**Utilities focus on integrating DA/DSM technologies**

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Wayne Beaty, Senior Editor – Power Delivery
Mark Hoske, News Editor

Distribution automation (DA) projects have increased from 38 in 1986 to 176 in 1990 and reached a spending level of $81 million, according to a survey by CSR Inc. Gail Ossandon reported on the completed survey at DA/DSM-92 in Ft. Lauderdale last January.

Ossandon said an emerging trend was integrating DA with automated mapping and facilities management (AM/FM) systems. It's noteworthy that most utilities considering or implementing integration were Canadian utilities in which generation and transmission services were provided by Ontario Hydro. The distribution utilities needed to economize on the purchase of power and also maintain reliable and efficient service to their customers.

The advantages of integrating the functions of AM/FM with DA include a chance to replace old technology; more efficient service restoration; better methods to analyze outages; greater service reliability via a complete model of the distribution system; and improved load control.

Public Service Electric & Gas Co., Newark, NJ, is implementing an integrated DA system. It includes supervisory control and data acquisition (SCADA), DA applications, load management and automatic meter reading (AMR).

The communications scheme uses a common packet-radio network. Intelligent remote terminal units (RTU) act as autonomous communications hubs, improving communications efficiency and supporting distributed substations as well as outside plant SCADA and DA.

As reported by Charles Gentz, PSE&IG, and Cliff Williams, DAQ Electronics, at the recent DA/DSM-92 conference in Ft. Lauderdale, open cooperation between vendors and utilities is a prerequisite to implementing an integrated system. Metricom supplied the packet-radio communications. DAQ was able to integrate some older RTU technology to protect some existing investments and direct current expenditures toward an integrated platform.

The PSE&G project integrates AM/FM and SCADA technologies. The integrated system provides real-time quality displays to assist utilities in service restoration, dynamic network analysis and distribution network planning.

A totally integrated information and response system cannot exist without suitable exchange of data with a customer information system (CIS). PSE&G's integration of DA, AM/FM and CIS is labeled Distribution Automation Information System (DAIS).

To achieve this goal, it required an open and easily integratable system with the IBM CIS and the UNIX-based AM/FM system.

**Communication technologies**

The shortage of frequency channels available to utilities if forcing the use of intelligent RTUs with advanced data communications concepts.

Dick O'Hara and Schlomo Scop, Motorola Inc., Schaumburg, IL, say that advanced FM radio communications methods used in DA systems allow utilizing both shared-trunked-radio infrastructures as well as private trunked systems owned by electric utilities. The more advanced RTUs allow combining several communications media in the same network.

Commonly used communications for DA include:

- Power line carrier which was popular in the past but does not offer reliable two-way communication.
- Dedicated wire lines between control centers and RTUs. This system allows point-to-point or point-to-multipoint (multidrop) communication. These options, however, are expensive and inflexible – e.g. adding RTUs – and over the years become unreliable. Wire lines do have an advantage over radio in those locations where radio waves don't propagate well.
- Conventional radio is normally used by most utilities on the same frequency for both voice and data since there is a shortage of frequencies.
- The 928-952 MHz band for data communication, which has been assigned by the FCC from part of the multiple address system (MAS) specifically for data communications and remote control and monitoring of DA elements. This system may provide full duplex data communications and the main advantage as its dedication for transmitting data.
- Spread spectrum communication is a new concept for DA communications that uses packet radios with low RF power transmitters that do not require licensing. It required a large number of radios and RTU installations to transfer data. It is not possible to combine data and voice.

O'Hara and Scop conclude that conventional radio networks are efficient, but they must use dedicated frequency channels for voice and data which requires installation of dedicated infrastructures.

There is no redundant solution in "system failure" situations. Such redundancy is essential when the channel assigned for data (or voice) is blocked or if the repeater has failed. The transmitter power is limited in most cases, making communication with distant locations difficult.

DA control networks that utilize a single radio communication channel are limited in terms of the communications between the central station and the RTUs (or between RTUs), to one session at a time.

In the past, utilities could live with communication system limitation, because DA requirements had not been so sophisticated. However, in order to address modern specifications for monitoring and controlling distribution networks, more efficient communications concepts must be implemented.

A unique and non-traditional method of communication includes a system that uses the distribution network as the communication medium. The Two-way Automatic Communication System (TWACS) was developed by Distribution Control Systems Inc., Hazelwood, MO.

The system is currently designed for operation on 35-kV or lower voltage systems and from distribution buses with capacities between 5 MVA to 200 MVA. Several fully operational two-way systems controlling and monitoring a few hundred thousand points exist today.

The outbound signal is based on modulating the power frequency voltage at a precisely controlled region near the voltage zero crossings.

**Fiber optics**

Fiber optics have a place in DA according to Robert Landman, H&L Instruments, Burlingame, CA. A 1990 survey conducted by the Utilities Telecommunications Council (UTC) reported that 66 of the 99 utilities surveyed had switched from telephone, microwave, powerline carrier, radio and other communications to (or increased their use of) fiber optics.

The primary reasons were increased bandwidth (capacity), cost savings, nonconductive benefits, improved reliability and low maintenance, and improved signal quality that features low noise and is EMI proof.

The Pacific Gas & Electric Co. fiber-optic installation was featured in the 1991 DA/DSM conference in Palm Springs and at the IEEE/PES T&D conference in Dallas. That installation proved that underground systems are a prime candidate because existing energized feeder ducts can be used to carry fiber cables.

Landman says that fiber, mistakenly, is assumed by many to be too expensive. But, as the UTC study shows, the prime reason utilities gave for choosing fiber is to save money. Fiber-optic components are still declining in cost. The cost of fiber has flattened due to the extensive deployment by telephone companies.

Landman points out an example in which a utility had decided on radio to link 30 pad-mounted S&C feeder switches because fiber was too expensive. The utility's

communications department had standardized on a 12 multimode, 12 singlemode loose tube gel-filled fibers in all fiber-optic cables. This would have required splicing all 24 fibers at each switch, patch panels at the SCADA master and at each switch and preterminated connector pigtails fusion spliced to the loose tube fibers.

The system really only required two multimode fibers and the distance was so short that it didn't make a lot of sense to put in excess fibers that most likely would never be used. Landman explained that radio has no excess capacity and no redundancy. The plan was switched back to fiber since under these circumstances, it was less expensive than the 900 MHz radio system.

Public Service Co. of Colorado is using fiber optics for its measurements data system to provide real time data as inputs to DA system. The system provides independent access to complex instantaneous and hourly dispatch and billing information.

By consolidating into one system, the previously independent functions of transducers for analog signals, watthour meters for hourly energy transactions and the communications function of RTUs.

PSCC selected the Jemtec Electronics Co. meter to meet the requirements of its new measurement system. It accommodates the interfaces between existing strip-chart recorders and analog inputs to RTUs.

The technology of fiber-optic communications with the Jem-3 meter was described at the First International DA/DSM Symposium in Palm Springs.

**Canadian experience**

Hydro-Quebec, just like many other utilities, stopped building generating plants early in the 1980s because of decreased demand. But because customers still demanded a higher quality of service, distribution automation has become technically feasible due to the advances in semi-conductor technology.

Engineers at Hydro-Quebec's Research Institute, reported at the DA/DSM-92 conference that they installed the first pilot feeder automation system in 1984 involving 22 25-kV lines, 3 substations and about 50,000 customers.

In 1987, the second generation equipment provided an opportunity to expand the program. Hydro-Quebec built its own equipment since suitable commercial items were not available for the environment then.

Since 1984, only two RTUs have failed due to IC failure. Hydro-Quebec learned that gel-type lead acid batteries last much longer than expected when operated in very harsh environments (from -25°C to 50°C). The batteries were replaced only once during an 8-yr period. Hydro-Quebec now buys some equipment from commercial vendors.

Feeder automation is only part of Hydro-Quebec's service strategy. A comprehensive energy management system has been planned that includes feeder automation, trouble-call diagnostics, work schedule reports, map generation and controlling main distribution equipment. The software is used mainly to locate faults and reconfigure the circuit by remotely controlling interrupting devices. Capacitor bank control will come next in the automation scheme.

**Alabama Power**

Alabama Power Co. implemented DA throughout its service territory in 1991. The effort began in 1985 by extending SCADA past the substation fence to include the distribution feeders. Alabama Power used the MAS communication technology and installed two pilot systems in 1986. It used a team concept to cut across department lines.

The team includes district operations, AM/FM, system communications, system procurement, marketing, substation design and operations, customer communications, load management and demand-side management departments.

The 950 MHz MAS communication system was determined to be the most economical. The system includes the master station, master radio, pole-mounted RTUs, and substation RTUs.

A master station is located in each of the six geographical division offices with workstations remotely located as far as 10 miles from the master station. Other equipment includes the Magnum RTU from Pentastar Electronics which can monitor and report faults up to 20 kA and recover the traditional analog values and time stamp events with 1 msec resolution.

The pole-mounted RTU includes a battery carryover for eight hours of operation in the event of a line outage. A Square D Co. line post sensor monitors phase voltage, current and power factor, and detects fault currents up to 20 kA. A low-energy output feeds directly into the RTU which samples the waveform 16 times per cycle to obtain the RMS fault current as well as monitor and report the normal condition on the distribution line.

Alabama Power had three main objectives for its DA strategic plan:

- Improve customer service reliability.
- Optimize capital expenditures.
- Expand distribution automation technology and concepts.

APCo has entered into a joint venture with ESCA Corp. and a consortium of electric utilities to develop advanced DA application software. It will be designed to remotely operate and coordinate the use of all distribution system components in a real-time mode.

Open architecture will ensure maximum use of popular interfacing standards. APCo sees DA as one of the tools used by the future workforce to perform assignments more efficiently.

**Con Edison's packet radio**

Consolidated Edison Co. of New York has had several years experience with packet-radio based 900 MHz distribution monitoring system. Its Genesis system from Itron has reduced outage time and the number of outages, and enabled faster, more efficient dispatching of crews.

The system monitors the vacuum reclosers on the 27-kV, 13-kV and the 4-kV overhead feeders. Con Edison's Staten Island Division has undertaken an R&D program to expand the system to provide remote control of vacuum reclosers and sectionalizing switches. A typical feeder arrangement is a five-recloser loop consisting of two feeder reclosers, two midpoint reclosers and a tie recloser. There are presently 19 recloser loops operating in the Staten Island Division.