PLATONIS : A Platform for Validation and Experimentation of Multi-protocols and Multi-services

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ABSTRACT. *Advance in network technology leads to the design of new protocols and services. In order to assure successful communication among those new products, testing and validation activities for conformance and interoperability play an important role in the development and deployment of them. In this paper, we introduce the* PLATONIS *platform, a platform for validating and experimentation of new protocols and services. It will, in particular, focus on WAP protocols and services but is expected to be general enough to be used for other protocols and services such as those of GPRS, UMTS, and wired networks.*

KEYWORDS: *Mobile network and services, WAP, Interoperability test, Conformance test.*

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1. Introduction

1.1. *Objectives*

The new trends in network technology (Internet, ATM) lead to the design of new protocols and services. In most of cases the latter shall interconnect heterogeneous elements which must be tested in order to certify their interoperability. Both interoperability testing and experimentation with these new products are hence becoming strategic activities in the telecom software industry, not only for the operators but also for equipment vendors and tool providers.

Companies have to develop an important activity in order to warranty the correct behaviours of their software implementing the protocols and services. Due to this validation effort and experimentation on real platforms, trustable services will be produced, and the time-to-market reduced.

The development and implementation of a validation and experimentation platform (multi-protocols and multi-services), in close relationship between academic world and industry, will address the companies concern of assessing applications in a systematic way, and will allow the academic members to experiment their innovations on a real-world test bed.

Mobility is the main focus on the platform. In particular, we plan to study protocols and services including mobility and the WAP, and also the technologies that allow the deployment of these services (GSM, GPRS, UMTS). Note though that the platform is generic enough to be used with other protocols and services, such as those of wired network.

A platform is a set of software tools and equipments offering complementary functions and allowing real experimentations. In particular, the PLATONIS platform is oriented to the cover all the aspects of conformance and interoperability testing (from specification, test selection, automated test generation to test execution).

Moreover, when designing, implementing and deploying a system, it must be checked that it not only supplies the expected functionalities, but that it also provides acceptable performances, in terms of loading rates, processing capacity, response time, etc. Such a study allows also to preview the collapse of the system by identifying the potential bottle-necks, and to determine an optimal configuration for the ressources (buffer sizes, number of servers, distribution of processes on the different machines, network topologies, etc.) according to criteria like “quality over cost”.

The PLATONIS platform will be opened to other users:

– companies wishing to experiment the new functionalities proposed by a given service;

– universities for research and teaching purposes (students’ training to these new technologies).

In this context, the project has the following main objectives:

1) the implementation of a platform for validating and experimentating new protocols and services;

2) the validation and experimentation of the platform related to the terminals mobility. We plan to check whether some protocol exchanges in WAP over GSM are correct and if different entities may interwork properly;

3) a method supported by tools, allowing to analyse some quality of service (QoS) properties, in consistency with the functional validation;

4) the openness: the platform will be used at the beginning for teaching GET [1] and university students of the academic partners, and also the engineers of the member companies. It is planned to widen the use of the platform to other companies and academic institutions to a legal and commercial framework defined by the PLATONIS consortium.

1.2. *Partnership and project management*

The PLATONIS project started in March 2001 and the duration of the project is two years. The project is managed by INT[2] which is in charge of the coordination between the sub-projects and is the representative to the ministry. The project is divided into four sub-projects:

1) *Platform and network implementation.* Partner in charge: INT. The INT owns a test laboratory [BES , BES 99, CAV 99].

2) *Protocols design and coding.* Partner in charge: France Télécom R&D. France Télécom R&D brings its experience on the modeling, the QoS, the protocol validation and is a contributor to standardization institutions (ITU, ETSI etc.) [ALA 99, MON 01].

3) *Experimentation and validation of proposed applications.* Partner in charge: LaBRI-Université de Bordeaux. The LaBRI[3] has a significant experience in the area of interoperability testing [CAS 94, CAS 00, RAF 90].

4) *Implementation of a demonstrator.* Partner in charge: Kaptech. Kaptech is a new telecom operator for companies, and will bring its experience in industrial applications.

5) Another partner, LIMOS[4] - Université Blaise Pascal, is also associated to this project. The LIMOS has already an experience in protocol testing, and will cooperate mainly in the first and third sub-projects [LAU 00].

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1.3. *Formal models*

One main activity associated closely with the PLATONIS platform is the formal modelisation of part of the system architecture and its behaviour: some protocol layers (the highest), some APIs and the service factory infrastructure. This should allow to integrate in several steps concepts like OSA (*Open Service Access*) and VHE (*Virtual Home Environment*). We chose the *Specification and Description Language* (SDL) for the behaviour formalisation and the *Unified Modeling Language* (UML) for the architecture.

The rationale for formalisation is the following:

– automatic production of test suites for different interfaces;

– QoS analysis starting from the service design and specification, taking into account the concepts of negociation (essential in the UMTS) between different peers;

– functional validation (simulation and animation) of protocols, of APIs and services in the context of the given architecture, but independently of a protocol or of a peculiar platform;

– it is important to make sure that the model, which includes the concepts of OSA (and APIs) and VHE, is really based on the independence of a layer respectively to different possible implementations. We believe that formalisation is the best way.

1.4. *Conformance and interoperability*

The validation platform provides two kinds of test: *interoperability testing* (in a first step between the clients and the server, and in a second step between two terminals), and *conformance* of a protocol layer (if there is no direct access to the layer under test, then *embedded testing* will be envisaged, i.e. testing the layer through the upper layers). Moreover loading and robustness tests are taken into account.

These tests are supposed to validate that different implementations interwork correctly, i.e. they provide the expected global service, while complying with the standards. Two kinds of standards are used: one is based upon the use of mobile phones using the WAP, and the second is based on the use of *Personal Digital Assistants* (PDA) either on the WAP stack or a WML/UDP/IP stack over GPRS or UMTS. The security layer is not considered in a first step.

The tests should be generated automatically, if possible, which implies a preliminary formal specification of the protocols and services. As mentionned previously we chose in that aim to modelise in SDL (standard of the ITU-TS). Once the protocol and the services are formally described, it will allow the automatic generation of the test sequences guaranting a coverage of the given specification, and allowing to detect different kind of faults, like output faults. The last step is the implementation of these test cases in a test architecture by a demonstrator.

There are three kind of services to be tested:

– *Terminal services.* The mobile terminal are characterized by data like the size of the screen, the character set, the available colours, telephonic abilities etc. These features are likely to be tested with methods from the Java Mexe (*Mobile station application EXecution Environment*). The WAP Forum yet proposes some tests validating the mobile phones functionalities. It is indeed possible to run on-line these tests on the terminals, thus they will be skipped in a first step.

– *Protocol-layer services.* These services are supplied by some protocol layers and are specified by event-driven diagrams.

– *Application services.* Thery are of two kind. The first kind is *general services*. These correspond to the execution of programmes interacting either directly or not with the end-users' mobile terminal. A mobile location service will be defined. Note that this kind of service requires the agreement of the operators, since access to this information is restricted. The second kind of application services is *specific services*. We plan to define and test a service of network management and equipment maintenance provided by Kaptech. The application services are harder to formalise than the previous ones.

The tests and procedures likely to be implemented under the proposed test architectures are the following:

– *Protocol-layer conformance testing.* These tests address the conformance of a given WAP layer. This assumes that the consortium owns its own WAP gateway.

– *Interoperability testing.* These tests allows to check, for instance, the interoperability between an application running on a terminal and an application on a server. They will be carried out with a terminal simulator, using log files. In a second step, and only if the emulation software can run on the wireless PDAs, then the tests will be executed on these latter.

2. The PLATONIS platform

2.1. *Architecture for mobile wireless applications*

In the first step, the PLATONIS network will not include a corporate WAP gateway: we will use the operator gateway offered by the industrial partner Kaptech. This architecture is shown in the right part of the figure 1. Three kinds of terminal connection are provided: connection of a mobile phone with WAP capability, connection of a PDA through a mobile phone and direct connection of a PDA to the cellular network. The reader will find details about terminal connections in section 2.2.

Note that the network includes a Network Access Server(NAS), which is a gateway allowing the authentication of the terminals (client) before accessing the WAP gateway.

The Kaptech operator will provide:

– a multi-gate access NAS (allowing to perform load tests);

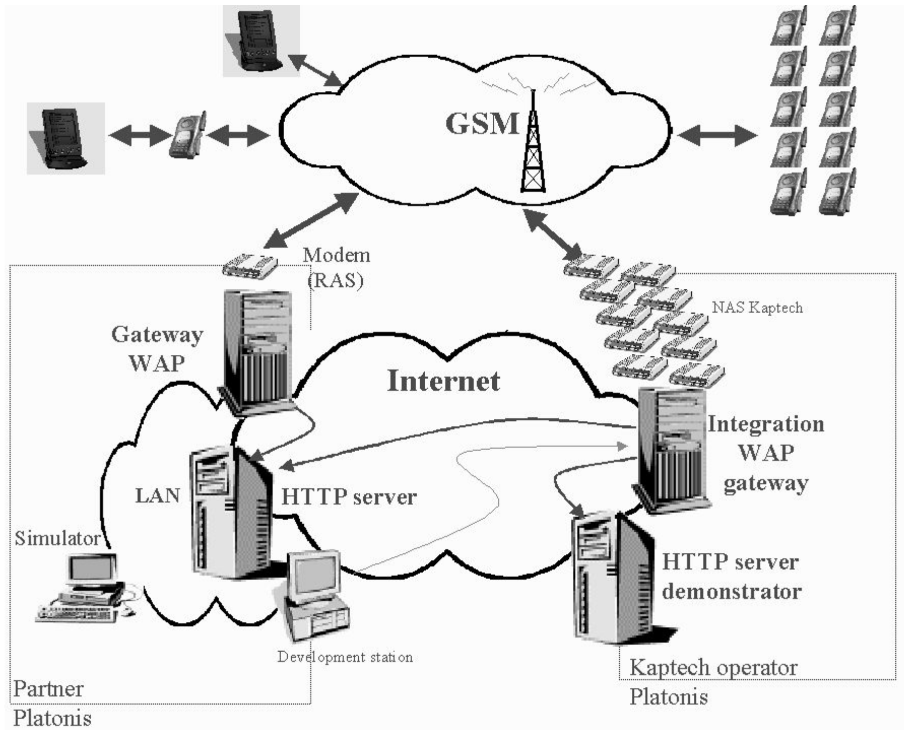

Figure 1. *The* PLATONIS *network*

– an integration WAP gateway (with a secure access using telnet from the development stations of the platform)

– an HTTP server demonstrator.

In the second step, the PLATONIS network will include a corporate WAP gateway, allowing then protocol layer testing. The architecture is shown in the left part of the figure 1. In this network each partner possesses his own development environment (more or less complete depending on their needs). Note that it includes a *Remote Access Server* (RAS), which is a smaller version of NAS, before accessing the WAP gateway.

2.2. *Connecting PDAs to wireless networks*

Recently there are a number of ways to connect a PDA to wireless network. In this section, we discuss various methods that are currently available for this connection. Figure 2 shows these configurations.

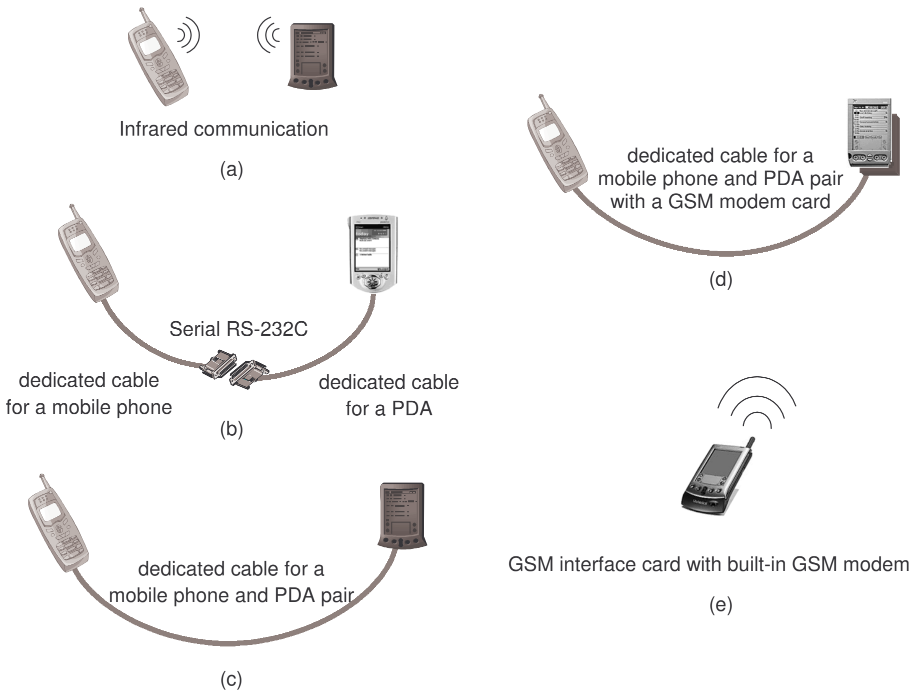

Figure 2. *Configurations for connecting PDAs to wireless networks*

The methods can be mainly categorized into twofold: one is with aid of a mobile phone and the other is without a mobile phone. If we have a mobile phone, there are four configurations for connecting PDAs to wireless networks, which depend on the availability of accessories and the capability of the products. If a mobile phone supports infrared communication, PDAs can be connected to wireless networks through infrared communication as shown in figure 2 (a). The advantages of this method are that no other accessory is needed and that it can be applied to many mobile phones and almost all PDAs since most of PDAs support infrared communication. However, the movement of the PDA and the mobile phone is restricted during communication. Otherwise the connection between them may be lost. The second configuration is to use two serial cables, each for a mobile phone and for a PDA as shown in figure 2 (b). The advantage of this method is that it can be applied to many mobile phones. However, a few number of PDAs have their serial cable for data communication and sometimes the cables are bulky[5]. The third configuration is to use one dedicated cable for a mobile phone and PDA pair. In some cases the cable accompanies a soft modem that is run on PDA. In other case the dedicated cable is accompanied by a GSM modem

5. Note that almost all PDAs have their serial cable for data synchronization with PC, not for data communication.

card as is shown in figure 2 (d)[6]. The advantage of this configuration is that it is lightweight. It is also noted that the soft modem or GSM modem provides better performance in wireless networks[7]. However, the mobile phone and PDA pairs supported by this cable are restricted.

We can connect our PDAs to wireless networks without aid of mobile phones by using a GSM interface card where GSM modem is usually already built-in. Recently many companies have developed GSM interface cards for PDAs but not so many products are available yet. The advantage of this method is that we don't need mobile phones. In addition, we can usually make a phone call with this card using a software and a headset. The supported PDAs, however, are very restricted.

If we consider the methods that will be available soon, we have more choices. A number of companies are developing a new product that is a combination of a mobile phone and a PDA. Some of them are already available now but not considered in this paper. A PDA can be connected to a mobile phone without any accessory if both of them support the Bluetooth technology. Some mobile phones already support the Bluetooth technology but currently no PDA supports it. Many PDA vendors are now integrating this technology to their PDAs.

3. Test methodology

3.1. *Interoperability test architectures*

We have mentioned in section 1.4 that the PLATONIS project aims at two kinds of tests: interoperability testing and layer conformance testing. Figure 3 shows test architectures for interoperability testing in the framework of the WAP. It is designed to validate and experiment new services related to mobility.

This study is focused on the WAP architecture because this technology is nowadays available but it is possible to extend our methodology to other ones, like GPRS and UMTS, when they are widely available.

The proposed test architectures use several distributed access points with a local WAP gateway. The behavior of each entity is observed through a Point of Observation (PO) and controlled through a Point of Control and Observation (PCO). Three levels of interoperability tests will be performed: the first one uses a PCO to control and observe the terminal exchanges, and two POs in the heart of the network, between the components (figure 3 (a)), to detect transmission errors and to perform some traffic analysis. This architecture can also be used for the network performance evaluation. In the second one we will observe and analyse the log files. A PCO is (still) on the terminal side, and a PO is located in the server side (figure 3 (b)) to check the behavior of the server. The last one considers the network as a black box that is observed and

6. Soft modem and GSM modem cards are regular GSM modems.
7. We didn't check this yet.

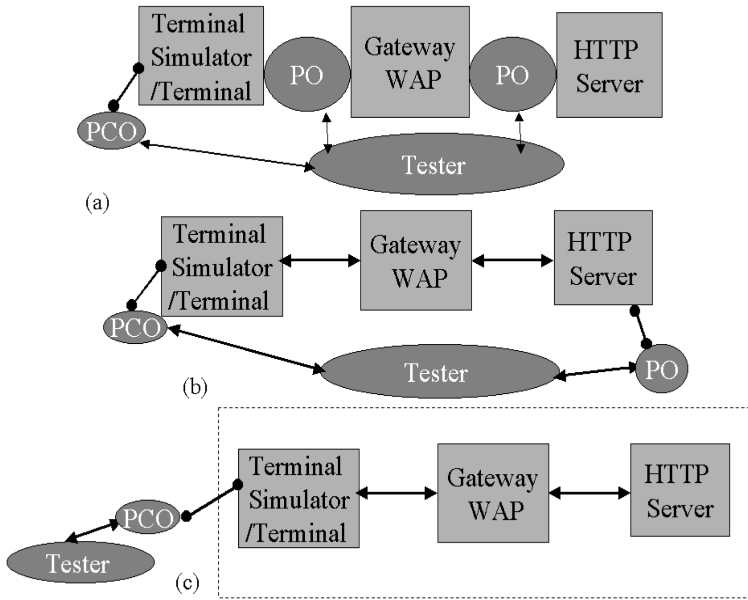

Figure 3. *Test architectures for interoperability testing*

controlled through the PCO of the terminal (figure 3 (c)). This test architecture will be adapted to test the application use-cases and QoS properties.

3.2. *A layer conformance test architecture*

In the PLATONIS project another type of test will be studied: the conformance testing of a layer of the WAP stack. For this, a test architecture is proposed in figure 4.

According to the WAP specification it is possible to access each WAP layer directly through service access points (SAPs), which facilitates the observation of the provided services of each layer [wap98]. However, it depends on the availability of application programming interfaces (APIs) of each layer. If such APIs are not available, we will consider embedded system testing where target protocol is accessed through context [CAV 99]. Concerning the specifications, France Télécom R&D will modelise the WSP and WTP layers in SDL.

4. Services to be studied

As we have mentioned in the previous sections, one of the objectives of the PLATONIS project is to define a methodology and an architecture for the validation and

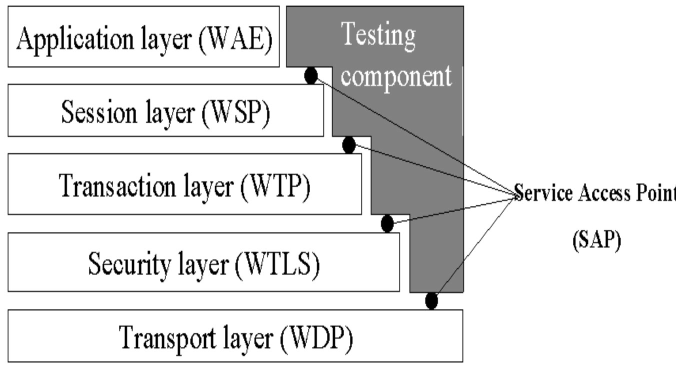

Figure 4. *Test architecture for layer conformance testing*

experimentation of services related to users mobility. Once this methodology and architecture will be defined, we plan to study new services, and particularly those based on WAP and IP. We plan to use terminals (cellular phones and PDAs) or terminal emulators allowing a direct access to terminal functions.

Two services will be studied, one based on the subscriber location, and another based on a distant network management. This latter has been proposed by one of the industrial partners of the project. From these services, a set of scenarios will be generated automatically or manually. These scenarios will allow to test the interoperability and also to detect errors related to non expected or erroneous messages. For instance, in the case of the service of a distant network management, the visualization of the equipment's deployment can be troubled by a connection cut. If the user continues to move, he will need to have a good synchronization between the visualization of the equipment's deployment and his new geographical location.

The proposed methodology will allow through these two examples to extend the possibilities of testing other types of services. We envisage to develop a demonstrator to show how to validate the proposed services. These services will be in the demonstrator and will be experimented by the partners. A pedagogical evaluation is also planned. Students and researchers will receive a training of the use of the platform. Practical works and projects in the framework of this training will be contributed to evaluate the use of the platform.

It is also expected that service providers will be able to test their services and configurations (for instance, services described using WML) through the use of the PLATONIS platform.

5. Migration to GPRS

For the first step of the project we will use the GSM network because this technology is nowadays used but when the GPRS and UMTS are available we will migrate to those technologies.

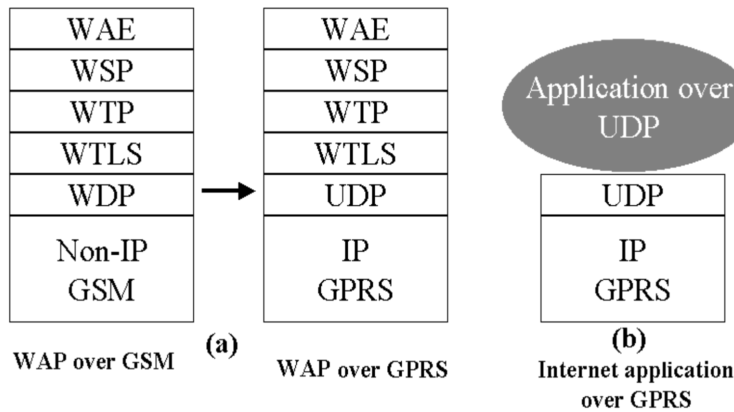

Figure 5. *Migration to GPRS*

The following step will be the incorporation of the GPRS packet-based interface on the existing circuit-switched GSM network. This incorporation will keep the use of the existing services. It will also facilitate several new applications that have not previously been available due to the limitation in speed of the circuit-switched data (9.6 kbps)[8]. In case of WAP application, the difference between GPRS and pure GSM network is the transport and the physical layers, as shown in figure 5 (a). In general, the WAP services will not change.

The GPRS also will allow Internet applications to be executed on mobile terminals *without the WAP stack*, as shown in figure 5 (b). It means that many services which are used over the wired Internet today will be available over the mobile network [BUC 00].

Acknowledgements

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8. A theoretical maximum speed up to 171.2 kbps is achievable with GPRS.

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Appendix

Table 1. *Connectivity of PDAs to wireless networks(May 2001)* [1]

Mobile Phone	**Feature**		**Connectivity with PDAs**				
	WAP	GPRS	Palm IIIc	Palm V	Visor Prism	Visor Platinum	Compaq iPAQ 3660H
Nokia 9110i	Yes	No	(a)	(a)	(a)	(a)	(a),(b)
Nokia 8210	No	No	(a)	(a)	(a)	(a)	(a)
Nokia 7110	Yes	No	(a)	(a)	(a)	(a)	(a),(b)
Nokia 6110	No	No	(a),(c)	(a),(c)	(a),(d)	(a),(d)	(a),(d)
Ericsson R520m	Yes	Yes	(a)	(a)	(a)	(a)	(a),(b)
Ericsson R380s	Yes	No	(a)	(a)	(a)	(a)	(a),(b)
Ericsson R320s	Yes	No	(a)	(a)	(a),(d)	(a),(d)	(a),(b),(d)
Motorola P7389	Yes	No	(a),(c)	(a),(c)	(a)	(a)	(a),(b),(c)
Motorola V.3690	No	No	(c)	(c)	-	-	(b),(c)
Siemens S35i	Yes	No	(a)	(a)	(a)	(a)	(a)
GSM Interface Card							
Nokia Card Phone 2.0	-	No	-	-	-	-	(e)
Ubinetics GA100	-	No	-	(e)	-	-	-
Ubinetics GC201	-	No	-	-	-	-	(e)
Handspring Visorphone	-	No	-	-	(e)	(e)	-

1. The mobile phones, PDAs, and GSM interface cards available in May 2001 are considered. For "Connectivity with PDAs" field, refer the figure 2. Note that the table is constructed with the information from the web site of each vendor.