MADAM: Towards a Flexible Planning-based Middleware

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ABSTRACT
By exploiting software components, component frameworks and architectural reflection, the European IST project MADAM aims to overcome the complexity of developing mobile context-aware adaptive systems. The MADAM middleware defines a domain and platform-independent flexible reference architecture that supports dynamic reconfiguration of both applications and the middleware itself. Furthermore it implements flexible context monitoring, adaptation planning and dynamic reconfiguration frameworks that embodies much of the complex logic of dynamic adaptation.

Categories and Subject Descriptors

General terms
Design, Languages.

Keywords
Adaptive middleware architecture, self-adaptation, planning, mobile computing.

1. Research context
With the increasing mobility and pervasiveness of computing and communication technology, software systems are often accessed using a variety of handheld-networked devices used by people moving around. This introduces significant and unpredictable dynamic variation both in the user needs and in the operating environment of the software. For example, communication bandwidth changes dynamically in wireless communication networks, power is often a limiting resource on battery-powered devices, and user interface preferences change when on the move, because light and noise conditions change, or because hands and eyes are occupied elsewhere. Under such circumstances, adaptivity is required in order to maintain usability, usefulness, and reliability of the provided services.
Implementing such adaptivity is complex and costly with traditional technology. The MADAM project [1] seeks to overcome this by providing adequate modelling, tool, and middleware support. Modelling and tool aspects are addressed in a separate research summary.

2. MADAM adaptivity approach
In the MADAM approach, applications are built as component frameworks. Explicit models of the application framework architecture that specify the variability are used by the MADAM middleware to reason about and control adaptations at runtime [2]. The central adaptation control loop of the middleware detects changes in the environment, reasons about and decides on suitable adaptations to fit the new operating conditions, and then implements the adaptations through reconfiguration of the running application(s).
To enable the middleware to discrimination between implementation choices at variation points, components are annotated with property evaluator functions (e.g., representing QoS characteristic). The decision on which adaptations to make, is done by the MADAM planning framework. The planning activity consist of dynamic discovery of implementation alternatives at the variation points of the application’s component framework, and further of selection of those that best matches the operational environment and provides the highest user satisfaction given the current user context. Adaptation alternatives evaluations are performed by a utility function which composes and weights results from the property evaluator functions of the components. The planning framework is domain-independent and has been applied to many adaptation types including device resource constraints, user interfaces and disconnection handling in mobile environments. The MADAM middleware itself is also built as an open component framework, and each of its main components dealing with adaptation management, context management, and dynamic reconfiguration and deployment are separated from the core. This openness makes it possible to support different adaptation strategies, dynamic deployment of new context components (e.g. context sensors) or yet to customize the adaptation management with domain specific planning algorithms .
The MADAM middleware approach is being evaluated in two trials where adaptivity is introduced in existing industrial real-life applications. This will bring concrete evaluation feedback for our future work, which will also concentrate on deploying our approach in distributed and decentralized environments.

3. References