

بِسْمِ اللَّهِ الرَّحْمَنِ الرَّحِيمِ

اقْرَأْ بِاسْمِ رَبِّكَ الَّذِي خَلَقَ (1) خَلَقَ الْإِنْسَانَ مِنْ عَلَقٍ (2) اقْرَأْ وَرَبُّكَ الْأَكْرَمُ (3) الَّذِي عَلَّمَ بِالْقَلَمِ (4) عَلَّمَ

الْإِنْسَانَ مَا لَمْ يَعْلَمْ (5).

(سوره العلق)

ACKNOWLEDGEMENT

First, I would like to thank Allah, the Merciful, for giving me the power and health to do this work.

This research project would not have been possible without the support of many peoples. I hope wishes to express my gratitude to my supervisor Dr. Rashid A. Saeed for his keen supervision unlimited help and invaluable guidance.

I would like to thank my parents for their emotionally support throughout my degree, In particular, the patience and understanding shown by my mum, dad and sister during the study.

Lastly, grateful acknowledgement is made to all those who participated with their time, effort,

advise and knowledge to make this a successful study.

Abstract

Network Mobility (NEMO) means moving the mobility functional from mobile nodes to a mobile network's routers, it is able to change its attachment point to the Internet in a manner that is transparent to attached nodes. With the development of various wireless and mobile technologies, mobile multicast becomes more important because it can provide many applications such as video conference, on-line Interactive game, video/audio broadcast and real time news/applications distribution etc....

A Network Mobility (NEMO) system is built up by at least one Mobile Router (MR) and a set of Mobile Network Nodes (MNNs). The MR handles all routing related tasks to provide connectivity between the MNNs and an access network including mobility management. Correspondingly the MR also subscribes to multicast groups and forwards emerging multicast traffic on behalf of a MNN. For optimize routing of multicast data a hierarchical multicast agent is introduced as an entity providing an anchor to the multicast tree.

The agent based (AB) procedure combines the strengths of Bi-directional Tunneling (BT) procedure in terms of low multicast tree reconstruction and Remote Subscription (RS) procedure in terms of minimum routing path distance, while counteracting their disadvantages.

The multicast anchor agent (MAA) is a multicast router enabled to receive and forward multicast traffic it should be located in between the AR and the Home agent (HA) of the NEMO's MR. All multicast data aimed at nodes outside the NEMO are tunneled to the MAA to separate mobility issues from the multicast tree. Because the multicast traffic is characterized by session duration, direction to or from the NEMO and service parameters as Quality of service (QoS) requirements, the suitable mechanism to support multicast services in NEMO environments is agent based approach. It could be solve most NEMO multicast problems, When a route optimization schemes is applied to avoid pinball routing problems.

The research discusses the cost functions of the three multicast schemes (BT, RS and AB) that developed from a probability model of engagement between any MNNs in multicast group to a HA. So the performance parameters required taken under continuous session duration constraints, taken in account the effects of nesting topology of network mobility system and movement of it NEMO cluster. The cost functions of providing multicast among BT, RS and AB are compared.

Then we used the probabilities of multicast anchor agent forwarding data to their destinations, to formulate the multicast path function as a 0-1 knapsack problem₁ to show the selected items (multicast paths) by MAA in combinatorial optimization selection manner. It was shown that the performance of AB multicast schemes is better than BT and RS, the probability of engagement is increasing function when the number of HAs is fixed and the numbers of nodes joining to multicast tree are increasing, and

¹ The knapsack problem is a problem in combinatorial optimization when we have Given a set of items, each with a weight and a value, determine the number of each item to include in a collection so that the total weight is less than or equal to a given limit and the total value is as large as possible[6].

the effect of NEMO cluster high speed is ignorable when we looked in overall performance.

المستخلص

تجوال الشبكة يعني انتقال وظيفة التحكم في التجوال من الجوال الي موجه شبكة متنقل يمكنه تغيير نقطة وصوله لشبكة الانترنت، مع ضمان استمرارية الاتصال لنقاط الشبكة المرتبطة به. نظام الشبكة المتجولة يُبنى علي الاقل من موجه متجول واحد ومجموعة من أجهزة الجوال المترتبة به بحيث انه يقوم بوظائف الاتصال والاتصال المتعدد وتحويل الاتصال بالانترنت من نقطة لآخرى بالنيابة عن أجهزة الجوال المترتبة به. اصبح بناء خدمات الاتصال المتعدد في الشبكة المتجولة تحديا، ولضرورة دعم هذه الخدمات في الشبكات المتجولة استخلص الباحثون ثلاثة انماط لهذا الدعم، النهج النفقي ثنائي الاتجاه و نهج طلب الاشتراك عن بعد ونهج يعتمد وجود وسيط لإدارة الاتصال المتعدد نيابة عن موجه الاتصال المتجول وهذا الاخير يجمع بين ميزات النهجين الاخرين ويتفادي العديد من عيوبهما.

وسيط الاتصال المتعدد هو موجه يقوم باستقبال وتوجيه حركة بيانات الاتصال المتعدد من والي الشبكة المتنقلة ، والذي أقترح ان يوضع بين موجه الوصول لشبكة الانترنت (AR) ووكيل الاتصال الخاص بالجوال (HA). وبما أن حركة خدمة الاتصال المتعدد تتميز باستمرارية جلسة الاتصال واتجاه الاتصال من والي الشبكة المتنقلة، لذا اصبح النهج المناسب لدعم هذه الخدمات في شبكة الاتصال المتعدد هو النهج الذي يعتمد وجود وكيل لإدارة الاتصال المتعدد. مع الاخذ في الاعتبار احد تقنيات التحويل الأمثل (RO) لبيانات الاتصال المتعدد وذلك لفادي المشاكل المصاحبة لعدم وجودها.

البحث تبني نقاش ومقارنة أداء الثلاث طرق لدعم الاتصال المتعدد في الشبكات المتنقلة، وذلك بتطوير نموذج احتمالي رياضي يصف ارتباط الجوال داخل عنقود الشبكة المتنقلة (MNNs)

بوكيل الاتصال (HA). وبالتالي متغيرات الاداء المطلوبة أخذت باعتبار استمرارية جلسة الاتصال المتعدد مع الأخذ في الاعتبار تداخل مستويات هرمية الشبكة وتغيرها المستمر وتأثير سرعة حركة الشبكة علي استمرارية الاتصال . الصيغة المستنتجة اظهرت تفوق نهج العميل علي النهجين الآخرين. ولوحظ أن دالة الاحتمال او التوزيع الاحتمالي لارتباط الجوال داخل الشبكة المتنقلة مع عميل واحد علي الاقل انها دالة متزايدة وذلك مع ثبوت عدد عملاء الاتصال وتزايد عدد النقاط الجواله\الشبكات الجواله التي تنضم أو تغادر مجموعة الاتصال المتعدد..كما لوحظ أن تأثير السرعة العالية لعنفود الشبكة المتنقلة في الاداء العام يمكن تجاهله إذا نظرنا للاداء ككل. ثم اقترحنا استخدام اسلوب نهج تكاملي للاختيار الامثل للمسارات المتعددة، يُستخدم بواسطة عميل الاتصال المتعدد لتحسين الاداء مستقبلاً في استخدام العميل لإدارة الاتصال المتعدد في الشبكات المتنقلة.

CONTENTS

أية.....	I
Acknowledgement.....	II
المستخلص.....	III
Abstract	VI
Contents.....	VII
List of Figures.....	X
Abbreviations.....	XII
CHAPTER ONE.....	1
1.1 Preface	2
1.2 Problem Statement.....	4
1.3 Aim and Objectives.....	5
1.4 Methodology.....	6
1.5 Thesis Outline.....	7
CHAPTER TWO.....	8
2. Literature Review.....	8
2.1 Introduction.....	9
2.2 NEMO Basic Support Protocol.....	9
2.3 Some of Extended Messages Format.....	11
2.3.1 Binding Update.....	11
2.3.2 Binding Acknowledgement.....	12
2.3.3 Mobile Network Prefix Option.....	13
2.4 Mobile Router Operation.....	13
2.5 Home Agent Operation.....	14
2.6 Hierarchical of Mobile Router Advertisement for Nested NEMO	

Structure.....	16
2.7 Multihoming Support in NEMO.....	19
2.7.1 Path Selection.....	21
2.8 Multi-homed Nested NEMO and Tree Discovery.....	23
2.8.1 Loops in Nested NEMO.....	24
2.8.1.1 Tree Discovery (TD).....	26
2.8.1.2 Network In Node Advertisement (NINA).....	28
2.9 NEMO Multicasting and Multicasting using Agents.....	29
2.9.1 Mobile Multicast Classification.....	30
2.9.2 Mobility, Control Protocol, Multi-hop and Multihoming Support Issues.....	33
2.9.3 NEMO Multicast Protocols.....	38
2.9.3.1 Protocol Independent Multicast (PIM).....	38
2.9.3.2 PIM Sparse Mode (PIM-SM).....	40
2.9.3.3 PIM Source Specific Multicast (PIM-SSM).....	42
2.9.3.4 ASM versus SSM.....	43
2.9.4 IGMPv3 and MLDv2.....	47
2.9.4.1 Basic Operation of IGMP.....	47
2.9.4.2 Multicast Listener Discovery (MLD).....	48
2.9.4.3 IGMP/MLD Proxying.....	49
2.9.4.4 Multicast Addressing.....	50
2.9.4.5 IGMP/MLD Snooping.....	51
2.10 Multicasting Using Agents.....	53
2.11 Multicast Agent Procedure.....	55
2.11.1 The New Functions Entities of MR.....	57
2.12 Related Works.....	61

2.13 Chapter Two Summary.....	62
2.14 CHAPTER THREE.....	63
3. Mathematical Representation of Multicast Schemes in NEMO.....	64
3.1 Performance Evaluation.....	65
3.1.1 Multicast Path Function.....	70
3.1.1.1 0-1 Knapsack Problem.....	72
3.1.1.2 Solving 0-1 Knapsack Problem.....	74
3.1.1.3 Dynamic-Programming Solution to the 0-1 Knapsack Problem.....	74
3.1.1.4 Running time of 0-1 Knapsack Problem Solution.....	75
3.2 Chapter Three Summary.....	77
CHAPTER FOUR.....	78
4. Numerical Results and Dissections.....	79
CHAPTER FIVE.....	88
5. Conclusion and Recommendation.....	89
REFERENCE	
APPENDIXS	

List of Figures

Figure 2.1	NEMO Basic Support Protocol.....	10
Figure 2.2	NEMO Nested Structure.....	10
Figure 2.3	Network Mobility.....	16
Figure 2.4	RA Conflicition Problem.....	17
Figure 2.5	(n,n,n) Multiple MRs, HAs, and MNPs.....	21
Figure 2.6	Looping in Nested Routers Structure.....	25
Figure 2.7	TIO Base Option.....	31
Figure 2.8	Mobile Multicast Classification.....	36
Figure 2.9	Multicast Protocol Architecture.....	38
Figure 2.10	Multicast Tree Construction in PIM-SM.....	41
Figure 2.11	SSM Framework: Elements in end-to-end.....	45
Figure 2.12	General Multicast Scenario.....	53
Figure 2.13	The Multicast Anchor Agent location.....	56
Figure 2.14a	The Exchanged Messages between an end User and the Corresponding agent.....	58
Figure 2.14b	The Exchanged Messages between an end user and the Corresponding agent.....	59
Figure 3.1	NEMO Scenario.....	66
Figure 3.2	(m) Nodes all move to HA1.....	67
Figure 3.3	The MR moves and attaches to a foreign link behind MR3.....	68
Figure 3.4	Knapsack Problem.....	71
Figure 4.1	Prob. Of Engagement VS No. of Nodes.....	79
Figure 4.2	Mean value of k.....	80
Figure 4.3	Cost Function for RS, BT and AB (L=2).....	81
Figure 4.4	Nesting Effects in Cost Faction.....	82
Figure 4.5	NEMO movement Effect in Cost Function.....	83
Figure 4.6a	Knapsack size =5000 & number of Items=10	85

Figure 4.6b	Knapsack size =4000 & number of Items=10.....	86
Figure 4.6c	Knapsack size =3000 & number of Items=10.....	86
Figure 4.6d	Knapsack size =2000 & number of Items=10	87
Figure 4.6e	Knapsack size =1000 & number of Items=10	87

Abbreviations

AB	Agent Base
AR	Access Router
BSP	Basic Support Protocol
BT	Bi-directional Tunnel
BU	Binding Update
CN	Core Network
CoA	Care of Address
GMP	Group Management Protocol
HA	Home Agent
IETF	Internet Engineering Task Force
IGMP	Internet Group Magnet Protocol
LMN	Local Mobile Nodes
MAA	Multicast Anchor Agent
MIP	Mobile IP
MIPv6	Mobile IP version 6
MLD	Multicast Listener Discovery
MN	Mobile Node
MNNs	Mobile Network Nodes
MNP	Mobile Network Prefix
MR	Mobile Router
MRA	Multicast Router Advertisement
MRD	Multicast Router Discovery
MRS	Multicast Router Solicitation
NEMO	Network Mobility

NINA	Network In Node Advertisement
PIM	Protocol Independent Multicast
PIM-DM	PIM Dense Mode
PIM-SM	PIM Sparse Mode
PIM-SSM	PIM Source-Specific Multicast
RA	Route Advertisement
RFC	Reference Of Comment
RS	Remote Subscribe
RO	Route Optimization
TD	Tree Discovery
TIO	Tree Information Option
TLMR	Top level Mobile Router
VMN	Visited Mobile Nodes