
**UNIVERSITI PUTRA MALAYSIA**

***AUTOMATIC GENERIC PROCESS MIGRATION SYSTEM IN LINUX***

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# AUTOMATIC GENERIC PROCESS MIGRATION SYSTEM IN LINUX

By

AMIRREZA ZARRABI

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

December 2012

## DEDICATIONS

*This thesis is dedicated to my lovely parents who gave me best supports by their hearts.*



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Abstract of thesis presented to the Senate of Universiti Putra Malaysia in fulfilment of the requirement for the degree of Master of Science

**AUTOMATIC GENERIC PROCESS MIGRATION SYSTEM IN LINUX**

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**AMIRREZA ZARRABI**

**December 2012**

**Chairman** : **Khairulmizam Samsudin, PhD**

**Faculty** : **Engineering**

Process migration refers to the act of transferring a process in the middle of its execution from one machine to another in a network. It introduces an intuitively appealing approach which facilitates dynamic load distribution, fault resilience, easy system administration, and data access locality. Process migration has not reached widespread use in Linux Operating System (OS) which was originally designed to run standalone. However, several packages exist which extend Linux with migration functionality. They generally depend on specific features in kernel or target some well behaved applications. These packages are specifically tailored for specific goals, result in predefined operation which contradicts with the concept of generic tools.

In this work, a process migration system architecture for Linux is proposed. It does not impose any requirement on the existence of specific infrastructure in the kernel. It is a multilayer architecture to confine every functionality independent section of the system in separate layer. This architecture is capable of supporting diverse applications due to



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dynamic structure that can be modified according to demands. A flexible interface to the underlying checkpoint/restart subsystem is designed which permits users to specify the migration mechanism according to process constraints.

A migration algorithm is designed which attempts to exploit the unique features of the basic migration algorithms to form a generic algorithm. Furthermore, to enhance the process migration system performance a number of optimizations are enforced in each layer, including: buffer aggregation and interleaving, operation parallelism, and early event request. The entire system is absolutely implemented in multiple kernel modules which results in ease of use and eliminates the burden of complex system administration.

The proposed architecture is evaluated qualitatively and compared with the proprietary products to reveal its significance. However, the quantitative experiments are conducted to assess the implementation performance. The early event request is deployed to speedup the migration event by reducing the process migration latency time by almost 27% to 77%. Using the migration event concurrency, the freeze time for the migration events would practically be similar irrespective to the number of processes involved in the event. Exploiting the concurrency in the proposed migration system and introducing the notion of parallelism for transferring of the shared resources, the state relocation time is reduced by almost 20% for nine processes sharing 1MiB of their address space.

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Abstrak thesis yang dikemukakan kepada Senat Universiti Putra Malaysia sebagai memenuhi keperluan untuk ijazah Master Sains

**AUTOMATIC GENERIK PROSES MIGRASI SISTEM DALAM LINUX**

Oleh

**AMIRREZA ZARRABI**

**Disember 2012**

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Proses migrasi merujuk kepada pendekatan memindahkan proses daripada satu mesin kepada mesin yang lain. Perpindahan sebegini berlaku semasa proses sedang dijalankan. Kaedah intuitif ini memudahkan pengagihan beban secara dinamik, daya tahan bersalah, sistem pentadbiran mudah dan lokaliti akses data. Tanpa mengambil kira matlamat ini dan usaha penyelidikan yang dijalankan, proses migrasi masih tidak mencapai penggunaan yang meluas. Satu penjelasan adalah kerumitan menambah ciri migrasi proses yang telus kepada sistem operasi (OS) yang pada asalnya direka untuk operasi bersendirian. Walau bagaimana pun, pembangunan sistem operasi baru dengan keupayaan proses migrasi dari peringkat awal merupakan pendekatan yang tidak realistik.

Dalam kerja ini, kami mencadangkan proses migrasi novel seni bina untuk Linux OS, yang tidak memerlukan sebarang keperluan kewujudan kemudahan baru dalam kernel dan boleh melakukan migrasi proses multithreaded tanpa mengira tingkah laku secara telus. la adalah satu struktur berlapis untuk menghadkan fungsi setiap lapis secara tersendiri



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dalam lapisan yang berasingan. Senibina ini mampu menyokong pelbagai jenis aplikasi disebabkan antaramuka ruang pengguna yang generik dan strukturk dinamik yang dapat diubah berdasarkan permintaan. Selain itu, untuk meningkatkan keupayaan proses migrasi, beberapa pengoptimuman dikuatkuasakan pada setiap lapisan, termasuk: pengagregatan penampan dan interleaving, penselarian operasi dan permintaan acara awal. Satu algoritma migrasi telah direka bagi mengeksploitasi ciri-ciri unik algoritma migrasi asas bagi membentuk algoritma yang generik. Keseluruhan sistem telah dibangunkan dalam beberapa modul kernel yang memberikan kemudahan penggunaan dan menghapuskan beban pentadbiran sistem yang kompleks.

Arkitektur yang dicadangkan telah dinilai secara kualitatif dan dibandingkan dengan produk-produk proprietari bagi mendedahkan kesignifikanannya. Walau bagaimanapun, eksperimen kuantitatif telah dijalankan juga bagi menilai prestasi pelaksanaan. Hasil awal yang diperoleh daripada ujian menunjukkan kesan saiz ruang alamat proses terhadap masa pendaman migarasi proses. Oleh itu sebarang algoritma migrasi yang bertujuan untuk mengurangkan overhed pemindahan ruang alamat akan mengurangkan masa pendaman dengan banyak. Dalam sistem migrasi yang dicadangkan, permintaan peristiwa awal digunakan bagi mempercepatkan peristiwa migrasi dengan mengurangkan masa pendaman migrasi proses antara 27% hingga 77%. Hasil kajian juga menunjukkan dengan menggunakan keserempakan peristiwa migrasi, masa beku untuk peristiwa migrasi adalah sama tanpa mengira bilangan proses yang terlibat dalam peristiwa. Dengan mengeksploitasi keserempakan dalam sistem migrasi yang dicadangkan dan memperkenalkan tanggapan keselarian pemindahan sumber-sumber yang dikongsi, tempoh penempatan semula diku-



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rangkan hampir 20% bagi sembilan perkongsian proses 1MiB ruang alamat.



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I certify that a Thesis Examination Committee has met on 28 December 2012 to conduct the final examination of Amirreza Zarrabi on his thesis entitled "Automatic Generic Process Migration System in Linux" in accordance with the Universities and University College 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 Master of Science.

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This thesis submitted to the Senate of Universiti Putra Malaysia and has been accepted as fulfilment of the requirement for the degree of Master of Science. The members of the Supervisory Committee were as follows:

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## DECLARATION

I declare that the thesis is my original work except for quotations and citations which have been duly acknowledged. 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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## TABLE OF CONTENTS





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