Transport for NSW

TfNSW Application of Uniclass

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1 Executive summary

Transport for NSW (TfNSW) is committed to the implementation of Digital Engineering (DE) in order to improve infrastructure delivery and asset owner outcomes. DE transforms the way project and asset information is managed, through the adoption of emerging technologies and new business processes, to create cost savings and improve productivity across the asset life cycle.

For DE to be successful and to deliver its full benefit, it is essential that all parties collectively adopt structured data. Failure to standardise data across and between projects results in significant cost, time and opportunity losses.

A fundamental inclusion of structured data is a standardised classification system to enhance the management of the 'digital twin'. Classification is critical for effective project planning and execution.

Appropriate classification enables information to be developed, exchanged, leveraged and reliably re-used by all parties interacting with the built environment. It is recognised that through the adoption of classification standards, asset owners gain considerably, including optimised project planning, delivery and asset management outcomes across all stages of the asset life cycle.

TfNSW recognises the importance of classification and has led detailed research, working with industry experts, to determine the most appropriate classification system to successfully enable DE within the TfNSW landscape.

Industry experts have recommended that TfNSW adopts Uniclass. This recommendation has been peer reviewed and further endorsed by the peak industry body NATSPEC.

Internationally, Uniclass is the UK Government's official construction sector classification system and is part of its Building Information Modelling (BIM) Level 2 resource set.

Support for Uniclass continues to grow:

- Austroads has independently recommended the adoption of Uniclass for classification of road assets.
- The Australasian Rail Industry Safety and Standards Board (RISSB) is considering the benefits of Uniclass for nationwide adoption.

TfNSW is currently working in collaboration with NBS, the custodian of Uniclass, to further develop Uniclass to meet transport requirements.

In summary

There are significant benefits and opportunities associated with common classification, relevant to both government and industry.

There is now an opportunity for government departments to pool resources and work collaboratively to further develop our application of Uniclass, establishing a comprehensive standardised classification system that will improve agency and inter-government cooperation, and promote industry innovation.

This document provides an introduction to TfNSW's adoption of a formalised DE Framework to date, and how classification is integral to the success of DE. It provides background on TfNSW's journey to select a standardised classification system and an overview of how this classification system is being utilised on projects.

2 Introduction

2.1 Overview

TfNSW is committed to the strategic implementation of Digital Engineering (DE) in order to realise greater infrastructure and customer outcomes. DE transforms the way project and asset information is managed, through the adoption of emerging technologies and new business processes, to create cost savings and improve productivity across the asset life cycle.

TfNSW has initiated the DE Framework program (see Figure 1 as an example) and recently published the digital standards, business processes, technology and training, developed to complement project delivery for its Infrastructure and Place (IP) division. The program provides a step change in the way the NSW Transport cluster[1] delivers projects, develops and manages information about its assets, and becomes a more effective, data-centric organisation. This program also helps to align information management across the Transport cluster and further enables other governance frameworks and initiatives.

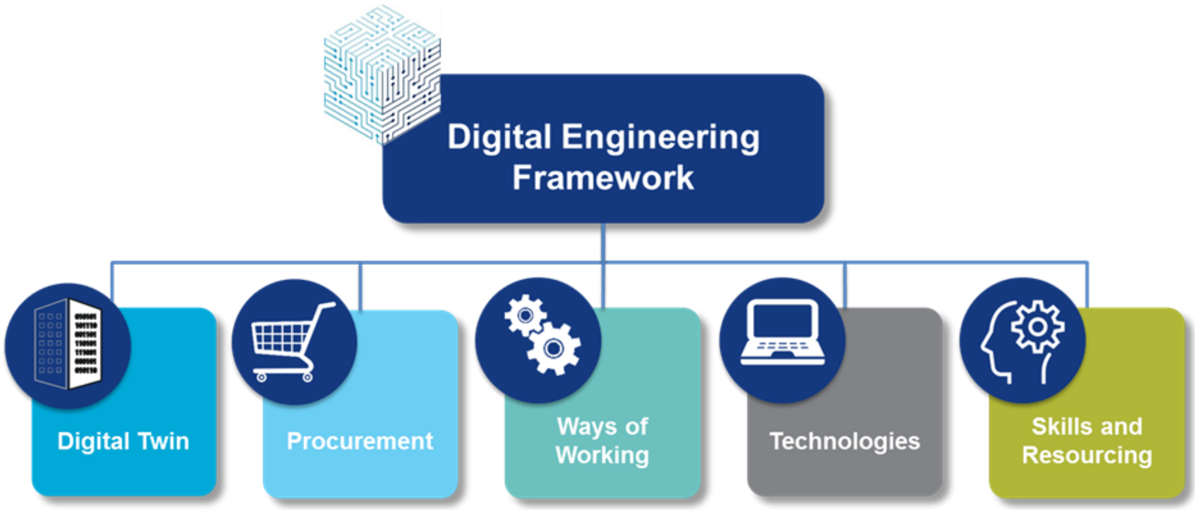


Figure 1 – Digital Engineering Framework

The DE Framework is an Australian first and has generated a significant amount of interest across governments, industry, peak bodies and academia. The DE Framework has been recognised as a catalyst for increased digital collaboration, bringing together numerous parties to develop standards and guidelines for the production of digital assets for the built environment.

For DE to deliver its full benefit, it is essential that standardised data and a classification system for data and information is mandated. This will enable information to be developed, exchanged, leveraged and reliably re-used by all parties associated with the built environment. In summary, asset owners stand to gain considerably from consistent DE, through optimised project planning, delivery and asset management outcomes across all stages of the asset life cycle.

[1] The Transport cluster is made up of an extended network of government agencies and private organisations which work together to deliver transport services. For more information refer to https://www.transport.nsw.gov.au/about-us/who-we-are/our-organisation.

2.2 TfNSW's DE journey

Over the past few years TfNSW has been successfully driving the development of DE nationally for the transport and infrastructure sector.

TfNSW's Infrastructure and Place (IP) division has undertaken extensive collaboration, research and planning, to define best practice DE based on global developments and emerging technologies. This has involved considerable engagement with experts and key stakeholders from other government agencies, industry, peak bodies and academia, both locally and around the globe (see Appendix A for stakeholder list). TfNSW has also led the National DE Working Group with senior membership from governments across Australia. This federally sponsored group was established to work collaboratively on a consistent national approach to DE for transport infrastructure.

TfNSW has **collaborated and consulted with over 100 organisations**, including government agencies, peak bodies, academia and industry to inform the development of the TfNSW Digital Engineering Framework.

In 2017, TfNSW released the *Data and Information Asset Management Policy* (CP17005) that formally recognises the value and critical importance of structured data. To realise the vision and principles of this policy, the TfNSW Executive also endorsed commencement of the DE Framework Program. This fully funded program has been running since 2017 and has brought together experts from around Australia to develop practical, cost-effective DE solutions based on global best practice. The resulting framework now defines how data and information is to be managed throughout TfNSW and across the full asset life cycle. TfNSW's DE Framework is now recognised by industry to be a leading government initiative. The TfNSW DE journey is shown in Figure 2.

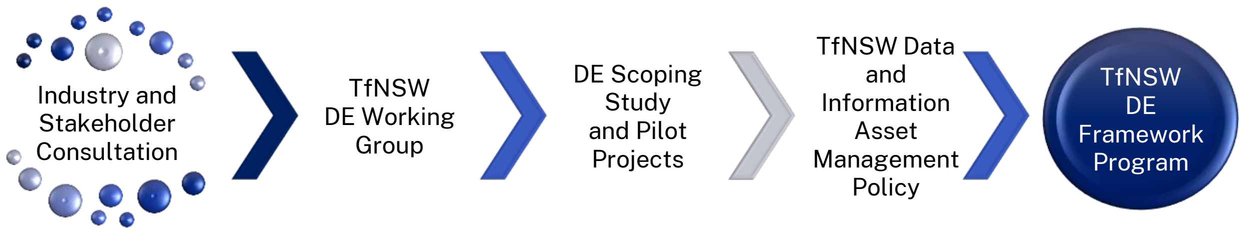


Figure 2 – TfNSW DE journey

2.3 Purpose of this document

The purpose of this document is to:

- raise awareness of the importance of consistent asset information classification
- articulate the benefits of adopting a cross-industry asset information classification standard
- provide insight into TfNSW's journey and the decision to implement Uniclass as the preferred asset information classification system
- present an overview and practical application of Uniclass.

3 Benefits of Digital Engineering

3.1 Business drivers

DE has the potential to significantly benefit asset intensive organisations that are seeking to improve value from assets across the end-to-end asset life cycle. The business drivers for DE are summarised in Table 1.

Table 1 – Business drivers

Business drivers	Organisational expectations
Asset acquisition cost	• Asset delivery projects costs are in line with industry best practice. • Project cost blow-outs and reliance of projects on contingency funding are minimised by improving cost certainty. For example, Digital Engineering supports virtual construction that greatly reduces project risk prior to physical construction. • Industry innovation and technology improvements can be effectively utilised on new projects as ways to reduce costs. For example, prefabrication, automated equipment, mobile technologies for team collaboration. • Process improvement and lessons learnt drive costs down. For example, organisational capability and process maturity is leveraged to drive cost efficiencies.
Asset total cost of ownership	• Understanding of asset usage and maintenance requirements drives asset selection and design choices. For example, asset usage is simulated in a digital environment to validate design assumptions and asset life expectations. • Historical asset performance information is used to inform asset selection and design parameters.
Safety and reliability	• Risks and safety objectives are validated during the design process. For example, through virtual reality users can experience the designed environment and provide valuable feedback allowing for designs to be modified. • Reliability risks across the asset life cycle are minimised.
Environmental impact	• Commitment to the delivery of better design, which is more environmentally friendly and sustainable, is clearly communicated to all stakeholders. • Delivery of environmentally sustainable solutions is assured through built-in project controls.

3.2 Business objectives

Organisations such as TfNSW are embracing DE to deliver an integrated digital approach for managing the use of information across the asset life cycle.

While DE provides new tools and techniques to support project and asset management, it must also transform the culture of the workforce to recognise the value of digital information as an asset.

Typical business objectives associated with DE are summarised in Table 2.

Table 2 – Business objectives

Business objectives	Description
Reduce project delivery risk and cost overruns	• Improve project delivery methodology by including the requirement to build the project twice, first digitally, then physically, in order to reduce project delivery risk and cost overruns. • Leverage digital models to provide the basis for cost estimation.
Improve information management	• Coordinate disparate information sources into a centralised, current, readily accessible information system. • Provide project teams with the right information at the right time to make informed decisions.
Improve efficiency and collaboration	• Enable project teams to develop, manage and share information in a secure, open and accessible environment. • Improve accessibility to accurate, up-to-date project information. • Provide significant improvements in design coordination, interface management and the ability to share data efficiently without loss, contradiction or misinterpretation. • Improve information exchange, project coordination and interface management across project delivery stakeholders and service delivery partners. • Simplify the handover of as-built assets to multiple asset owners.
Enable information re-use	• Update commercial contracts to enable future information re-use across project phases and partners to maximise re-use of previously purchased and assured information, to minimise duplicated efforts and improve productivity. • Provide better tools for exploiting existing information and standardised library objects.
Drive innovation	• Encourage governments, asset owners and the supply chain to develop innovative business processes and technologies. • Invest in smart ICT platforms to support collaborative efforts that drive innovation.
Deliver sustainable designs	• Leverage better tools for calculating project outcomes for example, energy and carbon use. • Re-use components that are proven to be efficient.

4 Project Data Building Blocks (PDBB)

4.1 Overview

A key enabler of DE is structured data. Projects implementing TfNSW's DE Framework are required to develop, implement, manage and control a core set of structured data, known as the Project Data Building Blocks (PDBB).

The PDBB ensure that the same piece of data within multiple datasets is represented in the same way. This means that datasets can be cross referenced, queried, interrogated and associated.

For each of the DE disciplines (for example, systems engineering, survey, 2D CAD, BIM modelling and asset data), the data that is required as a deliverable must be submitted in accordance with a discipline appropriate Project Data Schema (PDS). The PDS identifies the PDBB that are included in the specific dataset and also any discipline-specific data that must be provided (see Figure 3).

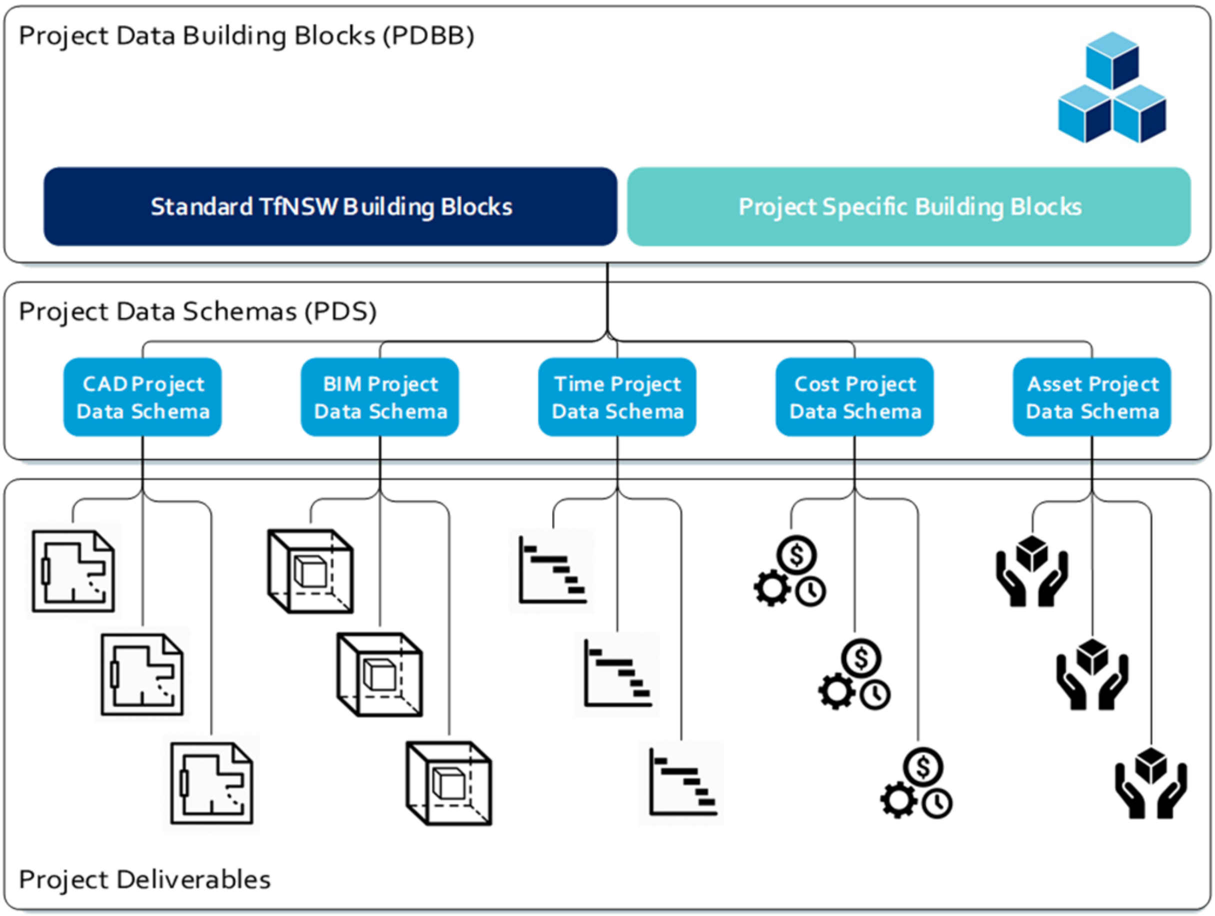


Figure 3 – PDBB and PDS relationship

4.2 Why classification is critical to PDBB

Structured data is achieved within IP projects through the application of PDBB and PDS. Together, the PDBB and PDS strategically organise information (representing the built environment). For this to be successful and useful, an effective classification system must be implemented that addresses the following fundamental requirements:

- provides a common language for people constructing and managing assets

- identifies all 'like things' and labels them consistently
- enables ability to search and retrieve all 'like things', for example, from a design model, project information database, or an asset register, and so on.
- enables ability to combine models, creating a network model
- enables related information to be aggregated for the purposes of measurement, estimation, purchasing, reporting, maintenance, and so on.
- enables business intelligence and insights to be built up over time, improving strategic decision-making and return on investment (ROI).

PDBB that incorporate appropriate classification enable us to move from the current state where work is completed in silos, to the future state of collaboration and integrated information (see Figure 4 as an example).

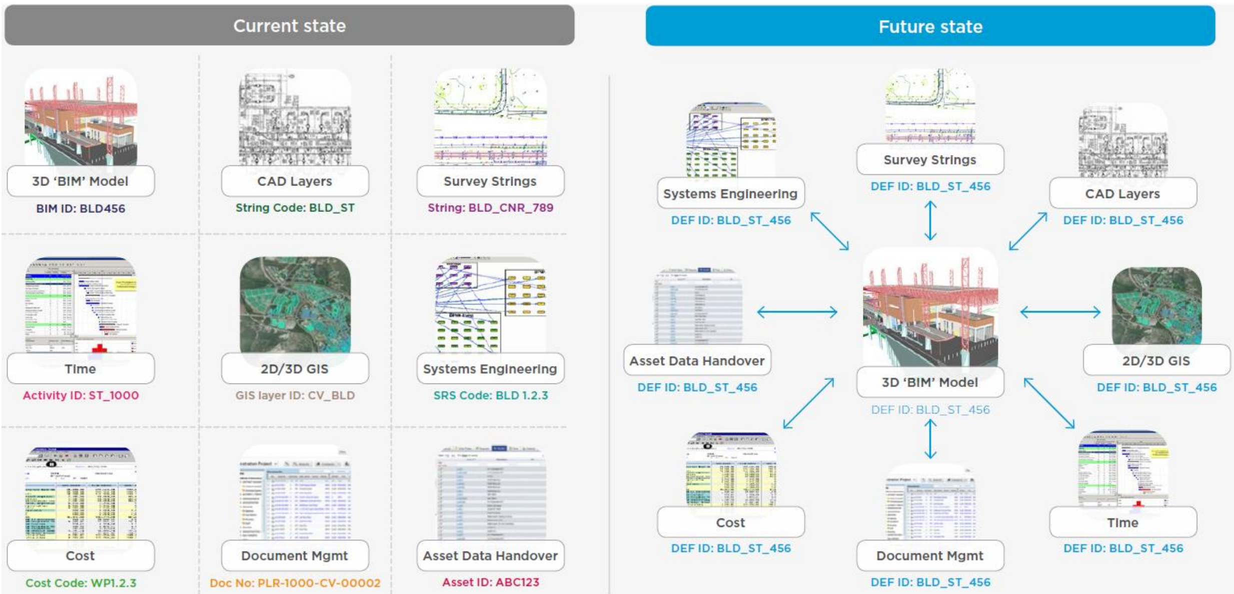


Figure 4: Classification enables achievement of the future state

5 Use of classification

There are many classification systems in use today by both asset owners and industry suppliers. Across Australia there are currently numerous ad hoc, in-house and segregated standards in operation, with little integration or data exchange across agencies, asset owners or governments.

This diversity is problematic as it introduces significant barriers to how information can be used and shared. In recent years, with the emergence of DE and, in particular, building information modelling (BIM), the importance of classification has become a significant topic of debate and industry focus.

For organisations that are looking to implement DE on infrastructure or construction projects, classification is critical to PDBB to enable effective project planning and execution. As illustrated in Figure 4 there are currently numerous classification systems applied across project disciplines. Considerable manual processes are therefore required to exchange and re-use information across siloed business disciplines, limiting efficiency and creating unnecessary cost.

To gain benefit through collaboration and federation across and between project disciplines, it is critical that a classification system is selected that can be applied consistently across these disciplines.

3D BIM

3D modelling enables a new project delivery approach whereby assets are effectively built twice; first digitally (that is, the digital twin) and then physically (see Figure 5 as an example).

Figure 5 – The digital twin

Digital representations of buildings and infrastructure are constructed using objects in a model that are related to one another. For instance, a precinct (or complex) comprises buildings and structures. Each building contains spaces, utilises systems and products, and so on, to deliver the intended functionality required by the customer. For these digital models to be used effectively, and for them to support modern collaborative project delivery processes involving multiple parties, they must be carefully managed. Critically, model objects must be labelled, classified and follow agreed conventions by all stakeholders to enable model integration and downstream processes.

4D BIM

The discipline of project programming and sequencing can also be improved by linking structured data within a project's work breakdown structure (WBS). When work packages cross-reference information such as project locations, assets, business/technical disciplines (all which are attributed with classification information), project managers can gain greater certainty that their plans are complete and accurate.

New visualisation techniques that integrate schedules and 3D models enable virtual construction, otherwise known as 4D BIM. This process can reduce construction risk by providing a visual aid that clearly communicates plans, improves contractor coordination, improves clarity of roles and responsibilities and compares planned works versus actual.

5D BIM

The application of standard classification on projects can also improve an organisation's ability to estimate project costs with greater certainty.

Industry is already maturing the tools to enable the practice of quantity take-off from 3D models that greatly improves the speed of validating quantities based on, or derived from, models. However, estimating total project costs must still be augmented with experience, case studies and project constraints as reference.

Classification can provide a useful method to organise information in a way that can be practically used across projects to benchmark and validate cost estimates.

Collaboration

On most projects today, there are numerous parties that provide specialised services. The need to share data between parties and stakeholders in a timely and cost-effective manner is paramount to the success of the project. Standards provide a common taxonomy, reduce ambiguity and improve efficiency, especially when collaborating across organisational boundaries, to deliver a single design (for example, federated models). Without classification standards and open data exchange standards, the flow of information between stakeholders becomes very challenging, as in the following typical scenarios between:

- project delivery partners (on a project)
- project delivery partners and asset owners (note: on infrastructure projects there can be many owners, for example, different transport agencies, councils, utilities, and so on)
- project delivery partners and asset maintainers.

The exchange of information between teams across the asset life cycle is illustrated in Figure 6.

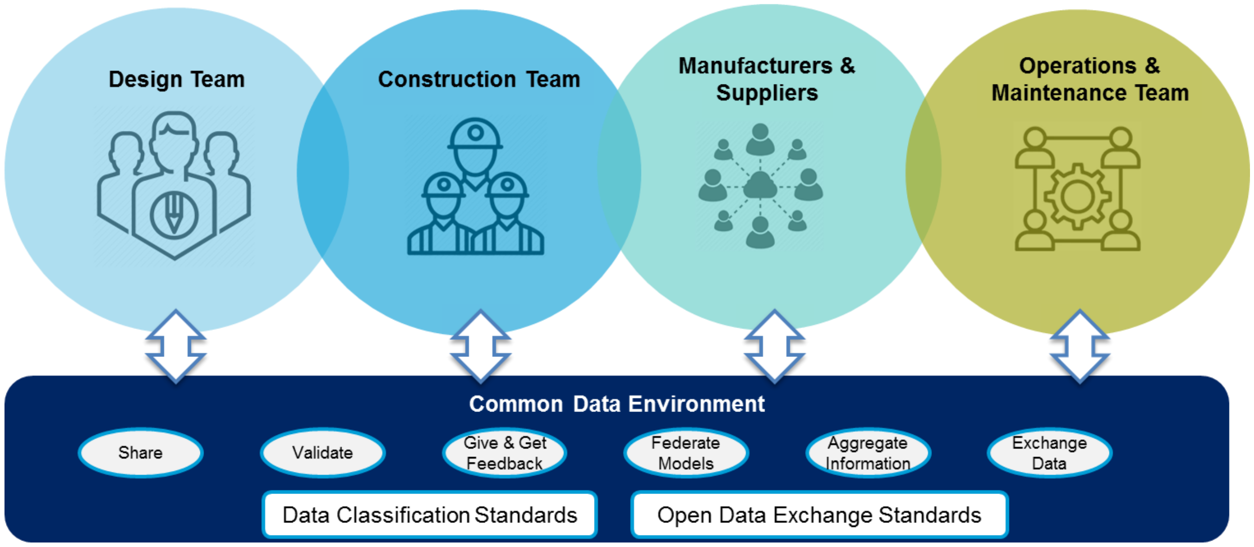


Figure 6 – Information exchange between teams across the asset life cycle

6 Why Uniclass?

6.1 Our selection criteria

Key requirements for DE must be considered when thinking about the choice of any standards:

- Standardised data structures are fundamental to project design, costing and delivery.
- Data standards should specify a range of asset attributes such as information type, location, business discipline and technical discipline.
- Collaboration and data sharing are both essential across a broad range of parties associated with the construction industry.
- DE leverages a broad range of industry tools, provided by an international community of software vendors.
- This is a dynamic industry with constant innovation and significant international investment.

In relation to asset classification, TfNSW has made the following considerations to determine an appropriate standard:

- **Open standards** – standards that are open, widely adopted and utilise global best practice (for example, ISO 12006-2:2015) should be considered where possible, as opposed to custom or bespoke standards.
- **Vendor support** – 'out-of-the-box' industry tools should be implemented when available, to assist how projects create, share, and validate information.
- **Access to industry expertise** – leverage expertise from industry delivery partners when available, to build project capability and reduce learning curves.
- **Compatibility with all stages in a project life cycle** – consider standards that support 'whole-of-life' activities, to enable incremental accumulation and validation of asset data across the multiple project delivery and investment gates.
- **Actively managed and dynamic** – consider standards that are actively managed and improved by a professional community of practitioners as best practice evolves.
- **Balance of influence with access to global expertise** – consider standards that are growing and maturing through real-world contributions and applications. This will limit the burden of governing in-house standards, by sourcing innovation developed through a global community.
- **Cost effective** – the cost of managing, mandating and enforcing the use of standards should be minimised and offset by the benefits they deliver.

6.2 Our decision

TfNSW has selected Uniclass, developed by the NBS (www.thenbs.com) as the preferred classification system. The choice to adopt Uniclass follows comprehensive analysis of the current state, and comparative research of available classification systems, industry-wide, against ISO 12006-2:2015 *Building construction – Organization of information about construction works – Part 2: Framework for classification*.

After the comprehensive review of various classification systems, including:

- Uniclass
- Omniclass
- GS1
- ASA ACS

Uniclass was selected as the preferred classification system to enable Digital Engineering.

These studies, sponsored by TfNSW and conducted by AECOM in 2016, highlighted that:

- There is no current unified approach for asset classification across all construction sectors in Australia.
- Multiple standards are used within the NSW Transport cluster.
- There is no agreed strategy to adopt a common classification standard at any level of state or federal government.
- Many organisations have developed their own classification systems, which represent a significant effort/cost to maintain and align.

The study recommended that:

- With respect to classification, TfNSW should leverage economies of scale, experience and best practice across the industry, both locally and internationally.
- TfNSW should adopt an international classification standard that is aligned to ISO 12006 set of standards.
- Uniclass is selected as the preferred classification system to be reviewed in greater depth.
- The ability to influence the development of the Uniclass standard would accommodate additional TfNSW's needs.

TfNSW subsequently engaged NATSPEC to undertake a peer review of the AECOM studies. This review supported the AECOM findings and recommendations, further reinforcing the case for Uniclass as the preferred asset classification standard.

As such, TfNSW has been working with NBS to continually improve the Uniclass standard, with detailed adaptations to support transport infrastructure assets.

While Uniclass is currently being rolled out by IP for use in asset delivery projects, the Asset Management Branch (AMB) (formerly ASA) and the DE Team are working collaboratively to improve the application of classification across the full asset life cycle.

7 Introduction to Uniclass

7.1 Overview

Originally released in 1997, Uniclass is a comprehensive system suitable for use across industry, including the infrastructure, landscape, engineering services as well as the building sector, and for all stages of the asset life cycle.

Support for Uniclass continues to grow:

- Austroads has independently recommended the adoption of Uniclass for classification of road assets (*Asset Data Harmonisation*).
- The Australasian Rail Industry Safety and Standards Board (RISSB) has recommended Uniclass for nationwide adoption (*Code of Practice – Digital Engineering)*

Uniclass provides a:

- unified classification system for the construction industry. For the first time, buildings, landscape and infrastructure can be classified under one unified scheme
- hierarchical suite of tables that supports classification from a university campus or road network to a floor tile or kerb unit
- numbering system that is flexible enough to accommodate future classification requirements
- system compliant with ISO 12006-2 that is mapped to RICS NRM 1: *Order of cost estimating and cost planning for capital building works* and supports mapping to other classification systems in the future
- classification system that will be maintained and updated by NBS.

Uniclass allows project information to be structured to a recognised standard, essential for the adoption of BIM. Information about a project can be generated, used and retrieved throughout the life cycle.

Uniclass has been carefully structured to be in accordance with ISO 12006-2:2015 *Building construction – Organization of information about construction works – Part 2: Framework for classification*. Aligned with this ISO, Uniclass is suited for use in an international context where mapping to other similarly compliant schemes around the world will be streamlined.

Uniclass is actively maintained and updated by NBS, in consultation with industry partners, including TfNSW. The structure of Uniclass is dynamic and supports further additions and revisions as new technologies or uses are introduced.

Refer to **Uniclass** on the NBS website for further information about Uniclass.

7.2 Uniclass tables

Uniclass is currently made up of 11 tables, based on ISO 12006-2:2015 *Building construction – Organization of information about construction works – Part 2: Framework for classification,* and designed to distinguish different classes of information, as described in Table 3.

Table 3 – Uniclass tables

Uniclass table	Description (Source: ISO 12006-2:2015)	Transport domain examples
Co – Complexes	Aggregate of one or more entities intended to serve at least one function or user activity.	Rail networks, road network, interchanges, facilities, ports and fleets*.
En – Entities	Independent units of the built environment with a characteristic form and spatial structure, intended to serve at least one function or user activity.	For TfNSW this includes structures (including buildings, stations, bridges, tunnels), corridors, roads, cars*, vessels*).
SL – Spaces/Locations	Space defined by built or natural environment or both, intended for user activity or equipment.	For TfNSW this includes lanes, lines, stops, concourses.
EF – Elements/Functions	Constituent of an entity with a characteristic function, form or position.	For TfNSW this includes structural elements and high-level functions.
Ss – Systems	Interrelated products that together perform a defined function.	For TfNSW this includes HVAC, security, communications, ticketing, FF&E, fire, control and constructions (pavement, walls, floors, ceilings, roofs and structures).
Pr – Products	Product intended to be used as a construction resource.	For TfNSW this includes all products at a maintenance managed item level.
Ac – Activities	Things that are happening or being done.	-
FI – Form of information	Information of interest in a construction process.	Mapped for use in project document management metadata.
PM – Project Management	Control activity on as construction process by one or more construction agents.	-
TE – Tools and equipment	Construction resource intended to assist in carrying out a construction process.	-
Zz – CAD	CAD layer naming.	Used by DE for CAD layer naming, refer to DMS-FT-535 – *CAD Layer Naming Table.*

Table note: * Uniclass does not yet support fleet, however, NBS has agreed to include fleet-related classification codes in future releases.

7.3 Uniclass classification specialisation

Each of the Uniclass tables follows a common internal organisation of classifications and features a four-level classification hierarchy (see Table 4), with each level providing a greater level of specialisation within a given classification group.

Table 4 – Uniclass classification hierarchy

Uniclass level	Code format
1. Group	Aa_00
2. Sub group	Aa_00_00
3. Section	Aa_00_00_00
4. Object	Aa_00_00_00_00

Each individual classification is assigned a 'Code' which follows a prescribed format, where the first two alphabetic characters identify the Uniclass table and the following set of numbers (separated by '_') not only serves to allocate a unique number to the classification but also communicates the level within the specialisation hierarchy.

Figure 7 is an example taken from the Ss – Systems table and illustrates the four levels of specialisation.

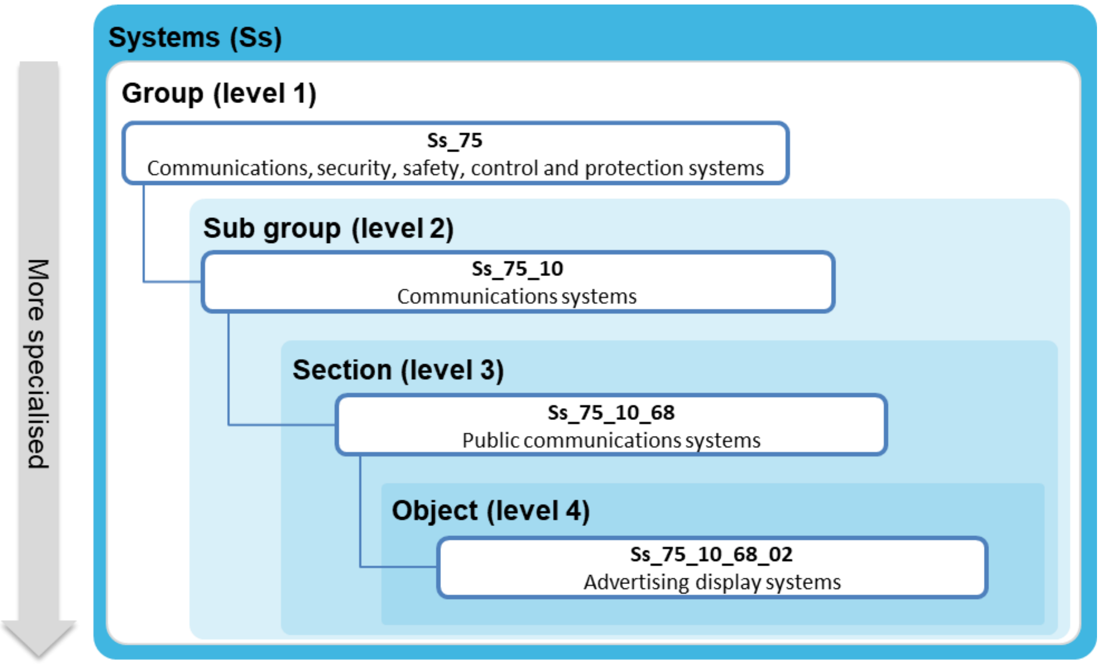
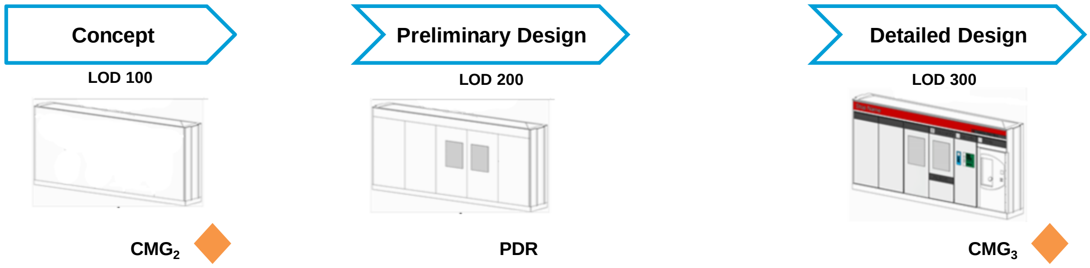


Figure 7 – Example of Uniclass classification specialisation

One of the benefits of this hierarchical organisation of classification codes is the ability to drill-down and inspect what codes are available before choosing the most appropriate classification. Conversely, it is also easy to identify any gaps in the classification system.

Another benefit of the hierarchical nature of Uniclass is that it can be used across the full asset delivery life cycle. For instance, during early design stages, when only general system requirements are known, users can select more general classification codes from the Ss table (for example, level 2). Later, when more specific requirements are established, the classifications can reflect the added level of detail by using level 3 or level 4 codes and then associating products that comprise the system. This development of classification over the project life is illustrated in Figure 8.



Ss_75_90	Ticket management systems
Ss_75_50	Communications, safety and protection systems

Ss_75_90_80	Ticketing systems
Ss_75_50_11_37	Help point systems
Ss_75_10_68_42	Information display systems

Ss_75_90_80	Ticketing systems	
	Pr_40_70_22_88	Ticket dispensers
Ss_75_50_11_37	Help point systems	
	Pr_75_75_04_70	Passenger assistance help points
Ss_75_10_68_42	Information display systems	
	Pr_75_75_15_24	Display screen monitors

Figure 8 – Example of applying more specific classifications with increasing levels of detail (LOD)

7.4 Differentiating classification and specification

While classification provides a general level of information about an object, the majority of information that is defined about an asset forms part of its specification (see Figure 9).

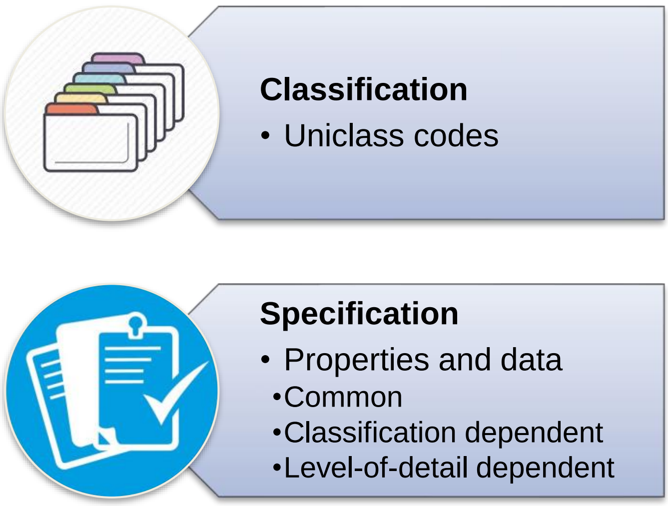


Figure 9 – Classification versus specification

Uniclass does not define what properties or data should be captured for a specific type-of asset, as these specifics should be defined by users.

The TfNSW AMB standard T MU AM 02001 ST – *Asset Information and Register Requirements* illustrates the governance and data necessary at different stages of the project life cycle and, in particular, at project handover for each class of asset. Some of these requirements may be tied in with specific classification codes.

TfNSW's adoption of Uniclass and implementation for projects is outlined in the next section.

For more information on Uniclass, refer to **Uniclass** on the NBS website

8 TfNSW application of Uniclass

8.1 Classification

TfNSW has selected Uniclass to support the following classifications:

- **Asset**: enables grouping of like assets by type and system
- **Location**: enables grouping of assets by location.

Table 5 provides a summary of classification types and their corresponding standard.

Table 5 – Classification standards

Classification	Sub-classification	Standard
Location	-	Uniclass, Complexes (Co), Entities (En), Spaces/Locations (SL)
Asset	Type	Uniclass, Elements/Functions (EF) or Products (Pr)
Asset	System	Uniclass, Systems (Ss)

The relationships between the classifications are illustrated in Figure 10.

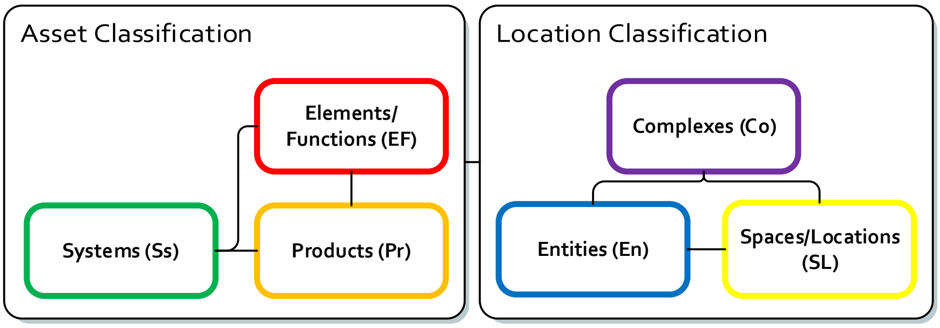


Figure 10 – Classification relationships

TfNSW's DE Framework stipulates that all DE deliverables (geometric and non-geometric), including drawings, models, engineering artefacts, documents and datasets, must include Uniclass classification codes as follows:

- As a minimum, any file uploaded to the TfNSW Enterprise Content Management (ECM) system is tagged with a Uniclass code
- Additionally, any data within files (such as records within a project asset register, objects in the BIM model, strings/layers in the CAD file, and so on) that refers to assets or locations is also tagged with a Uniclass code.

8.2 Referencing

When identifying individual location or asset objects, in addition to using a Uniclass classification code, a reference is required to distinguish individual objects using the same classification (see Figure 11).

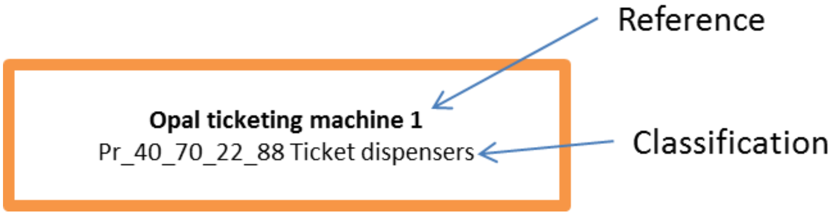


Figure 11 – Referencing versus classification

To allow for the complexity of TfNSW's network and program of projects, it is mandated that object references are to be unique within a 'local context'. As such, this means the following:

- **Location references** must be unique within a branch of a location hierarchy.

  For example, all stations within a corridor must be uniquely referenced.

- **Asset references** must be unique within an asset hierarchy.

  For example, if a security system has 10 cameras, each camera belonging to that system must be uniquely referenced.

As an example, see Figure 12, where there are four Opal card readers at the same light rail stop. Although each reader is classified in the same way, the reference used uniquely identifies each reader; *P1.1, P1.2, P2.1* and *P2.2*.

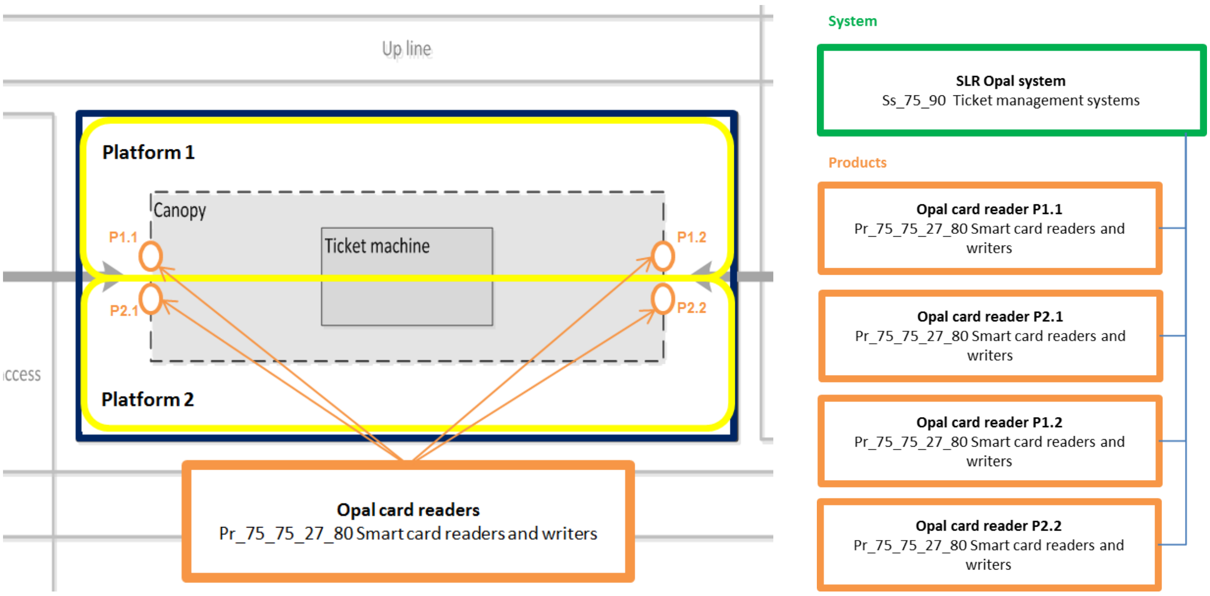


Figure 12 – Referencing of multiple Opal card readers at a light rail stop (plan view and hierarchical view)

From a global asset portfolio management perspective, it is also important to be able to uniquely identify individual assets. This requirement can be achieved if we consider that to uniquely identify an asset we must combine a location reference with an asset reference.

This approach ensures that large organisations, running many concurrent projects, can allow individual projects to build their own project asset registers. The organisation is then able to aggregate these into a single enterprise asset register, with minimum central overhead. (See Figure 13 as an example.)

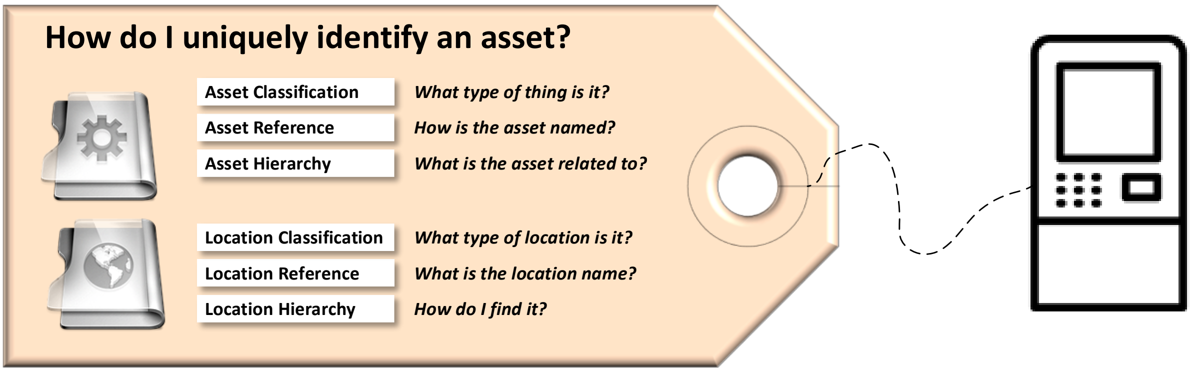


Figure 13 – A conceptual asset tag combines a location reference and an asset reference

See Section 8.8 for further guidance on associating assets with locations.

8.3 Locations and location hierarchies

A location may either be a physical place, or a logical container that allows for other locations, or assets, to be grouped together.

Locations are organised into location hierarchies to reflect a physical or logical view of assets (that is, as close as possible to how they are organised in the real world).

The hierarchy is created by way of parent–child relationships which communicate a 'part-of' relationship. As expected, in a hierarchy, a parent may have many children, but a child may only have one parent.

Example: Wynyard and Circular Quay railway stations are both part of the heavy rail network (see Figure 14).

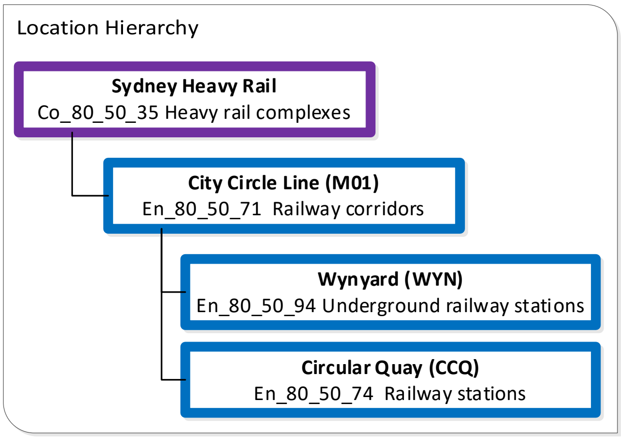


Figure 14 – Location hierarchy relationship example

There are no limits to the depth of an asset location hierarchy. This enables the project to determine the best appropriate location hierarchy to enable the project.

Example: Heavy Rail/North Shore Line/Chatswood Station/Paid Concourse/Passenger Toilets (see Figure 15).

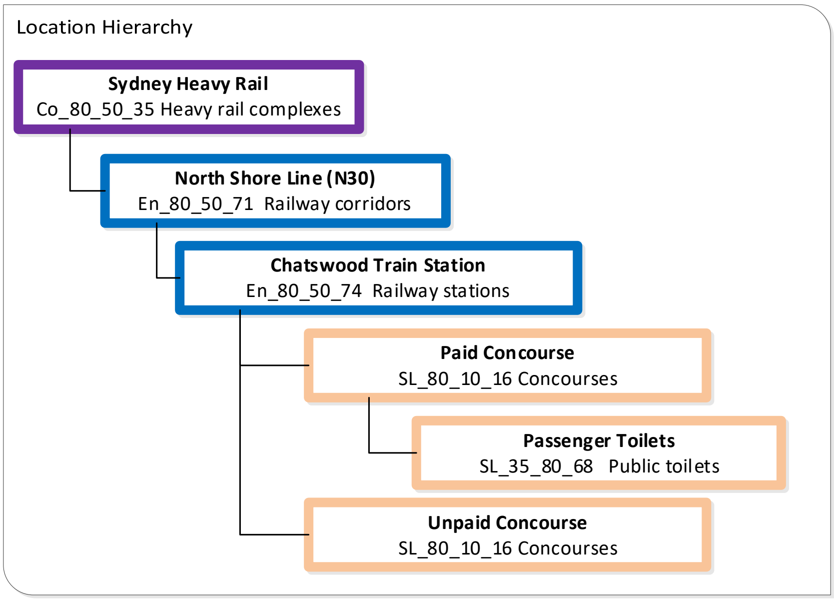


Figure 15 – Location hierarchy relationship example

Each record in a location hierarchy must have a corresponding location classification and reference.

8.4 Location hierarchy modelling conventions

Uniclass does not specify how Complexes, Entities and Spaces can or should be combined. Users of Uniclass define their own conventions for what constitutes a valid location hierarchy.

The TfNSW DE Team recommends the following general conventions:

- Complexes are always at the top of the location hierarchy.
- Complexes may be children of other complexes.
- Entities can only be children of complexes or other entities.
- Spaces may be related to complexes, entities or other spaces.

Example: If an interchange (complex) combines a heavy rail station (entity) and bus station (entity), and a footbridge is built between them, the footbridge can be associated with either the stations or the interchange. How the location hierarchy is established is a user preference. What is more important, however, is that users are consistent with their use of classification codes for the same types of objects.

Working within the TfNSW landscape, there may be multiple top-level locations defined to logically segregate asset families or portfolios of assets. For example, a project at Central Station may include works related to the heavy rail and light rail complexes.

Example: For project work, TfNSW may require the following top-level locations to reflect the various portfolios across the Transport cluster:

- Sydney Heavy Rail
- Sydney Light Rail
- Parramatta Light Rail
- Sydney Metro

- Sydney Maritime
- Sydney Buses
- Rural and Regional Buses, and so on.

All infrastructure and related fleet assets are grouped under these top-level locations.

Example: The Sydney Light Rail comprises both mobile assets (that is, fleet) and fixed infrastructure assets. We would expect to see all of these assets as related child locations of the Sydney Light Rail top-level location parent. (See Figure 16.)

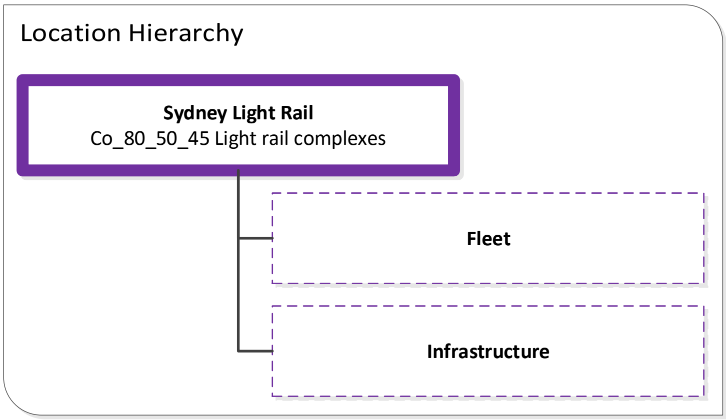


Figure 16 – Location hierarchy relationship example

The following additional examples illustrate the flexible nature of defining a location hierarchy.

- **Example (linear asset)**: In the case of linear assets, a rail corridor location allows the grouping of more specific asset locations such as the Up Main Track and the Down Main Track.
- **Example (facility)**: A railway station is a physical place which may be further broken down into more specific asset locations such as platforms, carparks, buildings, and spaces within a building such as rooms.

8.5 Work locations

In relation to project delivery, locations as defined in Section 8.4 are often synonymous with zones where project work is conducted and hence the terms ‘work location’ and ‘location’ are often interchangeable. However, this is not always the case and when dealing with linear assets there may be a need to define work locations separately.

Work locations are geospatially defined zones where construction activity is to occur and may be used in conjunction with project planning, such as in the definition of detailed work packages.

While each work location is typically assigned a unique reference, it may not be possible to classify a work location with a Uniclass code due to the fact the work location may encompass multiple ‘asset’ locations.

Figure 17 – Example of work locations from a light rail project

In Figure 17, work locations are represented with red rectangles. Each work location encompasses a portion of the light rail corridor (for example, WL01, WL02, WL03, and so on) as well as a section of the road corridor (for example, RC01, RC02 and RC03) which are both separate locations under Uniclass.

If work locations are used on projects, TfNSW requires that, at project handover, work locations are to be appropriately reclassified to reflect asset locations as required for operations and maintenance (O&M). This allows for documentation referencing work locations to be associated with asset locations appropriate for O&M.

Where complex location hierarchies are required to facilitate project delivery, it is recommended that the Project Manager and/or DE Manager (whoever is responsible for defining and classifying locations) contacts the DE Team to assist with defining the best appropriate location hierarchy.

8.6 Assets and asset hierarchies

During the design phases of a project, designers will determine a growing number of objects that will be identified and classified using the Uniclass Elements/Functions (EF) codes or Products (Pr) codes. This growing set of data must therefore be structured in a manner that improves our understanding of what assets are needed and how they are related.

Groups of assets that work together to deliver a function are linked together by identifying a system and applying a Uniclass Systems (Ss) code. As a TfNSW business rule, systems are the primary method of grouping assets as they define the combined function of the assets.

The relationship of Ss, EF and Pr codes creates an asset configuration hierarchy that enables a functional view of assets.

Example: A surveillance system is composed of cameras, networking system and recording equipment, and so on (see Figure 18).

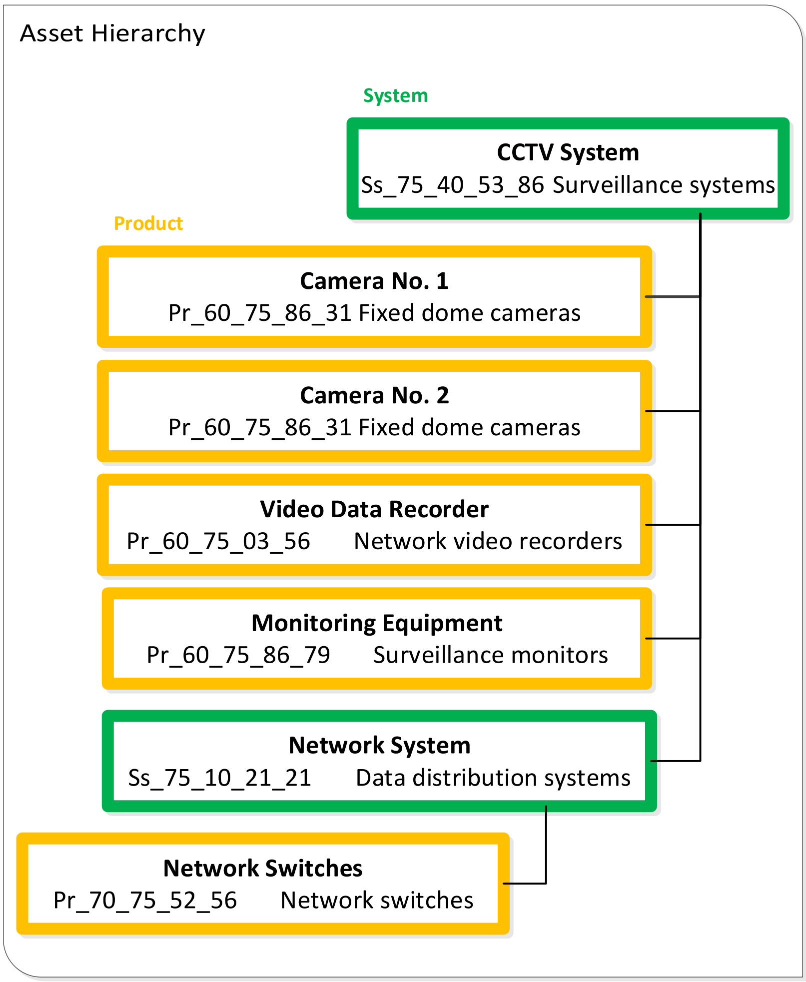


Figure 18 – Asset hierarchy example

Note: The way assets are organised into asset hierarchies is independent of their location and the location hierarchy. Both views are necessary, valid and co-exist at the same time.

8.7 Asset configuration hierarchy modelling conventions

Uniclass does not specify how systems, elements and products can or should be combined.

Users may define their own conventions to determine how these are consistently combined.

The TfNSW DE Team recommends the following minimum general conventions:

- Systems are always at the top of the asset configuration hierarchy.
- Systems may be subsystems of a parent system.
- All elements (EF) and products (Pr) must be associated with a parent system (Ss) by the time the project reaches configuration management review gate (CMG) 3 (that is, on completion of design).
- Typically, complex assets should be broken down until we reach the maintenance managed item (MMI).

The MMI is an asset or component that exists generally at the lowest level in the asset hierarchy and for which an owner will manage the asset and make decisions including to repair, rehabilitate or replace.

The granularity of the asset hierarchy is dictated during the project based on design requirements, with consideration given to what the MMI is for operations and maintenance purposes.

TfNSW requires that assets must be defined to the level of the MMI by CMG 3 (to determine the MMI, refer to the rules for the inclusion of assets in the asset register as specified in the TfNSW AMB standard T MU AM 02001 ST – *Asset Information and Register Requirements*, refer to section 9.4 Creation of assets in the asset register.

8.8 Associating assets to locations

8.8.1 Introduction

The flexibility and configurability of Uniclass allow users to associate assets within the asset hierarchy with the appropriate level of the location hierarchy, depending on the user's requirements and to best support user functionality.

Examples of a basic and detailed association are provided below.

8.8.2 Basic approach to asset location assignment

In this approach, all physical assets have been identified, however, only the high-level physical asset, that is, the CCTV system, is assigned an asset location, that is, the railway station (relationship A) (see Figure 19). This method leaves the detail out from the Asset Register and the user has to assume that all sub-assets can be located somewhere at the station.

Additional location detail (of where to locate the individual assets) may be provided by supplementing the asset record with an appropriate design model/drawing which shows the location of the physical assets. The model is stored in an electronic document management system and document metadata provides a way to relate the model to the location and the system (relationships B1 and B2).

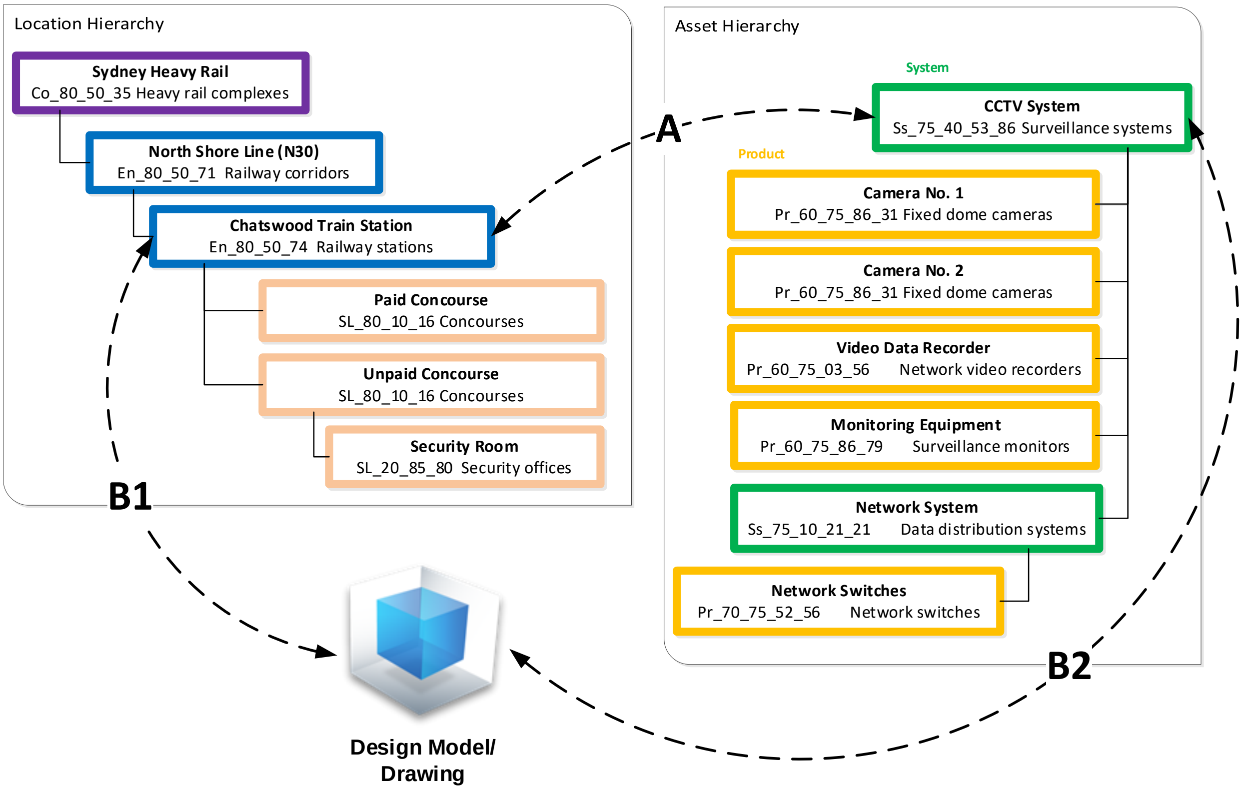


Figure 19 – Basic asset location assignment example

8.8.3 Detailed approach to asset location assignment

In this approach, each physical asset within an asset hierarchy is assigned an asset location independently (see Figure 20).

This method results in the most accurate representation of where to locate assets. The decision of whether to adopt a basic versus detailed approach for the project should be assessed based on the user needs. This includes consideration of the design team and O&M team requirements.

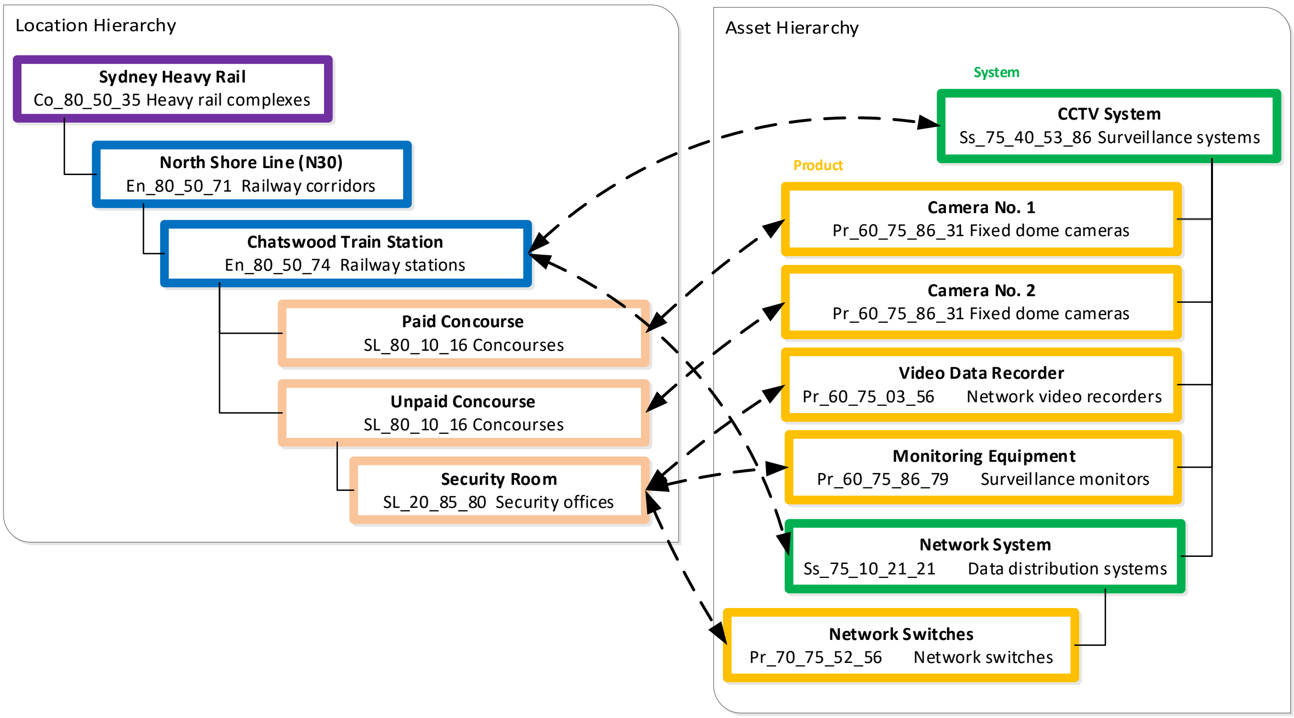


Figure 20 – Detailed asset location assignment example

9 TfNSW discipline classifications

9.1 Overview

For TfNSW projects there is also a need to assign organisational disciplines to project data and information. This classification is primarily used for assigning organisational responsibility (work breakdown structures (WBS), cost breakdown structures (CBS) and work packaging).

Discipline classification is separated into two broad categories:

- **Business discipline** – for information and data related to indirect (overhead) costs, resources, activities, and so on.
- **Technical discipline** – for information and data related to direct costs, resources, activities, and so on, related to specific asset: components (Products) or asset systems (Systems).

The codes used to define specific discipline classifications have been established by TfNSW (refer to DMS-FT-548 – *Project Data Building Blocks Template*). The DE Team has worked with the wider business to develop a set of discipline classifications that includes the discipline identification requirements of the TfNSW AMB standard T MU MD 00006 ST – *Engineering Drawings and CAD Requirements*, namely discipline classification for:

- projects
- CAD layer naming
- plan room
- asset management.

For use in DE enabled projects, both business and technical discipline classifications have been established at two levels:

- level 1 – high-level discipline groups
- level 2 (sub discipline) – more specialised discipline groups.

An example of one discipline and sub discipline grouping is provided in Table 6.

Table 6 – Example of discipline classification levels

Level 1 – Discipline	Level 2 – Sub disciplines
AR – Architecture	AS – Architectural signage system AT – Architectural design ID – Interior design LA – Landscaping UD – Urban design

9.2 Linkage to Uniclass

Each Uniclass System (Ss code) being utilised within the scope of a project is to be linked to a specific Technical Discipline (see Figure 21). This linkage primarily provides the project team with the ability to assign organisational responsibility for deliverables (for example, specific BIM models) and a higher-level grouping of deliverables, activities and costs, as required by existing TfNSW policies and procedures.

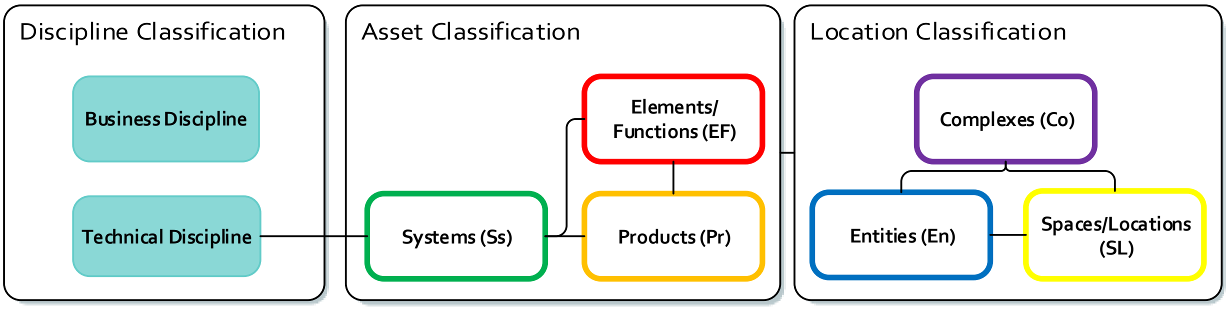


Figure 21 – Linkage between Technical Discipline and Systems (Ss)

10 How classification is utilised for project data and information

Classification is used to varying degrees in all DE discipline deliverables (see Figure 22).

Every file that is received as part of a submission from a supplier to TfNSW must be classified appropriately within the document metadata. This classification occurs when a file is transmitted via TfNSW's Enterprise Content Management (ECM) system.

Additionally, the data contained within files also often requires classification. For example, each object within a BIM model requires classification and each line within an asset register requires classification. Further classification of data is indicated in Figure 22.

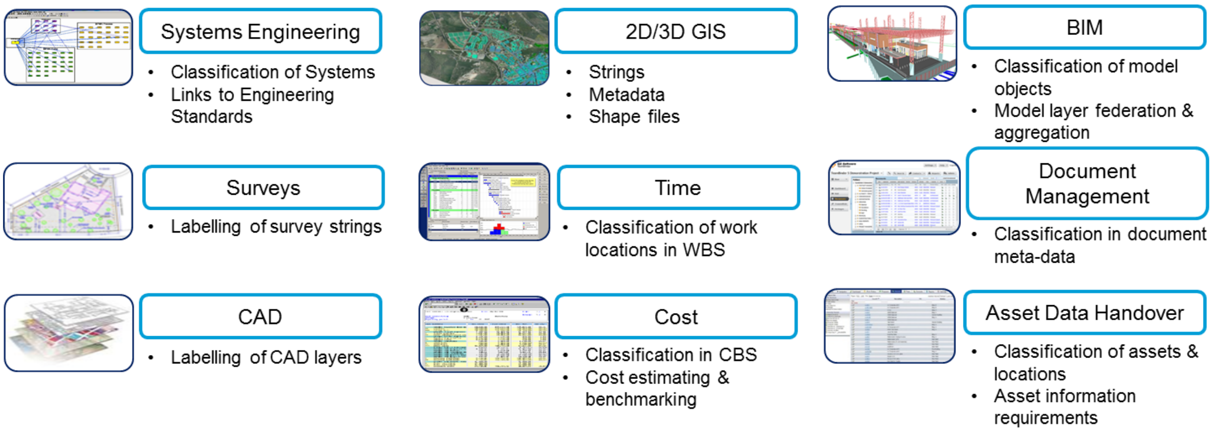


Figure 22 – Points of classification within DE deliverables

Table 7 provides a summary of the different classifications which are used in the creation of project data. Details on the specific way in which classification is to be utilised, as well as the additional data requirements, are included in the relevant DE deliverable technical guides (refer to DMS-ST-208 – *Digital Engineering Framework*, Version 4.0, Appendix B).

Table 7 – Use of classification in project data

Ref	DE deliverable	Location classification	Asset classification	Discipline classification
1	Documents	✓	×	✓
2	Systems engineering		TBC	
3	Surveys		TBC	
4	CAD drawings	✓ (Project Entity level only)	✓	✓
5	BIM models	✓	✓	✓
6	GIS		TBC	
7	Scheduling (4D)	✓	✓	✓
8	Cost estimating (5D)	✓	✓	✓
9	Asset data (6D)	✓	✓	✓

11 Case study – light rail network

11.1 Introduction

The following case study is illustrative only and has been developed to provide tangible examples of the concepts of location classification, asset classification, classification hierarchies and the asset-location relationship. These examples are not provided to define the classification structure for the real-world asset.

11.2 Building a location hierarchy for a light rail network

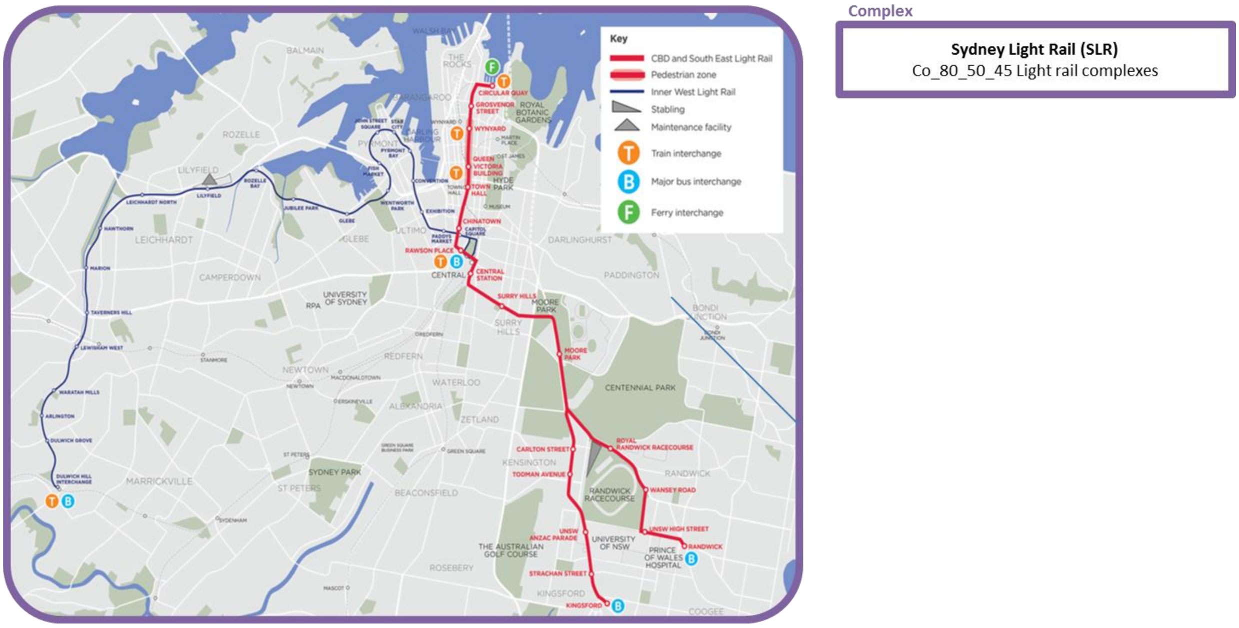


Figure 23 – Sydney Light Rail complex (case study)

The Sydney Light Rail (SLR) network is a complex which is made up of numerous entities and spaces (see Figure 23).

Identifying corridors

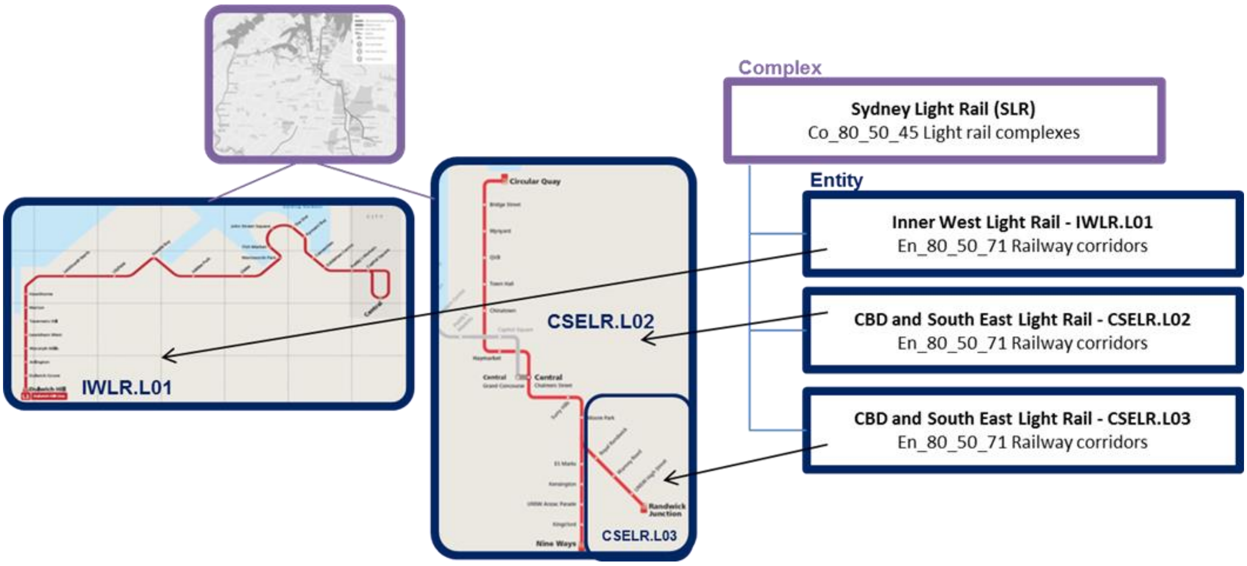


Figure 24 – Identifying corridors (entities) (case study)

The SLR complex comprises three separate corridors (entities) which are organised into an asset location hierarchy (see Figure 24).

Adding spaces

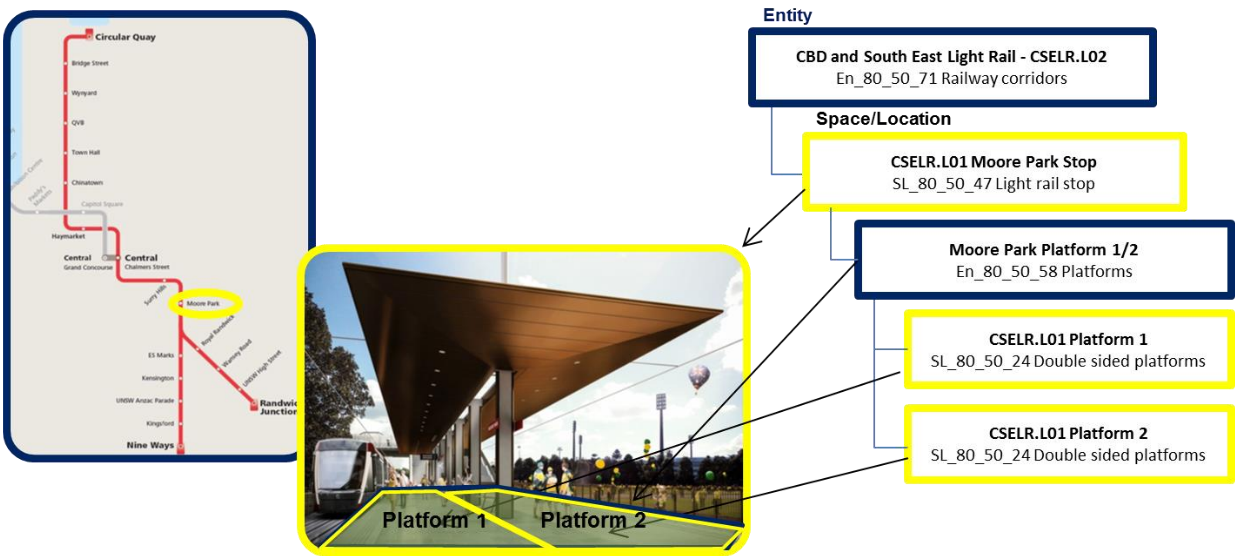


Figure 25 – Adding spaces (case study)

Each light rail corridor entity contains spaces which serve as containers for the linear assets, as well as designated stops (see Figure 25):

- Moore Park stop

At each stop, structures (entities) and spaces are designated for various functions, including the:

- platform structure
- space on the platform that is designated as Platform 1
- space on the platform that is designated as Platform 2.

11.3 Building the asset hierarchy

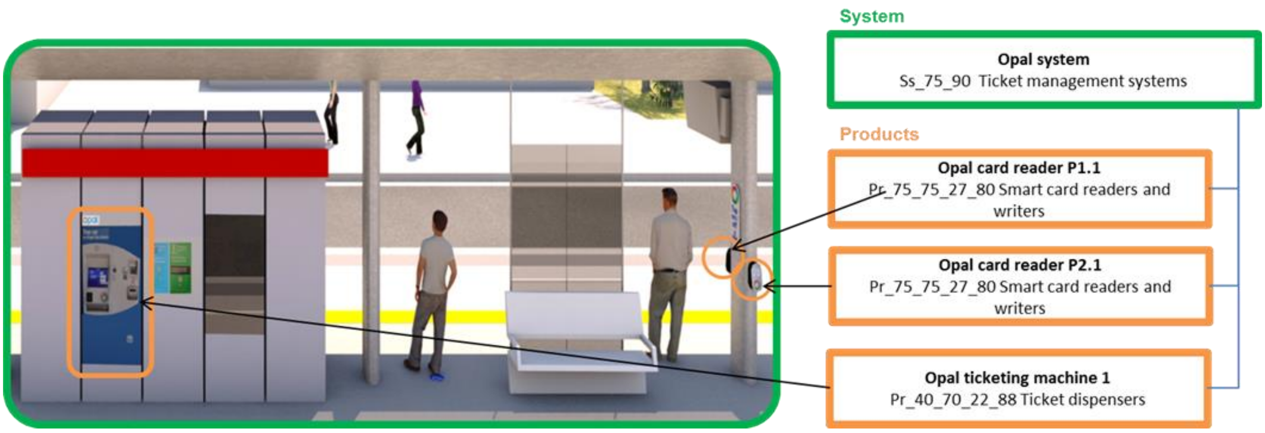


Figure 26 – Building asset hierarchy (case study)

The light rail ticket management system is made up of many products which are individually identified and labelled using agreed referencing naming conventions.

Products associated with a specific system instance can be related to one another and form an asset hierarchy enabling a functional view of assets (see Figure 26).

11.4 Associating assets to asset locations

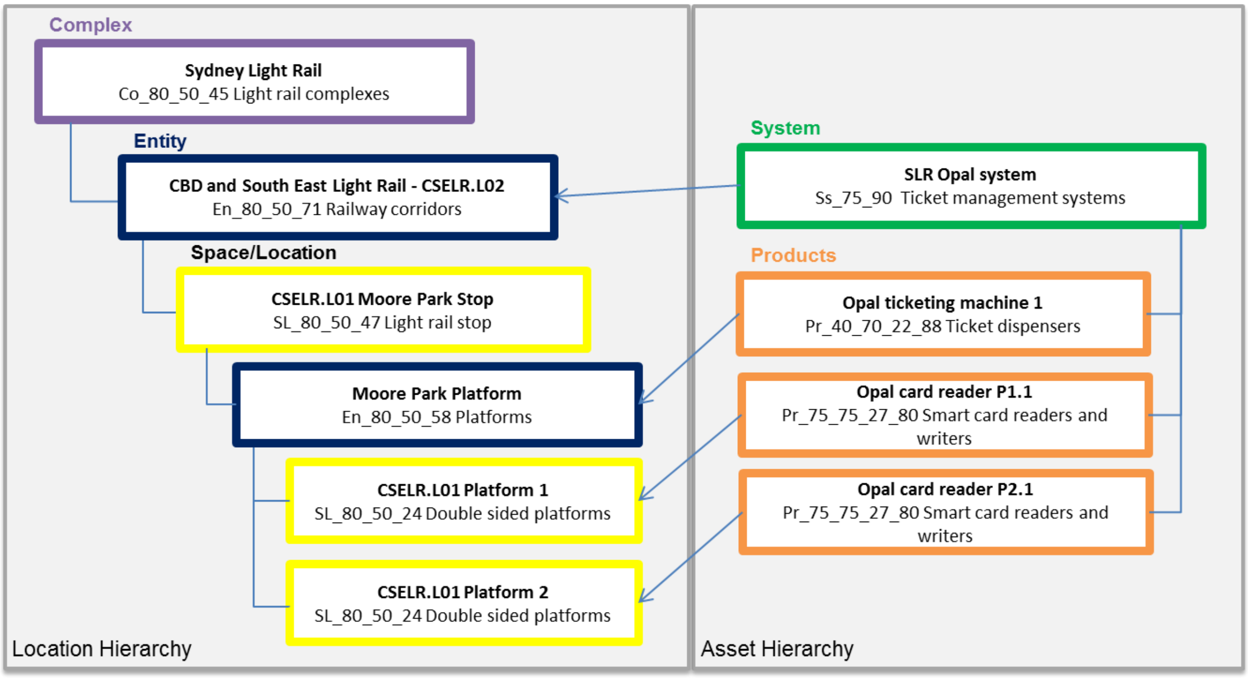


Figure 27 – Associating assets to asset locations (case study)

Figure 27 provides an example where assets are systems and products and asset locations are complex, entities and spaces.

In our example, the Opal system serves the whole corridor whereas the ticketing machine and card readers are specific to the stop (see Figure 27).

11.5 Linking systems to technical disciplines

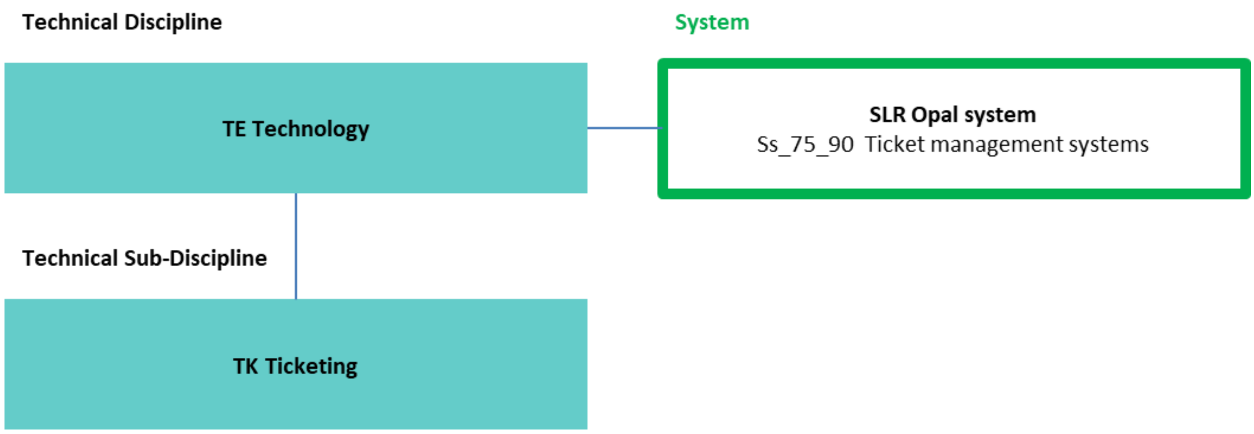


Figure 28 – Linking systems to technical disciplines (case study)

The ticket management system belongs to the Technology (TE) Technical Discipline and within that discipline, it falls into the Ticketing (TK) Sub-Discipline (see Figure 28).

12 Further support, guidance or feedback

For general enquiries and assistance with the application of the DE Framework and associated guidelines, education, training, or planning and commencing a digital engineering enabled project, please contact the Digital Engineering Team at **Digital.Engineering@transport.nsw.gov.au**.

The DE Framework embraces a culture of continuous improvement. Suggestions, comments and feedback are welcomed and encouraged.

For general information refer to the **TfNSW Digital Engineering website** (https://www.transport.nsw.gov.au/digitalengineering).

Appendix A Stakeholders consulted

This appendix lists the stakeholders consulted for the initial release of this document, (Version 1.0, 2018).

A.1 Government agencies

Federal

- Australian Department of Defence
- Department Infrastructure and Regional Development
- Infrastructure Australia

NSW

- Transport for NSW
- Department of Finance, Services and Innovation
- Department of Education
- Digital.NSW
- Emergency Information Control Unit
- Infrastructure NSW
- NSW Health Infrastructure
- NSW Justice Infrastructure
- NSW Trains Link
- Roads and Maritime Services
- State Transit Authority
- Sydney Metro Authority
- Sydney Motorway Corporation
- Sydney Opera House
- Sydney Trains

Other states

- ACT Transport Canberra and City Services
- NT Department of Infrastructure, Planning & Logistics
- Qld Department of Transport and Main Roads
- Qld Queensland Rail
- SA Department of Planning and Transport Infrastructure
- SA Power Networks
- Vic Dept of Economic Development, Jobs, Transport and Resources
- Vic Level Crossing Removal Authority
- Vic Office of Projects Victoria
- Vic Treasury and Finance
- VicRoads
- VicTrack
- WA Mainroads Western Australia
- WA Public Transport Authority

- WA Treasury – Strategic Projects

International

- China BIM Union
- Dubai Roads and Transport Authority
- Hong Kong MTR
- Malaysia MRT
- NZ Transport Authority
- UK Crossrail
- UK Group Digital Railway
- UK National Building Specification
- UK Network Rail
- UK Royal Institution of British Architects
- UK Transport for London

A.2 Industry bodies

Australian

- Australasian BIM Advisory Board
- Australasian Rail Association
- Australian Institute of Architects
- Australian Institution of Quantity Surveyors
- Austroads
- BIM-MEP Aus
- Collaborate ANZ
- Consult Australia
- Engineers Australia
- Facilities Management Association of Australia
- Institute of Public Works Engineering Australasia
- NATSPEC
- Rail Industry Safety Standards Board
- Smart Cities Council Australia New Zealand
- Spatial Industries Business Association
- Standards Australia
- Surveying and Spatial Sciences Institute
- Sustainable Built Environment National Research Centre
- Virtual Australia NZ Initiative

International

- British Standards Institute
- BuildingSMART International
- Institution of Engineers Malaysia
- Institution of Civil Engineers

A.3 Academia

- Curtin University – Australasian Joint Research Centre for BIM
- Swinburne University
- University of NSW – Geospatial Research and Innovation Development
- University of South Australia
- University of Sydney
- University of Technology Sydney (UTS)
- University of Wollongong – Smart Infrastructure Facility
- Western Sydney University

A.4 Industry

Local – Consultants (Engineering)

- AECOM
- Arcadis
- Arup
- Aurecon
- Beca
- Cardno Group
- Engenicom
- GHD
- Jacobs
- Meinhardt
- Mott MacDonald
- Opus
- Parsons Brinckerhoff
- Ridley
- SMEC
- Urban Circus
- Norman Disney Young

Local – Contractors

- Arenco
- AW Edwards
- Bouygues Construction Australia
- CIMIC
- Degnan Constructions
- Downer
- Edwards Construction
- EIC Activities
- Gartner Rose
- Haslin Constructions

- John Holland
- Laing O'Rourke
- Lend Lease
- McConnell Dowell
- Pacific Complete
- Stephen Edwards Constructions
- Thiess

Consultants/other

- GS1
- Industrie & Co
- McKinsey
- PCSG
- PwC

Software vendors

- 12d
- Autodesk
- Bentley
- InEight
- Red Eye
- RIB
- SAP
- theSmart.io