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Re-Engineering the Savannah River Site WIND System

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Summary

The Savannah River Site (SRS) emergency response consequence assessment capability, called the Weather INformation and Display (WIND) System, has been re-engineered. The WIND system (WINDS) was developed in the early 1970's to provide atmospheric monitoring and modeling to calculate the consequences of the transport and diffusion of materials in the environment as a result of operations at the SRS. Recent technological advances have been utilized to re-engineer the WIND System, changing it from a centralized to a distributed computing system. This change is designed to improve the stability and reliability of the WIND system computers; to increase the capture percentages of the meteorological data; to improve the robustness of data transfer and storage; to decrease the cost of the system operations, and to better facilitate the operator interface. An overview of the re-engineering will be presented.

I. Background

The Savannah River Site (SRS) is a large nuclear, industrial complex owned by the United States Department of Energy and operated by an integrated team led by the Westinghouse Savannah River Company (WSRC). The SRS currently processes and stores nuclear materials in support of the national defense and nuclear non-proliferation. The Savannah River Plant, as it was originally called, was built in the early 1950's primarily to provide nuclear materials for the nation's defense. The SRS complex covers 198,344 acres, or 310 square miles, in southwest South Carolina.

In the early 1970's, the SRS meteorological monitoring program underwent a major upgrade. The Weather Information and Display System[1], known as the WIND System, was developed. Originally, seven 200 feet towers equipped with meteorological instrumentation were erected in the forest canopy adjacent to each major production facility. The data from these instrumented towers were transmitted to a central computer by dedicated phone lines. Atmospheric transport, dispersion and dosimetric models were developed to provide consequence assessments to assist in emergency management and response decision making.

Over the past 25 years, this system was further developed, with redundancy and reliability greatly improved. However, the fundamental design of a central computing system, which conducted all tasks, remained unchanged. The computers polled instruments, processed, stored and displayed data, which were then input into consequence assessment models. This system of computer and other hardware and software redundancies, produced a consistently reliable system, with system availability in excess of 99% during the latter part of the

1980's and the 1990's. However, the structure was inflexible: modifications, such as adding towers or changing the model-user interfaces, were difficult to implement. Maintaining the system was also manpower intensive.

Although the computing system was upgraded over the years, it did not keep pace with the rapid changes in computing technology. The WIND system computers and architecture were considerably outdated when the funding was approved to re-engineer the WIND System in FY1998. The re-engineering entailed going from a centralized to a distributed computing and data processing system. The software and data base designs were changed to allow greater flexibility to the system.

II. System Architecture

The re-engineering of the WIND System involved distributing the data processing, storage and display, modeling functions, graphical user interfaces, as well as computer system operation and management.

A. Field Data Processing & Transmission

The raw signals (voltages and frequencies) from the meteorological instrumentation on the towers are processed by electronic signal conditioning cards to convert them to 0 to 5 volts for transmission. This part of the WIND system remained unchanged during the re-engineering.

1. Original WINDS. The previous WIND system design converted the signals from analogue to digital (A/D) for transmission in response to a request every 1.5 seconds from the WIND system computers. This required high signal to noise ratios so that typically in excess of 590 of the 600 data points were successfully transmitted for each 15 minute averaging period. The data were transmitted to the computers on dedicated signal conditioned telephone lines. The A/D data loggers had no data storage capabilities. If the telephone lines or computers were down, these units did not store the data.

   At each tower a second A/D data logger, installed primarily to access remotely instrument maintenance parameters, conducted some data averaging, sent one-minute data on dedicated telephone lines to the nearby facility control room, and stored several days' data. Unfortunately, downloading these data, to backfill the database in the event of an interruption in communication or computing service, was labor intensive.

2. Re-Engineered WINDS. The re-engineering replaced the two previous A/D data loggers with a single, more reliable unit that takes advantage of more powerful internal processing capabilities. The new data loggers process the data from the signal conditioning cards using quality assurance and statistical algorithms to create 15-minute data sets. These processed data are then transmitted to the WINDS computing system when prompted every 15 minutes. Typically, about one or two weeks of data, depending on the number and type of instruments installed at the tower, are stored at the remote tower site in these data loggers.

   Processing the data at the towers eliminates the need to balance the rate of data acquisition with the ability of the computing system to poll the entire tower network and transmit the required data. This allows the data logger to acquire data at a substantially faster rate if required. The current data acquisition rate is once per second.

   The transmission of the statistically processed data is less taxing and reduces the need for a high signal to noise ratio on the telephone lines. Software resident on the computers prompt the data loggers to download unsent data to the computers in the event of a communication or computing interruption. This is a more reliable and cost effective way to backfill the databases.

B. Computing Architecture

1. Original WINDS. The WIND System resided on two clustered and dedicated DEC VAX 8550 computers. These computers were located in a computer facility which had diesel power backup. They were accessed by terminals connected via optical fiber or by modems. A redundant backup DEC workstation was located in the site Emergency Operations Center (EOC), and observed data were sent to the workstation from the VAX's every 15 minutes.

2. Re-Engineered WINDS. The WINDS computer functions are distributed. The archiving of meteorological data is conducted by a dedicated DEC Alpha workstation that is a part of the Savannah River Technology Center (SRTC) cluster. The cluster is located in a computer facility that has Uninterruptible Power Supplies as well as diesel generators.

C. Computer Operations

Improved operational support and considerable savings were realized by operational and software cost sharing by multiple users on a shared cluster.

1. Original WINDS. The WIND System DEC VAX 8550 computers were maintained by a dedicated staff that was manned during regular day shift. A 24-hour watch of the system operations was available through the EOC staff. On-call computer staff would either manage the computers remotely from home via secure connections or come in and maintain the computers.

   The stand-alone nature of this computer cluster required that system and applications software resident on the computers were priced according to a dedicated VAX 8550 cluster. This arrange-ment made the cost of operating the WIND system unacceptably high in times of tighter budgets.

2. Re-Engineered WINDS. The new WIND system Alpha workstation operates as part of the SRTC cluster. It is managed by a staff, which maintains many VMS computer systems, databases, etc. This provides 24 hour round the clock operations and surveillance, while sharing staff costs through an organizational matrix arrangement. This sharing of resources saves costs in manpower, software and hardware, while providing better response to offshift outages.

D. WINDS Model Operation

1. Original WINDS. The atmospheric transport and diffusion models were resident on the central WINDS computers and were accessed by either hard-wired terminals attached to these computers, or accessed by modem. This facilitated access to the observed meteorological data, but did not take advantage of the recent advantages of powerful PCs at most work areas.

2. Re-Engineered WINDS. The software for the models was transferred from the VMS operating system of the WINDS DEC computers to IBM PC compatible computers operating under either WINDOWS-95 or WINDOWS NT.

E. Data Archiving

1. Original WINDS. The observed meteorological data archives on the WIND system utilized a dual approach: the original data structures, tailored for direct efficient ingestion into the transport and diffusion models, were kept current and on-line, while a relational data base was developed for access to the data for other uses.

2. Re-Engineered WINDS. The data archives were consolidated into a single relational database, ORACLE. The relational database was converted to ORACLE due to site licensing considerations. Data files tailored for the atmospheric models are created from the ORACLE data files.

F. Data Transmission for Models

1. Original WINDS. The observed meteorological data were resident on the VAX 8550's, the same computers that ran the models. Users accessed the WIND System via terminals hardwired or connected by fiber optic cable or telephone modem. This required specific terminals and access for onsite customers.

2. Re-Engineered WINDS. The observed and forecast meteorological data are resident on the WIND System Alpha workstation cluster. Data is transmitted to onsite clients' IBM PC's by a local area network (LAN). This facilitates use of site users' desktop personal computers and the site LAN for WIND System access and use. Data are transferred beyond the SRS security firewall for access by anonymous file transfer protocol.

III. Summary

The WIND System has been re-engineered to improve system computer platform stability and reliability by making use of distributed data processing architecture. The computers were upgraded from a dedicated VAX cluster to a shared DEC Alpha workstation cluster, resulting in significant cost savings. Moving the WINDS computers to a computer facility manned 24 hours per day improved off-hour computer maintenance response time. The upgrade of the A/D data loggers improved the meteorological data capture rate from 99% to virtually 100%. Transporting the WINDS models to a PC platform and improving the Graphical User Interfaces of the models has facilitated customer access and use.

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References

1. A.J. Garrett, M.R. Buckner, and R.A. Mueller, "The Weather Information and Display Emergency Response System", Nuclear Technology 60, 50-59, (1983).