Modernising the Northern Territory's GRS

Geospatial & GNSS CORS Forum

Kuala Lumpur, Malaysia

Amy Peterson; Rob Sarib
DIPL Land Information – Survey Services
Sunday 16 October 2016

NORTHERN TERRITORY GOVERNMENT

Presentation Outline

- Our Jurisdiction – The Northern Territory
- Our Department
- The NT Geospatial Reference System
- What it is used for
- A modernised GRS
  - Why?
  - How?
- Infrastructure, Systems

Facts & Figures
Northern Territory - Australia

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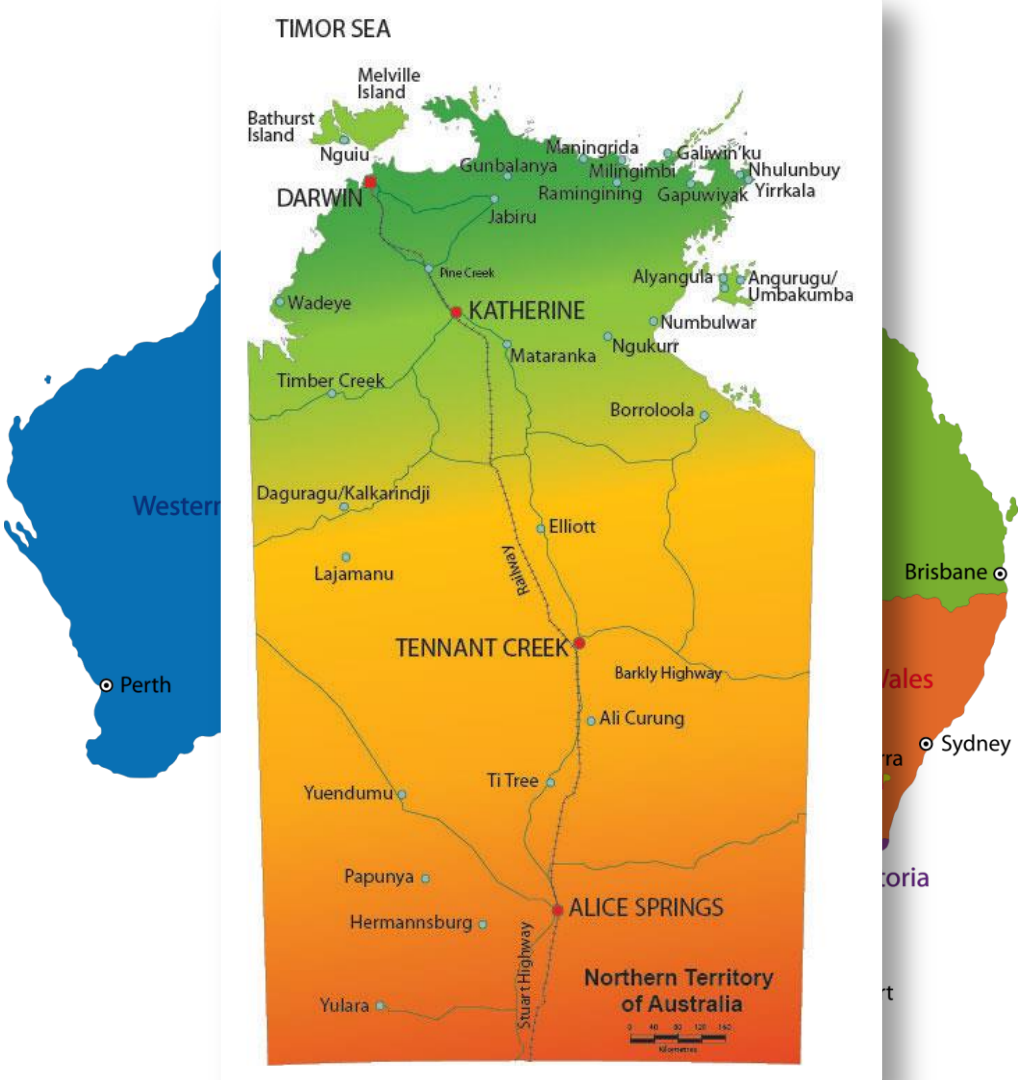

Population

244,307

People

Employment

98,916

Jobs

Gross Regional Product

$23.139

Billion

Northern Territory Facts & Figures

- 1 of 8 jurisdictions in Australia
- Capital city - *Darwin*
- Population ~240 000 (only 1% of the Australian population)
- It is estimated that 98,916 people work in NT
- Land area - 1,349,129 km^2
- 3rd largest of the States and Territories in area after Western Australia and Queensland, but the least densely populated jurisdiction
- Major industries include mining and tourism

Source ABS and CDU

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Northern Territory Facts & Figures . . .

- Has 2 climatic zones:
  the wet/dry tropics in the north; and the semi-arid to arid areas in the south
- Gross Regional Product is estimated at $23.139 billion (1.44% of Australia)
- The total value added by the NT economy is estimated at $21.723 billion (1.44% of Australia)
- Public Administration and Safety industry biggest contributor

Source ABS and CDU

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Department of Infrastructure, Planning and Logistics
Land Information - Survey

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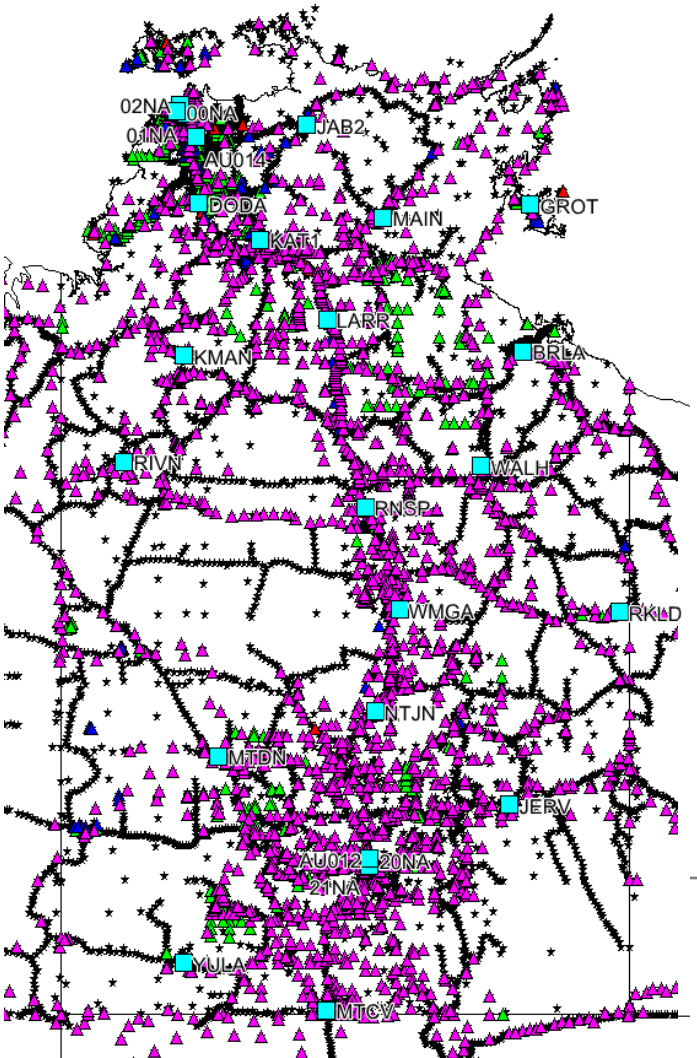

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DEPARTMENT OF INFRASTRUCTURE, PLANNING AND LOGISTICS

LAND INFORMATION, SURVEY

- Staff – 10 operational surveyors
- 2 offices – Darwin, Alice Springs
- Responsible for the administration of the geodetic framework, cadastre, and related survey infrastructure and systems
- ~ 100 000 parcels, 23 CORS, 28000 geodetic marks
- Annual Survey budget – operational and personnel $2.5 million
- Oracle spatial, web based architecture Integrated Land Information System ILIS

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What was the NT’s Geospatial Reference System (GRS)?

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- ***G****eocentric* ***D****atum of* ***A****ustralia* ***-GDA is a "static" /*** **plate fixed** datum.

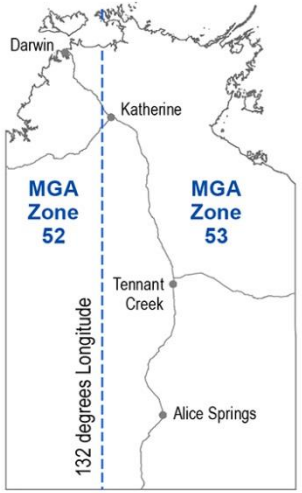
- *Based on* ***International Terrestrial Reference Frame*** *(ITRF) 1992 at epoch 1 January 1994,* Reference Ellipsoid - GRS80

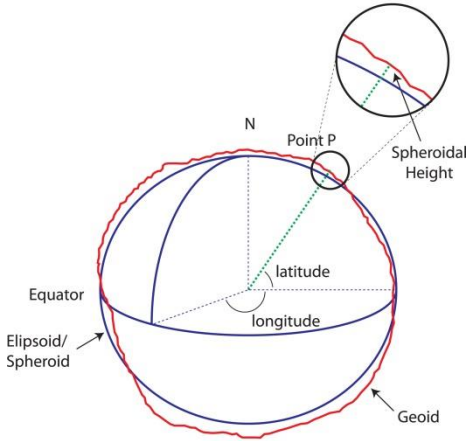
- **Grid coordinates:** UTM, *Map Grid of Australia 1994 (MGA94)* – **easting and northing** metres

- **Geographical coordinate set:** *Geocentric Datum of Australia 1994* (GDA94) - **latitude and longitude** degrees

- AusGeoid 98 (±0.5m); AusGeoid 09 (±0.1m) for GNSS measurements

- Working height surface AHD - Australian Height Datum





NT Geodetic datasets prior to modernisation

Originally –

- compromised of a “passive” network –
  terrestrial data, episodic / campaign style GPS measurements
- constrained by AFN (2), ANN (15) and TGN (120) GPS campaigns
- adjustment, observations, results information stored / accessed via a series of “static” file and paper based system
- estimate of national datum PU > 30mm – horizontally, >50 mm vertically

What is NT’s GRS used for?

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- Is the **reference layer that underpins** most geospatial land, water, space datasets and the spine of GIS or LIS
- Allows interoperability and integration of a nation's fundamental or foundation datasets
- Integral component of geospatial activity in surveying, mapping, "ubiquitous" positioning applications, location based services, and imagery data collection
- Recognised as essential and enabling infrastructure supporting informed decision making and sustainable economic development
- Critical to geoscience activity as it **measures and monitors the dynamics of the earth.**
- Capability to support global observing systems for accurate scientific research modelling -
  - inter / intra tectonic plate deformation,
  - sea level monitoring,
  - climate change,
  - atmospherics

What is a modernised GRS?

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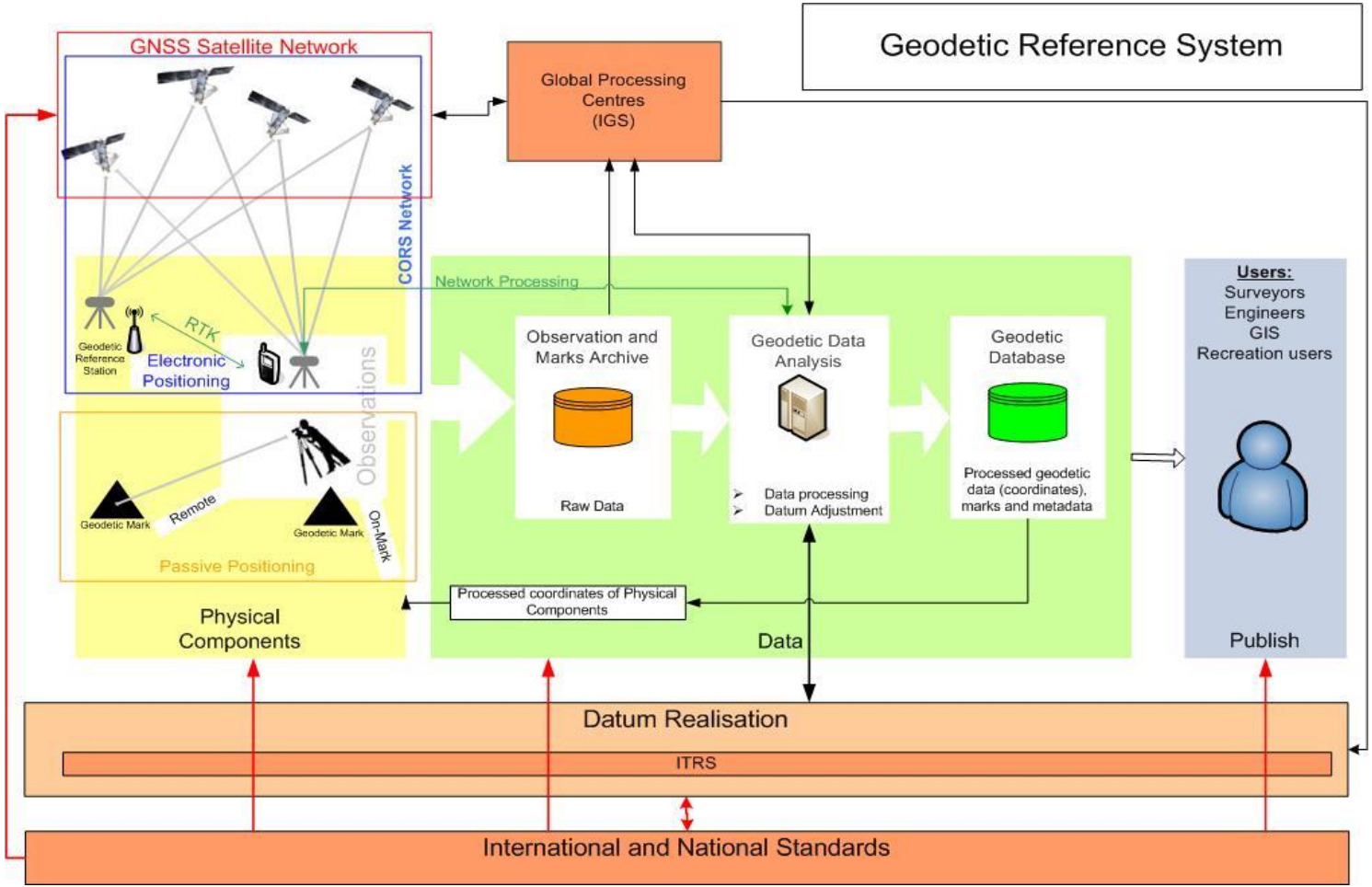
Characteristics of a Modernised GRS

- Propagation of co-ordinates and uncertainties via a rigorous, nationwide adjustment of geodetic information.
- Accurate traceable connection to ITRF
- Support positioning with HORIZ uncertainties < 20mm, VERT < 50mm
- 3D with a national Geoid model
- Seamlessly aligned with positioning infrastructure and services.
- Enable time-based correction plate and deformation models.
- Users contribute measurements to an automated system for exchange of geodetic data.
- Products and services are delivered through web based systems
- Datum (real time positioning) realised through digital communications and the Internet
- Support global trends in geospatial, location intelligence etc


Geodetic Reference System
GNSS Satellite Network
Global Processing Centres (IGS)
CORS Network
Network Processing
Geodetic Reference Station
RTK
Electronic Positioning
Observations
Geodetic Mark
Remote
Geodetic Mark
On-Mark
Passive Positioning
Physical Components
Observation and Marks Archive
Raw Data
Geodetic Data Analysis
Data processing
Datum Adjustment
Geodetic Database
Processed geodetic data (coordinates), marks and metadata
Processed coordinates of Physical Components
Data
Users:
Surveyors
Engineers
GIS
Recreation users
Publish
Datum Realisation
ITRS
International and National Standards

Why do we need to modernise?

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The NT GRS in the future will no longer be

“ fit for purpose ”

(for various reasons)

Drivers for Modernisation

1. NT GRS (GDA 94) not accurate enough to meet future users need ! (that is, for scientific to ubiquitous positioning - therefore improve GDA94 to be “mm” accurate)

2. NT GRS (datum) definition is not aligned with GNSS (GPS, Galileo, Compass etc); and regional / global reference frames (plate tectonics and local deformation, take advantage of modernised multi GNSS environment)

3. NT GRS (datum) will not be “aligned” with future positioning or location based service providers (…GNSS / Ubiquitous Real Time “centimetre accurate” positioning and location based services will be relative to a regional (APREF) or global reference frame (ITRF) – and so will big data providers)

To improve GDA94 and enhance it’s mathematical relationship with ITRF
AND
To facilitate the pursuit of more accurate positioning for “users”

We are located on a dynamic continent on a continually deforming planet !
THUS
We need to better understand this movement through measurement, modelling and monitoring

How to modernise the NT GRS

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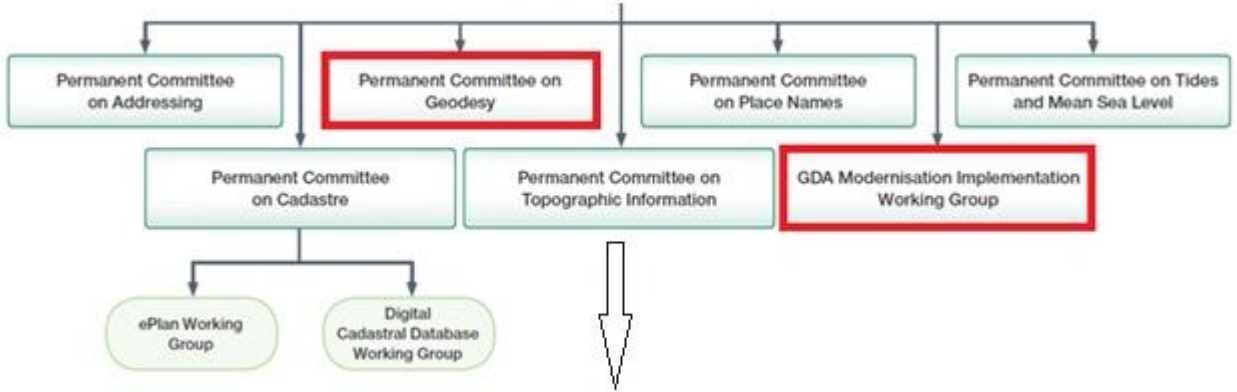
Organisational Structure

ANZLIC

ICSM
INTERGOVERNMENTAL COMMITTEE ON SURVEYING & MAPPING

AuScope



membership

Jurisdictional Representation

Develop -
polices / arrangements / procurement / finances / data agreements / legal / advocacy / communication plans etc

Implement technical aspects,
Establish standards / practices / guidelines

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www

The Operational Plan – 13 Steps

	Activity or Task	Type	Work time
1.	Complete the rollout of geodetic quality permanent GNSS CORS (i.e. AuScope stations) across the Territory by 2012/13	Operational	18 months
2.	Perform new high accuracy GNSS observations between GNSS CORS and the 110 TGN GPS stations that were occupied from previous GDA 94 campaigns	Operational	18 months
3.	Consider re-processing of critical or salient GDA 94 TGN GPS campaign data / baselines with present day algorithms, models, techniques and ITRF based orbits.	Operational	3 months
4.	Convert existing geodetic least squares adjustment data files from a "Newgan" application format to a "DynaNet" format and engine platform. It includes work such as the cleansing, combining, validating and then building the observational datasets; designing and implementing business rules to manage such data.	Operational	9 months
5.	Readjustment of the entire Territory geodetic network and subsequent survey control networks.	Operational	6 months
6.	Propagate the positional uncertainties for geodetic control.	Operational	3 months
7.	Integrate survey control positional uncertainty information into the Territory's geodetic survey control data base known as NTGESS.	Operational	6 months
8.	Adoption of the new ICSM PCG standards and best practices for datum control surveys, and the preparation of supporting Territory standards and best practices for datum control surveys.	Legal / Policy	6 months
9.	Support the implementation of *eGeodesy* as the geodetic data model and standard for the exchange of geodetic information, results and observations as espoused by Donnelly and Fraser (2010).	Institutional / Policy / Operational	On – going
10.	Consider and evaluate the creation of a vertical DynaNet data set for the Territory's bench mark network.	Operational	12 months
11.	Expand the recognised value standard position through the proliferation of "Regulation 13" certificates to eligible survey control marks, thus allow surveyors to achieve legal traceability of their GNSS measurements via position and comply with the National Measurement Act (NMA) 1960.	Legal / Policy / Operational	Ongoing
12.	Support and actively participate in ICSM endorsed initiatives that preserve and facilitate the development and maintenance of the Territory's geodetic datum.	Institutional	Ongoing
13.	Support and actively participation in national initiatives that promote positioning networks as enabling or critical infrastructure.	Institutional	Ongoing

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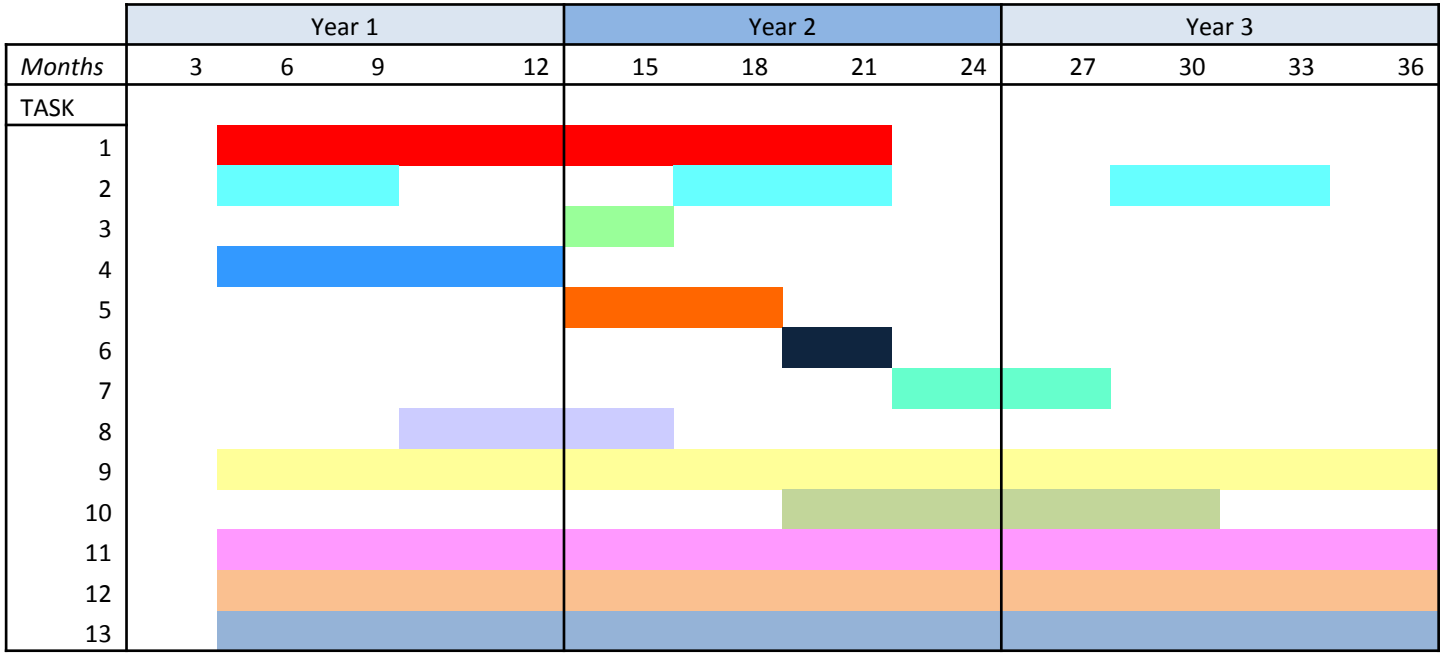
The Timeframe



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Geospatial / Geodetic Infrastructure

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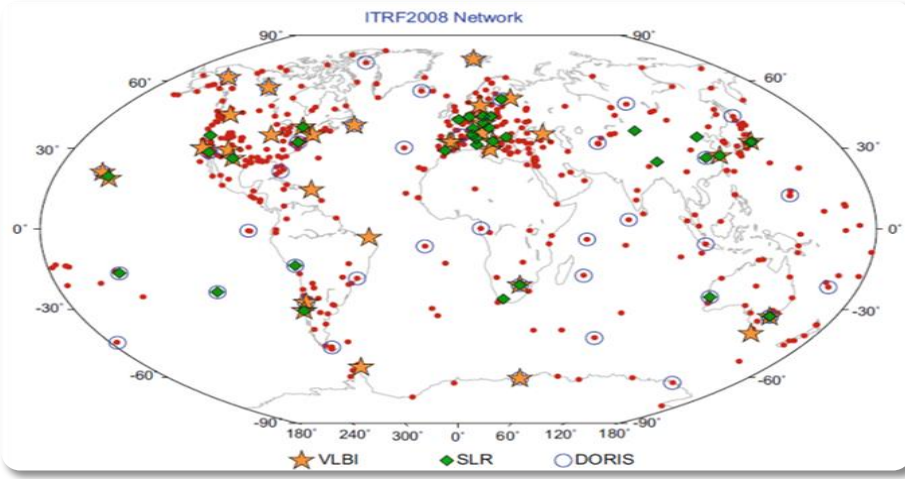
Supporting global positioning and datum realisation

AuScope's key geospatial infrastructure investment includes new and upgraded:

- Very Long Baseline Interferometry (VLBI) array
- Satellite Laser Ranging (SLR) facilities
- Global Navigation Satellite Systems (GNSS) ground stations and receivers, and
- Gravity measurement (GM) instruments.



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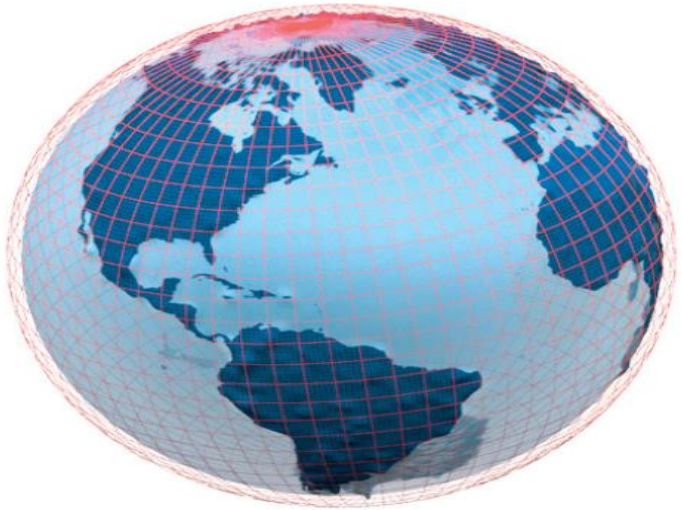
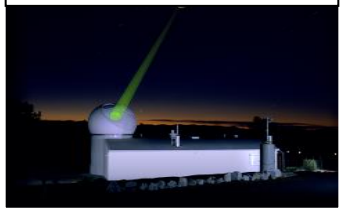
VLBI and Satellite Laser Ranging (SLR)

VLBI



SLR



VLBI Array

SLR

- VLBI: 140days/year
- VLBI: broadband receiver development
- SLR: two stations in the top 5 of ILRS network

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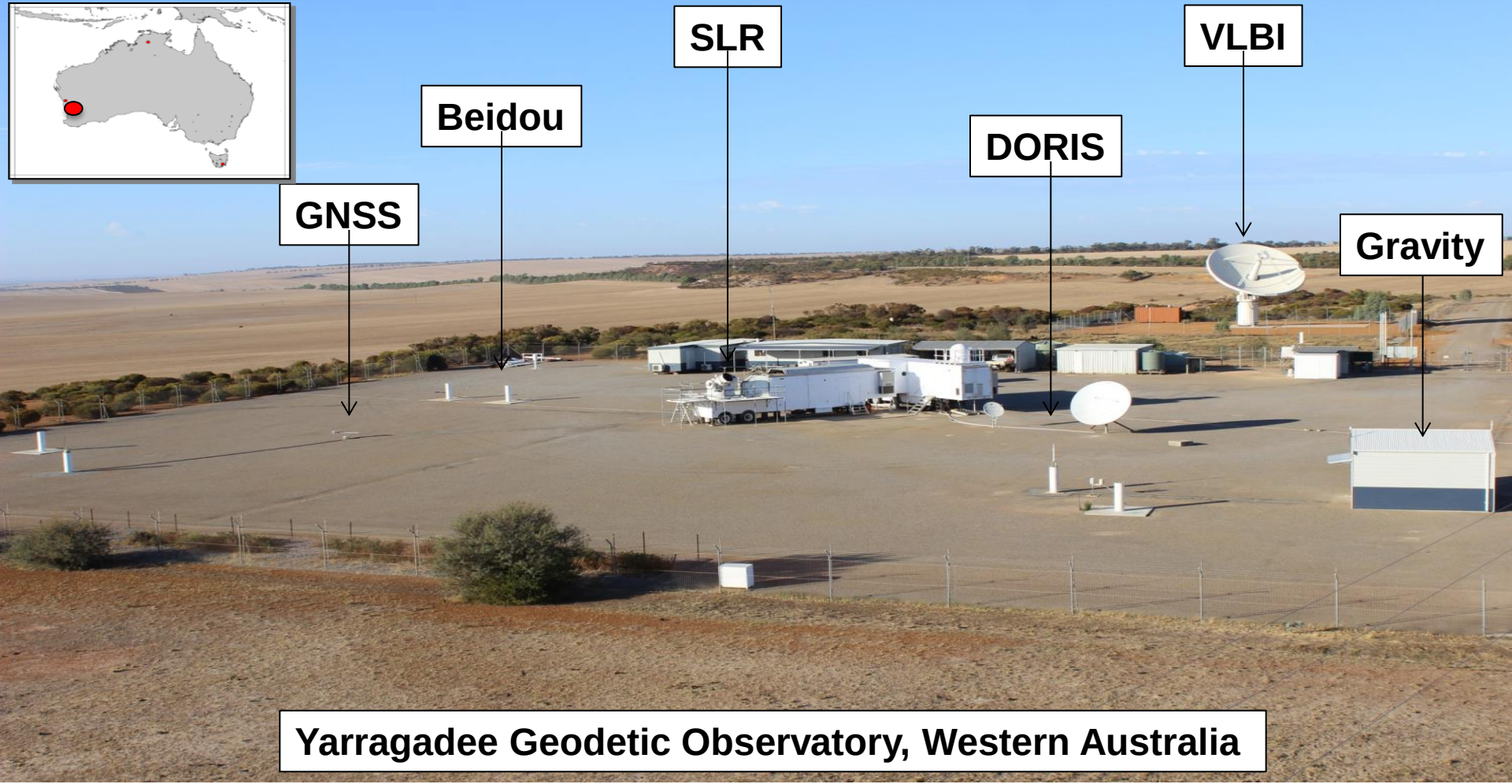
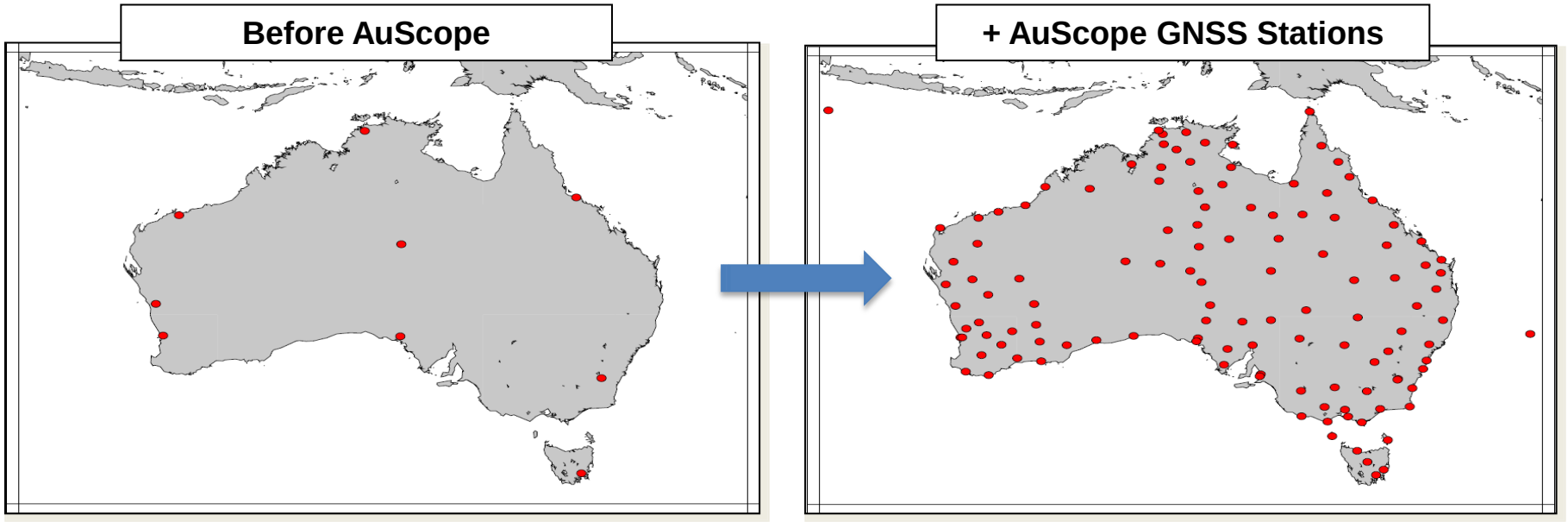


Yarragadee Geodetic Observatory, Western Australia

National GNSS Infrastructure



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GNSS Station

Permanent geodetic quality GNSS receivers and antennae, on geologically stable marks.

Monument

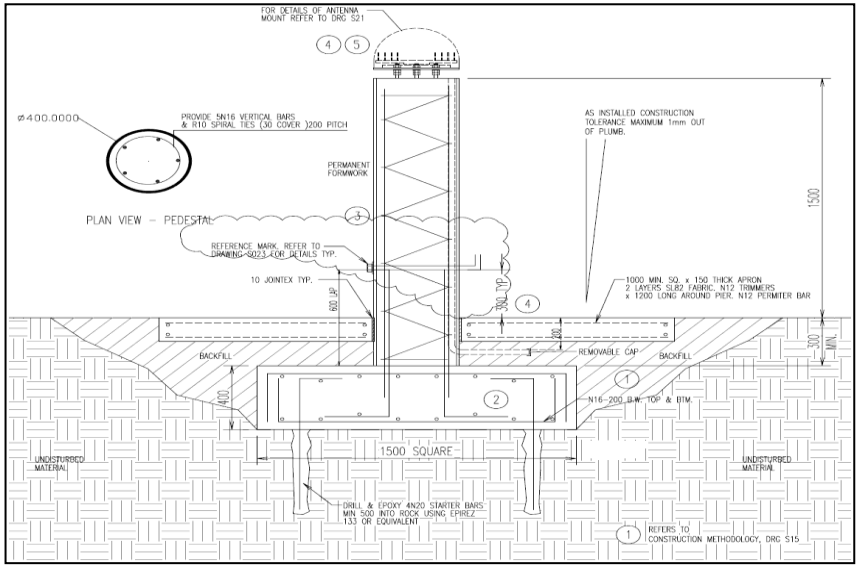
Antenna

Power

Receiver

Communication

National GNSS Network



http://www.icsm.gov.au/publications/sp1/Standard-for-Australian-Survey-Control-Network_v2.1.pdf

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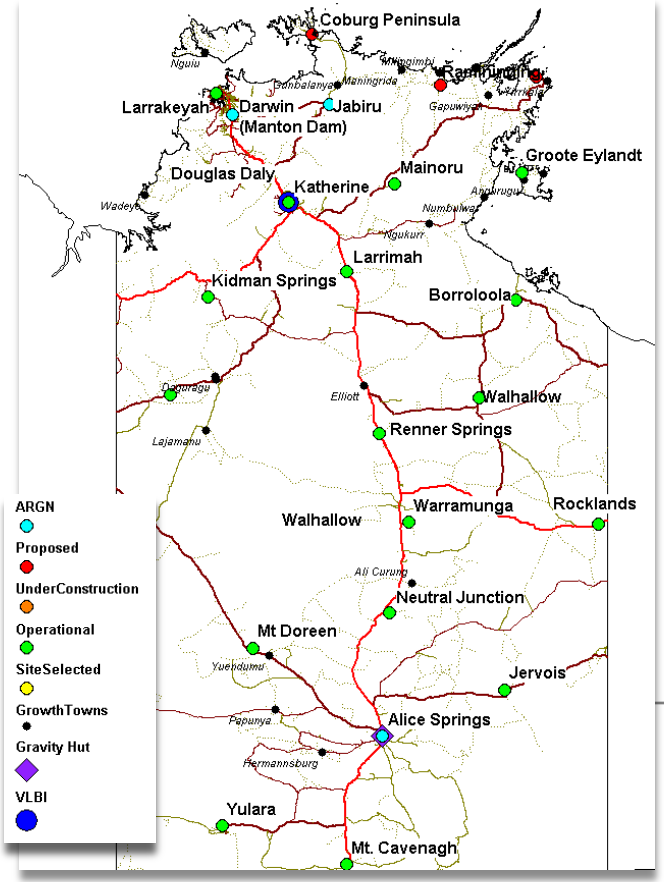
The NT GNSS CORS Network



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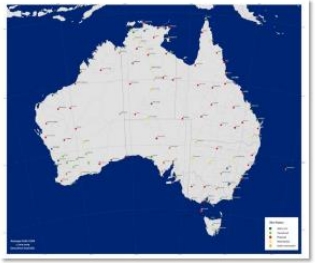
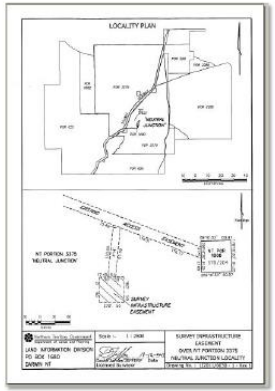
PROJECT MANAGEMENT PROCESS FOR THE CORS ROLLOUT

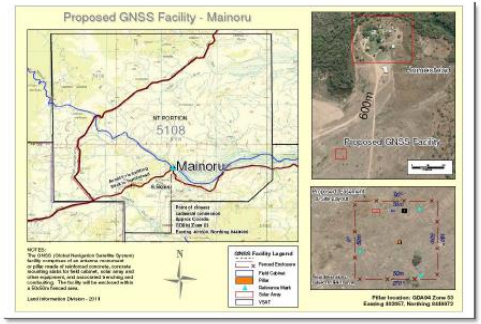




Network Design | Sourcing Funding | Reconnaissance | Approval in Principal | Land Acquisition | Clearances | Native Title Considerations | Finalising Site | Procurement of materials and equipment | Development of tender documentation | Release tender; assess; award of contract | Construction | Installation and Commissioning | Ongoing monitoring and maintenance

Northern Territory Government

AuScope

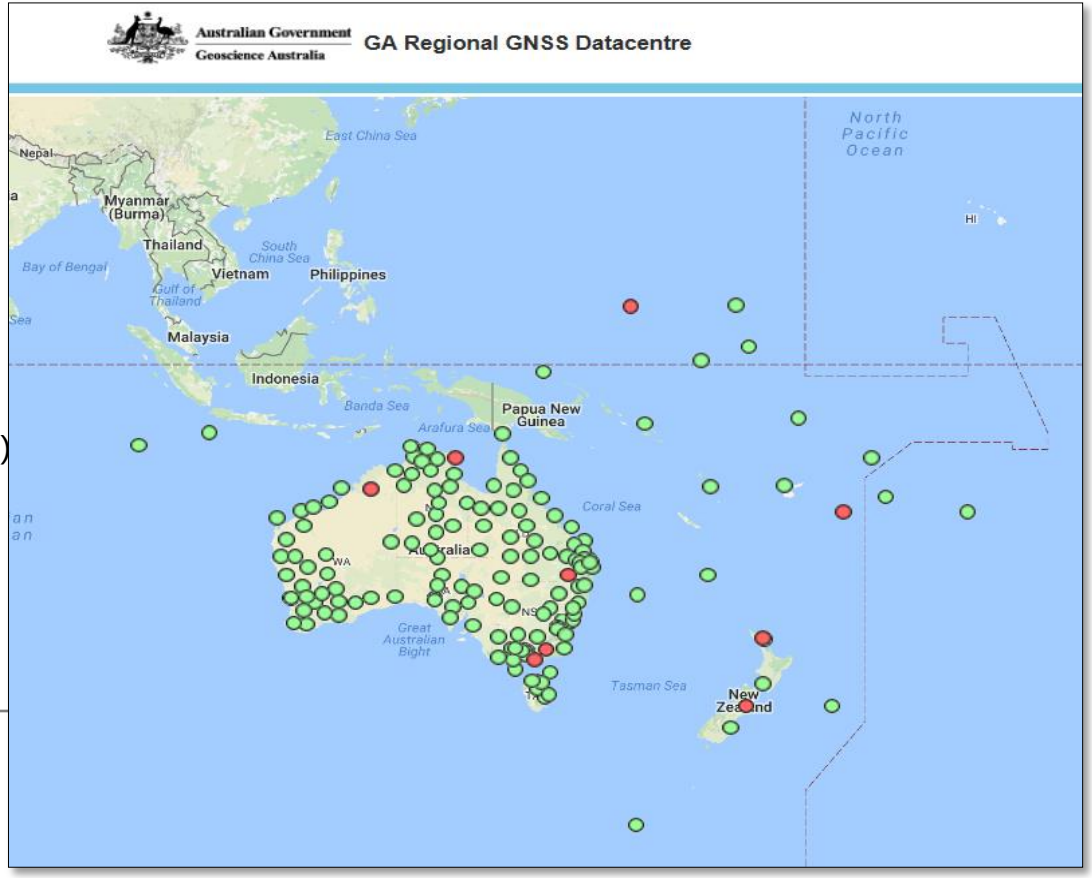


GeoScience Australia – the regional data centre

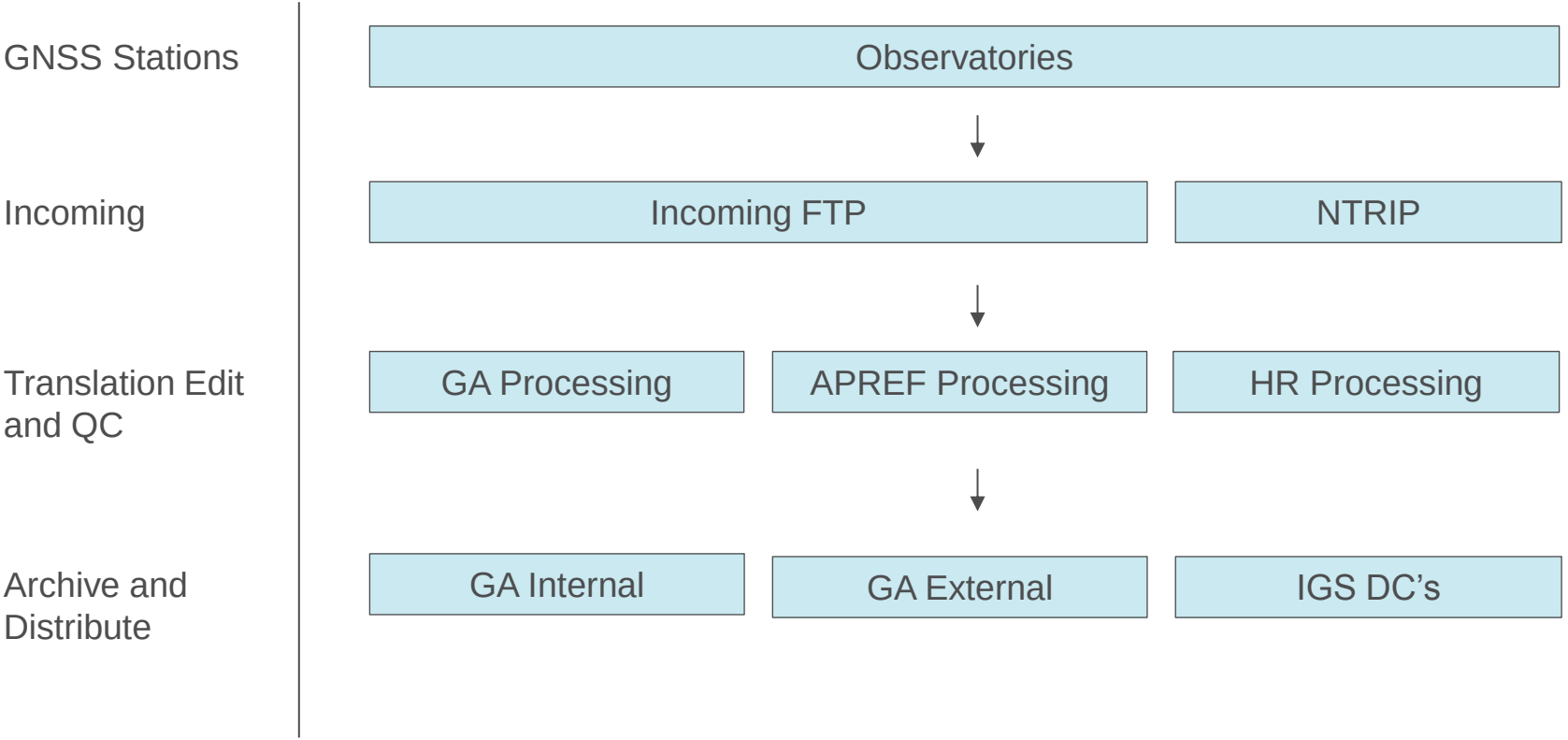
GeoScience Australia is the regional data centre responsible for managing, storing, analysing and archiving data and site logs, coordinates and maps from the co-operative network of Continuously Operating Reference Stations across the Australian region and the South Pacific.

GA also provides real-time GNSS data streams (AusCORS) and online processing facilities (AusPOS)

The NTG recognise that our 'role' is in supporting the ongoing densification, maintenance and operation of the infrastructure and to build capacity within our jurisdiction to assist in meeting national and regional objectives



High Level Workflow



Data Products and Accessibility

Product	Obs. Rate	Availability	Latency	Archived	Format
Daily	30 sec	24 hours	+ 2 hours	Permanently	RINEX2/3
Hourly	30 sec	1 hour	+ 5 minutes	7 Days	RINEX2
High-rate	1 sec	15 minute	+ 2 minutes	Permanently	RINEX2
Real-time	1 hz	continuous	+ 2 secs	-	RTCM3

Public Data Archive
ftp://ftp.ga.gov.au/geodesy-outgoing/gnss/

Asia Pacific Reference Frame (APREF)

- Data from 28 countries
- 16 national agencies participating
- Approximately 420 Asia Pacific stations
- Approximately 600 stations routinely analysed
- Four independent analysis centres
  - **Geoscience Australia**
  - Curtin University
  - Department of Sustainability and
  - Environment

  in Victoria, Australia
  - Institute of Geodesy and Geophysics, Chinese Academy of Sciences

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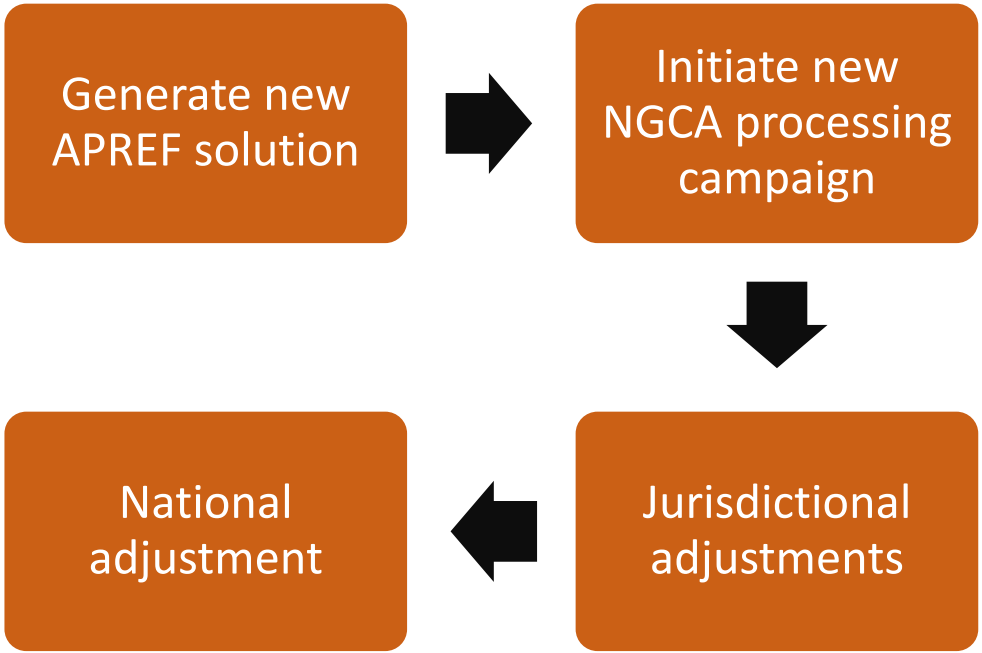

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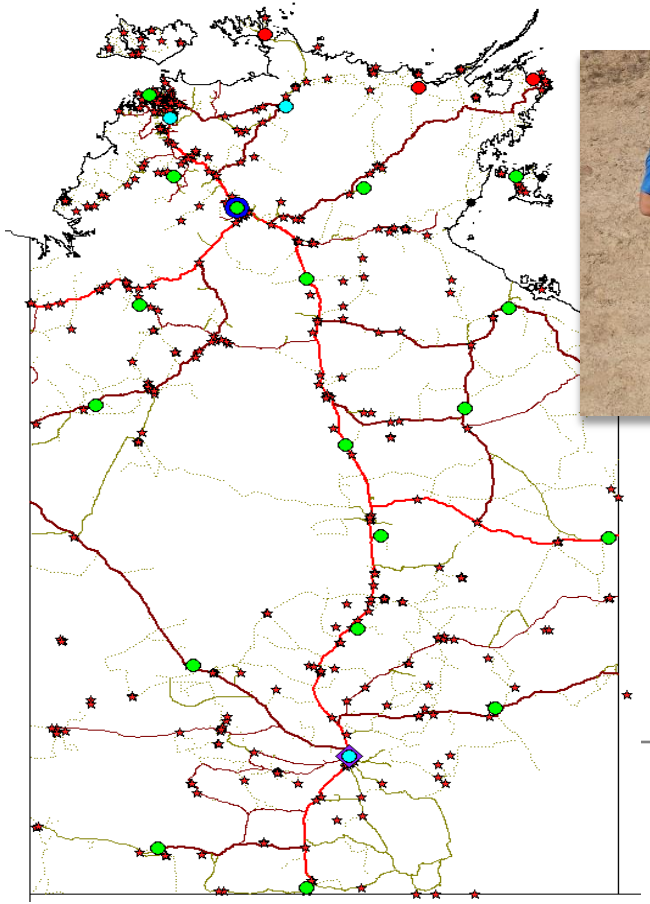
NGCA – National Geodetic Campaign Archive



- Ongoing contribution to the archives since March 2015
- Currently 744 static GNSS observations of duration > 6hrs (from 2000 – 2016)
- 600 + unique stations
- To be continuously supplemented with additional observations
- 95% of the TGN marks observed for GDA94 realisation have been re-observed during two concentrated campaigns in August 2015 and July 2016
- Client supplied data verified and included

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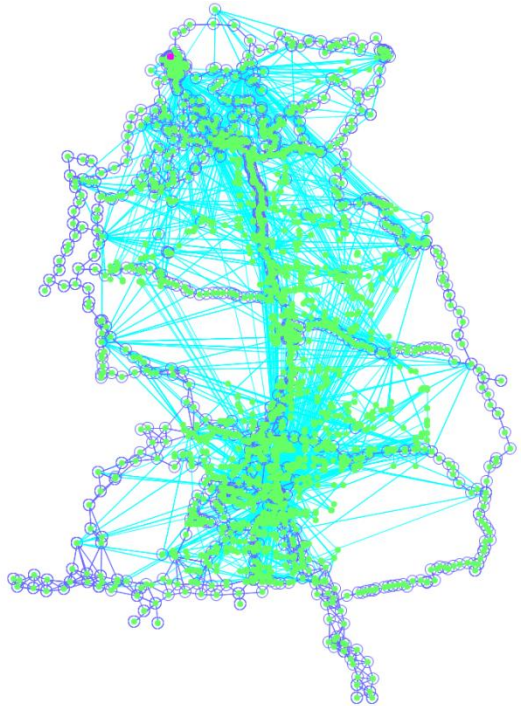
Jurisdictional Data Archive - JDA

- Creating a Jurisdictional Data Archive
  - Processing of >100 outstanding external consultant networks
  - Reprocessing existing observations and networks
  - Translation of existing datasets
  - Piecing together larger datasets (ZED and DNA)

- GNSS
  - GNSS in-fill to link disparate/isolated networks
  - GNSS coordination of “Lodged” ground marks
  - Collaborative Coordination program, supporting Industry in coordination activities
  - 6 hour GNSS observation on high quality AHD marks to fill in gaps in the NGCA network and supplement AusGeoid



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Jurisdictional Adjustments - JADJ

- JADJ includes the following data:
  - APREF solution
  - Jurisdictional data archive (JDA)
  - NGCA baselines
  - Seismic Zone Survey

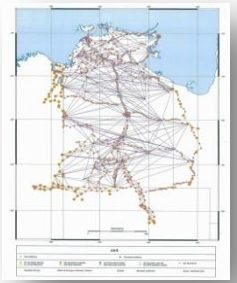
National Adjustment (NADJ)

- NADJ consists of
  - Adjusted coordinates from the previous adjustment
  - APREF solution
  - Results of JADJ
- combined mega adjustment comprises of 1.8 million observations and 235000 points
- first continental scale geodetic adjustment of this size
- GDA2020 version 1.0 finalised by end-October 2016

National GNSS CORS Solution

National GNSS Campaign Solution

Jurisdictional Adjustments



National Adjustment of Australian Terrestrial Reference Frame (ATRF)

Fully rigorous geometric adjustment

→ aspire for an all station and observations adjustment (down to the street corner)

→ phased adjustment strategy

→ work flows managed automatically (using e-Geodesy technology)

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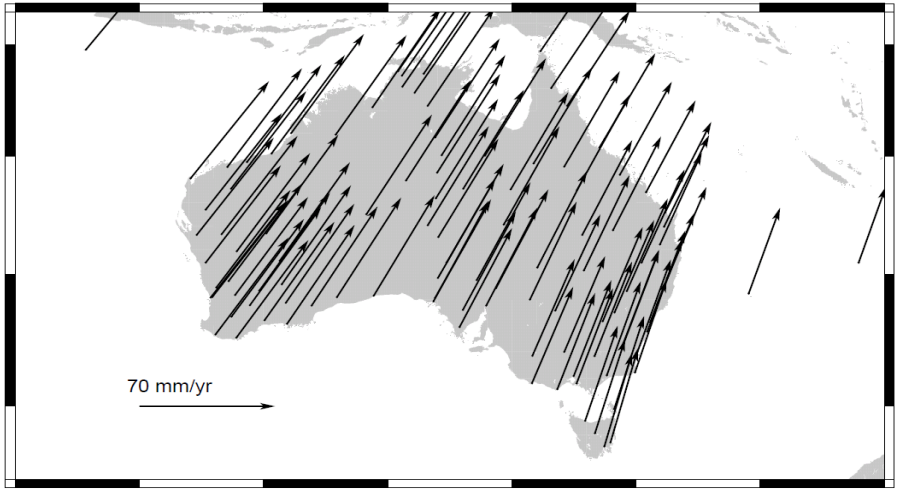
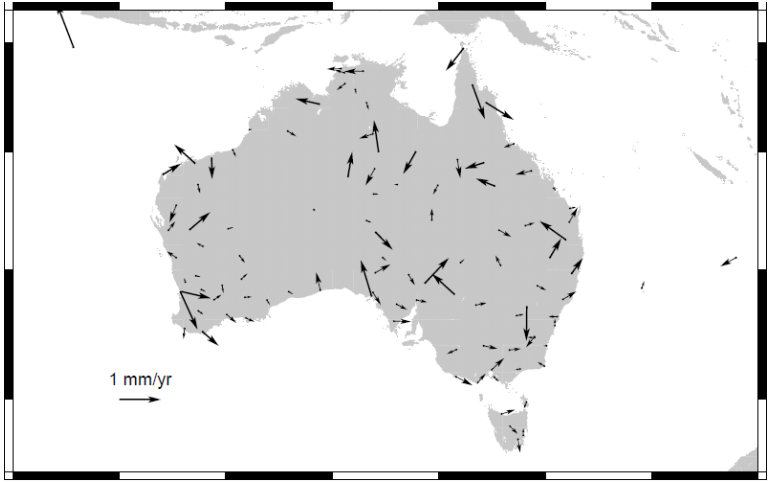
Develop time based correction, plate tectonic and deformation models.



Crustal Motion



Residual Crustal Deformation

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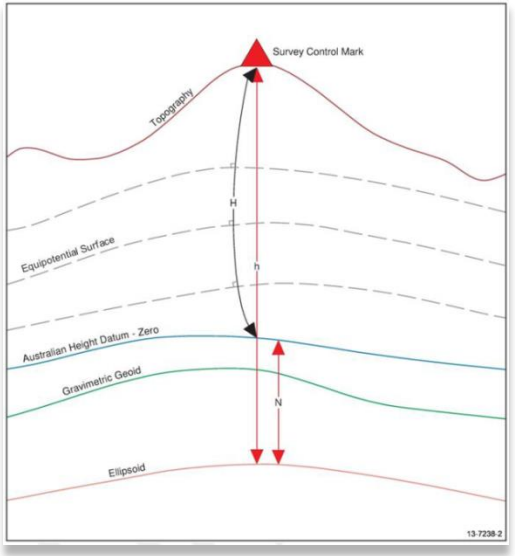
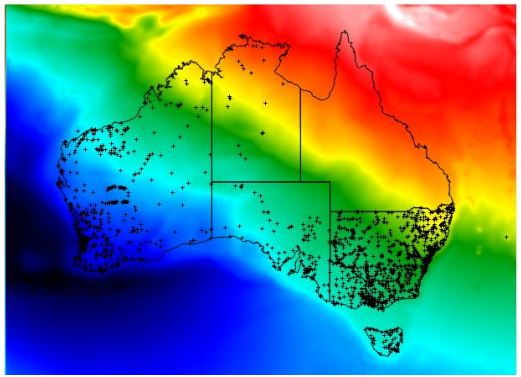
AusGeoid2020

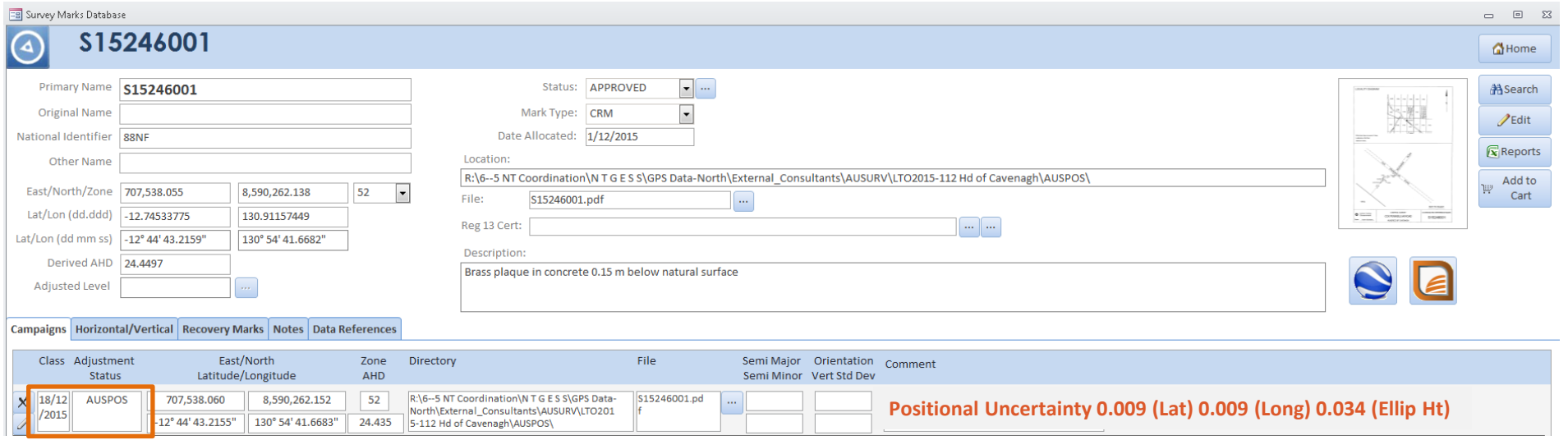
- Height information from GNSS is referenced to the ellipsoid
- To convert between the ellipsoid and a commonly used surface such as an approximation of sea level (MSL), a geoid model is often used.
- AUSGeoid2020 has been developed to convert GDA2020 ellipsoidal heights to AHD heights; it will also provide an uncertainty value.
- Aim to improve AUSGeoid contribution to support reliable AHD heighting using GNSS – make observations on benchmarks which have been orthometrically levelled.





AUSGeoid2020_Betav0.2 - GeoScience Australia

Local data management



How do we *manage* data?

- Databases for storing/archiving observations, resultant coordinates; metadata and attribute information, including epoch and positional uncertainty
- Transfer of data within and outside of our Organisation? **Apply standards**

Summary of OUR activities

- Establishment of infrastructure to support the maintenance of the ITRF
- Contribution of data to a regional reference frame realisation
- Enhancement of National geodetic adjustment
- Realisation of uncertainty with respect to datum

Ongoing . . .

Achieved through

- National collaboration, national approach - technical/financial/administrative commitment
- Efforts over a 10-year + period
- Consistent approach, supported by standards and guidelines

Actions and Challenges in the future?

- **Implementation and adoption of the new datum, GDA2020**
- Infrastructure and system maintenance, refinement and upgrade
- Maintaining relevancy within our Organisation – to receive support in terms of funding, committed FTE, resourcing, inclusion in strategic planning
- Supporting national objectives - *National Positioning Infrastructure (NPI)*
- *…. Among others*

Thankyou.

Amy Peterson *amy.peterson@nt.gov.au*
Rob Sarib *robert.sarib@nt.gov.au*

Survey Services – Land Information Division
Department of Infrastructure, Planning and Logistics

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