

MADAM

Scope

Mobile and pervasive computing introduce a growing demand for software systems that are able to adapt to dynamically changing environments. Dynamic adaptation happens at application run-time due to changing resource and context conditions. For example, applications may want to react dynamically to fluctuations in network connectivity, battery capacity, appearance of new devices and services, or to a change of user preferences.

Developing such applications is complex and costly and poorly supported by traditional software development environments. The objective of Madam project was to provide a comprehensive development framework aiming to alleviate the development of mobile applications with the capability to adapt dynamically to changing resource and context conditions.

Advances

At the end of the project a development environment has been provided and its benefits have been demonstrated through the development of several pilot applications. The development framework consists of:

- Modelling support in the form of a UML profile allowing the developer to model context dependencies, adaptation capabilities and the relationship between the two, using standard UML modelling tools.
- Transformation tools automating the generation of code representing these models at runtime
- Middleware using these models to detect relevant context changes, to do adaptation reasoning and decision making, and to carry out decided adaptations at runtime.

Positioning in global context

Clearly, Madam has not been the first project to tackle dynamically adaptive software systems. It is based on, incorporates, and extends earlier research work. However, Madam stands out since it provides a truly comprehensive solution that addresses adaptation from both the theoretical and practical perspective

Early adaptive systems addressed QoS concerns and QoS management involving maintenance and renegotiation of QoS – but these were not really context-aware and not targeting mobile computing. The emergence of adaptive middleware generalized earlier approaches to adaptation by providing open implementations and reflection as a general means to adaptation. However, these works are still very much QoS oriented focusing on adaptation of middleware level services. In later years, there has been an increasing interest in context-awareness and mobile

computing focusing on application-level adaptation. Madam falls under this category of projects.

Target users / sectors in business and society

The Madam technology targets software developing organizations which need to provide systems which are able to adapt to dynamic variations in user needs and available computing and communication resources. End users will benefit by experiencing better usability of software in such dynamic environments and that systems with such self-adaptation capabilities become affordable.

Overall benefits for business and society

The technology developed in this project has the potential to result in a broader set of ubiquitously available services both for business and private use. The adaptation of services will improve the service usability and other service quality properties in mobile settings. Also, the handling of quality attributes of the application will lead to more dependable solutions, and will improve the trust in the applications. Overall, this will enable increased use of computer based services in mobile settings, giving service users better support for their tasks when they are moving around.

Examples of use

Two realistic case studies were developed to evaluate the Madam approach. In the first scenario, which was derived from a real application of Condat AG written for Daimler Chrysler AG and Deutsche Bahn AG, service technicians are supported during their scheduled tasks regarding inspection, measurements and maintenance of technical equipment such as air conditioning plants or fire alarm installations. The technician uses a PDA for his work. In the original version of the application he had to handle different operating modes manually. With Madam, when the technician's environment changes during his roundtrip, the application on the PDA tries to self-adapt automatically in order to retain its usefulness. For example, in the original version of the application when a communication link deteriorated the technician had to wait until the connection was up again. Using Madam, the application automatically tries to transmit the data using alternative connections or buffer them temporarily on the local device. The second pilot application is SatMotion developed by Integrasy SA. It is a distributed application which supports the remote line-up of satellite antennas. The line-up is performed using a PDA to control the measurement equipment and a server over a wireless connection. The application receives the

signal traces and visualizes and evaluates them using a spectrum analyzer. This allows the installer to find the optimal alignment of the satellite antenna. In the original application, depending on the installer's tasks and context conditions, the installer could switch manually between different operating modes. In the new version based on Madam, the application automatically selects an appropriate operating mode.

Achievements

The following list summarises the main results achieved by the project:

- **Adaptation scenarios and reference requirements** aiming to facilitate the common understanding among the partners, and to determine a set of requirements for the targeted middleware.
- **A Theory of Adaptation** establishing a theoretical foundation for context awareness and self-adaptation.
- **Methodology, Notation and Tools** guiding and supporting the developer, while building context aware adaptive applications.
- **Adaptation middleware** automatically adapting Madam enabled applications executing on mobile devices.
- **Two Pilot applications** demonstrating the both the development time and runtime benefits of the technology.
- **Publications.** A number of scientific papers have been produced by the project. A list is available at the project website. A summary article has been accepted for publication in Software Practice and Experience.

The Madam development framework is a research prototype. It is openly available under an LGPL license from the project website: <http://www.intermedia.uio.no/display/madam/Home>. The development of the Madam technology is being continued in the Music project (www.ist-music.eu).



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