



International Civil Aviation Organization

THE SIXTH MEETING OF IONOSPHERIC STUDIES TASK FORCE (ISTF/6)

Bangkok, Thailand, 19 – 21 January 2016

Agenda Item 3: Review of status of States' activities and ISTF webconferences

REVIEW OF ACTIVITIES SINCE THE LAST MEETING (ISTF/5)

(Presented by Secretariat)

SUMMARY

This paper reviews the ISTF activities since the last meeting (ISTF/5).

1. INTRODUCTION

- 1.1 The last ISTF meeting was held in Okinawa, Japan, 16 – 18 February, 2015.
- 1.2 Four webconferences (ISTF#4, #5, #6, #7 and #8) were held over 6 months since ISTF/5 respectively on 19 June, 2 July, 26 August, 24 September and 4 December 2015.
- 1.3 Outcomes are presented in the discussion part.

2. DISCUSSION

- 2.1 ISTF#4 was attended by Australia, Japan, and served by ICAO. The GBAS threat mitigation strategy was presented and discussed. Details of discussions are summarized in **Attachment 1**.
- 2.2 ISTF#5 was attended by Australia, India, Japan, Republic of Korea and served by ICAO. SBAS safety case guidance material, ICAO WG-MISD (MET information and Services Development), collaboration between APANPIRG CNS and MET subgroups, publication and intellectual property of the ionospheric threat models and ISTF Work plan for 2015-2016 were discussed. Details of discussions are summarized in **Attachment 2**.
- 2.3 ISTF#6 was attended by Australia, India, Japan, Republic of Korea and served by ICAO. The status of AATR analysis for data on the ISTF data and use of LTIAM tool were discussed. Details of discussions are summarized in **Attachment 3**.
- 2.4 ISTF #7 was attended by Japan and served by ICAO. Preparation of a document describing high level operational needs of Space Weather to mitigate the effects of space weather on the regional CNS systems and operations and progress of analysis of ionospheric data were discussed. Details of discussions are summarized in **Attachment 4**.

2.5 ISTF #8 was attended by India, Japan, Republic of Korea and served by ICAO. Progress of the document describing high level operational needs of Space Weather to mitigate the effects of space weather on the regional CNS systems and operations and progress of analysis of ionospheric data were discussed. Details of discussions are summarized in **Attachment 5**.

3. ACTION REQUIRED BY THE MEETING

3.1 The meeting is invited to do the following:

- a) review the outcomes of the webconferences since ISTF/5; and
- b) discuss any relevant matters as appropriate.

ISTF webconference #4
19 June 2015

- Participants:
 - Dr. Mike Terkildsen, Research Scientist, Space Weather Services, Bureau of Meteorology, Australia
 - Dr. Mamoru Ishii, Director, National Institute of Information and Communications Technology, Japan
 - Dr. Takeyasu Sakai, Principal Researcher, Electronic Navigation Research Institute, Japan
 - Dr. Susumu Saito, Chief Researcher, Electronic Navigation Research Institute, Japan
 - Dr. Takayuki Yoshihara Chief Researcher, Electronics Navigation Research Institute
 - Mr. Frederic Lecat, ICAO APAC Regional Officer, CNS

The agenda was slightly amended and agreed as follows:

- 1 Review of actions
- 2 Outcome of ICAO PBN seminar 2015 and PBN ICG/2
- 3 Progress on ISTF work since ISTF/5
 - 3.1 Data collection
 - GTEX and SCINTEX format standardization at ITU-R (Dr. Ishii, NICT)
 - 3.2 Data analysis
 - 3.3 Data generation
 - 3.4 Threat models
 - GBAS threat mitigation strategy (Dr. Yoshihara, ENRI)
 - SBAS safety case guidance material (Dr. Sakai, ENRI)
 - 3.5 Space Weather
- 4 Publication and intellectual property of the ionospheric threat models
- 5 Work for next period
 - Report to APANPIRG CNS-SG/19
- 6 Dates for the next meeting/webconference
- 7 Any other business

- 1 Review of actions
- Action table updated as per 19 Jun 15 is placed at Attachment A.

- 2 Outcome of ICAO PBN seminar 2015 and PBN ICG/2

The key note 21 concerning ISTF work was an important outcome of the PBN seminar that took place 08-10 June 2015 in ICAO premises in Bangkok:

Industry is invited to consider implementing ionospheric threat models once available in APAC Regions

Attachment 1 - 2

- 3 Progress on ISTF work since ISTF/5
 - Data collection
 - GTEX and SCINTEX format standardization at ITU-R (Dr. Ishii, NICT)

Dr. Ishii presented a paper on the GTEX and SCINTEX Format.

He explained that the GTEX and SCINTEX Format originated from the necessity to harmonize the different vendors and future scintillation and total electron content (TEC) files. The GTEX and SCINTEX format are extensively based on the RINEX v2 and v3.01 format, respectively. The GTEX and SCINTEX formats were proposed to be used in ITU-R WP 3L/3M and were approved to add as standard format on ITUR P.311.

A WP to CNS SG/19 including the following draft decision will enable to post it on ICAO website as regional guidance.

Draft decision – ITU Standard for exchange and sharing of GNSS data

Considering the need for sharing GNSS data to study the ionospheric effects on navigation systems,

That, the SCINTEX and GTEX Formats placed at Attachment X and Y, respectively be adopted as ICAO APAC standard for exchange of GNSS data and posted on the ICAO regional office website.

- Data analysis

AATR analysis to be completed for end of August 2015

- Data generation
 - After AATR analysis, analysis using the LTIAM tool will start.
- Threat models
 - GBAS threat mitigation strategy (Dr. Yoshihara, ENRI)
Dr. Yoshihara explained how ionospheric anomaly impacts on GBAS and how it should be mitigated. It was noted that the range error of about 8.5m is possible and it could result in several 10s meter errors in vertical and/or horizontal depending on the satellite geometry. Recommended methodology to develop a threat model was presented.
- ISTF Work plan to be refined for 2015-2016
 - It was decided that the threat models will be delivered to be the CNS-SG/20 meeting in 2016. It was noted by Mr. Lecat that the CNS-SG/20 meeting will be held around May 2016, because 2016 is an ICAO assembly year. Therefore, the target date will be the end of April 2016.

Since the time allocated for the webconference ran out, it was decided to have additional webconference from 01:30 to 03:30pm on 2 July 2015 in the Bangkok time.

Attachment 1 - 3

The agenda for the meeting will be

- SBAS safety case guidance material (Dr. Sakai, ENRI)
- Space Weather
- Publication and intellectual property of the ionospheric threat models
- ISTF Work plan to be refined for 2015-2016
- Work for next period
 - Report to APANPIRG CNS-SG/19
- Dates for the next meeting/webconference
- Any other business

ISTF webconference #5
2 July 2015

- Participants:
 - Dr. Mike Terkildsen, Research Scientist, Space Weather Services, Bureau of Meteorology, Australia
 - Dr. Surendra Sunda, Sr. Manager (CNS), GAGAN Project Airport Authority of India, India
 - Mr. Pradeep V. Khekale, Sci/Engr 'SG', Indian Space Research Organization, India
 - Dr. Mamoru Ishii, Director, National Institute of Information and Communications Technology, Japan
 - Dr. Takeyasu Sakai, Principal Researcher, Electronic Navigation Research Institute, Japan
 - Dr. Susumu Saito, Chief Researcher, Electronic Navigation Research Institute, Japan
 - Dr. Takayuki Yoshihara Chief Researcher, Electronics Navigation Research Institute
 - Prof. Jiyun Lee, Korean Advanced Institute of Science and Technology, Republic of Korea
 - Mr. Frederic Lecat, ICAO APAC Regional Officer, CNS

The agenda was agreed as follows:

- 1 SBAS safety case guidance material (Dr. Sakai, ENRI)
- 2 Space Weather
- 3 Publication and intellectual property of the ionospheric threat models
- 4 ISTF Work plan to be refined for 2015-2016
- 5 Work for next period
 - 5.1 Report to APANPIRG CNS-SG/19
- 6 Dates for the next meeting/webconference
- 7 Any other business

- 1 SBAS safety case guidance material (Dr. Sakai, ENRI)

Dr. Sakai explained how SBAS ionospheric threat model is defined and how it is mitigated for the MSAS case as an example. Then the responses to the action items identified at the ISTF/5 meeting (AIs 5/3, 5/4, and 5/5) are presented. The summary of discussion on each AI is as follows:

AI 5/3: Identifying operational hazard for SBAS

The spatial variation of ionospheric delay is dominant and the temporal variation is not as significant as the spatial one. The meeting requested to include some typical values for range error for spatial and temporal variation.

AI 5/4: Identifying factors influencing SBAS ionospheric threat mitigation strategy

Observation density, fidelity of ionospheric model, availability of archived data, and system specific implementation of ionospheric correction are identified as the factors of importance.

AI 5/5: Developing a structure of a guidance material

A draft table of contents is presented. After discussion, it was requested to include APAC regional consideration and typical values of influencing factors for SBAS mitigation strategy.

2 Space Weather

▪ ICAO WG-MISD (MET information and Services Development)

Dr. Ishii explained on the ICAO WG-MISD under the ICAO MET Panel. The objective is to develop requirements on MET information, coordination, and develop ConOps. Space Weather subgroup is placed under the WG-MISD, and Dr. Ishii and Dr. Terkildsen are members of Space Weather subgroup as expert.

▪ Collaboration between APANPIRG CNS and MET subgroups

Dr. Saito explained that there was a discussion on the possible collaboration between the SGs for the study of regional aspects of space weather with Chairs of APANPIRG CNS and MET SGs during the APANPIRG ABSRTF/2 meeting in Bangkok. This is done to investigate the effects of space weather on CNS systems in the APAC Region as per ISTF TOR item 8. It was decided to develop high-level requirements for space weather services for CNS in APAC region. The first draft will be done by Dr. Saito and Dr. Ishii. The maturation of the draft will be done by a small group tentatively composed of Ms. Susan E. O'Rourke (MET SG chair), Mr. Lo Weng Kee (CNS SG Chair), Dr. Saito, Dr. Ishii, Mr. Peter Dunda (MET RO) and Mr. Lecat (CNS RO). Mr. Lecat will coordinate with the global level. Dr. Ishii will also coordinate with the ICAO WG-MISD Space Weather subgroup, being a member of the subgroup.

3 Publication and intellectual property of the ionospheric threat models

A draft working paper on the intellectual property and publication of ISTF outcomes to be presented at the CNS/19 meeting was presented. It was agreed that the ISTF outcomes, namely the GBAS threat model and SBAS guidance material, should be in public domain. They should preferably be published in some technical journals which allow free access of readers. Dr. Saito and Prof. Lee will search suitable journals.

4 ISTF Work plan to be refined for 2015-2016

It was discussed how the analysis will be performed. Since the analysis takes time, it was suggested to share the analysis effort. ROK (Prof. Lee) offered to take part in the analysis, in addition to Australia, India, and Japan. It was also noted that the cross-check of results are important. Dr. Sunda noted the difficulty he met in using the LTIAM tool. Prof. Lee pointed out that there is a manual of the LTIAM tool and was provided by her. It was also agreed to exchange information and experience in using the LTIAM tool. ICAO will offer webconference facility upon request.

5 Work for next period

5.1 Report to APANPIRG CNS-SG/19

Report on ISTF/5 meeting in February will be prepared by Mr. Lecat. It will also refer to the PBN seminar where ISTF activities were presented.

Two working papers will be prepared by Dr. Saito. One of them reports on the discussion and outcomes of the 4th and 5th webconferences. The other is on the publication and intellectual property of the threat model.

6 Dates for the next meeting/webconference

It was recalled that the next face-to-face meeting (ISTF/6) has been scheduled in January 2016 in Bangkok.

Attachment 2 - 3

The next webconference will be held from 12:00 to 14:00 on 26 August 2015 in Bangkok Time. The main topics are

- LTIAM experience exchange
- Report and review of AATR analysis results

7 Any other business

There was no particular item discussed under this agenda item.

ISTF webconference #6
26 August, 2015

- Participants:
 - Dr. Mike Terkildsen, Research Scientist, Space Weather Services, Bureau of Meteorology, Australia
 - Dr. Surendra Sunda, Sr. Manager (CNS), GAGAN Project Airport Authority of India, India
 - Dr. Mamoru Ishii, Director, National Institute of Information and Communications Technology, Japan
 - Dr. Susumu Saito, Chief Researcher, Electronic Navigation Research Institute, Japan
 - Dr. Takayuki Yoshihara Chief Researcher, Electronics Navigation Research Institute
 - Prof. Jiyun Lee, Korean Advanced Institute of Science and Technology, Republic of Korea
 - Mr. Frederic Lecat, ICAO APAC Regional Officer, CNS

The agenda was agreed as follows:

- 1 AATR results
- 2 Getting started with LTIAM tool
- 3 Any other business

1 AATR results

Dr. Saito reported the current status of AATR analysis for data on the ISTF data. AATR analysis for Thailand data has been finished. Plots and dates of interests will be provided in a few days. AATR analysis for other data sources will follow. The analysis took long because it was needed to modify analysis tools to take care of irregular data.

The Thailand AATR data appear to contain spikes as Dr. Sunda met with GAGAN-TEC data. It will be removed in calculating standard deviation of AATR for selecting dates of interests.

Since AATR data analysis of GAGAN-TEC data has been done by Dr. Sunda, Dr. Saito will analyze just a part of GAGAN-TEC data to cross-check the Dr. Sunda's results.

2 Getting started with LTIAM tool

▪ Status of LTIAM usage

Current status of using LTIAM tool in Australia, India, and Japan was reported.

▪ Australia

Request of obtaining LTIAM tool has been sent to FAA and reply from FAA is being waited. Dr. Terkildsen will send e-mail directly Mr. Joseph Gillespie.

▪ India

LTIAM tool has already been obtained from FAA and has been installed successfully to a 64-bit Windows machine. However, there are some issues in operating the LTIAM tool. For example, a problem occurred in reading RINEX data. Dr. Lee explained that it may be related to the slight difference in the format of the used RINEX data.

▪ Japan

ENRI has procured a workstation for LTIAM analysis with 16 logical cores of Intel Xeon CPU at 3.5GHz and 32GB memory. Request for LTIAM tool has been sent to FAA and reply from FAA is being waited.

Attachment 3 - 2

- Overview of LTIAM and its parameters

Dr. Lee presented an overview of LTIAM tool and its parameters. The structures of modules of LTIAM and related user-defined parameters were explained. It was a good briefing to get the LTIAM tool started.

It was discussed how to use AATR data for screening data. Dr. Lee suggested two options: one is to modify the Ionospheric Event Search module, and the other is to set only the pre-selected data based on AATR analysis. The second option was adopted in analyzing Brazilian data. It was agreed that the second option is the more realistic solution.

Dr. Sunda asked how to handle fragmented data into one-day RINEX data as required by LTIAM. Two freely-available tools, teqc and gpstoolkit were introduced. Dr. Terkildsen noted that gpstoolkit can handle NovAatel binary data which cannot be handled by teqc.

It was agreed that the participants will try running LTIAM tool in one month from now and exchange experiences at the next webconference.

3 Dates for the next meeting/webconference

The next webconference (#7) will be held from 09:30 to 10:30AM in Bangkok Time on 24 September 2015. The topic of the webconference is the exchange experiences in using the LTIAM tool.

The tentative schedule of 6th face-to-face meeting of ISTF was proposed to be 19-21 January 2016 at ICAO APAC office in Bangkok. There was no objection from the participants, and the dates have been kept tentatively.

ISTF webconference #7
24 September, 2015

- Participants:
 - Dr. Mamoru Ishii, Director, National Institute of Information and Communications Technology, Japan
 - Dr. Susumu Saito, Chief Researcher, Electronic Navigation Research Institute, Japan
 - Dr. Takayuki Yoshihara Chief Researcher, Electronics Navigation Research Institute
 - Mr. Frederic Lecat, ICAO APAC Regional Officer, CNS

The agenda was agreed as follows:

- 1 Space weather
- 2 Status of analysis
- 3 Any other business

1 Space Weather

Mr. Lecat reminded that in response to the terms of reference of ISTF to “investigate the effects of space weather on CNS systems in the APAC Region”, it had been agreed in July 2015 with Mrs Susan E. O’Rourke, the Chairperson of the MET subgroup, to prepare a document describing high level operational needs of Space Weather to mitigate the effects of space weather on the regional CNS systems and operations. In its first version, it would be a short document describing what is needed by CNS systems in APAC region. The needs should be addressed to a MET service provider offering space weather services.

After discussion, it was agreed that a two-step approach should be taken.

- The first step is to identify operational needs irrespective of their feasibility, as this feasibility should be discussed by/with the MET Subgroup.
- The second step is to examine their feasibility and whether the corresponding space weather solutions are global (and should be considered for inclusion at the global level accordingly) or regional only.

Dr. Saito will prepare the first draft by early next week. The draft will be reviewed by Dr. Ishii and Mr. Lecat. After refinement, it will be forwarded to Mrs O’Rourke as well as to Mr. Peter Dunda, the ICAO APAC Regional Officer, Aeronautical Meteorology.

2 Status of analysis

Dr. Saito reported that the LTIAM tool has been installed to the workstation in ENRI. However, the version of MATLAB is too new for the LTIAM to work correctly. Dr. Saito is trying to downgrade the MATLAB. Dr. Saito also reported that the AATR generation tool for GAGAN-TEC data had some software bugs. They have been fixed, and corrected version will be distributed.

It was also discussed on the way forward to make analysis progress. It was recalled that Prof. Lee, KAIST, ROC offered to take part in the analysis effort. Dr. Saito will write an e-mail to Dr. Lee, Dr. Sunda, and Dr. Terkildsen, BOM Australia to ask the status of using LTIAM and to which extent they will be able to analyze data.

Attachment 4 - 2

Dr. Sunda, Airport Authority of India, who could not attend this webconference for a technical reason, updated the LTIAM analysis status in India. He also uses newer MATLAB, but a workaround was found after discussion with Prof. Lee and her students. Now Dr. Sunda obtained first results using the LTIAM tool.

3 Dates for the next meeting/webconference

The next webconference (#8) has not been fixed. E-mail discussions will be utilized, and when it is needed, it will be requested to Mr. Lecat to arrange the next webconference.

ISTF Webconference #8

04 December 2015

Participants:

- Dr. Surendra Sunda, Sr. Manager (CNS), GAGAN Project Airport Authority of India, India
- Dr. Susumu Saito, Chief Researcher, Electronic Navigation Research Institute, Japan
- Dr. Takayuki Yoshihara, Chief Researcher, Electronics Navigation Research Institute
- Dr. Takeyasu Sakai, Principal Researcher, Electronic Navigation Research Institute, Japan
- Prof. Jiyun Lee, Korean Advanced Institute of Science and Technology, Republic of Korea
- Mr. Frederic Lecat, ICAO APAC Regional Officer, CNS

1 adoption of agenda

The agenda is adopted.

2 review progress and issues of tasks

- data analysis

ENRI:

- LTIAM installed, using Matlab 2010
- analysis of shared data has started using the Gradient estimation tool
- Data from Singapore present an issue

Actions:

- Hong Kong data on ENRI server to be made available to Jiyun
- Table to be done to divide the work by dates using all data from available stations

India:

- analysis of GAGAN data is done, manual validation will be finished for ISTF/6
- receivers GBAS Chennai (2013-now): LTIAM tool installed, 500 MB data
- Bangalore: 2 GAGAN stations receiver

Actions:

- Surendra urgently sends an email to Jiyun to modify LTIAM so that LTIAM reads RINEX data from local disk

ROK:

- Jiyun will start analysing HK data and continues with processing those data as agreed in the Table

Attachment 5 – 2

- GBAS safety case and model
Drafting of GBAS safety case has started
GBAS mitigation model needs the outcome of data analysis so has not started.

- SBAS safety case guidance material
Drafting of SBAS safety case has started

- Space Weather operational requirements
Version 2 was issued

Action:

Ishii-san to propose an assessment of feasibility as a space weather service provider

3 preparation of ISTF/6 19-21 Jan. 16

to draft WP regarding the topics above.

4 AOB

Nil
