International Civil Aviation Organization

THE FIFTH MEETING OF IONOSPHERIC STUDIES TASK FORCE (ISTF/5)

Okinawa, Japan, 16 – 18 February, 2015

Agenda Item 4b: Task 2 – Iono Analysis

REVIEW OF ACTIVITIES SINCE THE LAST MEETING (ISTF/4)

(Presented by Chairman of ISTF)

SUMMARY

This paper reviews the ISTF activities since the last meeting (ISTF/4).

1. Introduction

1.1 The last ISTF meeting was held from 5 to 7 February 2014 in New Delhi, India.

1.2 The last ISTF meeting (IST/4) decided to utilize webconference system hosted by ICAO to accelerate the activities of ISTF.

1.3 Three webconferences were held on 24 June, 16 September, and 8 December 2014.

2. Discussion

2.1 The 1st ISTF webconference was held on 24 June 2014. The meeting was attended by Australia, India, Japan, and ICAO. Outcomes from relevant meetings and conferences were reviewed. AATR (Along-arc TEC rate) based analysis to identify ionospheric disturbances were discussed. Working plan to the next CNS-SG meeting in 2015 was discussed. Details of discussions are summarized in **Attachment 1.**

2.2 The 2nd ISTF webconference was held on 14 September 2014. The meeting was attended by Australia, India, Japan, Malaysia and ICAO. AATR data generation tool, the AATR data format, and data mining based on AATR were discussed. Information on Ionospheric threat model especially for SBAS were investigated. Details of discussions are summarized in A**ttachment 2.**

2.3 The 3rd ISTF webconference was held on 8 December 2014. The meeting was attended by India and Japan. Data status of data collection was reported. Publications on SBAS ionospheric threat model were listed. Details of discussions are summarized in A**ttachment 3.**

3. Action required by the Meeting

3.1 The meeting is invited to do the following:

a) review the discussion made in the three webconferences; and

b) discuss any relevant matters as appropriate.

4. Attachment

[1] Summary of discussion ISTF webconference #1

[2] Summary of discussion ISTF webconference #2

[3] Summary of discussion ISTF webconference #3

_ _ _ _ _ _ _ _ _ _ _ _ _

ISTF webconference #1
24 June 14

- Participants:

  - Dr. Mike Terkildsen, Research Scientist, Space Weather Services, Bureau of Meteorology, Australia
  - Dr. Surendra Sunda, Manager (Communications), GAGAN Project, India
  - Dr. Susumu Saito, Chief Researcher, Electronic Navigation Research Institute, Japan
  - Dr. Mamoru Ishii, Director, National Institute of Information and Communications Technology, Japan
  - Dr. Takuya Tsugawa, Senior Researcher, National Institute of Information and Communications Technology, Japan
  - Frederic Lecat, ICAO APAC Regional Officer, CNS

- Review of actions

Action table updated as per 24 June 14 is placed at Attachment A.
For action 4/4, a presentation was provided by India. It reflects how India identifies dates relevant for data Analysis relating to equatorial ionospheric anomalies (Attachment B1), and the resulting days of interest (Attachment B2).

- Outcome of NSP

No significant outcome concerning the ISTF scope of work.

International GBAS WG was held in June 14, with a session of GBAS Iono WG. ISTF Chairman will share points of interest with ISTF participants through an email, including results of the Iono surveys conducted.

- Progress on ISTF work since ISTF/4
  - data collection

Philippines are almost ready to send out their data in GTEX format and are awaiting the official approval.
Australia can make available data from a FTP server, and Japan will download the relevant data to the ENRI server. Coordination will be done offline.
India will send the first set of sample data (3 seasons for 3 years) through a DVD to Dr. Saito, ENRI HQ end of June 14. Interesting dates will then be uploaded to the ENRI server, at the earliest, probably around end of July 14.
MICT is ready to upload their data by the end of June 14.

GTEX SCINTEX will be discussed in ITU-R meeting in Sep. 14 (Geneva) for final validation of the format. Yet data collection can be progressed meanwhile with the draft format currently defined.

  - data analysis

Could be based on raw AATR, but the approach would need to be further developed (see Attachment C AATR_ENRI.pdf).
On EGNOS side, they use AATF to detect worst cases.
A paper may be presented on the use of AATR based on world IGS data at the Institute Of Navigation (ION) meeting in Sep. 14, including APAC data.

- Work for the next period

The draft WP on ISTF activities for CNS SG/18 meeting includes a planning for the ISTF work. In view of CNS SG/18, Dr. Saito will circulate the draft paper to the ISTF participants by email.

Target Date	Achievements	Remarks
24 June 2014 (done)	Identify the details of data analysis methodology	1st webconference
16 September 2014	Implement analysis tools	2nd webconference
	Start TEC/Scintillation data generation	
	Collect available information on ionospheric threat definition on SBAS and GBAS systems	
	Start discussion on the methodology of Task 5	
December 2014	Review the generated data	3rd webconference
	Review and define the methodology of Task 5	
	Start assessments of need of the regional threat models for SBAS and GBAS	
February-March 2015	Review the preliminary evaluation of need of the regional threat models for SBAS and GBAS	ISTF/5
	Continue data generation	
	Continue assessment of need of regional threat models	
June 2015	Decide whether the regional threat model is needed or not. (If needed, threat model generation will take some more months.)	4th webconference
	Prepare report to the CNS-SG	
July 2015 (TBC)	Report to CNS-SG	CNS SG 19

To anticipate the work on Task 5, an early review of publications (MSAS/GAGAN/EGNOS if available) about existing ionospheric threat definitions will be started. The review will be conducted by Dr. Saito. Dr. Surendra Sunda will investigate about publications on GAGAN.

- Date for next meetings

See planning table.

NICT wrote an IP about their activities on space weather information (attachment D) for safe and secure use of telecommunications, broadcast, satellite positioning and international air aviation for the Meteorology (MET) Divisional Meeting (July 2014). It includes information on ionospheric activities.

- Any other business

None.

Attachment 2

ISTF webconference #2
16 September 14

- Participants:

  - Dr. Mike Terkildsen, Research Scientist, Space Weather Services, Bureau of Meteorology, Australia
  - Dr. Surendra Sunda, Manager (Communications), GAGAN Project, India
  - Dr. Susumu Saito, Chief Researcher, Electronic Navigation Research Institute, Japan
  - Dr. Mamoru Ishii, Director, National Institute of Information and Communications Technology, Japan
  - Dr. Tajul Ariffin Musa, Universiti Teknologi, Malaysia
  - Frederic Lecat, ICAO APAC Regional Officer, CNS

The agenda was adopted:

1. Review of actions
2. Outcome of CNS SG/18 and APANPIRG/25
3. Progress on ISTF work since ISTF webconference 1
   data collection
   data analysis
4. Work for Next period
5. First exchanges on the need for ionospheric mitigation models (GBAS/SBAS)
6. Date for next meetings, date and venue for ISTF/5
7. Any other business

- Review of actions

Action table updated as per 16 Sep.14 is placed at Attachment A.

- Outcome of CNS SG/18 and APANPIRG/25

The progress of the TF was noted by CNS SG/18 and APANPIRG/25 and the work plan adopted.

- Progress on ISTF work since ISTF/4
  - data collection

India, Philippines have provided their data which were uploaded on the data server.
Singapore and Hong Kong China have data ready for contribution. Data handover from Singapore to Japan will be arranged during an ICAO ATS Inter-Facility Data Communication AIDC Implementation Seminar (Bangkok, Thailand, 28 - 31 October 2014) if participation of Singapore and Japan is confirmed, or at SEA/BOB ADS-B WG/10 11-13 November 2014 in Singapore.
For Hong Kong China the volume of data allows an upload to the ENRI server.

  - Data analysis

AATR generation tool is ready. AATR generation by Japan will start at the end of September 2014 and will take 2 to 3 weeks. Data format for provision of AATR data has to be determined offline.

ISMR/ASCII data will be analyzed by India which will take approximatively 2 to 3 weeks as well.

From that point, data mining tool will be modified by Australia based on AATR data.
Then data mining will start consequently from 20 Oct. 14 and result delivered for mid or end of Nov. 14.
Close examination of results by ISTF participants will be appreciated before the webconference#3 (16 Dec. 14).

- Collect available information on ionospheric threat definition on SBAS and GBAS systems (MSAS/GAGAN/EGNOS)

To anticipate the work on Task 5, an early review of publications (MSAS/GAGAN/EGNOS if available) about existing ionospheric threat definitions has started. The review is conducted by Dr. Saito.

Dr. Surendra Sunda investigated about publications on GAGAN but could not find any publication yet.
For MSAS Dr Saito has found one IOM paper on the model that he will share with ISTF participants.
About EGNOS Dr. Surendra Sunda will coordinate with ESA (12 Dec.14).
WAAS: Dr Saito will take care of WAAS and MSAS (12 Dec. 14)

Also next CSG meeting will be the opportunity to be updated about how NSP members envisage the ionospheric mitigation model for GBAS. An early model was used for technical validation of GAST.

- Work for the next period

It will consist of data anaylisis and interpretation and collect available information on ionospheric threat definition on SBAS and GBAS systems.

- First exchanges on the need for ionospheric mitigation models (GBAS/SBAS)

GBAS: there is a consensus among the participants that a mitigation model is needed. It would be based on the existing basic model.
SBAS: APV service requirements are difficult to meet especially during equinox periods. While there is a consensus among the participants that a mitigation model is needed for these latitudes, it may take some more efforts/time than for GBAS to achieve this in low latitude areas. However the mitigation model would be linked to the different SBAS solutions available on the market. What would be the minimal set of standard requirements would have to be considered.

- Date for next meetings

  - **Webconference#3: 16 Dec. 2014, 10am-12am (UTC+7)**
  - Pending JCAB confirmation (in progress), **ISTF/5 will take place from 16 to 18 February 2015 in Ishigaki Island (Japan)**. Meeting will be on the first 2 days (16-17) and on 18 February there will be a technical tour. Participants willing to go back for Chinese New Year may do so on 17 evening. ISTF chairman tries to set a joint session with CSG chairman on 16 or 17 February with an agenda focusing on reciprocal expectations from both sides.

- Any other business
  Nil.

ISTF Webconference #3
8 December 2014

Participants

- Dr. Surendra Sunda, Manager (Communications), GAGAN Project, India
- Dr. Susumu Saito, Chief Researcher, Electronic Navigation Research Institute, Japan (ISTF Chair)

The discussions were carried out for the following three topics:

- Progress in data analysis
- Threat model development
- Work plan for the next period

The summary of discussions for each topics are as follows:

Data analysis

Dr. Sunda confirmed the tool for conversion of GAGAN-TEC data to AATR (ismra2aatr) is working at Airport Authority of India (AAI). He will test another tool for conversion of RINEX data to AATR (rinex2aatr) by using the same raw data as those used for ismra2aatr.

AATR conversion of GAGAN-TEC data for March and June 2012 has been completed by AAI. ENRI will start AATR analysis on the ISTF server from the data in 2004.

The threshold value of AATR to detect anomalous ionospheric events was discussed. Dr. Saito suggested 0.009 m/sec or 0.00625 m/sec which are half of the code-carrier-divergence (CCD) values appear in GBAS MOPS (DO-253C) as upper limits of nominal ionosphere.
Participants checked the sample AATR data provided by India and found that the AATR values in nominal conditions were of the order of 0.001 m/sec. It was also found that the AATR values can be more than 0.1 m/sec during plasma bubble events. Therefore, 0.009 or 0.00625 m/sec were considered to be reasonable numbers as a threshold value. The threshold value will be determined after taking distribution of AATR values in nominal conditions. This will be done when some amount of AATR values are obtained by analysis by India and Japan.

Threat model development

Threat model for SBAS

Dr. Sunda reported that the ionospheric threat model for EGNOS is not in a public domain, as per communication with Dr. Stefan Schlueter, ESA.

Dr. Saito presented four papers on ionospheric threat model for WAAS and MSAS:

[1] Altshuler, E. S., The WAAS ionospheric spatial threat model, Proceedings of ION GPS 2011, 2001.
[2] Altshuler, E., Improvements to the WAAS ionospheric algorithms, Proceedings of ION GPS 2002, 2002.
[3] Sakai, T., K. Matsunaga, and K. Hoshinoo, Modeling ionospheric spatial threat based on dense observation datasets for MSAS, Proceedings of ION GNSS 2008, 2008.
[4] Walter, T., A. Hansen, J. Blanch, P. Enge, T. Mannucci, X. Pi, L. Sparks, B. Iijima, B. El-Arini, R. Lejeune, M. Hagen, E. Altshuler, R. Fries, and A. Chu, Robust detection of ionospheric irregularities, Proceedings of ION GPS 2000, 2000.

Although these papers may not exactly describe the threat models used in WAAS and SBAS,

these papers were considered to be a good basis for our analysis of needs of a regional ionospheric threat model. Dr. Saito will coordinate with Dr. Sakai, ENRI, who is one of the task leads of Task-5 and the first author of the publication [3], for utilization of his tools used for his work [3]. Thus, a new action item was opened for Dr. Saito to coordinate with Dr. Sakai, ENRI for utilization of his tools for SBAS ionospheric threat model analysis for ISTF.

Threat model for GBAS

Parameters to be assessed for the GBAS ionospheric threat model was discussed. It was pointed out that the development baseline SARPs for Category II/III GBAS (GAST-D) includes a guidance material which describes the ionospheric threat model used for technical validation of the development baseline SARPs. The development baseline SARPs for GAST-D can be found at the ICAO public site:

http://www.icao.int/safety/airnavigation/Documents/gnss_cat_ii_iii.pdf

The threat model is described at section 7.5.6.1.7.1 on the 91th page of the document. The important values are the gradient (slope), width, depth, and velocity. It was agreed that these parameters should be analyzed for the GBAS ionospheric threat model assessment. It was also noted that the threat model described in the section is not a requirement, but the model used in technical validation of the feasibility of the development baseline SARPs and the values may change in the currently ongoing validation activities by ICAO NSP CSG.

It was also discussed what would be the minimum value to detect ionospheric anomalies for the parameter of "depth". Dr. Saito suggested 1.5 m, because it is the maximum range error allowed for GAST-D associated with ionospheric anomaly.

Work for the next period

The ISTF Chair informed that the State Letter for the ISTF/5 has already sent out from the ICAO APAC Regional Office, and will be held from 16 to 18 February, 2015, and that Joint session with ICAO NSP CSG will be organized on 17 February. The ISTF Chair will circulate the information to ISTF members, as it may take some time for the State Letter to propagate to them.