TOOLKIT SPECTRUM — AN INNOVATIVE SOLUTION FOR CHAPTER 10 DATA ANALYSIS

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Alexis CHATAIL–RIGOLLEAU
Safran Data Systems
Les Ulis, France
alexis.chatail-rigolleau@safrangroup.com

ABSTRACT

RF data analysis in Chapter 10 files traditionally requires replaying them on recorders, even for basic tasks such as assessing the file label or performing frequency spectrum analysis. However, input files can be poorly labeled or may require significant transfer times to the recorder. The Chapter 10 Toolkit addresses these challenges by providing a portable software-based solution for recorded data representation. The Toolkit offers a fast and comprehensive solution to streamlining Chapter 10 file analysis via waterfall spectrum display, packet data and header visualization, channel extraction tools, and specific packet search functions. Additionally, the Toolkit integrates a dynamic sampled representation of the recorded signal and cutting-edge AI-based prediction tool to analyze input data, predict signal waveforms and other characteristics. By leveraging advance algorithms, this predictive tool aids in the visualization, evaluation, and interpretation of test telemetry data.

INTRODUCTION

Signal processing engineers involved in telemetry frequently encounter significant obstacles when replaying and analyzing recorded data. Traditionally, Chapter 10 files must be replayed on dedicated radio signal recorders—a process that is both cumbersome and time-consuming. The primary limitations include:

- **Exclusive Read/Write Operations**: Traditional signal recorders do not support simultaneous playback and recording, forcing users to choose between analyzing data or capturing new signals.
- **Disorganized or Poorly Labeled Files**: Chapter 10 files are often insufficiently labeled or structurally inconsistent, requiring engineers to sequentially scan numerous records to locate relevant data, resulting in inefficiency and lost productivity.
- **Limited Signal Visibility**: Signal waveforms and critical characteristics stored in Chapter 10 files are not immediately accessible upon file opening; detailed content typically requires full playback on dedicated hardware.

The product developed "Chapter 10 Toolkit" directly addresses these challenges. The software offers a user-friendly, accurate, and highly portable solution for Chapter 10 data replay—whether in parallel with a recorder, on a separate workstation, or entirely offline. Key features include comprehensive spectral visualization for each channel, convenient signal playback, channel extraction and cropping tool, and a cutting-edge artificial intelligence module for waveform prediction.

SPECTRAL VIEW

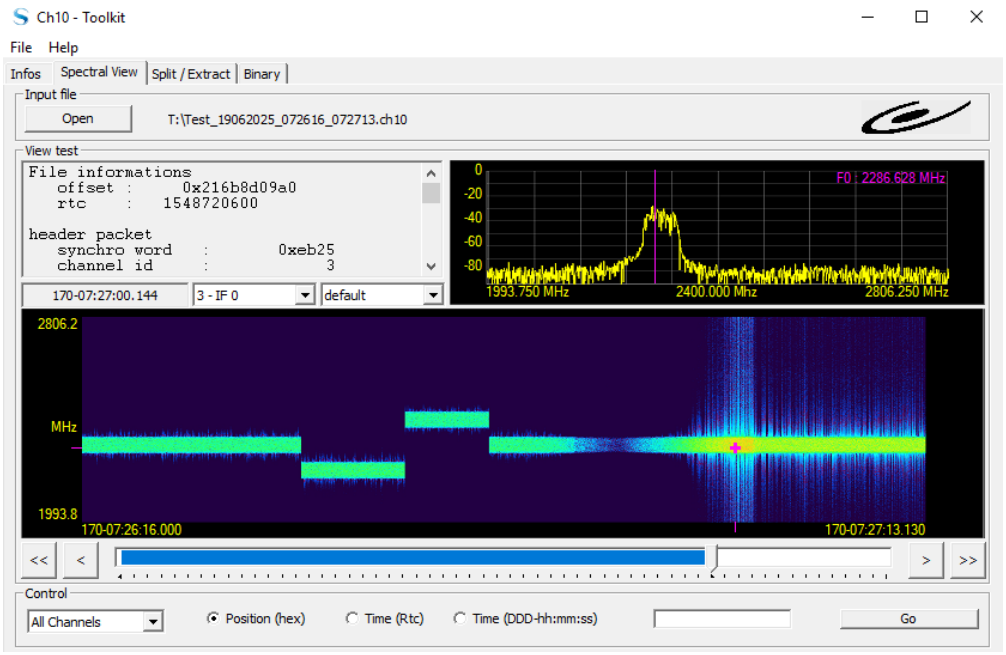

Figure 1: Chapter 10 Toolkit Spectral View window

One of the standout features of the Chapter 10 Toolkit is its Spectral View mode, which offers an intuitive and comprehensive visual overview of Chapter 10 file contents through advanced data visualization tools. This interface facilitates efficient analysis by incorporating multiple synchronized displays:

- **Power Spectral Density (PSD)**: For any selected data packet, Toolkit Spectrum computes and displays the spectral density, with the visualization dynamically updating according to the chosen offset in the data stream. This enables in-depth frequency-domain analysis of IF channels and enhances visibility with an interactive frequency cursor.

- **Waterfall Spectrum**: Leveraging advanced sampling algorithms, the software generates a waterfall plot (spectrogram) that graphically illustrates frequency content variation over time, without requiring complete file playback. The interactive plot allows for direct access to the power spectral density of any channel simply by clicking on the desired time-frequency region, further streamlining analysis.

- **Automatic Gain Control (AGC) Profile**: In full-screen mode, Toolkit Spectrum displays the AGC profile, instantly revealing amplitude scaling applied during signal acquisition. This feature empowers engineers to diagnose gain-related anomalies efficiently.

The full-screen capability also enables side-by-side comparison of two channels, making it easy to correlate data from multiple telemetry sources or channels.

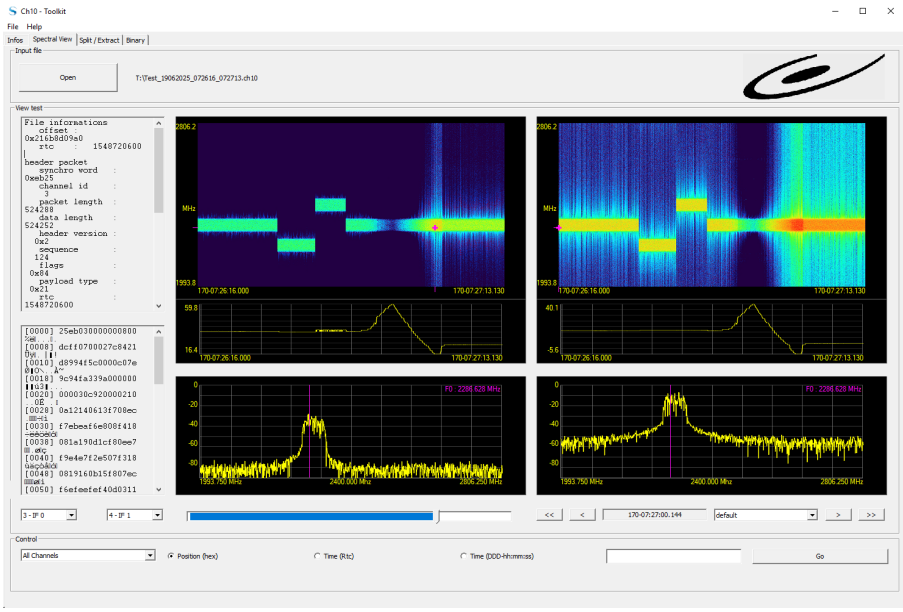

Figure 2: Chapter 10 Toolkit Spectral View full screen window

Finally, the Spectral View mode offers a Playback option. This feature offers an intuitive replay option of the sampled Chapter 10 file.

ADVANCED ARTIFICIAL INTELLIGENCE FEATURE

Toolkit Spectrum incorporates a sophisticated AI-driven functionality for automated waveform classification and prediction within Chapter 10 files. Upon file selection, the Toolkit extracts header information and critical metadata—such as channel sample rates and sample sizes—greatly accelerating initial dataset inspection and preprocessing. At its core, the embedded AI algorithm utilizes a robust gradient boosting model, extensively trained on a dataset exceeding 300,000 SOQPSK and PCM/FM waveform samples, encompassing a wide range of scenarios. Users can select any time and frequency segment of a Chapter 10 file for analysis—the software then isolates a centered frame and initiates its prediction process, displaying both the predicted waveform type and a confidence score for the selected segment. This allows for precise identification of multiple waveform types within a single file.

An integrated model dashboard displays detailed performance metrics, including loss score, accuracy, F1, precision, recall, and the Fowlkes–Mallows index. The confusion matrix further enhances transparency, facilitating in-depth monitoring of the model's predictive reliability and providing users with the option to supervise, refine, or retrain the underlying algorithm as required.

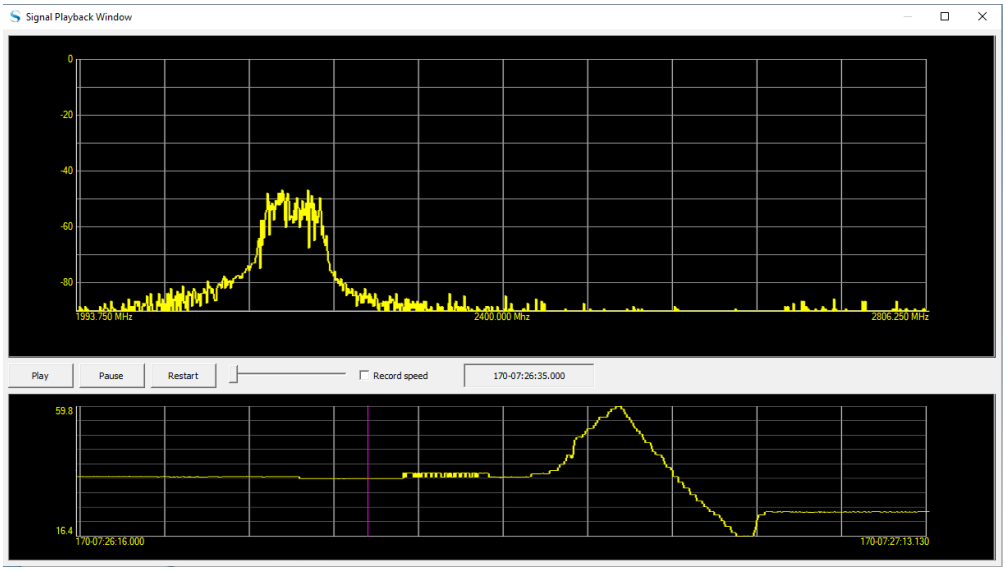

Figure 3: Chapter 10 Toolkit Playback window

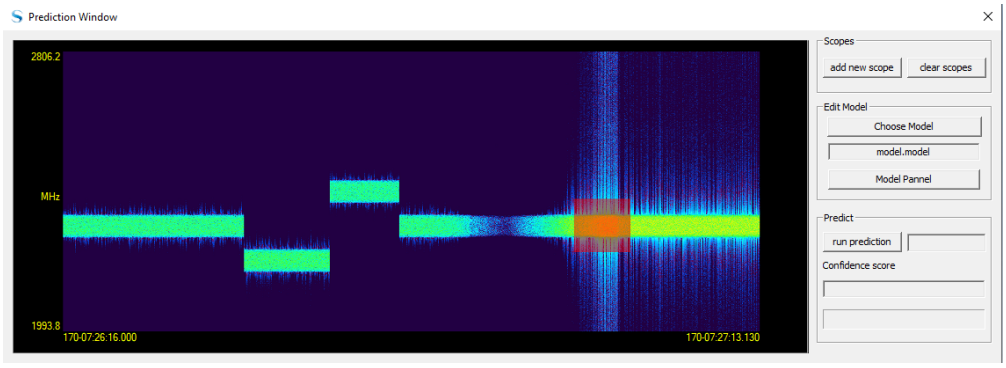

Figure 4: Chapter 10 Toolkit prediction window

CONCLUSIONS

With the Chapter 10 Toolkit, Safran Data Systems delivers a state-of-the-art, intuitive solution tailored for telemetry engineers, dramatically improving the accessibility, visualization, and processing of Chapter 10 data. The inclusion of advanced AI-powered analytics sets the Chapter 10 Toolkit apart, enabling faster, more insightful data interpretation and supporting smarter, data-driven decision-making, while the playback option can be used to simulate the replay on a recorder of the Chapter 10 file.