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Shared Internet Of Things Infrastructure Platform: ADD Application Software Architecture (H09B5a and H07Z9a) – Part 2a

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1. Attribute-driven design documentation

1.1 Decomposition 1: SIoTIP System (Av3, UC14, UC15, UC18)

1.1.1 Module to decompose

In this run we decompose the SIoTIP System.

1.1.2 Selected architectural drivers

The non-functional drivers for this decomposition are:

- *Av3*: Pluggable device or mote failure

The related functional drivers are:

- *UC14*: Send heartbeat (Av3)
This use case checks whether or not motes and pluggable devices are still operational.
- *UC15*: Send notification (Av3)
This use case sends a notification to a registered user.
- *UC18*: Check and deactivate applications (Av3)
This use case deactivates any application that requires deactivation, because of unavailability of essential pluggable devices or unassigned mandatory roles.

Rationale Av3 was chosen first since it has high priority and it is more relevant to the core of the system than the other quality requirements with high priority (M1 and U2). We believe that handling pluggable device failure/connectivity is more important to the whole of the system than M1 and U2, and that handling this first would give a stronger starting point for later ADD iterations than M1 or U2.

1.1.3 Architectural design

This section describes what needs to be done to satisfy the requirements for this decomposition and how involved problems/obstacles are solved.

Av3: Failure detection A SIoTIP gateway can autonomously detect failure of one of its connected motes and pluggable devices. timers?
heartbeat/timestamp tactic

Av3: Application deactivation Applications that can no longer operate due to failure of a pluggable device or mote should be automatically suspended and re-activated once the failure is resolved.

Applications need pluggable devices for the proper functioning. When the pluggable devices fail, the `PluggableDeviceManager` sends command and the `ApplicationManager` deactivate one or more applications using those devices. Availability and reliability of the shared platform offered to applications is important. To reduce the risk of frequent application downtime, an application provider can require a redundancy in the available pluggable devices. Multiple sensors or actuators for one application can be in one room. If one of sensor or actuator failed application just start using the other available sensor or actuator in room.

Av3: Notifications The infrastructure owner should be notified of any persistent pluggable device or mote failures. Customer organisations should be notified if one or more of their applications is suspended or re-activated. Applications using a failed pluggable device or any device on a failed mote should be notified. One of the important things for Av3 is notification. In the case of failure of sensor, it is mandatory to inform all involved parties about the failure to resolve the problem as soon as possible. The `NotificationHandler` notify an infrastructure owner

of any persistent pluggable device or mote failures. The infrastructure owner has to receive the notification in ten seconds in case mote failed or in thirty seconds if a pluggable device failed. Notification is also send to a customer organisation, when one or more of their application are suspended or re-activated. Applications using a failed pluggable device should be also notified via The `NotificationHandler`.

Av3: Application redundancy settings Application providers can design their applications such that they explicitly require redundancy in the available pluggable devices.

Alternatives considered

Av3: Alternatives for application deactivation As mentioned above, when some of pluggable devices fail the applation can operate normally, because of using the next available sensor. ??? could be?

1.1.4 Instantiation and allocation of functionality

This section describes the components which instantiate our solutions described in the section above and how the components are deployed on physical nodes.

Decomposition Figure 1.1 shows the components resulting from the decomposition in this run.

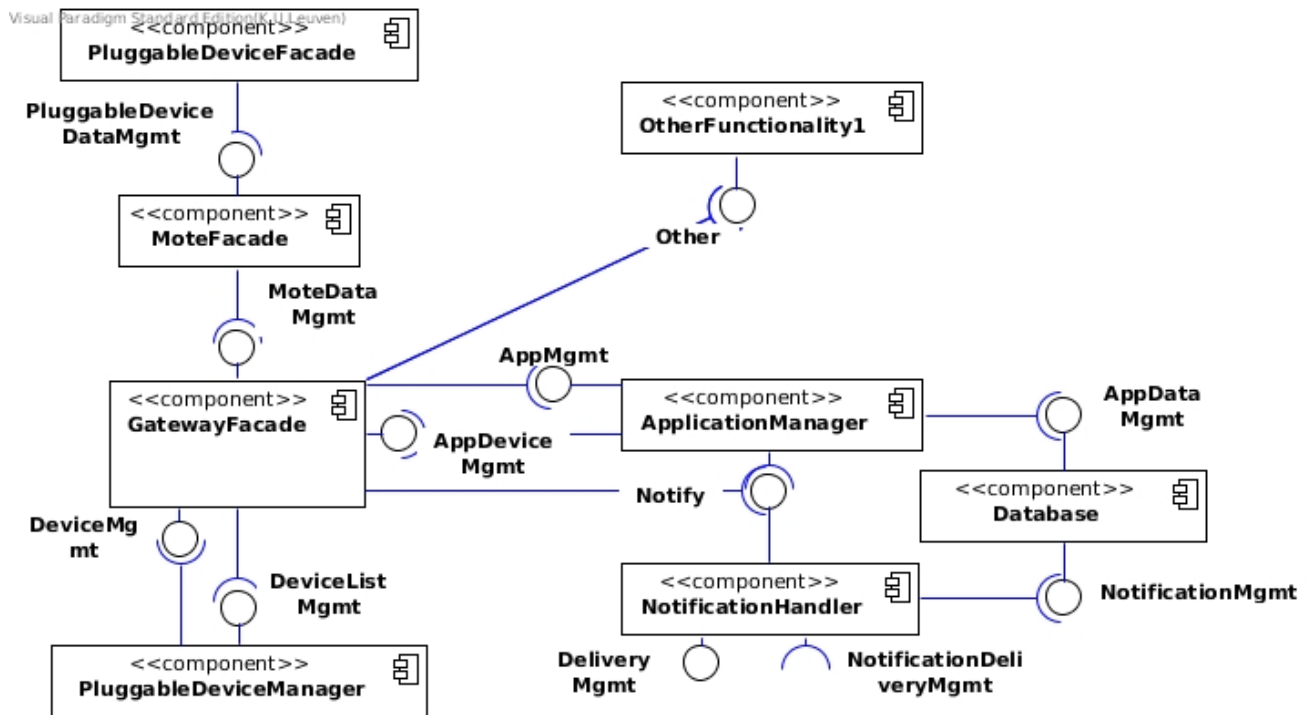


Figure 1.1: Component-and-connector diagram of this decomposition.

The responsibilities of the components are as follows:

ApplicationManager Responsible for deactivating applications and after this action calls method of the `NotificationHandler` to send notification to a customer organisation. When the `ApplicationManager` detects that application uses failed pluggable devices, then the notification is sent to an application.

set redundancy in the available pluggable devices?? (Av3) ??? check mandatory user roles

Database General database for other data. For instance the Database stores the data of notifications (Av3).

GatewayFacade Receives heartbeats from pluggable devices and sends heartbeats/device lists. The **GatewayFacade** sends commands to the **ApplicationManager** to shutdown applications, if it is needed.

send notification trigger ???(Av3)
forward data to applications

MoteFacade Sends heartbeats from pluggable devices to the **PluggableDeviceFacade**.

NotificationHandler Responsible for send notifications to infrastructure owner, customer organisation and applications (Av3).
stored by system – > contact DB?
lookup communication channel
users choose delivery method?

PluggableDeviceFacade Sends heartbeats to the **MoteFacade**.

PluggableDeviceManager Checks list of devices and see if there are pluggable devices for applications. the **PluggableDeviceManager** contains application preferences (e.g. amount of sensors required) and can send command to deactivate application. Send information about new/needed hardware is detected to the **GatewayFacade**, that sends command to reactivate application. check redundancy in the available pluggable devices??? is not the same like first sentence???

Deployment Figure 1.2 shows the allocation of components to physical nodes.

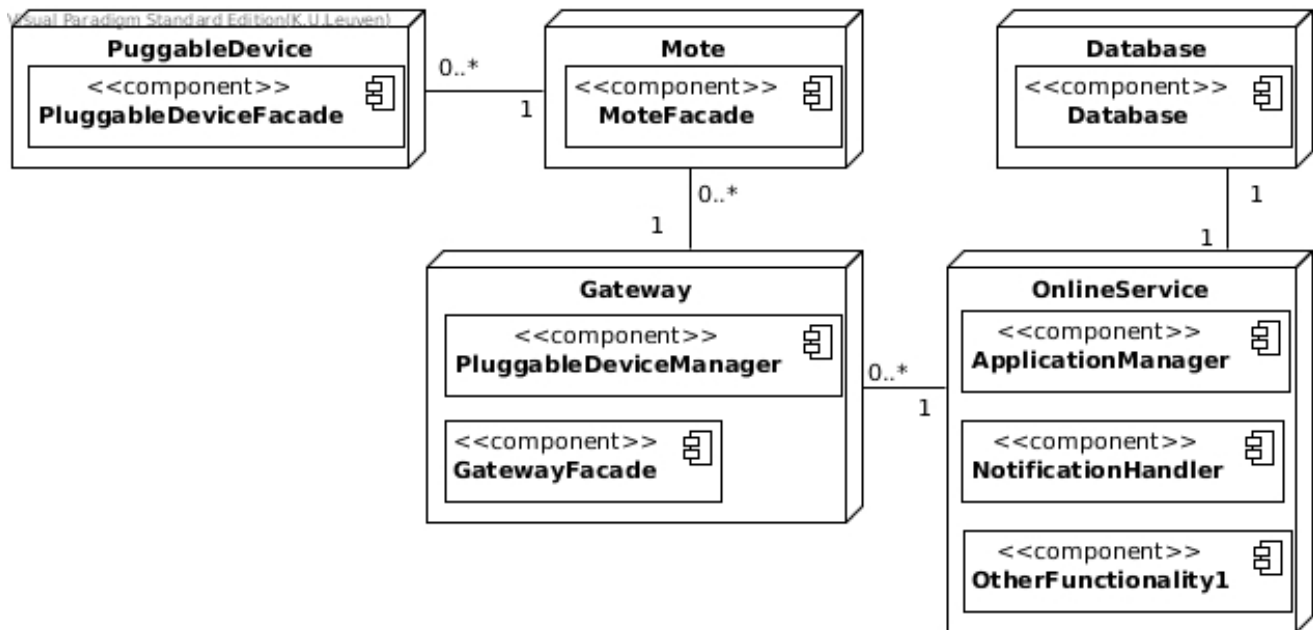


Figure 1.2: Deployment diagram of this decomposition.

1.1.5 Interfaces for child modules

This section describes the interfaces assigned to the components defined in the section above. Per interface, we list its methods by means of its syntax. The data types used in these interfaces are defined in the following section.

Each method shows which (part of a) quality attribute or use case caused a need for the method. However, this does not mean that a method is only to be used to satisfy that quality attribute or use case, it could be used for other causes not yet mentioned here.

ApplicationManager

- ForwardData
 - `void sendData(PluggableDeviceData data)`
 - * Effect: Send pluggable device data to an application that wants to use it
 - * Created for:
- AppMgmt
 - `void deactivateApplicationInstance(int applicationInstanceID)`
 - * Effect: Deactivates a running instance of an application.
 - * Created for:
 - `void activateApplicationInstance(int applicationInstanceID)`
 - * Effect: Activates a new instance of an application.
 - * Created for:

Database

- NotificationMgmt
 - `int storeNotification(NotificationData data)`
 - * Effect: Stores a new notification entry in the database. Returns the id of the new notification.
 - * Created for:
 - `void updateNotification(NotificationData data)`
 - * Effect: Updates an existing notification (e.g. change status to "sent").
 - * Created for:
 - `int lookupNotificationChannelForUser(int userID)`
 - * Effect: Returns the type of communication channel a user prefers. Different communication channels are mapped to integers.
 - * Created for:
- AppDataMgmt
 - `void updateApplication(ApplicationData data)`
 - * Effect: Updates an application in the database (e.g. change state to 'inactive').
 - * Created for:
 - `void updateSubscription(SubscriptionData data)`
 - * Effect: Updates a subscription in the database (e.g. change state to 'disabled').
 - * Created for:

GatewayFacade

- MoteDataMgmt
 - `void sendHeartbeat(int moteID, List<PluggableDeviceInfo> devices)`
 - * Effect: Sends a heartbeat to a certain gateway with information about operational devices.
 - * Created for:
- DeviceMgmt

- `List<DeviceInfo> getConnectedDevices()`
 - * Effect: Describe the effect of calling this operation.
 - * Created for:
- `void timerExpired(int deviceID)`
 - * Effect: Lets the gateway know that a timer for pluggable device or mote has expired. This will generate a notification for an infrastructure owner.
 - * Created for:
- `void deactivateApplicationInstance(int applicationInstanceID)`
 - * Effect: Deactivates a certain application. This could happen when mandatory pluggable devices for the application are missing.
 - * Created for:
- `void reactivateApplicationInstance(int applicationInstanceID)`
 - * Effect: Reactivate an application instance. This could happen automatically after a broken sensor has been replaced.
 - * Created for:
- **AppDeviceMgmt**
 - `bool areEssentialDevicesOperational(int applicationID)`
 - * Effect: Returns true if all essential devices for the application with id "applicationID" are operational.
 - * Created for:

MoteFacade

- **PluggableDeviceDataMgmt**
 - `List<DeviceInfo> getConnectedDevices()`
 - * Effect: Returns a list of information about devices that are connected to the mote.
 - * Created for:

NotificationHandler

- **Notify**
 - `void notify(int userID, String message)`
 - * Effect: Describe the effect of calling this operation.
 - * Created for:
- **DeliveryMgmt**
 - `void sendAcknowledgement(int notificationID)`
 - * Effect: Sends an acknowledgement to the system for a certain notification.
 - * Created for:

External notification delivery service

- **NotificationDeliveryMgmt**
 - `void notify(JSONObject data)`
 - * Effect: Deliver a notification to an end user using a specific delivery service.
 - * Created for:

PluggableDeviceManager

- **DeviceListMgmt**
 - `void sendHeartbeat(int moteID, List<PluggableDeviceInfo> devices)`

- * Effect: Send a heartbeat from a mote to check/update timers for operational devices.
- * Created for:
- `bool areEssentialDevicesOperational(int applicationID)`
 - * Effect: Returns true if all essential devices for the application with id "applicationID" are operational.
 - * Created for:

1.1.6 Data type definitions

This section defines the data types used in the interface descriptions above.

PluggableDeviceData contains data from a pluggable device at a certain point in time (value, type, date) (e.g. a sensor reading, an actuator status)

PluggableDeviceSettings contains settings for a pluggable device (power status, data update rate, ...)

PluggableDeviceInfo contains information about a pluggable device (device id, power status, data update rate, ...)

NotificationData contains data about a notification (message text, recipient, communication channel, date, status, source, ...).

ApplicationData contains data about an application instance (instance id, running status, ...)

SubscriptionData contains data about a subscription (subscription id, subscription status, subscription period, ...).

1.1.7 Verify and refine

The selected architectural drivers have been handled completely in this decomposition. This section describes per component which (parts of) the remaining requirements it is responsible for. If requirements are split in multiple parts, this is indicated by the addition of a letter (or number, depending on the structure of the requirement) after their title.

ApplicationManager

- *Av2*: Application failure
 - Prevention: a, b
 - Detection: a, b, c
 - Resolution: a, b, c
- *P1*: Large number of users: c
- *M1*: Integrate new sensor or actuator manufacturer: 1.c, 2.a
- *M2*: Big data analytics on pluggable data and/or application usage data: d, e
- *U1*: Application updates: a, b, c, d
- *U2*: Easy Installation: e
- *UC12*: Perform actuation command
- *UC17*: Activate an application: 3, 4

Database

- None

GatewayFacade

- *Av1*: Communication between SIoTIP gateway and Online Service
Resolution: b, c, d
- *M1*: Integrate new sensor or actuator manufacturer: 1.a, 2.b
- *U2*: Easy Installation: a, c, d
- *UC11*: Send pluggable device data: 1

MoteFacade

- *M1*: Integrate new sensor or actuator manufacturer: 1.a, 2.b
- *U2*: Easy Installation: b, c, d
- *UC04*: Install mote: 1, 2
- *UC05*: Uninstall mote: 1
- *UC06*: Insert a pluggable device into a mote: 2
- *UC07*: Remove a pluggable device from its mote: 2
- *UC11*: Send pluggable device data: 1

NotificationHandler

- *UC16*: Consult notification message: 5
- *UC17*: Activate an application: 5, 6

OtherFunctionality

- *Av1*: Communication between SIoTIP gateway and Online Service
Detection: a, b, c, d Resolution: a
- *P1*: Large number of users: a
- *P2*: Requests to the pluggable data database
- *M1*: Integrate new sensor or actuator manufacturer: 1.d
- *M2*: Big data analytics on pluggable data and/or application usage data: a
- *U2*: Easy Installation: e
- *UC01*: Register a customer organisation
- *UC02*: Register an end-user
- *UC03*: Unregister an end user
- *UC04*: Install mote: 3
- *UC05*: Uninstall mote: 2.b
- *UC06*: Insert a pluggable device into a mote: 3: topology part; alternative 3a.1.b
- *UC07*: Remove a pluggable device from its mote: 3.b
- *UC08*: Initialise a pluggable device: 1, 2, 4
- *UC09*: Configure pluggable device access rights
- *UC10*: Consult and configure the topology
- *UC11*: Send pluggable device data: 3
- *UC13*: Configure pluggable device
- *UC16*: Consult notification message: 1, 2, 3, 4
- *UC17*: Activate an application: 1, 2
- *UC19*: Subscribe to application
- *UC20*: Unsubscribe from application
- *UC21*: Send invoice
- *UC22*: Upload an application
- *UC23*: Consult application statistics
- *UC24*: Consult historical data
- *UC25*: Access topology and available devices
- *UC26*: Send application command or message to external front-end
- *UC27*: Receive application command or message to external front-end

- *UC28*: Log in
- *UC29*: Log out

PluggableDeviceDB

- *M1*: Integrate new sensor or actuator manufacturer: 1.a, 1.b, 2.b
- *M2*: Big data analytics on pluggable data and/or application usage data: b

PluggableDeviceFacade

- *U2*: Easy Installation: d

PluggableDeviceManager

- *U2*: Easy Installation: c, d
- *UC04*: Install mote: 4
- *UC05*: Uninstall mote: 2
- *UC06*: Insert a pluggable device into a mote: 3: uninitialised part; alternative 3a.1 3a.2 3a.4; 4
- *UC07*: Remove a pluggable device from its mote: 3.a, 3.c
- *UC08*: Initialise a pluggable device: 3
- *UC11*: Send pluggable device data: 2, 3a

PluggableDeviceDataScheduler

- *P1*: Large number of users: b
- *M1*: Integrate new sensor or actuator manufacturer: 1.a, 2.b
- *M2*: Big data analytics on pluggable data and/or application usage data: b, c

1.2 Decomposition 2: OtherFunctionality1 (M1, P2, UC11)

1.2.1 Module to decompose

In this run we decompose OtherFunctionality1.

1.2.2 Selected architectural drivers

The non-functional drivers for this decomposition are:

- *M1*: Integrate new sensor or actuator manufacturer
- *P2*: Requests to the pluggable data database

The related functional drivers are:

- *UC11*: Send pluggable device data (P2)
This use case stores pluggable device data in the pluggable device data storage. This could be a sensor reading or an actuator status.

Rationale We chose M1 as it was one of the remaining quality attributes with high priority. M1's focus on easily introducing new types of devices to the system is very important because of the fast growing market for IoT and development of applications for IoT. Thus, we want to handle this quality attribute before U2 (the other remaining attribute with high priority), as we presume that customer organisations are more interested in using new devices than the effort it takes for infrastructure owners to install the devices.

We also chose P2 because it is strongly related to M1; the whole data flow from devices to storage/applications needs to exist before modifications can even be made. This combination of M1 and P2 would force us to handle processing and storage of data while making the involved components as simple as possible to modify.

1.2.3 Architectural design

This section describes what needs to be done to satisfy the requirements for this decomposition and how involved problems/obstacles are solved.

M1: Handling new types of pluggable devices The new types of sensor or actuator data should be transmitted, processed and stored, and should be made available to applications. The infrastructure managers must be able to initialize the new type of pluggable device (UC8 : Initialise a pluggable device), configure access rights for these devices (UC9 : Configure pluggable device access rights), and view detailed information about the new type of pluggable device (UC10 : Consult and configure the topology).

The developers have to make changes to: component1, component2, datatype X. The new type of sensor needs to be able to be initialised so that it can send data. Thus, the PluggableDeviceFacade code that initialises devices should be updated for each new type of sensor. The PluggableDeviceData datatype should be updated to represent the new type of data. In this case, the new type will have to be added to the database that contains all different types of sensor data.

M1: Data conversions The pluggable data processing subsystem should be extended with relevant data conversions, e.g. converting temperature in degrees Fahrenheit to degrees Celsius. The `PluggableDeviceDataConverter` is responsible for converting data in system, for instance converting temperature in degrees Fahrenheit to degrees Celsius. System has to work with relevant data, otherwise problem may arise.

M1: Usage of new data by applications The available applications can be updated to use any new pluggable devices.

This is possible through the `RequestData` interface provided by `PluggableDeviceDataScheduler`. The application manager can get device data from the `PluggableDeviceDB` and return this data to applications in the `PluggableDeviceData` datatype. This datatype can easily be updated for new types of pluggable devices.

M1: Configuration of new device by infrastructure owners Initialisation: IO triggers the initialise() method which has been updated for the new pluggable device -¿ OK
Configure access rights: has absolutely fucking nothing to do with the new sensor type -¿ OK
Consult and configure topology: same as configure access rights

P2: Scheduling - In normal mode, the database processes incoming requests in a first-in-first-out order. - If the system fails to comply to the deadlines specified below, it goes in overload mode: requests are handled in the order that returns the system to normal mode the fastest, taking into account: the nature of the requests: storing new pluggable data (UC11 : Send pluggable device data) has priority over specific lookup queries (e.g. retrieving most recent measurement for a few sensors), which in turn have priority over broad queries (e.g. retrieving all sensor data for the last month). the priority of an application: requests from applications marked as critical by their sub- subscribers are processed before non-critical applications. - Also a mechanism should be in place to avoid starvation of any type of request.

dynamic priority scheduling
tactics: schedule resource, prioritize events, also limit event response?
starvation avoidance

P2: Pluggable data separation The processing of (large amounts of) requests concerning pluggable data has no impact on requests concerning other data, e.g. available applications.
"pluggable data has no impact on other data" two databases

Alternatives considered

Alternatives for solution A discussion of the alternative solutions and why that were not selected.

1.2.4 Instantiation and allocation of functionality

This section describes the components which instantiate our solutions described in the section above and how the components are deployed on physical nodes.

Unless stated otherwise the responsibilities assigned in the first decomposition are unchanged.

Decomposition Figure 1.3 shows the components resulting from the decomposition in this run.
The responsibilities of the components are as follows:

PluggableDeviceDB store data related to pluggable devices

PluggableDeviceDataScheduler scheduling, detect overload mode, store data, forward data

PluggableDeviceDataConverter M1: conversion of new type of data of new type of device

Deployment Figure 1.4 shows the allocation of components to physical nodes.

1.2.5 Interfaces for child modules

This section describes the interfaces assigned to the components defined in the section above. Per interface, we list its methods by means of its syntax. The data types used in these interfaces are defined in the following section.

Each method shows which (part of a) quality attribute or use case caused a need for the method. However, this does not mean that a method is only to be used to satisfy that quality attribute or use case, it could be used for other causes not yet mentioned here.

The interfaces and methods defined here are to be seen as an extension of the interfaces defined in previous sections, unless explicitly stated otherwise.

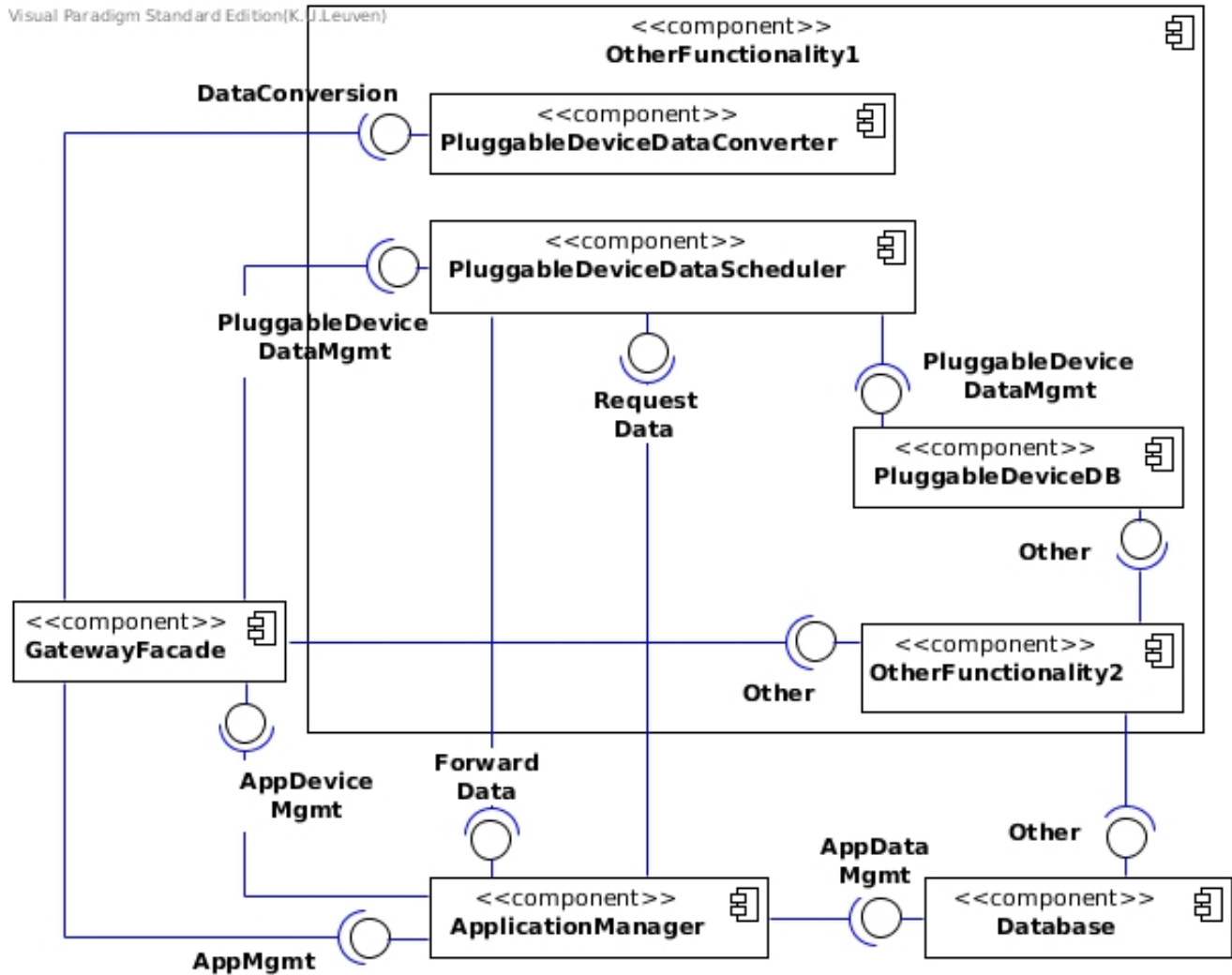


Figure 1.3: Component-and-connector diagram of this decomposition.

GatewayFacade

- MoteDataMgmt, last defined in section 1.1.5
 - void sendData(PluggableDeviceData data)
 - * Effect: Sends pluggable device data to the connected mote.
 - * Exceptions: None
- DeviceMgmt, last defined in section 1.1.5
 - void initialiseDevice(int deviceID, PluggableDeviceSettings settings)
 - * Effect: Initialises a pluggable device for use with the system.
 - * Exceptions: None
- AppDeviceMgmt, last defined in section 1.1.5
 - void configurePluggableDevice(int deviceID, PluggableDeviceSettings settings)
 - * For: Use case 11 step 3.b
 - * Effect: Causes certain settings to be set on a pluggable device that the gateway is connected to.
 - * Exceptions: None

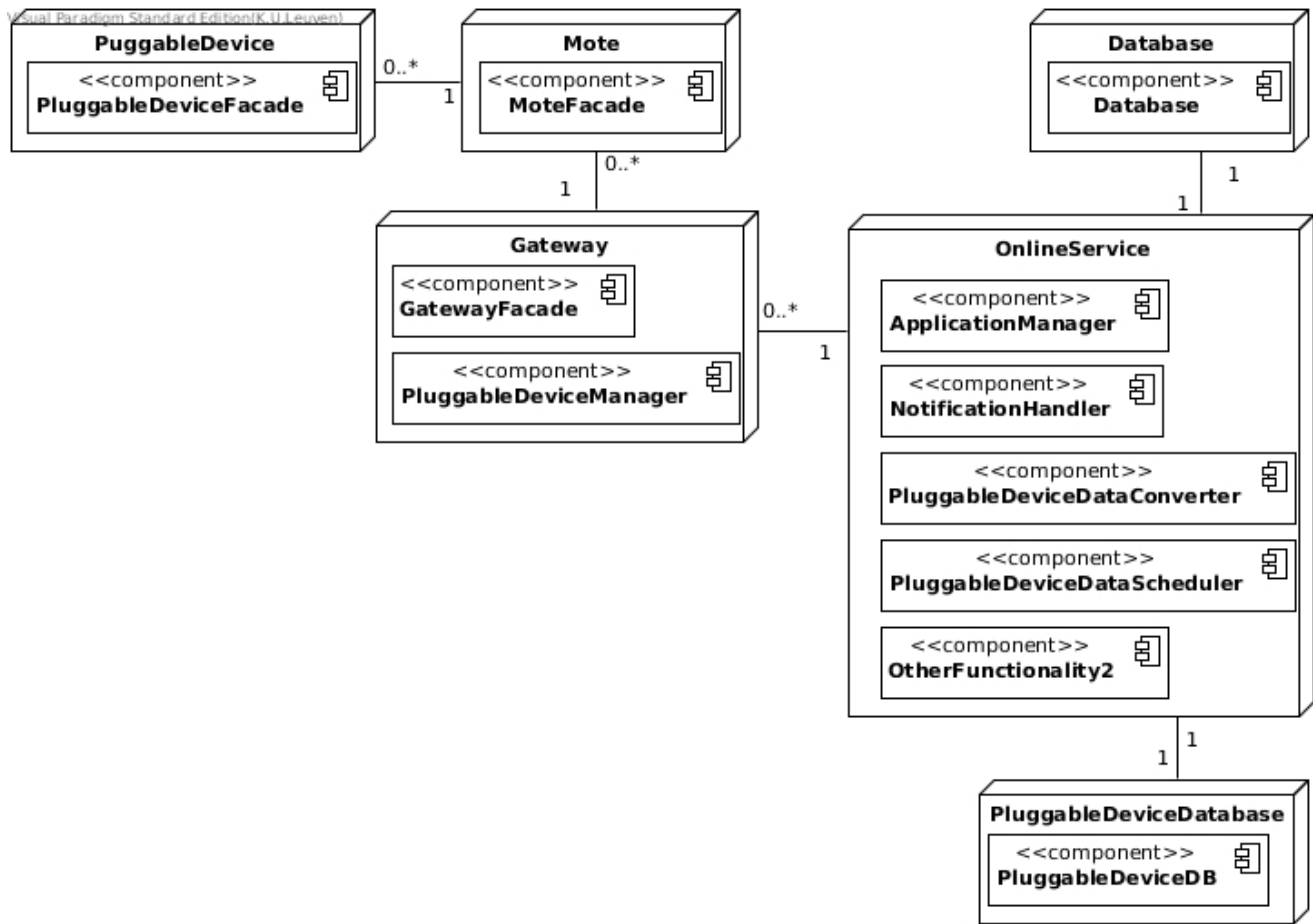


Figure 1.4: Deployment diagram of this decomposition.

MoteFacade

- PluggableDeviceDataMgmt, last defined in section 1.1.5
 - void sendData(PluggableDeviceData data)
 - * Effect: Sends pluggable device data to the connected mote.
 - * Exceptions: None
- PluggableDeviceMgmt
 - void initialise(int deviceID, PluggableDeviceSettings settings)
 - * Effect: Initialises a connected pluggable device according to some settings
 - * Exceptions: None

PluggableDeviceFacade

- PluggableDeviceMgmt
 - void initialise(PluggableDeviceSettings settings)
 - * Effect: Initialises the pluggable device according to some settings
 - * Exceptions: None

PluggableDeviceManager

- DeviceListMgmt, last defined in section 1.1.5

- `bool isDeviceInitialised(int deviceID)`
 - * Effect: Returns true if the device with id "deviceID" has been initialized.
 - * Exceptions: None

PluggableDeviceDataScheduler

- RequestData
 - `List<PluggableDeviceData> requestData(int applicationID, int deviceID, DateTime from, DateTime to)`
 - * Effect: Request data from a specific device in a certain time period
 - * Exceptions: None
- PluggableDeviceDataMgmt
 - `void sendData(PluggableDeviceData data)`
 - * Effect: Sends pluggable device data to the scheduler to be processed.
 - * Exceptions: None

PluggableDeviceDB

- PluggableDeviceDataMgmt
 - `void sendData(PluggableDeviceData data)`
 - * Effect: Sends pluggable device data to the DB to be stored.
 - * Exceptions: None
 - `List<PluggableDeviceData> getData(int deviceID, DateTime from, DateTime to)`
 - * Effect: Returns data from a specific device in a certain time period.
 - * Exceptions: None
 - `List<int> getApplicationsForDevice(int deviceID)`
 - * Effect: Returns a list of applications that can use the device with id "deviceID."
 - * Exceptions: None

1.2.6 Data type definitions

This section defines new data types that are used in the interface descriptions above.

DateTime Represents an instant in time, typically expressed as a date and time of day.

1.2.7 Verify and refine

The selected architectural drivers have been handled completely in this decomposition. This section describes per component which (parts of) the remaining requirements it is responsible for. If requirements are split in multiple parts, this is indicated by the addition of a letter (or number, depending on the structure of the requirement) after their title.

ApplicationManager

- *Av2*: Application failure
 - Prevention: a, b
 - Detection: a, b, c
 - Resolution: a, b, c
- *P1*: Large number of users: c
- *M2*: Big data analytics on pluggable data and/or application usage data: d, e
- *U1*: Application updates: a, b, c, d
- *U2*: Easy Installation: e
- *UC12*: Perform actuation command
- *UC17*: Activate an application: 3, 4

Database

- None

GatewayFacade

- *Av1*: Communication between SIoTIP gateway and Online Service
Resolution: b, c, d
- *U2*: Easy Installation: a, c, d

MoteFacade

- *U2*: Easy Installation: b, c, d
- *UC04*: Install mote: 1, 2
- *UC05*: Uninstall mote: 1
- *UC06*: Insert a pluggable device into a mote: 2
- *UC07*: Remove a pluggable device from its mote: 2

NotificationHandler

- *UC16*: Consult notification message: 5
- *UC17*: Activate an application: 5, 6

OtherFunctionality2

- *Av1*: Communication between SIoTIP gateway and Online Service
Detection: a, b, c, d Resolution: a
- *P1*: Large number of users: a
- *M2*: Big data analytics on pluggable data and/or application usage data: a
- *U2*: Easy Installation: e
- *UC01*: Register a customer organisation
- *UC02*: Register an end-user
- *UC03*: Unregister an end user
- *UC04*: Install mote: 3
- *UC05*: Uninstall mote: 2.b
- *UC06*: Insert a pluggable device into a mote: 3: topology part; alternative 3a.1.b
- *UC07*: Remove a pluggable device from its mote: 3.b
- *UC08*: Initialise a pluggable device: 1, 2, 4
- *UC09*: Configure pluggable device access rights
- *UC10*: Consult and configure the topology
- *UC13*: Configure pluggable device
- *UC16*: Consult notification message: 1, 2, 3, 4
- *UC17*: Activate an application: 1, 2
- *UC19*: Subscribe to application
- *UC20*: Unsubscribe from application
- *UC21*: Send invoice
- *UC22*: Upload an application
- *UC23*: Consult application statistics
- *UC24*: Consult historical data
- *UC25*: Access topology and available devices
- *UC26*: Send application command or message to external front-end
- *UC27*: Receive application command or message to external front-end
- *UC28*: Log in
- *UC29*: Log out

PluggableDeviceDB

- *M2*: Big data analytics on pluggable data and/or application usage data: b

PluggableDeviceFacade

- *U2*: Easy Installation: d

PluggableDeviceManager

- *U2*: Easy Installation: c, d
- *UC04*: Install mote: 4
- *UC05*: Uninstall mote: 2
- *UC06*: Insert a pluggable device into a mote: 3: uninitialised part; alternative 3a.1 3a.2 3a.4; 4
- *UC07*: Remove a pluggable device from its mote: 3.a, 3.c
- *UC08*: Initialise a pluggable device: 3,

PluggableDeviceDataScheduler

- *P1*: Large number of users: b
- *M2*: Big data analytics on pluggable data and/or application usage data: b, c

2. Resulting partial architecture

~~This section provides an overview of the architecture constructed through ADD.~~

*"Since you are a two-student team, you can skip the final step of the assignment/report ("2. Resulting architecture
This section should present the component diagram of the overall system (after two decompositions). At this point,
you are not required to provide the deployment diagram of the overall system.")"*