OBSTACLE DATA AND ELECTRONIC TERRAIN ISSUES

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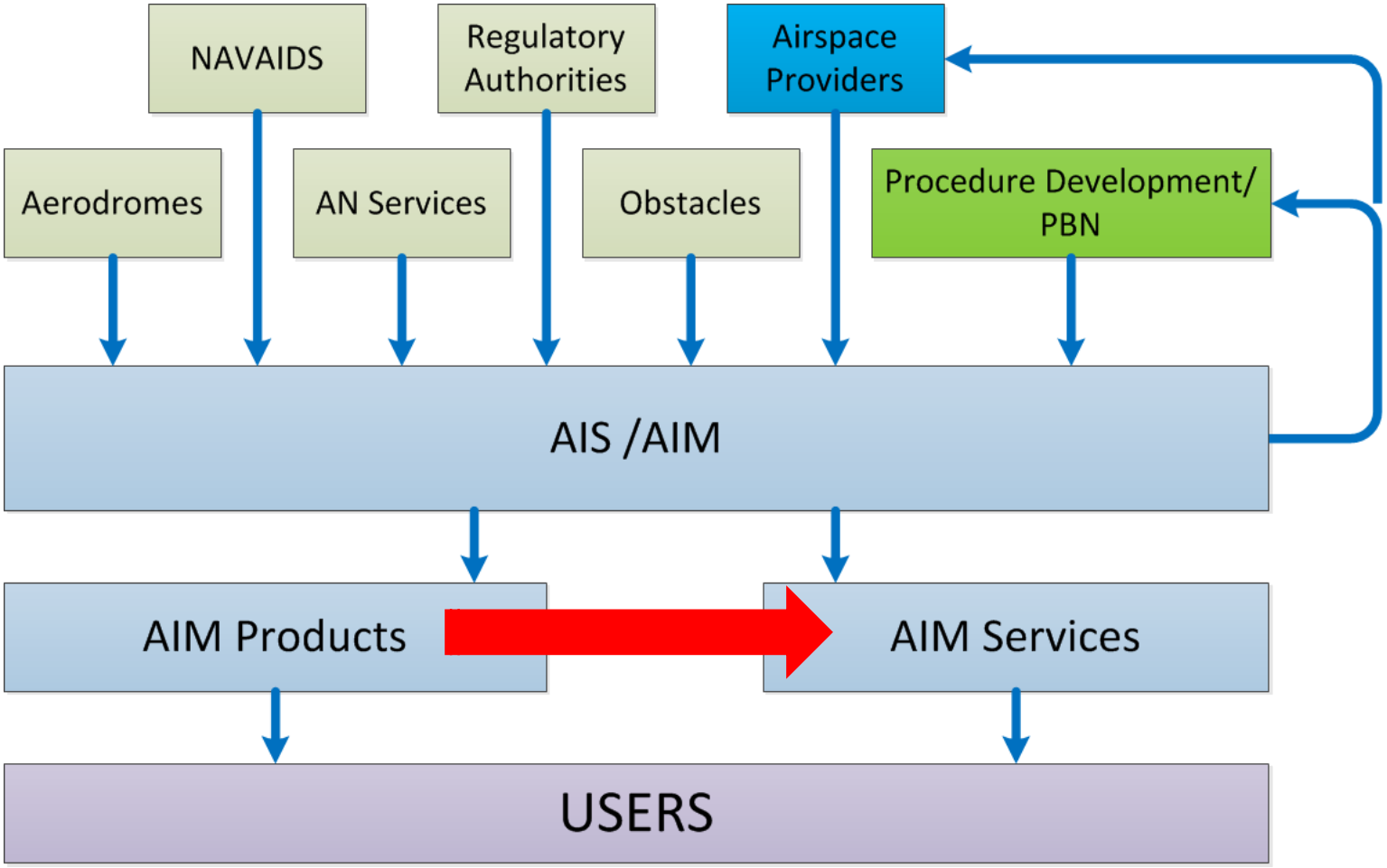
Outline

- AIM – PBN partner
- Obstacle Data sources – eTOD
- Data maintenance and management – WGS84

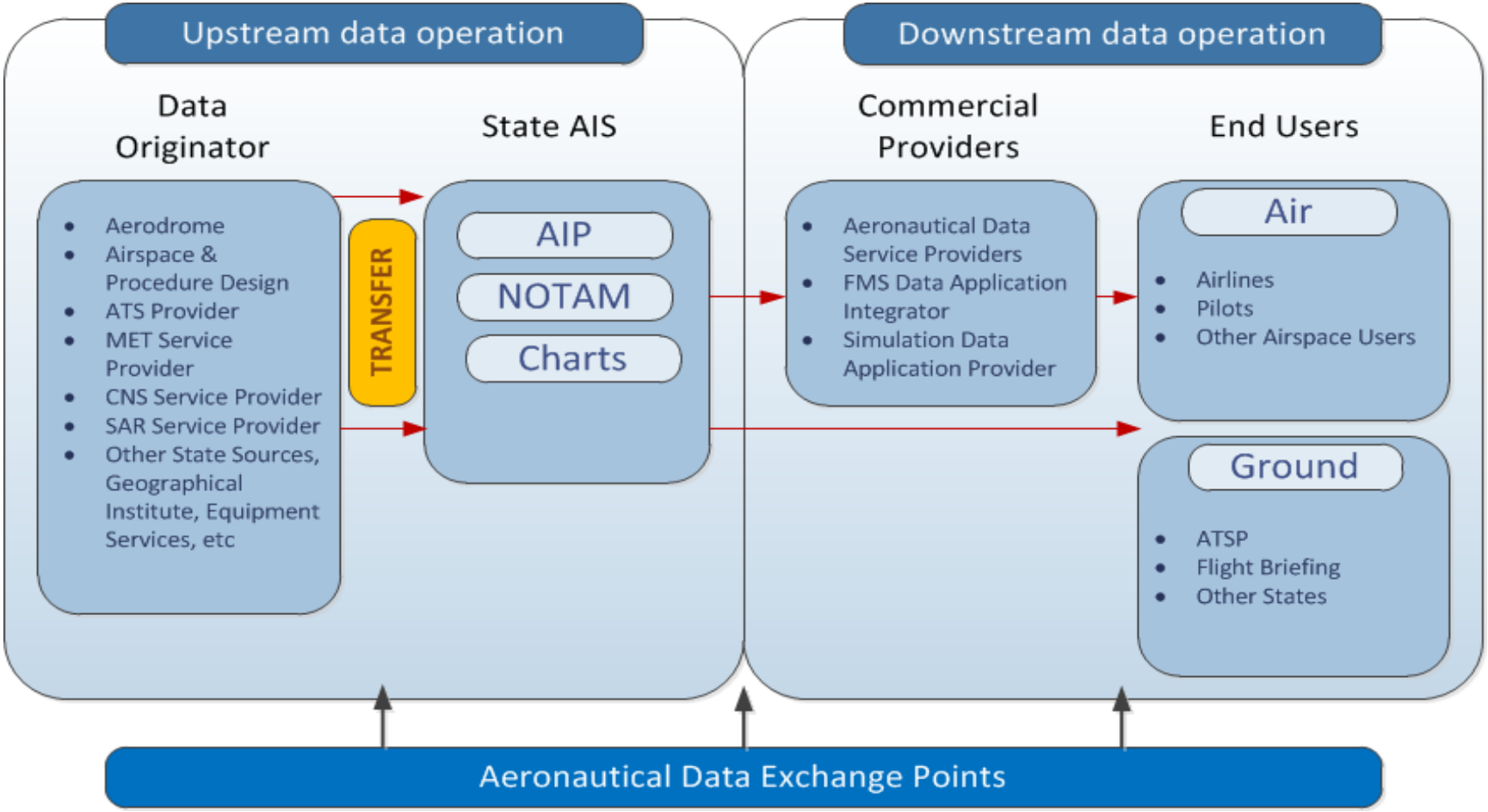
Aeronautical Information Management

- Principle partner in PBN
- Provides necessary information and data for PBN development
- Receives the output of PBN design
- Connects PBN developers with users
- PBN is both an originator and user of AIM

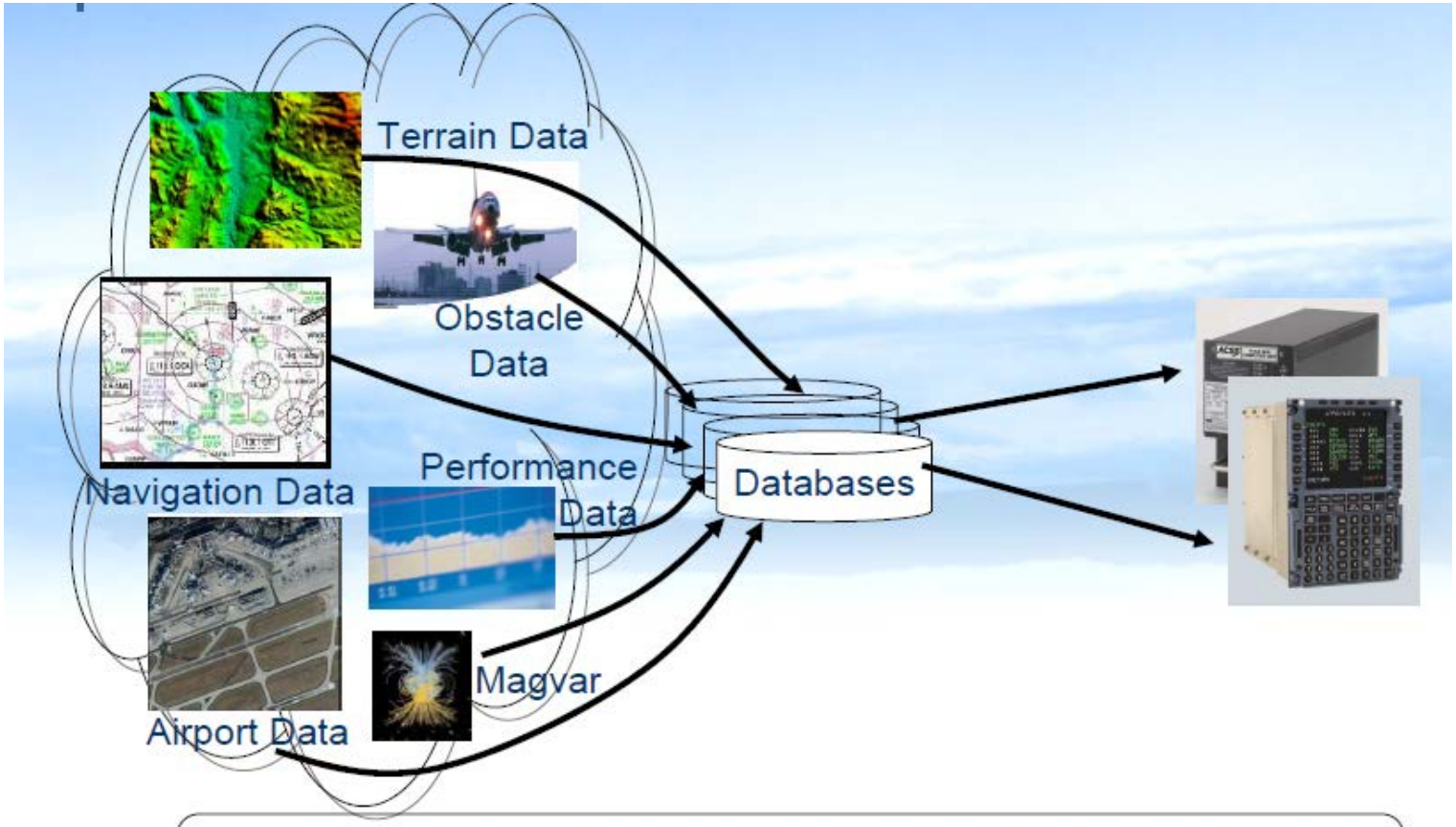
AIM / PBN Data relationship



Aeronautical Information and Data Chain



Aeronautical Data Management

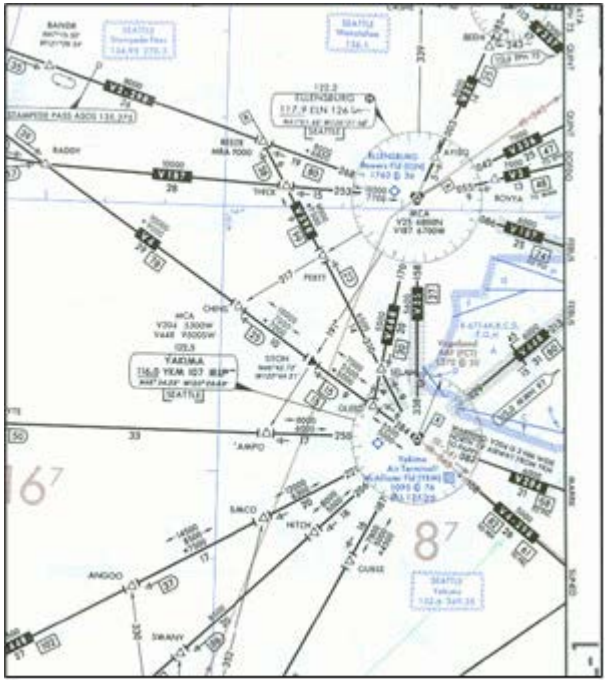


Databases are an essential component of a growing number of avionics systems

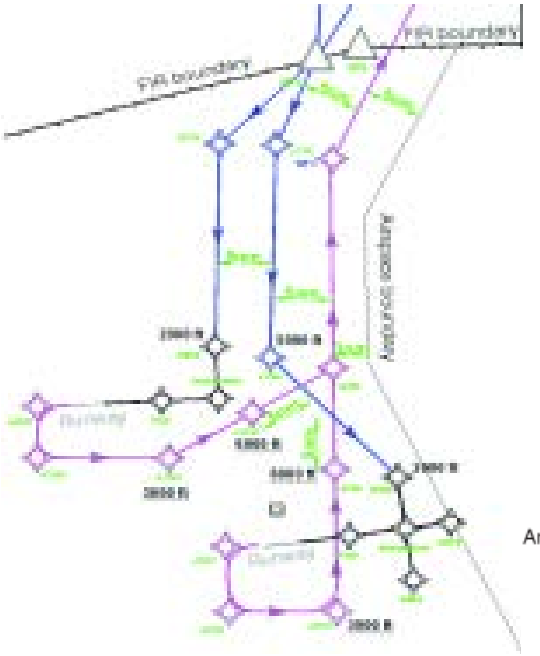
Fixed and Virtual Infrastructure

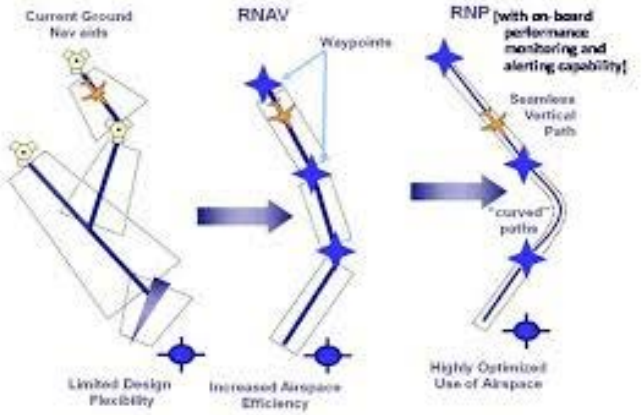
	Fixed	Virtual
Features	• Tangible • Observable	• Intangible • Not directly observed
Attributes	Measured	Calculated /determined
Coordinates	• Surveyed • Fixed to terrestrial reference	• Calculated • Derived from Fixed point
Error detection	Inaccuracies can be directly observed	Inaccuracies not always apparent

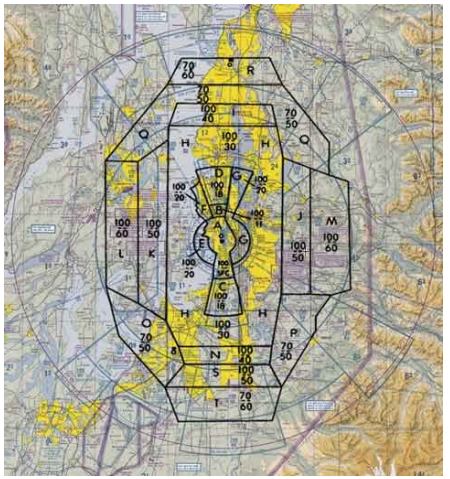
Fixed Infrastructure

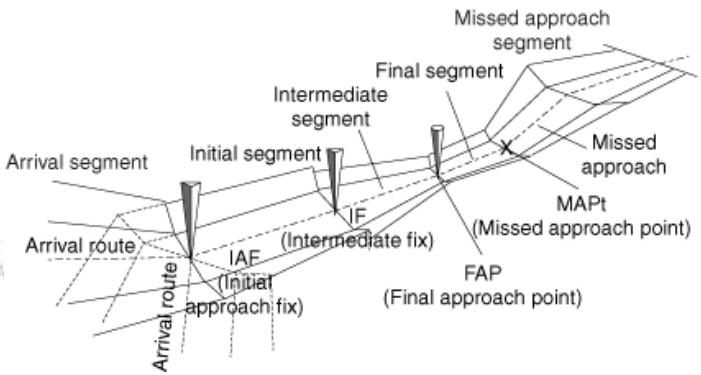


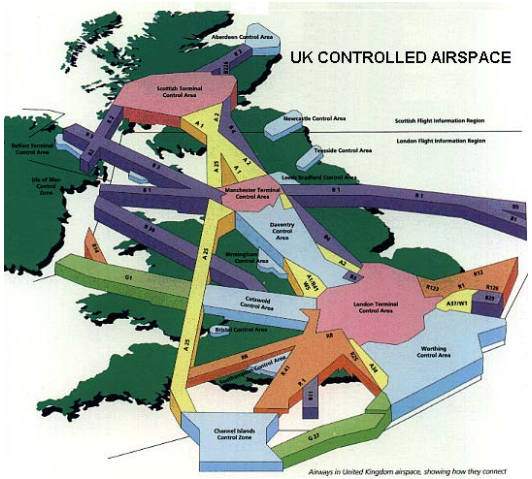
Virtual Infrastructure



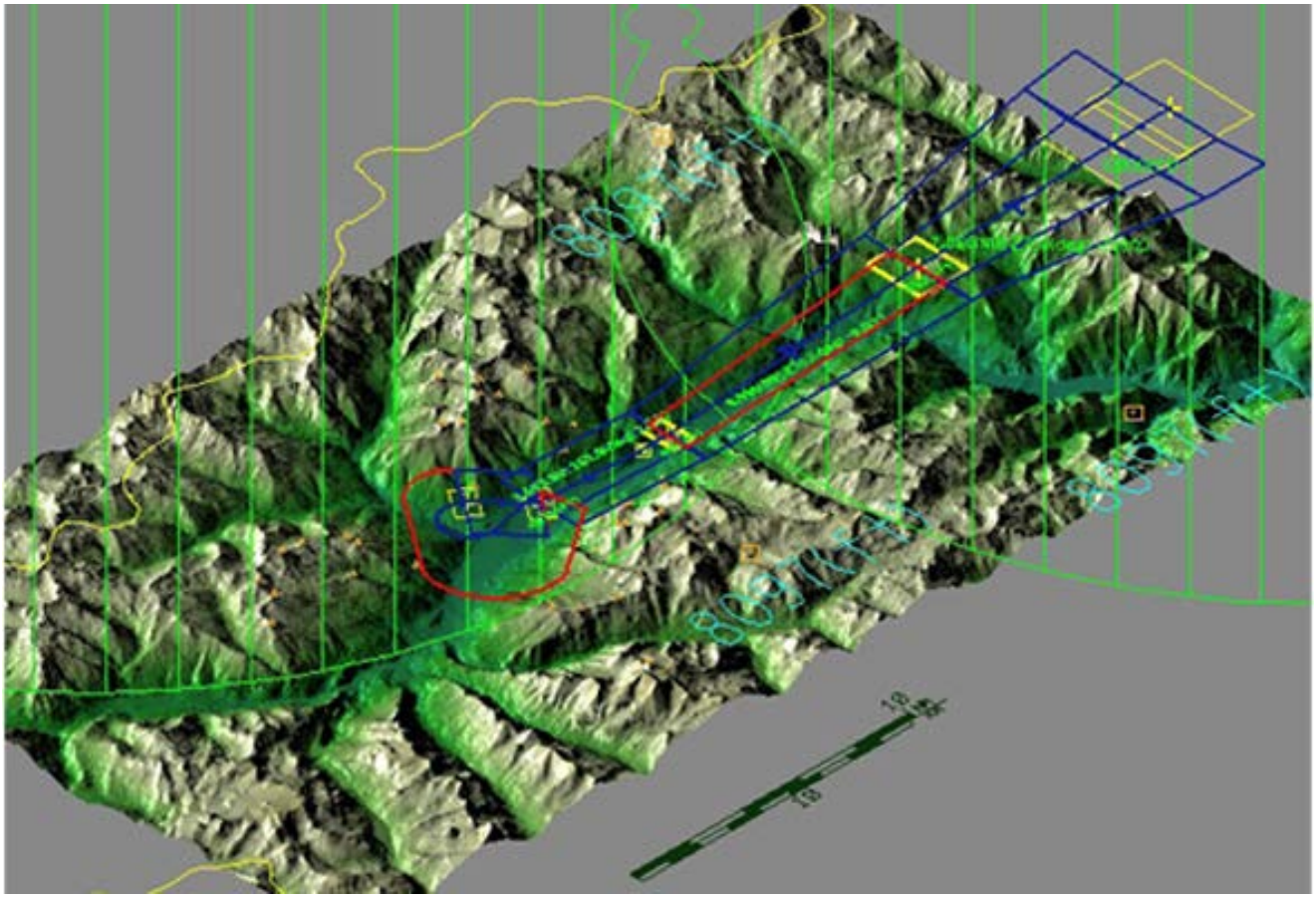






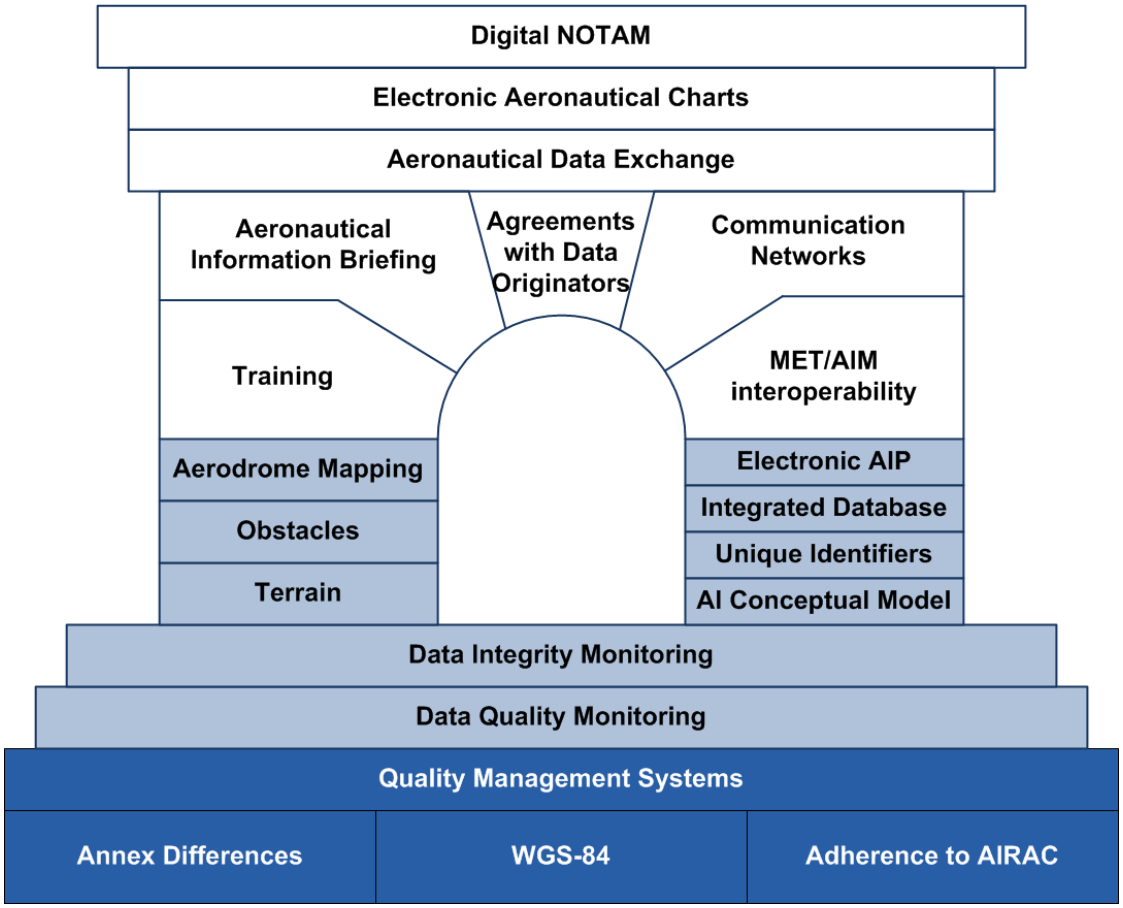


PBN Procedures Design – Build anywhere



PBN Operational Hazard – Build anywhere

AIM Roadmap

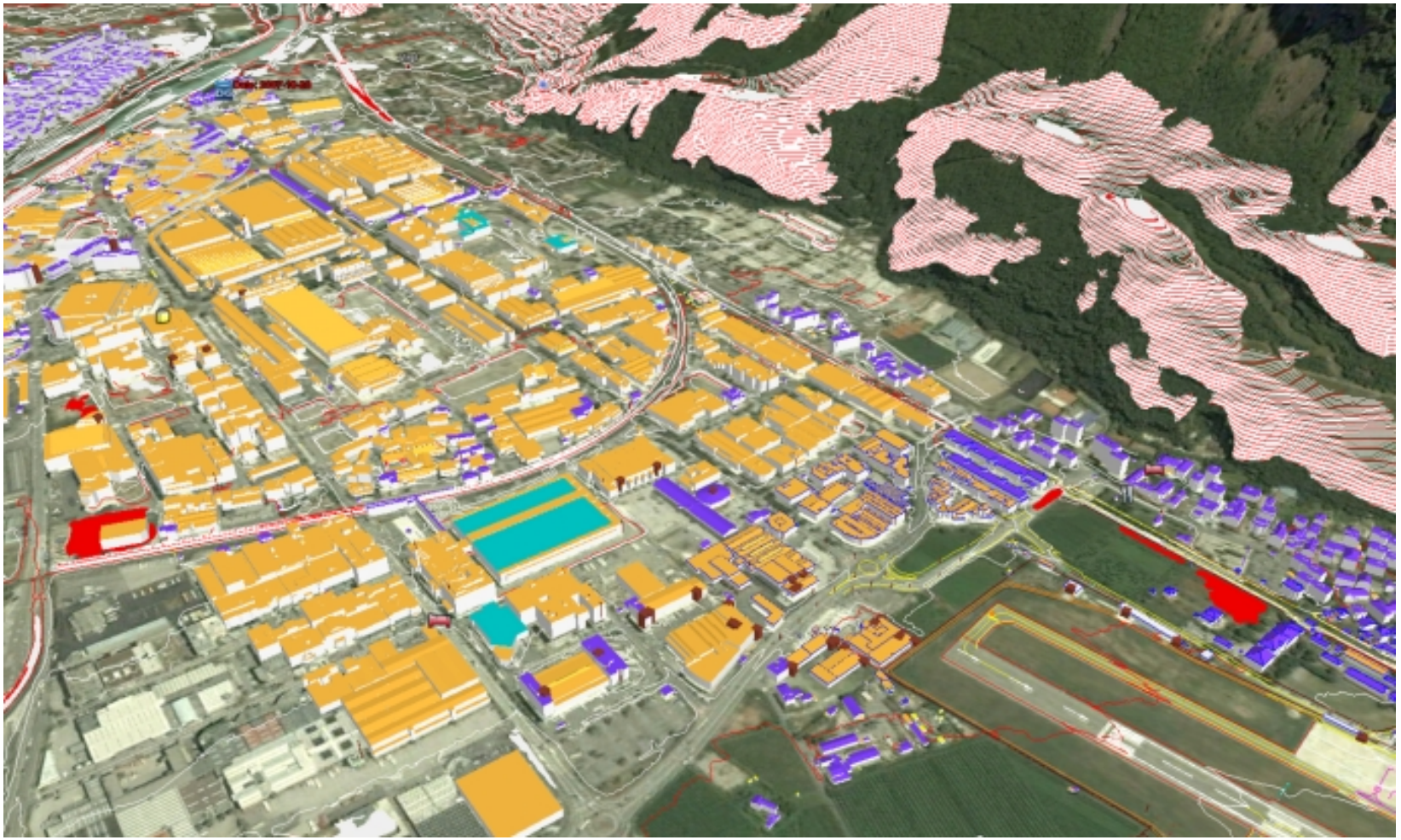


- Focus on going digital
- Focus on data and information quality management

eTOD

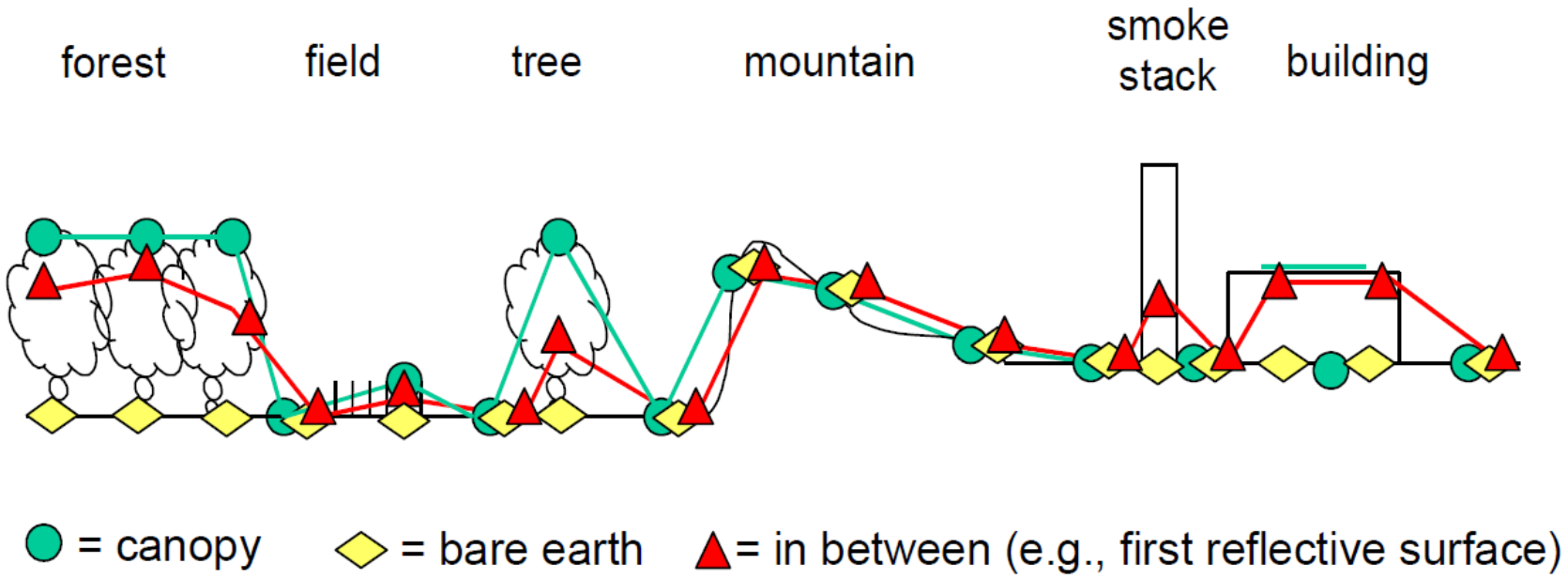
- Electronic Terrain and Obstacle Data
- Annex 15 specifies both collection and numerical requirements (resolution and integrity)
- Collection requirements may NOT provide a complete data set

eTOD – using digital data



Terrain Definition

The surface of the Earth containing naturally occurring features such as mountains, hills, ridges, valleys, bodies of water, permanent ice and snow and excluding obstacles



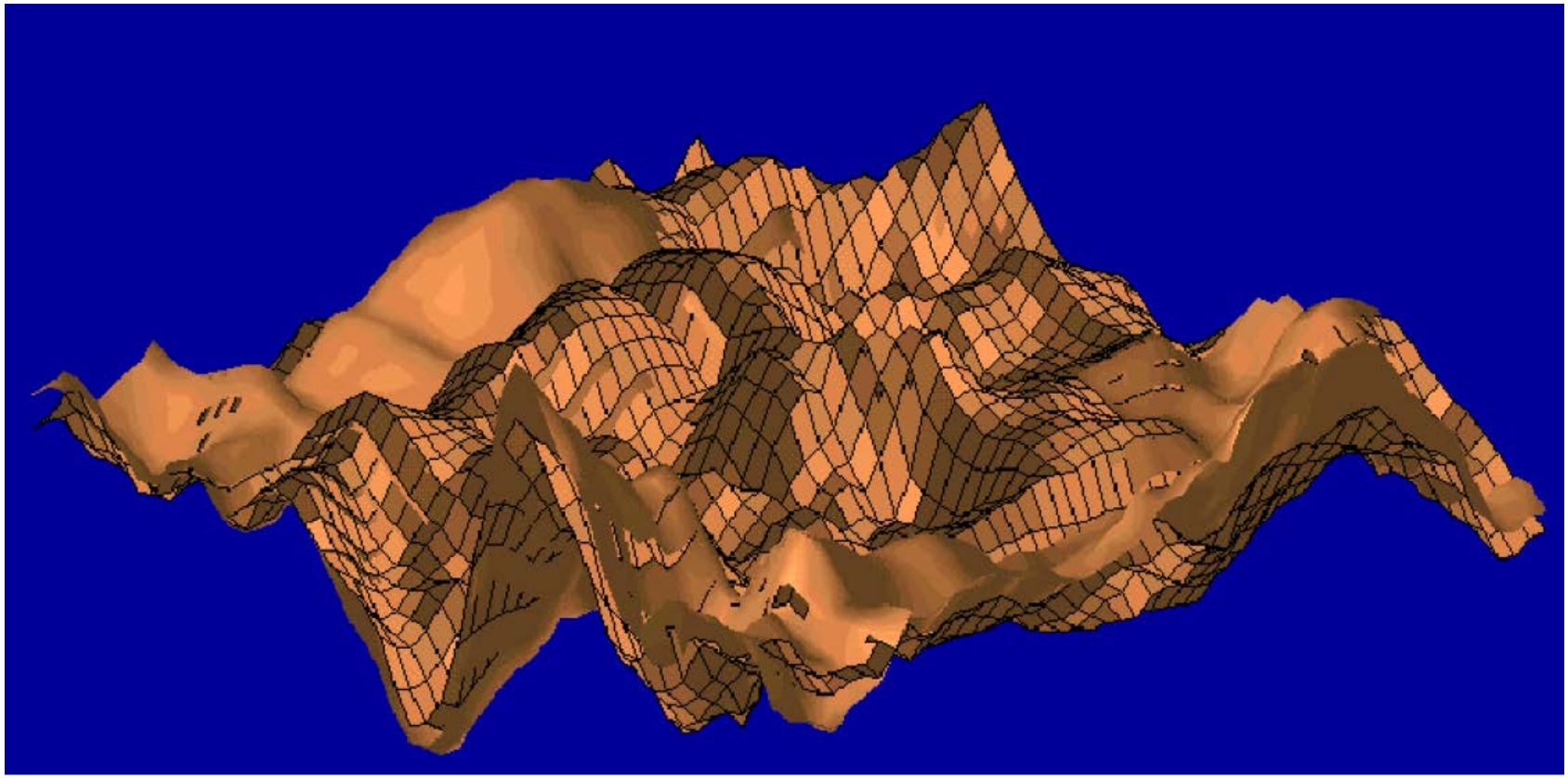
Terrain Features

- ***Bare Earth***: surface of the Earth including bodies of water and permanent ice and snow and excluding vegetation's and man-made objects (culture)
- ***Canopy***: bare Earth supplemented by vegetation height
- ***Culture***: all man-made features constructed on the surface of the Earth, such as cities, railways and canals

Modeling Terrain

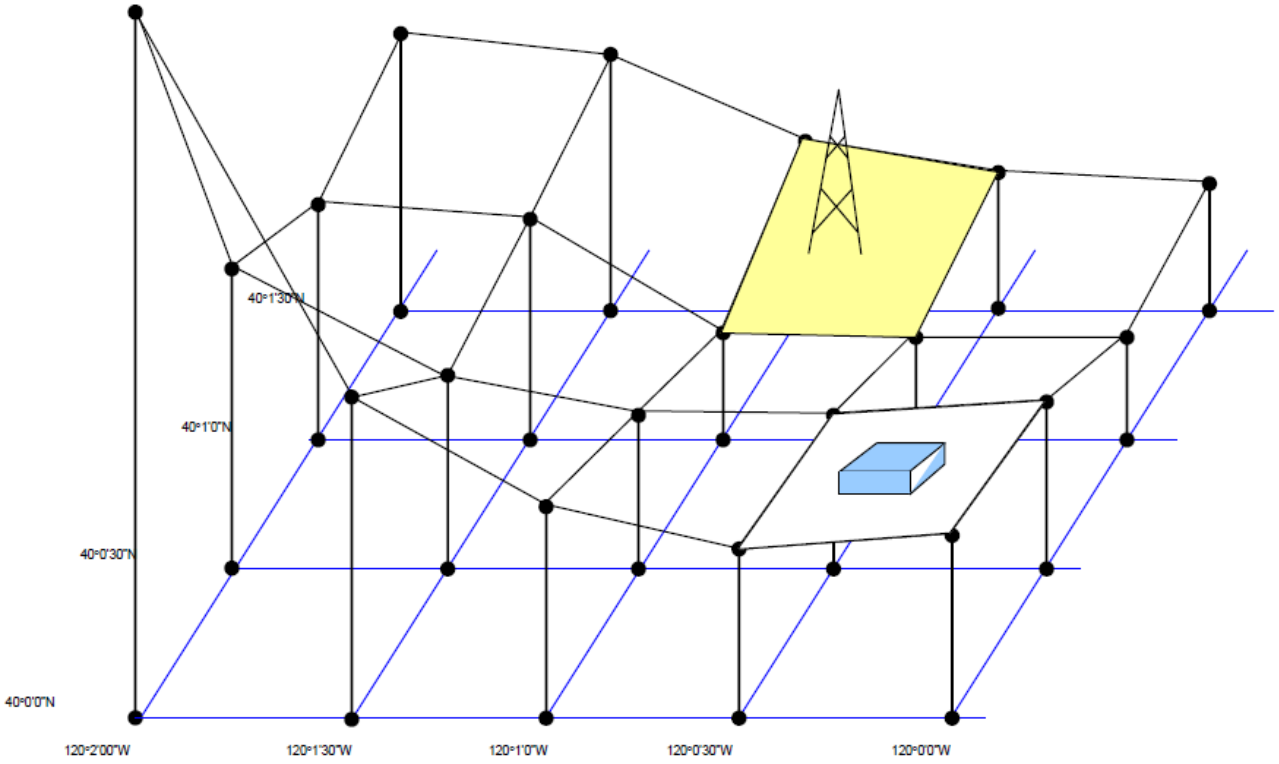
- ***Relief***: the inequalities in elevation of the surface of the Earth represented on aeronautical charts by contours, hypsometric tints shading or spot elevations
- ***Post spacing***: angular or linear distance between two adjacent elevation points

Digital Elevation Model (DEM)



Representation of terrain surface by continuous elevation values at all intersections of a defined grid, referenced to common datum

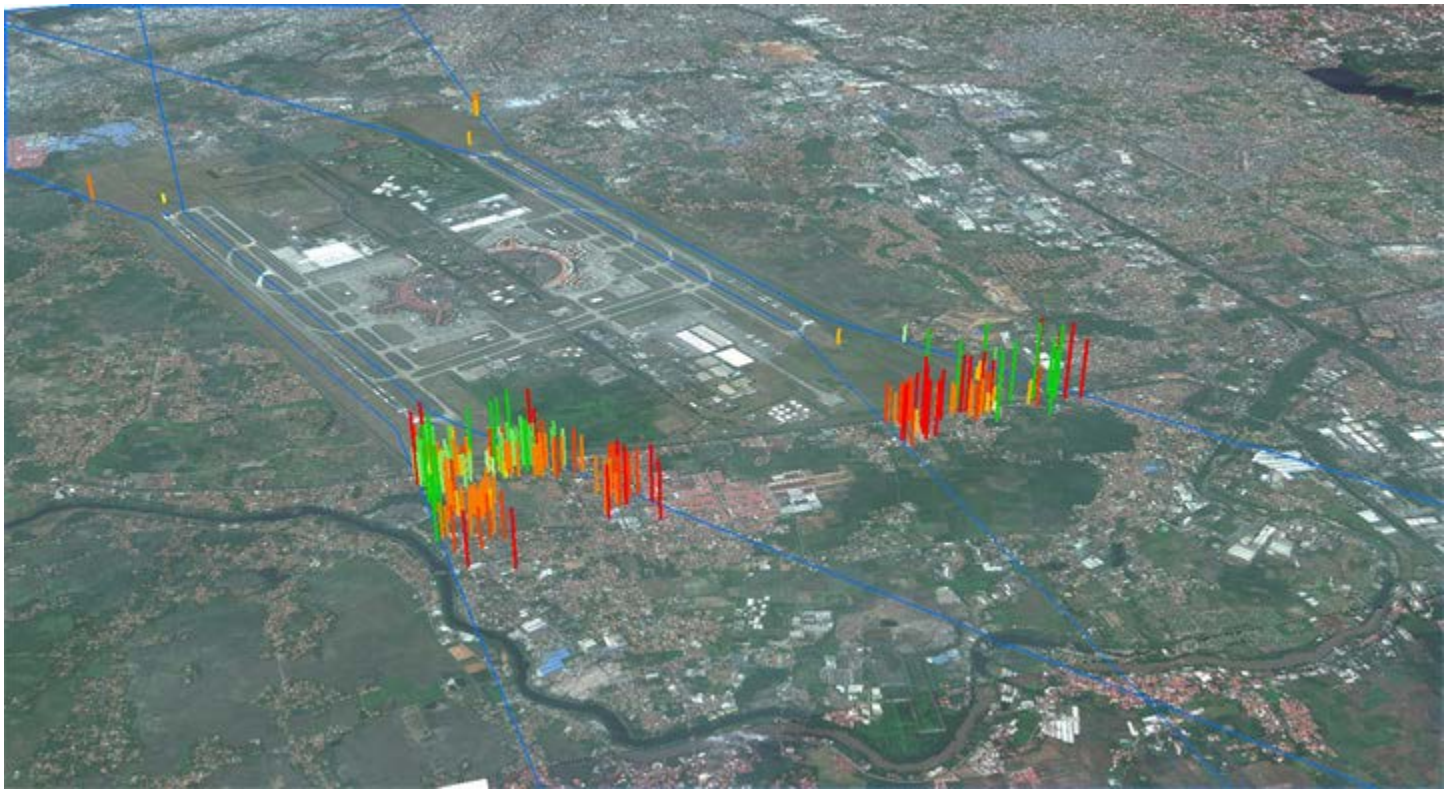
DEM and Post Spacing



Using eTOD

- Understand the limitations
- eTOD collection requirements are specified minimums
- Areas overlap
- Not all obstacles may be reported
- Treat the identification of sources and the collection of obstacle data as a specific task on a PBN project

Digital Obstacle Data



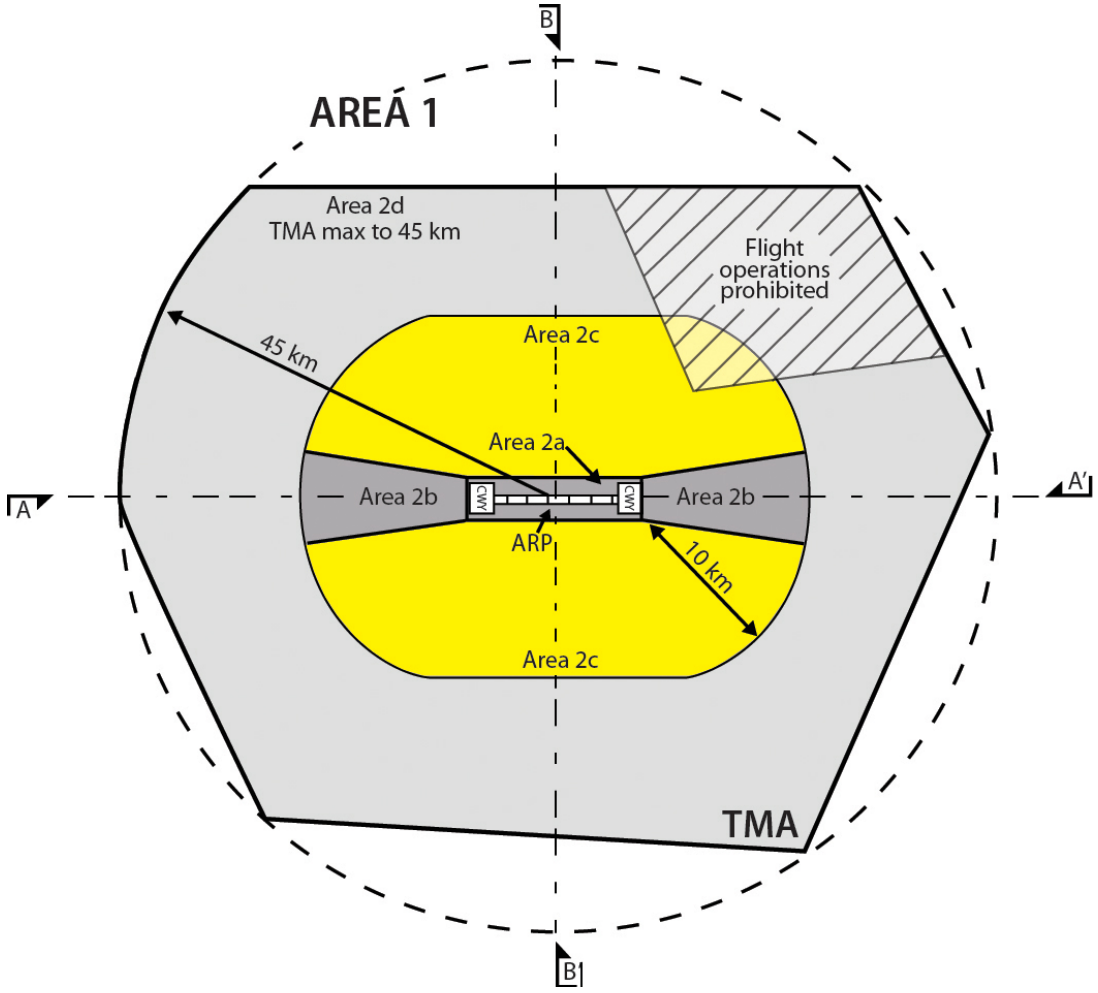
eTOD Areas

- **Data collection requirements specified by area:**
  - Area 1 - The territory of the State (“The World”);
  - Area 2 - The Terminal Airspace;
  - Area 3 - The Aerodrome Movement Area;
  - Area 4 - Precision Approach area

Obstacle Data Collection - Area 1

- Area 1: Entire State territory
- Data on every obstacle within Area 1 whose height above the ground is 100 m or higher shall be collected and recorded in the database in accordance with the Area 1 numerical requirements .
- Coincides with WAC obstacle requirements
- Numerical requirements are specified Annex 15, Table A8-2.

COVERAGE - AREA 2



Area 2a: a rectangular area around a runway that comprises the runway strip plus any clearway that exists.

Area 2b: an area extending from the ends of Area 2a in the direction of departure, with a length of 10 km and a splay of 15% to each side.

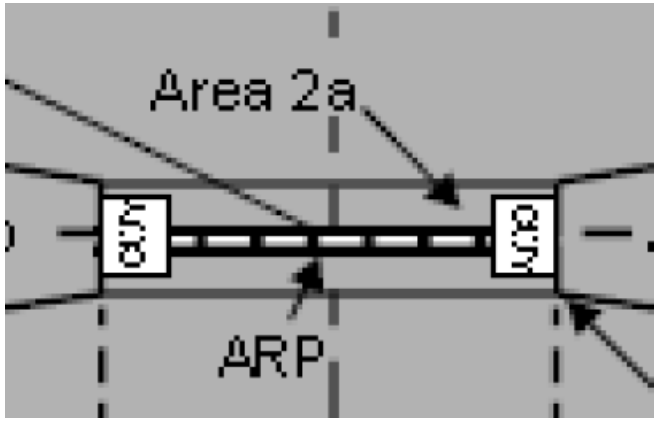
Area 2c: an area extending outside Area 2a and Area 2b at a distance of not more than 10 km from the boundary of Area 2a.

Obstacle data collection - Area 2

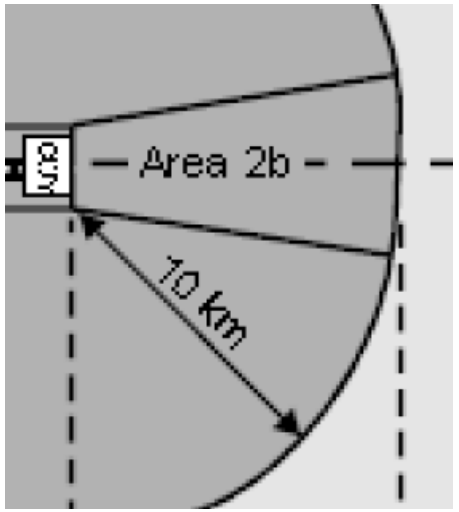
- Obstacles within Area 2 that are assessed as being a hazard to air navigation; and
- Any object penetrating an aerodrome obstacle limitation surface(s)

Obstacle data collection - Area 2

- Area 2a: Objects that penetrate a collection surface at a height of 3 m above the nearest runway elevation measured along the runway centre line, and for those portions related to a clearway, if one exists, at the elevation of the nearest runway end;

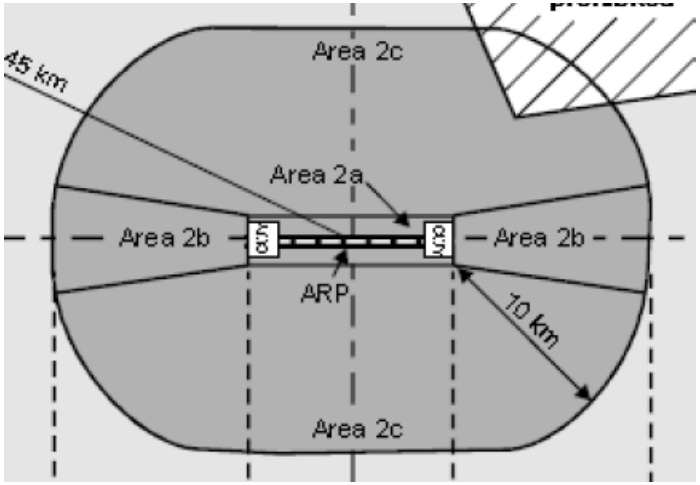


- Area 2b: Objects that penetrate a collection surface having a 1.2% slope extending from the ends of Area 2a at the elevation of the runway end in the direction of departure, with a length of 10 km and a splay of 15% to each side

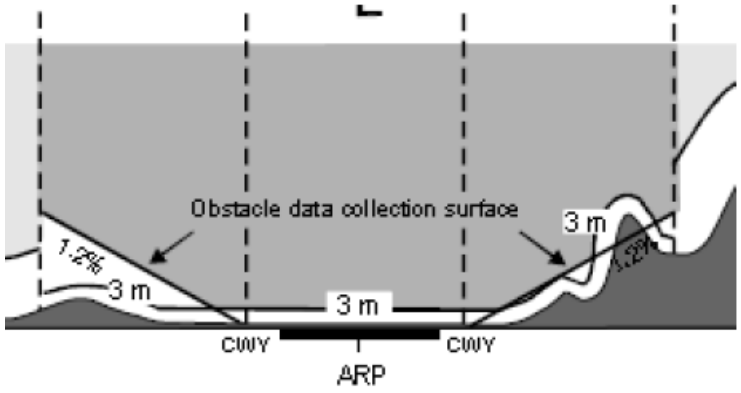


Obstacle data collection - Area 2 (Recommended)

- The Area 2c: Objects that penetrate a surface having a 1.2% slope extending outside Area 2a and Area 2b at a distance of not more than 10 km from the boundary of Area 2a.
  - The initial elevation of Area 2c shall be the elevation of the point of Area 2a at which it commences



- Area 2d: Objects that penetrate a collection surface having a height of 100 m above ground



eTOD Areas (con't)

Area 3

- Aerodrome – also overlaps with Aerodrome Mapping Data (AMDB)
- From runway edge to movement areas
- Should originate from Aerodrome operator

Area 4

- Pre-threshold
- Requirements based on Precision Approach Terrain Chart (PATC)

eTOD Data Origination

- **Area 1**
  - Geodetic survey
  - Obstacles are report or surveyed
- **Area 2**
  - Surveys by aerodromes and /or other agencies
  - Obstacles are report or surveyed
- **Area 3**
  - Surveys by aerodromes
  - Obstacles are reported by aerodrome
- **Area 4**
  - Aerodrome survey

eTOD issues

- Data acquisition is expensive
- Varying degrees of land use controls
- Not always clear who is responsible
- Difficult to relate the responsibility to collect ($$) with the benefit of use

Implementing eTOD

- **Report additional obstacles to AIS/AIM**
- **Make for vision for data maintenance**
  - Originators
  - Periodic survey
- **Collect metadata**
- **Clarify responsibilities for verification**
- **Partner with AIS/AIM**

WGS-84

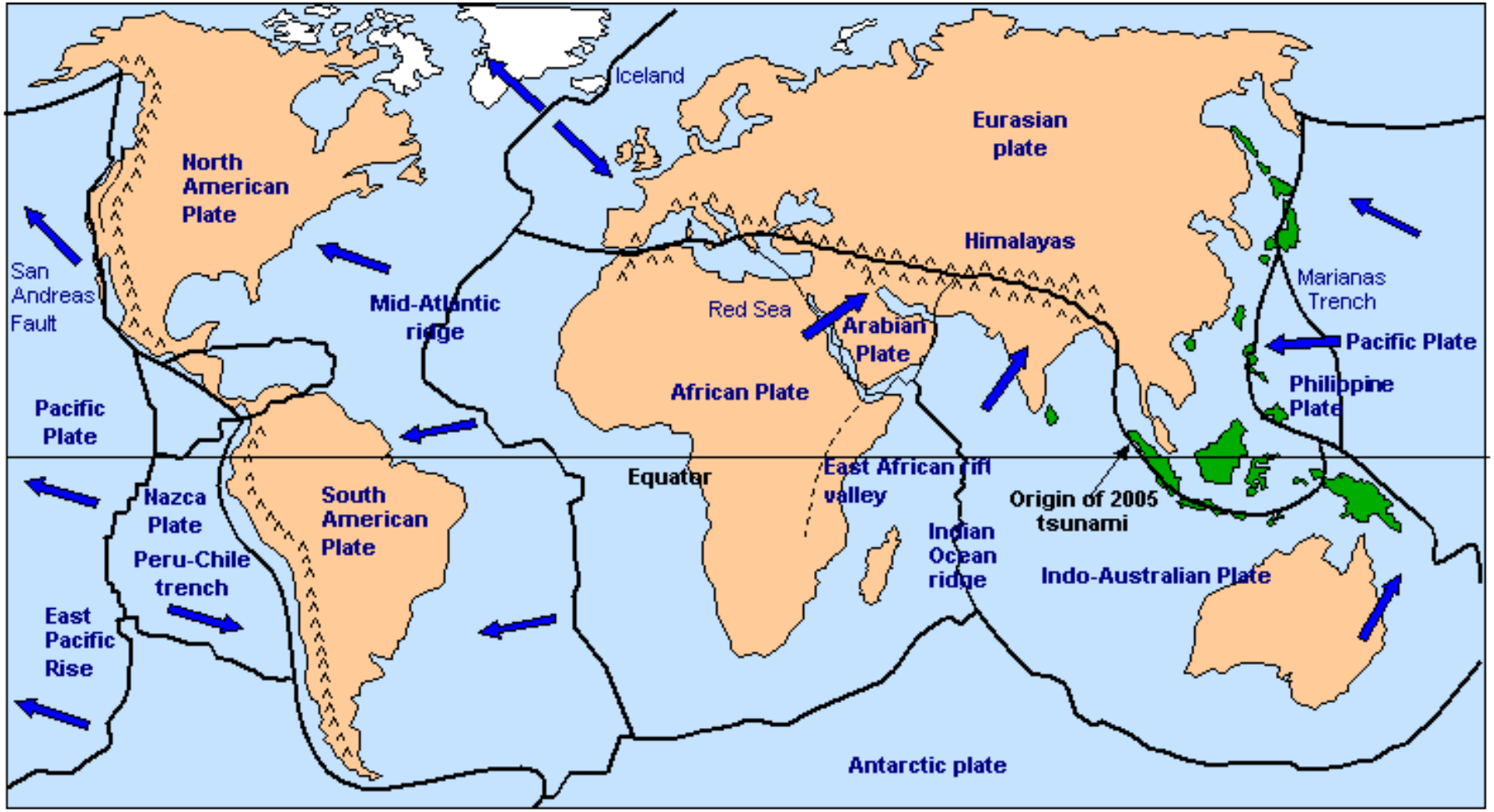
- ICAO standard since 1988
- Implementation not 100%
- Essential for GNSS based procedures
- Actual status of implementation is not always clear

The Earth is Not Static

the Mid-Atlantic Ridge (shown in Iceland)

Following earthquake activity

Continental Drift



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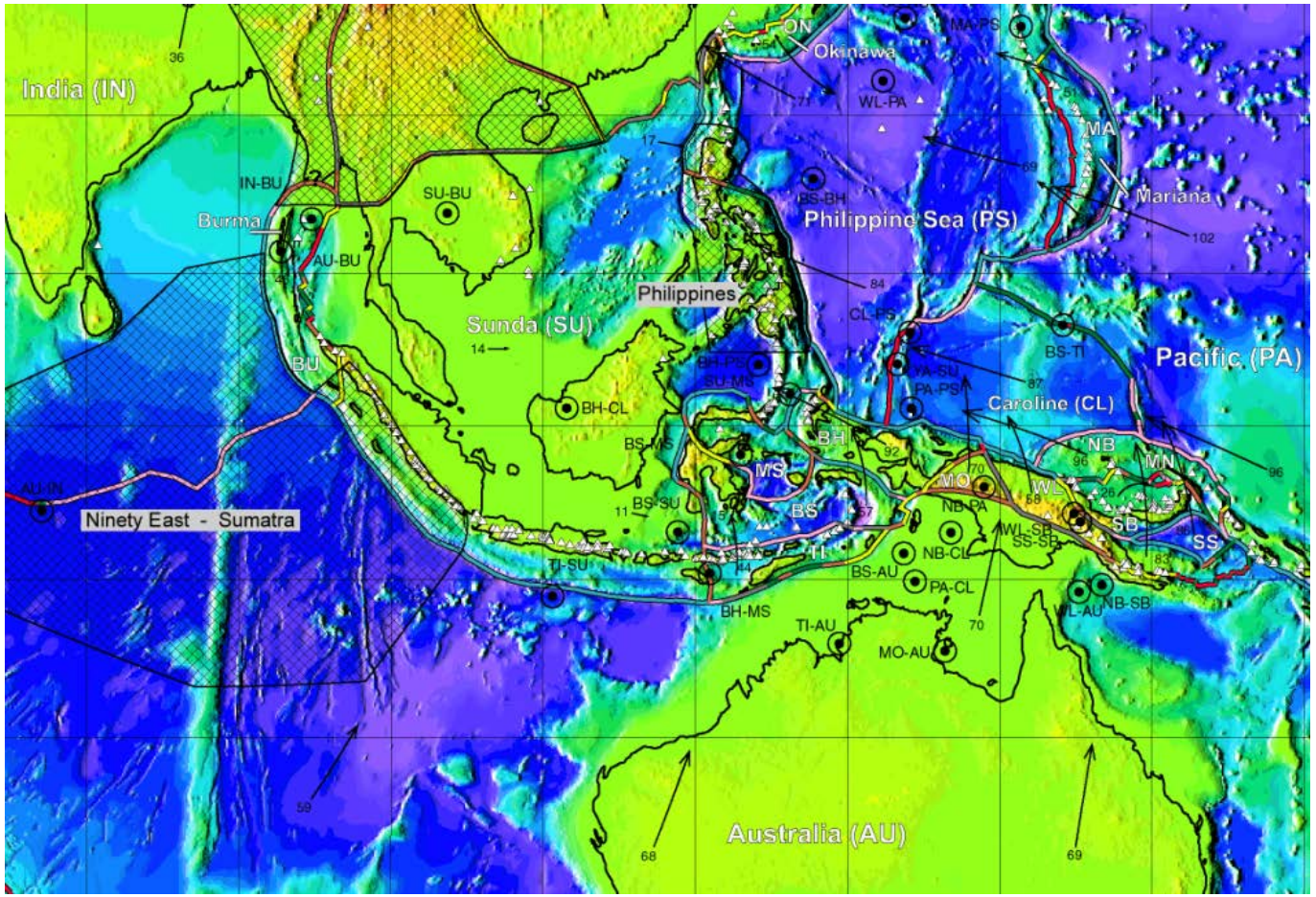
Tectonic Movement Zones



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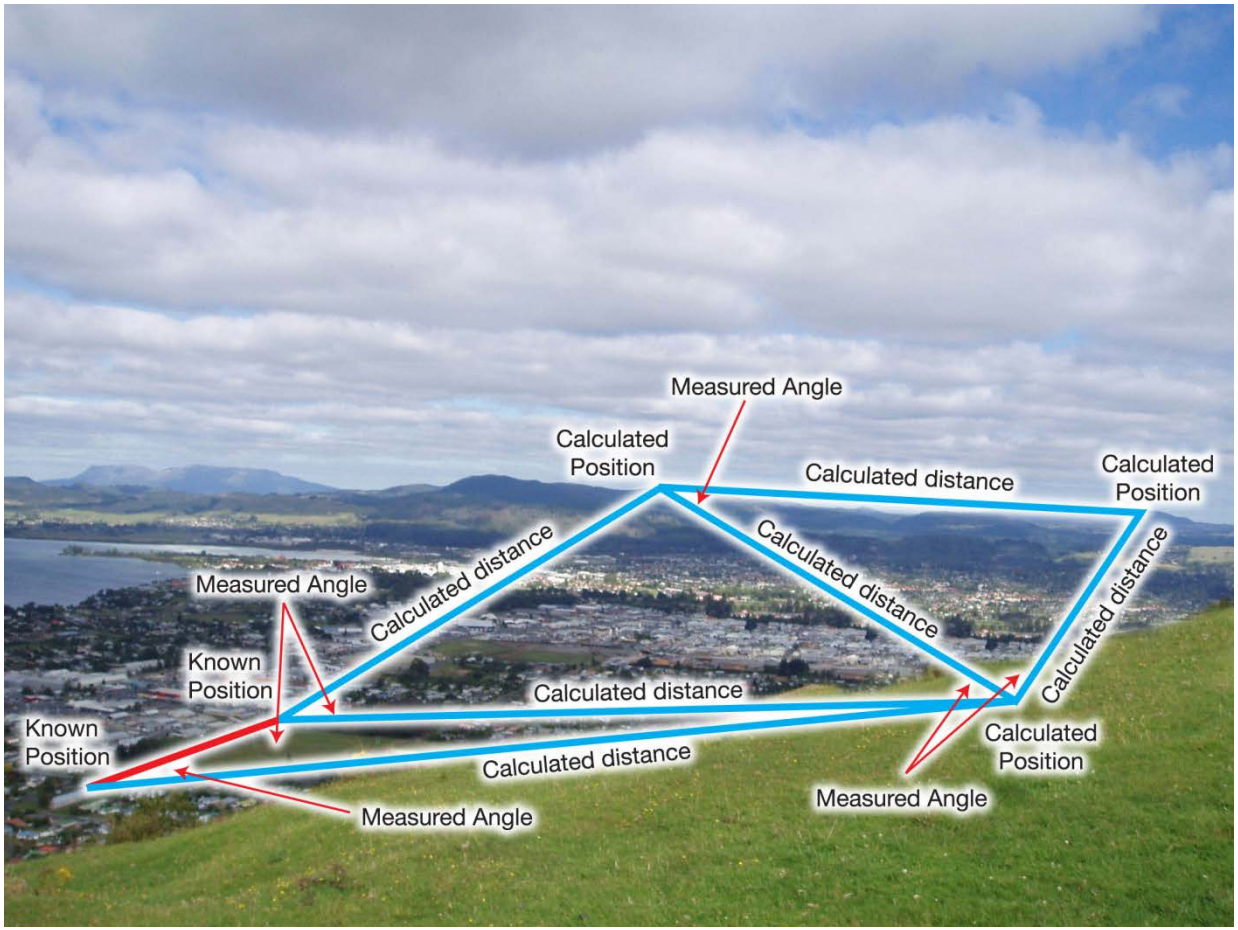
Survey Method



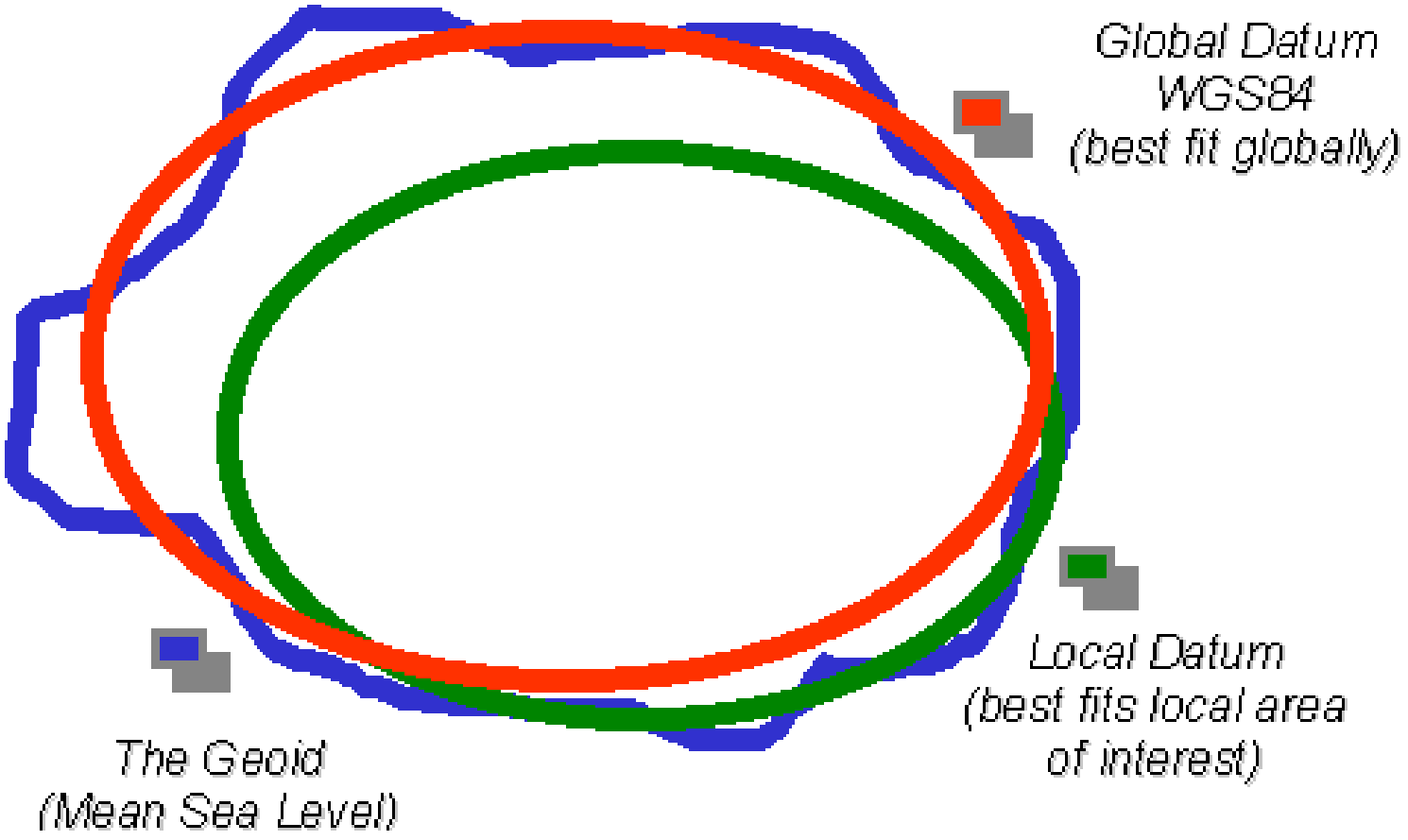
Triangulation starting from known position

Calculating new coordinates requires a reference system and datum

Understanding Coordinates

- **Reference frame**
  - An abstract coordinate system and the set of physical reference points that uniquely fix (locate and orient) the coordinate system and standardize measurements.
- **Datum**
  - a reference point or surface against which position measurements are made, and an associated model of the shape of the Earth for computing positions

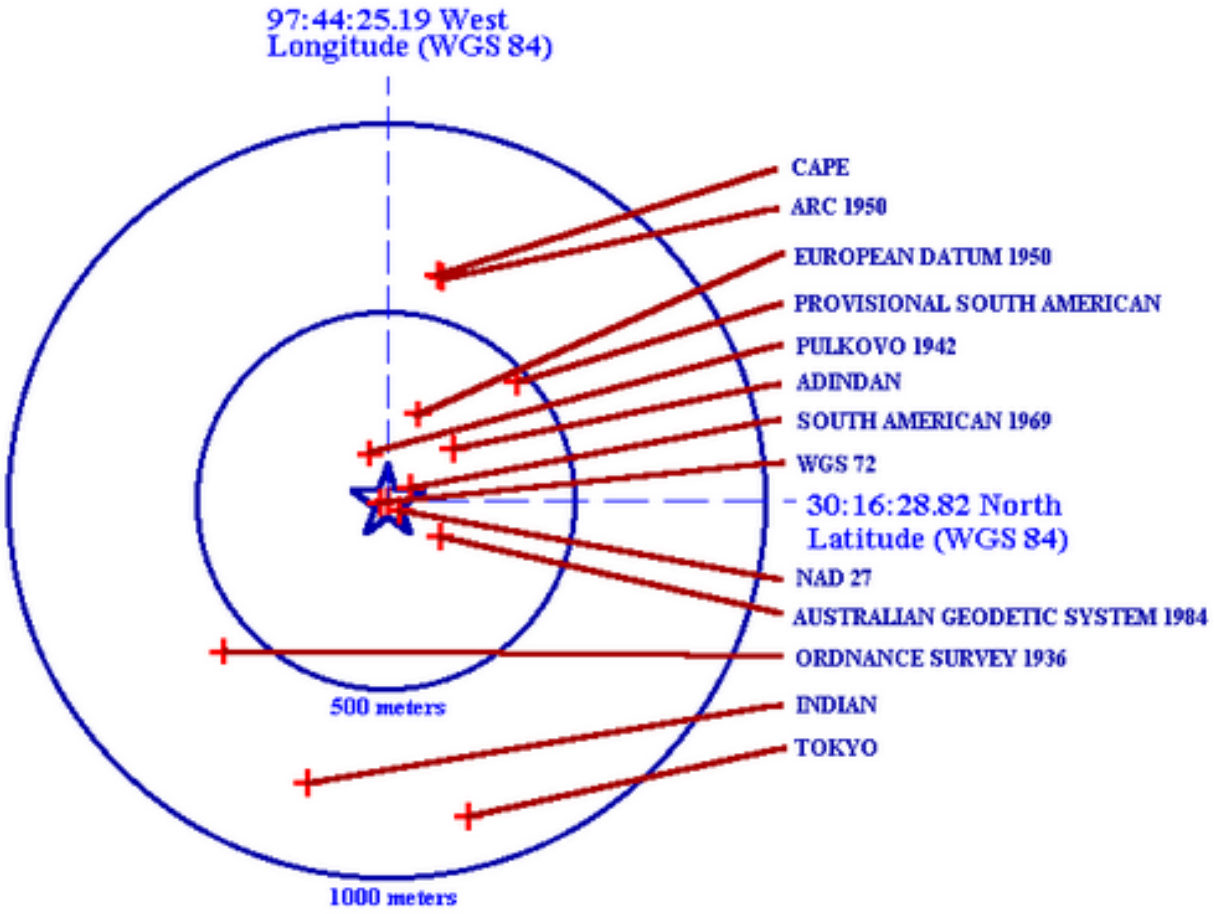
The Earth is not perfect



Terrestrial Coordinate Reference

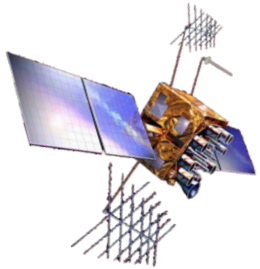
- **International Terrestrial Reference System**
- **regional geodesic system**
  - Large earth-centred, earth-Fixed
  - NAD83, SAD69, ETRS89
- **Local reference systems**
  - usually referenced to some convenient local reference point

Position Shifts from Datum References



Texas Capitol Dome Horizontal Benchmark

Terrestrial reference vs Space reference



WGS84 coordinates anchored to earth's center of mass

Continental drift
about 2,5 cm per year

Terrestrial coordinates
are anchored to the
tectonic plate

Tectonic plate

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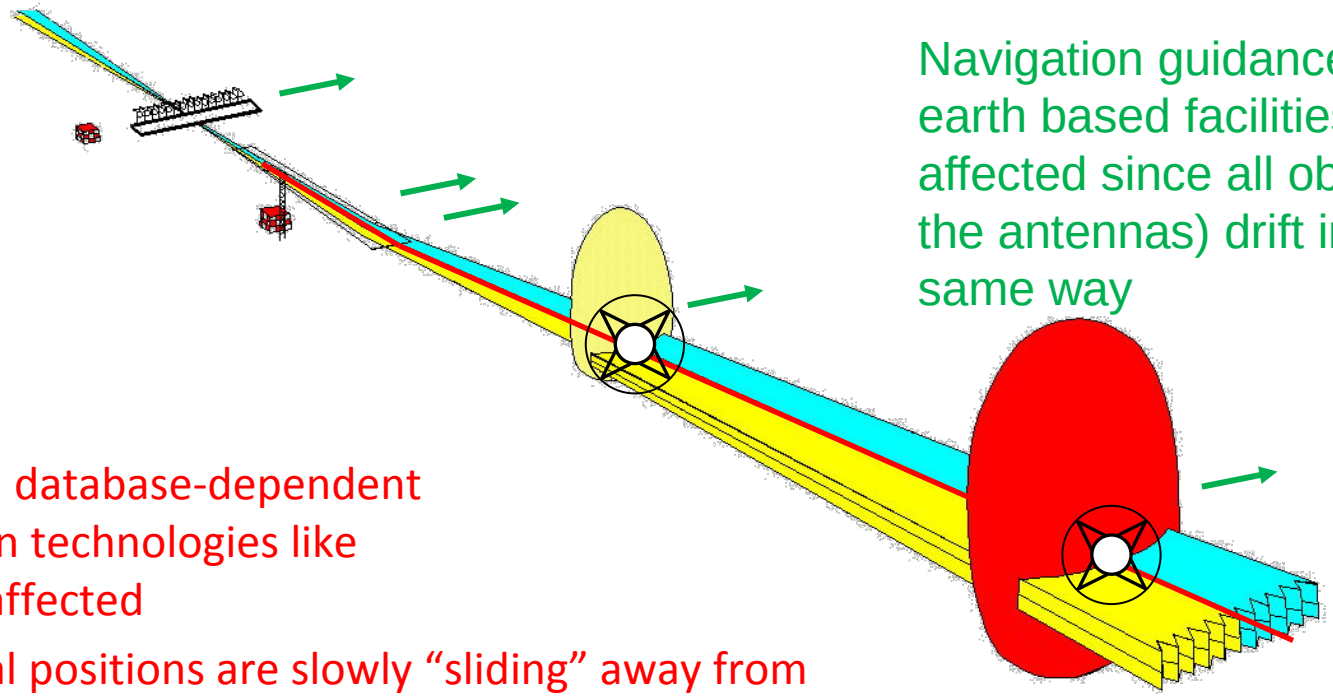
Impact on PBN



Navigation guidance use earth based facilities are less affected since all objects (incl. the antennas) drift in the same way

- However, database-dependent navigation technologies like PBN are affected
- The actual positions are slowly “sliding” away from the fixed waypoints defining the PBN procedures
- Regular re-surveying and coordinate transformations are necessary
- Expensive re-publication/approval of flight procedures may be required

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What to do?

- **Investigate and determine how coordinates are surveyed**
  - Derived (calculated) positions will be in the same reference coordinate system
- **Document metadata concerning reference systems**
  - Unit of measurement
  - Reference system used for the survey
  - Epoch / referance date
- **Don’t make assumptions - verify**

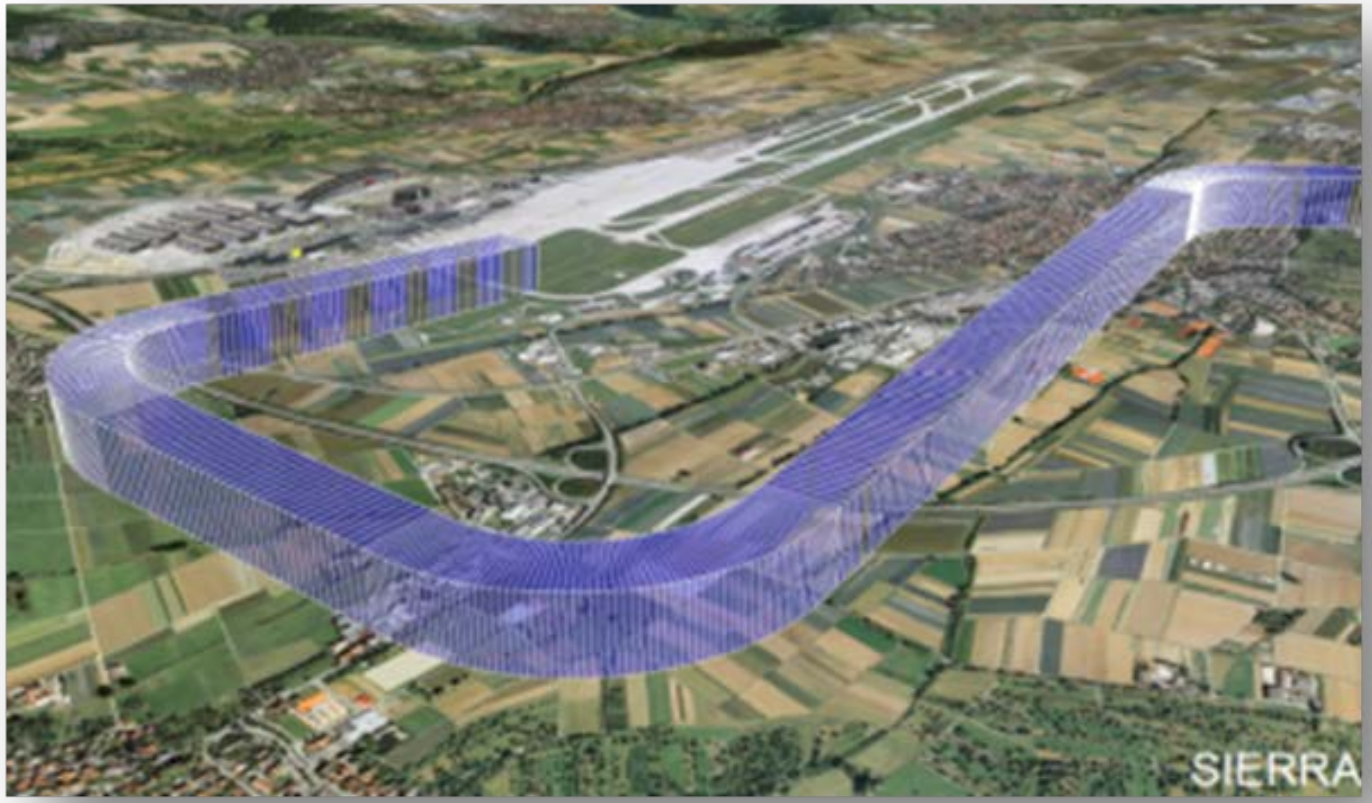
Summary

- Understand data sources
- AIM data quality management begins with the originator
- PBN is both an originator and a consumer of data
- The increasing application and integration of FMS requires robust and stringent data quality controls
- “get it right the first time”

… Summary

- Metadata is a key enabler to good data management
- Not all coordinates are equal
- PBN quality management must be seamless with AIM QMS

Digital Data Enables Digital Design Tools



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THANK YOU