User Manual

**for**

**ASTERIX DARR**

**(Display Analyzer Recorder & Replay)**

[akapetanovic@gmail.com](mailto:akapetanovic@gmail.com)

November 8, 2012

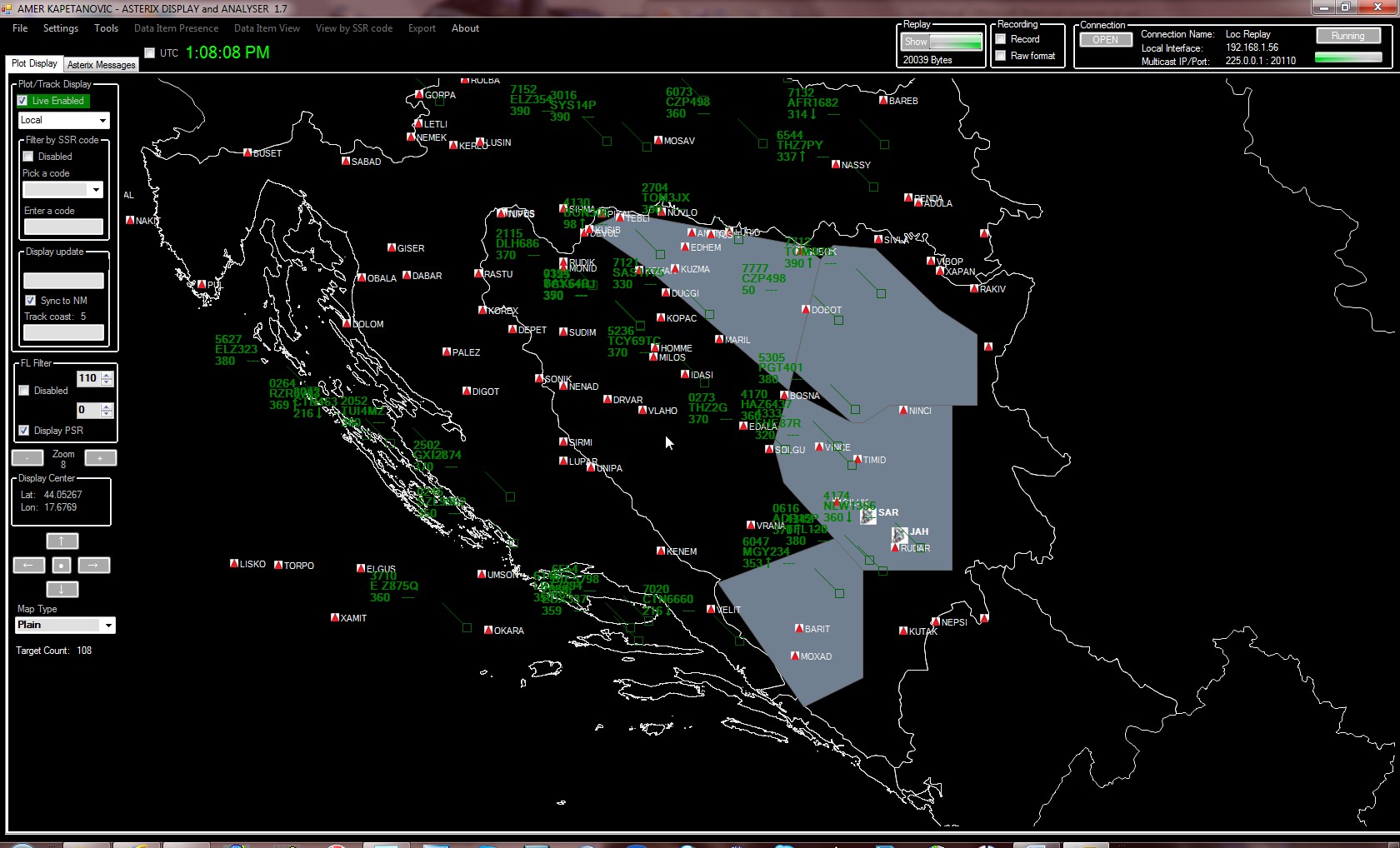


Table of Contents

[Introduction 3](#_Toc340146189)

[Initial Setup 4](#_Toc340146190)

[Main Windows and Functionality 5](#_Toc340146191)

[Setting up a connection 5](#_Toc340146192)

[6](#_Toc340146193)

[Figure 1: Connection Screen 6](#_Toc340146194)

[Start processing data 6](#_Toc340146195)

[Figure 2: Main Display Window 7](#_Toc340146196)

[Figure 3: Main Display Window (DISPLAY FROZEN) 7](#_Toc340146197)

[Figure 4: Main Capture Window 8](#_Toc340146198)

[Data Item Presence 9](#_Toc340146199)

[Figure 5: Data Item presences 9](#_Toc340146200)

[Data Item View 10](#_Toc340146201)

[Figure 6: Data Item View 10](#_Toc340146202)

[View by Mode-A Code 11](#_Toc340146203)

[Figure 7: View data by SSR code 11](#_Toc340146204)

[Export (Earth Plot or GePath) 12](#_Toc340146205)

[Figure 8: Export to Earth Plot format by Mode-A code 12](#_Toc340146206)

[Figure 9: 3D example in Google Earth of a real test flight over Bosnia and Herzegovina 12](#_Toc340146207)

[Live Display in Google Earth 13](#_Toc340146208)

[Figure 10: Live display in Google Earth 13](#_Toc340146209)

[Figure 11: Settings of Google Earth 14](#_Toc340146210)

[Local Plot/Track Display 14](#_Toc340146211)

[Figure 12: Map with user defined and Google terrain overlay 15](#_Toc340146212)

[Figure 13: Passive display no filter 16](#_Toc340146213)

[Figure 14: Passive filter – by Mode-A code 17](#_Toc340146214)

[Track Label 18](#_Toc340146215)

[Figure 15: Label in coast, AC is climbing and entered a CFL 18](#_Toc340146216)

[Display Attributes 19](#_Toc340146217)

[Figure 16: Menu to Access Display configuration windows 19](#_Toc340146218)

[Figure 17: Display Attributes 20](#_Toc340146219)

[Display Items 21](#_Toc340146220)

[Figure 18: Display Items 21](#_Toc340146221)

[Label Attributes 21](#_Toc340146222)

[Figure 19: Label Attributes Picker 22](#_Toc340146223)

[Choosing Category to Process 23](#_Toc340146224)

[Figure 20: Category decoder selector 23](#_Toc340146225)

[ASTERIX Recording & Forwarding 24](#_Toc340146226)

[Figure 21: Data Recording and Forwarding 24](#_Toc340146227)

[ASTERIX Replay 25](#_Toc340146228)

[Figure 22: ASTERIX Replay 25](#_Toc340146229)

[“Replay” to “Raw” 26](#_Toc340146230)

[Figure 23: Replay to Raw format 26](#_Toc340146231)

[Implemented Decoders (so far) 26](#_Toc340146232)

# Introduction

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 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 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.
   1. 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.

# 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. (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 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, as you might assume, there are no plots/tracks displayed. To see some action the data either has to be 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 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

### *C:\Users\bhdca\Desktop\Figure 1.jpg*

### 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, 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.

***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.

### C:\Users\bhdca\Desktop\Figure 2.jpg

### 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 “DISPLAY FROZEN” 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)

### C:\Users\bhdca\Desktop\Figure 4.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 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 I recommend to disable it as it improves the performances and uses less PC resources. This window is intended for quick analyzing 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.

### *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

### ScreenHunter_04 Jul. 24 21.37.jpg

### 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)

### 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

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 9.

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

# Live Display in Google Earth

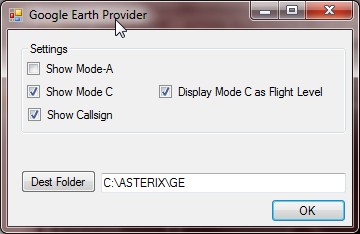


### Figure 10: Live display in Google Earth

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 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\Figure 12.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\Figure 13.jpg

### Figure 13: Passive display no filter

### C:\Users\bhdca\Desktop\Figure 14.jpg

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

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

# 

# Track Label

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

### 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. It provides the option to open up the Display Attributes Window. This window is used to adjust display attributes as shown Figure 16

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

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

To check/modify 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 17: Display Attributes

# Display Items

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

### Figure 18: 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 provides a simple way to dynamically enable/disable specific data item on the display. The selection gets saved between application sessions.

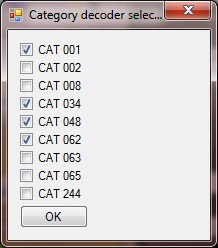
# Label Attributes

Label Attributes Window lets you configure Track/Plot Label attributes. The changes can be checked immediately by pressing the “Update” button. 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 19: Label Attributes Picker

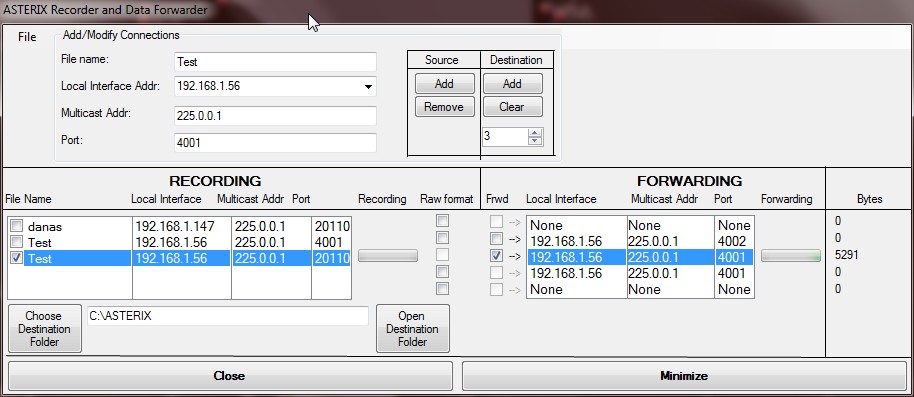
# Choosing Category to Process



### Figure 20: Category decoder selector

This option lets you choose what ASTERIX Category to process and what to ignore.

# ASTERIX Recording & Forwarding



### Figure 21: Data Recording and Forwarding

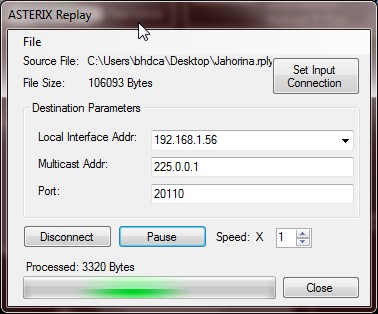
**Recording**

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 or in replay format to be used for Replaying. Note that Raw 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.

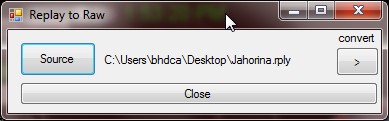
# ASTERIX Replay



### Figure 22: ASTERIX 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.

# “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

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

***NOTE***

***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:***

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

***Amer Kapetanovic***

***(akapetanovic@gmail.com)***