Software Architecture

Phase I: Requirements Engineering

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Contents

Chapter 1

Domain Model

The domain model is shown in figures 1.1 and 1.2. All concepts in the diagram can be looked up in the glossary (see 5, page 32).

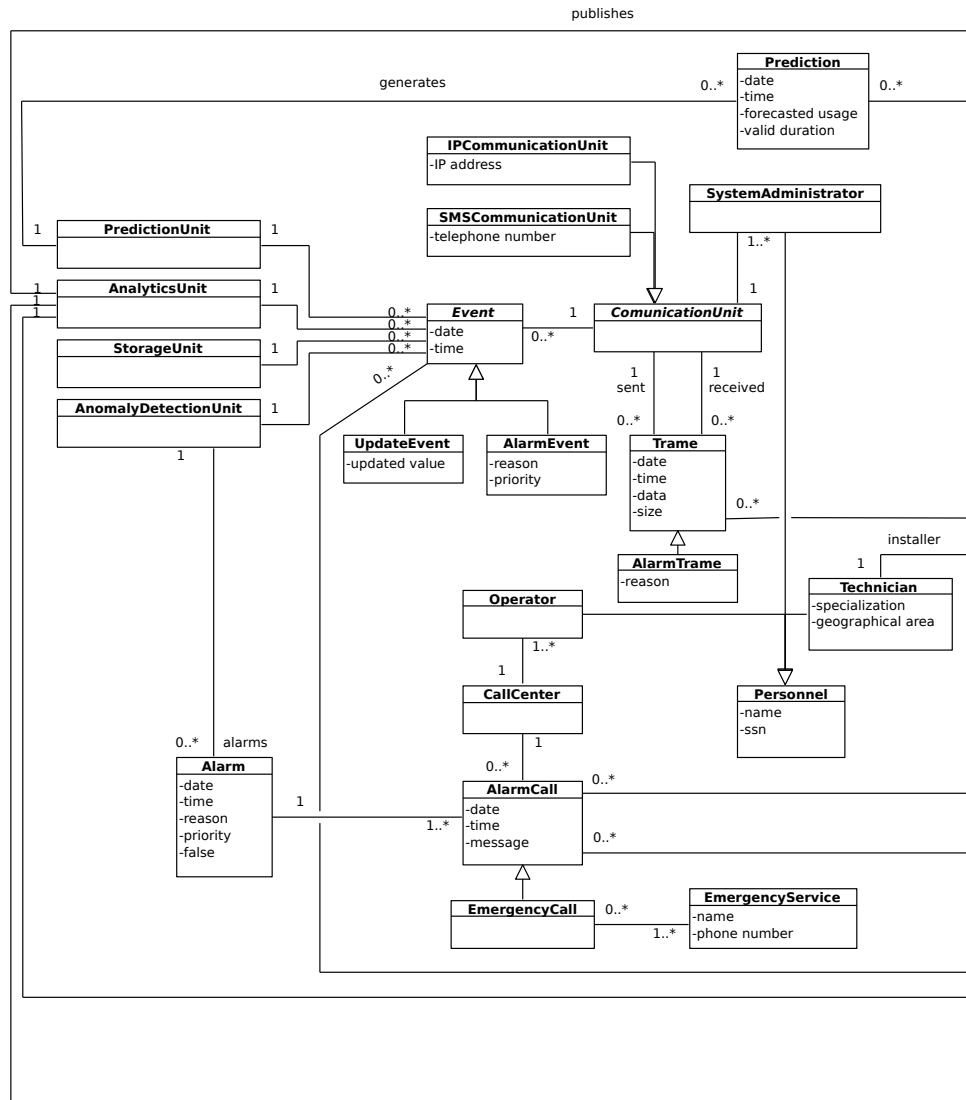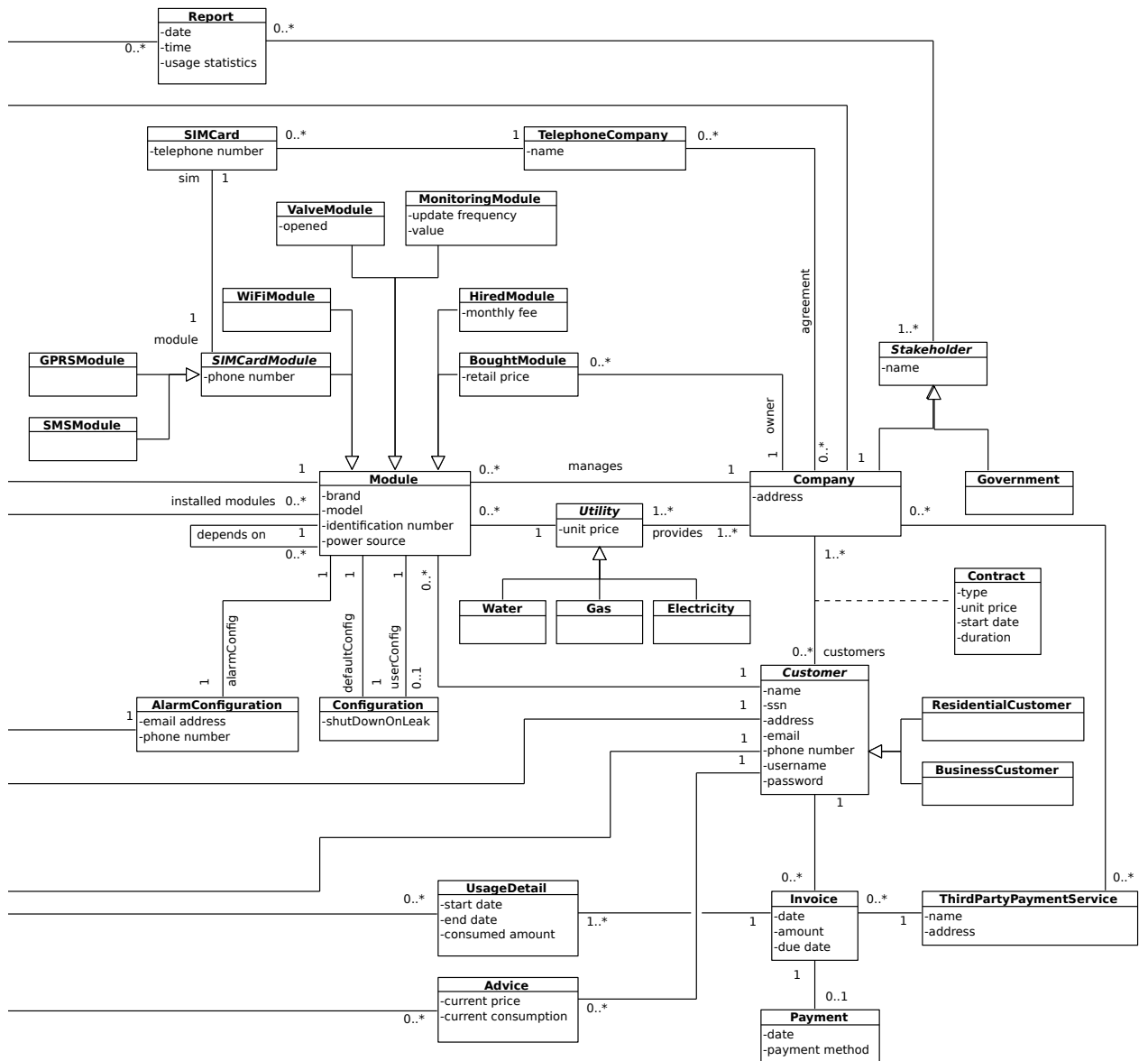**Figure 1.1:** The left hand side of the full domain model

Figure 1.2: The right hand side of the full domain model

Chapter 2

Use Cases

2.1   Use case diagram
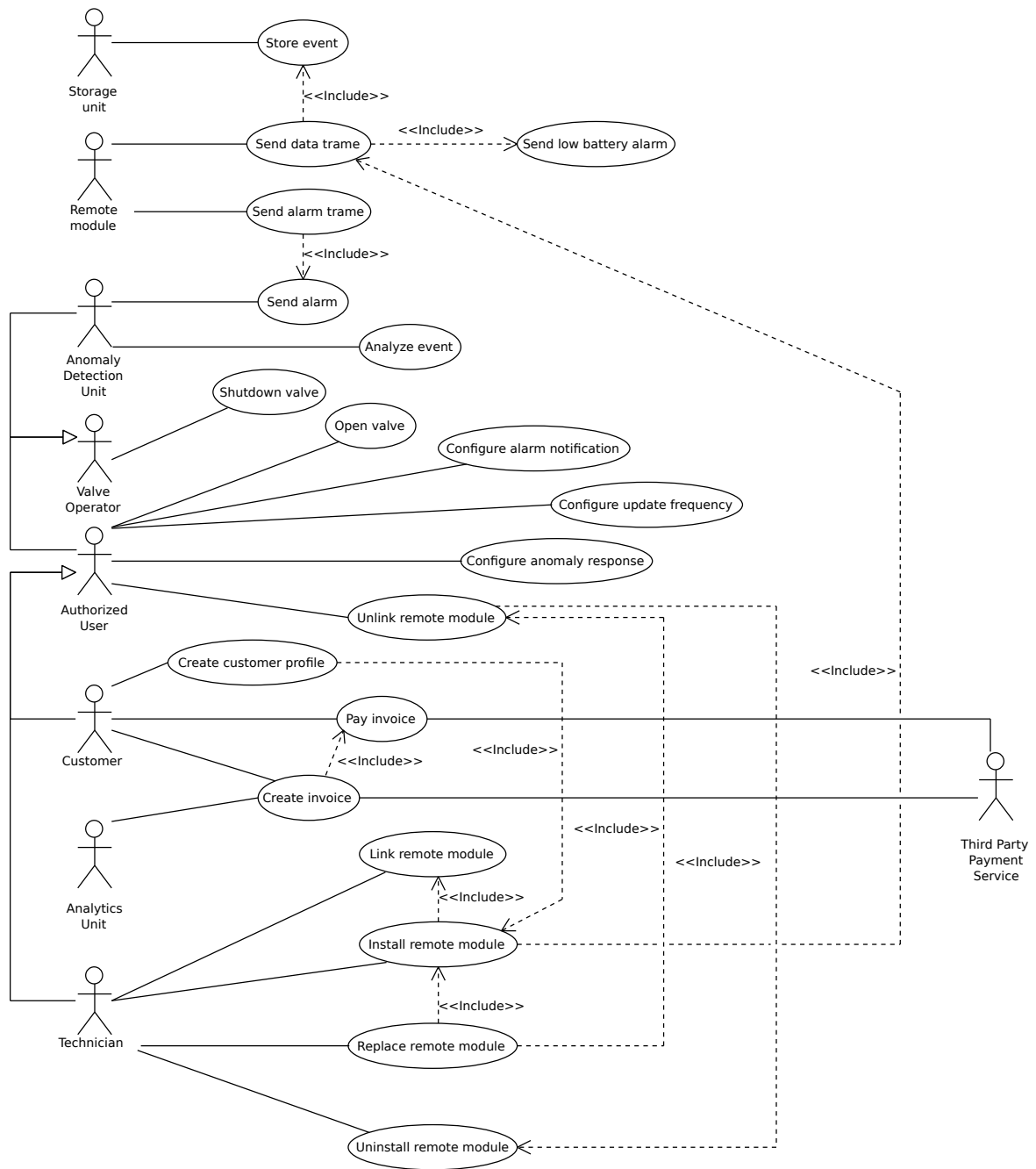
The use case diagram is shown in figure 2.1.

Figure 2.1: Use case diagram

2.2   Use cases

2.2.1   Create customer profile

Primary actor Customer

Interested parties ReMeS, Utility providing company, Call Center

Preconditions

- The customer needs to have a contract on record with at least one utility providing company participating in the ReMeS program.

Postconditions

- The customer has access to the ReMeS portal.

Normal flow

1. The customer contacts the ReMeS call center to request the necessary documents to be filled out.
2. A ReMeS employee operator sends the necessary documents to the residential user by regular mail.
3. The residential user fills out the required documents.
4. The customer sends the filled out forms back to ReMeS.
5. A ReMeS employee processes the customer's request and generates an authentication token (e.g. username and password)
6. A ReMeS employee sends an authentication token back to the residential user by regular mail.

Alternate flow

2a The customer is a business/the customer has a business contract.

1. a ReMeS employee sends the necessary documents to the business owner.
2. The alternate flow returns to step 3 in the normal flow.

6a The customer is a business/the customer has a business contract.

1. a ReMeS employee sends the authentication token back to the business owner.

Exception flow

5a There are errors in the application.

1. a ReMeS employee sends the form back to the customer with addional information about the application not passing.

2.2.2 Link remote module

Primary actor Technician

Interested parties Customer, ReMeS, Utility providing company, Call Center

Preconditions

- The technician must be logged in into the ReMeS Portal.
- The customer needs to have a remote module installed.
- The remote module is registered in the ReMeS system.

Postconditions

- The remote module is linked to the customer's profile.

Normal flow

1. The technician looks up the remote module profile.
2. The technician looks up the customer's profile.
3. The technician links the remote module profile to the customer's profile.
4. The technician confirms the link to be created between the two profiles.

2.2.3 Unlink remote module

Primary actor Authorized User

Interested parties Customer, Technician, Call Center, Utility providing company

Preconditions

- The authorized user is logged in.
- The remote module is registered.
- The remote module is activated.

Postconditions

- The remote module is removed from the customer's profile.
- The remote module is removed from the customer's premise.

Normal flow

1. The authorized user indicates which remote module he or she wants to unlink.
2. The authorized user confirms the removal of the module from the customer's profile.
3. The authorized user schedules an appointment to uninstall the module.
4. At the scheduled appointment, include use case 2.2.5 ("Uninstall remote module").

Exception flow

4a The customer is not present at the scheduled appointment.

1. A call center operator contacts the customer to schedule a new appointment.
2. Return to step 4 in the normal flow.

2.2.4 Install remote module

Primary actor Technician

Interested parties Customer, ReMeS, Utility providing company

Preconditions

- the customer needs to have an approved and activated customer profile in the ReMeS system.

Postconditions

- The remote module is installed at the customer's premise.
- The remote module is activated.

Normal flow

1. The technician arrives at the customer's premise.
2. The technician installs the module.
3. The technician registers the remote module with the ReMeS by entering the relevant information (e.g. serial number, brand, module type, location, initial meter value, other modules in front of this remote module, . . .).
4. The technician configures the module for data communication.
5. The technician seals the module to prevent tampering.
6. The technician links the module to the customer's profile. Include use case 2.2.2 ("Link remote module").
7. The remote module sends its first trame, initializing the usage monitoring. Include use case 2.2.10 ("Send data trame").

2.2.5 Uninstall remote module

Primary actor Technician

Interested parties Customer, ReMeS, Utility providing company

Preconditions

- The technician is logged in.
- The remote module is deactivated.
- The remote module is registered with ReMeS.
- The technician can physically reach the remote device (the customer is present and/or the module is reachable).

Postconditions

- The remote module is removed from the customer's premise.
- The remote module is unregistered from ReMeS.

Normal flow

1. The technician arrives at the customer's premise.
2. The technician searches the remote module profile.
3. The technician unregisters the remote module.
4. The technician uninstalls the remote module.
5. The technician leaves.

2.2.6   Replace remote module

Primary actor Technician

Interested parties Customer, ReMeS, Utility providing company

Preconditions

- The customer has a faulty or outdated remote module installed.

Postconditions

- The remote module is replaced.
- The new remote module is installed, registered and activated.

Normal flow

1. The technician arrives at the customer's premise;
2. The technician unlinks and uninstalls the module. Include use case 2.2.3 ("Unlink Remote module").
3. The technician installs and links the new module. Include use case 2.2.4 ("Install remote module").
4. The technician leaves.

2.2.7 Configure transmission frequency

Primary actor Authorized user

Interested parties Customer, ReMeS, Utility providing company

Preconditions

- The authorized user is logged into the ReMeS portal.
- The customer has an installed, registered and active monitoring module.

Postconditions

- The update frequency of the module has changed.

Normal flow

1. The authorized user indicates for which module he wants to reconfigure the update frequency.
2. The authorized user changes the update frequency for the monitoring module module.
3. The authorized user confirms the update frequency changes.
4. The communication unit sends the reconfiguration request to the correct remote module.
5. The remote module receives the request.
6. The remote module reconfigures itself.
7. The remote module acknowledges the change if successful.

Exception flow

5a The remote does not receive the request.
   1. The communication unit waits for a while.
   2. Return to step 4 of the normal flow.

6a Reconfiguration fails.
   1. The remote module keeps the old setting.
   2. An error message will be displayed on the ReMeS portal.
   3. The use case ends here.

2.2.8   Configure alarm notification

Primary actor Authorized User

Interested parties ReMeS, Utility providing company

Preconditions

- The authorized user is logged into the ReMeS portal.

Postconditions

- The new alarm configuration is stored.

Normal flow

1. The authorized user indicates for which remote module he wants to reconfigure the alarm notification.
2. The authorized user enters the required contact details, namely email address and (mobile) phone number.
3. The authorized user confirms the notification configuration change.
4. The ReMeS portal acknowledges the received changes.

Exception flow

2a One or more of the contact details are incorrect (for example an email address without a domain name).

1. The ReMeS portal notifies the authorized user.
2. Return to step 2 in the normal flow.

2.2.9   Configure anomaly response

Primary actor Authorized user

Interested parties Customer, ReMeS, Utility providing company

Preconditions

- The authorized user is logged in into the ReMeS portal.
- The customer has a remote valve installed.
- The remote valve is installed, active and registered in the ReMeS system.

Postconditions

- The new alarm configuration is stored.

Normal flow

1. The authorized user indicates for which remote valve he or she wants to (re)configure the anomaly detection response.
2. The authorized user sets the desired anomaly detection response (e.g. shut down automatically, delayed shut down, no shut down, ...).
3. The authorized user confirms the new anomaly detection response.

2.2.10   Send data trame

Primary actor Remote monitoring module

Interested parties Customer, ReMeS, Utility providing company

Preconditions

- The remote module is installed.
- The remote module is activated.

Postconditions

- The data center has collected a trame.

Normal flow

1. The remote module prepares a data trame with all the information (date and time, battery level, counter values, . . .).
2. The remote module sends the trame to the configured phone number by SMS.
3. The communication unit collects the trame.
4. The communication unit creates a corresponding event.
5. The storage unit stores the event.
6. The anomaly detection unit processes the trame.
7. The analytics unit processes the trame.

Alternate flow

1a The battery is low.

  1. Include Use Case 2.2.13 ("Send low battery alarm").

2a The remote module uses the internet to send trames.

  1. The remote module sends the trame to the configured IP address using the configured WiFi connection.
  2. Return to step 3 in the normal flow.

6a An anomaly is detected.

  1. Include use case 2.2.12 ("Send alarm").
  2. Return to step 7 in the normal flow.

Exception flow

2a The trame cannot be sent (timeout or wrong response code).

  1. The remote module waits for 5 minutes;
  2. Return to step 1 in the normal flow.

2.2.11 Send alarm trame

Primary actor Remote Monitoring Module

Interested parties Customer, Call Center, Utility providing company, ReMeS, Emergency services

Preconditions

- An anomaly detection algorithm triggered the alarm.
- The remote module is installed and active.
- The customer needs to have an alarm configuration.

Postconditions

- The event is logged.

Normal flow

1. The remote monitoring module prepares an alarm trame.
2. The remote monitoring module sends the alarm trame to the configured communication unit.
3. The communication unit collects the alarm trame.
4. The communication unit converts the alarm trame to an alarm event.
5. The storage unit saves the alarm event.
6. The anomaly detection unit processes alarm event.
7. The anomaly detection unit sends a notification to the customer. Include use case 2.2.12 ("Send alarm").

Alternate flow

4a The trame is coming from a remote gas monitoring module.

1. ReMeS sends a shutdown command to the remote valve, if a valve is present.
2. The remote valve shuts down.
3. The remote valve acknowledges to ReMeS if the shutdown was successful.

6a The data center recognizes this alarm trame as a false alarm.

1. ReMeS records a false alarm.
2. The use case ends here.

Exception flow

2a The trame could not been sent.

1. The remote module waits for 3 seconds.
2. Return to step 2 of the normal flow.

2.2.12 Send alarm

Primary actor Anomaly detection unit

Interested parties Customer, Call Center, Utility providing company, Emergency services

Preconditions

- The customer needs to have an alarm configuration registrered in ReMeS.
- An anomaly in the consumption pattern of a customer has been found OR an alarm event has been recorded at the communication unit.

Postconditions

- The event is logged.
- The customer is notified.
- If configured, the remote valve is shut down.
- In case of a gas leak, the emergency services are notified.

Normal flow

1. The call center takes preventive actions.
2. The call center notifies the customer about a potential anomaly detection (by email or by phone, depending on the alarm configuration).
3. The customer receives the notification.
4. The customer determines whether the alarm is indeed an anomaly.
5. The customer notifies ReMeS that the alarm is indeed an anomaly.

Alternate flow

1a There is a potential gas leak.

1. If a remote valve is available and it is configured to shut down in case of an anomaly, shut it down. Include use case 2.2.14.
2. Contact the emergency services.
3. Return to step 2 in the normal flow.

1b There is a potential water leak.

1. If a remote valve is available and it is configured to shut down in case of an anomaly, shut it down. Include use case 2.2.14.

5a The reported alarm is a false alarm.

1. The customer logs in into the ReMeS portal and indicates that the detected anomaly was a false alarm.
2. In case the emergency services were contacted, the alarm is called off.

Exception flow

2a The customer cannot be reached.

- ReMeS waits for a while.
- Return to step 2 in the normal flow.

2.2.13   Send low battery alarm

Primary actor Remote module

Interested parties Customer, Utility providing company, ReMeS

Preconditions

- A trame is collected
- The battery status of the collected trame indicates that the battery is indeed low.
- The trame comes from a battery powered module.

Postconditions

- The battery in the remote module is replaced.

Normal flow

1. The ReMeS sytems sends out an alarm to the designated customer using a user-defined alarm configuration.
2. The customer responds to the alarm notification by replacing the battery.

Alternate flow

1a An alarm is already sent in the last 24 hours.

  1. ReMeS waits until 24 hours since the last alarm have passed.

1b Multiple alarms (10) have been sent and the customer is not responding.

  1. ReMeS dispatches a technician.
  2. The technician replaces the battery.

2a The customer responds to the alarm by notifying the ReMeS call center to inform ReMeS the customer is not able to replace the battery.

  1. ReMeS dispatches a technician.
  2. The technician replaces the battery.

2.2.14 Shutdown valve

Primary actor Valve Operator

Interested parties Customer, ReMeS, Utility providing company

Preconditions

- The remote valve is installed at the customer's premise.
- The remote valve is registered.
- The remote valve is active.
- The remote valve is open.
- A request has been made to shut down the valve.

Postconditions

- The valve is shut down.

Normal flow

1. The valve operator indicates which remote valve needs to be shut down.
2. The communication unit sends a request to the remote valve to shut it down.
3. The remote valve shuts down.
4. The remote valve notifies the communication unit in case the shutdown is successful.

Exception flow

2a The communication unit cannot reach the remote valve.

1. The communication unit waits till the module calls the base.
2. Return to step 2 in normal flow.

4a The acknowledgement times out.

1. The remote module tries again for up to three times.

2.2.15   Create invoice

Primary actor AnalyticsUnit

Interested parties Customer, Utility providing company, Third party payment service

Preconditions

- The customer needs to be registrered in the ReMeS system.

Postconditions

- The customer now has a pending invoice.
- The utility providing company and third party payment service receive a copy of the invoice.

Normal flow

1. The system generates the usage detail for a certain period of time.
2. Using the information in the contract between the utility providing company and the customer, the system calculates the total price for the consumption.
3. This amount, together with the start and end date of the period, makes up the invoice.
4. The invoice is dispatched to the third party payment service and the utility providing company. This could be done either electronicly or by regular mail.

2.2.16   Pay invoice

Primary actor Customer

Interested parties ReMeS, Utility providing company, Third party payment service

Preconditions

- The customer has a pending invoice.
- The third party payment service has the invoice at it's disposal.

Postconditions

- The customer has no more pending invoices and the invoice is paid.
- The utility providing company and third party payment service each got their share of the paid invoice.

Normal flow

1. The third party payment service notifies the customer that there is a pending invoice
2. The customer transfer the correct amount of money to the payment service before expiration of the due date.
3. Upon receiving the correct amount of money from the customer, the payment service notifies ReMeS and the corresponding utility providing company.

Exception flow

2a The customer pays not enough during the grace period

1. The payment service discards the current invoice.
2. The payment service creates a new invoice containing the costs of the previous invoice and additional costs for the reminder and interests.

2b The customer pays too much

1. The payment service returns the excess amount to the customer.

Chapter 3

Additional constraints

- A utility providing company can only manage modules for the utilities it provides.

- The customer of every event is equal to the customer that belongs to the remote module that sent the trame, resulting in the generation of the event.

- Modules that depend on each other (monitor/valve combinations, multiple monitoring modules on the same line, . . .) should always concern the same utility.

- WiFiModules should always use an external power because the WiFi. connection consumes to much electricity.

- Only battery powered modules can send low battery alarms.

- The update frequency on battery powered devices can only be once per 24 hours.

- The cumulative values of subsequent measurements of a remote monitoring module should rise monotonically except when the monitoring module is installed on a utility that can supply to the grid (e.g. houses with solar energy).

- No access is granted to the ReMeS portal without authentication.

- No access to personal data in the ReMeS portal is allowed without authorization.

- No valves should be shut without a previous anomaly detection.

- No alarms should be triggered without a anomaly detection.

- In case of a gas leak, the customer and the emergency services should be notified.

- In case of a water leak, only the customer should be notified.

- A customer cannot receive invoices from a utility providing company with whom the customer has no contract.

- In order to create a user profile for ReMeS, the utility company should participate in the ReMeS program.

Chapter 4

Quality attribute scenario's

4.1 Availability

4.1.1 Remote module

Source Internal to the system

Stimulus Fault: due to a hardware failure, the software stops working.

Artifact Remote module

Environment During normal operation

Response

1. The system should detect and record the event.
2. As long as the corresponding module is not repaired, no data can be received from or sent to this module.
3. The customer of this module should be notified.
4. A specialized technician should be dispatched to repair or replace the module.

Response measure

1. The detection time should be at most the update frequency of the corresponding module.
2. In 98% of all cases the problem should be fixed within 2 days.
3. If these problems occur systematicly (rate > 2/year), usage analysis and revision of SLA should be done within one month.

4.1.2 Network

Source External to the system

Stimulus Fault: The transmission of data is unexpectedly (i.e. not by a scheduled maintenance) interrupted.

Artifact Communication channels

Environment During normal operation

Response

1. The system should detect the network failure.
2. During the breakdown, no additional measurements can be collected nor can alarms from modules be received.
3. To prevent a (useless) overreaction, some basic troubleshooting is passed through (checking the physical connections, rebooting the router, etc.).
4. In case none of the above basic tips solved the problem, the network provider should be notified about the crash.

Response measure

1. Detection should be done under 1 minute.
2. In accordance to the SLA with the telecom operator, the data flow should be re-established within the specified period.
3. If these problems occur systematicly (rate > 1/month), usage analysis and revision of SLA should be done within one month.

4.1.3 Data center

Source Internal to the system

Stimulus Hardware failure in the datacenter. Since the data center consists of several units, there could be various reasons for failure: at least one of units (analysis, prediction, anomaly detection or storage) servers goes down.

Artifact All of the entities which make up the datacenter could be the artifact :

1. Analysis unit
2. Prediction unit
3. Anomaly detection unit
4. Storage unit

Environment During normal operation

Response

1. Independent of the unit that goes down, the system should detect the crash.
2. If the *analysis* or *prediction* unit goes down:
   (a) Any pending operations on the server should be cancelled and those temporary results are lost (i.e. they have to be recalculated).
   (b) As long as the server is down, no new advices, predictions or alarms can be made.
   (c) Under no circumstances can this failure leave (or bring) the system in an inconsistent state.
   (d) A system administrator is dispatched to resolve the problem, this could be a replacement of one single component or the whole server. The system administrator could be belonging to ReMeS or the hardware manufacturer.
   (e) Upon resolving the problem, the server can resume his analysis, prediction or anomaly detection tasks.
3. If the *storage* unit goes down:
   (a) There should be at least one replica of all the data because ReMeS core business (i.e. predicting, monitoring and analyzing) all relies on (available) data.
   (b) Any pending operations on this (crashed) server should be cancelled and resumed or restarted on the replica. In this way the rest of the system has no knowledge of this recent crash.
   (c) Under no circumstances can this failure leave (or bring) the system in an inconsistent state.
   (d) A system administrator is dispatched to resolve the problem, this could be a replacement of one single component or the whole server. The system administrator could be belonging to ReMeS or the hardware manufacturer.
   (e) When the main server is back up and running, the replica can return control to the main server.

Response measure

1. The system has a guaranteed uptime of 99.9%, scheduled maintenance excluded.
2. In accordance to the SLA with the hardware manufacturer, the hardware is repaired or replaced on time with respect to the SLA.

4.2 Performance

4.2.1 Gas leak

Source Gas monitoring module, Internal to the system

Stimulus Gas leak alarm message

Artifact System

Environment During normal mode

Response

1. The system should record the message.
2. Upon processing the message, the customers who could experience inconvenience are notified.
3. The emergency services (i.e. the fire department) are notified.
4. All control modules in the neighbourhood of the leak are sealed off in any case.

Response measure

1. 95% of all notifications should reach the recipient in 30s.

4.2.2 Water leak

Source Water monitoring module, Internal to the system

Stimulus Water leak alarm message

Artifact System

Environment During normal mode

Response

1. The system should record the message.
2. Upon processing the message, the customers who could experience inconvenience are notified.
3. Depending on the profile of the involved customers, the system could seal off the valves.

Response measure

1. 95% of all notifications should reach the recipient within 3 minutes.

4.2.3 Low battery alarm

Source Battery-powered module, internal to the system

Stimulus Low battery alarm

Artifact System

Environment During normal mode

Response

1. The system sends a notification to the customer.
2. Customer replaces the battery or if the customer is not capable of doing so then a ReMeS technician will be dispatched to solve the problem.

Response measure

1. 98% of all the batteries should be replaced before the corresponding module stops sending trames as a result of a dead battery.

Chapter 5

Glossary

Advice *Advice* is information provided to the customer in order to reduce one's *utility* bill. This information is typically obtained through analysis of one's consumption.

Alarm An *Alarm* is a message sent by ReMeS to inform the customer that some anomaly is detected. This could be excessive usage of a cetrain *utility*.

AlarmCall An *AlarmCall* represents the telephone conversation or email message between ReMeS and the *Customer*.

AlarmConfiguration An *AlarmConfiguration* is a general name for the contact details of a *customer*. *Customers* can be reached via sms or email.

AlarmEvent An *AlarmEvent* is an event that is generated by the *CommunicationUnit* when an *AlarmTrame* is received. This is a unified format that every unit of the *DataCenter* can read and process.

AlarmTrame This is a *Trame* send by a *module* to report an *anomaly*. This could be in any format, depending on the *module*.

Anomaly An *Anomaly* is something that is not normal.

AnalysticsUnit The *AnalyticsUnit* is responsible for the analysis of all the monitoring data originating from the *customers*. This analysis includes several algorithms to generate detailed consumption patterns, *advices* and *reports*.

AnomalyDetectionUnit The *AnomalyDetectionUnit* runs several Machine Learning algorithms to detect leaks and other anomalies. Furthermore any *alarms* generated by *modules* are passed to this unit so it can take appropriate steps (i.e. generate an *alarm*).

Authorized User An *Authorized User* is a user that is granted to make changes in the ReMeS system. For instance, a technician can make changes on behalf of many other customers. A Customer can only make changes to to its own profile.

BoughtModule A *BoughtModule* refers to a *Module* that is bought by a utility providing company because they have decided to not outsource the billing aspect to ReMeS.

BusinessCustomer A *BusinessCustomer* represents a *customer* with a business contract.

CallCenter This is the contact center for troubleshooting and notifying customers. *Operators* of the call center will notify the *Customer* if an *Alarm* is triggered by the *AnomalyDetectionUnit*.

Company A *Company* is in the context of this project a *utility* providing company. A *Company* can provide more than one *utility*.

CommunicationUnit This unit is responsible for the collection of data from the *modules*. Data could be in different formats (dependent on the *module*) and could be received through various communication media.

Contract A Contract is negotiated between a *Customer* and a *Company* and connects both parties for a certain period of time. When one of the two parties wishes to terminate this *Contract* premature, they typically will have to have a valid reason also included in the *Contract*. Furthermore there is typically pricing information included.

Configuration A *Configuration* denotes the tuning of a *module*. This could e.g. the automatic closure of valves in case of an anomaly.

Customer A *Customer* is a consumer of a *Utility* in exchange for a payment based on the consumption. There are two kinds of *Customers*: *ResidentialCustomers* and *BusinessCustomers*.

DataCenter *DataCenter* is a general name for all the different units in the system. This is a clever notation to easily refer to the *AnalyticsUnit*, *PredictionUnit*, *StorageUnit*, *CommunicationUnit* and *AnomalyDetectionUnit* in one time.

Electricity *Electricity* is used in this context as the public service Electricity.

EmergencyCall An *EmergencyCall* is special kind of *AlarmCall*, namely to the *EmergencyService*.

EmergencyService Emergency services are organizations which ensure public safety and health by addressing different emergencies. The three main services are: Police, Fire and Medical Department.

Event An event is a message which is send from the *CommunicationUnit* to one of the units of the *DataCenter* (it is a one-way traffic message, so it is not send in the other direction). It forms a generalisation for *UpdateEvents* and *AlarmEvents*.

Gas *Gas* is used in this context as the public service Gas.

Government The *Government* is a stakeholder of ReMeS with as main concern having insight in the usage statistics of utilities in the country. Foreign *Governmnents* are also stakeholders if *Utilities* are exported or imported.

GPRSModule This refers to a specific kind of *Module* which communicates with the *CommunicationUnit* through the use of GPRS technology.

HiredModule A *HiredModule* is a *Module* hired by a *customer*. This occurs when a *company* has outsourced the billing aspect to ReMeS.

Invoice An *Invoice* is a document containing the consumption of a *Customer* for a certain utility during a certain period of time. Furthermore (and more important), this document also contains the total amount the *Customer* has to pay to the utility providing *Company* for this consumption.

IPCommunicationUnit This unit is responsible for the collection of measurement data through GPRS and WiFi. The collected data is then converted to unified *Events*.

Module This is a general name for all sorts of modules. There are *Modules* that monitor usage and *Modules* that can control the flow (valves). Another way in which *Modules* can differ is the communication type (i.e. GPRS, SMS and WiFi). A final distinction is the owner, modules can be owned by a *Company* or hired directly from ReMeS by a *Customer*.

MonitoringModule This is a *Module* which measures the consumption of a certain *utility*. The measured data is send to the *CommunicationUnit* in a certain format, dependent of the type of the *Module*.

Operator An *Operator* is a person who works in the *CallCenter*. The task of an *Operator* is dual. First of all to assist *Customers* in troubleshooting. Secondly, any kind of notification for a *Customer* is done by such a person.

Payment A *Payment* is the transfer of money, using a certain payment method (cash, credit card, etc.), from one party (such as a person or business) to another.

Personnel This is a general name for all different kind of employees. In this project there are *SystemAdministrators*, *Operators* and *Technicians*.

Prediction *Companies* want to know how much of which *Utility* they will have to produce in the coming period (this could a week, a month, a year, etc.). To Provide *Companies* with this information accurate *Predictions* are made which contain exactly the previously mentioned information.

PredictionUnit This unit is responsible for generating accurate *Predictions* based on the measurement data originating from the clients. This data comes from a *CommunicationUnit*.

ReMeS Portal The *ReMeS Portal* is an online application where *Customers* can access their account. They can also edit the different types of configurations (*AlarmConfiguration*, *Configuration*) and consult usage details and consumption advices. ReMeS *Personnel* can make changes to the system.

Report *Stakeholders* of ReMeS are interested in its activities and consumption patterns of its users. To provide the *Stakeholders* with the appropriate information, *reports* are published on fixed data.

ResidentialCustomer A *ResidentialCustomer* is a single person which is a *Customer* of a *utility* *Company*.

SIMCard A SIM Card (Subscriber Identification Module) contains the account information for mobile communication such as telephone number, serial number and default carrier, etc.

SIMCardModule A *SIMCardModule* is a *Module* which communicates with the *Communi-cationUnit* using a phonenumber. This is realized via a *SIMCard* placed in the *Module*. The *SIMCardModule* is in fact a generalisation for *SMSModules* and *GPRSModules*.

SMSCommunicationUnit This unit is responsible for the collection of measurement data through SMS. The collected data is then converted to unified *Events*.

SMSModule This refers to a specific kind of *Module* which communicates with the *Com-municationUnit* through the use of SMS.

StorageUnit The *StorageUnit* is responsible for the persistent storage of all *events*. The other units can collect their data in these persistent storage.

StakeHolder A *Stakeholder* is a party that can affect or be affected by the actions a company, in this case ReMeS.

SystemAdministrator A *SystemAdministrator* is a manager of a *CommunicationUnit* and is responsible for uptime and smooth operations.

Technician A *Technician* is responsible for the (un)installation and reparation of Modules and other hardware regarding the various units of the *DataCenter*. Furthermore he has more priviliges regarding the ReMeS portal to modify settings of customers.

TelephoneCompany A *TelephoneCompany* is a provider of certain communication services, such as (wireless) telephony.

ThirdPartyPaymentService This is a service for the electronic management of invoicing. It is in fact an intermediate between client and customer to collect the payments of any pending invoices.

Trame A *Trame* is a block of bits that contains certain meta-data and a data section in a predefined format. This format is different for each *Module*. The data section can be used in two different ways. One is for communication from the *Module* to ReMeS, in this case the data section contains actual measurements. The other way is for communication in the other direction, then it contains commands.

UpdateEvent An *UpdateEvent* is an event which is generate by the *CommunicationUnit* when a data *Trame* is received. This is a unified format that every unit of the *DataCenter* can read.

UsageDetail The *UsageDetail* contains a detailed description of the consumption of a certain *Customer*. This information is particularly useful for the invoicing.

Utility is a generalisation of *Water*, *Gas*, *Electricity*.

ValveOperator A *ValveOperator* is a person or machine who is granted to shut a valve in case of emergencies or anomalies. This can be either an *Authorized User* or the *AnomalyDetectionUnit*.

ValveModule This is a *Module* which controls the flow of a certain *utility*. The behaviour of this *Module* can be controlled by sending commands to configure it. An example is the automic sealing when a leak is detected.

Water *Water* is used in this context as the public service Water.

WiFiModule A *WiFiModule* refers to a specific kind of *Module* which communicates with the *CommunicationUnit* through the use of WiFi.