Case Study

Silicon Valley Power
Multi-use network for power AMI + free Wi-Fi

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Customer Highlights

Challenges

- Increase utility distribution system reliability
- Reduce time to detect and pinpoint power outages
- Increasing meter reading accuracy – both power and water
- Reduced utility operational costs
- Citywide outdoor public Wi-Fi access
- Cost effective network infrastructure capable of supporting smart grid and smart city applications in the future
- Field proven vendors

Solution

- A cost-effective citywide wireless broadband network capable of delivering the capacity, coverage, reliability, and security for SVP and municipal applications
- A single vendor capable of providing a cost effective metering LAN for support of automated meter reading of power and water meters

Systems and Services

- TropOS Mesh Routers - field area network
  - 200 TropOS 7320 mesh routers with battery backup
  - 400 TropOS 5320 mesh routers
  - SuprOS network management system
- Elster EnergyAxis - AMI
  - 45,000 Elster EnergyAxis REX2-EA meters (residential)
  - 7,000 Elster EnergyAxis A3 ALPHA® meters (industrial/commercial)
  - 57 Elster AMI Gatekeepers (900 MHz metering LAN)
  - Elster EnergyAxis Management System (MDMS)
- Meter Data Management System
  - Siemens EnergyIP
- LinkPath Communications – Services
  - Design, installation, customer service and maintenance of TropOS network

Silicon Valley Power (SVP) is a municipal utility that provides electricity to 52,000 customers across 19.3 square miles in the city of Santa Clara, California, the heart of Silicon Valley. Eighty-four percent are residential customers who consume 8.7% of power sales while 1,839 industrial customers comprise 88% of the utility's power sales. Industrial customers include large Fortune 500 companies such as Applied Materials, Microsoft, National Semiconductor, NVIDIA, Owens Corning, Oracle, and Yahoo.

SVP owns, operates and participates in 800 megawatts of electric generating resources (at least 25% of which is from renewable power sources) and serves a peak load of approximately 470 MW. SVP also owns and operates a 60-mile, four-ring 144 and 288 Mbps fiber backbone that connects SCADA and 28 substations, 37 data centers (dark fiber leasing program), 27 public schools, as well as local fire stations, libraries, and many other city government facilities.

In 2012, the utility achieved 99.994% system wide availability to customers. That same year, SVP was ranked first in the nation for business customer satisfaction based upon an annual survey conducted by E Source Business Marketing Services. Customers cited the utility's reliable power service and efforts to keep prices low as the primary reasons for the positive rating.

The Evolution of SVP's Smart Grid Plans

Before AMI

SVP's power utility infrastructure includes 28 substations, 10,000 utility power poles and 8,000 street light poles which are owned and maintained by the City. There are 52,000 electric meters and, like many utilities, most commercial and residential meter reading was done manually on a monthly basis. The same meter readers also had responsibility for manually reading 27,000 municipal water meters. Meter readers in the field were equipped with a handheld unit that was used for input of meter readings and was capable of automatically reading the approximately 8,300 residential power meters enabled with walk-by radio interrogation for consumption data. At the end of the day, the handheld devices were placed in a cradle at SVP offices to upload the meter data for analysis and billing.

SVP connected to its largest industrial customers over dial-up lines using Itron MV-90 Data Collectors which enabled periodic polling of data collected and stored at the customer site. Direct customer connectivity was also used to enable and verify SVP's "Power Reduction Pool" program, a voluntary load-shedding program that was created ahead of the energy crisis to avoid the need for rolling blackouts in Santa Clara. During system emergencies, SVP customers collectively reduce power by as much as 10 MW within 30 minutes. As a result, customers in Santa Clara did not see a single rolling blackout during the crisis.

SVP MeterConnect™ Conceived

In 1990, SVP began exploring advanced meter reading requirements, technologies, and benefits. Key benefits identified which would contribute to customer satisfaction included:

- increased distribution system reliability
- reduced time to detect and pinpoint outage locations
- ability to improve service and maintain lower cost of power to customers
- increased meter reading accuracy
- more timely access to metering data (especially critical in system planning for industrial customers)
- faster customer response time with ability to perform remote on/off service
- reduced operational costs

As SVP started considering the range of utility applications which comprise a smart grid, they realized a narrowband network could not provide enough bandwidth and performance to meet future needs, however, a wireless broadband network could. They developed the vision of a single citywide wireless network that could be used for AMI, distribution automation, outage detection, mobile workforce (work orders, trouble tickets, GIS, reports, etc.), disaster communications, and more. SVP proactively explored interest in a citywide wireless broadband network and quickly came to the conclusion that there was significant interest from other city departments – police, fire, water, transportation, building and fire inspectors, and recreation departments – all of whom had interest which would make this approach cost effective. Up until this time, those city departments that had networks utilized proprietary systems that did not cross departments and were not centrally managed thereby increasing operational costs. The events of 9/11 further strengthened the city's resolve that a common wireless broadband network for municipal services was the right approach for them to take to ensure all city workers could easily communicate and collaborate to better service the community.

Field Area Network Considerations

Several companies and technology choices were commercially available at the time for creating a field area network and metering LAN to support AMI. SVP chose to take a closer look at both Wi-Fi and WiMAX before moving forward.

One of the first options SVP considered for the AMI field area network was MetroFi, a now defunct company that provided wireless Internet services. MetroFi's business model was based upon offering free Wi-Fi funded by advertising. They had already deployed an outdoor network covering a large residential area of Santa Clara (approximately 7.4 square miles). The network utilized the SVP fiber network for backhaul with the total aggregate capacity of the network achieving 130-165 Mbps and the wireless nodes providing 1-2 Mbps peak access per user. The utility contacted MetroFi to explore using their network for backhaul of the metering LAN. However, MetroFi declined SVP's offer as it did not fit their advertising business model. When MetroFi went bankrupt in August 2008, the city purchased the network due to strong community support for free public Internet access.

At that time, SVP evaluated use of the network for AMI and determined it would not meet their needs for several reasons. First, coverage fell short of SVP's requirement for citywide coverage. The MetroFi network provided connectivity for only 70% of residential, 60% of commercial, and 1% of industrial meters. Second, there was no battery back-up to the nodes to ensure continuous power in the event of a power failure, affecting system reliability. Third, there was no longer support for the network equipment making it unusable for the utility's mission critical smart grid communications.

As a result of SVP's experience with the MetroFi network, however, they felt they had tested and proven that a wireless field area network would work for AMI and in fact could be used for the utility's smart grid applications that would improve reliability, operational efficiencies, and customer service. However, such a network would need to deliver high performance and reliability; strong security; and citywide coverage.

SVP MeterConnect Introduction

SVP launched "SVP MeterConnect" in 2008 and funded the program as part of the utility's infrastructure improvement initiative. The current program encompasses:

- Wireless field area network citywide to support SVP smart grid applications, public Wi-Fi access, and other municipal services
- AMI meters that will replace 52,000 power and 27,000 water meters
- Meter Data Management System (MDMS)
- Modifications to the Customer Information System (billing system)

SVP developed a set of economic justification and benefits for this project:

- Operational Efficiency: lowering operating costs over a range of utility applications including meter reading, distribution system maintenance, grid load analysis, tracking EV charging, and outage management, ability to share network for both power and water utility applications
- Revenue Protection: reduced losses from illegal activities, improved meter accuracy, reduced costs related to move-in/move-out, and reduced metering reading errors
- Customer Service Improvements: increased billing accuracy for electric and water meters, more up-to-date and accurate bills, fresh information on consumption available to customers every 4-6 hours, faster awareness and response to power outages.
- Environmental and Social Benefits: conservation, energy efficiency, reduced greenhouse gas emissions, and improved safety for SVP field personnel
- Improved customer satisfaction with SVP services
- Enhanced power system engineering and operations based upon access to system data.

SVP Field Area Network

SVP issued a public Request for Proposal (RFP) in July 2009 which included all the elements required for the SVP MeterConnect program – wireless field area network; AMI power meters; MDMS.

SVP Field Area Network Requirements

- Coverage: contiguous citywide wireless network coverage (19.3 square miles)
- Peak performance: at least 95% of routers capable of delivering a minimum of 3 Mbps bidirectional peak throughput; 100% of routers capable of 1 Mbps bidirectional simultaneous peak throughput
- Network availability better than 99.9% average
- Security: AMI-SEC System Security Requirements; NERC CIP 002-009, NIST Special Publication (SP) 800-53, NIST SP 800-82

Vendor Selection

SVP received and evaluated in-house the five vendors that responded to the RFP. Elster was chosen for AMI and ABB Wireless for the field area network; both vendors met or exceeded SVP's requirements.

"The combination of ABB Wireless and Elster significantly stood out above the others. ABB Wireless has a proven track record in deploying multi-use broadband networks for utilities and cities. Elster has a strong metering offering that provides a cohesive solution for power and water meters. The two together are a winning combination."

Larry Owens
Manager Customer Services
Silicon Valley Power

SVP MeterConnect Rollout

Plans

For SVP, customer service, including communications and education are a high priority. Before moving forward with their AMI plans, the utility undertook a survey of its customers which was completed in October 2010. The goal was to identify the advantages customers expected to realize from smart grid applications such as AMI, and to highlight areas of concern where more information or education might be necessary in the future. Survey results showed that two-thirds of the utility's customers were supportive of their smart grid ideas but an even higher priority for them was free outdoor Wi-Fi access.

SVP continued its efforts to educate the community using public meetings and written communication, about wireless communications, AMI meters, security, billing, and other topics. They launched a website siliconvalleypower.com/meterconnect to answer the common questions they received from citizens and continue to update it with current information. Communications with customers is supported throughout planning and rollout by a strong and proactive public relations campaign.

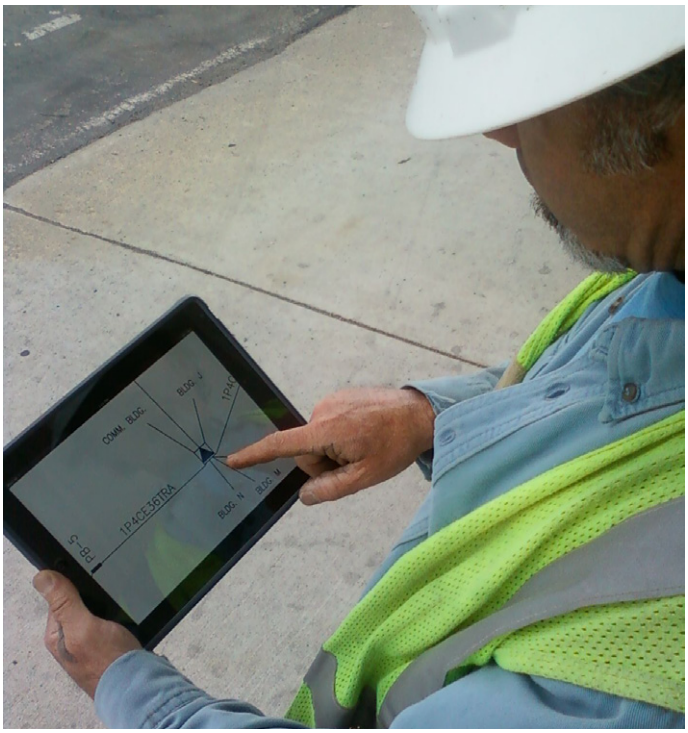
The SVP MeterConnect rollout is divided into three phases; completion of the 52,000 meter rollout is expected by 2016; 17,000 meters are scheduled for installation in 2013. The utility is conducting the rollout in combination with public outreach and education to ensure the community is prepared and has an understanding about the new services and value SVP MeterConnect will provide them. While there remains some public concern around privacy, security, and EMF exposure as it relates to wireless communications, SVP continues to address these with education. In addition, as many IOUs have already done, SVP has plans to offer its customers the ability to opt-out to AMI customers.

Phase 1 – Field Area Network, AMI Pilot, Public Wi-Fi

Based upon the strong feedback from the community, SVP decided to rollout the TropOS field area network first and offer free community Wi-Fi access. The goal was not to replace home/business "wired" broadband, but instead offer a limited bandwidth (1-2 Mbps per user) and support outdoor access only. This enables the community to use the network for light use applications around town, such as browsing the Internet or sending email while waiting in line or walking down the street. Users log onto the network using the SSID, "SVPMeterConnectWiFi," with no password or log-in key required making it simple to use.

The TropOS network is deployed across the 19.3 square miles of the city with one out of every ten wireless nodes acting as a gateway node and connecting to SVP fiber backhaul or multi-point microwave for capacity injection providing virtually unrestricted upstream capacity to a 1 Gb connection to the Internet. Each TropOS gateway node can support 34 Mbps peak throughput for an almost 200 Mbps capacity wireless system. The meshing network is designed to a three-hop maximum as specified by SVP.

Prior to opening the network for public access, the network was utilized by 15 of the utility's construction and billing support field workers who accessed the network and internal web-based applications via their Apple® iPads®. The network has improved efficiencies and accuracy for the workers, saving operational costs. For example, workers can download work orders and send updates from the field rather than returning to the office. Accurate up-to-date GIS maps can be quickly accessed in the field and have replaced often outdated paper maps, reducing time to solve problems.



LinkPath Communications, a local wireless system integration and consulting company that specializes in wireless network deployments, provided design and deployment services. They are also working closely with SVP to deliver ongoing operational support for customer service and maintenance of the TropOS network.

The AMI pilot rollout started with citywide installation of 57 Elster's AMI Gatekeepers that support a 900MHz wireless self-healing mesh network to connect AMI meters to each other and also to the Gatekeepers for collecting data 4-6 times each day. The TropOS self-healing mesh network connects to each AMI Gatekeeper delivering high performance network backhaul. Installing the metering LAN before the meters is intended to simplify rollout of meters in the next phases. In addition to providing communications, AMI Gatekeepers also act as data collectors for both Elster power and water meters which will simplify operations and save money for the city.

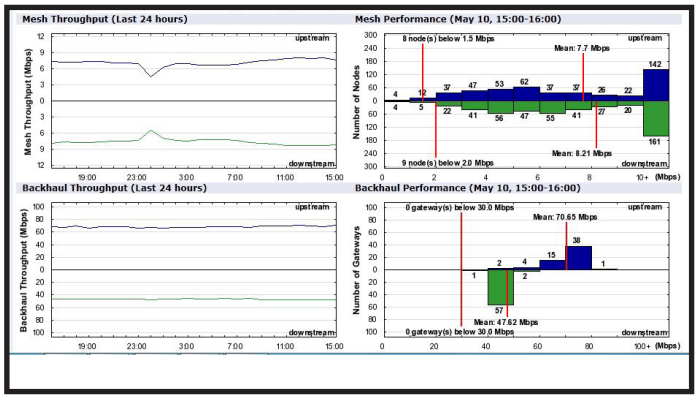
A pilot area of 175 residential (Elster REX2) and 20 commercial (Elster A3) power meters were installed to pilot the Elster EnergyAxis automated meter reading; the meters are connected to Elster AMI Gatekeepers which in turn communicate with the TropOS field area network. SVP realized there was significant effort required for integration with back office systems, billing systems, and meter data management systems to ensure a smooth transition once full-scale rollout is initiated. The plan is to prove all components of the system work in this small area before moving on to the next phase; target completion for this phase is July 2013.

Phase 2 – Commercial/Residential AMI
The second phase of the AMI rollout in scheduled to begin Fall/Winter 2013 with installation of 6,000 Elster EnergyAxisA3 meters to commercial customers and 11,000 Elster EnergyAxis REX2-EA meters to residential customers. The goal is for customers to be able to access their meter data via SVP's web portal within a few days after installation of each meter.

Phase 3 – Residential AMI
The final residential rollout of AMI Elster EnergyAxis REX2 meters is planned to start 6-12 months following the completion of the second phase to provide SVP time to ensure all the utility's business processes and staffing are operating smoothly.

Results of Building a Citywide Wireless Broadband Network

The TropOS network covers the city of Santa Clara with wireless nodes mounted on city-owned assets including light and power poles, traffic safety lamps, and buildings. The 58 gateways are all connected to City fiber and there is a designed maximum of three hops from any node to a gateway. Five-hundred seventy TropOS routers are installed today, with 30 in reserve for fill-in nodes as additional coverage or capacity is necessary. While SVP had specified the network capacity to be 3 Mbps, it delivers substantially more capacity, operating at 10-12 Mbps in most areas (see figure below).
In March 2013, the "SVP MeterConnect WiFi" network was



opened Citywide for free public access."We are the first utility in the nation to offer free, City-wide Wi-Fi as part of the smart meter rollout," said Owens. "The feedback is overwhelmingly positive with reports of better speeds and coverage than our old system. As a community service, this is a gem." In the first week, over 4,000 daily users were connecting to the network accessing 100 GB of data per day. Expectations are that demand will continue to grow quickly to an average of around 5,000 daily users. SVP limits individual user throughput to 1Mbps to ensure the network and adequate performance is available to everyone.

As the AMI meters are enabled throughout SVP territory, both the utility and its customers will derive benefits from the wireless communications network, improving service and enabling new services. Initially, these include: citywide free outdoor Wi-Fi access; centralized meter reading and monitoring (improved billing accuracy; ability for customer to view their usage in near-real time online at any time; faster awareness of outages and pinpointing of problem area; fewer truck rolls); utility worker efficiencies improve with access to up-to-date GIS maps easily accessible, remote work orders can be viewed and reports completed and submitted from the field eliminating truck rolls and improving the utility's operational efficiencies.

Future Applications Using TropOS Field Area Network

SVP: distribution monitoring; switching cap banks; outage detection; asset management; power losses analytics, ability to centrally switch power service on/off. Benefits: smart grid applications will enable more centralized visibility and control of the utility's assets increasing operational efficiencies while reducing costs and improving the quality of services to customers.

Water Department: remote meter reading (replacement of current meters with Elster products); leak detection; usage profiles by areas of the city, SCADA Benefits: more accurate billing; ability for customers to more closely monitor their own usage; faster detection and pinpointing of leaks and other problems; better balancing of system by time of day and area, remote monitoring and control of SCADA devices, reducing truck rolls.

Fire Department: ability to download building or patient information while on driving to a location; coordination with other emergency service units. Benefits: Fire fighters can respond faster and have more and better information before arriving at the scene of an emergency with the ability to quickly access and view information while in transit. Such information can include hazmat data, map of local fire hydrants, medical call history and current traffic information so they can select the best route to their destination. Oftentimes in emergencies, fire departments need to coordinate with other fire departments, police, EMS and other first responders to plan and coordinate actions, gather information, report to headquarters, etc. Access to reliable wireless broadband improves their communication, coordination, and efficiencies.

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