RTI UNIVERSITY PROGRAM

Durham University

CENTRE FOR ADVANCED INSTRUMENTATION

"DDS is eminently suitable for telemetry due to its flexibility and ability to process abstraction, data efficiency and location transparency, which make it very flexible... We found the RTI framework to be very valuable, very powerful and easy to learn to use. The support tools are brilliant for finding out what's going on under the hood."

Edward J. Younger
Software Engineer,
Centre for Advanced Instrumentation,
Durham University

A new generation of very large telescopes are ushering in important scientific discoveries through clear views into outer space. These massive instruments require adaptive optics technology to correct for the effects of the Earth's atmosphere on observations. Distortions must be detected and corrected rapidly, with mirror adjustments of upwards of thousands of times per second. One of the world's foremost research institutions uses RTI Connext DDS in the lab and in real-world deployments to handle this real-time information flow, reliably and at scale.

DURHAM UNIVERSITY CENTRE FOR ADVANCED INSTRUMENTATION

The Durham University Centre for Advanced Instrumentation (CfAI) develops state-of-the-art instruments across a wide range of disciplines including astronomical instrumentation, biophysics, remote sensing and fusion diagnostics. Its astronomical instrumentation group is involved in every level of astronomy, from researching next generation instruments to producing the telescopes and instruments. The researchers work on the largest observatories in the world, including Very Large Telescope (VLT) in Chile through the European Southern Observatory (ESO). This is the world's most advanced optical instrument, capable of reconstructing images with an angular resolution of milliarcseconds, equivalent to distinguishing the headlights of a car at the distance of the moon. The data and the findings from the VLT are prolific: Results from the observatory have led to an average of more than one peer-reviewed scientific paper published every day.

CHALLENGE

These massive instruments require adaptive optics to correct for the effects of the Earth's atmosphere on observations. When astronomers capture an image or spectrum of interest, they need to know the visual distortion in the incoming light wave front in order to reconstruct a near-perfect image. The adaptive optics technology measures distortions and then rapidly changes the shape of a mirror in the telescope to correct for the distortions. This process requires continuous adjustment at ultra-fast speeds, upwards of thousands of times per second.

SOLUTION

For these real-time computing requirements, CfAI relies on RTI Connext DDS. Since 2009, the lab has used RTI Connext DDS as the publish-subscribe telemetry middleware layer in its advanced instruments to handle thousands of messages per second and to provide astronomers with real-time data on system performance. DDS was found to be well suited for the rigors of telemetry due to its abstraction, efficiency and

location transparency features, as well as its ability to run without a central object broker, name service, or requirement for compile/runtime knowledge of publishers and subscribers.

CfAI uses RTI Connext tools to integrate with other applications in the adaptive optics system. Publishers and subscribers are constructed with minimal programming using the RTI XML-based application development framework, which writes the Quality of Service (QoS) specifications and data type specifications. The RTI C++ API directly interfaces to Python, which the team uses for prototyping and rapid application development. The RTI XML extension allows the researchers to only make changes to lower classes of data, leaving the applications alone. "We found this framework to be very valuable and very powerful," explains Younger. "I found it easy to learn to use. The RTI support tools are brilliant for finding out what's going on under the hood."

The lab also uses Connext DDS in its research into next generation astronomical instruments.

ABOUT THE UNIVERSITY OF DURHAM CENTRE FOR ADVANCED INSTRUMENTATION

The University of Durham Centre for Advanced Instrumentation (CfAI) is one of the major research groups in the Physics Department at Durham University, with 70 staff and research students. It develops state-of-the-art instruments for application across a wide range of disciplines including astronomical instrumentation, biophysics, remote sensing and fusion diagnostics. More information about CfAI can be found at https://www.dur.ac.uk/cfai/.

Optimized Middleware for Extremely Large Telescope-Scale Adaptive Optics

In a 2018 paper[1], a team of researchers evaluated the middleware technologies for adaptive optics real-time control against the requirements of the Green Flash project. The goal was to develop and prove prototype adaptive optics real-time control systems capable of meeting the requirements of first-generation instruments for the European Extremely Large Telescope under construction in Chile. One important objective of the study is to prove a system design that is flexible to form a standard platform between cohesive, highly-decoupled subsystems that could be easily adaptable to the needs of a specific instrument.

The study found that DDS was the preferred telemetry middleware for Green Flash, significantly outscoring other middleware in important criteria such as Location Transparency and Service Discovery, as well as in non-functional areas including standards compliance and long-term support. It also concluded that DDS was the preferred control layer for Green Flash based on outperforming other middleware on the assessment criteria as well as its ability to reduce the number of technologies used. The researchers used RTI Connext DDS in its evaluation of technologies for the study.

[1] *Middleware evaluation and selection for ELT-scale Adaptive Optics RTCS* by Edward J. Younger, Alastair G. Basden, Deli Geng, Damien Gratadour, Tim J. Morris, James Osborn, Denis Perret, Arnaud Sevin, Lazar Staykov, Matthew J. Townson. Presented at 2018 SPIE Astronomical Telescopes + Instrumentation conference, Austin, Texas. Vol. 10707 1070718-17; www.SPIEDigitalLibrary.org/conference-proceedings-of-spie.

ABOUT RTI

Real-Time Innovations (RTI) is the Industrial Internet of Things (IIoT) connectivity company. The RTI Connext® Databus is a software framework that shares information in real time, making applications work together as one, integrated system. It connects across field, fog and cloud. Its reliability, security, performance and scalability are proven in the most demanding industrial systems. Deployed systems include medical devices and imaging; wind, hydro and solar power; autonomous planes, trains and cars; traffic control; Oil and Gas; robotics, ships, and defense.

RTI lives at the intersection of functional artificial intelligence and pervasive networking℠.

RTI is the largest vendor of products based on the Object Management Group (OMG) Data Distribution Service™ (DDS) standard. RTI is privately held and headquartered in Sunnyvale, Calif.

Download a free 30-day trial of the latest, fully-functional Connext DDS software today: https://www.rti.com/downloads.

Your systems. Working as one.

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