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The complexity of communication networks in Smart Grid

Energetics and energy machine-building

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The authors researched the complexity of communication systems and real time monitoring in power network based on Smart Grid technologies. Possible infrastructure of communication technologies and security problems investigated and suggested convenient solutions by authors in this article. Using specific communication technologies and privacy protocol, that is able to be improved the real time monitoring in Smart Grid technologies. Apart from this, reliability of communication system is the most important aspect for data transfer among units in power systems.

Key words: Smart Grid, communication system, privacy protocol, data transfer, service provider, home area networks, wide area network, wireless technologies.

Introduction

Smart Grid can also be described as a terms of intelligent grid, intellectual power system, or future grid. The main purpose of Smart Grid technology is that to increase the reliability and efficiency of electrical energy to transmit from power station to consumer. Therefore, this expression is called the technology of 20th century. The conventional power systems (as shown in Fig.1) are basically, utilized to transmit electric energy from power stations to a numerous subscribers and customers, almost more remote and sparsely populated areas.

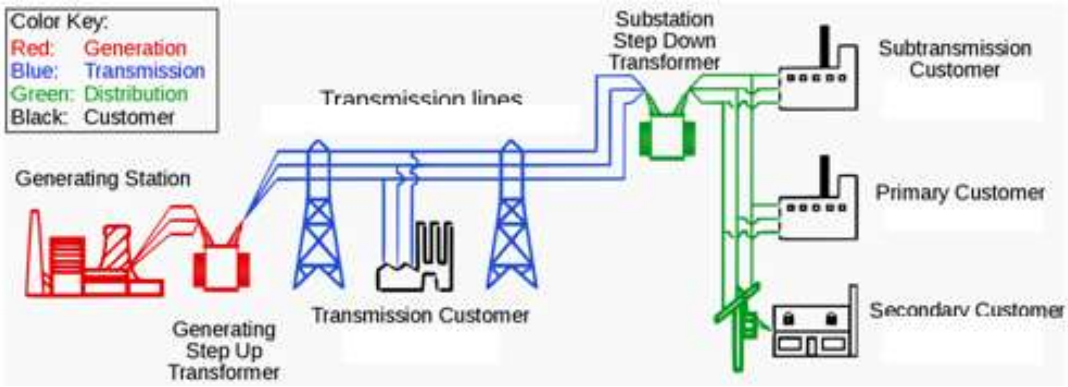

Fig.1. Example of the conventional power system

Smart Grid system (an example of which is shown in Fig.2) utilize two-direction energy flowing and communication technologies to establish an automated and distributed energy infrastructure compared with conventional systems.

Thereby the power would be delivered in more efficient ways and make more reliability. For example, if hardware failure event happens in any voltage level in the transmission or distribution grid, the intellectual technology will automatically operate the flowing of energy and maintenance the delivery of power immediately.

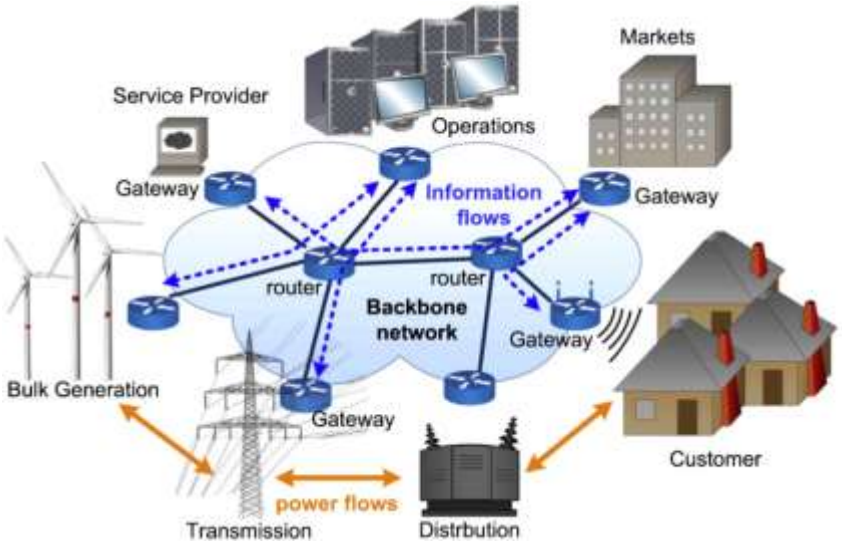

Fig.2. Example of Smart Grid

Statement of the problem

Power network is fairly complex physical system. Due to NIST's national model, Intellectual power system consists of 7 logical domains: Bulk Production, Distribution, Markets, Customer, Transmission, Operations and Service Provider. Generation, transmission, distribution and costumer levels use two way communication and energy flow. Markets, service provider and operation levels in Smart Grid system duty to collect information in real time and operate complex systems. Smart Grid also provide monitoring, sensing, communication and control applications in high and low voltage levels in power system.

The infrastructure of communication technologies can be listed as follows:

- Research the technical demands.
- This technology should be safe environment to attract investments in intellectual power system.
- Installation and operation costs should be low.

Solution of the problem

Communication systems play a main role that enable intellectual power system apllications. Various kinds of technological advances in communication systems encouraged by two specific communication media, wired and wireless should be utilized for information transfer among electrical installations and smart meters. The first data transfer was suggested by L.Wenpeng should be achieved through wireles systems or transmission line communication, such as Z-wave, and ZigBee; these advanced technologies can be considered the most benefit application for home area networks (HANs).The communication system covered with smart meters consists of some components:

- Electrical devices for providing two-way communication like smart meters. These devices can also record energy consumption.
- According to various applications for distribution, Home Area Network is the most important technology, because it provides the interchange of information among electrical devices.
- Neighborhood Area Network (NAN) collects datas from different types of HANs and pass the information to a concentrator.
- All datas are transferred from these networks to control centers. This level is called wide area network (WAN)

Advanced Security demands. Security is the most important aspect for Smart Grid technology, because all datas are transferred over communication networks during real time. According to Electric Power Research Institute (EPRI) reports cyber security is so challenging process for creating intellectual power system. Most of distributed generation systems incorporate unified

power system. Therefore cyberattacks to the power system will result different types of reliability problems. Cyber security can protect power system not only deliberate attacks such as industrial spying, but also human errors and equipment failures.

Quality- of- Service (QoS). The communication among the energy producer and energy customers is a basic matter of the intellectual power grid, it is important to guarantee Quality of Service to networking and communication technology. It also neccessary in all stages of the intellectual power grid, from generation to consuming. The processes like control command, emergency response and monitoring in smart grid must be applied reliably and information delivered to costumers would not be influenced by the number of costumers who use cell phone and traffic data of them.We suggested private wireles grid monitored for energy distribution stage to cope with these challenges.

Energy consuming data collected at the smart meter and distributed then behave as an information additional channel, exposing the habits of consumer's. One of the main important concern in Smart Grid technology is to ensure the privacy of data during collecting information about power system. Privacy is really neccessary for adopting of Smart Grid tecnhologies. Because the traffic of data is accomplished two-way between consumer and supplier in real time.

Thus four basic privacy are mainly defined:

- The first and foremost is Personal Privacy including territorial privacy and body privacy of customers.
- Privacy of information: this type of privacy levels related to sending data over different kinds of media protocols and can also be defined the privacy of communication.
- The privacy of corporation: this collect the private data about corporation such as poor and useful statisticts, available trends in the market forseeable future products etc.
- Moral and logical privacy: this types of privacy includes the morality of consumers, the feelings of them and their intellects.

Integration problems

Integrity defines to the reliability of information and generally defined in terms of protecting against unacceptable or unofficial changes. This process is very important and basic structure for grid and computer security. The data transferred by costumer or suppliers must be protected because unauthorized persons or systems can be intervene the security of information. These kinds of datas can be defined such as the values of transmitters or sensors, control commands in Smart Grid communication networks. If the integrity is violated it may cause different types of safety problems that is, person or electrical installation may be harmed.The main risks in Smart Grid technology is cyber attacks to the reliability of sending information.

In Smart Grid technology the trusthworthiness of system has become the primary demands for energy utilities. One of the main reliability problems for conventional power infrastructure is growing of system and lack of providing peak demands and energy consumption. Operating the potential of the modern and safe protocols in data communication networks and information technologies rapidly and more sturdy control devices, from substation and feeder to customer resources, will remarkably reinforce the system trusthworthiness and robustness. One of the main aspect of reliability is availability. Availability in Smart Grid technology defines the ability utilize the data or available resources desired. For Smart technology availability designates all the communication elements of the area such as safety systems, manufacturing execution systems, engineering workstations, control systems, operator workstations, as well as the communication systems among these elements and to the outside world.

Wireless technologies with constrained bandwidth and security and reduced installation costs can be a good choice for large-scale smart grid deployments. Then again, wired technologies with increased capacity, reliability and security can be costly. To provide system reliability, robustness and availability simultaneously with appropriate installation costs, a hybrid communication technology combined with wired and wireless solutions can be an ideal solution.

Conclusion

Cyber security and privacy issues in the Smart Grid are new areas in the fields of power industry, electrical engineering and computer science. More in-depth research is required to develop such a promising power grid in the near future. At this paper, we made a brief description in communication technologies, which are available for the operation in Smart Grids and safety requirements that need to be met to ensure the reliable operation of next generation electric power system. The success of future Smart Grid depends heavily on the communication infrastructure, devices, and enabling services and software. As communication is an underpinning technology for this huge development, we envisage that smart grids will be an exciting research area for communication engineers for many years to come.

References

1. Vehbi C. Güngör, Member, IEEE, Dilan Sahin, Taskin Kocak, Salih Ergüt, Concettina Buccella, Senior Member, IEEE, Carlo Cecati, Fellow, IEEE, and Gerhard P. Hancke, Senior Member, IEEE. Smart Grid Technologies: Communication Technologies and Standards.

2. Kalogridis G., Efthymiou C., Denic S.Z., Lewis T.A. and Cepeda R. Privacy for smart meters: towards undetectable appliance load signatures. / The First IEEE Internation Conference on Smart Grid Communications (Smart Grid Comm), Gaithersburg, MD. – 2010. – Pp.232-237.

3. Zeadally S., Pathan A., Alcaraz C. and Badra M. Towards Privacy Protection in Smart Grid. // Wireless Personal Communications. – 2012. – Vol.73. – Pp.23-50.

4. Report to NIST on Smart Grid Interoperability Standards Roadmap EPRI. – 2009.

5. Bauer M., Plappert W., Wang C., Dostert K. Packetoriented communication protocols for smart grid services over low-speed plc. / Proc. of IEEEISPLC'09. – 2009. – Pp.89-94.

6. Ye Yan, Yi Qian, Hamid Sharif and David Tipper. A Survey on Cyber Security for Smart Grid Communications.

Xülasə

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Ağıllı (smart) şəbəkələrdə kommunikasiya sistemlərinin mürəkkəbliyi

Müəlliflər elektroenergetika sisteminin real zaman kəsiyində izlənilməsini təmin etmək üçün istifadə olunan kommunikasiya sistemlərini araşdırmış və bu sistemlərdə informasiya mübadiləsi zamanı ortaya çıxan çətinlikləri təhlil etmişdir. Bundan əlavə ənənəvi elektrik şəbəkəsi sistemlərinə smart texnologiyaların inteqrasiyası zamanı meydana çıxan təhlükəsizlik, məxfilik, mürəkkəblik kimi məsələlərə baxılmışdır və mümkün variantlar təklif edilmişdir.

Açar sözlər: intellektual şəbəkə, kommunikasiya sistemi, məxfilik protokolu, informasiya mübadiləsi, xidmət provayderi, lokal kommunikasiya şəbəkəsi, qlobal kommunikasiya şəbəkəsi, naqilsiz texnologiyalar.

Резюме

Балазаде И.М., Ибрагимов Ю.А., Исмаилова Ш.И.

Особенности коммуникационных систем в умных (smart) сетях

Авторами рассмотрены коммуникационные системы, используемые для наблюдения за состоянием электроэнергетической системы в режиме реального времени. Проанализированы проблемы, возникающие в процессе обмена информацией. Рассмотрены вопросы безопасности, секретности и сложности, возникающие в процессе интеграции смарт-технологий в традиционные электрические сети и предложены варианты их решения.

Ключевые слова: интеллектуальная сеть, коммуникационная система, протокол секретности, обмен информации, провайдер обслуживания, локальная коммуникационная сеть, глобальная коммуникационная сеть, беспроводные технологии.