MHP-based mobile prototype implementing the INSTINCT middleware concept

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***Abstract* — This paper describes the top-level middleware architecture of the INSTINCT mobile terminal. This architecture supports the upcoming IP-based hybrid networks and integrates into the existing middleware solutions MHP and MIDP. In addition, the paper presents a prototype implementation based on a mobile Multimedia Home Platform (MHP) software stack. The current middleware situation in the field of mobile devices is described. Then the main components of the INSTINCT middleware concept are introduced. This is followed by the description of a mobile version of the MHP including the INSTINCT middleware and further extensions that adopt the MHP to mobile devices. Finally, a demonstrator platform comprising a mobile MHP PDA prototype, that is connected to a DVB-H receiver via WLAN, is presented.**

***Index Terms* — CDC, DVB, DVB-H, JAVA, INSTINCT, MHP, mobile terminal.**

I. Introduction

The INSTINCT (IP-based Networks, Services and TermINals for Converging sysTems) project [11] is an IST integrated project (IP) in the sixth framework programme of the EU involving 27 partners from the EU and Brazil. The main objective is to build and validate an open and scalable network architecture together with a flexible middleware architecture enabling hybrid services on mobile terminals. For the broadcast networks the architecture relies on DVB [10] technology (DVB-H [6], DVB-T). The INSTINCT activities include the definition and implementation of the network infrastructure, the user devices, and the generation of content, services and applications. INSTINCT was started in January 2004 and is planned to have a duration of 6 years, subdivided into three phases. Phase 1 deals with the research and development of technology necessary to fulfill the goals of the project. Phase 2 will aim at using the results of phase 1 to apply the technology, for example, by performing trials. This will lead to real large-scale field trials with a number of operators involved.

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The fifth work package of the INSTINCT project (WP5) deals with the definition and the prototypic implementation of the INSTINCT middleware concept for mobile terminals. This implies the functionalities of subscription, reception, storage, management, launch and control of hybrid services and applications. To achieve this, existing middleware solutions which can be found on state-of-the-art devices should be extended, if possible.

Figure 1 illustrates one of the typical workflows of the INSTINCT middleware. In this case, the process of the acquisition of a file-based broadcast application is presented. In a first step, service meta data, the so-called "Electronic Service Guide" (ESG) is received by the mobile terminal. The ESG describes the properties of and the relationships between services, service providers and content packages. The middleware presents this data to the user who is able to select a service. The middleware then configures its interfaces in a way that enables the reception of this particular service. After the reception, the service will be stored on the device. The user will be notified about the the successful reception of the service. The user is now able to launch the service and to consume the multimedia content.

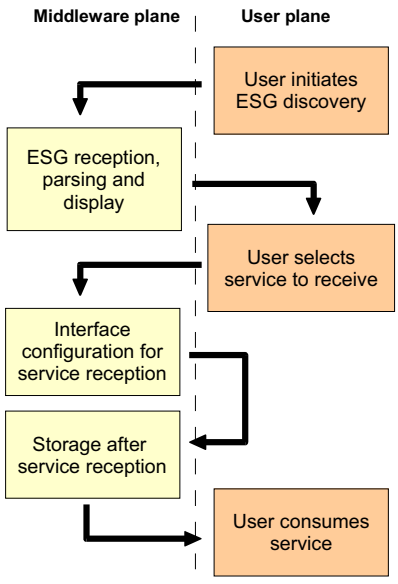

fig. 1: Service acquisition workflow in INSTINCT middleware

II. The INSTINCT demonstrator platform

The INSTINCT project addresses a number of hardware platforms to be used for demonstrator purposes. Two different use cases will be demonstrated. For a telecommunication-based use case, a cell phone demonstrator is planned. It will have access to a DVB-H receiver and provides an MIDP [7] middleware platform as an execution environment for applications. A second telecommunication-based demonstrator will be implemented on a state-of-the-art PDA device, also providing a MIDP environment.

The second, broadcast-based use case will be implemented by two MHP-based solutions – a small tablet PC and a PDA. For more detailed information about that PDA-based broadcast demonstrator see chapter VII.

III. Current middleware situation

At the beginning of the middleware definition process

within WP5, two major existing middleware solutions were identified. The middleware for interactive services defined by the Digital Video Broadcasting (DVB) project [10], [4] is the Multimedia Home Platform (MHP) [5]. This solution is based on Personal Java which relies on a Java Virtual Machine (JVM) comparable to the virtual machines known from the Java desktop world. MHP was designed initially for set-top boxes and integrated TV-sets, enabling interactive multimedia applications. Nevertheless, the solution can also be applied to mobile environments, for example in the car [2],[3]. The MHP relies on the DSM-CC object carousel [12] for the reception of data via the different broadcast channels. In line with the INSTINCT developments of a middleware solution for IP-based hybrid networks, the MHP has to be adopted to new broadcast transport protocols.

In the telecommunications world, most of the devices run the Java 2 Micro Edition environment (J2ME) with the Connected Limited Device Configuration (CLDC) and the Mobile Information Device Profile (MIDP). This solution relies on the K Virtual Machine (KVM), a derivative of the Java Virtual Machine (JVM). It is specially tailored to the typically restricted memory and CPU resources of mobile devices. Although MIDP and MHP are Java-based environments, they are not code-compatible due to the different Java Virtual Machines [1]. By today, MIDP does not support broadcast protocols. The INSTINCT middleware solution will extend MIDP-based environments for IP-based hybrid networks.

IV. INSTINCT MIDDLEWARE: THE CONVERGED APPROACH

As the INSTINCT middleware shall be used for the telecommunication-based as well as for the broadcast-based demonstrations, it has to be available for both MIDP and MHP environments. For this reason, WP5 agreed that the design of the INSTINCT middleware should support this approach as far as possible.

V. INSTINCT MIDDLEWARE: THE FUNCTIONAL ARCHITECTURE

Figure 2 presents an overview about the functional architecture of the INSTINCT middleware. Four main planes can be identified. The *connectivity management plane* includes mechanisms for data carousels, the management of the network interfaces and their configuration for session-based reception. The functionality for storage and content management of file-based multimedia content and services is provided by the *content management plane*. The *profile management plane* comprises two components dealing with device profile management and user profile management. The *service and application management plane* contains mechanisms for directly controlling services and applications. This plane further provides management functionality which includes the scheduling, subscription and discovery of services.

As depicted in figure 2, the functionality of each of the planes has been subdivided into software components which implement the particular functionality. The diagram further includes the application layer components that are relevant to the INSTINCT middleware. The ESG application user front-end enables the user to subscribe, unsubscribe, start and stop services, and to delete a locally stored service. The profile editor is the user front-end to adjust the device profile and the user profile.

In the following, the interactions of the particular software components of the INSTINCT middleware will be described by using the above mentioned example workflow (figure 1). At the beginning, the delivery session configuration component configures the transport reception component for receiving ESG meta data. After reception, the data will be stored on the device by the storage manager component as well as delivered to the meta data management component. This component parses the data and generates data objects describing the available services. Using the service search and discovery component enables the ESG application to request a list of services in accordance with the active user and device profile. The service search and discovery component requests the data from the meta data management and delivers the response consisting of meta data objects to the ESG application. That one can now display the list of services to the user. The user can choose a service, which will cause a call from the ESG application to the service subscription component. This component sends a notification to the delivery session configuration which configures the network interfaces in a way that enables the reception of the service. The data carousels of the IP transport reception handles the data and initiates its storage by the storage management component. The content handler component detects that the desired data has been received, and sends an appropriate notification to the application management. This component requests the service data from the storage manager and launches the service.

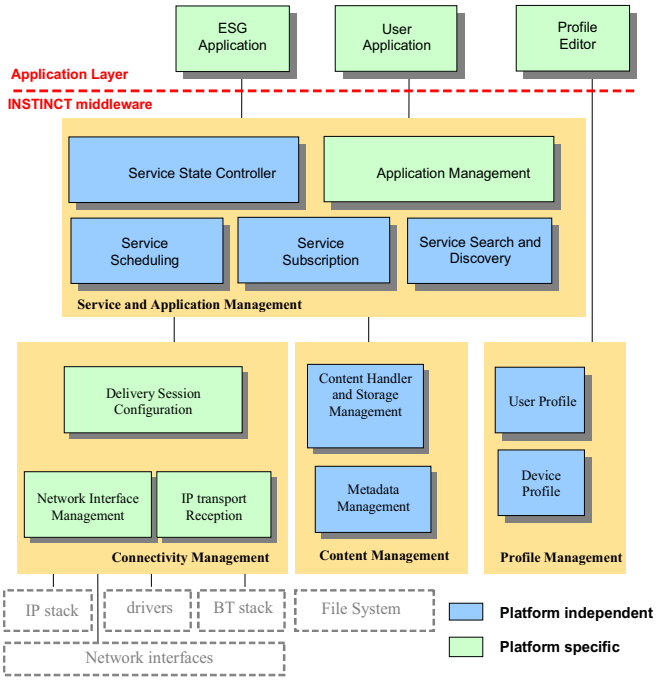

fig. 2: Architecture of the INSTINCT middleware for IP-based services

To enable the INSTINCT middleware to be compliant with both MIDP and MHP environments, each of the software components has been classified (see fig. 2). The classification of a component determines the way it will be specified and implemented during the next phases of the software development process of WP5. The core components have been classified as platform-independent in that sense that *design* and *specification* are platform-independent. Due to the different virtual machines of MIDP and MHP, the *implemented byte-code* will not be platform independent. As depicted in the diagram, the network-related components and the application layer-related components are categorized as platform-specific. The reason is that the MHP and MIDP software environments have different approaches in these areas. For a detailed comparison refer to [D5.1].

fig. 3: PDA showing the ESG application

VI. Extensions to the mobile MHP

To support the broadcast-based use case, the MHP stack was enhanced by a number of software extensions, defined within WP5 of INSTINCT:

- Support of lower screen resolutions and screen rotation
- Integration of the above described INSTINCT middleware
- Software extensions to support location-based services

The standard MHP only supports the standard TV screen resolutions. A mobile version of the MHP needs to support the screen resolutions of typical mobile devices like PDAs and smart phones. Typical resolutions are for example VGA, 640x320, 480x320, 320x320, 320x240, 240x240 and below. It is obvious that the services need to be able to scale to the different screen resolutions. In addition, some devices allow the rotation between portrait and landscape format which is supported by the mobile MHP variant.

The INSTINCT middleware has a number of software interfaces which connect to the existing MHP functionality. The INSTINCT ESG meta data is presented to the user via the ESG application (MHP Navigator). The MHP application management is connected to the service state controller to allow MHP applications to be delivered over IP-based networks.

A further extension is the support of location-based services by providing the applications with information concerning the geographical position of the terminal. The software interfaces are independent of the available positioning techniques.

VII. Prototype implementation of mobile device for INSTINCT

The Institute for Communications Technology at Braunschweig Technical University (Germany) is involved in the WP5 development process and implements a demonstrator for the broadcast-based use case on a PDA.

In a first step, an MHP-based prototype has been developed which allows the usage of the INSTINCT services on a mobile

fig. 4: Demonstrator architecture with a DVB-H receiver acting as an IP router and WLAN PDA.

device. This device is an of-the-shelf PDA connected to an external DVB-H receiver via WLAN (figure 4). The PDA hardware integrates a 400 MHz XScale processor, 128 MBytes of memory, a screen size of 240x320 pixel and WLAN and Bluetooth connectivity. The external receiver, which is based on a standard PC, acts as a router for the IP/UDP streams which will be extracted out of the DVB-H stream. The router does not modify the transmitted information in any way, which means that the PC can be seen as a DVB-H receiver module for the PDA. All signal processing which is necessary to filter the services out of the IP stream is carried out on the mobile device. In the next demonstrator version (planned for mid/end

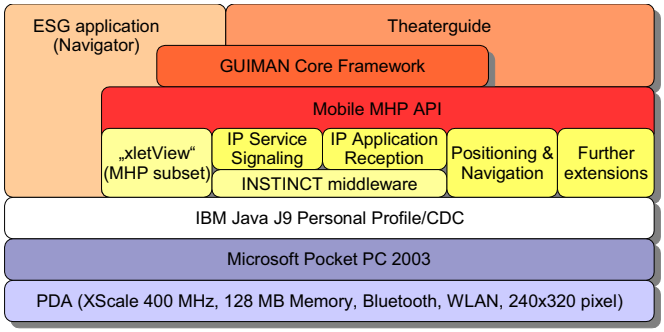

fig. 5: Software architecture of the PDA-based MHP demonstrator

of 2005), the DVB-H receiver will be integrated into the mobile device, as it is expected that DVB-H receiver modules for PDAs will be available soon. The MHP return channel can be set-up with the help of an additional mobile phone, which is connected via a Bluetooth connection.

Figure 5 depicts the software architecture of the mobile device. At the bottom the hardware platform is depicted, which is a typical XScale-based PDA with Bluetooth and WLAN support. The operating system is Pocket PC 2003. However, as all MHP functionality is implemented in Java, the operating system and the hardware platform can be easily exchanged if a

suitable Java Virtual Machine (JVM) becomes available. The chosen JVM is the so-called J9 from IBM, which supports the full Personal Profile [9]/CDC [8] configuration of Java. A just-in-time compiler is also available. The MHP implementation that is used for the demonstration, is the open source software "xleTView" [13] which has been ported by us from Java 1.4 Standard Edition to IBM J9 CDC with Personal Profile API. Although our modified version of "xleTView" is not a complete MHP implementation, it proved to be sufficient to support our MHP-compatible application framework GUIMAN [2] (which was tested on a large number of MHP-compatible devices).

The "xletView" is combined with the extensions to the mobile MHP that have been described above. The combination of these elements creates an extended, mobile version of the MHP API (figure 4). On top of this new API set, two demonstration applications have been implemented. Both applications take advantage of the GUIMAN framework. The GUIMAN is an MHP-compatible user interface engine for MHP applications. It uses XML descriptions to render the user interface and it allows a simple integration with external Java code from MHP applications.

fig. 6: PDA with Theaterguide application (design study)

The two implemented demonstration applications are the ESG application and the so-called Theaterguide.

The ESG application (figure 3) covers functionality, that in MHP is normally handled by the so-called Navigator application. The ESG application gives the user access to all available INSTINCT services. In case of a service request, the ESG application configures the INSTINCT middleware in order to access the desired services.

The Theaterguide (figure 6) is an MHP application that provides the user with information concerning plays in the local theaters. The available information consists of time table, information on the available plays as well as short video sequences of the most interesting scenes. In addition, it is possible to buy tickets via the return channel connection. The Theaterguide application is able to run on a large variety of MHP-compliant devices. These devices can for example be MHP set-top boxes, TV sets, PDAs or smart phones. The application can adapt to the various device capabilities, especially to the screen resolution and the input device available to the user.

The combination of PDA hardware, Java Virtual Machine and MHP implementation proved to be powerful and fast enough to execute MHP applications (like the Theaterguide) in an very acceptable manner.

VIII. Conclusion

In this paper some results from the EU project INSTINCT have been presented. A new software architecture for the consumption of IP-based services in hybrid networks was presented. This architecture was integrated into a mobile version of the Multimedia Home Platform, which was successfully set up to run on a standard PDA device.

With the proposed software architecture for the consumption of IP-based services it is possible to find, receive, store and execute services which can be delivered over any kind of IP-based network, either broadcast or point-to-point. The architecture consists of software components which can be put together in a modular way. It was shown that the proposed software architecture could be integrated into a mobile version of the MHP software stack.

Further, a demonstrator was presented that acts as a proof of concept. This demonstrator includes a DVB-H receiver and a PDA with a modified MHP software stack. Two MHP-compatible demonstration services proved to run on the demonstrator. These services are an ESG application which allows the selection of services through the user and the subsequent configuration of the INSTINCT middleware, as well as a Theaterguide application, which demonstrates some of the MHP functionalities in a mobile environment.

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References

[1] Public deliverable D5.1, INSTINCT project, http://www.ist-instinct.org, 05/01/25

[2] Klinkenberg F.; Schiek U.:
Extensions of the Multimedia Home Platform for Applications in an Automotive Environment,
IEEE Int. Conf. on Consumer Electronics (ICCE), vol. 22, p. 102 f. (TUPM 9.3), Los Angeles, USA, 03/06/17

[3] Klinkenberg, F.; Schiek, U.: *Wie die Set-Top-Box ins Auto kam*, IMA, vol. 2, p. 171-184, Braunschweig, Germany, 04/10/20

[4] Reimers, U.: Digital Video Broadcasting, Second Edition, Springer, 2004

[5] Digital Video Broadcasting (DVB), *Multimedia Home Platform Specification 1.0,* ETSI Standard [TS 101 812], 2003

[6] EN 302304 v1.1.1: Digital Video Broadcasting (DVB); Transmission System for Handheld Terminals (DVB-H). ETSI , 2004.

[7] J2ME Mobile Information Device Profile (MIDP) JSR 118: http://java.sun.com/products/midp/index.jsp, 05/03/29

[8] J2ME Connected Device Configuration (CDC); JSR 36, JSR 218, http://java.sun.com/products/cdc/index.jsp, 05/03/29

[9] J2ME Personal Profile, http://java.sun.com/products/personalprofile/index.jsp, 05/03/29

[10] DVB, Digital Video Broadcasting, http://www.dvb.org, 05/03/29

[11] Homepage of the INSTINCT project, http://www.ist-instinct.org, 05/03/22

[12] Information technology – Generic coding of moving pictures and associated audio information – Part 6: Extensions for Digital Storage Media – Command and Control (DSM-CC), International Standard ISO/IEC 13818-6, International Organisation for Standardisation (ISO), 1998

[13] xleTView, Open Source MHP implementation, http://xletview.sourceforge.net, 05/03/29