Australian Government
Geoscience Australia

POSITIONING AUSTRALIA

or what we are doing to improve our GNSS infrastructure

Developing a highly-available GNSS reference station network

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virtual presenter
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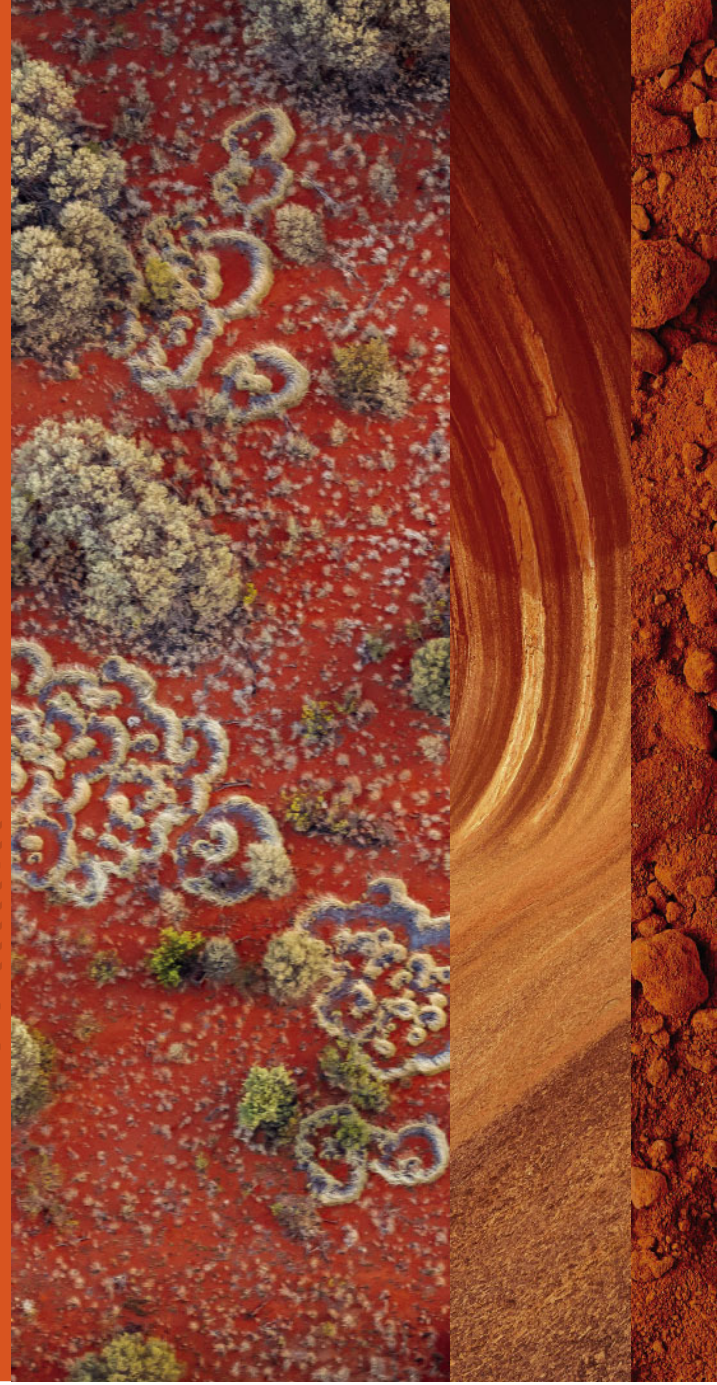
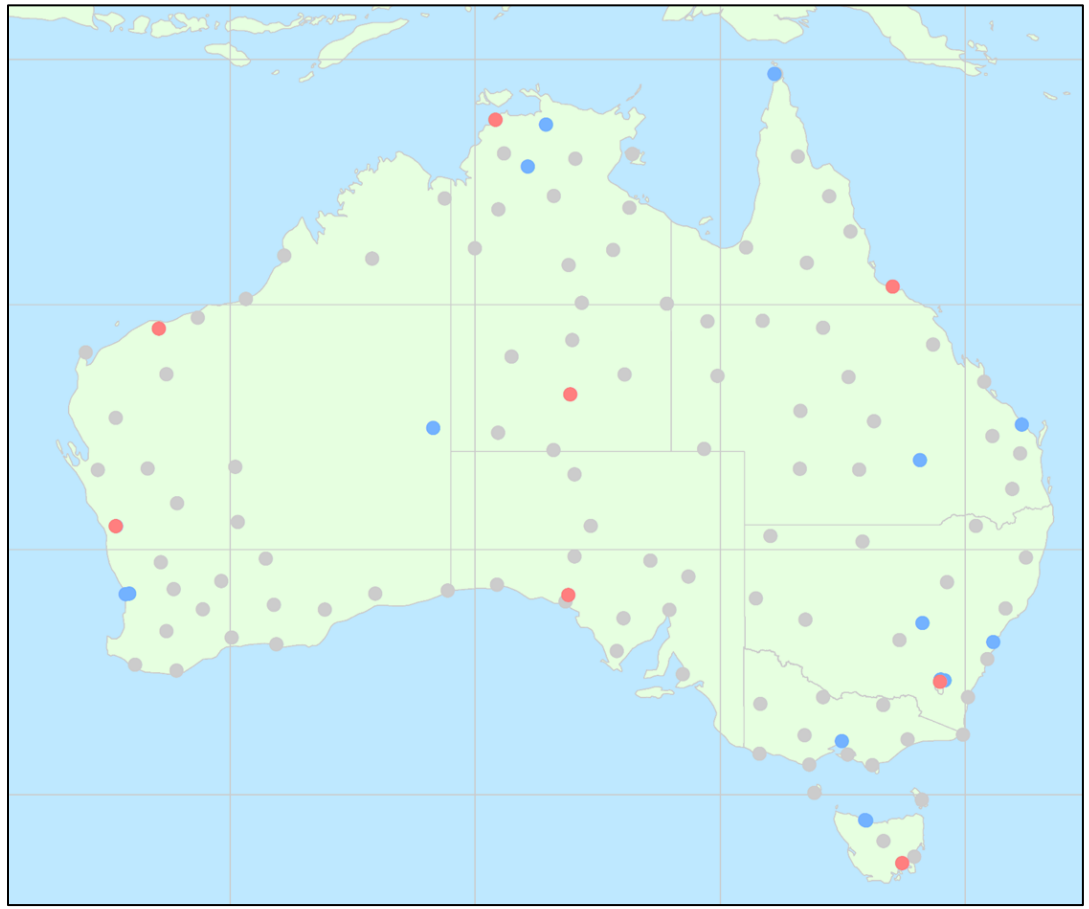


this presentation discusses how we have done it

There are many ways to build a GNSS reference station.

GNSS Network (before 2019)



Talking Points:

- GA has operated a network of GNSS reference stations since the early 90's. This network was designed to support our national datum, the ITRF and a myriad of scientific applications.
- Recently, our network has also been supporting Australian businesses through the delivery of positioning information in real-time.
- Through the Positioning Australia program we are rethinking how we build, operate and maintain our GNSS infrastructure to ensure accurate and reliable positioning information is available to all of our users.
- This presentation discusses the concept of a highly-available GNSS reference station and what we have improved in our station design to ensure an increased level of resilience.

Concept

What is a highly-available network?

The data when delivered to the user needs to be:

- correct (**accurate**).
- of good quality such that it can be trusted (**reliable**).

The infrastructure needs to be:

- of good quality and well-architected (**reliable**).
- be able to withstand or recover from damaging conditions (**resilient**).

We workshopped these concepts (and are continuously refining them)

Concept

official coordinate (traceability?)

What is a highly-available network?

who are our users and what are their requirements?

availability
latency
observables
quality
station spacing
coverage
...

The data when delivered to the user needs to be:

> correct (**accurate**).
> of good quality such that it can be trusted (**reliable**).

The infrastructure needs to be:

station uptimes
service uptimes
state of health
secure land tenure !!!!

> of good quality and well-architected (**reliable**).
> be able to withstand or recover from damaging conditions (**resilient**).

security
points of failure
coverage
time to recover (Australia is a big place!)

Specifications

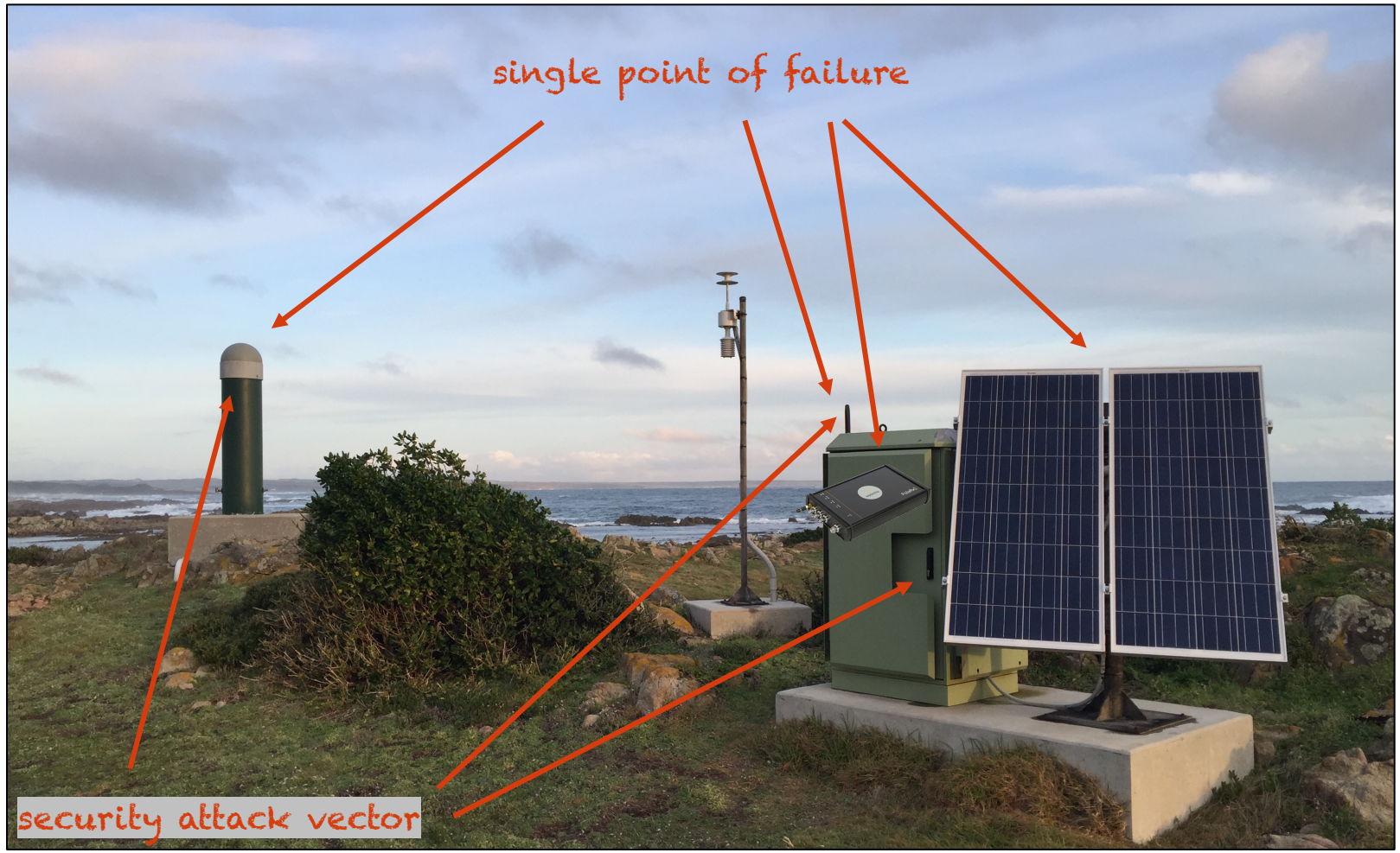
download them using this link

[Specifications for Positioning Australia GNSS Reference Stations]

Talking Points:

- We combined those concepts with international and national GNSS reference station guidelines and developed a set of specifications for our network.
- These specifications break the network into tiers.
- Tier 1 stations are those that contribute to geodetic networks and international programs, such as GGOS.
- Tier 2 are built to the same specifications but focus on our national datum.
- Tier 3 stations form a denser network that delivers datum to our users through real-time positioning.
- Tier 4 are those stations that are used to further densify the network to improve atmospheric models or deliver real-time positioning information, but don't contribute to the reference frame.

Improving our existing design



Talking Points:

- With the new specifications our technical team set to work developing a new station design.
- This involved identifying areas for improvement.
- We undertook a security gap analysis (which included both physical and cybersecurity).
- We identified single points of failure across the network and undertook an analysis of what level of duplication or redundant equipment was required.
- For example, the antenna was identified as single point of failure, but we are overcoming this risk by establishing a denser network and increasing the number dedicated reference frame stations across the network with dual pillars to increase resilience at these fundamental stations.

Station Design

We decided upon three station design templates. These are based on the regions where the stations are to be installed.

estimated response time

Region	TTR	Telecom.	Power	Battery Bank
Remote	7 days	Satellite	Off-Grid	~1800 Ahr
Regional	5 days	Wireless	Off-Grid	~1200 Ahr
Metro	3 days	Wireless	Grid	~600 Ahr

Common features:

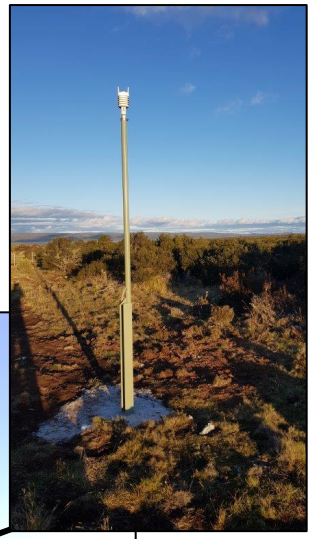
integrity monitoring

- dual receivers of different types (*site00aus and site01aus*).
- advanced state of health monitoring using AWS IoT tools.
- failover power system.
- secure protocols and paths for data transfer.

allows us to be more proactive in responding to issues

Regional Station Design

equipment cabinet



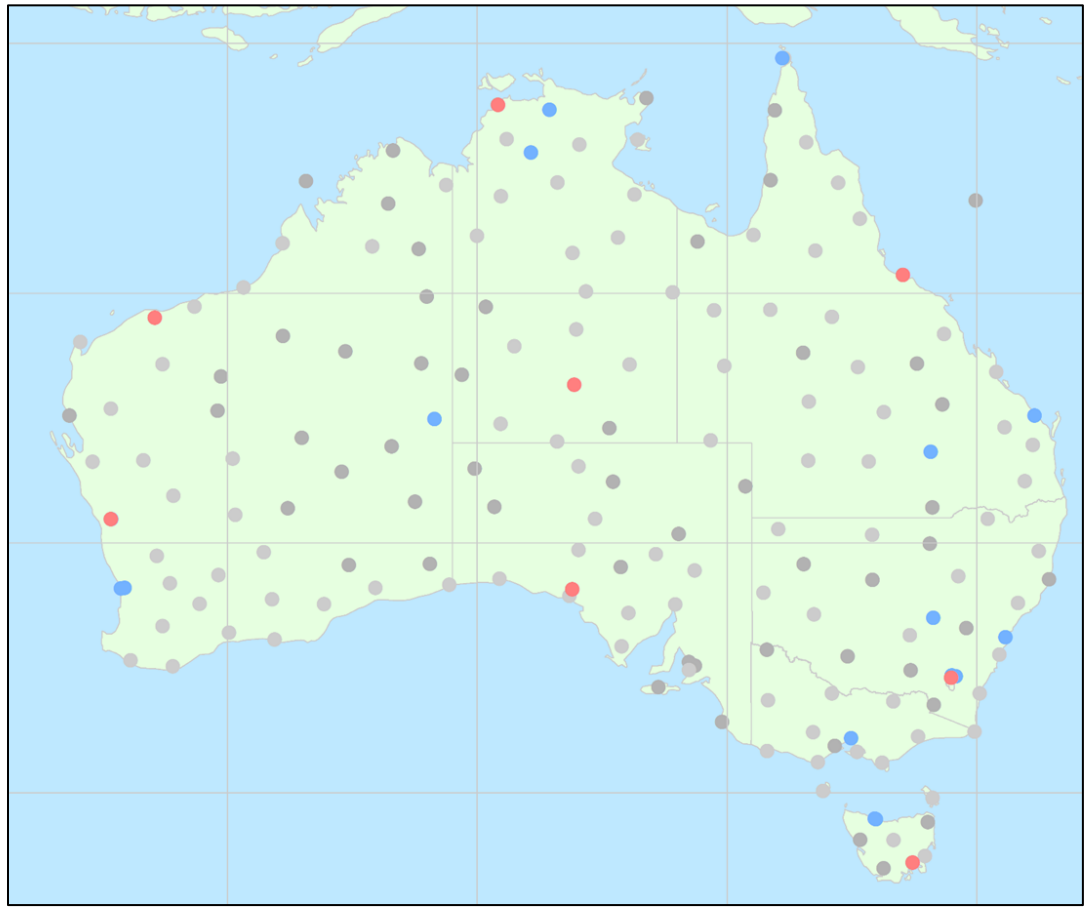
meteorological sensor on a 3m high pole recording temperature, pressure, humidity, rain and wind

Site ID: LIAWOOAUS

DM element choke-ring antenna on a 1.5m tall concreate pillar

GNSS Network (by 2022)

assuming travel restrictions are lifted



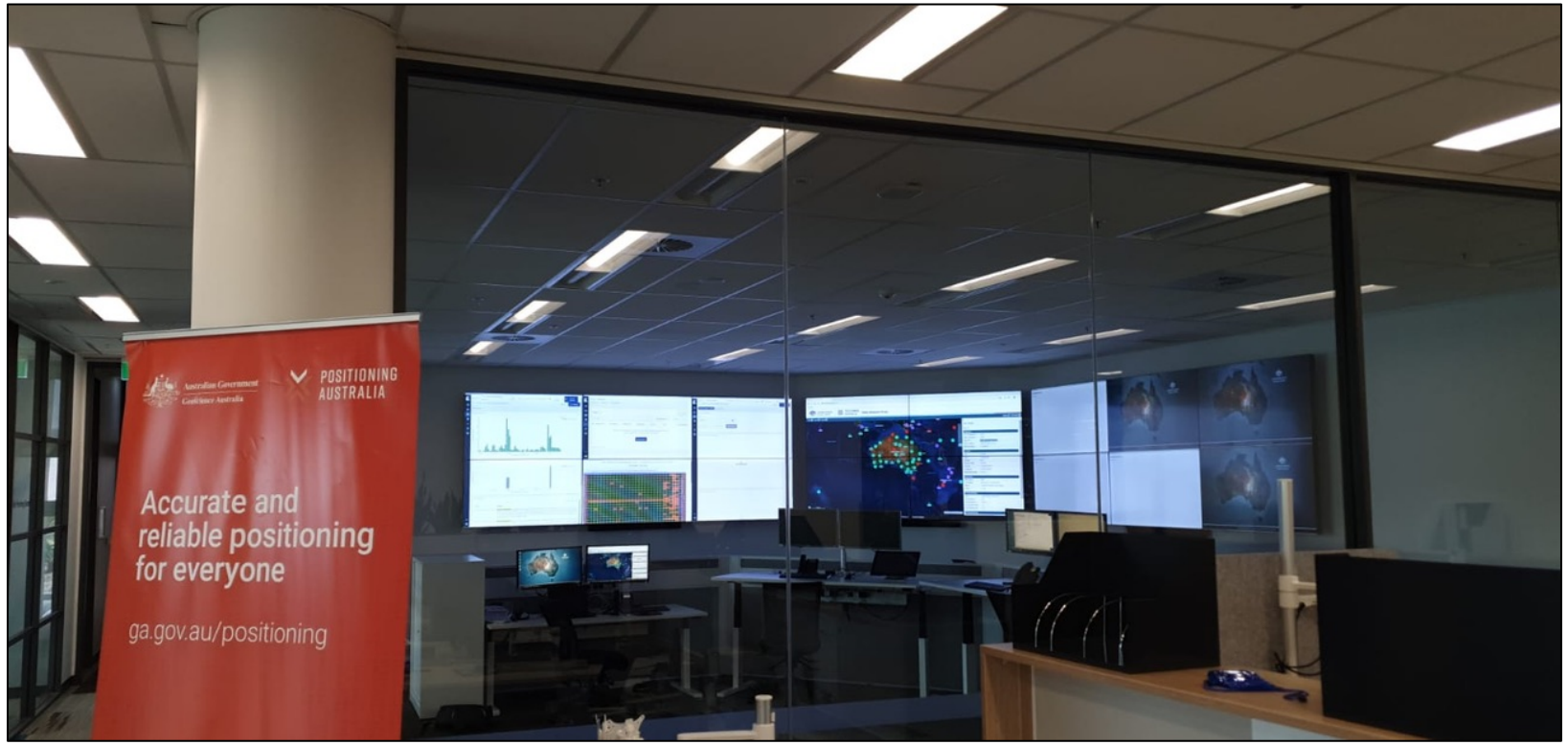
battery bank for remote build

metro build

Talking Points:

- The upgrade of existing stations began in January of this year. Before travel restrictions were imposed due to COVID-19 came into place we had upgraded 8 of the 130 existing stations and constructed 1 of 70 new stations.
- The intention is to have a 200 station highly-available GNSS network constructed by June 2022.
- To ensure the network remains highly-available we will continue to improve the design and regularly refresh the station equipment to ensure that the most modern positioning information is available.
- The integrity of the reference frame (or core) stations will be maintained through an increased number of co-located sites spread evenly across the country.
- To improve the coverage and performance of our real-time PPP solutions we are further densifying this network with another 500 public and privately owned stations across Australia.
- All data streams from this network will be **free** and **open** to all users.

Network Monitoring



#PositioningAustralia operations centre

Talking Points:

- The station design is only a small part of designing a highly-available GNSS network. The data streams and products need to be available and trusted by the users.
- While I don't have time to go into this today, we have spent a lot of time designing a highly-available architecture for our data repository and NTRIP broadcaster in the Cloud.
- This Cloud based data centre integrates with our reference stations through the state of health monitoring system and provides automated alerting of issues (such as a change in quality could indicate a decline in **reliability** or a change in coordinate which could indicate a decline in **accuracy**).
- **All deigns for the GNSS reference stations can be shared through a creative commons license and all Cloud systems are openly available**

take home message

Please leave questions in the comments section or contact me at:

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