ALLOW

Adaptable Pervasive Flows

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Deliverable D8.4

D8.4 - Demonstrator (phase 2)

Contributor...................:	ULANC, FBK, IPVS, IAAS, Imperial
Author............................:	Gerd Kortuem,
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Document History

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V 1.0	2011-07-12	Gerd Kortuem	Initial version
V 2.0	2011-08-15	Gerd Kortuem	Final version

Executive Summary

This report provides a summary of demonstration systems developed during Phase 2 of the ALLOW project. At the end of Phase 1, it had been decided to shift away from a single homogenous demonstrator system in favour of a set individual prototypes that highlight key ALLOW concepts. Thus the integration work has been shifted from the system level to the concept level.

This report describes two demonstrators for adaptive flows and two demonstrators for human-centric flows:

Adaptive Flows:

- Adaptable Pervasive Flows: Towards a more intelligent Environment
- Robust Flow Navigation

Human-centric Flows

- Situated Glyphs and Micro-Display Network
- Teleo-Reactive Policies for Pervasive Flows

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1 Introduction

At the end of Phase 2 all partners of the ALLOW project decided to refocus their system development efforts on a set of demonstrators. This was a major deviation from the original workplan that called for a single overarching demonstrator system.

Deliverable D8.3 Specification of Demonstrator and Architecture (Phase 2) outlined four demonstrators covering the following topics:

- Security: A simulation of a virtual patient ward, with doctors, nurses, visitors, rooms, equipment etc, will be developed to investigate and demonstrate security-aware workflows.
- User interfaces: A series of mobile projector-based user interfaces will be developed to investigate usability issues of flow-driven embedded interfaces and guidance strategies
- Adaptation: A workflow management system will be implemented to demonstrate the feasibility of various workflow adaptation strategies.
- Context and activity sensing: A series of user interfaces will be developed to investigate interface strategies for verifying and modifying sensor generated activity logs.

The overall goal of the demonstration work has been achieved: at the end of the project the ALLOW project delivered four demonstrators as follows:

Demonstrators for Adaptive Flows:

- Adaptable Pervasive Flows
- Robust Flow Navigation

Demonstrators for Human-centric Flows:

- Situated Glyphs and Micro-Display Network
- Teleo-Reactive Policies for Pervasive Flows

By and large the demonstrators fulfil the plan as outlined above. However, in some cases the focus of these demonstrators has slightly shifted as explained below:

- Security: This demo is in line with the plan, yet focuses particularly on teleo-reactive policies
- User interfaces: This demo was originally planned to showcase mobile projector-based user interfaces. However, the actual demo highlights situated glyphs and micro-display networks. The guidance aspect of interfaces has been retained.
- Adaptation: This demo is in line with the plan as it highlight the use of flows in the logistics scenario and dynamic flow adaptation.
- Context and activity sensing: This demo has been refocused to highlight robust flow navigation and context prediction, as the deep integration of activity sensing algorithms with flow navigation was seen as a highlight of ALLOW.

The following section provides an in-depths description of the four demonstrators.

2 Demonstrators

2.1 Demonstrators for Adaptive Flows

Name	Adaptable Pervasive Flows: Towards a more intelligent Environment
Involved Project Partners	FBK, USTUTT (IPVS)

ALLOW Concepts Illustrated:

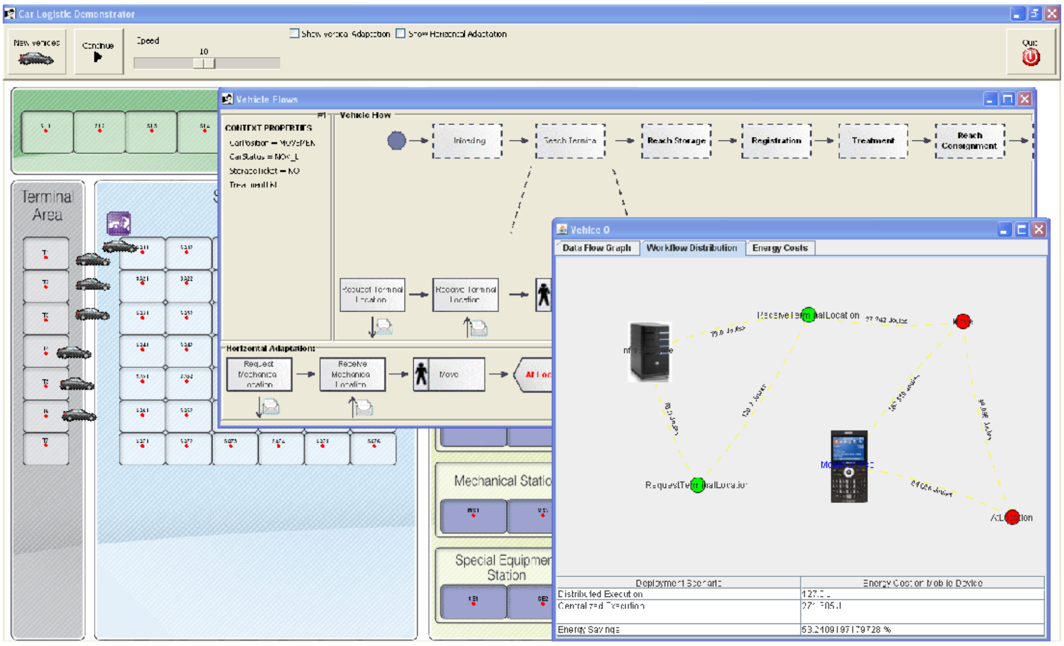
Adaptable Pervasive Flows, flow adaptation flow distribution

Description

In the ALLOW Project a new programming paradigm is being investigated for the design of human-oriented pervasive systems. Adaptable Pervasive Flows (APFs) are an extension of traditional workflow concepts to deal with dynamically changing environments in the real world (e.g. healthcare or logistics). They model the behavior of real world entities (e.g. human or cars) and adapt their execution plan to achieve well-defined goals. For this purpose, a flow is context-aware: during execution information on the underlying environment is obtained (e.g. status of object and humans) to identify possible adaptation needs. At the same, dynamic adaptations of the flows are triggered to reflect these changes. In particular, flows and their control plan are manipulated automatically at run- time, through a set of adaptation mechanisms (i.e., built-in, horizontal, vertical and fragment-based). To guarantee quality properties like performance, reliability, etc., the execution of APFs is distributed on different devices. In particular, APFs are partitioned into fragment and fragments are dynamically migrated to different nodes in the network where they are executed in a distributed fashion. One of the key result of ALLOW has been the design and the development of a framework to manage the execu- tion, adaptation and distribution of pervasive flows in an integrated way. To demonstrate the ALLOW framework in action, we use a real-world scenario from the domain of logistics. The scenario is based on processes in the automobile terminal of the Bremerhaven sea port, where nearly 2 million new vehicles are handled each year. At the sea port, cars arrive by ship and need to be delivered to retailers. Before the cars can be delivered, a series of activities needs to be completed such as customization procedures, car shipment and repair, etc. The management of car delivery is a highly complex process, as each car requires an individual treatment, and the processes might be disturbed by changes in the execution con- text such as car failures. This requires sophisticated modeling that allows for run-time adaptation, and distribution of the application. In our demonstration, we will illustrate the ALLOW framework in action and present the outcome of our algorithms to the end users. We have created a visualization environment (see Figure 4.1) which will enable users to interact with our framework and simulate how pervasive flows in the logistics domain can be executed, adapted and distributed. In particular, they are be able to:

- Run the reference “Car Logistics” scenario and simulate the execution of each business processes attached to each entity (i.e., vehicle, driver, storage locations, trucks, etc..),
- Generate unexpected events that trigger adaptation at run-time (i.e, car damage, driver not avail- able, resources not available, etc..),
- View the different adaptation strategies supported by our framework and how they are used during the scenario execution. This includes vertical and horizontal adaptation.
- Inspect the physical layout for the execution of the flows and see the outcome of a flow distribution algorithm. This illustrates how a decentralized execution of flows can save scarce energy resources on the devices used for interacting with the flows.

The goal of this demonstration is to show the novel concepts and advantages of the ALLOW Frame- work when applied to a real and complex pervasive system. It has been presented at the FET11 Exhibition (European Future Technologies Conference and Exhibition) in Budapest and at the 9th International Conference on Business Process Management (BPM 2011) in in Clermont-Ferrand, France.



Related Publications

A. Bucchiarone, A. Lluch-Lafuente, A. Marconi, and M. Pistore: A Formalisation of Adaptable Pervasive Flows. WS-FM 2009: 61-75

P. Bertoli, R. Kazhamiakin, M. Paolucci, M. Pistore, H. Raik, and M. Wagner. Control Flow Requirements for Automated Service Composition. In Proc. of ICWS'09, pages 17-24, 2009.

D. Fischer, S. Foll, K. Herrmann, and K. Rothermel. Energy-efficient Workflow Distribution. In Proc. of COMSWARE 2011. ACM, 2011.

Videos

Please visit the following links for a video snapshots of a live demonstration.

- http://www.allow-project.eu/demo/ALLOWCarLogistics1.mp4
- http://www.allow-project.eu/demo/ALLOWCarLogistics2.mp4

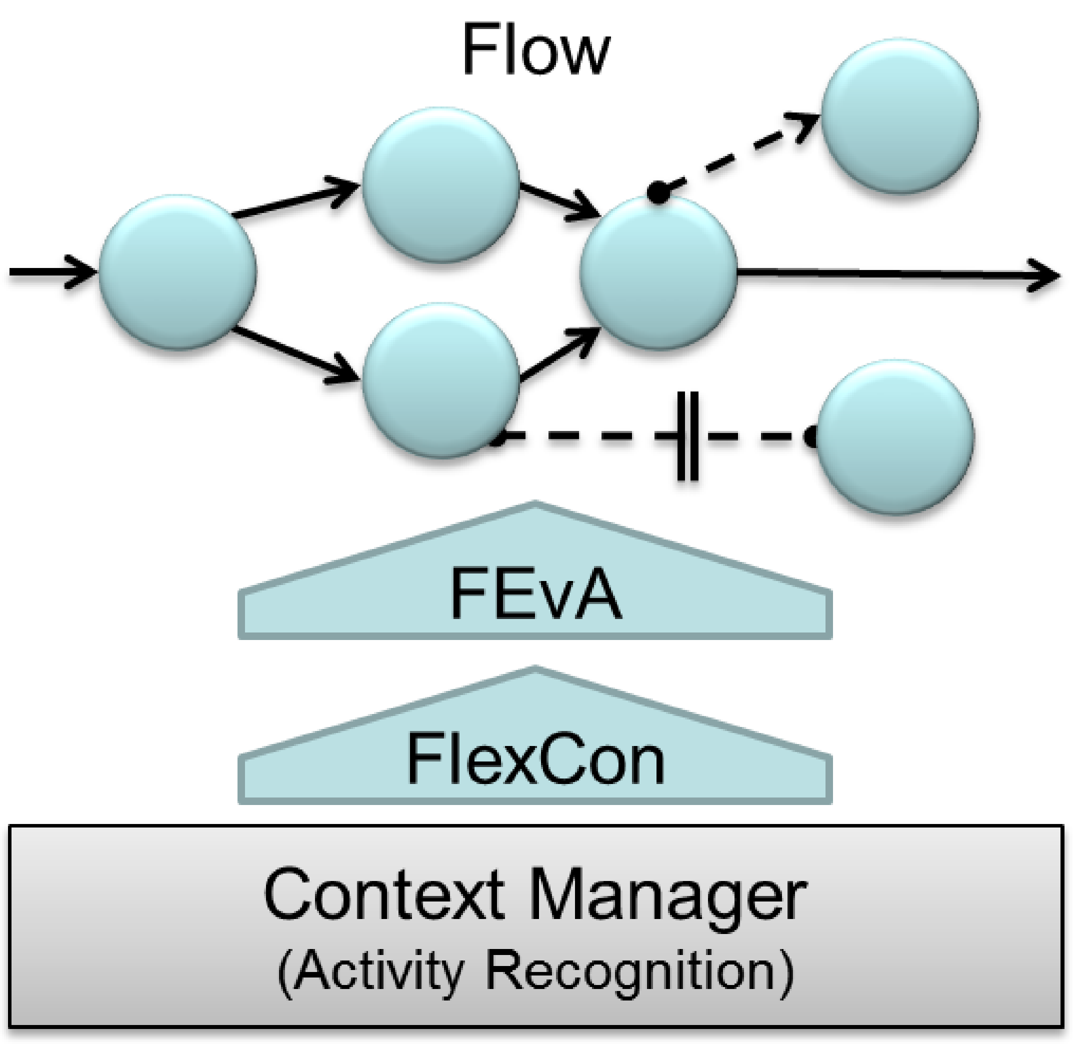
Name	Robust Flow Navigation
Involved Project Partners	USTUTT(IPVS)

ALLOW Concepts Illustrated:

Robust flow navigation

Description

When executing a context-aware application that depends on uncertain context information, the application has to interpret the context information correctly in order to be executed successfully. The systems we build, leverage the structural information encoded in an Adaptable Pervasive Flow (in short: *flow*) to overcome the issues that usually arise when interpreting context information. FlexCon uses this knowledge to decrease the uncertainty of a recognized context event by learning the statistical dependency of different events. FlexCon supports flows that are modeled using either the imperative or the declarative flow modeling paradigms or a mixture of both. FEvA deals with common mistakes in a sequence of recognized context events (false positives, missed events, out-of-order events). FEvA also uses the flow structure to identify possible errors in an event sequence delivered by the context management system and to resolve them using a best effort approach. This leads to a significantly higher number of successfully completed flows and leads to a graceful degradation as the error rate rises. Overall, FlexCon and FEvA establish the robustness in the execution of pervasive flows that is required to provide unobtrusive flow-based applications that run in the background and seamlessly support the user in her activities.



Related Publications

Hannes Wolf, Klaus Herrmann, and Kurt Rothermel. Robustness in Context-Aware Mobile Computing. In Proceedings of the 7th IEEE International Conference on Wireless and Mobile Com- puting, Networking and Communications (WiMob 2010), 2010.

Hannes Wolf, Klaus Herrmann, Kurt Rothermel. FlexCon Robust Context Handling in Human-oriented Pervasive Flows. CoopIs 2011.

2.2 Demonstrators for Human-Centric Flows

Name	Situated Glyphs and Micro-Display Network
Involved Project Partners	ULANC

ALLOW Concepts Illustrated:

Situated interaction framework for flows; situated glyph, wireless micro-display network

Description

User interfaces for pervasive flows have unique requirements that are determined by the characteristics of complex work environment such as hospitals and industrial sites:

- A key functions of flow interfaces is to help people discover the activities that can be performed in a given space, at a given time with the devices and objects at hand.
- Due to the prevalence of manual tasks interaction needs to be hands-free
- Due to time sensitivity of many task users need to be able to perceive and understand information with a minimum of attention, as quickly as possible and in a reliable manner.

Consider the situation depicted in Fig. 1, where a nurse can choose to perform multiple activities with multiple patients and objects. She might decide to use saline water with patient one or patient three, or she might decide to support patient two instead. In each case, she needs information that matches her activity. As existing studies have shown, medical personnel would benefit most from having specific information available (e.g., guidelines) about their *current activity,* linked to *equipment* and *patients* that are relevant to this activity.

These insights have led us to the development of a novel user interfaces concept based on *situated glyphs*, context-sensitive, adaptive and multivariate graphical signs that provide in-situ task information.

In the field of information visualization, a *glyph* is a single graphical unit designed to convey multiple data. Different parts of the representation or different visual attributes (e.g., shape, size, colour) are utilized to encode different values. Up until now glyph-based systems have primarily been used for desktop-based visualization. In contrast, we are interested in how glyphs can be embedded in the built environment (walls, doors, etc) and in digital equipment (machines and medical devices) to build situated work-place information systems. Due to their intrinsic capability of representing multiple variables with a single graphical representation, we see opportunities to use glyphs for exposing salient information in dynamic workplace environments such as hospitals. Our work on situated glyphs and situated information systems differs in a number of important aspects from previous work on ambient displays:

- Situated glyphs encode actionable information that directly influences actions of human actors in the environment.
- The information display of a situated glyph is highly place and time-dependent and relates to the real-world context of where the glyph is located.

This is exemplified by the hospital environment depicted on the right side of in Fig. 1. In this example, a number of miniaturized displays are distributed throughout a patient room. Glyphs visible on these displays encode information that is relevant to the devices or patients they are next to. For example a glyph next to a patient might displays task information for nurses ("next check-up for this patient at 14:00") or represent the quality of the care of the patient ("patient has been visited and interacted with 6 times over the last 12 hours"). One of the key functions of situated glyphs is to help people (in our case nurses) discover the activities that can or should be performed in a given space, at a given time with the devices and objects at hand. Another use of glyphs is to enable nurses and other personnel to reflect upon the overall quality of care they provide.

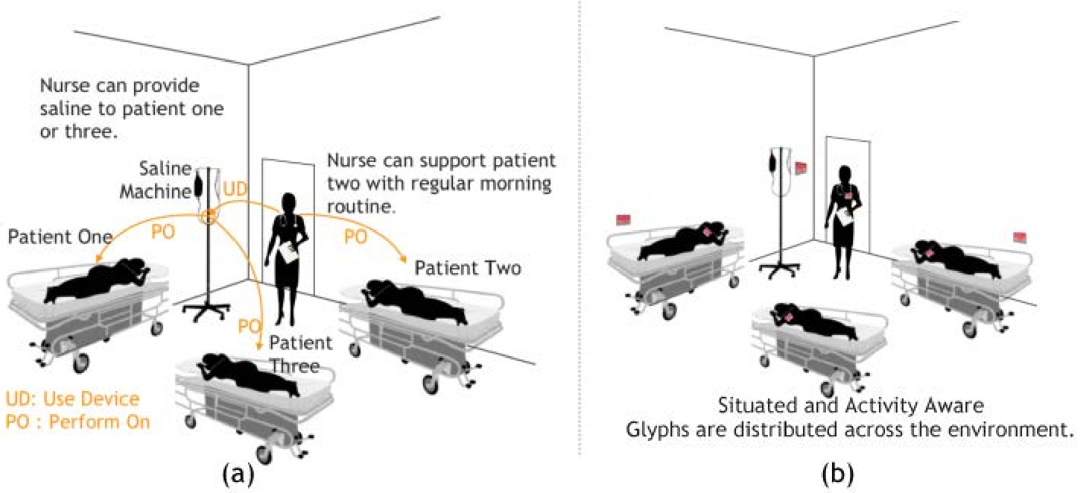


Figure 1. A Hospital Scenario without (left) and with (right) Situated Glyphs

Fig. 2 shows two variations of glyph design for the hospital domain. In the image on the left, text is used to describe a task while the numbers in the lower part define the target patient (left) and the assigned nurse (right). Background color represents the urgency of the task (from blue to red). In the image on the right, the same task is rendered as the combination of a bed icon and a task icon (a pill). In this case this glyph is supposed to be displayed in close proximity and aimed at all nurses, so those values are no longer required. Finally, urgency of the task is encoded in the bed icon colors (from green to red, for better contrast on black background). In this work we present the technical foundation for building glyph-based situated information systems. In particular, we present the design and system architecture of a display network that connects miniaturized, wireless display units into a coherent system.

Figure 2. Two different glyph designs for Hospital Scenario

Technical Details

In the following we present system architecture of a display network that connects miniaturized, wireless display units into a coherent system. The overall architecture is shown in Figure 3.

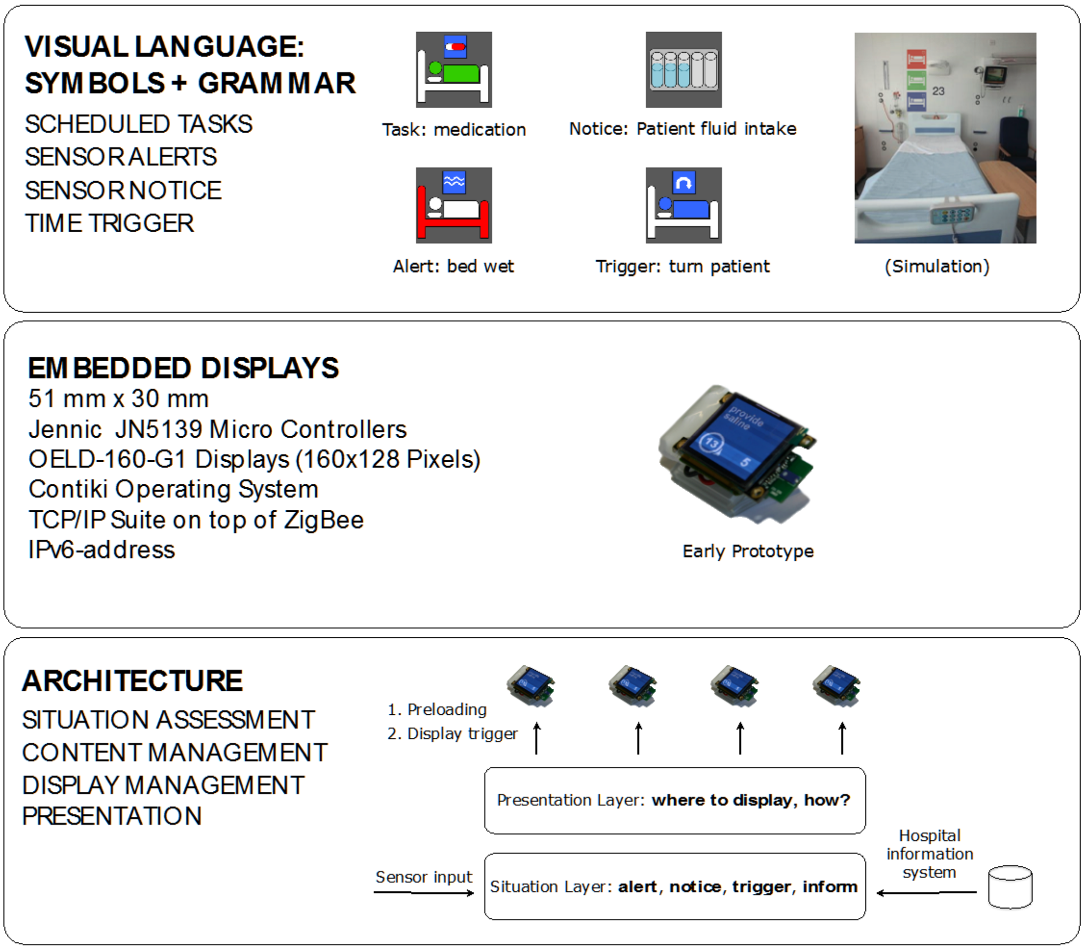


Figure 3. System Overview

Small wireless displays are gaining popularity and have been proven to be useful in consumer products such as Apples iPod Nano. These miniature displays, due to their form factor afford us to utilize them as placeholders for spatially distributed situated glyphs. However, currently available displays are not capable of providing all functionality required for our situated information system. These requirements are:

- Programmability to integrate the functionality of a situated glyph as discussed above.

- A two-way wireless connection to peer glyphs and to a central application server to control status of the glyphs remotely using a standardized low power protocol.
- Low power consumption to survive at least a day.
- High display resolution (matrix display) with good visibility from all angles.
- Minimal interaction support through touch or buttons.

We have developed a custom designed connected display system from off-the-shelf modules to satisfy these requirements (Figure 4). The device is based on Organic LED display. Wireless connectivity is provided by a separate microcontroller with embedded ZigBee 802.15.4 capabilities. Accordingly, our prototype consists of four modules:

- A OLED-160-G1 display module manufactured by 4DSystems, featuring a resolution of 160x128 pixels at 65k colors and consuming 110mA at maximum and 14 mA at minimum, with an average of about 20 mA at 4 V. Consumption depends on contrast which is regulated by environmental conditions.
- The core module is made of a Jennic JN5139 wireless microcontroller that integrates memory, CPU and IEEE 802.15.4/ZigBee connectivity. It has a wireless operating range of about 30m indoors and consumes 45mA during wireless operation. A port of Contiki to the Jennic JN5139 provides IPv6 communication capabilities. Wireless networking is based on the IEEE802.15.4 standard, which targets low-power wireless sensor networks and in our case is geared towards single-hop, reliable, high-speed operation. A sustainable throughput of 8 kb/s through a TCP- connection is achievable
- A rechargeable lithium-polymer battery of the same physical size as the display with a capacity of 1000mAh and associated power conversion unit.
- User interaction support with a touch panel. 0 n display assigns itself a unique IPv6-address. Applications on the Application Server connect to the TCP server on the display. The system is able to run at least for 6 hours with full bright display, constant wireless transmission and constant usage of input. In average settings, runtimes of 3 or more days are expected which fits our need. wIn th case this custom-made display network presenting situated glyphs designed to support complex dynamic activities in a hospital environment.

Figure 4. Wireless Micro-Display Device (51mmx30mm)

Related Publications

Gerd Kortuem, Fahim Kawsar, Phil Scholl, Michael Beigl, Adalberto L. Sime- one, and Kevin Smith. A Miniaturized Display Network for Situated Glyphs. Demo at The Ninth Inter- national Conference on Pervasive Computing (Pervasive 2011), San Francisco, CA, USA. June 12-15, 2011. (BEST DEMO AWARD).

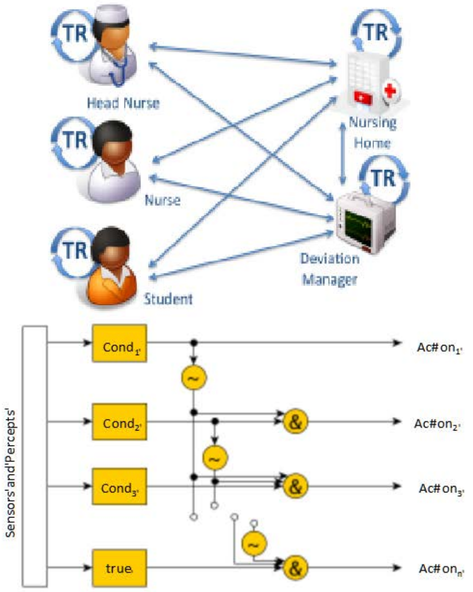
Name	Teleo-Reactive Policies for Pervasive Flows
Involved Project Partners	Imperial

ALLOW Concepts Illustrated:

Teleo-Reactive (TR) specifications

Description

Human-centric Pervasive Systems manage people and human actions as services within the system's operations. These systems are used in patient healthcare, workflow management, logistics etc. In order to manage Human Agents and Actions the pervasive systems need to address (i) the conditions under which actions that have been started may change while the actions are ongoing, (ii) humans may misbehave by delaying the requested actions or simply not do them, (iii) priorities are often required between multiple actions, (iv) some actions may need to be suspended to cater for more important ones. Event condition actions cannot cope with these issues. Our proposed solution are Teleo-Reactive (TR) specifications where conditions are continuously evaluated, actions are durative, and actions are hierarchically ordered and only the action associated with the highest true condition is run. Running actions are pre-empted when higher conditions become true or their associated condition is no longer true. The TR implementation runs on Java SE 1.5 and Android 1.6 platforms and also supports authorization policies.



Related Publications

Srdjan Marinovic, Kevin P. Twidle, Naranker Dulay, Morris Sloman: Teleo- Reactive policies for managing human-centric pervasive services. CNSM 2010: 80-87