Context-Aware Multimedia Services in a Pervasive Environment- The Daidalos Approach

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ABSTRACT
There is a clear trend towards making multimedia applications context-aware so as to customize them by taking into account any collection of information which may be relevant, such as e.g. user location. However, current multimedia services are dominated by IMS, which is seen as a service platform that uses the SIP protocol to access all services that the internet can provide. In this paper, we describe the Daidalos approach on making IMS based multimedia services context-aware. We also demonstrate, how generic sensor networks can be integrated into the context management system of our platform thus enabling sensor network detected events to influence behavior of context-aware multimedia applications.

Categories and Subject Descriptors
C.2.4 [Distributed Systems]: Distributed applications

General Terms
Management, Design.

Keywords

1. INTRODUCTION
The proliferation of multimedia capable mobile devices such as novel multimedia enabled cellular phones or PDAs has encouraged users to consume multimedia content and services while on move. On the other hand, sensor networks are expected to penetrate our daily life capable of sensing the environment. There is a clear trend towards making applications context-aware so as to take into account any collection of information about an entity such as its location, the surrounding temperature or anything else which may be relevant to it. As more and more small and powerful multimedia devices penetrate the environment, pervasive multimedia services seem to be not far away, which give the user the freedom to create, compose, discover, access and adapt multimedia services on a variety of devices, best suited for the given service.

These trends call for a flexible application development and management environment, which enables rapid development of context-aware multimedia applications and management of multimedia services in such pervasive environment. However, in the area of telecommunications network providers and operators, current multimedia services are dominated by IMS (IP-based multimedia subsystem), which provides end-to-end multimedia conversational services on IP layer. On a long term perspective, IMS is seen as a service platform that uses the SIP protocol to access all services that the internet can provide and users will access IMS through a variety of network technologies and terminals, usually combining several of them at the same time. Therefore, it seems natural to see IMS as an enabling platform which needs to be augmented in a modular way to support not only pervasive multimedia services of the future but also to define mechanisms to interact with sensor networks that can provide contextual data as input for making the multimedia service as context-aware as possible.

The key contribution of this paper is the Daidalos' context-aware multimedia service architecture that augments IMS in order to make it context-aware to provide novel context-aware multimedia services in a pervasive environment. It includes mechanisms to access sensorial data as part of contextual information. It is composed of core IMS components and augmented by several enhanced components that comprise a distributed service enabler plane and a server plane. Integration of any sensor network is achieved through a dedicated wireless sensor network proxy that decouples sensor network specific protocols and procedures and interacts with the context management system in the distributed service enabler plane. The system, while leveraging key IMS infrastructure, provides the user with powerful tools to rapidly create, compose, discover, access and adapt context-aware multimedia services.

1 www.ist-daidalos.org
The paper is structured as follows. In chapter 2, we describe how the IMS platform is extended in a modular way to enable context-awareness. Chapter 4 describes how sensor networks can be integrated into our platform by treating sensor network detected events as context changes. Chapter 5 presents the pervasiveness of such extended IMS and how context is handled in more detail.

2. Context Aware Multimedia Service Provisioning and Management Architecture

The Daidalos context-aware multimedia service architecture is build upon a distributed service enabler layer, interacting with IMS, in order to make IMS applications pervasive and context aware. Management features such as Personalization, Learning, Context, Service Discovery, Service Composition and Security and Privacy are incorporated in this layer. These atomic management features may be distributed among different servers (application enabling servers) where the user terminal also is seen by the applications as an “enabling server”. This type of architecture improves scalability when compared with IMS. The architecture is based on the following components:

- **Pervasive Services Management (PSM):** The PSM is composed of Service Discovery Manager (SDM), Composition Manager (CoM), and Deployment Manager (DeM) and is responsible for managing the discovery, filtering, composition, deployment and lifecycle of services. DeM controls the initiation, execution and termination of the various different types of services and the platforms upon which they run, thereby abstracting the low level details of services such as OSGi, Bluetooth and Web services. CoM builds the service based on discovery and composition in a single service logic. SDM is involved in starting the context-aware service discovery process, contacting the Service Discovery Server (SDS), in the case of a centralized discovery, or directly Service Provider Servers (SPSs) in the case of decentralized discovery.

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Coordination Engine (CE): coordinates actions from users’ applications with the invocations on both the SIP stack and the media stack taking into account the preferences and the context information given by the Distributed Service Enabler plane.

Multimedia Service Provisioning Broker (MMSPB): represents a set of components that includes IMS Call Session Control Functions (CSCF - Proxy, Interrogating and Server) to set-up IMS calls that may require network resource reservations or the involvement of additional network elements such as Application Servers, gateway elements, and so on.

Media Resource Manager (MRM): maps codecs into network parameters depending on the user profile and coordinates the invocations to other resource admission control components for QoS assurance (not shown in the picture). It provides support for session and terminal mobility.

Finally, the Server Plane encompasses the whole set of servers and databases needed to support above explained architecture. In the picture only the main ones are represented (i.e. conferencing server(s), streaming server(s), location server(s), context server(s), wireless sensor network (WSN) proxy to allow sensor network information to be transferred to context management data and service discovery servers (s)).

3. Sensor Networks as Context Sources
Sensor networks are an important source of context that are expected to have an impact on the behavior of multimedia services by raising awareness of situational context that cannot be inferred from location. The combination of multiple sensor network data will enable the inference of richer contextual information. To apply a rule such as “if in meeting, redirect the call to the answering machine” requires the combination of e.g. location data (“location” = “meeting room”) and other sensors (such as e.g. voice activity detection) in order to infer that a given person is currently participating in a meeting. Therefore, based on results from [6, 7], we provide the possibility to integrate data from multiple sensor networks in the form of context information. In this way, the internal details of sensor network specific protocols and entities are hidden and decoupled as much as possible from context management. The model is the following: each sensor reports data to (or can be queried by) a specific aggregator node, preconfigured at each sensor. This allows establishing security relationships between aggregator nodes and individual sensors thus protecting the integrity and confidentiality of the reported measurements. Aggregator nodes are organized into a hierarchy. Aggregators communicate with sinks, which again have security relationship with aggregator nodes. Sink nodes are responsible to communicate (push, pull or push/pull model) aggregated measurements to the outside world or store recorded data.

Figure 2: Daidalos WSN/Context Management Integration
A WSN Proxy, which can be co-located with the sink, serves as integration point between the Context Management System (CMS), which is comprised of context manager and context server and the WSN. Therefore, the WSN Proxy registers as one or more context sources (either one source that represents the aggregated values or multiple sources, each representing different derived metric or different sensors) with the context management system using the CMS Interface [8]. It is required that the CMS must be able to configure each registered context source with parameters such as sample rate, context type monitored, value thresholds, etc. This is because the context management system incorporates mechanisms that detect non-conformant behavior of the WSN. For example, it checks that reported measurement lie inside certain thresholds, and will refuse to accept data that is reported in too short intervals.

4. Pervasive IMS and Handling of Context
The distributed service enabler plane enables IMS based services to become pervasive. The PSM can use such services and manage their registration, their selection for use for a particular purpose, the composition of several individual services into a composed service, and the deployment and lifecycle of such a composed service [9]. A composed service can consist of components that are specifically selected to match the context and personal preferences of a user. It can be recomposed to reflect changes in the context trigger e.g. through sensor network detected events pushed through the WSN proxy into the CMS or/and personal preference changes of the user, or resource availability changes, thus adapting to environment and context. An IMS based service to become pervasive must provide information that allows it to be discovered, composed and deployed. This includes information about purpose, interfaces provided, parameters required, etc. This information is supplied through a service ontology such as OWL-based Web Service Ontology (OWL-S).

The core IMS-based elements (MMSP-UA and MMSP-B) can both act as context source (“Bob wants to talk to me”) and consumer by retrieving context information. Furthermore, they can subscribe for outcomes that are driven by preferences and context changes. Therefore, implementing a rule such as “when in meeting, redirect all calls” can thus be realized very easily. Another example is that the sensor network could detect that you are entering a very noisy environment. Such context change could trigger the MMSP-UA to switch to an audio codec that is optimized for such environment. All our IMS-based elements implement session mobility support, which enables a dynamic redirection of multimedia streams to different devices, based on device capabilities to optimize user experience. With the integration with context management, both terminal and network
initiated session mobility can be triggered by changes in preferences and context. Finally, the virtual identity concept allows selecting a user identity automatically based on preferences and context (“When entering office room, used BoB@Work VID”), and the correspondent profile uploaded wherever needed.

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6. REFERENCES