Address encoding versus traditional addressing – the state of play

A solution looking for a problem?

Any discussion around the need for new addressing systems must be grounded in a solid foundation of fact. There is a large amount of disinformation being quoted, requoted and misquoted. I must therefore start this paper by trying to set the record straight.

The number of unaddressed currently on this planet lies somewhere between zero and 2 billion (Rhind, 2015a), depending on how an address is defined. The oft-quoted 4 billion unaddressed has no basis in fact, and has no meaning when "address" is not defined. The source of this figure is a mystery. The most relevant reference to it, and one which is used most often to support this figure, is McDonald (2012), but that paper actually quotes that: "… 4 billion people are excluded from the rule of law because they do not have a legal identity." To extrapolate from this that these 4 billion have no addresses, as being the cause of their lack of legal identity, is fallacious, and easily disproved.

Allowing "address" to mean a postal address, and excluding access to post office boxes, the number of those without an address may be 2 billion. However, as we all occupy a place on the Earth's surface, a set of geographical co-ordinates (latitude and longitude) can be assigned to each of us at any moment in time. This fact is used by location encoding systems as the basis of their codes, and, this being the case, the number of unaddressed could also be argued to be zero.

Those people who do not have residential postal deliveries are not necessarily unaddressed. Even where streets are not named and buildings unnumbered, the inhabitants do not live in a vacuum and still describe their environments in ways which can be accepted as addresses, albeit unofficial ones. "The yellow building past the baobab tree in the street of the ladies of the night" will not mean much to the average tourist but is meaningful to locals, which brings us to the issue of why, and for whom, addresses are required.

An address needs to be fit for purpose – but the question is, whose purpose that is, and how far differing institutions will accept an "address" as such. A great part of the problem is not that people don't have ways of being addressed, but that these ways do not allow them to overcome the issues of being unaddressed as listed below. To the best of my knowledge, for example, no institution currently allows a geographical co-ordinate for a building to be used as an address. Also important to remember is that there can be different solutions to the same problem – it depends on the purpose of the address being created. A code, based on the geographical co-ordinate of a grid on the earth's surface, may be a useful way of providing addressing to slum dwellers where a physical infrastructure, which would allow a normal street address to be provided, is missing; or might enable delivery of help to disaster regions, though a geographical co-ordinate would do that too.

The reasons that people require addresses which are universally accepted is well documented elsewhere, and includes requirements for:

- Representation: voter registration, national identification cards, drivers' licenses

- Healthcare, emergency services, humanitarian and disaster relief
- Law enforcement, regulation compliance
- Education
- Employment
- Urban planning; public utility provision; tax collection
- Geolocation and navigation
- Postal and consumer communication; e-commerce; transportation logistics
- Tourism

Note again, however, that assuming that people who do not have traditional addresses have no access to any of these things is another fallacy – the situation differs everywhere. Assuming, for example, that no child in any slum without street names goes to school is incorrect.

That all said: the need for addresses for those who do not have them, however many they are, is a necessity for providing equal access to many rights and facilities, and working towards an address for everyone is a worthwhile and important project.

Traditional addressing systems

People created and used traditional addresses long before they were acquired and required for postal addressing. We named places, roads and buildings and those indicators, together with some additional tweaks to make addresses unique, such as building numbering and postal coding, were co-opted to create addressing as we largely understand it today. We have created, to a greater or lesser extent, a physical infrastructure to reflect this: place name signs as you drive into a city, street name boards, numbers on houses and so on. Unlike location codes, traditional addresses are written in a natural language which equates with other parts of the address, with the real world and with neighbouring addresses. With a few exceptions, similar addressing systems have arisen independently all over the globe.

Though most people use a traditional addressing system in one way or another, the infrastructure to support it is not in place for a substantial part of the Earth's population. Putting this infrastructure into place can be a time-consuming, expensive and complex process, and not all countries are able or willing to provide the resources necessary to do this.

The huge advantage that traditional addressing has is that it utilises the tangible structures with which we are familiar. We live in a world of thoroughfares (named or not, paved or not), of buildings, of settlements. We travel through them and live with them – they are part of our consciousness and of our mental maps. We speak of a railway station is a particular city, of the supermarket in a particular street and may even gossip about her at number 52, who's no better than she ought to be. Addresses may objectively seem long and complex, but they refer to the real world and have a shared syntax. They are usually structured and hierarchical. Numbers used are usually related to neighbouring numbers in an

identifiable pattern, and addresses usually refer to a building, which is in a street, which is near another street, which is in this part of that city, in this state and in that country. This makes traditional addressing understandable to us, whether that address is in our own neighbourhood or in a different part of the world which is otherwise unknown to us.

Though there are a few exceptions, almost every address in the world is based on similar concepts – settlements, thoroughfares, building names or numbers. Wherever you travel, though you may not recognise the format or even the language, most of the basic tenets are there. It is very easy for a person to remember a street address – much easier than for them to remember a code – and when codes are interleaved into addresses, and so become welded into them, such as postal codes, they also become easier to keep a grasp on. Codes in isolation, especially those unrelated to geography or to other codes, suffer in terms of their memorability, regardless of their brevity or form.

Traditional addresses have disadvantages. Though computerised address recognition and data entry systems have developed a long way in recent years, they can still be hard for computers to interpret and this interpretation can be prone to errors which have financial consequences in sectors such as e-commerce. Though they are fairly stable, especially higher up the hierarchy, place names, street and building names change, new buildings are built and others are demolished; and whilst these changes can be absorbed by traditional addressing systems, occasional re-numbering exercises are required, and data files need to be kept updated, an issue which location encoding systems do not have to deal with.

Anchored in the real world, traditional addresses are also sensitive to political and cultural pressures – disputed areas, disputed country names, undocumented boundaries etc. all create noise, duplication and so on in address systems. Finally, there are those countries and areas which have alternative existing traditional addressing systems, such as those where building numbers are related to building order and not to any geographical proximity to each other, which makes navigation in these areas very hard for non-locals. Interestingly, some location encoding systems have been designed in the same way and would suffer the same problems were they not interpretable though computer apps or websites.

Furthermore, traditional addresses do have a fundamental weakness in that they are designed for indicating the location of people through the location of buildings. In our world we often want to be able to address other objects, such as traffic lights, park benches or lamp posts, and also to be able to address people without needing to address a building, for example, addressing somebody at an alternative location, or to be able to deliver something when a person is outside a building, for example on that currently unaddressed park bench. That said, there is already a working system that does this – geographical co-ordinates. Locational addressing systems are not generally fine enough in terms of their grids to address single objects, and a requirement for them to be memorable is not really there in these cases.

For all the vagaries of many traditional address systems, people, living in a three dimensional world do not easily take to codes, and navigation, conversation and daily interactions are all likely to continue to make use of the world we live in and the names we use for the structures around us. People have an attachment to their addresses, as to their names, which is not always easy to understand, and that attachment would be difficult to break. This is not to say that encoding systems may not have a place in locational definitions, but I contend that their use is restricted and that they could never replace traditional addressing.

Address encoding systems

There is a basic schism between codes, useful for information technology, and traditional addresses, based on infrastructure and useful for humans. Humans don't relate easily to codes when they are divorced from the physical world. Equally, computers may have great problems interpreting notions such as postal addresses, which our brains can interpret without problem. The challenge is to overcome this distance. I believe that this must be done by integrating codes into the physical world. Generally, people have few problems in remembering codes which are part of addresses, such as postal codes. I believe that codes on their own, regardless of length or form, are easier to forget when they are divorced from the real world.

There is an assumption that the longer a string, the harder it is to remember. This is less the case when that string has a relevance to us and can be related to our real-world experience. Even in the cases of codes, if codes contain items we can recognise easily, such as standard abbreviations for cities (as is the case for postal codes in the United Kingdom, for example) they become much easier to remember – length is not all important.

In real life we need to remember much more than just our own location. We need to remember the addresses of our friends, our relatives and those businesses and institutions we transact with. In many cases, where we are lucky enough to have access to the tools, we are able to hide all this information behind buttons, and there is less requirement to remember them. I don't need to remember telephone numbers – they are hidden inside buttons on a telephone pointing to those contacts to whom the numbers belong. Similarly, people who use geographical co-ordinates every day don't need to remember them. They work with online maps, GPS systems and other tools to do the work for them. What I do not have, and what I do not foresee, is that we start hiding the contact names themselves behind codes. Those are people, tagged with (sometimes) long and complex names, but as part of our real-world experience, we interact with them without codes. And this is the case with traditional addressing – hiding real addresses behind codes is an anathema to many – it makes no sense. They are part of our world. Equally, were we to start hiding locations behind icons on technology then the requirement to have these codes is weakened – they could all be based on geographical co-ordinates as the requirement for memorability would be removed.

In this respect, I cannot see any coded address system replacing traditional address systems where they are mature, though I can foresee a certain take-up of codes if they are perceived as providing an advantage for the user (e.g. through their adoption by e-commerce sites) or where they become part of traditional addresses, as postal codes currently are in many countries. For those parts of the world which do not have traditional addressing infrastructure and where the local population use their own, unfixed, names for streets, whilst positional coding systems may provide a temporary fix, a traditional address infrastructure should be the final aim – they allow people to share their world with others in ways that codes do not.

As previously stated, the aims behind creating addressing systems will define how well or poorly traditional or encoded addressing will work. An aim, for example, to fast track countries to economic development and allow mail deliveries anywhere may lead to one address system being preferred above another; whereas an aim to provide people with addressing supported by local infrastructure would suggest that the adoption of a different addressing system being better. Addresses have many divergent requirements, which, with technological advantages straining traditional addressing systems, has resulted

in the fractured growth of alternative addressing systems, none of which, in my opinion, are yet well-placed to provide a complete replacement for traditional addressing.

Encoding addresses is not a new idea. Some systems have been around for over two decades, and latitude and longitude information clearly a long time before that. They have not been widely adopted, and whilst this is partially due to the wait for the technological infrastructure to become widely available, I would suggest that it has a lot more to do with these codes being poorly thought through and being not always related to the real world situation. In some cases, there's clear evidence of developers working in technology bubble, where codes have been thought up in isolation and clearly should work, but, without taking account of the real world and of user idiosyncrasies, clearly won't.

One of the major weaknesses of certain address encoding systems is their lack of hierarchy and their lack of a link to real world structures. Without this link to our world, and without a link to each other, codes become even less useful to humans – we have more problems interpreting them, without the aid of decoding tools. As an aside, codes without a hierarchical, geographical element are useless as a way of zoning or coding areas. In many countries, postal codes are used to define areas for the purposes of educational zoning, insurance risk, mean income and so on – this cannot be done with non-hierarchical and random codes. We also cannot close our eyes to the fact that, in many cases, codes have been developed with a profit motive in mind, so are skewed in their usefulness to resolving certain commercial problems of traditional addressing whilst ignoring the social aspects of addressing.

Error tolerance

Many creators of codes cite a reduction in the number of errors and variations that a user will make in entering a code as opposed to those made in entering traditional addressing in support of their systems. This is, however, a fallacy, because traditional addressing contains contextual information that reduces the impact of errors. For a human (though, admittedly, less so for a computer), interpreting

12 Mane St, NY NY 10956

as

12 Main Street, New York NY 10956

is no problem at all. For codes, especially those which are intended to replace traditional addressing rather than be integrated with it, a single dropped, transposed or mistyped character will make the code worthless as a locational tool. Note also that, in my experience, people are more likely to make errors in codes that relate to something non-tangible than to those parts of an address that represent a real object. Thus, I find that people are more likely to mistype a postal code than a house number. Errors in traditional addressing are less likely to affect its usefulness as a locational tool.

Technology and infrastructure

All mapping and addressing systems have some requirement for information provision, be it infrastructure (street name boards, place name signs, building numbers), maps, navigation devices or electronic interpretation via a website or app. For some systems, additional resources such as an internet connection or a mobile phone make their interpretation easier or are a requirement. Requirements such as these will always, by definition, reduce the universality of any solution – there will never be a time that every individual on this planet has access to all the resources required.

By their nature encoded addresses require a level of access to technology not available in many parts of the world. Only by creating a link to the real world, by creating an infrastructure in support of any encoding system, would I expect widespread adoption to follow. Creating infrastructure – signage, building numbering etc. – can be expensive and slow, especially when mired in unnecessary bureaucracy. Encoding systems can reduce the cost of infrastructural improvements and, whilst I continue to question the memorability of codes and systems which are not based on natural language and local knowledge and culture, as a short cut to providing addresses to those without them, it is a potential path to follow. I contend that only encoding systems with a direct link to local infrastructure can be a successful replacement of, or enrichment of, traditional addressing.

Open/Free

Some code systems are free and open source or, like traditional addressing systems, made available through social and political structures. Others are commercial and charge either the end-user or institutions (or both) wishing to implement their solution. By their very nature, commercial solutions are more prone to failure and certain solutions are more prone to gremlins – websites down, lack of signal or internet access, battery failure etc. – which those systems supported by a physical infrastructure do not have.

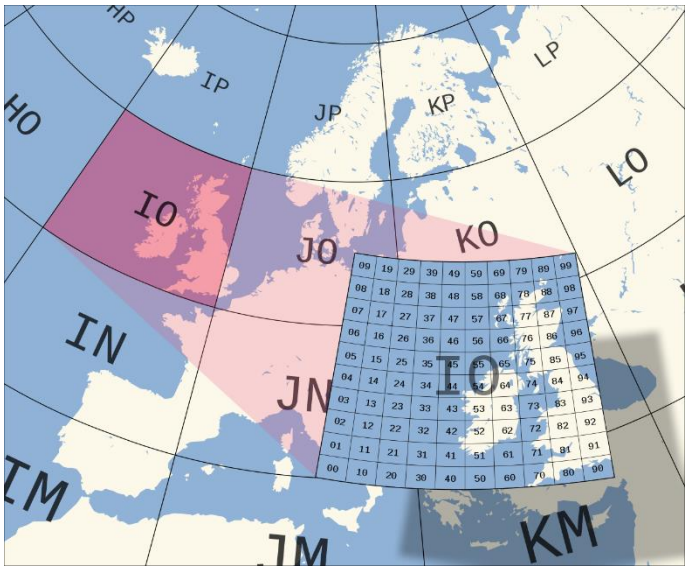
Address and location encoding systems developed up to now tend to fall into one of three main categories: delivery platforms, geographic co-ordinates-based (location encoding systems), and building-based (building encoding systems).

Delivery platforms

These are not addressing systems as such. They provide a digital platform (and, sometimes, a code) which allows users to link their code or login details to a number of optional delivery types and identifiers – e-mail, mobile phone number, geographic co-ordinate, postal delivery address etc. The user can use these online platforms to add, change or delete delivery information, such as an address, and allow users to specify different delivery requirements for different originators, times of day and so on. These systems could, in principle, use any of the other address encoding systems as a delivery type for their users. Users do not have to remember their code. These platforms require users to have a certain access to technology, such as an internet connection and/or a mobile phone, and could therefore never be a universal addressing solution. This type includes:

- edress - http://www.eddress.co/
- Exaactly - https://exaactly.com/
- Fetchr - https://fetchr.us/
- Locpin - https://www.locpin.com/
- Ship2MyID - http://www.ship2myid.com/

Geographic co-ordinates-based – Location encoding systems



Latitude and longitude is an existing system which allows any spot on the Earth's surface to be pinpointed. Its disadvantage is that it is a long number, may contain negative as well as positive numbers, and is difficult to remember. For the purposes of addressing, an exact point is not usually a requirement (though it would be to address objects such as lamp posts and park benches) so most systems using geographic co-ordinates as a basis have split the earth into same-sized grids (of various sizes) which enables them to reduce the length of any code required whilst still pointing to a square on the Earth's surface which, for most purposes, is accurate enough to locate a building or a group of objects. As these codes are built on an existing system, any suggestion that they create addresses where previously there were none is specious. Their usefulness is also limited where geographical co-ordinates can be used instead, such as for disaster relief.

Much effort is made to make the codes more memorable than geographic co-ordinates – they are shorter and remove the positive/negative values problem. Being memorable, however, cannot be the be all and end all for these codes. Without having a clear advantage for users, and without them being integrated into our mental maps and three-dimensional world, adoption is likely to be sluggish at best.

These systems have the advantage that they are immediately available and are future-proof – once a code has been created for any grid on the planet, that code can be fixed for a long time. A further advantage of a system which is divorced from the real world is that it overcomes issues of disputed and dynamic borders, disputed naming, countries coming into and going out of existence and so on.

Most of these systems have a technology requirement, as least at the initial stage. Users may have to have a GIS-enabled smart phone and be located at the location in question to be able to request the code. Other systems require the user to drop a pin on a map. In either case an internet connection or mobile phone access and connectivity is required. Map-reading is not a skill that everybody has, and certainly not in many less-developed regions that these encoding systems are purported to have been created to help, and mistakes are inevitable. Help through satellite imagery or Street View is not always available, as it may be limited by technology or by legislation.

Some of these codes are flexible and hierarchical inasmuch as the longer the code, the smaller the area to which it refers. These codes are often created to be replacements for traditional addressing. By definition these codes could be available universally but some systems are based only on a national territory (thereby further reducing code length).

Like the geographical co-ordinates upon which they are based, these codes resolve to a two-dimensional plane on the Earth's surface and therefore, without alteration, cannot be used to indicate height, so that many people, for example in tower blocks, may share a single code. This can be resolved by adding additional information to the codes, such as names, floor and apartment numbers, but this then weakens the claim that these codes are, in and of themselves, a replacement for traditional addressing without there being any need to integrate them into real world information. Some have suggested that this can be resolved in future through technological developments, such as the inclusion of altimeters in mobile phones, but this again pre-supposes the idea that all people everywhere have equal access to this type of technology. In their current form these codes could be used for, for example, navigation, but are less useful for, for example, emergency services, deliveries etc., where a more defined point may be required.

This type includes:

- Addressinghomes - http://www.addressinghomes.org
- C-Squares - https://en.wikipedia.org/wiki/C-squares
- Geohash - http://geohash.org
- GhanaPostGPS - https://ghanapostgps.com/
- GoCode - http://www.gocode.ie/
- Loc8 - http://www.myloc8ion.com/
- Maidenhead Locator System - https://en.wikipedia.org/wiki/Maidenhead_Locator_System
- Mapcodes - http://www.mapcodes.com/
- MPost – http://www.mpost.co.ke/
- NAC (Natural Area Coding) - http://www.nacgeo.com/nacsite/
- Open Postcode - http://www.openpostcode.org/
- Plus Codes - https://plus.codes/
- Posttude - http://www.posttude.com/
- qCodes - https://our-qcodes.com/index.html
- Snoocodes - https://snoocode.com/
- Universal Transverse Mercator (UTM) Co-ordinate System - https://en.wikipedia.org/wiki/Universal_Transverse_Mercator_coordinate_system
- What3Words - https://what3words.com/

- World Meteorological Organization Squares - https://en.wikipedia.org/wiki/World_Meteorological_Organization_squares

Building-based – Building encoding systems

These systems try to improve upon traditional addressing systems by finding ways of encoding the real world into a code, thus allowing infrastructure to be mapped more efficiently and more cheaply than traditional street naming and numbering projects. They suffer similar issues to traditional addressing systems – they need to be dynamic to keep up with changes in the real world, there is always a time lag between changes on the ground and implementation of those changes in any data file, and, like any database, if one stops maintaining the data, its usefulness deteriorates very quickly. As these systems require maintenance, they are more expensive to set up and maintain than location encoding systems. Implementation often goes hand in hand with the introduction of infrastructure to support the addressing system. By their nature, these systems are usually locally- or nationally-based rather than being global. This type includes:

- DIN (Digital Identification Number) - http://www.newindianexpress.com/cities/bengaluru/2017/nov/29/in-a-first-bengaluru-homes-to-have-unique-digital-identification-number-in-next-two-weeks-1713525.html
- Eircode - https://www.eircode.ie/
- eLoc (MapMyIndia) - http://www.mapmyindia.com/eloc/
- Makani - http://www.makani.ae/
- MOC (Munich Orientation Convention) - http://www.volksnav.de
- OkHI - http://www.okhi.com/
- Onwani - https://dmat.abudhabi.ae/en/Onwani/Pages/AboutOnwani.aspx
- Zippr - http://www.zip.pr/hyd/

The fire engine test

The usefulness and applicability of any addressing system can be tested through a simple scenario. We need to remember that true addressing systems mean that we don't just know our own address, but can interpret our environment to allow us to work out the addresses of others.

Imagine that I am looking out of a window and I see that one of the neighbouring buildings is on fire. I call the emergency number and need to explain where the emergency is. In the traditional addressing system this is fairly easy. I know my own address and, if the building is on my street, can work out the

(approximate) building number where the fire is located. If it's on another street, this being an area I know and travel through, part of my mental map, I could usually provide enough information to get the fire engines to the right place easily enough. Even if I'm in a place less known to me – a hotel, for example - I would normally know the street name (if it exists) and the city name where I am, and can provide that information accordingly.

Hierarchical encoding systems can also be useful for this exercise provided a person knows their own code – this is likely in their own home but much less so if they are staying elsewhere. They might have used the code to initially locate the hotel, for example, but have no reason to remember it after that. Random encoding systems fair worse in this respect – without any relationship between the code of where I am with that where the fire is, the only meaningful way of providing the emergency services with information is to start up an app (assuming I have a phone, and the app, and connectivity, and power and ….) and to try to work out where I and the fire are, losing valuable time and being very error prone.

This is just one scenario in many that encoding systems may be called upon to resolve, but I find it a very useful one for cutting through the marketing-speak and identifying systems that really work for people and those which do not.

Traditional addresses are an integral part of the human experience, and attempts to replace or augment them must be more than an exercise in technological innovation.

It is encouraging that many designers of encoded addressing systems are being flexible and adapting their designs to suit the real world requirements and preferences of their potential users. There remain a number who won't recognise any weaknesses of their designs and who forge ahead regardless, with their eyes on a prize which is financial rather than social. From my point of view, for any code to be successful it needs to fulfil a number of requirements:

- It must be hierarchical in form, with codes related to existing addresses, to what's on the ground and to each other. As far as possible they should be usable with, and be able to form a logical part of, traditional addresses, and be compatible with existing delivery systems and the mind maps and existential requirements of the users.
- It must be able to fulfil more than just a small sub-section of the requirements that people without traditional addresses have. It must, for example, take account of sub-building information, be as useful for delivery as for navigation, be able to locate a building but also a human being on the move, be accepted by utilities, to get an ID but also be useful for emergency services, and so on.
- It must be freely available, for both users and providers, and not be subject to the whims of, or financial health of, any private concern. Nobody should be allowed to own anybody else's address.
- It must not be dependent upon any technology that is not, or can't be made, available to any and every person, at all times and in all places. Systems that rely on mobile phone connectivity or internet connectivity, for example, fail this requirement.

Just as the form, coverage and utility of traditional addresses varies widely, so too do address encoding systems. The table below gives a guide to the situation as regards to certain relevant factors, but the situation differs between address and encoding systems.

	Traditional addressing	Building encoding	Location encoding
Passes the fire-engine test	Yes	Some partially	Some partially
Related to the real world	Yes	Partially	No
Hierarchical	Mostly	Somewhat	Partially
Uses natural language	Yes	Partially	No
Memorability	High	Medium	Low
Technological requirements	Low	Medium	High
Works in three dimensions	Yes	Partially	No
Error tolerant	Yes	Partially	No
Open/Free	Yes	Some	Some
Speed to implement	Slow	Medium	Fast
Cost to implement	High	Medium	Low
Stability	Medium	Medium	High
Maintenance requirements	High	High	Low
Sensitivity to political situation	High	High	Low

Encoding systems may have a place in locational definitions, but I contend that their use is restricted and that they could never replace traditional addressing.

With so many systems jostling for position, with many implemented to a greater or lesser extent in small areas of the world, it's hard currently to see any other scenario than that encoding systems provide a new layer of confusion for people trying to get around in the world. Whilst the developers of each system would like to see theirs become the default, the low and scattered adoption rates of each is creating a confusion of addressing systems in some countries from which traditional addressing, with its shared syntax, does not suffer. Inhabitants from one city using one encoding system, travelling to another city and being faced with a different system, will be confused rather than benefitted. Given the number of these systems available – more than thirty that I know of at the present time, and counting – this situation is unlikely to improve.

Selective Bibliography

Cartledge, James (2011): "Addressing the world: How geocodes could help billions start using the mail", https://postandparcel.info/43564/news/addressing-the-world-how-geocodes-could-help-billions-start-using-the-mail/

Chandramohan, Prash (2016): “My New Home: Sugars. Trees. Caring.”, http://www.mdmgeek.com/2016/07/11/new-home-sugars-trees-caring/

Chandran, Rina (20147): “A simple address unlocks new life for Indian slum dwellers”, https://www.reuters.com/article/us-india-landrights-address-idUSKBN16E1SE

Dobson, Mike (2015): “What3Words – Not.Quite.Right”, http://blog.telemapics.com/?p=589

Law, Merry & Rossouw, Pierre: “Addresses and Discrete Grid Systems”, *Mailing Systems Technology*, July-August 2017, pp 44-47

Matthews, Chris (2016): “Finding your way in a country without street addresses”, https://www.bbc.com/news/world-africa-35385636

McDonald, David (Editor) (2012): “Addressing the World – An Address for Everyone”, Universal Postal Union, Bern, http://news.upu.int/fileadmin/user_upload/PDF/Reports/whitePaperAdressingEn.pdf

Pigot, Alex (2016): “The GO Line – A discussion paper on how we can make postal addresses more useful in the 21st century”.

Prescott, Charles (2017): “Tonga adopts what3words as national postal addressing system”, http://www.globaladdress.org/2017/02/04/tonga-adopts-what3words-as-national-postal-addressing-system/

Privat, Ludovic (2015): “what3words: 3 Words to Solve the Lack of Physical Addresses Worldwide”, https://www.gpsbusinessnews.com/what3words-3-Words-to-Solve-the-Lack-of-Physical-Addresses-Worldwide_a5451_3.html

Rhind, Graham (2015a) : “4 billion people without addresses – balderdash”, https://grcdi.blogspot.com/2015/05/4-billion-people-without-addresses.html

Rhind, Graham (2015b): “Do we still need addresses?”, https://web.archive.org/web/20160728084117/http://blog.postcodeanywhere.co.uk/index.php/do-we-still-need-addresses/

Rhind, Graham (2016): “How Google could improve Open Location Codes”, https://web.archive.org/web/20170905224027/http://resources.pcapredict.com/index.php/google-open-location-codes/

Rinckes, D. *et al* (2015): “Location Encoding Systems – Could geographic coordinates be replaced and at what cost?”, https://gogeomatics.ca/location-encoding-systems-could-geographic-coordinates-be-replaced-and-at-what-cost/

Tadepalli , Siddharth (2015): “Want an 8-character code as your address?”, https://timesofindia.indiatimes.com/city/hyderabad/Want-an-8-character-code-as-your-address/articleshow/50360810.cms

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