UTILIZATION OF LDM AT THE STORM PREDICTION CENTER

Gregory H. Grosshans *
NOAA/NWS/NCEP/Storm Prediction Center
Norman, Oklahoma

1. INTRODUCTION

  The National Centers for Environmental Prediction (NCEP) Storm Prediction Center (SPC) has been using the UNIDATA Local Data Manager (LDM) software for over five years to support several operational data flows. Initially the LDM software was used to support three data streams: the National Weather Service Telecommunication Gateway (NWSTG) Family Of Services (FOS) Domestic Data Service (DDS), Public Products Service (PPS), and the local Automation of Field Operations and Services (AFOS). The latter AFOS is now decommissioned and no longer used but the use of LDM has expanded.

  Use of LDM at the SPC and in NCEP has evolved in three areas. First, with the commissioning of the Advanced Weather Interactive Processing System (AWIPS) the NCEP expanded the use of the LDM as a component to facilitate NCEP official product distribution via the NCEP Product Distribution System (PDS). Second, the SPC and NCEP Aviation Weather Center (AWC) started placing the NOAAPORT Receive System (NRS) data stream into LDM. And third, the SPC and AWC utilize LDM to provide redundancy of national mosaic radar data between the two National Centers. This paper describes the utilization of LDM in these three areas.

2. NCEP PRODUCT DISSEMINATION SYSTEM

  The NCEP Product Dissemination System (PDS) is used to transmit official NCEP products. A component of the NCEP PDS is the LDM.

_____

* Corresponding author address: Gregroy H. Grosshans, NOAA/NWS/NCEP/Storm Prediction Center, 1313 Halley Circle, Norman, OK 73069.
E-mail: gregory.grosshans@noaa.gov

2.1 Background

  In early 2000 the NCEP Central Operations (NCO) Director Carl Staton, now the NWS CIO, created the NCEP AFOS Decommissioning Technical Team. The mission of the team was to determine the best possible solution for replacing the AFOS system for product dissemination at the National Centers. The team was led by Scott Jacobs from the NCEP Computer Development Branch (CDB), with representatives from most National Centers: Luis Cano of NCO, Steven Danz of AWC, Gregory Grosshans of SPC, Salim Leyva of Tropical Prediction Center and Lauren Morone of NCEP Office of the Director.

  Since AFOS was used to disseminate text and binary products, a task of the team was to determine common short-term solutions to the immediate problem of product dissemination at the NCEP Service Centers. A long-term solution using AWIPS, common throughout the NCEP Service Centers, was also explored leading to the development and operational use of the NCEP Product Dissemination System (PDS). The team met with members of the NWS AWIPS Program Office (APO) and Office of Operational Systems (OOS) to discuss existing and potential mechanisms to disseminate NCEP products. Over the course of a few months the technical team created the PDS.

2.2 Development and Description

  Some of the software in the PDS already existed and other software required small changes. The various pieces of the PDS at a site included LDM, an AWIPS firewall, a NCEP client-server application, AWIPS Message Handling System (MHS) programs, UNIX scripts and subsequently the NCEP Wide Area Network (WAN).

  The LDM software was already used in many of the NCEP Service Centers and the software proved reliable. LDM was installed and configured on a workstation on the AWIPS local area network (LAN) and on a workstation on the NCEP LAN. Both hosts running LDM communicate via the AWIPS firewall (discussed below). The LDM systems were set up to pass data back and forth through the AWIPS firewall.

  Disseminating products timely in a manner for NWS Forecast Field Offices required products to be

disseminated from the NCEP AWIPS systems. SPC and other NCEP text and binary products are created outside of AWIPS. The APO agreed to allow NCEP to modify the firewall to allow LDM traffic. Utilizing the local firewall allows quick dissemination of all products. Otherwise some products would be received slowly in the field as they would traverse from the National Center to the NWSTG, then the Network Control Facility (NCF) for distribution over NOAAPORT.

Another key component is a client-server application from the NCEP Distributed Brokered Networking (DBNet) software package. The client-server from DBNet was modified for the PDS system. The client-server application is the InterFace Client (IFCP_npds) and InterFace Server (IFSP_npds). The InterFace Client and Server are implemented as Remote Procedure Calls (RPC). The application is capable of sending data and performing remote executions. The client-server software was modified to use a program number different from DBNet allowing the client-server software to co-exist on a computer system already running DBNet. Since the client-server application used in the PDS originated from DBNet the security is essentially the same. The application can be configured to allow access based on a combination of user identification (UID), host names, Internet Protocol (IP) addresses, IP subnets and a password set at compile time. This security is in addition to the security outside of the application (e.g. firewall, host based security).

As mentioned previously, National Centers generate both text and binary products. The standard AWIPS Message Handling System (MHS) program 'handleOUP.pl' was developed for text only products. Therefore, two other MHS programs 'distributeProduct' and 'msg_send' were used to meet NCEP requirements. distributeProduct is used to allow products to be stored in AWIPS as a National Category product. The msg_send program is used to transmit binary products (e.g. Redbook graphics).

A number of scripts were written to assemble all of the pieces. The main script closest to the forecaster is 'launch_prod' and it utilizes the client-server application to find an available PDS system. Once a PDS site is identified the client-server application is used to send the National Center product to an available PDS on the NCEP LAN running LDM. On the particular host the 'send_prod' script watches an incoming directory and once a file is found the file is inserted into the LDM queue. On the AWIPS host running LDM, the 'send_awips' script is executed via the LDM pqact program when a new product is received. Based on the filename of the product 'send_awips' determines how to act on the data. Using a script keying off of the filename provides great flexibility and has allowed several enhancements to be easily

added to the PDS system.

The NCEP WAN allows each National Center to use a PDS at another site. Currently a PDS host exists at the AWC, HPC, SPC and TPC. The NCEP WAN allows the local National Center to disseminate a product at any of the other NCEP PDS sites if the local AWIPS or PDS is not available.

A key aspect and safe guard of the NCEP PDS is to use an active PDS. An active PDS consists of:

> -a workstation on the NCEP LAN running LDM configured for the PDS
> -this workstation can perform an 'ldmping' to the LDM running on the AWIPS workstation configured for the PDS

An active PDS is critical because at commencement of product dissemination the launch_prod process checks for an active PDS host at each of the four National Centers.

In addition, the NCEP PDS contains a number of other safe guards to ensure the use of an active PDS. These safe guards are performed on the host on the NCEP LAN running LDM and the AWIPS host running LDM.

The workstation on the NCEP LAN running LDM performs a number of checks. A routine check of the IFSP_npds and send_prod processes is performed and if they are not running they are restarted. The LDM queue is checked and if its corrupted the queue is fixed via LDM. If LDM is not running the system automatically starts LDM. Finally, the LDM pqact, pqexpire and pqbinstats are started if they are not in the process list. With LDM running the first of two key points defining an active PDS are met.

Next, on the AWIPS workstation running LDM there are a number of checks performed. The LDM running on the local AWIPS workstation will continue to run when the following checks are successful:

> -the AWIPS disk system is less than the defined threshold (e.g. < 99%).
> -the AWIPS workstation can ping the DS.
> -the MhsServer process on the DS is running.
> -the AWIPS workstation can ping the NCF message server (i.e. testing WAN connectivity).

Also, the LDM queue is checked and if its corrupted a new queue is automatically created. If LDM is not running LDM is started. When LDM is running a check is made to ensure the pqact, pqexpire and

pqbinstats programs are running, if they are not they are restarted. When all of these checks are successful LDM will continue to run and can respond successfully to an ldmping from the LDM workstation on the NCEP LAN. Therefore the second of two key points defining an active PDS are met.

2.3 Application

The PDS allows a variety of data to be sent into the AWIPS system by the launch_prod script. The script accepts two arguments: type and file.

The valid 'type' consists of:

        text[_list]
                where list can be a comma separated list of sites to receive the product or 'ALL'
        internal
                a product is sent to the NCF for distribution on the AWIPS WAN

and

                subsequent storing and processing on AWIPS. The product is not sent over NOAAPORT or the NWSTG
        graphic
        grib
        vgf[_xx]
                where xx can be a specific RFC identifier.
        work
        system

The file argument is the complete path for the file to be sent. The following are rules for the filename by file type:

        text   the filename portion must be the AWIPS identifier of the form CCCCNNNXXX, e.g. KWNSSWODY1
        internal same as text type
        graphic   no special instructions
        grib   no special instructions
        vgf   no special instructions
        work   the filename portion must be the AFOS identifier of the form CCCNNNXXX, e.g. SPCWRKSPC
        system   no special instructions

Some examples of launch_prod follow:

launch_prod text \
$HOME/PRODUCTS/KWNSSWODY1

launch_prod graphic \
$HOME/PRODUCTS/NMCGPHHRY

The first example is the use of launch_prod to disseminate the SPC text day one outlook product. The second is an example of disseminating the SPC binary redbook graphic product containing Local Storm Reports.

The AWIPS workstation running LDM receives the product in the LDM queue and stores it to disk via LDM pqact. Next pqact executes the send_awips script and further processing is based on the 'type' specified as a command line argument to launch_prod.

If the type is 'text' with no extension, or address list, then handleOUP.pl is used to disseminate the product. If the extension is 'ALL' then distributeProduct is used with a class of 'STORE_NATPROD'. This allows the product to be stored as a National Category product at all sites. If an address list is provided then distributeProduct is used.

If the type is 'internal' then the product is addressed to 'ALLNCF' and distributeProduct is used. This results in the product being transmitted on the AWIPS WAN to the NCF. The NCF then transmits the product to all AWIPS sites via the WAN. The product is not transmitted over NOAAPORT or to the NWSTG. Further, the product received over the WAN is processed and stored correctly in the AWIPS database. One example use of this is for the internal NWS ADMSPC product.

If the type is 'graphic' or 'grib' then the msg_send program is used. This is the only MHS program capable of sending binary products.

If the type is 'vgf' a FTP script is called. At the present time this is used by the NCEP Hydrometeorological Prediction Center (HPC) to send vector graphic format (VGF) files to the NWS River Forecast Centers (RFC) for use in the National-AWIPS (NAWIPS) NMAP application.

If the type is 'work' then the product is written to the database with the AWIPS 'textdb' command.

Finally, if the type is 'system' the file is just stored to the local account with no further processing. This is useful to stage new PDS routines on the workstation with subsequent user intervention.

3. INGESTING NOAAPORT DATA INTO LDM

Prior to AWIPS the SPC inserted three data streams into the LDM for processing, decoding and making data available in NAWIPS. These data streams were AFOS and the FOS DDS and PPS. The SPC received a NRS prior to the receipt of AWIPS. The NRS allowed the SPC to begin utilizing the four NOAAPORT channels (i.e. GOES-EAST, GOES-WEST, NWSTG and NOAAPORT) and to incorporate the data more fully into SPC operations. The methods used to move the data from the NRS system into the SPC non-AWIPS systems have evolved over time to the point of inserting the data into LDM.

When NRS was initially received the SPC utilized the NRS support of file transfer protocol (FTP) to move the data from the NRS machine to an SPC host, a NOAAPORT Users External System (NUES). The NRS also supports the use of the network file system (NFS) but there is a performance penalty when writing to a NFS mount compared to using FTP. Using FTP to move data is useful for moving large intermittent products (e.g. satellite imagery). The SPC used this to stage satellite imagery. A script would check for new imagery at specified times and place the data in a location for access by SPC forecast operations. The satellite imagery obtained from NOAAPORT becomes the primary feed if the local SPC satellite ingest is disrupted.

Another method of moving NOAAPORT data from the NRS to a NUES is using the NRS supported client-server application. The server application executes on a NUES. The NRS is configured to execute the client and the NUES host is defined. As data is received it is sent from the NRS to the NUES over the network via the client-server application. This mechanism was implemented at the SPC for moving the GOES-EAST and GOES-WEST imagery to the NUES and then to SPC operations. AWIPS also uses the client-server method of moving data. The equivalent of the NRS in AWIPS are the CPSBN1 and CPSBN2 hosts.

The NOAAPORT NWSTG data stream was still not being utilized as efficiently as the GOES imagery from NOAAPORT. An efficient method to take the products and place them into existing decoders and store the data for access by operations was still needed.

Joan Brundage, Forecast Systems Lab (FSL) Facility Division, presented a talk on the "Development of a Prototype AWIPS Operational Data Repository System" at the National Weather Association's twenty-third Annual Meeting in October 1998 at Oklahoma City. Part of the talk discussed the NOAAPORT data flow at FSL, in particular inserting the NOAAPORT data into LDM. FSL had modified the NRS server code to insert the NOAAPORT data into LDM.

Through coordination between FSL and NWS Headquarters, the SPC obtained the FSL version of the server code acqserver. The FSL version inserted the NOAAPORT data "as is" into LDM. However, the decoders and processing software the SPC and other National Centers use requires data to look like the NWSTG FOS feed, following the World Meteorological Organization (WMO) Global Telecommunication System (GTS) standard.

The SPC modified the acqserver to remove the NOAAPORT Communications Control Block (CCB) from all NOAAPORT NWSTG products. In place of the CCB the WMO GTS standard is followed and the following is placed prior to the WMO header:

[SOH] [cr] [cr] [lf] nnn [cr] [cr] [lf]

and the following is placed at the end of each product:

[cr] [cr] [lf]] [ETX]

where,

-Start Of Heading (SOH) is 01 in hexadecimal,
-End Of Text (ETX) is 03 in hexadecimal,
-Carriage return (cr) is 0D in hexadecimal,
-Line feed (lf) is 0A in hexadecimal,
-Message sequence number (nnn).

The AWC also received a NRS and was allowed to obtain the enhancements to the acqserver by the SPC. Steve Danz at the AWC modified the acqserver code to take the AWIPS identifier line, immediately following the WMO line, and insert this information into LDM for use by the LDM meta tag /p. This enhancement allows the LDM to act on products based on the WMO header and the AWIPS identifier line.

Use of the SPC and AWC modified acqserver has allowed the SPC to ingest the NOAAPORT data for more robust use in SPC forecast operations. With this data stream the SPC no longer required the FOS DDS and PPS feeds. In fact, NWS Weather Forecast Office products are received slightly faster via NOAAPORT compared to the FOS DDS and PPS feeds. The timing differences are due to WFO products being received first at the NCF for uplink to NOAAPORT. From the NCF the products are sent to the NWSTG for distribution to a variety of circuits, including the FOS DDS and PPS feeds.

Since LDM is ingesting all four NOAAPORT channels the ldm queue was created with a size of 750 MB. This queue size has been adequately supporting SPC operations with the large amount of data inserted into the queue, primarily from NOAAPORT. For example, on October 3, 2001 NOAAPORT data totaling over 475,000 products with a combined size of 9.7 GB was inserted into the queue. Adding in the remaining LDM feeds results in over 625,000 products with a combined size of 12.4 GB.

The acqserver server continues to be an important part of SPC operations. This acqserver software is also in use at the NWS Central Region Headquarters and the National Climatic Data Center.

4. BACKUP FOR MOSAIC RADAR DATA

The SPC and AWC both ingest national mosaic radar imagery via satellite dishes at each Center. Each image is at least 300,000 bytes. The mosaic imagery is a key part of operations at each center. Steve Danz, AWC, developed a routine to insert the radar imagery into LDM using a specific feedtype. The SPC implemented this solution and moving radar imagery around at the SPC using this solution has proved useful.

The reception of radar imagery via the satellite dish has been good. However, in times of heavy rain or dish icing the signal strength will weaken resulting in the loss of imagery for forecast operations. The SPC and AWC desired to avoid imagery loss due to a decrease in the local signal strength. Since LDM was already utilized to move radar imagery around within each National Center, LDM was also configured to share the imagery between both Centers.

Specifically, an LDM host at each Center was configured to allow the other Center (i.e. downstream LDM) to request national mosaic radar imagery. The SPC's downstream LDM is AWC and the AWC's downstream LDM is SPC. In addition, each Center configured LDM to request the national mosaic radar imagery from the other Center. One feature of LDM is to not insert a duplicate product into the queue. Another feature is that LDM sends products larger than 16K in 16K blocks of data to a downstream site. Further, if the downstream LDM already has a product when it receives the first 16K block of data the LDM will reject the rest of the product since it is a duplicate.

With the above set up, under normal conditions each Center is inserting national mosaic radar imagery into the LDM queue from their local satellite receiver. The LDM at each Center then sends the first block of data for the image to the other Center. However, since the other Center already received the data from the local feed it rejects the additional blocks of data.

Under abnormal conditions, when one Center is experiencing problems with signal strength (i.e. rain fade or ice accumulation on the dish) resulting in no radar imagery receipt from the local satellite dish, the forecast operations continue to receive imagery. This is because the other Center received the radar imagery and inserted it into the LDM queue. The LDM at the Center with signal strength abnormalities receives the first block of data and the remaining data since it was not received locally. This LDM based solution results in continuous national mosaic radar imagery for operational forecasters even when the local satellite signal strength is weakened.

5. CONCLUSION

The use of LDM at the SPC has evolved over the last five years. Initially, LDM was used to receive small data streams such as AFOS and the FOS DDS and PPS. The LDM is now handling a significantly larger data stream from NOAAPORT via the local NRS and acqserver code. The data received via NOAAPORT is decoded and processed timely via LDM and made available for SPC forecast operations. LDM is one important component of the NCEP Product Dissemination System used at the SPC and throughout NCEP to transmit NCEP official products. Finally, AWC and the SPC are able to utilize LDM so forecast operations continues to receive national mosaic radar imagery when local satellite signal strength is weakened.

6. REFERENCES

Unidata's LDM Web page:
<http://www.unidata.ucar.edu/packages/ldm/>.

NWS's Web page on the WMO Message Structure:
<http://205.156.54.206/oso/head.shtml>.