

AUTHOR DECLARATION

IMPROVED MIXED INTEGER NONLINEAR PROGRAMMING
MODELS OF INTERNET PRICING SCHEME UNDER MULTIPLE
QOS NETWORK

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Thesis submitted in fulfillment for the degree of
DOCTOR OF PHILOSOPHY
IN
SCIENCE AND TECHNOLOGY

Faculty of Science and Technology
UNIVERSITI SAINS ISLAM MALAYSIA
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January 2015

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ACKNOWLEDGEMENT

At the first place I would like to record my gratitude to my supervisor, **Prof. Dr. Kamaruzzaman Seman** and my co-supervisor **Prof. Dr. Bachok M. Taib** for their supervision advice and guidance from the very early stage of this research as well as giving me extra ordinary experience throughout the work. Out of all they have provided me unflinching encouragement and support in various ways. Their constant assistance of idea inspires and enriches my growth as a student and as a researcher. I am indebted to them more than they know.

I also get assistance from committee member **Assoc. Prof. Dr. Zurina Shafii** for her support and discussion during my work. I am very thankful for her help during this study.

I would like to gratefully acknowledge the whole Islamic Science University Malaysia for giving me a status as a student and also provide the best facility in the university.

Where would I be without my family? My husband, **Muhammad Amran, S.Si** deserves special mention for his support, prayers and love during my tough life studying here alone. My twins, **Amya Bunga Fathiyah** and **Amya Bunga Fakhriyah** support their mother to complete the study well. My mother **Maheni Zaini**, my father **Muhammad Zaman Gaus**, my father in law **Somaddin** and my mother in law **Juaidah** who support me with abundant love and prayers and also by helping my husband to take care of my twins for the whole time since I was being away from my home town. I am very happy to have them all in my life. I dedicated this thesis to them all.

It is my pleasure to thank my colleague at Network Research Laboratory, **Wan Nourul Akmal Binti Abd Aziz**, for our best time in sharing the difficulty and happiness while I am living here. Heartfelt appreciations to MIS Scholarship that gave me sponsorship from year 2010-2013, LPDP Kementerian Keuangan RI for thesis financial aid assistance from year 2014-2015 as well as FRGS research grant 2011-2013 for supporting the financial part of this research.

Finally, I would like to thank everyone who was important to the successful realization of this thesis.

ABSTRAK

Oleh sebab internet menjadi semakin kritikal dalam bidang ekonomi, Pembekal Perkhidmatan Internet (ISP) masa kini berhadapan dengan permintaan yang tinggi bagi mempromosikan maklumat yang berkualiti baik. Walaupun pengetahuan berkenaan pembangunan pelan harga baru yang memberi layanan kepada pelanggan dan pembekal telah diketahui umum, namun, ianya hanya beberapa pelan harga yang melibatkan pelbagai rangkaian. Penyelidikan ini bertujuan untuk mengkaji dan menganalisa skema-skema harga bagi pelbagai rangkaian dan merumuskan pelan harga baru yang berfungsi secara dinamik dibawah pelbagai rangkaian QoS. Skema-skema harga yang dicadangkan adalah merujuk kepada pertimbangan syarikat-syarikat komunikasi terhadap rangkaian berwayar dan kelebihan-kelebihan skema-skema harga adalah bergantung kepada perspektif syarikat-syarikat komunikasi untuk memaksimumkan keuntungan mereka. Objektif kajian ini adalah untuk merumuskan skema harga baru yang lebih optimum berdasarkan pelbagai rangkaian QoS, mencadangkan skema harga tersebut yang memberi tawaran harga yang lebih baik yang mana dapat meningkatkan jumlah pelanggan dan memberi keuntungan kepada syarikat-syarikat komunikasi dan juga menentukan penyelesaian yang optimum bagi setiap skema harga internet berdasarkan pelbagai perkhidmatan dan rangkaian QoS. Analisis ini terbahagi kepada dua bahagian iaitu skema harga baru bagi pelbagai rangkaian perkhidmatan dan bagi pelbagai rangkaian QoS. Bagi setiap rangkaian, pendekatan yang terbaik digunakan dengan pemodelan skema-skema tersebut kepada MINLP dan diselesaikan secara berangka menggunakan aplikasi perisian LINGO 11.1. Matlamat ISP adalah untuk memaksimumkan keuntungan seperti untuk pemulangan semula kos disamping mempromosikan perkhidmatan tertentu, pemulangan semula kos disamping pengguna yang bebas memilih perkhidmatan, untuk bersaing dalam pasaran disamping pengguna yang bebas memilih perkhidmatan atau untuk bersaing dalam pasaran disamping mempromosikan perkhidmatan tertentu. Penyelesaian-penyelesaian daripada MINLP selari dengan matlamat yang ditetapkan ISP. Model yang ditambah baik ini telah dirumuskan dalam bentuk MINLP dan telah diselesaikan menggunakan LINGO 11.0. Cadangan model harga internet baru yang ditambah baik ini berfungsi dalam pautan tunggal perkhidmatan pelbagai rangkaian, pautan pelbagai perkhidmatan pelbagai rangkaian, pautan tunggal rangkaian QoS pelbagai kelas dan juga pautan pelbagai rangkaian QoS pelbagai kelas. Ia menunjukkan bahawa dengan mempertimbangkan parameter-parameter baru, keputusan boleh ubah dan kekangan, pendapatan yang lebih maksimum telah diperolehi. Kes-kes seperti penetapan harga asas dan kualiti premium sama ada perlu tetap atau berubah adalah bergantung pada strategi ISP untuk mengubahnya mengikut keutamaan bagi mencapai matlamat mereka. ISP boleh menggunakan kes-kes tersebut untuk disesuaikan dengan matlamat mereka. Penyelesaian-penyelesaian bagi model baru harga internet yang dipertingkatkan dalam kelas pelbagai rangkaian QoS menunjukkan bahawa model yang telah dipertingkatkan ini mempamerkan keputusan yang baik (perbandingan nilai keuntungan sebanyak 0.13 sehingga 40.8 bagi setiap kes) berbanding keputusan asal yang dicadangkan oleh kajian sebelum ini. Keputusan ini menyumbang kepada keuntungan yang maksimum kepada ISP.

ABSTRACT

As internet is becoming critical in economics life, Internet Service Providers (ISPs) now deal with high demand to promote good quality information. Although the knowledge to develop new pricing plans that serve both customers and supplier is known, only a few pricing plans involve multiple networks. This research seeks to study and analyze pricing schemes for multiple networks and formulate new pricing plans that can dynamically work under multiple QoS networks. The pricing schemes proposed are based on telcos concerns on wired networks and the advantages of new pricing schemes are under telcos' perspective to maximize their profits. The objectives are to formulate the new optimal pricing schemes under multiple QoS networks, propose the pricing schemes offer better pricing that can enhance the customers and make advantages to telcos and determine the optimal solution for each internet pricing scheme under multi service and multi QoS networks. The analysis is divided into two parts, the new pricing schemes for multi service networks and for multi QoS networks. For each network, the optimization approach is used by modeling the schemes into MINLP and is solved numerically by application software LINGO 11.0. The goals of ISP are to maximize the profit such as to recover cost while promoting certain service, recover cost while user can select service, to have market competition while user can select the service or to have market competition while promote certain services. The MINLP solutions show the intended ISP's goals. The improved models were formulated as MINLP and were solved using LINGO 11.0. The proposed new improved internet pricing models work in single link multi service network, in multi link multi service network, in single link multi class QoS networks and also in multi link multi class QoS network. It is shown that by considering new parameters, more decision variables and constraints, better revenue maximization were obtained. The cases to set up the base price and the quality premium to be fixed or to vary basically are ISP strategy to vary its preference to achieve their goals. ISP is able to adopt the cases to suit their goals. The solutions of new improved model of internet pricing in multi class QoS networks show that the improved models exhibited better results (the difference profit value is about 0.13 to 40.8 for each case) compared to original results proposed by past research. The results contribute the maximum profit for ISPs.

ملخص البحث

فقد تقوم من خلال العولة المؤسسات المتعددة، نحو التجاري والسياسي، ويتبع ذلك الجوانب الاجتماعية والثقافية وكل هذه المؤسسات تؤدي إلى حرجة شبكة الإنترنت للحياة الاقتصادية في هذا العصر. بذلك، الآن "موفر خدمة إنترنت (ISPs)" تتعامل مع ارتفاع الطلب لتعزيز المعلومات ذات النوعية الجيدة. وبالرغم أن هناك المعرفة لوضع خطط التسعير الجديدة لخدمة كلا المموم والمستخدم على حد سواء، ولكن لا يكون إلا عدد قليل من خطط التسعير التي تنطوي على شبكات متعددة. ويسعى هذا البحث إلى دراسة وتحليل خطط التسعير للشبكات متعددة وصياغة خطط التسعير الجديدة التي تمكن أن تعمل بشكل ديناميكي تحت شبكات جودة الخدمة المتعددة. وستكون خطط التسعير المقترحة بناء على الاهتمام من الشركات الاتصالات للشبكات البرمجة ومميزات خطط التسعير الجديدة تحت منظور شركات الاتصالات لزيادة أرباحهم. تمثل الأهداف لهذا البحث في صياغة خطط التسعير المثلى الجديدة تحت شبكات جودة الخدمة متعددة، واقتراح لتقييم أفضل خطط التسعير التي تمكن أن تعزز المموم، وتعطي لشركات الاتصالات المميزات الخاصة وتعدد الحل الأمثل لكل نظام التسعير الإنترنت تحت شبكات جودة الخدمة المتعددة والخدمات المتعددة. ويقسم الباحث التحليل إلى قسمين: خطط التسعير الجديدة لشبكات الخدمات المتعددة وخطط التسعير الجديدة لشبكات جودة الخدمة المتعددة. ويستخدم النهج الأمثل لكل الشبكة عبر اقتداء المخططات في MINLP ويتم الحل عدديا بتطبيق البرمجيات LINGO 11.0. وأهداف ISP هي لتحقيق أقصى الربح من حيث استرداد التكلفة بينما تعزز خدمة معينة، واسترداد التكلفة والمنافسة في السوق حين يمكن المستخدم اختيار الخدمة، أو أن يكون المنافسة في السوق في حين أتروج الخدمة معينة. وتبين الحلول MINLP الأهداف المقصودة لISP. قد صيغت الموديلات المحسنة نحو MINLP وتم حلها باستخدام LINGO 11.0. وهذه نماذج التسعير الإنترنت المتحسنة الجديدة المقترحة تقبل أن تعمل في رابط واحد شبكة خدمات متعددة، وفي وصلة متعددة شبكة خدمات متعددة، في وصلة واحدة متعددة جودة الخدمة من الدرجة وأيضا في الارتباط متعددة الطبقة متعددة شبكة جودة الخدمة. وتبين أن الحصول على أفضل الإيرادات تمت بالنظر إلى الحايير الجديدة والمزيد من متغيرات القرار والقيود. والقضايا التي يستخدم لإعداد السعر الأساسي والجودة المتميزة لتكون ثابتة أو متغيرة أساسا هي استراتيجية ISP كي تكو تفضيلها متنوعة لتحقيق أهدافهم. وISP قادرة على الاعتماد بالحالات لتناسب أهدافهم. والحلول من نموذج الجديد المتحسن لتسعير طبقات العديدة لإنترنت في شبكات جودة الخدمة تظهر أن النماذج المحسنة أظهرت نتائج أفضل (قيمة الفرق ربح حوالي 0.13 إلى 40.8 لكل حالة) مقارنة النتائج الأصلية التي اقترحها الباحث الماضي. وتساهم النتائج أقصى الربح لمزودي خدمات الإنترنت.

CONTENT PAGE

AUTHOR DECLARATION	ii
BIODATA OF AUTHOR	iv
ACKNOWLEDGEMENT	v
ABSTRAK	vi
ABSTRACT	vii
ملخص البحث	viii
CONTENT PAGE	ix
LIST OF TABLES	xiii
LIST OF FIGURES	xvi
LIST OF APPENDICES	xvii
ABBREVIATION	xviii
 CHAPTER I INTRODUCTION	
1.1 Overview	1
1.1.1 Pricing Scheme	1
1.1.2 Optimal Solution of Mixed Integer Nonlinear Programming Problem	3
1.1.3 Multiple Service Network	4
1.1.4 Multiple QoS Network	4
1.2 Problem Statements	5
1.3 Objectives of the Research	6
1.4 Research Question	8
1.5 Scope of the Research and Its Limitations	8
1.6 Target Audience and Expected Outcomes of the Research.....	8
1.7 Organization of Thesis	9
 CHAPTER II LITERATURE REVIEW	
2.1 Overview	10

		x
2.2	Review of Pricing Scheme	10
2.3	Multiservice Network Architecture	19
2.4	Quality of Service (QoS)	19
2.5	Network Service Charging Terminology	20
2.6	Utility and Optimization Objectives	20
2.7	Pricing Scheme in Multiservice Network	22
2.8	Pricing Scheme in Multiple Class QoS Networks	23
2.8.1	Pricing Scheme proposed by Byun and Chatterjee (2004)	23
2.8.2	Pricing Scheme in Single Bottleneck Link Multiple Class QoS Networks Proposed by Yang (2004)	24
2.8.2.1	Pricing Scheme in Single Bottleneck Link Multiple Class QoS Networks Proposed by Yang (2004) By Setting up the Base Price as a Fixed Value	24
2.8.2.2	Pricing Scheme in Single Bottleneck Link Multiple Class QoS Networks Proposed by Yang (2004) By Setting up the Base Price as a Variable	25
2.8.3	Pricing Scheme in Multiple Bottleneck Link Multiple Class QoS Network Proposed by Yang (2004)	26
2.8.3.1	Pricing Scheme in Multiple Bottleneck Links Multiple Class QoS Networks Proposed by Yang (2004) By Setting up the Base Price as Fixed Price	26
2.8.3.2	Pricing Scheme in Multiple Bottleneck Links Multiple Class QoS Networks Proposed by Yang (2004) By Setting up the Base Price as a Variable	27
2.9	LINGO 11.0 Software	28
2.10	Summary	30
 CHAPTER III RESEARCH METHODOLOGY		
3.1	Overview	31
3.2	Multi Service Networks and Multi QoS Networks	31
3.3	Model Formulation	34
3.3.1	Parameter Derivation	34
3.3.2	Decision Variables	36
3.4	Modeling Process	36
3.5	Summary	38

CHAPTER IV PRICING SCHEME FOR MULTISERVICE NETWORKS IN QOS NETWORKS

4.1	Overview	39
4.2	A New Approach on Pricing Scheme in Single Link Multiservice Network	39
4.2.1	Model Formulation of a New Approach to Pricing Schemes in Single Link Multiservice Networks	40
4.2.2	Optimal Solution of a New Approach to Pricing Schemes in Single Link Multiservice Networks	41
4.2.3	Analysis of a New Approach on Pricing Schemes in Single Link Multiservice Networks	43
4.3	A New Improved Model on Pricing Scheme of Single Link Multiservice Networks	44
4.3.1	Model Formulation of a New Improved Model on Pricing Scheme of Single Link Multiservice Networks	45
4.3.2	Analysis of the New Improved Model on Pricing Schemes of Single Link Multiservice Network	53
4.4	An Improved Model of Internet Pricing Scheme of Multiple Links Multiservice Networks	54
4.4.1	Model Formulation of an Improved Model of Internet Pricing Scheme of Multiple Links Multiservice Network	54
4.4.2	Optimal Solution of a New Improved Model on Pricing Scheme of Multiple Links Multiservice Network	63
4.4.3	Analysis of a New Improved Model on Pricing Scheme of Multiple Links Multiservice Network	65
4.5	Summary	66
CHAPTER V PRICING SCHEME IN MULTIPLE CLASS QOS NETWORKS		
5.1	Overview	67
5.2	Model Formulation of a New Modified Model of Internet Pricing Scheme in Single Bottleneck Link QoS Network	68
5.3	Optimal Solutions for Internet Pricing Schemes in Single Bottleneck Link QoS Networks	77
5.4	The New Modified Model for Internet Pricing Schemes in Multiple	

Bottleneck Link Multiple QoS Networks	80
5.4.1 Model Formulation of a New Modified Model for Internet Pricing Schemes in Multiple Bottleneck Link QoS Networks	81
5.4.2 Optimal Solution of the New Modified Model of Internet Pricing Scheme in Multiple Bottleneck Link QoS Networks when Setting up α_j to be Fixed and when Setting up α_j to Varies.....	92
5.4.3 Analysis of Pricing Scheme in Multiple Bottleneck Link QoS Networks	97
5.5 Summary	98
CHAPTER VI CONCLUSION AND RECOMMENDATION	
6.1 Conclusions	99
6.2 Recommendation for Future Work	101
BIBLIOGRAPHY	103
APPENDICES	109
PUBLICATIONS	132

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LIST OF TABLES

Table 1:	Objectives and the Method Used to Achieve the Objectives	7
Table 2:	Target of ISP in Adopting the Pricing Scheme Proposed by Byun and Chatterjee (2004)	35
Table 3:	Parameter Values Using the New Approach of Sain and Herper's Model	40
Table 4:	Comparison of Results between Sain and Herpers (2003) and This Study	42
Table 5:	Solver Status of Sain and Herpers' Model by Using LINGO 11.0	43
Table 6:	Additional Parameters for the New Modified Model of Internet Pricing Scheme in Single Link Multiservice Network	45
Table 7:	Solution of a New Improved Model on Pricing Scheme of Single Link Multiservice Network when α and β are Fixed	47
Table 8:	Solution of a New Improved Model on Pricing Scheme of Single Link Multiservice Network when α is Fixed and β Varies	49
Table 9:	Solution of a New Improved Model on Pricing Scheme of Single Link Multiservice Network when α and β Vary	51
Table 10:	Solution of a New Improved Model on Pricing Scheme of Single Link Multiservice Network when α Varies and β is Fixed	52
Table 1:	Solver Status of the New Improved Model on Pricing Schemes for Single Link Multiservice Networks	53
Table 2:	Comparison between the New Improved Model in Single Link Multiservice Networks and Sain and Herper's (2003) Results	54
Table 3:	Parameter Values of Internet Pricing in Multi Link Multi Service Network When Setting up α and β to be Fixed	56
Table 4:	Parameter Values of Internet Pricing in Multi Link Multi Service Network When Setting up α to be Fixed and β Varies	58
Table 5:	Parameter Values of Internet Pricing in Multi Link Multi Service Network When Setting up α and β Vary	60

Table 6:	Parameter Values of Internet Pricing in Multi Link Multi Service Network When Setting up α Vary and β is Fixed	62
Table 7:	Solver Status of Model Formulation on Pricing Schemes of Multiple Link Multiservice Networks using LINGO 11.0	63
Table 8:	Solution of Internet Pricing Schemes of Multiservice Networks in Link 1	64
Table 9:	Solution of Pricing Schemes of Multiservice Networks in Link 2	65
Table 20:	Parameter Values for The Original Model (Yang, 2004) of Internet Pricing Scheme in Single Bottleneck Link QoS Network when Setting up α_j to be Fixed	69
Table 10:	Parameter Values for The New Improved Model of Internet Pricing Scheme in Single Bottleneck Link QoS Network when Setting up α_j and β_j to be Fixed	70
Table 11:	Parameter Values for The New Improved Model of Internet Pricing Scheme in Single Bottleneck Link QoS Network when Setting up α_j to be Fixed and β_j Varies	72
Table 12:	Parameter Values for The New Improved Model of Internet Pricing Scheme in Single Bottleneck Link QoS Network when Setting up α_j Varies	73
Table 13:	Parameter Values for The New Improved Model of Internet Pricing Scheme in Single Bottleneck Link QoS Network when Setting up α_j varies and β_j to be Fixed	75
Table 14:	Parameter Values for The New Improved Model of Internet Pricing Scheme in Single Bottleneck Link QoS Network when Setting up α_j and β_j Vary	76
Table 15:	Solver Status for Internet Pricing Schemes in Single Bottleneck Link QoS Networks when α_j is Fixed	77
Table 16:	Solver Status for Internet Pricing Schemes in Single Bottleneck Link QoS Networks when α_j Varies	79
Table 17:	A Comparison of for Internet Pricing Schemes in Single Bottleneck Link QoS Networks when α_j is Fixed and when α_j Varies for Different Parameter Settings	80
Table 18:	Parameter Values for Original Model of Internet Pricing Scheme in Multi Bottleneck Link QoS Network when Setting up α_j to be Fixed	82

Table 30:	Parameter Values for The New Improved Model of Internet Pricing Scheme in Multi Bottleneck Link QoS Network when Setting up α_j and β_j are Fixed	83
Table 19:	Parameter Values for The New Improved Model of Internet Pricing Scheme in Multi Bottleneck Link QoS Network when Setting up α_j is Fixed and β_j Varies	86
Table 20:	Parameter Values for Original Model of Internet Pricing Scheme in Multi Bottleneck Link QoS Network when Setting up α_j Varies	88
Table 21:	Parameter Values for Original Model of Internet Pricing Scheme in Multi Bottleneck Link QoS Network when Setting up α_j Varies and β_j is Fixed	90
Table 22:	Parameter Values for Original Model of Internet Pricing Scheme in Multi Bottleneck Link QoS Network when Setting up α_j and β_j Vary	91
Table 23:	Solver Status for Internet Pricing Schemes in Multiple Bottleneck Link Multiple Class QoS Network when Setting up α_j to be Fixed	93
Table 36:	Solver Status for Internet Pricing Schemes in Multiple Bottleneck Link Multiple Class QoS Network when Setting up α_j Varies	94
Table 37:	Solution for Internet Pricing Schemes in Multiple Bottleneck Link Multiple Class QoS Network when Setting up α_j to be Fixed	95
Table 38:	Solution for Internet Pricing Schemes in Multiple Bottleneck Link Multiple Class QoS Network when Setting up α_j Varies	97

LIST OF FIGURES

Figure 1:	Pricing Classification by Stiller et al (2001)	2
Figure 2:	The Solution Outcomes of MINLP (Schrage, 2009)	3
Figure 3:	A Multiservice Integrated Network (Gupta et al., 1995)	4
Figure 4:	Network Pipes in a Multiservice Network (Ninan, 2004).....	19
Figure 5:	(a) Elastic Application, (b) Inelastic Application and (c) Partially Elastic Application.....	21
Figure 6:	(a) The Model Window of LINGO 11.0, (b) Solver Status of LINGO 11.0 Report Window and (c) Solution Report of LINGO 11.0 Report Window	29
Figure 7:	The Proposed Multiservice Networks	32
Figure 8:	(a) Pricing Scheme Diagram of Multiservice Networks, (b) in Single Bottleneck Links and (c) in Multiple Bottleneck Links	32
Figure 9:	(a) Pricing Scheme Diagram in Multiple Class QoS Network, (b) in Single Bottleneck Link QoS Networks, (c) in Multiple Bottleneck Link QoS Networks	33

LIST OF APPENDICES

Appendix A:	Internet Pricing Scheme Solved by LINGO 11.0	110
Appendix A.1:	Sain & Herper's Model (2003) Solved by LINGO 11.0	110
Appendix A.2:	A New Improved Model of Internet Pricing Scheme In Single Link Multi Service Networks when α_j is Fixed and β_j Varies Solved by LINGO 11.0	113
Appendix A.3:	A New Improved Model of Internet Pricing Scheme in Multi Link Multi Service Networks when α_j Vary and β_j is Fixed Solved by LINGO 11.0	117
Appendix A.4:	A New Improved Model of Internet Pricing Scheme in Single Link Multi QoS Networks when α_j and β_j are Fixed Solved by LINGO 11.0	122
Appendix A.5:	A New Improved Model of Internet Pricing Scheme in Multi Link Multi QoS Networks when α_j and β_j Vary Solved by LINGO 11.0	126

ABBREVIATION

DiffServ	Differentiated Services
ER	Elapsed Runtime
ESS	Extended Solver Steps
GMU	Generated Memory Used
ICT	Information and Communications Technology
IntServ	Integrated Services
ISP	Internet Service Provider
MINLP	Mixed Integer Nonlinear Programming
NP-hard	Non-deterministic Polynomial-time hard
OPCQP	Optimal Pricing, Capacity Location and QoS Problem
OPL	Optimization Programming Language
OPNET	Optimized Network Engineering Tools
PHBs	Per-Hop Behaviours
PMP	Paris Metro Pricing scheme
QoS	Quality of Service
RSVRP	Resource Reservation Protocol
SLA	Service Level Agreement
Telcos	Telecommunication companies
TSI	Total Solver Iterations