Kalkitech
Enabling the Smart Grid

Case Study

Automatic Meter Reading (AMR) For India's Northern Region Transmission Network

Client/Project Background

Client:
Power Grid Corporation Of India Limited

Website:
http://www.powergridindia.com

Region:
Northern India

Industry:
Transmission Utility

Solutions

Automatic Meter Reading (AMR)

Products

- Interface Communications Unit (ICU)
- Data Concentration Unit (DCU) - SYNC 2000
- Meter Data Acquisition System (MDAS) - SYNC 5000

This is India's largest AMR project in terms of geographical reach. Being the frst ever large-scale grid metering project, it would serve as a benchmark for similar projects being planned for the other fve regions in India.

Business Need

PGCIL wanted to enable remote monitoring of its substations so that they could be potentially operated without manual intervention. To achieve this, it decided to implement Automatic Meter Reading (AMR) for its interface meters and enable automatic disturbance data collection from Intelligent Electronic Devices (IEDs) installed at substations.

Solution

Kalkitech installed its SYNC Interface Communication Unit, SYNC 2000 Data Concentrator Unit and SYNC 5000 Meter Data Acquisition system to collect the data, convert it into the DLMS protocol and transmit it to the Northern Regional Load Dispatch Center (NRLDC), also known as the Central Data Collection System (CDCS).

Benefits

- Enabled 15% reduction in need for extra DCUs by installing SYNC 2000 DCU which has the ability to support up to 25 SEMs
- Saved investment on replacing meters by installing SYNC ICU to allow non-invasive data collection—by retaining the optical reading functionality for manual reading and providing a communication interface to support remote reading.
- Lowered operational and maintenance costs through standardized data collection and transmission
- Prevented data loss and improved data availability through the 14-day data storage feature of SYNC 2000
- Facilitated better planning, analysis, decision making and trouble-shooting besides improving response time by providing consumption data from SEMs at 15 minute intervals

- Improved billing accuracy by enabling automatic meter reading and eliminating manual reading errors
- Reduced lead time required to read meters resulting in quicker billing and payments
- Reduced operational and labor costs by eliminating manual effort

PGCIL is responsible for operating a large number of substations and had been evaluating the feasibility of unmanning substations for some time. As part of this initiative, PGCIL embarked upon two programs:

- Automatic Meter Reading (AMR) for its interface meters (also referred to as SEM or Special Energy Meters)
- Disturbance Data Collection from Intelligent Electronic Devices (IEDs) at substations

With the implementation of these two projects, PGCIL would be able to take significant step towards remote monitoring and control of its substations, with centralized data collection and processing. This would significantly reduce the maintenance and monitoring costs over time, as well as vastly improve response times for faults and issues, thereby improving efficiency of the grid overall.

The Northern Region (NR) AMR project is the first step towards smart grid metering and covers 236 substations and 1,328 energy meters spread across eight states and one union territory in India's northern region. It is the largest AMR project in terms of geographical reach in India as it connects the most number of SEMs compared to the other five transmission regions. Being the first ever large-scale grid metering project, it would serve as a benchmark for similar projects being planned for the other five regions in India.

Before the start of this project, data from each SEM was manually retrieved and emailed to the Northern Regional Load Dispatch Centre (NRLDC) in New Delhi. In fact, some substations were so remote that even internet connection was a challenge and data was transmitted via a USB device to the nearest town from where it was sent on a weekly basis.

Another issue was that manual reading of meters was prone to human errors. Since the data was usually aggregated on a weekly basis, it was difficult to pinpoint the time and place of the actual error. Such errors resulted in revenue losses, on both sides of the generation-transmission interface, where these SEM meters were placed. With the NR AMR project, the NRLDC hoped to rectify these issues, and vastly improve the overall efficiency in the operation and maintenance of the EHV lines.

Figure 1 shows the AMR System hierarchy. The Central Data Collection System (CDCS) is at the top of the hierarchy and is located in Delhi. The AMR system consists of 1,328 meters installed at 236 locations dispersed across the Northern Region.

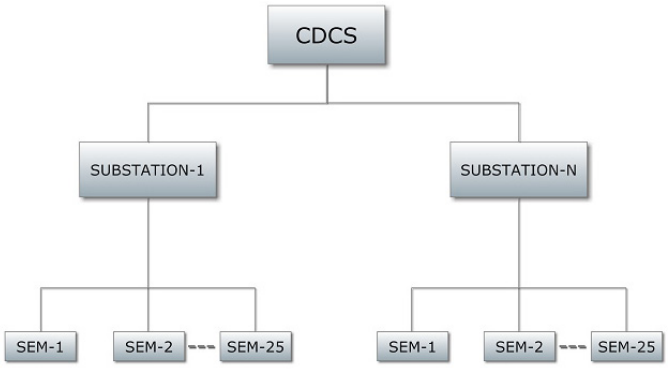

Fig 1: AMR System Hierarchy

POWER GRID being the Central Transmission Utility (CTU) is responsible for the installation of Special Energy Meters (SEMs). The Northern Regional Load Dispatch Centre (NR LDC) also called Central Data Collection System (CDCS) is responsible for collecting and processing the metered data of the northern region.

Solution

Figure 2 shows the basic high level architecture of the complete AMR system. Each substation location may have variable numbers of meters ranging from 2 to 25 or more. The entire AMR system is controlled from the Central Data Collection Centre in Delhi.

The data from the SEMs was collected using the IEC 61107 protocol and transmitted to the NRLDC via General Packet Radio Service (GPRS) with Virtual Private Network (VPN) encryption and other advanced security features. The Device Language Messaging Specification (DLMS) protocol was used to relay the data from the substation to the Control Centre.

The solution entailed using three communication devices, in order to collect data from the meters, convert the data to the DLMS protocol, and receive and analyse it at the Control Centre:

- Interface Communications Unit (ICU)
- Data Concentration Unit (DCU) + Intelligent Modem
- Meter Data Acquisition System (MDAS)

Interface Communications Unit at the meter level – SYNC ICU
Most of the SEMs used the old IEC 61107 protocol with only an optical/RS-232 interface to collect the data. Kalkitech created a customized product, the SYNC Interface Communications Unit (ICU), to efficiently collect the required information from these ports, and transmit it to the Data Concentrator Unit (DCU) at the substation via a serial connection. The ICU was designed taking the form factor of the meter model into consideration so that the ICU could sit firmly and secured to the meter device. More importantly, the ICU was provided with an additional optical interface output, so that the operator at the remote location need not remove the ICU device for manual reading of the meter data.

Data Concentrator Unit at the substation level - SYNC 2000
SYNC 2000 was the main collection and aggregation unit at the substation level that could connect up to 25 SEMs downstream, and transmit data at 15 minute intervals to the CDCS in Delhi. SYNC 2000 converted the data from the SEMs into the standard DLMS protocol which was transmitted over a VPN based encrypted GPRS network. Due to the specific requirements of the project, an external IP55 modem was customized by Kalkitech for this task.

Apart from the superior EMI/EMC requirements for the DCU (certified to meet IEC61850-3 standards), SYNC 2000 had IP51 enclosure for environmental (dust/water-proof) protection and storage for 14 days of meter data.

Meter Data Acquisition System at the Central Data Collection Centre – SYNC 5000
SYNC 5000 Meter Data Acquisition System provided the head-end for the metering project. It collected the data in the DLMS format from remote substations, and provided the interface and features to achieve configuration, data retrieval and data analysis. The distributed architecture, enhanced web-services support and database support of SYNC 5000 enabled better integration with 3rd party systems and billing applications including MDM systems. SYNC 5000 also facilitated the conversion of data to the NPS format (as required by the client) for sending the information to upstream billing and ERP systems.

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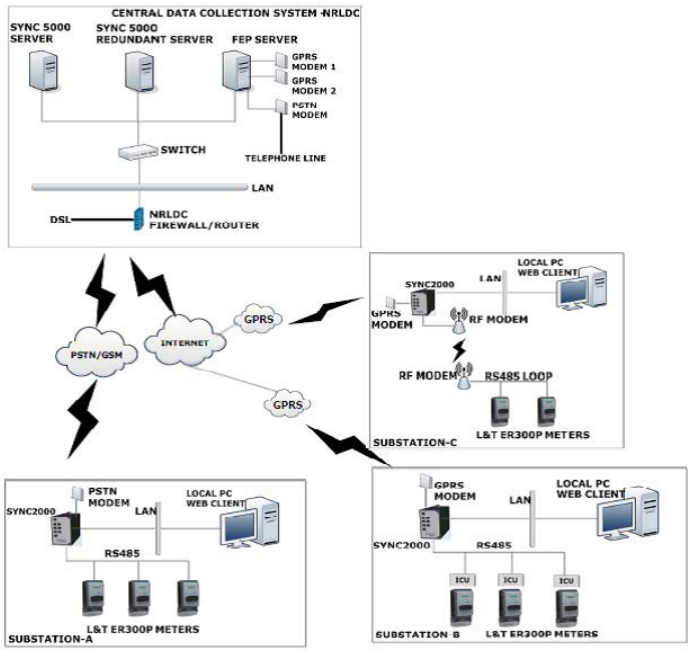

Fig 2: Architectural diagram of the AMR project

Benefits

The successful implementation of this project allowed PGCIL to remotely monitor and control its substations in the country's northern region and enabled centralized data collection and processing. This significantly reduced maintenance and monitoring costs over time, and vastly improved response times to real-time issues, thereby improving efficiency of the overall grid. Further it improved PGCIL's ability to reduce the time to bill by more than 15 days, thereby improving their revenue efficiency and collection efficiency.

Being the first large-scale grid metering project in the country in terms of geographic reach, its successful implementation will be the basis on which AMR projects in other regions will be rolled out.

The AMR project provides PGCIL with the following benefits:
- The CDCS in Delhi is able to poll for data at regular intervals once every 15 minutes from each SEM, providing the Control Centre and the substations near-time visibility over its operations and enables better monitoring
- Availability of 15 minute consumption data from energy meters facilitates better planning, analysis, decision making, troubleshooting as well as decreases response times when problems occur.
- Billing accuracy is considerably improved based on the use of near real-time consumption data. Automatic meter readings eliminate manual reading errors.
- Lead time required to read meter data is significantly reduced enabling quicker billing and payments.
- Remote monitoring/ unmanning of substations and automatic reading of energy meters saves personnel and operating costs.

Kalkitech's solution is designed to also provide the following benefits:
- SYNC 2000 DCU at the substation level supports up to 25 SEMs reducing the need for extra DCUs by around 15%. The external modem facilitates secure data transfer via a VPN network avoiding the need for separate VPN purchase from the GPRS network provider saving around 5% of total project cost.
- SYNC ICU allows a non-invasive mode of data collection from the SEMs, retaining the optical reading functionality for manual reading, facilitating ease of use for the operator. This saves the client huge investment in meter replacements with easily readable communication interfaces to support remote reading.
- Standardized data collection, as well as transmission to upstream systems like billing and ERP in NPS format using SYNC 5000 with native support for DLMS protocol, lowers operations and maintenance costs.
- Minimal data is lost via transmission from remote areas to the Control Centre using SYNC 2000's feature of 14 day data storage. The modem has a feature that can send emergency SMS alerts to both the MDAS as well as to a particular operator at the substation in case of power failure to the communication devices. This improves data availability and accountability for the energy generated / transmitted at the interface points.
- Data transmission from remote locations is more reliable. SYNC 2000 complies with the IEC61850-3 standard, the DCU with the IP51, and the external modem with IP55. This ensures that the substation equipment will perform reliably even under harsh environmental conditions. The DCU and the intelligent modem are placed in a larger enclosure for better protection from the environment.

Kalkitech's depth of experience in Substation Automation and Metering enabled it to undertake and implement a grid metering project of this magnitude (biggest in geographical area as well as substations covered) and create customized solutions where necessary (ICU, external modem, customization of SYNC 5000 for MDAS to poll for meter data as per Control Centre operator's requirements). Such a large scale roll-out also required project management skills which the Kalkitech team provided in a competent manner. Furthermore, Kalkitech will provide maintenance and support for four years after the first year of warranty.

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