ISGF White Paper

Last Mile Connectivity Options and Interoperability for Smart Metering

Abstract

Interoperability in smart metering is an issue that can impede large scale deployment. However, a pragmatic approach can easily lead to seamless operation of smart meters. One option is to choose a long-term rate contract with select meter vendors whose meters are inter-operable; and that will ensure meters are supplied by the same manufacturers at pre-agreed rates for future customers added to the AMI network. Another solution is to first choose the communication technology and then select the meter manufacturer/s. Utilities can also opt for third-party certification that will guarantee Device-Level interoperability. The most effective option is to select Wi-Fi for last mile connectivity which apart from being interoperable, is mature, scalable and cost effective. If all of the above options are not possible, a Utility may install multiple Head End Systems interfacing with a common Meter Data Management System, thereby enabling System-Level interoperability.

Disclaimer

Author

Reji Kumar Pillai – President
Hem Thukral – Sr. Smart Grid Specialist

India Smart Grid Forum (ISGF)
CBIP Building, Malcha Marg
New Delhi, India

www.indiasmartgrid.org

About India Smart Grid Forum

India Smart Grid Forum (ISGF) is a public private non-partisan initiative of the Ministry of Power (MoP), Government of India for accelerated development of smart grid technologies in the Indian power sector. ISGF was set up in 2010 to provide a mechanism through which academia, industry; utilities and other stakeholders could participate in the development of Indian smart grid systems and provide relevant inputs to the government's decision making.

Background

The release of the new Indian Standard ***IS 16444: AC Static Direct Connected Watthour Smart Meter – Class 1 and 2 Specification*** by BIS in August 2015 was a major achievement. Since the communication technologies advance much faster than electrical technologies, the BIS Technical Committee decided to allow all feasible communication technologies for AMI in order to encourage innovation. In lines with the IPv6 Roadmap issued by the Ministry of Communications and IT, IPv6 has been made mandatory for smart meter communications. Another standard ***IS 15959: Data Exchange for Electricity Meter Reading, Tariff and Load Control — Companion Specification*** has been revised and published as **IS 15959: Part 2-Smart Meter** in March 2016.

Traditionally, last mile connectivity has been a major challenge in successful AMI implementations around the world. Utilities have experimented multiple technologies, but have achieved little success. Standards-based RF-mesh canopy is the latest trend that is capturing attention. However, in view of the fact that by 2020, almost every building (residential/commercial/industrial/public institutions etc.) in urban and semi-urban areas on earth will have broadband internet connectivity (perhaps except in some conflict regions). Hence smart meters and smart appliances can be connected to the Wi-Fi network in the home/building/campus. This will eliminate the need of intermediate entities such as DCUs/gateways and will establish last mile connectivity at affordable cost.

With respect to interoperability, it is pertinent to mention that it can be achieved at Devices-Level or at the System-Level. Device-Level interoperability will enable smart meters manufactured by different meter manufacturers to communicate with each other. On the other hand, System-Level interoperability will enable different Head End Systems (HES) to communicate to the same Meter Data Management System (MDMS).

A) Comparison of Communication Technologies for Smart Metering

The following table depicts a comparison of the communication technologies for smart metering.

Table 1 – Communication options for smart metering

SMART METERING – COMMUNICATION OPTIONS		
Communications options	**Advantages**	**Disadvantages**
GPRS	• Mature technology • Rapid deployment • Communication modules are low cost and standardised • Best solution to get meter readings automatically from select set of customers scattered over a large geographical area	• Limited coverage (data network is poor in villages) • Limited reliability (cellular operators only guarantee performance on “best effort” basis) • Short technology lifecycle (2G => EDGE => 3G => LTE • Limited scalability (50 million smart meters would need additional towers) and spectrum • High operating cost - monthly recurring cost to cellular operators per SIM card • Most benefits of AMI cannot be achieved except meter reads
RF Mesh	• Lightweight (communication stack size) • Scalable (only DCUs/Gateways are needed) • Negligible operating cost	• Initial cost of building the RF mesh network high • Trained engineers required to setup the

	• Can be used in multiple frequency bands (2.4 GHz and 865 MHz) • Relatively long technology lifecycle (v/s GPRS) • Other electrical network elements such as DT monitoring devices, street light controllers, RTU/FRTUs for distribution automation etc. can also be connected to the same RF Mesh network • Best solution as of now for deriving most benefits of AMI such as: outage detection and faster restoration, remote load curtailment when needed, demand response signals, ToU tariff signals, online (almost real-time) energy auditing, detection of phase-imbalances etc. • Several options for backhaul (WAN) connectivity	RF Mesh network
PLC	• Ready infrastructure (power cables) • Communications possible in challenging environments such as underground installations, metal-shielded cases etc. • Relatively long technology lifecycle (v/s GPRS) • Good option for new residential colonies and newly electrified villages with new electrical network designed and built for PLC applications • Broadband PLC (BPL) can offer telephone and internet connections as well to customers	• Requires good quality power cables with crimped joints (in India mostly aluminium wires are have twisted joints which are not good for PLC) • Requires filters to clean the communication signal (from noise) • High total cost of ownership due to initial and on-going line conditioning and maintenance • Communication not possible in case of power outage (unless batteries are used in the modules and repeaters which is expensive) • Requires Bespoke engineering and trained manpower for O&M – every time new connections are added, all devices in that node need to be tuned (re-set)
Wi-Fi	• Use existing infrastructure (broadband internet connections in buildings and public places) to create Wi-Fi hotspots in meter rooms and public places; or share the customers broadband connectivity • Very low total cost of ownership o DCUs, Gateways, Routers not required o Low cost communication modules o Negligible operating cost • Mature technology and standardised equipment available • DISCOMs need not deploy telecom engineers to maintain and manage the communications network • Easy to implement • Relatively long technology lifecycle (v/s GPRS)	• Idea is relatively new (ISGF proposed in 2015) and few field trials are being undertaken now • Interference due to other devices operating in 2.4 GHz frequency band

B) Smart Meter Interoperability

In order to solve the issue of interoperability in smart meters, ISGF suggests the following options:

- **Long-term rate contract:** While procuring smart meters (and associated hardware and software for AMI), a rate contract of 7-10 years with select meter vendor (s) whose meters are interoperable may be considered. Hence when new customers are to be added to the AMI network, the same meter manufacturers can provide the existing/already deployed solution to the Utility at previously agreed rates. This will enable seamless integration of new smart meters.

- **Choose communications technology first:** Another approach is to first choose the communication technology and then select the meter manufacturer/s. In such a case, all potential meter manufacturers will have to integrate this communication technology into their meters. Hence Device-Level interoperability will be easily achieved. The communication solutions provider will certify that their network interface card (NIC) is integrated with the meters that will connect with the Head End System (HES).

- **Third-party certification**: A Utility can also opt for a third-party certification for ensuring Device-Level interoperability. In such a case, a Utility will ask the meter manufacturers to present an Interoperability Certificate acquired from the certification agency.

- **Wi-Fi for last mile connectivity:** By 2020, almost every building (residential/commercial/industrial/public institutions etc.) in urban and semi-urban areas on earth will have broadband internet connectivity. Hence the smart meter and smart appliances can connect to the Utility servers using Wi-Fi. Moreover, choosing Wi-Fi for providing last mile connectivity can solve issues of interoperability, scalability, maturity, reliability and cost effectiveness.

- **Multiple HES with one MDMS**: In case multiple communication technologies for smart metering are selected by a Utility (over successive tendors) each having its own Head End System (HES), a common MDMS may be chosen that can interface with multiple HES. In such a case, all communication interfaces will have to be standardised as per ***IEC 61968: Application integration at electric utilities - System interfaces for distribution management***. This is a series of standards that define interfaces for the major elements of an interface architecture for Distribution Management Systems in DISCOMs. This option is often the last resort if all the above options are not possible.

Table 2 – Comparison of options for achieving interoperability in smart metering

Option / Parameter	Long-term rate contract	Choose communications technology first	Third-party certification	Wi-Fi for last mile connectivity	Multiple HES with one MDMS
Feasibility	High	High	Moderate	High	Moderate
Cost effectiveness	High	High	High	High	Low
Integration Time*	Minimum	Minimum	Moderate	Minimum	Maximum
Expertise required by Utility	Least	Moderate	Least	Least	High

* Integration time is the time required to integrate new smart meters into the Utility's AMI network.

The DISCOM may choose the appropriate option to achieve interoperability in smart metering. Selecting Wi-Fi for providing last mile connectivity option proves to be the best solution as it is mature, scalable, reliable and cost effective.