Electronic Home Hospitalization Unit Distributed Management System

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Abstract

The Home Hospitalization Unit is a relatively young unit in Spanish hospitals. The main purpose of this unit is to give treatment to those patients that due to their illnesses have the possibility to be treated at their own home with their relatives. These units youngness is the main reason why they are not as computerized as they should be in order to reduce costs and improve effectiveness. Also, the relation this unit has with other hospital units as entrance, pharmacy, discharge and etc, makes harder to provide this unit with the optimal IT environment to allow them to realize a more efficient job with less effort and costs. The HHU management system which is going to be described has been developed thanks to several technologies and devices as: UMTS, GPRS, Table PCs, PDAs, Wi-Fi, MSV, Web Services, layer-architectures, etc…

1. Introduction

During last years, thanks to the competence transfer done by the Spanish government about health care to the different Spanish regions, the HHU activity has been greatly increased. This raising that has been reflected in every region's hospitals with an augmentation in the number of HHU. [2]

The HHU try to be an added aid to patients and doctors. Its basic function is to allow patients to be at their respective homes while receiving treatment. Noticing that this is only able to do with patients with certain and specific illnesses, this might be a great improvement in what refers to number of free beds and reduction of the waiting list, besides the patients life quality improvements thanks to being with their families.

Nevertheless, each HHU has its own limited resources but, one of the most restrictive ones is the number of "virtual beds" that can be managed by the members compounding the unit. So, a better management of resources, specially the most restrictive ones, improves in an immediate way the hospital management efficiency.

The HHU capacity also runs into other problems when it comes to its management. Some of those problems are the following:

- Patient clinic history access is very impeded by the paper work resultant by its everyday work.
- The data acquisition during the monitoring and the doctor's diagnostic must be available to be attached to patient clinical history.
- The information exchange between different hospital units is affected by the different information treatment that each unit realizes.
- The bad resources planning drives to an important lost of effectiveness.

The HHU management must take care of these problems, and be as effective and as efficient as possible with all the resources the unit has, in order to make possible a better management with a life quality gain for the patients, lower cost for the hospital and the best effort-result relation for doctors.

2. Methods and Materials

Several technologies are already well established in the market and in every day life. Many of those technologies can be used to improve the sanitary system in several ways. Continuing, a description of the main technologies used in this system will be made.

Bluetooth – IEEE-802.14.1 Standard

Bluetooth is an industrial specification for wireless personal area networks (PANs) first developed by Ericsson, later formalized by the Bluetooth Special Interest Group (SIG) and finally standardized by IEEE as IEEE-802.14.1.
The Bluetooth Special Interest Group (SIG) is a trade association comprised of leaders in the telecommunications, computing, automotive, industrial automation and network industries that is driving the development of Bluetooth wireless technology, a low cost short-range wireless specification for connecting mobile devices and bringing them to market.

The Bluetooth SIG is a privately held trade association and is not publicly traded. The Special Interest Group, whose name was inspired by the Danish King Harald Bluetooth, known for unifying Denmark and Norway in the 10th century, was founded in September 1998. Now, in the 21st century, unification is a guiding principle of Bluetooth wireless technology, as it connects innovative products and companies to consumer aspirations.

The Bluetooth SIG includes promoter member companies Agere, Ericsson, IBM, Intel, Microsoft, Motorola, Nokia and Toshiba, and thousands of Associate and Adopter member companies.

So far, the following versions of the standard:

- Bluetooth 1.0 and 1.0B
- Bluetooth 1.1
- Bluetooth 1.2
- Bluetooth 2.0

The most of the products existing nowadays follow Bluetooth v1.1

Bluetooth Technical Features

Bluetooth (BT) is a radio wave based technology for short-range wireless connectivity among portable and/or fixed electronic devices such as cellular phones, headsets, personal digital assistants and laptops, as well as for their connectivity to the Internet. The BT specification consists of the core and the profile part: the core part defines how the BT technology works and the profile part describes how the BT technology is used in specific scenarios and use cases.

The Bluetooth 1.1 Specification defines low-power radio link capable of voice or data transmission to a maximum capacity of 720 kbps per channel.

Radio frequency operation is in the unlicensed industrial, scientific and medical (ISM) band at 2.4 to 2.48 GHz, using a spread spectrum, frequency hopping, full-duplex signal at up to 1600 hops/sec. The signal hops among 79 frequencies at 1 MHz intervals to give a high degree of interference immunity. RF output is specified for three different types:

- 0 dBm (1 mW) for a communication range of less than 5 m.
- 4 dBm (2.5 mW) for a communication range of 10-20 m.
- +20 dBm (100 mW) for a communication range of around 100 m.

There are defined both voice channels (up to three simultaneous 64 kb/s synchronous voice channels) and data channel. A combination of both is also possible.

The asynchronous data channel can support maximal 723.2 kb/s asymmetric (and still up to 57.6 kb/s in the return direction), or 433.9 kb/s symmetric.

A BT device (acting as master) can share an asynchronous channel with up to 7 simultaneously active BT devices (acting as slaves) in a Piconet. By swapping active and parked slaves out respectively in the piconet, 255 slaves can be virtually connected.

Slaves can participate in different piconets and a master of one Piconet can be the slave in another, forming a Scatternet.

Bluetooth in HHU

Bluetooth is widely extended in the market comparing with other possible similar technologies like Ultrawideband.

Bluetooth in HHU is used to communicate the monitoring devices with PDA and Tablet PC.

USB 2.0 Standard

Universal Serial Bus (USB) provides a serial bus standard for connecting devices, usually to a computer, but it also is in use on other devices such as set-top boxes, game consoles and PDAs.

The USB 2.0 spec was developed by a team of seven industry-leading companies, collectively named the

USB 2.0 Promoter Group. The group consists of Compaq, Hewlett Packard, Intel, Lucent, Microsoft, NEC, and Philips.

USB Technical Features

A USB system has an asymmetric design, consisting of a host controller and multiple devices connected in a tree-like fashion using special hub devices. There is a limit of 5 levels of branching hubs per controller. Up to 127 devices may be connected to a single host controller, but the count must include the hub devices as well. A modern computer likely has several host controllers so the total useful number of connected devices is beyond what could reasonably be connected to a single computer. There is no need for a terminator on any USB bus, as there is for SCSI and some others.

The design of USB aimed to remove the need for adding separate expansion cards into the computer's ISA or PCI bus, and improve plug-and-play capabilities by allowing devices to be hot swapped or added to the system without rebooting the computer. When the new device first plugs in, the host enumerates it and loads the device driver necessary to run it.

USB can connect peripherals such as mice, keyboards, scanners, digital cameras, printers, hard disks, and networking components. For multimedia devices such as scanners and digital cameras, USB has become the standard connection method. For printers, USB has also grown in popularity and started displacing parallel ports because USB makes it simple to add more than one printer to a computer. As of 2004 there were about 1 billion USB devices in the world.

USB in HHU

In case is not possible to make the connection with the monitoring device through BT, the USB alternative is also available.

GPRS Standard [4]

The GPRS was developed by the 3GPP (3rd Group Partnership Project) as an improvement of the GSM standard.

The 3rd Generation Partnership Project (3GPP) is a collaboration agreement that was established in December 1998. The collaboration agreement brings together a number of telecommunications standards bodies which are known as "Organizational Partners".

The current Organizational Partners are ARIB, CCSA, ETSI, ATIS, TTA, and TTC.

The establishment of 3GPP was formalized in December 1998 by the signing of the "The 3rd Generation Partnership Project Agreement".

GPRS Technical Features

General Packet Radio Service (GPRS) is a mobile data service available to users of GSM mobile phones. It is often described as "2.5G", that is, a technology between the second (2G) and third (3G) generations of mobile telephony. It provides moderate speed data transfer, by using unused TDMA channels in the GSM network. Originally there was some thought to extend GPRS to cover other standards, but instead those networks are being converted to use the GSM standard, so that is the only kind of network where GPRS is in use. GPRS is integrated into GSM standards releases starting with Release 97 and onwards, first it was standardized by ETSI but now that effort has been handed onto the 3GPP.

GPRS is different from the older Circuit Switched Data (or CSD) connection included in GSM standards releases before Release 97 (from 1997, the year the standard was feature frozen) using a GSM phone, in that in the older system, a data connection establishes a circuit, and reserves the full bandwidth of that circuit during the lifetime of the connection. GPRS is packet-switched which means that multiple users share the same transmission channel, only transmitting when they have data to send. This means that the total available bandwidth can be immediately dedicated to those users who are actually sending at any given moment, providing higher utilization where users only send or receive data intermittently. Web browsing, receiving e-mails as they arrive and instant messaging are examples of uses that require intermittent data transfers, which benefit from sharing the available bandwidth.

Usually, GPRS data is billed per kilobytes of information transmitted while circuit switched data connections are billed per second. The latter is to reflect the fact that even during times when no data is being transferred, the bandwidth is unavailable to other potential users.

GPRS originally supported (in theory) IP, PPP and X.25 connections. The latter has been typically used for applications like wireless payment terminals although it has been removed as a requirement from the standard. X.25 can still be supported over PPP, or even over IP, but doing this requires either a router to do encapsulation or intelligence built into the end terminal.

Packet switched data under GPRS is achieved by allocating unused cell bandwidth to transmit data. As dedicated voice (or data) channels are setup by phones, the bandwidth available for packet switched data shrinks. A consequence of this is that packet switched data has a poor bit rate in busy cells. The theoretical limit for packet switched data is approx. 170 kbit/s. A realistic bit rate is 30-70 kbit/s. A change to the radio part of GPRS called EDGE allows higher bit rates of between 20 and 200 kbit/s. The maximum data rates are achieved only by allocation of more than one time slot in the TDMA frame. Also, the higher the data rate, the lower the error correction capability. Generally, the connection speed drops logarithmically with distance from the base station. This is not an issue in heavily populated areas with high cell density, but may become an issue in sparsely populated/rural areas.

GPRS class 8 is also known as 4+1. This means that 4 slots are allocated to downloading and 1 slot to uploading. This profile is appropriate for applications where data is mostly downloaded, such as web browsing. If the user reads more e-mail than he or she sends, this is also an appropriate profile. Class 8 is usually selected by default on mobile devices that support GPRS.

GPRS class 10 is also known as 4+2. This means that 4 slots are allocated to downloading and 2 slots to uploading, but no more than 5 slots may be used at the same time. This profile is appropriate for applications where data is sent back-and-forth in roughly equal amount, such as instant messaging.

Other classes exists, including GPRS class 6 (3+2) and GPRS class 4 (3+1) used in older devices. Some rare devices can do as much as 4+4 (up to 4 slots in both upload and upload, but maximum 5 total). Those are for industrial use only, through, as more than 2 upload slots are considered a health hazard for nearby user.

The transfer speed depends also on the channel encoding used. The best encoding scheme (CS-4) is available near the Base Transceiver Station (BTS) while the worst encoding scheme (CS-1) is used when the Mobile Station (MS) is further away from the BTS.

Using the CS-4 it is possible to achieve a speed of 21,4 kbit/s per time slot. However by using this scheme the cell coverage is 25% from the normal. CS-1 can achieve a speed of 9.05 kbit/s per time slot and has 98% of the normal coverage.

Each slot can reach a maximum of 14.4 kilobit per second.

	Download	Upload
GPRS 4+1	57.6 kbit/s	14.4 kbit/s (class 8 & 10)
GPRS 3+2	43.2 kbit/s	28.8 kbit/s (class 10)
CSD	9.6 kbit/s	9.6 kbit/s
HSCSD	28.8 kbit/s	14.4 kbit/s (2+1)
HSCSD	43.2 kbit/s	14.4 kbit/s (3+1)

Table 1: GPRS bit/rates

Like CSD, HSCSD establishes a circuit and is usually billed per second. For an application such as downloading, HSCSD may be preferred, since circuit-switched data is usually given priority over packet-switched data on a mobile network, and there are few seconds when no data is being transferred.

GPRS packet switched data is packet based. When TCP/IP is used, each phone can have one IP addresses allocated. GPRS will store and forward the IP packets to the phone during cell handover (when you move from one cell to another). A radio noise induced pause can be interpreted by TCP as packet loss, and cause a temporary throttling in transmission speed.

GPRS in HHU

GPRS is used to send visit data and monitoring to the main server and to get each day's agenda. If possible, the wireless connection it is done through UMTS, but not all devices include the possibility to connect to the 3G cellular phone network.

UMTS Standard [4]

Universal Mobile Telecommunications System (UMTS) is one of the third-generation (3G) mobile phone technologies. It uses W-CDMA as the underlying standard, is standardized by the 3GPP, and represents the European answer to the ITU IMT-2000 requirements for 3G Cellular radio systems.

UMTS is sometimes marketed as 3GSM, emphasizing the combination of the 3G nature of the technology and the GSM standard which it was designed to succeed.

UMTS Technological Features

UMTS supports up to 1920 kbit/s data transfer rates (and not 2 Mbit/s as frequently seen), although typical users can expect performance of around 384 kbit/s in a heavily loaded real-world system. However, this is still much greater than the 14.4 kbit/s of a single GSM error-corrected data channel or multiple 14.4 kbit/s channels in HSCSD, and offers the first prospect of practical inexpensive access to the World Wide Web on a mobile device and general use of MMS. The precursor to 3G is the now widely used GSM mobile telephony system, referred as 2G. There is also an evolution path from 2G, called GPRS, also known as 2.5G.

In the future today's UMTS networks will be upgraded with High Speed Downlink Packet Access (HSDPA), sometimes known as 3.5G. This will make a downlink transfer speed of up to 10 Mbit/s possible.

Marketing material for UMTS has emphasised the possibility of mobile videoconferencing, although whether there is actually a mass market for this service remains untested. Other possible uses for UMTS include the downloading of music and video content.

Simply put, UMTS is the combination of the W-CDMA air interface (the protocol that defines over-the-air transmissions between UMTS mobile phones and towers), GSM's Mobile Application Part (MAP) core (the protocol that provides mobile functionality like to route calls to and from mobile subscriber), and the GSM family of speech codecs like AMR and EFR (the protocols which define how audio is digitized, compressed and encoded). Technically speaking, W-CDMA (as per the definition of IMT2000) is merely the air interface, while UMTS is the complete stack of communication protocols designated for 3G global mobile telecommunications and as a direct successor to GSM. However, W-CDMA is frequently used as a general, umbrella term to collectively refer to the family of 3G standards that uses WCDMA as its air interface, that includes UMTS, FOMA and J-Phone.

Like other real-world W-CDMA implementations, UMTS uses a pair of 5Mhz channels, one in the 1900 MHz range for uplink and one in the 2100 MHz range for downlink. In contrast, cdma2000 uses one or more arbituary 1.25 MHz channels of each direction of transmissions. UMTS is frequently criticized for its heavy bandwidth requirements.

The specific frequency bands originally defined by the UMTS standard are 1885-2025 MHz for uplink and 2110-2200 MHz for downlink. For existing GSM operators, it is a simple but costly migration path to UMTS: most of the rest of their infrastructures may remain the same, but the cost of obtaining new spectrum licenses and overlaying UMTS at existing towers can be prohibitively expensive.

A major difference of UMTS compared to GSM is the air interface forming Generic Radio Access Network (GRAN). It can be connected to various backbone networks like the Internet, ISDN, GSM or to a UMTS network. GRAN includes the three lowest layers of OSI model. The network layer (OSI 3) protocols form the Radio Resource Management protocol (RRM). They manage the bearer channels between the mobile terminals and the fixed network including the handovers.

UMTS in HHU

The UMTS has exactly the same role as GPRS, but higher speed. The devices with this feature implemented use it instead of GPRS.

VPN [4]

A **Virtual Private Network**, or **VPN**, is a private communications network usually used within a company, or by several different companies or organizations, to communicate over a public network. VPN message traffic is carried on public networking infrastructure (e.g. the Internet) using standard (often insecure) protocols, or over a service provider's network providing VPN service guarded by well defined Service Level Agreement (SLA) between the VPN customer and the VPN service provider.

Authentication mechanism

VPN involves two parts: the protected or "inside" network that provides physical security and administrative security sufficing to protect transmission (sometimes it is not always the case), and a less trustworthy or "outside" network or segment (the internet is the biggest "jungle"). Generally, a firewall sits between a remote user's workstation or client and the host network or server. As the user's client establishes the communication with the firewall, the client may pass authentication data to an authentication service inside the perimeter. A known trusted person, sometimes only when using trusted devices, can be provided with appropriate security privileges to access resources not available to general users.

Many VPN client programs can be configured to require that all IP traffic must pass through the tunnel while the VPN is active, for better security. From the user's perspective, this means that while the VPN client is active, all access outside their employer's secure network must pass through the same firewall as would be the case while physically connected to the office ethernet. This reduces the risk that an attacker might gain access to the secured network by attacking the employee's laptop: to other computers on the employee's home network, or on the public internet, it is as though the machine running the VPN client simply does not exist. Such security is important because other computers local to the network on which the client computer is operating may be untrusted or partially trusted. Even with a home network that is protected from the outside internet by a firewall, people who share a home may be simultaneously working for different employers over their respective VPN connections from the shared home network. Each employer would therefore want to ensure their proprietary data is kept secure, even if another computer in the local network gets infected with malware. And if a travelling employee uses a VPN client from a Wi-Fi access point in a public place, such security is even more important.

There are several types of VPN but is not the objective of this paper to explain them.

VPN in HHU

The VPN is the technology the system uses for the communication between the mobile devices and the main server. This way, the system guarantees the security.

Web Service [6]

According to the W3C a **Web service**[1] is a software system designed to support interoperable machine-to-machine interaction over a network. It has an interface that is described in a machine-processable format such as WSDL. Other systems interact with the Web service in a manner prescribed by its interface using messages, which may be enclosed in a SOAP envelope, or follow a REST approach. These messages are typically conveyed using HTTP, and normally comprise XML in conjunction with other Web-related standards. Software applications written in various programming languages and running on various platforms can use web services to exchange data over computer networks like the Internet in a manner similar to inter-process communication on a single computer. This interoperability (for example, between Java and Python, or Microsoft Windows and Linux applications) is due to the use of open standards. OASIS and the W3C are the primary committees responsible for the architecture and standardization of web services. To improve interoperability between web service implementations, the WS-I organization has been developing a series of profiles to further define the standards involved.

Standards used

- Web Services Protocol Stack: The Standards and protocols used to consume a web service, considered as a protocol stack.
- XML: All data to be exchanged is formatted with XML tags. The encoded message may conform to a messaging standard such as SOAP or the older XML-RPC. The XML-RPC scheme *calls functions* remotely, whilst SOAP favours a more modern (object-oriented) approach based on the Command pattern.
- Common protocols: data can be transported between applications using any number of common protocols, such as HTTP, FTP, SMTP and XMPP.
- WSDL: The public interface to the web service is described by Web Services Description Language, or WSDL. This is an XML-based service description on how to communicate using the web service.
- UDDI: The web service information is published using this protocol. It should enable applications to look up web services information in order to determine whether to use them.
- ebXML: A modular electronic business framework is enabled using this set of specifications. The vision of ebXML is to enable a global electronic marketplace where enterprises of any size and in any geographical location can meet and conduct business with each other through the exchange of XML-based messages.
- WS-Security: The Web Services Security protocol has been accepted as an OASIS standard. The standard allows authentication of actors and confidentiality of the messages sent.

- WS-ReliableExchange: A SOAP-based specification that fulfills reliable messaging requirements critical to some applications of Web Services. Accepted as an OASIS standard.
- WS-Management: This specification describes a SOAP-based protocol for systems management of personal computers, servers, devices, and other manageable hardware and Web services and other applications.

Web Services in HHU

In HHU, the web services are used to make possible the communication of the mobile devices. VPN, GPRS, UMTS, web services, are the technologies that all together make possible the wireless communication.

3. Results

Starting form the bases established by a study realized in order to figure out which were the main services priorities a system must offer, some conclusions were found about what were the different use cases.

Also, two experiences in two of the main hospitals placed on the Spanish east coast, have provided useful information which has been carefully studied in order to elaborate the conclusions mentioned before. These conclusions drove to the cases are exposed following:

Team's Management: The HHU has several teams with doctors, nurses, psychiatrist and other specialist. They need to be assigned to each patient in the most efficient way so the resources get optimized. This use case must include special situations as vacancy of some professionals or possible illnesses of professionals and must not allow the team manager to assign them to any activity or visit because it will not be realized with the consequent problem that may produce in patient health and unit everyday work. The unit coordinator is the one in charge of assigning resources and the system must provide him updated information about them so the coordinator can realize an optimized work.

Patient Treatment: Once a patient is included in the HHU, a care path is developed for him/her. The best follow-up of this patient is needed looking forward his best recovery and his discharge. The best and fastest recoveries, the most efficient unit and more patients treated. Through this section, the availability on patients' clinical history is essential. The system must provide all information needed by the team leader in order to make him in position to assign the professional that fits the best way possible the activity requirements. Once the professionals have been assigned, they must prescribe the treatment the think is the best for each patient and keep register of every activity, treatment or visit that has been realized or prescribed.

Visiting the patient: This is one of the major differences with a regular hospitalization process. For HHU, the specialist must visit the patient at home with the great amount of time that that represent. The edge and newest wireless technologies are used to reduce or eliminate de trip time so the specialist is able to visit more patients within the same amount o time. Monitoring devices, MSV, are also needed so light monitoring can be realized at patients home without making the patient travel to the hospital. This data, and any other data acquired at patients home, must be sent back to the hospital to be registered as activities realized in patients clinical history. These devices provide the professionals a great advantage with regular devices that are much heavier and not as multifunctional as the devices provided in the two experiences previously mentioned. Some examples of the activities can be monitored by the MSV (Vital Signal Monitor) are: ECG, plethysmogram, respiration rate, blood pressure, blood oxygen and pulse.

Auto Monitoring: The patient can also decide to monitor him/herself due to indicators the professional said or by his/her own initiative. This auto monitoring can be realized by the patient guided by the device who will send the information once is acquired. This information is sent to the CMR (Response Medical Center) where it will be available for the professionals for viewing, analyzing, storing, and give response to the patient if needed.

CMR (Response Medical Center): This part of the system is dependant on the main system but can be launched without the other applications. The purpose of this independence is to be always launched to give professionals an updated register of auto monitored signals so patients can have their response the fastest way possible. If needed, this application also has access to patient's clinic history so the professional who views the data has an adequate environment to interpret them. The dependence mentioned before is for users and roles management what makes this application independent of the system for users already signed up in the main system.

Statistic reports: The correct generation and management of these reports will offer useful information to manage the unit. All information that has any relation with the HHU can be reflected in this reports so they can be used to improve the less efficient parts or develop a cost cutting plan in the most expensive ones. This reports added to the data base logs, allow having a complete trace of everything that it is done in the HHU and who realized it

System management: As mentioned before, the availability of professional and resources must be reflected in the system to assure the appropriate unit's work. The roles are also defined and managed through this use case. Although there are different professional in each team, a role needs to be defined in order to determine who is the team leader, the unit coordinator and other main roles that are not established by the professions themselves.

Through this use case definition we have run into some architectural concepts which are explained following.

The system architecture is mainly modular. There are several modules which have their own functions and interaction with internal or external devices. The image below shows system's architecture with all its modules that are explained below:

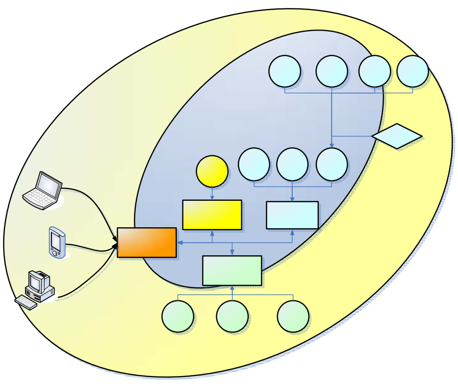

Figure 1: Modular Architecture[1]

In the figure, we can distinguish three main modules that are composed by different sections.

The Security Module is in charge of the communication security. This module ciphers de communications between the mobile devices and the main server. All communications are ciphered and compressed [5] to provide systems security but the network may also apply its own security methods as certificates and secure technologies (https, ssh, etc…). The Data Protection Law forces also that all patient data stored in the mobile devices must be ciphered. As other security device, there is a log where all activity as data base access or logins are registered. This will provide all information needed to find out whom and where did something.

The Patient Visiting Module is composed by three major activities: Monitoring, device assisted visit and the Medical Response center. The monitoring activity is available in the mobile devices assisted by the MSV(Vital Sign Monitor shown below).

Figure 2: The MSV

The MSV allows taking measures as ECG, plethysmogram, respiration rate, blood pressure, blood oxygen and pulse that will be sent to the device which will send them with all other visit data information to the main server. This data will be available for consulting in the system placed at the hospital.

Also an auto monitoring is permitted if the patient thinks he/she needs it. This monitoring will be done the same way mentioned before but it will be sent to the same server. The CMR (Medical Response Center) is in charge to show the data acquired to the professional in charge to check it and suggest solution if needed. The CMR checks for new data every few seconds or minutes, established by the professionals, in order to show them the data.

The team management module is the one who manages teams and patients assigned to each team with all updates needed as professional's vacancies, patient discharge, etc…

Ending this modular description is **the Patient Follow-Up Module**. It is in charge of keeping track of everything that is done to the patient. It is composed by several sections:

Patient Proposal: A patient must be proposed to join the unit before it actually joins it. This section manages all transactions and activities that are necessary for proposal's rejection or acceptance.

Patient List: This section manages the list of patients assigned to each team a globally in the Unit.

This allows not overcharging teams for a better unit's work.

Episode Management: This section is also composed by several ones:

Discharge Report: Once a patient is ready to leave the unit a discharge report must be fulfilled. This module provides all tools and interaction needed to write this discharge report.

Treatment: Keeps the agenda of all treatments assigned to each patient. This section is also able to print the treatment sheet, with all medications patient needs and the time when he/she must take it. The medical prescription can be printed in case is needed to give it to the patient if needs to buy any medication not available at hospital pharmacy.

Medical Follow-Up: Keeps track of all patient related activities. Diagnoses, procurements, activities, visits, notes… Through this sections is possible to consult everything that has been done to the patient and the agenda for all events programmed.

Unit's Clinical Histories: Stores all patient old episodes for consulting in case is needed.

Hospital's Clinical Histories: A consulting tool is provided in case other unit's old episode needs consultancy. It will recover the episode needed for a better assistance.

Once the modular description has been realized, the following section will describe how these modules interact with each other.

The following image shows the system's architecture.

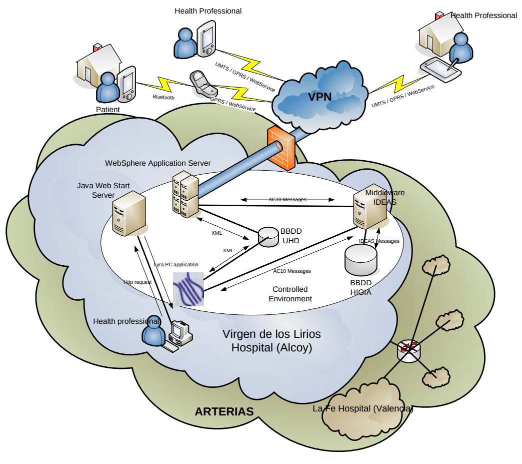

Figure 3: Hardware Architecture

There is a private network holding the systems core composed by the Application Server, the Web Service Server, the UHD Data Base, the government sanitary Data Base and the Middleware IDEAS.

Application server: This server has the last software version available and every user checks every time if his/her version needs upgrading, if needed, the new version is downloaded and executed.

Web Service Server: This server hosts the web services needed for the communication with mobile devices.

HHU Data Base: The Data Base that stores all activities, treatments, diagnoses, procurements, etc… mentioned before.

HIGIA Data Base: The government data base with all the sanitary and personal data needed for the hospitals.

Middleware IDEAS: The middleware the system asks for the information stored in HIGIA when needed.

Just outside this network, still in a secure network called ARTERIAS [3], are the hospitals computers where the main application will run.

The mobile devices are connected to this network through a VPN and GPRS/UMTS so they can send all data and monitoring collected during the visits.

4. Conclusion

A few years ago, with the sanitary competences transfer to each region government, a new horizon was established. Each region started to develop its own sanitary system and integration was defined as main subject.

The use of IT in sanitary area provides the possibility of better information management and thanks to this, a better patient treatment who see their problems attended in a faster and more efficient way. This solution improves the HHU providing a management system making possible a better information management and offering the integration possibility with the rest of hospital's units and other hospitals in the same region. Also, it has a new component that has the role of planning and keeping track of everything that has been done to the patient.

Even this system is open and is able to have interaction with other systems, a complete sanitary system integration is not available in a near future. There still is a lot of work to be done in order to accomplish that.

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