EPRI PEAC / Primen

Inventory of Utility Communications Technologies

Prepared for Consortium for Electric Infrastructure to Support a Digital Society

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primen

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Abstract

Utilities today use a variety of different technologies to communicate within their organizations and with their customers. Microwave, fiber, telephony, powerline carrier, broadband, and radio are some examples of the different communication mediums utilities use. The communication technologies are dependent on the particular communication need being considered — control room to substation, utility to meter, utility to customer, etc.

The communications infrastructure is a critical element of the future power system. The first large project initiated by the Consortium for Electric Infrastructure to Support a Digital Society (CEIDS) was the development of the architecture for utility communications systems that covers all aspects of communication requirements (the Integrated Electric Communication System Architecture — IECSA). As we implement applications under this architecture, it is important to understand how utilities can migrate from existing legacy systems to communication technologies of the future. We designed this project to help understand the legacy systems in place and utility views on the migration to new technologies.

In order to better understand the communication technologies that the utility industry uses, we undertook a study of utility communications and the applications they support. Our objective was to develop a general summation of the different technologies currently employed by electric utilities as a function of the different applications requiring communications (transmission, market operations, distribution, metering, etc.) Finally, we wanted to understand utility views on technology trends for different applications, including expected technologies that will be in use within five years.

Method

Our research began with a search of secondary sources of information. We looked at both publicly available sources as well as proprietary studies. Our search also looked at information already collected by EPRI, CEIDS, and other EPRI-related organizations. The search looked at both utility communication infrastructure in general and application infrastructure specifically. What we found was a lack of quality, in-depth information related to utility communications. Our search only uncovered a few general reports that did not provide the type of inventory information required to meet our objectives. (The bibliography resulting from the secondary search appears in **Appendix A**).

We then decided to interview individual utilities to gather the information required. As a statistically significant quantitative survey would be cost and time prohibitive, we targeted a general audience of utilities with a qualitative survey. Our goal was to interview approximately 15 of the 75 largest investor owned utilities (in terms of number of meters) and approximately five large municipalities.

We designed a qualitative survey instrument consisting of six primary questions. (A copy of the survey instrument appears in **Appendix B**). The main objective of the instrument was to identify the communication technologies utilities use for nine critical business applications:

- Market operations: load forecasting, generation scheduling and dispatching, and ancillary services
- Transmission SCADA/EMS, FRS and Wide Area Monitoring Systems (WAMS)
- Distribution SCADA (control room to and from substation)
- Distribution automation involving communication to devices on the distribution circuits
- Substation monitoring and power quality data collection
- Meter reading (basic revenue metering applications)
- Advanced meter reading including revenue metering with power quality and additional data collection
- Customer services: real-time pricing, load management, distributed generation coordination, etc.
- Internal work force communication

We began interviewing in November 2003. While we sought individuals at the utility who could provide a comprehensive overview of corporate communications, we quickly found that information was dispersed among a number of managers, each of whom focuses on only a few applications. As a result, we often had to interview multiple individuals at a utility in order to construct a complete picture. In other instances, we could not identify all the knowledgeable individuals at a utility. This resulted in only partial information. All respondents were promised confidentiality and only anonymous quotes are included in this report unless from a publicly available secondary source. We concluded the interviewing in January 2004. We list the 18 utilities we interviewed in **Table 1**.

Table 1. Utility respondents

AEP (IOU)	Oncor (IOU)
Austin Energy (Municipal)	PacifiCorp (IOU)
Cinergy (IOU)	Pacific Gas & Electric (IOU)
Consolidated Edison (IOU)	Portland General Electric (IOU)
Exelon (IOU)	Public Service Electric & Gas (IOU)
Idaho Power (IOU)	Southern California Edison (IOU)
LADWP (Municipal)	Southern Company (IOU)
National Grid USA (IOU)	Tampa Electric (IOU)
Omaha Public Power District (Municipal)	Xcel (IOU)

Key Findings

Many respondents indicated that they use multiple technologies for a single application. **Table 2** shows a distribution of responses for each technology and application and reflects this finding.

Table 2. Technology — Application Overview Matrix

	Communication technology							
Application	**Leased phone line**	**DSL**	**Cellular**	**Licensed MAS radio**	**Other licensed radio**	**Unlicensed spread spectrum (non-802.11 family)**	**Wireless (802.11)**	**Other wireless and radio**
Market operations load forecasting, generation scheduling and dispatching, ancillary services	3	0	0	5	0	0	0	1
Transmission SCADA/EMS, DFRs and Wide Area Monitoring Systems (WAMS)	11	0	0	11	4	1	0	2
Distribution SCADA (control room to and from substations)	13	0	1	7	5	0	0	0
Distribution automation invoicing communication to devices on the distribution circuits	1	0	2	0	7	0	0	1
Substation monitoring and power quality data collection	9	0	2	3	4	0	0	1
Meter reading (basic revenue metering applications)	11	0	2	1	4	0	0	7
Meter reading revenue metering with power quality and additional data collection	10	0	1	1	3	0	0	2
Customer services such as real time pricing, load management, distributed generation coordination, etc.	5	0	2	2	1	0	0	1
Internal work force communication	4	0	6	6	14	0	0	4

Note: Number of utilities using technology. Using more than one technology for an application is possible.

Table 2. Technology — Application Overview Matrix, continued

	Communication technology						
Application	**Dedicated fiber circuits**	**Satellite**	**Power line carrier**	**Public Internet**	**Other**	**Not available**	**Don't use**
Market operations load forecasting, generation scheduling and dispatching, ancillary services	4	0	0	5	0	8	0
Transmission SCADA/EMS, DFRs and Wide Area Monitoring Systems (WAMS)	10	2	2	0	0	1	0
Distribution SCADA (control room to and from substations)	4	0	0	0	0	1	0
Distribution automation invoicing communication to devices on the distribution circuits	0	0	0	0	0	2	5
Substation monitoring and power quality data collection	5	0	0	0	0	1	1
Meter reading (basic revenue metering applications)	1	0	3	0	0	3	0
Meter reading revenue metering with power quality and additional data collection	1	0	2	2	0	2	1
Customer services such as real time pricing, load management, distributed generation coordination, etc.	2	2	2	0	1	5	0
Internal work force communication	3	0	0	0	0	0	0

Note: Number of utilities using technology. Using more than one technology for an application is possible.

We also found that:

- Phone lines remain a major communication backbone for our respondents with phones being used for every single application. No other technology was as widely utilized.
- Transmission communication relies heavily on phone lines, microwave, and fiber, usually with the three mediums working together. However, utilities rely primarily on phone lines for distribution communications with a more limited use of microwave and radio.
- The majority of respondents are providing some level of communication for each application. However, five respondents indicated their company does not provide communication infrastructure for devices on their distribution system.
- Where automated meter reading is deployed, utilities rely heavily on phone lines. This is especially true where AMR deployments are limited to the largest commercial and industrial accounts.
- Offerings related to advanced metering and customer services are fairly limited among our respondents. Many respondents are offering trial or pilot projects and their communication infrastructure is scattered across several technologies.
- Radio is the primary technology for work force communication and is supplemented by phone lines, cell phones, and microwave.
- Microwave is used extensively for transmission and distribution communications. Utilities then piggyback other applications, including distribution device communication, market operations, and work force management, on to their microwave network.
- Only three respondents use either satellite or power line carrier (PLC) for any of the applications we reviewed.

Viewing each respondent's communication infrastructure by application provides additional insight. **Table 3** shows the types of technologies each responding company uses.

Table 3. Utility — Application Matrix

Application	Utility 1 (IOU)	Utility 2 (IOU)	Utility 3 (IOU)	Utility 4 (IOU)	Utility 5 (IOU)	Utility 6 (IOU)
	Communication technology					
Market operations load forecasting, generation scheduling and dispatching, ancillary services	N/A	N/A	N/A	Combination of fiber and microwave	N/A	95% microwave; 5% fiber
Transmission SCADA/EMS, DFRs and Wide Area Monitoring Systems (WAMS)	15% phone line; 75% microwave; 10% fiber	15% fiber optic, 60% microwave, 30% PLC, 0.1% Satellite	N/A	1/3 fiber; 1/3 phone line; 1/3 microwave	Primarily phone, some microwave, 2-3% radio	95% microwave; 5% fiber
Distribution SCADA (control room to and from substations)	Almost all phone line; very little microwave	80% microwave; 20% phone line; 10% cellular	N/A	80% microwave; 20% phone line	4% cellular; rest are combination of fiber and phone	75% phone; 25% microwave
Distribution automation invoicing communication to devices on the distribution circuits	Nothing; considered wireless pilot	N/A	N/A	80% microwave; 20% phone line	N/A	All phone
Substation monitoring and power quality data collection	Almost all phone line; very little microwave	10% fiber	N/A	Mainly phone lines	Phone lines for the few substations with power quality monitoring	All phone
Meter reading (basic revenue metering applications)	Mainly phone modems; 5 - 10% wireless	10% phone line; 90% manual	N/A	Almost all manual; <1% radio	Some Ethernet, little cellular, large percentage are manual	Almost all manual; 13% converting to PLC
Meter reading revenue metering with power quality and additional data collection	Mainly phone modems	15% fiber optic, 60% microwave, 30% PLC, 0.1% Satellite	N/A	Mainly phone lines	Primarily Ethernet	Mainly phone lines for larger customers
Customer services such as real time pricing, load management, distributed generation coordination, etc.	N/A	50% phone line; 50% cellular	N/A	Phone lines for VPN	N/A	Nothing now; migrating to PLC
Internal work force communication	Mainly VHF radio; some cellular; 5% microwave; 10% fiber optic	80% cellular, 20% radio	100% radio	Combination of radio, fiber, and leased phone lines	Primarily radio	All radio - 153 MHz

Note: Percentages refer to # of nodes
N/A = not available

Table 3. Utility — Application Matrix, continued

	Communication technology					
Application	**Utility 7 (IOU)**	**Utility 8 (IOU)**	**Utility 9 (IOU)**	**Utility 10 (IOU)**	**Utility 11 (IOU)**	**Utility 12 (IOU)**
Market operations load forecasting, generation scheduling and dispatching, ancillary services	N/A	N/A	Primarily fiber	N/A	N/A	Mainly phone line with a little microwave
Transmission SCADA/EMS, DFRs and Wide Area Monitoring Systems (WAMS)	Mainly satellite with some radio and a little phone line	90% phone, 10% radio (900MHz)	Primarily phone line with PLC to some points	Combination of microwave, telephone and fiber	95% phone line, 5% fiber or microwave	100% phone line
Distribution SCADA (control room to and from substations)	Primarily radio	50% phone, 50% radio (900MHz)	Primarily phone line	Primarily phone line	95% phone line, 5% fiber or microwave	100% phone line
Distribution automation invoicing communication to devices on the distribution circuits	Primarily radio - 900MHz	100% radio	Primarily radio (900MHz)	Nothing	Piloting cellular technology	Nothing
Substation monitoring and power quality data collection	Primarily radio - 900MHz	Combination of fiber, microwave and phone	Primarily phone line	Nothing	Primarily phone line	Phone line to larger stations; experimenting with cellular to smaller stations
Meter reading (basic revenue metering applications)	10% radio, paging or phone; 90% manual	N/A	<1% phone line for larger customers; mainly manual; studying radio and wireless	N/A	Primarily drive-by wireless with some phone line for C&I	Mainly manual; 80% of large C&I are phone line; 20% of large C&I are cellular
Meter reading revenue metering with power quality and additional data collection	10% radio, paging or phone	N/A	NA	N/A	Phone lines for largest C&I accounts	80% phone line; 20% cellular
Customer services such as real time pricing, load management, distributed generation coordination, etc.	Primarily satellite with some T1 connections	N/A	Few nodes use phone lines	N/A	N/A	80% phone line; 20% cellular
Internal work force communication	100% wireless	100% radio	Combination of radio (800MHz), phone line, microwave and wireless	95% radio, 5% microwave	1/3 phone line, 1/3 radio, 1/3 cellular	90% phone line; 10% wireless; also have radio

Note: Percentages refer to # of nodes
N/A = not available

Table 3. Utility — Application Matrix, continued

Application	Communication technology					
	Utility 13 (IOU)	Utility 14 (IOU)	Utility 15 (IOU)	Utility 16 (Municipal)	Utility 17 (Municipal)	Utility 18 (Municipal)
Market operations load forecasting, generation scheduling and dispatching, ancillary services	Combination of phone line and microwave	N/A	Combination of microwave and phone line	60% microwave, 35% phone, 5% fiber	Primarily microwave; migrating to fiber	80% fiber optics; 20% gigabyte Ethernet
Transmission SCADA/EMS, DFRs and Wide Area Monitoring Systems (WAMS)	Combination of phone line and microwave	100% radio (800MHz)	80% microwave; 18% phone; 2% fiber	50% phone, 42% microwave, 8% fiber	Moving to fiber and considering wireless	15% gigabyte Ethernet; 80% fiber optics; 5% microwave
Distribution SCADA (control room to and from substations)	Combination of phone line and microwave	65% radio; 15% phone line; 20% nothing	50% nothing; 30% phone; 18% microwave; 1.5% fiber; 0.5% radio	50% phone, 42% microwave, 8% fiber	60% fiber; 40% phone line; considering wireless	Licensed multi-point radio (6 and 2.4 gig)
Distribution automation invoicing communication to devices on the distribution circuits	Nothing	Radio (800MHz)	Nothing	Experimenting with radio (900MHz)	Combination cell phone, radio (900MHz) and wireless	Licensed multi-point radio (6 and 2.4 gig)
Substation monitoring and power quality data collection	Primarily phone line with some cellular	Radio (800MHz)	50% nothing; 30% phone; 18% microwave; 1.5% fiber; 0.5% radio	50% phone, 42% microwave, 8% fiber	Combination cell phone, radio (900MHz) and wireless	All fiber optics
Meter reading (basic revenue metering applications)	Primarily manual; <1% phone line; <1% wireless; <1% PLC	60% radio; 40% manual; small percentage phone line	98% wireless drive-by; 1% phone line; <1% pager; <1% radio; <1% PLC	Combination of phone lines, microwave and fiber	Almost all manual; <1% wireless; <1% phone line	33% fixed wireless, 8% spread spectrum, 41% manual
Meter reading revenue metering with power quality and additional data collection	Primarily phone line	60% radio; 40% manual; small percentage phone line	98% wireless drive-by; 1% phone line; <1% pager; <1% radio; <1% PLC	Satellite	Nothing currently; considering wireless solutions	Large customers use land line direct connection
Customer services such as real time pricing, load management, distributed generation coordination, etc.	Primarily phone line	Radio (800MHz)	Combination of microwave, phone line and fiber	Satellite	Combination of PLC and microwave	80% fiber optics; 20% gigabyte Ethernet
Internal work force communication	Microwave and fiber with radio (800MHz)	Radio (800MHz)	Combination of radio, microwave, fiber, phone line and cellular	Radio (800MHz) and pager	Combination of trunking radio (900MHz); single channel radio (48MHz); cellular	All radio with cellular as a back-up system

Note: Percentages refer to # of nodes
N/A = not available

This table shows the diffused nature of communication technology deployments. Very few utilities seem to have a single over-arching communications architecture that they leverage for most of their applications. Instead, technologies appear to be segmented between meter reading, transmission, distribution, and operations, with each segment utilizing its own particular technology or combination of technologies. Even within segments, the combination of technologies is extremely varied, most likely impacted by three factors:

- Time of deployment: our respondents indicated that dealing with legacy systems in all areas is an issue. Often the technology that is deployed to a customer or substation or employee is based upon when a particular program or location was brought into the company's communication infrastructure. Replacing existing architecture is expensive so it appears that utilities sometimes simply layer a newer form of technology into their network when they have a specific objective that cannot be accomplished by the older infrastructure.

- Physical location: Different communication technologies are used to reach different areas within a utility's territories. For example, certain substations may have a physical fiber optic connection while others rely on microwave, radio, and even phone lines due to their distance from other utility assets.

- Service territory combination: The wave of mergers and acquisitions that swept the industry in the past decade means that many utilities inherited different systems in different territories. Rather than spend additional resources to convert their now combined entity to a single standard, utilities will continue to use infrastructure from previous investments.

Other observations reflected in Table 3 include:

- Distribution and transmission communication are often piggybacked on one another. This means that a utility's ability to provide more complicated communications, for example to the device level, may be limited by the age and complexity of the existing transmission communication backbone.

- Meter reading is still done manually at many of our respondents. Very few of our respondents have large-scale AMR deployments. Most of the respondents do offer advanced metering services to their largest customers and have deployed AMR, primarily connected by phone lines, to these accounts. However, these deployments are fairly limited: a few thousand meters at the largest respondents and less than 30 at the smaller utilities.

- When it comes to communicating with their employees, utilities use a multitude of systems primarily for redundancy. Many companies rely heavily on radio, especially to communicate with work crews. However, this communication is supplemented with cellular phones, landlines, microwave transmissions, and wireless broadcasts. One respondent said that the industry faces a problem with its existing radio networks in the face of newer technologies:

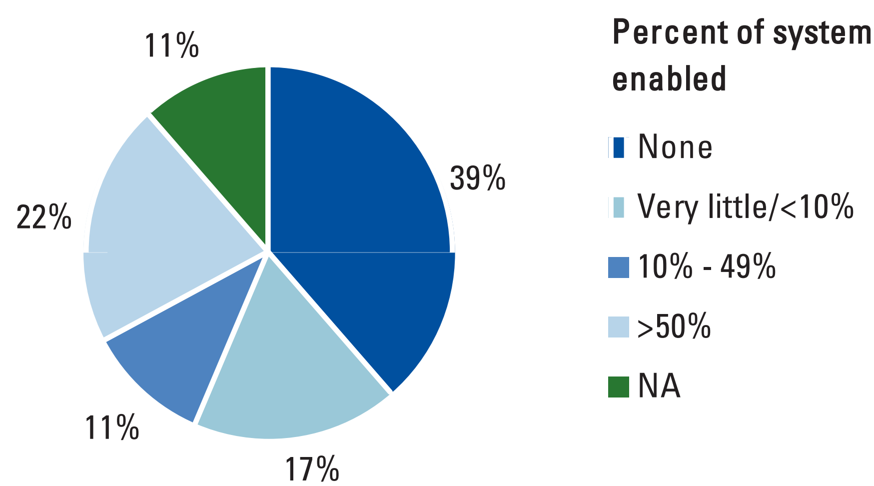
  We have a VHF radio system, and it's supposedly our primary (work force communication system), but it's really relegated to backup status. People tend to use the cellular phone more. Which is a huge industry issue, by the way. You've got this system which you've built and maintained, and now the FCC is going to reform it, and cause us to spend a whole lot of money on what has become somewhat of a backup system.

- Where companies have invested in higher cost communication assets like satellite or fiber, there does appear to be an attempt to leverage that asset for as many applications as possible. However, a review of the utilities in **Table 3** shows that only a handful appear to have a coordinated communication backbone: a single technology attempting to provide multiple applications.

- Table 3 also shows that some companies are experimenting with different communication mediums including PLC, wireless, and satellite. Other respondents indicated they had piloted technologies, but that they had abandoned them due to problems they encountered. For example, one utility said they tested a satellite system that they did not deploy because of communication latency.

As noted above, many of the utilities rely on older legacy communication mediums. This limits their ability to implement more advanced forms of communication. We asked each respondent what percent of their system is TCP/IP protocol enabled. **Figure 1** shows only 22% of respondents said the majority of their system can handle TCP/IP communications. (Only one company, a municipality, said 100% of their system is TCP/IP enabled.) Another 17% said "very little" of their system is enabled and 39% said none of theirs is TCP/IP accessible.

Figure 1. Percent of respondents with communication system TCP/IP enabled

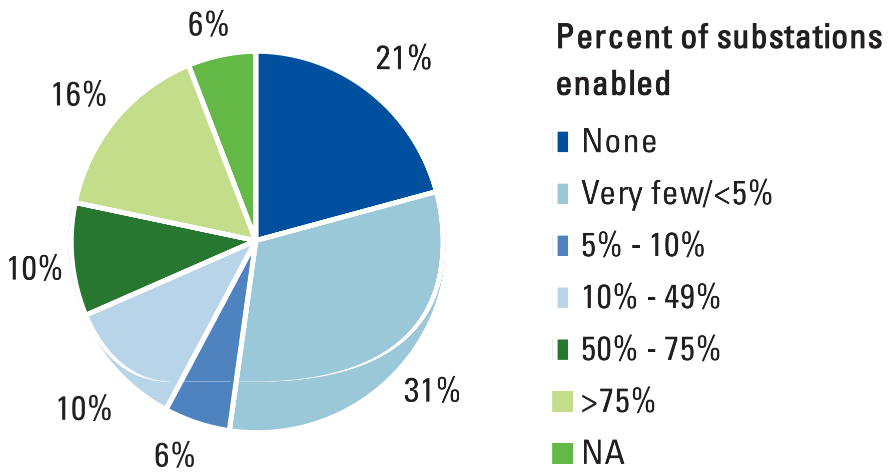


Some respondents indicated their systems can be adapted to handle TCP/IP but they are choosing not to use the protocol. One respondent said many utilities are reluctant to employ TCP/IP because of security concerns:

> *The whole rest of the world uses TCP/IP, but the utility industry, for whatever reason, says, "Oh, no, we can't use it. It's not secure." … I guess if we have a landline brought in from the local telco it would have TCP/IP, but we have doggedly stayed away from TCP/IP as far as the controls inside the substations. We have to go to some industry specific standard that nobody knows, and (costs) us a lot more.*

Similarly, most respondents said very few of their substations have high-speed (128 kbps or higher) communication capabilities. **Figure 2** shows that 21% of respondents have no high-speed substation communication backbone and 31% are fairly limited in their deployments.

Figure 2. Percent of respondents with substations capable of high-speed communications



Expected changes

Increasing substation communication speed is the change most often cited by respondents when looking out over the next five years. Respondents say utilities will need the increased speed to improve operational efficiency and handle new applications:

> *(It) is wise to upgrade, because a lot of the substation lines are analog today. So getting a high-speed digital circuit out to these substations, where you can do multiple things — SCADA, video surveillance, power quality stuff, relay information — is on the horizon. That's to the major substations, like the transmission substations.*

The types of applications mentioned above require not only more speed, but more connection time making systems such as phone lines cost prohibitive. Another respondent echoed this problem:

> *We just initiated a changeover from those dial up lines … to frame-relay lines. We looked into the costs that a frame-relay line would present to us, relative to the dial up lines. We actually get charged by the minute, and this charge keeps mounting up, and when we do a lot of communications with those substations … it becomes an expensive operation, because we constantly poll and all those (minutes) across a 24- hour period, are being charged. In looking at that cost package, we looked at putting a frame package in there and what the cost for that would be initially and also on an annual base, and we've actually come up with substantial savings, going to a frame system, with really no out of pocket costs, because there are a number of packages where they provide phone line management packages, where they are monitoring the schemes all the time, and they're proactive on repair, so we're saving a lot money.*

The utilities mentioned a variety of drivers that are creating the need for higher speeds and longer connections to their substations:

> *The SCADA infrastructure is being changed over to an IP LAN. Then, on top of that is substation monitoring: any device in the station that can be monitored needs to be equipped with communications, whether we automated it or not. What we're doing is beginning to extend an IP grid to the data beyond SCADA.*

> *The new project that I'm helping to coordinate will actually link to the communication in the substation to be able to tie our real SCADA to the distribution side, and validate that we didn't just lose the bus, we actually lost the circuit, and therefore open up the midpoint switch. So were adding some new technology, some more smarts to it. Our biggest challenge right now is to find an inexpensive way to get that com back on our fault indicators. We have 12,000-14,000 of these units out there. Way too many to go out there and try to find a little blinking light in pouring rain at three in the morning.*

Right now all of our stuff is analog. Within the next five years a lot of our stuff is going to be digital so we'll be able to go to a frame relay as far as the public network goes. That's the only big change that I see. We're not going to have fiber to any of the substations, we're going to have high-speed data to the substations.

I know they're looking to get higher-speed circuits out (to the substations), and be able to control them over the LAN environment. Obviously, it's a cost issue. If we had our own private system out to the locations, that's where they'd be placing them. Unfortunately, when you go to the phone company, looking for high-speed circuits, it's a cost issue. That's why we're pretty much sticking with the DDS2 digital circuits. They are toying with frame. But frame starts getting pricey. It's a balancing act on cost versus need… If you can't justify it you just don't put it in.

Our desire is to move towards integrating our substations into the network, and having local area networks in the station, smart relays, and smart subsystems (moving) away from a SCADA box that collects analog and digital data to a station network that has a number of different devices that talk on the network and are able to then utilize the network to get data back to our master stations. We're moving in that direction, but I don't know how fast we can move. Because of the legacy of equipment that we have out there.

(We'll see) increased use of the substation as a node for the control of a distribution network. In other words, intelligent switches hanging off of distribution lines, where you can do switching either manually or automatically, to keep customers online, for better quality and reliability.

Other changes some of our respondents foresee included:

- Voice over IP
- Migrating fiber optic infrastructure to ring typology
- Possible expansion of fiber optic networks

Integration

Many of our respondents complained about the diffuse nature of their communication systems. They pointed to several recent industry trends — deregulation, mergers and acquisitions, cost containment — as having created hodge-podge systems that make it difficult to efficiently perform operations. As a result, some respondents mentioned integration of technologies and systems as a major issue for them in the coming year. Respondents are studying, and in some cases, testing technology that allows them to tie a number of different applications together into a system architecture using a seamless communication network. One respondent pointed out how this type of integration benefits operational efficiency:

> *You want to be able to utilize your resources as efficiently as possible, and the telecommunications network really does afford that. You can break the boundaries of location, and be able to have your engineering resources or other resources, customer service and things like that, independent of location as much as possible, as the telecommunications networks get better. So we're really looking at a total network infrastructure plan as we speak. One that would take us into the next generation, not only in communications, but of technology to support mobile devices, real time job estimating for customers, and that type of thing.*

However, respondents believe actual investment in integration may be limited by its cost. As one respondent said:

> *In a regulated utility environment, one of the things that we all ought to be working on is making sure that we get recovery from the big investments that we make in communications. And as we go forward with whatever FERC does in RTOs or whatever the states do as far as granting our investments, it's a big issue. If you spend a billion dollars building a wonderful communications system, and you go to the state and they don't allow it in the rates, because they say, "You didn't need that," or "You're going to use it for some other business," or whatever. It's a huge issue. That's going to be a hell of a hit to our capital budget.*

Another respondent said:

> *While I'd like to think that we'd move toward some of the more advanced technologies, in reality, I don't think the business climate is such that it lends itself to incorporating them, at least not in five years. Maybe once we see someone else successfully implement them. I certainly don't want to be on the "bleeding edge" of technology.*

Powerline carrier/Broadband over Powerline

Very few of our respondents currently utilize PLC for their applications. However, there is interest in how the faster speeds that broadband over powerline (BPL) might benefit utility operations, as well as provide a revenue stream by offering broadband services to consumers. Two of our respondents said their utility operations groups are currently studying and/or piloting BPL, looking at the applications the technology could enable including metering and substation data. "It looks to be very promising," one respondent said. "Because it's high speed. Basically it ties into our network. There could be big opportunities there."

In January 2004, Primen provided a report to CEIDS on the status of BPL trials in the United States. Since that time, several significant developments have occurred in the BPL market:

- Cinergy launched broadband access service on a commercial basis and anticipates reaching a positive cash flow in three years. The company believes it can reach this goal at 260,000 households passed. As of early March, Cinergy's build-out is at 1,200 homes passed. ("Passed" is the number of the homes that will have access to the BPL network, not the actual number of subscribers.)

- PPL Telcom has reached 5,000 homes passed in their deployment in Pennsylvania.

- Progress Energy and EarthLink plan a market trial in North Carolina for 500 homes.

- Several other utilities have announced or plan tests of deployments this year, including Central Virginia Cooperative, IDACOMM, PUC Telecom Sault St. Marie, Ontario, and Ameren.

- The Federal Communications Commission announced plans to adopt new requirements and measurement guidelines for BPL to address interference concerns. (See 2/23/04 announcement at www.fcc.gov.)

Cinergy's Broadband Venture

On March 2, 2004 Cinergy made its anticipated announcement of entry into the broadband over powerline (BPL) business. Cinergy Broadband, along with partner Current Communications, aims to build a network that has the capacity to serve 55,000 households in the Cincinnati area by the end of year. It also plans on entering other states in Cinergy's territory. By late 2004, the venture could expand into Northern Kentucky and by 2005 into parts of Indiana.

According to Alex Pardo, a manager at Cinergy Broadband, of the initial 55,000 homes passed in 2004, Cinergy hopes for about 20% penetration, or about 10,000 to 15,000 actual subscribers.

Cinergy, along with Current Communications' existing investors, Liberty Associated Partners and EnerTech Capital, reports having collectively invested $70 million in Current Communications. *The Cincinnati Enquirer* pegs Cinergy's capital contribution at $10 million — comparable to investments some other utilities have made in other BPL technology companies.

Cinergy will offer its service to consumers at different prices, depending on connection speed. Monthly prices range from $29.95 for 1 megabit per second to $39.99 for 3 megabits per second. At these prices, says Pardo, Cinergy anticipates "having a positive cash flow in three years, and our target is 260,000 homes passed by that time."

It remains to be seen whether $30 to $40 per month BPL prices will lure dial-up customers, persuade cable or DSL customers to switch, or make much of a dent in the market that has not opted for high-speed access where it is available.

Pardo believes most of Cinergy's market will come from dial-up customers wishing to convert their service. "That being said, " notes Pardo, "we think there is potential for switchers as well." In the areas targeted by Cinergy, a considerable portion of customers already has access to DSL and cable.

Pardo thinks, "lots of people feel underserved," and will be interested in BPL service. He speculates in particular about being able to get cable customers to switch, since customer satisfaction with cable providers is often low and their prices are highest.

Beyond the broadband business, Cinergy is also aggressive about BPL due to the utility operational benefits the technology could bring. Cinergy is not implementing utility applications right away; it is waiting until the BPL network is expanded. But Pardo foresees several initial applications:

> *Power quality monitoring — voltage reading both sides of the transformer, and outage and restoration detection, we'll do right away. For outages, most utilities use a triangulation system, based on locations of calls. But when a BPL device is off we can determine if the reason is because of the device or an outage. That way we can do better outage monitoring. And down the road we see using BPL for direct load control applications and meter reading.*
>
> — Alex Pardo

Some utilities may consider BPL primarily for the operational benefits. For example, in a Primen teleconference held in February 2004, Tim Frost, Director of Corporate Planning at Con Edison, explained:

> *Our focus has been utility applications because that's what we know.... I know I don't know broadband. I do not know what the competitive responses of the other technologies will or will not be. Utility applications are attractive ...to the extent we can utilize BPL as a communications backbone for utility applications, as an efficient means of deploying capital to serve our customer better in our core business. At the same time, we have the potential for broadband delivery. That makes BPL very compelling.*
>
> — Tim Frost

Frost said Con Ed is studying a variety of applications ranging from outage management to predicting equipment failure to some "intelligent grid" possibilities.

> *We've been able to use PLC to identify and even predict device failure. In a handful of instances, we've created profiles of a healthy circuit and can identify noise created by a piece of equipment that's on its way to failure. For example, if a lightning arrestor was on its way to catastrophic failure, you may be able to identify its failure, thus avoiding the loss of service to our customers.*
>
> — Tim Frost

BPL is part of Con Ed's 3G (Third Generation) initiative, investigating possibilities for the distribution grid of the future with a 10 to 25 year time horizon.

> *The first thing to focus on is creating two-way systems, both for electric and communication systems…creating an intelligent grid. One thing better than new fancy hardware is better math solutions. We need to spend more time looking at reliability under uncertainty, using more probabilistic modeling when we look at what our alternatives are and how we achieve reliability. There is a whole lot of promise for new, non-linear optimization methods that will utilize feedback and communication from a new intelligent grid, that will potentially save energy, create new capacity, and figure locational value of assets, where to place distributed generation or distributed resources.*
>
> — Tim Frost

Looking toward the future, Frost suggests BPL could enable using smaller, nano-technology-based controls linked with new operating systems and algorithms to manage information on a real-time basis.

However if a company's primary focus regarding utility applications is once-a-month meter reading, then BPL is probably unnecessary. Ralph Abbott, President of Plexus Research and a long-time analyst of PLC and BPL, expressed this caveat.

> *We're enormously excited about the potential for this technology, as a broadband-access means. We frankly are more dubious about any presupposition about the confluence of consumer broadband services with utility applications. Why? Partly on an economic basis, because AMR economics are always challenging. Partly because we don't need broadband data rates to support utility custom applications such as AMR and load control — there just aren't that many bits to move. Partly because of the possible "Chinese wall" partition between regulated utility operations and unregulated communications subsidiary operations. Partly because of the difference in issues of coverage and ubiquity requirements between AMR data communications and between residential consumer broadband offerings. The economics of AMR are quite complex.*

> *The ideal BPL implementation will stand on its own economics as a broadband data communications services, and should not depend upon AMR, load control, or other utility applications as the economic band-aid to help what could be a precarious business case. Then, if the utility applications later turn out to fit, well — that is gravy.*
>
> *These comments assume that the "driver" behind BPL is to provide consumers with broadband access, either where it was not available or for less cost where it was available. In contrast, a utility like Con Edison may decide to employ BPL primarily for utility applications.*
>
> — Ralph Abbott

For his part, Frost agrees that BPL's niche is the likes of load management, load forecasting, and operating issues — applications more fully featured than once-a-month meter reading.

Conclusions

The interviews we conducted show that utilities face several challenges adopting new communication technologies as part of their system architecture. Primarily, the multitude of technologies currently being used in different ways means that there is unlikely to be a single backbone that can be the basis of new applications — these applications must consider the legacy of existing technologies in order to be considered. Other challenges include:

- **Diffused decision making.** Only two of our respondents appear to have a single individual who is responsible for the company's communication infrastructure. More common is the diffusion of responsibility among several individuals who, due to industry and company restructurings, may not even know each other. As one of our respondents said:

> *Because we've changed so — moving out of the regulated company and now being an unregulated company — a lot of names have changed, and we've gone through some offerings of early retirement. A lot of the old timers that I knew that were responsible for communication, who I used to call up, are gone now. I'm not familiar with these guys now… You don't know who's on first base without a scorecard, because they're continuously changing in the organization.*

- **Disparate systems.** Utility communication infrastructure is put in place in an "ad hoc" fashion with no over-arching architectural vision. This stems from different applications housed in different utility departments and each department tackling their communication needs with a technology best suited for their particular circumstances. In addition, utilities still hold on to several "legacy" systems, deferring communication upgrades, but also installing more up-to-date technologies when new applications come on-line.

Complicating the number of systems even further is the fact that utilities have to deal with a wide variety of both proprietary and third-party applications and infrastructure. One respondent said:

> *Mostly (we use) our own network of microwave, leased lines, and telephone lines. Then we use proprietary protocol of the particular manufacturer . . . It's all a proprietary system. It varies from manufacturer to manufacturer, using different protocols.*

Other utilities pointed out that interconnection requirements, especially with coordinating regional bodies, mean new requirements and new systems. For example, one utility said they are highly connected to their coordinating council and this means they have to do more planning around communications and consider more advanced technologies. However, they will have to adapt technologies that meet their interconnection needs, not necessarily their own operational needs or legacy requirements.

Recommendations

- The results of the IECSA project can help define the communications architecture requirements for various power system applications. These requirements must be addressed in terms of both legacy communication technologies and new technologies that are being adopted.

- Cost/benefit analysis method are needed to evaluate the alternative technologies meeting the requirements for important applications. These cost/benefit evaluations must consider the full range of applications that could be implemented using each communications technology.

- CEIDS should continue to monitor advancements in powerline carrier and broadband powerline applications. Standards will be needed for building power system applications and customer services on top of these technologies.

- Methods for migrating from legacy technologies to more advanced communications technologies should be developed to support this migration. Standard approaches, legacy support technologies that can be used in conjunction with new technologies, gateways, converters, etc. can help utilities manage the migration while minimizing disruptions to the applications and minimizing investment requirements.

Appendix A

Inventory of Communication Technology Project — Bibliography of Secondary Research Sources

Free Resources

1. **Communication Security Assessment for the United States Electric Utility Infrastructure, EPRI TR-1001174, December 2000.**

   Includes information about utility technologies employed and how vulnerable they are. Includes tables on the types of communication protocols and technologies used for the control center, distributed automation, AMR, and substation. Also has a table on Powerline Carrier Utilization. Results in tables are based on survey of 160 utilities: 64% co-ops, 22% G&T, 16% Municipality, 11% IOUS, and 8% other. Tables include results for the entire sample and for a subset of "large" utilities.

Resources Available for Purchase

1. **2003 AMRA Trials and Installations Report: A Snapshot of Ongoing Projects from the Utilities' Perspective.**

   Includes details about AMR deployments at 85 utilities that currently have a deployment project in progress. Includes the percent of projects that use radio frequency systems, PLC, telephone technologies, and hybrid systems. Also give the percent of units installed in these projects that use the above communication technologies.

   The resource does not list deployments completed before 2002. It includes only ongoing projects that utilities report on a voluntary basis.

   This report and previous year reports can be purchased for $75 per report.

2. **The Scott Report: AMR Deployments in North America, Seventh Addition, published by Cognyst Consulting LLC.**

   Includes communication technologies used by each vendor — RF-mobile, RF-fixed network, powerline communication, telephone and other; In each state or province shipments by vendor for all utilities; types of communication in each state or province; shipments to all utilities by type of communication.

   Includes shipments not installments for 2001 and 2002.

   This report is available for $895.

3. **The 2003 Worldwide Electric Utility Metering Technology report, by MicroUtility**

   The main focus of this report is on meter decision making issues — forecasts revenue and units through 2010, discusses strategic marketing and sales issues. It also provides technology assessment and market size metrics for each of the following: powerline communications, telephone communications, wireless LAN/WAN, and optical port.

   It is unclear how this information is segmented geographically. 170 countries are covered in the report and the information does not implicitly say that the market size metrics for the communication technologies is listed in total or by country.

   This report is available for $2,570.

4. **The Chartwell AMR Report, Phillip I. Dunklin President and Publisher. Chartwell, Inc., October 2003**

   Includes the types of technologies in use by electric and water utilities, number of units added by year, and leading vendors by market share.

   The information in this report is based on a 2000 survey of 100 utility executives and mangers and on 150 interviews that took place in 2003 with industry professionals (gas, electric, water utilities staff, vendors, and consultants).

   The report is available for $1,495.

Appendix B

CEIDS Communication Inventory Project
Interview Guide — Utility Version
Respondent Information

Name: ______________________________

Title: ______________________________

Company: ______________________________

Telephone Number: ______________________________

Interviewer: ______________________________

Interview Date: ______________________________

Interview Time: ______________________________

I. Introduction

Hello, this is __________ and I'm calling from Primen, a member of the EPRI family of companies. We're conducting research for CEIDS, the Consortium for Electric Infrastructure to Support a Digital Society. We are interested in finding out the different types of communication technologies your company employs and how they are used. I have a few questions that should take about 10 minutes of your time. Is this a convenient time for us to talk? (If not convenient, reschedule.)

II. Background

A. Briefly, what do your job responsibilities include within your company?

B. We are interested in finding out what types of communication technologies your company uses for a variety of applications. Which of the following application areas are you familiar with?

a. Market operations load forecasting, generation scheduling and dispatching, ancillary services

b. Transmission SCADA/EMS, DFRs and Wide Area Monitoring Systems (WAMS)

c. Distribution SCADA (control room to and from substations)

d. Distribution automation invoicing communication to devises on the distribution circuits

e. Substation monitoring and power quality data collection

f. Meter reading

g. Customer services such as real-time pricing, load management, distributed generation coordination, etc.

h. Internal work force communication

(For each application that respondent is not familiar with, try and get a referral to someone else within the organization.)

III. Communication Technologies Used for Each Application

A. Now I'd like to go through each application area you are familiar with and find out the breakdown of the different communication technologies that you are currently using for this application area.

For each application area find out the total number of communication nodes for that application. Then go through the list below and ask what percent of those nodes are comprised of each technology to fill in the attached matrix (inventory matrix.xls).

For meter reading determine the number of communication nodes and proportion of different technologies for basic revenue metering applications and for revenue metering with power quality and additional data collection.

FOR EACH TECHNOLOGY:

1. ***Specify available and utilized bandwidth***

2. ***Indicate which of these communication paths are TCP/ICP enabled/capable***

a. Leased phone line

b. DSL

c. Cellular phones

d. Licensed MAS radio (specify band being used; e.g. 900 MHz, 2 GHz)

e. Other licensed radio (specify band being used; e.g. 900 MHz, 2 GHz)

f. Unlicensed spread spectrum Non-802.11 family (specify band being used; e.g. 900 MHz, 2 GHz)

g. Satellite

h. Other radio

i. Dedicated fiber circuits

j. Wireless 802.11

k. Other Wireless

l. Powerline carrier (specify type and specific band(s) used; if more than one type collect separate data for each)

m. Public internet

B. *(Ask for each familiar application area)* Do you expect this breakdown to change in the next five years? Five years from now what do you expect the breakdown of communication technologies for [application] will be? *(Fill out new matrix sheet for 5 year projection.)*

C. What percentage of your substations has a high-speed (128kbps or higher) communication link back to a central location or wide area network?

D. Which of your communications systems are TCP/IP protocol enabled?

IV. Wrap-up

A. Is there anyone else in your company that we should talk with to get their perspectives on some of these issues/technologies?

B. If after reviewing my notes, I have some questions about the information would it be okay if I called you back to clarify?

Thank you for your time!