AMI Use Case:

D4 - Distribution Operator Locates Outage Using AMI Data and Restores Service

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Document History

Revision History

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1. Use Case Description

1.1 Use Case Title

Distribution Operator Locates Outage Using AMI Data and Restores Service

1.2 Use Case Summary

Utilities are constrained in their response to outages by the sensors and the information currently available to them. SCADA systems typically extend only to the substation. Remote Fault Indicators (RFIs) provide further insight into the distribution network, but are limited in number. Advanced Metering Infrastructure (AMI) offers opportunities for enhancing a utility's ability to identify and rectify outages. By definition, AMI is the only system that extends to the extreme ends of a utility network, sensing every line segment and transformer on the system. This capability can be used not only to pinpoint outages but also to verify power restoration, enabling utilities to proactively identify customers whose power has yet to be restored. Outages reported by other systems such as SCADA and DCMS (Distribution Control and Monitoring System), or by the customer directly, can be then explored to determine the extent of the outage. Because AMI systems improve the processes of identifying the cause and location of outages, the appropriate personnel and equipment can be dispatched, reducing labor and truck roll costs. Additionally, certain truck rolls can be eliminated by verifying that some customer reported outages are not due to utility problems, but rather due to customer equipment issues.

In this use case, the DOC (Distribution Operations Center) dispatcher uses individual customer outage information to reduce the duration of an outage. Data can be taken directly from the customer's meter or via the Edison SmartConnect Network Management System (NMS) that monitors the status of customer meters, to determine the extent of the outage. Using this data from Edison SmartConnect as an input, the utility is able to use other systems to locate the most probable failure point and can potentially re-configure the distribution network to minimize the impact of the fault and possibly the number of critical customers affected by the fault. The fault location is also used to dispatch repair crews to the trouble areas to facilitate restoration of power to the remainder of impacted customers. Upon repair, the distribution network is re-configured back to their original positions.

Key benefits of this use case include but are not limited to:

- Improved customer satisfaction by using meters to verify outages in a more timely manner. Ideally, the Outage Management System (OMS) will identify and validate an outage before the first customer calls arrive.
- Reduced number of crews dispatched to deal with nested outages by using meter responses to validate when power is restored.
- Reduced Customer Service Representatives (CSR) labor costs due to because the Voice Response Unit (VRU) uses meter responses to screen customer "no power" calls automatically filtering out calls where the customer actually has power, was disconnected due to

payment issues, or has created a customer-side failure. CSRs can also query meters under any circumstances to determine whether a work order is necessary, further reducing crew labor costs.

- Detection of outages at distribution transformers or other common points of failure, shortening response times and reducing restoration costs. Placing the neighborhood Cell Relay devices on lateral feeders and ensuring they report last gasp/AC Out messages improves this detection capability.
- Improved distribution network reliability statistics by detecting outages in a timely manner.
- Validation of liability claims. Detection and recording of outages allows utilities to know which claims attributed to outages actually correlate to an outage and which do not.

1.3 Use Case Detailed Narrative

The distribution operator uses individual customer outage information provided by the SmartConnect NMS and OMS to detect the outage, locate the cause of the outage, isolate the faulted portions of the distribution network, and develop the optimal solution for restoration of service.

Outage Management System and Customer-Provided Information

Typically, when an outage occurs, customers immediately contact the call center to inform the utility of the outage. In order to determine whether an outage is occurring in the distribution network and record its duration, the SmartConnect NMS sends the OMS outage reports. The OMS uses this information along with that from customer phone calls to determine the affected section of the distribution network and the probable location of the fault causing the outage. Data is collected by continuously monitoring the following sources:

- customer information provided over the phone to a call center
- outage detectors on distribution feeders
- SmartConnect Meters and Cell Relay devices
- crew reports on the repair status
- SCADA inputs (such as feeder measurements at substations and on various transformers in the distribution network), lockouts, protection trips, fault indications/location, etc.
- inputs from outage/fault-predicting devices

Customer Information

When outages occur, customers contact the call center to inform the utility of loss of power and obtain information on the cause of the outage, size of the affected area and the expected duration of the outage.

Outage Detection

Outages at individual customer sites (behind the meter) will not affect the meter's ability to communicate with the SmartConnect NMS. In these cases the meter can be queried for line-side voltage indicating that the supply-side of the meter is unaffected. When the customer calls to report the outage; the call center is able to inform them that the problem is at their own premises.

Area outages affecting many customers can interfere with the meter's to communicate with the SmartConnect NMS. Outage detection in this case utilizes *Last Gasp* or *AC Out* messaging from customer meters and other information from the NMS to determine the extent of the outage. When the NMS indicates contact with meters in an area that has been lost it allows the OMS to analyze the outage area and equipment involved.

Crew Dispatch

The distribution operator can dispatch repair crews to isolate an outage, repair the damage, and/or restore service. Using data received from the OMS the crew dispatcher issues a work order to the repair crew providing the outage location and other important information regarding the affected customers. The dispatched crews periodically report the status of the repair to the OMS.

Restoration

As crew work is completed, as in the case of a *nested outage,* it is important to communicate the success of the crew's efforts and that no customers remain in the dark. The OMS can query meters remotely to verify when 100 percent of customers have had their power restored.

Extreme Outage Events

When the area of an outage is large, as in the case of the loss of a substation or several transmission lines due to a fire or other natural disaster the number of Last Gasp/AC Out outage messages being transmitted by meters becomes a concern. In these cases, it is important that the Cell Relays and SmartConnect NMS throttle the number of notifications being provided to the OMS. This throttling and the original detection of the extent of the outage are greatly dependent upon up-to-date, accurate information about the topology of the network. Topology information can also be determined using SmartConnect technology via power-line-carrier devices (discussed in Use Case D7 on Transformer Load Monitoring).

This use case covers four scenarios:

1. **Distribution operator locates lateral outage using SmartConnect data and restores service.** This is the most typical outage scenario. An outage occurs on a distribution system lateral, and the SmartConnect Meters located on that lateral report the loss of AC power (AC out) to the SmartConnect Network Management System (NMS). The SmartConnect NMS forwards this information to the Outage Management System (OMS), which may also be receiving information about the outage from other sources. Using this information, the OMS identifies the most probable location of the outage and crews are dispatched to make repairs. Once repairs are complete, the crew dispatcher uses the OMS to query specific meters using the SmartConnect NMS and verify that power has been restored to all customers.
2. **A subset of customers remains without power after the outage ends.** The steps of this scenario, formerly described separately, are now included in scenario 1. These steps describe how the restoration of an outage is an iterative process in which the AC Restored messages from the meters serve as important tools for confirming that all outages have been repaired.

3. **OMS uses the SmartConnect system to verify no-power calls.** This scenario describes how the SmartConnect system can be used by the Customer Service Representative, the VRU and the Customer Service System to screen no-power calls from customers so that only true outage-related calls are submitted to the Outage Management System.
4. **Utility uses SmartConnect data to address emergency events.** This scenario describes how the utility can use the SmartConnect system to resolve emergency events happening on a large scale and how the Outage Management and SmartConnect systems behave differently than in the normal outage scenario. In general, the information provided by SmartConnect is less useful for detecting the outage area in this scenario, but is more useful in confirming outage restoration; therefore, while all restoration messages are important, Last Gasp/AC Out messages may be throttled or discarded after a certain threshold is reached,.

1.4 Business Rules and Assumptions

- This use case applies to customers with a load smaller than 200 kW (i.e. non-RTEM customers).
- Outages caused by a supply failure in the distribution network may involve one to many customers and may lead to meters not being able to communicate with the SmartConnect NMS for the duration of the outage.
- There is a benefit to knowing the locations of outages in the distribution system with a greater degree of accuracy than SCADA and OMS systems can provide.
- This use case is not intended to verify the VRU business process or the OMS algorithms, unless they affect data flow between these and SmartConnect systems.
- The number of Meter Status Requests required for confirming an outage and a restoration is the same – approximately 20 percent of the affected customers in the area
- The transformer-to-customer and circuit topology information in the Transformer Load Monitoring database is correct at the time of the outage.

2. Actors

Describe the primary and secondary actors involved in the use case. This might include all the people (their job), systems, databases, organizations, and devices involved in or affected by the Function (e.g. operators, system administrators, customers, end users, service personnel, executives, meters, real-time databases, independent system operators, power systems). Actors listed for this use case should be copied from the global actors list to ensure consistency across all use cases.

Actor Name	*Actor Type (person, device, system etc.)*	*Actor Description*
Cell Relay	Device	Communications device acting as a relay between the RF local area mesh network and wide-area network backhaul. In this use case it can also throttle some messages transmitted by Meters. Previously referred to as a Neighborhood Aggregator.
Crew Dispatcher	Person	Utility personnel who in case of an power failure use the OMS to determine problems and deploy repair crews. Also dispatches crews for maintenance.
Customer Service Representative (CSR)	Person	Utility personnel who respond to customer complaints, outage notifications, and customer requests to activate, modify and/or terminate delivery of service. CSRs also enroll customers in utility sponsored programs and answer questions related to the customer's energy consumption and cost data. Many off-cycle reading, billing, work orders and diagnostics requests are initiated by CSRs in response to customer contact.
Customer Service System (CSS)	System	Maintains customer contact information, calculates and formats customer bills, receives and applies payments for individual accounts. The system is responsible for storing customer information such as site data, meter number, rates, and program participation.
Fuse	Device	Electrical device responsible for protecting power system equipment by creating an open circuit when overloaded.
In-Home Display	Device	This device enables customers to view their usage and cost data from their home or business. Data is passed to this device via the SmartConnect Meter. Only utility-approved devices connect to the SmartConnect network and receive data and communication from the utility.
Last Gasp Service (LGS)	System	A mechanism that receives Last Gasp/AC Out messages from meters and transmits them to the OMS and other systems requiring the information. May be located in the SmartConnect NMS or elsewhere.

Actor Name	*Actor Type (person, device, system etc.)*	*Actor Description*
Outage Management System (OMS)	System	A distribution management system that uses an analysis engine to identify the location of outages. Using information from the Geographic Information Services, CSS, SCADA, and SmartConnect systems it correlates to end-point outages and infers root causes by identifying common failure points grouped upstream. Helps reduce outage duration and assists with restoration plans. Determination of outage locations is based on the system's knowledge of the power system topology.
SmartConnect Meter	Device	Advanced electric revenue meter capable of two-way communications with the utility. Serves as a gateway between the utility, customer site, and customer's load controllers. Measures, records, displays, and transmits data such as energy usage, generation, text messages, and event logs to authorized systems (i.e., the SmartConnect NMS) and provides other advanced utility functions.
SmartConnect Network Management System (NMS)	System	The utility's back-office system responsible for two-way communications with SmartConnect Meters to retrieve data and execute commands. Balances load on the communications network resulting from scheduled meter reads. It retries meters during communications failures and monitors the health of the advanced metering infrastructure. Remotely manages and implements firmware updates, configuration changes, provisioning functions, control and diagnostics.
Transmission and Distribution (T&D) Field Crew	Personnel	Performs manual operation of field devices, repair and construction work. Works on power system equipment in the field to fix faults as instructed by work orders and authorized by the Distribution Operator or Crew Dispatcher. Provides progress reports to the Distribution Operator or Crew Dispatcher.
Utility Web site	Web site	A platform allowing customers to view and analyze information such as usage and cost data while offsite. Can also display other information such as outage notices.
Voice Response Unit (VRU)	System	Automated telephone answering system. First tier of response to customer outage calls.

3. Step by Step analysis of each Scenario

Describe steps that implement the scenario. The first scenario should be classified as either a "Primary" Scenario or an "Alternate" Scenario by beginning the title of the scenario with either the work "Primary" or "Alternate". A scenario that successfully completes without exception or relying heavily on steps from another scenario should be classified as Primary; all other scenarios should be classified as "Alternate". If there is more than one relevant scenario (set of steps), make a copy of the following section (all of 3.1, including 3.1.1 and tables) and complete for additional scenarios.

3.1 Primary Scenario: Distribution operator locates lateral outage using SmartConnect data and restores service

In this scenario an outage occurs on a distribution system lateral (a branch off the main distribution circuit that typically serves 10 to 100 customers). The OMS receives information from the SmartConnect Network Management System (NMS) and other sources. The Dispatcher uses the information to identify the most probable location of the outage and dispatch crews to make repairs. Once repairs are complete, the Dispatcher uses the OMS to confirm that power has been restored to all customers.

Triggering Event	***Primary Actor***	***Pre-Condition***	***Post-Condition***
(Identify the name of the event that start the scenario)	*(Identify the actor whose point-of-view is primarily used to describe the steps)*	*(Identify any pre-conditions or actor states necessary for the scenario to start)*	*(Identify the post-conditions or significant results required to consider the scenario complete)*
Fault on a lateral causes fuse to open and loss of AC power to meters.	OMS, Dispatcher	OMS subscribes to the LGS via Web services.	Outage restored completely.

3.1.1 Steps for this scenario

Describe the normal sequence of events required to complete the scenario.

Step #	Actor	Description of the Step	Additional Notes
#	*What actor, either primary or secondary is responsible for the activity in this step?*	*Describe the actions that take place in this step. The step should be described in active, present tense.*	*Elaborate on any additional description or value of the step to help support the descriptions. Short notes on architecture challenges, etc. may also be noted in this column.*
1	Fuse	Fault occurs on the lateral causing fuse to open and loss of AC power to meters.	
2	SmartConnect Meter	Meters on the lateral emit AC Out messages.	AC Out message may be received by one or more live Meters and forwarded to the Cell Relay.
3	Cell Relay	Cell relay receives a AC Out message and forwards them to the NMS. Cell relays may also send AC Out messages for themselves.	Only after waiting to see if a restoration message will arrive for a configurable length of time.
4	SmartConnect NMS	SmartConnect NMS forwards the message to the Last Gasp Service (LGS), which in turn makes it available to the OMS.	LGS may be implemented as a part of the NMS or as a part of the MDMS.
5	OMS	Processes the AC Out message.	Treats the AC Out message as if it were a phone call or a distribution automation voltage sensor report.
6	OMS	Confirms the outage by sending a Meter Status Request to one or more meters via the Web service interface on the SmartConnect NMS.	
7	SmartConnect Meter	Meters that can still communicate send responses to Meter Status Requests, which the SmartConnect NMS forwards to the OMS.	

Step #	*Actor*	*Description of the Step*	*Additional Notes*
8	OMS	Calculates the location of the outage from the AC Out message, the Meter Status Request response information and other traditional data input sources.	
9	Crew Dispatcher	Receives indication of outage from OMS, reviews outage information in OMS, and dispatches crew to the outage location.	
10	Transmission and Distribution (T&D)Field Crew	Restores service.	
11	SmartConnect Meter	Sends an AC Restored message to the Cell Relay.	
12	Cell Relay	Sends the AC Restored message to SmartConnect NMS.	
13	SmartConnect NMS	Sends AC Restored message to OMS via web service.	
14	OMS	Updates the status of the outage based on the restored message.	
15	OMS	Sends a Meter Status Request to the meter(s) to confirm restoration.	
16	Crew Dispatcher	Determines if all outages were restored. If meters are still out, repeat from step 6.	
17	Crew Dispatcher	Using the OMS confirms that all outages are restored.	
18	SmartConnect NMS	Retrieves meter logs at end of day and forwards them to the OMS to ensure that no AC Restored events are lost.	

3.2 Alternate Scenario: A subset of customers is not restored after the outage ends

This scenario was not reviewed as a part of the 2008 workshops. It is intended that this scenario describe how to resolve nested outages in a way that prevents outages from being missed and unnecessary crew dispatches. This scenario was resolved by additions to Scenario 1.

Triggering Event	***Primary Actor***	***Pre-Condition***	***Post-Condition***
(Identify the name of the event that start the scenario)	*(Identify the actor whose point-of-view is primarily used to describe the steps)*	*(Identify any pre-conditions or actor states necessary for the scenario to start)*	*(Identify the post-conditions or significant results required to consider the scenario complete)*
Outage not restored completely	OMS	Lateral outage occurred previously	All customers restored

3.3 Primary Scenario: OMS uses SmartConnect system to verify no-power calls

This scenario describes how the SmartConnect system can be used by the CSR, the VRU and the CSS to screen no-power calls from customers ensuring that only true outage-related calls are submitted to the OMS.

Triggering Event	***Primary Actor***	***Pre-Condition***	***Post-Condition***
(Identify the name of the event that start the scenario)	*(Identify the actor whose point-of-view is primarily used to describe the steps)*	*(Identify any pre-conditions or actor states necessary for the scenario to start)*	*(Identify the post-conditions or significant results required to consider the scenario complete)*
Customer calls reporting lights out	Customer	Possible outage in progress	OMS receives only no-power notifications that are not: • Customer mistakes • Already known • No-pay issues • On customer side of meter

3.3.1 Steps for this scenario

Describe the normal sequence of events that is required to complete the scenario.

Step #	Actor	Description of the Step	Additional Notes
#	*What actor, either primary or secondary is responsible for the activity in this step?*	*Describe the actions that take place in this step. The step should be described in active, present tense.*	*Elaborate on any additional description or value of the step to help support the descriptions. Short notes on architecture challenges, etc. may also be noted in this column.*
1	Customer	Calls to report power is out.	
2	VRU	Screens the phone number, determines the appropriate meter, and checks OMS for a known outage in that area. If no known outage, VRU sends a Meter Status Request to the meter.	The VRU or CSR/CSS can send status request. No need to send status request if there is a known outage at the location.
3	Meter	Responds to Meter Status Request from VRU (if sent by VRU in Step 2) through the SmartConnect NMS.	See requirements (section 4.1) for contents of the response.
4	VRU	Provides summary of status information to customer.	Within one minute of request.
5	VRU	Determines further action for the following conditions: a. If a true outage exists, follow the current business process for outage notification. b. If not a true outage and user requests, enter the call in the customer service representative queue. c. If disconnect is open because of non-payment, connect customer to appropriate operator	
6	CSR	For the condition in described in step 5b, customer is connected to and talks with the CSR.	

Step #	*Actor*	*Description of the Step*	*Additional Notes*
7	CSS	Presents the CSR with the known outage information and/or the Meter Status Request already received (in Step 3). If necessary, or not previously requested, CSR can initiate a second Meter Status Request.	Checking line-side voltage at the meter.
8	SmartConnect Meter	Responds to a second Meter Status Request if required by the CSR.	
9	CSS	Logs the call, forwards call and meter status information to OMS if the CSR issues a trouble order.	
10	OMS	Adds call to current set of outage information.	
11	OMS	Sends outage status information to: • Meters and In-Home Displays via SmartConnect NMS • Web site • CSS	
12	SmartConnect NMS	Forwards outage status information to Meters.	
13	SmartConnect Meter	Displays outage status information.	Must match information available to CSR via CSS.
14	SmartConnect Meter	Forwards outage status information to In-Home Display, if present.	

3.4 Alternate Scenario: Utility uses SmartConnect data to address emergency events

This scenario describes how the utility can use the SmartConnect system to resolve emergency events happening on a large scale and how the Outage Management and SmartConnect systems behave differently than during a normal outage scenario. In general, the information provided by SmartConnect is less useful for detecting the outage area in this scenario, but is more useful in confirming outage restoration; therefore, while all restoration messages are important and should be saved, Last Gasp/AC Out messages can be throttled or discarded after a certain threshold is reached.

Triggering Event	***Primary Actor***	***Pre-Condition***	***Post-Condition***
(Identify the name of the event that start the scenario)	*(Identify the actor whose point-of-view is primarily used to describe the steps)*	*(Identify any pre-conditions or actor states necessary for the scenario to start)*	*(Identify the post-conditions or significant results required to consider the scenario complete)*
Major outage affecting more than 100,000 customers	OMS	(none)	All customers restored

3.4.1 Steps for this scenario

Describe the normal sequence of events that is required to complete the scenario.

Step #	***Actor***	***Description of the Step***	***Additional Notes***
#	*What actor, either primary or secondary is responsible for the activity in this step?*	*Describe the actions that take place in this step. The step should be described in active, present tense.*	*Elaborate on any additional description or value of the step to help support the descriptions. Short notes on architecture challenges, etc. may also be noted in this column.*
1	Customer	Network experiences a major outage affecting more than 100,000 customers -- one or more substations failed, multiple downed lines, generator failure, storm, fire, etc.	
2	SmartConnect Meter	Sends AC Out messages.	It is expected that only about 20 percent of affected meters will be able to report because only the first hop of the mesh network can report.

Step #	*Actor*	*Description of the Step*	*Additional Notes*
3	Cell Relay	Affected Cell Relays send AC Out messages for themselves. Unaffected Cell Relays detect and throttle high volume of Last Gasp/AC Out messages to the SmartConnect NMS.	
4	SmartConnect NMS	Detects and throttles high volume of AC Out messages to the OMS.	The Cell Relay and/or the NMS may throttle. Throttling may occur based on message volume alone or ideally, may be based on topology and the transformer serving the affected customers. Under any conditions, Cell Relay delays for a configurable length of time after receiving Last Gasp/AC Out messages to see if a corresponding AC Restored message occurs.
5	OMS	Receives AC Out messages from SmartConnect NMS, but primarily uses SCADA information to identify location and extent of larger outages.	
6	Crew Dispatcher	Sends crews to the outage location.	
7	T&D Field Crew	Restores service.	
8	SmartConnect Meter	As power is restored, meters send AC stored events to SmartConnect NMS through the Cell Relays.	
9	Cell Relay	Sends the AC Restored message to SmartConnect NMS.	No throttling occurs on AC Restored events.
10	SmartConnect NMS	Sends AC Restored message to OMS via Web service.	No throttling occurs on AC Restored events.

Step #	*Actor*	*Description of the Step*	*Additional Notes*
11	OMS	Updates the status of the outage based on the AC Restored messages.	
12	OMS	Sends a Meter Status Request through the SmartConnect NMS to selected meter(s) to confirm restoration.	
13	SmartConnect Meter	Responds to Meter Status Requests through the SmartConnect NMS.	
14	Crew Dispatcher	Determines if all outages were restored. If meters are still out, repeat from step 6.	
15	Crew Dispatcher	Using the OMS, confirms all outages are restored.	
14	SmartConnect NMS	Retrieves meter logs at end of day and forwards them to the OMS to ensure that no AC Restored events are lost.	

4. Requirements

Detail the Functional, Non-Functional and Business Requirements generated from the workshop in the tables below. If applicable list the associated use case scenario and step.

4.1 Functional Requirements

Functional Requirements	*Associated Scenario # (if applicable)*	*Associated Step # (if applicable)*
Meter shall transmit an AC Out message to the SmartConnect NMS upon detecting an outage.	1 4	2 2
The Meter shall log when it transmits AC Out or AC Restored messages.	1	2, 11
The SmartConnect NMS shall retrieve AC Out/AC Restored logs from meters and provide the information to the OMS for later analysis in case alarm messages are lost during the actual outage event.	1 4	18 14
The meter shall not generate an AC Out message if an outage appears only on the customer (load) side of the meter and it continues communications with the SmartConnect NMS.	1	2
Meters shall be able to forward messages from other meters during an outage.	1 2	2 2
Meter's AC Out message shall include the meter identifier and time of outage detection.	1	2
Meter shall differentiate between sags (power quality events) and an outage, and send AC Out messages only in the event of an actual outage.	1	2
Meter shall maintain functionality following an outage for a sufficient amount of time to differentiate between an outage and a power quality (PQ) event.	1	2
Meter shall maintain functionality following an outage for the amount of time required to send an AC Out message.	1	2
Cell Relay communications shall remain active during a power outage.	1	3
Cell Relays shall be able to sense voltage and send AC Out and AC Restored messages to the SmartConnect NMS for themselves.	1	3

Functional Requirements	*Associated Scenario # (if applicable)*	*Associated Step # (if applicable)*
The connectivity database used by the OMS shall include the locations of Cell Relays and distinguish them from Meters that are not Cell Relays.	1	3
Wherever possible, Cell Relays shall be located on laterals to improve the number of meters that are only one hop from a Cell Relay, to aid the OMS in determining the area of the outage and restoration.	1	3
The SmartConnect NMS shall forward AC Out and AC Restored messages from meters to the OMS via LGS.	1	4, 13
The OMS shall collect and track outage and restoration information (via AC Out and AC Restored messages) on a meter-by-meter basis.	1	5, 14
The OMS shall have access to customer–transformer connectivity information for each meter's end point, so it can identify the physical and power network locations of outages as they are reported by meters. (This information may be stored in the Transformer Load Monitoring Database – refer to Use Case D7)	1	5, 14
The OMS shall be able to process AC Out messages received from the SmartConnect NMS via the LGS to aid in determining the location and extent of outages.	1	5
The OMS shall have processing logic, which can be tuned/configured to filter out false-positive AC Out messages when identifying outages.	1	5
The SmartConnect NMS shall permit the OMS to send Meter Status Requests on-demand and shall forward responses to the OMS.	1	6, 15
The OMS shall send Meter Status Requests to the SmartConnect NMS either manually, at the request of an operator or Crew Dispatcher – or automatically, when it detects outages.	1	6, 15
The SmartConnect NMS shall permits clients (such as the OMS) to send broadcast or multi-cast Meter Status Requests to a selected set of meters based on grid connectivity/topology.	1	6, 15
Meter Status Requests sent to SmartConnect NMS from any other system (such as the OMS) shall include the identity of the meter or meter group and the time the request was sent.	1	6, 15

Functional Requirements	*Associated Scenario # (if applicable)*	*Associated Step # (if applicable)*
The SmartConnect NMS shall include the following information in responses to Meter Status Requests it forwards to clients (such as the OMS) from meters: • Success or failure – whether the NMS received a response within the configured timeout • Time that the NMS received the Meter Status Request (from external system) • Time when the Meter received the Meter Status Request from the NMS and responded • Time that the NMS received the Meter Status Request response from the meter • Length of time the meter was up at the time it received the Meter Status Request • Service switch status • Voltage on each side of the switch • Current • Meter's most recent register read value	1	6, 15
The OMS shall send its first Meter Status Request message to its calculated predicted open device in order to identify the extent of an outage.	1	6
Once the OMS receives a positive response from a Meter Status Request, it shall stop sending these requests and re-run its algorithm to identify a new predicted open device in order to determine the extent of an outage.	1	6
Each meter shall transmit an AC Restored message to the SmartConnect NMS upon detecting power restoration.	1 4	11 8
Each meter shall include shall include meter identifier, time of restoration detection, and voltage reading upon restoration in each AC Restored message.	1	11
The SmartConnect NMS and meter shall ensure AC Restored messages from meters are not lost due to other communications traffic.	1 4	13 10
The OMS shall be able to receive and process AC Restored messages from meters to update outage status following restoration.	1	14
Upon restoration, the OMS shall send Meter Status Requests to a random sampling of meters (known to be a part of the outage) not already reporting AC Restored messages.	1	15

Functional Requirements	*Associated Scenario # (if applicable)*	*Associated Step # (if applicable)*
The OMS, upon confirming an outage to a particular location (via Meter Status Request or other means) shall not issue additional Meter Status Requests to the area until restoration has been completed and confirmed by field resources or through receipt of AC Restored messages from the meters.	1	15
The SmartConnect NMS shall permit the VRU to send Meter Status Requests on-demand and shall forward the responses to the VRU.	3	2
The CSS shall be able to subscribe for notification of outages and restorations from the SmartConnect NMS to satisfy customer inquiries.	3	6
The SmartConnect NMS shall permit the CSR (via CSS) to send Meter Status Requests on-demand and shall forward the responses to the CSS.	3	7
The CSS shall forward meter status response information to the OMS at the request of a CSR as part of a trouble order.	3	9
The SmartConnect NMS shall permit the OMS to send outage status information to meters and In-Home Displays.	3	11
As the status of an outage changes (e.g. its area and predicted resolution time), the OMS shall send outage status information to the CSS, the utility Web site, and to meters and In-Home Displays via the SmartConnect NMS.	3	11
The CSS shall be able to display for the CSR the same outage status information that the customer can see on the meter or In-Home Display.	3	11, 13, 14
The In-Home Display shall show information related to planned outage timing and duration.	3	14
A Cell Relay shall not transmit an AC Out message if it receives a corresponding AC Restored message from the same meter within a configurable period of time.	4	3
A Cell Relay shall be able to throttle or aggregate a high volume of AC Out messages from meters in its reception area for transmission to the SmartConnect NMS. High volume has not yet been defined.	4	3
The Cell Relay shall be configurable for the interval it takes to wait for an AC Restored message from a meter after receiving an AC Out message (between 0 and 10 minutes).	4	3
The Cell Relay shall be capable of performing complex logic on the payload of incoming AC Out messages and synthesizing new messages to pass upstream, rather than just automatically forwarding incoming messages.	4	3

Functional Requirements	*Associated Scenario # (if applicable)*	*Associated Step # (if applicable)*
The SmartConnect NMS shall be able to throttle or aggregate a high volume of AC Out messages for sending on to the OMS.	4	4

4.2 Non-functional Requirements

Non-Functional Requirements	*Associated Scenario # (if applicable)*	*Associated Step # (if applicable)*
For outage notification to be useful, the SmartConnect communication system shall be at least as reliable as the power system it is monitoring and reporting on. A reliable communications system is needed to avoid needless crew dispatches.	1	3
The SmartConnect network shall be capable of communicating outage/restoration information simultaneously (200 meters) and instantaneously (5 seconds).	1 4	2, 13 2, 8
SmartConnect NMS shall report outage/restoration information to OMS in 1-5 minutes.	1 4	2, 13 2, 8
In order to act before the first customer calls, the LGS shall provide the OMS with AC Out messages within 5 minutes of the meters detecting the outage.	1	4
The OMS shall limit Meter Status Requests to verify restoration to one request per second for every 100 customers.	1	6
The OMS shall be able to send Meter Status Requests for up to 20 percent of the meters in the affected area beyond the predicted open device in order to validate outage location.	1	6
OMS shall send Meter Status Requests to at least one meter to confirm an outage.	1	6
The SmartConnect NMS shall provide the OMS with responses to Meter Status Requests within 1 to 2 minutes.	1	7
The SmartConnect NMS shall provide Meter Status responses to the VRU within 1 minute of the request.	3	3
The SmartConnect NMS shall be able to retrieve AC Out/AC Restored logs from meters and provide the information to the OMS on a daily basis for historical analysis.	4	14

4.3 Business Requirements

Business Requirements	*Associated Scenario # (if applicable)*	*Associated Step # (if applicable)*

5. Use Case Models (optional)

This section is used by the architecture team to detail information exchange, actor interactions and sequence diagrams

5.1 Information Exchange

Scenario #	Step #, Step Name	Information Producer	Information Receiver	Name of information exchanged
#	Name of the step for this scenario.	What actors are primarily responsible for producing the information?	What actors are primarily responsible for receiving the information?	Describe the information being exchanged
1	2	Meter	Cell Relay	AC Out Meter ID Time of outage
1	3	Cell Relay	SmartConnect NMS	AC Out – for meter or for self
1	4	SmartConnect NMS	LGS	AC Out
1	4	LGS	OMS	AC Out
1	6	OMS	SmartConnect NMS	Meter Status Request (to determine extent of outage) Meter ID or Meter Group ID
1	6	SmartConnect NMS	Cell Relay	Meter Status Request
1	6	Cell Relay	Meter	Meter Status Request

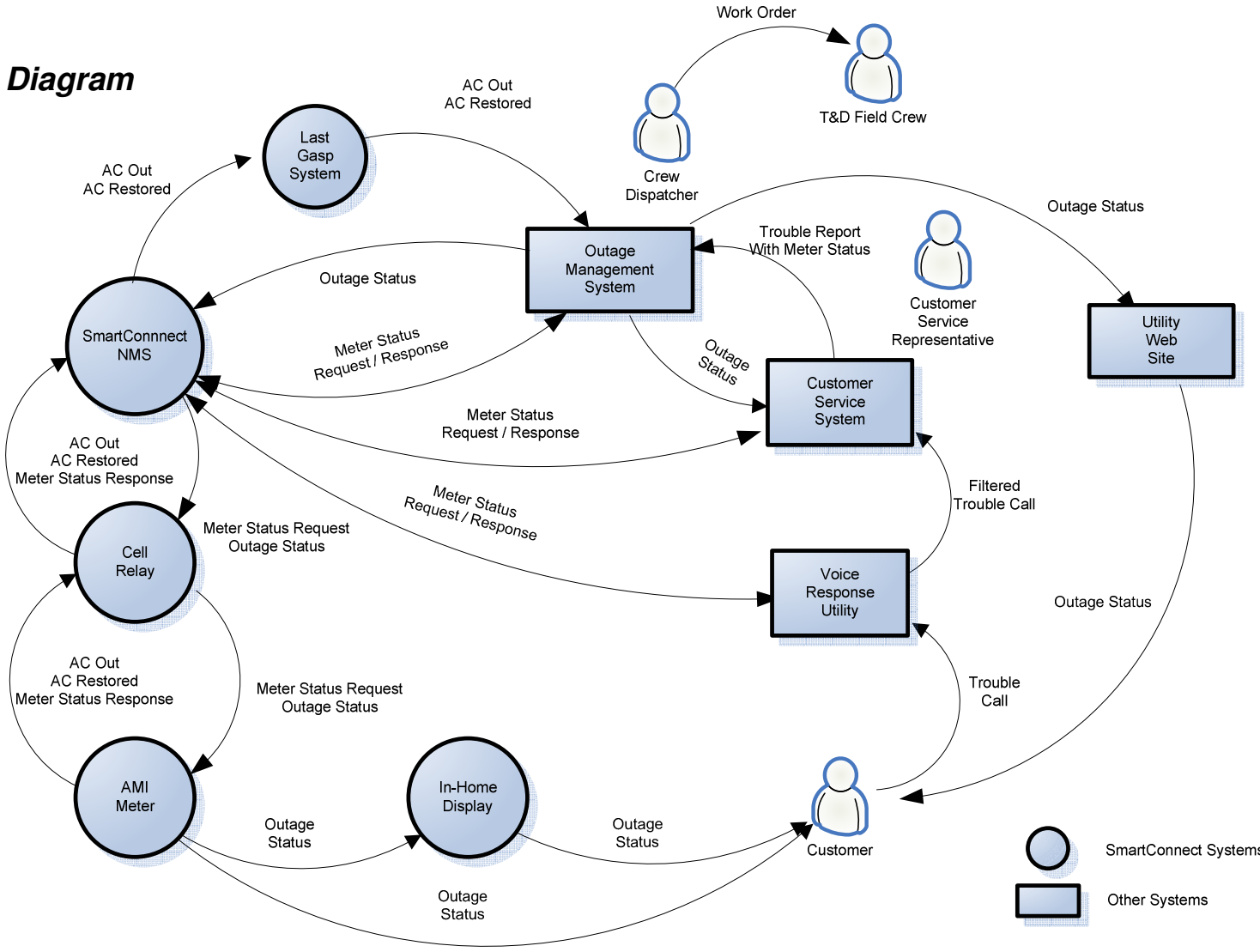
Scenario #	Step #, Step Name	Information Producer	Information Receiver	Name of information exchanged
1	7	Meter	Cell Relay	Meter Status Response • Time when the meter received the Meter Status Request from the NMS and responded • Length of time the meter had been up at the time of receiving the Meter Status Request • Service switch status • Voltage on each side of the switch • Current • Meter's most recent register read value
1	7	Cell Relay	SmartConnect NMS	Meter Status Response
1	7	SmartConnect NMS	OMS	Meter Status Response incl. • Success/failure of request • Time when NMS received the request • Time when NMS received the response
1	9	Crew Dispatcher	T&D Field Crew	Work Order
1	11	Meter	Cell Relay	AC Restored • Meter ID • Time of restoration • Voltage on restoration
1	12	Cell Relay	SmartConnect NMS	AC Restored
1	13	SmartConnect NMS	OMS	AC Restored
1	15	OMS	SmartConnect NMS	Meter Status Request (to confirm restoration)
1	15	SmartConnect NMS	Cell Relay	Meter Status Request
1	15	Cell Relay	Meter	Meter Status Request
1	15	Meter	Cell Relay	Meter Status Response
1	15	Cell Relay	SmartConnect NMS	Meter Status Response
1	15	SmartConnect NMS	OMS	Meter Status Response

Scenario #	Step #, Step Name	Information Producer	Information Receiver	Name of information exchanged
1	18	SmartConnect NMS	Cell Relay	Daily Read Request
1	18	Cell Relay	Meter	Daily Read Request
1	18	Meter	Cell Relay	Daily Read Response • Usage history • Event logs
1	18	Cell Relay	SmartConnect NMS	Daily Read Response
1	18	SmartConnect NMS	OMS	AC Out and AC Restored (taken from event logs – if not already sent)
3	1	Customer	VRU	Trouble call
3	2	VRU	SmartConnect NMS	Meter Status Request (check customer-side voltage)
3	2	SmartConnect NMS	Meter	Meter Status Request
3	3	Meter	SmartConnect NMS	Meter Status Response
3	3	SmartConnect NMS	VRU	Meter Status Response
3	4	VRU	Customer	Summary of Meter Status Response
3	5b	VRU	CSS	Filtered Trouble Call (forwarded) Meter Status Response
3	6	Customer	CSR	Filtered Trouble Call
3	7	CSS	SmartConnect NMS	Meter Status Request (check customer-side voltage)
3	7	SmartConnect NMS	Meter	Meter Status Request
3	8	Meter	SmartConnect NMS	Meter Status Response
3	8	SmartConnect NMS	CSS	Meter Status Response
3	9	CSS	OMS	Trouble Order Meter Status Response
3	11	OMS	Utility Web Site	Outage Status • Affected area • Estimated time to repair

Scenario #	Step #, Step Name	Information Producer	Information Receiver	Name of information exchanged
3	11	Utility Web Site	Customer	Outage status
3	11	OMS	CSS	Outage status
3	11	OMS	SmartConnect NMS	Outage status
3	12	SmartConnect NMS	Meter	Outage status
3	13	Meter	Customer	Outage status
3	14	Meter	In-Home Display	Outage status
3	14	In-Home Display	Customer	Outage status (information from all sources matches)
4	2	Meter	Cell Relay	AC Out
4	3	Cell Relay	SmartConnect NMS	AC Out (for meters and for themselves)
4	4	SmartConnect NMS	OMS	AC Out
4	6	Crew Dispatcher	T&D Field Crew	Work Order
4	8	Meter	Cell Relay	AC Restored
4	9	Cell Relay	SmartConnect NMS	AC Restored
4	10	SmartConnect NMS	OMS	AC Restored and reception times
4	11	OMS	SmartConnect NMS	Meter Status Request (to confirm restoration)
4	11	SmartConnect NMS	Cell Relay	Meter Status Request
4	11	Cell Relay	Meter	Meter Status Request
4	13	Meter	Cell Relay	Meter Status Response
4	13	Cell Relay	SmartConnect NMS	Meter Status Response
4	13	SmartConnect NMS	OMS	Meter Status Response

5.2 Diagrams

5.2.1 Data Flow Diagram



6. Use Case Issues

Capture any issues with the use case. Specifically, these are issues that are not resolved and help the use case reader understand the constraints or unresolved factors that impact the use case scenarios and their realization.

Issue
Describe the issue as well as any potential impacts to the use case.
Specific questions around Edison SmartConnect system capabilities regarding throttling of AC Out messages, propagation of AC Out messages through mesh network during outage, and overall communications capability during an outage should be addressed during roadmap and architecture development activities.
There are concerns about how long the mesh radio system requires to pair up and re-establish communications when outages are occurring.
Need to define an appropriate threshold level or algorithm for determining what is considered high-volume of Last Gasp/AC Out messages. A separate threshold or algorithm must be defined for Cell Relays and the NMS, in addition to the hold and wait algorithm described in this use case.
Need to determine how often it would be appropriate to issue Meter Status Request messages.
Need actual statistics on the occurrences of false positives with the existing SmartConnect system.
Need to confirm that Cell Relays can communicate Last Gasp/AC Out messages to the utility when power to the cell Relay is lost. The use case assumes that Cell Relays have up to 4 hours of battery life for the purpose of communicating such messages back to the utility.
A potential requirement was not resolved regarding whether the SmartConnect system could or should use the parent-child relationships between the Cell Relays and the meters (e.g. meters know what primary cell relay they're associated with in a communications pathway) to infer how much restoration has taken place. There was some concern about this relationship being too fluid to track in real-time.

7. Glossary

Insert the terms and definitions relevant to this use case. Please ensure that any glossary item added to this list should be included in the global glossary to ensure consistency between use cases.

Glossary	
Term	**Definition**
Outage	Voltage on all legs < 10 % of normal for greater than 1 minute. Not being able to communicate to meter for greater than 1 minute.
Meter Status Request	A message sent to a meter or other device to verify communications connectivity and AC power status.
AC Out	A message sent by the meter indicating it no longer detects AC power on the utility side. Sometimes referred to as a Last Gasp message.
AC Restored	A message sent by the meter indicating it detects AC power on the utility side again after an outage.
SCADA	Supervisory Control and Data Access system, used to gather real-time (4 second) status and measurement information from the transmission and distribution substation network.
Meter Data Management System (MDMS)	System that gathers, validates, estimates, and permits editing of meter data such as energy usage, generation, and meter logs. It stores this data for a limited amount of time before it goes to a data warehouse and makes the data available to authorized systems.

8. References

Reference any prior work (intellectual property of companies or individuals) used in the preparation of this use case

Intelligrid *Use Case* D-5.1,

Open AMI Use Case #12.

9. Bibliography (optional)

Provide a list of related reading, standards, etc. that the use case reader may find helpful.