UtilityAMI 2008 Home Area Network System Requirements Specification

A Work Product of the OpenHAN Task Force of the UtilityAMI Working Group
under the OpenSG Subcommittee of the UCA® International Users Group

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Ratification and Endorsement

Version 1.0 of this document was ratified by unanimous vote on Friday, March 7, 2008 by individual UtilityAMI OpenHAN Task Force members present for the vote from the following organizations:

- American Electric Power (AEP)
- BC Hydro
- CenterPoint Energy
- Consumers Energy
- Detroit Edison
- Electricité de France (EDF)
- Oncor
- Entergy
- Florida Power and Light (FPL)
- Pacific Gas and Electric (PG&E)
- San Diego Gas and Electric (SDG&E)
- Southern California Edison (SCE)

At the ratification vote meeting, the membership approved allowing the task force chairman to make grammatical and formatting changes to the document without calling for a new vote. Further, the membership approved listing eligible UtilityAMI member organizations endorsing this specification subsequent to the ratification vote in this section of the document and updating the list as necessary without a new vote.

Endorsing organizations:

- Duke Energy
- Reliant Energy

Document History

Revision History

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0.2	071126	IO	Copied over Section 3.0 – Requirements	N
0.3	071217	IO	Finalized requirements post-mapping (minor edits, couple additions/deletions)	Y
0.4	071224	IO	Minor Device Mapping edits, Copied over all Use Cases to Appendix	Y
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Contents

1. Introduction

With the emergence of Advanced Metering Infrastructure (AMI) systems that include Home Area Networks (HANs) and the general trend towards the "Smart Grid," the UtilityAMI OpenHAN Task Force worked diligently to draft the UtilityAMI 2008 Home Area Network System Requirements Specification.

This specification represents the collaboration of more than a dozen investor-owned North American utilities serving more than 28 million electric and gas customers in 17 states and provinces. It is the goal of the OpenHAN Task Force that this membership broadens to include international utilities as AMI systems become compelling to them. This specification was developed to be relevant to all AMI systems with HANs.

The System Requirements Specification (SRS) begins with a deeper discussion of the reasons the Utility members of the OpenHAN Task Force undertook this work. Section 2 follows with the Guiding Principles, and the System Architecture. The formal list of system requirements concludes the SRS in Section 3.

Although this document is a system requirements specification, it follows the IEEE 830-1998 Recommended Practice for Software Requirements Specifications given the focus on Home Area Network (HAN) applications for utilities and consumers.

1.1 Purpose

In an increasingly energy- and carbon-constrained world, it simply isn't a viable first option to continue to build additional power plants to meet current growth rates in energy demand. Policy makers in Europe, Asia, Australia, and North America have directed utilities in those regions to work on ways to enable consumers to reduce their electricity usage. Home Area Networks will play a role in achieving these goals by giving consumers more information on the cost of electricity and their usage than they have ever had before. This new consumer-focused information infrastructure will enable an energy-aware world.

To further these goals, the UtilityAMI OpenHAN Task Force developed the UtilityAMI 2008 Home Area Network System Requirements Specification (2008 HAN SRS). UtilityAMI is a forum to define serviceability, security and interoperability guidelines for Advanced Metering Infrastructure (AMI) and Demand Responsive Infrastructure from a Utility and Energy Service Provider perspective.

UtilityAMI develops high level policy statements that can be used to facilitate efficient requirements and specification development using a common language that minimizes confusion and misunderstanding between Utilities and vendors. Common architectures, language, and requirements ensure a competitive market place by driving down costs, increasing interoperability, and maximizing longevity and maintainability. UtilityAMI members are encouraged but not required to use and include sections of this document when procuring AMI systems with HANs and or gathering information with RFIs, RFQs, RFPs, etc.

The UtilityAMI 2008 Home Area Network System Requirements Specification:

- Promotes open standards-based HANs that are interoperable
- Provides the vendor community with a common set of principles and requirements around which to build products
- Ensures reliable and sustainable HAN platforms
- Supports various energy policies in a variety of states, provinces, and countries
- Empowers citizens with the information they need to make decisions on their energy use by enabling the vision of a home energy ecosystem

The audience for this specification is:

- Utilities considering deploying AMI systems with a HAN
- Vendors that make AMI systems for Utilities
- Vendors that make consumer products like communicating thermostats, energy management systems, load control switches, in-home displays, smart appliances, plug-in hybrid-electric vehicles, distributed generation resources, etc.
- Policy makers looking to understand how Utilities are implementing directives both within and outside of their jurisdictions

As AMI and HAN systems continue to evolve, the UtilityAMI OpenHAN TF maintains an open door policy and encourages interested utilities, regulators, and vendors to join the discussion.

1.2 Scope

The UtilityAMI 2008 HAN SRS covers the Guiding Principles, Use Cases, System Requirements, Architectural Drawings, and Logical Device Mappings for platform-independent HAN Devices that will be registered on a Utility's secured communication channel – regardless of ownership of the devices. As such, the scope of this document applies from the edge of the AMI System, where the Energy Services Interface (described in Section 1.4 and 2.2.1) resides, to all relevant HAN Devices in the home.

This SRS does not apply to Utility systems beyond the Energy Services Interface like the AMI Meter, Utility Communications Network, and Meter Data Collection and Management Systems. It also does not extend past HAN Devices in the home that do not reside on a Utility-secured communications channel (described in more detail in Section 2.2 – Architectural Considerations). Some examples of HAN Devices not covered in the scope of this specification are home automation, home health monitoring, and security system products.

The UtilityAMI OpenHAN Task Force develops platform-independent requirements and systems that Utilities can use regardless of the technology they select.

As developed through the Guiding Principles, Use Cases, and System Requirements, this specification establishes the initial requirements and framework for the development of well managed and secure customer communications systems. This is

important and necessary given the increased risk to the electricity grid accompanied by the installation of an in-premise gateway that can interact with control and pricing messages on the Utility network. As part of the Utilities' mandate to ensure a reliable electricity supply, security and registration requirements have been included in this specification for UtilityAMI-compliant HAN Devices.

The Utilities (and their regulatory organizations) that fully implement the UtilityAMI 2008 HAN SRS will provide utilities and consumers the potential to access more detailed energy consumption information and new energy programs and services.

1.3 Acronyms and Abbreviations

This subsection provides a list of all acronyms and abbreviations required to properly interpret the 2008 UtilityAMI OpenHAN System Requirements Specification.

AMI	Advanced Metering Infrastructure
CSS	Customer Service System
EMS	Energy Management System
ESI	Energy Services Interface
ESU	Energy Supplying Unit
FHDMC	Fixed Home Area Network Devices with Metering Capability
HAN	Home Area Network
IHD	In-Home Display
ISO	Independent System Operator
MHDMC	Mobile Home Area Network Devices with Metering Capability
PCT	Programmable Communicating Thermostat
SRS	System Requirements Specification
TOU	Time of Use

1.4 Definitions

This subsection provides the definitions of all terms required to properly interpret the UtilityAMI 2008 HAN SRS.

Active Event	Refers to a price event or emergency event that is underway
Advanced Metering Infrastructure	Advanced Metering Infrastructure refers to systems that measure, collect, and analyze energy usage from advanced devices such as electricity meters, gas meters, and/or water meters, through various communication media on request or on a pre-defined schedule. This infrastructure includes hardware, software, communications, customer-associated systems, and meter data management software.

Advanced Metering Infrastructure and/or Home Area Network Trust Center	A logical software entity that provides appropriate security interactions to establish proper credentials for advanced metering infrastructure to home area network interaction(s).
Advanced Metering Infrastructure System	"The big picture" - includes the Energy Services Interface, meter, Utility Communications Network, Meter Data Management, Utility business processes
Audit	A methodical examination or review of a condition or situation within a Home Area Network Device
Automated Data Collection System	A system that can communicate with Advanced Metering Infrastructure meters remotely (e.g., to program meters, test meters, retrieve data); the System is a component of the Advanced Metering Infrastructure.
Capacity Billing Rates	Demand charges based in the rate of consumption (e.g. kWh demand, cubic feet per minute)
Charging Interval	The period of time that is bound by a start and stop of charging
Commissioning	The local admission of a home area network device to the Utility-managed Home Area Network
Control	The runtime configuration of the Home Area Network that causes interactions between the Energy Services Interface and targeted Home Area Network devices to occur
Critical Peak Pricing	A monthly or seasonal schedule of energy charges which vary based upon a predetermined schedule of hours of the day and days of the week. In addition, the consumer receives real-time notification of critical hours subject to special higher prices for 1 to 2% of the hours in the year. This program has significant synergies with Direct Load Control programs.
Consumer	A person who consumes electricity, natural gas, water, or other utility and who has the greatest potential to conserve and manage the consumption of those utilities. The Consumer receives pricing and event information from the AMI, pre-programs responses to events into their HAN, and participates in Utility programs (e.g., Demand Response, tariffs). Consumers are distinct from Customers because the Consumer of the utility isn't always the Utility Customer that pays for the consumption.
Consumer Home Area Network	Equipment owned by the Consumer that may operate on the same Home Area Network as Utility Home Area Network Devices but that provides non-Utility use case services (e.g., security, child monitoring, home entertainment or other services). Prior to installation/commissioning, a subset of Consumer Home Area Network Devices could be attached to (or be part of) load bearing equipment and be capable of participation in Utility programs enabled by the HAN.
Consumer Override	Refers to a person adjusting the functional behavior of a device to ignore Utility messages

Customer Representative	Person or intelligent system with which the Consumer interacts to work with a business (e.g., Utility)
Customer Service System	A system (e.g. system used by the call center) that provides Utility employees ability to view Consumer-specific information regarding billing, tariffs, programs, metering, interval usage, etc.
Emergency Event	Independent System Operator- or Utility-initiated reliability events
Energy Cost Application	Calculates Home Area Network Device energy consumption cost. The application may use information from multiple sources including: Advanced Metering Infrastructure meter(s), the Advanced Metering Infrastructure System, the Energy Services Interface, other application(s), other Home Area Network Device(s), and/or Human Machine Interface(s)
Energy Management System	A computer program application used primarily for controlling energy-controllable devices (e.g., pool pump, Programmable Communicating Thermostat, light switches). Program may reside within a Programmable Communicating Thermostat, computer, cable set-top box, "smart" In-Home Display, or other computing device with ability to display parameters and accept user input.
Energy Services Interface	Provides security and, often, coordination functions that enable secure interactions between relevant Home Area Network Devices and the Utility. Permits applications such as remote load control, monitoring and control of distributed generation, in-home display of customer usage, reading of non-energy meters, and integration with building management systems. Also provides auditing/logging functions that record transactions to and from Home Area Networking Devices.
Energy Supplying Unit	An energy storage device (e.g., battery storage unit, electric vehicle battery) capable of providing power to a premise or the electric grid
Distributed Generation	Small-scale power generation technologies (typically in the range of 3 to 10,000 kW) located close to where electricity is used (e.g., a home or business) to provide an alternative to or an enhancement of the traditional electric power system
Home Area Network	In-premise communication system
Home Area Network Device	Within the scope of this specification, a device owned by a Consumer, Utility, or other 3rd party (i.e., ownership agnostic) and registered on the Utility-secured Home Area Network communication channel
Home Area Network Device Registration Application	A computer application logic that automates certain registration activities on behalf of a device or consumer
Health Check	Operation performed by Home Area Network Device to determine proper functionality

Hourly Energy Rate (aka Real-Time Pricing)	Energy charges which vary on an hourly basis
In-Home Display	A standalone device with minimal intelligence and storage capacity that simply receives data and displays information from the AMI system through the Energy Services Interface
Installed Service Point	Uniquely identifies the service delivery point
Installer	The entity responsible for placing the Home Area Network Device in service within the Consumer's premises; Installer can be a 3rd party installer or the consumer
Independent System Operator	Coordinates controls and monitors the operation of the electrical power system, usually within a single US State, but often encompassing multiple states
Labeling	Utility compliance and standards labeling
Least Privilege	The concept of least privilege is to operate using the least set of privileges necessary to complete a given task. The ultimate goal is to eliminate damage that can occur from accidental errors or malicious intent.
Manufacturer	Defined broadly to include Original Equipment Manufacturers, Distributors, and Value-added retailers and is accountable for ensuring proper out-of-box operation of the device
Measure	Determination of dimension, quantity, or capacity
Meter	The point of service meter permanently associated with the unique premise
Metering System	A system that can communicate with AMI meters remotely (e.g. program meters, test meters, retrieve data); this system is a component of the AMI
Mobile Home Area Network Devices with Metering Capability	A mobile end-use meter, downstream from the premise electric meter (i.e., point of service meter), that is communicated to via the Home Area Network (e.g., Plug-in Hybrid Electric Vehicle or Electric Vehicle)
Mobile Home Area Network Devices with Metering Capability Owner	A Consumer who is the person or organization responsible for Mobile Home Area Network Devices with Metering Capability account
Mode	A condition of the operational state (e.g., charging, discharging, power save)
Monitor	A device or arrangement for observing, detecting, or recording the operation of a machine or system
Mutual Authentication	A process in which both entities in a communications link authenticate each other
Network Management	The ability to remotely diagnose system components, and to monitor and control the communication system

Orphaned Charge	A Home Area Network Device that incurs a cost at a premise other than its registered, "home" premise and generates a billing charge to be reconciled through the Utility System. This term refers to proper premise association (e.g., a Plug-in Hybrid-Electric Vehicle that charges at a grocery store or a friend's house).
Pending Event	Refers to a price event or emergency event that is scheduled but has not yet happened
Pool Pump Controller	The controller is a separate device that resides between the timer and the pool pump, has minimal intelligence, and sends and receives signals through the Home Area Network
Pre-Commissioning	Depot level configuration setting
Premise	A geographical location (e.g., house) where the meter permanently resides
Price Event	Refers to a change in pricing sent to the device from the Utility
Commissioning	Describes the binding process of connecting a device to the network. Sometimes called provisioning.
Purchasing	Supports multiple distribution channels (e.g., retail, wholesale, Utility)
Rate Tiers/Blocks	Energy charges which vary based on the accumulated consumption during a period of time
Registration Configuration	Any required Utility-specific configurations
Remote Upgrade	The ability to correct defects, enable new features and applications, change recording and reporting intervals, refresh security, and optimize network operation without the cost of sending personnel to the customer site
Security	Those measures that protect and defend information and information systems by assuring their confidentiality, integrity, access controls, availability, and accountability
Smart Appliance	A HAN Device, typically a white good or other household appliance, that is capable of receiving signals from the Utility and adjusting its operational mode based on Consumer preferences (e.g., energy saving mode, delayed turn on/off)
State	A condition of the device (i.e., on/off)
System Operator	The entity responsible for operation and control of the electricity grid for a specific and defined geographic / service area
System Owner	The entity responsible for oversight and control of the entire system
Time of Use Rates	Energy charges which vary based upon a predetermined schedule of hours of the day and days of the week
Time of Day Demand Rates	Demand charges which vary based upon a predetermined schedule of hours of the day and days of the week
Utility Enterprise System	Includes Advanced Metering Infrastructure system, Distributed Automation, and all other enabling technologies of the Utility operation

Utility Home Area Network	Home Area Network Devices with Utility applications that securely communicate with the Utility via the Energy Services Interface; may be a logical sub-network of the premise Home Area Network

1.5 External Considerations and References

In addition to the fundamental shift in the Utility industry enabled by AMI deployments and HANs, a number of external developments motivated the drafting of the UtilityAMI 2008 HAN SRS.

Regulatory policy directives played a key role in pushing Utilities to deploy AMI systems that provide consumers with more detailed energy consumption information and demand-reduction capabilities, including the California Public Utilities Commission Energy Action Plan and AMI Directives, the California Energy Commission J45 Reference Design for Programmable Communicating Thermostats (PCTs), the Texas Public Utilities, and the Michigan 21st Century Energy Plan.

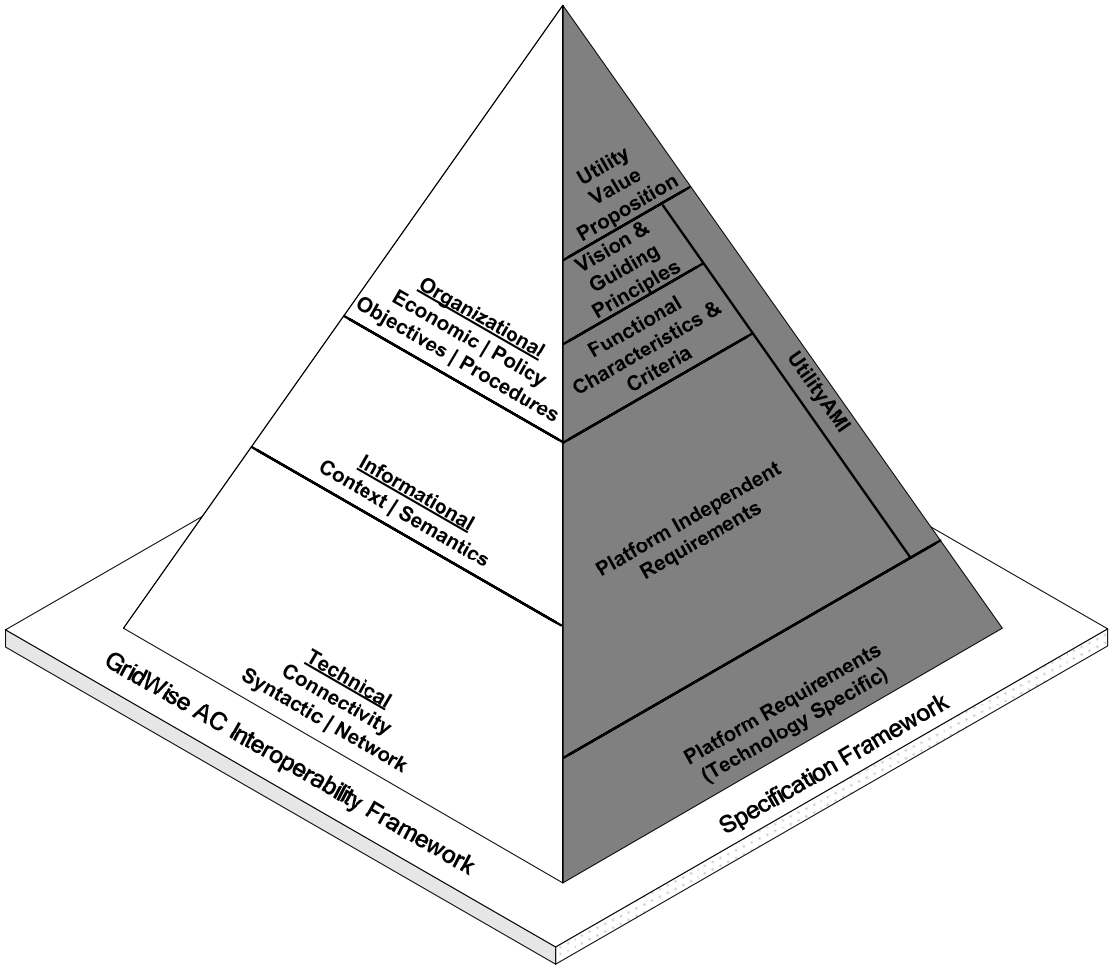
The UtilityAMI OpenHAN Task Force built upon other efforts and organizations in the Utility industry, in particular those of the Electric Power Research Institute and the GridWise Architecture Council These provided a template and foundation on which to approach the development of this system requirements specification.

Lastly, several external developments on the horizon such as emerging technology standards and the increased focus on carbon emissions were key factors in motivating this work. The proliferation of multiple technology standards for HANs motivated the OpenHAN Task Force to develop this specification to guide and direct the alliances responsible for those standards.

All signs seem to point to a future in which carbon emissions will be regulated. With increased awareness of climate change and the role of carbon emissions in it, governments in many states, provinces, and countries have already begun enacting rules and regulations to limit and control the emission of greenhouse gases. Electricity generation contributes a large portion to these emissions and enabling energy conservation programs and increased awareness was both a business and societal consideration in drafting this specification.

1.6 Overview

This document follows a top-down approach to system decomposition and conforms to the GridWise Architecture Council's framework as shown in the figure below:[1]



The figure above also provides the layout for the rest of this specification following the top-down approach. Section 2 describes the overall system, the Guiding Principles for the system and Architectural Considerations relevant to understanding the system.

Section 3 gives context for and lists all platform-independent OpenHAN System Requirements by category but does not map them to specific logical devices. The requirements categories are:

- Application
- Communication
- Security

[1] Adapted from Southern California Edison (SCE) Edison SmartConnect's™ Lifecycle Hierarchy

- Performance
- Operations, Maintenance, and Logistics

Section 4 contains the Appendices. It covers the high-level system Use Cases and then provides the requirements mappings for logical HAN Devices registered on the Utility network.

2. Overall Description

The UtilityAMI 2008 HAN SRS provides the foundation of the home energy ecosystem in which HAN Devices operating within a premise are able to engage with the Utility as much or as little as the consumer wishes.

This section defines the Guiding Principles the OpenHAN Task Force adopted to frame the capabilities and constraints of the system, the Architecture for HAN Device interaction with the Utility or other Energy Service Provider that permits a highly adaptable and flexible system depending on consumer preference, and the Assumptions for the system used as a starting point to drafting the Use Cases and Requirements found in Appendix 4.1 and Section 3, respectively.

2.1 Guiding Principles

The Guiding Principles represent the high level expectations from the perspective of the Utility and are used to guide and frame decision making in the development of functional and technical requirements. These expectations include the capabilities which are necessary to support both the Utility's vision statement and the value proposition. The principles also define those elements within the environment which constrain a HAN implementation.

Together, the high level capabilities and constraints help further define the system and show the major characteristics and behavior. The principles are authoritative and define the HAN implementation starting point. A complete implementation will provide technical methods and processes which meet or exceed a stated capability and adhere to the stated constraints. These principles, as stated, drive and define the functional characteristics and are the basis for the HAN Use Cases.

1. **Secure Two-way Communication Interface with the Meter**

   Description
   The capabilities of the system begin with the basic expectation that the AMI Meter has secure two-way communication to the Energy Services Interface (ESI), regardless of where the ESI is located. The meter contains consumer-specific energy information and is best suited to provide the HAN with near real-time access to the data.

   The ESI also possesses a secure two-way communication interface for HAN Devices registered with the Utility.

   Rationale
   The two-way communications expectation defines the AMI-to-HAN interface and creates and enables all other capabilities within the system. This interface may carry various data types including, sensitive data, confidential data, and

control data. Appropriate levels of security must be provided for these types of communications. Security is critical; the security implementation protects Utility and Consumer assets while enabling the next generation of applications and capabilities.

2. Supports Load Control Integration

Description
Load control is the concept of load being deferrable. A load control device has the capability to limit the duty cycle of equipment under control. Certain devices within the consumer's premise (e.g., PCTs, electric pumps) can be used to shed load through direct and indirect control.

Rationale
A capability to interface and integrate with load control systems enables the Utility's value proposition, and as such, it is critical that the capability be extended to the HAN. In addition to load control interfacing and integration, the HAN system has several consumer enabling capabilities. These capabilities include direct access to usage data and pricing information. This data is generated by the meter and provides additional justification for direct meter interaction.

3. Direct Access to Usage Data

Description
This platform provides the HAN with direct access to Consumer-specific information and enables a new class of energy services and products.

Rationale
One of the main requirements for energy conservation is a better informed Consumer. With more timely and detailed information at the hands of the Consumer, he will be able to make better choices about energy usage and conservation. With direct data access, the Consumer does not need to wait until the end of the month to see how changes in his usage have affected his bill. And with energy usage profiled in smaller increments, the Consumer can see the impact of changing his energy usage patterns.

4. Provides a Growth Platform for Future Products Which Leverage HAN and Meter Data

Description
A growth platform is typically a specifically named initiative selected by a business organization to fuel their revenue and earnings growth. The HAN is an example of a strategic growth platform. Strategic growth platforms are longer term initiatives where the initiative and results span multiple years. While AMI is the catalyst for HAN information exchange, the growth platform is not limited to the Utility, but to any organization that wants to create devices or services for the HAN.

Rationale

Beyond information delivery and basic demand response the Utility expects the HAN to support the next generation of applications including distributed generation, Plug-in Hybrid Electric Vehicles, and other metering applications as the technology, information, and capabilities of the HAN matures. By supporting open standards (see Principle 8), it is expected many vendors will be able to bring capabilities and innovation to bear on the HAN market.

5. Supports Three Types of Communications: Public Price Signaling, Consumer-Specific Signaling, and Control Signaling

Description
To support the anticipated market growth, the system must provide various types of communication. These communication types include public price signaling, consumer-specific signaling, and control signaling. Public pricing is the communication of material which is publicly available. Consumer-specific signaling would be signaling such as that which would support a home energy management system. Control signaling are those signals used to support load-shedding (see Principle 2).

Rationale
Each signal type is required to support the HAN as a growth platform (see Principle 4). Each signal type warrants individual security and privacy analysis and treatment. As such, the Utility does not take accountability and does not provide specific handling recommendations. Consumer-specific information signaling implies a level of privacy and additional privacy measures and methods are warranted. Control signaling for load control and direct Utility communications is a special use of the system and as such, requires robust handling methods. This capability expectation is based on Utility accountability for safe and secure delivery of the control data.

6. Supports Distributed Generation and End-Use Metering

Description
Distributed generation systems are small-scale power generation technologies used to provide an alternative to or an enhancement of the traditional electric power system. End-use metering is the idea that a second meter may be installed in the premise to support distributed generation production or measurement of discreet loads. Additionally, the OpenHAN and UtilityAMI architecture does not presume use of only electric meters. The HAN ESI may also communicate with gas and water meters and propagate their data through the HAN (e.g., to an IHD) or through the AMI network for transfer to an appropriate entity (e.g., an electric utility could gather water meter information and pass that information to the water utility).

Rationale
The ability to support communication to multiple HAN Devices provides greater value to the Consumer and Utility by facilitating automation and reducing redundancy in the systems required to capture metering information. As more homes and business become “green” it is anticipated that the Utility will need to support distributed generation sources such as solar panels, small wind

turbines, or Plug-in Hybrid Electric Vehicle or Electric Vehicles that may discharge back into the network. Non-revenue grade metering of end-use devices can provide consumers with additional information on the energy and cost associated with end-uses such as individual circuits, appliances, or plug loads.

7. Consumer Owns the HAN

Description
HAN ownership should not be confused with device ownership or communications accountability. Rather, Consumer ownership broadly defines the rights of the Consumer. Simply stated, the Consumer owns and controls the HAN.

Rationale
The Consumer for various reasons may concede control of her HAN. Typically, this concession is part of the normal Utility registration process for HAN Devices. That is, for certain types of communications the Consumer may allow Utility control.

8. Meter-to-HAN Interface Is Based on Open Standards

Description
From the IEEE P1003.0 Committee:

> "An open system is: A system that implements sufficient open specifications for interfaces, services, and supporting formats to enable properly engineered applications software to be ported across a wide range of systems with minimal changes, to interoperate with other applications on local and remote systems, and to interact with users in a style which facilitates user portability."

A key element of this definition is the term, "open specification," which is defined as:

> "A public specification that is maintained by an open, public consensus process to accommodate new technology over time and that is consistent with standards."

Rationale
Openness and accessibility are the keys to availability and prevalence. It also provides for a competitive market which drives down the price of Consumer goods. Requiring vendors to use non-proprietary standards puts competitive pressure on vendors because if any single vendor offers a proprietary solution, this is usually a stepping stone to increased maintenance and support costs.

The Utilities are constrained by the relative value of the HAN and any Utility investments needed to readily adapt to changes in the technology market. For this reason, this specification is written as platform and technology independent.

2.2 Architectural Considerations

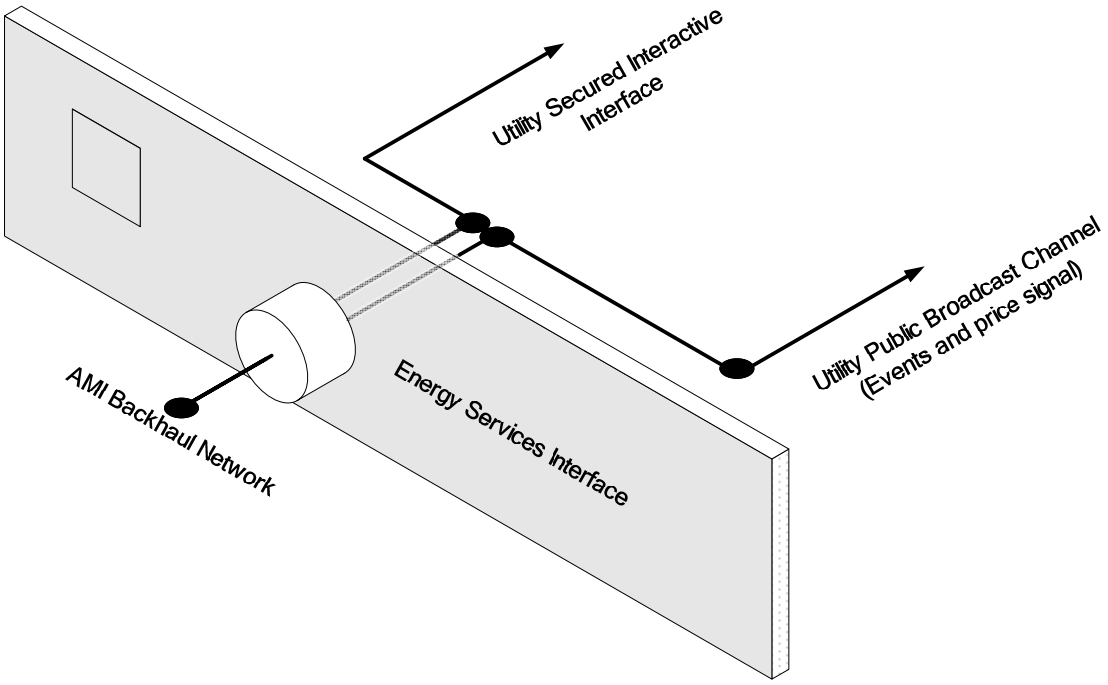
The architectural consideration section is not binding. That is, this section of the document is not considered "requirements." Rather, this section of the document provides further context and shows the Utilities' frame of mind during the production of the document.

Each of the following sections addresses various architectural concerns. In general, the specification is architecture agnostic. The requirements are targeted at logical devices. The following section simply provides additional clarifications and context.

2.2.1 Energy Services Interface

The AMI System provides two interfaces to the premise via the Energy Services Interface. The distinction between the two interfaces is based on the level of interaction, and control. The Utility-Secured Interactive Interface provides confidentiality, integrity, and availability. The second interface, the Utility Public Broadcast Channel, allows for anonymous receipt of information provided by the Utility. Further, the second interface is not "secured" by the Utility. This second interface is based on the assumption that users need information for conservation and awareness and do not want to exchange information with the Utility.

This interface designation creates logical segmentation within the premise. This logical segmentation can be viewed as two separate networks: the Utility-secured network and all other external networks.



2.2.2 Device Ownership

The specification as a whole is agnostic to device ownership. OpenHAN recognizes consumer rights, and this sentiment is stated explicitly in the Guiding Principles section of this document. With that being said, the architectural section does touch on additional aspects of ownership and control. The architecture section makes a further assumption beyond the Guiding Principle that devices in the premise can be supplied by either the Utility or the Consumer. Further, Utility-supplied devices (e.g., gas meter) will always use the Utility-Secured Interactive Interface. Devices owned by the Consumer (e.g., smart appliance, PCT) can either use the interactive and secured interface or use the anonymous public interface. Additionally, Consumer devices do not need to use or interact with the Utility. Devices within the premise that do not interact or receive Utility information are out of scope for this discussion (e.g., Home Health Care, Home Security)

2.2.3 Public Broadcast Interface

The public broadcast interface supplies a limited amount of information to the consumer premise. This interface is not secured by the Utility. That is to say, this interface has a fair amount of vulnerabilities and should be used for information only. The type of information can be used for general conservation. A sample message structure is proposed:

- Broadcast ID (e.g., Utility ID, SSID)
- Current Price (e.g., $0.XX/kWhr)
- Relative Price (e.g., high, medium, low)
- Message Expiration Time (e.g., 1 – 1440 minutes)
- Rate Descriptor (e.g., residential, commercial)
- Severity of Event Description (e.g., Stage 1, 2, 3)
- Integrity check (e.g., CRC)

The public broadcast interface should provide these types of information. Actual message structure will be defined within the technology platforms.

2.2.4 Utility-Secured Interactive Interface

The ESI provides a secure interface for Utility-to-Consumer interactions. To facilitate this interaction, the Utility must provide methods and materials. Further, this interaction implies a certain amount of exerted control and accountability. The control is granted by the Consumer and provided by the Utility. This granting is part of a Utility registration process. Security on this interface is robust and comprehensive. The communication between the ESI is protected with cryptographic methods. These methods include authentication, integrity, and confidentiality. Details should appear in technology-specific implementations.

2.2.5 Consumer HAN Devices

Consumer HAN Devices are devices within the architecture that are procured by the Consumer or a third party which is not the Utility. As an example, these devices include smart appliances, PCTs, and Energy Management Systems.

2.2.6 Utility HAN Devices

Utility HAN Devices within the premise are those devices which are typically provided by the Utility. As an example, these include metering devices (e.g., gas meter) and load control devices. Some of these devices are located within the Consumer premise while others sit on the outside of the premise. Regardless of placement, the Utility device always uses the Utility provided "secure" network.

Some devices can be provided by either the Utility or the consumer. This decision is between the consumer, Utility, and regulators. Further, this document provides architecture flexibility. That is, the UtilityAMI 2008 HAN SRS supports any desired configuration.

2.2.7 Cohabitation

Some devices can live on a third party network and the Utility's secured network. These devices need special security treatment such that they do not logically bridge the network. As an example, the Utilities expect third party Energy Management Systems to live on both networks (i.e., the Utility network and third party network). The actual platform implementation should address any security concerns associated with cohabitating devices.

2.2.8 Deregulated Utilities

Energy delivery varies from state to state. In certain deregulated markets, retail energy and the actual distribution operations are segmented. From an OpenHAN and architecture perspective, the "Utility" which provides the ESI is responsible for the "secure" network. That is, they are ultimately responsible for Consumer registration. There is an integration concern which must be considered. If an energy provider owns or operates a consumer device (e.g., PCT) then this energy provider will need to interface to the ESI. One option which facilitates this interface is for the ESI owner to provide an interface to an application gateway (retail ESP gateway or EMS) within the premise. That is, there is one device in the premise which provides ESI access (see Deregulated Scenario). If the device directly interacts with the ESI then this device should be on the "secured" network and registered with the ESI controller. A second integration strategy is based on the distribution and energy provider choosing to integrate the systems outside the HAN (e.g., back office integration). These decisions are outside the scope of the UtilityAMI OpenHAN Task Force and are only presented for context.

2.2.9 External Interfaces

The OpenHAN System Requirements Specification was written to support external interfaces to the HAN. The ESI requirements specified in the OpenHAN SRS do not presuppose an architecture in which the interface resides solely within the AMI meter or is owned solely by a distribution Utility. Pricing information, control signals, and messaging may be provided from a third party entity such as a Retail Energy Provider or Demand Response Aggregator. In this model, the AMI meter would continue to provide premise consumption information (e.g., real-time metrology) and would still be part of the HAN. Customers may also have an external interface into their HAN to enable remote configuration, monitoring, and other applications.

In the case of an external interface, there is still a need for a Utility-controlled ESI in order to maintain grid reliability, stability, and security.

2.2.10 Architectural Scenarios

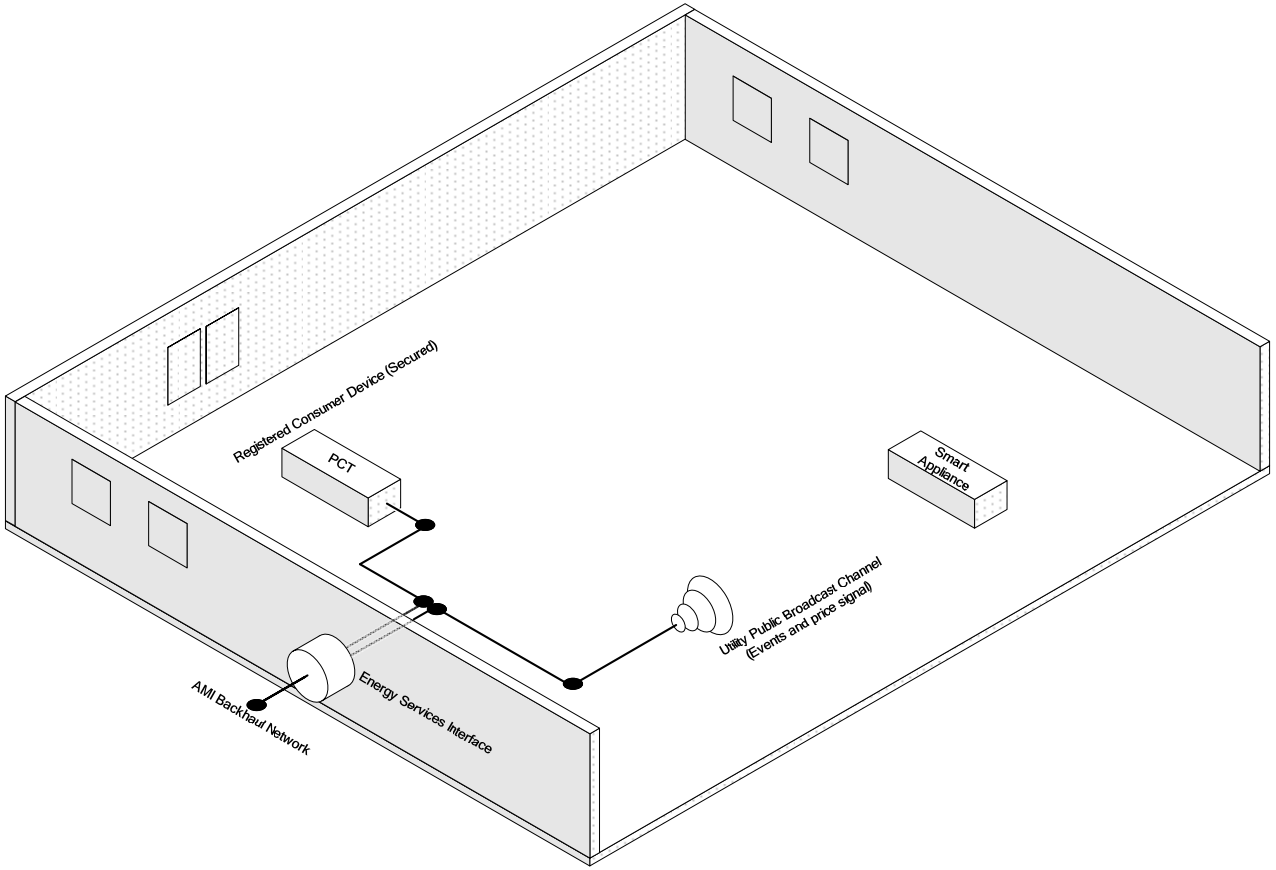


Figure 1: Scenario One (Inception) – Utility interacts with a registered (Voluntary) PCT. The Public Broadcast Channel interface is used to provide price signals and grid event messages to the Consumer's unregistered Smart Appliance. The ESI is located in the meter under glass.[2]

[2] Adapted from Southern California Edison (SCE) Edison SmartConnect™

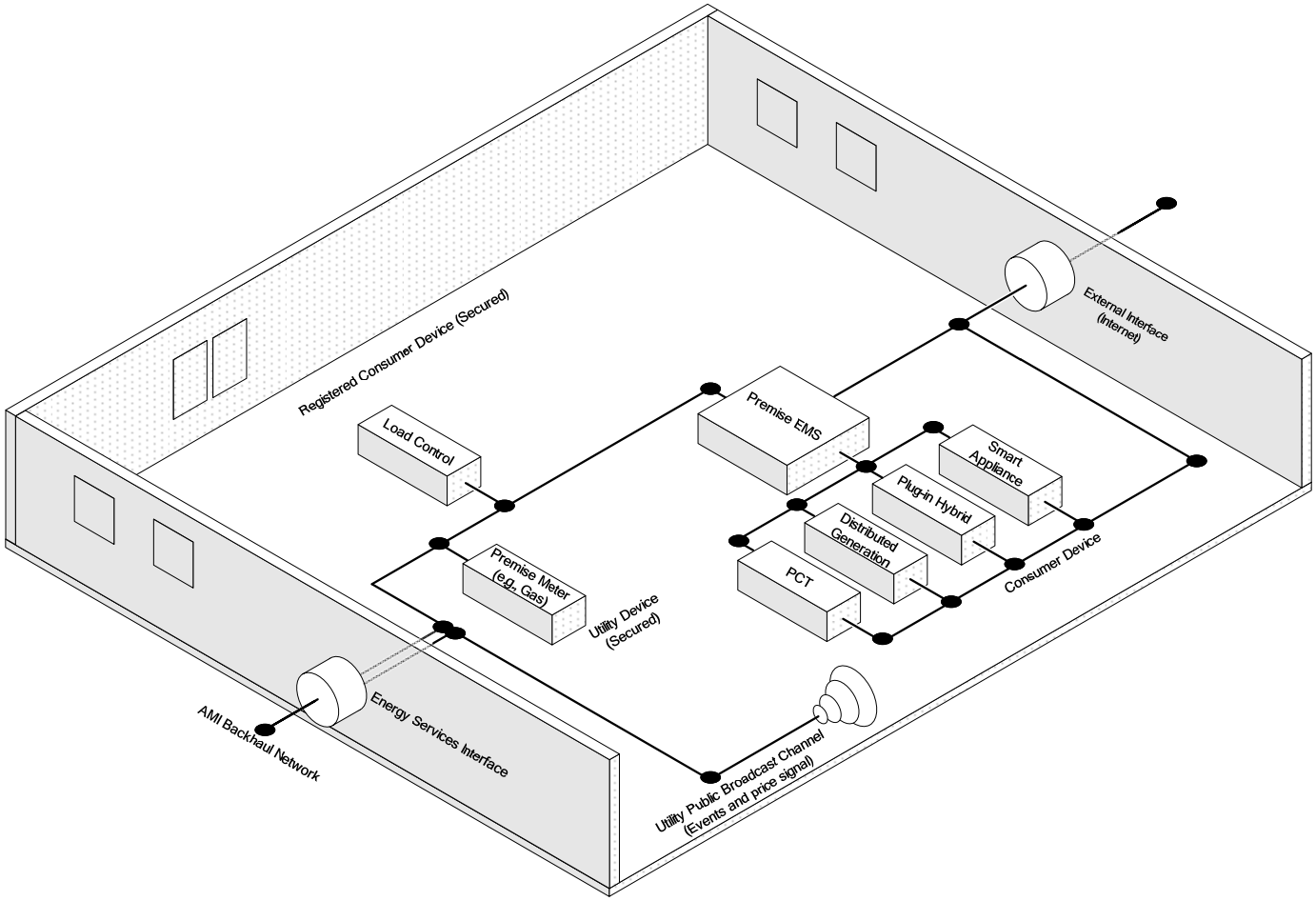


Figure 2: Scenario Two (Consumer Choice Example) – Consumer has placed the PCT and other devices on a third party network but chosen to register a load control device with the Utility. The Utility is also using the HAN for communications to a gas meter. The Utility Public Broadcast Channel is available but not used.[3]

[3] Adapted from Southern California Edison (SCE) Edison SmartConnect™

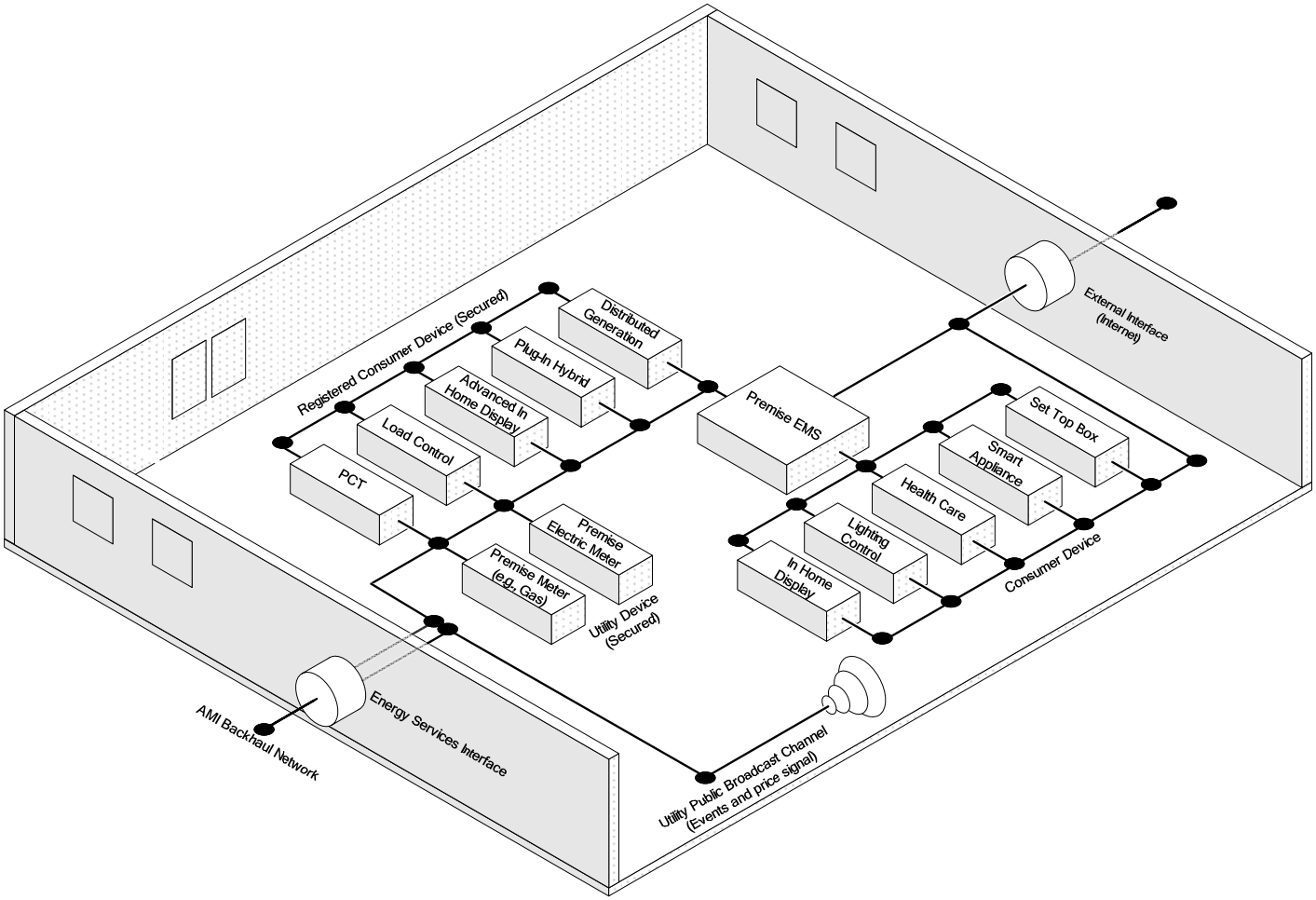


Figure 3: Scenario Three (Mature System) - Several Consumer and Utility devices, several of which are registered with the Utility. HAN Devices are accessible to the external interface/gateway (Internet). The Utility Public Broadcast Channel is available but not used.[4]

[4] Adapted from Southern California Edison (SCE) Edison SmartConnect™

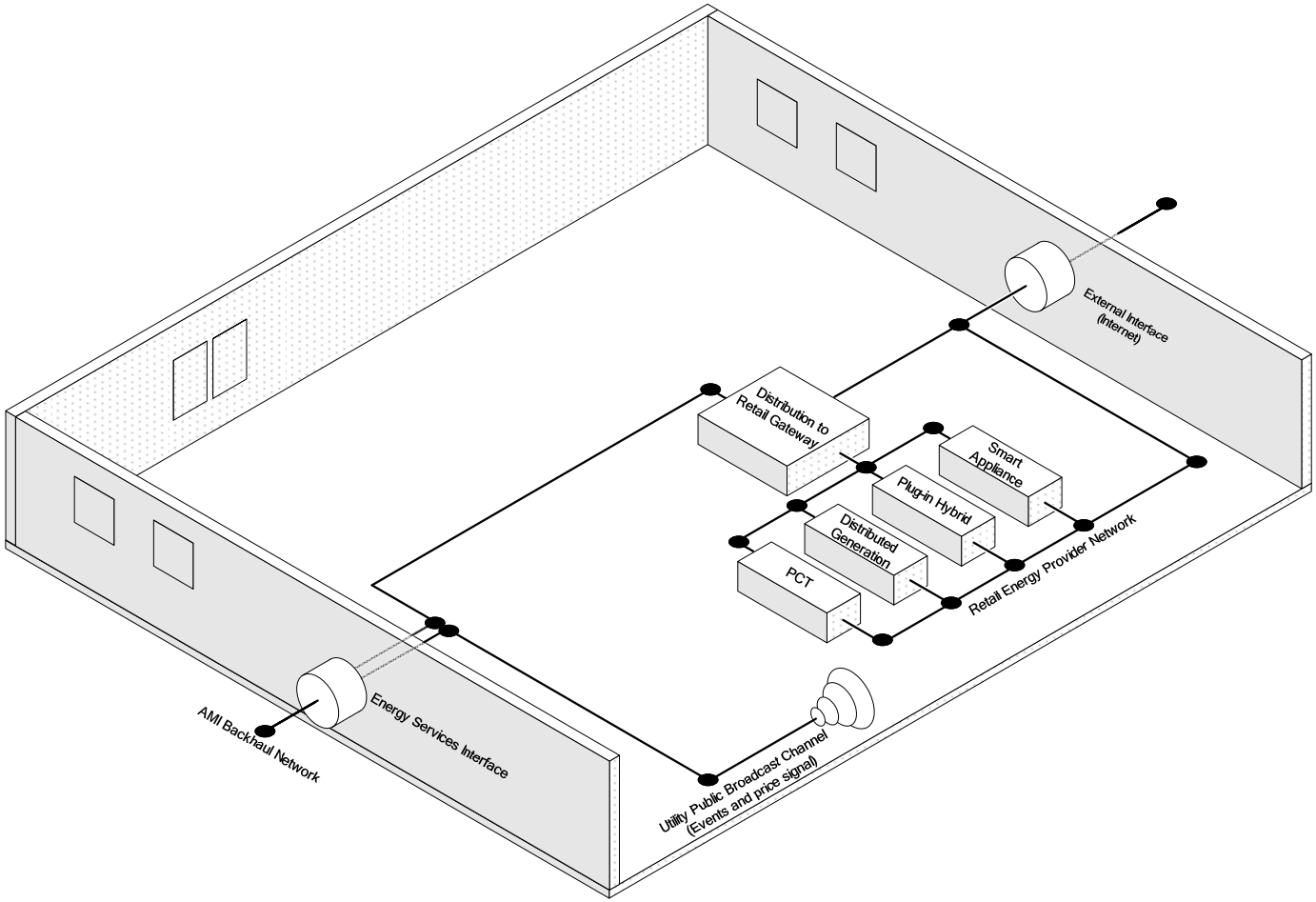


Figure 4: Scenario Four (Deregulated Example) - All devices sit on the third party network. The electric distribution company provides information through its Energy Services Interface. The distribution company's accountability boundary ends at the Retail Gateway device. The Utility Public Broadcast Channel is available but not used.[5]

[5] Adapted from Southern California Edison (SCE) Edison SmartConnect™

3. OpenHAN System Requirements

The OpenHAN System Requirements are the main focus of this document and provide the most important information to the various HAN stakeholders. They define and constrain the system to enable successful functionality for Consumers, Utilities, and society at large.

3.1 Requirements Framework

In designing the system, the OpenHAN Core Development team considered a number of criteria. They are:

- HAN Applications
- Communications
- Security
- Performance
- Operations-Maintenance-Logistics

HAN Applications is one of the most important categories from the Utilities' perspective. Any application that is enabled through the HAN will have one or more of the following characteristics: Control, Measurement and Monitor, Processing and Human-Machine Interface (HMI).

Control applications respond to control signals. The simplest control application is direct control, which turns loads on or off. Control applications can also cycle, which means they turn the load on and off at configurable time intervals. More sophisticated control applications can limit the load of an appliance based on configurable thresholds.

Measurement and Monitor applications generally provide internal data and status. These applications include distributed generation functionality where local energy input and output is measured and monitored. It can also have end-use metering functionality to measure and monitor device-specific energy consumption or production. A consumer Plug-in Hybrid-Electric Vehicle (PHEV), for example, can have end-use metering functionality as well as distributed generation. Applications can be as simple as measuring and monitoring the environmental state or whether a device is on or off.

Processing applications consume, process and act on external and internal data. These applications accept data from external systems and HAN measurement and monitoring applications. Applications with processing capability are generally more complex and costly. The following applications requiring processing:

- Energy Cost - Calculates current and overall energy cost
- Energy Consumption - Calculates current and overall energy consumption
- Energy Production - Calculates current and overall energy production

- Energy Optimization - Utilizes external and HAN data to determine desired response based on a consumer-configurable profile
- Energy Demand Reduction - Uses external and HAN data to reduce load based on a consumer configurable profile
- Environmental Impact - Calculates environmental impact of current energy consumption (e.g. based on the CO_2 emission profile of a Utility's generation portfolio)

Human Machine Interface (HMI) – Most applications will need an HMI in order to provide local user input and/or output. These applications are based on the data type.

- User Input - Provides Consumers with a means to input data into an application (e.g., touch screen, keypad)
- User Output - Provides an Application with a means to output data to the consumer (e.g., In-Home Display, text message)

Communications is one of the most challenging categories of the AMI systems. The working group has identified communications criteria for discovery, commissioning and control.

Discovery of a node is simply the identification of a new node within the HAN and it generally involves the following:

- Announcement – Both active and passive device notification methods
- Response - Includes both endpoints (e.g., announcing entity and recipient entity)
- Initial Identification - Device-type and address identification

Commissioning is the network process of adding or removing a node on the HAN with the expectation that the system is self-organizing (i.e., initial communication path configuration). This process is decoupled from Utility registration. Commissioning involves the following:

- Identification - Uniquely identifying the device
- Authentication - Validation of the device (e.g., the network key)
- Configuration - Establishing device parameters (e.g., network ID, initial path, bindings)

Control of a node is enabled by the platform specific technology and it involves:

- Organization - Communication paths (e.g., route)
- Optimization - Path selection
- Mitigation - Ability to adapt in response to interference or range constraints through detection and analysis of environmental conditions

Security goes hand-in-hand with Communications. Introduction of a communications technology for the home requires enhanced security to protect the overall AMI system. The OpenHAN Task Force expects the UtilityAMI AMI Security Task Force to address the security requirements of the AMI system in greater detail. However, due to the importance of this category, the OpenHAN Task Force addresses specific security criteria that pertain to the ESI's Utility-Secured Interactive Interface. The security

categories addressed are: Access Control and Confidentiality, Registration and Authentication, Integrity, and Accountability.

Access Controls and Confidentiality address levels of data protection based on data type. All data will have some level of access control, but there are various requirements associated with data-at-rest and data-in-transit based on data type.

- Public Controls (low robustness) - Protection methods for publicly available information (e.g., energy price)
- Private Controls (medium robustness) - Protection methods for confidential or sensitive data (e.g., Consumer usage)
- Utility Controls (high robustness) - Protection methods for Utility accountable data (e.g., load control, other premise metering data)

Registration and Authentication is crucial since to verify and validate HAN participation. Once a node is registered, it is trusted in the network. Therefore, registration and authentication involves the following:

- Initialization – Establishes the application/device as a validated node (i.e., logical join to the Utility's network)
- Validation – Validates the application's data (i.e., request or response)
- Correlation – Correlates an account (e.g., Consumer) with a HAN Device, application, or program (e.g., demand response programs, peak time rebate, etc.)
- Authorization – Governs rights granted to the applications
- Revocation – Removes an established node, correlation, or authorization

Integrity preserves the HAN operating environment through:

- Resistance – Methods which prevent changes to the application or application's data (e.g., tamper and compromise resistance)
- Recovery – Restores an application or the application's data to a previous or desired state (e.g., reloading an application, resending corrupted communications)

Accountability will allow for monitoring malicious activities through:

- Audit – Application log detected compromise attempts
- Non-repudiation – Applications and application operators are responsible for actions (e.g., can not deny receipt or response)

Performance requirements ensure applications or other factors do not limit the performance of the system. Since the OpenHAN SRS is written at a platform-independent level, these criteria are higher level than the others found in this document. The requirements associated with these criteria are also less detailed than others for the same reason that, depending on Utilities' technology selection, their performance requirements will differ. Performance of the system is usually dependent on the following:

Availability - The applications are consistently reachable

Reliability - The applications are designed and manufactured to be durable and resilient

Maintainability - The applications are designed to be easily diagnosed and managed

Scalability - The system supports a reasonable amount of growth in applications and devices

Upgradeability - The applications have a reasonable amount of remote upgradeability (e.g., patches, updates, enhancements)

Quality - The applications will perform as advertised

Operations, Maintenance and Logistics criteria address the challenges around deploying HAN Devices in a new market segment. The working group's goal is to keep maintenance to a minimum and make the operation of the system as easy as possible while not compromising security and performance. There are many activities involved in reaching this goal:

Manufacturing and Distribution - Vendor's pre-installation activities

- Pre-commissioning - Depot level configuration setting
- Registration configuration - Any required Utility specific configurations
- Labeling - Utility compliance and standards labeling
- Purchasing - Supports multiple distribution channels (e.g., retail, wholesale, Utility)

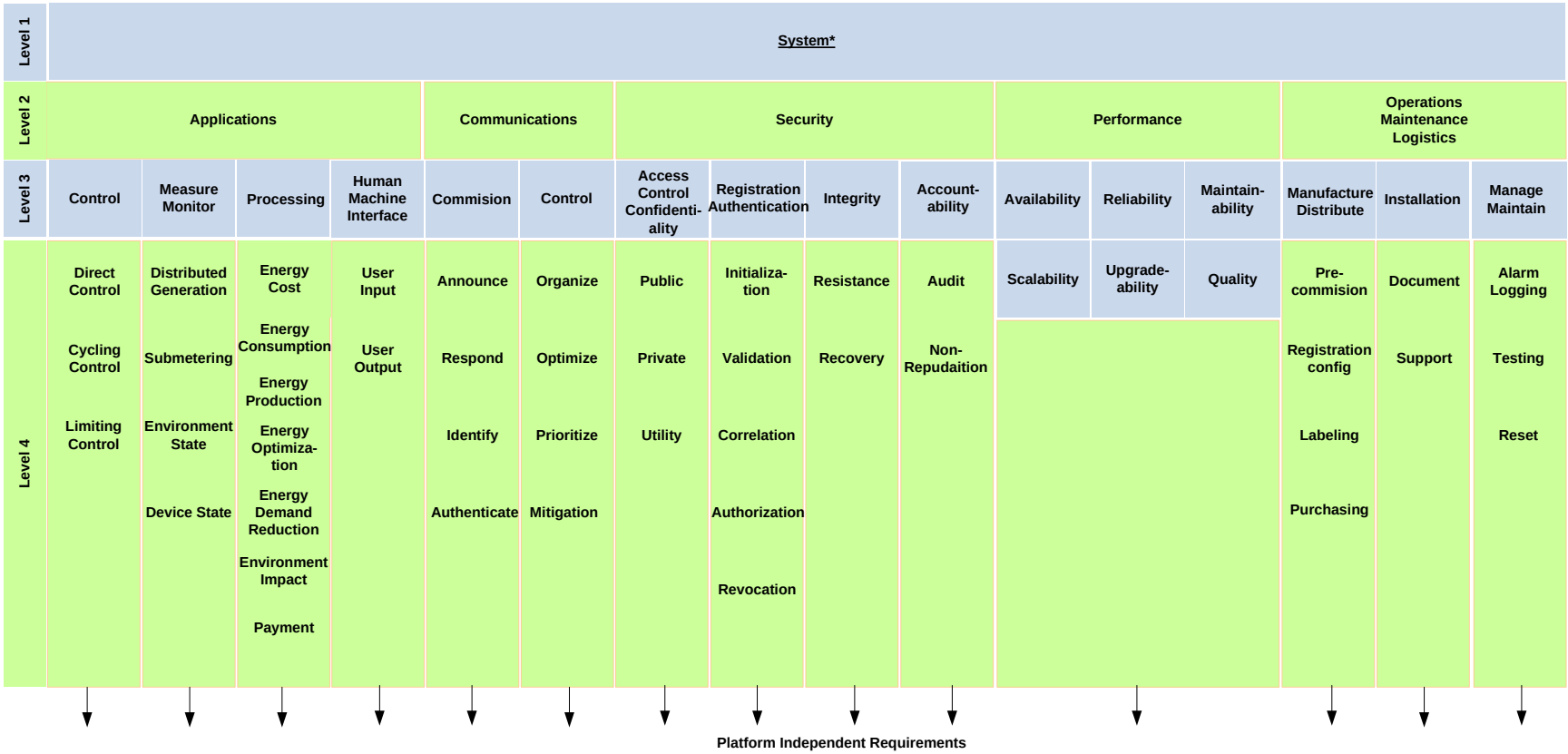
Installation - Physical placement of the device

- Documentation - Installation materials and manuals
- Support Systems - Installation support systems including web support, help line, other third party systems

Management and Diagnostics

- Alarming and logging - Event driven consumer and Utility notifications
- Testing - System and device testing
- Device reset - Resets the device to the installation state

Please refer to the Visio drawing on the following page to see a hierarchical illustration of the Requirements Framework and system decomposition.



3.2 Requirements Assumptions

This section documents the assumptions on which the requirements are based. It will be helpful to refer back to these throughout the rest of the specification.

1. Consumer owns his Premise and Utilities are granted access rights by the consumer or by regulatory authority.
2. The Utilities expect vendor differentiation and innovation in the marketplace.
3. Devices do not prioritize commands (e.g., last command overrides previous).
4. Assume orderly shutdown of operations (e.g., could be delayed until current process completes).
5. Does not presume source of message (i.e., Utility or certified premise EMS).
6. Does not cover the consequences or incentives associated with participation or compliance (e.g., Overriding mandatory control signals).
7. Certified premise EMS can proxy as the Utility.
8. EMS devices are viewed as aggregating functions within the system.
9. EMS can aggregate data from multiple sources.
10. Rate information can pass from the Energy Services Interface to the Energy Cost application.
11. Energy Cost applications are not intended to reconcile costs displayed on HAN Devices with bills generated by a Utility billing system. There are other elements associated with billing and revenue-grade metering that are outside the scope of these requirements (e.g., revenue-grade certification, rate recovery).
12. The Energy Cost applications are likely components of an Energy Management System.
13. Alarm features would likely be part of separate Energy Optimization applications (e.g., signal an alarm when the accumulated cost for the month is greater than $100).
14. For authentications to be considered secure they must not be able to be reversed with modern computing technology in the amount of time for which they are valid.

All requirements comprise a “shall…” statement that clearly outlines the requirement and minimizes the potential for confusion. The requirements listed in these sections are not prioritized by criticality or sophistication and include some fairly advanced functional capabilities that may be beyond the current state of the market. This is intentional.

Readers should refer to Appendix 4.2 – Logical Device Mappings for Utility-Registered Devices – for guidance on which requirements are mandatory for logical devices to be considered UtilityAMI compliant.

3.3 Application Requirements

Application requirements are the heart of Utility-to-HAN interactions and define what HAN Devices do. These applications include: Control, Measurement & Monitoring, Processes, and Human-to-machine interfaces and are broadly described here.

3.3.1 Control

Control applications respond to control commands from the Utility or authorized third parties. Commands typically tell a device to turn ON or OFF at configurable time intervals or thresholds or enter into an energy saving mode.

Requirements:

App.Control.1 HAN Device shall accept control signals from the Utility.

App.Control.2 HAN Device shall respond to requests to cease operational state (e.g., open contact).

App.Control.3 HAN Device shall respond to requests to resume operational state (e.g., close contact).

App.Control.4 HAN Device shall acknowledge receipt of control signal.

App.Control.5 HAN Device shall acknowledge execution of control request.

App.Control.6 HAN Device shall acknowledge execution failure of request (i.e., exceptions).

App.Control.7 HAN Device shall signal any consumer-initiated overrides.

App.Control.8 HAN Device shall respond to request to cease operation state at a specific time.

App.Control.9 HAN Device shall respond to request to resume operation state based at a specific time.

App.Control.10 HAN Device shall delay restoration of operational state based on a pre-configured time (e.g., random number).

App.Control.11 HAN Device shall respond to request to cycle operational state (i.e., duty cycle).

App.Control.12 HAN Device shall respond to request to limit operational mode based on thresholds, set-points, or triggers (e.g., price points).

App.Control.13 HAN Device shall respond to requests for variable output (e.g., load limiting, energy savings mode)

3.3.2 Measurement and Monitoring

Applications that provide internal data and status. These are functional requirements on the device. They do not speak to the organization of the system (e.g., net versus sub). The applications covered are distributed generation (e.g., solar, fuel cell, wind), metering of devices within the premise

(e.g., Consumer PHEV), monitoring of local conditions (e.g., temperature, humidity, time, airflow, ambient light level, motion), and monitoring of a device's state. These applications provide input to the HAN system and enable processing and action based upon that input.

Requirements:

App.Measure.1 HAN Device shall measure instantaneous demand (e.g., W).

App.Measure.2 HAN Device shall measure accumulated consumption (e.g., Wh).

App.Measure.3 HAN Device shall measure accumulated production (e.g., Wh).

App.Measure.4 HAN Device shall measure consumption per interval (e.g., Wh, BTU, HCF).

App.Measure.5 HAN Device shall measure production per interval (e.g., Wh).

App.Measure.6 HAN Device shall store intervals measurements (e.g., 30 days of interval reads).

App.Measure.7 HAN Device shall allow interval configuration (e.g., 15 Minutes).

App.Measure.8 HAN Device shall monitor energy state (e.g., state of charge, Watt-hour).

App.Measure.9 HAN Device shall measure available capacity (e.g., Watts, Volt-Amps).

App.Measure.10 HAN Device shall monitor the device state (e.g., operational, stand-by, maintenance).

App.Measure.11 HAN Device shall monitor the operational mode (e.g., charging, discharging).

App.Measure.12 HAN Device shall measure power quality (e.g., frequency, neutral voltage, harmonic content).

App.Measure.13 HAN Device shall monitor environmental state (e.g., temperature, motion, wind).

App.Measure.14 HAN Device shall monitor the operational mode of other devices (e.g., duty cycle).

App.Measure.15 HAN Device shall monitor environmental impact (e.g., CO_2).

3.3.3 Processing

Applications that consume, process, and act on external and internal data. These applications accept data from external systems and HAN measurement

& monitoring applications. In general, these applications that have a higher level of complexity and cost.

Requirements:

App.Process.1 The application shall calculate a HAN Device's energy cost of accumulated energy consumption as monetary value (e.g., $/kWh * accumulated kWh = $).

App.Process.2 The application shall calculate a HAN Device's energy cost of instantaneous power consumption as a monetary value per time interval, (e.g., $/Wh * instantaneous W= $/hr).

App.Process.3 The application shall calculate a HAN Device's cost for Hourly Energy rates.

App.Process.4 The application shall calculate a HAN Device's energy cost for rate tiers/energy blocks.

App.Process.5 The application shall calculate a HAN Device's energy cost for Time-of-Use (TOU) energy rates.

App.Process.6 The application shall calculate a HAN Device's cost for Critical Peak Pricing (CPP).

App.Process.7 The application shall calculate a HAN Device's cost for capacity billing rates.

App.Process.8 The application shall calculate costs for other billing determinants (e.g., monthly consumer charges, taxes & franchise fee, surcharges, discounts, ratcheted demand, bond charges).

App.Process.9 The application shall accept aggregated consumption and rate information from user-configurable sources (e.g., Energy Services Interface, AMI System, and/or HMI).

App.Process.10 The application shall calculate and forecast a HAN Device's consumption based on user-defined parameters (e.g., estimated kWh/month).

App.Process.11 The application shall calculate and forecast a HAN Device's production based on user-defined parameters (e.g., estimated kWh/month).

App.Process.12 The application shall forecast a HAN Device's estimated cost calculation based on user-defined parameters (e.g., monthly consumption at current rate/usage).

App.Process.13 The application shall calculate a HAN Device's consumption based on user-defined parameters (e.g., historical reporting).

App.Process.14 The application shall calculate a HAN Device's production based on user-defined parameters (e.g., historical reporting).

App.Process.15 The application shall calculate and/or predict a HAN Device's environmental impact based on user-defined parameters (e.g., historical carbon footprint, forecasted carbon credits earned).

App.Process.16 The application shall supply a method for local billing resolution (e.g., orphaned billing charge, consumption debits/credits).

App.Process.17 The application shall calculate and suggest methods to optimize energy consumption and cost based on user-defined parameters (e.g., PCT thresholds, lighting settings, pool pump cycling).

App.Process.18 The application shall calculate a HAN Device's relative efficiency (e.g., comparison can be based on historical data, baseline at install, manufacturer's parameters, industry/governmental standards, other devices, other premises).

App.Process.19 The application shall calculate available load for demand reduction based on user-defined parameters (e.g., percentage of load available for various response scenarios).

App.Process.20 The application shall calculate user-defined thresholds for consumption, production, and cost (e.g., if aggregated consumption reaches a certain level, an alert is generated).

3.3.4 Human-Machine Interface

Applications that provide local user input and/or output. These applications are constrained and based on the data type. They provide a method for users to interact with the HAN, enter preferences, configure the HAN and its devices, and obtain useful information from the HAN.

Requirements:

App.HMI.1 HAN Device shall provide visual indicators which indicate operational state (e.g., commissioned, registered, event status, device state).

App.HMI.2 HAN Device shall provide a power cycle input, which reboots the device.

App.HMI.3 HAN Device shall provide a user reset input, which returns the device to its pre-installation state (e.g., button).

App.HMI.4 HAN Device shall provide an alphanumeric display which indicates operational state (e.g., LCD screen).

App.HMI.5 HAN Device shall provide non-visual sensory feedback (e.g., motion, vibration, audible).

App.HMI.6 HAN Device shall provide a sight and hearing impaired interface.

App.HMI.7 HAN Device shall provide a user-configurable display.

App.HMI.8 HAN Device shall accept user configurations.

App.HMI.9 HAN Device shall accept user preferences (e.g., Celsius/Fahrenheit, color, language).

App.HMI.10 HAN Device shall provide alarm notifications (e.g., price threshold, event messages).

App.HMI.11 HAN Device shall accept Utility data source configurations (e.g., Energy Services Interface, other HAN Devices).

App.HMI.12 HAN Device shall display Utility data source configurations (e.g., Energy Services Interface, other HAN Devices).

App.HMI.13 HAN Device shall display application-specific information (e.g., cost, consumption, environmental impact, payment credit, remaining account credit).

App.HMI.14 HAN Device shall accept application-specific configurations (e.g., preconfigured periods (e.g., hour, day, week), configurable periods (e.g., interval length, TOU period), variable periods (e.g., Critical Peak Price period).

App.HMI.15 For battery-powered devices, HAN Device shall provide a battery life indicator.

App.HMI.16 HAN Device shall accept payment data from the consumer.

3.4 Communication Requirements

Communication requirements of OpenHAN are designed to provide reliable message transmissions between the Utility and the consumers HAN devices. These requirements include Commissioning and Control. Commissioning requirements describe how a new HAN device is added the communication network. Control requirements detail how the communication network and HAN device work together to maintain a reliable communication network.

3.4.1 Commissioning

Commissioning is defined as the network process of identifying and adding or removing a node on the HAN with the expectation that the system is self-organizing (i.e., initial communication path configuration). This process is decoupled from Utility registration.

Dependencies:

See App.HMI.5 and App.HMI.6

Requirements:

Comm.Commission.1 HAN Device shall accept network configuration data which allows for private Utility networking (e.g., private address/ID)

Comm.Commission.2 HAN Device shall accept commissioning configuration data by the manufacturer (e.g., link key).

Comm.Commission.3 HAN Device shall accept commissioning configuration from the Installer.

Comm.Commission.4 When Energy Services Interface is triggered (e.g., Allow Join Command), HAN Device location-/contact-specific data shall be provided to other HAN Devices in the premise.

Comm.Commission.5 When a HAN Device is triggered (e.g. Power-on, button), HAN Device shall provide the Energy Services Interface with device-specific information including device ID and device type.

Comm.Commission.6 When a HAN Device is triggered (e.g. power on, button), HAN Device shall provide the Energy Services Interface with device specific Utility information, including network ID, gateway ID, and Utility ID, if pre-configured with Utility information.

Comm.Commission.7 Energy Services Interface shall have the ability to accept or reject a request based on device type.

Comm.Commission.8 Energy Services Interface shall have the ability to accept or reject device requests based on Utility-specific information (e.g., network ID, gateway ID, or Utility ID).

Comm.Commission.9 HAN Device shall acknowledge successful commissioning requests (i.e., provide acknowledgement to the requesting HAN Device).

Comm.Commission.10 When a HAN Device is communicating with the Energy Services Interface, HAN Device shall indicate link connectivity.

Comm.Commission.11 HAN Device shall provide notification to the Installer of the commissioning status. Status conveyed shall be either: successful/unsuccessful.

Comm.Commission.12 Energy Services Interface shall maintain an updated list of commissioned (i.e., connected) HAN Devices.

Comm.Commission.13 Energy Services Interface shall have the ability to remove HAN Devices from the Utility HAN.

3.4.2 Control

Autonomous functions enabled by the platform-specific technology. These requirements speak to the efficient functioning of HAN communications and are intended to provide robust and reliable communication paths in the HAN.

Requirements:

Comm.Control.1 HAN Device shall accept network organization messages from the Energy Services Interface (e.g., gateway location, routing table, address).

Comm.Control.2 HAN Device shall accept network organization messages from peer devices (e.g., hidden node).

Comm.Control.3 HAN Device shall use the most reliable path to the Energy Services Interface (e.g., based on signal strength/quality).

Comm.Control.4 HAN Device shall only use Utility-designated routes.

Comm.Control.5 HAN Device shall have the ability to automatically adapt to communications interference through detection and analysis of environmental conditions (e.g., channel hopping, channel avoidance, signal-to-noise ratio).

Comm.Control.6 HAN Device shall include a data integrity mechanism for all communications (e.g., checksum).

Comm.Control.7 Energy Services Interface shall have the ability to activate and deactivate its HAN communication.

Comm.Control.8 HAN Device shall communicate its availability (i.e., 'heartbeat') to the Energy Services Interface at least once per day.

Comm.Control.9 HAN Device shall have a configurable availability communication (i.e., heartbeat) frequency to the Energy Services Interface.

Comm.Control.10 Energy Services Interface shall store a list of available, commissioned HAN Devices in the premise and make that list available to the AMI System upon request.

3.5 Security Requirements

The OpenHAN security requirements are designed to help insure the Utility to HAN communications are used for their intended purposes. These security requirements help to verify users' identities, maintain user privacy, and assure responsible use. These security requirements are divided into four sections: Access Controls and Confidentiality, Integrity, Accountability, and Registration.

3.5.1 Access Controls and Confidentiality

The goal of access control is to prevent the unauthorized use of HAN resources. Access control includes resource control; for example, preventing logon to local HAN Devices. For the purposes of this discussion, access control is not concerned with denying physical access. Access control is applied to an entity based on an identity or an authorization. An identity may represent an actual user, a process with its own identity (e.g., a program making a remote access connection), or a number of users represented by single identity (e.g., role-based access control).

Confidentiality refers to the security services, which prevent unauthorized disclosure of data (both stored and communicated). Confidentiality services prevent disclosure of data in transit and data at rest. Confidentiality services

also include “anonymity”, a service which prevents disclosure of information which leads to the identification of the source or end-user of the information. Because of its role in limiting authorized disclosure of information, confidentiality services are closely linked with access control services.

Requirements:

Security.Access.1 Energy Services Interface shall provide access control (i.e., logical segmentation) to Utility applications, data, and services (e.g., control data, consumer-specific consumption data).

Security.Access.2 HAN Device shall control access to persistent Utility HAN data (data at rest).

Security.Access.3 HAN Device shall control access to transmitted Utility HAN data (data in transit).

Security.Access.4 HAN Device shall provide protection of Utility HAN data while being processed (data in processing) (e.g., trusted processor).

Security.Access.5 HAN Device shall control access to data in accordance with a configurable Utility security policy (e.g., users, applications, devices, data access-read/write).

Security.Access.6 Energy Services Interface shall provide mechanisms to enforce a policy based on least privilege (i.e., explicit authorization).

Security.Access.7 Energy Services Interface shall have the ability to enforce policy periods (time constraints) for security policy elements (e.g., maintenance/firmware window).

Security.Access.8 HAN Device shall provide methods to query and report access control data settings.

Security.Access.9 HAN Device shall provide access control methods which prevent known attacks, including replay, man-in-the-middle, delay, spoofing, sequence change, and deletion attacks.

Security.Access.10 HAN Device shall implement mechanisms to prevent unintended disclosure of source/originator data to unauthorized principals.

Security.Access.11 HAN Device shall implement controls which limit access to audit information.

Security.Access.12 HAN Device shall support confidentiality and access controls that employ cryptographic operations (e.g., digital signatures).

Security.Access.13 HAN Device shall support confidentiality and access controls that employ cryptographic keys (e.g., encryption authentication, or digital signatures).

3.5.2 Integrity

The integrity security service addresses prevention of unauthorized modification of data (both stored and communicated). Modification of both stored and communicated data may include changes, insertions, deletions or duplications. Additional potential modifications that may result when data is exposed to communications channels include sequence changes. The integrity service also addresses the problem of ensuring that communicating components can correctly identify those that they are communicating with.

Requirements:

Security.Integrity.1 HAN Device shall protect the integrity of the HAN system (e.g., shall not adversely impact the operations of the HAN system by introducing malicious or unintended activity).

Security.Integrity.2 Energy Services Interface shall provide a configurable HAN filtering function that filters based on allowable message types.

Security.Integrity.3 Energy Services Interface shall provide a configurable HAN filtering function that filters messages based on structural integrity of the message.

Security.Integrity.4 Energy Services Interface shall provide a configurable HAN filtering function that filters based on allowable message rates.

Security.Integrity.5 HAN Device shall detect unauthorized modification of security-related data during storage.

Security.Integrity.6 HAN Device shall detect unauthorized modification of data during network transit (e.g., check sums and hashes).

Security.Integrity.7 HAN Device shall detect unauthorized modification of data attributes (e.g., modification to a message type).

Security.Integrity.8 HAN Device shall attempt to correct unauthorized modification of data attributes (e.g., NAK, resend).

Security.Integrity.9 HAN Device shall only accept data from an authorized, trusted source (e.g., Energy Services Interface, certified EMS).

Security.Integrity.10 HAN Device shall protect the HAN from malicious code (e.g., buffer overflow protection, limit executable code exposure).

Security.Integrity.11 HAN Device shall separate security critical functionality and data from non-security critical system data.

Security.Integrity.12 HAN Device shall validate the source of HAN security policy.

Security.Integrity.13 HAN Device shall detect unauthorized modification of HAN security policy.

Security.Integrity.14 HAN Device shall detect unauthorized modification of audit data.

Security.Integrity.15 HAN Device shall validate the integrity of all software updates, including source, structure, and version.

Security.Integrity.16 HAN Device shall use tamper-resistant hardware (e.g., epoxy, TPM).

3.5.3 Accountability

Accountability can be considered a special type of non-repudiation. The accountability security service holds each network entity responsible for its actions on that network.

Audit functionality is a critical element of the layered defense strategy for a system. Audit contributes to user and device accountability by recording security critical user actions while using HAN services. Audit also contributes to domain boundary enforcement services by recording activities of HAN services related to proper operation of security critical functions. In addition to auditing users and system activities, the accountability security service must be able to monitor the status of audit data to ensure its integrity and accuracy.

Requirements:

Security.Account.1 HAN Device shall alert the Energy Services Interface of all detected, security-related activities, including access control, authentication, and integrity violations.

Security.Account.2 HAN Device shall audit and store all security-related activities, including access control violations, authentication activities, etc.

Security.Account.3 HAN Device shall provide, at a minimum, the following information for all detected security events: date and time of the event, type of event, device/user identity.

Security.Account.4 HAN Device shall provide the AMI System access to audit data.

Security.Account.5 Energy Services Interface shall provide non-repudiation mechanisms for devices and users.

Security.Account.6 Energy Services Interface shall provide a mechanism for source identification of data (e.g., HAN and AMI System data).

Security.Account.7 Energy Services Interface shall provide the capability to audit both system and user operations as defined by the HAN security policy.

Security.Account.8 HAN Device shall provide the ability to perform searches, sorts and filters of audit data based on date and time, type and/or user identity.

Security.Account.9 HAN Device shall provide the capability to identify mandatory and configurable audit elements (In this context, mandatory refers to audit elements which are always enabled and configurable refers to audit elements which can be enabled or disabled at the discretion of the Consumer or Utility).

3.5.4 Registration

The registration and authenticating requirements are used in conjunction with most other security services. The first step of most security services is to determine the identities of one or more of the parties participating in an action. A trusted identity must be used for access control decisions and to provide accountability evidence. Knowing the identity of an entity and the existence of a peer relationship is also fundamental to establishing communication with confidentiality and integrity. If the identity of the peer in a secure communications path is not properly established, it leaves open the possibility that an unauthorized principal (an adversary) could masquerade as an authorized principal, exposing the data to disclosure or manipulation.

Requirements:

Security.Reg.1 HAN Device shall support mutual authentication.

Security.Reg.2 HAN Device shall authenticate the source of all control signals.

Security.Reg.3 HAN Device shall provide a mechanism which allows for multiple and configurable authentication materials (e.g., device ID, device type, key, serial key, Utility ID, and device configuration).

Security.Reg.4 HAN Device shall be configured with Utility-approved or -provided authentication materials (e.g., certificate, key).

Security.Reg.5 HAN Device shall not send authentication materials over the network in an insecure fashion (e.g., do not transmit passwords or keys in the clear).

Security.Reg.6 HAN Device shall be compatible with a Utility-defined registration process.

Security.Reg.7 HAN Device shall provide a means to update (i.e., change, reconstitute, rollover) authentication materials.

Security.Reg.8 Energy Services Interface shall allow registration revocation for connected HAN Devices.

Security.Reg.9 Energy Services Interface shall support a configurable registration and expiration period (e.g., registration timeout, registration persistence).

Security.Reg.10 HAN Device shall use security services (i.e., cryptographic services) which are either FIPS-approved or NIST-recommended.

Security.Reg.11 HAN Device shall support a registration method that employs cryptographic operations (e.g., digital signatures).

Security.Reg.12 Energy Services Interface shall provide an authentication mechanism which proxies for the AMI System (e.g., negotiates on behalf of the Utility).

Security.Reg.13 HAN Device shall provide notification to the Installer of the registration status. Status conveyed shall be either: registered/not registered.

3.6 Performance Requirements

The OpenHAN performance requirements are intended to maintain the quality of the Utility to HAN communications over the short and long term.

Performance requirements are designed to insure HAN applications and devices are:

- consistently reachable,
- designed and manufactured to be durable and resilient,
- easy to diagnose and manage,
- expandable to support future growth,
- remotely upgradeable (e.g., patches, updates, enhancements) without a field visit, and
- performing as advertised (i.e., quality).

Requirements:

Perf.1 HAN Device shall supply functionality that maintains communications availability to the Energy Services Interface.

Perf.2 HAN Device shall supply functionality that maintains application availability to the AMI System (e.g., software/hardware application watchdog).

Perf.3 After loss of power, HAN Device shall return to its post-configuration state (i.e., shall persist communication and registration configurations).

Perf.4 HAN Device shall supply adequate computational performance (i.e., Device shall not hamper overall operational state of the HAN)

Perf.5 HAN Device shall supply adequate communications performance (e.g., bandwidth and throughput).

Perf.6 HAN Device shall supply accurate time keeping and counter functions.

Perf.7 HAN Device shall not act on expired signals (e.g., message validity duration or sequence).

Perf.8 HAN Device shall provide configurable communications such that system is scalable (e.g., heartbeat and request frequency).

Perf.9 For battery-powered HAN Devices, HAN Device shall function for a minimum of 1 year without requiring replacement of the battery.

Perf.10 HAN Device shall supply a field-programmable software upgrade function (i.e., firmware upgrade).

Perf.11 HAN Device shall supply a remote software upgrade function (i.e., firmware upgrade).

Perf.12 HAN Device shall meet the quality, interoperability, and testing (i.e., certification) requirements of its respective technology platform body.

Perf.13 HAN Device shall accept network time synchronization from the Energy Services Interface

Perf.14 Energy Services Interface shall accept time synchronization from a Utility-approved source.

3.7 Operations, Maintenance, and Logistics Requirements

OpenHAN requirements for operations, maintenance, and logistics speak to supply chain standards for HAN Devices, including manufacturing, configuring, labeling, and packaging as well as standards for installation assistance, user manuals, online support, and device self-testing and troubleshooting.

3.7.1 Manufacturing and Distribution

These requirements speak to a vendor's pre-installation activities, including manufacture, depot, distribution, and point-of-sale. The goal of these requirements is to clearly establish responsibilities and enable the widest diversity of supply chain options for Utilities and their customers.

Requirements:

OML.ManuDist.1 Prior to installation (e.g., factory, depot), HAN Device shall support placement of commissioning data (e.g., pre-placed device credentials).

OML.ManuDist.2 Prior to installation (e.g., factory, depot), HAN Device shall support placement of registration data (e.g., pre-placed registration credentials).

OML.ManuDist.3 HAN device shall support pre-placed methods or materials that support commissioning and registration by multiple Utilities (does not imply simultaneous Utility registration).

OML.ManuDist.4 HAN Device shall support pre-placement of application-specific configurations (e.g., cost, consumption, environmental impact, configurable time/rate intervals).

OML.ManuDist.5 HAN Device shall have and display appropriate certification (e.g., electrical, safety, and communications requirements) on its packaging or body.

OML.ManuDist.6 HAN Device shall have and display appropriate commissioning and registration information on its packaging and body (e.g., serial number, registration code).

OML.ManuDist.7 HAN Device shall display Utility compatibility guidance to verify that a HAN Device is compatible with a particular AMI system on its packaging.

OML.ManuDist.8 HAN Device shall display its HAN network technology compatibility on its outside packaging and body.

OML.ManuDist.9 HAN Device shall display UtilityAMI compliance on its packaging.

OML.ManuDist.10 HAN Device shall display Enhanced UtilityAMI compliance on its packaging.

OML.ManuDist.11 HAN device shall display, on its packaging, any secondary device requirements (e.g., required EMS, bridge device).

OML.ManuDist.12 HAN Device shall be manufactured to support multiple distribution channels (e.g., retail, direct Utility).

3.7.2 Installation

These requirements speak to vendor responsibilities in support of physical placement of the HAN Device. The goal of these requirements is to ensure a smooth installation process regardless of the Installer with a minimum need for Consumer support from the Manufacturer and the Utility.

Requirements:

OML.Install.1 HAN Device Manufacturer shall include installation documentation that includes instructions for installation (e.g., placement), commissioning, and registration, including any external dependencies.

OML.Install.2 HAN Device Manufacturer shall include a HAN Device user's manual in the Device packaging.

OML.Install.3 HAN Device Manufacturer shall include Manufacturer contact information in the Device packaging.

OML.Install.4 HAN Device Manufacturer shall supply technical support services (e.g., help desk, web site).

3.7.3 Manage, Maintain

These requirements speak to vendor responsibilities for customer support. They ensure HAN Devices enable diagnostic, management, and troubleshooting capabilities. The goal of these requirements is to grant Utilities the ability to remotely resolve problems with HAN Devices to quickly determine whether a customer needs to contact the Manufacturer's customer support for further assistance.

Requirements:

OML.Maintain.1 HAN Device shall have a self-check (initialization) function that notifies the Installer the HAN Device is functioning properly.

OML.Maintain.2 Energy Services Interface shall have a configurable ability to log all AMI System-to-HAN System communications.

OML.Maintain.3 When the HAN Device is rebooted, HAN device shall reset to its configured (i.e., post-installation commissioning and registration) state and shall reestablish communication with the Energy Services Interface.

OML.Maintain.4 HAN Device shall have a user-operable testing function that is equivalent to the self-testing function.

OML.Maintain.5 HAN Device shall supply a maintenance port for field diagnostics.

OML.Maintain.6 HAN Device shall simulate Utility events for diagnostic purposes.

OML.Maintain.7 HAN Device shall supply network management functions for diagnostic purposes.

OML.Maintain.8 For battery-powered devices, HAN Device shall communicate low battery state to the AMI System.

OML.Maintain.9 HAN Device Manufacturer shall supply and support a flaw remediation process.

OML.Maintain.10 HAN Device shall support a communications feedback mechanism (i.e., ping).

4. Appendices

4.1 UtilityAMI OpenHAN Task Force Use Cases

4.1.1 Introduction

The UtilityAMI OpenHAN Task Force developed these Use Cases as a way to bound the development of the system decomposition and requirements. They are written at a very high level and are by no means comprehensive. They are highly dependent on other utility back office systems and processes that are assumed to exist and be in place. Each utility looking to implement a HAN will want to expand upon these Use Cases.

4.1.1.1 Scope

The scope of the Use Cases is to define and limit the use case scenarios between the Utility AMI Network and the HAN.

4.1.1.2 Methodology

These Use Cases focus on functional capabilities rather than device-specific capabilities. Use case actors and scenarios may refer to a device, but the working group generally strove to describe the use case by its function.

4.1.1.3 Use Case Categories

Use cases are broken into four general use case categories:

- Load (kW) and Energy (kWh) Management
    - Voluntary Load Reduction
    - Mandatory Load Reduction
    - Energy Management System
- User Information
    - Complex Interactive
    - Simple One-way
- In-premise Metering
    - Energy Storage and Generation
    - Fixed HAN Device with Metering Capability
    - Mobile HAN Device with Metering Capability
- System Configuration and Management
    - HAN Installation & Commissioning

- HAN Utility Registration (e.g. application/devices)
- HAN Device Remote Diagnostics and Troubleshooting
- HAN Device Diagnostics and Maintenance
- HAN Device Depot Configuration (optional)

4.1.1.4 Use Case Template

The template for Use Cases is as follows:

- Use Case Title
- Use Case Description
- Use Case Business Rules and Assumptions
- Use Case Scenarios (sequenced)

4.1.2 Definitions / Assumptions / Actors

Actor Name	**Actor Type**
Consumer	Person
HAN Devices	Devices
AMI	System
Metering System	System
Energy Services Interface (ESI)	Device
Customer Service System (CSS)	System
AMI and/or HAN Trust Center	System
Automated Data Collection System	System
Utility HAN	Devices
Consumer HAN	Devices
Pool Pump Controller	Devices
Customer Representative	Person or System
HAN Device Registration Application	Application
In-Home Display (IHD)	Device

Energy Management System (EMS)	Application

4.1.3 Use Case Assumptions

This section documents the assumptions on which the Use Cases are based. It will be helpful to refer back to these throughout the rest of the specification.

1. The Utility AMI-to-HAN interface exists.
2. All communications between the Utility AMI network and HAN Devices pass through the ESI.
3. A process exists to connect/bind the Consumer's HAN Devices to the ESI.
4. HAN communications are limited to the Consumer's HAN Devices connected and bound to the ESI.
5. HAN Devices have been safety tested and are approved by a well recognized test facility (Manufacturers to determine).
6. HAN Devices comply with all applicable regional regulatory requirements (e.g., electrical, safety, and communications requirements).
7. Additional certifications may be needed based on geographic and political boundaries.
8. The original equipment manufacturer will provide operating manuals and technical support for HAN Devices to the end-use Consumer. This includes installing, operating, and troubleshooting materials.
9. If net metering, the premise's electric panel upgrade has occurred and the electrical circuits and wiring can handle the discharging process.
10. For Mobile HAN Devices with Metering Capability (e.g., EV/PHEV), the vehicle has some onboard intelligence and communication capability.
11. Consumers can override a non-emergency curtailment request (e.g., pricing events).
12. Non-Interoperable HAN Devices will not participate in Utility-sponsored rates and programs.
13. In order for Consumer HAN Devices to communicate with the Utility's AMI network, suitable and appropriate security methods (including privacy protection) and capabilities within the AMI and HAN devices are implemented.
14. The UtilityAMI 2008 HAN SRS requirements apply to all Consumers, specifically to those under 200kW in demand.
15. The ISO (i.e., transmission operator) and Utility have determined that demand response programs and events (e.g., Critical Peak Pricing) are necessary for grid management.
16. Load control device(s) at the Consumer site will take action based on price or specific event (dependent on presence of the control devices and compliance with Utility requirements).
17. The Consumer shall have the ability to pre-program the load control device at their site to respond to event messages and/or pricing.
18. Consumers must be enrolled in a demand response program to enable communications between the Utility and the Consumer's HAN Devices.

19. Consumers may, but do not have to, negotiate another communication method (e.g., Internet) for price, consumption, load, event messages between their HAN devices and the Utility.
20. Consumers will have the choice of which HAN Devices participate in any offered demand response program (subject to technical conformance with the offered demand response program from the Utility). For example, the Consumer may have door open/close sensors attached to the same HAN as their lights and thermostat but may choose to only enroll the lights and thermostat in the demand response program.
21. If a HAN Device requires registration with the Utility, the device is expected to contain volatile and non-volatile memory. A portion of the non-volatile memory will retain registration information in case there is a loss of power. Once power and communication is restored to the device, it will automatically re-register itself based upon the last known "good" registration.
22. The HAN Device is compatible and able to interoperate with the Utility's AMI system.
23. The AMI System supports meter device-specific, Consumer-specific and location-specific rates/billing. (e.g., Electric Vehicle (EV), Plug-In Hybrid-Electric Vehicle (PHEV)).
24. Display options are supported as required for the specific application including, but not limited to, display of Utility-provided data.
25. FHDMC have a certification process for meter accuracy as required by the Utility or jurisdiction.
26. FHDMC may supply capabilities beyond basic metering (e.g., measurement, monitoring, and device state information).
27. AMI System may provide data to the FHDMC.
28. MHDMC has a certification process for meter accuracy as required by the Utility or jurisdiction.
29. The MHDMC and premise are properly authorized to operate within the jurisdiction and Utility.
30. AMI System may provide data to the MHDMC.
31. MHDMC records bi-directional MHDMC usage for audit purposes.
32. Any required installation will meet the appropriate building and safety codes.
33. Individual Utility providers may only require a subset or additional requirements from those provided in this document.
34. This is not a static document and the list of requirements may be updated from time to time.
35. Specific examples given in the document are exactly that. Innovation in the market place is always encouraged.
36. While specific requirements may not be economically appropriate in today's market, it is assumed that these will become more viable over time as technology and availability improve.

4.1.4 Load and Energy Management

4.1.4.1 Voluntary Use Case for Registered HAN Devices

Description

A major benefit of the AMI System is that it supports Consumer awareness of his instantaneous kWh electricity pricing, consumption, projected costs, rate tiers, and voluntary load reduction program events, and it can support the Utilities in the achievement of load reduction needs. As Utilities see increased electricity demand on the grid, energy shortages may result, therefore triggering the need for Utilities to reduce energy consumption in support of grid stability. The AMI System will help facilitate load reduction at the consumer's site by communicating instantaneous kWh pricing and voluntary load reduction program events to the Consumer and to various enabling devices connected to the ESI, each of which contains the requisite AMI-specific functionality at the Consumer's site. Voluntary load reduction events may be scheduled with a large amount of advanced notice (24 hrs) or near real-time. For the Utility to receive the desired Consumer response, it must provide timely pricing, event, and usage information.

Related to this scenario is the measurement of the response to financial incentives, energy price adjustments, and other voluntary demand response programs. The Consumer responses will be used to determine how and/or if Consumers have responded to a pricing event, if the Utility needs to launch other demand response events to achieve the needed demand reduction, and help the Utility determine how to structure future voluntary load reduction programs, to ensure the Utility receives the best Consumer response.

This scenario includes the actual mechanism to distribute price signals and voluntary load reduction events to Consumers (direct electronic delivery to the Consumer meter or display device within the home/business, automated telephone calls, e-mail, pager, commercial broadcast radio, newspapers, etc.). It includes the mechanism by which the HAN will display current pricing and voluntary load reduction event information within the consumer's home/business. The AMI System will initiate automatic load reduction at the Consumer's premise by communicating event and pricing information to Consumer HAN Devices, which will take action based on the Consumer's predefined settings. The Consumer will be able to program their load control specifications and refuse Utility load reduction requests. The Consumer will also be able to manually curtail load based upon informational messages communicated to them through the AMI System.

This scenario also includes the actual Home Area Network functionality for Consumer HAN Devices and describes the scenario for separate HAN Devices classes and AMI-related behavior of the HAN Devices.

Troubleshooting for installation, registration, and event failure should refer to the *HAN Use Case – Maintenance*

Use Case Business Rules and Assumptions

- If the HAN Device offers a display, it is capable of displaying actual price of power for a unit of time and/or providing an indication of relative price (e.g., low, medium, high, critical).
- The HAN Device is capable of differentiating between emergency/reliability and/or price-response event signals.
- If the HAN Device offers a display, it is able to display messages comprised of alphanumeric characters, as delivered or triggered remotely from the AMI System.
- Certain HAN Devices can distinguish or support various event types and take appropriate action based on the event.
- HAN Devices do not need to register with the Utility AMI system to obtain Utility messaging (e.g., price or event signals). However, the Consumer must enroll in a demand response program or tariff and must register the HAN Device with the Utility for the HAN Device to confirm its successful actuation of the event.

Use Case Scenario

Utility initiates a voluntary demand response event (e.g., Critical Peak Pricing Event).

Triggering Event	Primary Actor	Pre-Condition	Post-Condition
The Utility determines the need for a demand response event.	HAN Device	The Installation Use Cases are successfully completed. The Registration Use Cases are successfully completed. The ESI has either been pre-programmed to respond appropriately to price, consumption, load or event messages and/or the Consumer has manually programmed or used the ESI to program the HAN Device.	The Consumer will have been notified of an event, the event will have been autonomously launched by the AMI System, the HAN Devices will have actuated and the event will have ended and the Consumer equipment returned to its original state.

Steps for this scenario

These steps apply for both event actuation and restoration to initial HAN Device state.

Step #	Actor	Description of the Step
1	AMI System	AMI System sends a message to the Consumer's display device and/or control equipment, via ESI for Consumer viewing, that an event start time has arrived.
2	ESI/HAN Devices	The Consumer's HAN Device receives the message, update the event status (e.g. to active) and the HAN Device will take Consumer preprogrammed action (e.g. raise thermostat by 4 degrees, lower thermostat to original state) reacting to pricing and/or event type.
3	Consumer	Consumer may choose not to participate in economic or pricing event. Consumer overrides the automatic HAN Device actuation sequence.
4	ESI/HAN Devices	The Consumer's HAN Device may send a receipt that it received the event message to AMI (dependent on type of Consumer equipment), via the ESI. If a message is sent to the ESI by the HAN Device, the message includes the device ID, message received date/time (in UTC time) by the display/control equipment and action taken (e.g. receive event info, raised thermostat by 4 degrees, A/C off) and date/time action taken. The HAN Device may also log events for future Consumer analysis and audit or send events to a different HAN Device to log events. If the Consumer overrode the event, the message will signify message received but overridden by Consumer.
5	Utility	Curtailment period ends and ESI sends the command to restore HAN Devices to previous state.
6	HAN Devices	HAN Devices may restore load on a random restoration schedule so as to create minimal impact to the distribution system.
7	HAN Devices	HAN Devices respond back to the ESI confirming the receipt of event end notification.

4.1.4.2 Mandatory Use Case

Description

The mandatory load and energy management use case refers to demand response resources dispatched for reliability purposes. These events are mandatory due to the potential of the demand for power exceeding supply as a result of unexpected power plants going offline or congestion in transmission and/or distribution lines. The Consumer may be (1) enrolled in, or (2) as condition of service, be defaulted on a mandatory demand response program used for grid management. For voluntary enrollment in a Utility's program, the Consumer is generally compensated with a credit on her monthly bill.

Control of a Consumer's HVAC can be accomplished via a Utility-AMI OpenHAN-compliant PCT as the HAN Device. Other HAN Devices may include an EMS, a pool pump switch, A/C switch, or even a passive device (one that does not actually shed load) such as an IHD that warns of potential power shortages in the near future or a load shed event in progress. The PCT may act as both a load shedding and passive/informational device. The ESI will forward curtailment messages to the HAN Device(s) capable of receiving this. Upon receipt and successful execution of the load shed, the HAN Device(s) may return an acknowledgement back to the ESI, including logging and device status.

Mandatory/emergency load and energy management events may not allow Consumers the option to override the load shed request. The Utility relies on firm load shed to avert rotating outages. Giving Consumers the option to override a mandatory load shed request increases the possibility a complete power outage. For public safety purposes, the Utility must be able to immediately remove a Consumer off the program due to a medical emergency and restore operation to the HVAC as soon as possible.

The Utility will be informed by at least two levels of advanced warning:

- Long term (24 hours) and short term (few hours notice) predicted energy shortages
- Emergency shortage (few minutes notice)

The following is a list of use case scenarios:

1. Predicted mandatory load curtailment for grid management – Warnings are issued for possible electrical system overload or potential lack of generation resources.
2. Consumer requests an immediate opt-off due to a medical emergency.

Use Case Business Rules and Assumptions

- Medical Opt-out devices are pre-registered or may register upon Consumer contacting the Utility to exclude their HAN device from mandatory events.

Use Case Scenarios

Scenario 1

Utility initiates a mandatory demand response event due to a possible electrical system overload or potential generation/demand imbalance. Warnings issued to Consumers are optional.

Triggering Event	Primary Actor	Pre-Condition	Post-Condition
The Utility determines the need for a demand response event.	HAN Device	The Installation Use Cases are successfully completed. The Registration Use Cases are successfully completed. The HAN Device has been programmed by the Utility to shed load on command.	The Consumer may have been notified of an event, the event will have been autonomously launched by the AMI System, the HAN Devices will have actuated and the event will have ended and the Consumer equipment returned to its original state.

Steps for this scenario

These steps apply for both event actuation and restoration to initial HAN Device state.

Step #	Actor	Description of the Step
1a	Utility	Utility anticipates the need to dispatch a mandatory curtailment program.
1b	Utility	Utility anticipates the need to dispatch a mandatory curtailment program and sends a warning message to the Consumer.
2	HAN Devices	HAN Devices receive the warning message that a mandatory event occurred and displays the appropriate message (e.g., lights the appropriate LED) (** optional step **)

Step #	Actor	Description of the Step
3	Utility	Utility sends a mandatory load shed message.
4	HAN Devices	HAN Devices receive the mandatory load shed notification of the scheduled curtailment.
5	HAN Devices	Han Devices enter appropriate “off” and/or “energy minimum” state(s).
6	HAN Devices	HAN Devices respond back to the ESI, confirming the receipt of the mandatory load shed notification.
7	Utility	Curtailment period ends and ESI sends the command to restore HAN Devices to previous state.
8	HAN Devices	HAN Devices restore load on a random restoration schedule so as to create minimal impact to the distribution system.
9	HAN Devices	HAN Devices respond back to the ESI, confirming the receipt of event end notification.

Scenario 2

Utility initiates a mandatory demand response event due to a possible electrical system overload or potential lack of generation resources. Consumer calls the Utility to opt-off the program due to a medical emergency.

Triggering Event	Primary Actor	Pre-Condition	Post-Condition
The Utility determines the need for a demand response event.	HAN Device	The Installation Use Cases are successfully completed. The Registration Use Cases are successfully completed. The HAN Device has been programmed by the Utility to shed load on command.	The Consumer is opted-off the program and device being controlled by the HAN Device is restored to the initial state.

Steps for this scenario

These steps apply for both event actuation and opting the Consumer off the program.

Step #	Actor	Description of the Step
1	HAN Devices	HAN Devices receive the notification from the Utility Services Interface to start the curtailment.
2	HAN Devices	HAN Devices enter appropriate “off” and/or “energy minimum” state(s).
3	HAN Devices	HAN Devices respond back to the ESI, confirming the receipt of the mandatory load shed notification.
4	Consumer	Consumer contacts the Utility to restore load.
5	Utility	Utility sends the message to deregister and restore load to the appropriate HAN Devices.
6	HAN Devices	HAN Devices immediately restore load.
7	HAN Devices	HAN Devices respond back to the Utility, confirming the device has received the command to deregister and load is restored.
8	HAN Devices	HAN Devices un-enroll from mandatory load and energy management program.

4.1.5 Energy Management System

Description

Energy Management System (EMS) integrates with the respective HAN, and the Utility AMI System, and responds to commands to drop load for grid reliability, price responsive programs.

Use Case Business Rules and Assumptions

- The EMS is aware of or can retrieve the types of HAN Devices and the status of those devices connected to the HAN upon registration or change-out. (e.g., fridge on/off).
- EMS controls production, consumption, and storage within the HAN (e.g., Controls charging/discharging of an Electric Vehicle).
- The EMS can be pre-programmed to respond to Utility signals and commands (e.g., reliability event).
- Use case does not imply the Utility’s preferred configuration or communication for reliability programs (e.g., Utility may still require HAN device registration).

Use Case Scenario

Utility calls a demand response event and controls load by communicating with the EMS through the ESI.

Triggering Event	Primary Actor	Pre-Condition	Post-Condition
The Utility determines the need for a demand response event.	EMS	The Installation Use Cases are successfully completed. The Registration Use Cases are successfully completed.	EMS curtails load until event is concluded.

Steps for this scenario

Step #	Actor	Description of the Step
1	Utility	Utility sends notification of event and for price response case, the appropriate pricing information to the EMS.
2	EMS	The EMS sends a signal to all connected HAN devices and attempts to control consumption or production.
3	EMS	The EMS responds back with an acknowledgment message (e.g., Consumer override, load successfully dropped by x%, etc) to the ESI.
4	AMI System	The AMI System sends a restore signal to the ESI upon conclusion of the event.
5	EMS	The EMS is restored to the pre-event state.

4.1.6 User Information

Consumer receives Utility initiated messages and electric usage updates via an In Home Display (IHD)

Description

An IHD integrates with the respective HAN and the Utility AMI System and provides usage information and Utility-initiated messages to the Consumer.

Use Case Scenarios

A simple IHD provides basic display of Utility-generated price and Consumer-specific usage information

Triggering Event	Primary Actor	Pre-Condition	Post-Condition
Consumer obtains IHD.	Consumer	The Installation Use Cases are successfully completed. The Registration Use Cases are successfully completed Installer installs IHD in the premise The IHD has either been pre-programmed to respond appropriately to price, consumption, load or event messages and/or the Consumer has manually programmed the IHD.	none

Steps for this scenario

Step #	Actor	Description of the Step
1	IHD	The IHD indicates the status of the communication link with the ESI.
2	IHD	Displays Utility-generated messages. (e.g. emergency event)
3	IHD	The registered IHD requests Consumer-specific data (e.g., demand, electric energy usage) from the ESI.
4	ESI	ESI provides usage data as requested. (e.g., demand (watts) every 6 seconds)

4.1.7 Energy Storage and Generation

Consumer uses a storage or generation unit to provide energy to their home or the grid.

Description

The Energy Supplying Unit (ESU) connects with the premise HAN, the ESI, and the electric system (home, vendor, or Utility's). The ESU identifies itself and the account it is associated with, and provides energy to the home or grid. This use case also describes the scenarios documented in *The Sub Metering Use Case* and *The Load and Energy Management Use Cases*, in that the ESU behaves according to these use cases.

Use Case Business Rules and Assumptions

- Energy Supplying Unit (ESU) already contains energy.
- All Utility safety measures and rules are in place to provide power to the grid.

Use Case Scenario

The following scenario addresses storage and generation for the purpose of providing energy to the home or grid.

Triggering Event	Primary Actor	Pre-Condition	Post-Condition
Incentives or Utility requirements are in place for providing energy to the home or grid.	ESU	The Installation Use Cases are successfully completed. The Registration Use Cases are successfully completed. Units are transfer ready and properly connected.	Energy is successfully transferred.

Steps for this scenario

Step #	Actor	Description of the Step
1	EMS, ESI, other entity, ESU (Consumer acts on EMS or ESU)	Signals ESU to transfer energy.
2	ESU	Performs a self-check for sufficient capacity and generation readiness.
3	ESU	Transfers energy.
4	EMS, ESI, other entity, ESU (Consumer acts on EMS or ESU)	Signals to end transfer event. (e.g., due to drop in price, inadequate energy availability, Consumer preference, or Utility preference)
5	ESU	Ceases transfer of energy.

4.1.8 Fixed HAN Devices with Metering Capability

Description

The FHDMC connects with the premise HAN and identifies itself and the account it is properly associated with to the Utility, where premise owner's charges are reconciled. This use case also describes the scenario documented in *The Load and Energy Management Use Cases*, in that the FHDMC may behave according to that use case. The following scenario is defined: bi-directional metering (i.e., distributed generation) and third-party (i.e., gas meter).

Use Case Scenario

The following scenario addresses FHDMC, where bi-directional electric and third-party metering takes place.

Triggering Event	Primary Actor	Pre-Condition	Post-Condition
FHDMC is connected and enabled	FHDMC	The Installation Use Cases are successfully completed. The Registration Use Cases are successfully completed.	Device owner meters the device and gets billed for the appropriate amount on their electricity bill or other third-party bill.

Steps for this scenario

Step #	Actor	Description of the Step
1	FHDMC	Device indicates positive status of the communication link with the appropriate ESI.
2	FHDMC	Device provides the Consumer (end user) with the appropriate information. (e.g. current rate of consumption, etc)
3	FHDMC	Device accumulates usage (delivered or received) and returns the information to the ESI.
4	FHDMC	(optional) The device provides the ESI with additional state information if applicable (e.g. state of charge of a storage device).

4.1.9 Mobile HAN Device with Metering Capability

Description

The MHDMC connects with the premise Home Area Network (HAN), identifies itself and the account it is properly associated with the Utility. MHDMC's and premise owner's charges are reconciled, as applicable. This use case also describes the scenario documented in *The Load and Energy Management Use Cases*, in that the MHDMC may behave according to that use case. The mobile (e.g. any Consumer PHEV/EV) scenario is defined in this document.

Use Case Scenario

The following scenario addresses MHDMC, where bi-directional electric metering takes place.

Triggering Event	Primary Actor	Pre-Condition	Post-Condition
MHDMC is connected and enabled temporarily	MHDMC	The Installation Use Cases are successfully completed. The Registration Use Cases are successfully completed.	MHDMC owner and premise owner bills are properly reconciled.

Steps for this scenario

Step #	Actor	Description of the Step
1	MHDMC	Device indicates positive status of the communication link with the appropriate ESI.
2	MHDMC	(optional) Device provides the Consumer (end user) with the appropriate information. (e.g., percentage of charge, current rate of consumption, etc)
3	MHDMC	Device indicates to the user whether the MHDMC is recognized by the Utility (i.e., for billing purposes)

Step #	Actor	Description of the Step
4	MHDMC	Device accumulates usage (delivered or received) and returns the information to the ESI.
5	MHDMC	(optional) The device provides the ESI with additional state information if applicable (e.g., state of charge of a storage device).

4.1.10 System Configuration and Management

4.1.10.1 HAN Installation and Commissioning

Description

The installation and commissioning use cases covers the activities associated with physical installation and the admission to the local HAN. Admission to the local network establishes the communication path to the ESI. This interface can then be used to register devices with the Utility. This implies that the registration and commissioning processes are actually discrete operations.

Devices that are commissioned have the ability to receive public information from the ESI but do not have the ability to communicate with the Utility. Utility communication requires registration.

This use case covers all HAN Devices including, but not limited to, EV/PHEV, PCT, pool pump switch, EMS, etc. Premise commissioning ignores mobility related functions (e.g., PHEV moving from premise to premise). That is, Mobility is an aspect of registration.

The Installer may perform other diagnostics that the meter and HAN Devices cannot perform by itself. These steps are specific to the underlying technology and not covered in the high level use of the system.

It is important to note this Use Case covers all the staging scenarios, including Utility HAN Devices (e.g., PCT), Utility delivers additional HAN Devices and attaches to the existing Consumer HAN Devices at time of meter installation, and Consumer connects HAN Devices to the ESI after Utility installation of an AMI System.

Use Case Business Rules and Assumptions

- For control devices, device is installed in-line at the appropriate control point (e.g., in series with the information or energy flow).
- All appropriate safety precautions are taken (e.g., qualified electrician is required for certain installation routines).
- Devices and applications are procured or provided through multiple distribution channels (e.g., retail, Utility-provided, etc.).
- Devices meet all applicable electrical, safety, and communications laws.
- Pre-commissioning routines have been successfully executed (e.g., pre-placed network key has been loaded).

Use Case Scenario

Triggering Event	Primary Actor	Pre-Condition	Post-Condition
Consumer takes position of HAN device.	Consumer or Installer	ESI with two-way communications capability is present.	The Consumer device has been added to the local network and has established communications with the ESI (i.e., the HAN has been established).

Step	Actor	Description of the Step	Additional Notes
1	Consumer or Installer	Installer locates appropriate installation point.	Appropriate installation point considerations includes: signal strength at location, appropriate control point, etc.)
2	Consumer or Installer	Device is installed.	Installation includes removing previous equipment and connecting the device to external power (if necessary)

Step	Actor	Description of the Step	Additional Notes
3	HAN Device	HAN Device performs self-check and reports results to installer.	In certain installation instances, a filed tool can assist in the device initialization and configuration.
4	Consumer of Installer	Installer inputs any required pre-commissioning materials (e.g., physical location, LAT/LONG, etc),	
5	Consumer or Installer	Installer enters commissioning data (e.g., network key) or performs any necessary commissioning actions (e.g., proximity)	
6	HAN Device	HAN Device notifies the ESI or other network coordinator.	This process is part of the technology-specific beaconing and discovery process. If a third-party device performs the actual commissioning, then the ESI needs to be notified through a separate process.
7	ESI	ESI acknowledges notification and authenticates network credentials	
8	ESI	Sends HAN Device any necessary configuration data (e.g., preferred communication paths, updates, etc.)	
9	ESI	Device is added to the network. The device is added to the list of registered devices.	
10	HAN Device	HAN device notifies the Installer (successful installation)	
11	ESI	ESI provides registration instruction *Optional*	

4.1.10.2 HAN Utility Registration (e.g. application/devices)

Description

The Registration use case covers device–to-Utility registration. As a prerequisite to the use case, the device has already been commissioned to the local network. Whereas,

the installation and commissioning use case resulted in admission to the local HAN, the registration use case covers the steps necessary admit a device to the Utility AMI network (i.e., the WAN network). This implies the registration is a higher level function.

Form a security point of view, the commissioning establishes directional trust from the device to the ESI. The registration process establishes a directional trust between the ESI and the device. Together, the commissioning and registration use cases establish mutual trust between the HAN Device and the Utility (i.e., mutual authentication)

The Registration use case does not cover details associated with account retrieval, bindings, billings, etc. These back office steps, while necessary, are outside the scope of this activity. Along these lines, mobility related functions associated with devices moving from premise to premise (e.g., PHEV) have special back office accounting requirements. These requirements are not discussed; rather, the registration that all devices have in common are discussed.

Use Case Business Rules and Assumptions

- Command and control communications (e.g., load control) require Utility participation and imply accountability (i.e., require registration).
- Consumer specific communications (e.g., consumer consumption) require Utility participation and imply accountability (i.e., require registration).
- Local HAN commissioning establishes the base communication capability, Utility registration rides on top of this commissioning.

Use Case Scenario

Triggering Event	Primary Actor	Pre-Condition	Post-Condition
The Utility determines the need for authenticated device communications.	HAN Device	The Installation and Network Commissioning Use Cases have been successfully completed.	The Consumer device will be registered with the Utility. All communications with the device will be protected, authenticated and acknowledged.

Steps for this scenario

Step	Actor	Description of the Step	Additional Notes
1	Consumer	Consumer procures or is provided HAN equipment that is compatible with the AMI System.	
2	Consumer	Consumer installs HAN Devices per manufacturer's instructions.	There may be additional commissioning-related steps associated with device commissioning (see Commissioning use case)
3	Consumer	Consumer makes decision to participate in Utility AMI-related programs.	Potential regulatory involvement could force use.
4	Customer Representative	Customer Representative receives notification from Consumer that Consumer is ready to have one (or more) of their HAN Devices connected to the AMI System for program purposes.	This process can be automated through a web based interface. (i.e., the web application is the Customer Representative)
5	Customer Representative	Customer Representative gets appropriate Consumer information (address, verification information, etc) and locates Consumer information from CSS	
6	Customer Representative	Customer Representative activates HAN Device Registration Application.	
7	HAN Device Registration Application	HAN Device Registration Application initiates Utility AMI HAN discovery process which identifies the Consumer's HAN Device.	If this process fails then the device has not been commissioned.
8	Consumer	Consumer provides unique registration information from HAN Device (e.g., registration key, serial number).	
9	Customer Representative	Customer Representative and Consumer determine the appropriate program(s) the Consumer and his HAN Devices will participate in.	This sequencing could occur prior to step 8.

10	HAN Device Registration Application	HAN Device Registration Application attempts to create an authenticated link with HAN Device using registration information.	This step can be staged. Depending on several performance and design constraints the ESI can participate in the registration.
11	HAN Device Registration Application	HAN Device Registration Application sends appropriate registration, configuration, and initiation messages to all applicable HAN and ESI devices.	To reduce AMI load, the meter can be updated and act on behalf of the Utility (e.g., registration materials are pushed down to the ESI)
12	HAN Device(s)	HAN Device(s) acknowledges activation and readiness state(s) to HAN Device Registration Application.	
13	HAN Devices Registration Tool	HAN Device Registration Application communicates all necessary information to CSS and other applicable systems for storage and any required internal registrations	
14	Customer Representative	Customer Representative confirms with the Consumer that HAN Devices have now been initialized into the AMI System and the applicable program(s) are now activated.	

4.1.10.3 HAN Device Remote Diagnostics and Troubleshooting

Description

This use case discusses the scenario associated with remote Utility diagnostics. This use case does not cover all resolution scenarios. Resolution scenarios are specific to the underlying technology and based on warranties, ownership and accountability. These discussions are outside the scope of the base use case.

Use Case Business Rules and Assumptions:

- The scope of Utility responsibility for diagnostics and maintenance is limited.
- Accountability for troubleshooting is driven by several factors not addressed in these use cases.

Use Case Scenario

Triggering Event	Primary Actor	Pre-Condition	Post-Condition
A Utility-configured device fails or does not initialize.	HAN Device	The Installation and Network Commissioning and Registration Use Cases have been successfully completed.	The Consumer device is returned to an operational state.

Steps for this scenario

Step	Actor	Description of the Step	Additional Notes
1	Consumer	Contacts Customer Representative.	
2	Customer Representative	Identifies Consumer (verifies) and records Consumer issue.	
3	Customer Representative	Retrieves Consumer account (e.g., billing data, device registrations, program registrations, etc.)	
4	Customer Representative	Validates account status	
5	Customer Representative	Corrects account or registration information (e.g., updates billing, updates program participation) and ends call.	
5a	Customer Representative	Starts remote diagnostics application.	
6	Remote Diagnostics application	Retrieves device commissioning data from ESI.	
7	Remote Diagnostic Application	Attempts to connect to HAN Device	
8a	Remote Diagnostic Application	Connection successful – commissioning confirmed,	
8b	Remote Diagnostic Application	Connection unsuccessful – repeat installation commissioning use case	
9	Customer Representative	Notifies Consumer that the Utility can or can not communicate with the HAN Device	

10a	Customer Representative	Schedules onsite maintenance	See HAN Device Diagnostics and Maintenance use case
10b	Customer Representative	Starts Registration Diagnostics Application	
10	Remote Diagnostic Application	Check application layer communication (e.g., send registered control signal)	
11	Customer Representative	Notifies the Consumer that the device is functioning or is not functioning correctly	
12a	Customer Representative	Registration communication unsuccessful – execute registration use case	See HAN Device Diagnostics and Maintenance use case
12b	Customer Representative	Schedules onsite maintenance	See HAN Device Diagnostics and Maintenance use case

4.1.10.4 HAN Device Diagnostics and Maintenance

Description

This use case discusses the scenario associated with Utility maintenance and onsite diagnostics. This use cases does not cover all resolution scenarios. Resolution scenarios are specific to the underlying technology and based on warranties, ownership, and accountability. These discussions are outside the scope of the base use case.

Use Case Business Rules and Assumptions

- The scope of Utility responsibility for diagnostics and maintenance is limited.
- Accountability for troubleshooting is driven be several factors not addressed in these use cases.

Use Case Scenario

Triggering Event	Primary Actor	Pre-Condition	Post-Condition
A Utility configured device fails or does not initialize	HAN Device	The Installation/Commissioning and Registration Use Cases have been successfully completed or attempted	The Consumer device is returned to an operational state.

Steps for this scenario

Step	Actor	Description of the Step	Additional Notes
1	HAN Device	HAN Device(s) cannot communicate with AMI System.	
2	HAN Device	HAN Devices notifies installer of communication failure.	
3	Consumer or Installer	Installer or Consumer uses field tool or HAN Device diagnostic capabilities to test network communication.	
4a	Consumer or Installer	Installer validates whether device is faulty.	
4b	Consumer or Installer	Installer validates adequate HAN network connectivity exists.	
5a	Consumer or Installer	Installer replaces HAN Devices, if appropriate.	
5b	Consumer or Installer	Reports marginal coverage if appropriate.	
6	Consumer or Installer	Performs problem and device specific resolution (e.g., installs a bridging device to mitigate poor signal strength, installs a higher power or more capable device, etc.)	

4.1.10.5 HAN Device Depot Configuration (optional)

Description

The device depot configuration use case discusses the steps associates with the preparation of the HAN Device (e.g., required certifications, pre-placed materials, or support modes). The depot (e.g., factory) steps show any necessary Utility to manufacturer interactions.

Use Case Business Rules and Assumptions

- HAN Devices can be configured prior to installation.
- Compliance implies compatibility.

Use Case Scenario

Triggering Event	Primary Actor	Pre-Condition	Post-Condition
A HAN Device has been produced.	Manufacturer	Device supports required configurations and materials.	The HAN device is ready for installation and commissioning.

Steps for this scenario

Step	Actor	Description of the Step	Additional Notes
1	Manufacturer	Checks Utility registration and authentication requirements (UtilityAMI).	
2	Manufacturer	Determines any special destination-specific configurations (Optional)	
3	Manufacturer	Request Utility materials (e.g., Keys, certificates, methods/functions)	
4	Manufacturer	Adds registration specific materials/methods.	
5	Manufacture	Adds appropriate compliance/certification labeling.	
6	Manufacturer	Notifies or provides destination Utility with materials (e.g., keys) (Optional)	

4.2 UtilityAMI OpenHAN Task Force Logical Device Mappings for Utility-Registered Devices

This section maps requirements to logical HAN Devices and should be used as guidance to vendors. The term “logical device mappings for Utility-registered devices” has been chosen carefully to indicate the devices should be thought of as a function rather than as a physical device. This allows vendors to design and build physical “containers” that include one or more logical devices or functions. When reviewing this section, it will be helpful for the reader to think in terms of logical functionality rather than the physical embodiment of the device.

It is hoped this approach will foster innovation with time. The first generation products are likely to be one function per box. Over time, it is hoped that price efficiencies will allow for a physical box to have many functions. These boxes could perform as two or more logical devices or functions. For example:

- A combined PCT and EMS
- EMS and Display integrated into a PC Software Package
- A smart appliance with EMS, PCT and Display capabilities.

Innovation and vendor differentiation are encouraged!

4.2.1 Mapping Introduction

The following letters indicate how the specific requirement maps to a logical device:

- **B or Basic** – Minimum compliance threshold. These are requirements basic to the function or logical device. Logical devices must comply with all basic requirements to be considered UtilityAMI OpenHAN Basic-compliant.

- **E or Enhanced** – Advanced compliance. More sophisticated logical devices shall meet all Enhanced requirements to be considered UtilityAMI OpenHAN Advanced-compliant. Enhanced requirements are meant to drive the marketplace and allow vendors to differentiate themselves through more advanced products.

- **O or Optional** – Suggested requirement; some Utilities may require. These are requirements that are suggested to be included for this logical device. Vendors are encouraged to include optional functionality in a logical device where appropriate or cost effective. It is possible that some Utilities may choose to include these as Basic or Enhanced requirements in their procurements.

- **NA or Not Applicable** - This requirement is not applicable to this logical HAN Device.

By mapping the devices, the UtilityAMI OpenHAN Task Force has provided a template for Utilities to incorporate this material into their procurements in whatever way they deem most useful and relevant. Vendors are also able to plan their product roadmaps and offerings to meet a wide number of Utilities' common requirements for HAN Devices registered on their network regardless of the ownership of the devices.

4.2.1.1 Device Types

The OpenHAN Task Force has limited the scope of HAN Devices to HAN Devices which have Utility applications and therefore must be registered with the Utility and communicate on the Utility-Secured Interactive Interface (refer to Section 2.2 – Architectural Considerations). This list is intended to expand and grow as new classes

of devices and ideas for energy management become available. The logical HAN Devices are described along with their primary functionality in the chart below:

Object	Description	Primary Functionality
Energy Services Interface	The device responsible for providing gateway, bridging, and general AMI connectivity between the Energy Service Provider and the HAN	Network Control and Coordination
PCT	Programmable Communicating Thermostat	HVAC Control
Display	In Home Display, especially of consumer HAN status and electric usage and cost	Energy Information Display
EMS	Energy Management System - Provides premise management of HAN Devices; can proxy for many Utility-registered HAN Device (e.g., not revenue grade HAN Devices); aggregates HAN coordination functions	Premise Control
Load Control	Limits connected electric load based on user-configuration.	Resource Control
HAN Electric Meter	Meter that measures specific electric loads in the premise.	Energy Measurement
HAN Non-Electric Meter	Meter that measures specific non-electric loads/flows in the premise.	Resource Measurement
Smart Appliance	A self-aware appliance that communicates and reacts to Utility and other control signals based on user configuration	Energy Awareness

4.2.1.2 Energy Services Interface

The Energy Services Interface (ESI) is a special class of device. The ESI is network centric and can also be thought of as a gateway. The ESI will provide a secure path between the in-premise HAN and the Utility network. As such, it has additional unique requirements that don't apply to other logical devices. All of these requirements are network related in the areas of:

- Communications
- Network management
- Security
- Performance

The same rules apply to the ESI as other logical devices in that the ESI functions could be coupled with another other logical device, if appropriate.

4.2.2 Logical Device Mappings

The logical HAN Device list covers a broad range of uses. While defining the application requirements, all logical devices were considered. As a result only a subset of the broader requirements may apply to a logical device. Please refer to the specific mappings for more detail.

In general, Application requirements apply most granularly due to the different primary functionalities of HAN Devices. Almost all other requirements apply uniformly to all HAN Devices with the exception of the Energy Services Interface, which is a unique class of HAN Device. The Energy Management System also shares some requirements with the ESI due to it being a higher order HAN Device.

The requirements are labeled with descriptive identifiers that provide context to their intended function.

Requ. ID	OpenHAN System Requirements	Energy Services Interface	PCT	Display	EMS	Load Control	HAN Electric Meter	HAN Meter (non-electric)	Smart Appliance
App.Control.1	HAN Device shall accept control signals from the Utility.	NA	B	B	B	B	B	B	B
App.Control.2	HAN Device shall respond to requests to cease operational state (e.g., open contact).	NA	B	NA	B	B	NA	NA	E
App.Control.3	HAN Device shall respond to requests to resume operational state (e.g., close contact).	NA	B	NA	B	B	NA	NA	E
App.Control.4	HAN Device shall acknowledge receipt of control signal.	NA	B	NA	B	B	NA	NA	E
App.Control.5	HAN Device shall acknowledge execution of control request.	NA	B	NA	B	E	NA	NA	O
App.Control.6	HAN Device shall acknowledge execution failure of request (i.e., exceptions).	NA	E	NA	E	E	NA	NA	O
App.Control.7	HAN Device shall signal any consumer-initiated overrides.	NA	B	NA	B	E	NA	NA	O
App.Control.8	HAN Device shall respond to request to cease operation state at a specific time.	NA	B	NA	B	E	NA	NA	O
App.Control.9	HAN Device shall respond to request to resume operation state at a specific time.	NA	B	NA	B	E	NA	NA	O
App.Control.10	HAN Device shall delay restoration of operational state based on a pre-configured time (e.g., random number).	NA	B	NA	B	E	NA	NA	O
App.Control.11	HAN Device shall respond to request to cycle operational **state** (i.e., duty cycle).	NA	E	NA	O	E	NA	NA	O
App.Control.12	HAN Device shall respond to request to limit operational **mode** based on thresholds, set-points or triggers (e.g., price points).	NA	B	NA	B	E	NA	NA	O

Requ. ID	OpenHAN System Requirements	Energy Services Interface	PCT	Display	EMS	Load Control	HAN Electric Meter	HAN Meter (non-electric)	Smart Appliance
App.Control.13	HAN Device shall respond to requests for variable output (e.g., load limiting, energy savings mode)	NA	E	NA	E	E	NA	NA	E
App.Measure.1	HAN Device shall measure instantaneous demand (e.g., W).	NA	NA	NA	E	NA	B	B	E
App.Measure.2	HAN Device shall measure accumulated consumption (e.g., Wh).	NA	NA	NA	E	NA	B	B	O
App.Measure.3	HAN Device shall measure accumulated production (e.g., Wh).	NA	NA	NA	E	NA	B	NA	O
App.Measure.4	HAN Device shall measure consumption per interval (e.g., Wh, BTU, CCF, HCF).	NA	NA	NA	E	NA	E	E	O
App.Measure.5	HAN Device shall measure production per interval (e.g., Wh).	NA	NA	NA	E	NA	E	NA	O
App.Measure.6	HAN Device shall store intervals measurements (e.g., 30 days of interval reads).	NA	NA	NA	E	NA	E	E	O
App.Measure.7	HAN Device shall allow interval configuration (e.g., 15 Minutes).	NA	NA	NA	E	NA	E	E	O
App.Measure.8	HAN Device shall monitor energy state (e.g., state of charge), where applicable (e.g., for HAN Devices with storage capability).	NA	NA	NA	E	NA	E	NA	O
App.Measure.9	HAN Device shall measure available capacity (e.g., W, Volt-Amps), where applicable (e.g., for HAN Devices with storage capability).	NA	NA	NA	E	NA	E	NA	O
App.Measure.10	HAN Device shall monitor the device state (e.g., operational, stand-by, maintenance).	NA	NA	NA	E	NA	E	NA	O

Requ. ID	OpenHAN System Requirements	Energy Services Interface	PCT	Display	EMS	Load Control	HAN Electric Meter	HAN Meter (non-electric)	Smart Appliance
App.Measure.11	HAN Device shall monitor the operational mode (e.g., charging, discharging).	NA	NA	NA	E	NA	E	NA	O
App.Measure.12	HAN Device shall measure power quality (e.g., frequency, neutral voltage, harmonic content).	NA	NA	NA	E	NA	O	NA	O
App.Measure.13	HAN Device shall monitor environmental state (e.g., temperature, motion, wind).	NA	B	O	O	NA	O	O	O
App.Measure.14	HAN Device shall monitor the operational mode of other devices (e.g., duty cycle).	NA	O	NA	B	NA	O	O	O
App.Measure.15	HAN Device shall monitor environmental impact (e.g., CO2).	NA	O	NA	O	O	O	O	O
App.HMI.1	HAN Device shall provide visual indicators which indicate operational state (e.g., commissioned, registered, event status, device state).	NA	B	B	B	O	E	E	B
App.HMI.2	HAN Device shall provide a power cycle input, which reboots the device.	NA	B	B	B	B	B	B	B
App.HMI.3	HAN Device shall provide a user reset input, which returns the device to its pre-installation state (e.g., button).	NA	B	B	B	B	B	B	B
App.HMI.4	HAN Device shall provide an alphanumeric display which indicates operational state (e.g., LCD screen).	NA	B	B	B	O	O	O	E
App.HMI.5	HAN Device shall provide non-visual sensory feedback (e.g., motion, vibration, audible).	NA	O	O	O	O	O	O	O
App.HMI.6	HAN Device shall provide a sight and hearing impaired interface.	NA	O	O	O	O	O	O	O

Requ. ID	OpenHAN System Requirements	Energy Services Interface	PCT	Display	EMS	Load Control	HAN Electric Meter	HAN Meter (non-electric)	Smart Appliance
App.HMI.7	HAN Device shall provide a user-configurable display.	NA	E	E	E	O	O	O	O
App.HMI.8	HAN Device shall accept user configurations.	NA	B	E	B	O	O	O	O
App.HMI.9	HAN Device shall accept user preferences (e.g., Celsius/Fahrenheit, color, language).	NA	B	E	B	NA	NA	NA	O
App.HMI.10	HAN Device shall provide alarm notifications (e.g., price threshold, event messages, internal device alarms).	O	B	B	B	O	O	O	E
App.HMI.11	HAN Device shall accept Utility data source configurations (e.g., Energy Services Interface, other HAN Devices).	NA	O	O	O	O	O	O	O
App.HMI.12	HAN Device shall display Utility data source configurations (e.g., Energy Services Interface, other HAN Devices).	NA	O	O	O	O	O	O	O
App.HMI.13	HAN Device shall display application-specific information (e.g., cost, consumption, environmental impact, payment credit, remaining account credit).	NA	B	B	B	NA	NA	NA	E
App.HMI.14	HAN Device shall accept application-specific configurations (e.g., preconfigured periods (e.g., hour, day, week), configurable periods (e.g., interval length, TOU period), variable periods (e.g., Critical Peak Price period).	NA	E	E	E	E	E	E	O
App.HMI.15	For **battery-powered** devices, HAN Device shall provide a battery life indicator.	NA	B	B	B	B	B	B	B
App.HMI.16	HAN Device shall accept payment data from the consumer.	NA	NA	NA	O	NA	O	O	NA

Requ. ID	OpenHAN System Requirements	Energy Services Interface	PCT	Display	EMS	Load Control	HAN Electric Meter	HAN Meter (non-electric)	Smart Appliance
App.Process.1	The application shall calculate a HAN Device's energy cost of accumulated energy consumption as monetary value (e.g., $/kWh * accumulated kWhrs = $).	NA	NA	E	E	NA	NA	NA	O
App.Process.2	The application shall calculate a HAN Device's energy cost of instantaneous power consumption as a monetary value per time interval, (e.g., $/Wh * instantaneous W= $/hr).	NA	NA	E	E	NA	NA	NA	O
App.Process.3	The application shall calculate a HAN Device's cost for Hourly Energy rates.	NA	NA	E	E	NA	NA	NA	O
App.Process.4	The application shall calculate a HAN Device's energy cost for rate tiers/energy blocks.	NA	NA	E	E	NA	NA	NA	O
App.Process.5	The application shall calculate a HAN Device's energy cost for Time-of-Use (TOU) energy rates.	NA	NA	E	E	NA	NA	NA	O
App.Process.6	The application shall calculate a HAN Device's cost for Critical Peak Pricing (CPP).	NA	NA	E	E	NA	NA	NA	O
App.Process.7	The application shall calculate a HAN Device's cost for capacity billing rates.	NA	NA	E	E	NA	NA	NA	O
App.Process.8	The application shall calculate costs for other billing determinants (e.g., monthly Consumer charges, taxes & franchise fee, surcharges, discounts, ratcheted demand, bond charges).	NA	NA	E	E	NA	NA	NA	O

Requ. ID	OpenHAN System Requirements	Energy Services Interface	PCT	Display	EMS	Load Control	HAN Electric Meter	HAN Meter (non-electric)	Smart Appliance
App.Process.9	The application shall accept aggregated consumption and rate information from user-configurable sources (e.g., Energy Services Interface, AMI System, and/or HMI).	NA	NA	NA	B	NA	NA	NA	NA
App.Process.10	The application shall calculate and forecast a HAN Device's consumption based on user-defined parameters (e.g., estimated kWh/month).	NA	NA	O	E	NA	NA	NA	O
App.Process.11	The application shall calculate and forecast a HAN Device's production based on user-defined parameters (e.g., estimated kWh/month).	NA	NA	O	E	NA	NA	NA	O
App.Process.12	The application shall forecast a HAN Device's estimated cost calculation based on user-defined parameters (e.g., monthly consumption at current rate/usage).	NA	NA	E	E	NA	NA	NA	O
App.Process.13	The application shall calculate a HAN Device's consumption based on user-defined parameters (e.g., historical reporting).	NA	NA	O	E	NA	NA	NA	O
App.Process.14	The application shall calculate a HAN Device's production based on user-defined parameters (e.g., historical reporting).	NA	NA	O	E	NA	NA	NA	O
App.Process.15	The application shall calculate and/or predict a HAN Device's environmental impact based on user-defined parameters (e.g., historical carbon footprint, forecasted carbon credits earned).	NA	NA	O	E	NA	NA	NA	O

Requ. ID	OpenHAN System Requirements	Energy Services Interface	PCT	Display	EMS	Load Control	HAN Electric Meter	HAN Meter (non-electric)	Smart Appliance
App.Process.16	The application shall supply a method for local billing resolution (e.g., orphaned billing charge, consumption debits/credits).	NA	NA	NA	O	NA	O	NA	NA
App.Process.17	The application shall calculate and suggest methods to optimize energy consumption and cost based on user-defined parameters (e.g., PCT thresholds, lighting settings, pool pump cycling).	NA	NA	NA	E	NA	NA	NA	O
App.Process.18	The application shall calculate a HAN Device's relative efficiency (e.g., comparison can be based on historical data, baseline at install, manufacturer's parameters, industry/governmental standards, other devices, other premises).	NA	O	NA	O	NA	NA	NA	O
App.Process.19	The application shall calculate available load for demand reduction based on user-defined parameters (e.g., percentage of load available for various response scenarios).	NA	O	NA	O	NA	NA	NA	O
App.Process.20	The application shall calculate user-defined thresholds for consumption, production, and cost (e.g., if aggregated consumption reaches a certain level, an alert is generated).	NA	E	NA	E	NA	NA	NA	O
Comm.Commission.1	HAN Device shall accept network configuration data which allows for private Utility networking (e.g., private address/ID)	B	B	B	B	B	B	B	B

Requ. ID	OpenHAN System Requirements	Energy Services Interface	PCT	Display	EMS	Load Control	HAN Electric Meter	HAN Meter (non-electric)	Smart Appliance
Comm.Commission.2	HAN Device shall accept commissioning configuration data by the manufacturer (e.g., link key).	B	B	B	B	B	B	B	B
Comm.Commission.3	HAN Device shall accept commissioning configuration from the Installer.	B	O	O	O	O	O	O	O
Comm.Commission.4	When Energy Services Interface is triggered (e.g., Allow Join Command), HAN Device location-specific/contact-specific data shall be provided to other HAN Devices in the premise.	B	NA	NA	NA	NA	NA	NA	NA
Comm.Commission.5	When a HAN Device is triggered (e.g. Power-on, button), HAN Device shall provide the Energy Services Interface with device specific information including device ID and device type.	NA	B	B	B	B	B	B	B
Comm.Commission.6	When a HAN Device is triggered (e.g. power on, button), HAN Device shall provide the Energy Services Interface with device specific Utility information, including network ID, gateway ID, and Utility ID, if pre-configured with Utility information.	NA	B	B	B	B	B	B	B
Comm.Commission.7	Energy Services Interface shall have the ability to accept or reject the request based on device type.	B	NA	NA	NA	NA	NA	NA	NA
Comm.Commission.8	Energy Services Interface shall have the ability to accept or reject device requests based on Utility-specific information (e.g., network ID, gateway/ Utility ID)	B	NA	NA	NA	NA	NA	NA	NA

Requ. ID	OpenHAN System Requirements	Energy Services Interface	PCT	Display	EMS	Load Control	HAN Electric Meter	HAN Meter (non-electric)	Smart Appliance
Comm.Commission.9	HAN Device shall acknowledge successful commissioning requests (i.e., provide acknowledgement to the requesting HAN Device).	B	NA	NA	B	NA	NA	NA	NA
Comm.Commission.10	When a HAN Device is communicating with the Energy Services Interface, HAN Device shall indicate link connectivity.	NA	B	E	B	O	O	O	O
Comm.Commission.11	HAN Device shall provide notification to the Installer of the commissioning status. Status conveyed shall be either: successful/unsuccessful.	NA	B	E	B	O	O	O	O
Comm.Commission.12	Energy Services Interface shall maintain an updated list of commissioned (i.e., connected) HAN Devices.	B	NA	NA	NA	NA	NA	NA	NA
Comm.Commission.13	Energy Services Interface shall have the ability to remove HAN Devices from the Utility HAN.	B	NA	NA	NA	NA	NA	NA	NA
Comm.Control.1	HAN Device shall accept network organization messages from the Energy Services Interface (e.g., gateway location, routing table, address).	NA	B	B	B	B	B	B	B
Comm.Control.2	HAN Device shall accept network organization messages from peer devices (e.g., hidden node).	NA	O	O	O	O	O	O	O
Comm.Control.3	HAN Device shall use the most reliable path to the Energy Services Interface (e.g., based on signal strength/quality).	NA	B	B	B	B	B	B	B
Comm.Control.4	HAN Device shall only use Utility-designated routes.	B	B	B	B	B	B	B	B

Requ. ID	OpenHAN System Requirements	Energy Services Interface	PCT	Display	EMS	Load Control	HAN Electric Meter	HAN Meter (non-electric)	Smart Appliance
Comm.Control.5	HAN Device shall have the ability to automatically adapt to communications interference through detection and analysis of environmental conditions (e.g., channel hopping, channel avoidance, signal-to-noise ratio).	B	B	B	B	B	B	B	B
Comm.Control.6	HAN Device shall include a data integrity mechanism for all communications (e.g., checksum)	B	B	B	B	B	B	B	B
Comm.Control.7	Energy Services Interface shall have the ability to activate and deactivate its HAN communication.	B	NA	NA	NA	NA	NA	NA	NA
Comm.Control.8	HAN Device shall communicate its availability (i.e., 'heartbeat') to the Energy Services Interface at least once per day.	NA	B	B	B	B	B	B	B
Comm.Control.9	HAN Device shall have a configurable availability communication (i.e., heartbeat) frequency to the Energy Services Interface.	NA	O	O	O	O	O	O	O
Comm.Control.10	Energy Services Interface shall store a list of available, **commissioned** HAN Devices in the premise and make that list available to the AMI System upon request.	B	NA	NA	NA	NA	NA	NA	NA
Security.Access.1	Energy Services Interface shall provide access control (i.e., logical segmentation) to Utility applications, data, and services (e.g., control data, consumer-specific consumption data).	B	NA	NA	NA	NA	NA	NA	NA

Requ. ID	OpenHAN System Requirements	Energy Services Interface	PCT	Display	EMS	Load Control	HAN Electric Meter	HAN Meter (non-electric)	Smart Appliance
Security.Access.2	HAN Device shall control access to persistent Utility HAN data (data at rest).	B	B	B	B	B	B	B	B
Security.Access.3	HAN Device shall control access to transmitted Utility HAN data (data in transit).	B	B	B	B	B	B	B	B
Security.Access.4	HAN Device shall provide protection of Utility HAN data while being processed (data in processing) (e.g., trusted processor).	O	O	O	O	O	O	O	O
Security.Access.5	HAN Device shall control access to data in accordance with a configurable Utility security policy (e.g., users, applications, devices, data access-read/write).	B	O	O	O	O	O	O	O
Security.Access.6	Energy Services Interface shall provide mechanisms to enforce a policy based on least privilege (i.e., explicit authorization).	B	NA	NA	NA	NA	NA	NA	NA
Security.Access.7	Energy Services Interface shall have the ability to enforce policy periods (time constraints) for security policy elements (e.g., maintenance/firmware window).	E	NA	NA	NA	NA	NA	NA	NA
Security.Access.8	HAN Device shall provide methods to query and report access control data settings.	B	O	O	O	O	O	O	O
Security.Access.9	HAN Device shall provide access control methods which prevent known attacks, including replay, man-in-the-middle, delay, spoofing, sequence change, and deletion attacks.	B	B	B	B	B	B	B	B

Requ. ID	OpenHAN System Requirements	Energy Services Interface	PCT	Display	EMS	Load Control	HAN Electric Meter	HAN Meter (non-electric)	Smart Appliance
Security.Access.10	HAN Device shall implement mechanisms to prevent unintended disclosure of source/originator data to unauthorized principals.	O	O	O	O	O	O	O	O
Security.Access.11	HAN Device shall implement controls which limit access to audit information.	B	B	B	B	B	B	B	B
Security.Access.12	HAN Device shall support confidentiality and access controls that employ cryptographic operations (e.g., digital signatures).	B	B	B	B	B	B	B	B
Security.Access.13	HAN Device shall support confidentiality and access controls that employ cryptographic keys (e.g., encryption authentication, or digital signatures).	B	B	B	B	B	B	B	B
Security.Integrity.1	HAN Device shall protect the integrity of the HAN system (e.g., shall not adversely impact the operations of the HAN system by introducing malicious or unintended activity).	B	B	B	B	B	B	B	B
Security.Integrity.2	Energy Services Interface shall provide a configurable HAN filtering function that filters based on allowable message types.	B	NA	NA	NA	NA	NA	NA	NA
Security.Integrity.3	Energy Services Interface shall provide a configurable HAN filtering function that filters messages based on structural integrity of the message.	B	NA	NA	NA	NA	NA	NA	NA
Security.Integrity.4	Energy Services Interface shall provide a configurable HAN filtering function that filters based on allowable message rates.	B	NA	NA	NA	NA	NA	NA	NA

Requ. ID	OpenHAN System Requirements	Energy Services Interface	PCT	Display	EMS	Load Control	HAN Electric Meter	HAN Meter (non-electric)	Smart Appliance
Security.Integrity.5	HAN Device shall detect unauthorized modification of security-related data during storage	B	B	B	B	B	B	B	B
Security.Integrity.6	HAN Device shall detect unauthorized modification of data during network transit (e.g., check sums and hashes).	B	B	B	B	B	B	B	B
Security.Integrity.7	HAN Device shall detect unauthorized modification of data attributes (e.g., modification to a message type).	B	B	B	B	B	B	B	B
Security.Integrity.8	HAN Device shall attempt to correct unauthorized modification of data attributes (e.g., NAK, resend)	B	B	B	B	B	B	B	B
Security.Integrity.9	HAN Device shall only accept data from an authorized, trusted source (e.g., Energy Services Interface, certified EMS).	B	B	B	B	B	B	B	B
Security.Integrity.10	HAN Device shall protect the HAN from malicious code (e.g., buffer overflow protection, limit executable code exposure).	B	B	B	B	B	B	B	B
Security.Integrity.11	HAN Device shall separate security critical functionality and data from non-security critical system data.	O	O	O	O	O	O	O	O
Security.Integrity.12	HAN Device shall validate the source of HAN security policy.	B	O	O	O	O	O	O	O
Security.Integrity.13	HAN Device shall detect unauthorized modification of HAN security policy.	B	O	O	O	O	O	O	O
Security.Integrity.14	HAN Device shall detect unauthorized modification of audit data.	B	E	O	E	O	O	O	O

Requ. ID	OpenHAN System Requirements	Energy Services Interface	PCT	Display	EMS	Load Control	HAN Electric Meter	HAN Meter (non-electric)	Smart Appliance
Security.Integrity.15	HAN Device shall validate the integrity of all software updates, including source, structure, and version.	B	B	B	B	B	B	B	B
Security.Integrity.16	HAN Device shall use tamper-resistant hardware (e.g., epoxy, TPM).	O	O	O	O	O	O	O	O
Security.Account.1	HAN Device shall alert the Energy Services Interface of all detected, security-related activities, including access control, authentication, and integrity violations.	NA	B	B	B	B	B	B	B
Security.Account.2	HAN Device shall audit and store all security-related activities, including access control violations, authentication activities, etc.	B	E	E	B	E	E	E	E
Security.Account.3	HAN Device shall provide, at a minimum, the following information for all detected security events: date and time of the event, type of event, device/user identity.	B	E	E	B	E	E	E	E
Security.Account.4	HAN Device shall provide the AMI System access to audit data.	B	E	E	B	E	E	E	E
Security.Account.5	Energy Services Interface shall provide non-repudiation mechanisms for devices and users.	B	NA	NA	NA	NA	NA	NA	NA
Security.Account.6	Energy Services Interface shall provide a mechanism for source identification of data (e.g., HAN and AMI System data).	B	NA	NA	NA	NA	NA	NA	NA

Requ. ID	OpenHAN System Requirements	Energy Services Interface	PCT	Display	EMS	Load Control	HAN Electric Meter	HAN Meter (non-electric)	Smart Appliance
Security.Account.7	Energy Services Interface shall provide the capability to audit both system and user operations as defined by the HAN security policy.	B	NA	NA	NA	NA	NA	NA	NA
Security.Account.8	HAN Device shall provide the ability to perform searches, sorts, and filters of audit data based on date and time, type and/or user identity.	B	O	O	O	O	O	O	O
Security.Account.9	HAN Device shall provide the capability to identify mandatory and configurable audit elements (In this context, mandatory refers to audit elements which are always enabled and configurable refers to audit elements which can be enabled or disabled at the discretion of the Consumer or Utility).	B	O	O	O	O	O	O	O
Security.Reg.1	HAN Device shall support mutual authentication.	B	B	B	B	B	B	B	B
Security.Reg.2	HAN Device shall authenticate the source of all control signals.	B	B	B	B	B	B	B	B
Security.Reg.3	HAN Device shall provide a mechanism which allows for multiple and configurable authentication materials (e.g., device ID, device type, key, serial key, Utility ID, and device configuration).	B	B	B	B	B	B	B	B
Security.Reg.4	HAN Device shall be configured with Utility-approved or Utility-provided authentication materials (e.g., certificate, key).	B	B	B	B	B	B	B	B

Requ. ID	OpenHAN System Requirements	Energy Services Interface	PCT	Display	EMS	Load Control	HAN Electric Meter	HAN Meter (non-electric)	Smart Appliance
Security.Reg.5	HAN Device shall not send authentication materials over the network in an insecure fashion (e.g., do not transmit passwords or keys in the clear).	B	B	B	B	B	B	B	B
Security.Reg.6	HAN Device shall be compatible with a Utility-defined registration process.	B	B	B	B	B	B	B	B
Security.Reg.7	HAN Device shall provide a means to update (i.e., change, reconstitute, rollover) authentication materials.	B	B	B	B	B	B	B	B
Security.Reg.8	Energy Services Interface shall allow registration revocation for connected HAN Devices.	B	NA	NA	NA	NA	NA	NA	NA
Security.Reg.9	Energy Services Interface shall support a configurable registration and expiration period (e.g., registration timeout, registration persistence).	B	NA	NA	NA	NA	NA	NA	NA
Security.Reg.10	HAN Device shall use security services (i.e., cryptographic services) which are either FIPS-approved or NIST-recommended.	B	B	B	B	B	B	B	B
Security.Reg.11	HAN Device shall support a registration method that employs cryptographic operations (e.g., digital signatures).	B	B	B	B	B	B	B	B
Security.Reg.12	Energy Services Interface shall provide an authentication mechanism which proxies for the AMI System (e.g., negotiates on behalf of the Utility).	B	NA	NA	NA	NA	NA	NA	NA

Requ. ID	OpenHAN System Requirements	Energy Services Interface	PCT	Display	EMS	Load Control	HAN Electric Meter	HAN Meter (non-electric)	Smart Appliance
Security.Reg.13	HAN Device shall provide notification to the Installer of the registration status. Status conveyed shall be either: registered/not registered.	O	B	E	B	O	O	O	O
Perf.1	HAN Device shall supply functionality that maintains communications availability to the Energy Services Interface.	NA	B	B	B	B	B	B	B
Perf.2	HAN Device shall supply functionality that maintains application availability to the AMI System (e.g., software/hardware application watchdog).	B	B	B	B	B	B	B	B
Perf.3	After loss of power, HAN Device shall return to its post-configuration state (i.e., shall persist communication and registration configurations).	B	B	B	B	B	B	B	B
Perf.4	HAN Device shall supply adequate computational performance (i.e., Device shall not hamper overall operational state of the HAN)	B	B	B	B	B	B	B	B
Perf.5	HAN Device shall supply adequate communications performance (e.g., bandwidth and throughput).	B	B	B	B	B	B	B	B
Perf.6	HAN Device shall supply accurate time keeping and counter functions.	B	B	E	B	E	B	E	E
Perf.7	HAN Device shall not act on expired signals (e.g., message validity duration or sequence).	B	B	E	B	E	B	E	E

Requ. ID	OpenHAN System Requirements	Energy Services Interface	PCT	Display	EMS	Load Control	HAN Electric Meter	HAN Meter (non-electric)	Smart Appliance
Perf.8	HAN Device shall provide configurable communications such that the system is scalable (e.g., heartbeat and request frequency).	B	B	E	B	E	B	B	E
Perf.9	For **battery-powered** HAN Devices, HAN Device shall function for a minimum of 1 year without requiring replacement of the battery.	B	O	O	O	O	O	O	O
Perf.10	HAN Device shall supply a field-programmable software upgrade function (i.e., firmware upgrade).	B	E	E	E	E	E	E	E
Perf.11	HAN Device shall supply a remote software upgrade function (i.e., firmware upgrade).	B	E	E	E	E	E	E	E
Perf.12	HAN Device shall meet the quality, interoperability, and testing (i.e., certification) requirements of its respective technology platform body.	B	B	B	B	B	B	B	B
Perf.13	HAN Device shall accept network time synchronization from the Energy Services Interface.	NA	B	E	B	E	B	E	E
Perf.14	Energy Services Interface shall accept time synchronization from a Utility-approved source.	B	NA	NA	NA	NA	NA	NA	NA
OML.ManuDist.1	Prior to installation (e.g., factory, depot), HAN Device shall support placement of commissioning data (e.g., pre-placed device credentials).	B	B	B	B	B	B	B	B
OML.ManuDist.2	Prior to installation (e.g., factory, depot), a HAN Device shall support placement of registration data (e.g., pre-placed registration credentials).	B	B	B	B	B	B	B	B

Requ. ID	OpenHAN System Requirements	Energy Services Interface	PCT	Display	EMS	Load Control	HAN Electric Meter	HAN Meter (non-electric)	Smart Appliance
OML.ManuDist.3	HAN device shall support pre-placed methods or materials that support commissioning and registration by multiple Utilities (does not imply simultaneous Utility registration).	B	B	B	B	B	B	B	B
OML.ManuDist.4	HAN Device shall support pre-placement of application-specific configurations (e.g., cost, consumption, environmental impact, configurable time/rate intervals).	B	E	E	E	E	E	E	E
OML.ManuDist.5	HAN Device shall have and display appropriate certification (e.g., electrical, safety, and communications requirements) on its packaging or body.	B	B	B	B	B	B	B	B
OML.ManuDist.6	HAN Device shall have and display appropriate commissioning and registration information on its packaging and body (e.g., serial number, registration code).	B	B	B	B	B	B	B	B
OML.ManuDist.7	HAN Device shall display Utility compatibility guidance to verify that a HAN Device is compatible with a particular AMI system on its packaging.	B	B	B	B	B	B	B	B
OML.ManuDist.8	HAN Device shall display its HAN network technology compatibility on its outside packaging and body.	B	B	B	B	B	B	B	B
OML.ManuDist.9	HAN Device shall display UtilityAMI compliance on its packaging.	B	B	B	B	B	B	B	B

Requ. ID	OpenHAN System Requirements	Energy Services Interface	PCT	Display	EMS	Load Control	HAN Electric Meter	HAN Meter (non-electric)	Smart Appliance
OML.ManuDist.10	HAN Device shall display Enhanced UtilityAMI compliance on its packaging.	E	E	E	E	E	E	E	E
OML.ManuDist.11	The HAN device shall display, on its packaging, any secondary device requirements (e.g., required EMS, bridge device).	B	B	B	B	B	B	B	B
OML.ManuDist.12	HAN Device shall be manufactured to support multiple distribution channels (e.g., retail, direct Utility).	B	B	B	B	B	B	B	B
OML.Install.1	HAN Device Manufacturer shall include installation documentation that includes instructions for installation (e.g., placement), commissioning, and registration, including any external dependencies.	B	B	B	B	B	B	B	B
OML.Install.2	HAN Device Manufacturer shall include a HAN Device user's manual in the Device packaging.	B	B	B	B	B	B	B	B
OML.Install.3	HAN Device Manufacturer shall include Manufacturer contact information in the Device packaging.	B	B	B	B	B	B	B	B
OML.Install.4	HAN Device Manufacturer shall supply technical support services (e.g., help desk, web site).	B	B	B	B	B	B	B	B
OML.Maintain.1	HAN Device shall have a self-check (i.e., initialization) function that notifies the Installer that the HAN Device is functioning properly.	B	E	E	E	E	B	E	E
OML.Maintain.2	Energy Services Interface shall have a configurable ability to log all AMI System-to-HAN System communications.	B	NA	NA	NA	NA	NA	NA	NA

Requ. ID	OpenHAN System Requirements	Energy Services Interface	PCT	Display	EMS	Load Control	HAN Electric Meter	HAN Meter (non-electric)	Smart Appliance
OML.Maintain.3	When the HAN Device is rebooted, HAN device shall reset to its configured (i.e., post-installation commissioning and registration) state and shall reestablish communication with the Energy Services Interface.	NA	B	B	B	B	B	B	B
OML.Maintain.4	HAN Device shall have a user-operable testing function that is equivalent to the self-testing function.	O	E	E	E	E	E	E	E
OML.Maintain.5	HAN Device shall supply a maintenance port for field diagnostics.	O	O	O	O	O	O	O	O
OML.Maintain.6	HAN Device shall simulate Utility events for diagnostic purposes.	O	O	O	O	O	O	O	O
OML.Maintain.7	HAN Device shall supply network management functions for diagnostic purposes.	O	O	O	O	O	O	O	O
OML.Maintain.8	For **battery-powered** devices, HAN Device shall communicate low battery state to the AMI System.	E	E	E	E	E	E	E	E
OML.Maintain.9	HAN Device Manufacturer shall supply and support a flaw remediation process.	B	B	B	B	B	B	B	B
OML.Maintain.10	HAN Device shall support a communications feedback mechanism (i.e., ping).	B	B	B	B	B	B	B	B