UNIVERSITI PUTRA MALAYSIA

COMPARITIVE EVALUATION OF GEOMETRIC DYNAMIC CHANNEL ALLOCATION OVER OTHER CHANNEL ALLOCATION SCHEMES

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BY

ABDULLA KHADER

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To my parents

Abd-AL.Rahman Fayyad & Nawal Mahmoud

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LIST OF ABBREVIATIONS

ADCA	Anarchic Dynamic Channel Allocation
BCO	Borrowing with Channel Ordering
BDCL	Borrowing with Directional Channel locking
CDMA	Code-Division Multiple-Access
CDPD	Cellular Digital Packet Data
CEPT	Conference of European Post and Telecommunications
CIR	Carrier to Interference
DCA	Dynamic Channel Allocation
DECT	Digital Europe Cordless Telephone
FA	First Available
FCA	Fixed Channel Assignment
FDMA	Frequency Division Multiple Access
FPLMTS	Future Public Land Mobile Telephone System
GDCA	Geometric Dynamic Channel Allocation
GSM	Global System for Mobile Communication
HCA	Hybrid Channel Assignment
LAN	Local Area Network
LODCA	Locally Optimized Dynamic Assignment
MSQ	Mean Square
NN	Nearest Neighbour

NN+1	Nearest Neighbour plus One
PCS	Personal Communication Services
PLDCA	Priority List Channel Dynamic Allocation
SHCB	Simple Hybrid Channel Borrowing Strategy
TDMA	Time Division Multiple Access
UMTS	Universal Mobile Telecommunication System

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COMPARISON EVALUATION OF GEOMATRIC DYNAMIC CHANNEL ALLOCATION
GDCA OVER OTHER STRATEGIES

BY

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Wireless services are one of the strongest growth areas in telecommunications today. Cellular voice is well established as a high-end service in most areas, but demand is increasing rapidly.

In cellular systems, the geographical region is split using a regular topology, into cells each containing one base station. The base station should assign a channel that is not currently used within some specified distance.

There are many kinds of channel assignment methods used in mobile communication starting with Fixed Channel Assignment

(FCA), through Dynamic Channel Assignment (DCA) and Hybrid Channel Assignment (HCA).

Personal Communication Services (PCS's) have been introduced as a mass-market phone service. The capacity, however, is now a critical issue for all of these services. The solution to the increasing spectrum efficiency demand in Personal Communication Services (PCS's) is the implementation of Dynamic Channel Allocation (DCA) strategy with distributed control.

This thesis concentrates on one specific class of dynamic channel allocation called the Geometric Dynamic Channel Allocation (GDCA). The main feature of the GDCA lies in its ability to organise the dynamic resource assignment so that the resulting carrier usage pattern resembles what corresponds to other strategies, as long as that is compatible with the offered traffic pattern. Besides that, the overall performance advantage of GDCA over other strategies increases, as the offered traffic becomes larger.

Comparing the performance of the GDCA over other strategies such as the FCA, Anarchic DCA and Priority List DCA, it could be shown that GDCA offers better performance (less blocking probability) compared to those strategies. Thus, it is hoped that this will assist in the design of the cellular system.

This thesis proposes to extend the GDCA by referring to Markov Chain of call attempts and the Set Theory of mathematical model description. This can be elucidated more comprehensively by comparing GDCA over other strategies, qualitatively and quantitatively.

Abstrak tesis yang dikemukakan kepada Senat
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PENILAIAN PEMBANDINGAN ANTARA GEOMETRIC DYNAMIC CHANNEL ALLOCATION GDCA DENGAN STRATEGI-STRATEGI LAIN

Oleh

ABDULLA KHADER

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Fakulti: Kejuruteraan

Dalam bidang telekomunikasi masa kini, salah satu perkembangan terbesar ialah perkhidmatan tanpa-wayar. Suara bersel telah diiktirafkan sebagai satu perkhidmatan tercekap dalam kebanyakan bidang namun desakan permintaan didapati masih meningkat.

Dalam sistem selular, kawasan geografinya dibahagikan kepada sel, yang mana setiap sel mengandungi satu stesen pangkalan. Stesen pangkalan tersebut mengagihkan satu saluran yang tidak digunakan dalam jarak tetentu.

Terdapat berbagai kaedah pengagihan saluran yang digunakan dalam komunikasi bergerak bermula dengan Peruntukan Saluran

Tetap (PST) kepada Peruntukan Saluran Dinamik (PSD), dan juga Peruntukan Saluran Hibrid (PSH).

Perkhidmatan Komunikasi Peribadi (PSS) telah diperkenalkan dangan meluas sebagai perkhidmatan telefon pasaran massa. Meskipun begitu, muatannya menjadi isu kritikal dewasa ini. Pelaksanaan strategi Peruntukan Saluran Dinamik (PSD) dengan kawalan teragih merupakan jalan penyelesaian terhadap masalah tersebut.

Tesis ini memberi tumpuan kepada satu kelas tertentu dalam lingkungan Peruntukan Saluran Dinamik (PSD) yang dikenali sebagai Peruntukan Saluran Dinamik Geometrik (PSDG). Ciri utama PSDG terletak pada kecekapannya untuk mengatur pengagihan sumber dinamik sehingga kesan corak penggunaan pembawa adalah bersamaan dengan strategi-strategi lain selagi ianya serasi dengan corak laluan trafik. Di samping itu kecekapan menyeluruh PSDG berbanding dengan strategi lain meningkat apabila laluan trafik bertambah besar.

Melalui pembandingan prestasi PSDG dengan strategi-strategi lain seperti PST, Anarchic PSD dan Senarai Keutamaan PSD, dapat ditunjukkan bahawa PSDG boleh memberi prestasi lebih baik berbanding dengan strategi lain. Ini diharapkan dapat membantu dalam mereka bentuk sistem selular.

Tesis ini mencadangkan untuk memperluaskan PSDG dengan merujuk kepada cubaan panggilan Markov Chain dan Perihalan model matematik Teori Set. Ini dapat diterangkan dengan lebih komprehensif dengan membandingkan PSDG dengan strategi-strategi lain, secara kuantitatif dan kualitatif.

CHAPTER I

INTRODUCTION

Background

Wireless services are one of the strongest growth areas in telecommunications today. Cellular voice is well established as a high-end service in most areas, but demand is increasing rapidly (Jordan and Schwabe, 1993).

In cellular systems, the geographical region is split, using a regular topology, into cells each containing one base station. A mobile wishing to initiate a call must request a channel from the base station in the cell in which the mobile currently exists. The base station must assign a channel that is not currently used within some specified distance.

Personal Communication Services (PCS) have been introduced as a mass-market phone service. On the other hand, wireless data services are appearing in the form of Cellular Digital Packet Data (CDPD) and wireless local area networks (WLANs).

Cellular systems passed through many generations starting with first generation and looking forward to the third generation. In the early 1970s [Stuber, 1996], the emergence of the radio technology needed for the deployment of mobile radio systems in the 800/900 MHz band was at a reasonable cost. In the early 1980s, many countries have deployed first generation cellular system based on frequency division multiple access (FDMA) and analog FM technology.

Since the initial deployments, the cellular subscriber base has been growing 20% to 50% per year [Stuber, 1996]. Current expectations are that 50% of telephone traffic will use wireless link by the year 2000. Rapid development in microelectronics have made second generation digital cellular system viable. Digital cellular systems have many advantages over analog cellular systems including the provision of voice and data services. Most if not all, second-generation digital cellular systems use either time division multiple-access (TDMA) or code-division multiple-access (CDMA).

In 1982, the Conference of European Post and Telecommunications Administrations (CEPT) established Group Special Mobile (GSM), the GSM now known as "Global System for Mobile Communications". In North America, second generation digital cellular

systems were developed with the constraint of making a seamless transition from the Advanced Mobile Phone Service (AMPS) system.

In Japan, development of a second-generation digital cellular system began in 1989. In 1991, the Ministry of Post and Telecommunications standardized the new system, named Personal Digital Cellular (PDC).

In March 1992, World A administrave Radio Conference (WARC) approved a worldwide allocation in support of the Future Public Land Mobile Telephone System (FPLMTS) (third generation now called IMT-2000) in the 1885-2200 MHz band. This new frequency allocation is leading to the development of a wide array of new wireless systems and services.

In Europe, the intermediate goal is the Universal Mobile Telecommunication System (UMTS). The basic idea of UMTS is to provide mobile service any time and every where. Some effort is being made to extend current standards such as GSM, DCS1800 (Digital Cellular System), and DECT (Digital Europe Cordless Telephone) for this purpose.

Capacity, however, is now a critical issue for all of these services. A solution to the increasing spectrum efficiency demand in Personal Communication Networks (PCN's) is the implementation of Dynamic Channel Allocation (DCA) strategy with distributed control [Jordan Scott, 1995].

The third generation of cellular systems is expected to cope with formidable capacity increase, one of the most successful second generation standards is the Global System for Mobile Communication (GSM) mobile radio network [Mouly and Pautet, 1992].

As mentioned earlier, the geographical region is split, using a regular topology, into cells each containing one base stations. The base station must assign a channel that is not currently used within some specified distance. There are many kinds of channel assignment methods used in mobile communication starting with Fixed Channel Assignment (FCA), through Dynamic Channel Assignment (DCA) and finishing with Hybrid Channel Assignment (HCA).

The call blocking probability is defined as the probability that a call arriving to a cell finds all channels busy. Simulation results showed [Katzela and Naghshineh, 1996] that systems with the most dynamic channels give the lowest probability of queuing for load increase up to

15 percent over the basic load. For load increase of 15-32 percent, systems with the medium dynamic channels give the best performance. For load of 32-40 percent, systems with low dynamic channels give the best performance. Finally, for loads of over 40 percent systems with no dynamic channels give the best performance.

New schemes were discovered that performs better than traditional schemes (FCA, DCA, HCA) such as the Geometric Dynamic Channel Allocation GDCA, the Anarchic DCA and Priority List DCA strategies. All these schemes are derived from the basic DCA scheme.

At present, the GSM network already has a Fixed Carrier Allocation (FCA) strategy where a semi-permanent carrier-to-cells assignment is present. As the first step in the migration from GSM toward third-generation system, the introduction in the GSM cellular network of a Dynamic Channel Allocation (DCA) strategy with a distributed control is proposed.

GDCA is one of the proposed strategies [Mouly and Puatet, 1992]. The main feature of the GDCA lies in its ability to organize the dynamic resource assignment so that the resulting carrier usage pattern resembles that corresponding to other strategies, as long as that is compatible with the offered traffic pattern. Besides, the overall

performance advantage of GDCA over other strategies increase as the offered traffic increases [Andrea, 1994].

By comparing the performance of the GDCA over other strategies such as the FCA, Anarchic DCA and Priority List DCA strategies, it could be shown that the GDCA offers better performance (less blocking probability) compared to other strategies.

By referring to Markov Chain of call attempts and set theory of mathematical model description, it is possible to further elucidate the GDCA strategy.

Objectives of the Research

1. To compare the GDCA over other strategies qualitatively and quantitatively.
2. To extend the set theory model and to develop the algorithmic approach in a more comprehensive validation in order to obtain the performance of the GDCA strategy.

By comparing the GDCA strategy over other strategies, the future works on extending the description of the GDCA algorithm will be easier to be simulated.