The Role of GNSS Ground Infrastructure Elements: How integrated can they become?

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Presentation Outline

- Motivations for this Presentation;
- My perspective from recent experiences;
- Concentration here on types of Ground Stations and their Characteristics and Drivers (subset of the overall issue);
- Comments on Possibilities for Integration;
- Suggestions for ICG.

Motivations for this Presentation

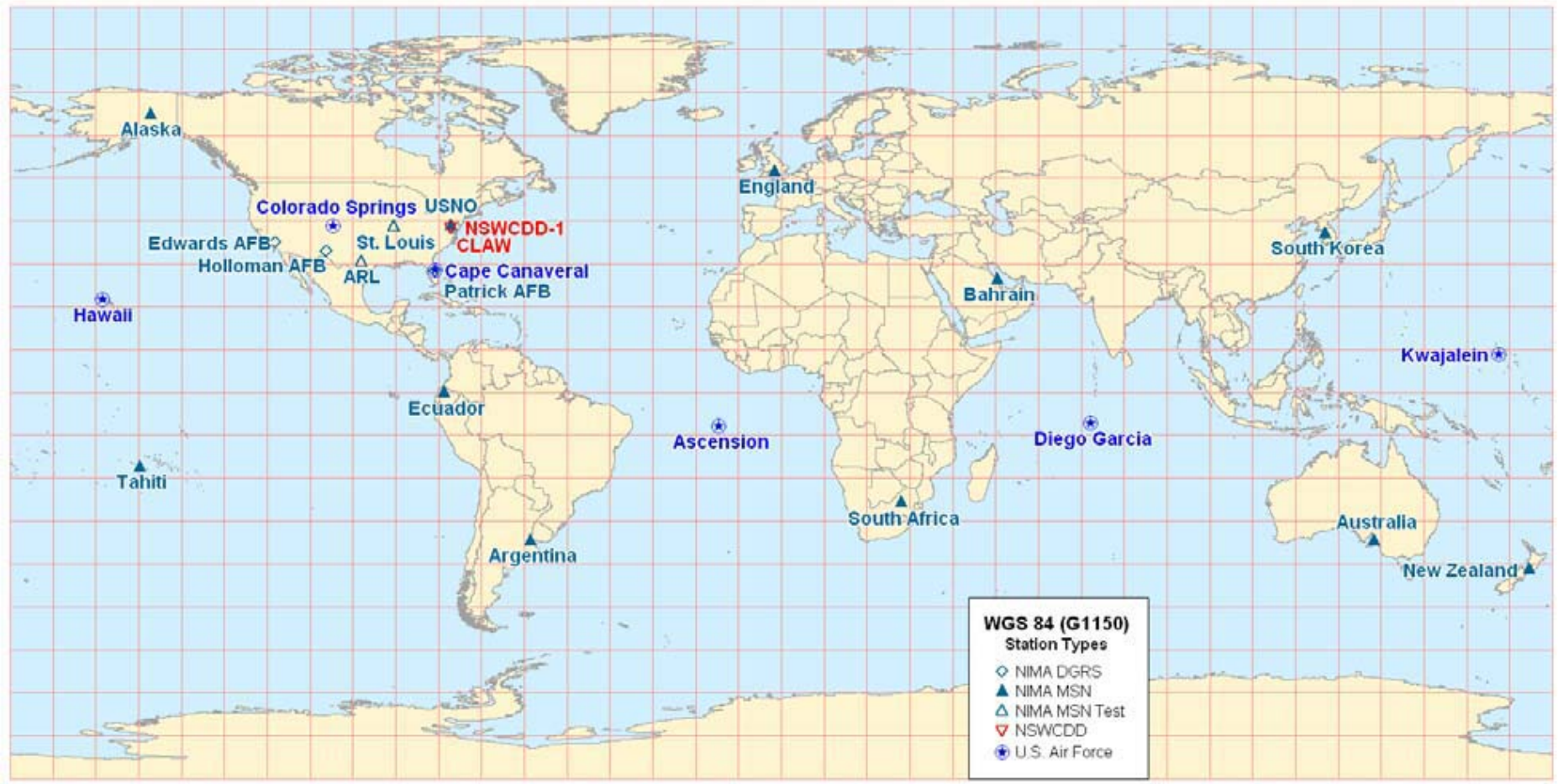
- ICG concepts about ideal interoperability include the possibility of shared ground facilities;
- An example is the WG-A Recommendation in Tokyo about international GNSS Monitoring and Assessment ~ *optimizing existing and planned capabilities and identifying additional activities*;
- This presentation makes some comments on the need to recognize some of the realities beyond ICG, such as the requirements of the nation hosting a given ground facility;
- Within host nations, high level decision makers see all these separate stations as duplication… but is it necessary duplication?

Perspective from Recent Experiences

- Some recent experiences that inform this presentation include:
  - Long history of development and operation of CORS in Queensland, Australia;
  - Participation in development of Australia's GNSS Strategic Plan and National Positioning Infrastructure;
  - Work in relation to possible hosting of foreign owned ground stations in Australia:
    - EOI to host a Galileo Sensor Station;
    - Proposal for a test ground station for the Russian SDCM;
    - Proposal for testing Chinese made CORS Receivers in Australia as part of collaboration between Australia's Cooperative Research Centre for Spatial Information and Wuhan University;
  - All of which are subject to Australian Government Policy in relation to foreign owned space assets ~ *"full knowledge and concurrence".*

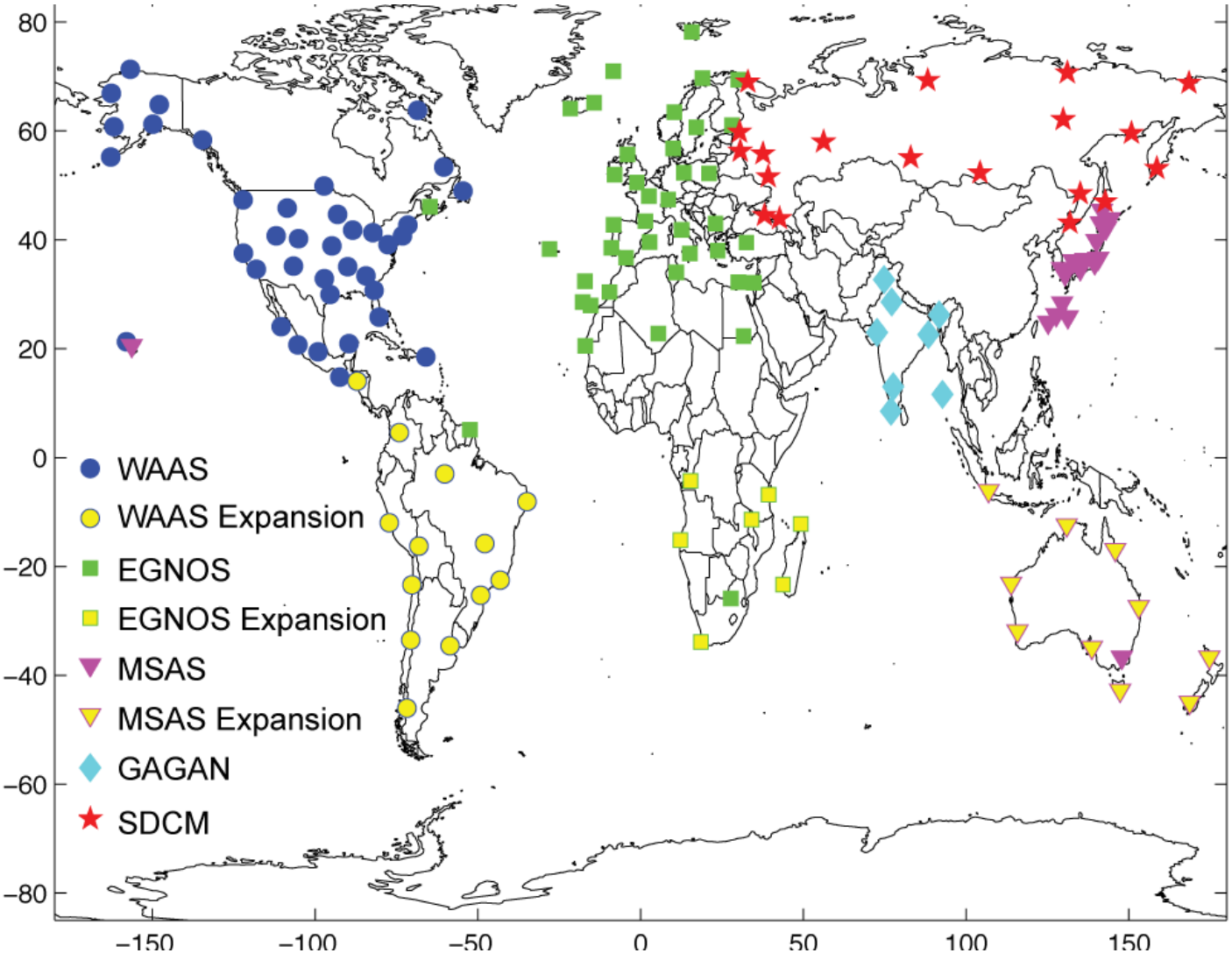
GNSS Monitor Stations

This example from GPS ~ WGS 84 (G1150) Reference Frame Stations



(Source: Wiley, 2011 – ICG WG-D Geodetic Reference Template – WGS84)

SBAS Stations

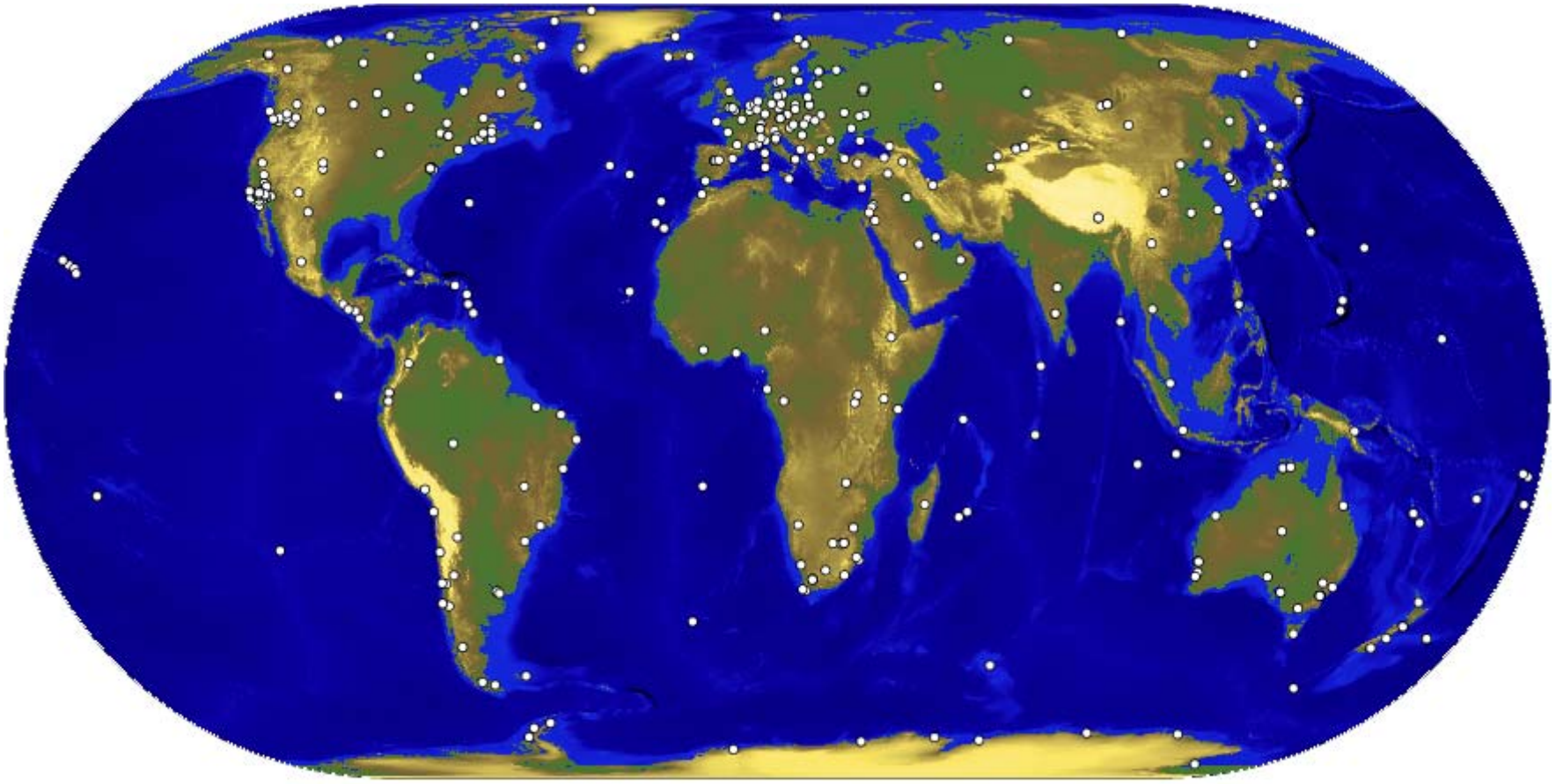


(Source: Lawrence, ICG-6, 2011)

CORS

IGS Tracking Network

400 active global tracking stations



Source: igs.org

Comparing Ground Stations

Characteristics / Drivers	System Monitor Station	SBAS Station	CORS
Purpose	System Performance	Safety-of-life	Multi-purpose
Driver	Monitoring and Maintenance	Integrity + others	Accuracy + others
Uniformity	Very High (within each system)	Very High (ICAO unifying influence)	Varies across tiers but High at IGS Tier 1
Redundancy (equipment, power, comms)	Very High	Very High	Medium indidually but high at network level
Station Control	GNSS Provider	SBAS Provider / Host	Typically individual host
Station Data Accessibility	Low (but varies between systems and with real-time vs post access)	Possible subject to not compromising network	IGS Open and Free but varies at lower tiers and with real time vs post processed
Service Accessibility	Open Services Free	Free	IGS Products Free but varies at lower tiers

Comparing Ground Stations

Characteristics / Drivers	System Monitor Station	SBAS Station	CORS
Observables	Raw?	Emphasis on Ranging but uses Carrier Phase	Strong emphasis on Carrier Phase
Frequencies	All available?	Dual for station ~ Single for user	Dual currently but eager to evolve to all available
GNSS Service Accessed	Authorised and Open	Open	Open
Governance	Provider with Host Nation	Provider with Host Nation and ICAO Oversight	IGS by "Concensus" but evolving ~ varies at lower tiers according to business model
Host Nation Sovereignty	National Security significant concern	Airspace Sovereignty a concern	Varies between nations but emphasis on a base national capability and coordination across tiers
Changeability	Low? (security and reliability driven)	Low (certification driven)	High (experiment and/or service driven)

Comparing Ground Stations

Could do other Tables for other ground elements ,
e.g. Uplink stations more factors come into play.

Characteristics / Drivers	System Monitor Station	SBAS Station	CORS

Could do more rows, i.e. These characteristics are only a first attempt.

Also variation within columns,
e.g. interference monitoring perhaps best done at Tier 3 CORS due to high station density.

Could do other columns, e.g. for DGNSS or GBAS or precise time etc

Thoughts on Possibilities for Integration

- The Table is meant to show that while integration is ideal it might:
  - Not be allowed, e.g. provider preference vs host nation preference on equipment control and data flow;
  - Not be best outcome, e.g. rather than risk compromising an SBAS station for CORS purposes it might be easier to build a separate CORS in the area ~ necessary vs unnecessary duplication;
- Geodetic and Timing References an obvious first step and does not require physical integration of ground elements, i.e. integration can be done at the “data level”;
- Where physical integration of equipment etc is not possible co-location of facilities might be next best option.

Concluding suggestion to ICG

- Even given all of the factors and issues outlined in this presentation, ICG should still pursue the possibility of integrated ground elements, if only to tease out the *devils in the detail* and find ways to address those *devils*;
- In doing so, it is hoped that the issues raised here are useful input to the ICG work on this matter.

IGNSS 2013

Gold Coast, Queensland, Australia
16th to 18th July 2013
www.ignss.org

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International Global Navigation Satellite Systems Society Inc.

Open to suggestions for attaching an ICG activity to this event…

Thanks for your attention - matt.higgins@qld.gov.au