

UNIVERSITI TEKNOLOGI MARA

**ENHANCED MULTI-DIMENSIONAL
GROUP COMMUNICATION MODEL
FOR COLLABORATIVE
APPLICATIONS**

NORZILAH BTE MUSA

Thesis submitted in fulfillment
of the requirements for the degree of
Doctor of Philosophy

Faculty of Computer and Mathematical Sciences

March 2019

ABSTRACT

A collaborative workspace consists of dynamically assembled groups of different skills and backgrounds. These dynamic groups share information collaboratively and communicate easily using various kinds of media, even though they do not share the same physical working environment. In line with that, various communication patterns such as sub-group, inter-group and intra-group are created so that users can involve with more than one group at the same time. This phenomenon contributes to the area of: formation of multidimensional communication activity. This is where, one dimension is defined as one group activity per user who shares one communication medium. Though communication is a central and important activity in any collaborative work, most collaborative applications are designed for a single dimension communication activity. This activity is a fixed and pre-defined communication media, which focuses on standard workflow routine and a planned agenda. Beside formal interactions, users are also engaged in unplanned and unstructured interactions. In addition, most programming languages either conventional or non-conventional, do not naturally support or manage multi-dimensional communication activities for any permutations internal group formation. As permutation group formation growth exponentially, the more complex of human-to-human or human-to-objects relationship. This multi-dimensional group communication needs to be coded as part of the system. As most applications do not support this kind of communication, users turn to back-channel interaction such as social media in order to discuss office issues. Therefore, this thesis focuses on the specification and design of the structured shared media for various purposes of communication activities in a single software platform. In particular, it addresses the problem of methods used in facilitating human-to-human communication in multiple group collaborative activities, which can be viewed as an instance of a multi-dimensional group communication problem. A real-life case study of Disaster Recovery Activation (DRA) on server malfunction in one operational unit was conducted with the aim to provide real working scenarios and group collaboration activities. Thirteen real-life scenarios are identified and abstracted to facilitate the relevant extraction parameters that involved in multi-disciplinary groups' interaction and complex information sharing. Next, multi-dimensional groups' communication specification is defined and modelled by using mathematical notations. The model is transformed into a set of language constructs using JACIE, a non-conventional language that supports rapid prototyping for collaborative applications. The extension of this new set of language constructs requires new modification to the JACIE compiler. The code translator is updated with one hundred and eighteen new JAVA classes to support various kind of communication patterns with graphical user interface. A prototype of an online meeting application is developed using this new version of JACIE. In order to measure the practicality and usability of the proposed model, a post-survey study was conducted to determine user acceptance. The results of the survey indicate that the dynamic communication platform in the application provides users with freedom and support of their creativities. Users can carry out their tasks without compromising the management of the working group. With the proposed model, it is envisaged that new parts of the collaborative work within such working environment can be explored, thus allowing the perceived benefits of the computer-mediated communication to be fully realised.

ACKNOWLEDGEMENT

Many people have supported and helped me in many ways throughout my Ph.D. program and I offer to all of them my gratitude. First of all, I would like to express the greatest of thanks towards my supervisor Prof Dr Siti Zaleha Zainal Abidin and my co-supervisor Dr. Nasiroh Omar. Both of them have always managed to shed light during my darkest of days, which makes me see the world from a different and new angle. I wholeheartedly thank them for their precious knowledge, constant support, belief and guidance they have given me during this journey. Without their guidance, this thesis would not have been possible.

A substantial amount of indebtedness goes to Prof. Min Chen from the Oxford e-Research Centre (University of Oxford). Constructive discussions that I have had with him during his stopover at the FSKM, UiTM Shah Alam and at his place of work, has helped me to gain useful insights into the Ph.D. process.

This thesis would not have been made possible without the love and support from my family. I would like to thank my mother, Zabedah Musa, for the endless support she has given to me throughout my study. To my husband, Mohd Yazid. Who deserves recognition for his patience, understanding and unwavering support in my academic endeavours and not forgetting my children, Amirul Haziq, Amirul Haikal and Amirul Hilman for all their love and understanding.

Finally, the credit also goes to all my friends in FSKM, especially to Zehan, Fiza, Fairuz, Anom, Izan and Nana for their friendship, help, and support.

This research project was partly funded by the Fundamental Research Grant Scheme (FRGS) project sponsored by the Ministry of Higher Education Malaysia, under the grant number FRGS 600-RMI/FRGS 5/3 (161/2013) and the Bumiputera Academic Training Scheme (SLAB) Malaysia.

Thanks to all of you from the depth of my heart.

TABLE OF CONTENTS

	Page
CONFIRMATION BY PANEL OF EXAMINERS	ii
AUTHOR'S DECLARATION	iii
ABSTRACT	iv
ACKNOWLEDGEMENT	v
TABLE OF CONTENTS	vi
LIST OF TABLES	x
LIST OF FIGURES	xi
LIST OF ABBREVIATIONS	xiii
CHAPTER ONE: INTRODUCTION	1
1.1 Introduction	1
1.2 Background of The Study	4
1.3 Problem Statement	8
1.4 Research Questions	11
1.5 Objectives	11
1.6 Scopes and Limitations	11
1.7 Contributions	12
1.7.1 Collaborative Workspace	12
1.7.2 Software Engineering	13
1.8 Organization of Thesis	13
CHAPTER TWO: LITERATURE REVIEW	15
2.1 Technology Trends	15
2.2 Collaboration	16
2.2.1 Coordination	20
2.2.1.1 <i>Coordination Features</i>	21
2.2.1.2 <i>Coordination Mechanism</i>	24
2.2.2 Communication Media	26

2.2.2.1	<i>Selection of Communication Media</i>	30
2.2.2.2	<i>Media Sharing</i>	32
2.3	User	36
2.3.1	Sub-group	36
2.4	Collaborative Software Development	38
2.4.1	Functional Features of Collaborative Applications	39
2.4.2	Component of Program Language for Collaborative Application	44
2.5	Research Gap	51
2.6	Summary	51
 CHAPTER THREE: RESEARCH METHODOLOGY		53
3.1	Introduction	53
3.2	Research Methodology	53
3.2.1	Preliminary Study	54
3.3	Analysis of Study	55
3.4	Model Construction	57
3.5	Application Development	61
3.6	Evaluation and Conclusion	63
3.7	Summary	67
 CHAPTER FOUR: DESIGN AND MODEL DEVELOPMENT		69
4.1	Introduction	69
4.2	Case Study	69
4.2.1	Participants	70
4.2.2	Data Collection Activity	70
4.2.3	Data	70
4.3	Requirement Analysis	71
4.3.1	Personas	71
4.3.2	Scenarios	74
4.3.3	Analysing Abstract Scenes	85
4.3.3.1	<i>Normal Communication Pattern</i>	87
4.3.3.2	<i>Sub-group Communication Pattern</i>	88
4.3.3.3	<i>Inter-group Communication Pattern</i>	90