# 4.6 NWS WSR-88D AND TDWR-SPG DATA COLLECTION AND DISTRIBUTION NETWORK STATUS AND PLANS

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## 1. INTRODUCTION

Since the last report to the American Meteorological Society Interactive Information and Processing Systems audience in 2007, the National Oceanic and Atmospheric Administration's (NOAA) National Weather Service (NWS) and Next Generation Weather Radar (NEXRAD) agencies have been planning for and implementing several new exciting capabilities to improve Weather Surveillance Radar – 1988, Doppler (WSR-88D) data and the electronic distribution of these data and products in real time. These new capabilities not only include WSR-88D Level II data (also known as "base data") and Level III products, but also access to Federal Aviation Administration (FAA) Terminal Doppler Weather Radar (TDWR) – Supplemental Product Generator (SPG) generated products (Istok et al 2009).

These changes have been driven by NWS real-time operational and archive requirements. The results of these expanded data and products; and increased access should be: improved forecast and warnings by the NEXRAD agencies; further atmospheric understanding based on research; and increased use of radar data by the commercial weather enterprise and public. There are no restrictions on the redistribution and use of real-time or archive WSR-88D / TDWR-SPG data and products. Commercial use of the data is encouraged.

This paper describes progress the NWS has made during the last three years in expanding federal weather radar real-time and archive data availability; increasing data quality; and increasing the reliability of Level II WSR-88D data delivery. Plans and possibilities for even further improvements are also included.

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The views expressed are those of the authors and do not necessarily represent those of the National Weather Service.

## 2. STATUS OF NWS LEVEL II DATA COLLECTION AND DISTRIBUTION NETWORK AND PLANS

As of February 2010, 121 NWS, 5 FAA, and 13 Department of Defense (DoD) WSR-88Ds constitute the NWS Level II Data Collection and Distribution Network. These data are transmitted to the National Environmental Prediction Center (NCEP), the National Climatic Data Center (NCDC) and other users (e.g., other government agencies, laboratories, universities, commercial entities) in real time. The listings of sites sending WSR-88D Level II data and any planned additions of sites are at: (http://www.roc.noaa.gov/WSR88D/Level_II/Level2Info.aspx). Level II data are also available from the two DoD WSR-88Ds in Korea on a next-day basis from the NCDC archives (http://hurricane.ncdc.noaa.gov/pls/plhas/has.dsselect).

The flow of Level II data from WSR-88D sites to the four Level II top-tier sites and to users implemented in 2004 (Figure 1) leveraged the successful Collaborative Radar Acquisition Field Test (CRAFT) Project (Kelleher et al 2007). The architecture relied on a complex networking of commercial communication lines and the NWSNet communications network between NWS weather forecast offices (WFOs) and their regional headquarters (located at Bohemia, NY; Fort Worth, TX; Kansas City, MO; and Salt Lake City, UT). The regional headquarters servers sent the data via commercial communications to a designated regional Abilene Network/Internet2 gigapop (http://abilene.internet2.edu) to enter the data into the Abilene Network/Internet2 Wide Area Network. Using the Unidata Local Data Manager (LDM) technology, the data are routed to four Level II Internet2 top-tier sites:

- University of Maryland (MAX)
- Education and Research Consortium of the Western Carolinas (ERC), Hunter Goosmann, 828-350-2415, hgoosmann@ercwc.org
- Purdue University, Professor Matthew Huber, 765-494-3258, huberm@purdue.edu
- University of Oklahoma, Craig Cochell, 405-325-8689, Craigc@ou.edu

This architecture with complex interfaces and separate dependencies (some of which did not provide

24/7 restoration service) met initial NWS network reliability and data latency requirements. However, occasional NWS Region-wide outages of the Level II data stream did not meet the reliability requirements of several data users.

## 3. A NEW WSR-88D LEVEL II NETWORK APPROACH

In order to address the need to provide a technology refreshment for servers and other IT equipment installed for the initial 2004 Level II network operations and to address the increased data delivery reliability desires, the WSR-88D Radar Operations Center (ROC) has designed and is implementing a new Level II data collection and distribution network architecture (Figure 2). This change takes advantage of a NOAA initiative to consolidate NWS weather communication networks into a single architecture – NOAANet that provides 24/7 response capability. It makes use of NOAANet's flexibility to route data directly to a single aggregating source versus first aggregating the data at the NWS Regions. The change will establish two clusters (one at the NWS Telecommunications Gateway (NWSTG)) and the other at the WSR-88D ROC that provide a single aggregating source as well as a hot-backup that can quickly and automatically switch to be the aggregating source without loss of data. The new implementation provides for architectural redundancy, high availability networking and 24/7 monitoring with well established procedures for outage notification and restoration services.

The NWS recently began transitioning sites to the new Level II architecture at an average of six sites per week. As of the end of February, 22 sites have been transferred and the remaining sites are scheduled for transfer by June 2010. When completed, the transfer will include the planned addition of the remaining 8 DoD CONUS WSR-88Ds to the Level II network in the summer of 2010.

## 4. RECENT AND FUTURE CHANGES TO WSR-88D LEVEL II DATA

The WSR-88D Open Radar Data Acquisition (RDA) deployment (Cate and Hall 2005), completed in October 2006, has enabled many RDA changes that improve Level II data and provide new capabilities. A summary of the major changes implemented thus far follows:

- 2007. SZ-2 (Sachi Dananda – Zrnic) Algorithm that provides a technique to alleviate the effects of the fundamental range-velocity ambiguity of Doppler radars on the lowest elevation scans.
- 2008. Super Resolution data on the lowest elevation scans (all moments now have 0.25 km range gate spacing and higher resolution azimuthal data ($0.5^{o}$)). In addition, the availability of Doppler data is extended to 300 km. This change also required a change of the Level II data from the MSG1 format to the MSG31 format.
- 2009. Clutter Mitigation Decision Algorithm that automates the clutter bin identification process, useful to identify and remove clutter data caused by Anomalous Propagation.

The NEXRAD agencies are preparing to modify the WSR-88D to add a dual polarization (Dual Pol) capability (Istok et al 2009). Three additional moments of data will be added to the Level II data stream: differential reflectivity, differential phase, and correlation coefficient. The NWS is planning on distributing these additional Dual Pol moments from at least the NWS WSR-88Ds upon installation. The Dual Pol Beta Test is scheduled to begin 4CY10 and final deployment is scheduled for completion in 4CY12.

The addition of Super Resolution data increased the Level II data flow from a site by a factor of approximately 2.4. The addition of the dual polarization moments is estimated to double the Level II data flow per site, over that of Super Resolution.

More information on the Dual Pol data will be sent via NWS technical implementation notices (TINs) and public information statements (PNSs). Check the Dual Polarization section of the ROC web site for additional information: http://www.roc.noaa.gov/WSR88D/.

## 5. RECENT AND FUTURE CHANGES TO WSR-88D PRODUCTS

To meet increased NWS requirements for access to additional WSR-88D products, several changes have been made and will be made in the products readily available via the NWS Family of Services (FOS), NWS Radar Product Central Collection Dissemination Service (RPCCDS), and Satellite Broadcast Network (SBN).

- The addition of select higher-resolution products in 2010. These products contain 8-bit data resolution vice the original 4-bit resolution. These are not Super Resolution data.
- The addition of select Dual Pol products when the products become available.

## 6. RECENT ADDTION OF TDWR-SPG PRODUCTS

In early 2009 the NWS completed connection to all 45 operational TDWR sites and the generation and central collection of SPG-generated products ingesting TDWR base data. This added product flow per site is comparable to the flow of WSR-88D products from a

site, prior to high resolution and Dual Pol products. The TDWR-SPG products are available via the FOS, RPCCDS, and SBN just as WSR-88D products are. At this time, there is no schedule for adding collection and distribution of the TDWR-SPG Level II/base data. (Istok et al 2009). These data are also available from the NCDC archives.

## 7. NCDC ARCHIVE ACCESS AND DISPLAY TOOLS FOR THE ADDITIONAL RADAR LEVEL II DATA AND PRODUCTS

The NCDC archiving capacity has increased in step with the amount of available data and products while maintaining their high standards for service and dependability. In addition, the NCDC has developed user-friendly software (NOAA Weather and Climate Toolkit (WTC)) to help users display archived Level II data, WSR-88D generated products and TDWR-SPG products (http://www.ncdc.noaa.gov/oa/wct/). Additional information about the WTC is in (Ansari et al 2009).

The NCDC archives now contain over 1.5 petabytes of WSR-88D Level II data and products. The annual increase of radar data in the archive is now approximately 400 terabytes (TB). These data are available electronically via FTP and in nearly all cases without charge to the users. To demonstrate the demand for archived Level II data, the NCDC services ~4300 requests and transfers over 4 TB of data to users monthly. Over 60% of the requests originate from domains other than .gov, .edu, and .mil.

## 8. NOAA RESOURCES FOR RADAR PRODUCTS AND LEVEL II DATA

The NWS is stepping up its outreach of information to radar data and product users. Several NWS TINs and PNSs have recently been released concerning planned changes to radar data and products. More of these will be coming and will be available: http://www.nws.noaa.gov/om/notif.htm.

The WSR-88D Radar Operations Center pages focusing on Dual Pol, product data changes, Level II, and TDWR-SPG data are available: http://www.roc.noaa.gov/WSR88D/

Software from the WSR-88D Radar Product Generator, which uses Level II data to generate Level III products, is available in the Common Operations and Development Environment (CODE) (Ganger et al. 2005): http://www.weather.gov/code88d/

An expanded version of the IIPS presentation was given at the NWS FOS meeting two days later. Please see the presentation, which contains more details about several topics – especially data flow rates: http://www.roc.noaa.gov/WSR88D/Level_II/Level2Info.aspx

The NCDC Radar Resources web site includes a vast amount of information about the radar data in the archives, including the NOAA Weather and Climate Toolkit: http://www.ncdc.noaa.gov/oa/wct/). A presentation titled, "Weather Radar Data Services at NOAA's National Climatic Data Center" presented at the 12th Workshop on Meteorological Operational Systems, 2 - 6 November 2009, is available at: http://www.ecmwf.int/newsevents/meetings/workshops/2009/MOS_12/Presentations/index.html.

## 9. SUMMARY

The last 5 years have been exciting times for those interested in increased access to real-time and archived WSR-88D Level II and products, and TDWR-SPG products. More sites and products are available with significant increases in data quality and data resolution. In collaboration with NCDC, electronic access to these data has continued, along with new graphical tools to display the new Level II data streams and products.

The new NWS Level II Data Collection and Distribution Network architecture should further improve the reliability of delivery of Level II data in real time to all users.

## 10. ACKNOWLEDGEMENTS

Just as the CRAFT experiment was a successful collaboration of many partners, the continued operation of and the new architecture of the Level II Data Collection and Distribution Network has been a team effort among many organizations besides the WSR-88D Radar Operations Center. Particularly helpful have been the Level II top tier sites: the University of Oklahoma, Purdue University, the Education and Research Consortium of the Western Carolinas, and the University of Maryland; Unidata; the staffs of the National Weather Service's Office of Science and Technology, Office of the Chief Information Officer, the NWS weather forecast offices and regional headquarters of the eastern, southern, central, western, and Pacific regions; and Internet2.

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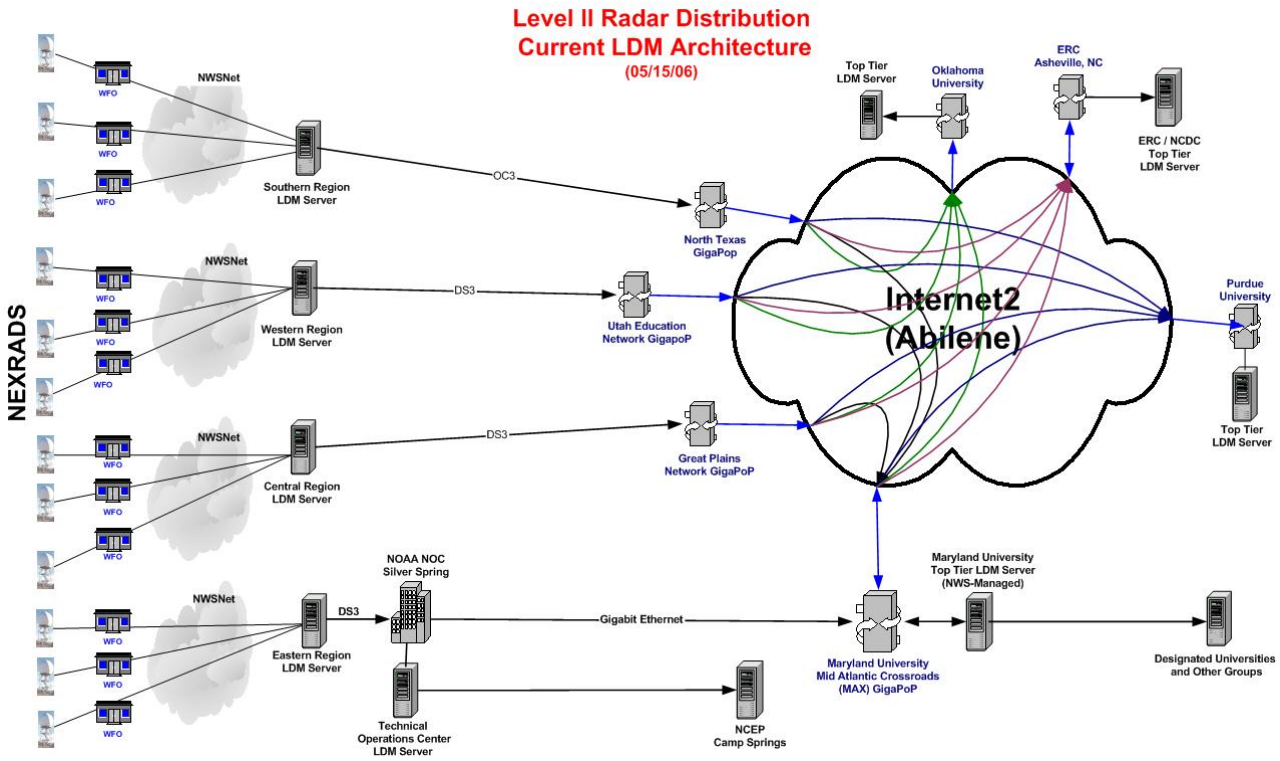


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Figure 1. The flow of Level II data from individual WSR-88D sites to their regional headquarters through the NWS communications infrastructure and Internet2 to the top-tier sites. Design implemented in 2004.

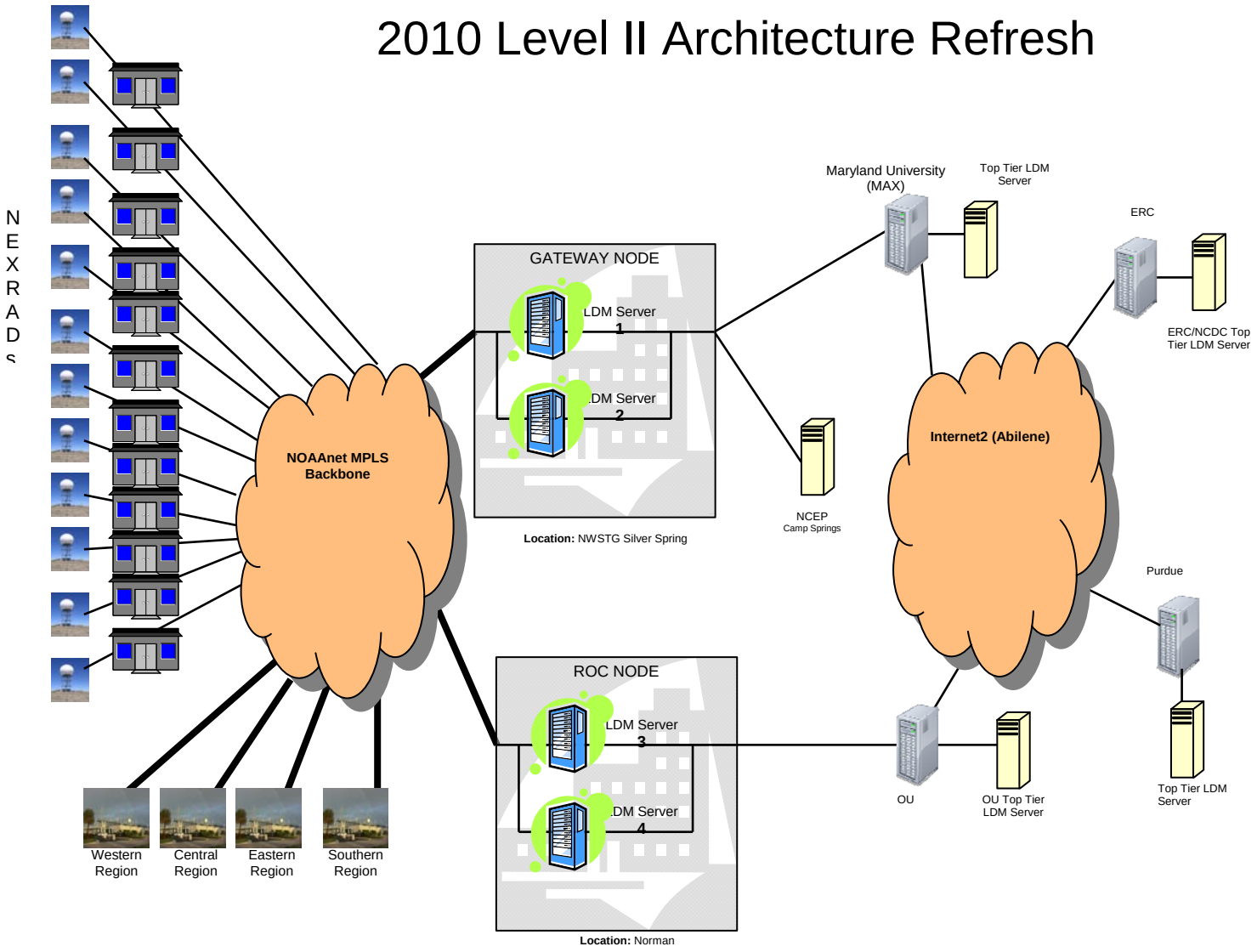


Figure 2. The refreshed network architecture for the real-time collection and distribution of Level II data via NOAANet and Internet2 to the top-tier sites. Design being implemented in 2010. Note, at the completion of the transition (June 2010), the flow of data to/from the four NWS regions will cease.