IST-002057 **PalCom**

Palpable Computing:

A new perspective on Ambient Computing

Deliverable 48 (2.14.5)

Demonstration kit

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PU	Public	PU
PP	Restricted to other programme participants (including the Commission Services)	
RE	Restricted to a group specified by the consortium (including the Commission Services)	
CO	Confidential, only for members of the consortium (including the Commission Services)	

Integrated Project

Information Society Technologies

1 Table of Contents

2 Executive Summary

Note: *The prototypes in the demonstration kit are also part of the D50 deliverable. For that reason the presentation of the prototypes in this deliverable (D48), and in the D50 are more or less identical.*

This deliverable is the second version of the demonstration kit. In principle the demonstration kit consists of all the prototypes developed within workpackage 7-12. However as was presented at the IST event in Helsinki 2006, a range of prototypes were selected as part of the demonstration kit due to their dissemination qualities. Thus, the demonstration kit consists of the biomonitor, the overview prototype, the sitetracker, the incubator and the tiles. The demonstration kit is in essence the prototypes themselves and is therefore covered by the description from the prototype deliverable D50 as stated in the opening note.

The demonstration prototypes function as exemplary PalCom devices for exposing the basic elements of palpability. In order to secure that the main issues covered by the prototypes in the demonstration kit, are available also after the ending of the Palcom project, WP14 has supplemented the physical demonstration kit with an extension of the prototype description on the PalCom webpage with a presentation of the demonstration kit. The demonstration kit application for the website is described in further detail in section 7.

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4 WP7 Prototypes

4.1 Objectives

In WP 7, the focus has been on further development of the SiteTracker. The work on SiteSticks has been continued in WP 8 in connection with identification and position tracking of patients/personnel. In addition, WP7 has driven developments of Topos and the Assembly Browser targeted for end user (in contrast to the EclipseBrowser targeted for developers). Developments in this Workpackage are re-used/developed in other Workpackages and used domains. The Services and devices developed for the SiteTracker, for example, were used in connection with the remote controlling of the Axis Camera in the Major Incident Overview prototype used at the Tall Ships' Races, Aarhus, July 2007. The WP7 prototypes have especially focused on exploration of ways to support the balance between:

- Construction, De-construction, and Re-construction of devices and assemblies in relatively stable settings and for own use (the user is also the one who constructs/deconstructs/reconstructs)
- Visibility, Invisibility, and Inspection of PalCom devices and of the not-builded but imaginary future ("What-If-Scenarios")
- Heterogeneity and Coherence: When lots of different devices and assemblies are in use they have to seem alike, although they might not be alike.

4.2 SiteTracker

The SiteTracker tracks positions and overlays location information on live video. It is informed by studies of, and can support, the work of Landscape and Visual Impact Assessment (LVIA) in landscape architecture. The focus has especially been on potential impact of large development projects on views and experiences in large study areas (e.g. for windfarms, industrial buildings), where it is difficult for professionals to keep track of position and extent of proposed (not yet existing) developments. In addition to features presented at the year 3 review, where we had first versions of the various 'building blocks', the SiteTracker has now been physically designed and has been tested on fictitious projects in the country side near Aarhus.

Figure 1: Original SiteTracker vision

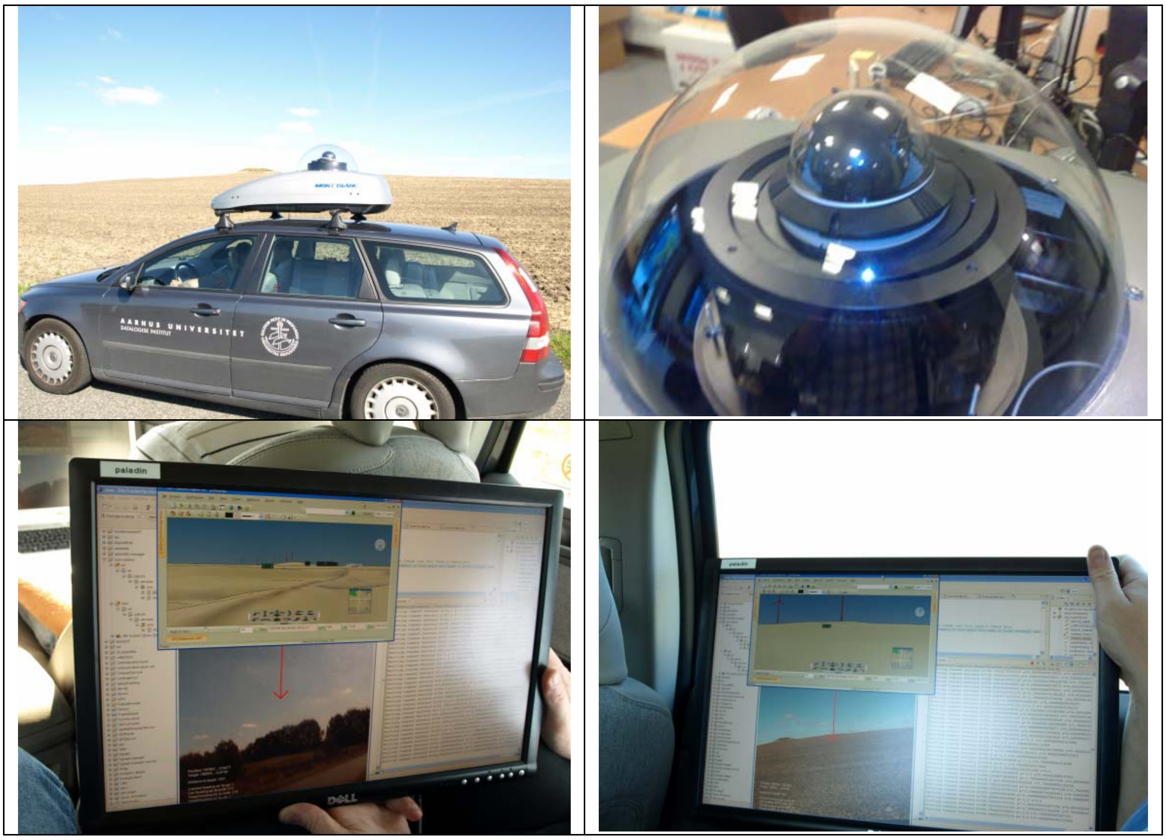

Figure 2: SiteTracker in live experiments Sept. 2007

4.3 Future Work

Work is being carried out in order to combine the two views in Figure 2, i.e. 'on-the-fly' combination of the live video with a 'blue-screened' overlay from the digital Topos model, fascilitating that instead of the read arrow above, we may actually draw the visible portion of the turbines.

4.4 On Site references

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5 WP 8 Prototypes

The Major Incidents prototypes are meant to support emergency responders in their work; at the incident site and/or in related command stations.
As the previous years two main prototype assemblies of ubiquitous computing devices and services have been in focus: The Biomonitoring System and the Major Incidents Overview (MIO). During year four we have spent almost all resources on preparing and bringing MIO as close to authentic use as possible, by implementing it as a tool to support emergency responders – especially police and fire fighters – during the major event Tall Ships' Races 2007, held in Aarhus, July 5th – 8th. As a consequence only minor resources have been used on further development of the Biomonitoring System prototype.

5.1 Major Incidents Overview (MIO)

Note: *The MIO prototype is part of both WP8 and WP14. For that reason the presentation of the prototype in this deliverable (D50), and in the deliverables D48 and D52 are more or less identical*

The MIO prototype supports emergency responders (fire fighters, doctors, ambulance people and police) in obtaining and maintaining an updated overview of an incident and the ongoing emergency response process. The prototype is informed by studies of and can support emergency responders in all emergency responder's different work tasks – spanning from everyday public service tasks or minor incidents, to major events or emergencies.
MIO is designed to allow professionals to assemble large numbers of pervasive computing devices and services, to get an overview of their resources, and to get data from devices to produce an overview of the situation on the ground and thereby support collaboration.

5.1.1 MIO at the last review

At the year three review we showed the different aspects of the MIO prototype assemblies being worked on for the purpose of using it in the Tall Ships' Races in July 2007. So, the third year review demonstration was meant as a proof-of-concept of the set-up for the Tall Ships Races 2007. We showed the non-PalCom node Topos, with a 2D model of the harbour area, becoming the scene for the Tall Ships Races. We also showed some initial 3D modelling of specific buildings in the area. Moreover Topos was integrated with PalCom services and devices via a Topos gateway: We used the same video-camera set-up as was demonstrated in wp7, and via simulated positioning we showed how an on-line video-feet can be presented geo-referenced in Topos, e.g. to show where specific persons are situated. Moreover we demonstrated integration of the Wireless Biomonitoring system (Figure 3).

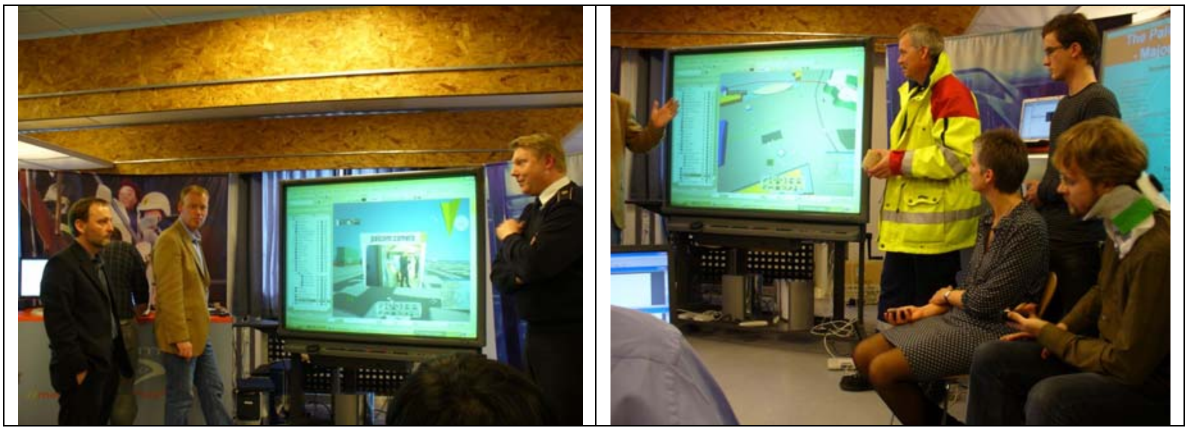


Figure 3: MIO at Year Three review

5.1.2 Development during the year

After the proof-of-concept demonstration at the year three review, we put a lot of effort in turning MIO into a running prototype that would be meaningful – i.e. support the professional responder’s work and collaboration – and make sense for them during the Tall Ships’ Races. In this process we decided to concentrate on a prototype set-up mainly supporting the two groups of professionals playing the most essential roles during the Tall Ships Races’ during “peace-time”: the fire fighters and the police officers. However we also had in mind the healthcare rescuers (doctors and ambulance staff). We focused on:

- Integration with several static video cameras
- Integration with a fully, within Topos, controllable video camera
- Integration with several Nokia N95 mobile phones, with GPS and camera functionality
- Physical design of equipment, especially regarding the video-cameras and the communication of data from them
- Tests of e.g. different network infrastructure and specific bearer solutions
- 3D modelling of the harbour within Topos
- Integration with GIS data, 3D terrains and aerial photography.
- Integration with the Automatic Identification System (AIS) (third party system)
- Storage services for GPS paths and periodic video still images

After Tall Ships’ Races we have made a demo-version of the Tall Ships’ Races set-up, e.g. with simulated GPS positions. This version is used in Siemens’ lab in Munich and has moreover been used for different demonstrations in Denmark (e.g. the HI Industry 2007).

5.1.3 Current status of MIO

Here follows a description of MIO based on the set-up during the Tall Ships’ Races 2007.

MIO consists of a number of PalCom devices and services integrating with and visualized through the 3D application, Topos™. In Topos PalCom-enabled resources can be shown geo-referenced in relation to 2D maps, GIS data and 3D terrains. We utilize data that the emergency agencies and their public service partner organizations (such as the council’s planning and traffic engineering departments) already have.

MIO, as described below, was implemented and used during the major event Tall ships' Races (TSR) in Aarhus, July 5th – 8th 2007.
Aerial photographies can be draped over a 3D terrain of the area of an event or emergency (Figure 4, item 1), so that real surfaces and existing buildings and vegetation are visible. GIS data draping and maps can be turned on or off for clarity (9). Additionally, the models and the GIS information of permanent and temporary structures (e.g. buildings and tents) can be inserted (3, 10). A GIS inspector enables users to search tabular GIS information. The boat-shaped models (5) represent the Tall Ships, indicating where they are *supposed* to dock before the start of the race.
Live position tracking of different resources (e.g. ships via Automatic Identification System (AIS – see (6)) and people via their mobile phones (4)), is enabled via signals from various PalCom positioning services. Sketching functionality enables users to make drawings of e.g. newly decided access roads or cordoning off (not shown).

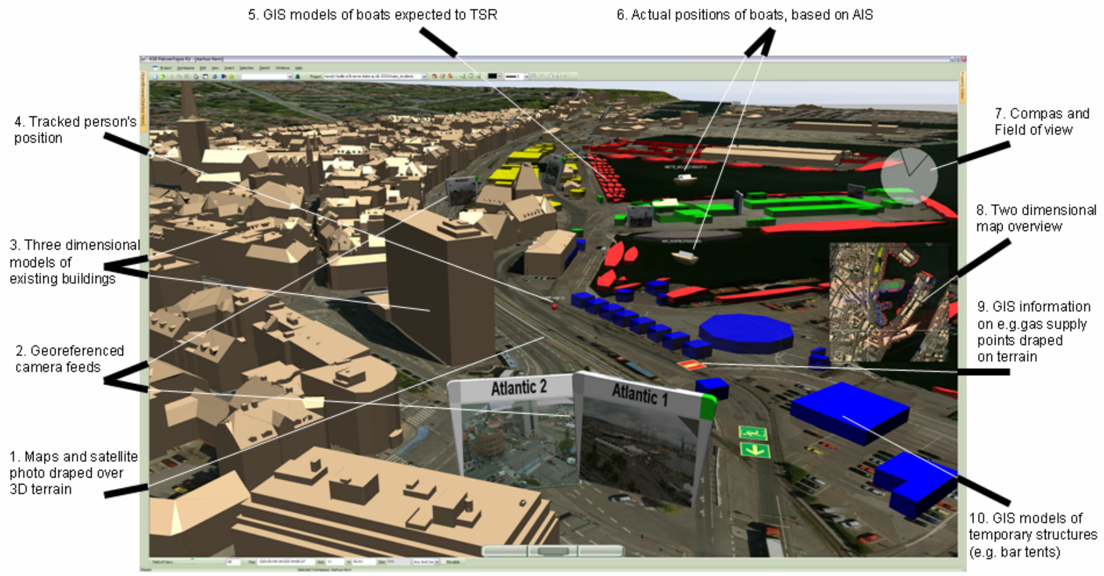


Figure 4: MIO in 3D mode

The screenshot, taken on the day before the TSR event shows that two ships are arriving in the harbour (6) The small white 'boxes' that can be seen on top of these representations are the associated radar transponder AIS (Automatic Identification System) retrieved locations, that is, the ship's *actual* position. Live streaming of video and still images captured through GPS tracked mobile phones can also be shown at geo-referenced positions (2). A 2D Overview (8) provides at-a-glance awareness of one's own position within the model, and a 2D Bird's eye mode (not shown) enables easy navigation.

MIO was set up in and around the command centre established in the strategically located old customs house at the harbour (Figure 5). In the command centre the large smartboard screen was used to display the Topos model, to sketch and discuss on the model and images sent by personnel on the ground, to interact with the devices and to interrogate them. In addition, three computers were used, mainly by developers, to monitor the status of devices within the MIO assembly and to support the staff in using MIO.

Figure 5: The Tall Ships' Race command centre with MIO, and a view of the harbour during the preparations for the event

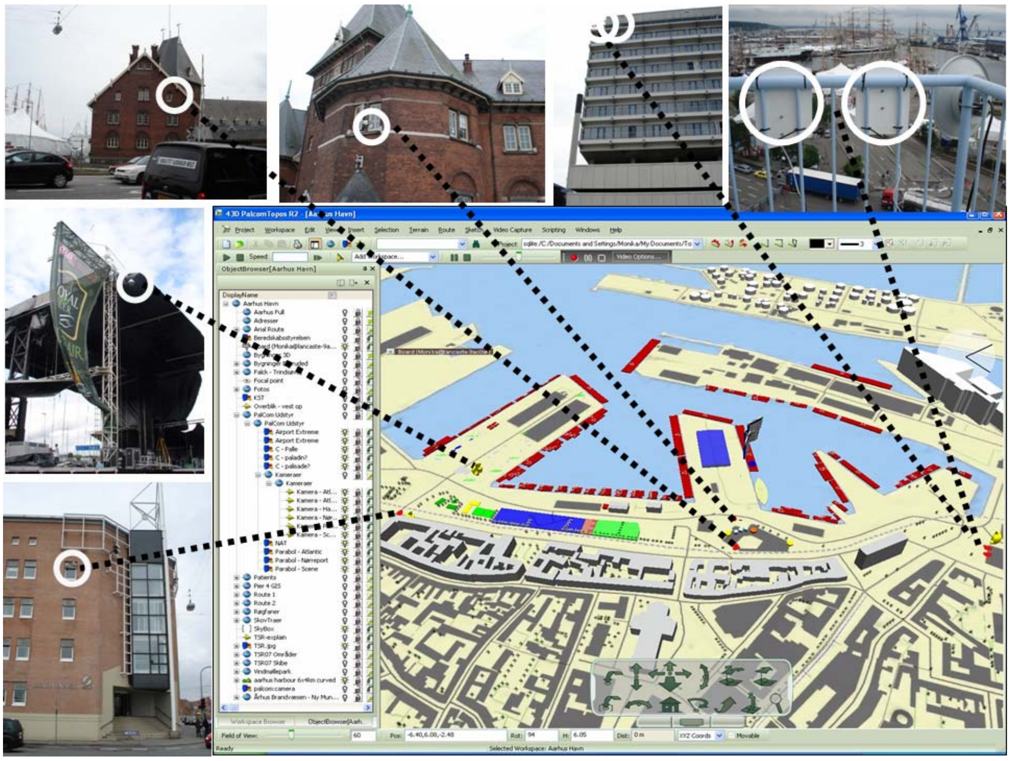


Figure 6: Web-cams on Tall Ships' Race

Figure 7: Tracked person (Jens Fonseca) and boat with rescue divers. Pictures taken by tracked personnel in top left corner

Figure 8: Pictures taken of patrolling officers, sent to and presented in Topos in command centre

Six geo-positioned video cameras were assembled into the MIO application via PalCom services: five fixed web cams and a remote controllable dome-camera, all mounted in strategically important places (Figure 6). So too were six Nokia N95 phones incorporating GPS, four of which were carried by different officers on patrol in the event area, while the fifth was on a rigid inflatable boat (RIB) patrolling the harbour with rescue divers (Figure 7). Apart from being tracked via the phones' GPS unit, the officers also used the phones to take pictures of specific incidents they wanted to report to/discuss with the officers in the command centre. In the Topos application the images from the cameras (video and mobile phones) are geo-positioned according to the actual location of the cameras/officers. This enables staff at the command centre to see the live pictures in the context of the modelled surroundings. Figure 8 shows two examples on pictures used in managing the event. To ensure enough bandwidth for streaming video we set up our own wireless network with small directional satellite dishes.

The current system architecture is composed of three main assemblies, each of which is responsible for orchestrating different devices and associated services. The choice regarding the exact number of assemblies utilized relies solely on a logical and conceptual separation of the different functionalities offered. This enables the designers and users to maintain a proper overview of the different constituents. The first assembly is in charge of assembling the mobile phones, the web cameras and the 3rd party application, Topos™. Additionally, the assembly manages the task of registering and storing every GPS position received from every GPS enabled device participating in the assembly. This is achieved by means of the purely virtual GeoPathDumperService, i.e., no physical device is or needs to be associated with it. There are many such purely software-based services participating in the prototype. In the case of the mobile phones and their ability to take pictures and geo-reference these, a GeoConverterService and StorageService are used. Secondly, the AIS assembly manages the task of assembling AIS information from the AISService with the Topos™ application. Thirdly, the GeoFrameDumper assembly manages the task of periodically storing images from every web camera assembled. Interaction with and status of services and devices can be carried out by use of different browsers (Figure 9 shows a screenshot from the Overview Browser).

The system architecture of the MIO prototype utilizes/challenges the PalCom open architecture in various ways. Firstly, it challenges it in relation to the scalability of the system, that is, the diverse and large number of devices and services involved. During the event at any given moment about 30-40 devices (though, not all directly PalCom-enabled) and 80-100 PalCom services were actively participating in the prototype. The prototype also requires the ability to dynamically start, restart, remove and add services on the fly while still maintaining crucial functionality. To maintain such a complex system, various inspection mechanisms at the architecture level and inspection tools utilizing these were required (Figure 9).

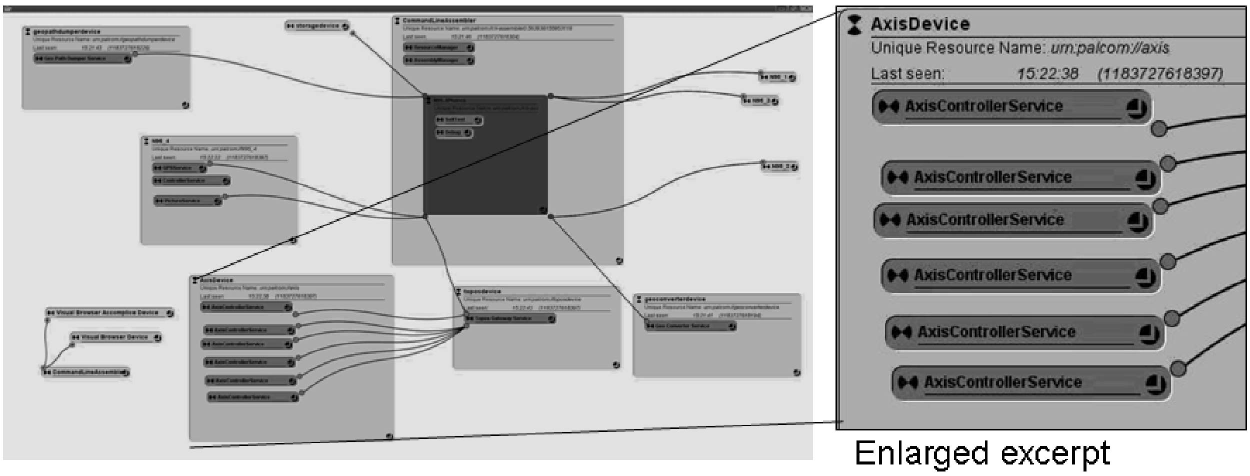


Figure 9: Screenshot of the Overview Browser showing all active/inactive devices, services and connections involved in the Overview prototype at TSR with some details of some devices and services unfolded (detail on the right, showing that there is one AxisControllerService for each of the six video-cameras)

5.2 The Biomonitor assemblies

The Biomonitor assemblies have the purpose to explore how to collect, assemble and distribute different data regarding (injured) persons. We have primarily focused on data, collected by monitors, assembled with person id and location information.

5.2.1 The biomonitor assemblies at the last review

At the third year review we demonstrated use of two biomonitors, and how these became assembled with id-units (RFID readers) and then became visible in Topos Figure 3). We demonstrated how visual information (use of colors) indicated status of the assembly.

5.2.2 Development throughout the year

Since the last review the main efforts have been on fully integrating the prototype in the PalCom service framework, instead of running on top of the communication stack only. Furthermore the RFID service have been implemented and tested, and so has the storage component, developed in WP9. Moreover focus has been on the use situations. The use situations and the implications for the architecture and further design of the physical properties have been discussed and explored at workshops (Figure 10, 11 and 12).

Figure 10**: Workshop at the Palcom Lab**

Figure 11**: Demo and discussions at the ambulance station**

Figure 12**: Use situtations explored**

5.2.3 Current status of the biomonitor assembly

5.2.3.1 The Biomonitor

The biomonitor currently exists in two versions: One for dissemination purposes (the white model with red and black stripes – fig.13) and one for use at future labs and workshops. The version for dissemination has high end surface qualities and lights up in red to simulate a triage category. The version for workshops and future labs is made of silicone with the sensors encapsulated in the moulding. The silicone model offers the possibility of producing small series for fieldwork and as the sensor fittings are robust and the material can follow the curving of the patient's body. In order to do field testing with several monitors in use, 3 extra models have been made.

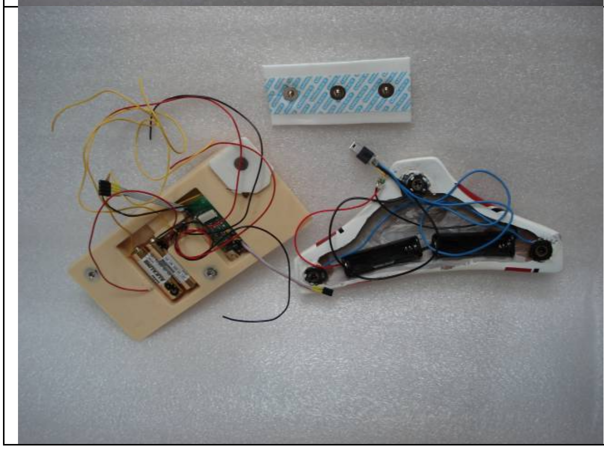
	Left: Silicone model of the biomonitor, made for use at workshops and future labs. Right: Biomonitor model made for dissemination purposes, presenting the biomonitor framework for the public.
	Backside of the biomonitors and the ECG sensors.

Figure 13**: The biomonitor hardware**.

5.2.3.2 Identification unit

The identifications unit has been a primary focus in the future workshops. Important issues and design decisions are described in (Kramp, Kristensen, Pedersen). This identification unit is implemented using RFID technology, as seen in figure 14.

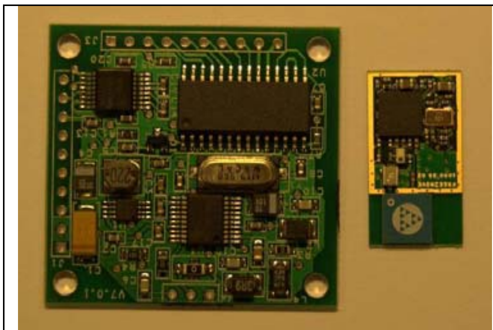
	RFID reader and Bluetooth module for communication
	One of the RFID readers

Figure 14**: The RFID hardware**

5.2.3.3 Positioning unit

The position unit consists of a microprocessor and a radio module. The positioning is based on triangulation between 3 to 5 other nodes. The nodes are positioned 7-15 meters apart, resulting in a precision between 2-4 meters (depending on obstacles). The precision is thus comparable to GPS, but the unit works indoor, under trees, etc. Distances between the nodes are calculated based on the RSSI value. To avoid interference from Bluetooth and other 2.4 GHz technologies the communication is based on 868 MHz (figure 15). The positioning has not yet been evaluated with end users.

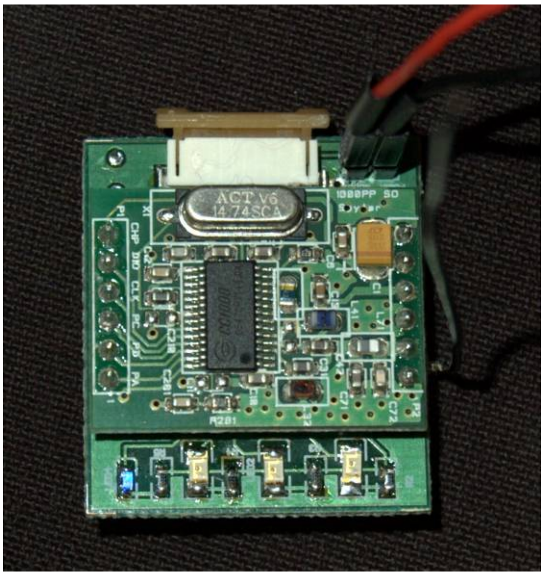


Figure 15**: Positioning hardware**

5.2.3.4 Architecture and infrastructure

Apart from the biomonitoring devices the Biomonitoring System prototype provides the infrastructure to be used in accidents when deploying one or more biomonitoring devices. The infrastructure consists of a number of basestations that construct an ad hoc network on the incident site. These basestations act as access points for any biomonitoring device at the accident site. A simple illustration of a biomonitoring device connected to the basestation is shown in figure 16, where the light grey elements illustrate the components of the biomonitoring device that are not yet fully integrated and that have not yet been evaluated with users future workshops.
The distributor uses the storage component (developed within WP9) from the PalCom Service Framework to store and make the mapping between RFID tag, Biomonitor and Display.
As can be seen in Figure 16, the basestation are accessible for other devices using either WIFI or Bluetooth. These devices might be display units, links to further infrastructure etc.

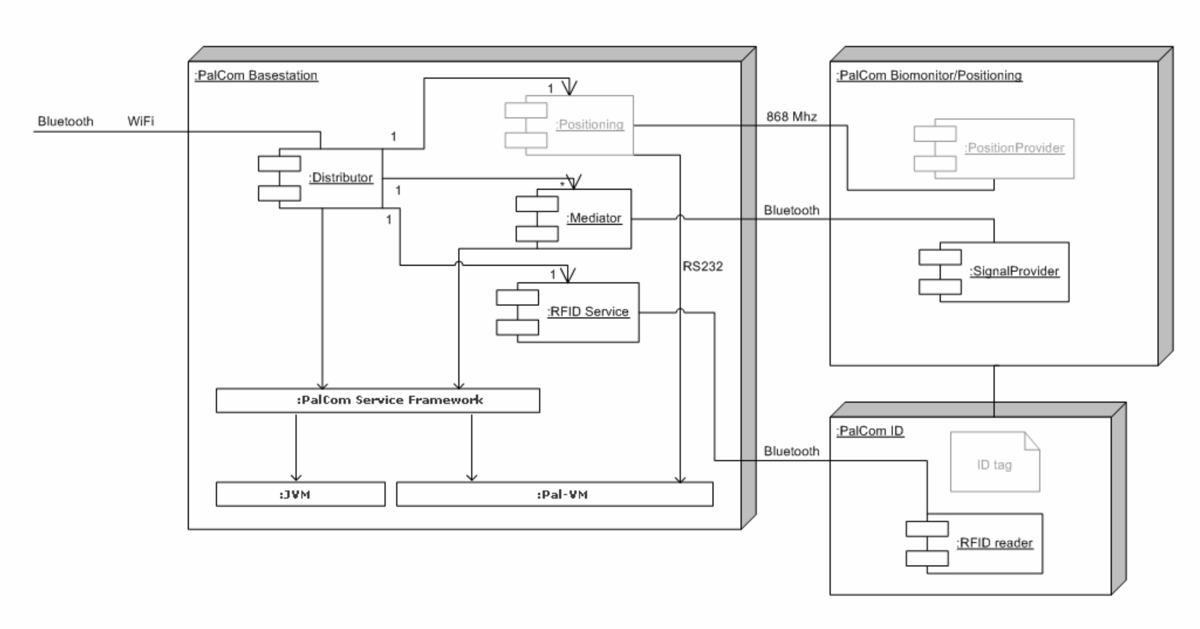


Figure 16**: Architecture of the prototype.**

5.3 Palpability in use

As described in the plan we have especially had the following PalCom challenges in mind:

- Change – stability in settings and situations that are highly dynamic, stressful, unexpected and unknown and where work has to be carried out immediately
- Understandability – scalability of palpable applications, meaning that the application(s) and the body of possible assemblies should be used and be useful in both small and large scale settings – and be understandable whatever 'level' of scale we have
- User control – automation in settings and situations as described above. What should be in control of the user and what should happen automatically, will possibly change, depending on the size of an incident. How to handle contingencies in these settings is of special interest.

However, all PalCom challenges have indeed been considered and dealt with in our work with MIO in Tall Ships' Races.

5.4 Prototype specific references

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Morten Kyng, Esben Toftdahl Nielsen, Margit Kristensen, “Challenges in Designing Interactive Systems for Emergency Response Proc. DIS conf. Designing Interactive Systems, Pennsylvania, 2006, pp. 301-310.

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6 WP 11 Prototypes

6.1 The Active Surface Application Prototype

6.1.1 Introduction

Active Surface is a modular system for supporting physical and cognitive rehabilitation in a swimming pool. Active Surfaces consists of a number of position aware floating units, called tiles, able to communicate with each other and to provide different feedback in respect to the users' abilities (see Figure 17). On the top of each tile is a replaceable plastic cover also held in place by magnets. The image on the cover depends on the game. On each side of the tiles light emitting diodes (LEDs) provide visual feedback to the user. Inside each tile an embedded system uses infrared light to communicate with and detect the presence of other tiles. Two tiles can only communicate if they are close to each other. Systems of modular tiles have been explored in many research projects during the last few years. Our focus on a particular environment such as the swimming pool and the Palpable qualities (such as understandability, end-user composition, change/ stability) makes Active Surfaces different in respect to these other systems of modular tiles [2, 3]. The main purpose is to enable therapists to react flexibly (both in pre-therapy preparation and on-the-fly while engaged in the therapy session) to the diverse and dynamically changing needs of different patients.

Figure 17**: Active Surfaces in use**

6.1.2 Active Surfaces as presented at the last review:

Active surface was under development both in Siena and Aarhus and a physical watertight casing for the tiles were presented. Both prototypes served different scopes, but both utilized the physical casing developed by Aarhus school of Architecture. Data exchange was allowed using IR. The Siena prototype was under testing with the aim of simulating a real context with end users and an early investigation of the Assembler Tile concept. The tests aimed at evaluating real interactions with disabled adults and children. The Aarhus prototype presented at the review showed the PalVM running on a linux-based UNC20 micro processor, able to demonstrate a rudimentary game logic. The main achievement however was not on casing or game logic, but on implementing the PalVM in a resource constrained environment and be able to develop services with small footprint for the target system.

6.1.3 Development during the year

The development during the year has been focused around six main activities;

1. Development of different services targeting the PalVM running on the Tiles.
2. User trials with the final prototype running the PalVM.

3. Evaluate use; strengths and limitations.
4. Conduct further user studies.
5. Feedback to the open architecture based upon user trials and development experience.
6. Dissemination of palpability and implementation towards both the research community and the general public.

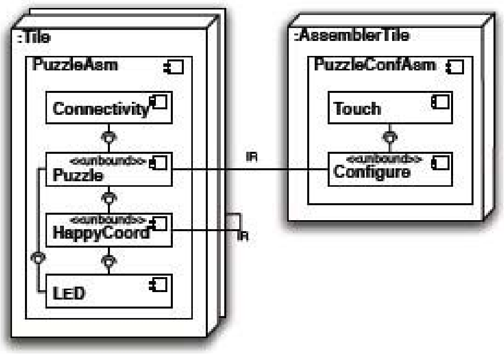
Aarhus and Lund University have both been involved in finalizing the software within the tiles. This work has been driven by input from fieldwork and software development activities carried out by the University of Siena. This work involves both development within the PalVM and its components as well as services running on top of the PalVM and a user interface based upon the Developer Browser.

Due to limited bandwidth, the University of Aarhus and Lund University has both put an effort into the development of a non-XML based protocol for palpable computing, based upon the feedback from trials with the Active Surfaces. This non-XML based communication model goes beyond the scope of the Active Surfaces and has informed the continuous development of components such as for example the generic PalCom Discovery service.

6.1.4 Active Surface current status

The Active Surfaces

The tiles support multiple games by having an intuitive appearance and a multipurpose programmable hardware. Figure 18 shows an UML deployment diagram outlining the structure of the implementation.




```
1 assembly PuzzleAsm {
2   devices {
3     device = urn:palcom://Tile_1;
4   }
5   services {
6     Connectivity on device = Connectivity;
7     Puzzle on device = Puzzle;
8     HappyCoord on device = HappyCoord;
9     LED on device = LED;
10  }
11  connections {
12    Connectivity -> this;
13    Puzzle -> this;
14    HappyCoord -> this;
15    LED -> this;
16  }
17  script {
18    when connectivityUpdate from Connectivity {
19      send connectivityUpdated(thisevent.param) to Puzzle;
20    }
21    when localHappy from Puzzle {
22      send setled('1 1 1 1') to LED;
23    }
24    when sideHappy from Puzzle {
25       send setled(thisevent.sides) to LED;
26    }
27    when localHappy from Puzzle {
28      send localHappy() to HappyCoord;
29    }
30    when sideHappy from Puzzle {
31       send sideHappy() to HappyCoord;
32    }
33    when globalHappy from HappyCoord {
34      send setled('2 2 2 2') to LED;
35    }
36  }
37 }
```

Figure 18**: Services in the puzzle game**

In the puzzle game there are two types of tiles – the normal tiles and the assembler tile. The normal tiles communicate with each other and with the assembler tile using IR communication. In the normal tiles the PuzzleAsm assembly (listed in Figure 18) connects the basic services to the unbound services handling the game logic. The Puzzle service receives connectivity events from the Connectivity service (line 18-20 in Figure 18) and determines the local state of the tile. This information is sent to the LED service (line 21-26) and to the Coord service (line 27-32) that coordinates the global state using the algorithm specified above. If all tiles are correctly aligned the Coord service notifies the LED service (line 33-35).

The assembler tile contains a Configure service with the responsibility of initiating and configuring the game and the PuzzleConfAsm assembly to connect it to the basic services [1].

The Simulator

To ease the development of game logic and software for the tiles a simulation framework has been developed (see Figure 19). This simulator provides a transparent environment for deployment of services, i.e. services developed for the tiles can be downloaded in the simulator and vice versa. Having a simulator available makes it possible to develop software and hardware in parallel and high level tools that are not available for the embedded platform can be used for debugging and profiling. Furthermore, testing involving repeated rearrangement of the tiles is much easier done using a mouse in a graphical user interface than physically moving the actual tiles around.

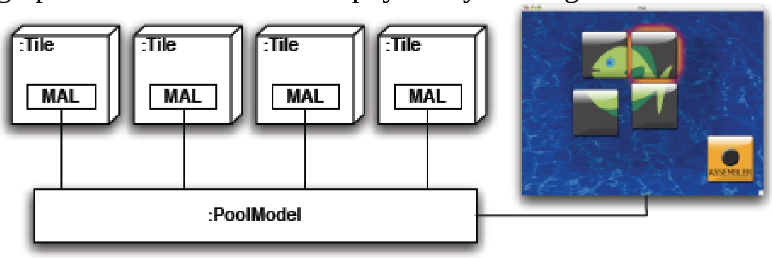


Figure 19: Simulation Framework

A further description of the Active Surface state of the art can be found in [1].

6.1.5 Palpability in Use

The Active Surfaces prototype presents a number of Palpable qualities and challenges. Apart from providing input to the architecture on how users perceive an assembly and how they can work with this assembly, the Active Surfaces challenges the architecture by requiring a small footprint since the UNC20 is a truly embedded system.
The Active Surfaces represents a truly mobile and modular system where end user composition is a key point, addressed by different interaction modes and interfaces based upon the current user and the current needs. Here different end-user programming schemas have been looked into and the idea of 'Physical Programming/Programming by Demonstration' seems to fit the palpable framework in respect to configuration, macro recording and scripting during the activity in the swimming pool, while the scripting language developed within the PalCom project fits well with the user requirements in a pre- and post-activity phase [4]. The Active Surface Prototype will undergo testing at the rehabilitation Centre " Chiossone" in Genova, Italy. The primary objectives of the study are to assess how the notion of assembly can support the creation of new games and adaptation during the activity.

6.1.6 Active Surfaces references

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2. Deliverable 33 (2.13.1), Documentation of work analysis, participatory design and evaluation of exploratory prototypes, http://www.ist-palcom.org/publications/review2/deliverables/Deliverable-33-[2.13.1]-work-analysis-pd-and-evaluation.pdf
3. Grönvall, E., Marti, P., Pollini, A., Rullo, A., Active surfaces: a novel concept for end user composition, NordiCHI 2006, Oslo, Norway, 16-18 October 2006

4. Grönvall E., End User Control in Ubiquitous Systems, PhD thesis, in preparation, 2007.

6.2 The Incubator Prototype

6.2.1 Introduction

The Incubator prototype consists of the BioBelt (a bio-sensitized belt) prototype developed within the Palcom project, the use of the current existing Pulse Oximeter, the use of a software Ventilator simulator, the Mattress prototype, communication nodes connecting the existing equipment with PalCom and the Assembly Browsers, used to manage the devices and the communication. The Palcom Open Architecture is introduced in an incubator setting and integrated through the specific Incubator Assembly, with other standard medical devices in order to provide an adaptable and reliable monitoring station for newborns able to monitor SpO_2, electrocardiogram (ECG), Heart Rate (HR), Breathing Rate (BR), respiratory movement, skin temperature (SKT) and interface pressures in specific anatomical points.
The palpable devices (e.g. the BioBelt) can be assembled in combination with the current equipment (e.g. the Pulse Oximeter) through the Assembly Browsers and can result in a deeper understanding of the baby's conditions for the medical staff. Indeed in this way any failure in the functional connections among the assembly components can be easily detected, in particular those which directly affect the baby's conditions (Grönvall et al., 2007).

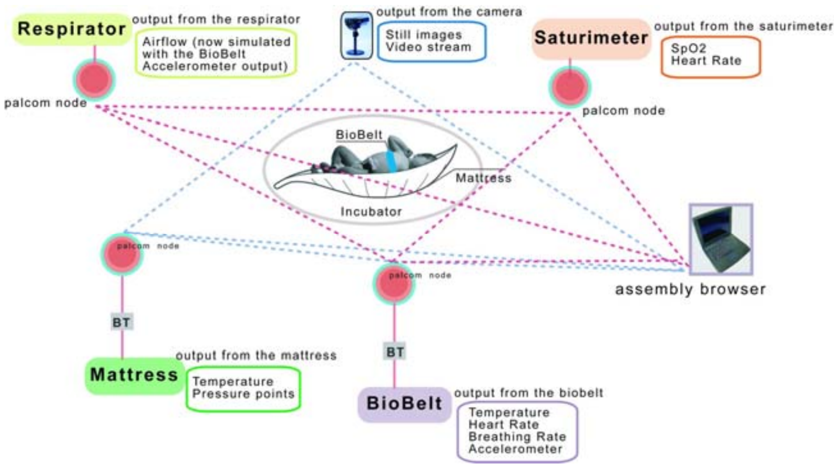

Figure 20: **The Incubator prototype: the system overview**

The Incubator Prototype (Figure 20) consists of:
The BioBelt: A wearable device augmented with a set of sensors placed around the infant's abdomen.
The Mattress: A special mattress made of a gel structure and equipped with body pressure, and temperature sensors.
The PalCom-node: This node is an I/O-device functioning as a bridge between non-palpable devices (existing technologies in the ward) and the PalCom technologies. This allows non-palpable equipment to take part in palpable assemblies.
The Assembly Browsers: With these browsers users can manage assemblies throughout the whole assembly lifecycle (Svensson et al., 2005). They allow the users to construct assemblies as well as reconfigure and turn off assemblies during the activity. The Assembly browsers exist today in two versions: One targeting

developers (Developer Browser), and another version intended for end-users (Overview Browser).

6.2.2 Status of the prototype last year

The Incubator prototype as presented during the last review was composed by a number of running devices and services. These services could be assembled in the Developer Browser (i.e. the development tool for service inspection and composition).
The developed devices and services were:

1. Saturimeter (Device and Service): Connected a Radical Masimo Pulse Oximeter, by a RS232 connection, to the Palpable Framework. Updated once a second, the service could communicate SpO_2 and Heart-rate values to other Palpable services.
2. BioBelt (Device and Service): A part from the physical device itself, a software device and service was developed and presented at the last review. The service gets bio-signals from the BioBelt that communicates over Bluetooth and presents them to other running palpable entities.
3. Display (Device and Service): A palpable device with a running service had been developed to emulate a 3-digit, 7-segment led-display. This device could take a three-digit input and display this data on the simulated display.
4. AlarmDevice (Device and Service): This device with its running services can take two input values and depending on their inter-relation, raise two different alarms as output.
5.

6.2.3 Development during the year

The development during the year has been four-folded:

1. To make existing software more stable
2. Exploring the design and implementation of the Assembly Browsers, tailored for the NICU domain (Figure 21)
3. To develop the Mattress prototype (hardware and software)
4. To develop a display service for the mattress

In relation to this last point, the mattress has been realized and validated through dry-run tests to check reliability, repeatability and accuracy of the measurements.

6.2.4 Current status of the prototype

Thanks to the system developed within the PalCom project, the neonatal doctor can correlate the monitored values and in this way explore new correlations. The values that are surveyed by the BioBelt can be combined by the neonatal doctor in order to have a more comprehensive monitoring of the conditions of the child. For example, the neonatal doctor can compare the values of the SpO_2 (monitored by the Pulse Oximeter) with the diaphragmatic movements of the child (monitored by the BioBelt), in order to improve the monitoring of the hypoxia / apnoea (Marti et al., 2007a).

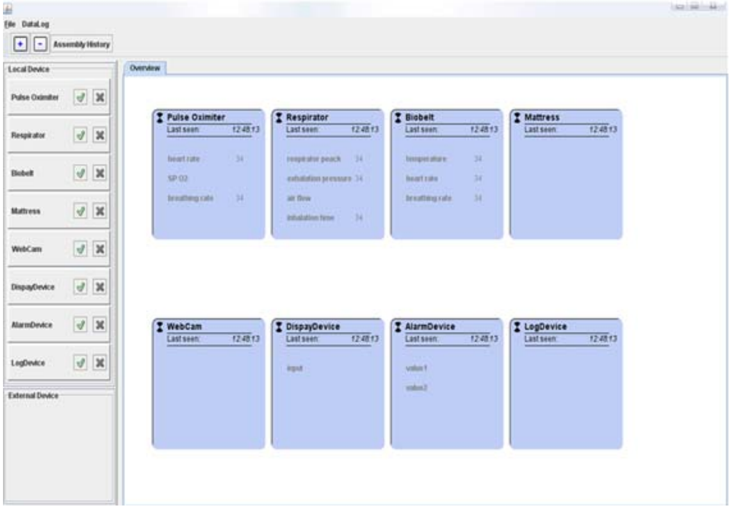

Figure 21: **Tentative layout for the Incubator Assembly Browser**

6.2.5 The BioBelt

The Biosensor belt is a sensitized band. The belt is made possible by a system of sensors inserted in the textile fibre that can be configured in combination with the parameters detected by the other machinery in the Neonatal Intensive Care Unit, according to the specific monitoring needs of the child. In a phase of evaluation the BioBelt prototype was developed by integrating sensors and transducers for the monitoring of the cardiac and respiratory frequencies, the respiratory movements and the temperature (Panfili et al., 2006; Piccini et al., 2004). Thanks to the Bluetooth transmission system the BioBelt can wirelessly send the signals to a generic, remote position, thus offering new possibilities for the non-invasive monitoring of fundamental parameters for the child (Di Rienzo et al., 2004; Andreoni et al., 2005). For further technical details on the implementation and use see (Grönvall et al., 2007) (Figure 22).

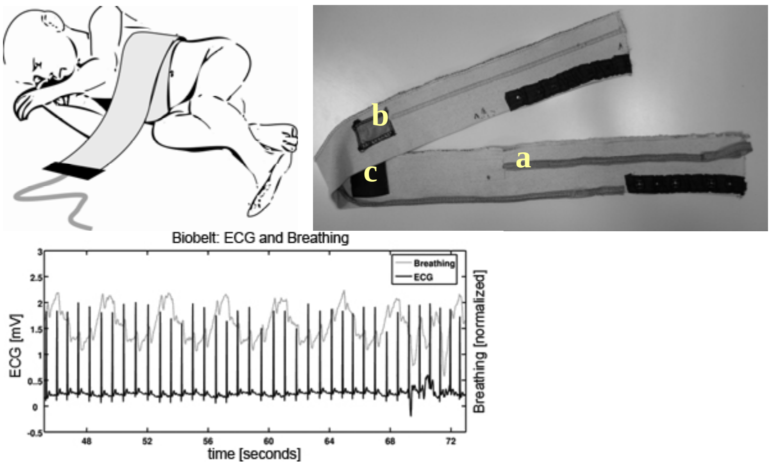

Figure 22: **The Belt prototype: (Left): The biobelt envisioned in use. (Middle): The respiratory sensor (a), an electrode for ECG (b), and the pocket for the accelerometer/temperature sensor (c); (Right): The ECG signal and breathing signal acquired through the Belt (adult people).**

6.2.6 The Mattress

The mattress prototype has been developed in polyurethane gel with embedded sensors for the recording of interface pressures in specific anatomical points, temperature, and movements.
The gel has anti-decubitus properties because it distributes interface pressures along a wider surface with respect to standard foams and with isotropic behavior so relieving the contact points on the body (For a complete description of the gel features see: www.technogel.it).
The pressure and temperature sensors can be embedded in a matrix distribution so they cover all the area under the body. These allows for the measurements of pressure, temperature, respiration acts (indirect measure from the pressure rhythmical variation in time) and movements. These values can be combined by the neonatal team with other data coming from other equipment in the incubator prototype to support specific monitoring (e.g. the web cam or the BioBelt).
The signals are collected through a dedicated DAQ, UBS connected to and powered by a PC where the visualization and setting software is resident. If the PC is a notebook the newborn portability is assured with continuous monitoring (Figure 23).

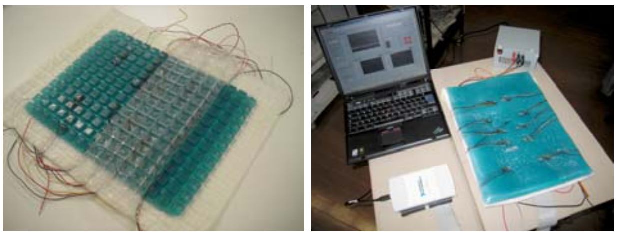

Figure 23: **The Mattress prototype in the construction phase.**

6.2.7 Palpability in use

The incubator prototype embodies specific features of the Palcom Open Architecture, most evident in the following qualities:

- *Resilience*. In the Incubator Prototype when a value in not anymore reliable due to any system's malfunction, the system can automatically switch the input coming from the damaged device to the substitute one, which the user has previously configured.
- *Assemblability*. A specific interface has been designed to allow the neonatal doctor to explore the assembly possibilities. In this same way it is possible to create novel assemblies dedicated to the monitoring of other, precise correlations.
- *Inspection*. The incubator prototype supports a specific notion of user inspection enabled by palpable computing. The medical staff use assemblies and the possibility to inspect running entities to discover problems related both to the machinery and the child health.
- *Adaptability***.** In the incubator prototype, the neonatal doctor can reconfigure the assembly of devices transferring the output of the display device from the centralized display placed at the NICU, to a PDA when necessary.

The Incubator Prototype will undergo clinical testing with the neonatal team at the NICU of Siena Hospital. The primary objectives of the study is to assess how the notion of assembly can support the diagnostic work and the inspection strategies of the neonatal team and how some of the qualities of the open architecture have been interpreted in the use of this prototype.

A part from this assessment closely related to the PalCom Open Architecture, we have submitted a proposal for an experimental study to the Italian Health Ministry that is now under evaluation by the Ethical Board at the Siena Hospital. The study compares the use of the BioBelt and the Mattress prototype with the monitoring device currently adopted for the measurement of the temperature, and the cardiac and respiratory frequencies.

6.2.8 Incubator prototype references

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7 Demonstration kit web application

7.1 Introduction

A primary objective within WP14 is to make the results and activities available not only to the research community but also to the public and industry in general. A central driving force in the Palcom project has been the prototypes. First of all to provide input to the software architecture but also to function as examples of palpability in use. The prototypes are already used for the latter in presentations made by the different partners and by live demos at events and conferences. To secure that the concept and ideas of the demonstration kit also are available beyond the end of the Palcom project, WP14 has made a demonstration kit web application for the Palcom website. The web application presents and describes the developed prototypes in the project and positions them in relation to the Palcom challenges and the Palcom qualities. The website will be launched medio-ultimo December 2007.

7.1.1 Structure of the web application

The structure of the demonstration kit web application is presented in the following and is shown in fig 17.

The demonstration kit webpage is reached from the main palcom homepage by activating the >Demonstration Kit link on the left side column. This action brings you to the Demo-kit frontpage consisting of three main actions choosing between **Challenges, Prototypes and Qualities**. By choosing **Challenges** this brings you to a page describing the palcom challenges and their connection to the prototypes. Choosing one of the five demo-kit **prototypes** (fig.17 top) brings you to the Prototype selection page (fig.17 bottom) consisting of a step-by-step presentation of how the prototypes work. Finally, by choosing **Qualities** this brings you to a page describing the Palcom qualities (see the WP1 deliverable D53 and the WP2 deliverable D54 for information about the PalCom qualities/properties) and the connection between the prototypes and the Palcom qualities/properties.

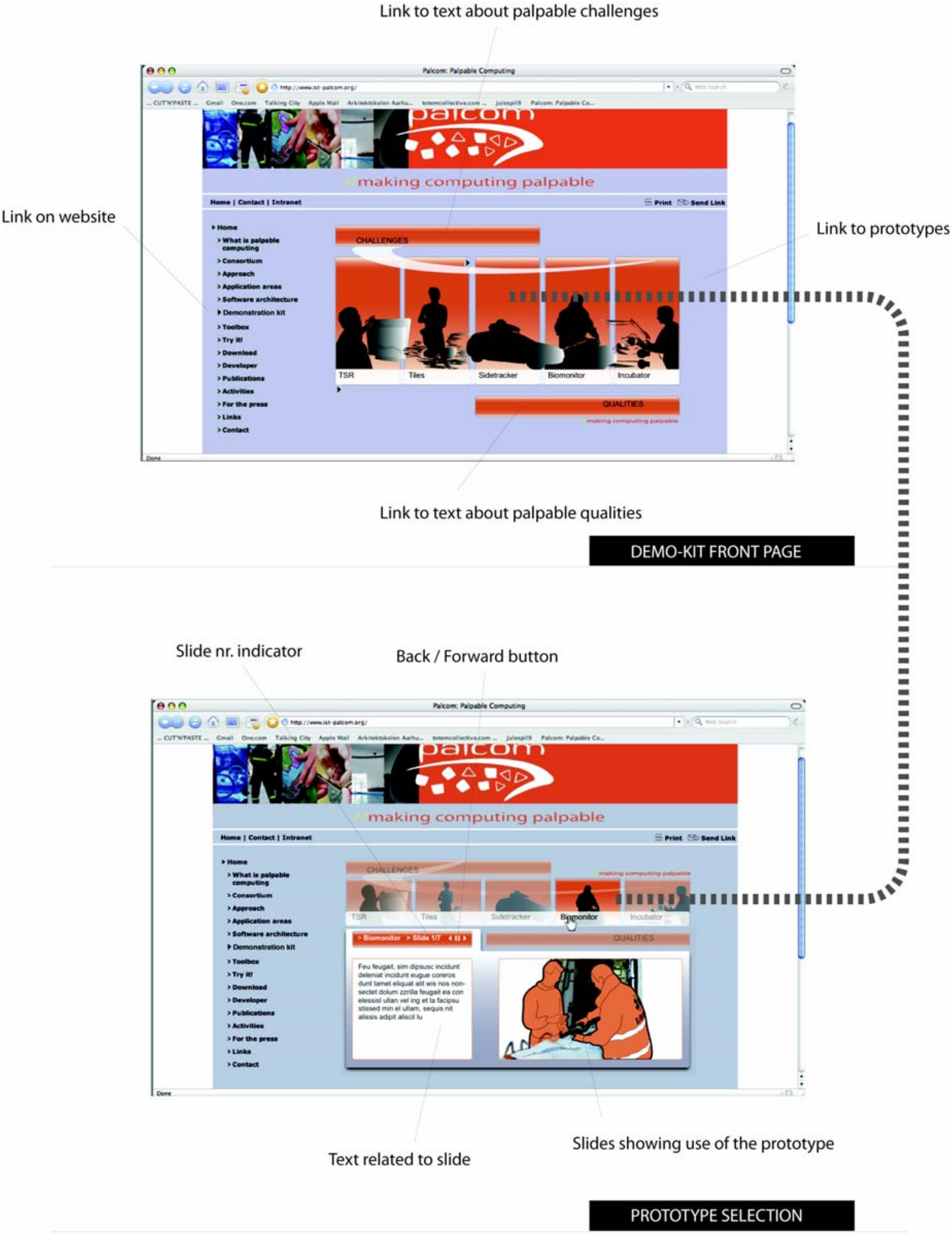

Figure 24: Screendumps from PalCom web, illustrating access to the demonstration kit webpages