Mobile Web Services

Mobile Web services are designed to provide access to Web content anywhere and anytime, and often on any device. This book describes the key network elements, software components, and software protocols that are needed to realize these services, including the concept of user context and its potential to create personalized services. Major functions needed to implement the wireless mobile Web are explained in detail and cover location representation and tracking, security schemes, content personalization approaches, privacy mechanisms, and XSLT processing for browser content generation. WAP and i-mode mobile network architectures are examined. The author reviews latest mobile phone features and describes key aspects of browser markup languages (WML, cHTML, and XHTML MP). Ontology concepts and their application to enable the wireless Semantic Web are described and this book puts forward a novel definition and categorization of mobile user context with a detailed specification of the context ontology in W3C's Resource Description Framework (RDF) Schema. A mobile network architecture is presented, with in-depth explanation of each function, software infrastructure, and communication protocols (including SOAP, and the related WSDL) and an elaborated case study with code samples in XML and Java is included. The book is intended for wireless Web architects, network managers, and graduate students in electrical engineering and computer science.

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To Itai, Elad, and Tamar.

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Preface

The future mobile Web

The "always on" vision of mobile Internet access has become a reality with the nearly ubiquitous coverage provided by cellular networks. Communication speeds have also increased significantly with the advent of third generation (3G) cellular networks that enable data transfer rates supportive of real-time video. In addition, competing access technologies such as wireless local area networks provide hotspots where a wireless user can experience Internet data rates similar to these available with broadband connectivity in the fixed network.

Over 100 million wireless Internet users were recorded as of September 2003, with the majority in Japan and Korea, while fast growth rates were experienced in Europe. Significant growth is expected in specialized mobile services such as driving directions, traffic reports, tour guides, and commerce services such as mobile shopping. To use these services, the mobile terminal plays the role of both a "network computer" for retrieving relevant information and a "wallet PC" for enacting related transactions. Users could use their mobile terminal to search and order products to be delivered at a nearby store, and, once at the store, they could use e-money to pay for the products with their mobile terminal.

The present book, as its title "Mobile Web Services" suggests, describes the building blocks needed to put together mobile networks that can wirelessly deliver Web content. Included is extensive coverage of the network elements, languages used to represent browser content, communication protocols, network services, and related software components that are used in the operation of such networks. The described network services include user location tracking, security schemes, content personalization approaches, privacy mechanisms, and style sheet processing for browser content generation.

While on the move, a mobile user faces many challenges such as a mobile terminal's limited screen size, restricted input capabilities, battery power constraints, and air time costs. This is where knowledge of a user's context can be leveraged to drive and personalize the interaction between user and Internet server so as to ease the communication exchange and focus the delivery of Web content to information that is directly

applicable to a user's situation. This book presents scenarios of mobile users that seek Web content and describes the pertinent elements of context that affect content delivery. A corresponding ontology of user and environment context and its formal representation in the W3C's Resource Description Framework (RDF) Schema is elaborated upon.

Context-aware Web access requires the support of network services that are realized in a mobile Web network architecture whose network element functions, message flows, and system software support are explained. The book concludes with a description of an experimental mobile Web network. This network delivers tourism information to mobile users in a city environment and the system description includes related code samples in XML and Java.

Readers of "Mobile Web Services" include mobile Internet engineering managers, system architects, software developers, and engineering students wishing to learn how to design mobile Web networks.

How this book is organized

Chapter 1: *The mobile Web landscape* introduces the concept of mobile Web services and the mobile Web networks that provide the framework where mobile Web services can be deployed. A description of context, a key element in the realization of mobile services follows. Finally, this chapter lists the standards organizations that contribute mobile Web-related specifications, and concludes with an introduction to XML, the language used in most program examples provided in this book.

Chapter 2: *Wireless system architecture* explains the wireless system architecture specified by the WAP Forum (now the Open Mobile Alliance). A description of NTT DoCoMo's i-mode wireless architecture follows. This chapter describes how both the WAP and i-mode architectures have converged to a wireless Internet system, and shows how these architectures are realized over GSM's GPRS data network.

Chapter 3: *Wireless terminals and wireless content* reviews some of the most recent mobile phone capabilities and includes a description of browser-based applications, and the associated markup languages used in the creation of wireless content: WML, Compact HTML, and XHTML Mobile Profile. The chapter concludes with an elaboration of the evolution of browser capabilities.

Chapter 4: *User mobility and location management* starts with a review of IP addressability and the mobile IP standard followed by a description of handset-based and network-based approaches for locating mobile users. Tree-based hierarchical schemes for representing location and spatial information are described next, with an ensuing description of moving objects databases for storing spatial-temporal information. The chapter concludes with a description of the US E911 emergency services solutions for locating mobile users in distress.

Chapter 5: *Wireless network security* reviews the objectives of security for mobile environments. This chapter describes common methods for securing the transmission of messages. It proceeds with a depiction of mobile terminal and server authentication, and layouts an authorization framework. This chapter describes in detail Web services security as specified by the W3C and the OASIS standards organization.

Chapter 6: *Personalization and privacy* introduces the benefits of personalization of mobile interactions. Approaches used to build user behavior models are reviewed, followed by an elaboration of recommenders that tailor Web information delivered to mobile users. Included is a description of the architectural components needed to realize a personalization system. This chapter also addresses privacy concerns and details the related W3C's P3P effort.

Chapter 7: *Ontologies and RDF Schema* reviews ontology concepts and their application to enable the wireless Semantic Web. Efforts related to mobile services in the W3C and FIPA standards organizations are described. Approaches and criteria used in the generation of ontologies are elaborated upon next. An introduction to the W3C-defined RDF and RDF Schema (RDFS) are introduced next, as they provide a formal framework for defining an ontology. This chapter concludes with a description of the evolution of Web ontology languages that build on RDFS.

Chapter 8: *Ontology of mobile user context* provides a motivation for the definition of a mobile user's context. Four major scenarios of wireless Internet access by mobile users that wish to access Web-based content are presented. For each scenario, the activity of a corresponding context-aware service that delivers Web content is elaborated upon. Associated static and dynamic context elements are described and presented in the form of RDFS graphs and RDFS code.

Chapter 9: *XSLT for Web content presentation* starts by explaining how to generate XML representations of Web-based content that take into account user context. A description follows on how an XSLT processor can apply XSLT style sheets to XML representations to generate browser markup. Core capabilities of XSLT style sheet programming are introduced, and it is shown how to leverage XSLT for generating displayable content that reflects awareness of a mobile user's situation.

Chapter 10: *Mobile Web network* layouts the architecture of a network that includes a context manager and enables the delivery of mobile Web information. The functions of each network element, as well as message flows, are elaborated upon. All fixed network elements are implemented as Web services, and this chapter provides a detailed description of the underlying W3C SOAP communication protocol and WSDL Web services interface specification.

Chapter 11: *Context-aware tourist information system* elaborates on an experimental mobile Web network referred to as CATIS. CATIS implements a context-aware architecture that delivers tourism information to mobile users in a city environment. This chapter describes the network's architecture, network element functions, message

flows, system interfaces, and managed content. Included are detailed code samples in XML and Java.

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