ROLTA

Maximizing Smart Grid Return through GIS Accuracy

A Case Study of Alabama Power Company's GIS Update

GIS and the Smart Grid

The promise of an intelligent electric delivery system that manages field assets, conducts advanced network analytics, and most importantly, reduces costs through improved efficiency has encouraged utility providers worldwide to invest in the development and implementation of Smart Grid technology. These benefits, coupled with an aging, inefficient system[1] being outpaced by the growing demands of energy consumption, highlight the need for effective Smart Grid deployment. But the question utility companies must first answer is: What should this deployment look like?

With investments in Smart Grid technology growing at a rapid pace[2], many providers seem to have answered this question by utilizing funds, like those created through the American Recovery and Reinvestment Act, to complete the installation of Smart meters and sensors throughout their installed network. These fixtures of Smart Grid technology provide pivotal data to utilities, monitoring a customer's power quality, recording statistics on consumption and on flow throughout the distribution network, and even reporting outages in real time. However, as many utilities are discovering, an Advanced Metering Infrastructure (AMI) is simply not enough to fully realize the Smart Grid concept on its own. A provider's AMI must work in concert with other Smart Grid technologies such as a fully functional SCADA system that includes strategically placed automated line devices, an intelligent control center switching application and other advanced applications such as Volt/VAR control, etc. This comprehensive Smart Grid platform must be built on the foundation of an accurate and comprehensive GIS model of the network.

For utilities, a GIS network model is critical, and represents the most comprehensive inventory of an installed network. Combining a visual representation of installed assets with multiple layers of attribute data in one connected mapping environment, an accurate GIS model gives utility providers a unifying dashboard through which impactful analysis of Smart Grid data can be conducted. It is capable of illustrating the spatial relationship between utility assets to each other, as well as their surroundings. It can provide a means for comprehensive queries, and can determine the most optimal locations for additions to the network based on a number of criteria. Perhaps most notably, it can contextualize the advanced metrics and statistics produced by Smart Grid fixtures, allowing utilities to visualize trends geographically. An accurate GIS model can even represent the basis for implementation of an Automated Distribution Management System (ADMS). Based on this, a utility provider's GIS model represents a fundamental piece of their Smart Grid development. However, a number of challenges arise when that model is both spatially inaccurate and out-of-date.

As noted earlier, many utilities have prioritized the installation of an Advanced Metering Infrastructure over ensuring the quality of the GIS network model, but the essential issue here is that any meaningful Smart Grid advancements will rely heavily on the data supplied by that model. Locational accuracy and up-to-date feature attributes are of paramount importance, with errors leading to potential power outages or even accidents in the field. However, because of the various import procedures that go into creating a full GIS network, many utilities will find that their GIS network model simply doesn't meet the necessary requirements. Features that were added from differing map projections, imported from CAD or paper maps over time, created from incorrect entries in a database, or simply missing altogether are just some of the issues that lead to a GIS network full of inconsistencies. Simply put, without first reconciling the GIS network to what's physically present in the field, utilities may find themselves making decisions based on data that isn't relevant, effectively limiting the benefits of Smart Grid advancement! With all the investment in Smart Grid development, utilities should balk at the concept of limited advancement, and in order to maximize it, place great emphasis on an accurate and complete GIS network. This is the exact conclusion reached by Alabama Power Company in 2010.

1. A 2009 Morgan Stanley report estimates that power outages cost the US Economy as much as $180 billion annually

2. According to figures from Bloomberg New Energy Finance, Smart Grid investment is expected to see an annual growth rate of 10.4% globally over the next five years, totaling $25.2 billion by 2018

Smart Grid Implementation at Alabama Power Company

Servicing more than 1.4 million homes, businesses, and industries throughout the southern two-thirds of the state, Alabama Power Company (APCO) is a branch of Southern Company, one of the nation's largest producers of electricity. On the distribution end, their Smart Grid development, like that of many other utility providers, began with the installation of a Smart Grid infrastructure, including meters and sensors, with an ultimate goal of the successful implementation of a unique Integrated Distribution Management System (IDMS). Alabama Power's IDMS is an application that integrates incoming information from multiple Smart Grid platforms and presents it to the system operators in a singularly mapped interface. It enables real-time communication throughout the network between the customer and provider, and paves the way toward creating a self-healing network, capable of managing and repairing outages independently, thereby improving efficiency, reliability and costs.

However, as we have already highlighted, without a GIS model that accurately reflects the installed network or access to relevant data, the IDMS simply cannot make informed, defensible decisions. The data supplied to the system has to be pristine in both the attributes of its features and their spatial locations. But, because APCO's GIS network was built up over decades, using various mapping records and work order updates, this was simply not the case. To compound the problem, much of the GIS network was constructed prior to the widespread availability of quality aerial imagery, so while many assets were placed in proper relation to road and parcel layers, these layers were often spatially inaccurate. Figure 1 illustrates the disparity that existed between APCO's GIS model and the actual installed network. So in order to fully realize the promises of Smart Grid development, APCO placed a high priority on the reconciliation of their GIS network, capitalizing on funds awarded through the Smart Grid Investment Grant (SGIG) to facilitate the project.

The SGIG program, as a part of the Energy Independence and Security Act of 2007, was funded to accelerate the modernization of the nation's electric transmission and distribution systems and promote investments in the development and actualization of Smart Grid technologies. A stringent, merit-based selection process resulted in the funding of 99 SGIG projects nationwide. Each of these, including APCO's selected project, were eligible to receive federal financial assistance for up to 50% of applicable costs upon successful completion.

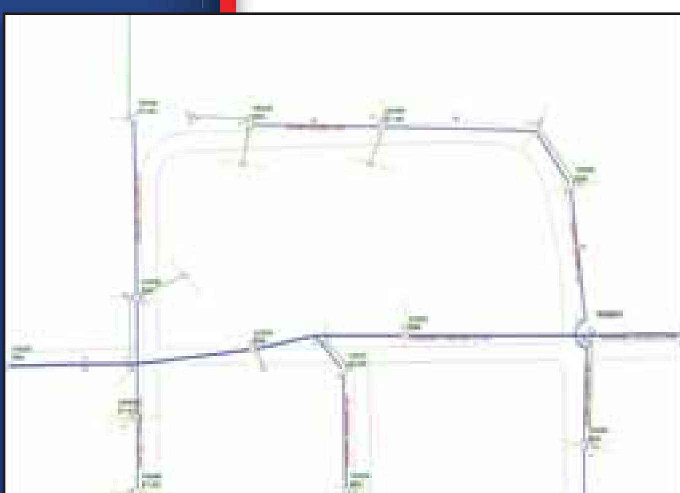

Figure 1. Though features are placed in proper relation to road and parcel layers, these layers are often spatially inaccurate.

A Full Field Inventory

Endeavoring to clean up their entire GIS network model, Alabama Power's GIS Reconciliation project covered the spatial relocation and data maintenance of every applicable feature for more than 1,400 feeders throughout their electric distribution network. These features included all primary and secondary lines, sectionalizing devices, transformers, poles, anchors and lights, among several others. In order to facilitate these necessary changes, a massive amount of data had to be collected, and in 2010,

APCO initiated this process by seeking the help of a local staffing agency. Aiding not only in the mobilization and deployment of a team, but also in its composition, the staffing agency hired crews comprised entirely of retired APCO distribution field employees, tasking them with the execution of a full field inventory review.

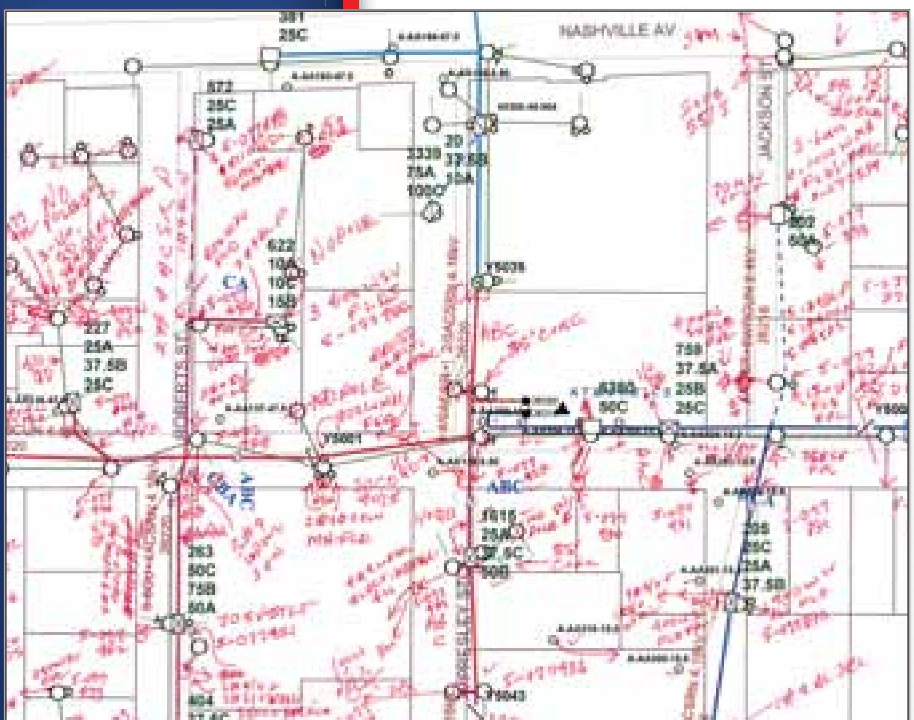

Figure 2. A typical example of a red-line markup indicating required changes to the GIS network against a printed copy of the existing model.

The decision to staff this review with former linemen, engineers, crew foremen, etc. was pivotal to its success. Their familiarity with the distribution network, as well as construction regulations and standard notations ensured a rapid start-up to the project and the detailed accuracy of the information collected.

Beginning at the substation for each feeder and stretching all the way out to each customer endpoint, field crews were responsible for verifying existing information, adding or removing assets as needed, and recording additional details for each feature associated with a feeder. Feature details included equipment size and type, wire size, phasing arrangement, as well as various other associated attribute information. In addition, they also noted the spatial relocation of features where extreme discrepancies existed. Figure 2 shows a typical example of the necessary changes to the GIS network, as noted by the field crew. Because of time constraints, as well as the additional costs of equipment and training associated with a mobile solution, APCO elected to expedite the field review process through the use of paper maps. Field crews employed a simple red-lining methodology, recording changes or additions to the network against a printed map of the existing model. Each field verified map constituted a single unit within a grid system, encompassing the full coverage area of Alabama Power Company. This grid system became the dividing unit for work done against each feeder, and even represented the means through which productivity and quality tracking could be implemented once the process of executing the noted changes to the GIS network had begun.

With the field review well underway, it became clear early on that with a project end date of December 2012 in mind, the implementation of these noted changes could not be executed by APCO's current GIS staff alone. The sheer volume of work, as well as the attention to detail necessary in reconciling each of the 1,400+ feeders, was simply too much for a team already overworked by requirements such as engineering support, legacy system posting, sectionalizing and work order management. In order to meet the project deadline while still maintaining the level of quality necessary, APCO sought outside assistance.

A Partnership Formed

After reviewing proposals from multiple vendors, APCO selected Rolta International, Inc. as its partner in the GIS Reconciliation Project. Rolta was selected based on a number of factors including:

- Senior management's level of experience, with a combined total of more than 100 years, established through the completion of several multi-million dollar projects
- A proven track record within the Utilities sector
- Rolta's demonstrated readiness to facilitate a process flow around the project and execute it from concept to completion
- Ability to minimize overall costs while maintaining a dedicated project management team, continually driving production and quality
- Rolta's highly beneficial concept of a team-based culture that would intrinsically improves upon the skills and functionality of a contracted workforce

These factors, coupled with their capacity to staff the project and initiate production quickly made Rolta the perfect fit to meet the project's demands, and although conversion companies are often associated with offshore work, Rolta presented an entirely local team, with all work being done in Alpharetta, GA. Ultimately, the candor and expertise displayed by the Rolta team from the outset of the proposal process, as well as their locality, ensured APCO's trust in their ability to act as an extended service arm of APCO's own Data Management team.

Establishment of a Team-Structured Process Flow

With a large and growing backlog of field-verified grids to work through, Rolta and APCO quickly initiated a structure for the GIS update process. APCO's Data Management team provided training for the initial groups of Rolta employees, imparting knowledge not only of specific records policies and GIS network requirements, but of the rules and concepts inherent to power delivery and electric distribution. This enabled the Rolta team to handle issues regarding a wide range of topics, including voltage progression, phasing changes, and protective/sectionalizing devices. As the number of resources grew from an original group of four employees to more than 70, so did the expertise of the Rolta staff, which eventually took over all electric distribution training, streamlining the classroom training time from two weeks to four days.

Concurrently, the Rolta management team introduced a strictly enforced process flow, shown in Figure 3, which kept quality at the forefront while maximizing productivity. At the heart of this was Rolta's team-based production concept that encouraged a friendly yet competitive atmosphere, while still allowing for the individual attention needed for each technician's continuous improvement and growth over the course of the project. Teams, each managed by a dedicated Team Lead, were comprised of 8-10 GIS technicians who worked grid-by-grid

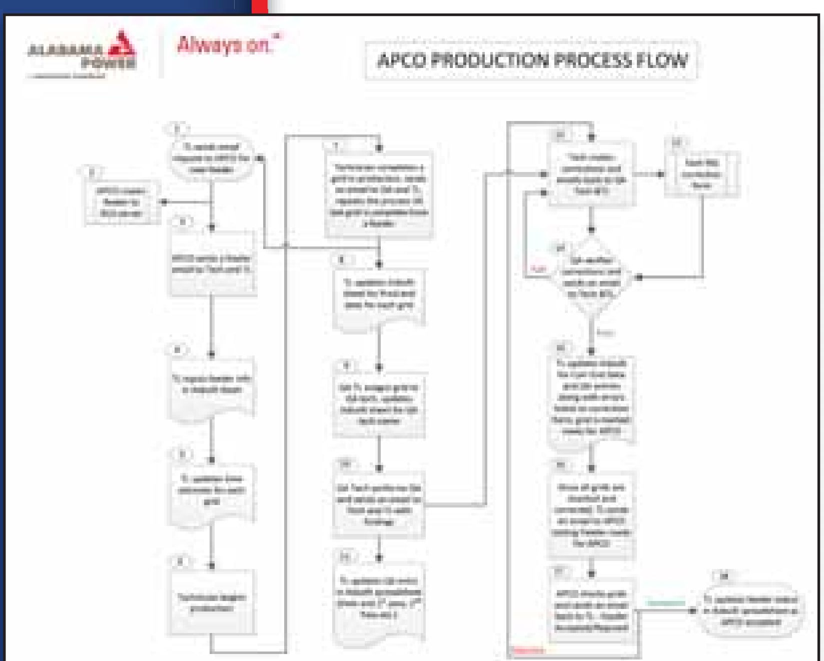

Figure 3. Rolta's process flow was strictly enforced throughout the duration of the project, and kept quality at the forefront while still maximizing productivity.

Figure 4. Google Street view offered the closest view of all poles on a given street, and referenced the viewer's position and direction of sight on the aerial photo of the same location.

through an entire feeder, posting two ArcFM sessions per day directly to APCO's GIS application through a secure CITRIX environment. In each grid, Rolta's technicians were responsible not only for executing the changes noted by the field crews, but also for ensuring the spatial integrity of all features, even when a movement wasn't indicated by the field verified map. This step was made possible through the use of available imagery throughout the Alabama Power service territory. Google Maps' Street View, shown in Figure 4, offered the closest view of installed assets and allowed the user to reference their position on the street with a satellite or 45° image of the same location. Additionally, Bing Maps' Birds Eye view offered a large coverage area, with the ability for the user to rotate their line of sight in four directions around a given point. This innovation was pivotal to the overall success of the GIS reconciliation, ensuring pinpoint accuracy in the placement of all installed assets.

Quality Assurance

Prior to a feeder's final approval, each of its grids were subjected to a thorough QA process, conducted internally by Rolta's own QA team. Comprised primarily of senior level technicians, the QA team was responsible for verifying all edits conducted by a GIS technician during the edit process, as well as checking for any field notes that were missed, or any other criteria for completion not met. While this process evolved over time, in the early stages of the project, Rolta employed a QA method that laid crucial groundwork toward the eventual expertise its team attained.

This initial QA method highlighted the project-wide accountability that Rolta maintained throughout the GIS Reconciliation project, recording each error and categorizing them by grid and type. With quality statistics for each technician being closely monitored by their team lead, trends were identified and addressed quickly. Additionally, this initial QA method emphasized individual improvement and development, requiring technicians to go back over their mistakes and make each correction themselves. For the Rolta staff, improvements on the individual level led to multiple improvements at the overall project level.

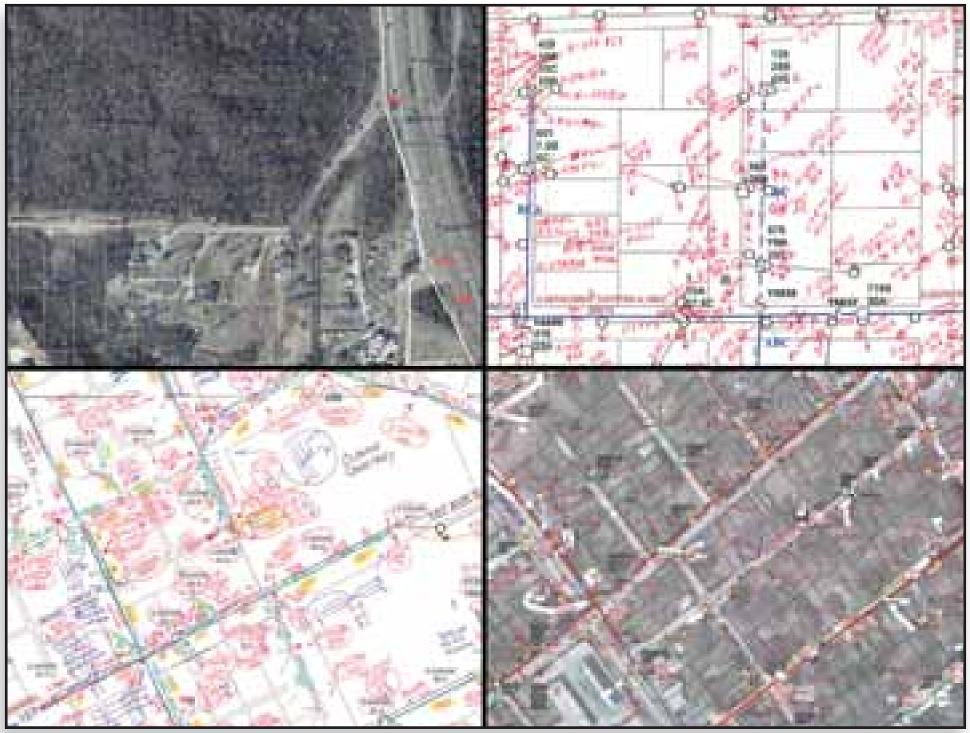

Figure 5. While the majority of notations were standard across the field inventory, large variations existed between individual field technicians.

Process Improvements

Specifically within the QA process, the Rolta team developed an Auto-QA tool for use within ArcMap that systematically checked a technician's work for the most common attribute mistakes, prior to each session submission. Use of the Auto-QA tool instantly led to a drastic improvement in project-wide error counts.

As error counts per grid continued to fall, Rolta was able to institute additional improvements to their internal QA process, including a tiered system of QA. A technician's work was subjected to one of three different QA levels, in accordance with their established quality numbers.

These levels included the standard QA process previously mentioned, a QA posting process in which each grid was fully checked and any errors found were corrected on-the-spot by the QA team, and finally a sampling process, performed on the work of technicians with an established history of high quality. This tiered QA system facilitated massive gains in the speed and efficiency of the QA process, and also allowed technicians with an established high level of quality to focus all their efforts on production.

Within that production environment, many additional process improvements were made over time, often in response to specific challenges. For example, as Figure 5 illustrates, while notation symbology remained fairly standard across the field inventory review, large variations existed between the individual field technicians.

Variations in notation style, how facility relocation was illustrated, color coding, or even differences in handwriting took time to learn and interpret quickly, but Rolta was able to circumvent this adjustment process. As their experience in interpreting the field notations developed, the Rolta team was able to differentiate between individual field technicians, allowing some of their personnel to specialize in various styles. By assigning particularly difficult or unique field verifies to a GIS technician already familiar with that specific field engineer, Rolta increased productivity by limiting the amount of time spent by GIS technicians familiarizing themselves with a particular notation style.

While several other improvements were made during the project, the most notable occurred with the advent of estimated completion times for individual grids. Established through a formula that accounts for the number of features within a specific grid, as well as project-wide time averages for those features, estimates revolutionized the ability of project management to track production.

Grid estimates gave team leads the ability to anticipate how much time a grid should take to complete, target feeder completion dates, and analyze a GIS technician's productivity. At the management level, estimates helped establish a per-feeder productivity benchmark, and project-wide, the ability of technicians and team leads to set production goals led to monumental increases in overall productivity.

This process of continuous improvement throughout the duration of the project paved the way for exceeded expectations at nearly every targeted level. As shown in Figure 6, after initial stages typical of any project where specifications must be learned and understood, the productivity and quality numbers for Rolta's team saw a steady progression over time, coming in consistently much lower than the targeted figures of 3.5 weeks per feeder and 5 errors per grid. These results remained relatively constant until Rolta's completion of the final feeder in November, 2012.

Figure 6. After initial onboarding and ramp up periods, Rolta's staff consistently met or exceeded expectations in both productivity and quality.

Conclusions

Alabama Power's GIS Reconciliation project was a resounding success, with completion coming a full month ahead of the projected end date. APCO's selected partner in the project, Rolta International, Inc. was able to facilitate a consistent, reliable production process that showed continued improvement throughout the project's duration. Additionally, the Rolta team's overall knowledge development in the day-to-day concepts crucial to power delivery gave APCO an unquestioned confidence in the quality of the work this project produced. Further evidence of this lies in APCO's successful launch of the first stages of its IDMS in October, 2012. Because the IDMS relies so heavily on the spatial integrity of the GIS Network, APCO's GIS Reconciliation was an obvious catalyst behind this successful launch.

Alabama Power has now placed itself among the industry leaders in terms of Smart Grid development. Not only has it invested in an advanced metering infrastructure, thousands of automated line devices, SCADA systems, an intelligent electronic switching platform and Volt/VAR control technology, but it rightly identified the need for all that investment to work in concert with an accurate GIS network model. With this goal achieved, APCO's integrated systems now possess an intrinsic ability to make intelligent, defensible decisions based on Smart Meter data streams, grounding all incoming metrics in accurate spatial reasoning.

"Alabama Power Company for many years has had forward thinking executive leadership that supported the advancement of technology for operating our distribution system and improving customer satisfaction. The decision was made in 2000 to implement our ESRI GIS system, but we simply converted old data to the new platform. In 2005 when we made the commitment to build our Integrated Distribution Management System, we knew that our GIS would serve as a critical data source for the project but we also knew our data was not pristine, to say the least. We made the decision to implement a full scale cleanup effort. I had the answer for gathering the data in the field but I knew I did not have the resources for the mammoth effort that would be required for data resolution in our GIS model. I started the search for a vendor that had the knowledge and resources that could partner with us on this critical project. I found that very capable partner in Rolta. Because of their knowledge and their dedication to ensure that quality and quantity were top priorities, a very successful partnership was formed. I knew we would have some hurdles to overcome on a project of this magnitude but frankly, because of the leadership at Rolta and because of a very competent and dedicated workforce, the hurdles have been far fewer than I anticipated. Looking back, I am certainly thankful that I selected Rolta to partner with Alabama Power Company on this very critical endeavor".

Brian Lindsay – Alabama Power Company GIS Manager

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ALABAMA POWER
A SOUTHERN COMPANY

About Alabama Power

Alabama Power provides electric service to more than 1.4 million homes, businesses and industries in the southern two-thirds of Alabama. It is one of four U.S. utilities operated by Southern Company, one of the nation's largest producers of electricity. Alabama Power was the first electric utility in the U.S. to establish an Economic Development Department. Southern Company and Alabama Power generate power from the combination of fossil, nuclear, hydro-electric and gas turbine plants. For more information, please visit www.alabamapower.com.

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About Rolta

Rolta is a leading provider of Geospatial Solutions, Consulting and Managed Services for many vertical segments, including Utilities, Oil & Gas, Financial Services and Manufacturing. Rolta's solutions for Utilities empower hundreds of major Electric, Gas and Water operations across the globe. Consultants average more than 15 years of Utilities, firm management and systems consulting experience. In addition to its GIS expertise, the company offers solutions for Asset Performance & Management, Construction Management, Plant Accounting, Planning & Budgeting, Customer Management & Billing and Outage Management. For more information, please visit www.Rolta.com.