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COMMUNICATING WITH AN ENERGY METER USING IEC 62056 THROUGH TCP/IP PROTOCOL

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Abstract - Device Language Message Specification (DLMS) is an application layer protocol designed to support messaging to and from energy distribution devices in a computer integrated environment. COSEM, the Companion Specification for Energy Metering, addresses the meter as an integrated part of a commercial process, which starts with the measurement of the delivered product (energy) and ends with the revenue collection. The DLMS/COSEM specification specifies a data model and communication protocols for data exchange with metering equipment. Communication with electricity metering equipment using the COSEM interface classes is based on the client – server paradigm, where the Meter plays the role of server and the client is a Meter Reading Instrument. Different types of communication media are used to retrieve parameters from energy meter. This paper aims to establish a communication with energy meter by using DLMS/COSEM and access meter data with TCP/IP based communication media.

***Keywords* -** *DLMS, COSEM, OBIS, IEC62056, Logical Device, Interoperability.*

I. INTRODUCTION

An energy meter is a device that measures the amount of electrical energy supplied to a residential or commercial building. The most common unit of measurement made by a meter is the kilowatt hour, which is equal to the amount of energy used by a load of one kilowatt in one hour. Standardization of a messaging system - DLMS originally stands for Distribution Line Message specification is one of the most important events in the meter communications domain. The existence and the growing popularity of this standard clearly shows that the Energy Industry is beginning to recognize the importance of a non-proprietery, internationally standardized communications protocol for its own needs.

Device Language Message Specification (DLMS) is comparable to a set of rules or a common language, on which the various operators have agreed. The DLMS-protocol enables the integration of energy meters with data management systems from other manufacturers. Companion Specification for Energy Metering (COSEM) is an interface model of communicating energy metering equipment, providing a view of the functionality available through the communication interfaces. The DLMS/COSEM [1] specification specifies a data model and communication protocols for data exchange with metering equipment. Fig. 1 the three steps approach of DLMS Modelling – Messaging – Transporting.

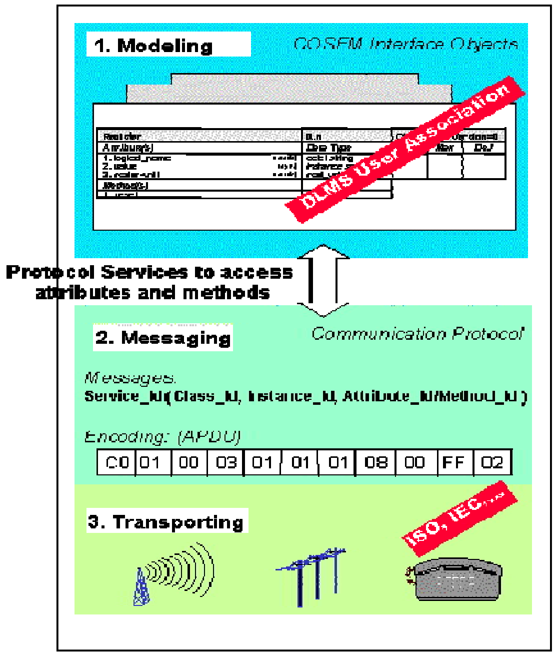

Fig. 1 : The three steps approach of DLMS Modelling – Messaging – Transporting

- Step 1, Modelling: This covers the data model of metering equipment as well as rules for data identification. The data model provides a view of the functionality of the meter, as it is available at its interface(s).
- Step 2, Messaging: This covers the communication services and protocols for mapping the elements of the data model to application protocol data units (APDU)[1].
- Step 3, Transporting: This covers the services and protocols for the transportation of the messages through the communication channel.

Step 1 specifies the COSEM interface classes (ICs), the OBIS object identification system, and the use of interface objects for modelling the various functions of the metering equipment. Step 2 and 3 are specifies communication profiles for various communication media and the protocol layers of these communication profiles. The top layer in any profile is the COSEM application layer. It provides services to establish a logical connection between the client and the server(s). It also provides the xDLMS messaging services to access attributes and methods of the COSEM interface objects. The lower, communication profile specific protocol layers transport the information.

International Electrotechnical Commission (IEC) is standardizing DLMS to provide –a 'common language' for all kinds of communicating applications of the Energy Industry: The main objective is to ensure interoperability of meters and other communications equipments (metering data concentrators, etc.) of a meter communications network, built on the DLMS basis**.** At the same time DLMS based communication is simple enough – it should be implemented in meters, which generally do not have a lot of resources -, independent on the metering application - open for new applications - and also independent on the communications medium.

COSEM, the Companion Specification for Energy Metering, addresses these challenges by looking at the meter as an integrated part of a commercial process, which starts with the measurement of the delivered product (energy) and ends with the revenue collection. The meter is specified by its “behaviour” as seen from the utility's business processes. The formal specification of the behaviour is based on object modeling techniques (interface classes and objects). The specification of these objects forms a major part of COSEM. The COSEM server model represents only the externally visible elements of the meter. The client applications that support the business processes of the utilities, customers and meter manufacturers make use of this server model. The meter offers means to retrieve its structural model (the list of objects visible through the interface), and provides controlled access to the attributes and specific methods of these objects. The set of different interface classes (ICs) form a standardized library from which the manufacturer can assemble (model) its individual products. The elements are designed so that with them the entire range of products (from residential, commercial, industrial and transmission & distribution applications) can be covered. The choice of the subset of ICs used to build a meter, and the instantiation and implementation of those ICs are part of the product design and therefore left to the manufacturer. The concept of the standardized metering interface class library provides the different users and manufacturers with a maximum of diversity without having to sacrifice interoperability.

Recent technology developments enable to build intelligent metering equipment, capable of capturing, processing and communicating this information to all parties involved. Further analysis of this information, for the purposes of billing, load, customer and contract management, it is necessary to uniquely identify all data collected manually or automatically, via local or remote data exchange, in a manufacturer independent way. The definition of such identification codes is termed as OBIS codes.

Various communication media are used to communicate with the Energy Meters such as TCP/IP, Zigbee, RS232, Optic Fiber and GSM/GPRS based modem etc. through which we can retrieve the various parameters from Energy meter. There is a two way communication establishment between Meter and PC through TCP/IP based wired and wireless communication media. W2150/2250 Plus wireless device servers are used for connecting serial devices such as meters to an IP-based wireless LAN or Ethernet LAN. A software will be able to access the serial devices from anywhere over a local LAN, WLAN, or the Internet. Moreover, the WLAN environment offers an excellent solution for applications in which the serial devices are moved frequently from place to place.

II. IEC OVERVIEW

The IEC (International Electro technical Commission) is a worldwide organization for standardization comprising all national electro technical committees (IEC National Committees). IEC62056 is a set of standards for Electricity metering – Data exchange for meter reading, tariff and load control by International Electrotechnical Commission. The IEC62056 standards are the International Standard versions of the DLMS/COSEM specification. The object of the IEC is to promote international co-operation on all questions concerning standardization in the electrical and electronic fields. The IEC collaborates closely with the International Organization for Standardization (ISO) in accordance with conditions determined by agreement between the two organizations.

This IEC 62056 describes hardware and protocol specifications for local meter data exchange. DLMS Metering Communication Protocol, standardized under the IEC-62056 series.

- IEC62056-53: COSEM Application Layer [5]: handle Meter data and perform the basic functions of data set/get/action operations in the Meter.
- IEC62056-62: Interface Classes[4]: This specification defines the standard Interface Classes[3] which can be used to represent all possible kinds of Meter Data. Using this

specification meter data is abstracted into high-level objects, which can then be operated upon by the protocol stack.

- IEC62056-61: OBIS- Object Identification System defines a standard list of Meter data object identifiers in the form of a 6 character code for each object. This list is maintained by the DLMS-UA
- IEC62056-21: Direct Local Data Exchange
- IEC62056-46: HDLC Data link Layer: HDLC defines a standard Data link layer performing the functions of low-level addressing, data integrity checks, data sequencing, segmentation and assimilation, link-level handshaking, data-flow control etc.

III. CATEGORIES OF ELECTRICITY METER

Three categories of electricity meters have been selected for compiling comprehensive list of metering parameters with their data identifiers has required for data network in India for COSEM procedure and services. The meters complying with this specification shall be considered as servers in a data network.

1) Category A [6] Meter: This meter is identified for use at sub-station feeders and Distribution Transformer Centres. The parameters listed for this category is for "Energy Accounting and Audit" purposes.

2) Category B Meter: This meter is identified for use at Meter Banks and Network boundaries. The parameters listed for this category is for import / export of energy. This meter is also suitable for Availability Based Tariff (ABT) regime.

3) Category C Meter: This meter is identified for use at HT (PT and CT operated) and LT [6] (CT operated) consumers. The parameters listed for this category is for import / export of energy. For consumers who also supply energy to grid the category B Meter is recommended.

Interoperable software which is compactable for all categories of electricity meters irrespective of the manufactures. The interoperability is the capability of the data collection system to exchange data with meters of different makes and the capability of the metering equipment to exchange data with different type of data collection systems. In the DLMS/COSEM environment, interoperability and interconnectivity is defined between client and server APs. A client and a server AP must be interoperable and interconnectable to ensure data exchange between the two systems. Fig. 2 shows the interoperability between different energy meters. Interoperability ensures,

- Any system can read any meter
- Any meter can be read by any system
- No special involvement of vendors
- To achieve interoperability we need standards and DLMS is the most popular metering standard.

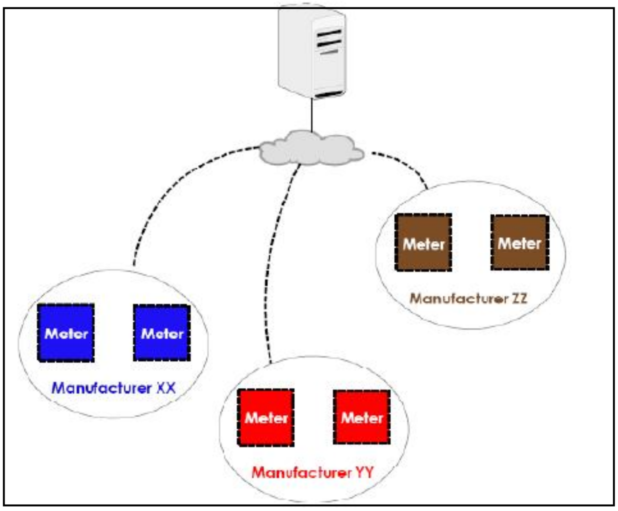

Fig. 2 Interoperability

IV. DLMS/COSEM COMMUNICATION

DLMS is an object oriented application model. It makes use of a method called 'abstract object modelling' in order to fully describe the DLMS device model and the DLMS service procedures. This secures that the energy supplier gets the full advantage of the meter functions.

COSEM, the Companion Specification for Energy Metering, addresses challenges by looking at the meter as an integrated part of a communication system which requires the ability to convey measurements of the delivered product (energy) from the diverse points where these measurements are made to the business processes which use them, over a variety of connecting media. Using object modelling techniques established in the world of information science the data to be supplied by the meter is defined in a standard way that is accessible to the utility's business processes and relevant parts of its behaviour are similarly represented, while the communications is defined following the Open Systems Interconnection that is fundamental to the telecommunications world. The formal specification of interface classes and objects, which enables this, forms a major part of COSEM.

DLMS/COSEM defines an interface model, valid for all kind of energy types, like electricity, gas, water, heat etc. Each interface object has a unique standard identifier, identifying the data on the display and over the communication line. This model is completely independent from the protocol layers used for transporting the data. It supports innovation and future evolution by allowing manufacturer specific instances, attributes, methods, and the possibility to add new interface classes and versions without changing the services to access the objects, thus maintaining interoperability. Fig .3 shows the DLMS/COSEM specification.

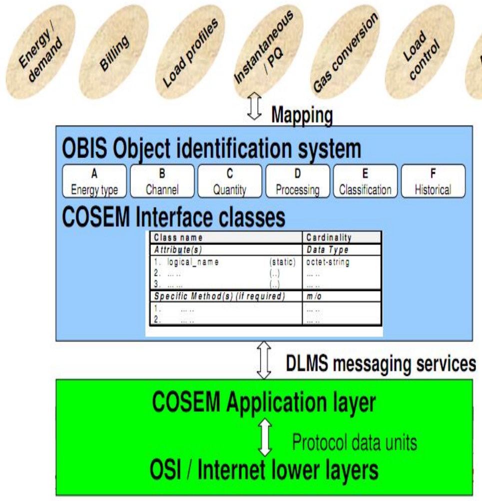

Fig. 3 : DLMS/COSEM specification

A. *The COSEM Server Model*

The COSEM model represents the meter as a server, used by client applications that retrieve data from, provide control information to, and instigate known actions within the meter via controlled access to the attributes and specific methods of objects making up the server interface. This client may be supporting the business processes of utilities, customers, meter operators, or meter manufacturers. Fig. 4 shows the COSEM Server Model. The COSEM server is structured into three hierarchical levels,

- Physical device
- Logical device
- Accessible COSEM objects

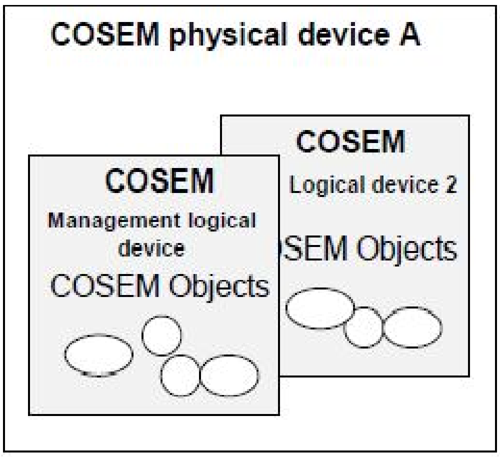

Fig. 4 : The COSEM Server Model

1) *The Physical Device*: The Physical device which is our Energy Meter has ability to support one or more communication profiles depending on the customer requirement. Currently, the Standard specifies two profiles: the 3-layer, connection oriented HDLC-based profile, and the TCP-UDP/IP based profile with physical address.

2) *The Logical Device:* A physical device hosts single or multiple Logical Devices. Each logical device models a specific functionality of the physical device. For example, in a multi-energy meter, one logical device could be an electricity meter, another, a gas-meter etc. The COSEM logical device contains a set of COSEM objects. Each physical device shall contain a "Management logical device".

Each logical device has an address, called the logical device address. The addressing of COSEM logical devices shall be provided by the addressing scheme of the lower layers of the protocol stack used. The COSEM logical device can be identified by its unique COSEM logical device name. The logical device name is defined as an octet -string of up to 16 octets. In order to access COSEM objects in the server, an application association (AA) shall first be established with a client. The management logical device is a mandatory element of any physical device.

According to the Standard, all physical devices have to host a special logical device called the management logical device, with the predefined address 0x0001. The management logical device itself may contain a lot of information but, at the minimum, it has to contain a description of all the logical devices available in the physical device, with their logical addresses and names.

3) *Accessible COSEM objects:* A logical device is a container for COSEM objects. A COSEM [1] object is simply a structured piece of information with attributes and methods. All objects that share the same structure are of the same COSEM Interface class. There are many COSEM Interface classes (about 50) because there are many objects kinds. Since a logical device may contain many objects of different classes, then how do we identify the information that we are interested in? This is possible because, by definition, the first attribute of each object is its Logical Name.

B. *COSEM Interface Classes*

The standardized objects and interface classes (ICs) form an extensible library from which the manufacturer can assemble (model) its products according to national specifications or contract requirements. COSEM interface classes (ICs) [1] are used to create interface objects – instantiations of the ICs – are used for communication purposes. Data collection systems and metering equipment from different vendors, following these specifications, can exchange data in an interoperable way.

COSEM interface classes (ICs) gives interface objects which contains attributes and methods. Attributes represent the characteristics of an object. The value of an attribute may affect the behaviour of an object. The first attribute of any object is the "logical_name". It is one part of the identification of the object. An object may offer a number of methods to either examine or modify the values of the attributes. Objects that share common characteristics are generalized as an IC, identified with a class_id. Fig. 5 shows an interface Class and its Instance.

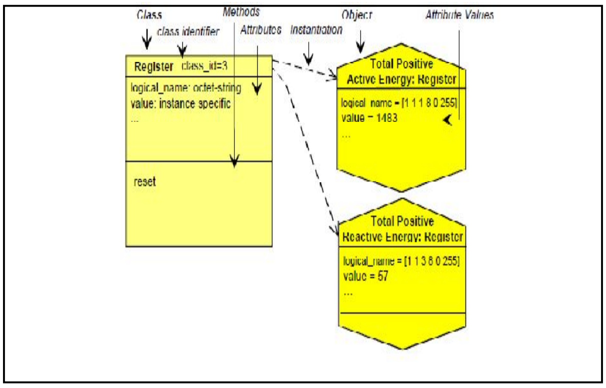

Fig. 5 : An interface Class and its Instance

V. THE CLIENT-SERVER MODEL

The data exchange between host and the meter uses the client-server model, where the Metering Equipment plays the role of server and the client is a Meter Reading instrument. Fig. 6 shows Client Server model for DLMS communication.

Communication profiles comprise a number of protocol layers. Each layer has a distinct task and provides services to its upper layer and uses services of its supporting layer(s) The 3-layers profile[2] are Physical layer, the HDLC layer and the Application layer.

1) The physical layer: The lowest layer is the physical layer. It is a serial cable between a COM port of our PC and the appropriate connector of our meter. The connection between the two peer layers is accomplished by mechanically connecting the two sides.

2) The HDLC layer: HDLC [2] layer corresponds to the layers 2 to 4 of the OSI model. The HDLC layer is connection oriented. It means that the peer HDLC layers must first build a logical connection with each other by exchanging and negotiating some connection parameters (as handshaking between client and server). The data elements exchanged by the HDLC peer layers are called HDLC-frames.

In HDLC layer, the client address is always 1 byte, the server address consists of two parts and there are three variants:

- One byte addressing: There is just an upper address. It is a byte value.
- Two bytes addressing: There is an upper address of 1 byte and a lower address of 1 byte.
- Four bytes addressing. There is an upper address of 2 bytes and a lower address of two bytes.

3) The Application layer: The last layer of the 3-layers profile is Application layer. After having connected the physical layer and the HDLC layer, we have to connect the Application layer. After the connection is established successfully it will associate with the meter according to the type of client. Therefore, to establish an association, we send an Association request and expect an Association response. Then, if the association has been correctly established, we continue to send requests and receive responses until we are finished. Finally, we release the association by disconnecting the HDLC-Layer.

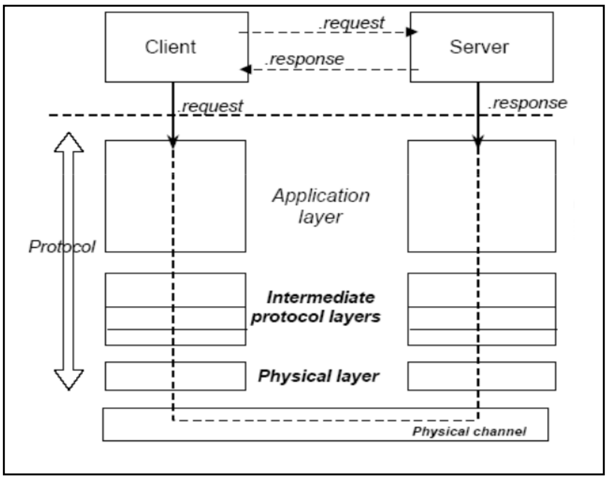

Fig. 6 Client/Server relationship and protocol

VI. ACCESS METER DATA WITH TCP/IP BASED COMMUNICATION MEDIA

TCP/IP is usually found on Ethernet, but it can be used on other networks as well. This smart electric meter has been designed to work over any Internet, LAN or WAN [4] connection. The meter data (energy register, load profiles) will be transmitted in transparent mode via different interfaces. The data can be sent through the Ethernet LAN. It's also possible to collect the data by means of wireless media, such as Wireless LAN. Local area networks (LANs) have become a major tool to many organizations in meeting data processing and data communication needs. Prior to the use of LANs, most processing and communications were centralized; the information and control of that information were centralized as well. Now LANs logically and physically extend data, processing and communication facilities across the organization.

1) *Ethernet LAN:* Local area networks (LANs) have become a major tool to many organizations in meeting data processing and data communication needs. TCP establish a connection oriented communication with Energy Meter. We must assign a valid IP address (192.168.126.254) to the NPort(virtual port) before it will work with network environment. Network system administrator should provide you with an IP address and related settings for the network. The IP address must be unique within the network; otherwise the NPort will not have a valid connection to the network. An IP address is a number assigned to a network device (such as a computer) as a permanent address on the network. Computers use the IP address to identify and talk to each other over the network. Fig. 7 shows the

Communication establishment with Energy Meter through Ethernet Adaptor (using TCP/IP Protocol).

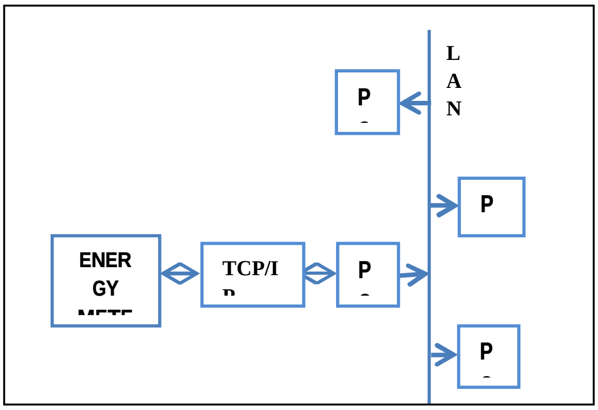

Fig. 7 Two-way communication set up using Ethernet LAN

2) Wireless LAN: Meter data travelling by air can be intercepted without physical access to the wiring of an organization. Any person, sitting in the vicinity of a WLAN with a transceiver with a capability to listen/talk, can pose a threat. The IEEE 802.11 standard specifies the requirements for implementing wireless LocalArea Networks. Fig. 8 shows Two-way communication set up using Wireless LAN.

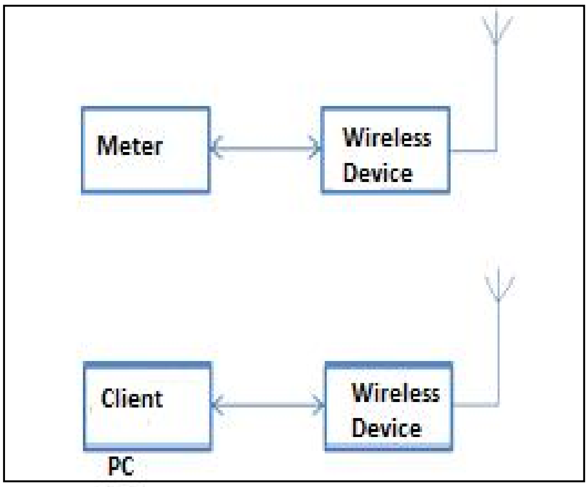

Fig. 8 Two-way communication set up using Wireless LAN

VII. CONCLUSION

Device Language Message is the suite of standards developed and maintained by the DLMS User Association and has been co-opted by the IEC TC13 WG14 into the IEC 62056 series of standards. International Electrotechnical Commission (IEC) is

standardized DLMS to provide –a 'common language' for all kinds of communicating applications of the Energy Industry. The interoperability of meters and other communications equipments (metering data concentrators, etc..) of a meter communications network, built on the DLMS basis. At the same time DLMS based communication is implemented in meters are independent on the communication medium. By the use of DLMS/COSEM protocol, we can establish a communication with Energy Meter through DLMS protocol and access meter data using TCP/IP based communication media.

VIII. ACKNOWLEDGEMENT

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