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# INTERFACE DESIGN AND MOBILITY IN UBIQUITOUS ACCESS TO THE HISS (Hospital Information System for Students)

<http://research.unicampus.it/hiss/>

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**“Applied Mobile Technology Solutions in Learning Environments – 2003”**

# HSS

**Campus Bio-Medico University** was founded in Rome in 1991.

- Currently it includes the Faculty of Medicine and the Faculty of Engineering.

- The University Hospital (15 departments- 124 beds) is close to the didactic seat

- it includes an out patients Clinic, a day-hospital unit, operating theatres, unities of intensive care



**Campus Bio-Medico University** was the ideal stage for the development of this project: we were able to test the application in real working conditions and have feedback from people with the same background and requirements of final users.

# HSS

## GOALS

- enhance the hospital level of technology by improving the accessibility to the information system through mobile devices;
- improve teaching and learning in the wards through a faster access to clinical data;
- analyse the geographical mobility needs;
  - test new technologies for seamless connectivity;
- performance evaluation.

# HISS

## PHASES

- ❖ 1<sup>st</sup> Phase (September-December 2003): development of a simulated HIS restricted to clinical information, leaving aside all the administrative modules and some specialized areas (e.g., radiology)
- ❖ 2<sup>nd</sup> Phase (January-March 2004): first users' trial; analysis of the first results and of students' feedback
- ❖ 3<sup>rd</sup> Phase (April-May 2004): development of a new version of HISS
- ❖ 4<sup>th</sup> Phase (June-July 2004): second testing phase and gathering of proposals for final implementation



# HISS Architecture

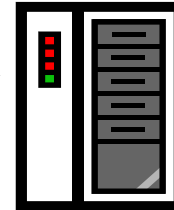


- Windows Mobile 2003 with Pocket IE
- Linux with the ``Dillo`` browser
- integrated WLAN



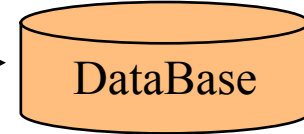
ACCESS POINT

- 3 for each ward
- WEP 64 bit
- MAC filtering



SERVER

- Windows 2000 Server
- .NET Framework
- IIS 5.0



- DBMS: SQL Server 2000

The HISS DB collects basic in-patients' data from the actual HIS through a limited read-only access

# HSS Architecture

Two main issues from the technology viewpoint:

- **Contents adaptation** to the features of the mobile terminals:
  - no keyboard
  - small screen
- **Seamless connectivity** for mobile users
  - heterogeneous network technologies

# HSS Interface (1)

## PROBLEMS

- Conversion of the written note into an Electronic Patient Record (EPR) suitable for handheld computers
- Designing of new interfaces for small devices to collect and examine data at the bedside
- Frequent changes in contents due to users' feedback

## SOLUTIONS

- ✓ We developed the structure and contents of EPR studying some existing models and addressing the specific needs of our Hospital
- ✓ In order to achieve a higher acceptance degree of both teachers and students we based on the existing paper models and resorted to predefined answers to make easier the data entry
- ✓ Thanks to few XML tags we were able to build more than 30 different data entry masks and to change rapidly their contents, without rewriting the code.

# HSS Interface (2)

- <Sezione>
  - <Titolo>**Diagnosi**</Titolo>
- <Voce>
  - <NomeVoce>**Tipo di diagnosi**</NomeVoce>
  - <Valore>
    - <Drop>
      - <Opzione>**Morbo di Crohn**</Opzione>
      - <Opzione>**Rettocolite ulcerosa**</Opzione>
    - </Drop>
    - </Valore>
  - </Voce>
- <Voce>
  - <NomeVoce>**Zone interessate**</NomeVoce>
  - <Valore>
    - <Check>
      - <Opzione>**Colon**</Opzione>
      - <Opzione>**Retto**</Opzione>
      - <Opzione>**Ileo**</Opzione>
    - </Check>
    - <Testo />
    - </Valore>
  - </Voce>
- <Voce>
  - <NomeVoce>**Complicanze**</NomeVoce>
  - <Valore>
    - <Check>
      - <Opzione>**Fistole**</Opzione>



XML data entry visualized on the handheld device

# HSS Interface (3)

Multiple sections masks  
to avoid  
too long HTML pages

Anamnesi alimentare

Scegli la sezione:

Substitution of text boxes with drop  
down lists or check lists of options

Ha mai seguito una dieta?:

deve farmaci?:

si  
no

Distinction between

frequently and less used options

Pranzo (diete comuni):

Pranzo (diete non comuni):

Capo:

specifica

Bulbi oculari in asse:

Occhio:

esoftalmo

endoftalmo

miosi

midriasi

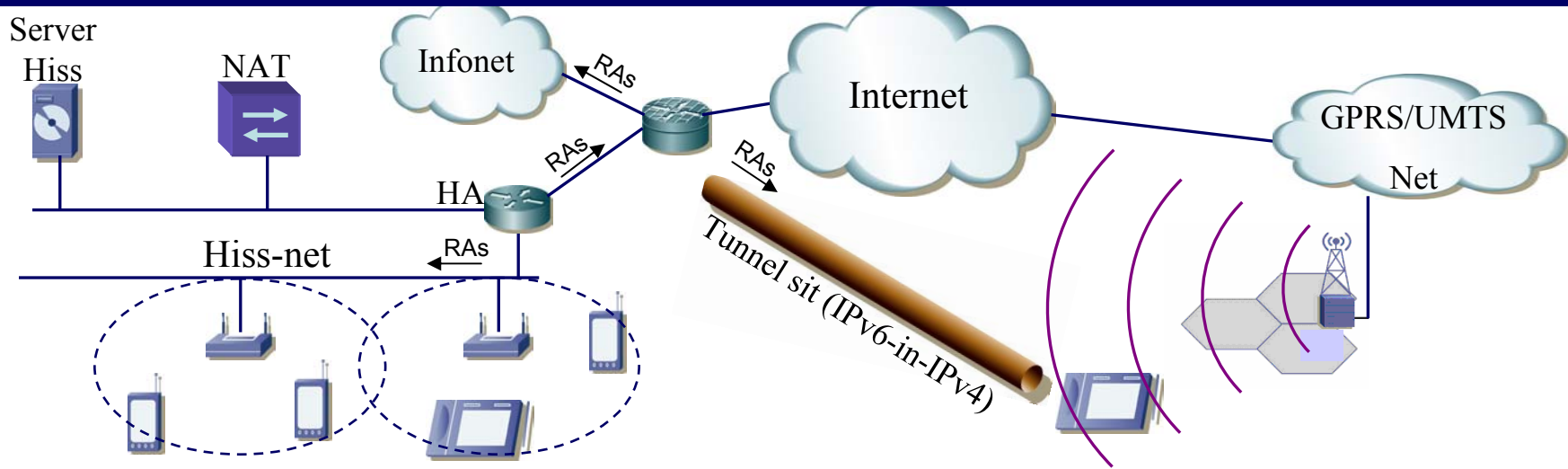
anisocoria ds > sin

anisocoria sin > ds

altro

Text boxes of different sizes (short, medium  
and large) at the end of the list to insert  
additional information.

# HSS Seamless Connectivity



➤ *Seamless* connectivity means that:

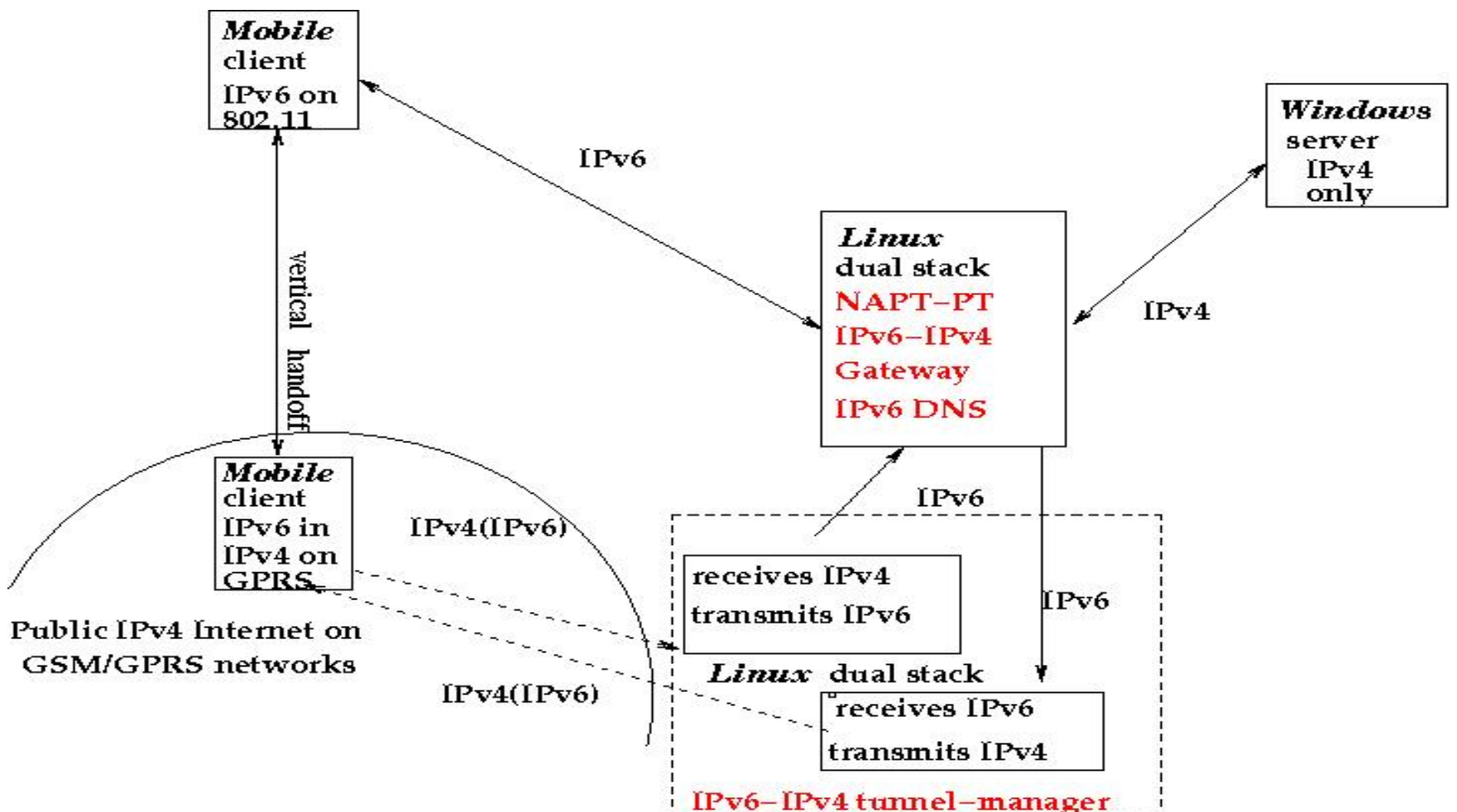
- access must be guaranteed when moving through different subnets, based on different technologies: Ethernet LANs, IEEE 802.11 WLANs, and 2.5/3G cellular data networks (for off-site access).
- sessions must be seamlessly maintained through different subnets. *Handoff* must be fast enough not to cause service degradation.
- no additional configuration effort must be required to final users.

# HSS Seamless Connectivity

- We found that a comprehensive solution to address these issues is provided by **IPv6**.
  - IPv6 is the *next generation* version of the IP protocol.
  - The principal benefit of IPv6, and the main reason for initial deployment, is a vastly increased address space compared with its predecessor IPv4.
- However transition mechanisms are required because a number of HSS systems/services still run plain IPv4 and do not support *mobility*.

# HSS Seamless Connectivity

To this purpose we developed an **IPv6-IPv4** (and *viceversa*) Network Address Translator.



# HSS Seamless Connectivity

Very simple solution: clients needs only to use a DNS server that supports IPv6 addresses.

- Most of the providers who offer IP over GSM/GPRS/UMTS do not support IPv6 at this time, so there is the need of *tunneling* IPv6 traffic in IPv4 packets when the Mobile IPv6 clients make use of the cellular networks
- A problem we found during the experimental tests is the long time required by the *vertical handoff* between wireless (or wired) LAN and cellular networks.

# HSS Seamless Connectivity

- Although there are cards able to support multiple (e.g., 802.11 and GPRS) networks, the time required by existing switching procedures can be in the order of **seconds**.
- To solve the problem we implemented a new mechanism in which the *handoff* is implemented at data link layer instead of network layer.
- The experimental results showed a dramatic improvement. The time required by the *handoff* is now well below 1 second (**0.2/0.4** sec.).

# HSS Participants

110 students used pocket pc to record data concerning 1500 patients and to accomplish 30 different tasks (e.g., drugs prescription and administration)



## RECORDS:

The Medicine students entered 495 records;  
the Nursing students 243;  
the Dietetics students 193 while their tutors 919.

# HSS Bioengineering

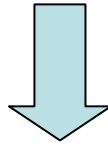
**Bioengineering students** accomplished different tasks:

- followed courses to prepare the hardware and software installation;
- set up the hardware devices in the wards;
- set up the software;
- gave instructions to medicine, nursing, dietetics students concerning the use of HP handheld devices and of the applications;
- monitored usage and collected comments, bug notices, proposals and other information from the users.



# HSS Feedback

A crucial indicator for PDA acceptance was  
**ACCURACY.**



Students using handheld devices for data entry were more accurate than those writing on *a blank piece of paper*; the first ones noticed more things (having different questions to answer) and were more precise.

Another advantage was considered continuous  
**Data Availability.**

Students were able to access the latest available data directly at patients' bedside

# ~~Future directions for the HISS~~

- The results obtained so far are encouraging and show that ubiquitous access to a Hospital Information System *via* portable devices is **feasible and useful**
- A pilot project is in progress at this time in the **Surgery** department involving students and physicians.
- From the technology viewpoint we are studying the effects at transport (TCP and UDP) level of the change in communication speed caused by the vertical *handoff* between 802.11 and cellular networks.