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Field Area Networks: An Introduction

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Abstract Field Area Network (FAN) is a broadband wireless network providing essentially ubiquitous regional coverage for current and future utility applications. It provides connectivity to a large number of devices spread throughout a large geographic area.

It is a private, multiple purpose network capable of providing last-mile connectivity with low latency and high availability. The importance of FANs will continue to increase as they provide the foundation for future grid applications. This paper provides a brief introduction to field area networks.

Keywords field area networks, broadband wireless, WAN/MAN/LAN

Introduction

Field devices requiring communication are increasing every year. Industries such as utility, mining, and oil and gas are increasingly using wireless communications networks to monitor and control devices in the field and at outdoor facilities. These communications networks as known as field area networks [1].

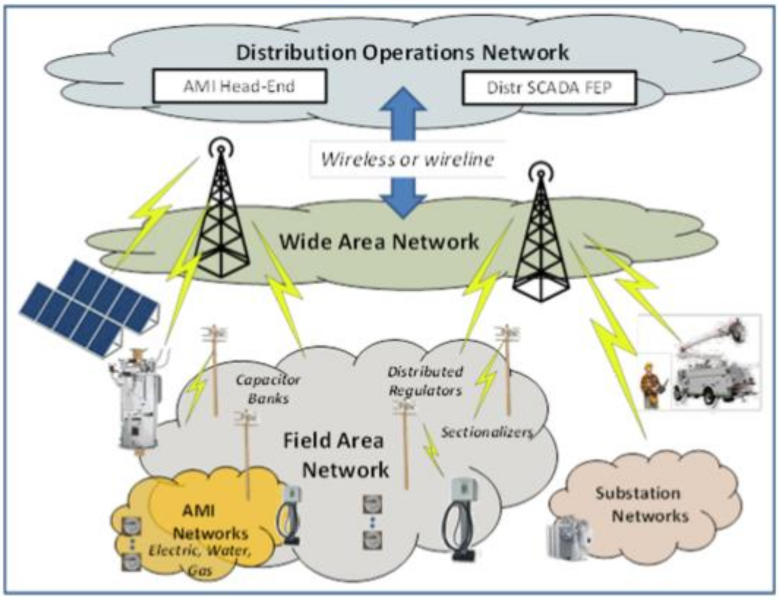

Figure 1: The relationship between FAN and other networks [2]

They serve thousands of devices including intelligent devices, industrial controllers, and SCADA devices. They support different applications such as telemetry, mining, monitoring. automated metering infrastructure, monitoring and logging for oil and gas, traffic signal management, and video monitoring for transportation. In the past, utilities and other industrial companies have often used proprietary low-speed wireless communications systems with little security to implement their field area networks [1].

File area network (FAN) (or file-area network) consists of technologies that facilitate file sharing and data management over a network. It is a computer networking approach that uses multiple means for file sharing and data management over a network. It may be regarded as an extension of WAN/MAN/LAN. The relationship between FAN and other networks is illustrated in Figure 1 [2]. The main goal of FAN is to improve and organize unstructured data and it uses different mechanisms to achieve this. It is designed to carefully integrate and coordinate network control and monitoring systems.

Overview of FAN

FAN covers the entire utility service area. It could be a wireless or a wireline network. Power line carrier (PLC) technologies and fiber-optic networks are widely used infrastructures to support wireline capabilities. On the other hand, wireless networks provide a number of cost-effective, quick to deploy features, and they are compatible with existing utility infrastructure. They can operate in the licensed or unlicensed spectrum, as worldwide interoperability for microwave access (WiMAX)) and Long Term Evolution (LTE) [3]. A FAN is similar to storage area network (SAN) in that it stores and manages bulk data in a computer networking environment.

The main core elements of FAN include [4]:

- *File Virtualization:* Virtualization provides a full logical access to the physical locations of the data. Data migration can be easily performed at any time without affecting the physical locations or end users.
- *WAN Optimization:* This is the most effective method of FAN and is used to eliminate geographical dependency.
- *Storage Devices:* FAN was built for storage infrastructure. It does not matter whether the computer's environment is SAN or network attached storage.
- *Namespaces:* These are used to provide data access to authorized end clients only.
- *File Security*: This element of FAN enables centrally managing and controlling security policies.
- *End Client:* Clients working on FAN can use any platform.
- *Connectivity:* Network file system and common Internet file system are commonly used to connect namespaces and end clients.

FAN Requirements

FANs are most often implemented with wireless networking technologies because of their large geographical scope. The enabling wireless technologies include cellular, narrowband point-to-multipoint (PTMP), broadband PTMP, and broadband wireless mesh networks.

To support several applications concurrently, FANs must meet the following requirements [5]:

- *High Reliability:* FANs must operate even when events disable the electric grid. They meet stringent utility requirements for reliability and resilience.
- *Scalable*: FANs must scale to cover large geographic areas and support millions of connected devices.
- *High Performance:* Because a FAN must support the requirements of all deployed applications, low latency is essential. Utility FANs must deliver sufficient capacity to support all current and future smart grid applications and provide latency that is low enough to support the most delay sensitive application.
- *Secure:* Wireless FANs come with potential vulnerability to cyber-attacks. Designers must include security components in all aspects of FAN networking.
- *Flexible:* To support a wide variety of applications and devices, the FAN must be built on industry standards such as TCP/IP, 802.11 (Wi-Fi), and 802.3 (Ethernet).
- *Mobility:* In order to provide communications for field personnel, FAN must support mobility.

Applications

FANs can be used for a wide range of applications, each with its own specific communications requirements. We will consider application to smart grid, since this is the most application. FANs are engineered to support utility-specific applications and requirements. They are playing prominent role in smart grid infrastructure.

Communication networks are key components to smart grid implementation.

These are two-way broadband communication networks, which link people and devices in the field. Figure 2 shows some communication networks for smart grid [6]. FANs make the communications network for smart grid applications easier to deploy and manage. They fill the communication gap between the core IP-based network and devices in the field. FAN is used to connect various devices located in an electric utility's field of operations such smart meters, concentrators, distribution assets, capacitor banks, distributed regulators, control and protection equipment, and substation equipment. FANs support diverse utility applications including distribution automation, remote asset management, and smart metering (advanced metering infrastructure, or AMI).

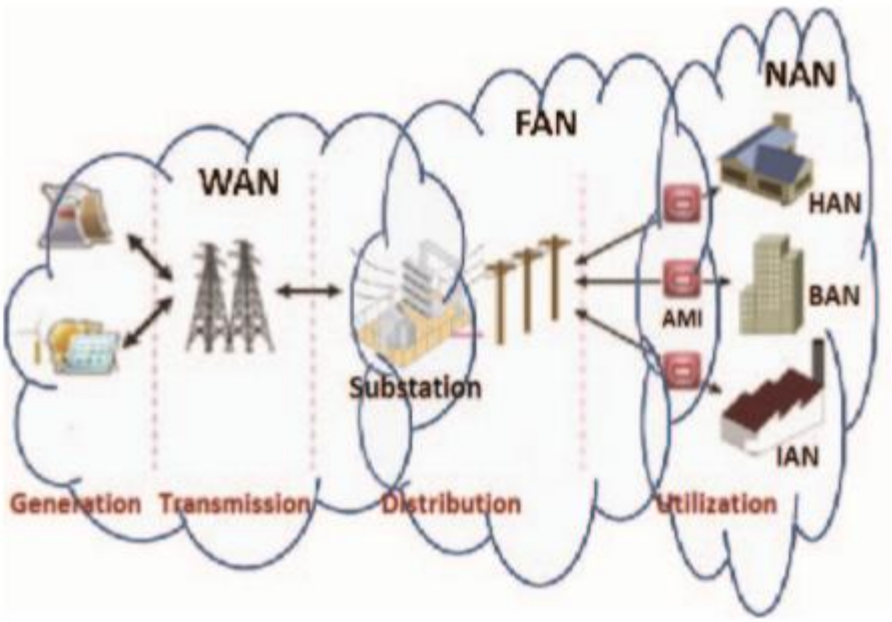

Figure 2: Communication networks for smart grid [6]

FAN is also applied in public safety, disaster relief, government applications, and critical Infrastructure. It is also important for future applications such as distributed power generation and energy storage, electric vehicle (EV) charging, and microgrids.

Benefits and Challenges

Real-time wireless communication enables utility workers to bring a virtual office anywhere in their service territory. This improves productivity, data accuracy, task management and scheduling, management of equipment maintenance, production tracking and compliance. Other benefits of a field-area network include [7]:

- Optimizes communication technologies for a wide range of applications
- Deploys a single converged IP-based architecture
- Simplifies migration roadmaps for grid modernization
- Shortens schedule risks and cost over-runs by recommending mature and robust networking technologies
- Eliminating engineering, cost, time, and risks associated with design, deployment, and operations of proprietary systems
- Follows IT best practices and eliminates the need of proprietary architecture

- Enable quick and cost effective turn up of future applications based on integrated multi-service capabilities.

In spite the necessity of FANs for the overall success of the smart grid, there are still some challenges. The challenges faced by FANs include [8]:

- FAN is the largest, possible the most complex piece of communications network as it provides "last-mile" communications to end-devices
- FAN has a vast area of coverage both in terms of geography and functionality. These functionalities pose very stringent bandwidth and latency requirements
- Proprietary wireless technologies and protocols
- Without standards of interoperability, there are no guarantees that new technologies will be "plug-and-play" which limits investment from utilities and other venture capital sources
- Lack of commercial tools to provide visibility into wireless FAN communications
- Interference almost always increases everywhere due to very large number of nodes

Conclusion

FANs are specialized networks that connect people, processes, and devices to smart utility networks for real-time communication. They have gained considerable attraction due to their prominent role in grid modernization initiatives. They will provide critical infrastructure for the "second wave" of information and communication technologies (ICT) enabled utility systems. Development of the FAN is growing rapidly as smart grid technologies are being deployed by utilities across the country.

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