UNIVERSITI PUTRA MALAYSIA

MULTI-LEVEL MOBILE CACHE CONSISTENCY SCHEMES BASED ON APPLICATION REQUIREMENTS

DOHA ELSHARIEF MAHMOUD YAGOUB

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By

Doha Elsharief Mahmoud Yagoub

Thesis Submitted to the School of Graduate Studies, Universiti Putra Malaysia, in Fulfilment of the Requirements for the Degree of Doctor of Philosophy

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DEDICATION

To the Soul of my beloved father Elsharief Mahmoud,
"Rahimuh Allah"
To my beloved mother Suad Abdeljaleel

Doha

Abstract of thesis presented to the Senate of Universiti Putra Malaysia in fulfilment of the requirement for the degree of Doctor of Philosophy

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January 2012

Chair: Hamidah Ibrahim, PhD

Faculty: Faculty of Computer Science and Information Technology

In mobile environment, maintaining cache consistency is challenging due to the inherited limitations of mobile environment. In particular, there is a need for supporting multiple levels of consistency (strict and weak levels) when maintaining mobile cache to enhance the performance of data access in a mobile environment.

The multiple levels of cache consistency provided by the existing scheme are based on the mobile client interest, i.e. each mobile client is responsible to determine the consistency level of each of its cached data items based on its current requirements on that item. However, this is not an appropriate idea since the consistency of the cached data items should be determined based on the requirements of the application on that item. The mobile application may allow a degree of weak consistency to some cached data items and some critical cached data items have to be up to date with data in the source. To address this issue, this thesis proposes a new stateful scheme to maintain cache consistency in the mobile environment called Application

Based Multi-Level Mobile Cache Consistency Scheme (ABMMCCS). ABMMCCS is considered the first scheme that provides multiple levels of cache consistency based on the application requirements and therefore is suitable to various mobile applications.

The other issue addressed in this thesis, is the degradation in the efficiency of the stateful schemes when the application system is used by a large workgroup of mobile users with sharing data. Degradation appears in the extra overhead of the base server to assure the delivering of the updates to the massive number of clients and the increasing in the uplink bandwidth consumption. Towards this an Adaptive Dynamic Application Based Multi-level Mobile Cache Consistency Scheme (AD-ABMMCCS) is introduced. AD-ABMMCCS scheme has proven that it enhances the efficiency of the stateful scheme ABMMCCS when the mobile application is used by a large group of users with sharing data.

The proposed schemes are evaluated analytically and experimentally. The results show that under all consistency levels, ABMMCCS has significantly reduced the overhead of the mobile client and the base server and achieved better utilization to the wireless network bandwidth compared to Multi-Level Cache Consistency Protocol (MCCP) scheme. Also the results reflect the high rate of saving in the uplink bandwidth achieved when applying AD-ABMMCCS.

Abstrak tesis dikemukakan Kepada Senat Universiti Putra Malaysia Sebaga memenuhi keperluan untuk ijazah Doktor Flasafah

SKIM KONSISTENSI CACHE MOBIL PELBAGAI PERINGKAT BERASASKAN APLIKASI

Oleh

DOHA ELSHARIEF MAHOMUD YAGOUB

Januari 2012

Pengerusi: Hamidah Ibrahim, PhD.

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Dalam persekitaran bergerah, menyelenggara konsistensi cache adalah mencabar disebabkan oleh batasan yang diwarisi daripada persekitaran bergerah. Khususnya, terdapat satu keperluan untuk menyokong pelbagai peringkat konsistensi (peringkat tegas dan lemah) apabila menyelenggara cache bergerah untuk meningkatkan prestasi capaian data dalam satu persekitaran mobil.

Pelbagai peringkat konsistensi cache yang disediakan oleh skim sedia ada adalah berdasarkan kepentingan pelanggan bergerah iaitu setiap pelanggan mobil adalah bertanggungjawab untuk menentukan tahap konsistensi untuk setiap item data cache berdasarkan keperluan semasa pada item itu. Walau bagaimanapun, ini bukan satu idea yang sesuai memandangkan konsistensi item data mestilah ditentukan berasaskan kepada keperluan aplikasi pada item itu. Aplikasi mobil membenarkan suatu tahap konsistensi lemah untuk beberapa item data cache dan beberapa item data cache kritikal perlu terkini dengan data dalam sumber. Untuk menangani isu ini,

tesis ini mencadangkan satu skim *stateful* yang baharu untuk menyelenggara konsistensi cache dalam persekitaran bergerah dipanggil Aplikasi Berasaskan Skim Konsistensi Cache Bergerah Pelbagai Peringkat (ABMMCCS). ABMMCCS dianggap skim pertama menyediakan pelbagai peringkat konsistensi cache berasaskan keperluan aplikasi dan oleh itu adalah sesuai untuk pelbagai aplikasi mobil.

Isu lain yang ditanggani dalam tesis ini adalah degradasi dalam kecekapan skim *stateful* apabila sistem aplikasi digunakan oleh kumpulan kerja pengguna mobil yang besar dengan perkongsian data. Degradasi muncul dalam overhed tambahan pelayan asas untuk memastikan penyampaian kemas kini kepada bilangan besar pelanggan dan peningkatan dalam penggunaan lebar jalur uplink. Berikutan ini, Aplikasi Dinamik Mudah Suai Berasaskan Skim Konsistensi Cache Bergerah Pelbagai Peringkat (AD-ABMMCCS) telah diperkenalkan. Skim AD-ABMMCCS telah membuktikan bahawa ia meningkatkan kecekapan skim *stateful* ABMMCCS apabila aplikasi mobil digunakan oleh sekumpulan besar pengguna dengan perkongsian data.

Skim yang dicadangkan telah dinilai secara analitis dan uji kaji. Keputusan menunjukkan bahawa di bawah semua peringkat konsistensi, ABMMCCS telah mengurangkan secara signifikan overhed pelanggan mobil dan pelayan asas dan mencapai penggunaan yang lebih baik terhadap rangkaian lebar jalur tanpa wayar berbanding dengan skim Protokol Konsistensi Cache Pelbagai Peringkat (MCCP). Keputusan juga mencerminkan kadar yang tinggi dalam penjimatan lebar jalur *uplink* yang dicapai apabila menggunakan AD-ABMMCCS.

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My sincere thanks. May ALLAH bless and bring pleasure and prosperity to all of you.

Doha

I certify that a Thesis Examination Committee has met on 16 January 2012 to conduct the final examination of Doha Elsharief Mahmoud Yagoub on her thesis entitled" "Multi-Level Mobile Cache Consistency Schemes Based On Application Requirements" in accordance with Universities and University Colleges Act 1971 and the Constitution of the Universiti Putra Malaysia [P.U.(A) 106] 15 March 1998. The Committee recommends that the student be awarded the Doctor of Philosophy

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DECLARTION

I declare that the thesis is my original work except for quotations and citations which have been duly acknowledge. I also declare that it has not been previously and is not concurrently, submitted for any other degree at Universiti Putra Malaysia or at any other institution.

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DOHA ELSHARIEF MAHMOUD YAGOUB
Date: 16 January 2012.

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