Evolving a new Geodetic Positioning Framework: An Australian Perspective

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Outline

- Introduction
- Precise Positioning
- National Geospatial Reference Systems
- Asia Pacific Reference Frame
- IAG’s Global Geodetic Observing System
- Conclusion
Precise Positioning

• Real time positioning
• Focus is on the interaction between instantaneous precise positioning (<5cm) and spatial data
• Applications are numerous
• Applications produce economic efficiencies, public good benefits and support Critical Infrastructure elements
• Accuracy and integrity requirements are increasing
• Precise positioning capability is not uniformly available globally because of infrastructure requirements and service provision
• Relies on accurate coordinate reference framework
GNSS supports a diverse market for positioning applications & critical infrastructure
Land, Sea, Air Navigation
- Aviation
- Marine navigation
- Fleet management
- Intelligent transport

Surveying and Mapping
- Civil engineering
- Mining
- Precision agriculture
- GIS

Military Applications
- Target designation
- Smart weapons
- Air support

Recreational Uses
- Hiking
- Image referencing

Timing
- Time transfer
- Financial transactions
- Cellular networks
- Electrical power grids

Scientific Research
- Tectonic movement detection
- Deformations
- Datum
- Environmental studies
- Forestry & Fisheries
Neotectonics

• Example: Bangkok from Satirapod et al, IUGG 2011

• Post Sumatra-Andaman Earthquake deformation in Bangkok is $10 \text{ mm yr}^{-1}$
  – Not clear how long this deformation will continue for? 25 Years

• Sea level change in Gulf of Thailand is $4-5 \text{ mm yr}^{-1}$
GPS monitoring of subsidence caused by groundwater pumping in Perth WA
**National Geospatial Reference Systems**

- Accuracies continue to improve generally by an order of magnitude every decade
- The number of users needing access to the datum is growing rapidly
- The Earth is a dynamic planet
- Static National Datum no longer serving the precise positioning applications
National Geospatial Reference System (Datum)

• Need to be a coordinate framework that is accurate, reliable and accessible
• Linkage to an International Reference Frame that is accurate and stable
• Flexible enough to allow for tectonic and measurement science changes
• Must provide systems and tools to allow the transformation of legacy data onto the current reference system
What are the attributes of a dynamic system that we want
Time series signals
Time series steps

UN Global Geospatial Information Management Forum, HangZhou China
Asia Pacific Reference Frame (APREF) Network
GNSS sites across SE Australia
Global Geodetic Observing System

- A uniform coverage of observing techniques
- Modern and sustainable infrastructure
- Continued refinement of analysis techniques
- Product development underpinned by robust science
Global Geodetic Observing System (GGOS)

- Provides quantitative measurements of the dynamic nature of the Earth including:
  - Plate tectonics / intraplate tectonics
  - Anthropogenic Subsidence
  - Earthquake induced crustal deformation
  - Sea Level Rise
  - Atmospheric Modelling
Australia’s contribution to the definition of the International Terrestrial Reference Frame – through GGOS

Inter-technique Local Tie Surveys
AuScope Geospatial Infrastructure Program

- 3 new 12m VLBI telescopes;
- A VLBI observation correlation facility;
- 4 new Gravity instruments (1 Microg FG5 absolute gravimeter plus 3 gPhone Earth Tide Metres) and observation program around a national network;
- A Laser power upgrade at the Mt Stromlo Satellite Laser Ranging observatory;
- 100 new GNSS sites
VLBI Telescopes at Hobart, Katherine and Yarragadee

Photo courtesy of Jim Lovell, UTAS
AuScope GNSS Network with VLBI and SLR sites
Australian Geophysical Observing System

- A pool of GNSS instrumentation (100 sets)
- A geodetic calibration system including VLBI and GNSS antenna measurement systems
- Construction of arrays of survey marks for use with the pool of GNSS equipment and radar reflectors
- Installation of the 4 new permanent GNSS stations at key sites
- Development of a Remote sensing web portal including a pool of INSAR data
National Geodetic Datum - Roadmap

Static Datum
Name: GDA2020
Frame: ITRF@2020
Realised annually

1990                         2000                         2010                         2020

Static Datum
Name: GDA94
Frame: ITRF92@1994

RVS Update
Static Datum
Name: GDA94
Frame: ITRF92@1994 (realised in ITRF2008)

Dynamic Datum
Name: GDA
Frame: ITRF
Realised continuously

Coordinate differences from GDA94 (horizontal, vertical)

3, 7cm  150+7cm/yr, 10cm
150, 10cm
Next Step – Development of a National Positioning Infrastructure

• End-to-End
• Hardware
• Software
• Monuments
• Communications
• Processing
• Analysis
• Monitoring
• Delivery
Conclusion

- The reliance of national and local positioning capabilities on the Global Geodetic Observing System is growing
- Governments need to consider investing in GGOS infrastructure as well as GNSS infrastructure
- The need for knowledge about the state of the crust; and the down stream benefits of an improved RF are driving greater investment in infrastructure
- Continued effort is required to make data available, and have it analysed homogeneously