Modelling 2012 - Project Assignment

Instituto Superior Técnico,
Universidade Técnica de Lisboa, Portugal

Group T-23

Project Phase 4

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Introduction

This report aims to document the modelling process undertaken by our group regarding a complex system of systems (SoS) called Weather Network (WN). This process was made in the context of the Modelling course's project with the aid and feedback of the course's teachers. In this context, our group works for the company BestModel Inc which secured a contract from the Foundation for the Measurement of the Environment (FME) for the elicitation and specification of requirements, analysis and design of the aforementioned SoS. Our goal is to lay the groundwork and design the architecture upon which two other companies (LogicalInc and PhysicalInc) will develop, deploy and maintain the WN.

Our analysis of the WN SoS is based on the decomposition of this system in 3 subsystems which we interpreted as such:

AWS A purely physical system that is responsible for the measurement of atmospheric conditions, the logging of these measurements and their communication to a second system called BWS. A WN may have multiple AWS deployed in remote locations and each AWS communicates with a BWS that is common to the entire WN.

BWS Another purely physical system that is responsible for receiving data from each AWS and routing it to the MeteoNet system. This system is, in a nutshell, a simple computational server running a Linux operating system and containing a specialized communication board that connects to each AWS of the network.

MeteoNet A logical system that resides and runs inside the BWS. This system is responsible for the management of the entire WN and stores information about each AWS. It redirects error notifications from malfunctioning AWSs to the WN Operational Manager, thus aiding him/her plan activities such as inspections and repairals. In addition, it also provides a functional interface that allows the management and querying of the WN by external information systems operated by third-party entities.

This report was written in 4 different phases, each one focusing on a different viewpoint of the system and tackling different issues. The goal was that, when done, it would provide a solid and sound system architecture developed in compliance with all the best modelling practices taught during the course and according to the ISO-IEC-IEEE 42010:2011 international standard.

Whenever measurements (or readings) are mentioned, we assume that the following measurement units are implicitly assumed:

Measurement	Unit
Temperature	C
Humidity	%
Wind speed	Km/h
Wind direction	Degrees

Measurement	Unit
Barometric Pressure	Mb
Precipitation	mm/time unit
Ultraviolet Radiation	W/m^2
Location (latitude, longitude, altitude)	(degrees, degrees, m)

We also assume that contracts have already been made with external providers and, as such, we don't worry with specificities regarding the internal structure/functionality of components provided by the aforementioned entities. Therefore, we only specify requirements regarding the integration of said components on the overall system structure.

Furthermore, it is also assumed that the BWS and MeteoNet will always be able to handle the messages arriving from the AWS Driver and that the GPRS network has 100% reliability. This allows us to simplify our modelling effort by ignoring bottlenecks and handling of delays/packet loss.

Artefact 1 - Effort and Work-Breakdown

Number	Name	Phase 1	Phase 2	Phase3	Phase 4	Total per student
68114	Alexandre Fonseca	15	25	25	21	86
68131	David Forte	12	23	18	16	69
68142	Fernando Macedo	8	7	8	7	30
68178	Pedro Luz	12	23	20	15	70
Total per phase		47	78	71	59	

Table 1: Effort per student.

Artefact	Page	68114	68131	68142	68178
1	2	O, M			
2	3	d, m	O, M	d	
3	4-7	O, M			
4	8	d			O, M
5	9-11	d, m			O, M
6	12	d, m	d	O, M	
7	13	d, m		d	O, M
8	14-16	D, M		O, M	
9	17	d	O, M		
10	18-20	d, m	O, M		
11	21-27	O, M			
12	28-29		O, M		
13	30				O, M
14	31			O, M	
15	32-35	O, M			
16	36			O, M	
17	37-43				O, M
18	44		O, M		
19	45-47	O, M			
20	48	O, M			
21	49				O, M
22	50				O, M
23	51		O, M		
24	52-54		O, M		
25	55	M		O	
26	56-58				O, M
27	59-60		O, M		
28	61-64	O, M			
29	65-71	O, M			

Table 2: Work-breakdown per student.

Artefact 2 - AWS Context

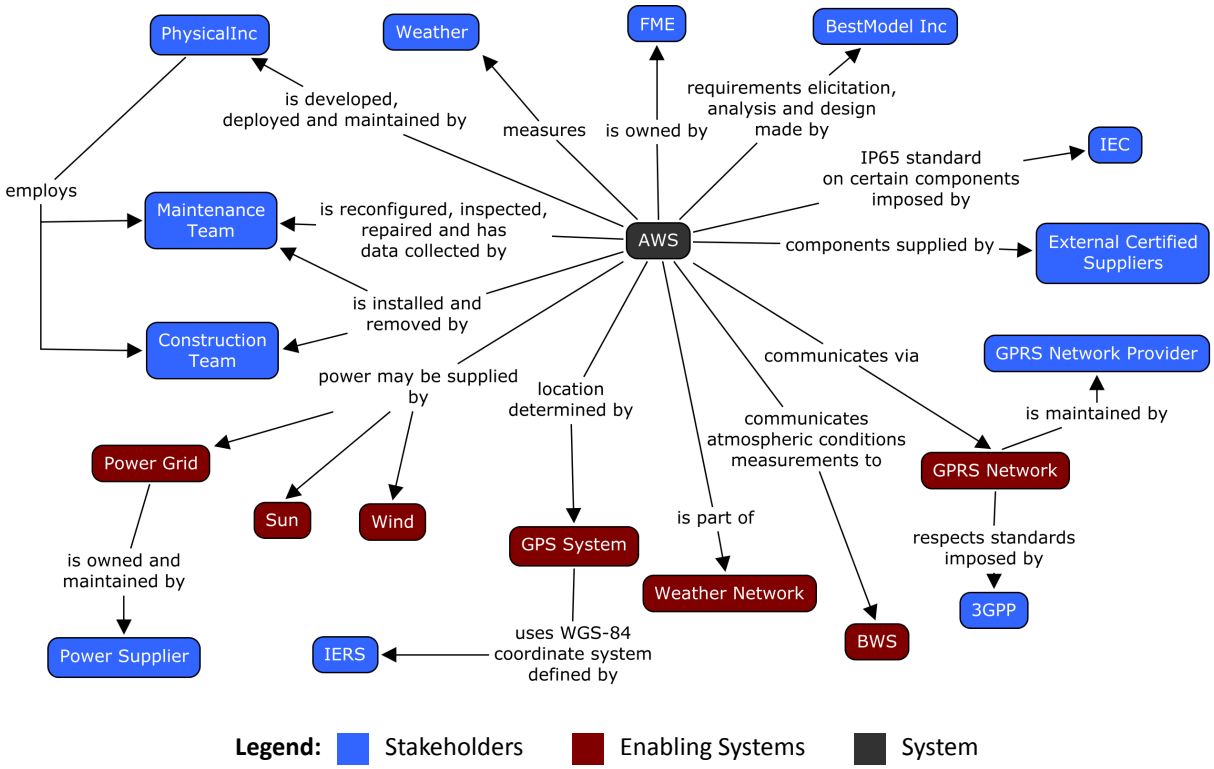

Figure 1: AWS Context Model

Artefact 3 - AWS Requirements

ID	Source	Type	Description
1	Lines 13-14	F	An AWS must measure atmospheric conditions.
1.1	Lines 16-17, 101	NF	An AWS can measure temperature.
1.2	Lines 16-17, 101-102	NF	An AWS can measure barometric pressure.
1.3	Lines 17, 101	NF	An AWS can measure humidity.
1.4	Lines 17, 101-102	NF	An AWS can measure wind speed.
1.5	Lines 17, 101-102	NF	An AWS can measure wind direction.
1.6	Lines 17, 101-102	NF	An AWS can measure precipitation.
1.7	Lines 17, 101-102	NF	An AWS can measure ultraviolet radiation.
2	Lines 35, 78	NF	In order to measure atmospheric conditions, an AWS must have sensor packs.
2.1	Table 1, Lines 113-114	NF	Each sensor pack must have an ID.
2.2	Table 1	NF	Temperature must be measured using a thermistor.
2.3	Table 1	NF	Barometric pressure must be measured using a barometer.
2.4	Table 1	NF	Humidity must be measured using a resistive humidity sensor.
2.5	Table 1	NF	Wind speed must be measured using an anemometer.
2.6	Table 1	NF	Wind direction must be measured using a wind vane.
2.7	Table 1	NF	Precipitation amounts must be measured using a rain gauge.
2.8	Table 1	NF	Ultraviolet radiation must be measured using a photometic UV sensor.
2.9	Table 1	F	A sensor pack can retrieve location measurements (such a sensor pack is called a GPS).
2.10	Lines 47-48, 80-81	NF	Each sensor pack must be located outside the enclosure, on the station platform.
2.11	Line 84	NF	Each sensor pack must be powered by the power supply.
2.12	Lines 93, 111-112	NF	The output of each sensor pack must be connected to an input port on the digital hub.
2.12.1	Line 93	NF	The connection between a sensor pack and the digital hub must be made by a weather-proof coated cable.
2.13	Lines 97-98, Lines 44-46 (Clarif.2)	F	When the global electronic timer performs an 'up' transition, the readings of the sensor pack must be exposed to the digital hub input ports.
3	Line 97	NF	An AWS must have a global electronic timer to be able to perform periodic operations.
3.1	Line 97	NF	The global electronic timer must be connected to each sensor pack.
3.1.1	Lines 99-100	NF	The connection between the global electronic timer and a sensor pack must be made by a weather-proof coated digital connector cable.
3.2	Lines 44-47 (Clarif.2)	NF	The global electronic timer must be connected to each data logger.
3.3	Lines 44-47 (Clarif.2)	NF	The global electronic timer must be connected to the communication device.
4	Line 111	NF	An AWS must have a sensor hub that routes sensor readings to output devices.
4.1	Lines 111-112	NF	A sensor hub input port must accept output from a single sensor pack.
4.2	Lines 113-114	NF	A sensor hub input port must contain the ID of the sensor pack connected to it.
4.3	Lines 111, 115-118	NF	The sensor hub must output sensor data.
4.4	Lines 119-120	NF	Each connection to the sensor hub output port must be made through a digital 48 bit long parallel cable bus.
5	Lines 122-123	F	An AWS can store measurements.
6	Lines 38, 122	NF	If an AWS stores measurements, these must be stored using a data logger.
6.1	Line 124	NF	Each data logger's input port must be connected to the output port of the sensor hub.
6.2	Line 133	NF	Each data logger must be powered by the power supply.
6.3	Line 239	F	Measurement data can be collected from a data logger.
6.3.1	Lines 124-125	NF	Measurement data collection must be made through an USB port on the data logger.
6.4	Line 46 (Clarif. 2)	NF	Upon detecting a "down" transition from the global electronic timer, each data logger must store the value on the output port of the sensor hub.
7	Line 29	F	An AWS must communicate collected data to a BWS.

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Table 3 -- Continued

ID	Source	Type	Description
7.1	Line 31	NF	Communication between an AWS and a BWS must be unidirectional. As such, an AWS must not receive any commands from a BWS.
8	Line 135-136	NF	Communication between an AWS and a BWS must be made using a packaged communication device.
8.1	Line 138	NF	The communication device's input port must be connected to the output port of the sensor hub.
8.2	Lines 46-47 (Clarif. 2)	NF	Upon detecting a "down" transition from the global electronic timer, the communication device must send the value on the output port of the sensor hub to the BWS.
9	Line 34	NF	An AWS must have a identifier (ID) that identifies the AWS within the WN.
10	Line 36	NF	An AWS must have a weather-proof enclosure.
10.1	Lines 47-48	NF	The AWS's enclosure must be mounted on the station platform.
10.2	Line 63	NF	The AWS's enclosure must house the power supply components.
10.3	Line 63	NF	The AWS's enclosure must house the digital hub.
10.4	Line 63	NF	The AWS's enclosure must house the data loggers if they are present on the AWS.
10.5	Line 63-64	NF	The AWS's enclosure must house the communication device.
10.6	Line 99	NF	The AWS's enclosure must house the global electronic timer.
10.7	Line 64	NF	The AWS's enclosure must be attached to the platform using 4 bolts.
10.7.1	Line 64	NF	Each bolt attaching the AWS's enclosure to the platform must measure 40x10mm.
10.8	Line 66-67	NF	All connector cables to and from the sensors must be routed through a cable routing opening.
10.9	Line 67-68	NF	All power supply cables must be routed through a cable routing opening.
10.10	Line 68	NF	Power cables and sensor cables must never be routed through the same cable routing opening.
10.10.1	Line 65	NF	The AWS's enclosure must have 2 cable routing openings.
10.10.1.1	Line 65	NF	Each cable routing opening must be 20mm in diameter.
10.10.1.2	Lines 65-66	NF	Each cable routing opening must be covered with a weather-proof insulator.
10.11	Line 69	NF	The AWS's enclosure can be made of weather-proof fiberglass.
10.12	Line 69	NF	The AWS's enclosure can be made of stainless steel.
10.13	Line 69	NF	The AWS's enclosure must verify either 10.11 or 10.12.
11	Line 40	NF	An AWS must have a mast to elevate the platform.
11.1	Line 42	NF	The mast must be composed of a hollow reinforced stainless steel tube.
11.1.1	Line 42	NF	The mast's tube must have a wall thickness of at least 5mm.
11.1.2	Lines 42-43	NF	The mast's tube must have a diameter of 10cm.
11.2	Line 52	NF	The mast can height 3 meters.
11.3	Line 52	NF	The mast can height 10 meters.
11.4	Line 52	NF	The mast can height 30 meters.
11.5	Line 52	NF	Exactly one of 11.2, 11.3 or 11.4 must be verified.
12	Line 43-44	NF	An AWS must have a station platform to support the enclosure.
12.1	Line 43	NF	The AWS's station platform must sit on top of the AWS's mast.
12.2	Line 44	NF	The AWS's station platform must be made of a stainless steel plate.
12.2.1	Line 44	NF	The stainless steel plate must be 80x80cm in dimension.
12.2.2	Line 44	NF	The stainless steel plate must be 5mm thick.
12.3	Lines 44-45	NF	The AWS's station platform must have a circular hollow socket on its underside.
12.3.1	Line 45	NF	The socket on the platform's underside must have a height of 30cm.
12.3.2	Line 45	NF	The socket on the platform's underside must have a diameter of 10cm.
12.3.3	Lines 45-46	NF	The socket on the platform's underside must be secured to the mast using 6 bolts.
12.3.3.1	Line 46	NF	Each bolt that secures the socket on the platform's underside to the mast must be 40x10mm in dimension.
12.3.3.2	Line 46	NF	The bolts that secure the socket on the platform's underside to the mast must form an angle of 60º between them.
13	Lines 49	NF	The AWS's overall structure can be secured by tension cables.
13.1	Line 50	NF	The tension cables must be installed in groups of three.
13.2	Line 50	NF	The tension cables must have an angle of 120º between them.

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Table 3 -- Continued

ID	Source	Type	Description
13.3	Line 51	NF	The tension cables must be attached to the mast tube.
13.4	Lines 58-59	NF	A 3 meter mast can have at most one group of cables.
13.5	Line 60	NF	A 10 meter mast must have exactly one group of tension cables.
13.6	Line 61	NF	A 30 meter mast must have a minimum of two groups of tension cables.
14	Line 144	NF	An AWS must have a power supply component.
14.1	Line 144	NF	A power supply component must have a battery.
14.1.1	Line 144	NF	The battery must produce stable 12V DC.
14.1.2	Line 146	F	The battery can be recharged by a regulator.
14.1.3	Line 153	NF	The battery must be installed inside the enclosure.
14.1.3.1	Lines 154-156	F	When the battery reaches 5% of its capacity, it must cut power to all connected AWS components (AWS enters standby mode).
14.1.3.2	Lines 156-157	F	When the battery reaches 10% of its capacity and the AWS is in standby mode, it must resume power to all connected AWS components (AWS leaves standby mode).
14.2	Line 144	NF	A power supply component must have a regulator.
14.2.1	Lines 147	NF	A regulator must provide stable tension of 12V.
14.2.2	Lines 148	NF	A regulator must get its power from external power sources.
14.2.3	Line 153	NF	The regulator must be installed inside the enclosure.
14.3	Lines 144-145, 148	NF	A power supply component must have at least one external power source.
14.3.1	Line 149	NF	The external power source can be a photovoltaic cell array.
14.3.1.1	Line 152	NF	The photovoltaic cell array must be installed on the station's platform outside the enclosure.
14.3.2	Line 150	NF	The external power source can be a wind turbine.
14.3.2.1	Line 152	NF	The wind turbine must be installed on the station's platform outside the enclosure.
14.3.3	Line 151	NF	The external power source can be a DC rectifier.
14.3.3.1	Line 151	NF	The DC rectifier must be connected to a 12V transformer.
14.3.3.1.1	Line 151	NF	The 12V transformer must be connected to an AC power grid.
14.3.3.1.2	Line 153	NF	The transformer must be installed inside the enclosure.
15	Section 1.1 (Clarif.)	F	A user must be able to cut the power provided by the battery to the components.
16	Section 1.1 (Clarif.)	F	A user must be able to restore the power provided by the battery to the components.
17	Line 4 (Clarif.)	NF	The control of the battery power must be done through a power switch.
17.1	Line 5 (Clarif.)	NF	The power switch must be accessible from outside the enclosure.

Table 3: AWS Requirement List

Context Information

- (Lines 115-116) The sensor data outputted by the sensor hub must contain sensor readings.
- (Line 117) The sensor data outputted by the sensor hub must contain the sensor id associated with the reading.
- (Line 135) The communication device must use a GPRS mobile network.
- (Lines 69-70) A stainless steel enclosure must conform to the IP65 standard.
- (Line 53) A 3 meter mast must be used to measure weather parameters at ground level.
- (Lines 55-56) A 10 meter mast must be used to measure weather parameters without interference from other objects.
- (Lines 55-56) A 30 meter mast must be used to measure weather parameters without interference from other objects.
- (Lines 86-87) A GPS sensor must have an integrated ADC allowing it to directly output a digital value.
- (Lines 94-96, Lines 44-47 (Clarif. 2)) The global electronic timer has a period of SendFrequency seconds between 0 and 86.400 seconds.
- (Lines 44-45 (Clarif.2)) The global electronic timer must spend half a period on the 'up' state and the other half on the 'down' state.
- (Line 111) A sensor hub has 16 input ports.

Artefact 4 - AWS Use Cases

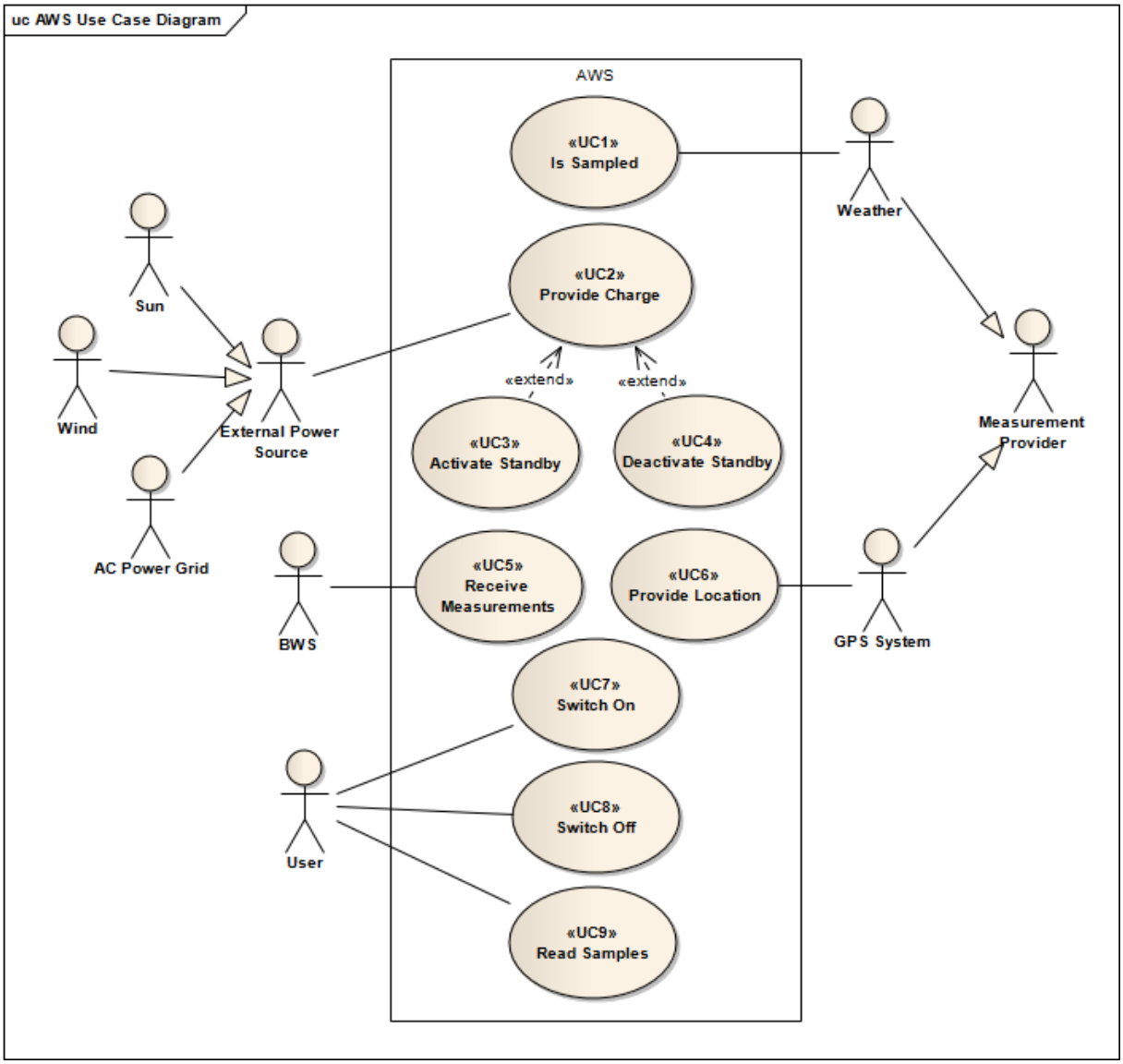

Figure 2: AWS Use Cases

Artefact 5 - AWS Use Case Scenarios

ID and Name	UC-1: Is Sampled
Summary	Provide weather conditions.
Rationale	Sensors should be sampled and analogic measurements of weather conditions should be converted to digital values. This operation occurs every time the AWS's global electronic timer sends a signal to the sensors.
Actors	Weather.
Pre-conditions	The AWS's global electronic timer must have transitioned to an 'up' state.
Primary Scenario	1. Weather conditions are measured by the AWS.
Post-conditions	AWS obtains updated measurements of Weather conditions.

Table 4: Scenarios of the AWS UC1 – Sample.

ID and Name	UC-2: Provide Charge
Summary	External power sources provide energy to charge AWS batteries.
Rationale	External power sources provide energy to charge the batteries. The battery needs to be charged in order to keep all powered components operational.
Actors	External Power Source
Pre-conditions	
Primary Scenario	1. An external power source provides energy to charge the AWS.
Post-conditions	The AWS has increased battery charge.

Table 5: Scenarios of the AWS UC2 – Provide Charge.

ID and Name	UC-3: Activate Standby
Summary	External power sources fail to charge the battery thus inducing a "Standby mode" in the AWS.
Rationale	If external power sources don't provive enough energy to keep the AWS battery's charge above 5%, then the AWS stops powering all its components and the system enters in "Standby mode" to prevent complete charge depletion.
Actors	External Power Source
Pre-conditions	The AWS battery reaches a charge lower than 5% and the system is not in "Standby Mode".
Primary Scenario	1. The external power source(s) does not provide enough power to charge the battery.
Post-conditions	AWS enters "Standby mode" and stops powering its components.

Table 6: Scenarios of the AWS UC3 – Activate Standby.

ID and Name	UC-4: Deactivate Standby
Summary	External power sources provide enough energy allowing the AWS to leave "Standby mode".
Rationale	If external power sources provide enough energy to charge the AWS battery above 10%, then the AWS should restored power to all AWS components thus leaving "Standby mode".
Actors	External Power Source
Pre-conditions	The AWS battery reaches a charge over 10% and the system is in "Standby Mode".
Primary Scenario	1. The external power source(s) provide(s) enough power to recharge the battery.
Post-conditions	AWS leaves "Standby mode" and restores power to all its components.

Table 7: Scenarios of the AWS UC4 – Deactivate Standby.

ID and Name	UC-5: Receive Measurements
Summary	BWS receives sampled measurements from an associated AWS.
Rationale	A BWS must be able to receive sampled measurements from associated AWS.
Actors	BWS.
Pre-conditions	The AWS's global electronic timer must have transitioned to a 'down' state.
Primary Scenario	1. The BWS receives a message containing updated weather measurements, sent by this AWS.
Post-conditions	

Table 8: Scenarios of the AWS UC5 – Receive Measurements.

ID and Name	UC-6: Provide Location
Summary	GPS System provides AWS coordinates.
Rationale	An AWS must be able to obtain its current location.
Actors	GPS system.
Pre-conditions	The AWS's global electronic timer must have transitioned to an 'up' state.
Primary Scenario	1. The GPS system provides information to the AWS regarding its location.
Post-conditions	The AWS has updated location measurements.

Table 9: Scenarios of the AWS UC6 – Provide Location.

ID and Name	UC-7: Switch on
Summary	An user turns the AWS on through its power switch.
Rationale	The machine must be turned on for it to be operational.
Actors	User.
Pre-conditions	The AWS must be turned off.
Primary Scenario	1. The user turns the AWS on.
Post-conditions	The AWS is turned on.

Table 10: Scenarios of the AWS UC7 – Switch On.

ID and Name	UC-8: Switch off
Summary	An user turns the AWS off through its power switch.
Rationale	The machine must be turned off during invasive human operation.
Actors	User.
Pre-conditions	The AWS must be turned on.
Primary Scenario	1. The user turns the AWS off.
Post-conditions	AWS is turned off.

Table 11: Scenarios of the AWS UC8 – Switch Off.

ID and Name	UC-9: Read Samples
Summary	An user reads samples stored in the AWS data loggers.
Rationale	It should be possible to retrieve all logged samples on the data loggers of the AWS.
Actors	User.
Pre-conditions	An AWS must have data loggers installed.
Primary Scenario	1. The user collects samples stored on the AWS through the USB ports of its data loggers.
Post-conditions	

Table 12: Scenarios of the AWS UC9 – Read Samples.

Note: UC7 and UC8 are executed before and after some human intrusive operation, respectively. However, it is our opinion that such requirements should not be presented as preconditions of the respective scenarios since they represent business rules. Nonetheless, we do mention them on the rationale for the scenarios since these behaviours were added with that objective in mind.

Note: In UC7, UC8 and UC9 the described use cases are normally performed by the MTeam. However, this is a business rule that has no relevance to the design of the AWS (since there is no login system or similar) thus we chose to represent their actors as generic users.

Artefact 6 - BWS Context

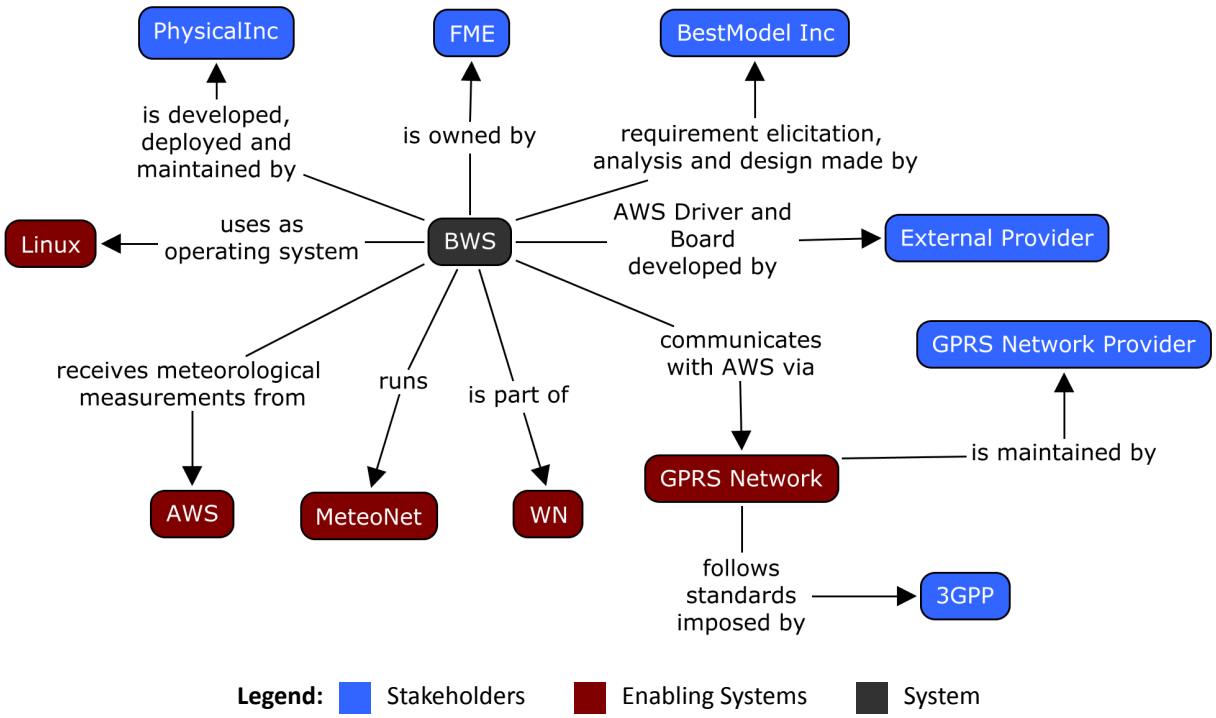

Figure 3: BWS Context Model

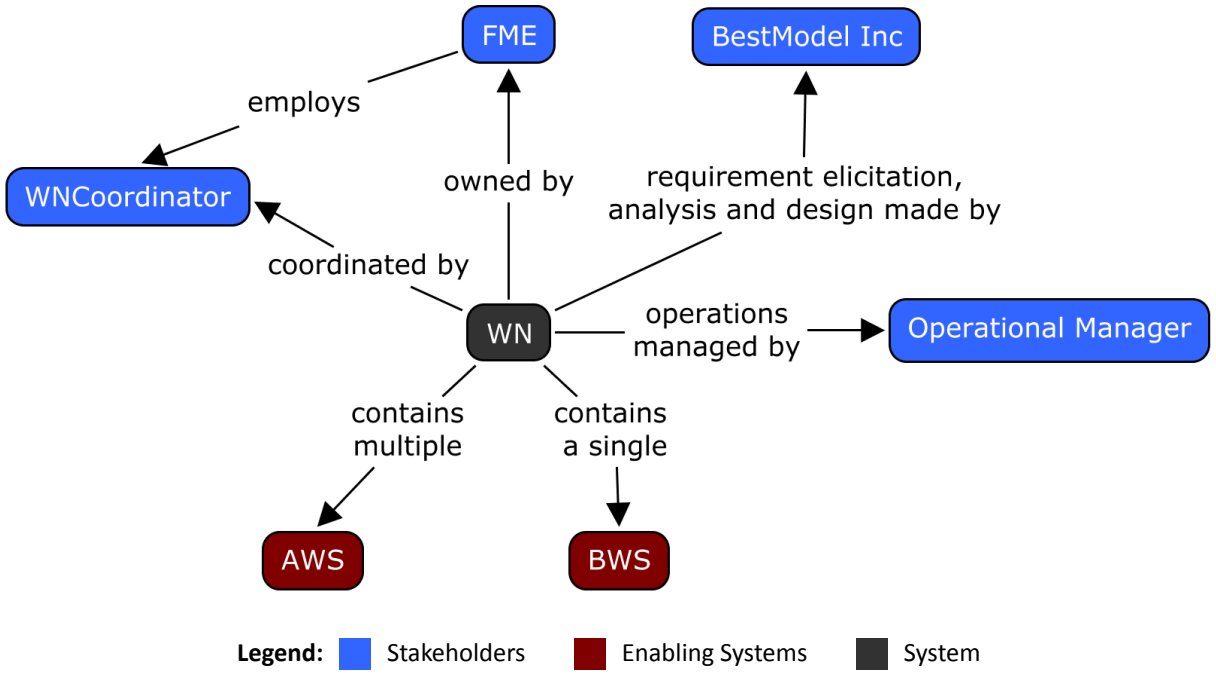

Figure 4: WN Context Model

Artefact 7 - MeteoNet Context

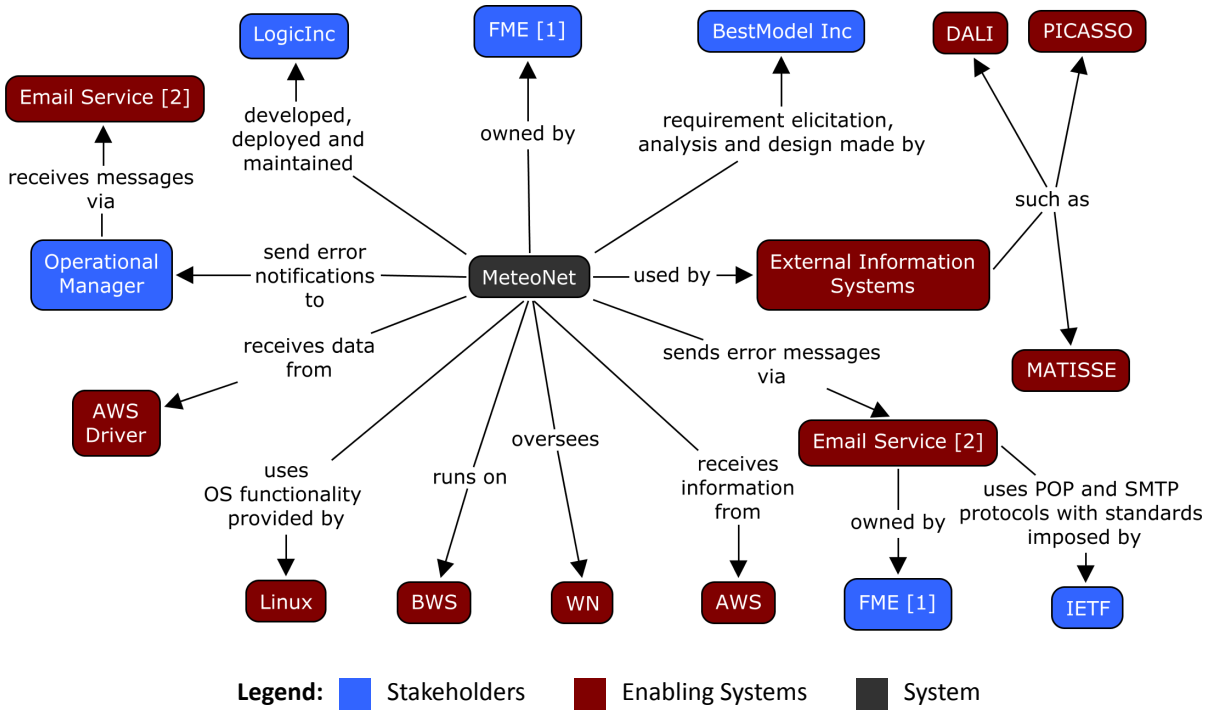

Figure 5: MeteoNet Context Model

Artefact 8 - MeteoNet Requirements

ID	Source	Type	Description
18	Line 160	NF	The MeteoNet system must run on a Linux operating system.
19	Line 171	F	The MeteoNet system must record information of all the AWS within the WN.
19.1	Line 172	NF	An AWS record must include the AWS ID.
19.2	Line 173	NF	An AWS record must include information about installed sensors.
19.2.1	Line 173	NF	Information about an installed sensor on an AWS must include the type of the sensor.
19.2.2	Line 173	NF	Information about an installed sensor on an AWS must include the serial number of the sensor.
19.2.3	Line 173	NF	Information about an installed sensor on an AWS must include the provider of the sensor.
19.2.4	Lines 173-174	NF	Information about an installed sensor on an AWS must include the date of installation of the sensor.
19.2.5	Lines 173-174	NF	Information about an installed sensor on an AWS must include its sampling period.
19.3	Line 175	NF	An AWS record must include information about problems with its sensors.
19.3.1	Line 175	NF	Information about problems with an AWS sensor must include the timestamp of when the problem was reported.
19.3.2	Line 175	NF	Information about problems with an AWS sensor must include the sensor identifier.
19.3.3	Line 175	NF	Information about problems with an AWS sensor must include the error type.
19.4	Line 176	NF	An AWS record must include information about all readings retrieved from the AWS.
19.4.1	Line 176	NF	Information about a reading retrieved from an AWS must contain the timestamp of when the reading was retrieved.
19.4.2	Line 176	NF	Information about a reading retrieved from an AWS must contain the content of the reading.
19.5	Line 178	NF	An AWS record must include information about the configuration of the AWS.
19.6	Line 179	NF	An AWS record must include information about the geographical location of the AWS.
20	Lines 163-164	NF	Receival of messages from each AWS must be made through a specific AWS driver.
20.1	Lines 3-5 (Clarif. 2)	NF	For each message received, the AWS driver must make a service call to the MeteoNet interface passing a XML structure with the record of the message.
20.2	Line 5 (Clarif. 2)	NF	The record of the message must contain a header.
20.2.1	Lines 5-6 (Clarif. 2)	NF	The header of the record must contain the identifier of the AWS that sent the message.
20.2.2	Lines 5-6 (Clarif. 2)	NF	The header of the record must contain the time the message was received by the AWS Driver.
20.3	Line 7 (Clarif. 2)	NF	The record of the message must contain a list of attribute pairs.
20.4	Line 7 (Clarif. 2)	NF	Each attribute pair must contain the identifier of a sensor on the AWS.
20.5	Line 8 (Clarif. 2)	NF	Each attribute pair must contain a 5-byte binary string of the reading of the sensor referenced in 20.4.
20.5.1	Line 89	NF	The 4 LSB must represent the measurement data of the sensor.
20.5.2	Line 90	NF	The 1 MSB must represent a status code.
20.5.2.1	Line 91	NF	A zero-valued status code must mean that the sensor is operating normally.
20.5.2.2	Line 92	NF	A non-zero-valued status code must represent an error code.
21	Line 168	F	The MeteoNet system must communicate errors in the WN to the Operational Manager.
21.1	Line 167	NF	An error can represent the receival of an error code (as per 20.5.2.2).
21.2	Lines 34-35 (Clarif. 2)	NF	An error can represent the need to repair an AWS.
21.2.1	Lines 25-27 (Clarif. 2)	NF	An AWS must be considered as needing repairs if it did not send any reading for more than 3 periods of its timer.

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Table 13 -- Continued

ID	Source	Type	Description
21.2.2	Lines 28-29 (Clarif. 2)	NF	An AWS must be considered as needing repairs if atleast one of its sensors sent two consecutive error codes (as per 20.5.2.2).
21.3	Line 168	NF	Error communication must be done via a preconfigured email message.
21.3.1	Lines 168-169	NF	Each email message for error communication must include the ID of the AWS that reported the error.
21.3.2	Lines 168-169	NF	Each email message for error communication must include the ID of the sensor that reported the error.
21.3.2.1	Lines 32-33 (Clarif. 2)	NF	In case the error represents a need to repair an AWS, the ID of the sensor must be zero.
21.3.3	Lines 168-169	NF	Each email message for error communication must include the timestamp of the time when the error was detected.
21.4	Line 169-170	NF	Error communication must be done separately for each error.
22	Line 187	F	The MeteoNet system must provide a functional interface to manage the associated WN.
22.1	Table 2	F	The MeteoNet functional interface must allow the addition of a new AWS station to the WN.
22.1.1	Table 2	NF	The addition of a new AWS station to the WN must be performed via the *AddStation* service.
22.1.1.1	Table 2	NF	The *AddStation* service must receive the ID of the new AWS as input.
22.1.1.2	Table 2	NF	The *AddStation* service must receive the configuration of the new AWS as input.
22.1.1.3	Table 2	NF	The *AddStation* service can output an error code.
22.2	Table 2	F	The MeteoNet functional interface must allow the removal of an AWS station from the WN.
22.2.1	Table 2	NF	The removal of AWS stations from the WN must be performed via the *RemoveStation* service.
22.2.1.1	Table 2	NF	The *RemoveStation* service must receive the ID of the AWS to remove as input.
22.2.1.2	Table 2	NF	The *RemoveStation* service can output an error code.
22.3	Table 2	F	The MeteoNet functional interface must allow the listing of AWS stations in the WN.
22.3.1	Table 2	NF	The listing of AWS stations in the WN must be performed via the *GetStations* service.
22.3.1.1	Table 2	NF	The *GetStations* service must not receive any input.
22.3.1.2	Table 2	NF	The *GetStations* service must output a list.
22.3.1.2.1	Table 2	NF	Each entry of the list outputted by the *GetStations* service must contain the id of an AWS.
22.3.1.2.2	Table 2	NF	Each entry of the list outputted by the *GetStations* service must contain the attributes of the respective AWS.
22.4	Table 2	F	The MeteoNet functional interface must allow the retrieval of AWS station readings.
22.4.1	Table 2	NF	The retrieval of AWS station readings must be performed via the *GetStationReading* service.
22.4.1.1	Table 2	NF	The *GetStationReading* service must receive the ID of the AWS from where to retrieve the reading.
22.4.1.2	Table 2	NF	The *GetStationReading* service must receive the ID of the sensor whose reading we wish to retrieve.
22.4.1.3	Table 2	NF	The *GetStationReading* service must output the most recent reading of a specified sensor of a given station.
22.5	Table 2	F	The MeteoNet functional interface must allow the retrieval of readings from all AWS on a given circular area.
22.5.1	Table 2	NF	The retrieval of area readings must be performed via the *GetAreaReadings* service.
22.5.1.1	Table 2	NF	The *GetAreaReadings* service must receive the ID of the sensor whose reading we wish to retrieve.
22.5.1.2	Table 2	NF	The *GetAreaReadings* service must receive the desired time interval of the readings.
22.5.1.3	Table 2	NF	The *GetAreaReadings* service must receive the centre of the circle.

Continued on Next Page…

Table 13 -- Continued

ID	Source	Type	Description
22.5.1.3.1	Table 2	NF	The centre of the circle received by the *GetAreaReadings* service must include a latitude.
22.5.1.3.2	Table 2	NF	The centre of the circle received by the *GetAreaReadings* service must include a longitude.
22.5.1.4	Table 2	NF	The *GetAreaReadings* service must receive the radius of the circle (in meters).
22.5.1.5	Table 2	NF	The *GetAreaReadings* service must output a list.
22.5.1.5.1	Table 2	NF	Each entry of the list outputted by the *GetAreaReadings* service must contain the id of an AWS.
22.5.1.5.2	Table 2	NF	Each entry of the list outputted by the *GetAreaReadings* service must contain a reading of the respective AWS.
22.6	Table 2	F	The MeteoNet functional interface must allow the retrieval of readings from all AWS on the WN.
22.6.1	Table 2	NF	The retrieval of readings from all AWS on the WN must be performed via the *GetWNReadings* service.
22.6.1.1	Table 2	NF	The *GetWNReadings* service must receive the ID of the sensor whose reading we wish to retrieve.
22.6.1.2	Table 2	NF	The *GetWNReadings* service must receive the desired time interval of the readings.
22.6.1.3	Table 2	NF	The *GetWNReadings* service must output a list.
22.6.1.3.1	Table 2	NF	Each entry of the list outputted by the *GetWNReadings* service must contain the id of an AWS.
22.6.1.3.2	Table 2	NF	Each entry of the list outputted by the *GetWNReadings* service must contain a reading of the respective AWS.
22.7	Table 2	F	The MeteoNet functional interface must allow the retrieval of AWS that did not communicate with the BWS during a time interval (silent stations).
22.7.1	Table 2	NF	The retrieval of silent stations must be performed via the *GetSilentStations* service.
22.7.1.1	Table 2	NF	The *GetSilentStations* service must receive the desired time interval when the stations were silent.
22.7.1.2	Table 2	NF	The *GetSilentStations* service must output a list.
22.7.1.2.1	Table 2	NF	Each entry of the list outputted by the *GetSilentStations* service must contain the id of a silent AWS.
22.8	Table 2	F	The MeteoNet functional interface must allow the retrieval of sensor errors from all AWS on the WN.
22.8.1	Table 2	NF	The retrieval of sensor errors from all AWS on the WN must be performed via the *GetSensorErrors* service.
22.8.1.1	Table 2	NF	The *GetSensorErrors* service must receive the desired time interval of when the errors were reported.
22.8.1.2	Table 2	NF	The *GetSensorErrors* service must output a list.
22.8.1.2.1	Table 2	NF	Each entry of the list outputted by the *GetSensorErrors* service must contain the timestamp of the error.
22.8.1.2.2	Table 2	NF	Each entry of the list outputted by the *GetSensorErrors* service must contain the ID of the AWS that originated the error.
22.8.1.2.3	Table 2	NF	Each entry of the list outputted by the *GetSensorErrors* service must contain the ID of the sensor that originated the error.
22.8.1.2.4	Table 2	NF	Each entry of the list outputted by the *GetSensorErrors* service must contain the code of the error.
22.9	Lines 16-17 (Clarif.)	F	The MeteoNet functional interface must allow the saving of the system's domain in the file system.
22.9.1	Line 16 (Clarif.)	NF	The saving of the system's domain must be performed via the *GetDomain* service.
22.9.1.1	Line 17 (Clarif.)	NF	The system's domain must be saved in a XML file.

Table 13: MeteoNet Requirement List

Artefact 9 - MeteoNet Use Cases

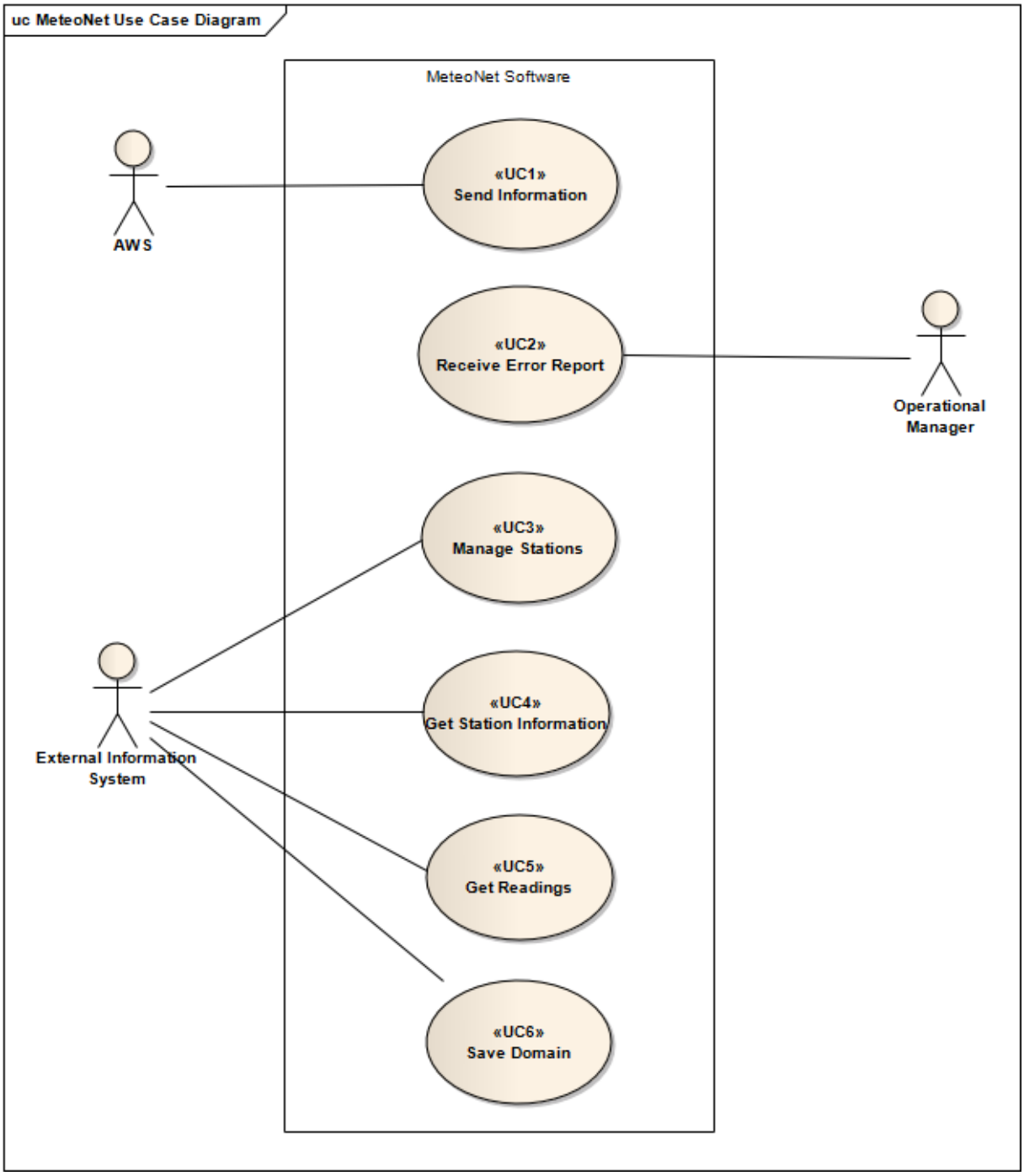

Figure 6: MeteoNet Use Cases

Artefact 10 - MeteoNet Use Case Scenarios

ID and Name	UC-1: Send Information
Summary	An AWS sends data packets with retrieved information to MeteoNet.
Rationale	The autonomous AWS stations must be able to send information to the MeteoNet system. This information is accessed through an AWS Driver accessible to MeteoNet.
Actors	AWS.
Pre-conditions	MeteoNet is waiting to receive messages.
Primary Scenario	1. An AWS sends a message to MeteoNet with information. 2. MeteoNet parses the received message and updates stored information.
Post-conditions	MeteoNet saved information contained in the message.

Table 14: Scenarios of the MeteoNet UC1 – Send Information.

ID and Name	UC-2: Receive Error Report
Summary	In case a message from an AWS identifies an error code, the OperationalManager receives a preconfigured email message from the MeteoNet Software.
Rationale	The MeteoNet system must be able to notify the OperationalManagers of errors communicated by deployed AWS so that action can be taken to resolve the situation.
Actors	OperationalManager.
Pre-conditions	A message received by the Meteonet system identifies an error code.
Primary Scenario	1. The OperationalManager receives an email message containing the ID of the AWS and the ID of the sensor associated with the error.
Post-conditions	

Table 15: Scenarios of the MeteoNet UC2 – Receive Error Report.

ID and Name	UC-3: Manage Stations
Summary	The External Information Systems request additions of new AWS or removal of existing AWS.
Rationale	The External Information Systems must be able to request additions or removals of AWS from the WN.
Actors	External Information System.
Pre-conditions	
Primary Scenario	1. An External Information System uses one of the MeteoNet services "AddStations" or "RemoveStations" to add or remove an AWS. (a) The External Information System provides the aws_id of the AWS to be affected. (b) The External Information System receives a status code with the result of the operation.
Post-conditions	MeteoNet has an updated view of the WN.

Table 16: Scenarios of the MeteoNet UC3 – Manage Stations.

ID and Name	UC-4: Get Station Information
Summary	An External Information Systems retrieves of information about AWS in a WN.
Rationale	The External Information Systems must be able to retrieve information about the installed AWS on a network.
Actors	External Information System.
Pre-conditions	
Primary Scenario	1. An external information system uses one of the MeteoNet services "GetStations", "GetSilentStations" or "GetSensorErrors" to obtain information about AWS. (a) The external information system provides the necessary input to the service. (b) The external information system receives a list containing information about the requested AWS from MeteoNet.
Post-conditions	

Table 17: Scenarios of the MeteoNet UC4 – Get Station Information.

ID and Name	UC-5: Get Readings
Summary	An External Information System retrieves meteorological readings from AWS in a WN.
Rationale	The External Information Systems must be able to retrieve meteorological readings from the installed AWS on a network.
Actors	External Information System.
Pre-conditions	
Primary Scenario	1. An external information system uses one of the MeteoNet services "GetStationReading", "GetWNReadings" or "GetAreaReadings" to obtain readings from AWS. (a) The external information system provides the necessary input to the service. (b) The external information system receives a list containing the requested readings from MeteoNet.
Post-conditions	

Table 18: Scenarios of the MeteoNet UC5 – Get Readings.

ID and Name	UC-6: Save Domain
Summary	An external information system saves information about the domain of the MeteoNet system at a given instant on the file system of the BWS.
Rationale	The external information systems must be able to save the internal domain of the MeteoNet system at a given instant.
Actors	External Information System.
Pre-conditions	
Primary Scenario	1. An external information system uses the MeteoNet service "GetDomain", to save the domain of the system at that given moment. (a) The external information system invokes the service providing no input. (b) MeteoNet builds an unique XML file according to a schema with the current instances of AWS classes and related information and saves it in the BWS file system.
Post-conditions	The domain of the MeteoNet system has been saved on the BWS.

Table 19: Scenarios of the MeteoNet UC6 – Save Domain.

Artefact 11 - AWS Structure

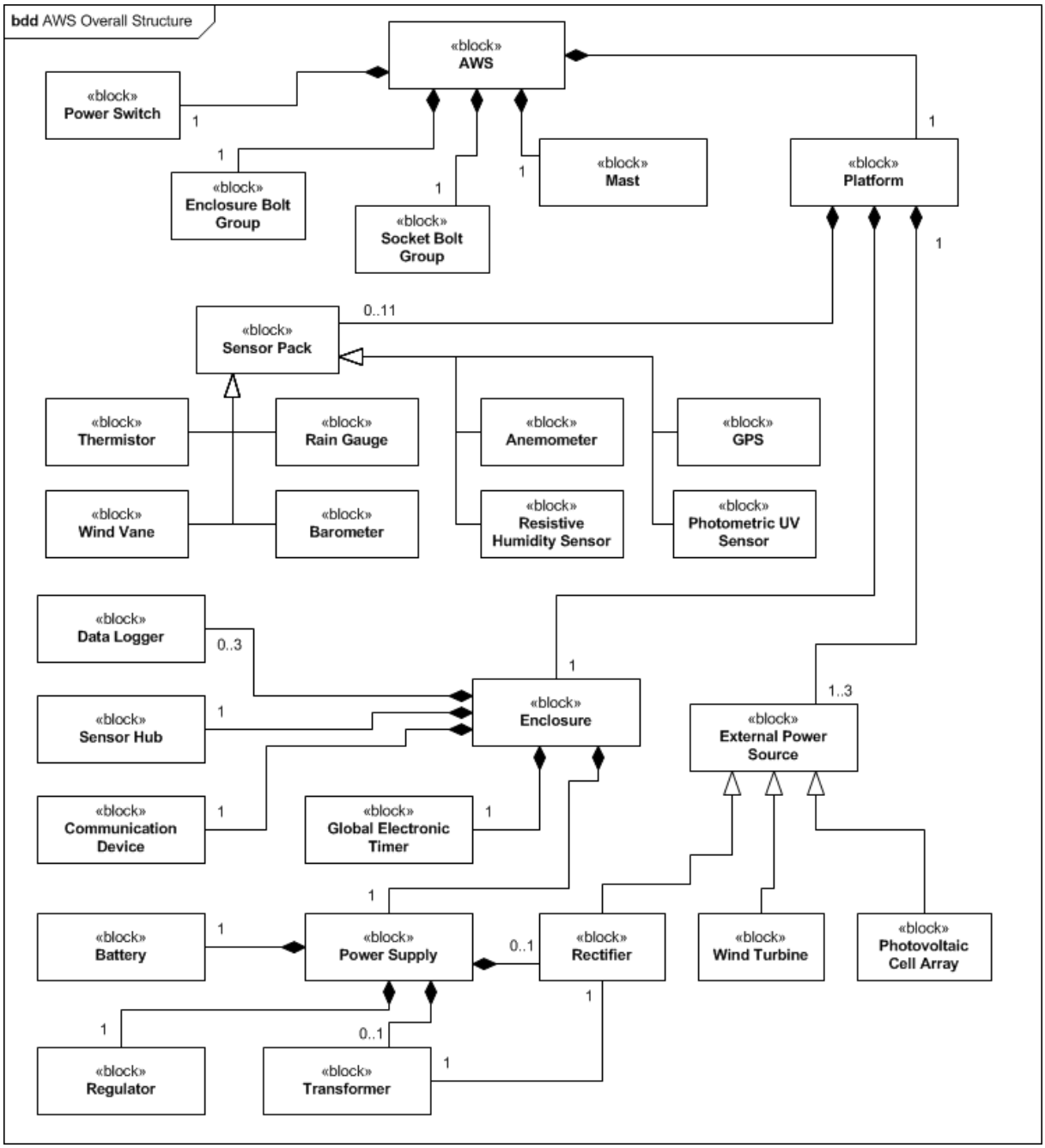

Figure 7: AWS Overall Structure - SysML bdd

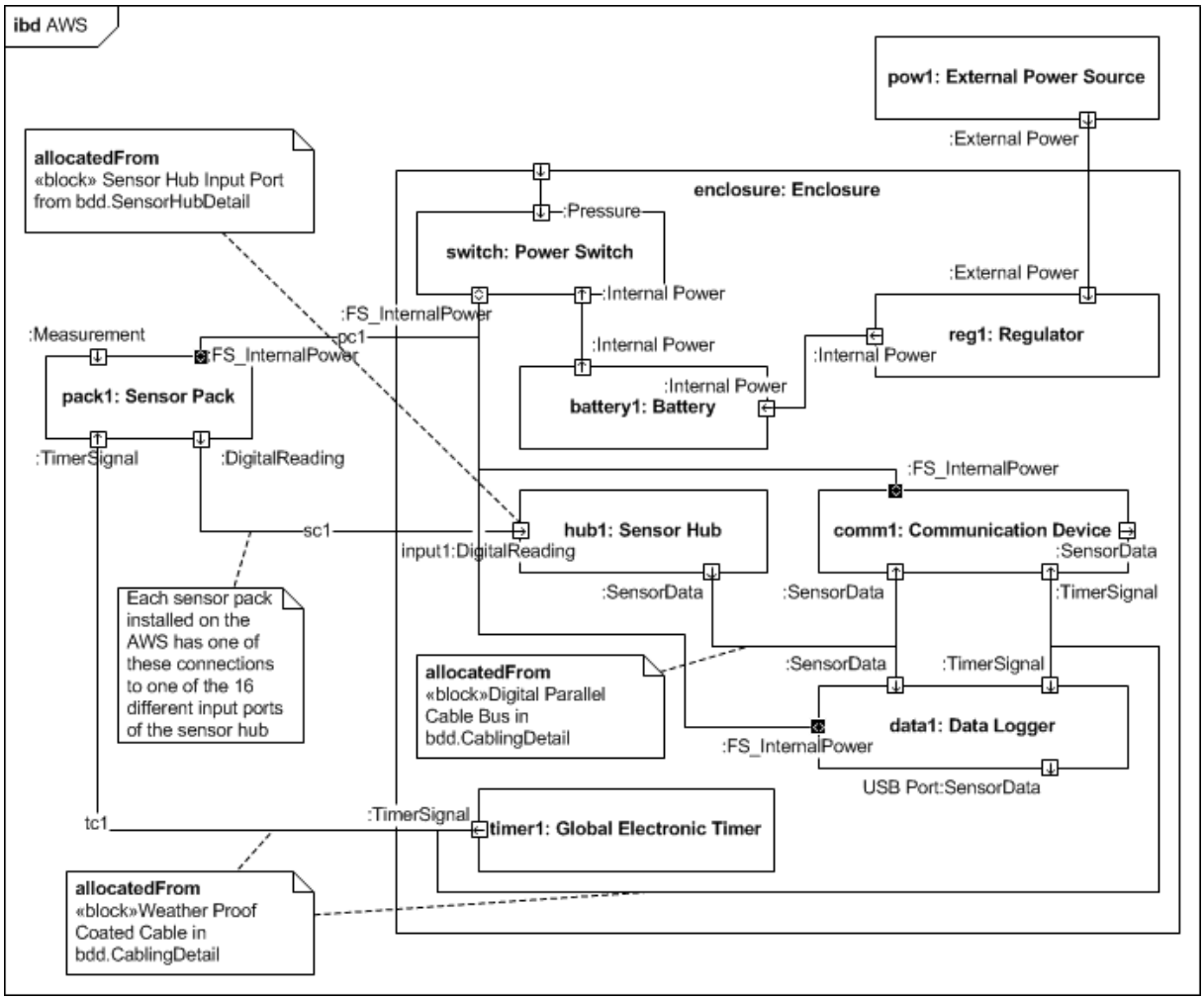

Figure 8: AWS Overall Structure - SysML ibd

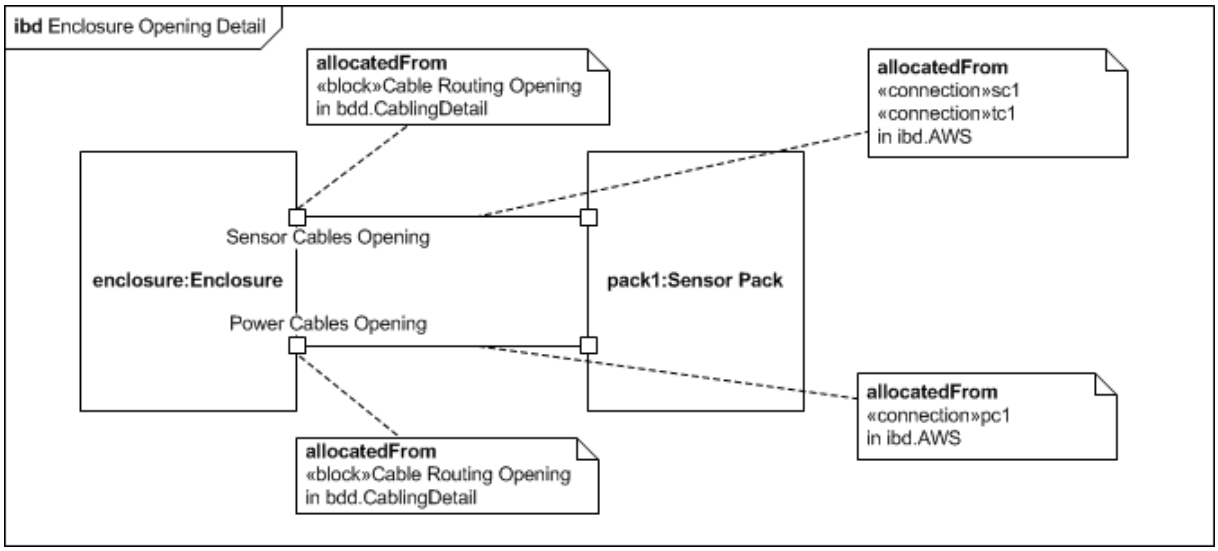

Figure 9: AWS Enclosure Opening Detail - SysML ibd

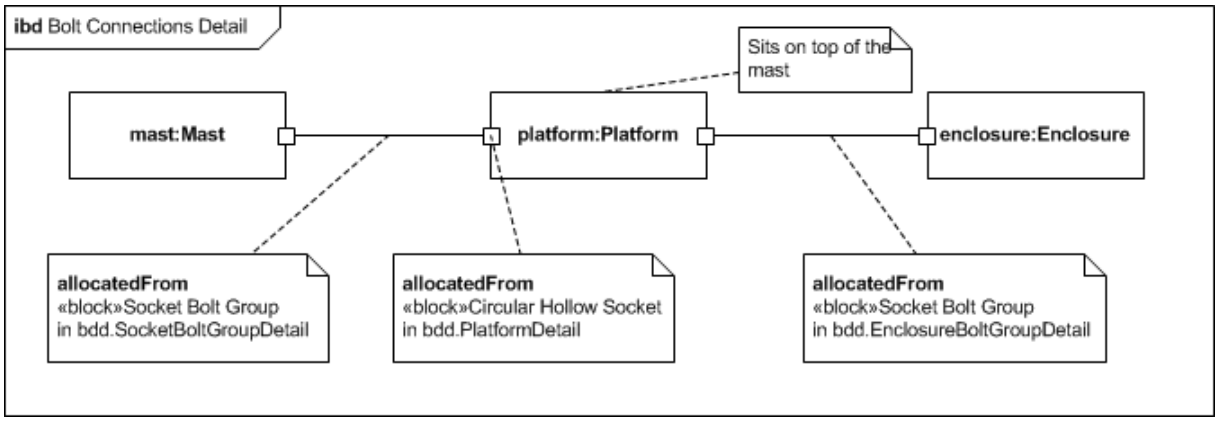

Figure 10: AWS Bolt Connections Detail - SysML idd

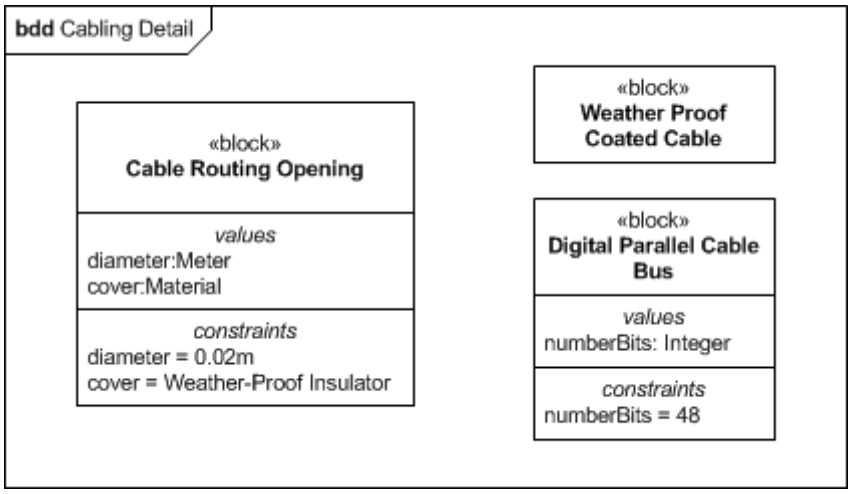

Figure 11: AWS Cabling Detail - SysML bdd

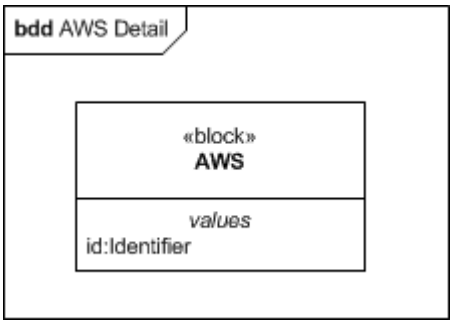

Figure 12: AWS Detail - SysML bdd

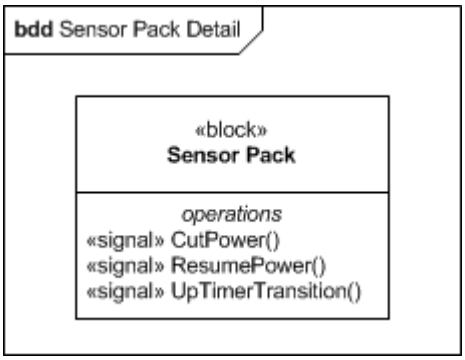

Figure 13: Sensor Pack Detail - SysML bdd

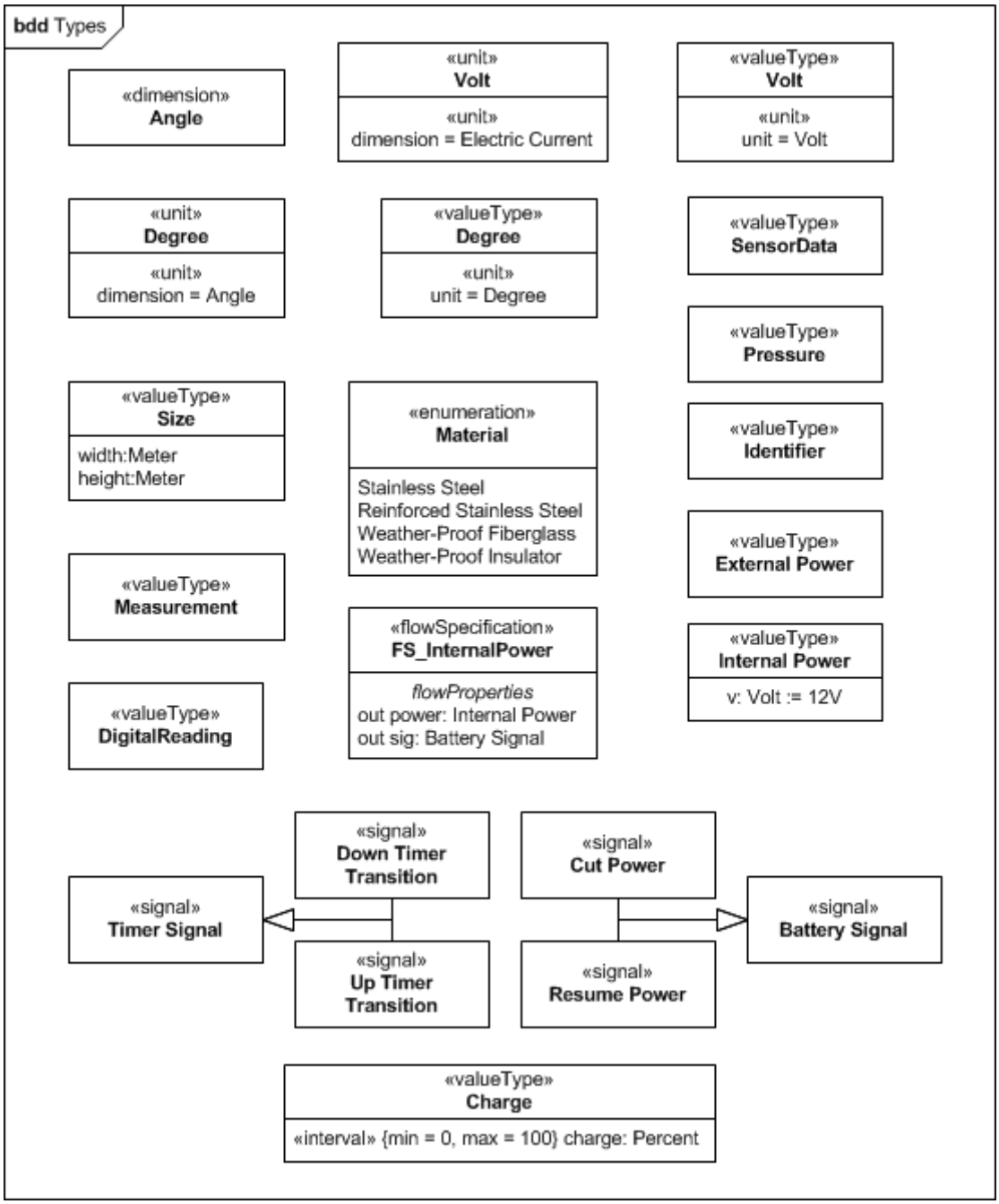

Figure 14: Types - SysML bdd

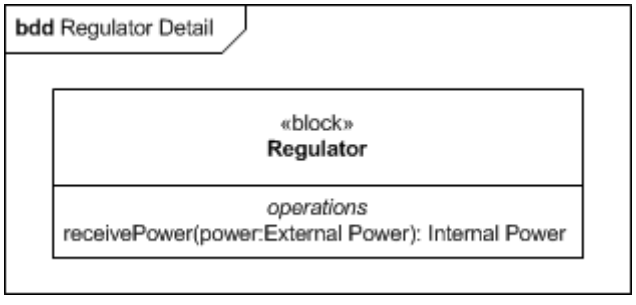

Figure 15: Regulator Detail - SysML bdd

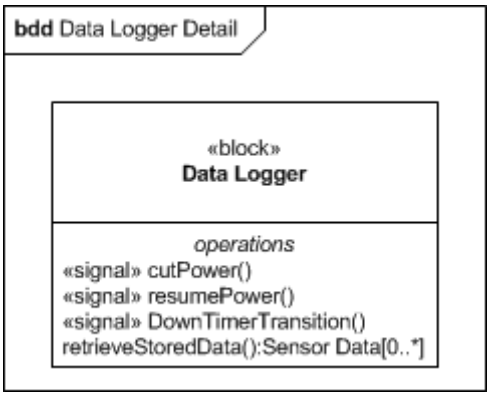

Figure 16: Data Logger Detail - SysML bdd

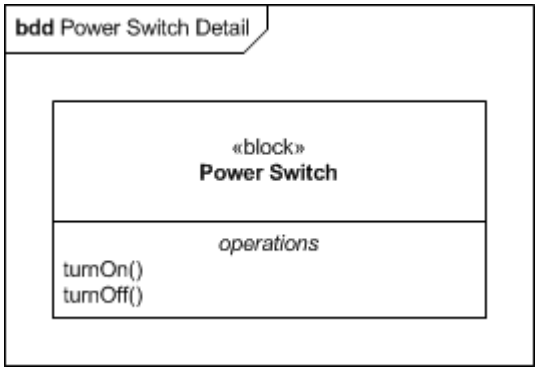

Figure 17: Power Switch Detail - SysML bdd

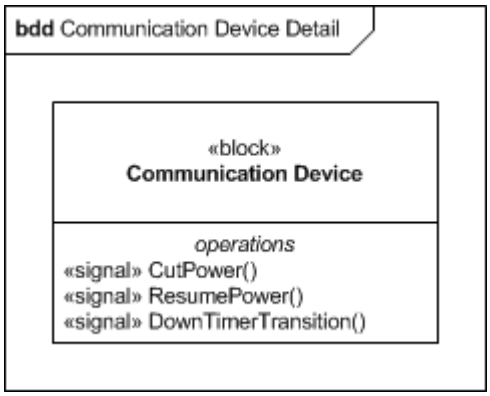

Figure 18: Communication Device Detail - SysML bdd

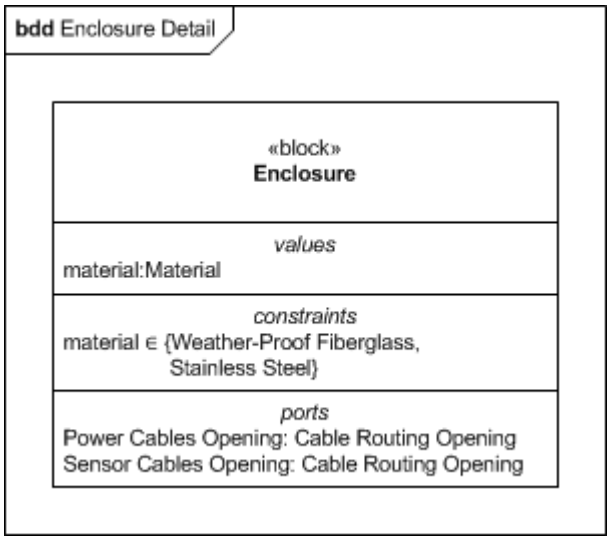

Figure 19: Enclosure Detail - SysML bdd

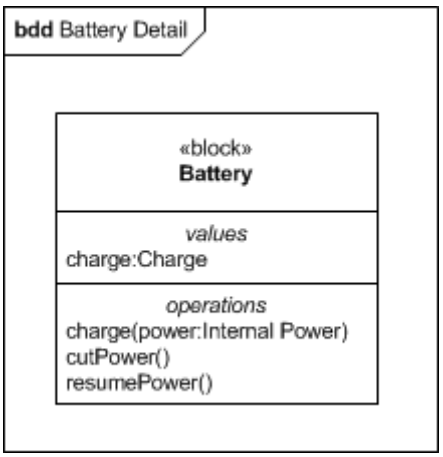

Figure 20: Battery Detail - SysML bdd

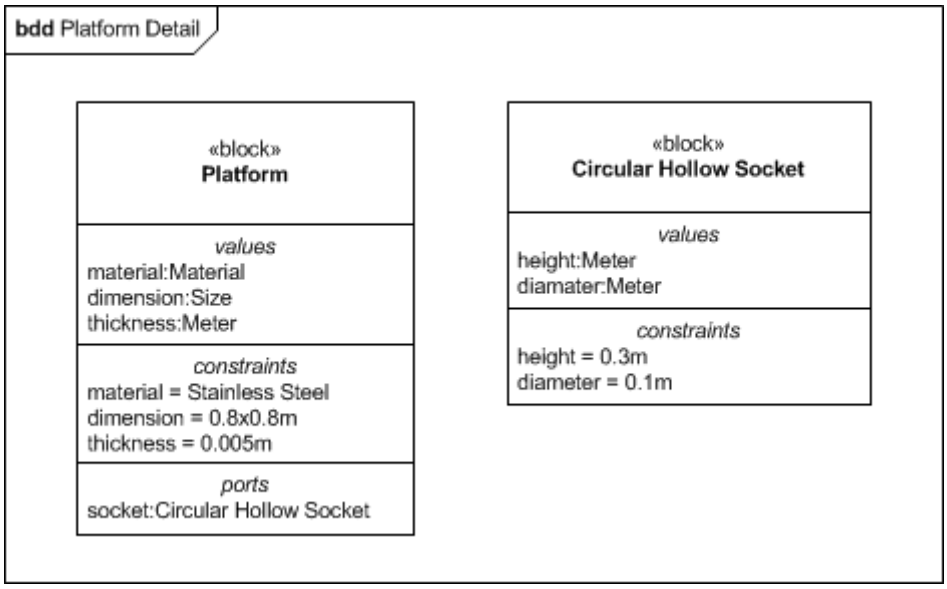

Figure 21: Platform Detail - SysML bdd

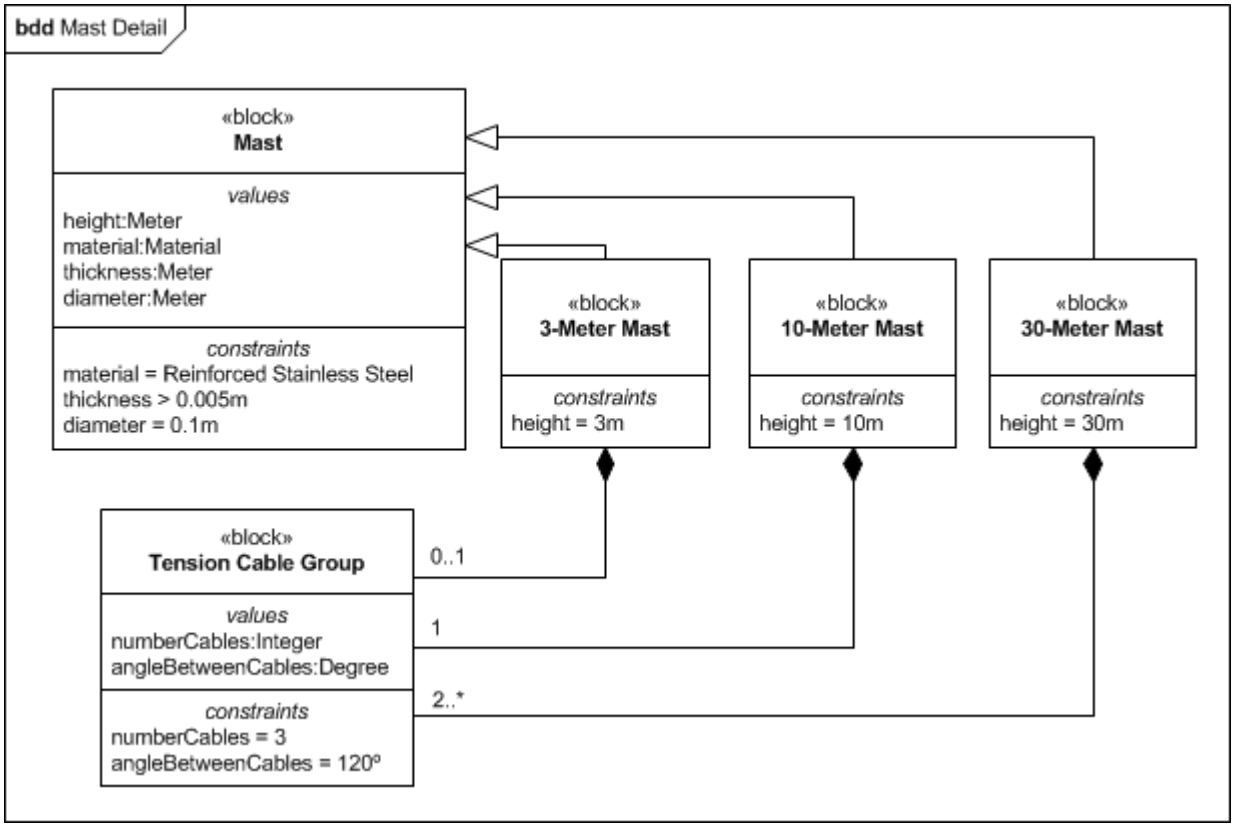

Figure 22: Mast Detail - SysML bdd

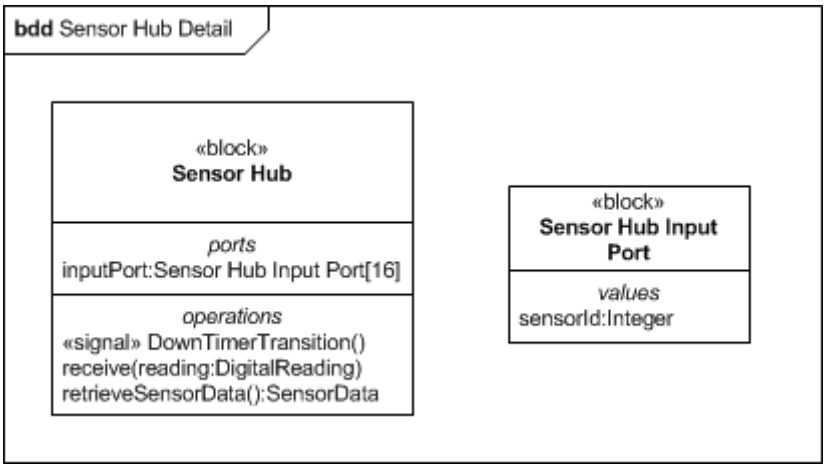

Figure 23: Sensor Hub Detail - SysML bdd

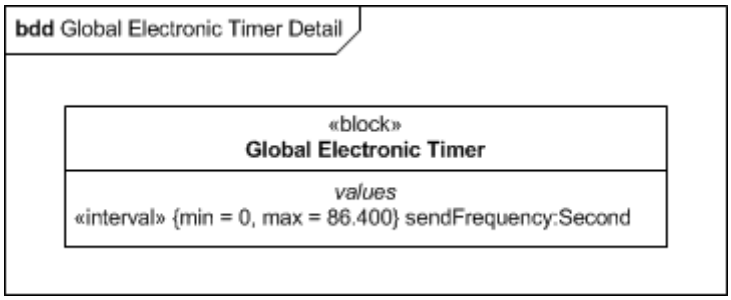

Figure 24: Timer Detail - SysML bdd

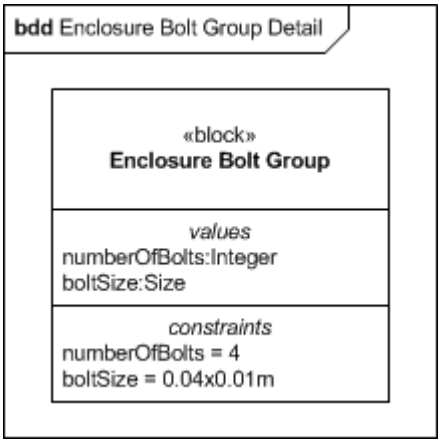

Figure 25: Enclosure Bolt Group Detail - SysML bdd

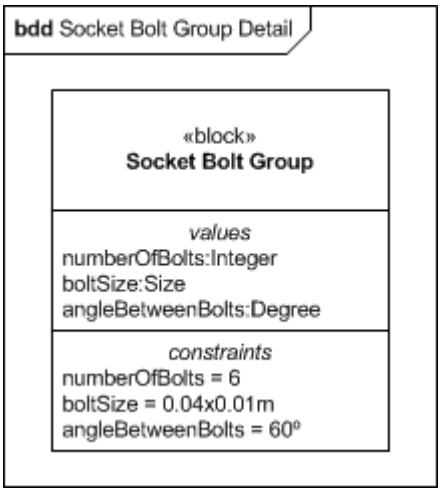

Figure 26: Socket Bolt Group Detail - SysML bdd

Artefact 12 - MeteoNet Classes

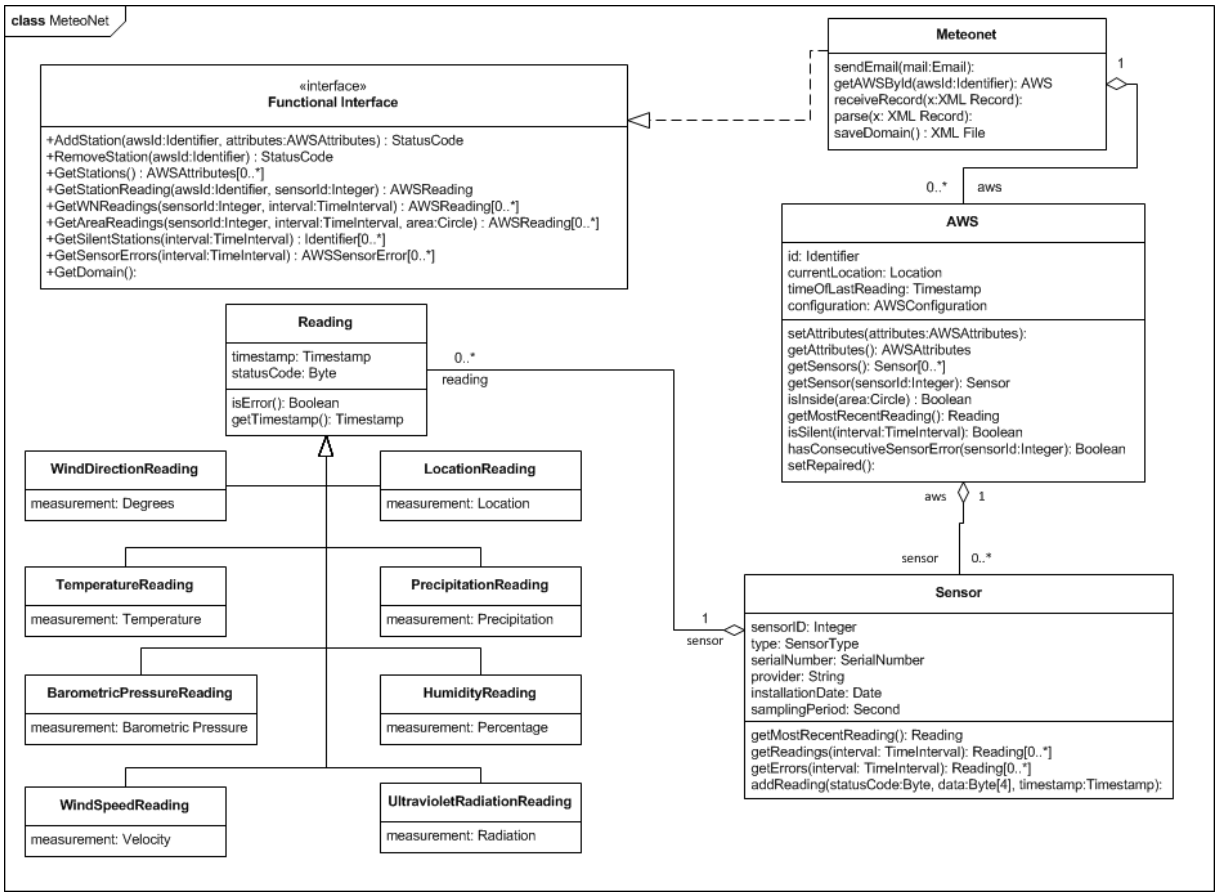

Figure 27: MeteoNet classes

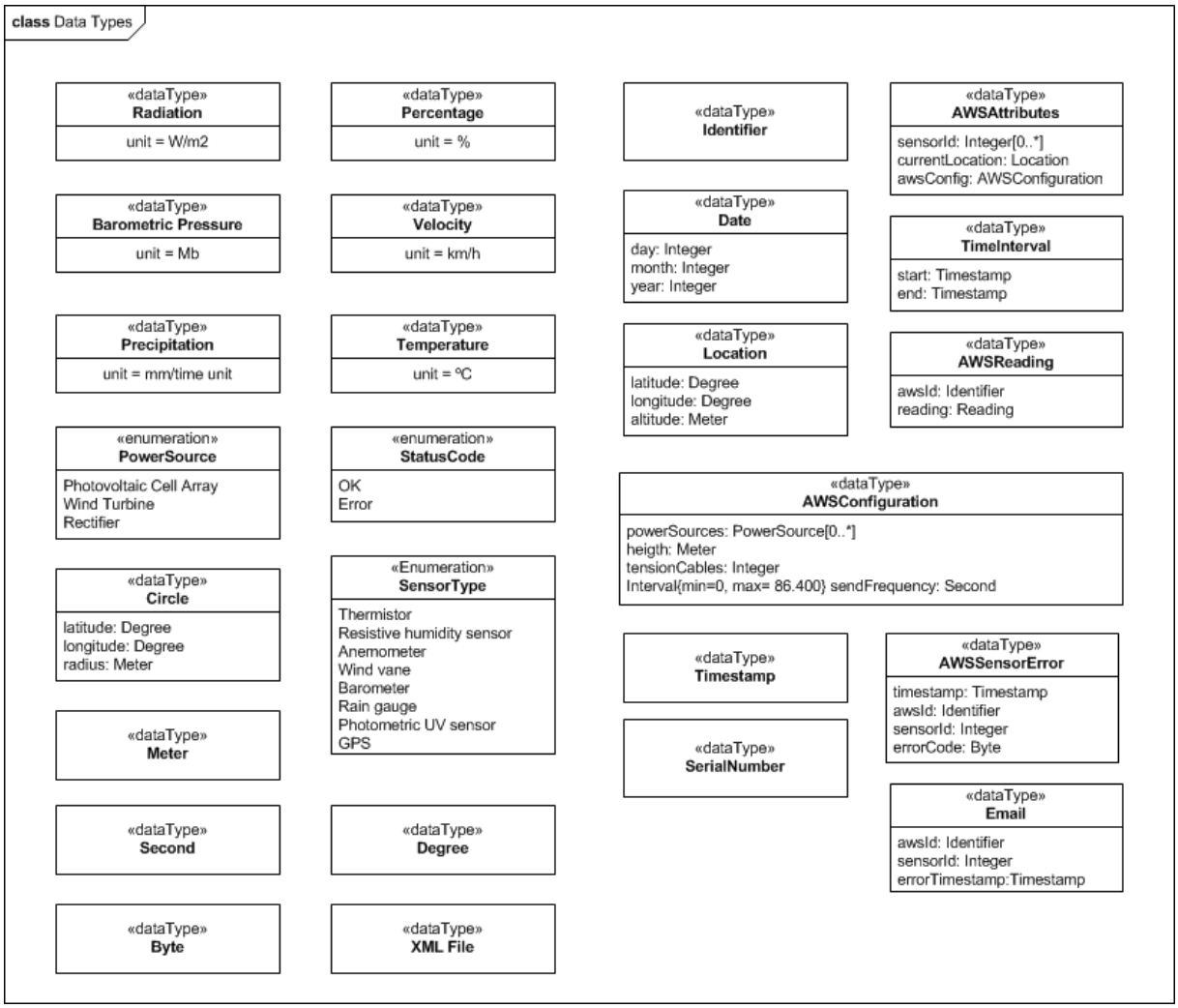

Figure 28: MeteoNet types

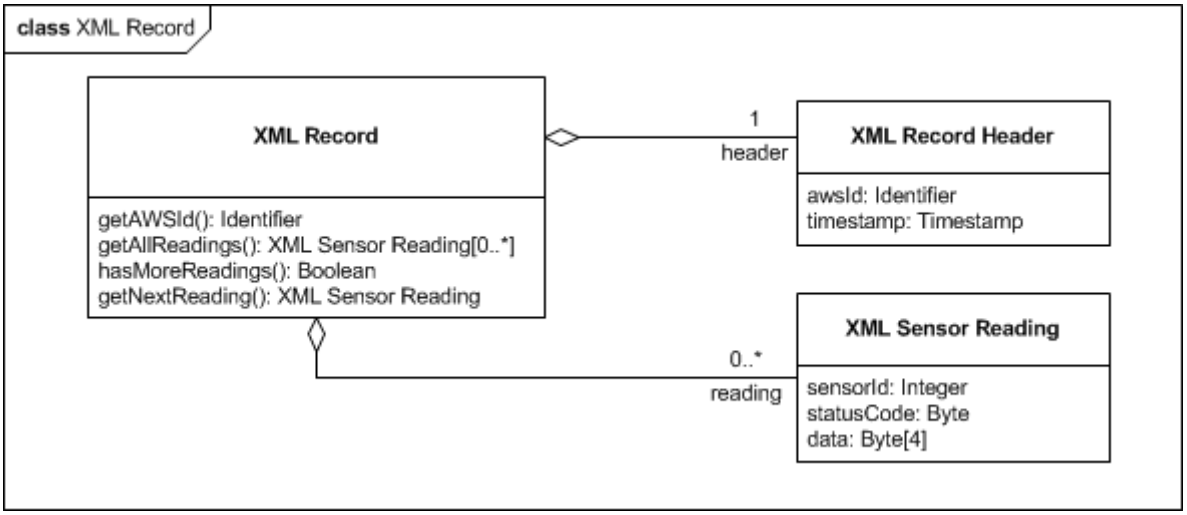

Figure 29: MeteoNet XML Record

Artefact 13 - MeteoNet Components

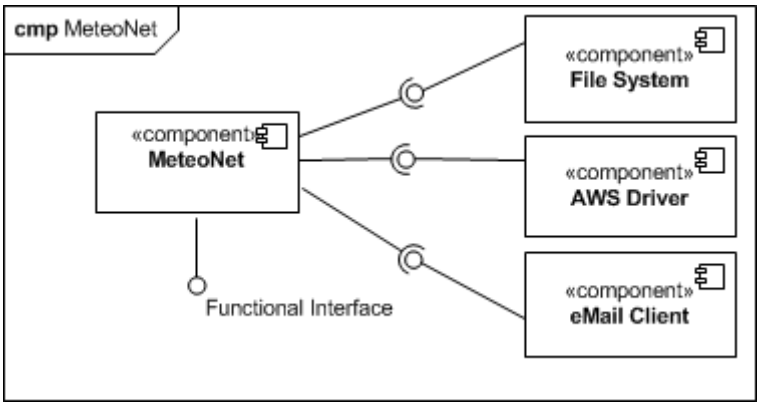

Figure 30: MeteoNet Components

Artefact 14 - MeteoNet Deployment

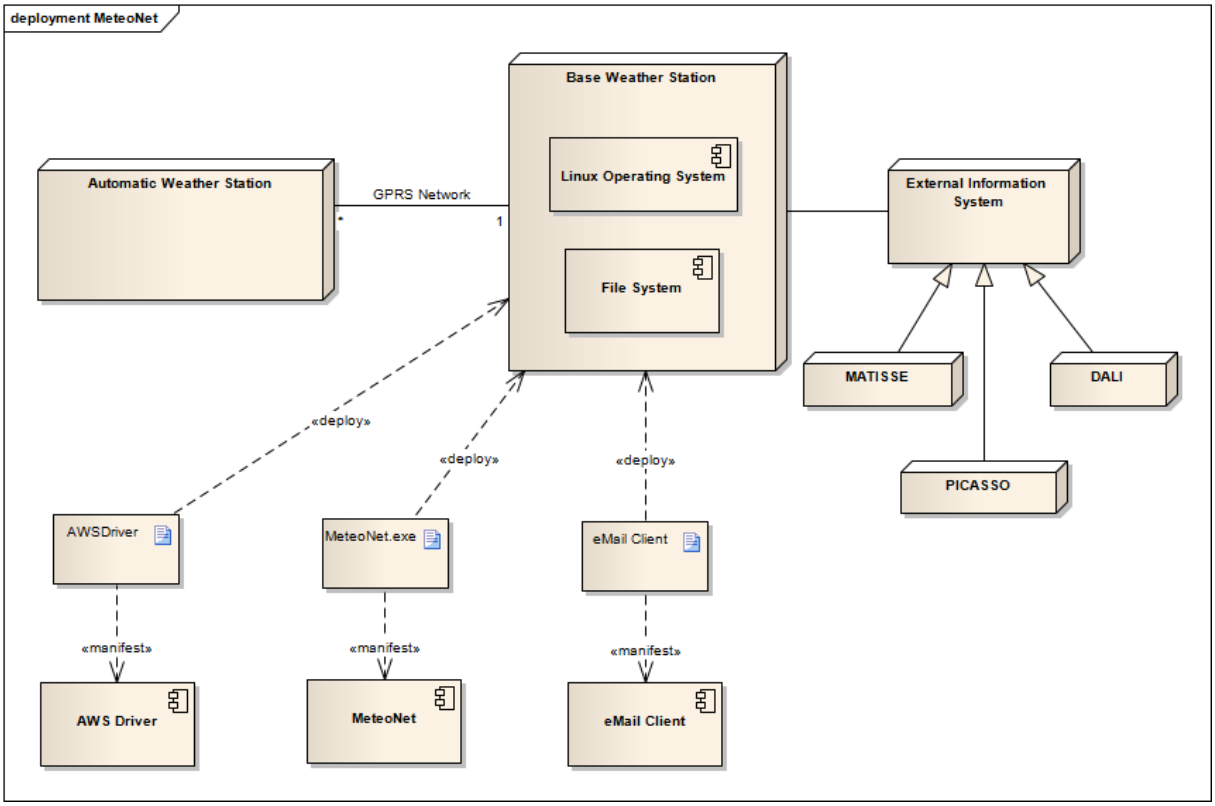

Figure 31: MeteoNet Deployment

Artefact 15 - AWS Behaviour

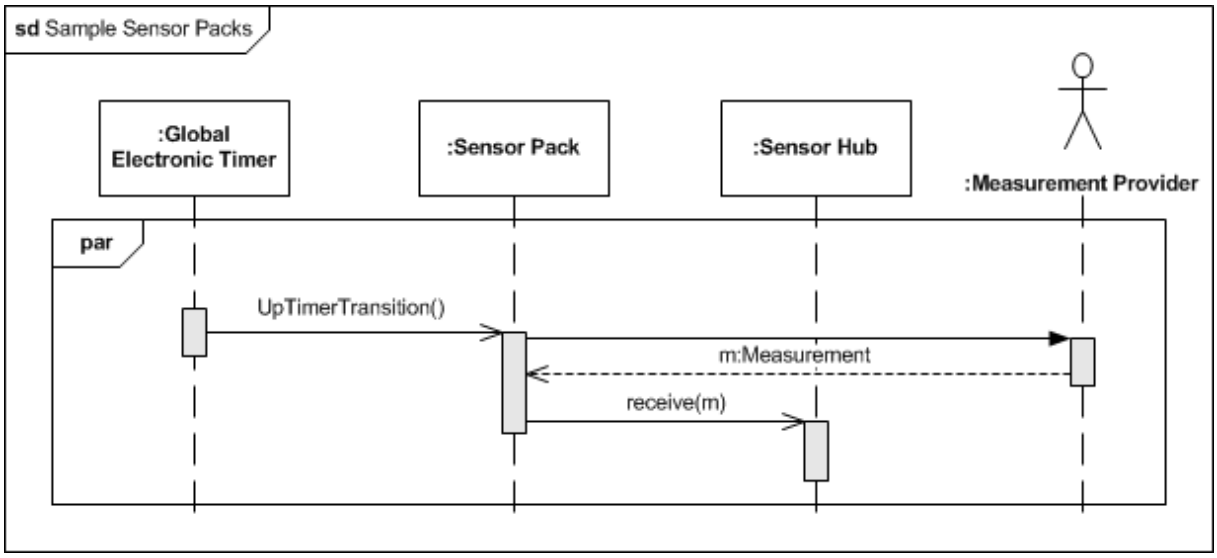

Figure 32: Sample Sensor Packs - SysML sd

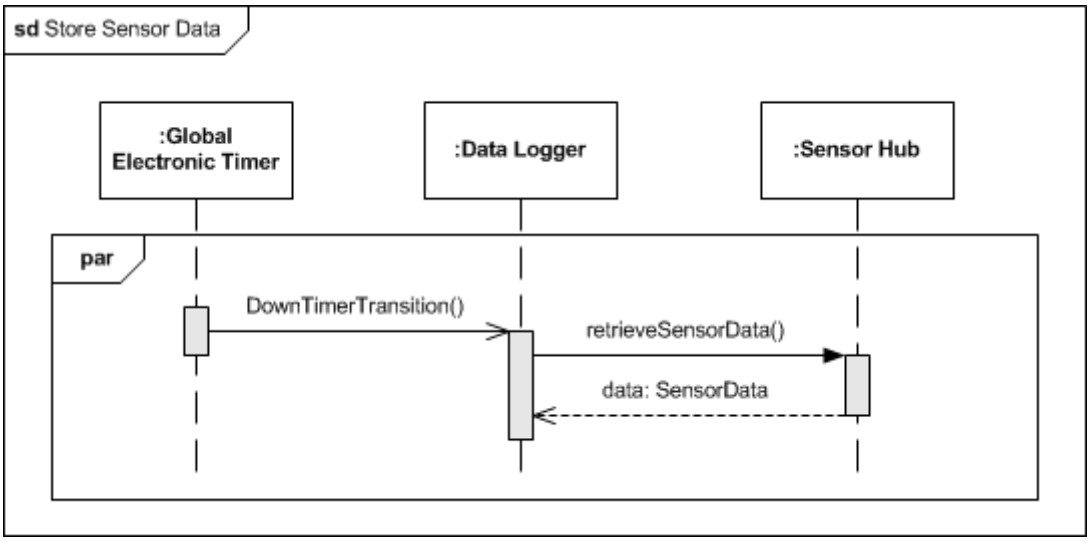

Figure 33: Store Sensor Data - SysML sd

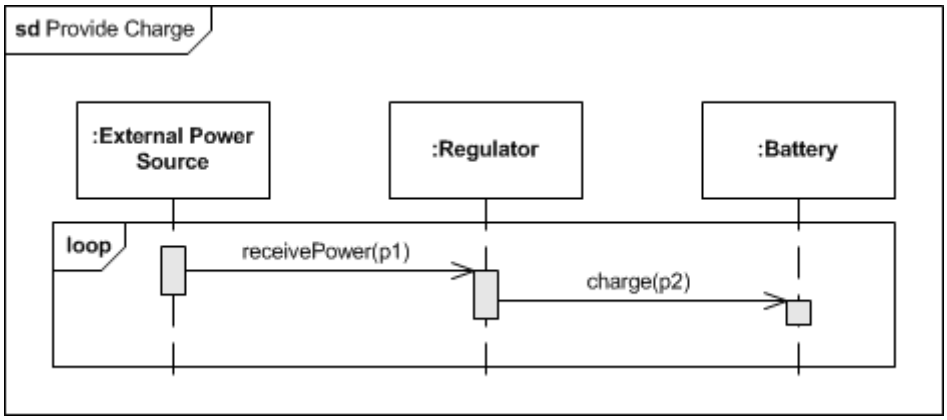

Figure 34: Provide Charge - SysML sd

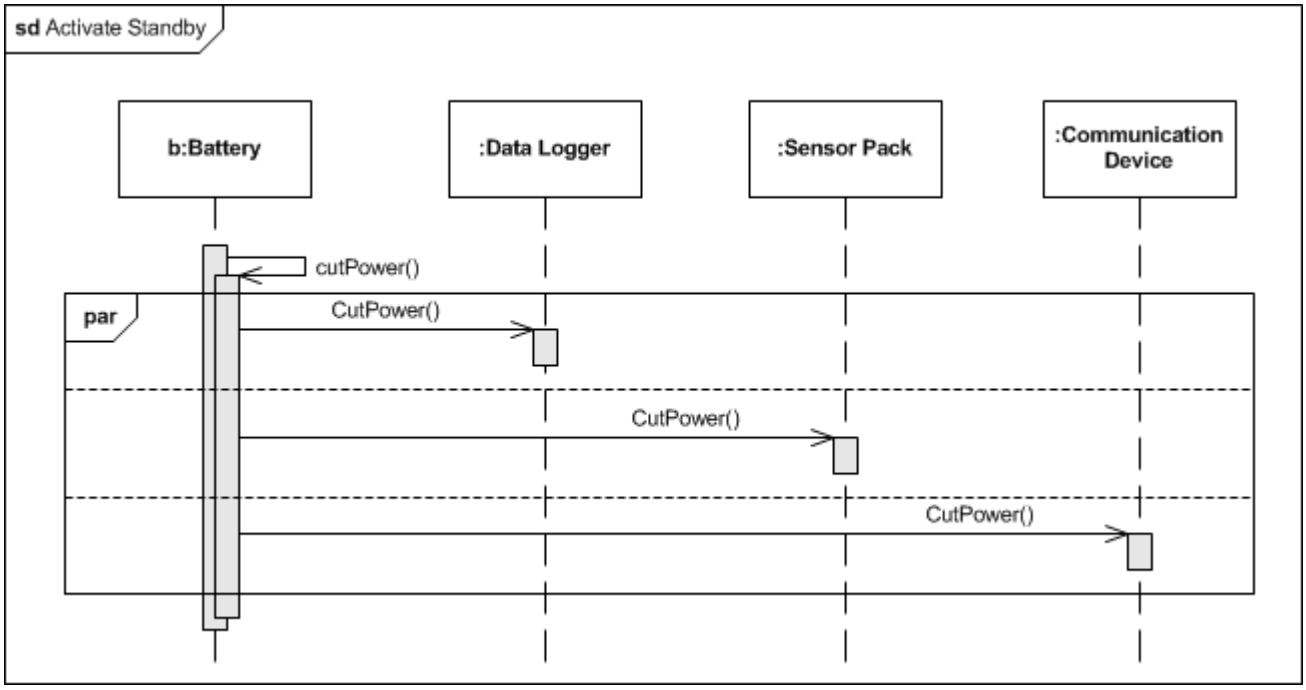

Figure 35: Activate Standby - SysML sd

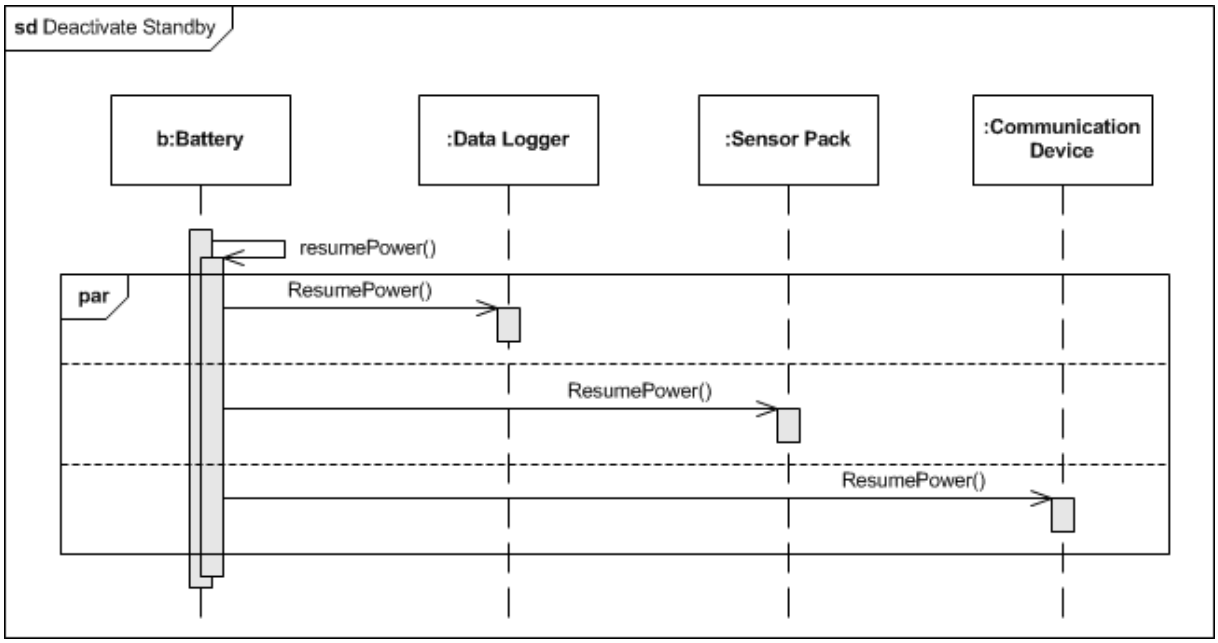

Figure 36: Deactivate Standby - SysML sd

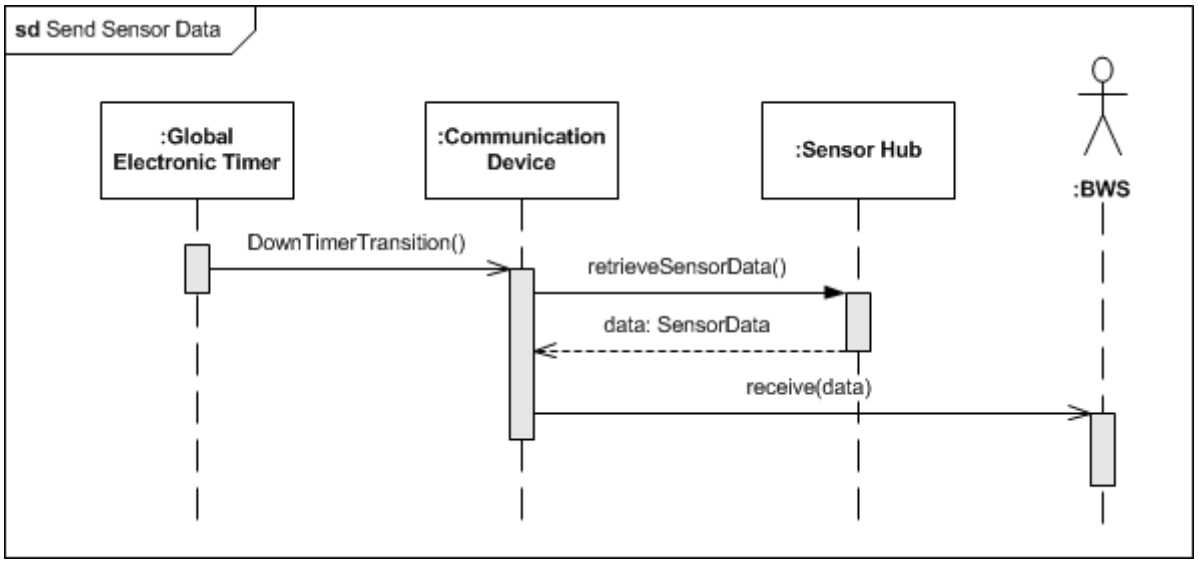

Figure 37: Send Sensor Data - SysML sd

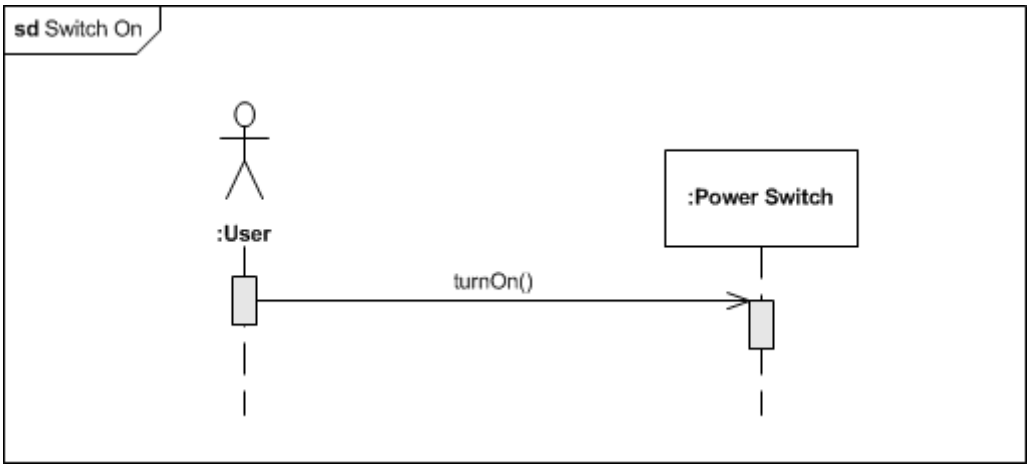

Figure 38: Switch On - SysML sd

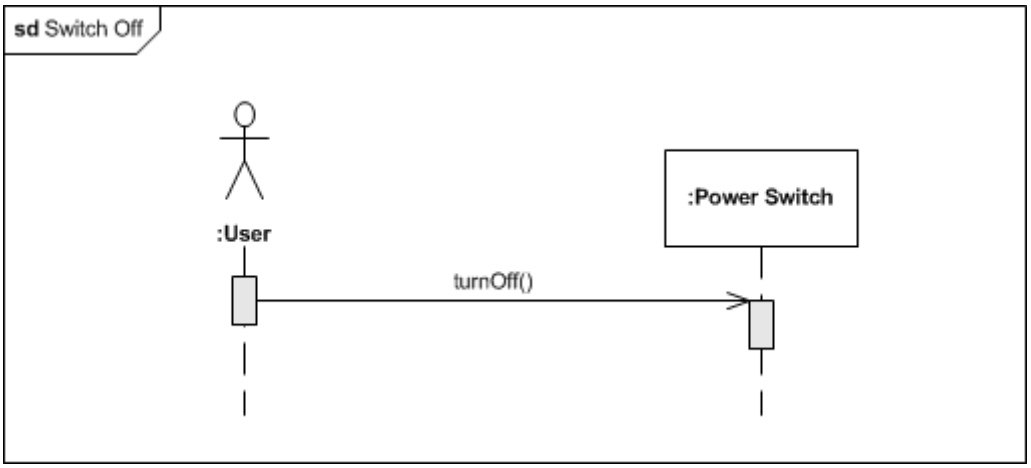

Figure 39: Switch Off - SysML sd

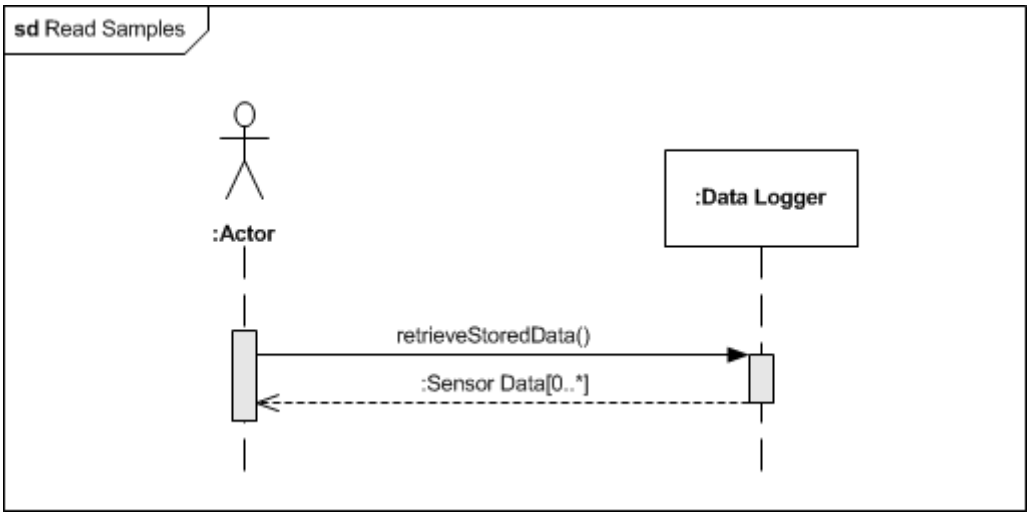

Figure 40: Read Samples - SysML sd

Artefact 16 - AWS States

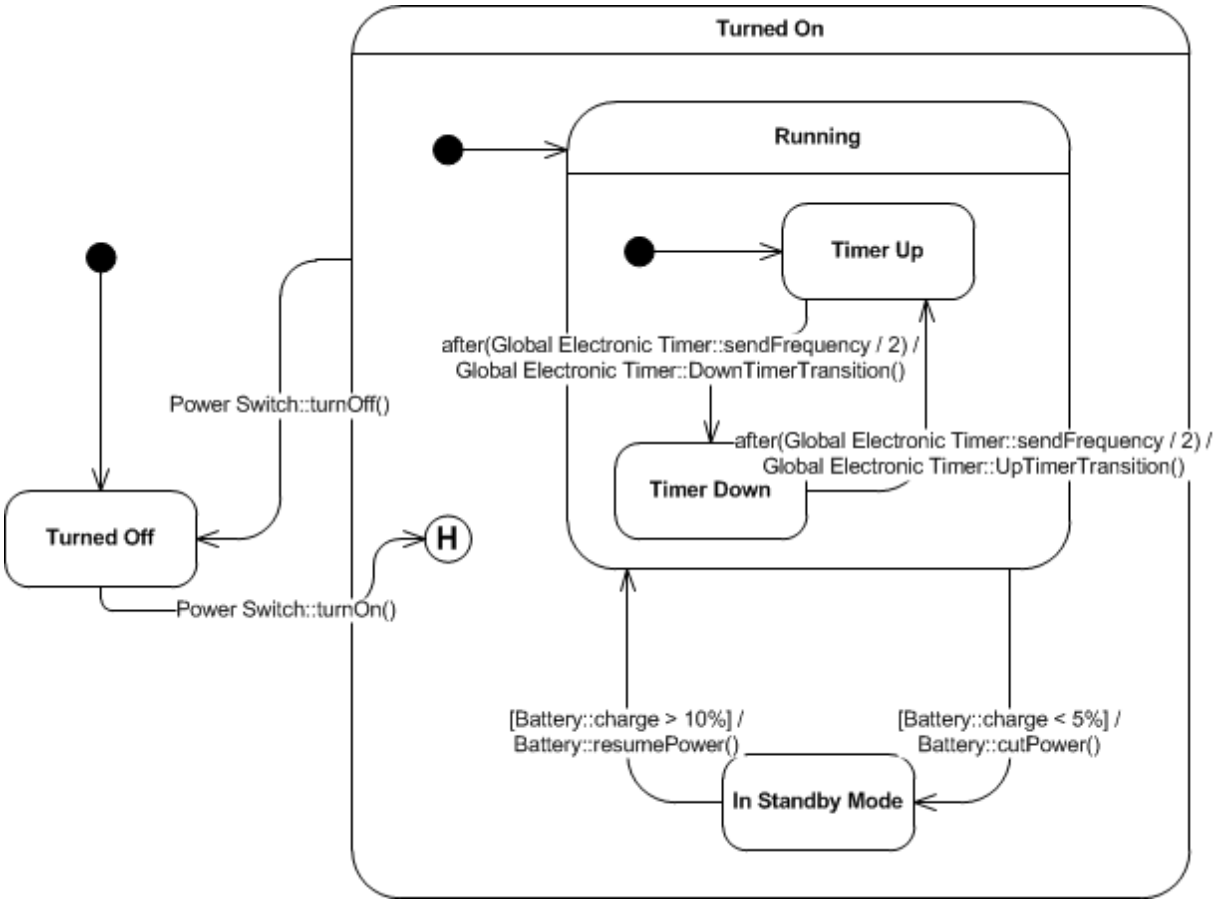

Figure 41: AWS States

Artefact 17 - MeteoNet Behaviour

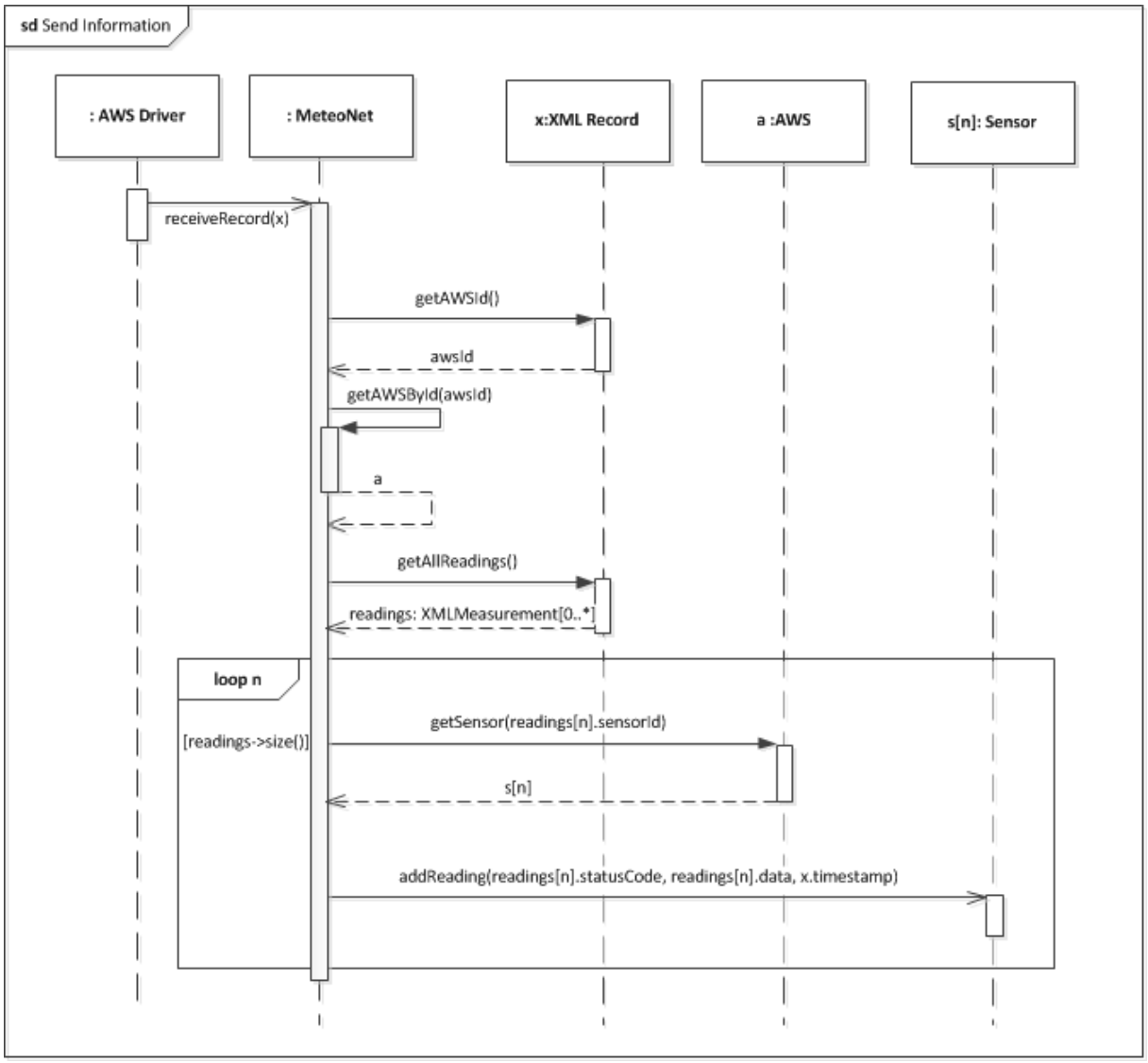

Figure 42: Send Information - SysML sd

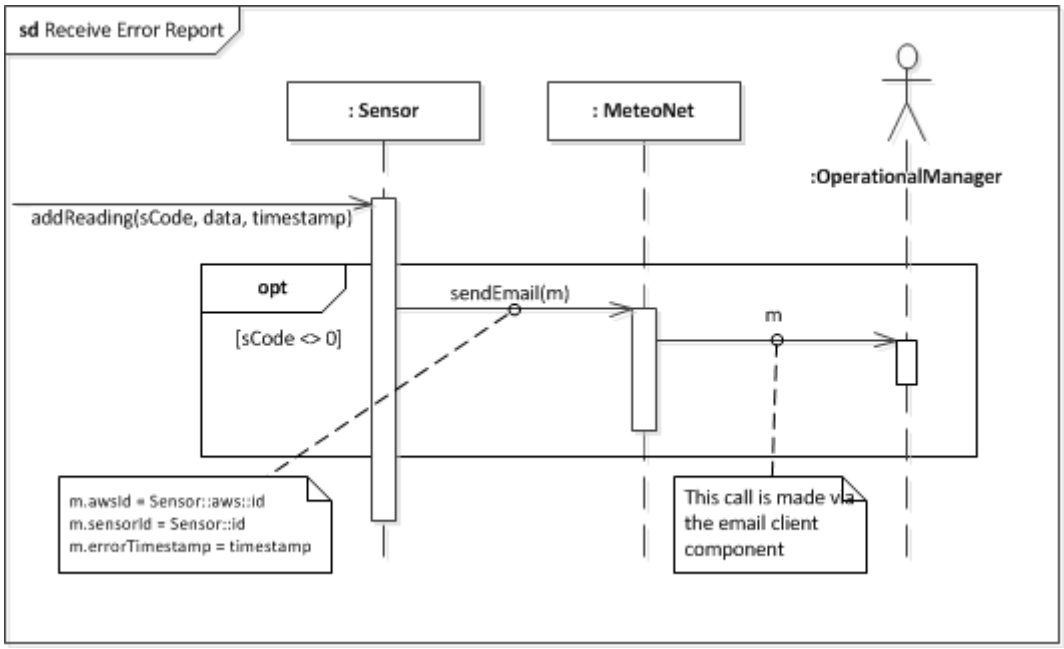

Figure 43: Receive Error Report - SysML sd

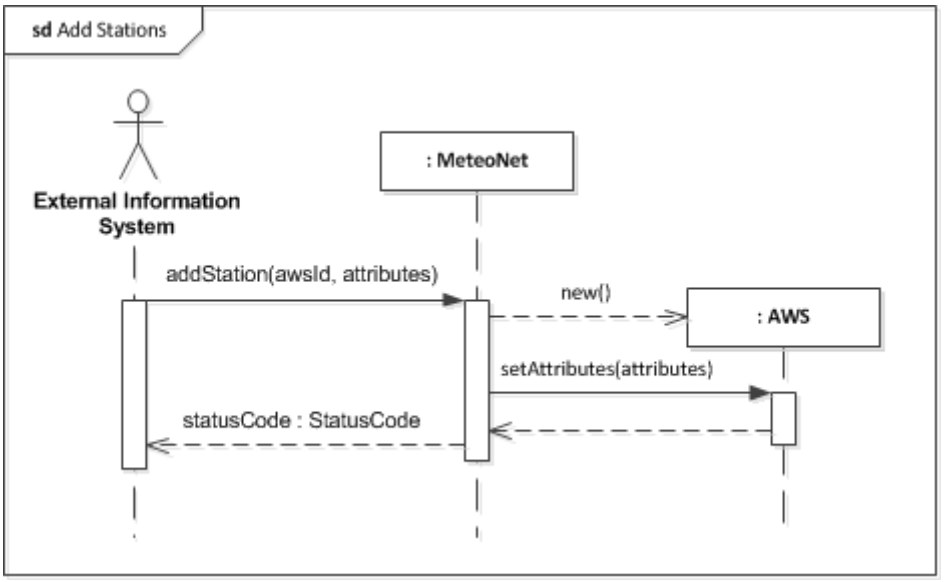

Figure 44: Add stations - SysML sd

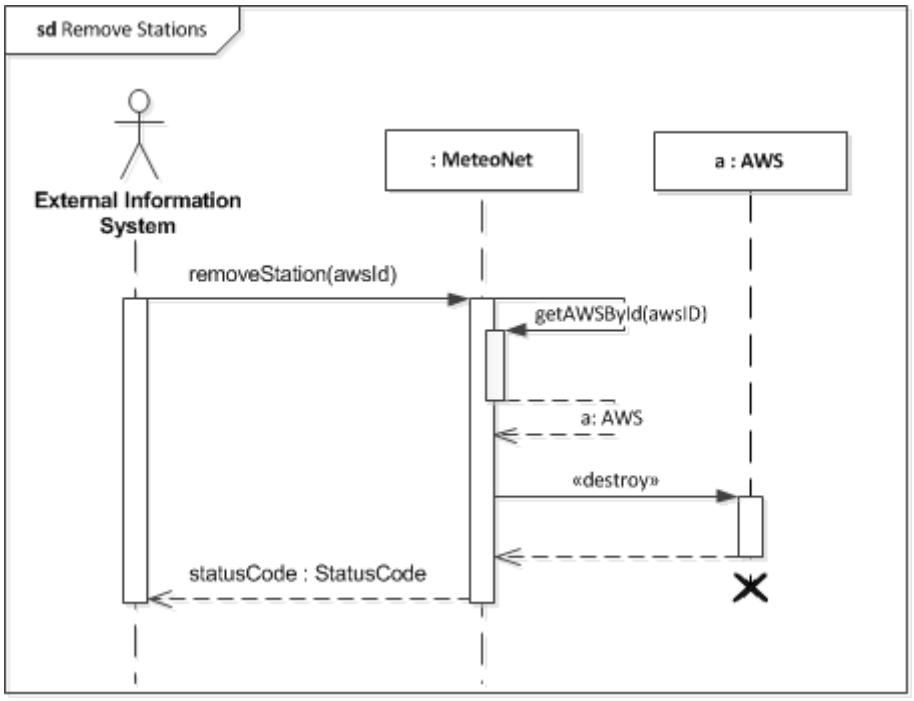

Figure 45: Remove station - SysML sd

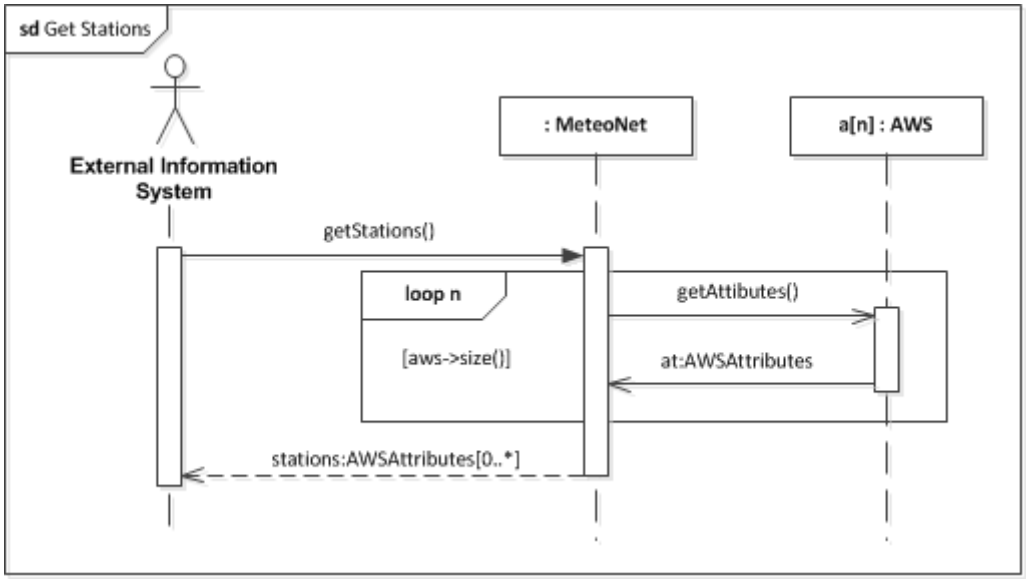

Figure 46: Get stations - SysML sd

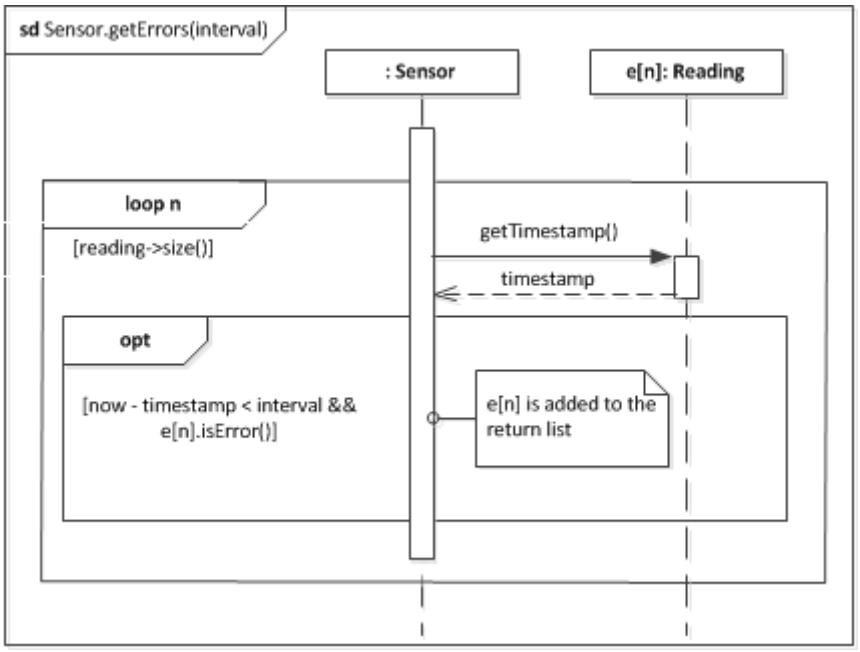

Figure 47: Get sensor error - SysML sd

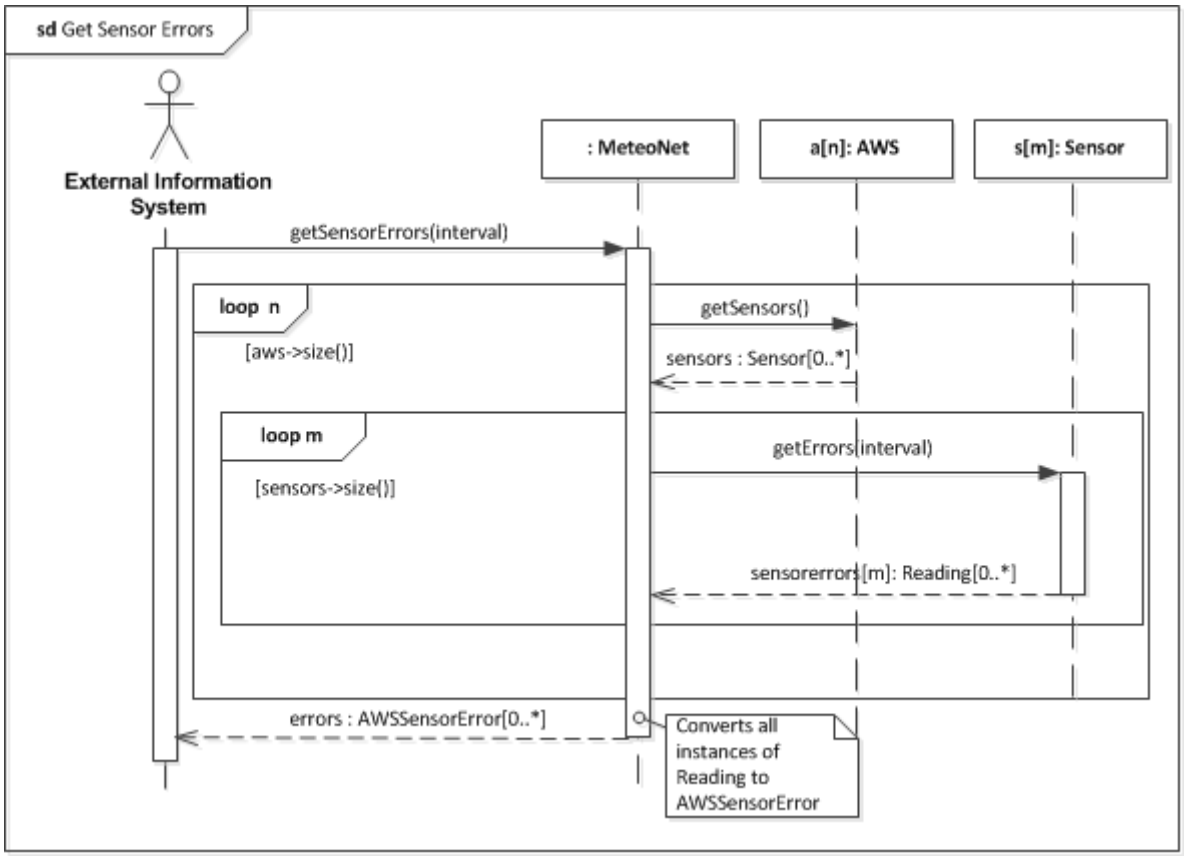

Figure 48: Get sensor errors - SysML sd

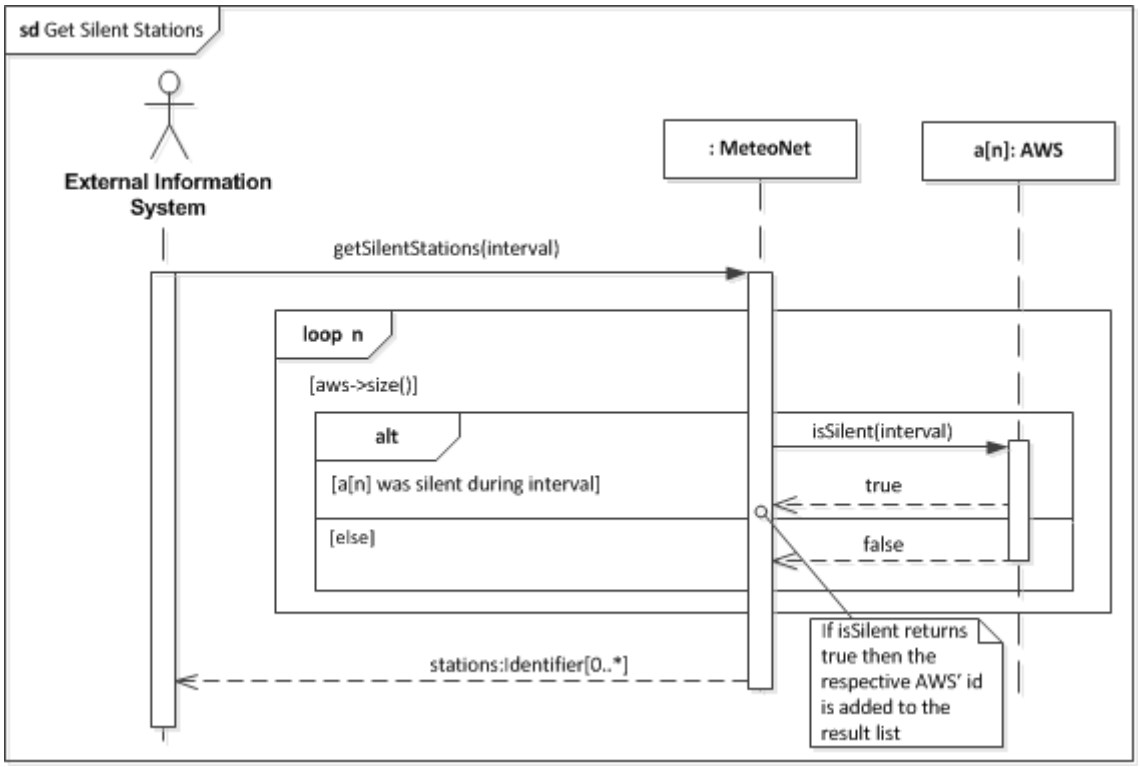

Figure 49: Get silent stations - SysML sd

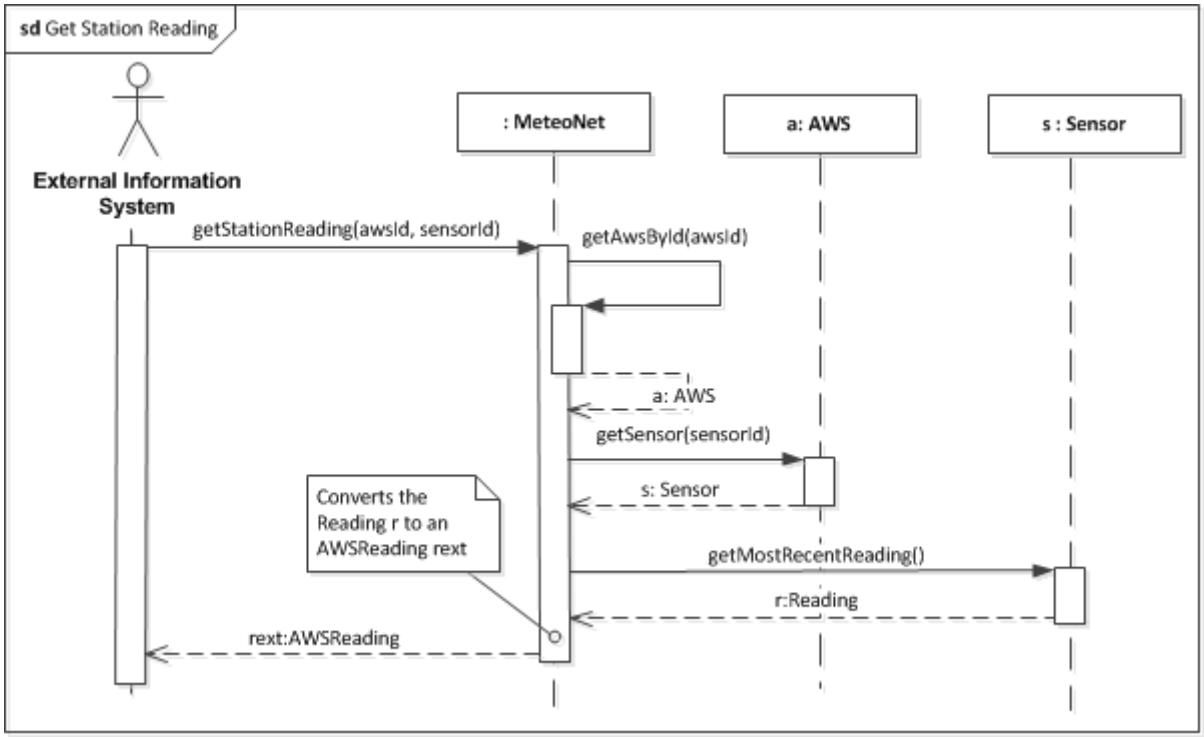

Figure 50: Get station readings - SysML sd

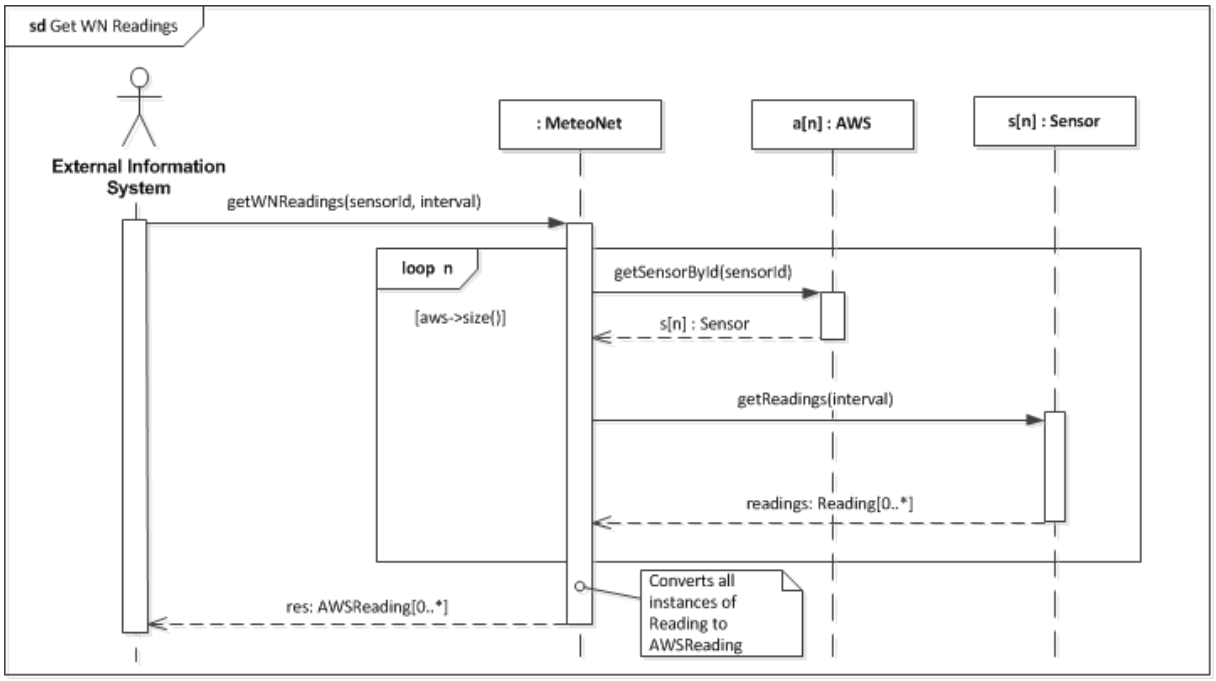

Figure 51: Get WN Readings - SysML sd

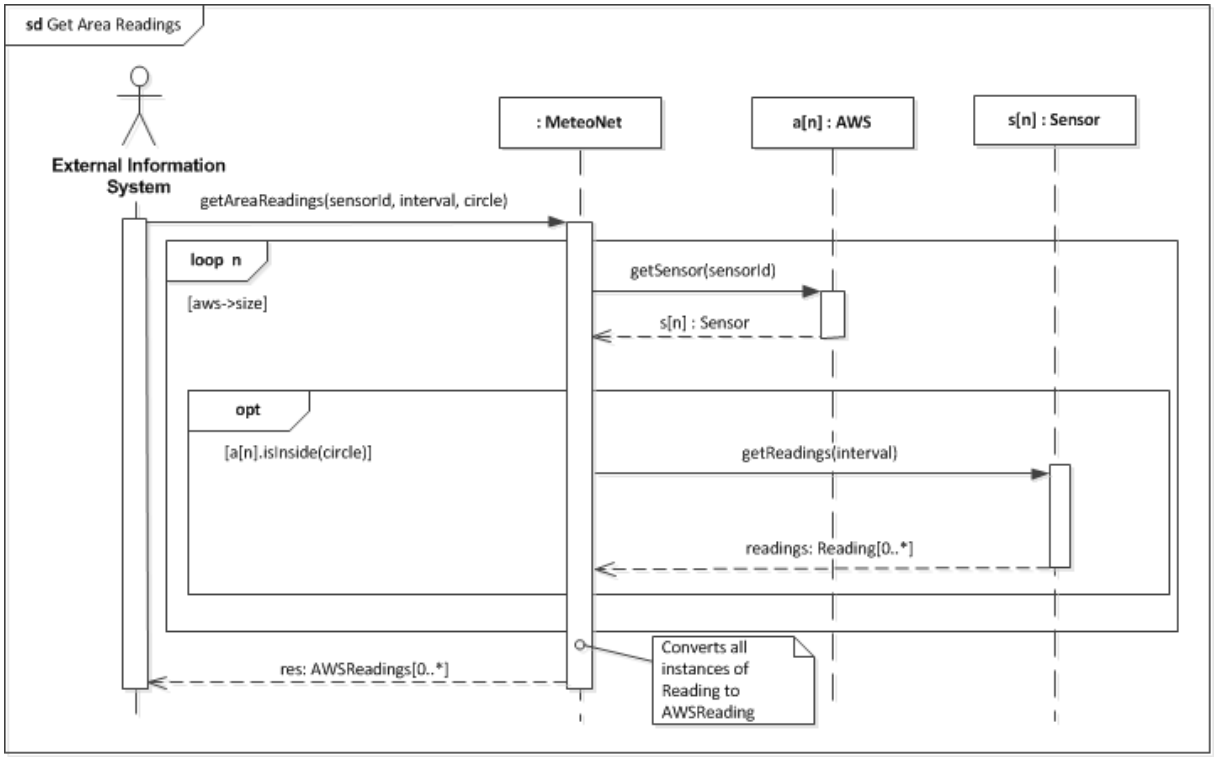

Figure 52: Get area readings - SysML sd

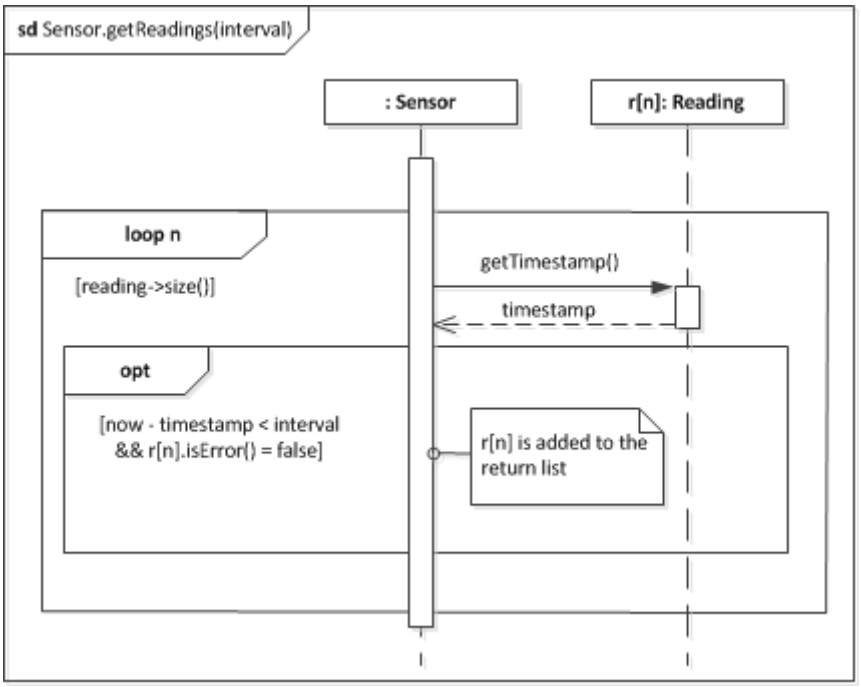

Figure 53: Get sensor readings - SysML sd

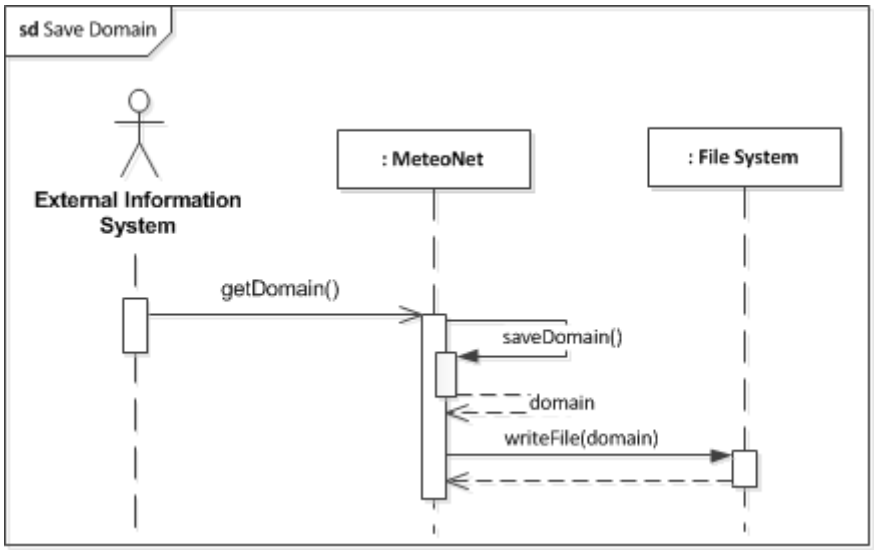

Figure 54: Save domain - SysML sd

Artefact 18 - MeteoNet States

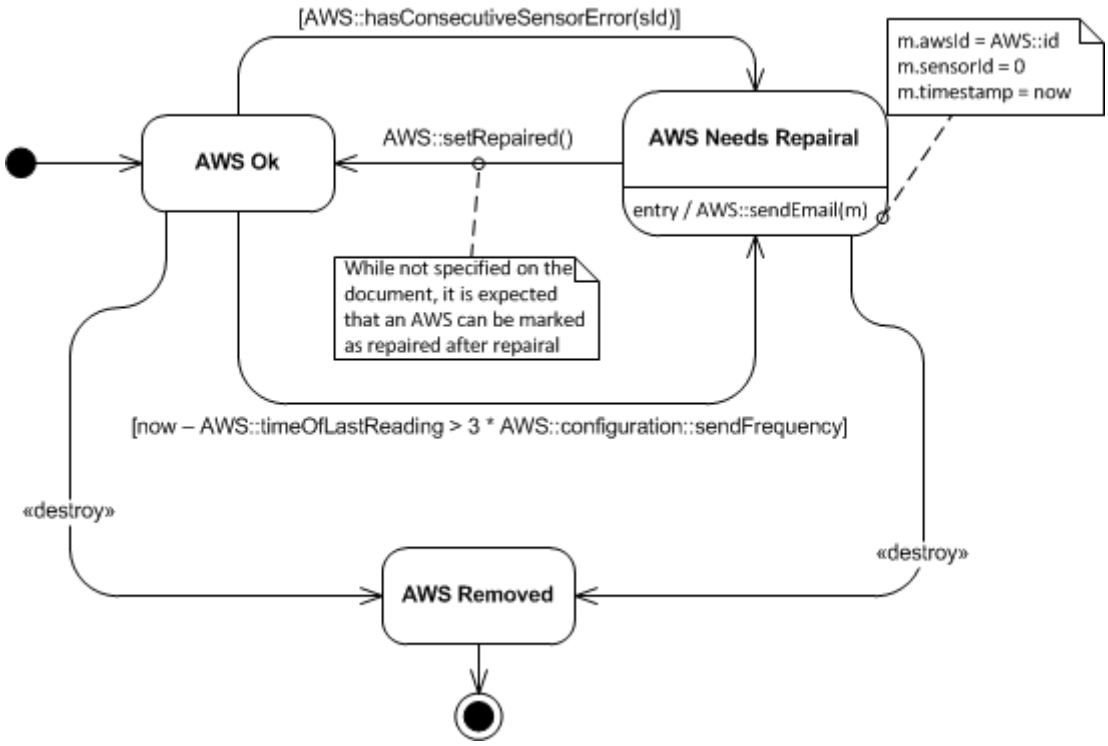

Figure 55: MeteoNet AWS States

Artefact 19 - DWP Management Process

ID	Source	Type	Description
23	Lines 201-203	NF	The OperationalManager must be responsible for the Daily Work Plan (DWP) management process.
24	Line 203	NF	The Daily Work Plan (DWP) must be executed by the MTeam.
25	Line 203-204	NF	The Daily Work Plan (DWP) must be executed by the CTeam.
26	Line 206	NF	The OperationalManager must create the DWP daily between 08:00 and 10:00.
26.1	Lines 210-211, 212	NF	The creation of the DWP must take into account the requests for installation, reconfiguration or removal of an AWS.
26.1.1	Lines 212-213	NF	The requests for installation, reconfiguration or removal of an AWS must be sent by the WNCoordinator.
26.2	Lines 210-211, 215	NF	The creation of the DWP must take into account the error messages received from the MeteoNet software.
26.3	Lines 210-211, 218	NF	The creation of the DWP must take into account the reports from the MTeam.
26.4	Lines 210-211, 218	NF	The creation of the DWP must take into account the reports from the CTeam.
26.5	Lines 210-211, 220	NF	The creation of the DWP must take into account the requests for data collection.
26.5.1	Lines 220-221	NF	A request for data collection must be created by a Data Requester.
26.5.2	Lines 221-222	NF	A request for data collection must be authorized by the WNCoordinator.
26.5.3	Lines 222-223	NF	If the WNCoordinator accepts a request for data collection, he must send the request to the OperationalManager.
26.6	Lines 210-211, 224	NF	The creation of the DWP must take into account the periodic enclosure inspections.
26.6.1	Lines 70-71	NF	A fiberglass enclosure must be inspected every year.
26.6.2	Lines 72-73	NF	A stainless steel enclosure must be inspected every two years.
26.7	Lines 243-244	NF	The creation of the DWP must take into account the trimestral data collection from AWS with data logger(s).
26.8	Lines 296,297	NF	The creation of the DWP must take into account the annual mast inspections.
27	Line 207	NF	The OperationalManager must send the DWP to the teams (MTeam and CTeam) no later than 10:00.
28	Lines 207-208	NF	If there are no operations to be performed, the DWP must state that ``No action is required''.

Table 20: DWP Management Process Requirement List

Context Information for artefacts 19-25

- (Lines 290-291) All communication between the MeteoNet, CTeam, MTeam, WNCoordinator, Sensor Provider and OperationalManager is done via email.

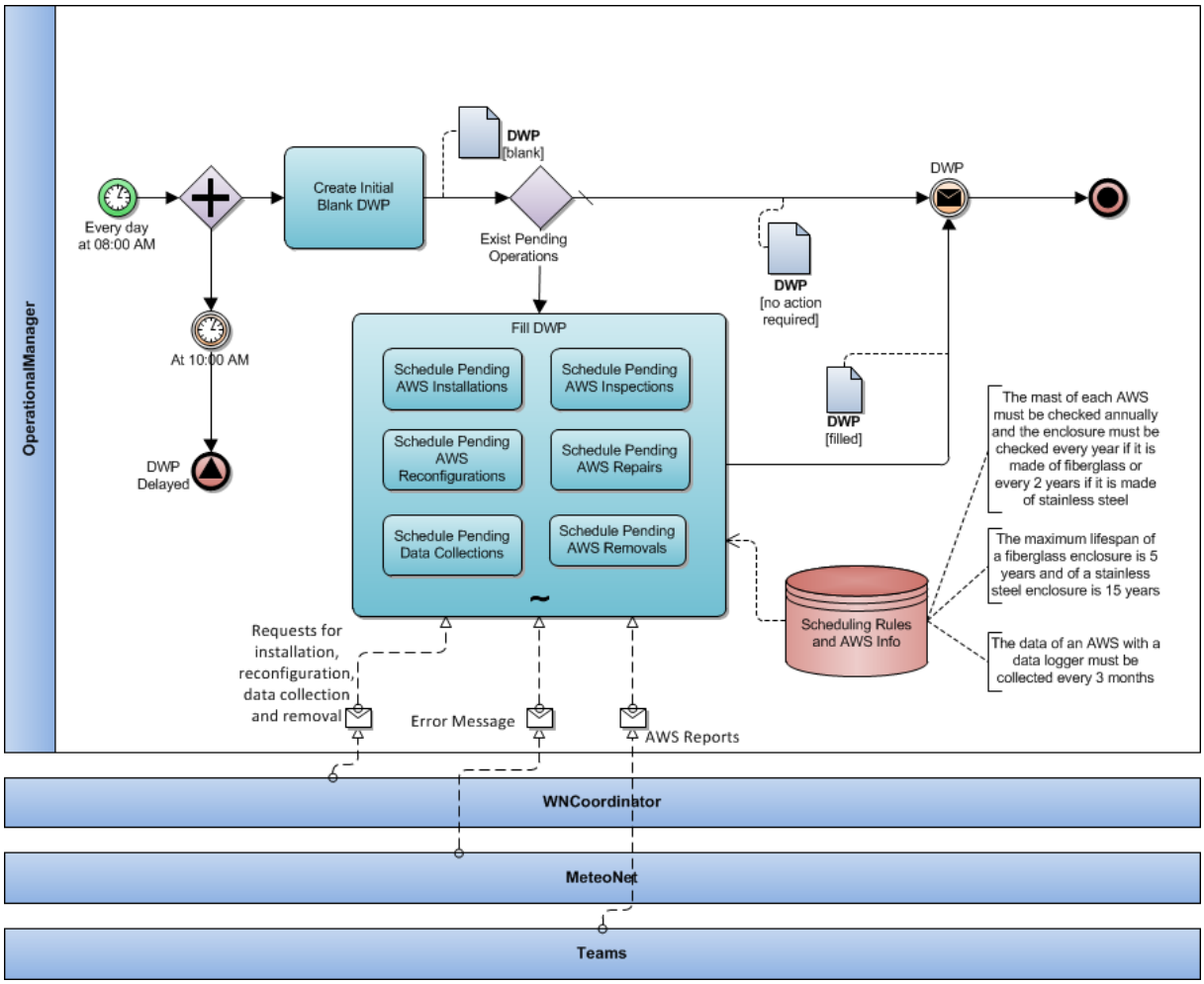

Figure 56: DWP Management - BPMN Process

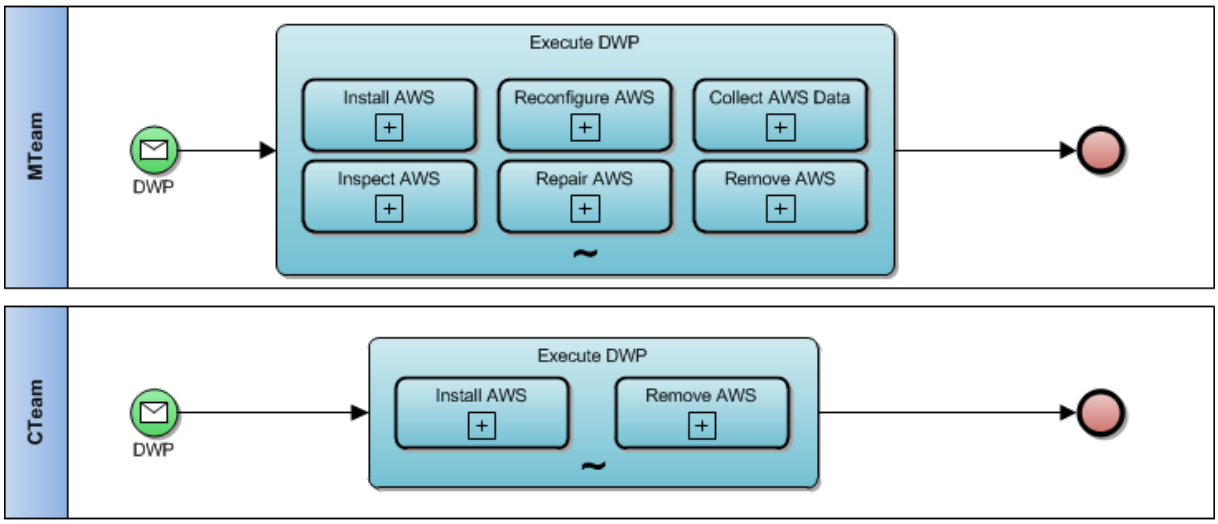

Figure 57: DWP Execution - BPMN Process

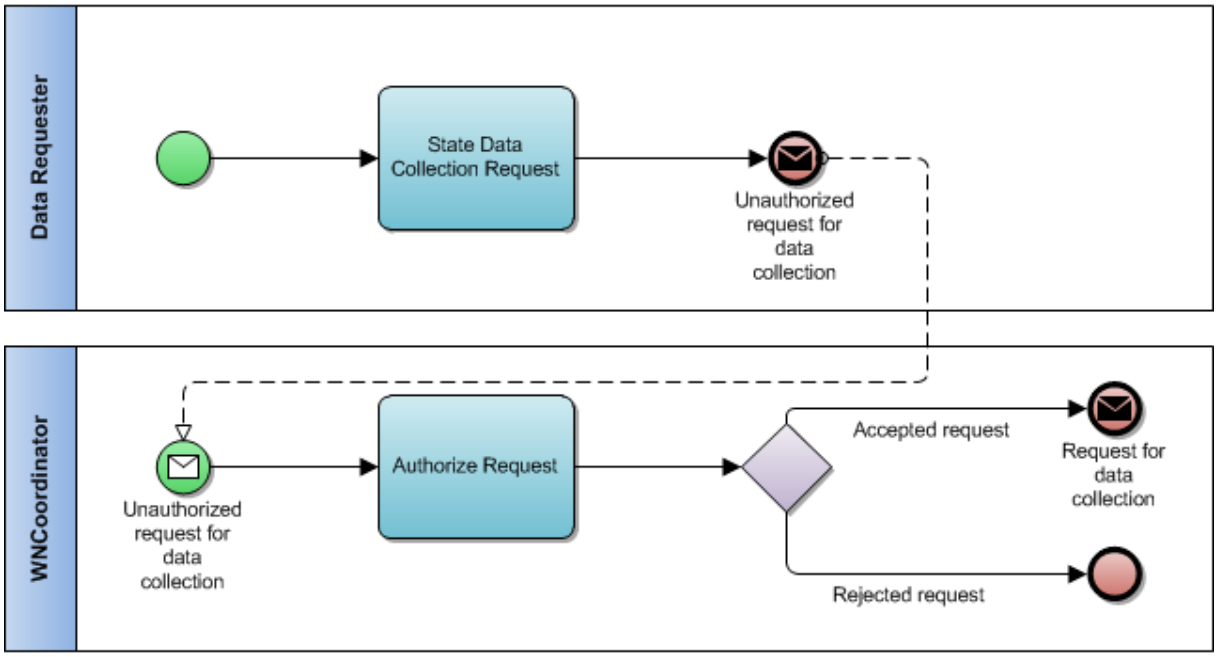

Figure 58: Authorization of Data Collection Request - BPMN Process

Artefact 20 - Installation Process

ID	Source	Type	Description
29	Line 233	NF	An AWS installation must be made by the CTeam.
30	Line 233	NF	An AWS installation must be made by the MTeam.
31	Line 229	NF	An AWS installation must entail the setup of the initial configuration of the AWS.
31.1	Lines 231-232	NF	The initial configuration of the AWS must involve deciding on what sensors to equip the AWS with.
31.2	Lines 231-232	NF	The initial configuration of the AWS must involve deciding on what external power sources will be used by the power supply system.
32	Line 229	NF	An AWS installation must entail the deployment of the AWS.
33	Lines 5-6 (Clarif. 1)	NF	The AWS must be turned on for normal operation.

Table 21: AWS Installation Process Requirement List

Context Information

- (Lines 28-29) The location of deployment must be measured using a GPS device and WGS-84 coordinates.

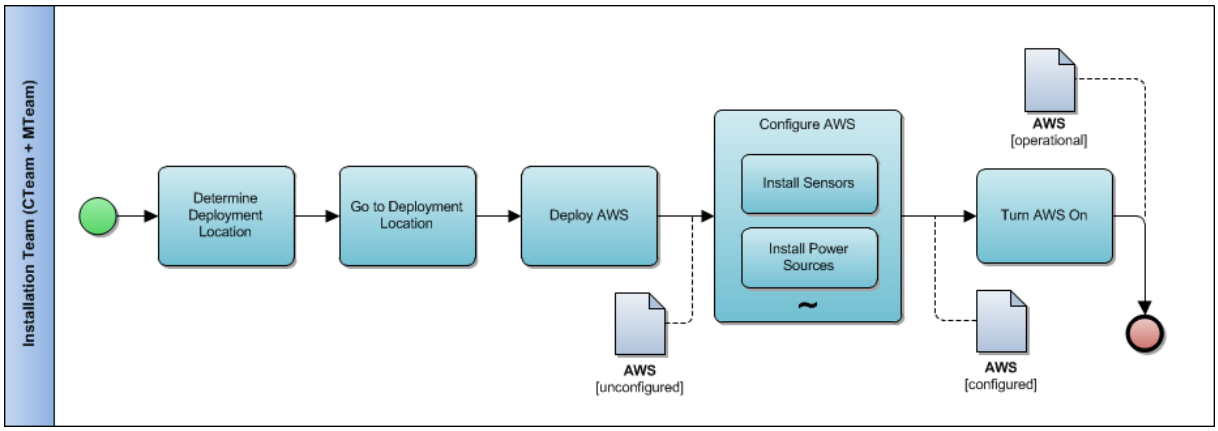

Figure 59: Install AWS - BPMN Process

Artefact 21 - Reconfiguration Process

ID	Source	Type	Description
34	Lines 31-32	F	An AWS can be reconfigured.
34.1	Line 32	NF	An AWS reconfiguration must be made on site.
34.2	Lines 32-33, 235	F	New sensors can be added to an AWS upon reconfiguration.
34.3	Lines 32-33, 235	F	Sensors can be removed from an AWS upon reconfiguration.
34.4	Lines 32-33, 235-236	F	The frequency of communication between an AWS and its BWS can be changed upon reconfiguration.
34.5	Line 237	NF	An AWS reconfiguration must be made by the MTeam.
34.6	Line 238	NF	An AWS reconfiguration must entail the inspection of the overall AWS.
35	Section 1.1 (Clarif. 1)	NF	The AWS must be turned off before any human invasive operation.

Table 22: AWS Reconfiguration Process Requirement List

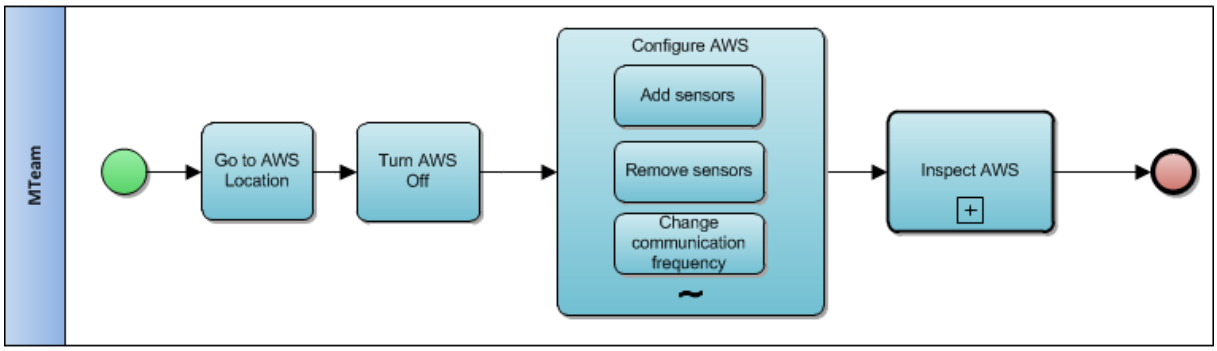

Figure 60: Reconfigure AWS - BPMN Process

Artefact 22 - Data Collection Process

ID	Source	Type	Description
36	Lines 239-240	F	Data has to be collected from the data loggers installed on AWS.
36.1	Line 241	NF	The data collection is performed by MTeam.
36.2	Line 242	NF	An AWS data collection must entail the inspection of the overall AWS.
35	Section 1.1 (Clarif. 1)	NF	The AWS must be turned off before any human invasive operation.

Table 23: AWS Data Collection Process Requirement List

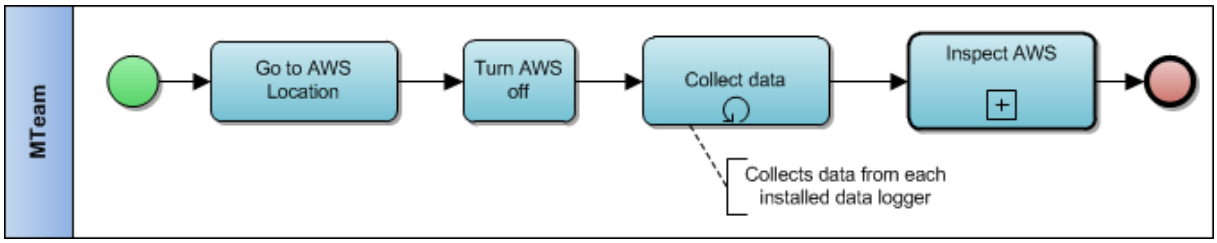

Figure 61: Collect AWS Data - BPMN Process

Artefact 23 - Inspection Process

ID	Source	Type	Description
37	Line 245	F	An AWS can be inspected.
37.1	Line 246	NF	AWS inspection is made by the MTeam.
37.2	Line 247	F	AWS inspection can detect problems with the AWS.
37.2.1	Line 247	F	The MTeam must log problems detected during an AWS inspection.
37.2.2	Line 247	F	The MTeam must email problems detected during an AWS inspection.
37.2.2.1	Lines 247-248	NF	The email with the detected problems during an AWS inspection must be sent to the OperationalManager.
37.2.2.2	Lines 247-248	NF	The email with the detected problems during an AWS inspection must be sent after the inspection is concluded.
33	Lines 5-6 (Clarif. 1)	NF	The AWS must be turned on for normal operation.
35	Section 1.1 (Clarif. 1)	NF	The AWS must be turned off before any human invasive operation.

Table 24: AWS Inspection Process Requirement List

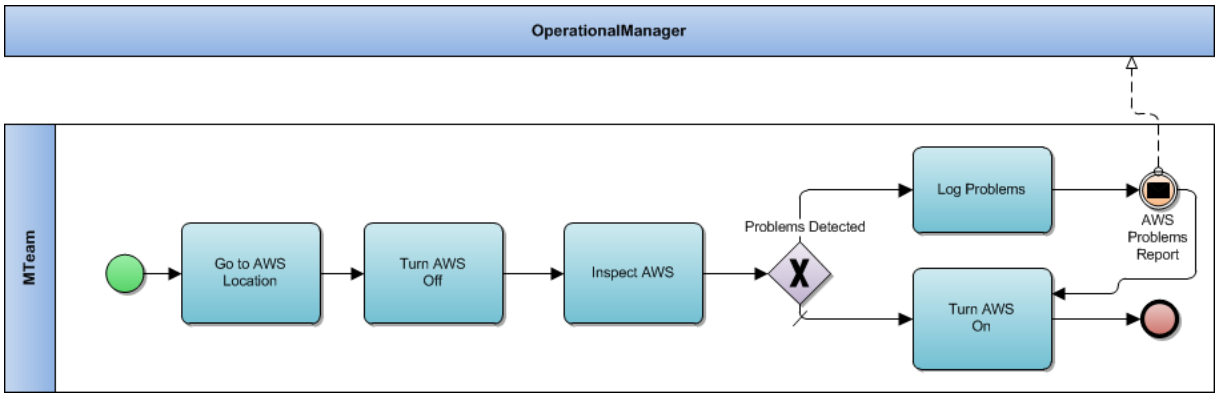

Figure 62: Inspect AWS - BPMN Process

Artefact 24 - Repair Process

ID	Source	Type	Description
38	Lines 251-252	F	The OperationalManager must check if there are replacement sensors on the inventory upon receiving a problem reported by the sensors.
38.1	Lines 253-254	F	If there are no replacement sensors, the OperationalManager must order a new sensor from the Sensor Provider.
38.1.1	Line 254	NF	For a new sensor to be ordered, the available budget must allow for it.
38.1.2	Lines 254-255	NF	If the Sensor Provider has available sensors, it must send a new sensor within the 24 hours after the request is placed.
38.1.3	Lines 255-256	NF	If the Sensor Provider doesn't have available sensors, it must send an expected delivery date.
38.1.3.1	Lines 256-257	F	Based on the delivery date, the OperationalManager can decide to keep the order.
38.1.3.2	Lines 256-257	F	Based on the delivery date, the OperationalManager can decide to cancel the order.
39	Line 249	F	An AWS can be repaired.
39.1	Line 259	NF	An AWS repair is made by the MTeam.
39.2	Line 259	F	The MTeam can replace faulty sensors.
39.3	Lines 259-260	F	If a sensor cannot be replaced, the MTeam must remove the faulty sensor.
39.3.1	Lines 264-265	F	The MTeam must test the faulty sensor.
39.3.2	Lines 261-262	F	The MTeam must reconfigure the AWS to operate without the faulty sensor.
40	Line 263	F	The MTeam must return all sensors removed from an AWS to the OperationalManager.
40.1	Lines 263-264	F	The OperationalManager must decide if the sensors can be repaired.
40.2	Lines 265-267	F	If a sensor cannot be repaired, the OperationalManager must decide whether to order a new sensor or not.
40.2.1	Lines 266-267	NF	The decision of ordering a new sensor must take into account the current number of replacements on inventory.
40.2.2	Lines 266-267	NF	The decision of ordering a new sensor must take into account the budget.
41	Line 268	F	All sensors that can be repaired must be sent to the Sensor Provider.
41.1	Lines 269-270	F	The Sensor Provider can return a new sensor to the OperationalManager.
41.1.1	Lines 269-270	NF	The Sensor Provider can only return a new sensor if the sent one was deemed unsavageable.
41.1.2	Lines 269-270	NF	The Sensor Provider can only return a new sensor if the sent one was under warranty.
41.2	Lines 270-271	F	The Sensor Provider can return the repaired sent sensor to the OperationalManager.
41.2.1	Line 270	NF	The Sensor Provider can only return a repaired sensor if the sent one was deemed repairable.
42	Line 272	NF	All sensors that are not in use must be stored on the inventory.
43	Line 283	F	All inventory operations must be registered on the Inventory Log.
43.1	Line 284	NF	Inventory operations can be registered on the Inventory Log by the OperationalManager.
43.2	Line 284	NF	Inventory operations can be registered on the Inventory Log by the MTeam.
33	Lines 5-6 (Clarif. 1)	NF	The AWS must be turned on for normal operation.
35	Section 1.1 (Clarif. 1)	NF	The AWS must be turned off before any human invasive operation.

Table 25: AWS Repair Process Requirement List

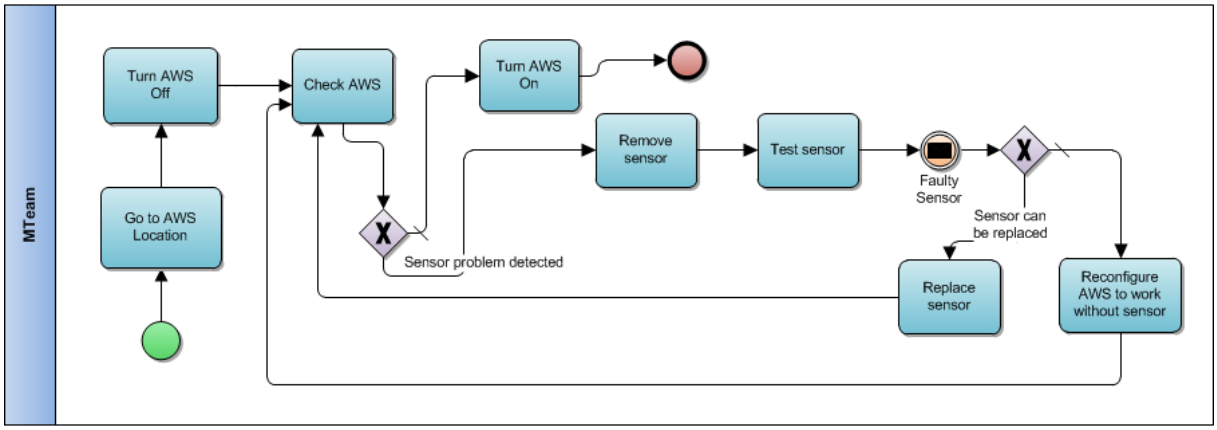

Figure 63: Repair AWS - BPMN Process

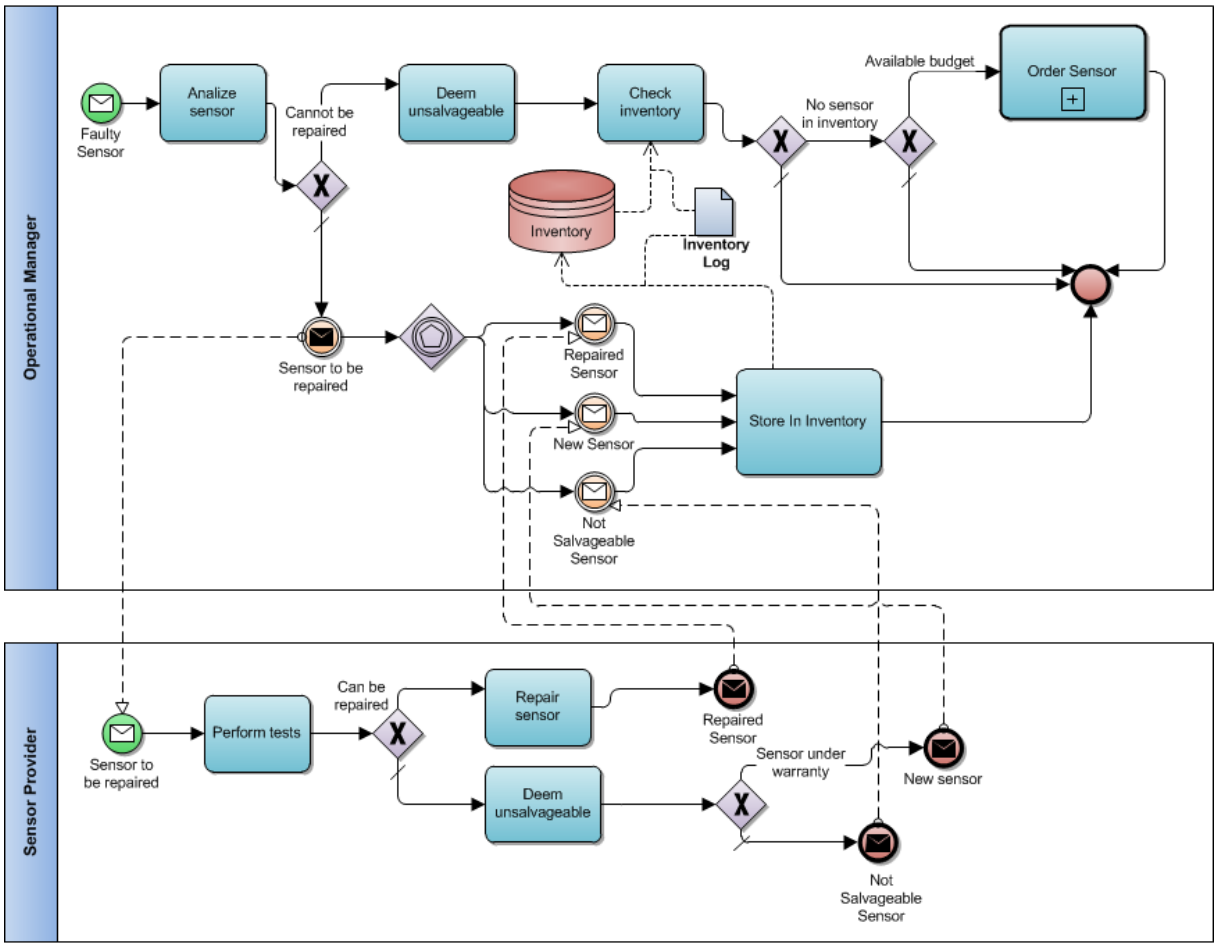

Figure 64: Faulty Sensor Handling - BPMN Process

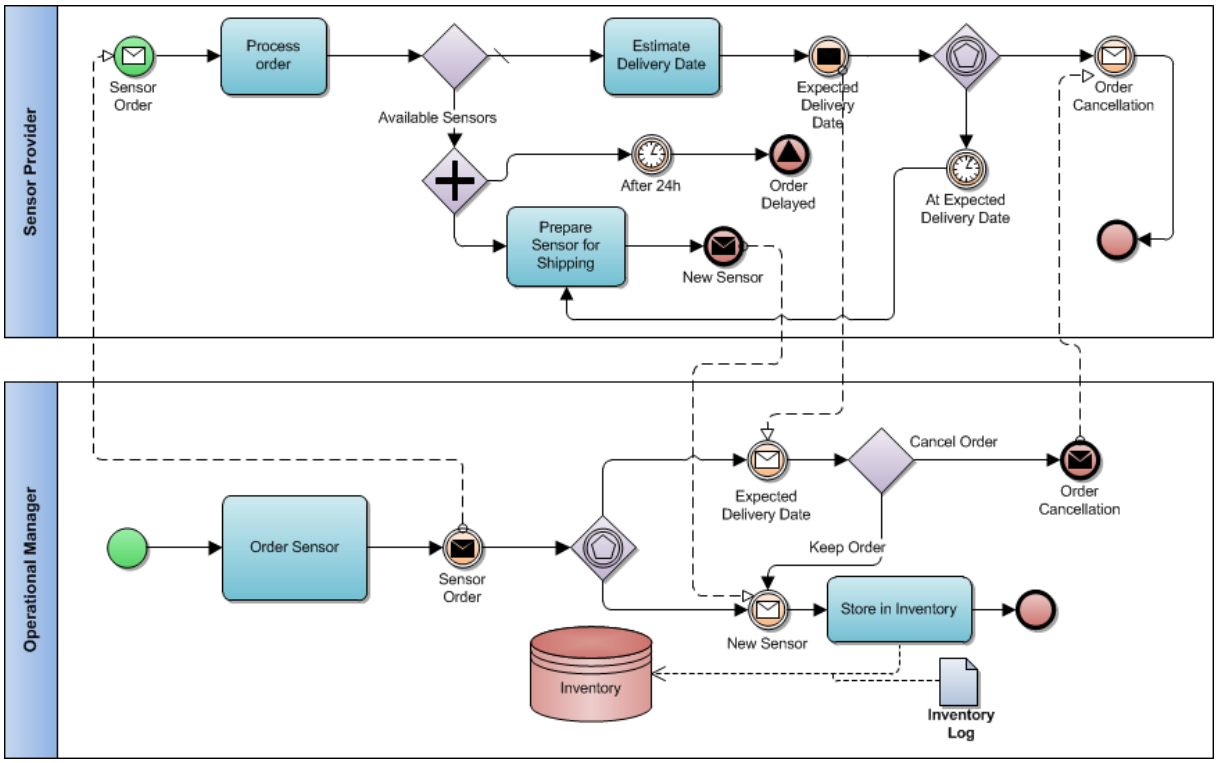

Figure 65: Order Sensor - BPMN Process

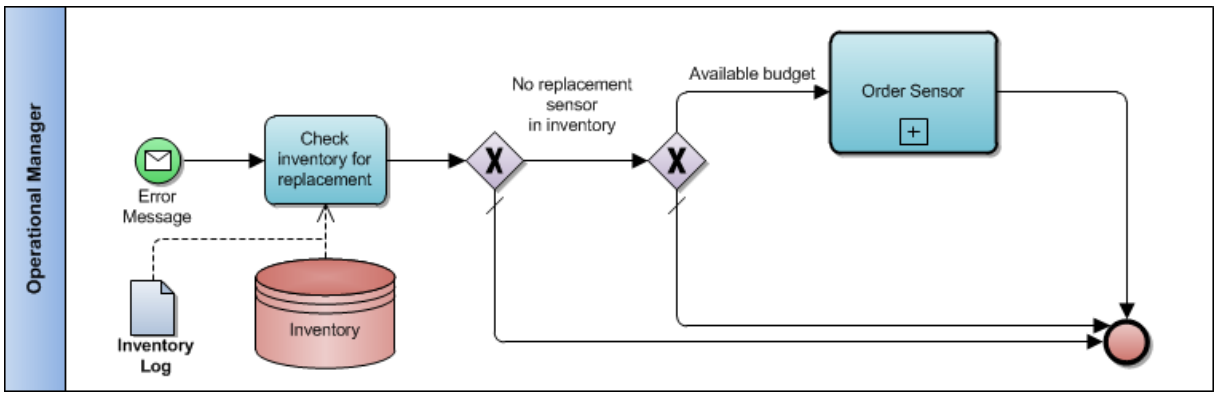

Figure 66: AWS Error Handling - BPMN Process

Artefact 25 - Removal Process

ID	Source	Type	Description
44	Line 285	F	An AWS can be removed.
44.1	Line 286	NF	An AWS removal must be made by the CTeam.
44.2	Line 286	NF	An AWS removal must be made by the MTeam.
44.3	Line 287	F	All sensors must be removed from the AWS upon removal of the AWS.
44.3.1	Line 287	F	All removed sensors must be returned to the inventory.
44.4	Line 288	NF	The AWS ceases to be operational after removal.

Table 26: AWS Removal Process Requirement List

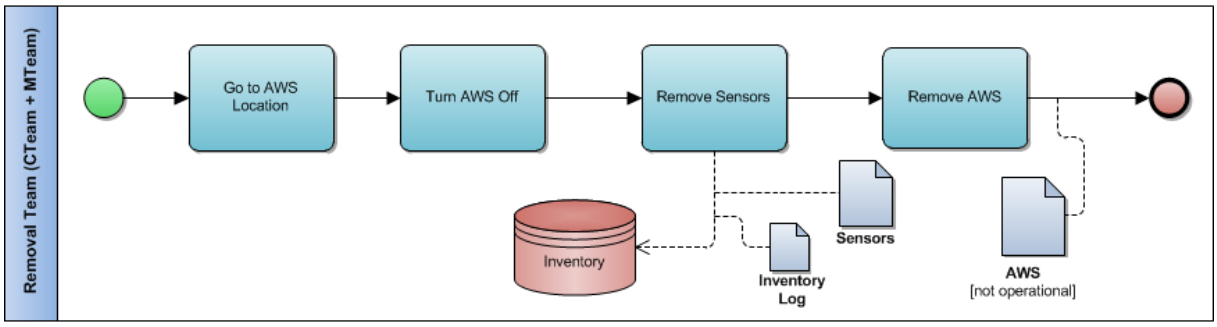

Figure 67: Remove AWS - BPMN Process

Artefact 26 - AWS Traceability Matrix

Req ID	UC 1	UC 2	UC 3	UC 4	UC 5	UC 6	UC 7	UC 8	UC 9
1	X								
2.9						X			
2.13	X								
5					X				
6.3									X
7					X				
13.1.2		X							
13.1.3.1			X						
13.1.3.2				X					
14								X	
15							X		

Table 27: AWS Use Case Traceability Matrix.

Req ID \ Figure	7	8	9	11	19	14	13	12	20	21	22	25	26
1.*	X												
2	X	X											
2.2 to 2.8	X												
2.10	X	X	X										
2.11 and 2.12		X											
2.14	X												
3	X	X											
3.*		X											
4	X	X											
4.1 and 4.3		X											
4.4		X											
6	X	X											
6.1 and 6.2		X											
6.3.1		X											
6.4							X						
7.1		X											
8		X											
8.1		X											
9								X					
10					X								
10.1	X												
10.2 to 10.6	X	X											
10.7		X											
10.7.1	X											X	
10.8 to 10.10.1			X										
10.10.1.*				X									
10.11 to 10.13					X								
11	X												
11.*											X		
12	X												
12.2										X			
12.3										X			
12.3.1 and 12.3.2										X			
12.3.3													X
13											X		

Continued on Next Page...

Req ID \ Figure	7	8	9	11	19	14	13	12	20	21	22	25	26
14 and 14.1	X												
14.1.1		X				X							
14.1.3	X	X											
14.1.3.*									X				
14.2	X												
14.2.1	X					X							
14.2.2 and 14.2.3		X											
14.3	X												
15							X		X				
16							X		X				
17	X												

Table 28: AWS SysML Structural Traceability Matrix 1.

Req ID \ Figure	10	18	16	15	17	23	24
2.1						X	
4.2						X	
8		X					
8.3		X					
10.7	X						
12.1	X						
12.3	X						
14.2.2				X			
15		X	X				
16		X	X				
17					X		

Table 29: AWS SysML Structural Traceability Matrix 2.

Note: Figure 24 isn't mapped to any requirement since it only defines the period of the timer (an intrinsic property of it and thus context information). That definition is, however, needed because the period of the timer is used on the behavioural diagrams (namely artefact 16).

UC / Figure	UC 1	UC 2	UC 3	UC 4	UC 5	UC 6	UC 7	UC 8	UC 9
32	X					X			
33	X								
34		X							
35			X						
36				X					
37					X				
38							X		
39								X	
40									X

Table 30: AWS Use Case and Sequence Diagram Traceability Matrix.

Figure / Req ID	41
14.1.3.*	X
15	X
16	X
17	X

Table 31: AWS State Machine Diagram Traceability Matrix.

Artefact 27 - MeteoNet Traceability Matrix

Req ID	UC 1	UC 2	UC 3	UC4	UC5	UC6
19	X					
21		X				
22.1			X			
22.2			X			
22.3				X		
22.4					X	
22.5					X	
22.6					X	
22.7				X		
22.8				X		
22.9						X

Table 32: MeteoNet Use Case Traceability Matrix.

Figure / Req ID	27	28	29	30	31
18					X
19.1	X				
19.2	X				
19.2.1	X				
19.2.2	X				
19.2.3	X				
19.2.4	X				
19.2.5	X				
19.3	X				
19.3.1	X				
19.3.2	X				
19.3.3	X				
19.4	X				
19.4.1	X				
19.4.2	X				
19.5	X				
19.6	X				
20				X	X
20.1	X				
20.2			X		
20.2.1			X		
20.2.2			X		
20.3			X		
20.4			X		
20.5.*			X		
21.3	X			X	X
21.3.1		X			
21.3.2		X			
21.3.3		X			
22	X				

Table 33: MeteoNet UML Structural Traceability Matrix.

UC / Figure	UC 1	UC 2	UC 3	UC4	UC5	UC6
42	X					
43		X				
44			X			
45			X			
46				X		
47				X		
48				X		
49				X		
50					X	
51					X	
52					X	
53					X	
54						X

Table 34: MeteoNet Use Case and Sequence Diagram Traceability Matrix.

Figure / Req ID	55
21	X
21.2.*	X
21.3.*	X
22.2	X

Table 35: MeteoNet Machine State Diagram Traceability Matrix.

Artefact 28 - Architectural Description

This artefact aims to establish a relationship between all artefacts and the concepts specified in the ISO-IEC-IEEE 42010:2011 standard. As such, this artefact can be seen as a *model-based architecture description* of the Weather Network for it tries to express the way the *architectures* of all 3 *systems of interest* (the AWS, the BWS and MeteoNet) are captured by the different models.

Each of the artefacts 2-27 represent a *model* of one of the aforementioned *systems of interest*. Each *model* composes a *view* that is constructed according to a *viewpoint* that specifies the conventions to which the *model* adheres and frames a set of *concerns* described and analysed in that *model*. Artefacts are also related to other artefacts and, as such, establish *correspondences* between *architecture description elements* (AD Elements).

The two main *architecture description languages* used on this document are *UML* and *SysML*. *UML* is focused on modelling logical components, systems, their interactions and their stakeholders. On the other hand, *SysML* has similar concerns but related to physical components and systems.

Note: We have not followed the exact table format shown on the clarifications document because we believe that it contains a lot of redundant information when taking into account the remaining artifacts (e.g: the stakeholders section given the context maps of artefacts 2, 6 and 7 and the architect section given the work distribution table of artefact 1).

Model	Artefact 1
Viewpoint	Project Management - Concerns related to the effort and responsabilities of the team elements on this project.
View	Effort and Responsabilities
System of Interest	Weather Network (and subsystems: AWS, BWS and MeteoNet)
Model Kind	Tables

Model	Artefact 2
Viewpoint	Analysis - Concerns related to the environment of the system of interest (identification of stakeholders and enabling systems).
View	Context
System of Interest	AWS
Model Kind	Concept Map

Model	Artefact 3
Viewpoint	Analysis - All requirements of the system of interest.
View	Requirements
System of Interest	AWS
Model Kind	S.M.A.R.T requirement list.

Model	Artefact 4
Viewpoint	Analysis - Behavioural concerns, in particular those related to active and meaningful participartion of the system in the interaction.
View	Behaviour
System of Interest	AWS
Model Kind	SysML use case diagram.

Model	Artefact 5
Viewpoint	Analysis - The same as artefact 4 but at a greater detail.
View	Behaviour
System of Interest	AWS
Model Kind	Use case template table.

Model	Artefact 6
Viewpoint	Analysis - Concerns related to the environment of the systems of interests (identification of stakeholders and enabling systems).
View	Context
System of Interest	BWS and WN
Model Kind	Concept Map

Model	Artefact 7
Viewpoint	Analysis - Concerns related to the environment of the system of interest (identification of stakeholders and enabling systems).
View	Context
System of Interest	MeteoNet
Model Kind	Concept Map

Model	Artefact 8
Viewpoint	Analysis - All requirements of the system of interest.
View	Requirements
System of Interest	MeteoNet
Model Kind	S.M.A.R.T requirement list.

Model	Artefact 9
Viewpoint	Analysis - Behavioural concerns, in particular those related to active and meaningful participartion of the system in the interaction.
View	Behaviour
System of Interest	MeteoNet
Model Kind	UML use case diagram.

Model	Artefact 10
Viewpoint	Analysis - The same as artefact 9 but at a greater detail.
View	Behaviour
System of Interest	MeteoNet
Model Kind	Use case template table.

Model	Artefact 11
Viewpoint	Design - Concerns related to the structure of the system of interest and the connections between the different parts of the system of interest.
View	Structure
System of Interest	AWS
Model Kind	SysML 1.0 block definition diagrams (bdd) and internal block definition diagrams (ibd).

Model	Artefact 12
Viewpoint	Design - Concerns related to the structure of the system of interest and the connections between the different parts of the system of interest.
View	Structure
System of Interest	MeteoNet
Model Kind	UML 2.2 class diagram.

Model	Artefact 13
Viewpoint	Design - Concerns related to the components that compose the structure of the system of interest and their interfaces which allow them to connect with other external components.
View	Structure
System of Interest	MeteoNet
Model Kind	UML 2.2 component diagram.

Model	Artefact 14
Viewpoint	Design - Concerns related to how the logical components specified on artefact 13 are instantiated as artefacts and deployed on the hardware nodes.
View	Structure
System of Interest	MeteoNet
Model Kind	UML 2.2 deployment diagram.

Model	Artefact 15
Viewpoint	Design - Concerns related to the clarification of the internal system behaviour and the messages exchanged to achieve that behaviour in the context of the elicited use cases.
View	Behaviour
System of Interest	AWS
Model Kind	SysML 1.0 sequence diagram.

Model	Artefact 16
Viewpoint	Design - Concerns related to the different states the system can be in as well as what triggers the transitions between said states and what results from those transitions.
View	Behaviour
System of Interest	AWS
Model Kind	SysML 1.0 state machine diagram.

Model	Artefact 17
Viewpoint	Design - Concerns related to the clarification of the internal system behaviour and the messages exchanged to achieve that behaviour in the context of the elicited use cases.
View	Behaviour
System of Interest	MeteoNet
Model Kind	UML 2.2 sequence diagram.

Model	Artefact 18
Viewpoint	Design - Concerns related to the different states the system can be in as well as what triggers the transitions between said states and what results from those transitions.
View	Behaviour
System of Interest	MeteoNet
Model Kind	UML 2.2 state machine diagram.

Model	Artefact 19
Viewpoint	Business - Concerns related to the business process rules and requirements of the process that is responsible for the management of DWP and the messages exchanged during its execution.
View	Business Process
System of Interest	Weather Network
Model Kind	BPMN 2.0 Process Diagram

Model	Artefact 20
Viewpoint	Business - Concerns related to the installation process of a new AWS on the WN.
View	Business Process
System of Interest	Weather Network
Model Kind	BPMN 2.0 Process Diagram

Model	Artefact 21
Viewpoint	Business - Concerns related to the reconfiguration process of an AWS on the WN.
View	Business Process
System of Interest	Weather Network
Model Kind	BPMN 2.0 Process Diagram

Model	Artefact 22
Viewpoint	Business - Concerns related to the data collection process of an AWS on the WN.
View	Business Process
System of Interest	Weather Network
Model Kind	BPMN 2.0 Process Diagram

Model	Artefact 23
Viewpoint	Business - Concerns related to the inspection process of an AWS on the WN.
View	Business Process
System of Interest	Weather Network
Model Kind	BPMN 2.0 Process Diagram

Model	Artefact 24
Viewpoint	Business - Concerns related to the repairal process of an AWS on the WN and interactions with the external providers.
View	Business Process
System of Interest	Weather Network
Model Kind	BPMN 2.0 Process Diagram

Model	Artefact 25
Viewpoint	Business - Concerns related to the removal of an AWS on the WN.
View	Business Process
System of Interest	Weather Network
Model Kind	BPMN 2.0 Process Diagram

Model	Artefact 26
Viewpoint	Analysis - Concerns related to traceability between requirements listed on artefact 3 and all other artefacts that have the AWS as the System of Interest.
View	Traceability
System of Interest	AWS
Model Kind	Traceability matrix.

Model	Artefact 27
Viewpoint	Analysis - Concerns related to traceability between requirements listed on artefact 8 and all other artefacts that have the MeteoNet as the System of Interest.
View	Traceability
System of Interest	MeteoNet
Model Kind	Traceability matrix.

Model	Artefact 29
Viewpoint	Analysis - Concerns related to traceability of changes between different phases of this report.
View	Traceability
System of Interest	Weather Network (and subsystems: AWS, BWS and MeteoNet)
Model Kind	Change log using bullet points.

Artefact 29 - Change log

Phase 1 → Phase 2

- **New Artefacts:** Artefact 11 - AWS Structure, Artefact 12 - MeteoNet Classes, Artefact 13 - MeteoNet Components, Artefact 14 - MeteoNet Deployment.
- Introduction
  - Removed assumption regarding contracts with external suppliers not having been established yet.
  - Added assumptions regarding this second phase.
- Artefact 1 - Effort and Work-Breakdown
  - Updated both tables to reflect work done on this phase.
- Artefact 2 - AWS Context
  - Changed all associations between entities so that they map outward from the main system in each context map rather than inward to the main system.
- Artefact 3 - AWS Requirements
  - Removed all requirements over external components of the system that don't have a direct influence on the modelling of the AWS in accordance with the revised assumptions.
  - Added new requirements (see requirement 17) according to the the project clarifications document.
  - Separated the GPS sensor from the remaining sensors since it doesn't measure an atmospheric condition but rather the location of the AWS.
- Artefact 4 - AWS Use Cases
  - Changed the names of the use cases to reflect the viewpoint of the actor and not the system.
  - Removed the GPRS Network actor from the 'Receive Measurements' use case.
  - Added the 'Determine Location' use case.
  - Added the 'Read Samples' use case.
  - Added the 'Activate Standby' and 'Deactivate Standby' use cases extending the recharge one.
  - Added the 'Switch On' and 'Switch Off' use cases for maintenance and reconfiguration operations.
- Artefact 5 - AWS Use Case Scenarios
  - Changed the description of the use case scenarios to further reflect the viewpoint of the actor and not the system.
  - Collapsed the primary and alternative scenarios in the UC1 descriptions into a single primary scenario
  - Removed the alternative scenario in UC2 description as it is now a use case of its own.
  - Removed the GPRS Network from the actor list in the UC3 description
  - Added descriptions for all new use cases added on artefact 4.
- Artefact 6 - BWS Context
  - Changed all associations between entities so that they map outwards from the main system in each context map rather than inwards to the main system.
  - Added a new context map representing the overall context of the WN.
- Artefact 7 - MeteoNet Context
  - Changed all associations between entities so that they map outwards from the main system in each context map rather than inwards to the main system.
  - Removed incorrect 'employs' association between the 'Operational Manager' and 'LogicInc'.
- Artefact 8 - MeteoNet Requirements

  - Removed superfluous requirement 27.1 since that information is already evident by the 'functional interface' of requirement 27.
  - Added new requirements according to the the project clarifications document.

- Artefact 9 - MeteoNet Use Cases
  - Changed the names of the use case to reflect the viewpoint of the actor and not the system.
  - Removed the AWS Driver actor from the 'Send Information' use case.
  - Added a new 'Save Domain' use case.

- Artefact 10 - MeteoNet Use Case Scenarios
  - Changed the description of the use case scenarios to further reflect the viewpoint of the actor and not the system.
  - Removed exception scenario from the description of UC1.
  - Removed exception scenario from the description of UC2.

- Artefact 26 - AWS Traceability Matrix
  - Added new traceability matrixes for the SysML diagrams.

- Artefact 27 - MeteoNet Traceability Matrix
  - Added new traceability matrixes for the UML diagrams.

- Artefact 28 - Architectural Description
  - Changed the structure of this artefact to a more pragmatic table-based approach.
  - Added new entries regarding the models produced on this phase.

Phase 2 → Phase 3

- **New Artefacts:** Artefact 15 - AWS Behaviour, Artefact 16 - AWS States, Artefact 17 - MeteoNet Behaviour, Artefact 18 - MeteoNet States.
- Introduction
  - Added new assumptions according to the clarifications document.
- Artefact 1 - Effort and Work-Breakdown
  - Updated both tables to reflect work done on this phase.
- Artefact 2 - AWS Context
  - Added other external power suppliers (sun and wind).
  - Clarified the relationship between the AWS and the MTeam and CTeam.
- Artefact 3 - AWS Requirements
  - Added new requirements according to the provided clarifications document.
  - Moved previous requirement 4.4.1 regarding the integrated ADC of the GPS sensor to context information.
  - Readded requirements related to the input ports of the sensor hub.
  - Removed all requirements related to the business model.
- Artefact 4 - AWS Use Cases
  - Added 'UC x' labels to each use case.
  - Generalized 'AC Power Grid', 'Sun' and 'Wind' actors as External Power Sources.
  - Replaced the MTeam actor with a general Actor since the collection of data by the MTeam constitutes a business rule.
  - Changed the name of UC1 to 'Sampled' to reflect the action performed by the actor.
  - Changed the text of UC-6 to 'Provide Location' to further emphasize the actor's perspective.
- Artefact 5 - AWS Use Case Scenarios
  - Removed internal actions from the primary scenario of UC1.
  - Revised the pre/post-conditions of all use-cases to reflect the changes on the system.
  - Moved the second step of the primary scenario of both UC3 and UC4 to the post-condition.
  - Added the global electronic timer signals as pre-conditions of UC5 and UC6.
- Artefact 6 - BWS Context
  - Clarified the relationship between BWS and Linux.
- Artefact 7 - MeteoNet Context
  - Generalized the relationship between MeteoNet and the external information systems (DALI, PICASSO, MATISSE).
- Artefact 8 - MeteoNet Requirements
  - Added new requirements according to the provided clarifications document.
  - Clarified the concept of 'error code' in the context of an analysis of incoming data.
  - Removed requirement 27.9.1.1.1 related to the uniqueness of the XML file.
- Artefact 9 - MeteoNet Use Cases
  - Added 'UC x' labels to each use case.
- Artefact 10 - MeteoNet Use Case Scenarios

  - Revised the pre/post-conditions of all use-cases to reflect the changes on the system.

- Artefact 11 - AWS Structure
  - Abstracted the concepts of Sensor and ADC on a Sensor Pack.
  - Corrected agregations to compositions on the overall bdd.
  - Removed the charge analyser block since it is built in on the battery.
  - Changed the generalization between External Power Source and Transformer to External Power Source and Rectifier.
  - Placed the Power Switch between the battery and all the other components instead of signaling the battery.
  - Removed the Charge Analyser from the ibd as it is internal to the battery.
  - Changed 'allocatedTo' in figure 9 to 'allocatedFrom'.
  - Updated the Types bdd to remove types invalidated by the changes on this artefact.
  - Changed the representation of the way Socket Bolt Group and Enclosure Bolt Group connect the Platform to the Mast and the Enclosure to the Platform.
  - Added new bdds referring to the Sensor Hub and Timer.
  - Added connections between the Timer, Communication Device and Data Logger on the overall ibd.
  - Differentiated between external and internal power types on the overall ibd.
  - Added methods to all blocks according to the behaviour diagrams added on this phase.
- Artefact 12 - MeteoNet Classes
  - Revised the connections between the AWS, Sensors, Readings, and Sensor Errors.
- Artefact 13 - MeteoNet Components
  - Removed the 'Domain' component as it isn't particularly relevant to the modelling effort.
  - Clarified the 'eMail Service' component, naming it 'eMail Client'.
- Artefact 14 - MeteoNet Deployment
  - Generalized the DALI, PICASSO and MATISSE nodes.
  - Clarified the 'eMail Service' component and artifact, naming them 'eMail Client'.
- Artefact 26 - AWS Traceability Matrix
  - Added new traceability matrixes for the SysML behavioural diagrams.
- Artefact 27 - MeteoNet Traceability Matrix
  - Added new traceability matrixes for the UML behavioural diagrams.
- Artefact 28 - Architectural Description
  - Made the types of views evident. They were being implicitly referred on the Viewpoint Concerns.
  - Made the viewpoints evident. They were being implicitly referred on the Viewpoint Concerns.
  - Added entries regarding artefacts 1 and 29.
  - Added new entries regarding the models produced on this phase.

Phase 3 → Phase 4

- **New Artefacts:** Artefact 19 - DWP Management Process, Artefact 20 - Installation Process, Artefact 21 - Reconfiguration Process, Artefact 22 - Data Collection Process, Artefact 23 - Inspection Process, Artefact 24 - Repair Process, Artefact 25 - Removal Process.
- Artefact 1 - Effort and Work-Breakdown
  - Updated both tables to reflect work done on this phase.
- Artefact 2 - AWS Context
  - Added a reference to the WN system in which the AWS is integrated.
- Artefact 3 - AWS Requirements
  - Changed requirements 1.1-1.7 to NF since they consist of restrictions on requirement 1.
  - Removed all requirements pertaining exclusively to the ADCs since from the viewpoint of the person designing the system, the sensors are provided as packs.
  - Merged requirements 2 and 2.3 since the latter provides a justification for the former.
  - Removed all requirements that describe properties of the timer and added it as context information.
  - Reformulated requirement 2.8 so as to make it seem more like a requirement of the AWS and not the sensor pack.
  - Removed requirements 2.9.1 and 2.9.2 since they do not impose any restrictions to the AWS.
  - Clarified requirement 4 so as to justify the need for a sensor hub.
  - Removed requirement 4.1 as it is context information.
  - Removed requirement 4.1.2.1 since it is not something we can enforce (nor is directly specified by the requirement document.
  - Changed requirement 6.5 to NF since it imposes a restriction on when the action can be executed.
  - Moved requirement 7.1 to context information since it is not really a requirement of the AWS.
  - Reordered subrequirements of 10.8 to make it evident why there is a need to have 2 cable routing openings.
  - Reformulated requirements 11-12 to make it evident why they are needed.
  - Repliaced references of the charge analyser on requirements 14.1.4.2 and 14.1.4.3 with the battery since the latter is an internal component of the former.
  - Reformulated requirements 15.* so as to make it evident that they exist to allow an user to switch the battery on or off.
- Artefact 4 - AWS Use Cases
  - Renamed the 'Sampled' use case to 'Is Sampled'.
  - Renamed the 'Actor' actor to 'User' to reduce confusion.
  - Added a generalization of the 'GPS System' and 'Weather' as 'Measurement Provider'.
- Artefact 5 - AWS Use Case Scenarios
  - Renamed the 'Sampled' use case to 'Is Sampled'.
  - Renamed the 'Actor' actor to 'User' to reduce confusion.
- Artefact 6 - BWS Context
  - Added a reference to the WN system in which the AWS is integrated.
  - Clarified the relationship between the BWS and Linux.
  - Removed 'makes received information available to' from the association between the BWS and MeteoNet.
  - Reversed direction of the relationships between the GPRS Network and other concepts.

- Artefact 7 - MeteoNet Context
  - Added a reference to the WN system which MeteoNet oversees.
  - Added a relationship between the OperationalManager and the Email Service.
- Artefact 8 - MeteoNet Requirements
  - Merged requirements 17 and 19 and changed the order to clarify the remaining requirements.
  - Changed requirement 17.1.1 to NF.
  - Clarified the reasons why requirement 20 exists.
- Artefact 11 - AWS Structure
  - Merged the associations between the sensors and the AWS on figure 17 with figure 7 to remove redundant information.
  - Put the power switch completely inside the Enclosure and add an extra port to this enclosure to allow access to the switch from outside.
  - Removed the sensor and ADC concepts from figure 13 and removed the sensor especializations that are now present on figure 7.
  - Removed associations, Timer, ADC, Sensor Hub, Data Logger and Communication Device from figure 11 and added the cable info as annotations in figure 8.
  - Removed the specializations 'Meteorological Measurement' and 'Location Measurement' that have since lost relevance with previous changes.
- Artefact 12 - MeteoNet Classes
  - Merged the 'SensorError' and 'Reading' classes by adding a 'error' property to the Reading.
  - Removed the 'ErrorCode' type since it is no longer used.
- Artefact 13 - MeteoNet Components
  - Removed the 'External Service' component.
- Artefact 14 - MeteoNet Deployment
  - Removed the 'External Service' component.
- Artefact 15 - AWS Behaviour
  - Merged figures 31, 32 and 33.
  - Removed the 'store' operation from figure 34.
  - Removed the 'convert' operation and added an infinite loop to figure 35.
  - Added interactions of the battery with the connected components in figures 36 and 37.
  - Removed the loop from figure 41.
- Artefact 16 - AWS States
  - Added information regarding traceability of the methods/signals to SysML block methods/signals on the transitions of the STM.
- Artefact 17 - MeteoNet Behaviour
  - Merged figures 43 and 44 and removed error analysis from the merged diagram.
  - Removed figure 45.
  - Removed the null verification on figure 47.
  - Completed figure 48 with interactions with each AWS.
- Artefact 18 - MeteoNet States
  - Completely changed the state machine since the previous one tried to replicate sequence behaviour and not states.

- Artefact 26 - AWS Traceability Matrix
  - Removed dual requirement<->UC mapping from table 21 (14.1.4.1 and 15.2).
  - Completely rewrote the traceability matrixes to ensure all requirements are accounted for.
- Artefact 27 - MeteoNet Traceability Matrix
  - Completely rewrote the traceability matrixes to ensure all requirements are accounted for.
- Artefact 28 - Architectural Description
  - Merged Viewpoint and Viewpoint concerns rows.
  - Changed 'Viewpoint Model Kind' to 'Model Kind'.
  - Changed 'View Model ' to 'Model'.
  - Added entries regarding the new artefacts.