



Service Provisioning From Resource Constrained Mobile Devices

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B.Sc. (Hons), M.Eng.

A thesis submitted in fulfillment of the
requirements for the degree of
Master of Philosophy

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June 2011

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Abstract

The primary goal of this thesis is to investigate how the service-oriented architecture can be extended to mobile environments, facilitating resource constrained mobile devices to host services. With the advances in mobile devices and wireless communications, the opportunities to run resource-demanding applications on the mobile devices are growing. The increasing processing power, storage and support of multiple network interfaces enable the mobile devices to host services and participate in service discovery networks. These characteristics facilitate that mobile devices can act both as service consumers and service providers. Besides, roaming of mobile devices across wireless networks provides nomadic characteristics to the service providers to be available anytime and anywhere. As in web services architecture, service consumers and providers are loosely coupled and dynamically bound; this architecture is especially advantageous for the frequently changing mobile environments.

Nevertheless, service provisioning from mobile devices is challenging, as the resources are far more constrained compared to the Internet servers that are originally targeted for web services technologies. Mobile devices have limited processing power and memory space; and suffer from lower bandwidths, higher error rates, and frequent disconnections compared to fixed networks. A few efforts have been taken to verify the feasibility of provisioning web services from mobile devices. However, they have not addressed the issue about how to host heavy-duty services on resource-constrained mobile devices with limited processing power, memory space, and transmission bandwidth.

This thesis attempts to overcome the issues by introducing a framework which partitions the workload of resource-demanding services involving complex business processes and keeps the web service

interfaces on mobile devices. The framework effectively leverages the capability of mobile devices, by offloading the partitioned computing load to resource-rich surrogates. Therefore, the mobile device works as the integration point with the support of surrogate nodes and other web services. The functions that require the resources of the mobile device or interaction with the mobile user are executed locally.

The framework introduces an efficient partitioning approach for execution offloading from resource constrained mobile devices. The proposed approach considers the dynamic status of the resources of a mobile device to partition the tasks effectively. The framework provides a distributed platform for executing services, which adaptively offloads by considering both the interaction properties and the resource consumption of the tasks. The designed framework is analyzed using prototype experiments and the results have shown the effectiveness and efficiency of the approach in provisioning heavy-duty services from resource constrained mobile devices.

Statement of Originality

This is to certify that the thesis is my own original work and it has been written by me. No part of this thesis has been submitted to any other institution other than Macquarie University as part of any other degree or diploma.

In addition, I certify that all information sources and literature used in the thesis are properly indicated. Any help and assistance that I have received in my research and the preparation of the thesis have been appropriately acknowledged.

Mahbub Hassan

30 June 2011

To my parents.

Acknowledgements

First and foremost, I would like to express my sincere gratitude to my principal supervisor Professor Jian Yang, for offering me the opportunity to do this research and for her continuous support and guidance that have made my research possible. Prof. Yang gave me the honor of becoming one of her students and has provided me the freedom to pursue my own research interests. Without Prof. Yang's help and support throughout my candidature, this work would not have been possible.

I owe much gratitude to my co-supervisor Dr. Weiliang Zhao, for his guidance, continuous support, encouragement, insightful ideas and critical evaluation of my work during my research period. I express my sincere thanks to him for agreeing to become my supervisor when I was critically in need of his expertise and guidance.

I would like to gratefully thank Dr. Abhaya Nayak and Ms. Jane Yang for their continuous support in all difficult situations throughout my candidature. I am also indebted to Dr. Rajan Shankaran for the encouragement he has given me and for offering me help in understanding research issues whenever I needed.

I would like to thank especially my colleague Ms. Yi Wang, and my friends Mr. Rezaul Bashir and Ms. Shermin Akther for their support on preparing the thesis. I sincerely thank all the people in the Department of Computing of Macquarie University, for their warm support and help.

Finally, I would like to thank my parents Mr. Shahjahan Miah and Mrs. Tahera Gulshan for their love, support, and encouragement throughout the whole period of my study and in so many ways. Without their support this work would have never been accomplished.

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List of Acronyms

Acronym	Meaning
ANSI	American National Standards Institute
AOE	Adaptive Offloading Engine
API	Application Programming Interface
ARM	Advanced RISC Machine
ARQ	Automatic Repeat Request
ASCII	American Standard Code for Information Interchange
BEEP	Blocks Extensible Exchange Protocol
BiM	Binary Format for Metadata
BPEL	Business Process Execution Language
BTS	Base Transceiver Station
CORBA	Common Object Request Broker Architecture
CPU	Central Processing Unit
DCOM	Distributed Component Object Model
DHCP	Dynamic Host Configuration Protocol
DNS	Domain Name System
DoD	Department of Defense
DOM	Document Object Model
DS	Device Service
EAI	Enterprise Application Integration
EDA	Event Driven Architecture
EDGE	Enhanced Data rates for GSM Evolution
ESAX	Encoded Simple API for XML
ESB	Enterprise Service Bus
EVM	Edge and Vertex Matching
GIS	Geographic Information Systems
GPRS	General Packet Radio Service
GPS	Global Positioning System
GSM	Global System for Mobile communications
GSR	Gateway Service Registry
GUI	Graphical User Interface
HEM	Heavy Edge Matching
HTML	HyperText Markup Language
HTTP	HyperText Transfer Protocol

ID-WSF	Identity Web Services Framework
JB1	Java Business Integration
JDK	Java Development Kit
JMS	Java Message Service
JMX	Java Management Extensions
JRE	Java Runtime Environment
JSR	Java Specification Request
JTAG	Joint Test Action Group
JVM	Java Virtual Machine
LBS	Location Based Services
LDAP	Lightweight Directory Access Protocol
LEM	Light Edge Matching
LRU	Least Recently Used
LSR	Local Service Registry
MHM	Multiplexed Hierarchical Modelling
M-Learning	Mobile Learning
MMS	Multimedia Messaging Service
MPEG	Moving Picture Experts Group
MSG	Mobile Services Gateway
MSP	Mobile Service Platform
MTOM	Message Transmission Optimization Mechanism
NAT	Network Address Translation
NMR	Normalized Message Router
NMS	Nomadic Mobile Service
OGC	Open Geospatial Consortium
OS	Operating System
OTA	Over-the-air provisioning
OWL	Web Ontology Language
P2P	Peer to Peer
PDA	Personal Digital Assistant
PDF	Portable Document Format
PPM	Prediction by Partial Match
QoS	Quality of Service
QRP	Query Routing Protocol
RDF	Resource Description Framework
RISC	Reduced Instruction Set Computing
RM	Random Matching
RMI	Remote Method Invocation

RPC	Remote Procedure Call
RTT	Round-Trip Time
SDRAM	Synchronous Dynamic Random Access Memory
SOAP	Simple Object Access Protocol
SMS	Short Message Service
SMTP	Simple Mail Transfer Protocol
SS	Surrogate Service
STL	Standard Template Library
SwA	SOAP with Attachments
TCP	Transmission Control Protocol
UDDI	Universal Description, Discovery and Integration
UDP	User Datagram Protocol
UMTS	Universal Mobile Telecommunications System
UPnP	Universal Plug and Play
URI	Uniform Resource Identifier
URL	Uniform Resource Locator
WAP	Wireless Application Protocol
WASP	Web Applications and Services Platform
WBXML	WAP Binary XML
WLAN	Wireless Local Area Network
WSA	Web Services Activity
WSDL	Web Services Description Language
WSE	Web Service Enhancement
WSFL	Web Service Flow Language
WWW	World Wide Web
XML	eXtensible Markup Language
XPATH	XML Path Language
XSD	XML Schema Definition
XSLT	Extensible Stylesheet Language Transformations

List of Publications

- **Hassan, M.**, Zhao, W. and Yang, J. (2011), *A Partitioning Approach for Resource Constrained Mobile Devices to Host Services*, The Ninth International Conference on Mobile Systems, Applications, and Services (MobiSys 2011), Washington, DC, USA (submitted).
- **Hassan, M.**, Zhao, W. and Yang, J., (2010), *Provisioning Web Services From Resource Constrained Mobile Devices*, The Third IEEE International Conference on Cloud Computing (CLOUD 2010), pp. 490-497, Miami, Florida, USA.
- **Hassan, M.** (2009), *Mobile Web Service Provisioning in Peer to Peer Environments*, The IEEE International Conference on Service-Oriented Computing and Applications (SOCA 2009), pp. 138-141, Taipei, Taiwan.

