Analyzing the Performance of the Australian-NZ SBAS Test Bed Services

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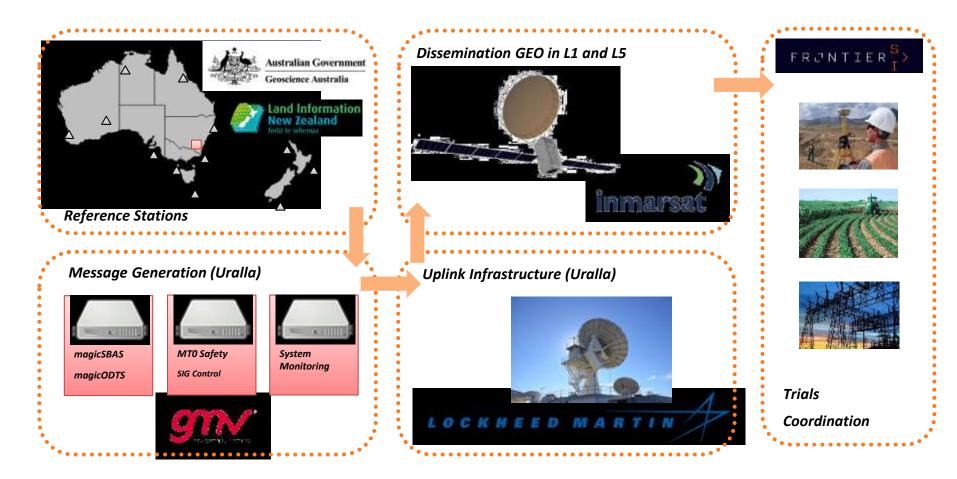TS08E Cost-Effective Positioning – Thursday 25 April 2019

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OUTLINE

- **Australian and New Zealand SBAS and PPP Testbed is broadcasting four Augmentation Services**
  - o **SBAS L1 Legacy (code pseudoranges)**
  - o **SBAS L5 DFMC (code pseudoranges)**
  - o ***PPP through SBAS L1 (carrier phases)***
  - o ***PPP through SBAS L5 (carrier phases)***
- **Early availability of the Australia and New Zealand SBAS Testbed allows receiver manufacturers to develop new products and experiment with the new services.**
- **Septentrio receiver implementation of SBAS L1 & L5 services for kinematic applications are evaluated in this presentation.**

AUSTRALIA AND NEW ZEALAND TESTBED

Reference Stations

Dissemination GEO in L1 and L5

Message Generation (Uralla)

magicSBAS
magicODTS

MT0 Safety
SIG Control

System Monitoring

Uplink Infrastructure (Uralla)

Trials

Coordination

AUSTRALIA AND NEW ZEALAND Services

Australia and New Zealand TB is broadcasting 4 different services within the Inmarsat-4F1 footprint:

- **Non SOL SBAS L1 Legacy (DO-229)**
  - GPS L1CA
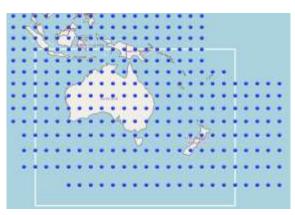 - Australia + New Zealand Area (IGP definition)

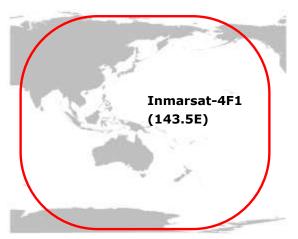- **SBAS L5 DMFC (MOPS v0.3.8_10 Mar 2017 Draft)**
  - GPS L1CA/L5 + GAL E1/E5a
  - GEO footprint

- **PPP through SBAS L1 (GMV proprietary msg)**
  - GPS L1CA/L5
  - GEO footprint

- **PPP through SBAS L5**
  - GPS L1CA/L5 + GAL E1/E5a
  - GEO footprint

Inmarsat-4F1 (143.5E)

Receiver implementation

- **Constellations and signal tracking**

  - GPS, Galileo, GLONASS, BeiDou, QZSS, IRNSS and SBAS

  - L1, L2, L5 and L6 bands

- **Receivers used to collect L1/L2/L5 observables and navigation data**

  - Receiver placed in in Australia (Canberra)

  - Data post-processed in different SBAS modes

- **New DFMC SBAS L5 software module (MOPS v0.8_12 Oct 2018 Draft)**

  - Augmentation: GPS L1CA/L2P + GAL E1/E5a

  - Developed in the context of the Galileo Test User Receiver - ESA

  - Continuous updates as per latest version of draft MOPS

  - Can be deployed in any Septentrio model or used in post-processing
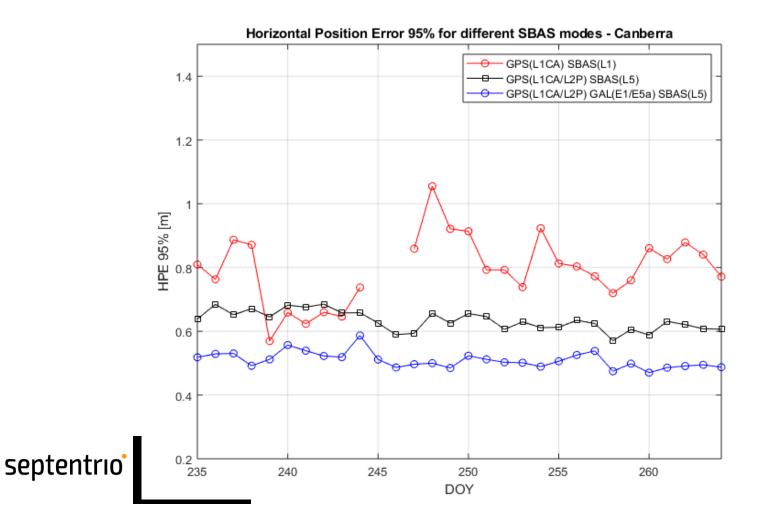
SBAS Performances

Positioning in Canberra (Static)

- Receiver with DFMC software implementation enabled

- Iono Delay removed by dual frequency measurements, satellite orbit and clocks corrections provided by SBAS
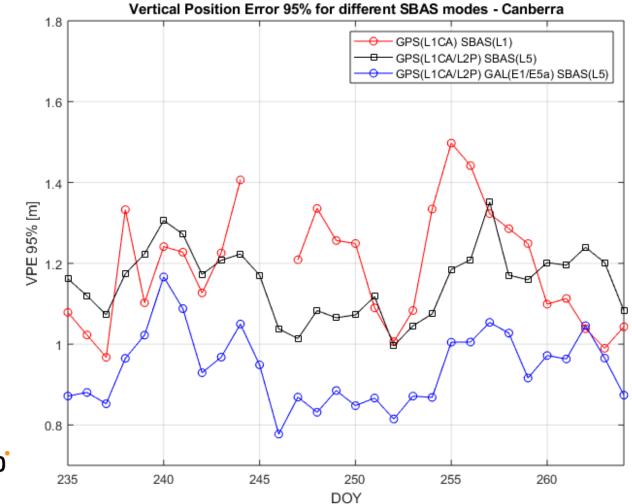
Positioning in Canberra (Horizontal Accuracy)

- SBAS Positioning Performances have been evaluated for 30 days in 2018 (1 sample per second). The following plots shows P95 Horizontal Errors for different SBAS solutions.

Horizontal Position Error 95% for different SBAS modes - Canberra

Positioning in Canberra (Vertical Accuracy)

- SBAS Positioning Performances have been evaluated for 30 days in 2018 (1 sample per second). The following plots shows P95 Vertical Errors for different SBAS solutions.

Vertical Position Error 95% for different SBAS modes - Canberra

Positioning in Melbourne (Kinematic)

- Kinematic tests executed with an AsteRx-U across greater Melbourne in Jan 2019, covering urban areas (around Fitzroy Gardens), highways, rural areas and airport surroundings.

Positioning in Melbourne (Horizontal Accuracy)

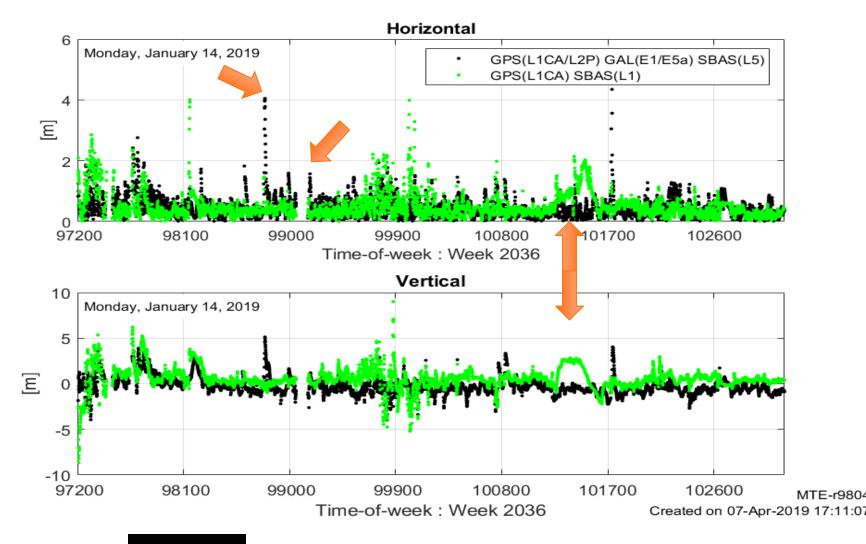- SBAS Positioning Performances have been evaluated for car test drive for approximately 2 hours.

Driving Environments

Positioning in Melbourne – DFMC Accuracy

- Positional errors using the RTK fixed (GPS+GLO+GAL) trajectory as reference:

Positioning in Melbourne – Accuracy in different modes

MODE (for 2hr data sets)	Horizontal [m]				Vertical [m]			
	StdDev	Mean	P95	RMS	StdDev	Mean	P95	RMS
GPS(L1CA) SBAS(L1)	0.415	0.496	1.414	0.646	0.965	0.889	2.758	1.312
GPS(L1CA)	0.419	0.567	1.156	0.705	1.100	1.659	3.159	1.990
GPS(L1CA/L2P) GAL(E1/E5b)	0.462	0.793	1.481	0.918	1.228	1.173	4.149	1.698
GPS(L1CA/L2P) SBAS(L5)	0.558	0.719	1.769	0.910	1.267	1.210	3.517	1.752
GPS(L1CA/L2P)	0.687	1.136	2.137	1.327	1.796	1.603	5.376	2.408

Conclusions

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- **Availability of the Australia and New Zealand SBAS testbed allows the early experimentation of these DFMC receivers.**

- **The results obtained are compatible with the ones expected for the SBAS testbed in terms of accuracy.**

    - **<u>Static mode</u> P95 accuracies around 60 cm plan & 1m in vertical,**

    - **<u>Kinematic tests</u> indicate P95 accuracies in the order of 1m P95 plan & 2m in vertical in dynamic scenarios (vehicle driving around urban centres).**

- **SBAS L-band transmission is highly dependent on SBAS visibility**

- **Alternative transmision of DFMC (& PPP) must be considered for urban environments, especially for applications demanding high-integrity**

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