RTI UNIVERSITY PROGRAM

University of Oklahoma

PHASED-ARRAY RADAR (PAR) TECHNOLOGY FOR SEVERE AND HIGH-IMPACT WEATHER RESEARCH

RTI Connext gave us the ability to integrate real-time processing software developed independently by three different organizations into a single working radar system — that was a key factor in the success of this project.

Dr. Sebastián Torres
Senior Research Scientist,
CIWRO, University of Oklahoma

Phased-array radar (PAR) technology has the potential to significantly improve the speed and accuracy of severe weather forecasts and warnings. In fact, the faster scanning capability of PARs could even shorten tornado-warning lead times, which are vital for public safety. The Cooperative Institute for Severe and High-Impact Weather Research and Operations (CIWRO) at the University of Oklahoma is using RTI Connext® to send electronic steering commands in real-time to the front-end software that controls that antenna and collects the data for weather processing.

CIWRO AT THE UNIVERSITY OF OKLAHOMA

The Cooperative Institute for Severe and High-Impact Weather Research and Operations (CIWRO) extends cooperative programs between the National Oceanic and Atmospheric Administration (NOAA) and the University of Oklahoma (OU) that have existed continually since 1978. CIWRO provides a mechanism that links the scientific and technical resources of OU and NOAA together, to create a center of research for mesoscale meteorology, regional climate studies and related subject areas. This research contributes to the NOAA mission by improving the observation, analysis, understanding and prediction of weather elements and systems, and climate anomalies ranging in size from cloud nuclei to multi-state areas.

CIWRO's Advanced Radar Techniques (ART) team is tasked with conducting research and development of innovative signal-processing and remote sensing techniques, with the goal of improving the quality, coverage, accuracy, precision and timeliness of meteorological products from weather radars. A great example of this work is the National Weather Radar Testbed Advanced Technology Demonstrator (NWRT ATD), a joint project funded by NOAA and the Federal Aviation Administration (FAA) that included participation from NOAA's National Severe Storms Laboratory (NSSL), OU's CIWRO, Massachusetts Institute of Technology's Lincoln Laboratory (MIT/LL), and General Dynamics.

CHALLENGE

Radar equipment is of course highly complex, so finding ways to accelerate their development and testing is paramount as new technologies are being evaluated and observation needs continue to evolve. CIWRO engineers have a long history with this particular type of radar, as the NOAA's NWRT was a repurposed U.S. Navy SPY-1A PAR built in the 1970s, tested and evaluated in Norman, Oklahoma from 2003 to 2016.

The goal of the new ATD project has been building the first full-scale, S-band, dual-polarization PAR designed specifically for use as a weather radar, taking advantage of the latest advances in radar technology. However, to successfully observe severe weather with a PAR, the commands for radar control and monitoring must be both lightning fast and available to all system components in real time.

SOLUTION

Installed at the NWRT facility, the ATD went live in 2021: It is the first full-scale, S-band, dual-polarization PAR built from the ground up and designed specifically for use as a weather radar for tracking tornadoes and other severe storms. It has a planar antenna comprising 76 panels with 4,864 radiating elements, enabling the ATD to steer the radar beam electronically left-to-right and up-and-down while the antenna remains stationary.

CIWRO radar engineers have created approximately 1.8 million lines of code to operate the most advanced weather radar in the world. Software running on a cluster of 20 computers tells the antenna where and how to transmit, collects data from the radar front-end, and processes the data to produce meteorologically meaningful information. Many of the applications in the computing cluster use the Data Distribution Service (DDS™) protocol to communicate with each other, and the software runs on different machines within the computing clusters.

To support crucial application connectivity for the state-of-the-art ATD project, RTI Connext® was chosen for its powerful software framework that can handle the need for real-time radar processing. With Connext in the mix, scanning commands are delivered to the radar front-end on time, while large volumes of collected data can now be processed in real-time to produce meteorological products.

BENEFITS

The ATD project involves collaboration among NSSL, CIWRO, MIT/LL, and General Dynamics, which necessitated a way to make all software solutions from each organization work together seamlessly. The fact that General Dynamic's distributed radar processing software was built on top of the DDS standard was the first step in this direction. RTI Connext, built on top of the DDS standard, was able to easily integrate real-time processing software developed independently by these different organizations into a single working radar system on an aggressive timeline.

Today, the application software uses Connext to distribute scan commands (100s per second) to the radar front end and to receive four 4 Gb/s data streams that are routed to the signal processing applications. These productivity and performance gains provide a foundation for CIWRO engineers to accelerate research efforts on the understanding of severe and high-impact weather processes, the socioeconomic impact of such phenomena, and the importance of their accurate monitoring and early detection. Connext also helps provide significant long-term savings by enabling different applications from the different collaborating agencies to work as one integrated system.

ABOUT RTI

Real-Time Innovations (RTI) is the largest software framework company for autonomous systems. RTI Connext® is the world's leading architecture for developing intelligent distributed systems. Uniquely, Connext shares data directly, connecting AI algorithms to real-time networks of devices to build autonomous systems.

RTI is the best in the world at ensuring our customers' success in deploying production systems. With over 2,000 designs, RTI software runs over 250 autonomous vehicle programs, controls the largest power plants in North America, coordinates combat management on U.S. Navy ships, drives a new generation of medical robotics, enables flying cars, and provides 24/7 intelligence for hospital and emergency medicine. RTI runs a smarter world.

RTI is the leading vendor of products compliant with the Object Management Group® (OMG®) Data Distribution Service (DDS™) standard. RTI is privately held and headquartered in Sunnyvale, California with regional offices in Colorado, Spain and Singapore.

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CORPORATE HEADQUARTERS

232 E. Java Drive, Sunnyvale, CA 94089
Telephone: +1 (408) 990-7400
Fax: +1 (408) 990-7402
info@rti.com

rti.com
company/rti
rti_software
connextpodcast
rtisoftware
rti_software