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DEVELOPMENTAL UTILITIES FOR THE WSR-88D COMMON OPERATIONS AND DEVELOPMENT ENVIRONMENT

Andrew D. Stern* and Thomas J. Ganger
Mitretek Systems, Inc., Falls Church, VA

Sean A. Dobbs
Carnegie Mellon University, Pittsburgh, PA

Michael J. Istok
National Weather Service, Office of Science and Technology, Silver Spring, MD

1. INTRODUCTION

With the deployment of the Open Radar Product Generator (ORPG) and the creation of the WSR-88D Common Operations and Development Environment (CODE), a whole new set of opportunities to expand the science of radar meteorology has begun. CODE is part of the NEXRAD Product Improvement (NPI) Program's initiative to increase the pace of technology infusion into the WSR-88D. CODE includes the ORPG's system services that provide access to the WSR-88D algorithm applications programming interface (API) and internal data sets.

In order to support the creation, validation and integration of new algorithms, the NPI Program is sponsoring the development of a suite of utilities known as CODEview. CODEview contains powerful programs to allow scientists to easily explore and display the contents of the ORPG data stores as intermediate or final products. In addition, there are graphical utilities that allow for the display of the products as they are built. These utilities are free of the constraints of the legacy Principal User Processor (PUP) and allow for creativity at maximum resolution. This paper will discuss the CODEview utilities and how they will play a part in WSR-88D CODE's success and the new paradigm in algorithm development.

2. ORPG LINEAR BUFFERS

One key to unlocking the power of CODE is understanding the ORPG Linear Buffer (LB). The LB is a software component that supports inter-process communications, message passing, data buffering, data storage, and configuration management within the ORPG (Jing, 2000).

Each LB contains its own internal management routines. These range from the ability to control read/write access to providing message inventories, memory allocation and version control. Some LBs are memory resident for speedy data access, though most reside on disk.

The principal types of LBs that are of most interest to new algorithm developers are the product database LB (PDLB), product specific LBs and intermediate LBs. Each is described briefly below.

The PDLB is a large persistent (disk resident) data storage container that typically holds about 7500 messages. The message sizes are variable in length. The messages themselves are the results of algorithms, which create products for distribution or display. Developers will frequently access this LB to see the formatted results of their algorithms.

* *Corresponding author address*: Andrew D. Stern Mitretek Systems; 3150 Fairview Park Drive South, Falls Church, Virginia 22042-4519;
Email: astern@mitretek.org

For each algorithm that results in the distribution of a final product, there is a product specific LB. This LB is much smaller than the PDLB because it only contains a 96 byte header for each instance of a product that is generated. Most important, the message contains the index location of where the entire completed message can be found within the PDLB. Other information within the message includes details that uniquely identify the product, which is used by the ORPG infrastructure to control product storage and distribution.

Intermediate LBs are used to hold information between processing tasks. The messages contained within them can be stored in any format. This lack of a standardized format for these messages makes it difficult to create generic tools that can be used to display these data. Because of this, some common intermediate structures have been proposed for use with the CODE utilities.

3. THE CODEVIEW SUITE OF UTILITIES

In order to facilitate the exploration and display of messages within linear buffers, the CODEview suite of programs has been created.

CODEview Text (CVT) is a command line program that is used to textually explore both the inventories of linear buffers as well as their contents.

CODEview Graphics (CVG) is a program that uses a graphical interface to display both legacy and new radar products.

Both of these utilities rely on the fact that output messages must be compliant with an established standard.

The ICD (Interface Control Document) for the RPG Associated PUP (Radar Operations Center, 1998) describes the standard format that all final products must use in order to be processed and displayed by the WSR-88D. CODEview utilities take advantage of these standards and provide services to display most of the specified formats.

3.1 CODEview *Text (CVT)*

CVT is a utility that allows for the textual exploration of ORPG linear buffers at several different levels.

At the highest level, CVT can be used to display the inventories of linear buffers. The most simple command, 'cvt i', lists the contents of the PDLB (Figure 1).

The leftmost column (labeled MSG#) represents the positional counter of a message within the linear buffer. All subsequent accesses of a specific product use this message number. The next column, labeled LBMSGID, represents the "Linear Buffer Message ID". This ID is an integer that is associated with a LB where a message (or in the case of a final product, the message header) is stored. It differs from the commonly used “Product Code” of the product, however, and is often confused with the LB ID. For example, in Figure 1, the first message contains a product that is stored in LB ID 2. The product code for this LB is 19, which is the 16-level base reflectivity product.

The center column, labeled MSGLEN, shows the number of bytes stored within the linear buffer associated with the message. The last two columns show which WSR-88D volume and elevation the messages are associated with.

```
CODEview Text (CVT) Version 1.4


      ORPG Products Database Inventory Utility
filename: /noaa/datacdb1_19/pdist/product_data_base.lb

 Inventory of the Product Database Linear Buffer
  MSG#  LBMSGID  MSGLEN  VOLNUM  ELEV
    1     002    027178    01     01
    2     004    022070    01     01
    3     172    027178    01     01
    4     171    086622    01     01
    5     008    034218    01     01
```

Figure 1. CVT Inventory Display

CVT has several message search capabilities, Using the command “cvt req LBNAME” returns the contents of all messages in the product request LB. The parameter, LBNAME, is the name of the request LB to be searched.

To search the PDLB for products with specific LB IDs, use the search command, “cvt searchlb LBID”, where LBID is the LB ID number. The result is a listing indicating all occurrences of products with the LB ID as 2 (Figure 2).

```
      ORPG Products Database Search Utility: LB ID=2
filename: /noaa/datacdb1_19/pdist/product_data_base.lb

 Search was a Success!
  MSG#  LBMSGID  MSGLEN  VOLNUM  ELEV
    1     002    027178    01     01
   12     002    027052    01     02
   18     002    026834    01     03
   28     002    024640    01     04
```

Figure 2. Results of the CVT LB Search Command

At lower levels, CVT has the ability to display formatted output all of the blocks and packets of ICD compliant products. The ICD format requires that all products contain a message header and product description block. These identifying blocks are displayed both in decimal and hexadecimal so that developers can verify its contents.

In addition, ICD complaint products can contain optional blocks. The symbology block can contain one or more layers of data. Each layer can contain one or more packets of data. Several packets can actually contain other packets. CVT has the ability to display the contents of each of these components in a descriptive and formatted way.

Other optional blocks that can be displayed are the Graphic Alphanumeric Block (GAB) and the Tabular Alphanumeric Block (TAB). The GAB is used to contain text and table information that is to be displayed within the main display. The TAB is used to display alphanumeric information that can be associated with a graphic product.

CVT has the ability to display the contents of radials or rows of data within the ICD formatted message. For radial products, the output can be any sequence of radials by absolute position (where they fall within the output) or by actual azimuth. Similarly, raster data can be displayed by showing one or more rows. In both cases, the output type can be selected. The output can be run length encoded (in hex), decoded (in decimal), or scaled.

For intermediate products that do not conform to the ICD format, CVT has an export and hexadecimal dump capability. The export command takes the contents of the LB message and produces a binary file on disk. The hexadecimal dump command takes the contents of the LB message and provides an ASCII text output formatted in 16 byte rows of data.

Finally, CVT has full on line help detailing command line parameters as well as a full listing of all ICD packets.

3.2 *CODEview Graphics (CVG)*

CVG is the graphical user interface sibling of CVT. CVG is an X-Windows/Motif application that provides a graphic display capability for most legacy WSR-88D products as well as a framework to test and display new algorithm output. CVG has been designed so that its internal decoder is not hardwired to any particular product. Instead, each block, layer or packet is decoded in turn allowing maximum flexibility for the development and display of new products.

The CVG main interface has a simple layout (Figure 3). The “Select Product” section is used to choose one of 3 sources for the data. The sources include products contained within the PDLB, any (disk resident) product specific or intermediate linear buffer, or a disk file, which contains an ICD compliant product. This last option was added to allow for the display of images from the NWS central radar server or to read images extracted to disk by CVT from LBs.

The contents of intermediate linear buffers can only be graphically displayed if they are in ICD complaint formats or one of the CVG supplied structures for radial or raster data.

CVG has the ability to display and manipulate one or two images simultaneously, either independently or linked (Figure 4). The link feature allows for the comparison of data values at the same location in each image.

Each image is displayed on a large digital canvas. The right side of the canvas contains full identifying information for the display and a full color legend. If the image contains a GAB, then it will be displayed at the top of the canvas (similar to the display on a legacy PUP). Images can be displayed with county map backgrounds, azimuth lines and range rings.

CVG contains an image pan and zoom feature, which allows for images to be magnified by a factor of 8. Similarly, image resolution can be set for new products directly on the main interface screen so that any overlay layers will be properly displayed.

CVG contains two types of image animation. The first type of animation uses a ‘time series’ feature, which displays one image per volume. The animation can include volume products or elevation products at the same level in each volume. The second type of animation is ‘elevation series’. This animation allows for looping through an elevation product from the lowest to highest levels within one volume scan.

Looping can be single stepped or continuous with automatic updates when new products are added or old products are purged from the PDLB. Both can be in forward or reverse directions. If two images are displayed and linked, then the animation control can be used to advance both images simultaneously.

CVG is fully customizable with screens that guide the user through the registration of new products. This registration links LB ID codes to specific color palette, resolution and scale information.

A tool to help with the creation of color palettes is also under development to complement CVG. CVG allows for color palettes to have up to 256 color levels.

Output can be in non-compressed GIF or PNG formats.

4. CONCLUSION

New algorithm development in the ORPG will be made easier with the introduction of the CODEview Utilities. The utilities offer the ability to explore LB data stores both textually and graphically and provide for many formats for output.

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5. REFERENCES

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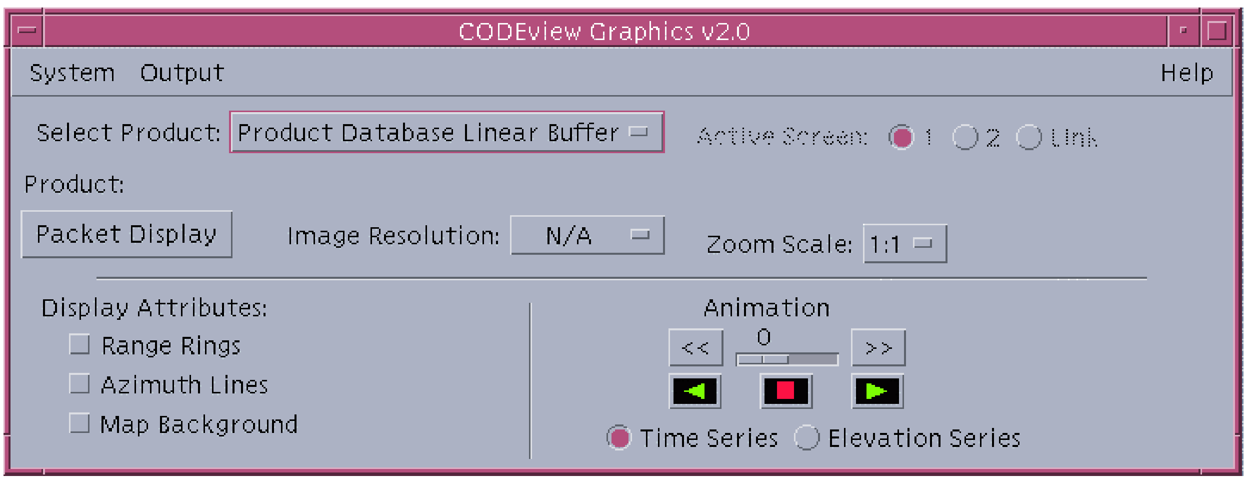

Figure 3. CVG Main Interface

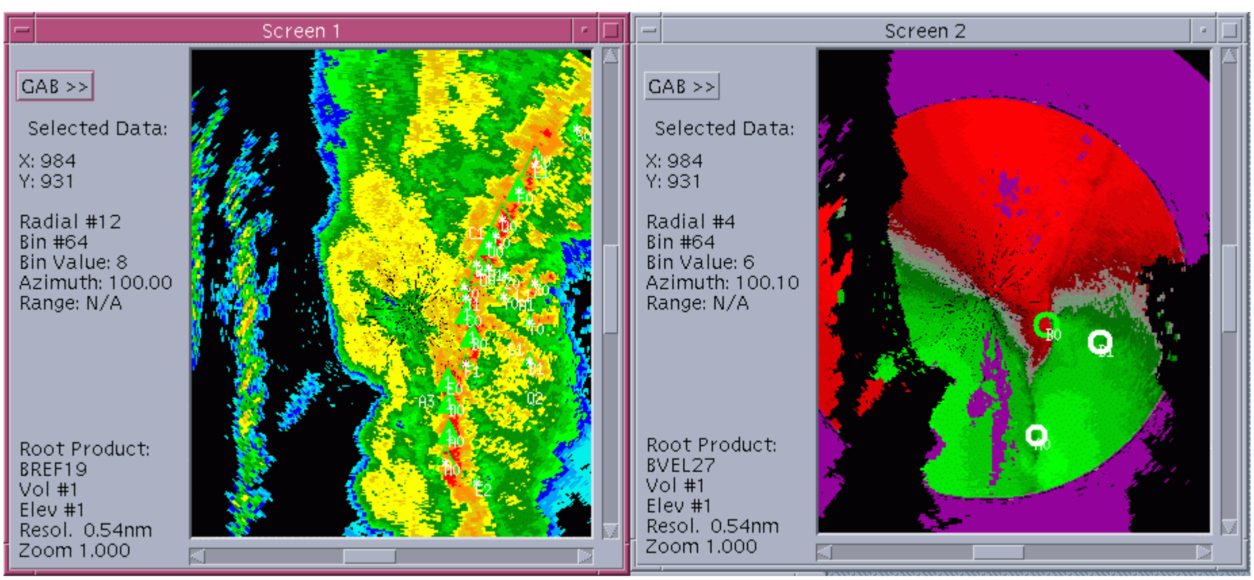

Figure 4. Linked CVG Display Windows showing Overlay fields on Reflectivity (left) and Velocity (right) images.