The Journal of CPRI,
Vol. 10, No. 1, March 2014 pp. 57-64

DLMS Data Connectivity Architecture for Energy Meters

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DLMS is a platform that provides communication between meter and data collection devices. The companion specification provides secure and efficient transfer of electricity data. Many of data exchange approaches have been proposed to develop an open standard. In this paper, a client /server model of the DLMS / COSEM architecture with HDLC as the data-link layer and parameter identification of energy meters has been discussed with some of the issues also discussed in Indian context.

Keywords: *COSEM, Data concentrator unit, DLMS, IEC.*

1.0 INTRODUCTION

DLMS was developed by electricity de France in association with Landis+Gyr. Initially, it was named as Distribution Line Specification and then it re-baptized to Device Language Message Specification (DLMS). Standardization of a messaging system DLMS is one of the most important events in the meter communications. The energy sector is transforming their energy metering network through communication network technology [1]. Distribution automation system has already been used by electricity suppliers in power sector. Remote metering, demand side management and tariff control, etc. are also required for customer services. All these possibilities can be achieved using DLMS / COSEM data exchange structure [2].

IEC standardized DLMS as platform to provide interoperability of meters and other communicating devices or meter communication network. IEC 62056 specifies the protocol application layer and object-related services. COSEM stands for Companion specification for energy metering. Open efficient and secure transfer of electricity metering data as per the application and protocols of international standards intended to use companion specification [1].

An open protocol standards are providing many possibilities to research for the development of interoperability and interconnection standards. It is well known that initially telecom sector was facing the problem of proprietary standards in which new devices, emerging technologies were developed, but all these were not interoperable. This issue was resolved by introducing open system interconnection (OSI) model and this model comprises two components (a) seven layer model and (b) set of specific protocols. Similar, kind of situation resolved in the power sector by the International Electro-technical Commission (IEC) [1].

IEC 62056 series DLMS / COSEM mainly designed to support data communication between distribution devices and data concentrator units. It comprises mainly direct local data exchange, Physical layer, Data link layer using HDLC, COSEM Application Layer, Object Identification

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System (OBIS), Interface Classes, and COSEM Transport Layers for IPv4 networks [3-8].

DLMS COSEM protocol may also provide the smart metering in smart grid scenario that is one of the most advanced techniques in power sector for enhancing the capability of the old metering infrastructure for energy preservation.

Development of this technology is also raising many challenges like data handling, interoperability, scalability, development of standards and network designing. Data handling and interoperability are other big challenges for successful deployment of smart metering infrastructure [2], [9].

Generally, Interoperable devices in DLMS categorize as server and client. Data collection device act as a client that supports system dependent features, parameters, functions and classes requesting data from the server. In this structure, communication protocol stack is independent of application layer so both devices may communicate different media. The COSEM model is using compression techniques for efficient data exchange [10-11].

There are various organizations working to develop an open standard protocol for energy meters. Many of data exchange approaches have been proposed to develop communication standards, but some issues are also there at implementation stage e.g. installation of such kind of meters, designing of such standards that easily ports into existing application software, efficiency and comprehensiveness of meters, and hardware limitation and communication protocols. DLMS based communication can be implemented in meters, which are an independent and open communication medium [2], [12].

In this paper, we are discussing DLMS / COSEM data connectivity architecture for data exchange of energy meters. The paper comprised as follows: section I as introduction, section II is providing parameter identification of energy meters, section III is providing an architecture model of DLMS/COSEM and finally, paper is concluded in section IV.

2.0 PARAMETER IDENTIFICATION OF ENERGY METERS

Electrical energy meters are used for measuring the amount of energy consumed by the consumer. Energy meters may have the connection of single phase or three phases. Energy meters have the capability to provide data, information that comprises electrical parameters, tampering conditions, event conditions, etc. This information about meters has to be stored, displayed, and made available at the meter communication terminals so that utilities can directly access meter information through data concentrator unit (DCU). DCU is used for collecting the data / information that covers all electrical parameters, abstract parameters and event conditions etc. It provides information similar in the way like meter, but supports faster communication, and has a larger storage capacity than meters [13].

a) Energy accounting and Audit Meters

b) Interface meters

c) Consumer meters

India is planning to provide uniformity in electrical energy meter specifications so that utilities will procure only standardized list of parameters, abstract parameters, and event / tamper conditions with communication protocols. With the support of information technology or current technological capabilities, data / information can be transmitted over a communication channel to the data center, and all applications like energy accounting, energy auditing, billing data generation etc. are possiblewith application programs. In Indian electricity network following energy meters are envisaged [13].

Energy accounting and audit meters are identified for use at sub-station feeder and distribution transformer centers. Interface meters are identified for use in meter banks, network boundaries, for Availability Based Tariff (ABT) metering and whenever the consumer is drawing / injecting from/ to the grid. Consumer meters are identified for HT, PT and CT operated and LT-CT operated consumer meters who imported energy. All these meters have data / information that has measured in the field and it is made available on the communication terminal of the meters.

TABLE 1

CATEGORY DETAIL OF ENERGY METERS

SI. No.	Meter Type	Data / Information
A	Energy Accounting and Audit Meters	Instantaneous Parameters (e.g. Real time clock, voltage, current, cumulative energy import / export etc.) Block Profile / Load Survey data (e.g. Block energy kWh, kVArh for lag/ lead etc.) Accounting / billing Parameters (All parameters that lies in instantaneous and block profile) Name plate details (e.g. Manufacturer name, meter serial number, internal CT/PT Ratio etc.) Programmable parameters (e.g. Billing date, demand integration period, Block capture time etc.) Event / tamper conditions (e.g. Over voltage in any phase, voltage unbalance, low voltage in any phase, date and time of event etc.)
B	Interface Meters	Instantaneous Parameters (e.g. Singed active and reactive power + Import/ - export, real time clock, voltage, current etc.) Block profile / Load survey data (e.g. System power factor, net energy, KVAh quadrant 1, 2, 3 & 4 etc.) Accounting / billing Parameters (All parameters that lies in instantaneous and block profile) Name plate details (e.g. Manufacturer name, meter serial number, internal CT/PT Ratio etc.) Programmable parameters (e.g. Billing date, demand integration period, Block capture time etc.) Event / tamper conditions (e.g. Over voltage in any phase, voltage unbalance, low voltage in any phase, date and time of event etc.)
C	Consumer Meters	Instantaneous Parameters (e.g. Voltage R/Y/B phase, current R/Y/B phase, Real time clock, signed power factor R/Y/B phase, active power forward/reverse, reactive power lag / lead etc.) Block Profile / Load Survey data (e.g. Block energy kWh, kVArh for lag/ lead etc.) Accounting / billing Parameters (e.g. All parameters that lies in instantaneous and block profile) Name Plate Details (e.g. Manufacturer name, meter serial number, internal CT/PT Ratio etc.) Programmable parameters (e.g. Billing date, demand integration period, Block capture time etc.) Event / tamper conditions (e.g. Over voltage in any phase, voltage unbalance, low voltage in any phase, date and time of event etc.)

Each parameter assigned object identification system (OBIS) Code. The parameter list of each individual energy meter can be seen in Table I.

3.0 ARCHITECTURE

The COSEM object model is based on client/ server model and this is used for data exchange between data collection systems and metering equipment. All categories of energy meters (A/B/C) are acting as a server and connected to base computer system that acts as a client. The connectivity block diagram between the meter and base computer system are shown in Figure 1. The server shall support minimum two ports for data communication as P1 and P2 [10].

P1 shall be used for the remote access for the host or data concentrator. An electrical compatible RS 232 or RS 485 specification is used in P1 port. Whereas P2 optical port is used for local access from a hand held unit.

P1 and P2 are supporting minimum and default baud rate of 9600 with 3 layer connection oriented COSEM / HDLC profile.

If simultaneously both ports are accessed then the optical port shall have priority. The meter allows one association to be open at one time, this means that if optical port is connected then attempt to connect on electrical port shall be returned with Disconnected Mode (DM) because the connection is on optical port. Similarly, if data is being accessed from electrical port of meter using RS 232 or RS 485 specifications, same time attempt to connect optical port, then optical port connection processed for disconnection mode [10].

All practical purposes, LLC is non-operational and simply passes on services between the service user layer COSEM and the MAC sub-layer. Data Link (DL) connection/disconnection services to the service user layer is provided by the LLC sub layer but it uses the services of the MAC sub-layer to execute these services as shown in Figure 2 [14].

MAC sub-layer uses the HDLC frame format type 3 as can be seen in Figure 3 [14]. This frame enables additional error protection, identification of both source and destination, and longer frame size [10].

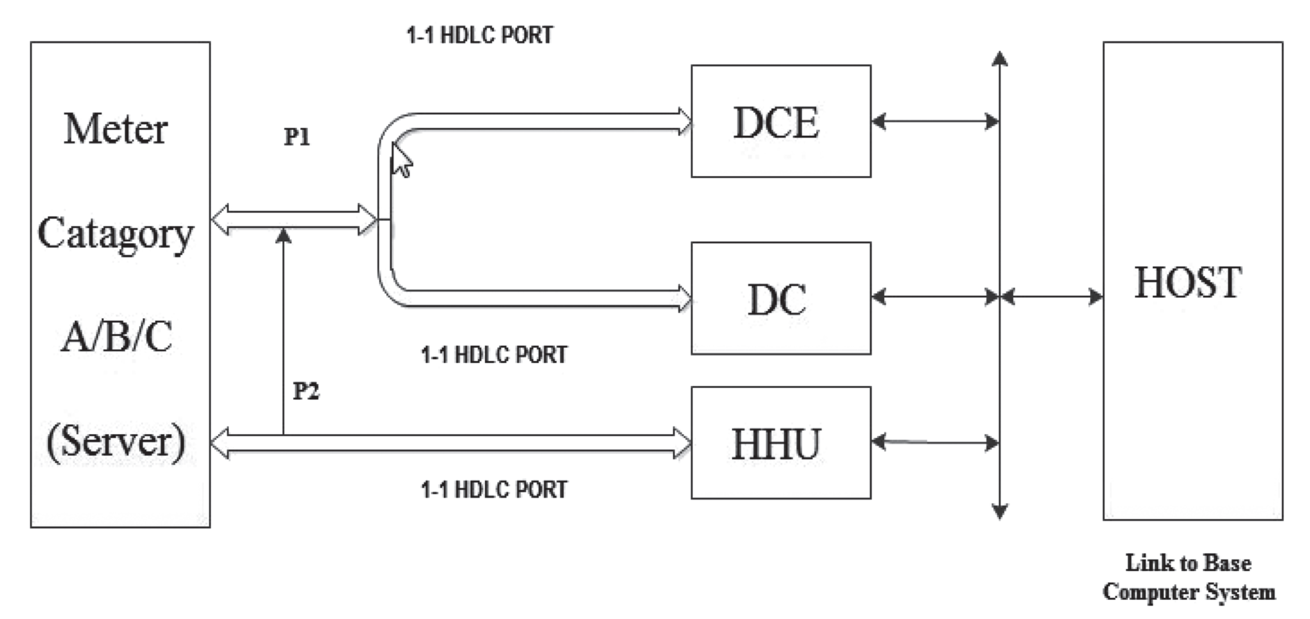

FIG. 1 CONNECTIVITY DIAGRAM BETWEEN SERVER (ENERGY METER) AND CLIENT

DCE: Data Communication Equipment; DC: Data Concentrator; HHU: Hand Held Unit; P1: RS 232/ RS 485 port for remote access; P2: Optical port for local access

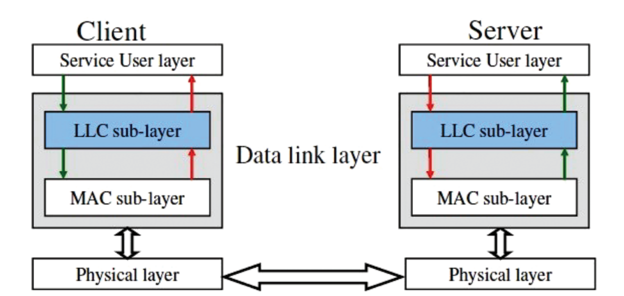

FIG. 2 SETTING UP DL CONNECTION / DISCONNECTION

Frame	Frame format	Destination Address	Source Address	Control	HCS	Information	FCS	Flag

FIG. 3 HDLC FRAME FORMAT

The modeling of meter data values into the DLMS object is first task for implementation of DLMS / COSEM server protocol in a meter. The meter data values are at first modeled into appropriate OBIS code for identifying the specific quantity then select appropriate interface class that represent the quantity. The OBIS code is associated with the interface class, therefore the selection of classes are limited [10-11].

Metering devices are different in design, functionality and measurement algorithms. But all data held by the meter can be classified into different categories called as objects. An object is an entity which has attributes and methods. The attributes describe the properties of the object. The methods can be used to examine or modify the attributes. The most important attribute of an object is its name called as the Logical Name, which describes the meaning of the information held by the object. Attributes can be static, which are not changed by the metering process, or dynamic e.g. measured values, which are continuously updated by the metering process. When we are dealing with the objects, we are not concerned how the dynamic values are updated by the metering process [10].

DLMS communication is based on client and server model. This model comprises three layers:

a) Physical Layer
b) HDLC layer
c) Application layer

These layers establish the communication between server and client. Illustration of data transfer between server and client can be seen in Figure 4 [12]. Physical layer is the lowest layer that provides a connection between server and client by physical means of a cable between the meter and a COM port of our PC. Second layer is the HDLC layer that builds a logical connection. The logical connection is providing an exchange of hand shaking signals between client and server. The data elements exchanged by the HDLC peer layers are called HDLC-frames. In HDLC, the client address is always 1 byte and the server address consists of two parts which are upper address and lower address. Third layer is the application layer after the connection between the physical layers and the HDLC layer and the Application layer connection will associate with the meter according to the type of client [10]. In COSEM model, meter acts as a server and data server used by the client application [11].

The client data may be used for utilities or meter manufacturer. The COSEM server structure is segregated in three levels:

a) Physical device
b) Logical device
c) Accessible COSEM object

The energy meter acts as a physical device which support one or more communication profile depending upon the requirement. A physical device can be a single or multiple logical devices like electricity meter, gas meter, etc. A logical device has a number of COSEM objects. A COSEM object comprises information with attributes and methods.

As these objects present the information and the behavior of the meter and it can be seen via its communication interfaces, they are called interface objects. Interface objects which have the same attributes and methods make an interface class.They are identified by their class names and versions. All COSEM object attributes and methods can be accessed using the same DLMS service set so that they can be transformed as a series of bytes. Interoperability is providing a connection between two devices so that devices can exchange their data [11].

Metering industry has multiple communication protocols. The communication between meter and other equipment is another big challenge as these meters are being read automatically or remotely by various techniques. The choice of communication medium is equally important as it, along with a protocol, assures seamless connectivity in the chosen distribution network and ensures successful implementation of the application.

India has adopted various parts of IEC 62056 for meter data exchange that is briefed in section I. Other country like United States has implemented ANSI C12.19 for communication and application protocol-services. These standards are C12.18 / IEEE 1701 for ANSI type 2 Optical port, ANSI C12.21 / IEEE 1702 for communication through telephone modem, and ANSI C12.22 / IEEE 1703 for interfacing to data communication networks.

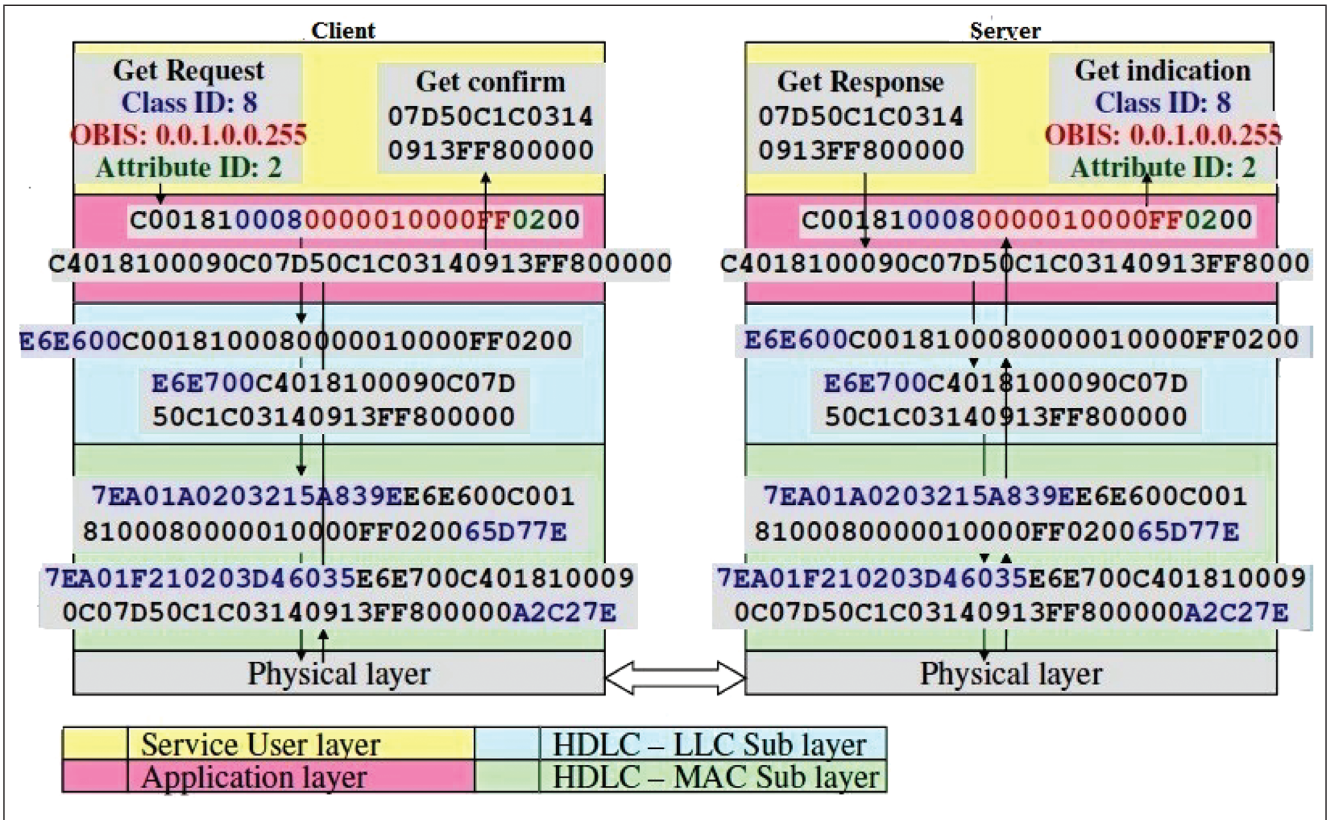

FIG. 4 CONNECTIVITY DIAGRAM BETWEEN SERVER (ENERGY METER) AND CLIENT

Class id 26 of IEC 62056-62 preferably referred in ANSI C12.19. So any implementation of the data model of IEC 62056-62 is applicable in ANSI C12.19 for communication and application standards [6], [15].

4.0 CONCLUSION

The DLMS is providing a common language to energy meters and communicable devices of power sector. The essential requirement of common language protocol is to make the system easy to communicate. The present work has discussed DLMS / COSEM standards relevant to the metering data exchange techniques, parameter identification of energy meters, and architecture of the connectivity scheme between server and client. This paper provides an understanding of the DLMS / COSEM structure with defined standards of IEC 62056 families. Authors hope that the present paper will help researcher in having a better understanding of DLMS / COSEM architecture and also provide more clarity for evolving interconnection methods between meters and other communication devices.

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