



GridOps Management Suite 3.10

Advanced Metering Infrastructure Interface

Functional Specification

Document Version: 1.0

Updated: June, 2024

The information contained in this document is confidential, privileged and protected under the applicable laws. This document is only for the information of the intended recipient and may not be used, published, or redistributed without the prior written consent of Schneider Electric.

This document has undergone extensive technical review before being released. While every care has been taken in preparing these documents in order to keep the information herein as accurate and up to date as possible, neither Schneider Electric nor any of its affiliates or subsidiaries shall be responsible or liable for misuse of the information contained herein, nor for errors or omissions or for damages resulting from the use of the information contained herein.

The content of this document is subject to change without prior notice.

Life Is On



Table of Contents

1. REFERENCES	7
2. ASSUMPTIONS AND PREREQUISITES	8
3. INTRODUCTION	9
3.1. General Architecture.....	10
4. INTERFACE OVERVIEW	11
5. GETMETERREADINGS SERVICE	13
5.1. GetMeterReadings Operation	13
5.1.1. Overview	13
5.1.2. Use Cases.....	14
6. RECEIVEMETERREADINGS SERVICE	16
6.1. CreatedMeterReadings Operation	16
6.1.1. Overview	16
6.1.2. Use Cases.....	18
7. RECEIVEENDDEVICEEVENTS SERVICE	25
7.1. CreatedEndDeviceEvents Operation	25
7.1.1. Overview	25
7.1.2. Use Cases.....	27
8. SENDCONFIGURATIONEVENTS SERVICE	33
8.1. CreatedConfigurationEvents Operation	33
8.1.1. Overview	33
8.1.2. Use Cases.....	33
9. MESSAGES.....	35
9.1. Common	35
9.1.1. Header.....	35
9.1.2. Reply and Fault	37
9.2. GetMeterReadings Operation Messages	38
9.2.1. Request	38
9.2.2. Response	43
9.2.3. Fault	46
9.3. CreatedMeterReadings Operation Messages	46
9.3.1. Request	46

9.3.2.	Response	52
9.3.3.	Fault	55
9.4.	CreatedEndDeviceEvents Operation Messages	55
9.4.1.	Request	55
9.4.2.	Response	60
9.4.3.	Fault	62
9.5.	CreatedConfigurationEvents Operation Messages	62
9.5.1.	Request	62
9.5.2.	Response	65
9.5.3.	Fault	65
10.	DEPLOYMENT SPECIFICATION	66
11.	INTERFACE CONFIGURATION	67
12.	PERFOMANCE	68
12.1.	Performance Best Practices	68
13.	APPENDIX.....	69
13.1.	WSDL	69
13.2.	Message Examples	69
14.	RELEASE NOTES	70
14.1.	Software Version 3.8.0	70
14.2.	Software Version 3.8.1	70
14.3.	Software Version 3.9	71
15.	DEFINITIONS AND ABBREVIATIONS	72

Table of Figures

Figure 3.1 – AMI integration business process diagram.....	10
Figure 4.1 – The AMI integration high level use case diagram	12
Figure 5.1 – The asynchronous ping meter status sequence diagram.....	13
Figure 5.2 – The asynchronous poll meter voltage sequence diagram.....	14
Figure 6.1 – The CreatedMeterReadings operation execution.....	17
Figure 7.1 – The CreatedEndDeviceEvents operation execution.....	26
Figure 8.1 – The CreatedConfigurationEvents sequence diagram	33
Figure 9.1 – The header section	37
Figure 9.2 – The Reply and Error field contents.....	38
Figure 9.3 – The GetMeterReadings request message	39
Figure 9.4 – GetMeterReadings.xsd	40
Figure 9.5 – The MeterReadingsResponse message	43
Figure 9.6 – MeterReadings.xsd.....	44
Figure 9.7 – The MeterReadingsFault message	46
Figure 9.8 – The CreatedMeterReadingsEvent message	46
Figure 9.9 – The MeterReadingsResponse message	52
Figure 9.10 – The MeterReadingsFault message	55
Figure 9.11 –The CreatedEndDeviceEvents event message.....	55
Figure 9.12 – EndDeviceEvents.xsd.....	56
Figure 9.13 – The EndDeviceEventsResponse message	60
Figure 9.14 – The EndDeviceEventsFault message	62
Figure 9.15 – The CreatedConfigurationEventsEvent message	62
Figure 9.16 – ConfigurationEvents.xsd.....	63
Figure 9.17 – The ConfigurationEvents response message	65
Figure 9.18 – The ConfigurationEventsFault message	65

Table of Tables

Table 5.1 – The GetMeterReadings use cases	14
Table 6.1 – AMI Integration Common Use Cases	18
Table 6.2 – Common CreatedMeterReadings Use Cases	19
Table 6.3 – On Demand Reads-Asynchronous Response Use Cases	21
Table 6.4 – Unsolicited Readings Use Cases	24
Table 7.1 – The CreatedEndDeviceEvents use cases	27
Table 8.1 – The CreatedConfigurationEvents use cases	34
Table 9.1 – GetMeterReadingsRequest – the smart metering model mapping	41
Table 9.2 – The GetMeterReadings service – the Reading Type Codes	42
Table 9.3 – MeterReadingsResponse – the smart metering model mapping	45
Table 9.4 – CreatedMeterReadingsEvents – the smart metering model mapping	48
Table 9.5 – The ReceiveMeterReadings service – the Reading Type Codes	49
Table 9.6 – CreatedMeterReadingsResponse – the smart metering model mapping	53
Table 9.7 – CreatedEndDeviceEvents – the smart metering model mapping	57
Table 9.8 – The EndDeviceEventType codes	58
Table 9.9 – EndDeviceEventsResponse – the smart metering model mapping	61
Table 9.10 – CreatedConfigurationEvents – the smart metering model mapping	64
Table 10.1 – The deployment specification	66
Table 11.1 – The configuration files specification	67

Table of Documents

No table of figures entries found.

1. REFERENCES

#	Title	Description
1.	EcoStruxure GridOps Management Suite 3.10 Outage Management - Functional Specification	The document describes the Outage Management component. The Outage Management functionality tracks all information about the power disturbances in the network and organizes the response to the disturbance into a user-friendly, efficient and safe workflow.
2.	EcoStruxure GridOps Management Suite 3.10 Enterprise Integration Platform - Functional Specification	The document represents a set of common integration principles applied to all baseline integration adapters.
3.	EcoStruxure GridOps Management Suite 3.10 Advanced Metering Infrastructure Interface	EcoStruxure GridOps Management Suite 3.10 Advanced Metering Infrastructure Interface zip file contains essential configuration information, as well as web service definitions complemented with message examples.

2. ASSUMPTIONS AND PREREQUISITES

The AMI integration is designed with the following assumptions:

- EcoStruxure GridOps shall interface with client's AMI HES and/or MDM System.
- Information about the meter ID is in scope of the CIS Interface. This information will be populated in the EcoStruxure GridOps through the CIS Interface. Besides meter ID, information about the meter type (meter catalog ID) should also arrive from CIS.
- According to the terminology, depending on the types of meters that exist in distribution network, meters can be classified in following groups:
 - 1-way meter – meter is able to issue power down (“last gasp”) and power up events.
 - 2-way meter – contains the functionality of 1-way meters, plus the functionality to ping meter status.
 - Advanced meter – contains the functionality of 2-way meters, plus the voltage poll functionality (solicited voltages).
 - Bellwether meter – contains the functionality of advanced meter just introduced in periodic meter voltage reading (unsolicited meter readings).
 - Super meter – contains the functionality of the Advanced meter plus ability to issue event when the meter voltage is below/above threshold, i.e. the voltage sag/swell.
- In the event that the power goes out or up, the meter, if capable, will report power loss and restoration statuses to EcoStruxure GridOps.
- Message exchange is supported utilizing two integration patterns: publish/subscribe and request/reply.

3. INTRODUCTION

EcoStruxure GridOps Management Suite is a family of solutions designed to help electric utilities in the operations and management of their grid. It is offered as EcoStruxure ADMS, EcoStruxure Grid Operation, EcoStruxure DERMS or EcoStruxure Energy Transmission Operation solutions, which share the same technology platform.

NOTE: The functionality described in this document applies to the following solutions: EcoStruxure ADMS and EcoStruxure Grid Operation.

NOTE: Most images presented in this document are related to the EcoStruxure ADMS solution and should be used as an example. The images for other solutions may differ slightly.

Improving the systems for determining the extent of outages and location of faults in the distribution system is essential to serving the utility's customers. In Distribution Networks that possess Advanced Metering Infrastructure (support smart metering capability), outages/faults can be reported with the help of smart meters. In addition to the information collected from AMI HES such as power down and power up, the EcoStruxure GridOps works with supervisory control and data acquisition (SCADA) and reported trouble tickets to proactively discover, predict, identify outages and help narrow the predicted fault location.

When SCADA senses a momentary change in the distribution network, it could mean many things. Sometimes the event signals start of a potential outage, other times it might indicate a temporary over-current event that resolves itself before becoming an outage. At the utility, a SCADA event may prompt the AMI system to automatically ping a series of so-called bellwether or the recommended meters, at critical junctures on each feeder.

When a potential outage is identified either through SCADA, AMI strategic pinging, the down event sent from meter or through received calls, the utility may choose to verify the extent of the outage (automatically or manually) by pinging meters along affected sections of the distribution system to identify meters that are out of power, but the customer has not called in yet.

Besides the ability to ping meters in order to obtain their statuses, the software has the capability to poll voltage, current, active and reactive power for appropriate meters. Those readings are introduced into the software and used to verify if there is an issue on the meter itself, so that crew dispatching can be avoided (if the problem is not utility's responsibility, in case of the reported voltage problem by the customer).

Common business processes that depict basic activities between the EcoStruxure GridOps and AMI HES (or MDMS) are shown in Figure 3.1.

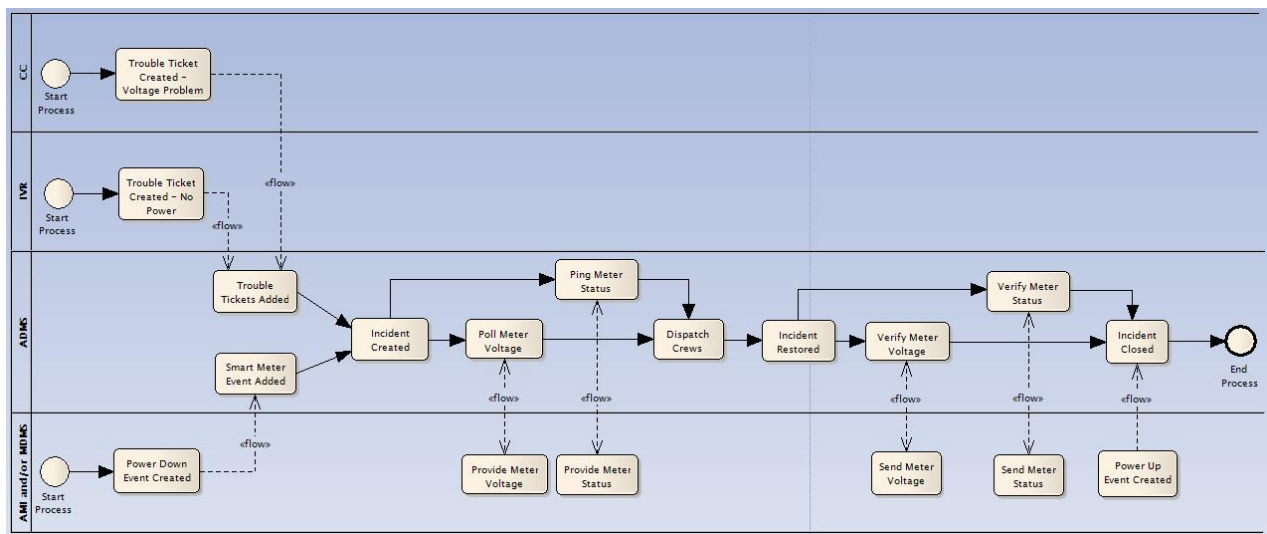


Figure 3.1 – AMI integration business process diagram

In case of a power loss or voltage problem, customers report trouble tickets through the Call Center, Outage Portal or IVR. Also, if meters have a capability, they will send different types of events to the EcoStruxure GridOps. Customer Service Representatives create trouble tickets and send them to the EcoStruxure GridOps. Based on the received trouble tickets and received smart meter events, the new incident(s) is created. In order to verify whether the outages truly exist operators usually ping/poll meters in order to obtain meter status/voltage. Once the problem is located, crews are dispatched to the field in order to restore the power to the customers. After the crew resolves the problem in the field and restores the power to customers, operators can verify whether the incident is resolved by pinging the meter status or polling the meter voltage again. After successful verification and after all callbacks for one incident are restored (if there were any), the incident is closed.

3.1. General Architecture

It is thoroughly described in the *EcoStruxure GridOps Management Suite 3.10 Enterprise Integration Platform - Functional Specification* [2].

4. INTERFACE OVERVIEW

The product AMI interface is implemented within the AMI Adapter component. The aforementioned adapter hosts several interfaces (the SOAP based Web Services) or behaves as a client to the already hosted Web Services on the client side. The AMI Adapter implements logic in order to support various use cases which fall within the scope of the AMI integration to:

- Provide the meter status via ping for a particular meter or group of meters.
- Provide the voltage, current, active and reactive power readings via poll for a particular meter or group of meters.
- Accept inbound unsolicited meter readings from bellwether meters.
- Accept the power down, power up, voltage sag (undervoltage), voltage swell (overvoltage) and return to normal meter events.
- Basic administration/configuration of the following items:
 - Prevent/allow the AMI HES (or MDMS) to emit the power down or power up events on demand (e.g. during a storm). This feature is needed in order to prevent continuous notification about the power down or power up events that can harm performance and increase storage consumption.
 - Configure interval for collecting the power down and power up events (by default, it is 300 seconds).

The following chapters provide more details about the implementation (business process) that these web services cover and appropriate web service operations, data mappings (CIM Profiles → Outage/SmartMetering Models), error handling scenarios, etc.

The support for above aforementioned use cases is achieved through the implementation of the following web services or web service clients:

- *GetMeterReadingsService* – used for on demand obtaining of the meter status, voltage, current, active and reactive power. Since asynchronous communication is used between the EcoStruxure GridOps and AMI Head End (or MDMS), this interface is used only for sending requests, while *ReceiveMeterReadingsService* is used as a callback service, for receiving asynchronous responses:
 - *GetMeterReadings* operation
- *ReceiveEndDeviceEventsService* – used for receiving the power down, power up, undervoltage, overvoltage and return to normal meter events:
 - *CreatedEndDeviceEvents* operation
- *ReceiveMeterReadingsService* – used for receiving the unsolicited meter readings and asynchronous responses for on demand reads (status, voltage, current, active and reactive power):
 - *CreatedMeterReadings* operation
- *SendConfigurationEventsService* – used to enable/disable sending of the end device events from the AMI HES (or MDMS) to EcoStruxure GridOps:
 - *CreatedConfigurationEvents* operation

The high-level use case diagram that represents common participants (actors) of the mentioned interfaces in the AMI integration is presented in Figure 4.1.

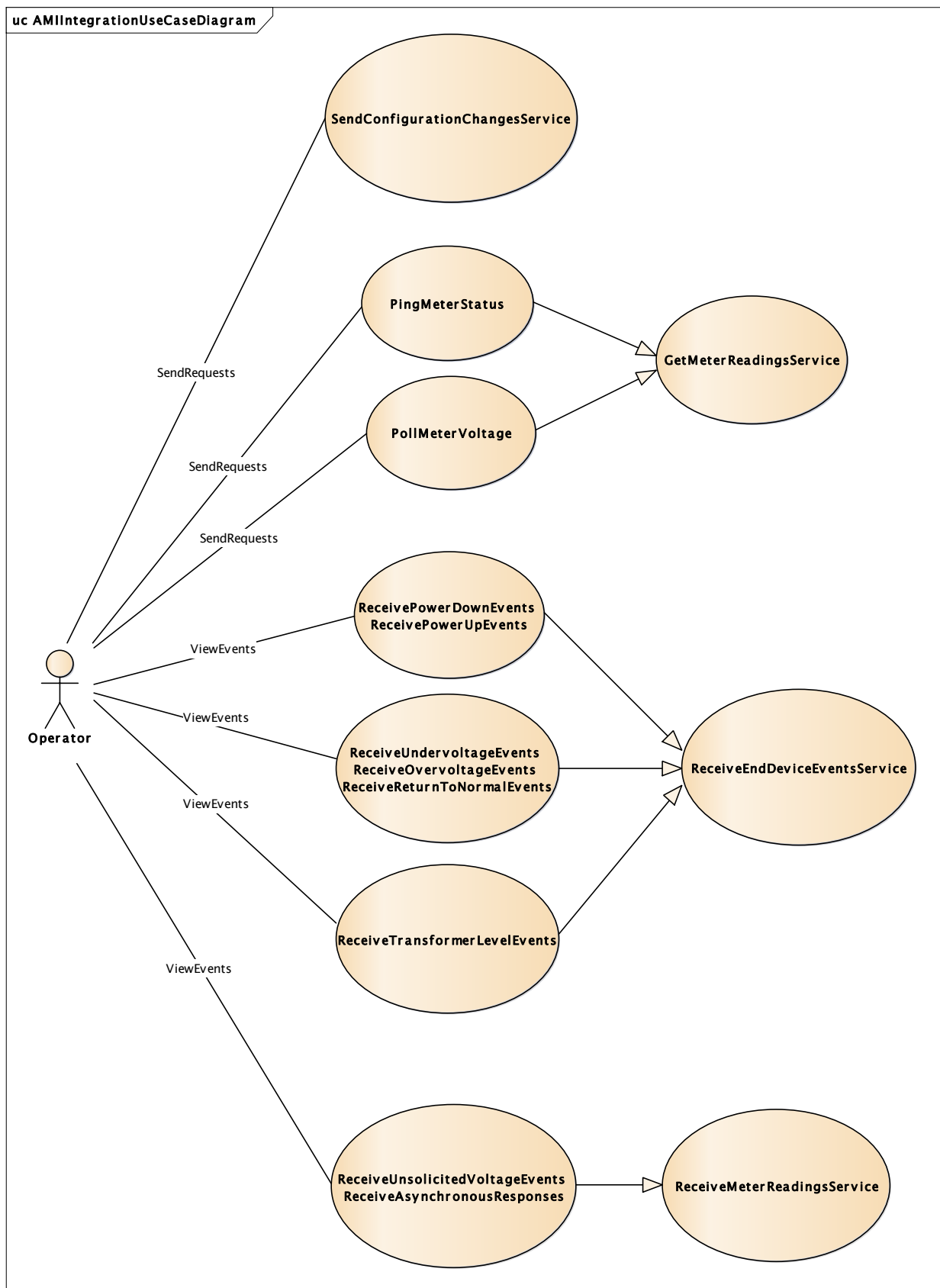


Figure 4.1 – The AMI integration high level use case diagram

5. GETMETERREADINGS SERVICE

5.1. GetMeterReadings Operation

5.1.1. Overview

In case when a trouble ticket is reported from a call center or via a smart meter, in order to check whether the outage or some other issue actually exists, operators have the possibility to request meter (UsagePoint) status or poll meter to obtain its voltage, current, active and reactive power. When the operator initiates meter ping or poll in the DMD application, a new smart meter request is created within the software for that particular meter or a group of meters.

The AMI Adapter is subscribed to appropriate changes in the software and it receives a publication each time when the meter ping/poll is requested (a new smart meter request is created). After receiving the publication, the AMI Adapter converts it into appropriate intermediate format and sends the *GetMeterReadings* request message to the AMI HES (or MDMS), via the web service call. The appropriate web service is hosted on the client's side.

The AMI HES (or MDMS) responds synchronously with an acknowledgment message. After some period, the EcoStruxure GridOps HES (or MDMS) invokes the *ReceiveMeterReadingsService* and asynchronously responds with an appropriate response message which contains correlation ID that corresponds to the request message ID, along with the appropriate response values, depending on the on demand read (ping or poll).

The AMI Adapter performs initial validation of the response message, transforms it into the appropriate internal format and applies it to the DMZ system (updates the status of appropriate smart meter request). All changes introduced to the DMZ are asynchronously replicated to the CORE system.

The sequence of events for asynchronous meter status ping or meter voltage poll is presented in Figure 5.1 and Figure 5.2.

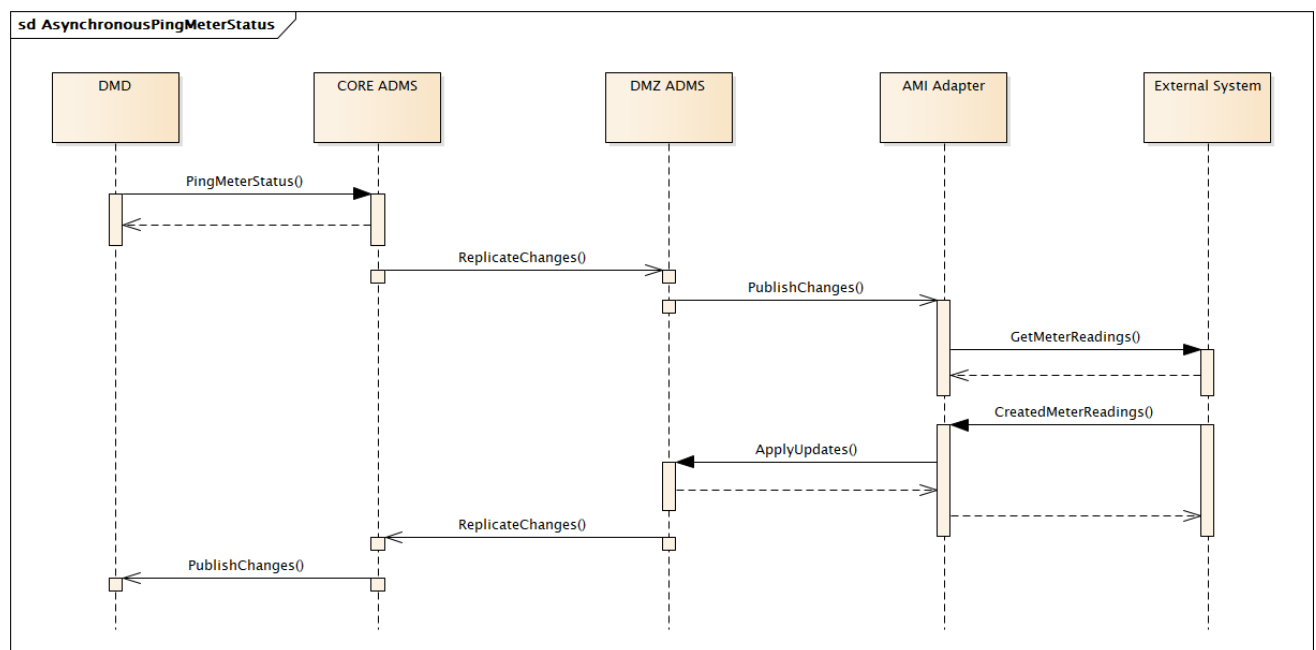


Figure 5.1 – The asynchronous ping meter status sequence diagram

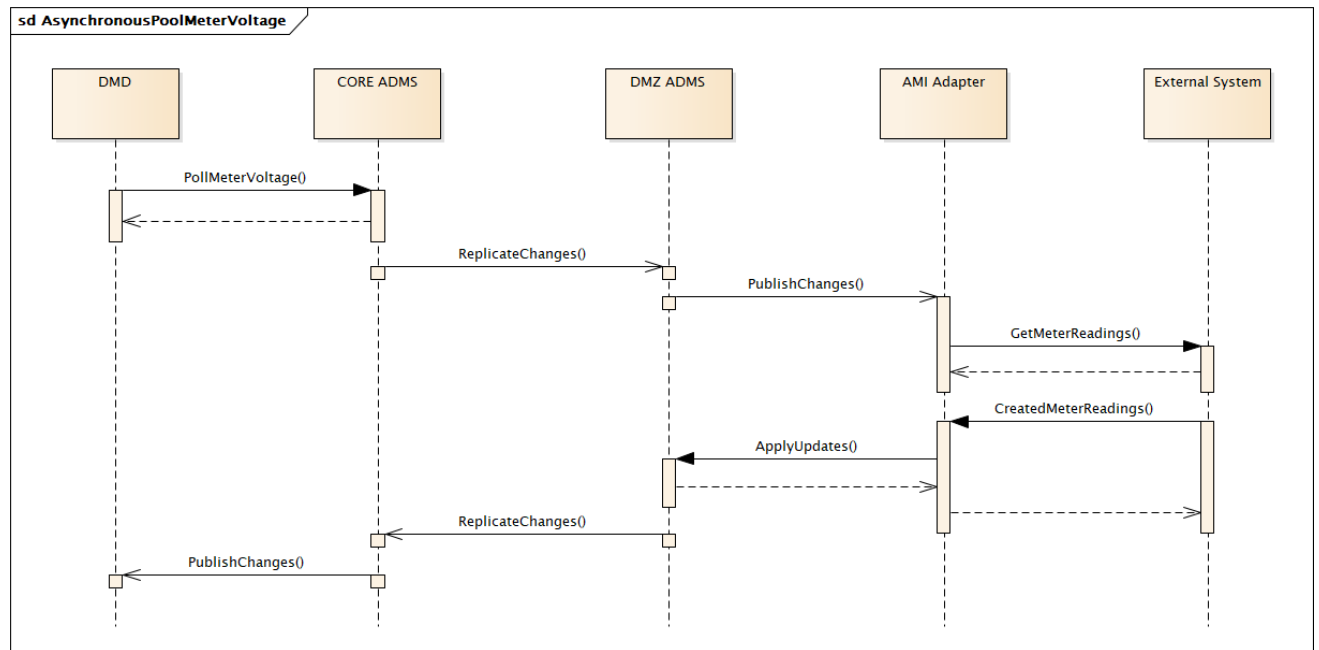


Figure 5.2 – The asynchronous poll meter voltage sequence diagram

5.1.2. Use Cases

The list of possible use cases and corresponding faults is presented in Table 5.1.

Table 5.1 – The GetMeterReadings use cases

Use Case	Message Mapping			Action
	Property	Type	Value	
Ping Meter – Successful Scenario	Result	String	OK	The <i>GetMeterReadings</i> request message is sent from the EcoStruxure GridOps to AMI HES or MDMS. The synchronous acknowledgement message is received from the external system by AMI Adapter with reply result OK and the appropriate CorrelationID.
	Error.code	String	N/A	
	Error.level	String	N/A	
	Error.reason	String	N/A	
	Error.details	String	N/A	
Ping Meter – AMI HES or MDMS Is Not Available	Result	String	FAILED	The AMI Adapter tries to send the <i>GetMeterReadings</i> request message from the EcoStruxure GridOps to AMI HES or MDMS and after N retries the adapter logs an exception. The status of an appropriate smart meter request is set to Failed by AMI Adapter.
	Error.code	String	N/A	
	Error.level	String	N/A	
	Error.reason	String	N/A	
	Error.details	String	N/A	
Ping AMI Meter Status – Replay Result Is Failed	Result	String	FAILED	The <i>GetMeterReadings</i> request message is sent from the EcoStruxure GridOps to AMI HES or MDMS. The synchronous acknowledgement message is received from the external system by AMI Adapter with reply result FAILED and the appropriate CorrelationID. The status of appropriate smart meter request is set to Failed by AMI Adapter.
	Error.code	String	N/A	
	Error.level	String	N/A	
	Error.reason	String	N/A	
	Error.details	String	N/A	
Poll Meter – Successful Scenario	Result	String	OK	The <i>GetMeterReadings</i> request message is sent from the EcoStruxure GridOps to AMI HES or MDMS. The
	Error.code	String	N/A	

Use Case	Message Mapping			Action
	Property	Type	Value	
	Error.level	String	N/A	synchronous acknowledgement message is received from the external system by AMI Adapter with reply result OK and the appropriate CorrelationID.
	Error.reason	String	N/A	
	Error.details	String	N/A	
Poll Meter – AMI HES or MDMS Is Not Available	Result	String	N/A	The AMI Adapter tries to send <i>GetMeterReadings</i> request message from the EcoStruxure GridOps to AMI HES or MDMS and after N retries adapter logs an exception. The status of an appropriate smart meter request is set to Failed by AMI Adapter.
	Error.code	String	N/A	
	Error.level	String	N/A	
	Error.reason	String	N/A	
	Error.details	String	N/A	
Poll Meter – Replay Result Is Failed	Result	String	FAILED	The <i>GetMeterReadings</i> request message is sent from the EcoStruxure GridOps to AMI HES or MDMS. The synchronous acknowledgement message is received from the external system by AMI Adapter with reply result FAILED and the appropriate CorrelationID. The status of an appropriate smart meter request is set to Failed by AMI Adapter.
	Error.code	String	N/A	
	Error.level	String	N/A	
	Error.reason	String	N/A	
	Error.details	String	N/A	

6. RECEIVEMETERREADINGS SERVICE

6.1. CreatedMeterReadings Operation

6.1.1. Overview

The *ReceiveMeterReadings* service is used for handling of:

- Unsolicited meter (UsagePoint) readings.
- Asynchronous responses for the meter (UsagePoint) ping/poll.

This operation is similar to the *CreatedEndDeviceEvents* since the message is inbound rather than initiated as a request from the EcoStruxure GridOps.

The AMI HES (or MDMS) invokes the *ReceiveMeterReadings* service in the following occasions:

- Sending of the unsolicited meter readings from the AMI (bellwether) meters – when the unsolicited meter readings are sent to the AMI Adapter, AMI HES (or MDMS) creates a package consisting of the collected data and sends it periodically, on a configurable time period.
- Sending of asynchronous responses for the solicited meter ping or poll requests – when request for the meter status, voltage, current, active and reactive power was previously sent from the EcoStruxure GridOps.

In both occasions, the data is sent in form of the *CreatedMeterReadingsEvents* message. Once the appropriate web service operation is invoked, the AMI Adapter performs initial validation of the message Verb. If the Verb is created, unsolicited meter readings process will be triggered. In case when the Verb is set to reply, asynchronous response for solicited meter reading will be processed. Either way, received data will be validated and transformed into appropriate internal format. After transformation, data is applied to the instance in the DMZ system. All changes introduced to the DMZ are asynchronously replicated to the CORE system.

When the *ReceiveMeterReadings* service is used for handling of unsolicited meter readings, an appropriate reading entity is created in the smart meter model. Bellwether meter readings (analog signal values) are displayed within appropriate browser, within the DMD.

When the *ReceiveMeterReadings* service is used for handling of asynchronous responses for the requested (solicited) meter ping or poll, statuses of appropriate smart meter requests are updated in the smart meter model based on the correlation ID from the message, as described in *GetMeterReadings* Operation.

Once the operation is finished, the appropriate response is returned in form of the *MeterReadingsResponse* message. If some error occurs, the *MeterReadingsFault* message is returned.

The visual representation for the described sequence of events is presented in Figure 6.1.

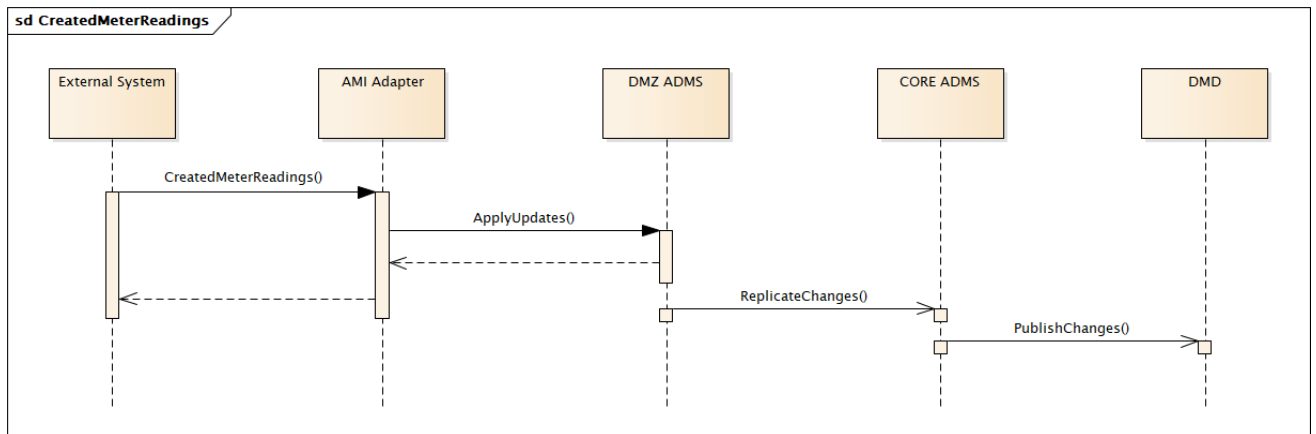


Figure 6.1 – The *CreatedMeterReadings* operation execution

6.1.2. Use Cases

Common use cases for all operations that fall in scope of AMI Integration (*GetMeterReadings*, *CreatedMeterReadings*, *CreatedEndDeviceEvents* and *CreatedConfigurationEvents*) such as *Invalid Verb*, *Invalid Noun*, *Element not found in message*, *Unsupported message revision in Header*, *Mandatory Element Missing*, *Non-active site fault* and *Unable to process the request* are described only in Table 6.1.

Table 6.1 – AMI Integration Common Use Cases

Use Case	Message Mapping			Action
	Property	Type	Value	
Invalid Verb	Result	String	FAILED	The AMI HES or MDMS sends the request/event message with invalid Verb. The response message is sent by AMI Adapter with the FAILED result and the message is discarded. The response with this error will be sent if the verb is valid according to XSD, but not semantically.
	Error.code	String	2.9	
	Error.level	String	FATAL	
	Error.reason	String	InvalidVerb	
	Error.details	String	Verb {0} is not valid for requested operation.	
Invalid Noun	Result	String	FAILED	The AMI HES or MDMS sends the request/event message with invalid Noun. The response message is sent by AMI Adapter with the FAILED result and the message is discarded.
	Error.code	String	2.5	
	Error.level	String	FATAL	
	Error.reason	String	InvalidNoun	
	Error.details	String	Noun {0} is not valid for requested operation.	
Mandatory Element Missing	Result	String	FAILED	The AMI HES or MDMS sends the request/event message in which some of the mandatory elements are missing. The response message is sent by AMI Adapter with the FAILED result and the message is discarded.
	Error.code	String	1.8	
	Error.level	String	FATAL	
	Error.reason	String	InvalidMessage	
	Error.details	String	Received message is invalid against xsd schema. Reason: {0}.	
	Result	String	FAILED	

Use Case	Message Mapping			Action
	Property	Type	Value	
Unable to process the request	Error.code	String	5.3	The AMI HES or MDMS sends the <i>CreatedMeterReadingsEvents</i> message, but for some reason the message processing fails due to various internal server error. The response message is sent by AMI Adapter with the FAILED result and message is discarded.
	Error.level	String	FATAL	
	Error.reason	String	InternalServerError	
	Error.details	String	{0}.	

Common use cases for *CreatedMeterReadings* operation are given in the Table 6.2.

Table 6.2 – Common *CreatedMeterReadings* Use Cases

Use Case	Message Mapping			Action
	Property	Type	Value	
Different Correlation and Message Ids	Result	String	OK	The AMI HES or MDMS sends the <i>CreatedMeterReadingsEvents</i> message for unsolicited readings in which the correlation Id and message Id are not the same. The response message is sent by AMI Adapter with the OK result and the message is processed.
	Error.code	String	2.8	
	Error.level	String	INFO	
	Error.reason	String	DifferentCorrelationAndMessageIds	
	Error.details	String	Correlation and message Ids are not the same.	
ReportedDateTime is in future	Result	String	PARTIAL/FAILED	The AMI HES or MDMS sends the <i>CreatedMeterReadingsEvents</i> message for the solicited/unsolicited meter readings where some of the meter readings have reported datetime in future. The valid entries are processed while for invalid ones, an appropriate error is returned. The response message is sent by AMI Adapter with the PARTIAL/FAILED result.
	Error.code	String	6.1	
	Error.level	String	WARNING/FATAL	
	Error.reason	String	InvalidReportedDateTime	
	Error.details	String	ReportedDateTime is greater than current datetime for Meter(s)/UsagePoint(s): {0}.	
	Result	String	PARTIAL/FAILED	The AMI HES or MDMS sends the <i>CreatedMeterReadingsEvents</i> message for the solicited/unsolicited meter readings where some of the meter readings have
	Error.code	String	6.1	

Use Case	Message Mapping			Action
	Property	Type	Value	
Reading ReportedDateTime is before timeStamp	Error.level	String	FATAL	reading timestamp before reported datetime. The valid entries are processed while for invalid ones, an appropriate error is returned. The response message is sent by AMI Adapter with the PARTIAL/FAILED result.
	Error.reason	String	ReadingReportedDatetimeBeforeTimeStamp	
	Error.details	String	Meter reading reported datetime is before timestamp for Meter(s)/UsagePoint(s): {0}.	
Reading timestamp is in future	Result	String	PARTIAL/FAILED	The AMI HES or MDMS sends the <i>CreatedMeterReadingsEvents</i> message for the solicited/unsolicited meter readings where some of the meter readings have reading timestamp greater than current datetime. The valid entries are processed while for invalid ones, an appropriate error is returned. The response message is sent by AMI Adapter with the PARTIAL/FAILED result.
	Error.code	String	6.1	
	Error.level	String	FATAL	
	Error.reason	String	InvalidReadingTimeStamp	
	Error.details	String	Meter reading timestamp is greater than current datetime for Meter(s)/UsagePoint(s): {0}.	
Invalid Reading Type	Result	String	PARTIAL/FAILED	The AMI HES or MDMS sends the <i>CreatedMeterReadingsEvents</i> message with some invalid reading type codes. Type codes must correspond to the verb of the message. MeterReadings with the valid reading type codes are processed, while for invalid ones, an appropriate error is returned. The response message is sent by AMI Adapter with the PARTIAL/FAILED result.
	Error.code	String	2.6	
	Error.level	String	WARNING	
	Error.reason	String	InvalidReadingType	
	Error.details	String	Invalid reading type code: {0} for given message verb for following meter(s): {1}.	
Invalid Reading Value	Result	String	PARTIAL/FAILED	The AMI HES or MDMS sends the <i>CreatedMeterReadingsEvents</i> message with some invalid reading values. MeterReadings with valid reading values are processed, while for invalid ones, an appropriate error is returned. The response message is sent by AMI Adapter with the PARTIAL/FAILED result.
	Error.code	String	2.7	
	Error.level	String	INFORM	
	Error.reason	String	InvalidReadingValue	
	Error.details	String	Invalid reading value(s): {0} for meter(s): {1}.	
	Result	String	PARTIAL/FAILED	

Use Case	Message Mapping			Action
	Property	Type	Value	
Multiple Reading Types for Same Code	Error.code	String	6.1	The AMI HES or MDMS sends the <i>CreatedMeterReadingsEvents</i> message with multiple reading types for the same code. MeterReadings with valid data are processed, while for the invalid ones, an appropriate error is returned. The response message is sent by AMI Adapter with the PARTIAL/FAILED result.
	Error.level	String	FATAL	
	Error.reason	String	MultipleReadingTypesForSameCode	
	Error.details	String	Multiple reading types occurred for same reading type code for following meter(s)/UsagePoint(s): {0}.	
ReportedDateTime is older than last update time	Result	String	PARTIAL/FAILED	The AMI HES or MDMS sends the <i>CreatedMeterReadingsEvents</i> message where some of the solicited/unsolicited meter readings have reported datetime older than last update time. MeterReadings with valid reported datetime are processed, while for invalid ones, an appropriate error is returned. The response message is sent by AMI Adapter with the PARTIAL/FAILED result.
	Error.code	String	6.1	
	Error.level	String	FATAL	
	Error.reason	String	ReadingReportedDateTimeOlderThanLastUpdateTime	
	Error.details	String	ReportedDateTime is older than last update time for meter(s)/UsagePoint(s): {0}.	

The list of use cases and corresponding faults for On Demand Reads asynchronous responses are given in Table 6.3.

Table 6.3 – On Demand Reads-Asynchronous Response Use Cases

Use Case	Message Mapping			Action
	Property	Type	Value	
On Demand Meter Readings - Status Is Successfully Updated	Result	String	OK	The AMI HES or MDMS sends the <i>CreatedMeterReadingsEvents</i> message. The status of an appropriate smart meter request is updated. The response message is sent by AMI Adapter with the OK result. Note: when timeStamp is omitted from the request message, reportedDateTime will be used to identify the moment when the reading was captured. If both timeStamp and reportedDateTime are omitted from the request message, meter reading time will be defaulted to the moment when the request was processed.
	Error.code	String	N/A	
	Error.level	String	N/A	
	Error.reason	String	N/A	
	Error.details	String	N/A	

Use Case	Message Mapping			Action
	Property	Type	Value	
On Demand Meter Readings – Voltage, Current, Active and Reactive Power are Successfully Updated	Result	String	OK	<p>The AMI HES or MDMS sends the <i>CreatedMeterReadingsEvents</i> message. The response message is sent by AMI Adapter with the OK result and appropriate CorrelationID. In the Smart Meter Browser Voltage, Current, Active and Reactive Power are shown for appropriate phases (L1, L2, L3 (A,B,C)).</p> <p>Note: when timeStamp is omitted from the request message, reportedDateTime will be used to identify the moment when the reading was captured.</p> <p>If both timeStamp and reportedDateTime are omitted from the request message, meter reading time will be defaulted to the moment when the request was processed.</p>
	Error.code	String	N/A	
	Error.level	String	N/A	
	Error.reason	String	N/A	
	Error.details	String	N/A	
On Demand Meter Readings - Time Out Expired	Result	String	N/A	<p>The AMI HES or MDMS does not send the <i>CreatedMeterReadingsEvents</i> message within the preconfigured time interval. After N (configurable number) retries, the status of an appropriate smart meter request is set to the Failed.</p>
	Error.code	String	N/A	
	Error.level	String	N/A	
	Error.reason	String	N/A	
	Error.details	String	N/A	
On Demand Meter Readings – External System sends notification that the meter timed out	Result	String	OK	<p>The AMI HES or MDMS sends the <i>CreatedMeterReadingsEvents</i> message with Reason field populated, where detailed information why particular On Demand Read failed is specified. Status of an appropriate smart meter request is set to the Failed/Timeout by AMI Adapter. The response message is sent by AMI Adapter with the OK result.</p>
	Error.code	String	N/A	
	Error.level	String	N/A	
	Error.reason	String	N/A	
	Error.details	String	N/A	
On Demand Meter Readings - More than one meter reading present in response message	Result	String	FAILED	<p>The AMI HES or MDMS sends the <i>CreatedMeterReadingsEvents</i> message as an asynchronous response for the <i>GetMeterReadings</i> with more than one meter reading element. Since the request-response correlation is 1-1, the response message is sent by AMI Adapter with the FAILED result and the message is discarded.</p>
	Error.code	String	6.1	
	Error.level	String	FATAL	
	Error.reason	String	MeterReadingsOverload	
	Error.details	String	Message has more meter readings than allowed for current operation.	

Use Case	Message Mapping			Action
	Property	Type	Value	
On Demand Meter Readings - Invalid Correlation ID	Result	String	FAILED	The AMI HES or MDMS sends the <i>CreatedMeterReadingsEvents</i> message as an asynchronous response for <i>GetMeterReadings</i> with wrong CorrelationID. After N (configurable number) retries, the status of the appropriate smart meter request is set to Failed by AMI Adapter.
	Error.code	String	2.8	
	Error.level	String	FATAL	
	Error.reason	String	InvalidCorrelationID	
	Error.details	String	There are no active smart meter requests that correspond to provided CorrelationID: {0}.	
On Demand Meter Readings - Meter/UsagePoint Correlation ID mismatch	Result	String	FAILED	The AMI HES or MDMS sends the <i>CreatedMeterReadingsEvents</i> message as an asynchronous <i>GetMeterReadings</i> response where the correlationId is valid, but the Meter/UsagePoint ID is invalid for sent request. The response message is sent by AMI Adapter with the FAILED result. After N (configurable number) retries, the status of an appropriate smart meter request is set to Failed.
	Error.code	String	2.4	
	Error.level	String	WARNING	
	Error.reason	String	Meter/UsagePointCorrelationIdMismatch	
	Error.details	String	Meter/UsagePoint {0} is invalid for provided correlation id	
TimeStamp is older than last update time	Result	String	PARTIAL/FAILED	The AMI HES or MDMS sends the <i>CreatedMeterReadingsEvents</i> message where some of the solicited meter readings have timeStamp older than last update time. Meter readings with valid timeStamp are processed, while for invalid ones, an appropriate error is returned. The response message is sent by AMI Adapter with the PARTIAL/FAILED result.
	Error.code	String	6.1	
	Error.level	String	FATAL	
	Error.reason	String	ReadingTimeStampOlderThanLastUpdateTime	
	Error.details	String	Meter reading timeStamp {0} is older than last update time for meter(s)/UsagePoint(s): {0}.	

The list of use cases and corresponding faults for Unsolicited Readings are given in Table 6.4.

Table 6.4 – Unsolicited Readings Use Cases

Use Case	Message Mapping			Action
	Property	Type	Value	
Unsolicited Meter Readings - Unsolicited reading is successfully created	Result	String	OK	<p>The AMI HES or MDMS sends the <i>CreatedMeterReadingsEvents</i> message. The response message is sent by AMI Adapter with OK result and the appropriate CorrelationID. The new unsolicited reading (voltage, active power, reactive power) is created successfully.</p> <p>NOTE: Multiplier unit conversion is performed if needed.</p>
	Error.code	String	N/A	
	Error.level	String	N/A	
	Error.reason	String	N/A	
	Error.details	String	N/A	
Invalid Meter(s)/UsagePoints	Result	String	PARTIAL/FAILED	<p>The AMI HES or MDMS sends the <i>CreatedMeterReadingsEvents</i> message with some invalid Meter/UsagePoint (that do not exist in the system). MeterReadings with the valid meter.mRIDs/UsagePoints.mRIDs are processed, while for invalid ones, an appropriate error is returned. The response message is sent by AMI Adapter with the PARTIAL/FAILED result.</p>
	Error.code	String	2.4	
	Error.level	String	WARNING	
	Error.reason	String	InvalidMeter(s)/UsagePoints	
	Error.details	String	Following meter(s)/usage point(s) does/do not exist in ADMS: {0}.	
Receive Meter Readings - Reading reported datetime is older than configurable age validity (default 24 hours)	Result	String	PARTIAL/FAILED	<p>The AMI HES or MDMS sends the <i>CreatedMeterReadingsEvents</i> message where some meter readings have reading timestamp older than configurable age validity comparing to the timestamp when message was received. MeterReadings with the valid data are processed, while for invalid ones, an appropriate error is returned.</p> <p>The response message is sent by AMI Adapter with the PARTIAL/FAILED result.</p>
	Error.code	String	6.1	
	Error.level	String	FATAL	
	Error.reason	String	InvalidReportedDateTime	
	Error.details	String	Reported datetime is older than configurable age validity {1} hours in ADMS for following meter(s)/usagePoint(s): {2}.	

7. RECEIVEENDDEVICEEVENTS SERVICE

7.1. CreatedEndDeviceEvents Operation

7.1.1. Overview

Through the *ReceiveEndDeviceEvents* web service, the following smart meter events are processed:

- Power down
- Power up
- Undervoltage
- Overvoltage
- Return to normal

The aforementioned web service is used for outage reporting, outage restoration and voltage notifications. The *CreatedEndDeviceEvents* operation differs from the ping requests and voltage poll because the message is inbound rather than initiated as a request from the EcoStruxure GridOps.

The AMI HES (or MDMS) collects the events from AMI meters, creates a package consisting of the collected data and sends it periodically, on a configurable time period, to an appropriate service hosted on the EcoStruxure GridOps side. The data is sent in form of the *CreatedEndDeviceEvents* message. Once the appropriate web service operation is invoked, the AMI Adapter performs initial validation of the received data, transforms it into the appropriate internal format and applies it to the DMZ system. All changes introduced to the DMZ are asynchronously replicated to the CORE system.

If the event type is power down, a new smart meter event with power down semantics is created for the appropriate meter. If the event type is power up, a new smart meter event with power restored semantics is created for the appropriate meter. Once the operation is finished, an appropriate response is returned in form of the *EndDeviceEventsResponse* message. If some error occurs, the *EndDeviceEventsFault* message is returned. All smart meter events are displayed within the **Smart Meter Event Browser** window of the DMD application.

When the SCADA incident is created (circuit breaker lockout), smart meters will generate power down events, since they lost the power, but those events don't have any benefit for the operator and they present load for the system. For that reason, whenever the software creates SCADA incidents, power down events for affected smart meters will be ignored (out-of-the-box behavior). Such events will not be processed, since they will be filtered out on the AMI adapter level. Also, if the customer is already affected by the confirmed outage, smart meter event will not be created for that customer. However, due to advanced configurability of AMI Adapter, such behavior can be altered so that smart meter events are created regardless of the incident confirmation (confirmed, unconfirmed) and creation type (SCADA, non-SCADA).

The visual representation for the described sequence of events is presented in Figure 7.1.

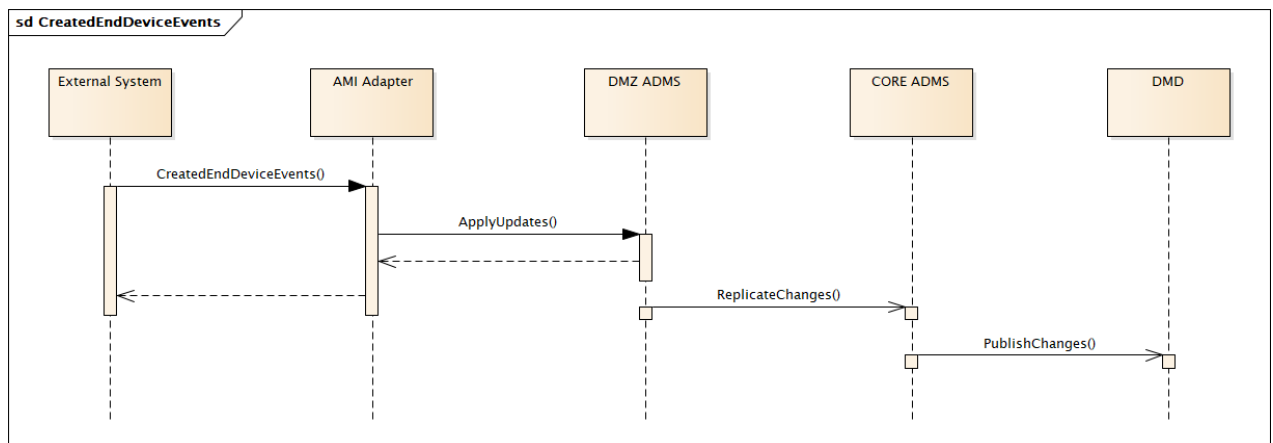


Figure 7.1 – The `CreatedEndDeviceEvents` operation execution

7.1.2. Use Cases

The list of possible use cases and corresponding faults is given in Table 7.1.

Table 7.1 – The CreatedEndDeviceEvents use cases

Use Case	Message Mapping			Action
	Property	Type	Value	
Supported common use cases are described in Table 6.2 – Common CreatedMeterReadings Use Case				
UsagePoint Under Disabled Incident Subtype	Result	String	OK	The AMI HES or MDMS sends the <i>CreatedEndDeviceEvents</i> message where some of the UsagePoints are already under outage which has certain subtype specified within AMI Adapter configuration file. The smart meter events are not created for meters that are affected by outages with preconfigured subtypes. The response message is sent by AMI Adapter with the OK result. NOTE: Based on the appropriate AMI Adapter configuration attribute, filtration of smart meter events can be fine grained in terms of incident subtype (by default end device events for meters affected by momentary incidents are being discarded).
	Error.code	String	6.1	
	Error.level	String	INFORM	
	Error.reason	String	UsagePointUnderDisabledIncidentSubtype	
	Error.details	String	Usage point(s): {0} is/are affected by incident with subtype for which creation of smart meter event is disabled.	
Affected Usage Points Threshold Exceeded	Result	String	FAILED	The AMI HES or MDMS sends the end device event message when most of the system is in some significant power outage. In those situations, number of affected usage points is usually greater than preconfigured value (by default 0). AMI adapter will not create smart meter events since they do not bring any value to the operators, in order to lower down the system load. The response message is sent by AMI Adapter with the FAILED result and the message is not processed.
	Error.code	String	6.1	
	Error.level	String	INFORM	
	Error.reason	String	AffectedUsagePointsAboveThreshold	
	Error.details	String	Number of affected usage points is above threshold: {0}. Smart meter event(s) was/were not created.	
Power Down Event Handling – Meter/UsagePoint Is Already Under Confirmed Outage	Result	String	PARTIAL/FAILED	The AMI HES or MDMS sends the <i>CreatedEndDeviceEvents</i> message where some of the Meters/UsagePoints are already under confirmed outage. The smart meter events are not created for meters that are affected by confirmed outage, while for the ones not affected, the smart meter event is created. The response message is sent by AMI Adapter with the PARTIAL/FAILED result.
	Error.code	String	6.1	
	Error.level	String	INFORM	
	Error.reason	String	Meter/UsagePointUnderOutage	

Use Case	Message Mapping			Action
	Property	Type	Value	
	Error.details	String	Meter(s)/UsagePoint(s): {0} is/are already affected by an {1} outage. Smart meter event(s) was/were not created.	NOTE: Based on the appropriate AMI Adapter configuration attribute, filtration of smart meter events can be fine grained in terms of incident creation type (All, Scada, Non-Scada, None).
Power Down Event Handling - Meter/UsagePoint Is Not Under Confirmed Outage	Result	String	OK	The AMI HES or MDMS sends the <i>CreatedEndDeviceEvents</i> message for the meter which is not under outage. The smart meter event is created. The response message is sent by AMI Adapter with the OK result.
	Error.code	String	N/A	
	Error.level	String	N/A	
	Error.reason	String	N/A	
	Error.details	String	N/A	
Power Up Event Handling – Meter/UsagePoint Is Already Under Outage	Result	String	OK	The AMI HES or MDMS sends the <i>CreatedEndDeviceEvents</i> message. In the EcoStruxure GridOps, Smart Meter Event is restored. The response message is sent by AMI Adapter with the OK result.
	Error.code	String	N/A	
	Error.level	String	N/A	
	Error.reason	String	N/A	
	Error.details	String	N/A	
Power Up Event Handling - Meter/UsagePoint Is Not Under Outage	Result	String	OK	The AMI HES or MDMS sends the <i>CreatedEndDeviceEvents</i> message. In the EcoStruxure GridOps, a new smart meter event is created. The response message is sent by AMI Adapter with the OK result.
	Error.code	String	N/A	
	Error.level	String	N/A	
	Error.reason	String	N/A	
	Error.details	String	N/A	
Voltage Event Handling - Undervoltage, Overvoltage, ReturnToNormal event creation	Result	String	OK	The AMI HES or MDMS sends the <i>CreatedEndDeviceEvents</i> message. In the EcoStruxure GridOps, a new smart meter event is created. The response message is sent by AMI Adapter with the OK result.
	Error.code	String	N/A	
	Error.level	String	N/A	
	Error.reason	String	N/A	
	Error.details	String	N/A	

Use Case	Message Mapping			Action
	Property	Type	Value	
Invalid UsagePoint(s)	Result	String	OK	<p>The AMI HES or MDMS sends the <i>CreatedEndDeviceEvents</i> message with some invalid usage points (that do not exist in the software). The <i>EndDeviceEvents</i> with the valid usage points are processed, while for the invalid ones, unlocated smart meter event is created, and an appropriate warning is returned. The response message is sent by AMI Adapter with the OK result.</p> <p>Note: This error is reported for usage point addressing mode. Also, this error will be reported for meter addressing mode if usage point is sent in message and it is invalid. Meter id won't be taken into account beside it valid or not.</p>
	Error.code	String	2.4	
	Error.level	String	WARNING	
	Error.reason	String	UnlocatedEndDeviceEvent	
	Error.details	String	Non-existing UsagePoint(s) mRID is/are sent {0}. Unlocated Smart Meter Event is created.	
Invalid Meter(s)	Result	String	PARTIAL/FAILED	<p>In adapter registry configuration file addressing mode is set to Meter. The AMI HES or MDMS sends the <i>CreatedEndDeviceEvents</i> message with some invalid meters (that do not exist in the software). Message does not contain usage point object. The <i>EndDeviceEvents</i> with the valid meterIDs are processed, while for the invalid ones, an appropriate error is returned. The response message is sent by AMI Adapter with the PARTIAL/FAILED result.</p>
	Error.code	String	2.4	
	Error.level	String	WARNING	
	Error.reason	String	InvalidMeter(s)	
	Error.details	String	Following meter(s) does/do not exist in ADMS: {0}.	
Invalid Transformer(s)	Result	String	PARTIAL/FAILED	<p>The AMI HES or MDMS sends the <i>CreatedEndDeviceEvents</i> message with some invalid transformers (that do not exist in the software). The <i>EndDeviceEvents</i> with the valid transformer IDs are processed, while for the invalid ones, an appropriate error is returned. The response message is sent by AMI Adapter with the PARTIAL/FAILED result.</p>
	Error.code	String	2.4	
	Error.level	String	WARNING	
	Error.reason	String	InvalidTransformer	
	Error.details	String	Following transformer(s) does/do not exist in ADMS: {0}.	
No PowerOn Signal	Result	String	PARTIAL/FAILED	<p>The AMI HES or MDMS sends the <i>CreatedEndDeviceEvents</i> message with Transformer Level Event semantics for a transformer that does not have a PowerOn signal assigned to it. The <i>EndDeviceEvents</i> with the valid transformers are processed, while for the invalid ones, an appropriate error is</p>
	Error.code	String	2.4	
	Error.level	String	WARNING	
	Error.reason	String	NoPowerOnSignal	

Use Case	Message Mapping			Action
	Property	Type	Value	
	Error.details	String	Following transformer(s) does/do not have PowerOn signals assigned to them: {0}.	returned. The response message is sent by AMI Adapter with the PARTIAL/FAILED result.
Invalid Reading Type	Result	String	PARTIAL/FAILED	The AMI HES or MDMS sends the <i>CreatedEndDeviceEvents</i> message with some invalid reading type codes. Reading type codes must correspond to the message verb. The <i>EndDeviceEvents</i> with the valid reading type codes are processed, while for the invalid ones, an appropriate error is returned. The response message is sent by AMI Adapter with the PARTIAL/FAILED result.
	Error.code	String	2.6	
	Error.level	String	WARNING	
	Error.reason	String	InvalidReadingType	
	Error.details	String	Invalid reading type code(s): {0} for given message verb for following meter(s)/usage point(s): {1}.	
Invalid Reading Value	Result	String	PARTIAL/FAILED	The AMI HES or MDMS sends the <i>CreatedEndDeviceEvents</i> message with some invalid reading values (not correlated with the appropriate reading type code). The <i>EndDeviceEvents</i> with valid reading values are processed, while for the invalid ones, an appropriate error is returned. The response message is sent by AMI Adapter with the PARTIAL/FAILED result.
	Error.code	String	2.7	
	Error.level	String	INFORM	
	Error.reason	String	InvalidStatusValue(s)	
	Error.details	String	Invalid status value(s): {0} for meter(s)/usagePoint(s): {1}.	
Transformer Level Event Stale Value	Result	String	PARTIAL/FAILED	The AMI HES or MDMS sends the <i>CreatedEndDeviceEvents</i> message with some reading values that are the same as current status values of the signals on the corresponding transformers. The <i>EndDeviceEvents</i> with valid reading values are processed, while for the stale ones, an appropriate error is returned. The response message is sent by AMI Adapter with the PARTIAL/FAILED result.
	Error.code	String	2.7	
	Error.level	String	INFORM	
	Error.reason	String	EndDeviceEventStaleValue	
	Error.details	String	Stale status value(s): {0} for following transformer(s): {1}.	
Transformer Level Event Outdated	Result	String	PARTIAL/FAILED	The AMI HES or MDMS sends the <i>CreatedEndDeviceEvents</i> message with some reading values that are the same or older age than last update timestamps of the signals on the corresponding transformers. The <i>EndDeviceEvents</i> with valid reading values are processed, while for the stale
	Error.code	String	6.1	
	Error.level	String	FATAL	
	Error.reason	String	StatusTimeStampOlderThanLastUpdateTime	

Use Case	Message Mapping			Action
	Property	Type	Value	
	Error.details	String	Transformer Level Event timeStamp: {0} is older than last update time for transformer(s): {1}.	ones, an appropriate error is returned. The response message is sent by AMI Adapter with the PARTIAL/FAILED result.
Status DateTime is not provided	Result	String	PARTIAL/FAILED	The AMI HES or MDMS sends the <i>CreatedEndDeviceEvents</i> message where some meter events do not have provided status datetime. The <i>EndDeviceEvents</i> with the valid data are processed, while for the invalid ones, an appropriate error is returned. The response message is sent by AMI Adapter with the PARTIAL/FAILED result.
	Error.code	String	1.2	
	Error.level	String	FATAL	
	Error.reason	String	StatusDateTimeMissing	
	Error.details	String	Status datetime element not found in message.	
Status DateTime greater than current date time	Result	String	PARTIAL/FAILED	The AMI HES or MDMS sends the <i>CreatedEndDeviceEvents</i> message where some meter events have the status datetime greater than current datetime. The <i>EndDeviceEvents</i> with the valid data are processed, while for the invalid ones, an appropriate error is returned. The response message is sent by AMI Adapter with the PARTIAL/FAILED result.
	Error.code	String	6.1	
	Error.level	String	FATAL	
	Error.reason	String	InvalidEndDeviceEventStatusDateTime	
	Error.details	String	Status date time: {0} is greater than current date time for meter(s)/usagePoint(s): {1}.	
Status DateTime greater than CreatedDateTime	Result	String	PARTIAL/FAILED	The AMI HES or MDMS sends the <i>CreatedEndDeviceEvents</i> message where some meter events have the status datetime greater than CreatedDateTime. The <i>EndDeviceEvents</i> with the valid data are processed, while for the invalid ones, an appropriate error is returned. The response message is sent by AMI Adapter with the PARTIAL/FAILED result.
	Error.code	String	6.1	
	Error.level	String	FATAL	
	Error.reason	String	InvalidEndDeviceEventStatusDateTime	
	Error.details	String	Status datetime {0} is greater than created datetime for meter(s)/usagePoint(s): {1}.	
Status DateTime older than configurable age validity (default 24 hours)	Result	String	PARTIAL/FAILED	The AMI HES or MDMS sends the <i>CreatedEndDeviceEvents</i> message where some meter events have the status datetime older than configurable age validity. The <i>EndDeviceEvents</i> with the valid data are processed, while for the invalid ones, an appropriate error is returned. The response message is sent by AMI Adapter with the PARTIAL/FAILED result.
	Error.code	String	6.1	
	Error.level	String	FATAL	
	Error.reason	String	InvalidEndDeviceEventStatusDateTime	

Use Case	Message Mapping			Action
	Property	Type	Value	
	Error.details	String	Status date time: {0} is older than configurable age in ADMS for following meter(s)/usagePoint(s): {2}.	
CreatedDateTime is greater than current date time	Result	String	PARTIAL/FAILED	The AMI HES or MDMS sends the <i>CreatedEndDeviceEvents</i> message where some meter events have the created date time greater than current date time. The <i>EndDeviceEvents</i> with the valid data are processed, while for the invalid ones, an appropriate error is returned. The response message is sent by AMI Adapter with the PARTIAL/FAILED result.
	Error.code	String	6.1	
	Error.level	String	FATAL	
	Error.reason	String	InvalidCreatedDateTime	
	Error.details	String	CreatedDateTime: {0} is greater than current date time for following meter(s)/usagePoint(s): {1}.	

8. SENDCONFIGURATIONEVENTS SERVICE

8.1. CreatedConfigurationEvents Operation

8.1.1. Overview

The *SendConfigurationEvents* service is used in case of a storm, when there is a need to prevent the large influx of the *EndDeviceEvents* (power up and power down) into the EcoStruxure GridOps, since they provide no incremental value to the system. In the event of the storm operators have the possibility to change the configuration from the DMD and disable sending of the *EndDeviceEvents* from the AMI HES (or MDMS) to EcoStruxure GridOps.

When the operator changes proper configuration, a new configuration event is created within the software. The AMI Adapter is subscribed to mentioned changes and it receives a publication each time when appropriate configuration change is made (reception of the power up and power down events is enabled/disabled). After receiving the publication, the AMI Adapter converts it into proper intermediate format and sends the *CreatedConfigurationEvents* event message to the AMI HES (or MDMS) via web service call. The appropriate web service is hosted on the client's side.

Once the event message is received, the AMI HES (or MDMS) needs to prevent sending of the *EndDeviceEvents* to EcoStruxure GridOps, until an appropriate message that enables sending of the mentioned events is received. After the message is processed, it is up to the receiving system to return properly populated the *CreatedConfigurationEventsResponse* message. If some error occurs during the message processing, an appropriate error message is returned (the *ConfigurationEventsFault* message).

The sequence of events in case of a configuration change is depicted in Figure 8.1.

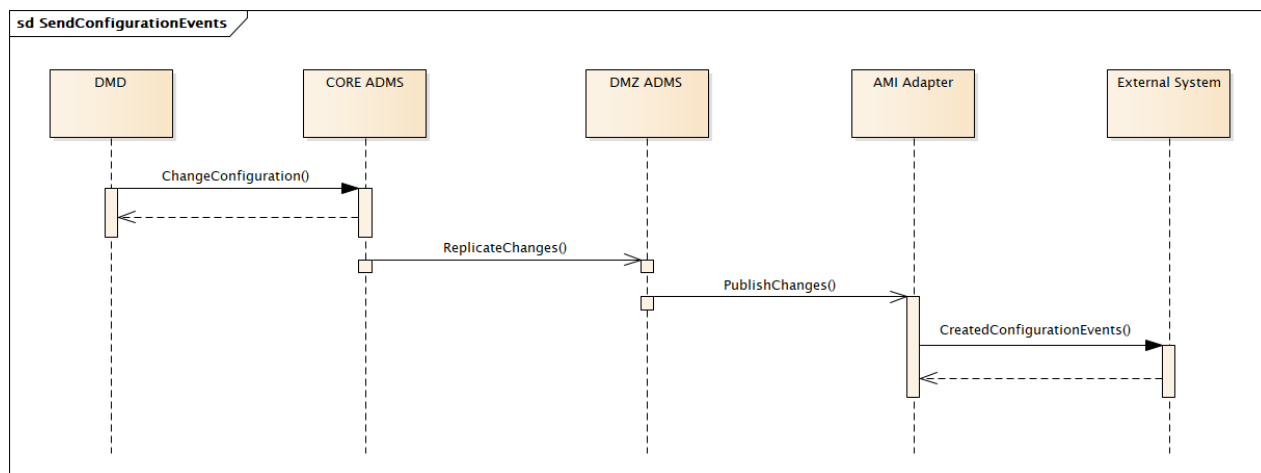


Figure 8.1 – The *CreatedConfigurationEvents* sequence diagram

8.1.2. Use Cases

The list of possible use cases and corresponding faults is given in Table 8.1.

Table 8.1 – The CreatedConfigurationEvents use cases

Use Case	Message Mapping			Action
	Property	Type	Value	
Send Configuration Events - Successful Scenario	Result	String	OK	The <i>CreatedConfigurationEvents</i> message is sent from the EcoStruxure GridOps via AMI Adapter. The synchronous acknowledgement message is received from the external system by AMI Adapter with reply result OK and the appropriate CorrelationID.
	Error.code	String	N/A	
	Error.level	String	N/A	
	Error.reason	String	N/A	
	Error.details	String	N/A	
Send Configuration Events - AMI HES (or MDMS) is not available	Result	String	N/A	The AMI Adapter tries to send the <i>CreatedConfigurationEvents</i> message from the EcoStruxure GridOps to AMI HES or MDMS. After N retries, the adapter logs an exception. The event is written in the event database.
	Error.code	String	N/A	
	Error.level	String	N/A	
	Error.reason	String	N/A	
	Error.details	String	N/A	

9. MESSAGES

9.1. Common

9.1.1. Header

The header section is defined according to the IEC 61968-100. Currently, there are two required fields that must be populated:

- **Verb** – to identify a specific action to be taken. There is an enumerated set of valid verbs, where commonly used values include “get”, “create”, “change”, “cancel”, “close”, “execute” and “reply”. Within event notification messages “past tense” verbs are used, which can include “created”, “changed”, “canceled”, “closed” and “executed”. Implementations should treat deprecated verbs “update” and “updated” as synonyms to “change” and “changed”.
- **Noun** – to identify the subject of the action and/or the type of the payload, such as the EndDeviceEvents, MeterReadings, etc.

Fields that can be optionally supplied include the following:

- **Revision** – to indicate the revision of the message definition. By default, this needs to be “1”.
- **ReplayDetection** – this is a complex element with a timestamp and a nonce used to guard against replay attacks. The timestamp is generated by the source system to indicate when the message was created. The nonce is a sequence number or randomly generated string (e.g., UUID) that would not be repeated by the source system for at least a day. This serves to improve encryption.
- **Context** – a string that can be used to identify the context of the message. This can help provide an application level guard against incorrect message consumption in configurations where there may be multiple system environments running over the same messaging infrastructure. Some example values are the PRODUCTION, TESTING, STUDY and TRAINING.
- **Timestamp** – an ISO 8601 compliant string that identifies the time the message was sent. This is analogous to the JMSTimestamp provided by JMS. Either Zulu (‘Z’) time or time with a time zone offset may be used.
- **Source** – identifying the source of the message, which should be the name of the system or organization.
- **AsyncReplyFlag** – the Boolean data type (“true” or “false” values) that indicates whether a reply message will be sent asynchronously. By default, replies are assumed to be sent synchronously.
- **ReplyAddress** – the address to which replies should be sent. This is typically used for asynchronous replies. This should take the form of a URL, topic name or queue name. This is analogous to the JMSReplyTo field provided by JMS. This is ignored when using unidirectional integration patterns (e.g., AckRequired=false). If the reply address is a topic, the topic name should be prefixed by “topic”. If the reply address is a queue, the queue name should be prefixed by “queue”. If the reply address is a web service, the reply address should be a URL beginning with “http://” or “https://”.
- **AckRequired** – the Boolean data type (“true” or “false” values) that indicates whether an acknowledgement is required. If it is false, this would indicate that a unidirectional integration pattern is being used for communicating transactional messages.

- **User** – a complex structure that identifies the user and associated organization. Should be supplied as it may be required for some interfaces, depending upon underlying implementations. This allows the UserID string and optional the Organization string as sub-elements.
- **MessageID** – a string that uniquely identifies a message. Use of the UUID or sequence number is recommended. This is analogous to the JMSMessageID provided by JMS. A process should not issue two messages using the same MessageID value.
- **CorrelationID** – this is used to “link” messages together. This can be supplied on a request, so that the client can correlate a corresponding reply message. The server will place the incoming CorrelationID value as the CorrelationID on the outgoing reply. If not supplied on the request, the CorrelationID of the reply should be set to the value of the MessageID that was used on the request, if present. This is analogous to the use of the JMSCorrelationID provided by JMS. Given that the CorrelationID is used to ‘link’ messages together, it may be reused on more than one message. Use of a UUID or sequence number is recommended.
- **Comment** – any descriptive text, but shall never be used for any processing logic.
- **Property** – a complex type that allows custom name/value pairs to be conveyed. The source and targets would need to agree upon usage. These are analogous to the Property as defined by JMS.
- **Any** – it can be used for custom extensions.

The graphical representation of the header section is shown in Figure 9.1.

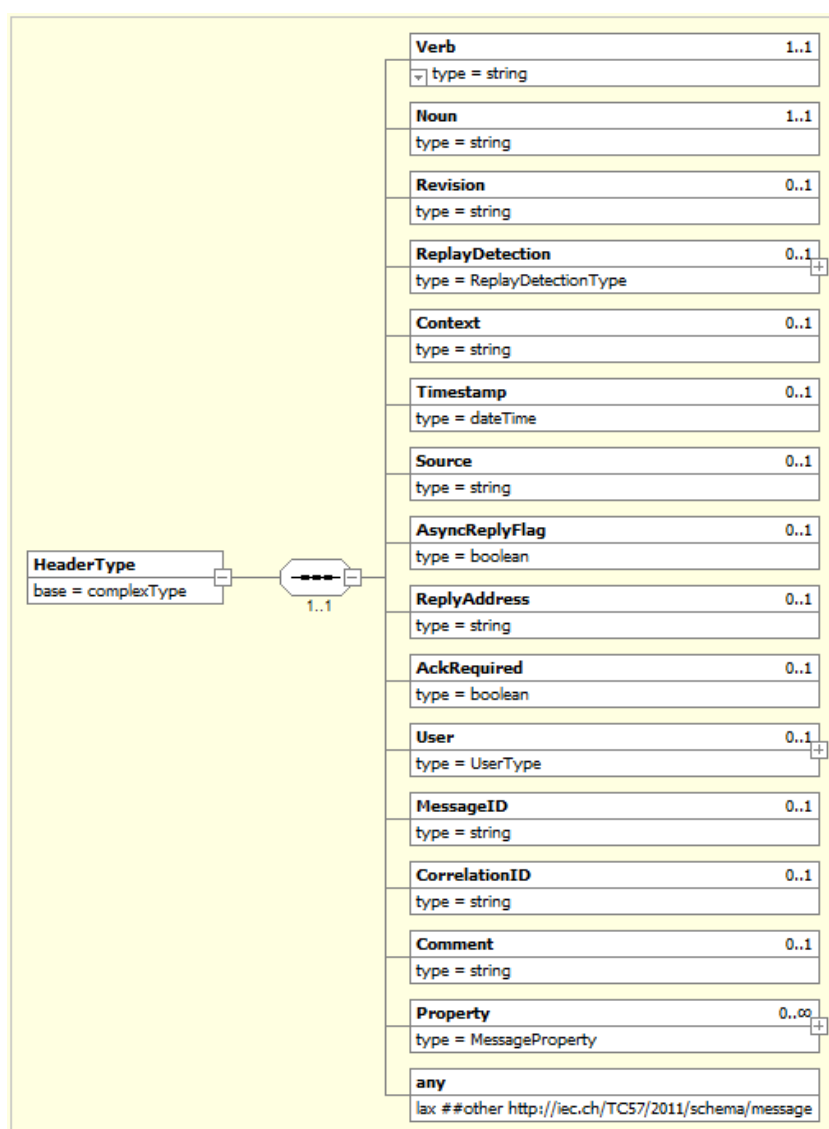


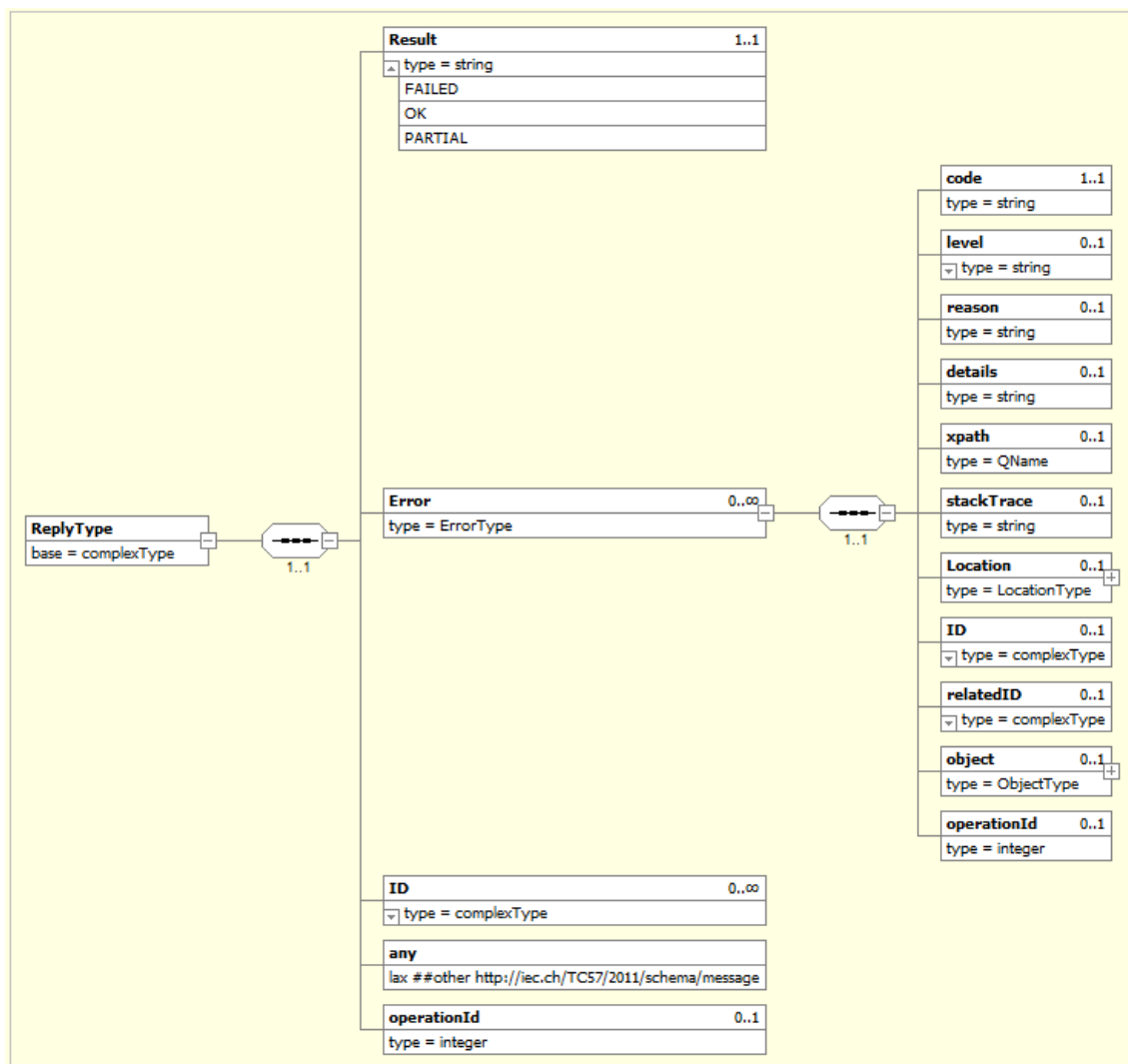
Figure 9.1 – The header section

9.1.2. Reply and Fault

The Reply.result value is an enumeration and would be populated in the following manner:

- "OK" – if there are no errors and all results have been returned. There is no requirement that the Reply.Error element be present.
- "PARTIAL" – if only a partial set of results has been returned, with or without errors. Existence of errors is indicated with one or more the Reply.Error.code elements.
- "FAILED" – if no result can be returned due to one or more errors, indicated with one or more the Reply.Error elements, each with a mandatory application level "code".

If the result type is "PARTIAL" or "FAILED", the **Error** field will be populated with the appropriate error description. The contents of the **Reply** and **Error** fields are presented in Figure 9.2.

Figure 9.2 – The **Reply** and **Error** field contents

9.2. GetMeterReadings Operation Messages

The operation definition:

MeterReadingsResponse GetMeterReadings(*GetMeterReadingsRequest*)

9.2.1. Request

The *GetMeterReadingsRequest* message is defined according to the IEC 61968-100 and contains the following three sections (Figure 9.3):

- Header
- Request
- Payload

The Request section carries the CIM defined payload depicted in Figure 9.4 based on which appropriate meter readings are requested from the AMI HES (or MDMS).

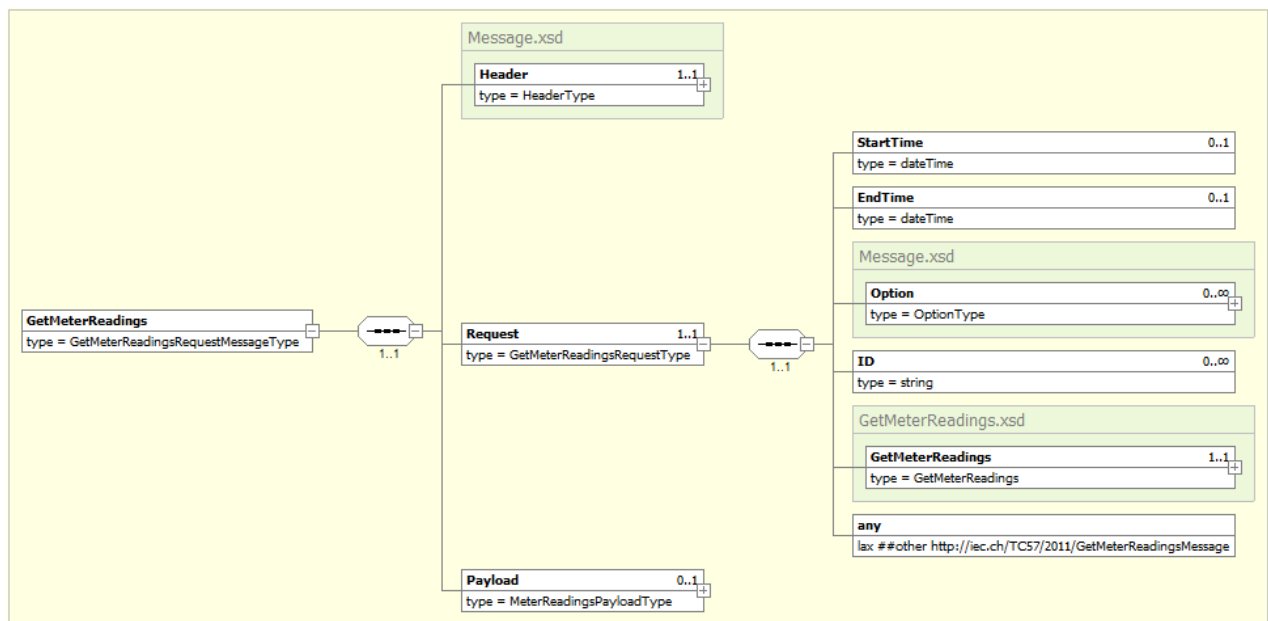


Figure 9.3 – The *GetMeterReadings* request message

The Request section carries the CIM defined payload (*GetMeterReadings.xsd*) according to the IEC 61968-9 edition 2. The visual representation of the schema is given in Figure 9.4.

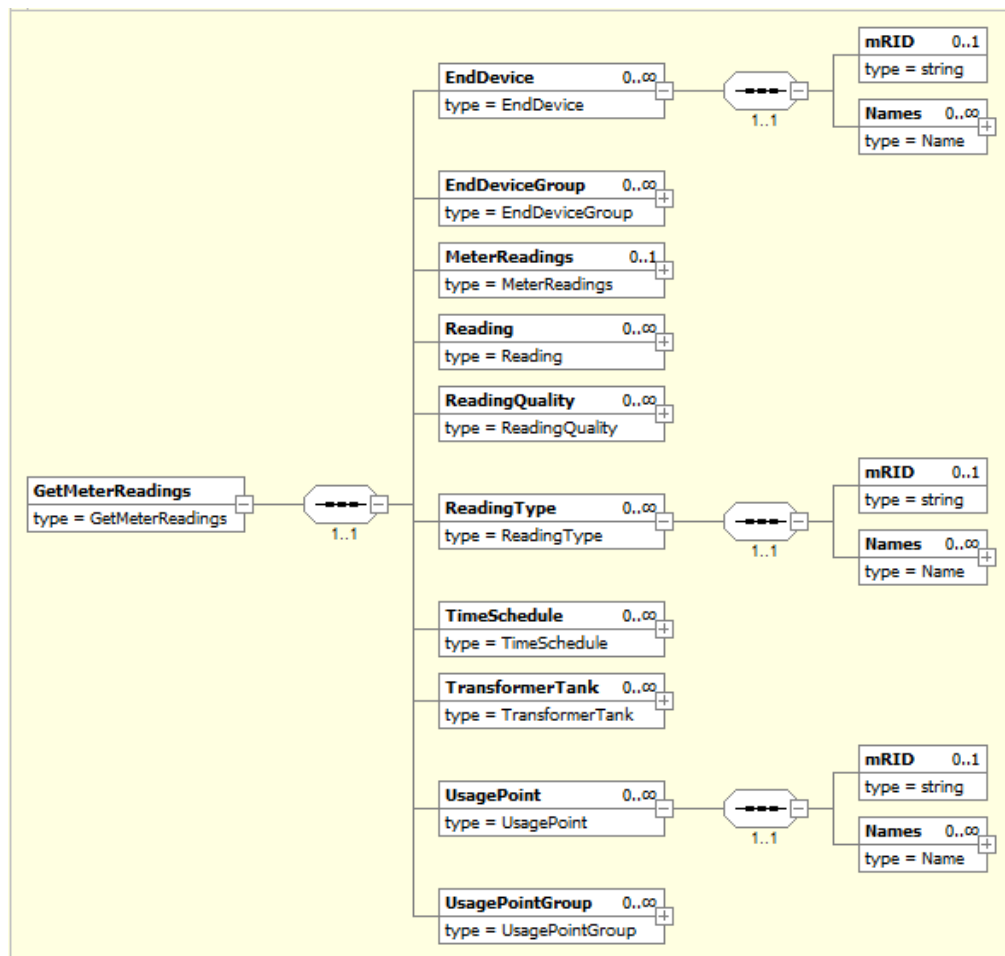
Figure 9.4 – `GetMeterReadings.xsd`

Table 9.1 defines the mapping between the *GetMeterReadings.xsd* and the appropriate entities in the smart meter model.

Table 9.1 – *GetMeterReadingsRequest* – the smart metering model mapping

GetMeterReadings message			Description	Smart meter model		
Section	Property	Type		Property	Type	Model Code
Header	Verb	String	The identifier for a specific action to be taken. For this message, the Verb is get.	Populated by AMI Adapter	N/A	N/A
Header	Noun	String	The identifier for the subject of the action and/or the type of the payload. For this message, the Noun is MeterReadings.	Populated by AMI Adapter	N/A	N/A
Header	Revision	String	Revision of CIM standard used. The default value is 2.0.	Populated by AMI Adapter from configuration file	N/A	N/A
Header	Timestamp	DateTime	Timestamp when message was produced. Example: 2015-12-31T12:34:56+02:00	Populated by AMI Adapter	N/A	N/A
Header	Source	String	Source system or application that sends the message. For this message, Source is the EcoStruxure GridOps.	Populated by AMI Adapter	N/A	N/A
Header	MessageID	String	The unique message ID to be used for tracking messages.	Populated by AMI Adapter	Long	SMMS_ELEMENT_OBJ_GID
Header	CorrelationID	String	The same as message ID.	Populated by AMI Adapter	Long	SMMS_ELEMENT_OBJ_GID
Request	EndDevice.mRID	String	The unique meter identifier.	MeterId	String	SMMS_REQUEST_METER_ID
Request	Reading.timePeriod.end	DateTime	Restoration time of the SDP, based on which request message can be routed either to the AMI HES or MDMS.	SdpRestorationTime	DateTime	OMS_SDP_RESTORATION_TIME
Request	ReadingType.mRID	String	The type of data conveyed by a specific Reading. It is used to identify the meaning of the reading, data type of the value and the meaning of the different time values.	Populated by AMI Adapter	N/A	N/A
Request	UsagePoint.mRID	String	The unique service delivery point identifier.	SdpCustomID	String	SMMS_READING_REQUEST_SDP_CUSTOM_ID_REF

The Reading Type Codes utilized within on demand read use cases are given in Table 9.2.

Table 9.2 – The GetMeterReadings service – the Reading Type Codes

Reading Type Code (ReadingType.mRID)	Description
0.0.0.0.0.1.11.0.0.0.0.0.0.0.0.109.0	electricitySecondaryMetered energization (status)
0.0.0.6.0.1.54.0.0.0.0.0.0.0.0.3.29.0	indicating electricitySecondaryMetered voltage (kV)
0.0.0.6.0.1.4.0.0.0.0.0.0.0.0.0.5.0	indicating electricitySecondaryMetered current (A)
0.0.0.12.20.1.37.0.0.0.0.0.0.0.0.3.38.0	instantaneous total electricitySecondaryMetered active power (kW)
0.0.0.12.20.1.37.0.0.0.0.0.0.0.0.3.63.0	instantaneous total electricitySecondaryMetered reactive power (kVAr)
0.0.0.6.0.1.54.0.0.0.0.0.0.0.0.128.3.29.0	indicating electricitySecondaryMetered voltage phaseA (kV)
0.0.0.6.0.1.54.0.0.0.0.0.0.0.0.64.3.29.0	indicating electricitySecondaryMetered voltage phaseB (kV)
0.0.0.6.0.1.54.0.0.0.0.0.0.0.0.32.3.29.0	indicating electricitySecondaryMetered voltage phaseC (kV)
0.0.0.6.0.1.4.0.0.0.0.0.0.0.0.128.0.5.0	indicating electricitySecondaryMetered current phaseA (A)
0.0.0.6.0.1.4.0.0.0.0.0.0.0.0.64.0.5.0	indicating electricitySecondaryMetered current phaseB (A)
0.0.0.6.0.1.4.0.0.0.0.0.0.0.0.32.0.5.0	indicating electricitySecondaryMetered current phaseC (A)

9.2.2. Response

The *MeterReadingsResponse* message is defined according to the IEC 61968-100 and contains the following three sections:

- Header
- Reply
- Payload

The content of the response message is given in Figure 9.5.

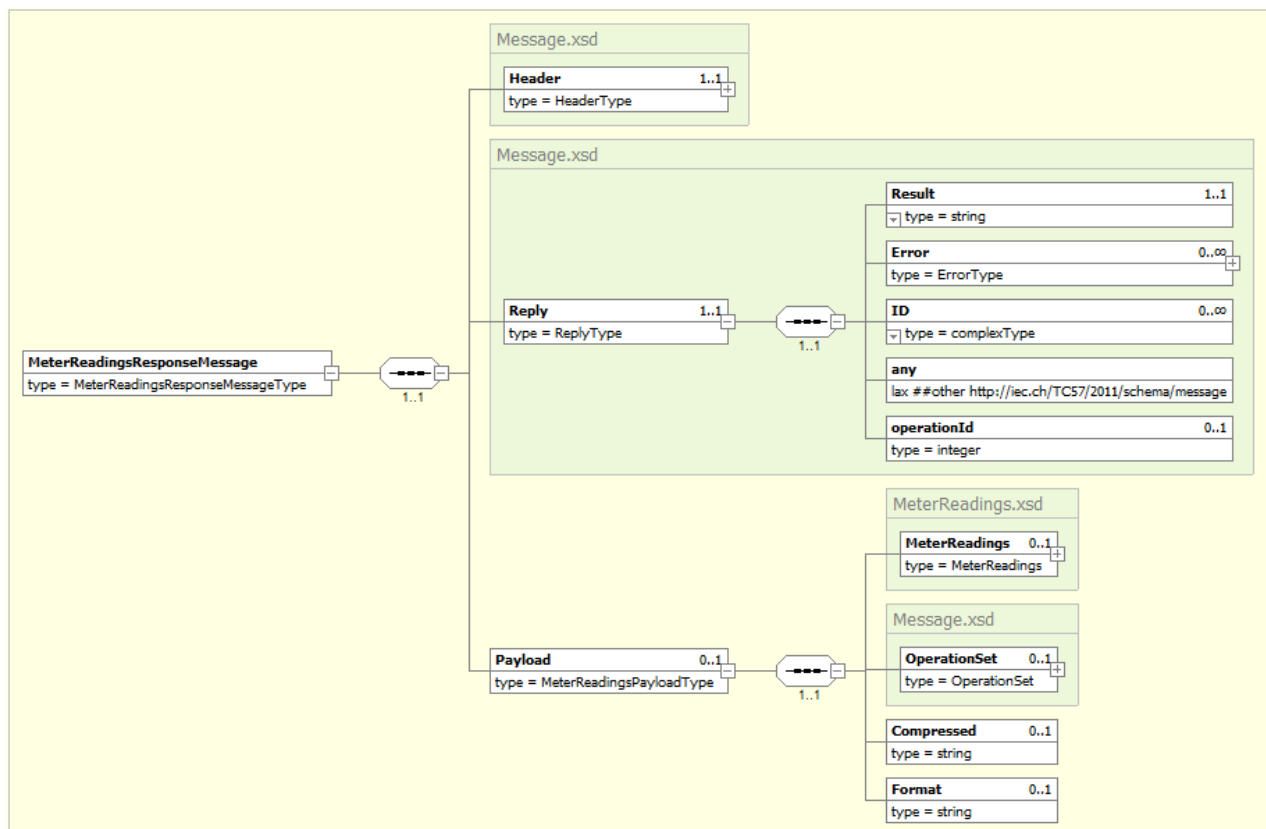


Figure 9.5 – The *MeterReadingsResponse* message

The Payload section carries the CIM defined payload (*MeterReadings.xsd*) according to the IEC 61968-9 edition 2. The visual representation of the aforementioned schema is given in Figure 9.6.

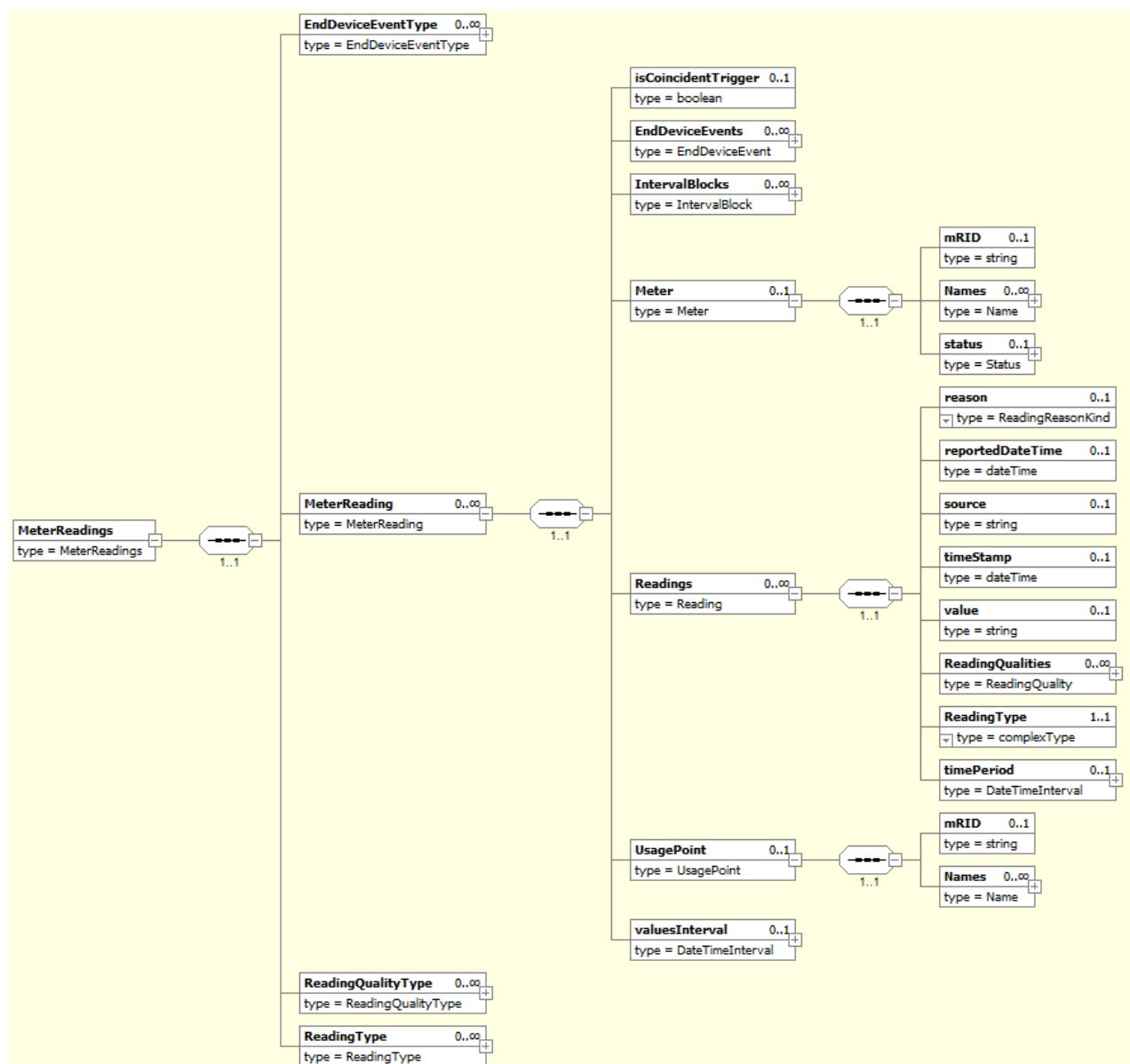


Figure 9.6 – MeterReadings.xsd

Since asynchronous communication is utilized for on demand reads, reply message contains the Header and Reply sections, where the Reply.Result attribute is set to OK if the request is processed successfully on the AMI HES (or MDMS) side. If some error occurs, the Fault message is returned with the FATAL as a result type. Besides that, the appropriate Error field is populated by the AMI HES (or MDMS) with error code, reason and description of the error.

Table 9.3 defines the mapping between the *MeterReadings.xsd* and the appropriate entities in the smart meter model.

Table 9.3 – *MeterReadingsResponse* – the smart metering model mapping

MeterReadingsResponse message			Description	Smart meter model		
Section	Property	Type		Property	Type	Model Code
Header	Verb	String	The identifier for a specific action to be taken. For synchronous meter ping/poll response the Verb is reply.	Populated by AMI HES or MDMS	N/A	N/A
Header	Noun	String	The identifier for the subject of the action and/or the type of the payload. For this message, the Noun is MeterReadings.	Populated by AMI HES or MDMS	N/A	N/A
Header	Revision	String	Revision of CIM standard used. Default value is 2.0.	Populated by AMI HES or MDMS	N/A	N/A
Header	Timestamp	DateTime	The timestamp when the message was produced. Example: 2015-12-31T12:34:56+02:00	Populated by AMI HES or MDMS	N/A	N/A
Header	Source	String	The source system or application that sends the message.	Populated by AMI HES or MDMS	N/A	N/A
Header	MessageID	String	The unique message ID to be used for tracking messages.	Populated by AMI HES or MDMS	Long	SMMS_ELEMENT_OBJ_GID
Header	CorrelationID	String	For synchronous meter ping/poll acknowledgment response the CorrelationID is the same as CorrelationID, generated by the software, received within an appropriate request message.	Populated by AMI HES or MDMS	Long	SMMS_ELEMENT_OBJ_GID
Reply	Result	String	Returned as a part of synchronous acknowledgment response. The valid values are: OK, PARTIAL or FAILED	If FAILED, AMI Adapter sets the status of smart meter request to Failed.	N/A	N/A
Reply	Error.Reason	String	Description of error for meter reading request. Propagated to SMMS service as Failure Description.	Populated by AMI HES or MDMS	String	SMMS_RESPONSE_FAILURE_DESCRIPTION

9.2.3. Fault

The *MeterReadingsFault* message is depicted in Figure 9.7.

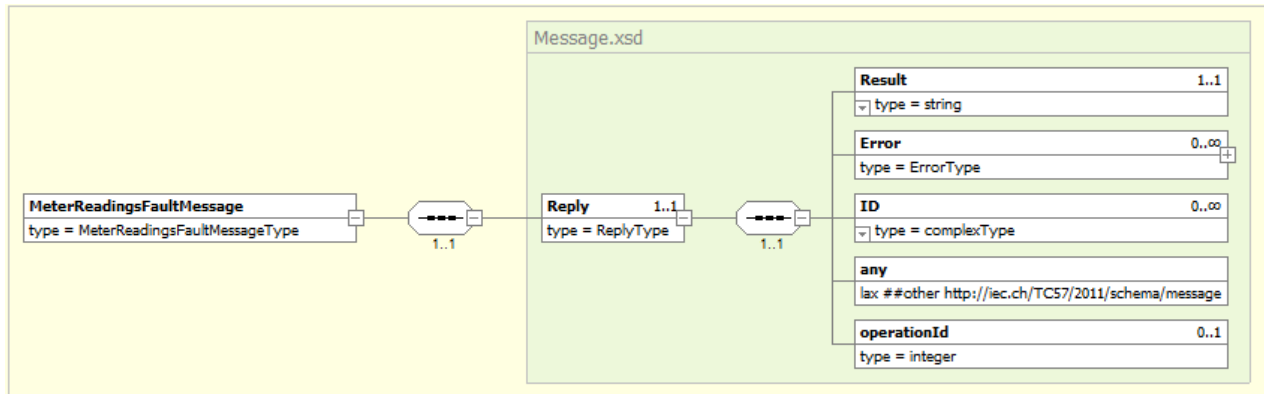


Figure 9.7 – The *MeterReadingsFault* message

9.3. CreatedMeterReadings Operation Messages

The operation definition:

CreatedMeterReadingsResponse *CreatedMeterReadings*(*CreatedMeterReadingsEvent*)

9.3.1. Request

The *CreatedMeterReadingsEvent* message is defined according to the IEC 61968-100 and contains the following two sections:

- Header
- Payload

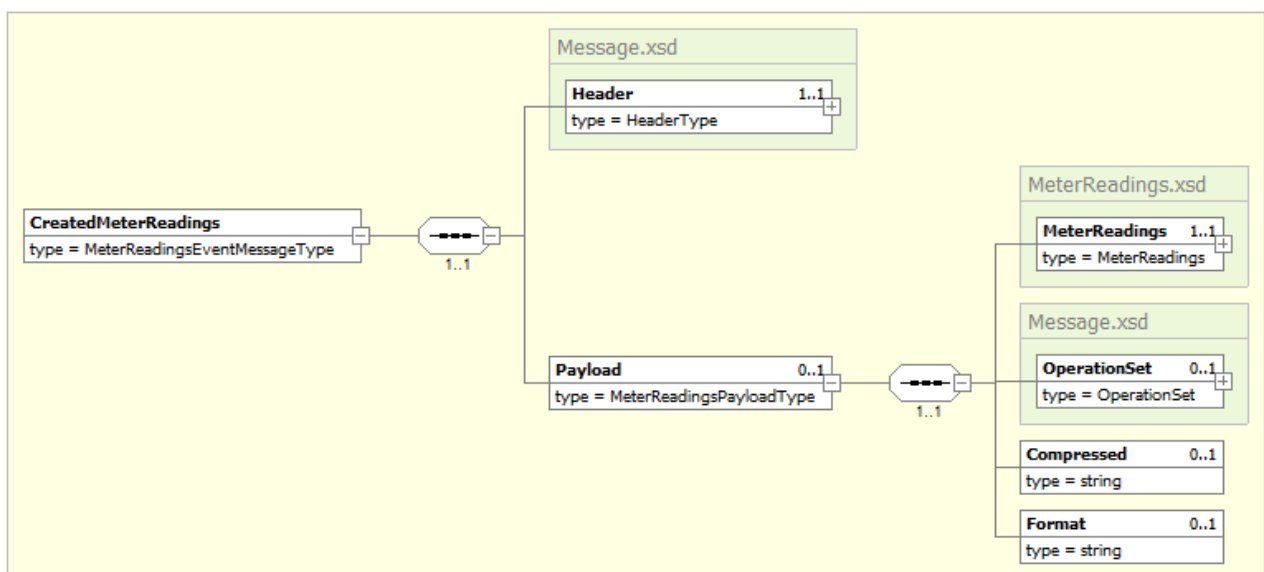


Figure 9.8 – The *CreatedMeterReadingsEvent* message

The Payload section carries the CIM defined payload (*MeterReadings.xsd*) according to the IEC 61968-9 edition 2, based on which status of the appropriate smart meter request (meter ping or meter poll) is updated. Also, the unsolicited meter readings are updated based on that message. The visual representation of the aforementioned schema is given in Figure 9.6.

Table 9.4 defines the mapping between the *MeterReadings.xsd* and the appropriate entities in the smart meter model.

Table 9.4 – CreatedMeterReadingsEvents – the smart metering model mapping

CreatedMeterReadings message			Description	Smart meter model		
Section	Property	Type		Property	Type	Model Code
Header	Verb	String	The identifier for a specific action to be taken. For asynchronous meter ping/poll response the Verb is reply. For the unsolicited meter readings, the Verb is created.	Populated by AMI HES or MDMS	N/A	Determines which action AMI Adapter should execute. Update of smart meter request or creation of unsolicited reading.
Header	Noun	String	The identifier for the subject of the action and/or the type of the payload. For both asynchronous meter ping/poll response and unsolicited meter readings the message Noun is MeterReadings.	Populated by AMI HES or MDMS	N/A	N/A
Header	Revision	String	Revision of CIM standard used. Default value is 2.0.	Populated by AMI HES or MDMS	N/A	N/A
Header	Timestamp	DateTime	The timestamp when the message was produced. Example: 2015-12-31T12:34:56+02:00	Populated by AMI HES or MDMS	N/A	N/A
Header	Source	String	The source system or application that sends the message. For this message, the Source is AMI or MDMS.	Populated by AMI HES or MDMS	N/A	N/A
Header	MessageID	String	The unique message ID to be used for tracking messages.	Populated by AMI HES or MDMS	Long	SMMS_ELEMENT_OBJ_GID
Header	CorrelationID	String	For asynchronous meter ping/poll response, the CorrelationID is same as the CorrelationID from appropriate request message. For the unsolicited meter readings CorrelationID is same as MessageID.	Populated by AMI HES or MDMS	Long	SMMS_ELEMENT_OBJ_GID
Payload	MeterReading. Meter. mRID	String	The unique meter identifier.	MeterID	String	SMMS_RESPONSE_METER_ID
Payload	MeterReading. Meter. status.	String	Used only when the meter times out in order to provide detailed explanation to the operator.	FailureDescription	String	SMMS_REQUEST_FAILURE_DESCRIPTION

CreatedMeterReadings message			Description	Smart meter model		
Section	Property	Type		Property	Type	Model Code
	reason					
Payload	MeterReading. Readings. reportedDateTime	DateTime	The timestamp when the reading was actually reported. If it is not populated, defaulted to DateTime.UtcNow.	ResponseTime TimeStamp	DateTime	SMMS_RESPONSE_TIMESTAMP
Payload	MeterReading. Readings. timestamp	DateTime	The timestamp when the message was created. If it is not populated, defaulted to DateTime.UtcNow.	ReceivedTime	DateTime	SMMS_RESPONSE_RECEIVED_TIME
Payload	MeterReading. Readings. value	String	<p>The value of the reading. Possible values:</p> <ul style="list-style-type: none"> 0.0 – deenergized, 1.0 – energized, float value for solicited or unsolicited meter readings. 	Status PhaseAVoltage PhaseBVoltage PhaseCVoltage PhaseACurrent PhaseBCurrent PhaseCCurrent ActivePower ReactivePower	Enum / Float	SMMS_READING_PHASE_A_VALUE SMMS_READING_PHASE_B_VALUE SMMS_READING_PHASE_C_VALUE
Payload	MeterReading. Readings. ReadingType	String	The reference to a reading type from the request message. Determines the type of the meter request (ping or poll) or unsolicited meter reading which adapter should update/create.	N/A	N/A	N/A
Payload	MeterReading. UsagePoint. mRID	String	The unique service delivery point identifier.	ServDeliveryPoint	String	SMMS_SRVDELIVERYPOINT.CUSTOMID

The Reading Type Codes utilized within the *CreatedMeterReadings* use cases are given in Table 9.5.

Table 9.5 – The *ReceiveMeterReadings* service – the Reading Type Codes

Reading	ReadingType Code	Description
unsolicited	0.0.n.12.0.1.54.0.0.0.0.0.0.0.128.3.29.0	n-minute instantaneous electricitySecondaryMetered voltage phaseA (kV)
	0.0.n.12.0.1.54.0.0.0.0.0.0.0.64.3.29.0	n-minute instantaneous electricitySecondaryMetered voltage phaseB (kV)
	0.0.n.12.0.1.54.0.0.0.0.0.0.0.32.3.29.0	n-minute instantaneous electricitySecondaryMetered voltage phaseC (kV)
	0.0.n.12.20.1.37.0.0.0.0.0.0.0.3.38.0	n-minute total electricitySecondaryMetered active power (kW)
	0.0.n.12.20.1.37.0.0.0.0.0.0.0.3.63.0	n-minute total electricitySecondaryMetered reactive power (kVAr)
solicited	0.0.0.0.0.1.11.0.0.0.0.0.0.0.0.109.0	electricitySecondaryMetered energization (status)
	0.0.0.6.0.1.54.0.0.0.0.0.0.0.3.29.0	indicating electricitySecondaryMetered voltage (kV)
	0.0.0.6.0.1.4.0.0.0.0.0.0.0.0.5.0	indicating electricitySecondaryMetered current (A)
	0.0.0.12.20.1.37.0.0.0.0.0.0.0.3.38.0	instantaneous total electricitySecondaryMetered active power (kW)
	0.0.0.12.20.1.37.0.0.0.0.0.0.0.3.63.0	instantaneous total electricitySecondaryMetered reactive power (kVAr)
	0.0.0.6.0.1.54.0.0.0.0.0.0.0.128.3.29.0	indicating electricitySecondaryMetered voltage phaseA (kV)
	0.0.0.6.0.1.54.0.0.0.0.0.0.0.64.3.29.0	indicating electricitySecondaryMetered voltage phaseB (kV)
	0.0.0.6.0.1.54.0.0.0.0.0.0.0.32.3.29.0	indicating electricitySecondaryMetered voltage phaseC (kV)
	0.0.0.6.0.1.4.0.0.0.0.0.0.0.128.0.5.0	indicating electricitySecondaryMetered current phaseA (A)
	0.0.0.6.0.1.4.0.0.0.0.0.0.0.64.0.5.0	indicating electricitySecondaryMetered current phaseB (A)
	0.0.0.6.0.1.4.0.0.0.0.0.0.0.32.0.5.0	indicating electricitySecondaryMetered current phaseC (A)

Note: n can have following values – 6 (5 minute), 1 (10 minute), 2 (15 minute - **default**), 7 (60 minute)

If needed, multiplier unit conversion (16th digit in the reading type code, or third from the right side) is supported as out-of-the-box functionality. Default units are given in the table above (exponent with base 10). For solicited meter readings AMI Adapter will always send the reading type code with the default unit multiplier (as stated in the table above). It is up to the AMI HES/MDMS to return the meter reading within asynchronous response message with the value and corresponding unit multiplier. If the unit multiplier in the response message is matched to the one from the request message, no conversion will be performed. If the unit multiplier is different, appropriate conversion will be performed by the AMI Adapter. Same process is applied to the unsolicited meter readings, with

minor modification where there is no request message. AMI Adapter will perform the conversion of the unit multiplier when it differs from the one specified in the table above, that is AMI Adapter's configuration file.

9.3.2. Response

The *MeterReadingsResponse* message is defined according to the IEC 61968-100 and contains the following three sections:

- Header
- Reply
- Payload

The content of the response message is given in Figure 9.9.

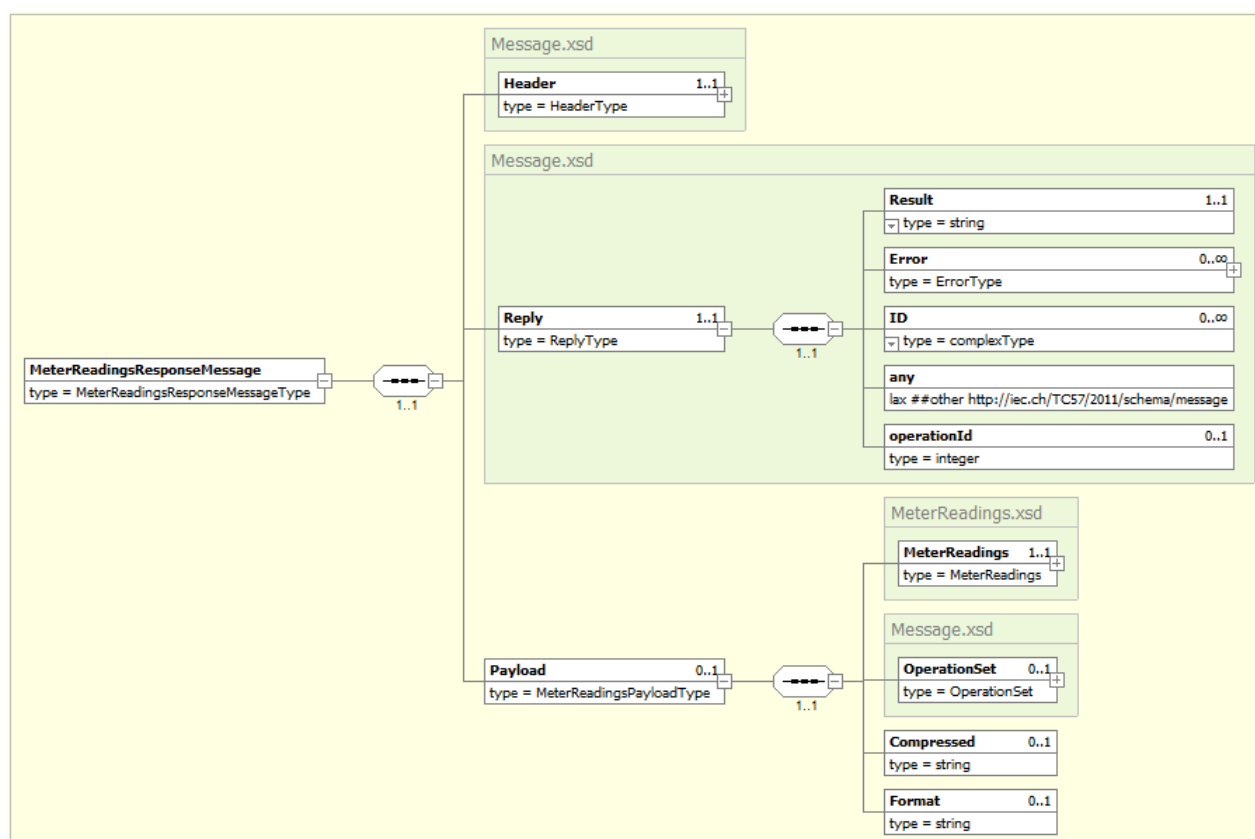


Figure 9.9 – The *MeterReadingsResponse* message

Depending on the outcome of request processing, the AMI Adapter can return several responses. The OK response is when there is no error during request message processing. The PARTIAL response is returned when some of the received meter readings were processed successfully, while other ones resulted in an error (applicable only for unsolicited meter readings). The FAILED response is returned in situations when none of received meter readings were processed successfully. The Fault message is returned if some exception occurred during operation execution. Besides the Reply.Result field, the appropriate Error fields are populated with error code, reason and description of the error.

Table 9.6 defines the mapping between the content of the *MeterReadings.xsd* response message and the appropriate entities in the smart meter model.

Table 9.6 – CreatedMeterReadingsResponse – the smart metering model mapping

MeterReadingsResponse message			Description	Smart meter model		
Section	Property	Type		Property	Type	Model Code
Header	Verb	String	The identifier for a specific action to be taken. For this message, the Verb is reply.	Populated by AMI Adapter.	N/A	N/A
Header	Noun	String	The identifier for the subject of the action and/or the type of the payload. For this message, the Noun is MeterReadings.	Populated by AMI Adapter.	N/A	N/A
Header	Revision	String	Revision of the CIM standard used. Default value is 2.0.	Populated by AMI Adapter.	N/A	N/A
Header	Timestamp	DateTime	The timestamp when the message was produced. Example: 2015-12-31T12:34:56+02:00	Populated by AMI Adapter.	N/A	N/A
Header	Source	String	The source system or application that sends the message. For this message, the Source is the EcoStruxure GridOps.	Populated by AMI Adapter.	N/A	N/A
Header	MessageID	String	The unique message ID to be used for tracking messages.	Populated by AMI Adapter.	N/A	N/A
Reply	Result	String	Request processing status. OK, PARTIAL or FAILED.	Populated by AMI Adapter.	N/A	N/A
Header	CorrelationID	String	The same as CorrelationID from request message.	Populated by AMI Adapter.	N/A	N/A
Payload	MeterReading. Meter. mRID	String	The unique meter identifier.	MeterID	String	SMMS_RESPONSE_METER_ID

MeterReadingsResponse message			Description	Smart meter model		
Section	Property	Type		Property	Type	Model Code
Payload	MeterReading. Meter. status. value	String	The update status of appropriate analog signal. The update status of requested meter status.	Populated by AMI Adapter with OK.	N/A	N/A
Payload	MeterReading. UsagePoint. mRID	String	The unique service delivery point identifier.	ServDeliveryPoint	String	SMMS_SRVDELIVERYPOINT.CUSTOMID

9.3.3. Fault

The *MeterReadingsFault* message is depicted in Figure 9.10.

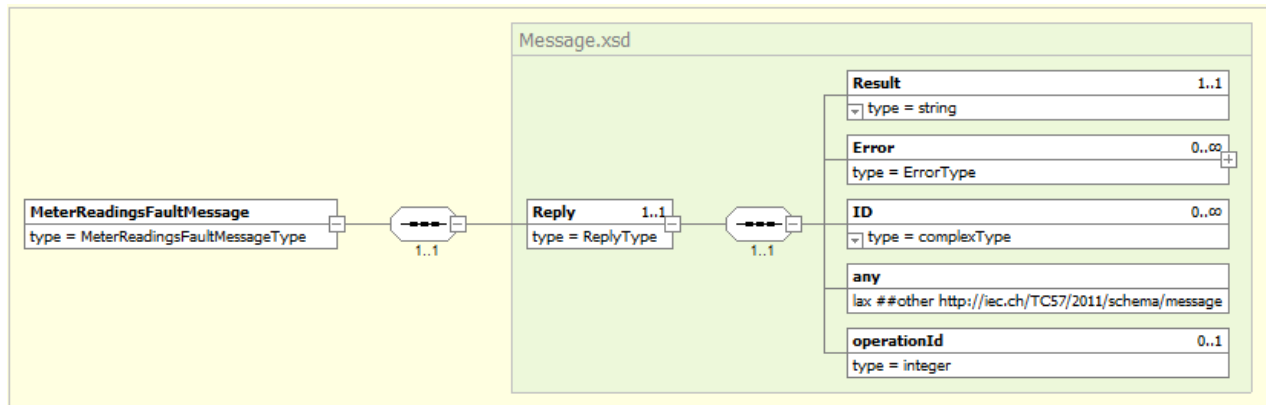


Figure 9.10 – The *MeterReadingsFault* message

9.4. CreatedEndDeviceEvents Operation Messages

The operation definition:

CreatedEndDeviceEventsResponse CreatedEndDeviceEvents(*CreatedEndDeviceEventsEvent*)

9.4.1. Request

The *CreatedEndDeviceEvents* message is defined according to the IEC 61968-100 and contains the following two sections:

- Header
- Payload

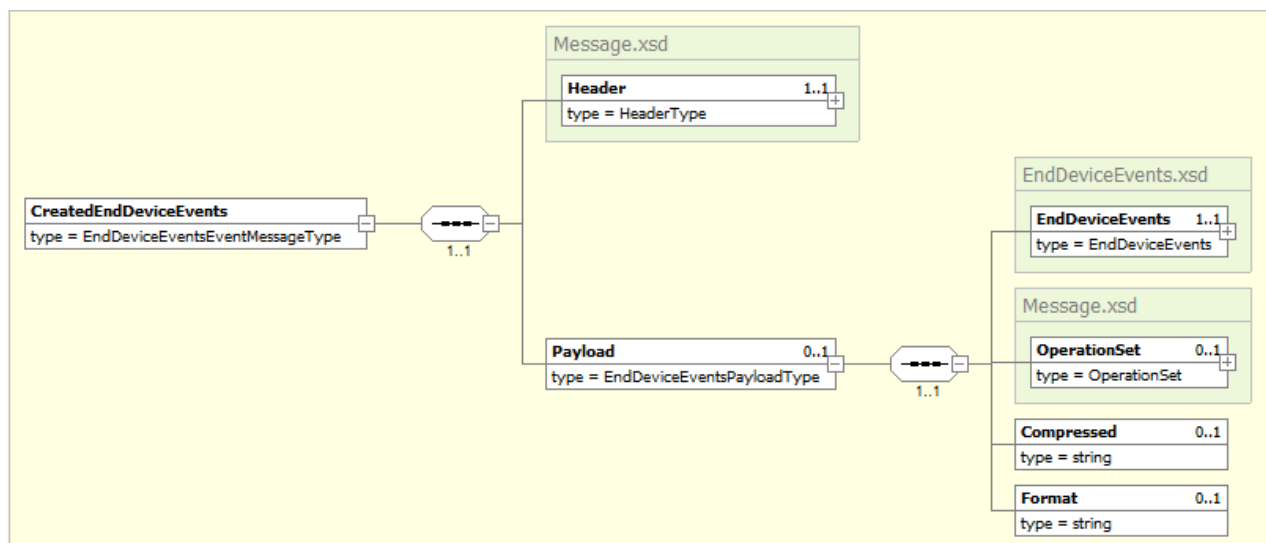


Figure 9.11 – The *CreatedEndDeviceEvents* event message

The Payload section carries the CIM defined payload (*EndDeviceEvents.xsd*) according to the IEC 61968-9 edition 2. The visual representation of the aforementioned schema is given in Figure 9.12.

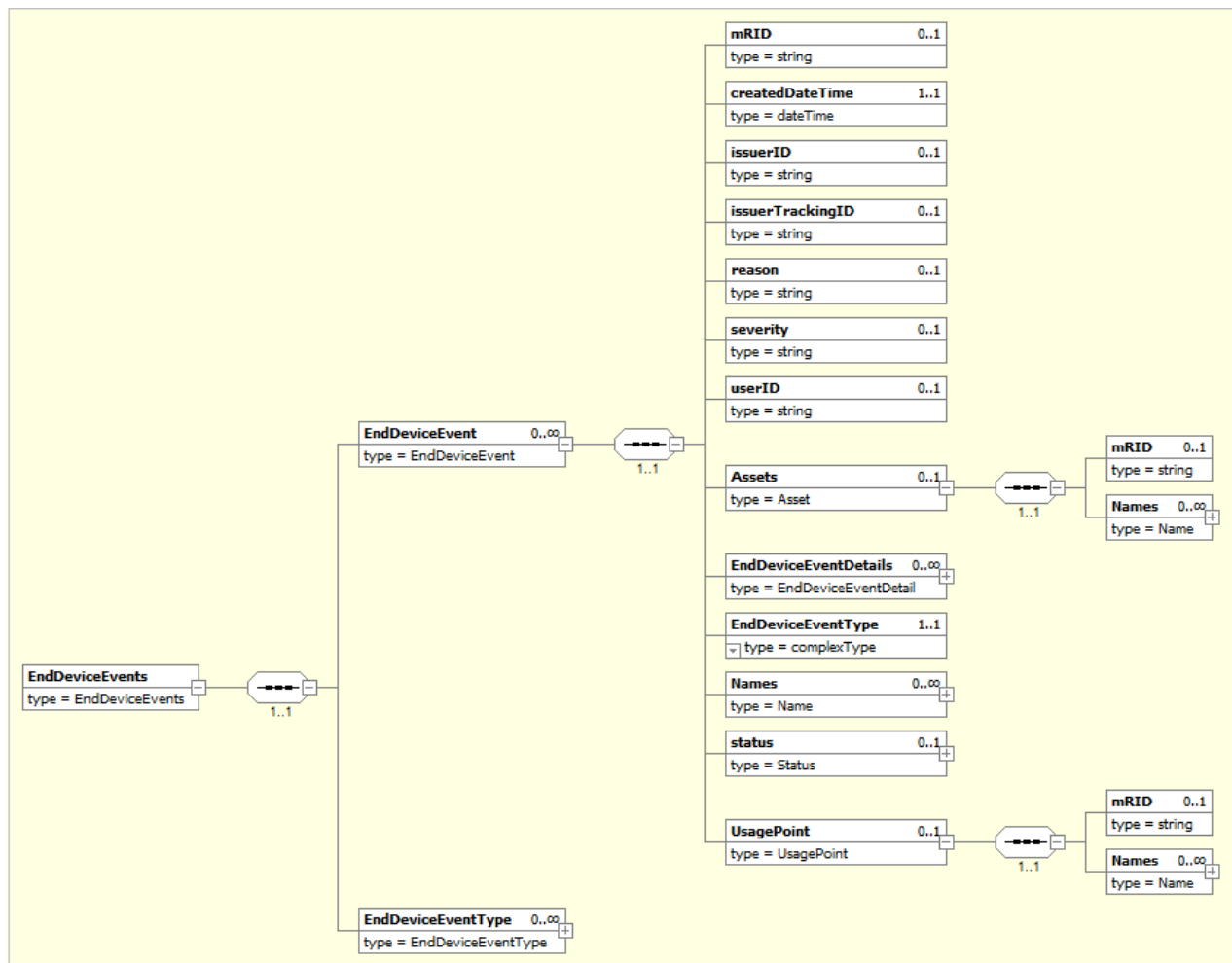


Figure 9.12 – *EndDeviceEvents.xsd*

Table 9.7 defines the mapping between the *EndDeviceEvents.xsd* and the appropriate entities in the smart meter model.

Table 9.7 – CreatedEndDeviceEvents – the smart metering model mapping

CreatedEndDeviceEvents message			Description	Smart meter model		
Section	Property	Type		Property	Type	Model Code
Header	Verb	String	The identifier for a specific action to be taken. For this message, the Verb is created.	Populated by AMI HES or MDMS	N/A	N/A
Header	Noun	String	The identifier for the subject of the action and/or the type of the payload. For this message, the Noun is EndDeviceEvents.	Populated by AMI HES or MDMS	N/A	N/A
Header	Revision	String	Revision of CIM standard used. Default value is 2.0.	Populated by AMI HES or MDMS	N/A	N/A
Header	Timestamp	DateTime	The timestamp when the message was produced. Example: 2015-12-31T12:34:56+02:00	Populated by AMI HES or MDMS	N/A	N/A
Header	Source	String	The source system or application that sends the message. For this message, the Source is AMI or MDMS.	Populated by AMI HES or MDMS	N/A	N/A
Header	MessageID	String	The unique message ID to be used for tracking messages.	Populated by AMI HES or MDMS	Long	N/A
Header	CorrelationID	String	The same as message ID.	Populated by AMI HES or MDMS	Long	N/A
Payload	EndDeviceEvent. createdDateTime	DateTime	The date and time when the message was created.	RecTime	DateTime	SMMS_EVENT_RECEIVED_TIME
Payload	EndDeviceEvent. Assets. mRID	String	The unique meter identifier NOTE: In case of receiving Transformer Level Power Down Event, this field is populated with transformer customID. If addressing mode is Meter	MeterID	String	SMMS_EVENT_SRVDELIVERYPOINT_METERID

CreatedEndDeviceEvents message			Description	Smart meter model		
Section	Property	Type		Property	Type	Model Code
Payload	EndDeviceEvent. EndDeviceEventType	String	Reference to the EndDeviceEventType code. Determines the type of generated event: power up, power down, overvoltage, undervoltage, return to normal.	EventReasonRef TypeValueName	Long String	SMMS_EVENT_TYPE_VALUE_NAME
Payload	EndDeviceEvent. status. dateTime	DateTime	The date/time at which the event occurred.	EventTime TimeStamp	DateTime	SMMS_EVENT_TIMESTAMP
Payload	EndDeviceEvent. status. value	String	The value of the event. Possible values: 0.0 – deenergized, 1.0 – energized, float value for sag/swell/RtN voltage events.	Must be paired with EndDeviceEventType	N/A	SMMS_EVENT_PHASE_A_VALUE SMMS_EVENT_PHASE_B_VALUE SMMS_EVENT_PHASE_C_VALUE
Payload	EndDeviceEvent. UsagePoint. mRID	String	The unique service delivery point identifier. Specified only for the meter events. NOTE: In case of receiving Transformer Level Power Down Event, this field is populated with transformer customID. if addressing mode is UsagePoint	SdpCustomID N/A	String N/A	SMMS_EVENT_SRVDELIVERYPOINT_ID

The Reading Type Codes utilized within the *EndDeviceEventType* use cases are given in Table 9.8.

Table 9.8 – The EndDeviceEventType codes

EndDeviceEventType Code	Description
3.26.0.85	Meter Outage (Power down / Last gasp / Power out)
3.26.126.85	Loss of power or voltage on phase A
3.26.134.85	Loss of power or voltage on phase B
3.26.135.85	Loss of power or voltage on phase C

EndDeviceEventType Code	Description
3.26.0.216	Meter Restoration (Power on)
3.26.126.216	Restoration of power or voltage on phase A
3.26.134.216	Restoration of power or voltage on phase B
3.26.135.216	Restoration of power or voltage on phase C
3.26.131.223	Voltage Sag Started (PhaseA) - UNDERVOLTAGE
3.26.131.224	Voltage Sag Stopped (PhaseA) - UNDERVOLTAGE_RETURN_TO_NORMAL
3.26.131.248	Voltage Swell Started (PhaseA) - OVERVOLTAGE
3.26.131.249	Voltage Swell Stopped (PhaseA) - OVERVOLTAGE_RETURN_TO_NORMAL
3.26.132.223	Voltage Sag Started (PhaseB) - UNDERVOLTAGE
3.26.132.224	Voltage Sag Stopped (PhaseB) - UNDERVOLTAGE_RETURN_TO_NORMAL
3.26.132.248	Voltage Swell Started (PhaseB) - OVERVOLTAGE
3.26.132.249	Voltage Swell Stopped (PhaseB) - OVERVOLTAGE_RETURN_TO_NORMAL
3.26.133.223	Voltage Sag Started (PhaseC) - UNDERVOLTAGE
3.26.133.224	Voltage Sag Stopped (PhaseC) - UNDERVOLTAGE_RETURN_TO_NORMAL
3.26.133.248	Voltage Swell Started (PhaseC) - OVERVOLTAGE
3.26.133.249	Voltage Swell Stopped (PhaseC) - OVERVOLTAGE_RETURN_TO_NORMAL
3.26.38.223	Voltage Sag Condition - UNDERVOLTAGE
3.26.38.224	Voltage Sag Cleared - UNDERVOLTAGE_RETURN_TO_NORMAL
3.26.38.248	Voltage Swell Condition - OVERVOLTAGE
3.26.38.249	Voltage Swell Cleared - OVERVOLTAGE_RETURN_TO_NORMAL
8.26.0.85	Transformer Level Power Down Event
8.26.0.216	Transformer Level Power Up Event

9.4.2. Response

The *EndDeviceEventsResponse* message is defined according to the IEC 61968-100 and contains the following three sections:

- Header
- Reply
- Payload

The content of the response message is given in Figure 9.13.

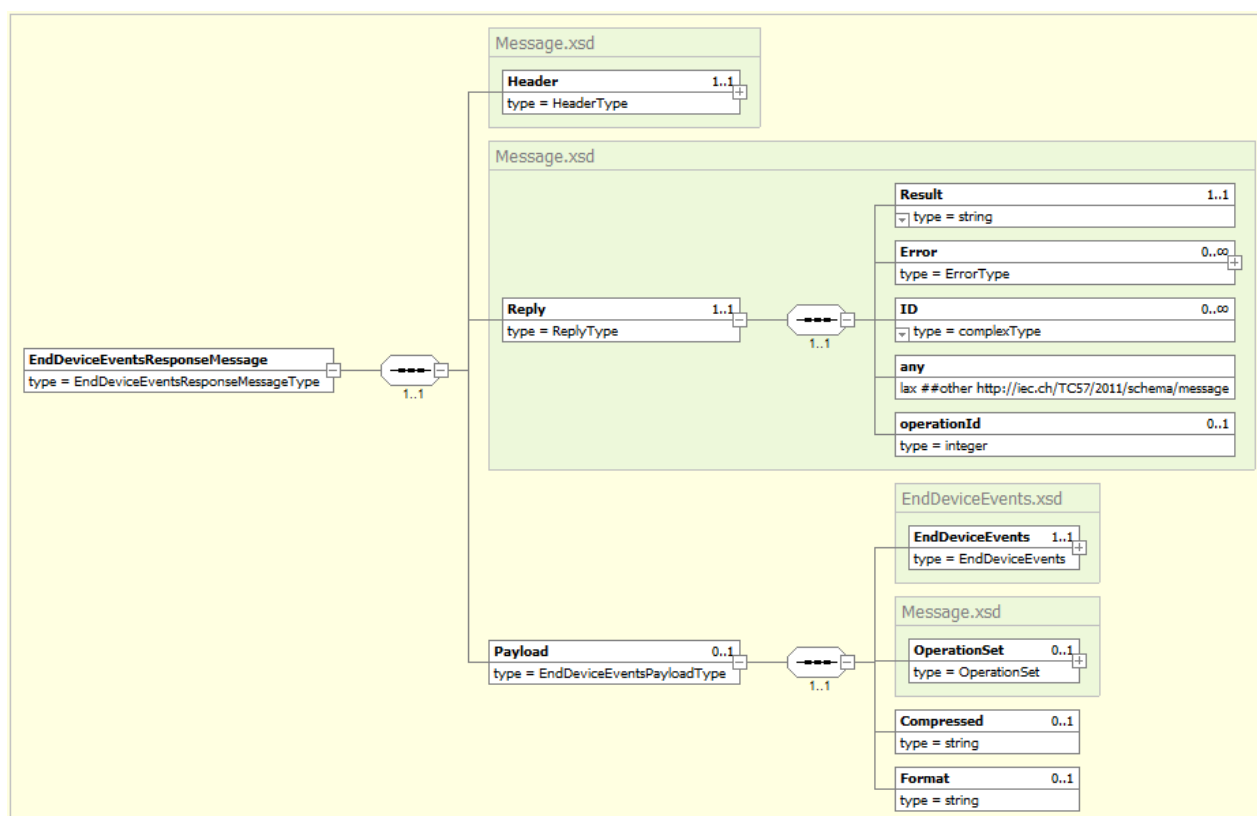


Figure 9.13 – The *EndDeviceEventsResponse* message

Two types of response messages may be sent back to the calling system. One approach implies that the response message contains only the Reply.Result field populated with OK. Other approach implies that the response message contains information about each end device event creation result. If some of the end device events are not valid, the response message is returned with the PARTIAL as a result type, while when all end device events are invalid, the FAILED is returned. Besides that, the appropriate Error fields are populated by the AMI Adapter with error code, reason and description of the error. If some error occurs during the operation execution, the Fault message is returned.

In case when the source system requires that the response message is populated with each *EndDeviceEvent* creation result, Table 9.9 defines the mapping between the *EndDeviceEvents.xsd* and the appropriate entities in the smart meter model.

Table 9.9 – *EndDeviceEventsResponse* – the smart metering model mapping

EndDeviceEventsResponse message			Description	Smart meter model		
Section	Property	Type		Property	Type	Model Code
Header	Verb	String	The identifier for a specific action to be taken. For this message, the Verb is reply.	Populated by AMI Adapter.	N/A	N/A
Header	Noun	String	The identifier for the subject of the action and/or the type of the payload. For this message, the Noun is EndDeviceEvents.	Populated by AMI Adapter.	N/A	N/A
Header	Revision	String	Revision of CIM standard used. Default value is 2.0.	Populated by AMI Adapter.	N/A	N/A
Header	Timestamp	DateTime	The timestamp when the message was produced. Example: 2015-12-31T12:34:56+02:00	Populated by AMI Adapter.	N/A	N/A
Header	Source	String	The source system or application that sends the message. For this message, the Source is the EcoStruxure GridOps.	Populated by AMI Adapter.	N/A	N/A
Header	MessageID	String	The unique message ID to be used for tracking messages.	Populated by AMI Adapter.	N/A	N/A
Header	CorrelationID	String	The same as CorrelationID from the request message.	Populated by AMI Adapter.	N/A	N/A
Response	Assets.mRID	String	The unique meter identifier.	MeterID	String	SMMS_EVENT_SRVDELIVERYPOINT_METERID
Response	UsagePoint.mRID	String	The unique service delivery point identifier. Used only when the meter level events are generated.	SdpCustomID N/A	String N/A	SMMS_EVENT_SRVDELIVERYPOINT_ID
Response	status.value	String	The creation status of the appropriate power down or power up event.	Populated by AMI Adapter	N/A	N/A

9.4.3. Fault

The *EndDeviceEventsFault* message is depicted in Figure 9.14.

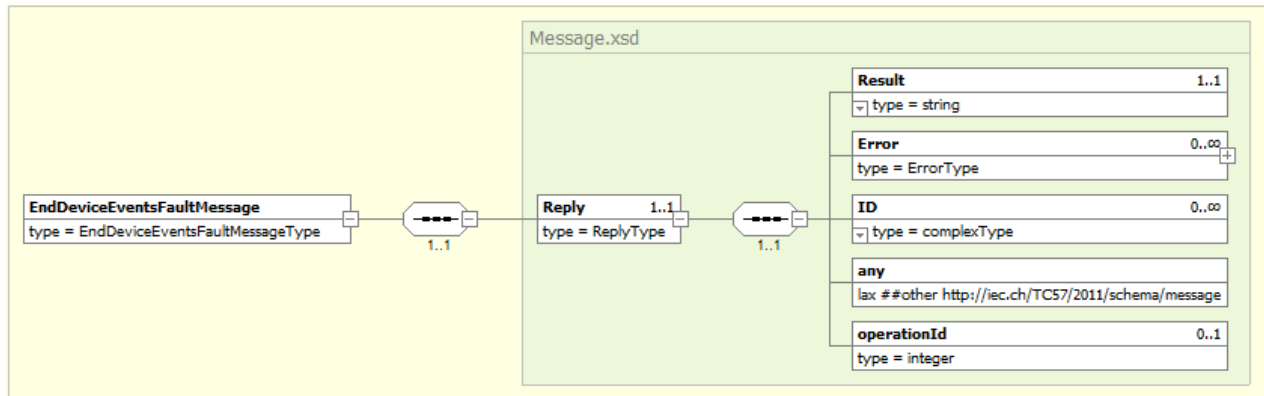


Figure 9.14 – The *EndDeviceEventsFault* message

9.5. CreatedConfigurationEvents Operation Messages

The operation definition:

CreatedConfigurationEventsResponse

CreatedConfigurationEvents(CreatedConfigurationEventsEvent)

9.5.1. Request

The *CreatedConfigurationEventsEvent* message is defined according to the IEC 61968-100 and contains the following two sections:

- Header
- Payload

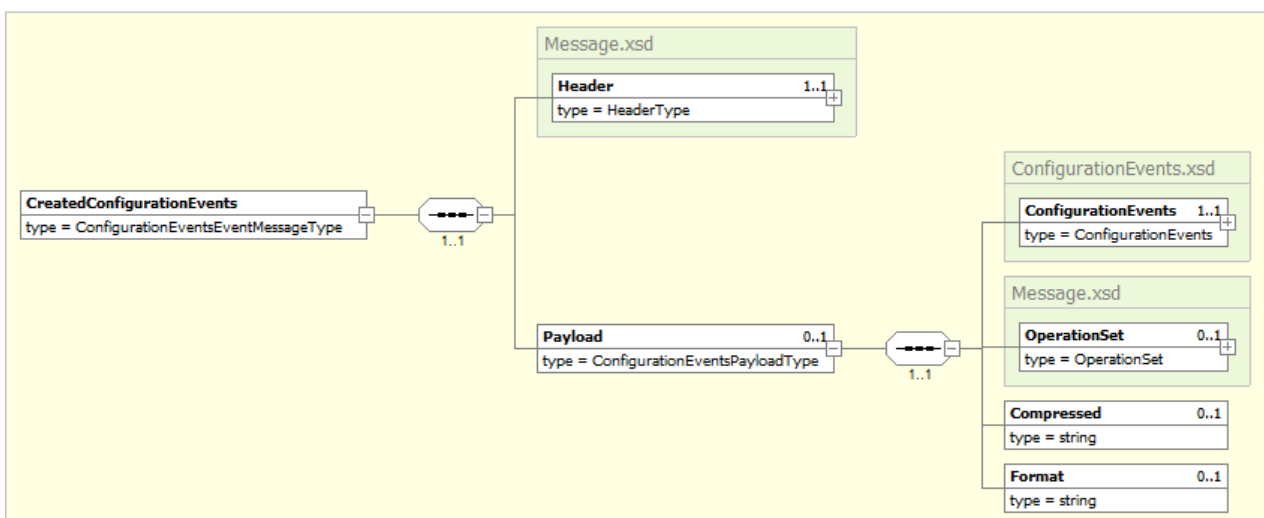


Figure 9.15 – The *CreatedConfigurationEventsEvent* message

The Payload section that carries the CIM payload (*ConfigurationEvents.xsd*) is defined according to the IEC 61968-9 edition 2. The visual representation of the aforementioned schema is given in the Figure 9.16.

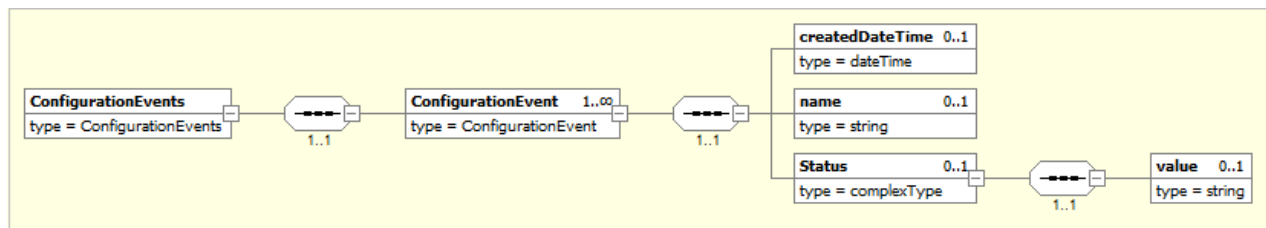


Figure 9.16 – *ConfigurationEvents.xsd*

Table 9.10 defines the mapping between the *ConfigurationEvents.xsd* and the appropriate entities in the smart meter model.

Table 9.10 – CreatedConfigurationEvents – the smart metering model mapping

CreatedConfigurationEvents message			Description	Smart meter model		
Section	Property	Type		Property	Type	Model Code
Payload	createdDateTime	DateTime	Timestamp when the configuration event was created. It will be set to DateTimeNow	Populated by AMI Adapter	N/A	N/A
Payload	name	String	Property defined in adapter configuration xml file and its value correspond to configuration name. Default value is Global Configuration	Populated by AMI Adapter	N/A	N/A
Payload	Status.reason	String	Name of the event that needs to be enabled/disabled: PowerUp, PowerDown	SmartMeterEventType	Long	SMMS_CONFIG_POWER_UP_ENABLED SMMS_CONFIG_POWER_DOWN_ENABLED
Payload	Status.value	String	Value used for enabling/disabling of power up or power down events: ON, OFF	Populated by AMI Adapter	N/A	N/A

9.5.2. Response

The *CreatedConfigurationEvents* response message is defined according to the IEC 61968-100 and contains the following three sections:

- Header
- Reply
- Payload

The content of the response message is given in Figure 9.17.

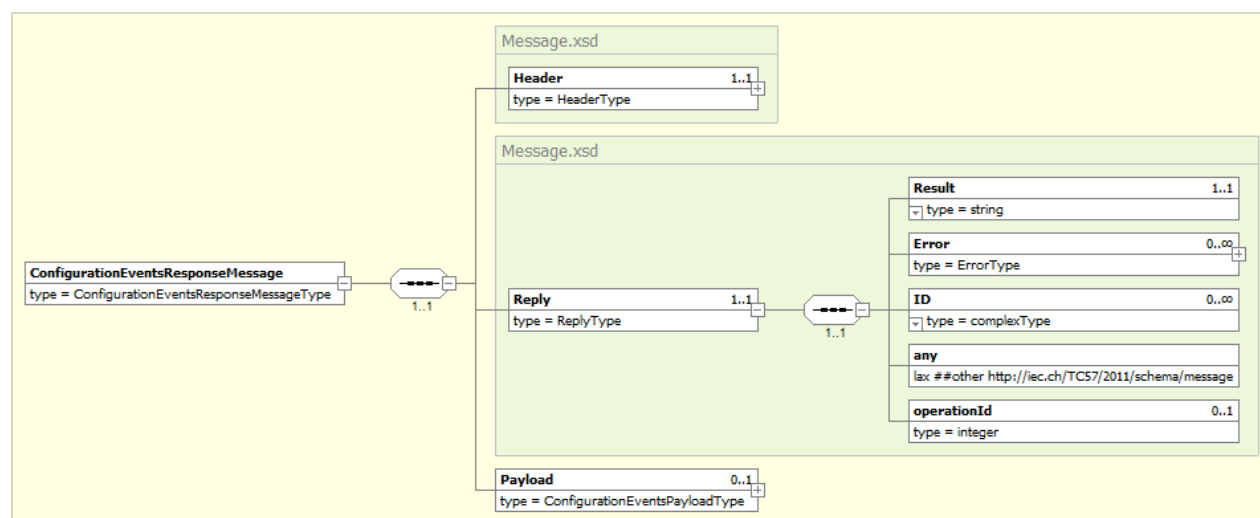


Figure 9.17 – The ConfigurationEvents response message

It is expected that the destination system returns the Response message with OK as a Result, if the message is successfully processed. If some error occurs, the Fault message is returned with the FATAL as a result type. Besides that, the appropriate Error field is populated by the AMI HES (or MDMS) with error code, reason and description of the error.

9.5.3. Fault

The *CreatedConfigurationEventsFault* message is depicted in Figure 9.18.

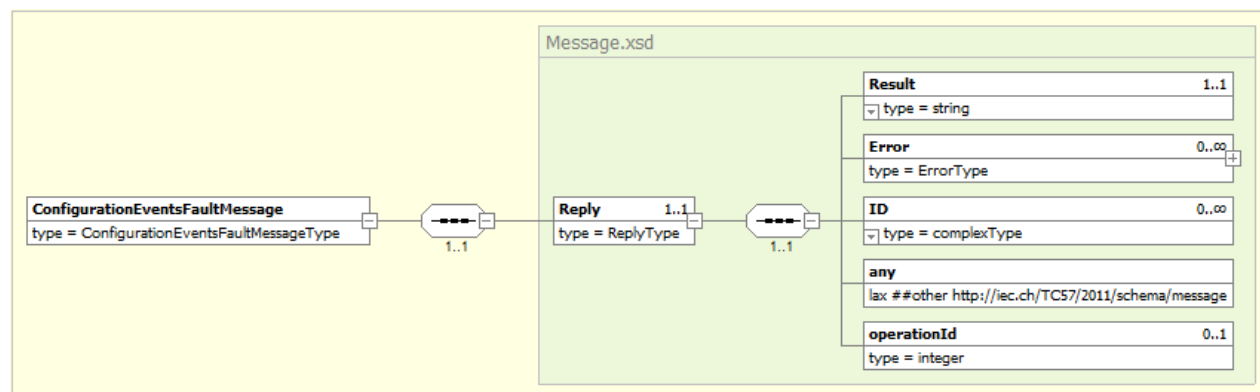


Figure 9.18 – The ConfigurationEventsFault message

10. DEPLOYMENT SPECIFICATION

It is thoroughly described in the *EcoStruxure GridOps Management Suite 3.10 Enterprise Integration Platform - Functional Specification* [2].

The deployment specification is provided in the following table:

Table 10.1 – The deployment specification

Deployment Specification	
Application	AmiAdapter
Critical process	No
OASyS service	OASyS DNA DMS_INTEGRATION Service
Servers	pdmz-int-1, pdmz-int-2, bdmz-int-1, bdmz-int-2
Zone	pdmz, bdmz
Installation Type	Product
Installation add-on name	Integration Adapters

11. INTERFACE CONFIGURATION

AMI adapter provides certain amount of configurability so that smaller adjustments in the functionality can be easily applied to the system, without interface down time. Such feature is provided through dedicated configuration files of the AMI adapter. Initially, following configuration files are used the adapter:

Name of the config file	Configuration File Description
AdapterAmi	Registry configuration xml file
ErrorConfiguration_AmiAdapter	Error configuration xml file
AdapterAmi_WebServiceConfiguration	Web service configuration xml file

Table 11.1 – The configuration files specification

For more details about adapters configuration files refer to the *EcoStruxure GridOps Management Suite 3.10 Enterprise Integration Platform - Functional Specification* [2].

Detailed content of the above-mentioned configuration files is provided within the *Configuration* folder in the *EcoStruxure GridOps Management Suite 3.10 Advanced Metering Infrastructure Interface.zip* file [3].

12. PERFORMANCE

12.1. Performance Best Practices

In order to achieve better performances, following guidelines should be followed:

- UsagePoint addressing mode should be used because validation of entity existence is faster on the UsagePoint basis.
- Group as many events within single message on the AMI HES/MDSM/ESB side.
- Use multiple (concurrent) web service clients on the source system side (ESB).

13. APPENDIX

13.1. WSDL

The WSDL file, XSD schemas and sample messages defined according to the IEC61968-9 and IEC 61968-100 for all AMI web services are provided within the *Web Service Definitions* folder in the *EcoStruxure GridOps Management Suite 3.10 Advanced Metering Infrastructure Interface.zip* file [3].

13.2. Message Examples

Message examples for several use cases are provided within the *Message Examples* folder in the *EcoStruxure GridOps Management Suite 3.10 Advanced Metering Infrastructure Interface.zip* file [3].

14. RELEASE NOTES

The following new features related to Product AMI Interfaces were introduced in the software, starting from version 3.8.

14.1. Software Version 3.8.0

Feature	Description
Data Validation Extension	<p>Data validation during processing of smart meter events, solicited and unsolicited meter readings was enhanced. Complex use cases were broken down which lead to straightforward ones. The end result was propagation of more intuitive validation errors to the external system which could be utilized for further user notification. Additionally, following use cases were implemented with detailed error descriptions:</p> <ul style="list-style-type: none">• Receive Meter Readings - Reading timestamp is in future,• Receive Meter Readings - Reading timestamp older than configurable age validity (default 24 hours),• Status DateTime greater than current date time,• Status DateTime greater than CreatedDateTime,• Status DateTime greater than last update time,• Status DateTime older than configurable age validity (default 24 hours),• CreatedDateTime is greater than current date time.

14.2. Software Version 3.8.1

Feature	Description
Meter ping end-2-end process optimization	When operators ping meters, AMI Adapter pulls information whether pinged meters are restored or not. For restored ones, restoration time is pulled and sent within the request message. Based on provided attribute, message can be routed either to the MDMS or AMI HES, so that response is received promptly.
Fine grained smart meter event creation	AMI Adapter was enhanced with additional functionality which enables fine grained smart meter event creation. Based on external configuration attribute users can now set for which confirmed incidents they want to have smart meter events created.
Multiplier unit conversion	Unit conversion is introduced during reception of solicited and unsolicited meter readings. Regardless of the received multiplier unit for specific reading, value will be converted to default unit.

Feature	Description
Meter Timeout Handling	Capability to handle meter timeout messages from AMI HES was added. Once meter timeout message is received, AMI Adapter will update the status of appropriate smart meter request to timeout.
Poll of additional electrical characteristics	Capability to poll additional electrical characteristics, such as current, active and reactive power, was added. When poll is executed from DMD, next to the meter voltage users now have possibility to request values for current, active and reactive power through the AMI Adapter. Based on the received data from AMI HES or MDMS, appropriate values will be updated.

14.3. Software Version 3.9

Feature	Description
AMI Interface - Alignment reportedDateTime and timeStamp processing with IEC specification	<p>ReceiveMeterReadings Interface is changed so that reportedDateTime and timeStamp processing is aligned with IEC specification. The timeStamp is used to identify when the reading was captured.</p> <p>The optional reportedDateTime can be used to identify when the reading was actually reported.</p>

15. DEFINITIONS AND ABBREVIATIONS

Definition/Abbreviation	Description
ADMS	Advanced Distribution Management System (to be provided by Schneider Electric).
AMI	Advanced Metering Infrastructure
CIM	Common Information Model
CIS	Customer Information System
DERMS	Distributed Energy Resources Management System
DMD	Dynamic Mimic Diagram
DMZ	Demilitarized Zone
ESB	Enterprise Service Bus
HES	Head End System
HTTP	Hypertext Transfer Protocol
IVR	Interactive Voice Response
JMS	Java Messaging Service
MDMS	Meter Data Management System
SFTP	Secure File Transfer Protocol
SOAP	Simple Object Access Protocol
SSL	Secure Socket Layer
UsagePoint	Logical or physical point in the network to which readings or events may be attributed. Used at the place where a physical or virtual meter may be located; however, it is not required that a meter be present.
UUID	Universally Unique identifier
WCF	Windows Communication Foundation
WS	Web Service
XML	Extensible Markup Language
XSD	XML Schema Definition