Automatic Meter Reading with Satellite Technology

By

Edwin Phala
In recent years, metering technology has evolved from basic mechanical instrumentation to sophisticated multi-functional electronic devices, with meter having become an integrated device capable of supplying data for use in many applications. Metering is essential for the successful operation of the Electricity Supply Industry. Metering is also a key factor contributing to Utility’s business success, in terms of customer focus and maintaining an optimal network. The metering discipline plays an important role within various business functions or processes and presents to business systems, validated information related to the flow of energy. It is key factor contributing to Utility’s business success, in terms of customer focus and maintaining optimal network. It provides the Utility with statistical information when making important financial and technical decisions.

**OVERVIEW OF METERING SYSTEMS**

The energy information process includes all the elements of metering and data acquisition. The metering process includes the installation, operation and maintenance of the metering equipment. Data acquisition has traditionally been viewed as part of either the metering or billing processes, since data acquisition was, and to a large extent still is, performed by resources from one of these functional areas. However, with the implementation of new systems and procedures for acquiring and storing data, it is important to view data acquisition as a separate sub process, complementing the metering process, both of which are sub processes of the energy information process.

This process view provides data acquisition with the prominence that it requires and decouples it from the application or use of the data. The application of the metering data also constitutes a sub process in the energy information process. A simple process representation of energy information is shown in figure 1.

The sub processes shown in figure 1 can be defined as:

- **Provide Appropriate Resources** refers to all the resources that are required to implement a reliable metering system. These resources include trained staff, suppliers and appropriate standards and procedures.

- **Provide Reliable Metering Installations**. This is the process of installing, maintaining and ensuring the reliability and accuracy of metering installations.
Acquire and Store Metering Data and Present to Business Systems. This is the process of ensuring that the right data is retrieved and stored in such a way that it is accessible to all authorised users and can be turned into usable information. This process contains all the activities surrounding the flow of data.

![Diagram showing the flow of data from needs to customers](image)

### Figure 1

- **Apply Metering Data**, refers to the usage of metering data to produce bills and statistical information, such as load profiles for various customer types, forecasts, tariff studies, etc. This sub-process will not be considered further in this document.

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The flow of data from the meter to the data store is presented pictorially in figure 2. The primary plant that provides the input to the meter and the subsequent processes of analysing...
and presenting data are also depicted, to emphasize the link between metering, the customer and business systems.

Figure 2. Metering data flow

The elements of the metering data flow are:

- **Primary Plant Inputs** - voltage, current, frequency and time

- **Gather Data**. This is the process of taking the primary plant inputs from the primary plant, through a meter, relay or transducer and converting it into data.

- **Acquire Data**. This is the process of transporting the data from the measurement device to the data store.

- **Store Data**. This is the process of storing the data in a reliable database.

- **Analyse and Manipulate the data**. This is a function performed by the user of metering data.

- **Present the data**. This is where the customer is presented with a bill, or the results of statistical analysis are applied within the business.
Conventionally three types of meter reading exist:

1. Manual Meter Reading (MMR) performed by a meter reader capturing data on paper.

2. Electronic Meter Reading (EMR) where a meter reader gathers data using an electronic hand held device.

3. Automatic Meter Reading (AMR) where the data acquisition process occurs without any human intervention, using remote communications.

**MANUAL METER READING**

**ADVANTAGES:**

- Guaranteed site visits.

**DISADVANTAGES:**

- The process is very reliant on human intervention, where the possibility of inaccurate meter reading exists.

- Meter sheets might not be delivered on time to the billing offices resulting in late issuing of bills.

- The process does not accommodate the retrieval of load profile data, which is important information required for expansion and operational management.

**REMOTE COMMUNICATION**

**ADVANTAGES:**

- The process accommodates the retrieval of load profile data from meter.

- The process minimises operational cost, as no site visits are required for meter reading.

- There process is quick and real-time
**DISADVANTAGES:**

- Remote communication is not possible or cost justifiable at all Large Power User sites.
- With a high number of electromechanical meters already installed, none can be interrogated remotely, except through a costly electronic data recorder, which makes it not cost justifiable.
- The process is reliant on availability of fixed line telecom network, which is also not reliable. This could result in late issuing of bills.

**ELECTRONIC METER READING (HAND HELD UNITS)**

**ADVANTAGES**

- The process accommodates retrieval of load profile data, which will be stored in the RAM drive of HHU after the meter has been interrogated.
- The application software on the HHU also has the capability of electronically setting the time of the meters after it has been interrogated. This will result in a cost saving because metering technicians will not have to visit metering sites specifically for this purpose any more.
- This system can be used as an effective back up system to remote communication.
- This process is much less labour intensive and the possibility of human errors is theoretically eliminated.
- This process provides an auditable log record as each action that the meter reader performs on the HHU will be logged and stored in Central Routemaster
- Electronic data transmission from the HHU to the Local Routemaster will save operational cost in terms of manual data delivery. It will ensure that the data is accurate and on time, which will ensure that bills will be issued in time
- Onsite meter point inspection and auditing as each time the meter reader visits the site.
SATELLITE COMMUNICATION - OVERVIEW

Satellite technologies are creating innovative communication solution for power utilities. The high costs and signal delay that limited the use of satellites in the past are giving way to expanded capabilities of small, low earth orbit (LEO) satellites. Three types of satellites exist, Low Earth Orbit (LEO) satellites, Medium Earth Orbit (MEO) satellites, Geostationary Orbit (GEO) satellites. The satellites are classified according to orbit altitude, operating radio frequency (RF) and bandwidth allocation.

The Advantages of LEO (low Earth orbit)

The lower orbit altitude of LEO systems provides higher link margin, greater availability and less delay.
### Features

<table>
<thead>
<tr>
<th></th>
<th>LEO</th>
<th>MEO</th>
<th>GEO</th>
</tr>
</thead>
<tbody>
<tr>
<td>Altitude (km)</td>
<td>750 - 1500</td>
<td>750 - 11000</td>
<td>36000</td>
</tr>
<tr>
<td>Operating Radio</td>
<td>VHF and UHF below 500 MHz</td>
<td>L &amp; S microwave 1.6 &amp; 2.5Ghz</td>
<td>K band 19 &amp; 29 GHz</td>
</tr>
<tr>
<td>Number of satellites for global coverage</td>
<td>48 – 70 satellites</td>
<td>10 – 12 satellites</td>
<td>3 satellites</td>
</tr>
<tr>
<td>Time delay</td>
<td>10 milliseconds</td>
<td>80 milliseconds</td>
<td>250 milliseconds</td>
</tr>
<tr>
<td>Hours to orbit</td>
<td>1.5 hours</td>
<td>5 – 12 hours</td>
<td>24 hours</td>
</tr>
<tr>
<td>Services offered</td>
<td>Data</td>
<td>Voice and data</td>
<td>Video, voice and data</td>
</tr>
</tbody>
</table>

**LOW EARTH ORBIT (LEO) SATELLITE**

Offers the best solution to broad range of bi-directional communication requirements requirement where:

- Total amount of information to be transmitted is relatively small with message length being approximately 500 characters.
- Ubiquitous coverage is needed across a region or across the globe.
- Low-cost terminal equipment and usage is necessary

**MEDIUM EARTH ORBIT (MEO) SATELLITES**

Offers the best solution for:

- Mobile voice communication
• Data communication where the amount of data to be transmitted is significant and warrants the inherent cost of communication link set-up and take-down time.

• Ubiquitous coverage is needed across a region or across the globe

• Application that can justify higher-cost terminal equipment and service rates of $3.00/minute

GEOSTATIONARY ORBIT (GEO) SATELLITES.

Utilised where:

• Continuous service or bandwidth-on-demand is needed

• Very high data rates, 1.544 Mbps and above are required

• Application do not require mobility

• Dish antennas of 1-3 meters can be accommodated.

• Terminal prices of up to $25K and month continuous services rates of $50 – 100k are justified.

LEO satellites for Utility Communication

Power Utility primary internal communication needs are for SCADA telemetry, metering and for mobile messaging and data communications in support of asset management and workforce automation.

LEO system is best option for broad range bi-directional data communication with total amount of data to be transmitted being relatively small and the length of individual message is short (typically 500 characters). LEO technology address market needs where near real time services is critical and service reliability is critical and financial risks are low.

With regard to utilities, the application is for requirements with low-cost terminal equipment and low service rates. Application of interest in the utility includes remote meter reading, managing power demand of customer loads, including hot water heaters and air conditioner. Other applications include load profiling and analysis, system control, alarm notification, and near real time monitoring of peak electricity use for customer. LEO are definitely not suitable for use of real time SCADA systems at substations that require device scanning every seconds.
Metering and connect / disconnect services are conventional telemetry examples. As discussed earlier, high-cost metering typically requires a disproportionate amount of time and resources and is clearly a prospect for satellite communications. In a typical utility with remote terrain as little as 3% of the meters can account for nearly 20% of the meter reading cost.

**LEO Satellite Communication Overview**

*Leo One System Overview*

Transfer of data takes place in a store and forward mode. A sender’s message, using pocket-sized transceiver with a short flexible whip antenna, fitted on the metering installation, goes to the nearest satellite in view. The metering data is translated to the gateway center on earth for validation and optimal routing. Where appropriate, the metering data is then returned to the satellite and stored briefly until the intended receiver, which is the billing center, is in view. The message is then delivered to the recipient. Alternatively, the gateway center will use terrestrial infrastructure or leased line to link the metering data to its destination. The metering data is then returned to the satellite and stored briefly until the intended receiver is in view.
The RF gateways will control the communication network and provide access to and from satellites to the terrestrial telecommunication. Minor equipment is required for a Home Gateway, as little as a PC. The network includes a dedicated leased line for communicating between the Network Management Center (NMC), the Constellation Management Center (CMC) and all the gateways. The gateways provide interfaces to the Internet, public data networks, dedicated private networks of large clients, and the public switched telephone network (PSTN) for message origination and delivery.

**TECHNICAL DESCRIPTION**

LEO satellites operate at altitudes of 950 km. They operate at radio frequencies of VHF (148 to 150 MHz) and UHF (455-456 and 459-460MHz) uplink, UHF (400.15 to 401MHz) downlink, thus being able to penetrate foliage and building structures. The message size is typically between 100 and 500 Bytes/character. The link margin of 19dB will combat fading due to building penetration loss and interference. The low altitude of the satellites will give the reduced path delay thus being able to meet the Utility applications towards real time demands.

LEO systems are designed with a high level of overlapping footprint that will enhance reliability. Should any of the satellite fail, the overlapping footprint will ensure minimum impact to customer services. Because of the small footprint, the constellation of 48 satellites will be deployed to give ubiquitous coverage. The lifetime in space of each satellite including de-orbiting is 7 years.

Satellite technology, specifically the technology for small, low earth-orbit (LEO) satellites, will makes it possible to remotely monitor and control dispersed equipment and systems by using relatively inexpensive, rapidly deployable infrastructure on the ground.

**SATELLITE COMMUNICATION FOR METER READING**

**TECHNICAL**

As mentioned, normal telephone lines are used effectively for Automatic Meter Reading purposes. Satellite communication can also be used for the same purposes, and in some cases, might even be a better solution than GPO phones. The reasons for this statement can be quantified as follows:

- Satellite communication is digital, making use of the latest technology that market has to offer, increasing the reliability and quality of service provided.
Satellite communication is nationally, and is immediately available. It might take up to weeks for the local Telco to install a telephone line, whereas you the customer can be purchase the required equipment and perform the installations in-house, minimising the time and cost involved.

- Distance communication is not a problem. In South Africa the cost of the telephone call increases proportionally to the distance of the call. In the case of satellite, the cost to interrogate a meter, installed 10km from the Data Acquisition System will be the same as for the one installed a 1000km from the DAS.

- The cost of satellite communication has always been a problem. Fortunately, with technology like LEO, the cost has been reduced, and is now comparable with normal telephone communication.

It is therefore theoretical possible to cost effectively interrogated all the meters in Africa from one central Data Acquisition System.

**HUMAN RESOURCES**

One of the biggest concerns, from a Human Resources point of view is the social impact i.e. possible loss of jobs that comes with Automatic Meter Reading. This is normally not the case because the technicians responsible for the meter reading perform this function as part of their job description. In other Utilities, the technicians performing meter reading are also responsible for the maintenance of the network.

In the case of dedicated meter readers, it is recommended that these people be re-skilled to perform other tasks. Meter readers can also be retrained to perform metering audits and meter replacements. They can also be trained to focus on customer services, as they are ideal candidates, because they know the environment, the technology and the clients.
## Cost Comparison

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<tr>
<th></th>
<th>Eskom Metering Current Cost</th>
<th>Leo Cost</th>
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<tbody>
<tr>
<td>Volume of Data per Transaction per Point</td>
<td>5</td>
<td></td>
</tr>
<tr>
<td>Number of Points</td>
<td>20000</td>
<td></td>
</tr>
<tr>
<td>Transactions per Day</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>Transactions per Week</td>
<td>7</td>
<td></td>
</tr>
<tr>
<td>Transactions per Month</td>
<td>30</td>
<td></td>
</tr>
<tr>
<td>Cost of Device</td>
<td>R 5,500.00</td>
<td>R 900.00</td>
</tr>
<tr>
<td>Cost of Communications per Month per Point</td>
<td>R 100.00</td>
<td>R 3.00</td>
</tr>
<tr>
<td>Total Capital</td>
<td>R 110,000,000.00</td>
<td>R 18,000,000.00</td>
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<tr>
<td>Total Operational Cost per Month</td>
<td>R 2,000,000.00</td>
<td>R 60,000.00</td>
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<tr>
<td>Charge to Client per Month per Point</td>
<td></td>
<td>R 12.00</td>
</tr>
<tr>
<td>Total Profit per Month</td>
<td>R 180,000.00</td>
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</table>

Based on the cost comparison, it is evident on the cost savings that LEO satellite will generate as compared to traditional Automatic Meter Reading

## Conclusion

LEO application has the potential to improve operational efficiencies of the power utility as well as offering new revenue opportunities.

Recent and future generations of low earth orbiting (LEO) satellites are promising new possibilities for using space communications to achieve operational improvements and business expansion in energy sector.

In order for satellites to be widely used by utilities, they must satisfy those requirements at a lower cost than terrestrial options, including telephone circuits, Internet virtual private networks, microwave radio, and the large broadband fiber-optic networks that many utilities are installing for their most data-intensive, corporate-level applications.

Satellites can be combined with terrestrial systems to provide economical coverage that meets diverse needs.

Satellites will provide innovative opportunities for expanding utility customer bases and offer additional services.
Biography

Speaker: Edwin Phala - Mr
Position: Managing Director
Company: EON Solution Africa
Country: South Africa

Edwin Phala is the managing director of EON Solution Africa.

He joined Eskom’s Generation Engineering in 1988 as an engineer in training. In 1991, he joined Sasol 2, a petro-chemical plant in South Africa in as instruments and projects engineer. He rejoined Eskom in 1993 as senior engineer and later Chief Engineer in the Technical Audits Division. He left Eskom in 1998 to form a black empowered company called Kutlwano Engineering Consulting (KEC), where he holds a position of Chairman. KEC formed a joint venture company with Eskom Enterprise, called Y2K Solutions Africa, which is now called EON Solution Africa, where he holds a position of Chief Executive Officer. He holds the position of directorships in the four subsidiary companies of KEC, namely Power Network Optimisation, joint venture with Transmission Grid Consulting, Shilangane Engineering (Electrical Construction company), Tunza Integrated Solutions (IT company) and Concelio Project Management. He holds a degree in Electrical Engineering and Master in Engineering from Pretoria University in South Africa.

Y2k Solutions Africa has done projects in many Utilities in Africa, including Kenya Power & Light company (Kenya), Tanesco (Tanzania), Uganda Electricity Board (Uganda), Zesco (Zambia), Eletricidadae de Mozambique (Mozambique), and Nampower (Namibia).