FIG WORKING WEEK 2019

22–26 April, Hanoi, Vietnam

"Geospatial Information for a Smarter Life and Environmental Resilience"

ORGANISED BY FIG

PLATINUM SPONSORS esri THE SCIENCE OF WHERE Trimble

FIG WORKING WEEK 2019
22–26 April, Hanoi, Vietnam
"Geospatial Information for a Smarter Life and Environmental Resilience"

Towards an Implementable Data Schema for 4D/5D Cadastre Including Bi-Temporal Support

Rod Thompson (Australia)
Peter van Oosterom (Netherlands)
(Presenter) Sudarshan Karki (Australia)

ORGANISED BY FIG

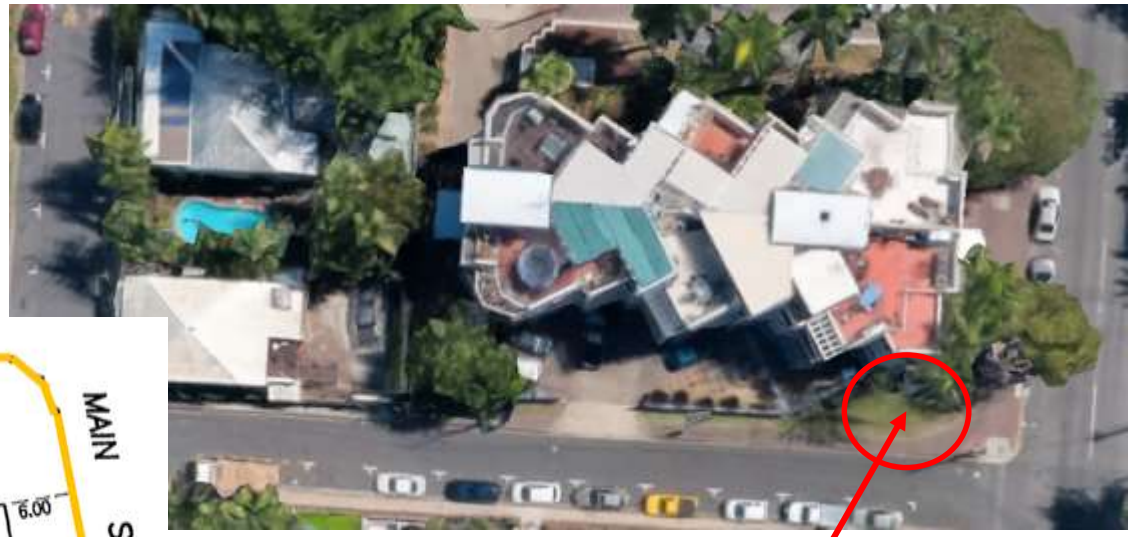
PLATINUM SPONSORS esri Trimble

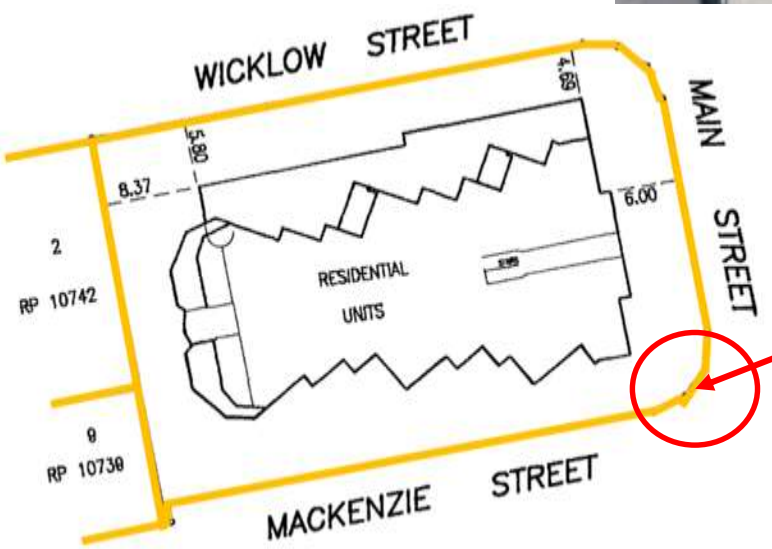
Key points

- Cadastral boundaries are physical or legal
- Cadastral records are different "instances in time"
- Important to have history of cadastre (bounds and transactions)
- Important to maintain history of database and real world events
- Professionals wish to see planning cadastre
- Bi-Temporal schema created based on LADM classes
- Implement 2D/3D/4D in existing or new databases – fit for purpose

Legal boundary with variable physical location

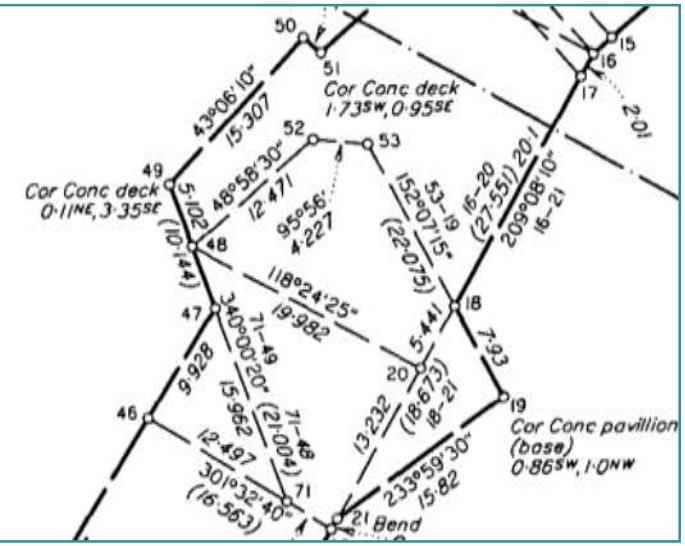
Legal rights, Physical missing – no issues



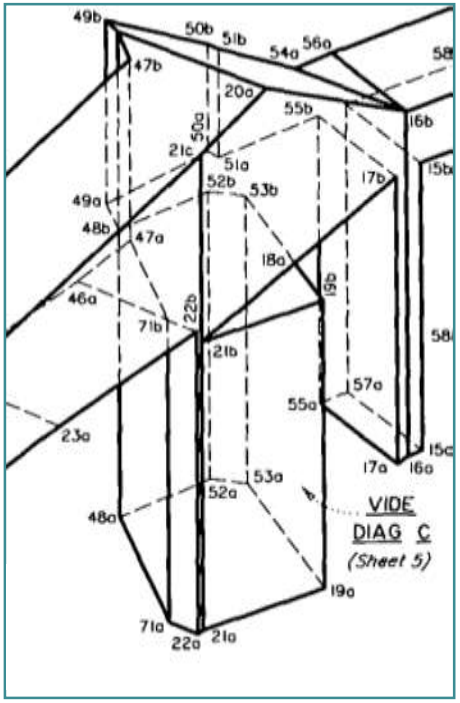


This fiat boundary is legally enforceable, but is not a physical object in the real world

Legal and Physical Boundaries of a 3D Object



Footprint of volume in cadastral plan



Isometric view in cadastral plan

Real world construction

Point "Movements" – Database Events (DBEvent)

- The point may be legal, may or may "not there" to measure (e.g. volumes)
- The position may be improved – without the point moving (e.g. coordinate corrections, positional accuracy upgrade)
- The position may be found to be incorrect, and then fixed (both DBEvent and RW)
- Ground movements (e.g. earthquake, tectonic plate – may be both DBEvent and Real-world event);
- Datum changes – (Changes in coordinates – DBEvent, does not affect point)

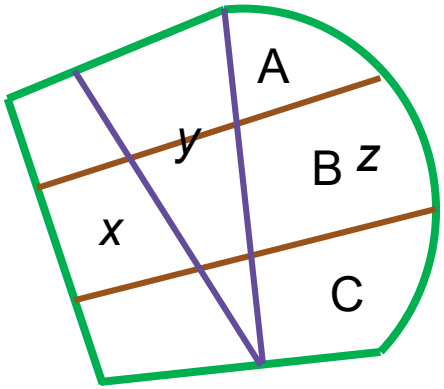
A change of point coordinates can not be assumed to indicate a real-world boundary change

Point "Movements" – Real-world events

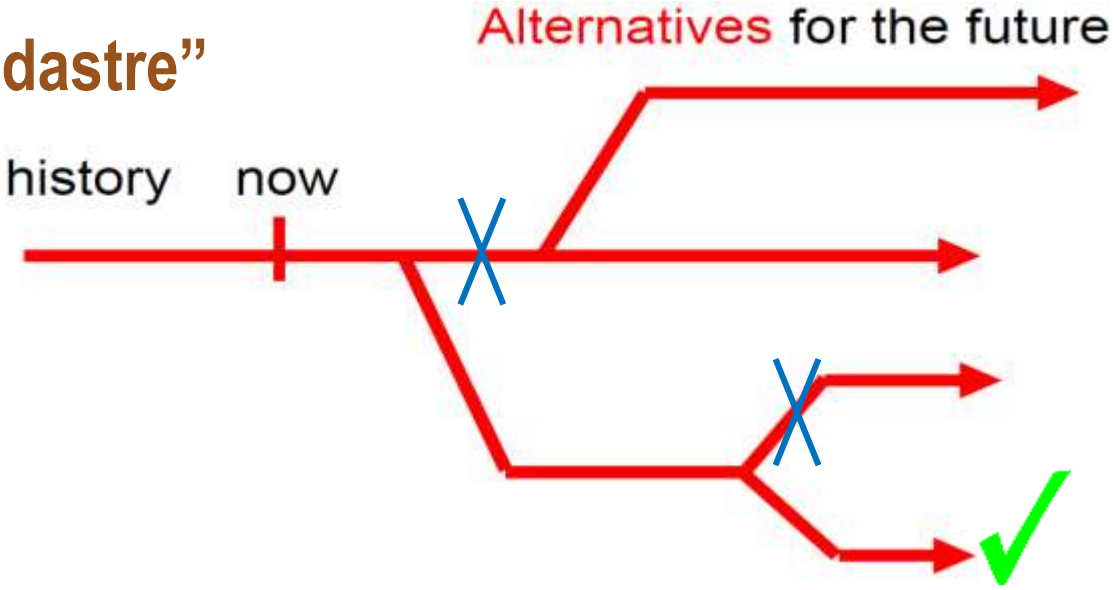
- Boundaries created (e.g. Subdivisions - both Real-world and DBEvent – Chronologically flexible)
- Error fix - Boundary position may be altered (Real-world event, may be DBEvent)
- Resurvey – Positional improvement (May be both Real-world and DBEvent)
- Infrastructure, Buildings etc. – (may create more RW points, will create DBEvent)

A change in Real-world points will more likely be reflected as a Database event

Proposed "planning cadastre"



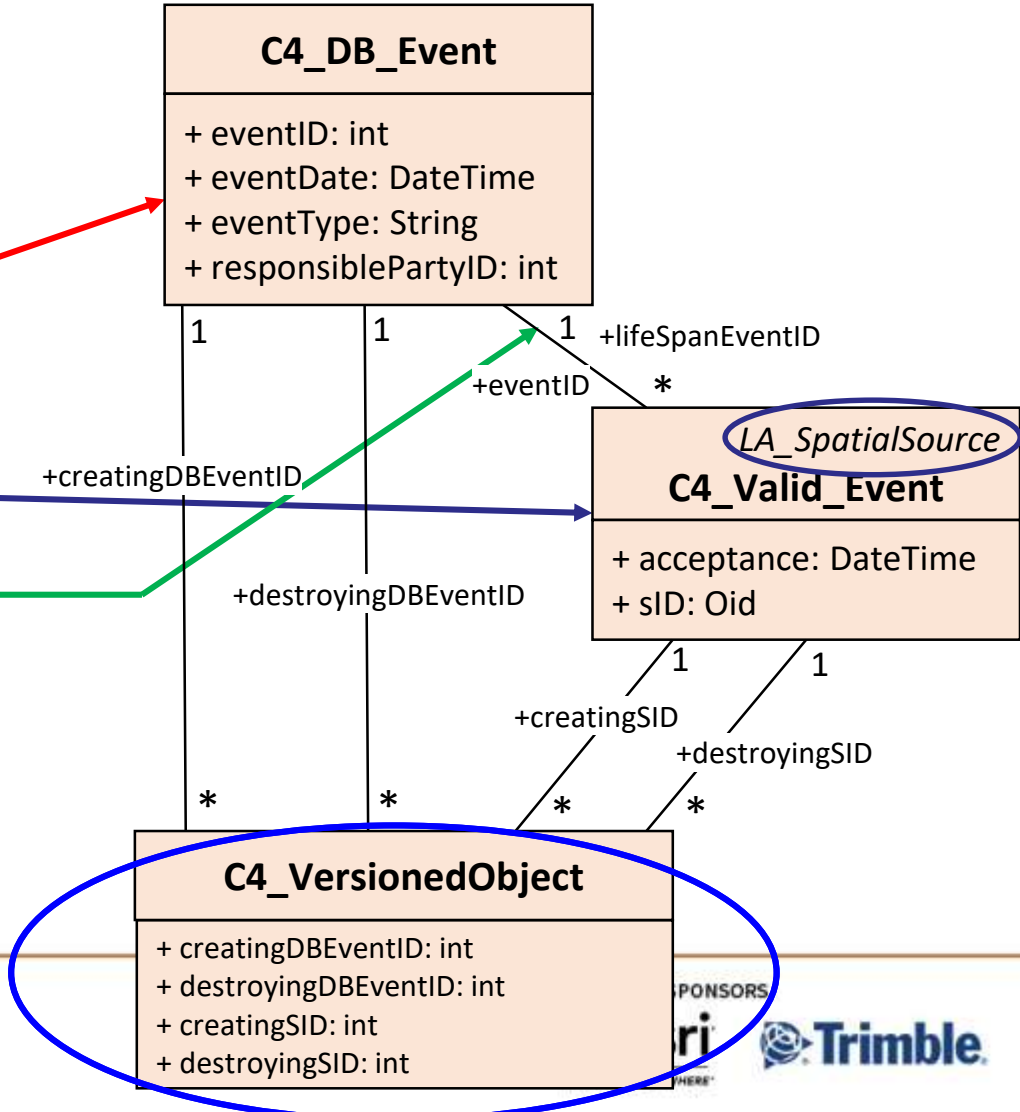
Future topology may be incompatible



- As time passes, alternatives are dropped
- Tentative proposals do not become real data unless actioned in some way

Bi-Temporal Package

- Versioned object is bi-temporal
- Database history
- Real-world history
- Record of when a valid event is entered into the database



C4 = Cadastral 4th Dimension

Bi-Temporal History

- It is important to know what has happened in the past – where subdivision activity has been strong, who has owned the land, what its value was, etc.
- We want this to be as accurate as possible, and if we find inaccuracies or errors, we would like to fix them.
- It is also important to know what our knowledge of the cadastre was in the past, e.g. if a decision was made that now seems irrational, we want to know what information was available at the time leading up to that decision.
- This sort of history should not be "corrected" (it is an audit trail).

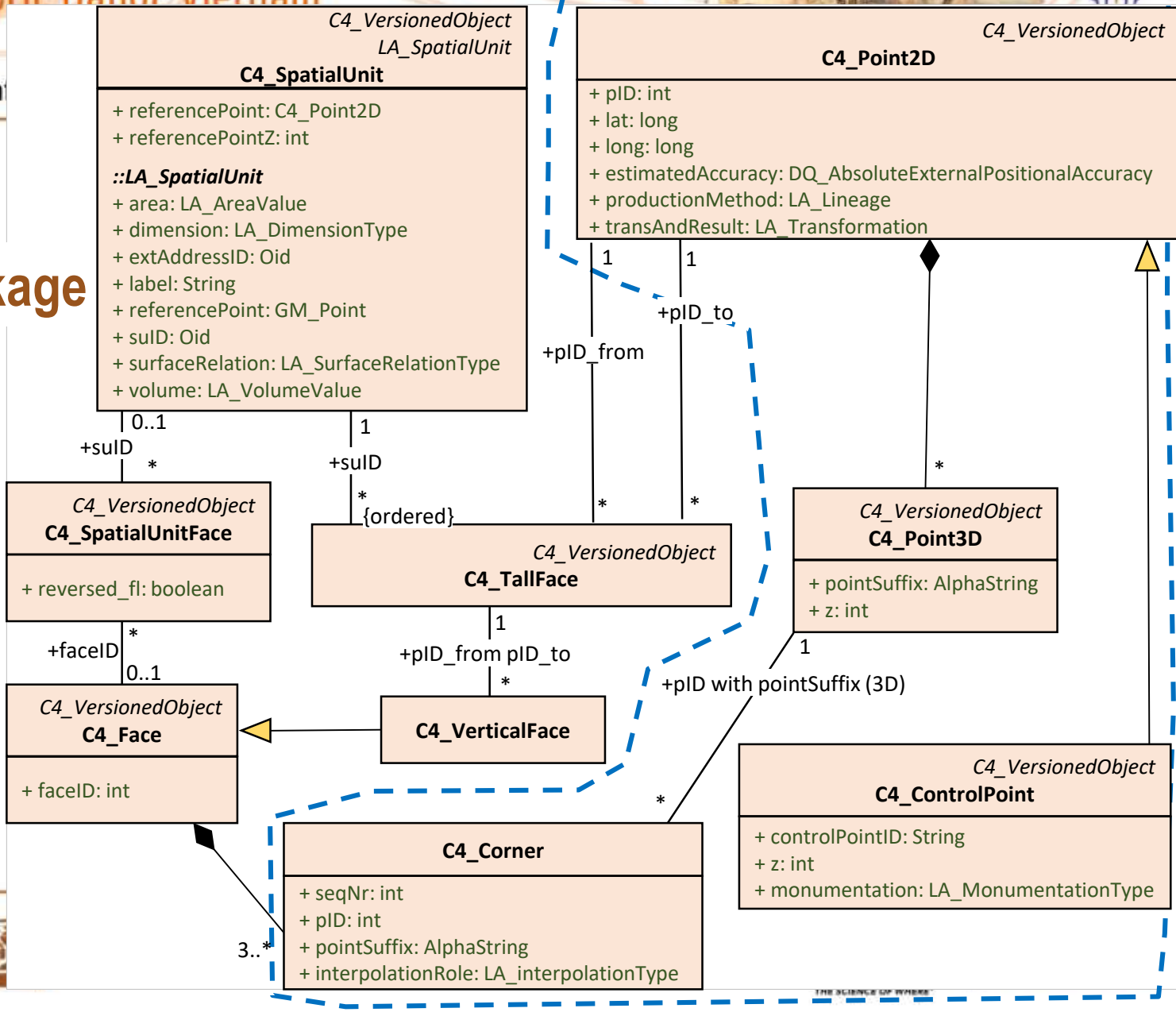
Bi-Temporal Data

- Real World – Physical parcels, Buildings, Fences, Infrastructure, Marks
- Activities – Subdivision, Position movement, Build etc.

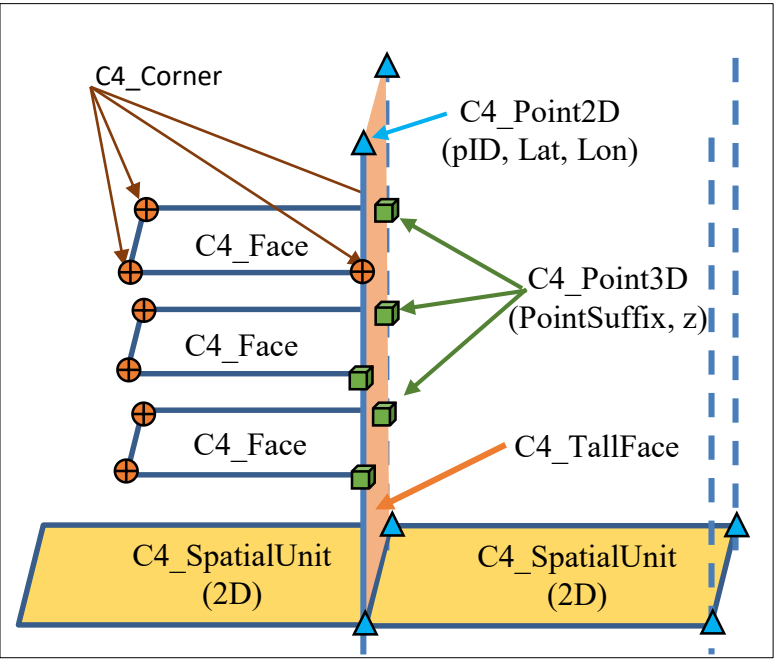
- Database – Record Parcel descriptions, Other Attributes.
- Activities – Record real-world transactions, database transactions etc.

Boundary Package

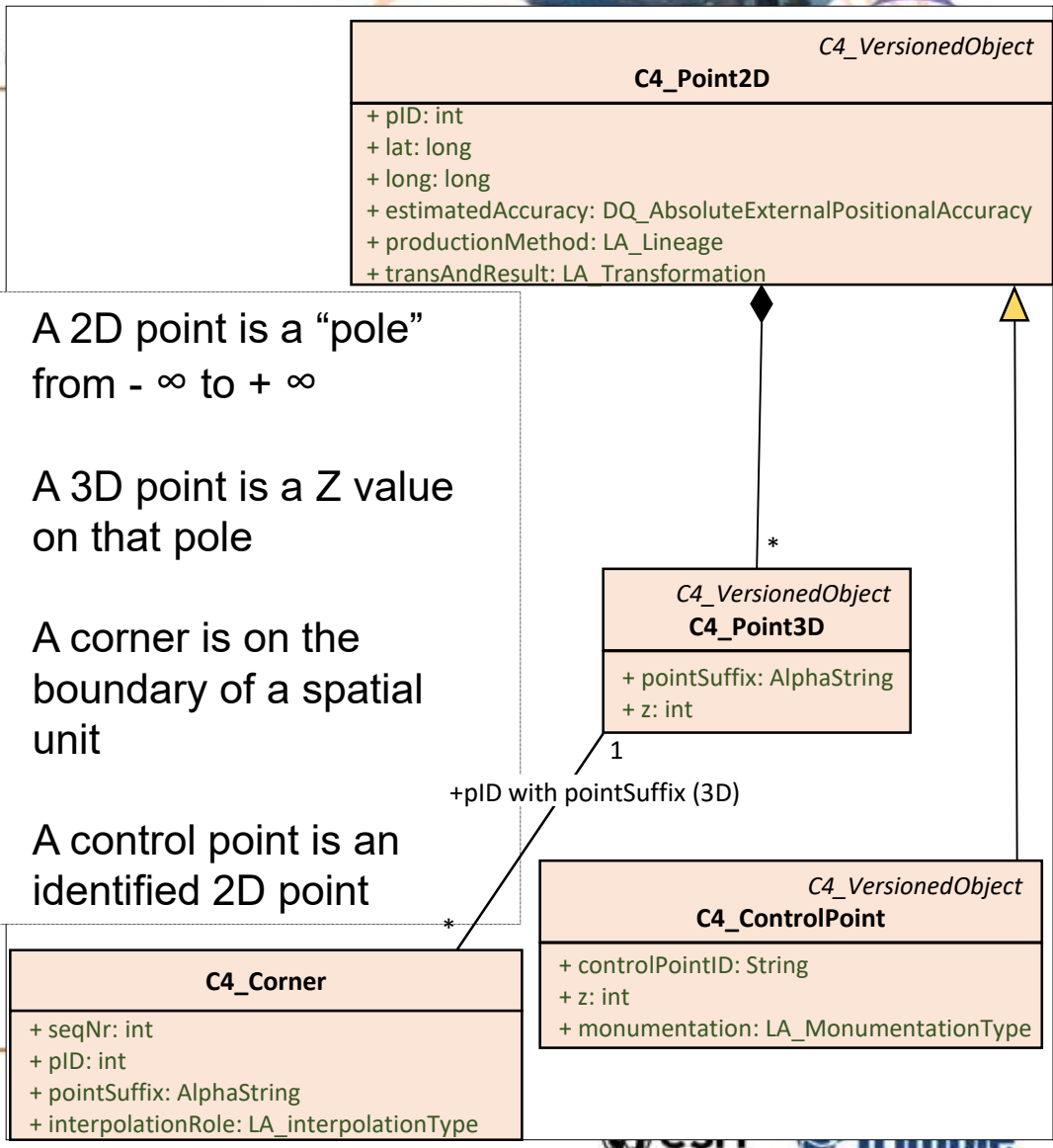
Spatial units and their geometry



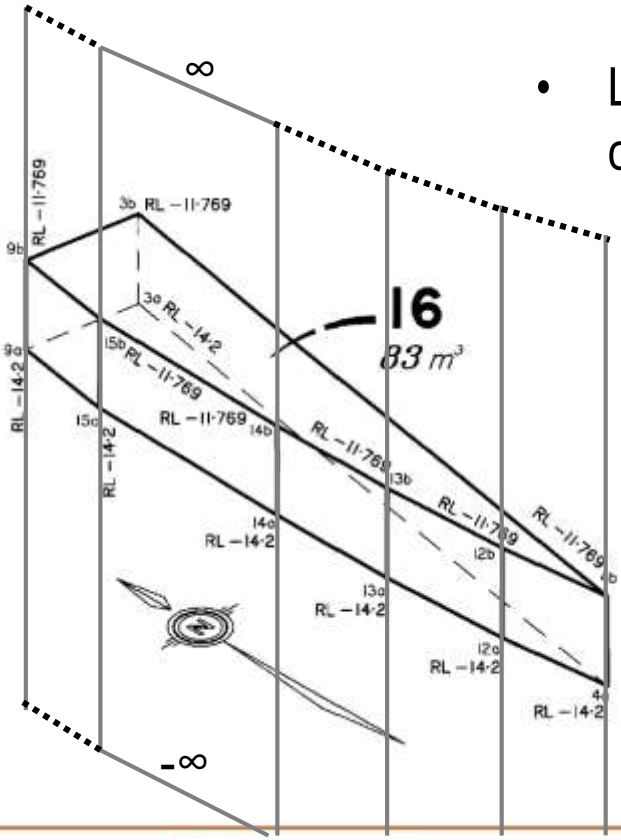
Point in 2D and 3D



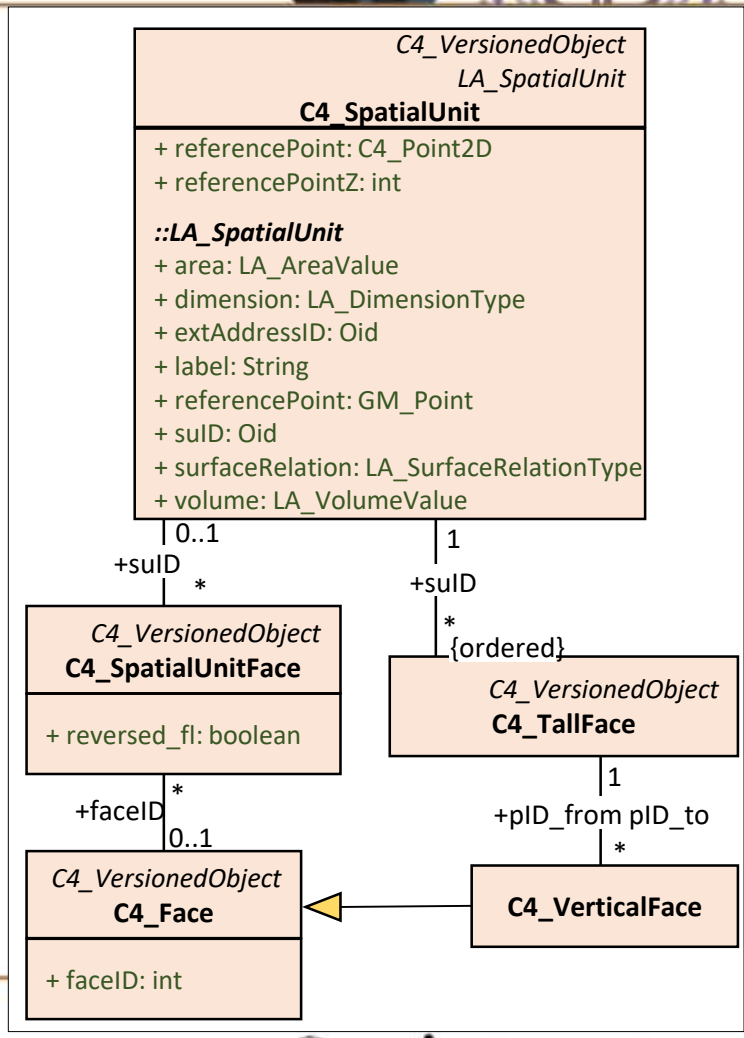
- A 2D point is a "pole" from - ∞ to + ∞
- A 3D point is a Z value on that pole
- A corner is on the boundary of a spatial unit
- A control point is an identified 2D point



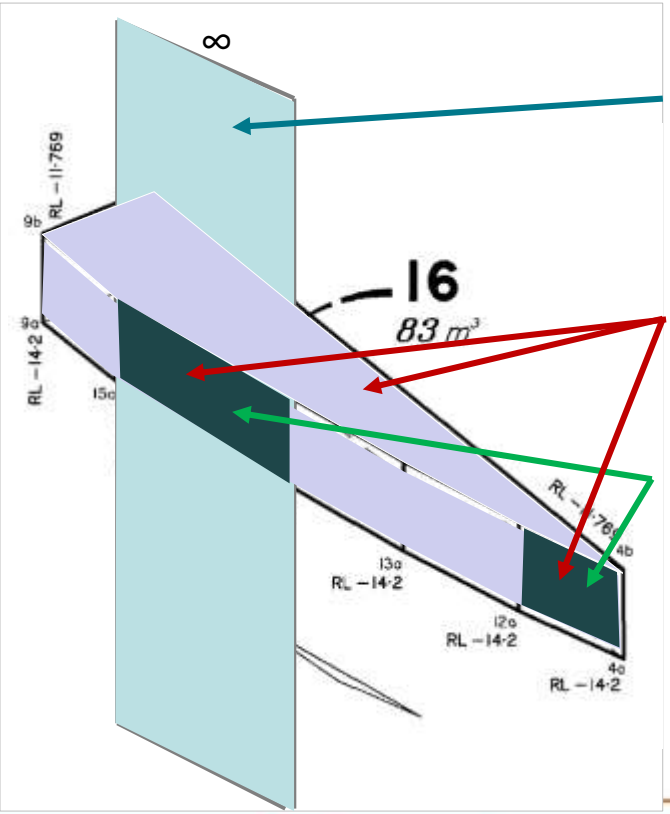
Face String / Tall Face



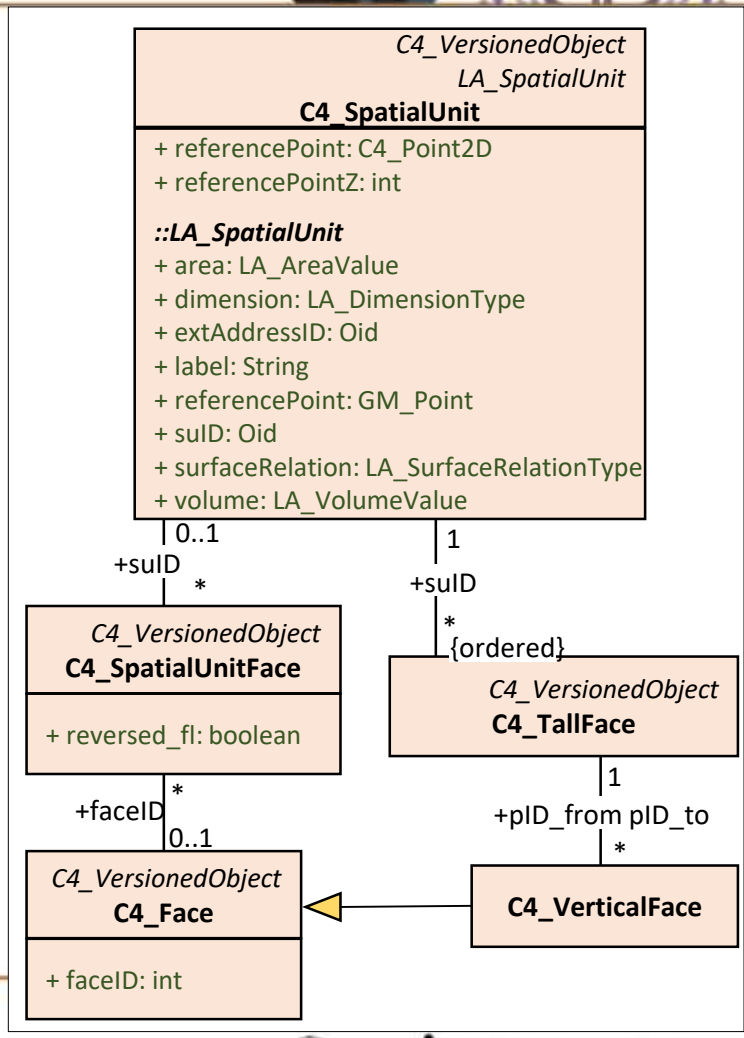
- LADM FaceString – a collection of tall faces



Tall Face, Face and Vertical Face

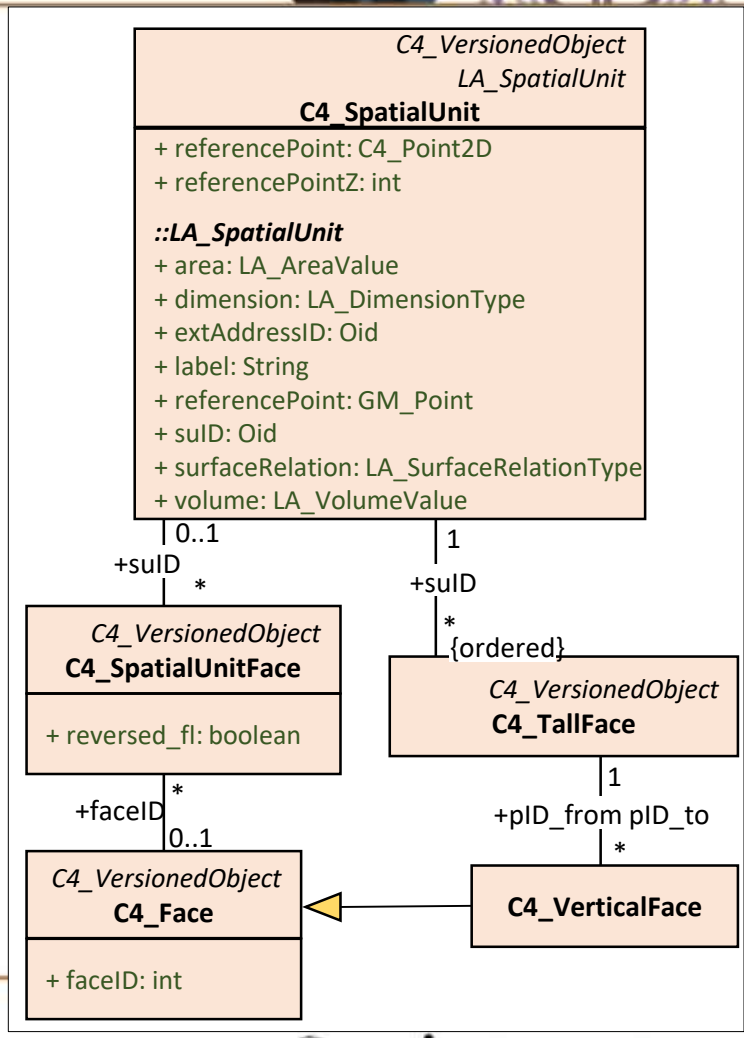


- Tall Face – an extrusion of a 2D line segment from -∞ to ∞
- Face – any finite surface patch in 3D
- Vertical Face – a Face that lies within a Tall Face



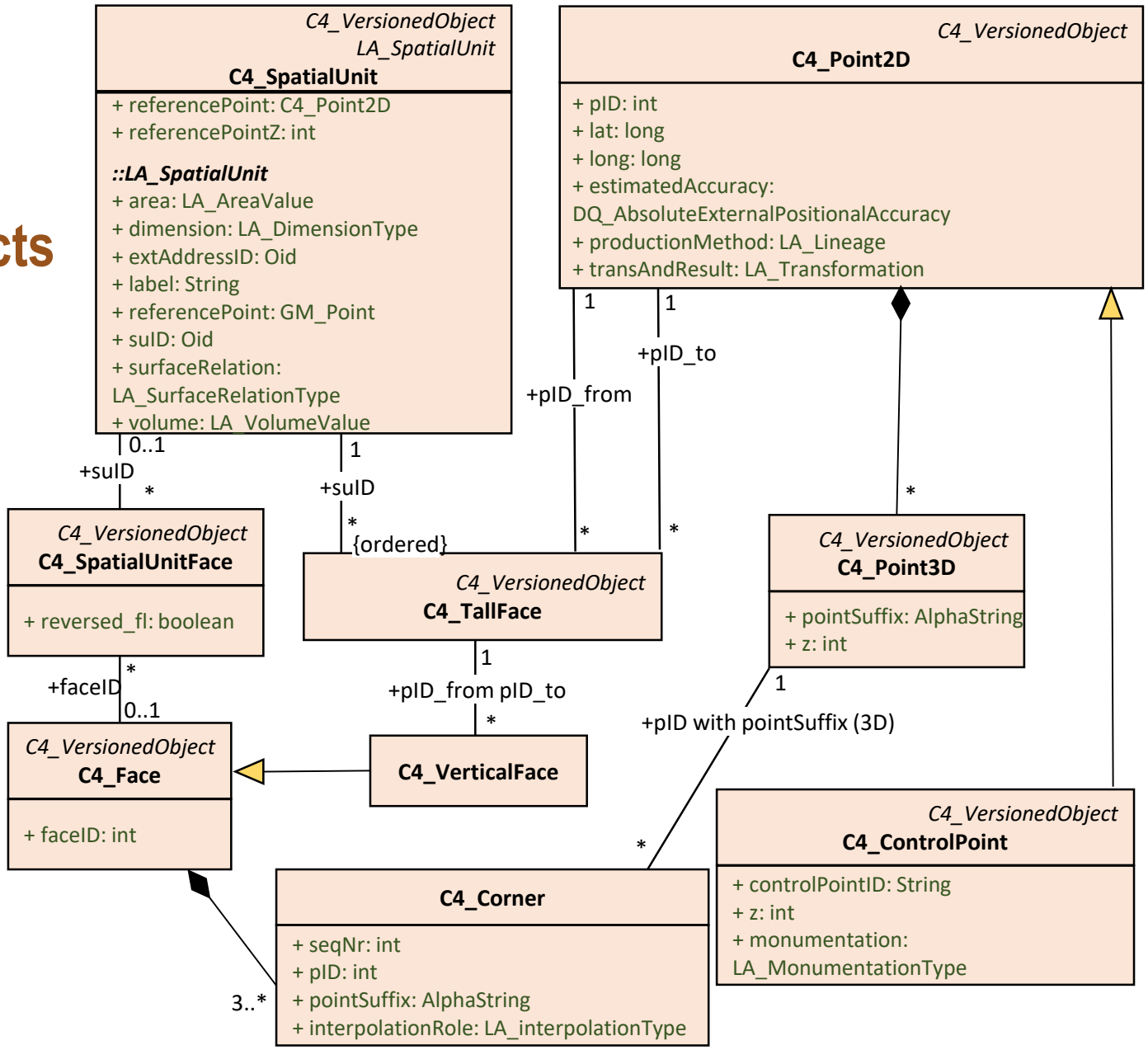
Spatial Units

- 2D Spatial Units are defined by an ordered collection of tall faces. This is equivalent to a polygon, but defines a 3D prism of space.
- 3D Spatial Units are also bounded by an ordered collection of tall faces. This defines the 2D "footprint" of the spatial unit.
- In addition, a set of faces limit the volume within the prism defined by the footprint
- Faces may be shared
- Vertical faces might not be stored.

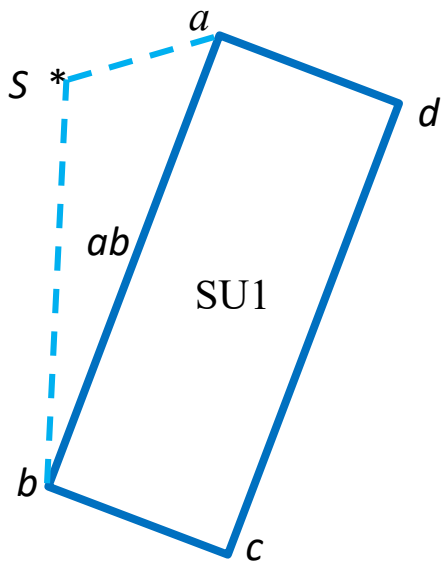


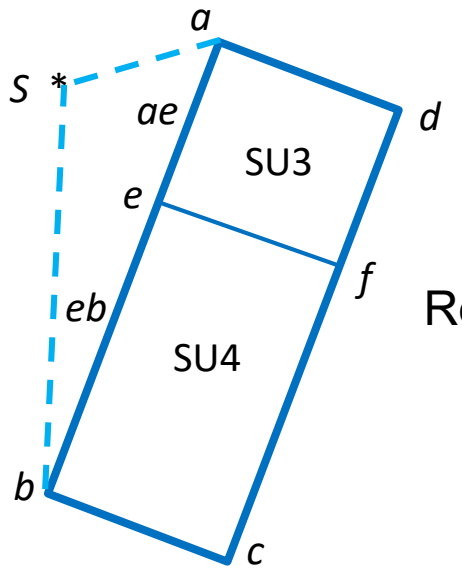
Temporal Aspects

- All the major tables inherited from Versioned Object
- The database is bi-temporal in nature.



Simple Subdivision Example

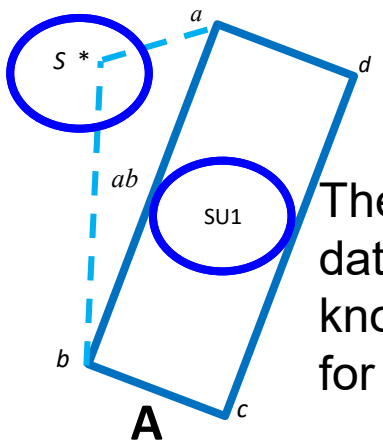




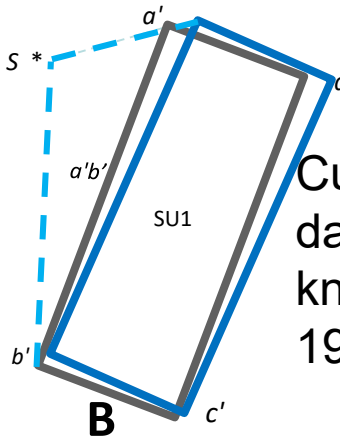
Real-world change

Subdivision with Data Improvement

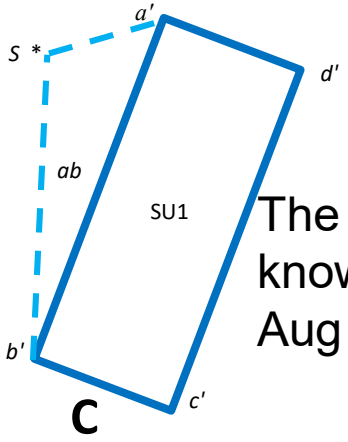
- In 1966 control point placed
- In 1970 SU1 created
- In 2000 database loaded
- In Aug 2018, survey for subdivision
- In Sep 2018, subdivision entered into DB



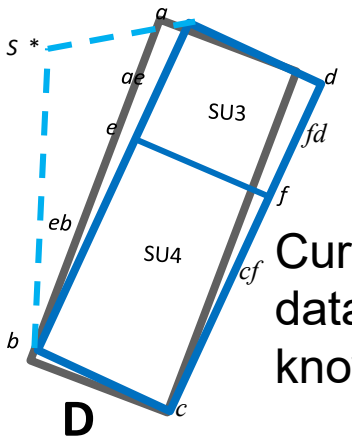
The 2000 database knowledge for 1970



Current database knowledge of 1970 situation



The database knowledge for Aug 2018



Current database knowledge

Conclusions

- A fit-for-purpose schema has been proposed which supports 3D spatial units and temporal history in the same database as 2D spatial units
- The schema is bi-temporal in nature, and includes the “Valid date” and “Database Event” time-stamping
- The proposed schema supports the ”Tentative Time” approach for the inclusion of development proposals
- The various “time events” can be queried from the database

- Rod Thompson: rodnmaria@gmail.com
- Peter van Oosterom: P.J.M.vanOosterom@tudelft.nl
- Sudarshan Karki: Sudarshan.Karki@dnrme.qld.gov.au