P364 THE WSR-88D: STILL THE BEST AND GETTING BETTER

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1. INTRODUCTION

As of January 2011, the average age of the Nation's network of Weather Surveillance Radar-1988, Doppler (WSR-88D) systems is over 17 years. Since the radars were first deployed (1991-1997), the Next Generation Weather Radar (NEXRAD) Program has executed a near continuous program of modifications, retrofits, technology refreshments, and pre-planned product improvement upgrades. The aim of this continual modification was to avoid obsolescence, meet new mission requirements, improve system maintainability and reliability, and control operations and maintenance costs. The technology refreshments have been made to both hardware and radar meteorological science.

This approach has resulted in over 130 WSR-88D hardware modifications, over 80 software releases, and several major radar science upgrades. As a result, today's WSR-88D is "state of the art", arguably the best operational S-band weather surveillance radar in the world – and getting better.

This paper summarizes the major milestones in the growth of WSR-88D capabilities since its deployment. We also present a plan to continue WSR-88D operations beyond 2020 and, if required, until the next generation weather radar network (e.g., Phased Array Radar technology) is deployed and operational.

2. BACKGROUND

The NEXRAD Program Agencies (DOC, DoD, and DOT) all require similar information concerning the location, development, and movement of hazardous weather activity detectable by radar. In response to this need, these agencies jointly developed and deployed the WSR-88D system. Early program planning and subsequent experience indicated a need for the continuation of a joint, centralized, common support effort once the system became operational. The triagencies agreed to create a jointly funded and staffed WSR-88D Radar Operations Center (ROC) that would focus on reducing life cycle costs, maintaining system reliability, network integrity, and integrating technological advancements. (WSR-88D ILSP)

3. SUSTAINING ENGINEERING/RETROFIT PROGRAM

The ROC leads design and engineering responsibility for sustaining engineering modification projects, including technology refresh retrofits, of the WSR-88D system. The ROC also performs WSR-88D system software maintenance based on approved triagency changes to the operating system, the applications software, support software, background maps, adaptable parameters, and diagnostics. Software maintenance includes source code development or modification, testing, developing and updating technical documentation, configuration management, and distribution to WSR-88D sites. Presently, the ROC distributes "major" software releases annually and "minor" releases, primarily for security updates, quarterly. For more information on the WSR-88D modifications, visit the ROC web site: http://www.roc.noaa.gov/radar.

4. PRE-PLANNED PRODUCT IMPROVEMENT

The NWS Office of Science and Technology (OST) leads the design and engineering responsibility for major upgrades accomplished through NEXRAD Product Improvement (NPI) projects and retrofits of the WSR-88D system. These projects continue to provide state-of-the-art technology insertion to enhance radar capabilities, improve reliability, control operations and maintenance costs, and address component obsolescence. (Crum et al, 1998) The original WSR-88D computers were proprietary and very expensive to expand/adapt to new mission requirements. In the late 1990s, the NEXRAD Program began moving to an "Open System" model for hardware and software. The Radar Product Generator (RPG) was the first to transition to Open Systems architecture (2002). (Saffle et al, 2002) This change to Commercial off the Shelf (COTS) equipment has enabled the WSR-88D Program to meet requirements for increased computing capacity, control operations and maintenance costs, increase the system's capacity to meet new agency mission and security requirements,

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and enable faster transition of new radar science from research to operations. The Radar Data Acquisition (RDA) computers, receiver, and signal processor were replaced by COTS equipment in 2006. A technology refreshment of the RPG was subsequently completed in 2008, and information technology (IT) and communications equipment have been upgraded along the way. The only main WSR-88D components that have not changed are the transmitter, facilities, uninterruptible power supply, tower, radome, and pedestal.

5. NEW RADAR SCIENCE

The initial WSR-88D baseline system had a suite of meteorological algorithms to aid forecasters with forecast and warning operations. (Klazura and Imy, 1993; Crum and Alberty, 1993) However, the NEXRAD agencies have required progressively more accurate algorithms with expanded capability to meet operational requirements. Via the NPI Program, a series of radar science breakthroughs were integrated into the WSR-88D resulting in new products and algorithms listed on the poster (Fig. 1). These new algorithms and products have kept the WSR-88D on the leading edge of radar meteorology science.

The ultimate NPI upgrade of the WSR-88D's capability is the Dual Polarization modification that will be fielded in 2011 – 2013. This will result in the first nationwide network of S-band dual-polarized weather surveillance radars. This upgrade will provide benefits for many aspects of America's commerce, transportation, and water resource management through improved weather forecast and warnings, especially for flash flood, hail, and tornado detection.

6. PLANS FOR CONTINUED SUPPORT AND OPERATIONS

Upon completion of the dual polarization deployment, additional investments will be needed to extract its full potential from the system**,** just as the original WSR-88D capabilities have been refined and expanded through research and development. Technology refreshments will continue to be required to ensure mission needs are met and that the Open Systems COTS hardware remains supportable and able to meet growing IT security needs.

While no replacement for the WSR-88D has been determined, there is considerable research being done to explore the benefits and capabilities of Phased Array Radar Technology. (Williamson et al, 2011; Weber et al, 2007; Zrnic et al, 2007) Much of the PAR work has been led by the National Severe Storms Laboratory (NSSL), similarly to what it did during the early development stages of the WSR-88D. It is important to note that a substantial amount of the research and development being conducted on the PAR is transferable to the WSR-88D and vice versa.

The WSR-88D was built to meet a 20-year useful life of continuous operation. The NEXRAD Program is confident that with the continual modification/retrofit/technology refreshment activities described earlier, the WSR-88D continues to be upgradable, reliable, and maintainable through at least 2020, thus significantly exceeding the original design life. However, to meet the potential scenario that the WSR-88D fleet will be needed well beyond 2020, it is important to plan for a major WSR-88D Service Life Extension Program (SLEP). The SLEP will ensure the WSR-88D continues to meet its mission requirements through 2030, or until replacement technology is operational. The SLEP will focus on the major components of the WSR-88D that have not been modified since installation: an upgrade or replacement of the transmitter, refurbishment or replacement of the pedestal, replacement of the uninterruptible power system, and refreshment of facilities. However, the SLEP will start with a technology refresh of the signal processor and computers in the RDA when the Original Equipment Manufacturer (OEM) support ends.

7. SUMMARY

The WSR-88D is arguably the world's best operational weather surveillance radar. The NEXRAD Program has increased capabilities while maintaining operations and controlling costs through new science infusion, sustained engineering, NEXRAD Product Improvement efforts, and technology refresh investments. Continued new science infusion is particularly important to leverage the large investment and potential of the Dual Polarization modification. The WSR-88Ds are aging and, if not replaced by the mid 2020s, will need a Service Life Extension Program investment to continue to remain viable through 2030 or until replacement technology is operational. The NEXRAD Program believes it is important to support not only sustainment of the WSR-88D capabilities, but to continue to enhance them.

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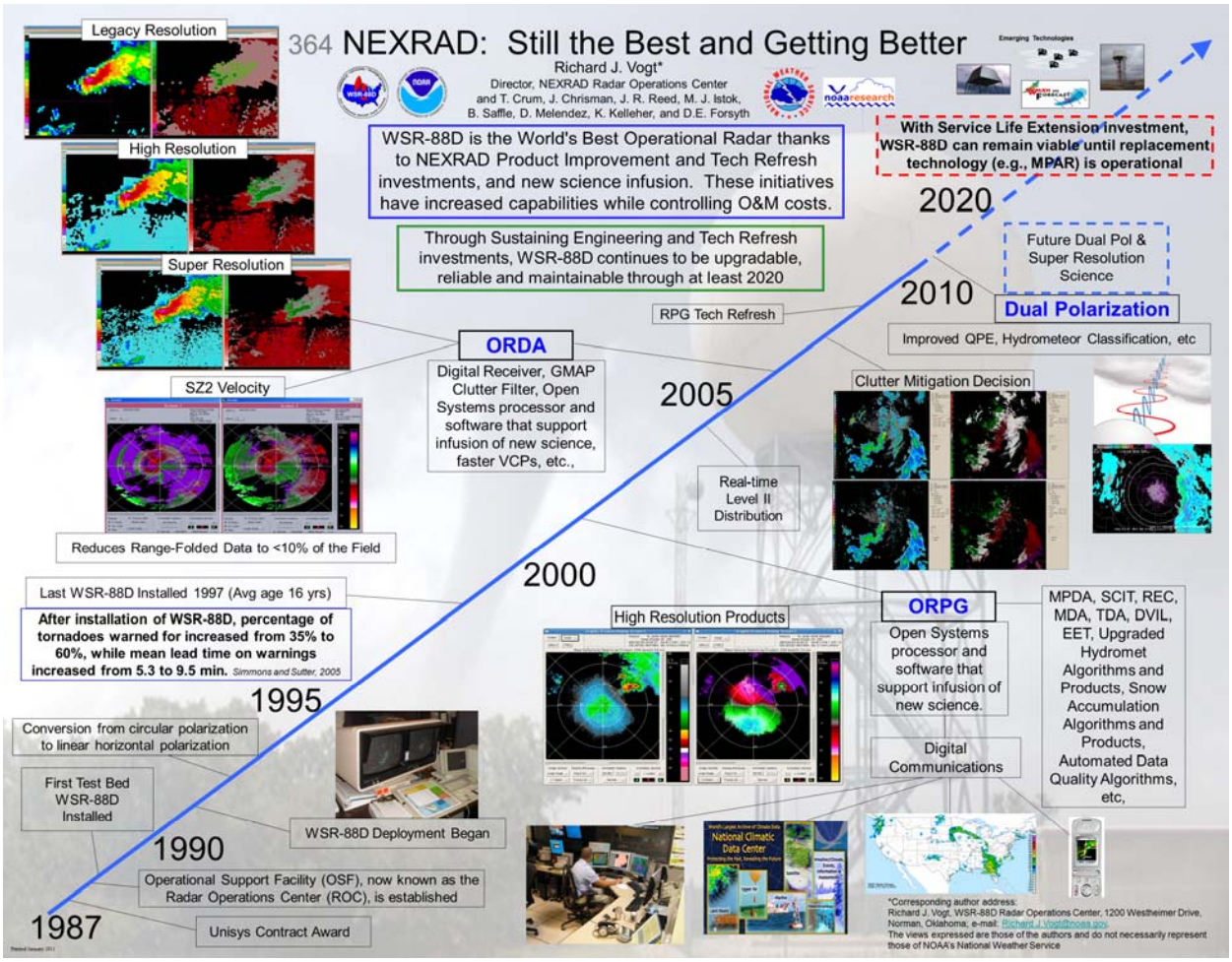
Legacy Resolution
High Resolution
Super Resolution
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WSR-88D is the World's Best Operational Radar thanks to NEXRAD Product Improvement and Tech Refresh investments, and new science infusion. These initiatives have increased capabilities while controlling O&M costs.
Through Sustaining Engineering and Tech Refresh investments, WSR-88D continues to be upgradable, reliable and maintainable through at least 2020
With Service Life Extension Investment, WSR-88D can remain viable until replacement technology (e.g., MPAR) is operational
2020
Future Dual Pol & Super Resolution Science
2010
Dual Polarization
Improved QPE, Hydrometeor Classification, etc
RPG Tech Refresh
ORDA
Digital Receiver, GMAP Clutter Filter, Open Systems processor and software that support infusion of new science, faster VCPs, etc.,
2005
Clutter Mitigation Decision
SZ2 Velocity
Reduces Range-Folded Data to <10% of the Field
Real-time Level II Distribution
2000
Last WSR-88D Installed 1997 (Avg age 16 yrs)
After installation of WSR-88D, percentage of tornadoes warned for increased from 35% to 60%, while mean lead time on warnings increased from 5.3 to 9.5 min. Simmons and Sutter, 2005
High Resolution Products
ORPG
Open Systems processor and software that support infusion of new science.
MPDA, SCIT, REC, MDA, TDA, DVIL, EET, Upgraded Hydromet Algorithms and Products, Snow Accumulation Algorithms and Products, Automated Data Quality Algorithms, etc,
1995
Conversion from circular polarization to linear horizontal polarization
First Test Bed WSR-88D Installed
WSR-88D Deployment Began
Digital Communications
1990
Operational Support Facility (OSF), now known as the Radar Operations Center (ROC), is established
1987
Unisys Contract Award
National Climatic Data Center
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