NEXRAD Now

June, 1999

Issue 8

What's inside?

RDA in the 21st Century

The OSF and the National Severe Storms Laboratory (NSSL) are in a partnership to create the next advance in NEXRAD radar signal processing. The joint teams, consisting of engineers in both organizations, are developing a new computing environment and an advanced signal processor. This system, Open RDA (ORDA), which is the follow on to the Open RPG and Open PUP, will pave the way for significant advances in the quality of the radar base data products, allowing the OSF to implement many of the results from research sponsored at both NSSL and the National Center for Atmospheric Research (NCAR). For several years, these laboratories have been pursuing ways to eliminate some of the fundamental problems with the Doppler radar data. These problems include the familiar range folding and velocity aliasing artifacts caused by the classic "Doppler dilemma" and contamination of products from anomalously propagated clutter. Unfortunately, the present radar signal processor and Microfive host computer cannot support the necessary changes, nor can the system be expanded to incorporate the planned dual polarization modification. The existing signal processor is a highly customized and proprietary combination of hardware and software, which makes it expensive and risky to incorporate modifications. The software is written in a unique assembly level code and is nearly impossible to maintain. The NSSL/OSF team effort will provide a modern, expandable and reprogrammable environment capable of moving the RDA to 21st century capabilities.

Technical Design - This new system replaces four major elements of the current RDA: the RDA System Control Computer (RDASC), the Hardwired Signal Processor (HSP), the Programmable Signal Processor (PSP), and the Wide Band (WB) data processor. These subsystems

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RDA in the 21st Century

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are indicated in figure 1. The RDASC, HSP and

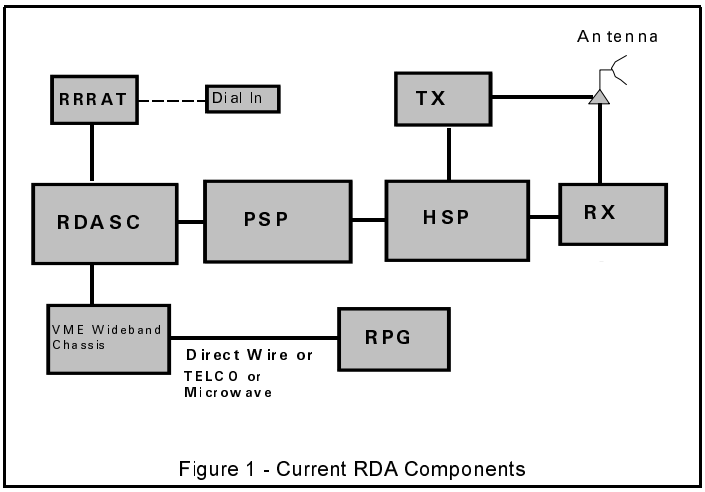

Figure 1 - Current RDA Components

PSP will be combined into a single Versa Module Eurobus (VME) system based on the ANSI VME-64 standard, and using the widely accepted real time operating system VxWorks™. This operating system is scalable and supports a wide variety of hardware platforms, for ease in future changes and expansion of capability. VxWorks complies with the popular POSIX standard as well. The signal processor employs another standard compute environment based on the Super Harvard Architecture Computer (SHARC™) provided by Analog Devices, Inc. The SHARC processors will be connected and supported in another industry standard environment known as the RACEway™, an interconnection scheme developed by Mercury Computer Systems. The team will use ANSI standard C as the computer language. The use of all these trademark and standard systems means that hardware devices and software applications from many vendors can be supported in this structure, ensuring the future growth and supportability of our radar signal processing capability. A simplified block diagram of the new ORDA components can be found in Figure 2. The system can be expanded to contain any number of SHARC DSP's as needed.

Advances in Radar Base Data - The new processing environment allows OSF and NSSL engineers to implement dramatic advances in radar signal design. Our research into the range-velocity ambiguity problem indicates that the use of phase coded transmitter pulses has the best potential for reducing range folding, the familiar "purple plague." In this scheme, the reference phase of each transmitted pulse is changed in a predetermined way. The signal processor then uses the pattern to sort out echoes between the first and second trips. The existing system simply does not have the power to implement this change. The new advanced signal processor also may allow use of direct spectral analysis, applying improved techniques for recognizing the difference between returns that represent clutter and radar signals due to weather. The new processor is also needed before project

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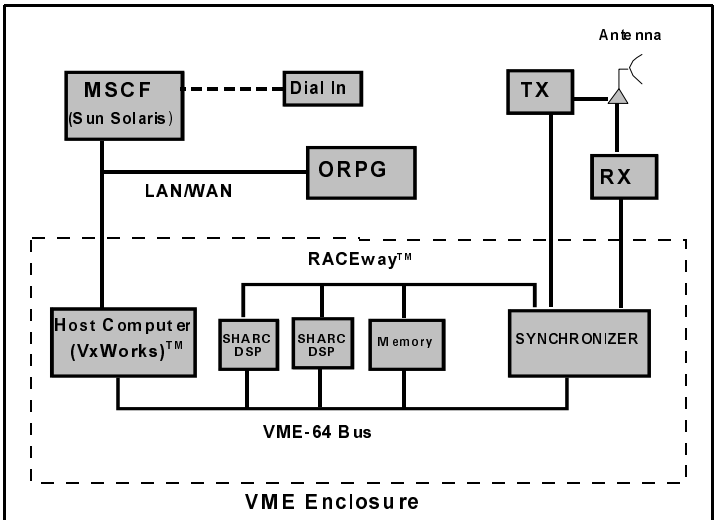

Figure 2 - Open RDA Components

RDA in the 21st Century

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engineers can develop and deploy the much anticipated change to polarization diversity. The radar will have many new capabilities using signals of different electromagnetic orientation, or polarization. Some of these include greatly improved precipitation estimation and the ability to discriminate between different types of precipitation such as hail, ice, and snow. A dual polarization system will have a much improved ability to separate precipitation from ground clutter, a major problem in today's systems. Such a system may also be able to provide more accurate wind estimates and may also be more immune to calibration instabilities.

Project Plan and Schedule - Project managers currently expect that the new signal processor and computer can be deployed in late 2002. The OSF and NSSL teams plan to work hard to meet that date. For the next year or so, NSSL will be preparing for a proof of concept demonstration. This will show that the new hardware and software environment is capable of supporting and controlling the various parts of the radar, including the antenna, transmitter, and receiver, and that the signal processor can properly calculate the base data products. This will not be a fully complete system with all the attendant calibration, diagnostic and support functionality, but will provide the basic functions. These critical support and auxiliary functions will be developed during the production engineering phase which follows. The joint teams plan to fully test the product before production and deployment. This test program will include an extended series of field tests to ensure the new system meets all operational and support requirements. NSSL is currently getting established in their new laboratory and they are also moving the KOUN WSR-88D system into an environment that will make the development task easier. The OSF will play a key role in defining and helping develop some of the maintenance and calibration support infrastructure and will conduct most of the production engineering tasks needed to move the project to deployment. OSF engineers have already obtained a prototype development platform and are becoming familiar with the hardware design.

Related Plans - The OSF plans to provide as much support as possible to the NSSL team in order to keep the ORDA project on track. Our engineers are also working on defining the detailed hardware and software requirements and will be updating the appropriate specifications to ensure the design provides all current capabilities while allowing for future growth. Some of this growth potential includes the possible addition of a digital receiver, which provides components that replace most of the intermediate frequency (IF) portion of the receiver. This modification will improve the reliability of the receiver system as well as greatly streamline the receiver calibration process. The digital receiver will also ease the transition to dual polarization since that modification requires two separate receiver channels. The digital receiver components can be selected such that they are easily compatible with the new signal processor since many digital receiver vendors are beginning to market RACEway compatible products. This is only the beginning of the exciting advancements made possible by the ORDA project.

Rich Ice
STA/Systems Engineering

NEXRAD Preparing for Y2K

Inquiries to the OSF have been on the increase and it seems as though everyone wants to know if the WSR-88D software is Year 2000 (Y2K) compliant. The OSF's initial investigation into Y2K compliance began early in 1996. At that time, preliminary testing disclosed no significant century transition problems with the software.

Additional formal testing has been performed on a number of occasions since early 1996. Each time, the system and associated software performed well and there were no system failures. All products generated by the RPG and displayed at the PUP were unaffected by the year 2000 crossover. In addition, the year 2000 is properly treated as a leap year so when February 29 rolls around, the WSR-88D will provide no surprises.

The WSR-88D application software maintained by the OSF uses a Julian date based on the number of days since January 1, 1970. Therefore, the year 2000 has no special significance. Internally, the applications software will simply refer to January 1, 2000, as the integer 10958, the number of days between January 1, 1970 and January 1, 2000.

Two very minor problems with the WSR-88D applications software have been revealed by the series of Y2K tests. The system status logs at the RPG (viewed by the ST,S command at the UCP) and at the PUP (viewed by the S,S command at the PUP applications terminal) will only display a single digit for the years 2000 through 2009. Because of this, a status message created in the year 2000 at the UCP will look something like this on January 1, 2000:

1/ 1/ 0 00:05:34>>>Narrow Band line 19 is CONNECTED in 1 Attempt(s)

At the PUP, the same problem exists but looks like this:

01/01/0 00:05 LINE 3 REQUESTED DSCNCT

Although it may look a bit strange, the single digit year is unambiguous in this context. Because the single digit year can be accurately interpreted by users, no system change or procedures will be necessary.

A somewhat more observable anomaly was detected within WSR-88D support software that is not maintained by the OSF. The Concurrent Computer Corporation utility named FASTCHEK, used by WSR-88D field sites, is not Y2K compliant. Our assessment of this anomaly reflects some potential for limited impact to field users. The OSF determined it was in the best interest of the government to issue work-around procedures to users at field sites. These procedures have been developed and are currently undergoing review and validation at the OSF.

After additional review and final testing, the procedures will be disseminated to all field sites as well as placed on the OSF web page (http://www.osf.noaa.gov). It is expected that the procedures will be available on the OSF web page in the June time-frame and mailed to each field site shortly thereafter. The OSF Hotline will be issuing a FaxBack notification to all sites when the procedures are available on the web page.

It is important for site personnel to note that the execution of the procedures must be performed AFTER the system clock crosses over into the year 2000. The procedures only have to be executed once for each RDA, RPG and PUP system. Execution of each procedure will

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Electronic Documentation

The OSF System Documentation Section (SDS) has been posting Time Compliance Technical Orders (TCTO), DOD Memos, Modification Notes, Maintenance Notes, Software Notes, Electronic Equipment Modifications, Site Publication Bulletins, and FAA Notices on the OSF Homepage since 1996. These documents were limited to general information and did not include specific operational/maintenance instructions, figures, etc. Starting in June 1999, the documents added to the homepage will cover all information that is in the printed version (including all procedures, figures, etc.). These documents will provide improved information access for all WSR-88D sites. The documents can be located on the OSF Homepage at **http://www.osf.noaa.gov/ssb/sysdoc/techman/tmlinks.htm.**

The SDS also developed a WSR-88D Electronic Technical Manuals CD-ROM. The new CD-ROM was distributed to all WSR-88D sites and headquarters offices in June 1999. This CD-ROM includes Adobe Acrobat Exchange software, 10 technical manuals in Adobe Portable Document Format (PDF), a fillable Publication Change Request form, customer survey, and an Exchange help file. The PDF technical manuals include hypertext links that make the documents easier to navigate. Users can also perform word searches and copy text to paste into word processing programs. There are also capabilities to attach personalized notes on the documents and save the file to the hard drive. Our goal is to streamline the development cycle and reduce the number of paper copies produced. WSR-88D sites are requested to use the CD-ROM for 60 days, complete and return the customer survey form back to SDS to provide feedback.

Danny G. Green
OSF System Support Branch

NEXRAD Y2K

take about 15 minutes. The work-around procedure essentially consists of a system reboot with minor changes to allow system operation in the year 2000.

Look for the Hotline's fax this summer and rest assured that the OSF is doing its part in making the year 2000 milestone a “worry-free” one for all WSR-88D users.

Brian Klein
OSF Engineering Branch

NEXRAD Now is a periodical of the WSR-88D Operational Support Facility published in February, June and October of each year.

We encourage our readers to submit articles for publication. *Please note: August* 27th is the deadline for submission of articles for the October, 1999 issue.

Please send all comments and articles via email to: **rjackson@osf.noaa.gov**

All previous issues of *NEXRAD Now* can be viewed on the OSF Home Page located at: **http://www.osf.noaa.gov**

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Editor.....Ruth Jackson

FAA Weather and Radar Processor

The Federal Aviation Administration (FAA) has developed and will soon begin installation of an improved weather processing system, the Weather and Radar Processor (WARP). This system supports air traffic control and traffic management functions in the 21 Air Route Traffic Control Centers (ARTCC) in the United States, and fully exploits the capabilities of the WSR-88D. The mission of an ARTCC is to manage and control air traffic en route, after an aircraft has reached its cruise altitude and before it descends into the destination airport terminal. Therefore, mid-to-upper-tropospheric weather conditions have more relevance to en route operations than conditions near the surface.

The Configuration Now - The initial configuration of WARP, called Stage 0, is now operational. It is a leased service providing a weather workstation for the Center Weather Service Unit (CWSU) meteorological staff and briefing terminals for traffic managers (traffic managers perform a strategic route planning function). The Harris Corporation of Melbourne, FL, acting as the WARP vendor, owns the WARP hardware and software and provides the weather information data stream. The FAA is leasing the system and paying a recurring fee for the data.

The WARP vendor acquires its weather information from conventional sources: NOAA Family of Services, GOES Tap, the NOAA lightning stroke vendor and one of the NIDS vendors. The total suite of products is available to the CWSU meteorologists through their WARP workstation. A subset of these products is addressed to the slaved briefing terminals (BTs) to support the traffic management specialist in the Traffic Management Unit (TMU). Several briefing terminals are also located in the work areas of the ARTCC so supervisors of the air traffic controllers can provide tactical guidance to their charges. The WARP, Stage 0 system and its components are an interim step in the modernization of the FAA's weather support to air traffic control.

The present source of *weather reflectivity* information sent directly to the air traffic controllers is a network of L-band radars, the Air Route Surveillance Radar (ARSR). The primary purpose of the ARSR is to provide aircraft target position information, but a weather channel of the ARSR provides a reflectivity product. However, the ARSR is calibrated to detect point targets not beam-filling precipitation and the result is highly accurate aircraft target information, but a somewhat degraded weather product. Nevertheless, at the time the system was designed, the weather product was considered adequate for air traffic control purposes.

Current display technology used by air traffic controllers in the ARTCC is very constraining. The system is called a Plan View Display (PVD). The display system has limits on how many characters vectors can be displayed; the priority, of course, given to aircraft targets, their identifying labels and tracks. This places upper bounds on the amount of weather that can be displayed at any one moment.

The Configuration to be Deployed - Significant changes in the ARTCCs are now occurring. Almost simultaneously, the WARP and the air traffic controller's display system will be upgraded. The new WARP configuration called Stage 1/2 is shown in Figure 1. WARP, Stage 1/2 will be owned, operated and maintained by the FAA. However, the Harris Corporation will continue to provide the service of packaging the data for the field units (the data acquisition function in Figure 1).

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As this article is being written (May 1999), factory acceptance testing has been completed. Site acceptance testing will begin at the Seattle ARTCC this month. Following an operational system test period and independent operational test and evaluation, the system at Seattle will be commissioned in early 2000. Installation and commissioning at the other 20 ARTCC will proceed after first article completion. Stage 1/2 will be completed at all locations by August 2000. On the air traffic control automation side of the interface, the PVDs will be replaced by the exotically-named Display System Replacement (DSR). "Smart" situational displays, consisting of 21-inch color monitors connected to a local area network (LAN), will replace the highly constrained PVD. WARP will connect to this LAN through a gateway.

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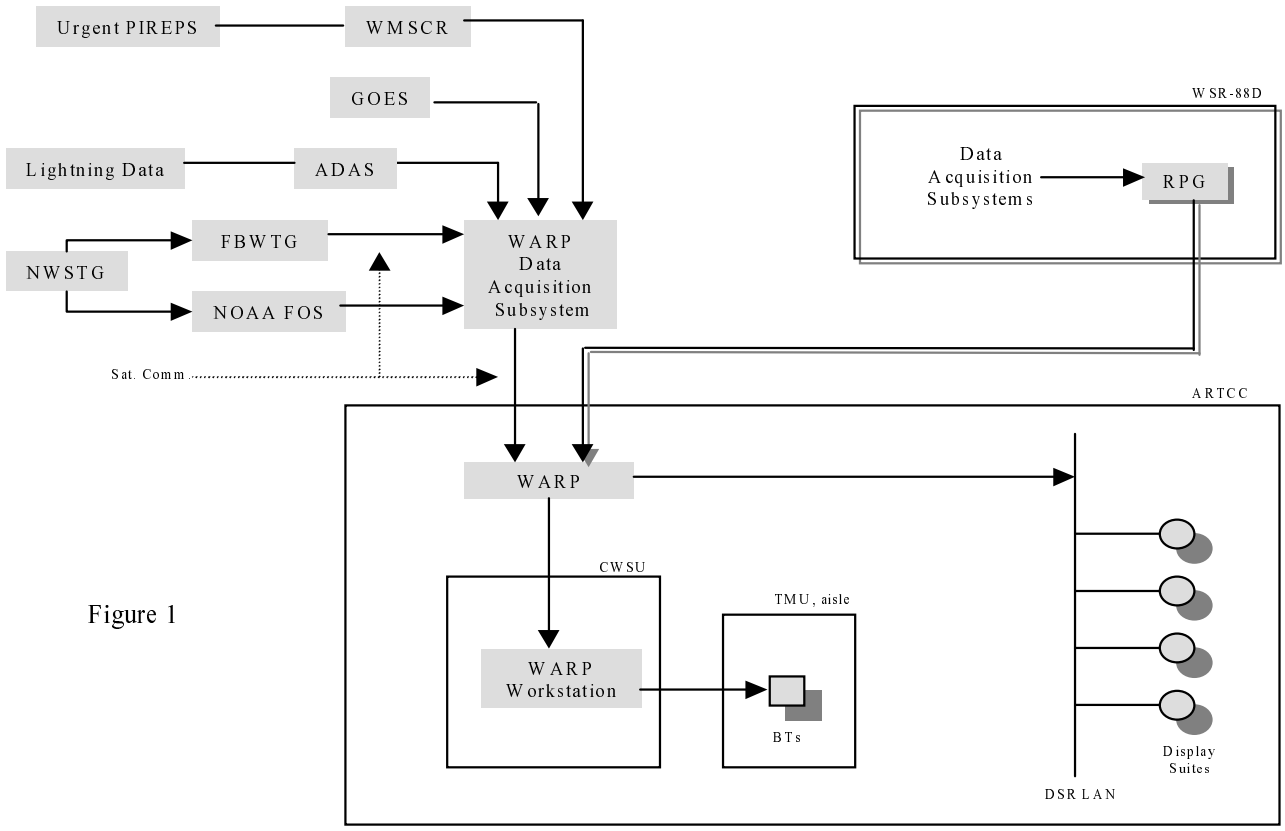

Figure 1

Figure 1 - WARP, Stage 1/2 configuration showing data sources and sinks. Notice that WARP, Stage 1/2 has Associated PUP connections to WSR-88Ds and a direct connection to the air traffic controller's display system, the latter for the purpose of delivering four WSR-88D reflectivity products.

FAA WARP

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WARP, Stage 1/2 has several new features to improve speed, quality and efficiency. WARP will acquire WSR-88D products through direct Associated PUP connections (14.4 kbps, Class I) to all radars within the ARTCC geographical boundary (Fig. 2). The CWSU meteorologist will have direct access to all products generated by these radar product generators. Some products will be received automatically every radar volume scan, others will be acquired on a request-reply basis.

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Figure 2

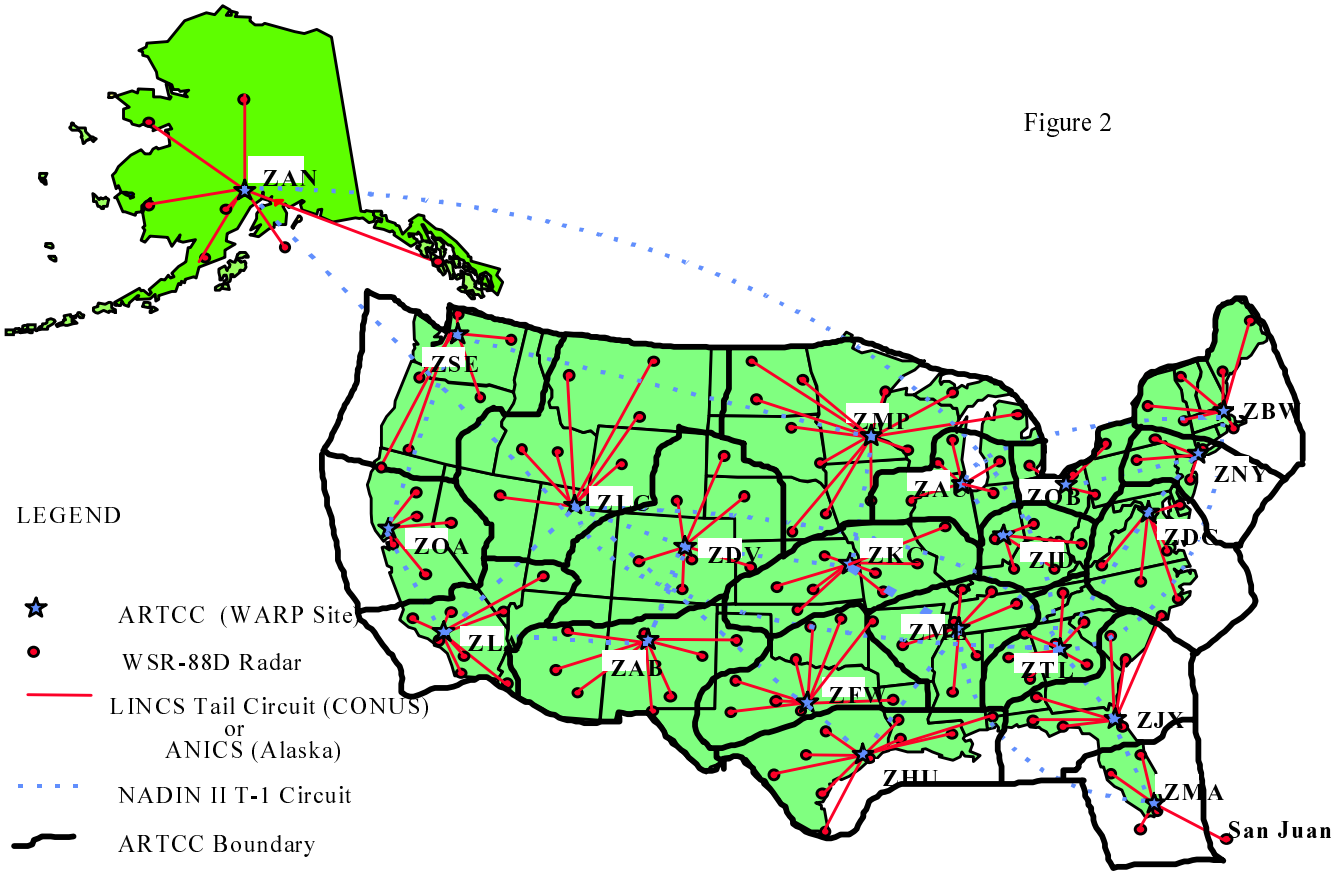

Figure 2 - WSR-88D connections to WARP within each ARTCC. Every CONUS network WSR-88D is connected to at least one WARP.

FAA WARP

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WARP will receive gridded products from the National Centers for Environmental Prediction (NCEP) on a new satellite communications link, part of the capability of the FAA Bulk Weather Telecommunications Gateway (FBWTG). Lightning stroke information will be acquired from the FAA's surface observation concentrator, Automated surface observing system (ASOS) Data Acquisition System (ADAS), located in the ARTCC. Additionally, ADAS will provide surface observation data updated every minute to the WARP processor. Software in the WARP will allow the meteorologist to plot surface depiction or contour maps much more frequently than once an hour. These can be combined in overlay form with radar images, lightning strike positions and weather satellite images. The result is the transformation of synoptic products into meso-scale products by use of data assimilation tools available in WARP. This capability, not available in any other system, will be a powerful assist to aviation interests.

WARP as a Delivery System for Air Traffic Controllers' Weather - The Stage 1/2 version of WARP has the responsibility of delivering four WSR-88D reflectivity products to the DSR gateway for air traffic controllers' displays. The four products, each in mosaic form, are the composite reflectivity, and three reflectivity layer composite products. Each of these products will be in three data levels in 4 km resolution. Mosaics will be updated every 25 seconds with whatever refreshed data is available to WARP from the source WSR-88Ds. This makes the asynchronous updating of the radar, the Volume Coverage Pattern (VCP), and the boundaries of the radar source transparent to the air traffic controller.

Through adaptation, WARP will consolidate the 8-data level reflectivity products to three data levels. Using the legacy VIP quantization as an easily understood reference, the three data-levels will be VIP levels 2, 3-4 combined and 5-6 combined. Figure 3 shows an example of the air traffic controller's display with WSR-88D reflectivity. Displaying only three data levels and only reflectivity above 30 dBz to the air traffic controllers minimizes screen clutter and masking of aircraft target information. The reflectivity information is displayed in three shades of blue. Keep in mind that these air traffic controllers work in a dark environment and sharp contrasts and bright colors are distracting. This was the main reason for using a single primary color for the reflectivity. In comparison, the CWSU meteorologist has access to the full range and highest resolution weather radar data available so that appropriate interpretive skills can be employed on weather patterns.

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FAA WARP

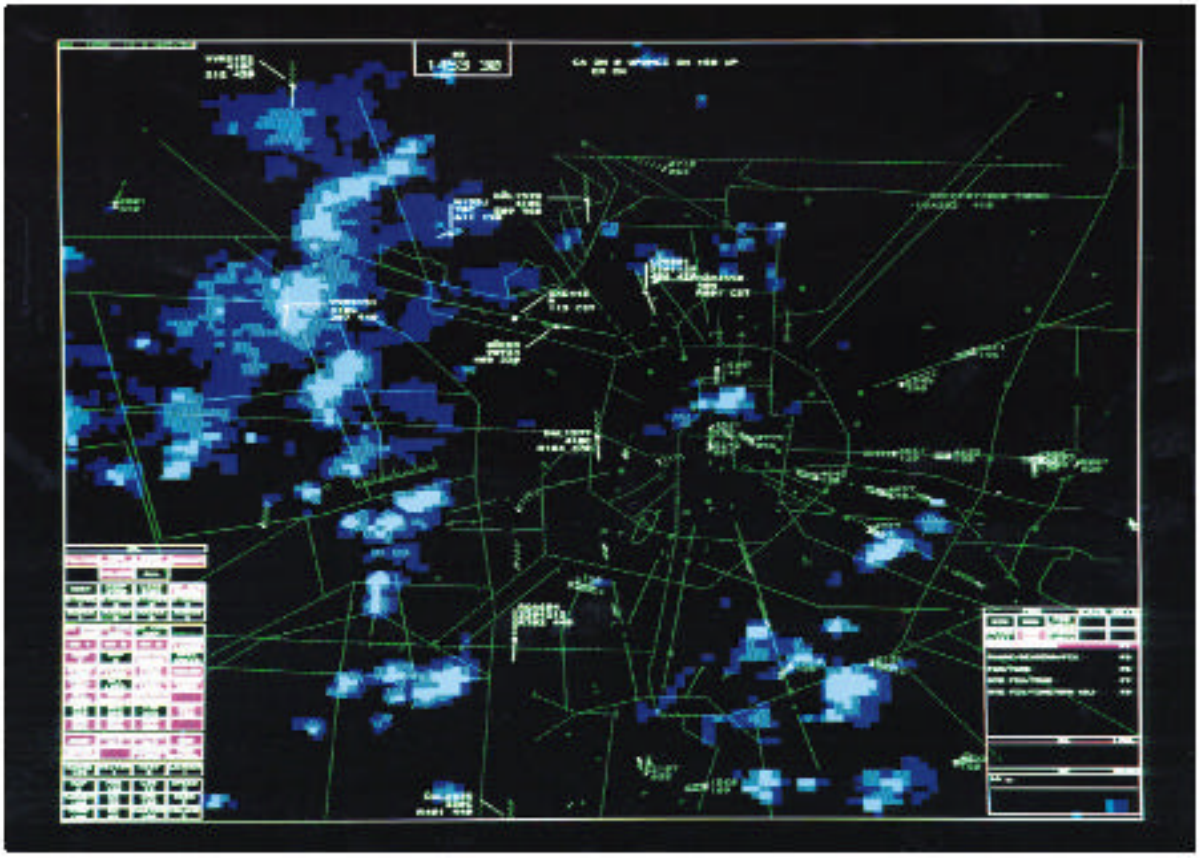

Figure 3. Example of en route air traffice controller's display. The reflectivity source is the WSR-88D via the pathway and systems shown in Figure 1. Aircraft target information comes from the Air Route Surveillance Radar (ARSR) system. Other lines and characters are jet routes and navigational aid positions. The box in the upper left contains elements for the air traffic controller to reconfigure his display (see text for further information).

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The three reflectivity layer composite products are similar to the composite reflectivity product. Each reflectivity layer composite is a vertical segment of the composite reflectivity. The vertical segmentation of the reflectivity information exactly matches the way aircraft targets are vertically segmented. Now, the air traffic controller working the "high" or 24,000 to 33,000 foot sector, will see only aircraft targets *and* weather for that layer. It will be the responsibility of the CWSU meteorologist to provide the added value to

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FAA WARP

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reflectivity products by informing the air traffic controllers of storms with hail, circulation, explosive vertical growth and dissipation, and estimated position and intensity (severity). The new capabilities provided by WARP, Stage 1/2 will be operationally available at all locations by the summer of 2000.

The CWSU meteorologist also benefits from the direct connections to the WSR-88Ds. There will be real time regional updates and automated receipt of data from all radar within the geographical area of the ARTCC. WARP will send their local mosaic maps to the FAA's Air Traffic Control System Command Center (ATCSCC) in Herndon, VA (a Washington, D.C. suburb) for the development of a national mosaic. The national mosaic will be updated every five minutes and distributed through satellite broadcast. These maps will not have the value added edit of a radar meteorologist so it is important that the data from the source WSR-88D be as free of anomalous propagation and ground clutter as possible.

A Glimpse of What Lies Beyond - WARP, Stage 3 is in the planning phase. A significant new feature of Stage 3 will be to build a server subsystem capability into WARP. WARP, then, will be the FAA source and distributor of weather information. Not only will WARP provide selected weather products to air traffic controllers and traffic management specialists, but also to flight service station specialists, airline dispatchers, and pilots. In this way, all personnel who participate in the en route operation will be using the same products.

R. Craig Goff
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ARTCCs Apply NEXRAD Data

With the completion of Operational Test and Evaluation of a Harris-built, Weather and Radar Processor (WARP) System Stage 1 on the horizon (October 1999), air traffic control centers are working to integrate WSR-88D data onto controller displays. Following the testing period, the FAA plans to begin routing a composite layered reflectivity, mosaic product directly to the displays used by air traffic controllers. Until now, weather information data was obtained from the FAA's own long-range radar sites. Those sites were designed to view aircraft and electronic beacons carried by aircraft. Weather depiction is a supplemental function. Soon it will be possible to take greater advantage of the accuracy and Doppler technology afforded by WSR-88D systems.

What does the WARP implementation mean to Unit Radar Committees (URC)? Air Route Traffic Control Centers (ARTCC) may (at least initially) seek a more participative role on the committee. Today, most ARTCCs are associated with the nearest Weather Forecast Office and are considered a "Primary User" for a single WSR-88D. With WARP Stage 1, the ARTCC will be directly connected to six or more WSR-88D sites, making them primary users for more than one site. With this comes the opportunity to participate in the URCs for each directly connected site. This could be quite a job for centers with up to 20 directly connected WSR-88Ds.

WSR-88D Issues of interest to ARTCCs:

- Data quality.
- When to expect system shutdowns, their duration and how notifications will be coordinated.
- What influence can an ARTCC have on the shutdown schedule. For example, shutdowns during periods of inclement weather would logically be less helpful than shutdowns during fair weather. Additionally, can shutdowns be cancelled if the weather dynamics change?
- How best to participate in URC proceedings.

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UPDATE : Real-Time WSR-88D Wideband Data

Since 1994 a growing number of NEXRAD agencies and external users have been receiving WSR-88D wideband data in real time on a limited, experimental basis via Radar Interface Data Distribution Systems (RIDDS). The RIDDS data streams are the same data, less the metadata that Build 10 added to the archive tapes, that are available via archived Level II data. The RIDDS data streams have been used by the NEXRAD agencies to support operations and research, by universities and research laboratories to support development of new radar algorithms, and by researchers while conducting experiments in real-time initialization of numerical forecast models.

The RIDDS is a SUN workstation that connects to the wideband3 port in the RPG at 38 sites scattered throughout the country. External users connect to an 8-port Ethernet hub. Only two RIDDS systems are left for deployment and change requests for these systems are in process. When deployed, the Open System RPG will provide the capability for external connections to WSR-88D base data streams at all WSR-88D systems, where the required hardware is installed.

The Center for Analysis and Prediction of Storms at the University of Oklahoma is leading a collaborative project to establish a prototype system for ingesting WSR-88D wideband data in real time from up to 8 radars in Kansas, Oklahoma, Texas, and Arkansas. Known as the Collaborative Radar Acquisition Field Test (CRAFT), this project is serving as a mechanism for testing various aspects of data compression, ingest, and quality control, as well as the use of wideband data in creating high resolution analyses and forecasts for real-time operational evaluation.

Until recently, WSR-88D wideband data had only been transported via a T1 connection at 1.544 mbps. In CRAFT, Unidata Local Data Manager (LDM) software running on a Pentium-based PC is compressing the wideband data at a 15 to 1 ratio and transmitting the data to Norman, OK on a 56 kbps line.

A part of CRAFT is a project known as SAMEX (Storm and Mesoscale Ensemble Experiment), which is a national, multi-institutional, multi-model numerical forecast experiment. SAMEX will use the real-time wideband data to demonstrate the impact of initializing "storm-scale" numerical weather prediction models (grid resolutions of 1 to 3 km) with data of spatial resolution comparable to the scales being predicted. Tests have shown that the wideband data offers the potential to improve the ability of the model to forecast convection intensity and location. The model output can be seen at the following WEB address: http://hubcaps.ou.edu. Storm-scale numerical weather prediction is a goal of the National Centers for Environmental Prediction (NCEP) and will have a major impact on severe weather forecasts and warnings, along with forecasts of aviation hazards.

Tim Crum
OSF Operations Branch, Chief

ARTCCs Apply NEXRAD Data

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There are two communities at an ARTCC, air traffic (our NWS on-site persons support them) and airway facilities (concerned about system health, verification of accuracy, and maintenance considerations). It has not been determined who would/could provide the best expertise during URC meetings. Perhaps ARTCC representation would vary depending on the issue.

- Need to execute any new letters of understanding (LOU) or memorandums of agreement (MOA).

Undoubtedly, ARTCCs will be learning as they go and will most certainly appreciate the assistance that established URCs can provide.

Randolph Wickers
Systems Engineer
Lockheed Martin, NISCII