



IGNSS 2018

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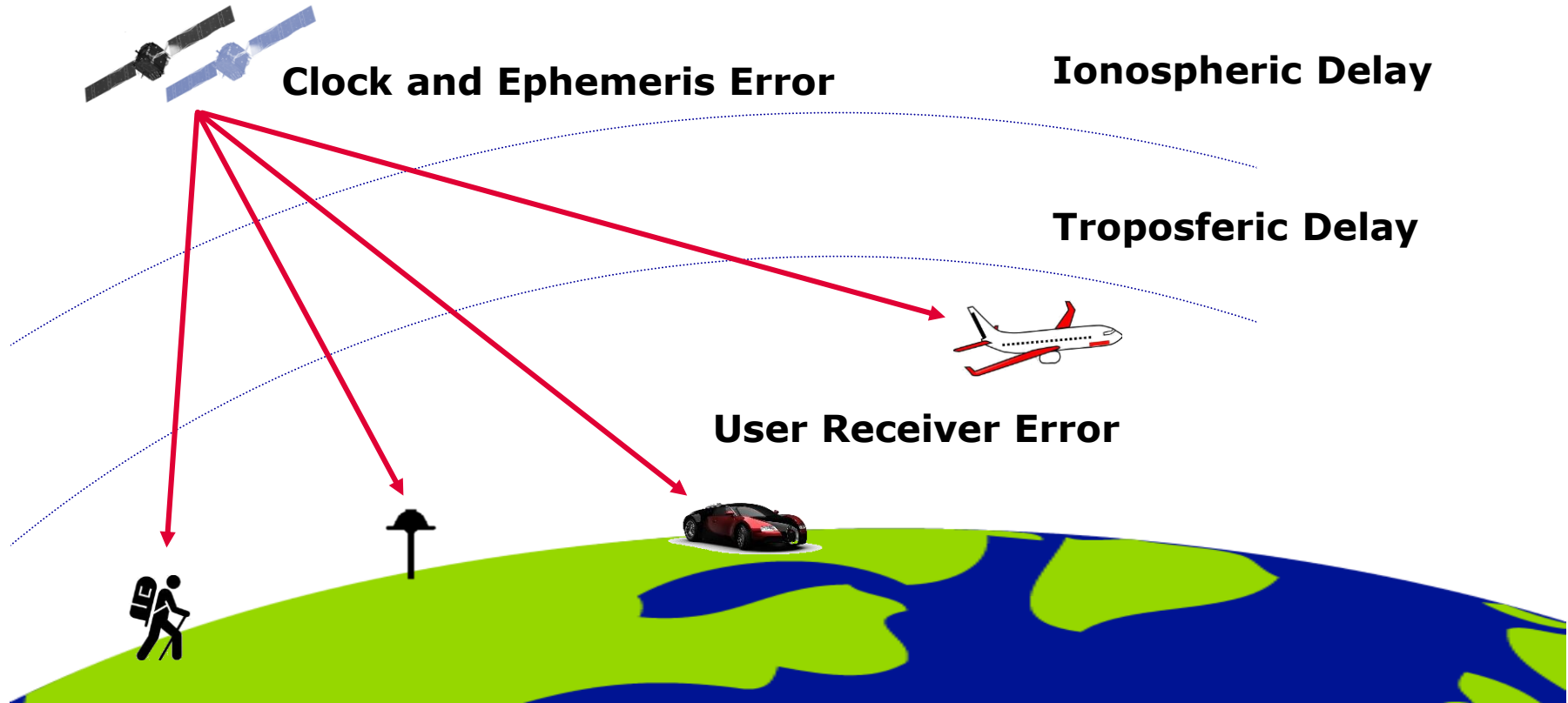
Australian and New Zealand Second Generation Satellite Positioning Augmentation System (Technical Overview)

Speaker

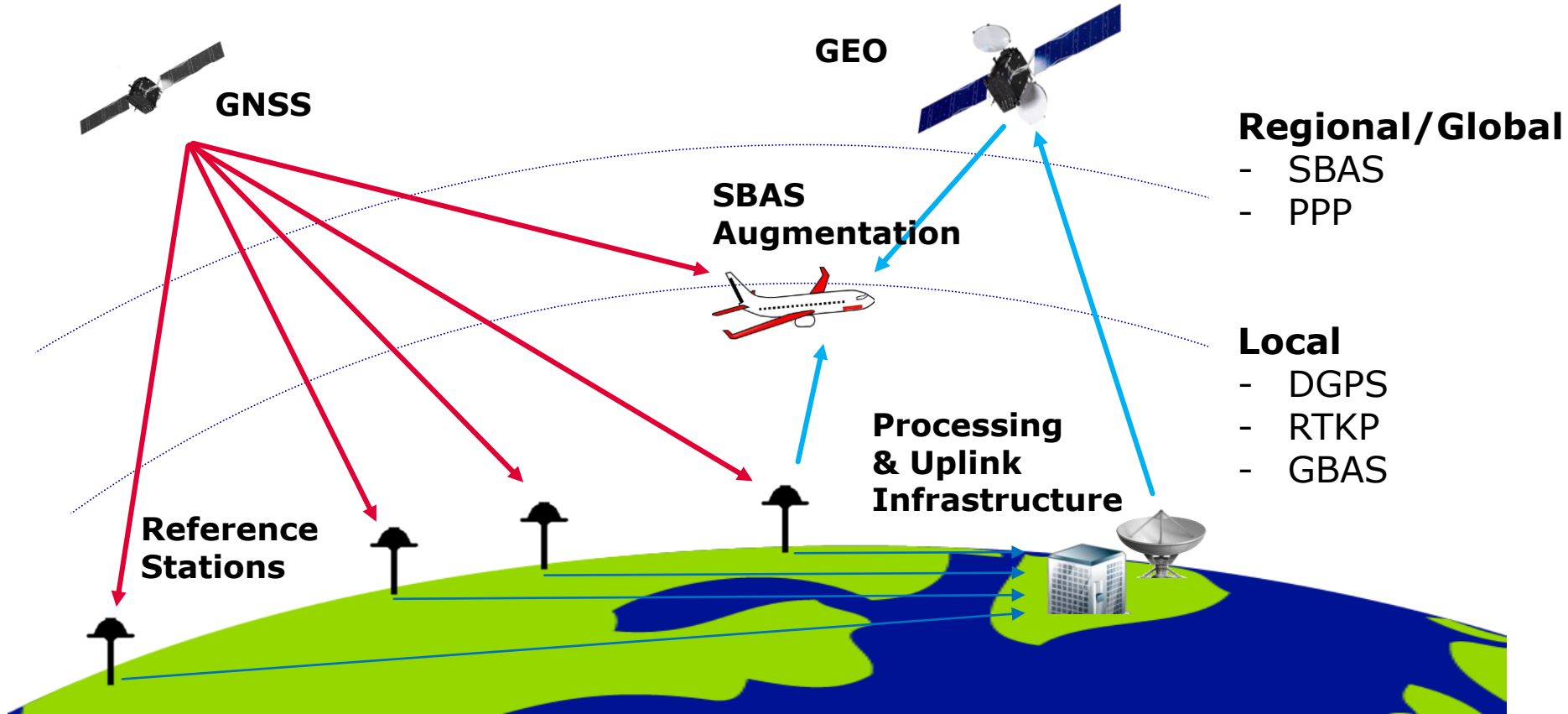
Julián Barrios (GMV)

jbarrios@gmv.com

Why an Augmentation System?



What is Augmentation System?



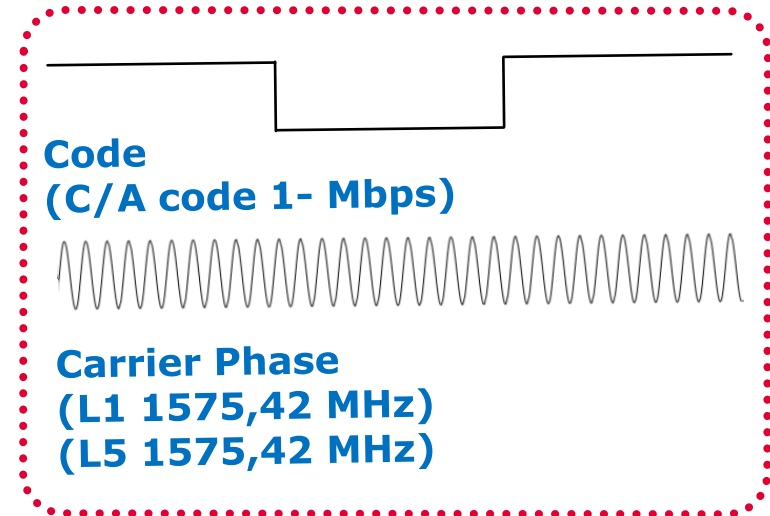
SBAS and PPP Augmentation

- PPP algorithm uses a **more accurate** observable (Phase) than SBAS (Code) leading to a **more accurate** user solution, but it **needs better SV corrections**
- It needs the estimation of the phase ambiguities which leads to a **greater convergence time**

	SBAS	PPP
Observables	Code (smoothed)	Code + Phase
User Accuracy (*)	~ 1m	~ 10 cm
Convergence	< 3 min	~ 20-40 min (**)
SV Corrections	< 0,5 m	< 0,05 m

(*) RMS For static geodetic receivers and antennae

(**) For decimetric accuracy





CITIZEN

J. SOCK USA 6 6 4

M. CILIC CRO 4 3 3

GAME SCORE
0 - 15

US OPEN

Emirates Airline

usopen.org

IBM

124

CHASE

US OPEN

CHASE

usopen.org

CITIZEN

1:36

Emirates Airline

UNITED STATES
FEDERAL SERVICE

AMERICAN
EXPRESS



CITIZEN		90.4
J. SOCK USA	6 6 4	
M. CILIC CRO	4 3 3	
GAME SCORE		
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US OPEN		

GPS alone



CITIZEN

J. SOCK USA	6 6 4
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GAME SCORE	
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SBAS L1



PPP



AUS & NZ SBAS Test Bed through L1

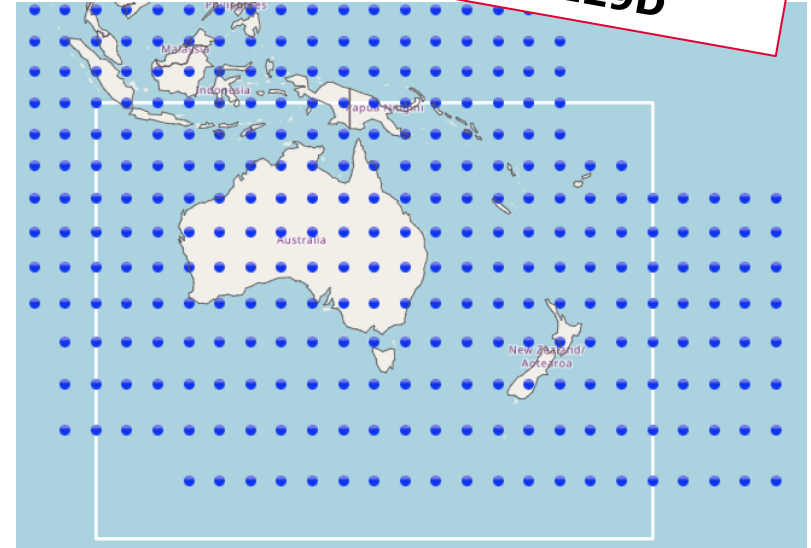
- **Non-SoL SBAS L1 Legacy Service**

- ✓ Augmentation for GPS L1 single-frequency users.
- ✓ Compatible with COTS SBAS-enable receivers (**Septentrio, Novatel, Arrow, Honeywell, etc...**)

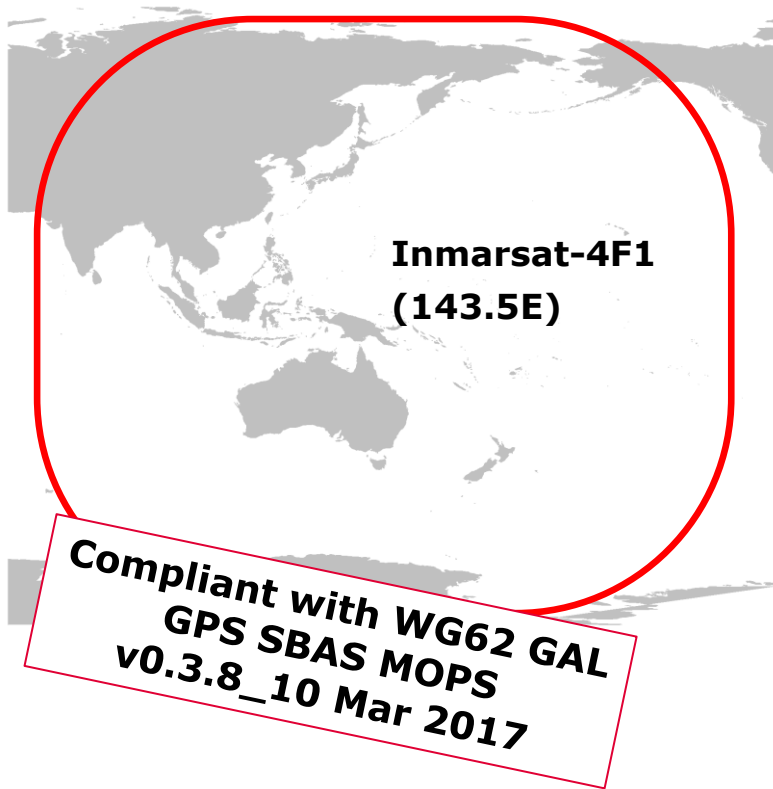
- **Non-SoL PPP augmentation through SBAS L1 signal**

- ✓ Augmentation for GPS L1/L2 dual-frequency users.
- ✓ Service accessible from ***magicAPK*** and ***magicUT*** user terminals

Compliant with
RTCA/DO-229D



AUS & NZ SBAS Test Bed through L5



- **Non-SoL SBAS L5 DFMC for GPS L1/L2 and Galileo E1/E5a**
 - ✓ Augmentation for GPS L1/L2 + Galileo E1/E5a dual-frequency users.
 - ✓ Signal Prototype. User terminal made available in the Test Bed.)
- **Non-SoL PPP augmentation through SBAS L5 signal**
 - ✓ Augmentation for GPS L1/L2 + GAL E1/E5 dual-frequency users.
 - ✓ Service accessible from ***magicAPK*** and ***magicUT*** user terminals

SBAS Enable Receivers

	L1 Signal	L5 Signal
SBAS Service	GPS L1 Legacy RTCA/DO-229	GPS L1/L2 + GAL E1/E5a WG62 GAL GPS SBAS MOPS
SBAS Enable	<p>GNSS only solution is combined when SBAS information when available. Restrictions specified by aviation SBAS standards are not applied.</p> <p>The service focus on accuracy and solution availability but doesn't provide protection levels.</p>	
PPP Service	GPS L1/L2 Proprietary ICD Embedded bits	GPS L1/L2 + GAL E1/E5a Proprietary ICD Embedded bits

AUS & NZ SBAS Test Bed Schedule

SBAS L1 Service is active since:

28/05/2017

SBAS L5 Service is active since:

18/09/2017

PPP L1 and L5 Services are active since:

18/09/2017

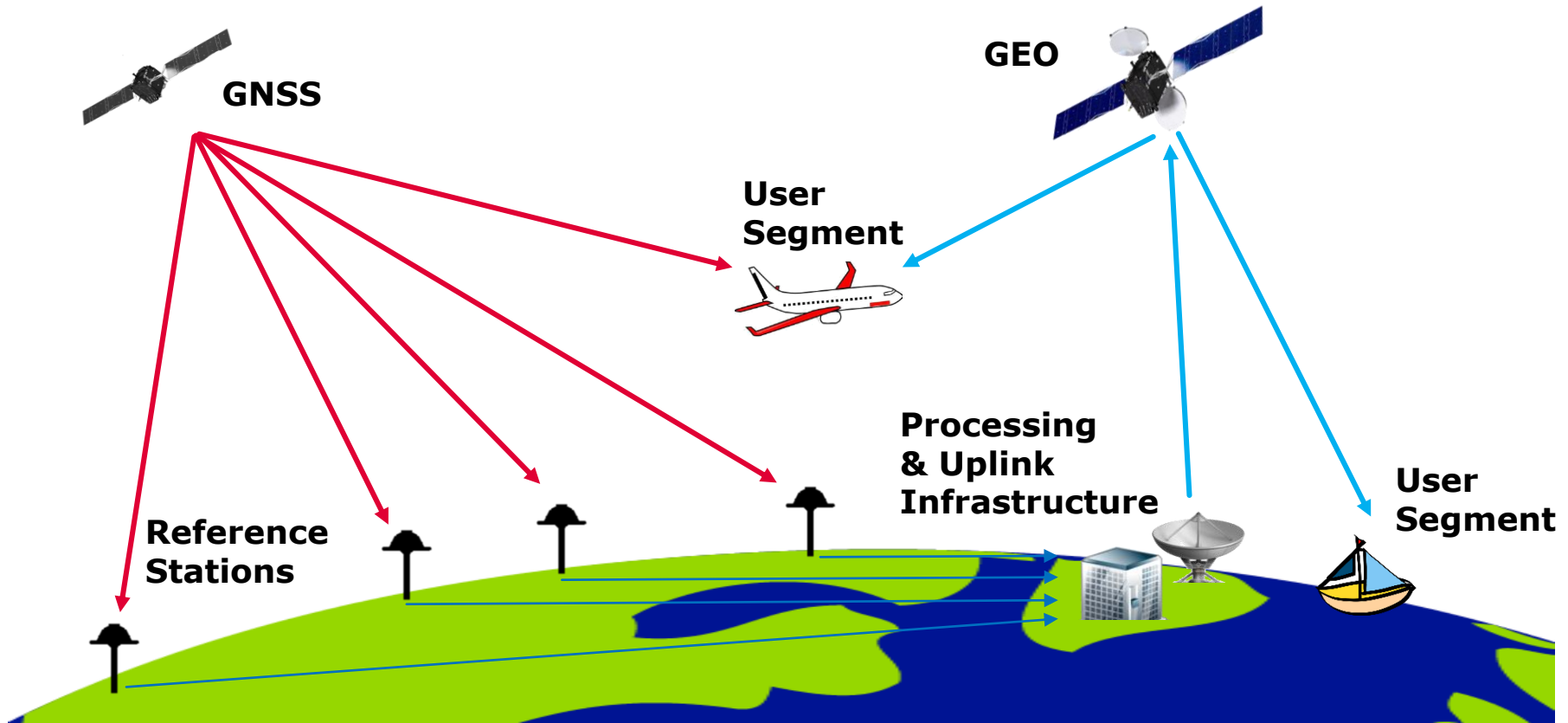
End of Transmission:

01/02/2019

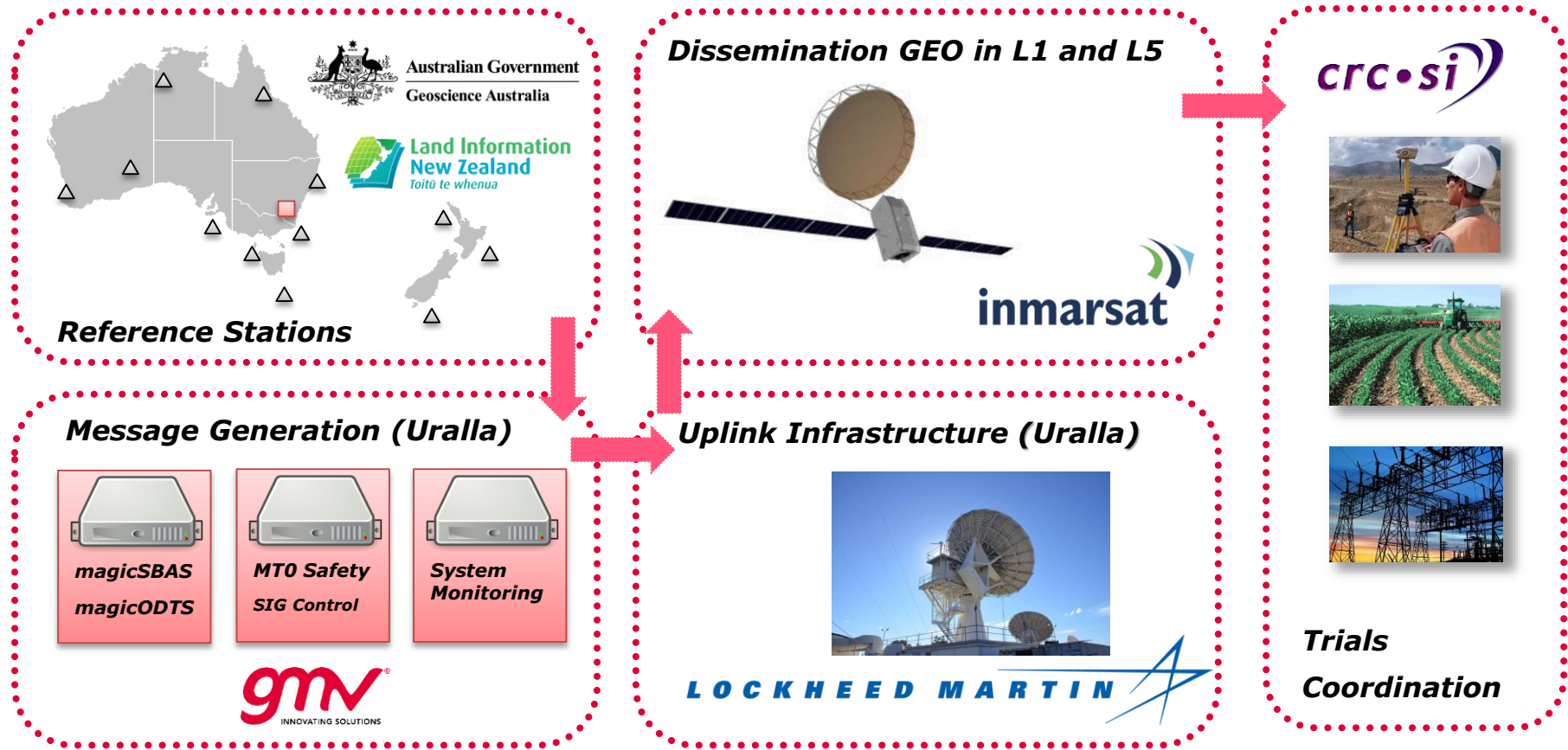
Other considerations:

- Monthly Maintenance Slot each Month (coordinated with GA and CRC SI)
- Capability to switch to GPS L1/L5 service during 2018
- Backup Internet Stream for situations without GEO visibility.

AUS & NZ SBAS and PPP infrastructure



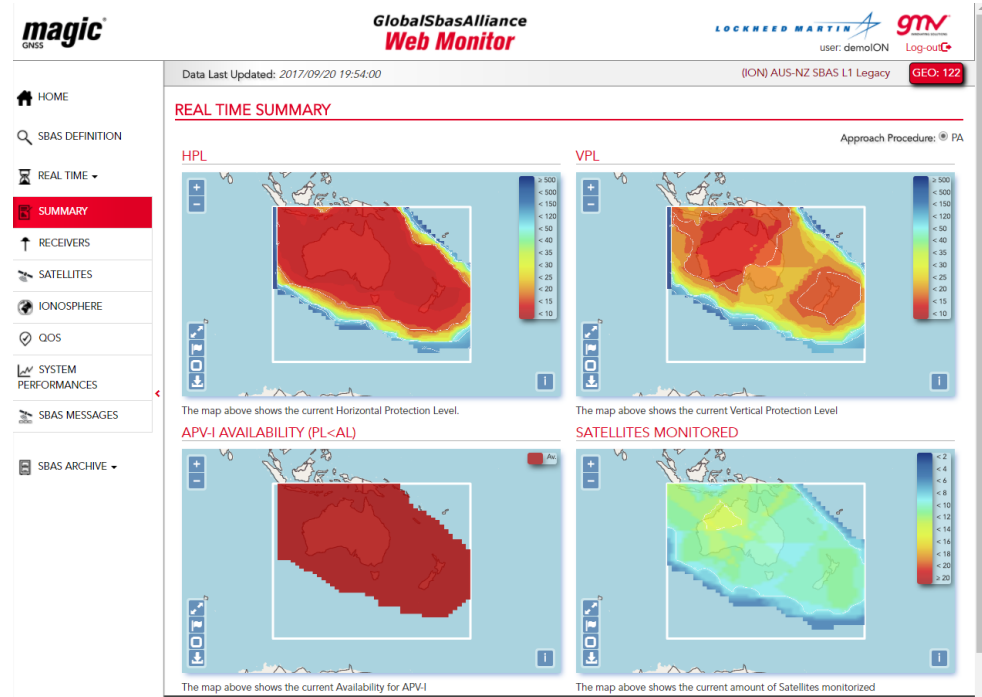
AUS & NZ SBAS Test Bed Technologies



AUS & NZ Test Bed Real Time Monitoring

Monitoring Platform:

- ✓ Real Time Signal Availability
- ✓ Real Time SBAS Availability
- ✓ SVs Monitoring
- ✓ Ionospheric Monitoring
- ✓ PPP Performances



<https://www.globalsbasalliance.com/>

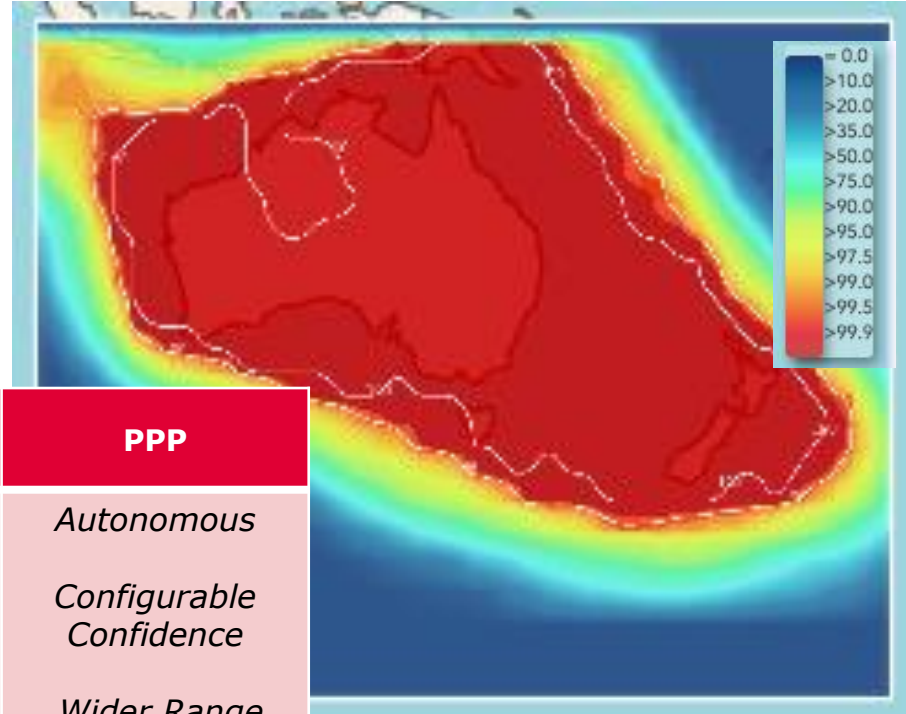
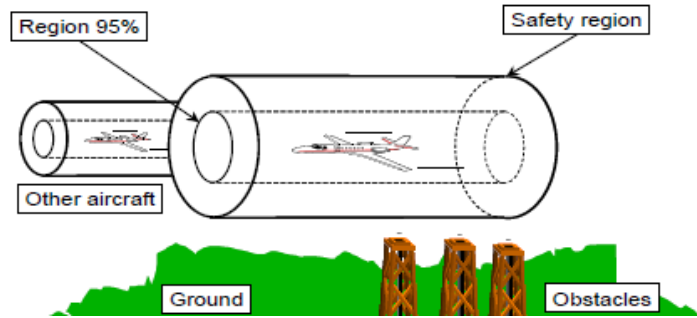
AUS & NZ Test Bed User Segment

magicGNSS User Terminal

- SBAS and PPP Handheld User Terminal
- Integrated Novatel OEM7 board
- Stand-alone user tool.



AUS & NZ Test Bed Integrity Targets



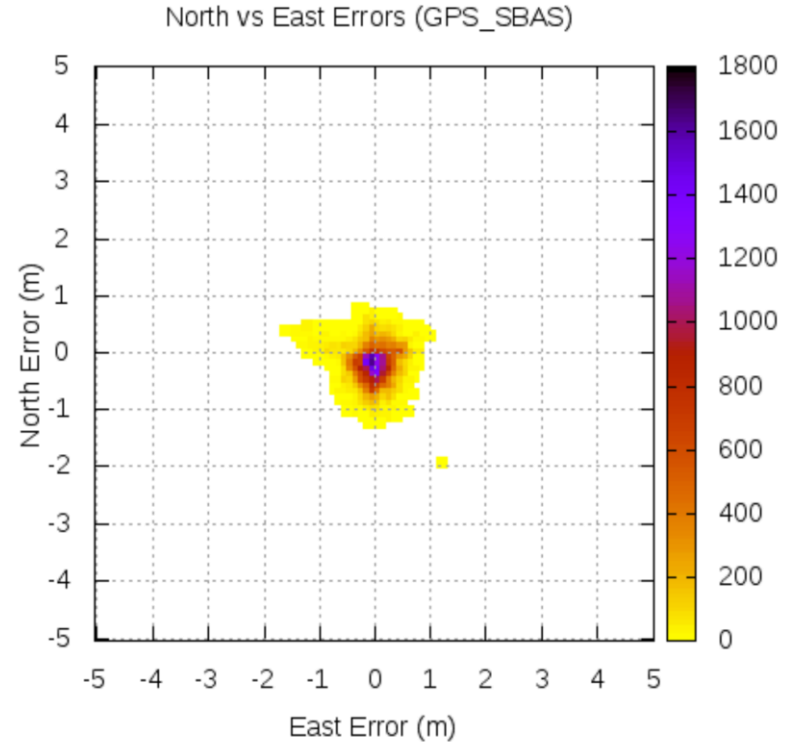
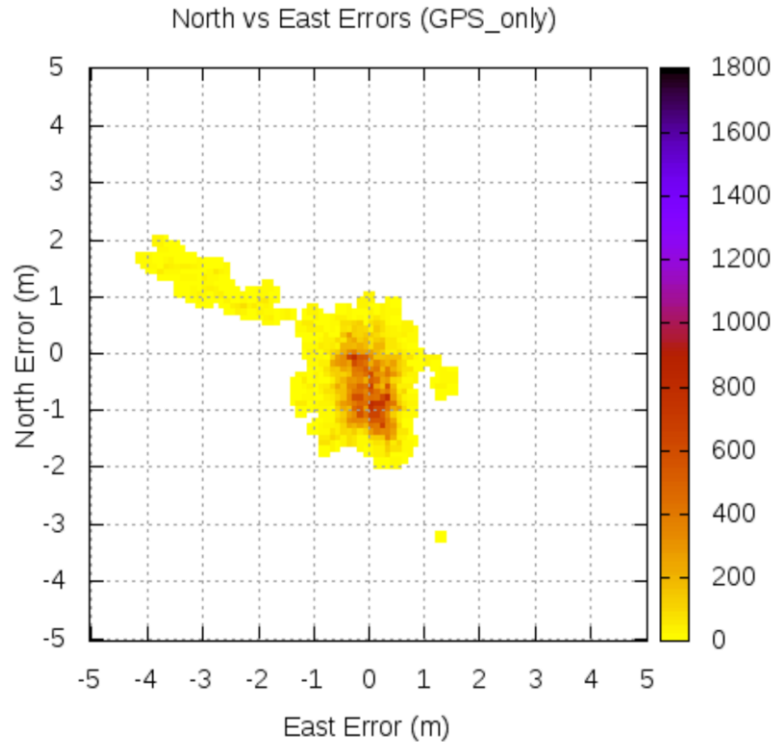
**SBAS L1 LPV-200 Availability
3/12/2017**

	SBAS L1 (LEGACY)	SBAS L5 (DFMC)	PPP
Non-Sol Integrity	<i>SBAS Integrity</i> <i>APV-I (50m)</i> <i>LPV200 (35m)</i> <i>Aeronautical Receivers</i>	<i>SBAS Integrity</i> <i>LPV200 (35m)</i> <i>CAT-I (15m)(*)</i> <i>Aeronautical Receivers</i>	<i>Autonomous</i> <i>Configurable Confidence</i> <i>Wider Range Receivers</i>

(*) Upon complete GPS+GAL constellations

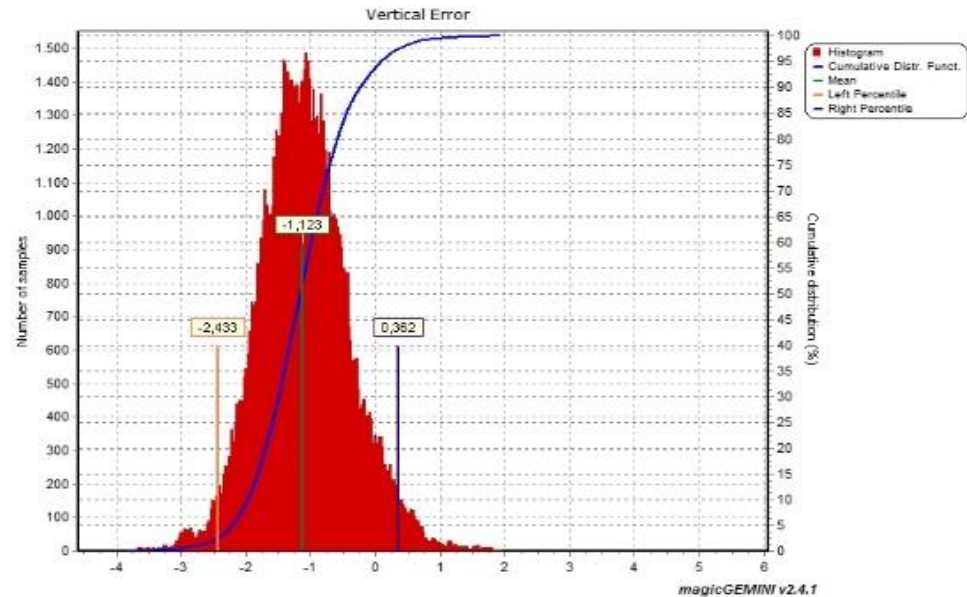
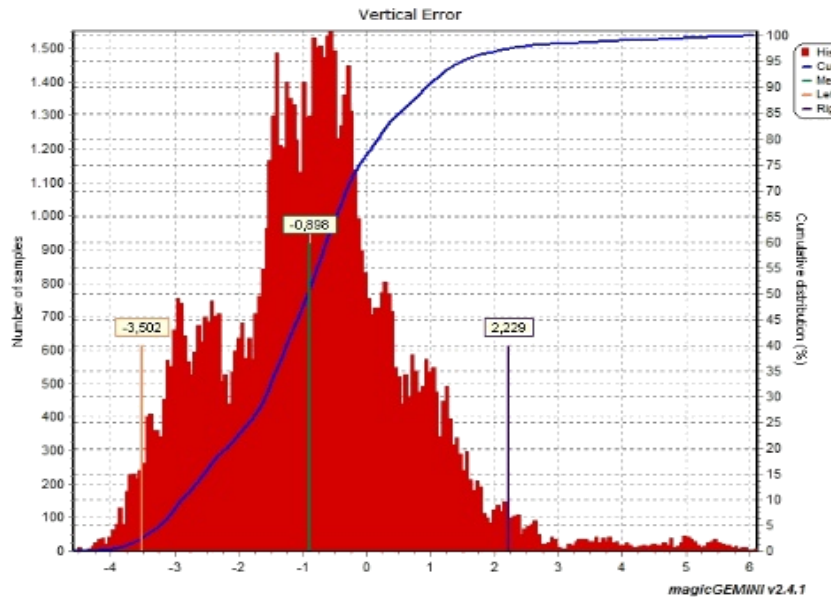
Example SBAS GPS vs GPS+SBAS

Horizontal Error (Colour Map)

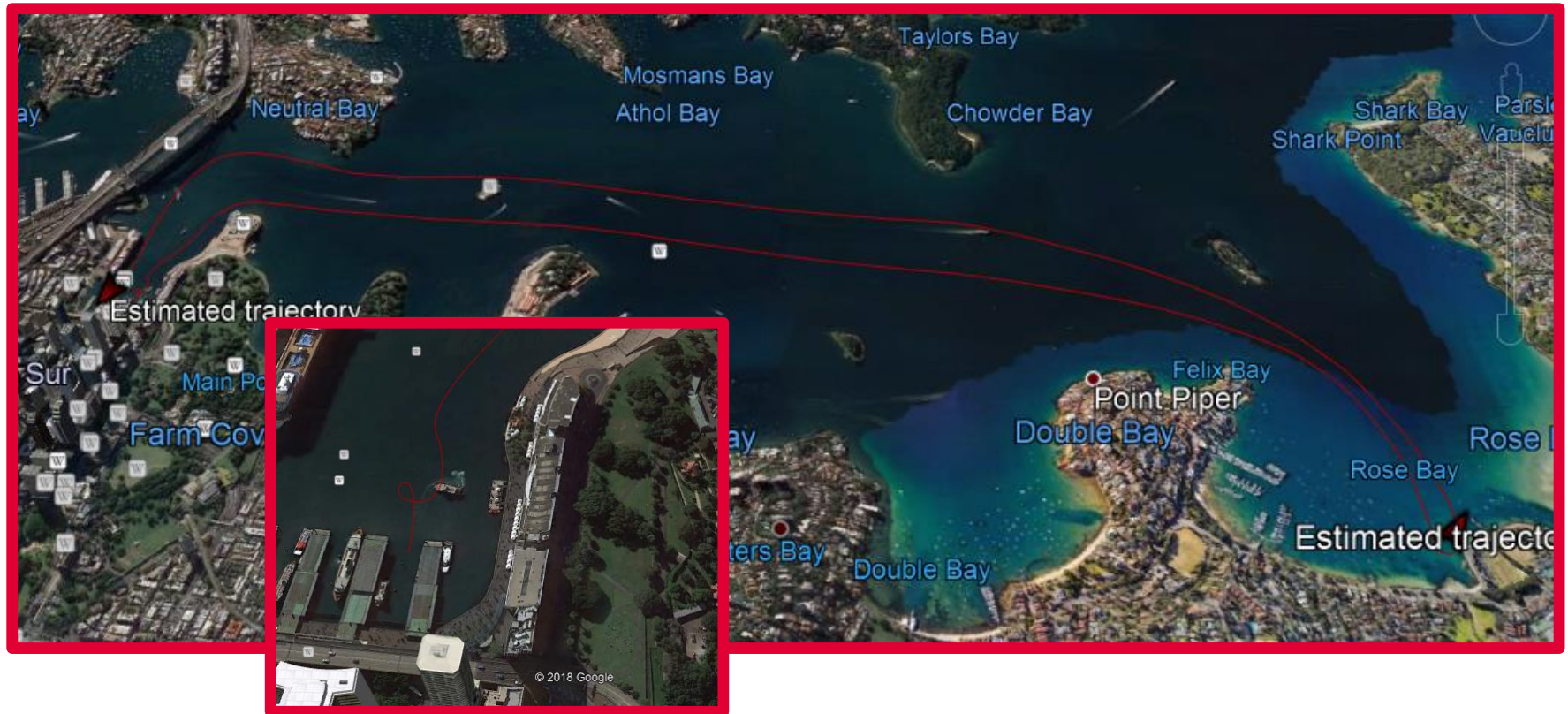


Example SBAS GPS vs GPS+SBAS

Vertical Error (Histogram)

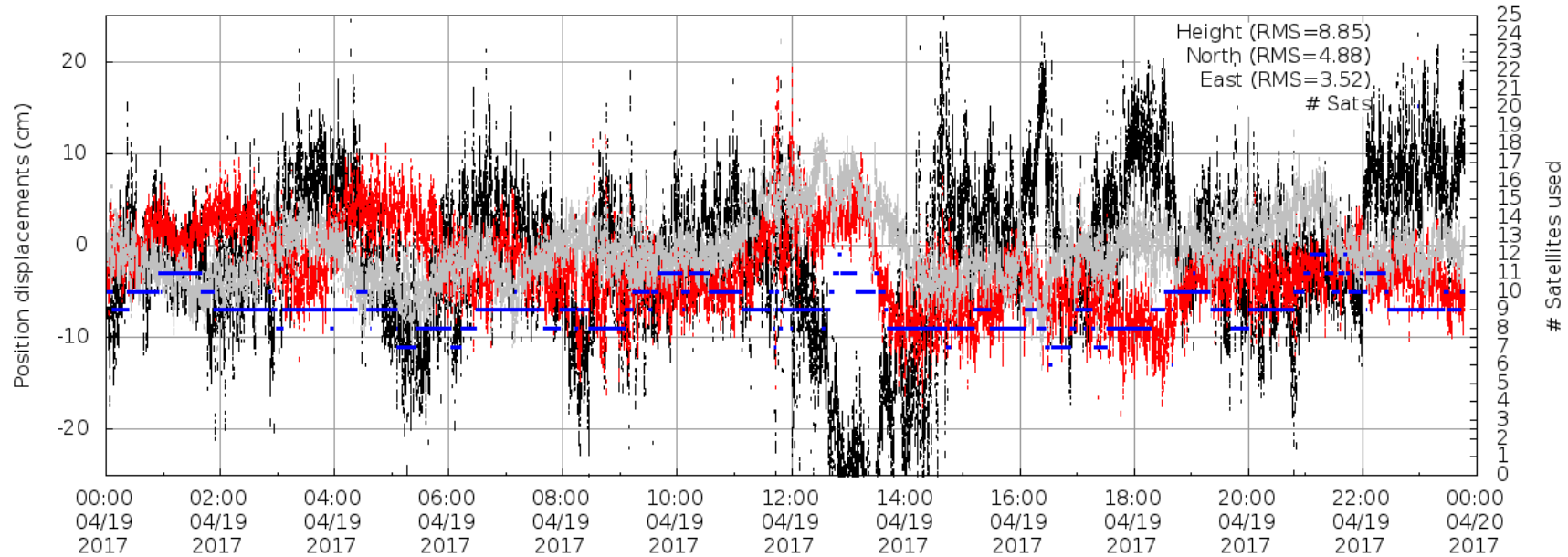


SBAS test at Sydney (06/07/2018)



Example PPP through SBAS L1

610_DF_NOF120_L1



**More Details on Test Bed PPP Performances
on Friday at PPP Technical sessions**



Julián Barrios

jbarrios@gmv.com

www.gmv.com

THANK YOU

Additional Slides

SBAS and PPP Augmentation

	SBAS L1 (LEGACY)	SBAS L5 (DFMC)	PPP
SV Corrections	< 0,5 m	< 0,5 m	< 0,05 m
Constellations	GPS only	Multi-constellation	Multi-constellation
Observables	Code (smoothed)	Code (smoothed)	Code + Phase
User Type	Single-frequency	Dual-Frequency	Dual-Frequency
Augmentation	SV Clk + Ephem Ionosphere	SV Clk + Ephem	SV Clk + Ephem
User Accuracy (*)	~ 1m	~ 1m	~ 10 cm
Convergence	< 3 min	< 3 min	~ 20-40 min (**)
Integrity	At Augmentation	At Augmentation	At Receiver
Dissemination	GEO L1 (Regional)	GEO L5 (Complete footprint)	Internet, Satellites (World-Wide)
Standardization (SoL)	Yes (MOPS, ICAO)	In progress	No

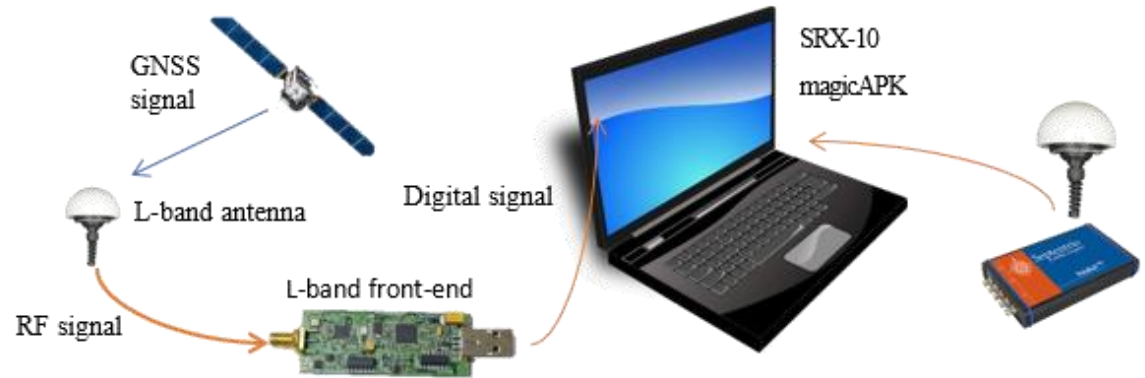
(*) RMS For static geodetic receivers and antennae

(**) For decimetric accuracy

AUS & NZ Test Bed Analysis Tools

Performance Analysis SW

- SBAS and PPP tools capable of processing external receivers in PPP or SBAS mode
- **SRX-10** for acceding to SBAS L5 signal
- **magicGEMINI** for SBAS Processing (RT and Post-processing)
- **magicAPK** for PPP processing (only RT)



CRCSI coordinates the use user equipment's made available within the Test Bed.

AUS & NZ SBAS Reference Network

- Different Networks for SBAS L1 and SBAS L5
- ~60 Reference Stations are configured. Number of stations is oversized to mitigate issues with regular internet access to the data.

SBAS L1 Regional Network for IONO monitoring



SBAS L5 DFMC World Wide Network



Australian Government
Geoscience Australia

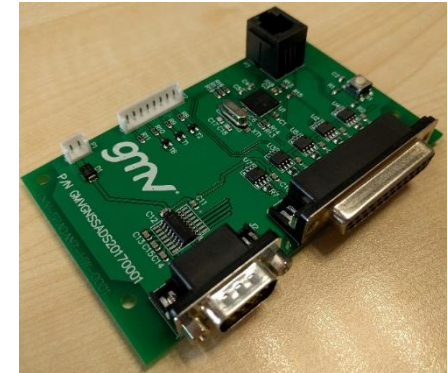
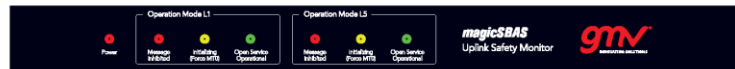


Land Information
New Zealand
Toitū te whenua

Uplink Safety Monitor

The **USM (Uplink Safety Monitor)** is the SW+HW element that runs in a microcontroller. It is in charge of performing the safety checks:

- the SBAS data broadcast meets the requirements:
 - MT0 message is broadcast at least once each 6 seconds.
 - MT1 mask contains only one GEO (PRN 122).
 - GEO PRN and Service Provider ID in message MT17 are according to TB definition
 - IGP Mask (MT18) is according to TB definition
 - Service Area information in MT27 is according to TB definition
- The data is broadcast using the correct PRN
- Any data received was previously sent.



Figures and Photographs References.

- [RD.1] Uralla Photo by Rachel Baxter. <http://www.theland.com.au/story/4863180/new-positioning-technology-unlocks-industry-potential-gallery/#slide=2>
- [RD.2] Tennis court imagen by <https://www.pexels.com/photo/people-sitting-on-bench-watching-tennis-event-on-field-during-daytime-171568/>
- [RD-3] Maps generated with open street maps
- [RD-4] Satellite views generated with Google Earth