COMMON DATA FILE FORMAT

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ABSTRACT

The purpose of this paper is to expose the necessity to get standards for a common data file format dedicated to flight inspection recordings.

For the flight Inspection of Navaids located in French overseas territories, DSNA/DTI has developed partnership with different flight inspection services. They don't use the same Flight Inspection System as our system in France. So, we get curves, results, and data files with not the same format as we used to. There are also different sign conventions (DDM, Errors…) and ways of calculation flight inspection parameters. I have developed a software to play back recoded runs and present curves in our way with data sources providing from different FI systems. In the other hand a Navaid Service provider, can have recordings from ground roll measurements, UAV/drone measurements, simulations, and airplane flight inspection, all of them will be in a different standard file. A common data file format for ILS, VOR and DME measurements, with defined parameters and their precision will be very helpful for technical ground team in charge of following the performance of Navaids. This paper will present our experience of data playback and computation, with examples of solutions and a draft data file, as a first step for a common data file format.

INTRODUCTION

In legacy of his long history, France has different overseas territories all around the world. Most of them are equipped with airports and so Navaids for IFR operations, now with also PBN procedures. The overseas French navaids total is 7 ILS (6 Cat I, 1 Cat III) and 12 VOR
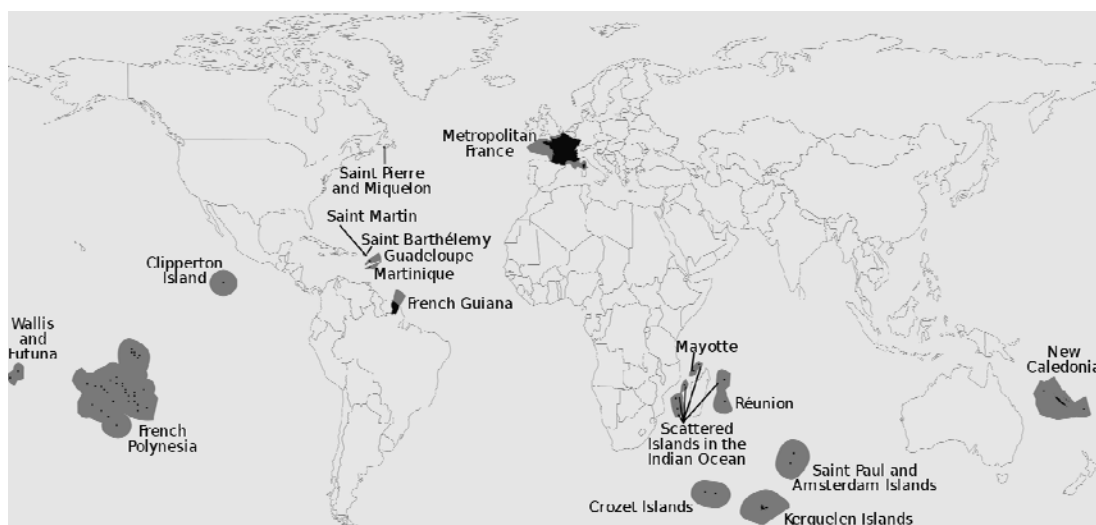

Figure 1 French Overseas Territories

To achieve the flight check of these fare away navaids from the mainland, we have 3 solutions:

- Send one of our aircrafts from France with a problem of cost in term of ferry flight hours and some logistic difficulties. We have done it for special occasions but it's not efficient for periodic Flight checks.

- Use a local plane after doing some modifications needed for the Flights inspection activities (antennas, cables, avionics in the cockpit…) and send just our portable FI system, to install it on board during the deployment. This is now our first choice, if possible. Most of our overseas territories are done like this today.

- Submit a contract or have an agreement with a Flight Inspection company located in the aera. In this case the French FI Service just send one flight inspector to be on board, his job will be to procced the Flight Inspection following the French rules and manners. This solution is still used for New Caledonia (A call for tender for the next years is in progress) and Reunion Island where we have a partnership with ASECNA. In the past, we used to work with Nav Canada in St Pierre & Miquelon, a small French archipelago close to Newfound Land (Canada) and with Aerpearl Ltd in French Polynesia. We have also done some Flight Tests of Wallis VOR (Small Island in the middle of the South Pacific Ocean) with Airways New Zealand.

For some overseas territories, we used both solutions, so having comparative curves is needed.

We put a great importance in curves, we don't want just only average results from a run but a complete curve which can give you more details about the Navaid performances (Bends, scallops, multipath…) but also the quality of the measurements (Following of the nominal trajectory, detection of tractography error…).

During all these years, we obtained a lot of records from 5 different systems.

I have developed a software tool working on Excel in Visual Basic Application to process data files, to do recalculation and plot curves in a way we use to it, in term of scale, parameters, conventions and so one. The first step is to import the files, to extract parameters and standardized their name, then to make data conversions: if the sign convention is different that we used to or if the unit doesn't fit (% to µA or meters to feet…). After this, a step a recalculation of error (ILS, VOR) is available, if needed. At the end the software plot curves, in the way we want to be "look alike" with our FI system.
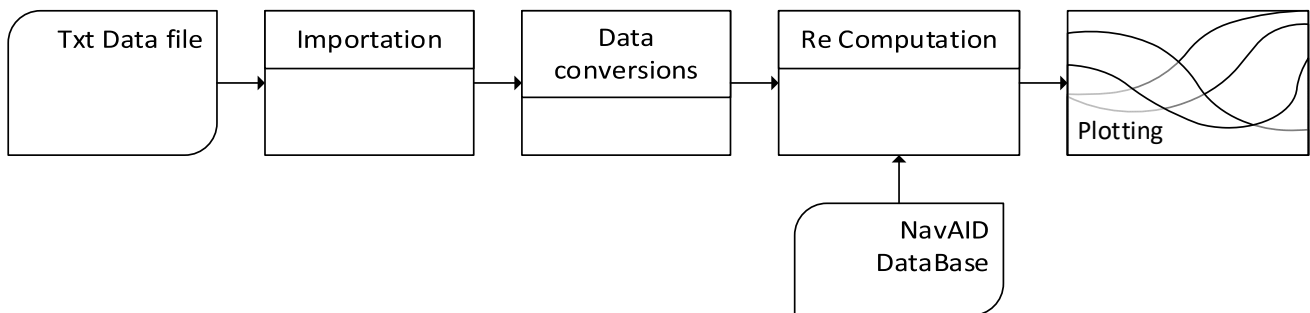
Figure 2 Data Processing

Most of the FI systems we were be confronted, can export data files of each run, but with their own format and sometimes after some updates of the system, the file format has also changed. I have quite an experience to deal with these files, but most of the time, after each mission, I have to adapt and make some corrections on my software, to be able to read and process the data files exported.

From my experience, I have concluded that a common data files format, of any type (txt, csv, xml, json) will be helpful for everybody who wants to playback FI data.

Also, data recordings on Navaid are increasing a lot now, with ground roll from ILS receiver installed in a vehicle, measurements or done by UAV and exported data from simulation software. A ground engineer who wants to compare, superpose and merge all the data will have the same problematic. It will be a complicate and long task to do so.

	** ADAAS RUN DATA ** ST. PIERRE, FRANCE SP06 ILS Alignment @ 9/26/2018 2:49:38 PM************																
Rrdno	GPS Time Of Day	A/C Horz Angle	A/C Vert Angle (GP)	GPS ALT ASL	Temp (Cabin)	LOC Pri RF (c w/SA)	LOC1 SDM (c w/SA)	GPS Corr Age	GPS Corr %	FIS DC Current	FIS 400Hz Current	FIS 60Hz Current	GPS Day	GPS Diff Stat	GPS LOC Back Thld Dist (Nm)	LOC Dist (Nm)	Thld Dist (Nm)
1	67777900	0.039826725	2.591487909	1983.001972	*0	65.95339999	40.125	0	100	15.53039551	0.651855469	4.010009766	26	FIXED	-7.813251499	7.934378255	6.840774013
2	67778000	0.039862561	2.593730166	1983.182418	*0	65.95339999	40.125	1000	100	15.53039551	0.651855469	4.010009766	26	FIXED	-7.808095809	7.929228227	6.835618323
3	67778100	0.039902017	2.595981695	1983.362864	*0	65.95339999	40.225	1000	100	15.53039551	0.651855469	4.010009766	26	FIXED	-7.802941347	7.924079434	6.830463861
4	67778200	0.039928491	2.598234181	1983.546591	*0	65.95339999	40.125	1000	100	15.53039551	0.651855469	4.010009766	26	FIXED	-7.797787084	7.918930869	6.825309599
5	67778300	0.039957672	2.60047183	1983.717195	*0	65.95339999	40.125	1000	100	15.53039551	0.651855469	4.010009766	26	FIXED	-7.792633694	7.913783096	6.820156209
6	67778400	0.039977748	2.602736719	1983.910764	*0	65.95339999	40.125	1000	100	15.53039551	0.651855469	4.010009766	26	FIXED	-7.787481252	7.908636429	6.815003768
7	67778500	0.039998869	2.604982259	1984.08793	*0	65.95339999	40.025	1000	100	15.53039551	0.651855469	4.010009766	26	FIXED	-7.782329864	7.903490715	6.80985238
8	67778600	0.040012811	2.60726606	1984.291342	*0	65.95339999	40.125	1000	100	15.53039551	0.651855469	4.010009766	26	FIXED	-7.777179699	7.898346402	6.804702215
9	67778700	0.040025171	2.609534986	1984.48163	*0	65.95339999	40.125	0	100	15.53039551	0.651855469	4.010009766	26	FIXED	-7.772030582	7.893203058	6.799553098
10	67778800	0.040027378	2.611802452	1984.668638	*0	65.95339999	40.125	0	100	15.53039551	0.651855469	4.010009766	26	FIXED	-7.766882281	7.888060516	6.794404798

```
# Format Version = 3
#
# inspection information
# 2019-11-05_NWWW_ILS_11_R

# AC 'VH-FIX'; Company 'DTI'; Operator 'D. Shepherdson'; Regulations 'ICAO'; Schedule 'Periodic_Monitor'
#
# procedure information
# NWWW, Nouma La Tontouta, RWY 11 DGPS: NWWW-WW1204-Ref

# THR Approach, from 7 to 0 [NM], 2000 [ft] AMSL, 1940 [ft] HGT LLZ: TX1-AS, GP: TX1-AS, DME1: LT.TX1, DME2: LT.TX1
#
# export time: UTC 2019-11-04 23:00:44; RTS time: UTC 2019-11-04 23:00:55
# output frequency: 10 [Hz]
#
# Unconnected Data Channels:  -- NONE --
#
#
# Event Parameter Defined:  -- NONE --
#
# - ----------------------+ - ----------------------+ - ----------------------+ - ----------------------+ - ----------------------+ - ----------------------
# : 2                      : 4                        : 6                        : 8                        : 10                       : 12
# : time                   : EPERunStatus             : GPSTime_UTC              : dme1AgcCorr              : dme1El                   : dme1ErrRng
# : [HH:mm:ss.SSS]         : [Status]                 : [HH:mm:ss.SSS]           : [dBW/m²]                 : [°]                      : [NM]
# - ----------------------+ - ----------------------+ - ----------------------+ - ----------------------+ - ----------------------+ - ----------------------
  O   23:00:55.200         O   3 unknown              O   23:00:54.777          C   -72.67067714473771      O   2.218475309995663      C   -0.0028995753858962847
  O   23:00:55.300         O   3 unknown              O   23:00:54.877          C   -72.66772241296837      O   2.2198801032321187      C   1.9839131595856115E-4
  O   23:00:55.400         O   3 unknown              O   23:00:54.977          C   -72.66812970353035      O   2.221358315080445       C   -0.004517921128597498
  O   23:00:55.500         O   3 unknown              O   23:00:55.077          C   -72.66716603861792      O   2.222802787595742       C   -0.0014226830613153247
  O   23:00:55.600         O   3 unknown              O   23:00:55.177          C   -72.66796339165255      O   2.224250577325265       C   0.0016704625040998493
```

Figure 3 Examples Flight Inspection Data file

The purpose is not to provide a software which is able to proceed any of data files from Navaid recordings but to try to define a common data format to simplify this task. Any users (Ground personals or flight inspectors) can develop their own tools to plot curves and perform their reports without dealing with conventions, field separator, decimal and thousand separators, units ....

THE COMMON DATA FILE

The data file structure must be separate in sections, with first, a header clearly defined, included all the parameters used for the recording. An example of minimum list can be:

- Type of rover (Vehicle, Plane, UAV)

- Identification of the ROVER (Type and registration Id)

- Crew (Pilots, Flight Inspectors)

- Receivers Used (Model, Reference number, Date of calibration)

- Flight Inspection System with software version used.

- Tractography system used

- Procedure information

  o LLZ, Glide, VOR

  o TX 1 or 2

  o DME TX 1 or 2

  o Type of run (Approach, Flight level, Orbit, Partial Orbit…) with distance of beginning and of end altitudes.

- o Date and time in UTC

- o Sample rate in Hz

- Sign conventions for DDM and Errors can also be added in the header.

- Additional info

A second section with average results of the run can insert before the data section.

The first line of the data section will be easily identifiable with a specific make-up, in case of the size of the previous sections are not constant.

All parameters have to be stamped in time and in status (Validate or not) with associated units. Of course, they must be synchronized.

Like in the header a minimum list has to defined for each navaid and each type of run (axis, coverage…)

For example, in a Localizer axis run file you can find at minimum:

- Tim e (HH:mm:ss.SS)

- 90Hz mod depth (%)

- 190Hz mod depth (%)

| With the 90Hz and 150Hz mod depths who can calculate SDM and DDM with the convention you used to it |

- LLZ injection (dBm) and/or LLZ Field strength (dBW/m^2)

- Distance from the Localizer (Nm or meters)

- Azimuth from the Localizer in degrees (°) *with the same convention for all systems*

- Height from the Localizer (ft or meters)

- Latitude, longitude and WGS84 Altitude of the Localizer antenna of the rover with minimum of 7 digits for Lat and Lon. To offer the possibility of recalculation of the rover Localizer antenna position in a reference runway defined by the user.

- DME parameters (Ranging, Response Rate, Distance and height from DME ground antenna)

- Additional parameters

This is not the purpose of the document to describe for each run the minimum parameters list, but this work will be the major step of the definition of common data file.

We can also describe a folder structure where all the runs are stored with additional files for configuration options.

TYPE OF FILE

These date files must be text files, easier to open, to read and to proceed and now memory file size is no longer a problem, so it's not needed to use binary files. The best way is to have one files for each run and for ILS one file for the LOC and for the Glide in case of measurements of both in the same run (Like ILS Axis structure).

There have two major options: **csv** files (**c**omma **s**eparate **v**alues) files and **XML** files (**E**xtensible **M**arkup **L**anguage)

A **csv** file is a delimited text file that uses a comma to separate values. Each line of the file is a data record. Each record consists of one or more fields, separated by commas. So, in this case, comma must not be used for decimal (like in France) or for separate thousands. Some of FI systems already export their data in this text file format, and Excel software you can open modify and save file in this format. So, it's the easier way to start for a common data file.

XML is a markup language and file format for storing, transmitting, and reconstructing arbitrary data. XML can be use also for a definition of common data format. The characters making up an XML document are divided into *markup* and *content*, which may be distinguished by the application of simple syntactic rules. Generally, strings that constitute markup either begin with the character < and end with a >

If we chose XML, we must define an XML Schema, so we can use XLM parser to get Data needed to be plotted or processed inside the files. XML also can be used with Excel after importation of the XML Schema.

For the time being, I don't have any experience with XML data files for FI runs, all the different systems I used to process files provide text files some in csv format and some with tabulations to separate field and values.

Most of FI systems now export kml (or kmz) files which are XML files for Google Earth Software.

JSON (**J**ava **S**cript **O**bject **N**otation) can also be an alternative to generate these Data Files. It is a common data format with diverse uses in electronic data interchange, including that of web applications with servers.

XML file can be easily transformed in JSON file.


```
<data_list>
  <data>
    <DataId>1</DataId>
    <Validate>True</Validate>
    <Time>23:00:55.200</Time>
    <90Hz(%)>19.24</90Hz(%)>
    <150Hz(%)>21.81</150Hz(%)>
    <LLZ_Agc(dBm)>-77.2</LLZ_Agc(dBm)>
    <LLZ_Field_Stregnth(dBW/m2)>-86.4</LLZ_Field_Stregnth(dBW/m2)>
    <LLZ_Ref_Dist(Nm)>8.00</LLZ_Ref_Dist(Nm)>
    <LLZ_Ref_Angle(°)>0.12</LLZ_Ref_Angle(°)>
    <LLZ_Ref_Height(ft)>2500</LLZ_Ref_Height(ft)>
    <Lat_Ref(°)>45.0125784</Lat_Ref(°)>
    <Lon_Ref(°)>1.2547891</Lon_Ref(°)>
    <AltWGS84_Ref(m)>845.50</AltWGS84_Ref(m)>
  </data>
  <data>
    <DataId>2</DataId>
    <Validate>True</Validate>
    <Time>23:00:55.300</Time>
    <90Hz(%)>19.25</90Hz(%)>
    <150Hz(%)>21.82</150Hz(%)>
    <LLZ_Agc(dBm)>-77.3</LLZ_Agc(dBm)>
    <LLZ_Field_Stregnth(dBW/m2)>-86.5</LLZ_Field_Stregnth(dBW/m2)>
    <LLZ_Ref_Dist(Nm)>7.99</LLZ_Ref_Dist(Nm)>
    <LLZ_Ref_Angle(°)>0.12</LLZ_Ref_Angle(°)>
    <LLZ_Ref_Height(ft)>2495</LLZ_Ref_Height(ft)>
    <Lat_Ref(°)>45.0125783</Lat_Ref(°)>
    <Lon_Ref(°)>1.2547892</Lon_Ref(°)>
    <AltWGS84_Ref(m)>844.30</AltWGS84_Ref(m)>
  </data>
</data_list>
```

```
"FI data": [
    {
      "DataId": 1,
      "Validate": "True",
      "Time": 23:00:55.200,
      "90Hz(%)": 19.24,
      "150Hz(%)": 21.81,
      "LLZ_Agc(dBm)": -77.2,
      "LLZ_Field_Stregnth(dBW/m2)" = -86.4
      "LLZ_Ref_Dist(Nm)": 8.00,
      "LLZ_Ref_Angle(°)": 0.12,
      "LLZ_Ref_Height(ft)": 2500,
      "Lat_Ref(°)": 45.0125784,
      "Lon_Ref(°)": 1.2547891,
      "AltWGS84_Ref(m)": 845.50
    },
    {
      "DataId": 2,
      "Validate": "True",
      "Time": 23:00:55.300,
      "90Hz(%)": 19.25,
      "150Hz(%)": 21.82,
      "LLZ_Agc(dBm)": -77.3,
      "LLZ_Field_Stregnth(dBW/m2)" = -86.5
      "LLZ_Ref_Dist(Nm)": 7.99,
      "LLZ-Ref_Angle(°)": 0.12,
      "LLZ_Ref-Height(ft)": 2495,
      "Lat_Ref(°)": 45.0125783,
      "Lon_Ref(°)": 1.2547892,
      "AltWGS84_Ref(m)": 844.30
    },
```

Figure 4 (XML & JSON example)

PBN AND OTHERS FLIGHT INSPECTIONS RUNS

For now, I only focus on Navaid FI files but for also PBN Flight Inspection a common format file we be help full as well. A file, where you can find all the GNSS parameters needed for post processing (Numbers of GNSS satellites in view and used, PDP, HDOP, VDOP, Horizontal and vertical Cross tracks, Latitude, Longitude, Altitude in WGS84…).

The standardization of Data format can be also applied to other Flight Inspection mission like VHF coverage flight or RADAR and ADSB test flights.

We can also think about a common format for NavAid Data base using for example SQL(**S**tructured **Q**uery **L**anguage) standard.

These standards for data file have to be improved and adapted any time needed to follow evolution of the FI activity.

<u>CONCLUSIONS</u>

A common data file format is something that will be very useful for Navigation Service providers who have different systems or contractors for Flights Inspections. It's more and more needed today by the multiplication of data recordings on Navaid (UAV, Software simulation). This can be the task of the ICASC comity to initiate and to manage this project. Maybe create a task group involved of this issue with the FI System providers, flight inspectors and Navaid ground engineers interested to get these standards.

I will be please to share my experience and give my expertise, if such a project will be raised.