Global Navigation Satellite System Implementation Team - Report

Purpose: Consideration
Submitted by: GIT Co-Chair
1. GENERAL

The 22nd Meeting of the Asia Pacific Economic Cooperation (APEC) Global Navigation Satellite System (GNSS) Implementation Team (GIT/22) was hosted by Chinese Taipei from 25-28 April 2017 in conjunction with the 44th APEC Transportation Working Group (TPTWG) meeting.

Eight APEC Economies, namely China, Japan, Republic of Korea, New Zealand, Russia, Chinese Taipei, Thailand, and the United States participated in GIT/22 meeting. The GIT/22 included industry participation to incorporate the views of the private sector.

Presentations covered the GIT project: Regional GNSS Receiver Autonomous Integrity Monitoring (RAIM) Prediction System, and an update on the APEC GIT website. Presentations also included economy reports on GNSS implementation in APEC economies, covering GNSS applications in air transportation including discussion of the cost and benefits analysis of a regional Satellite-Based Augmentation System (SBAS).

A special session on GNSS technology and applications is held to cover GNSS applications in weather forecasting, unmanned aerial systems, maritime, intermodal transport, and intelligent transport systems. During this special session, GIT has joint meeting with aviation safety sub-group (AEG-SAF), and intermodal and intelligent transport system (IIEG) to discuss possible cooperation and project proposals on topics of aviation weather, and intermodal transport and intelligent transport systems, respectively.

Updated information on GNSS constellations and augmentation systems was provided with a report on Beidou from the People’s Republic of China, QZSS and MSAS from Japan, KASS from Republic of Korea, GPS, WAAS, and NDGPS from the United States, and GAGAN from India which were well received by the GIT.

The working language during GIT/22 was English. The GIT recommended having at least two full days to meet during future TPTWG meetings.
2. OPENING OF THE APEC GIT/22

Dr. Jaching Chou, Co-chair of the GIT from Chinese Taipei provided welcoming remarks and encouraged GIT attendees to enjoy the beautiful Taipei city. Ms. Karen Van Dyke, Co-chair of the GIT from the United States expressed appreciation to Dr. Jaching Chou for all of his work in preparation for GIT/22 and she expressed a great appreciation from the GIT to Papua New Guinea for hosting GIT/21.

3. AGENDA ITEM 1: ADOPTION OF THE AGENDA

The GIT Co-Chairs reviewed the draft agenda and the GIT/22 representatives adopted it. The agenda is attached as Appendix A to this report.

4. AGENDA ITEM 2: Report of the 21st Meeting of the APEC GIT/21 Summary to IIEG in TPTWG-43

Dr. Jaching Chou, GIT Co-Chair, summarized the GIT activities during its 21st meeting in April 2016 in Port Moresby, Papua New Guinea, and his report to the IIEG at TPTWG-43 which was held in September 2016 in Kuala Lumpur, Malaysia. The GIT/22 reviewed and endorsed the GIT/21 report, as shown in Appendix B.

5. AGENDA ITEM 3: Joint Ministerial Statement, 9th APEC Transportation Ministerial Meeting, 09 October 2015, Cebu, Philippines

The GIT reviewed the GNSS related directives of Joint Ministerial Statement, 9th APEC Transportation Ministerial Meeting, and agreed to discuss intersessionally regarding draft Joint Ministerial Statement for 10th APEC Transportation Ministerial Meeting to be held in Papua New Guinea in October 2017.

Action Item 22-1: GIT Members should submit any proposed language for 10th Transportation Ministerial Meeting to the GIT Co-chairs.

6. AGENDA ITEM 4: Draft recommendations for TPTWG reform and modernization from TPTWG Lead Shephard

The GIT reviewed draft recommendations from a special meeting of TPTWG-43 HODs was held on 5 September 2016, in Kuala Lumpur, Malaysia, to consider options for reforming and modernizing the TPTWG’s structure, and discussed the possible impact to the arrangement GIT meeting under the recommendation of “If an Expert Group decides it needs a special sub-group discussion at a forthcoming TPTWG meeting, this must be agreed in advance by HODS, ideally at the previous TPTWG meeting. The host economy has the final decision, since they will be meeting the additional costs of the meeting room.” The GIT acknowledges the benefits of meeting in conjunction with TPTWG.

7. AGENDA ITEM 5: TPTWG Work Plan on 2017

The GIT reviewed TPTWG Work Plan on 2017, and there are two actions GIT related directed by APEC Leaders which are “promote the implementation and use of satellite navigation systems across transport modes”; and “Support supply chain diversity, growth,
integration and resilience, including through such initiatives as supporting ITS and GNSS improvements and uptake.” The GIT held a workshop to promote GNSS and its support on supply chain growth and ITS and a special session in TPTWG/44 was held to share and promote GNSS applications on weather aviation, maritime, cross border cold chain logistics, connected vehicles and autonomous vehicles, and fleet management and Internet of things.

8. **AGENDA ITEM 6: REVIEW OF GIT/21 ACTION ITEMS**

The GIT reviewed the action item from GIT/21 related to the GIT website hosted by the Republic of Korea and deferred discussion to Agenda Item 8.


As discussed at GIT/21, it was agreed to update the GIT Strategy to reflect priorities from 9th Transportation Ministerial Meeting related to the safety, security, and resilience of GNSS and topics of discussion at recent GIT meetings.

Discussion topics at GIT/22 for an updated version of the GIT strategy include:

- Economic benefit analysis of GNSS and augmentation systems
- Increasing the resiliency of GNSS through adoption of best practices for receiver implementation and mitigation of threats to GNSS
- Evaluation of expansion of SBAS capabilities for all modes of transportation and other applications, in particular those within APEC regions that do not currently have SBAS capability
- Focus on use of GNSS in conjunction with other navigation and sensor technologies for unmanned applications for various modes of transportation

**Action Item 22-2**: GIT Members should identify any additional focus area for the GIT 2017-2022 strategy.

10. **AGENDA ITEM 8: Progress updates on On-Going APEC GIT Projects and Activities**

10.1 **APEC GIT Website**

The Republic of Korea provided a presentation on enhancement of the APEC GIT website to provide all APEC economies an opportunity to share developments on GNSS activities and share this information with the public to enhance visibility and educational outreach activities. The main change of the website is adding function for registration of member economies and uploading the material of each economy.

Website operation was changed by installing the server in a security-enhanced site. It is not possible to access website’s management page by external site. There was a request for changing the front image on website to economy’s representative image at last APEC GIT meeting. However, it requires high quality images that are copyright-free.
It is suggested using APEC TPT images for the APEC GIT homepage. All materials for APEC GIT meeting will be gathered by Chairs of APEC GIT before meeting and will be transferred to the manager of the website for updating.

**Action 22-3:** GIT members to continuously provide recommendations to the Republic of Korea for improvement to the GIT website, and encourage members to submit GNSS-related information, including news items, to the Co-Chairs further for the Republic of Korea to upload to the website for information sharing. Also, if economies have GNSS-related images that are copy-right free, they are encouraged to provide them for use on the website.

### 10.2 Enhancing Aviation Connectivity and Emissions Reduction via Implementation of Performance-Based Navigation (PBN) Assistance Program

This is a repeat project funded by APEC, sponsored by Thailand, the United States, and the target economies of Indonesia and Mexico. This project is also cross-fora collaboration with Energy Working Group. Separately, the United States has agreed to provide FAA guidance material on the implementation of PBN procedures. Project completed and reports can be downloaded from APEC Web site.

Ms. Emily White, Chair of the Aviation Experts Group, expressed appreciation via e-mail to the GIT Co-Chair, thanking the GNSS Implementation Team for their endorsement of the PBN project. The final reports are now posted on the APEC web site. The United States FAA will be following up on the recommendations for both economies and just signed a technical assistance project with Mexico and PBN assistance is one of the items in the plan. The United States FAA also is working an assistance project agreement with Indonesia which we expect will also have PBN as an item of assistance. Additionally, the ICAO North America office in Mexico City will be checking in with Mexico periodically on their progress.

She noted that this is a repeat project. The first project was concluded in 2013 with Malaysia and the Philippines. Since that time, both economies have significantly improved their ICAO implement rates of PBN. Malaysia, increasing from 28.6% to 71.4%, and The Philippines, increasing from 26.7% to 53.3%. She is hopeful to see similar progress from Indonesia and Mexico.

### 10.3 Regional RAIM Prediction System

Thailand presented the meeting with the latest update on Regional Receiver Autonomous Integrity Monitoring (RAIM) prediction system via web application named www.netra.aero. Two more economies (Vietnam and Myanmar) have joined the NETRA RAIM prediction system. Therefore, NETRA RAIM prediction system can support the service within Bangkok FIR, Vietnam FIR, and Myanmar FIR. Also, Thailand invited APAC ICAO member States and APEC economies to share use the system under a cost-sharing arrangement.

### 11. AGENDA ITEM 9: Update on Satellite Constellations and Plans (Including Augmentation Systems)

Global Positioning System
On behalf of the U.S. National Coordination Office for Space-Based Positioning, Navigation and Timing (PNT), Mr. Ken Alexander presented an update on U.S. GNSS and its augmentations. U.S. GPS policy issued in 2004 remains unchanged since being reaffirmed by 2010 Space Policy which addressed the use of other economies PNT services to augment and strengthen the resiliency of GPS. The Federal Communications Commission’s rules for use of other economies GNSS signals and provisions for waiver request were overviewed along with the status of a European Union waiver request for Galileo use in the U.S.

The configuration and details of the GPS constellation’s four generations of satellites was presented along with a scorecard showing 35cm as the best day signal-in-space performance and 67.3 cm as the worst day performance over the past year. Additionally, an independent GPS performance review was completed that confirms all performance commitments are met http://www.gps.gov/systems/gps/performance/. An updated GPS performance standard is anticipated in 2017.

GPS III is the newest block of GPS satellites and have a design life of 15 years. GPS III adds the new L1C signal planned for initial transmission in 2021. The first GPS III satellite completed assembly and test and was placed into storage earlier this year for expected launch in 2018. Nine additional satellites are in various stages of production. A production readiness feasibility assessment is ongoing in support of a full and open competition for satellites 11 through 32. Twenty-four satellites should be broadcasting L2C and L5 in the in the 2021 and 2024 timeframes respectively.

Mr. Alexander presented the Federal Aviation Administration (FAA) update on the Wide Area Augmentation System (WAAS) including a system overview, current Localizer Performance Vertical (LPV) performance and worst case performance during a March 2016 ionospheric event. Details were provided on WAAS sustainment and modernization activities that will enable dual-frequency operations to increase the availability of SBAS vertical services during ionospheric disturbance events. Dual-frequency, multi constellation capabilities (DFMC) are being pursued to leverage other compatible constellations through advanced RAIM (ARAIM) capabilities, as a complement to SBAS, with an initial focus on horizontal navigation (H-ARAIM).

Recent ARAIM activities include: airborne prototype flight testing, offline ground monitoring, development of a preliminary safety case, ICAO/RTCA standards support and plans for new GPS messages (MT 38/39) to provide a capability to broadcast an ARAIM integrity support message (ISM) for GPS and potentially other constellations. Prototype activities are underway to add Galileo processing on a trial basis to the WAAS G-III reference receiver fielded at all reference stations via a software update expected in mid 2017. Currently there are over 95,000 SBAS equipped aircraft in the U.S. with numbers expected to significantly increase as operators equip for the 2020 ADS-B Out rule. In the past year, commercial aircraft manufactures announced plans for provision of SBAS capabilities in support of U.S. and international ADS-B requirements.

Ground based augmentation system (GBAS), also known as local area augmentation system (LAAS), is implemented at two U.S. airports as airport owned and operated equipment. Additional airports are interested in acquiring GBAS with support from their airline operators. FAA approval of a Honeywell SLS-4000 block II upgrade in 2016 improves performance when there is elevated ionospheric activity and in equatorial regions. In March 2017, the
FAA signed a bilateral agreement with Brazil to assist in ionospheric threat model development for lower latitude applications.

In December 2016, the ICAO NSP approved single-frequency GBAS GAST-D standards for approach and landing operations to CAT III minima and RTCA approval of the corresponding minimum operational performance standard (MOPS) for CAT III capable avionics is planned in May 2017. System design approval activities for the Honeywell SLS-5000 GAST-D GBAS remain underway. The International GBAS Working Group (IGWG) organized by FAA and EUROCONTROL to foster communication and collaboration among states implementing GBAS met in Atlanta, Georgia this past week.

The U.S. Nationwide Differential GPS (NDGPS) coverage was reduced from 83 sites to 46 sites on August 4, 2016 and 44 sites are currently retained. Inland coverage was eliminated with exceptions for the great lakes and St Lawrence Seaway. Additionally, redundant maritime coverage was eliminated in most areas. Equipment removal has started and should complete in 2018. The U.S. is continuing to evaluate future NDGPS needs as other GPS augmentation systems mature including potential future reductions and alternatives.

BeiDou

China Satellite Navigation Office (CSNO) has published The Whitepaper of BDS, which demonstrated the BDS a 3-phase system development plan. The BDS regional system, or BD-2 possessed FOC on 2012. The BDS global system, or BD-3 is expected to possess FOC by 2020. Two GBAS sites GBAS have been in the procedure of certification and operational approval, one is based on the GPS and the other is based on DFMC. China has already started the construction of SBAS, which name is BDSBAS. The service of BDSBAS will be provided by 3 geostationary satellites to be launched between 2018 and 2020. BDSBAS will provide dual frequency service over L1/B1C and L5/B2a. It will augment BDS and GPS initially, with the possibility to augment Galileo and GLONASS as well if recommended by ICAO. The targeted service area includes China and surrounding areas. The service level is APV-1 initially and CAT-I for the longer term. The full operational capability is foreseen by 2022.

QZSS

The QZSS, Quasi-Zenith Satellite System, is Japanese regional satellite navigation service providing GPS-complement ranging signals, GNSS augmentation signals, and two-way messaging service. It begins the operation with 4-satellite constellation in April 2018 and will have 7 satellites around 2023. The QZSS program will integrate Japanese SBAS service called MSAS in 2020; Japan continues the operation of SBAS, which has been operational since 2007, with an upgrade to be capable of the vertical guidance likely in 2023. The test of the Dual-Frequency Multi-Constellation L5 SBAS will be initiated in 2017 using QZSS L5S signals transmitted from IGSO as well as GEO, and participations to this activity from APEC Economies are highly expected.

KASS

This presentation is to introduce of Korean SBAS program named KASS (Korea Augmentation Satellite System). KASS program and development is overviewed in presentation. The goal of KASS program is to achieve the Korean SBAS system with APV-I
SoL service to 2022. KASS program’s organization structure and development plan is viewed. The goal of KASS is to develop a satellite-based augmentation system in compliance with performance requirements from ICAO. It will provide APV-I SoL service in airports of Korean peninsula area and start open service (2020) and APV-I service (2022) also. It is presented that road map of KASS program, organization, and architecture. And application of KASS is provided with plan.

**GAGAN**

The GAGAN system, which is the 4th SBAS system in the world and the only SBAS system in the world with certified algorithm specifically designed for the equatorial region (adjusted for ionospheric disturbances often seen in the equatorial areas). The system was certified to APV1 in 2015 and since certification, the system performance has been continuously stable. The current configuration contains 2 GEO satellites, 3 uplink stations, 2 master control stations and 15 reference stations. Last year an additional GEO satellite (GSAT15) was launched, which is being integrated to the certified GAGAN system and signal will be available later this year. The 3rd GEO satellite can be adjusted to provide service coverage outside of the current GAGAN footprint.

Additional GEO satellites can be added in the future if there is a need for additional GEO footprint. Furthermore, the GAGAN system can accommodate up to 45 reference stations (thus additional 30 stations can be added). Analyses conducted indicated the improved system performance when additional reference stations are added to the GAGAN system outside of India. The second part of the study (conducted by an independent consultant firm, KPMG) will also quantify the additional benefits SBAS brings to other sectors and the results will be available in the summer of 2017. Therefore, now is an opportunity for neighboring economies to join the GAGAN system to leverage the certified SBAS capability (with accuracy and integrity) without the significant initial investment of an SBAS system.

**Action Item 22-4:** SBAS cost benefit analysis from KPMG will be shared with the GIT when it is completed (anticipated for June 2017). GIT members were encouraged to also share any GNSS-related cost benefit analysis information they were aware of.

12. **AGENDA ITEM 10: REPORT FROM INTERNATIONAL ORGANIZATIONS**

No reports from international organizations were provided.

13. **AGENDA ITEM 11: ECONOMY REPORTS ON INITIATIVES/ACTIVITIES ON GNSS IMPLEMENTATION**

**China**

CAAC has published PBN procedures based on GNSS at all 218 Airports. 310 ADS-B ground stations will be deployed by the end of 2017, CAAC will provide initial ADS-B OUT operation service in some core airspace and routes firstly, especially in Non-Radar Surveillance routes. CAAC has published “Civil Aviation Technical Requirements for Ground-Based Augmentation System Ground Equipment - Category I Precision Approach” and “Civil Aviation Testing Procedure for GBAS (CAT-I)”. “Sitting Criterion for Civil Aviation Ground-Based Augmentation System Ground Equipment" has been drafted.
The DFMC GBAS (GAST-F) research project has been initiated since November 2016, supported by CAAC and MOST (Ministry of Science and Technology of China), the trial system will be deployed and tested by the end of 2020. Application of BDS on General Aviation has been carried out for flight tracking and dispatching.

**New Zealand**

On 17 January 2017 the Australian Ministers of Infrastructure and Resources announced that the Federal Government would be providing A$12M to fund a SBAS test-bed and trial programme. On 10 February 2017 Geoscience Australia announced that the test-bed would be provided by a consortium of Lockheed Martin from the USA, GMV from Spain and Inmarsat from the UK.

On Friday, 17 February 2017 the Prime Ministers of Australia and New Zealand announced that the New Zealand would be joining a satellite-based augmentation system trial programme and providing A$2M.

CRCSI (http://www.crcsi.com.au/sbas/) is organising the trial programme which will focus across 10 sectors, including aviation, maritime, road, and rail applications.

**Papua New Guinea**

PNG Air Services Ltd. finally signed its GNSS Project contract with IDS Corporation of Australia in late February this year. The project will basically see the provision of the design of RNP APCH LNAV and design of RNP APCH LNAV/VNAV approaches at 45 selected airports within PNG that can support such procedures and to provide SIDs and STARS for Jackson’s International Airport. There is an opportunity to provide GNSS approaches to additional airports/airstrips and this will require additional WGS-84 Surveys to be conducted as well.

**Russia**

Russia presented a government supported project aimed to ensure safety on transport by using satellite navigation system which called “ERA-GLONASS”. The Russian Federation also noted the active use of the GLONASS jointly with the GPS system in the field of civil aviation. Russia illustrated the usage of the satellite-based navigation and communication systems in sea and inland waterways areas.

The Russian Federation considers it is possible to use indigenous satellites to accommodate Automatic Information System (AIS) payloads on space vehicles launched under the GLONASS program, the installation of ground-based stations for information processing in Russia.

**Chinese Taipei**

The new ATC control tower complex of Tao-Yuan international airport (RCTP) is under construction. This project is planned to build a 65 meters height ATC control tower that can support RCTP airport handles its getting higher flight numbers, and can sustain the estimation of yearly flight services around 340,000-400,000 vehicles in the next 20 years. Chinese Taipei implemented its first PBN route in November 2016. The new route is a RNAV 2
specification route that can offload Japan and Korea bound flights and relieve the existing routes congestion in Taipei FIR.

The United States

Mr. Ken Alexander presented an update on U.S. PNT resiliency policy and activities. The U.S. Department of Transportation is completing a GPS/GNSS adjacent band compatibility assessment for the L1 band to identify adjacent band transmit power levels that can be tolerated by existing GNSS receivers for civil applications. The Department in conjunction with the Volpe Center led the assessment and the FAA conducted a parallel analysis activity for certified aviation avionics that are designed and tested to established international interference standards.

Since GNSS products, other than certified avionics, do not have documented interference standards, radiated test data was collected in an anechoic chamber, conducted test data was collected in a laboratory environment and antenna characterization data was collected for each of the GNSS receiver and antenna combinations. The GNSS receiver test plan and outcomes were vetted through multiple public notices and workshops. 80 receivers representing six categories of GPS/GNSS receivers: cellular receivers, general aviation (non-certified), general location/navigation, high precision and networks, timing, and space based receivers were tested using both 1 MHz and 10 MHz wireless LTE representative signals. The receivers were tested in an environment that included the GLONASS, BeiDou, Galileo and GPS L1 signals. interference tolerance masks (ITMs) were then developed based upon a 1 dB rise in signal to noise ratio criteria consistent with ITU standards. This criterion was tested and found to be a good indicator of pending loss of satellites data by the receivers. Subsequently, through inverse propagation modeling, separation distance and power limits were derived to support use case scenarios for each of the receiver categories.

Results were presented at a public workshop on March 30, 2017 and can be viewed at: https://www.rita.dot.gov/pnt/gps_adjacent_band_compatibility_workshop/agenda6. The cellular receiver category was the only category of receivers that was more robust than the certified aviation receiver standards. The high precision and space based receivers categories were the most susceptible to interference and produced the bounding interference tolerance mask. As an example, an interfering signal at 1530 MHz had an impact region that extended greater than 10 km from the transmitter for EIRP of 29 dBW and 1.5 to 2 km for an EIRP of 10 dBW (approximately 10 Watts). A final report is in preparation for public vetting and comment.


Pending RTCA GBAS standards and FAA SBAS TSOs include recommendations to address the DHS “Best Practices” document as well as include cross-checks of GNSS sensor data against: independent position sources and/or through integration with other systems at the aircraft level, and to include aircraft equipment cybersecurity information security vulnerability mitigation techniques. Public comment closed April 17, 2017 and more
The U.S. has continued to investigate provision of a Complementary PNT (CPNT) capability. Recent activities identified and assessed alternatives including a broad mix of terrestrial RF and autonomous PNT technologies, a cooperative research and development activity with Industry and public stakeholder input on a timing backup capability obtained by Federal Register Notice. The 2016 National Defense Authorization Act (NDAA) has now tasked the DoD, DHS, & DOT Secretaries to jointly conduct a study to assess and identify technology-neutral requirements to backup and complement the PNT capabilities of the Global Positioning System for national security and critical infrastructure and subsequent tasks by December 2017.

In 2016, the FAA published a performance-based navigation (PBN) strategy document that retains and refreshes DME infrastructure to enable DME/DME RNAV, without the need for an inertial reference unit, for operations in Class A airspace and at larger airports.

PBN route structure will be provided where needed with direct point-to-point navigation where structure is not necessary. Most Jet Routes and Victor Airways will be removed and replaced with RNAV Q/T Routes, where needed. VORs will remain in the NAS for the foreseeable future at a VOR minimum operational network (MON) level established with public input. All existing CAT-II/III ILS will be retained to provide access for commercial aircraft in low/zero visibility and CAT-I ILSs will be assessed to identify any systems that might be discontinued.

In summary, all GNSS is vulnerable to intentional interference/spoofing. Intentional Interference and Spoofing are radio frequency (RF) cyber attacks, and the threat and capability of spoofing is likely to increase in the future. Backup systems and mitigations allow continued safe operation at reduced levels of efficiency and capacity. Additional mitigations are available and also necessary.

14. AGENDA ITEM 12: Consideration of New Concept Notes and Project Proposals

The Joint Multi-GNSS Demonstration for the applications on transportation field in the Asia Pacific region proposed by Japan had been previously discussed at GIT/19 to be submitted in early 2014 discussed under Agenda Item 6. This concept note is dismissed by Japan, and a new Concept Note in the area of SBAS could be proposed in the next GIT meeting.

At GIT/20, the Russian Federation presented its Concept Note “Sharing Best Practices on GNSS-based Tools and Applications for Road Accidents Emergency Response”. The project is targeted at saving lives and mitigating injuries resulted from road traffic accidents or other road emergencies through implementation and promotion of new Global Navigation Satellite Systems (GNSS) applications. Russia requested the GIT to keep this Concept Note open for potential consideration at a future GIT meeting.

15. AGENDA ITEM 13: ARRANGEMENT FOR THE NEXT MEETING

The meeting noted the venue and period of past meetings as shown below:
• GIT/1 in Los Angeles, U.S.A., February 2002;
• GIT/2 in Brisbane, Australia, September 2002;
• GIT/3 in Kobe, Japan, February 2003;
• GIT/4 in Chiang Mai, Thailand, October 2003;
• GIT/5 in Taipei, Chinese Taipei, March 2004;
• GIT/6 in Phuket, Thailand, October 2004;
• GIT/7 in Bali, Indonesia, February 2005;
• GIT/8 in Seoul, Korea, October 2005;
• GIT/9 in Penang, Malaysia, April 2006;
• GIT/10 in Manila, the Philippines, October 2006;
• GIT/11 in Tokyo, Japan, June 2007;
• GIT/12 in Bangkok, Thailand, May 2008;
• GIT/13 in Singapore, July 2009;
• GIT/14 in Seattle, USA, June 2010;
• GIT/15 in Brisbane, Australia, June 2011;
• GIT/16 in Bangkok, Thailand, February 2012;
• GIT/17 in St. Petersburg, Russia, July 2012;
• GIT/18 in Bali, Indonesia, July 2013;
• GIT/19 in Christchurch, New Zealand, April 2014;
• GIT/20 in Jeju, Republic of Korea, May 2015;
• GIT/21 in Port Moresby, Papua New Guinea, April 2016;

The next APEC GIT/23 meeting is planned to be held in conjunction with APEC TPTWG meeting 2018, and the GIT also encourages members to consider hosting GIT/23.

16. AGENDA ITEM 14: Special Session on GNSS Technology and Applications

According to TPTWG Work Plan on 2017, and there are two actions GIT related directed by APEC Leaders which are “promote the implementation and use of satellite navigation systems across transport modes”; and “Support supply chain diversity, growth, integration and resilience, including through such initiatives as supporting ITS and GNSS improvements and uptake.” This special session, an action to these two actions, is held to promote the implementation and use of satellite navigation systems across transport modes, and to support supply chain connectivity, and ITS. Topics covered include GNSS applications on weather aviation, maritime, cross border cold chain logistics, connected vehicles and autonomous vehicles, and fleet management and Internet of things.

During this special session, GIT has joint meeting with aviation safety sub-group (AEG-SAF), and intermodal and intelligent transport system (IIEG) to discuss possible cooperation and project proposals on topics of aviation weather, and intermodal transport and intelligent transport systems, respectively.

16.1 GNSS and Weather Forecasting

Ms. Vicky Chu, program director of FORMOSAT-7, from National Space Organization (NSPO), Chinese Taipei demonstrated that through measuring GPS and GNSS signals, FORMOSAT-3 and FORMOSAT-7 satellites can provide the profiles of temperature and
humidity. A lot of studies show the radio occultation data can improve the accuracy of weather forecast. The FORMOSAT-3 data can be accessed through http://tacc.cwb.gov.tw/en/index.htm. NSPO also endeavors to develop the GPS/GNSS-related hardware. Space-grade GPS receivers and cost effective GPS receivers are now commercially ready. The GNSS-reflectometry instrument and its data processing are under development.

16.2 ADS-B Value Added Applications on Aeronautical Meteorology

Professor Shau-Shiun Jan from National Cheng Kung University, Chinese Taipei talks about the possible use of ADS-B data to augment the current aviation weather system. In the presentation, the download message from ADS-B is demonstrated, and this could be useful for weather information. To identify the correlation between the weather condition and the aircraft maneuver, the machine learning method, SVM algorithm, and the feature selection technique are implemented to the system. Compared to the pilot report, this proposed system is more similar to the actual weather condition close to aircraft than that of the traditional ground-oriented weather information.

16.3 2nd Generation SBAS: Issues, Opportunities, and Applications

Mr. Robert Jackson from Lockheed Martin, USA presents that recent developments in Global Navigation Satellite Systems (GNSS) open a range of possibilities for improved navigation in all transportation sectors. In addition to the Global Positioning System (GPS), new GNSS core constellations are coming into service, including Galileo, BeiDou, and modernized GLONASS. These core GNSS constellations are - or will soon be - broadcasting new ranging signals on another protected frequency. When augmented with correction and integrity data from a Satellite Based Augmentation System (SBAS), there is now a solution in hand for global safety-of-life, multimodal transportation applications.

The introduction of dual frequency SBAS will also meet the most demanding requirements in the equatorial region, where availability has been limited with single-frequency SBAS. Taken together, dual frequencies and multiple constellations hold the potential for a revolution in GNSS. The opportunity also exists for Economies and the private sector to collaborate in meeting the positioning, navigation, and timing requirements for a broad spectrum of users with a cost-effective business model. Lockheed Martin, GMV, and Inmarsat, together with Australia and New Zealand, are implementing a 2nd Generation SBAS Testbed to demonstrate the concept and applications. Other APEC Economies are invited to participate.

16.4 and 16.5 Inmarsat’s role in SBAS and the Benefits of Future SBAS Architectures for Aviation Infrastructure and Safety: Enabling Advanced Operations in Remote Areas, Small Airfields and Difficult Terrain

Mr. Claudio Soddu and Dr. Hannes Griebel from Inmarsat present Inmarsat’s involvement in SBAS systems worldwide and views on using SBAS to improve aircraft operations in remote locations with difficult terrain and visibility. Inmarsat, a world leader in global mobile satellite services delivering a broad base of high bandwidth communication services and content to the mobile market, has been at the forefront of pioneering the concept of augmenting satellite navigation systems such as GPS or GLONASS with a separate satellite data and ranging channel. What was originally proposed to provide a critical level of positive integrity to aviation users eventually evolved to become the current SBAS concept. A brief
excursus of Inmarsat involvement in satellite navigation is provided and Inmarsat’s contribution to operational systems, such as WAAS and EGNOS, is described with attention to the space segment component (i.e. navigation transponder), which is where Inmarsat plays a major role.

With respect to future adoption of SBAS for aviation operations, we will explore how SBAS can help remote and difficult to access regions benefit from the positive impact of aviation. By providing a significant improvement to navigational accuracy, SBAS can be one of the key enabling factors in reducing the cost and improving the reliability of aircraft operations in areas where today the use of ground-based infrastructure is cost prohibitive or downright impossible. Exploring future technical possibilities, we will look at some of the factors that will enable advanced operations and safety improvements, while at the same time being more accessible and affordable. Therefore, we will show how globally accessible, affordably priced advanced SBAS services can become a significant contributing factor to a region’s infrastructure and economic growth.

16.6 The Innovative Applications of Unmanned Aircraft System

Dr. Cheng-Fang Lo from GEOSAT, Chinese Taipei summarized the Federal Aviation Administration’s (FAA) Roadmap for Integration of Civil Unmanned Aircraft Systems (UAS) in the National Airspace System (NAS). Unmanned aircrafts offer new ways for commercial enterprises and public operators to increase operational efficiency and decrease costs, however challenges remain for the safe, long-term integration of UAS in the NAS. Ultimately, UAS must be integrated into the NAS without reducing existing capacity, decreasing safety, or increasing the risk to airspace users or persons or property on the ground any more than the integration of comparable new and naval technologies.

In order to implement all the innovative applications, it is necessary to develop revised regulations and new procedures for enabling manned and unmanned aircraft to operate cohesively in the same airspace. Two critical technology challenges should be taken closely into account: “Sense and Avoid” (SAA) capability and Control and Communications (C2) system performance requirements. SAA must provide for self-separation and ultimately for collision avoidance protection between UAS and other aircraft. C2 requirements need to support the minimum performance required to achieve higher-level (UAS level) performance and safety requirements.

Dr. Lo proposed a cloud based surveillance platform for UAS transportation management, which suggests that UAV is equipped with tracker for identification and is monitored on-the-fly by the surveillance station via LTE/4G communication network. Defining the 3D restricted space for UAV, the Geo-Fence can be downloaded and updated inside UAV’s flight control computer to prevent from infringing. Based upon the above platform, drone delivery could be implemented via path planning, with terrain or geo-fence avoidance and landing by authenticating receiver QR code in sub-urban area under 4G mobile communication and cloud surveillance.

16.7 Applications of AIS on Air Quality Management

Dr. Yung-Fang Chiu from Institute of Transportation, Chinese Taipei mentioned that in order to meet the need for collision avoidance on ships and Vessel Traffic Services (VTS) around Chinese Taipei surrounding waters, an automatic tracking system through via VHF to
monitor ship traffic around Chinese Taipei was established, and effectively enhance the management and safety of ship transportation. Since 2016, the Automatic Identification System (AIS) has established 24 AIS stations including 17 inland stations on Chinese Taipei and 7 offshore stations on other islands. The results of AIS have been applied to compute the amounts of air pollutants emitted by ships at the five major harbors in Chinese Taipei, to evaluate their impacts on the ambient air quality around Kaohsiung, and to develop real-time air quality forecasting system for primary pollutants around Kaohsiung by combining AIS with air quality dispersion model AERMOD.

16.8 GNSS Applications Experiences of Cross Border Cold Chain Logistics

Mr. I-Shinn Tien from Industrial Technology Research Institute, Chinese Taipei presented GNSS applications on cold chain logistics. Cold chain logistics is vital for the safe and sanitary delivery of temperature sensitive items such as food. A quality logistics service solution further assists in reducing energy consumption and delivery cost. With the assistance of the professional team and the supports of the industries in Chinese Taipei which developed a technology that provides a total solution for cold chain logistics services. The technology is based on a lightweight smart cool box that is visually monitored through a temperature management platform.

By means of this technology, a logistics service provider can manage multi-temperature storage spaces in all vehicle shipments to meet a chain store’s small-volume large-variety joint distribution requirement. In addition, the professional team also developed a temperature sensor tag as well as an automatic temperature information collecting and transmitting solution through the 3G/4G/Wi-Fi applications to establish a cargo's logistics pedigree as it relates to its entire delivery process. Information derived from this solution can link to the aforementioned temperature management platform, which can help enterprises monitor and track cargo delivery records.

16.9 Positioning Issues of Connected Vehicles and Autonomous Vehicles

Dr. Che-Cheng Chang from Automotive Research and Testing Center, Chinese Taipei addressed that vehicles are one of the most used transport facilities for people’s daily life. To enhance the capabilities of modern vehicles, many advanced assistant safety techniques have been developed for various scenarios. Among those techniques, localization is at the center of the signal processing chain. For example, connected vehicles for collision avoidance needs better positioning information to avoid false positive and false negative situations. However, due to outages and multi-path appearance of GPS signals frequently occur in some scenarios, it is not always useful for some particular applications. Hence, we propose a novel concept of vehicle positioning system to enhance not only the accuracy but also the reliability of vehicle positioning system. The demonstration shows that our vehicle positioning system works well for autonomous cars.

16.10 GNSS Applications of Fleet Management and Internet of Things

Dr. Po-Chou Lin from Chunghwa Telecom Laboratories, Chinese Taipei presented GNSS applications of fleet management and several interesting Internet of Things (IoT) applications. The GPS/GNSS module migration in the last 10 years is summarized, which includes high acquisition/tracking sensitivity, embedded EE (CGEE/SGEE) and smart power saving. The GNSS technology combined with untethered dead reckoning (UDR) are feasible
for tunnel or packing garage applications. Benefits of fleet management system including logistics, taxi dispatch and public eBus system are presented. GNSS related new IoT applications, such as usage based insurance (UBI), UAV/drone and safety jacket/camp are also introduced. According to the OVUM analysis, the positioning technology is required in most of the IoT Applications.

17. **AGENDA ITEM 15: ADOPTION OF THE MEETING REPORT, CONCLUDING REMARKS**

The GIT adopted the report of its 22nd meeting as shown in this document. The APEC GIT requested the report to be tabled at the closing Plenary Session of TPTWG44.

The GIT expressed gratitude to Chinese Taipei for the excellent arrangement of the meeting and warm hospitality extended to the participants, also for the administrative support which had been provided to the meeting. Finally the GIT co-chairs thanked the GIT participants for their active involvement in the discussions during the meeting.

- END -
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