

A Suggested Terminology for Point-Like Entities in a Bi-Temporal Representation of 2D and 3D Land Administration Data

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What is a Point?

“0-dimensional geometric primitive, representing a position”
(ISO19107: Geographic Information - Spatial Schema Page 10)

Once we know where a point is, we know everything about it (?)

A point has no attributes apart from its position (?)

Points are not all Equal

Fence line is built according to the survey plan

It could be incorrectly placed!

The actual Cadastral corner is not visible

Survey mark is placed in the road kerbing, and helps fix the parcel corner

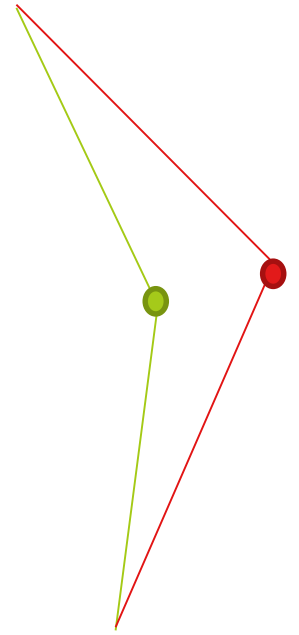


A Point

- Used to define the location of something more complex – such as:
 - A real-world feature (e.g. the top of a mountain)
 - A vertex of a cadastral boundary
 - A place to place a text label
 - Etc.
- ISO 19103 defines a "Direct Position", which is used to quantify the location of a point (using coordinates in relation to a Coordinate Reference System).

Point “Movement”

- It is easy to become confused between the adjustment of a point position, and the movement of a feature to a new point
- Is it an adjustment, or has the official property boundary been changed
- The result is different for the property owner
- So – consider what can cause a change in the coordinates of a point

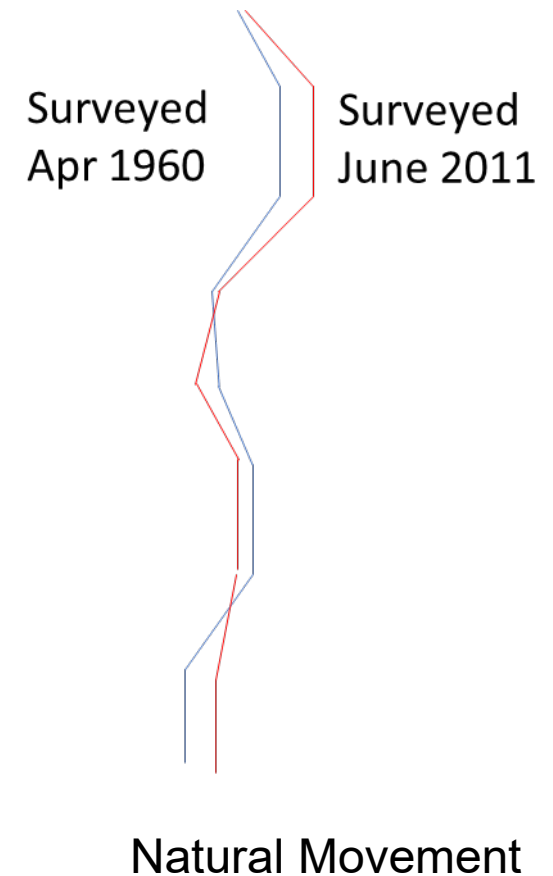


Point “Movements”

- Tangible Movement:
- Correction:
- Natural Movement: (*)
- Datum Change:
- Dynamic Datum:
- Local Deformation:

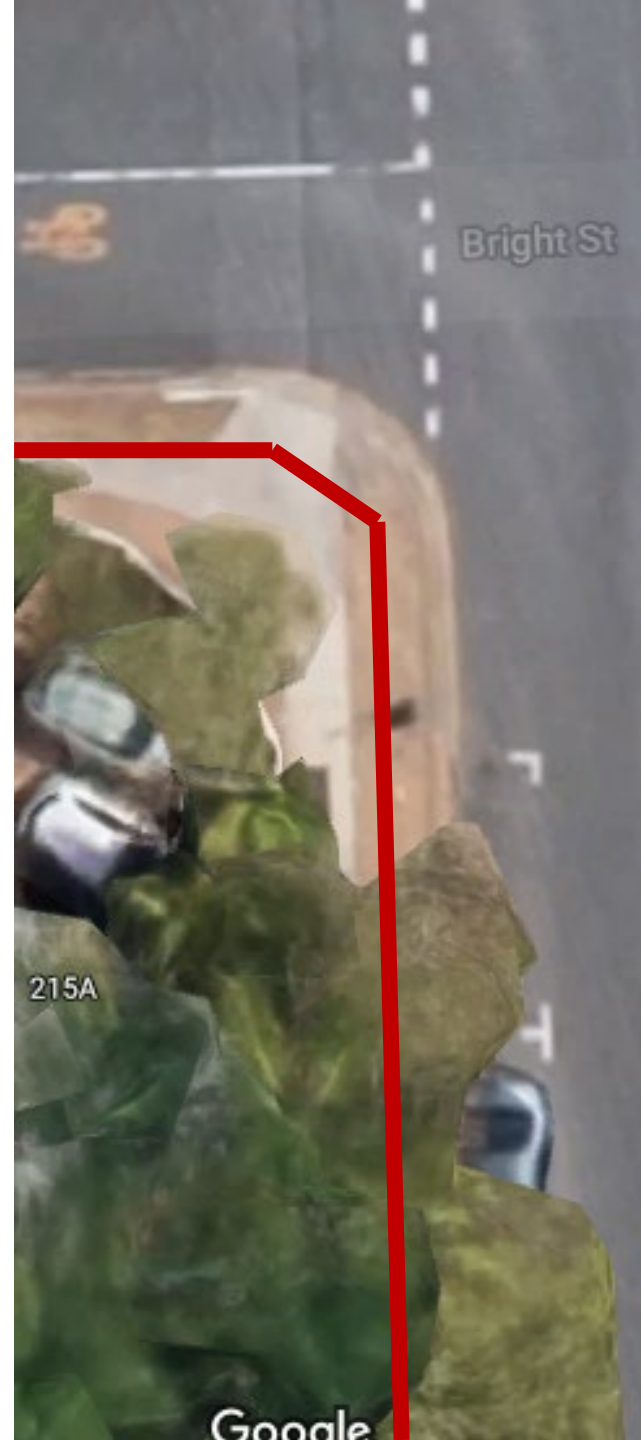
Is it a real-world change of position?

Or a change to Database representation only?



But what does “Real World” mean?

- In most mapping it indicates a tangible object (like a river)
- Here it can be a fiat object – that cannot be seen in the real world – like a property boundary
- In this discussion, “real world object” means both kinds.
- In the case of fiat boundaries – it refers to the location in the real world where the boundary has been determined to be.



Datum Change

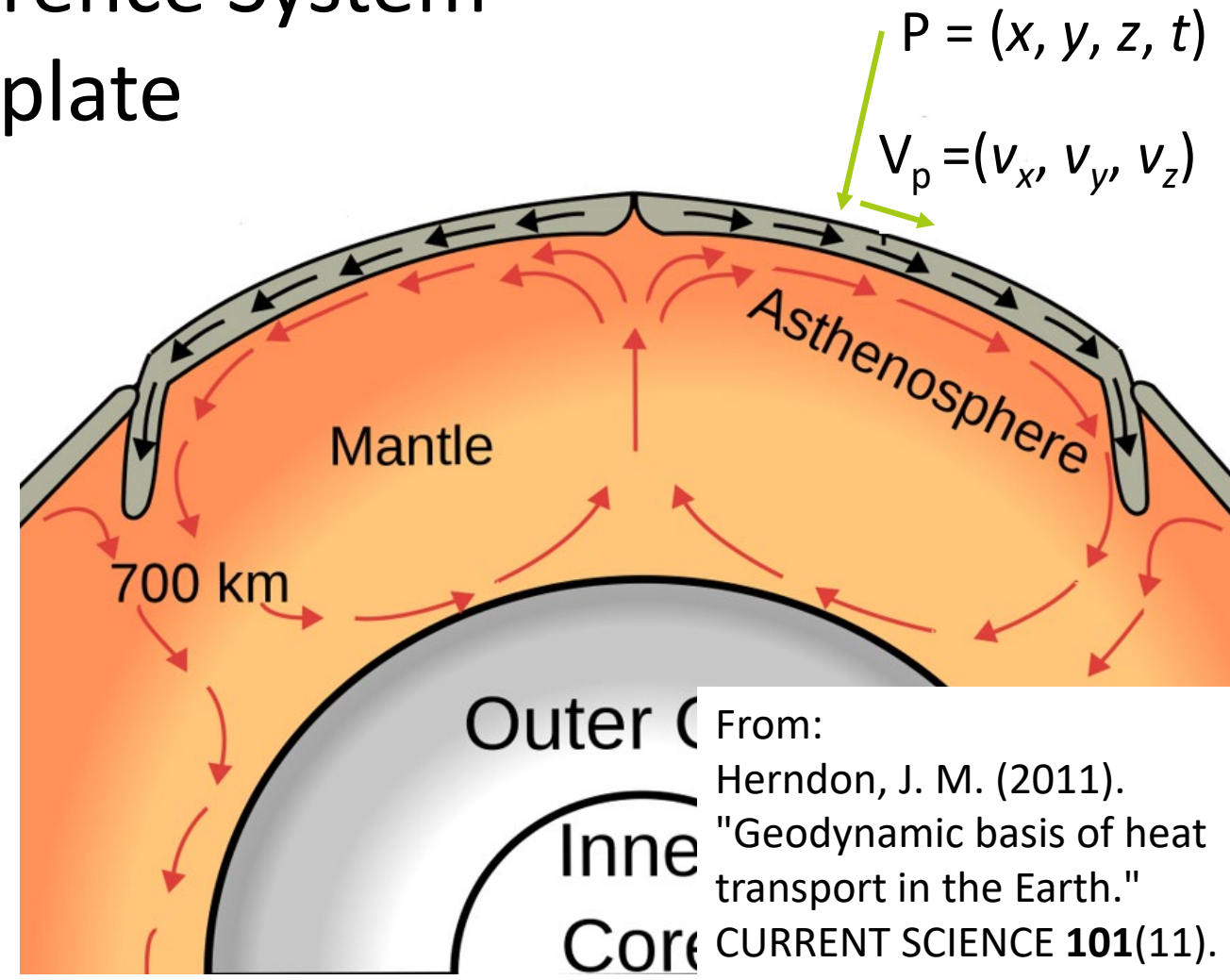
- A direct position is related to a Coordinate Reference System. If it must be translated to a different CRS, the coordinate values must be changed. This is not a tangible movement.
- A series of Spatial Reference IDs (SRID) have been defined, and ISO19107 indicates how the direct position may connect to a SRID.
- It is expected that if a point has coordinates (x,y,z) in SRID s , and (x',y',z') in SRID s' , these map to the same point in the real world to within the accuracy of the data.

Datum Change

Coordinate Reference System
moves with the plate

Periodically, a new SRID is
allocated, and all the
coordinates change

About every 30 years



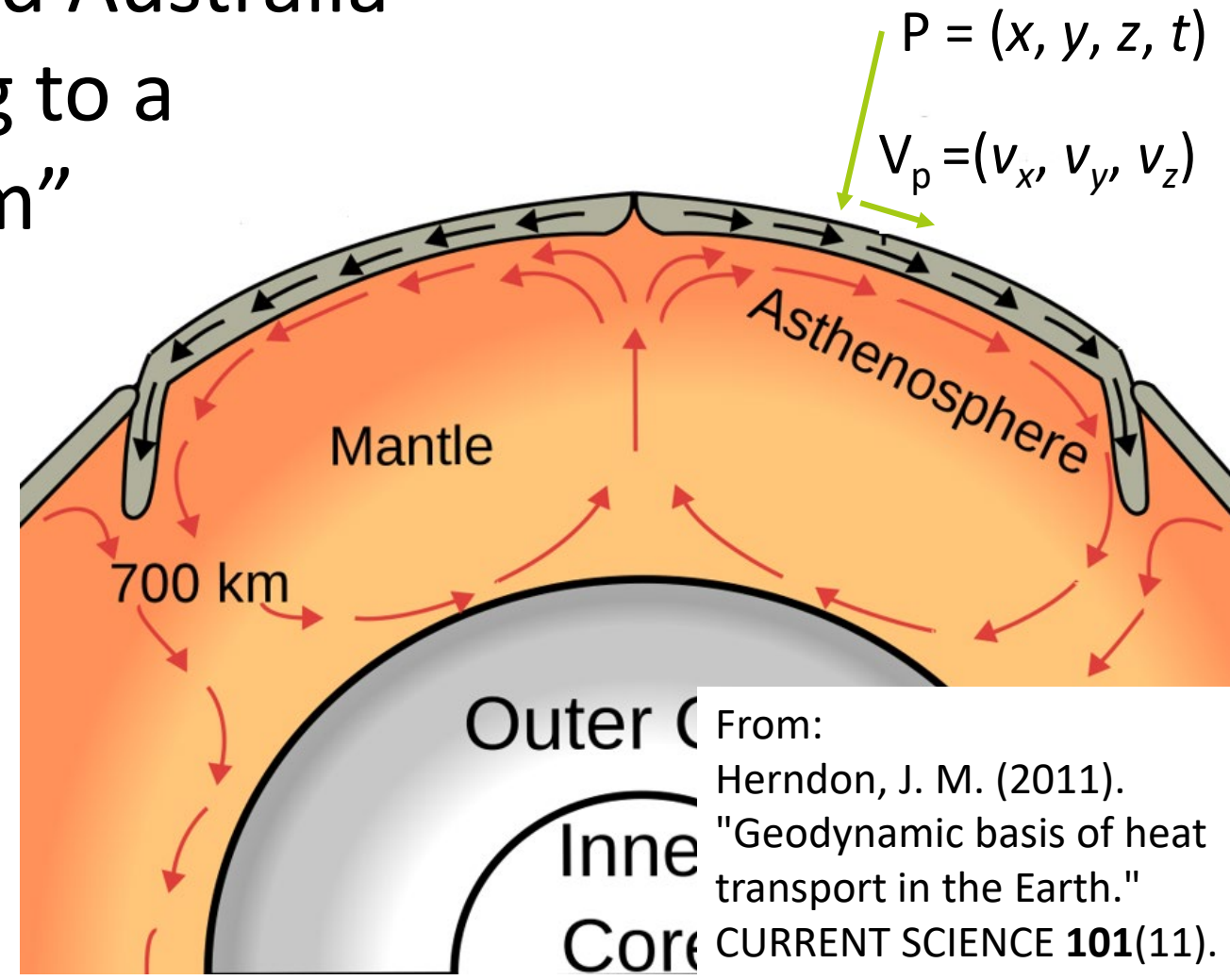
From:
Herndon, J. M. (2011).
"Geodynamic basis of heat
transport in the Earth."
CURRENT SCIENCE **101**(11).

Dynamic Datum

New Zealand and Australia
are transitioning to a
“Dynamic Datum”

Point P carries location
and velocity coordinates
($x_0, y_0, z_0, v_x, v_y, v_z$)

(But the velocity will not
be stored on every point)

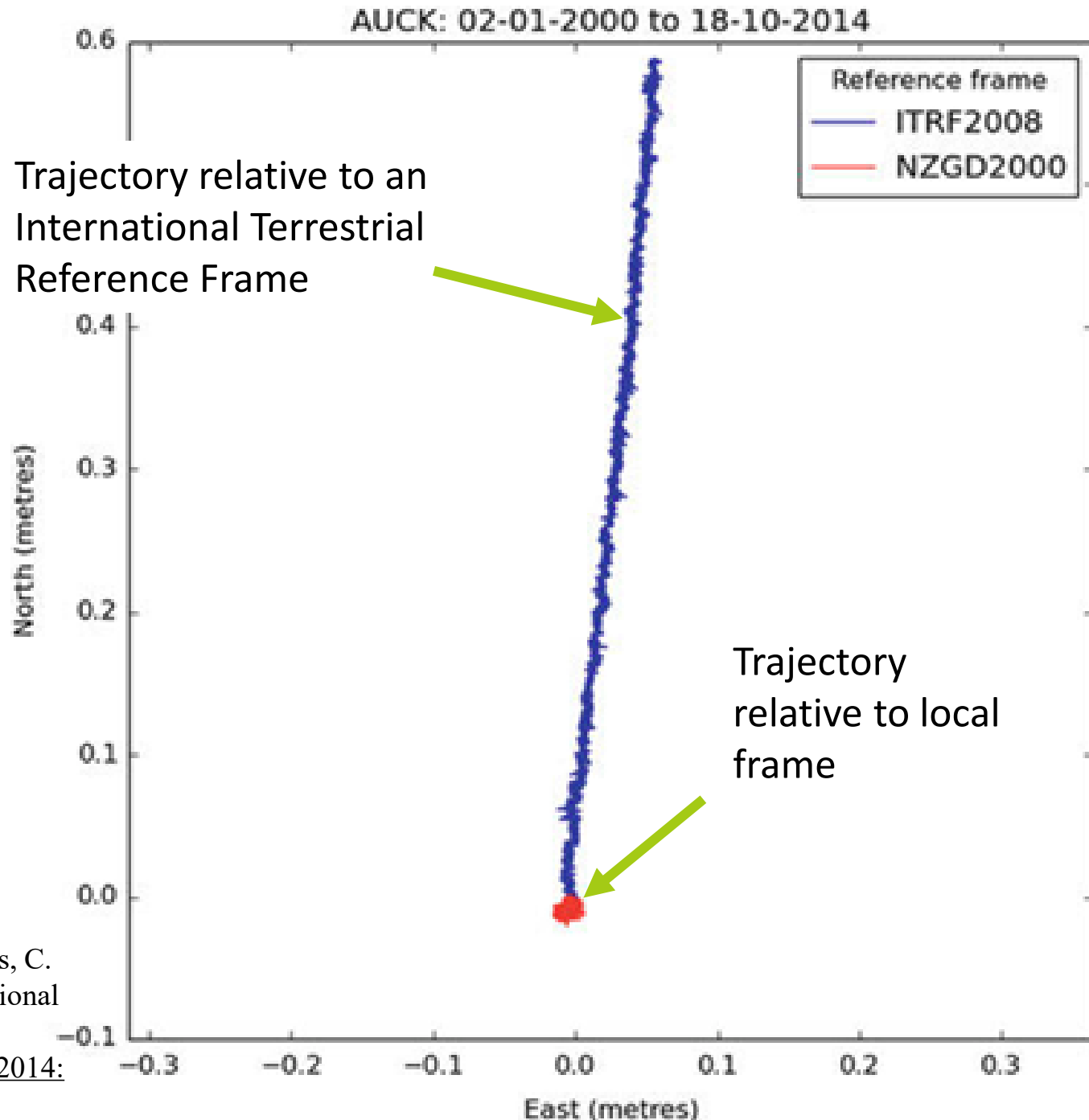


From:
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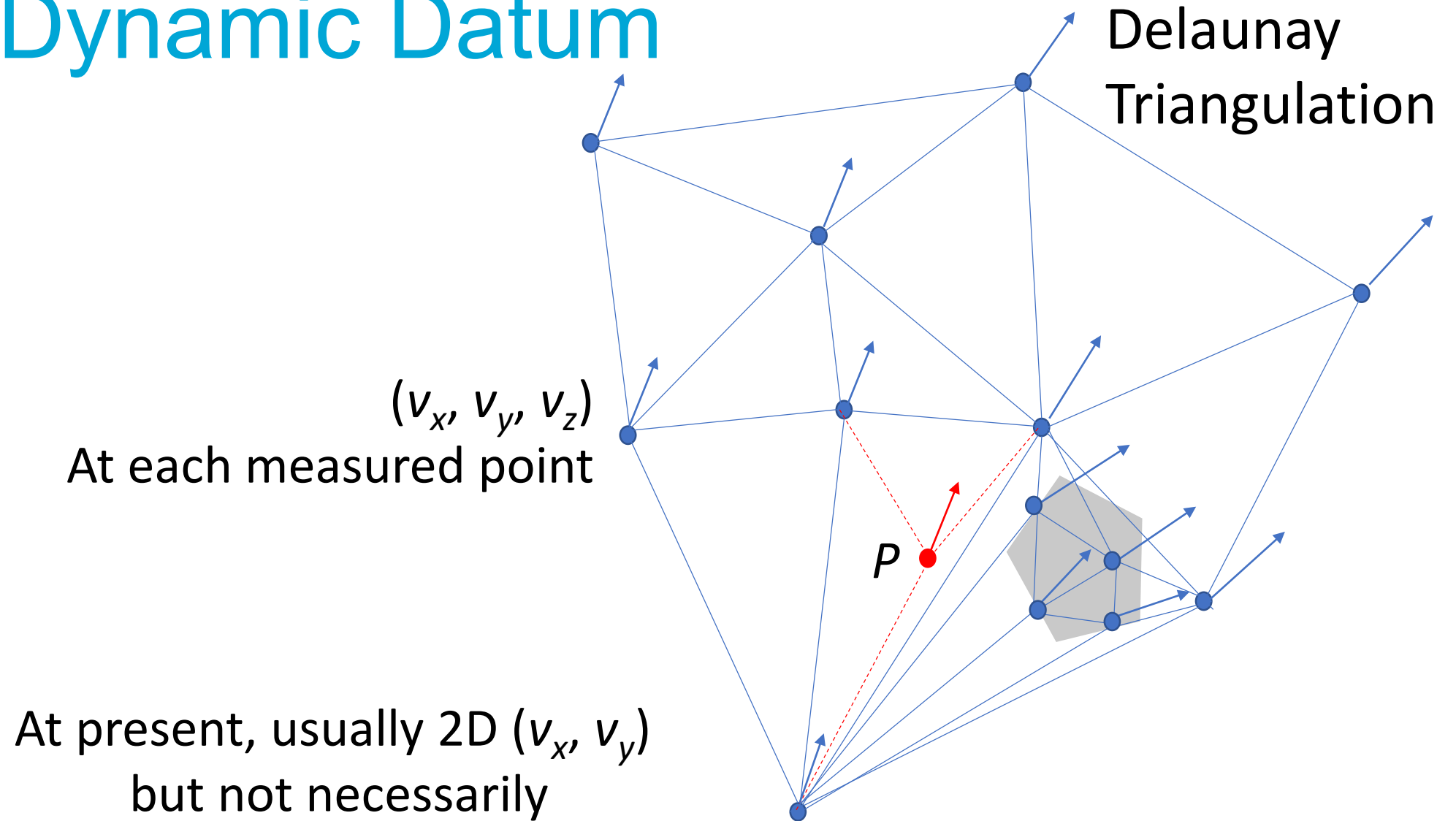
Plate Movement New Zealand

Measurement of
position of a survey
reference point

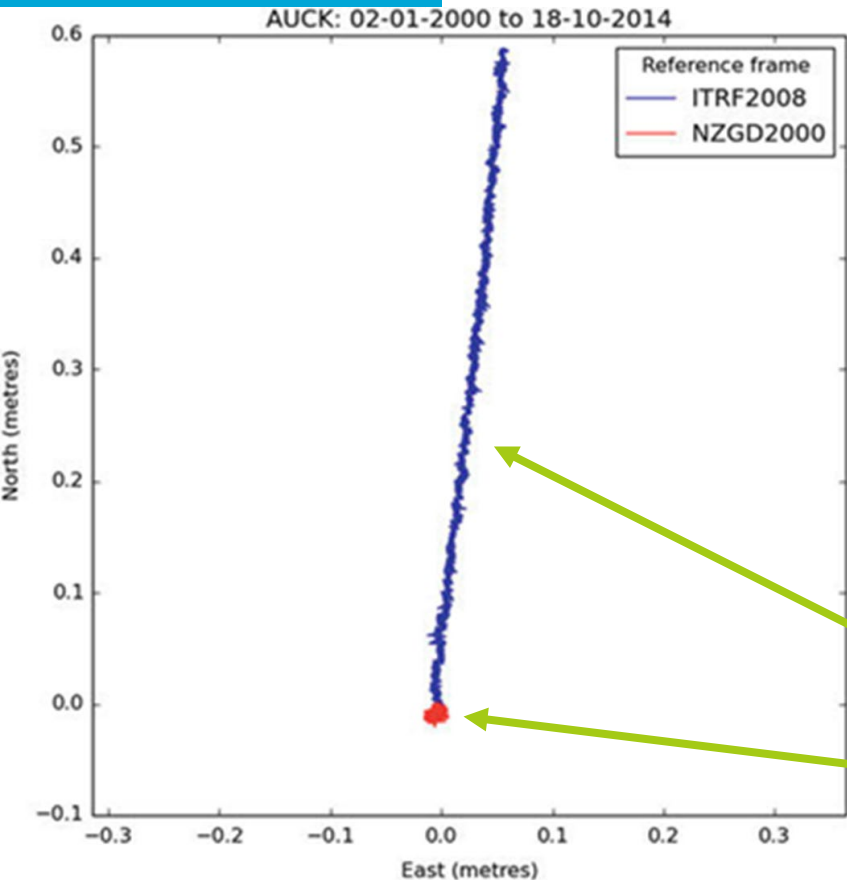
Donnelly, N., C. Crook, R. Stanaway, C. Roberts, C. Rizos and J. Haasdyk (2015). A Two-Frame National Geospatial Reference System Accounting for Geodynamics. IAG Commission 1 Symposium 2014: (REFAG2014). Luxembourg,



Dynamic Datum



Suggested Terminology



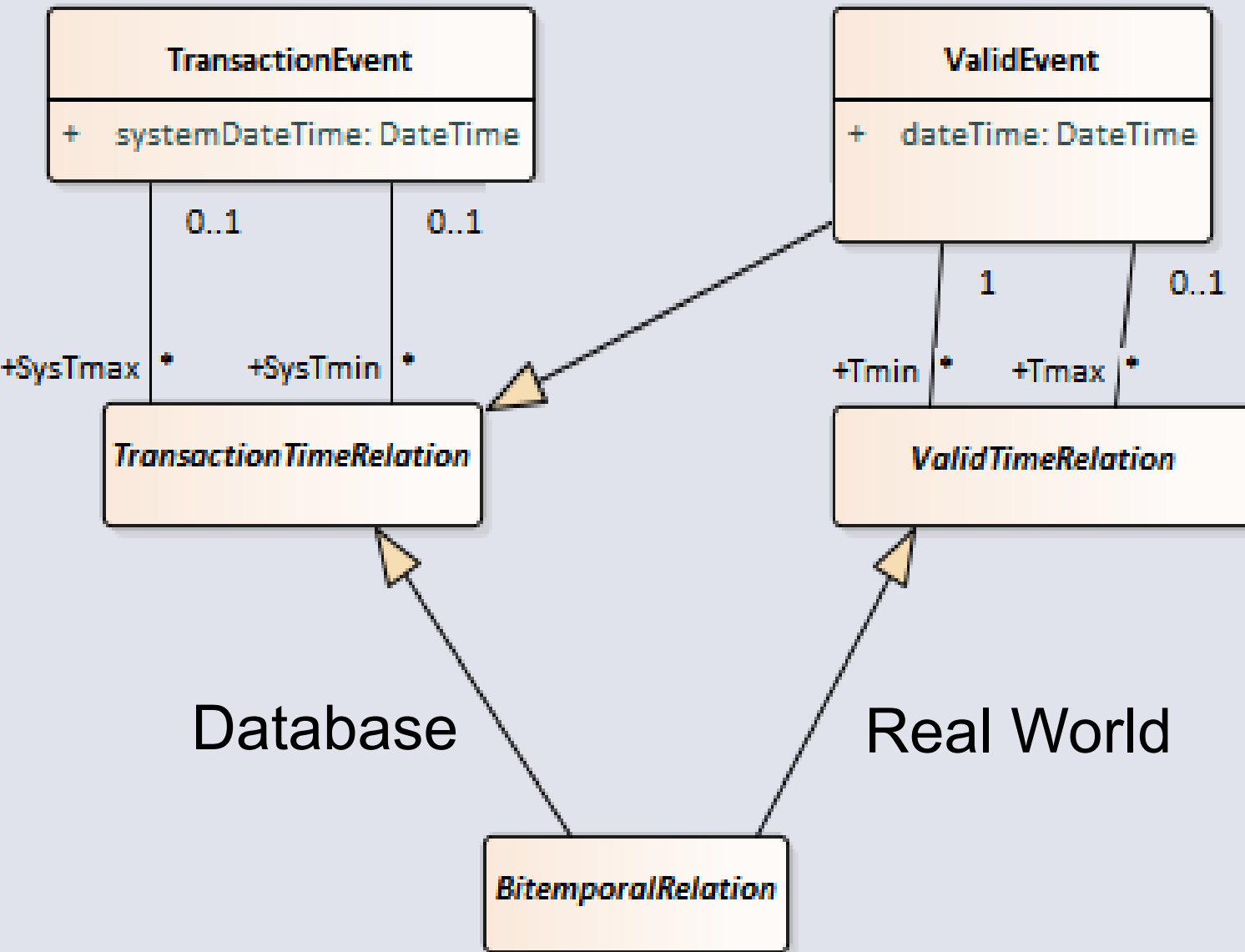
- EarthFixedLocation: (real-world)
- PlateFixedLocation: (real-world)
- PointInstant: (x, y, z, t) and SRS
- DirectEarthPosition: (not very useful in cadastre)
- DirectPlatePosition: (x, y, z) and SRS (virtually all cadastral points)
- DirectPlateTrajectory:
- PlateFixedPoint: (real-world)
- EarthFixedPoint: (real-world)
- Point: (in this paper = PlateFixedPoint)

PlateFixedPoints

- The corner of the official property boundaries,
 - The fence corner itself and
 - The survey mark
- Are all PlateFixedPoints.



Bitemporal Data



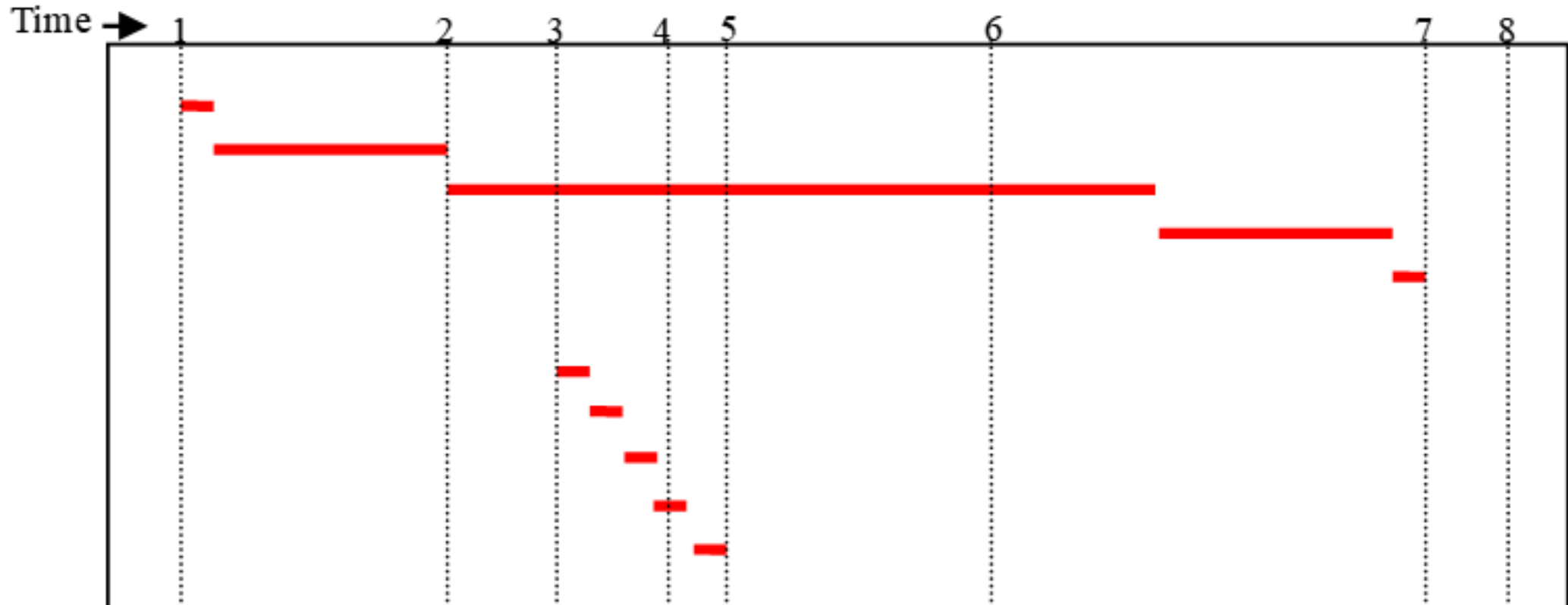
Temporal query:

What was the pattern of subdivision in 1975

Bitemporal Query:

What did we think in 2018 the pattern of subdivision was in 1975

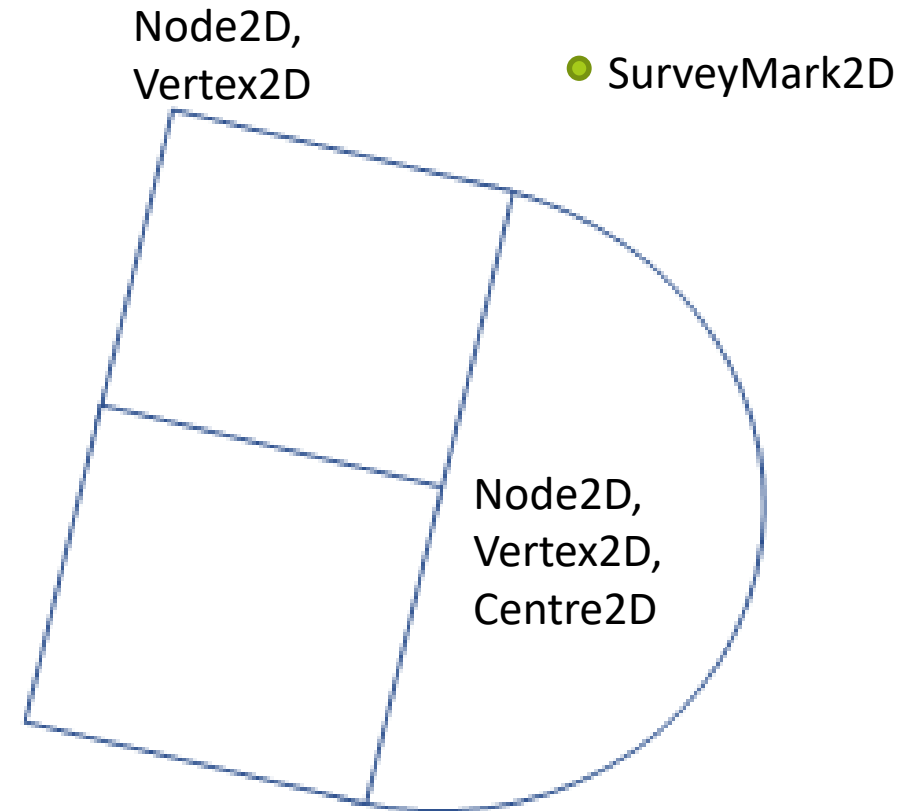
ACID (Atomicity, Consistency, Isolation and Durability) in History



Real-world Point-like Objects in 2D

A corner of a 2D cadastral spatial unit is a:

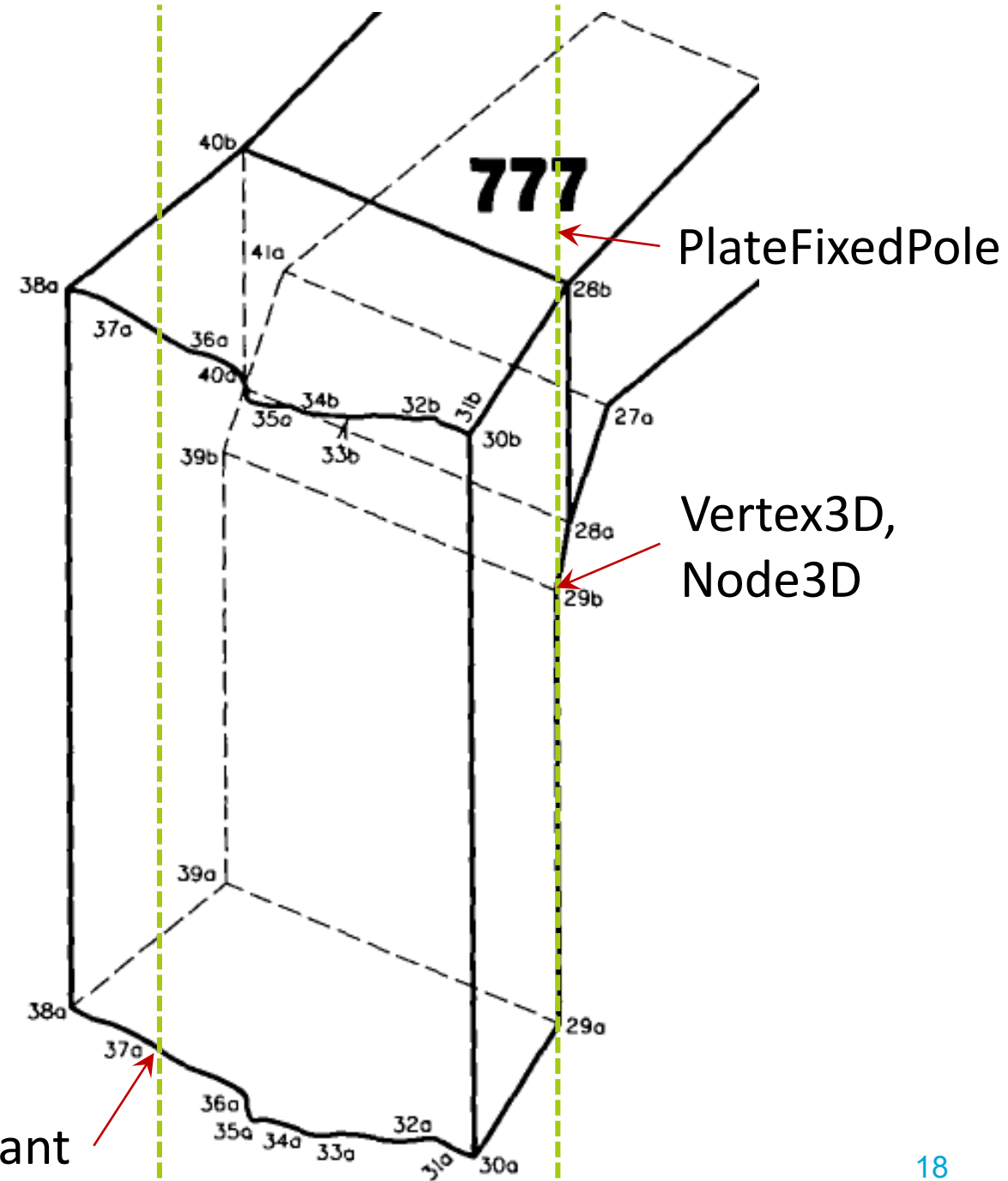
Vertex2D and possibly a **Node2D**, which is a **PlateFixedPoint** (or simply a **Point**) located at a **PlateFixedLocation**, with coordinates specified in a **PlateFixedPosition** (x, y, z , SRID)



In 3D

- **PlateFixedPole:** The pole defined by a PlateFixedPoint (x_0, y_0, z_0)

Defined as all PlateFixedPoints (x, y, z) such that $x=x_0, y=y_0, -\infty < z < \infty$.



Conclusions – Point-like Objects

- The concept of “Point” has been explored in terms of spatial dimensions, temporality, and mobility – leading to a significant number of concepts and terms for point-like objects (mostly from other sources, but some invented):
- Instant, Direct Position, EarthFixedLocation, PlateFixedLocation, PointInstant, DirectEarthPosition, DirectPlatePosition, DirectPlateTrajectory, PlateFixedPoint, EarthFixedPoint, Point (!), Vertex2D, Node2D, Knot2D, Centre2D, Focus2D, TraversePoint2D, SurveyMark2D, PlateFixedPole, Vertex3D, Node3D, Knot3D, Centre3D, Focus3D, TraversePoint3D, SurveyMark3D,

Conclusions – Bi-temporal History

Bi-temporal history has been reviewed, with the identification of concepts:

- Transaction Time (System Time), Valid Time (Application Time), Instant, TransactionEvent, ValidTimeEvent, ValidTimeRelation, TransactionTimeRelation, BitemporalRelation, VersionedObject.
- These are not necessarily the most appropriate terms.

Conclusions - Variations of Location

Various events have been identified that cause changes in the recorded position of point-like objects, and the historical outcomes of these changes investigated:

- Tangible Movement, Correction, Natural Movement, Datum Change, Dynamic Datum, Local Deformation, Unanticipated Deformation

Further Research

- This paper is limited to point-like objects – it needs to be extended to 1, 2, and 3 dimensional objects.
- There are subtleties that occur in bitemporal relations that need further investigation – especially where corrections to the valid time historic record can be made.

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