



Using the PLASTIC Middleware for the Creation of Context-aware, Adaptive Mobile Services

**Dr. Heinz-Josef Eikerling
Siemens AG**

C-LAB Report

Vol. 8 (2009) No. 1

Cooperative Computing & Communication Laboratory

ISSN 1619-7879

C-LAB ist eine Kooperation
der Universität Paderborn und der Siemens AG
www.c-lab.de
info@c-lab.de

C-LAB Report

Herausgegeben von Published by

**Dr. Wolfgang Kern, Siemens AG
Prof. Dr. Franz-Josef Rammig, Universität Paderborn**

Das C-LAB - Cooperative Computing & Communication Laboratory - leistet Forschungs- und Entwicklungsarbeiten und gewährleistet deren Transfer an den Markt. Es wurde 1985 von den Partnern Nixdorf Computer AG (nun Siemens AG) und der Universität Paderborn im Einvernehmen mit dem Land Nordrhein-Westfalen gegründet.

Die Vision, die dem C-LAB zugrunde liegt, geht davon aus, dass die gewaltigen Herausforderungen beim Übergang in die kommende Informationsgesellschaft nur durch globale Kooperation und in tiefer Verzahnung von Theorie und Praxis gelöst werden können. Im C-LAB arbeiten deshalb Mitarbeiter von Hochschule und Industrie unter einem Dach in einer gemeinsamen Organisation an gemeinsamen Projekten mit internationalen Partnern eng zusammen.

C-LAB - the Cooperative Computing & Cooperation Laboratory - works in the area of research and development and safeguards its transfer into the market. It was founded in 1985 by Nixdorf Computer AG (now Siemens AG) and the University of Paderborn under the auspices of the State of North-Rhine Westphalia.

C-LAB's vision is based on the fundamental premise that the gargantuan challenges thrown up by the transition to a future information society can only be met through global cooperation and deep interworking of theory and practice. This is why, under one roof, staff from the university and from industry cooperate closely on joint projects within a common research and development organization together with international partners. In doing so, C-LAB concentrates on those innovative subject areas in which cooperation is expected to bear particular fruit for the partners and their general well-being.

ISSN 1619-7879

C-LAB
Fürstenallee 11
33102 Paderborn
fon: +49 5251 60 60 60
fax: +49 5251 60 60 66
email: info@c-lab.de
Internet: www.c-lab.de

© Siemens AG und Universität Paderborn 2009

Alle Rechte sind vorbehalten.

Insbesondere ist die Übernahme in maschinenlesbare Form sowie das Speichern in Informationssystemen, auch auszugsweise nur mit schriftlicher Genehmigung der Siemens AG und der Universität Paderborn gestattet.

All rights reserved.

In particular transfer of data into machine readable form as well as storage into information systems, (even extracts) is only permitted prior to written consent by Siemens AG and Universität Paderborn.

Inhaltsverzeichnis

1	Introduction	4
1.1	Context-awareness.....	4
1.2	Automatic communication management.....	4
1.3	Dependability.....	5
2	The PLASTIC platform.....	5
2.1	The development environment	5
2.1.1	Modelling tools.....	5
2.1.2	Code generation tools	6
2.2	The middleware	6
2.2.1	Multi radio device management.....	6
2.2.2	Communication layer.....	6
2.2.3	Service layer.....	6
2.3	The validation framework.....	7
3	Some Example Applications	8
3.1	eBussines	8
3.2	eHealth	8
3.3	eLearning.....	9
3.4	eVoting	9
4	Achievements & Future Work	9
5	References	11

1 Introduction

The wireless landscape has been continuously advancing towards a world where mobile communications is affordable and thus available on nearly every possible aspect of daily life. Today, 3G networks and services are expanding at a good pace: there are already 2.5 billion GSM subscribers and 3G has reached 130 million users worldwide with a steady growth rate [1]. But the mobile revolution is expanding even further in order to provide access to Broadband networks wherever we are using all access technologies surrounding us (WiFi, Bluetooth, GRPS/UMTS, etc.). This is what can be called B3G (Beyond 3G) technology and networks. The IST FP6 PLASTIC (Providing Lightweight & Adaptable Service Technology for pervasive Information & Communication) project [2] directly addresses several challenges arising in the development of adaptable and mobile services in such B3G environments.

One such challenge is adaptability. Services should take into account information about the environment in which they are executed in order to permit choices and adjustments. Ideally, a service should automatically adapt itself considering the device that is being used, the network available and the other services available at that particular moment, and even the time of the day or geographical location. Adaptability is achieved in PLASTIC by a set of features, which include:

1.1 Context-awareness

Context-awareness is an enabler for adaptability and thus a key feature of the PLASTIC platform. It means that services running on top of the PLASTIC platform can adapt themselves dynamically and transparently to changes in the environment (context) in which they are used.

1.2 Automatic communication management

Automatic handover between the various available communication resources is required if for instance a service subscriber leaves a WiFi zone and needs to switch seamlessly to a GPRS network in order to insure session continuity. In such case the challenge is to ensure the proper service execution without loosing data, session or starting all over again the different steps of a transaction. In case of loosing connection, dynamic service reconfiguration is needed in order to automatically continue the transaction through a new equivalent service without loosing the state and its corresponding data reached with the previous service.

1.3 Dependability

Requirements for dependability, such as security and reliability, plus other quantitative requirements, such as performance and scalability, are part of the quality of service requirements. In order to guarantee quality of service, each service must count with clear information from the commitments assumed by every service that it invokes.

2 The PLASTIC platform

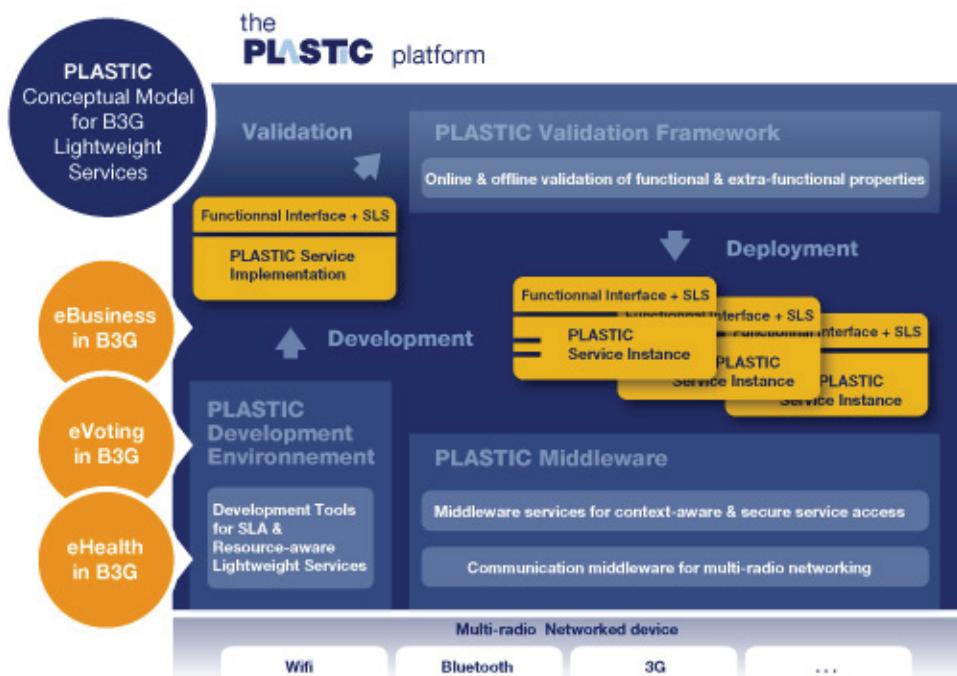


Figure 1: PLASTIC Middleware.

2.1 The development environment

As shown in Figure 1, the development environment comprises a set of tools which assist the designer and developer through the whole service life cycle, from conceptual design to deployment and validation. Its most important building blocks are described now in more detail.

2.1.1 Modelling tools

UML2 was chosen as the graphical design language. To support a comprehensive design approach we have defined the PLASTIC UML2 profile, which allows designers to create service models conforming to the PLASTIC notion. According to this, a service is defined by a number of different models,

grouped in 5 views: the *Requirement View* (containing use case descriptions), the *Structural / Behavioral View*, the *Components, Implementation* and *Deployment View*. The service model editor is a general CASE modelling tool which supports the UML 2 standard.

The SLA editor is a graphical editor for the specification of Service Level Agreements. These are a set of rules and non-functional service characteristics which are mutually agreed by 2 parties, in order to provide a given quality of service.

2.1.2 Code generation tools

These tools provide the transformations between the modelling tools (by converting between different entities) and tools used in the development life-cycle (by generating code for lower layers).

2.2 The middleware

The PLASTIC middleware empowers the service-oriented architecture with B3G networking capabilities, in particular enabling adaptive lightweight services to be run on mobile nodes and access to services over multi-radio, multi-network links.

The middleware delivers multi-radio, multi-network connectivity to services through a comprehensive layered architecture:

2.2.1 Multi radio device management

The multi-radio device management and networking layers together abstract multi-radio connectivity, selecting the optimal communication link to/from nodes, according to quality parameters.

2.2.2 Communication layer

The communication layer allows for communication in the B3G networking environment B3G SOAP in particular enriches traditional functionalities of a SOAP engine to allow for SOAP-based point-to-point and group-based interactions in the B3G network, and enables access to services on distinct networks thanks to multi-network routing. B3G Content-based Routing (CBR) provides content-based networking, complementing traditional unicast and multicast addressed-based networks, to support the communication modes underlying large-scale, loosely coupled, multi-party, distributed applications.

2.2.3 Service layer

The middleware services layer brings advanced distributed resource management functionalities customized for the B3G networking environment. The

Discovery Service enables the dynamic advertising and locating of networked services, in particular accounting for extra-functional properties. The Context-awareness Services feature concepts for managing contextual information and further easing the adaptation of services to best match user situations. The lightweight WS-Security Services allow for adapting the security provision to the capacity of mobile device resources. The Publish-Subscribe Service enables effective event-based communication in the B3G network through CBR.

2.3 The validation framework

The PLASTIC platform comprises a comprehensive validation framework for testing and validating services before and after deployment. An application can be validated in three stages:

1. off-line testing,
2. on-line pre-publication, and
3. on-line pre-usage.

Off-line testing refers to validation activities conducted during development of the service, in a mock-up environment. On-line validation instead refers to testing software deployed in its real environment; in particular in the context of services, PLASTIC distinguishes between validating the service behaviour before it is made available for general public invocation, or after, in which case the validation is synonymous for monitoring. The validation framework contains tools for functional testing, where the correct functionality of the system is tested and also for non-functional validation, where dependability features, corresponding to quality of service are validated. For functional testing, PLASTIC devises a methodology which allows the automatic testing of services based on the UML model on which it was previously defined. The model-based approach is also used for non-functional validation, by augmenting the service models with quality of agreed attributes.

Another challenge identified was how to validate the provided quality of service of an application, keeping the aspects that pertain strictly to the observed system separate from the aspects which depend on the underlying platform (network, devices etc.) For this we provided an off-line test bed in which the underlying platform and network can be simulated in a realistic way.

PLASTIC also offers a tool for on-line monitoring, where the point-to-point attributes can be measured in real usage. Here care was taken to insert the monitoring probes into the right places, to keep the overhead introduced by data collection and analysis to a minimum.

3 Some Example Applications

The PLASTIC project consortium tested its new platform by developing several advanced mobile services and applications using them. For conveying the advantages of developing B3G services by means of PLASTIC, let us describe some of the implemented services and explain the features deriving directly from the PLASTIC technology. More detailed information about all the designed services and applications can be found at the project web site [2].

In general, PLASTIC impacts organizations willing to introduce mobile technologies either as final users or as providers. As part of the project, the assessment of PLASTIC is certified through advanced prototype applications with the following mobile solutions:

3.1 eBusiness



The Field Service Management (FSM) application permits to dispatch dealer alerts to field workers issued by the service division of a car manufacturer, which is in charge to resolve complex vehicle issues.

The application features the distribution of dealer alerts to field workers in the B3G environment, content-based routing of issues within the field force and adapting issue assignments to the actual context (location, agenda, preferences) of the field workers.

3.2 eHealth



The application comprises services providing access to Medical Care at home and elsewhere. Medical information is delivered to the specialist that best fits the demand.

The scenario extensively features B3G networking over multiple user devices and SLA agreement checks among the stakeholders. Through PLASTIC the solution could be simulated and tested prior to deployment on the real network.

3.3 eLearning



The e-Learning applications implements a simple remote learning scenario in which three users are communicating with each other and with a content repository in order to collaboratively manage the learning content.

The main focus on this application served as a hotbed for the PLASTIC light-weight security. The application has to be highly adaptive to prevailing conditions for ensuring robustness. For example, a battery switch off while content downloads are pending is a highly undesirable event.

3.4 eVoting



The e-Voting application targets market-research and opinion-research companies and aims at exploiting PLASTIC to achieve a reliable and secure voting process among dispersed and heterogeneous nodes.



It permits to perform an election over a network of peers with no central management of security or tallying. P2p decision making and opinion research are two variations of this theme.

These features became possible with the PLASTIC communication framework: the Multi-radio networking module and B3GSOAP.

4 Achievements & Future Work

The Figure 2 groups the most outstanding technical advantages when designing mobile services by means of PLASTIC. With PLASTIC, service developers and providers will have a unique opportunity to release enterprise mobility services fulfilling the broader and differentiated requirements coming from the various market segments. The PLASTIC platform specifically enables robust service provision in the open wireless environment. Most elements of the PLASTIC platform are released under open source license and may be downloaded at the project web site [3].

The most important breakthrough of the PLASTIC platform is that it cuts off much of the design and modelling effort, improving considerably the design

quality. This is highly important when building commercial-level applications. It has to be mentioned that the learning curve is long compared to state of the art design methodologies and practices. From an engineering point of view PLASTIC constitutes a substantial advancement over the state of the art in the engineering of mobile and adaptive services since it provides a coherent specification, implementation and validation approach for this discipline. The concepts are backed by a model-based approach, a middleware and a couple of supporting tools geared towards supporting nearly all phases of the mobile services life-cycle (except for deployment).

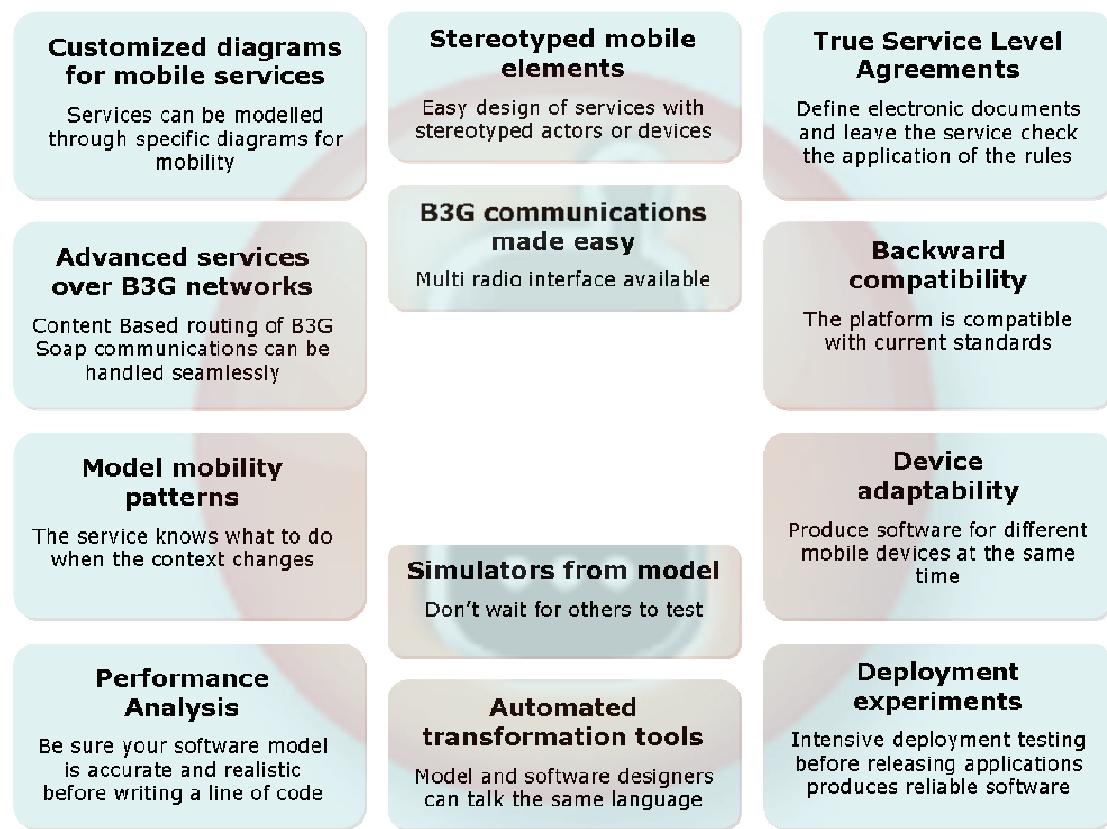


Figure 2: PLASTIC at a glance.

During the course of the project some issues pertaining to the integration, particularly of the various middleware constituents, emerged. For instance, during the implementation of the eBusiness scenario content-based routing and context-awareness were featured to achieve adaptiveness in the process of delivering issues to field workers. Instead of replacing one approach by the other in order to meet the bare functional requirements, both can be combined. I.e., predicates for content-based routing of issues could be dynamically evaluated and configured by using contextual information. Such principle could be applied to various business processes other than CRM.

This leads to another question addressing the impact of adaptations in business processes and the underlying featured services concerning SLAs. Using PLASTIC, mainly a simulative (though effective) approach (design service / SLA, monitor fulfillment) can be supported. Instead of non-functional properties (SLAs), also functional properties could be checked for; i.e., whether an adaptive service is still functioning in case of contextual changes.

In order to further increase the effectiveness of the design methodology a formal approach to designing SLAs not only for mobile services would be of benefit: i.e., define an SLA for a given set of services and model the contextual changes; breaches of the SLA could then be reported immediately. The other way around, for a given service/SLA a set of contexts could be computed leading to SLA breaches. Of course, the computational complexity particularly for checking functional equivalence of different editions of the adapted service has to be taken into account.

5 References

- [1] 3G Americas: 2.5 Billion GSM Subscribers Worldwide - More than a Million New Users Daily (press release), 5 June 2007.
http://www.3gamerica.org/English/News_Room/DisplayPressRelease.cfm?id=2982
- [2] PLASTIC web site, <http://www.ist-PLASTIC.org/>
- [3] PLASTIC tool web site, <http://www-c.inria.fr/PLASTIC/PLASTIC/software-download>