CSU Migrates to the Utility Network of the Future

Colorado Springs Utilities (CSU) has reliably provided area residents with electricity, natural gas, water, and wastewater services since 1924. It is one of the nation's largest city-owned utilities, serving the Colorado Springs community with an approximate population of 442,000 across 2,600 square miles of service territory.

CSU network engineer John Sawtell leads a team of just five professionals with responsibility for managing the utility's entire communications network infrastructure. Sawtell and his team recognized it was time to evolve their infrastructure toward the utility network of the future. Taking a methodical, phased implementation approach, they sought a more advanced infrastructure, adding packet-based network capabilities alongside legacy TDM applications, and setting the stage for Ethernet-based services.

Sitting near the foot of Pikes Peak, CSU headquarters is home to one of the nation's highest-performing utilities. In J.D. Power's 2012 Electric Utility Residential Customer Satisfaction Survey, CSU scored well above the national average. CSU also ranked higher in each of the three major categories—including power quality and reliability—than the only other Colorado utility in the survey.

Phase I – Core Transport Network Replacement

In 2006, CSU's core network primarily comprised OC-3 connections and lacked a meshed network design. The network also did not have the resiliency required by the utility. Following an RFP process that required vendors to focus on core network device, edge network device, and network management system, CSU chose to work with Fujitsu.

The first objective of Phase 1 was to rebuild a new core network (eight nodes) with OC-192 links and then gradually replace the legacy nodes on the edge of the core network (34 nodes) with OC-48, OC-12, or OC-3 nodes. This new strategy would allow CSU to design the network in a more efficient manner, allowing it to size the bandwidth for the applications required at each site.

By John Chowdhury

The new network required Ethernet transport as well as SONET and had to interoperate with CSU's legacy transport and exist-

ing microwave equipment. CSU uses microwave radios in the more mountainous areas of its service territory. Fujitsu installed the FLASHWAVE 4500 MSPP equipment in the core and utilized it and/or the FLASHWAVE 4100ES Micro Packet Optical Networking Platform (Packet ONP) equipment on the core's edge. The edge network was flexibly designed to provide a fully resistant mesh network back into the OC-192 core and to provide the proper amount of bandwidth capacity per site. By ensuring adherence to industry standards, CSU was able to implement a phased approach to deployment and provided interoperability between multiple vendors at all times.

Phase 2 – Access Upgrade and Multivendor Network Integration Support

In 2008, CSU was notified by its DCS and Channel Bank supplier that its installed equipment was approaching end-of-life. The aging and soon-to-be discontinued elements were supporting SCADA systems, voice and fax capabilities on ISDN lines, voice compression, and low speed data teleprotection circuits.

At the time, CSU also relied on digital access cross-connect systems (DACSs) to connect regional nodes in its circuit-switched network. This legacy technology was originally effective when network traffic flows, once established, remained fairly static. But the networking industry has evolved toward dynamic packet transport networks.

In addition to a new access strategy, CSU wanted a true multivendor network integration capability from its selected partner, which also must understand the first four layers of the OSI Reference model. Fujitsu Master Network Integrator services allowed CSU to rely on a single partner to design, procure, configure, test, integrate, and deploy the solution, without any downtime.

The multivendor network solution included additional FLASHWAVE 4100 ES Micro Packet ONP elements as well as the RAD Megaplex-2100 (M-2100) and RAD Megaplex-4100 (M-4100) multiplexers. The RAD M-4100s provide the 3/1/0 digital cross connect capability at four locations. The RAD M-2100s were utilized primarily in substation locations for multiplexing low-speed serial and DS0 circuits onto DS-1s.

The Fujitsu FLASHWAVE 4100 Packet ONP platforms can simultaneously support multiple traffic types, including CSU's existing TDM traffic. This capability allowed the utility to continue using its legacy DACS units while its network transition was in progress.

Another major benefit of the Fujitsu FLASHWAVE optical platforms is their support for Carrier Ethernet/Connection-Oriented Ethernet (COE). Carrier Ethernet/COE is a MEF standards-based, Layer 2 technology that provides a primary path and a pre-defined backup data path across a packet network. These capabilities deliver scalability, reliability, management, and quality of service (QoS). Further, Carrier Ethernet/COE offers the high level of security that CSU and other utilities demand. As a Layer 2 technology, Carrier Ethernet/COE does not utilize any protocols that require an exchange of routing or control information. IP-oriented control protocols such as BGP and OSPF, as well as Layer 2.5 protocols such as MPLS, dynamically exchange information for topology updates and routing. These protocols listen for updates and are inherently vulnerable to malicious attacks such as spoofing and denial of service. As a result, security administration of these protocols can be cumbersome. Because these protocols are inherently IP-based, they also have the potential to be exposed to the internet at large. Each

As telecom lead engineer of network infrastructure services for Colorado Springs Utility, John Sawtell guides a team of professionals responsible for advanced telecom engineering and analytics, including network design, engineering, implementation, and operations. He is responsible for continually overseeing the performance of existing network connections and bandwidths. He evaluates the need for new network capabilities and selects vendors and technologies to enable those capabilities. Sawtell has more than 20 years of experience in network communications and holds Bachelor of Science degrees in Electrical Engineering Technology and Telecom Engineering from Colorado Technical University.

of these traits opens the network to intrusion and theft. Because Carrier Ethernet/COE does not leverage a dynamic control plane, DoS types of threats are completely avoided.

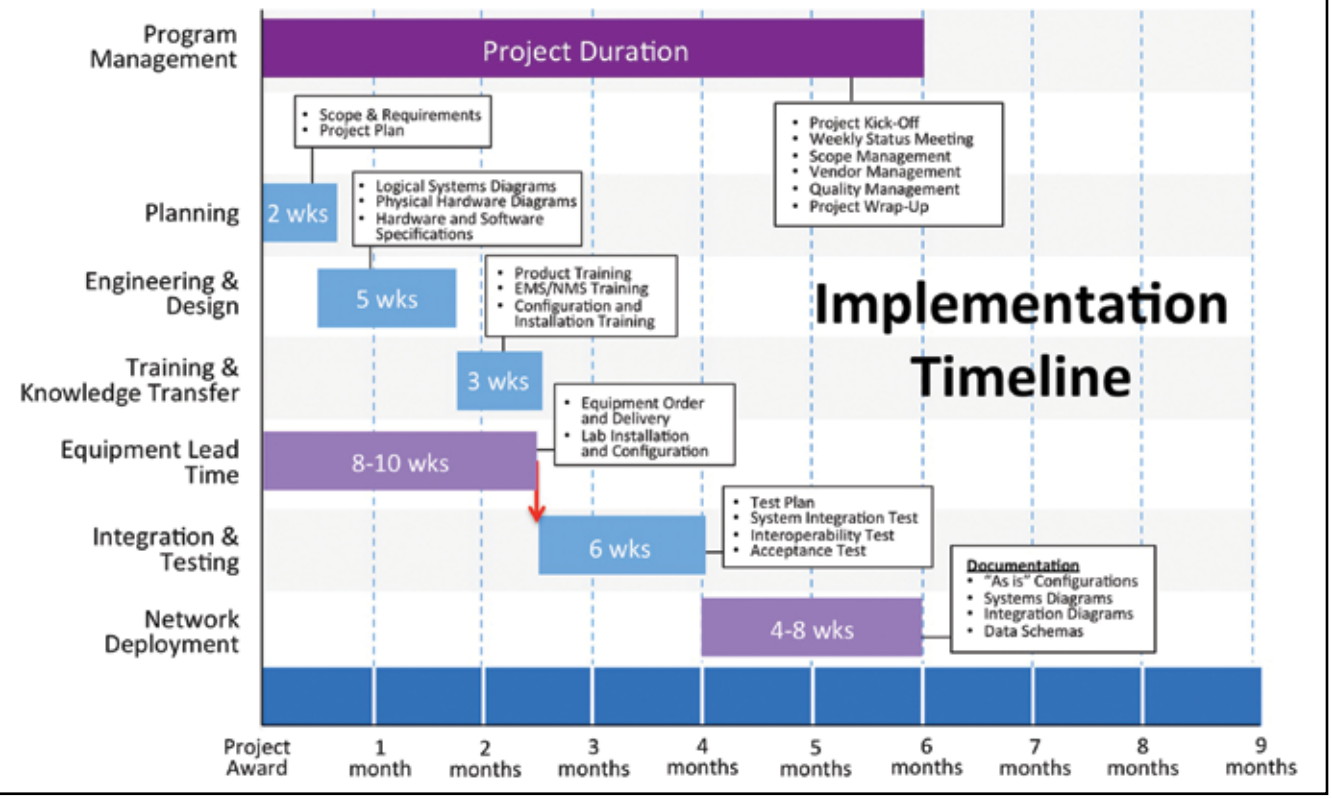
With the CSU Carrier Ethernet/COE implementation, the Fujitsu NETSMART 1500 management system acts as the control plane. The primary and backup paths are statically configured by the provisioning engineer. If a path has a committed information rate established for it, the NETSMART 1500 software calculates all the bandwidth and capacity resources available in the network and provisions the paths. No routing protocols, such as OSPF-TE, LDP, or RSVP-TE, are being run at either the end points or within the NETSMART 1500 system. This results in pure Layer 2 transport that is not using "access points" with routable protocols. With no routable protocols in the substation communications network, CSU does not require firewalls and intrusion detection systems at these locations. This significantly simplifies the network architecture and reduces CapEX as well as OpEX.

"I felt our infrastructure was more secure as we went with a Carrier Ethernet/COE rather than an MPLS solution," Sawtell said. "Staying at Layer 2 means we remain at the OSI physical and transport layers where there are far fewer security vulnerabilities."

All of these services and circuits are now connected through RAD M-2100 multiservice access multiplexers, which excel at collecting low-speed data and voice traffic from the CSU sites. The RAD M-2100 multiplexers are connected to the CSU regional access and core SONET ring networks using the Fujitsu FLASHWAVE Packet ONP equipment.

Fujitsu collaborated with CSU on a network plan that would deliver a lower total cost of ownership and also improve service availability. The two organizations worked together on an implementation timeline, mapping out a cost-effective network implementation based on best

The implementation timeline takes the utility from inception through the ending of Phase 2.



practices, standards, and QoS. This activity was led and managed by the Fujitsu MNI project team.

Among the project considerations, none was more important than the value CSU placed in the comprehensive systems integration testing that Fujitsu provided. All Fujitsu and third-party products to be deployed in a customer's network are first tested to help ensure error-free interoperability when they arrive at the customer's site. Also, all new software releases are regression tested first in the Fujitsu laboratory before introduction into the commercial network.

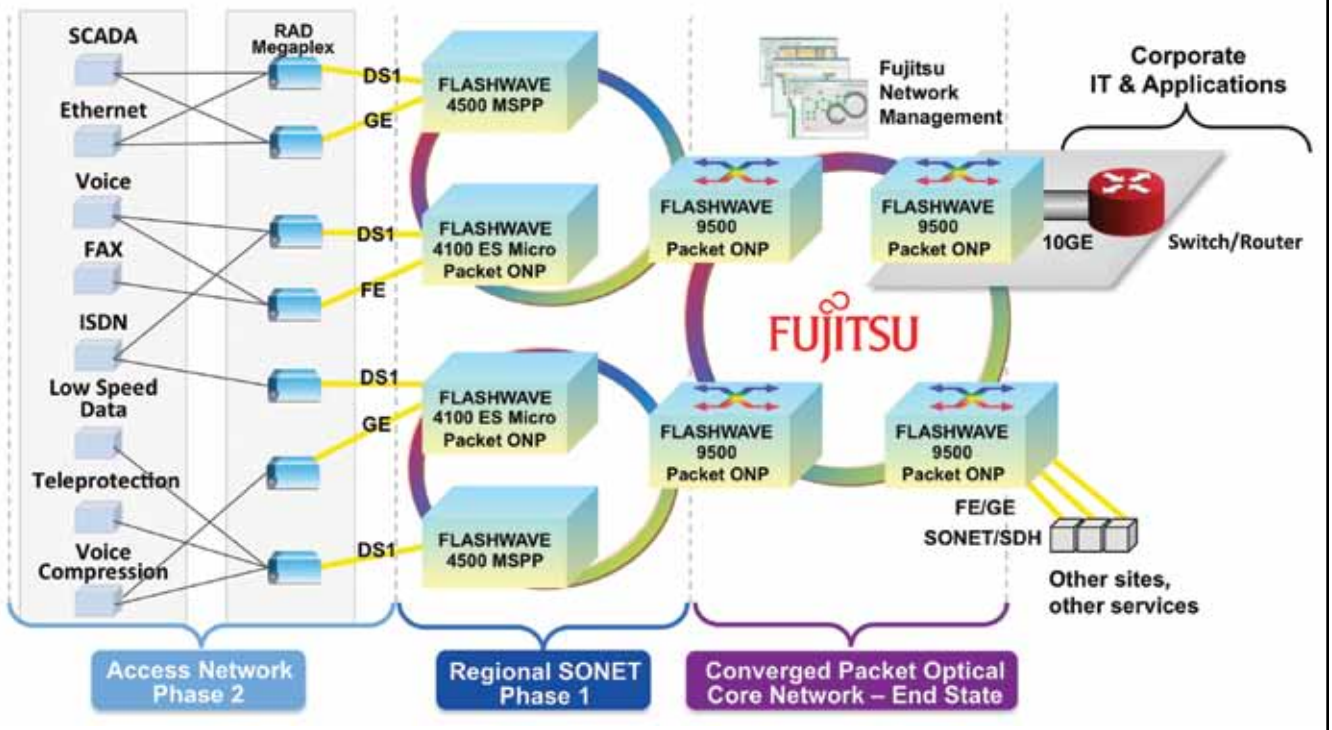
"We understand that utility customers need utility-grade networks. The Fujitsu Master Network Integrator approach architects and designs resilient networks and then rigorously tests interoperability of multivendor networks to ensure proper functionality and performance," said Greg Manganello, senior vice president - services at Fujitsu. "We also use network laboratory assets as a service, called Lab as a Service, to support ongoing multivendor maintenance, so utility customers can call one network provider for network troubleshooting and resolution."

"The Fujitsu Master Network Integrator offering gives us one 'back to pat' for all aspects of our network migration and ongoing management," Sawtell said. "Unlike reseller relationships we've had in the past, Fujitsu will bring in the right solution, regardless of the manufacturer. And we know that solution will have been pre-qualified and configured specifically for our network."

Phase III – Converged Packet Core

Once CSU and Fujitsu completed replacement of the DACS platforms and channel banks, they were ready to move on to the next and final phase in the network's evolution. This last phase involved migrating CSU's Ethernet over SONET (EoS) network into a converged network. Converging

CSU's final phase, the utility network of the future



traffic on a single platform reduces complexity, port costs, CapEX, and OpEx.

CSU added the Fujitsu FLASHWAVE 9500 Packet ONP into its core FLASHWAVE 4500 MSPP network. The FLASHWAVE 9500 Packet ONP shelf utilizes a 320G switch fabric with an Ethernet over anything (EoX) gateway. With a large amount of Ethernet services using Low-Order VCAT, as well as video requirements that have doubled in the past year, CSU and Fujitsu recognized an opportunity to implement a centralized Ethernet gateway using the FLASHWAVE 9500 Packet ONP platform. The EoX Gateway converts EoS VLAN traffic from the access network into native Ethernet traffic for aggregation and transport to the wide area via routers or around the core network via Carrier Ethernet/COE. The FLASHWAVE 9500 Packet ONP equipment supports bridging and MEF services such as E-Line, E-Tree, and E-LAN.

Utilities are slowly migrating to Ethernet-based SCADA systems especially because manufacturers are offering remote terminal units with Ethernet ports into the substation. CSU is positioned to make this transition to full Ethernet SCADA backhaul with the current network design. The long-term benefit to CSU is the ability to migrate from EoS and other TDM/SONET-based services to native Carrier Ethernet/COE at its own pace.

To manage its network infrastructure, CSU relies on the Fujitsu NETSMART 1500 system and RADView Management. Both management systems send alarm and status information to CSU's manager of managers.

CSU selected the NETSMART 1500 management system because it greatly reduces the time and complexity associated with the migration to a fully converged packet network. The software allows CSU to work from a central, remote console and execute end-to-end circuit provisioning.

CSU's core network now provides a reliable and scalable infrastructure for current and future application requirements. Its Ethernet core supports multiple interfaces, QoS, greater bandwidth scalable to 100G, increased security, and reduced costs.

Conclusion

"Working with Fujitsu is the closest thing to a true vendor-customer partnership I've seen in my career," Sawtell said. "Still today when we conduct our bi-weekly engineering team meetings, we include our Fujitsu MNI team and support representatives. We cover all aspects of the current project as part of our quality process. From time to time, we'll also use these meetings to whiteboard ideas around the direction we want to take with our infrastructure. The Fujitsu team contributes to these discussions and our plans by sharing their product and technology roadmap."

"Fujitsu made this about the smoothest migration I've ever been a part of. Sixty percent of our services are packet-based today, and we're increasing that by about 25 percent every year. Simultaneously, we're running better than 99.999 percent uptime. We never have sacrificed, and never will sacrifice, security or reliability as we continue to add services that please our internal and external customers."

Migrating to the utility network of the future isn't only about the technology. As CSU will attest, it's also about selecting a partner with a shared sense of commitment.

As utility practice director at Fujitsu, John Chowdhury develops unique network integration solutions, modernization programs, and network operations offerings tailored to support utilities as they adapt their communications networks to meet new demands for scalability, reliability, standards, and security. During his 25-year career, Chowdhury has provided strategic business and technology guidance to energy entities in the areas of smart grid/AMI/distribution automation, business case development, customer relationship management, billing, and telecommunications/wireless networks. His work with utilities and governments included architecting the first smart grid solution in the United States. He holds a BSBA in Management Information Systems from Tulsa University and an MBA from the University of Texas at Dallas.