Communication Architectures in Smart Grid

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***Abstract*—The current power systems are serving us for the past 5 decades and that they trust heavily on fossil fuels. The present world is giving more importance to renewable energy resources for the fact that they do not release large amount of carbon dioxide in the atmosphere. In the next- generation electrical power systems that incorporate varied renewable energy resources, machine-controlled and intelligent management could be a essential element that determines the effectiveness and potency of those power systems. Smart Grid is the upgrade and renovation of traditional power grid, which hold all the features of traditional power grid. In the smart grid, many distributed renewable energy sources like wind, solar, small hydro and waste will be connected to the power transmission line and distribution systems as integral components. These sources generate extra electricity that supplements the electricity generated from large power plants and when there is an increase in demand the electrical energy generated from these small power plants can be sent to the power grid. This system consists of seven blocks specifically generation, transmission, distribution, operation, market, client and repair supplier. For proper functioning of these smart grids many communication techniques can be used and they should meet some basic expectations like reliability, security, data delivery criticality. These communication systems are used for substation control, transmission line monitor.ing, automatic meter reading, demand response decisioning and energy usage scheduling.**

***Index Terms*— data delivery criticality, substation control, automatic meter reading, demand response decisioning..**

I. INTRODUCTION

The communication architectures to be used in the smart grid provide the platform to build the automated and intelligent management function systems. To effectively manage the smart grids which enable bidirectional dynamic energy flows a co-located communication infrastructure is required to coordinate the distributed functions across the entire power system..

II. GENERATION

The demand in the power grid is more during the day-time and it falls during the night time. During these peak hours, the surplus energy from small power plants is sold back to the power grid. This generation domain will be connected to the transmission domain and market domain. It comprises of electrical equipment including RTUs, programmable logic controllers, equipment monitors and fault recorders.

III. TRANSMISSION

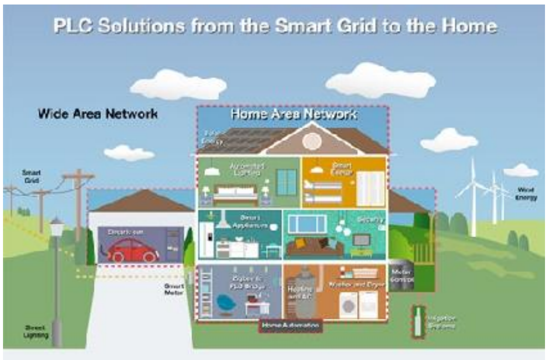
The generated electricity is transmitted to the distribution domain which is maintained by RTOs and ISOs. The RTO is accountable for maintaining the soundness of the transmission lines. the knowledge concerning several

regions within the grid are going to be sent to the management stations. The biface communications between management centers and substations square measure handled during this domain.

IV. DISTRIBUTION

This section includes distribution feeders and transformers to supply electricity. This domain takes the responsibility of delivering electricity to energy customers. It includes several equipments like DERs, PEVs, sensors and communication capability.

V. OPERATION



This maintains efficient and optimal operations of the transmission and distribution systems. It uses field area and wide area networks to obtain information of the power systems like monitoring,control, fault management, maintainance, analysis and meeting. The information is obtained using SCADA(Supervisory Control and Data Acquisition) systems.

a. Smart Grid Expectations

The next-generation electric power systems should also possess the following additional features:

- Support for diverse devices.
- Superior power quality.
- Operation efficiency and optimization.
- Grid security.
- Grid self-correction
- Consumer participation.

VI. COMMUNICATIONAL ARCHITECTURE

The communication networks can be categorized into three classes:

- Wide area networks.
- Field area networks.
- Home area networks.

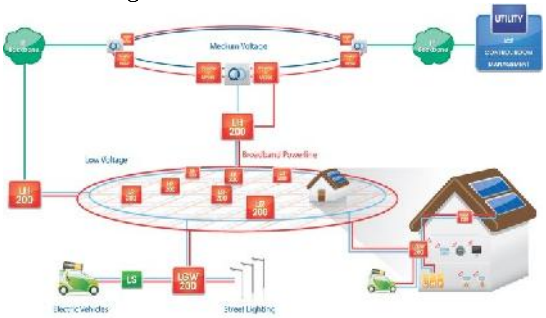
VII. SUPPORTING NETWORK TECHNOLOGIES:

Many network technologies are available for efficient management of smart grids:

- Power line communication.
- Wireline Network.
- Wireless network.

A. Power Line Network

The power lines used for transmitting electrical energy can also be utilized for data transmissions. The power line communication systems can operate by sending modulated carrier signals on transmission wires. Since data signals cannot propagate through transformers, communication is limited within each line segment between transformers.



Data lines on power lines vary from a number of many bits of second to scores of bits of second, during a reverse proportional relevancy the proportional relevancy the facility line distance. Hence, power cable transmission is employed for in-door setting to supply an alternate broadband infrastructure while not putting in dedicated network lines.

B. Wireline Network

Dedicated wireline cables can be used to construct data communication networks that are separate from the electric power lines. These dedicated networks require extra investement but they can offer high communication capacity and shorter communication delay. Depending on the transmission medium used, the wireline networks include SONET/SDH, Ethernet, DSL and coaxial cable access network.

C. Wireless Network

Advancement in wireless networking technology has enabled us to connect devices in a wireless way, eliminating the installation ofwirelines In general, wireless signals area unit considerably subject to transmission attenuation and environmental interference.

VIII. COMMUNICATION REQUIREMENTS

The communication infrastructure in smart grid undertakes important information exchange responsibilities which are the foundations for the function diversified and location distributed electric power devices to work synergistically. The following are the important communication requirements:

- Network Latency.
- Data delivery criticality.
- Reliability.
- Security.
- Time Synchronisation.

A. Network Latency

Network latency defines the maximum time in which a particular message should reach the destination through a communication network. The network communication and architecture medium must support the diverse requirements. The data architecture will determine if the message sent from one communication entity ereaches the other and the data rates supported by the communication medium will decide how fast the information reaches the receiver.

B. Data Delivery Criticality

The protocol used for a particular power system application must provide different levels of data delivery criticality depending on the needs of the application. This need can be decided at the time of connection establishment between two applications.

C. Reliability

The communication devices used in the power grid form the backbone of a successful smart grid management. Hence, it is extremely important for the communication backbone to be reliable forsuccessful and timely message exchanges. A resource failure implies failure of the end nod which initiates communication or receives messages.

D. Security

Moreover, if a wireless communication medium is used as a part of the communication network, security concerns are increased because of the shared and accessible nature of the medium. Hence to provide security protection for power systems, we need to identify various communication use cases(e.g., demand site management, advanced meter reading, communication between intelligent energy management and Intelligent fault management devices, and local area communication by IEM devices) and find appropriate solutions for each use case.

E. Critical Timing Requirements

Timing is vital in good grid communications, that is that the most elementary distinction from the opposite communication systems. The communication delay in good grid is outlined because the time lapse between the causing of a message at the supply Intelligent Electrical Devices (IEDs) and therefore the receiving of message at the destination IED. In common practice for power device protection, the circuit breaker must open immediately if the voltage or current in a power device exceeds the normal values. Such protection actions must be made within a time of 3ms in order to be effective. So critical timing requirements must be satisfied for efficient functioning of the smart grids.

IX. CONCLUSION

The next generation electric power system is expected to alleviate the energy shortage problem by exploiting energy resources. The new system is fundamentally different from the current system in energy management. In order to achieve high degree of efficiency in smart grids the communication system used in smart grids should be reliable, secured and customer friendly.

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