

ISGF White Paper

Case Studies on Power Line Carrier Communication Implementation in India

Abstract

The prime users of Power Line Carrier (PLC) communications, the electric utilities, are keen to use the power lines for communications for automating their operations. The fact that PLC communications uses the existing infrastructure, that is, the power lines, strengthens their case. Transmission utilities have been using PLC technologies since the past few decades, however, now the distribution companies are starting to use the power lines for smart grid applications primarily for Advanced Metering Infrastructure (AMI) and Supervisory Control And Data Acquisition (SCADA). Tata Power Delhi Distribution Limited (TPDDL), Uttar Haryana Bijli Vitran Nigam (UHBVN), Uttar Gujarat Vij Company Limited (UGVCL) and Reliance Energy have successfully deployed PLC technology in their distribution grid. This White Paper explains the objective, scope, list of parameters exchanged and reliability of the major PLC pilots undertaken in India so far.

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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.

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Abbreviations

DoT – Department of Telecommunications

ISGF – India Smart Grid Forum

PLC – Power Line Carrier

TWACS – Two Way Advanced Communications System

IEEE – Institute of Electrical and Electronic Engineers

IEC – International Electrotechnical Commission

ITU – International Telecommunication Union

CENELEC – European Committee for Electrotechnical Standardization

SCADA – Supervisory Control And Data Acquisition

TPDDL – Tata Power Delhi Distribution Limited

UHBVN – Uttar Haryana Bijli Vitran Nigam

UGVCL – Uttar Gujarat Viji Company Limited

PoC – Proof of Concept

PRIME - PowerLine Intelligent Metering Evolution

1. Introduction

The prime users of Power Line Carrier (PLC) communications, the electric utilities, are keen to use the power lines for communications for automating their operations. The fact that PLC communications uses the existing infrastructure, that is, the power lines, strengthens their case. Transmission utilities have been using PLC technologies since the past few decades, however, now the distribution companies are starting to use the power lines for smart grid applications primarily for Advanced Metering Infrastructure (AMI) and Supervisory Control And Data Acquisition (SCADA). Tata Power Delhi Distribution Limited (TPDDL), Uttar Haryana Bijli Vitran Nigam (UHBVN), Uttar Gujarat Vij Company Limited (UGVCL) and Reliance Energy have successfully deployed PLC technology in their distribution grid.

2. Demonstrations of PLC technology in India

As stated above, some Indian electric utilities have undertaken pilots to test PLC technology and the results have been extremely successful. Key details regarding these demonstrations are mentioned below sections.

2.1 OSGP demonstration at TPDDL

2.1.1 Objective

The Open Smart Grid Protocol (OSGP) has been implemented at Tata Power Delhi Distribution Limited (TPDDL). The goal of the study was to test the reliability and speed of the Networked Energy Services (NES) System's load profile collection mechanism in a real-world installation under challenging conditions. The number of meters per transformer varied in this demonstration and three low-voltage grid sections were used. Each had a large number of meters per transformer and each had repeating functions in use (in order to put maximum load onto the network and provide the most difficult test possible). In addition, load profile information was collected once every day.

2.1.2 Scope of Installations

Scenario 1: 65 meters under one transformer. All consumers in the transformer covered. An underground network was used.

Scenario 2: 19 meters under one transformer. An overhead network was used.

2.1.3 List of parameters exchanged

In each scenario, the following testing methodology was used:

Each meter was configured to deliver a daily load varying between 10*4 channels to 12*4 channels based on 15-minute intervals. The test was performed for two consecutive weeks more than 6 months.

For each scenario, the meter configuration included

- Configuring the network to collect data at 15 minutes interval and transmitting every 6 hours to the Head End System (HES)
- Configuring alarm transmission immediately
- Automated billing data reads
- Automated load profile reads
- Automated device alarm collection
- Automated meter event log data collection

- On-demand power quality data reads
- On-demand instantaneous power reads
- On-demand billing reads
- On demand operation of the meter disconnect switch
- On-demand Billing reads
- On demand operation of the meter Disconnect Switch
- Maximum Power limits: Turning off power to the consumer based on maximum instantaneous power consumption over a defined threshold
- Display of meter discovery data (automated topology management including phase description for each meter connected or meter down status).

Meters at different times were setup for transmission of data at 4 hours, 6 hours and in some cases every one hour to test the performance of the narrowband transmission and the GSM/GPRS connectivity.

2.1.4 Key findings

The NES System was proven to offer very high reliability and fast delivery of the load profile values to the data concentrator, as well as to the head-end enterprise system. In addition, no significant performance loss was observed when the number of channels was doubled.

Transmission of data from the smart meter to the Data Concentrator Unit (DCU) in all conditions was about 95 % on a four or six hourly basis. On a daily basis it increased to about 98 %. The pilot is still going on and the results will be validated once again. The non-delivering meters differed throughout the test period, so no data was lost.

However, in one transformer the mesh was not properly created as the number of end consumers with 600 units and above was very low. This transformer had over 400 consumers and it was sought to install meters in only 20 consumers. 14 meters communicated but rest did not communicate. The recommendation to add about 10 more meters was not implemented by the utility.

2.2 Meters and More demonstration at TPDDL

2.2.1 Objective

The objective of the pilot was to test Meters and More protocol for smart metering application on one of the chosen overhead LT networks at TPDDL.

2.2.2 Scope of Installations

No of Meters Installed: 63

Single Phase Meters: 60

Three phase Meters: 3

Data Concentrator Unit: 1

93% of the total meters installed on the DT were installed with smart meters by Enel.

2.2.3 List of events/parameters sent from the smart meter to the utility

The frequency of acquisition was optimized (reading cycle of 6 hours) in order to guarantee full reachability of the meters installed, and to collect all the related readings within 24 hours. Data extracted from the AMI system shows that readings were successfully acquired from all the 63 meters installed with a performance that complies with Enel's standards (reachability index > 95% @24hr).

As already known, noise on network and GPRS communication issues varied dynamically throughout the whole day. By adopting a good reading cycle strategy, it is therefore possible to deal with temporary unreachability of some meters.

Data is related to:

- Active energy import current
- Active energy export current
- Maximum power demand import current with its date and time
- Maximum Power demand export current with its date and time

Load profiles

Based on the data acquired from field 100% of load profiles were successfully acquired, based on 12 times per day acquisition.

Power quality data

Based on the data acquired from field, 100% of voltage variations were successfully acquired, based on 4 times per day.

Interruptions Data

Interruptions recorded by the meter could be viewed at any moment from the HES.

2.2.4 Reliability in field

The reliability of PLC communications using Meters and More technology/protocol was around 94% for data transfer on a 6 hourly basis and it increased to about 98% on a 24 hour basis. The pilot is still going on and the results will be validated once again.

Other Indian utilities have also demonstrated the Meters and More protocol.

2.3 TWACS demonstration at UHBVN

As part of the 14 Government of India approved smart grid pilot projects, Uttar Haryana Bijli Vitran Nigam (UHBVN) is in the process of implementing smart grid functionalities at Panipat, a city that has a peak demand of 42 MVA, has 3 number of 33KV feeders and 8 number of 11 KV feeders. Also, it has 539 distribution transformers and the LT: HT ratio is 1.8:1. The AT&C losses are 23.15% and the number of consumers is 31623.

AMI and SCADA will be demonstrated in 3 feeders, namely Tehsil Camp, City -1 and Conduit Feeders.

Two Way Advanced Communications System (TWACS) protocol will be used for PLC communications which is a technology that uses 200-600 Hz of the spectrum. This technology will be used at Panipat for both, smart metering and SCADA.

The objectives of this project are:

- To reduce theft
- To improve the quality and reliability of power
- To shift the peak load to off-peak hours using demand response
- To study consumer consumption behaviour
- To perform outage management

The reliability of TWACS communications at Panipat is around 98%.

2.4 Multiple PLC protocols demonstrated at UGVCL

As part of the 14 Govt. approved smart grid pilot projects, Uttar Gujarat Vij Company Limited (UGVCL) has demonstrated Proof of Concept (PoC) for 4 PLC protocols. The details are given in the table below:

PoC	Protocol Used for Communication	Communication Frequency Range	1 phase			
			Meter to DCU		DCU to Central server	
			Technology	Nos. of Smart Meters installed	Technology	Nos. of DCU Installed
1.	DLT 645 2007	25 KHz to 478 KHz	PLC	295	GPRS	5
2.	Not defined in Documents	Not defined in Documents	PLC	235	GPRS	5
3.	PRIME	41.992 KHz to 88.867 KHz	PLC	297	GPRS	5
4.	Not defined in Documents	2 MHz to 12 MHz	PLC- Broadband over Power Line (BPL)	280	GPRS	5

2.5 PLC implementation at PGCIL

Power Grid Corporation of India Limited (PGCIL) is the oldest user of PLC technology in India. It uses PLC technology for both, protection and monitoring of the transmission grid. The frequency of operation is between 36 KHz and 500 KHz and the communication technology is proprietary. The system is working with a reliability of around 97-98%.The maximum throughput is 28 kbps. Around 99% of the 132 kV and above feeders are monitored and controlled by PLC communication.