Contract No. 004420

eu-DOMAIN - enabling **u**sers for
Distance-working & **O**rganizational **M**obility
using **A**mbient **I**ntelligence **N**etworks

D7.2 Testing platform for validation

Specific Targeted Research or Innovation Project

Project start date 1st June 2004 **Duration 36 months**

Published by the eu-DOMAIN Consortium **10th May 2007 Version 3.0**
Lead Contractor C International Ltd.

Project co-funded by the European Commission
within the Sixth Framework Programme (2002 -2006)

Dissemination Level: Confidential (CO)

Document file: D7.2 Test platform for validation.doc

Work package: WP7 – System Integration

Task: T7.1 – Integration of system components

Document owner: Pablo Antolín Rafael (TID)

Document history:

Version	Author(s)	Date	Changes made
1.0	Pablo Antolín Rafael (TID)	03/05/2007	Initial version
2.0	Jesper Thestrup (IN-JET)	04/05/2007	Added demonstrator 1 and 2
3.0	Pablo Antolín Rafael (TID)	10/05/3007	Added demonstrator 3

Review history:

Reviewed by	Date	Validated
Matts Ahlsen (CNET)	09/05/2007	

Index:

1. Introduction

1.1 The purpose of this document

The main purpose of this document is to explain the testing platform that is used in eu-DOMAIN. This testing platform will remain accessible, the same as the prototype of communication infrastructure one year after the project end. The nature of this deliverable is a prototype that includes and integrates the work performed by the different technical partners in the scope of the eu-DOMAIN project towards the implementation of the eu-DOMAIN platform.

1.2 Contents of this deliverable

This deliverable presents the integration approach taken within the eu-DOMAIN project. The document provides an overview of the eu-DOMAIN integration tasks and the partner involvement in them.

The document also presents how integration was performed in order to build the different demonstrators presented through out the life of the eu-DOMAIN project on top of the prototype infrastructure: the ESN demonstrator (Budapest, 2005), the PaC demonstrator (Madrid, 2006) and the Final demonstrator (Valladolid, 2007).

The demonstrators based on the ESN and PaC scenario are explicitly described in the document, presenting the scenario and the scenes that were implemented to show the functionality of the platform in different domains.

In general terms, system integration has involved the following tasks and developments:

- On the client side, all devices needed for the scenarios have been prototyped and communication links have been established.
- Client gateways have been loaded with the OSGi framework and relevant service bundles.
- On the server side, the main database, management structures and network intelligence have been integrated along with web service provisioning servers with application intelligence.
- The communication infrastructure has been established and services between gateways and servers have been enabled.
- All web services have been enabled with live access to and from content repositories and content providers.

1.3 Reader prerequisites

The reader is assumed to be familiar with the referenced deliverables of eu-DOMAIN.

2. eu-DOMAIN integration

2.1 eu-DOMAIN Demonstrators

This deliverable describes the progress of demonstration scenarios in the eu-DOMAIN project. A series of progressively more complete and complex demonstration platforms was developed during the project.

In a project with a large number of different components that will eventually be integrated, one can in principle build demonstration platforms through a vertical or a horizontal approach. In the first approach, each component is basically finished in depth before the next is started. In the horizontal approach, only small layers of each component are finished, in order for some basic functionality to be demonstrated. Then slowly more and more functionality is implemented. We use the term Happy Path for the latter approach.

The Project Steering Board decided at the technical meeting in Heraklion on 28 March 2005 to adopt the “Happy Path” approach in order to obtain an optimal platform for both internal validation and for fast external demonstration capabilities of the fundamental uniqueness of eu-DOMAIN.

The Steering Board has thus adopted the following plan for carrying out demonstration activities during the project’s annual review:

2.1.1 First review – May 2005

A rudimentary demonstration platform will be operational for the first annual review in May 2005. This demonstrator will contain a simple gateway prototype setup and a basic web service server.

The gateway prototype setup provides a realistic test-bed of the eu-DOMAIN client-side, which can either be easily transported to another location, i.e. the site of the review or run stationary at the UAAR site. To be able to move the prototype easily, a separate eu-DOMAIN communication network will be created.

The demonstration will enact selected parts of the ESN scenario with an aim of including as many Happy Path functionalities as possible. Only those parts of the scenario that can be emulated with a reasonable effort and without delaying future work will be demonstrated. The main trust will be on showing some of the unique features of the full eu-DOMAIN platform, with a sensible usability and a few nice user interfaces. This means that hard coding combined with a few well-designed user interfaces will be preferred over complex services that can only be demonstrated by using low level programming instructions.

2.1.2 Second review – May 2006

The demonstrator for the second annual review will be a fully working demonstration platform able to enact major parts of both the ESN (industrial) and the PaC (healthcare) scenarios.

2.1.3 Third and final review – May 2007

The demonstrator for the third and final review of the project will be a fully working demonstration platform able to show how the eu-DOMAIN infrastructure can be used in a third and different domain, in this case a Domotica scenario.

Technical innovation

The following table shows the main technical innovation in each demonstrator.

Issue	1st Demonstrator	2nd Demonstrator	3rd Demonstrator
Server infrastructure	Rudimentary & distributed	Almost integrated	Robust platform
Client infrastructure	First implementation	Robust platform	Robust platform
Interoperability	WS calls	WS calls & integration	WS calls & integration (unchanged)
Security	User certificates	None	Online authorisation and certificates
Mobility	Mobile Worker (PDA)	None	Mobility, mobile gateway (PDA)
Ambient intelligence	Simple rules	Simple rules	Complex rules (several devices)
External Content Provider	Grundfos (pdf file)	Columna & WS calls	Add another legacy system
Multimodal interfaces	PDA	PC	PC + PDA + perhaps two-way SMS
Localization	None	Simple	Simple
Configurability	None	User configurability	Configurability and modifiability
Semantic	None	WS integration (with Columna)	None

Table 1 Progress in technical innovation in the developed demonstrators

None of the demonstrators has caused any reason for concern in terms of availability and deployability of the involved technologies or in the functionalities and services that can be developed on the basis of the eu-DOMAIN platform.

Further, the socio-economic validation performed in the EASW workshops did not reveal any real differences in the potential of eu-DOMAIN exploitability within each of the domains.

Consequently there have been only minor adjustments necessary to the functional and extra-functional features of the eu-DOMAIN platform, as it was planned in initial requirement specification and there is still a high level of confidence about future potential of eu-DOMAIN.

Several requests, recommendations and comments have been received from the projects external reviewers during the two reviews. These inputs have been dealt with in detail in other deliverables and are mostly related to the deployment of the eu-DOMAIN platform in existing environments such as Facility Management and Healthcare systems. Besides from the impact on security architecture, which is implemented in the 3rd demonstrator, the comments have mostly influenced the socio-economic aspects of eu-DOMAIN.

3. First demonstrator: The ESN scenario

A rudimentary first demonstration platform was presented for the first annual review in May 2005. The demonstrator contained a simple gateway prototype setup and a basic web service server.

3.1 Work undertaken to build the first demonstrator

The demonstration enacted selected parts of the ESN scenario with an aim of including as many Happy Path functionalities as possible. The main trust was on showing some of the unique features of the full eu-DOMAIN platform, with a sensible usability and a few nice user interfaces. The figure shows the software components used to implement the scenario on top of the prototype platform:

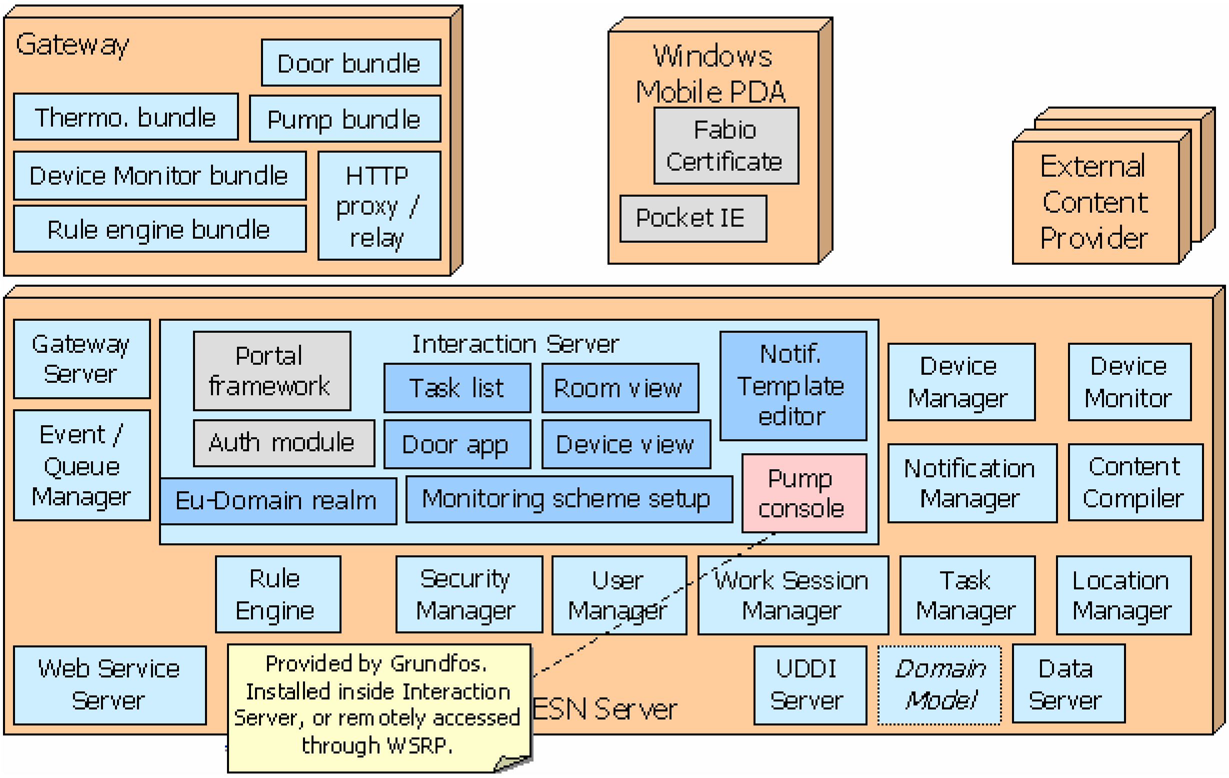


Figure 1: ESN Demonstrator Components

The integration of this demonstrator prototype was performed having the functionality distributed among the different partners. The client side (gateway) was implemented by UAAR, including the pump, the door and the thermometer devices that were used in the demonstrator. SAG held some part of the ESN Server Park, more precisely, the Data Server and the Domain Model. CNET held another part of the server park in another server, including the Rule Engine and the Work Session and Task Manager among other components. Finally, TID run the Interaction Server in a separate server. The implementation of a Service Oriented Architecture (SOA) enabled these three servers to interoperate and act as a single machine thanks to the use of web services. Moreover, the client side was also incorporated into the infrastructure using web services.

The client side was settled in Aarhus (Denmark), while the server park was geographically distributed in Madrid (Spain), Stockholm (Sweden) and Valladolid (Spain). Then, and in order to show the demonstrator during the review, servers, devices and gateways were moved to Budapest, where connections were made again. Next picture shows part of this integration work performed in Budapest.

Figure 2: First year review integration

3.2 The client prototype demonstrator

This section describes the components and the technical layout at the client side. The demonstrator is aimed at the ESN scenario. However, much of the material is relevant to the server side as well as the PaC scenario.

The fundamental decision that has been made is that the gateway and the server will NOT be connected on-line for the first demonstration. This will be reserved for the second demonstration, when we hopefully will have more control over the infrastructure.

We cannot assume that there will be network connectivity during the review meeting in Budapest or even network connectivity of a reasonable quality. Therefore the gateway will have to perform its own part of the demonstration based on hard coded functionality, whereas the server demonstrations will be either on-line (if connectivity is available) or emulated in some way One possibility is to install the whole server setup on laptops.

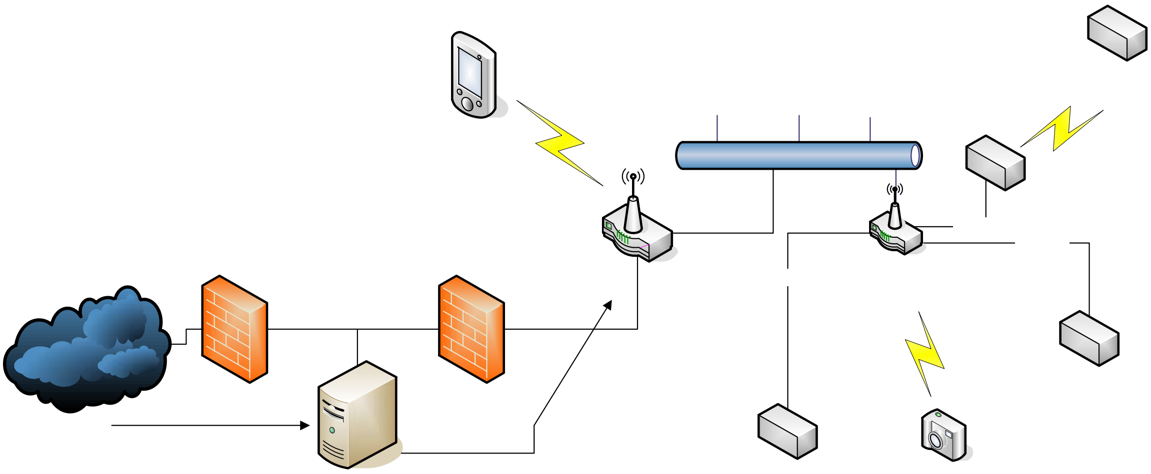


Figure 3 Client Prototype #1

Figure 3 shows a physical view of the prototype. This setup is created in order to provide a realistic stationary test-bed of the eu-DOMAIN client-side within UAAR as well as in order to be able to move the prototype to another location easily. To be able to move the prototype easily, a separate eu-DOMAIN network is created.

Furthermore, the setup allows access (on ports 80 and 8080) from machines on the internet, which is useful for integrating with software written by other partners.

The nodes of the prototype are:

- *Linux Server* that will have a local copy of the eu-DOMAIN server side. If needed, it will run VMWare[1] to run Windows. It will also function as an OpenSSL[2] Certificate Authority (CA). It is installed in a DMZ at the Computer Science Department, University of Aarhus.
- *Wireless Access Point/Gateway* The access point[3] will function as a gateway between the internal eu-DOMAIN network and the rest of the network at the Computer Science Department, University of Aarhus, as well as an access point, e.g., for a PDA terminal. It simulates the router providing internet access at the location of a customer where eu-DOMAIN is installed.
- *OSGi Gateway.* This is the central component of the eu-DOMAIN client-side that runs the Knopflerfish OSGi framework[4].
- *Devices*
  - The *Grundfos Pump* is a Grundfos UPE 25-40 pump which has an RS485 interface that is transformed to an RS232 interface transformed to a Bluetooth interface
  - The *Video Camera* is a TRENDnet TV-IP200W camera which allows for streaming and still images over WiFi
  - The *Thermometer* is a Pico TH03 serial thermometer
  - The *X10* equipment is Marmitek X10[5], which allows for power line communication
  - The door lock is a RUKO electrical door lock
  - The movement sensor is provided by UAAR
  - The *PDA* terminal is a Fujitsu-Siemens Pocket LOOX 720 with among others WiFi, Bluetooth, and GSM/GPRS capabilities

[1] http://www.vmware.com/
[2] http://www.openssl.org/
[3] A Linksys WRT54G wireless router and access point
[4] http://www.knopflerfish.org/
[5] http://www.x10.com/

3.3 The server prototype demonstrator

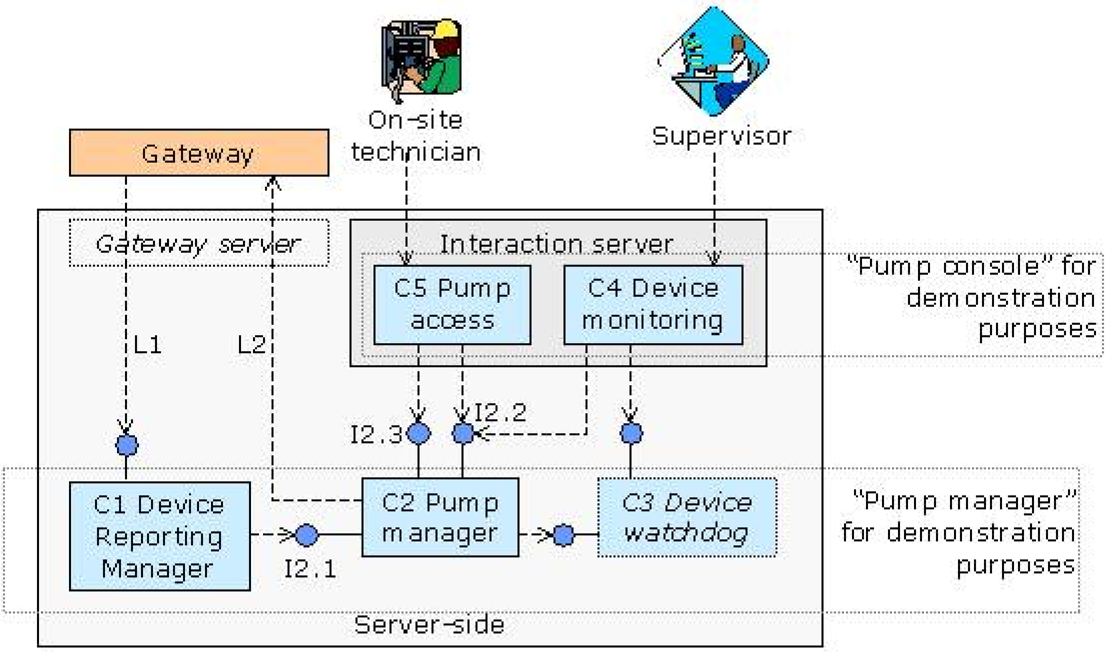


Figure 4 Server prototype #1

In this document, the term "gateway server" means a collection of OSGi bundles that can be invoked at the gateway in order to perform the functions required in the scenes.

The term "ESN server" is used for the collective functionality of the various managers installed at the eu-DOMAIN server, i.e. the "Pump manager", the Notification Manager, etc.

The Domain Model would be XML Schemas modelling all the information interchanged between components and the WSDL interfaces of all components. In the first demonstration it would not be much dynamic but mainly hard coded.

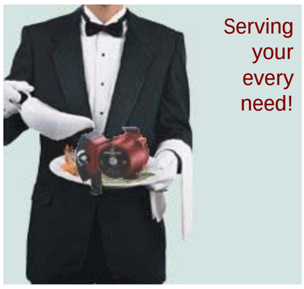
Also, the demonstration will not really use UDDI but have hard coded addresses for services.

Things that were not in this demonstration include:

- Access to external content providers
- Security
- Queuing (e.g. there are no provisions for retrying on L1 or L2 if the communications is unavailable)

3.4 The ESN scenario

The underlying scenario used for the first demonstrator is the "Serving your Every Need" scenario of the European Service Network (ESN) described in deliverable *D2.1 User Validation Framework*.



Serving your every need!

In a world where customers are the primary driving force in shaping product characteristics, features and use of pumps, combined with the existence of a sophisticated communication infrastructure, i.e. the eu-DOMAIN, the basic product function of a pump will shift from simply moving water (or fluids) to be an integral, maybe even a crucial part, of the customers solution. The value created by the "ambient intelligence" functionality of the pump becomes a major part of the customers overall value creation. The pumps are "serving you – wherever you are – whatever you do – whenever you want it". We call this scenario: "Serving your every need!"

The scene shows a typical service or installation situation involving pumps and related technical equipment in or around 2010. The characters are persons engaged in some form of technical activity. Some of the people involved are employees of Grundfos, either at headquarters or on-site, but also personnel from the distribution chain or independent service organisations participate. The skills of the people involved vary between scenarios and the play, but there is always a need to communicate in a multilingual environment. All scenes are set in buildings or mobile installations, even though some rural installations may also be introduced on the scene.

Most of this element is determined in the script, but a few elements enter the scene also. All actors rely heavily on visual communication rather than written. The cost of communication is low, so there is no limit to e.g. multimedia content or graphics being send across the network. Also, devices are ready to use through extensive use of Plug & Play technology.

The main thrust for the plays on the scene are the commercial benefits to be derived from the under laying business case. Each scenario has a commercial aim as seen from the side of Grundfos. Sometimes it is cost savings (e.g. installation costs); sometimes it is stimulation of sales and earnings.

The customer also has a range of specific aims. Some of these are related to personal comfort and security. Others are related to resources i.e. water and energy conservation, while yet others are related to a regulatory framework (e.g. documentation of operations).

3.5 Demonstration ESN-1-1

Scenario text:

Today, Fabio, one of Servizio Provinzia's new service technicians, is paying a visit to the Kings's plant in Sossano (VI). The ESN monitoring system has identified performance degradation in one of the 8 main pumps. When Fabio enters the plant, his virtual identity is sent from his PDA via the wireless network to the eu-DOMAIN service that authorizes his certificate and establishes the relevant object profiles at the plants service gateway. The system downloads and installs three relevant device drivers and a user profile for using the plant's intranet and broadband connections.

3.5.1 Scene and script

The scene:

The scene is the reception area of the plant. To the left is the door leading to the factory. To the right is the reception window. Visitors to the factory have to report here for registration, before they can enter the plant. Visitors are only allowed into the plant if they are either being escorted by a King's employee or if they are approved and registered with the ESN.

The location gateway is installed in the reception area behind the window counter. The gateway is also the WiFi access point for

Figure 5 Reception area

thereception area. The door is equipped with a RUKO electrical door lock and can be remotely controlled from the location gateway.

The actor's script:

Fabio enters the reception area through the main door. He activates his PDA and searches for a WiFi net. The PDA recognises the plant's WiFi and he can now log-on to the ESN application. First, he sends his personal ID with certificate from the PDA to the gateway. The gateway server forwards his ID to the ESN server and shortly after, an authorisation of Fabio comes back accompanied by a workplan for the visit.

> Since Fabio's visit has been scheduled, a workplan has been generated by Riccardo in Servizio Provinzia's computer system and send to Gianfranco, the manager of the cold store, who has authorised it. The workplan contains a description of the work to be performed, identification of the installed pumps that needs to be checked, the time and expected duration of the visit, the identity of the service technician (Fabio) and other pertinent data about the job.

The gateway server looks up the workplan in the plants internal authorisation system and compares the ID of Fabio with the authorisation. Since Fabio has been recognised as a bona fide person to perform the service job at the plant, he is now assigned to the task and he acknowledges that he will in fact do the task at this time. Both his and the plants acknowledgments are stored at the ESN server and will later be used for billing purposes.

Since Fabio's workplan has now been authorised and activated, the first thing to do is to download various tools to his PDA.

The first tool is an electronic key to unlock relevant doors in the plant, so that he can physically enter the location where the pumps are installed. Secondly, he receives a WEP key for the company's wireless network and a guest ID with password for using the intranet. Lastly, a customised browser-based device driver for pump interface is downloaded.

The workplan, data history and service records, device drivers and other bundles will be collected by the gateway server from various sources, i.e. the ESN server and the local plant server. The download of these items will not be implemented in real time in this demonstration. Rather, a pre-assembled package will be stored on the gateway server. In a parallel demonstration, a manual request will be submitted to the ESN server to demonstrate also the server functionality.

Figure 6 Electronic key control on PDA

The gateway server now establishes a guest profile in the plant's local ESN network, which identifies the authorisations provided to Fabio, e.g. the permissible access areas, the duration of his visit and other key data that would allow him to move around freely in the sections of the plant that are relevant to his work.

Fabio goes to the door leading to the plan. He calls up the electronic key application on his PDA, unlocks the door and enters the plant.

3.5.2 Use cases

Use case nr. 3.2: Access the commercial building, obtaining identification and authorization

Description	The technician has to access the commercial building, obtaining identification and authorization and he has to be able to download some relevant information such as a list of the installed pumps, the building in which they are installed, etc.
Service	Access, identification, authorization, information download
Type of service	Information, control
Actor	Technician, eu-DOMAIN system
Need	To obtain identification and authorization and to download information related to the building
Content	Text, image
Information direction	Pull/push
Time dependence	Not time-critical, real time
Position dependence	Yes, absolute

Requirements:

3.2.1 The technician has to be able to enter the plant

3.2.2 Only authorized technicians can be enabled to enter the plant

3.2.3 The technician has to be able to send his virtual identity from his PDA via the wireless network to the eu-DOMAIN service

3.2.4 The technician has to be able to have his certificate authorized by the eu-DOMAIN service

Validation:

Most of the requirements of use case 3.2 can be fulfilled. The information related to the building must be further specified.

3.5.3 Gateway implementation

The implementation was foreseen using the following OSGi bundles (data to be obtained from the ESN server will be hard-coded for this first demonstration).

1. Communication with PDA and exchange of technician ID / certificate (Fabio) from PDA (send/receive)
2. Communication with ESN server for authorisation of technician.
3. Extraction of workplan based on plant ID, date and time (and perhaps worker ID)
4. Verification of workplan authorisation from the plant's local server.
5. Acknowledgement of workplan from the technicians PDA (send/receive)
6. Registration at ESN server of workplan being acknowledged.
7. Download of binary data to PDA (device drivers, passwords, keys)
8. Communication with door lock (open signal)

Further, the following browser-based applications are needed for the PDA:

1. Application to send ID
2. Application to receive and acknowledge workplan
3. Application to open door

Authorizing the technician

The technician uses the PDA to access "https://eu-domain". This will cause the HTTP Service on the gateway to be contacted. The PDA will be identified based on its certificate issued by the eu-DOMAIN. No data will be sent to the ESN server in the first demonstration.

Receive and acknowledging workplan

The browser application on the PDA displays details of the workplan, i.e. description of the work to be performed, identification of the installed pumps that needs to be checked, the time and expected duration of the visit, the identity of the service technician and other pertinent data about the job. The technician is able to acknowledge the workplan and to enter the actual time he has started the job. The data are send back to the gateway server and stored. The gateway server will forward the data to the ESN server, but this will not be implemented in the first demonstration.

PDA downloads device drivers

Obtaining devices drivers from the ESN and local plant servers is outside the scope of the first demonstration. However, a bundle on the gateway is able to send the files to the PDA including the Grundfos applet, which will be used for communication with the pump.

Unlocking door

The PDA sends the technicians certificate to the gateway. The gateway server checks the ID of the sender and unlocks the RUKO electronic door lock, which is attached to the gateway USB. Unlocking is provided by applying 12V DC to the door lock for app 5 seconds.

3.5.4 Server implementation

The implementation at the server is foreseen implementing the following Managers. The server is evoked manually rather than on-line from the gateway server. The transmission of data from the gateway server to the Interaction Server of the ESN server is emulated using a laptop PC.

1. Interaction Server must handle request for authorisation of technician
2. ESN server must be able to identify, locate and submit workplan to the gateway server
3. ESN server must be able to identify, locate and submit device drivers for the relevant pumps and download them to the gateway server

Authorisation of technician

The Interaction Server checks the certificate and returns an authorisation.

Identification and submission of workplan

Log acknowledgement of workplan

Download drivers

Find and submit the device drivers (applets) to be used in the pumps mentioned in the workplan.

3.6 Demonstration ESN-1-2

Scenario text:

> Fabio has received all data history and service records for the pump system on his PDA. From Grundfos product database he has also downloaded all the product information and tutorials he needs, so he can go directly ahead and perform the procedures. He feels very comfortable with this procedure, since he has only attended a single product-training course.

3.6.1 The scene and script

The scene:

Fabio has entered the plant area and is now in the engine room where the eight pumps are installed. He is now preparing for the job.

The actor's script:

Fabio checks his tools and starts to download the data history and service records for all the pumps. His PDA provides a list of pumps in the installation, each of them showing a download button for "pump history", "service record", "service procedure", and "product information". When he presses one of the buttons, the relevant file is downloaded. There is also a button marked "download all" where he can download the entire collection. After download, the information can be displayed on the PDA.

3.6.2 Use cases

Use case nr. 3.3: Receive the information relevant to his profile and task

Description	Once entered the plant and reached the faulty pump, the technician has to receive on his PDA all the information relevant to his profile and task to be performed to repair the faulty pump
Service	Information filtering
Type of service	Information
Actor	Technician, eu-DOMAIN system
Need	To exactly know the purpose of his intervention and the work he has to do on the faulty equipment
Content	Text, image
Information direction	Push
Time dependence	Time-critical but not life threatening, real time
Position dependence	Yes, absolute

Requirements:

3.3.1 The system has to be able to establish the relevant object profiles at the plants service gateway

3.3.2 The technician has to be able to know in real time the operations he has to perform in the plant he has entered

Validation:

Both of the requirements of use case 3.3 can be fulfilled, but 3.3.1 is more logically performed as part of demonstration ESN-1-1. A download from the plant's server of a list of the eight installed pumps and their location (object profiles) cannot be performed at this stage, but the information must be incorporated in the workplan.

Use case nr. 3.4: To receive on the PDA all data history and service records for the installed pumps.

Description	Once entered the plant and reached the faulty pump, the technician asks the back-office database for all data history and service records for the installed equipments
Service	Information filtering
Type of service	Information
Actor	Technician, eu-DOMAIN system
Need	To receive information on the specific equipment to be checked
Content	Text, historical data
Information direction	Pull
Time dependence	Time-critical but not life threatening
Position dependence	No

Requirements:

3.4.1 The technician has to be able to have access to the historical data on the installed equipments

3.4.2 The technician has to be able to receive on his PDA the service records for the installed equipments

3.4.3 The technician has to be able to filter only the information relevant to his purpose

Validation:

All of the requirements of use case 3.4 can be fulfilled, but 3.4.3 needs to be defined first.

3.6.3 Gateway implementation

The implementation is foreseen using the following OSGi bundles (data to be obtained from the ESN server will be hard-coded for this first demonstration).

1. Download to PDA list of installed pumps with identification of the availability of relevant information for each pump.
2. Receive data from the PDA for information requested by the user
3. Download from ESN server (hard-coded in this demonstration) to gateway server of the requested information.
4. Download of the same information to the PDA.

Further, the following browser-based applications are needed for the PDA:

1. Application to display list of pumps and send selected item to gateway server
2. Application to receive and store relevant information
3. Application to render the received information

PDA downloads location data

A demonstration bundle on the gateway server is able to send a data file to the PDA.

PDA downloads service records

A demonstration bundle on the gateway server is able to send a data file to the PDA.

Obtaining product information and tutorials

This information is found using the server's semantic agents, but in the first demonstration the gateway server sends a data file to the PDA.

3.6.4 Server implementation

The implementation at the server is foreseen implementing the following Managers. The server is evoked manually rather than on-line from the gateway server. The transmission of data from the gateway server to the Interaction Server of the ESN server is emulated using a laptop PC.

1. ESN server must be able to identify and read data history for the relevant pumps and download them to the gateway
2. ESN server must be able to identify and read service records for the relevant pumps and download them to the gateway
3. ESN server must be able to search for and retrieve relevant device drivers (applets) for the pumps.

Establishment of information package

The Task Manager informs the Mobile Content Compiler that "Fabio will do Detailed On-Site Testing of Grundfos pumps". The MCC starts by retrieving data and service records for the pumps from the external content provider. It also retrieves other relevant product information and tutorials that might be needed by Fabio. It is all put together in an Information Package.

The information package is downloaded to the gateway server.

If we want to include access to some external content provider, this should be added here. For this we could include the step "1.2.5 Obtaining product information and tutorials" into the script, and add also the "Mobile content compiler" and/or some "Device documentation manager".

3.7 Demonstration ESN-3-1

Scenario text:

Every pump in the installation is now available to him. As he goes through his test procedures, one pump does not perform as expected. He can see from the service record that 2 weeks ago, Grundfos remotely updated the software in the pump to adjust its performance to the actual load conditions. This was part of the new energy saving features of their pumps and customers loved it, because it could save them up to 18% of their energy costs. Fabio now suspects that there might have been an under laying problem with the operating conditions of this pump, precisely as his records indicated.

Figure 7: Engine room with eight pumps

The scene:

Fabio has now entered the engine room where, amongst other installations, the eight pumps are installed. Each of the pumps is connected through an RS485 interface that is transformed to an RS232 interface which is transformed to a Bluetooth interface. The pump can thus communicate with the location gateway through Bluetooth.

Fabio can communicate with the pump either directly through the Bluetooth communication channel or through the gateway. In this case, Fabio communicates directly via Bluetooth using the drivers he downloaded when entering the plant.

The actors script:

Figure 8: Pump measuring screen

Fabio loads the pump testing application on his PDA and establish communications with the first pump.

He can control the various functions of the pump from h is PDA using the downloaded application. He then runs the performance test procedure, which is stored in his application. The test procedure involves reading the current set point defined by the head (pump pressure in meter water heights) and flow rate (in cubic meters per hour). In addition, he reads the temperature gradient of the pump exterior (difference between pump temperature and ambient temperature).

> The set point reading and pump temperature are obtained via the communications protocol build into the pump. The ambient temperature is obtained from the external thermometers via the gateway. On the Grundfos Magna demonstration web page (www.magna.grundfos.com) is a complete demonstration of the control GUI. The control is affected with a java applet. This applet must be transferred to a PFA platform.

Once the desired operating conditions are established, Fabio shifts to a measuring application on the PDA. In this application, he can read and store measurements for later upload to the ESN server. When he analyse the operating data over a long time span, he can check the need for a permanent change in the pumps operating setup. This will save the customer money on his electricity bill.

> The data collection is programmed in the gateway. A data collection bundle is initialised. This bundle will measure operating parameters at regular intervals and upload them for storage at the ESN server.

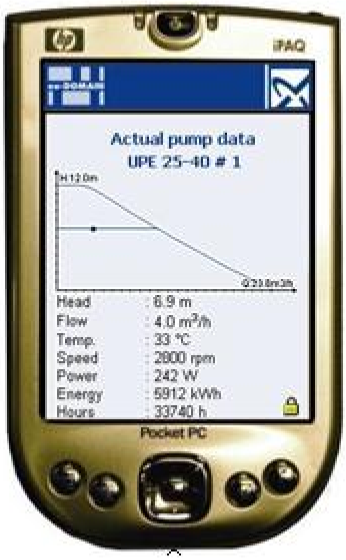


Figure 9: Pump control screen

3.7.1 Use cases

Use case nr. 2.4: Develop a "fingerprint" of each piece of equipment, based on the collected data

Description	Servizio Provinzia has to be able to develop a sort of "fingerprint" of each piece of equipment, identifying any performance degradation or any critical or diverging operating conditions, on the basis of the collected data from the pumps.
Service	Monitoring, archive creation and elaboration
Type of service	Information, control
Actor	Servizio Provinzia, eu-DOMAIN system
Need	To allow predictive maintenance and reduce failure rates.
Content	Text, image, historical data
Information direction	Pull
Time dependence	Not time-critical
Position dependence	No

Requirements:

2.4.1 Servizio Provinzia has to be able to archive the historical data related to the performances of the installed equipments

2.4.2 Servizio Provinzia has to be able to elaborate the data in order to allow predictive maintenance

2.4.3 Servizio Provinzia has to be able to update the information in the archives

Use case nr. 3.1: Record and communicate the data and the ID of the installed equipment to GRUNDFOS and to Servizio Provinzia

Description	The technician has to record and communicate the data and the ID of the installed equipment from his PDA to GRUNDFOS and to Servizio Provinzia in order to enable GRUNDFOS to remotely upload the software and populate the historical database related to the equipment
Service	Identification, archive creation
Type of service	Information, communication
Actor	Technician, Servizio Provinzia, GRUNDFOS, eu-DOMAIN system.
Need	To enable GRUNDFOS to remotely upload the software and populate the historical database related to the equipment
Content	Text, image
Information direction	Pull
Time dependence	Not time critical
Position dependence	No

Requirements:

3.1.1 The technician has to be able to record and communicate the data and the ID of the installed equipment from his PDA to GRUNDFOS and to Servizio Provinzia

3.1.2 The technician has to be able to create an archive (populate the database) for each equipment he installs

3.1.3 The technician has to be able to remotely contact GRUNDFOS and his own organization

3.7.2 Gateway implementation

The gateway implementation is developed under the assumption that interactions between Fabio and the pump would be conducted locally using gateway server and PDA. In SAG's description of server implementation, the interaction is taking place via the server. The implementation is foreseen using the following OSGi bundles.

1. Data collection bundle for collecting operating data and storing them locally
2. Bundle for transfer of stored operating data to the ESN server.

Further, the following applications are needed for the PDA:

a. Application to control the pump

b. Application to read data from pump

c. Application to initialise data collection bundle on gateway

Data collection to gateway

The bundle should read data from the pump (via Bluetooth or RS232) and from the thermometer at preset regular intervals.

Data transfer from gateway

The data are store in a local database until upload to the ESN server is requested. The upload can either be when the local database is full, or at other preset time intervals. The Gateway Client Service will be a web service and it invokes the server side through SOAP. The Gateway Client Service is the sole entry point to the gateway from the server side.

Control pump from PDA

The pump can be controlled from a GUI and a java applet developed by Grundfos. This applet (or a similar version) must be made to run on the PDA platform. Communication with the pump will be via the direct Bluetooth link.

Read pump data to PDA

The pump data can be read by a java applet developed by Grundfos. This applet (or a similar version) must be made to run on the PDA platform. Communication with the pump will be via the direct Bluetooth link.

Initialise data collection bundle

An application on the PDA, which can initialise a data collection bundle on the gateway, is needed.

3.7.3 Server implementation

The server implementation is developed under the assumption that interactions between Fabio and the pump would be conducted via the gateway server and the ESN server. In UAAR's description of gateway implementation, the interaction is taking place locally. In this demonstration, the server is evoked manually rather than on-line from the gateway server. The transmission of data from the gateway server to the Interaction Server of the ESN server is emulated using a laptop PC.

The following services are foreseen (see figure 2).

C1: Service receiving the status updates being sent from devices inside the gateway

C2: Service owning the pump status and records. It would offer several interfaces related with pump data:

I2.1: Notify pump status (invoked by C1)

I2.2: Retrieve pump status and historic records

I2.3: Update pump parameters

C4: User interface for monitoring/notifying (most effective for demo would be continuous visual monitoring), by accessing C2 (I2.2) and C3. C4 could be used to be notified about the degradation of the pump, and to supervise the progress of the demo.

C5: User interface for accessing the pump service records and updating the pump parameters, invoking C2 (I2.2 and I2.3). C5 would be used by the technician.

Device reporting manager

C1 is a blind server-side component. In my view it is not the same as the gateway server, but a specific component offering a specific interface common to every eu-Domain installation allowing devices to notify its status. The gateway server would sit between C1 and the gateway, checking/ queuing gateway messages and then forwarding them to C1 and other components.

Although the gateway demonstration is detached from the server, the following two communications between them are nonetheless required and must be emulated by the PC:

L1: The pump reporting its status (gateway -> C1). This should be a standard SOAP call issued from the gateway (i.e. no OSGi protocol involved).

Pump manager

C2 is a blind server-side component (managers).

Although the gateway demonstration is detached from the server, the following two communications between them are nonetheless required and must be emulated by the PC:

> L2: The server modifying the pump parameters (C5 -> I2.3 (C2) -> gateway). This depends on how we plan to invoke, from the server, operations implemented inside the gateway. This would also be a standard SOAP call from the server-side to a web service running inside the gateway.

For demo purposes, C1, C2 (and C3) could be bundled together into a single "Pump manager".

Pump access

C4 is an interactive web application running inside the interaction server.

Device monitoring

C5 is an interactive web application running inside the interaction server.

C4 and C5 could also be bundled into some single "Pump console", although maybe it is not a good idea because they would be used by different people through different terminals.

3.8 Demonstration ESN-4-1

Scenario text:

Before leaving, Fabio sets up his own condition monitoring schemes, which will notify him over the coming days, if the faulty indication in operating condition reappears.

The scene:

Fabio is still in the engine room and his PDA is now connected to the gateway.

The actors script:

Fabio sets up his a condition-monitoring scheme using his PDA. He wants to monitor how long time the pump operates continuously at more than 90% capacity. To do this, he sets up a monitoring scheme for the instantaneous operating power consumption of the pump and a threshold corresponding to 90% of the capacity. He also sets up an internal timer. The timer is reset every time the operating power is less than the threshold. Finally, he sets up an alarm to monitor the timer. When the timer exceeds 48 hours, an alarm is triggered. The alarm condition is notified via SMS.

Much of the programming is already coded in a template in the application. Fabio only needs to enter the threshold values.

3.8.1 Use cases

Use case nr. 3.8: Detect and eliminate further risks of non-performance

Description	To optimize his activity, the technician has to be able to detect and eliminate further risks of non-performance as concerns the pumps
Service	Monitoring, control
Type of service	Control
Actor	Technician, eu-DOMAIN system,
Need	To detect under laying problems with the operating conditions of the installed equipments
Content	Software
Information direction	Pull
Time dependence	Not time-critical, on demand
Position dependence	No

Requirements:

3.8.1 The technician has to be able to install new software for the detection and elimination of further risks of non-performance

3.8.2 The technician has to be able to remotely receive the software he needs

3.8.2 Gateway implementation

The gateway implementation was developed under the assumption that interactions between Fabio and the pump would be conducted locally using gateway server and PDA. In SAG/CNET's description of server implementation, the interaction is taking place via the server. The implementation is foreseen using the following OSGi bundles.

1. Bundle for setting up monitoring scheme
2. Bundle for getting monitoring templates from ESN server
3. Bundle for setting up alarm condition at server and notification via SMS.

Further, the following applications are needed for the PDA:

1. Application to set up monitoring scheme

Monitoring

The data collected from the pump are continuously fed through a rules engine embedded in a service bundle on the gateway. Thresholds, and other parameters, are user selectable (via a template) and stored in a database in the gateway.

Monitoring templates

The monitoring scheme templates are stored at the server and can be downloaded to the gateway in libraries. The relevant templates are then transferred to the PDA for data entry.

Setting up alarm conditions

The alarm conditions are entered from the PDA into the template and transferred to the gateway. The alarm conditions are fed to the rules engine. When an alarm state is entered, the server is notified and the alarm manager notifies Fabio via SMS.

3.8.3 Server implementation

The server implementation was developed under the assumption that interactions between Fabio and the pump would be conducted via the gateway server and the ESN server. In UAAR's description of gateway implementation, the interaction is taking place locally. In this demonstration, the server is evoked manually rather than on-line from the gateway server. The transmission of data from the gateway server to the Interaction Server of the ESN server is emulated using a laptop PC.

The following services are foreseen:

C3: Manager monitoring performance of devices, which would be notified by C2 about changes on the pump (in a real system, this notification would be done through the Notification Manager). This component would not be needed if the detection of pump degradation is done in the gateway, as proposed by UAAR.

Device Watchdog

First a pump (or maybe rather a thermometer) sends an alarm/alert that temperature is outside the range. That is received by the GW Server that passes it on to Application Intelligence that initiates a Session Object and applies its rules against it.

This should involve the following elements on the server side:

- Thermometer notification (GW -> Server)
- Gateway server
- Network Intelligence [Should be Network Intelligence]
- Task Manager
- Notification Manager
- Pump reset notification from GW -> Server, which has to reach the Task Manager and/or Application Intelligence
- Content provider to receive tasks done by Fabio
- Resource Manager
- Maybe Location Manager
- User Interface for Fabio notifying acknowledgement about that he will perform detailed on-site testing - e.g. the same web app for viewing notifications
- Mobile Content Compiler
- Web Service Server
- Content provider(s) with data about pumps (e.g. Grundfos)

All the User Interfaces listed above could be merged into a single "Task List" providing all functionality (with data extracted from the Task Manager).

4. Second demonstrator: The PaC scenario

The demonstrator presented for the second annual review in September 2006 was a working demonstration platform able to enact major parts of the PaC (healthcare) scenarios. The infrastructure used was more mature than the used for the first demonstrator and more components were integrated in the same server park.

4.1 Work undertaken to build the second demonstrator

All the components (managers, interpreter, devices and terminal) needed to implement the PaC scenario are depicted in the following diagram:

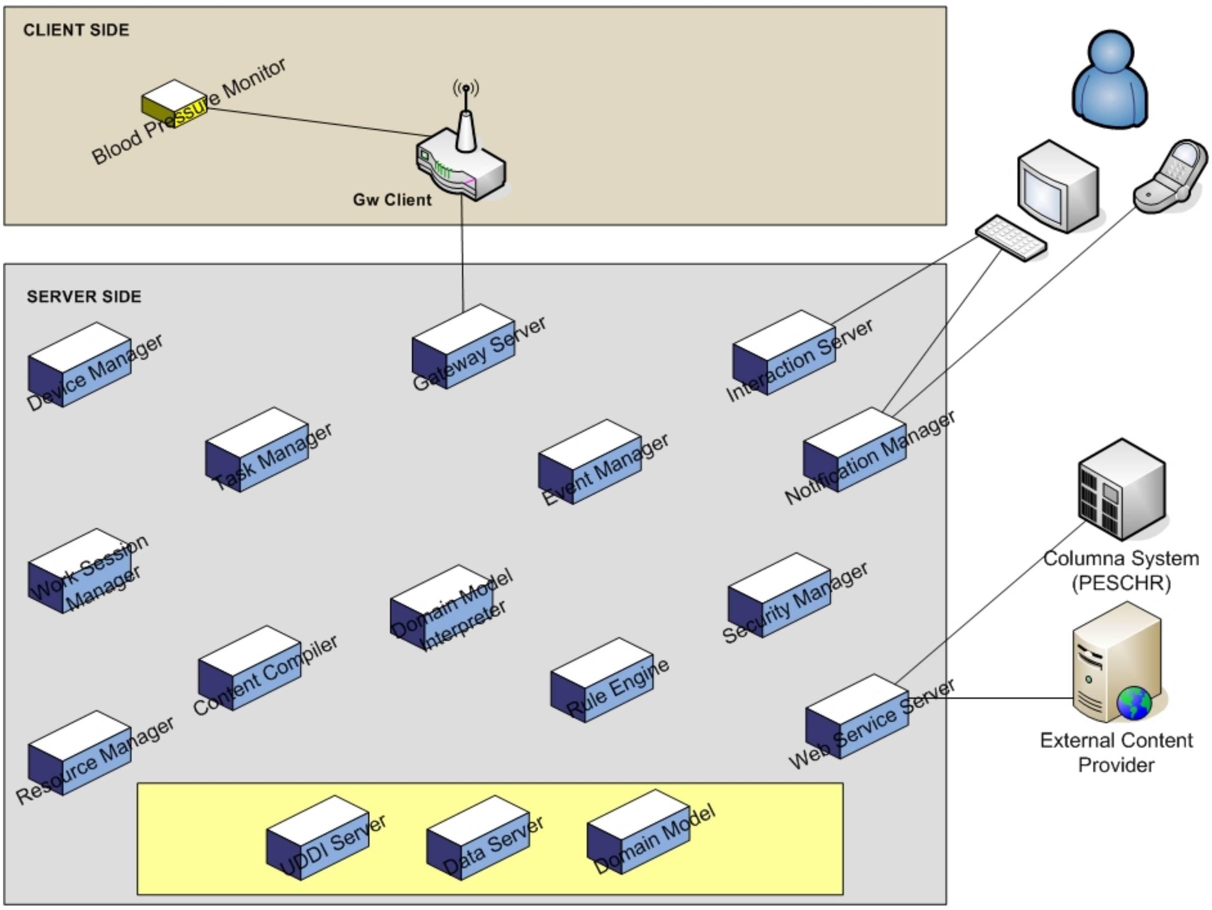


Figure 10: PaC scenario general architecture

In the case of this second demonstrator, TID integrated in their Server Park the different developments from SAG, CNET and UAAR. Thus, a complete eu-DOMAIN server installation is running from that time in Valladolid (Spain). On the other side, UAAR integrated the client gateway of the PaC demonstrator, including the blood pressure monitors from FORTH and TID.

The Server Park and the client side were taken to Madrid, where the second review took place, to be locally integrated.

This section describes the components and the technical layout and architecture of the eu-DOMAIN platform used in the second demonstrator, which is aimed to implement and demonstrate the PaC scenario.

The next figure shows all the connections needed between the components identified. The connections will be explained using sequence diagrams through out the document.

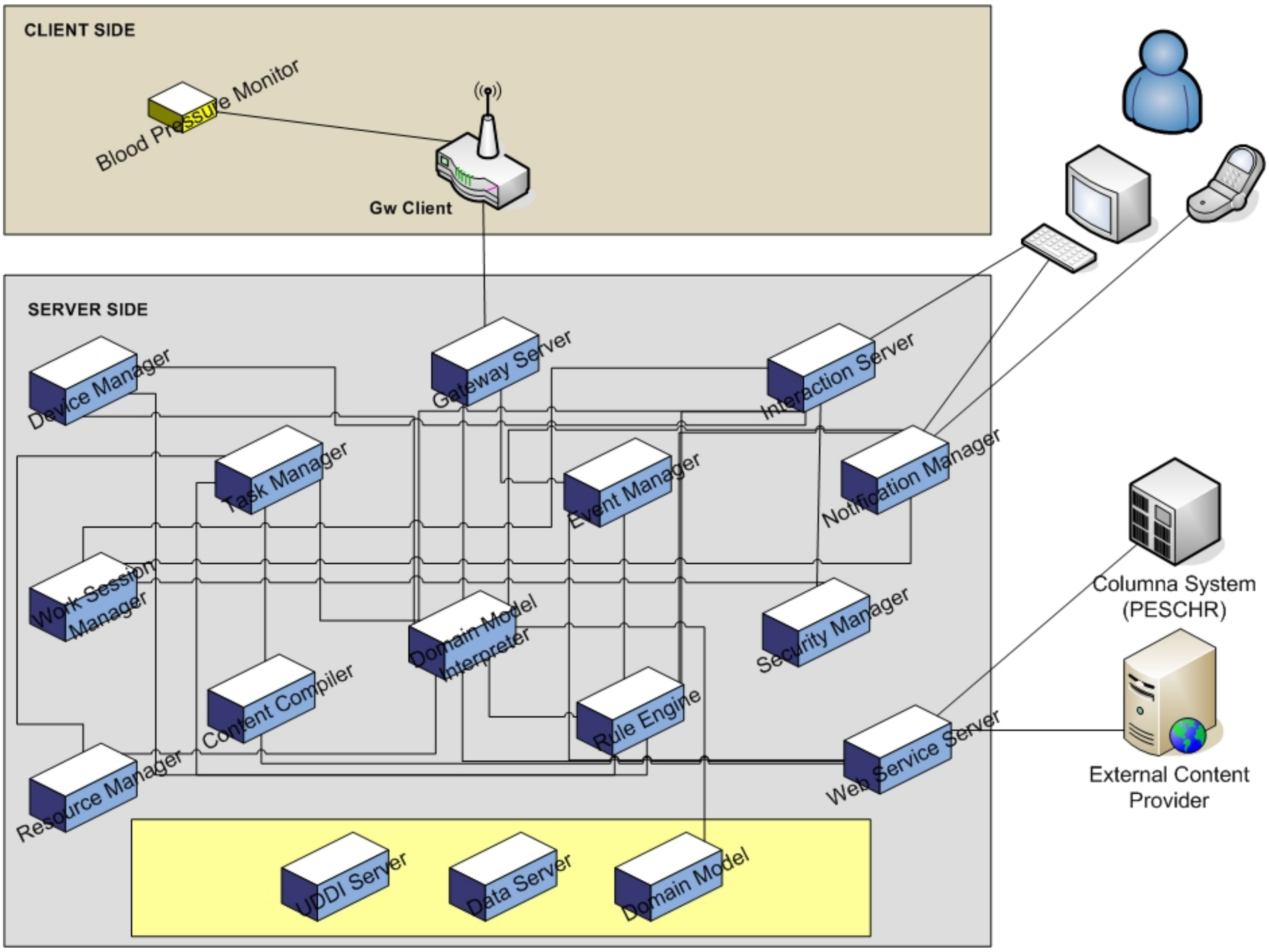


Figure 11: PaC scenario general architecture (with connections)

The following components are needed:

- The **Gateway Server** is an infrastructure component through which all communications between Gateways and the PaC server pass (see D3+4.1). It's a transparent firewall located at the entrance of the server side infrastructure
- The **Event Manager** is an infrastructure component that handles both queuing and prioritising of asynchronous messages, and subscription to events (see D3+4.1).
- The **Patient Record Manager (PESCHR)** will be in charge of accessing and managing the information about the patients that are stored in PaC eu-DOMAIN scenario. An adaptor for the Columna System based in the Domain Model will provide the services needed.
- The **Rule Engine** is a rule/expression evaluator that supports some forms of "intelligent" behaviour of other components, like Monitoring Schemes (implemented by the Device Monitor).
- The **Data Server** is a supporting component of other components, providing data persistence as described in D3+4.1
- The **Security Manager** is the central component that handles all security-related operations such as adding credentials to messages, verifying certificates and credentials, checking access policies, etc. It is either implemented as a manager alongside other managers on the server

accessible via web services (in the figure it has been taken out of the server for simplicity) or as a stand alone application. It also handles information about users and their rights to access the functionality provided.

- The **Domain Model** is the meta-information defining, both at development and run times, all the information defined above for the Domain Model.
- The **Domain Model Interpreter** manages the information stored in the Domain Model
- The **Work Session Manager** stores all the information related to life-cycle of an actor in the system. It handles meta-information
- The **Task Manager** is the component handling Task classes from the Domain Model, implementing all of its methods: create Task, list tasks of a user, retrieve Task details, etc.
- The **Device Manager** is the component handling Device classes from the Domain Model, in the server implementing many of its methods, like getting Device details. However, note that methods of Devices (or its subclasses) that are to be executed in the client side will be implemented by bundles in the gateway.
- The **UDDI Server** is an infrastructure component that performs mapping of Domain Model operations to its actual SOAP endpoints. Actually it is part of the Domain Model.
- The **Notification Manager** is in charge of sending notifications to end users, as described in D3+4.1. For this, it processes the Notification Templates previously created by the end user.
- The **Web Service Server** is an infrastructure component through which all communications between the eu-DOMAIN Server Park and Web Services pass (see D3+4.1)
- The **Interaction Server** is a Web Application Server that runs all the applications in eu-Domain that interact directly with the end user. It is expected to be Jboss.
- The **Portal framework** is a runtime that handles portlets (Liferay). Interactive applications in eu-Domain will be portlets. It is expected to be some JSR 168-compatible product. The Interaction Server is built upon this element
- The **Content Compiler** is the component that creates Information Packages for a given Task and User.
- The **Resource Manager** is responsible for managing and delivering information about available resources such as workers, vehicles, tools, and medical equipment needed to provide the eu-DOMAIN service to end-users.

The next sections show what should be done in the scenario in more detail. We should always take into account that not all of the functionality described could be developed in the demonstrator.

4.2 The second demonstrator – Patients as Customers scenario

The underlying scenario used for the first demonstrator is the “Patients as Customers” (PaC)

scenario of the healthcare for tomorrow as described in deliverable D2.1 User Validation Framework.

Patients as customers!

The healthcare system is multi-faceted. A large amount of new methods, devices and medication are available from various service providers, each of them offering their services to an informed patient - sometimes in competition; sometimes in cooperation. The patient chooses the providers that are most suited to her/his needs. We call this scenario: “Patients as customers!”

The scenes in the scenario are typical healthcare situations around 2010. The actors are participating in care programmes, which are in line with major government policies already known today. There is an open environment, where patients are routinely informed about the procedures, most decisions are made locally and always with a view to the cost-benefit. Government initiated programs and strict requirements for documenting improvements are in force. The healthcare professionals are always engaged in some kind of mediation management and education of patients.

The main thrust for the scenario plays are related to questions of self-management or attempts to give the patients some kind of self-control over their disease.

Most of this element is determined in the script, but a few elements enter the scene also.

The scenario also supports the general development in healthcare provisioning in Europe leading away from hospitalisation and towards providing more local and home-care health services, thus moving some healthcare services traditionally provided by hospitals (e.g. rehabilitation and monitoring) to the local health clinics and/or into the patient’s home. The trends within healthcare provisioning and the demographic developments also indicate a greater focus on and need of healthcare services not only outside hospitals, but increasingly also in patients’ homes. Such developments depend to a great extent on the implementation of eHealth service and mobile health service such as the services realised by the eu-DOMAIN.

The issue of cooperation and communication between various healthcare providers, and between the public and private sector, also plays an important role for the efficiency and quality of healthcare services to the patients and is also incorporated into the scenario. Communication routes are readily available and the cost is low. Also, devices are ready to use through extensive use of Plug & Play technology.

The main thrust for the plays on the scene are the potential for cost/benefit improvement to the healthcare commissioners (to be derived from the under laying business case) combined with increase quality of life on behalf of the patients. Each scenario has a quality of life aim as seen from the side of the patient. Sometimes it is security and safety (e.g. monitoring and alarms); sometimes it is comfort (e.g. clinical consultations done while the patient remains in her/his home).

The healthcare providers also have a range of specific aims. Some of these are related to cost containment (e.g. decreased hospitalisation, less transportation). Others are related to resources i.e. better resource planning, staff scheduling, etc), while yet others are related to a regulatory framework (e.g. documentation and security/privacy of data).

It is important to note that the scenario does not aim at discovering and testing new clinical methods or techniques. It is solely addressing the issue of improving workflow procedures.

4.3 Demonstration PaC-1

Scenario text:

Mrs. Tahira Khan is a 65-year-old lady who recently arrived in the UK to join her son and daughter-in-law - Kamal and Asma in Birmingham – after her husband died. Tahira speaks little English and has relatively poor literacy in her own language. Shortly after her arrival in the UK, she sees Dr. Hayworth, their local GP, for a health check. It transpires that she has had type II diabetes for about three years and has made no efforts to change her diet. The GP explains her condition and outlines various pathways that she must consider to cope with her decease and changing lifestyle. The complexity of her condition and the options available to her confuses her profoundly and she asks Kamal and Asma to help her.

4.3.1 Scene and script

The scene:

Figure 12 GP's office

The scene is an ordinary office of a GP (General Practitioner or family doctor) in Eastern Birmingham, UK. The clinic also has a reception room with patient waiting area and various clinical investigation rooms and storage facilities.

Doctor Hayworth has few technical installations in his office. They consist of his desktop PC and some standard medical instruments. From his PC, Dr. Hayworth has access to the eu-DOMAIN platform and to the Eastern Birmingham PCT Electronic Patient Record system (EBPCT-EPR). He also has a local service gateway with wireless LAN installed in the reception, by which he is able to test various medical devices that he uses for his home care programs. The medical devices are all stored in one of the investigation room, which he occasionally uses to test the devices before giving them to the patients.

In the room are only Dr. Hayworth and Tahira Khan with her son Kamal.

The script:

Dr. Hayworth poses a series of clinical questions to the patient and performs a simple blood test to determine her blood glucoses level. From her significantly elevated glucoses level as well as her general medical history, Dr. Hayworth determines that most likely Mrs. Tahira Khan suffers from a mild diabetes type II.

Dr. Hayworth carefully explains the immediate medical implications of suffering from Diabetes II such as hypertension, severe hyperglaecemia leading to diabetic coma and ketoacidosis. He also explains the long term effects such as blindness and diabetic ulcers in the lower extremities. He further explains that they do not pose an imminent risk to her health condition and quality of life, but he strongly recommends that she admits herself to a carefully orchestrated treatment plan in order to contain the illness and avoid that her medical condition deteriorates.

Her clinical pathway is mostly based on a combination self-management with expert advice based on careful monitoring and instant feedback. After a few initial investigations Tahira will have to monitor various health parameters on a regular basis. She can either expect to come to the GP's office once or twice a week or she can have the medical devices at home that support the monitoring and allow health care professionals to remotely evaluate her condition. Having little understanding of English, Dr. Hayworth asks Kamal to consider the various options available to Tahira and report back to him the family's decision.

Since there is no doubt that Mrs. Khan must enter a treatment plan, Dr. Hayworth goes to his PC and starts to create a user profile for her in the eu-DOMAIN platform.

Registration of a new patient's clinical path in the eu-DOMAIN platform requires the creation of a "Mission". The Mission identifies the patient and the specific goals for the patient in the eu-DOMAIN context. When the clinical path becomes clearer, specific workflows i.e. monitoring, referrals, etc. can be added to the Mission. The initial creation of a Mission involves the following steps:

First, Mrs. Khan's patient data must be instantiated in the Domain Model. Dr. Hayworth uses a web based GUI on the PC to create a new patient in the Domain Model and enters the relevant information on the patient.

Secondly, a personal Mission must be created for Tahira Khan. The Mission governs her clinical pathways and is created in the Mission Manager. It will later be extended with specific workflow tasks and subtask as is relevant for her clinical pathway. Dr. Hayworth uses a web based GUI on his PC to create the Mission. The starting date is today and there is no ending date.

Thirdly, he creates a hook into the EBPCT EPR system allowing a secure connection to be established between the EPR system and the eu-DOMAIN Web Service Server. This connection will be used to transmit monitoring data and other patient information from eu-DOMAIN to the EPR system.

4.3.2 Use cases

There is no use cases developed for this part of the scenario.

4.3.3 Client side implementation

Nothing foreseen at this moment

4.3.4 Server side implementation

In the first scene of the PaC scenario, Dr Hayworth access eu-DOMAIN functionality through the Interaction Server. His certificate is used to authenticate him and to give him his proper rights in the system. Security checks are performed against the Security Manager to know the role and functionality Dr Hayworth can access. As a result of this action, a number of portlets are rendered in the web portal to be used by the doctor.

The doctor uses a portlet that allow him creating new patients in the eu-DOMAIN system. This means creating a Domain Model Instance and a new Patient Registry (basic data stored in eu-DOMAIN)

Secondly, a new Mission for the patient is created in the Work Session Manager. In order to perform this task, a portlet is used by the doctor in the Interaction Server.

Finally, a secure access to an external content provider plugged to eu-DOMAIN and referenced from the DMI is created. The external communication should pass through the Web Service Server, the component managing the interaction from and to external content providers.

These interactions are graphically described in the next sequence diagram.

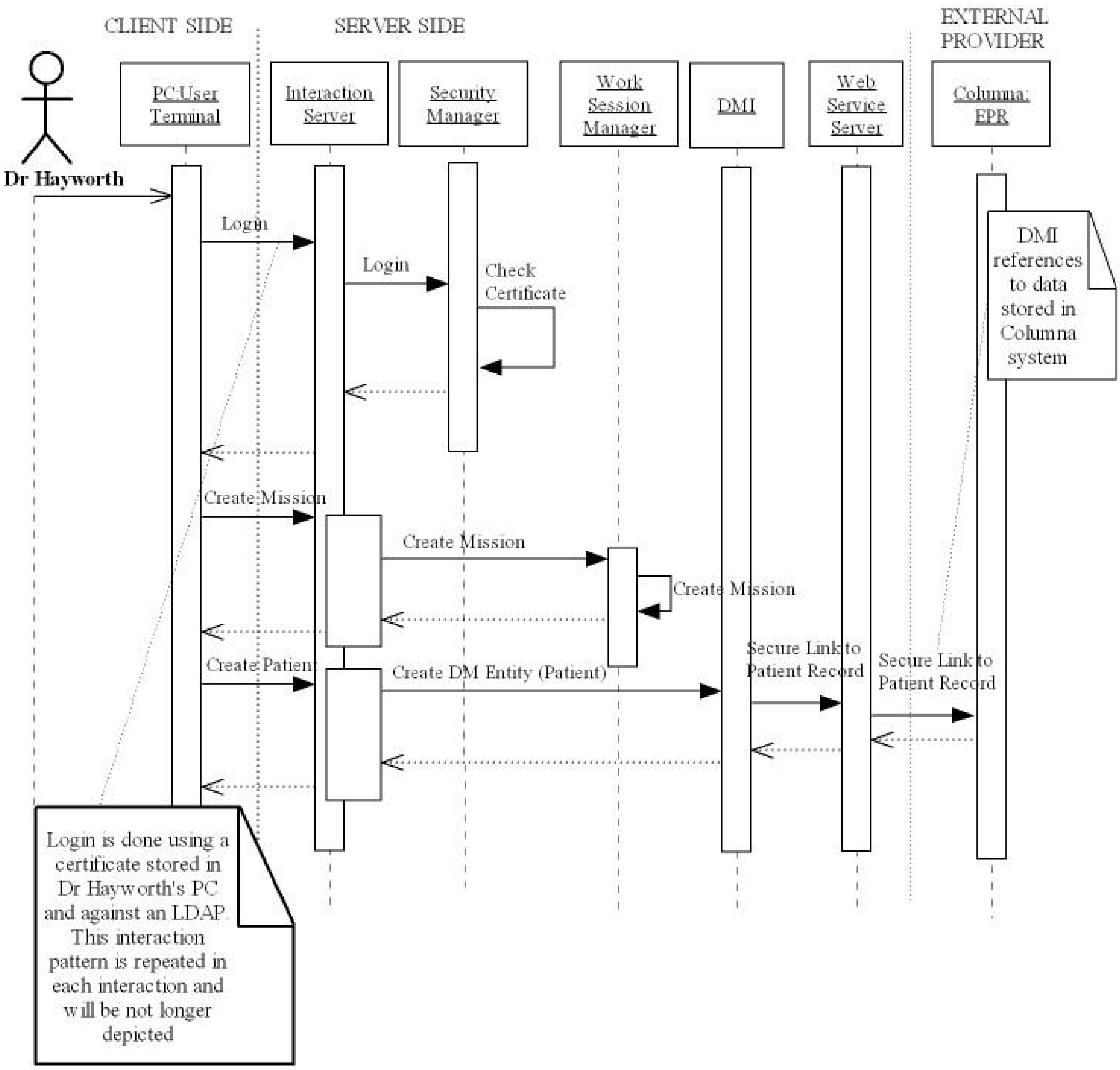


Figure 13 PaC-1

4.4 Demonstration PaC-2

Scenario text:

Having moved into the Birmingham PCT area she has access to the PCT's Patient Advisory and Liaison Service (PALS) outreach service. Kamal sends an email to the PALS co-ordinator to ask for help in accessing primary care services for Tahira. The PALS co-ordinator passes the EPR details (Tahira's must sign the email with her electronic signature to authorize the release of patient records) to the Muslim Health Diabetes Support Service (MHDSS) who have a specialist contract with the PCT, to support such client groups.

4.4.1 Scene and script

The scene:

There is no particular scene for this part of the scenario. It can be assumed that it takes place in the office of Dr. Hayworth.

The script:

After internal discussion in the family, Kamal has decided that his mother needs to be attended by the PALS and he rings Dr. Hayworth to inform him about their decision.

In his office, Dr. Hayworth creates a workflow procedure in Tahira's Mission from his PC. The workflow process establishes possible and permissible links to other healthcare providers that can or may be involved in the treatment of Tahira, and thus allows for the involvement of the PALS and their employees to see the relevant parts of Tahira's personal data.

Kamal should now confirm Tahira's enrolment in the PALS with a digitally signed e-mail using his mother's signature, but this part of the scenario will not be implemented until the final demonstrator.

In relation to NHS security policies, there is strictly speaking no need for Tahira to confirm the release of her health data among official health care providers as long as it is used to support essential NHS activities. However, it has been included in the scenario in order to demonstrate the security architecture available in eu-DOMAIN and the possibility for patients to individually authorise different treatment plans available to them.

In the UK, The procedure needs to be consistent with the Caldicott Principle, so data records must be masked in order to only release information that is relevant to the PALS.

The co-ordinator at PALS browses the health data available to her in Tahira's EPR. She only has access to relevant data such as:

- Results of blood tests and other tests performed by Dr. Hayworth
- Tahira's relevant clinical history and diagnosis
- Notes from Dr. Hayworth's diagnosis
- The suggested clinical pathway
- Relevant personal, demographic and ethnical information about Tahira.

While the data are stored in the EBPCT EPR system, the workflow procedure provides the mask used to determine what data can be released to the PALS.

The PALS co-ordinator has access to the patient data through a special web based eu-DOMAIN GUI.

The data displayed are partly derived from the Domain Model, partly from the workflow procedures and partly from EPR data extracted via external web services. The overlaying business procedures and logic is governed by the business rules engine.

Based on the clinical diagnosis, the ethnicity of Tahira and her Muslim faith, the co-ordinator decides to transfer her to the Muslim Health Diabetes Support Service (MHDSS) in Birmingham. This is one of the transferrals available to PALS in the workflow procedure. The co-ordinator selects and accepts the transferral on the same web based GUI and the data is passed on to the MHDSS in the same way as they were transferred to the PALS from Dr. Hayworth.

4.4.2 Use cases for actor no. 1 – The patient

There is no use cases developed for actor 1 in this part of the scenario.

4.4.3 Use cases for actor no. 2 – The informal carers

There is no use cases developed for actor 2 in this part of the scenario.

4.4.4 Use cases for actor no. 3 – The formal carers

Use case no. 3.1: the PALS coordinator has to pass the EPR details to the MHDSS

Description	The PALS coordinator has to receive the electronically signed e-mail by the patient, authorizing him to release the patients records (EPR) to the MHDSS, that is in charge to create the PESCHR for the patient
Service	Matchmaker service, messaging, e-mail
Type of service	Information, communication
Actor	PALS coordinator, MHDSS
Need	To enable the MHDSS to support particular client groups
Content	Text, personal and medical data
Information direction	Pull
Time dependence	Not time-critical, on demand
Position dependence	No

Requirements:

3.1.1 The PALS coordinator has to be able to register in the eu-DOMAIN the permission received from the patient

3.1.2 The PALS coordinator has to be able to contact the MHDSS informing that there is a new patient

3.1.3 The EPR is accessed by the MHDSS by logging on to the eu-DOMAIN from their PC and choosing “new patient”

3.1.4 The eu-DOMAIN system will update the PESCHR pulling some information from the EPR (because it has permission to do that)

3.1.5 The PALS coordinator has to be able to protect the private and medical data

Validation:

The functional and security requirements of use case 3.1 can be fulfilled.

4.4.5 Client side implementation

Nothing foreseen at this moment

4.4.6 Server side implementation

The doctor creates a workflow for Tahira using a portlet. As part of the workflow he gives permission (rights) to other actors and entities, such as the PALS coordinator to see Tahira’s patient record. Once this is done, PALS coordinator is notified about this situation, using the Notification Manager. It’s the Work Session Manager the component that triggers the notification, once the right has been given. The Notification Manager is used to alert the PALS coordinator about the situation.

The PALS coordinator, using his certificate to enter eu-DOMAIN, can browse Tahira’s personal data due to the rights Dr Hayworth has given to him. A portlet let him access Tahira’s Domain Model Instance and the data stored in the EPR plugged to eu-DOMAIN infrastructure, passing through the Web Service Server. Moreover, he gives rights to the MHDSS.

All this sequence is expressed in the following diagram:

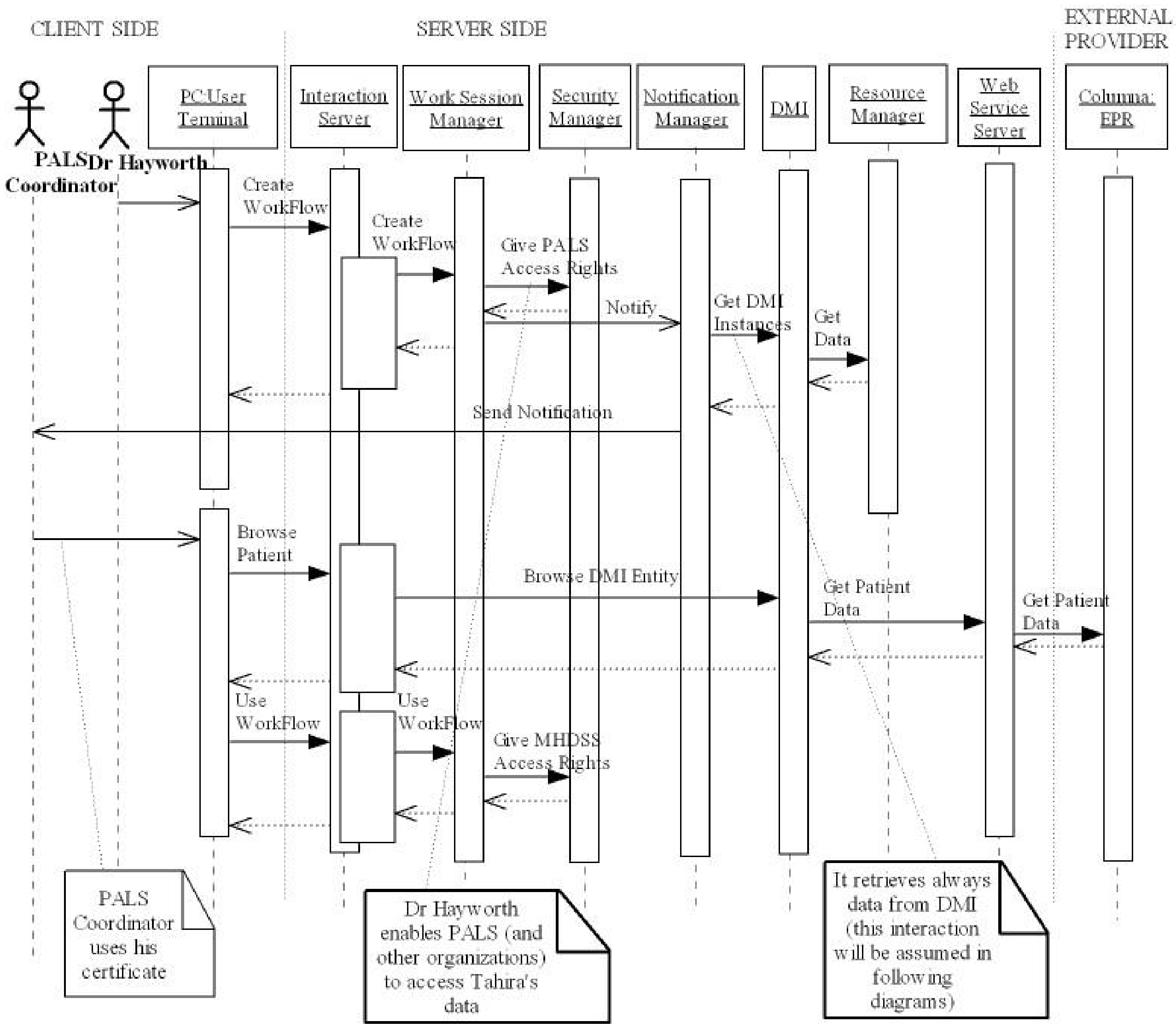


Figure 14 PaC-2

4.5 Demonstration PaC-3

Scenario text:

Tahira is seen and assessed by Sania, the outreach healthcare assistant. Sania identifies a series of her personal health and social care needs. Her initial three blood pressure readings are high (the mean is 160/100) and she is mildly overweight and confused about her condition. This information is uploaded from the blood pressure device in real time into a newly created Personal Electronic Health and Social Care Record (PESCHR). From here, Dr. Hayworth, her local pharmacist and the local health and social care team can access her details on-line. Her details are also uploaded into the PCT's diabetes register and an epidemiological five and ten-year initial risk assessment is produced. This remains incomplete whilst awaiting the results of blood and cardiac tests but identifies Tahira as already being at high risk of cardiovascular disease.

Figure 15 The MHDSS clinic

4.5.1 Scene and script

The scene:

The scene is the outpatient clinic of MHDSS. In the room are Tahira and the healthcare assistant Sania. Sania uses a blood pressure gauge which is connected to a local eu-DOMAIN service gateway. She also has a desktop PC at her disposal.

The script:

Since this is the first visit by Tahira to the MHDSS, Sania starts out by accessing the eu-DOMAIN via the web based user GUI. She calls up the Domain Model information, Mission and workflow procedures related to Tahira. Confirming the validity of the data she then attaches the MHDSS special workflow process to the Mission and activates it.

Every actor identified in the Domain Model should have at his disposal a library of workflow procedures that can be attached to Missions. The workflow procedures describe the workflow for typical procedures undertaken by the actor.

During the activation, a subtask is created which accesses the EPR and creates a special PESCHR for Tahira.

The PESCHR is a subset of the comprehensive data stored in the EPR to be used by external services in specific clinical cases. Since security requirements are very high on access to the EPR, EBPCT has decided that access to and manipulation of data in the EPR by external services can only be performed on specially created subsets known as the PESCHR. These subsets are stored inside the EPR but are accessible through secure communication lines for authorised external services.

Sania then measures Tahira's blood pressure and the data are transferred via the service gateway to the eu-DOMAIN server and from there to the PESCHR.

There is no information in the scenario as to how Tahira is identified by the gateway. This can be done by e.g. Bluetooth ID or a biometric device or by a handheld device like a PDA.

Once the PESCHR is activated and data have been stored, the eu-DOMAIN notification manager sends out a notification to Dr. Hayworth, and other actors subscribing to this service. A special workflow procedure has been defined for this task, i.e. notify these people when the blood pressure in the PESCHR exceeds a clinically established threshold.

The eu-DOMAIN Task Manager collects pre-described data from the PESCHR and sends them through the Web Service Server to the PCT's on-line diabetes center to request an epidemiological five and ten-year initial risk assessment based on Tahira's medical record.

> This is an external web service. It will have to be based on a mock-up in the demonstrator since such service is unlikely to exist today. The result of the enquiry could be a simple document with some descriptions and data, preferably related to the online request, e.g. the time and name the patient. The document could also be customised according to the information transmitted as described in the scenario.

4.5.2 Use cases

There is no use cases defined for this scene.

4.5.3 Client side implementation

The blood pressure monitor is plugged to the client gateway in the MHDSS. A PubSub hub is used to store and forward the events generated from and to the Client side.

4.5.4 Server side implementation

Sania, using her certificate enters into eu-DOMAIN system and adds a new workflow, a MHDSS workflow in the Work Session Manager, to Tahira's mission. She also retrieves Tahira's medical information from the PESCHR system. Then she configures the Blood Pressure Monitor in order to sign the measurement with her certificate and to indicate that the patient is Tahira. A portlet is used to provide this functionality. First of all, the DMI is called, which in turn calls the Device Manager to get the list of the blood pressure monitors available. She selects the properly one and the blood pressure monitor is reached to indicate that the measurements taken from that moment on are associated with Tahira.

To minimize the possibility of artefacts in the measurements, three consecutive measurements will be taken and only the median value will be published as an event in the PubSub Hub (operational rules running on the gateway). Furthermore Sania has the possibility to repeat the test.

Once the measurement is taken, and the event is published in the PubSub Hub in the client side, the event is forwarded to the Event Manager in the server side, which distributes a copy of the measurement to the Web Service Server to handle the information and store it in the PESCHR System, while another copy is sent to the Rule Engine. A rule is triggered with the information, and it's decided that Dr Hayworth should be informed. In order to perform this task, a template is used to warn the doctor about the new measurement using the Notification Manager.

A rule previously defined by Dr Hayworth states that an epidemiological five and ten-year risk assessment information package for Tahira has to be created periodically. The rule is triggered when supposed and a new task is created to manage this situation. The DMI is invoked to retrieve Tahira's specific patient data such as age, sex, ethnicity, diagnosis, etc. from the EPR. Then the PCT's Diabetes Center's Health Portal (external web service provider) is invoked and the information received is properly packaged (in pdf format, for instance) to be consulted by Tahira. In order to let Tahira know about the new assessment information package, the Task Manager calls the Notification Manager to inform Tahira about the situation.

Finally, Tahira is able to see the assessment information viewing a portlet from her terminal via web.

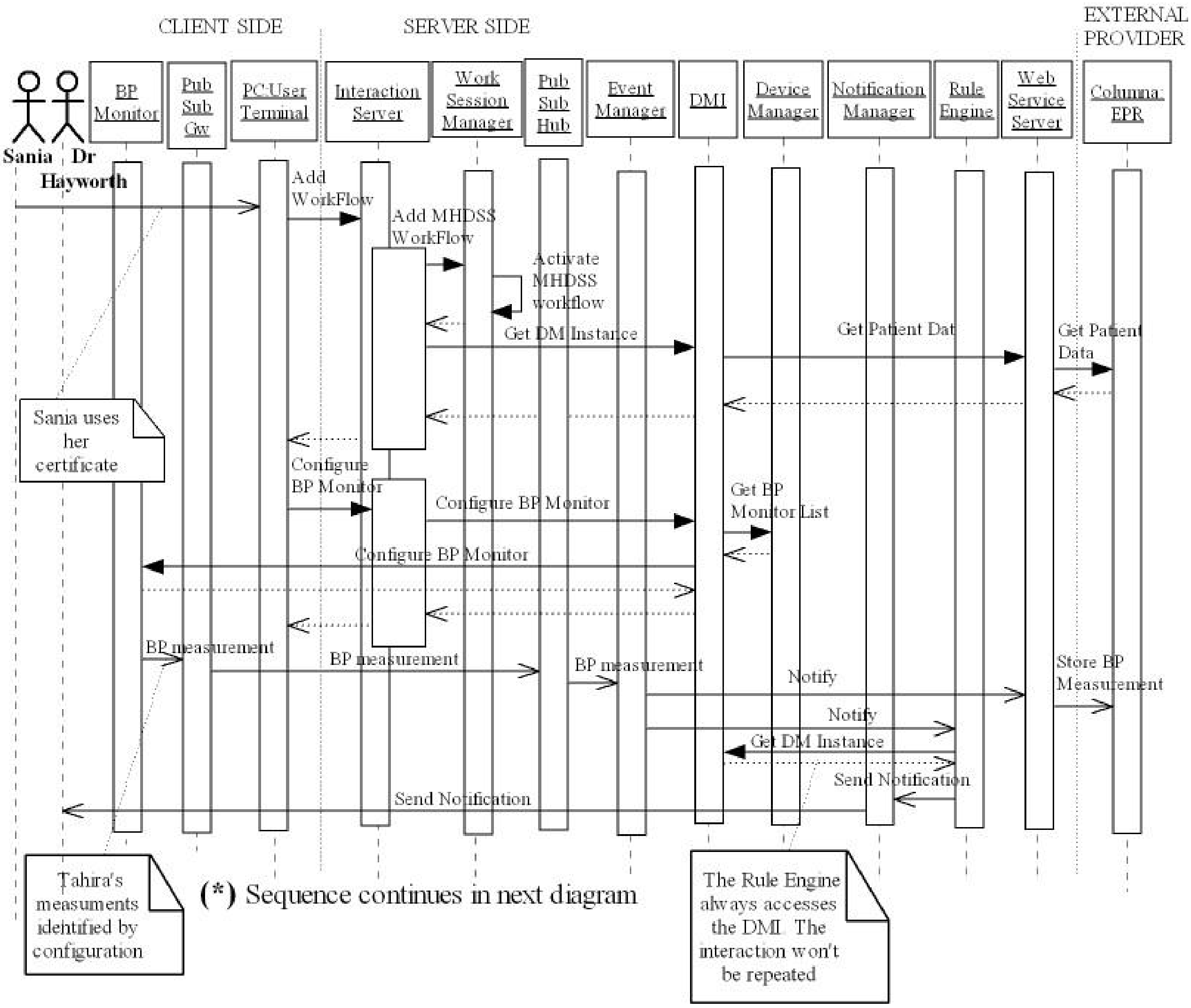
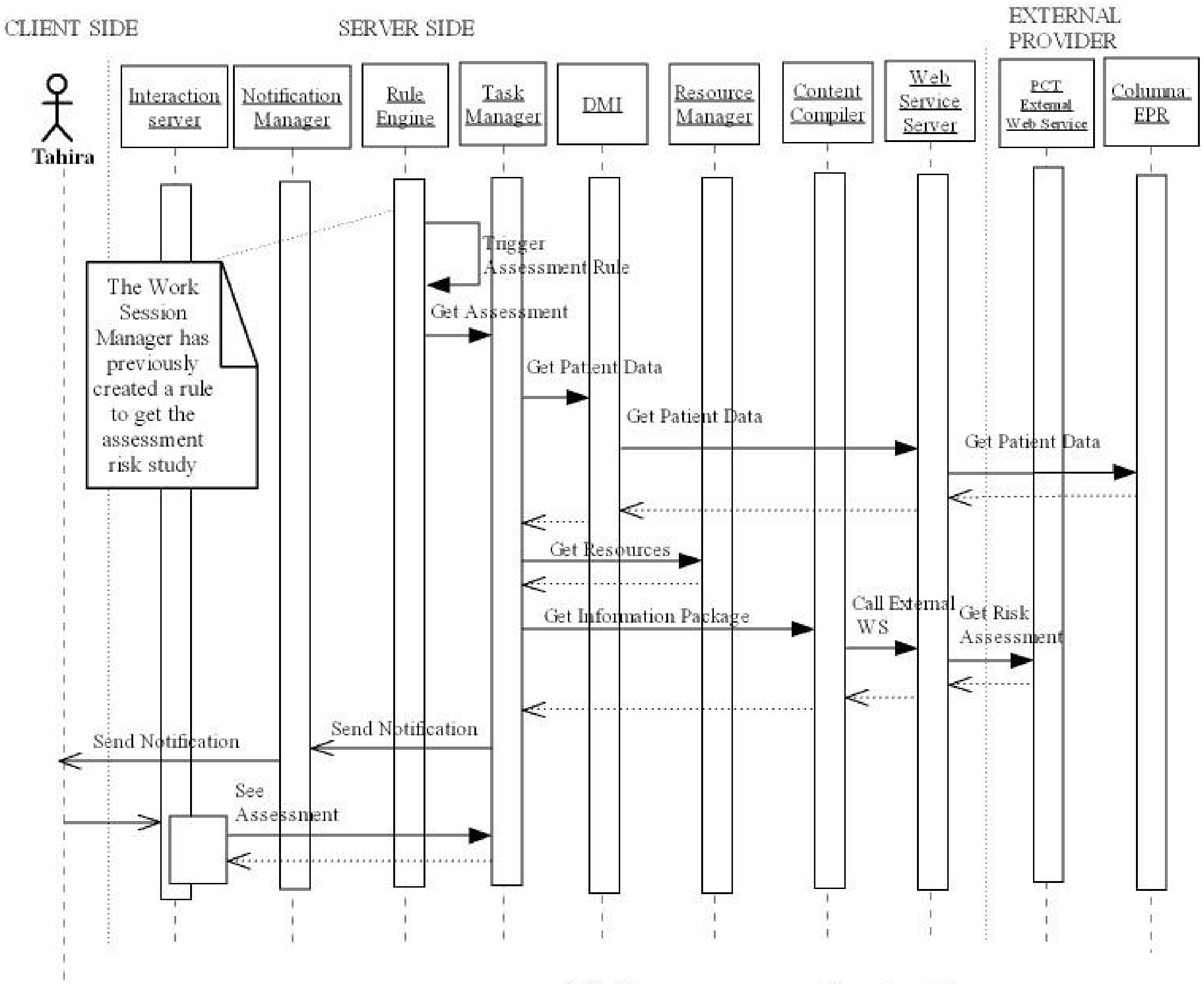


Figure 16 PaC-3 (I)



(*) Sequence comes from last diagram

Figure 17 PaC-3 (II)

4.6 Demonstration PaC-4

Scenario text:

Given the likely hypertension Tahira is referred to an initial 24-hour ambulatory blood pressure monitoring via the eu-DOMAIN network that recently was installed by the Eastern Birmingham PCT as the first in the country. Kamal finds a suitable and trusted device from the company MediTest. When Kamal brings the blood pressure device home, it automatically configures itself using Tahira's digital signature and data from the PESCHR. Dr. Hayworth is informed electronically when the device is operating, and after having checked the readings, he gives his permission (using his certificate) to upload the results automatically into her PESCHR. He also sets up his own monitoring scheme, which will make eu-DOMAIN platform monitor Tahira and warn him, if her mean blood pressure is outside preset limits for more than three consecutive days. A technician also visited the home of Kamal Khan to install the ambient intelligence environment. Based on a range of house sensors, the eu-DOMAIN will be able to monitor critical situations when Tahira is alone in the house. It will also be able to make intelligent decisions in respect to who and how to organise assistance. Minor things will involve the immediate family, Kamal and Asma, via mobile telephones. If they are unreachable, Kamal has made an agreement with the neighbours. She is a housewife and is most of the day at home, in case Tahira gets ill.

4.6.1 Scene and script

Figure 18 In Tahira's home

The scene:

The scene is now in Tahira's home in Birmingham. Kamal has brought home the blood pressure gauge which is connected to the eu-DOMAIN service gateway. Other medical devices may be introduced as part of the extended PaC scenario. A technician has also installed ambient intelligence sensors, including a movement sensor, a remotely controlled door lock, controllable light switches, etc.

The script:

Kamal unpacks the blood pressure device and connects it to the mains. As soon as the device has identified itself, the local service gateway starts to communicate with it seeking to establish its identity.

The gateway will ask the server to provide a proper driver to communicate with the device. When the driver is located, it is bundled and downloaded to the gateway. Before the driver is installed, the identity of Tahira is confirmed using her digital signature.

> The server will do so using semantic search methods. This part of the scenario may be omitted from the demonstrator, if it is too complicated. Instead, the drivers can be pre-bundled and stored in the bundle library.

When the device has configured itself and is operational, Kamal helps his mother to obtain the first reading from the device. The measured data are uploaded via the eu-DOMAIN to the PESCHR.

Before this can be done, a workflow procedure for automatic remote monitoring and data caption must activated at the server. Each gateway installation at a patient's home identifies the user by an IP address. In this way, each event from the client side comes with the sender IP address (client gateway) that can be interpreted in the server side in order to know the patient that is behind of that IP address. The Network Intelligence Manager stores and manages the information about the client IP addresses in the system.

When the measured data appears at the PESCHR, the Notification Manager sends out a notification to Dr. Hayworth alerting him of this situation. Dr. Hayworth can now access the PESCHR from his PC using a web based GUI. He controls the reading and checks it with the other readings performed at the MHDSS. Since the data are consistent, he gives his permission to upload data automatically.

This permission enters an operational rule running on the gateway. A workflow procedure for remote blood monitoring specifies e.g. one reading per day between 08:00 and 10:00 and only after permission from the GP. The monitoring bundle on the gateway is activated every time a new reading is performed with the device. The operational rule then checks the time of the day and the authorisation (together with other technical parameters) before uploading the data to the PESCHR.

Dr. Hayworth has instructed Tahira and Kamal to make three consecutive blood pressure measurements in the morning and three in the evening. Tahira has to rest for a minimum of three minutes before each measurement.

A bundle on the gateway monitors the procedure and performs the average of the three measurements. The bundle also measures the time between measurements. After the third measurement, the results are uploaded to the eu-DOMAIN server for further processing.

Dr. Hayworth now sets up his own monitoring scheme from his PC using a special web based GUI. He wants to know how the blood pressure evolves over time. If the blood pressure is over certain limits for three consecutive days, he wishes to be informed.

The operational rule is rather complex, since it requires storage of data from at least three consecutive days. The rule will reset itself every time there is a reading inside the allowable maximum. If there have been three readings for three consecutive days without a reset, a notification is initialised.

Dr. Hayworth programs his monitoring scheme by adjusting the parameters of an already created rule template. He will use this template to generate SMS or e-mail messages to himself in case of deviations.

Also Kamal can access the eu-DOMAIN monitoring system and create similar rules. Using the other sensors in the room, he can call-up different rules on a browser based GUI and enters various parameters. He can for example create a rule that also notifies him, if Dr. Hayworth's monitoring scheme is giving an alert. He can also use the movement sensors to determine if Tahira has actually been moving around in the apartment within a specific time. This way, he can feel assured that she has not suffered for diabetic coma. He can also make a rule that will alert the neighbours rather than him self. If he wishes to do so, he can use the door lock to open the door for them and the light switch to turn on the light in the apartment.

4.6.2 Use cases for actor no. 1 – The patient

Use case no. 1.3: To have its blood pressure remotely monitored daily 24 hours a day

Description	The patient's blood pressure has to be continuously monitored remotely by the formal carers
Service	Monitoring, control
Type of service	Control, information
Actor	Patient, medical devices, formal carers
Need	To ensure the health of the patient
Content	Medical data
Information direction	Push (the readings are transmitted automatically from the device to the database when the device is operating)
Time dependence	Time critical (there is a preset number of readings at a specific time during the day)
Position dependence	No

Requirements:

1.3.1 The patient has to be able to use a blood pressure medical device

1.3.2 The blood pressure medical device has to be able to monitor the patient's blood pressure by reading it at several preset times during the day

1.3.3 The blood pressure medical device has to be able to automatically transmit the readings to the GP work station

1.3.4 The blood pressure medical device has to be configured in such a way that it is operating only at certain agreed times

1.3.5 The blood pressure medical device has to have a "Symptom reporting function"

Use case no. 1.4: The patient has to buy a blood pressure device which has to automatically configure itself using the patient's digital signature and data from the PESCHR

Description	Once the blood pressure device is brought home, it has to automatically configure itself by using the patient's digital signature and the data uploaded on the PESCHR
Service	Identification, configuration, profiling, access
Type of service	Information
Actor	Patient, blood pressure device, Ambient Intelligence Environment
Need	To enable the patient to rely on user-friendly intelligent devices and to configure it easily and rapidly
Content	Encrypted data, medical data
Information direction	Push
Time dependence	Real time, not time-critical
Position dependence	No

Requirements:

1.4.1 The device has to be able to discover the gateway or the other way round

1.4.2 The device has to be associated with the gateway in some way

- Wireless, physical contact, etc. (depending on the security architecture)
- Involving user interaction

1.4.3 The gateway has to be able to contact the eu-DOMAIN to download a bundle for that device

1.4.4 The bundle has to be installed into the gateway

1.4.5 A technician has to install the ambient intelligence environment in the patient's home

Use case no. 1.5: The patient has to be monitored (by means of several house sensors) in case of critical situations when he is alone in the house

Description	The eu-DOMAIN system has to be able to monitor the patient when he/she is alone in the house in order to alert the formal or informal carers in case of critical situations. For this purpose several house sensors could be used, such as movement sensors and others.
Service	Surveillance, monitoring, alert
Type of service	Control
Actor	Patient, sensors, ambient intelligence environment
Need	To provide immediate assistance to the patient in case of critical situations
Content	Notifications, alerts (and maybe also audio, image, live video)
Information direction	Push
Time dependence	Time critical, real time

Position dependence	Yes, relative

Requirements:

1.5.1 The eu-DOMAIN system has to be able to monitor the patient when it is alone in the house

1.5.2 The eu-DOMAIN system has to be able to notify/alert the formal/informal carers in case of critical situations

1.5.3 The ambient intelligence environment has to be provided with several house sensors, such as movement sensors and others

4.6.3 Use cases for actor no. 2 – The informal carers

Use case no. 2.1: The patient's immediate family has to be notified by the eu-DOMAIN system in case of minor critical situations by mobile phones

Description	In case of minor critical situations, the eu-DOMAIN system has to notify the patient's immediate family by mobile phones.
Service	Notification, alert
Type of service	Control
Actor	Informal carers, medical devices
Need	To make intelligent decisions in respect to who and how to organize assistance
Content	SMS, notification, alert
Information direction	Push
Time dependence	Time critical, real time
Position dependence	No

Requirements:

2.1.1 The informal carers have to be able to receive alerts and/or notifications on their mobile phones in case of minor critical situations

2.1.2 The system has to be able to inform the informal carers by means of vocal messages or text messages on mobile phones in case of minor critical situations involving the patient

2.1.3 The informal carers have to be able to receive this information even if they are not at home and at any time and place.

Use case no. 2.2: The patient's neighbours have to be notified by the eu-DOMAIN system in case the patient's immediate family is unreachable during minor critical situations

Description	In case of minor critical situations the patient's immediate family must be notified. In case the immediate family's mobile phones are unreachable the patient's neighbours must be notified.
Service	Notification, alert
Type of service	Control
Actor	Informal carers, medical devices
Need	To make intelligent decisions in respect to who and how to organize assistance
Content	SMS, vocal message, notification, alert
Information direction	Push
Time dependence	Time critical, real time
Position dependence	No

Requirements:

2.2.1 The informal carers have to be able to receive alerts and/or notifications on their mobile phones in case of emergency

2.2.2 The informal carers have to be able to receive this information even if they are not at home and at any time and place

2.2.3 The system must be set in order to contact other informal carers in case the patient's immediate family is unreachable by mobile phones

2.2.4 The system must be set in order to inform the informal carers by means of vocal messages or text messages on mobile phones in case of minor critical situations involving the patient

4.6.4 Use cases for actor no. 3 – The formal carers

Use case no. 3.2: The GP has to be informed electronically when the patient's blood pressure device is operating

Description	The GP has to control that the patient is using the blood pressure device at the planned times during the day
Service	Notification, control
Type of service	Control
Actor	GP, blood pressure device
Need	To have the expected number of readings of the patient's blood pressure
Content	Notification
Information direction	Push
Time dependence	Time-critical but not life threatening, real time
Position dependence	No

Requirements:

3.2.1 The GP has to be able to receive notifications/alerts in case the patient is not using the blood pressure medical device at the planned times during the day

3.2.2 The GP has to be able to receive this notification/alert at any time and place

3.2.3 The system must be set in order to notify the GP by several means, such as e-mail, SMS or other means, when it is operating

Use case no. 3.3: The GP has to receive an alert in case the patient's mean blood pressure is outside preset thresholds for more than 3 consecutive days

Description	The GP has to be alerted immediately in case the patient's mean blood pressure is outside preset thresholds for more than 3 consecutive days
Service	Alert
Type of service	Control
Actor	GP or other formal carers, blood pressure device
Need	To provide immediate assistance to the patient
Content	Alert
Information direction	Push
Time dependence	real time
Position dependence	No

Requirements:

3.3.1 The eu-DOMAIN system has to be able to immediately alert the formal carers in case of emergency

3.3.2 The blood pressure device has to be provided with a “symptom reporting function”

3.3.3 The formal carers have to be able to receive notifications/alerts in case of emergency

3.3.4 The formal carers have to be able to receive this notification/alert at any time and place

3.3.5 The system has to be able to notify the formal carers by several means, such as e-mail, SMS or other means

Use case no. 3.4: The GP has to give permission (using his certificate) to upload automatically the readings of the patient’s blood pressure in the patient’s PESCHR

Description	After having checked the readings of the patient’s blood pressure, the GP has to give permission to upload automatically these readings in the patient’s PESCHR. To ensure that he has authorization to allow this uploading he has to use his certificate.
Service	Authorization, information uploading
Type of service	Information
Actor	GP
Need	To complete the PESCHR by a subject surely authorized to do this
Content	Medical data
Information direction	Pull
Time dependence	Not time-critical, real time
Position dependence	No

Requirements:

3.4.1 The GP has to be able to log on to the eu-DOMAIN system from his office PC

3.4.2 The GP has to be able to search for the patient, select the patient and get a list of all the medical data available for that patient

3.4.3 The GP has to be able to use his certificate to authorize the automatic uploading of the readings of the patient’s blood pressure in the patient’s PESCHR

3.4.4 The information on patient’s blood pressure has to be uploaded in real time from the device to the PESCHR

3.4.5 The information on patient’s blood pressure has to be uploaded in real time from the device to the PCT’s diabetes register

3.4.6 The PCT’s diabetes register has to be updated frequently and at different times (with the new information available on patient’s blood and cardiac tests)

Use case no. 3.5: The GP has to be able to set up his own monitoring scheme

Description	The GP has to be enabled to remotely enter rules in the blood pressure device using a simple user interface. The physician has to test the rules by simulating the rules based on input from the GP. The GP then saves the settings and the monitoring scheme is set up
Service	Monitoring scheme setting up
Type of service	Control
Actor	GP, other formal carers

Need	To enter monitoring rules in the blood pressure device to remotely monitor the patient's blood pressure
Content	Text, medical data, rules
Information direction	Push/pull
Time dependence	Not time-critical
Position dependence	No

Requirements:

3.5.1 The GP has to be able to log on to the eu-DOMAIN system from his office PC

3.5.2 The GP has to be able to search for the patient, select the patient and get a list of all equipment available for using with that patient (the blood pressure device)

3.5.3 The system has to be able to detect a blood pressure device and the physician has to be provided with an interface for exactly that device.

3.5.4 The GP has to be enabled to enter rules using a simple user interface such as drop down boxes and text fields or drag and drop.

3.5.5 The physician has to be able to test the rules by simulating the rules based on input from the GP

3.5.6 The GP has to be able to save the settings so that the monitoring scheme is set up

3.5.7 The GP has to be able to have the patient management plan automatically altered by fixing full diabetes review and blood pressure monitoring at new set time.

3.5.8 The eu-DOMAIN system has to be able to reduce or increase the number of measurement per day

3.5.9 The eu-DOMAIN system has to be able to automatically plan full diabetes review with the formal carers, according to the medical data collected and the rules set by the formal carers.

4.6.5 Client side implementation

A blood pressure monitor at Tahira's home sends events to the PubSub Hub in the client side, whenever a new measurement is taken. The gateway IP at Tahira's home identifies her measurements.

A gateway bundle must be able to read in data and make average of three consecutive measurements, measure the time between each measurement and upload the validated average to the server.

4.6.6 Server side implementation

Once the first measurement is taken, a local rule in the bundle triggers an event of a new reading, but not validated blood pressure measurement. This event is handled by the PubSub Hub and forwarded to the Event Manager in the server side. The Rule Engine is subscribed to that type of event (topic) so that it receives a copy of the measurement. A rule is triggered, and as the measurement has not been validated, a flag that indicates that the measurements from that BP monitor need supervision is set in the Device Manager. Moreover, Dr Hayworth is notified about the situation using the Notification Manager. Each patient in the system is identified by the gateway IP address when events come from his home installation. The Network Intelligence Manager is in charge of managing and controlling the addresses of the different users in the system.

Dr Hayworth uses his PC to validate and approve the measurement. This is done through a portlet in the Interaction Server that changes a flag of the blood pressure monitor in the Device Manager. Then, the portlet uses the Device Manager to retrieve the last measurements from the BP monitor, and events with the date are published in the Event Manager, which again forwards it to the Rule Engine. The rule triggered now in the Rule Engine says that the measurement can to be stored in the PESCHR. A monitoring rule is triggered which states that if three consecutives averages are above a threshold, a notification should be sent to the doctor (the average is calculated among the 3 measurement taken during the morning and during late afternoon each day).

Some time after, Dr Hayworth wants to create a Monitoring scheme. A Portlet allows him creating several rules for different purposes. These rules will trigger notifications using templates stored in the Notification Manager.

This textual description is explained as a sequence diagram in the following figure:

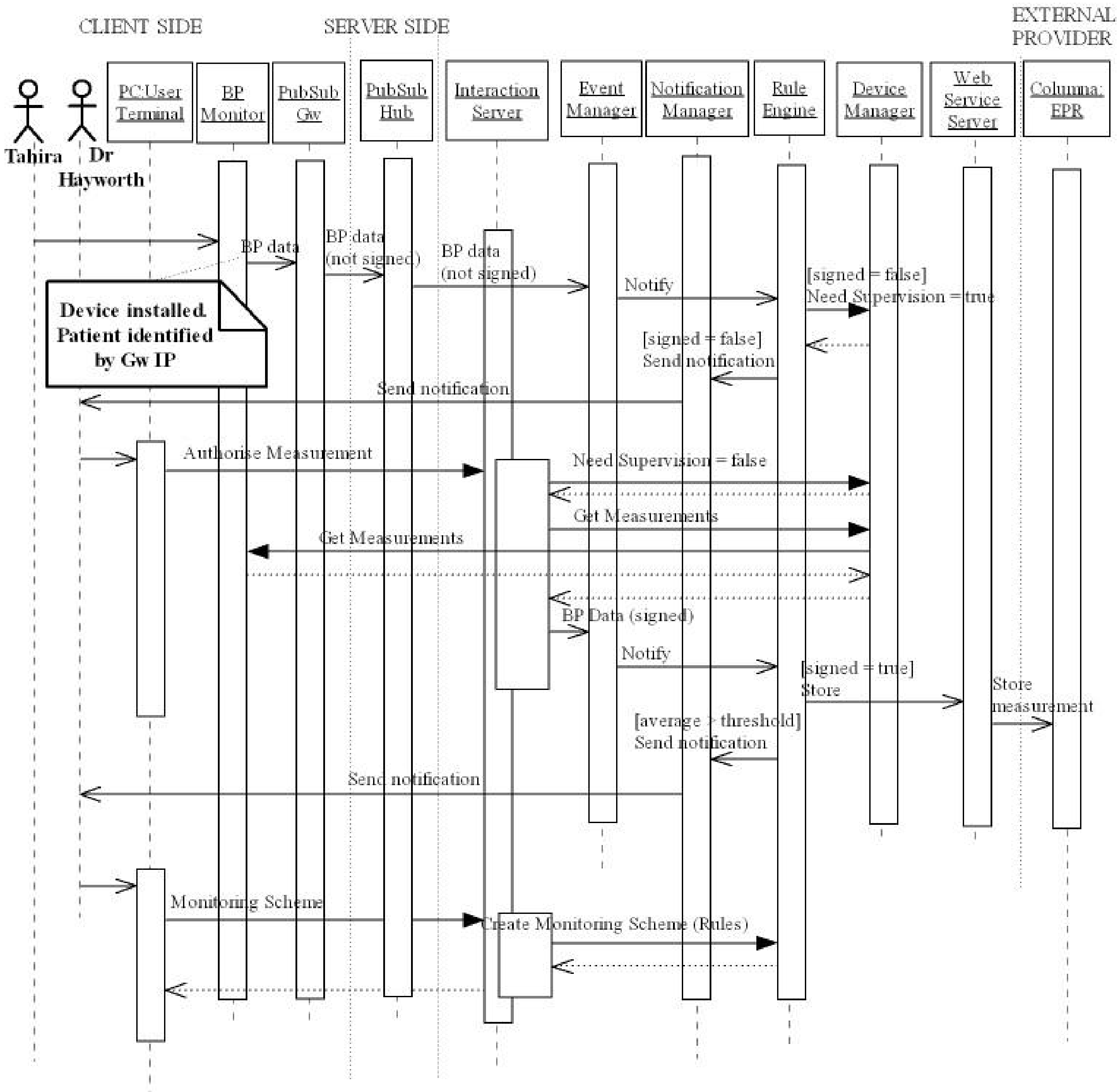


Figure 19 PaC-4

4.7 Demonstration PaC-5

Scenario text:

As part of the initial assessment, Tahira already had the initial 24-hour ambulatory monitoring and Mrs. Cumberland advise her to keep the MediTest device, so they can continue to monitor her blood pressure. Mrs. Cumberland switched the device to “compliance mode” from her PC. The device will now only send information, when Tahira uses it. eu-DOMAIN will monitor how frequently she uses it and remind her, if her measurements become too infrequent. Tahira and Asma are also taught to use the “Symptom Reporting function”. Dr. Ahmad has suggested twice daily monitoring of blood pressure for a month with each reading uploaded into a blood pressure profile of the PESCHR and the Nurse Practitioner Mrs. Cumberland monitors the readings remotely and sets up a “Suspected Abnormal Behaviour” monitoring scheme. Kamal will now receive a text message when there is a suspected deviation from her norm profile. All goes well and within three weeks whilst remain asymptomatic, Tahira’s blood pressure reaches the target of 140/85. At the review by her GP Dr. Hayworth, Tahira is shown her blood pressure profile on-line and her efforts at increasing her physical activity, improving her diet, and losing weight are all praised. Her management plan is now altered so that she will be seen every six monthly for a full diabetes review whilst she monitors her blood pressure weekly with the MediTest remote device. Mrs. Cumberland will continue to monitor her remotely. Dr. Ahmad will ensure Tahira completes her health promotion and health educational courses as well as medication management.

4.7.1 Scene and script

<u>The scene:</u>

The scene for this demonstrator is the nurse practitioner Mrs. Cumberland’s office in the clinic of Dr. Hayworth. Tahira is with her some times, while at other times, she is on-line in her home.

<u>The script:</u>

Mrs. Cumberland accesses the eu-DOMAIN device manager on-line and gets a settings panel on her PC. The settings allowed for her to adjust are determined by the device in question. She can now adjust the device according to her need.

> The settings mentioned in the scenarios are just examples. The actual possibilities depend on the device used. This script is only included to demonstrate two-way communication possibilities in eu-DOMAIN.

With the device Mrs. Cumberland now sets up various monitoring schemes with notifications to both healthcare providers and to Kamal. She also determines which data should be monitored (weight, blood pressure, etc.) based on the clinical pathway. Her monitoring interval is weekly and there is a notification to Mrs. Cumberland if she does not perform the blood test measurement.

Finally, she sets up a long term timer that notifies Tahira when her next appointment with Dr. Hawthorn is due.

4.7.2 Use cases for actor no. 1 – The patient

<u>Use case no. 1.11:</u> The patient has to be monitored in its frequency of use of the blood pressure device and has to be reminded if the measurements become too infrequent.

Description	The patient must be controlled in order to check whether its pressure is monitored at due times. In case the pressure measurements become too infrequent, the patient has to be warned and recommended to use the blood pressure medical device.
Service	Alert, control, monitoring
Type of service	Control
Actor	Patient, formal carers, blood pressure device
Need	To monitor the effective use of the device by the patient
Content	Alert, notification
Information direction	Push
Time dependence	Time critical, real time
Position dependence	No

Requirements:

1.11.1 The eu-DOMAIN system must be set in order to monitor how frequently the patient uses the device.

1.11.2 The eu-DOMAIN system must be set in order to remind the patient to use the blood pressure device at the established times.

4.7.3 Use cases for actor no. 2 – The informal carers

There is no use cases developed for actor 2 in this part of the scenario.

4.7.4 Use cases for actor no. 3 – The formal carers

Use case no. 3.8: The nurse practitioner has to switch the patient's blood pressure device to "compliance mode" from her PC

Description	The nurse practitioner has to be enabled to remotely act on the patient's blood pressure device, establishing to which mode it should be switched.
Service	Remote access and action on a device
Type of service	Control
Actor	Nurse practitioner
Need	To collect blood pressure information directly from the device, but only when the patient uses it
Content	Text, files
Information direction	Pull
Time dependence	Not time-critical, real time
Position dependence	No

Requirements:

3.8.1 The nurse practitioner has to be able to switch the patient's blood pressure device to any desired mode of operation from her PC

3.8.2 The nurse practitioner has to be able to change the blood pressure device into a different mode of operation

3.8.3 The nurse practitioner has to be able to remotely act on the patient's blood pressure device

Use case no. 3.9: The nurse practitioner has to remotely monitor the patient's blood pressure profile uploaded on the PESCHR and to set up a "Suspected Abnormal Behaviour" monitoring scheme.

Description	The nurse practitioner has to have remote access to the patient's PESCHR and she has to monitor the blood pressure profile, setting up a "Suspected Abnormal Behaviour" monitoring scheme.
Service	Access, monitoring scheme setting up
Type of service	Control
Actor	Nurse practitioner, blood pressure device
Need	To enter monitoring rules in order to remotely ascertain whether the patient's blood pressure profile is normal or not
Content	Text, medical data, rules
Information direction	Pull
Time dependence	Not time-critical
Position dependence	No

Requirements:

3.9.1 The nurse practitioner has to be able to log on to the eu-DOMAIN system from her office PC.

3.9.2 The nurse practitioner has to be able to search for the patient, select the patient and get the relative PESCHR.

3.9.3 The system has to be able to detect a blood pressure device and the nurse practitioner has to be provided with an interface for exactly that device.

3.9.4 The nurse practitioner has to be enabled to enter rules using a simple user interface such as drop down boxes and text fields or drag and drop.

3.9.5 The nurse practitioner has to be able to test the rules by simulating them

3.9.6 The nurse practitioner has to be able to save the settings so that the monitoring scheme is set up

4.7.5 Client side implementation

A blood pressure monitor, which is plugged to a Client Gateway, is configurable through the Interaction Server (a portlet)

4.7.6 Server side implementation

Mrs Cumberland accesses a blood pressure monitor to configure it using a portlet. The portlets uses the DMI to contact the blood pressure monitor and be able to configure it (i.e. set the acquisition times).

She can also create new monitoring schemes (rules in the Rule Engine) as she has the proper rights to perform this task.

This last scene of the PaC scenario is expressed as a sequence diagram in the following diagram:

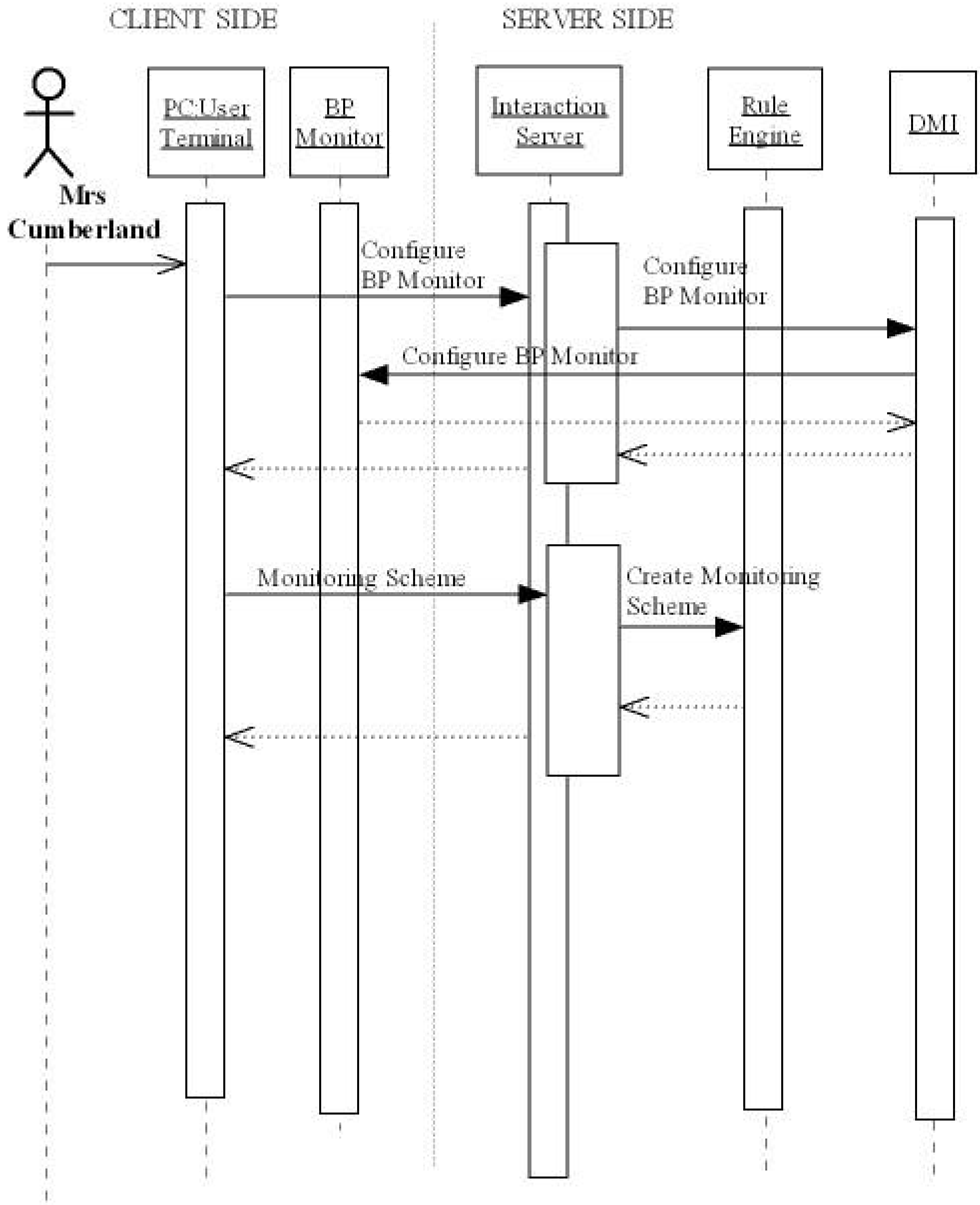


Figure 20 PaC-5

5. Third and final demonstrator: Domotica integration

The demonstrator for the final annual review is built on top of the final, evaluated demonstration platform with full functionality. The platform has been tested and validated according to the user validation plan. This final demonstrator makes use of the infrastructure that was finished in the year 2 of the project but applied to a different domain, the Domotica case (intelligent home), where different home appliances are controlled from the infrastructure (lamp, blind, water pump and RFID identification).

This section describes the scenes to be shown in the final demonstrator.

5.1 Demonstration Domotica-1

5.1.1 Scene and script

<u>The scene:</u>

The scene takes place is an intelligent house where an eu-DOMAIN gateway has been installed and configured, so it can make use of the functionality provided by the server infrastructure. Vicente Conde discovered the eu-DOMAIN system for home automation a year ago, and he can now control a number of appliances at home using very different interface means.

<u>The script:</u>

Vicente Conde arrives home. He has preconfigured an ambient intelligence rule, so that every time the RFID recognition system identifies him entering his room, the lights are switched on.

5.1.2 Client side implementation

OSGi framework bundles to control the RFID recognition system and the lamp. Every change in any of the bundles is published in the Event Manager (Publish/Subscribe system) so that the server part is aware of those changes.

5.1.3 Server side implementation

In the first scene of the Domotica scenario, once Vicente enters the room, the RFID system publishes an event with the id of the user. The rule engine is listening to new events, so when this one appears a rule is triggered. That rule says that if Vicente enters the room, the lights are switched on.

These interactions are graphically described in the next sequence diagram.

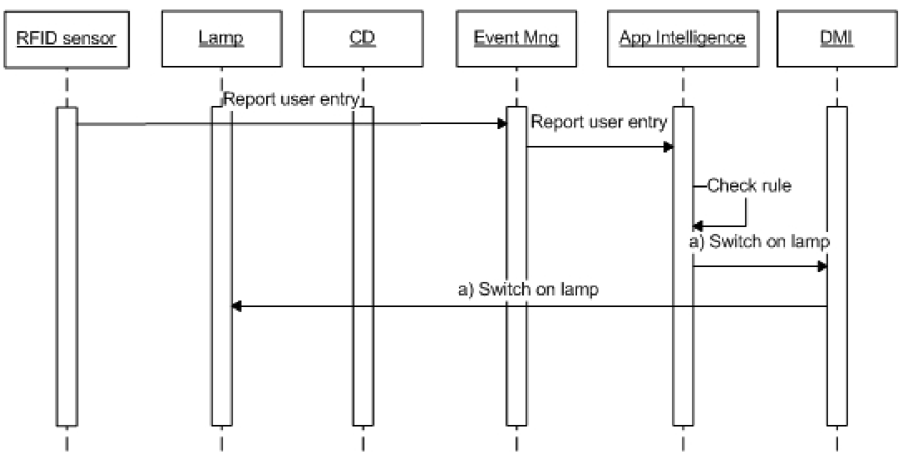


Figure 21 Domotica-1

5.2 Demonstration Domotica-2

5.2.1 Scene and script

The scene:

The scene takes place at Vicente's intelligent room. The blind and the lamp are involved in the scene.

The script:

Vicente Conde finds that there is still day light. He sends a SMS to the system to pull up the blind. A preconfigured rule says that if this happens, the lamp has to be switched off.

5.2.2 Client side implementation

OSGi framework bundles to control the lamp and the blind.

5.2.3 Server side implementation

In the second scene of the Domotica scenario, the Notification Manager receives a SMS to pull up the blind. The blind is pulled up, the state of the blind is published and a rule is triggered at the Rule Engine so the lamp service is contacted to switch it off.

These interactions are graphically described in the next sequence diagram.

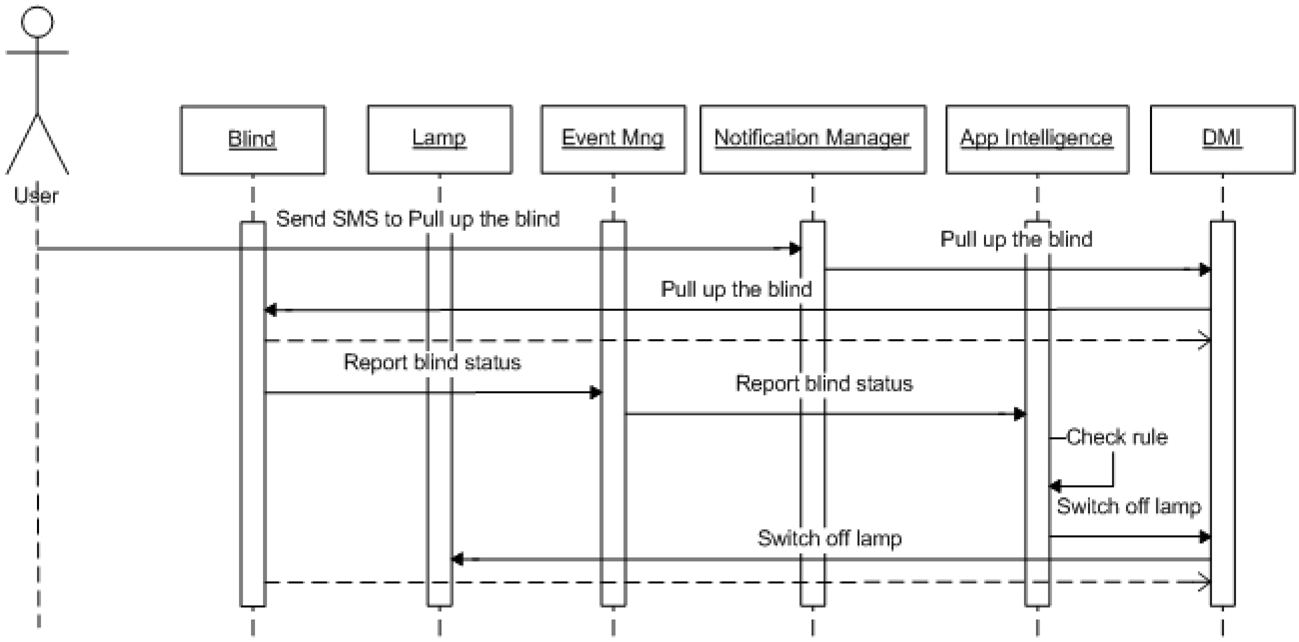


Figure 22 Domotica-2

5.3 Demonstration Domotica-3

5.3.1 Scene and script

The scene:

The scene takes place at Vicente's intelligent room.

The script:

Vicente wants to integrate a new device in the system, a thermometer. He contacts the service provider to call a technician to install the device.

5.3.2 Client side implementation

No client side implementation involved in this scene.

5.3.3 Server side implementation

In this third scene, the user makes use of the Interaction Server to interact with the system. He asks for technical support so a new workflow is created. As part of this workflow, an available technician with the appropriate skills is contacted via SMS to install the thermometer device.

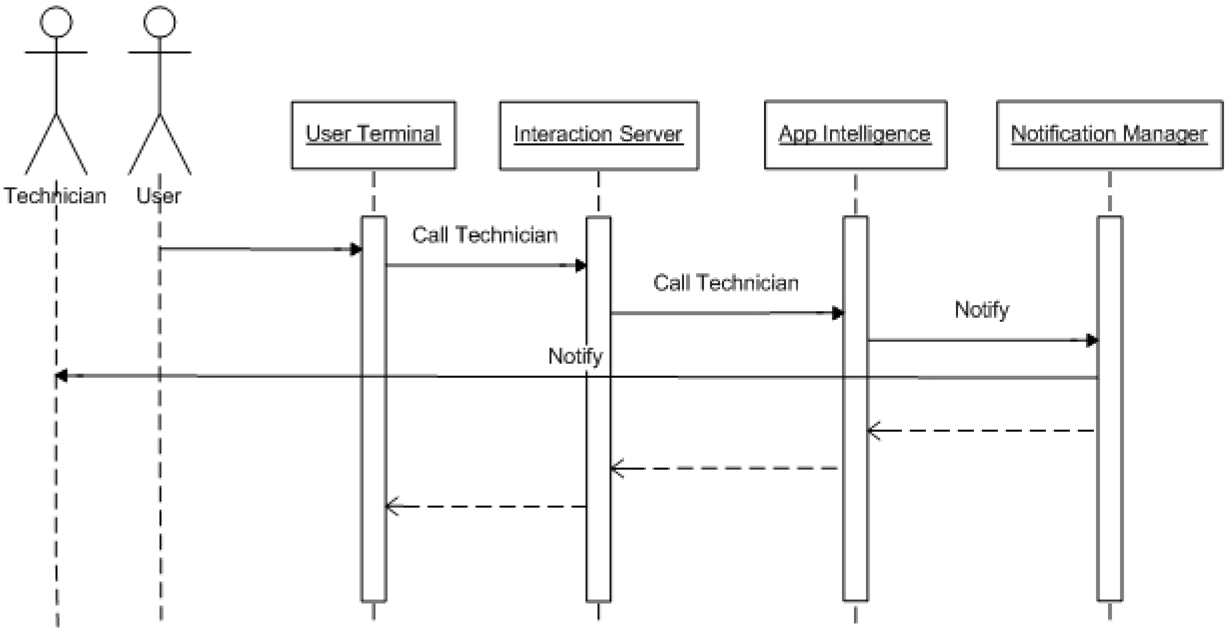


Figure 23 Domotica-3

5.4 Demonstration Domotica-4

5.4.1 Scene and script

The scene:

The scene takes place at Vicente's house, where the technician, Rafael Fraile, appears to install a thermometer.

The script:

Rafael, the technician, appears at home with his PDA, he is authenticated against the Security Manager and retrieves the list of available appliances at home.

5.4.2 Client side implementation

No client side implementation involved in this scene.

5.4.3 Server side implementation

In this scene, Rafael Fraile accesses eu-DOMAIN functionality through the Interaction Server using his PDA. His certificate is used to authenticate him and to give him his proper rights in the system. Security checks are performed against the Security Manager to know the role and functionality Rafael can access.

Rafael selects the task to be performed (installation of a thermometer) and he then retrieves the list of devices at home.

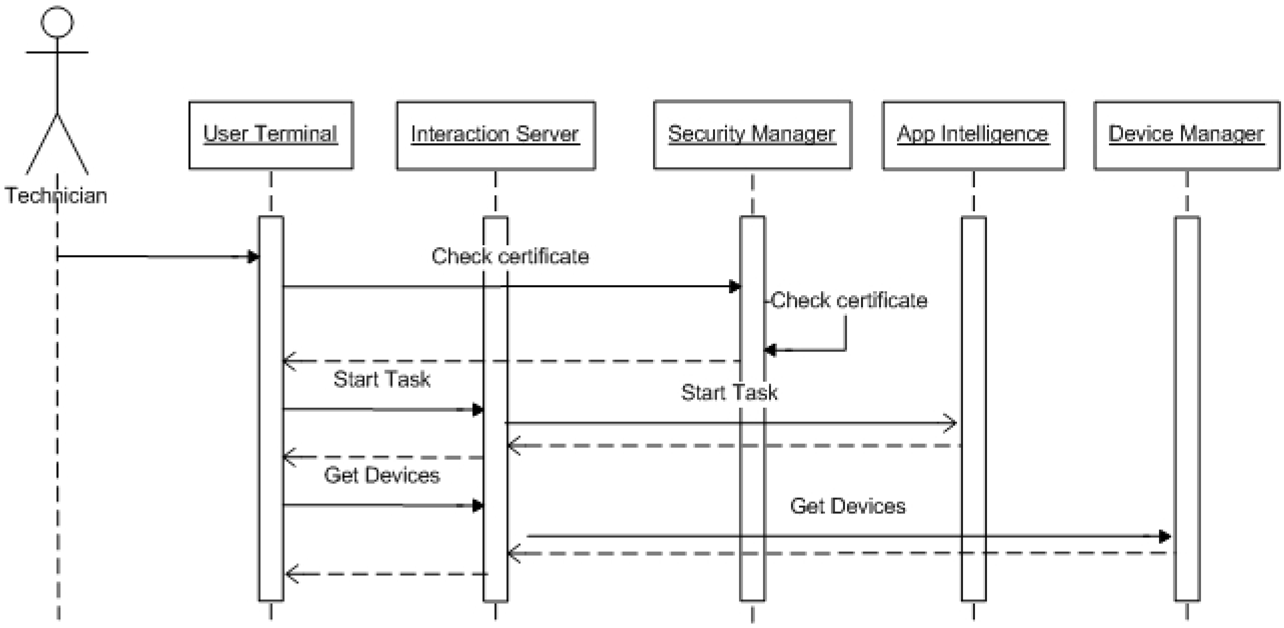


Figure 24 Domotica-4

5.5 Demonstration Domotica-5

5.5.1 Scene and script

The scene:

The scene takes place at Vicente's house, where the technician is installing a thermometer.

The script:

Rafael, the technician, appears at home with his PDA, he is authenticated against the Security Manager and retrieves the list of available appliances at home.

5.5.2 Client side implementation

Installation of the appropriate bundle to control the thermometer in the OSGi framework that controls the client gateway.

5.5.3 Server side implementation

In the fifth scene, Rafael, using his PDA, chooses a Domain Model that incorporates a thermometer, so that the system can manage the new device. The model is loaded and the thermometer is physically connected to the gateway. The gateway identifies the new device as a thermometer and retrieves the appropriate bundle from a bundle repository. The thermometer bundle is installed in the gateway and to check that the device was installed, Rafael retrieves the list of available devices at home: the thermometer appears.

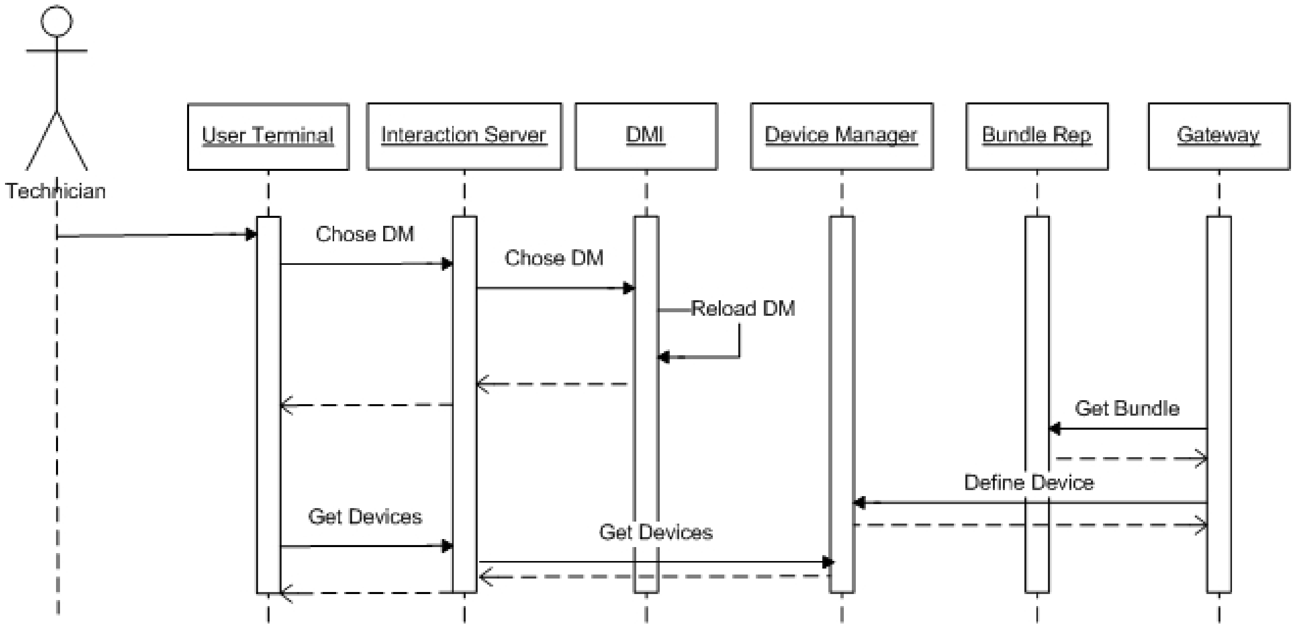


Figure 25 Domotica-5

5.6 Demonstration Domotica-6

5.6.1 Scene and script

The scene:

The scene takes place at Vicente's house.

The script:

Rafael gives rights to Vicente to use the thermometer.

5.6.2 Client side implementation

No client side implementation involved in this scene.

5.6.3 Server side implementation

In this scene, Rafael gives rights to Vicente to use the thermometer using his PDA.

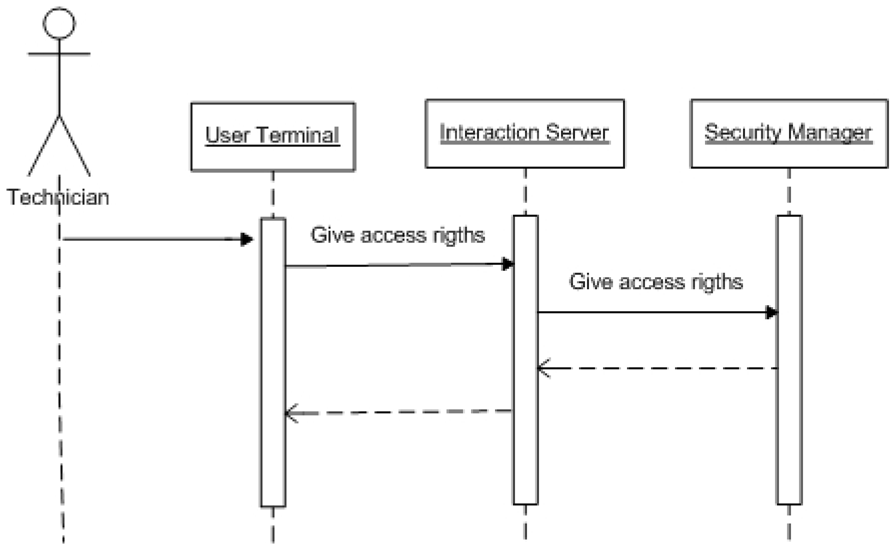


Figure 26 Domotica-6

5.7 Demonstration Domotica-7

5.7.1 Scene and script

The scene:

The scene takes place at Vicente's house.

The script:

Rafael finishes the job.

5.7.2 Client side implementation

No client side implementation involved in this scene.

5.7.3 Server side implementation

In seventh scene, Rafael end his workflow and the details of the task performed is retrieved from the Task Manager in the server side.

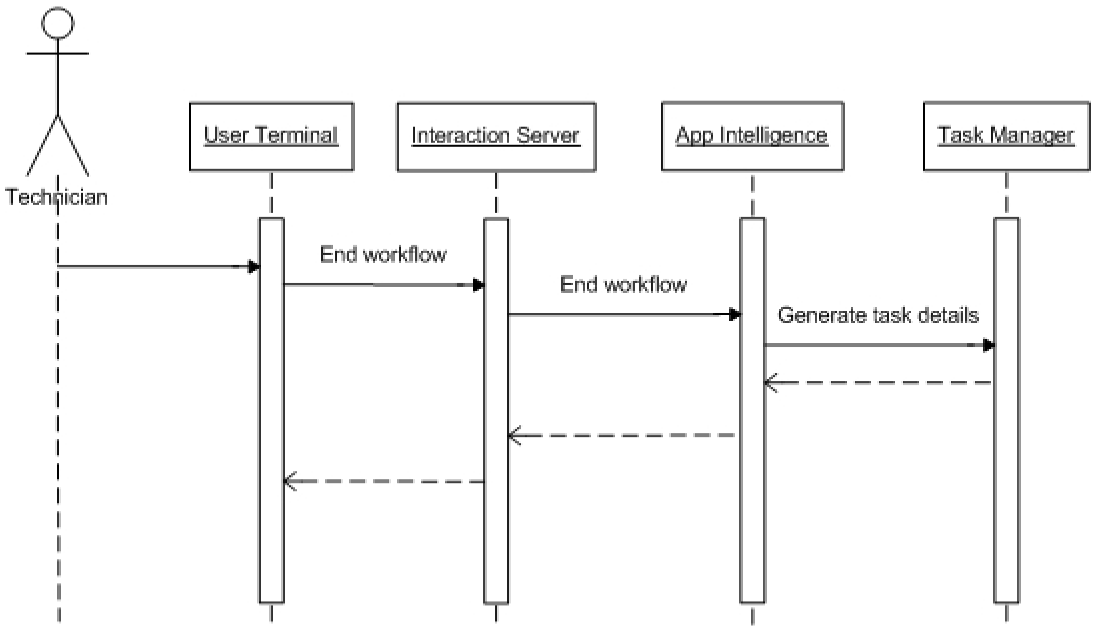


Figure 27 Domotica-7

5.8 Demonstration Domotica-8

5.8.1 Scene and script

The scene:

The scene takes place at Vicente's house.

The script:

Vicente creates a new rule.

5.8.2 Client side implementation

No client side implementation involved in this scene.

5.8.3 Server side implementation

Once Rafael has left user's house, Vicente defines a new rule in the system, so that every time the temperature in the room is above 22º, a pump waters a plant. When Vicente retrieves the list of devices, he can now see and use the thermometer previously installed.

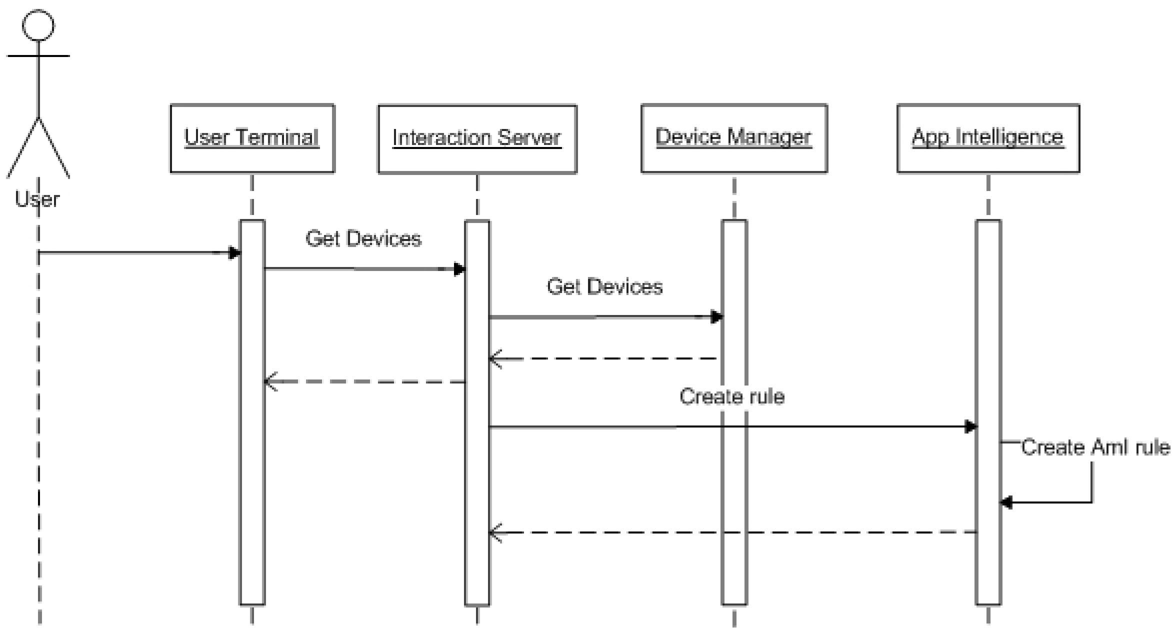


Figure 28 Domotica-8

5.9 Demonstration Domotica-9

5.9.1 Scene and script

The scene:

The scene takes place at Vicente's house.

The script:

The rule created is triggered.

5.9.2 Client side implementation

OSGi framework bundles to control the thermometer and the water pump.

5.9.3 Server side implementation

The temperature in the room is above 22º, the rule is triggered and the pump waters a plant.

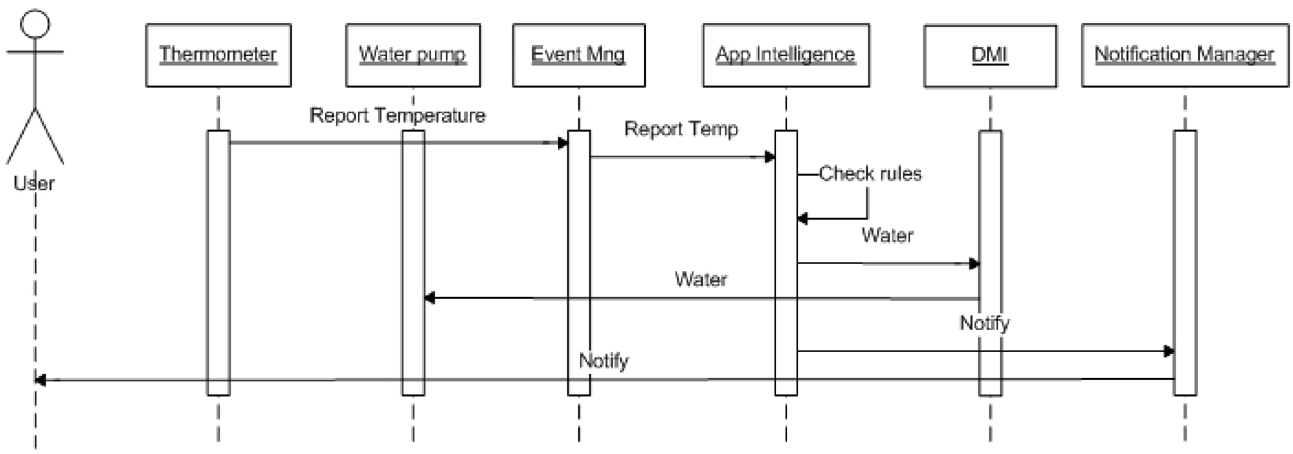


Figure 29 Domotica-9

5.10 Demonstration Domotica-10

5.10.1 Scene and script

The scene:

The scene takes place at Vicente's house.

The script:

The user sees the system log.

5.10.2 Client side implementation

No client side implementation involved in this scene.

5.10.3 Server side implementation

All the activity in the system is logged and the administrator of the system can retrieve that information using the Interaction Server.

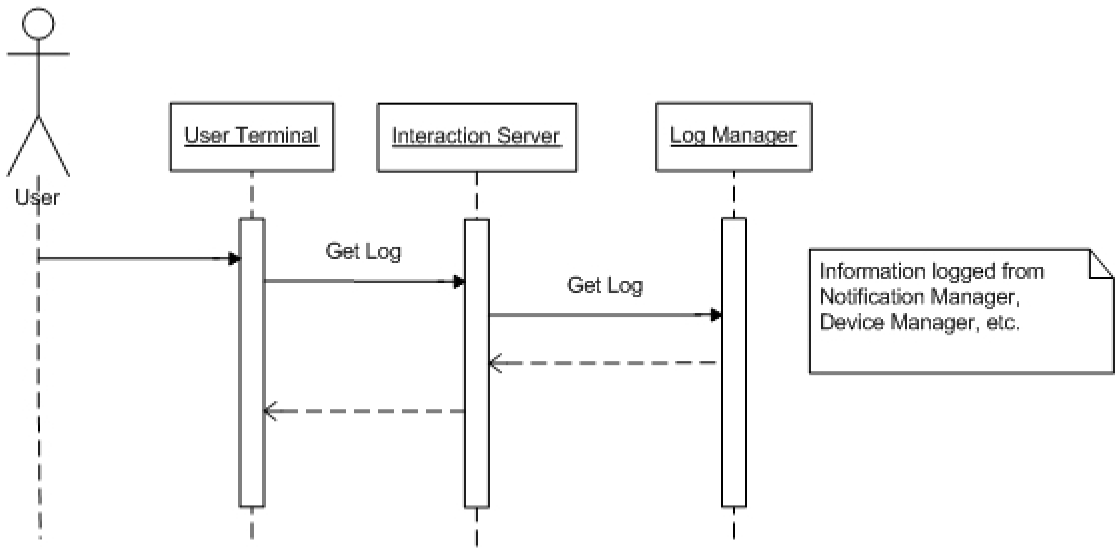


Figure 30 Domotica-10

6. Integration approach

As it was explained before, the eu-DOMAIN prototype platform implements a Service Oriented Architecture (SOA) using web services for integrating the different components of the architecture. This allows the components of the infrastructure to run in different machines allocated in different countries. The first integration approach used for the first demonstrator was to implement the different components and services by the different partners locally to be integrated at service level by web services calls. This approach was taken in the first steps of the project. Nevertheless, a complete prototype platform had to be installed and integrated at TID facilities in Valladolid (Spain) and be available for one year after the project end, so this integration model was not appropriate for the requirements of the project and the consortium had to decide on the best approach to perform the real integration of all the components of the system.

The consortium took into consideration the use of different virtual machines to integrate the whole system. For this reason, a study about the available virtual machine solutions was performed; Table 2 compiles the main features of the most relevant virtual machines. This approach gave us some advantages at integration time. It would be easier to maintain and to integrate the single components of the eu-DOMAIN system. However, installing several virtual machines on a same server will increase the resources consume.

VMWare	Bochs	QEMU	Virtual PC 2004
Not open source.	Open source.	Open source.	Not open source.
Not free. Needs payment license.	Highly portable.	Integrated VNC server with USB tablet emulation.	Free.
Does not support graphic accelerators.	Emulation of the Intel x86 CPU, common I/O devices, and a custom BIOS.	Support for high performance full virtualization using the QEMU accelerator.	Only available for host systems: Win2000/XP/2003.
The emulated system is fastly run.	It has several bugs, such as mouse, interrupt controller, timer, network card, VGA...	Support for ARM Integrator/CP board system emulation.	Ease migration from host OS to emulated one.
It can share the ethernet card between all the emulated OS as well as the host OS, each with a different MAC and IP.	Emulation of 386, 486, Pentium, Pentium Pro or AMD64 CPU, including optional MMX, SSE, SSE2 and 3DNow! instructions.	Support for MIPS R4K system emulation.	Virtual PC has a number of settings that control how the product interacts with the physical computer, allocates resources, and so on.
Devices such as floppy disk, cd, etc, cannot be used simultaneously by all the OS. Though they can be plugged/unplugged easily.		Networking options for VLAN support between several QEMU instances.	Deploy throughout your company a standard configuration that avoids problems caused by minor differences between hardware platforms.
Solves the problems with hardware configuration, as it uses common and simple hardware.		USB support.	Users can copy, paste, drag, and drop between guest and host. Virtual PC provides additions that you install in a guest operating system to enable this functionality.
Protects the host system avoiding possible attacks.		Initial SMP support on x86	Simple to install.
It uses physical RAM, the swap is not a valid option.			

Table 2 Virtual Machines comparison

Finally, the virtual machine-type solution was discarded and the consortium decided to integrate all components at TID servers in the "classical" way, which means that all components are installed, configured and integrated in the Server Park by TID and helped by the developers of the services. Basically, Telefónica I+D collected all parts from partners and integrate them on available servers with the support of the rest of the partners.

Some useful tools were used to make the integration tasks easier; such as:

- Common code repository – Subversion
- Collaborative Workspace – BSCW
- Forums
- Partners repositories

The first step was to install the enabling technologies in the servers at TID facilities. This tasks involves installing the Java based and .NET environments, the databases and the tools related to the Web Services, such as the UDDI Registry, Axis or Tomcat. Then, once all the components were collected, they were integrated at TID servers. Mainly, these components offered web services interfaces, so it was needed to register these services on the UDDI Server installed at TID servers. Finally, Telefónica I+D developed the user interfaces by means of portlets to allow the access to the eu-DOMAIN functionality.

6.1 System integration

6.1.1 Integration Platforms

Two servers running Windows and Linux as Operative Systems are used as Server Park at TID.

- The Linux Server has deployed the Kannel WAP and SMS gateway allowing the Notification Manager to send the SMS messages to mobile phones when a special event occurs.
- Over the Windows OS, two different programming platforms are used:
  - Java based platform is needed to run the web services infrastructure (Tomcat, Axis), the business process technologies (BPEL), the database (Tamino) and the Interaction Server (Liferay as portlet container).
  - .NET based platform is needed to run the .NET web services developed by CNET.

6.1.2 Server Side

The Server Park installed at TID facilities, as explained before, is composed by two servers. Figure 31 shows the Windows Server where most of the services and applications developed within the eu-DOMAIN platform are deployed and the Linux one where the Kannel SMS gateway is installed.

Two implementation platforms, .NET and Java, were chosen to implement the functionality of the system by means of web services. On the Windows Server the software agents, both the Java and the .NET based ones, are allocated. The Interaction server, which is also installed on the server, allows the user to access to the eu-DOMAIN functionality (user interfaces). More information about the services deployed can be found on [eu-DOMAIN D8.3, 2005] and [eu-DOMAIN D8.3, 2006]

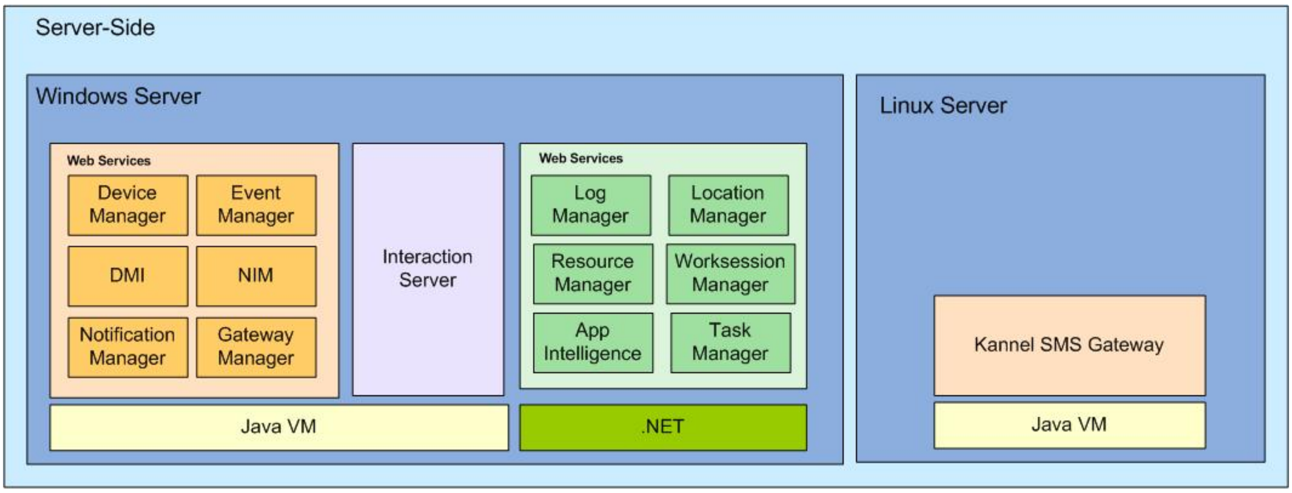


Figure 31 Server Park – platforms & services

6.1.3 Client Side

A client gateway will be installed at TID facilities to be used in the final demonstrator of eu-DOMAIN representing the client side. However, different gateways can be installed in any location as they can access to the Server Park installed in TID facilities and take advantage of the functionality the eu-DOMAIN platform provides. This has been demonstrated during validation, where different clients were installed in Denmark, Germany and Italy, being able to take advantage of the services provided by the eu-DOMAIN service infrastructure.

The client side at TID facilities will be installed in a Windows machine running an OSGi framework with the suitable bundles in charge managing devices, such as blood pressure monitors, blinds, lamps, etc.

Two other client gateways, at UAAR and at FORTH facilities, will be running at least until the project ends. The client sides at those locations consist on an installation of an OSGi framework where the properly bundles to control the devices are registered. Figure 32 depicts the devices and bundles allocated at each partner servers at this moment.

The devices installed at UAAR facilities are related to the ESN scenario, while the devices used in TID and FORTH are related to the PAC scenario. Moreover, TID will implement a new gateway for the final review that allows controlling different domotic devices such as a blind, a lamp, a plug and a RFID reader.

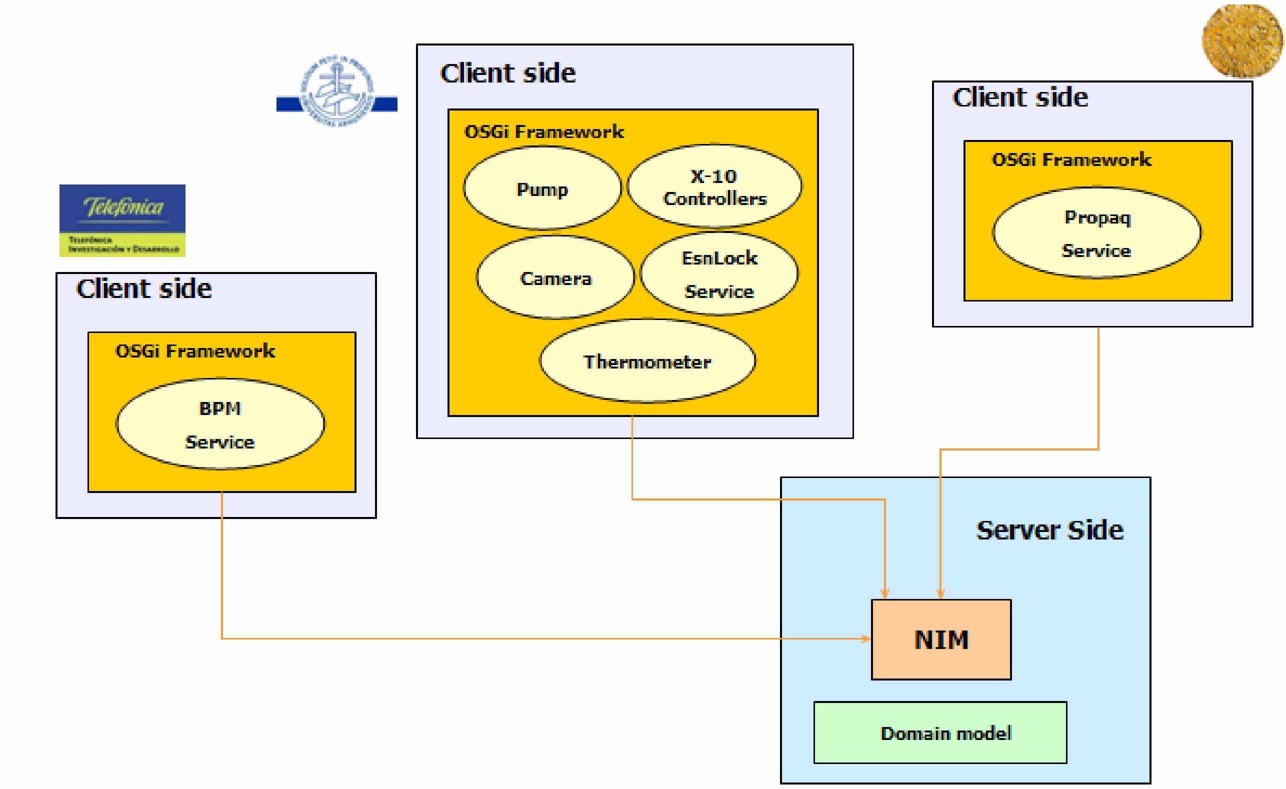


Figure 32 Client side & Server Park connections

6.1.4 Communication infrastructure

The communication infrastructure prototype is running and ready to use at TID facilities. Two accesses are possible, via fixed or wireless networks. In the deliverables D5.1 and D5.2 [eu-DOMAIN D5.1, 2006] and [eu-DOMAIN D5.2, 2007] the reader can find more information about this communication infrastructure. Next figure shows the communication infrastructure prototype of the project.

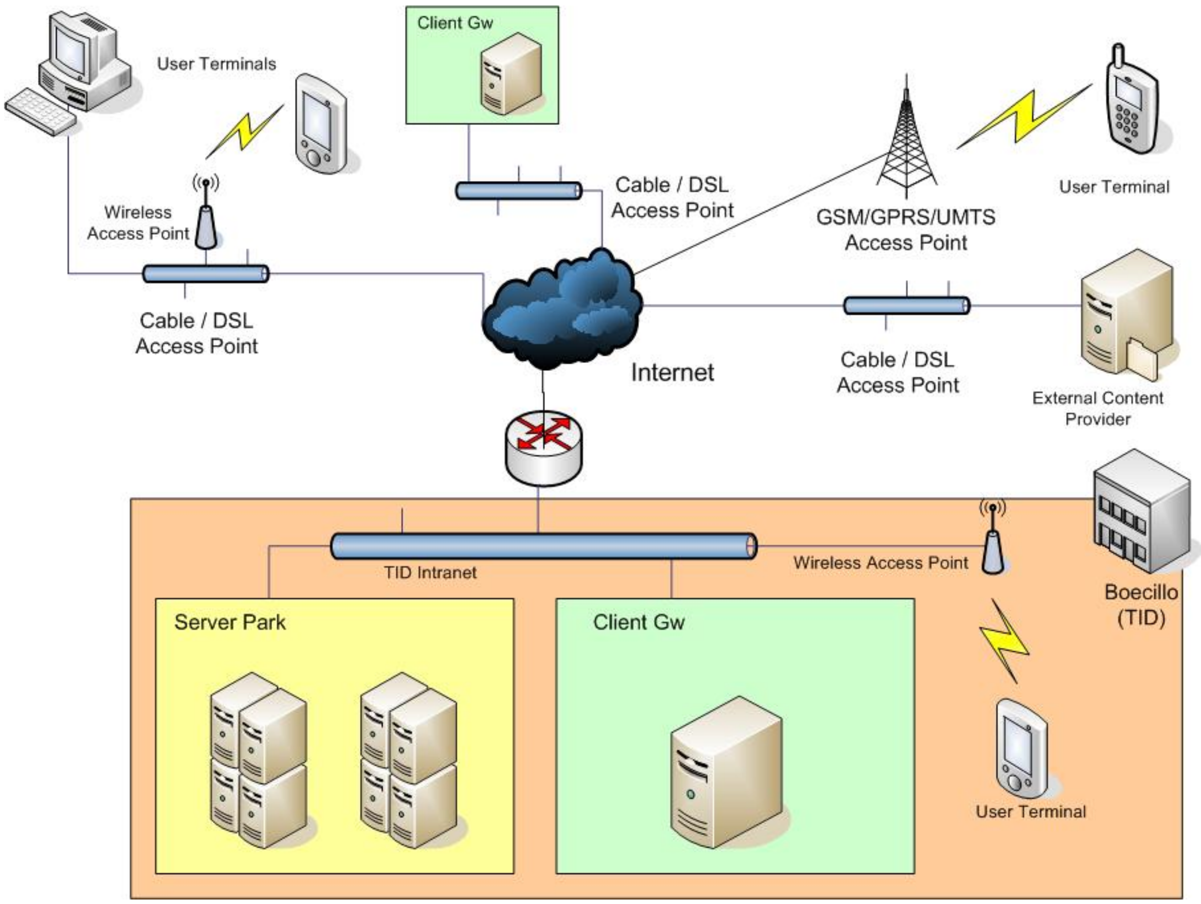


Figure 33 Communication infrastructure prototype

6.1.5 Integration Goal

Finally, Figure 34 depicts a possible eu-DOMAIN SOA platform when installed for exploitation purposes, where different clients (gateways) are connected to the integrated Server Park using different communication technologies in order to use the functionality provided by the platform.

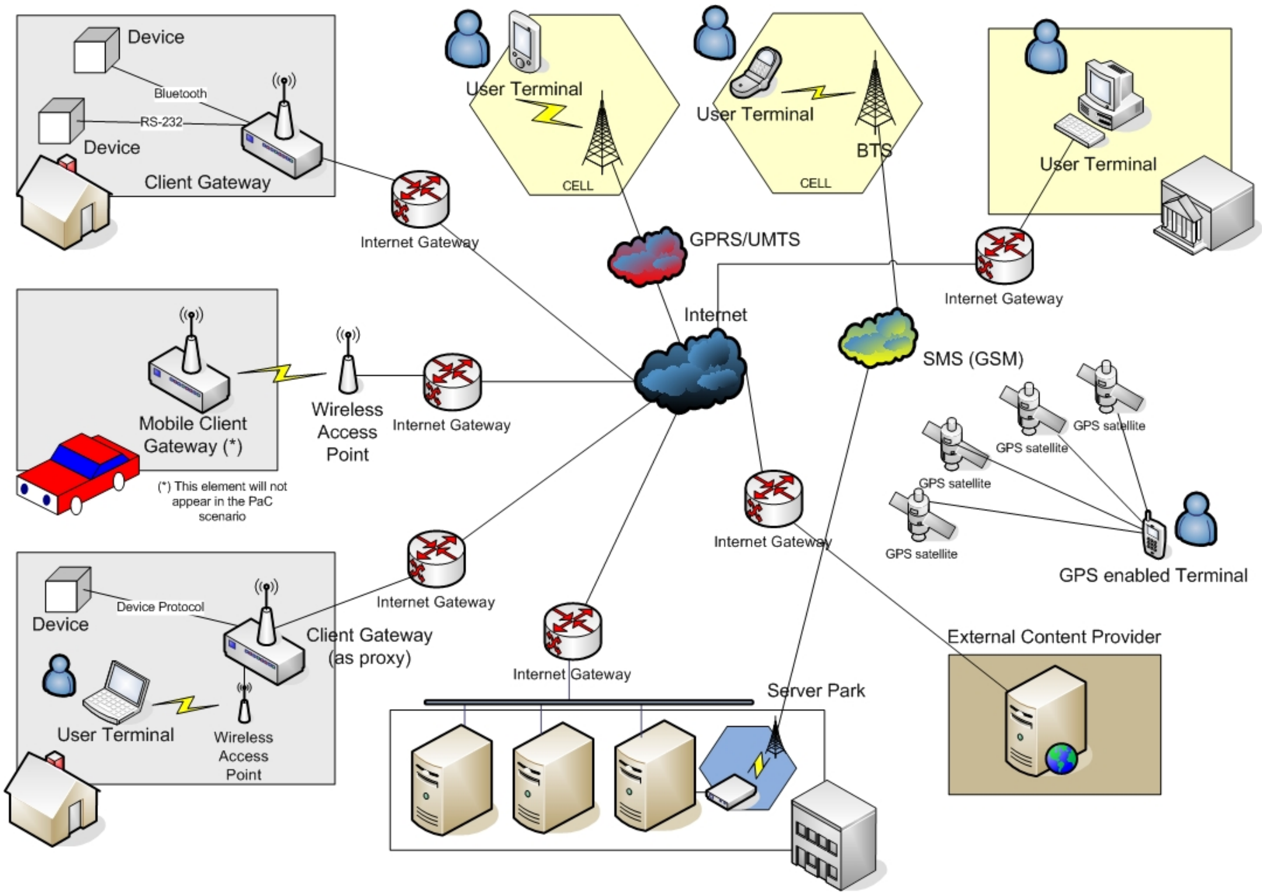


Figure 34 eu-DOMAIN platform

6.2 Partners involved

The following figure shows the eu-DOMAIN partners involved in the system integration. The system integration is led by TID, the rest of the partners involved are those who have a close relationship with any aspect of the server or client software development within the eu-DOMAIN demonstrators.

Figure 35: eu-DOMAIN technical partners

The following list shows the developments performed by each technical partner. Those are also the partners involved in the system integration.

- CNET
  - AppIntelligence (Rule Engine)
  - Task Manager (including Resource Scheduler and Skills Manager)
  - Mobile Content Compiler (MCC)
  - Location Manager
  - Log Manager
  - Resource Manager
  - Worksession Manager (Mission Manager)
  - Web service server (WSS)
- SAG
  - Domain Model
  - Domain Model Interpreter
    - Java DMI
    - WS Interface (for .NET services)

    - Network Intelligence
- UAAR
    - eu-DOMAIN OSGi framework
    - OSGi bundles
    - Security Manager
    - Firewall
    - Event Manager
    - Driver Repository Manager
    - Patient Manager (via Columna)
- FORTH
    - Propaq device Bundle
- TID
    - Interaction Server
        - Liferay (portlet container)
    - Event Manager
        - Apache Pubscribe
    - Notification Manager
        - Kannel
    - OSGi bundles

7. Conclusions

This deliverable is a prototype that includes all the software integrated at TID Server Park. This document helps the reader understand how this integration was performed.

The document has also presented how integration was performed in order to build the different demonstrators presented through out the life of the eu-DOMAIN project on top of the prototype infrastructure: the ESN demonstrator (Budapest, 2005), the PaC demonstrator (Madrid, 2006) and the Final demonstrator (Domotica) (Valladolid, 2007). The project has used an iterative integration process towards having the final test platform running at TID where all components are installed, configured and integrated in the Server Park at TID. TID has collected all components from partners and integrated them on available servers with the support of the rest of the partners.

The scenarios used to demonstrate the functionality of the software infrastructure in different domains (the ESN, PaC and Domotica scenarios) have been described in this document, providing also the sequence diagrams that drove the implementation of those scenarios.

Regarding the integration tasks, and in order to integrate all the components of the platform, client gateways have been loaded with the OSGi framework and relevant service bundles that control all devices needed for the scenarios. Then, communication links to the Server Park have been established. Then, on the server side, the main database, management structures and network intelligence have been integrated along with web service provisioning servers with application intelligence. At the same time, all web services have been enabled with live access to and from content repositories and content providers and finally the communication infrastructure has been established and services between gateways and servers have been enabled.

Integration tasks have been performed by SAG, UAAR, CNET, FORTH, and IN-JET and led by TID.

8. References

[eu-DOMAIN D3.1+D4.1, 2005] UAAR, CNET (2005), *Software Architecture Specification,* eu-DOMAIN deliverable

[eu-DOMAIN D5.1, 2006] TID (2006), *Communication architecture description,* eu-DOMAIN deliverable

[eu-DOMAIN D5.2, 2007] TID (2007), *Prototype of communication infrastructure,* eu-DOMAIN deliverable