



Advanced Transportation Technology News

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TRAFFIC MANAGEMENT

Tolerating Faults Improves Control

The issue of controlling legacy field equipment with advanced traffic management systems is one that the intelligent transportation systems (ITS) industry has focused on for years. Stable, robust systems that use standard, easily obtained and maintained technology are another desirable goal.

Advanced Traffic Control (ATC, 1515 University Dr., Suite 105, Coral Springs, FL 33071; Tel: 866/282-4487, Fax: 954/340-2625; Email: info@atc4its.com, Website: www.atc4its.com) has developed a system that offers both. Frank Roark, president, and Chris Hatch, senior project engineer, have developed the technology as it evolved through successive (and successful) bridge and tunnel projects for the Virginia Department of Transportation (VDOT, 1401 East Broad St., Richmond, VA 23219; Tel: 804/786-2701, Fax: 804/786-2940). Roark and Hatch first worked with VDOT as engineers for ModComp, but now do so as an independent company.

ATC begins with the premise that supervisory control and data acquisition (SCADA) process and control software, used to control and monitor industrial manufacturing processes, can be used to

control devices in a traffic network. A SCADA systems can collect digital or analog data and is completely scalable. Well-known protocols and techniques can be used to expand the system to accept input from any device, whether legacy or new.

Applying SCADA to ITS was the innovation Roark and Hatch brought to the Hampton Road bridge project in 1999 (ATTN, April 1999). The control system installed in 1999 offered VDOT data fault tolerance—data was stored in multiple databases, so that if one failed, a backup existed.

The system worked well; however, during the project Roark and Hatch realized that in addition to data fault tolerance, hardware and software fault tolerance were needed. With hardware fault tolerance, if for some reason the server controlling the network (which includes variable message signs and traffic lights managing traffic) failed due to a hardware failure, a backup system would be in place to immediately assume control.

To gain the desired fault tolerance, ATC found that available off-the-shelf solutions were inadequate. Although hardware fault

tolerance could be attained with off-the-shelf options, appropriate software fault tolerance could not.

To meet the rigorous fault tolerance requirements, ATC designed a system that included a new device, called a Fail Over Controller (FC). The system consists of two servers, designated primary and backup, that are connected via a dedicated Ethernet connection. The computers share data via this connection, maintaining data fault tolerance for the system. The Ethernet protocol is chosen for the bandwidth it provides.

In addition, each server is connected to the FC via a RS232 serial port. The signal over the connection between the FC and server is the one that determines which server is primary and communicating with the network.

A second serial connection to the FC from each server serves as a "heart beat" signal, designed to indicate to the FC that the server is functioning properly. If the heartbeat is interrupted, for example if the primary is turned off, then the FC immediately switches control to the second computer. The switchover occurs in a matter of seconds, as demonstrated to *ATTN* by ATC.

The design also offers software fault tolerance. As the design evolved, ATC realized that they were limited not by hardware, or database loss, but by periodic crashing of the operating system. Systems with hardware fault tolerance could not survive the "blue screen of death" that seems to be the occasional bane of every user of the Microsoft Windows operating system.

Software updates and patches are facts of life for network server administrators, no matter what the operating system. The Microsoft Windows operating system is specified by VDOT.

Unlike most, Roark was willing to talk on the record about the challenges—and advantages—of the Microsoft operating system.

Users face a trade-off, Roark says. There are more stable and robust operating systems than Windows, however no other operating system offers users the variety and convenience in developer tools. Applications for other operating systems, not so well supported, can take months, as engineers must write code for more aspects of the system, in particular the graphical interface. The same change in Windows can be done in an afternoon using Visual Basic tools.

So the issue becomes whether the desire for robustness is great enough to support the longer (and thus more expensive) development time. For vehicle power train systems, OS failure is catastrophic, so the leaner OS still dominates. But for a traffic control center with a system that is data, hardware, and software fault tolerant, robustness becomes less important than having developer tools that permit applications to be programmed and implemented quickly.

With the fail over controller in place, software fault tolerance is in place. So the backup computer server can be updated with any applicable service packet and then rebooted. If for some reason the system crashes, operation of the traffic control center is not affected. Once the backup computer is updated, the fail over controller can simply be switched manually so that the backup computer assumes primary control of the traffic network to allow the same updates to be made to the primary system.

With this system, ATC offers DOTs data fault tolerance, hardware fault tolerance, and software fault tolerance for their con-

trol centers. But ATC also offers a means to connect and control older legacy equipment with the control system. With an inventory that includes both older and newer traffic sensors, there is a need to transmit multiple protocols over a single line.

To meet this need, ATC developed a bank of serial switches, built into a standard rack, that can be connected to any device operating under any RS232 serial standard in the field. A single line controls the serial switches from the FC to decide which system has access to the field. The data destined for the field goes through normal serial hardware and driver software.

Rather than worry about having the control software be compatible with the signal from legacy devices, ATC uses programmable chips within the switches' microcontroller boards to receive the incoming field signal. Each switch can receive signals for up to eight devices. The switches then transmit data to the controller, removing the requirement that the servers talk directly to the field and conform to the field equipment's packet format or timing requirements.

ATC normally looks to fill its design needs with off-the-shelf, easily attainable and maintained equipment. But as with the fault tolerant hardware, they found nothing currently on the market that does what their bank of switches does. ATC intends to market the serial switch bank, which has not yet been branded, as a separate product.

With the bank of switches, the issue of applicable communication protocol for connecting to the server is eliminated. Rather than altering the controller software when new devices are installed, the chip onboard the switch can be programmed with

the correct protocol. The protocol of the data stream to the server is unaffected.

With its evolved traffic control design and new fail over controller and serial bank of switches, ATC is looking to expand beyond bridges and tunnels in the state of Virginia. The company's most recent project in Virginia is the traffic control system for the Monitor-Merrimack Memorial Bridge Tunnel.