

COMMUNICATION TECHNOLOGIES IN SMART GRID

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ABSTRACT:

In this paper a brief introduction is given about a smart grid and their associated communication technologies. This paper also gives details about different communication frameworks and their associated technologies. Comprehensive technologies related to communication issues are explained here related to smart grid. The given framework given can be useful for properly design a smart grid communication system. In this paper short description of three entities, communication oriented framework for the best communication network in the smart grid is explained.

KEYWORDS: Local area network (LAN), Wide area monitoring and control network (WAMCN), Smart meters, local energy management, smart grid, control centers and consumer network gateway.

INTRODUCTION:

Until now electricity grid has four major systems, power distribution, transmission, generation and most importantly a grid operation. Grid in electrical network plays a vital role in transferring and protecting electrical circuit. Power generation is accomplished by fossil fuels like nuclear, thermal, hydro and other non conventional sources. Electricity generated by all generating stations is being fed to the transmission network by using generating substation which is used for boosting the voltage, which serves the purpose of reducing losses in the transmission network. The transmission network is also classified high voltage and extra high voltage and ultra high voltage transmission lines and accordingly substation and grids are also classified. The extra and ultra high voltage lines are incorporated to transmit the power over long distance. Power generation monitor mainly remote terminal units are used for the collection of various measurements. Traditional grids are designed in such a way that it provides a information about various measurements to the operator. Here smart grid makes the difference; smart grids are not only enabling with the communication to for displaying various measurement

to operator but it also enables the operator to take decision based on the history of the network. If self healing algorithm is employed in the smart grid it can take a decision on its own and it need not have operator intervention. After serving for more than a century from its inception by Sir Thomas Alva Edison, traditional types of grid are not capable of satisfying 20th century demands. That is the only reason why researchers have started out looking for new technology called smart grid. today the biggest challenge even to the smart grid is integration of small wind and photovoltaic plants to smart grid as this power is very vulnerable to fluctuation of voltage levels and integration is done at lower power level.

At any given instant generation and consumption shall be same so that excess generation will not result in the waste of energy and natural resources and if generation is lower than the demand unnecessary power loss will occur which may result in outages and in turn loss of revenue to the distribution company.

SMART GRID FRAMEWORK:

The smart grid mainly operates on the strong communication network and it consists of three different networks.

1. Operation network
2. Business network
3. Consumer network

As shown in figure no.1. each part of these network part is very vital for forming a communication network for the smart grid for better, fast and accurate measurement.

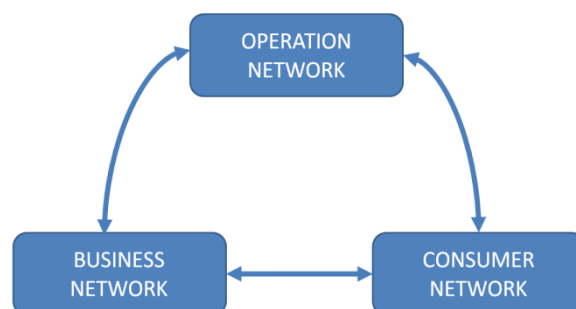


Fig. No. 1. Communication framework for smart grid.

In this model operation network is opted for power companies and it helps in maintaining the functionality of the grid. Business network is developed for the participants in the big electricity market for effectively delivering electricity to the customers. The consumer network is used by every customer for managing energy usage in home and offices. The operation network plays an important role in the smart grid and it forms the backbone of the smart grid communication network.

COMMUNICATIONS WITHIN AND BETWEEN ENTITIES:

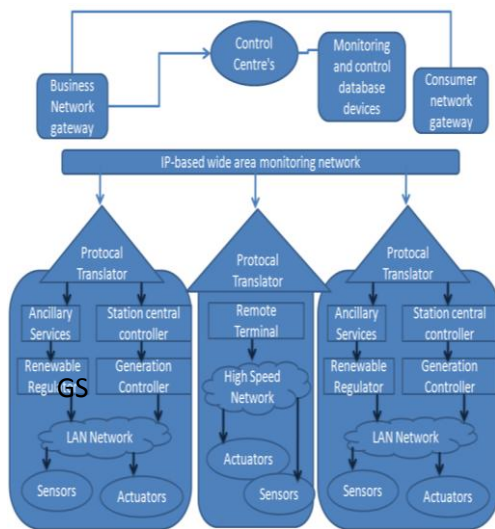


Fig. No.2. The operation network

The operation network consists of seven different equipments: business network gateway(BNG), control centers (CC), consumer network gateway(CNG), generation stations (GS), substations(SS), wide area monitoring and control network (WAMCN) and transmission facilities. Mainly the BNG and CNG are used for communication purpose and it connects the operation network with other system named as two different entities. This function is very important and all three different entities are used by different parties and serves different purpose based on configuration. BNG and CNG are acts as a firewall to the whole communication network in smart grid; it also served the purpose of isolation between operation network and external malicious attacks. Control centers termed as CC's are central control units of smart grid. The functions like monitoring and storing the information task is accomplished here. This is where difference between smart grid and traditional grid comes in picture. When operator in control center of smart grid, is already empowered with knowledge of database at a click and history data is also readily available, in smart grid all operation related information is stored on a real time

basis. In case of traditional grid CCs follows a strict hierarchical design, with each sub area and in turn control the upper control center. A distributed CC design a stochastic approach and has a numerous advantages over the centralized CC for maintaining service availability. Therefore distributed CC design in could be a future of smart grid across the globe.

The GS system consists of a collection of data from large power generation stations, for which it may contain many sensor and actuators connected with high speed local area network for faster transmission of data to a local control unit. The local control unit in every GS system with CCs through WAMCN by usage of gateway. This is another gateway which complements the CNG and BNG is used for prevention of insider.

The substation (SS) component is the collection of data from transmission and electricity distribution substation. It typically possesses communication structure similar to that of generation substation GS. As SS component are located near to consumer and that's why they are configured for accessing consumer data via the CNG, the privacy of those data must protected by using proper encryption method. Apart from this communication at GS and SS are mostly same.

The TF component has assets involved in long distance transmission of electricity and these includes all electrical transmission means e.g. overhead transmission line and underground transmission. The TF units also consist of sensors and actuator and these sensors and actuators are made accessible to local area network for sharing real time measurement data to the control centre.

The WAMCN is blood for the operation of these communication network and it is used for transferring the data in huge volumes amongst the GS, SS, TF and CC components. The following constraints must be addressed while designing an WAMCN.

1. High security
2. High availability
3. Service quality
4. Compatibility

COMMUNICATIONS IN THE CONSUMER NETWORK:

The consumer network is made of six major units: BNG and operation network gateway, smart meter component and home electronics (HE) Component, local energy management, smart controller and LAN systems. The BNG and ONG serves purpose of the primary protectors of the information within consumer network against intrusions by outsiders. As data protection requirements at the consumer end are normally less stringent as compared to business networks, designing these two gateways is a simpler task. The only major

concern is protection of consumer database by proper encryption method.

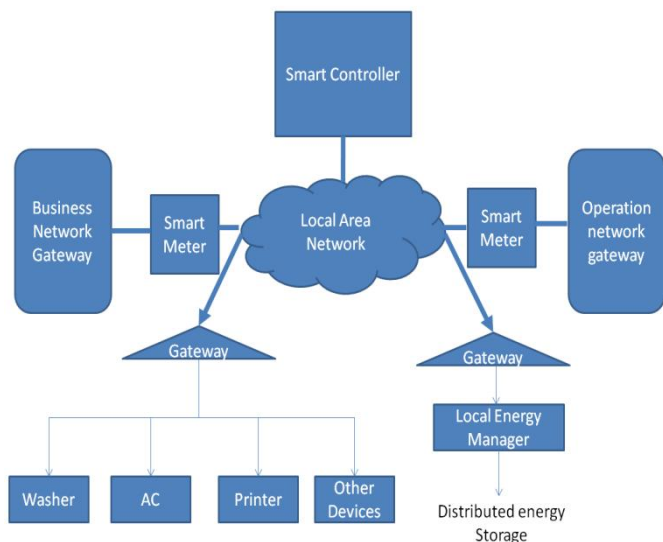


Fig. No.3. The consumer communication network.

COMMUNICATIONS IN THE BUSINESS NETWORK:

The problem with business network can possess dedicated communication architecture as many partners are involved in this activity. In this model many partners are players in the electric environment is involved using an IP based virtual private network (VPN) as shown in figure 4, smart meter service provider, electric market regulator, demand responder, and electricity market participants have become a major players in the business network. There are various other parties involved in communication with consumer and operation network for getting smart meter readings are update same to database of smart grid control centers.

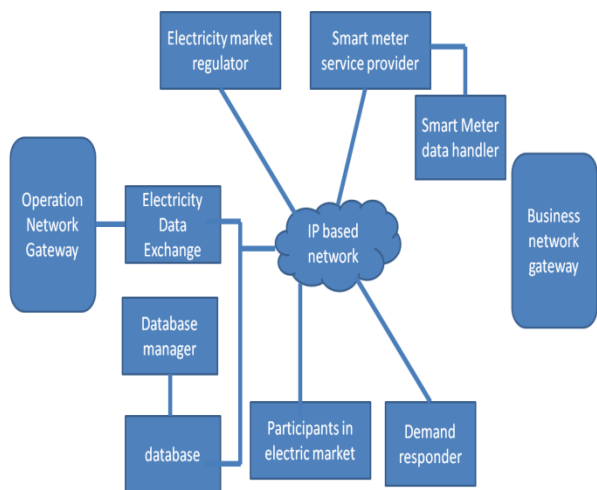


Fig. No.3. The communication network for business

CONCLUSION:

While designing the communication system considering operation network, compatibility must be checked with existing technologies is foremost important should be considered. Moreover while designing the business and consumer network requires innovating ideas for enhancing the user experience at the same time data encryption becomes topmost addressed concern. While implementing communication system most important link is supervisory control and data acquisition system (SCADA). This system is used by all operators to monitor the current status of the system and run the commands as per load demands. But SCADA system is little slow as compared to wide area measurement system (WAMS) hence if we implement WAMS, implementing decision in crisis situation will be faster. Taking this point in consideration many researchers are looking at WAMS as the future of smart grid communication system.

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