CASE ESB NETWORKS: POLE-TOP COMMUNICATION INCREASES EFFICIENCY IN IRELAND

Viola's solution for remotely operating pole-top reclosers and switches increases reliability, cuts operating costs and helps to meet and exceed regulatory performance targets.

ESB Networks Limited is the independent Distribution System Operator (DSO) in the Republic of Ireland. ESB serves around 1,7 million electricity customers and its distribution network spreads across the 70,000 km^2 country with over 160,000 kilometers of power lines. The electricity distribution network includes all distribution stations, overhead electricity lines, poles and underground cables that are used to bring power to Ireland's 2 million domestic, commercial and industrial customers. ESB Networks is responsible for constructing and managing all the sub-transmission, medium and low voltage electricity network infrastructure in the country.

Market Growth and New Regulations Demand Network Modernization

Ireland has one of the fastest-growing electricity markets in the developed world. During the period 1990-99, the average annual growth in electricity consumption was 5.2% - the highest in the European Union. Because of growing electricity demand and new regulations that specify the required power quality and allowable network downtime, ESB initiated in 2001 a project to renew the entire transmission and distribution network in Ireland. With a total cost of around €6.5 billion, this was the largest power infrastructure project ever undertaken by any electricity distribution company in Europe. Automation and the remote monitoring and control of pole-top reclosers and switches (implemented by Viola) was one part of the total project.

Communication to Pole-tops Emerges as a Key Challenge

ESB Networks has a large number of field devices that are dispersed around the country, and due to distances and network length it could take maintenance crews sometimes up to two hours to reach a fault destination. Fault location, isolation and routine network sectionalizing was thus proving very costly, and ESB identified that the pole-top devices used to sectionalize the network would need to be put under central control. It was thus decided to equip these pole-top switches with a solution that would allow them to be monitored and operated remotely from the SCADA control centres in Dublin and Cork. Reclosers were also installed and these too needed to be controlled and monitored via SCADA.

Reclosers and switches also play a central role in reducing network downtime. Improvements in continuity of supply is a key business objective and is incentivized by Regulator targets and performance rewards. The Regulator places a strong emphasis on improvements through financial inducements. The sums involved are significant.

The ability to communicate with pole-top devices is extremely useful, but not critical. Therefore, it was not necessary to build a proprietary communication infrastructure to gain access to these devices. Another solution, based on public networks, had to be found.

Overcoming the Communications Gap

As Frank Browning, SCADA specialist at ESB Networks' Dublin Control Centre puts it: *"The main technical challenge was how to communicate with the pole-tops devices."* At first, ESB tried to piggyback on top of the radio system that was being used for substation communication. The idea was, however, soon scrapped because many recloser sites were in areas where radio coverage was poor and the low signal strength disrupted communications. It also became evident that the radio system did not have enough capacity for the number of devices envisaged.

GSM was then tried. GSM was definitely an improvement over radio modems, but required regular polling of the field devices. In order to control a device, SCADA operators had to initiate the call to that device and, as the number of devices grew, they became frustrated as it was becoming increasingly difficult to find a free modem for the connection. This also led to delays in getting feedback from the reclosers.

ESB Networks then sought help from Anthony Gray, Telecommunications Specialist from Telecoms Planning. It quickly became obvious that only one feasible option existed: GPRS. As a proprietary system was out of the picture the only way to get universal coverage was using a public carrier network.

GPRS provides "always on" connectivity and is capable of being used for real-time communication without the need for regular polling. GPRS also eliminated the scalability issues GSM presented. GPRS also had the benefits of being easy to deploy, working almost everywhere and of having lower communication costs than GSM. The only problem was that pole-top devices use a serial protocol, IEC 101, whereas with packet-based communications such as GPRS this protocol does not work. GSM uses the IEC 101 protocol but its large-scale deployment would have required significant investment in modems at the SCADA end to ensure timely feedback. The identified communications gaps of each technology are illustrated in [Figure 1].

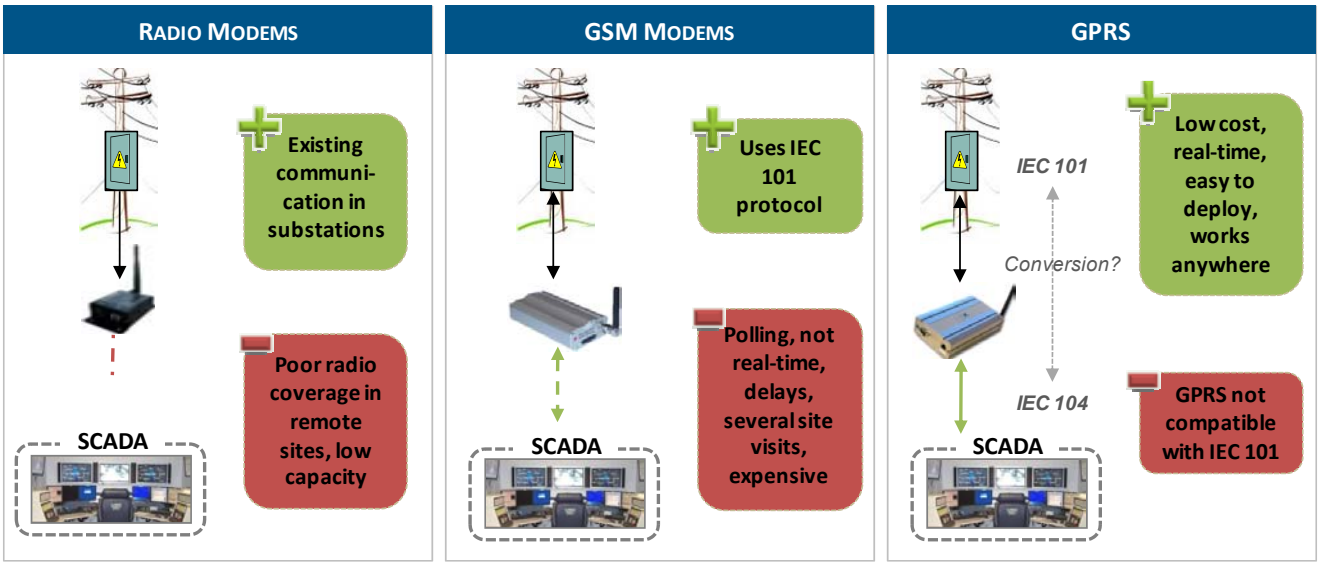

Figure 1: Communications gap - Comparing radio modems, GSM and GPRS

GPRS seemed to provide significantly more benefits than GSM, but ESB Networks was now facing a new challenge: could they find a GPRS solution that was able to perform IEC 104/IEC 101 protocol conversions?

Viola Emerges as an Answer to ESB's Needs

ESB's Anthony Gray explains the supplier search process: *"Basically we searched on the internet and stumbled on the Arctic 104 Gateway box with protocol conversion on Viola's website. Further investigation showed that no other solution was available that could demonstrate a functioning application."*

Although Viola's solution seemed to be the perfect answer to ESB's needs, ESB needed assurance that the system operated successfully in other utilities before starting negotiations. Viola arranged visits to two utilities in Finland that were already using solutions similar to that required by ESB. The solution was deemed viable and negotiations were initiated and successfully brought to a conclusion.

A Robust End-To-End Solution for Secure Communications

Viola's experts set to work with ESB to design the system architecture as well as the configuration and addressing schemes. Since security is a top priority in the power network, a series of meetings followed between Viola, ESB's IT security people and the carrier, Vodafone, to establish a communication system that would enable two-way operation between SCADA and the pole-top devices while providing secure, redundant connections. The solution was a private APN (Access Point Name) system where all Arctic devices were equipped with SIM cards with strictly defined authorizations for contact and activities. The system was designed to give fault-tolerant reliability – all critical parts of the network were duplicated, so that if one of the SCADA centres is inaccessible, the Arctic device uses an alternative communication path to reach the second SCADA centre (see Figure 2).

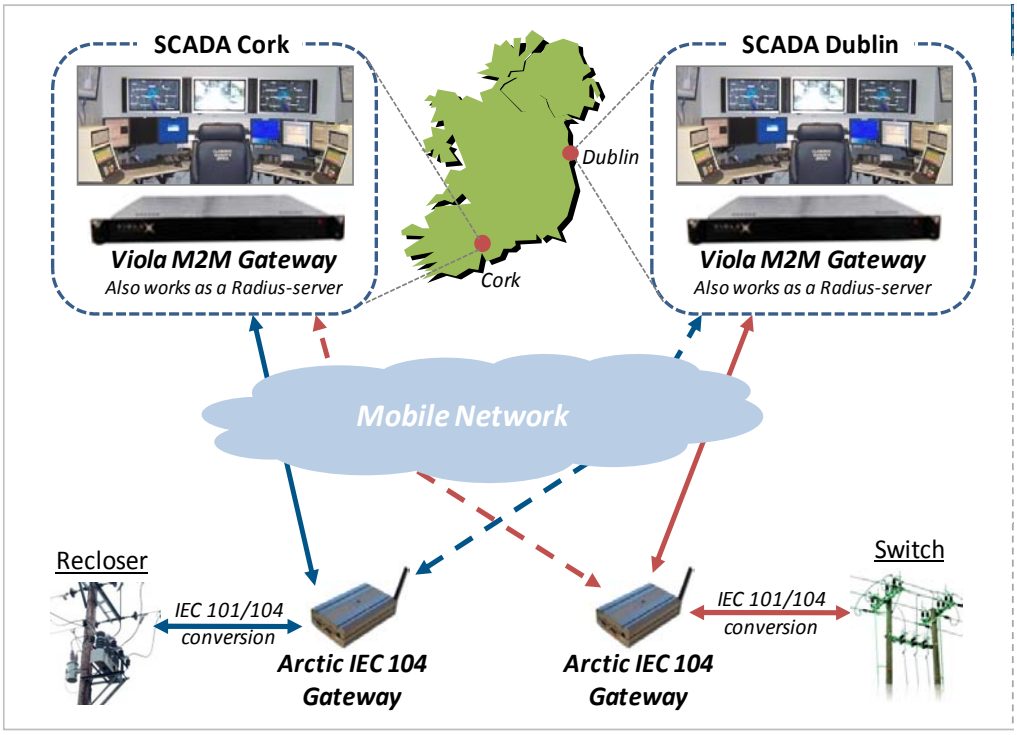

Figure 2: Fault-tolerant connections with Arctic devices

Each pole-top device was equipped with an Arctic Gateway device, which gives SCADA monitoring abilities and control over all reclosers and switches – devices historically invisible to SCADA operators. After successful field testing, ESB Networks purchased a trial system. When the trial system was running satisfactorily, more devices

were ordered. The total number of Viola devices in ESB's network is more than one thousand. A summary of the Viola devices used in the project can be seen in [Table 1].

Table 1: Summary of the Viola products used in ESB's distribution network

Network Position	Viola Systems Product	Number of Devices	Functionality
SCADA	Viola M2M Gateway	2	*Provides fixed IP addresses to all Arctic devices enabling two-way operation, as well as remote maintenance control via a VPN tunnel*
Reclosers	Arctic IEC-104 Gateway	~450	*Offers real-time remote control and monitoring, thus enabling fast fault isolation and efficient recovery from blackouts*
Switches	Arctic IEC-104 Gateway	~650	*Offers real-time remote control and monitoring, thus enabling fast fault isolation and efficient recovery from blackouts*

Complementing Services: Systems Design and Pre-Configuration

Throughout the project Viola complemented its offering with services. With previous experience from similar projects, Viola was well-equipped to carrying out systems design, configuration and addressing schemes as well as consultation.

For ease of installation and deployment, the addressing and configuration schemes was designed in a way that allowed for every Arctic device to be pre-configured. Pre-configuration of the devices greatly alleviated the most time-consuming part of the deployment process, the physical installation, since the installation only involved fastening the devices on the recloser DIN rails and connecting power. Connection to SCADA was automatic as long as the antenna was attached. Pre-configuration was especially appreciated since installation was sometimes handled by external contractors that didn't need to be especially trained to master Viola's specific technology. Only a screwdriver was needed to complete the installation on-site.

Financial Benefits from Better Availability and Reduced Maintenance

Viola's solution enables deeper SCADA penetration into the medium and low voltage networks, thereby providing an efficient and remotely operational FLISR (Fault Location, Isolation & Service Restoration) solution. ESB Networks is now able to get near real-time information from the network while significantly cutting operating and maintenance costs.

"Viola's system allows reconfiguration of the network in a way that minimizes the results of faults to customers", says ESB's Anthony Gray. *"This is not only important for customer service, it also helps us meet regulator targets."* Frank Browning sees the benefits at the SCADA centre: *"Control room operators are happy with this solution. It is "always-on", so they now get almost instant access to the pole-top devices."* Mr. Browning also points out the savings in maintenance: *"From the Control Centres we can identify a fault location and use remote control to re-sectionalize the network thereby minimizing the extent of the outage. We can then direct field staff to the fault location."*

Both men recognize the cost-benefit ratio of the solution. The size of the pole-top automation investment in relation to the entire modernization project is small, yet produces notable improvements in running the

network. According to Mr. Browning, ESB has calculated that the return on investment for lines with high fault rates is close to 8%. This is achieved with the implementation of automation (reclosers) and remote control of poletop devices.

Business Case for Automation and Remote Control

To quantify the benefits of the automation solution, ESB drew up a typical feeder design: below the substation level a recloser is positioned at about 50% and two switches at 25% and 75% of the feeder line. Network operators are penalized per outage and per customer hour lost (CHL), so the penalty per fault cannot be reduced if the number of faults isn't reduced. Assuming that fault occurrence stays the same before and after the automation, with the automated pole-top devices the fault can now quickly be remotely isolated to the correct 25% of the feeder. Since the fault has now been isolated to a quarter of the feeder, we can conservatively estimate that the customer kW Hours saving is improved by approximately 12% with the additional facility for the operator in the central distribution control room to control the operation of the sectionalizing switches.

The benefits achieved with automation and remote control of reclosers and sectionalizing switches are improved quality of supply to customers and a reduction in the number of customers hours lost during an outage of a feeder. By automating the sectionalizing switches an improvement in fault response is achieved

Viola – A Respected Partner

As the demands on power distribution networks are expected to grow in the future, Mr. Browning says this type of solution is well scalable for future needs. *"ESB is embracing the principles of sustainability and introducing this type of Smart Grid functionality allows us to operate the network more efficiently."*

ESB Networks are happy working with Viola Systems. *"They are experts in their field and provided good support throughout. Any technical issues which emerged were resolved quickly",* concludes Mr. Browning.