

**JUST QUEUING: POLICY-BASED SCHEDULING MECHANISM FOR
PACKET SWITCHING NETWORKS**

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**JUST QUEUING: POLICY-BASED SCHEDULING MECHANISM
FOR PACKET SWITCHING NETWORKS**

**A Thesis submitted to the UUM College of Arts and Sciences in
fulfilment of the requirements for the degree of Doctor of Philosophy
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by

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Abstrak

Keberleluasaan Internet dan aplikasinya menyebabkan penambahan terhadap permintaan pengguna bagi mendapatkan lebih banyak perkhidmatan pada harga yang berpatutan. Kepelbagaian trafik Internet memerlukan beberapa pengkelasan dan pemberian keutamaan dilakukan kerana terdapat kategori trafik menghendaki lengahan dan kehilangan bingkisan yang sedikit berbanding yang lain. Mekanisma penjadualan bingkisan yang sedia ada lebih cenderung kepada keseimbangan di antara tiga ciri utama iaitu keadilan, kerumitan dan perlindungan. Oleh itu, persoalan yang masih wujud ialah bagaimana untuk meningkatkan ciri-ciri keadilan dan perlindungan melalui pelaksanaan penjadualan yang kurang rumit. Kajian ini mencadangkan penambahbaikan dalam mekanisma penjadualan bingkisan dengan ciri-ciri keadilan serta perlindungan yang mampan serta pelaksanaan yang mudah bagi meningkatkan kualiti perkhidmatan khususnya untuk aplikasi masa nyata. Elemen tambahan diterapkan dalam persamaan utama keadilan bagi memperbaiki ciri keadilan. Kajian ini menggunakan dasar caj terhad yang memberikan perlindungan kepada pengguna biasa. Dalam aspek kerumitan, algoritma genetik digunakan kerana ianya mempunyai kelebihan bagi menyimpan skor kecergasan baris gilir pada ruang storan berasingan yang berpotensi meminimumkan kerumitan algoritma. Kesepaduan antara pendekatan konsep, analisis dan eksperimen mengesahkan kecekapan mekanisma yang dicadangkan. Keputusan penilaian menunjukkan taburan lebar jalur yang adil setanding dengan mekanisma popular Weighted Fair Queuing (WFQ). Malah dari aspek perlindungan, keputusan yang diperolehi adalah lebih baik berbanding mekanisma WFQ dan dua mekanisma penjadualan lain. Mekanisma yang dicadangkan juga menunjukkan ciri kerumitan mencapai tahap $O(\log(n))$ yang dianggap rendah. Memandangkan mekanisma ini adalah terhad kepada rangkaian berwayar, kajian lanjut harus dilakukan di masa hadapan bagi penambahbaikan untuk digunapakai dalam rangkaian mudah alih ad-hoc atau mana-mana rangkaian tanpa wayar yang lain. Selain itu, mekanisma yang dicadangkan ini boleh ditambahbaik lagi untuk meningkatkan penggunaannya dalam rangkaian pensuisan litar maya seperti rangkaian mod penghantaran tak segerak.

Kata kunci: Baris Gilir, Mekanisme Penjadualan, Dasar Caj, Algoritma Genetik, Rangkaian Pensuisan Bingkisan, WFQ, OPNET.

Abstract

The pervasiveness of the Internet and its applications lead to the potential increment of the users' demands for more services with economical prices. The diversity of Internet traffic requires some classification and prioritisation since some traffic deserve much attention with less delay and loss compared to others. Current scheduling mechanisms are exposed to the trade-off between three major properties namely fairness, complexity and protection. Therefore, the question remains about how to improve the fairness and protection with less complex implementation. This research is designed to enhance scheduling mechanism by providing sustainability to the fairness and protection properties with simplicity in implementation; and hence higher service quality particularly for real-time applications. Extra elements are applied to the main fairness equation to improve the fairness property. This research adopts the restricted charge policy which imposes the protection of normal user. In terms of the complexity property, genetic algorithm has an advantage in holding the fitness score of the queue in separate storage space which potentially minimises the complexity of the algorithm. The integrity between conceptual, analytical and experimental approach verifies the efficiency of the proposed mechanism. The proposed mechanism is validated by using the emulation and the validation experiments involve real router flow data. The results of the evaluation showed fair bandwidth distribution similar to the popular Weighted Fair Queuing (WFQ) mechanism. Furthermore, better protection was exhibited in the results compared with the WFQ and two other scheduling mechanisms. The complexity of the proposed mechanism reached $O(\log(n))$ which is considered as potentially low. Furthermore, this mechanism is limited to the wired networks and hence future works could improve the mechanism to be adopted in mobile ad-hoc networks or any other wireless networks. Moreover, more improvements could be applied to the proposed mechanism to enhance its deployment in the virtual circuits switching network such as the asynchronous transfer mode networks.

Keywords: Queuing, Scheduling Mechanism, Charge Policy, Genetic Algorithm, Packet Switching Networks, WFQ, OPNET.

Declaration Associated with this Thesis

Some parts of this work have published or accepted in the following articles:

- 1.** Yaser Miaji and Suhaidi Hassan, A Survey on the Chronological Evolution of Timestamp Schedulers in Packet Switching Networks, in the Proceedings of the 2nd IEEE International Conference on Broadband Network & Multimedia Technology, 2009 (IC-BNMT '09), pp. 213-219, Beijing, China, 18-20 Oct. 2009. Published by the IEEE, Indexed in ISI and Scopus, ISBN: 978-1-4244-5005-3. Library of Congress Number: 2009903988
- 2.** Yaser Miaji and Suhaidi Hassan, Just Queueing (JQ): Scheduling Algorithm for the Internet, in the Proceedings of the First International Conference on Networks and Communications 2009 (NetCom-09), pp. 161-165, Chennai, India, 27-29 Dec. 2009. Published by the IEEE Computer Society, Indexed by Scopus, Los Alamitos, California, USA, ISBN 978-0-7695-3924-9.
- 3.** Yaser Miaji and Suhaidi Hassan, A Comparative Survey of Scheduling Mechanisms in the Internet, in the Proceedings of the IEEE Region 10 Conference (TENCON 2009), pp. 1-6, Singapore, 23-26 Nov. 2009. Published by the IEEE, Indexed in ISI and Scopus, ISBN: 978-1-4244-4547-9. Library of Congress Number: 2009903904.
- 4.** Yaser Miaji, Osman Ghazali and Suhaidi Hassan, Survey on the Event Orderings Semantics Used for Distributed System, Journal of Computer Science and information Technology (IJCSIT), Volume 2, Number 3, pp 150-158, India, June 2010, ISBN: 978-1-4244-5005-3, Library of Congress Number: 2009903988, http://airccse.org/journal/ijcsit2010_curr.html.
- 5.** Yaser Miaji and Suhaidi Hassan, A Novel Max-min Definition to Achieve an Optimum Fairness in Scheduling Packets over the Internet, in the Proceedings of the 4th International Symposium in Information Technology ITSIM2010, Volume 2, Number 1, pp 871-821, Kuala Lumpur, Malaysia, 15-17 June 2010, Published by the IEEE, Indexed in Scopus, ISBN: 978-1-4244-6716-7, IEEE Catalogue Number: CFP1033E-PRT.
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- 8.** Yaser Miaji and Suhaidi Hassan, "Breaking the Legend: Maxmin Fairness notion is no longer effective," International Journal on Applications of Graph Theory

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Table of Contents

Abstrak	ii
Abstract	iii
Declaration Associated with this Thesis	viii
Acknowledgement.....	x
List of Tables	xii
List of Figures.....	xiii
List of Abbreviations.....	xvii
CHAPTER ONE INTRODUCTION	1
1.1 Overview	1
1.2 Background	1
1.3 Research Motivation.....	2
1.4 The Statement of Problem.....	4
1.5 Research Objectives	4
1.6 Research Scope	5
1.7 Significance of the Research.....	6
1.8 Dissertation Outline	7
CHAPTER TWO BACKGROUND AND LITERATURE REVIEW	9
2.1 Introduction	9
2.2 Technical Review	10
2.2.1 Packet Switching.....	10
2.2.2 Internet Traffic: Attributes and Control	11
2.2.3 Real-time Applications	17
2.2.4 Quality of Service Requirements	18
2.2.5 Client Requirements	19
2.2.6 Section Synopsis	19
2.2.7 Properties of Scheduling Mechanism	20
2.2.8 Categorisation of Scheduling Mechanisms	27

2.3	Related Works.....	32
2.3.1	Survey on Fair Queuing Scheduling Mechanisms.....	32
2.3.2	Theories Pertinent to Scheduling Mechanism	49
2.3.3	Scheduling Using Genetic algorithm.....	53
2.3.4	Charge Policy	54
2.3.5	Survey on Fairness Notions.....	56
CHAPTER THREE RESEARCH METHODOLOGY		68
3.1	Overview	68
3.2	Research Methodology Flowchart.....	69
3.3	Problem Definition, Goals, and Assumptions	71
3.4	Conceptual Framework	73
3.5	System Modelling.....	76
3.6	Experimental Design	77
3.6.1	Simulation Tools.....	78
3.7	Implementation Strategy Using OPNET and Genetic Algorithm	82
3.7.1	Simulation Using OPNET	82
3.7.2	Genetic Algorithm Setting	84
3.7.3	Simulation Setting, Topology, Statistics, and Analysis	89
3.8	Evaluation Technique.....	94
3.8.1	Compared Mechanisms	95
3.8.2	Simulation Scenarios	95
3.9	Verification and Validation.....	96
CHAPTER FOUR DESIGN OF THE PROPOSED MECHANISM.....		101
4.1	Overview	101
4.2	Just Queuing.....	101
4.3	System Design: Concepts and Objectives.....	102
4.3.1	Justice as Fairness	102

4.3.2	Protection: Punish for Justice.....	104
4.3.3	Complexity: Protection and Fairness are Simple.....	105
4.4	Scheduling Mechanism: Concept to Model	106
4.4.1	Model: Definitions and Notions.....	106
4.4.2	Fairness.....	108
4.4.2	Modelling of JQ	111
4.4.3	Fairness Analysis	113
4.4.4	Complexity	116
4.4.5	Protection.....	123
4.5	Flowchart of the Design	124
CHAPTER FIVE IMPLEMENTATION OF JUST QUEUING.....		128
5.1	Overview	128
5.2	Implementation Objectives and Tool	128
5.3	Implementation Using Genetic Algorithm.....	129
5.3.1	Chromosome	130
5.3.2	Population.....	132
5.3.3	Crossover.....	133
5.3.4	Mutation	133
5.4	Simulation Experiments: Design and Implementation.....	134
5.4.1	State Transition Diagram.....	136
5.4.2	Packet Arrival State	139
5.4.3	Packet Dequeue State	140
5.4.4	Definition of the Just Queuing Profiles Structured Attribute.....	142
5.4.5	Configuration of the IP Objects	147
5.5	Verification of the Mechanism	148
CHAPTER SIX VALIDATION AND EVALUATION OF JUST QUEUING		162
6.1	Overview	162

6.2	Validation.....	163
6.2.1	Data collection	163
6.2.2	Validation scenario	164
6.2.3	Results and Analysis.....	165
6.3	Simulation Scenario 1	167
6.3.1	Just Queuing vs. Weighted Fair Queuing.....	170
6.3.2	Just Queuing vs. Custom Queuing.....	176
6.3.3	Just Queuing vs. Priority Queuing.....	182
6.4	Simulation Scenario 2	187
6.4.1	Just Queuing vs. Weighted Fair Queuing.....	193
6.4.2	Just Queuing vs. Custom Queuing.....	198
6.4.3	Just Queuing vs. Priority Queuing.....	202
CHAPTER SEVEN CONCLUSION AND FUTURE WORK.....		206
7.1	Overview	206
7.2	Summary of the Research	206
7.3	Contribution	207
7.4	Research Limitation.....	208
7.5	Conclusion	209
7.6	Recommendation for Future Work.....	210
REFERENCES		211

List of Tables

Table 2.1	Internet Traffic Classification	13
Table 2.2	Characteristics of Internet Traffic	14
Table 2.3	Behaviour of Internet Traffic	15
Table 4.1	Table of Symbols	107
Table 4.2	ToS Field Used in IP Header	109
Table 5.1	Genetic Coding	131
Table 5.2	Genetic Coding for ToS	132
Table 5.3	Chromosome Representation for 3 Packets	132
Table 5.4	Queue Parameters for Verification 1	149
Table 5.5	Timetable for State Transmission Diagram for JQ	153
Table 5.6	Queue Parameters for Verification 2	156
Table 5.7	Specification for Client 3	157
Table 6.1	Queue Parameters for JQ vs. WFQ	171
Table 6.2	Queue Parameters for CQ	177
Table 6.3	Queue Parameters for PQ	183
Table 6.4	IP Telephony QoS Requirements.	188
Table 6.5	HTTP Traffic Specifications	190
Table 6.6	FTP Traffic Specifications	190
Table 6.7	IP Telephony Traffic Specifications	191
Table 6.8	Video Conference Traffic Specifications	192
Table 6.9	Parameters for Just Queuing	192
Table 6.10	Parameters for WFQ	193
Table 6.11	Parameters Setting for Custom Queuing	198
Table 6.12	Parameters for Priority Queuing	203

List of Figures

Figure 2.1. Classification Methods for Internet Traffic	12
Figure 2.2. Delay, Jitter and Loss Sensitivity	14
Figure 2.3. Traffic Shaping	16
Figure 2.4. Traffic Policing	16
Figure 2.5. Main Components of QoS	19
Figure 2.6. Operation of FIFO	21
Figure 2.7. Protection Weakness in WFQ	23
Figure 2.8. Scheduling Function	27
Figure 2.9. The Process of FIFO	28
Figure 2.10. Simple Description of PQ [6]	29
Figure 2.11. Class Based Weighted Fair Queueing [58]	30
Figure 2.12 a. Basic Example of WFQ [37]	31
Figure 2.12b. Advanced Example of WFQ [13]	31
Figure 2.13. Time Stamp Scheduler	33
Figure 2.14. Fair Queueing	34
Figure 2.15: Virtual Starting and Finishing Time in WF2Q	37
Figure 2.16. Round Robin Scheduler	44
Figure 2.17. Literature Mapping	49
Figure 2.18. Literature Mapping of Fairness Principles	58
Figure 2.19. Users Share the Same Resource	61
Figure 2.20 a. Max-Min Fairness Figure 2.20 b. Proportional Fairness	63
Figure 2.21. Example of Utility Fairness	64
Figure 3.1: Research Methodology Frameworks	70
Figure 3.2. Factors Influence the Scheduling Mechanism	71
Figure 3.3. Conceptual Frameworks	74
Figure 3.4. GUI for OMNet++	79
Figure 3.5. Tools and Editors for OPNET	80
Figure 3.6. Simplified User View of NS2	81
Figure 3.7. Forced State and Unforced State for OPNET	84
Figure 3.8. Example of Network Nodes Available in OPNET	90
Figure 3.9. Dumbbell Architecture	91

Figure 3.10. Generic Network Scenario for Implementation and Evaluation	92
Figure 3.11. Simple Explanation of Verification and Validation	97
Figure 3.12. The Schematic of the Verification and Validation Process [144]	98
Figure 3.13. Stages of Verification and Validation	99
Figure 3.14. Models of OPNET	100
Figure 4.1. Simple Example of Scheduling Function	103
Figure 4.2. The Enqueue Routine	117
Figure 4.3. The Dequeue Routine	118
Figure 4.4. The pkt_arrival Stage	125
Figure 4.5. The pkt_deq Stage	126
Figure 5.1. Crossover Process for JQ	133
Figure 5.2. Mutation for JQ	134
Figure 5.3. Internal Hierarchy Structure of the IP Router Node Model	135
Figure 5.4. The Available Scheduling Mechanism in OPNET Routers	136
Figure 5.5. State Transition Diagram of ip_output_iface Process Model	137
Figure 5.6. State Transition Diagram of Just Queueing Process Model	138
Figure 5.7. Packet Arrival state Diagram	139
Figure 5.8. Packet Dequeue State Diagram	141
Figure 5.9. JQ Profiles Attribute	142
Figure 5.10. An Example of Assigning Individual Queue Limit	143
Figure 5.11. Classification Scheme	144
Figure 5.12. Configuration of Classification and Queue Size	145
Figure 5.13. Flowchart of Attribute Profile for JQ Function	146
Figure 5.14. IP Layer Process Objects of the IP Object	148
Figure 5.15. Network Model for Performance Verification of Just Queueing	149
Figure 5.16. Incoming Traffic to Queues Q0 and Q1, in (packets/sec) vs. Time	150
Figure 5.17. Just Queueing vs. Packet Arrival Time	151
Figure: 5.18. ancJQ vs. Packet Departure Time	152
Figure 5.19. Outgoing Traffic from Q0 and Q1	152
Figure 5.20. JQ in Router 2	154
Figure 5.21. Verification Scenario 2	155
Figure 5.22. Incoming Traffic to Queues	155
Figure 5.23. Just Queueing Stamp vs. Packet Arrival Time	156
Figure 5.24. ancJQ Stamp vs. Packet Arrival Time	158

Figure 5.25. ancJQ vs. Packet Departure Time	159
Figure 5.26. Outgoing Traffic from the Queues	160
Figure 6.1. Network Map for MYREN Core Nodes	164
Figure 6.2. Validation Scenario	165
Figure 6.3. Two Conforming Sources	166
Figure 6.4. Conforming and Non- conforming Source	167
Figure 6.5. Network Model for Scenario 1	168
Figure 6.6. The Attribute of QoS	169
Figure 6.7. Incoming Traffic to Queues	170
Figure 6.8. JQ vs. WFQ, Outgoing Packets	171
Figure 6.9. Buffer Usage for JQ and WFQ	172
Figure 6.10. Total Buffer Size for JQ and WFQ	174
Figure 6.11. Traffic Dropping for JQ and WFQ	174
Figure 6.12. Queuing Delay for JQ vs. WFQ	175
Figure 6.13. Steps for Configuring Byte Count Value	178
Figure 6.14. JQ vs. CQ, Outgoing Traffic from Queues	179
Figure 6.15. JQ vs. CQ, Buffer Usage for Queues	180
Figure 6.16. JQ vs. CQ, Total Buffer Usage for Queues	181
Figure 6.17. JQ vs. CQ, Queuing Delay in Queues	181
Figure 6.18. JQ vs. CQ, Traffic Dropped from Queues	182
Figure 6.19. JQ vs. PQ, Outgoing Traffic from Queues	184
Figure 6.20. JQ vs. PQ, Buffer Usage for Queues	185
Figure 6.21. JQ vs. PQ, Queuing Delay in Queues	186
Figure 6.22. JQ vs. PQ, Traffic Dropped from Queues	187
Figure 6.23. Simulation Scenario 2	189
Figure 6.24. JQ vs. WFQ, HTTP Page Response Time	194
Figure 6.25. JQ vs. WFQ, FTP Downloads Response Time	195
Figure 6.26. JQ vs. WFQ, IP Telephony, Voice Packet End-to-End Delay	196
Figure 6.27. JQ vs. WFQ, IP Telephony, Voice Packet Delay Variation	196
Figure 6.28. JQ vs. WFQ, Videoconferencing Packet End-To-End Delay	197
Figure 6.29. JQ vs. CQ, HTTP Page Response Time	199
Figure 6.30. JQ vs. CQ, FTP Response Time	199
Figure 6.31. JQ vs. CQ, IP Telephony, Voice Packet Delay Variation	200
Figure 6.32. JQ vs. CQ, IP Telephony Voice Packet End-To-End Delay	201

Figure 6.33. JQ vs. CQ, Videoconferencing Packet End-To-End Delay	202
Figure 6.34 JQ vs. PQ, FTP Download and Average Download Response Time	203
Figure 6.35. JQ vs. PQ, IP Telephony, Voice Packet End-To-End	204
Figure 6.36. JQ vs. PQ, Videoconferencing Packet End-To-End Delay	205

List of Abbreviations

CBQ	Class Based Queueing
DDRR	Dynamic Deficit Round Robin
Delay-EDD	Delay Earlier Due Date
DRR	Deficit Round Robin
FIFO	First In First Out
FQ	Fair Queueing
FTP	File Transfer Protocol
GPS	Generalised Process Sharing
GPS-M	Generalised Process Sharing with Maximum rate control
GrFQ	Greedy Fair Queueing
HPFQ	Hierarchical Packet Fair Queueing
HSDRR	Hierarchical Shaped Deficit Round Robin
IETF	International Engineering Task Force
IP	Internet Protocol
IPTV	Internet Protocol Television
Jitter-EDD	Jitter Earlier Due Date
LFVC	Leap Forward Virtual Clock
MD-SCFQ	Minimum Delay Self Clocked Fair Queueing
MSPFQ	Mean Start Potential Fair Queueing
NSPFQ	New Start Potential Fair Queueing
OTFQ	One Timestamp Per Queue
PQ	Priority Queueing
QoS	Quality of Service
RFB	Relative Fairness Bound
RPS	Rated Proportional Server schedulers
RR	Round Robin
SCFQ	Self Clocked Fair Queueing

SFQ	Start Time Fair Queueing
SMTTP	Simple Message Transfer Protocol
SPFQ	Starting Potential Fair Queueing
SRR	Smoothed Round Robin
SVC	Shaped Virtual Clock
SWFQ	Simplified Weighted Fair Queueing
TCP	Transmission Control Protocol
TS	Time Stamp Schedulers
UDP	User Datagram Protocol
VC	Virtual Clock
VoIP	Voice over IP
WF2Q	Worst Case Weighted Fair Queueing
WF2Q-M	WF2Q with Maximum Rate Control
WFI	Worst Case Fair Index
WFQ	Weighted Fair Queueing
WRR	Weighted Round Robin

CHAPTER ONE

INTRODUCTION

1.1 Overview

Scheduling mechanism is the key factor for prompt transmission of packets in a datagram network. Scheduling is concerned about the "which" and "when" issues of such a transmission [1]. Its primary issue is deciding which packet is to be transmitted and from which queue. The second issue is deciding when this packet is to be transmitted or in other words the promptness. Therefore, there are two functions that are to be addressed by the scheduling mechanism, namely ordering and promptness [2].

These functions are tightened by five properties namely; fairness, protection, complexity, flexibility, and bounding delay [3]. A more specific issue is the combination of all five properties in one single scheduling mechanism. The trade-off between these five properties had actually been investigated in many previous studies. Consequently, designing a scheduling mechanism that combines all these properties optimally is a challenge.

This research had concentrated on adopting different methods for implementing a scheduling mechanism. These newly adopted concepts and algorithms have resulted in a combined scheduling mechanism based on charge policy as the primary change in scheduling design. Section 1.2 provides a general background about the research topic. Section 1.3 presents the research motivation. The following sections are concerned about the statement of problem which is followed by research objectives, research scope, and the significance of the research. The outline of the dissertation is described in Section 1.8. Finally, the chapter summary is shown in Section 1.9.

1.2 Background

The ubiquitousness of the Internet and the pervasiveness of its applications lead to the potential increase in the users' demands for more services with economical prices [4]. Furthermore, the emergence of new applications in daily usage, such as videoconferencing, online gaming, and voice conversation, has resulted in a pressing necessity for novel mechanisms and policies to serve this steep improvement in the

The contents of
the thesis is for
internal user
only

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