Progress towards fully digital cadastral survey data exchange in Australia and New Zealand

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SUMMARY

Major digital transformation activities are currently underway in Australia and New Zealand to modernise jurisdictional land administration systems so that they meet the future digital needs of government, industry and community. Significant developments are being undertaken in digital cadastre upgrades, automated validation and processing of digital cadastral information, digital examination, digital titling and registration systems, online spatial data portals, and digital twins. An important step that each Australian and New Zealand land administration agency will take on its respective digital transformation journey is the introduction of mandatory digital lodgement of cadastral survey data.

To support the implementation of a unique, sustainable and international standards-based approach for the exchange of cadastral data throughout Australia and New Zealand, the Intergovernmental Committee on Surveying and Mapping (ICSM) is leading the development of a new standard, coined '3D Cadastral Survey Data Model.' This new standard is central to achieving ICSM's vision for all cadastral systems – a cyclic flow of digital data between surveying professionals and the agencies.

To date, ICSM and key partners have produced a harmonised data model that describes all the 2D and 3D cadastral survey elements that jurisdictions require for the exchange of cadastral data. The data model has been defined at the conceptual and logical levels and uses existing internationally recognised standards and ontologies wherever possible. Moreover, profiling has been included to support jurisdiction-specific requirements and nuances in cadastral legislation and policy. From this model, a 2D standard reference implementation in JSON has been developed and made available (via open source channels) for public testing and implementation. Next steps involve developing 3D extensions to the JSON encoding specification, producing additional jurisdiction profiles, testing and refinement of the model, and implementation by Australian and New Zealand land agencies. In view of a successful, nationally-consistent implementation across the various jurisdictions, engagement with survey software vendors is also underway.

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1. INTRODUCTION

Today's surveyors routinely collect survey data in digital format and process it using advanced surveying and 3D modelling software. Yet the resultant cadastral survey data is not able to be readily and reliably transferred in digital format to the land administration agencies for recording in the cadastre and for future re-use by other surveyors.

The Cadastre 2034 strategy developed by the Intergovernmental Committee for Survey and Mapping (ICSM) outlines a digital future for the cadastre in Australia. New Zealand has a similar strategy. That future recognizes the role of the cadastre in enabling digital twins, smart 3D cities, integrated planning, utility management, and other forms of digital leverage.

ICSM, through the '3D Cadastral Survey Data Model' (3D CSDM) project, has developed (1) a conceptual data model for 3D cadastral information and (2) a data exchange format specification in JSON-LD with provisions to support jurisdictional profiling. The model has been based on surveying standards, international data standards, and harmonised vocabularies formed from Australian and New Zealand jurisdictional legislative frameworks and surveying practices. The exchange format will form the backbone of data interoperability and allow transition from paper and PDF file submissions to a legal digital document.

2. BACKGROUND

Across Australia and New Zealand there have been a range of approaches and varying levels of industry uptake for the submission of digital cadastral survey data. Significant investment has been made in the adoption of LandXML in particular, with New Zealand mandating LandXML submission since 2007. Several Australian jurisdictions implemented capabilities for LandXML data validation, submission and electronic plan examination, although no mandates were introduced and uptake reached 20% at its peak. Other jurisdictions have mandated custom and proprietary formats, such as Western Australia (Cadastral Survey Dataset) and the Northern Territory (CEXML).

More recently, Australian jurisdictions have been exploring alternative methods of sourcing and generating digital data using defined Computer-aided Drafting (CAD) layering standards that can be translated into LandXML or an alternative format. While this approach has reduced reliance on survey software vendors to generate LandXML directly from their products, it has resulted in differing layering standards across jurisdictions. Post-lodgment digitisation services have also been utilised to generate digital data from lodged PDF documents to support enhanced plan examination.

Goal 5 of the Cadastre 2034 strategy is for 'a federated cadastral system based on common standards'. To achieve this goal, a longer-term solution is needed to harmonise the diverse set of approaches currently being implemented for submission of cadastral survey data. In 2020, ICSM's Cadastre Working Group commenced a project to develop a 3D CSDM that would better meet the needs of Australia and New Zealand.

Previous stages of the 3D CSDM project developed the technical requirements of the specification and shortlisted recommendations of format adoption. As a ready-published solution does not currently exist, an extendable data standard was preferred. ICSM selected JSON and JSON-LD to enable jurisdictional profiling. JSON can be parsed without heavyweight plug-in code and aligns with international developing standards from the international standardisation community. The conceptual and logical cadastral data model, final report and data exchange option report from the 2023 reference implementation project are published on the ICSM website: https://icsm.gov.au/what-we-do/cadastre/3d-cadastral-survey-data-exchange-program.

Initial discussion with survey software vendors indicated that they are willing to adopt JSON/JSON-LD as a data standard subject to a unified strategic approach across all jurisdictions and the availability of a published format aligned to international standards. While some survey software vendors indicated that their packages do not currently support JSON, most advised that support for JSON is in their forward technology roadmap. It is envisioned that jurisdictional publishing, and adoption of the format will direct enable the accessibility of the format via multiple vendors.

3. 3D CSDM FORMAT

The 3D CSDM data model adopts several existing international (ISO and OGC) standards and ontologies. Accordingly, cadastral datasets published using the JSON/JSON-LD format are intended to be interoperable with other datasets based on similar international standards. The files are intended to be machine readable, yet human understandable. The format is designed to be implemented in multiple jurisdictions and for multiple product types, using profiling to enable localised language as masks over technical standards. References to existing and developing standards provide a format that can evolve to enable best practice and be backwards compatible.

The completed two-dimensional specification components and three jurisdictional profiles can be found on GitHub:

ICSM Common - https://github.com/icsm-au/3d-csdm-profile-icsm
ICSM 3DCSDM Common Model - https://github.com/icsm-au/3d-csdm-common
ICSM Profile - https://github.com/icsm-au/3d-csdm-profile-icsm
New Zealand Profile - https://github.com/icsm-au/3d-csdm-profile-nz
Victoria Profile - https://github.com/icsm-au/3d-csdm-profile-vic
Western Australia Profile - https://github.com/icsm-au/3d-csdm-profile-wa

Initial vocabulary files for element values have been harmonised and hosted in a private environment for later hosting publicly. The vocabulary files are available from:

https://github.com/icsm-au/3d-csdm-profiles/tree/main/vocabularies

3.1. OGC Standards and Ontology

3D CSDM inherits from parent formats. This means that the language within 3D CSDM will be the same as other formats within the published OGC ecosystem. Remaining within the OGC

API standards will also enable other collaborators such as vendors to adopt and configure for individual jurisdictional use cases.

The 3D CSDM dependencies as shown in Figure 1 below indicate how existing formats are utilised in an interrelated manner. For a single survey measurement between two points the OGC Semantic Sensor Network Ontology (SOSA) format provides the language to describe and record the instrument used, while geoJSON and JSON-FG Feature elements describe the points utilising the language inherit to that component.

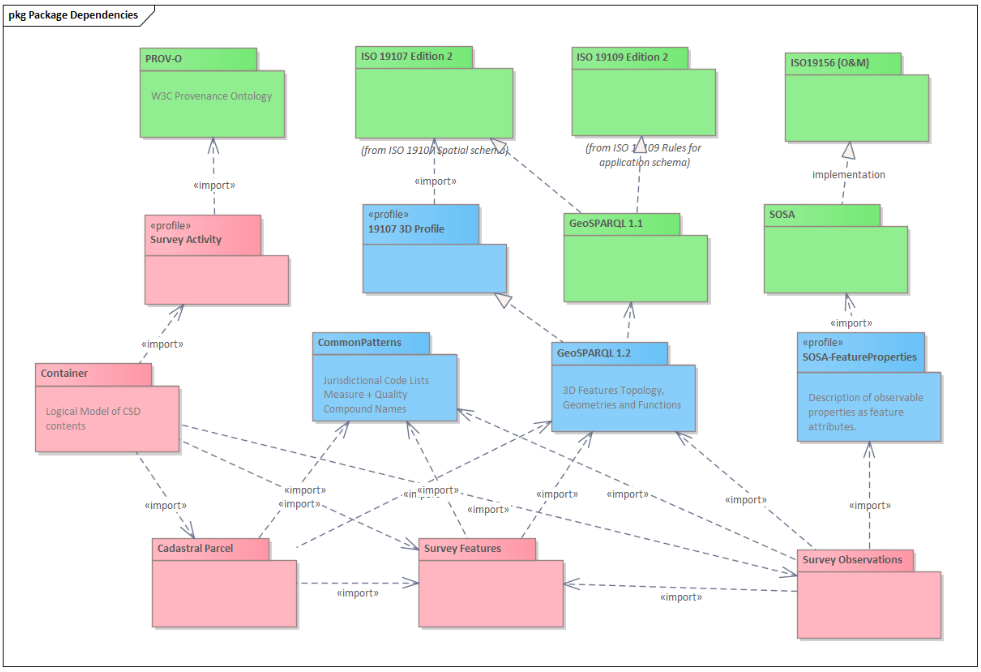


Figure 1 – 3D CSDM OGC dependencies
https://icsm-au.github.io/3d-csdm-design/2022/spec.html#_relationship_to_other_models
Also see https://icsm-au.github.io/3d-csdm-schema/bblock/icsm.csdm.features.CSD

A separate ICSM project is currently developing a standard for property addressing within Australia. This development will create another standard which 3D CSDM can reference, allowing another modular component to be included in a version of the specification. As per the 3D CSDM specification, this is developed as a modular solution.

3.2. 3D CSDM elements

3D CSDM itself is also inherited within its own ecosystem. A jurisdictional profile is published for each Australian state and New Zealand, which references the national ICSM schema, which in turn references the OGC dependencies.

Where jurisdictional differences do exist, a common format is used within the common 3D CSDM schema and localised with the jurisdictional schema. An example of this is the differences for identifying local government areas. The ICSM common schema sets the format for an ‘adminUnit’ and the language that will be used. Then the jurisdictional schema identifies and populates the ‘adminUnit’ parameter with the elements that are required.

```
New Zealand
"icsm-admin-unit-type:landDistrict"
"icsm-admin-unit-type:territorialAuthority"
Victoria
"icsm-admin-unit-type:localGovernmentArea"
"icsm-admin-unit-type:locality"
"icsm-admin-unit-type:county"
"icsm-admin-unit-type:parish"
Western Australia
"icsm-admin-unit-type:localGovernmentArea"
"icsm-admin-unit-type:locality"
```

Where existing schema elements could not be utilised 3D CSDM either extends or modifies the parameters to meet ICSM requirements. 3D CSDM has introduced unique elements to enable jurisdictional requirements such as ‘tenureType’, ‘planType’, ‘purpose’ and a collection of unique elements for points, lines, and polygons.

A full list of dependencies has been published as part of the 3D CSDM, and the hosted schema files contain a full list of elements allowed within the specification and hosted as context.json files.

The context component of a JSON-LD file is where the linked data (-LD) of the specification provides additional information. This can be utilised in two ways. As per Figure 2 example the geoJSON element is linked and given the name ‘geojson’ which is then later used to help define the geometry data types and shortens the linking element. This element can also be used as a direct link to an external element such as a published vocabulary or hosted data repository.

```
{
  "@context": {

    "geojson": "https://purl.org/geojson/vocab#",
    "rdfs": "http://www.w3.org/2000/01/rdf-schema#",
    "oa": "http://www.w3.org/ns/oa#",
    "dct": "http://purl.org/dc/terms/",
    "sosa": "http://www.w3.org/ns/sosa/",

    "type": "@type",
    "id": "@id",
    "properties": "@nest",
    "geometry": {
    "bbox": {
    "Feature": "geojson:Feature",
    "FeatureCollection": "geojson:FeatureCollection",
    "GeometryCollection": "geojson:GeometryCollection",
    "LineString": "geojson:LineString",
    "MultiLineString": "geojson:MultiLineString",
    "MultiPoint": "geojson:MultiPoint",
    "MultiPolygon": "geojson:MultiPolygon",
    "Point": "geojson:Point",
    "Polygon": "geojson:Polygon",
    "features": {
    "links": {
```
Figure 2 – example context json component

The outcome of this process is an individual file that contains context and schema elements which align with the published jurisdictional profiles json, informed by its own context.json-ld and parents linked specifications.

Jurisdiction profiles have been created for New Zealand and two Australian States: Western Australia and Victoria. In 2024 a research student at the University of NSW generated profile documentation for another state, New South Wales, although this information is subject to validation prior to being published.

3.3. Cadastral surveying is relative

As surveying datasets in Australia and New Zealand are typically not based on absolute positions and in order to describe relationships between the data elements, 3D CSDM extends the geoJSON format to use the same language in a different way.

The investigative stages of 3D CSDM identified that existing data specifications are dependent on absolute positioning and require all information to be in the same coordinate reference frame. The OGC standards are also held to this and GeoJSON requires all coordinates to be in WGS84. Jurisdiction profiles will allow each jurisdiction to specify an alternative datum based on specific requirements and regulations.

In this context 3D CSDM will allow a coordinate reference system to be stated in the document by utilising coordinate system elements ‘horizontalCRS’, ‘verticalCRS’, and/or ‘compoundCRS’. This allows the document to use EPSG codes to express the coordinate reference system in which the document is published.

Cadastral survey information is not typically absolute positions. Instead, cadastral surveying information needs to describe the relationships between surveyed points.

An example of how coordinates for a point are traditionally referenced is as follows.

```
"geometry": { "type": "Point",   "coordinates": [116.0045347, -31.88682252]},
```

Similarly, when describing a line element between two points the coordinate values are also traditionally stated, and this is repeated for multi-line and polygon elements.

```
"geometry": { "type": "LineString",
   "coordinates": [[116.0045347, -31.88682252], [115.85307516, -31.95335671]]},
```

This prevents reuse of points to efficiently create topological relationships throughout the document. To address this shortcoming, 3D CSDM deprecates the use of the ‘geometry’ element which is now declared as ‘null’ and adopts to concept of node identifiers for points, lines, polylines and polygons enabling reuse and ensures unique identifiers are used to define boundaries.

For example, points are defined using the element of ‘place’ which allows point data to be expressed as easting, northing, height values as declared by the relevant CRS component.

```
"feature": [ {
  "id" : "187",
  "features" : [{
    "geometry" : null, "place": {  "coordinates" : [ "399529.112", "6462628.624", "10.45" ]}}]},
"id" : "188",
  "features" : [{
    "geometry" : null, "place": {  "coordinates" : [ "399560.451", "6462632.273", "10.45" ]}}]],
```

This then enables other data elements to be constructed from relationships of elements.

Linear elements are then described using ‘id’ rather than coordinates in a ‘topology’ component.

```
"features" : [{
  "id" : "106", "type" : "Feature", "geometry" : null,
  "topology" : {"type" : "LineString", "references" : [ "187,188" ]},
```

Which, in turn, allows polygons to be constructed using line elements

```
"id" : "42",
"geometry" : null,
"topology" : {"type" : "Polygon",
    "references" : [ "106","302","303","290","291","292","293","294","295","296","297","298","299","300" ]},
```

The outcome of this is that the 3DCSDM file produced is more focused on the survey data and relationships and topology rather than static point positions or coordinates, as these will change over time.

This in turn will retain this information for utilisation in boundary re-instatement and in adjustment processes such as Least Square Adjustments. A submitted 3DCSDM file can be spatially adjusted and the only resultant data change will be the coordinate values, while the relationships between these elements remain unchanged.

3.4. Surveying geometry elements

While surveying is typically constructed in straight line components, the results often express themselves as curves or compound shapes. These are a collection of historical methodologies and modern computing elements.

The geoJSON elements are utilised and therefore there is no restriction from creating multipoints, multilinestrings and multipolygons within 3DCSDM. Where restrictions may be required this will be a restriction added at a jurisdictional level and at a product level.

JSON-FG elements of Arc, Circle, CompoundCurve, MultiCompoundCurve, CurvePolygon, MultiCurvePolygon, and CurveGeometryCollection are permitted in 3D CSDM, using the same philosophy of Point, LineString and Polygon as described above.

To enable surveying type elements the element types of Arc Segment with Centre, Arc Segment by Chord, Arc Length, and Circle by Centre have been detailed and we are attempting to have these implemented within future versions of international geometry schemas.

Western Australia is unique in requiring angles to be recorded rather than bearings as used by other jurisdictions. This necessitated the creation of the 'subtended angle' element. In this example, 95 is the node from which the angle is taken (in a clockwise direction) from line 99 to 98.

```
"topology" : {
  "type" : "SubtendedAngle",
  "references" : [ "95,99,98" ]
```

This element is constructed as per the relationship methodology previously referenced.

3.5. Vocabularies

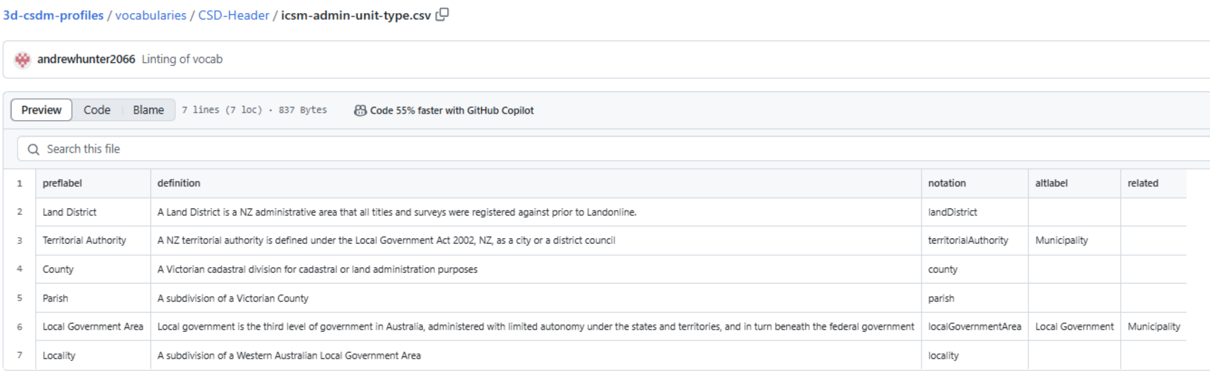
To assist with validation, vocabularies for specific elements have been created. These are lists that contain a preferred label, a definition, the computer notation, and alternative label which may be used in other formats, and a list of related elements.

For example, the Western Australia CRS vocabulary (wa-crs.csv) includes the following:

```
...
gda2020,             Geodetic Geographic 2D,        7644,              ,,
GDA2020/MGA zone 46, Projected GDA2020/MGA zone 46, 7846, "46, MGA2020,,
...
```

These lists are intended to allow users and vendors to reference these files within their working environment and validate files generated. Jurisdictions will be able to update their current versions of these files and ensure previous versions are retained as new versions are published.

In creating jurisdictional profiles, several common words used across multiple jurisdictions were identified. These were placed in a common profile and any variation from that vocabulary are identified in a jurisdiction profile to maintain compatibility with local legislation and terminology. Master normalised lists with common terms have been created and published as 'icsm' vocabularies and specific vocabularies have a jurisdictional prefix such as 'nz', 'vic', or 'wa'. Figure 3 shows an example of common terms in the 'icsm-admin-unit-type' profile.



preflabel	definition	notation	altlabel	related
Land District	A Land District is a NZ administrative area that all titles and surveys were registered against prior to Landonline.	landDistrict		
Territorial Authority	A NZ territorial authority is defined under the Local Government Act 2002, NZ, as a city or a district council	territorialAuthority	Municipality	
County	A Victorian cadastral division for cadastral or land administration purposes	county		
Parish	A subdivision of a Victorian County	parish		
Local Government Area	Local government is the third level of government in Australia, administered with limited autonomy under the states and territories, and in turn beneath the federal government	localGovernmentArea	Local Government	Municipality
Locality	A subdivision of a Western Australian Local Government Area	locality		

Figure 3 – Example vocabulary file – normalised 'icsm-adminUnit-Type'

As an example, a Western Australian submission will require a "horizontalCRS" element as defined by the wa schema.json which will have the context component reference the 'wa-crs' vocabulary as a lookup requirement. The value from 'notation' such as "epsg:7850" will pass a validation check. This value in turn can be referenced by software to display the more human informative 'preflabel' value of "GDA2020 / MGA zone 50" rather than the machine friendly EPSG code.

A machine will be able to read the file, and an informed user will be able to read "epsg:7850", and a layperson can have the value presented as the 'preflabel' with a 'description' if relevant.

3.6. Jurisdictional products

3D CSDM is designed to not be restricted to a jurisdiction or a product. Comparable products from jurisdictions will be produced the same way with appropriate localisations. Each jurisdiction has legal requirements that may necessitate that specific values be presented within the file such as Victoria's unique requirement for a 'Parish'.

Within a jurisdiction, multiple products will utilise 3D CSDM to transfer data. A Western Australian Community Title subdivisional plan has a mandatory requirement for the subject's land address to be stated within the document, but this not required for a Freehold subdivision.

Within Western Australia, unique elements will be required for each of the subdivisional plan types, a unique database extract product type will be required, and survey field record raw data file will be required. Each type will have mandatory and optional components which will be developed at a jurisdictional level.

The providence component of 3D CSDM files will be represented in different ways. In a plan the lodging surveyor will have their details retained with the submission, while a spatial database extract may only contain high-level metadata pertaining to the extraction methodology and date.

Components unique to a jurisdiction such as Western Australia's subtended angle components are creatable by 3D CSDM compatible software but will fail validation rules on lodgement with jurisdictions which do not allow them within submissions.

Some jurisdictions may allow multipolygons with parcel components, while others may require each parcel to have a single unique polygon for multiple parcel component inside databases rather than 3D CSDM files.

4. PUBLISHING

The 3D CSDM profile elements have been published to a public GitHub repository and are now available for use. It is intended for this initial version to be used for stakeholder and vendor engagement from which any future refinements can be made as jurisdictions begin to use the specification. We encourage interested parties to validate and test using the standard.

Vocabulary files for jurisdictional value of components are currently hosted in a private GitHub repository and can be made available on request.

ICSM is engaging in discussions on the most appropriate way to publish these components permanently as the technical support documents will need to perpetuate. The schema and vocabularies will need to be editable while maintaining version controls.

Discussions include publishing in a single platform or separating vocabularies by jurisdictions as they may be utilised outside of the 3D CSDM products in national and jurisdictional databases.

5. THIRD DIMENSION

3D CSDM is intended to be a three-dimensional solution. The currently published OGC standards have not adopted a recognised format for this aspect. This has restricted our ability to solve this component of the specification.

The proposed solution that has been introduced in 3D CSDM is to extend the geoJSON 'coordinates' component to include a height value.

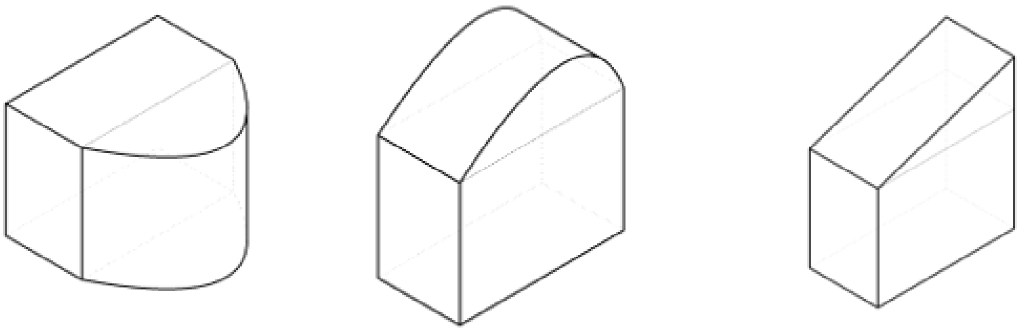
```
"place": {  "coordinates" : [ "399529.112", "6462628.624", "10.45" ]}
```

To enable the proposed solution for parcel components, 2.5D elements of 'zmin' and 'zmax' have been included with 3D CSDM. These values will allow values as defined by the declared ‘verticalCRS’. Jurisdictions are also able to configure values to enable restricted and unrestricted heights, such as the examples below.

```
"properties" : {
  "appellation" : {  "label" : "Restriction in depth and height by Reduced Level"},
  "zmin" : "10.152", "zmax" : "20.418" }
  "properties" : {
"appellation" : {  "label" : "Restriction in depth by Reduced Level and unrestricted in height"},
  "zmin" : "10.152", "zmax" : null   OR "zmax" : "unrestricted" }
  "properties" : {
"appellation" : {  "label" : "Unrestricted in depth by and restricted in height by structure"},
  "zmin" : null  OR  "zmin" : "unrestritced",
  "zmax" : "structure"   OR  "zmax" : "undersurface of ceiling or plane produced"}
```

It is the preferred option for ICSM to align with OGC standards where these become available and as of January 2025 initial discussion with the OGC geoSPARQL group have been initiated.

While fully formed 3D volumes are desired, the solution may depend on what solution can be created and adopted by the wider community.



Within surveyed land components three-dimensional shapes are typically complex on the two-dimensional plane with restrictions in the vertical component. More complex representations can be found in community tenure and where corridors interact with larger land boundaries. 3D CSDM is designed to support the variety of complex shapes that can be found in cadastral surveying.

The development of an appropriately complex three-dimensional schema will ensure that the goal of a fully representative legal document can be achieved.

6. NEXT STEPS

ICSM is continuing work on digital plan lodgements. The 3D CSDM solution is the backbone of the solution and a sub-committee has been established to coordinate engagement with survey software vendors and other stakeholders, review technical feedback and ensure future maintenance of the specification.

All ICSM jurisdictions have committed to supporting the adoption of 3D CSDM in the future, however implementation plans are subject to individual jurisdictions to prepare and progress.

7. SUMMARY

ICSM has made significant progress towards the development of a 3D cadastral survey data exchange format. The challenge of producing an international data transfer standard that can be leveraged by jurisdictions to meet ICSM and jurisdictional goals has been achieved. Importantly the outcome has harmonised common elements across jurisdictions and has established a methodology to accommodate differences in regulatory environments.

Further work is required regarding three-dimensional representation and testing from software vendors and jurisdictions. At present, further work is being undertaken to evaluate the use of GeoSPARQL for the encoding of complex 3D spatial objects. This technology will not only allow the encoding of objects, but the analysis and spatial querying relating to 3D clash detection and validation of complex 3D land parcel definitions.

It is hoped that by publishing the standard in the public domain, ICSM is encouraging a collaborative approach to ongoing enhancement of 3D CSDM and compatibility with other open standards. It will also encourage feedback from software vendors who are interested in implementing the standard. ICSM welcomes any feedback from interested parties regarding the model and draft exchange format.

REFERENCES

ICSM 3D CSDM repositories. Available online at https://github.com/icsm-au?q=&type=public&q=csdm+OR+icsm

ICSM Conceptual Model for 3D Cadastral Survey Dataset Submissions. Available online at https://icsm-au.github.io/3d-csdm-design/2022/spec.html

SURROUND, 2022, 3D Cadastral Survey Data Model and Exchange – Final Report.

SURROUND, 2022, Data Exchange Option Report.

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Colin Stewart is Principal Consulting Surveyor at Landgate and is responsible for the maintenance of cadastral data, processes, policy, and ensuring cadastral support for the Western Australian land titling system. He has worked in both the private and government land development sectors, and has assisted in Western Australian legislative, computer system, and cadastral process reform projects. Colin is a representative on ICSM's Cadastral Working Group and the 3DCSDM development sub-committee.

Anselm Haanen has been the Surveyor-General at Toitū Te Whenua Land Information New Zealand since 2018. He was previously the Deputy Surveyor-General. He holds a Master of Surveying degree from the University of Otago and has worked in various technical capacities since joining the department in 1978. He was heavily involved in the development of Landonline, New Zealand's automated survey and title system, and helped develop New Zealand's Cadastre 2034 strategy. Anselm is the ICSM Sponsor of the 3D Cadastral Survey Data Model Programme.

Jeff Needham is Deputy Surveyor General at Toitū Te Whenua Land Information New Zealand (LINZ) and fulfils the role of SAFe Agile Business Owner in the Survey and Title Enhancement Programme (STEP) which is redeveloping the Landonline system. His background includes 25 years in private consulting focussed on Land Development, Infrastructure and digital information technologies. Jeff was the surveying profession's Stakeholder Representative involved in the original development of Landonline between 1999 and 2003. Jeff is a Fellow and past President of Surveying and Spatial NZ. Jeff is the Product Owner for ICSM on the development work underway on the 3D Cadastral Survey Data Model Programme.

Roger Fraser is Chief Geospatial Scientist at the Department of Transport and Planning, Victoria. Roger has been involved in several state and national geodetic and cadastral infrastructure projects including GDA94, GDA2020, Standard for the Australian Survey Control Network (SP1), AuScope GNSS, GeodesyML, DynAdjust and Victoria's digital cadastre modernisation.

Steve Tarbit is Principal Survey Advisor, Geodesy and Positioning at the Queensland Department of Natural Resources and Mines, Manufacturing, and Regional and Rural Development. Steve's career with the department has spanned cadastral surveying, geodesy and implementation and management of spatial information systems. Steve is a registered cadastral Surveyor and Qld representative on the ICSM Geodesy Working Group.

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