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NEXRAD PRODUCT IMPROVEMENT – CURRENT STATUS OF WSR-88D OPEN RADAR DATA ACQUISITION (ORDA) PROGRAM AND PLANS FOR THE FUTURE

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1. BACKGROUND

The Weather Surveillance Radar-1998 Doppler (WSR-88D) is one of the key underpinnings of the NWS Modernization effort begun more than a decade ago. The NEXRAD tri-agencies established the NEXRAD Product Improvement (NPI) Program shortly after the initial WSR-88D deployment. They recognized the need to update the system hardware and software to take advantage of new technologies (Saffle et al. 2002). The ultimate objective is to achieve performance goals of the user agencies, including those NWS objectives developed in response to the Government Performance Results Act (e.g. increase tornado warning leadtime, reduce false alarm rate and improve detection accuracy).

The Open Radar Product Generator (ORPG) was the first WSR-88D sub-component to be developed and successfully deployed under NPI. Even while the ORPG was still in development, the National Severe Storms Laboratory (NSSL) began efforts on a Proof-of Concept for the Open Radar Data Acquisition (ORDA) subsystem. NSSL demonstrated the Proof-of-Concept in May 2000, clearing the way for the initiation of the NPI ORDA Program. The NEXRAD Program Management Committee (NPMC) authorized a study of possible commercial alternatives in February 2002. In May of 2002, the NPMC accepted the recommendation to modify the ORDA Program approach to use the commercial SIGMET RVP8/RCP8 system. The ORDA is currently in the test phase. A future major project is the modification to NEXRAD to implement dual polarization functionality. Dual Polarization is in the initial planning stages.

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2. ORDA PROGRAM ORGANIZATION

The three agencies supporting NEXRAD are the National Oceanic and Atmospheric Administration (NOAA) of the U.S. Department of Commerce, the Federal Aviation Administration (FAA) of the U.S. Department of Transportation, and the United States Air Force of the Department of Defense.

To create an orderly WSR-88D system evolution, the three NEXRAD agencies established the NPI Program as a long-term program to plan, manage, and execute major improvements to the WSR-88D system. The NPI Program began in fiscal year (FY) 1993 as part of the NEXRAD JSPO Product Improvement (PI) Program. NPI moved to the NWS Office of System Development (OSD) in FY 1994 and subsequently became the responsibility of the Office of Science and Technology (OS&T) in the NWS restructure.

The contract for ORDA was awarded to RSIS, Inc., a Commerce Information Technology Solutions (COMMITS) Contractor, in July 2001. OS&T Program Management and Project Engineering staff are collocated with RSIS in Norman to provide timely and consistent program and technical direction. Focusing ORDA Program activity in Norman provides the opportunity to team with subject matter experts at the Radar Operations Center (ROC) and NSSL.

3. ORDA TECHNICAL ASPECTS

Earlier conference papers summarized RDA functionality and the components of the RDA subsystem to be replaced by the ORDA Program (Zahrai et al. 2002). Figure 1 illustrates the RDA architecture and those components being replaced. A subtle but important characteristic of the ORDA Project using the SIGMET COTS solution is that the primary focus is on integration; design is performed in the context of the SIGMET system and is constrained by the legacy technical environment.

ORDA is composed of SIGMET's RVP8 Signal Processor/Digital Receiver, RCP8 Antenna/Radar

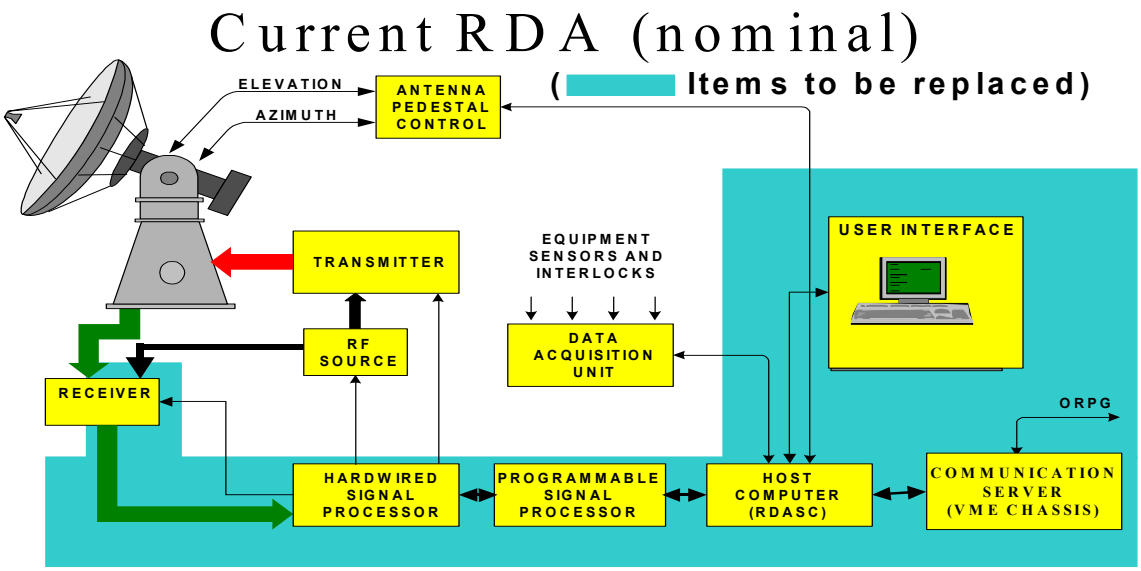

Figure 1

Controller and Intermediate Frequency Digitizer (IFD). Both the Signal Processor and the Control Processor hardware use the same chassis, I/O card, and PCI-based single board computers (SBCs) with dual Pentium processors running the Linux operating system. Commercially available processor technology makes custom signal processor hardware and a real-time operating system unnecessary. RSIS is specifying commercially available cables and simplified hardware interface panels. These steps will reduce the time required for installation, decrease the complexity of the installation, and make life-cycle support simpler and less expensive. This design also replaces the communications interface to the RPG with a communications server using TCP/IP, allowing the elimination of the outdated X.25 communications interface to the RPG.

The capability to infuse new science is an important requirement for ORDA. The SIGMET approach incorporates the Application Programming Interface (API), a collection of functions that defines an interface between SIGMET applications and user-developed applications. This API structure allows SIGMET to preserve their software baseline integrity and still provide flexibility in software development and maintenance.

An advantage of SIGMET software is it contains signal processing and control features that are targets for future RDA enhancements. These new features will be disabled in the initial deployment; the SIGMET implementation requires validation, and RPG and display software may require modification. However, SIGMET provides a roadmap, if not a solution for future RDA technical improvements.

RSIS has developed the operator interface application, replacing the legacy system's command line input with a Human-Computer Interface (HCI) Java-based application, permitting rapid implementation of an interface for local and remote users. The new HCI retains similar terminology and functional performance as the legacy system, to ease the RDA HCI user transition to the new system.

Another key objective of the ORDA Project is to improve supportability and reliability. The new system will allow the elimination of 48 receiver and processor assemblies and 131 cables. Preliminary data indicates the new ORDA components are more reliable and less expensive than the components they replace.

4. ORDA PROGRAM STATUS

ORDA development for the NWS and DOD single thread configuration is complete and is currently in testing. The testing program includes extensive data quality analysis (comparing performance of the new system to operational systems), field-testing using portable ORDA systems

at sites which present particularly challenging environments for clutter processing (mountains, coastal zones) and extensive beta testing. Deployment planning will take into account the sites' climatology, coverage by neighboring systems, and weather conditions at the scheduled time for deployment.

5. FUTURE PLANS

The next major product improvement is dual polarization. The ORDA SIGMET solution was selected and implemented to allow integration of dual polarization without significant change to the fundamental architecture. Much of the dual polarization modification will involve mechanical changes to the antenna (waveguide, feedhorn, rotary joints, etc). IT-related changes will involve addition of a second receiver path as well as the software to support acquiring, processing and managing the dual polarization data.

Early planning calls for initial implementation of a dual polarization production prototype on the Radar Operations Center (ROC) Pedestal Test Facility. Use of the Pedestal Test Facility will allow design and integration of antenna modifications without impacting the operation of the two test and development radiating antennas in Norman. Once the Pedestal Test Facility installation has been completed and approved, the modification will be made to NSSL's KOUN antenna.

This production prototype is a key first step. The current concept for NEXRAD dual polarization is to divide the power from the transmitter to provide the distinct horizontal and vertical transmitted pulses, reducing transmitted power and thereby resulting in reduction of the radar's sensitivity. It is imperative that the effect of this reduced sensitivity on legacy algorithms and meteorological utility be assessed as early as feasible.

New dual polarization products will be introduced incrementally, leveraging off work previously conducted by developers at NSSL in the areas of precipitation estimation and hydrometeor classification.

Other future activities include implementing the capability of the RDA to produce super-resolution data. To improve severe weather warning lead times, potential tornadic storms need to be identified as soon as possible. The current WSR-88D data resolution is 1 degree in azimuth by 1 km in range. Super- resolution data improves this resolution to .5-degree azimuth by .25 km range.

The improvement in beam width resolution increases the range at which small tornado parent circulation patterns (down to 4 km diameter) can be detected. Super-resolution also provides additional detail to aid in severe storm analysis. Extending the range of Doppler data and providing Doppler data earlier in the process of a volume scan provides velocity data more quickly than current scan techniques.

Super-resolution does present technical challenges, including how to address the reduced number of samples available, given the ½ degree beam width and the desire to maintain antenna rotation rates. Reduced number of samples is problematic for processing by legacy algorithms, clutter processing and possibly RV mitigation. Research is underway on oversampling and whitening techniques with the goal to address the adverse impact of the reduced number of samples. In the meantime, we are evaluating the operational utility of providing a visual representation of super-resolution base products to users, while continuing to produce the standard legacy products until the technical issues with super-resolution are addressed.

(Note: The views expressed are those of the author(s) and do not necessarily represent those of the National Weather Service.)

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