Table of Contents

[Introduction 3](#_Toc339806377)

[Initial Setup 4](#_Toc339806378)

[Main Windows and Functionality 5](#_Toc339806379)

[Setting up a connection 6](#_Toc339806380)

[Figure 1: Connection Screen 6](#_Toc339806382)

[Start processing data 7](#_Toc339806383)

[Figure 2: Main Display Window 7](#_Toc339806385)

[Figure 3: Main Capture Window 8](#_Toc339806387)

[Data Item Presence 9](#_Toc339806388)

[Figure 4: Data Item presences 9](#_Toc339806390)

[Data Item View 10](#_Toc339806391)

[Figure 5: Data Item View 10](#_Toc339806393)

[View by Mode-A Code 11](#_Toc339806394)

[Figure 6: View data by SSR code 11](#_Toc339806396)

[Export (Earth Plot or GePath) 12](#_Toc339806397)

[Figure 7: Export to Earth Plot format by Mode-A code 12](#_Toc339806399)

[Figure 8: 3D example in Google Earth of a real test flight over Bosnia and Herzegovina 12](#_Toc339806401)

[Live Display in Google Earth 13](#_Toc339806402)

[Figure 9: Live display in Google Earth 13](#_Toc339806403)

[Figure 10: Settings of Google Earth 14](#_Toc339806404)

[Local Plot/Track Display 14](#_Toc339806405)

[Figure 11: Map with user defined and Google terrain overlay 15](#_Toc339806407)

[Figure 12: Passive display no filter 16](#_Toc339806409)

[Figure 13: Passive filter – by Mode-A code 17](#_Toc339806411)

[Figure 14: Label in coast, AC is climbing and entered a CFL 18](#_Toc339806413)

[Display Attributes 18](#_Toc339806414)

[Figure 15: Menu to Access Display configuration windows 19](#_Toc339806416)

[Figure 16: Display Attributes 20](#_Toc339806418)

[Display Items 21](#_Toc339806419)

[Figure 17: Display Items 21](#_Toc339806421)

[Label Attributes 22](#_Toc339806422)

[Figure 18: Label Attributes Picker 22](#_Toc339806424)

[Choosing Category to Process 23](#_Toc339806425)

[Figure 19: Category decoder selector 23](#_Toc339806426)

[ASTERIX Recording & Forwarding 24](#_Toc339806427)

[Figure 20: Data Recording and Forwarding 24](#_Toc339806428)

[Implemented Decoders (so far) 25](#_Toc339806429)

# 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 became a full plot/tracker display providing filters, different map overlays, indication of the “track in coast” state, moving labels, and assigning CLF (Cleared Flight Level). In addition to the above it is also provides the following:

1. Record (up to 6 different data streams) and reading in ASTERIX data in raw format.
2. Export of imported/buffered data in KML/KMZ format in order to visualize it in Google Earth.
3. Export of live data in real time to Google Earth in order to use it as a data display. This is done via Google Earth Network Connection feature.
4. Forwarding 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. 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 machine where software is running (WIN OS) 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 itself contains 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 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 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 in real time from LAN.

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

To read in live 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.

*In my case, for the testing purpose, I use a host WINDOWS machine and one virtual LINUX machine where an ASTERIX recorded data (I provide CAT48 data sample (****jahorinaJan\_cat.48****) that is re-played (****I use gengate provided by SkyGuide****) on the same network as my host machine, using the following setup:*

1. *Host PC: 192.168.5.104, 255.255.255.0*
2. *Virtual Linux ASTERIX replay (CentOS): 192.168.5.103, replaying data on 231.27.80.1, port 4001*

*Of course, if available you can connect* ASTERIX Display & Sniffer *to any live ASTERIX data provider or use other tools, such as* Bittwist (runs on Windows) to locally replay the radar data.

***NOTE: Data Replay functionality is planned for the software release.***

# 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.

### *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

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

### Figure 3: 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 tells you 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 4: 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 5: Data Item View

# View by Mode-A Code

This view provides the following data (CAT 001 or CAT048), filtered by Mode-A code in the order received:

* Distance 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 6: 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 7: 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 8: 3D example in Google Earth of a real test flight over Bosnia and Herzegovina

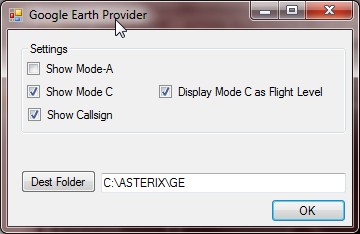
# Live Display in Google Earth

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 (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 9: 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”***



### Figure 10: Settings of Google Earth

**“Dest Folder”** is 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.

# Local Plot/Track Display

Local Plot 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) 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), as depicted in Figure 11 and Figure 12. In addition to that it is 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 11: 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 12: Passive display no filter

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

### Figure 13: Passive filter – by Mode-A code

While the application does provide GUI for re-centering and zoom in and zoom out functions, it is also possible to use mouse middle button for zoom and right button for moving the maps.

The following depicts a track that is in:

* Coast state (indicated by the down pointing arrow next to Mode A 6544
* AC is climbing (indicated by upper pointing arrow next to Mode C 334
* A track that has a CFL 600 entered (next to Mode C)
  + To enter a CFL right click over CFL field.

Please note that the label box is shown only when a mouse is over the label.

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

### Figure 14: 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 15: 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 right button mouse click from the Display Window that will then provide the option to open up the Display Item

Display Item is provides a simple way to 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

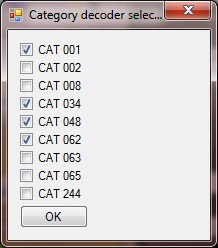
Label Attributes Window lets you configure Track/Plot Label attributes. The changes can be checked immediately by pressing “Update” button and then will be applied to the display. Once satisfied with the selection the settings can be saved using “Save” button so they remain same between sessions.

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

### Figure 18: Label Attributes Picker

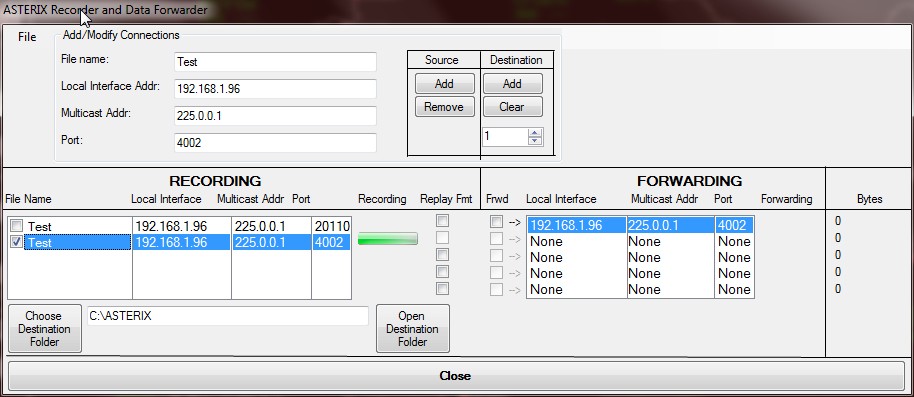
# Choosing Category to Process

This option lets you choose what ASTERIX Category is to be processed. 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 file name same provided during the configuration appended with the recording start date and time. The data is recorded in the raw format and later one 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>)

**Forwarding**

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

# 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

Amer Kapetanovic (akapetanovic@gmail.com)