International Civil Aviation Organization

THE SECOND MEETING OF IONOSPHERIC STUDIES TASK FORCE (ISTF/2)

15 – 17 October 2012, Bangkok, Thailand

Agenda Item 5: **Review Progress of Tasks**

a) Task 1 – Data Collection

DATA FORMAT FOR SHARING IONOSPHERIC SCINTILLATION MEASUREMENTS

(Presented by Japan)

SUMMARY

This paper presents an example of data format for sharing ionospheric scintillation measurements. The data format is proposed as a common data format to share ionospheric scintillation data in ISTF activities.

1. INTRODUCTION

1.1 The first Ionospheric Studies Task Force (ISTF/1) meeting identified five tasks and their sequence was identified. Task 1 is “Data Collection” which is responsible for collection, integration, administration and distribution of data collected from States and Administrations (Ref. WP8, APANPIRG CNS/MET SG-16).

1.2 The Task Details of the Data Collection task include defining data sharing format.

1.3 The data sources identified by the Data Collection Templates include various kinds of receivers (Ref. WPX, ISTF/2) both for ionospheric delay and ionospheric scintillation. To facilitate data sharing among parties involved in the ISTF activities, common data formats need to be defined.

2. DISCUSSION

2.1 There are two kinds of ionospheric data relevant to the ISTF activities. One is the ionospheric delay (or equivalently the ionospheric total electron content: TEC) data, and the other is the ionospheric scintillation data. Because these are totally different items, two different data formats are necessary to record the ionospheric delay and ionospheric scintillation data.

2.2 The data format can be either in binary or human readable text format. Binary data formats can generally save the file size; however, it is difficult for humans to read binary data directly without special software. Text data formats are directly human readable, though they generally need bigger file size than binary formats. Considering that the disk space is getting cheaper and the network bandwidth is getting more affordable, text data formats would be preferable to share data amongst the parties involved in the ISTF activities.

2.3 In the Workshop on the Ionospheric Data Collection, Analysis, and Sharing to Support GNSS Implementation held in Bangkok, Thailand in May 2011, a data format for ionospheric scintillation data was introduced as an example. It is not a complex format but is a binary format. Therefore, another data format in human readable text format should preferably be defined in addition.

2.4 Recently, National Institute of Information and Communication Technology (NICT), Japan developed a format for ionospheric scintillation data named "SCINTEX". It can record amplitude and phase scintillation indices as well as the raw measurements of signal strength (Carrier-to-Noise Ration, C/N0) and carrier phase. The details of the SCINTEX format are described in Attachment 1 of this paper.

2.5 A tool to convert the GSV4004B receiver specific data, which are the majority of shared data, into SCINTEX is under development and will soon be available. For those who have already generated ionospheric scintillation data, a conversion tool to SCINTEX can be developed easily.

2.6 To define a scintillation data format suitable for ISTF activity, feedback from the ISTF members is absolutely necessary. It would be useful to discuss on the data format through the ISTF Forum on the ICAO portal website.

3. ACTION BY THE MEETING

3.1 The meeting is invited to:

a) review the data format of ionospheric scintillation measurements presented in this Working Paper;

b) consider the data format as a basis of the common data format for sharing ionospheric scintillation measurements; and

c) participate in discussion on data format on ionospheric delay data through the ICAO ISTF Forum.

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ATTACHMENT

SCINTEX: The Scintillation Exchange Format

Draft 0.1

5 October 2012

1. Background

The purpose of the SCINTEX (Scintillation Exchange Format) is to share scintillation data from each receiver. The scintillation data may be in two forms, low frequency and high frequency data. Low frequency data records reduced parameters such as the S4 index, phase sigma index, or averaged signal strength. High frequency data records raw measurements of signal amplitude and phase at a high sampling rate from which the scintillation indices can be calculated.

The structure of SCINTEX is designed in such a way that the structure is as close to RINEX 2 as possible, because RINEX 2 is a *de facto* standard in exchanging GNSS observation data and potential users of SCINTEX would be familiar with RINEX 2.

However, because of different sampling frequencies between low and high frequency data, the structure of the SCINTEX format includes some additional features to RINEX 2.

2. General Description

The SCINTEX data file consists two parts, the header and the scintillation data blocks. The header block structure is similar to that of RINEX 2. Two observation type descriptors, “W” for amplitude scintillation index (S4 index) and “X” for phase scintillation index (phase sigma), are introduced. All the header items defined in RINEX 2 can be used in SCINTEX as well.

The scintillation data block starts from a line(s) with a time stamp and list of satellites with the same format as “EPOCH/SAT” field of RINEX 2. Following the EPOCH/SAT field scintillation data as defined by “# / TYPES OF OBSERV” field of the header. When there are low and high frequency sub-blocks, the low frequency sub-block is recorded first.

3. Example of data in SCINTEX

An example of TEC data in SCINTEX is shown below. The example is generated based on data obtained from 15:40:00 GPS Time on 23 September 2012 at “SYO1” station installed in the Syowa base in Antarctica and analyzed by NICT. The file name format is similar to the RINEX format and defined as follows: {SSSS}{DDD}0.{YY}_SNT ; where SSSS is the four-character marker name, DDD is the day of year and YY is two-digit year. In this case, the file name is syo12670.12_SNT.

First 25 lines describe the header. For low frequency data, 6 types of data (S4, phase sigma, and signal strength for L1 and L2 signals) are recorded (17th line). For high frequency data, 2 types of data

(amplitude and phase of L1 signal) are recorded (18th line). The sampling intervals of low and high frequency data are 60 and 0.02 sec (19th and 20th line).

The scintillation data block starts from the 26th line. The first epoch is 15:40:00 GPS Time on 23 September 2012. From 26th to 46th lines describe low frequency data. 10 GPS satellites (PRN 25, 29, 23, 31, 30, 32, 2, 20, 4, and 12) were tracked (26th line). From 47th to 57th lines describe high frequency data recorded at 5:40:00 GPS Time on 23 September 2012 with 10 tracked GPS satellites (PRN 25, 29, 23, 31, 30, 32, 2, 20, 4, and 12). High frequency data sub-blocks until 15:40:59.98 GPS Time follows before the next low frequency sub-block comes.

Example of SCINTEX data.

(Filename: syo12670.12_SNT)

```
     2.10           OBSERVATION DATA    G (GPS)             SCI   VERSION / TYPE
autosci ver1.23     NICT, JAPAN         12SEP24 00:46       PGM / RUN BY / DATE
                                                            COMMENT
                                                            COMMENT
SYO1                                                        MARKER NAME
NICT, JAPAN         NICT                                    OBSERVER / AGENCY
NYM10210012         GSV4004B            9.140S43            REC # / TYPE / VERS
NAE10300032         GPS-702-GG                              ANT # / TYPE
  1766253.5812  1460032.8828 -5932342.9801                  APPROX POSITION XYZ
   -69.0081808    39.5780543       46.1490                  POSITION LAT,LON,HGT
     TYPES OF OBSERV  = W : S4 index                        COMMENT
                        X : sigma phase index               COMMENT
                        S : signal strength                 COMMENT
        0.0000        0.0000        0.0000                  ANTENNA: DELTA H/E/N
     6    S1    X1    S1    W2    X2    S2                 # / TYPES OF OBSERV
    60.000                                                  INTERVAL
  2012     9    23    15    40    0.0000000     GPS         TIME OF FIRST OBS
  1766253.5812  1460032.8828 -5932342.9801                  COMMENT XYZ
   -69.0081808    39.5780543       46.1490                  COMMENT LLA
### indices recorded below do not correspond to raw ###     COMMENT
                                                            END OF HEADER
 12  9 23 15 40  0.0000000    10G25G29G23G31G30G32G 2G20G 4G12
         0.034          0.032          42.032          0.032          0.032
        42.032
         0.034          0.032          42.032          0.032          0.032
        42.032
         0.034          0.032          42.032          0.032          0.032
        42.032
         0.034          0.032          42.032          0.032          0.032
        42.032
         0.034          0.032          42.032          0.032          0.032
        42.032
```

```
          0.034           0.032          42.032           0.032           0.032
         42.032
          0.034           0.032          42.032           0.032           0.032
         42.032
          0.034           0.032          42.032           0.032           0.032
         42.032
          0.034           0.032          42.032           0.032           0.032
         42.032
          0.034           0.032          42.032           0.032           0.032
         42.032
 12  9 23 15 41  0.0000000    10G25G29G23G31G30G32G 2G20G 4G12
          0.034           0.032          42.032           0.032           0.032
         42.032
```
