Guam Power Authority
Multi-use wireless network for smart grid communication
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Guam Power Authority (GPA) needed a robust communication infrastructure. They selected ABB’s TropOS wireless broadband network to provide smart grid communications.

Challenges
- Utility relied on customers to report outages and outage location, lengthening time to restore power
- Inaccurate reading of analog electric meters and under billing
- Costly and time consuming manual meter reads each month
- Average of 400 – 800 utility truck rolls per month for disconnect/reconnect/new service
- Typically took two-three weeks to assess a customer’s bill when closing an account
- Customer assessed relatively high power service reconnection fees
- Customers desired faster service for turning power service on/off
- Reduce cost of leased line services for power and water SCADA

Solution
- Highly reliable private wireless field area network (FAN) capable of supporting communications for multiple smart grid applications and survivability in typhoon force winds
- Cost effective replacement of leased lines for power and water SCADA communications, leveraging common FAN
- Replacement of 52,000 analog power meters with Advanced Metering Infrastructure (AMI) meters and metering LAN
- Meter Data Management (MDM) for collection and centralize analysis of metering data
- Outage Management System (OMS) to accelerate outage detection and enable faster restoration
- Substation automation for centralized monitoring of Intelligent Electronic Devices (IEDs)
- Monitoring and control of renewable power source

Results
- Reduced electric meter reading costs by $433,417 per year using AMI
- Reduced metering operating and maintenance costs by $120,990 per year through AMI and centralized service switching ability
- Reduced fleet usage from 400-800 truck rolls/month to three/month, improving customer service and reducing operational costs
- Improved power service reliability and accelerated outage restoration
- Reduced time to switch service on/off - from 48 hours down to two minutes
- Utility lowered reconnection fee from $35 to $10; same day reconnection fee from $99 to $10
- Reduced time for billing close out – from two-three weeks down to a few minutes
- Customers have greater visibility and control over their energy usage
- Lowered line losses from over 7% to 4.5%
- 13% increase in customer satisfaction
- Conversion of SCADA communications from leased lines to combination of wireless mesh and fiber saves over $300,000 annually in communications costs
- Same FAN leveraged by both GPA and Guam Waterworks Authority (GWA) providing further cost savings and operational efficiency
- No loss of utility jobs with AMI deployment

Systems and Service
- ABB Wireless
  - 400 TropOS 7320-XA routers
  - SuprOS network management
- ABB Professional Services
- Landis & Gyr AMI power meters and metering LAN
  - 52,000 Focus meters
  - Gridstream RF mesh (metering LAN)
- Milsoft OMS
- Harris Utilities MDM and customer Internet portal
  - SmartWorks MeterSense (MDM)
  - SmartWorks CustomerConnect (custom Internet portal)
  - Residential and business account portals
- Black & Veatch
  - Program management office support
  - IT support during rollout
GPA Background

GPA was established in 1968 and has headquarters in Mangilao. GPA is a public corporation and enterprise fund agency of the Government of Guam with an elected five-member Commission on Consolidated Utilities, and is regulated by the Guam Public Utilities Commission. The utility provides power to 50,000 residences and business on the island of Guam, which is approximately 210 square miles. Like most island nations, Guam has no conventional energy resources and relies on petroleum products shipped in by tanker to meet most of their energy needs. They have a goal in place to reduce their petroleum consumption 20% from a 2010 baseline by 2020. GPA operates both as both a generation and distribution utility and employs approximately 468 people down from about 550 in FY 2014. They have 381 megawatts of conventional fossil-fueled generation capacity, 26.5 MW of solar PV, and the 40 MW Aggreko Temporary Power Plant. GPA maintains 663 miles of transmission and distribution lines and operates 29 substations.

Challenges

GPA’s strategic planning and operations research division (SPORD) was a driving force in outlining and driving forward the utility’s smart grid project. Some of the key objectives they identified as part of the initial phase were:

- Reduced meter reading costs and improved accuracy
- Reduced operating and maintenance costs
- Reduced costs due to equipment failures, distribution line losses and theft
- Reduce time to detect outages and location
- Reduced time to deliver customers a final bill when they close an account
- Improved power delivery reliability and power quality
- Reduced truck rolls cost and time savings
- Reduced time to deliver power on/off/reconnection
- Reduced cost to customers for power on/off/reconnection
- Reduced greenhouse gas and pollutant emissions
- Diversification of energy sources (renewables, alternative fuels)

To meet the project goals, it was clear that it would require GPA to deploy multiple smart grid applications along with a more robust and extended network communications infrastructure to support them. This was the largest capital improvement project ever undertaken by the utility outside large power generation capital projects.

Smart Grid Applications

AMI

Before AMI, GPA’s customer services department performed between 400 to 800 meter disconnects/reconnects/new services connections each workday. The large transient U.S. Military personnel on the island further amplified these numbers. The time to respond to service requests took three to five days and required a truck roll each time. In addition to the costs associated with each truck roll (personnel, vehicle maintenance, gas, insurance), GPA was concerned about the contribution it made to greenhouse emissions.

In addition, manual meter reading of the utility’s analog power meters, large numbers of estimated bills, and the age of these analog meters led to billing inaccuracies and about a 1% under-billing. When a customer closed their account it took an average of two to three weeks to assess their final bill.

OMS

Prior to having an OMS, the utility relied upon customers to call and report outages and their location. As an area frequented by storms, power restoration could take hours at times. GPA also did periodic drives through villages to find problems and restore power, however this was a highly inefficient approach.

Leased Line Replacement for SCADA

GPA historically had connected its SCADA devices using data circuits leased from private carriers. To reduce costs and increase reliability they sought to replace these leased lines leveraging their own smart grid FAN and an existing internal, island-wide fiber network. In addition, they identified the opportunity for Guam Waterworks Authority (GWA) to leverage the same communications network for their SCADA and other telemetry and control applications.

Substation Automation

GPA sought to installed smart relays and transformer health sensors to monitor these devices centrally enabling timely identification of potential problems in seven of 29 substations.

Smart Grid Communications

To enable the new smart grid applications – AMI, OMS, leased line replacement, GPA knew they would need a multi-tiered wireless and wired communications network. They would need a metering LAN that would connect the smart meters to collectors and a field area network to connect the collectors and eventually DA and other devices, to the utility’s substations and fiber.
GUAM POWER AUTHORITY CASE STUDY

Solution
GPA applied for and was awarded a $16.7 million smart grid grant funded by the American Recovery and Reinvestment Act (ARRA) of 2009 through the U.S. Department of Energy. The U.S. Department of Energy chose GPA as one of 100 utilities to receive federal stimulus funds as part of the ARRA program.

The ARRA funding required that GPA match dollar-for-dollar the funds for the project. The overall project included a territory-wide AMI deployment; an OMS; substation automation equipment including voltage regulators, fault indicators, smart relays and transformer monitors; an energy management system; and a customer portal. The utility issued bonds in fiscal 2010 to raise the matching $16.7 million towards funding the project.

Multiple GPA operations teams were involved in various aspects of rolling out GPA’s smart grid program for AMI, OMS, leased line replacement for SCADA, substation automation and smart grid communications. For example, the Power Systems Control Center worked extensively on the outage management work stream. Engineering led the substation automation deployment. GPA’s IT Department was involved in all of the smart grid application and infrastructure rollouts. The utility brought in Black & Veatch to staff a program management office, overseeing the rollout of the project as well as providing IT staff support. Their expertise and knowledge helped accelerate the successful project rollout.

Smart Grid Rollout
GPA had a limited amount of time to complete the project as the grant mandated an aggressive schedule. The approach taken was to rollout by meter billing route, starting with deployment of the communications infrastructure closest to where AMI collectors were to be installed and expanding from there. The rollout included the private FAN, which provides backhaul for the metering LAN, and narrowband metering LAN, which provides communications between the AMI meters and collectors. Immediately following the communications network was installation of the AMI meters. These activities had to be very well coordinated so that GPA did not outstrip the utility’s ability to bring back meter information immediately after installation.

Field Area Network
GPA selected ABB’s TropOS wireless broadband communications network as the result of a competitive bid process. The utility’s central Engineering Division created a very small pilot project to assess power line carrier (PLC) technology. The SPORD proposal team canvassed inputs from throughout GPA and evaluated two technologies: point-to-multipoint and mesh radio technologies. GPA chose mesh radio as it offers the best self-healing capabilities should a node fail, which is important consideration in an area such as Guam that has a high risk of category 4 and 5 typhoons which can bring winds up to 200 mph.

The Guam PUC approved rollout of an ABB TropOS-based FAN that spans GPA’s entire territory, which comprises approximately 80% of the island of Guam. GPA and GWA are collaboratively purchasing and installing additional TropOS-based infrastructure to capture 100% island-wide coverage. The FAN provides bidirectional communication between the AMI collectors and the utility head-end systems. For backhaul of the FAN, GPA used fiber where it was available (approximately 56% of the utility’s substations have fiber); in other locations, contracted communication services are used.

Plans are for the FAN to be leveraged for multiple smart grid applications including substation automation, distribution automation, distribution management system, outage management system, and load control management system.

Installation of the TropOS network presented some environmental challenges. Specialized reinforced mounting hardware for the TropOS routers was needed to boost survivability of 200mph winds.

GPA selected ABB Professional Services as the prime contractor for installation of the communications network, which included the TropOS and fiber installation. For the TropOS network, the ABB Professional Services team provided network design, site survey, project management, support of the installation of the TropOS mesh routers which was performed by GPA staff, network optimization, setup and administration of SuprOS, and final test and acceptance of the network. For installation of the fiber, ABB brought in a local subcontractor and project managed the installation.

AMI
Territory-wide rollout of the first Landis & Gyr smart power meters began in October 2012 and was completed in June 2014. Each meters took approximately two minutes to install by crews and once powered, immediately connected to the communications network. Approximately 88% of the meters are residential with commercial and industrial making up the remaining 12%. While GPA offers customers the ability to opt out of AMI, fewer than 27 customers have done so.
The smart meters connect to Landis & Gyr’s Gridstream RF mesh, a narrowband metering LAN that provides bi-directional communication between smart meters and utilizes the TropOS FAN for backhaul to connect to the utility’s head-end systems. AMI enables many new efficiency improving and cost saving services such as remote service connect/disconnect, outage notification, restoration verification, tamper/theft notification, and HAN connectivity.

MDM
GPA selected SmartWorks MeterSense, an MDM solution that manages, analyzes and interprets the growing volumes of meter data. It links staff and operations to other applications, including the AMI system, staff and operations.

OMS
The Milsoft OMS works synergistically with the AMI system to provide operational intelligence that allows more efficient and accurate outage detection and restoration verification. With the OMS in place, GPA can pinpoint outages and any isolated customers, quickly enabling restoration teams to work quickly in restoring power.

Substation Automation and Leased Line Replacement
GPA installed smart relays and transformer health sensors to monitor these devices centrally to identify potential problems in seven of 29 substations.

GPA intends to convert all of its SCADA data circuits from private carriers to its own TropOS wireless and internal, island-wide fiber network. This will save GPA over $300,000 annually and eliminate GWA communication spending by over $500,000 per annum and support SCADA and other operations telemetry and control applications.

Customer Portal
The SmartWorks CustomerConnect web portals are Internet applications providing GPA residential and business customers, to view their own power usage and costs enabling them to better manage consumption and bills. GPA customers use their own Internet service to access the portal.

Monitoring and Control of Renewable Power Source
GPA is leveraging the TropOS network for bidirectional communications to a wind turbine generator enabling remote monitoring and control of the device.

Results
GPA has experienced significant benefits as a result of rolling out their smart grid project, including a 13% increase in customer satisfaction in just a short period. Specific benefits:

AMI
With the ability to reliably read meters remotely the utility reduced electric meter reading costs by $433,417 per year. Additional cost savings of $120,990 per year were realized through reduced metering operating and maintenance costs. Truck rolls dropped from 400-800/month to 3/month saving on vehicle fuel costs and reducing greenhouse gas emissions. The time to turn power service on/off dropped drastically from an average of 48 hours (due to scheduling and truck roll) to 2 minutes. As a result, the utility lowered its reconnection fee for customer from $35 to $10. The time for billing close out when a customer cancelled service dropped from 2-3 weeks down to a few minutes which has also increased payment collections.

OMS
Combined with the AMI system, the OMS has enabled GPA to be more responsive to power problems, improving power service reliability and accelerating outage restoration. When crews go out into the field they now know the physical location of the outage and which customers are affected. Also, operations personnel can remotely ping meters during an outage to confirm service restoration rather than phoning customers.

Leased Line Replacement
GPA leveraged the network to connect a host of SCADA devices, which had previously been connected using leased lines. By converting all SCADA data circuits from private carrier to TropOS wireless and internal island-wide fiber they will save over $300,000 annually and eliminate spending of more than $500,000 each year for new applications such as SCADA and other telemetry and control applications.

Substation Automation
Lowered line losses from over 7 percent to 4.5 percent by using smart grid data as part of distribution studies supporting distribution capacitor program.

Customer Portal
Customer can view their own usage data on the next-day providing them with great visibility and foresight to better control over their own energy usage. The portal is accessed using a secure Internet web-based portal. The SmartWorks suite allows the use of sophisticated dashboards, baselining, and alarm settings to help manage usage.
Pre-paid Metering Service
GPA offers pre-paid meter service through its Oracle Customer Care & Billing application. This application receives its meter information from the MDMS.

Some of the key lessons learned by GPA, as a result of the smart grid project, which they recommend to other utilities deploying a smart grid:

Assembling a dedicated implementation team and establishing a program management office and experienced personnel to work alongside and guide the core project team. This was a critical success factor given the scale of the deployment and size of the utility.

The GPA team drove commitment, alignment and partnership across multiple divisions to overcome some of the challenges initially encountered by internal organizational silos. GPA groups that had a role in the decision-making included operations, customer services, communications, engineering, IT, program management office and the general manager for consolidated utility services.

GPA’s general manager established a project issue resolution team that was chartered with resolving implementation issues quickly, helping keep the overall project schedule on track.

Buy-in and support of the utility’s executive leadership.

Future
GPA is continuing to enhance its smart grid deployment. Several Home Area Network (HAN) applications are being tested and the program is under development.

In addition, GPA is expanding the coverage of the TropOS field area network. Other smart grid applications planned which will leverage the TropOS network, include:

- Substation automation – will be converting RTU communications to utilize the TropOS network
- Demand side management (TOU pricing, direct load control)
- Mobile workforce management (MWFM) applications will operate atop mobile TropOS routers.
- Converting SCADA RTUs to use the TropOS network for communications

Guam Waterworks Authority
Guam Waterworks Authority (GWA) is a Government of Guam Public Corporation and Enterprise Fund that delivers water to over 41,000 customers and wastewater service to approximately 25,000 customers. Plans are underway for GWA to leverage the same GPA TropOS communications network for modernizing multiple water utility applications.

It is noteworthy that GPA and GWA both have managerial oversight by the Consolidated Commission on Utilities (CCU) and therefore the two organizations are encouraged to collaborate to achieve cost savings and improve operational effectiveness where possible. The sharing of the TropOS by both GPA and GWA is based on a Memorandum of Agreement (MOA) between the two organizations.

Water AMR
In 2016, GWA completed installation of Badger Meter Orion AMR water meters for all except for its three largest customers. There are plans to move the three remaining customers to AMR meters after the replacement/repair of several valves that will allow for isolating the water lines feeding these accounts. GWA’s goal in adopting AMR was to reduce unaccounted water losses by 20% in addition to improving efficiencies in reading meters. GWA has been maintaining a 99% successful AMR electronic read percentage for over 41,000 active meters for almost 2 years. The AMR meters now allow GWA to improve service with access to usage information not previously available to the ratepayers. As the readings are more quickly and efficiently captured each month, the GWA Meter Reading Unit has realized efficiencies in manpower needed to complete the scheduled reads. This has allowed GWA to divert these resources to other equally important tasks.

To further improve its metering infrastructure, GWA will be implementing a water AMI pilot which includes connecting 1,000 meters. By moving to AMI, GWA will have bidirectional communication to the meters enabling remote service connect/disconnect reducing the amount of time to open and close accounts and eliminating the costs associated with a truck roll; demand response; improved ability to detect leaks, in addition to the ability to remotely read meters and the other capabilities provided by AMI.

AMI technology for GWA will no doubt allow GWA to increase customer engagement and service quality. Huge water consumers value real time, granular data on water consumption with Guam’s hotel industry seeking access to such useful information on their operations. Using an AMI system will empower GWA to focus on enhancing the customer experience and overall service quality as the access to real time information for consumers has such a direct effect on water users. Additionally, having the ability to inform consumers of water of continuous water flow usually indicative of private side leakages allows consumers to
address private line damage immediately upon occurrence and in the long run will conserve water for everyone’s benefit.

One other benefit GWA can realize with an AMI system is the ability to capture reads throughout the water system inclusive of production wells, improving GWA’s ability to identify problem areas system wide. Also, GWA’s response time to problems can be greatly reduced with quicker access to information. Water audits can be performed more consistently and methodically as well.

Implementing the AMI pilot involves retrofitting each of the 1,000 water meters with a Landis & Gyr Gridstream RF communications module, which operate at 900 MHz and form a mesh topology for the metering LAN. The meter RF communications modules connect to Landis & Gyr Gridstream RF collectors and in turn, leverage the TropOS network for backhaul to the utility’s Command Center as well as to the Landis & Gyr Gridstream MDMS. The metering data is also sent to the Customer Information System (CIS) which is shared by GWA and GPA for combined billing of both power and water, providing an additional operational efficiency.

Asset Management
GWA has an asset management pilot project underway that utilizes TropOS mobile routers mounted on utility vehicles to remotely access the Lucity asset management (AM) system. GPA IT, SPORD and Customer Services departments are providing support to GWA on the TropOS network as part of this project. When proven successful, GWA will equip operations and maintenance crews with tablets and TropOS mobile routers for their vehicles to remotely access the Lucity AM system to manage the preventative and corrective maintenance and provide operational information of GWA assets throughout the island.

Video Surveillance
GWA is currently deploying video camera surveillance system to monitor several water reservoirs and is planning to deploy a video camera surveillance system to remotely monitor critical water wells to protect these assets from burglaries and vandalism that have plagued GWA for years. Deployment of a video camera surveillance system for other sites will be assessed on a case by case basis.

SCADA
GWA will be building out a new SCADA System in separate phases. The initial phase involves the design and deployment of a Central SCADA System, approximately thirty-two water and wastewater facilities upgraded with SCADA RTU/PLC and instrumentation, and the expansion of the TropOS network to link the SCADA-upgraded water and wastewater facilities to the Central SCADA System. Subsequent phases will add additional water/wastewater sites, additional field instrumentation and additional TropOS routers throughout the island as needed to complete the system.

For the Central SCADA System, GPA and GWA had mutually agreed to enter into a bid process for the procurement of a single Central SCADA System that will run power, water and wastewater SCADA on a common platform. The bid was awarded on December 2016 to Benson Guam Enterprise Inc. who has teamed with Siemens to use a Siemens Spectrum Power system solution. The timeline for deployment is approximately fifteen months.

GWA has initiated other capital improvement projects (CIPs) to upgrade water and wastewater facilities with SCADA RTU/PLC and instrumentation. When completed, it will be integrated with the Central SCADA System using the TropOS network to connect the SCADA RTUs to the Central SCADA System.