Deployment Architecture of the various Classes for Advanced Metering Systems

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Abstract: ***Advanced metering systems are comprised of state-of-the-art electronic/digital hardware and software, which combine interval data measurement with continuously available remote communications. These systems enable measurement of detailed, time-based information and frequent collection and transmittal of such information to various parties. AMI or Advanced Metering Infrastructure typically refers to the full measurement and collection system that includes meters at the customer site, communication networks between the customer and a service provider, such as an electric, gas, or water utility, and data reception and management systems that make the information available to the service provider. In this paper, we propose a various classes of such architectures with varying security properties and analyze them in detail.***

Keywords: Advanced metering systems, Bidirectionally, Communications Infrastructure, Smart Grid, electric grid.

1. Introduction

AMI is not a single technology, but rather an integration of many technologies that provides an intelligent connection between consumers and system operators. AMI gives consumers the information they need to make intelligent decisions, the ability to execute those decisions and a variety of choices leading to substantial benefits they do not currently enjoy. In addition, system operators are able to greatly improve

consumer service by refining utility operating and asset management processes based on AMI data.Through the integration of multiple technologies (such as smart metering, home area networks, integrated communications, data management applications, and standardized software interfaces) with existing utility operations and asset management processes, AMI provides an essential link between the grid, consumers and their loads, and generation and storage resources. Such a link is a fundamental requirement of a Modern Grid.

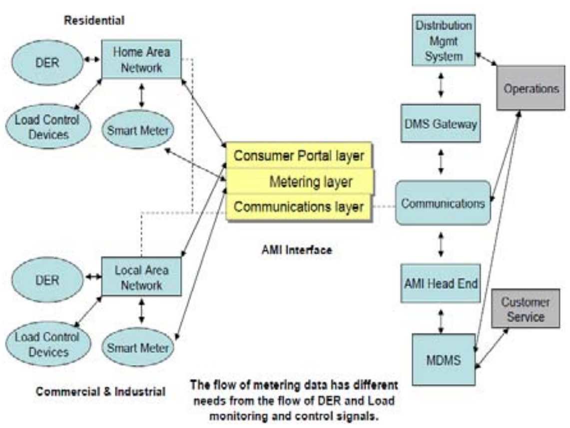

Figure 1: AMI Interface

At the consumer level, smart meters communicate consumption data to both the user and the service provider. Smart meters communicate with in home displays to make consumers more aware of their energy usage. Going further, electric pricing information supplied by the service provider enables load control devices like smart thermostats to modulate electric demand, based on pre-established consumer price preferences. More advanced customers deploy distributed energy resources (DER) based on these economic signals. And consumer portals process the AMI data in ways that enable more intelligent energy consumption decisions, even providing interactive services like prepayment.

2. Communications Infrastructure

The AMI communications infrastructure supports continuous interaction between the utility, the consumer and the controllable electrical load. It must employ open bi-directional communication standards, yet be highly secure. It has the potential to also serve as the foundation for a multitude of modern grid functions beyond AMI. Various architectures can be employed, with one of the most common being local concentrators that collect data from groups of meters and transmit that data to a central server via a backhaul channel. Various media can be considered to provide part or all of this architecture:

- Power Line Carrier (PLC)
- Broadband over power lines (BPL)
- Copper or optical fiber
- Wireless (Radio frequency), either centralized or a distributed mesh
- Internet
- Combinations of the above

Future inclusion of smart grid applications and potential consumer services should be considered when determining communication bandwidth requirements.

3. Logical Security Architecture Overview

Smart Grid technologies will introduce millions of new components to the electric grid. Many of these components are critical to interoperability and reliability, will communicate bi-directionally, and will be tasked with maintaining confidentiality, integrity, and availability (CIA) vital to power systems operation.

The definitions of CIA are defined in statue and can be summarized as follows:

Confidentiality: "Preserving authorized restrictions on information access and disclosure, including means for protecting personal privacy and proprietary information…." [44 U.S.C., Sec. 3542]

- A loss of confidentiality is the unauthorized disclosure of information.
  Integrity: "Guarding against improper information modification or destruction, and includes ensuring information non-repudiation and authenticity…." [44 U.S.C., Sec. 3542]
- A loss of integrity is the unauthorized modification or destruction of information.
  Availability: "Ensuring timely and reliable access to and use of information…." [44 U.S.C., SEC. 3542]
- A loss of availability is the disruption of access to or use of information or an information system.
  The high-level security requirements address the goals of the Smart Grid. They describe what the Smart Grid needs to deliver to enhance security. The logical security architecture describes where, at a high level, the Smart Grid will provide security.

This report has identified cyber security requirements for the different logical interface categories. Included in Appendix B are categories of cyber security technologies and services that are applicable to the common technical security requirements. This list of technologies and services is not intended to be prescriptive; rather, it is to be used as guidance.

4. Related Work

4.1 Deployment Approaches for the Various Classes

Deployment approaches will depend upon the utility's starting point, geography, regulatory situation and long-term vision. For those utilities that already have deployed an AMR system, the question will be whether they can build on that system or need to start afresh. If the system includes a two-way communications infrastructure, it should be possible to upgrade the metering to accommodate a range of AMI applications. Where the communications infrastructure is unidirectional (i.e. outgoing only), it may be possible to overlay a return channel using a complementary technology. This option would have to be compared to the cost and benefits of installing a new integrated two-way communications infrastructure. The speed, reliability and security of the communications infrastructure will determine the range of applications it can support. For utilities with widespread and diverse territories, it may be that multiple communications solutions will be needed Pilot programs that explore the performance of various solutions can be useful as the first phase of an AMI deployment.

4.2 The choice of an AMI communications infrastructure is also influenced by the utility's long-term vision for AMI.

If AMI is seen as the foundation for overall grid modernization, the communications system will need to accommodate anticipated future needs and have the flexibility to handle applications that are not even currently on the utility's radar screen. Experience has shown that these evolving grid modernization applications often produce major benefits, as discussed in later sections.

4.3 The deployment of AMI is a strategic initiative that must be endorsed by the utility regulator.

The benefits of AMI, and ultimately of overall grid modernization, flow to not just the utility, but also to the consumer and society in general. Hence regulators need to consider the possibility that traditional utility economic analysis may not capture the true value of an AMI strategic initiative and that an expanded framework may be more appropriate, as discussed later in this document. Some regulators may see AMI and grid modernization as very desirable and they will encourage their utilities to move aggressively. Others may be less proactive and will expect their utilities to broach AMI and bring with them a compelling argument on its merits. In either case, recognition of the wide-ranging societal benefits of AMI must be addressed.

5. Benefit for this Modern AMI

Increased bandwidth and broader area coverage generally lead to more opportunities for grid modernization.

In other words, a ubiquitous AMI communications network could be designed, for a small incremental cost, to also accommodate transmission and distribution automation systems, reducing the total cost of both AMI and other forms of grid modernization. And a useful by product could be the use of excess bandwidth to provide broadband services, such as internet access and voice over IP, to consumers. Enhanced functionality can be achieved when the AMI infrastructure sequences into a fully enabled modern grid (see Figure 2.). When that occurs, EPRI (Electric Power Research Institute) estimates that at least a 4 to 1 total benefit to cost ratio will be realized.

6. Conclusion

AMI is an integration of technologies that provides an intelligent connection between consumers and system operators. Through the integration of technologies such as smart metering, home area networks, integrated communications. In this paper we provide communication and provide various classes to deploy then to increase the band width of the grids.

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