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Dynamic multimedia content access in a ubiquitous and distributed computing environment

Letian Rong
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Dynamic Multimedia Content Access in a Ubiquitous and Distributed Computing Environment

*A thesis submitted in fulfilment of the
requirements for the award of the degree*

Doctor of Philosophy

from

University of Wollongong

by

Letian Rong

B.E. (Computer) (Hons.)

School of Electrical, Computer and Telecommunications Engineering

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Abstract

Ubiquitous computing is the concept of embedding many heterogeneous devices within our everyday environment in such a way that they operate seamlessly and become transparent to the person using them. It covers a wide range of applications and services, but of particular interest is multimedia resource adaptation which involves customization and dynamic adaptation of resources according to usage environments and user preferences; this aims to provide consumers with transparent access.

This thesis proposes a content negotiation architecture for dynamic adaptation of multimedia content according to usage environment attributes. The architecture shields users from complex configuration details related to the adaptation of multimedia content, while guiding them through user related choices. The architecture also dynamically updates the multimedia content during transmission and consumption when related usage environment attributes are changed. The content negotiation mechanism in the proposed architecture is then extended and deployed in a mobile computing environment to accommodate transfer of multimedia content application session state between devices in a seamless manner. An application session transfer architecture which allows sessions to be directed, stored and transferred through an intermediary session server is proposed.

The thesis also considers the foregoing work on the adaptation of multimedia resources applied to sharing in a Peer-to-Peer (P2P) network. It proposes a super peer based dynamic resource adaptation architecture which employs ‘pull’ and ‘push’ two-stage adaptation approach. This guides users through resource search and

configuration details without exposing them to unnecessary technical details; the result is that requested content is transparently adapted to heterogeneous terminal devices. Two separate, but related, modifications are proposed to further improve the performance of the proposed P2P architecture. Firstly, peers are clustered according to registered geographic location information and secondly, based on that registered location information, a locality-based service is introduced which allows users to search services according to their geographic locations. The latter encourages service providers to increase the uptime of their devices and hence provide spare computing power for active adaptation of resources for low-end peers.

Resource replication is an important aspect of a P2P system and an adaptive resource replication strategy based on the proposed P2P architecture is presented. It uses resource request rate as the metric to trigger the resource replication process, and proportionally replicates multimedia resources into various configuration states according to the properties of peers and the size of peer clusters. Also, the strategy uses peer related information stored on super peers to determine which peers should be selected to perform adaptive replications and where the resulting replicas should be stored. The proposed adaptive replication strategy demonstrates that the network delays are reduced while resource hit rate is increased in comparison to other replication strategies.

Investigation of the deployment of a BitTorrent (BT) - like approach in the proposed P2P resource adaptation architecture is also considered in this thesis. In addition, the architecture's peer selection strategy is adopted and evaluated as a way to enhance the peer selection process in BT. The strategy uses super peers as trackers to intelligently select peers according to their capabilities and shared resource segments

and overcome the scalability issue of existing BT implementation. The proposed selection strategy reduces average access time and increases download speed when compared with the existing BT peer selection process with randomly selected peers. Also, the deployment of BT in the proposed P2P architecture shows that it greatly reduces the congested download problem which was previously reported.

Statement of Originality

This is to certify that the work described in this thesis is entirely my own, except where due reference is made in the text.

This document has not been submitted for qualifications at any other academic institution.

Signed

Letian Rong

25/02/2007

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List of Abbreviations

BSD	Bitstream Syntax Description
CC/PP	Composite Capabilities/Preferences Profile
DC	Dublin Core
DHT	Distributed Hash Table
DI	Digital Item
DIA	Digital Item Adaptation
DID	Digital Item Declaration
DIDL	Digital Item Declaration Language
DRM	Digital Rights Management
DTD	Document Type Definition
IETF	Internet Engineering Task Force
ISP	Internet Service Provider
HTML	Hypertext Mark-up Language
HTTP	Hypertext Transfer Protocol
LAN	Local Area Network
LRU	Least Recently Used
MIME	Multipurpose Internet Mail Extensions
MPEG	Moving Picture Experts Group
PDA	Personal Digital Assistant
QoS	Quality of Service
RDF	Resource Description Framework
RTT	Round Trip Time
SGML	Standard Generalized Mark-up Language

SMIL	Synchronized Multimedia Integration Language
SMPTE	Society of Motion Picture and Television Engineers
TTL	Time To Live
UAProf	User Agent Profile
UCD	Universal Constraints Description
URI	Uniform Resource Identifier
URL	Uniform Resource Locator
UMA	Universal Multimedia Access
XML	eXtensible Mark-up Language
XSD	XML Schema Definition
XSLT	XML Transformations
W3C	World Wide Web Consortium
WAP	Wireless Application Protocol
WML	Wireless Markup Language