

User Manual

for

ASTERIX DARR 1.9

(Display Analyzer Recorder & Replay)

akapetanovic@gmail.com

November 20, 2012

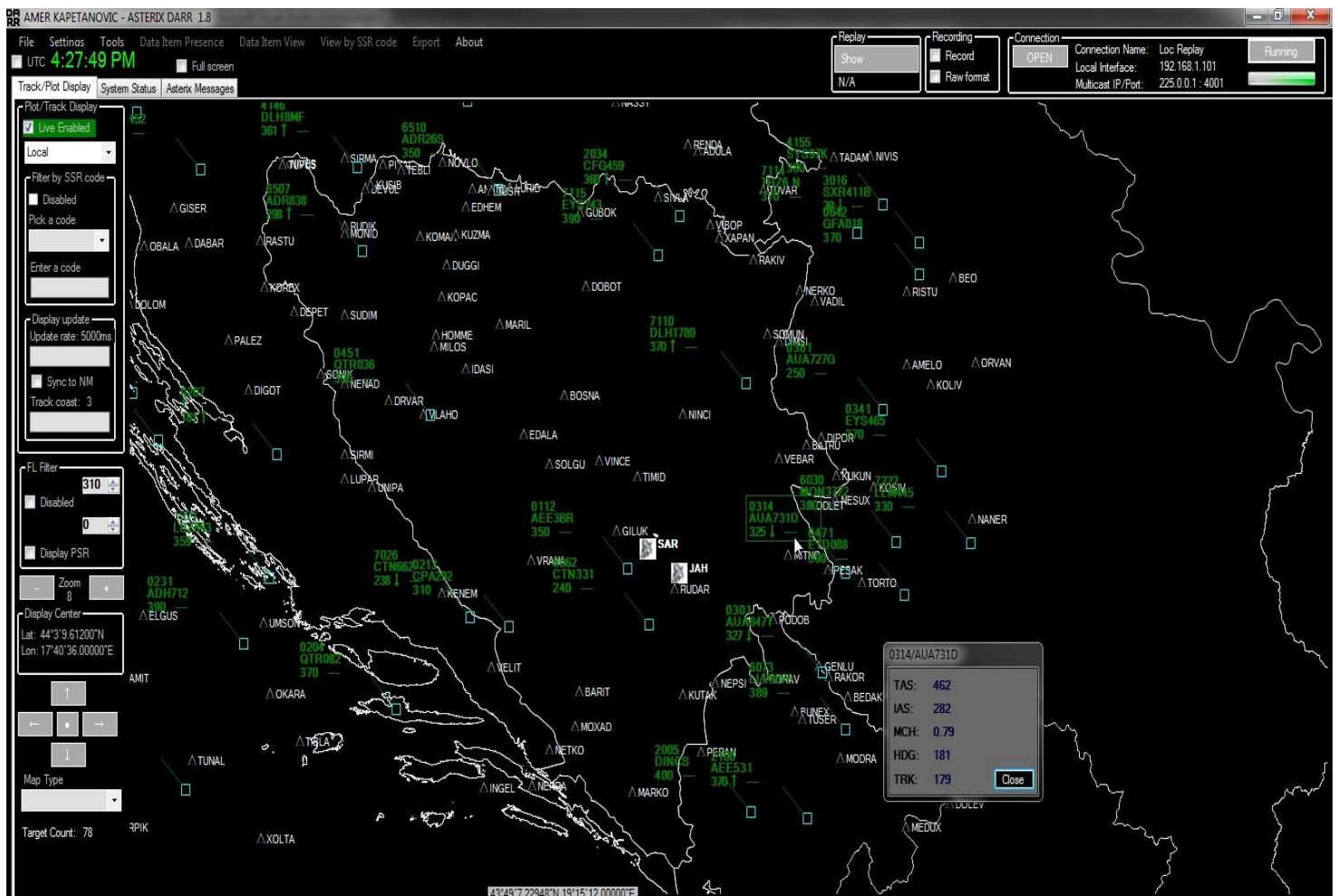


Table of Contents

Preface	5
Initial Setup.....	6
Main Windows and Functionality.....	8
Setting up a connection	8
.....	8
Figure 1: Connection Screen.....	8
Start processing data	9
.....	9
Figure 2: Main Display Window, with full screen selected.....	9
Figure 3: Main Display Window (DISPLAY FROZEN)	10
.....	11
Figure 4: Main Capture Window.....	11
Data Item Presence	12
.....	12
Figure 5: Data Item presences.....	12
Data Item View	13
.....	13
Figure 6: Data Item View	13
View by Mode-A Code	14
.....	14
Figure 7: View data by SSR code.....	14
Export (Earth Plot or GePath)	15
.....	15
Figure 8: Export to Earth Plot format by Mode-A code.....	15
.....	15
Figure 9: 3D example in Google Earth of two (black and pink) landings at Sarajevo airport.	15
Live Display in Google Earth	16
Figure 10: Live traffic display in Google Earth	16

Figure 11: Settings of Google Earth	17
Local Plot/Track Display.....	17
.....	18
Figure 12: Map with user defined and Google terrain overlay	18
.....	19
Figure 13: Passive display no filter	19
.....	19
Figure 14: Passive filter – by Mode-A code	19
Track Label.....	20
.....	20
Figure 15: Label in coast, AC is climbing and entered a CFL.....	21
Figure 15.1: Extended label (shows additional data for the selected label, currently for CAT062/380)	21
Display Attributes	22
.....	22
Figure 16: Menu to Access Display configuration windows	22
.....	23
Figure 17: Display Attributes	23
Display Items	24
.....	24
Figure 18: Display Items.....	24
Label Attributes	24
.....	25
Figure 19: Label Attributes Picker.....	25
Choosing Category to Process	25
Figure 20: Category decoder selector.....	25
ASTERIX Recording & Forwarding.....	26
Figure 21: Data Recording and Forwarding	26
ASTERIX Replay	27
Figure 22: ASTERIX Replay	27
“Replay” to “Raw”	27
Figure 23: Replay to Raw format	27

System Configuration and Status 28

 Figure 24: Three screen shoots of System Status Display (GO, History and Data Loss) 28

Miscellaneous Settings 29

 Figure 25: Miscellaneous Settings 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.
7. Monitor system status and configuration via CAT034/050

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 from 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*)
 - Draws sector borders. See the file for the proper syntax and modify it as needed.
- **States.txt** (*To be manually modified*)
 - Draws 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*)
 - Draws fixpoints. 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**
- **Runways.txt** (To be manually modified)
 - Draws runway and taxiway borders. See the file for the proper syntax and modify it as needed.

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

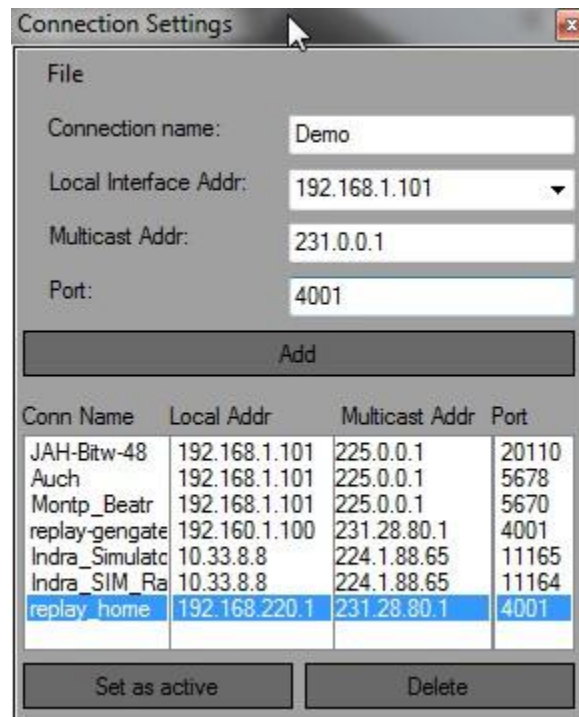


Figure 1: Connection Screen

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.

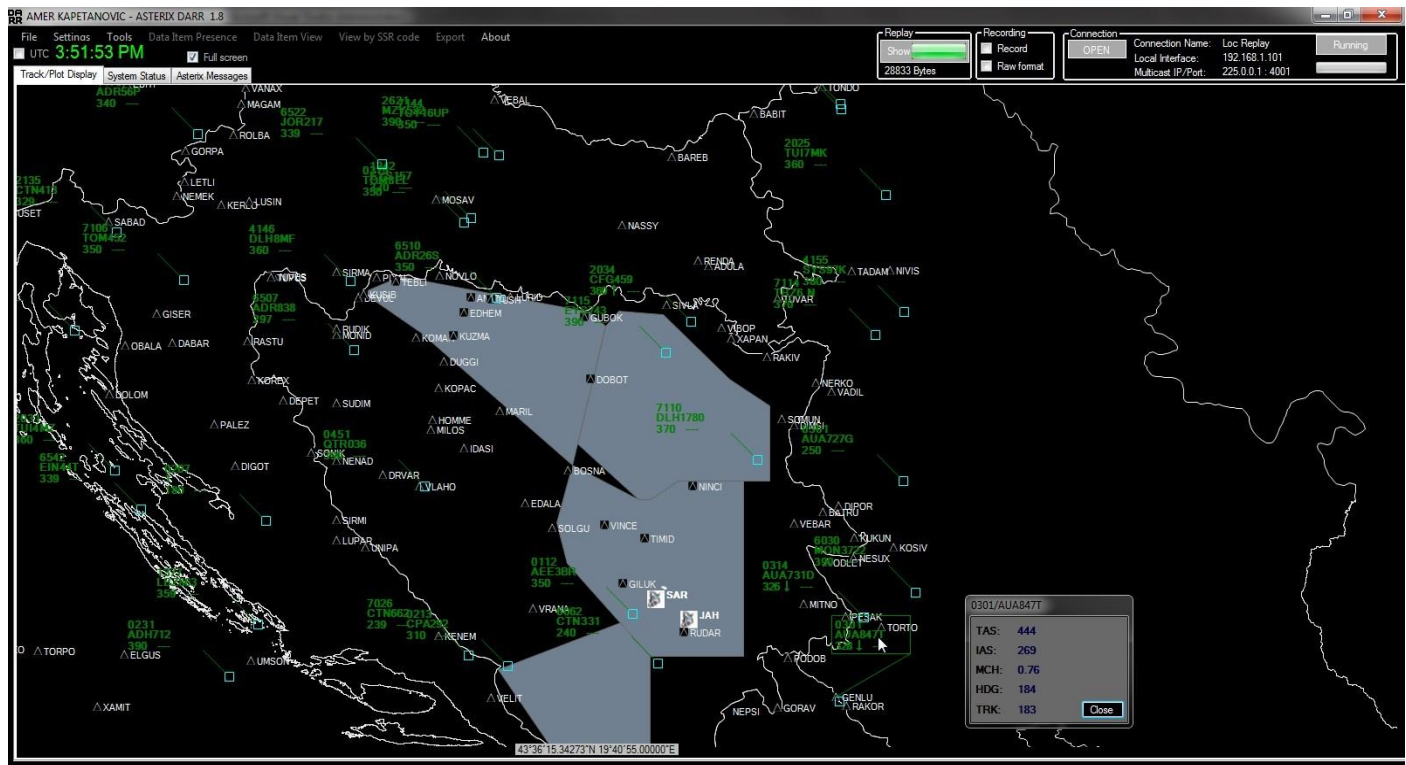


Figure 2: Main Display Window, with full screen selected

- The map center can be adjusted either by using GUI buttons or using UP/DOWN/LEFT/RIGHT keyboard keys.
- Zoom IN and Zoom OUT can be adjusted either by GUI buttons or +/- keyboard keys.
- Recommended way to move the map and control ZOOM is to use the middle mouse button.
By moving a mouse while holding middle button the map can be moved. By clicking anywhere

on the map and scrolling the middle button (forward and backward) the zoom is increased or decreased.

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)

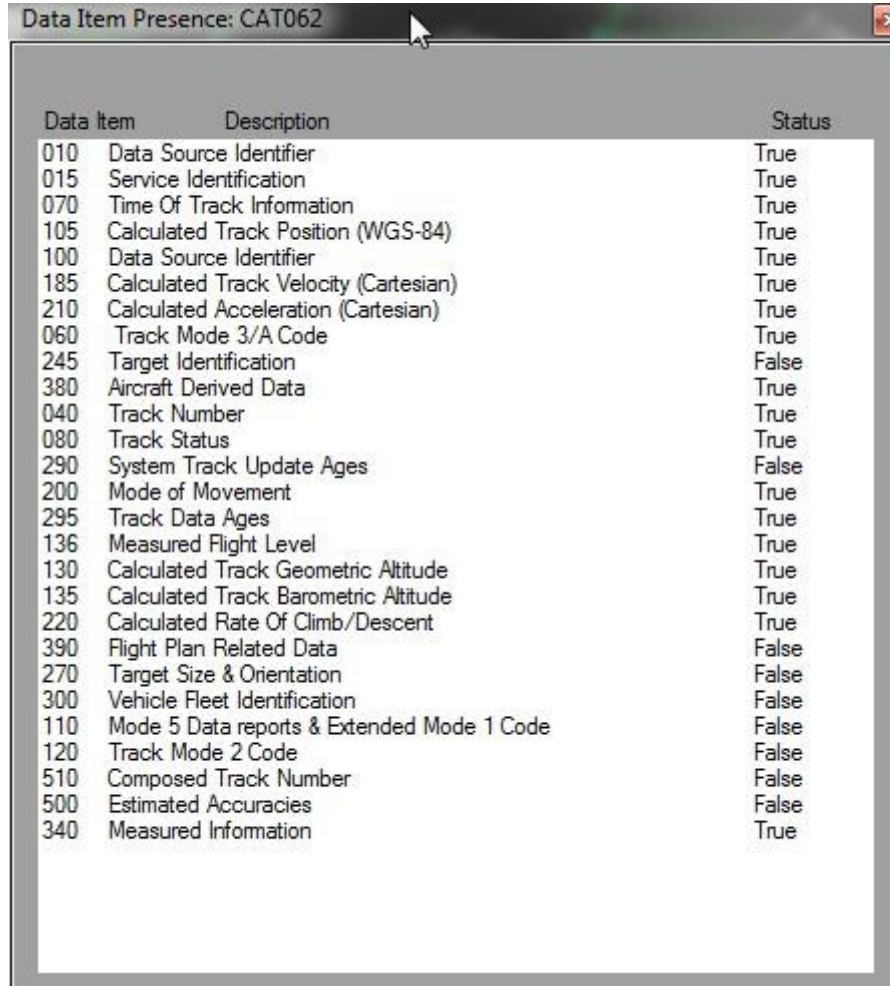


Figure 4: Main Capture Window

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.



The screenshot shows a window titled "Data Item Presence: CAT062". Inside the window is a table with three columns: "Data Item", "Description", and "Status". The table lists 30 data items with their corresponding descriptions and whether they were detected (True) or not (False).

Data Item	Description	Status
010	Data Source Identifier	True
015	Service Identification	True
070	Time Of Track Information	True
105	Calculated Track Position (WGS-84)	True
100	Data Source Identifier	True
185	Calculated Track Velocity (Cartesian)	True
210	Calculated Acceleration (Cartesian)	True
060	Track Mode 3/A Code	True
245	Target Identification	False
380	Aircraft Derived Data	True
040	Track Number	True
080	Track Status	True
290	System Track Update Ages	False
200	Mode of Movement	True
295	Track Data Ages	True
136	Measured Flight Level	True
130	Calculated Track Geometric Altitude	True
135	Calculated Track Barometric Altitude	True
220	Calculated Rate Of Climb/Descent	True
390	Flight Plan Related Data	False
270	Target Size & Orientation	False
300	Vehicle Fleet Identification	False
110	Mode 5 Data reports & Extended Mode 1 Code	False
120	Track Mode 2 Code	False
510	Composed Track Number	False
500	Estimated Accuracies	False
340	Measured Information	True

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”.

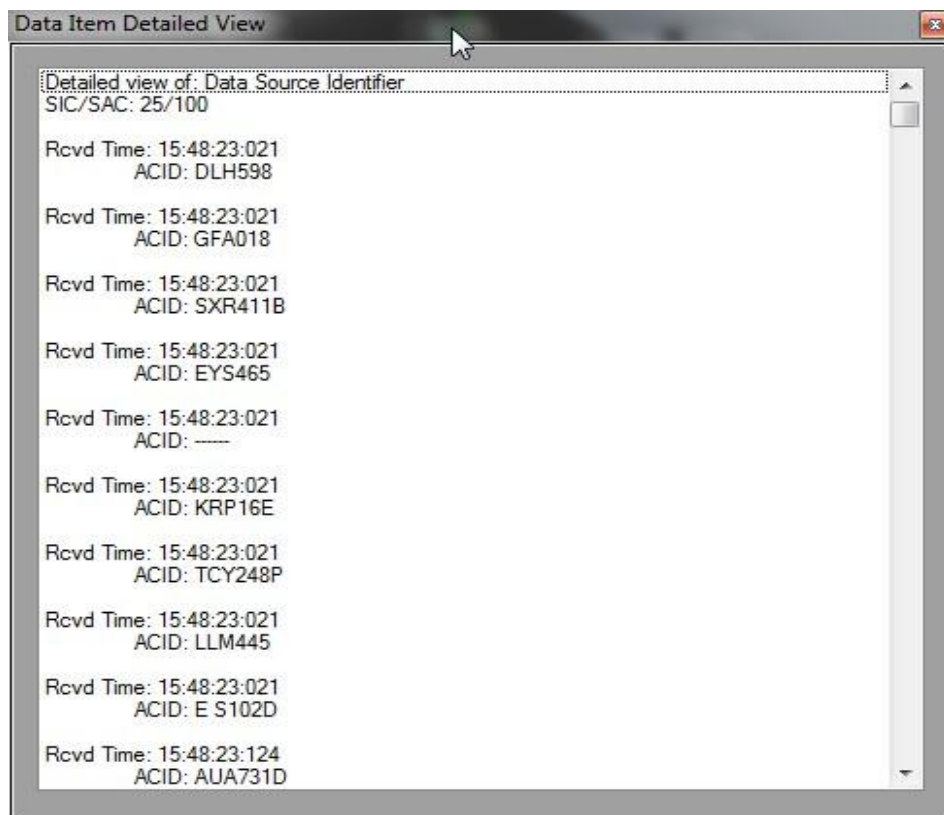


Figure 6: Data Item View

View by Mode-A Code

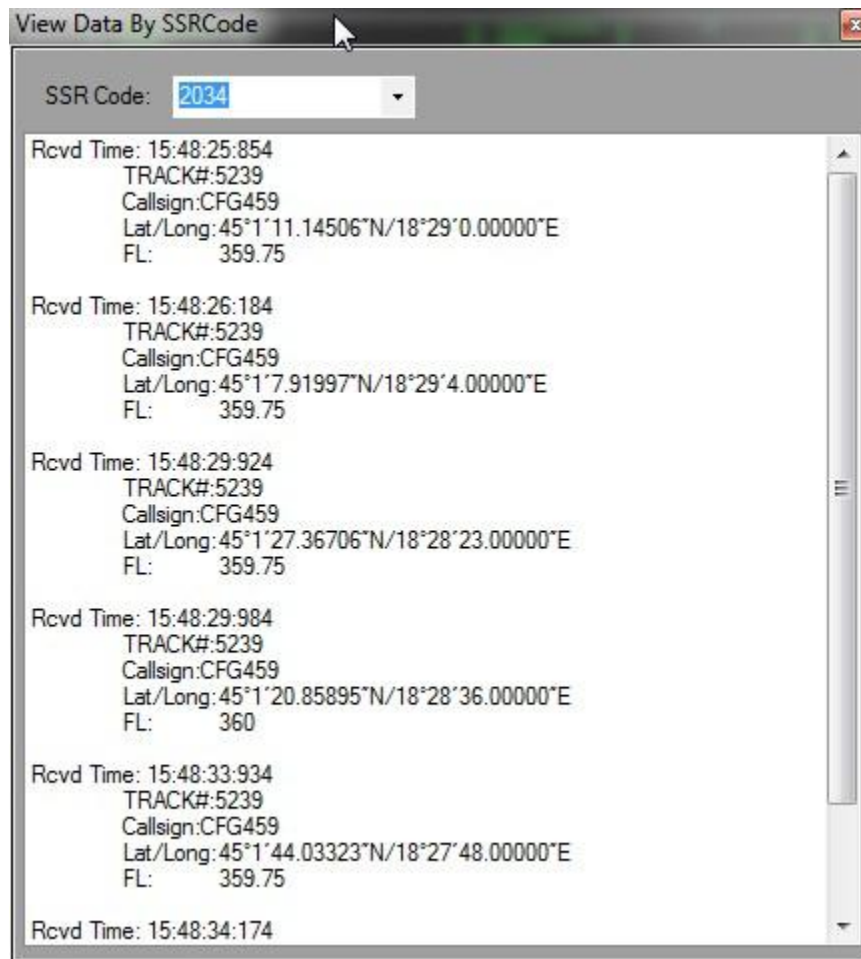


Figure 7: View data by SSR code

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)

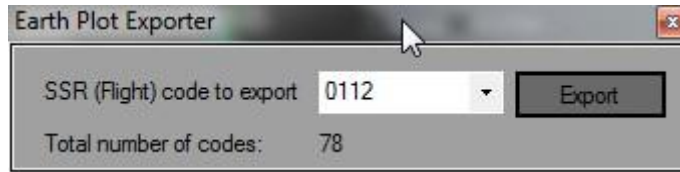


Figure 8: Export to Earth Plot format by Mode-A code

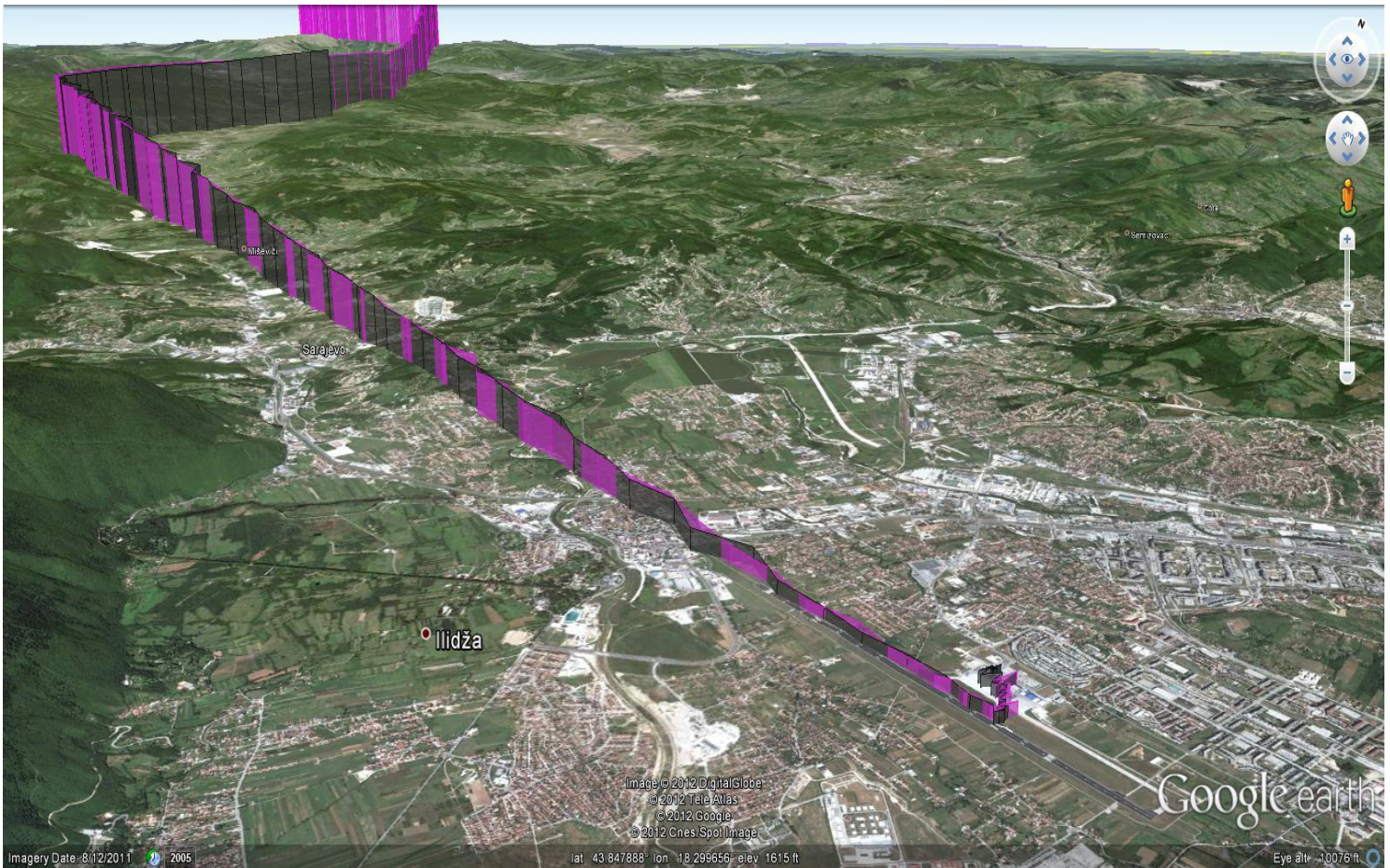


Figure 9: 3D example in Google Earth of two (black and pink) landings at Sarajevo airport.

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

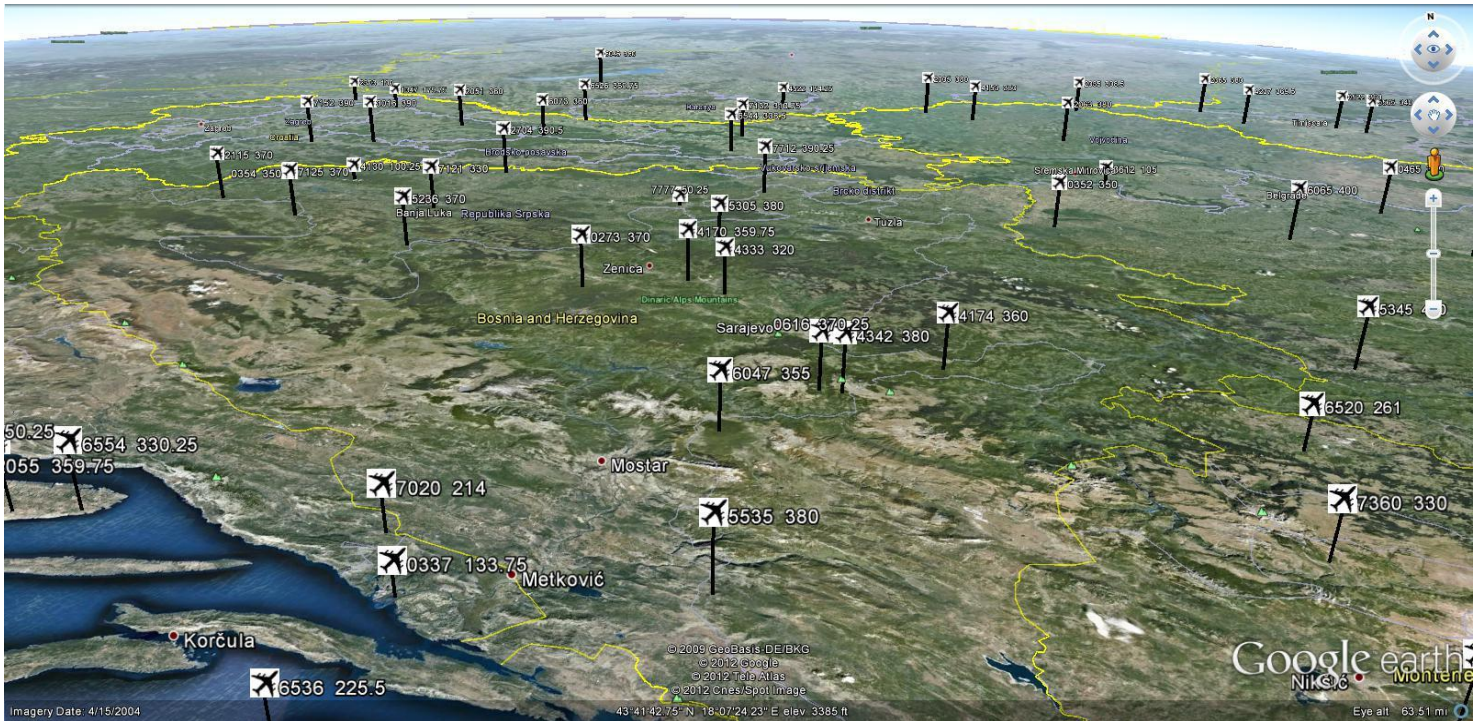


Figure 10: Live traffic display in Google Earth

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).

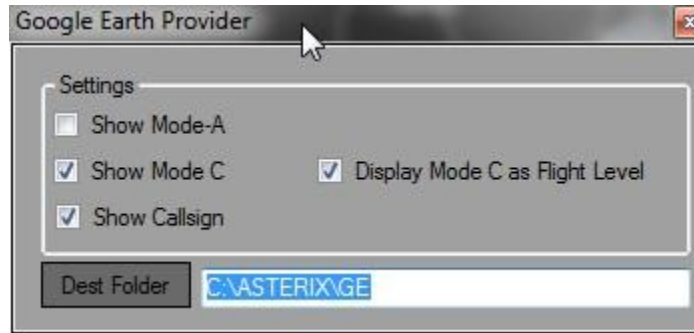


Figure 11: Settings of Google Earth

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 cycle 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. **Note: In the case no North Mark message is available “Sync to NM” has to be unchecked in order to see Plots/Tracks. As the application is looking for one to update the display.**

The data display can be real time or passive. The passive display is an option to visualise all the buffered data (each received 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.



- 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.

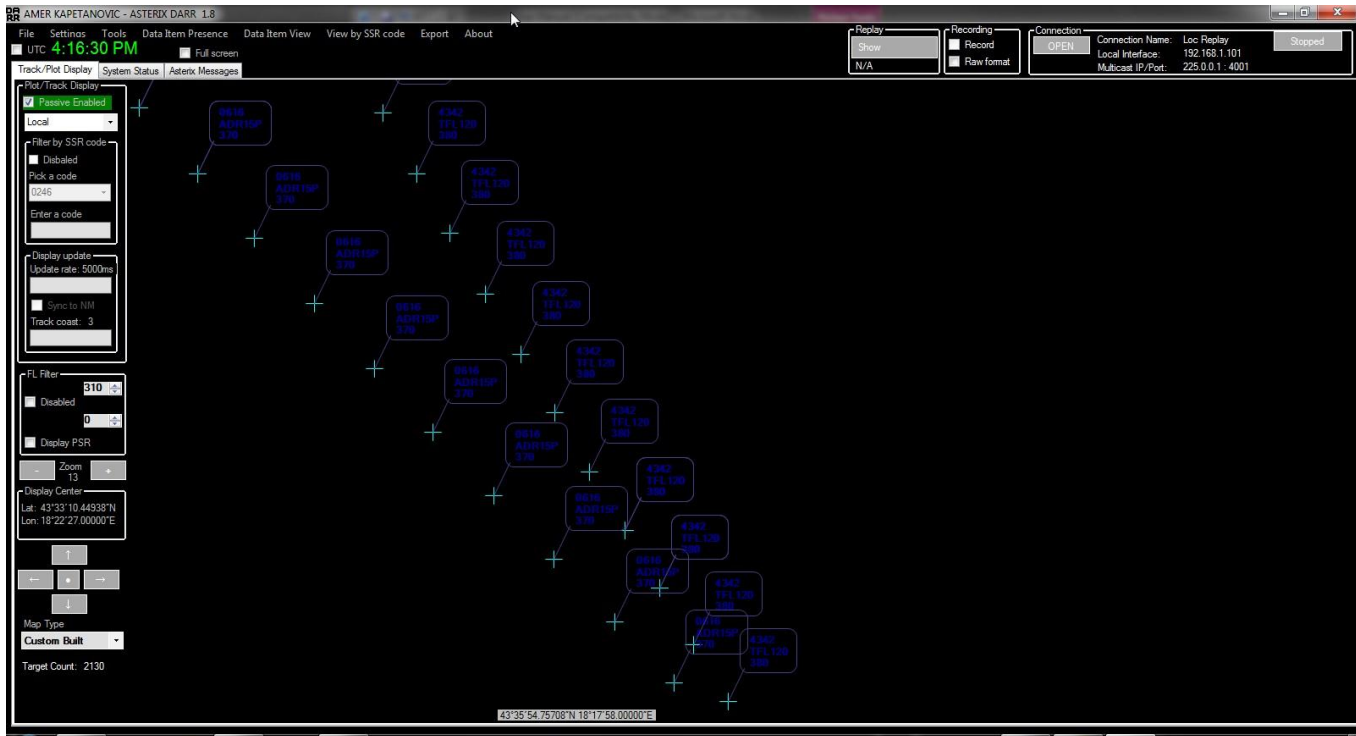
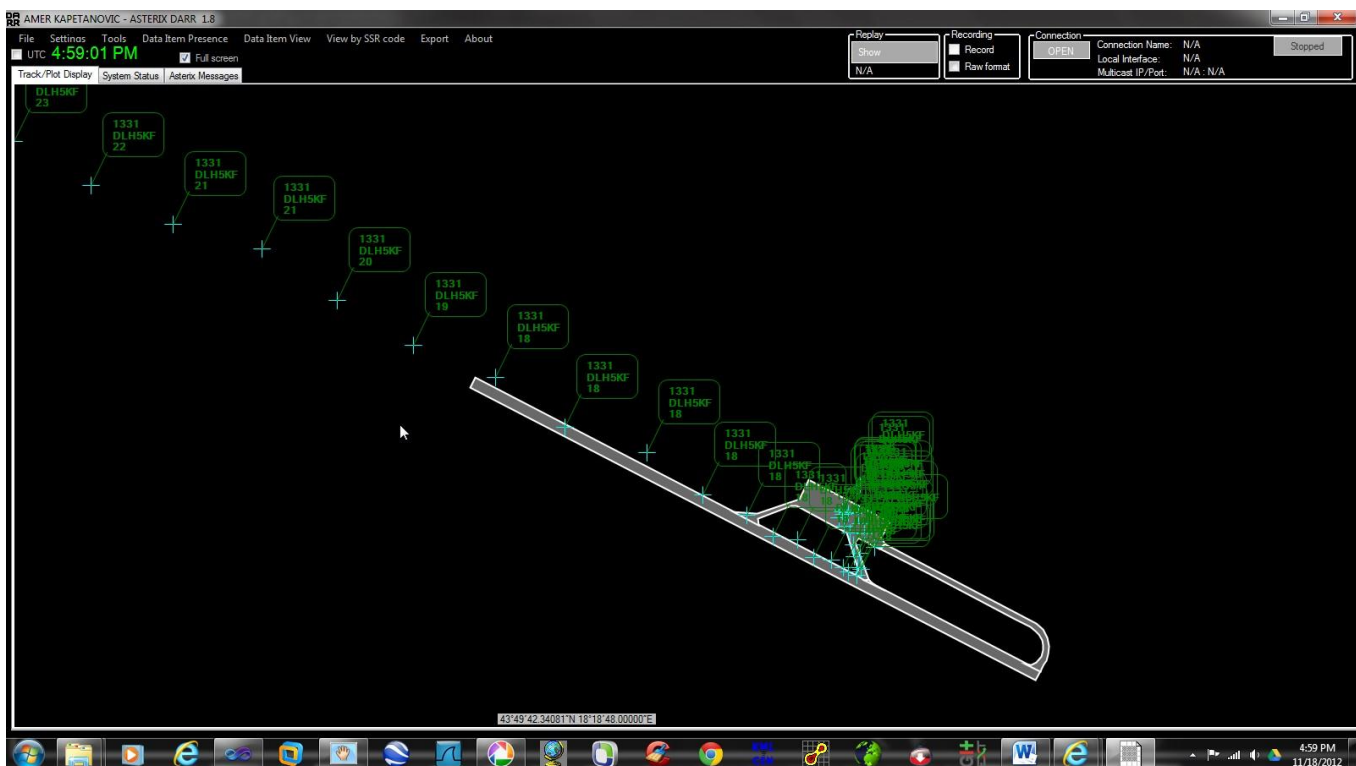


Figure 13: Passive display no filter



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



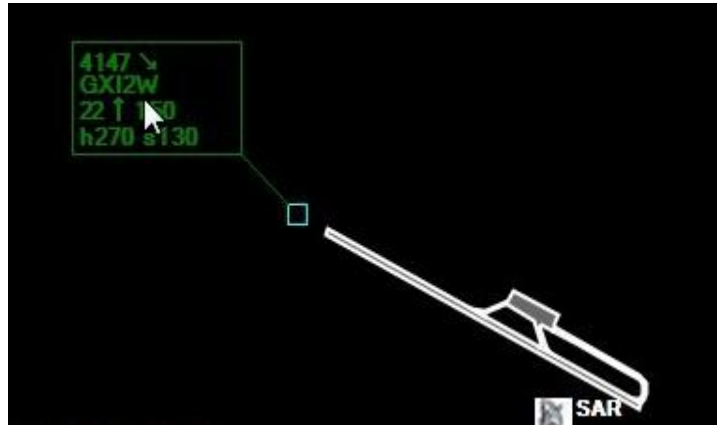


Figure 15: Label Examples

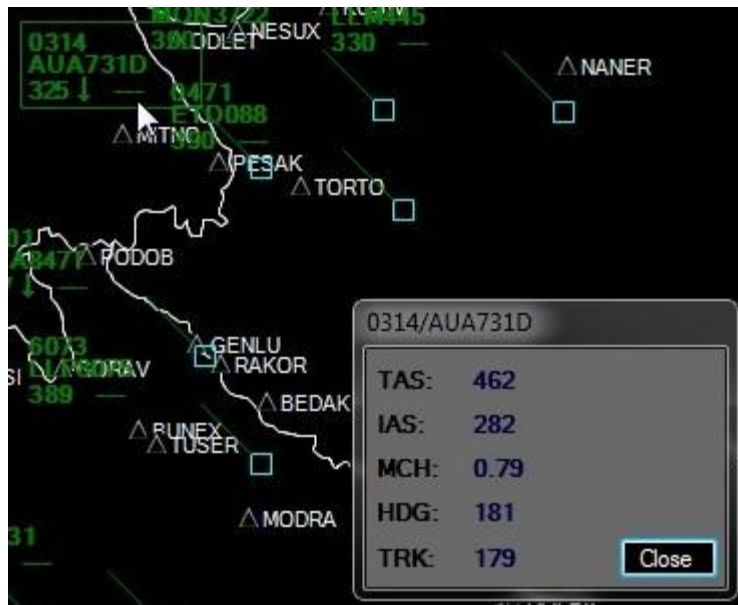


Figure 15.1: Extended label (shows additional data for the selected label, currently for CAT062/380)

Track label can be in **selected** (mouse hovers above it) and **non-selected state**. Selected label shows more information than non-selected. The following are available data fields.

- Mode-3A (**selected and non-selected**)
- Callsign (when available) (**selected and non-selected**)
- 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. (**selected and non-selected**)

- AC vertical profile (Mode-C and Climbing/Descending indicator up or down arrow) (**selected and non-selected**)
- Assigned CFL (user enterable) (**selected and non-selected**)
- Assigned HDG (user enterable)(**selected**)
- Assigned SPD (user enterable)(**selected**)

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.*

Display Attribute Picker

Default display origin (DDD:MM:SS) + compas direction

Latitude: 44 3 9.61 N

Longitude: 17 40 36 E

Background Color

Color: Black

Display Attributes

Display Item: Radar

Text Attributes

Color: White

Font: Microsoft Sans Serif

Size: 10

Sample TEXT

Line Attributes

Color: White

Type: Solid

Width: 1

Area/Polygon/Sector Attributes

Color: Black

Image Size (PIXELS)

Y: 20

X: 20

Close Update Display Save Settings

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.

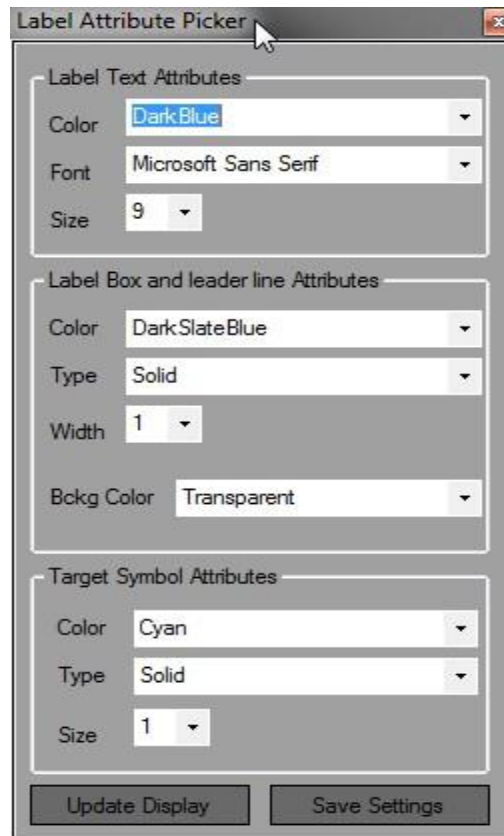


Figure 19: Label Attributes Picker

Choosing Category to Process

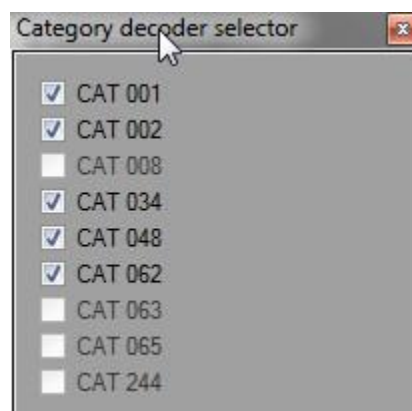


Figure 20: Category decoder selector

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

ASTERIX Recording & Forwarding

ASTERIX Recorder and Data Forwarder

File Add/Modify Connections

File name:

Local Interface Addr: 192.168.1.101

Multicast Addr:

Port:

Source	Destination
Add	Add
Remove	Clear
	1

RECORDING					FORWARDING						
File Name	Local Interface	Multicast Addr	Port	Recording	Raw format	Frwd	Local Interface	Multicast Addr	Port	Forwarding	Bytes
<input checked="" type="checkbox"/> JAH-Bitw-48	192.168.1.101	225.0.0.1	20110	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	-> 192.168.1.101	225.0.0.1	4002	<input type="checkbox"/>	0
<input type="checkbox"/> Auch	192.168.1.101	225.0.0.1	5678	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	-> 192.168.106.1	225.0.0.1	4002	<input type="checkbox"/>	0
<input type="checkbox"/> Montp Beatr	192.168.1.101	225.0.0.1	5670	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	-> 192.160.1.100	225.0.0.1	4002	<input type="checkbox"/>	0
<input type="checkbox"/> replay-qenqate	192.160.1.100	231.28.80.1	4001	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	-> 192.168.106.1	225.0.0.1	4004	<input type="checkbox"/>	0
<input type="checkbox"/> Indra Simulator	10.33.8.8	224.1.88.65	11165	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	-> 192.168.106.1	225.0.0.1	4003	<input type="checkbox"/>	0

Choose Destination Folder: C:\Users\CAAS\Documents\ASTERIX_DATA

Open Destination Folder

Close Minimize

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

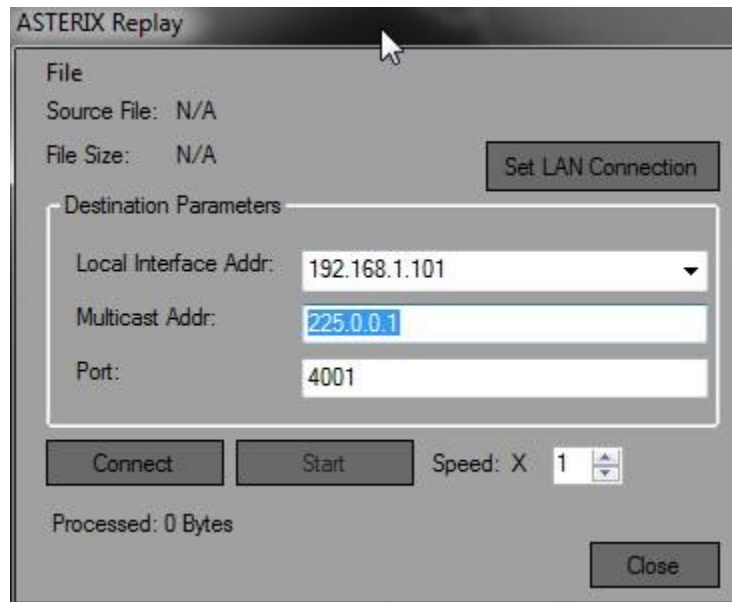


Figure 22: ASTERIX Replay

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”

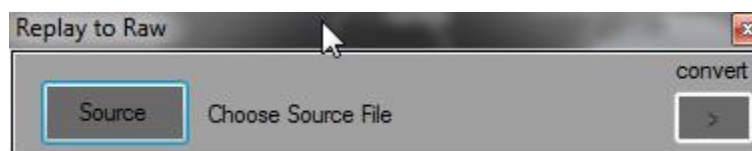


Figure 23: Replay to Raw format

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.

System Configuration and Status

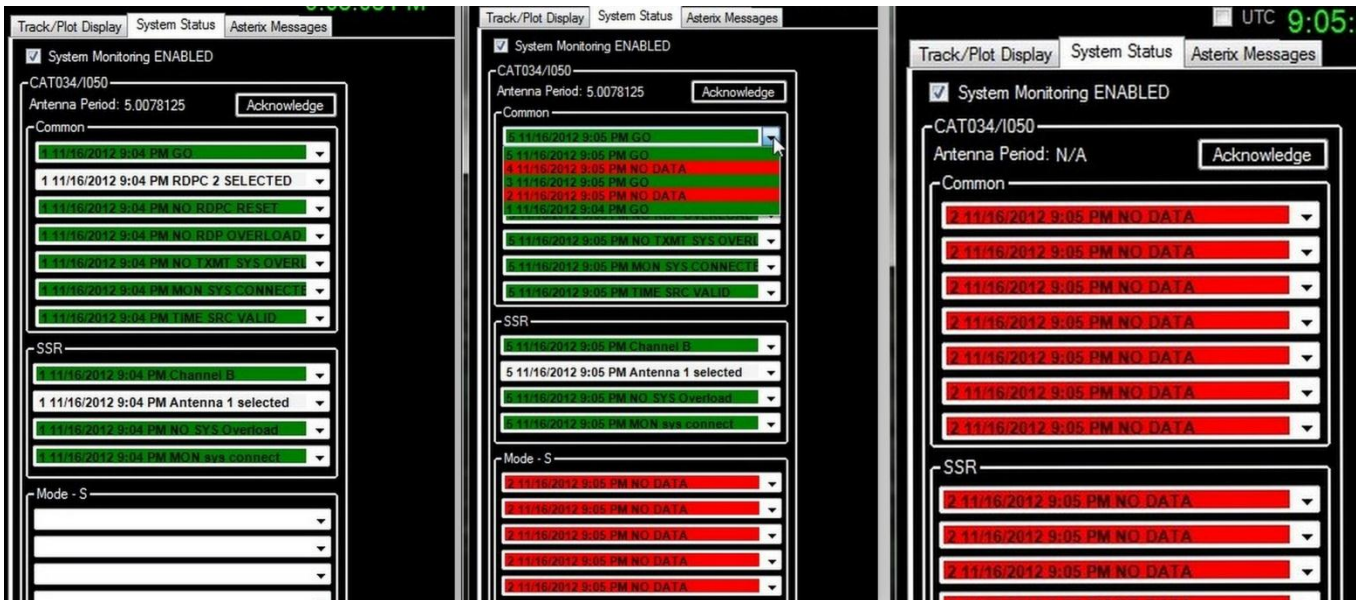


Figure 24: Three screen shoots of System Status Display (GO, History and Data Loss)

System status is based on CAT034/I050 (System Configuration and Status) data. It constantly monitors the message and anytime a change in a single data item is detected it is logged with a timestamp in the dedicated place. This way it is possible to list all status and configuration events since the last time they are acknowledged by the provided button. System critical events in the case of failure are marked in **red** while fail condition is present. Once NOGO event transitions GO it marked in **Green**.

Miscellaneous Settings

1. "Display Mode C as FL" if checked off then displays Mode C exactly as received from the sensor.
2. "Display position in decimals" if checked then LAT/LNG of the mouse position is displayed in decimal degrees format.

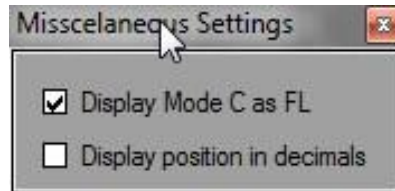


Figure 25: Miscellaneous Settings

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
 Subfield # 3: Magnetic Heading
 Subfield # 5: True Airspeed (TAS)
 Subfield # 17: Track Angle
 Subfield # 26: Indicated Airspeed (IAS)
 Subfield # 27: Mach number

Amer Kapetanovic
(akapetanovic@gmail.com)