

PROJECT FINAL REPORT

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² The home page of the website should contain the generic European flag and the FP7 logo which are available in electronic format at the Europa website (logo of the European flag: http://europa.eu/abc/symbols/emblem/index_en.htm ; logo of the 7th FP: http://ec.europa.eu/research/fp7/index_en.cfm?pg=logos). The area of activity of the project should also be mentioned.

Final publishable summary report



The objective of OPEN is to provide users with migratory interactive services, which enable users to change interaction platform and still continue their tasks through an interface adapted to the new context of use.

At a Glance

Project:

OPEN - Open Pervasive Environments for migratory iNteractive Services.

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Further information:

Project website : <http://www.ict-open.eu/>

One important aspect of ubiquitous environments is to provide users with the possibility to freely move about and continue the interaction with the available applications through a variety of interactive devices (including cell phones, PDAs, desktop computers, digital television sets, and intelligent watches). Indeed, in such environments one big potential source of frustration is that people have to start their session over again from the beginning at each interaction device change.

Migratory interactive services can overcome this limitation and support continuous task performance. Migratory applications are applications that are able to follow users, sense the users' context and adapt to its changes, e.g., changes in the set of available devices, while also preserving the continuity of application sessions. This implies that interactive applications are able to follow users and adapt to the changing context of use while preserving their state.

Therefore, in order to increase possible services and application scenarios in several contexts (services for citizen, business, games, new interactive and collaborative method in work or educational applications, and so on), OPEN aims to offer a novel

infrastructure able to:

- Deliver seamless and transparent support to users in carrying out their tasks when changing available devices, even in multi-user interactive applications;
- Provide and coordinate dynamically changing/reconfiguring services in ubiquitous contexts;
- Offer personalized user interaction by exploiting different interaction modalities and network technologies through an infrastructure able to provide the necessary context information (e.g. available devices, connectivity, users and related transformations for content adaptation).

More specifically, migration is obtained through the OPEN Migration Service Platform (OPEN MSP), a middleware for migratory applications. With a migratory application, users can change which interactive devices and which networks are used to interact with the application, can have the interaction adapted to the form and features of the new set of devices, and can seamlessly continue their work, using their existing sessions with the application.

Figure 1 presents a high-level view of the intent of the OPEN Migration Service Platform, which is to enable software developers to turn an application into a migratory application. The migration platform should be able to take already existing applications and with a small effort making them migratory.

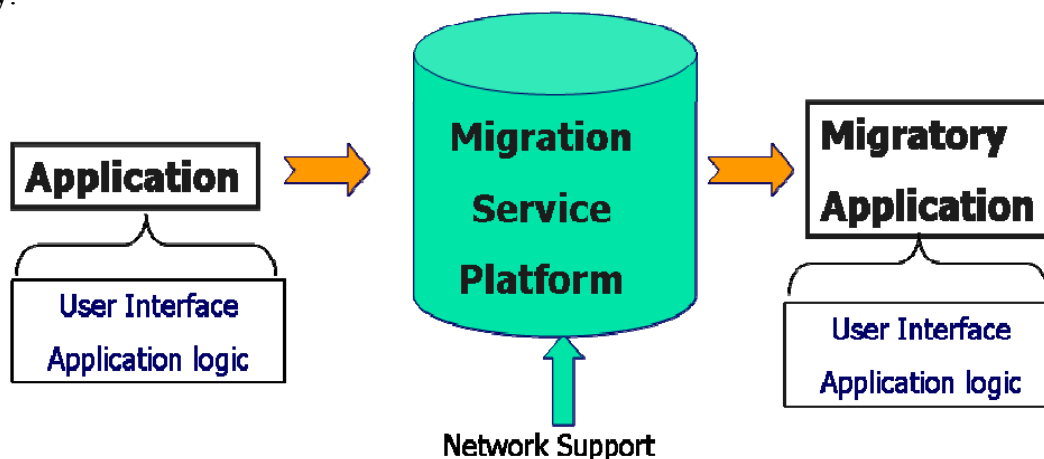


Figure 1: Migratory Application Supported by MSP and Network

As indicated in Figure 1 an application consists of two basic types of components of relevance to OPEN: User Interface (UI) components and application logic components. Both of these can be migrated and adapted by a migratory application with the aid of the OPEN MSP. In addition, a migratory application can adapt to changes in the availability or quality of the networks in the current environment of the user. Thus, as users move about or as their environment changes, a migratory application can perform three basic types of actions, which can be done singly or together:

- **Migration of the user interface:** This type of migration allows users to change the interaction device and to continue their current tasks. The OPEN platform also allows for partial migration of a user interface. Partial migration enables users to switch from single device interaction to multiple device interaction or vice versa. UI Migration also involves adaptation of interaction to the form and capabilities of the target device, e.g., a switch from a large display to a small, touch-based screen.
- **Application Logic:** This concerns the reconfiguration, and sometimes the migration, of the logical (computational) components of the application. Whenever the new device or new devices provide a new set of features or functions which are not supported by the current devices, a migration and reconfiguration of the application logic may be required. A reconfiguration often requires a change in the set of currently active application components. Some new components might be needed; others might be not needed anymore.
- **Network:** Network availability, connectivity and quality can vary from place to place, from device to device, and from time to time. Migratory applications can react to such variation by switching which networks are used by which devices, or by re-configuring how the networks are used by the devices. If the networks support it, migratory applications can also simultaneously switch to a different device and a different network without interruption to their sessions, e.g. audio or video sessions.

The OPEN architecture has been derived through a mixture of top-down analysis starting from the application scenarios and requirements, and bottom up analysis starting with the identification of

relevant functions based on the experience of the partners. It is a service-oriented architecture, based on a client-server model. Basically, our architecture foresees a number of migratory applications associated with a number of devices, with which the user can interact. An application consists of components, which can be of two basic types: interactive (user interface) and functional (computational). The OPEN architecture is also designed to work with a wide range of application platforms, e.g., Web applications, Microsoft Silverlight applications, Java applications. It is also designed to minimize the effort required to turn an application into a migratory application.

By using the OPEN client interface, applications can request migrations. The OPEN server, in turn, completes migration requests by performing adaptations, and by instructing the target clients to execute the adapted migrating application components after restoring their states. In this way, the user has task continuity after the migration. Thus, with the help of the platform, migratory applications are able to adapt to changes in context, e.g., different devices, different networks or the presence of other users. The OPEN server may reside on any device, so long as it is reachable by the OPEN Migration Clients and fulfils the necessary hardware specifications. OPEN Migration Clients are registered to a particular OPEN Server, but might handover as the user moves from one domain to the other.

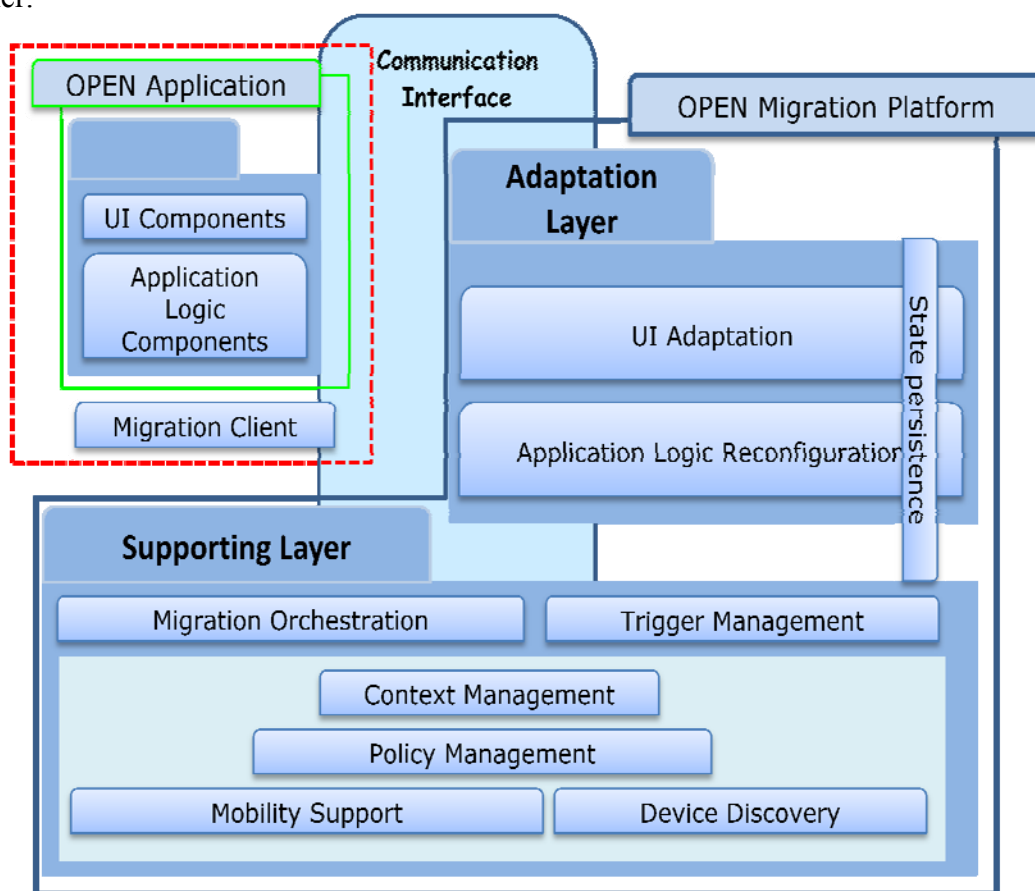


Figure 2: Overview of Architecture and Major Components

Figure 2 depicts some of the major components of the architecture of the OPEN Migration Platform. The platform components are divided into two types: Adaptation Layer and Supporting Layer. The difference between them is mainly that the first type is more closely tied to the type of application, and, therefore, may be application specific (e.g. specific to Web applications), while the second one is more general.

The Migration Client is a client-side component that can discover the devices in the vicinity. Through it the user can see the available device(s), select a target device(s), and trigger a migration. This is done by sending the migration request to the Migration Orchestration to perform the UI migration process. The Migration Orchestration, in turn, utilizes the UI Adaptation component and

the State Persistence components: the first is responsible for UI adaptation, the last for preserving the application state so that task continuity is maintained.

If there has been a change in the underlying networks, the Mobility Support component is used to adapt to it. In essence, this component performs any necessary network reconfiguration. This may be done as part of UI migration, or independently as part of adapting to changes in network connectivity or quality. In addition, the Trigger Management (TM) module is the one that decides which configuration (which means: a set of application components on a set of devices) to choose for migration, based on a set of configurations made available by the Migration Orchestration, which collects information about registered application components. Indeed, deciding which configuration to use can be done either manually (directly by the user), or automatically based on observations of contextual information from the environment such as device and network capabilities. Such information is provided by the Context Management module, which gives information about e.g. the situation of the user, the user's activity, the network state, and any other information that describes the situation of potential candidate devices for target migration. Such information is a good indicator on when and where to migrate and, as said, is the basis for the decisions taken in the Trigger Management, which chooses consequently the configuration that maximizes the quality in the current context.

In order to show the feasibility of the approach, two application examples have been considered and developed during the life of the project.

The first one is an **Emergency prototype** based on a scenario where governmental agencies, organizations and companies representatives work together in order to provide public security in emergency situations (in our case it is a flood event). The Emergency prototype makes it possible gathering and integrating all that information on one screen: thus, it enables experts to better analyze and plan response activities in the flood emergency situation. In addition, it gives them more flexibility for the visual representation of their data on a map because it supports the migration of different application components to one target device. By migrating the necessary components or even whole applications to one target, experts have all the needed information overlaid on one map at their disposal. The prototype uses the OPEN Migration Service Platform (MSP) to register devices on it (target and source devices), to gather context information about the target device and to accomplish the migration. The Emergency prototype is implemented together with a map application as a Rich Internet Application (RIA). The implementation utilizes Microsoft Silverlight, since it offers a wide range of animation and multimedia capabilities as well as lean connectivity to the backend. The communication layer uses XML remote procedure calls for the internal communication bus as well as for the communication with the Open server.

By interacting with the migration control panel, the user can activate either total or partial migration. Each component can be selected for migration and the component that currently is on focus on the map is accordingly highlighted. In the migration settings one can choose to delete the component to migrate from the source device after migration or to keep source and target devices in synchronization. With the help of the Emergency prototype a lot of time that is precious in disaster situations can be saved and mistakes due to oversight can be more easily avoided. The prototype can support decision makers and experts as it enables migration from one to another device, where whole applications as well as application components can be migrated. Migrated components merge with each other and can be kept synchronized with the source device.

The second application that has been developed is a **Social Game** that offers several functionalities, including chatting, betting, watching IPTV, playing a multiplayer racing game and each functionality takes up a different area of the screen. The Social Game is inspired by a scenario in which the user has the possibility to compete against real pilots while watching a live grand prix event, and to interact with other members of a gaming community through a chat service and simulate betting on a set of different parameters. Some additional information about the track and the participants is also

available, as well as pilots' performances and lap records. Moreover, the user has the possibility to bet on the live race's results according to different parameters. The developed application allows the user to play a multiplayer racing game, watch a video, chat with other users. The elements exploit different technologies and this makes the application an interesting use case for experimenting with migration functionalities across various platforms. For instance, the IPTV (on the top-left) is simulated through a Flash player and allows users to watch in streaming recorded videos, to switch among the channels, to pause and restart the video being watched, as well as to control the volume and to switch to full-screen mode. The Chat is JavaScript -based and provides basic chat functionalities, such as a dialog window and the buddy list. The Betting is a JavaScript and Ajax service, which allows the user to bet on the live race results, according to different parameters. The technology adopted is based on an embedded browser object in form of plug-in implemented in C++. The game can be controlled by the keyboard and the mouse of a desktop PC or, alternatively, by the keyboard of a mobile phone. As for the authentication system, to access the Racing Game, the Betting and the Chat, the user needs to log into the application using her/his own username and password. The final Social Game application makes full use of the Migration Service Platform, and showcases the use of its functionalities, including: the Migration Orchestration, the Context Management Framework and the Web UI Migration.

The OPEN Migration Service Platform represents the main output of the OPEN Project and the basis for all other key results: it enables the development and execution of migratory applications, which can have three primary capabilities: user interface migration, application logic reconfiguration and network reconfiguration. This has been obtained by delivering a middleware that is able to consider and integrate various aspects: adapt and preserve the state of the software application parts dedicated to interacting with end users; support techniques for application logic reconfiguration; and identify suitably flexible mechanisms available in the underlying network layers. The resulting middleware is also able to interoperate with existing technologies. The platform contains functions to deal with the various requirements that must be fulfilled to support migratory applications. These functions which more or less corresponds to the implemented modules are: User Interface Migration, Application Logic Reconfiguration, Mobility Support, Context Management, Migration Orchestration and Trigger Management. Such modules can be exploited in various way by several applications.

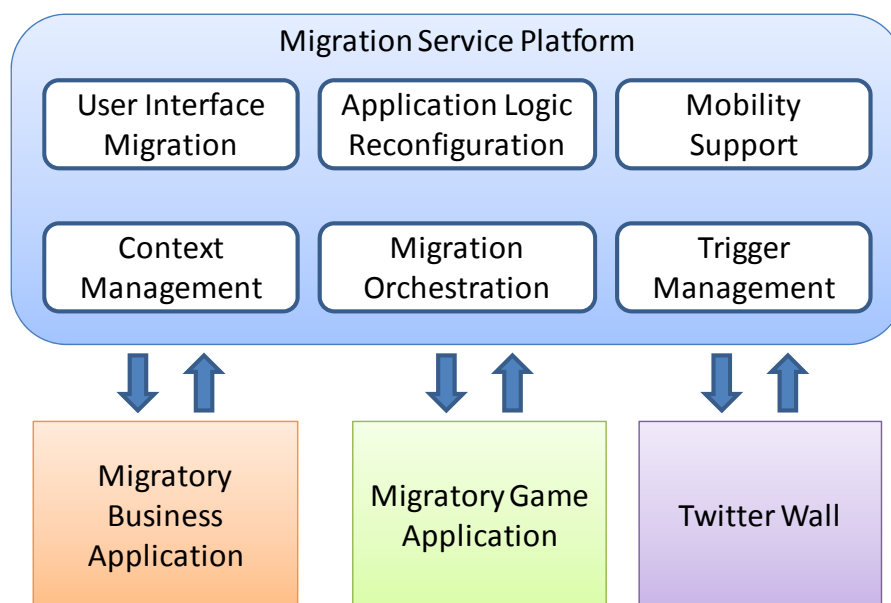


Figure 3: Key results of the OPEN project

More specifically, if we consider the various technical aspects involved in the migration, the results that have been obtained are the following, according to the main aspects involved in the migration itself.

From the point of view of dynamic generation of migratory user interface in multi-device environments, the main results have been i) the production of a device-dependent content adaptation and presentation supported by a Cost-based, bi-directional, semantic redesign; ii) the delivery of a user interface state logging and persistence module that gives support for Forms, Cookies, Sessions, JavaScript; the building of Tools and techniques to support multi-user interfaces in migratory interactive services, iii) the possibility for the user to interactively select the component to migrate by directly interact with the Web applications.

From the point of view of system support for migratory application interworking, the main results have been i) a Network support successfully integrated, validated and tested the implemented components in the migration platform: this implied the delivery of four basic modules of our Migration Platform: the Context Management (based on existing solution from MAGNET Beyond with an OSGi extension) , the Trigger Management (score based and model based trigger detection and decision framework developed), the Migration Orchestration (generic orchestration framework developed), the Mobility Support (SOCKs based solution developed)); ii) the analysis of some components in terms of performance (e.g. reliability);

From the point of view of application logic reconfiguration, the main results that have been achieved are i) the development of a component supporting the dynamic reconfiguration of component-based applications based on context information, using a technology independent specification of adaptation behaviour, and integrated with the trigger management and the orchestrator of the OPEN platform to perform the reconfiguration; ii) the development of a (template-based) concept for the realization of mobile adaptive applications that supports the specification of an application without referencing application components directly.

The other two key results are the two applications that have been considered in the project (which have been described above), and which show the capabilities of the Migration Service Platform. Indeed, such two applications not only have shown the feasibility of the MSP to manage such two quite radically different domains, with different requirements and characteristics, which is a good sign of the generality of the approach but also the evaluations that have been done on them have demonstrated a reasonably high quality results. Indeed, for the Emergency prototype the evaluation results showed that the necessary time for executing a migration operation is quite short (which is a critical factor for the emergency scenario considered), and the prototype has an average to high level of maturity, while for the social game prototype the evaluation has shown that the user experience was sufficiently good.

Overall, the trends analyzed by OPEN indicate a future in which people are always online at broadband speeds and with multi-media access, using a range of devices, and engaged in a number of social networks or social games. Actors in the telecommunications market have responded to these trends with efforts like the ‘multi-screen ambition’, which aims to provide the ability to deliver the same service to any device, wherever and whenever required, and with a recognizably similar (if not identical) user and developer experience. OPEN enables an expansion of this vision to the simultaneous use of many devices, or the sequential use of one or more, without disruption to the services being used.

At first, such functionality may be offered by means of proprietary mechanisms. But, just as users eventually demanded open interfaces to databases to avoid vendor lock-in, so eventually, users will demand open interfaces, like those developed in the OPEN project. Their introduction will have an impact on several players in the ecosystem; from service designers to transport networks. It could

also introduce a new role in the value chain and new type of business models e.g. considering a 'migration feature' as a new service to be offered.

The range of opportunities that migratory applications open up can be beneficial in radically different application domains: for instance, applications whose tasks require time to carry out (such as games, business applications) or applications that have some rigid deadline and thus need to be completed wherever the user is (e.g.: online auctions). Indeed, in current interactive applications there is limited support for state persistence and continuity across various types of devices.

Various other markets were also identified as potential beneficiaries of the OPEN Platform. In the following subsections we will briefly outline the main key markets trends in order to outline future market scenarios where the OPEN project's results (e.g.: the OPEN Migration Platform) will be useful and directly applicable. These trends will generate opportunities in the ICT arena to create new services, have impact on several players/stakeholders and it could even introduce new types of business models. In the next paragraphs we discuss some possible impacts.

Telco Industry

a) Broadband (BB) access:

Broadband is moving beyond the PC: it will be about connecting numerous devices, providing consumers with a range of multimedia services in an always-on digital world. Therefore, the ability of gadgets of all sizes to connect to the Internet and download or stream content will be more and more prevalent in coming years, and this will progressively lead to make connected portable devices (from net-books to game consoles, ..) to complement "traditional" items such as mobile phones and desktop computers.

In addition, mobile devices with increased power, faster communications capabilities and higher resolution displays are already increasingly saturating everyday life, in the future they will likely have more options for connecting to the mobile internet and the access will be more ubiquitous.

Also, wireless broadband networks and technology developments are paving the way for a far more flexible broadband environment that will increasingly allow users portable and nomadic access to content, applications and services.

Finally, the world of telecommunications is in constant flux, with fast, mobile networks enabling uninterrupted access to new internet-based products and service. Technical progress, increasing levels of network coverage, greater bandwidths allowing higher data speeds are factors which will expedite the progress of digitization and networking.

b) Multimedia Services

The area of multimedia services can be considered another trend in which the migration features can be exploited in the future. This can be explained by highlighting a number of factors. First, broadband internet access is popping up in TVs: new TV sets have built-in networking connections requiring no additional set-top boxes for getting online, the usage of online video services is rising quickly and HDTV is gaining ground.

To this respect, a key role is played by IPTV, which has the potential to transform the TV experience, not just by offering more choice and flexibility, but by integrating aspects of communications and social computing. Indeed, the future home will be a place where consumers can watch what they want, when they want and by whichever device they want, and the average family might have a TV in every room, with each family member might be using them for something completely different (e.g.: watching one of hundreds of channels, playing video games or watching DVDs or YouTube clips). Then, IPTV expands the range of what's possible with TV. In addition to viewing video content, the TV can become a screen to view our personal digital photos or to make a video phone call. It also frees us from watching TV in the home; IPTV means we can take our content with us, wherever we go.

c) Social computing

In many areas of life, digital networking is taken for granted and the importance of these technologies will continue to increase. Digitalization and networking ensure that anyone can stay in touch with people and things at any time. Social media encourages also the formation of communities around a topic (e.g. a community around a game as the one on EA's Pogo – <http://www.pogo.com> for example) and in turn enhances the game itself. The growth of digitalization and networking with broader bandwidth, faster speeds and more widespread use of mobile broadband connections will further influence and shape the way we communicate.

d) Gaming

Cross-platform gaming (e.g., solutions across interactive TV, online and mobile platform, such as role play games with several online players) is gaining momentum and in the future, leisure activities will be strongly influenced by digitalization and networking (for instance, it will become common to listen to music or radio over the Internet, access videos at any time or fill in waiting times by playing games on mobile handsets, ..). Connected (online) mobile games will also gain momentum with increasing network capabilities in terms of latency and throughput. Some technologies that will become more common in mobile games (such as the mobile phone cameras) will encourage the development of games with new interaction styles. Technology enhancement will drive flexible game interaction functionality (such as the use of voice chat simultaneously with game playing, presence and messaging) as well as an increasing quality of the mobile games (through the use of hardware accelerated 3D graphics).

Multi-Screen Ambitions

In the context of 4G Technologies, the core of this idea is the ability to deliver the same service to any device, wherever and whenever required and with a recognizably similar (if not identical) user and developer experience. This ambition is, in its turn, driven by two other trends: the emergence of Internet video content, and the growth of multimedia-enabled consumer devices. Long term trends, such as 4G technologies, will influence and redesign end user device markets and scenarios; new handset categories have emerged with each network generation, so let's have a look at what we can anticipate with the transition to the coming generation. Next generation devices present an opportunity for multi-screen players, who integrate services across device types. To play this game, Service Providers aim to expand their platform influence beyond mobile devices, extending the reach to the connected home and the extended home. In this arena, software platforms and the surrounding ecosystem of developers are vital assets in realizing this vision.

The Migration Service Platform plays a key role in the "multi-screen ambition" in order to offer a completely immersive user experience. From the architecture point of view the platform plays as an "abstraction layer", able to separate content delivery platforms from the end-user devices. In the end-to-end ecosystem, this Migration Service Platform will be a new "element" that enables device agnostic access to the end user point of consumption. Depending on the various value chain viewpoints, OPEN MSP introduces different types of scenarios:

- Content Providers (BBC, Warner Brothers, SKY ...) could add "as a new feature" a migration capability to their network
- Carriers/Services Providers (Mobile Operator like Vodafone, AT&T, ...) could introduce migration capabilities to their network as a new service;
- A new type of player could appear in the value chain: a Migration Provider, which offers "just" migration services. This means for instance that in a cloud based paradigm [an emerging approach especially in the mobile playing field], a Migration Provider offers "as a

Service” migration capabilities to everyone who needs it. From the end user point of view, it would play in a horizontal way, across different carrier networks.

The introduction of a Migration Service Platform in the end-to-end service ecosystem also could impact developers and device manufacturers. In the design phase, developers have to consider new continuity capabilities offered by underlying layers that could enrich the overall service/application and also could open the door for new types of end user interaction. Device manufacturers could introduce new hardware features leveraging Migration Capabilities, or design new device interfaces considering service continuity as a commodity.

Digital Signage

Digital signage aims to replace paper signs with digital displays, novel social games, and, the fast-growing ‘public safety and hazard prevention’ market. Regarding the Digital Signage, this has been judged as an interesting use case for the Open Migration Platform, in that it could be considered an excellent addition to the Digital Signage ecosystem. By allowing users to migrate their applications onto a public display (e.g. in an airport) we achieve an unprecedented level of engagement, being able to reach users in new ways and generating new revenue streams. Consider the issue of dwell time in front of a Display: As Helios Interactive puts it, “What is initially captivating about Digital Signage –



Figure4. Some of the functionalities of the Open Platform have already been used in the Information Surfaces demo

Motion, color, movement – can quickly become commonplace, as the technology spreads”. Today’s competition in Digital Signage does not deal with information provisioning, but rather with attention grabbing. Engagement is the key to increased dwell times and eventually conversions. In summary “Without True Interactivity, a Sign is Just a Sign”.

It is not uncommon for users on the go to yearn for a larger resolution and size display which makes their work lighter. Numerous public displays already exist in shared spaces such as waiting rooms, airports, train stations, etc... Consider then the possibility of running your applications on said displays, be it because you need more resolution or want to share it with

people (e.g. the Emergency Scenario) or because you are aiming at a more social usage of your application (e.g. TwitterWall and Social Game).

Using the OPEN platform, such displays could be used modularly, both supporting user applications and its originally intended content, which ranges from concrete information like flight schedules, all the way to targeted advertisement.

The whole OPEN Platform comes into play in such scenarios:

- Partial migration is used to run both the users intended content and the Displays’
- Multiuser interfaces play a role in allowing multiple users to share a display
- Privacy Policies are considered within the Trigger Management modules to protect the user information
- Device discovery mechanisms allow the user to connect to the display and migrate their application
- Content Adaptation can be used to tailor the application to the display characteristics, and Application Logic Reconfiguration takes place to adapt to the new interaction models.

For all these reasons, the OPEN Platform clearly fills a gap in the growing business of Digital Signage, providing differentiators that not only offer new functionalities to users, but also provide novel opportunities for several stake holders, including Digital Signage software vendors, installation owners and hardware vendors.

Safety And Hazard Prevention

The Public safety market is an active growing market (for example, Motorola expects next generation public safety, wireless broadband, command and control to grow at a higher rate, typically 10% plus on a compounded basis). A large amount of activity is taking place within this market, which include systems for handling e.g. chemical emergencies, earthquakes, fire or wildfires, floods, hazardous material, nuclear power plant emergency, terrorism, thunderstorm, tornado, tsunami, volcanoes, landslides, winter storms, ...

Emergency public information is an essential part of emergency planning and preparedness. Disaster response and recovery efforts require timely interaction and coordination of public emergency services in order to save lives and property. Also early warning is critical in reducing the scale and cost of the disaster damages. Information Technology is used in the field of safety and hazard prevention only to a limited extent, but there is a tremendous potential for increasing efficiency and effectiveness in coping with disasters. Pervasive and Grid computing also referred to as ubiquitous computing, may hold the key to new flood monitoring and alert systems. Pervasive computing describes the increasing numbers of computing devices that we carry all around i.e. not just desktop and laptop personal computers but mobile phones, PDAs (Portable Digital Assistants), digital cameras and other electronic accessories. Pervasive computing devices provide an exciting opportunity for intelligent sensing of the natural environment. Web-based technology, GIS spatial data and GPRS communications technology also add value to these systems.

Lesson Learned

Regarding the lessons learned a number of aspects can be highlighted, with respect to the different aspects that have been covered in OPEN.

Regarding the migration of the user interface, we learned that dynamic migration of Web Applications without posing constraints on the authoring techniques is possible. Indeed, the OPEN Migration Platform, through a reverse engineering step is able to reconstruct the logic of the web page and then redesign it according to the characteristics of the new platform, without requiring the use of specific tools from developers of web pages. Giving the huge number of web pages that already exist in the Web and considering that they will likely be growing in the future, this is a powerful characteristic of our approach that opens lots of possibilities for exploitation and encourages us to still convincingly pursue this direction. However, some issues have still to be addresses (e.g. especially in the management of the JavaScript part of web pages). Other directions to be further investigates are issue associated with security and privacy, as well as relations between migration and the emerging field of cloud computing.

Regarding the application logic reconfiguration: we learned about the advantage of separating the reconfiguration from the application logic: indeed, Separating the reconfiguration and the application logic reduces the complexity of the code and enhances the maintainability. In addition, another lesson learned was the need of adopting a technology independent description of adaptation behaviour, which enabled reconfiguration of components, which are realized by different technologies, and an easy integration of application logic reconfiguration in state-of-the-art middleware. Finally, another lesson was the importance of specification an application without referencing application components directly : it Enables integration of new components into

applications that were not known during application development time. At run time new components can join the system, if structural and functional constraints are fulfilled.

Regarding the network issues, some conclusions can be derived as well. In particular, one was the fact that the type of migration application and its behaviour are important aspects needed to be considered when deciding upon triggering a migration. Also, link and network performance are crucial for the success of a migration process, which therefore needs to be monitored and controlled by a migration platform. More specifically, focusing on the Context management, we noticed that shifting to an OSGi based platform has significantly made working with the CMF easier and opens for further easy (re)configuration of the CMF. In addition, reliability study of access to dynamic context information provides helpful insight into how a context management may reconfigure systems for higher performance. Furthermore, in the context of the Trigger Management, we derived that the key importance for automatic triggering is reliable and confident estimated data. To this regard, adaptive model based approaches to decide upon automatic triggering will be needed for more complex system settings.

In addition, we were able to extract some lessons also from the applications we considered. The most relevant one is that developing a general platform supporting all languages and technologies in different application domains is very demanding. Nevertheless, though it is more difficult to adapt an existing application to make it migratory than starting with the migration in mind, we found a number of advantages of using the platform, which include the building of coherent UIs for different devices (automatically adapted), the abstraction of network layer, the automatic reconfiguration for application logic, the support for task continuity, the easy access to context information.

The OPEN Book

One important dissemination channel of OPEN is the OPEN book, which has been delivered by the OPEN Consortium and published in the Human-Computer Interaction Series of Springer. It is a joint effort of all partners and it describes in a coherent way the objectives and the major results of the OPEN Project as well as their applicability.

The book is structured into a number of chapters that provide a comprehensive and coherent view on the topics introduced and provides an interdisciplinary (involving disciplines such as user interface software and technologies, software engineering, distributed systems) contribution to address emerging issues in ubiquitous environments.

We start with a discussion on where it is useful to migrate, and what is specific to that environment and adaptation opportunities from the mobile operator perspective by Vodafone. Then there is a description of the state of the art from various viewpoints provided by Aalborg and CNR. Next, we have the chapters dedicated to the migration platform design. In such platforms we distinguish the support in terms of user interfaces, network and protocols, and application logic. An introduction to the OPEN Migration Service Platform architecture and the possible solutions is provided by NEC. User interface migration based on the use of logical descriptions is discussed in a chapter by CNR while Service Migration Network Support is considered in another one by Aalborg. Then we have the Application Logic Reconfiguration based on application and component descriptions by Clausthal. In terms of application we have reported the design and development of a migratory application based on OPEN Migration Service Platform by Arcadia, migratory services in an Emergency scenario by SAP, and integration of User Interface and Application Logic Migration (the PacMan example) by CNR and Clausthal. Lastly, we discuss the usability evaluation and the programmability assessment of migration by Vodafone and the technological partners, followed by an indication of potential exploitation and some conclusions.

4.1 Use and dissemination of foreground

Section A (public)

The project has published and will continue to publish in the near future contributions in international conferences and journals in the areas of human-computer interaction, software engineering, ubiquitous systems, advanced applications, middleware, networks. Tutorials will be presented as well. The web site will continue to be alive to allow interested parts to download the public deliverables and videos of the demos. The topics of the project will be in particular addressed in the ACM Engineering Interactive System Conference 2011, which will take place in Pisa (Italy) in June 2011. The results of the project will also be considered in the W3C standardization body, in particular in the group dedicated to create standards exploiting model-based descriptions of user interfaces.

TEMPLATE A: LIST OF SCIENTIFIC (PEER REVIEWED) PUBLICATIONS, STARTING WITH THE MOST IMPORTANT ONES

NO.	Title	Main author	Title of the periodical or the series	Number, date or frequency	Publisher	Place of publication	Year of publication	Relevant pages	Permanent identifiers ³ (if available)	Is/Will open access ⁴ provided to this publication?
1	<i>Ambient intelligence for supporting task continuity across multiple devices and implementation languages</i>	<i>Paternò F., Santoro C., Scorcia A.</i>	<i>Computer Journal</i>	<i>March 2009</i>	<i>The British Computer Society</i>	<i>Oxford University Press</i>	<i>2009</i>		http://hiis.isti.cnr.it/demo/hiis/attachments/publications/2009-A0-014.pdf	Yes
2	<i>MARIA: A universal, declarative, multiple abstraction-level language for service-oriented applications in ubiquitous environments</i>	<i>Paternò F, Santoro C. and Spano L.D.</i>	<i>ACM Transactions on Computer-Human Interaction (TOCHI)</i>	<i>Volume 16, Issue 4 (November 2009)</i>	<i>ACM</i>	<i>New York, USA</i>	<i>2009</i>	<i>19</i>	http://hiis.isti.cnr.it/demo/hiis/attachments/publications/2009-A0-055.pdf	Yes
3	<i>Adaptive Reactive Rich Internet Applications</i>	<i>Kay-Uwe Schmidt</i>	<i>Annals of Information Systems: Web 2.0 & Semantic Web</i>	<i>6</i>	<i>Springer</i>	<i>New York</i>	<i>2010</i>	<i>79-104</i>	http://www.springerlink.com/content/g983r35t118628kt/	No
4	<i>Using ontologies in an adaptive interface for measuring user perceived portal quality</i>	<i>Kay-Uwe Schmidt</i>	<i>International Journal of Human-Computer Studies</i>		<i>Elsevier</i>		<i>2010</i>		Accepted to be published	
5	<i>Personalization in e-Government: An Approach that Combines Semantics and Web 2.0</i>	<i>Kay-Uwe Schmidt</i>	<i>Semantic Technologies for E-Government: A</i>		<i>Springer</i>	<i>Berlin / Heidelberg</i>	<i>2010</i>	<i>261-286</i>	http://www.springerlink.com/content/m0481gr57160t557/	No

³ A permanent identifier should be a persistent link to the published version (full text if open access or abstract if article is pay per view) or to the final manuscript accepted for publication (link to article in repository).

⁴ Open Access is defined as free of charge access for anyone via the internet. Please answer "yes" if the open access to the publication is already established and also if the embargo period for open access is not yet over but you intend to establish open access afterwards.

			<i>European Perspective</i>							
6	<i>On-demand Cross-Device Interface Components Migration</i>	<i>G.Ghiani, F.Paternò, C.Santoro</i>	<i>Proceedings of Mobile HCI 2010, Lisbon</i>	<i>September 2010</i>	<i>ACM Press</i>	<i>New York, NY, USA</i>	<i>2010</i>	<i>299-308</i>		Yes
7	<i>Socially filtered web search: an approach using social bookmarking tags to personalize web search</i>	<i>Kay-Uwe Schmidt</i>	<i>Proceedings of the 2009 ACM Symposium on Applied Computing (SAC)</i>		<i>ACM</i>	<i>Honolulu, Hawaii, USA</i>	<i>2009</i>	<i>670-674</i>	10.1145/1529282.1529420	No
8	<i>Emergency Management System, Proceedings of the International Conference on Pervasive Services</i>	<i>A. Rausch, D. Niebuhr, M. Schindler, D. Herrling</i>	<i>Proceedings of the International Conference on Pervasive Services 2009 (ICSP 2009)</i>	<i>2009</i>	<i>ACM</i>		<i>2009</i>		http://ftp.tu-clausthal.de/pub/institute/informatik/sse/web/Publikationen/Dokumente/2009-SSE-RNSH09-Emergency%20Management%20System.pdf	Yes
9	<i>OPEN: Open Pervasive Environments for Migratory Interactive Services</i>	<i>Anders Nickelsen, Fabio Paterno, Agnese Grasselli, Kay-Uwe Schmidt, Miquel Martin, Bjørn Schindler, Francesca Mureddu</i>	<i>Accepted for publication in the International Conference on Information Integration and Web-based Applications & Services</i>	<i>No. 12, 2010</i>	<i>ACM/Austrian Computer Society</i>	<i>Paris, France</i>	<i>2010</i>			
10	<i>Client-Side Event Processing for Personalized Web Advertisement</i>	<i>Kay-Uwe Schmidt</i>	<i>ODBASE</i>	<i>Lecture Notes in Computer Science Volume 5871</i>	<i>Springer</i>	<i>Berlin / Heidelberg</i>	<i>2009</i>	<i>1069-1086</i>	10.1007/978-3-642-05151-7_23	No
11	<i>Lifting Events in RDF from Interactions with Annotated Web Pages</i>	<i>Kay-Uwe Schmidt</i>	<i>ISWC</i>	<i>Lecture Notes in Computer Science Volume</i>	<i>Springer</i>	<i>Berlin / Heidelberg</i>	<i>2009</i>	<i>893-908</i>	10.1007/978-3-642-04930-9_56	No

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12	<i>Desktop-to-Mobile Web Adaptation through Parametric Bidimensional Semantic Redesign</i>	<i>F. Paternò, G. Zichitella</i>	<i>Proceedings of HCSE 2010</i>	<i>LNCS 6409</i>	<i>Springer</i>		<i>2010</i>			Yes
13	<i>Guaranteeing Correctness of Component Bindings in Dynamic Adaptive Systems</i>	<i>D. Niebuhr, A. Rausch.</i>	<i>Proceedings of the 35th EUROMICRO Conference on Software Engineering and Advanced Applications (SEAA)</i>	<i>No 35, August 2009</i>	<i>IEEE Computer Society</i>	<i>Patras, Greece</i>	<i>2009</i>	<i>454-457</i>		Yes
14	<i>Achieving Dependable Component Bindings in Dynamic Adaptive Systems – A Runtime Testing Approach</i>	<i>Dirk Niebuhr and Andreas Rausch and Cornel Klein and Juergen Reichmann and Reiner Schmid</i>	<i>Self-Adaptive and Self-Organizing Systems, International Conference on</i>	<i>2009</i>	<i>IEEE</i>	<i>Los Alamitos, CA, USA</i>	<i>2009</i>	<i>186-197</i>	http://doi.ieeecomputersociety.org/10.1109/SASO.2009.40	Yes
15	<i>How precise should localization be? A quantitative analysis of the impact of delay and mobility on reliability of location information</i>	<i>Rasmus Loevenstein Olsen and Joao C.P. Figueiras and Jakob Rasmussen and Hans-Peter Schwefel</i>	<i>IEEE Globecom 2010 - Communications QoS, Reliability and Modelling Symposium</i>		<i>IEEE</i>	<i>IEEE conference proceedings</i>	<i>2010</i>	<i>N/A yet</i>	<i>N/A yet</i>	
16	<i>Online estimation of context dynamics and its impact on context sensitive applications</i>	<i>Morten Lomholt Jakobsen, Rasmus L. Olsen, Jakob Gulddahl Rasmussen</i>	<i>International Conference on Wireless Communication, Vehicular Technology, Information Theory and Aerospace;</i>	<i>1st</i>	<i>IEEE</i>	<i>IEEE conference proceedings</i>	<i>2009</i>	<i>p. 921-925</i>	<i>ISBN: 978-1-4244-4066-5</i>	Yes

			<i>Electronic Systems Technology, 2009. Wireless VITAE 2009</i>							
17	<i>Gaining Reactivity for Rich Internet Applications by Introducing Client-side Complex Event Processing and Declarative Rules</i>	<i>Kay-Uwe Schmidt</i>	<i>AAAI Spring Symposium on Intelligent Event Processing</i>		<i>Association for the Advancement of Artificial Intelligence</i>		<i>2009</i>	<i>67-72</i>	http://www.aaai.org/Papers/Symposia/Spring/2009/SS-09-05/SS09-05-012.pdf	Yes
18	<i>Partial Web Interface Migration</i>	<i>G. Ghiani, F. Paternò, C. Santoro</i>	<i>AVI 2010</i>	<i>June 2010</i>	<i>ACM Press</i>		<i>2010</i>	<i>pp.414</i>	http://hiis.isti.cnr.it/demo/hiis/attachments/publications/p414-ghiani.pdf	Yes
19	<i>Service Migration Protocol for NFC Links</i>	<i>Anders Nickelsen, Miquel Martin, Hans-Peter Schwefel</i>	<i>Networked Services and Applications - Engineering, Control and Management</i>	<i>16th EUNICE//FIP WG 6.6 Workshop</i>	<i>Springer, Lecture Notes in Computer Science</i>	<i>Trondheim, Norway, 2010</i>	<i>2010</i>	<i>p. 41-50</i>	Volume 6164/2010, ISSN: 0302-9743 (Print) 1611-3349 (Online)	No
20	<i>Open Pervasive Environments for migratory iNteractive services (OPEN) Poster</i>	<i>Anders Nickelsen, Rasmus L. Olsen and Carmen Santoro</i>	<i>Proceedings of Future Internet of Services 2008 (FIS2008)</i>	<i>2008</i>	<i>1st Future Internet Symposium</i>	<i>FIS website</i>	<i>2008</i>		Poster, available online at http://www.fis2008.org/images/stories/open-poster-fis2008_nickelsen.pdf	Yes
21	<i>A middleware enabling dynamic reconfiguration of component-based applications</i>	<i>André Appel, Holger Klus, Dirk Niebuhr, Andreas Rausch</i>	<i>9th Workshop on Adaptive and Reflective Middleware (ARM 2010)</i>	<i>2010</i>			<i>2010</i>			Yes
22	<i>Progetti europei di ricerca e innovazione, opportunità da cogliere</i>	<i>Vodafone</i>	<i>INNOVAZIONE, idee, reti, business</i>	<i>9</i>	<i>Polo Tecnologico di Navacchio</i>	<i>Navacchio, Italy</i>	<i>2010</i>	<i>13</i>	http://www.lobbyinnovazione.it/index.php?option=com_docman&task=doc_view&gid=21&tmpl=component&format=raw&Itemid=6&language=it	Yes