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Introduction

1.1. Context-Aware Services

In personal communications, people often condense their speech by omitting information that can be directly deduced from the circumstances: such an awareness of surroundings, or context, assists the efficient exchange of ideas. Further, one of the parties to a discussion may notice or introduce a change in context, and react to this change as the situation demands. As for the nature of this information, in classical rhetorical theory the constituents of *circumstantiae* usually include time, place, events, manner, causes, persons and instruments related to an incident.

In the same way, computer applications could be made responsive to users' wishes if they were context aware, that is capable of inferring the users' true intentions by taking into account any relevant auxiliary information supplied for the purpose. Thus changes in different types of context information could cause a variety of actions to be initiated by the applications, just as a person might respond to the same signals.

This book describes and discusses the underlying principles of a contextware system that can handle the authoring, creation, management and operation of on-the-fly context-aware services, or indeed, any advanced network services, although context-aware ones present the most intriguing challenge. The reader of this book should be well versed in the ways of the Internet, since familiarity with its basic technologies is a prerequisite for embracing the presented ideas. However, although the book is not intended to be a tutorial on the key topics, it will contain reviews of technologies such as Active networks and Management Systems and as such it will gradually introduce the reader to the main subjects of the book. Thus, the book can also be used as a general introduction to the area of advanced telecommunications services for management and support personnel within network and service provider organisations, as well as a detailed reference book for professional technical staff and graduate-level students.

The following paragraphs present the authors' view of context-aware services and the role of selected technologies in the overall solution. This is followed by a preview of the individual chapters of the book.

The notion of networked applications receiving and making use of information about objects and circumstances around them, and thus presenting a context-aware service to users, has received a lot of attention, exemplified by services like location-aware tourist guides available in mobile terminals. Still, although there have been many context-aware systems and applications tested over the last decade, most of them are still prototypes only available in research labs and in academia. One of the main drawbacks lies in the complexity of capturing, representing and processing the contextual data. The implementations have also lacked generality and flexibility in the sense that only a predefined set of context information has been utilised, with no allowance for customisation or augmenting the scope of the information as the need arises. Yet the range of potentially useful context information is limitless and unforeseeable. One notable source of useful pieces of 'raw' context information has been recognised, though: the network.

Until recently, the sole purpose of the Internet infrastructure, that is interconnected routers, was thought to be to move traffic around as efficiently as possible. This was also the state of the affairs when the notion of active, and subsequently programmable networks arrived. The main idea with these new technologies is to allow a network's behaviour to be modified instantaneously and without service interruption.

1.2. The Context Project

On the context-aware service side of things, what the existing systems are missing is malleable and extensible context information processing, in a word, programmability. As it happens, this is the hallmark of active and programmable networks, specifically these networks are able to modify their behaviour on-the-fly. Recalling that the required information in many cases depends on data extracted from the networks, the inescapable conclusion is that context information can only be generated in a flexible manner by active or programmable networks. This foundational idea, presented by Prof. Alex Galis, was the basis for a European Community-funded research project, CONTEXT.

This project implemented and demonstrated an efficient solution for the automated creation, delivery and management of context-aware services using a very practical form of programmable network technology. The degrees of freedom made possible by this approach are notable: The collection and distribution of necessary context information for a service can be arranged by the service designer in parallel with the creation of other service logic.

At the time of writing this book, project CONTEXT has delivered its final reports, which include the conclusion that active/programmable network nodes can and should be augmented with the means to provide network configuration, status and other useful information, to be refined into context information according to an information model specified at the same time as the service needing the information (or later). This has a noteworthy consequence: No standardisation needs to precede the deployment of such models.

Such network context awareness is a potent and unifying ingredient to be added to the arsenal of service developers. Combined with prediction, information passing, proactiveness and other forms of intelligence, context-aware services can offer tangible benefits.

For the further benefit of service developers, a trial service management system was developed, encompassing authoring of the required information models and policies, service creation and deployment subsystems and policy-based management functionality. These project results are applicable to any advanced service making use of programmable network technology, not just the context-aware ones.

1.3. Structure of the Book

A brief summary of the remaining chapters of this book is provided below:

Chapter 2, ‘Context-Awareness and Modelling: Background’, sets the scene by laying out the principles involved with the expansive modelling of the context information. The chapter also is a short analysis of the current state of the art in Context-Aware Services.

Chapter 3, ‘The Service Lifecycle Functional Architecture’, shows what steps needs to be taken during the life of a service, and outlines the required functional abstractions to cater for them.

Chapter 4, ‘CAS and the Network Layer’, describes what is expected from a network to support context-aware services. The chapter also presents the design approach chosen by the authors.

Chapter 5, ‘Baseline Technology’, presents the starting point that was available for the creators of CONTEXT system. The major technological inputs are highlighted, including programmable network implementations.

Chapter 6, ‘CAS Creation and Management – System Architecture and Design Considerations’, lays out the fruits of the work carried out to outline and design a concrete system to handle the functional and nonfunctional demands presented.

Chapter 7, ‘Active Application Layer – System Architecture and Design Considerations’ brings us to the arena of real action, the network proper. The chapter reveals the main characteristics of the Active Application Layer, design approaches of special interest and the fine points of select aspects of active technology.

Chapter 8, ‘System Evaluation’, describes the methods of evaluation, evaluation criteria, execution of the tests and the results.

Chapter 9, ‘Conclusions’, pulls together the themes presented in the previous chapters and discusses the possible ways to improve the present system for wider applicability.

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The information and the source codes for many system components produced during the project are available at <http://context.upc.es/>, under a special ‘CONTEXT’ breed of an open source licence.

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