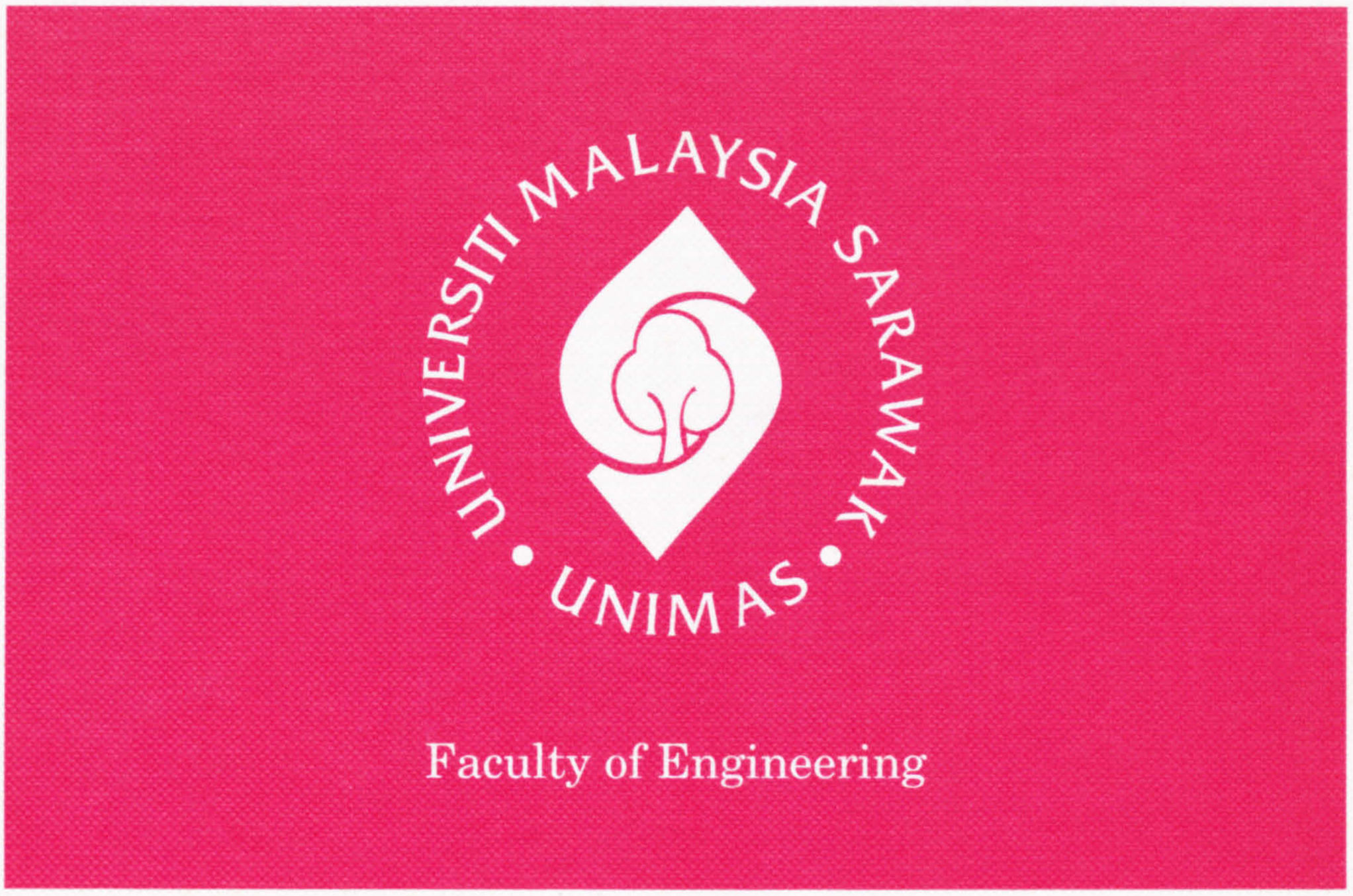


ANALYSIS OF MICROCELLULAR NETWORK WITH QUALITY OF SERVICE (QOS) PROVISIONING FOR DATA TRAFFIC

Dzatul Ithri Amran

Bachelor of Engineering with Honours
(Electronics and Computer Engineering)
2004

UNIVERSITI MALAYSIA SARAWAK

fk

BORANG PENGESAHAN STATUS TESIS

Judul: ANALYSIS OF MICROCELLULAR NETWORK WITH QUALITY OF SERVICE (QoS) PROVISIONING FOR DATA TRAFFIC

SESI PENGAJIAN: 2000 - 2004

Saya DZATUL ITHRI AMRAN
(HURUF BESAR)

mengaku membenarkan tesis ini disimpan di Pusat Khidmat Maklumat Akademik, Universiti Malaysia Sarawak dengan syarat-syarat kegunaan seperti berikut:

1. Hakmilik kertas projek adalah di bawah nama penulis melainkan penulisan sebagai projek bersama dan dibiayai oleh UNIMAS, hakmiliknya adalah kepunyaan UNIMAS.
2. Naskhah salinan di dalam bentuk kertas atau mikro hanya boleh dibuat dengan kebenaran bertulis daripada penulis.
3. Pusat Khidmat Maklumat Akademik, UNIMAS dibenarkan membuat salinan untuk pengajian mereka.
4. Kertas projek hanya boleh diterbitkan dengan kebenaran penulis. Bayaran royalti adalah mengikut kadar yang dipersetujui kelak.
5. * Saya membenarkan/tidak membenarkan Perpustakaan membuat salinan kertas projek ini sebagai bahan pertukaran di antara institusi pengajian tinggi.
6. ** Sila tandakan (✓)

☐	SULIT	(Mengandungi maklumat yang berdarjah keselamatan atau kepentingan Malaysia seperti yang termaktub di dalam AKTA RAHSIA RASMI 1972).
☐	TERHAD	(Mengandungi maklumat TERHAD yang telah ditentukan oleh organisasi/ badan di mana penyelidikan dijalankan).
✓	TIDAK TERHAD	

(TANDATANGAN PENULIS)

Alamat tetap: 939, JALAN TEMPLER,
SECTION 8, 46050 PETALING JAYA,
SELANGOR DARUL EHSAN.

Tarikh: 1 MAC 2004

Disahkan oleh

(TANDATANGAN PENYELIA)

EN. HUSHAIRI ZEN
(Nama Penyelia)

Tarikh: 7/4/04

CATATAN * Potong yang tidak berkenaan.
** Jika Kertas Projek ini SULIT atau TERHAD, sila lampirkan surat daripada pihak berkuasa/ organisasi berkenaan dengan menyertakan sekali tempoh kertas projek. Ini perlu dikelaskan sebagai SULIT atau TERHAD.

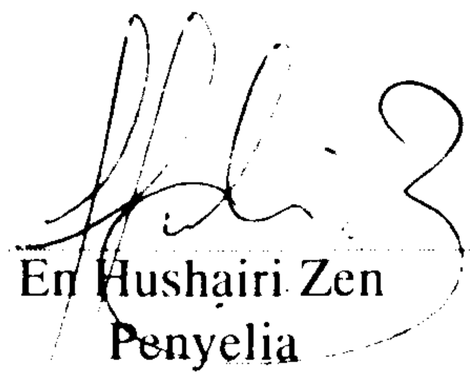
Laporan Projek Tahun Akhir berikut:

Tajuk: **Analysis of Microcellular Networks with Quality of Service (QoS) Provisioning for Data Traffic**

Nama penulis: **Dzatul Ithri Amran**

Matrik: **5511**

telah dibaca dan disahkan oleh:



En Hushairi Zen
Penyelia

7/4/14
Tarikh

ANALYSIS OF MICROCELLULAR NETWORK WITH QUALITY OF SERVICE (QOS) PROVISIONING FOR DATA TRAFFIC

DZATUL ITHRI AMRAN

This project is submitted in partial fulfilment of
the requirements for the degree of Bachelor of Engineering with Honours
(Electronics & Computer Engineering)

Faculty of Engineering
UNIVERSITI MALAYSIA SARAWAK
2004

To my beloved Family

ACKNOWLEDGEMENT

First of all, I would like to dedicate this project to my family members especially to my parents for giving me their fully support, encouragement and love during the period of this study.

I would also like to take this opportunity to express my fully gratitude to my supervisor, Mr. Hushairi Zen for being supportive and willing to sacrifice his precious time in providing guidance and advice to make this project in success. Not forgetting to my coursemates of electronic and computer engineering program batch 2000/2004 for their support and help.

Last but not least, I wish to express my most appreciation to the Faculty of Engineering for allowing me to use all kind of resources available in the laboratory.

ABSTRACT

Early civilian mobile radio voice communications were developed primarily for police and taxi dispatching and used frequency in the VHF band. The demand for private mobile telephone applications grew and additional portions of the radio spectrum were allocated at higher frequencies in the UHF band. The need to accommodate large numbers of mobile telephone subscribers using limited spectral resources led to the concept of cellular radio. Cellular systems are deployed simultaneously in different parts of the world using the cellular technology approach. In United States, several systems deployed for two reasons. First, consumers much more rapidly accepted the technology where it provides the funding for rapid technological advancement and rapid deployment. Second, because large areas of United States remain outside cellular coverage zones and it was profitable to expand into new territory rather than deploy in areas that already had cellular service. Understanding the basic concepts of cellular systems is important before further analyzing the performance of the cellular networks in transmitting data. Then only the deployment of the system can be extended.

ABSTRAK

Komunikasi radio bergerak pada awalnya hanya direka untuk kegunaan pihak polis dan perkhidmatan teksi serta penggunaan frekuensi pada jalur VHF. Permintaan terhadap penggunaan telefon bergerak peribadi meningkat penambahan sebahagian spectrum radio diletakkan pada frekuensi yang lebih tinggi di dalam jalur UHF. Keperluan untuk menampung bilangan pengguna telefon bergerak yang banyak dengan sumber spektra yang terhad membawa kepada konsep radio selular. Sistem selular digerakkan secara serentak di semua bahagian berbeza di dunia menggunakan pendekatan teknologi selular. Di Amerika, kebanyakan sistem dicipta atas dua sebab Pertama, konsumer lebih menerima teknologi yang menawarkan kemajuan dan penggunaan teknologi yang pantas. Kedua, keluasan Amerika yang besar menyebabkannya berada di luar zon liputam selular dan adalah lebih menguntungkan jika meluaskannya ke daerah yang baru selain menggerakkannya di tempat yang sudah mempunyai khidmat selular. Pemahaman terhadap konsep asas sistem selular adalah sangat penting sebelum melakukan analisis terhadap prestasi rangkaian selular dalam penghantaran data.

TABLE OF CONTENTS

LIST OF FIGURES

CHAPTER 1

INTRODUCTION

1.1 Project Overview

Nowadays, communication requirements for mobile cellular are bound to increase due the search for improved efficiency, entails rapid circulation of information. Users of mobile cellular will most likely experienced undesired effects such as bad quality of speech, dropped calls when moving from one location to another or busy network when making a call. The reason is because of low service rate due to bad quality of data handover and high congestion in wireless network. This is why it is important to understand and analyze on the quality of data handover and the operation of data traffic provisioning QoS.

In 1894, Marconi had seen the commercial possibility for a system to be operated free from the limitations of wire when he turned the theory into practical reality. When using a cellular phone, several undesired effects such as dropped calls when moving from one location to another, busy network when attempting a call and poor speech quality are most likely experienced **[15]**. It is a purely matter of convenience; receive and make calls at leisure, any time and any place **[13]**. Thus, it is important to examine the performance of the existing cellular networks to transmit data.

Micro-cellular network with Quality of Service (QoS) provisioning for data traffic requires allocation and control of wireless network resources to ensure that probability of receiving rate is satisfied to a predefined level. This project involves studies on the quality of data handover with Quality of Service (QoS) provisioning based on cell-cluster concept done by Mahmoud Naghshineh and Anthony S. Acampora, which focused on the call admission control algorithms. The methodology of the design and control is defined by three metrics: *call blocking probability, cell overload probability* and *probability that the available wireless bandwidth per mobile is less than some specified threshold* **[11]**.

In the past, several solutions were proposed in order to reduce the congestion probability while providing high radio spectrum utilization efficiency in cellular networks such as based on power control, dynamic or hybrid channel allocation schemes and layered architecture. These approaches do not impose control on the admission of new calls and as the load of the cellular network increases, the radio congestion probability will rise. **[11]** Other solutions permit dropping or queuing the hand-off calls and servicing with higher priority relative to new call requests. For call admission control, congestion and low service rate can be eliminated where it involves sharing of bandwidth instead of queuing or dropping.

1.2 Objectives

The main objective of this final year project report is to study the call admission control based on cell-cluster concept done by Mahmoud Naghshineh and Anthony S. Acampora in their research titled design and control of microcellular network with QoS provisioning for data traffic.

The first stage of the studies requires understanding of basic cellular concept of microcellular system. The characteristics of microcellular network, handoffs issues and concept of Erlang are studied from the related sources. Quality of Service (QoS) is also taking into considerations, as it is one of the criteria in this study.

The second stage involves implementation of call admission control in the network and develops the results using MATLAB application. Before implementation, theory of the method should be understood.

Technically, the objective of this final year project are as stated below:

i) To analyze the call admission control based on cell-cluster concept done by Mahmoud Naghshineh and Anthony S. Acampora

ii) To understand on the basic cellular concept of microcellular system and QoS provisioning

iii) To describe a call admission control methodology for the design together with the analytical model

iv) To apply the algorithm and reproduce the results of the probabilities by using MATLAB application

1.3 Report Outline

Final year project report outline will briefly describe the chapters in this report.

Introduction of the final year project report is discussed in Chapter 1. Background of cellular system is briefly explained also a little bit of introduction on cellular concept and MATLAB application. The objectives of the final year project report are also stated.

Chapter 2 and Chapter 3 content the literature review that is relevant to the final year project report Chapter 2 will go further on the theoretical explanation of Microcellular System, the concept and characteristics. Chapter 3 explained on Quality of Service (QoS), which is required in this study.

The implementation of the call admission control using MATLAB is described in Chapter 4. The method and the function of each model are further explained in details.

Chapter 5 showed and discussed the result obtained using MATLAB application. Explanation of the graphs is given, so as comparison between the real results (from the work done by Mahmoud Naghshineh and Anthony S. Acampora) and the results obtained from this study.

Lastly, Chapter 6 will give the conclusion of the report. Recommendation is also included for further reference.

1.4 Introduction to Cellular Concept

In 1940s, the employees of Bell Labs developed the basic cellular concept. In 1971, AT&T proposed to the Federal Communications Commision (FCC) a cellular-based system for voice transport. The bandwidth allocated was previously used for UHF TV. The range of the spectrum is from 806 MHz to 890 MHz was seized in 1974. Initial testing was carried out to demonstrate the concept to the FCC. FCC then agreed in principle that the concept worked in 1981. In 1984, AT&T, the parent of Bell Labs, got half the spectrum and the other half to the competitor. **[12]**

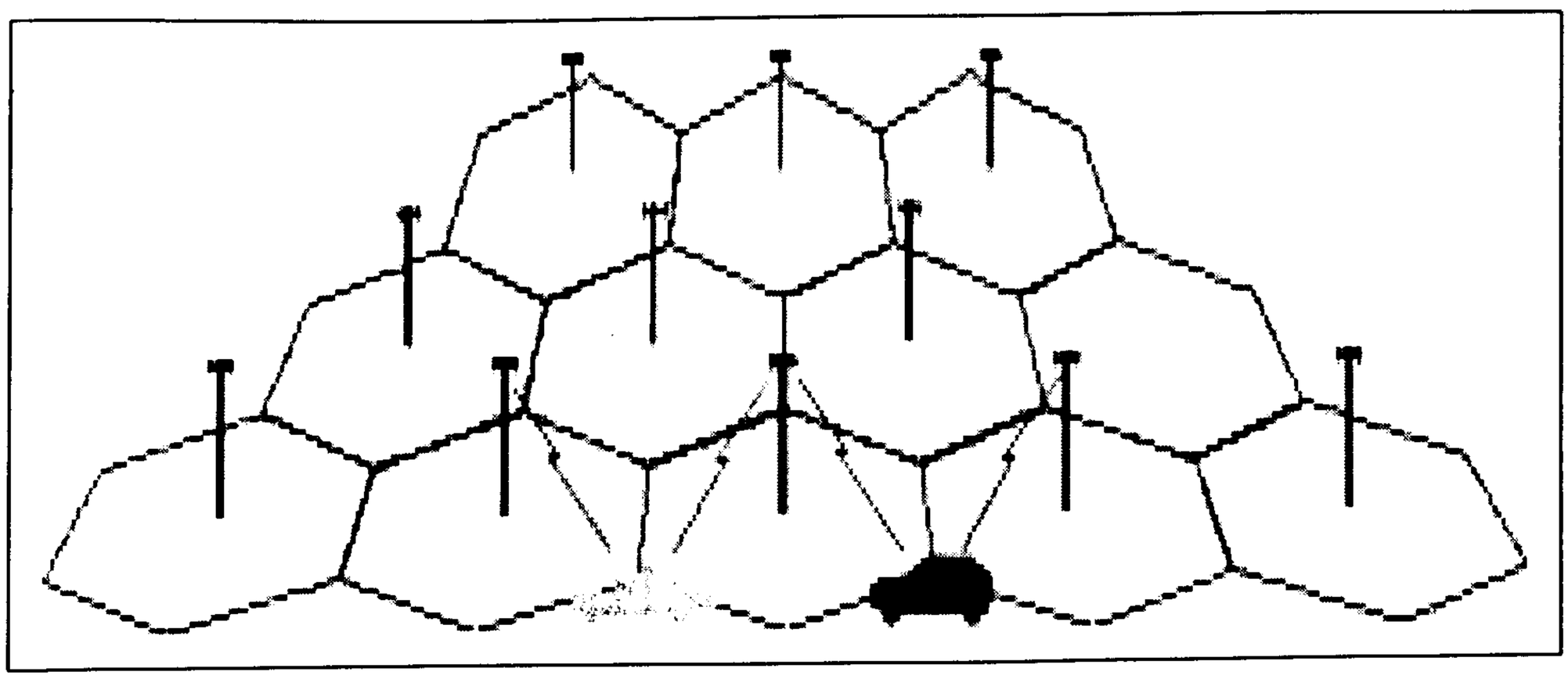


Figure 1.1 The Cellular Concept

Figure 1.1 shows the cellular concept. The reason of calling it "cellular" is that personal wireless services tend to operate on a cellular concept. As a mobile called passes from one cell site's service area to the next cell site's service area, the call is "handed off" from one transceiver to another. These overlapping calls ensure that a caller never gets dropped.

Cells are designed for mobility: a call is "handed off" from one cell to another as the caller leaves one cell and enters another. However, when too many callers demand the use of one cell site, those callers who are connected first or who are closest to the cell site's antennas get priority. Callers who are late or at the edge of the cell site could get dropped or be denied access. This "over-demand" leads to the need for a new cell site which, when installed, will serve a smaller cell. Wireless carriers call this increased coverage, but it really is increased capacity.

The basic cellular concept is composed of two fundamentals **[12]**:

i) Reuse the spectrum (frequency reuse)

ii) Divide the service area into a group of small regions called cells

A cell is a specific region where a portion of the frequency spectrum is used. Co-channel cells are cells using the same group of frequencies.

In each cell is one base station with a transceiver capable of spanning the entire cell. Each radio link is limited to a single cell and a slight overlap with its adjacent partners. Since the power output of the base station is low, those frequencies can be used by another cell's base station to communicate with other user in a nonadjacent cell. Thus, the same frequency is used many times over in any cellular system. The frequency can be used as long as no sides of any two cells touch each other.

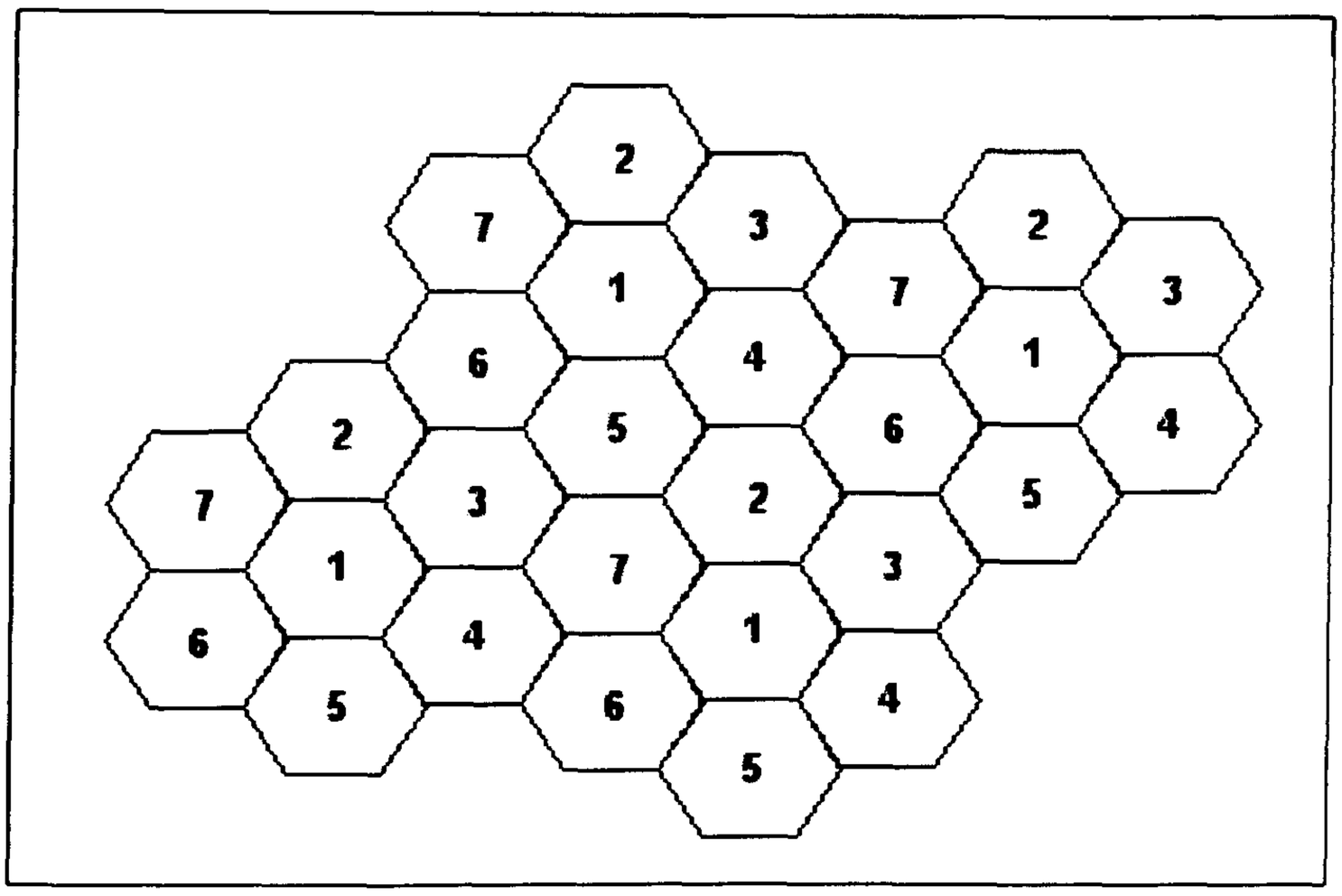


Figure 1.2 Frequency Reuse Concepts Showing a Seven-Segment Cluster

Figure 1.2 illustrates the concept of frequency reuse. It shows a cluster of seven cells with four clusters of size seven repeatedly across the pattern. In each cell of cluster, a different group of transmitting and receiving frequencies is used. Any cellular telephone operating anywhere in a cluster uses different frequency. The number of cells in the cluster divides the total spectral allocation for a cellular system. Then the base station in each cell in every cluster uses that portion of the total spectral allocation to communicate with any mobile system located in that cell. Therefore, the total number of possible communication channels is the same.

Every cellular system has six basic components as shown in *Figure 1.3* below. All cellular systems today follow the same model developed by the TR-45 standards group. It is an architectural model identifying the names and functions of the subcomponents that every cellular system uses. The main components are as below:

i) Gateway into the Wireline System

ii) Base Station (BS)

iii) Databases

iv) Security Mechanism

v) Air Interface Standard

vi) Cellular Telephones

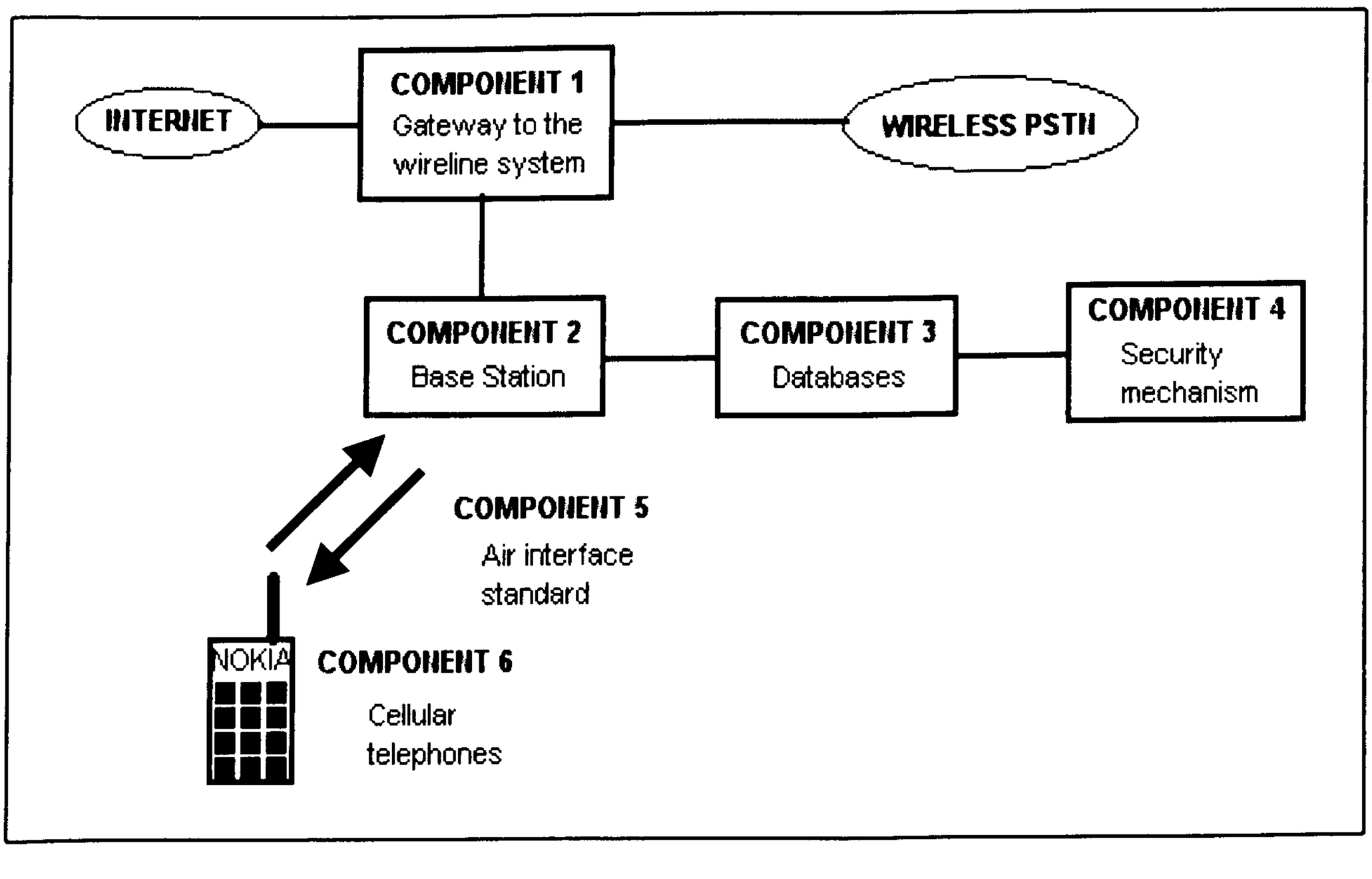


Figure 1.3 Six Components of Cellular System

1.5 Introduction to MATLAB

MATLAB stands for matrix laboratory. It is a high-performance language for technical computing. It integrates computation, visualization, and programming in an easy-to-use environment where problems and solutions are expressed in familiar mathematical notation. Typical uses include:

i) Math and computation

ii) Algorithm development

iii) Modeling, simulation, and prototyping

iv) Data analysis, exploration, and visualization

v) Scientific and engineering graphics

vi) Application development, including graphical user interface building

MATLAB is an interactive system whose basic data element is an array that does not require dimensioning. This allows user to solve many technical computing problems, especially those with matrix and vector formulations, in a fraction of the time it would take to write a program in a scalar non-interactive language such as C or Fortran.

MATLAB has evolved over a period of years with input from many users. In university environments, it is the standard instructional tool for introductory and advanced courses in mathematics, engineering, and science. In industry, MATLAB is the tool of choice for high-productivity research, development, and analysis.

MATLAB features a family of application-specific solutions called toolboxes. Very important to most users of MATLAB, toolboxes allow user to learn and apply specialized technology. Toolboxes are comprehensive collections of MATLAB functions (M-files) that extend the MATLAB environment to solve particular classes of problems. Areas in which toolboxes are available include signal processing, control systems, neural networks, fuzzy logic, wavelets, simulation, and many others. **[5, 9]** *Figure 1.4* below shows the example of MATLAB 6.1 window.

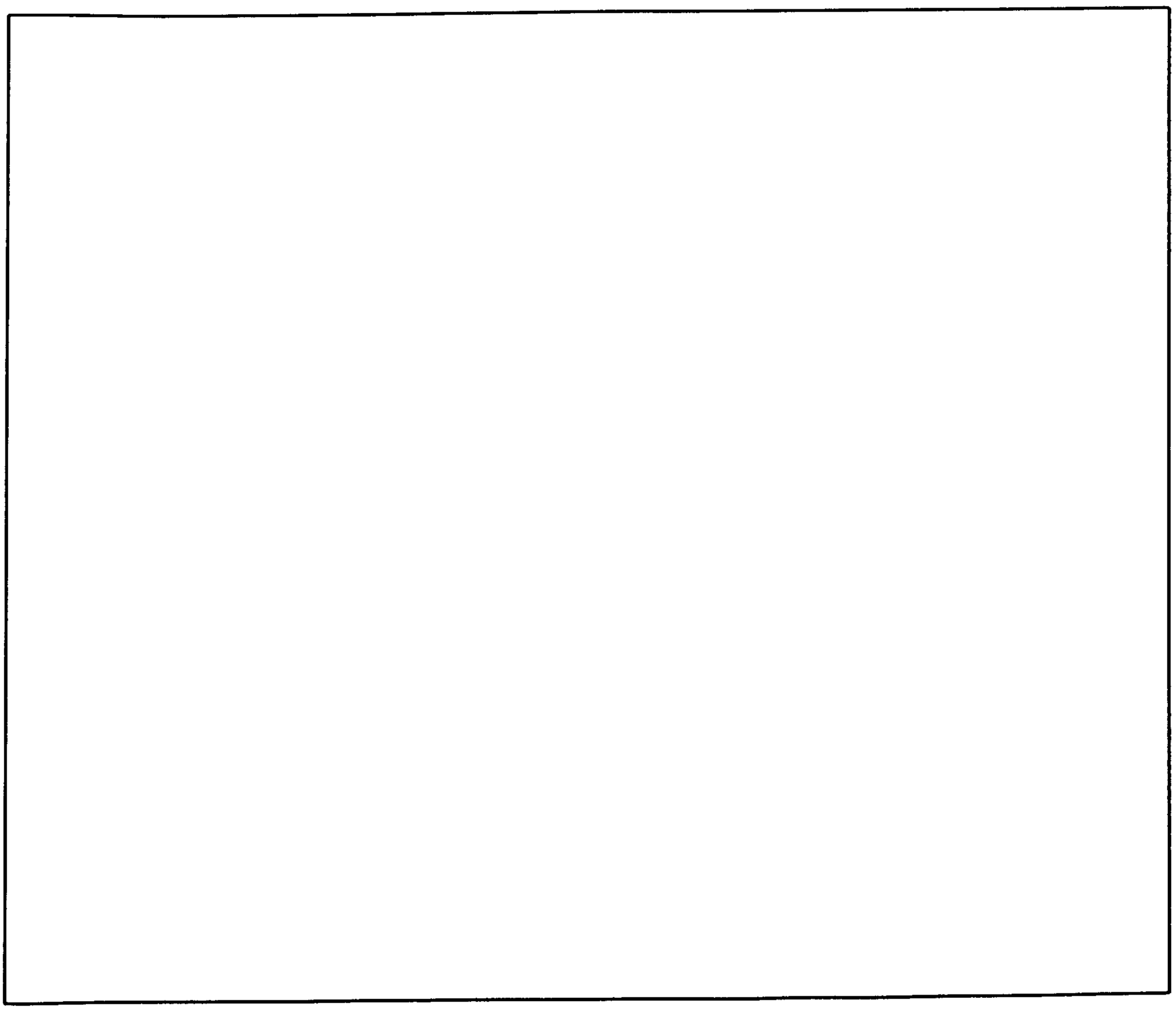


Figure 1.4 Example of MATLAB 6.1 window

1.5.1 The MATLAB System

The MATLAB system consists of five main parts:

1.5.1.1 Development Environment

This is the set of tools and facilities that help user to use MATLAB functions and files. Many of these tools are graphical user interfaces. It includes the MATLAB desktop and Command Window, a command history, and browsers for viewing help, the workspace, files, and the search path.

1.5.1.2 The MATLAB Mathematical Function Library

This is a vast collection of computational algorithms ranging from elementary functions like sum, sine, cosine, and complex arithmetic, to more sophisticated functions like matrix inverse, matrix eigenvalues, Bessel functions, and fast Fourier transforms.

1.5.1.3 The MATLAB Language.

This is a high-level matrix/array language with control flow statements, functions, data structures, input/output, and object-oriented programming features. It allows both "programming in the small" to rapidly create quickly and dirty throwaway programs, and "programming in the large" to create complete large and complex application programs.