SmartConnect Use Case:
D7 – Distribution Planner uses SmartConnect to Optimize Asset Utilization

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Document History

Revision History

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Approvals

This document requires following approvals.

Name	Title
Bryan Lambird	Project Manager, Edison SmartConnect
Robert Yinger	Consulting Engineer, TDBU Engineering Advancement

Contents

1. Use Case Description

1.1 Use Case Title

Distribution Planner Uses SmartConnect to Optimize Asset Utilization.

1.2 Use Case Summary

This use case describes how a distribution planner can leverage the SmartConnect communications technologies and use customer meter data gathered by the SmartConnect system to more efficiently deploy, maintain and replace distribution transformers and other distribution grid assets.

1.3 Use Case Detailed Narrative

Presently, the utility can only estimate, not accurately predict, how heavily loaded a distribution transformer is and when it might fail. This estimate is based on the average load profiles of similar transformers, the nameplate rating of a transformer, transformer age, a list of connected customers (possibly incorrect as topology information is imperfect), and monthly energy usage.

Using the SmartConnect system makes it possible to know with much greater accuracy how much energy is flowing through the transformer at any given time, creating an actual load profile for that specific transformer based on measured data. This capability provides a number of potential benefits for the utility, including:

- Reducing unplanned outages by predicting failures and replacing overloaded transformers before the onset of heat storm season, when typically 1500-2000 transformers are lost.
- Sound decision-making to determine whether to move a given customer from one transformer to another.
- Discovering suspect transformers while investigating voltage complaints.
- Relocating lightly-loaded transformers for better utilization and moving overloaded transformers to areas with less load.
- Understanding how much load growth can be accommodated by any given transformer.
- Choosing the appropriate transformer size when replacing failed transformers.
- Knowing whether transformers are performing according to their published specifications.
- Improving customer service and avoiding emergency/overtime work by replacing a large percentage of unplanned outages with planned maintenance.
- Accurately optimizing capacitor bank size and location based on actual Volt/VAR readings.

- Troubleshooting voltage problems by knowing the voltage at each customer access point on the feeder.
- Scheduling maintenance and adjusting load based on accurate indications of conductor, sectionalizer and regulator overload rather than estimates and periodic scheduling.

This use case proposes using a Transformer Load Calculation Engine (TLCE) application to calculate (based on meter load profile data retrieved from the Meter Data Management System (MDMS)) an odometer-like measurement for each configured transformer or group of transformers that reflects not only total kWh, but age and severity of use as well. The application also records load profile, statistics, and lifespan predictions for the transformer at various loading levels. As the system matures, the application bases its predictions for a given transformer on data gathered from other transformers of similar type using their nameplate ratings, ages and load at the time of failure.

Calculations are based on the sum total of metering data for all customers connected to a particular transformer. An accurate database of the topology of the system, especially transformer-to-customer mapping, is necessary for these calculations. Although the existing utility Transformer Load Management (TLM) database stores this type of information, improving the quality of the data would significantly enhance its usefulness.

This use case assumes the existence of a new device installed either within the meter or directly associated with it to improve the TLM connectivity data between customer and transformer. The device uses Power Line Carrier (PLC) technology to identify all the meters connected to a particular distribution transformer. Each meter builds a list of known neighbors (i.e. those connected to a common transformer and phase) based on messages exchanged between the various PLC information technology devices (PLC IT Device). A new application known as a Topology Correlation Engine gathers these neighbor lists and uses them to calculate and store an accurate transformer-to-customer mapping in the TLM Database. This information can then be used to update the Geographical Information System (GIS), Outage Management System (OMS) and other applications that could benefit from improved transformer/customer relationship data.

Mounting sensors directly on transformers or other distribution assets are also addressed in this use case to determine their effectiveness in detecting alarm conditions such as high temperature, low oil level, and high or low pressure. The information provided by these sensors can be transmitted back to the appropriate organization by way of the metering system facilitating preventative rather than reactive or periodic maintenance of assets.

Six scenarios are covered in this use case:

1. **Utility gathers circuit and/or transformer load (TLM) profiles.** This scenario describes how the Topology Correlation Engine builds the necessary transformer-to-customer mapping.
2. **Planners improve transformer utilization using SmartConnect data.** This scenario describes how the Transformer Load Calculation Engine regularly creates transformer load profiles, statistics and remaining-life predictions.
3. **Utility uses SmartConnect technology to support condition-based predictive asset replacement programs**. This scenario describes how sensors on the transformers and other distribution equipment communicate alarm conditions to the appropriate organizations in the utility via the metering system.
4. **Planners schedule maintenance using meter load data.** This scenario describes how planners use exception reports generated from the transformer loading data to schedule maintenance work.
5. **Planner uses Volt/VAR information to resize capacitor bank.** This scenario describes how planners use voltage and VAR information gathered from SmartConnect meters to determine the appropriate size for a capacitor bank.

6. **Field crew uses SmartConnect data to diagnose a low voltage complaint.** This scenario describes how a Transmission and Distribution (T & D) field crew uses SmartConnect data to diagnose and determine the course of action for a customer low voltage complaint.

1.4 Business Rules and Assumptions

- Circuit topology has been captured down to the feeder level.
- A TLM database exists to associate meters, transformers and structures.
- Circuit topology and connectivity updates are **not** real-time.
- The TLM database maintains updates to the topology on the secondaries (below the distribution transformers).
- All the new smart meters on a circuit have been installed.
- The meter data used to calculate loading are validated and able to pass through the MDMS before calculation.
- The Enterprise Asset Management module of the ERP stores and tracks records of meters, sensors, and topology discovery devices.

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, ISOs, 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
Condition Sensor	Device	Monitors the physical condition of utility primary equipment such as transformers, circuit breakers, or switches. Measures items such as fluid level, temperature, pressure, or operation counts. Different than other types of sensors used by utilities; it does not measure operational information such as voltage, current or the position of switches, it merely reports on the health of the equipment that makes up the electrical network.
Crew Dispatcher	Person	Responsible for dispatching field crews to investigate outages or customer complaints. Uses the OMS.
Customer	Person	A residential or small business energy user that has contracted with the utility to receive electrical service from the utility and has a SmartConnect meter installed. May or may not participate in programs provided by the utility including pricing events, load control or distributed generation.
Customer Service System (CSS)	System	Maintains customer contact information. Calculates and formats customer bills. Receives and applies payments for individual accounts. Responsible for storing customer information such as site data, meter number, rates, and program participation.
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. Enrolls customers in utility sponsored programs and answers 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.
Distribution Transformer	Device	Provides the final step-down of voltage from distribution levels to customer level. Approximately 750,000 in the SCE system.
Enterprise Asset Management (EAM)	System	Module of the Enterprise Resource Planning systems concerned with storing and updating information regarding utility assets.
Geographic Information system (GIS)	System	Manages information about the power grid, location of grid assets, and capabilities and relationships between assets. At SCE, this system is a subsystem of the OMS.

Actor Name	Actor Type (person, device, system etc.)	Actor Description
Management Dashboard	System	A software application that provides transformer maintenance information to planners.
Meter Data Management System (MDMS)	System	Gathers, validates, estimates, and permits editing of meter data such as energy usage, generation and meter logs. Stores this data for a limited amount of time before it goes to the Meter Data Warehouse and makes the data available to authorized systems.
Meter Data Warehouse	System	Responsible for long-term storage of meter data including energy usage, demand, generation, events, logs, and other time-related information measured by the meter or calculated from that data. Does not contain information on the configuration, management, diagnostics, and maintenance of the meters themselves. Includes certain software applications responsible for filtering, analyzing, and reporting meter data.
Meter Data Collector	Device(s)	Collects data, messages, etc. from repeaters, meters and/or premise gateways and forwards them to the SmartConnect NMS through the WAN.
Outage Management System (OMS)	System	A distribution management system that uses an analysis engine to identify outage locations. Correlates end-point outages and infers root causes by identifying common failure points that are grouped upstream using information from the GIS, CSS, SCADA, customer calls, and SmartConnect systems. OMS requires knowledge of the power system topology. It helps reduce outage duration and assists with restoration plans.
Planning Data Warehouse	System	A storage location for planning-related information. Not related to usage or demand data, such as voltage and VAR histories.
Power Line Carrier Information Technology Device (PLC IT)	Device	Contained within or strongly associated with a meter, it communicates with other PLC IT devices on the same transformer secondary and phase, allowing the meter to identify its neighbors.
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). Provides additional 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.

Actor Name	Actor Type (person, device, system etc.)	Actor Description
T&D Engineering	Organization	Responsible for the total engineering process within transmission and distribution projects including typical design, detailed design, testing, and commissioning.
T&D Field Construction	Organization	A department that includes field service personnel for power transformers. Performs manual operations, repair, and construction work as instructed by work orders developed and authorized by the T&D planning department.
T&D Field Crew	Person(s)	Performs manual operation of field devices, repair and construction work. Works on power system equipment in the field, as instructed by work orders and authorized by the distribution operator or other utility personnel dispatched by a system operator to fix a fault.
T&D Planner	Person	Develops, designs, and schedules changes to and maintenance of the distribution network.
Topology Correlation Engine	System	A software application that uses information provided by customer meters to build the Transformer Load Management (TLM) database containing the mapping between customers and transformers.
Transformer Load Calculating Engine	System	A software application that gathers raw customer usage data from the MDMS and totals it to periodically calculate odometer readings, load profiles, statistics, and remaining-life estimates for each transformer, switch, segment, circuit breaker, feeder, or other element of the distribution system.
Transformer Load Management (TLM) Database	System	Stores two primary types of information: connectivity data describing which customers are connected to which transformers, switches, segments, circuit breakers, feeders or other elements of the distribution system; and historical loading data, capturing how much load is on any of these elements at a given time. Utilizes software applications to generate analyses and reports (periodically or on request) from the collected data.
Utility	System	A generic term referring to the collection of systems, business functions, and organizations that form an electric utility organization. The term is used whenever the precise actor is not known or many actors utilize a service.

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 word "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 or relevant set of steps, make a copy of the following section (all of 3.1, including 3.1.1 and tables) and complete the additional scenarios.

3.1 Primary Scenario: Utility gathers transformer-to-meter connectivity information

As described in the main narrative section, this scenario uses the SmartConnect system to gather topology information sufficient for calculating load profiles and stores the information in the TLM Database.

Triggering Event	***Primary***	***Pre-Condition***	***Post-Condition***
(Identify the name of the event that initiates 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 complete the scenario)*
A SmartConnect Meter or a Distribution Transformer is replaced, repaired, moved, or installed.	Utility	The TLM database is in place and ready to accept changes. The OMS and GIS already contain connectivity information down to the distribution transformer level.	TLM database is automatically updated when topology changes are made allowing applications such as the OMS and GIS to utilize current updated topology data.

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 step value to help support the descriptions. Short notes on architecture challenges, etc. may also be noted in this column.*
1	T&D Field Crew	Connects a SmartConnect Meter to a new Distribution Transformer.	May be a new installation, maintenance, or repair.
2	PLC IT Device	Transmits identification messages from the meter it's strongly associated with to all other meters connected to the same transformer and phase.	Devices on other transformers cannot see these messages. The transformer may also have an associated PLC IT device permitting it to transmit its own identification to all the connected meters.
3	SmartConnect Meter	Builds a new neighbor list from the PLC messages and transmits it to the Topology Correlation Engine at the end of the day.	Other meters on the same transformer send updates at the end of the day when they identify a new neighbor. If the transformer has a PLC IT device it appears on the neighbor list of each meter. The meters can elect a master meter as the only meter to send an update and reduce message traffic.
4	Topology Correlation Engine	Back-office use of updated neighbor lists to update meter-to-transformer connectivity information in the TLM database.	
5	Topology Correlation Engine	Sends topology updates to other systems that subscribe to this information (e.g. OMS, GIS, etc.).	

Step #	Actor	Description of the Step	Additional Notes
6	Topology Correlation Engine	Generates reports indicating when meters appear to be mismatched or unattached to any transformer.	
7	Utility	Accesses the updated topology and/or customer data through related applications (i.e. OMS, etc).	

3.2 Primary Scenario: Planners improve transformer utilization using SmartConnect data

This scenario describes how planners can, regularly or on-demand, receive load profiles, statistics and TLM odometer readings for all transformers in the system.

Triggering Event	***Primary Actor***	***Pre-Condition***	***Post-Condition***
(Identify the name of the event that initiates 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 complete the scenario)*
Planner requires information regarding the loading of a particular transformer to determine whether it should be replaced.	Planner	Edits and updates have been made to the TLM Database so the topology of transformers and customers is accurate, per the scenario in 3.1.	Transformer load profiles and statistics are stored in the TLM Database regularly so the planner is able to retrieve the necessary information about the transformer in question.

3.2.1 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 step value to help support the descriptions. Short notes on architecture challenges, etc. may also be noted in this column.*
1	MDMS	Gathers and stores interval usage data for all meters in 15-minute or hourly intervals on a daily basis.	
2	Transformer Load Calculating Engine	Periodically requests usage data from MDMS for customers based on the transformers configured and the topology information in the TLM Database.	Configuration intervals may be daily to weekly. Window of calculation is 3 months.
3	Transformer Load Calculating Engine	Performs the following functions for each configured transformer: • Totals hourly interval data for all customers associated with the transformer in the customer-to-transformer database • Calculates hourly loading profiles for the transformer • Performs calculations of summary statistics • Updates TLM odometer • Calculates remaining life metrics	Calculations of interval data for the transformer help determine load imbalance. The same calculations can be made for groups of transformers (feeders or circuit segments) and other distribution equipment such as switches or sectionalizers.
4	Transformer Load Calculating Engine	Stores the transformer load profile, summary statistics, transformer odometer reading, and remaining life metrics in the TLM database.	
5	Planner	Retrieves load profile and statistics information from the TLM database including weekly exception reports.	May also request reports on specific transformers at varying intervals.
6	Planner	Reconfigures the distribution system to ensure the transformer is not overloaded.	

3.3 Primary Scenario: Utility uses SmartConnect technology to support "condition based" predictive asset replacement programs

This scenario describes how alarm conditions such as oil temperature, level, and pressure are communicated through the metering system to the appropriate organization.

Triggering Event	***Primary Actor***	***Pre-Condition***	***Post-Condition***
(Identify the name of the event that begins 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 complete the scenario)*
A sensor on a distribution transformer (or other distribution grid asset) raises an event.	Distribution Transformer or other distribution grid asset.	Transformer and other distribution sensors are connected to the metering network.	The EAM system sends daily exception reports to T&D Planning and T&D Field Construction on the condition of transformers and other assets.

3.3.1 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 step value to help support the descriptions. Short notes on architecture challenges, etc. may also be noted in this column.*
1	Condition Sensor	A condition sensor on a distribution transformer (or other distribution grid asset) detects an alarm event.	May be due to changes in oil level, temperature, voltage, pressure, or other condition such as fault indications.
2	Condition Sensor	Communicates the event via a SmartConnect enabled communication network, through network data collector points.	
3	Meter Data Collector	The meter collector point returns data to the SmartConnect NMS over the WAN.	
4	SmartConnect NMS	The SmartConnect NMS provides data to an EAM system.	
5	EAM System	EAM produces a daily exception report on asset conditions.	Report is sent to T&D Planning and T&D Field Construction.

3.4 Primary Scenario: Planners schedule maintenance using meter load data

This scenario describes how planners use transformer load monitoring information to determine when maintenance of transformers is necessary.

Triggering Event	*Primary Actor*	*Pre-Condition*	*Post-Condition*
(Identify the name of the event that initiates 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 complete the scenario)*
Planner periodically receives an exception report from the TLM Database.	Planner	The scenario described in section 3.2 is complete.	T&D Field Crew receives the order to schedule maintenance on the transformer.

3.4.1 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 step value to help support the descriptions. Short notes on architecture challenges, etc. may also be noted in this column.*
1	TLM Database/Meter Data Warehouse	Periodically sends an exception report to the planner.	Part of the scenario described in D7-02.
2	T&D Planner	Evaluates the exception report, comparing odometer data and remaining life metrics with actual status as determined by ad hoc reviews of latest data available in the Meter Data Warehouse.	Replacement metrics thresholds are based on correlation with failures, metrics, and/or asset type/vendor/age.
3	T&D Planner	Identifies all transformers requiring maintenance repair and/or replacement.	
4	T&D Planner	Prepares a work order identifying the problem and its location. Work order is completed by construction personnel.	Construction personnel are for power transformers.
5	T&D Planner	Sends maintenance work order to the department or personnel that schedules the construction maintenance work.	
6	T&D Field Construction	Department for power transformers that receives the maintenance work order and schedules the work.	
7	T&D Field Crew	Receives the scheduled maintenance work order.	

3.5 Primary Scenario: Planner uses Volt/VAR information to resize capacitor bank

This scenario describes how planners use voltage and VAR information gathered from SmartConnect meters to determine the appropriate size for a capacitor bank.

Triggering Event	***Primary Actor***	***Pre-Condition***	***Post-Condition***
(Identify the name of the event that initiates 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 complete the scenario)*
Time has come for periodic review of reactive compensation on all feeders	Planner	SmartConnect NMS and SmartConnect meter have been previously configured to gather Volt/VAR information from a subset of meters	Planner has placed a work order to resize a capacitor bank.

3.5.1 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 step value to help support the descriptions. Short notes on architecture challenges, etc. may also be noted in this column.*
1	Meter	A selected subset of SmartConnect meters report voltage and VAR readings as part of their daily read response.	Subset of meters and sampling rate must be selected so that samples are statistically valid for isolating daily, weekly, monthly and seasonal variations. Only one meter out of multiple meters located at electrically equivalent positions needs to report voltage/VAR data.
2	SmartConnect NMS	Separates voltage and VAR readings and sends them to the Planning Data Warehouse. Sends usage data to MDMS.	
3	T&D Planner	Queries voltage and VAR history for the subset of meters collecting voltage and VAR readings on a specific feeder from the Planning Data Warehouse.	Future queries may be performed by a Distribution State Estimator
4	T&D Planner	Notes periods in the feeder history when voltage drops or VARs increase excessively, either due to daily, seasonal, or other regular patterns.	
5	T&D Planner	Issues work order to resize and possibly relocate capacitor bank to compensate for the voltage drop.	

3.6 Primary Scenario: Field Crew uses SmartConnect data to diagnose low voltage complaint

This scenario describes how a T&D Field Crew can use SmartConnect data to diagnose and determine the course of action for a customer low voltage complaint.

Triggering Event	***Primary Actor***	***Pre-Condition***	***Post-Condition***
(Identify the name of the event that initiates 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 complete the scenario)*
Customer calls complaining of low voltage.	T&D Field Crew	Voltage on a particular feeder is low.	T&D Field Crew has successfully resolved the trouble call.

3.6.1 Steps for this 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 step value to help support the descriptions. Short notes on architecture challenges, etc. may also be noted in this column.*
1	Customer	Calls CSR to report low voltage event.	
2	CSR	Issues trouble report regarding low voltage complaint.	
3	Crew Dispatcher	Queries OMS for voltage and VAR information on the affected feeder for the most recent week and day.	
4	Outage Management System	Reads voltage and VAR history from Planning Data Warehouse and displays it for the dispatcher.	
5	Crew Dispatcher	Attaches voltage history to trouble report and dispatches T&D Field Crew to investigate the problem.	
6	T&D Field Crew	Uses voltage history to locate the voltage problem.	
7	T&D Field Crew	Requests present voltage reading for a particular premise by: a. Using Field Tool to Home Area Network to meter b. Calling dispatcher who initiates an on-demand read request from the OMS	
8	Meter	Reports current voltage reading to T&D Field Crew via: a. Home Area Network to Field Tool b. SmartConnect NMS, OMS and Dispatcher	
9	T&D Field Crew	Uses voltage reading to investigate and resolve complaint.	

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)
The GIS and OMS shall maintain an accurate representation of connectivity between feeders and distribution transformers.	1	Precondition
Each meter shall be associated with a PLC IT Device capable of determining, through power-line carrier (PLC) or other means, whether it shares the same Distribution Transformer and phase with other such devices.	1	2
Each PLC IT Device shall be strongly associated with exactly one SmartConnect Meter. The device may or may not be physically part of the meter itself, but must be unmistakably associated with the meter.	1	2
The PLC IT Device and the SmartConnect Meter shall participate in a registration process to ensure that only one PLC IT device is associated with one meter at a time.	1	2
The EAM system shall register and track all PLC IT Devices as individual devices associated with exactly one SmartConnect Meter.	1	2
PLC IT Devices shall emit and receive PLC signals indicating which meter they are associated with.	1	2
A PLC IT Device may be associated with a Distribution Transformer, in which case it shall transmit PLC signals to all the meters connected to that transformer indicating the identity of the transformer.	1	2
PLC IT Devices shall inform their associated meter when messages are received indicating the presence of neighboring meters.	1	2
PLC IT Devices shall not emit any signal beyond the immediate Distribution Transformer secondary winding to which they are connected.	1	2
PLC IT Devices shall not identify as their neighbor any device located on a remote Distribution Transformer.	1	2

Functional Requirements	*Associated Scenario # (if applicable)*	*Associated Step # (if applicable)*
Each meter shall use a PLC IT Device to listen for and build a neighbor list of meters that share the same signal and the same Distribution Transformer.	1	3
Each meter shall provide its transformer neighbor list to the Transformer Correlation Engine upon request.	1	3
Each meter shall denote the date and time of changes to its transformer neighbor list.	1	3
One meter on each Distribution Transformer may be elected as the master meter for that transformer. This master meter shall maintain the official neighbor list for that transformer and be the only meter associated to a given transformer responsible for transmitting the neighbor list to the utility. This should reduce the number of neighbor lists transmitted on the network.	1	3
Each meter shall include the identity of its Distribution Transformer in the neighbor list it sends to the Transformer Correlation Engine if the transformer is transmitting that identity via PLC.	1	3
A Topology Correlation Engine application shall gather neighbor lists from meters and update a TLM Database containing meter-to-transformer connectivity.	1	4
The Topology Correlation Engine shall make use of previously collected TLM connectivity information.	1	4
The Topology Correlation Engine shall provide changes in meter-to-transformer connectivity to the TLM Database and to other systems using this information (e.g. OMS, GIS, etc.).	1	5, 6
The Topology Correlation Engine shall produce reports indicating potentially mismatched or unattached meters for further investigation.	1	5, 6
The Transformer Load Calculating Engine shall over a specified time period, on-demand or periodically, retrieve customer meter usage data from the MDMS or Meter Data Warehouse and generate a load profile for a specific transformer or a select group of transformers based on the list of meters associated with the transformer(s) from the TLM Database.	2 4	4 1
The Transformer Load Calculating Engine shall calculate summary statistics for a given transformer or group of transformers (e.g. a circuit segment) based on interval loading data for the meters associated with it.	2 4	5 1
The Transformer Load Calculating Engine shall calculate remaining-life metrics for a given transformer or group of transformers.	2 4	4 1

Functional Requirements	*Associated Scenario # (if applicable)*	*Associated Step # (if applicable)*
The Transformer Load Calculating Engine shall update the TLM odometer metric for the transformer or group of transformers after running statistical analyses. This TLM odometer metric shall be based at a minimum on the total kWh passing through the transformer, but may also be calculated based on how often and by how much the transformer was overloaded, its original nameplate rating, and its current age.	2 4	4 1
The Transformer Load Calculating Engine shall permit a planner to retrieve a load profile for a specific transformer or selected group of transformers over a specified period of time, on-demand.	2 4	6 5
The Transformer Load Calculating Engine shall forecast a future load profile for each transformer based on history and predicted temperature and/or other predicted factors.	2 4	4 1
The Transformer Load Calculating Engine shall update replacement metric thresholds based on correlations with failures, metrics, and asset type/vendor/age, gathered from the EAM.	4	2
The Transformer Load Calculating Engine, using the TLM Database linked to OMS maps, shall have the ability to calculate the load on every distribution circuit segment.	4	1
The Transformer Load Calculating Engine shall provide overload calculations for distribution circuit segment conductors, sectionalizers, and regulators.	2	4
The Transformer Load Calculating Engine shall store in the TLM Database, all its calculations, including TLM odometer reading, load profiles, statistics and replacement metrics.	2 4	4 1
The TLM Database shall permit multiple authorized applications and users to query or subscribe to data produced by the Transformer Load Calculating Engine.	2	5
The TLM Database shall periodically produce a prioritized exception report for Planners indicating transformers, conductors, sectionalizers, and regulators that are overloaded or excessively under-loaded, requiring scheduled maintenance based on pre-configured tolerances.	2 4	6 1
Sensors on distribution transformers shall report oil temperature and hot spot alarms through the SmartConnect NMS.	3	1
Sensors on distribution transformers shall report oil level alarms through the SmartConnect NMS.	3	1
Sensors on distribution transformers or switches shall report pressure alarms through the SmartConnect NMS.	3	1

Functional Requirements	*Associated Scenario # (if applicable)*	*Associated Step # (if applicable)*
The SmartConnect NMS and SmartConnect communications network shall permit condition sensors mounted on distribution equipment other than transformers to report condition events appropriate to their equipment type through the SmartConnect network.	3	1
The EAM system shall hold static asset data for distribution grid equipment, including distribution transformers.	3	5
The EAM system shall subscribe or query for notification of distribution equipment condition sensor events by the SmartConnect NMS.	3	5
When condition sensor events occur, the EAM system shall note them in an exception report and send it to T&D Planning and T&D Field Construction.	3	5
The SmartConnect Meter and SmartConnect NMS shall permit any subset of all meters to be configured to report voltage and VAR readings as a part of their daily read.	5	1
The SmartConnect NMS shall send any Voltage and VAR data from daily reads to the Planning Data Warehouse rather than the MDMS.	5	2
The Planning Data Warehouse shall permit T&D planners to query voltage and VAR data by feeder or any arbitrary grouping of meters in daily, weekly, monthly, and seasonal histories.	5	3
The Planning Data Warehouse shall permit multiple applications such as the OMS or a Distribution State Estimator to query voltage and VAR data simultaneously.	5 6	3 4
A Distribution State Estimator, if added in the future, shall be able to produce a quarterly report highlighting voltage losses on particular feeders.	5	3
The OMS shall be able to query voltage and VAR history per feeder at the request of the Crew Dispatcher.	6	4
The OMS shall be able to create a work order with a voltage history attached.	6	5
The meter shall allow the field tool to read the present voltage and VAR value over the Home Area Network.	6	7a, 8a
On-demand, the meter and SmartConnect NMS shall permit applications such as the OMS to perform a request for the present voltage and VAR reading on a particular meter.	6	7b, 8b

4.2 Non-Functional Requirements

Non-Functional Requirements	*Associated Scenario # (if applicable)*	*Associated Step # (if applicable)*
The Topology Correlation Engine shall provide updates to the TLM database at least once a day. It may need to do so more often on circuits with frequent outages because the true requirement is that the topology information must be updated before the next outage at that location.	1	4
The TLM Database shall provide updates of the meter-to-transformer connectivity model to other applications (e.g. OMS, GIS, etc.) once a day.	1	5
The Topology Correlation Engine shall retrieve neighbor lists from meters or master meters once a day.	1	3
Each meter shall aggregate changes to its neighbor list over a period of one day to avoid false notifications.	1	3
The Topology Correlation Engine shall update the topology information in the TLM Database either periodically, or by exception as changes occur.	1	4
The Transformer Load Calculating Engine shall run statistical analyses for each transformer or group of transformers over at least a 3-month window.	2 4	4 1
The Transformer Load Calculating Engine shall permit T&D planners to configure TLM calculations on interval data to run between once a day and once a week, for at least 750,000 transformers on each run.	2 4	4 1
The Transformer Load Calculating Engine shall produce a minimum, maximum, and average load profile for a specific transformer or select group of transformers weekly, monthly, quarterly and annually, or on-demand.	2 4	6 1
The TLM Database shall permit T&D planners and T&D engineering to perform queries on detailed loading of a specific transformer 50 to 200 times per week, at one-week intervals.	2 4	6 1
The TLM Database shall produce an exception report identifying distribution equipment exceeding loading thresholds at least once per week.	2 4	6 1
The OMS shall permit users to generate a feeder voltage report to T&D Field Crews from 2 to 50 times per week.	6	4

Non-Functional Requirements	*Associated Scenario # (if applicable)*	*Associated Step # (if applicable)*
Out of 750,000 transformers, the SmartConnect NMS shall be capable of processing 150,000 to 200,000 condition sensor events per day, many of which are likely coincide with other adverse events such as outages.	3	4
Scheduled maintenance and sensor deployment shall align with GO 95 (OH) and 128 (UG) regulations.	3	5
The EAM system shall create an exception report of condition sensor events at least once a day.	3	5
The SmartConnect Meter shall be configurable to enable recording of voltage and VAR information with sufficient frequency so that planners are able to statistically identify daily, weekly, monthly, and seasonal patterns.	5	1

5. Use Case Models (optional)

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

5.1 Information Exchange

For each scenario, detail the information exchanged in each step.

When updating this information exchange table, provide the reason for any additional steps and be sure the sequence diagram has also been updated to reflect the changes.

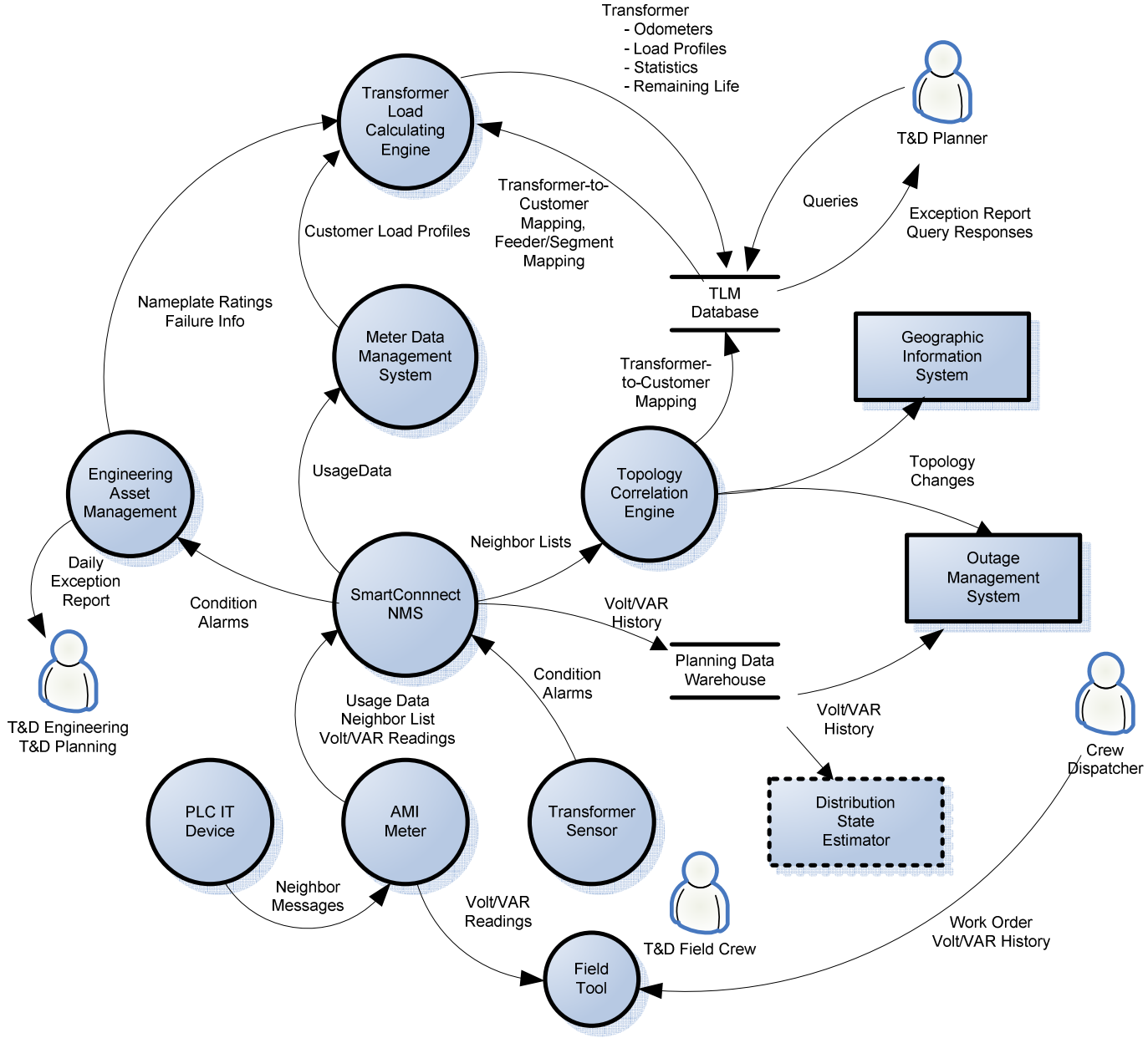
Scenario #	Step #, Step Name	Information Producer	Information Receiver	Name of information exchanged
#	Name of the step for this scenario.	What actors are primarily responsible for producing the information?	What actors are primarily responsible for receiving the information?	Describe the information being exchanged.
1	2	PLC IT Device	Meter	Registration to ensure only one device is associated with a meter
1	2	PLC IT Device	PLC IT Device	Identification of associated meter or distribution transformer
1	2	PLC IT Device	Meter	Neighbor messages identifying connected meters or distribution transformers
1	3	Meter	SmartConnect NMS	Neighbor list built from neighbor messages
1	3	SmartConnect NMS	Topology Correlation Engine	Neighbor list
1	4	Topology Correlation Engine	TLM Database	Transformer-to-customer mapping
1	5	Topology Correlation Engine	OMS or other systems	Topology changes
1	6	Topology Correlation Engine	T&D Planner	Topology Exception Reports when meter appears to have no neighbors or topology appears contradictory
1	7	TLM Database	OMS or other systems	Topology queries

Scenario #	Step #, Step Name	Information Producer	Information Receiver	Name of information exchanged
2	2	MDMS	Transformer Load Calculating Engine	Usage data
2	3	EAM	Transformer Load Calculating Engine	Calculations for TLM odometer: • Nameplate information – age, rating • Condition alarms
2	4	Transformer Load Calculating Engine	TLM Database	Calculations for transformers or other distribution assets: • TLM odometer • Load profiles • Statistics • Remaining life
2	5	TLM Database	T&D Planner	Query responses
2	5	TLM Database	T&D Planner	Exception report of equipment that has exceeded thresholds
3	2	Condition Sensor	SmartConnect NMS	Condition alarms including at least: • Oil temperature • Oil pressure • Oil level • Voltage high/low • Fault indications
3	4	SmartConnect NMS	EAM	Condition alarms
3	5	EAM	T&D Planner, T&D Field Construction	Exception report of equipment with raised condition alarms
5	1	Meter	SmartConnect NMS	Voltage/VAR readings
5	2	SmartConnect NMS	Planning Data Warehouse	Voltage/VAR readings
5	3	Planning Data Warehouse	T&D Planner	Voltage/VAR history – daily, weekly, monthly, seasonal
5	3	Planning Data Warehouse	OMS or other systems like Distribution State Estimator	Voltage/VAR history

Scenario #	Step #, Step Name	Information Producer	Information Receiver	Name of information exchanged
6	5	OMS/Crew Dispatcher	Field Tool	Voltage/VAR history attached to work order
6	8	Meter	Field Tool	On-demand voltage/VAR reading
6	8	Meter	SmartConnect NMS	On-demand voltage/VAR reading
6	8	SmartConnect NMS	OMS or other systems	On-demand voltage/VAR reading

5.2 Diagrams

5.2.1 Data Flow Diagram



6. Use Case Issues

Capture any issues with the use case. Specifically, 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.
It is necessary to provide a detailed definition of the statistics to be calculated on transformer loading information such as: • How quickly a response is needed • Which statistics – maximum, minimum, average, etc. • Time frames – per minute, per hour, etc. • CPF points, – weekly, yearly • Remaining-life metrics
It is necessary to determine how often the utility needs to capture transformer temperatures.
It is not yet clear how transformer sensors such as hot spot, oil level etc. will be communicated – PLC, ZigBee, metering WAN, GPRS, etc.
What additional condition items can be monitored on each transformer?

7. Glossary

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

Glossary	
Term	**Definition**
HAN	Home Area Network - local communication network at customer premise that allows devices to communicate with each other.
PLC	Power Line Carrier - used for telecommunication, tele-protection and tele-monitoring between electrical substations through power lines at high voltages, such as 110kV, 220kV, 400kV for Transmission/substation applications.
SCADA	Supervisory Control and Data Acquisition - The computer, communications system and remote devices that monitor and control the distribution network. Information from the SCADA network is usually updated every 2 to 4 seconds.
TLM	Transformer Load Management - a database application of associated customer and transformer information; which maintains the secondary topology and updates the GIS mapping data.

8. References

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

9. Bibliography (optional)

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