Comparative Evaluation of Alternative Addressing Schemes

Konstantin Clemens
Technische Universität Berlin
Service-centric Networking
konstantin.clemens@campus.tu-berlin.de

***Abstract*—Alternative addressing schemes are developed to be flexible and user friendly, while at the same time unambiguous and processable in an automated way. In this paper, four schemes are compared to WGS84 latitude and longitude coordinates - an addressing scheme for itself. An experiment with human users checks how user friendly the various schemes are and what classes of errors the users make. The results show that comprehensible and recognizable address elements are contributing towards a user friendly address scheme.**

Keywords–Geocoding; Address Schemes; Geohash; GIS.

I. INTRODUCTION

Nowadays, when referencing a location, most often postal addresses are used. That is because postal addresses are especially easy to use: A postal address is a compound of entities such as city, district, or street names. Obviously, addresses make more sense with more knowledge about the area of a specified destination: The destination can be located more accurately. At the same time, if an address refers to a location someone has little knowledge about, only the rough area is identifiable. Interestingly, this correlates with the usage pattern of an address: Users would want to recognize nearby addresses, while they would not care about the precise location of an address in a distant and unfamiliar city. Thus, humans can resolve addresses to a level that that matches their need and knowledge about the destination. Generally, the ways postal addresses are put together in various countries are specified by multiple organizations [1]. It is a special challenge to process postal addresses automatically, because in various countries different, often times not compatible, schemes for postal addresses are used [2]. Also, different address elements are reused in different addresses, when, e.g., a city name is also the name of a street in another city, or when multiple cities share the same name. Multiple on-line geocoding [3] services like [4], [5], or [6] resolve postal addresses into their WGS84 coordinates [7]. This process, however, is complex and error-prone [8], [9].

For that reason, *alternative addressing schemes* (AAS) are developed, that strive to provide both: Addresses that are easy to comprehend and to remember for a human, while also unambiguous and simple to process for a computer. However, while postal addresses grew naturally as needed, AAS are designed by hand. Key differences worth pointing out are:

1) Instead of points on the globe, postal addresses reference abstract entities, like groups of buildings, single houses, or specific entrances. A postal address of a house would remain valid, if the house is rebuild so that the main entrance moves along the street. AAS reference specific points or areas on the globe instead, so that a rebuild house could require a different alternative address.
2) AAS reference points or areas on the globe, which can be empty spaces or even open water. While a valid postal address can only address existing entities, perfectly valid AAS can reference any point on earth.
3) Postal addresses resolve to a variable degree of accuracy, as it is required. In urban centers, where many entities are to be addressed in a small area, multiple postal addresses address every single one naturally. In some cases additional address elements are added to, e.g., specify a lot within a mall with one house number. In rural areas, on the other hand, postal addresses may refer to areas with groups of buildings. AAS uniformly resolve to a fixed accuracy on the entire globe.
4) Postal addresses are composed from geographic area names as cities and regions. These areas usually have existed for a long time. Because of that, their names are well-known and easy to remember for humans. Elements of AAS on the other hand are, yet, mostly opaque for a user.

In this paper, five AAS are evaluated for their user experience: One AAS is provided by the service what3words [10]. Three words are used to identify a location. Mapcode [11] is a service that generates very short Geohash keys. Geo-poet [12] is another service that encodes Geohashes in rhymes of four words. Finally, Syllagloble [13] is another Geohash based system generating human-friendly Geohashes out of syllables. While the former two services are available and competing on the market, the latter two systems have been implemented for this paper solely. WGS84 coordinates can, as the four AAS, address any point on the globe. These coordinates make an addressing scheme for themselves. Therefore, WGS84 is used as the base line addressing scheme.

An experiment has been conducted revealing how well various AAS can be remembered for a short time. The experiment gives insight into the classes of mistakes done when using AAS. Next, the various schemes are described in detail. In Section III, the experiment and its outcomes are presented. Finally, the conclusions are drawn in the last section.

II. ADDRESSING SCHEMES

As base line, WGS84 is used in this paper. In this scheme two orthogonal plains meeting in the center of the earth are defined. Every point on the surface is described by a vector from the center of the earth to the point. Vectors are specified by WGS84 latitude and longitude coordinates, which are the two angles between the vector to the two plains. These angles can thereby be arbitrarily precise.

Three AAS evaluated in this paper are based on Geohashes. Geohashes are keys of Quadtrees [14]. There are various ways to implement a Quadtree that all share the same basic idea: Areas or tiles, e.g., squares, rectangles, or even triangles [15], are split into a fixed number of smaller sub-tiles of the same shape. This process is repeated, until the desired size of a tile is reached. Keys of Quadtrees consist of multiple parts. Each

 ISBN: 978-1-61208-469-5

TABLE I. EXAMPLES OF LOCATIONS ENCODED WITH VARIOUS SCHEMES

	WGS84	what3words	Mapcode	Geo-poet	Syllagloble
Berlin	52.5167,13.4	dramatic liner common	VJMMB.60XJ	requesting emanation entitles demarcation	lay uxri mes ixsi
London	51.50642,-0.12721	crush activism proven	VHGQZ.RD3J	debenture consummation lamented dissertation	lac ekha kam etni
Paris	48.85693,2.3412	national slope delved	VHPM9.JZKN	unvarnished usurpation covalent obfuscation	lac igpi dav avba
Rome	41.90322,12.49565	shoebox inflame speaker	TJLFF.MR0Y	unfairly inspiration prepayment conflagration	sab isca poc uhvi

next part thereby specifies the next sub-tile to split. Having a Geohash on-hand (and knowing the way it has been computed), therefore, specifies the last sub-tile – an area inside the original space covered by the Quadtree. A Geohash that starts on a tile spanning the entire world can be used as an addressing scheme, with one extra property: Common prefixes of two Geohashes imply that the two areas addressed are located close to each other. Note, however, that differing prefixes do not imply that two areas are far apart.

Geo-poet is an address scheme that uses Geohashes. The system has been developed for this paper. Geo-poet tries to create human friendly and easy to remember Geohashes by using spoken language. Particularly, for every part of the Geohash, Geo-poet chooses a word from a specific set. The words for each part are thereby chosen so that a distich, i.e., a poem with two lines and four words, is formed. The corpus of words used in this system are taken from [16]. From this collection of words that are annotated with possible pronunciations, 289 rhyming and 5929 non-rhyming words with a specific metre have been picked. Beginning with the outer tile covering the entire world, for each word of the poem, the current tile is split in either 289 or 5929 sub-tiles, depending on whether the next word should rhyme or not. This way, Geo-poet is addressing tiles with an inner diagonal not longer than $26.1m$. This maximal distance between two points on the globe having the same Geo-poet address is reached along the equator.

A system similar to Geo-poet is Syllagloble. Similar to Geo-poet, it strives to provide easy-to-use Geohashes and has been developed for this paper. Instead of words, however, syllables are used in this addressing scheme. From a corpus of words, 13666 most common syllables have been picked so that they are easy to combine. The generated Geohashes are words that are fourteen characters long and assembled of four syllables. Thus, beginning with the outer tile, tiles are split four times enabling Syllagloble to address tiles with a diagonal not longer than $7.7m$ using a word that is easy to pronounce.

Mapcode is another system based on Geohashes, so called Mapcodes that are assembled from letters and numbers. The goal of this system is to provide Mapcodes that are short and easy to use. For that, next to global Mapcodes, many regions are also addressed with regional Mapcodes. Since the starting tile of the Geohash only need to span a region for regional Mapcodes, very short Geohashes may be used. E.g., for the region of Netherlands just four characters are addressing tiles with ca. $10m$ diagonal. The back side of regional Mapcodes is the required context, which is specifying the outer tile of the Geohash. Therefore, regional Mapcodes are out of scope for this evaluation. Only global Mapcodes with no need for context, nine characters, and roughly the accuracy of the regional tiles were used. However, Mapcode is flexible enough to provide more accuracy where needed: As with Gohashes in Quadtrees, longer Mapcodes address smaller tiles.

Another alternative addressing scheme is what3words. Like Geo-poet it uses words to encode tiles with ca. $4m$ diagonal length. However, what3words uses three random words for that and is not Geohash based. Therefore, unlike in the three previous systems, common words do not imply that two locations are close to each other. Also, changing the order of the words describing one location results in another unrelated location being addressed. The actual algorithm behind what3words is not public.

Overall, all AAS seem to be more user friendly than plain WGS84 coordinates. Also, their accuracy has the same order of magnitude: Although addressing areas and not points, all seem suitable to specify a navigation destination for a human user. Table I presents some locations encoded with each AAS. Note that Paris and London have a (very short) common prefix in Mapcode and Syllagloble. That means, both cities are in the same tile addressed by the first part of the Geohashes.

III. EXPERIMENT

The measurement undertaken for this paper is disguised as a memory quiz and is available at [17]. Not more than six participants knew the rational before taking the quiz; most of the participants followed a link advertised on various social media. Since the quiz is set up as simple as possible, it is not possible to map answers to specific participants as they are not required to identify themselves. The quiz consists of five parts, one for each AAS. Each part consists of eight questions: Eight times a specific point on the globe is encoded with the respective scheme and shown to the user for four seconds. After that, the participant has to pick the previously presented result from a list of eight possible answers. Besides the right answer, one incorrect choice within $50m$ distance of the correct answer is generated as well as six more distant options. This way, the experiment not only observes how often the correct answer is chosen. It also observes how often an incorrect choice that is close to the right answer is picked by the user. The quiz is laid out in a way that ensures only complete participations with answers to all 40 questions are taken into account. While the quiz is still on-line and collecting data, this paper only considers the 2600 data points of the first 65 participants.

The measurement results are visualized in Figure 1. The bars for each AAS are split into three parts: A part visualizing

 ISBN: 978-1-61208-469-5

the portion of the correctly picked answers, a part for those answers that were not correct, but within 50m of the correct answer, and a part for incorrect and far-off results given. Note that to highlight the differences, the bars begin at 80%.

Looking at the correct answers, the AAS can be put into three groups: With 82.8% hit rate WGS84 is the least rememberable scheme. Mapcode and Geo-poet have 92.9% and 91% correct answers respectively and therefore are clearly more user friendly. Using what3words 96.5% and using Syllagloble 96.9% of the participants were able to recall the encoded position correctly.

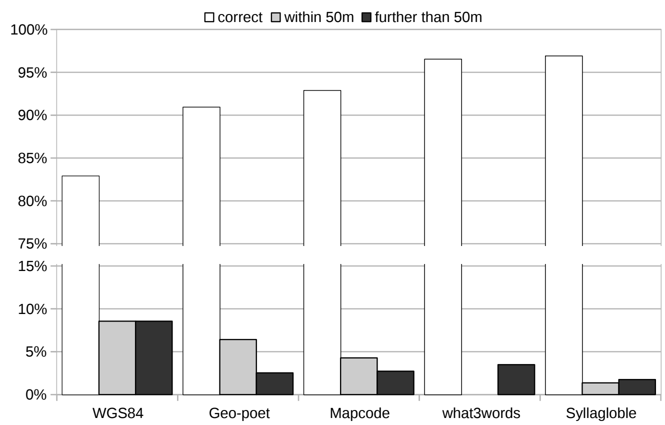

Figure 1. Error types and rates of the various alternative addressing schemes.

A closer look at the splits of the incorrect answers reveals that these are not evenly spread for the various systems. For what3words, all incorrectly picked choices were further away than $50m$ of the correct answer. Of the other AAS, most noteworthy 71.1% of incorrectly chosen answers for Geo-poet were close to the right one. Geo-poet is followed by Mapcode with 61.1%, WGS84 with 50% and Syllagloble with 43.7%. All these rates of incorrectly picked answers near the correct one are extraordinarily high: If the incorrect answers were picked at random, only 14.3% of them would have been within $50m$ radius as it is only one of the seven possible incorrect answers. Note that in total only 18 answers of what3word and 16 answers of Syllagloble encoded addresses were answered incorrect. These numbers are small enough to not represent the proper distributions of the incorrect choices.

IV. CONCLUSION

While still pretty easy to remember in the quiz, WGS84 coordinates are the least human friendly addressing scheme. This is not surprising, as WGS84 was not designed with the human use case in mind.

Geohash based AAS benefit from the common prefix property: Users often remembered parts of the address picking a wrong but similar answer. Wrong choices often become less critical therefore, as they are not too far off from the actual location. This effect is also observable with WGS84 latitude and longitude. While not exactly a Geohash, coordinates with common prefix are closer to each other too.

Interestingly, adding one single word to a scheme seems to make remembering it much harder: The ratio of incorrect answers grew from 3.4% with what3words to 8.9% with Geo-poet. At least partially, this is caused by the words chosen by what3words and Geo-poet. A look at the words in Table I strengthens this assumption: The words of what3words are all shorter. They are therefore easier to remember them selves. Potentially, Geo-poet can be made more user-friendly by tweaking the words used to encode a location. Similarly, carefully choosing the syllables used by Syllagloble, might ensure that it generates words that are even easier to recall.

A long-term experiment setup could verify how well users remember various AAS over a longer time frame. Such an experiment would also reduce the presentation bias. For example, in the experiment for this paper the AAS were always evaluated in the same order, one after the other. Moreover the choices for Geo-poet were presented using two lines each, while for every other AAS the choices only used one line. That made the result list much longer so that a participant was more likely required to scroll to the right answer. Also, a comparison to postal addresses needs to be undertaken. Such a comparison is not fair: As discussed, addresses are not covering the entire world and have a varying accuracy. Still, AAS need to gain acceptance over postal addresses if they intend to replace them in day to day use eventually.

Some of the introduced AAS work with predefined corpora of possible address elements. Geo-poet and what3words have specific sets of words; Syllagloble has definite syllables available. This property can be utilized to introduce error correction. For once, valid possibilities could be suggested as the user types. Finally, implicit error correction could be incorporated into the Geohashes. Addresses, misremembered to a certain extent, could still be resolved correctly this way.

REFERENCES

[1] S. Coetzee, A. Cooper, M. Lind, M. Wells, S. Yurman, E. Wells, N. Griffiths, and M. Nicholson, "Towards an international address standard." 10th International Conference for Spatial Data Infrastructure, 2008.

[2] K. Clemens, "Automated processing of postal addresses," in GEOProcessing 2013, The Fifth International Conference on Advanced Geographic Information Systems, Applications, and Services, 2013, pp. 155–160.

[3] D. Goldberg, J. Wilson, and C. Knoblock, "From text to geographic coordinates: The current state of geocoding," URISA-WASHINGTON DC-, vol. 19, no. 1, 2007, p. 33.

[4] "Google Developers," https://developers.google.com, Dec. 2015.

[5] "Yahoo! BOSS Geo Services," https://developer.yahoo.com/boss/geo/, Dec. 2015.

[6] "Yandex API," http://api.yandex.com, Dec. 2015.

[7] Defense Mapping Agency, "Department of defense world geodetic system 1984: Its definition and relationship with local geodetic systems." Navtech Seminars & Book and Software Store, Incorporated, 1993.

[8] K. Clemens, "Geocoding with openstreetmap data," GEOProcessing 2015, 2015, p. 10.

[9] C. Davis and F. Fonseca, "Assessing the certainty of locations produced by an address geocoding system," Geoinformatica, vol. 11, no. 1, 2007, pp. 103–129.

[10] "what3words," https://map.what3words.com/, Dec. 2015.

[11] "Mapcode," http://www.mapcode.com/, Dec. 2015.

[12] "Geo-poet," http://geo-poet.appspot.com/, Dec. 2015.

[13] "Syllagloble," http://syllagloble.appspot.com/, Dec. 2015.

[14] H. Samet, "The quadtree and related hierarchical data structures," ACM Computing Surveys (CSUR), vol. 16, no. 2, 1984, pp. 187–260.

[15] A. Szalay, J. Gray, G. Fekete, P. Kunszt, P. Kukol, and A. Thakar, "Indexing the sphere with the hierarchical triangular mesh," Microsoft Research, Tech. Rep. MSR-TR-2005-123, Sep. 2005.

[16] Carnegie Mellon University, "The CMU Pronouncing Dictionary," http://www.speech.cs.cmu.edu/cgi-bin/cmudict, Dec. 2015.

[17] "Mem-quiz," http://mem-quiz.appspot.com/, Dec. 2015.

