



UNIVERSITI PUTRA MALAYSIA

**AN AUTOMATIC DRIVER DEPLOYMENT MECHANISM IN THE OSGi
GATEWAY FOR SMART HOMES**

LAU SIAN LERK

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**AN AUTOMATIC DRIVER DEPLOYMENT MECHANISM IN THE OSGi
GATEWAY FOR SMART HOMES**

By

LAU SIAN LERK

Thesis submitted to the School of Graduate Studies, Universiti Putra Malaysia,

In Fulfilment of the Requirements for the Degree of Master of Science

April 2008



DEDICATION

To the one who loves me unconditionally,
“I will not be shaken, for you are right beside me
No wonder my heart is filled with joy
Because you will not leave my soul among the dead
You will show me the meaning of life
Granting me the joy of your presence
And the pleasure of living with you forever”



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

AN AUTOMATIC DRIVER DEPLOYMENT MECHANISM IN THE OSGi GATEWAY FOR SMART HOMES

By

LAU SIAN LERK

April 2008

Chairman: Professor Borhanuddin Mohd. Ali, PhD

Faculty: Engineering

Smart home consists of smart appliances that provide services to home users. Home users should be able to purchase additional new smart appliance anytime and use it instantly at home without any configuration involved. In this thesis, we explore a typical scenario for smart homes that utilizes an OSGi-powered residential gateway that provides interoperation between heterogeneous smart appliances.

Drivers play a significant role in OSGi gateway to provide an integral aspect of services to users, as interoperation can only be possible if the gateway recognizes all heterogeneous smart appliances. An enhancement to OSGi Device Manager named A-ODM (Advance-OSGi Device Manager) is proposed to provide a zero-configuration environment to smart homes. A-ODM is an automatic driver deployment mechanism for OSGi gateway to resolve driver dependency externally.



A smart home simulation with driver provisioning architecture have been designed and implemented to demonstrate the feasibility of a network delivery of driver provisioning through web service architecture. A-ODM is tested on several OSGi implementations to compare its performance. We observed that A-ODM performed better in OSGi implementations with smaller footprint.



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

**MEKANISMA PEMACU PERANTI AUTOMATIK DALAM OSGi
GATEWAY UNTUK RUMAH BESTARI**

Oleh

LAU SIAN LERK

April 2008

Pengerusi: Profesor Borhanuddin Mohd. Ali, PhD

Fakulti: Kejuteraan

Pelbagai alat bestari yang terdapat di dalam sesebuah rumah bestari membekalkan servis kepada pengguna rumah. Pengguna rumah seharusnya dapat membeli alat-alat bestari tambahan pada bila-bila masa dan menggunakannya tanpa sebarang konfigurasi. Dalam tesis ini, senario untuk sesebuah rumah bestari menggunakan pintu masuk kediaman OSGi yang memberi kemudahan operasi antara berbagai alatan bestari diselidiki.

Pemacu peranti memainkan peranan penting bagi pintu masuk kediaman OSGi untuk memberi satu aspek penting tentang servis kepada pengguna rumah, kerana operasi antara alatan hanya terjadi jikalau pintu masuk memperakui kepelbagaian alat-alat bestari. Penambahbaikan ke atas Pengurus Alat OSGi (OSGi Device Manager) dikenali A-ODM (Advance-OSGi Device Manager) dicadang untuk membekal persekitaran bebas konfigurasi kepada rumah bestari. A-ODM adalah satu



mekanisme mengatur kedudukan pemacu peranti automatik untuk pintu masuk kediaman OSGi yang menyelesaikan pergantungan pemacu peranti secara luaran.

Simulasi rumah bestari bersama dengan seniba peruntukan pemacu peranti direka bentuk dan dilaksana untuk menunjukkan kebolehlaksanaan rangkaian penghantaran pemacu peranti melalui senibina servis laluan. A-ODM diuji ke atas beberapa implementasi OSGi untuk membuat perbandingan terhadap prestasinya. Pemerhatian ujian A-ODM mendapati prestasi A-ODM lebih baik dalam implementasi OSGi yang kurang menggunakan sumber komputer.

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I wish to express my sincere gratitude to my family members, notably my parents for their loving support and care over all these years. Without you, there will never be me.

Last, but certainly not least, be all glory unto my Lord Jesus Christ, my savior. You have given me hope in my life.



I certify that an Examination Committee has met on **28 APRIL 2008** to conduct the final examination of Lau Sian Lerk on his Master of Science thesis entitled “An Automatic Driver Deployment Mechanism in the OSGi Gateway for Smart Homes” in accordance with Universiti Putra Malaysia (Higher Degree) Act 1980 and Universiti Pertanian Malaysia (Higher Degree) Regulations 1981. The Committee recommends that the candidate be awarded the relevant degree. Members of the Examination Committee are as follows:

SUDHANSHU SHEKHAR JAMUAR, PhD

Professor
Faculty of Engineering
Universiti Putra Malaysia
(Chairman)

RUSLI HJ. ABDULLAH, PhD

Faculty of Information System and Information Technology
Universiti Putra Malaysia
(Internal Examiner)

MOHD. FADLEE A. RASHID, PhD

Faculty of Engineering
Universiti Putra Malaysia
(Internal Examiner)

SULAIMAN MOHD. NOR, PhD

Associate Professor
Faculty of Engineering
Universiti Teknologi Malaysia
(External Examiner)

HASANAH MOHD. GHAZALI, PhD

Professor/Deputy Dean
School of Graduate Studies
Universiti Putra Malaysia

Date:



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

Borhanuddin Mohd. Ali, PhD

Professor

Department of System Computer and Communication Engineering

Faculty of Engineering

Universiti Putra Malaysia

(Chairman)

Dzaharudin Mansor, PhD

Research Fellow

Microsoft Malaysia

(Member)

AINI IDERIS, PhD

Professor and Dean

School of Graduate Studies

Universiti Putra Malaysia

Date: 28 April 2008



I certify that an Examination Committee has met on **28 APRIL 2008** to conduct the final examination of Lau Sian Lerk on his Master of Science thesis entitled “An Automatic Driver Deployment Mechanism in the OSGi Gateway for Smart Homes” in accordance with Universiti Putra Malaysia (Higher Degree) Act 1980 and Universiti Pertanian Malaysia (Higher Degree) Regulations 1981. The Committee recommends that the candidate be awarded the relevant degree. Members of the Examination Committee are as follows:

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Universiti Putra Malaysia
(Internal Examiner)

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Faculty of Engineering
Universiti Putra Malaysia
(Internal Examiner)

SULAIMAN MOHD. NOR, PhD

Associate Professor
Faculty of Engineering
Universiti Teknologi Malaysia
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Department of System Computer and Communication Engineering

Faculty of Engineering

Universiti Putra Malaysia

(Chairman)

Dzaharudin Mansor, PhD

Research Fellow

Microsoft Malaysia

(Member)

AINI IDERIS, PhD

Professor and Dean

School of Graduate Studies

Universiti Putra Malaysia

Date: 10 July 2008



DECLARATION

I hereby declare that the thesis is based on my original work except for quotations and citations which have been duly acknowledged. I also declare that it has not been previously or concurrently submitted for any other degree at UPM or other institutions.

LAU SIAN LERK

Date: 6 June 2008



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LIST OF ABBREVIATIONS

A-ODM	Advance-OSGi Device Manager
ADSL	Asymmetric Digital Subscriber Line
API	Application Programming Interface
BP	WS-I Basic Profile 1.1
CEBus	Consumer Electronic Bus
DAS	OSGi Device Access Specification
DL	Driver Locator
DS	Driver Selector
DSL	Digital Subscriber Line
DVR	Digital Video Recorder
HES	Home Electronic System
IAD	Integrated Access Device
IP	Internet Protocol
IPTV	Internet Protocol Television
JAR	Java Archive
JVM	Java Virtual Machine
KF1	Knopflerfish Version 1
KF2	Knopflerfish Version 2
LAN	Local Area Network
ODM	OSGi Device Manager
OS	Operating System
OSGi	Open Service Gateway Initiative



OSI	Open System Interconnection
PC	Personal Computer
QoS	Quality of Service
RGW	Residential Gateway
SDP	Bluetooth Service Discovery Protocol
SH	Smart home
SOA	Service-oriented Architecture
SOAP	Simple Object Access Protocol
SOHO	Small Office Home Office
SSDP	Simple Service Discovery Protocol
STB	Set-Top Box
UDDI	Universal Discovery, Description and Integration
UPnP	Universal Plug and Play
UUID	Universal Unique Identifiers
VoIP	Voice-over IP
WAN	Wide Area Network
WSDL	Web Service Description Language
WS-I	Web Services Interoperability Organization



CHAPTER 1

INTRODUCTION

This chapter presents an overview of this thesis. Firstly, an introduction is given on smart homes. Next, the motivation of this thesis is presented by deriving issues from the context of smart home users. Finally, objectives are summarized in point form to present the purpose of this thesis.

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1.1 Smart Homes

Smart homes are intelligent, self-learning, and provides the ability to control appliances, lightings and any part of the home environment. It provides a new paradigm for a better home living through automation, giving convenience and comfort to home users. The number of smart homes are proliferating at an accelerated pace [1]. This is made possible by the wide availability of large but cheap computing power which can be embedded into appliances and provides an opportunity to network together.

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Each appliance at home provides one or more services to home users. Multi-appliance service, a composite service involving two or more appliances, can work together in providing a more natural and realistic approach for users at home to conduct their activities based on tasks instead of individual appliance functionalities.

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Such approach enables tasks to be performed and accomplished in an easier manner.

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One of the ways to implement this approach is by adopting a common architecture

based on residential gateway (RGW). RGW itself can be a home Internet gateway, a stand-alone computer or even a set-top box for Cable or Satellite TV.

RGW is useful in smart homes with several functionalities. RGW can act as a host or centralized intelligence that manages all home appliances. It can also act as an intermediary to facilitate interoperability between heterogeneous appliances. RGW is also a suitable platform for application development to access and control appliance services at home. A centralized user interface can be packaged together in the RGW to provide a complete management for home users. RGW can also act as a gateway to external network such as Internet and service provider that gives extra services and users can control and manage appliances at home remotely.

In the ideal scenario, RGW is assumed capable of accommodating all appliances, enables interoperability between heterogeneous appliances and works together under one roof, regardless of its vendor, supporting interfaces and protocols. In reality, today's smart homes are mostly based on closed architectures [2, 3] where its protocols and relevant hardware details are not made available to third party, and hence limits the interoperability to between appliances of the same vendor. This poses a significant problem in the implementation of RGW, as in reality of life home users purchase normally products from different vendors.

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Maintenance and support of RGW are issues often overlooked by vendors [4]. As the number of appliances proliferates at home, home user should not play the role of maintaining and servicing their home appliances. Instead of sending technicians on-

site to resolve system configuration issues, an automated and hassle-free system should implement to create a zero-configuration smart home. Research works such as [2, 5] attempted to provide solutions from the aspect of description language and hardware middleware.

With an implementation of RGW based on open standards [6], it is possible to make the smart home and its appliances more usable. An open platform such as Open Service Gateway Initiative (OSGi) [7] gives a better approach to support multiple protocols through a higher level of abstraction without affecting underlying hardware layer through drivers.

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1.2 Motivation

As open platform such as OSGi can to provide a better avenue to support multi-vendor environment through drivers, but the danger is that it poses greater complexity in maintaining the RGW as appliance drivers might be required at each instance where a new appliance is added in a smart home. Manual configuration of drivers and system maintenance can be a hassle to home users as conflicts or unexpected peculiar behavior of the system might occur during configuration. Thus, a mechanism is needed to automatically configure the RGW with driver tailored for specific appliance in providing an automated environment which is normally known as zero-configuration.

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This raises several questions to be pondered upon, which leads to the motivation of

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this thesis. They are as follows:

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- How can all home appliances interoperate in a smart home without standardizing all home appliances by using a specific communication protocol?
- How can a zero configuration support and management are made possible to integrate all heterogeneous home appliances to provide multi-appliance services in smart homes regardless of different rule sets and configuration as predefined by manufacturers?

The motivation of this thesis is to alleviate the weakness of Device Access Specification (DAS), part of OSGi Service Platform Specifications by means of a method to provide a zero-configuration smart home through OSGi-based RGW. Automated driver deployment that resolves and provides compatible appliance services to RGW is achievable through obtaining one or more relevant drivers from external sources via web services. This gives home users a no-fuss smart home experience.

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1.3 Objectives

The topic of this thesis is to design and prototype an automatic driver deployment mechanism for smart homes, based on an open RGW platform, supporting multi vendor appliances.

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