Software Architecture: ReMeS, part 1

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March 2014

Contents

1 Domain analysis

1.1 Conceptual models of the problem domain

In the diagrams a yellow color denotes concepts that are not under our control,
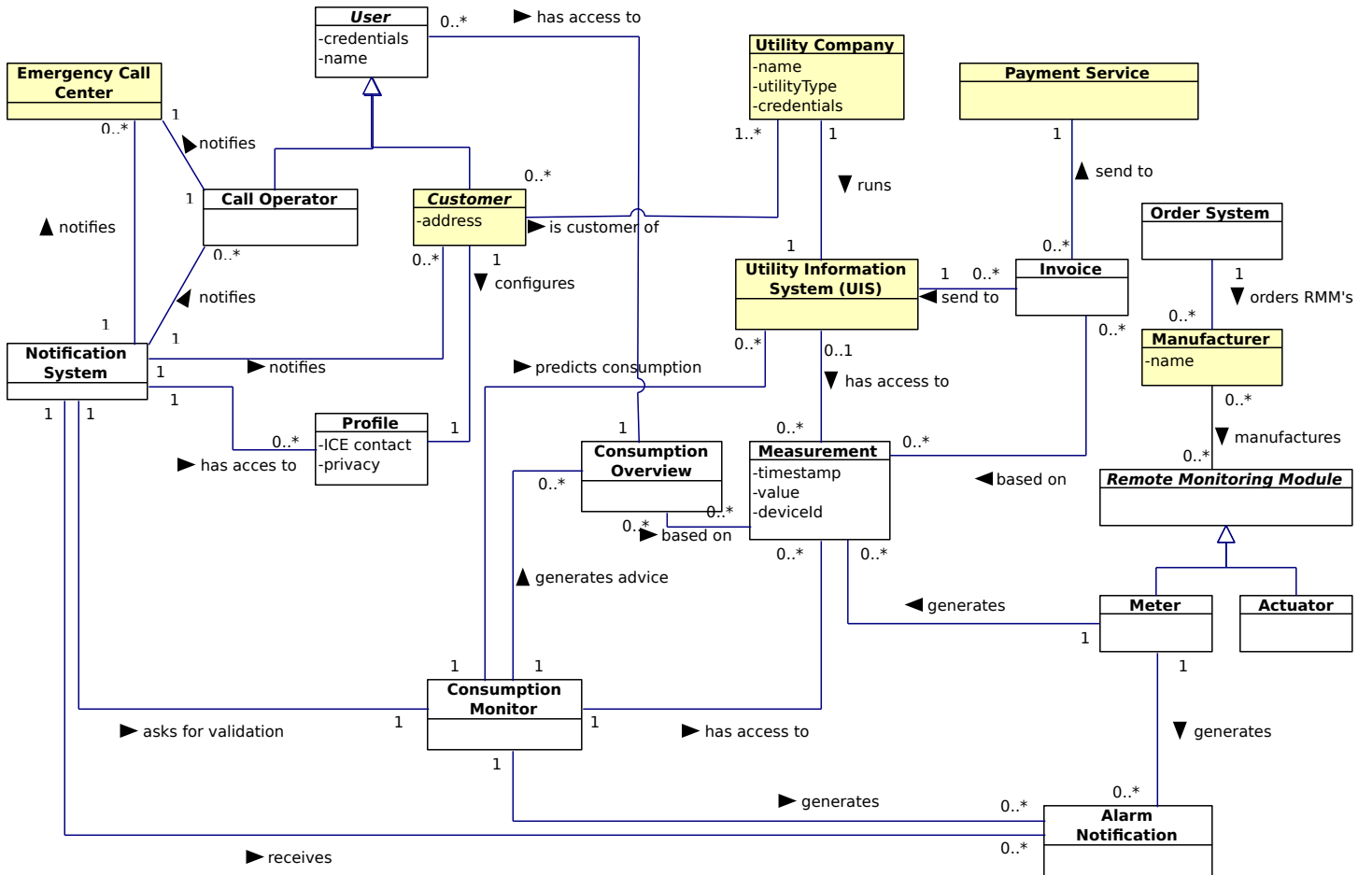for example we do not control the Emergency Services.

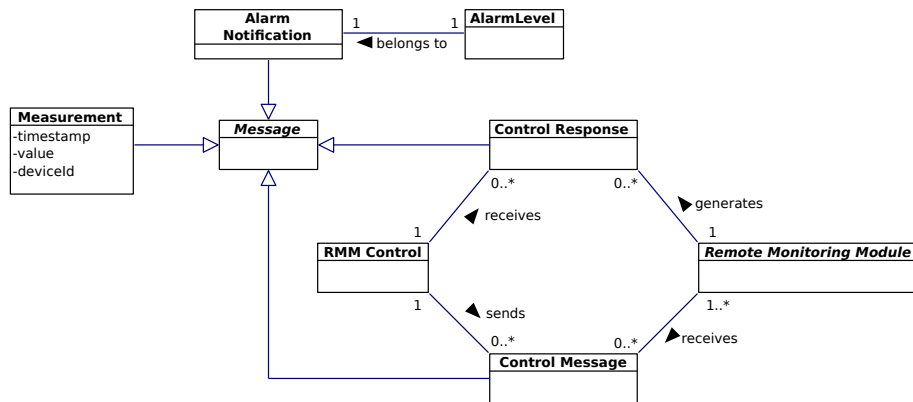Figure 1: Domain Model: Main Diagram

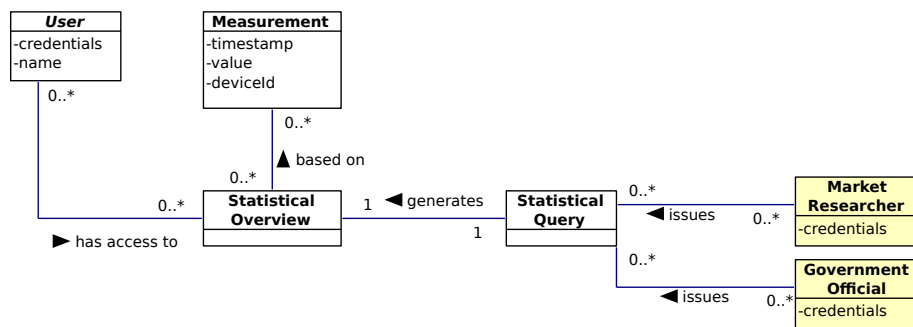Figure 2: Domain Model: Messages
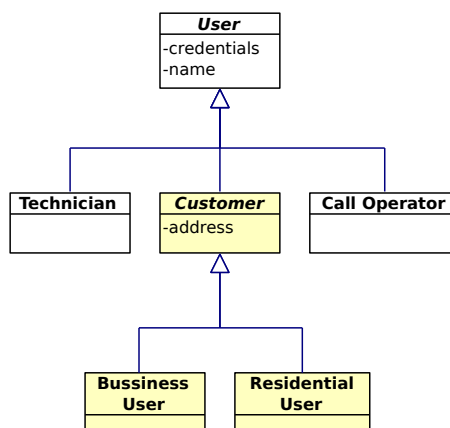
Figure 3: Domain Model: Statistics
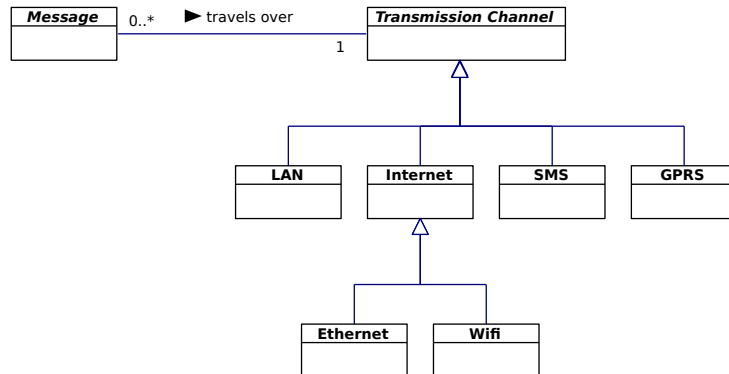
Figure 4: Domain Model: User

Figure 5: Domain Model: Transmission Channel

1.2   Relevant additional domain constraints

- As a Customer, you will get access to a Consumption Overview that is based on Measurements obtained via your *own* devices.

- Call Operators will get to a Customers Consumption Overview when they give permission.

- Market Researches and Government Officials can only access Statistical Overviews based on the Measurements of at least 10 different Customers.

- The information disclosed to a Utility Company is only related to Customers that are also a customer of that specific Utility Company.

- Invoices for Customers (type 1, see glossary) are based on the Measurements obtained via their own devices.

- The Notification System can warn the RMM Control of leaks. The RMM Control can then control the Actuators.

1.3   Glossary

Control Messages These are used to control Actuators but also to configure RMM's or to request current measurements from Meters.

Notification System The Notification System handles all notification from ReMeS to Users and the Emergency Services.

Consumption Monitor The Consumption Monitor monitors all Measurements for leaks, advice and predictions. It can generate Alarms and validate alarms that were received (through the Notification System) from RMM's.

Invoices

Three types of invoices are in use:

1. those based on the Measurements of the Customers, as a service to Utility Companies,

2. those based on the services we offer Customers,

3. those based on the services we offer Utility Companies.

Order System When customers register, ReMeS can automatically order RMM's through this system.

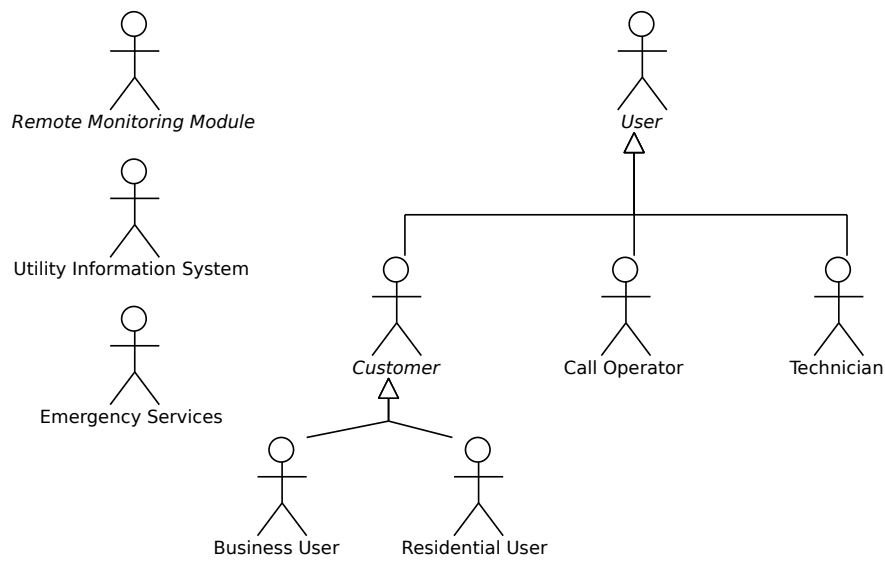# 2 Functional Requirements

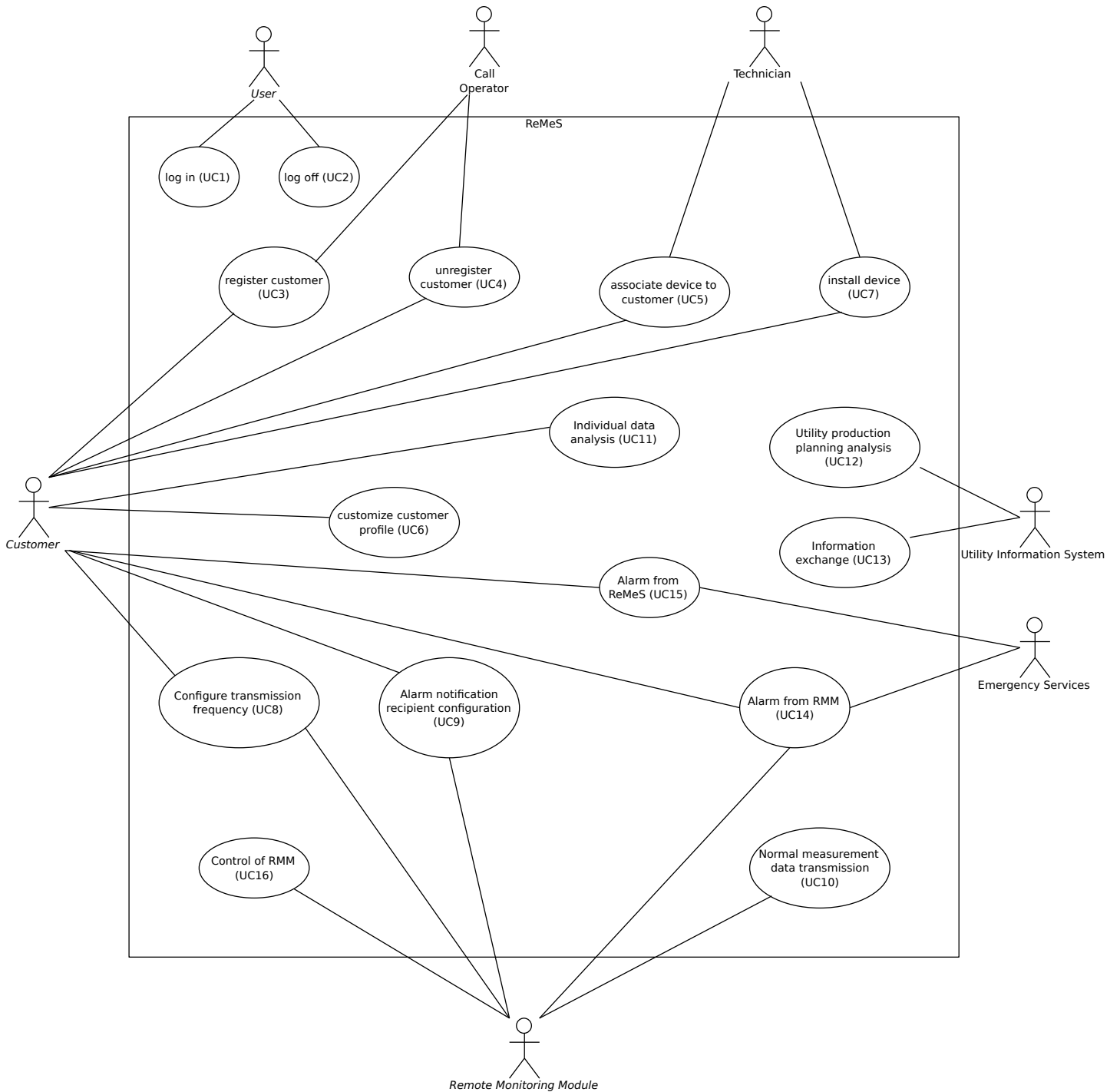## 2.1 Use Case overview diagram

Figure 6: Actors

Figure 7: Overview

2.2 Use Cases

2.2.1 *UC7:* Install device

Name: Install device

Primary Actor: technician

Interested parties:

- *ReMeS*: wants to receive measurements.
- *Customer*: wants an accurate overview of his utility consumption.
- *Technician*: installs the customer's device(s) and wants this to be as smooth as possible.

Preconditions:

- The user has to be registered at ReMeS (cf. *UC3*).
- The technician is logged in (cf. *UC1*).

Postconditions:

- The device is installed.
- The device is sealed.
- The device has made contact with ReMeS
- The device is ready to be associated with a customer.

Main scenario:

1. The technician indicates that he is ready to install a device for a customer.
2. The technician verifies whether he is at the right location and whether the installation should proceed.
3. The technician verifies whether the utility had been shut off.
4. The technician verifies whether the device has access to a transmission channel.
5. The technician installs the device.
6. The technician seals the device.
7. The technician notifies ReMeS of the current meter value.
8. The technician activates the device.
9. The technician verifies whether the meter has made a proper connection with ReMeS.
10. The technician reports that the utility can be put to use again.

Alternative scenarios:

2b. The technician cannot proceed and cancels his assignment.
4b. The device does not have access to a transmission channel. The technician troubleshoots the device.
9b. The technician contacts a ReMeS Call Operator and together they troubleshoot the connection.

2.2.2 *UC8:* Configure transmission frequency

Name: Configure transmission frequency

Primary Actor: Customer

Interested parties:

- *Customer*: wants to be able to control his privacy level.
- *Utility Company*: wants to have accurate forecasts.

Preconditions:

- The customer is logged in (cf. *UC1*).

Postconditions:

- The transmission frequency has been adjusted to the wishes of the customer.

Main scenario:

1. The customer selects the right utility.
2. The customer adjusts the transmission frequency.
3. ReMeS processes the result by sending control messages to the devices.
4. The devices acknowledge the configuration.

Alternative scenarios:

3b. The devices are not reachable. The customer is notified and is asked to troubleshoot.

2.2.3 *UC9:* Alarm notification recepient configuration

Name: Alarm notification recepient configuration

Primary Actor: Customer

Interested parties:

- *Customer*: wants to configure who receives alarm notifications.
- *ReMeS*: wants recent contact information.

Preconditions:

- Customer is logged in (cf. *UC1*).

Postconditions:

- The alarm notification recipient has been configured.

Main scenario:

1. The customer selects the module he wishes to configure.
2. The customer adds an e-mail address and a phone number.

3. ReMeS performs a validation of the address and phone number.

4. The customer performs the required action for validation.

5. ReMeS updates the customer's profile.

Alternative scenarios:

3b. ReMeS does not receive a confirmation message. ReMeS cancels the reconfiguration and notifies the customer.

2.2.4 *UC10:* **Normal measurement data transmission**

Name: Measurement transmission

Primary Actor: Remote Monitoring Module

Interested parties:

- *Remote Monitoring Module*: sends measurements to ReMeS
- *ReMeS*: gathers measurements.

Preconditions:

- Remote Monitoring Module is linked to a customer.
- Remote Monitoring Module is connected to a transmission channel.

Postconditions:

- ReMeS has received and stored the measurement.

Main scenario:

1. RMM constructs a trame containing the current measurement.

2. RMM sends the trame to ReMeS over the transmission channel.

3. ReMeS receives and stores the measurement.

Alternative scenarios:

2b. The RMM is not able to acccess the transmission channel, it retries a set number of times. If it is not successful it remembers this so it can try again when the connection is restored.

3b. ReMeS detects that measurements have not been received from a certain module for a while. The customer is notified and if necessary a technician is dispatched.

2.2.5 *UC11:* **Individual data analysis**

Name: Individual data analysis

Primary Actor: Consumption Monitor

Interested parties:

- *Customer*: wants good advice and swift notification of leaks.

Preconditions:

- The customer is linked to a RMM.

Postconditions:

- The consumption monitor has analysed the customer's data.

Main scenario:

1. The consumption monitor analyses the customer's data.
2. The consumption monitor compares the analysis with previous analyses of the customer and the analysis of the average similar customer.
3. The consumption monitor adds advice to the customer's profile.
4. If an anomaly is detected, appropriate actions are taken according to the alarm level.

2.2.6   *UC12:* Utility production planning analysis

Name: Utility production planning

Primary Actor: Consumption Monitor

Interested parties:

- *Utility company*: wants an accurate report of usage.

Preconditions:

- The utility has an active subscription to production planning analyses.

Postconditions:

- The utility company has an accurate overview of consumption.

Main scenario:

1. The consumption monitor runs an analysis on the data for all customer's of the utility company in question.
2. The consumption monitor sends the result of the analysis to the utility company (through the UIS).

2.2.7   *UC13:* Information exchange towards UIS

Name: Information exchange

Primary Actor: ReMeS

Interested parties:

- *ReMeS*: wants a flexible way of communication to suit many UIS.
- *Utility Company*: wants up to date consumption information.

Preconditions:

- ReMeS has information to send.
- The UIS is subscribed to this service.

Postconditions:

- The UIS is provided with accurate information.

Main scenario:

1. ReMeS checks whether the UIS is available.
2. ReMeS checks the contract with the UIS. If needed, ReMeS encrypts the information.
3. ReMeS sends the information.
4. ReMeS waits for an acknowledgment from the UIS.

Alternative scenarios:

4b. If the acknowledgment does not arrive ReMeS resends the information.

2.2.8 *UC14:* Alarm from RMM

Name: Alarm from RMM

Primary Actor: Remote Monitoring Module

Interested parties:

- *Customer*: wants to be notified of possible problems.
- *Emergency Services*: rely on quick and accurate problem information.

Preconditions:

- An anomaly is detected by the RMM.

Postconditions:

- The customer (and if needed the emergency services) is notified.
- If needed the appropriate actuators have been adjusted appropriately.

Main scenario:

1. RMM creates an alarm notification of the appropriate alarm level.
2. RMM sends the notification to the Notification System.
3. RMM verifies whether the notification has arrived.
4. The Notification System asks the Consumption Monitor to verify the alarm.
5. The Notification System notifies the Customer.
6. If needed the Notification System asks the RMM Control to initiate a valve shutdown.
7. If needed the Notification System notifies the Emergency Services.

Alternative scenarios:

3b. If no acknowledgement arrives the alarm notification is resent.

2.2.9 *UC15:* Alarm from ReMeS

Name: ReMeS alarm

Primary Actor: Consumption Monitor

Interested parties:

- *Customer*: wants to be notified as fast as possible of possible problems.
- *Emergency Services*: rely on quick and accurate problem information.

Preconditions:

- The consumption monitor has detected an anomaly.

Postconditions:

- Customer has been notified of the problem.
- If needed the Emergency Services will have been notified.

Main scenario:

1. The consumption monitor creates an alarm notification with the appropriate alarm level.
2. The consumption monitor sends the alarm notification to the notification system.
3. The consumption monitor verifies whether the notification has arrived.
4. The customer is notified.
5. If needed ReMeS sends the control command to initiate the valve shutdown. (cf. *UC16*)
6. If needed ReMeS notifies the emergency services.

Alternative scenarios:

3b. If no acknowledgement is received the consumption monitor retries.

2.2.10 *UC16:* Control of Remote Monitoring Modules

Name: RMM Control

Primary Actor: ReMeS

Interested parties:

- *ReMeS*: wants to be able to control RMM's.

Preconditions:

- The RMM is linked to a customer.

Postconditions:

- The RMM has acknowledged the execution of the control command.

Main scenario:

1. ReMeS creates an appropriate control message.
2. ReMeS sends the control message.
3. ReMeS starts waiting for a response from the RMM.
4. The RMM executes the required action.
5. The RMM replies with a control response.

Alternative scenarios:

3b. If ReMeS does not receive a control response, it retries.
4b. The RMM is unable to perform the required action and sends a control response containing this information.

3 Non-functional Requirements

3.1 Availability: *Consumption Monitor failure*

Source: Internal

Stimulus: The consumption monitor crashes.

Artifact: Internal subsystem

Environment: Normal execution

Response:

- This does not affect the availability of other services, such as:
  - configuration of RMM
  - control of RMM
  - acquisition of measurements
  - statistical queries
- Prevention: The consumption monitor should have a guaranteed minimal up-time.
- Detection:
  - The ReMeS Operators are notified of this problem.
  - ReMeS is able to detect this problem and goes into degraded modus:
    * Consumption overviews will be updated with a note that the data is not current.
    * The UIS are notified that current planning information is not available.
    * The notification system will not ask the consumption monitor for validation of alarms from the RMM's.
- Resolution:

- The notified ReMeS Operators restart the consumption monitor subsystem.
- All measurements that have been registered while in degraded modus are immediately processed (leak detection).
- Relevant notes are removed from consumption overviews.
- The UIS are notified that current planning information is again available.
- The notification system is notified.
- Normal operation is resumed.

Response measure:

- Prevention: The consumption monitor should at least be 99.9% up and running.
- Detection:
  - Detection happens within 5 seconds.
  - Operators are notified within 1 minute.
  - In the transition between normal and degraded modus:
    * consumption overviews, production planning information are not updated;
    * alarms from RMM's are not validated;
    * alarms are not generated.
  - In degraded modus no alarms are generated (except by RMM's) and no consumption overviews and production planning information are generated.

3.2 Performance: *Requests to the consumption monitor*

Source: Internal

Stimulus: The notification system and the customer (when retrieving a consumption overview) send requests to the consumption monitor.

Artifact: Internal subsystem

Environment: Normal execution

Response:

- In normal modus tasks are handled according to precedence:
  1. requests from the notification system,
  2. detection of alarms,
  3. generation and communication of production planning information,
  4. request for consumption overviews.
- If the system fails to comply to the specific deadlines listed below, it goes into overload modus and drops the least important tasks.

- In overloaded modus the consumption monitor's services are limited to alarm detection and validation.

Response measure:

- Alarm validation is handled within 2 seconds. (control of RMM is involved)
- Generation of production planning information in accordance to the subscription of the utility company.
- Requests for consumption overviews are handled within 5 seconds.

3.3 Modifiability: *Rise of (Wireless) Sensor Networks*

Source: Utility of measurements other than water, gas and electricity.

Stimulus:
- Businesses want to outsource the collection and analysis of arbitrary measurements. (e.g.: pressure, temperature, radiation)

Artifact:
- the back-end system has to cope with different kinds of sensors (multiple values, leak detection algorithms are generalised to anomaly detection algorithms),

Environment: at design time

Response:

- The new solution does not affect the ReMeS dealing with gas, water and electricity meters.
- The new solution is flexible in the sense that it allows for a wide range of sensor modules.

Response measure:

- takes less than 60 man months to design, implement, test and deploy.
- and costs less than half a Million Euro.