details please refer to [4].

A. Shortcomings of the Current Subsidy Model

In specific, the current subsidizing models suffer in general from the following main limitations [2] – [4]:

1) The subsidizing entity is isolated from the control of the distribution activity. This isolation leaves the door wide open for corrupted merchants to sell the subsidized goods in the black market.

2) The distribution process is a chain with the subsidizing entity at one end and the target consumers at the other. Along this chain, leakage of subsidized commodities to black market may occur instead of going to eligible consumers.

3) The subsidizing system is complex to be used by various stakeholders. This complexity reflects on the usability of the system by the subsidizing entity as well as the consumer.

4) It is impossible to effectively and efficiently track and report accurate data regarding the current status of the

subsidized commodities. This reduces the effectiveness of the distribution process, and leaves the subsidizing entity with uncertainty to plan future demand and capacity.

Even with the introduction of the smart card based solution there are still many shortcommings. Connectivity is a main limitation that hinders the application of the system as planned. Because of this limitation, many of the sites are working offline which left the door open for leakage resulting from the possible manipulation of the ration information. Frequent power outage in some areas is another limitation that interrupts the service. Consumers are still tied to a specific merchant; moreover they cannot do multiple transactions during the same month to acquire parts of their ration. The system also does not carry unused balance forward to the next month.

B. Mobile Technology Renders itself as a Solution

In the meantime, mobile technologies have deeply penetrated into the typical life-style of the Egyptian culture at its all population sectors and levels. According to the *ICT indicators in brief* [5], mobile penetration reached around 92% of the population with 27% increase from the year before. This means that mobile based approaches to tackle this problem will have ground success factors.

In this paper, we present a solution based on mobile technologies to tackle the subsidies distribution in Egypt, and for any developing country in general. Accordingly, the main purpose of our solution is to design, develop, and implement a prototype to demonstrate an innovative solution for the subsidies distribution problem using simple and popular mobile phones.

Despite the fact that Smart Mobile Phones gained rapid adoption among mainstream consumer segments across markets [6], we chose to design and implement our system, so that any java-enabled mobile device is sufficient to use the system.

C. Our Solution

Our solution is a type of Mobile government (m-government), which may be defined as [7] "*a strategy and its implementation involving the utilization of all kinds of wireless and mobile technology, services, applications, and devices for improving benefits to the parties involved in e-government including citizens, businesses, and all government units*"

The solution provides the software along with the enabling connectivity to avail the following functions.

1) Enable consumers to acquire and obtain their subsidized rations in smooth way using a mobile device regardless of the device's sophistication (first generation mobile will suffice)

2) Enable Merchants to distribute rations to beneficiaries and have visibility on their accounts using our. This solutin hosts domain software and can be interfaced to variety of terminals (and possibly systems) such as Smart Cards, Mobile devices, and Back-end database server/servers.

3) Enable the subsidizing entity to establish, manage, and control subsidy elements including items, merchants, and

consumers, and be able to align these elements based on indicators provided by the system.

This solution intends to transform the entire subsidy distribution process into a technology assisted that is usable by end beneficiaries with minimum investment.

The rest of the paper is organized as follows: In Section 2, we discuss the main requirements that govern the solution starting from a high level usage scenario that shows the main concept of the solution along with the use case modeling of these requirements. The solution architecture with its different views is given in Section 3. Section 4 is dedicated to detailed design summary. Section 5 presents some related design and implementation issues. Section 6 is a discussion that highlights the current status of the solution. We conclude in Section 7.

II. SOLUTION KEY REQUIREMENTS

In this section, we present the key requirements of the solution. We start by introducing a high level usage scenario that abstracts the main idea of the system and is used to derive the system major requirements. We follow by presenting the key system requirements and constraints. Functional requirements of the system modeled as use cases are discussed next.

A. Basic Usage Scenario

To have some high level idea of how the system will support the subsidy distribution process and lay the ground for comprehending the technical discussion that follows, we briefly describe a usage scenario of our solution when it is up and running. In this scenario, we assume that a consumer has her/his own mobile device and is willing to have her/his ration (typically monthly) from a merchant who is previously registered with the system. The consumer has also been registered with the system as well as his monthly quota is known. The scenario takes the following steps, which are also shown on Figure 1 below:

1) The consumer sends her/his id code, merchant code, and choices to the central system.

2) The system verifies the consumer's and the merchant's codes, and balance availability

3) The system sends a transaction number to the consumer and to the merchant

4) Both consumer and merchant should approve the transaction in order for the system to commit the transaction

Fig. 1 shows the common case in which we assume that all consumers have their own mobile devices to post her/his ration request. Our solution takes into consideration a less common case where the consumer does not own a mobile. In this latter case, the consumer may use the merchant mobile device for the same purpose (of course with a secret PIN).

A variation of the device used in executing the scenario is also possible. One possibility is the use of Near Field Communication (NFC) enabled mobile phones [8]. The merchant can also use a PC with a USB mobile modem, a point of sale or his mobile phone. There is still the possibility to use a mobile point of sale, too. We again affirm that any java-enabled mobile device is sufficient to use the system.

B.   Reqirements Collection and Constraints

Our approach of collecting user requirements adopted a User Centered Design methodology [9] and has sought to understand user needs from the users directly through observation and user interviews. This user data gathering has focused on the usage of existing (smart card based) and the prior (paper based) systems, and their perception of the important requirements of any future systems. This information has then been used to determine the basic requirements and even assisted in designing an interface proposal for our solution.
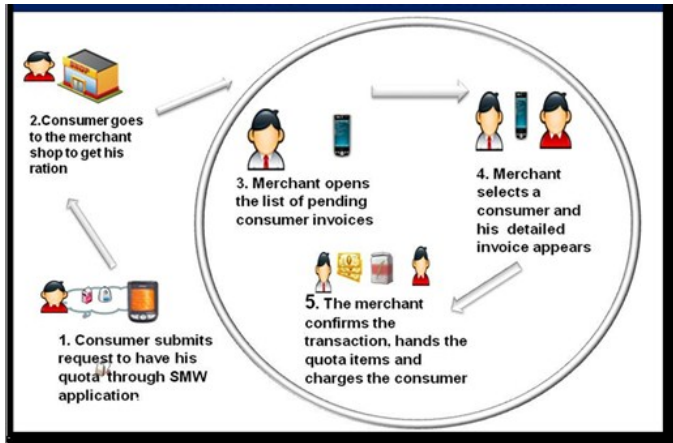

Figure 1. Basic Usage Scenario.

To understand existing systems and collect the new system requirements w have conducted two major studies. We also benefited from studies done by other researchers in the same respect [3]. The focus of our first study was on the subsidy problem in Egypt with the objective of understanding the main challenges that preclude the implementation of effective and efficient subsidy systems. In addition, the study explored current technological solutions developed to cope with these challenges. The outcome of this study was a comprehensive subsidy study report that exposed many of the proposed system requirements.

Our second study was a large ergonomic study which is concerned with the problems and requirements from a user perspective. In order to understand the user perspective, the work has focused on two classes of user (merchants and consumers). Four regions have been selected that are characterized as having users of varied experience.

One main determining factor which governs our solution is minimizing potential sources of corruption and maximizing the added value for users. A set of basic functional and non-functional requirements [10] must be met that represents the heart of the system. We may view some of these requirements as constraints or assumptions in some sense as given by the following sample. We present functional requirements as use cases (to follow shortly):

1)   *System must be mobile-based*

2)   *Traditional Mobile devices must suffice to interact with the system at least for consumers.*

3)   *A consumer can request all or part of his quota.* This is very different from limitations imposed by the existing system

(or the system before) where a consumer is required to request all items of his monthly quota.

4)   *A consumer can request quota from any merchant.* This is also very different from limitations imposed by the existing system (or the system before) where a consumer is registered with and tied to one specific merchant.

5)   *Consumers own java enabled Mobile to run simple application (or otherwise she/he may use the merchant mobile device)*

6)   *Merchant owns java enabled Mobile to run simple application.*

7)   *Merchant has some IT skills to run a mobile application*

8)   *Customer can respond to simple confirmation messages, and can reply with his pin code.*

In addition to the above basic scenario and the set of constraints/assumptions that represent very basic mandatory requirements, the following section provides discussion about the functional services expressed as a set of the UML use cases [11], [12]. This set of use cases concretizes the basic scenario, and lists the basic services to be provided by the solution. These services achieve the goals of the three main actors of the system: the Consumer, Merchant, and the subsidizing entity; mainly the government in our case. If the system can deliver the services that achieve goals of its actors, then such a system to a large extent meets the functional requirements of the system. Summarization of these services is given in the next section in the form of the system use cases.

C.   Use Case Model

As a whole the system comprises twenty three main use cases and three main actors. Use cases included cover the main functionalities (services) to be provided by the solution to its actors. These use cases are grouped functionally as follows:

1)   *Consumer use cases:* Use Cases that serve consumers.

2)   *Merchant use cases:* Use Cases that serve Merchants.

3)   *The Subsidizing entity use cases:* Use Cases that serve the *subsidizing entity*.

4)   *Data Maintenance use cases:* Use Cases that provide services to enable building and maintaining the basic data of the system.

5)   *Authentication uses cases:* Use Cases that provide authentication and validation services.

Please notice that a use case can be used by more than one actor. An example of such use cases are those related to authentication. Notice also that Data Maintenance Use Cases are mainly used by the subsidizing entity actor for building and maintaining the basic data of the system.

Three main actors are identified: Consumer, Merchant, and the subsidizing entity. There were suggestions to consider mobile operator as a fourth actor but this suggestion is ruled out at this stage as mobile operator has no clear role within the current scope except passing different interactions between the three main actors. Figure 2 provides a brief description for each of the three actors.

Each use case is described using a simple template including commonly used attributes for use cases. In addition to the use case name and actors, the description includes for each use case, the basic scenario, alternative scenarios (if any), Preconditions and Post conditions.

Figure 3 is an example of the *Lookup Consumer Information* use case description following this template. This use case is available to the subsidizing entity actor.

User Class	Description
Consumers	The target group that benefits from the subsidized goods, they have to be registered in the system in order to be able to use the service.
Merchants	Refers to subscribed merchants that have to be registered in the system in order to be able to distribute goods to customers.
subsidizing entity	Is the entity that owns and runs the system and its database; in our case it is the government but it can be NGOs, food banks or any entity willing to manage the distribution of subsidized goods

Figure 2. System Main Actors.

III. ARCHITECTURAL DESIGN

In this section, we discuss the architectural design of our solution from different views [13]. Views to be discussed here are: the logical, style (pattern), and deployment views.

A. Logical View

The system could be simply viewed as 3 main interacting sub-systems linked by a wireless network. The first subsystem is a very simple application hosted by the consumer mobile device. The second is also a simple application that is hosted by the merchant mobile device (or simple point of sale). Most of the business logic and transactional data are within the back end where the system database resides too. Figure 4 shows this high level logical view of the system.

B. System Architectural Pattern

Our solution architecture adopts the well-known layered architectural pattern (style) to organize the solution into a number of layers [14] – [17]. Layered architecture is chosen in order to ensure flexibility and modularity. Organizing software architecture into layers is a very common architectural style used in various industrial systems [18]. The architecture consists of 5 layers in addition to the user interface layer that we do not have space to cover.

1) Terminal Interface Layer (TIL): This layer handles user inputs from various possible user interfaces (e.g., smart card, desktop terminal, cell phone terminal). This layer also converts user requests into commands that can be processed by the Business Logic Layer (BLL). Finally, this layer is also responsible for appropriately formatting the output for display on various possible channels. In the current design, two presentation layers do exist. The first layer resides within thin clients running normal web browser for subsidy control at subsidizing entity side. The second presentation layer is

implemented with java to run on merchant and consumer mobile phones.

2) Business Logic Layer (BLL): This layer has the following responsibilities:

a) Processes the business logic commands passed from the TIL layer and composes security requests that will be passed to the Security Layer (SL).

b) Interprets the server responses for the TIL layer.

c) Provides support for application specific business processes and the enforcement of business and data integrity rules.

Lookup Consumer Information
Actor
3rd Party
Basic Flow of Events
1. The actor enters ID of the Consumer he/she wants to look up and click Search.   2. The system retrieves the Consumer information from the database   3. The system displays the information   4. The system allows the actor to print out the report.
Alternative Flows
1. If the Actor wants to see the reports for all the consumers in the database, he/she does not fill in the ID of the Consumer and clicks Search.   2. The system displays the information about all Consumers.   3. The system allows the actor to filter data by location, status,…etc.   4. The system allows the actor to print out the report.
Preconditions
1. actor is logged on to the system   2. actor is authorized to record new consumer   3. Consumer already exists in the database
Post conditions
A report of information about a particular Consumer is displayed /printed.

Figure 3. Lookup Consumer Information Use Case.

3) Translation Layer (TL): This layer is responsible of converting the high level commands which are created in the presentation and business logic layers into a stream of byte arrays to be sent to the communication layer.

4) Security Layer (SL): This layer performs the basic security operations needed in order to keep all commands and their associated data secure. This layer performs encryption/decryption operations, and it filters out unauthorized responses.

5) Wireless Communication Interface Layer (WCIL): This layer is responsible for preparing encrypted commands and data passed by the SL for transmission according to a specific data transmission protocol used by the underlying wireless network backbone.
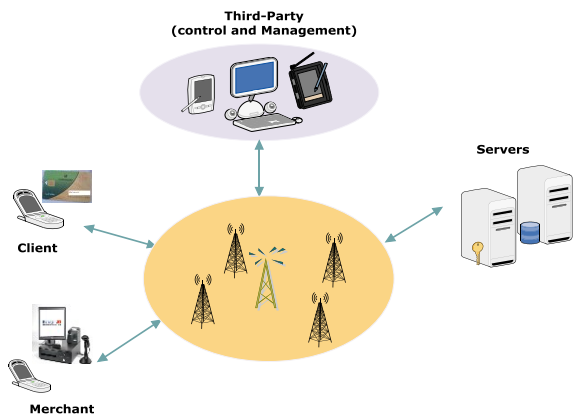

Figure 4. Architecture Logical View.

C. Deployment View

The Deployment View of the solution describes the likely physical network and hardware configurations on which the system will be deployed. This view has been informed by a number of the architecturally significant decisions such as: Centralized Database, Layered Architecture Style, Wireless Network, and Mobile Technology.

The deployment view of the system is represented as UML deployment diagram as shown on Figure 5. Deployment diagrams are large-scale instance diagrams and are important for modeling software architectures in UML [19].

This diagram presents our solution as four UML nodes where each node is connected to the other nodes (mostly) through a wireless network. Each node hosts a subsystem of the solution. The first three subsystems encapsulate the services provided to our principal actors: customer, merchant, and the subsidizing entity.

The fourth subsystem encapsulates the central database that holds subsidy and subsidy-related information along with a large part of the business logic. We may refer to this part as the solution server. Please note that the first and the second nodes abstract mobile devices processing elements that will host software to be used by consumers and merchants. The subsidizing entity may use thin clients or mobile device too.

IV. DETAILED DESIGN SUMMARY

Our solution is designed using the common practiced Object Oriented approach where main system entities are perceived as objects. In this respect the detailed design took the following summarized steps:

1) Elaborate business scenarios into more technical (concrete) scenarios.

2) Reformat use cases identified into a set of business operations that represents the minimum system functional commitments.

3) Elaborate business operations identified in 2 above into design elements.

4) Parallel to steps 1-3, develop the class diagram assisted by other UML models (e.g., Sequence and activity diagrams).

5) Decide on persistence and hence lay out the database design

6) Develop user interface

In this section we discuss some of these detailed design activities. For space limitation we are unable to give full details. Details given here are intended for shedding light on the system as a whole. In subsequent papers we dedicate greater details that encompass these activities.

A. Typical Business Scenario from a Design Perspective

In this design activity we elaborate the main business oriented usage scenario into system-wide technical interaction. Compare the following scenario (from a design perspective) to the business scenario shown on Figure 1.

1) The consumer runs the application from her/his mobile device and connects to the back end.

2) The system prompts the consumer to enter her/his ID and PIN code to login, if it is the first time to use the system, the consumer is directed to a registration form.

3) The consumer's information is validated at the server side.

4) Consumer sends a request asking for her/his monthly ration.

5) The server responds at the Merchant side by sending a list of consumer names who wants their rations.

6) The Merchant selects a consumer from the list to service by sending to the server the consumer and his ration data including consumer ID, quota type, and details of required quota items.

7) The server responds with a summary of the interaction to the consumer that includes the consumer and merchant identities as well as quota details (including items, ration's month and year, and the total to be paid by the consumer).

8) When the consumer commits this information, the database is updated with this finalized transaction.

B. Mapping Key Business Operations into Design Elements

Here, use cases are analyzed and grouped into a set of key business operations (*Command* is the corresponding technical term used later) that the solution is committed to provide. Identified business operations are then mapped into design elements using more than one model. For example:

1) UML Sequence and activity diagrams are employed in order to capture timing and sequencing of the various commands and activities for each system operation.

2) Trigger-Action-Response (TAR) Model which is a low level behavior model used to specify each operation in terms

of: Command Trigger, Server Actions, and Command Response.

Figure 6 depicts a high-level grouping of the key business operations in the proposed design. As shown in the figure, business operations are grouped into four main categorizes:

- User Account Management operations: These operations deal with the registration of the customers and merchants to the system. The operations also cover various activities related to the management of the created account, such as the change of the user PIN.
- Subsidize-Out operations: These operations present the core of the solution. They cover the activity of claiming subsidized items from a merchant. The Subsidize-Out operations include the customer request, merchant approval, and customer approval processes.
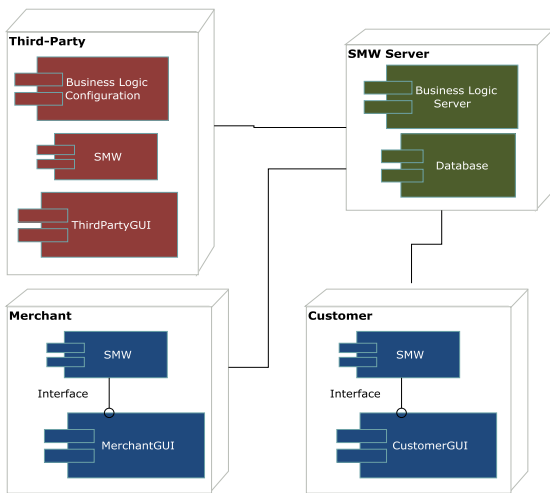

Figure 5. Deployment Diagram.

- Management and Control operations: these operations focus on the activities related to the supply of subsidized items to the merchants and monitoring of the status of these items throughout their life-cycle from their arrival to the merchant until they are claimed by consumers.
- Enquiry-related operations: these operations cover all relevant enquires that are useful for various stakeholders in the system. This includes, for example, operations about enquires related to merchant information, customer available balance, list of customer transactions, etc.

Dealing with each of the leaf business operations as a command, we show on Figure 7 how the command is triggered, and how it climbs up or down the solution layers, and how each layer manipulates the command until its success or failure.

The figure provides an example of how one of the business operations Purchase-Customer request traverses the different solution layers from the moment it is triggered and how it is manipulated along different layers. The role of each layer in processing the command is apparent.

C. Class Diagram

Our class diagram encompasses 2 main categories of classes: business domain classes and utility classes. A major part of the business domain classes are persistent classes too. These include business entity classes such as Items, ration quota, consumer, merchant, and other related classes e.g. organizations, governorates, cities, and subscription. This set of classes forms the core of the system database.

Utility classes span all layers of the system architecture to provide system wide support functionalities. These can further be divided into general utility classes, client interaction classes, and server interaction classes.
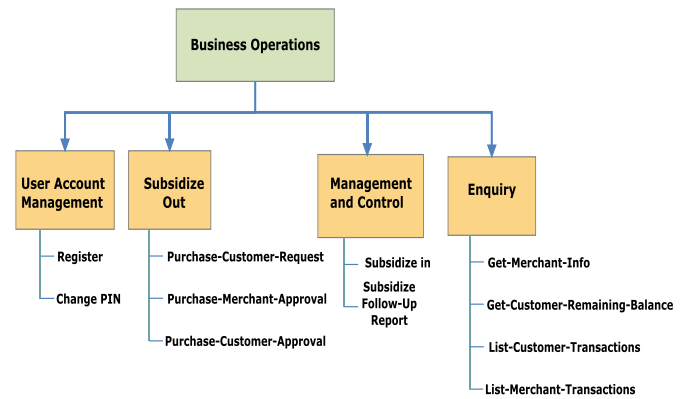

Figure 6. Key Business Operations.

General Utility Classes model abstractions such as user request/response, Translation class (responsible of converting command data into byte array to be sent to the server), and encoding/decoding classes

Client Interaction Classes are a set of other client classes that work just below the user interface classes to initiate a command (service) based on user entry and send the created command to the translation layer, or receive the response of previously sent command and handle errors if found .

Server Interaction Classes represent database wrappers that shield the server database. Any interaction with the back end database is done through this database wrapper.

V. DESIGN AND IMPLEMENTATION ISSUES

In this section we briefly discuss some issues related to both design and implementation of the solution. This discussion sheds some light on our solution specifics and justifies some technical decision we made.

A. Design Issues

Heavy Use of Inheritance: our class diagram is characterized by heavy use of Inheritance mandated by the nature of the solution (in specific the structure of the utility classes). In addition to being a necessity as we perceive it in our case, heavy use of inheritance in our solution agrees with the common Java programming practice [21]; the language we used to implement the solution.

Assigning Responsibility to classes: in finalizing the class diagram starting from the domain model of the problem concepts, we have employed UML Sequence diagrams along with the basic design patterns. This way we could concretize use case (business operation) interactions in a systematic way

and hence assigning responsibilities to different classes. This leads to reduced coupling and increased cohesion of the classes [22]. We also used UML activity diagram to flesh out algorithmic logic for some of the class operations.

Command Triggering

Input from TIL	A customer-purchase command code with parameters: Merchant ID, Item list
BLL Action	Append Mobile phone, Customer PIN and compose the command
Output to SL	A request to encode the composite command

Server Actions

If the submitted data are valid
    Generates a new transaction number
    Store the Transaction information in the transaction database with transaction status marked 'not-confirmed'.
    Send the transaction number to Customer.
    Send the complete transaction information to Merchant
Else
    Send error code to Customer
End if

Customer Response

Input from SL	Server response containing transaction number or error code
BLL Action	Store the purchase transaction number if found, On error, interpret the error code
Output to TIL	Trigger the Transaction-Started event, or Trigger the Transaction-Rejected-Error event

Merchant Response (Conditional)

Input from SL	Decrypted server response containing transaction information
BLL Action	Add the purchase transaction information to the list of pending transactions
Output to TIL	Trigger the Pending-Transaction-List-Updated event

Figure 7. Life Time of the *Purchase-Customer* Command.

B. Implementation Issues

Java is used as the programming language for coding the system. Java provides all we need to implement the solution. Java is also selected for its native support to network communication. As the reader may have noticed, an important part of the system relies on network communication to send commands and receive responses.

For the back end implementation we are employing Oracle products to host data, business logic, and the part of the application used by the subsidizing entity. Oracle database engine (Oracle 10g) hosts the solution persistent data briefly discussed earlier. The database engine also hosts stored procedures and database triggers that implement the core of the business logic. The part of our application that should be used by the subsidizing entity for maintaining the data and extracting indicators is implemented using Oracle development tools too.

VI. DISCUSSION

Our solution has passed through typical phases of development: planning, analysis, design, coding, and testing interleaved in an iterative way as the recent best practices recommend. We can say that what we have today is a prototype that has been demoed to relevant stakeholders and communities. We received many valuable comments and advices. Many of these comments are business oriented and few are technical. Business comments are centered on extending the solution to cover different spans of subsidies such as subsidies provided by NGOs. Many comments also suggested incorporating other forms of subsidies in our solution such as gasoline.

Examples of technical comments include the need for: more thorough testing and validation, dealing with security issues, performance concerns, and solution usability.

We do not claim that the prototype is ready to be deployed now to a real working environment. Still more work is required to productize the solution. Luckily we have thought of many of the comments and questions raised during the demos. For example we have taken into consideration while designing the system both on the level of the clients and the back end that it can accommodate extensions in different dimensions. The current version of the solution supports other donors of subsidy such as NGOs not just government. It is also true that the solution requires more testing especially performance and usability testing. Concurrency and synchronization issues require more analysis too.

As for the security issue of our solution, we believe that it is too critical to be overlooked. We have a draft pits and pieces of a complete solution that addresses the problem from different angles but it is not complete yet. We also realize that a security solution for our system is complex due to different factors. Many sub-systems form our system including operating systems, databases, web applications, and mobile applications. Many actors are supposed to use the system with different roles. Added to these is the need to address two security aspects that intersect with the above factors, namely secure communication and access control. We have laid out some visionary model that encompasses these different factors and aspects but we did not concretize it yet.

Within this context we still need to evaluate different available options and tradeoffs. For example we are studying the viability of encrypting information while in transit. We also evaluate the level of auditing we should incorporate into the solution and the effect this will have on the system performance. A work is also required to prepare a full access matrix mixed with role-based privilege assignment.

Currently, there is undergoing discussions and negotiations with the key stakeholders of the subsidizing entities to finish the above issues and productize the prototype. This will be followed by deploying the system in a metropolitan area for experimenting with the solution. We will report later about the emerging status of our solution including the security model.

VII. Conclusion and Future Work

In this paper we presented a complete high level picture of the requirements, design, and implementation of consumption subsidy solution that provides automated support for the subsidy distribution process using mobile technology. The application can run on any java-enabled mobile and interacts with a back end server maintained by the subsidizing entity(s). The system provides the level of control and visibility over subsidy distribution process from the side of the subsidizing entity (typically governments) that helps in minimizing leaks to black market. In addition, it makes the process easy for consumers and merchants. For consumers it provides them with new services of requesting his ration from any registered merchant and is no longer tied to a specific one. Also consumers are not required to ration all (monthly) quota at the same time.

Our next steps include productizing the solution by completing the issues of security, performance and usability. More rounds of thorough validation and testing are also among our next steps. The completion of these steps and the deployment of the solution in a metropolitan area for more experimentation with the solution rely largely on the success of the undergoing negotiations with the key stakeholders of the subsidizing entities to sponsor and finance the required work.

Acknowledgment

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A Diagram Method to Analyze Illogical Thinking

Modeling Typical Logical Mistakes concerning Information Security and Industrial Safety

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Abstract—we propose a graphical method to express and analyze logical failure of human operators. Human factor is the weakest link on information security and industrial safety, and mare human mistakes have been making many severe accidents. Human thinking process is unstable and not always correct. There exist certain tendencies of cognitive misunderstanding, and people easily commit mistakes of such patterns. In the scene of computer crime, many attackers use those cognitive biases to deceive their victims. The cognitive biases are also the generator of critical misjudgments that brought severe industrial accidents. We nominate the most frequent patterns of irrational processing in order to identify the mechanisms of accidents on computer security and industrial safety. We can decompose processes of misjudgments into easy steps that reflect popular patterns of the cognitive biases by using the graphical method. In this paper, we try to reason patterns of thinking failures that took place in real cyber-attacks and an industrial accident.

Keywords-logical fallacy; cyber attack; social engineering; information security; human factors

I. INTRODUCTION

Human operators in industries are the weakest link on safety. People often commit mistakes when the situation is confusing. It is true in cyber security too. Cyber attackers can easily deceive people by using *social engineering* strategies [1][2].

Human operators can cause serious wrong decisions that result in the worst accidents. Compared to machines, human operators have broader and stronger rights to control the situation, so wrong judgments made by the human operators can be critical.

In this paper, we propose a graph method for step-by-step analysis of human logical mistakes.

In traditional safety engineering, researchers consider illogical thinking as an important factor. However, there remain some difficulties to study the origin of mistakes. Some researches try to consider human operators as logical processing units [3]. Such researches explain human mistakes are results from overload on human thinking process. However, the excess of mental loads is not the sole cause of cognitive mistakes since cool-headed people can also commit mistakes on logical thinking.

Other researchers explain the origin of the human misconceptions by proposing cognitive models, such as category-based induction [4], fuzzy logic [5], and logical

fallacy phenomena discussed in behavioral economy [6]. In the field of child education, Van Lehn has listed up children's common logical mistakes in solving calculus problems [7]. Using those lists of mistake patterns, we can predict human mistakes and estimate the risk of accident on human-machine systems.

However, it is quite difficult to use them to explain real accidents caused by human logical failure. The processes of wrong thinking are complicated and hard to describe with ordinary words.

The aim of this research is to present a clear and consistent method to explain human logical fallacies.
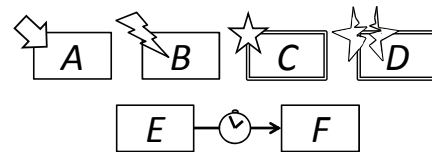

Figure 1. Auxiliary expressions standing for the following meanings: Proposition *A* is found true. Reliability of *B* is fabricated. Action *C* is carried out. Action *D* is not carried out. *E* affects *F* after a while.

TABLE I. PROPOSED GRAPH EXPRESSIONS OF LOGIC.

Formula expression	Graphic expression
State and action	
$A \Rightarrow B$	
$A \Leftrightarrow B$	
$A \Rightarrow \neg B$	
$\neg A \Rightarrow B$	
$(A \Rightarrow B) \wedge (A \Rightarrow C)$	
$(A \Rightarrow B) \vee (A \Rightarrow C)$	

Logic	Diagram
$(A \Rightarrow C) \land (B \Rightarrow C)$	A, B → C
$(A \land B) \Rightarrow C$	A, B → (AND-gate) → C
"$A \Rightarrow B$" is probably true.	A → B (solid arrow)
"$A \Rightarrow B$" is hardly true.	A ⇢ B (dashed arrow)
A is an axiom. (A is unconditionally true.)	φ → A

TABLE II.   TRANSFORMATION OF COMMON HUMAN LOGICAL FALLACIES.

Fallacy	Transformation
Affirming the consequent	A → B ⟹ A ↔ B
Negation fallacy	A → (Not) → B ⟹ A (Not) → B
Misunderstanding a self-justifying tautology as true	(A looping) ⟹ A
Conjunction fallacy	A, B → C ⟹ A, B → (AND-gate) → C
Ignoring hidden factors on an unbalanced AND-gate	A →, B ⇢ (AND-gate) → C ⟹ A → C
Hasty affirming a disjunction on an unbalanced OR-gate	A → (OR-gate) → B (solid), ⇢ C (dashed) ⟹ A → B

II. Visual Expression of Logic and Misconception.

Graphical expressions are suitable for explaining and understanding complex process of human misconception. We adopt graphical expression of logic gates to explain human thinking (Table I) with auxiliary expressions (Fig. 1).

There are already several methods to express logic graphically. The *semantic tableau* (or *truth tree*) is the most ordinary way to organize and connect propositions as graphs. In the field of the software industry, we often need a large volume of arguments to verify the correctness of software, so the visualization methods are strongly required to understand the logic. The fault tree analysis (FTA) and its variations have been used for software verification [8][9].

The method that we propose expresses logical relationships to describe logical fallacy of human reasoning in graph structure.

Thanks to the precedent studies on human logical fallacy, we can list the most typical ways to convert proper logic into wrong thinking. We nominate the six most common patterns of the irrational transforms shown in Table II. The six patterns are not complete but practically enough to explain most of the real accidents of industries and information security.

A. Analysis of Phone fraud

The tremendously popular swindle in Japan is the phone fraud starting the conversation with the phrase of "Hello! It's me!" This trick is to pretend the real son. So many elderly people have mistaken the malicious speaker for real children. The swindlers deceive the elders to send a huge amount of money for them eventually.

At the beginning of this swindle, the victims can have four correct propositions. (Fig. 2 is the diagrammatic expression of the four propositions.)

P1: the speaker on the phone is the son or another person.
P2: the parent should respect the son's request.
P3: the son's voice is a male voice.
P4: other people may speak in a male voice.

Then, the victims tend to convert those propositions in wrong ways.

P1-transformed: the speaker on the phone is possibly the son, according to experience. (Transformation of *hasty affirming a disjunction*.)
P3-transformed: the son's voice is a male voice, so the voice is spoken by the son. (Transformation of *affirming the consequent*.)
P4-transformed: ignore the possibility that a stranger is speaking. (Transformation of *hasty affirming a disjunction*.)

After those wrong transformations, the victims obey the swindler since they have a wrong mindset described as Fig. 3.

We can say that this phone fraud mainly consists of tactics based on statistical unbalance. People have a psychological tendency named *normalcy bias*. We often prejudge the present event is normal and similar to uneventful situations in personal experience. This bias makes us reduce vigilance, so it will be comfortable for us if the occurring event is harmless. However, the swindlers can use it as a weapon against security.
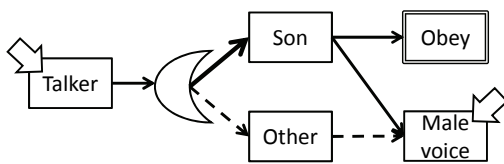
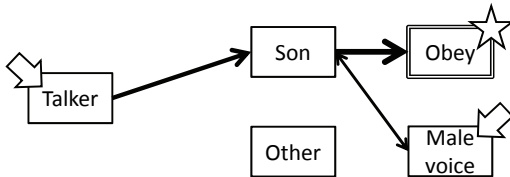Figure 2. The correct mindset of the victims in the beginning of the phone fraud pretending the real son.

Figure 3. Typical but wrong transformation of the mindset of Fig. 2.

If we analyze the process described above only with words or logical formula expression, it would become rather complicated. The graph expression allows us to analyze clearer.

B. Analyses of Common Cyber Attack Strategies

Let us see more examples of analysis with the graph expressions.

1) Pretexting technique

Adding pretexts in the story can gild false statements. The bias of *conjunction fallacy* makes us regard statements as true when many words about contexts and circumstance accompany the statements. *Pretexting* is one of such techniques, and it commonly used for fraud including cyber attacks (Fig. 4).

2) Tautological validation

Trap email claim itself as legitimate mail. Typically, such mail says that it is an alert issued by the security authority. It is a self-validating tautological message, and there is no evidence to support the correctness. However, it is enough to fool people in some cases.

3) Baiting technique

The attackers often make trap mail with messages suggesting that the attachment file provides attractive information for the recipient. It would drive the recipient to open the attachment file, and the malware in it can work.

4) Example of technique combination

We analyzed the scheme of trap email that contains an attachment of malware. In the scheme of this attack, the adversary makes the recipient open the attachment file by the following strategies (Fig. 5).

1. The adversary usually attaches a malware file of commonplace and non-executable format (such as Adobe PDF and Microsoft Word) to make the recipient less cautious.

2. The adversary writes messages of *baiting* or *tautological validation*.

3. The adversary may fabricate the senders address as safe senders, which imply safety of the mail. The

cognitive bias of "*hasty affirming a disjunction*" makes the recipient mishandle the or-gate separating safe email and trap email, which is badly balanced. Eventually, they judge the mail safe.

C. Analysis of Critical Human Machine Interaction

The proposed graph expression technique is also useful to analyze industrial accidents. For example, we can arrange of the process of the airplane crash of Air France 447 on 2009 as Fig. 6. According to the accident report [10], the pilot controlled the pitch angles up and down inconsistently; meanwhile the airplane have been losing its speed and facing the danger of stall.

The system emitted the stall warning to the pilot, but the pilot did not strongly consider the risk of stall. It is curious, and there must have been unfortunate structure to fail the communication between the pilot and the system.

Because of the inertia of the airplane, there was some delay between the timings of pitch control and emitting the warning. It was terribly misleading that the warning appeared just after the pilot made right actions. Lack of synchronism makes logical relationships complex. The delayed alarms confused the pilot trying to grasp the logical relationship of the circumstance. If the pilot made the pitch angle flat and increased the propulsion power consistently, the airplane would have avoided stall.

We think that the cognitive bias of *ignoring hidden factors* was the basic mechanism of the pilot's failure. During normal level flight, controlling airplane's heading with the rudders is easy and commonplace, so it has priority over adjusting thrust with controlling of the engines. Therefore, the pilot may be reluctant to control the engine power, and the thrust issue becomes a hidden factor.

III. CONCLUSION AND FUTURE WORK

We proposed a method to analyze human logical failure by using gate-logic-like graphical way. The merit of the proposed method is as the following:

- It can express complicated connections of propositions.
- We can deal with the typical patterns of logical mistakes as conversion of graph connection.
- The diagrammatic method is easy to analyze the weakest points of the logical structure. On the diagram, we can discuss the easiest transformation to bring wrong conclusion.

Our work is in progress, and those analysis examples were processed by hands. In the future work, we try to create automatic analysis system to check the cognitive flows. We will calculate probabilities of that people commit the typical logical fallacy patterns shown in Table II, and then we will be able to evaluate the weakest points on the logic and amount of the risks quantitatively.

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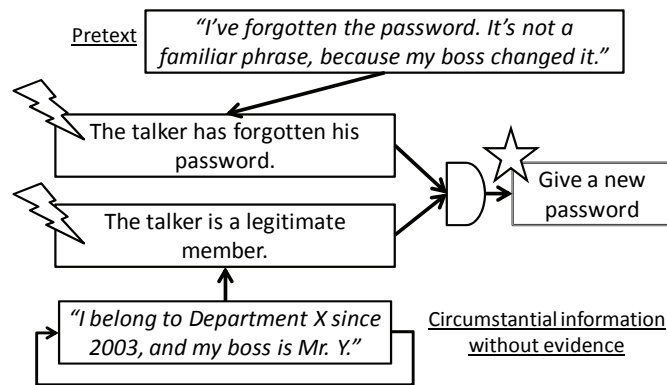
Figure 4.   A common scheme to steal password with *Pretexting* technique.
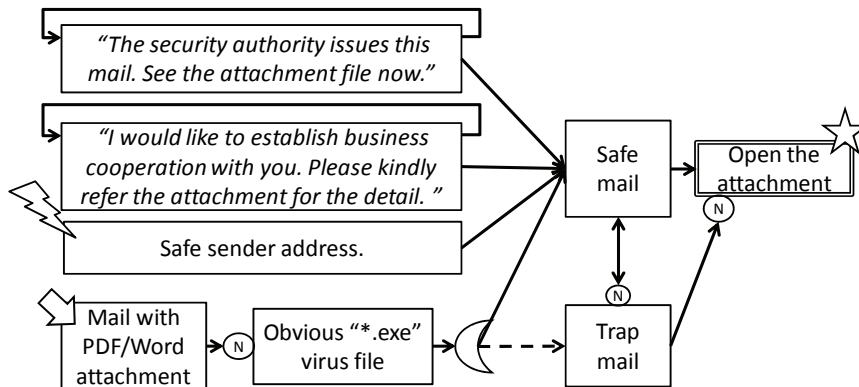

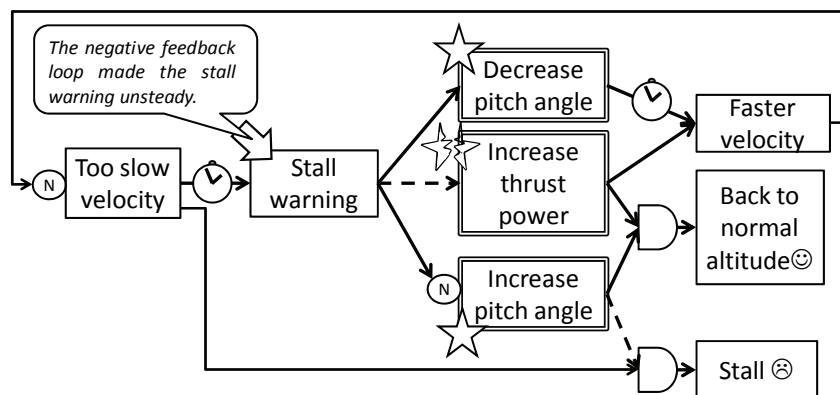Figure 5.   A typical mechanism of trap email.

Figure 6.   Estimated the pilot's mindset at the crash of Air France 447 on 2009. The broken arrows are causal relationships ignored by the pilot. This feedback loop with delays cased intermitted and unstable stall warning that resulted in contradicting control of the airplane's nose up and down.

The Usefulness of Audit to Guarantee the Security on the Electronic Systems

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Abstract—In a conventional system, people have created a mechanism to take advantage of collateral security by using audits without being checked by users. However, in recent electronic systems, the users need to do many things to guarantee the security. In this paper, we discuss how to use audit systems to archive security in digital communications.

Keywords-Audit; Security; Usability.

I. INTRODUCTION

Recently, in terms of ensuring convenience and cost effectiveness, a lot of paper-based services have been replaced by network services, for example, postal mail by email. The more people use digital information and network communications, the more people surface information security issues. For example, the number of the exploitation of information and money has been increasing in the Internet.

Although there are several things that a user must do in order to improve security, a user cannot be told to do something. It is difficult for a user not only to show the state of security, but also whether a user can select the state of the security on the setup mode of the computer. One example to show security to the users is a trial that show warning to the users in the Internet browsers, such as Internet Explorer [6] and Firefox [7].

If a user cannot verify a web server in SSL/TLS [1], the user can see warning sign on the screen such as the Figure 1 and Figure 2 [3]. The site certificate for SSL/TLS is installed in Browsers.

If a user tries to connect to a server via SSL/TLS and the server's site certificate is valid, then an SSL/TLS connection is established between the user and the server. On the other hand, if a server's site certificate is invalid, that is, the server's certificate is not in the certificate chain, the user must see warning that she should not connect the server.

A service shows instructions that the user should push the button to ignore. Even browsers show the warning, the service encourage users ignore warning, select to push "red" button, and connect the server which is not confirmed. That is because servers do not buy right server certificate for SSL/TLS and install the certificate correctly. That means that the user cannot understand the read sign meaning, that it is unable to verify the certificate and the user might connect fake serer. After the user sees that the server recommends

pushing "red" button, the user misunderstand it is right way to push "red" button. The user cannot recognize the server has got the risk and avoid the dangerous server.

In recent years, this problem is solved because most web sites have got right certifications. We need to discuss that the user has misunderstood such that the server recommends ignoring the warning. The way to ignore the warning is wrong way to lad to the user misunderstanding for security.
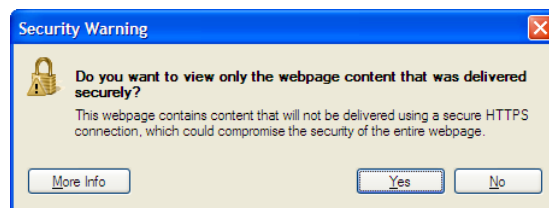

Figure 1.   IE8 Security warning.

Users do not have to do anything to archive security in the non-digitized system. One example is the voting system. People do not have to see all processes, but know all processes proceed correctly. This is because users know there is a strict law and the system uses audit system.

In digital communications, a lot of kinds of process are designed simplify and straightforward. In the conventional systems, people have created a mechanism to take advantage of collateral security by using audits without having checked by users. In the current social system, taking advantage of even such as audit and evaluation and certification, and has incorporated confirmation by third-party organization. This is because you cannot verify that their users to understand how everything on the market, if they are realized as how it works.

In this paper, we discuss how to use audit system to archive security in digital communication.

We take two examples for the conventional system: voting system and board of audit in the government. In addition, as they are digitized system, we discuss how to show security in two situations key issue by using card or SSL/TLS in browsers.

Figure 2.   IE8 Security warning (in Japanese), they say "There is a problem that security certificate for this Web site."IE8 Security warning.

A. Outline

The paper is organized as follows. Section 2 introduces the relationship of the current audit and security. Section 3 shows and discusses two example of audit for electronic communication. Section 4 discuses another topic for audit. Section 5 concludes the paper.

II.   RELATIONSHIP OF THE CURRENT AUDIT AND SECURITY

A. Conventional Voting

We explain how to archive security in the current voting system. We describe how to prohibit unauthorized acts such as double voting and how to protect privacy [4].

1) Prohibition double voting fraud

In order to prevent double voting fraud, it has to check to pass the ballot correctly and to vote properly. The Board of Elections manages this process by using the poll book.

According to the poll book, the Board sends the information by mail to a person, who has the election franchise, before the Election Day. This information is a kind of a certificate or a ticket for voting, include where and when the person can vote, and organize number. A person brings the mail to the polls and shows the mail to vote officers who checks whether he or she has the right to vote in this election.

To prevent double voting fraud is made sure that vote officers are able to check whether the voter has the right mail.

2) The correctness of elections

In conventional voting, it is difficult for most people to check whether their ballot is counted correctly because users do not see all process of voting after the elections.

To solve this problem, in conventional voting scrutinizer, there is a person called a scrutinizer who has selected from the electoral roll and checks voting correctly. In other words, there is audit system to verify all procedure correctly by neutral observers.

The scrutinizer selected by the Board of Elections see every process of vote counting such that this procedure is third party verification. The poll watcher checks whether the people vote correctly, and sends ballot box to ballot-counting

station. After checking all process, ballot-counting officers count the votes under checking by scrutinizer.

3) Privacy

In election, nobody is able to link between ballots which is written by voter and the poll book, so nobody knows anyone who vote for.

To achieve this privacy requirement, the current system selects the following system:

- Voting paper does not include voter's name
- People use the same ballot paper; so, it is very difficult to select which paper is whose.

The voter knows, by third party such as scrutinizer, that this procedure is correct and the privacy is protected.

In the current systems, people do not have to check that an election is correct by them, because of checking by third party audit.

B. Board of Audit

In this section, we explain who check the government uses our taxes legally by Board of Audit.

1) Tax Obligation

People living are obligated to pay taxes. It is necessary to gain taxpayer acceptance for the use of taxes. That means that people need to check the way tax money is used because tax is by people.

2) Board of Audit

Because taxpayers want to check the use of tax, for this checking, there is Board of Audit. The Board of Audit is a constitutional organization that is independent of the Cabinet and belongs neither to the Diet nor to the Courts. The Board of Audit audits the national accounts as well as those of public organizations and other bodies as provided by laws, and also supervises of public accounting to ensure its adequacy.

Because there is this kind of system, taxpayers do not have to check national account by themselves.

III.   CONVINCING USERS ON SECURITY

It is important to convince users that the system is secure. In this section, we explain how to show to archive security and discuss how to reduce user's burden in two recent systems: the process of key issue to card and warning of SSL/TLS at the browser.

A. Key Issue to IC Card

In a PKI system, the issuer of root certificate issues user's key, who asks to be provided the service. We explain how to get secret key to user by the issuer to service.

1) Security Requirements

In this process, the most important thing is a user's secret key issued by a rigorous process. The user signs a document

with the key. A verifier verifies the signature of the document by the public key of the user.

The secret keys are known only by the user. The difficulties of this situation are difficulties how to explain to create key by the user. After creating the key correctly, to manage the key, which not reveal the key to anyone, is important but difficult for the user. If the computer might be contaminated such as a virus, the key might leak to adversaries.

The solution is to keep the key in the card of tamper-proof.

2) How to protect secret keys

If the system adopts the card process, still there are some difficulties for the user.

When the user creates the key by herself to be provided the service, she must use her personal computer or electronic computing equipment. However, when the card system adopts is the user's equipment, the process of key issue might be under adversaries' attacks.

To solve these problems, Japanese government adopts the dedicated system to create the user's key. To use this system, when the user needs the keys for the service, the user do not have to get the special system before getting the card but the user needs to go to the municipal office [5].

The user's process of key issue is as follows:
1. When a user wants to get certificate for electronic application by the government, she goes to the municipal office.
2. The user asks the municipal officer to create it; the municipal officer and users do the paperwork. By the paperwork, the officer is able to check the user identities.
3. The municipal officer asks to the user to go to the dedicated system in the office. The dedicated system is able to create public and secret keys of PKI and save these keys to the user card. Even the municipal officer, nobody is able to know keys information without the user.
4. The user creates public and secret keys of PKI and saves the keys to her card by using the dedicated system by her.

In this process, there is only the user in front of the dedicated system. That means this keys are known by only the user. Even officers to help users are not able to know it.

Officers have to wait near the user during the user creates the keys. This process is very complicated.

3) Discussion

After this process, the user might be convinced PKI better that the secret key is known by only user. However, this approach is very time consuming; the user needs to go to municipal office, and the officer needs to help during creating keys by users but does not see the user's operation.

This system have been under the assumption that the government officer is not able to be trusted. It is time-consuming that the user needs to go the municipal office and go to two places in the office. If there is a mechanism to audit system and users are able to trust the system, then there

is an easier way to issue generate a key pair; generating the card of the key pair is in the trusted factory audited to third-party organization, and the card is delivered by trusted mail process.

There might increase the risk of leakage of the secret key because more people involved in this process; but this problem should be resolved in an operational process. This process makes people be better time-consuming that a user does not have to go to the municipal office and operate the system by herself.

All what a user has to do is to receive the card by mail.

B. SSL/TLS in Browsers

Over the Internet communication, such as web surfing, it is important for a user to protect from attacks that the user is able to verify the person whether a user wants to communicate. One solution is to use SSL/TLS communication.

1) SSL/TLS

SSL/TLS is based on PKI. In the beginning of the connection to a server via SSL/TLS, the browser asks the server to send the public key certificate.

The company to manage the root certificate checks the web's legitimacy; create a secret key, the public key, and the certificate for the keys, and sends them to the web site. After the web server receives the certificate, the server installs them to their web server software. If the server installs correctly, the user can connect SSL communication to the server.

2) Discussion

In issuing the certificate of public key site by CA, there is a kind of audit process to manage a web site. By using this process, a user does not have to install certificates of all public keys of web sites. This is to reduce the trouble of the user without one problem.

If a user wants to connect a server which has not installed the web certificate correctly, the browser shows the waning sign in the Figure 1. That means the browser recommend to the user to keep securely. However, the user is able to ignore warning [2]. That is because there is a description written by the web server that the user ignore the warning sign, up on the shelf the server cannot be installed properly.

The registration process is correct way but the user can be avoided from correct process. This means the audit is able to be eliminated by pressing the red button even having correct audit.

IV. SOFTWARE AUDIT

In this section, we discuss other items for resolution for audit in information technology system.

It is difficult to make sure that the security features are implemented correctly in the software. If a software is open-sourced and this is a kind of third party evaluation, the software is confirmed but has a problem of maintenance and integrity. Because a conventional IT system is simple, it is difficult to mix unjustness function. As the complexity of the

recent IT systems increased, it is difficult understand all of the software details.

Therefore, there is a need for a mechanism of verification for the implementation of the software audit.

V. CONCLUSION AND FUTURE WORK

In the recent systems, security measures are required; but, it must have a way that can be used without difficulty by the user. For non-electronic security measures, the burden of the user is reduced; so, goes with the audit of the election.

In this paper, we discussed that audit process is necessary for IT system. Not only the audit, but the process should be realized in a right operational process. To ensure that all, security should be ensured.

When developers create security systems, they have to discuss the balance between security and usability. Because nowadays developers have high skills for IT and especially security, and they tend to make the system which made full use of advanced technology. However users do not have such high advanced technology skills; so, the users cannot master such systems. On the other hand, users who have not

IT skills fall to the hole of security easily. Before creating a system, there should have a discussion about the usability and security between developers and users since the system engineer has to do ad hoc security patch after the system starts.

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Improving the Ridge Based Fingerprint Recognition Method Using Sweat Pores

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Abstract—**Among several biometric traits possible to be used for people identification, fingerprint is still the most used. Current automated fingerprint identification systems are based on ridge patterns and minutiae, classified as first and second level features, respectively. However, the development of new fingerprint sensors and the growing demand for more secure systems are leading to the use of additional discriminative fingerprint characteristics known as third level features, such as the sweat pores. Recent researches on fingerprint recognition have focused on fingerprint fragments, in which methods based only on first and second level features tend to obtain low recognition rates. This paper proposes a robust method developed for fingerprint recognition from fingerprint fragments based on ridges and sweat pores. We have extended a ridge-based fingerprint recognition method previously proposed in the literature, based on Hough Transform, by incorporating sweat pores information in the matching step. Experimental results showed that although the reduction of Equal Error Rate is modest, a significant improvement was observed when analyzing the FMR100 and FMR1000 metrics, which are more suitable for high security applications. For these two metrics, the proposed approach obtained a reduction superior to 10% of the rates, when compared to the original ridge-based approach.**

Keywords-biometrics; fingerprints; ridges; sweat pores

I. INTRODUCTION

In the modern society, several situations from secure login in information systems to prevention of terrorist attacks, make the personal identification in high safety mode a necessity. Traditionally, the common ways of personal identification are through possession, such as cards, keys, or documents, and knowledge, such as password or personal data.

However, these approaches present drawbacks, since a possession can be lost, stolen or used fraudulently by third parties, and knowledge can be forgotten or inferred by others. These vulnerabilities have been exploited by fraudsters, causing major leaks in the vaults of banks, consumers and service providers. As an alternative to these identification methods emerges Biometrics. Biometrics is the science of recognizing the identity of a person based on its physical or behavioral attributes such as face, fingerprints, voice, and iris [1].

Among many biometric traits, fingerprint is the most widely deployed biometric characteristic, because of its well-known distinctiveness (individuality) and persistence properties, as well as the low cost and maturity of products.

A fingerprint is the exterior appearance of the fingertip epidermis, produced when a finger is pressed against a plain surface [2]. The most evident structural characteristic of a fingerprint is the pattern of interleaved ridges and valleys [3], which appears in a fingerprint image as dark lines (ridges) or bright lines (valleys).

Fingerprint features are generally categorized into three levels [4][5]. First level features are the macro details of the fingerprint, such as the ridge flow, singular points, and pattern type. Second level features are the minutiae, such as ridge endings and bifurcations. Finally, third level features include some finnest attributes of the ridges, such as ridge path deviation, width, shape, pores, edge contour, incipient ridges, breaks, scars, and other permanent details [4]. Some examples of these three fingerprint level features are showed in Figure 1.
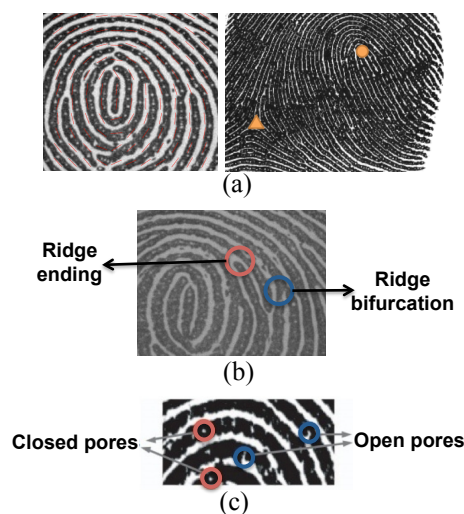

Figure 1. Some examples of fingerprint level features. (a) First level features (ridge orientation field and singular points), (b) Second level features (minutiae), and (c) Third level features (pores).

Statistical analysis show that first level features do not contain enough information to identify a person, however, they can be used for fingerprint classification and to reduce the search space. Second level features have sufficient discriminatory power to establish the individuality of fingerprints [6], and are considered permanents, immutables, and uniques by forensic experts. Likewise the second level, third

level fingerprint features are uniques for each individual, that is, they can provide discriminatory information for human identification [3].

In general, the current Automatic Fingerprint Identification Systems (AFIS) are based only on first and second fingerprint features [7], and require 500 dpi fingerprint images in order to extract the fingerprint characteristics. However, the Scientific Working Group on Friction Ridge Analysis, Study and Technology (SWGFAST) recommended, in 2005, the use of higher resolution images in order to allow the inclusion of third level features and follow the FBI standards [4].

Due to the new standards, the advent of high resolution fingerprint sensors, and the increasing requirements on the accuracy and robustness of the fingerprint recognition, researches have been developed to investigate and quantify the discriminatory power of third level fingerprint features [5][7][8][9].

Third level features are oftenly investigated by forensic experts when the other two levels are not enough to decide an identity, mainly when they are analysing fingerprint fragments. In such cases, the overlapping area of the two fingerprints being compared can be very small and, therefore, the reduced number of paired minutiae may be insufficient to permit a reliable fingerprint recognition [3].

With the trend of the reduction size of sensors in several applications, especially for mobile devices, the proper treatment of fingerprint fragments has great relevance.

The aim of this work is to propose and assess a third level features based fingerprint matching method, which extends the ridge-based fingerprint recognition method proposed by [10]. This new method incorporates sweat pores information in the fingerprint recognition stage, in order to improve the robustness and the reliability of the identification.

The rest of this paper is organized as follows. In Section II, we present a review of pore extraction methods. In Section III, the ridge-based fingerprint matching using Hough Transform, proposed by Marana and Jain [10], is described. In Section IV, we present the proposed approach for fingerprint recognition based on sweat pores, the evaluation database, and the assessment protocol. In Section V, we present the obtained results. Finally, in Section VI, we present the conclusions of this work and point future research directions.

II. REVIEW OF PORE EXTRACTION METHODS

The earliest pore extraction methods were based on skeletonization. Stosz and Alyea [11] used a custom-build sensor, whose resolution were around 2000 dpi. In their method, a preprocessing step is firstly applied, where the image is smoothed, binarized, and thinned to produce the raw skeleton image. From the skeleton, the terminations and the bifurcations can be easily found by examining the neighborhood of a pixel component of the skeleton. Termination

points have only one neighbor and bifurcation points have three neighbors, assuming that the skeleton pixels are eight-connected [11]. The pore detection is performed by tracking the skeleton. Each termination point is used as a starting location to track the skeleton. The tracking stage requires analyzing the current element, storing its coordinates, and determining the location of the next element in the path. The tracking algorithm proceeds until one of the stop criteria is satisfied: i) another termination point is detected, ii) a branching point is detected, and iii) the path length exceeds the maximum allowed value.

Afterwards, Kryszczuk et al. [12] worked with fingerprint fragments, in order to assess the performance of fingerprint recognition applied on images captured by small sensors, which are a tendency. They proposed an authentication system that can handle fingerprint image with reduced dimensions, but with high resolution. In order to align the ridges structures from the template and test images, first the ridge structures are cleaned using Gabor wavelet filtering, and then they calculate the 2D normalized correlation coefficient for every possible location of the fragment within the reference image. The decision on which part of the template image matches the test fragment is done by finding the highest correlation factor [12]. In order to detect the pores, they binarize the original grayscale image and look for closed pores, which are entirely surrounded by the ridge pixels and appear as holes in the ridges. Some heuristics are applied to remove spurious pores. So, to detect open pores (pores that intersects with a valley between two ridges), they skeletonize the valleys of the binarized image and compute the distance between the end of each spur and the skeleton of valleys. From the experiments the authors observed that the smaller are the fingerprint fragments, the better are the benefits of using sweat pores for fingerprint recognition.

However, as pointed by Jain et al. [4] the first methods proposed for fingerprint recognition based on pores have some drawbacks: i) skeletonization leads to some limitations due to its strong dependence on the image quality: ii) the alignment is computationally expensive; iii) they were validated by using small databases; and iv) only custom built optical sensors (2000 dpi), rather than commercially available live-scan sensors (1000 dpi) were used in these studies.

The next generation of pores detection methods were based on isotropic filters. Ray et al. [13] proposed a method to be applied on grayscale fingerprint images of 500 dpi, using an approach based on a modified 2D Gaussian function. First, this method calculates an error map for the image. Then, the map is binarized so that only areas of high pore probability are retained. Pores are detected in these areas as a local minimum in a neighborhood.

Posteriorly, Jain et al. [4][8] proposed a new pore detection method based on the observation that pore positions often give high negative frequency response as the intensity

values change abruptly from white to black. They used Gabor filters to enhance the ridges, this way separating ridges from valleys (since pores are naturally distributed along the ridges). And, to capture this abrupt changes, they apply the Mexican hat wavelet transform with an experimentally defined scale parameter. By adding the responses of both filters, they obtained an enhancement of pores, as well as of the borders between ridges and valleys, since pores are naturally distributed only along the ridges. Lastly, an empirically determined threshold (= 58) is applied to extract pores with blob size less than 40 pixels.

More recently, Zhao et al. [5] have investigated the spatial appearances of pores on fingerprint images, and have showed that some representative pore structures are not isotropic. In these cases, isotropic filter-based approaches do not work properly. Another limitation of isotropic approaches is that the pore extractor can not adapt itself, and the pore scales and ridge/valley widths can vary greatly from one fingerprint to another, or from one region to another in the same fingerprint [5]. Regarding this, Zhao et al. [5] proposed a Dynamic Anisotropic Pore Model (DAPM), which has two parameters to adjust: scale and orientation. These two parameters are adaptively determined according to the ridge frequency and orientation, respectively. The DAPM is defined as:

$$\begin{cases} P_0(i,j) = e^{(-j^2/2\sigma^2)} cos\left(\frac{\pi}{3\sigma}i\right) \\ -3\sigma \le i, j \le 3\sigma \end{cases} \quad (1)$$

$$\begin{cases} P_\theta(i,j) = Rot(P_0, \theta) = e^{(-j^2/2\sigma^2)} cos\left(\frac{\pi}{3\sigma}i\right) \\ \hat{i} = icos(\theta) - jsen(\theta), \hat{j} = isen(\theta) + jcos(\theta) \\ -3\sigma \le i, j \le 3\sigma \end{cases} \quad (2)$$

where Equation 1 is the zero-degree model and Equation 2 is the rotated model. In these equations σ is the scale parameter (to control the pore size) and θ is the orientation parameter (to control the direction of the pore model). To apply the DAPM, Zhao et al. [5] use a block-wise approach, where the blocks are classified into three kinds: well-defined (where the ridge orientation and frequency are directly estimated), ill-posed (where the parameters are estimated by interpolation the neighboring blocks), and background blocks. The block partition is performed in a hierarchical way, starting with a large block size and analyzing the consistency of ridge orientation and the intensity contrast, in order to classify the block. Background blocks are excluded, well-defined blocks are recorded and are not further partitioned. On the other side, a block larger than the minimum size is partitioned into four equal sub-blocks and are further examined [5]. After the fingerprint partition and parameters estimation, the ridge map is extracted. So, the pores are detected, using the DAPM based detection to well-defined blocks, and an Adaptive Difference of Gaussians (DoG) based, proposed in [9], to ill-posed blocks. The ridge map is then used to mask the pore detection response, since the pores lies on the

ridges. Finally, pos-processing steps are applied to remove false detections (pores with very low intensity, out of the specified size range).

In our approach, we choose the DAPM based pore extraction, since according to the literature review this method has the best average pore detection accuracy. Figure 2 shows two examples of pore extraction using DAPM method.
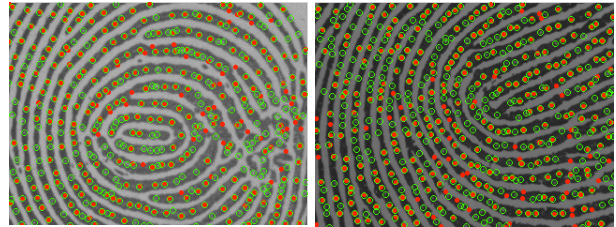

Figure 2. (Color online) Examples of pore extraction resulted using DAPM method. The ground truth pores are in green, and the DAPM detected pores are in red.

III. Ridge-Based Fingerprint Matching Using Hough Transform

In the ridge-based fingerprint recognition approach proposed by Marana and Jain [10], the features extraction stage is composed by three main steps: i) Ridge extraction and thinning: based on the method adopted in [14], where firstly the fingerprint orientation field is estimated, so the fingerprint area is separated from the background and after the ridges are extracted and thinned; ii) Straight line extraction: the most significant straight lines that lie on the fingerprint ridge pixels are extracted using the Hough transform; iii) Ridges classification: using the straight lines associated to a ridge, it is computed the ridge curvature, and then, based on such curvature, the ridge is classified into one of five categories ranging from category 1, in which the ridge seems a straight line, to category 5, in which the ridge seems a loop line. Figure 3, extracted from [10], illustrates the ridges extraction stage.
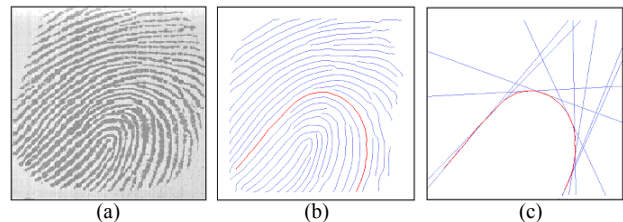

Figure 3. (Color online) Ridges extraction stage. (a) Fingerprint image; (b) Thinned ridges detected from the fingerprint; (c) Straight lines detected from a given (highlighted) fingerprint ridge by using the Hough Transform [10].

The fingerprint matching consists in two main steps: i) Registration: in which the translation and rotation parameters are estimated to align the query fingerprint image with the

template, using the Hough space peaks; ii) Comparison: in which the ridge matching score (RS) is calculated from the ridge alignment matrix C as follows:

$$RS = \frac{2\left(\sum_{i=1}^{n_1}\sum_{j=1}^{n_2} C(i,j)^2\right)}{a+b} \quad (3)$$

where n_1 and n_2 mean the numbers of ridges of the query and template images, respectively, and a and b are defined by Equation 4 and 5.

$$a = \sum_{i=1}^{n_1} (R_q(i)_{nop})^2 \quad (4)$$

$$b = \sum_{i=1}^{n_2} (R_t(i)_{nop})^2 \quad (5)$$

where $R_q(i)_{nop}$ is the number of pixels of the *i-th* ridge of query fingerprint, and $R_t(i)_{nop}$ is the number of pixels of the *i-th* ridge of the template fingerprint. Only the ridges of one fingerprint image that intercepts at least one ridge of the other fingerprint image are considered in the computation of a and b.

Figure 4 shows the matrix of ridge alignments obtained from a genuine and an impostor fingerprint matching. In the genuine case, high-valued peaks are mostly spread along the matrix's main diagonal. On the other hand, in the impostor case, low-valued peaks are spread over the matrix [10].
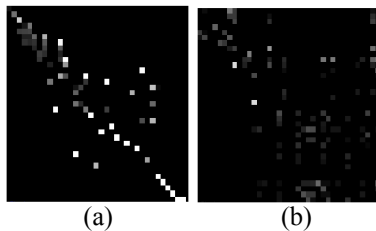

| (a) | (b) |

Figure 4. Matrix of ridge alignments obtained from (a) genuine fingerprint matching, and (b) impostor fingerprint matching.

IV. PROPOSED METHOD

Analyzing the ridge-based method proposed by Marana and Jain [10], we can observe that one of its weaknesses is that some impostor matchings can generate high scores, especially when only fragments of fingerprints are compared.

The aim of this work is to extend this ridge based fingerprint recognition method using sweat pores information in the fingerprint matching step, focusing on fragments of fingerprints. The method used to extract pores is the DAPM, proposed by Zhao et al. [5]. Figure 5 presents a diagram illustrating the proposed approach.

Firstly, there is a preprocessing step, based on Hong et al. work [14], in order to enhance the fingerprint input images,
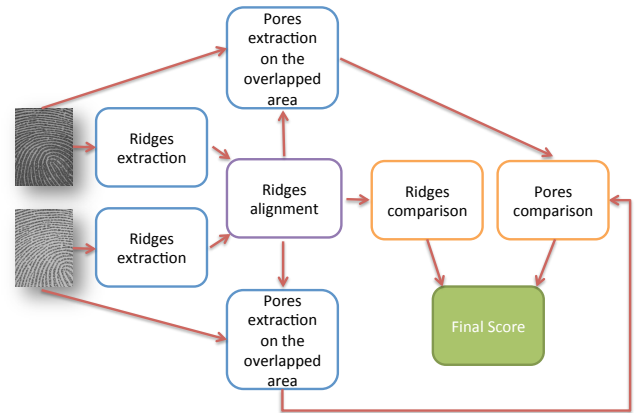

Figure 5. Proposed approach using two kinds of third level features (ridges and pores).

and to extract the orientation field and the frequency from the ridges.

The preprocessing output and the parameters extracted from the ridges are used by both methods, the ridge-based and the pore-based. So, to the ridge-based fingerprint recognition method, we down-sample the enhanced images and then execute the extraction, alignment and matching steps.

The alignment obtained by the ridge-based method is used to register the query and the template images. Then, after the alignment, the sweat pores are extracted only in the overlapped area. We use the original image instead of its downsampled version, because pore detection requires high resolution images. The ridge orientation and frequency obtained in the preprocessing step are used to compose the parameters of the DAPM. After the pore extraction and the post-processing, we label the pores according to the ridge where they are located.

For the pore matchings, we have adopted a correlation-based method, and, due to the natural fingerprint distortion, we use a bounding box around the detected pores in the template image in order to establish the pairwise correspondence with the detected pores in the query image. To increase the confidence of the pore matchings, we use the matched ridges information calculated by means of Marana and Jain method [10], taking the peaks of the ridge alignment matrix C and analysing the pores labels.

The pore matching score is calculated following the Equation 6.

$$PS = \frac{|MP|}{min(T_{nop}, Q_{nop})} \quad (6)$$

where MP is the matched pores set, $|MP|$ denotes the number of elements in the set MP, T_{nop} and Q_{nop} are the number of pores found in the fingerprints overlapped area from the template and query images, respectively.

Lastly, the scores calculated for the ridges and the pores matchings are combined through the weighted sum scheme.

To assess the proposed approach, we have used a public database containing partial fingerprints with high resolution. In the next subsections, we describe the database, the protocol, and the score fusion strategy adopted in this work.

A. Database

To assess the proposed approach we have used The Hong Kong Polytechnic University (PolyU) High-Resolution-Fingerprint (HRF) Database [15]. We have used the test set from the database PolyU HRF DBI, which consists of 1480 partial fingerprint images of 148 fingers. These fingerprints were collected in two sessions, separated by two weeks apart. In each session, five images of each finger were captured, using a custom built sensor, with resolution of 1200 dpi, generating fingerprint images of 320x240 pixels. When the database was captured, the participants were asked to naturally put their fingers on the prism of the scanner, without any exaggeration, in order to avoid severe fingerprint deformation.

The PolyU HRF database is very challenging. Besides presenting the most common problems, such as non-linear distortions, rotations, and translations, the overlapping area of the partial fingerprint is very small, making difficult to register properly the fingerprints. Figure 6 shows some samples of the PolyU HRF DBI test set.
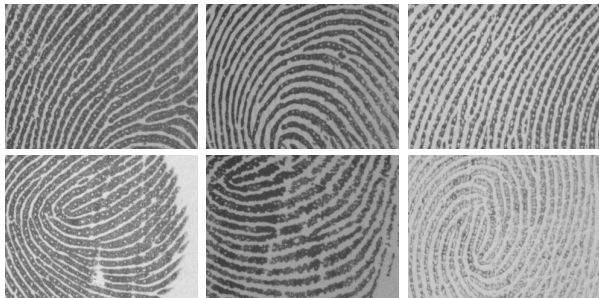

Figure 6. Some samples from the PolyU HRF DBI test set fingerprint images.

B. Protocol

In order to evaluate the performance of the proposed method for fingerprint recognition based on ridges and pores, we have performed experiments according to the following:

- *Genuine comparisons:* each fingerprint image of the second session was compared with the five fingerprint images of the first session of the same individual, totalizing 3,700 genuine comparisons;
- *Impostor comparisons:* the first fingerprint image of the second session of an individual was compared with the first fingerprint image from the first session of all other individuals, totalizing 21,756 impostor comparisons.

With all genuine and impostor matching scores we have calculated three metrics: EER (Equal Error Rate), the error rate at a given threshold where the False Match Rate (FMR) and False Non-Match Rate (FNMR) have the same value, FMR100 (value of FNMR for FMR = 1/100), and FMR1000 (value of FNMR for FMR = 1/1000) [16].

C. Score analysis

In the experiments, we have analyzed the recognition accuracy for three situations: i) using only ridge matching scores; ii) using only pore matching scores (but, using the ridges for alignment and labeling); and iii) using the fusion of ridge and pore matching scores, through the weighted sum scheme, calculated as follow:

$$FS = \omega.RS + (1 - \omega).PS, \qquad (7)$$

where RS is the ridge matching score, PS is the pore matching score, ω is the weight for RS ($\omega \in [0, 1]$).

V. EXPERIMENTAL RESULTS

Figure 7 presents the EER using only ridges ($\omega = 0$), pores ($\omega = 1$), and varying the associated weight for each score. In the best case, the EER decrease from 23,50% (original ridge-based algorithm) to 22,30% using pores information together.

Figure 8 shows the FMR100 and the FMR1000, varying the weight of pores with respect to ridges. As shown in this Figure, combining the scores, the proposed approach reaches significant improvements, with reductions above 10% compared to the original ridge-based method. The original ridge-based method obtained 87,03% of FMR1000 and 68,70% of FMR100. After the fusion with pores matching scores, the FMR1000 reduced to 76,21%, and the FMR100 reduced to 57,81%.
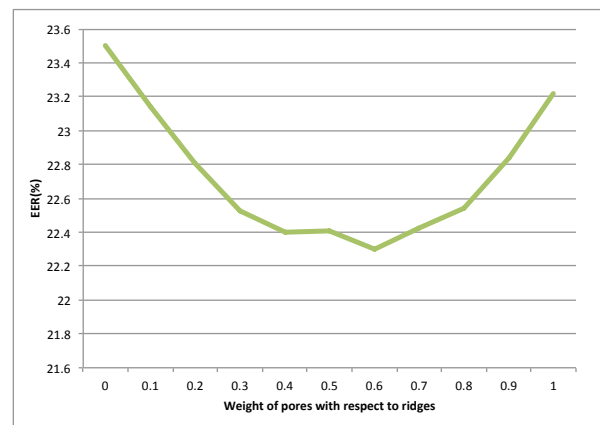

Figure 7. The EER of proposed approach when different weights to pore score are used.

The high error rates obtained in the experiments may be explained by the adopted database, which, as said, is very
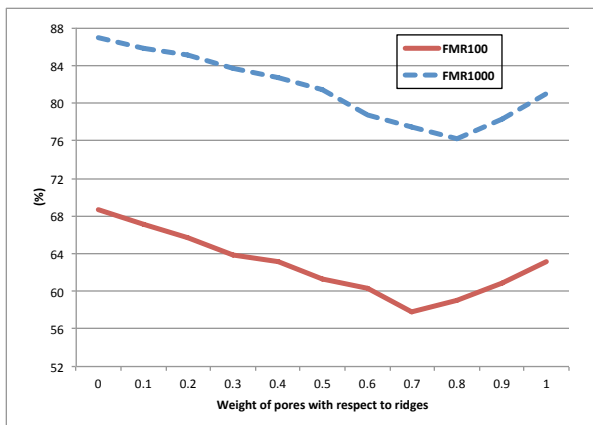
Figure 8. The FRM100 and the FMR1000 of proposed approach when different weights to pore score are used.

challenging, since it is composed of fingerprint fragments, which lead to small overlapping areas during the fingerprint matchings.

Table I reports the experimental results obtained on PolyU HRF Database following the protocol described in section IV-B. The best result was obtained when the ridge matching scores were fused with the pore matching scores.

Table I
COMPARATIVE RESULTS OBTAINED IN THE EXPERIMENTS.

Rate	Ridge-based	Pore-based	Ridge and Pore-based
EER	23,50%	23,22%	22,30%
FMR100	68,70%	63,19%	57,81%
FMR1000	87,03%	80,97%	76,21%

VI. CONCLUSIONS AND FUTURE WORK

This paper presents a fingerprint recognition technique that uses two kinds of third level fingerprint features: ridges and sweat pores. The ridge-based fingerprint matching method, proposed by Marana and Jain [10], used as start point, is extended to incorporate sweat pores information in the matching step. The alignment obtained by the ridge-based method is used to register the query and the template. Then, the pores obtained from the fingerprints, by using the DAPM pore extraction method, are used in the matching step to increase the confidence and performance of the matching.

The proposed approach obtained a reduction of more than 10% in FMR100 and FMR1000, comparing with the original ridge-based algorithm, when applied on a public database composed of fingerprint fragments. These results proved that the use of sweat pores can improve the fingerprint recognition rates in applications where the fingerprint sensor has high resolution and a reduced sensing area.

In order to continue the investigation with sweat pores, we intend to evaluate their use in other steps of the fingerprint recognition process, such as in the alignment. We also intend

to test and compare the current approach against commercial minutiae-based methods, and investigate the best approaches to combine ridges and pores based methods.

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Security Assurance Requirements for Hypervisor Deployment Features

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*Abstract-*Virtualized hosts provide abstraction of the hardware resources (i.e., CPU, Memory, etc.) enabling multiple computing stacks to be run on a single physical machine. The Hypervisor is the core software that enables this virtualization and hence must be configured to ensure security robustness for the entire virtualization infrastructure. Among the various combination of hypervisor types and hypervisor hardware platforms, we have chosen a reference architecture as the basis for our set of deployment features. For each deployment feature, this paper looks at the configuration options and analyzes the security implications of the options/deployment feature to derive a set of assurance requirements that are either (a) provided by each of the configuration options; or (b) required for that deployment feature as a whole regardless of configuration options.

Keywords-Virtual Machine; Virtual Network; Hypervisor; Virtualized Host; Security Assurance Requirements

I. INTRODUCTION

Virtualized hosts provide abstraction of the underlying hardware resources to enable multiple computing stacks (consisting of an O/S, Middleware and Applications) to be run on a single physical host. Because of many beneficial features such as efficient utilization of hardware resources, elasticity, flexibility and in some instances better security, virtualized hosts are being increasingly deployed in many data centers built for in-house enterprise use or offering cloud-based services.

The core software that provides the virtualization capabilities in a virtualized host is called the Hypervisor. The hypervisor provides the following major functions: (a) Abstraction of all underlying hardware resources (e.g., CPU, Memory, etc.). This enables multiple computing stacks called Virtual Machines (VMs) (each with its own different brand of O/S) to be run on a single physical machine; (b) Isolation of run-time process stack in one VM from another; (c) Selective connectivity or communication among VMs through a suitable network configuration inside the virtualized host (called Virtual Network); and (d)

Sharing of hardware resources statically through pre-defined resource limits and dynamically through multiplexing/scheduling features [1]. These functions together with some associated housekeeping functions could broadly be classified under two feature sets: (a) Hardware Abstraction feature set and (b) Virtual Machine Management feature set. The virtual machine management feature encompasses all functions relating to the life cycle of VMs – create, stop, suspend, activate etc.

The hypervisor software as a software entity as well as in combination with its hardware platform can have different architectures. For example, both of the two major feature sets could be provided by a monolithic software module or they could be split between two modules – with the first module called Hypervisor providing just the hardware abstraction function while a separate module called Virtual Machine Manager (VMM) provides the virtual machine management function [2]. A further variation in the case of those hypervisor architectures with a separate VMM module is that the VMM module can be run as a separate protected VM with higher privileges than other VMs (usually called Guest VMs) [3]. Some of them are directly installed on the hardware (or bare metal) (Type 1), while some need an operating system (called a host operating system) on the physical host to be installed (Type 2) [2]. There could also be variation in terms of whether the platform provides hardware assistance for virtualization or not. Hardware-assisted features for virtualization include the availability of two execution modes (i.e., root mode and non-root mode) and multiple privilege rings (i.e., enabling different commands to run at different privilege levels) in addition to memory management features (e.g., nested page table or extended page table, etc.). The consequence of the hardware providing some virtualization functions is that the corresponding hypervisor module can be thin (enabling better security verification/attestation) and, at the same time, be able to provide a feature called full virtualization (enabling guest VMs to run unmodified versions of

commercial O/S offerings instead of a version that is specially modified and ported to run on virtualized platforms) [3].

The reference hypervisor platform we have chosen for security analysis in this paper consists of a Type 1 hypervisor that provides full virtualization with either a monolithic or two-piece software module. For each deployment feature pertaining to this architecture, we look at the configuration options available for enabling that feature. We then analyze the security implications of these options/deployment features to derive a set of security assurance requirements that are either (a) provided by each of the configuration options, or (b) required for that deployment feature as a whole regardless of configuration options.

II. HYPERVISOR LOCAL USER MANAGEMENT AND AUTHENTICATION

All commercial hypervisor offerings come with a Management server, almost eliminating the need for creating local users and groups on each hypervisor (virtualized) host. However, some tasks cannot be accomplished through the management server [4] alone, such as the need to troubleshoot the hypervisor boot and configuration problems and the need to audit the hypervisor host configuration and remote access. In spite of the need for local users and groups, it is a good practice to restrict the number of users to just two or three. A local user on a hypervisor always performs only administrative functions and is not a typical business application end-user.

With respect to local user management and authentication on a hypervisor, the two options are:
(a) Manage the users and groups associated with a hypervisor locally;
(b) Manage the users and groups by integrating with a local directory infrastructure (e.g., Active Directory) and using a directory-based authentication mechanism (e.g., Kerberos). The security analysis of these options is given below:

A. *Managing the users and groups associated with a hypervisor locally:*

Local users and groups for the hypervisor host are usually created using a service console (if the hypervisor architecture includes one) or through a dedicated client interface. The programs for this usually include features to set a password for the user account as well as options to set basic access mode permissions (e.g., SSH, VPN, etc.) [4].

Security issues associated with managing users and groups locally through the manual process are:

(a) When an administrative user having user accounts on some hypervisor hosts, quits the organization or moves over to a different division within the company, the user account associated with him/her has to be manually deleted in all hypervisor hosts. If not done properly, it can leave zombie accounts which can be exploited resulting in a security breach of the hypervisor host [5].

(b) Any changes to organization policy such as the password policy has to be enforced manually on each hypervisor leaving room for some mismatches in some hypervisor hosts.

B. *Managing the users and groups through a Directory Infrastructure*

In this option, the users and groups are still created through either the service console command line interface or through a dedicated hypervisor client but there are three differences [4]:

(a) The administrative user account names created here match those already present in the enterprise directory.

(b) No passwords are assigned while creating these user accounts.

(c) A suitable command modifies the configuration to specify that the authentication will take place through a mechanism appropriate for the directory infrastructure (e.g., through the domain controller in an Active Directory infrastructure using an authentication mechanism such as Kerberos).

The advantages in managing the users of the hypervisor host through the directory infrastructure are:

(a) User account changes (such as deletion) can be done centrally at the directory level. This way, an account for a user no longer with the organization, though still present in the hypervisor host, cannot be used for logging in, since password and forms of authentication have to be done at the directory infrastructure level. The latter will fail since the user account no longer exists there [4];

(b) Password policies such as complexity, expiration times, etc., can be centrally defined and enforced; and

(c) Robust Authentication mechanisms can be set up because of integration of authentication function with the directory infrastructure that is not available locally in the hypervisor host.

III. HYPERVISOR CPU SCHEDULER CONFIGURATION

Most hypervisors provide the following configuration options for sharing the physical CPU of the virtualized host

among the multiple virtual CPUs of the VMs: (a) Guaranteed CPU time slots for VMs based on their assigned weights and (b) Fair-share scheduling where a VM gets physical CPU time based upon its weight but subject to a cap for the amount of CPU.

The proportional fair-share scheduling option is recommended for most VM workloads from both a load balancing and security point of view [6]. In scheduling options with time guarantees, an errant process in a rogue or compromised VM could hog all the CPU resources of the virtualized host resulting in **denial of service** to other VMs. However, for VMs running applications with critical response times, (e.g., process control application), the only scheduling option is the one that provides time guarantees.

IV. HYPERVISOR ACCESS CONTROL CONFIGURATION

There are two main classes of administrative operations (no user operations) in a hypervisor (virtualized) host: (a) Virtual Machine Management operations; and (b) Configuration of Virtual Network involving the VMs. These classes determine the overall deployment of the entire virtualized infrastructure. The granularity at which access control permissions can be set for these operations contributes towards the security robustness of the infrastructure. Our reference architecture for hypervisor platform admits instances where these operations are either performed by core hypervisor software (monolithic hypervisor architecture) or through an interface provided by a separate VMM module installed as a secure dedicated VM (e.g., Dom0 in Xen hypervisor and Parent Partition in Hyper-V hypervisor)[3].In both variations, the following architectural options for performing access control functions exist:

(a) Built-in Access Control Module: In this approach, there is a built-in access control module that is an integral part of the hypervisor executable.

(b) Pluggable Access Control Module: In this approach, a pluggable, external, custom access control module can be specified as a component of hypervisor kernel modules and then it can be booted together during the hypervisor boot-up. Using the interfaces provided by the module, policies are then defined based on the set of access control models (e.g., RBAC, MAC, Type Enforcement, etc.) supported by that module. This approach has been adopted in hypervisors such as Xen. Loading of custom access control modules requires the implementation of a generic security framework; the name of such a framework in the Xen context is known as Xen Security Module (XSM) [3].

Irrespective of the type of access control module, the module should provide the following features in two feature classes to obtain robust security for the virtual infrastructure.

(a) Feature Class – Aggregation: The access control module should provide capabilities for defining artifacts containing (i) arbitrary combination of users (Custom Group); (ii) arbitrary combination of permissions (Custom Role); (iii) combination of objects based on any administrator-defined logic (Custom Objects - e.g., set of VMs that house a Webserver, set of VMs that together form all tiers of a multitiered application); and (iv) A parent-child relationships using objects (Object Hierarchy).

(b) Feature Class – Permission Assignment Granularity: The access control module should provide the flexibility to assign permissions at various levels of granularities. The minimal requirements are: (i) All administrative permissions on a single object or a custom object (e.g., all life-cycle operations on a designated VM); (ii) A particular type of permission (e.g., view) on all objects (e.g., view the list of all VMs in the virtualized host but not exercise any other operations on those VMs); (iii) Arbitrary combination of permissions (contained in a Custom Role) on arbitrary combination of objects (Custom Object); and (iv) Have a set of permissions on an object at the top or middle of an object hierarchy but negation of those permissions for a specific child object (e.g., ability to take snapshots, start and stop all VMs except a designated VM running a sensitive application).

V. HYPERVISOR DEVICE DRIVERS CONFIGURATION

Device drivers are software pieces that provide access to a physical device such as a hardware drive or network interface card to guest VMs. Generally, these device drivers are either supplied by physical device vendors or written by third parties and hence are traditionally held as untrusted code. They form one of the weakest links in the security configuration of a virtualized host (hypervisor platform).

The following device driver configuration options depend upon the architecture of hypervisor platform [7]: (a) In the monolithic hypervisor architecture, the device driver module is an integral part of the code for the hypervisor build; and (b) In a hypervisor architecture with a separate VMM, the device drivers may be located either in the parent partition that houses the VMM module or it may

be run in a dedicated guest VM (e.g., Driver Domain in Xen hypervisor platform)[3].

The security assurance requirement for each of the above two device driver configuration options are:

(a) Some hypervisor offerings provide a feature to pre-define a secure configuration for the entire hypervisor platform installation by what are known as "Host Image Profiles" (e.g., VMware VSphere 4)[4]. Such a host image profile can be used to specify acceptable drivers (based on assessments by third-party certifiers) or specify an acceptance level for the device driver that is part of the hypervisor build.

(b) When device drivers are run in a VM different from the parent partition (VM that houses the VMM module), that VM should contain just the barebones guest O/S, the device driver software designated to run on it and any other software required for that VM to share the device with other domains. This configuration requirement is needed since the VM that runs the driver code that enables other VMs to share devices is theoretically part of the Trusted Computing Base of the hypervisor platform.

VI. HYPERVISOR MANAGEMENT INTERFACE CONFIGURATION

The hypervisor should be accessible and configured only through a dedicated management network. The management interface (also called VMKernel interface) of the hypervisor is accessed through a special port (or port group) called the VMKernel portgroup in some offerings [4]. By assigning this port or portgroup (with its associated VLAN ID) to its own virtual switch and connecting this virtual switch to a dedicated physical network interface card (pNIC) of the virtualized host (with a redundant pNIC standby), a dedicated management network can be created. There should also be restrictions on services (e.g., DNS) and network locations (e.g., IP addresses) that can interact with the management interface [8]. These restrictions can be defined and enforced through a firewall whose configuration has the following options:

(a) A firewall external to the virtualized host; or

(b) A firewall built into the hypervisor module

Irrespective of the firewall used, the following security checklist should apply:

(a) All incoming and outgoing traffic must be blocked, except those that are needed for the hypervisor management access. These include but are not limited to: SSH (TCP port 22), DNS (UDP port 53) and DHCP (UDP port 68).

(b) The previous configuration setting merely specifies the set of allowed services. It is also necessary to restrict the clients that can avail of these services. It is a well-understood practice that hypervisor management should be limited to a restricted set of (preferably local) IP addresses or range of IP addresses (subnet).

VII. HYPERVISOR VIRTUAL NETWORK CONFIGURATION

A virtual network is a network defined entirely within a single physical (virtualized) host; a typical configuration is given in Figure 1. It consists of software-defined virtual network interface cards (vNIC) associated with VM that are connected to software-defined virtual switches (vSwitch), which in turn are connected to the physical network interface cards (pNIC) of the virtualized host [9]. The vNICs and vSwitches are defined using the hypervisor management interface and they together with the network traffic flowing between them reside entirely in the memory of the virtualized host. Multiple portgroups (each with its associated virtual LAN ID) can be defined on a single vSwitch and each is connected to one or more vNICs on the VMs. Network traffic between VMs connected to the same vSwtich and portgroup never leaves the virtualized host. The virtual network thus enables communication among the VMs within the virtualized host as well as communication with the enterprise network outside the virtualized host.

The presence of this virtual network poses a threat to the hypervisor in the following ways [10]:

(a) A compromised application within a VM can attack the hypervisor

(b) An application within a VM can be used as a launching pad to compromise applications in other VMs on the same virtualized host.

To protect the hypervisor, use one of the following configuration options:

(a) Install a firewall service virtual appliance as a hypervisor module. This appliance uses the virtual machine introspection API of the hypervisor [11] and hence has visibility into all traffic flowing inside the virtual network, including traffic that never leaves the virtualized host. Specifically, this appliance sets up a firewall filter to intercept all traffic flowing between a vNIC of a VM and the vSwitch and thus provides a capability to control traffic flowing into and out of every VM resident on the virtualized host.
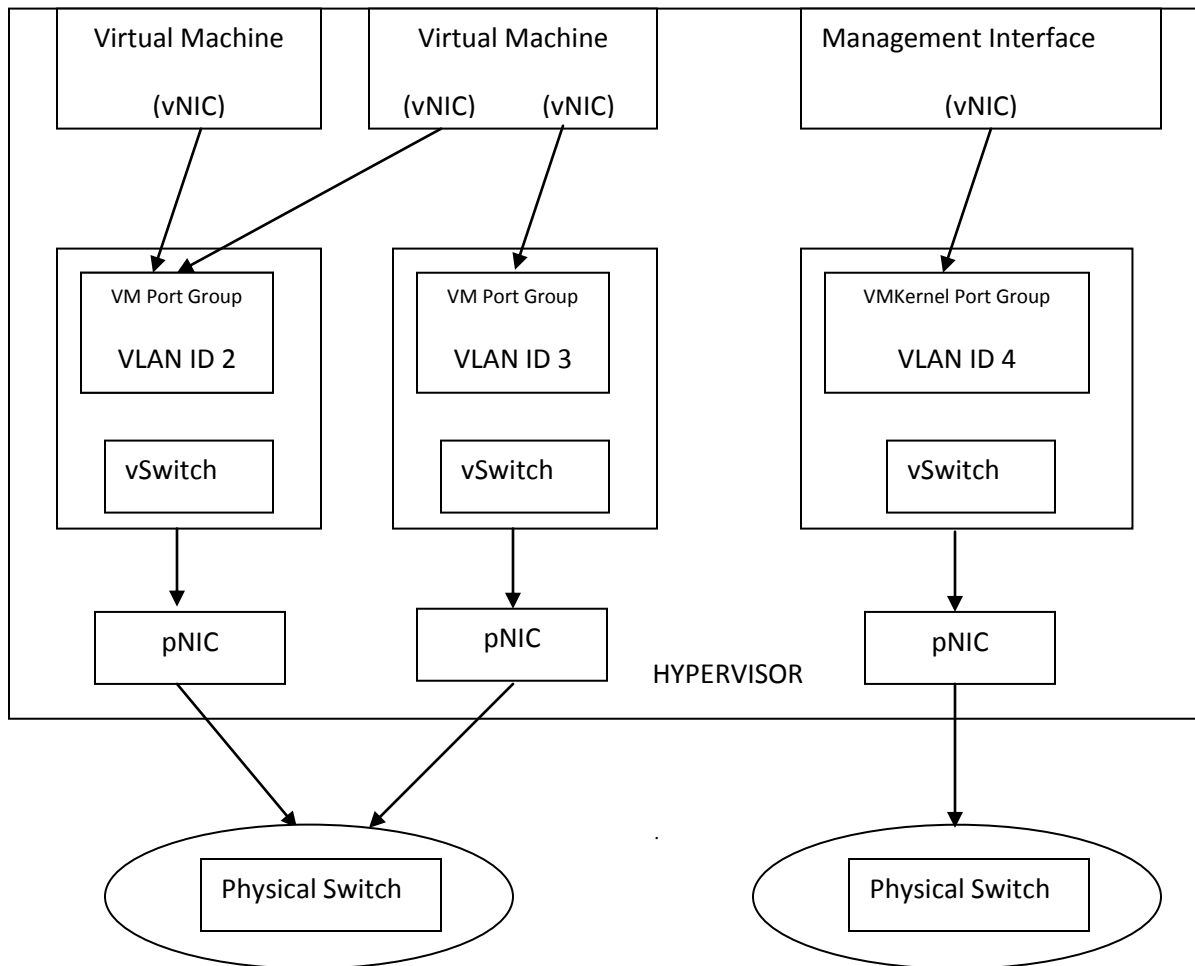
Figure 1. Typical Virtual Network Configuration

(b) Isolate the network traffic flowing among VMs using the concept of VLAN [4]. By this configuration approach, different portgroups are defined in a vSwitch and each is associated with a unique VLAN ID. A network packet originating from a VM and landing on a portgroup in a vSwitch is tagged with that associated VLAN ID. A vSwitch is connected to one or more pNICs of the virtualized host which in turn are connected to a physical switch configured as a VLAN trunk. Access control policies based on VLAN IDs are defined on this physical switch. The physical switch serves to segment traffic among the VMs resident on that host for monitoring and controlling. The difficulty with this configuration option is that the VLAN traffic inside each virtualized host must be routed to the external physical switch where access control policies are enforced on inter-VLAN traffic.

The Security requirements for the virtual network traffic isolation feature for the firewall option are:

(a)The firewall appliance should be a stateful one

(b) There must be flexibility in defining objects that will participate in policy rules. The objects should be static or dynamic. In terms of granularity of entities at the network level, objects designating portgroups and vLAN Ids should be supported. At the VM level, object definitions should cover a single designated VM, all VMs in the virtualized host or all VMs with similar connectivity or function (e.g., Web Server) [12].

(c) Traffic filtering rules by themselves cannot provide assurance against attacks on the virtual network. This requires an IDS/IPS. Since IDS/IPS systems with robust analytical capabilities are now found only in versions built for physical networks, the firewall should support rules for mirroring virtual network traffic to external network devices to leverage this capability.

Table 1. Hypervisor Deployment Feature (Option) & Security Assurance

Deployment Feature (Configuration Option)	Security Assurance Requirements
1. Local User Management and Authentication (using Directory Infrastructure)	No Zombie Accounts, Enforcement of Password policies, Robust Authentication Mechanism
2. CPU Scheduler Configuration (proportional fair-share)	Situations that result in Denial of Service to VMs must be minimized
3. Access Control Configuration (all options)	Arbitrary combination of Users, Permissions & Objects and Flexibility to assign Permissions at various granularity levels
4. Device Drivers Configuration (all options)	Certified Drivers, Barebones/Secure Configuration of domains running Device driver code
5. Management Interface Configuration (all options)	Dedicated Management Network, Restricting the type of Network traffic and IP address locations for Management Interface Access
6. Virtual Network Configuration (Firewall & VLAN)	Capability to define and enforce inter-VM network traffic rules and IDS/IPS function support

VIII. CONCLUSIONS & ADVANTAGES

The hypervisor is the central software that provides all of the virtualization functions on a virtualized host. Apart from the usual user account management and access control configuration options encountered on any host, a virtualized host presents a sophisticated management interface which supports functions for multiple workloads in the form of VMs and a software-defined network called virtual network. This presents a rich set of deployment features and associated with each deployment feature there are multiple configuration options. In this paper, we analyzed the security implications of these options/deployment features to derive the security assurance requirements that are either (a) provided by each

of the configuration options; or (b) required for that deployment feature as a whole regardless of configuration options. The security assurance requirements are summarized in Table 1 above.

The advantages of the deployment feature-driven approach for deriving security assurance requirements are:

(a) The security assurance requirements have direct traceability to each deployment feature and hence provide an automatic test of completeness.

(b) Provides a true picture of the security posture of the operational virtualization infrastructure as the security guarantees of each deployed configuration is known in advance.
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Overcoming the Risks of the Perimeter-based Security with Strong Federated Identification Mechanisms

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Abstract—**Nowadays, corporate networks appear completely unprepared to deal with threats from new technologies of communication, risk behavior of users, interoperability with third-party systems and outsourcing. The perimeter-based traditional security approach (model of the "castle and the moat") hinders the development of enterprise systems and creates the delusion of protection in both administrators and users. To overcome these threats, a new data-safety oriented paradigm called 'deperimeterisation' appeared in the last decade. However, it depends on an effective federated identity mechanism to reach the goal of a borderless network. The main contribution of this work is to fill this gap with a proposal of a strong federated identification mechanism, based on the SAML protocol and smart-cards.**

Keywords-network security; *de-perimeterisation*; *federated identity*; *smart-cards*; *SAML.*

I. INTRODUCTION

The revolution brought by the ICT (Information and Communication Technology) to modern society carries within it a set of new threats enterprise networks are not prepared to face, creating resistance in adopting new tecnologies, like Wi-Fi, peer-to-peer, cloud computing, outsourcing and home-office.

Such resistance stems from the traditional "Rings of Trust" [1] approach of security, adopted in the corporate world, shown in Figure 1. In this approach, security is viewed as a protection effort that must be centered in the division of layers (rings), focusing especially in the upper strata.

In this model, the protection of information is "guaranteed" through a physical/logical perimeter that separates the enterprise network (internal network) of the Internet (external network). According to [2], the term "castle and moat" is thus commonly used in analogy to traditional defense mechanisms in computer networks: firewall, proxy, IDS (Intrusion Detection System), IPS (Intrusion Prevention System).

This view of security, however, is inadequate to deal with threats from the current context in which corporate networks are in. Maintaining this model hinders development of enterprise systems and creates the delusion of protection in both administrators and users. So, a new approach of security is necessary in nowadays corporate networks.

In Section II, the risks of maintaining a perimeter-based security will be presented. Section III shows the de-perimeterisation paradigm, its goals and lacks. Section IV presents a proposal of a strong federated identification mechanism, aimed to fill one of the lacks of the de-perimeterisation paradigm, being the main contribution of this work. Section V shows the implementation aspects of the mechanism and the results obtained. Finally, Section VI defines the conclusion obtained from the work and will present the correlated future work.
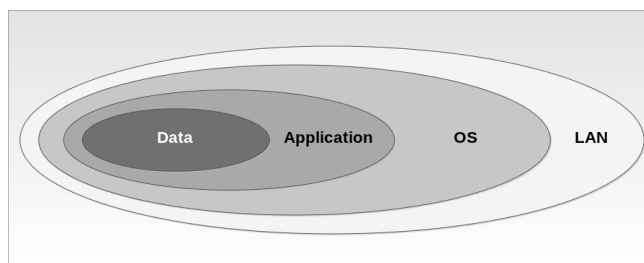

Figure 1. Conventional "Rings of Trust" Model of Security [1].

II. RISKS OF THE PERIMETER-BASED SECURITY

According to [3], after the 16th century, the castle began to decline as a defense, mainly due to the invention and development of heavy guns and mortars. Today, likewise, perimeter-based security systems face new threats for which they are not prepared:

1) Mobile conectivity: Smartphones and 3G/4G modems are becoming common belongings. Nothing prevents an employee from connecting them in the office computer to access content blocked by the enterprise security policy.

2) Wi-Fi hotspots: If there isn't a security protection at the link layer of the network (like IEEE 802.1X [4]) Wi-Fi access points can be connected to the network, providing internal network access to "wardrivers". The same threat occurs when using deprecated security protocols (WEP, for instance) or in the leakage of the shared password

in the WPA/WPA2 (if 'personal' mode is used instead of 'enterprise', RADIUS-based).

3) Using VPN to bypass network security policy: Software like OpenVPN™ [5] enables the user to establish a connection with a remote point over the network perimeter, bypassing it, like shown in Figure 2. Also, these software can perform encryption and HTTP encapsulation, masquerading their traffic like a regular HTTPs connection.
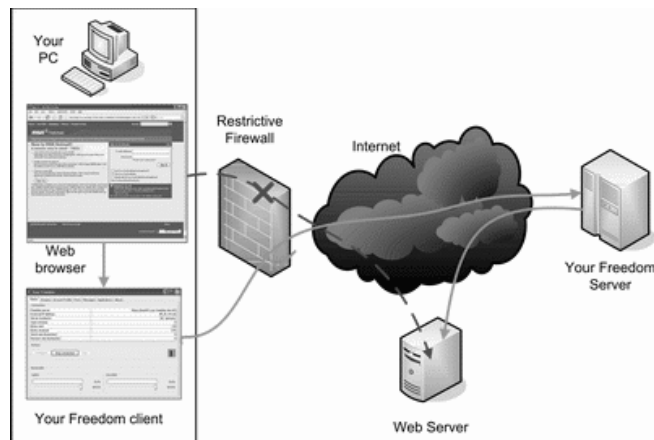

Figure 2. Bypassing Security Policy through VPN [6].

4) Malware: Malware can also perform encryption and HTTP encapsulation. A *trojan*, for instance, can estabilish a connection to a bot-net, delivering full-control of the host to the attacker. The traffic can also be encrypted, hiding it from detection of the network administrator.

5) BYOD: The BYOD ("Bring Your Own Device") [7] trend will presents a new defy to corporations in the next years. Nowadays, it is increasing the number of personal gadgets (smartphones, tablets, notebooks) connected to the corporate network. Generally, these devices are outside the scope of the enterprise configuration management, needing specific rules to be in compliance with the corporate security policy.

6) Mobility of the information: Even if the perimeter were perfect, it assumes that all assets remain inside. However, with the use of laptops, smartphones and pen-drives, valuable information leaves the organization all the time, in a totally unprotected way, bypassing both physical and electronic perimeter.

III. DE-PERIMETERISATION

In order to deal with the risks ignored by perimeter-based security, a new approach began to be investigated in the last decade. In this approach the security is brought close to the data, which are, ultimately, what we want to protect.

Figure 3 outlines the 'De-perimeterised' [1] model of security, which can be compared to the 'Rings of Trust' model showed in Figure 1. In the conventional model each ring establishes a perimeter that protects the interior of what is around them, providing communication from the "secure" to the "insecure". On the other hand, in the de-perimeterised model data is considered independent of context and does not depend on the application, operating system or network to remain safe.

It this in this scope emerges, based on studies of the Jericho Forum [8], a new vision of network security, centered in the concept of de-perimeterisation: it breaks up the traditional view of the network as a finite space, with interior and exterior sides and a perimeter separating them. According to the Jericho Forum, modern computer networks face a so wide variety of threats that the only reliable security strategy is to protect the information itself, rather than the network or the rest of the ICT infrastructure of the organization.
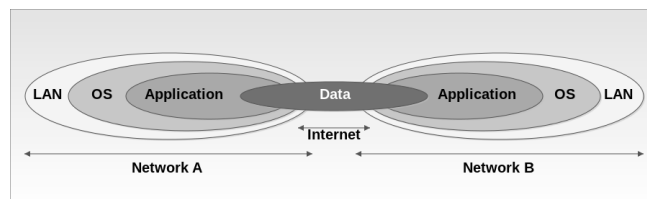

Figure 3. De-perimeterised Model of Security [1].

A. The "four-phases" toward de-perimeterisation

According to the Jericho Forum, all organizations must go through four stages to reach the point where they can develop their business processes safely in a completely de-perimeterised environment:

- **Phase 1**: Start leaving the perimeter. The first step of de-perimeterisation is making web applications leave the border of the corporate network, approaching people who will use them.
- **Phase 2**: Relaxing the perimeter. At this stage, one abandons claim to increasingly strengthen the perimeter, focusing on the availability of transport schemes of encrypted data and authenticated access to organization internal data.
- **Phase 3**: The perimeter ceases to exist. At this point, the encryption has already reached the data level and an authentication mechanism is already implemented in the connection level - thus eliminating the need for perimeters.
- **Phase 4**: Communication without borders. Business processes are already operating in a totally de-perimeterised environment. Data presents global security properties, which are directly handled in the endpoints. Mechanisms for identity management, authentication and authorization are distributed through a network of federated trust.

B. Missing items to accomplish a borderless network

Despite of being an interesting proposal to improve security in nowadays computer networks, the de-perimeterisation

paradigm lacks most of the parts needed to accomplish its four phases. Mechanisms such as authentication at data level and federated identity management are still in the conceptual universe.

Phases '1' (start leaving the perimeter) and '2' (relaxing the perimeter) could be immediately applied, if systems were equipped with an effective validation tool for identity checking. This is one of the items present on stage '4' (communication without borders), which states the need for mechanisms of federated identity, authentication and authorization. Only then stage '3' (the perimeter ceases to exist) could commence.

We conclude, therefore, that the path to de-perimeterisation necessarily involves the adoption of a safe and efficient mechanism for federated identity, which is studied in the following.

IV. A STRONG FEDERATED IDENTIFICATION MECHANISM

A. Opting for smart-cards

Remote user authentication using smart cards is a good solution for many e-based applications [9]. Comparing different authentication mechanisms used for Internetbanking [10], smart-cards based on a PKI infrastructure (X509 certificates) earned the highest evaluation in the security category (along with SIM chips), although they present less economic and convenient features when compared to other traditional methods (user/password pairwise, for instance).

Considering the corporate world, smart-cards could easily be adopted. In fact, many companies are replacing traditional name tags with smart-cards, providing a value-added badge - their adoption, thus, wouldn't create a considerable economic impact. Unlike the Internetbanking enviroment, the use of smart-cards could be extremely convenient, given that porting id-badges is a common practice in the corporate environment (often a rule of the company).

B. Using SAML to provide federated identification

The SAML (Security Assertion Markup Language) [11] is a XML-based framework designated to provide mechanisms of authentication and authorization. It defines an open data format for creating and exchanging security information between online partners.

For the purposes of this work, SAML was chosen as it enables SSO (Single-Sign-On) and the separation between the authentication process and the service access, delivering federated identification in a WebService manner. Also, SAML is a recommended standard in the e-PING [12], the official brazilian interoperability pattern for e-government.

As stated by SAML, three participants take place in the authentication/authorization process:

- **Subject:** the entity to be authenticated. It can be a person, a computer, an organization. Also known as 'principal'.

- **IdP:** the Identity Provider, which performs the authentication process and generate assertions about the 'principal'. It is the *asserting party*.
- **SP:** the Service Provider, the system which the 'principal' intends to access. In the SAML context it acts as the *relying party*, consuming assertions generated by the IdP. One SP can rely and trust in different and independent IdPs, thus creating a federated identity network surrounding that service.

The UML (Unified Modeling Language) sequence diagram of the federated identification mechanism proposed is shown in Figure 4.
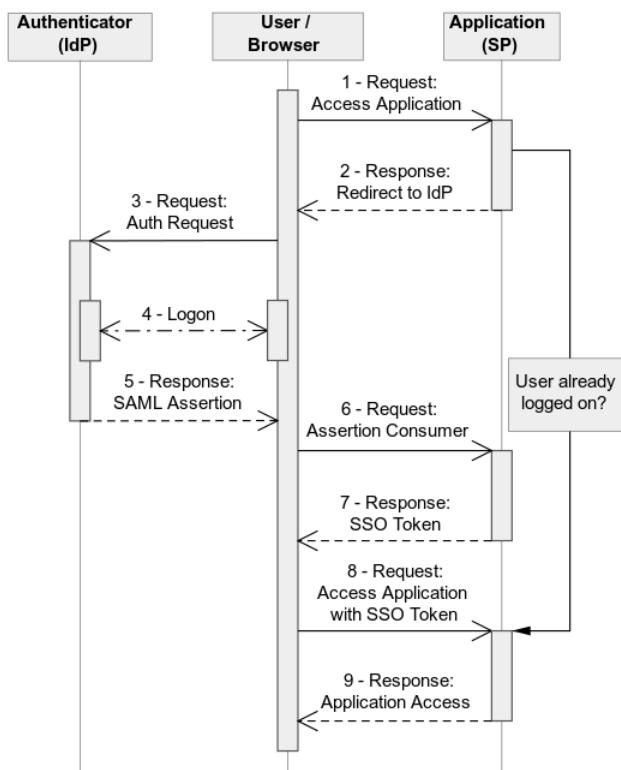

Figure 4.   Sequence Diagram of SAML Federated Single-Sign-On.

C. The Logon Process

As shown in Figure 4, the logon process acts apart the entire SAML SSO process. The SAML framework does not defines *per se* a specific implementation for the credential validation of the principal, as it depends on specific enviroment issues (legal restrictions, institutional requirements, users database, directory model, and others).

Figure 5 shows the UML sequence diagram of the logon process for SAML identification through smart-cards.

V. IMPLEMENTATION AND RESULTS

The proposed federated identification mechanism was implemented in Java language, through a combination of an applet and a servlet.
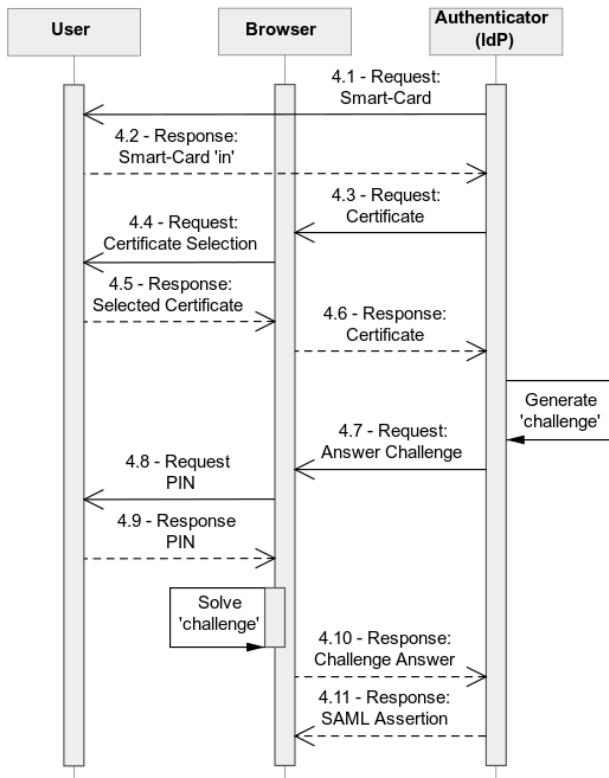
Figure 5. Sequence Diagram of Smart-Card Logon Process.

Since the operation with smart-cards needs communication with PKCS#11 libraries in the local computer file system, a signed applet was designed to interface with the user and his smart-card. The servlet, by his turn, is responsible for dealing with the SAML protocol. This design increases performance and security, because reduce the size of the applet (speeding up the loading process) and protects the IdP private key (stored on the server running the servlet), used to sign the SAML assertions.

The applet is loaded when an application compatible with SAML (SP) redirects the browser to the identification mechanism (IdP), carrying a <samlp:AuthnRequest> element in the URL (steps 2 and 3 of Figure 4). After initialization, the applet performs the logon process (Figure 5), asking for the user certificate and PIN code to access the cryptographic functions on the smart-card. The applet loads the "User Alternative Names" (present in the user certificate) and send then to the servlet.

The servlet, by his turn, receives the "User Alternative Names" and creates a signed <samlp:Response> element, which contains an SAML assertion with the user attributes. The browser is redirected to the application assertion consumer, which validates the <samlp:Response> and creates a SSO Token, allowing access to the service.

A. Tests

The mechanism was tested with third party tools and implementations of the SAML protocol. For tracking the SAML messages, it was used the SAMLTracer [13], a plugin for the Mozilla Firefox browser.

To validate the IdP feature of the mechanism, two SP reference implementations were used: SimpleSAMLphp [14] and TestShibTwo [15]. In both cases, the proposed federated identification mechanism sucessfully was able to receive and process the <samlp:AuthnRequest> from the SP, perform the user authentication, and generate the <samlp:Response>, which was validated by the application assertion consumer.

VI. Conclusion and Future Work

This work presented the problems of the traditional perimeter-based security view, exploring the risks of maintaining this approach in a corporate environment. It was shown that a new paradigm, called de-perimeterisation, has been studied in recent years, and is designed to deal with problems ignored by the perimeterised security model. However, this new approach of security lacks certain parts to be implemented, especially a safe and effective mechanism for federated identity. For this goal, a proposal was presented, using the SAML framework and smart cards, being the main contribution of this work.

This proposal was implemented using Java language, through a combination of an applet and a servlet. This design aimed to improve perfomance and security to the developed mechanism.

It was performed a set of tests using third party reference implementantions of service providers (SP), proving the effectiveness of the mechanism.

As future work, it is intended to apply the the proposed authentication architecture in a real corporate network, accomplishing phases '1' and '2' of the de-perimeterisation process.

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