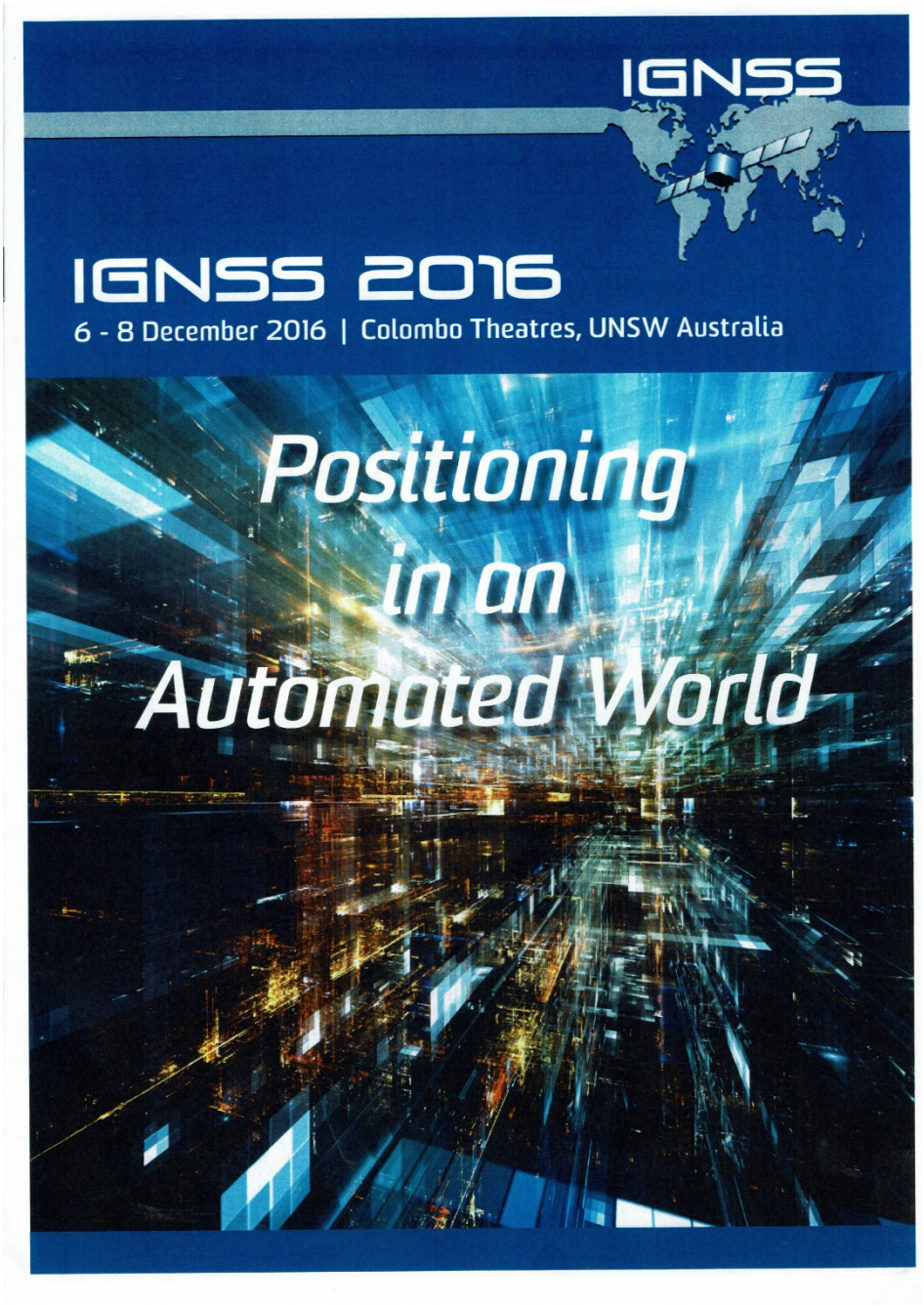
2016 IGNSS Conference at UNSW Australia's Sydney campus on 6 - 8 December 2016

"Positioning in an Automated World"

Report to AIN Members by Captain Gavin Permain



It is not the intention of this report to finely detail the papers presented as some of the material is commercially sensitive and it would be impossible to do justice to the R & D that has contributed to what was presented.

I recommend readers go to the IGNSS2016 website where it is expected links to papers will be posted during January 2017.

Conference Overview

IGNSS runs the SE Asian region's premier conference on Global Navigation Satellite Systems (GNSS) and related Position, Navigation and Timing (PNT) technologies. This year's IGNSS conference was held in Sydney, Australia from 6 to 8 December 2016 and brought together leaders in GNSS and PNT to examine the latest technology, present cutting edge research and discuss in open forums the implications for policy, market development and positioning infrastructure deployment. IGNSS 2016 showcased a number of contemporary topics including, the role of PNT in automated land and aerial vehicles, the growing range of commercial precise positioning services, hard infrastructure issues such as space based augmentation systems, and soft infrastructure issues such as datum modernisation and mitigation of system vulnerabilities. These hot topics were discussed in the context of the latest system developments fuelling the Multi-GNSS Era. Featured topics this year were as follows:

• Emerging Application Areas for GNSS • Key Industries and their Reliance on GNSS • Aviation and Avionics • Cooperative Intelligent Transport Systems • Machine Guidance in Agriculture, Construction and Mining • Maritime Applications • Unmanned Aerial Systems • Alternatives to GNSS • National Positioning Infrastructure • Policies and Standards • GNSS Augmentation including SBAS • Datums and Geodesy • National and International GNSS Developments • Embracing the Multi-GNSS Era • GNSS Receiver Development • GNSS Vulnerability

The Facilities, Organization, Content and Speakers

This was the first occasion that the conference was held without a PCO (Professional Conference Organizer), as I had not attended previous conferences I could not make direct comparison. My view of the conference given the self management was extremely positive.

Colombo theatres are at the UNSW Sydney Campus accessible directly from High Street, Kensington with convenient bus stops. In future there will also be light rail on ANZAC Parade when completed. The 3 theatres are spacious, air conditioned, all seating is row stepped and has attached folding tables. Excellent A/V technology is standard. The theatres are connected by a large hall which allows for exhibitors to display their equipment, there are tables, chairs and couch seating for attendees to freely communicate and exchange ideas. Morning and Afternoon smokos are also occur in this space. A cooked meal was provided at the separate cafeteria with a good choice including vegetarian options on the 1st and 2nd day of the conference. On the 3rd (last) half day a Bar-Be-Que sausage sizzle was held in the court yard adjacent to the common hall.

It is not always appreciated by attendees just how much effort goes into preparing such a conference with many speakers attending from across the globe, with their papers presented in advance for review. Consideration must be given to how the groups of subjects are compartmentalized and presented across 3 theatres with minimal conflict for interested parties I.e. the audience. There is also the accommodation and catering requirements, as well as the evening cruise on Sydney Harbour. That this all took place with apparent seamlessness to those outside, great credit must go to our own President Professor Chris Rizos and Cheryl Brown both of UNSW along with their support staff.

The quality of content and speakers was diverse and of excellent standard encompassing:

- an overview of the likely future along with associated challenges: environmental and ethical, in getting there
- Space Applications
- Hardware technical design and development to overcome the challenges
- existing system Status and the future from the service providers
- Applications to industry: driverless cars, UAV's, aviation, maritime, agriculture, mining, structural monitoring, railways, container movement loading/stacking/discharging, warehousing, surveying, Security
- Testing and field experiments of different systems, methodologies and configurations to determine accuracy (horizontal and vertical), stability, susceptibility to ionospheric disturbance, RF interference, time to convergence, ambiguity resolution of multi frequency, multi constellation, augmented and non-augmented systems
- Algorithms and Methods
- Datum Modernisation

Whilst minimal improvements might be suggested there could also be reasons why not to, for example:

- Video to capture the sessions so that persons do not miss a presentation due to conflicting time slots – at times commercially sensitive information may be presented and the free flow of information may be stymied by a camera recording

- Further background of topics available if required pre- presentation to enable attendees to better select topics
- Invitation to representatives from Government as in Minister or support staff and Department of education so as to emphasise the importance of the disciplines of mathematics and the sciences in our primary and secondary education systems.
- Representative from media, eg. ABC Catalyst. – Apparently an invite was sent to the media however no interest was shown.

Official Opening and Introduction – Chair Matt Higgins

"A decision has been made to keep the IGNSS Society running. Thanks attributed to UNSW and Chris Rizos for their support. One future possibility however is to roll the Society into the Institute of Navigation.

For this conference the same committee as previously remains in place. Thanks also to Cheryl Brown for her work and to all the speakers presenting. Fewer exhibitors were planned than last year but more Sponsors".

Keynote Address: Alan Cameron - Journalist for GPS World and Geospatial Solutions

"Driverless cars, UAV's, and Consumer Location Data: Where GNSS Went Next"

Alan provided and enlightened and entertaining address, when available it is worth linking to and reading for a general likely overview of the road we are currently on and some pitfalls along the way.

Keynote Address: Rod Bryant -u-blox (Foreword of Presentation)

Senior Director, Positioning Technology, u-blox "Positioning Challenges for Automation"

At u-blox we're being confronted by requirements way beyond anything previously even considered in the past.

Greater positioning accuracy is being required by cars, UAV's, agricultural machinery, mining machinery, factories & warehouses, container handling and probably dozens of others.

Cars – 1m/95%, Very high integrity (trust), high price sensitivity, operate in an urban environment.

UAV's – Accuracy to deci-meters, high price sensitivity, urban environment

Agriculture - Accuracy to deci-meters, integrity and price sensitivity not as demanding, open environment

Open Cut mining - Accuracy to deci-meters, moderate integrity and price sensitivity not as demanding, high wall environment (half sky visible)

Factory Automation – Congested indoor environment

Containers - Congested out door environment

Timing and Synchronization critical, requirement to operate in cluttered environments and mass market price points – all great challenges.

Now – Standard grade GPS positioning meets price requirements, but fails to meet accuracy and integrity.

- High precision GPS receivers are expensive but they do meet the accuracy requirement, although require expensive correction services. Don't offer high integrity.

Aviation receivers provide high integrity but not under the sort of conditions where multi-path is prevalent. They also don't offer high accuracy and are expensive.

Rod Bryant went on to explain how mass market indoor positioning was currently an unmet need and not "just around the corner".

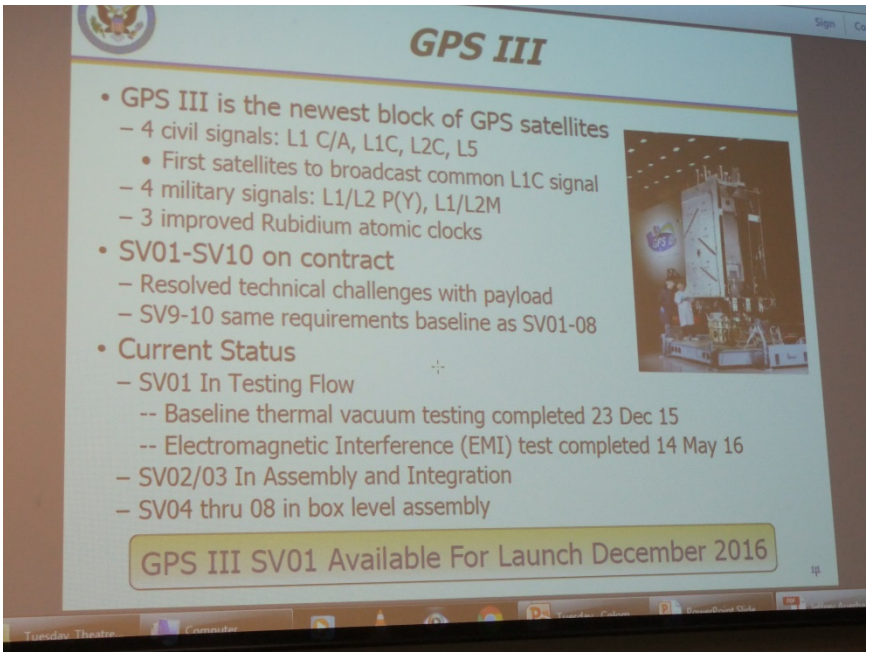
System Providers

Presentations were made by representatives from USA (GPS) – Mr. Jeffrey Aubach, Russia (GLONASS) – Mr. Roman Muravyev and China (BeiDou) – Mr. Chang Kewu.

Ongoing commitment to global co-operation was expressed and each representative gave an update to the current status of their systems and future plans/upgrades.

GPS Civil Service Update and U.S. International GNSS Activities

Mr. Jeffrey Auerbach – GNSS Senior Adviser, U.S. Department of State, Office of State and Advanced Technology.



A slide from Mr. Auerbach's presentation indicating GPS III Status.

SBAS Status

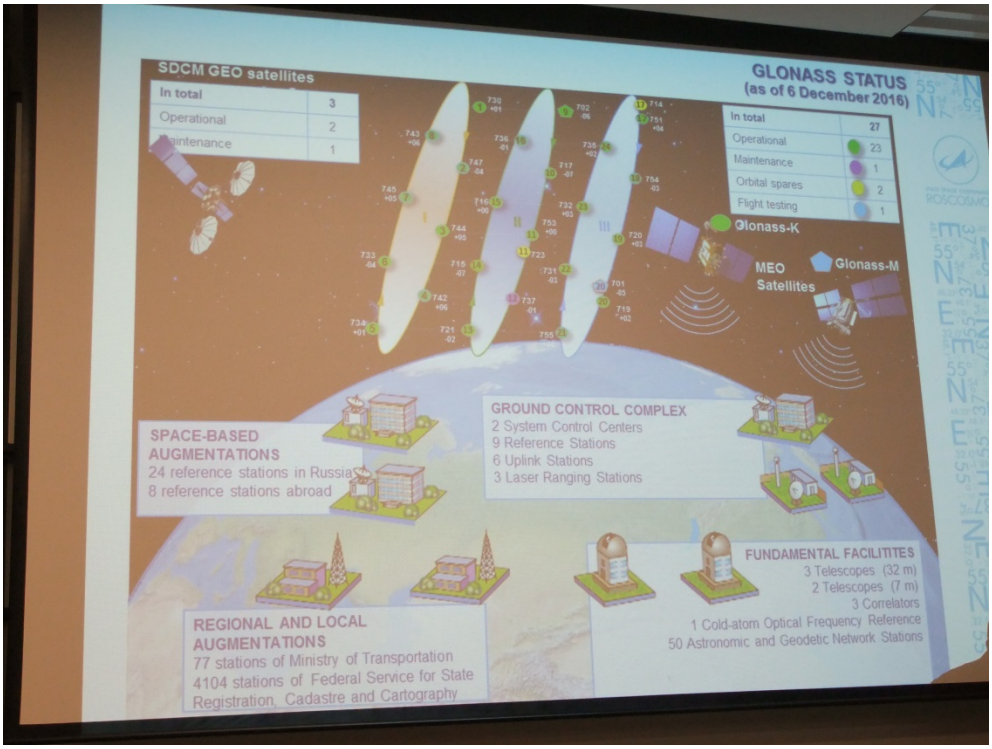
The following countries have SBAS (ICAO SBAS) in various stages of implementation:
Operational as at 2016:
 US –Wide Area Augmentation System (WAAS) – there are now more GPS/WAAS supported approaches than CAT 1 ILS
 Canada – a part of WAAS
 Mexico – a part of WAAS
 Europe (Joint collaboration) -EGNOS
 Japan – Multi-Function Satellite Augmentation System (MSAS)
 India – GPS & Geo-Augmented Navigation System (GAGAN)

Being developed as at 2016:
 Russia – System for Differential Corrections and Monitoring (SDCM)
 China – Satellite Navigation Augmentation System (SNAS)

Being considered as at 2016:
 Korea plans to tender for an SBAS in 2016. **CONTRACT NOW SIGNED Oct 2016**
 South America and Caribbean – SACCSA is reported as implementing an initial SBAS capability over the Caribbean and parts of South America.
 African nations are considering a collaborative approach to an SBAS system based on the European EGNOS system. A preliminary phase is being supported by funding from the intra-ACP 10th European Development Funds.

GLONASS Status and Performance Improvement

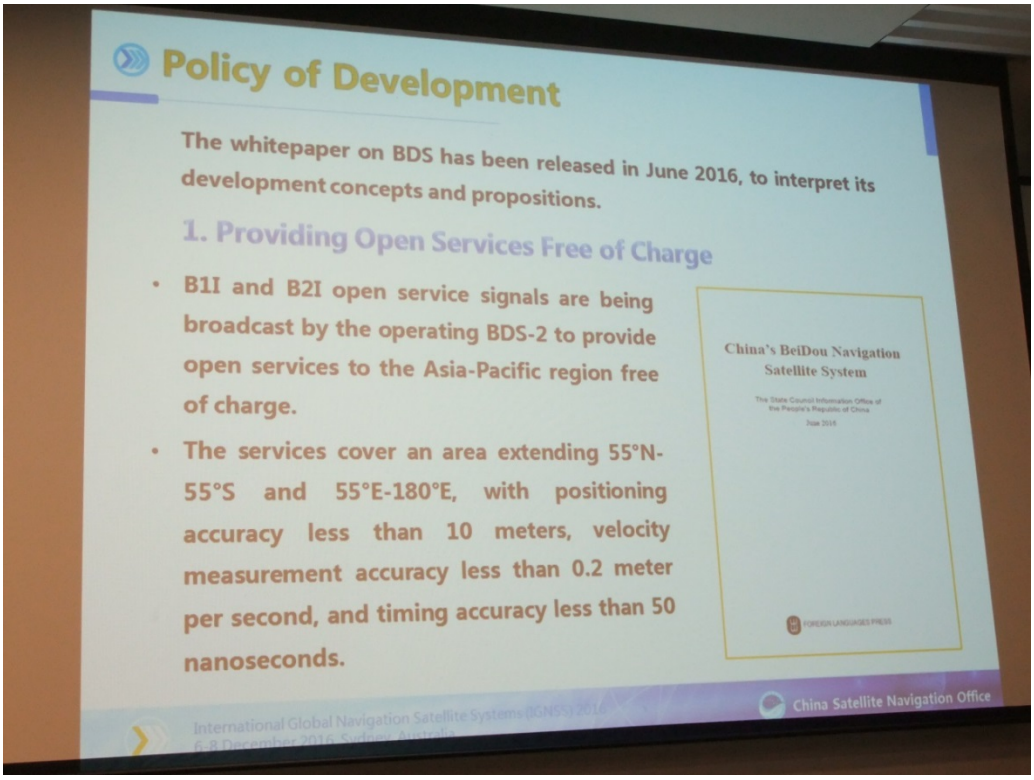
Mr. Roman Muravyev presenting the latest information and update status of GLONASS.



Status of GLONASS as at 6th December 2016

BeiDou Status and Plans

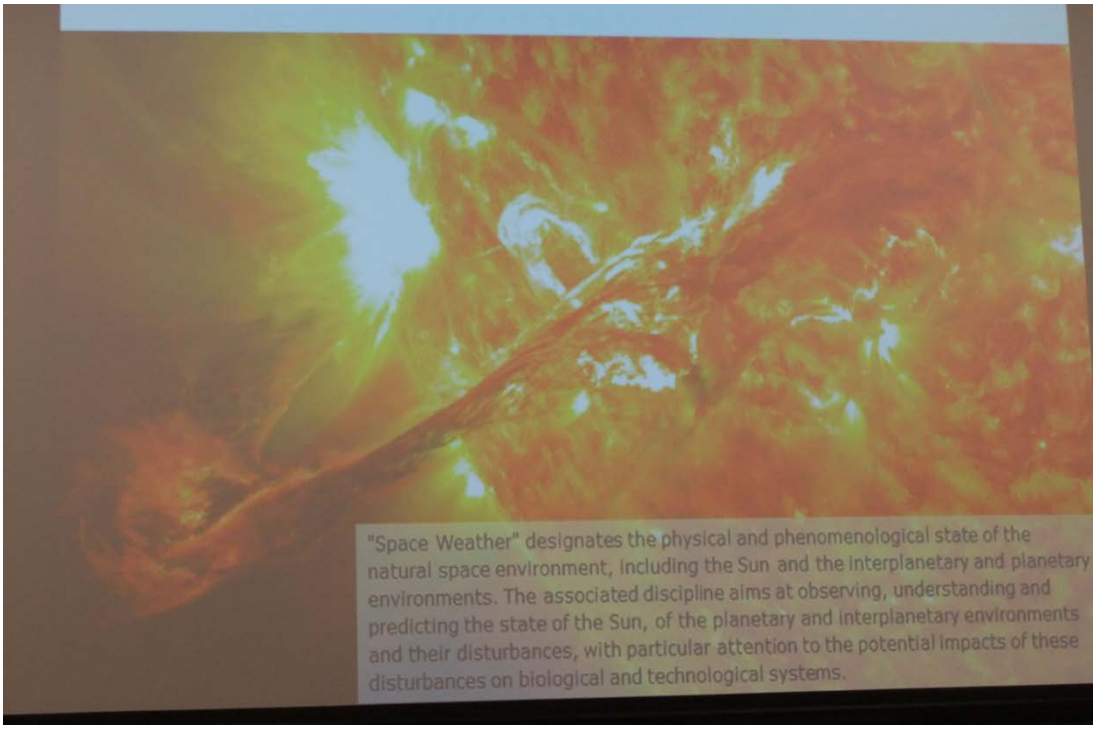
Mr. Chang Kewu Program Director of China Satellite Navigation Office presents BeiDou overview



Ionospheric Prediction Service

Mr. Mike Terkildsen of the Ionospheric Prediction Service – Australian Bureau of Meteorology

Mr. Mike Terkildsen of the Ionospheric Prediction Service



This remarkable photograph taken from a NASA Satellite shows a flare emanating from the sun. The length of the flare is equivalent to 30 earth diameters.

General Discussion in the Common Area

E-Loran

Whilst not one of the specific topics, I was keen to sound out delegates in the know on the status of E-Loran, a long range hyperbolic system updated from the conventional Loran system seen as a potential back up for space based satellite systems. Unfortunately this program appears to be in reverse due to lack of funding and interest from some areas. Some European Countries have actually closed stations making other potential stations unusable due to the co-dependency of the system.

As an alternative to overcome potential satellite system vulnerabilities there is still the risk that E-Loran stations themselves could also be vulnerable to interference or disablement.

Do not expect anything anytime soon.

All is not lost→

Keynote Speaker – Greg Gutt – Satelles

Greg Gutt is the Chief Technical Officer of Satelles and gave an inspiring address on the Satelles purchase and rejuvenation of the Iridium Satellite System. Originally a Satellite Mobile phone service, Iridium has undergone a major software upgrade to turn it in into a fully-fledged global navigation satellite system with some major advantages over GPS. It is the only system based on LEO (low earth orbit) satellites. The orbit is 25 times closer to earth than GPS satellites giving it a distinct power advantage, approximately 1000 times. Essentially STL (Satellite Time and Location) is a service hosted on Iridium. The system was switched on in April 2016.

There are 66 L band satellites in the network with pole to pole coverage, “overlapping spot beams provide location-specific encryption codes that change every second for maximum security”

The service provides “Time Synchronization”, independent of GPS

The signal strength is such that it allows for “Deep Indoor Penetration”

The system “proves rather than asserts” location making it extremely difficult to spoof

Trusted Location-3D has a 20-50M precision and with Differential mode 5-10M. Altitude is also provided.
The next generation “Iridium Next” consists of approximately 80 satellites with building currently in progress.

Serious consideration must be given to Iridium and its many advantages, as part of or as a standalone system depending on user requirements.
And yes, the phone service still exists.

Morning Smoko

Exchanging ideas in the common hall at morning smoko
At Left: L to R Jack Scott - ICAO SBAS with Gary Johnstone – GeoScience Australia
At Right: L to R Rod Bryant u-Blox, Suelynn Choy - RMIT University, Rod MacLeod - Novatel

The Best Paper

Allison Kealy presents the award for best paper to Tao Li and Stavros Melachroinos for "Real-Time Slip Detection and Repair for Network Multi-GNSS, Multi Frequency Data Processing".

SBAS (Space Based Augmentation System) / GBAS

There were a number of addresses in relation to SBAS. (for detail refer to web links when posted)

Mr Jeffrey Auerbach's GPS Service presentation included an update on the status of WAAS/SBAS. (as above)

Mr. Manoj Deo of Curtin University – Evaluation of Accuracy and Availability of ARNS Multi-Constellation Signals for Aviation Users in Australia

Mr. Jack Scott – SBAS Update

Ms. Suelynn Choy RMIT University Senior Lecturer – Different Shades of GNSS SBAS

Mr. Bob Jackson – Lockheed Martin Space Systems Company – 2nd Generation SBAS: Opportunities, Applications and Issues

Wednesday 7th Sydney Harbour Cruise and Dinner

Evening day 2 – Sydney Harbour cruise and dinner.
Left: Mr. Roman Muravyev (GLONASS) Information & Analysis Centre for PNT
Right: Mr. Chang Kewu (BeiDou) China Navigation Satellite Office

Evening day 2 – Sydney Harbour cruise and dinner. The exchange of ideas continues.

Datum Modernisation

Gary Johnstone - Branch Head Geodesy & Seismic Monitoring Geoscience Australia

Mr. Johnstone indicated that a change to datum was to be promulgated from 1st January 2017. This has been brought about not by Government Agencies but "you people, the people of the GNSS community have driven this need for change in datum, we've had a paradigm shift since the last datum. You used to deliver co-ordinates from survey control marks now you deliver co-ordinates for users from space and that means we need to manage the spatial data otherwise the information is completely useless if not interfaced with spatial data at some level, the position is coming to us in a frame that's very closely aligned to the ITRF in some form or another, so basically this data is now really designed to just allow the management of spatial data interfaced with positions from space".

GDA2020 to be gazetted 1st January 2017 and at 2020 continuously realized reference frame to be gazetted.

The requirement for change has been bought about due to the advent of precise positioning and the fact that people are now achieving positioning accuracies far exceeding the accuracy of the datum both in terms of its place on the planet we know that there is a 1.8m difference between ITRF and GDA94 as of now because of the 7cm a year but we also know that there is some inconsistencies within the datum itself that need to be addressed.

Datum Modernisation: Objectives

- Supports +/-2cm user positioning (PU 95% CL)
- Has a known relationship to the ITRF at +/- 2cm (PU 95% CL) or better
- Fully 3-D (i.e. ellipsoidal)
- Supports the computation of relative uncertainty between any survey mark
- Updated continuously as new observations are contributed and blunders detected
- Supports the continuous update of the national Geoid model
- Supports time-based corrections (i.e. deformation models)
- Has tools and services that facilitate its use by the mass market

Mariners –

Australian nautical charts use WGS 1984 datum which undergoes continuous updates through new edition charts so the above will not have direct significance.

Opinion

The Federal Government has espoused the need for innovation as a way to the future for Australia. This conference provided a great example of what can be achieved and has been achieved in the past through Academia, Department of Defence, technology development companies and end user customers collaborating on the global stage to produce truly innovative products along with ancillary supporting devices that will shape the future.

Many of the industry leaders from Australian companies had completed their academic training at Australian Universities and gone on to form their own successful companies producing high quality equipment and are further open to the upcoming challenges, quote from Rod Bryant – u-blox: "You give us a problem, we'll solve it".

The author found it notable that the majority presenting research papers were not of Australian origin, co-incidentally on Tuesday 8th there was a report on the News that less and less Australian secondary students were studying Mathematics and Science and that our standards were on a continual time decline compared with Asian countries in our region and Europe, for example Australia now 2 ½ years behind the equivalent aged Singaporean Mathematics students.

While there is definitely a future it may be less and less likely in this field for Australian students. The likely end result will be that our future industry leaders will be initially sourced from overseas. It would be heartening to think that the number of Australian secondary school students studying mathematics and the sciences might achieve the required results and so too could contribute to this significant technological future.

Perhaps a visit from government and The Department of Education to observe the reality might sow the seeds for redress.

In Conclusion:

The conference provided a forum for presentation and exchange of information by leading minds in the IGNSS industry. Many quality research papers were presented by students detailing the results of analysis of multiple systems in differing configurations including the affects of environmental interference, natural and manmade.

I recommend this conference to any one with the remotest interest in the subjects of Automation, Global Positioning and Timing to hear from the brightest minds forging our future; what is where and where might it apply next. And even if you think you are not interested you may just be surprised!

Schedule:-

Tuesday, 6th December

IGNSS2016

	Colombo Theatre A		Colombo Theatre B		Colombo Theatre C
	Keynotes *Chair: Matt Higgins*				
9:00	Official Opening & Introduction				
9:30	**Alan Cameron** Journalist for GPS World and Geospatial Solutions **"Driverless cars, UAVs and Consumer Location Data: Where GNSS Went Next"**				
10:00	**Rod Bryant** Senior Director, Positioning Technology, u-blox **"Positioning Challenges for Automation"**				
10:30	Morning Tea				
	Space Applications *Chair: Ben Southwell*		**Interference** *Chair: Graeme Hooper*		**System Providers** *Chair: Matt Higgins*
11:00	Simulation of GPS-based Launch Vehicle Trajectory Estimation using UNSW Kea GPS Receiver	Sanat Biswas, Australian Centre for Space Engineering Research (ACSER), UNSW Australia	RF Interference Types & Causes	Graeme Hooper, GPSAT Systems Australia Pty Ltd	• GPS Civil Service Update and U.S. International GNSS Activities Mr Jeffrey M Auerbach, GNSS Senior Advisor, U.S. Department of State, Office of Space and Advanced Technology
11:20	Multi-GNSS for Space Service Volume	Arunkumar Rathinam, Australian Centre for Space Engineering Research (ACSER), UNSW Australia	Interference Detection and Geo-location Research and Development: Evolution of GEMS to Griffin 1000	Ediz Cetin, Australian Centre for Space Engineering Research (ACSER), UNSW Australia	• GLONASS Status and Performance Improvement Mr. Roman Muravyev, Head of the GLONASS General Designer Administration Information and Analysis Center for PNT Central Research Institute for Machine Building Roscosmos
11:40	Results from Kea V4.1 Performance Testing	Eamonn Glennon, Australian Centre for Space Engineering Research (ACSER), UNSW Australia	Updates on Griffin 1000: a GNSS Jammer/Spoofer Detection and Geolocation System	Ryan James Richard Thompson, GPSAT Systems Australia Pty Ltd	BeiDou Status and Plans Mr. Chang KEWU, Programme Director, China Satellite Navigation Office, P. R. China
12:00	Lunch				
	Multi GNSS *Chair: Noor Raziq*		**CITS** *Chair: Andrew Dempster*		
13:00	Real-Time Cycle Slip Detection and Repair for Network Multi-GNSS, Multi-Frequency Data Processing	Tao Li & Stavros Melachroinos, CRCSI, Geoscience Australia	Cooperative P2I Localization Using UWB and Wi-Fi	Salil Goel, The University of Melbourne	
13:20	Preserving Multi-GNSS Performance	Rod MacLeod, NovAtel Inc.	Integrity Monitoring Methods for Co-operative Intelligent Transport Systems	Elizabeth Smith, University of New South Wales	
13:40	Trimble RTX Orbit Determination and User Positioning Performance with BeiDou Satellites	Nick Talbot, Trimble Navigation Australia	Cooperative Positioning in Urban Environments: Opportunities and Challenges	Joon Cheong, Australian Centre for Space Engineering Research (ACSER), UNSW Australia	
14:00	Evaluation of Accuracy and Availability of ARNS Multi-Constellation Signals for Aviation Users in Australia	Manoj Deo, Curtin University	Integration of IMU in Positioning Systems for Accurate Tracking in NLOS Environments	Shenghong Li, CSIRO	
14:20	Positioning Infrastructure in a Multi-GNSS World	James Millner, Position Partners	Trustworthy Positioning: Why we need to take it seriously	Chris Rizos, UNSW Australia	
14:40			Quality of Service (QoS) and Bi-Directional Communication in LBS Using MQTT	Izwan Idris, Charles Wang & Yanming Feng, Queensland University of Technology	
15:00	Afternoon Tea				
	PANEL *Moderator: Andrew Dempster*				
15:30	**Automated and Connected Vehicles** Leading experts from industry, government and academia will come together and discuss: **"How to achieve 1m 95% for C-ITS?"** • Paul Alexander (Cohda) • John Wall (Transport for NSW) • Andrew Mehaffey (Roads and Maritime Services, NSW) • Stewart Worrall (Australian Centre for Field Robotics) • Vinayak Dixit (rCITI, UNSW Australia)				
16:25	*Closing Remarks*				
16:30	Drinks and Trade Exhibition				
18:00	Day End				

Wednesday, 7th December

IGNSS2016

	Colombo Theatre A		Colombo Theatre B		Colombo Theatre C	
	Keynotes *Chair: Chris Rizos*					
9:00	**Joseph Winter** Head of AIS Innovation, R&D, Australian Institute of Sport **"Testbed for Wearable Electronic Sensors"**					
9:30	**Mike Terkildsen** Ionospheric Prediction Service, Australian Bureau of Meteorology **"Ionospheric Space Weather: Monitoring, modelling and mitigation"**					
10:00	**Greg Gutt** Chief Technical Officer, Satelles **"A New Robust System for Assured PNT - Satellite Time and Location - Hosted on Iridium"**					
10:30	Morning Tea					
	Australia's Next Generation Multi-GNSS Analysis Capability *Chair: Allison Kealy*		**Alternatives to GNSS** *Chair: Salil Goel*		**Algorithms and Methods I** *Chair: Joon Wayn Cheong*	
11:00	Multi-GNSS PPP-RTK network processing; achieving the accuracy	Peter Teunissen, CRCSI	Locata: Serving those Positioning, Navigation & Timing (PNT) Applications that GNSS can not	Chris Rizos, School of Civil & Environmental Engineering, UNSW	Seamless Train Localization Based on Beidou/INS/Odometer Multi-Sensor Navigation System	Wei Jiang, Beijing Jiaotong University
11:20	Development of the Multi-GNSS Analysis Centre Software	Stavros Melachroinos, Geoscience Australia	GNSS-based Positioning Schemes & Applications in Safety-critical Systems of Rail Transport	Chengming Jin, Beijing Jiaotong University/ University of Melbourne	Systematic Errors in UAS Aerial Photogrammetry	Yincai Zhou, University of New South Wales
11:40	BeiDou solar radiation pressure and attitude modelling	Stavros Melachroinos, Geoscience Australia	Inter-Pseudolite Range Augmented GNSS PPP Navigation for Airborne Pseudolite Systems	Panpan Huang, UNSW Australia	Dual GNSS / INS / Odometer post-processing	Michael Reichman, Advanced Navigation
12:00	Lunch					
	Construction, Mining and Structural Monitoring *Chair: Nick Talbot*		**SBAS/PPP I** *Chair: Suelynn Choy*		**Algorithms and Methods II** *Chair: Yanming Feng*	
13:00	BELS: GNSS Bridges between Europe and South East Asia	La The Vinh, Hanoi University of Science and Technology	A LEX-only QZSS LEX Signal Demodulation Scheme for LEX-PPP services	Huiben Zhang, Queensland University of Technology	Quantifying Mis-Modelling Effects in the GNSS Yaw-Attitude Determination	Thomas Papanikolaou & Stavros Melachroinos, CRCSI, Geoscience Australia
13:20	Developing an Integrated Wi-Fi-Based Positioning System and GIS for Improving Productivity Analysis of Construction Projects	Samad Sepasgozar & Sara Shirowzhan, Faculty of Built Environment, UNSW Australia	Biases in Multi-Constellation Triple-frequency PPP Models with a Float Ambiguity Solution	Manoj Deo, Curtin University	A Geometry-Free Approach for Estimation of Uncalibrated Signal Delays in GPS Triple Frequency Signals	Yanming Feng & Yongchao Wang, Queensland University of Technology
13:40	Third Generation of Positioning Systems for Underground Mine Environments, the Latest Progress	Binghao Li, University of New South Wales	Local Augmentation to Wide Area PPP Systems: a Case Study in Victoria, Australia	Suelynn Choy, RMIT University	Efficient Processing of Long Duration GNSS Signal Observations	Md Sohrab Mahmud, University of New South Wales, Canberra
14:00	Accuracy of stockpile volume determination using UAS photogrammetry	Luke Chidzey, Yincai Zhou, Craig Roberts, UNSW Australia	The Performance of Precise Point Positioning (PPP) using Triple-frequency GPS Measurements	Viet Tuan Duong, RMIT University	Influence of Individual GPS Antenna Calibrations on High Precision Geodetic Positioning, Case Study: Northern Surat Basin Queensland 2015 GPS Campaign	Guorong Hu & Michael Moore, Geoscience Australia
14:20	AeroPoints: Low-cost, Automated Ground Control Points for Aerial Surveying	Propeller	SBAS Update	Jack Scott	IRNSS/NavIC L5 Attitude Determination	Safoora Zaminpardaz, Curtin University
14:40			Comparison of Different Precise Point Positioning Ambiguity Resolution (PPP-AR) Methods	Shuyang Cheng, UNSW Australia	Assessment of the Variation of Covariance Matrices of Triple-Frequency GNSS Measurements and its Impact on Positioning Results	Yongchao Wang & Yanming Feng, Queensland University of Technology
15:00	Afternoon Tea					
15:30	**PANEL** *(Colombo Theatre A)*: Two separate panels, Industry vs Academia, will battle it out one after the other on the topic of: **"The rise of multi-GNSS: will GPS be the gold standard in five years?"** Industry Panel *Chair: Craig Roberts* • Nick Talbot (Trimble) • Gary Johnston (Geoscience Australia) • Nunzio Gambale (Locata) • Rod Bryant (u-blox) Academic Panel *Chair: Martin Nix* • Peter Teunissen (CRCSI) • Suelynn Choy (RMIT) • Andrew Dempster (UNSW ACSER) • Chris Rizos (UNSW)					
16:50	*Closing remarks*					
17:00	*Day End*					

19:00	**Embark on Harbour Cruise at King St Wharf Berth 9**
19:30	**Cruise Departs at 7:30pm sharp**
22:30	*Disembark, Evening End*

Thursday, 8th December

IGNSS2016

	Colombo Theatre A		Colombo Theatre B		Colombo Theatre C	
	Datum Modernisation *Chair: Matt Higgins*		**GNSS Hardware Design and Signal Processing I** *Chair: Elizabeth Smith*		**Alternatives to GNSS II** *Chair: Binghao Li*	
9:10	This session will explore how modern coordinate frameworks are moving away from traditional localised coordinate systems fixed to tectonic plates and instead relating to satellite based positioning systems through stable orbits. This transition will have challenging implications but will enable a kaleidoscope of new applications enabled by homogenous, global positioning systems. *Featuring: Matt Higgins (DNRM QLD), John Dawson and more to be announced...*		The Effect of the Sampling Frequency and the Front-End Bandwidth on the DLL Code Tracking Performance	Vinh Tran, Australian Centre for Space Engineering Research (ACSER), UNSW Australia	ARTags	Binghao Li, University of New South Wales
9:30			Improving Sensitivity on Kea CubeSat GPS Receivers	Eamonn Glennon, Australian Centre for Space Engineering Research (ACSER), UNSW Australia	Coarse-time Positioning without Continuous GPS Signal Tracking	Wonjae Yoo, Korea Aerospace University
9:50			RF Design for GNSS Receiver Front Ends	Kevin Parkinson, General Dynamics Ltd		
10:10						
10:30	**Morning Tea**					
	GNSS Networks, Processing and Calibrations *Chair: James Millner*		**GNSS Hardware Design and Signal Processing II** *Chair: Eamonn Glennon*		**SBAS/PPP II** *Chair: Peter Ramm*	
11:00	Recent IGS Analysis Centres Coordinator Activities	Guorong Hu & Michael Moore, Geoscience Australia	Integrated Techniques for Interference Source Localisation in the GNSS Band	Joon Cheong, Australian Centre for Space Engineering Research (ACSER), UNSW Australia	Different Shades of GNSS SBAS	Suelynn Choy, RMIT University
11:20	The Status of China's Proposed International GNSS Monitoring and Assessment System (iGMAS)	Su Mudan, China Satellite Navigation Project Center (CSNPC)	An Ultra-Low-Cost Antenna Array Frontend for GNSS Application	Vinh Tran, Australian Centre for Space Engineering Research (ACSER), UNSW Australia and Thuan Nguyen Dinh, HUST, Vietnam	Ambiguity resolved PPP a case study in NSW	Thomas Grinter, Volker Janssen and Craig Roberts, UNSW Australia
11:40	Upgraded AUSPOS and Refined Solution Uncertainty	Dr Minghai Jia, Geoscience Australia	Receiver Losses when using Quadrature Bandpass Sampling	Andrew Dempster, Australian Centre for Space Engineering Research (ACSER), UNSW Australia	2nd Generation SBAS: Opportunities, Applications, and Issues	Bob Jackson, Lockheed Martin Space Systems Company
12:00	Supporting Positioning in Australia through Open Access Multi-GNSS Data	Ryan Ruddick, Geoscience Australia	Simulators, and their applications in developing and testing GNSS systems	David Pearce, Vicom Australia & New Zealand		
12:20	**BBQ Lunch**					
13:20	Event End					