FUTURE OF ADDRESS INFORMATION IN AUSTRALIA AND NEW ZEALAND

INTRODUCTION

TECHNOLOGICAL DEVELOPMENTS HAVE ALWAYS IMPACTED THE WAY IN WHICH WE LIVE OUR LIVES. WHO KNEW, IN 2008, THAT THE SMARTPHONE WAS GOING TO HAVE SUCH A PROFOUND IMPACT ON THE DEMOCRATISATION OF DIGITAL CONNECTIVITY AND ACCESS TO INFORMATION; ANYTIME, ANYWHERE (WITHIN RANGE OF A MOBILE TOWER)?

The rate of change generated by technology will continue to be fast and outpace the traditional methods that governments have maintained for sharing and use of data and information. It will also create changes that we cannot even begin to imagine – food delivery via drone is not something that the private sector would have contemplated as economically feasible even two years ago.

Big Data, Artificial Intelligence and Machine Learning are terms that are used often along with a multitude of opportunities to solve societal challenges. However, since the technology of today may not be that of tomorrow, the idea of future proofing data interoperability and usability is important. Platform-agnostic solutions based in well-architected and documented modelling and open standards will enable data collected today to be used and reused/shared continually across the future.

These same strategies will also contribute to an efficient public sector which the citizen trusts to deliver services; enter customer data once and by default it will be shared safely across other services that the citizen indicates they need, which will change over their lifetime. It will also result in less reporting and registration by the business sector, faster digitisation and fewer errors in dealing with government, and new opportunities to develop data-based services due to common data repositories.

There is data that public authorities use and depend on in their daily business, such as: personal, business, property, address, geographic and income data, etc. This data needs to be accurate, up-to-date and readily accessible across the different government sectors that use them.

At present, the above data is likely stored and defined differently from one government agency, or level of government, to another. For example, Cadastre, land registry, business register, and the utilities sector would all hold address information and personal information that may have useful additional information only available to that particular database holder rather than across the public sector as a whole.

The future of addressing will not just be the modern technical delivery of the information. It will also be unified for discovery, access and use across government organisations and service providers, for the benefit of citizens. By enabling "address" to be an index into a range of sources of detailed information, the machine readability of a semantic address model will allow all that information to be discovered and accessed. This future will require both a social and technical approach and solution.

THE ADDRESSING STRATEGY NOW

The members of the ICSM AWG are representative of the public sector addressing aggregators and understand that the expectations and demands of both government and citizens are constantly changing. They also understand that the addressing supply chain must be continuously maintained and developed; for example to handle the mobile platforms and new operational concepts such as cloud computing. However, they know that the public sector does not have the financial resources to reactively change to meet these demands without a plan.

The ICSM Addressing Strategy 2035 is an outwards communication piece that dedicates space to outlining the need for a modern and integrated approach to address creation, discovery and use. The pillars consolidate the pain points described by workshop participants during the consultation process and the issues that arise because of these pain points. It also provides high-level approaches to dealing with the pain points. What it may be missing is a certain amount of addressing community-specific detail, particularly describing an addressing data model, that would guide the addressing community's actions in the short term - before a national approach to implementation is taken.

While it may seem prudent to avoid promoting hasty, and perhaps unilateral, address community member action, it is likely that direction on some initial address model elements can be suggested and then used, that won't lead to members stepping away from any final regime implemented by the community as a whole. Visible trends and technology cycles give a reasonable degree of certainty with regard to likely future address model elements, based on current, similar, modelling in Australia, broad modelling trends, and interaction with addressing members at the forefront of system and model implementation.

THE PROPOSED APPROACH

There are approaches to facilitate tasks in disparate data regimes - of which the addressing community is clearly one - that are known to work. As understood by the addressing community, these approaches should adhere to modular, verifiable, well-documented and well-implemented models for data exchange and storage. Sharing data management methodologies and infrastructure components, particularly for authoritative reference data, are key to building new approaches.

For model development, a social and technical approach is suggested that applies regardless of domain and which is also the modus operandi of a project in a related domain: the current ICSM 3D Cadastre project.

The approach is a "co-designed, testable, requirements-driven, and contextualised" model creation process that identifies and caters for stakeholders' needs. It demonstrates that model elements match those needs, that the model works with related models, and is in line with longer-term modelling interoperability needs. The methods for ensuring that the model really does match requirements via model tests are crucial; it is critical to show what the motivation for each model part was, who had input and where.

Additionally, model development should create a common 'core' model with satellite 'modules' that cater for different communities' particular needs. These communities may be jurisdictions or different technical communities. For this aspect of the proposed approach, verifying that data built according to the satellite models conforms to the core is critical. Formal procedures for this are well established and have been implemented in projects such as the current ICSM 3D Cadastre.

This participatory and test-driven approach is derived from proven modern agile software methodology for application development. One of its many advantages is to ensure that a technical delivery partner really is catering for the client's needs, even when the delivery partner brings certain approach expectations to a project, as per the last paragraph of the previous section.

MODEL DIRECTIONS

The future model needs of the ANZ addressing community raised during this strategy development project need to cater for:

1. **Better complex / multi address representation**
2. **Shared addressable object / address conception**
3. **Model interoperability**
4. **Model profiling and mapping**
5. **International model uptake**
6. **New address dimensions**
7. **Enhanced address life-cycle management**
8. **Address validation at creation point**
9. **Verifiable model conformance**
10. **Multi-lingual and alternate name addressing**

Details for these model directions are presented in the following list at a higher level of specificity than the current, outwardly-focused strategy document, followed in the next section by a mapping of them to the 2035 strategy document "pillars".

1. Better Complex/Multi Address representation

Current address models do not provide either enough modelling skill or interoperability with modelling systems to allow for the representation of objects with "complex" addressing, where complexity can be a result of:

- Addressable Objects with multiple Addresses, differentiated by their role (e.g., "deliver", "street", "emergency entry" etc.
- Addresses with variable geometry (e.g., the address has multiple geo locations for some reason)
- Differences, or discrepancies, in the data, to do with Addressable Object geometries and address locations (e.g., the Addresses of an Addressable Object appear not to be located either with the object or on its boundary)

Use of modern geometry models, and sector-specific geometry model profiles, with addressing models would cater for many of the points above, regarding representation skill of geometry properties such as role and the relations between multiple features and multiple geometries. Verifiable/ executable models would allow for data tolerance thresholds to be defined and tested with validators indicating where discrepancies are and perhaps prevent their creation; GeoSPARQL 1.1 is an example of such a model. Figure 1 highlights some of the concepts.

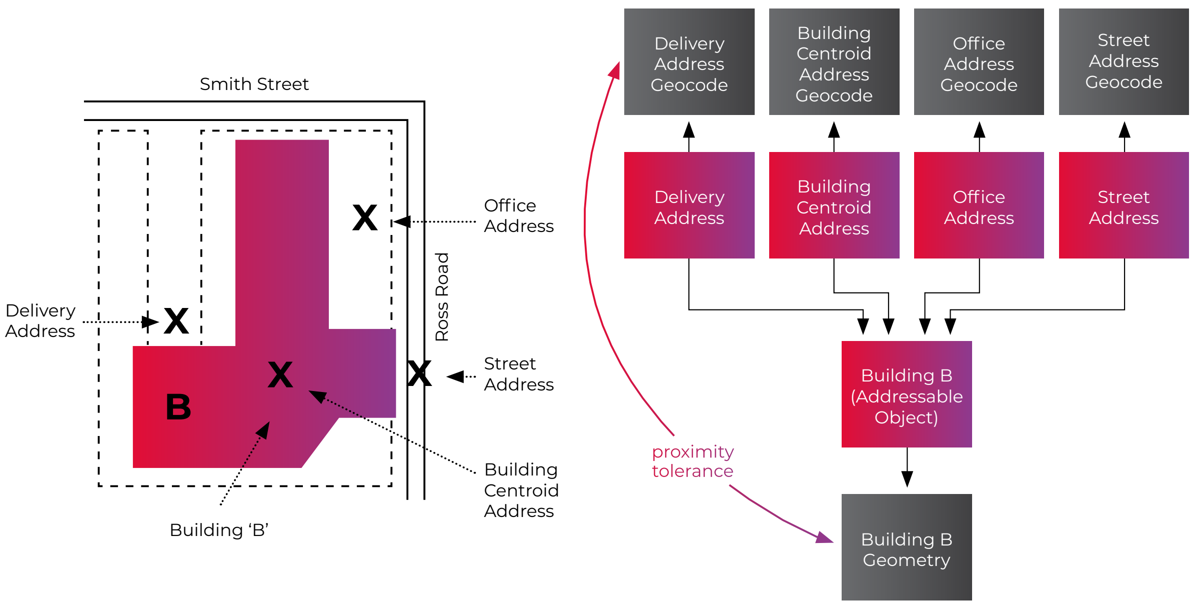

Figure 1: A fictitious complex address scenario where an Addressable Object, Building B, has multiple Addresses defined. The Addresses have their own geocodes (geometric points) which are spatially related to the building's geometry, a polygon, but are not in or on the border of it. A proximity tolerance may be required of Address / Addressable Object geometries.

2. Shared Addressable Object / Address conception

There is a lack of a shared conception of an Addressable Object / Address split, as referenced above, across all address creators and users in the addressing supply chain. Such a split is present in modern address model standards, such as ISO 19160 and local variants, including the Geocoded National Address File (G-NAF) but it is not always recognised or used. The lack of this shared conceptionalisation means not all addresses in Australia are able to be linked to independently-definable objects, in particular objects defined externally to the addressing system, such as Place Naming, Cadastre, Road networks etc. In addition to links with other objects, a universal shared split understanding would allow for a better apportionment of annotation properties between Addresses and Addressable Objects, such as state, creation date, life-cycle stage (Address) and geometry, feature type, etc. (Addressable Object).

Communicating the reasons for, and implementation of, an Addressable Object / Address split is similar to related splits such as Place / Place Name, Feature / Geometry etc. See *Figure 2*.

3. Model Interoperability

"No data is an island" (apologies to John Donne) and we now expect data to work across system and organisational silos. Addressing data needs to be demonstrably interoperable with related data - Cadastre, Roads, etc. - and further data - personal details, census info etc. Currently, common shared mappings from address data to these other forms of data exist in Australian & New Zealand jurisdictions (ANZ). One issue here is that the data coordination bodies in ANZ haven't provided a "standards baseline" for addressing and other related groups to refer to for interoperability within the generalised spatial domain. Another is that there appears not to be formal inheritance of addressing model elements from more conceptual modelling. For example, more generally than being an "Addressable Object", what is an "Addressable Object"? According to some OGC/ISO modelling systems, it would be a form of "Geospatial Feature". Such formal mappings need to be made as they will allow for interoperability beyond a spatial "standards baseline". See *Figure 2*.

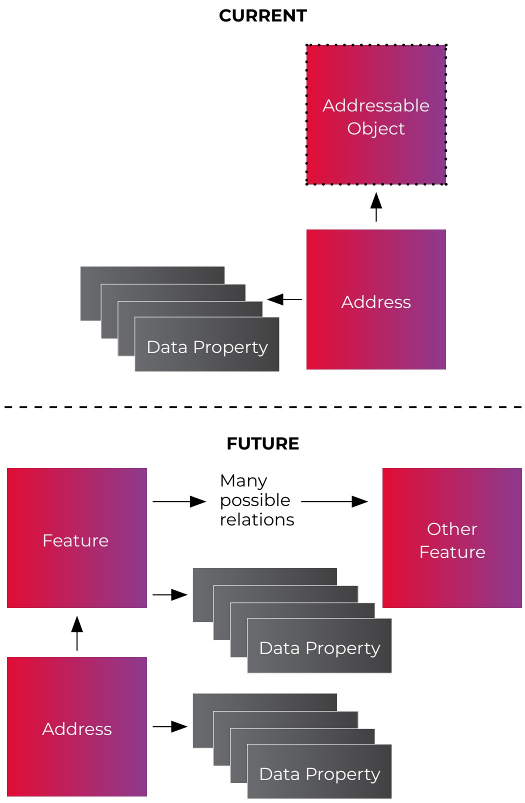

Figure 2: Current and Future Address model elements. Currently, a lack of universal use of Addressable Objects prevents many possibilities, such as independent identification of the object addressed and properties for that object. Further, if Addressable Objects were aligned with more general *Feature* elements in other models, many possible relations between Addressable Objects and other systems' Features could be utilised. An example of this is work currently underway with ICSM that demonstrates the linking of Cadastral and environmental observations models to "peer" models and also more general models.

4. Model Profiling and Mapping

The needs of the addressing community are various and while a future addressing model for ANZ must contain a certain number of core elements to allow for interoperability, it should, and could, also contain an ability for implementers to work with extended profiles of the core that are specialisations for particular needs. Recent model specialisations, such as the European environmental agencies extensions to the DCAT metadata model, work when the specialisations are formalised and also for the specialisation creation process. Additionally, sometimes terminological differences between communities need not result in model profiles but just term mappings. This is likely the case for address status or life-cycle stage terminology.

The 3D Cadastre employs both profiling and mapping.

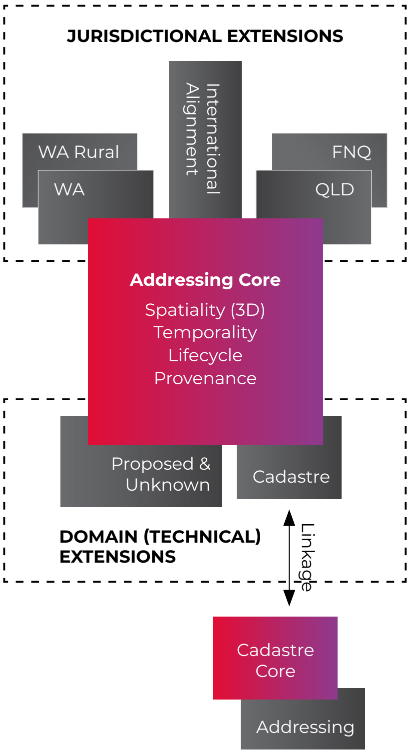

Figure 3: Here an Addressing "Core" is shown with compartmentalised jurisdictional and technical "profiles". Such a multi-part model allows for interoperability but also specialisation within addressing subcommunities.

5. International Model uptake

The existing address standards for Australia and New Zealand need to be reviewed and updated to include the work currently being undertaken at the International level led by the Universal Postal Union (UPU) and International Standards Organisation (ISO). In particular:

- AS/NZS 4819 [review of this standard has been raised by Geoscape, on behalf of the Addressing Working Group, through Standards Australia IT-004]
- AS 4590 [review of this standard has been raised by Margie Smith through Standards Australia IT-027]
- ISO19160 suite of Address standards - NZ already has a working profile of this standard that could be used as a starting point [this work will occur through IT-004]
- NZ Property Data Management Framework and current Cadastre work.
- GeoSPARQL 1.1 [new possibilities for objects with multiple geometries, the adoption of which will assist with many current addressing "pain points"]

While there is sometimes a hesitancy in the adoption of international models, Australian and New Zealand addressing data already partly matches some of the relevant ones (ISO19160 - a demonstration of GNAF data mapped to it exists, see **http://linked.data.gov.au/dataset/gnaf/address/GAACT714845933** and a NZ profile (Consultation on a new addressing profile for New Zealand) of it exists, as mentioned above).

6. New address dimensions

The formality, purpose, and role of addresses are properties of addresses identified in some international models, such as ISO19160, and they have analogues in related data such as Place Names. Shared dimension identification and values (code lists) are needed across ANZ and likely also mapping between local dimension identity and values. For example, WA and Qld might have a concept of an address' status/formality which are analogous but use different property names and allowed values but which can still be mapped to a unified model.

Beyond current standards, potential address dimensions such as role, or purpose, are known to be needed. These could likely be made available to address objects with straightforward extensions to an ISO19160-like address model, especially if the model is developed as a graph model. As per currently-defined dimensions (spatial, status etc.), characterisation (modelling) and allowed value list establishment (code lists/vocabularies) are needed.

In recent modelling work at Geoscience Australia, multiple dimensions of spatial and observational data were modelled to create an integrated "hypercube" of statistical and observations data that can be used to answer questions about resource allocations for disasters. That system implements code lists that are able to be shared between data contributors and the code lists are to be hosted by ICSM. ICSM may similarly host address model code lists.

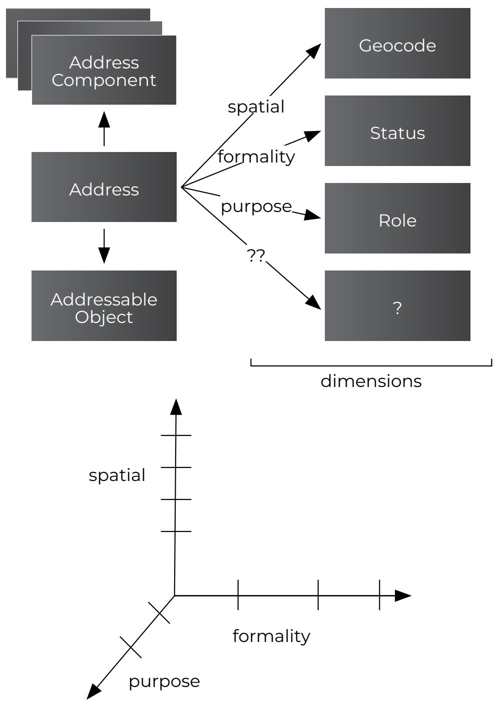

Figure 4: Address relations to Addressable Objects, Address Components and N-number of other dimensions. Any dimension that has a series of fixed values - perhaps there are only a few accepted address purposes - may have allowed values implemented as a vocabulary.

7. Enhanced address life-cycle management

Life-cycles of addresses are a dimension of them and are included in standards such as ISO 19160. Special attention needs to be paid to them due to the potential of life-cycle information to be critical to national addressing system information flow verification. For example, the life-cycle stage of an address may dictate who needs to know about it (councils, jurisdiction, national aggregator, industry, government address data user etc). Therefore, beyond dimension identification and allowed value establishment (and perhaps term mappings), state flows and required stage indicators or time limits will likely be useful to characterise.

8. Address validation at creation point

Address validation is already a major task undertaken in multiple places in Australia. It seems that certain address creators - land developers, councils etc. - do not have, or are not required to use, a validator or process to ensure that addresses created are valid "from creation". It may be that modelling extensions for proposed addresses are needed to enable the testing of them for known potential invalidity watch points e.g., not being properly associated with a correct Addressable Object.

9. Verifiable model conformance

Not all models enable content claiming to conform to them to be automatically validated, but the best ones do. Addressing data in Australia would be able to be validated if normative validation artifacts are supplied alongside a future addressing model. This will reduce model use interpretation errors.

Such validators are in development for 3D Cadastre data and other national Australian model data, such as shared environmental observations for the Department of Agriculture, Water and the Environment.

The co-publication of multiple artifacts within a standard with both normative and non-normative status, such as a *Specification* (normative), a *Validator* (normative) and perhaps *Implementation Examples* (non-normative) is an established model publication pattern now used by standards bodies such as the OGC and W3C.

10. Multi-lingual and alternate name addressing

Some jurisdictions, such as New Zealand, may have a requirement for multilingual addresses. Other jurisdictions may have a requirement for alternate name elements within addresses, such as indigenous country names.

While the inclusion of such address properties might seem to greatly enhance the complexity of addressing models, they need not. The Address / Addressable Object split means whole multilingual addresses can be considered just another a form of alternate address for the same object, as corner blocks with two street addresses currently are. Additional address parts, such as indigenous country names, can be included within the general ISO 19160-based address component handling without affecting other address components. Most modern taxonomy models and ontologies provide multilingual label options for most model elements.

Figure 5 shows informal modelling for an example of these scenarios.

Figure 5: A fictitious scenario of an Addressable Object, X, with a primary address, a street-based alternate, an element variant to the primary and a language-based alternate address. The language variant of the primary - inclusion of "Wiradjuri Country" is the primary address with an additional non-functional address *component*. In contrast, the alternate language address, indicated by a language code, is fully functional.

The above points are model focused but non-model address-strategic concerns should be considered too; such as data sharing regimes and data use feedback mechanisms. However, implementing a better model and better model use will solve or sidestep many issues which otherwise would need much community effort to solve. This approach will also allow future initiatives to easily consume well managed, described, and delivered address data.

MODEL DIRECTION / PILLARS MAPPING

The "pillars" from the addressing strategy document are, as numbered in the document with main focus areas:

1. Harmonised supply chain
2. Addressing standards and model driven implementation
3. Customised pathways for jurisdictions
4. Data linkages to other valuable datasets
5. Accurate and authoritative addressing

Below is a mapping of the addressing modelling directions suggested here and the pillars to which they are relevant.

DIRECTION ID	DIRECTION	PILLAR ID
1	Better complex/ multi Address representation	2
2	Shared addressable object / address conception	2, 4
3	Model interoperability	1, 2, 4
4	Model profiling and mapping	3
5	International model uptake	2
6	New address dimensions	5
7	Enhanced address life-cycle management	1, 3, 5
8	Address validation at creation point	1, 5
9	Verifiable model conformance	2, 5
10	Multi-lingual and alternate name addressing	3

The table above indicates that for the directions proposed:

a. Each align with one or more pillars; and

b. No pillar is left un-mapped from a proposed direction.

(ADDRESS) DATA MODERNISATION ACROSS GOVERNMENTS IS NOT NEW

There are successful international examples of work to improve public data across jurisdictions and layers of government. The Danish Basic Data Program began around 2005 with their dwelling register being shared publicly as well as aggregating and releasing their address data held across 200+ local governments. The outcomes from this initial work have been seen as beneficial across all sectors and have been investigated and reported on by the open data community - [Denmark's Open Address Data Set](). The demonstrable success of their initial program led to the 2012 Danish Basic Data Program [(GOOD BASIC DATA FOR EVERYONE – A DRIVER FOR GROWTH AND EFFICIENCY)](), which has morphed into an ongoing government funded plan towards common digital architecture split across data, distribution and data modeling.

This clearly demonstrates that if data benefits are to be realised, there is a requirement to focus on sustainable data collection, maintenance and distribution. Denmark documents realised benefits for the public, business and government through the creation of a government shared registry.

Whilst this is not within the scope of this strategy currently, in order to share data the Denmark example shows that substantial effort must be put into fostering efficiency improvements, harmonising interfaces, standards and data models, and promoting dialogue between the public and private sector to continually improve the data held by the government.

The enhancement of interoperability across ANZ spatial data would require ICSM to look at emulating the Danish move, and standard operating procedure in many standards domains, by implementing/specifying a common model baseline for all domain working groups to extend upon. Also the acknowledgement of the need to upskill and support those tasked with creating and collecting the data as well as improving dialogue across the supply chain is something that must not be lost in the work of this group. This program enables the high quality well described data to be re-used for the benefit of citizens, public and private sector and, importantly, the next generation technology that appears in the future.

As outlined in this paper, we believe that an approach of a "co-designed, testable, requirements-driven, compartmentalised" modelling process will allow the ICSM AWG members to engage in modernising their supply chain infrastructure without compromising their individual requirements, and to allow engagement in the process as their resources allow. Re-use of components by default and using open standards will avoid provider lock-in with proprietary solutions and will benefit citizens and the public and private sectors alike well past the future of this strategy.