DIGITALLY RECORDED DATA REDUCTION ON A PC USING CAPS 2.0

Michael J. Rarick and Ben-z Lawrence

ABSTRACT

The Common Airborne Processing System (CAPS) provides a general purpose data reduction capability for digitally recorded data on a PC. PCM or MIL−STD−1553 data can be imported from a variety of sources into the CAPS standard file format. Parameter dictionaries describing raw data structures and output product descriptions describing the desired outputs can be created and edited from within CAPS. All of this functionality is performed on an personal computer within the framework of the graphical user interface provided by Microsoft Windows. CAPS has become the standard for digitally recorded data reduction on a PC at Eglin AFB and many other sites worldwide. New features, such as real-time inputs and graphical outputs, are being added to CAPS to make it an even more productive data reduction tool.

KEY WORDS

Data Reduction, Personal Computer (PC) Software, MIL−STD−1553

INTRODUCTION

Traditionally, telemetry data reduction and analysis has been accomplished using a tightly coupled collection of hardware and software components. The process of digitizing, reducing and analyzing data on a large computer systems was often time consuming and always costly. Replacing telemetry systems led to extensive data reduction software rewrites or required new software development. Changes in data analysis processes again necessitated software modifications. The advent of digital recorder technology has eliminated errors induced during the transfer of information between the analog and digital domains, but has done little to control software development costs. CAPS provides a standardized, flexible, PC-based tool for meeting evolving data reduction and analysis requirements. CAPS can thereby control software development costs while simultaneously reducing analysis time.

CAPS was developed by the Air Force's 96th Communications Group at Eglin AFB, Florida for the Navy's Airborne Instrumentation System (AIS). The AIS Test

Instrumentation Pod (TIP) is an AIM-9 type pod designed to support Operational Test and Evaluation missions using tactical operational configured aircraft. The pod is designed for MIL−STD−1553, Global Positioning System (GPS), and inertial sensor measurement, acquisition and recording. Following a test mission, the TIP data can be immediately downloaded from the pod to a portable PC and reduced using CAPS. After satisfying the AIS requirements, CAPS was extended to accept additional data formats and added capabilities, making it a powerful generic data reduction tool.

DESIGN

CAPS uses telemetry data descriptions and processing to perform extraction and engineering unit (EU) conversion of data parameters. CAPS also supports specialized post-EU conversion processing by chaining follow-on data processing programs to individual output files. Output results can be obtained in several commercial off-the-shelf (COTS) formats as well as virtually any user-defined ASCII or binary format. All user interaction with CAPS is accomplished through the Microsoft Windows graphical user interface (GUI). In order to use CAPS, three key ingredients are required:

- Instrumentation Data — the raw data from the user's instrumentation pod, data monitor card, or real-time device.

- Data Description — a description of the location and type of individual instrumentation parameters within the data, usually called an Interface Control Document (ICD).

- Description of Desired Results — the user's idea of what the results should look like, or the format that a follow-on program may require.

These three ingredients are combined and manipulated within CAPS to produce flexible output products as shown in Figure 1. A master data description could be used many times on data collections of the same type of instrumentation data. Or, the same type of output products may be desired on several data collections. Conversely, multiple output products may be desired from the same set of instrumentation data. All of these scenarios are supported by CAPS.

The primary function of CAPS is to provide a general purpose data reduction capability for the extraction and engineering unit conversion of either IRIG PCM Class I / II or MIL−STD−1553 message data. CAPS currently imports data from the file formats listed in Table 1. This list of supported file types can be quickly and easily expanded to satisfy user requirements.
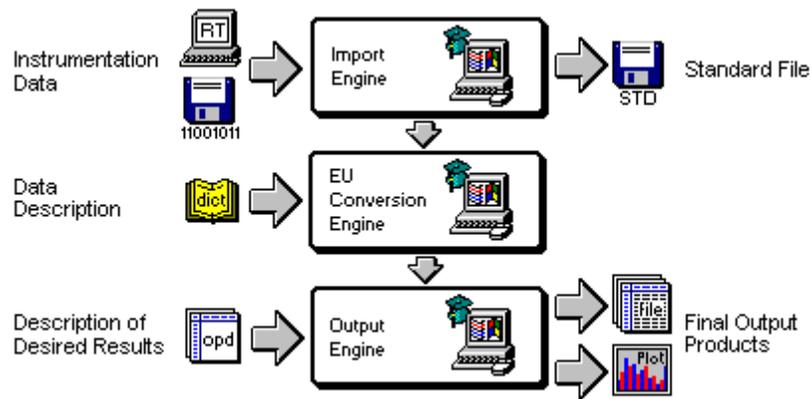
Figure 1 - CAPS Block Diagram

Table 1 - CAPS Import Data Types

Extension	File Type
.DAT	Navy Airborne Instrumentation System (AIS) Pods (Phase I & II)
.ARC	SBS PASS–1000 Archive
.LOG	NovAtel Reference Receiver Binary
.IP5	Phase Two IP Format
.DAT	High Dynamic Instrumentation Set Solid State Recorder (HDIS SSR), GRDCUS and ARDS formats
.DTA	Comptek Data Bus Recorder
.DAT	RAJPO Reference Receiver format
.STD	DataProbe STD file

DataProbe STD files have an internal structure similar to CAPS standard files and can be interchanged between these two software applications. Therefore, CAPS can accept data directly from any software that currently produces STD files, such as the Standardized MARS-II Analysis and Reduction Tool (SMART).

CAPS supports a variety of data formats, including bit-, byte-, and word-swapped data. Parameters can be as long as 80 bits (stored internally as 64-bit double precision) and concatenated from two separate word/bit positions in the raw data file. The specific data types that CAPS currently supports include: Unsigned Integer, 2's Complement Integer, Signed Magnitude Integer, VAX Floating Point Numbers, ASCII Character, Inverted 2's Complement Integer, IEEE Floating Point Number, MIL–STD–1750A Floating Point Number, AAMP Floating Point Number, and Binary Coded Decimal.

Each parameter can have an unlimited number of dependent parameters with a logical "OR" performed on the test conditions. Dependent parameters can, in turn, have dependencies in order to support a logical "AND" test.

CAPS can produce virtually any output file format with user-defined ASCII and binary Output Product Descriptions (OPDs). Several pre-defined output formats are also available for ease of use with commercial of-the-shelf (COTS) tools including ASCII, ASCII Comma Separated Values (CSV), ASCII with Column Titles, Binary, Lotus (.wks), dBase (.dbf), and MATLAB (.mat).

During CAPS import of raw data files, time words are automatically modified to a 48-hour format in order to avoid a false "time backup" at midnight rollover. Time can be formatted for ASCII output in several pre-defined formats such as 24hr HH:MM:SS.sss, 24hr HH:MM:SS.sssss, 24hr Integer Milliseconds, 48hr HH:MM:SS.sss, 48hr HH:MM:SS.sssss, or 48hr Integer Milliseconds. For binary output files, time can be output as 24hr Floating Seconds, 24hr Integer Milliseconds, 48hr Floating Seconds, or 48hr Integer Milliseconds.

Additional unit conversions can be performed on individual parameters. Compression algorithms can also be applied such as N^{th} sampling and limiting output to certain test conditions. CAPS supports the following variable output formats: Integer, Real (float), Real (exponential), DDD:MM:SS.sss, +DDD:MM:SS.sss, Boolean (1/0), Boolean (T/F), Boolean (Y/N), Octal, Hexadecimal (lowercase), and Hexadecimal (uppercase).

Finally, if a customer's output requirements cannot be met, CAPS supports dynamically-linked libraries (DLLs) to perform any specialized formatting or follow-on processing. This truly gives CAPS unlimited output capabilities.

OPERATION

The primary user interface of CAPS is the Session window. A Session usually corresponds to a specific data collection effort that is performed on a specific date. In order to produce engineering unit outputs, a Session must define a raw data file, a dictionary, and one or more output product descriptions (OPDs). The mission number, project number, mission date and comments are recorded on the main Session window to help identify the Session for future use. CAPS Sessions may be saved to a file and recalled at a later time. A sample Session window is shown in Figure 2.
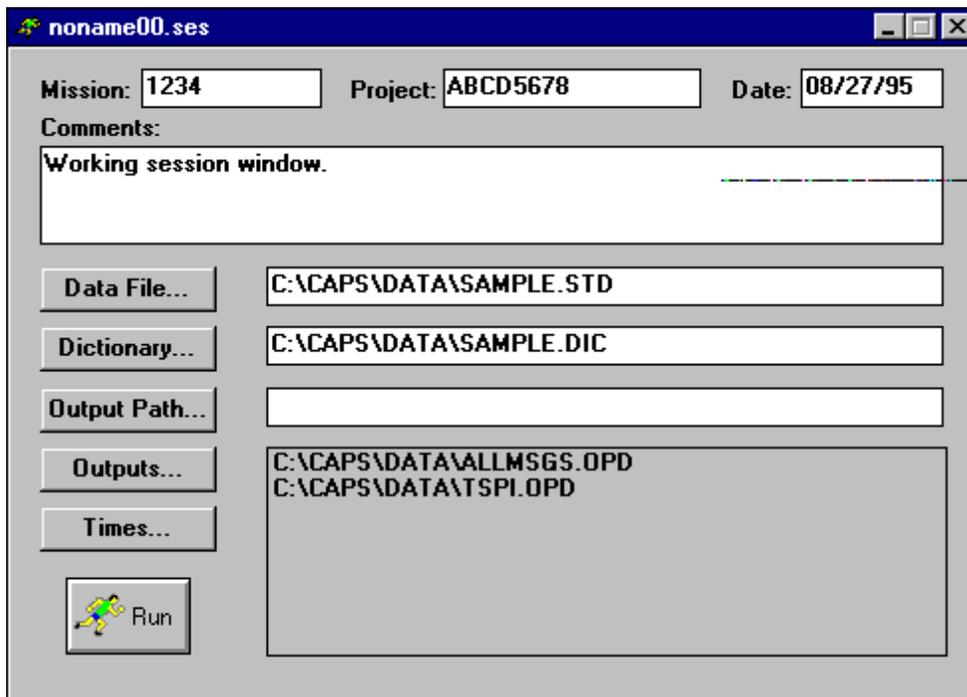
Figure 2 - Session Window

CAPS Sessions require raw data files to be in the CAPS standard format. CAPS provides a facility to import data from a variety of other formats. Several options are available during import such as specifying start/stop times, adding/subtracting a time bias and prompting the user when time "jumps" or "backups" are detected.

A data file must have a corresponding parameter dictionary to describe the format of the raw data. The dictionary is a low-level description of individual parameters within the telemetry data. The dictionary controls the extraction and engineering unit conversion of data. Dictionary editing is performed using the dictionary window as shown in Figure 3.

Output product descriptions (OPDs) describe the format or layout of CAPS outputs. The format of the overall file output as well as individual variables is detailed in the OPD. An OPD provides a description of the contents of individual records that make up a single ASCII or binary result file. A raw data file can have several corresponding OPDs producing multiple output files. OPDs are created and edited using the OPD Windows shown in Figures 4 and 5.

Figure 3 - Dictionary Window
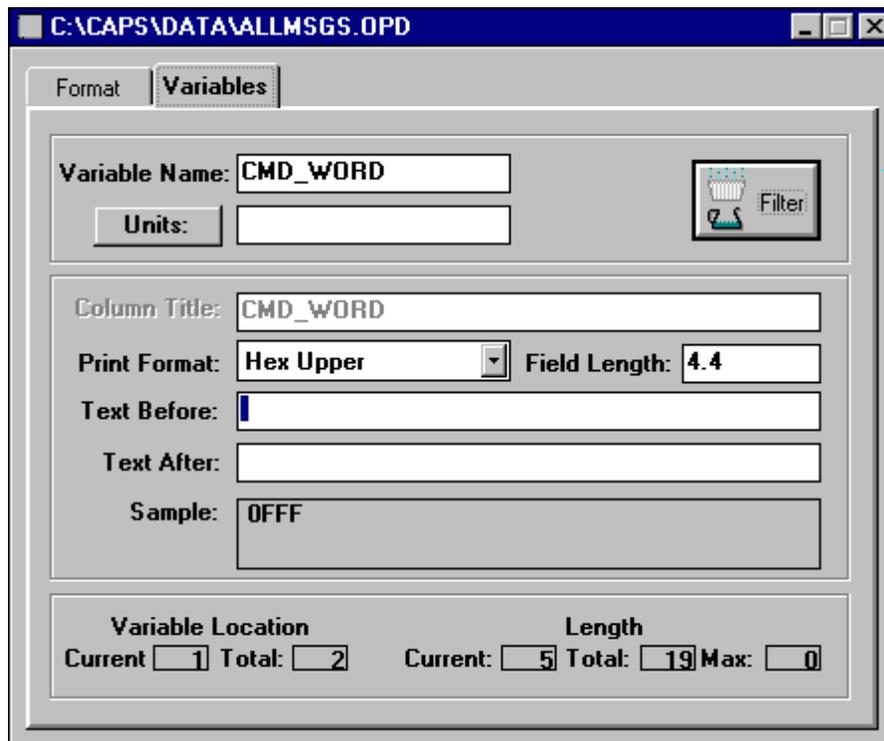

Figure 4 - OPD Window, Format Page

Figure 5 - OPD Window, Variables Page

CAPS provides all of this functionality using a professional Windows 3.x graphical user interface (GUI) as shown in Figure 6. The user provides input through standard dialogs and windows and the menubar or toolbar. A statusbar and full on-line help is provided to assist the user during operation. CAPS is a multiple document interface (MDI) Windows application, allowing multiple windows open at the same time. This allows the user to quickly "cut and paste" parameters from one dictionary to another or into an Output Product Description.

FUTURE DEVELOPMENT

Portability and reusability issues continue to influence the design of CAPS. CAPS is currently a 16-bit Windows 3.x application. Although the current version will run under Windows NT/95 as a 16-bit application, a 32-bit version is being developed to take advantage of features such as multi-threading, Object Linking and Embedding (OLE) 2.0, and long filenames.

Additional usability features are also being designed, such as allowing multiple data segment parameters and chaining algorithms together to provide derived parameters and advanced mathematical calculations. A dictionary import facility to convert standard ICD databases such as TMATS into CAPS dictionary format is a powerful tool envisioned for CAPS. Additional data import modules are continually being added to the expanding list of compatible CAPS data types.
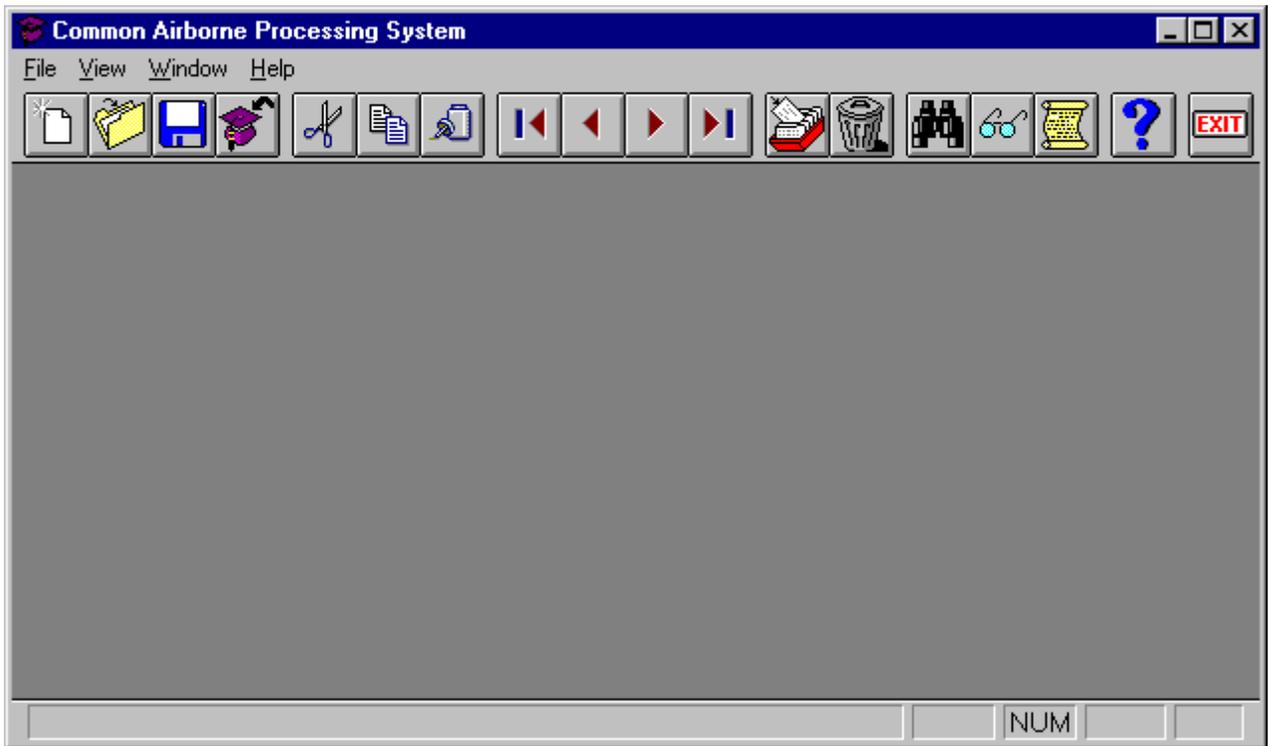
Figure 6 - CAPS Main Window

The boldest addition currently being added to CAPS is the capability to accept real-time inputs. This will allow CAPS to establish TCP/IP sockets and accept data from any device on a network. Coupled with a graphical output capability, this feature will allow real-time data-monitoring using CAPS.

The next major revision of CAPS (Version 2.0) is currently under development. This release will be a full 32-bit Microsoft Foundation Class (MFC) application, optimized for Windows NT/95, and contain many of the features discussed above.

CONCLUSION

CAPS has succeeded in its goal to provide an easy-to-use generic data reduction tool available on a low-cost platform. It serves as a bridge from digital recording to data analysis using a common graphical user interface. As telemetry processes are re-engineered, the reusability of software such as CAPS will become invaluable. Continued support and development will enhance its capabilities, making CAPS useful well into the future. A demonstration version of the software is available to anyone who desires it. To obtain a demonstration or full version of CAPS, contact Mr. Neal Urquhart at (DSN) 872-8470 or (904) 882-8470.

REFERENCES

Rarick, Michael J. and Lawrence, Ben-z, <u>Common Airborne Processing System (CAPS) User's Guide</u>, Department of the Air Force, Eglin AFB, Florida, 1994.

Swan, Tom with Arnson, Robert and Cantù, Marco, <u>Object Windows 2.0 Programming</u>, Borland Press, New York, New York, 1994.