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# Introduction

ASTERIX Display & Sniffer is a C# /.NET application developed using Microsoft Visual Studio 2010. Initially it started as a small test application intended to read and decode ASTERIX messages. Over the time I have added data display functionality that eventually grew to a full plot/tracker display providing data display filters (by Flight Level Band or Mode-A code), different map overlays, indication of the “track in coast” state, moving track labels, and assigning CLF (Cleared Flight Level). In addition to the above it is also provides the following:

1. ASTERIX stream Recording (up to 6 different data streams).
   1. Recoding can be in “raw” or proprietary “replay” format.
2. Replay of ASTERIX “replay” Recordings in the original or up to 10 X faster pace.
3. Opening of ASTERIX “raw” recordings in raw format to analyze and visualize data.
4. Export of imported/captured data in KML/KMZ format in order to visualize it in Google Earth.
5. Export of live/replayed data in real time to Google Earth in order to use it as a data display.
   1. Done via Google Earth Network Connection feature.
6. Forwarding of ASTERIX data streams (up to 5) between networks or to a different multicast address/port.

Note that the application uses Visual Basic Power Pack that needs to be installed on the application host machine. It can be downloaded at: <http://msdn.microsoft.com/en-us/vstudio/bb735936.aspx>

On my development machine I have it installed at *C:\Program Files\Reference Assemblies\Microsoft\VBPowerPacks\v10.0\Microsoft.VisualBasic.PowerPacks.Vs.dll* and referenced form VS2010.

Lastly, make sure that host machine’s localization is set to English U.S.

The software uses .NET libraries (i.e. double.Parse) that depend on localization. If not set as expected the software is not able to correctly parse configuration files located in the ***C:\ASTERIX\ADAPTATION*** directory.

# Initial Setup

The application is configured via following configuration files that are located in ***C:\ASTERIX\*** directory that consist of the following directories and configuration files:

***C:\ASTERIX\ADAPTATION***

* ***DisplayAttributes.txt*** (*Not to be manually modified*)
  + Defines display attributes for the display maps. The application itself provides GUI for changing display attributes (see: ***Display Attributes*** for details).
* ***Main\_Settings.txt*** (*Not to be manually modified*)
  + - The system ***display origin point*** (LAT/LNG of the default center of the display map. The parameter is set to the center of Bosnia and Herzegovina but can be modified using application GUI. (See: ***Display Attributes*** for details).
    - Display ***background color***. The parameter is defaulted to black, but can be modified using application GUI. (See: ***Display Attributes*** for details).
* ***Radars.txt*** (*To be manually modified*)
  + Defines radar positions (LAT/LNG). Please see the file for the proper syntax. If no file is provided then by default Sarajevo APP and Jahorina radars are defined. ***All radar data streams to be processed have to be defined in this file.***
* ***Sectors.txt*** (*To be manually modified*)
  + Defines sector borders. See the file for the proper syntax and modify it as needed.
* ***States.txt*** (*To be manually modified*)

* + Defines state borders. See the file for the proper syntax and modify as needed. I got my data from <http://www.gadm.org/country>. Some manual modification is needed tough.
* ***Waypoints.txt*** (*To be manually modified*)
  + Defines system waypoints. See the file for proper syntax and modify as needed.
    - ***NOTE:*** *The last parameter is needed but does not have any impact at this moment. It is intended to flag the point as a COP (Coordination point) and is included for the future application growth.*
* ***LabelAttributes.txt*** (*Not to be manually modified*)
  + Defines Track/Plot Label display attributes. Use provided GUI for modification. Please see ***Label Attributes***.

***C:\ASTERIX\IMAGES***

* ***radar.jpg*** (jpg image to be used for radar presentation on the local display)
* ***waypoint.jpg*** (jpg image to be used for waypoint presentation on the local display)

***C:\ASTERIX\GE***

* ***ac\_image.png*** *(an image that Google Earth uses for Track/Plot display when displaying in real time.*
* ***ASTX\_TO\_KML*** *(auto generated file that is used by Google Earth to display data in real time).*

***C:\ASTERIX\***

* ***Asterix\_Export.txt*** *(auto generated by the Google Export functionality)*

# Main Windows and Functionality

Once started the ***Main Screen*** opens up and, as you might assume, there are no any plots/tracks displayed. To see some action the data either has to be imported from a “raw” ASTERIX recording or processed from LAN (live or replayed).

To open up a recording go to ***File -> Open Asterix Recording*** and browse to the file.

To read in live/replayed data the PC where ASTERIX Display & Sniffer is running has to be on the same network as the hardware which is providing the data so that application gets the ASTERIX data via known multicast IP and PORT number.

**NOTE:** For demonstration/testing purposes I provide two data samples located in the VS2010 solution in DATA SAMPLE directory. Those can be used to either open up a data sample data in “raw” or replay using the replay functionality.

# Setting up a connection

To start, from the Main Screen (Figure 2) open up ***Settings -> Connection Settings or directly from the Main Screen under Connection*** (Figure 1), and enter required data. It is possible to enter several connections and save them in a file. Later on, you can open up the file and just activate one of the saved connections. Upon opening the form the software will check for the available network interfaces and pre-fill the “Local Interface Addr” combo box with IP addresses. It is also possible to enter one manually.

### *C:\Users\bhdca\Desktop\Temp\Open-Set Connection.jpg*

### Figure 1: Connection Screen

# Start processing data

Once a connection is activated to start processing the data it is necessary to enable it from the Main Screen using the upper right button (***Stopped/Running***). Once the processing is activated the screen will start to populate as shown in Figure 2 & 3.

### C:\Users\bhdca\Desktop\Temp\Full Screen.jpg

### Figure 2: Main Display Window

If no valid ASTERIX data is received for 2 seconds while a connection is activated “Running” and Plot/Track display is enabled then “DISPLAY FROZEN” message in red is displayed on the screen. This is to warn the user that no display is being updated.

### Figure 3: Main Display Window (DISPLAY FROZEN)

### C:\Users\bhdca\Desktop\Temp\Asterix Capture.jpg

### Figure 4: Main Capture Window

Once some data is buffered stop the buffering and then you can analyze the data either by looking at the Main Screen or by one of the below listed options:

# Data Item Presence

This view provides info on what data items were detected for a given message category for the latest buffered data sample.

### *C:\Users\bhdca\Desktop\Documentation\Data Item Presence.jpg*

### Figure 5: Data Item presences

So far the data item presence for the following ASTERIX categories is implemented:

* CAT 001
* CAT 002
* CAT 008
* CAT 034
* CAT 048
* CAT 062
* CAT 063
* CAT 065

# Data Item View

This view lists all the given data items in the order they were received for the given data sample. It does not filter the data so for CAT001 and CAT048 it is much better to use “View by SSR Code”.

### C:\Users\bhdca\Desktop\Documentation\Data Item View.jpg

### Figure 6: Data Item View

# View by Mode-A Code

This view provides the following data (CAT001 or CAT048), filtered by Mode-A code in the order received:

* Range from the surveillance source
* Azimuth from the surveillance source
* Lat/Long from the surveillance source
* Mode C code Validated (TRUE/FALSE)
* Mode C code Garbled (TRUE/FALSE)
* Mode C code value

### ScreenHunter_04 Jul. 24 21.37.jpg

### Figure 7: View data by SSR code

# Export (Earth Plot or GePath)

This option decodes and exports a data sample, filtered by a Mode-A code, to either Earth Plot or GePath supported file formats that then can be used to export data into a KML file, used by Google Earth. The final result is possibility to display/visualize a track from the data sample as a 3D track in Google Earth, as shown in Figure 8.

Auto generated file is upon Exporting placed in ***C:\ASTERIX\Asterix\_Export.txt.***

### C:\Users\bhdca\Desktop\Documentation\Plot Exporter by SSR Code.jpg

### Figure 8: Export to Earth Plot format by Mode-A code

### C:\Users\bhdca\Desktop\Documentation\3D Example of a test flight over BiH exported via ASTERIX SNIFFER.jpg

### Figure 9: 3D example in Google Earth of a real test flight over Bosnia and Herzegovina

# Live Display in Google Earth

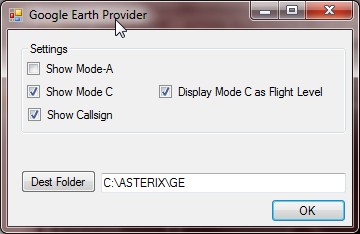
It is possible to set up the application to auto-generate xxx.kmz file (every update cycle) that is then automatically processed by Google Earth (via Network Connection). The final result is that Google Earth can be used as a 3D data display. If desired, a web server could be configured to provide the xxx.kmz file so that data could be accessed via a web browser (Google maps) or any other web page with embedded Google maps.



### Figure 10: Live display in Google Earth

The live display in Google Earth is enabled by selecting the display mode from the Plot Display Tab to ***“Google Earth”*** or ***“Local and Google E”***

Using Google Earth Provider (Settings -> Google Earth) it is possible to specify what data items will be forwarded/display in the Google Earth. In addition to that it is possible to specify the **“Dest Folder”** as a location where application places ***ASTX\_TO\_KML.kmz*** file. Google Earth is to be configured via its Network Connection to monitor the folder for the update data.



### Figure 11: Settings of Google Earth

# Local Plot/Track Display

Local Plot/Track display functionality provides capability to display received plots/tracks either in real time or buffered/imported data. It provides filter capability (by Mode-A code and/or Flight Level band) as well as to dynamically adjust update rate in order to match the antenna full circle time period of a specific radar in the case no North Mark message is available. If North Mark message is available it is recommended to use ***“Sync to NM”*** option.

The data display can be real time or passive. The passive display is an option to visualise all the buffered data (each recived target) including options to use one of the available filters (By Mode-A code or Flight Level band), as depicted in Figure 12 and Figure 13. It is also possible to filter out PSR targets. The filters are applicable to passive and real time displays.

***Please note:*** *Application uses WEB map provider Google, so the first time it is started it is necessary to have an internet access so application is able to cache the maps. While on the internet zoom in so maps with the appropriate resolution are downloaded. Later on no internet connection is required as maps are locally cached and application can be used offline.*

### *C:\Users\bhdca\Desktop\ScreenHunter_02 Oct. 02 13.51.jpg*

### Figure 12: Map with user defined and Google terrain overlay

The following four options are available via ***Map Type*** list box:

* Google Plain
* Google Satellite
* Google Terrain
* Google Hybrid
* Custom Build

Custom Build elements are always shown. However, the individual elements of the Custom Built map can be enabled or disabled as described in Display Items section of the User Manual.

### C:\Users\bhdca\Desktop\Temp\Passive Display no Filter.jpg

### Figure 13: Passive display no filter

### C:\Users\bhdca\Desktop\Temp\Passive display with Filter Mode-A.jpg

### Figure 14: Passive filter – by Mode-A code

Display zoom-in and zoom-out can be done via mouse middle button while mouse right button is used moving the maps. The same is also possible via application provided GUI.

# Track Label

The following depicts a track label that is in:

* Coast state (indicated by the down pointing arrow next to Mode A 6544)
  + Coast indicates that track has not been updated for the present update cycle.
* AC is climbing (indicated by upper pointing arrow next to Mode C 334)
  + Climbing/Descending is displayed once Mode-C changes between update cycles.
* A track that has a CFL 600 entered (next to Mode C)
  + To enter a CFL right click over CFL field.

To move a label just place the mouse over the label and move it in the desired direction while holding left mouse button. Please note that the label box is shown only when a mouse is over the label.

### C:\Users\bhdca\Desktop\Example1.jpg

### Figure 15: Label in coast, AC is climbing and entered a CFL

# Display Attributes

Display attributes window is accessed either via the Main Window from ***Settings -> Display Attributes*** or by right button mouse click from the Display Window, that will then provide the option to open up the Display Attributes Window. This window is used to control various display attributes as shown below in the Figure 15

### C:\Users\bhdca\Desktop\ScreenHunter_06 Sep. 12 14.54.jpg

### Figure 16: Menu to Access Display configuration windows

To check/modify a specific display attribute first select ***Display Item***, and then modify an applicable attribute.

***NOTE: Although not all attributes are applicable to each Item all attributes are available for the implementation simplicity. Example: Line Attribute is not applicable to radar but is to State Border line.***

### C:\Users\bhdca\Desktop\ScreenHunter_05 Sep. 12 14.54.jpg

### Figure 16: Display Attributes

# Display Items

Display attributes window is accessed by the right button mouse click from the Display Window that then provides the option to open up the Display Item

Display Item is provides a simple way to dynamically enable/disable specific data item on the display. The selection gets saved between application sessions.

### C:\Users\bhdca\Desktop\ScreenHunter_07 Sep. 12 14.58.jpg

### Figure 17: Display Items

# Label Attributes

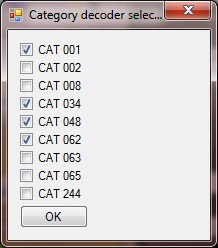
Label Attributes Window lets you configure Track/Plot Label attributes. The changes can be checked immediately by pressing the “Update” button. Once satisfied with the selection the settings can be saved using “Save” button so they persist between sessions.

### C:\Users\bhdca\Desktop\ScreenHunter_08 Sep. 12 14.59.jpg

### Figure 18: Label Attributes Picker

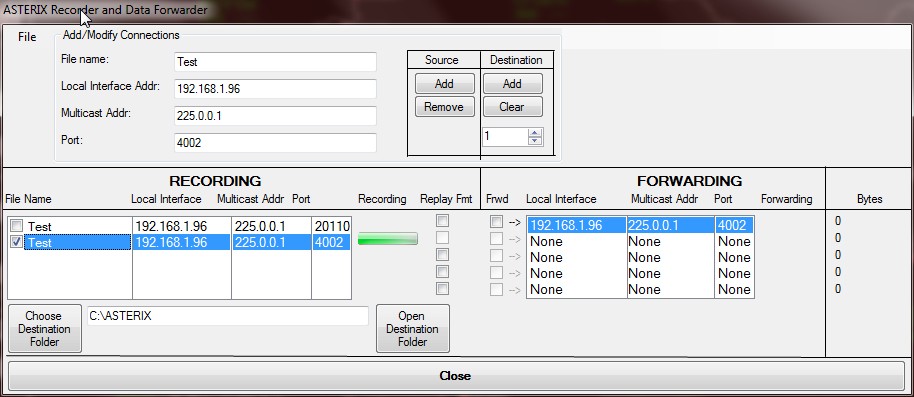
# Choosing Category to Process

This option lets you choose what ASTERIX Category to process. Usually, the one to be expected needs to be selected and in the case of using the application in order to display the data only category needed should be selected in order to improve performance. Choosing all available options lets you use the application to determine what categories/data items are present on the given interface.



### Figure 19: Category decoder selector

# ASTERIX Recording & Forwarding



### Figure 20: Data Recording and Forwarding

**Recording**

Provides capability to record up to 5 data streams + one that can be enabled from the Main Window. The data is stored in the destination directory with the same file name as provided during the configuration appended with the recording start date and time. The data is recorded either in the raw format that later can be imported and analyzed/visualized via Local or Google Earth display. The same recording can be opened by the Asterix Inspector (<http://sourceforge.net/projects/asterix/?source=directory>), in the “replay” format that later can be replayed using the built in Replay functionality (see Replay for Details).

**Forwarding**

Provides capability to forward up to 5 data streams to a different network interface or IP address/port.

# Replay

Replay function requires an ASTERIX recording (xxx.rply) file that can be recorded using the built in Recorder and selecting an appropriate option. To start Replay it is necessary to define network interface, multicast address and port number and lastly to select recoding file. By default the recording is done at the same speed as the original data stream but it is possible to dynamically adjust recoding speed to up to 10 times faster. It is also possible to pause and resume replay.

# Implemented Decoders (so far)

CAT01

020 Target Report Descriptor

040 Measured Position in Polar Coordinates

070 Mode-3/A Code in Octal Representation

090 Mode-C Code in Binary Representation

CAT02

000 Message Type

020 Sector Number

030 Time of Day

041 Antenna Rotation Period

CAT48

020 Target Report Descriptor

040 Measured Position in Slant Polar Coordinates

070 Mode-3/A Code in Octal Representation

090 Flight Level in Binary Representation

240 Aircraft Identification

CAT34

000 Message Type

030 Time-of-Day

020 Sector Number

041 Antenna Rotation Period

CAT62

015 Service Identification

105 Calculated Track Position (WGS-84)

060 Track Mode 3/A Code

040 Track Number

136 Measured Flight Level

380 Aircraft Derived Data

Subfield # 2: Target Identification

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