AMI Use Case:

D4 - Distribution operator locates outage using AMI data and restores service

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Author: Robert Yinger

Document History

Revision History

Revision Number	Revision Date	Revision / Reviewed By	Summary of Changes	Changes marked
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1.0	060131	Prafs Diwate	Initial document	N
1.1	060307	Prafs Diwate	Updated the document according to D4W2 final notes	
1.2	060313	Bob Yinger	Misc edits and additions	Y
1.5	060419	Bob Yinger	Incorporate edits from Charles Vincent, Kevin Wood and Mega Team Leads	Y

Approvals

This document requires following approvals.

Name	Title
Robert Yinger	*Mega Team Lead*
Robert G. Woods	*Use Case Team Lead*
Kevin Wood	*System Architecture Team Chair*
Charles Vincent	*Engineering Team Chair*

Contents

1. Use Case Description

1.1 Use Case Title

Distribution Operator locates Outage Using AMI Data and Restores Service

1.2 Use Case Summary

AMI offers excellent opportunities for enhancing a utility's ability to identify and rectify outages. Currently, utilities are constrained in their response to outages by the sensors, or information available to them. SCADA systems typically extend only to the substation. Remote Fault Indicators (RFIs) provide insight further into the network, but are limited in number. AMI is the only system that extends (by definition) to the extreme ends of the utility network. AMI systems can sense every line segment and transformer on the system. This capability can be used to verify not only pinpoint outages but power restoration as well, enabling utilities to proactively identify customers who have not yet been restored. Outages reported by other systems (SCADA, DCMS or even customers) can be explored to determine the extent of the outage. This capability can reduce labor and truck roll costs by better identifying the cause of outages and sending the proper people and equipment. Further truck rolls can be eliminated by verifying customer reported outages are not customer equipment issues.

In this use case, the DOC (Distribution Operations Center) dispatcher uses individual customer outage information to reduce the duration of outages. This utilizes the messaging from the customer meters or status of customer meters from the AMI system to determine the extent of the outage. Using this data, the utility locates the most probable failure point and re-configures distribution switches to minimize the impact of the fault (possibly by minimizing the number of critical customers affected by the fault). The fault location is also used to dispatch repair crews to the trouble areas to allow restoration of power to the remainder of the customers. Upon repair, the switches are re-configured back to their original positions.

Key Benefits of include but are not limited to:

- Improved customer satisfaction by using meters to help verify an outage.
- Detection of outages at distribution transformers or other common points of failure reduces the response time and potentially the cost of restoration
- Timely detection of outages allows for potentially improving the distribution network reliability statistics
- Detection and recording of outages allows for validation of liability claims (Utility would know which claims attributed to outages actually correlate to an outage and which ones do not)

1.3 Use Case Detailed Narrative

The distribution operator uses individual customer outage information provided by the AMI System and Outage Management System (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 the restoration of service.

In order to determine that an outage is occurring and record the duration of an outage in the distribution network, the OMS is sent outage reports by the AMI System.

Outage Management System (OMS)

The OMS determines the affected section of the distribution network and the probable location of the fault causing the outage from information sent to it by the AMI System and customer phone calls. For this it continuously monitors

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

Customer information

If an outage occurs, customers will contact the call center to inform the utility of the outage and to obtain information from the utility on the cause of the outage, the size of the affected area and the possible duration of the outage.

Outage detection

Outages at the individual customer site that are behind the meter will not affect the meter capability to communicate with the AMI system. In this case the meter will report the outage and will indicate that the supply side of the meter is not affected. This provides information to the call center that when the customer calls to report the outage; they can be informed that the problem is at their own premises.

Area outages can affect many customers and affect the ability of the meter to communicate with the AMI system. Therefore the outage detection in this case utilizes so called “last-gasp” messaging from the customer meters or other information from the AMI system to determine the extent of the outage. The AMI System indicates contact with meters in an area has been lost and allows the Outage Management System to deduce the outage area and equipment involved.

Crew Dispatch

The distribution operator can dispatch repair crews to isolate the outage and/or restore service and /or repair the damage. For this purpose he issues a work order to the repair crew. This work order includes the outage location and information regarding the affected customers from the Outage Management System. The crews are dispatched and periodically report the status of the repair to the Outage Management System.

1.4 Business Rules and Assumptions

- The use case applies to customers with a load smaller than 200 kW (i.e. non-RTEM customers)
- Outages that are caused by a supply failure in the distribution network involve several to many customers and may lead to meters not being able to communicate anymore with the AMI system
- If the Outage is at the customer site only, the meter will continue to communicate with the AMI system
- There is a benefit in knowing what locations in the distribution system are experiencing an outage to a higher degree of resolution than the current SCADA system can provide

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, customer, end users, service personnel, executives, meter, real-time database, ISO, power system). 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*
System Operator	Person	In case of an outage, the system operator controls switches and instructs service crews to restore power
Dispatcher	Person	In case of an outage (power failure) the dispatcher looks at the OMS system to determine the problem and send crews to do repairs
Customer Service System (CSS)	System	Customer Service System, also know as Customer Information System. Maintains customer contact information, calculates and formats customer bills, receives and applies payments for individual accounts.
Outage Management System (OMS)	System	A distribution management system that provides a rule based analysis engine which can correlate end point outages and infer root causes by identifying points of commonality among multiple endpoints using information from AM/FM (Automated Mapping & Facilities Management), GIS (Geographical Information System), CIS (Customer Information System), SCADA (Supervisory Control and Data Acquisition) and AMI. Typically Outage Management Systems help reduce outage duration and assist with the development of appropriate restoration plans. They also support event notification and prioritization, case management and summarizations.
Meter	Device	Advanced electric revenue meter capable of two-way communications with the utility. The meter can receive, record, display and transmit data (e.g. energy data for billing and operations, power quality data, customer data, tariff data, etc.) to and from authorized systems and provides other advanced utility functions.
Call Center	System	Location that customers call when they want to report an electrical system outage. This call center them forwards the information from the customer call to the Outage Management System for analysis
T&D Crew	Person	When a problem on the distribution system is identified, a T&D crew is dispatched to diagnose and repair the failed equipment. This crew will keep the Call Center

Actor Name	*Actor Type (person, device, system etc.)*	*Actor Description*
		informed of progress for restoration of power.

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 starting 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 scenario (set of steps) that is relevant, make a copy of the following section (all of 3.1, including 3.1.1 and tables) and fill out the additional scenarios.

3.1 Primary Scenario: Lateral Outage

In this scenario, an outage occurs on a distribution system lateral (a branch off of the main distribution circuit that typically has 10 to 100 customers on it). The Outage Management System OMS) is fed information from the AMI System and other sources. Using this information, the OMS is able to identify the most probable location of the outage and dispatch crews to make repairs. Once repairs are completed, the AMI system confirms that all customers now have power.

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)*
Occurrence of outage	Outage Management System	Electrical system operating normally	Outage restored completely

3.1.1 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	Meter	Meter reports outage (meter #, ISVC #, date/timestamp of outage), opens meter disconnect.	
2	OMS	OMS receives outage information.	
3	Call center	Call center notified of the outage.	
4	OMS	OMS calculates outage location.	
5	Dispatcher	Crew dispatched by dispatcher.	
6	T&D Crew	Crew restores service.	
7	Meter	Meter reports restoration to OMS. • Disconnect closes after random interval. • Devices that were under load control will be restored after a random interval if the load control period has expired	
8	Dispatcher	Dispatcher verifies if all customers are restored using OMS.	
9		Outage restored completely.	

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

In some cases, when the main outage cause is repaired, some customers will still be without power due to other problems that occurred at the same time as the initial outage. This scenario describes what will be done to detect these outages and dispatch crews to make the needed repairs

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	Outage Management System	Lateral outage has occurred previously	All customers restored

3.2.1

3.2.2 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.*
8.1.1	OMS	Subset of customers not restored as determined by the AMI System and communicated to OMS	AMI System will be able to determine if power to some meters are not restored when the outage is repaired
8.1.2	OMS	Dispatcher determines which crew will be sent to fix the problem based on OMS information. Go to step # 5 (Main Scenario)	

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)*
AMI System shall maintain access to or have its own copy of a customer – transformer structure link to support outage location.	1	1
Meter shall communicate if it is energized (has voltage)	1 2	2, 8 8.1.1
AMI System shall record outage information on a meter by meter basis	1	2
AMI System shall record the duration of outage for later statistical analysis.	1	2
Meter shall report restoration information (voltage quality and quantity)	1 2	7 8.1.1
OMS shall receive outage/ restoration information from the AMI System for many meters over a short period of time	1	2
Meter shall differentiate between sags (power quality events) and an outage	1	1
Meter disconnect switch shall operate only on events that are true outages	1	1
Meter shall maintain sufficient function for a sufficient amount of time to differentiate between an outage and a PQ event	1	1
Operational setpoints for the disconnect switch in the meter (disconnect / reconnect) shall be configurable by the utility. Default parameters are specified in the nonfunctional requirements, but these setpoints may need to be modified to meet specific system conditions. Configuration parameters should include minimum voltage and duration of that voltage to trigger disconnects.	1	1

Functional Requirements	Associated Scenario # (if applicable)	Associated Step # (if applicable)
For overvoltage, maximum voltage and duration will also be supported.		
The meter shall be functional for a long enough period of time to provide for correct operation of the meter disconnect as the meter is powering down during an outage	1	1
For outage notification to be useful, the AMI 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	1
The Call Center shall be able to see the same information that the customer can see on the meter / home display	1	1
The in home display shall show information related to planned outage timing and duration	1	1
The Call Center will be able to accept notification of outages and restorations from the AMI system so that customers inquiries can be satisfied	1	3, 8

4.2 Non-functional Requirements

Non-Functional Requirements	Associated Scenario # (if applicable)	Associated Step # (if applicable)
The internal disconnect shall close after a random interval of 0-30 sec upon restoration of voltage	1	7
Devices under load control shall be restored after a random interval of 0-30 min upon restoration of voltage if the load control event has expired	1	7
AMI System shall be capable of communicating outage/restoration information of 200 meters simultaneously and instantaneously (5 sec).	1	2, 7
AMI System shall report outage/restoration information to OMS within 1-5 min.	1 2	2, 7 8.1.1
AMI System shall be 99% accurate in reporting outages so that repair crews can be dispatched	1	2, 7

Non-Functional Requirements	Associated Scenario # (if applicable)	Associated Step # (if applicable)
to the correct locations (see NFR4)		
The internal disconnect operates if voltage <= 85 v for more than 3 sec (This voltage is so low that customer equipment might be damaged)	1	1
The internal disconnect operates if voltage >= 135 v (112% of nominal) for more than 3 sec.	1	1
Reconnection of the internal meter disconnect switch shall occur after voltage has returned to and remained above 90% of nominal voltage for at least 3 sec. Reconnection after a low voltage initiated disconnect will apply the same rules	1	7
Outage information to be reported to the OMS system will include: • meter number • ISVC number • date/time of outage	1	1,2

4.3 Business Requirements

Business Requirement	Associated Scenario # (if applicable)	Associated Step # (if applicable)
SCADA, AMI, OMS, and communications systems must work together to identify fault occurrence and location	1 2	

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

For each scenario detail the information exchanged in each step

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
1.1	1	Meter	OMS	(meter #, Service Point, ISVC #, date/timestamp of outage)
1.1	3	OMS	Call Center (via CSS)	Outage Notification (start time, customers affected by logical grouping)
1.1	5	OMS	Dispatcher	Root Cause

5.2 Diagrams

The architecture team shall use this section to develop an interaction diagram that graphically describes the step-by-step actor-system interactions for all scenarios. The diagrams shall use standard UML notation. Additionally, sequence diagrams may be developed to help describe complex event flows.

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 have an impact of the use case scenarios and their realization.

Issue
Describe the issue as well as any potential impacts to the use case.

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 min
Low voltage	Voltage < 85 v for at least 3 sec
High voltage	Voltage > 135 v for at least 3 sec
Part lights	Voltage is present only on one leg of the meter
DOC	Distribution Operations Center

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,

OpenAMI Use Case #12.

9. Bibliography (optional)

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