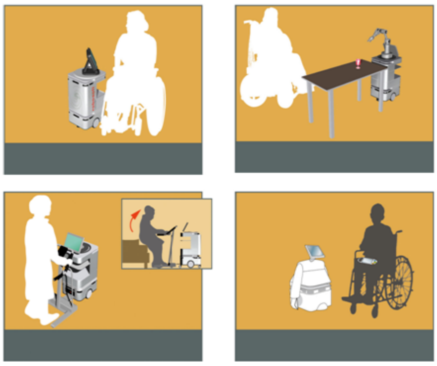


DOMEO Project

AAL-2008-1-159

D6.2 Telecommunication connections integration report

Document id: R-TAS-1_0-D6.2 Telecommunication connections integration report

Document Information	
Title	Telecommunication connections integration report
Workpackage/Deliverable	WP6 / D6.2
Responsible	TAS
Due Date	31/03/2011
Actual Date	20/05/2011
Type	Deliverable
Status	Version 1_0
Dissemination Level	Public
Authors	Pascal LOCHELONGUE – Xavier LADJOINTE
Project URL	N/A

Keyword List:
Telecommunication, Interfaces, Connections, Integration

Summary

Socially active robots can support the elderly in their everyday life. The DOMEO project of the Ambient Assisted Living Joint Programme of the European Union aims to develop and validate a new companion robotic system that would allow cognitive assistance to the elderly. The project brings together patients (elderly), healthcare professionals and telemedicine contact centres' staff to improve healthcare follow-up and quality of life of the elderly. While patients live at home, healthcare professionals work in their offices and telemedicine contact centres' staff manages calls in a third place, there is a need for secure and reliable network infrastructure to interconnect these actors.

While deliverable D6.1 "Telecommunication network architecture" provided an overall vision of the DOMEO network architecture and main components, deliverable D6.2 "Telecommunication connections integration report" introduces how equipment or components are required to be integrated together with peripheral sub-systems. The document provides information concerning equipment physical connection and configuration to meet the DOMEO requirements.

Section 1 is a short introduction of the purposes of the document,

Section 2 introduces the testbed set up to realise the technical validation of the DOMEO system and services,

Section 3 is the main section of the document and provides detailled connection schemes and setting up procedures concerning the home place, the telelemedIcine contact center and the healthcare professional office subsystems. It addresses hardware and software subsystems,

Section 4 introduces preparation of the technical validation and preliminary test plan.

Table of Content

List of Figures

List of Tables

List of acronyms

1G	1st Generation Mobile System
2G, 2.5G	2nd Generation Mobile System
3G	3rd Generation Mobile System
4CIF	4 × CIF : 704 × 576
ADSL	Asymmetric Digital Subscriber Line
ADSLF	ADSL Forum
AMPS	Advanced Mobile Phone Service
AVI	Audio Video Interleave
CDMA	Code Division Multiple Access
CIF	CIF 352 × 288
CO	telephone Central Office
DSL	Digital Subscriber Line
DSLAM	Digital Subscriber Line Access Multiplexer
DVB-RCS	Digital Video Broadcasting – Return Channel via Satellite
DVB-S	Digital Video Broadcasting via Satellite
ECG	Electrocardiogram
EDGE	Enhanced Data rates for GSM Evolution
ETSI	European Telecommunications Standards Institute
FDMA	Frequency Division Multiplexing Access
FLV	Flash Video codec
FTP	File Transfer Protocol
GPRS	General Packet Radio Service
GSM	Global System for Mobile communication
HMI	Human Machine Interface
HR	Heart Rate
HTTP	HyperText Transfer Protocol
IMT	International Mobile Communications
IP	Internet Protocol
IPTV	TV over IP
IR	Infra Red
ITU	International Telecommunications Union
LAN	Local Area Network
LDAP	Lightweight Directory Access Protocol
MAP	Mean Artery Pressure
MDD	Medical Device Directive
MF-TDMA	Multi-Frequency Time Division Multiple Access
MP3	Moving Picture Experts Group Layer-3 Audio file format
MPEG	Moving Picture Experts Group
NAT	Network Address Translation
OGG	open standard container format used to provide more efficient streaming and higher quality presentation
OSAS	Obstructive Sleep Apnoea Syndrome
PCMCIA	Personal Computer Memory Card International Association
POTS	Plain Old Telephone Service
PSTN	Public Switched Telephone Network
QCIF	CIF/2 : 176 × 144
QoL	Quality of Life

QoS	Quality of Service
RADSL	Rate-Adaptive Digital Subscriber Line
RCST	Return Channel Satellite Terminal
RTCP	Real-time Transport Control Protocol
RTP	Real Time Transport Protocol
SDSL	Symmetric Digital Subscriber Line
SIM	Subscriber Identity Module
SIT	Satellite Interactive Terminal
SLAM	Simultaneous Localization And Mapping
Speex	Lossy audio codec optimized for speech
TCP	Transmission Control Protocol
UDP	User Datagram Protocol
UMTS	Universal Mobile Telecommunications System
USB	Universal Serial Bus
VDSL	Very-high-data-rate Digital Subscriber Line
VOD	Video On Demand
VPN	Virtual Private Network
VSAT	Very Small Aperture Terminal
WAN	Wide Area Network
WAV	Waveform Audio File Format
WIFI	IEEE 802.11b wireless networking
WMV	Windows Media Video
xLAW	Standard compression algorithms : (1) µ-law (2) A-law

1. Introduction

The DOMEO scenarios include several actors and sites, namely the patient home, the caregiver office, the telemedicine center that require communication links implementation for data transmission. The distances and data rates vary from technology and place, but the solutions have to handle DOMEO needs by using standards based off the shelf equipment and network technologies that can easily be deployed. To be quickly and cost affordable to deploy the DOMEO system is determined to be necessary without the need for highly trained technicians.

This document introduces how integration has been performed to proceed with telecommunication technologies and system validation. A testbed has been set up at TOULOUSE hospital premises to validate equipement configuration and interconnection and to analyse how the system is running over the different network technologies, either 3G, DSL or satellite. The purpose of the testbed is to be as close as possible to real cases' implementation to investigate technical matters, to tune as well as optimize the trafic (whatever its type -data, video or audio) in order to secure the use of Robumate or Robuwalker.

Globally, the testbed aims at :

- Performing hardware components integration,
- Providing networking and hosting facilities to perform the planed industrial tests,
- Performing industrial validation, including as far as posisble QoS, networking and routing functions,
- Defining and realizing performance tests,
- Validating access to the DOMEO's services and operation before user deployment.

2. Overall system architecture

The DOMEO overall system architecture has been already illustrated as follow in Deliverable 6.1 "Telecommunication Overall System description".

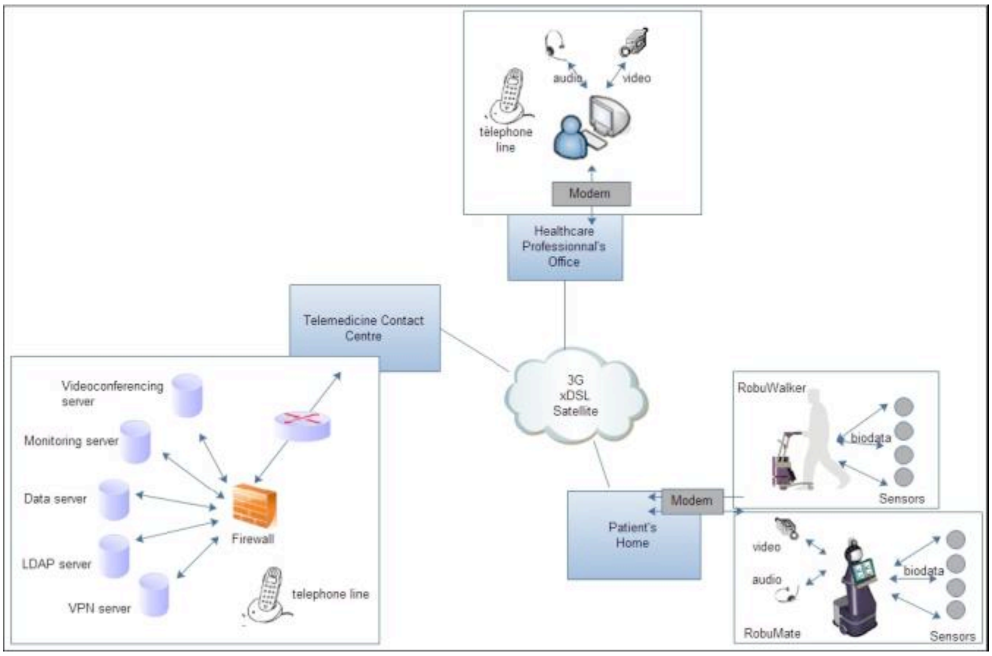


Figure 1 : DOMEO's Architecture

It is composed of four main componants, namely:

The patient's Home, which is the place where the robot and the modem are installed. The modem allows to connect the patient's home to the DOMEO telecommunication network: it interfaces on one side with the robot and local area network to collect the patient and home data and on the other side with the wide area network to transmit those data to the telemedicine center.

The Healthcare Professionnal office, which is the place from which the specialist will provide its diagnosis : it will connect to the Telemedicine contact centre to access to patient's data as well as with the patient's home to hold videoconferencing.

The telemedicine contact centre, which serves as the hub for medical parameters monitoring and disease management. Delivering patient support or medical information for healthcare professionals on the telephone requires the coordination of numerous tasks by telemedicine contact center operators (e.g. making and receiving calls, answering questions, filling in questionnaires, sending documentation). The answers must be given rapidly, whilst being personalized and adapted to the medical protocol of the program.

The telecommunication network, which is the piece of the architecture which allows to link the end-points to the telemedicine contact center. It can be split also in two subsystems: the local area network inside the patient home, and the wide area network, outside the patient home. Basically the LAN is based on Ethernet, WIFI, Bluetooth, IR technologies while the WAN is based on mobile (3G), terrestrial (xDSL) or satellite (DVB-RCS) technologies.

For DOMEO's project purposes, we have been setting up such architecture. According to the new DOW and project's updates, it has been agreed that patient's home trials will be rather replaced with laboratory tests. Then, equipement and devices are installed in order to realise the tests in laboratory and the architecture is kept as closed as possible to the patien's home architecture.

The healthcare giver office is installed in Toulouse at IET premises. A group of specialized health professionnals and general practitioners provides remote assistance to the elderly, by analysing the received patient's biomedical measurements, setting up real time audio/video communication and remotely controling the robot to get the right information from the patient and its environment.

Regarding the Telemedicine Contact Centre, the componants have been integrated from various partners facilities :

- The VPN and LOKARRIA servers are part of ROBOSOFT platform and allow remote command and monitoring of the Robot using a secured connection
- The videoconferencing server is part of Thales Alenia Space platform and allow live audio/video communication between the care giver and the patient's home
- The medical patient database is part of CHU Toulouse service provider

The DOMEO Telemedicine Contact Centre is then currently based on a distributed architecture but should be integrated for further DOMEO's operationnal and commercial use on a unique site.

The Figure 2 gives an overview of the deployed DOMEO testbed architecture whose subsystems will be described in Chapter 3.

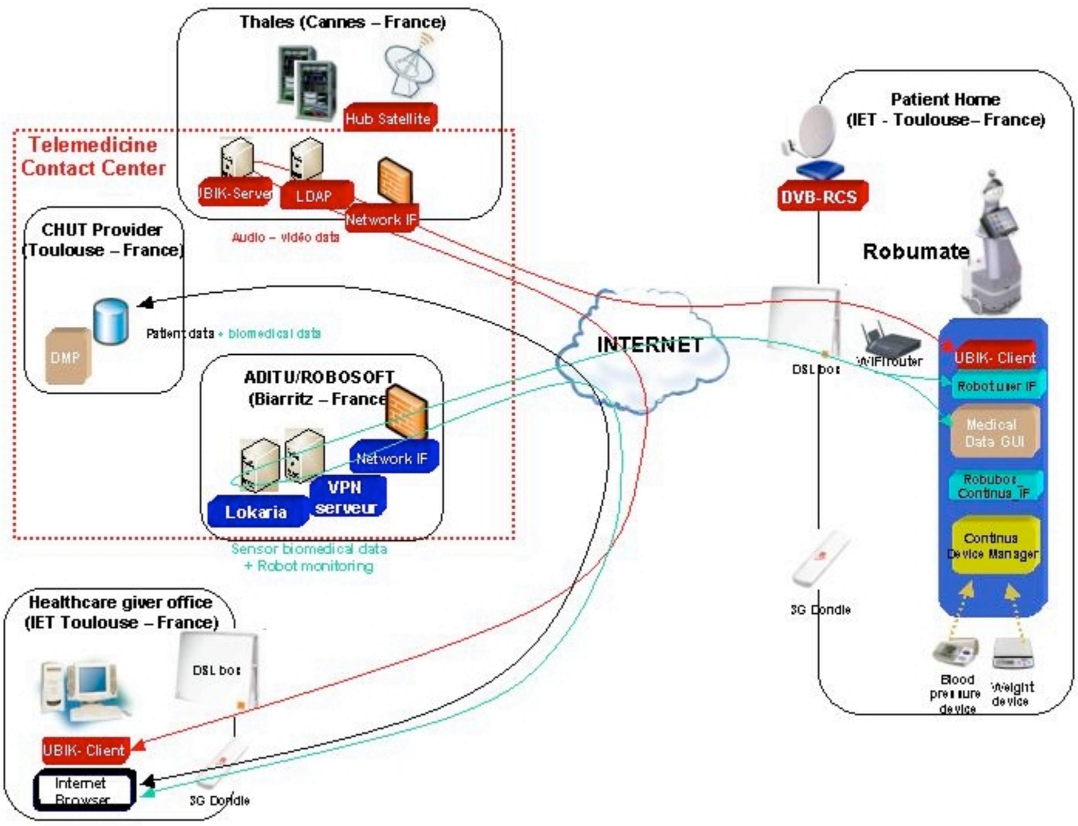


Figure 2: Implemented DOMEO test bed architecture

3. DOMEO SYSTEM's CONNECTIONS

This part provides detailled connection integration schemes and setting up procedures related to :

- the home place
- the telelemedIcine contact center
- the healthcare professional office

3.1. Home environment integration

Basicaly, the home environment includes the followings :

- the Robot (Robumate or Robutwalker)
- a WIFI router
- a modem : 3G, DSL or satellite modem that enables to link the elderly home to the telemedecine center, respectively through 3G, DSL or Satellite link.
- biomedical sensors

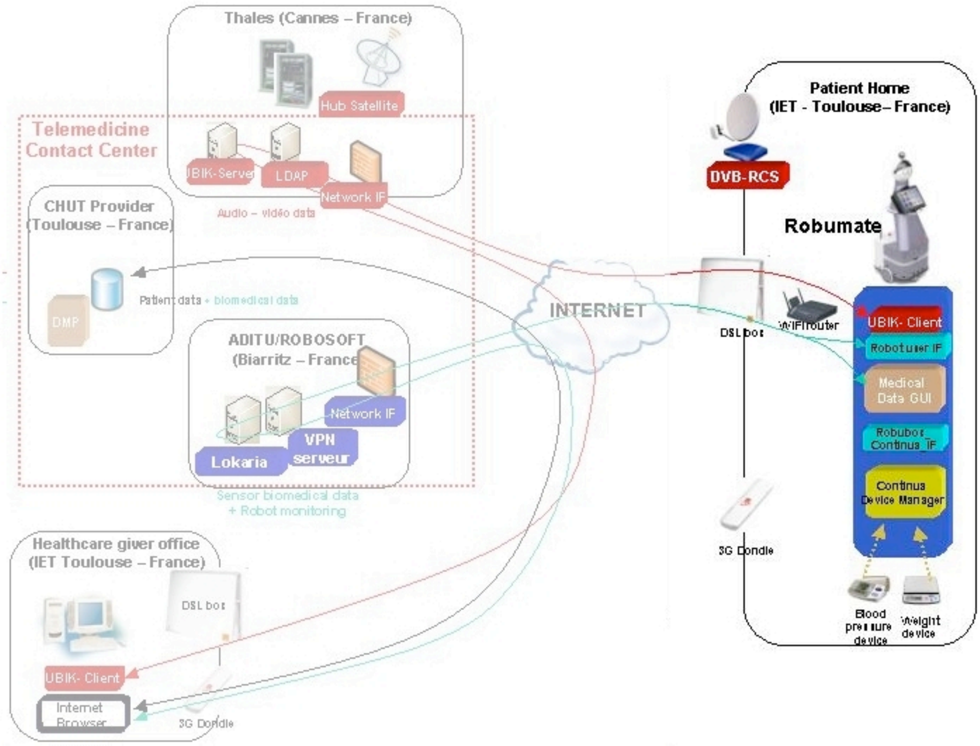


Figure 3 : Home environment

3.1.1. Home subsystems interconnection

The Robot integrates WIFI built-in data transmission capabilities to communicate with the local WIFI router installed in the room. This local WIFI router build then a wireless local network to which the Robot and modems shall be connected. It also integrates 3G data transmission capabilities according to the use of a 3G USB key.

Satellite Modem connection : The satellite modem is linked to the WIFI Router via a 100BASE-TX connection, which is the predominant form of Fast Ethernet running over two wire-pairs inside a category 5 or above cable. According to the media type designation, the transmission speed is 100 Mbit/s. The "BASE" refers to baseband signalling, which means that only Ethernet signals are carried on the medium.

DSL Modem connection : the DSL Modem is linked to the WIFI Router via a WIFI wireless connection. This modem is the usual one included in tripple-play offer of Internet services providers.

3G Modem connection : the 3G Modem is a USB dongle provided with the integrated WIFI router as described in next section. The dongle is plugged in an USB port of the router.

Biomedical sensors connection : biomedical sensors are linked via a Bluetooth wireless connection to the Robot to exchange data over short distances

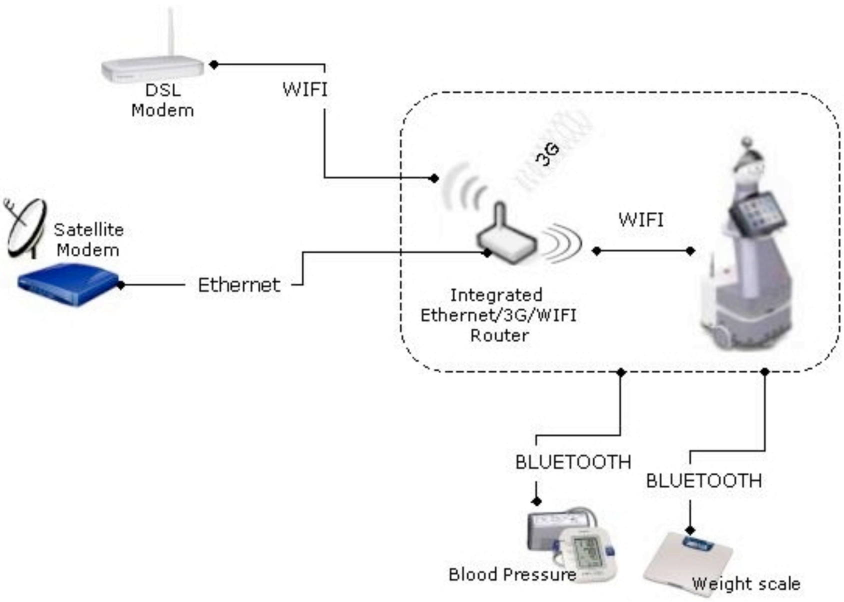


Figure 4 : Home environment connections

3.1.2. Integrated 3G/WIFI Router

The WIFI router plays a critical role within the home network architecture.

We are in the wireless age of digital communications. With wireless systems, it is possible to connect to a Local Area Networks (LAN), Wide Area Networks (WAN), and the Internet without the physical connection of wires like UTP cables for instance. The WIFI router is a device that perform the same functions of a normal router only wirelessly. It forwards data packets along networks and connects different networks (two LANS or WANs, LAN and WAN, or LAN and the internet) and acts as a gateway.

The WIFI router determines the best path for forwarding the data packets. When data is sent from one network to another, routers oversee this activity and direct the data packets to the correct location using the best path possible. With the wireless features, WIFI routers can carry out this basic function through radio signals alone.

Within the DOMEO's architecture, the WIFI router helps the robot to connect to the modem (DSL, 3G or satellite modem), then to an existing network (Internet, Mobile or Satellite network).

3.1.2.a. WIFI Router's description

The integrated WIFI router is namely the **HUAWEI WIFI/3G D 100 router.** This router provides the full set of Robumate required connections : Ethernet to connect to the satellite modem, WIFI to connect to the ADSL modem and to the Robot as well as 3G with the possibility of inserting in top a standard 3G USB dongle. The dongle permits the sharing of 3G broadband with any device in the area.

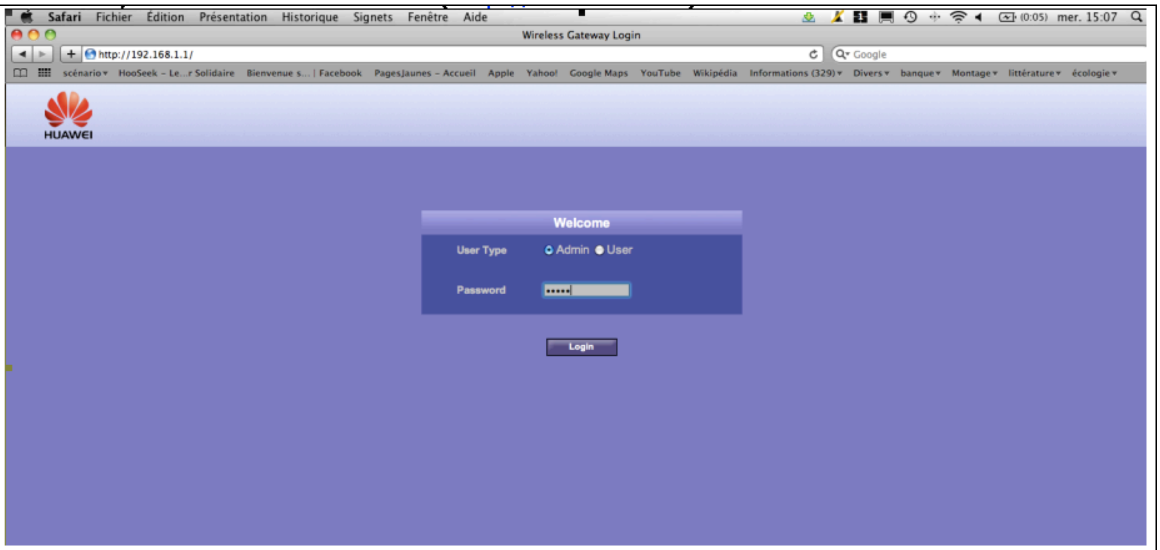
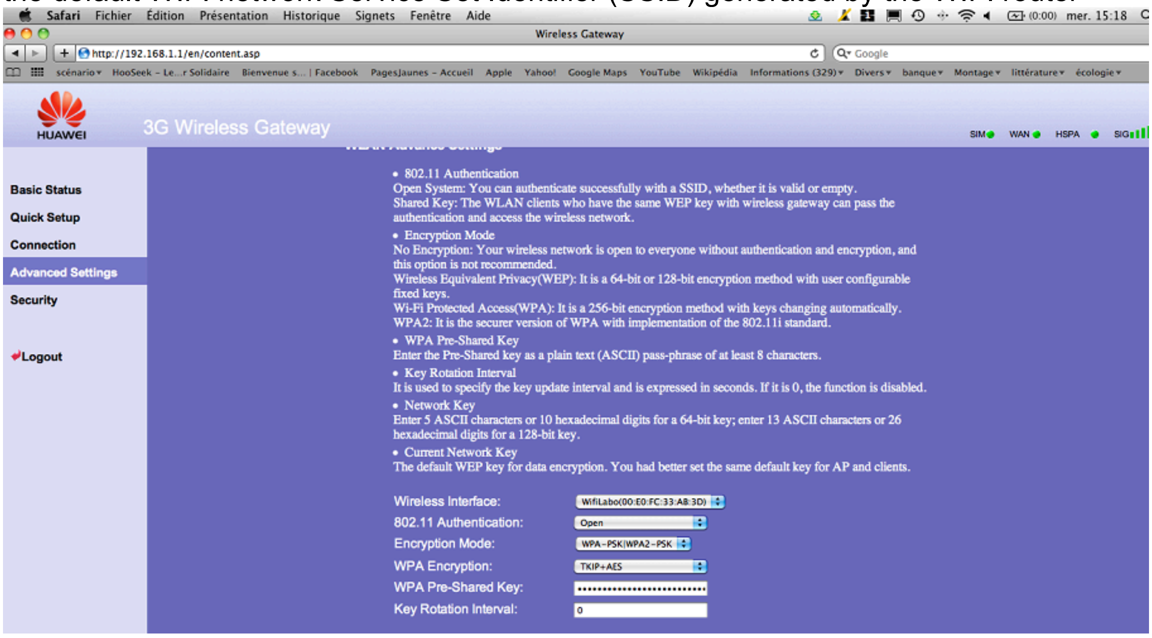
Router's Specifications :

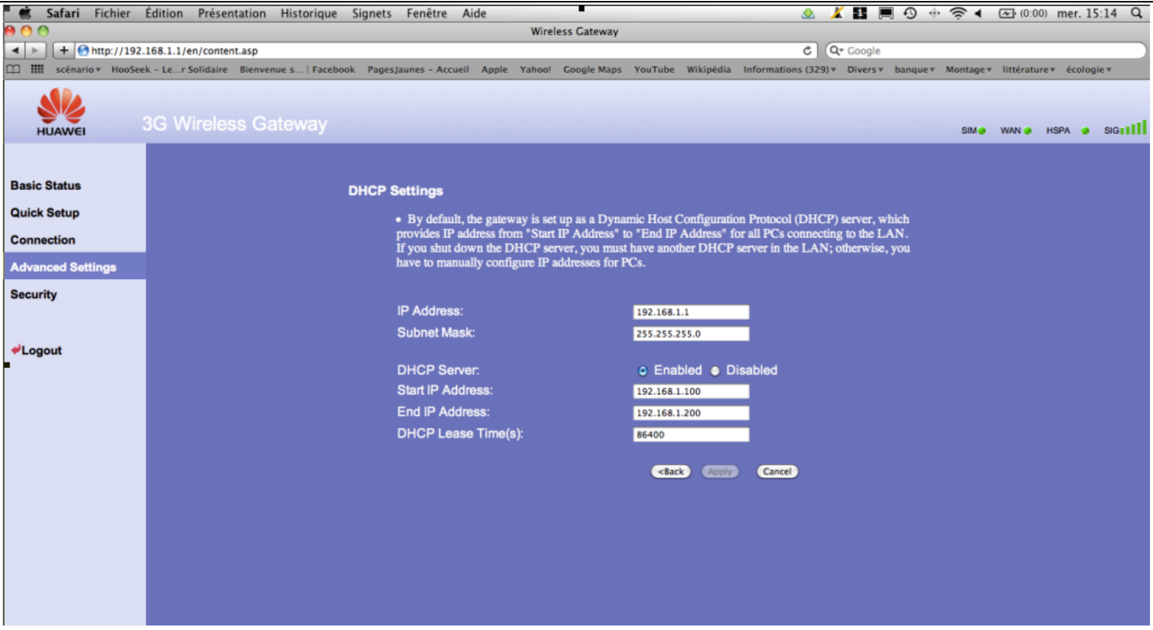
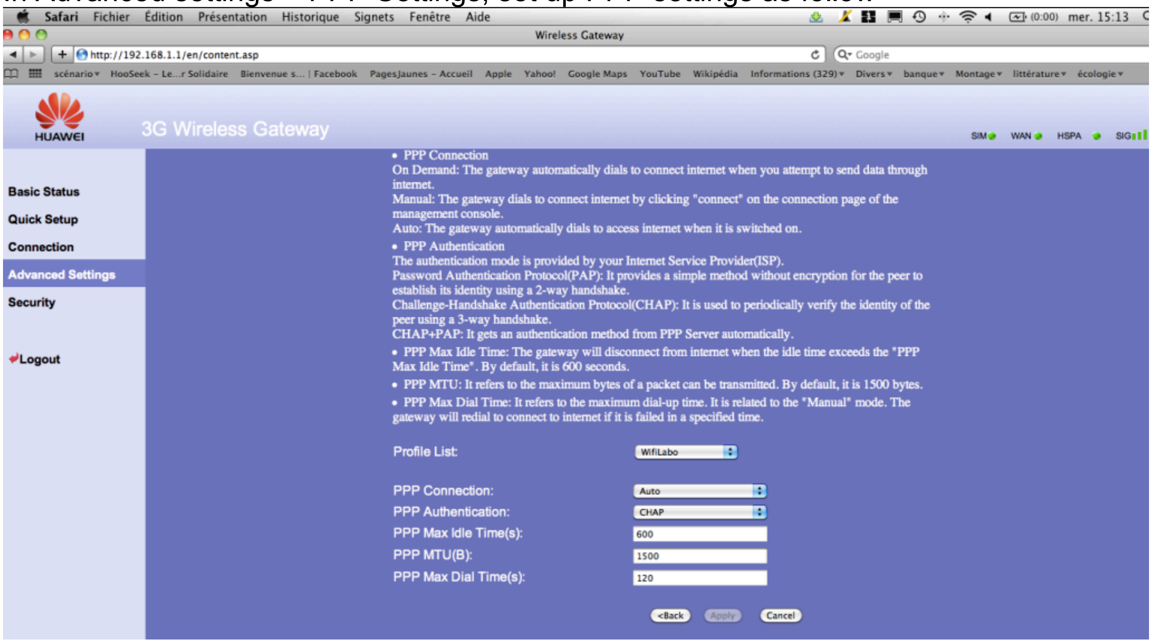
Special Features	Compatible with Huawei USB Modems Supports Multi-users Supports Wi-Fi speed rates of up to 54Mbps Supports RJ45: One LAN/WAN convertible port
Device Type	Wireless Router
Interface	RJ-45 USB for 3G
Ports	1 x RJ-45 1x USB for 3G
Standards	IEEE 802.11g IEEE 802.11b IEEE 802.3 10BaseT IEEE 802.3u 100BaseTX
Transfer Rate	10Mbps 11Mbps 54Mbps 100Mbps
Network Architecture Types	Infrastructure
Antenna Type	Built-In
LED indicators	1 x Power 1 x WLAN 1 x Mode 1 x Signal

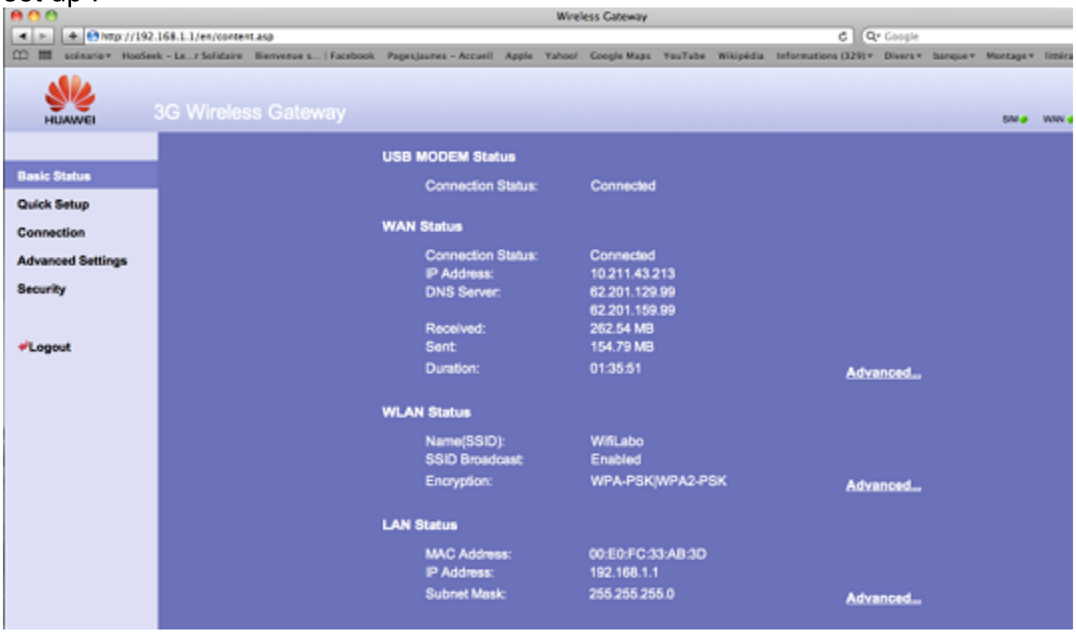
3.1.2.b. **Setting up the WIFI Router's**

In order to proceed with the DOMEO technical integration and connection validation, it is necessary to set up properly the WIFI router's settings according to the following procedure.

STEP	PRODECURE
1	Connect to the router at http://192.168.1.1 using a web browser

<table>
<tr><td></td><td>
</td></tr>
<tr><td>2</td><td>Check in Advanced settings > WLAN settings > WLAN Basic settings, that “WIFILabo” is the default WIFI network Service Set Identifier (SSID) generated by the WIFI router

</td></tr>
<tr><td>3</td><td>Verify in Advanced settings > DHCP Settings that the DHCP settings goes from 192.168.1.100 to 192.168.1.200</td></tr>
</table>

	
4	In Advanced settings > PPP Settings, set up PPP settings as follow 
5	In Advanced settings > DHCP Settings, set up the LAN IP addresses according to the WAN access network technology : For ADSL > IP : 192.168.1.10 Msk : 255.255.255.240 Gw : 192.168.1.1 For 3G > IP : 192.168.1.1 Msk : 255.255.255.0 For Satellite > IP : 192.168.1.1 Msk : 255.255.255.0
6	In Advandced settings > WLAN Settings > WAN Basic Settings, set up the IP route according to the WAN access network technology : For ADSL > No route For 3G > No route For Satellite > Subnet: 10.0.11.0 Msk: 255.255.255.0 Gw: 192.168.1.20

7	In Advandced settings > WLAN Bridge, set up the WAN IP addresses according to the WAN access network technology : For ADSL > No need to set up WAN parameters. Only LAN parameters are used For ADSL, the WIFI router will only serve as a relay to the DSL modem which will be in charge of the IP address translation from LAN to WAN. For 3G > No need to set up WAN parameters. Default 3G WAN IP 10.211.43.21 is used When Robumate is connected through the 3G network, WIFI router will perform the IP address translation toward the 3G network automatically since the 3G dongle is plugged into the WIFI Router. For Satellite > IP : 10.10.172.146 Msk : 255.255.255.240 Gw : 10.10.172.145 In Satellite mode, the WIFI router will accomplish the IP address translation toward the satellite network (into 10.10.172.x). Moreover a static route is added to route the IP adress from the LAN network to the Satellite networok.
8	Finally, in Basic Status, review the main router settings and check that they are properly set up :  Note : USB Modem status refers to the 3G connection status

3.1.3. Robumate

Robumate is a companion-robot with support functions (reminder, games), communication facilitation function (videoconferencing with telemedicine standards if required) and a security function (embedded-visual and videoconferencing link to a telealarm operator for appropriate reaction). The operation of Robumate is transparent to the user. Robumate is intent to be part of a service package including a remote operator providing homecare support and coordinating access to telemedicine.

3.1.3.a. Robumate hardware architecture

As illustrated in Figure 7, regarding the telecommunication part, Robumate includes :

- A Tablet PC
- A WifiCard
- An IP camera
- A PC CE card (Robot controller)

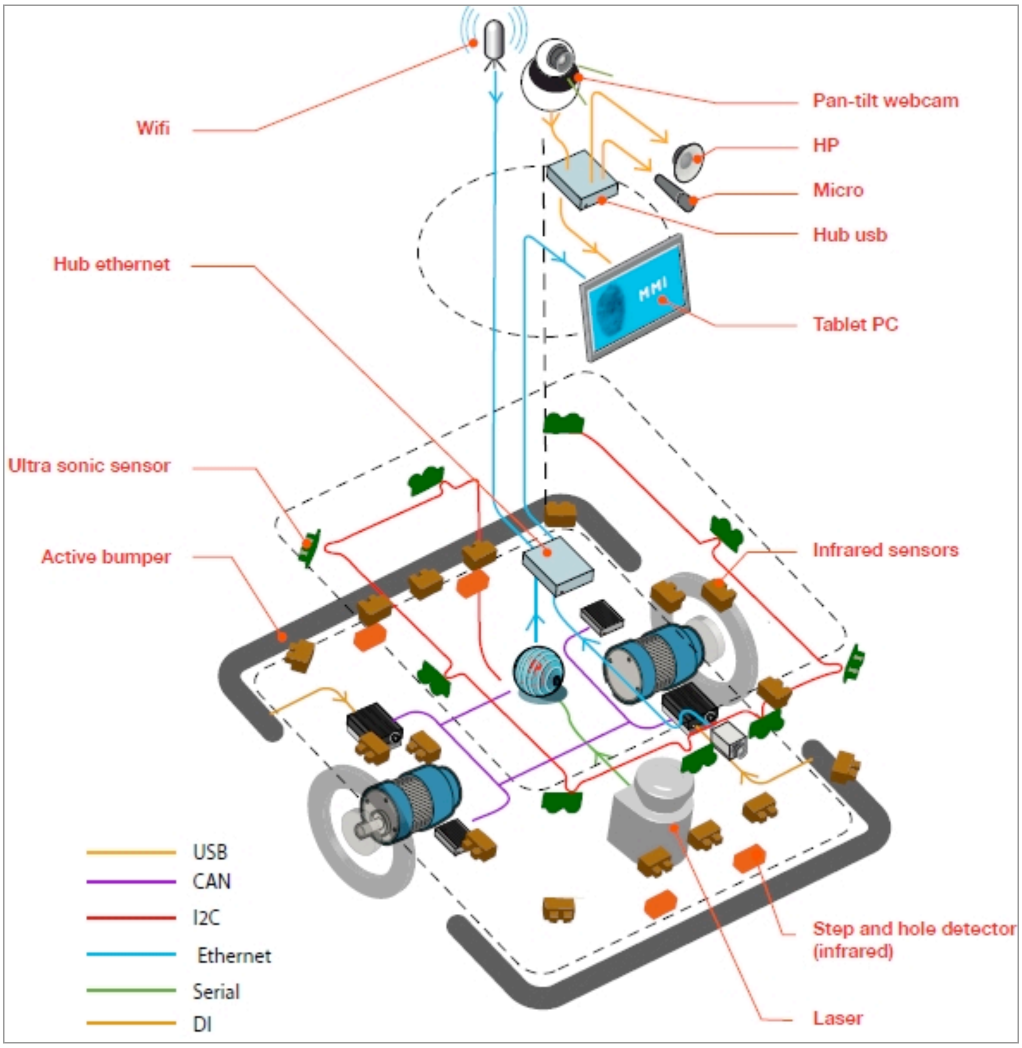


Figure 5 : Robumate Hardware architecture

3.1.3.b. **Robumate software architecture**

The aim of this section is to remind the Robumate main software componants to understand the data telecommunication issues adressed in the next chapter.

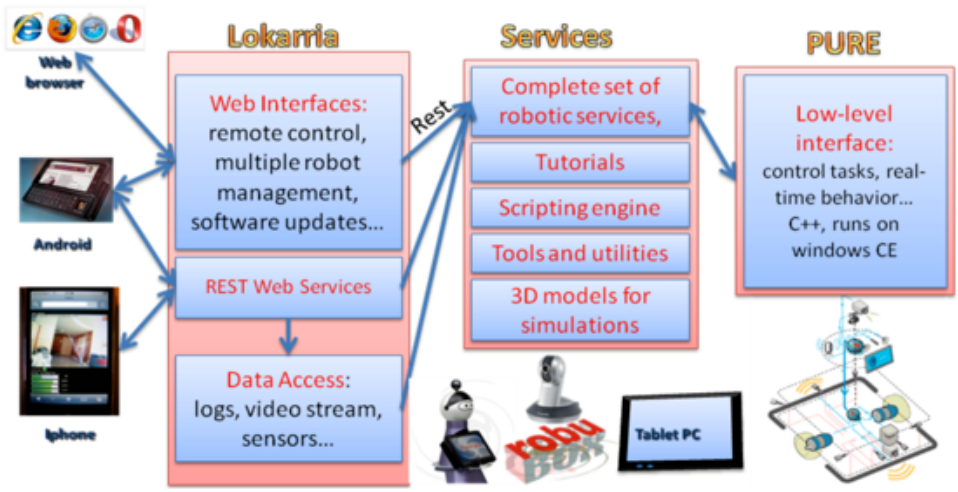


Figure 6 : Robumate software architecture

PURE is built on the windows CE real time operating system and is in charge of the low level control tasks (feedback control loops + state machines).
PURE has the following features:

- Supports commonly used hardware in Robotics (CAN, I2C, RS232/422, TCP/IP, USB)
- Executes low level control tasks. (feedback control loops + state machines),
- Exhibits real time behavior, with respect to Robosoft applications (this has been fixed to 10 milliseconds, +/- 10%),
- Exposes different interfaces to meet most of Robosoft customers needs.

LOKARRIA is a suite of software services that provides remote access to robots over the Internet. It is also a web interface for managing robots: remote control with video and sensor feedback, monitoring (logs and alerts), updating robot software.

The **Tablet PC** hosts the end users applications :

- UBIK client for the videoconferencing
- Robot user interface that enables the user to access to all services
- Medical data GUI which shall present the health measurements
- Robubox Continua Interface (IF) which shall interface the Continua device manager with the Robot user interface

Continua Device manager in charge of health data mesurement through bluetooth (Blood pressure device and weight device)

The tablet PC allows the end-user to access to the aplications. From the tablet PC interface, the elderly can interact with the Robot and make measurement of its vital signs. From the tablet PC as well, the elderly can start a videoconferencing session with the healthcare giver. The IP Camera (Web Pan-Tilt camera) transmits the image of the user.

3.1.3.c. Robumate IP configuration

Each of the componants has got its own IP settings according to the DOMEO expected tests. Some parameter (noted x) depends on the telecommunication technology : 3G, satellite or DSL.

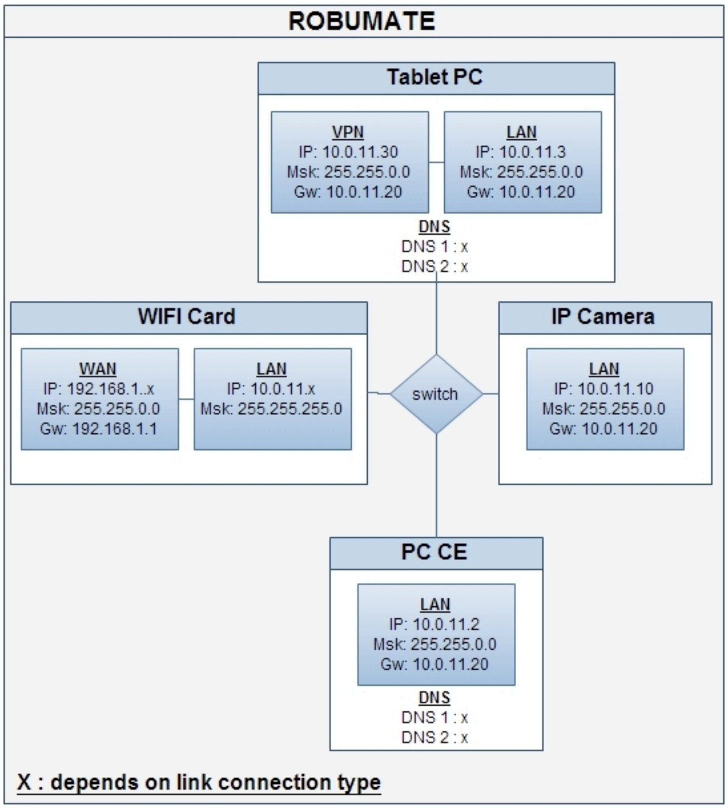


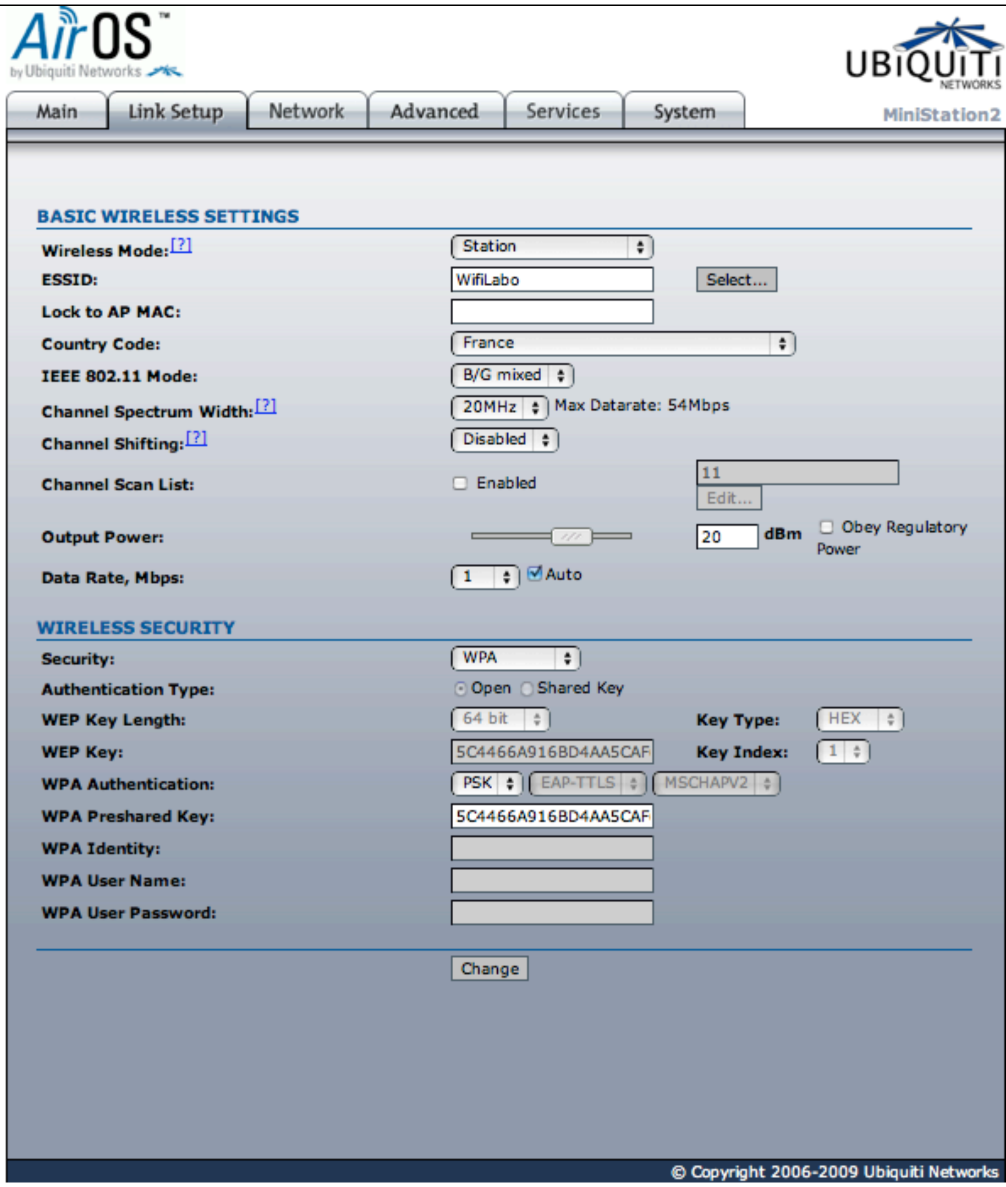
Figure 7 : Robumate IP configuration

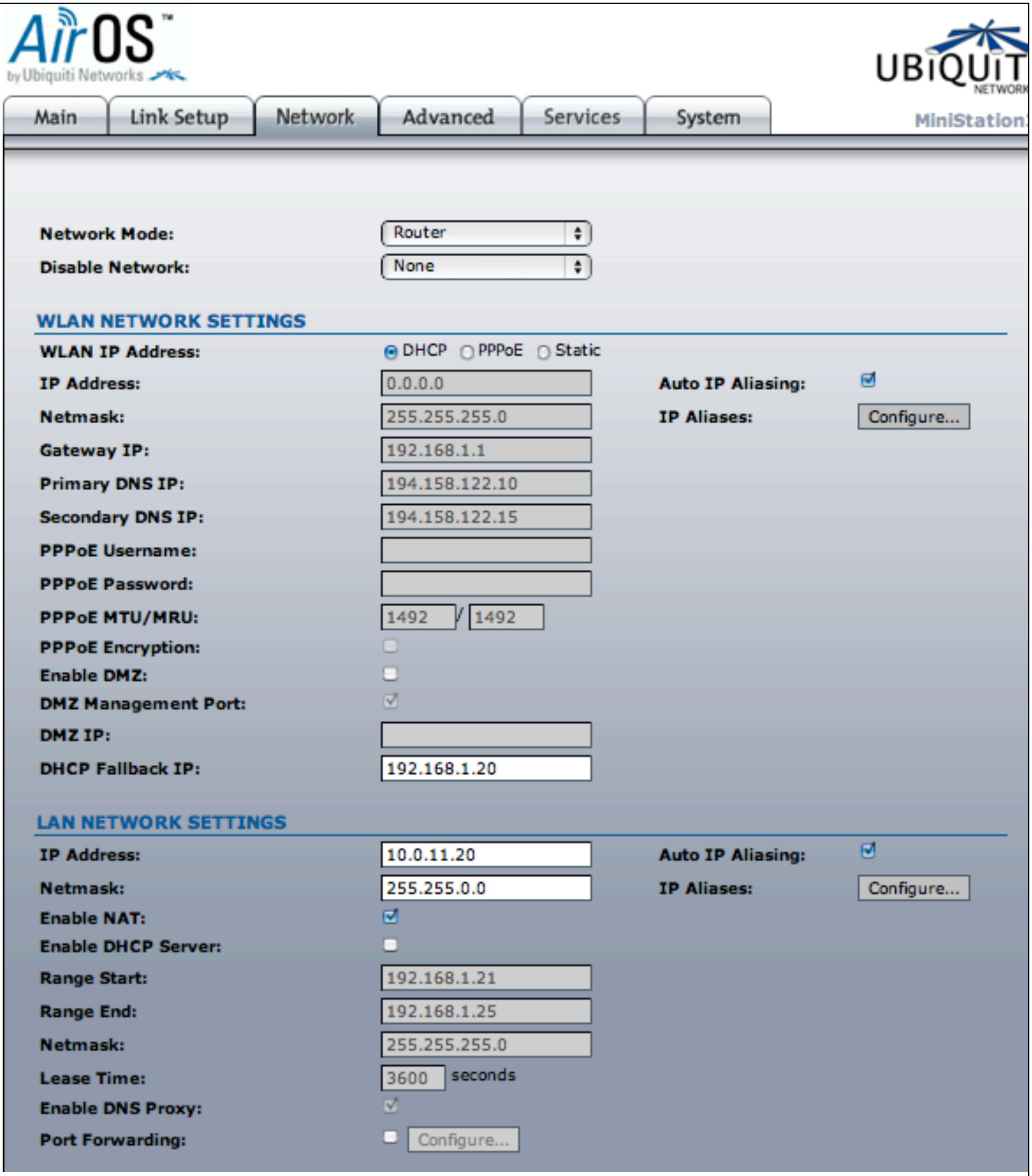
The following section provides the procedure to set up the right parameters for each of the componants.

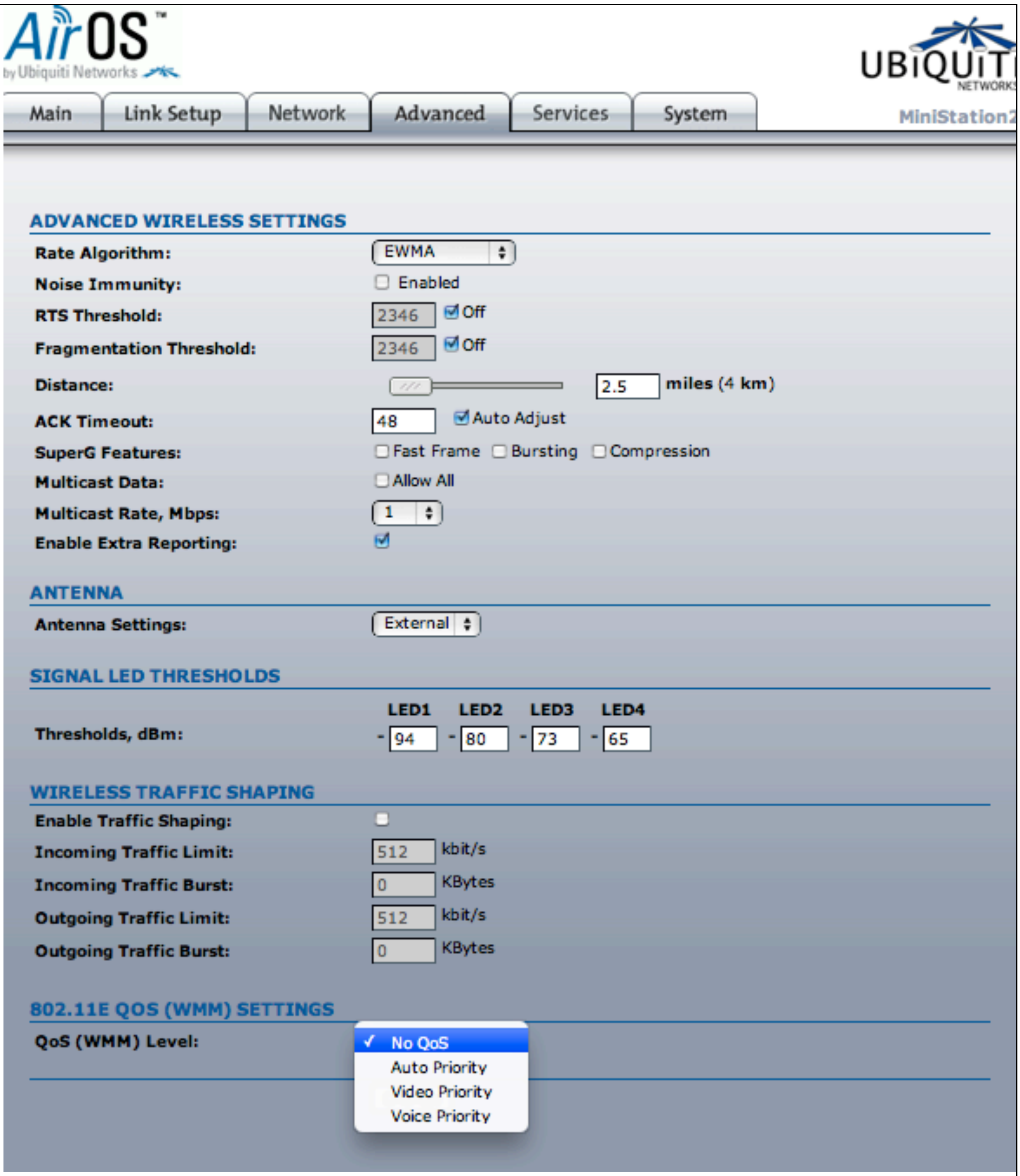
3.1.4. Robumate WIFI card set up

The WIFI Card acts as a router that link a subnet (Robumate Tablet-PC, IP camera and CE card) to the Internet using VPN secured connections.

#	PROCEDURE
1	Connect a PC to the WIFI router, open a web browser and enter in adress bar: http://192.168.1.20 (default address)
2	Enter username and password. By default: ubnt, ubnt.
3	In the Link Setup tab - set Wireless Mode to: Station - set ESSID to: WifiLabo

	
4	In the Network tab, enter the following parameters to set up the WIFI Card as a router • Network Mode: Router. • Disable Network: None. • Specify the WLAN NETWORK SETTINGS to connect to your access point WIFI-Router in DHCP mode or as follows : - IP address : 192.168.1.102 - NetMask : 255.255.0.0 - Gateway : 192.168.1.1 (WIFI Router) - • Specify LAN NETWORK as follows : - IP Address: 10.0.11.20 - NetMask : 255.255.0.0. - Check "ENABLE NAT".

	
5	In Advanced tab, make sure No Qos is set :



NOTE : QoS will ne adjusted during the transmission validation and performance tests phase.

3.1.5. Setting up the PC CE card (PURE CONTROLLER)

The PC CE is the Robot controller system, also called the Pure controller. It should already be configured.
The IP settings of the PURE controller can be changed through a command line utility program installed on the controller. The instructions given here assume that it is achieved from a Windows based computer equipped with TELNET utility.

#	PROCEDURE
1	Open a a telnet session. For this, open a command prompt. ("Start Menu > Run", then enter "cmd" and click "Ok"). At the prompt, type the following command: telnet 192.168.1.2
2	• Use the ***netcfg.exe*** utility In the telnet session, type the following command to change the address to 10.0.11.2, with a gateway address 10.0.11.20: netcfg 10.0.11.2 255.255.0.0 10.0.11.20 After a few seconds, you will get a confirmation message.
3	You can now reboot the controller to have the changes taken effect. This can be done either by powering off and on the controller or by using the following telnet command: devctl reboot ***Warning: Once the IP settings have been changed, modify robuBOX PURE server configuration file from Tablet-PC (store\UDPTransport.config.xml) with the new CE card IP address.*** This configuration file specifies to robuBOX applications the location of the pure UDP server. If you don't change it, robuBOX will not be able to connect to PURE.

3.1.6. Setting up the IP Camera

The IP Network Camera with its functional and smart design offer a high quality yet affordable video surveillance solution. Using progressive scan technology, the camera provide VGA or HDTV (AXIS M1054) images of moving objects without motion blur.
Multiple H.264 and Motion JPEG streams can be provided simultaneously, individually optimized for different quality needs and bandwidth constraints.
The IP camera is designed for easy and flexible installation. It offers the choice of either a wireless or a wired connection to the network.
The IP camera may integrate a PIR sensor for detecting movement even in the dark, and a white LED for illuminating the scene at an event. It provides a two-way audio support with built-in microphone and speaker, allowing remote listening in an area, as well as communication with individuals directly or using uploaded or recorded audio clips.

	PROCEDURE
1	From the Tablet PC, open a web browser and enter http://192.168.1.10 Enter username and password Username:root Password :root
2	Change IP setting with the following: • Address: 10.0.11.10 • Mask: 255.255.0.0

	• Gateway: 10.0.11.20
3	*Warning: Once the IP settings have been changed, modify robuBOX configuration file from Tablet-PC (store\applications\robulab\monitoring\AxisCameraViewer.config.xml) with the new camera IP address.* This configuration file specifies the camera IP address in monitoring application.

3.1.7. Set up the Tablet-PC

The Tablet PC is a high-performance system designed with intuitive input capabilities including a capacitive multitouch screen and pen. With just a stroke of your fingertips, it is possible to :

- Scroll through large Web pages
- Zoom in on graphics, photos or online maps
- Enlarge e-mails to aid reading
- Close your screen
- Collaborate in real time

The Tablet PC allows to run the DOMEO end-users applications assuming that a VPN connection has been previously set up. The following procedure describes how to set up the VPN connection before running applications, which will be later described.

1	Install and configure OpenVPN (if not done)
2	Install OpenVPN.
3	Copy the authentification files into your OpenVPN\config directory
4	Create a file name config.ovpn in OpenVPN\config directory which contains: client remote 85.31.147.134 1195 proto udp dev tap resolv-retry infinite nobind ca "OpenVPN directory\\config\\ca.crt" cert "OpenVPN directory\\config\\clientname.crt" key "OpenVPN directory\\config\\clientname.key" comp-lzo persist-key persist-tun verb 3
5	Delete all tap* interfaces: launch OpenVPN directory\\bin\\deltapall.exe **TAPs** are virtual network kernel drivers. They implement network devices that are supported entirely in software, which is different from ordinary network devices that are backed up by hardware network adapter.**TAP** simulates an Ethernet device.
6	Create a tap interface: launch OpenVPN directory\\bin\\addtap.exe
7	Configure your tap to obtain automatic IP address (the tap interface is a network interface).
	Change IP settings
8	Set the following IP settings into your tablet-PC: • Address: 10.0.11.3

	• Mask: 255.255.0.0 • Gateway: 10.0.11.20 (Wifi Card)
9	Set DNS depending on the link : | | DSL | 3G | Satellite | | Primary DNS | From DSL Provider | 62.201.129.95 | 192.168.29.1 | | Secondary DNS | From DSL Provider | 62.201.129.95 | 193.48.73.2 | DNS are important to be able to access to Internet and communicate with Lokarria and UBIK server
10	Bridge Tap interface with main LAN interface
11	Select the two interface (ctrl + click), rigth-click and select: "Bridge".
12	Configure bridge with following IP settings: - IP Address: 10.0.X.30 - NetMask: 255.255.0.0 - Gateway: 10.0.X.20
13	Set DNS depending on the link : | | DSL | 3G | Satellite | | Primary DNS | From DSL Provider | 62.201.129.95 | 192.168.29.1 | | Secondary DNS | From DSL Provider | 62.201.129.95 | 193.48.73.2 | DNS are important to be able to access to Internet and communicate with Lokarria and UBIK server

3.1.8. **Set up the modem**

The modems carry out many tasks. While modems minimize the errors that occur while the transmission of signals, they also have the functionality of compressing the data sent via signals.

Modems also do the very important task of regulating the information sent over a network :
Error Correction: In this process the modem checks if the information they receive is undamaged. The modems involved in error correction divide the information into packets called frames. Before sending this information, the modems tag each of the frames with checksums. Checksum is a method of checking redundancy in the data present on the computer. The modems that receive the information, verify if the information matches with checksums, sent by the error-correcting modem. If it fails to match with the checksum, the information is sent back.

Compressing the Data: For compressing the data, it is sent together in many bits. The bits are grouped together by the modem, in order to compress them.

Flow Control: Different modems vary in their speed of sending signals. Thus, it creates problems in receiving the signals if either one of the modems is slow. In the flow control mechanism, the slower modem signals the faster one to pause, by sending a 'character'. When it is ready to catch up with the faster modem, a different character is sent, which in turn resumes the flow of signals.

Depending on the technology tested in the frame of the DOMEO project laboratoty tests, three types of modem can be used :

- satellite modem
- 3G modem

- DSL modem

3.1.8.a. Satellite Modem and related devices

The satellite modem, also called IDU (In-Door Unit), provides a data interface over the broadband interactive satellite system for network access, interfacing between the Antenna (ODU : Outdoor Unit) and the Wifi-Router. It exchanges IF and other signals with the ODU via the IFL, and IP traffic over Ethernet with the Wifi-Router. The following are some of the key features of the IDU:

- Set-top box based design,
- Over-the-air or Internet software download capability,
- Automatic acquisition of the Forward Link signaling and traffic,
- Automatic acquisition of the Return Link signaling (when feature is enabled),
- Standard-based compliant receiver to receive TDM traffic from the gateway (i.e., Forward Link),
- Remote and local control capability through SNMP,
- Transmit traffic at variable Return Link burst rates from a burst time plan transmitted from the gateway (i.e., on the Forward Link),
- Process real-time traffic.

Figure 8 : The Satellite modem

Typical characteristics of the satellite modem are described in the following table:

Model	EMS 5100
SW release	4002. R03
Guaranteed bandwidth	512 Kbps
Best effort bandwidth	2 Mbps
TX frequency (Hz)	141985000
RX frequency (Hz)	12580735

Combined with the IDU, the ODU contains the RF portions of the ST and is located outdoors. The ODU is composed of the antenna system and transceiver system and provides the following functionality :

- Reception of Ku-band down-link signals from a satellite,
- Amplification and down-conversion of received signal to L-band,
- Up-conversion and amplification of transmit signal, and
- Transmissions of transmit signal.

The transceiver can be either a 1W or 2W output version. The antenna size is basically 1.2m.
The transceiver consists of the following components :

- Ku-Band BUC (Transmitter),
- Ku-Band LNB.

The transceiver interfaces with the OMT/transmit reject filter assembly of the antenna system. The transceiver is connected to the IDU via the IFL. The IDU provides the transmit IF, a 10 MHz frequency reference and DC power to the BUC on a single co-axial cable. The IDU monitors the BUC current to determine the health of the BUC. The IDU provides DC power to the LNB via the receive cable.

The antenna system provides the following functionality:

- Transmit and receive air interface,
- Superstructure for mounting the transceiver,
- Means of adjusting,
- Means to accurately point the antenna.

The Antenna System is made up of the following components:

- Main reflector,
- 12/14 GHz feed horn,
- 12/14 GHz OMT,
- Transmit Reject Filter,
- Bracket to mount the transceiver,
- Antenna mounting superstructure,
- Azimuth/Elevation pointing mechanism,
- Pole Mount Mast (Mast not included).

The antenna system provides a means to support the transceiver and allow for polarization adjustment. Approximately +/- 45 degrees of fine adjustment is required at each setting. The Pole Mast Mount allows the antenna to be mounted on a wall or ground area.
Users site upload bandwidth's per antenna size:

The ODU, antenna, is a Type 123 1.2m LFL Antenna from Channel Master. This is the Outdoor Unit of the system.
The antenna alignment parameters are :

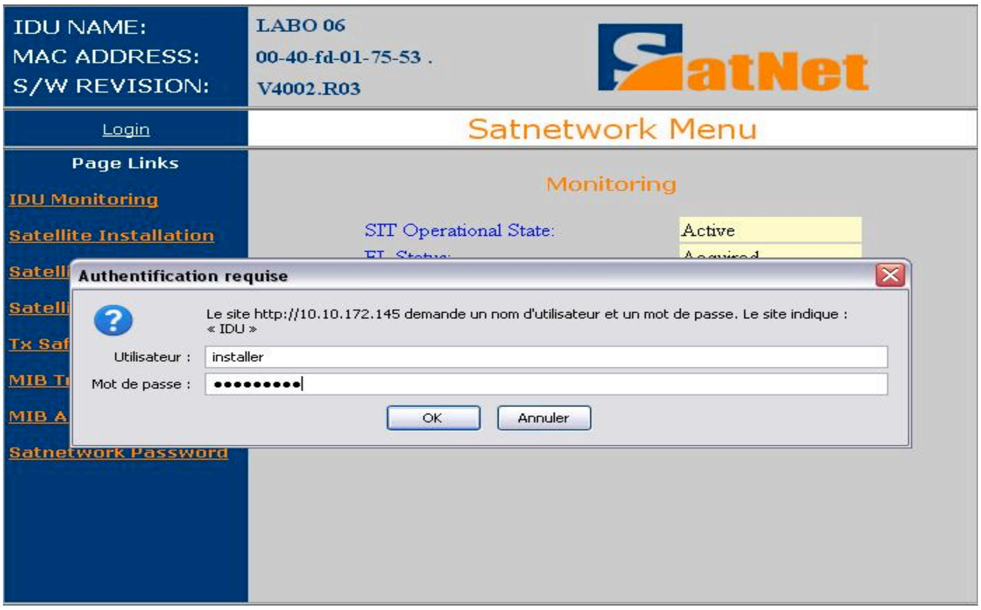
- Frequency: 12585 MHz
- FEC: 7/8
- Rate: 1,5 M Symbols / s
- Polarisation: Vertical Linear
- BUC: 2W
- Satellite: Eutelsat AB1 at 12,5 degre West / Elevation : 39 degrés

Figure 9 : Antenna installed at Toulouse hospital

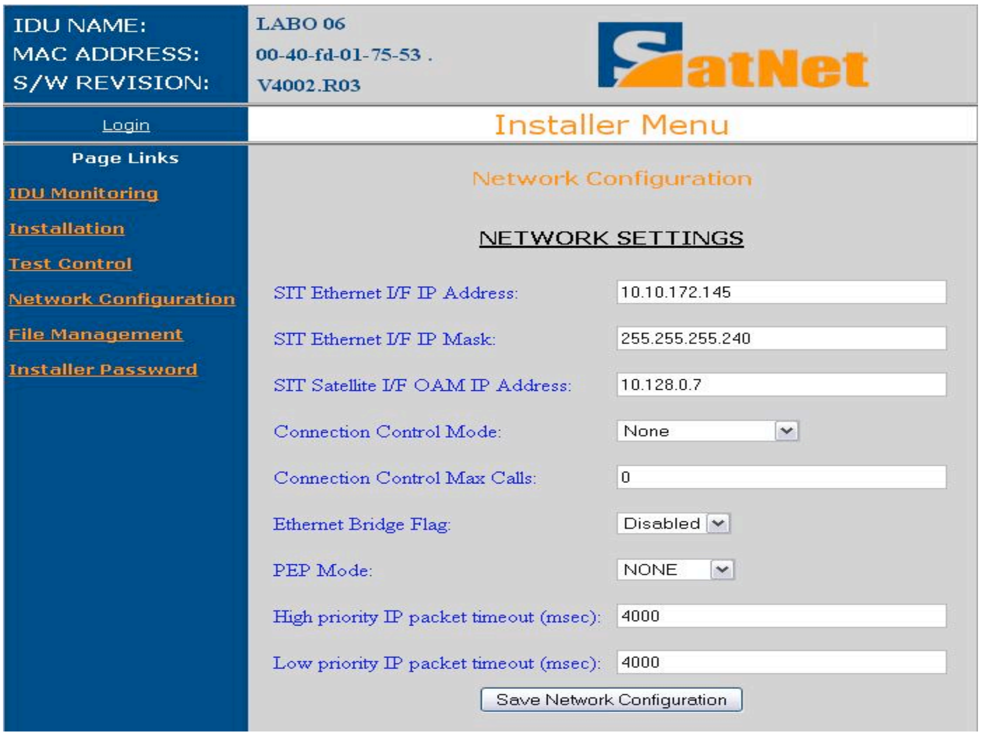
The IDU and the ODU installed at IET premises is the transparent DVB-RCS satellite terminal that is used to access to the Thales satellite DVB-RCS network.

To set up properly the satellite modem parameters, proceed as described in the following procedure :

<table>
<tr><td>1</td><td>Connect a PC to the satellite modem, open a web browser and enter in adress bar: http://10.10.10.10 (default address)</td></tr>
<tr><td>2</td><td>Enter the requested username and password. By default: installer, ins001pwd



</td></tr>
<tr><td>3</td><td>In Network Configuration Menu, set up the IP parameters as follows :



Note : The OAM IP address is the WAN address on the satellite network.</td></tr>
<tr><td>4</td><td>Connect the satellite modem to the WIFI Router</td></tr>
</table>

3.1.8.b. **DSL Modem**

The DSL modem is the one delivered by the Internet Service Provider and installed at elderly's premises. The configuration is very simple and already set up according to the Internet Service Provider rules. The only point is to check that the LAN IP address and UpNP parameters are properly set up.

Typical characteristics of the DSL modem are summerized in the following table:

Model	Livebox 2
Dowload bandwidth	Up to 20 Mbps
Upload bandwidth	Up to 1 Mbps
Connections	RJ 11 (WAN) RJ 45 (LAN) 4 Ethernet port

To set up properly the DSL modem parameters, proceed as described in the following procedure :

1	Connect a PC to the DSL modem, open a web browser and enter in adress bar: http://192.168.1.1 (default address)
2	Enter requested user and password. By default: admin, admin
3	In the LAN configuration tab, make sure that the following LAN IP Address is properly set up: IP adress : 192.168.1.1 Mask : 255.255.255.0
4	In Advanced tab, make sure UpnP protocol is activated.

3.1.8.c. **3G Modem**

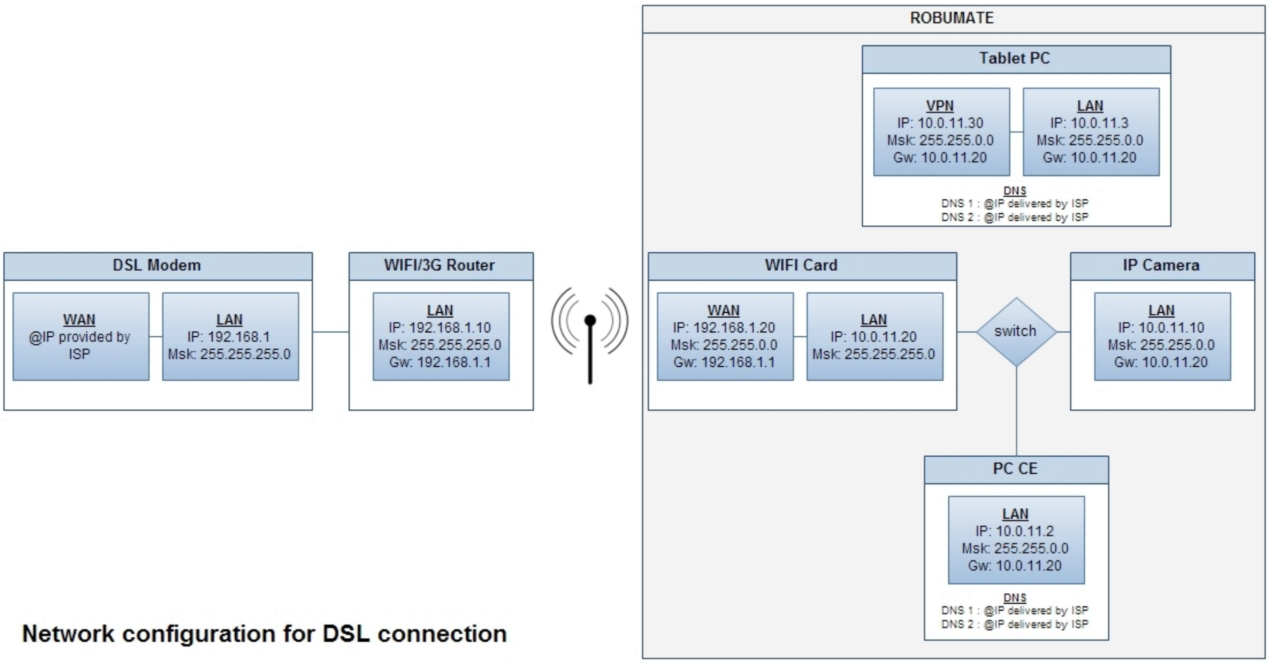
A 3G USB dongle is a portable device that attaches to a USB port to enable a PC to connect to 3G networks. The Huawei D100 WIFI router allows the connection of such standard 3G USB dongle to share the 3G broadband connection with any other device in the room or patient's home. In that way, any data or information is sent/received to/from the Telemedicine Centre or Caregiver Office via the 3G mobile network available in the area.

Technology	UMTS/EDGE/GPRS/GSM
Down link bandwith	7,2 Mbps
Up link bandwith	2 Mbps HSDPA for the link optimisation between 800 K and 1,4 Mbps
WAN	10.211.43.213

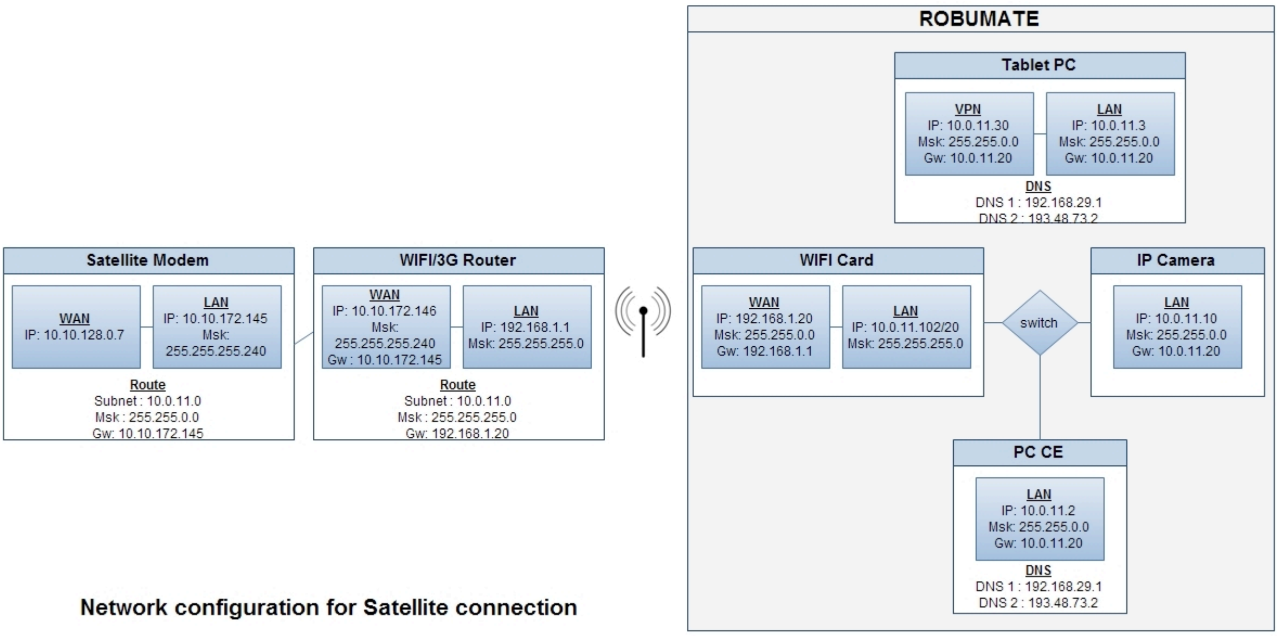
There is no specific configuration procedure as for satellite or DSL modem, just to plug the 3G dongle into the WIFI-Router installed at elderly's home.

3.1.9. **Home network configuration synthesis**

Figure 10 summarizes the IP network configuration according to the telecommunication technology :



Network configuration for DSL connection



Network configuration for Satellite connection

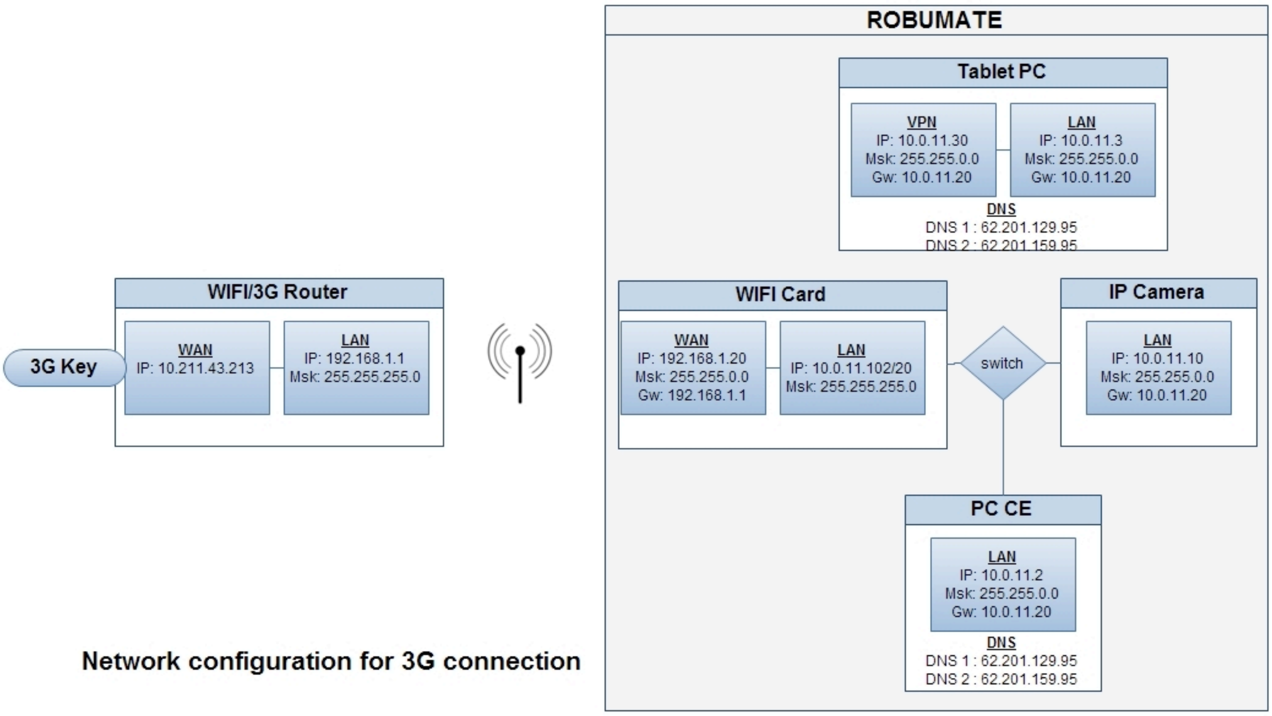


Figure 10 : Synthesis of IP configurations

3.2. **Telemedecine Contact Center connection integration**

As previously explained, the telemedecine contact center gathers componants from Thales Alenia Space, ROBOSOFT and CHU-Toulouse platforms.

This includes servers and all required network infrastructure to guarantee the correct and secured data transmission between patient home, telemedicine center and medical professionnal office.

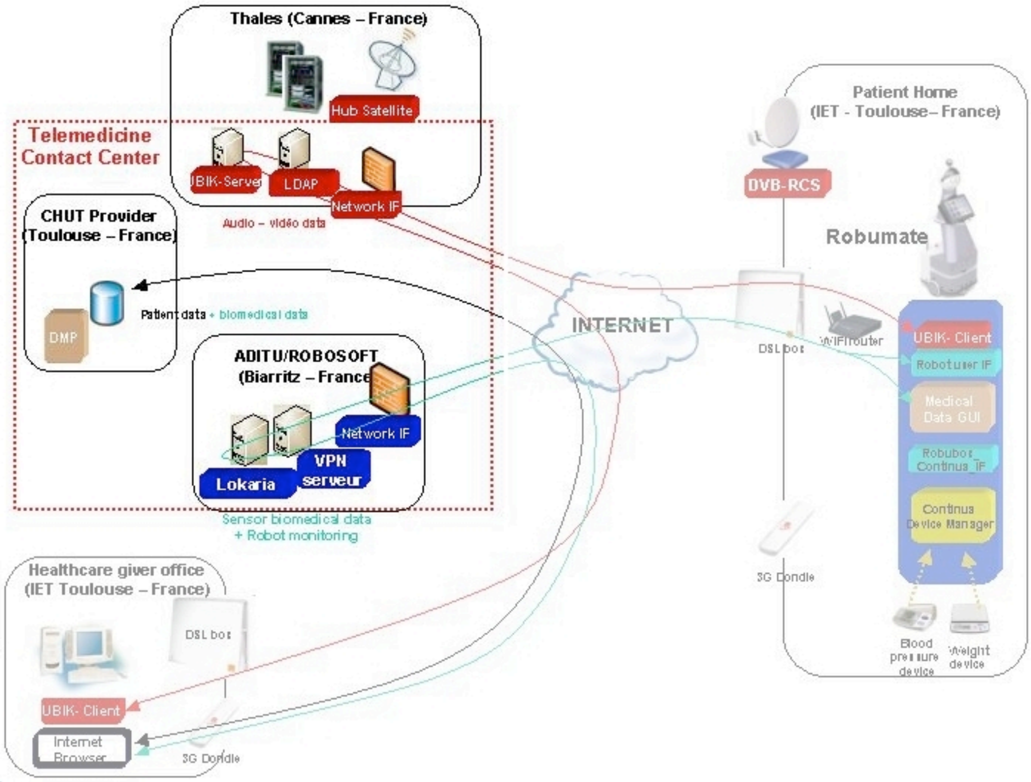


Figure 11 : Implemented Telemedicine Contact Center

3.2.1. **Thales Alenia Space Telemedicine Centre componants**

Thales Alenia Space offers its applications platform in Cannes to validate the videoconferencing module based on Visiomeeting software optimized for satellite data transmissions as well as some parts of the telecommunication infrastructure to test and validate the DOMEO system.

The applications platform includes :

- System and network infrastructure including security, Multicast, QoS, satellite gateway, terrestrial link.
- Servers including videoconferencing and LDAP

3.2.1.a. **System & Network infrastructure**

As for any secured system and network infrastructure, the firewall is mandatory. Based on a FreeBSD operating system, it manages value added functions as follow :

- Networking
  - **DHCP**, only for end-user within the local network
  - **DNS server,** for each DVB-RCS end user terminal when connecting themselves to the application servers

- **Central router** (network and port translation) that enables to translate DVB-RCS end-user private IP addresses into public addresses for communication with applications from other DOMEO's platforms or any Internet client.
- **Dynamic multicast routing**

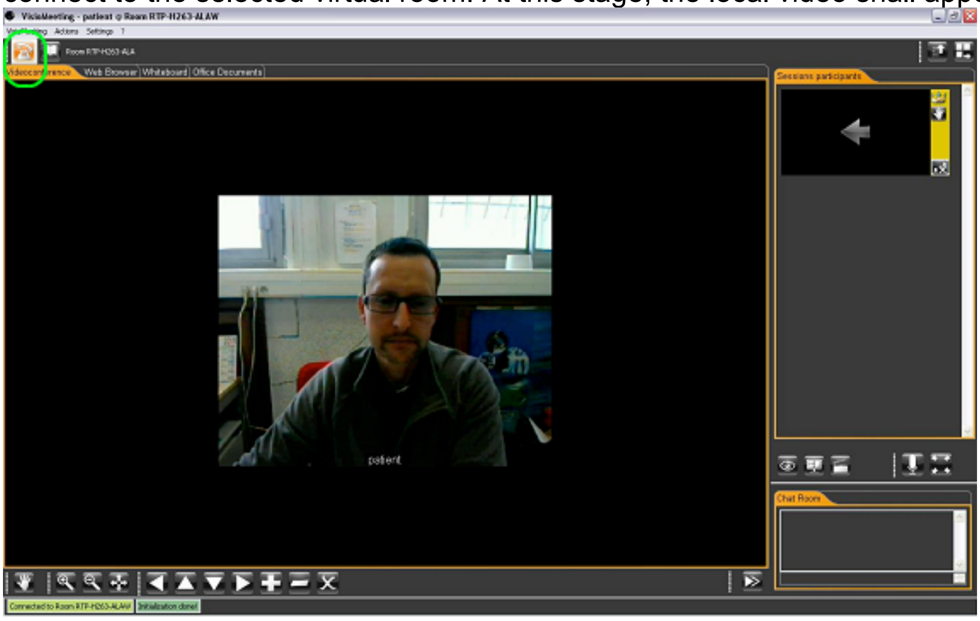
- Security
  - **Firewall** with "Statefull Inspection" filtering to block undesired client or data flows. By default all traffic are denied. Depending on each application, traffic is filtered at IP level according to port number, client address and destination address (server).
  - **Public DMZ area** to enable "public" client (such as Internet client or end-user client from a partner's network) to access to the application servers.

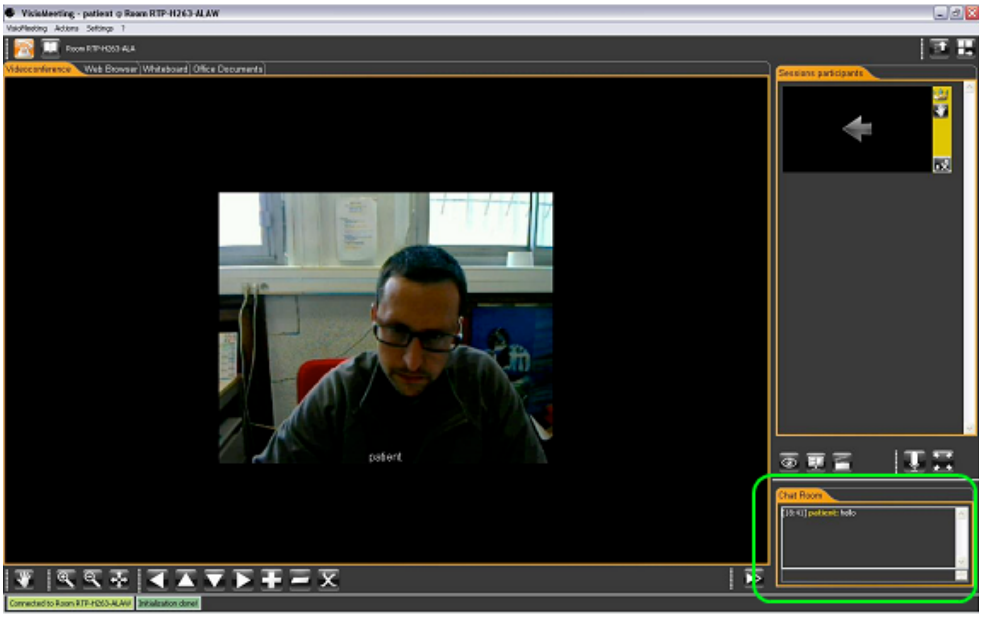
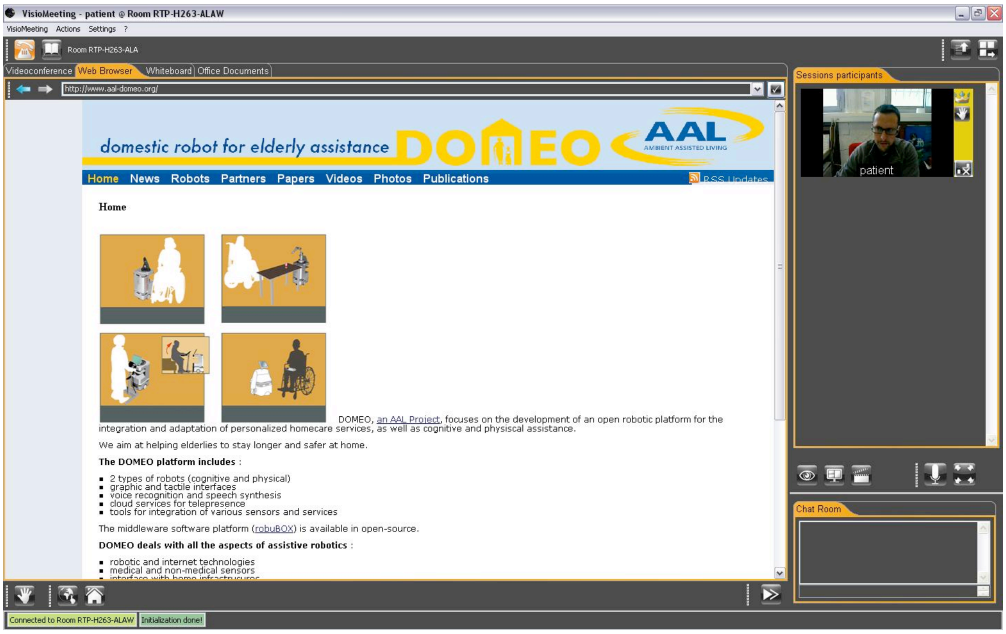
3.2.1.b. Videoconferencing & Collaborative Work Server

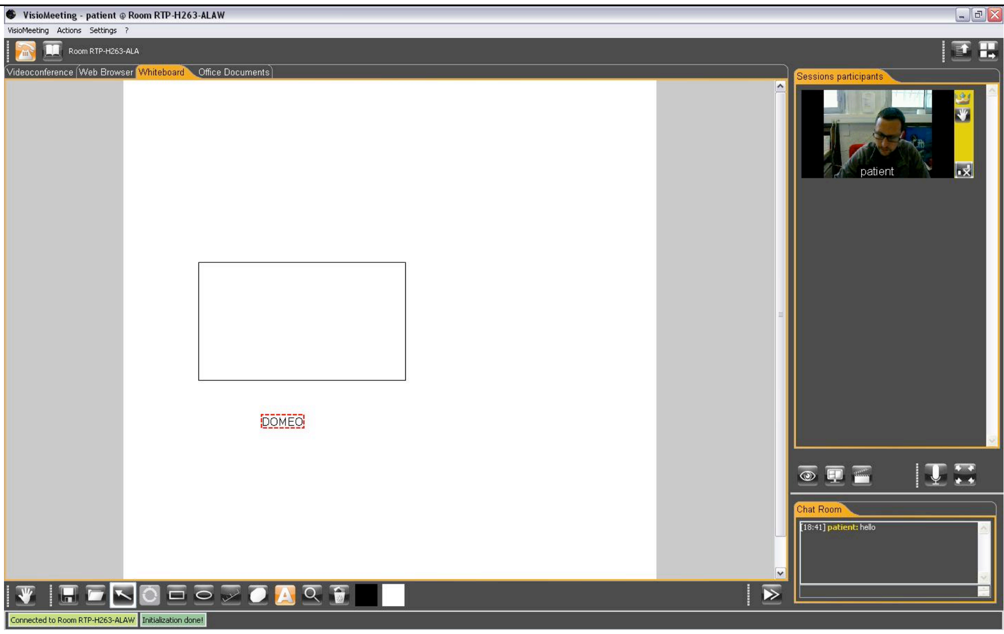
Thales Alenia Space application platform hosts servers running application such as videoconferencing. Before to proceed further with videoconferencing validation, it is necessary to manage user rights via the LDAP server, which is also co-located.

The videoconferencing solution is based on Visiomeeting software. Visiomeeting allows to hold virtual meetings with audio / video / application sharing / chat ... A dedicated virtual room has been defined and set up for DOMEO purposes.
In the frame of the DOMEO Project, the main purpose concerning videoconferencing is to enable the healthcare professionnal to realize a teleconsultation with the patient at home and to get some live images from the patient's home in case nobody answers to the call.

During the validation phase, the videoconferencing software will be tested. The following procedure introduces the main features and capabilities of the software which will be tested.

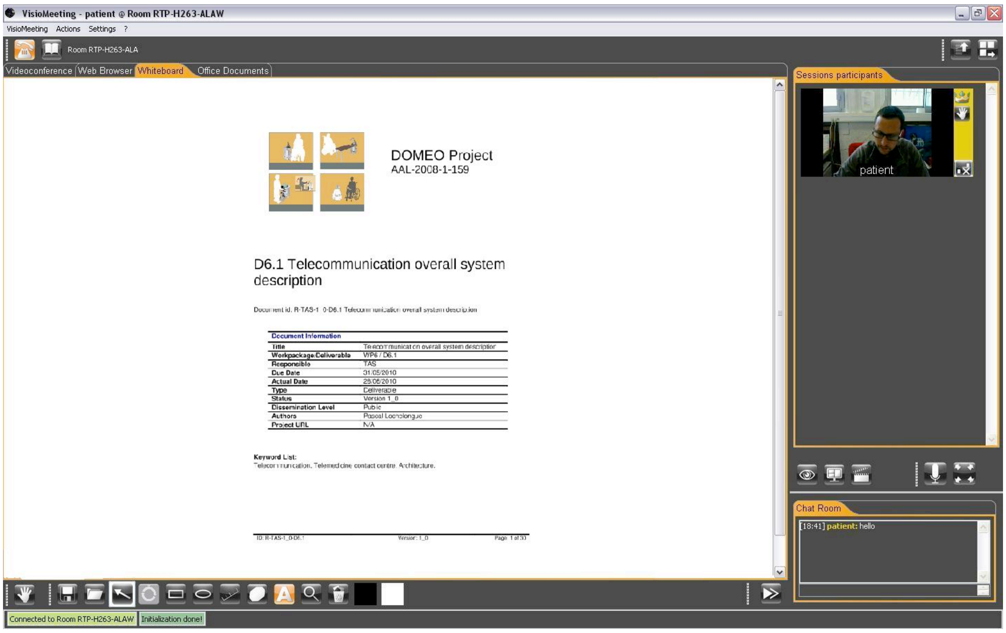
1	**Launch the videoconferencing session** Provided that the Visiomeeting client has been correctly set-up, click on the phone icon to connect to the selected virtual room. At this stage, the local video shall appear : 
2	**Test audio and video** Check that you can hear and see the remote participant
3	**Test the Chat**

	Writte a message in the Chat area : 
4	**Test the shared Web Browser** Cick on the Web Browser tab, then share any web page with your remote participant : 
5	**Test the Whiteboard** Click on the Whiteboard tab, then share a drawing with your remote participant :



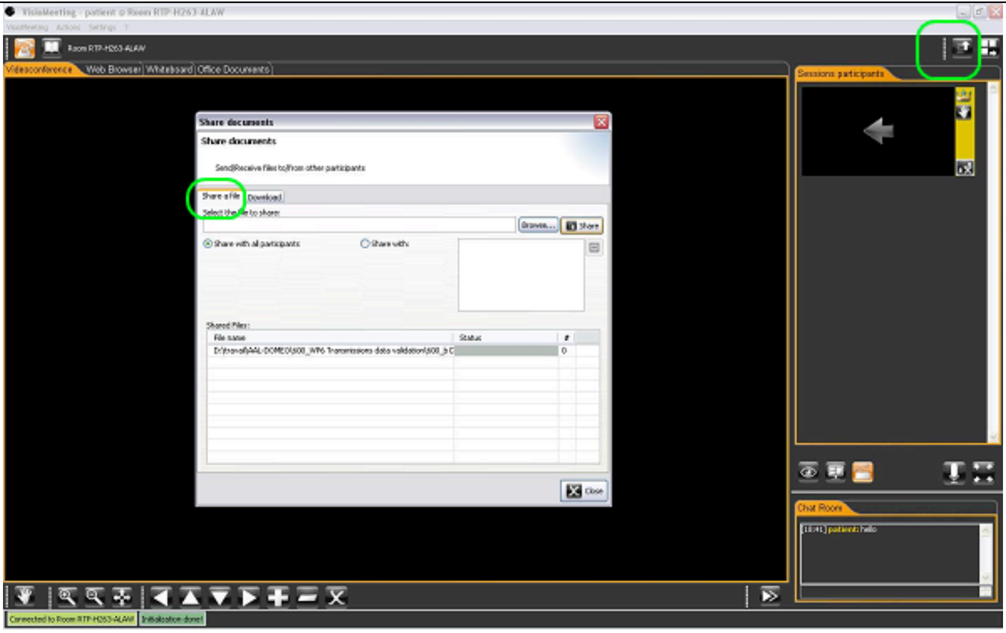
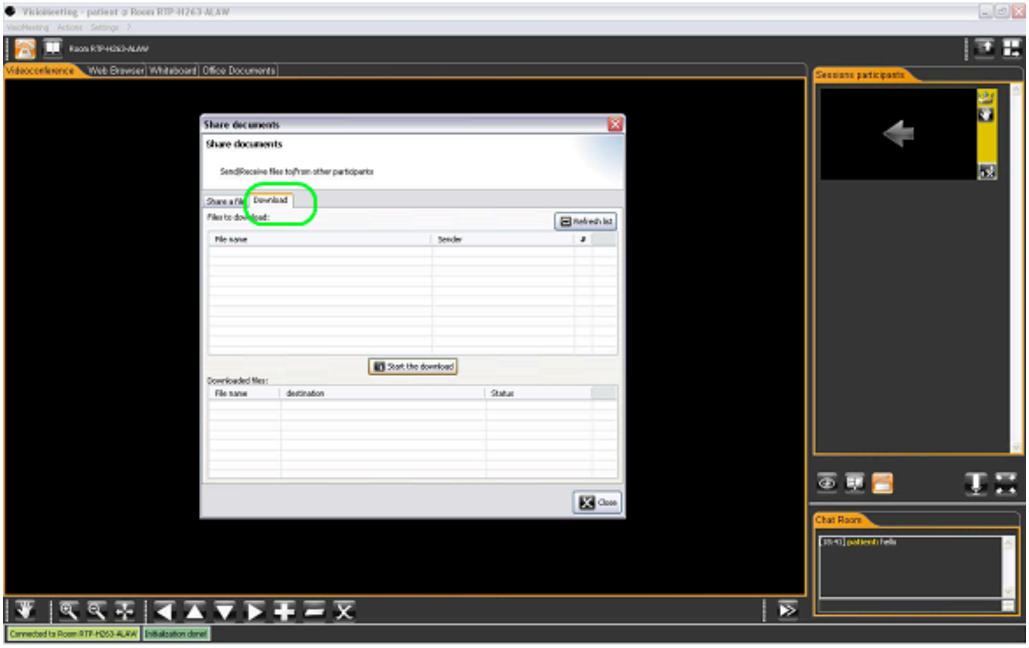
6 **Test the Document sharing function**

Click on the Office Document tab, then share any document with your remote participant :



7 **Test the File Transfer function**

Click on the arrow icon in the upper right corner, then select a file in the “Share File” tab and transfer it to the remote participant

	
8	**Test the File reception function** In the Download tab, select and download the file received from the remote participant : 

Videoconferencing relies on data, video and audio whose main characteristics (protocol, bit rate, format, …) are introduced in the following table :

Data	Category	Protocol	Bit rate	Source	Format	Output
Video	Video	RTP/RTCP or UDP	From 50 Kbps to 5 Mbps From 1 to 25 fps	Client - Server	X.264, H263, MSPEG4, MPEG4, WMV2	Client - Server
Audio	Audio	RTP/RTCP or UDP	From 12 Kbps to 256 Kbps	Client - Server	a-LAW, MP3	Client - Server

Image	Data	TCP	From 1Kbps to 1 Mbps	Client - Server	jpg	Client - Server
White-Board	Data	TCP	From 1Kbps to 1 Mbps	Client - Server	Text	Client - Server
Document	Data	TCP	From 1Kbps to 1 Mbps	Client - Server	Open Office	Client - Server
Chat	Data	TCP	From 1Kbps to 1 Mbps	Client - Server	Text	Client - Server
Session Control	Control	TCP	From 1Kbps to 1 Mbps	Client - Server	XML	Client - Server
File Transfer	File	FTP	From 1 Kbps to 10 Mbps	Client - Server	Depend on File Format	Client - Server
Cam Control	File	TCP	From 1Kbps to 1 Mbps	Client	PTZ	Client

Table 1 : Videoconferencing data characteristics

Protocol : Video and Audio will be transmitted in both way over RTP/RTCP or UDP protocol. File transfer will used FTP protocol whereas all other data will be transmitted over TCP.
Each data flow has been marked in order to identify them easely during the data transmission validation and performance test.

Format : Several virtual rooms with various audio and video codec will be defined and then evaluation performed to determine the suited codecs according to the DOMEO usage.

Destination : Most of the data goes from the home client to the health professional client transiting through the videoconferencing server.

3.2.2. ROBOSOFT Telemedicine Centre componants

As for Thales Alenia Space Telecommunication centre, ROBOSOFT premises hosts the necessary network componants (Firewall, DHCP, DNS, DMZ) to allow proper data transmissions as well as a VPN Server that enables the health professional to command and monitor remotely and securely the robot (Robumate) installed at patient home via the LOKARRIA application.

3.2.2.a. VPN server

The VPN server implements a DOMEO virtual private network (VPN) to build **secured site-to-site connection** (between patient's home and healthcare professional's office) and to handle patient's confidential biomedical data as well as robot's information.

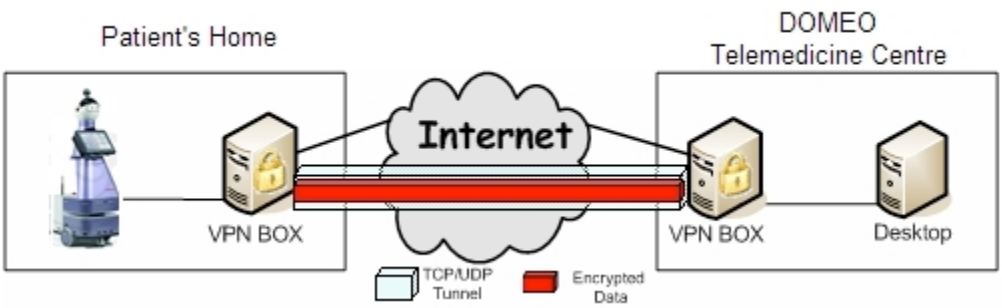


Figure 12 : VPN site-to-site connection

The VPN server is based on OpenVPN, a full featured SSL VPN software solution that integrates OpenVPN server capabilities, enterprise management capabilities, simplified OpenVPN Connect UI, and OpenVPN Client software packages that accommodate Windows, MAC, and Linux OS environments. The VPN server is the underlying component in OpenVPN Access Server that does all of the background work like routing, tunneling, encryption, user management, authentication etc. OpenVPN Access Server comes with a Web GUI that helps to manage the underlying components of the VPN server.

In addition, OpenVPN is able to run through network address translators (NATs) and firewalls.
It allows peers to authenticate each other using the DOMEO certificate. In this multiclient-server configuration, it allows the server to release an authentication certificate for every client, using signature and Certificate authority based on OpenSSL encryption library.

In DOMEO, the implemented VPN tunnel is a layer-3 based IP tunnel (TUN) that can carry any type of Ethernet traffic.

3.2.2.b. **The LOKARRIA server**

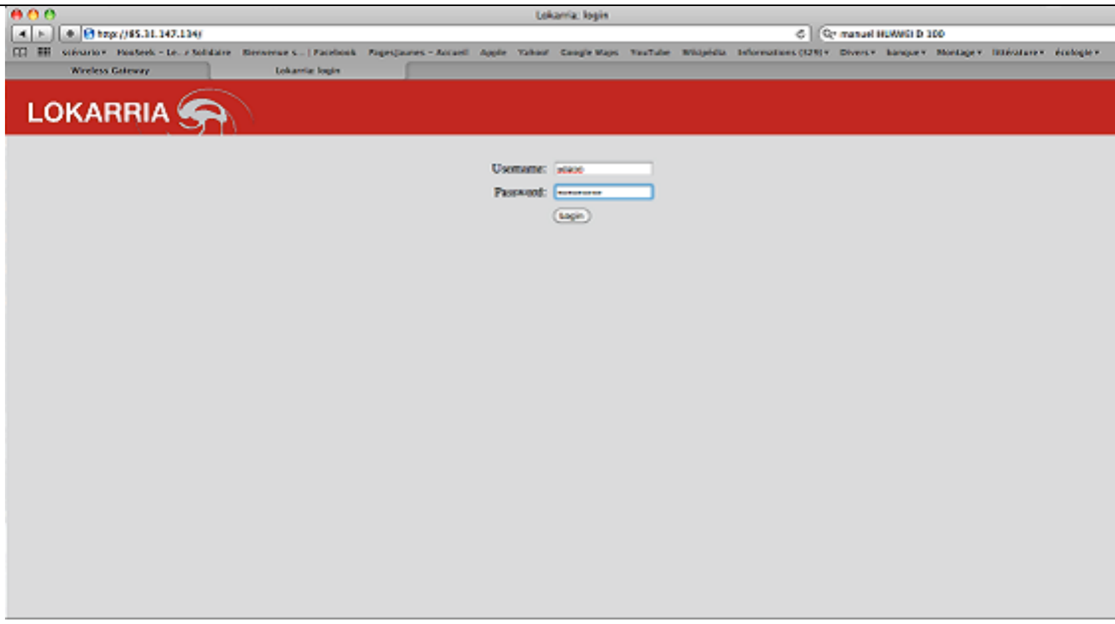
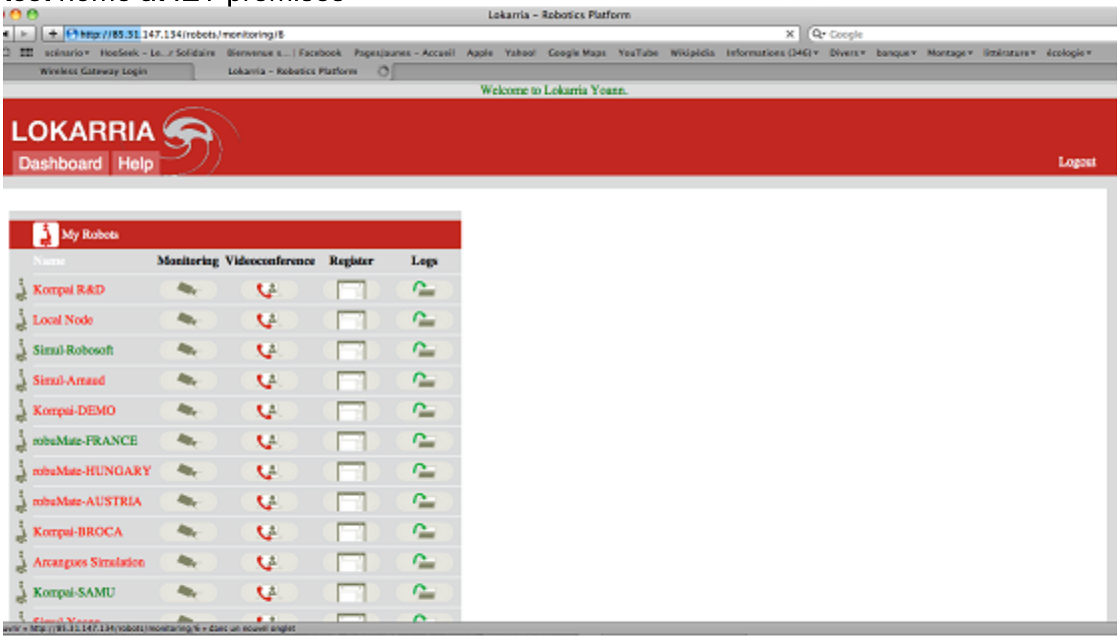
As introduced in chapter 3.1.3.b, LOKARRIA is a suite of software services that provides remote access to robots over the Internet. It is also a web interface for managing robots: remote control with video and sensor feedback, monitoring (logs and alerts), updating robot software.
The LOKARRIA server hosts this suite of software services.
The application is developped with a .NET 3.5 framework.

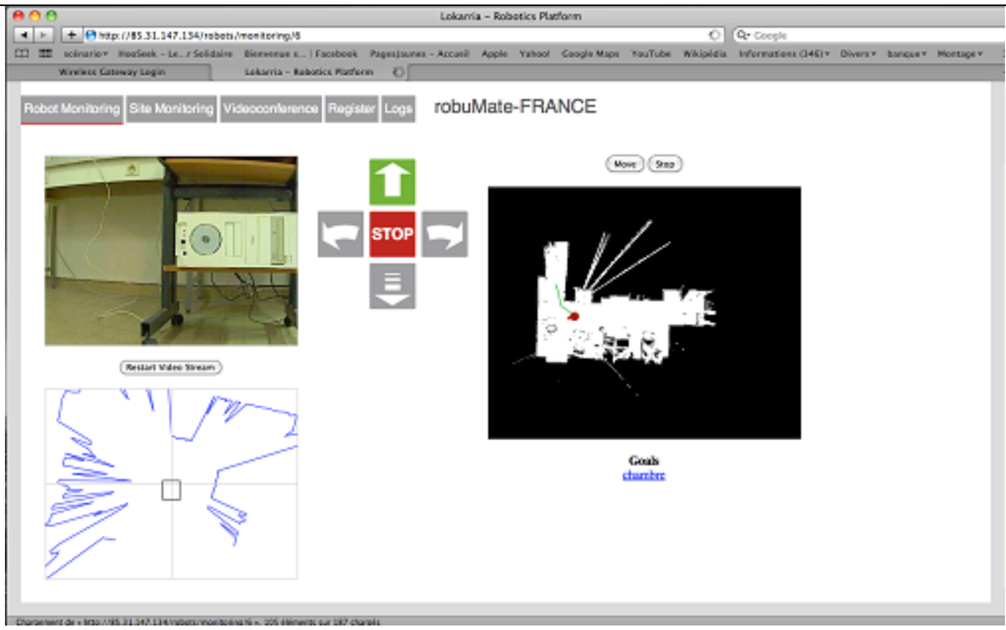
Lokarria is a set of services for controlling, monitoring and managing the robots through the web:

- Manage robots through a single web interface,
- Enable to command the robot mainly through HTTP POST protocol and to monitor it through HTTP GET protocol.
- View the logs and alerts, configure logging from a web interface, activate several debug levels, check robots' status,
- Check if the software running on the robots is up to date, securely install the required or recommended updates without risks, a kind of "windows update" for the robots,
- Remote control robots from a web interface, including real-time video, sensor feedbacks, console, etc. Multiple users supported at the same time (one control, other are spectators) from different locations. Performances are not downgraded thanks to Robosoft servers that multiplex and cache video streams and data.

Lokarria services are also available through a REST API, making possible the development of dedicated clients (for mobile phones, for example).

1	Connect your PC to the Internet, open a web browser and enter in adress bar: http:// 85.31.147.134
2	Enter requested username and password. Default username and password are: yoann, y04nnp0ns

	
3	In the dashboard page, click on Robumate-France Robot, the one present in the patient test home at IET premises 
4	Click a point on the map then click on move. Verify that the robot reaches the specified localisation :



3.2.3. **CHU Toulouse Telemedicine Centre componants**

The DOMEO project aims at recording elderlys' biomedical data to remotely check and manage their health status.

Currently, data measured by biomedical sensors at patient's home are stored on the Tablet PC for further use. Either the nurse or the general practionner consulting at home can then connect to the Tablet PC and check the stored data to update the treatment.

A simple Human Machine Interface (HMI) has been designed to help user interaction with the Tablet PC as well as easy access to and display of stored medical records as illustrated on Figure 13.

Figure 13 : HMI for Medical Data access

Data are currently stored in text format, as well as in a format compliant with storage in the future French Medical Patient File.
Interconnection with the French Medical Patient File database is currently under discussion with CHU Toulouse and depends at National level on further decision concerning design and realisation of such database.

3.3. **Healthcare professional office**

The Healthcare Professional Office system is composed of a personal computer (PC) equiped with videoconferencing and Web browsing capabilities and a DSL or 3G modem.

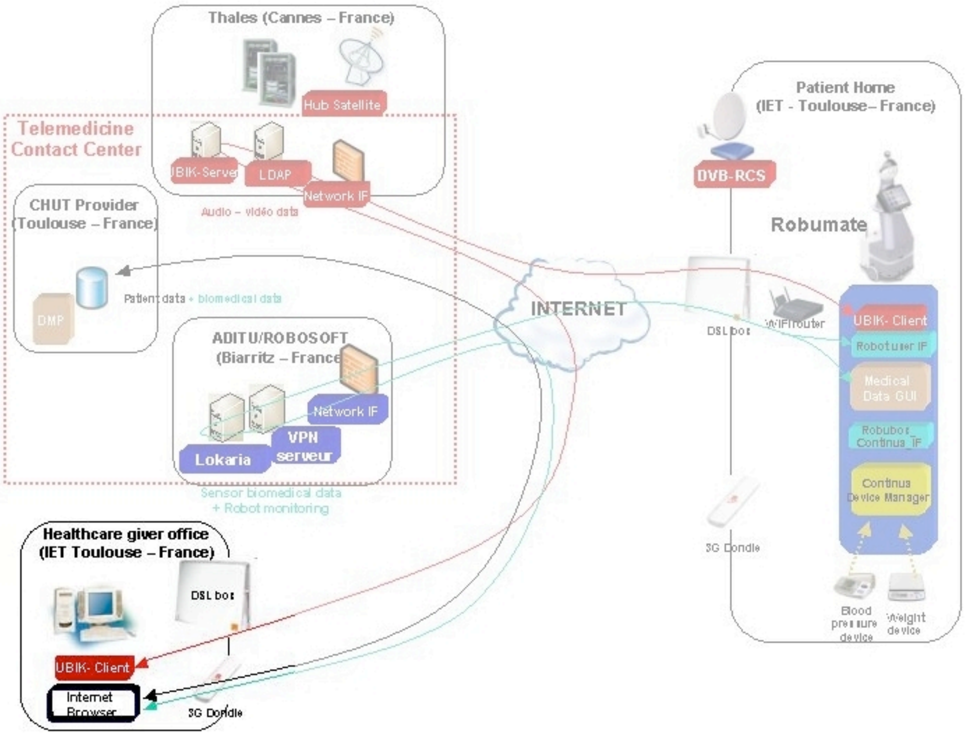


Figure 14 : healthcare professional office

DSL Modem connection : The DSL Modem is the usual one included in tripple-play offer of Internet services providers. It is linked to the PC either with an Ethernet cable or a WIFI wireless connection.

3G Modem connection : The 3G Modem is an usual USB 3G key delivered by Mobile Services Providers for nomadic user. It is directly plugged in PC's USB port.

Videoconferencing : The videoconferencing system installed at healthcare professional premises includes his personal computer equiped with the convenient Visiomeeting software, a headset and webcam. Headset and webcam are plugged into the computer via a USB cable. The computer is linked to the home DSL modem either via a WIFI wireless or Ethernt connection.

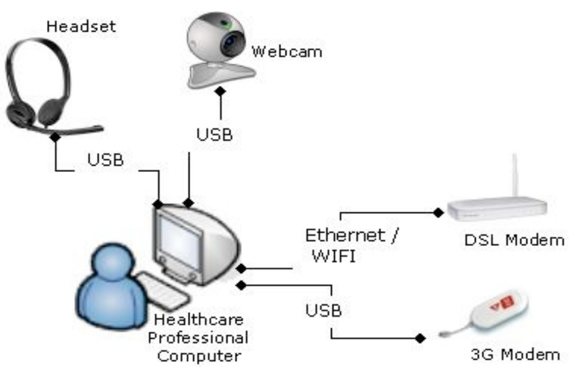


Figure 15 : Healthcare professional office connections

3.4. The Satellite network

The most usual telecommunication technologies used in the frame of the DOMEO's project are DSL and 3G ones. Satellite telecommunication technology is considered as complementary of both previously mentionned technologies, particularly in areas where the telecommunication infrastructure remains poor or insuffisiant.

The purpose of satellite technology in the DOMEO project is to validate and propose some alternate solution for elderlies living in white areas and which do not benefit from SDL or 3G networks capabilities. Validation is based on DVB-RCS satellite technology and will use Thales Alenia Space infrastructure installed in Cannes.

The DVB-RCS system standard calls for a forward link based on a DVB/MPEG-2 data format and a return link using Multi-Frequency – Time Division Multiple Access (MF-TDMA) scheme, allowing a two-way exchange of data. The network consists of a central Hub station, one or more Satellite Interactive Terminal (SIT) at the remote location as described on Figure 16.

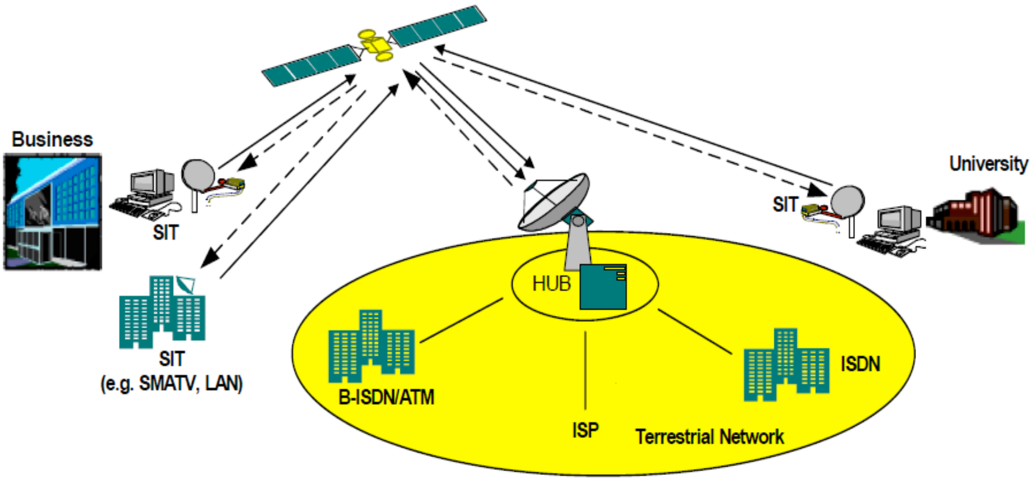


Figure 16 : DVB-RCS satellite network

3.4.1. DVB-RCS Hub short description

Within the Hub station are located the Forward Link Subsystem, the Return Link Subsystem, the Terrestrial Interface Sub-System, the Timing and Frequency Sub-System, the Access Control Sub-System and the Network Management & IP Subsystem..

- **FLSS**: The Forward Link Sub-System (FLSS) hosts the transmission and MAC functions that are related to the operation of the forward link. It mainly includes DVB modulator and IP gateway. This module reuses all the IP DVB-ST A9721 system.
- **RLSS**: The return link Sub-System (RLSS) hosts all the functions required at the gateway side to operate the return link. It handles MAC functions (synchronization, power control and scheduling) in addition to PCR insertion and multi-carrier demodulation.
- **TISS**: The Terrestrial Interface Sub-System (TISS) makes the interface between the FLSS/RLSS subsystems and the terrestrial network. Depending of the options, it includes either a simple Edge Router or a Broadband Access Server.
- **TFSS**: The Timing and Frequency Sub-System is responsible for regenerating the 10MHz stable clock reference for the gateway and for providing the 1PPS (pulse per second) time reference to the RLSS for system synchronization purposes.

- **ACSS**: The Access Control Sub-System handles Terminal authentication and admission connection identifiers and delivers the bandwidth capacity allocation according to SLAs recorded in the GMSS
- **GMSS**: The Gateway Management Sub-System (GMSS) includes all the management functions for the Gateway equipment and the Terminals.

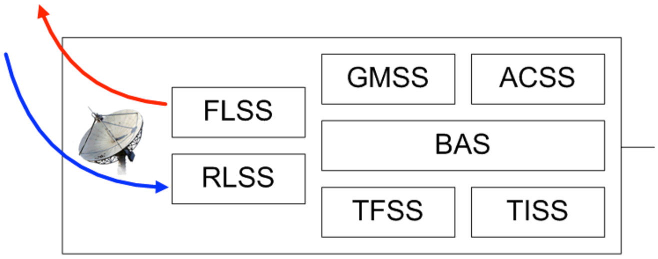


Figure 17 : DVB-RCS hub subsystems

The following table provides a correlation between sub-system names and function.

Denomination	Functions
RFSS	Antenna, High power amplifier, Up converters, Low noise amplifier, Down converters, RF redundancy switches, Uplink Power Control, IF splitter / combiner
FLSS	IP Encapsulator, DVB Multiplexer, DVB modulator, Redundancy switches
RLSS	MF-TDMA Receivers, MF-TDMA Scheduler /controller, SIT Manager, Forward Signaling Handler, Time Frequency Sub System (TFSS)
NMS	Local Hub Management, Terminal Management System
ACSS	Gateway Access Controller
TISS	Traffic routing, Terrestrial Network Interface

Table 2 : Satellite hub subsystem functions

3.4.2. Satellite Telecommunication Quality Of Service

The satellite DVB-RCS Hub includes level 2 to level 7 (as defined by the OSI standard model) dynamic quality of service using PacketShaper technology.
At the IP level, the **IP QoS manager,** installed at Thales Alenia Space DVB-RCS gateway's location ensures :

- IP traffic monitoring.
- Packets priorisation / sessions shaping.
- TCP optimization.
- Layer 2 (MAC) to layer 7 (application) auto discovery.

The PacketShaper has been configured according to the needs of each application which will be tested during the industrial validation phase.

The Management stations (STNM) ensures satellite bandwidth allocation and traffic monitoring at the ATM level. Communication between two DVB-RCS remote terminal is not authorized and must go through Thales Alenia Space applications platform to guarantee the proper implementation of QoS rules.

4. PREPARATION TO VALIDATION AND PERFORMANCE TESTS

The testbed described in this document has been built to test and validate a complete DOMESTIC ROBOT FOR ELDERLY ASSISTANCE system including various types of telecommunication links (satellite, 3G, DSL).

The following table introduces a preliminary list of tests which will be completed early before the realization of the tests and used during the data transmission validation and performance phase whose results will be reported in D6.3 “Data transmission validation and performance report. These tests refer either to medical, technical or functionnal matters.

Test ID	Brief Description	DSL	3G	SAT
CARE 1	The healthcare giver connects to the Internet.	X		
CARE 2	The healthcare giver connects to the Medical Patient file DB from his office.	X		
CARE 3	The healthcare giver consults biomedical data of the elderly from his office.	X		
CARE 4	From his office, the healthcare giver commands remotely the robot to move from one point to another point in patient’s home.	X		
CARE 5	The healthcare giver starts a videoconferencing session with the patient.	X		
CARE 6	The healthcare giver speaks with the patient through the videoconferencing system	X		
MATE 1	At home, connect Robumate to the local WIFI Network	-	-	-
MATE 2	At home, open a VPN link between Robumate and the Lokarria server	X	X	X
WIFI 1	Set up the WIFI Router according to chosen the telecommunication technology.	X	X	X
WIFI 2	Connect the local WIFI router to the 3G network		X	
WIFI 3	Connect the local WIFI router to the Satellite network			X
WIFI 4	Connect the local WIFI router to the DSL network	X		
PAT 1	Connect Bluetooth sensors to Robumate	-	-	-
PAT 1	Command Robumate with the joystick	-	-	-
PAT 2	The patient connects to Internet from Robumate and consults e-mails	X	X	X
PAT 3	The patient connects to a videoconferencing session with the health professional.	X	X	X
PAT 5	Both patient and healthcare giver communicate in video, data and audio conference	X	X	X
DATA 1	The patient realizes biomedical measurements using sensors	-	-	-

DATA 2	The patient transmits its biomedical measurements for storage in the patient medical database and for consultation by the healthcare professional	X	X	X

Table 3 : Preliminary test plan

End of document