User Manual

for

ASTERIX DARR

(Display Analyzer Recorder & Replay)

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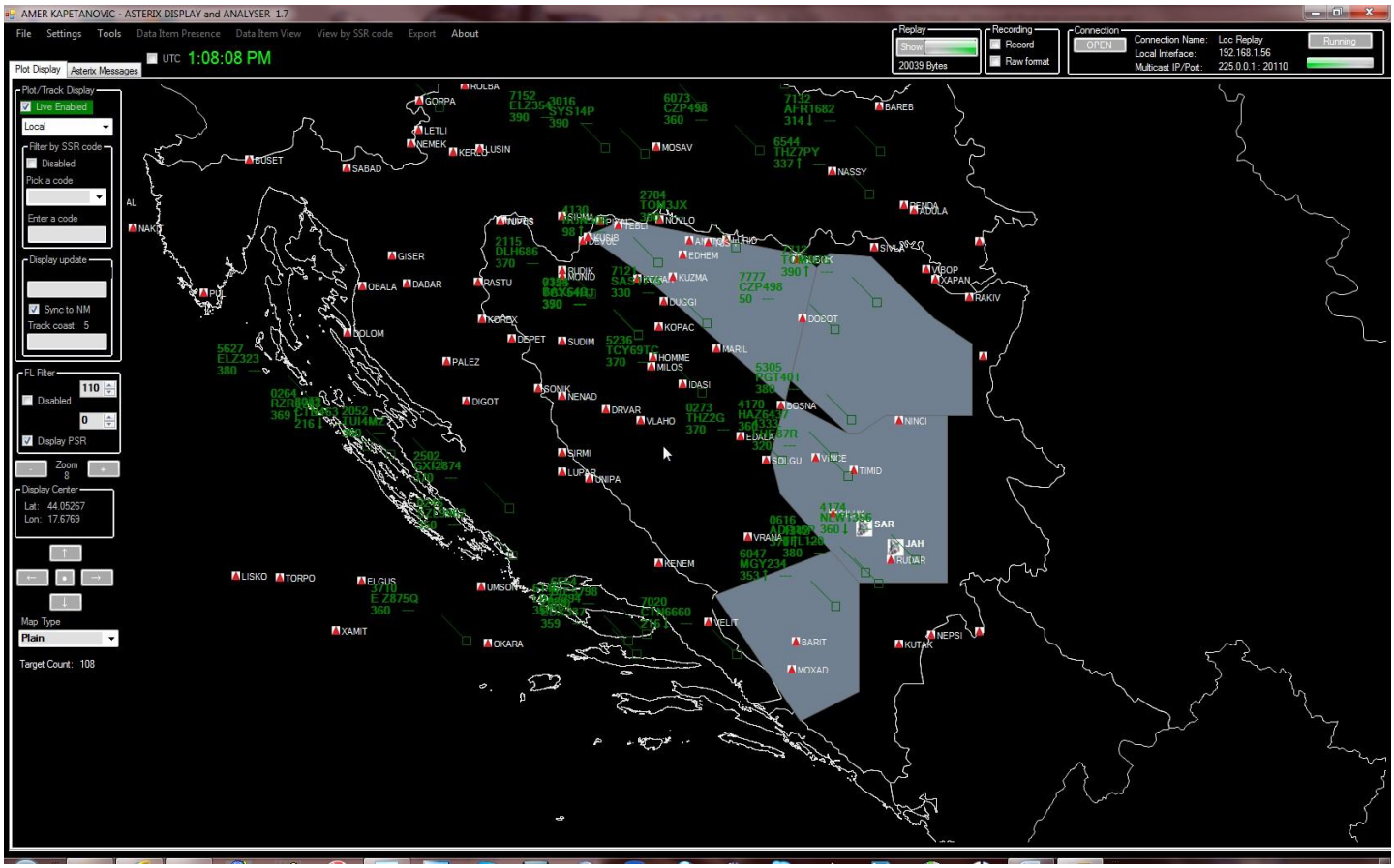


Table of Contents

Preface 4
Initial Setup 5
Main Windows and Functionality 7
Setting up a connection 7
..... 7
Figure 1: Connection Screen 7
Start processing data 9
Figure 2: Main Display Window 9
Figure 3: Main Display Window (DISPLAY FROZEN) 10
Figure 4: Main Capture Window 11
Data Item Presence 12
Figure 5: Data Item presences 12
Data Item View 13
Figure 6: Data Item View 13
View by Mode-A Code 14
Figure 7: View data by SSR code 14
Export (Earth Plot or GePath) 15
Figure 8: Export to Earth Plot format by Mode-A code 15
Figure 9: 3D example in Google Earth of a real test flight over Bosnia and Herzegovina 15
Live Display in Google Earth 16
Figure 10: Live display in Google Earth 16
Figure 11: Settings of Google Earth 17
Local Plot/Track Display 17
Figure 12: Map with user defined and Google terrain overlay 18
Figure 13: Passive display no filter 19
Figure 14: Passive filter – by Mode-A code 20
Track Label 21
Figure 15: Label in coast, AC is climbing and entered a CFL 21

Display Attributes 22
Figure 16: Menu to Access Display configuration windows 22
Figure 17: Display Attributes 23
Display Items 23
Figure 18: Display Items 24
Label Attributes 24
Figure 19: Label Attributes Picker 25
Choosing Category to Process 26
Figure 20: Category decoder selector 26
ASTERIX Recording & Forwarding 27
Figure 21: Data Recording and Forwarding 27
ASTERIX Replay 28
Figure 22: ASTERIX Replay 28
“Replay” to “Raw” 29
Figure 23: Replay to Raw format 29
Implemented Decoders (so far) 29

Preface

ASTERIX DARR (Display Analyzer Recorder & Replay) 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 interactive track label currently consisting of an assignable CFL (Cleared Flight Level) field. In addition to the above it also provides the following:

1. ASTERIX stream Recording (up to 6 different data streams).
    a. Recording can be in "raw" or proprietary "replay" format.
2. Replay of ASTERIX "replay" Recordings in the original or up to 10 X faster speed.
3. Opening of ASTERIX "raw" recordings in raw format to analyze and visualize data in Local or Google Earth Display.
4. Export of imported/captured data in KML/KMZ format in order to analyze/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.
    a. Implemented via Google Earth Network Connection feature.
6. Forwarding of ASTERIX data streams (currently limited 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. 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. It can be downloaded at: http://msdn.microsoft.com/en-us/vstudio/bb735936.aspx

Lastly, make sure that host machine's localization is set to English U.S. as application uses .NET libraries (i.e. double.Parse) that depend on localization setting. If not set as expected the software is not able to correctly parse configuration files located in the ***C:\ASTERIX\ADAPTATION*** directory.

The application has been tested using the following data samples:

1. Jahorina MSSR Mode-S: CAT001, 002, CAT034, CAT48
2. Sarajevo APP: CAT001, 002, CAT034, CAT48
3. BiH installation of ARTAS: CAT62
4. All publicly available data samples at: http://www.recherche.enac.fr/asterix/doku.php?id=userfr

I would appreciate that anyone with an access to additional data sample sends it to me so that additional testing and validation can be performed. The data samples can be in the following formats:

- Raw, using any available recording tool, including this application as well.
- Replay. (using this application)
- Final Format. (gengate tool)

Initial Setup

The application is configured via following configuration files that are located in ***C:\ASTERIX*** directory that 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 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 defaulted to the center of Bosnia and Herzegovina but can be modified using application GUI to any other location. (See: ***Display Attributes*** for details).
    - Display ***background color***. The parameter is defaulted to black but can be modified using application GUI to a desired color. (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. Provided data was obtained from http://www.gadm.org/country. Some manual modification is needed though.
- ***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 is not used at this time. 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 initially there are no plots/tracks displayed. ASTERIX data has to be either imported from a "raw" ASTERIX recording or acquired from LAN (live or replayed).

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

To acquire live/replayed data the PC where ASTERIX DARR 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 two sets of data samples are provided located in the VS2010 solution in DATA SAMPLE directory. Those can be used to either open up sample data in "raw" or "replay" using the replay functionality.

Setting up a connection

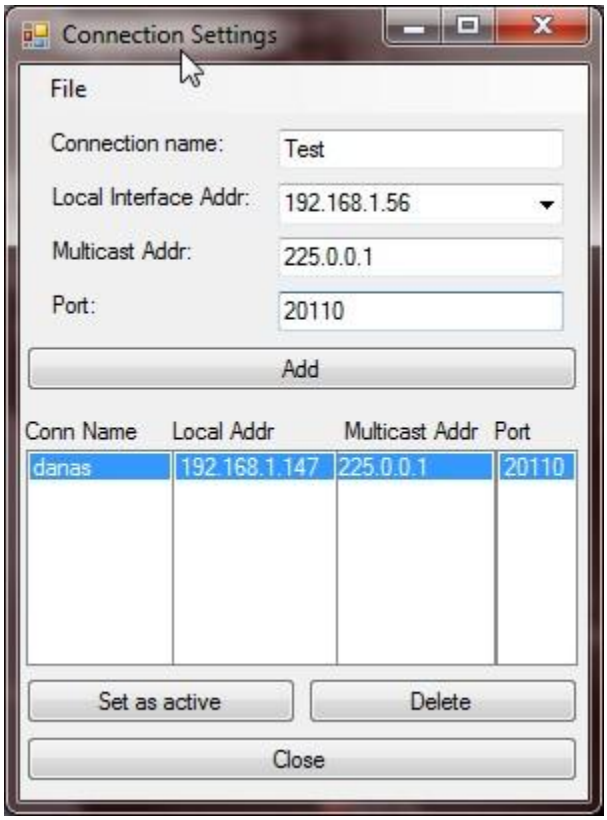


Figure 1: Connection Screen

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, one can open up the file and 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.

Tip: *In the case that data is replayed using build in Replay functionality then the fastest way is to also set up the connection from the Replay GUI. (See Replay ASTERIX for details).*

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.

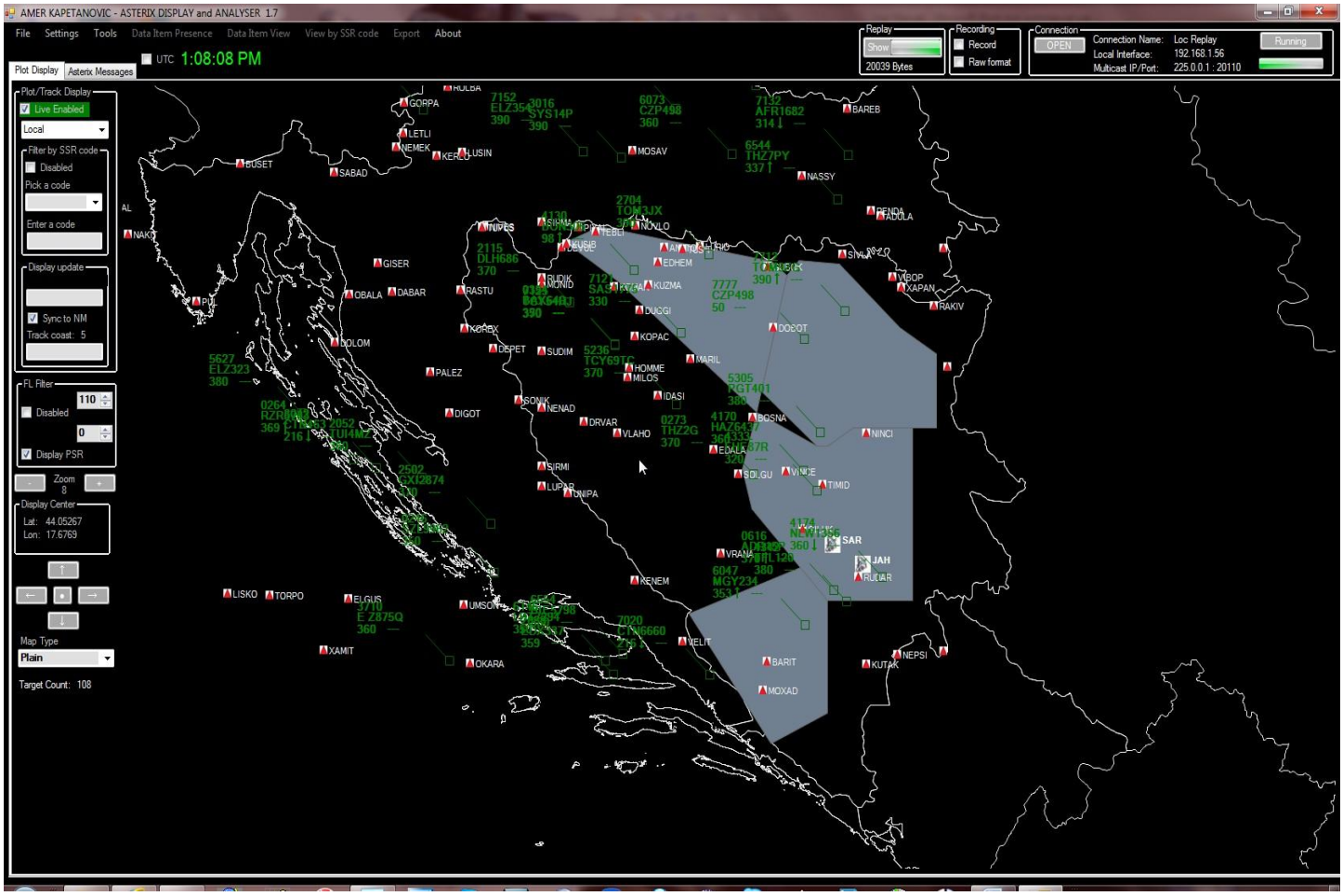


Figure 2: Main Display Window

FROZEN DISPLAY:

If no valid ASTERIX data is received for 2 seconds while a connection is activated “Running” and Plot/Track display is enabled then “FROZEN DISPLAY” message is displayed on the screen. This is to warn the user that display is not being updated.

Figure 3: Main Display Window (DISPLAY FROZEN)

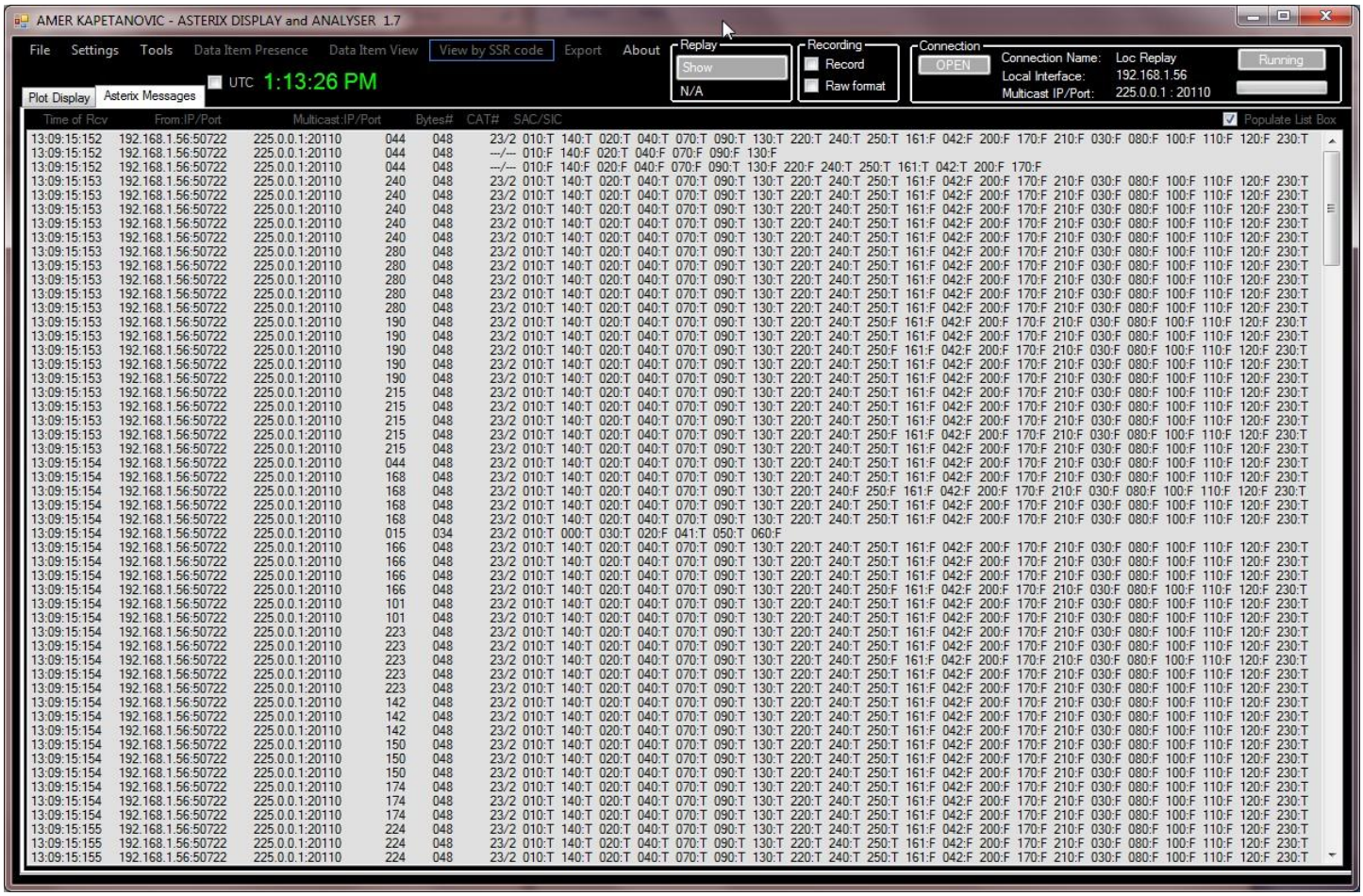


Figure 4: Main Capture Window

Once some data is buffered, it can be analyzed either by looking at the Main Screen under the Asterix Messages tab or by one of the below described options. Note that live update of the Asterix Messages tab can be enabled or disabled. In the case the application is used only for displaying, it is recommended to disable it as it improves the performances and uses less PC resources. This window is intended for quick analysis tasks and should not be used for long sessions.

Data Item Presence

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

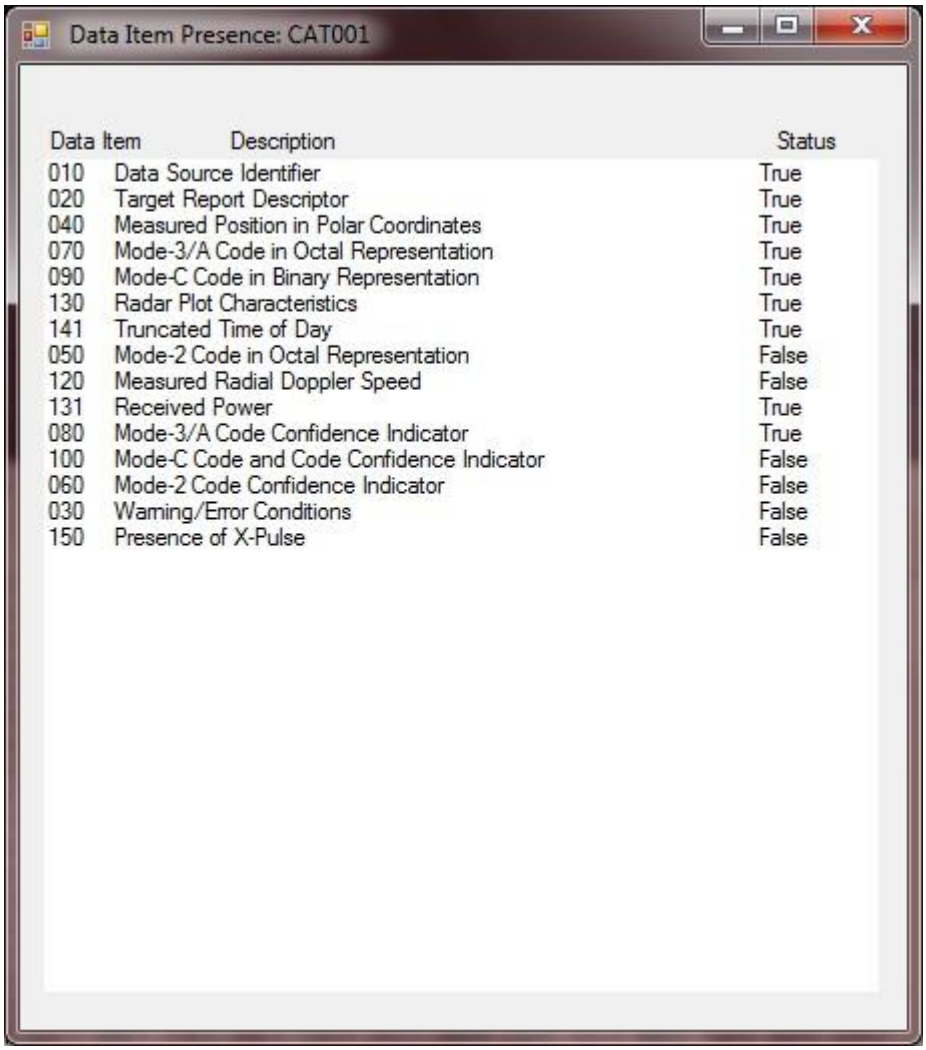


Figure 5: Data Item presences

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”.

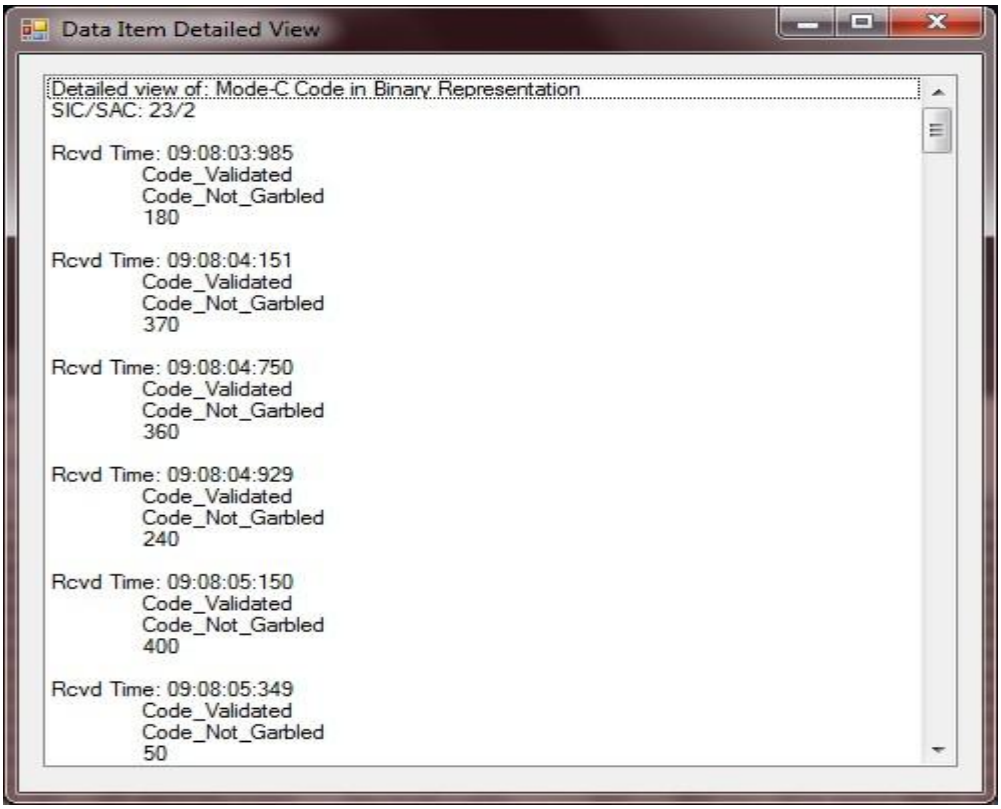


Figure 6: Data Item View

View by Mode-A Code

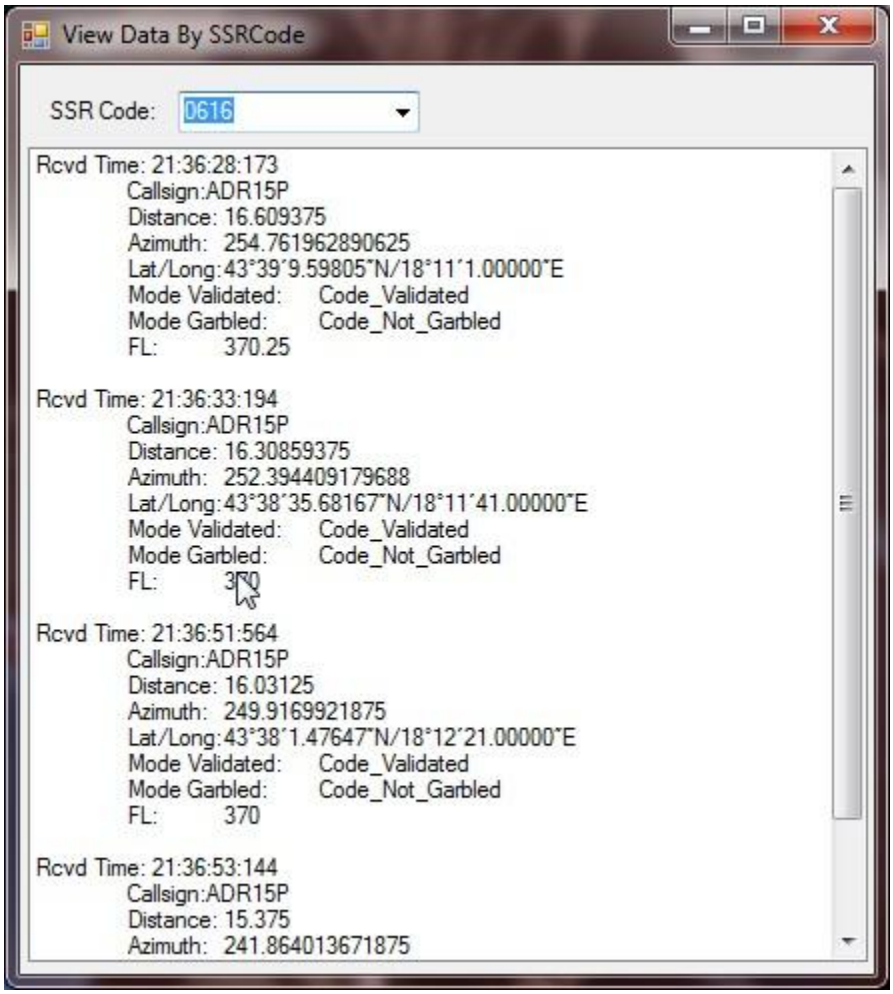


Figure 7: View data by SSR code

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 value

Export (Earth Plot or GePath)

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

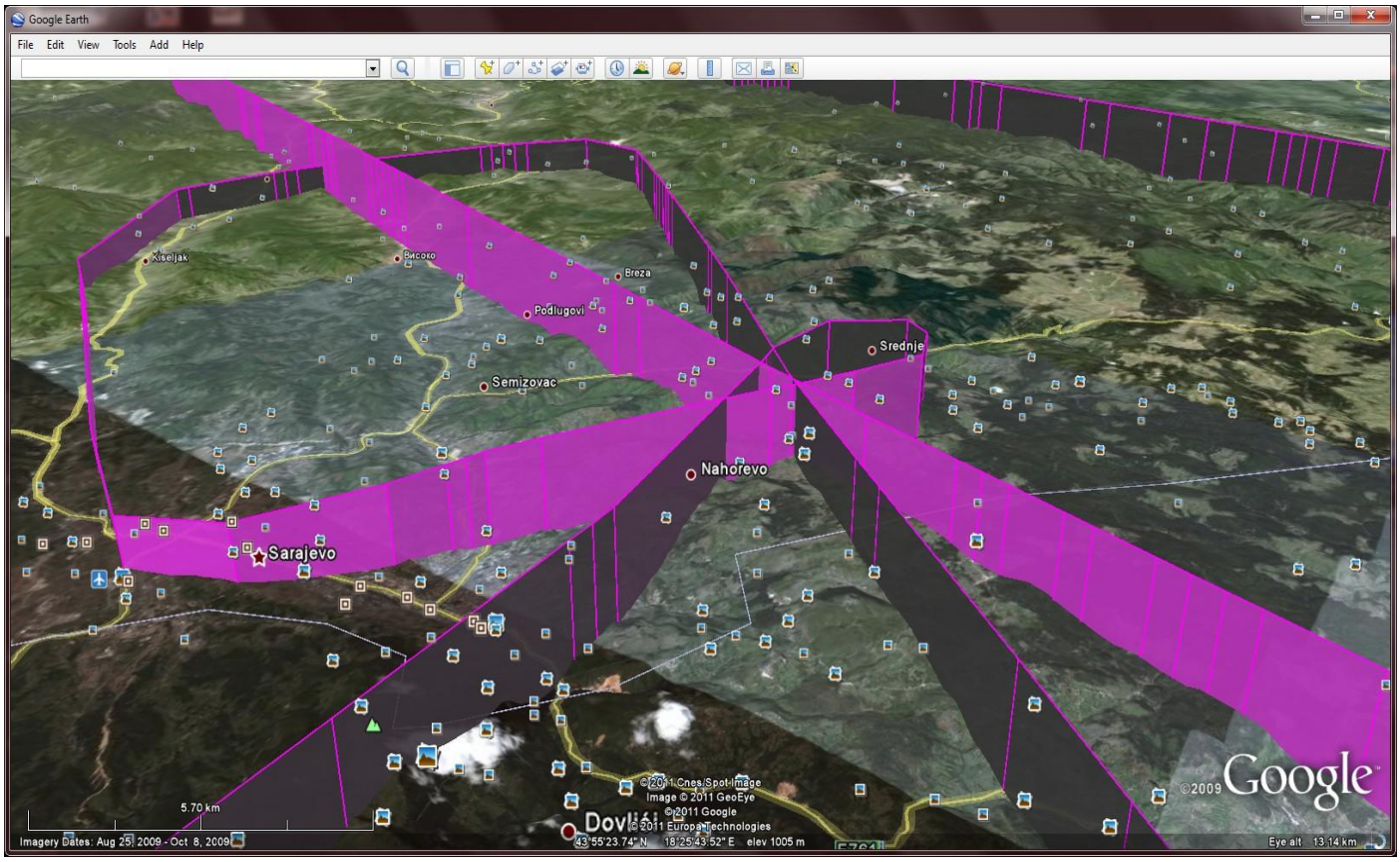


Figure 9: 3D example in Google Earth of a real test flight over Bosnia and Herzegovina

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 the possibility to display/visualize a track from the data sample as a 3D track in Google Earth, as shown in Figure 9.

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

Live Display in Google Earth

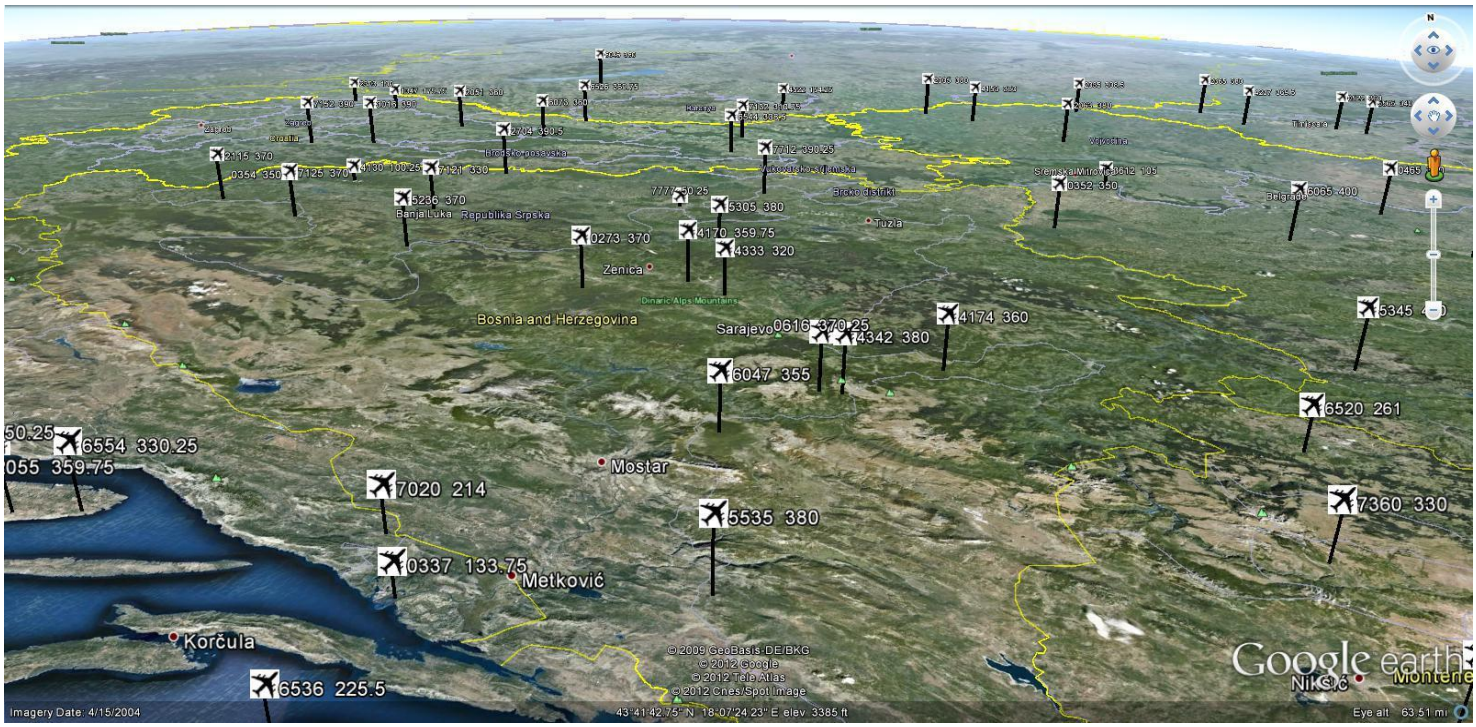


Figure 10: Live display in Google Earth

It is possible to set up the application to auto-generate xxx.kmz file (each 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.

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 are displayed 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 updated data (xx.KMZ file).

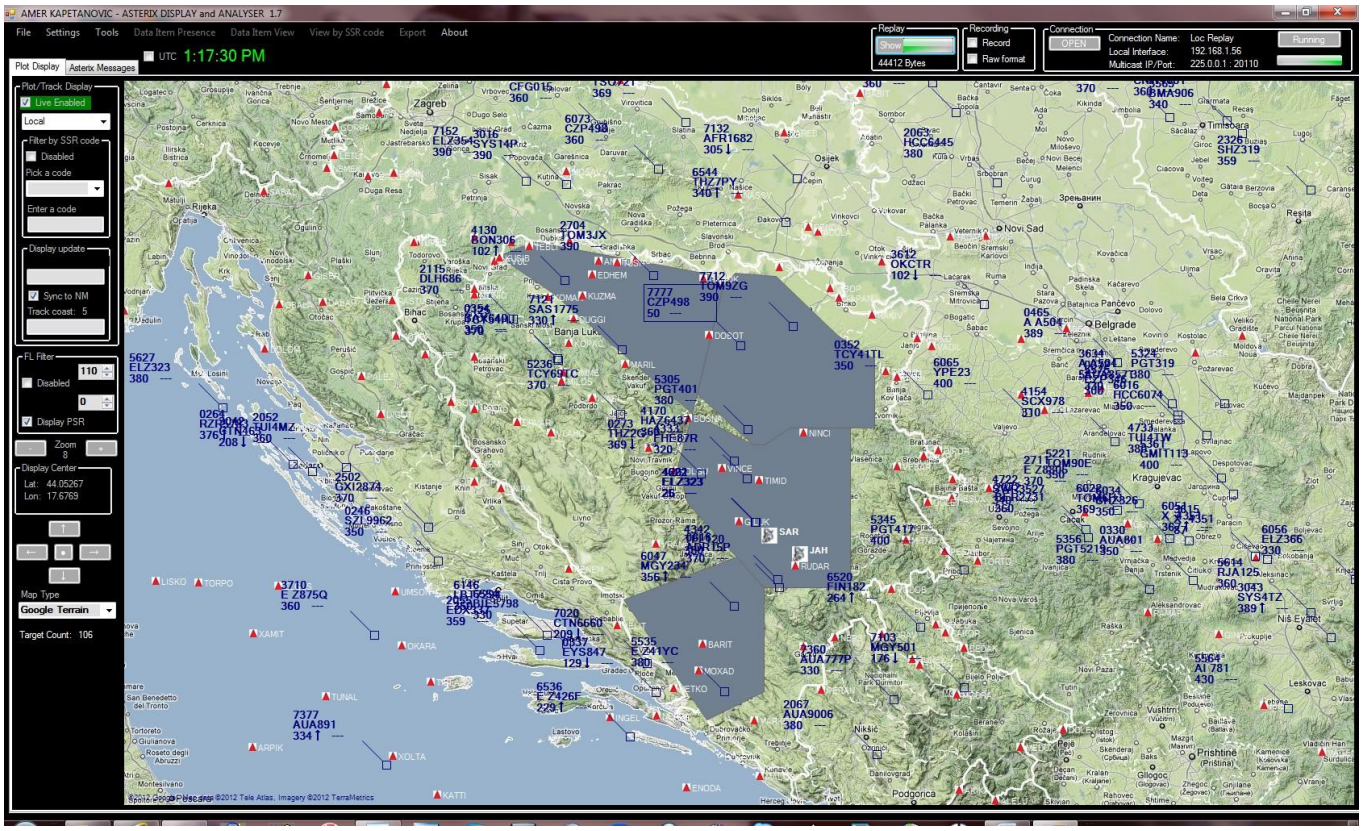
Figure 11: Settings of Google Earth

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 13. It is also possible to filter out PSR targets. The filters are applicable to passive and real time displays.

NOTE: *Application uses WEB map provider Google, so the first time it is started it is necessary to have an internet connection 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.*


AMER KAPETANOVIC - ASTERIX DISPLAY and ANALYSER 1.7
File
Settings
Tools
Data Item Presence
Data Item View
View by SSR code
Export
About
UTC 1:17:30 PM
Plot Display
Asterix Messages
Plot/Track Display
Live Enabled
Local
Filter by SSR code
Disabled
Pick a code
Enter a code
Display update
Sync to NM
Track coast: 5
FL Filter
Disabled
Display PSR
Zoom
Display Center
Lat: 44.05267
Lon: 17.6769
Map Type
Google Terrain
Target Count: 106
Replay
Show
44412 Bytes
Recording
Record
Raw format
Connection
OPEN
Connection Name: Loc Replay
Local Interface: 192.168.1.56
Multicast IP/Port: 225.0.0.1 : 20110
Running
Zagreb
Belgrade
Novi Sad
Banja Luka
Podgorica
Pristina
Kragujevac
Leskovac
Osijek
Timisoara
Resita
Zrenjanin
Sarajevo
Mostar
Split
Rijeka
Zadar
Pula
Dubrovnik
Ploce
Bihac
Karlovac
Varazdin
Sisak
Slavonski Brod
Vinkovci
Vukovar
Sombor
Subotica
Kikinda
Zrenjanin
Pancevo
Smederevo
Valjevo
Uzice
Cacak
Kraljevo
Novi Pazar
Kosovska Mitrovica
Prizren
Gjakova
Peja
Gnjilane
Vranje
Nis
Zajecar
Bor
Negotin
Pozarevac
Jagodina
Kragujevac
Kraljevo
Sabac
Loznica
Tuzla
Zenica
Doboj
Bijeljina
Brcko
Derventa
Gradiska
Prijedor
Sanski Most
Bihac
Cazin
Velika Kladusa
Livno
Tomislavgrad
Mostar
Trebinje
Nevesinje
Foca
Visegrad
Rogatica
Sokolac
Pale
Vlasenica
Zvornik
Srebrenica
Bratunac
Milici
Kladanj
Olovo
Visoko
Kakanj
Zavidovici
Maglaj
Teslic
Doboj
Modrica
Orasje
Odzak
Samac
Derventa
Gradiska
Kozarska Dubica
Novi Grad
Bosanska Krupa
Velika Kladusa
Cazin
Bihac
Sanski Most
Prijedor
Banja Luka
Jajce
Travnik
Novi Travnik
Zenica
Kakanj
Visoko
Ilidza
Sarajevo
Pale
Foca
Gorazde
Visegrad
Rogatica
Sokolac
Vlasenica
Zvornik
Srebrenica
Bratunac
Milici
Kladanj
Olovo
Tuzla
Lukavac
Gracanica
Doboj
Teslic
Maglaj
Zavidovici

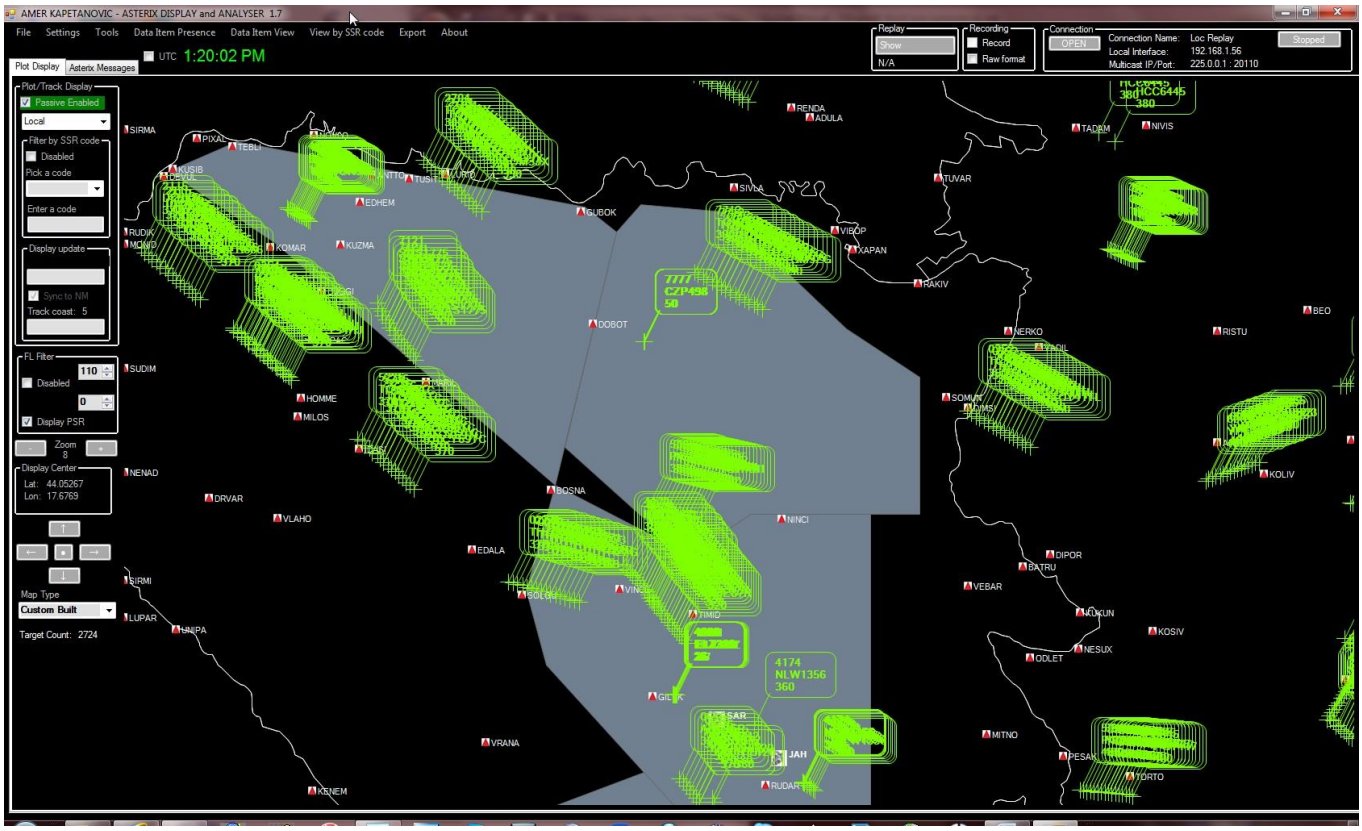


Figure 13: Passive display no filter

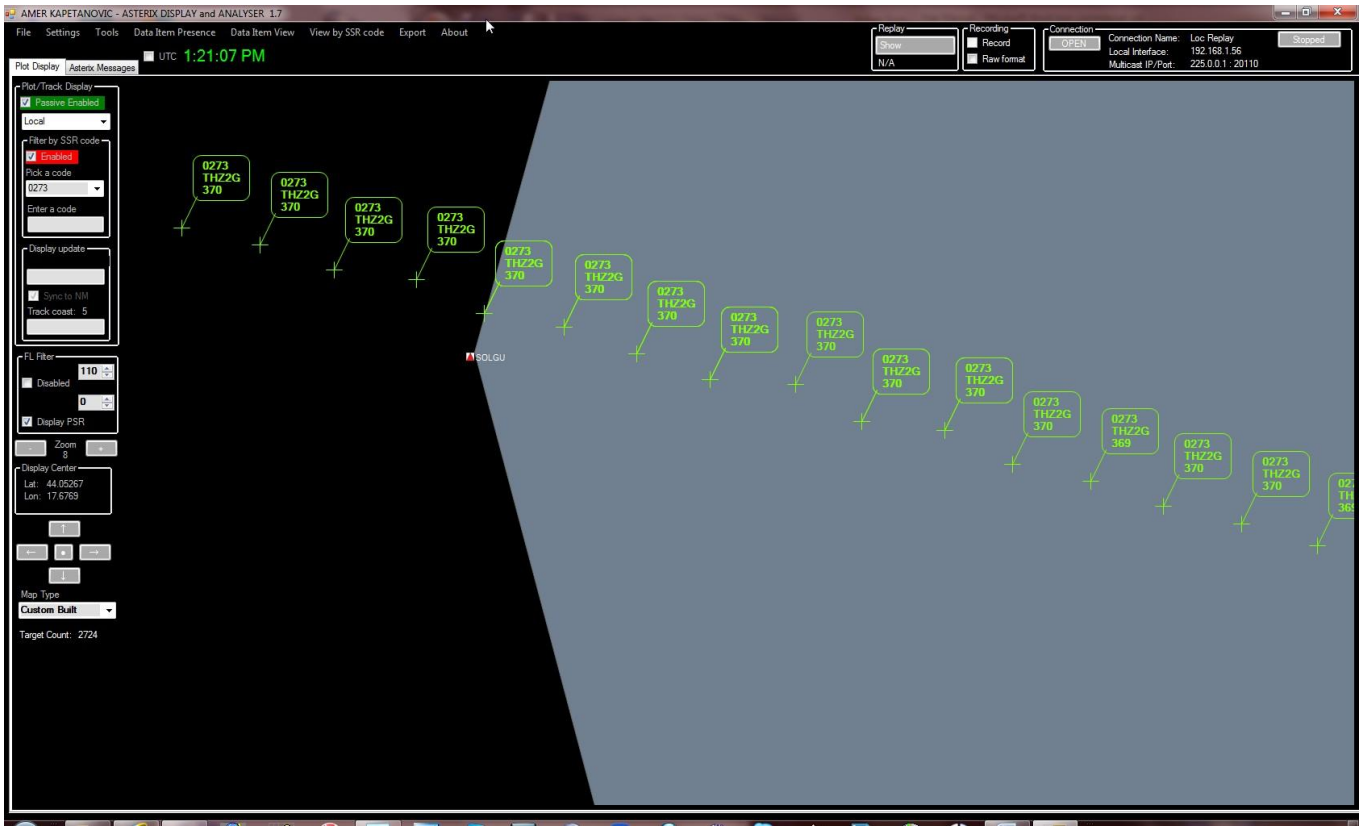


Figure 14: Passive filter – by Mode-A code

Display zoom-in and zoom-out can be done via mouse middle/scroll button. Map can be moved in any direction using the mouse while holding the right mouse button pressed. Both functions are also provided via application GUI.

Track Label

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

Figure 15 depicts a track label that is in:

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

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 -where an option to open up the Display Attributes Window is shown. This window is used to adjust display attributes as shown in Figure 16

Figure 16: Menu to Access Display configuration windows

To check/modify specific display attribute first select ***Display Items***, 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.***

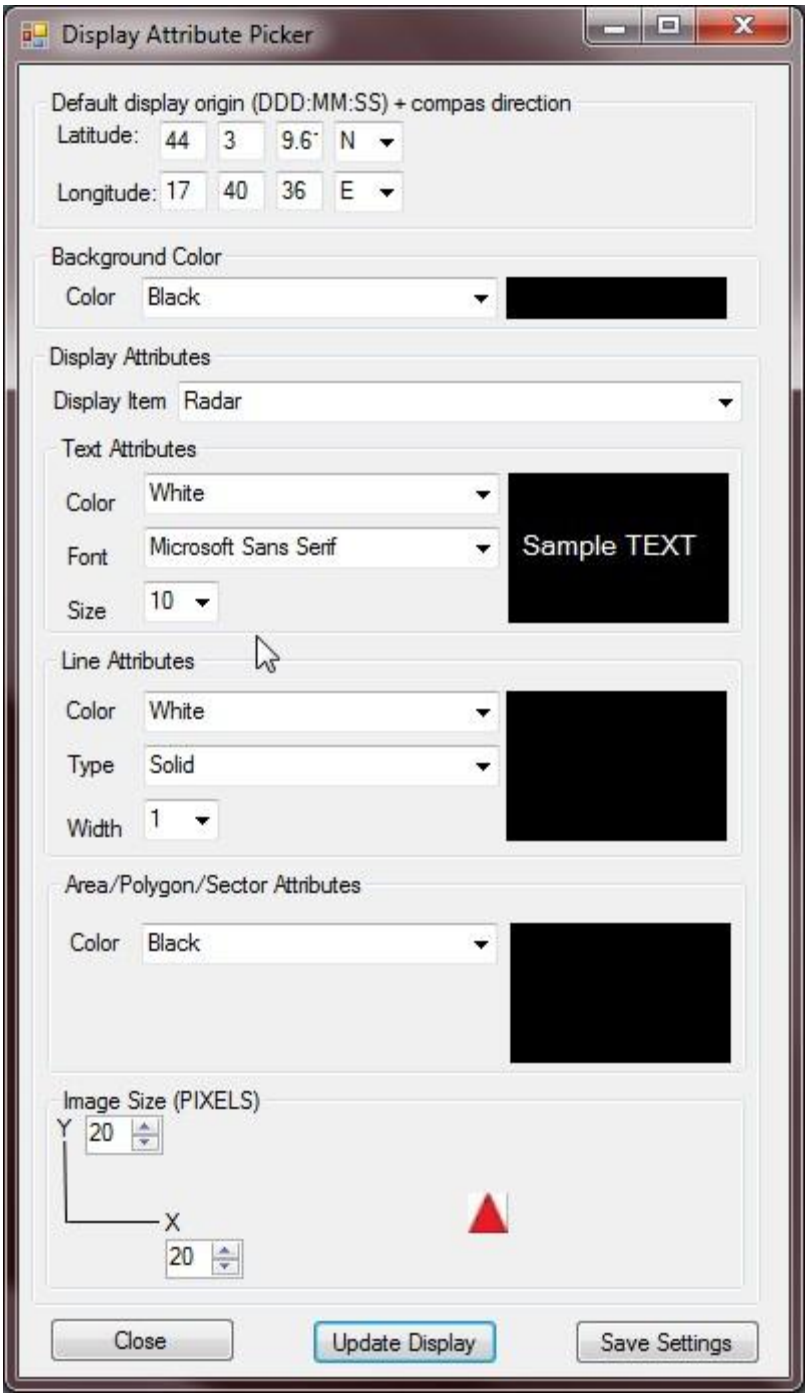


Figure 17: Display Attributes

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 Items

Figure 18: Display Items

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

Label Attributes

Label Attributes Window lets you configure Track/Plot Label attributes. The changes can be checked immediately by pressing the “Update” button. Satisfactory selection of the settings can be saved using the “Save” button, in which case they will persist between sessions.

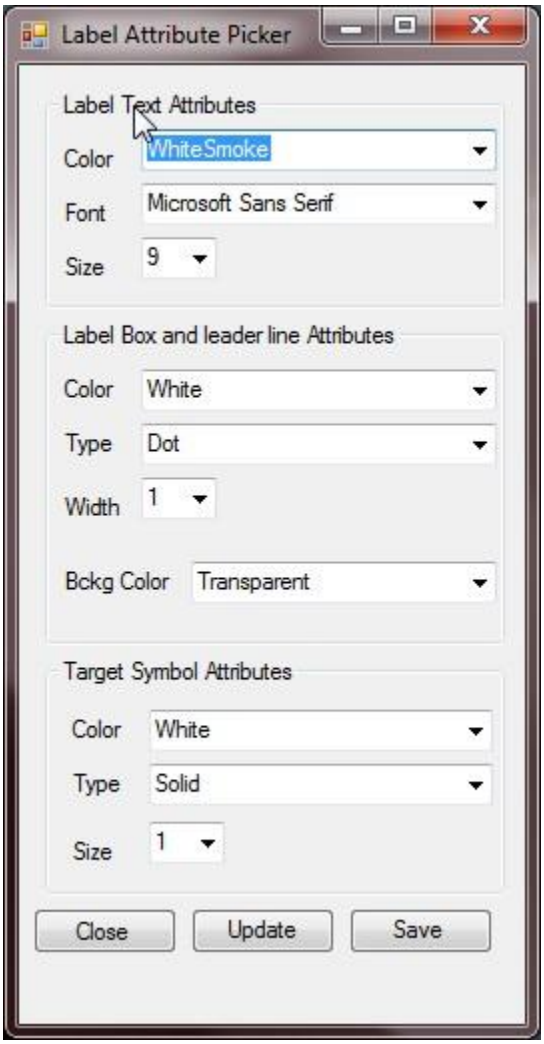


Figure 19: Label Attributes Picker

Choosing Category to Process

Figure 20: Category decoder selector

This option allows the user to choose which ASTERIX Category to process and which to ignore.

ASTERIX Recording & Forwarding

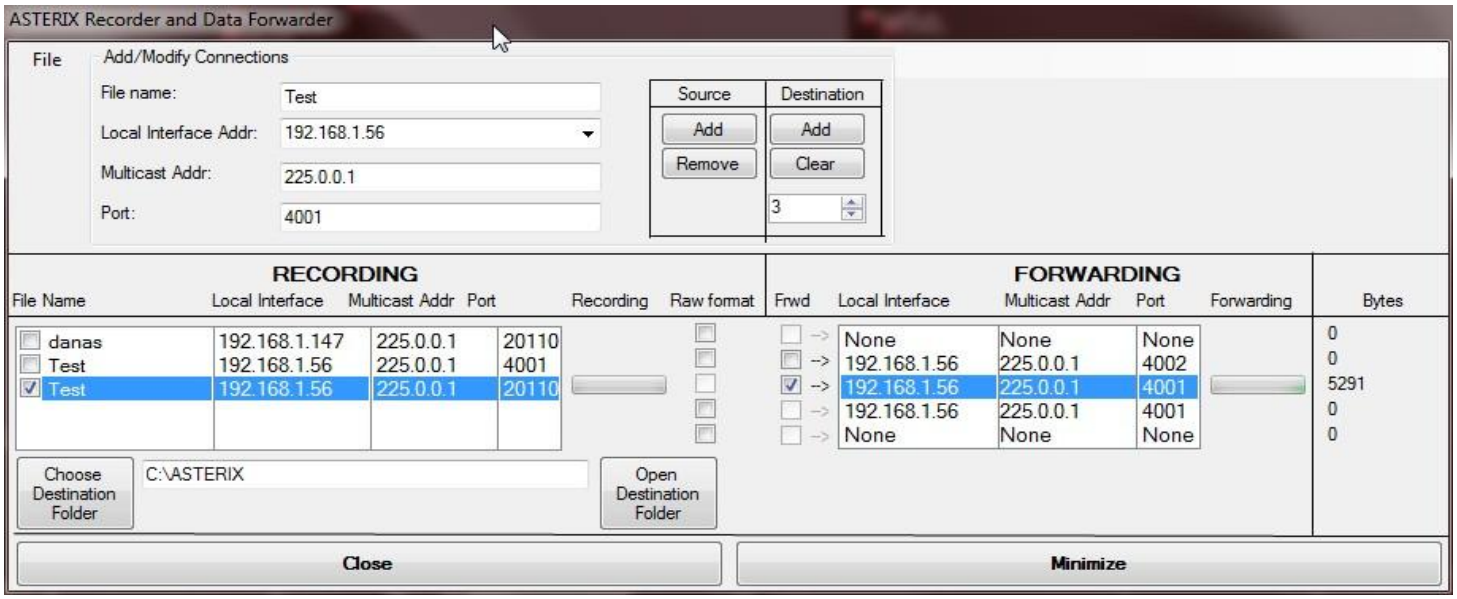


Figure 21: Data Recording and Forwarding

Recording

This function provides the capability to record up to 5 data streams plus of one that can be enabled from the Main Window. The data is stored in the destination directory. The recorded data file has the same file name as was entered during the configuration; it is 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, or in replay format to be used for Replaying. Note that Raw recording can be opened with the Asterix Inspector (http://sourceforge.net/projects/asterix/?source=directory)

Forwarding

This function provides the capability to forward up to 5 data streams to a different network interface or IP address/port.

ASTERIX Replay

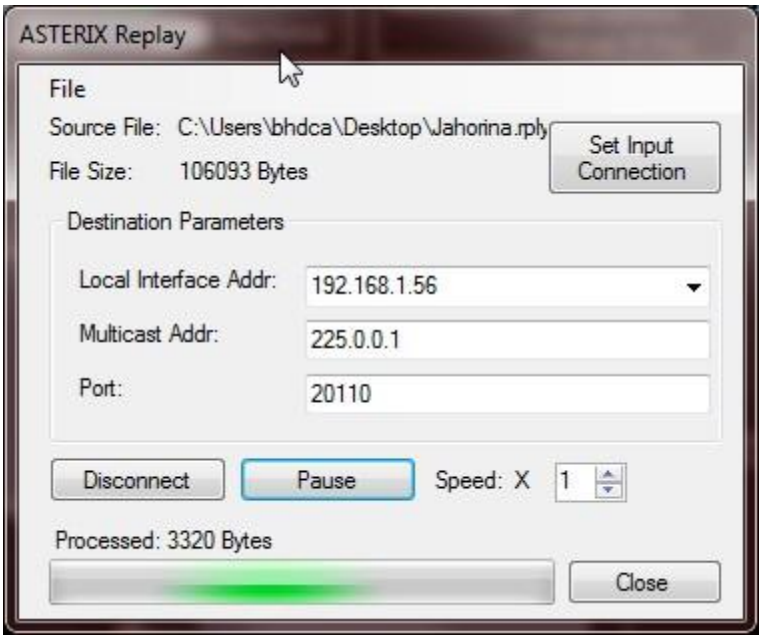


Figure 22: ASTERIX Replay

The Replay function requires an ASTERIX recording (xxx.rply) file that can be recorded using the built in Recorder. It also requires 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.

"Replay" to "Raw"

Figure 23: Replay to Raw format

This tool provides an option to convert ASTERIX "replay" recording to "raw" format. The tool removes the proprietary headers from the data blocks so the file can be either imported "at once" or used with other ASTERIX tools that support "raw" data formats.

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
050 System Configuration and Status

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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