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The Australian SBAS Program: Progress and Motivation for a PPP Service

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Australia's Positioning Program

Vision: an integrated national positioning capability to accelerate the adoption and development of location-based technology and applications in Australia

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Australia's Positioning Program

SBAS

NPIC

SBAS services
Open access PPP (10cm)

High reliability core network
Open access CORS data
Open source software

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SBAS and Australia

- **1997-2011**: SBAS development discussed in Australia by the aviation sector for over two decades. Investment case based solely on benefits to aviation considered weak.
- **2013-2016**: Geoscience Australia, the agency responsible for national PNT coordination, renewed advocacy for SBAS investment as a multi-industry capability
- **2016**: Australian Government funds 2-year test-bed
  - February 2017 to January 2019. Lockheed Martin, GMV, Inmarsat technology partners
  - New Zealand Government joins program
- **2018**: Australian federal budget allocates funding for SBAS development over the forward estimates (then ongoing).

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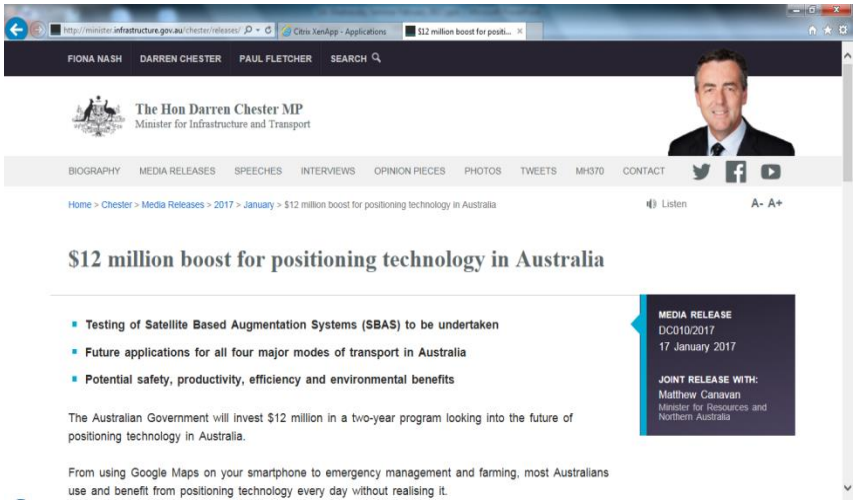
SBAS Test-bed



2-year SBAS test-bed completed February 2019

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crc•si

LOCKHEED MARTIN

Land Information New Zealand
Toitū te whenua

inmarsat

gmv
INNOVATING SOLUTIONS

27 projects across 10 sectors
(road, rail, maritime, aviation, utilities, resources, spatial, consumer, agriculture, construction)

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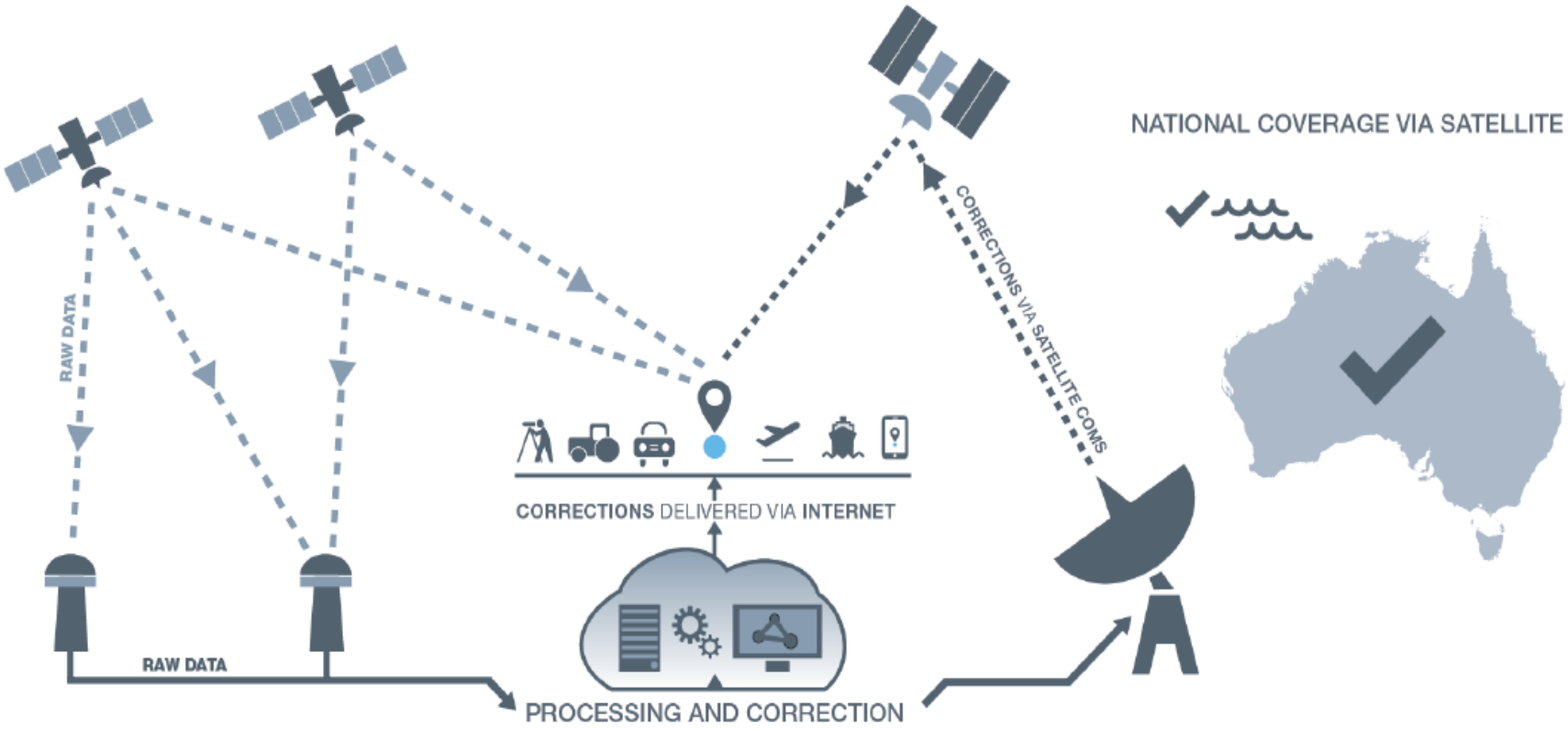
Satellite-Based Augmentation System (SBAS)



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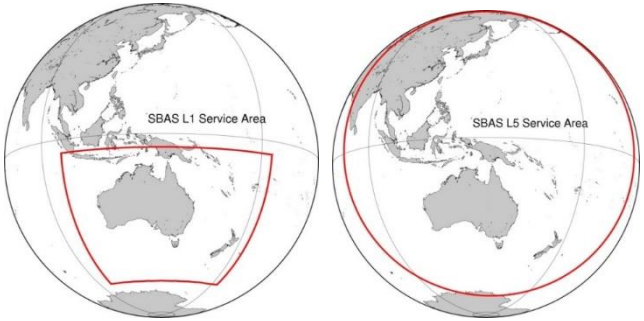
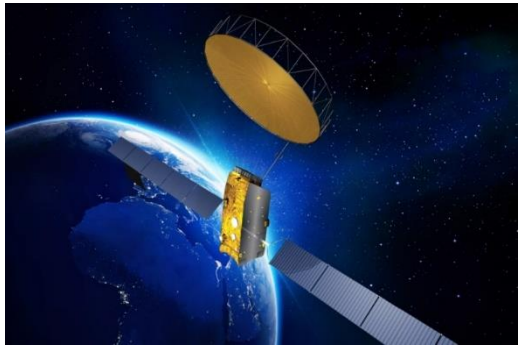
SBAS Test-bed Configuration





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Test-bed Capabilities

SBAS

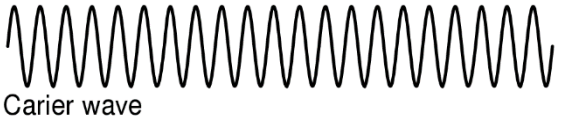
- L1 GPS only
- WAAS, EGNOS

DFMC SBAS

- L1/L5 GPS &
- E1/E5a Galileo

Precise Point Positioning (PPP)

- GPS Precise Satellite Clocks and Orbits
- GPS and Galileo Precise Satellite Clocks and Orbits
- 10 cm accuracy after convergence



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Ground Network

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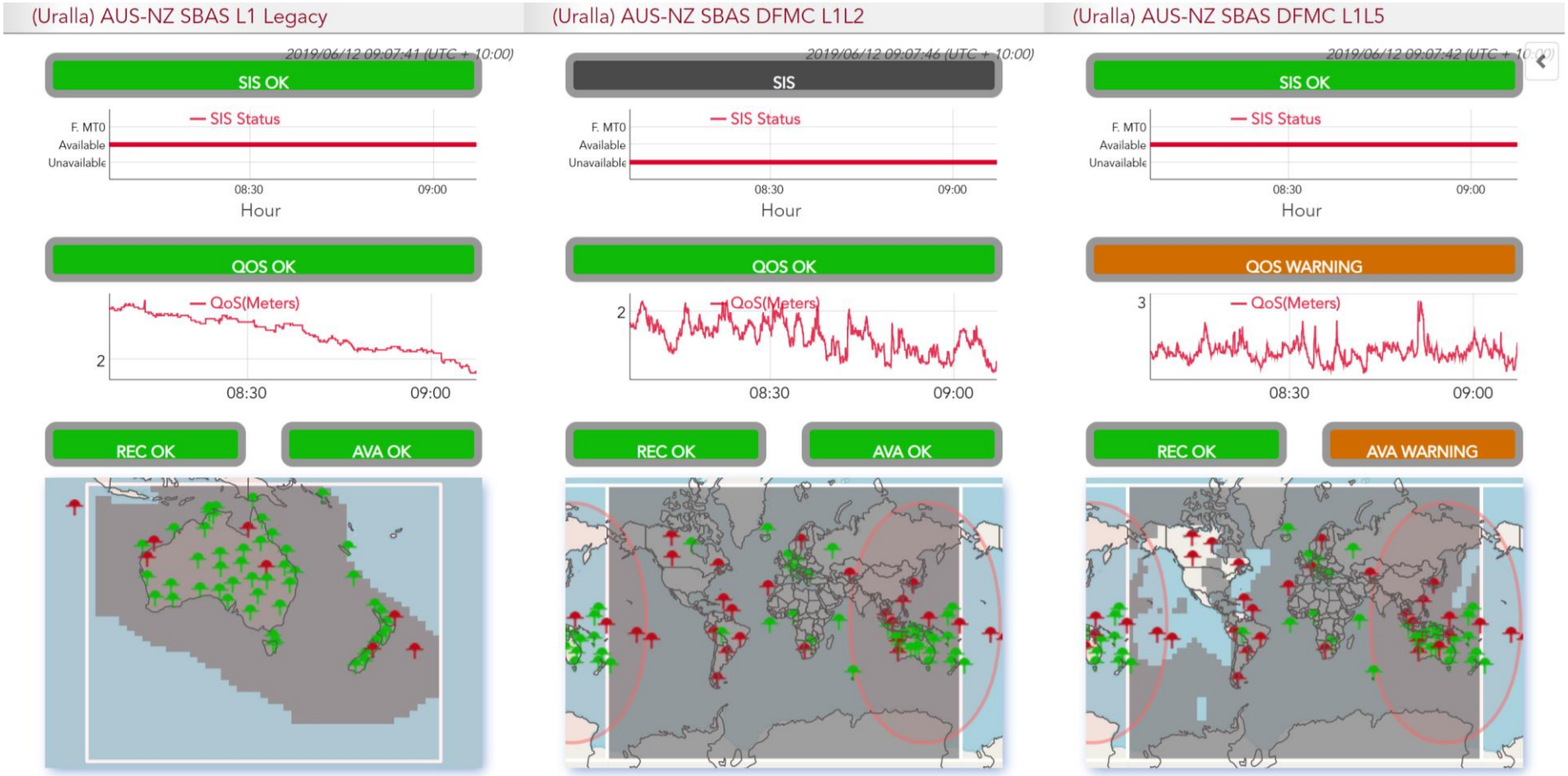
Test-Bed Services



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Economics Benefits Analysis

- Successful 2-year program exploring benefits of SBAS technology for Australia and NZ
- Public report to be available in coming weeks
- Strong case for investment
- Resources (mining), agriculture, construction sectors have major benefits

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Program Progress

- Staff recruitment (engineering, project management, internal legal, program promotion)
- Request for Information (in-space components)
  - → Complete
- Test-bed extension (31 July 2019)
- Request for Information (cybersecurity components)
  - → Complete
  - → Cybersecurity advisor appointed
  - → Program supported by national security agencies
- Legal and probity advisors appointed

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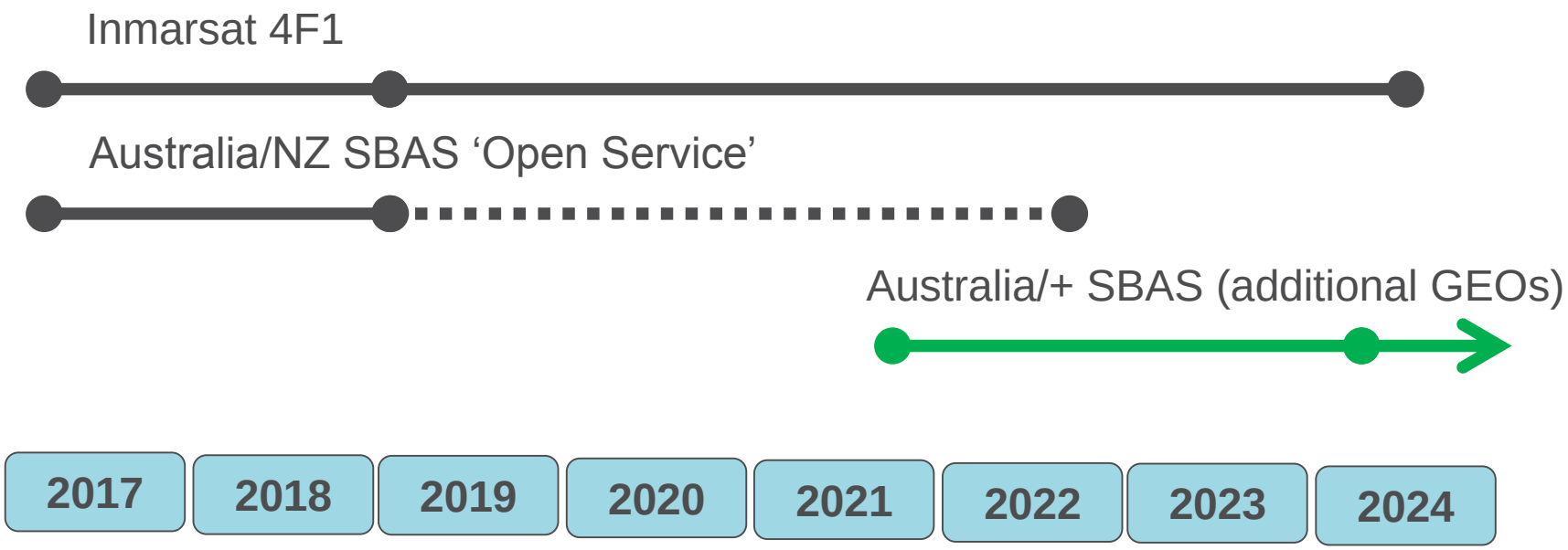
Program Schedule



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PPP Test-bed Service

- Reference Frame: ITRF2014 realised from APREF solution
- Time reference: hydrogen-maser infrastructure
  - Tidbinbilla (master), Katherine (backup), Yarragadee (additional backup), Hobart (inter-system bias)
- Corrections GMV proprietary format
- Only satellite clocks and orbits via satellite
- Clocks C1P2 reference (IGS P1P2)
- Orbits - transmitter reference (IGS centre of mass)
- L1 service – GPS-only PPP augmentation
- L5 service – GPS/Galileo PPP augmentation

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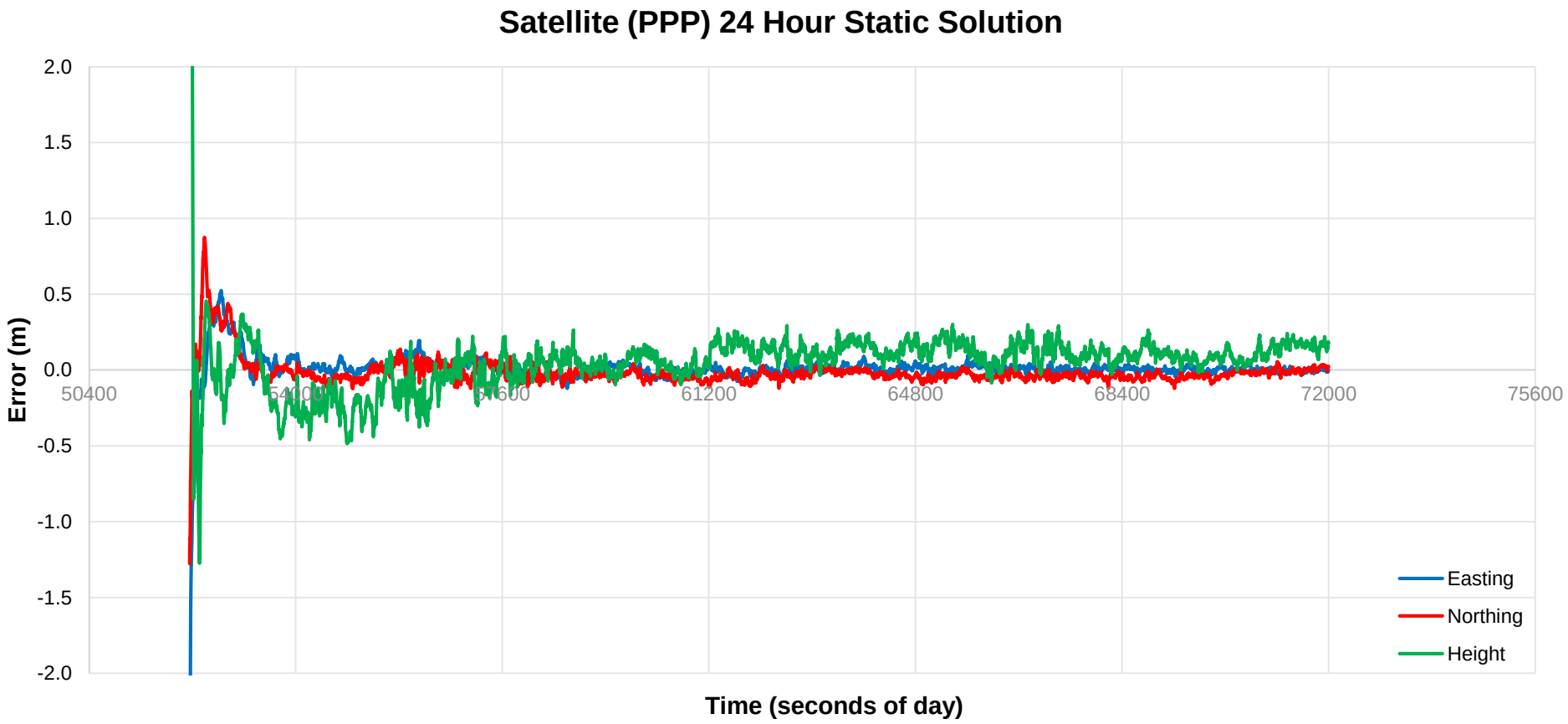
SBAS Test-bed Performance (PPP)



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Maritime Sector		
Signal	Expected horizontal performance at 95% CI (m)	Expected vertical performance at 95% CI (m)
SBAS L1	0.91	1.93
DFMC	1.38	3.77
PPP	0.10	0.22

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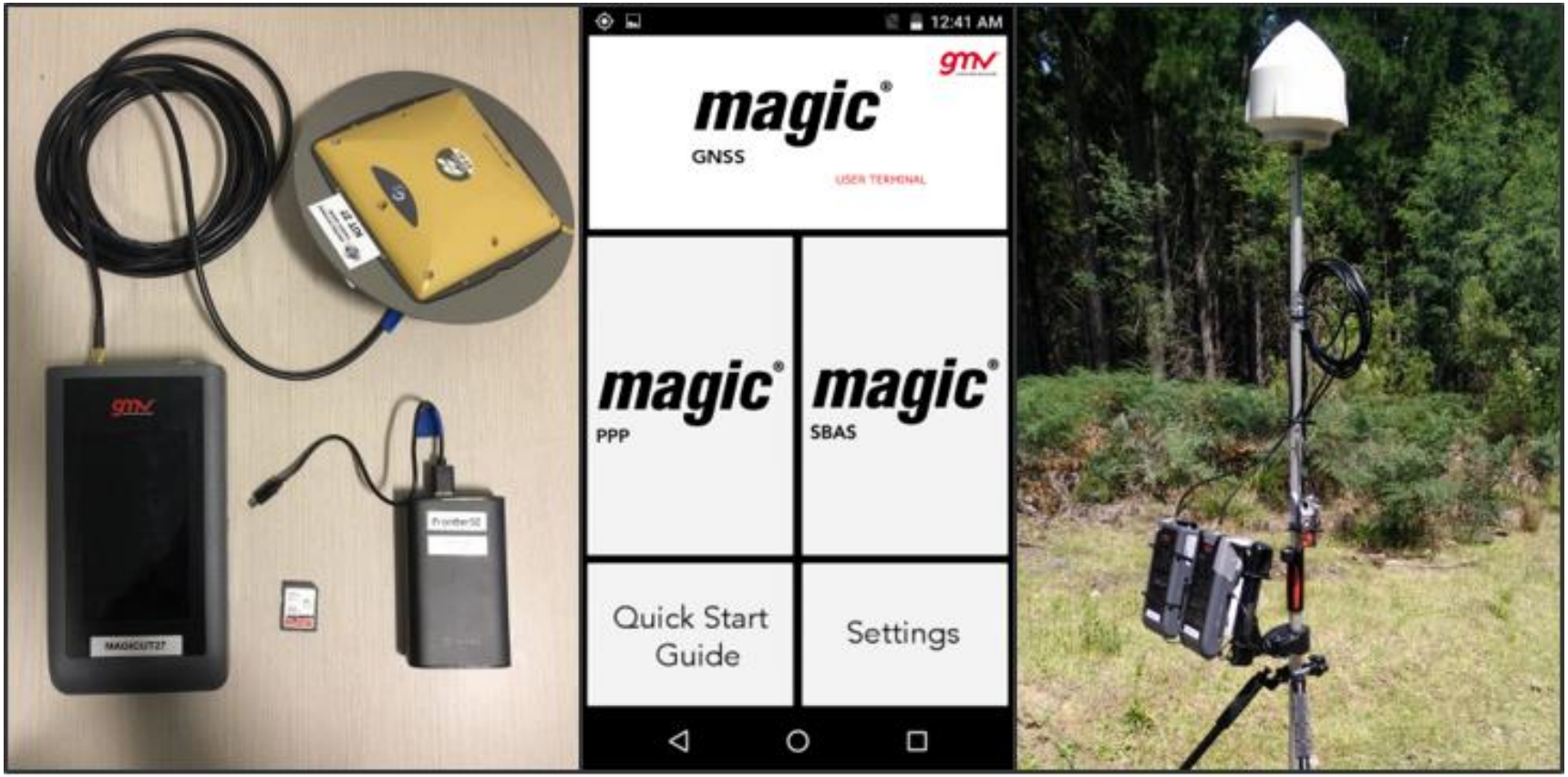
User Device Develop for Australian Test-Bed



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Virtual Fencing in Agriculture

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Drone Positioning

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Parcel Delivery

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Precision Agriculture

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SBAS IWG and PPP

- SBAS Interoperability Working Group is a collaborative forum for developing concepts of operations and promoting the use of SBAS for all applications
- Europe, Africa, and Australia have identified applications that will benefit from delivery of PPP services via satellite
- Constraints:
  - Existing GNSS services must not be adversely affected—particularly Safety-of-Life (aviation)
  - Approach should be standardised to increase uptake by industry
  - Needs to be supportable by system owners (WAAS, EGNOS, Africa-SBAS, Australian SBAS, etc.)
- Options include: channels (L1, L5, E5b, E6, L6), systems (EGNOS, GAL), services (float ambiguity, biases, delays), integrity
- Each option has its own challenges

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Final Comments

- Australia encouraging of PPP correction standardisation
- IWG appropriate forum to select an appropriate satellite broadcast channel
- ICG appropriate forum to define the message format
- Australia ultimately moving to open access PPP (maybe as part of next phase of SBAS program)

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