Smart Meters and Power Monitoring at Florida Power & Light

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Introduction

It is estimated that sixty percent of the electrical load in the United States today is controlled by electronic devices of one sort or another. Due to this large penetration and our increasing dependence on the proper operation of these devices, Florida Power & Light (FPL) customers have become more and more sensitive to disturbances on both sides of the meter. Commercial and Industrial (CI) customers' operations can easily be shut down by disturbances lasting less than half a second. The project described below proposes the replacement of approximately 4000 Solid State Data Recorders (SSDR's) with Smart Meters. We call them Smart Meters because they provide features far superior to the present SSDR's. Smart meters measure, monitor, and report dozens and dozens of different electrical quantities. They are, in fact, very smart devices, smart enough to provide advanced Power Quality Monitoring and Reporting services.

As the nation moves towards deregulation, data collected by these meters provides an advantage in providing useful, cost-effective products and services that customers need, demand, and expect from their utility. In one sense, they provide a key component in assuring the ultimate survivability of FPL as a utility.

Smart Meters provide benefits that go beyond the basic function of measuring demand and consumption information for billing. Smart meters provide information used internally by a utility to better analyze events that occur on the power system. These meters also provide the opportunity to offer additional services to customers, helping to meet customer needs and differentiate us from the competition.

Smart Meters with Power Quality/Reliability reporting are able to provide important data as the customer sees it, not just as the utility sees it back at the substation. When a power problem occurs that is outside limits preset by FPL, the meter will initiate a call to a Power Quality master station. The master station will receive the information from the meter, process it, then initiate any number of possible actions. These actions can include:

- Paging customer, FPL account manager, or a contact of choice
- Faxing a message to a group of people
- Sending a phone message to a group of people
- Sending a file or link to FPL's Trouble Call Management System(TCMS) to automatically generate a trouble ticket for the customer
    - This will also provide FPL real time data on what is actually happening at the customer site.
    - Can be used to minimize wasted trips to customer sites by providing real time data on feeder voltage problems before a troubleman is sent.
    - Has the ability to verify customer side problems when customers are unsure of internal or external causes

Overview

Below are the highlights of the project:

- Replace FPL's existing 4050 SSDR's with Smart Meters.
- Project will require approximately 5000 Smart Meters
- These meters presently are used to bill over $1 billion in annual revenue
- Presently interrogate 1500 units via phone lines and 2500 units with Handheld EMR devices
- Investigate telephone vs wireless communications media
- All of these units were paid for and are maintained by Distribution Metering
- The majority of these SSDR's were purchased in the early '80's and are very outdated. They will need to be replaced in the next 2 to 4 years due to high maintenance costs and unavailability of repair parts
- Customers have been asking for the following services and information not available through existing SSDR's:

  Power quality data
  Number of outages & date/time of outage
  Low/high voltage
  Harmonic distortion alert
  Instantaneous active and reactive power
  Power factor
  Harmonic distortion
  Volts and amps per phase
  Graphs and charts of the above

These new meters will provide additional benefits:

- They are Y2K compliant
- Reduce maintenance expense and reduce delayed / incorrect billing
- Smart Meters can call out during power outages to notify FPL that the power is out and initiate automated TCMS Trouble Tickets
- Improve our position and standing with in-territory customers
- Enhanced services could be offered to these customers

Smart Meters with Power Quality Monitoring and Reporting allows FPL to offer a service that automatically notifies FPL of customer problems, gives specific feedback to customers that we are aware of their problems, and working on them, possibly before the customer even knows there are any problems. This type of pro-active service is exactly what today's customers are demanding.

Strategic Fit

The features and services available through Smart Meters provide a great fit between FPL and its CI customers. They give the customer something desperately needed, while also providing the utility with cost-effective means to meet those needs. Customer billing and customer service processes are enhanced. Everybody has better information. Power quality problems are readily identified, outage times are reduced, customers sleep better at night, secure in the knowledge they now possess. Everyone wins.

The services available through the Smart Meter also fit, and add value to FPL's EDMpro.com Energy Data Management (EDM) service. EDM service is provided in national marketplace and requires a drop-in, Load Profile and Power Quality Monitoring device.

Smart Meters provide an effective tool to allow FPL to better trouble shoot power problems on the FPL side of the meter. They point FPL towards countermeasures appropriate to remedy the situation discovered. Further, they help identify situations were customer initiated actions are the cause of the customer's power quality problems.

Data is transformed into information, and appropriate actions are initiated. Information vs gut feelings drive decisions. Smart Meters truly position us to better meet the needs of the customer.

Market Analysis

Smart Meters and their enhanced services are geared to the Commercial/Industrial customer segment. The enhanced services lend themselves to a monthly service fee.

The majority of FPL's commercial and industrial accounts are candidates for these services. This type of customer includes:

- Large commercial/industrial accounts including; plastic extrusion, semiconductor manufacturers, hospitals, aerospace, medium to heavy manufacturing as well as others.
- Governmental Accounts are good candidates and critical city/county accounts. This includes fire rescue/911, water/sewer plants, major lift stations, schools, as well as many others.
- Small CI & National Accounts - This can be a positive step in taking services beyond our service territory.
- The service can be expanded to include smaller businesses.

FPL Credibility

Customers depend on us to restore service and correct problems in a timely manner. This type of service can improve our credibility by providing feedback to the customer that we know there is a problem and we are working on correcting it. This would be accomplished automatically without the customer having to initiate the communication and offering a higher level of customer service for those customers who have critical power needs.

Project Team

A Smart Meter project team was established during the summer of 1998. The team's mission was to investigate options for the replacement of FPL's aging SSDR's, while possibly, at the same time providing for advanced power quality monitoring and reporting capability. Representatives from all effected functional areas were invited to participate. These areas included:

- Distribution Meter Engineering
- Distribution Field Meter Operations
- Distribution Meter Shop Operations
- Power Billing
- Meter Reading
- Information Technology – Systems
- Information Technology – R&D (communications)
- Commercial / Industrial Sales and Marketing
- Energy Data Management
- Power Supply
- Year 2000 Team

Project Beginnings

The team began its deliberations in the summer of 1998. The majority of these activities were conducted by a core group of about five members. The rest of the team serving as advisors and reviewers.

The team quickly concluded to focus on metering/PQ devices that:

- Built on existing metering technology
- Added power quality functionality to the meter vs utilizing a meter with a PQ box off to the side
- Included a communications modem "under the glass" vs a modem box off to the side
- Were able to communicate during power outages

Year 2000 Efforts

Initially, the team believed that replacement of all FPL's existing SSDR's by fully Y2K compliant Smart Meters could save FPL the cost associated in making the existing SSDR's compliant. Upon further evaluation, it was determined it prudent to de-couple these two projects. The Y2K risk was too great to depend on our ability to fully implement this project before it was too late to do something else. Therefore, the decision to visit and reprogram all 4000 SSDR's was made and implemented. Essentially all units were reprogrammed by the end of 1998.

Telephone versus Wireless Communications

The team was very interested in investigating opportunities presented by wireless technologies. The present mix of FPL SSDR's utilize approximately 1500 telephone lines, mostly dedicated, to collect billing data on a daily or weekly basis. The remaining 2500 or so SSDR's are interrogated manually, utilizing meter readers equipped with handheld Itron Premier Plus Electronic Meter Reading (EMR) devices. This data is collected monthly as part of regular meter reading routes by meter readers walking through neighborhoods.

Wireless technologies had been investigated several times in the past. Analog cellular and CDPD were looked at pretty closely. When all was said and done, FPL stuck with telephone lines for the following reasons:

- Initial cost of the wireless equipment was high – often costing a premium of $500-1000 over the cost of a telephone modem
- Wireless modem "under glass" was not available, thereby adding another $100-200 for installing the modem box off to the side
- On-going airtime costs were higher than telephone lines
- Coverage (or lack thereof) was an issue – major holes existed in FPL's service territory

In order to take a current look at the whole wireless situation, the team commissioned FPL's Information Management R&D group to investigate. This group brought quite a bit of communications expertise to the task at hand. In their normal duties, they continually investigate new communications technologies and systems. They have great practical knowledge of what could work for us, or not.

This group eventually investigated a dozen or more wireless technologies. Systems from many different suppliers and wireless providers were considered. Public and private networks were evaluated. By mid-fall, 1998, the group concluded:

- Initial cost of the wireless equipment was high – often costing a premium of $400-800 over the cost of a telephone modem
- Wireless modem "under glass" was not available, thereby adding another $100-200 for installing the modem box off to the side
- On-going airtime costs ran anywhere from about the same as to approximately half the cost telephone lines
- Coverage (or lack thereof) was an issue – large holes existed in FPL's service territory

Sounds familiar ….. better, but not quite good enough to overcome the economic justification required to displace telephone lines.

Airtime Model

In order to standardize the assumptions used in pricing wireless airtime, the team established the following functional criteria to be used in calculating airtime:

Monthly Communications per Meter			
Type	**Frequency**	**Time of Day**	**Amount of Information**
Load Profile Data Collection	Daily	Typically at 2:00 AM	24 hours of one channel of 15 minute load profile data – Data content is approximately 144 Bytes
Power Quality Events	8 times per month	Random	Power Quality Notification – Short Message
Ad Hoc Queries	6 times per month	Typically 8:00 AM to 5:00 PM	Meter Reading – Short Message

Specifications and Request for Proposal

At the end of 1998, the team developed a set of specifications, developed a Request for Proposal (RFP), and sent the RFP out to a six to ten potential suppliers. These suppliers generally were those in the marketplace with utility grade electronic meters and those with associated power quality devices.

Proposals were received and evaluated in the first quarter of 1999. FPL's decision and award was imminent when we were made aware of project underway at Duke Power Company, with many similarities to the FPL project. Their project, in fact, looked so promising, we decided to put our decision on hold until a better review and understanding could be obtained. Further, the Duke project utilized wireless communications, under the glass, just what we were looking for. We stopped to take a much closer look.

Duke Power and Smart Meters

Duke Power was in the middle of an evaluation of Smart Meters utilizing Skytel two-way paging as the communications medium. For this evaluation, Duke had selected Siemens Power T&D as their meter provider and system integrator. CEPG (now XP Technologies) was selected as the wireless equipment provider. Duke, Siemens, CEPG, and Skytel established a relationship that allowed for:

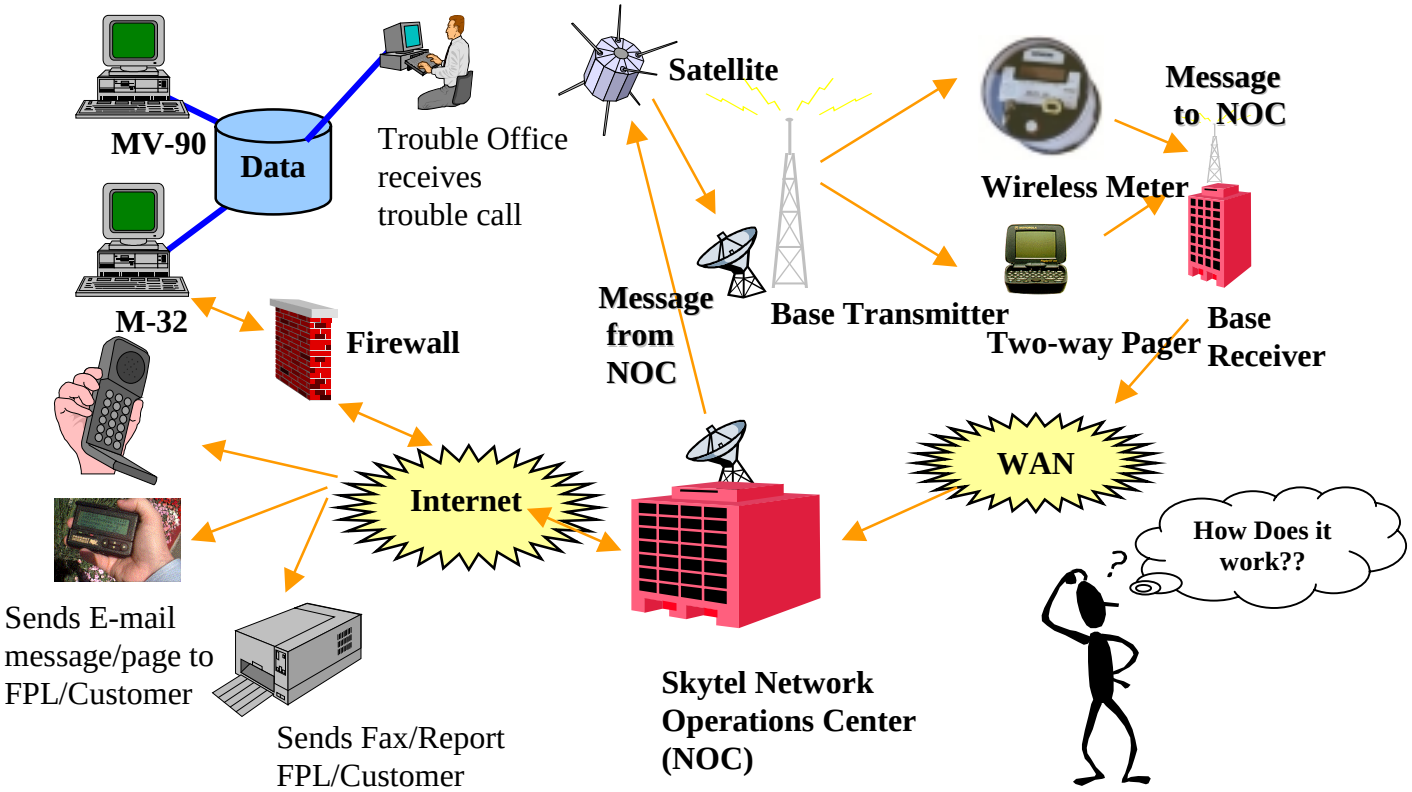
- Utility metering functions to be provided by the Siemens S4 Smart Meter
- Wireless communications board to be built by CEPG under the glass of the S4 meter (initially was a box off to the side, but soon to be under glass)
- Wireless communications to be provided by Skytel
- CEPG to provide their M32 Master Station to collect and process the metering data

FPL and Smart Meters

The FPL team conducted several discussions with Duke and concluded their program was sound and appeared very promising in meeting FPL's needs. Numerous discussions, presentations, skull sessions and the like followed with the Siemens / CEPG / Skytel team. FPL's Power Quality Monitoring needs were addressed. Existing functionality within the S4 was brought to bear. New functionality was developed for the CEPG communications board.

Functionality, specifications, contract issues, implementation plans, product testing, and numerous other activities followed during the spring, summer, and fall of 1999. A contract was signed and the first PQ Smart Meters were delivered in late winter 2000.

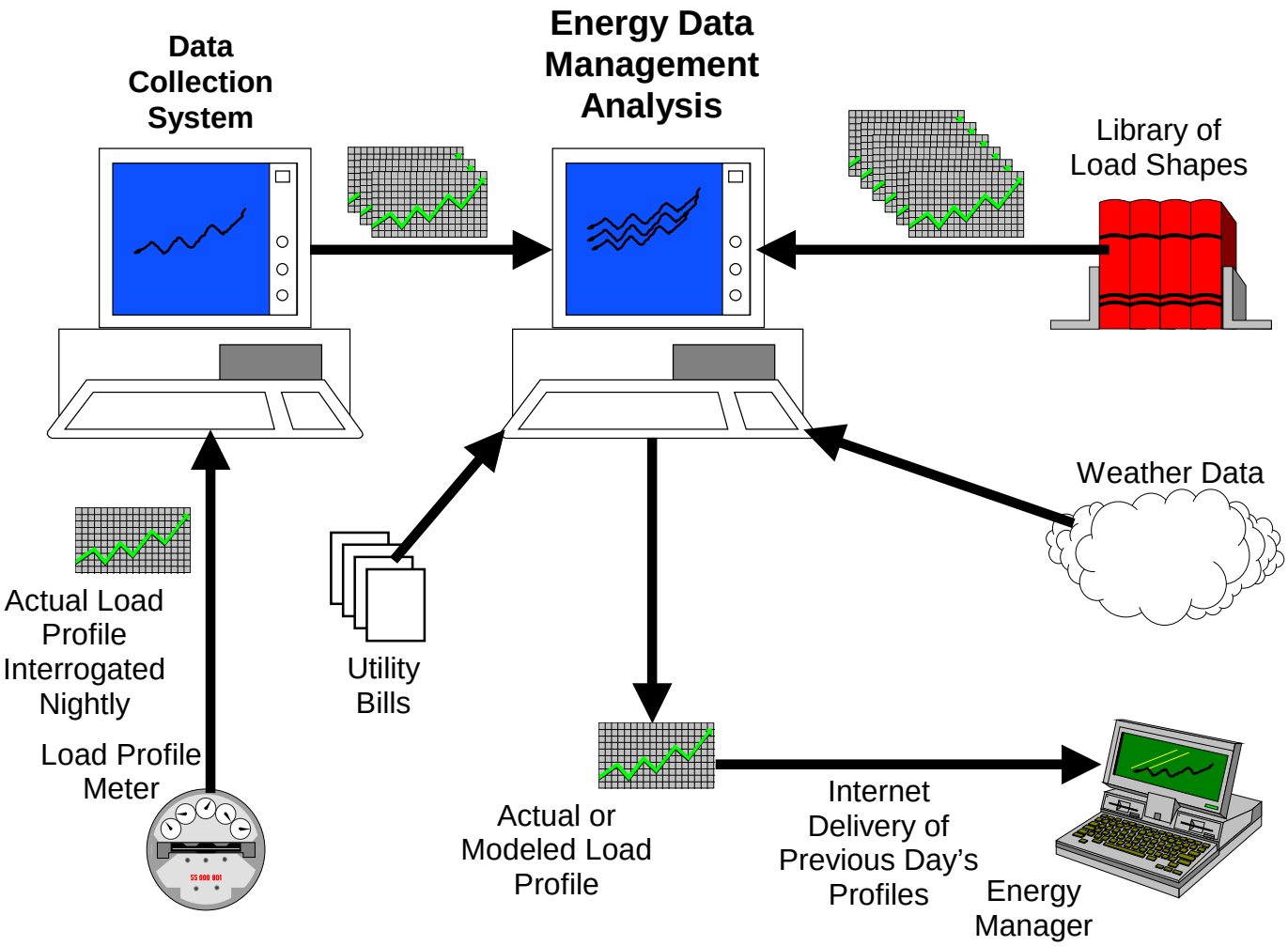
Smart Meter System Operation



Smart Meters and Energy Data Management

Smart Meters with wireless communications also provide the means to satisfy a need of FPL's EDMpro.com Energy Data Management (EDM) business. EDM is a utility bill processing, bill auditing, bill payment, analysis and services business aimed at national accounts. Fundamental to the services offered is a strong emphasis on using data to find savings for customers.

Information required for thorough rate and efficiency analysis quickly lead one to require hourly Load Profile data on customer usage patterns. Since EDMpro.com customers are located all over the country, it is very desirable to have a drop-in load profile meter solution that is national in scope. The Siemens/CEPG/Skytel Smart Meter gets us there.



Power Quality and Outage Notification Requirements

Smart meters offer the potential for vastly improved power quality data for both FPL and the customer. Smart meters offer the potential for automated trouble ticket generation from customer outage and voltage problems.

Similar to many other large utilities, FPL incorporates a Trouble Call Management System (TCMS) to pinpoint the area affected by a power outage/problem, in order to direct personnel to the area being affected. This is accomplished by the input of trouble tickets by the Customer Care Center personnel. As the TCMS system receives calls inputted into the system, it groups the calls by where on the system the customer is and automatically narrows down the possible devices on the FPL system that could be affected. This can include a transformer affecting a few customers up to a fuse or breaker that is affecting thousands of customers.

The chief drawback in the present system is that, in most cases, FPL is unaware of any customer problems unless the customer calls in, gets through to the phone center, and gets a trouble call entered. The customer waits, not knowing the status of the restoration effort. Customers often call their FPL account manager for more information. Initially, the account manager probably knows less than the customer. Several phone calls later, a clearer picture emerges, but the customer is probably still waiting for his problem to be fixed. This level of service is unacceptable to many of our large and highly automated business customers. They can't understand why FPL is unaware of their problem. After all, we live in a high tech world of computers, the Internet, whiz-bang communications, instant everything. Why exactly, don't we know …..

Smart Meters with remote Power Quality and Outage notification provide the solution. With "just a little bit of software" trouble tickets are entered directly into FPL's trouble call system (TCMS) without any human intervention. Once there, the tickets are worked at the same priority as they would have been worked, had the customer called in via phone. The big difference, however, is that the customer did not have to make the call, and further, has the assurance that his PQ needs are being attended to.

Further, the system can easily generate messages for the customer, his maintenance or operating personnel, FPL account managers, and others. Messages are generated and sent via alpha-numeric pager, fax, or e-mail. These messages can contain the following information:

- Voltages – A, B and C phase
- Reason for Message – Power outage, low voltage, power restored, etc.
- Other useful information from the Smart Meter – lots to choose from

Power Quality Specifications

The Power Quality system will be equipped to monitor and report power quality in the following two modes.

1. The first mode is the spontaneous reporting of Power Quality (PQ) events, where the meter reports these events unsolicited.

2. The second mode allows querying each meter for an archived file of PQ events..

Power Quality functions and definitions are described as follows:

Outage

An outage event is defined as a voltage drop below 50% on any phase for a user defined time (from 1 to 10 minutes).

High/Low Voltage Event

A high/low voltage event is defined as the voltage on any Phase deviating from the normal voltage on any phase by a user defined percentage (from +/- 5 to 20%) for a user defined time (from 1 to 30 minutes). The phase voltages are to be included in the response to the Master Station

Voltage Unbalance

A voltage unbalance event is a deviation of any of the three phase-to-phase voltages from the average voltage on by a user defined percentage (from 2 to 6%) for a user defined time (from 15 to 30 minutes). The average voltage is the sum of the three phase-to-phase voltages divided by three. Voltage unbalance will be calculated at a minimum every 5 minutes. The phase voltages are to be included in the response to the Master Station

Momentary Interruption/Voltage Sag

A momentary interruption/voltage sag (MIVS) is defined as the voltage on any phase deviating from the normal voltage on any phase by a user defined percentage (below 80%) for more than 3 cycles (50 ms). A MIVS event will have occurred when a user programmable number of MIVS events (1 to 10) have occurred within a user defined time window (from 1 to 60 minutes).

Wireless Coverage Verification

As described, earlier, FPL's previous investigations into wireless communications resulted in the understanding that all wireless systems were not the same. In fact, there were striking differences in the coverage provided in FPL's service territory by each of the different systems. Nobody was able to guarantee, or even claimed, to offer 100% coverage. The FPL Information Technology, R&D group was again commissioned to help validate the wireless technology considered and its effectiveness in satisfying our requirements.

For this evaluation, Skytel was provided a list of addresses for the 4,000 existing FPL SSDR sites. Skytel evaluated these addresses and reported back that their coverage maps and calculations estimated that between 80% and 85% of our locations should be within good 2-way coverage areas. Further, they believed that we should be able to achieve good coverage at approximately 90% of our sites, within a year, based on their expected infrastructure build outs.

These coverage numbers sounded good to us, but being good, conservative, utility people, we naturally responded … show us. FPL retained a wireless consultant, who jointly with all parties (Skytel, CEPG, Siemens, and FPL) developed a methodology and plan for actual field validation of Skytel's coverage estimate.

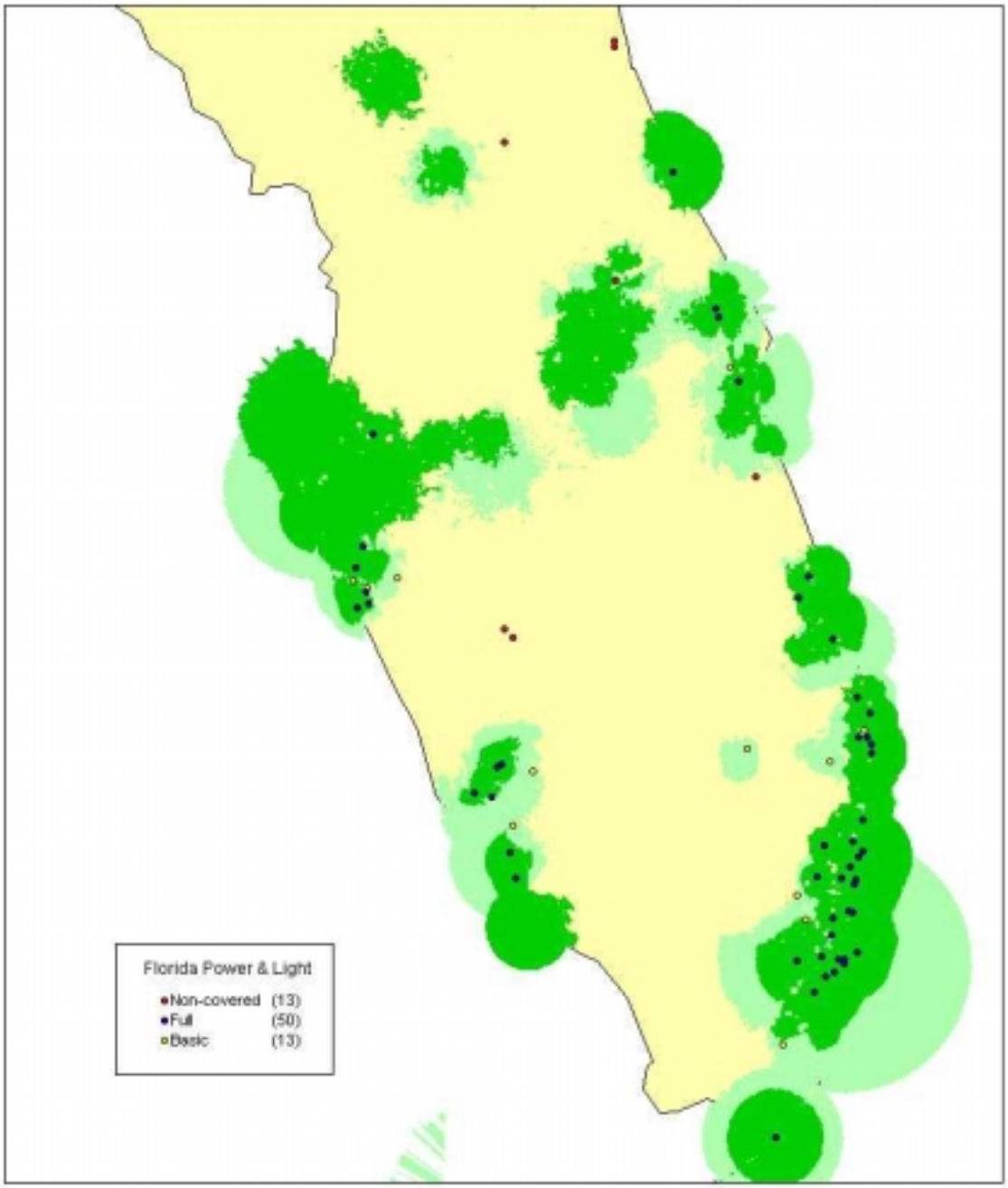
The plan included the following elements:

- Approximately 65 locations, spread through out Florida Power & Light's service territory
- Locations in good, poor and questionable areas, as determined by the Skytel maps
  - Higher weighting given to questionable coverage areas
  - Next highest weighting given to poor coverage areas
- Field equipment closely resembling the hardware to be deployed in a full rollout
- Measurement of received signal strengths
- Sending of many messages from the meter to Skytel
  - Mix of short, medium, and long messages
  - Sent over 10-15 minute period per location
- Capturing the specific GPS coordinate of the site
- Picture of each site and test equipment in place
- Capturing the number of base receivers hits by each message
- Formal documentation of all the above

When completed, the testing revealed that Skytel's original estimates were valid. The field measurements confirmed that we had a very sound communications infrastructure, and should proceed.

The FPL Information Technology R&D group also provided and evaluation of Skytel's communication technology. Skytel's Reflex Telemetry Service was examined and found to be a good fit for our needs. The ability to send messages of different lengths was viewed as quite attractive in making effective use of airtime.

SkyTel Fixed Wireless Coverage



Coverage as shown is approximate. map depicts street level coverage only and may vary due to terain, weather, building density, and interference. Map appearance may vary based on scale.

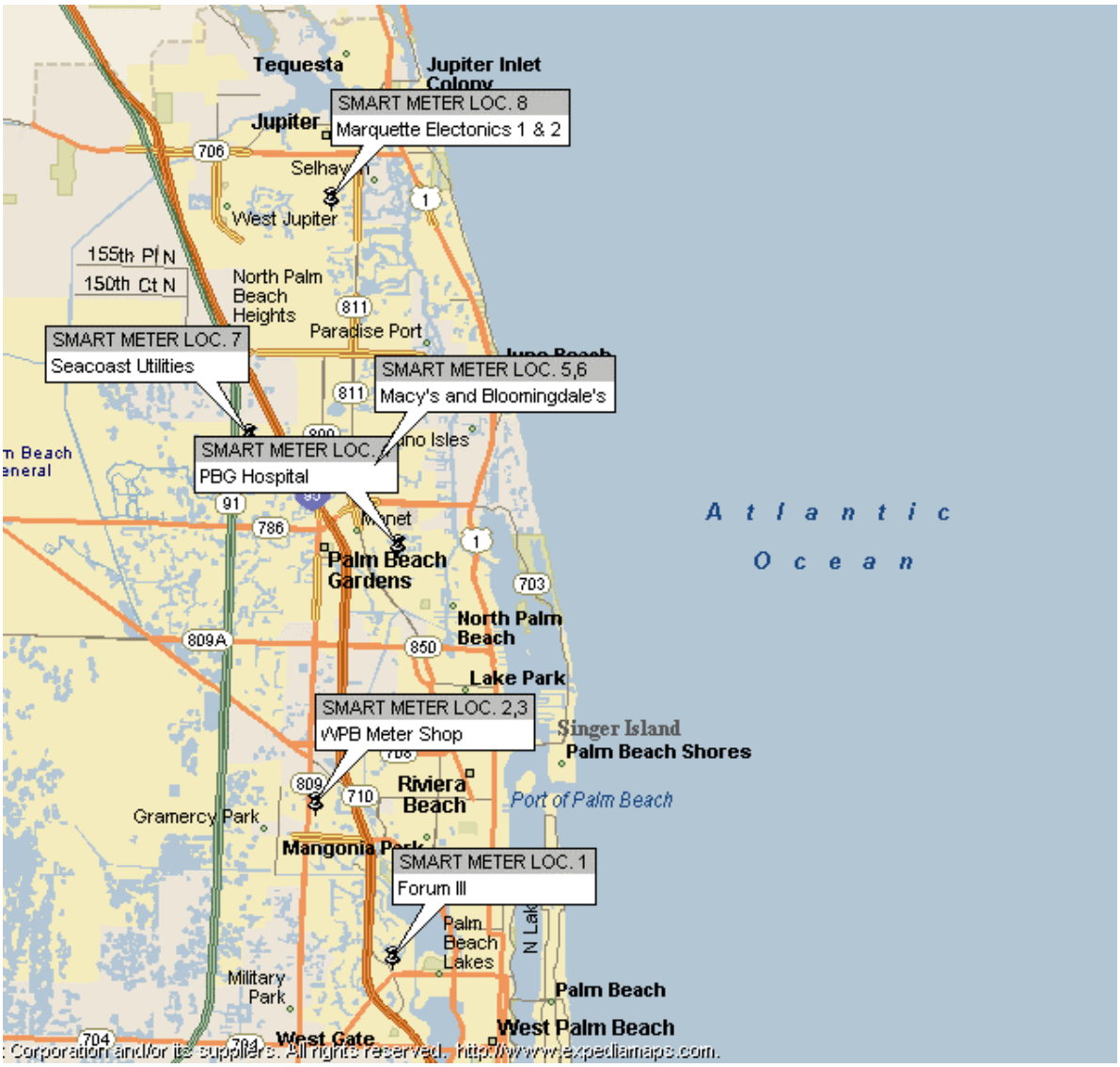
Basic Service Full Service

Typical Test Location

Goals of the Smart Meter Pilot

- Test technology applications
- Compare data to that obtained through FPL's MV-90 billing system
- Generate revenue for FPL through enhanced service offerings
- Test and demonstrate all the PQ features
- Test customer acceptance of these services
- Verify the ability to collect Load Profile (LP) metering data via Skytel
- Verify that the LP data matches the existing data
- Verify that the LP data can be passed to billing
- Verify PQ operates as intended
- Upon completion of the pilot, immediately move towards full implementation of the remaining 4000 SSDR's
- Investigate opportunities to expand into Commercial Industrial Load Control

Smart Meter Pilot Typical Locations



Pilot Implementation Plan

FPL is currently in the middle of a pilot to demonstrate the benefits of Smart Meters with Power Quality Monitoring. The pilot also provides for the implementation and testing of interfaces to other FPL systems

- Purchased and installed M-32 Master Station in late 1999
- Purchased 550 Smart Meters in early 2000
- Approximately 12-15 meters presently installed in parallel with existing SSDR's in the field
- Remaining meters to be received by end of June, 2000
- ANSI C12 Validation testing is completed
- Power Billing validation testing is nearly completed
- Expect to begin installation of the remaining meters in July, 2000
- Pilot should be concluded by 4th quarter of 2000
- 100% deployment to begin in 2001.

Conclusions

We believe Smart Meters with Power Quality Monitoring and Reporting provide us with a valuable tool in moving ahead. They satisfy a number of valid customer needs. Enhanced products and services can be provided to customers. Billing data, needed for today's rate structures, is provided in a very effective manner. Data required for future rate offerings will be readily available, when needed. Data is transformed into information and everybody wins.

In deciding to move forward, choose your partners wisely. The folks you do business with should be much more than suppliers, they truly become your partners. Only then, will a project of this magnitude work out. We truly have partners, and together we will be successful.