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A Review on Smart Grid Communication Application Layer Protocols

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ABSTRACT: A Changing legacy of Power grid systems into smart grid systems is becoming priority of many countries. This Optimization will be based on grid integrated real time communication between different grid elements in generation, transmission, distribution and loads.
In automated metering infrastructure communication technology plays important role. This paper present analysis and comparison of five application layer protocols in the advanced metering infrastructure. The compared protocols are Zigbee 2.0, ANSI C 12.19, DLMS/COSEM, SML and IEC 61850.
The protocols are compared with qualitative criteria, size of message and different binary encoding in protocols.

KEYWORDS: Smart grid, communication network, network performance and reliability, demand response.

I. INTRODUCTION

Traditional power grid is changes to Smart Grid. The term grid is used for an electricity system that may support electricity generation, electricity transmission, electricity distribution and electricity control. A smart grid also called as future grid or intra grid. The smart grid is two way transmissions of electricity as well as information. It uses cyber secure communication technologies and computational intelligence in an integrated fashion between generation, transmission, substation and distribution. The advantages of smart grid are emerging power reliability and quality.

A communication system is the main component of this infrastructure. The smart grid is integrated with advanced metering infrastructure which is quickly growing. It consists of household smart meters which support two way communications to the back office of the service provider.

The importance to use this infrastructure is mainly driven by three points

1. Shift of resources usages from high demand time to low demand time.
2. Create an infrastructure that can be used by other metering services.
3. Promote economizing behavior about consumption and costs with more feedback to their consumers.

Smart metering communication is the goal of several standardization efforts [1] and part of national smart grid. But the majority of the installed advanced metering infrastructures use their own protocols that do not communicate as per the international standards. It is necessity to concentrate on open standard. This will increase a free market leading to lower cost.

In this paper five different application layer protocols are compared with respect to their support for advanced metering application. By application layer we refer to the layer of the internet protocol suite, which includes the session and presentation layer of the OSI model and sites on top of TCP. The protocols under the comparison are the Zigbee 2.0, ANSI C12.19, DLMS/COSEM, SML and IEC61850.

There is different network topologies are being used in advanced metering infrastructure. General form of topologies is displayed in Fig 1. In this meters communicate with home gateway which acts as outside world interface. The application layer protocols that we look at can all be used over the TCP/IP protocol stack and are thus applicable for internet communication and over local networks such as Ethernet and Wi-Fi. In addition the protocols can be used over other lower layer protocols. DLMS/COSEM can be used over UDP, HDLC, M-BUS and narrow band powerlines protocols such as IEC61334-5. SML can be used over serial lines and M-BUS.

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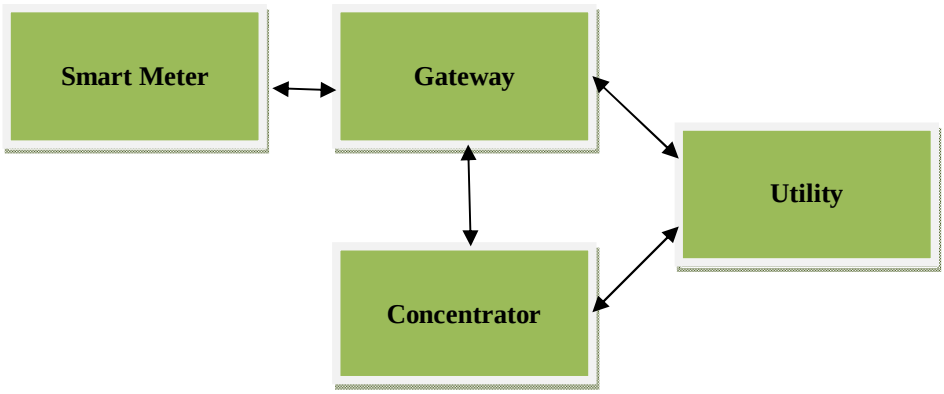

Fig. 1

II. QUALITATIVE CRITERIA

The comparison of all application layer protocols is based on their qualitative and efficiency analysis. The points which are look into this analysis are discussed in paper.

First is information type support: In smart grid application advanced metering infrastructure need to transfer some parameter which is related to tariff, consumption etc. It transfers the data in different subset. In advanced metering infrastructure exchange data to and from the smart meter. All protocols support the information exchange of measured data such as energy, power, voltage, unit consumption. But protocol can differ by their support for load profile and digital signature. A synchronized clock is important for meters that store data or meters that deviate between tariff registers based on timetable. As gateway and their communication modules are getting improved so it becomes to be able to update the firmware remotely.

Second is ability to push metering data: Some application layer protocol is allowing only client-server associations. This association only started by the client. In the advanced metering infrastructure the smart meter is only server and client is entity that wants to read or write data inside smart meter. Some protocols also support peer to peer communication. In this both entity and smart meter can act as client or server.

Third is availability of an interface object model: The smart meters having an interface object model built inside, which is object oriented fashion and acts as the visible information interface to the client.

Fourth is built in security mechanism: In advanced metering infrastructure we grow technology with advanced communication. But it needs to take care of data security. For this purpose a protocol can have built in security mechanism.

III. QUALITATIVE AND EFFICIENCY ANALYSIS

The Smart Message Language [SML] was developed as part of the synchronous modular meter project [11]. It defines messages and used hierarchical message structure. Messages are coded with unique encoding for both request or response message. The SML can send response message without a request except for simple username and password. SML has no any security. It uses a TCP/IP, SSL/TLS protocol.

The Device Language Message Specification [DLMS] and Companion Specification for Energy Metering [COSEM] form together as DLMS/COSEM application layer communication protocol [3]. It only allows client-server structure. It supports clock synchronisation and transmission of measurement profile with standardization [9].

IEC61850 follow client-server principle. It is originally designed for to be used in substation automation.

Zigbee is a fairly new but promising WPAN standard for wireless networks. That consists of devices with very low response requirements. Zigbee use 128 bit symmetric encryption keys to provide security amongst network. Zigbee

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application layer is divided in two sub layer, the ZDO and manufacturer defined application object (up to 240 maximum objects).

ANSI C12.19 is optical port communication between client and server. It also supports peer to peer communication topology. In this Data encryption and digital signature is used for security purpose.

Qualitative comparison of all application layer protocols is given in Table I and Table II gives idea about TCP payload size in bytes as function of the number of measurement values requested(y).

Table I

Feature	SML	DLMS	IEC61850	Zigbee 2.0	ANSI C12.19
Load Profile	√	√	√	√	√
Digital Signature	√	√	X	√	√
Clock Synchronization	X	√	√	√	√
Firmware update	X	X	X	√	√
Push Metering data	√	X	X	√	√
Interface object model	X	√	X	√	X
Includes Security Mechanisms	X	√	X	√	√

√ = supported by protocol

X = not supported by this protocol

Table II

Message Type	**SML**	**DLMS/COSEM**	**IEC61850**	**Zigbee2.0**	**ANSI C12.19**
Request	64+31y	12+11y	64	433	98
Response	63+46y	12+6y	30+6y	320+32y	98+45y

IV. CONCLUSION

The comparison of smart metering application layer protocols for advanced metering infrastructure is done in this paper, on the basis of qualitative and efficiency of transmission and securing data within smart grid communication topology. As per the observation all the application layer protocols having their own importance for particular parameter. So there is no any single protocol is superior in all point of view.

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