USB Remote Connect/Disconnect (RCD) Business Processes and De Facto Standards

Final

February 2008

UTILITY STANDARDS BOARD

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1.1 Introduction to Utility Standards Board (USB) De Facto Standards Projects

1.1.1 Scope of the USB Projects

The Customer Care Research Consortium (CCRC), an executive forum of seventeen leading utilities for discussing strategy, co-funding research, and acting collectively on select issues, established the Utility Standards Board (USB) in late 2007. The USB, currently including six[1] of the CCRC utilities, is charged with developing de facto standards for the interface between the Advanced Metering Infrastructure (AMI) and the Enterprise Bus (AMI/EB interface), based on those utility business processes which exchange information across that interface.

The scope of AMI/EB interface is shown in Figure 1, namely the interface between the AMI systems which reach out to the meters and customer gateways, and other systems via an "Enterprise Bus" which provides connections to utility information systems, including back office systems and certain distribution operations systems, and can provide basic service management such as traffic and performance management, and sometimes including interface adapters which translate between the standard messaging formats and legacy system data formats.

Although implementation configurations of these systems can vary significantly, the basic architecture remains the same, namely that it is at this AMI/EB interface that information standards must be applied to provide the interoperability required for modern Smart Grid integration.

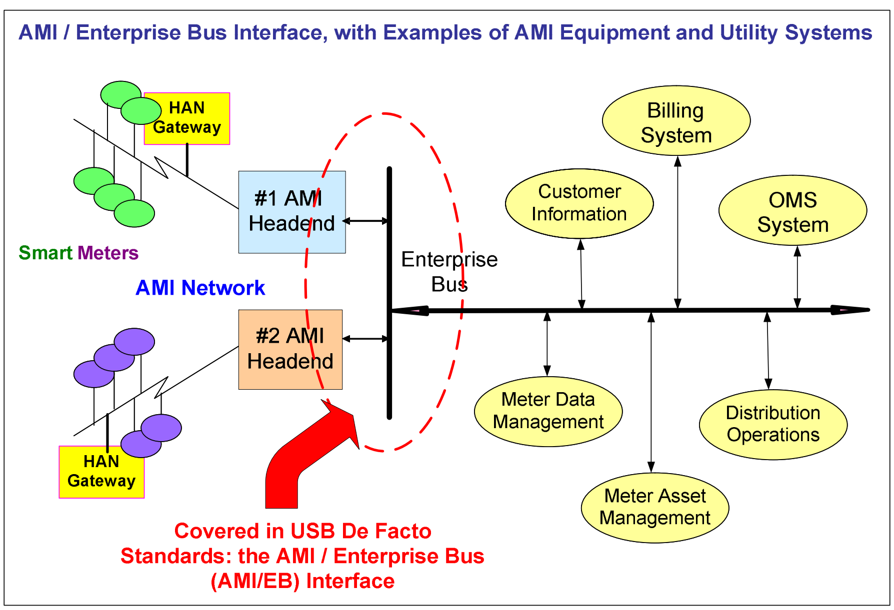

Figure 1: USB Scope: Interface between the AMI Systems and the Enterprise Bus

[1] AEP, Dominion, Duke, Exelon (ComEd and PECO), Hydro One, and PHI

1.1.2 Business Processes, Use Cases, and Information Standards

The development of information standards at an interface fundamentally relies on understanding those business processes which must exchange information across that interface. ***Business processes are best understood by the stakeholders who use them; not by the vendors who are asked to implement them nor by the standards-making groups who need to define the information exchange standards.*** Therefore it is always critical to have the stakeholders define their business processes preferably in a methodical manner which can be subsequently used for the development of the actual information standards.

As described by the International Electrotechnical Commission (IEC) Publicly Available Specification (IEC/PAS 62559) [2], the best method for defining business processes is through Use Cases. These Use Cases provide examples, preferably from many stakeholders, on business processes that require information flows across specific interfaces. Although business process may vary greatly among different stakeholders, generally it is possible to extract from these Use Cases the superset of information that needs to flow across the interface. This superset of information can then be structured into standardized object models and messaging.

1.1.3 USB Development Procedure

The USB De Facto Standards Development Procedure shown in Figure 2 was based on this IEC PAS 62559 procedure.

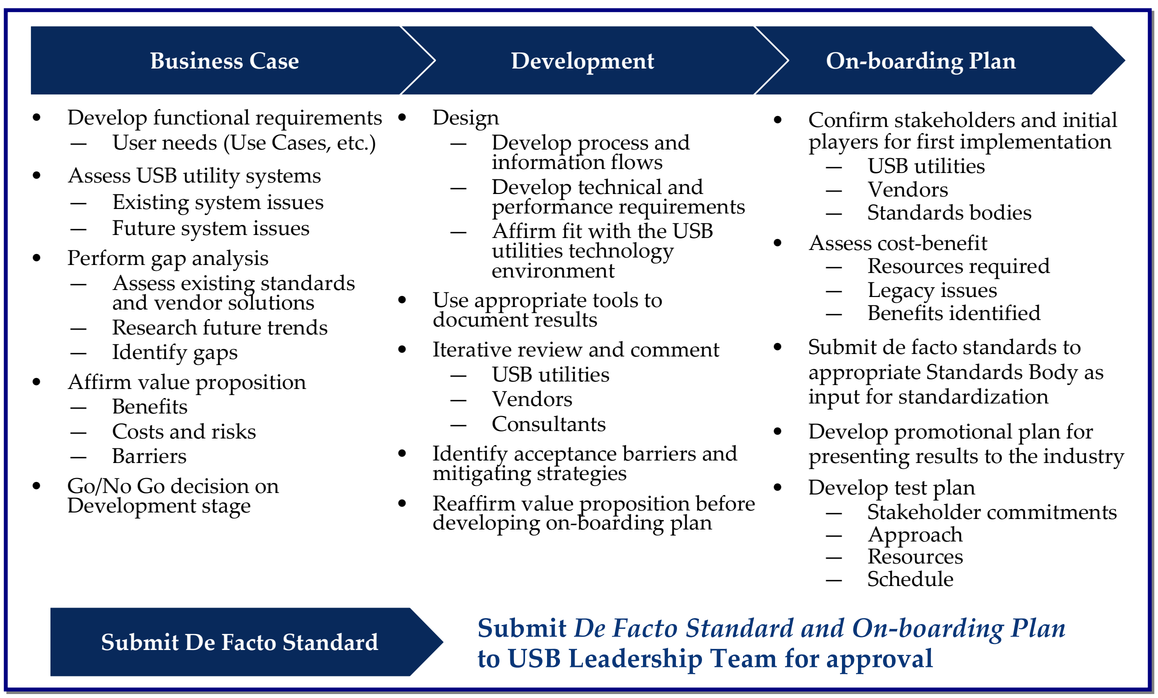

Figure 2: USB De Facto Standard Development Process

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2 IEC/PAS 62559: IntelliGrid Methodology for Developing Requirements for Energy Systems, 2008, purchasable from the IEC at http://iec.ch

1.1.4 Business Processes Utilizing the AMI/EB Interface

The USB's first step was to develop a set of business processes which could involve information exchanges across the AMI/EB interface. These business processes are shown in Figure 3, although many additional business processes could also directly or indirectly require information to go across the AMI/EB interface[3].

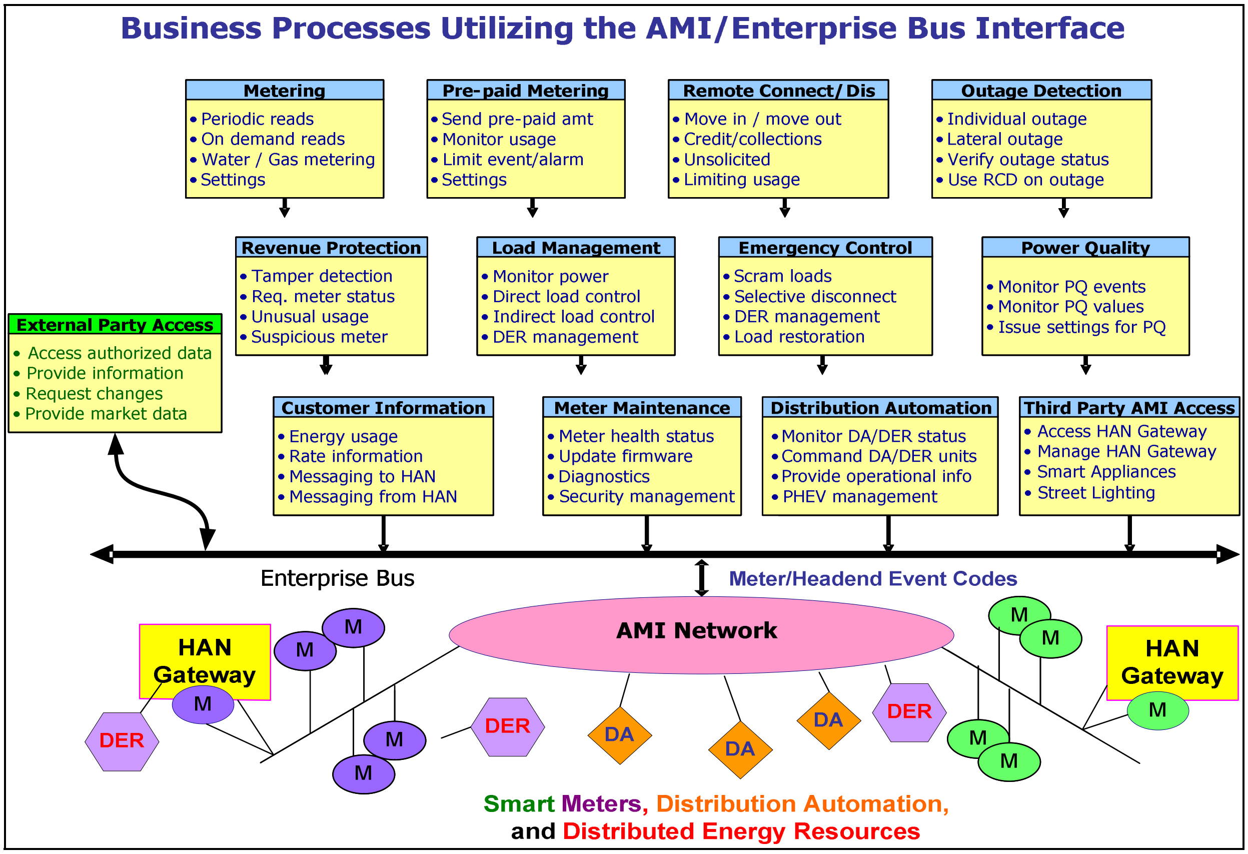

Figure 3: Primary Business Processes Utilizing the AMI/EB Interface

The USB selected some key Business Processes to initiate the de facto standards procedure:

- Meter/AMI Headend Event Codes (MHEC)
- Remote Connect/Disconnect (RCD)
- Outage Detection and Restoration (ODR)

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3 A separate USB document describes these Business Processes in more detail: *Business Functions as Stakeholders in AMI Systems (Draft) December 2008*

1.2 Overview of Remote Connect / Disconnect (RCD) De Facto Standards Project

1.2.1 Scope of RCD Project

This report covers Phase 1 (Business Case Development) and Phase 2 (De Facto Standards Development) of the Remote Connect/Disconnect (RCD) project. This RCD work stream was labeled a Collaborative Work Team initiative rather than a Standards Work Team initiative because this work on RCD standards includes significant collaboration with existing IEC and MultiSpeak efforts in the development of RCD standards.

1.2.2 RCD Business Processes: Challenges of Remote Connect / Disconnect Capabilities

Using the remote connect/disconnect switches at the meter to connect or disconnect customers presents many challenges. These challenges are both policy challenges and technical challenges. In order to understand what the technical solutions needed to handle, the policy issues needed to be understood first.

The policy challenges reflect utility business decisions, regulatory requirements, and safety concerns. Different utilities are responding to the capability to remotely connect and disconnect customers in very different ways. Some have decided never to use the RCD switch, but most have determined that the cost-benefits of avoiding unnecessary truck rolls are worthwhile. Although the debate is continuing, utility policies and business practices appear to include combinations and variations of the following:

1. Local Use of RCD Switch:
    a. No use of the RCD switch capability for either connect or disconnect
    b. Allow authorized utility workers, contractors, and other third-person service representatives to manually disconnect the customer through local access to the RCD switch
    c. Allow authorized utility workers, contractors, and other third-person service representatives to manually connect the customer through local access to the RCD switch, usually only after contacting the utility for authorization
2. Remote Disconnect
    a. Only remotely disconnect customers in specific categories, such as those in high turn-around housing or for customers who regularly fail to pay their bills, whose meter is difficult/dangerous to access, or who are in a prepay or energy usage limiting program.
    b. Include significant attempts to warn customers of impending disconnections and undertake many other revenue protection activities before actually performing the disconnection.
    c. Remotely disconnect all move-out customers at a mutually agreed-upon time.
    d. Use remote disconnect as surgical equivalent to load shedding during emergencies, including power shortages and natural disasters.
3. Remote Connect
    a. Only remotely connect customers when a service representative is on site.
    b. Only remotely connect customers in specific categories, such as those in high turn-around housing or commercial customers or those who have specifically requested remote connection.

c. Only remotely connect customers after a service representative has directly contacted them by phone or other communications.

d. Remotely connect customers even though attempts to contact them have failed.

e. Remotely connect all move-in customers at a mutually agreed-upon time.

These business processes for using the RCD switches on the smart meters provide utilities with examples of different methods and policies for utilizing these powerful and beneficial remote connect and disconnect capabilities. The business processes themselves should not be standardized, since different utilities have different needs, constraints, and regulatory environments. However, they provide the basis for extracting those information exchange requirements across the AMI/EB interface, and thus ensuring that the standards can meet all of the different types of utility requirements.

1.2.3 RCD Standards: Technical Challenges of Remote Connect / Disconnect Capabilities

In this new AMI business arena, few definitive architectures have been defined as to which functions are performed by which systems, while different deployments of the same functions at different utilities could involve very different information flows. For instance, some basic VEE functions could be performed by the AMI system itself (e.g. has a meter reading been collected for each interval), while others could be performed by the MDM system and/or by the CIS. Nonetheless, the ultimate result is the same – validated meter readings ready for billing.

This document does not attempt to assign functions to specific systems, but rather states “only if such-and-such information is to cross the AMI/EB interface, then it shall use the “such-and-such” standardized messaging structure to transport the information”.

Significant technical work has been undertaken in developing standards at the interface between the AMI headend and back office systems, but that work is not complete. These ongoing standardization efforts include those of:

- AMI-oriented Use Cases developed by Southern California Edison (SCE) addresses the functional requirements for AMI systems
- The standardization work of the IEC TC57 WG14 in IEC 61968-9 and in the Common Information Model (CIM) covers many aspects of remote connect/disconnect
- MultiSpeak for the NRECA cooperatives provides some basic interfaces.

The primary technical challenge was to determine what aspects of these efforts could meet the USB RCD requirements, once those requirements were derived from the various policies and business processes.

1.3 RCD Project Methodology

1.3.1 RCD Tasks

Phase 1 of this RCD project entailed determining the most appropriate procedure for determining the USB requirements for RCD, and then working with the USB team to implement the procedure. Using the state-of-the-art method of Use Cases, two main tasks were undertaken. These are illustrated in Figure 4:

- Describe examples of the various business processes involving RCD. Each USB member was assigned a few examples to develop either in narrative form or even in Use Case step format (subtasks 1-3).
- Extract the common RCD interface requirements from these business process examples, convert them to formal UML Activity Diagrams, and perform a gap analysis against the existing IEC and MultiSpeak documents (subtasks 4-6).

During the Phase 2 of the project, these common RCD interfaces were converted to changes, extensions, and additions to the IEC document (MultiSpeak is also being harmonized with the IEC) as XML Message Schema (as currently used in the IEC and MultiSpeak documents) (subtask 7).

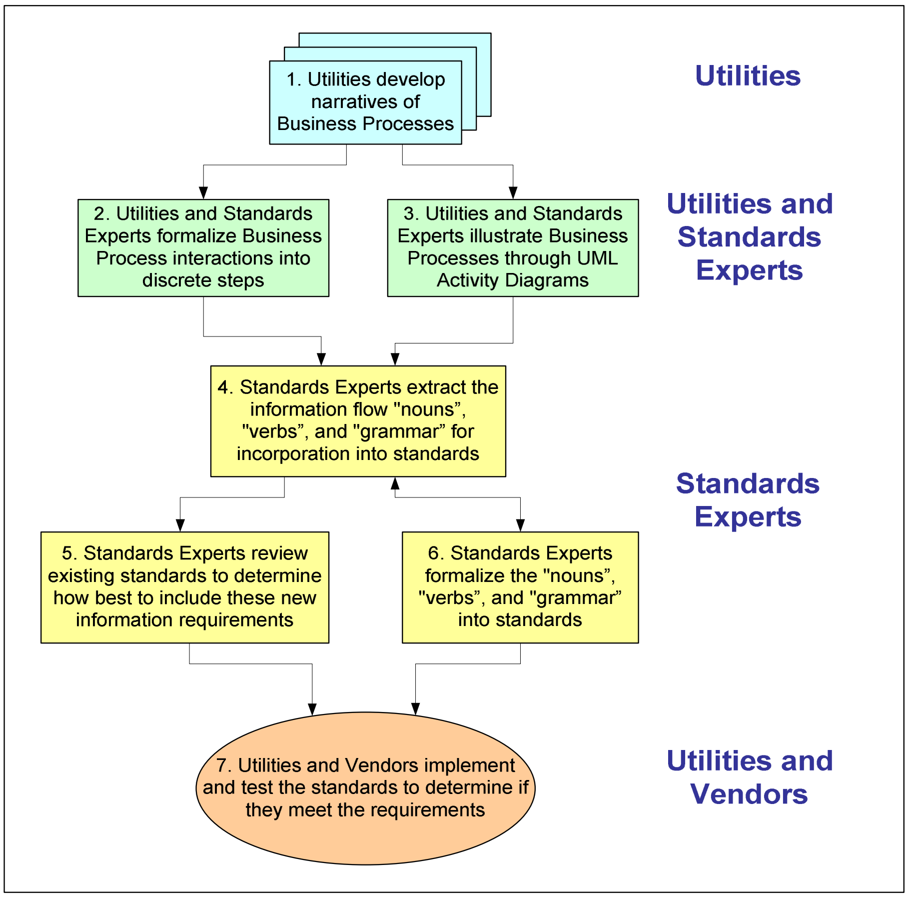


Figure 4: Procedure for Going from Business Processes to De Facto Standards

1.3.2 Results of RCD Project

The USB team developed 20 business processes involving the RCD capability, many with sub-cases involving variations on a basic process. The business processes are:

- Routine turn-on of service (move in)
- Routine shut-off of service (move out)
- Credit & Collections termination of service

- Credit & Collections reinstatement of service
- Local/on site shut-off of service
- Local/on site turn-on of service
- Credit & Collection Service Limiting
- Emergency Response / Load Shedding
- Exceptions processing related to unsolicited change of state of disconnect switch

During subsequent discussions, it was clear that even more variations on these business processes could be envisioned or were actually being implemented at different utilities. However, it was also clear that with respect to the actual interface between the AMI systems and the back office systems, there were only a limited set of interactions. These are listed in the following table.

In performing preliminary gap analysis with the IEC 61968-9 document, they cover the 1st, 2nd, and 3rd interactions but not the remaining interactions. In performing preliminary gap analysis with the MultiSpeak document, they cover the 3rd, 5th, and 6th interactions. Therefore, the 4th and 7th interactions are not addressed at all. Additional analysis during Phase 2 determined that additional Message Schemas were needed.

Table 1: Gap Analysis for IEC 61968-9 and for MultiSpeak

USB Requirements	In IEC 61968-9	In MultiSpeak
1. Remote connect command	Partial	Partial
2. Remote disconnect command	Partial	Partial
3. On-request meter read	Yes	Yes
4. Check status of the RCD switch	Partial	Partial
5. Unsolicited connect event	No	Partial
6. Unsolicited disconnect event	No	Partial
7. Exception handling, covering many different types of errors and events	No	No

1.3.3 RCD Security Issues

Advanced Metering Infrastructure (AMI) is becoming of increasing interest to many stakeholders, including utilities, regulators, energy markets, and a society concerned about conserving energy and responding to global warming. AMI technologies, rapidly overtaking the earlier Automated Meter Reading (AMR) technologies, are being developed by many vendors, with portions being developed by metering manufacturers, communications providers, and back-office Meter Data Management (MDM) IT vendors.

In this flurry of excitement, very little effort has yet been focused on the cyber security of AMI systems. The comment usually is "Oh yes, we will encrypt everything – that will make everything secure." That comment indicates unawareness of the more severe security threats of AMI – a technology that will reach into a large majority of residences and virtually all commercial and industrial customers. What if a smart kid hacker in his basement cracked the security of his AMI system, and sent out 5 million RCD disconnect commands to all customer meters on the AMI system …? More subtly, what if a disgruntled utility employee used the RCD capability to cause 7-minute outages at random intervals to millions of random meters …?

Although the USB RCD Team recognizes that security issues will need to be addressed, it is focusing its current efforts on developing the business processes and de facto standards.

1.3.4 Benefits from RCD Project Methodology

The benefits from the USB RCD process are many. These include:

- **Exchange of ideas:** The RCD team has found the exchange of ideas on the RCD business processes across different utilities to be extremely useful. The RCD team expects this exchange of ideas to increase in usefulness as the USB utilities implement their AMI systems and the standardization process proceeds.
- **Decreased effort – only once:** USB utilities are going to have to implement the interfaces between the AMI and the Back Office systems at least once. If standards are in place, then this will be the only time that effort is required, no matter how many AMI systems, MDM systems, or upgrades to these systems are implemented.
- **Decreased expense:** The need to standardize the interface between the AMI system and the back office systems is becoming of increasing importance as more AMI systems and MDM systems from different vendors are implemented in different utilities with different business processes. Without standardization, each implementation will become a nightmare of customization – expensive for both the vendors and the utilities.
- **Smart Grid Reliability:** As utilities rely increasingly on the AMI systems both as a source of information and a means to reduce truck rolls, these systems and their interfaces will need to become increasingly reliable for both operational and financial reasons, despite multiple AMI systems, on-going upgrades, new vendors, new capabilities, and new requirements. Standard interfaces can help provide this reliability. A recent Smart Grid workshop sponsored by the DOE emphasized this benefit.
- **Utility perspective:** The USB is providing the utility perspective and utility requirements to the standards process that is sorely needed. All too often standards are developed by vendors with limited understanding of utility needs and with product-driven agendas. This involvement by the RCD team in the standards process will be a major benefit to the overall quality of the standards.
- **International Support:** Due to significant interest in these IEC and MultiSpeak standards by vendors and utilities world-wide, the USB team will find real support as the details of the RCD message formats and structures are tackled in Phase 2. Therefore, this work will not become "one more document gathering dust on a shelf", but will become an integral part of an international standard. At a recent IEC meeting, there was great interest in the USB efforts and a desire to see the de facto standards as soon as they were available.
- **USB Leading the Way:** Although the RCD function is only one of many interactions across the AMI/EB interface, it is one of the more complex and demanding. It is not surprising that the other standards efforts left the more difficult aspects undefined. The USB can now provide significant insight into the RCD requirements, so that these requirements can be included in the overall standards efforts.

- **Strong Standards:** Without the continued support by the USB team, the additional effort to complete the RCD task may be set aside by the overworked standards groups who are trying to undertake the monumental task of defining all requirements across the interface. This has led to weak standards in the past, and should not be allowed to occur with this important interface.

2 Procedure for Undertaking the USB Standardization Projects

2.1 Generic Phase 1 Methodology

2.1.1 Development of Business Processes to Extracted AMI/EB Interface Modules

The generic procedure for going from Business Processes to de facto standards is shown in Figure 5, using the Use Case/UML methodology and reviewing on-going standards work. This procedure consists of 7 steps. Phase 1 has consisted of the first 6 steps, while the 7th step will be undertaken in Phase 2. Of the Phase 1 steps, the first 3 directly involve the Business Processes, while the remaining 3 steps involve the identification of the information exchanges to be standardized.

1. **Narratives of Business Processes.** Utilities develop narratives of their business processes, describing them and explaining their justification and alternatives for handling different situations, writing paragraphs and illustrating them with drawings if possible. These narratives cover the normal procedures, as well as any exception handing, errors, and alternatives. They can include manual procedures and utility-specific operations. These business processes are important not only for providing the raw material for the standards process, but also because they provide useful background as to why or why not the utility undertakes some different procedures.
2. **Formalize Interactions in Business Processes.** These business process narratives are converted to formal UML Steps which identify the triggering condition, the information producer, the information receiver, the process, and the types of information exchanged.
3. **Illustrate Business Processes through Activity Diagrams.** Business processes can also be illustrated through UML Activity Diagrams which can help clarify the interactions, particularly for non-linear procedures. The decision whether to "describe" a business process though UML Steps or via Activity Diagrams is based on which is the most useful for understanding the interactions – either will work for setting the stage for the next task.
4. **Extract Interactions across the AMI/EB Interface.** In order to meet utility-specific requirements, different business processes from different utilities can utilize different sequences and types of interactions across the AMI/EB interface. Because these utility-specific requirements are the result of business policies and decisions, they cannot and should not be standardized. However, many of the AMI/EB interactions can be extracted from the rest of the business process and modularized into short sequences of steps and activities. Ultimately these modules can account for the majority of interactions. ***It is these interactions which can and should be standardized.***
5. **Formalize these AMI/EB Interface Modules into Steps and Activity Diagrams.** After the common interactions have been identified, they are formalized by breaking them into specific steps and documenting them via Activity Diagrams.
6. **Review the IEC 61968-9 and MultiSpeak documents.** The on-going IEC and MultiSpeak efforts towards standardizing interfaces, including the AMI/EB interface, reflect significant work by a wide variety of utilities, vendors, and industry experts. Their focus has been on standardizing the messaging structure through the use of "well-defined names" of data elements and standardized formats for these data elements, using XML Schema (XSD) to document these message structures. They are not yet complete or extensive enough to provide a full interface standard for remote connect/disconnect activities, but should be considered as a base to extend and to harmonize with.
7. **(Phase 2) Extend or develop additional standard message formats and structures reflecting the interactions across the AMI/EB interface.** Using the IEC and MultiSpeak work as a base, additional data element formats and structures can extend and harmonize those that have already been developed (but are not yet standards).

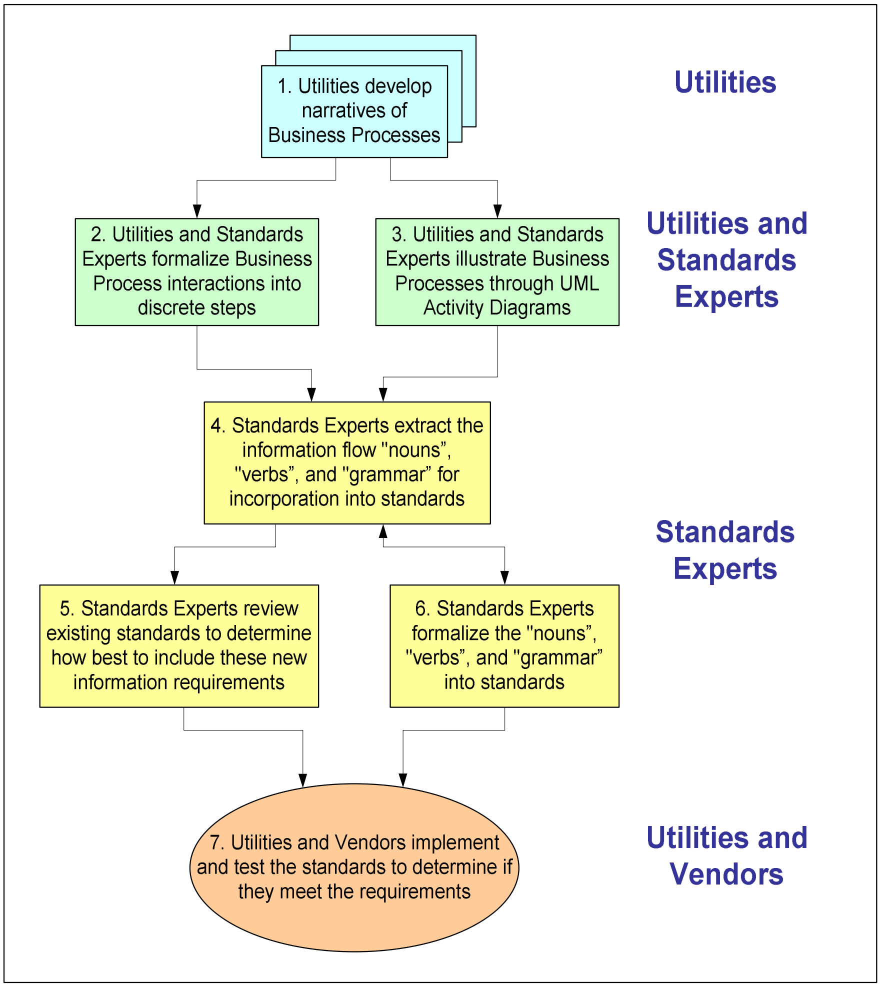


Figure 5: Procedure for Going from Business Processes to Standards

The Meter Remote Connect/Disconnect (RCD) Business Processes are shown either as a series of steps or as Activity Diagrams (and sometimes both). The interactions between the Enterprise Bus and the AMI System will modeled as sets of "well-defined" (standardized) CIM information models and XSD message elements, similar to the message elements in IEC 61968-9 and in MultiSpeak. These message elements will permit most interactions (80-20 rule) involving RCD to be handled in a standardized way.

2.1.2 3-Layer Modules: Business Process Scenarios, Basic Modules, and AMI/EB Interface Modules

The most effective means for capturing business processes using the UML methodology of formal Use Case Steps and/or Activity Diagrams requires breaking them into modules which can be reused. This modular approach allows each module to be described/diagrammed only once, then referenced as needed, thus avoiding repeating identical portions of different business processes. In addition, these modules can be "nested" or layered; AMI/EB interface modules can be used within basic modules, which in turn can be incorporated within the business process scenarios.

In this RCD document, three layers of modules are used:

- **Business process scenarios**, which describe the actual business activities by using the basic modules in addition to scenario-specific steps. These business processes capture the purposes of the interactions, the **"What and Why"**. They are usually specific to individual utilities, but are very useful as examples.
- **Basic modules**, which describe frequently-used processes incorporating the AMI/EB interface, in addition to module-specific steps. These modules capture the **"How"** the interactions take place, plus all the exception notifications. They could be viewed as commonly used interactions, but would not be formally standardized so as to avoid restricting utility choices or vendor value-added processes.
- **AMI/EB interface modules**, which are the information exchanges across the AMI/EB interface that will be standardized, first as USB de facto standards, and then presented to the IEC for formal standardization. These modules capture the **"Standards".**

This concept of nested modules is illustrated in Figure 6.

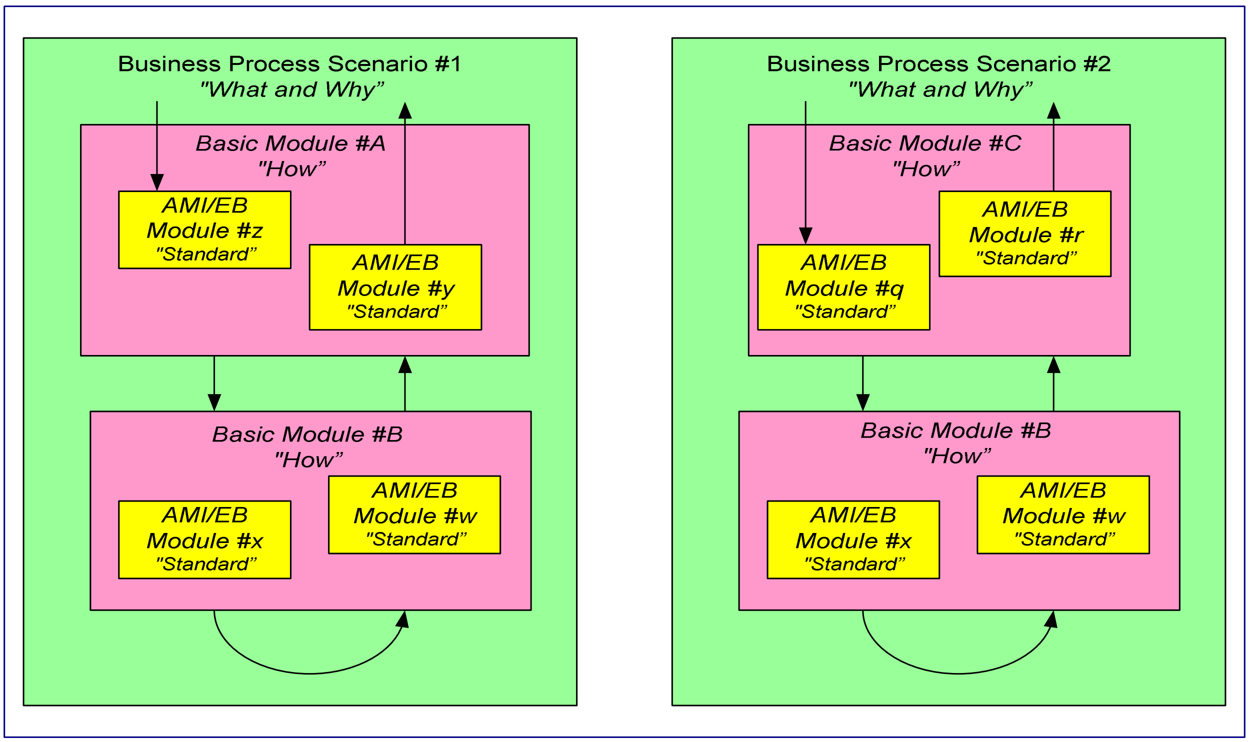


Figure 6: Illustration of Nested Modules: *What and Why, How, and Standards*

2.2 Remote Connect/Disconnect (RCD) Modules

2.2.1 Overview of RCD Business Processes – What and Why

The RCD business processes capture the "What and Why" of remote connect and disconnect activities. These business processes are examples from different utilities and amalgamations of ideas, and should not be viewed as standards in themselves – they are useful as informative narratives of different processes and as sources for extracting the information flow requirements across the AMI/EB interface.

The development of a wide range of RCD-related utility business processes is critical as the best method for identifying the RCD information exchange requirements across the AMI/EB interface. These business processes, although reliant on modular interface standards, should not be standards themselves since businesses need the flexibility to select which interface standard modules to include in their design to meet their needs. For instance, although the "on-request meter read module" and the "connect command module" can be standardized modules, one business process could consist of a single on-request read and a connect command, while another business process could include an initial on-request read, the connect command, then a second on-request read.

The RCD business processes included in this document are:

- Routine turn-on of service (move in)
- Routine shut-off of service (move out)
- Credit & Collections termination of service
- Credit & Collections reinstatement of service
- Local/on site shut-off of service
- Local/on site turn-on of service
- Credit & Collection Service Limiting
- Emergency Response / Load Shedding
- Exceptions processing related to unsolicited change of state of disconnect switch

These RCD business processes are described in Section 3.

2.2.2 Overview of RCD Basic Modules – How

The RCD basic modules capture the "How" of remote connect and disconnect activities. These modules typically involve a key action, plus all the exception notifications.

The RCD basic modules include the following:

- RC – RCD Connect
- RD – RCD Disconnect
- RU – RCD Unsolicited Change in RCD Switch
- RI – RCD Integrity Check
- RL – RCD Limiting Energy Usage

These RCD basic modules are described in Section 4.

2.2.3 Overview of RCD AMI/EB Interface Modules – Standards

The RCD AMI/EB interface modules are those that have been extracted from the RCD Business Processes as acceptable for turning into standards, after fulfilling the following criteria:

- The modules involve only interactions across the AMI/EB interface.

- The modules reflect basic interactions. No business process-specific interactions are included.

The following RCD modules fulfill these criteria:

- **SOR**: Standard On-request Meter Read module
- **SRC**: Standard Remote Connect Command module
- **SRD**: Standard Remote Disconnect Command module
- **SCV**: Standard Check Load Value at Meter module
- **SEL**: Standard Energy Limiting Usage module
- **SUC**: Standard Unsolicited Connect Event module
- **SUD**: Standard Unsolicited Disconnect Event module
- **SRE**: Standard for Determining Existence of RCD Switch module
- **SCS**: Standard Check Status of RCD Switch module
- **SCP**: Standard Change RCD parameters Command module
- **Exx**: Many exception handling modules

These RCD AMI/EB interface modules are defined in Section 5.

3 Utility Business Processes Using Remote Connect/Disconnect Capabilities: "What and Why"

The RCD business processes are examples that capture the "What and Why" of remote connect and disconnect activities.

3.1 Connect Business Processes

3.1.1 BC Scenario 1 – Routine Move-in Connection Procedure

Customer initiates a request to move into a location that has electric service but is currently disconnected at the meter. The request is for immediate action. There are no permit, inspection or construction requirements that necessitate on-site activities by a utility field employee.

Table 2: BC Scenario 1 – Routine Move-in Connection Procedure

#	Triggering Event	Information Producer	Information Receiver	Description of Process/Activity	Information Exchanged	Additional Notes
1	Customer call	Customer	CIS	Start process to open an account	Verbal or other internal data exchanges	
2	Customer request to open account	Utility Service Representative	CIS	• Enters Open order into CIS • CIS will default to a requested action code that indicates for the meter to be remotely energized • Follows existing procedures for suspicious activity	• Data for opening an account; • Date for activating the account • Communicates to the customer that their service will be remotely energized without service personnel visiting their property • Communicates safety information	
3	Effective date of connect request	CIS	EB	Initiates the connect order at the time and date specified	• Meter id; • Connect request	
RC	**Initiate Connect Request via RC Remote Connect Basic Module**					

#	Triggering Event	Information Producer	Information Receiver	Description of Process/Activity	Information Exchanged	Additional Notes
5	RC Remote Connect Procedure was successful	EB	CIS	Results of connect request provided to CIS	Meter id; Connect confirmation	No error was encountered
6	RC Remote Connect Procedure was successful	CIS	Customer	Results of connect request provided to customer	Verbal confirmation that meter is now connected	No error was encountered
7	RC Remote Connect Procedure not was successful	EB	CIS	Error handling	Meter id; Error type code and additional error information	Error was encountered, and subsequent error handling is required

3.1.2 BC Scenario 2 – New Customer Requests Service at a Future Date with No On-Site Activities Necessary

A new customer contacts the local utility to request electrical service for a future date. There are no permit, inspection or construction requirements that necessitate on-site activities by a utility field employee.

Table 3: BC Scenario 2 – New Customer Requests Service at a Future Date with No On-Site Activities Necessary

#	Triggering Event	Information Producer	Information Receiver	Description of Process/Activity	Information Exchanged	Additional Notes
1	Customer call	Customer	CIS	Start process to open an account	Verbal or other internal data exchanges	

#	Triggering Event	Information Producer	Information Receiver	Description of Process/Activity	Information Exchanged	Additional Notes
2	Customer request to open account at a specific time in the future	Utility Service Representative	CIS	• Enters Open order into CIS • CIS will default to a requested action code that indicates for the meter to be remotely energized • Follows existing procedures for suspicious activity	• Data for opening an account; • Date for activating the account • Communicates to the customer that their service will be remotely energized without service personnel visiting their property • Communicates safety information	
3	X (24?) hours before account activation and phone number exists	Out-bound phone call from CIS	Customer	If phone number exists and if part of optional procedure: • Places an automated outbound courtesy call to the customer (if a phone number exists) could be done no less than 24 hours before the requested move-in date. No phone number- no call.	• Restates the safety communications made during the initial call • Includes no confirmation step that the customer is ready or not ready for their service	This step occurs if a phone number exists and if required as part of an optional procedure
4	Effective date of connect request	CIS	EB	Initiates the connect order at 5 AM.	• Meter id; • Connect request	
RC	**Initiate Connect Request via RC Remote Connect Basic Module**					
6	RC Remote Connect Procedure was successful	EB	CIS	Results of connect request provided to CIS	Meter id; Connect confirmation	No error was encountered

#	Triggering Event	Information Producer	Information Receiver	Description of Process/Activity	Information Exchanged	Additional Notes
7	RC Remote Connect Procedure was successful	CIS	Customer	Results of connect request provided to customer	Verbal confirmation that meter is now connected	No error was encountered
8	RC Remote Connect Procedure not was successful	EB	CIS	Error handling	Meter id; Error type code and additional error information	Error was encountered, and subsequent error handling is required

3.1.3 BC Scenario 3 – New customer is requesting service on a future date with no requirements, but RCD fails after working hours

The AMI meter failed to energize after normal business hours or on a weekend or holiday.

A new customer contacts the local utility to request electrical service. Their requested is for a future date. There are no permit, inspection or construction requirements. The remote energize failed to occur at the meter. Service was not energized.

Table 4: BC Scenario 3 – New customer is requesting service on a future date with no requirements, but RCD fails after working hours

#	Triggering Event	Information Producer	Information Receiver	Description of Process/Activity	Information Exchanged	Additional Notes
1	Customer call	Customer	CIS	Start process to open an account	Verbal or other internal data exchanges	

#	Triggering Event	Information Producer	Information Receiver	Description of Process/Activity	Information Exchanged	Additional Notes
2	Customer request to open account	Utility Service Representative	CIS	• Enters Open order into CIS • CIS will default to a requested action code that indicates for the meter to be remotely energized • Follows existing procedures for suspicious activity	• Data for opening an account; • Date for activating the account • Communicates to the customer that their service will be remotely energized without service personnel visiting their property • Communicates safety information	
3	X (24?) hours before account activation and phone number exists	Out-bound phone call from CIS	Customer	If phone number exists and if part of optional procedure: • Places an automated outbound courtesy call to the customer (if a phone number exists) could be done no less than 24 hours before the requested move-in date. No phone number- no call.	• Restates the safety communications made during the initial call • Includes no confirmation step that the customer is ready or not ready for their service	This step occurs if a phone number exists and if required as part of an optional procedure
4	Effective date of connect request	CIS	EB	Initiates the connect order at 5 AM.	• Meter id; • Connect request	
RC	**Initiate Connect Request via RC Remote Connect Basic Module**					
5	RC Remote Connect Procedure was not successful	EB	Work Management Application	Issue manual connect work order	Customer connect information	RCD command fails,

#	Triggering Event	Information Producer	Information Receiver	Description of Process/Activity	Information Exchanged	Additional Notes
6	RCD failure	Work Management Application	Field technician	▪ Failed energize order remains in work queue until the next business day ▪ Presents failed energize message to field technician		
7	Failure repaired	Field Technician	CIS	▪ Identifies failed AMI meter failure by order type ▪ Follows current procedures for Open orders to energize service ▪ Completes order via mobile data computer		
RU	**Unsolicited Connect Event Received via RU Basic Module**					
8	Meter reading received, either from UC event or via mobile data computer	EB	CIS	▪ Receives Order completion message with meter reading ▪ Provides meter reading and meter status to CIS		
9	Connect completed	CIS	Premise application	▪ Updates premise with meter reading and meter stats		

3.1.4 BC Scenario 4 – New customer is requesting service on a future date with no requirements but backfeed detected

The AMI meter failed to energize during normal and non-normal business hours because backfeed current was detected.

A new customer contacts the local utility to request electrical service. Their requested is for a future date. There are no permit, inspection or construction requirements. The remote energize failed to occur at the meter. Service was not energized. The AMI meter detected backfeed current and did not energize service.

Table 5: BC Scenario 4 – New customer is requesting service on a future date with no requirements but backfeed detected

#	Triggering Event	Information Producer	Information Receiver	Description of Process/Activity	Information Exchanged	Additional Notes
1	Customer call	Customer	CIS	Start process to open an account	Verbal or other internal data exchanges	
2	Customer request to open account	Utility Service Representative	CIS	• Enters Open order into CIS • CIS will default to a requested action code that indicates for the meter to be remotely energized • Follows existing procedures for suspicious activity	• Data for opening an account; • Date for activating the account • Communicates to the customer that their service will be remotely energized without service personnel visiting their property • Communicates safety information	
3	X (24?) hours before account activation and phone number exists	Out-bound phone call from CIS	Customer	If phone number exists and if part of optional procedure: • Places an automated outbound courtesy call to the customer (if a phone number exists) could be done no less than 24 hours before the requested move-in date. No phone number- no call.	• Restates the safety communications made during the initial call • Includes no confirmation step that the customer is ready or not ready for their service	This step occurs if a phone number exists and if required as part of an optional procedure
4	Effective date of connect request	CIS	EB	Initiates the connect order at 5 AM.	• Meter id; • Connect request	
RC	**Initiate Connect Request via RC Remote Connect Basic Module**					

#	Triggering Event	Information Producer	Information Receiver	Description of Process/Activity	Information Exchanged	Additional Notes
5	NC Remote Connect Procedure was not successful due to backfeed detected	EB	CIS MRO	▪ Issue investigative order ▪ Routes the investigation order to Work Management application ▪ Adds a note on the premise account that the remote energize order failed	Customer connect information Adds a note on the premise account that the remote energize order failed because backfeed current detected and order routed to Work Management application	RCD command fails, due to backfeed detected
6	Investigative order received	CIS	MRO	▪ Routes failed energize requests because of back-fed voltage to the Work Management application ▪ Adds a note on the premise that meter alert message indicating backfeed current detected and order routed to the field		
7	Investigative order received	MRO	CIS	▪ Identifies investigation order because meter alert message detected backfeed current by new order type ▪ Follows current procedures for investigation order		

3.1.5 BC Scenario 5 – New customer is requesting service on a future date with no requirements, but fails during working hours

The AMI meter failed to energize during normal business hours

A new customer contacts the local utility to request electrical service. Their requested is for a future date. There are no permit, inspection or construction requirements. The remote energize failed to occur at the meter. Service was not energized.

Table 6: BC Scenario 5 – New customer is requesting service on a future date with no requirements, but fails during working hours

#	Triggering Event	Information Producer	Information Receiver	Description of Process/Activity	Information Exchanged	Additional Notes
1	Customer call	Customer	CIS	Start process to open an account	Verbal or other internal data exchanges	
2	Customer request to open account	Utility Service Representative	CIS	• Enters Open order into CIS • CIS will default to a requested action code that indicates for the meter to be remotely energized • Follows existing procedures for suspicious activity	• Data for opening an account; • Date for activating the account • Communicates to the customer that their service will be remotely energized without service personnel visiting their property • Communicates safety information	
3	X (24?) hours before account activation and phone number exists	Out-bound phone call from CIS	Customer	If phone number exists and if part of optional procedure: • Places an automated outbound courtesy call to the customer (if a phone number exists) could be done no less than 24 hours before the requested move-in date. No phone number- no call.	• Restates the safety communications made during the initial call • Includes no confirmation step that the customer is ready or not ready for their service	This step occurs if a phone number exists and if required as part of an optional procedure
4	Effective date of connect request	CIS	EB	Initiates the connect order at 5 AM.	• Meter id; • Connect request	
RC	**Initiate Connect Request via RC Remote Connect Basic Module**					

#	Triggering Event	Information Producer	Information Receiver	Description of Process/Activity	Information Exchanged	Additional Notes
5	NC Remote Connect Procedure was not successful	EB	Work Management Application	▪ Issue manual connect work order ▪ Receives failed energize message from Enterprise Bus ▪ Routes the failed order to Work Management application	▪ Customer connect information ▪ Adds a note on the premise account that the remote energize order failed and order routed to Work Management application	RCD command fails,
6	RCD failure	Work Management Application	Field technician	▪ Failed energize order remains in work queue until the next business day ▪ Presents failed energize message to field technician		
7	Failure repaired	Field Technician	CIS	▪ Identifies failed AMI meter failure by order type ▪ Follows current procedures for Open orders to energize service ▪ Completes order via mobile data computer		
RU	**Unsolicited Connect Event Received via RU Basic Module**					
8	Meter reading received, either from UC event or via mobile data computer	EB	CIS	▪ Receives Order completion message with meter reading ▪ Provides meter reading and meter status to EB		
9	Connect completed	CIS	Premise application	▪ Updates premise with meter reading and meter stats		

3.1.6 BC Scenario 6 – Credit & Collections Reinstatement of Service

Assumption: This narrative assumes that utility service to the customer has been remotely disconnected for non-payment and that the customer has now paid the bill. Service must now be restored/reconnected.

Exception: If the customer who was disconnected for non-payment is different (old customer moved, new customer never established service until the cut) than the customer being restored/reconnected, use case #2 Routine turn-on of service (move in) applies.

Exception: In ComEd's remote disconnect application, the process to execute the remote restore/reconnection of service is handled manually on the MAS server after the CIS system produces the remote restore/reconnect order. User is notified of the pending restore/reconnection via a work flow manager (WFM) notification in the CIS system.

Exception: If the disconnected meter does not have remote capability, the order to restore/reconnect is routed to a work queue for manual dispatch.

A customer's utility service was remotely disconnected for non-payment by the local utility. The customer has now paid the bill. The customer system is notified of the payment by either automated process or by a call from the customer. If the customer calls to notify that payment has been made, the customer must provide a receipt or confirmation number as proof of payment. The customer information system (CIS) creates an order to restore/reconnect service.

The CIS system (through the Enterprise Bus) is programmed to recognize the characteristics (size/type, form/voltage, etc.) of the disconnected meter and the restore/reconnect order is routed to the AMI Head End. The AMI Head End sends a command to the disconnected meter telling it to restore/reconnect. The meter receives and executes the command, restoring/reconnecting service to customer. A message indicating that the restore/reconnect was successful is sent back to the AMI Head End along with the time of execution and the kWh reading from the meter. The data is transferred back to the CIS system where the order is marked complete and appropriate notations made to the customer's account noting the successful restore/reconnect, time of execution and the kWh meter reading.

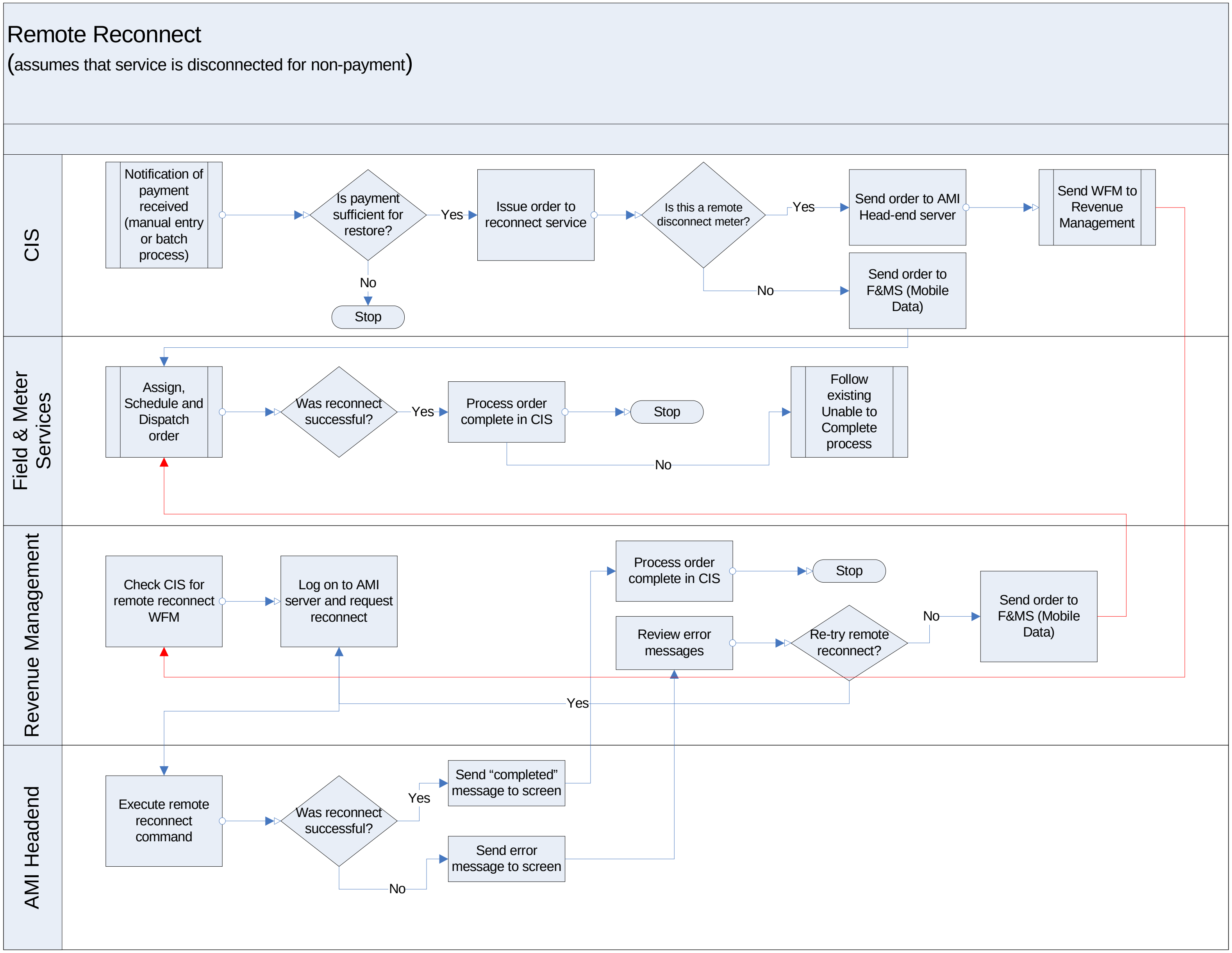
If the restore/reconnect of the meter is not successful, a message indicating such is also sent back to the AMI Head End. If the restore/reconnect can not be completed due to a safety issue (load side voltage present, detected customer load, etc.), a message is sent back to the AMI Head End indicating such. The AMI Head End sends the failure message and reason for the failure back to the CIS system where the account is noted accordingly. The restore/reconnect will not be re-tried until the customer confirms the clearance of the safety issue. If the failure is not safety related and the AMI Head End is programmed with logic to retry the restore/reconnect process, than the system will follow that logic. If the system is not programmed to retry the command or the subsequent retry attempts remain unsuccessful, the uncompleted order is returned to the CIS system and routed a work queue for manual dispatch. The AMI Head End or MDM system should also produce reports that display the status of requested orders and their success or failure.

Upon dispatch of the failed restore/reconnect, the energy technician will investigate why the remote command from the AMI Head End failed. If the condition can be corrected without a meter exchange, the technician will perform the repair. If so equipped, the energy technician can issue the restore/reconnect command on site via a hand-held device or laptop computer. If the technician can not issue the restore/reconnect command on site, they will contact the dispatcher. The dispatcher will either reissue the order to restore/reconnect (so that the automated process is initiated) or will manually interface the AMI Head End to send the restore/reconnect command to the meter. If the restore/reconnect is successful, a message indicating that the restore/reconnect was successful is sent back to the AMI Head End along with the time of execution and the kWh reading from the meter. The data is transferred back to the CIS system where the order is marked complete and appropriate notations made to the customer's account noting the successful restore/reconnect, time of execution and the kWh meter reading.

If the technician can not repair the condition that caused the restore/reconnect to fail, the technician will have to exchange the meter like for like. If the "in" meter is sent to the field with the disconnect open, the technician will have to call the dispatcher. The dispatcher will issue a command to restore/reconnect the new meter. If the "in" meter is sent to the field with the disconnect switch closed, the energy technician will perform all of the required safety checks for a manual restore/reconnect before installing the new meter. If the service can be safely restored, the technician will do so. The meter exchange order will be processed per company procedure so that the affected systems are updated accordingly.

The diagram below captures these interactions.

Table 7: BC Scenario 6 – Credit & Collections Reinstatement of Service



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3.2 Disconnect Business Processes

3.2.1 BD Scenario 1 – Routine Immediate Move-out Disconnect Procedure

For most service termination situations the utility has the option of sending a field technician to physically disconnect the service or to perform what is know as a "soft" turn off. The scheduling of field resources to visit the customer sites is complex and costly and occasionally the activity cannot be carried out at the time the customer wanted. The efficiencies provided by the remote connect include less man hours on site, faster switchover of customers, less opportunities for safety incidents, less intrusive to customers and overall improved customer service.

Utilities are looking to AMI metering to provide the capabilities to improve the efficiency of the service termination process through remote turn off functions. The business transactions for routine shut off of service (move out) will be investigated in this use case.

Table 8: BD Scenario 1 – Routine Immediate Move-out Disconnect Procedure

#	Triggering Event	Information Producer	Information Receiver	Description of Process/Activity	Information Exchanged	Additional Notes
1	Customer request a move-out	Customer	CIS	Internal business process within the CIS that determines that a disconnect command should be issued	Customer Account information, Electric Service Disconnection date & time	
2	Request to validate a remote disconnect of a specific meter	CIS	Application that performs validations of disconnect requests	Validate meter is eligible for remote disconnect: switch should be able to respond to disconnect command	Meter id; Disconnect switch available and/or eligible	
3	Disconnect request is valid	Application that performs validations of disconnect requests	EB	Initiate the disconnect request	Meter id; Disconnect request	
RD	**Initiate Disconnect Request via RD Remote Disconnect Basic Module**					

#	Triggering Event	Information Producer	Information Receiver	Description of Process/Activity	Information Exchanged	Additional Notes
5	Confirmation of disconnect action	EB	CIS	Issue final bill and change account meter/ status	Meter id; Meter reading, date, and time of disconnect, worked by (user ID)	
6	RD Remote Disconnect Procedure not was successful	EB	CIS	Error handling	Meter id; Error type code and additional error information	Error was encountered, and subsequent error handling is required

3.2.2 BD Scenario 2 – Pre-planned Move-out Disconnect Procedure

This Scenario is identical to the previous scenario, except that there is a time-delay to issuing the disconnect command.

Table 9: BD Scenario 2 – Pre-planned Move-out Disconnect Procedure

#	Triggering Event	Information Producer	Information Receiver	Description of Process/Activity	Information Exchanged	Additional Notes
1	Customer requests a move-out at a specific time in the future	Customer	CIS	Internal business process within the CIS that determines that a disconnect command should be issued	Customer Account information, Electric Service Disconnection date & time	

#	Triggering Event	Information Producer	Information Receiver	Description of Process/Activity	Information Exchanged	Additional Notes
2	Request to validate a remote disconnect of a specific meter	CIS	Application that performs validations of disconnect requests	Validate meter is eligible for remote disconnect: switch should be able to respond to disconnect command	Meter id; Disconnect switch available and/or eligible	
3	Disconnect is valid and the effective date/time of disconnect request has arrived	Application that performs validations of disconnect requests	EB	Initiates the disconnect order at the indicated time	Meter id; Disconnect request	
RD	**Initiate Disconnect Request via RD Remote Disconnect Basic Module**					
5	Confirmation of disconnect action	EB	CIS	Issue final bill and change account meter/ status	Meter id; Meter reading, date, and time of disconnect, worked by (user ID)	
6	RD Remote Disconnect Procedure not was successful	EB	CIS	Error handling	Meter id; Error type code and additional error information	Error was encountered, and subsequent error handling is required

3.2.3 BD Scenario 3 – Credit & Collections Termination of Service

The termination of service in support of credit and collections activities requires a physical interruption of service until appropriate financial arrangements are made to demonstrate that the customer will honor their obligations. Credit and collections service termination orders carry with them the possibility of physical risks to the field technicians. The scheduling of field resources to visit the customer sites to disconnect a customer for non pay is complex and costly and often due to resource limitations the activity cannot be carried out. The efficiencies provided by the remote disconnect include less man hours on site, less opportunities for safety incidents, less opportunities for physical abuse of field reps by non pay customers, able to work more orders, less uncollectibles, and overall improved customer service.

Utilities are looking to AMI metering to provide the capabilities to improve the efficiency of the service termination process through remote turn off functions. The business transactions for shut off of service for non pay will be investigated in this use case.

Table 10: BD Scenario 3 – Credit & Collections Termination of Service

#	Triggering Event	Information Producer	Information Receiver	Description of Process/Activity	Information Exchanged	Additional Notes
1	Customer eligible for disconnect for credit reasons	CIS	CIS	Internal business process within the CIS that determines that a disconnect for non pay command should be issued	Customer Account information, Electric Service Disconnection date & time	All regulatory requirements have been met
2	Request to validate a remote disconnect of a specific meter	CIS	Application that performs validations of disconnect requests	Validate meter is eligible for remote disconnect: switch should be able to respond to disconnect command	Meter id; Disconnect switch available and/or eligible	
3	Valid disconnect request	Application that performs validations of disconnect requests	EB	Determines whether the meter can perform remote disconnects	Meter id: AMI headend id; Yes/no Any additional information needed for disconnect action	
RD	**Initiate Disconnect Request via RD Remote Disconnect Basic Module**					
5	Confirmation of disconnect action	EB	CIS	Issue final bill and change account meter/ status	Meter id; Meter reading, date, and time of disconnect, worked by (user ID)	Assumes waiting period has expired.

#	Triggering Event	Information Producer	Information Receiver	Description of Process/Activity	Information Exchanged	Additional Notes
6	RD Remote Disconnect Procedure not was successful	EB	CIS	Error handling	Meter id; Error type code and additional error information	Error was encountered, and subsequent error handling is required

3.3 Unsolicited Change in RCD Switch State

These unsolicited change business processes cover the following situations, some with variations:

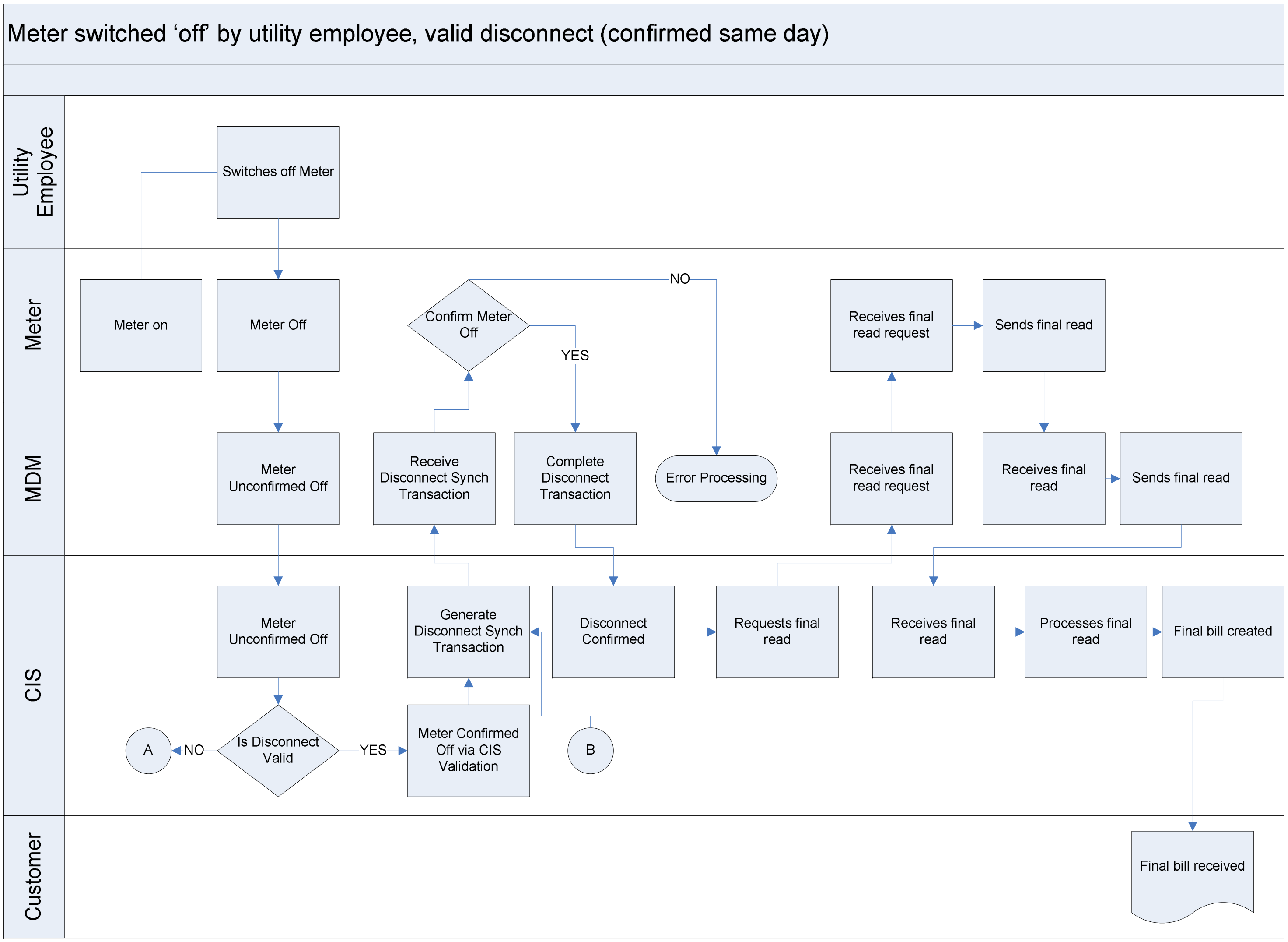
- Meter manually switched off by utility employee, including both valid and invalid switching
- Meter manually switched off by unknown party, including both valid and invalid switching
- Software/hardware failure switches meter off/on (also includes unauthorized command causing switch)
- Miscellaneous event causes meter to switch off/on
- Meter manually switched on by utility employee, including both valid and invalid switching
- Meter manually switched on by unknown party, including both valid and invalid switching

Since these business processes were very completely developed as flow diagrams, the RCD Basic Modules for RCD Unsolicited Switch Changes, RCD Connect Request, and RCD Disconnect Request are not explicitly shown. However, they can be envisioned as essentially replacing the Meter and MDM swimlanes in these diagrams, although in the RCD Unsolicited Switch Change module, verification of the changed state of the RCD switch in the meter is performed before the CIS validation that such a change has/has not been requested.

3.3.1 BU Scenario 1: Meter manually switched off by utility employee

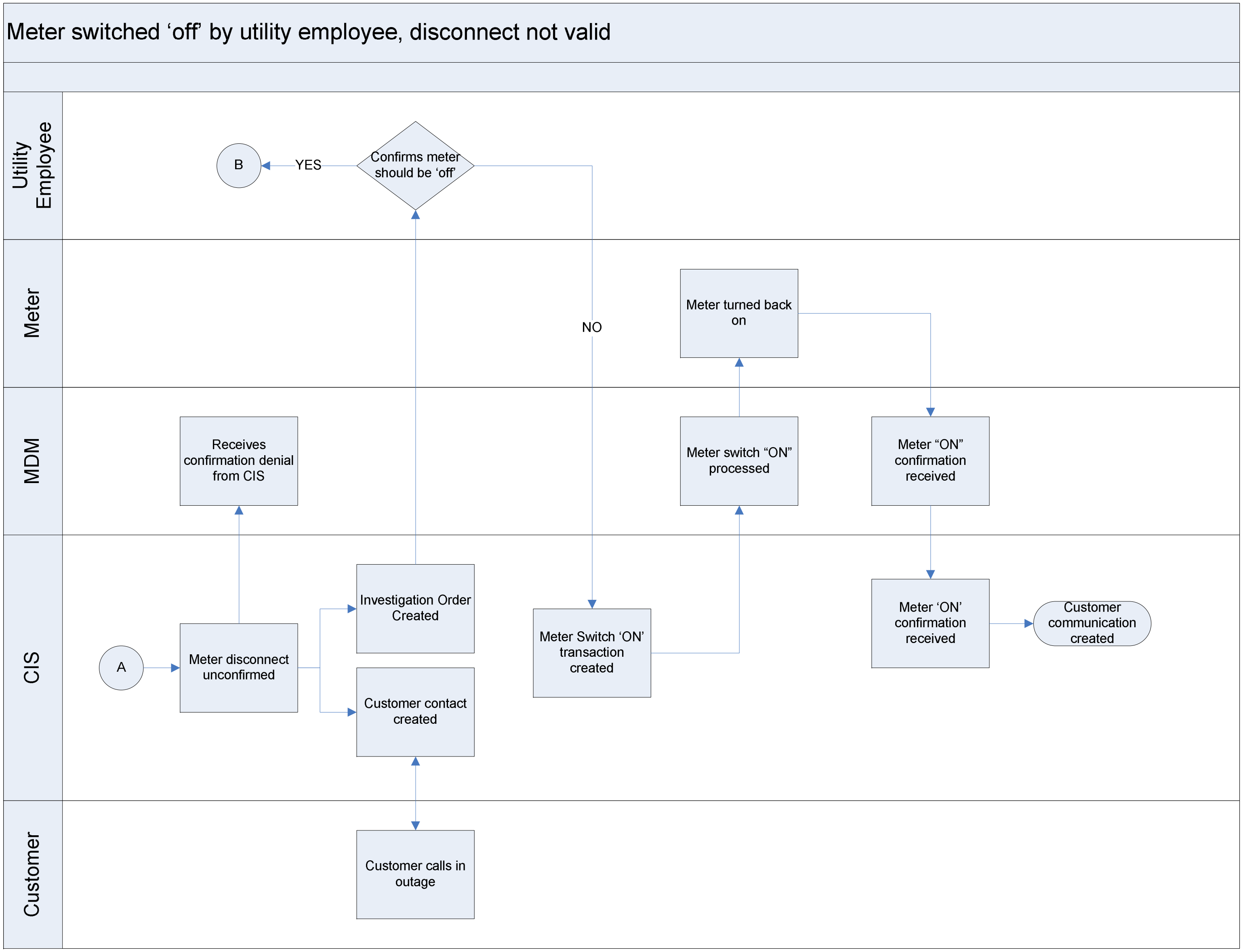
3.3.1.1 BU Scenario 1.1: Meter switch is valid (confirmed programmatically)

Table 11: BU Scenario 1.1: Meter switch is valid (confirmed programmatically)



3.3.1.2 BU Scenario 1.2: Meter switch not valid (cannot be confirmed programmatically)

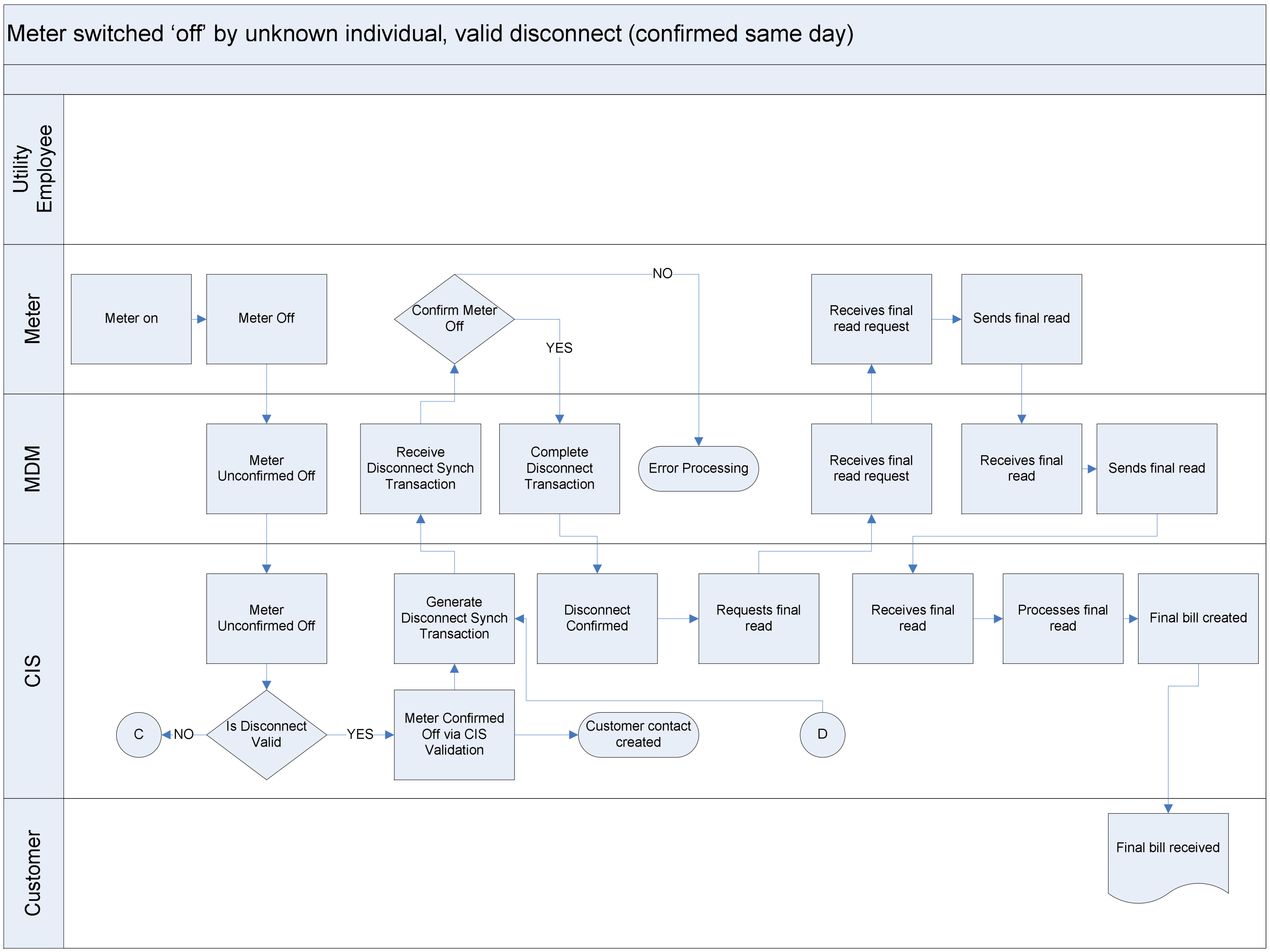
Table 12: BU Scenario 1.2: Meter switch not valid (cannot be confirmed programmatically)



3.3.2 BU Scenario 2: Meter manually switched off by unknown party

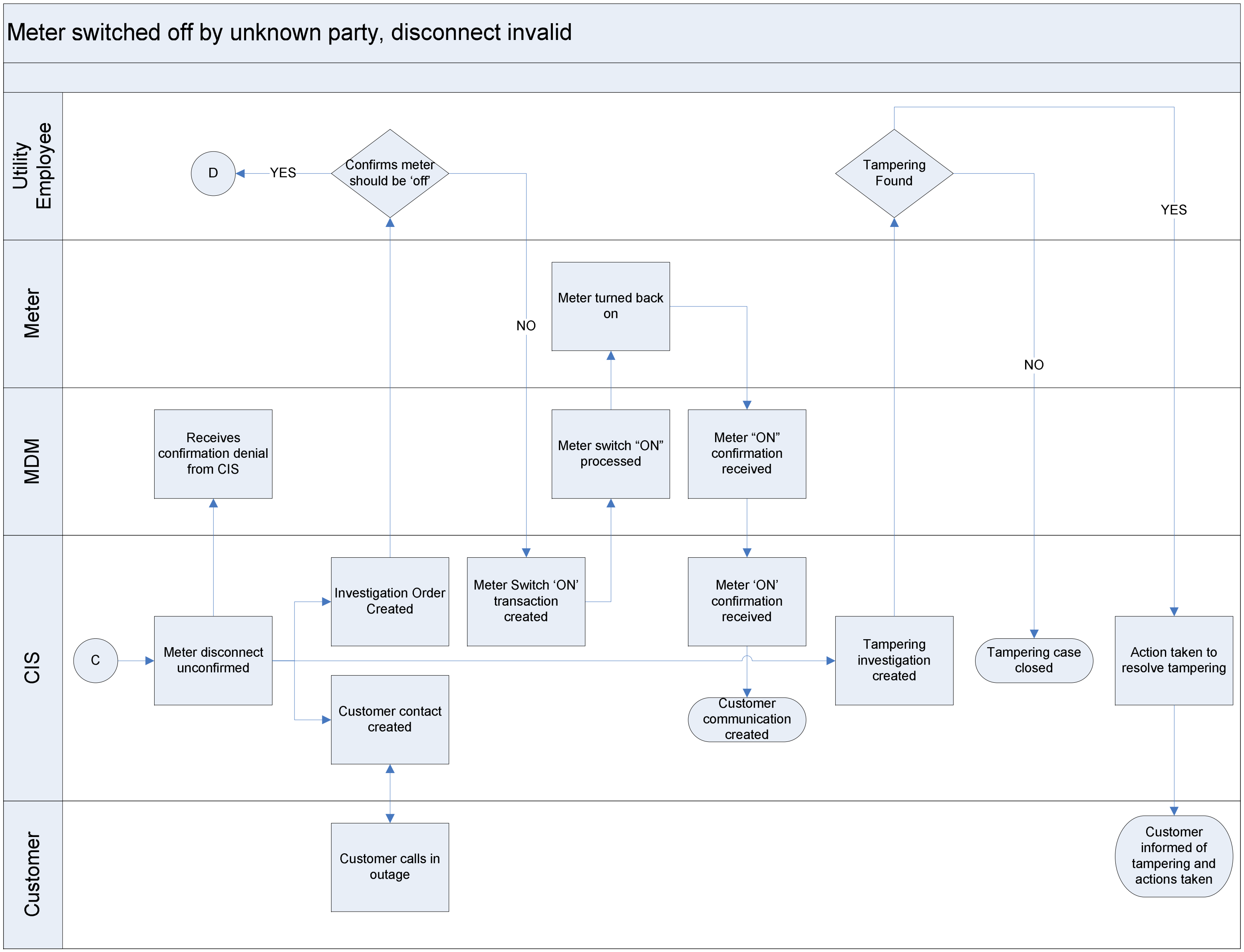
3.3.2.1 BU Scenario 2.1: Meter switch is valid (confirmed programmatically)

Table 13: BU Scenario 2.1: Meter switch is valid (confirmed programmatically)



3.3.2.2 BU Scenario 2.2: Meter switch is invalid (cannot be confirmed programmatically)

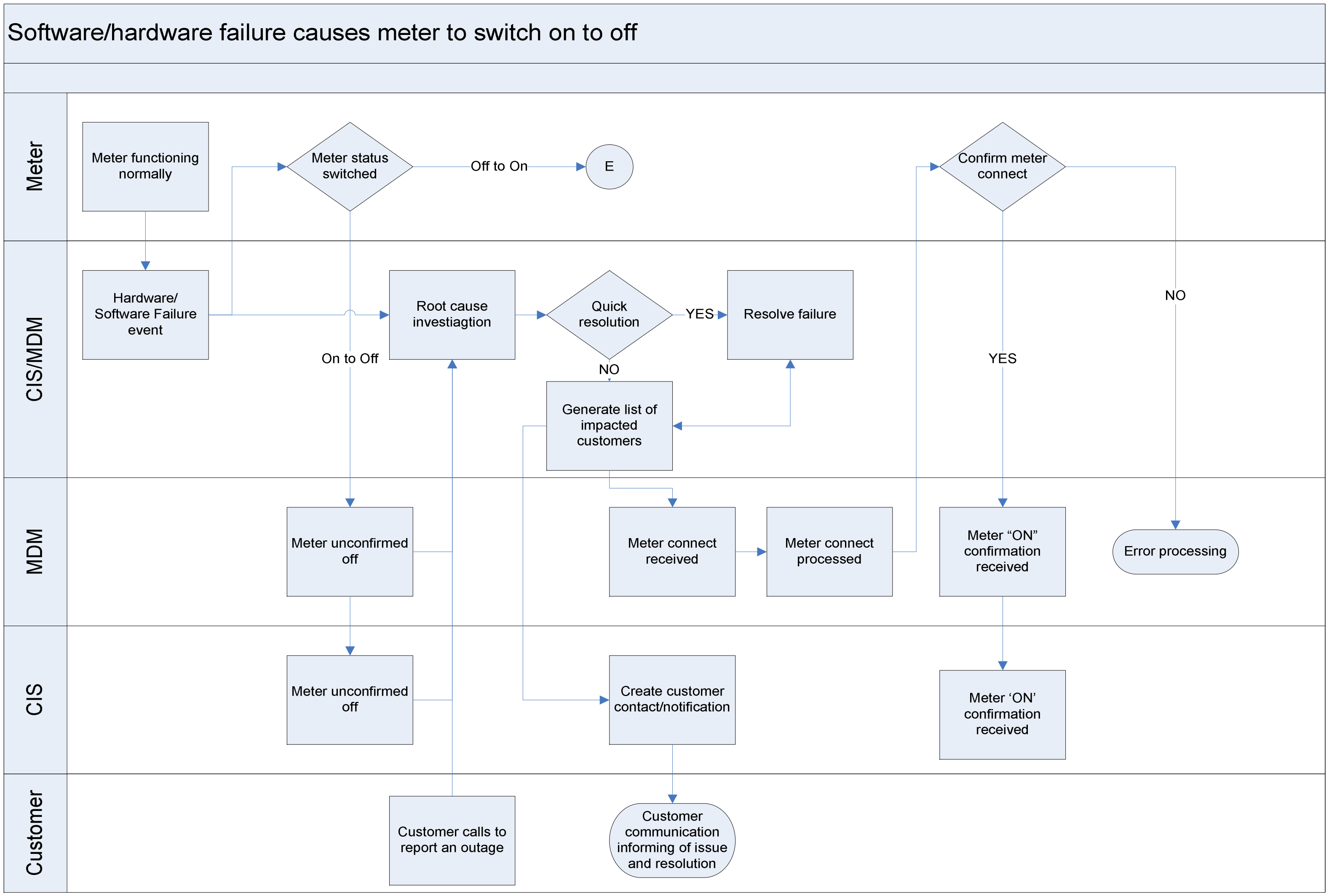
Table 14: BU Scenario 2.2: Meter switch is invalid (cannot be confirmed programmatically)



3.3.3 BU Scenario 3: Software/hardware failure switches meter off/on (also includes unauthorized command causing switch)

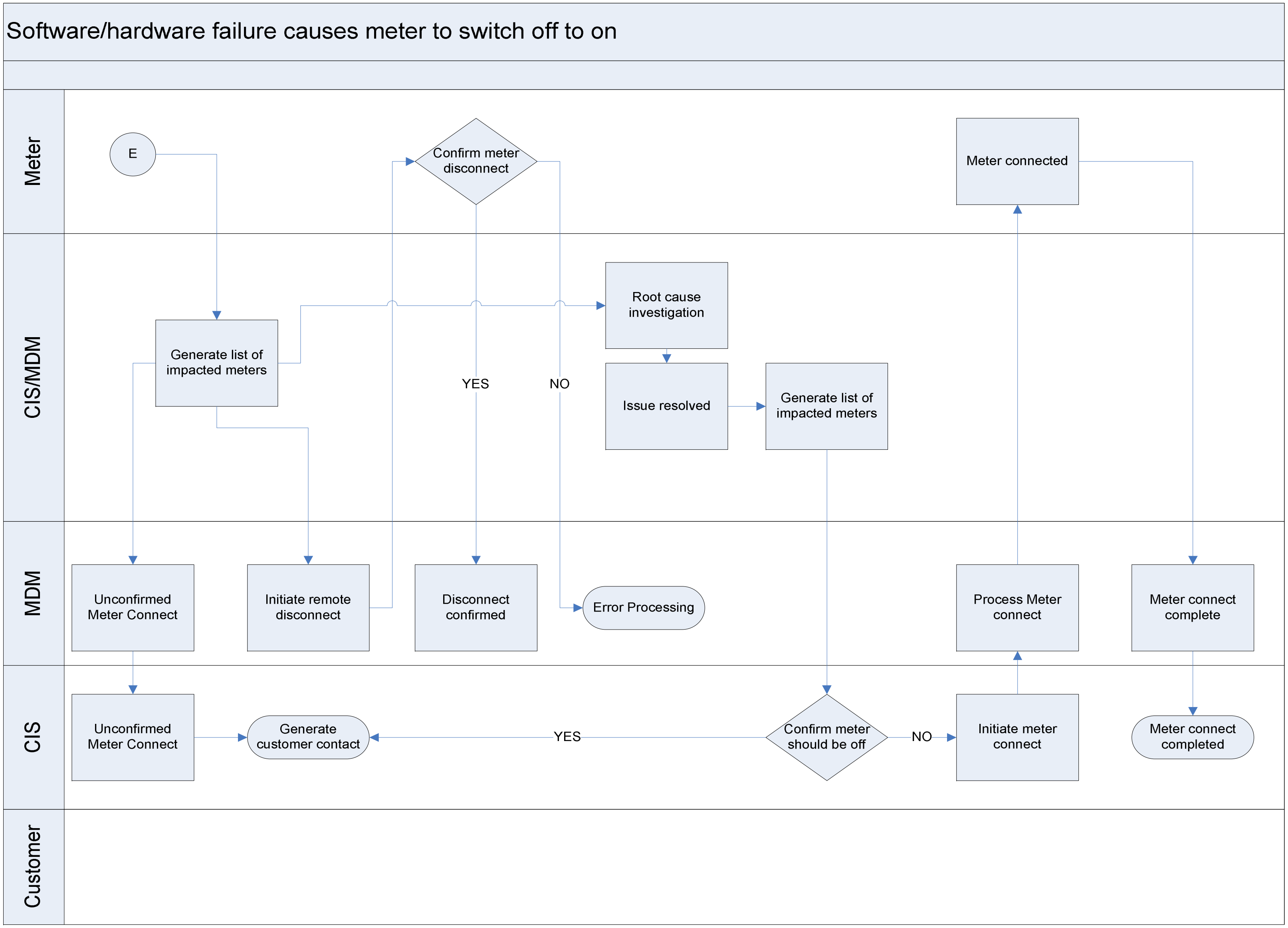
3.3.3.1 BU Scenario 3.1: Failure switches meter from on to off

Table 15: BU Scenario 3.1: Failure switches meter from on to off



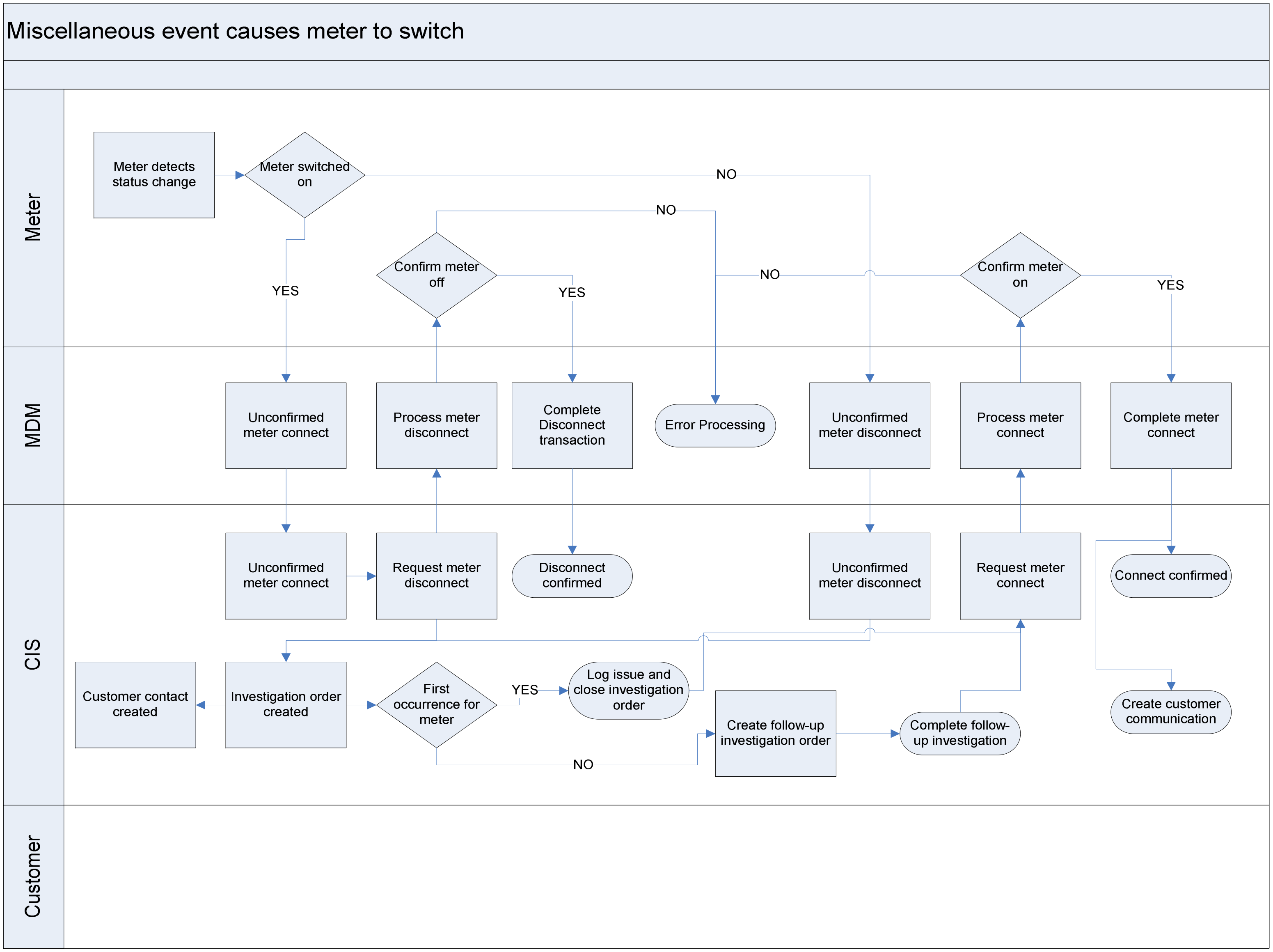
3.3.3.2 BU Scenario 3.2: Failure switches meter from off to on

Table 16: BU Scenario 3.2: Failure switches meter from off to on



3.3.4 BU Scenario 4: Miscellaneous event causes meter to switch off/on

Table 17: BU Scenario 4: Miscellaneous event causes meter to switch off/on



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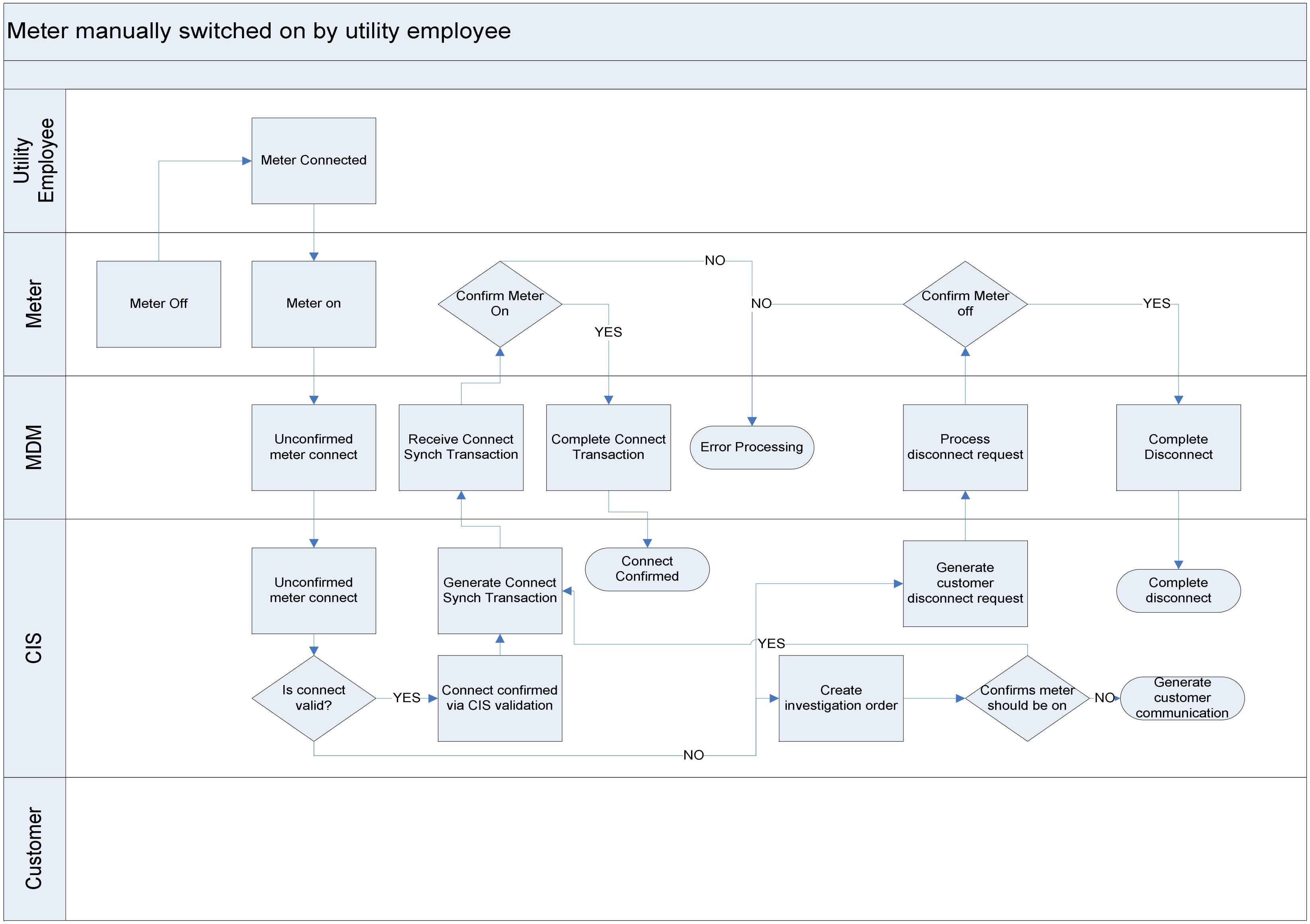
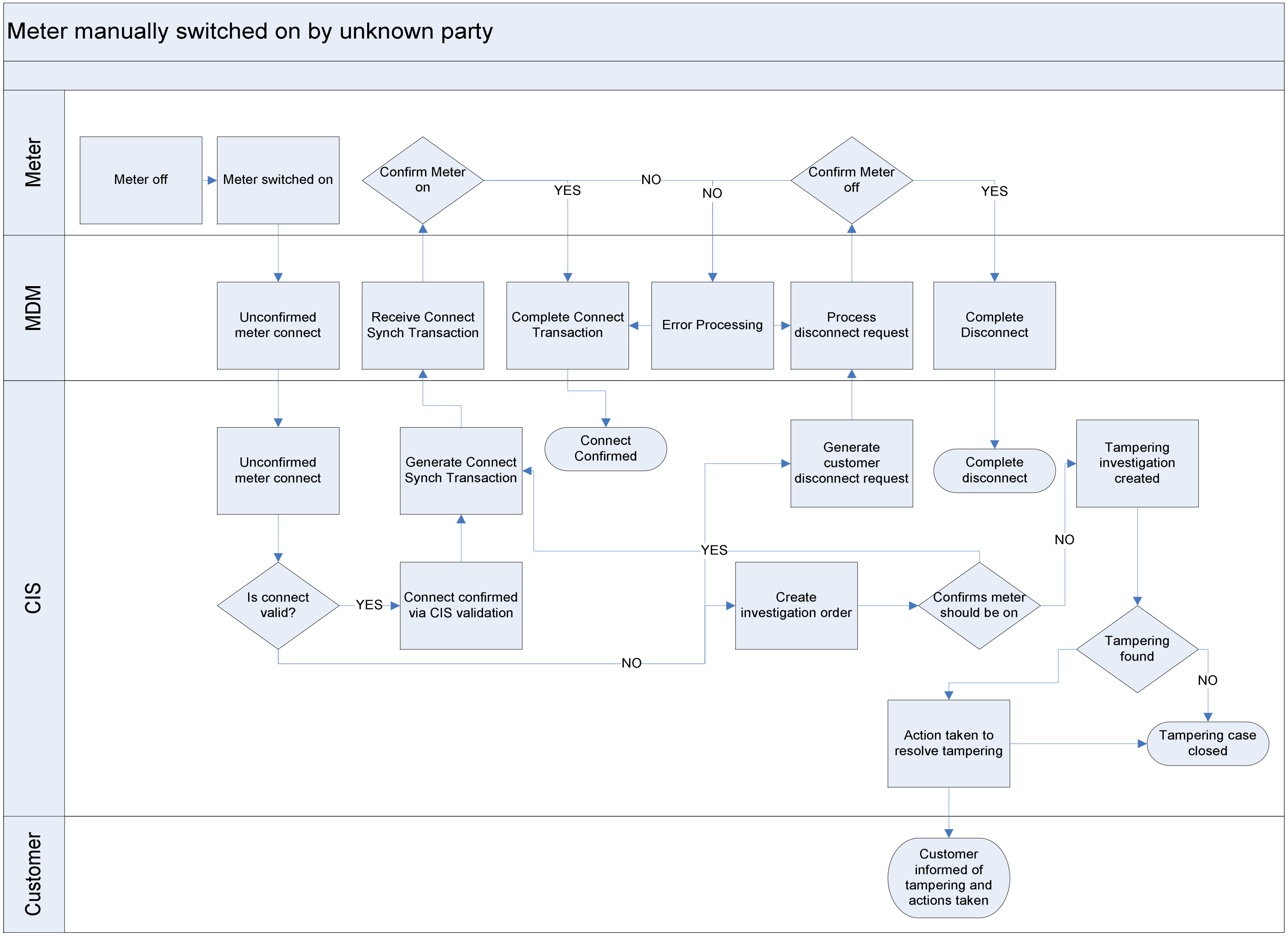
3.3.5 BU Scenario 5: Meter manually switched on by utility employee

Table 18: BU Scenario 5: Meter manually switched on by utility employee



3.3.6 BU Scenario 6: Meter manually switched on by unknown party

Table 19: BU Scenario 6: Meter manually switched on by unknown party



3.4 Emergency Load Shedding

3.4.1 BE Scenario 1 – Use of Remote Disconnect Meters for Emergency Load Shed

This Use Case defines the process for the temporary suspension of electric service in support emergency load shed activities. This is an alternative to wide-scale rolling blackouts and circuit level interruptions. Customers who choose to participate in such a program are eligible to have their power cut during the critical periods.

This type of selective black-out provides the means for reducing power demands on the overall grid while selectively maintaining service to critical customers such as public infrastructure (i.e. traffic lights) and medical facilities.

A specific rate would need to be developed to support this type of service.

Remote Disconnect/Reconnect Meters enable such functionality.

Table 20: BE Scenario 1 – Use of Remote Disconnect Meters for Emergency Load Shed

#	Triggering Event	Information Producer	Information Receiver	Description of Process/Activity	Information Exchanged	Additional Notes
1	A Load-Shed event / emergency is declared by system operators.	System Operations	CIS	Internal business process that defines the criteria and process for a load-shed event. Customers participating in the load shed program are selected for immediate remote disconnect.	Customer Account information, Electric Service Disconnection date & time (Immediate)	
2	Request to validate a remote disconnect of a specific meter	CIS	Application that performs validations of disconnect requests	Validate meter is eligible for remote disconnect: switch should be able to respond to disconnect command	Meter id; Disconnect switch available and/or eligible	

#	Triggering Event	Information Producer	Information Receiver	Description of Process/Activity	Information Exchanged	Additional Notes
3	Disconnect request is valid	Application that performs validations of disconnect requests	EB	Initiate the disconnect request	Meter id; Disconnect request	
RD	**Initiate Disconnect Request via RD Remote Disconnect Basic Module**					
5	Confirmation of disconnect action	EB	CIS	Automatic Remark of load-shed participation in customer account record.	Meter id; Meter reading, date, and time of disconnect, worked by (user ID)	
6	RD Remote Disconnect Procedure not was successful	EB	CIS	Error handling	Meter id; Error type code and additional error information	Error was encountered, and subsequent error handling is required

3.4.2 BE Scenario 2 – Remote Connect After Load Shed

When an emergency load shed event is complete, this use case defines the process for restoring power to customers who have been temporarily disconnected during the event. This only applies to customers who have opted to participate in such programs. Remote Disconnect/Connect Meters enable such functionality.

Table 21: BE Scenario 2 – Remote Connect After Load Shed

#	Triggering Event	Information Producer	Information Receiver	Description of Process/Activity	Information Exchanged	Additional Notes
1	A Load-Shed event / emergency is declared complete by system operators.	System Operations	CIS	Internal business process that defines the conclusion of a load-shed event. Customers participating in the load shed program are selected for immediate remote connect.	Customer Account information, Electric Service Connection date & time (Immediate)	
2	Request to validate a remote connect of a specific meter	CIS	Application that performs validations of connect requests	Validate meter is eligible for remote connect: switch should be able to respond to connect command	Meter id; Disconnect switch available and/or eligible	
3	Valid connect request	Application that performs validations of connect requests	Application that issues connect commands to meter	Determines whether the meter can perform remote connects	Meter id: AMI headend id; Yes/no Any additional information needed for connect action	
4	Meter is eligible for remote connect command	Application that issues connect commands to meter	EB	Issue a remote connect command to a specific meter	Meter id; Connect command Date and time	
RC	**Initiate Connect Request via RC Remote Connect Basic Module**					
6	RC Remote Connect Procedure was successful	EB	CIS	Results of connect request provided to CIS	Meter id; Connect confirmation	No error was encountered

#	Triggering Event	Information Producer	Information Receiver	Description of Process/Activity	Information Exchanged	Additional Notes
7	RC Remote Connect Procedure was successful	CIS	Customer	Automatic Remark of load-shed participation in customer account record.	Verbal confirmation that meter is now connected	No error was encountered
8	RC Remote Connect Procedure not was successful	EB	CIS	Error handling Update meter status to reconnected (not able to accept connect command)	Meter id; Error type code and additional error information	Error was encountered, and subsequent error handling is required

3.5 Credit & Collection Service: Limiting Energy Usage

Customers may be signed up for a program that limits their energy usage. They may be warned on getting close to their limits. The RCD switch may be disconnected upon their reaching their energy limit. When their usage is reset, the RCD switch may be reconnected.

Other customer programs could limit customer demand through direct load control. These programs would not ordinarily involve the RCD switch since that switch is expected to cut all power to a metered location, not just certain loads. It is conceivable that under certain circumstances, an RCD switch could be used for load control, but that possibility should be handled as part of a broader load management analysis and is beyond the scope of this document.

3.6 Maintenance-Related Business Processes

3.6.1 BM Scenario 1: Integrity Check

The statuses of RCD switches are periodically checked to verify that no undetected changes have taken place and that the RCD parameter settings reflect those in appropriate databases. This periodic check could be scheduled upon start-up, daily, weekly, monthly, upon anomalous events, and at other times as deemed useful.

3.6.2 BM Scenario 2: Change RCD Parameters

RCD parameters can be changed to reflect different operational procedures. For instance, the switch may now be required to be armed before a connect is initiated, the customer-side voltage level for allowing connects may be modified, or remote disconnects may be prevented.

4 Remote Connect/Disconnect (RCD) Basic Modules: "How"

The RCD basic modules capture the "How" of remote connect and disconnect activities. These modules typically involve a key action, plus all the exception notifications. All actions are expected to have an associated acknowledgment either of success or an exception.

The Remote Connect/Disconnect (RCD) Basic modules include:

- **RC**: RCD Connect, made up of the AMI/EB modules SOR, SCV, SRC, SRS, and Exx
- **RD**: RCD Disconnect, made up of the AMI/EB modules SOR, SRD, SRS, and Exx
- **RU**: RCD Unsolicited change in RCD switch, made up of the AMI/EB modules SOR, SUC, SRS, and Exx
- **RI:** RCD Integrity check of RCD switch, made up of AMI/EB modules SRE, SRS, and Exx

4.1 RC – RCD Connect Request

All business processes which involve the issuing of a connect command to the RCD switch are variations on the basic sequence:

- SRE – Check existence of RCD switch
- SOR – Read meter
- SCV – Check on customer-side voltage at meter
- SAR – Arm RCD switch (optional)
- SRC – Connect RCD switch
- SRS – Check RCD switch status
- Exx – Exception handling for each of these steps

Some implementations may require each of these steps to be initiated from the RCD applications through the Enterprise Bus to the AMI system, while other implementations may perform these steps internally within the AMI system. In either case, the responses back to the initiating RCD applications will receive Meter/Headend Event codes through response messages to indicate success or any exceptions.

This RCD Connect (RC) request procedure is shown in the Activity Diagram, Figure 7.

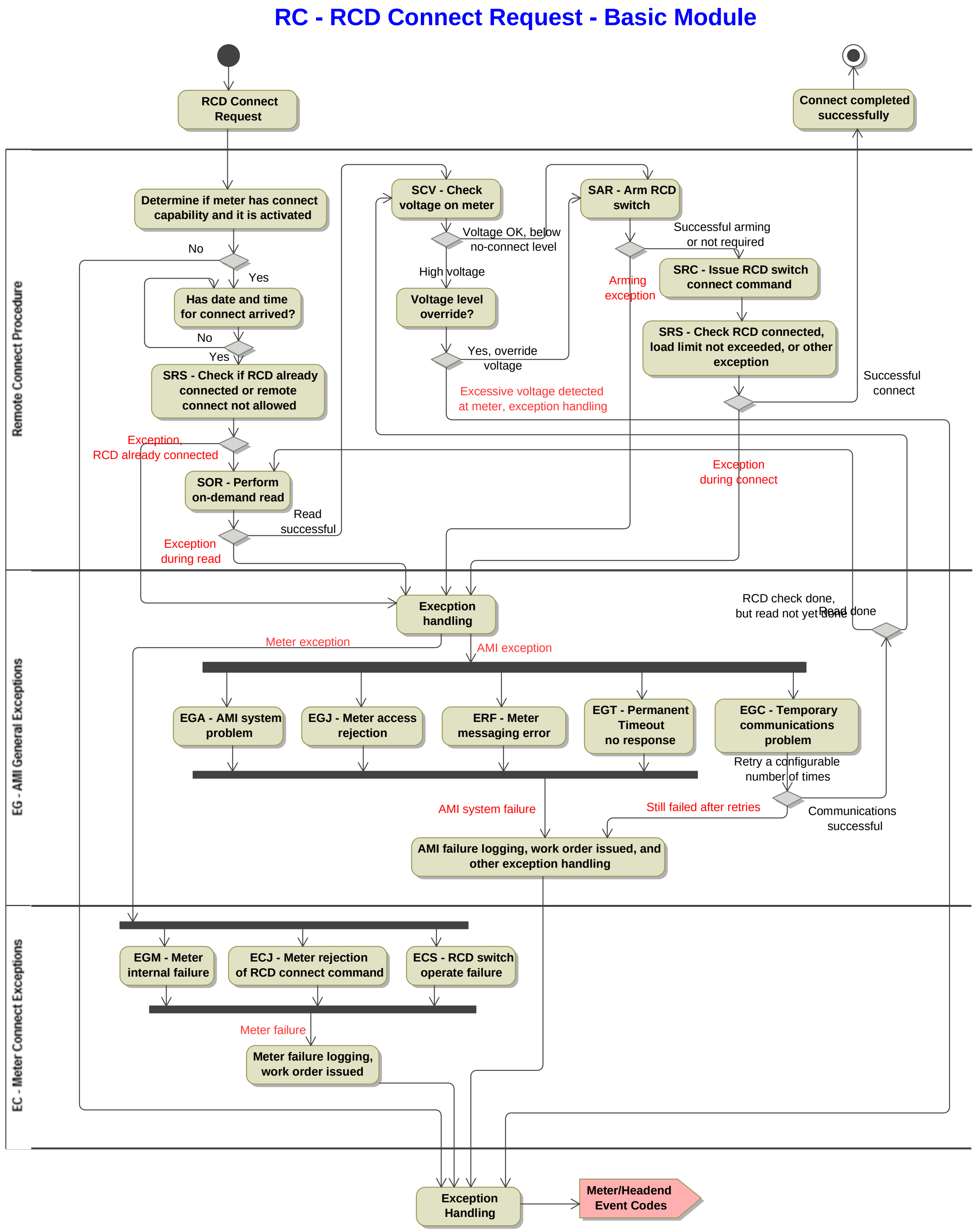


Figure 7: RC – Activity Diagram for RCD Switch Connect Request

4.2 RD – RCD Disconnect Request

All business processes which involve the issuing of a connect command to the RCD switch are variations on the basic sequence:

- SRE – Check existence of RCD switch
- SRS – Check RCD switch status
- SAR – Arm RCD switch for disconnect (optional)
- SRC – Disconnect RCD switch
- SOR – Read meter
- Exx – Exception handling for each of these steps

Some implementations may require each of these steps to be initiated from the RCD applications through the Enterprise Bus to the AMI system, while other implementations may perform these steps internally within the AMI system. In either case, the responses back to the initiating RCD applications will receive Meter/Headend Event codes through response messages to indicate success or any exceptions.

This RCD Disconnect (RD) request procedure is shown in the Activity Diagram, Figure 8.

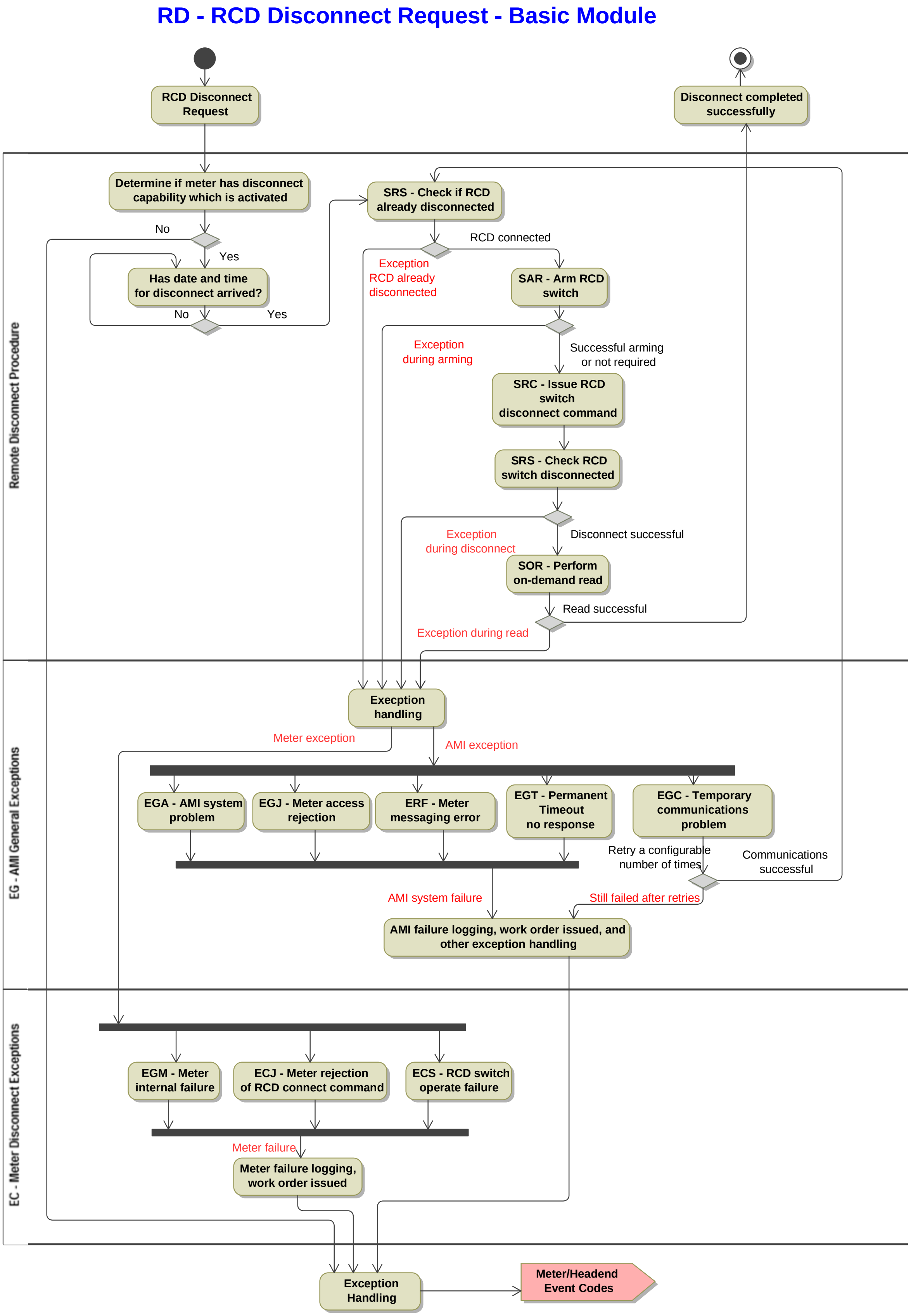


Figure 8: RD – Activity Diagram for RCD Switch Disconnect Request

4.3 RU – RCD Unsolicited Change in RCD Switch

All business processes which involve unsolicited changes of the RCD switch are variations on the basic sequence:

- SUC – Detect unsolicited RCD connect event
- SUD – Detect unsolicited RCD disconnect event
- SRS – Check RCD switch status
- SOR – Read meter
- Exx – Exception handling for each of these steps

Some implementations may require each of these steps to be initiated from the RCD applications through the Enterprise Bus to the AMI system, while other implementations may perform these steps internally to the AMI system. In either case, the responses back to the initiating RCD applications will receive Meter/Headend Event codes through response messages to indicate success or any exceptions.

This RCD Unsolicited (RU) change request procedure is shown in the Activity Diagram, Figure 9.

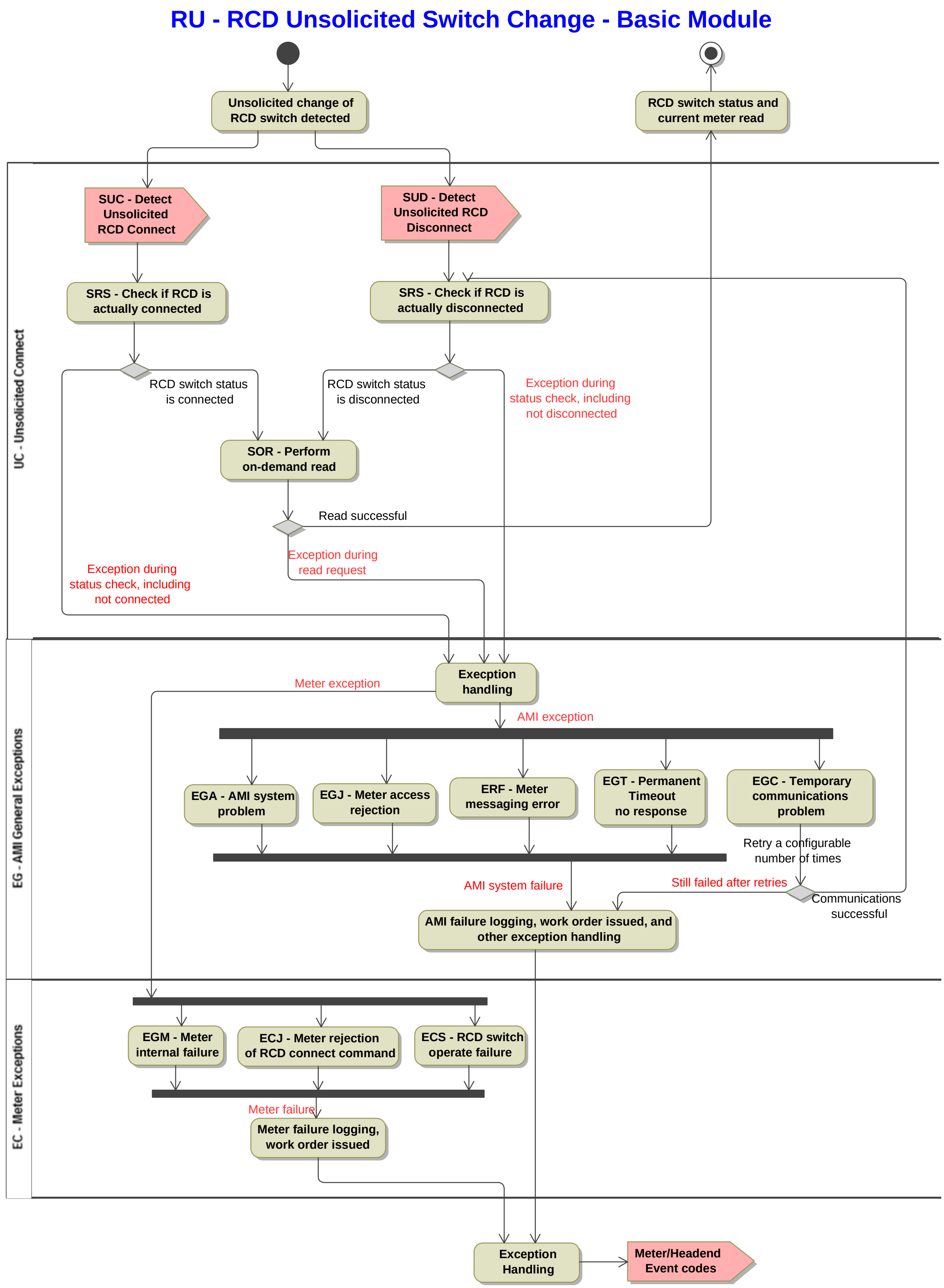


Figure 9: RU – Activity Diagram for RCD Unsolicited Switch Change

4.4 RI – RCD Integrity Check

A periodic "integrity check" can be used to determine if the status of each meter's RCD switch (and other key values) are consistent with the status of the switch in the relevant databases on the Enterprise Bus. This check can be necessary particularly upon installation of a meter, upgrading of a meter, or after a communications disruption since some event-driven information from the meter may not always get to the AMI/EB interface.

This RCD Integrity Check (RI) change request procedure is shown in the Activity Diagram, Figure 10. In essence, it uses the SCS Check Status of RCD Switch.

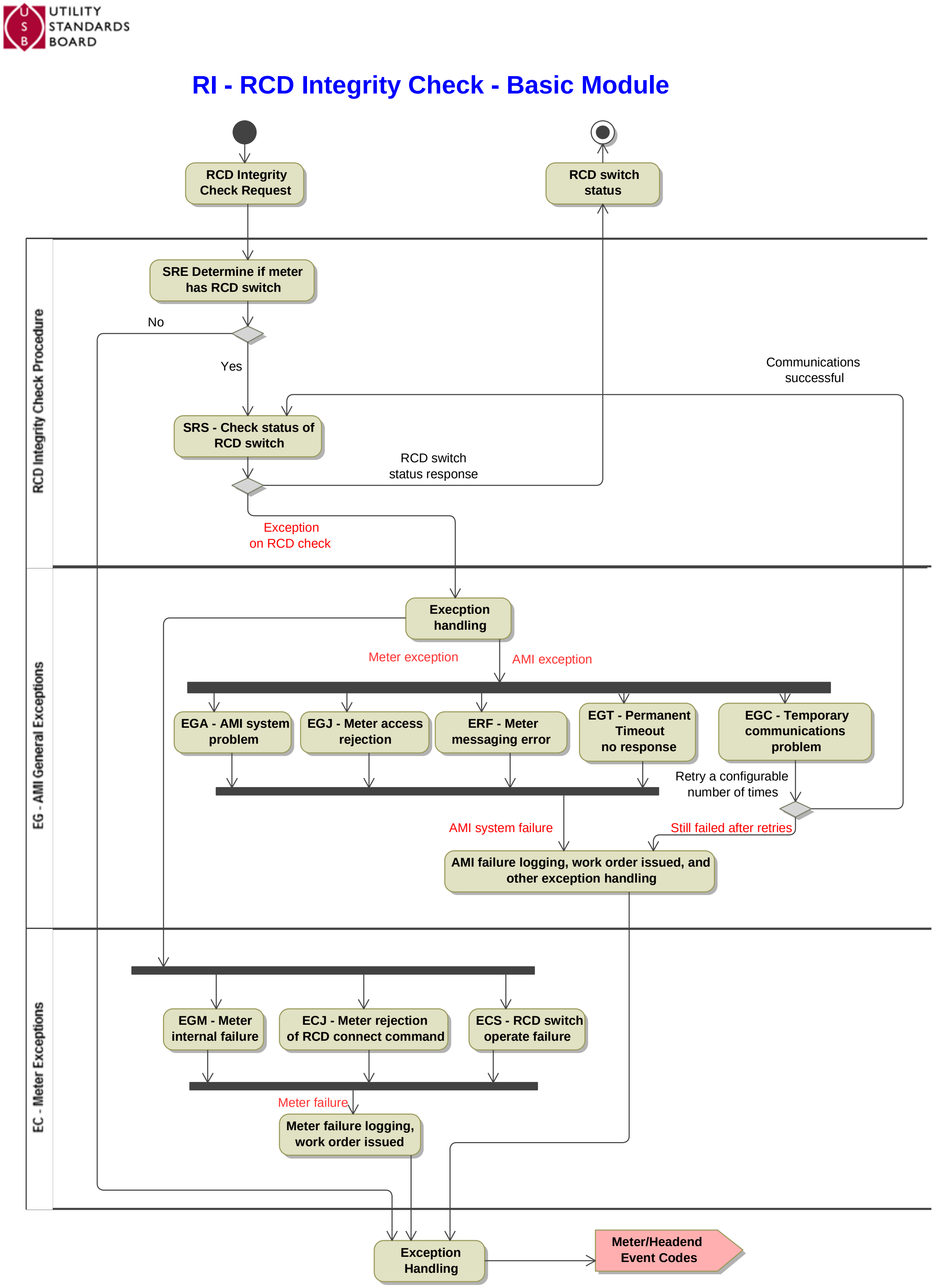


Figure 10: Activity Diagram for RI – RCD Integrity Check

4.5 RL – RCD Limiting Energy Usage

Customers may be signed up for a program that limits their energy usage over specific time intervals. They may be warned on getting close to their limits. The RCD switch may be disconnected upon their reaching their energy limit. When their usage is reset, the RCD switch may be reconnected.

Different implementations could involve different procedures. For example, the management of limiting energy usage could be performed step-by-step via applications on the Enterprise Bus:

- Meter Reading application reads energy usage of a meter
- Energy Limiting application determines that the usage exceeds the limit
- Disconnect application issues an RCD disconnect command to the AMI system

This procedure uses SOR, SCS, and SRD, and therefore is not modeled in its own Activity Diagram.

However, if the AMI system and the Smart Meter are responsible for the management of limiting energy usage, then new capabilities and information exchanges need to be added to the AMI/EB interface. These interactions would include:

- Energy Limiting application on the Enterprise Bus sets the limit of energy usage in meter
- Smart meter determines that the energy usage exceeds first the warning level and then the absolute limit, and reports back to the Energy Limiting application
- AMI system or the Smart Meter performs the RCD disconnect if no further action is taken by the Energy Limiting application to, say, reset the energy usage

A similar procedure in reverse for when the energy usage is reset would consist of:

- Energy Limiting application resets the energy usage at the meter
- Smart meter determines that the energy usage is now below the usage limit
- AMI system or the Smart Meter performs the RCD connect

These latter procedures are in the Activity Diagram, Figure 11.

RL - RCD Limiting Energy Usage - Basic Module

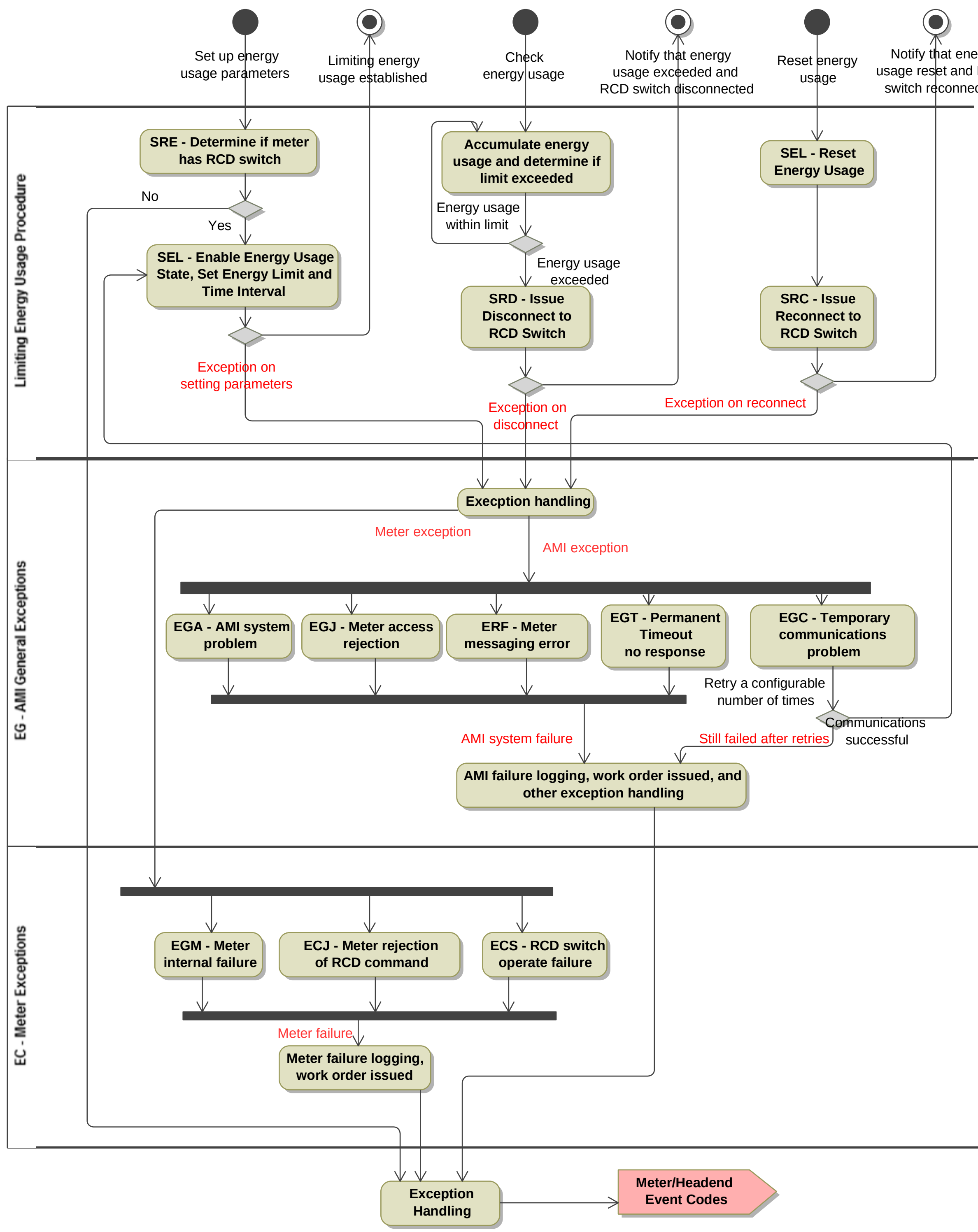


Figure 11: Activity Diagram for RL – RCD Limiting Energy Usage

5 Remote Connect/Disconnect (RCD) AMI/EB Modules: "Standardization"

The Remote Connect/Disconnect (RCD) AMI/EB modules are those that have been extracted from the RCD Business Processes and the RCD Basic Modules and are appropriate for de facto standardization since they fulfill the following criteria:

- The modules involve only interactions across the AMI/EB interface, although in some implementations they may be handled internally in the AMI system.
- The modules reflect basic interactions. No business process-specific interactions are included.

The following RCD modules fulfill these criteria:

- SOR: Standard on-request meter read module (this module is provided in both the IEC 61968-9 document and the MultiSpeak document, and therefore no USB model is provided in Section 8)
- SRC: Standard remote connect command module
- SRD: Standard remote disconnect command module
- SCV: Standard check customer voltage values module
- SEL: Standard energy limiting usage using RCD switch module
- SUC: Standard unsolicited connect event module
- SUD: Standard unsolicited disconnect event module
- SRE – Standard for determining existence of RCD switch module
- SCS: Standard status check of the RCD switch module
- SCP: Standard change parameters command for the RCD switch module
- Exx: Many exception handling modules (covered in Section 5.3.2) These are predominantly Meter/Headend Event Codes.

5.1 Modules for Utility-Initiated RCD Commands

5.1.1 SOR – Standard On-Request Meter Read Module

The standard on-request meter read procedure is shown in Activity Diagram in Figure 12. This procedure has been modeled in both the IEC and MultiSpeak, who are working to resolve discrepancies between their models. Since both models already provide all on-request meter reading requirements of remote connect/disconnect, it is assumed that the resulting resolution will continue to provide those requirements. Therefore, no USB messaging model for on-request meter read is included in Section 8.

SOR - Standard On-Request Meter Read

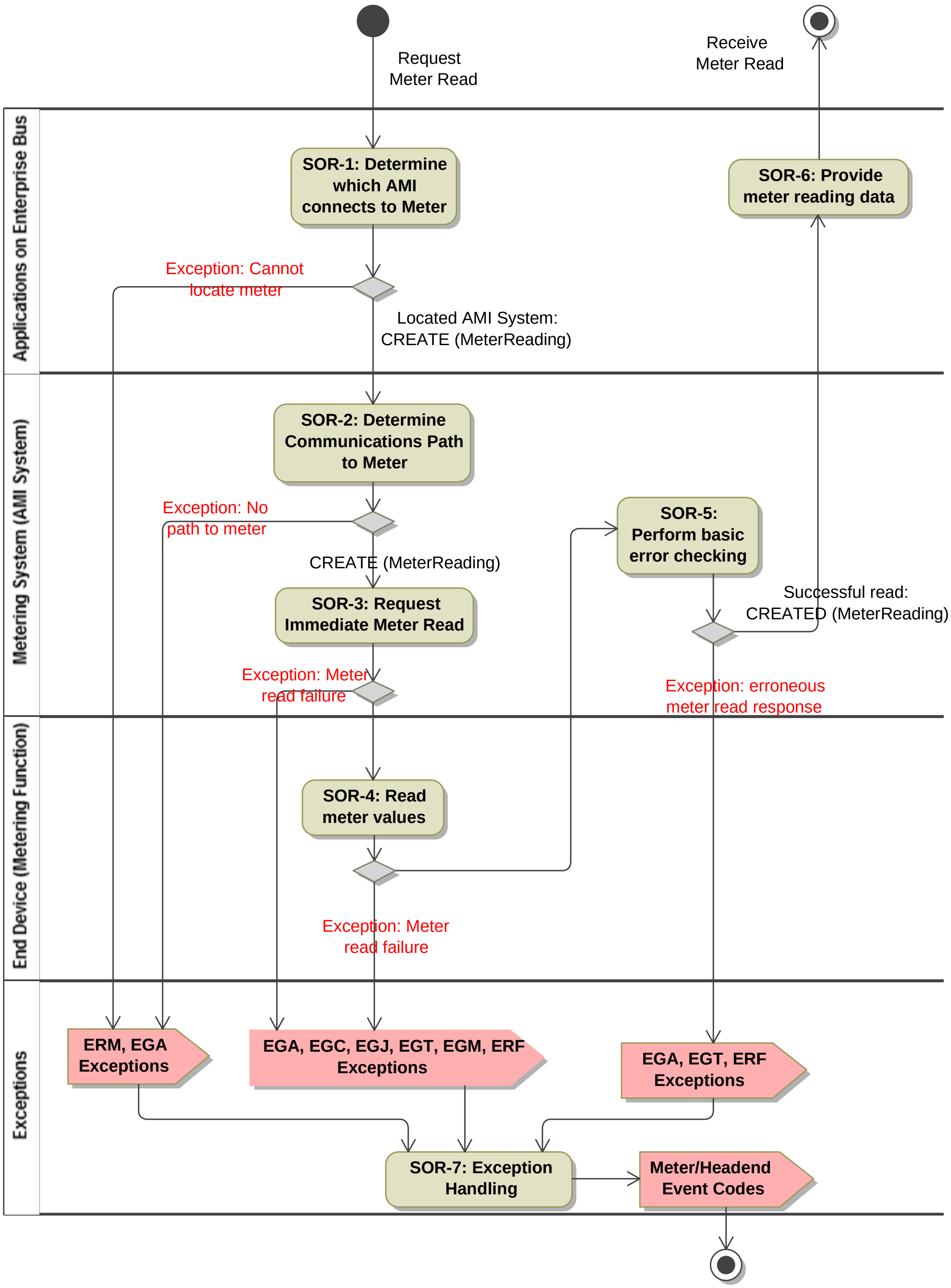


Figure 12: SOR – Standard On-request Meter Read Module

5.1.2 SRC – Standard Remote Connect Command Module

The Activity Diagram in Figure 13 shows the standard RCD connect procedure, regardless of what business process triggers the connect request to be made. As described in the RC – RCD Connect Request basic module, all checking has been previously performed, so this module just issues the connect command.

SRC - Standard RCD Connect

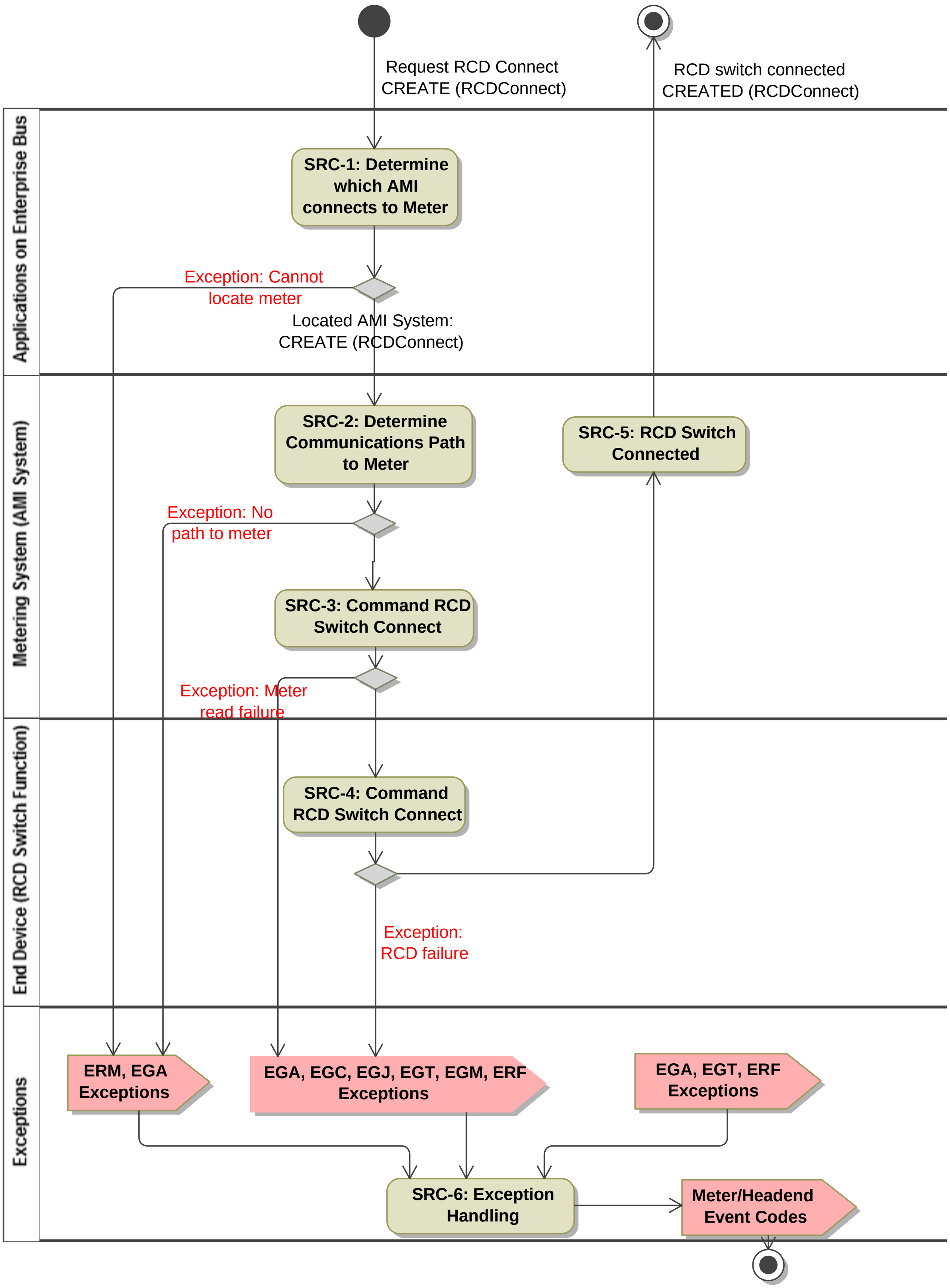


Figure 13: SRC –Standard Remote Connect Command Module

5.1.3 SRD – Standard Remote Disconnect Command Module

The Activity Diagram in Figure 14 shows the normal disconnect procedure, regardless of what business process triggers the disconnect request to be made. As described in the RD – RCD Disconnect Request basic module, all checking has been previously performed, so this module just issues the disconnect command.

SRD - Standard RCD Disconnect

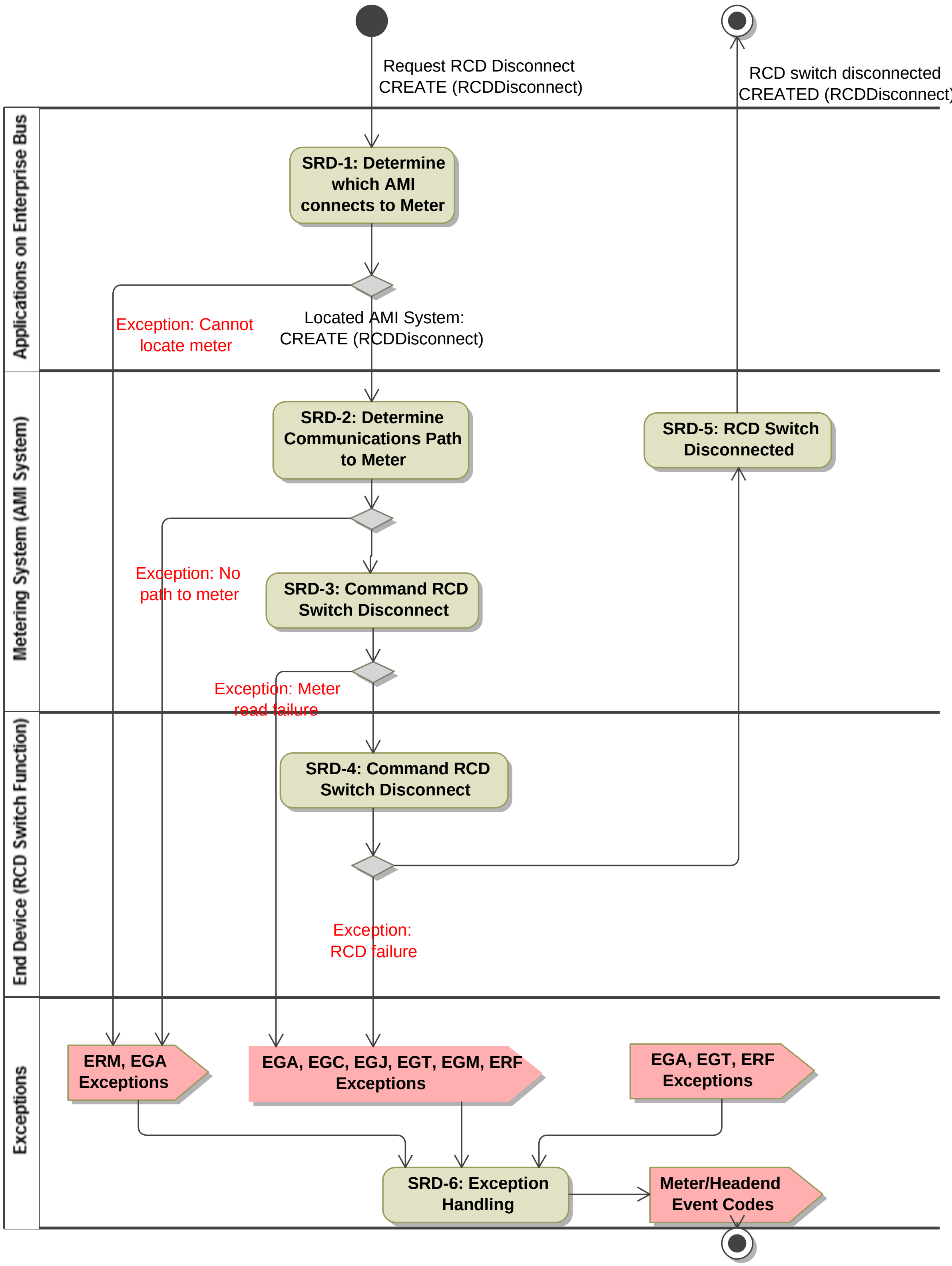


Figure 14: SRD – Standard Remote Disconnect Command Module

5.1.4 SCV – Standard Check Customer Voltage Value at Meter

The Activity Diagram in Figure 15 shows the procedure for determining whether there is voltage on the customer side of the meter, typically to be checked before a remote connect command so that it will not close into customer generation. This step may be done as part of the AMI system connect procedure, or may be requested by an application through the Enterprise Bus.

SCV - Standard Check Customer Voltage at Meter

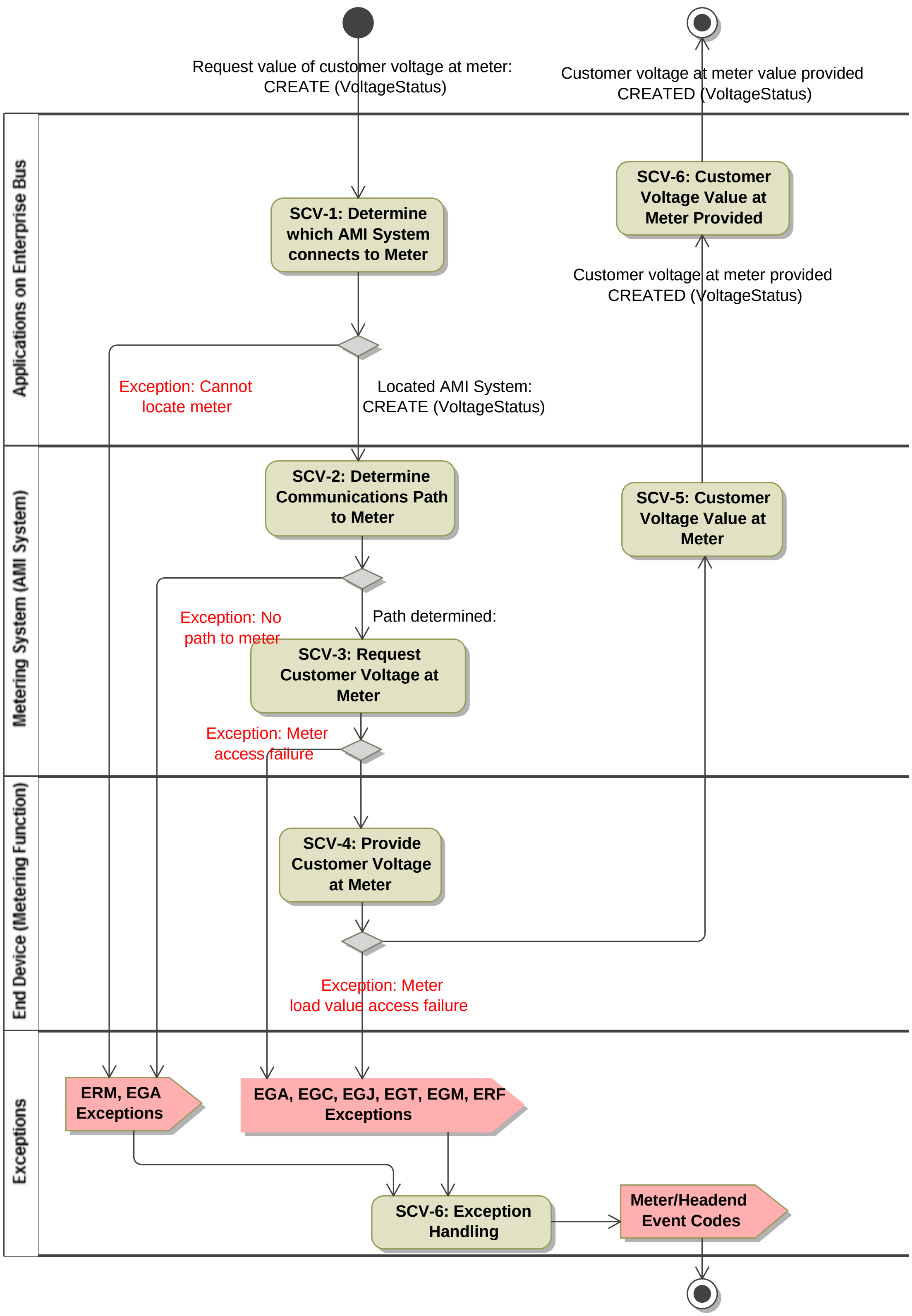


Figure 15: SCV – Standard Check Customer Voltage Value at Meter

5.1.5 SEL – Standard Energy Limiting Usage using RCD Switch Module

The Activity Diagram in Figure 16 shows the procedure for the management of energy limiting usage. Different implementations could involve different procedures.

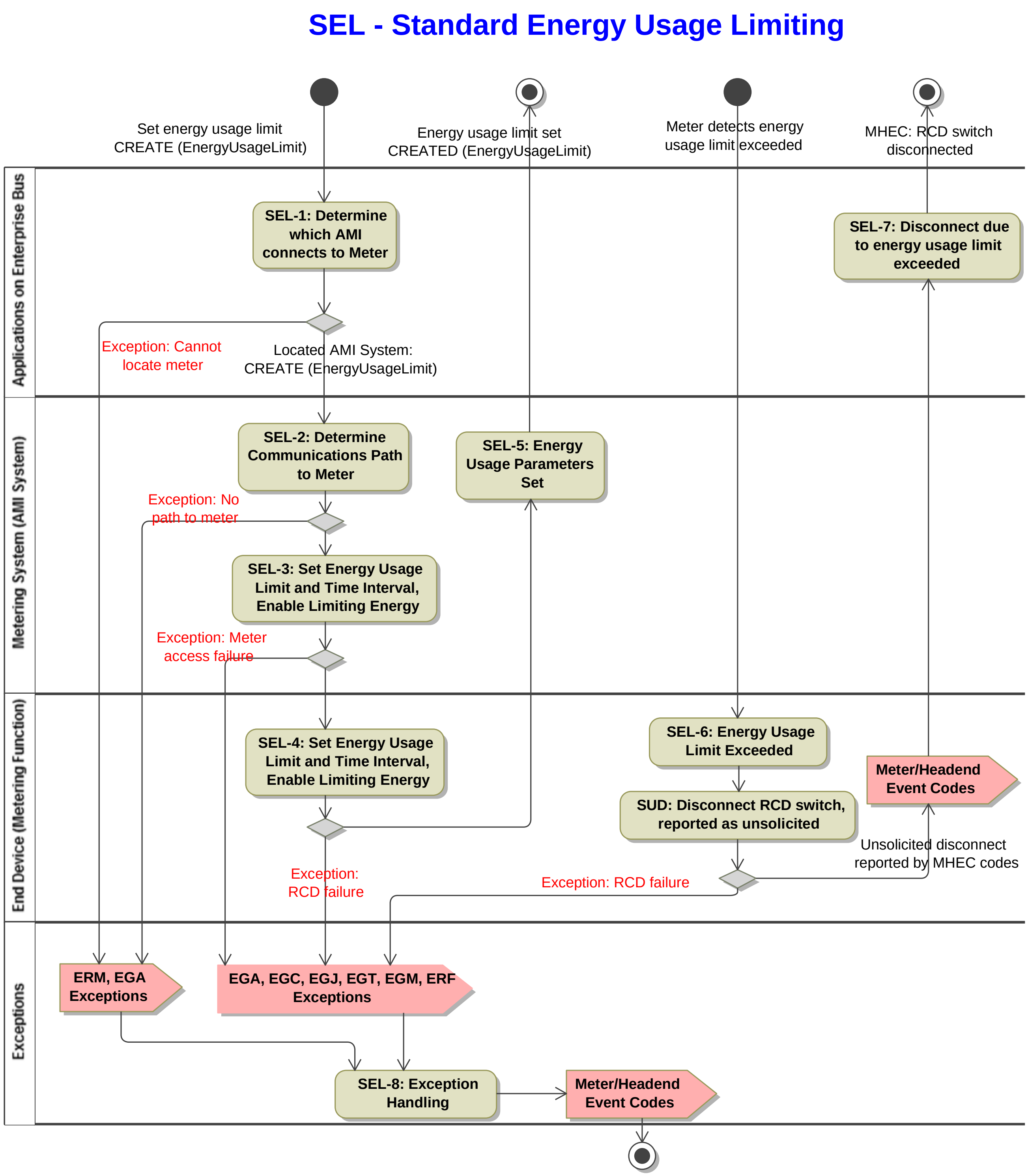


Figure 16: SEL – Standard Energy Limiting Usage Module

5.2 Modules for Unsolicited Change in RCD Switch State

5.2.1 SUC – Standard Unsolicited Connect Event Module

The Activity Diagram in Figure 17 shows the procedure when an unsolicited connect event is detected. It assumes that the RCD switch in the meter is monitored by the AMI system, even if remote connect actions are not permitted or have not been used with this meter for business reasons.

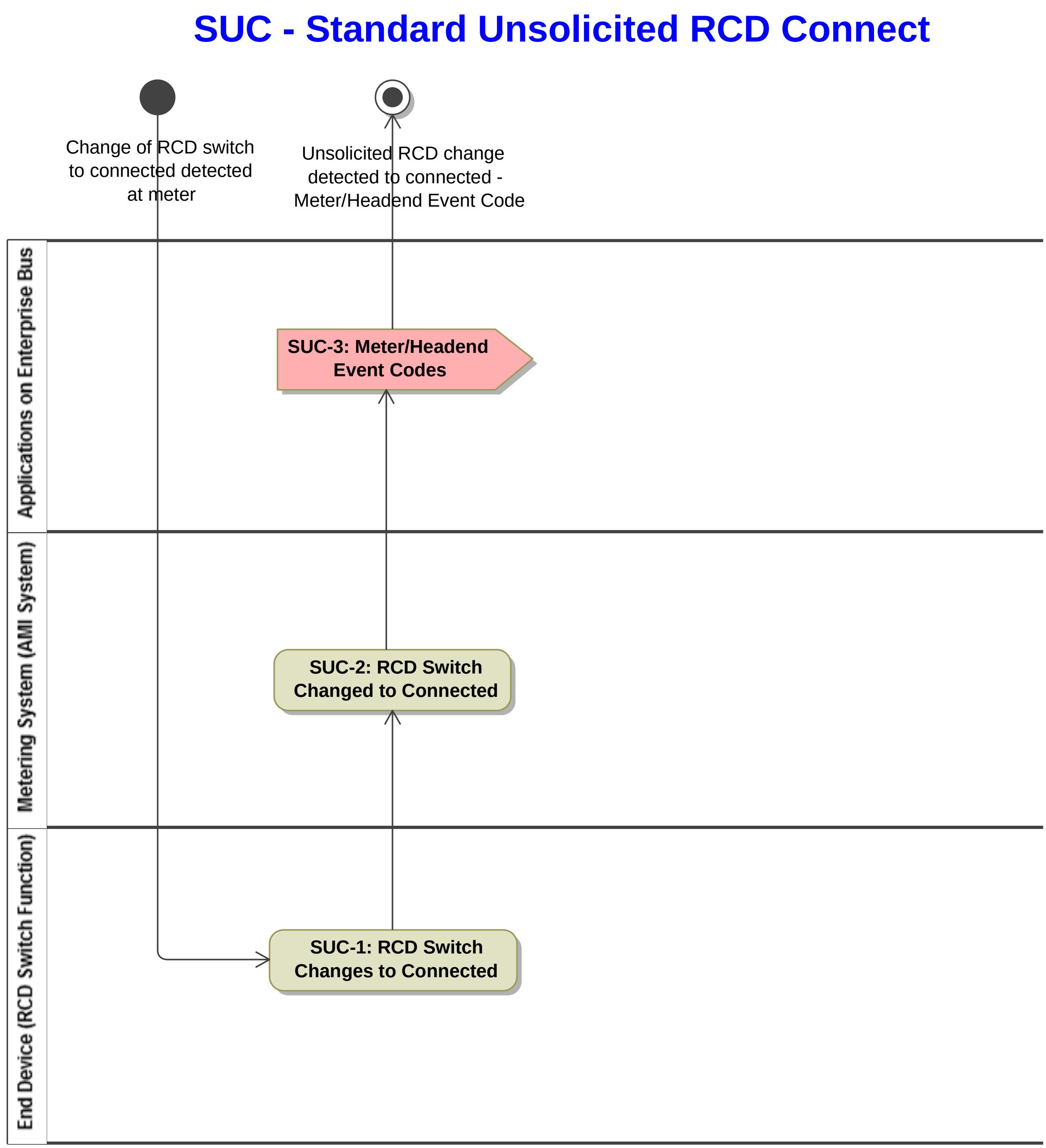


Figure 17: SUC – Standard Unsolicited Connect Event Module

5.2.2 SUD – Standard Unsolicited Disconnect Event Module

The Activity Diagram in Figure 18 shows the procedure used when an unsolicited disconnect event is detected. It assumes that the RCD switch in the meter is monitored by the AMI system, even if remote disconnect actions are not permitted or have not been used with this meter for business reasons.

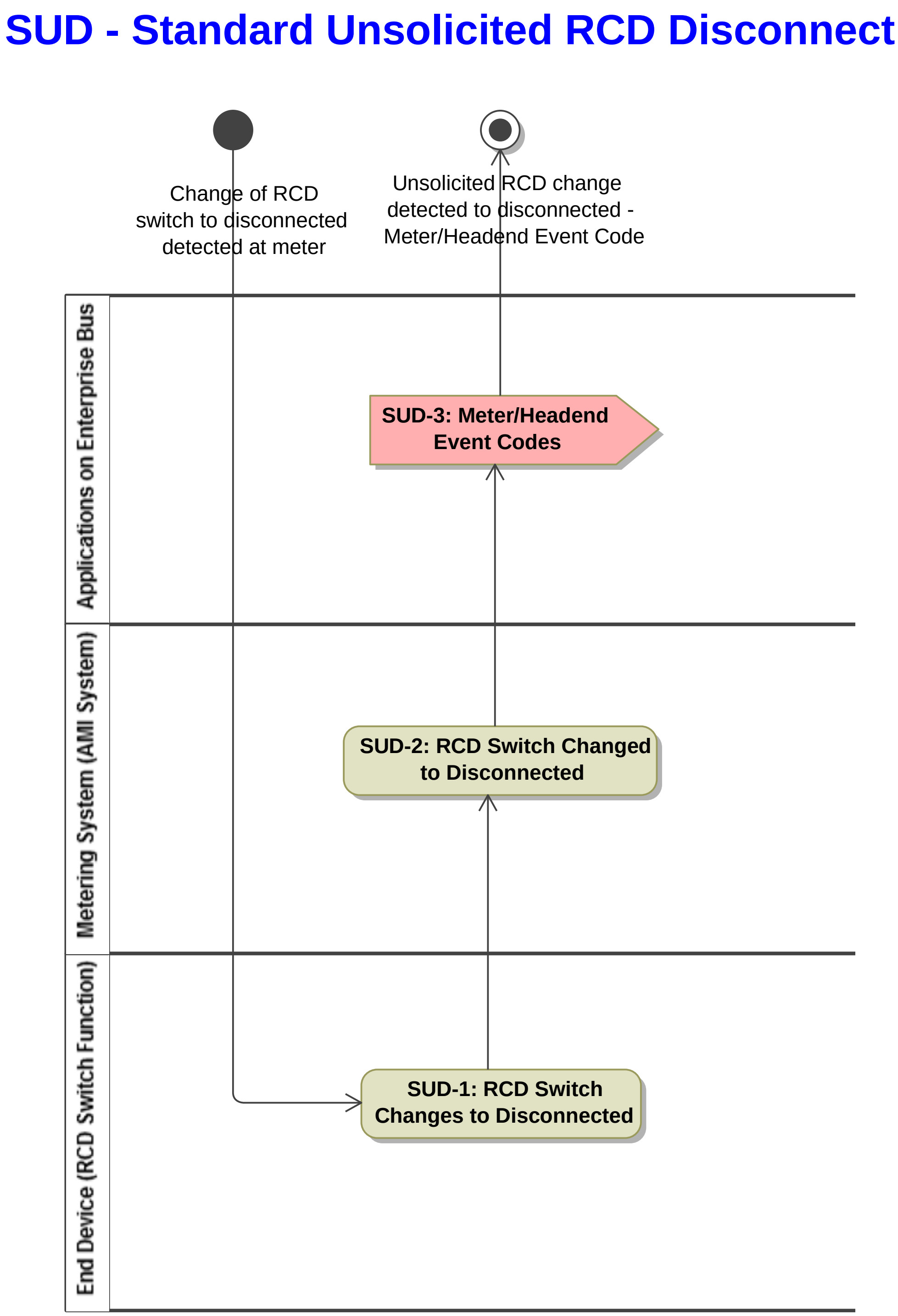


Figure 18: SUD – Standard Unsolicited Disconnect Event Module

5.3 Modules for RCD Maintenance

5.3.1 SRE – Standard for Determining Existence of RCD Switches Module

Although asset databases of meters should contain the information on which meters have RCD switches, maintenance of this database must include the ability to check whether it is accurately reflecting field conditions, and allow the database to be updated. Therefore an additional module requests the existence of an RCD switch in a meter, including its activation state, current status and other information.

SRE - Standard RCD Switch Existence and Information

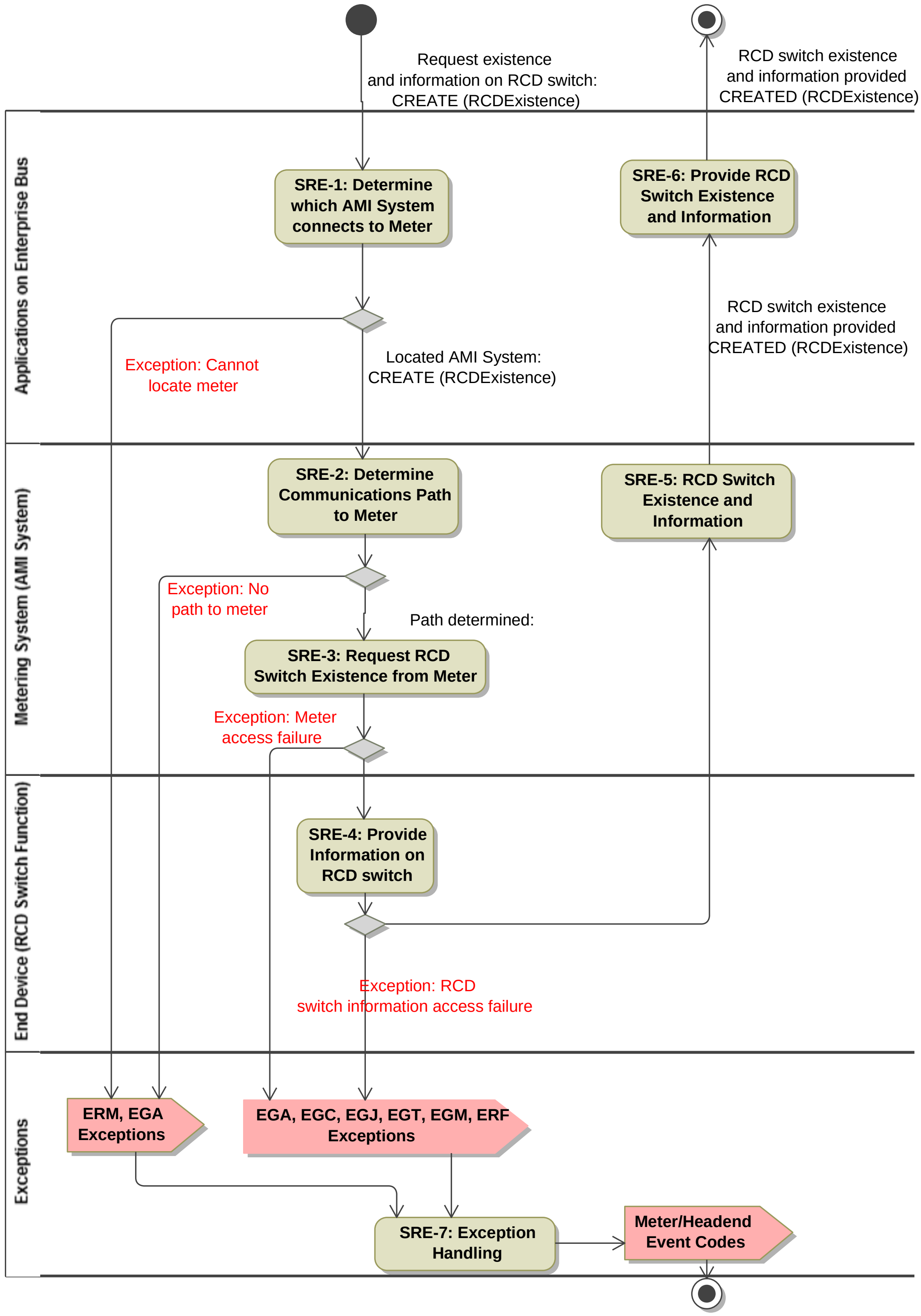


Figure 19: SRE – Standard RCD Switch Existence and Information

5.3.2 SCS – Standard Check Status of RCD Switch Module

The Activity Diagram in Figure 20 shows the standard check status of RCD switch procedure. This check can be made after the initial installation of a meter with an RCD switch, upon an RCD connect or disconnect command, upon an unsolicited RCD switch change, and periodically to ensure the integrity of the RCD switch which may not have been detected by the normal exception-reporting.

The information returned from a RCD switch status check can include:

- Device identity
  - Id of the RCD switch
  - CIM name of RCD switch (optional)
- RCD switch status
  - State of RCD switch – open or closed or unknown
  - Quality code showing normal status or exception (see MHEC codes for possible exceptions)
  - Last action of RCD switch state – manual, remote action, customer pushbutton action
  - Timestamp of last RCD switch operation
  - RCD switch control state – enabled for control, disabled for control
  - RCD switch control allowed - enabled for local control, enabled for remote control
- RCD arming status
  - RCD armed status – armed or not armed
  - Arming control allowed – required, allowed, not allowed
- Limits for connecting the RCD switch
  - Customer voltage limit
  - Customer voltage limit used (or not used) to prevent connect
  - Load limit
  - Load limit used (or not used) to prevent connect or initiate immediate disconnect after a connect command
- Customer pushbutton status
  - Pushbutton existent or not existent
  - Pushbutton status – pushed after being armed, or not pushed after being armed, or not armed
  - Timestamp of last pushbutton operation
- Next RCD action
  - Pending or not
  - Action to take
  - Date/time of action
- Associated meter identity
  - Id of the meter
  - CIM name of meter (optional)

- Service location of the RCD switch (which may or may not be different from the location of the associated meter)
- "Location" on the power grid of the RCD switch

SCS - Standard Check Status of RCD Switch

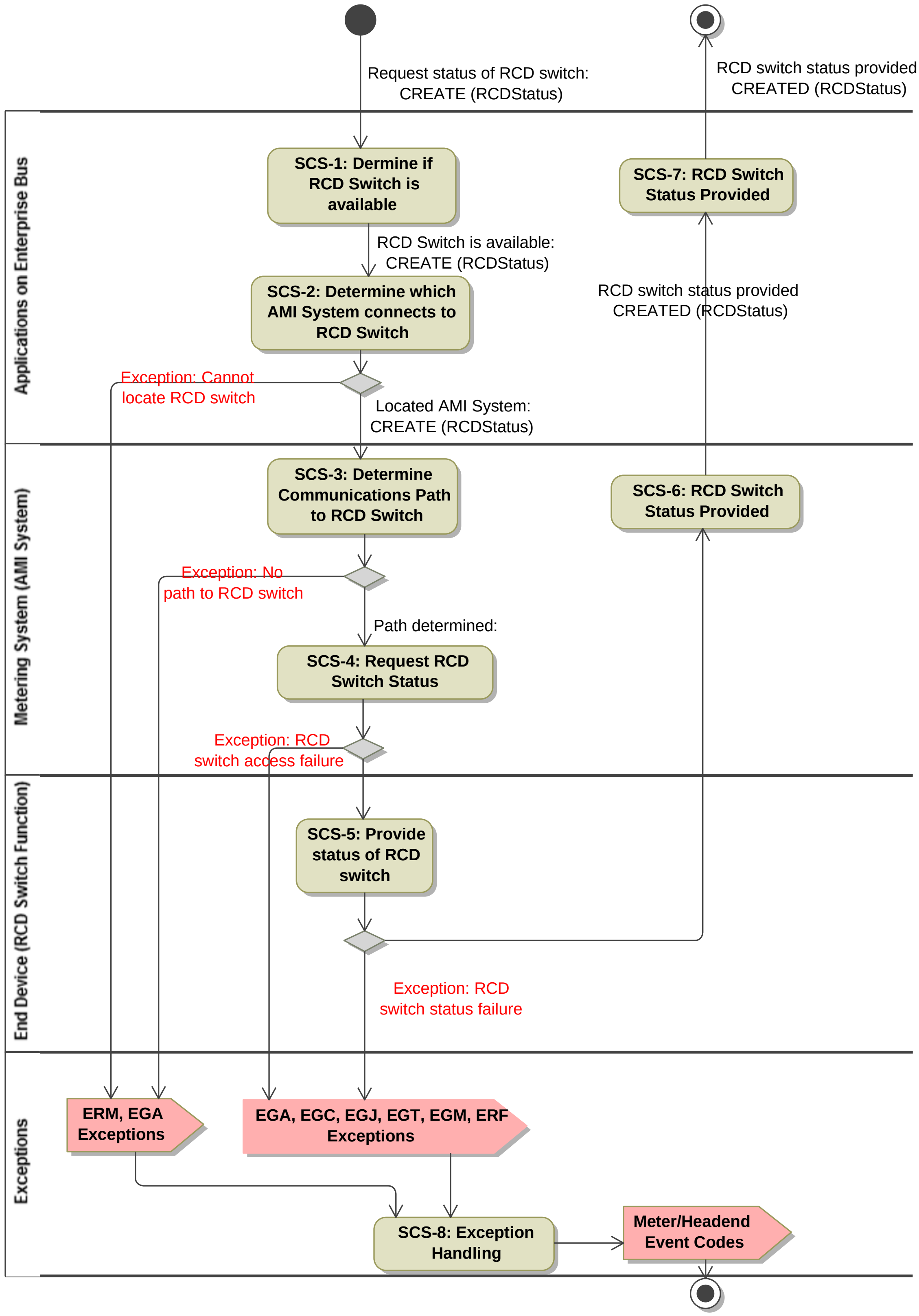


Figure 20: SCS – Standard Check Status of RCD Switch Module

5.3.3 SCP – Standard Change Parameters Command for the RCD Switch Module

The Activity Diagram in Figure 21 shows the standard change parameters command for the RCD switch. This parameter change command can be use to set different parameters, such as:

- Remote control of the RCD switch enabled or disabled
- Arming to be used or disabled for connect operation
- Customer voltage level for the voltage check before a connect operation
- Load level for immediate disconnect
- Energy usage limit for disconnect
- Reset of energy usage accumulation

SCP - Standard Change Parameters of RCD Switch

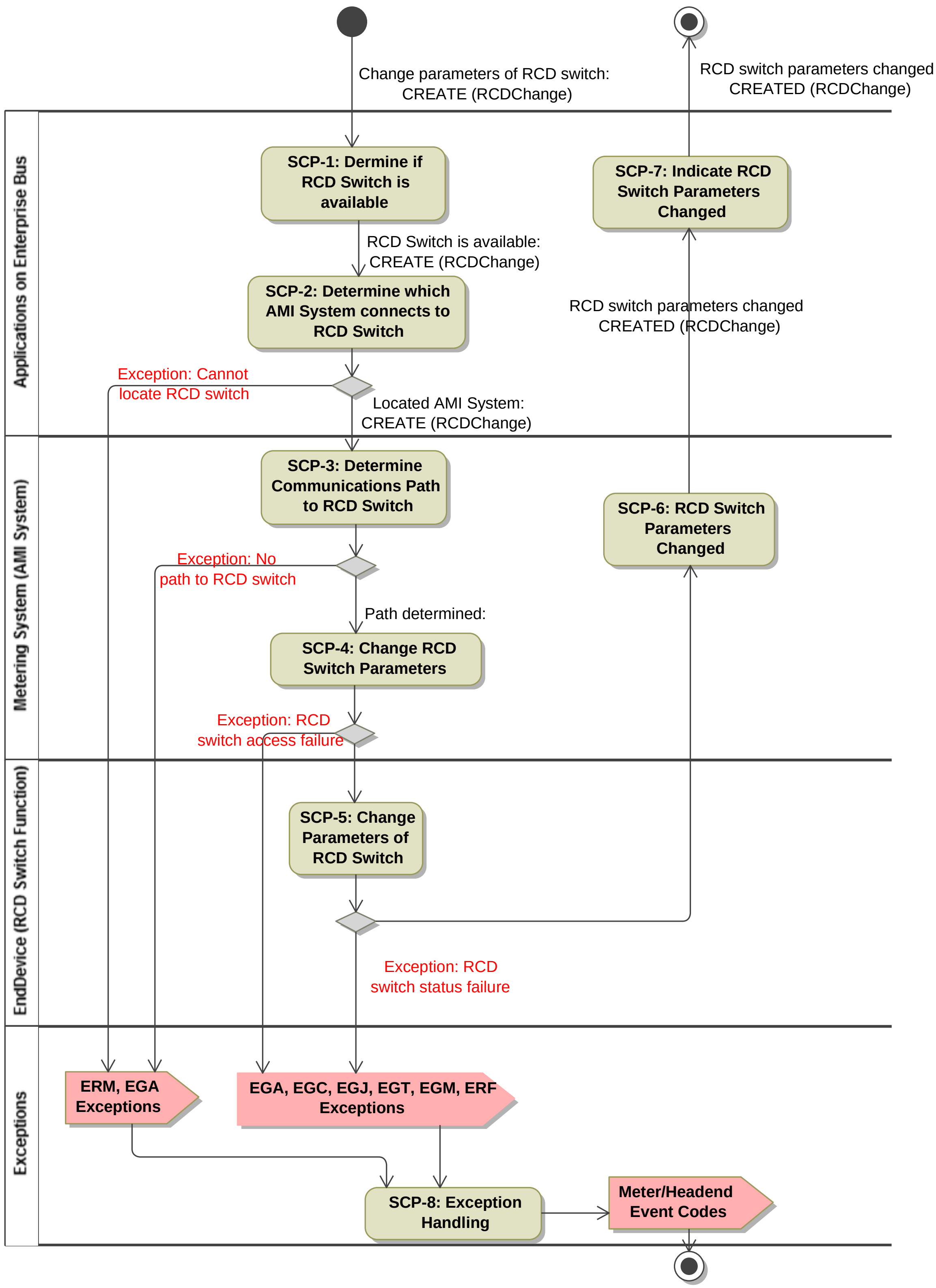


Figure 21: SCP – Standard Change Parameters of RCD Switch

6 Exception Procedures for RCD Modules

Exception handling often is the least standardized of interfaces, due to the multitude of potential error or event situations. Although not all exceptions can therefore be foreseen and standardized, nonetheless, if a majority of the basic exceptions can be identified and standardized, then the additional exceptions can utilize similar procedures and similar messages, thus minimizing the amount of custom interface effort,

Exceptions related to the AMI/EB interface will make use of the Meter / Headend Event Codes (MHEC)[4] that have been developed in the parallel USB project. Recommended practices (not standards) for which MHEC codes to use for which specific exceptions should be developed eventually, but are not part of this document.

6.1 EG Use Cases – AMI System General Exception Modules

The AMI System General Exception modules handle all situations in which the EB could not access the meter through the AMI system, including:

- EGA – AMI system was not able to access the requested meter due to an AMI System problem, such as a communications failure, inability of the AMI System to "find" the meter, mismatch of meter id with the meter itself, or message formatting errors.
- EGC – AMI system is temporarily not able to access the requested meter due to congested communications, or other temporary problem. This type of exception should include retries.
- EGJ – AMI system access was rejected by the requested meter, such as invalid meter id, security authorization rejection, or message contains invalid parameters for this type of meter.
- EGM – AMI system was unable to access the requested meter due to an internal meter failure, such as memory error, battery too low,
- EGT – AMI system failed to respond to EB within watchdog timeout period.

Most of the exception procedures use the same information flows, so a single Activity Diagram can capture that flow, as shown in Figure 22. Only the EGC (temporary communications failure) entails additional activities,

Some exceptions do not involve automated interactions between the EB and the AMI System. In these cases, a manual procedure must be undertaken. These include:

- Meter does not have a remote connect disconnect (RCD) switch.
- Meter's RCD switch is not active – even though the hardware is present, the AMI system cannot or is not authorized to issue switching commands
- On-site actions must be performed before the connect or disconnect can be initiated locally

[4] See *USB MHE Codes Categorized v8 Dec 2008.pdf, December 2008*

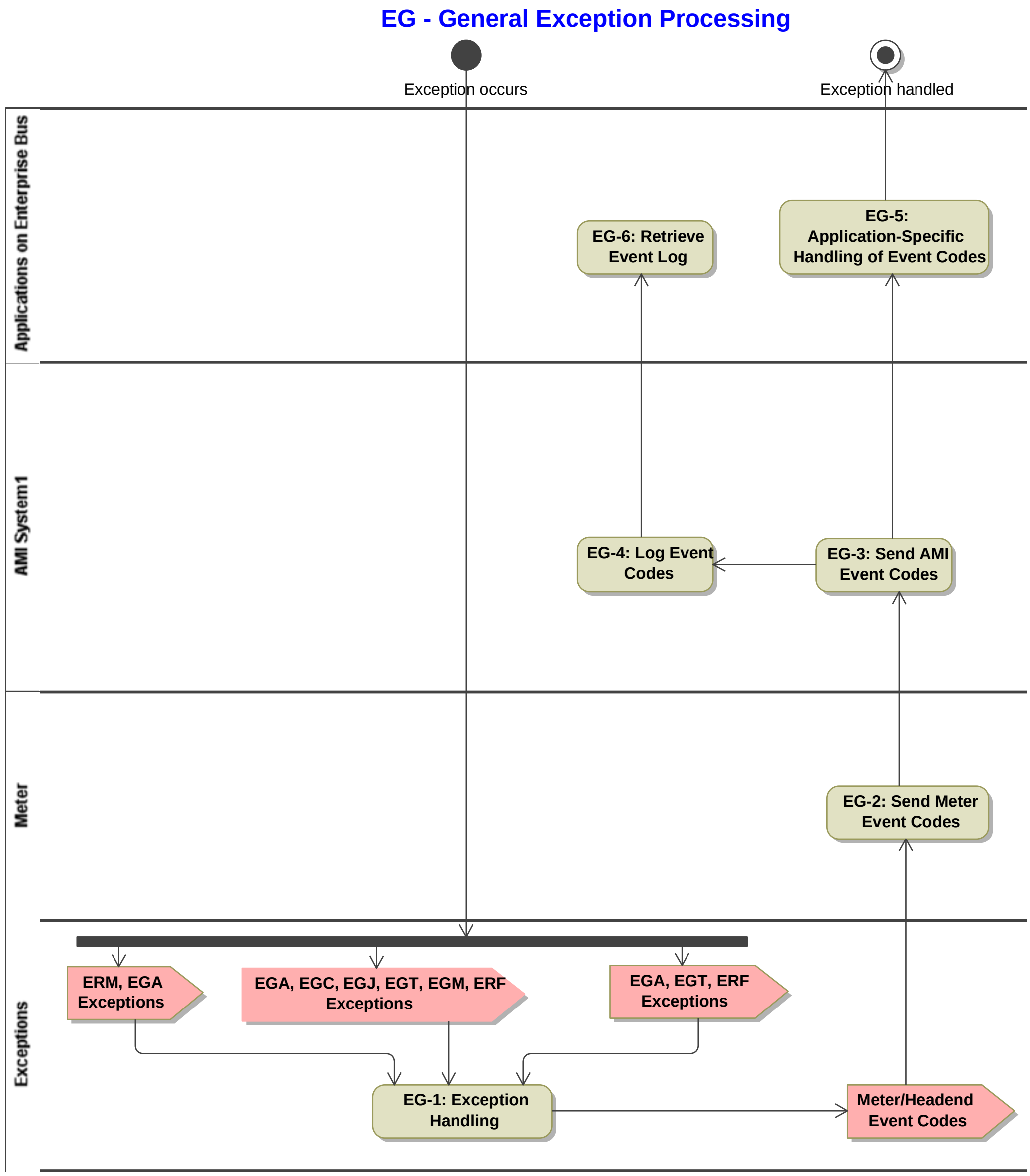


Figure 22: EG: General Exception Processing Flow

6.1.1 EGA – General Exception Due to AMI System Problem

AMI system was not able to access the requested meter due to an AMI System problem, such as a permanent communications failure, inability of the AMI System to "find" the meter, mismatch of meter id with the meter itself, or message formatting errors.

Table 22: EGA – General Exception Due to AMI System Problem

#	Triggering Event	Information Producer	Information Receiver	Description of Process/Activity	Information Exchanged	Exception Handling
EGA-1	Exception: AMI System problem	AMI Headend	EB	AMI System could not find or access the meter. This is a hard failure: retries are not beneficial.	Meter id; Error codes: • RCD connect failed • Meter access failed • (additional event codes indicating the nature of the failure)	
EGA-2	Notification of AMI system problem	EB	Initiating Application and Event Log	EB logs exception information and notifies the appropriate Error Processing Application	Meter id; Error codes: • RCD connect failed • Meter access failed • (additional event codes indicating the nature of the failure)	

6.1.2 EGC – General Exception Due to Temporary Communications Access Problem

AMI system is temporarily not able to access the requested meter due to congested communications, or other temporary problem. This type of exception should include retries. In some cases, a temporary communications failure becomes permanent. In that case, EGA exception handling is used.

Table 23: EGC – General Exception Due to Temporary Communications Access Problem

#	Triggering Event	Information Producer	Information Receiver	Description of Process/Activity	Information Exchanged	Exception Handling
Exception: temporary communications problem – process repeated up to the limit of number of retries						
EGC-1	Exception: Communication access problem	AMI Headend	EB	AMI system has not accessed the meter due to a communications failure or congestion that is possibly temporary. If this is the first exception for this meter during this session, EB sets the limit on the number of retries. For both the first time and subsequent times, EB starts a retry timer to trigger the next attempt.	Meter id; Exception data on type and location of communications problem	
EGC-2	Retries has not exceeded limit	EB	AMI headend	Re-issue initiating application request to the meter	Meter id; Request from the initiating application	
EGC-3	Retry timer times out	EB	EB	Check if the number of retries has exceeded limit. If not, increment count of retries and go to EGC-2. Otherwise go to EGC-4.	Meter id; Number of retries left	
Permanent communications failure						
EGC-4	Number of retries exceeded limit	AMI headend	EB	Receive communications failure response (including no response within timeout) on request.	Meter id; Response	Possible exceptions: EGA
Communications available						
EGC-5	Communications available	EB	Initiating Application	Receive response	Meter id; Response	

6.1.3 EGT – General Exception Due to No Response (Timeout)

Exception is due to the AMI system not responding within the timeout period to a message that entails a response. This response failure could be due to software, hardware, or communication problems. Depending upon the type of message, additional attempts may or may not be attempted – since retries depend upon the business process, the retry steps are not included.

Table 24: EGT – General Exception Due to No Response (Timeout)

#	Triggering Event	Information Producer	Information Receiver	Description of Process/Activity	Information Exchanged	Exception Handling
EGT-1	Exception: non-response by AMI System	AMI Headend	EB	AMI system did not respond within the timeout period	None Timeout occurred	
EGT-2	Notification of non-response by AMI system	EB	Initiating Application and Event Log	EB logs exception information and notifies the appropriate Error Processing Application	Meter id; Error codes: • Non-response within timeout period • (additional event codes indicating the nature of the failure)	

6.1.4 EGJ – General Exception Due to Meter Rejection of Communication Access by AMI System

Exception is due to the meter rejecting access by the AMI system. This could occur due to incorrect meter identity, security authorization failure, invalid message, meter failure, or other incompatibility between the AMI system and the meter.

Table 25: EGJ – General Exception Due to Meter Rejection of Communication Access by AMI System

#	Triggering Event	Information Producer	Information Receiver	Description of Process/Activity	Information Exchanged	Exception Handling
EGJ-1	Exception: Meter rejection of AMI access	AMI Headend	EB	The meter rejected access by the AMI system. This is a hard failure: retries are not beneficial.	Meter id; Error codes: • Meter access failed • (additional event codes indicating the nature of the failure)	
EGJ-2	Notification of meter rejection of AMI access	EB	Initiating Application and Event Log	EB logs exception information and notifies the appropriate Error Processing Application	Meter id; Error codes: • Meter access failed • (additional event codes indicating the nature of the failure)	

6.1.5 EGM – General Exception Due to Meter Internal Failure

Exception is due to the meter failing to respond correctly to a message sent through the AMI system. This could occur due to internal meter software or hardware failures. Indications of an internal meter failure could include a specific error message from the meter that indicates a failure, or the AMI system could get no response from the meter or the AMI system could get invalid messages from the meter.

Table 26: EGM – General Exception Due to Meter Internal Failure

#	Triggering Event	Information Producer	Information Receiver	Description of Process/Activity	Information Exchanged	Exception Handling
EGM-1	Exception: Internal meter failure	AMI Headend	EB	An internal meter failure or error is indicated either explicitly or implicitly to the AMI system This is a hard failure: retries are not beneficial.	Indeterminate	

#	Triggering Event	Information Producer	Information Receiver	Description of Process/Activity	Information Exchanged	Exception Handling
EGM-2	Notification of meter rejection of AMI access	EB	Initiating Application and Event Log	EB logs exception information and notifies the appropriate Error Processing Application	Meter id; Error codes: • Internal meter failure • (additional event codes indicating the nature of the failure)	

6.2 EC Use Cases – Exceptions for RCD Switches

RCD switch exception processing handles all situations in which there is some error condition related to the remote connect command. These include:

- ECJ – Meter rejected the command for the RCD switch due to a meter situation, such as the RCD switch does not exist, the RCD switch is not active, the RCD function has failed, the RCD switch is already in the requested state, or backfeed current was detected on a connect command.
- ECS – Meter executed the command but the RCD switch failed to operate correctly.
- ECW – Meter accepted the remote connect command but failed to execute it because the activation date and time is in the future. This may or may not be an error, but should cause a different set of steps to occur.

Most of the exception procedures use the same information flows, so the same Exception Activity Diagram can capture that flow, shown in Figure 22.

6.3 ER Use Cases – Exceptions for Meter Read Modules

Meter exception processing handles all situations where there is an error condition related to the meter. Since this report focuses on RCD and not all meter functions, the following are just a subset of the exceptions.

- ERF – Meter failed to respond correctly to the on-request read performed due to a meter problem.
- ERM – On-request Meter Read Exception in Which Meter is not Assigned to an AMI System
- ERF – On-request Meter Read Exception Due to Error or Incorrect Response. ERF handles the basic meter read exception

Most of the exception procedures use the same information flows, so the same Exception Activity Diagram can capture that flow, shown in Figure 22.

6.4 EU Use Cases – Exceptions for Unsolicited Connect or Disconnect Events Modules

Unsolicited connect and disconnect events by definition evoke exceptions by issuing meter / headend event codes.

- EUC – Unsolicited Connect Exception
- EUD – Unsolicited Disconnect Exception

Most of the exception procedures use the same information flows, so the same Exception Activity Diagram can capture that flow, shown in Figure 22.

7 CIM IEC 61968-9 and MultiSpeak XSD Elements Related to Remote Connect/Disconnect

The following sections provide RCD diagrams from existing standards efforts related to remote connect/disconnect. In neither case (IEC's CIM and MultiSpeak) is the standard fully developed and/or adequate for implementation by larger utilities. At the same time, significant effort is underway to make these two standards compatible/conformant with each other. The USB de facto standards are filling in the gaps of the combined IEC/MultiSpeak standards with the RCD requirements of larger utilities.

7.1 Procedure for Extracted AMI/EB Common Modules to De Facto Standards

The on-going work by the IEC 61968-9/CIM and MultiSpeak has provided a basic structure for developing interface standards, namely the development of **XML-based message formats and Common Information Models (CIM)**, as illustrated in Figure 23. These USB results are being submitted to the IEC TC57 WG14 to extend the existing XSD and CIM models to meet the USB utility requirements.

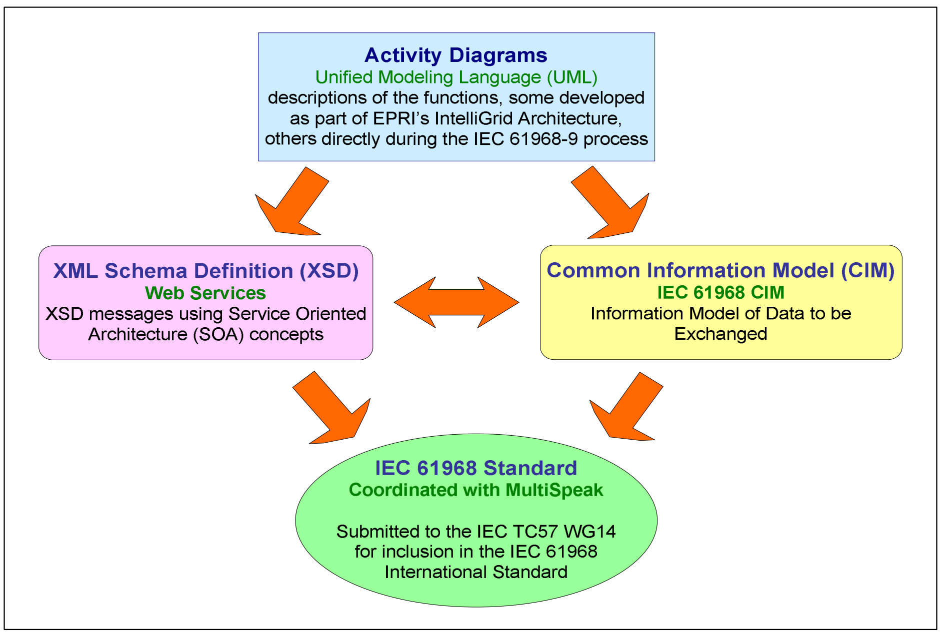


Figure 23: Procedure for Phase 2: RCD Activity Diagrams to IEC Standards

7.2 IEC 61968 Message Schema and CIM

7.2.1 IEC 61968 Message Schema Concepts

The IEC 61968-9 is still an evolving standard, currently at a "Committee Draft for Vote" stage. Therefore, the following subsections only illustrate the IEC TC57 WG14 efforts up through December 2008 (WG14 is the group in charge of IEC 61968 series of standards). Although this means that changes may occur, it also means that the USB de facto standards submissions can be more easily incorporated.

Without getting into great technical detail, WG14 develops both Message Schemas and Common Information Model (CIM) object models derived from Use Cases. The Message Schemas (which can be thought of as defining what types of information should be exchanged for each type of interaction e.g.

read meter, disconnect RCD switch, detect outage) are typically developed first as being most directly derived from the actual information flows identified in the Use Cases. Once the Message Schemas are relatively solid, then the formats of the information in the messages are defined in more detail in the CIM.

Conceptually, Message Schemas provide a "toolkit" of standardized messages. To be compliant with the standard, implementations must use these standardized messages – but do not need to use those portions of the message that are not relevant. In essence:

- IF a system is to send some specific type of information AND IF that specific information exists in a Message Schema, THEN it MUST use that Message Schema.
- IF the system doesn't need to send some information that may be included in the Message Schema, THEN it does not have to include it in the message, thus "contracting" the message.
- IF the Message Schema does not include some specific information that is required for the implementation, THEN the Message Schema MAY be extended according to specific extension rules to accommodate the information, thus "extending" the message (but only for that implementation – that extension is not part of the standard).
- For COMPLIANCE TESTING, specific scenarios are selected (e.g. read meter, disconnect meter, detect outage). Systems then exchange Message Schema metamodels as part of the Discovery Activity. "Contracted" Message Schemas MUST be automatically "understood", while clearly additional manual intervention is allowed for "extended" Message Schemas.
- Eventually, some of the "extended" messages may be added to the standard Message Schemas if they appear generally useful.

The Common Information Model (CIM) of these data objects is in a state of flux, and does not readily lend itself to inclusion in this RCD document. Therefore the focus of the RCD effort is on RCD Message Schemas.

7.2.2 IEC 61968-9 Reference Model

The IEC has developed a reference model (shown in Figure 24) which is being used to identify the information exchanges covered by the IEC 61968-9 document.

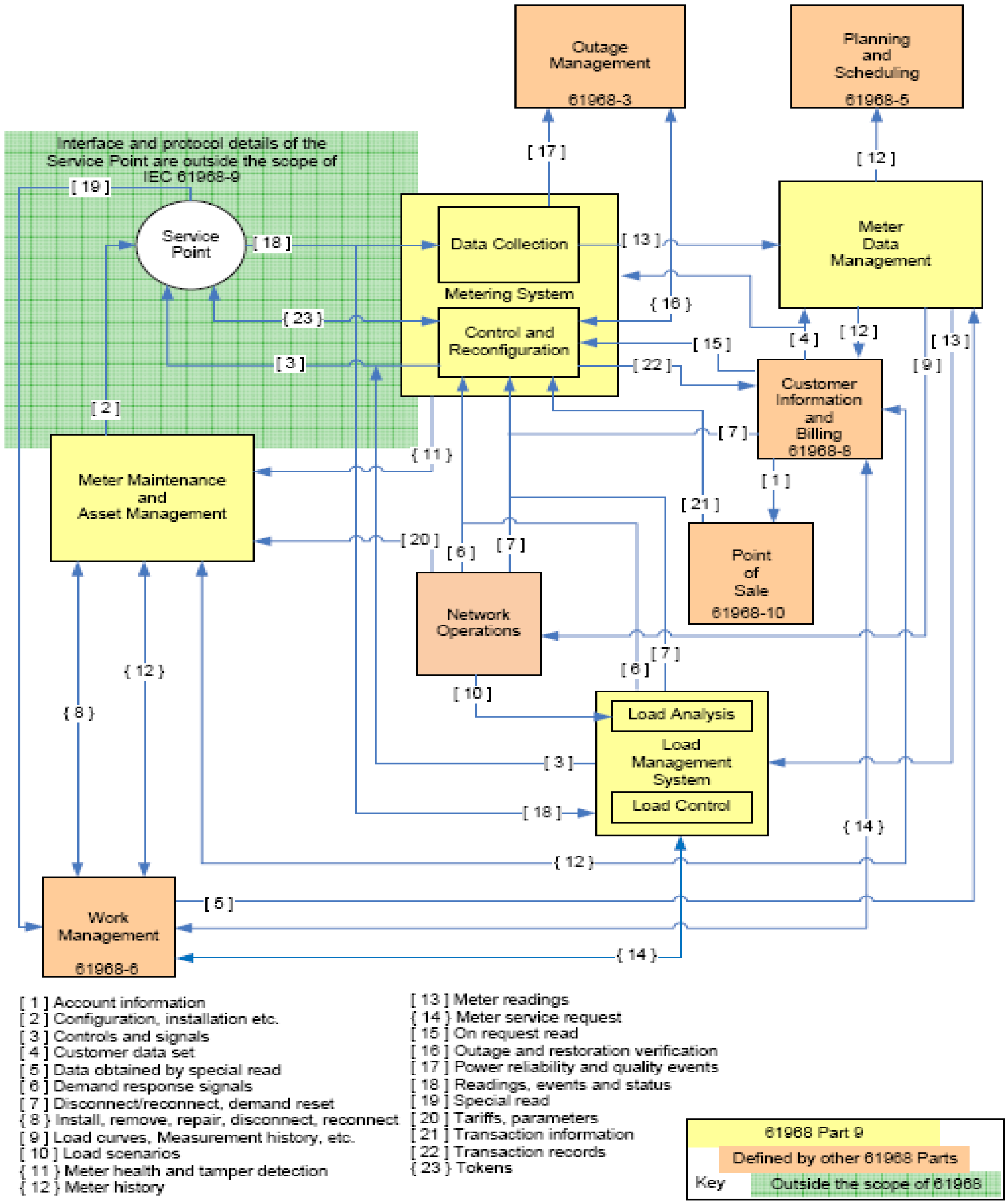


Figure 24: IEC 61968-9 Reference Model

7.2.3 IEC 61968-9 Meter Readings Message Schema

The IEC 61968-9 (draft) has define a meter reading Message Schema shown in Figure 25 (the "m" in front of each name indicates it is an IEC name).

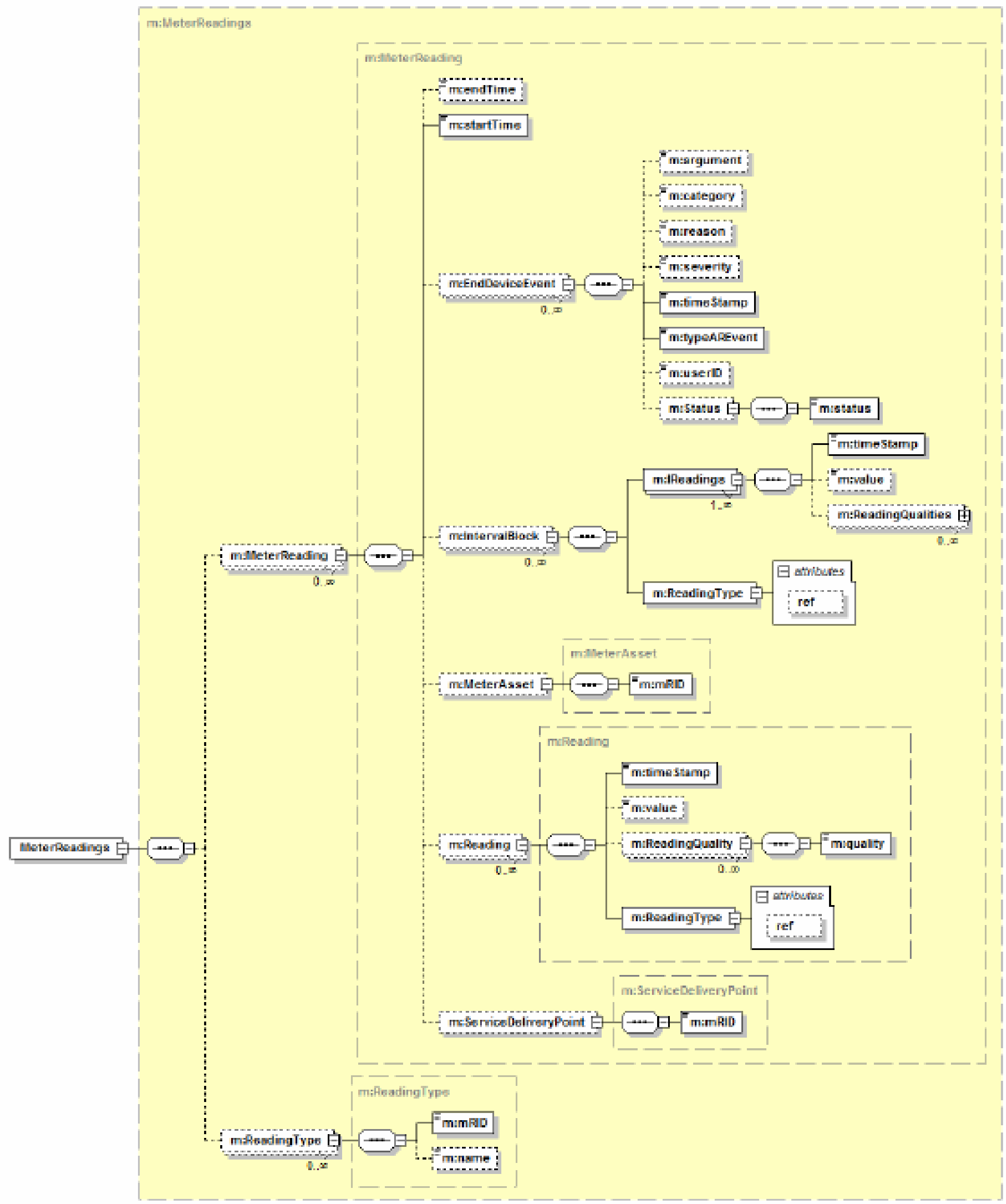


Figure 25: IEC 61968-9 Meter Readings Message Format

7.2.4 IEC 61968-9 End Device Control Message Schema

The IEC 61968-9 proposes to use the end device control Message Schema for issuing remote connect/disconnect commands. This Message Schema is shown in Figure 26.

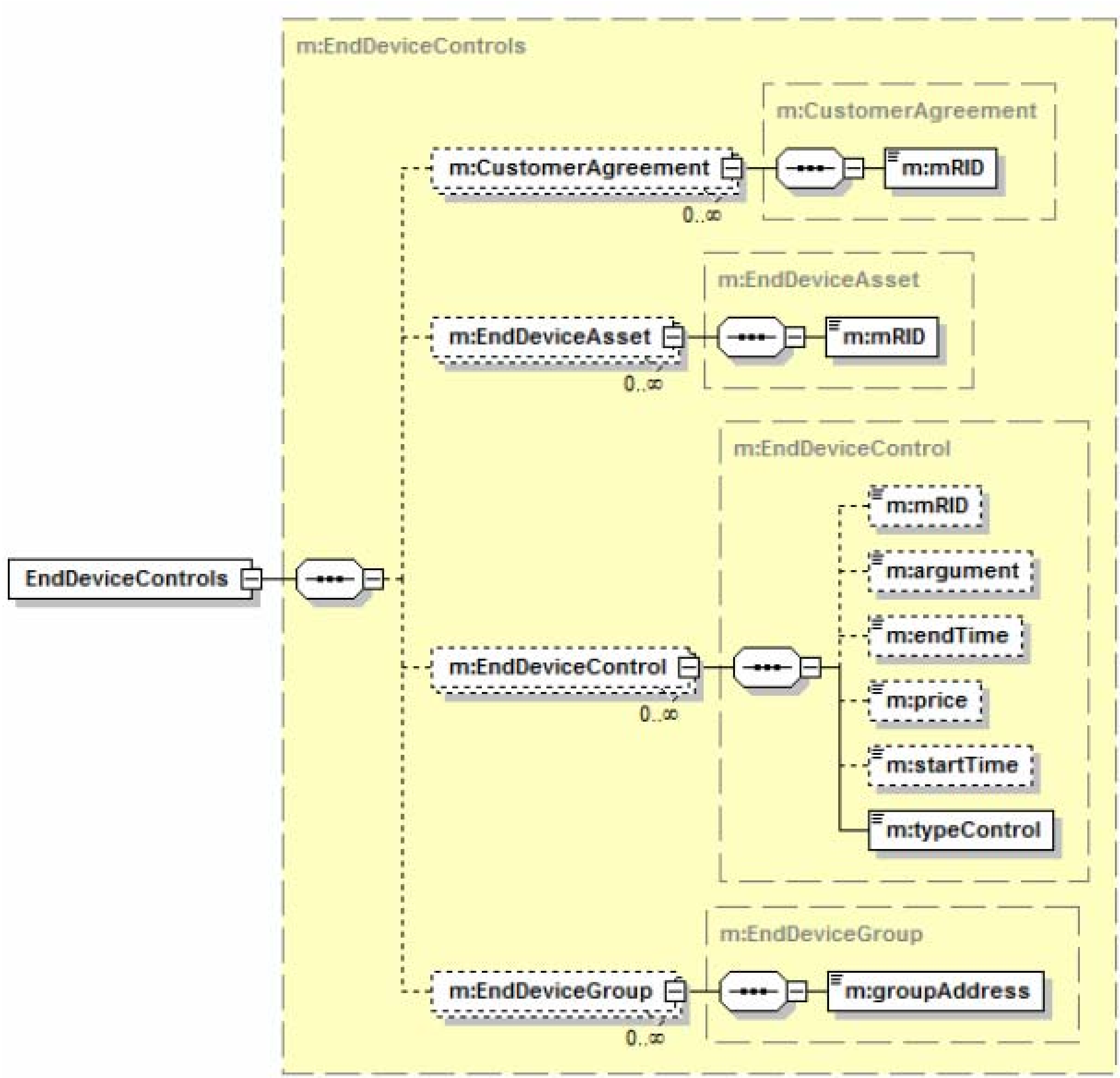


Figure 26: End Device Control Message Format

7.3 MultiSpeak Version 3 Models

MultiSpeak has issued version 3 of their information exchange models, but is currently working on version 4. However, this latter version is not available yet, so only version 3 is being included in this document for illustrative purposes only. It is expected that version 4 will have some modifications to the models shown below.

7.3.1 MultiSpeak Process Model

MultiSpeak has developed a process model (see Figure 27) showing the different interactions between some of the main systems used by smaller utilities and cooperatives.

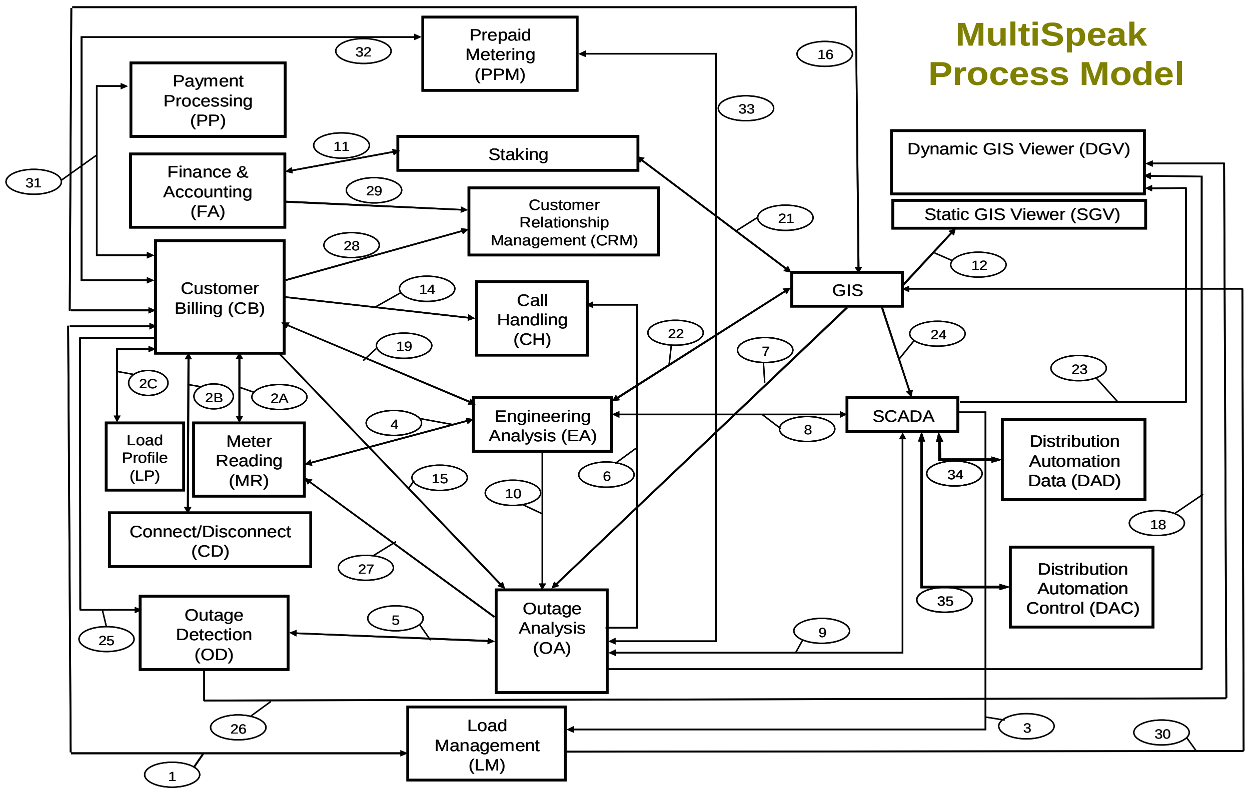


Figure 27: MultiSpeak Process Model

7.3.2 MultiSpeak Meter Reading Message Schema

The MultiSpeak Meter Reading Model is shown in the following three figures, Figure 28, Figure 29, and Figure 30. (The "msp" in front of each name indicates that it is part of MultiSpeak).

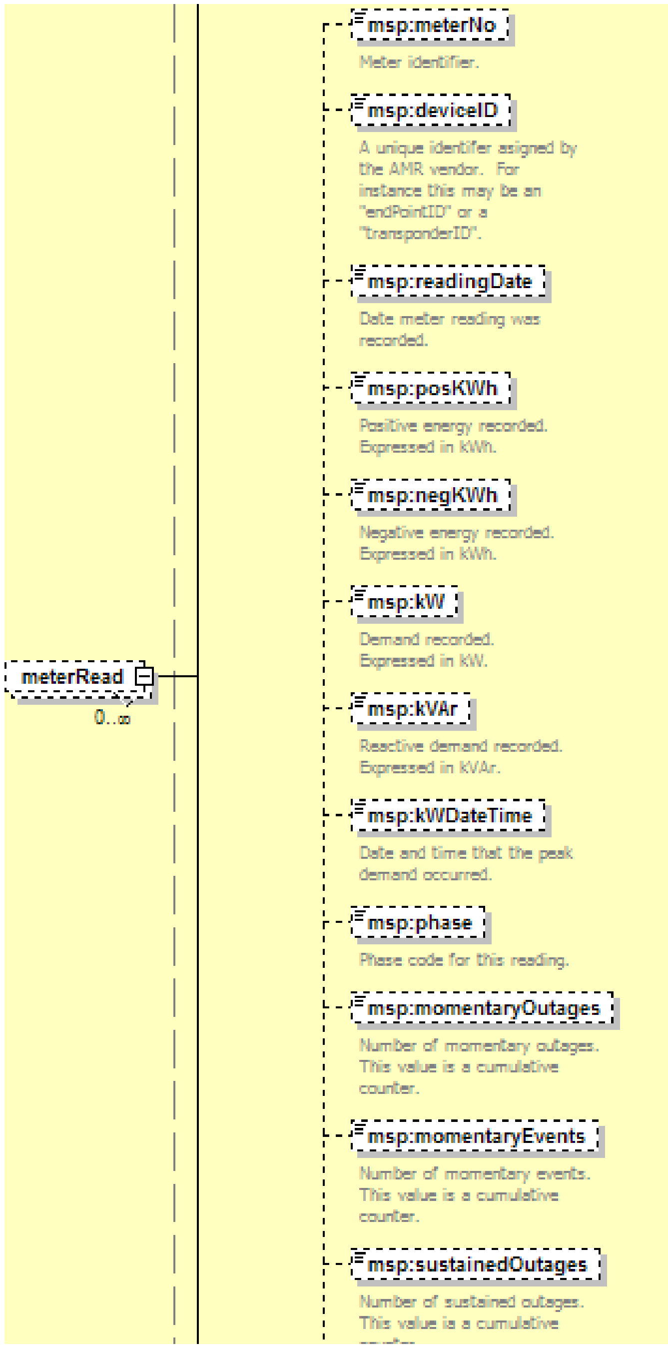


Figure 28: MultiSpeak Meter Reading Message Schema (part 1)

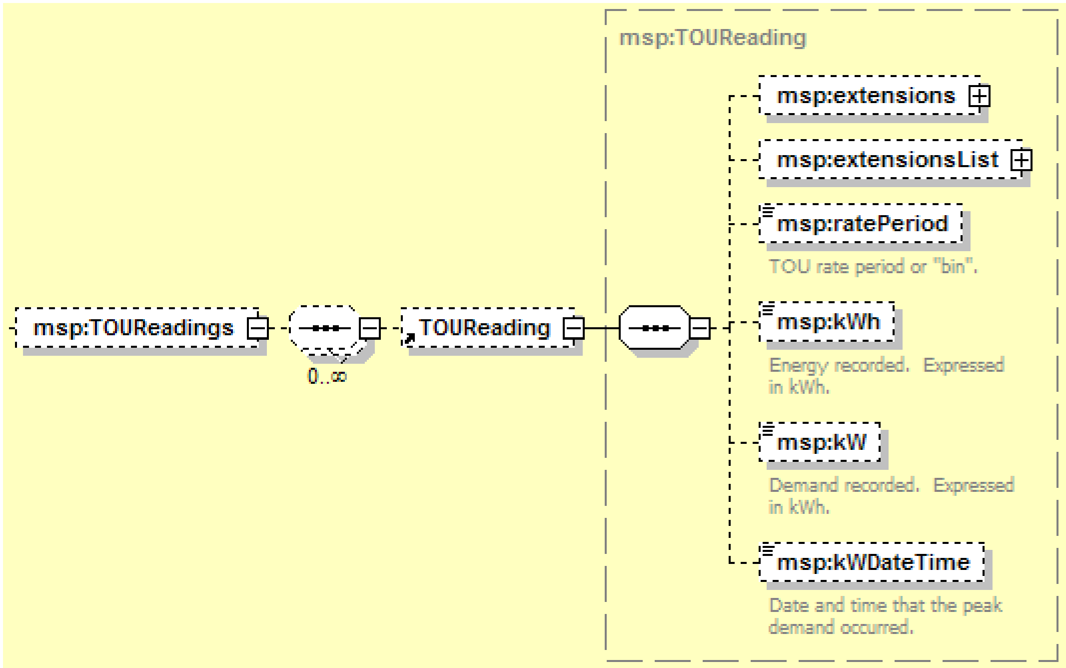


Figure 29: MultiSpeak Meter Reading Message Schema (part 2)

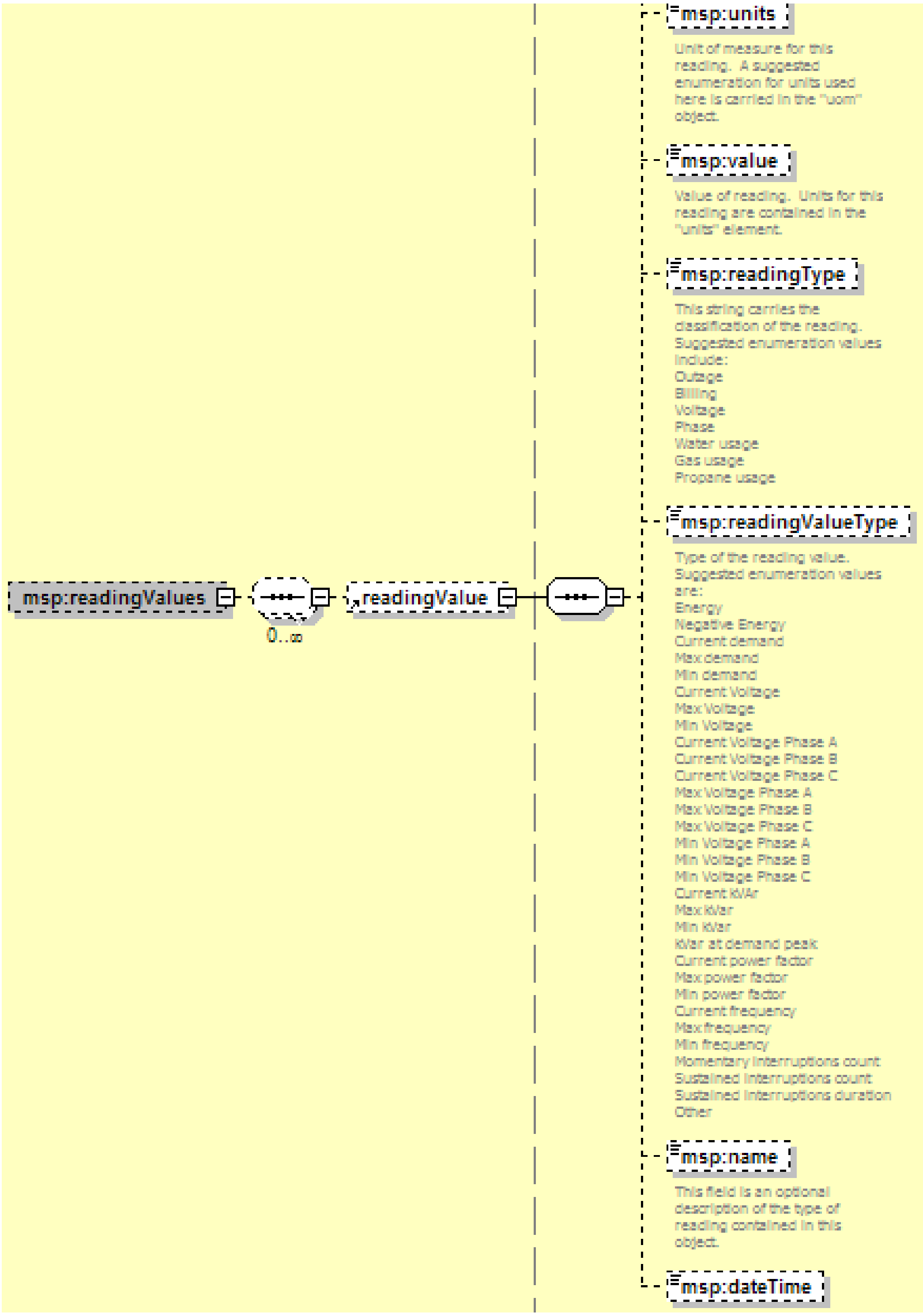


Figure 30: MultiSpeak Meter Reading Message Schema (part 3)

7.3.3 MultiSpeak Connect/Disconnect Event Message Schema

The key elements in the MultiSpeak Connect/Disconnect Event are shown in the Message Schema in Figure 31.

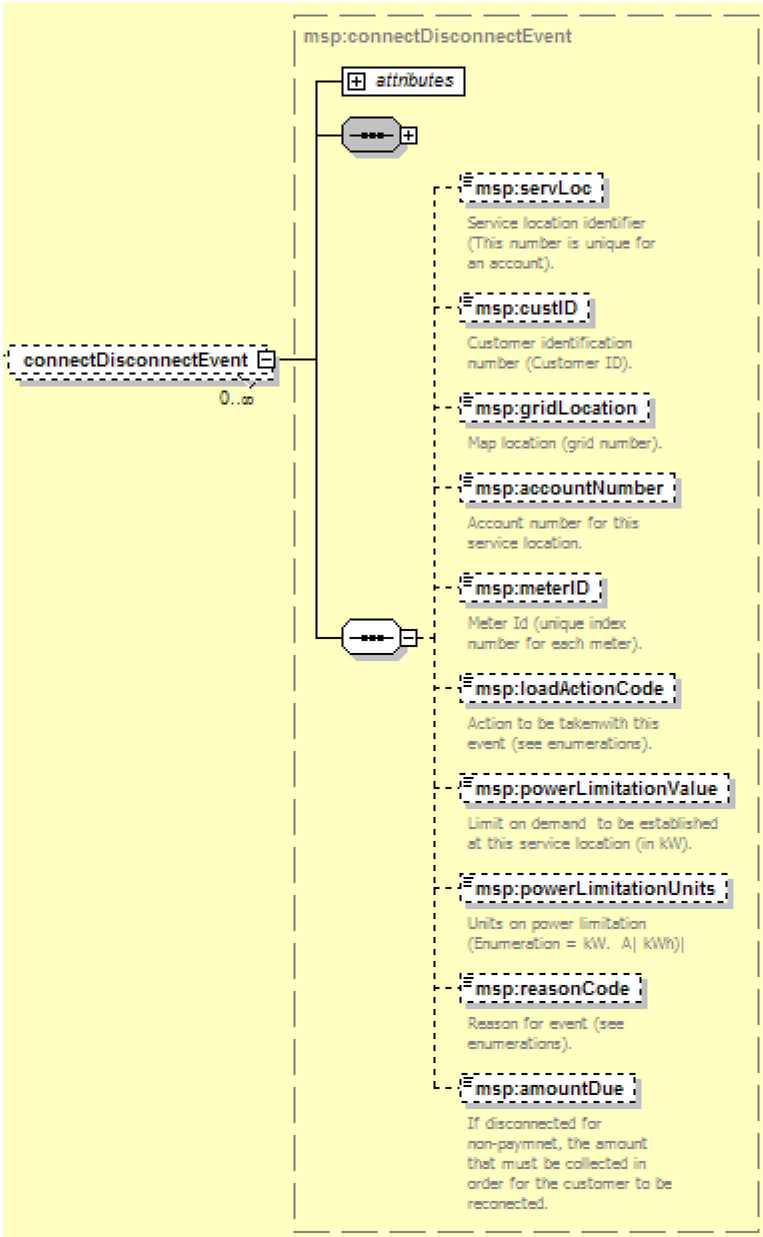


Figure 31: MultiSpeak Connect/Disconnect Event Model

7.3.4 MultiSpeak Connect/Disconnect List Message Schema

The MultiSpeak connect/disconnect list Message Schema provides a connection between meters to be disconnected and the customer identity and address. This list is not expected to be sent across the AMI/EB interface, but does capture part of the overall RCD process.

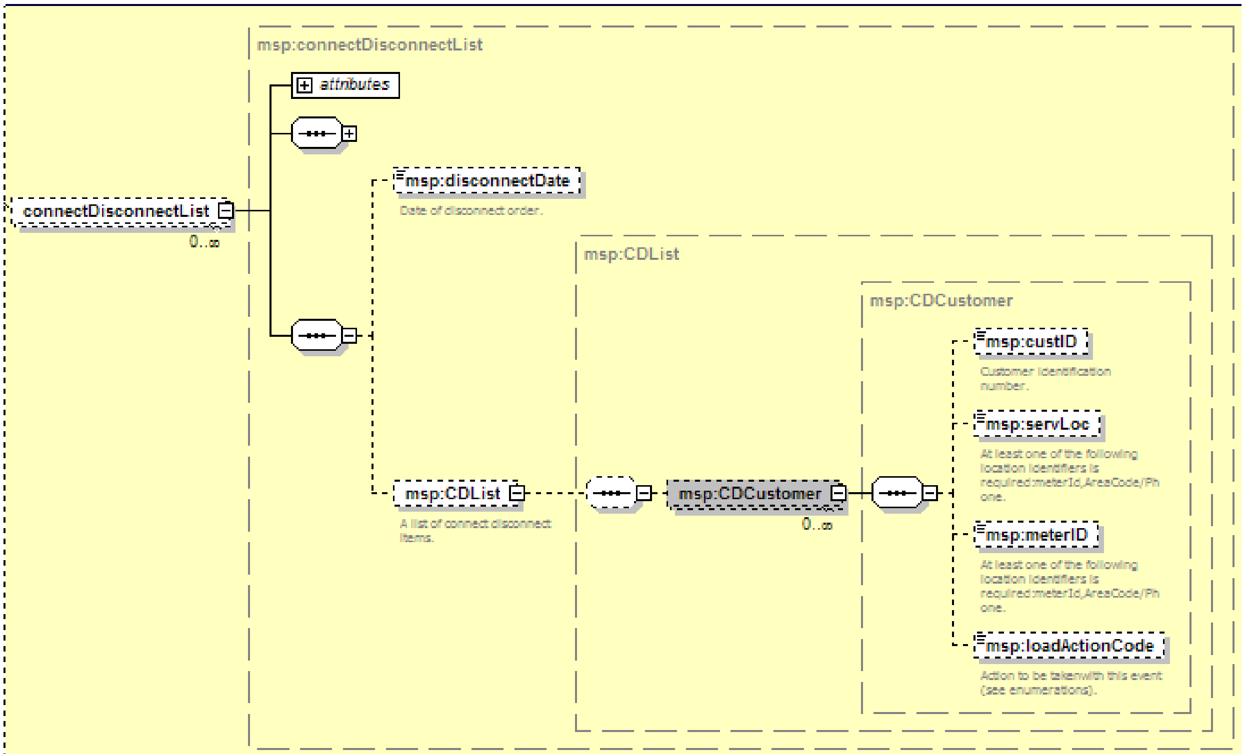


Figure 32: MultiSpeak Connect/Disconnect List

8 Proposed Draft De Facto Standard RCD Message Schemas

The following RCD Message Schemas are the proposed draft de facto RCD standard, which are being discussed with the IEC and MultiSpeak project teams.

Both IEC 61968-9 and MultiSpeak assume a generic device control command can be used for RCD switch control. This may eventually be possible, but only if the AMI system control process handles all control activities, includes checking load before connect, verifying the current status of the RCD switch, and getting a successful meter reading. If more individual control over different RCD switches is needed to meet the differing needs of customers, applications on the Enterprise Bus will need to be responsible for establishing the different limits and processes. Therefore, specific RCD status checking and control commands are proposed to provide this flexibility.

8.1 Acceptable Message Schemas Provided by IEC and/or MultiSpeak

A number of Message Schemas have already been developed by the IEC and/or MultiSpeak which appear adequate to handle some of the requirements for Remote Connect/Disconnect. These include:

- The On-Request Meter Reading Message Schema (SOR) can comply either with the final IEC 61968-9 (see 7.2.3) or the MultiSpeak version 4, and provide the functionality required by the RCD function.
- The Determine Existence of RCD Switches Message Schema (SRE) can comply with the MultiSpeak Connect/Disconnect List message.
- The USB Meter/Headend Event Codes has been accepted by MultiSpeak and is being presented to the IEC. Therefore, no additional details are necessary in this document for exception handling using event codes.

8.2 SRC Message Schema – Remote Connect Command

The SRC Message Schema for the Remote Connect Command of the RCD switch is shown in Figure 33. Although it could be possible to use the IEC 61968-9 EndDeviceControl message (see Section 7.2.4) if all the arming is performed within the AMI system, more individual control can be provided by this RCD Control message.

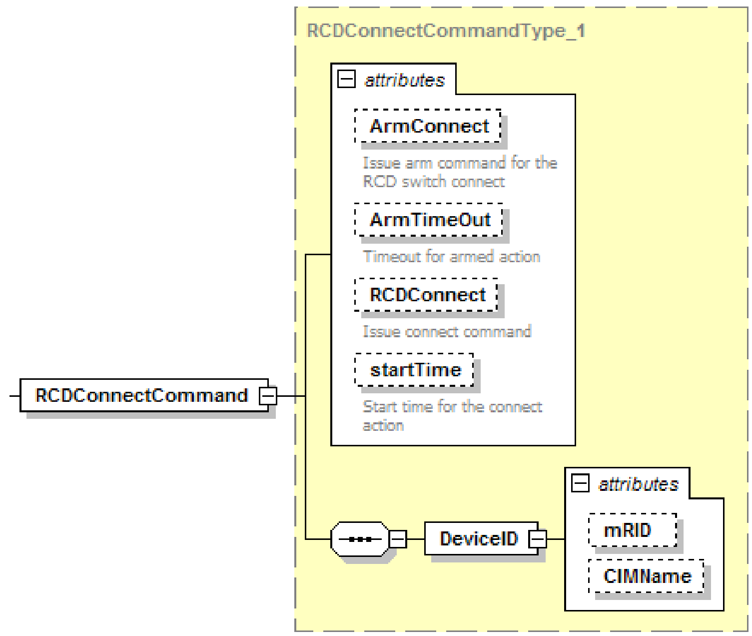


Figure 33: SRC Message Schema – Remote Connect Command

8.3 SRD Message Schema – Remote Disconnect Command

The SRD Message Schema for the Remote Disconnect Command of the RCD switch is shown in Figure 34. Although it could be possible to use the IEC 61968-9 EndDeviceControl message (see Section 7.2.4) if all the arming is performed within the AMI system, more individual control can be provided by this RCD Control message.

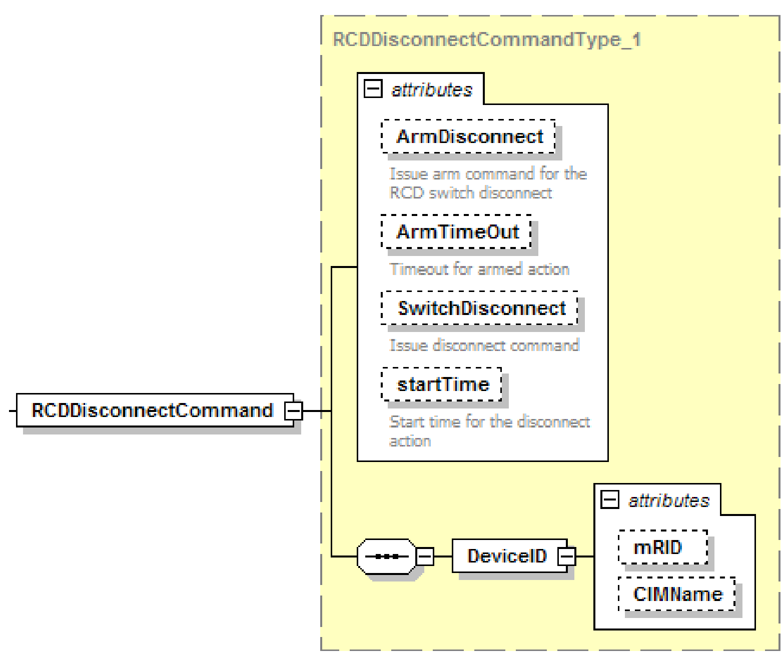


Figure 34: SRD Message Schema – Remote Disconnect Command

8.4 SCV Message Schema – Check Customer Voltage Value Request

The SCV Message Schema for the Check Customer Voltage Value Request at the RCD switch is shown in Figure 35. In different implementations, this check may be part of the SCS Check RCD Status Request, but it may also be handled separately since voltage values can be used for other purposes than for checking connections. In addition, different voltage values may be desired, including instantaneous grid-side voltage, averaged interval voltage values, maximum or minimum voltage levels during specific time periods, etc. The same message should be able to be used, with just voltage codes to indicate which type of voltage is desired.

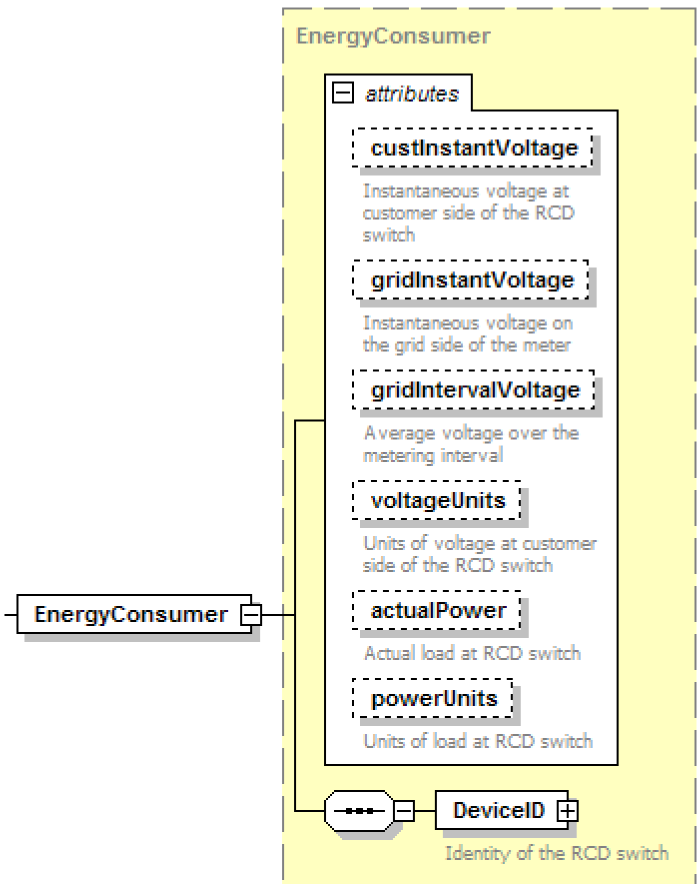


Figure 35: SCV Message Schema – Check Customer Voltage Value Request

8.5 SCS Message Schema – Status Check of RCD Switch Request

The SCS Message Schema for the Status Check of the RCD switch are shown in Figure 36 (overall message), and Figure 37, Figure 38, Figure 39, and Figure 40 (details).

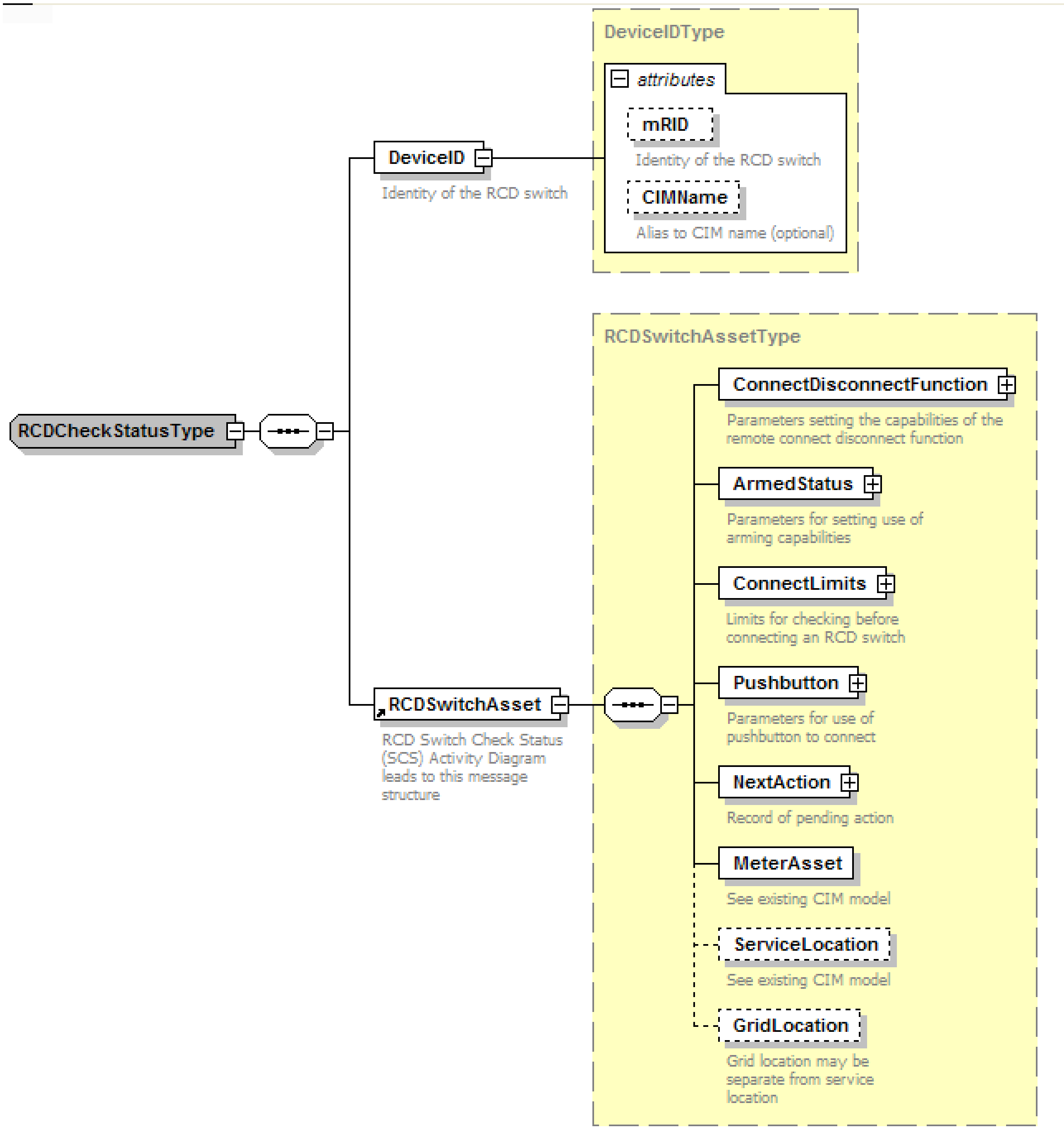


Figure 36: SCS Message Schema – Status Check of RCD Switch Request – Overview

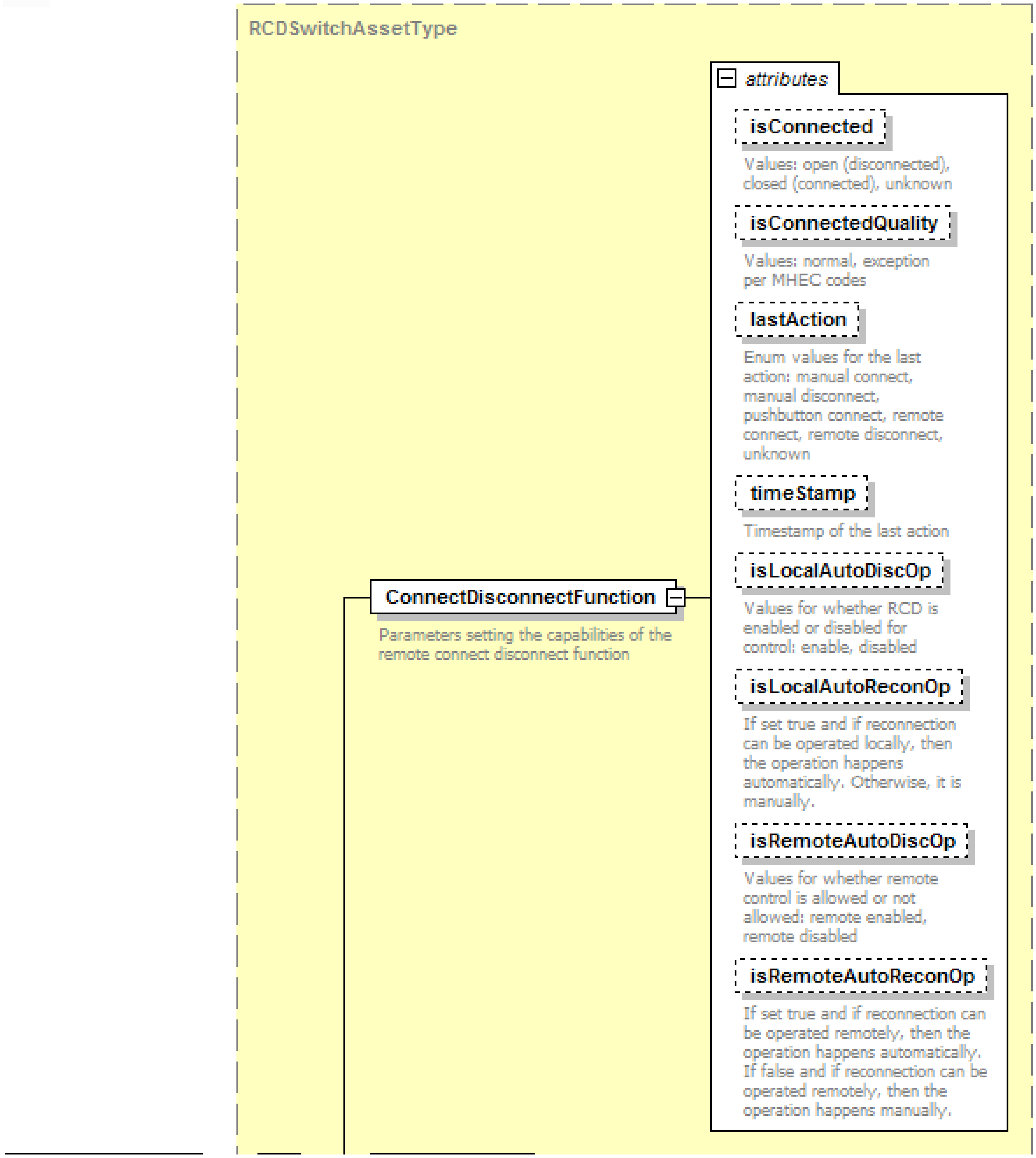


Figure 37: SCS Message Schema – Detail #1

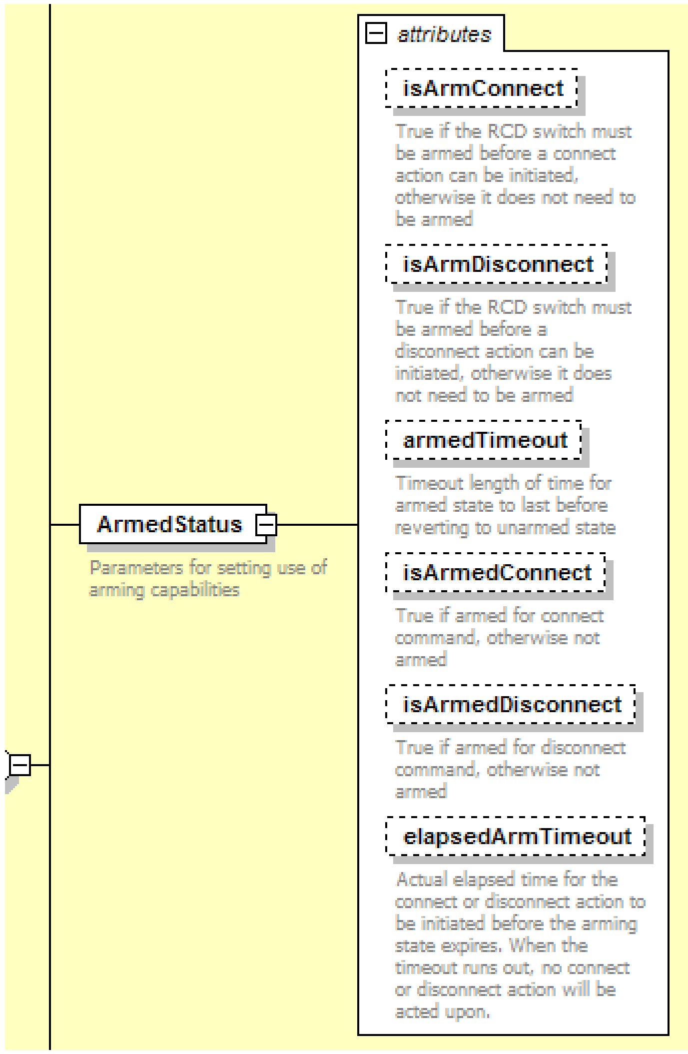


Figure 38: SCS Message Schema – Detail #2

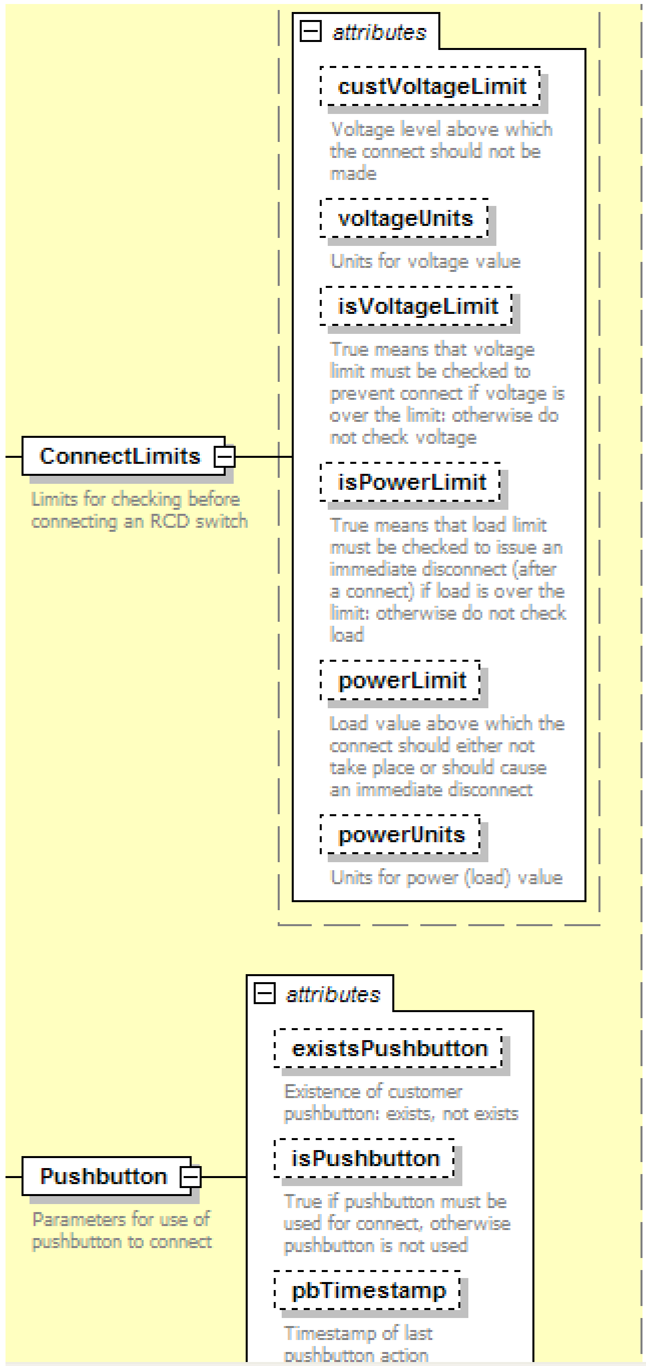


Figure 39: SCS Message Schema – Detail #3

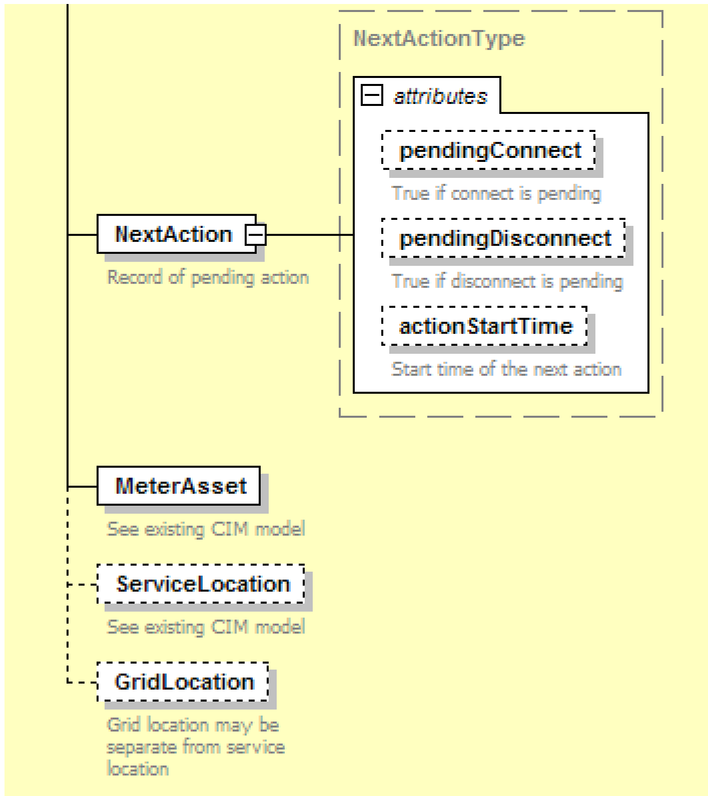


Figure 40: SCS Message Schema – Detail #4

8.6 SCP Message Schema – Change RCD Parameters Command

The SCP Message Schema for the Change RCD Parameters Command of the RCD switch are shown in Figure 41. The expanded messages are the same as for the SCS message schema.

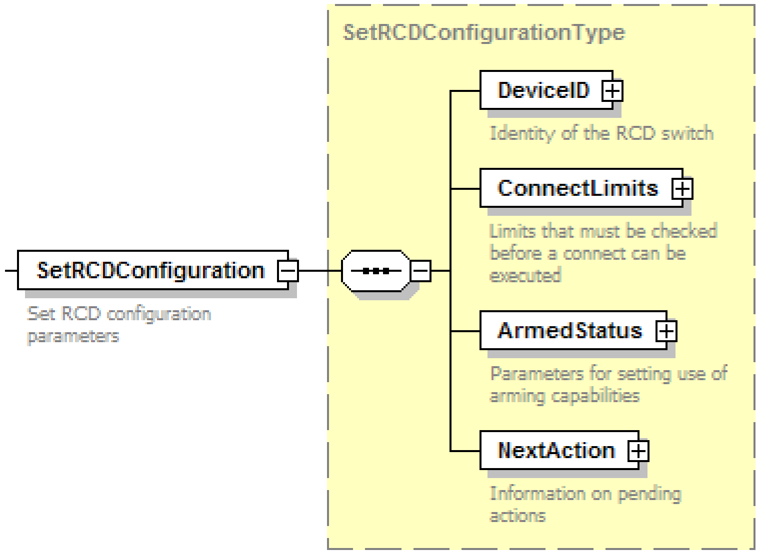


Figure 41: SCP Message Schema – Change RCD Parameters Command – Overview

8.7 SEL Message Schema – Set Energy Usage Limiting

The SEL Message Schema for Setting Energy Usage Limiting are shown in Figure 42.

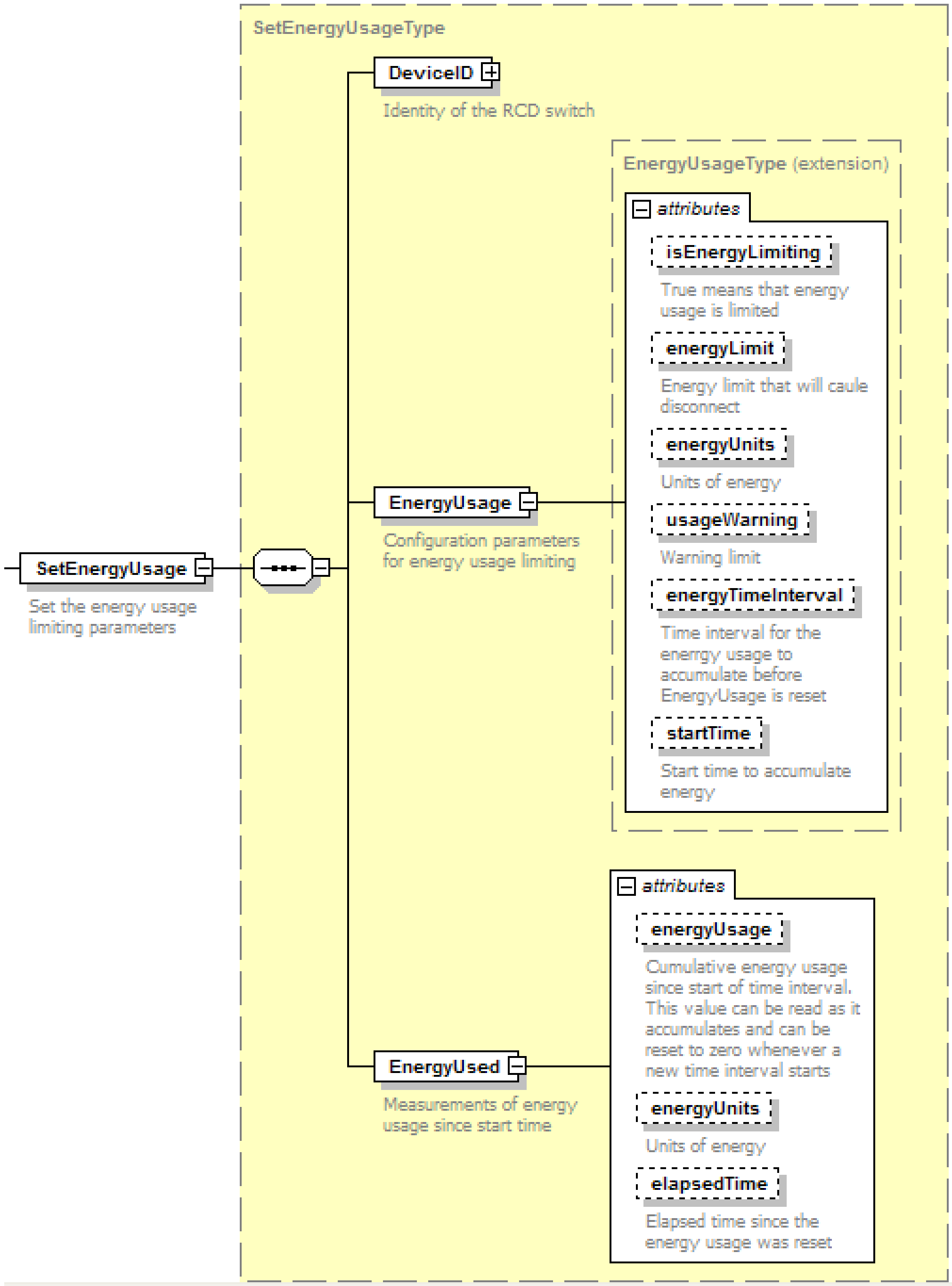


Figure 42: SEL Message Schema – Energy Usage Limiting

9 References

9.1 Normative References

- IEC 61968-9: System Interfaces For Distribution Management – Part 9: Interface Standard for Meter Reading and Control

9.2 Informative References

- SCE Use Cases, specifically B2: Utility remotely limits usage and/or connects and disconnects customer
- MultiSpeak

9.3 Abbreviations

Abbreviation	Definition
AMI	Advanced Metering Infrastructure
ANSI	American National Standards Institute
CIM	Common Information Model
EB	Enterprise Bus
IEC	International Electrotechnical Commission
IEEE	Institute of Electrical and Electronic Engineers
MDM	Meter Data Management
OMS	Outage Management System
UML	Unified Modeling Language
VEE	Validation-Editing-Estimation
WSDL	Web Services Definition Language
XML	eXtended Markup Language
XSD	XML Schema Definition

9.4 Glossary of Terms

Term	Description
AMI Headend	The AMI headend manages the information exchanges between the AMI network and the Enterprise Bus (EB)

Term	Description
AMI System	AMI systems provide the communications between the customer sites and utility systems. AMI systems can be viewed as consisting of the following components: • **Smart Meter –** The smart meter is the source of metrological data as well as other energy-related information, and can provide interval data for customer loads as well as distributed generation, can contain remote connect/disconnect switches, and initiate load control activities. • **Customer Gateway –** The customer gateway acts as an interface between the AMI network and customer systems and appliances within the customer facilities, such as a Home Area Network (HAN) or Building Management System (BMS). It may or may not be co-located with the smart meter. • **AMI Communications Network –** This network provides a path for information to flow from the meter to the AMI headend. • **AMI Headend** – This system manages the information exchanges between the AMI network and the Enterprise Bus, a generic interface to utility systems.
CIS (Customer Information System)	CIS contains (or manages) all customer interconnection information, including physical location, electrical characteristics, financial billing status, tariff information, etc.
CIS Connect Application	Software application that initiates a remote connect command, associated in this context with the CIS, although not necessarily part of a CIS implementation
CIS Disconnect Application	Software application that initiates a remote disconnect command, associated in this context with the CIS, although not necessarily part of a CIS implementation
Common Information Model (CIM)	IEC 61968 / 61970 standard for models of power system information
Customer	Entity (person, company) that is responsible for the usage of the energy provided through the meter

Term	Description
Enterprise Bus (EB)	The Enterprise Bus is the generic term for the interface between the AMI headend and other utility systems, including back office systems such as the MDM, as well as distribution operations systems, such as the outage management system. It provides basic service management (traffic and performance management, communication error handling, and some interface adapters) and provides connections to utility information systems, including back office systems and certain distribution operations systems. The use of this generic term allows utilities to develop architectures without preconceived design constraints, since the purpose is the standardization of the interface, not the systems at either side of the interface. For instance, the MDM, often considered the primary interface to the AMI, may only filter some, not all of the interactions across the AMI/EB interface. *In this document, the Enterprise Bus is used as a proxy for any of the utility systems that require the exchange of information with AMI systems.*
MDM (Meter Data Management)	MDM retrieves and stores metering data, and acts as one conduit (although possibly not the only conduit) between this metering data and other utility back office systems. Its primary functions are to: • Access metering information via the AMI system (through the AMI headend) • Provide some error checking of the metering information (but typically not complete VEE) • Manage the metering information database • Provide appropriate metering information to authorized entities (people and software applications) • Issue commands to meters through the AMI system
Meter	In this context, the meter is a smart meter. The smart meter is the source of metrological data as well as other energy-related information, and can provide interval data for customer loads as well as distributed generation, can contain remote connect/disconnect switches, and initiate load control activities.
Meter RCD Capability Application	Software application that determines whether a meter can be remotely connected or disconnected, including the RCD switch hardware as well as whether the capability has been activated
On-request Meter Read Application	Software application that initiates a meter read on demand
Utility Field Employee	Utility field employees interact with the meter on the customer site, including reading the meter and manually connecting or disconnecting the meter
WMS (Work Management System)	The WMS manages and issues work orders for utility field employees