What makes a co-ordinate unique?

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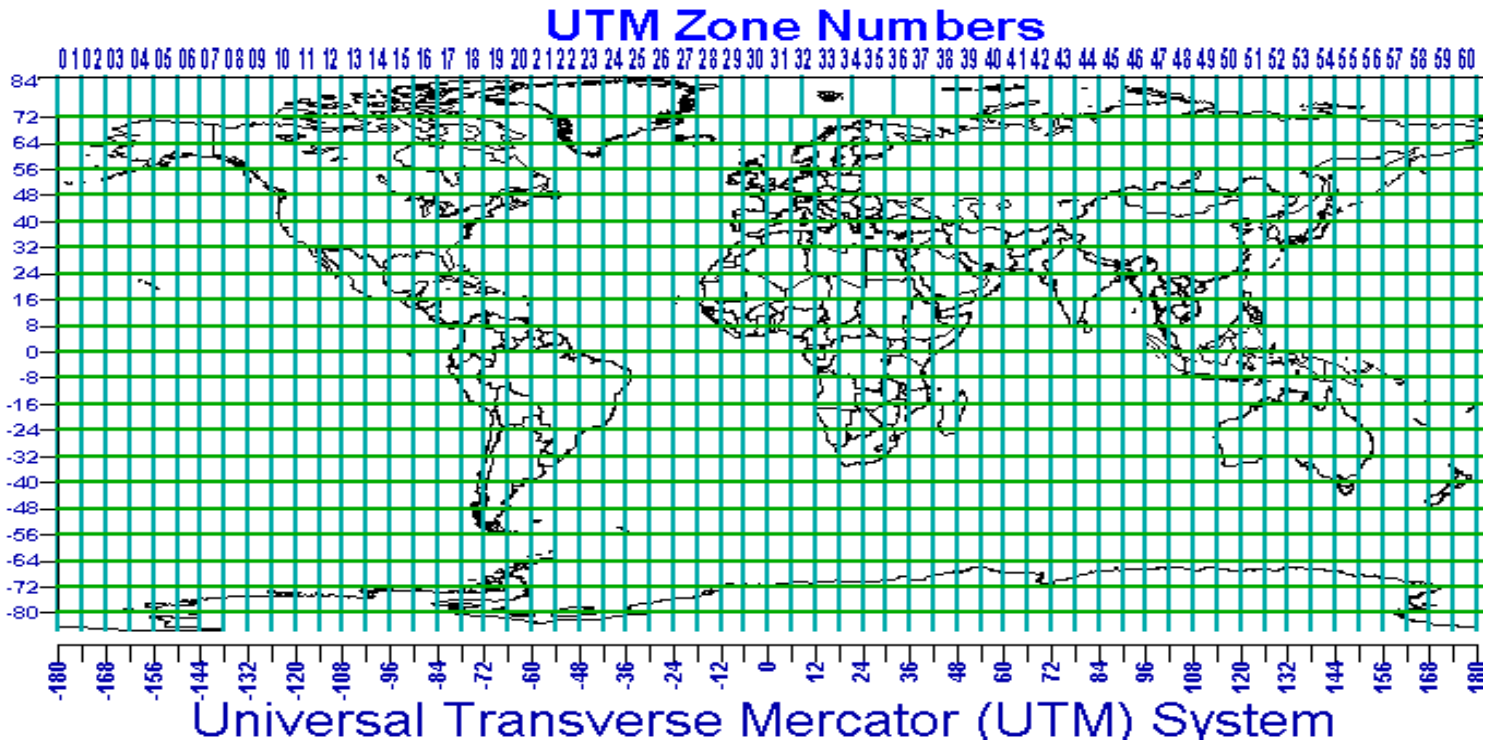
Co-ordinates easily allow us to express positions uniquely ?

Position the Rig at:

6319306.082 N 378508.277 E - UTM metres

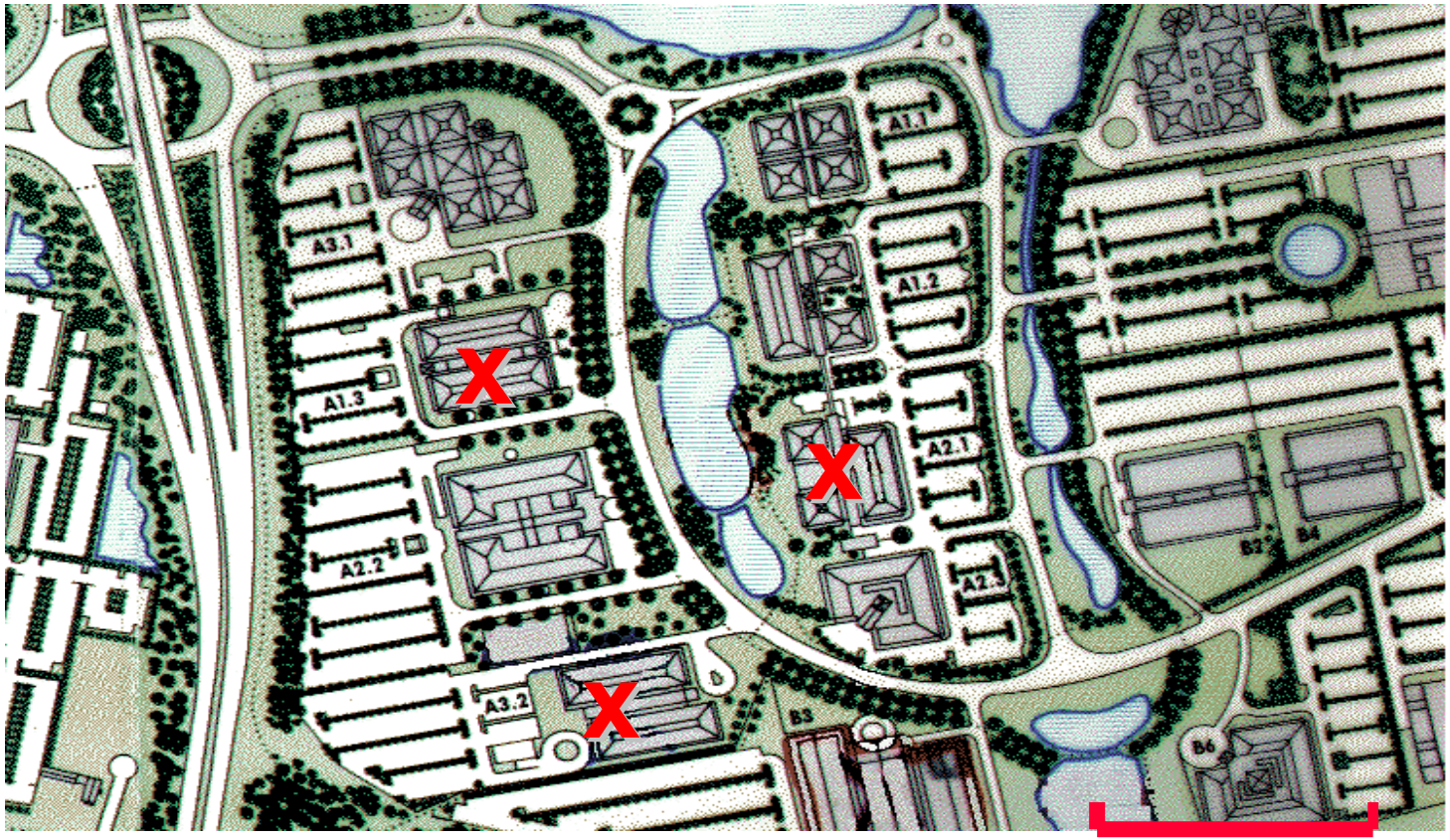
57° 0' 0.000"N 1° 0' 0.000"E



Common Myths - I

“Latitude and longitude is all you need to uniquely define a point on the ground.”

What makes a set of geographical co-ordinates unique?

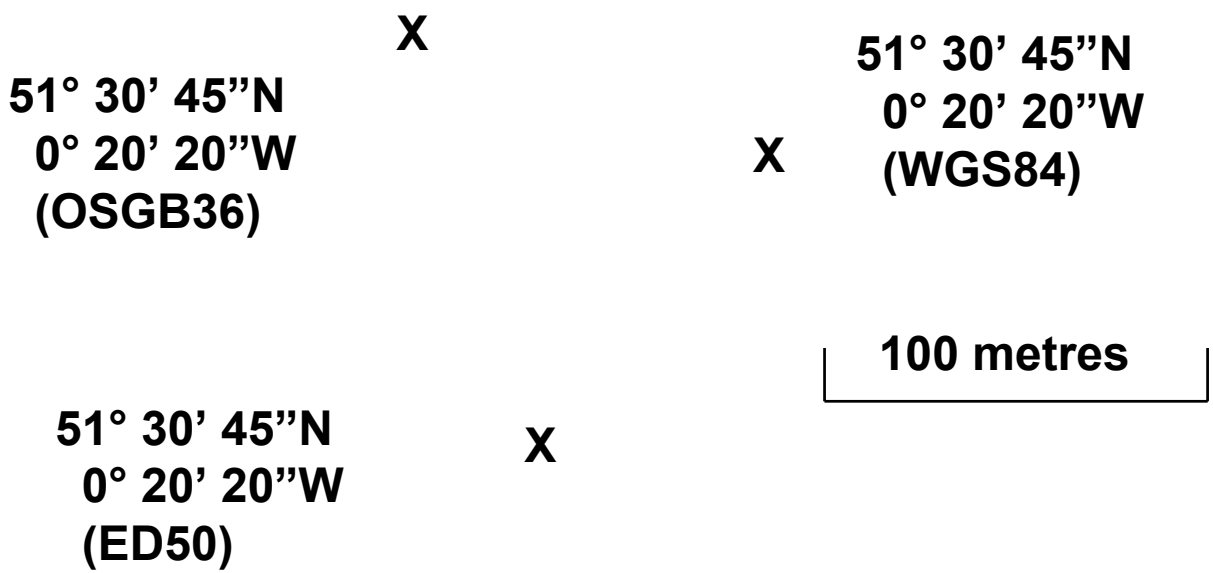


51° 30’ 45”N
0° 20’ 20”W

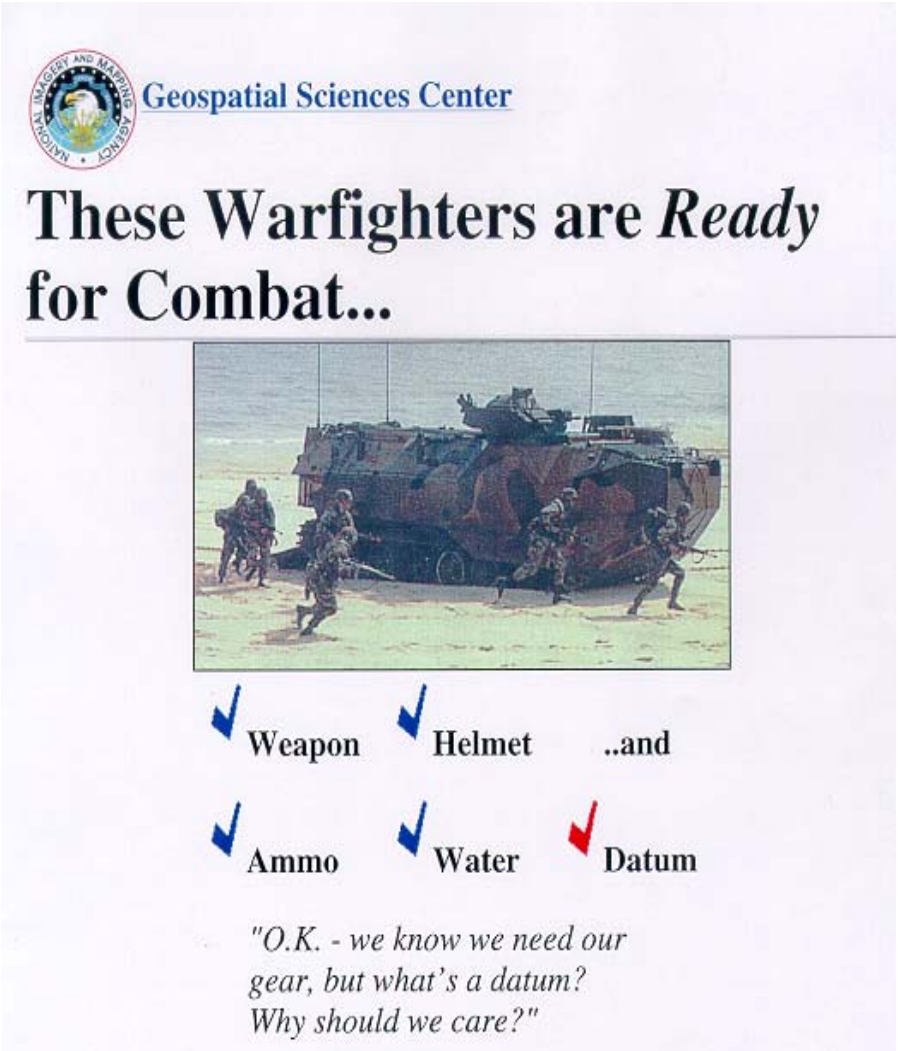
Why the difference in position?

Locations with same latitude and longitude values on three different geographical co-ordinate reference systems (CRSs)

- geographical co-ordinates are only unique when qualified by the geodetic datum name.
- the corollary is that a point has different latitude and longitude when the geodetic datum is changed.



Insufficient/inaccurate knowledge can hurt!



- **Why are these Warfighters being trained in the need for knowledge of Datums?**

Contentious Statement - I

"In the past, the main source of positioning risk was during data acquisition"

What we would like to do is this ...

… instead we do this ...

Development of Guidance Notes and the adoption of Standards have had a dramatic effect on positioning integrity

Contentious Statement - II

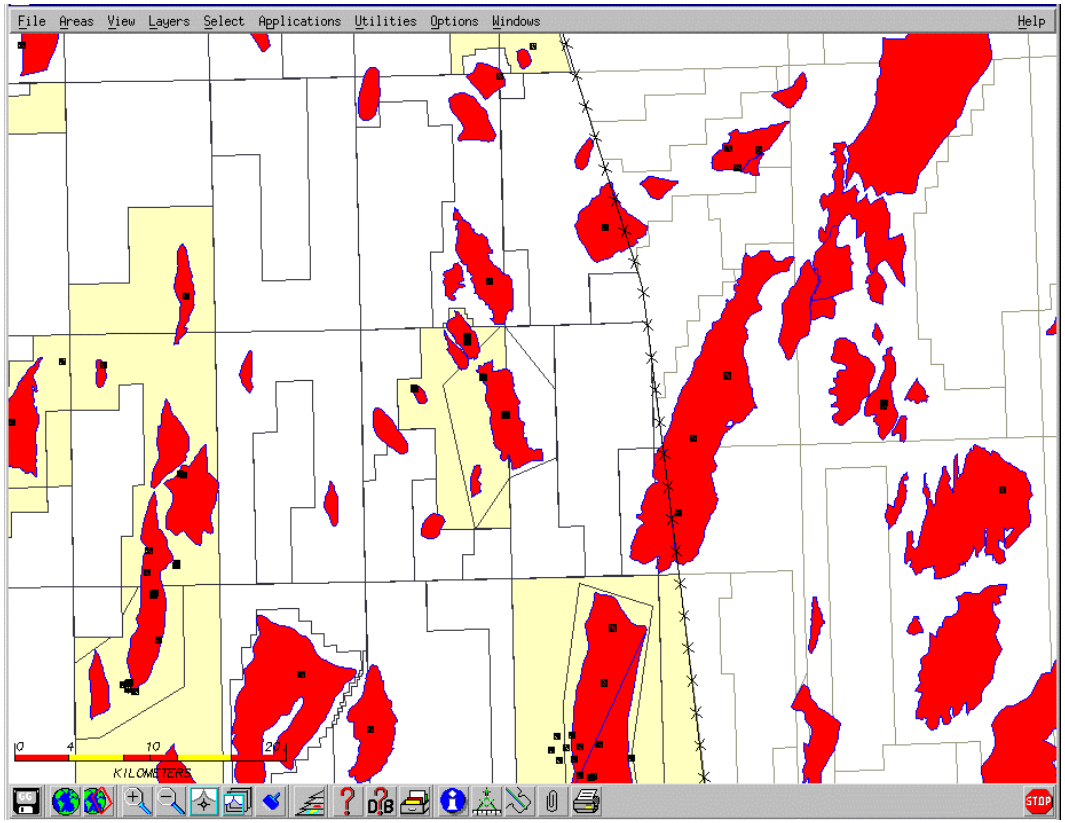
“Today, the main source of positioning risk is no longer data acquisition, but data management!”

We need to MANAGE Co-ordinate Data

Be Datum aware

$10,000,000 per metre!

Always quote the co-ordinate reference system (CRS) name with any co-ordinates

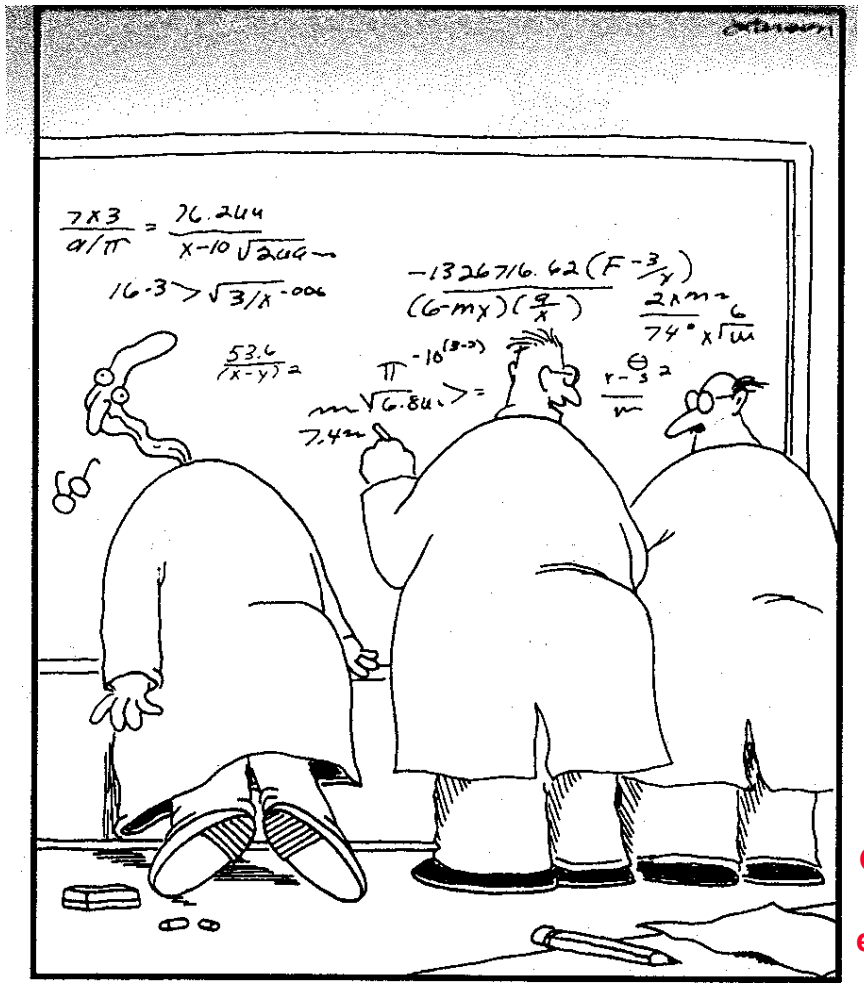


Common Myths - II

"There are exact mathematical formulae to change between geographical co-ordinate systems"

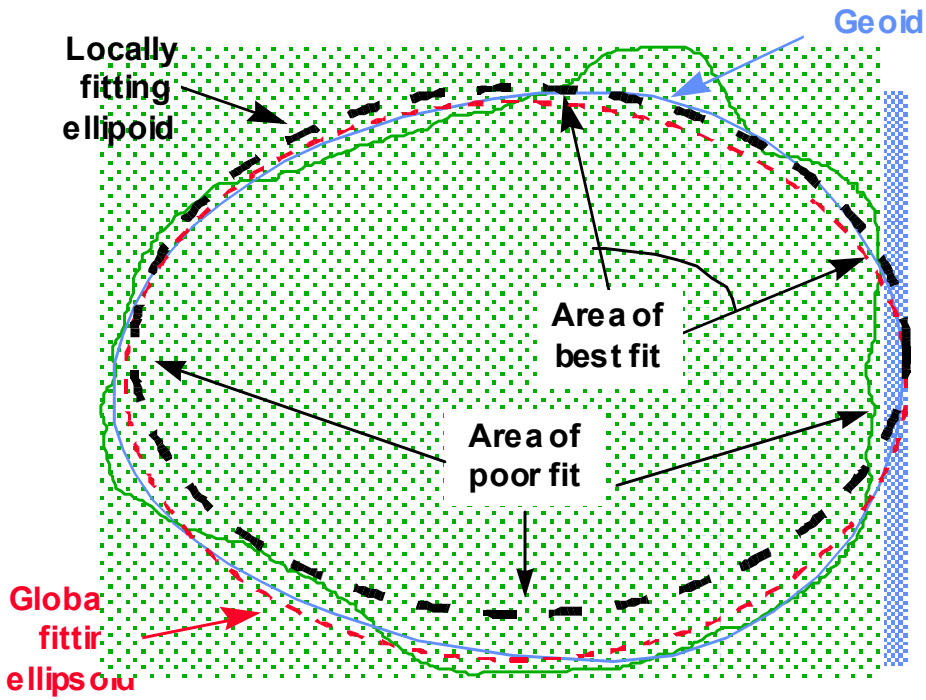
True or False?

Exact Formulae?



"Ha! Webster's blown his cerebral cortex."

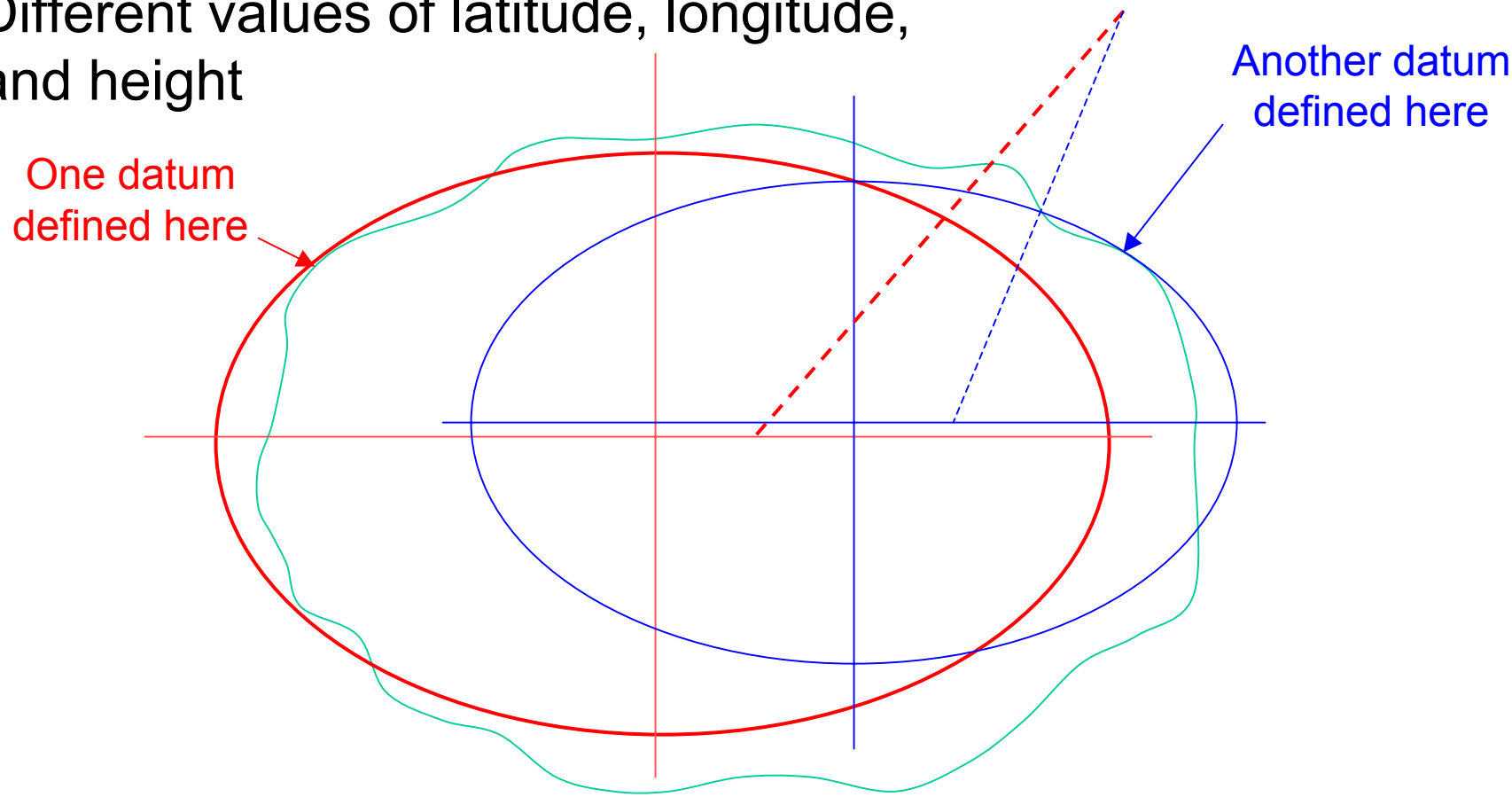
Exact formulae only apply in the realm of perfect geometry – not the real world of co-ordinates on the ground!



What happens when we shift between models?

Shift in position (plus orientation and scale) of axes

Different values of latitude, longitude, and height



Case study - 1

- Rig move to “location”
  - Rig move contractor doing positioning
  - Client Rep onboard
- Case:
  - The scene, S. North Sea, rig on tow between locations. Surveyor went to bed, leaving engineer to look after the navigation.
  - Engineer did familiarise himself with the software, but didn’t realise he had changed the reference ellipsoid.
  - Surveyor back on shift, approaching location, navigation good, no problems, on “location”, textbook job.
  - Looked on radar, platform where it shouldn’t be, did checks, wrong ellipsoid (Everest rather than International)!!!
  - Rig 1.5 km off location, in another company’s block, very near a major pipeline.
  - Anchor tugs recalled, rig moved again. **Cost: $ 350,000**

Ellipsoid Issues

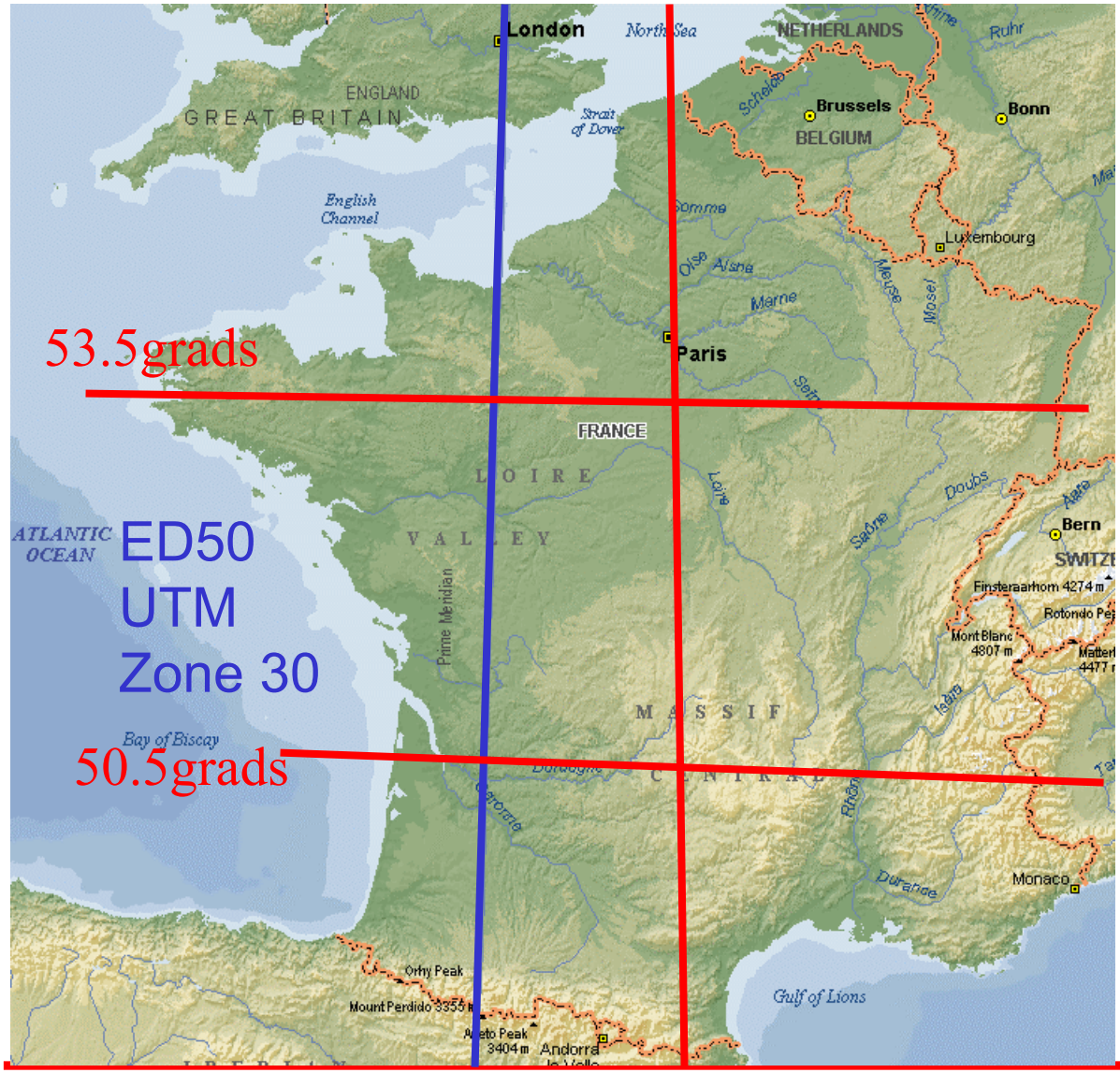
- Many ellipsoids of revolution have been defined.
- EPSG define 40 in common useage for mapping purposes.
- Most (certainly the major ones) are defined and published internationally
- Why then do different software applications use different parameters and call them by different names.
- Ellipsoids should be linked to geodetic datums, so that once a user selects the geodetic datum, the right ellipsoid is implicitly selected.
- However we need to **Standardise** on their parameters**!**

Geographic Coordinate Reference Systems

In summary, a GeogCRS consists of the following essential elements:

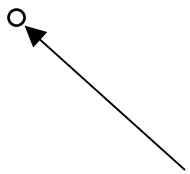
- Geodetic datum
- Ellipsoid
- Prime meridian
  - Usually Greenwich, but there are exceptions
  - Norway: Oslo Prime Meridian
    (10° 43’ 22.5” east of Greenwich)
  - Paris Meridian
    (2.5969213 grads east of Greenwich)
  - Rome Meridian
    (12º 27’ 8.4” east of Greenwich)

What Co-ordinate Reference Systems are used for France?



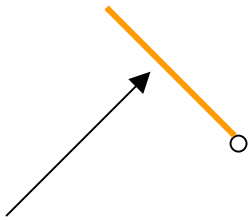
- ED50 UTM
- NTF (Paris) / Nord France superseded in 1972 by NTF (Paris) / Lambert zone I
- NTF (Paris) / Centre France superseded in 1972 by NTF (Paris) / Lambert zone II
- NTF (Paris) / Sud France superseded in 1972 by NTF (Paris) / Lambert zone III
- RGF93 / Lambert-93

Realisation of datums



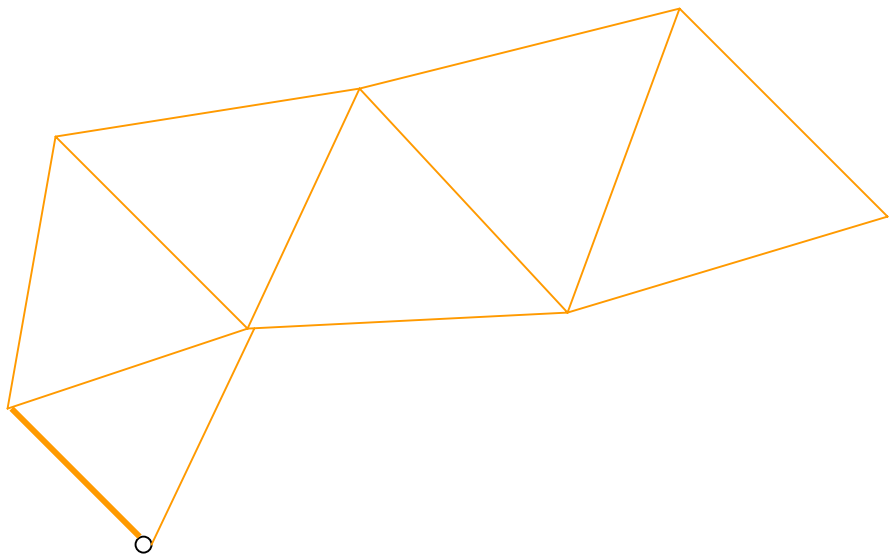
Define datum at origin

Realisation of datums

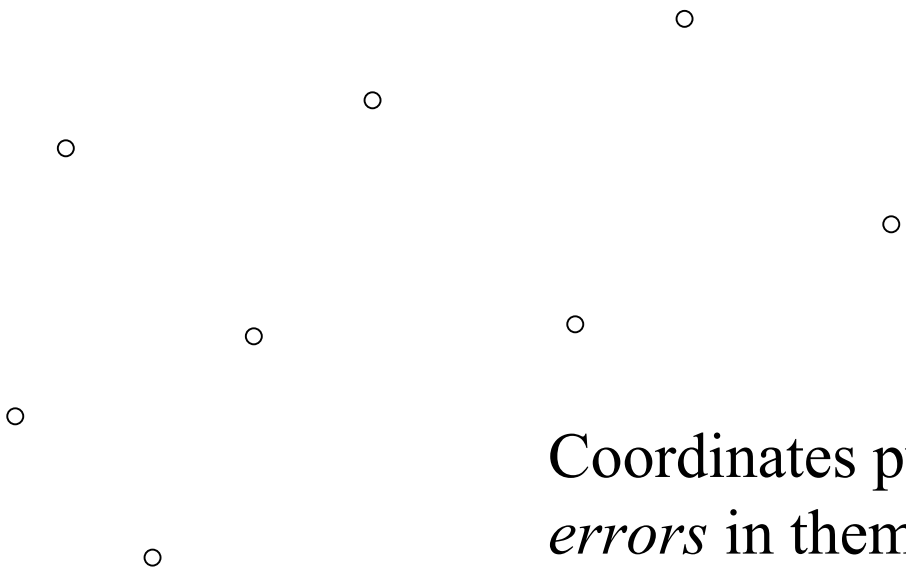


Observe base line

Realisation of datums



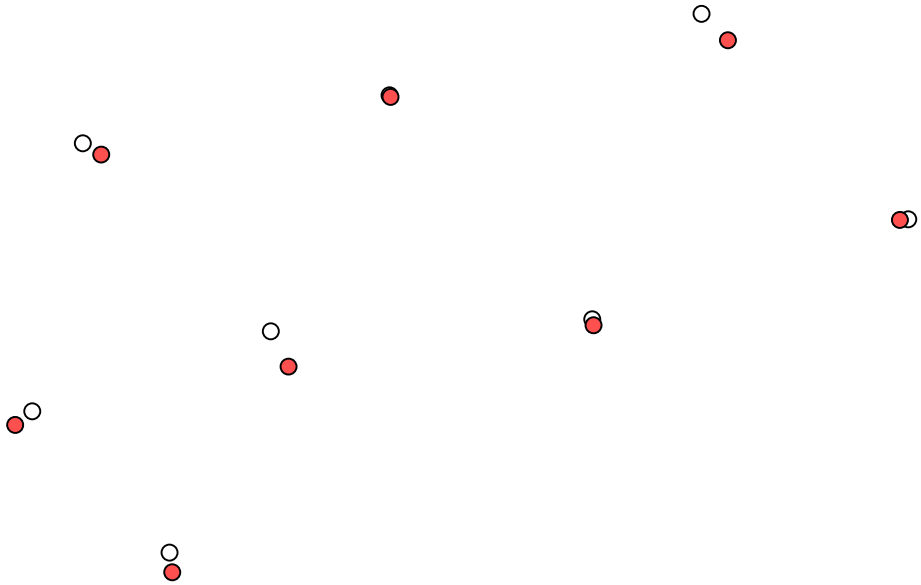
Realisation of datums



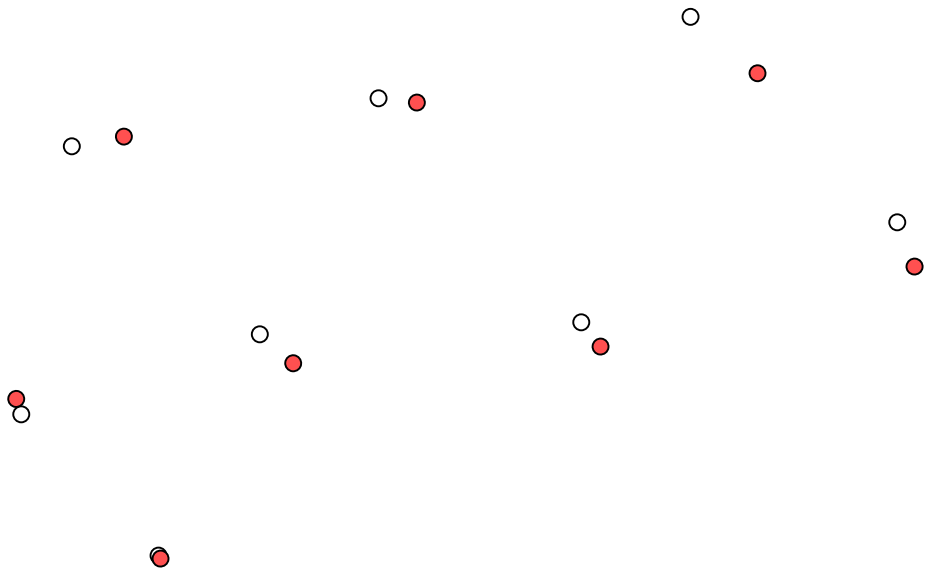
Coordinates published have *errors* in them

But these errors ***are part of the datum***

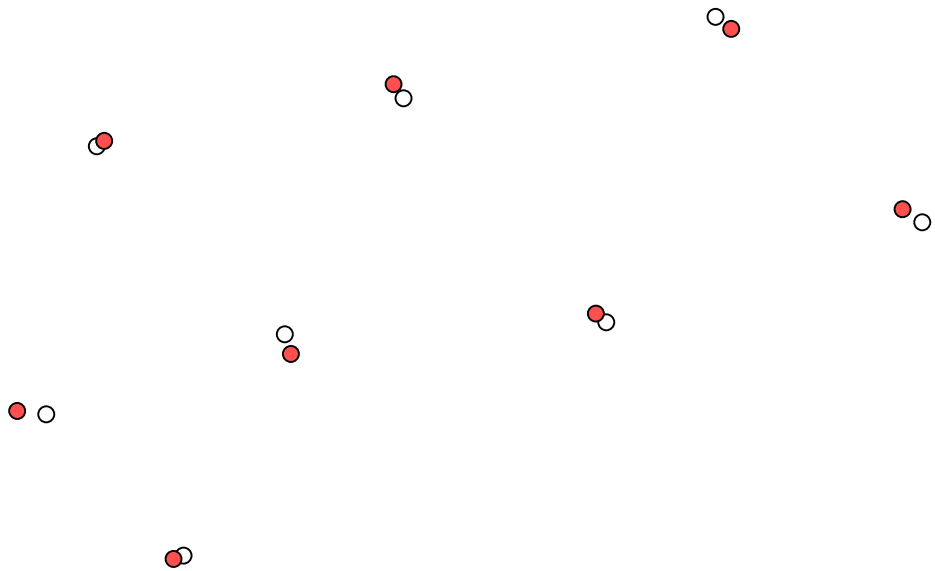
Inadequacy of similarity transformations

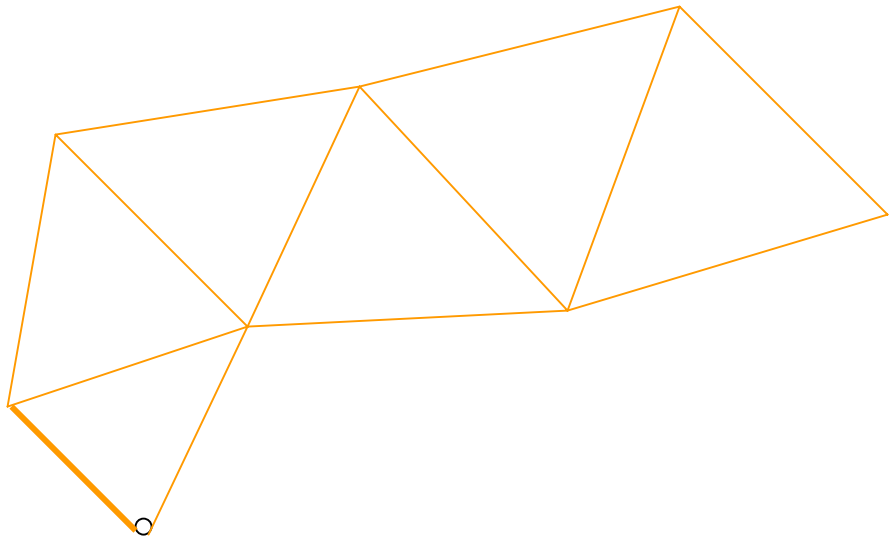


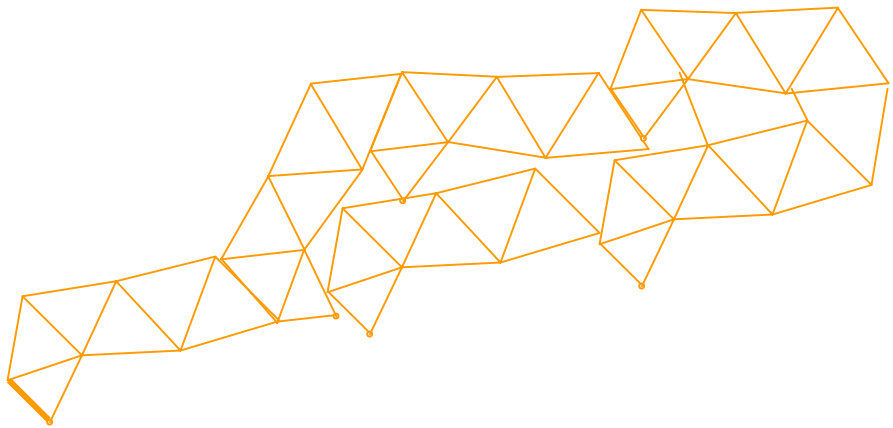
Inadequacy of similarity transformations



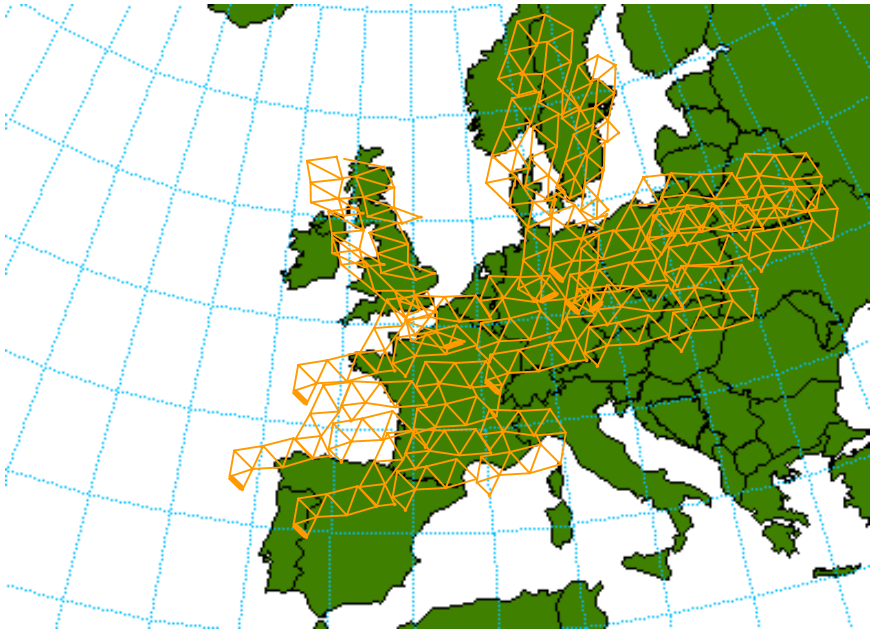
Inadequacy of similarity transformations



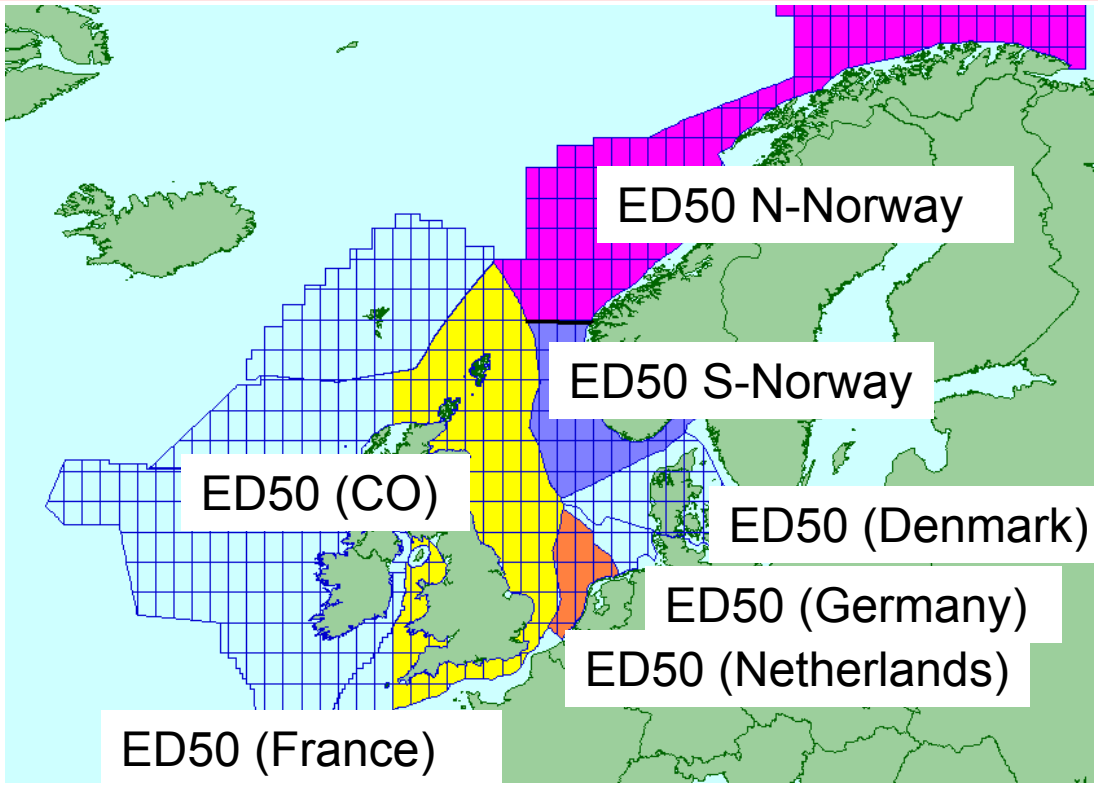




How ED50 was established over Europe



ED50 – It really is one datum!



Two types of **co-ordinate operation** should be recognised:
conversions and **transformations**.

- **Conversions** change co-ordinates without there being a change of datum.
- **Transformations** change co-ordinates to a CRS based on a different datum.

Datum transformation issues

Contrary to common usage of the term ‘datum transformation’, you don’t transform the datum but the co-ordinates.

"Transformations" describe the relationship between two co-ordinate reference systems.

They do not describe the relationship between a co-ordinate reference system and the earth - this is done through a datum definition.

Geodetic transformations therefore are not required for co-ordinate reference system identification.

There are often more than one set of transformations for any pair of source/target CRS’s.

Different co-ordinate transformations should be applied for the transformation to WGS 84, depending on the area of validity for each transformation.

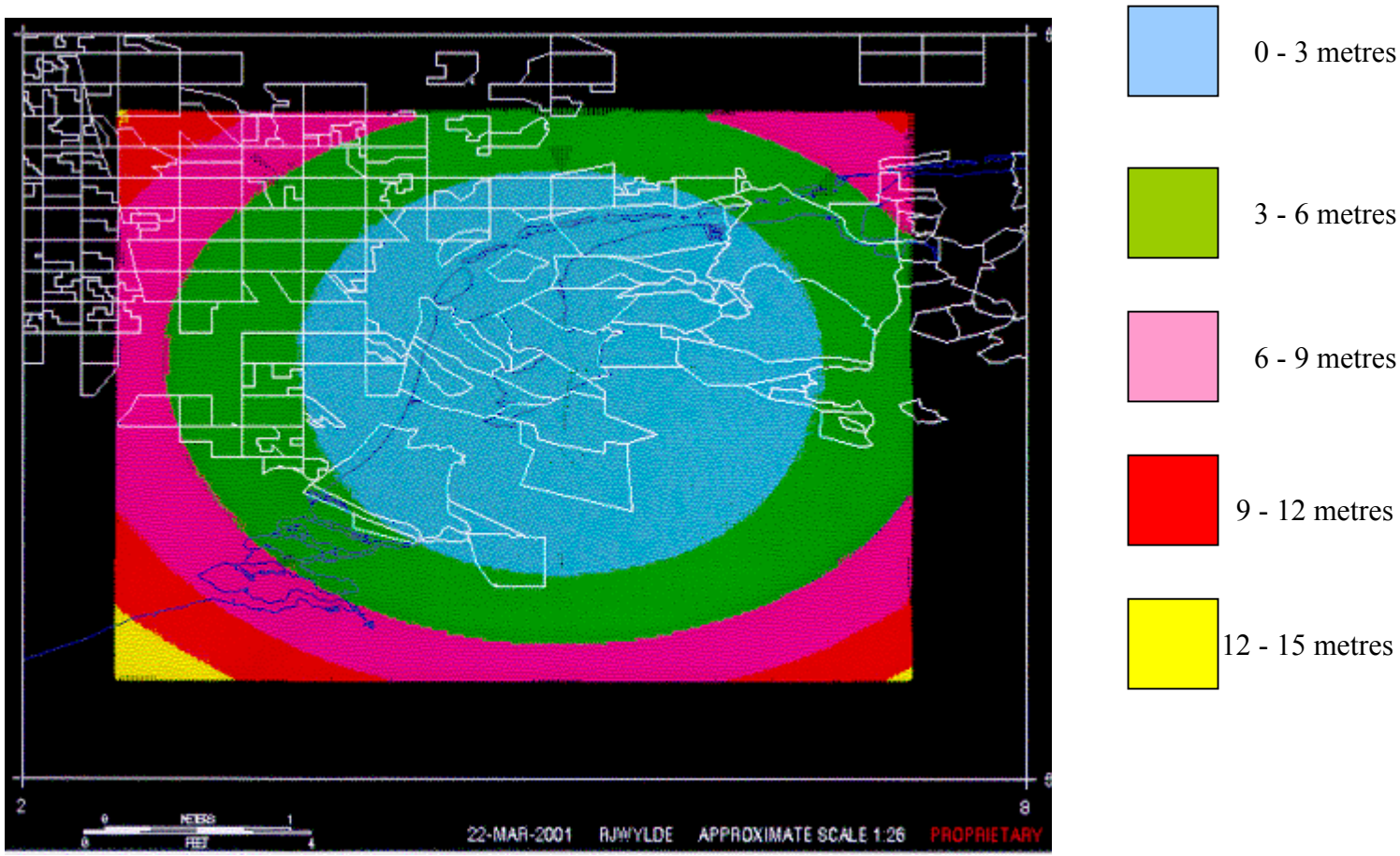
Projection issues

- Different versions of the projection formulae exist
- European and “Snyder” (USGS)
- Important to use the right ones
- However we need to **Standardise** on their algorithms**!**

  i.e. enhance: GCTP_II General Cartographic Transformation Package: National Mapping Program Technical Instructions, U.S. Geological Survey, National Mapping Division, Oct 1990 with PSG Guidance Note 7.

Onshore Netherlands
Rijksdriehoeksmeting Stereographic Projection

Diagram showing the differences in metres between European and “Snyder” (USGS) algorithms for the RD Niew projection parameters.



Data exchange issues

- The lack of standardisation in this area introduces both a substantial operational overhead concerning manual data handling, but also introduces a very real risk of incorrect interpretation, use and archival of the data.

- e.g. US Air Force uses degrees, minutes and thousandths of a minute, whereas the Army uses degrees, minutes and seconds.

- The EPSG feel that application developers should implement the ISO/OGC/EPSG data model to support proper spatial referencing and to enable exchange of spatial referencing metadata

What does the EPSG have to offer

- EPSG, through its geodesy working group, maintains and publishes a geodesy data set of parameters for co-ordinate reference system and co-ordinate transformation (http://www.epsg.org), and updates it at regular (typically 6-monthly) intervals.

- This offers a convenient means of succinctly identifying co-ordinate reference systems. The EPSG Geodetic parameters have been included as reference data in the GeoTIFF data exchange specifications, in the Iris21 data model and in Epicentre (the POSC data model).

- EPSG produces an occaisional series of **Guidance Notes** for its member use. Some are made publicly available from the above web site.

- EPSG are currently working on a Guidance Note for spatial data handling targeted at application developers

Associations with other organisations

EPSG has

- category A liaison membership of the International Standards Organisation (ISO) Technical Committee 211, Geographic Information/Geomatics.
- a strong, but informal, relationship with the UKOOA Survey and Positioning Committee.
- a strong, but informal, relationship with the Petrotechnical Open Software Corporation, (POSC) to which it provides geodetic advice and support through the EPSG geoesy working group.
- EPSG geodesy working group members maintain a liason with the Open GIS Consortium over spatial referencing and coordinate transformation.
- EPSG maintains links with the Americas Petroleum Survey Group, APSG

Summary

- Co-ordinates describe the positions of data relative to other data.
- Co-ordinates as numbers do not uniquely describe position.
- Identification of co-ordinate reference system (CRS) is essential.
- To merge data sets, the relationship between CRSs is required.
- We need to **Standardise!**
- So....
- What do we want from ~~vendor~~ software application developers?

What do we want from software application developers?

+ Any co-ordinate or co-ordinate set shall include the co-ordinate reference system identification.
+ CRS identification shall conform to the provisions of internationally accepted standards:
  - ISO 19111 – Geographic Information: Spatial referencing by co-ordinates,
  - the POSC Epicentre vx.y datamodel,
  - the Open GIS Consortium abstract specification topic 2, Spatial Referencing by Co-ordinates, version 1.0.2, document OGC-01-063r2,
  - EPSG geodetic data model and dataset v6.1 or later.
  - EPSG Guidance Note No. 5 – Co-ordinate Reference System definition.
+ Applications shall use the terminology and nomenclature from these standards.
+ Use of Internationally accepted Data Exchange Formats (for both import and export of data)
+ Co-ordinate reference system identification should be possible without a transformation to a common CRS being required.
+ Data management applications shall retain an audit trail of co-ordinate operations performed on data such that original co-ordinates may be recovered.
+ Spatial data applications shall be able to refer to EPSG co-ordinate reference system and transformation descriptions.
+ Applications should use algorithms that are consistent with those given by EPSG.

And finally

"If you don't know where you are going, any road will get you there.

If you don't know where you are, a map won't help."

Lewis Carrol- Alice in Wonderland

Case study - 2

- Offshore Angola turn-key Topsides installation
  - Topside construction completed onshore
  - Route survey undertaken, on behalf of the Topsides engineering contractor, to be sure of sufficient water clearance
  - Client had QC onboard for the tow and installation to the jacket
  - Everything should have been fine.

Platform topsides …

Under tow navigation/positioning on Local Datum - Camachupa …

Just a minute… wasn't the route survey done on WGS 84? …