The New Architectured WSR-88D Level II Data Collection, Distribution, and Archive Network

The National Weather Service (NWS) collects Weather Surveillance Radars – 1988, Doppler (WSR-88D) Level II data at select sites via OPSnet. As the interest and use of Level II data has grown, the methods for data transport, immediacy and storage have evolved accordingly. The number of WSR-88D sites on the Level II network has grown to all of the 121 NWS WSR-88Ds, plus 13 DOD and 5 FAA sites (139 sites in all). An additional eight CONUS DOD sites are scheduled to be added to the Level II distribution network in 2011.

The NWS has a requirement to archive WSR-88D Level II data for post event analysis, algorithm development, etc. When data collection and archiving started network-wide in 1994, the data was recorded on 8mm tapes in the Radar Data Acquisition (RDA) shelter and physically shipped to the National Climatic Data Center (NCDC). The equipment in the RDA efficiently stored 10 tapes but was plagued with a relatively high failure rate. The recording approach also required a technician to go to the RDA shelter to retrieve the recorded tapes and send them to NCDC. Data latency (time between data collection and data archive at NCDC) was up to a month.

Over time, an operational requirement developed for the availability of real-time Level II radar data for assimilation into numerical forecast models at the National Center for Environmental Prediction (NCEP). Meeting this operational requirement required a new approach to Level II data collection. The concept of a real-time network transmission of Level II data was proved in a collaborative effort (Collaborative Radar Acquisition Field Test project - CRAFT) involving 59 WSR-88D sites. CRAFT included several NOAA Offices, the University of Oklahoma, the University of Washington, National Science Foundation, Unidata, and private industry. In April 2002 the NWS Corporate Board's Operations Committee approved using funds for the deployment of a network-based solution to collect WSR-88D Level II data in real-time.

The NWS Office of Science and Technology System Engineering Center, NWS Office of the Chief Information Officer, and Radar Operations Centers (ROC) collaborated to design the NWSNet / Internet 2 WSR-88D Level II Archive Data Network. The initial solution was to aggregate the data from each WSR-88D site to one of four associated regional headquarters. The regions would then transmit the data over Internet 2, making it available to users in a matter of seconds. The NWS Telecommunications Operations Center (TOC) was tasked to monitor, support and maintain the system when it became operational in 2004. Level II data flow was monitored via the MAX, a server located at the University of Maryland. Local Data Manager (LDM) developed by Unidata, was selected as the software application used to disseminate across the Level II network. LDM was chosen for its rich suite of software tools, reliability of data transmission, flexibility with how the data is handled, and ease of configuration.

Using 8mm tapes, data availability at NCDC ranged between 40-60%. The NWSnet regional-server Level II design boosted availability to over 95% with a latency of a few seconds. However,

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the regional architecture exposed two significant issues. The first was staffing. The majority of the network IT equipment was only staffed during normal working hours. Secondly, the servers at the NWS regional headquarters were designed for high availability; however, the network connectivity from each region to their independent Internet 2 gateways was not. The combination of these two issues left the system prone to extended regional outages. These outages led to demands by the user community for higher data delivery reliability.

In 2009, the ROC was tasked with improving the Level II Archive Data network-based design. The regional server implementation was eliminated in favor of a nationalconcept. In addition to increasing data reliability, the refresh addressed the need of replacing IT equipment that had exceeded end-of-life support.

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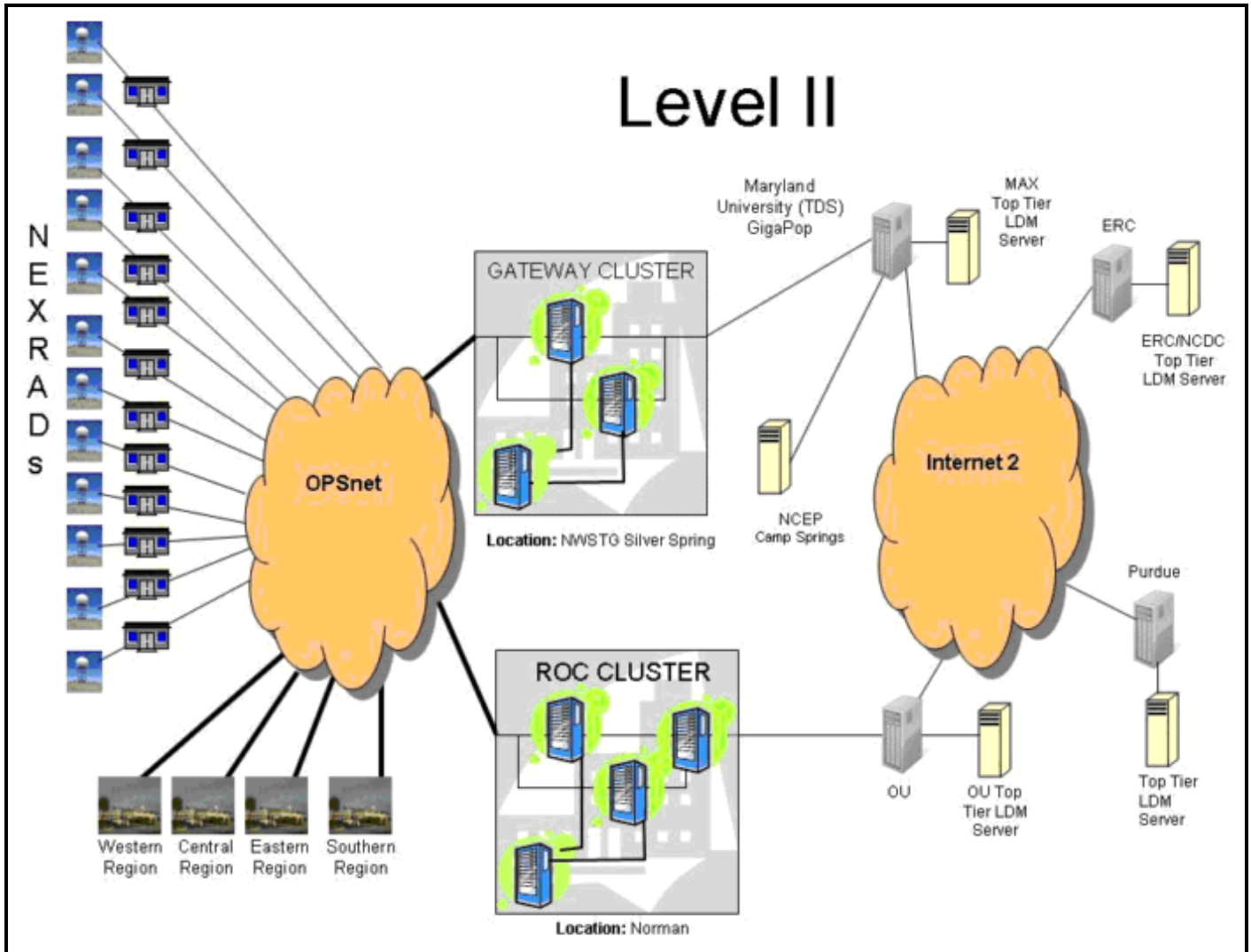

Figure 1: Level II Refresh Overview

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The new national system (Figure 1) continues to be monitored 24/7 by the TOC. The NWSnet (region frame relay) connection to Internet 2 has been migrated to NOAAnet, now OPSnet. To reduce the single point of failure concerns, an online backup facility has been established at the ROC in Norman, OK. The ROC houses a 24/7 support center for WSR-88D systems that provides backup monitoring of the Level II network. A second Internet 2 access gateway has been implemented at the University of Oklahoma. The new design ensures duplicate Level II data feeds onto Internet 2 from two geographically diverse locations.

Redundancy and Backup

Each facility (TOC and ROC) houses a cluster of servers that allow for seamless aggregation of data. The biggest constraint on the new design was the limited bandwidth from each WSR-88D site. This complicated the design by requiring only one stream of Level II data be transmitted per site. As it was not feasible to increase bandwidth at each site due to the cost, the new design relied upon each national server monitoring system status and automatically changing roles as needed.

The automatic changing of roles ensures only one national Level II server is allowed to communicate directly with WSR-88D sites at any given time. Any one of the four processors in the Level II system can support the aggregation role. A set of deterministic rules is used to determine the role of each server. The primary cluster is at the NWS TOC and the alternate cluster is at the ROC.

In "Normal" or default operation, the TOC receives (aggregates) the Level II data directly from the WSR-88D sites. If the primary server fails (or goes off-line for maintenance), the secondary server within the cluster is automatically promoted to primary server and takes over the aggregation role. If both servers in the TOC fail, or go off-line, the aggregator role will be automatically transferred to the primary server in the alternate cluster at the ROC in Norman. When a TOC server comes back on line, the system will automatically return aggregation to the TOC. Server roles can be manually assigned to a primary server at any time. An example of a server monitoring screen (at the TOC and ROC) is shown in Figure 2.

The new monitor page shows additional information. It shows the connectivity to the WSR-88D sites, between the Level II clusters, and to the Level II Top Tiers. The monitor gathers the Level II data and can provide historical information, as well (Level II and WSR-88D).

The Level II network hardware at the MAX was deployed in 2004 and is the last vestige of the original infrastructure, and is beyond the end of serviceable life. The ROC is planning to deploy a TOC Distribution Server (TDS) to disseminate the WSR-88D Level II data to the Top Tiers, in spring 2011. This would meet the Internet 2 gateway functional requirements the MAX serves today. The ROC is working with the additional clients of the MAX to determine what can be done to ensure they continue to have access to Level II data.

The new national Level II system is part of the WSR-88D baseline and is supported as part of the WSR-88D system. The ROC is responsible for hardware, software, security, testing, and configuration management for the system. As part of this

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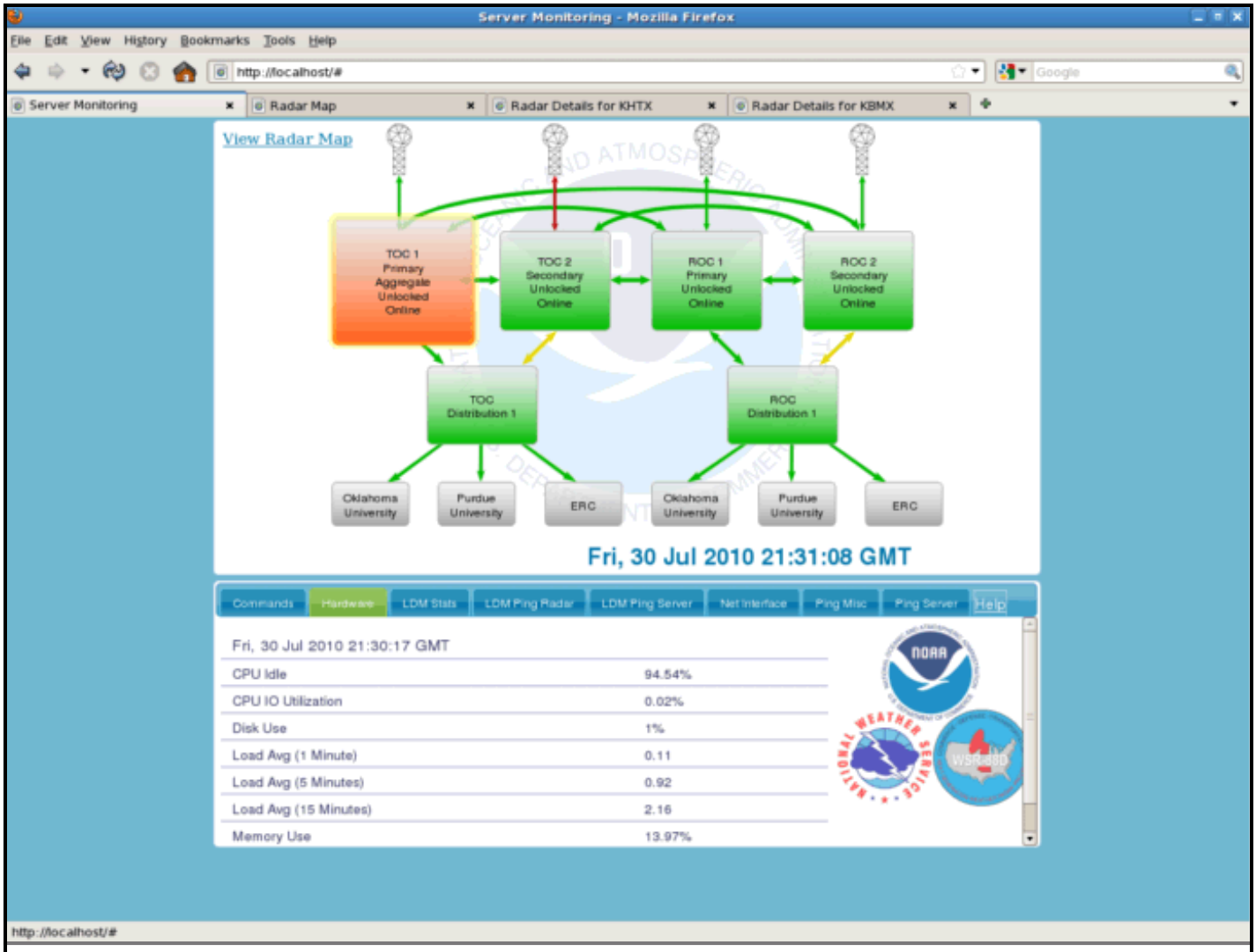

Figure 2: Level II Monitor (Server View)

effort, a new and comprehensive test facility was built at the ROC. The test facility allows developers and engineers to test the complete path of Level II data from collection at the WSR-88D to the final dissemination over Internet 2.

The Future

The ROC support for Level II is an ongoing effort. There are several approved projects which will further increase the capacity and stability of Level II data flow. The next major effort for the Level II system is to connect the Radar Product Generator (RPG), which transmits Level II from a WSR-88D directly to OPSnet. This will remove all regional and site specific connections to ensure no other active component is dynamically involved in the transmission of data to the Level II system.

Beginning in 2011, the WSR-88Ds will be upgraded to dual polarization technology. The dual polarization data will be added to the Level II

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