Sudan University of Science and Technology
College of Engineering
School of Electronics Engineering – Communication Department

HANDOVER IN LEO SATELLITE MOBILE NETWORKS.

A Research Submitted In Partial fulfillment for the Requirements of the Degree of B.Sc. (Honors) in Electronics Engineering.

Prepared By:

1. **Ahmed Hashim Ahmed Mohammed.**
2. **Ahmed Hashim Alhassan Abdel-rahman.**
3. **Samer Mubarak Abdel-raheem Khojali.**
4. **Rahmet-allah Mohammed Ahmed Bur.**

Supervised By:

Dr.Ashraf Gassim Alseed.

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بسم الله الرحمن الرحيم

إقرأ باسم ربِّك الّذي خلق *
خلق الإنسان من علق *
إقرأ وربُّك الأكرم * الّذي
علّم بالقلم * علّم الإنسان
ما لم يعلم *

صدق الله العظيم

سورة العلق ... الآية (1-5)

Dedication

الى من قامن في الليل الداجي يمتهن رضاعتنا و يواسيينا عند الأسقام

اليهن و هنيطّز رلنا حضناً كي نلبسه في البرد القارس و يلبسنا في ساعة خوفٍ ليلية.

الى الأمهات....

الى روح الزميل الراحل / عثمان محمد العوض

وهي ترفرف صعودا الى بارئها متلفحة ذكريات السنوات الاخيرة ، أمنحك هذه الأطروحة،

و وردة على قبرك المعتم.

Acknowledgement

First and foremost, thank God Almighty for giving us the energy needed to complete this project ….. And also like to thank all those who helped us in completing this research, led by faithful always Dr. Ashraf Gasim El-Seed, who helped us to understand and absorb this research as well as helped us in arranging and coordinating the pages of the first to the last character in it.

Abstract

In this project we talked about the communication in satellite communications systems based on wireless, and focused our study on the topic of cell phone movement from the coverage area of the first satellite to the coverage area of the second satellite, and depending on the idea in second-generation systems “cellular systems-GSM” as well as in third generation systems “UMTS”, and this process known as the handover process.

As well as reviewed the types of handover in the satellite communication systems as we discussed some of the problems associated with this process, such as the congestion problem and the problem of the handover failure and dealt with the some of the solutions expected to reduce these problems or prevent them if possible.

Were also identified geographic area and have been studied and then was assumed three satellites to achieve and implement the handover process and determine potential problems and to imagine possible solutions.

المستخلص

في هذا المشروع تحدثنا عن أنظمة الاتصال في الأقمار الصناعية اعتماداً على أنظمة الاتصالات اللاسلكية ، و تمحورت دراستنا حول موضوع انتقال الهاتف الخليوي من منطقة التغطية الخاصة بالقمر الصناعي المحدد الى منطقة تغطية خاصة بقمر صناعي آخر فيما يعرف بعملية التسليم ، و ذلك اعتمادا على فكرته في أنظمة الجيل الثاني"الأنظمة الخليوية " و كذلك في أنظمة الجيل الثالث.

و كذلك استعرضنا أنواع عملية التسليم الموجودة في أنظمة الاتصال في الأقمار الصناعية كما قمنا بمناقشة بعض المشاكل المصاحبة لهذه العملية مثل مشكلة الازدحام و مشكلة فشل عملية التسليم و تطرقنا الى بعض الحلول المتوقعة لتقليل هذه المشاكل أو منع حدوثها اذا أمكن.

كما تم تحديد منطقة جغرافية و تمت دراستها ومن ثم تم افتراض ثلاث أقمار صناعية لتحقيق و تطبيق عملية الانتقال " التسليم " و تحديد المشاكل الممكنة و تصور الحلول الممكنة لها.

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Abbreviations

Term	Abbreviation
2G	Second-generation
3G	Third-generation
4G	Fourth generation
8QPSK	8*Quadrature Phase Shift Keying*
ADCA	Adaptive Dynamic Channel Allocation
AMPS	Advanced Mobile Phone System
BCN	Broadband Convergence Network
BS	Base Station
C-450	Cellular System Operating at 450 MHz
CCI	Co-channel Interference
CDMA	Code Division Multiple Access
DAB	Digital Audio Broadcasting
DCA	Dynamic Channel Allocation
DVB	Digital Video Broadcasting
DDBHP	Dynamic Doppler Based Handover Prioritization
DECT	*Digital Enhanced Cordless Telecommunications*
ECL	Elastic Channel Locking
EDGE	Enhancement Data Rate for GSM Evolution
ES	Expanded Spectrum
FCA	Fixed Channel Allocation
FCC	Federal Communications Commission
FDMA	Frequency Division Multiple Access
FIFO	First In First Out
FPLMTS	Future Public land Mobile Telecommunication System
GCAC	Geographical Connection Admission Control
GMSK	*Gaussian Minimum Shift Keying*
GPRS	General Packet Radio Service
GSM	Global System for Mobile Communication
HEO	High Elliptical Orbiting Satellite
HG	Handover with Guard channel
HQ	Handover with Queuing
HSCSD	High Speed Circuit Switched Data
ID	*Identification Number*
ISL	Inter-Satellite Link
JDC	Japanese Digital Cellular
LCN	Logical Channel Number

LEO	Low-Earth Orbiting Satellite
LMSS	Land Mobile Satellite System
LUI	Last Useful Instant
MBPS	Measurement Based Priority Scheme
MEO	Middle-Earth Orbiting Satellite
MS	Mobile Station
MSC	Mobile Switching Center
NMT	Nordic Mobile Telephones
NTT	Nippon Telephone and Telegraph
Pb	Probability of Blocking
PDC	Personal Digital Cellular
Pf	Probability of Dropping
QoS	Quality of Service
RSS	Really Simple Syndication
SCS	Satellite Control Station
SCTP	*Stream Control Transmission Protocol*
SIR	*Security Industry Registry*
SMP	Satellite Mobility Pattern
SU	Subscriber Unit
TACS	Total Access Communication Systems
TCP	*Transmission Control Protocol*
TCRA	Time based Channel Reservation Algorithm
TDMA	Time Division Multiple Access
ttH	Handoverthreshold
UDP	*User Datagram Protocol*
UMTS	Universal Mobile Telecommunication System
WACS	Wireless Access Communications Systems

CHAPTER ONE

Chapter One
Introduction

1.1 Preface

Terrestrial wireless networks such as cellular networks provide mobile communication services with limited geographical coverage. In order to provide global coverage to a heterogeneously distributed user population, satellite communication networks are utilized to co-exist with terrestrial networks. Therefore, the role of satellites broadens from the traditional telephony and TV broadcast services to user oriented data services. This trend is expected to continue in the future. Due to this reason, next generation mobile networks will use smart satellites that will incorporate functions such as switching, buffering, and beam switching in addition to signal reproduction. In addition, satellite systems can play a significant role in broadband convergence networks (BCN). In BCN, the connection among heterogeneous networks both on horizontal and vertical structures, interaction among network-dependent elements of those networks should be carefully designed. Due to coverage superiority, a LEO satellite constellation may become a crucial element for supporting BCN. Therefore, this paper focuses on handover management problem for LEO satellite constellation.

A typical LEO satellite takes about 100 minutes to orbit the earth, which means that a single satellite is "in view" of ground equipment for only a few minutes. As a consequence, if a transmission takes more than the short time period that any one satellite is in view, a LEO satellite system must hand over between satellites to complete the transmission. In general, this can be accomplished by constantly relaying signals between the satellite and various ground stations, or by communicating between the satellites themselves using "inter-satellite links" (ISLs). LEO satellites are also designed to have more than one satellite in view from any spot on the earth at any given time, minimizing the possibility that the network will loose the transmission. Due to the fast-flying satellites, LEO systems must incorporate complicated tracking and switching equipment to maintain consistent service coverage. In this paper, we focus on the handover management of satellite networks, which is a crucial design problem for supporting mobile communication services in the co-existing terrestrial and LEO satellite networks.

1.2 Problem Statement

Excessive handovers lead to heavy handoff processing loads and poor communication quality, which may be due to the following: (i) the more attempts at handovers, the more chances that a call will be denied access to a channel, resulting in a higher handover call dropping probability, (ii) a lot of handover attempts causes more delay in the MSC processing of handover requests, which will cause signal strength to decrease over a longer time period to a level of unacceptable quality. Also, the call may be dropped if sufficient SIR is not achieved. Handover requires network resources to connect the call to a new BS. Thus, minimizing the number of handovers reduces the switching load.

1.3 Proposed Solutions

A typical LEO satellite takes less than two hours to orbit the earth, which means that a single satellite passes over the same geographical area of the earth in repeating periods of time. This characteristic provides a satellite mobility pattern (SMP) scheme which includes when and where a satellite passes over a location.

From this fact we predict the time of handover occurrence and handover requests can be done over short period of time.

1.4 Aim and Objectives

The aim of the project is:

. To reduce the loss energy in handover.

. To solve failure problem in handover.

1.5 Methodology

Using Matlab research team will introduce a handover procedure through it we can decrease undesirable features of handover.

1.6 Research Outlines

This report contains five chapters. Chapter 2 provides background information and a literature survey on handover, believed to be the most comprehensive survey of the subject to the date. Chapter 3 provides the physical model and geographical area surveying and applying the handover criteria at specified area. Chapter 4 provides the discussion and illustrates the simulation results. Chapter 5 provides the conclusion of this project and recommendations.

CHAPTER TWO

Chapter Two

Cellular and Satellite Systems

2.1 Background

We start this section with explaining the development of the cellular communication system that represented in four generations.

2.1.1 First-generation analogue mobile systems

In 1980 the mobile cellular era had started, and since then mobile communications have undergone significant changes and experienced enormous growth. Figure 2.1 shows the evolution of the mobile networks. First-generation mobile systems used analogue transmission for speech services. In 1979, the first cellular system in the world became operational by Nippon Telephone and Telegraph (NTT) in Tokyo, Japan. The system utilized 600 duplex channels over a spectrum of 30 MHz in the 800 MHz band, with a channel separation of 25 kHz. Two years later, the cellular epoch reached Europe. The two most popular analogue systems were Nordic Mobile Telephones (NMT) and Total Access Communication Systems (TACS). In 1981, the NMT-450 system was commercialized by NMT in Scandinavia. The system operated in the 450 MHz and 900 MHz band with a total bandwidth of 10 MHz TACS, launched in the United Kingdom in 1982, operated at 900 MHz with a band of 25 MHz for each path and a channel bandwidth of 25 kHz. Extended TACS was deployed in 1985. Other than NMT and TACS, some other analogue systems were also introduced in 1980s across the Europe. For example, in Germany, the C-450 cellular system, operating at 450 MHz and 900 MHz (later), was deployed in September in 1985. All of these systems offered handover and roaming capabilities but the cellular networks were unable to interoperate between countries. This was one of the inevitable disadvantages of first-generation mobile networks. In the United States, the Advanced Mobile Phone System (AMPS) was launched in 1982. The system was allocated a 40-MHz bandwidth within the 800 to 900 MHz frequency range. In 1988, an additional 10 MHz bandwidth, called Expanded Spectrum (ES) was allocated to AMPS.

2.1.2 Second-generation & phase 2+ mobile systems

Second-generation (2G) mobile systems were introduced in the end of 1980s. Low bit rate data services were supported as well as the traditional speech service. Digitaltransmission rather than analogue transmission was used by these systems. Consequently, compared with first-generation systems, higher spectrum efficiency, better data services, and more advanced roaming were offered by 2G systems. In Europe, the Global System for Mobile Communications (GSM) was deployed to provide a single unified standard. This enabled seamless services through out Europe by means of international roaming. The earliest GSM system operated in the 900 MHzfrequency band with a total bandwidth of 50 MHz. During development over morethan 20 years, GSM technology has been continuously improved to offer betterservices in the market. New technologies have been developed based on the originalGSM system, leading to some more advanced systems known as 2.5 Generation (2.5G)systems. So far, as the largest mobile system worldwide, GSM is the technology ofchoice in over 190 countries with about 787 million subscribers [GSM web].

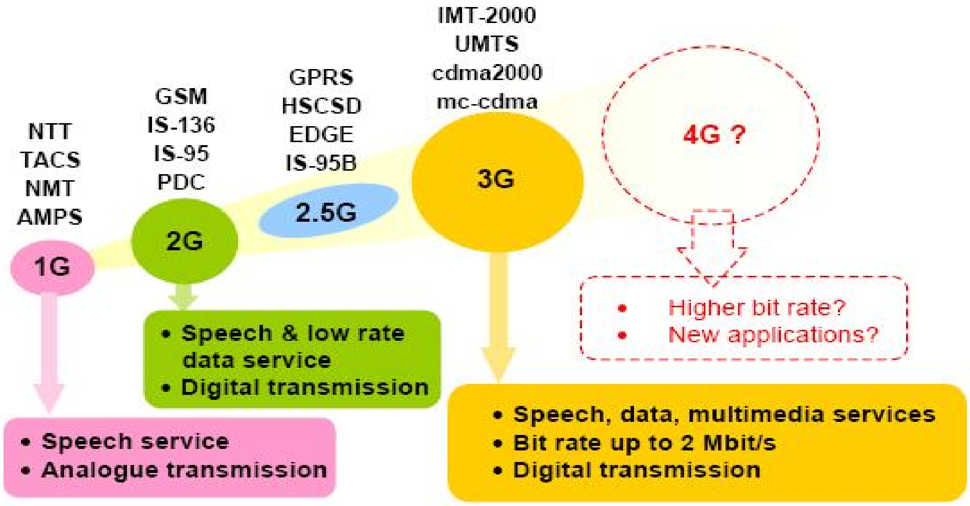


Figure 2-1: Evolution of mobile networks

In the United States, there were three lines of development in second-generationdigital cellular systems. The first digital system, introduced in 1991, was the IS-54(North America TDMA Digital Cellular), of which a new version supportingadditional services (IS-136) was introduced in 1996. Meanwhile, IS-95 (CDMA One)was deployed in 1993. The US Federal Communications Commission (FCC) alsoauctioned a new block of spectrum in the 1900 MHz band, allowing GSM1900 to enter the US market. In Japan, the Personal Digital Cellular (PDC) system, originally known as JDC (Japanese Digital Cellular) was initially defined in 1990. Commercial service was started by NTT in 1993 in the 800 MHz band and in 1994 in the 1.5 GHz band. Nowadays, second-generation digital cellular systems still dominate the mobile industry throughout the whole world. However, they are evolving towards thirdgeneration (3G) systems because of the demands imposed by increasing mobile traffic and the emergence of new type of services. The new systems, such as HSCSD (High Speed Circuit Switched Data), GPRS (General Packet Radio Service), and IS-95B, are commonly referred as generation 2.5 (2.5G). HSCSD, GPRS and EDGE are all based on the original GSM system. HSCSD is the first enhancement of the GSM air interface: it bundles GSM timeslots to give a theoretical maximum data rate of 57.6 Kbit/s (bundling 4´14.4 Kbit/s full rate time-slots). HSCSD provides both symmetric and asymmetric services and it is relatively easy to deploy. However, HSCSD is not easy to price competitively since each timeslot is effectively a GSM channel.

Following HSCSD, GPRS is the next step of the evolution of the GSM air interface. Other than bundling timeslots, 4 new channel coding schemes are proposed. GPRS provides "always on" packet switched services with bandwidth only being used when needed. Therefore, GPRS enables GSM with Internet access at high spectrum efficiency by sharing time slots between different users. Theoretically, GPRS can support data rate up to 160 Kbit/s (current commercial GPRS provides 40 Kbit/s).

Deploying GPRS is not as simple as HSCSD because the core network needs to be upgraded as well. EDGE uses the GSM radio structure and TDMA framing but with a new modulation scheme, 8QPSK, instead of GMSK, thereby increasing by three times the GSM throughput using the same bandwidth. EDGE in combination with GPRS will deliver single user data rates of up to 384 Kbit/s. For more details on GSM phase 2+and on GSM's evolution towards 3G systems.

2.1.3 Third-generation mobile systems and beyond

The massive success of 2G technologies is pushing mobile networks to growextremely fast as ever-growing mobile traffic puts a lot of pressure on networkcapacity. In addition, the current strong drive towards new applications, such aswireless Internet access and video telephony, has generated a need for a universalstandard at higher user bitrates: 3G.

2.1.4 Fourth-Generation (4G) Systems

With the completion of many aspects of thestandardization of 3G systems, attention has now focused on the definition and standardization of 4G technologies. The influence of the Internet will have a significant bearing on 4G capabilities, as operators move towards an all IPenvironment. In this scenario, the legacy of 2G technologies, in particular the CN and radio interface solutions will diminish, although perhaps not to the extent to which 1G influenced 3G. As technology continues to develop and evolve, the ability to deliver faster, broadband services at a premium QoS will be implicit requirements of next-generation technologies.

While 3G can rightly claim to have brought forward the convergence of mobile and Internet technologies, 4G will herald the convergence of fixed, broadcast and mobile technologies. The possibility of converging UMTS and digital video broadcasting (DVB) and digital audio broadcasting (DAB) is an area for further investigation. Such a solution would allow broadcast quality television to be beamed directly to the mobile user, for example. It is in such an environment that cellular, cordless, WLL and satellite technologies will combine to open up new possibilities for the telecommunications sector.

2.2 Integrated Systems

Integrated system divides into three categories:

1) Integrated Wireless System.
2) Integrated Terrestrial System.
3) Integrated Terrestrial and Satellite System.

2.2.1 Integrated Wireless Systems

Integrated wireless systems are exemplified by integrated cordless and cellular systems,integrated cellular systems, and integrated terrestrial and satellite systems.

Such integrated systems combine the features of individual wireless systems to achievethe goals of improved mobility, low cost, etc.

2.2.2 Integrated Terrestrial Systems

Terrestrial intersystem handover may be between two cellular systems or between acellular system and a cordless telephone system. Examples of systems that needintersystem handovers include GSM-DECT, CDMA in macro cells, and TDMA in microcells.

When a call initiated in a cellular system controlled by an MSC enters a systemcontrolled by another MSC, intersystem handover is required to continue the call.

In this case, one MSC makes a handover request to another MSC to save the call. TheMSCs need to have software for intersystem handover if intersystem handover is to beimplemented. Compatibility between the concerned MSCs should be considered, too.There are several possible outcomes of an intersystem handover: (i) a longdistance call becomes a local call when an MS becomes a roamer; (ii) a long distancecall becomes a local call when a roamer becomes a home mobile unit; (ii) a local callbecomes a long distance call when a home mobile unit becomes a roamer; (iv) a localcall becomes a long-distance call while a roamer becomes a home mobile unit.There is a growing trend toward service portability across dissimilar systems,such as GSM and DECT. For example, it is nice to have an intersystem handoverbetween the cordless and cellular coverage. Cost effective handover algorithms forsuch scenarios represent a significant research area. This paper outlines differentapproaches to achieving intersystem handover. Simulation results are presented forhandover between GSM and DECT/WACS. It is shown that a minor adjustment tothe DECT specification can greatly simplify the implementation of an MS capable ofan intersystem handover between GSM and DECT.

2.2.3 Integrated Terrestrial and Satellite System

In an integrated cellular/satellite system, advantages of satellites and cellular systemscan be combined. Satellites can provide wide area coverage, completion of coverage,immediate service, and additional capacity (by handling overflow traffic). A cellularsystem can provide a high capacity economical system. In particular, the procedures of the GSMare examined for their application to the integrated systems.

The future public land mobile telecommunication system (FPLMTS) will providea personal telephone system that enables a person with a handheld terminal toreach anywhere in the world. The FPLMTS will include low-earth-orbit (LEO)or geostationary-earth-orbit (GEO) satellites as well as terrestrial cellular systems.When an MS is inside the coverage area of a terrestrial cellular system, the BS will actas a relay station and provide a link between the MS and the satellite. When an MSis outside the terrestrial system coverage area, it will have a direct communicationlink with the satellite. Different issues such as system architecture,call handling,performance analysis of the access, and transmission protocols are discussed in. The two handover scenarios in an integrated system are described below.

- **Handover from the Land Mobile Satellite System (LMSS) to the TerrestrialSystem.** While operating, the MS monitors the satellite link and evaluatesthe link performance. The RSSs are averaged (e.g., over a thirty second time period)to minimize signal strength variations. If the RSS falls below a certain thresholdN consecutive times (e.g., N=3), the MS begins measuring RSS from the terrestrialcellular system. If the terrestrial signals are strong enough, handover is made to theterrestrial system, provided that the terrestrial system can serve the BS.

- **Handover from the Terrestrial System to the Land Mobile SatelliteSystem (LMSS).** When an MS is getting service from the terrestrial system, theBS sends an acknowledge request at predefined intervals to ensure that the MS isstill inside the coverage area. If an acknowledge request signal from the MS is notreceived at the BS for N consecutive times, it is handed off to LMSS. The lowest levelin the hierarchy is formed by microcells. Macro cells overlay microcells and formthe middle level in the hierarchy. Satellite beams overlay macro cells and constitutethe topmost hierarchy level. Two types of subscribers are considered, satellite-onlysubscribers and cellular/satellite dual subscribers. Call attempts from satellite-onlysubscribers are served by satellite systems, while call attempts from dual subscribersare first directed to the serving terrestrial systems with the satellites taking care ofthe overflow traffic. An analytical model for tele-traffic performance is developed, andtermination probabilities are evaluated for low speed and high speed users.

2.3 Basic Principles of Satellite Communication

Satellite communication is one of the most impressive spinoffs from the space programs and has made a major contribution to the pattern of international communications. A communication satellite is basically an electronic communication package placed in orbit whose prime objective is to initiate or assist communication transmission of information or message from one point to another through space. The information transferred most often corresponds to voice (telephone), video (television), and digital data.

Communication involves the transfer of information between a source and a user. An obvious example of information transfer is through terrestrial media, through the use of wire lines, coaxial cables, optical fibers, or a combination of these media. Communication satellites may involve other important communication subsystems as well. In this instance, the satellites need to be monitored for position location in order to instantaneously return an upwardly transmitting (uplink) ranging waveform for tracking from an earth terminal (or station). The term earth terminal refers collectively to the terrestrial equipment complex concerned with transmitting signals to and receiving signals from the satellite. The earth terminal configurations vary widely with various types of systems and terminal sizes. An earth terminal can be fixed and mobile landbased, sea-based, or airborne. Fixed terminals, used in military and commercial systems, are large and may incorporate network control center functions.

Transportable terminals are movable but are intended to operate from a fixed location, that is, a spot that does not move. Mobile terminals operate while in motion; examples are those on commercial and navy ships as well as those on aircraft.

2.4 Types of satellite

There are three types of satellite:

2.4.1 High elliptical orbiting satellite (HEO)

An HEO satellite is a specialized orbit in which a satellite continuously swings very close to the earth, loops out into space, and then repeats its swing by the earth. It is an elliptical orbit approximately 18,000 to 35,000 km above the earth’s surface, not necessarily above the equator.

HEOs are designed to give better coverage to countries with higher northern or southern latitudes. Systems can be designed so that the apogee is arranged to provide continuous coverage in a particular area. By definition, an apogee is the highest altitude point of the orbit, that is, the point in the orbit where the satellite is farthest from the earth.

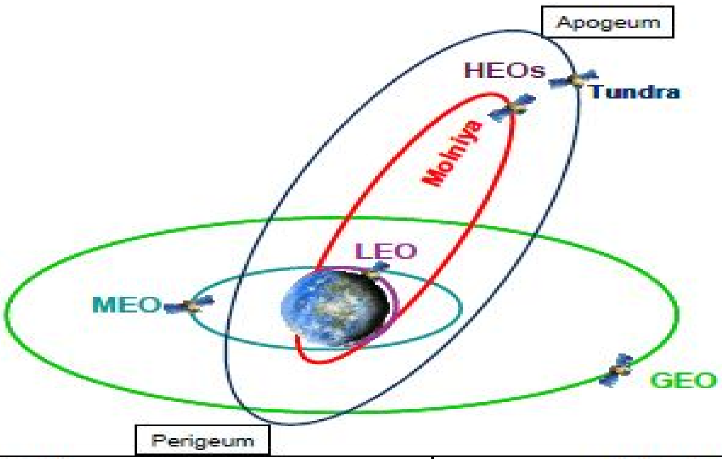
2.4.2 Middle-earth orbiting satellite (MEO)

An MEO is a circular orbit, orbiting approximately 8,000 to 18,000 km above the earth's surface, again not necessarily above the equator. An MEO satellite is a compromise between the lower orbits and the geosynchronous orbits. MEO system design involves more delays and higher power levels thansatellites in the lower orbits. However, it requires fewer satellites to achieve the same coverage.

2.4.3 Low-earth orbiting satellite (LEO)

LEO satellites orbit the earth in grids that stretch approximately 160 to 1,600 km above the earth's surface. These satellites are small, are easy to launch, and lend themselves to mass production techniques. A network of LEO satellites typically has the capacity to carry vast amounts of facsimile, electronic mail, batch file, and broadcast data at great speed and communicate to end users through terrestrial links on ground-based stations.

With advances in technology, it will not be long until utility companies are accessing residential meter readings through an LEO system or transport agencies and police are accessing vehicle plates, monitoring traffic flow, and measuring truck weights through an LEO system, types of satellites orbiting shown in figure 2-2.



Orbit	Height [km]
LEO: Low Earth Orbit	200 – 2.000
MEO: Medium Earth Orbit	2.000-GEO; normally: 10.000-20.000
GEO: Geostationary Orbit	35.786
HEO: High Elliptical Orbit	500-50.000

Figure 2-2: Satellite Orbiting

2.5 Introduction to Handover

Some of the terminology used in cellular communications is explained next [5].

- **Mobile Station (MS).** The mobile station is intended for use while in motionat an unspecified location.
- **Base Station (BS).** The base station is a fixed station used for radio communicationwith MSs.
- **Mobile Switching Center (MSC).** The mobile switching center coordinatesthe routing of calls in a large service area.
- **Forward Channel.** The forward channel is the radio channel used for thetransmission of information from the base station to the mobile station. It isalso known as the downlink.

- **Reverse Channel.** The reverse channel is the radio channel used for thetransmission of information from the mobile station to the base station. It isalso known as the uplink.
- **Handoff.** Handoffis a process of transferring a mobile station from one basestation or channel to another. The channel change due to handoff occursthrough a time slot for time division multiple access (TDMA), frequency bandfor frequency division multiple access (FDMA), and codeword for code divisionmultiple access (CDMA) systems [9].
- **Channel Interference (CCI).** The co_channel interference is caused whenthe desired signal and another signal in some remote cell are using the samefrequency or channel.

2.5.1 Handover Process

Handover is the basic criteria of mobility of the user in cellular networks. The handover is to provide the link of mobile services to a user moving over cell boundaries in a cellular communication network. During an ongoing communication of a user when the user crosses the cell boundary it is better to use the radio resources of the new cell also called the target cell because the strength of signal in the preceding cell is weaker than the next one that is the target-cell. Now the whole process of the terminating of connection of user from previous cell and establishing the new connection to target cell is called handover.

In other words handover can be defined as the transformation of user connection from one radio channel to another radio channel. The main purpose of handover is to maintain the ongoing call of user during its mobility because the mobility of the user may be in high speed. In this situation sometimes the call may drop. Also in the case of multiple users with ongoing calls changing the cell area the network needs to change the frequency of an ongoing call.

2.5.2 Handover Requirements

There are four possible situations when handover is required to a user

- When MS moves from one cell to another.
- In overlapping of adjacent cells.
- MS experiencing interference from adjacent cell and fast motion of MS.
- Less Power Emission.

2.5.3 Handover Categories

There are different types of handovers

- **Hard handover**

Hard handover is the type of handover where the old connection is break before the new one is established between user and radio network. Hard handover is known as the break before the make. This type of handover is used in the GSM cellular systems where each cell was assigned a different frequency. When a user want to establish a new call first the old one will be disconnected before the new connection established at different frequency in the desired cell. The hard handover uses simple algorithm. When the strength of signal in new cell is greater than that of previous cell then hard handover is used by mobile station with a given threshold.

Advantages

- In the hard handover one call uses only one channel at any instant of the time.
- In the hard handover the phone hardware does not require to accomplish to receive two or more parallel channels.

Disadvantages

- The main disadvantage of the hard handover is the call may be terminated during the handover process.

- **Soft handover**

Soft Handover is that in which channel in the source cell is retained and used for a while in parallel with the channel in the target cell. In this scenario before the connection to the source is broken the connection to the target is made. This handover is called make before break.

Advantages

- In the Soft handover source cell connection is broken when the reliable connection is established with the target cell.
- In the Soft handover in multiple cells channels are at the same time maintained, when the channels are interfered then call could be fail.

Disadvantages

- More complex hardware will be needed in order to continue the processing in several parallel channels.
- In soft handover in single call several parallel channels are used.

- **Softer handover**

The softer handover is a special type of soft handover in which all the radio links belong to same node that is the coverage area of correlated base stations from which several cells can be served, types of handover shown in figure 2-3.

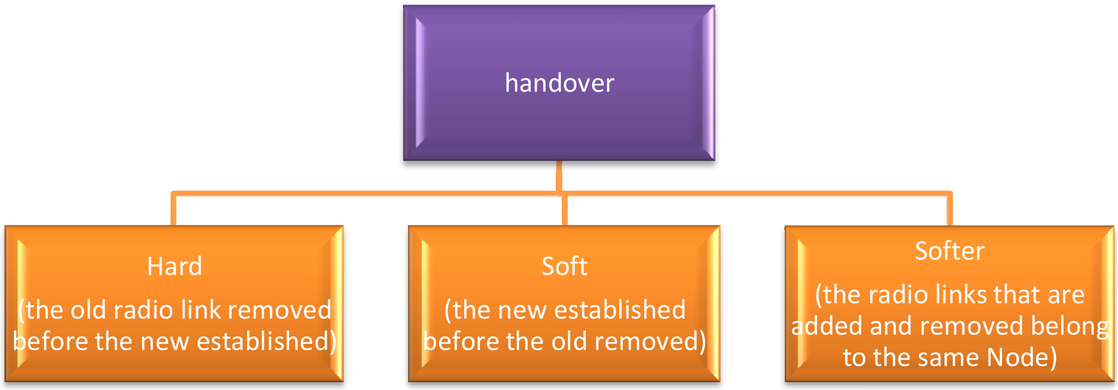


Figure 2-3: Types of Handover

2.5.4 Objectives of Handover

Handover can be described in the following ways:

- During the mobility of user across the boundaries of cellular network the guarantee of the network service continuity.
- To maintain the required quality of service.
- The roaming between different networks.
- Load balancing between the cells.

- To keep connected the mobiles with strong base stations to reduce interference level.

2.6 Handover in LEO Satellite Systems

To support continuous communication over a LEO satellite system, we may need to change one or more links as well as the IP address of the communication endpoints. Thus, both link layer and higher layer handovers may be required for satellite networking. Handovers in satellite networks can be broadly classified as:

2.6.1 Link Layer Handover

Link layer handover occurs when we have to change one or more links between the communication endpoints due to dynamic connectivity patterns of LEO satellites. It can be further classified as:

- **Spot-beam Handover:** When the end point users cross the boundary between the neighboring spot-beams of a satellite, an intra_satellite or spot-beam handover occurs. Since the coverage area of a spot-beam is relatively small, spot-beam handovers are more frequent (every 1-2 minutes) [1].
- **Satellite Handover:** When the existing connection of one satellite with the end user's attachment point is transferred to another satellite, an intersatellite handover occurs.
- **ISL Handover:** This type of handover happens when a LEO satellite passes over the polar area. Due to the change of connectivity patterns in neighboring satellites, the inter-satellite links (ISL) have to be switched off temporarily near the polar areas. Then the ongoing connections using these ISL links have to be rerouted, causing ISL handovers.

The performance of different link layer handover schemes can be evaluated using two classic connection level QoS criteria [13]:

- **call blocking probability (P_b),** the probability of a new call being blocked during handover.
- **forced termination probability (P_f),** the probability of a handover call being dropped during handover.

There is a tradeoff between P_b and Pf in different handover schemes. The priority can be given via different treatments of new and handover calls to decrease handover call blocking [1].

2.6.2 Network Layer Handover

When one of the communication endpoints (either satellite or user end) changes its IP address due to the change of coverage area of the satellite or mobility of the user terminal, a network or higher layer handover is needed to migrate the existing connections of higher level protocols (TCP, UDP , SCTP, etc.) to the new IP address. This is referred to as Network or higher layer Handover. Three different schemes can be used during this kind of handover [4]:

- **Hard handover schemes**: In these schemes, the current link is released before the next link is established.
- **Soft handover schemes**: In soft handover schemes, the current link will not be released until the next connection is established.
- **Signaling Diversity schemes**: Similar to soft handover. Only exception is that, in signaling diversity schemes, signaling flows through both old and new link and the user data goes through the old link during handover [4].

Among all the link layer handovers, spot-beam handover issues have been studied in depth in the literature, as it is the most frequent link handover experienced in LEO systems. The network layer handover has also recently received a lot of attention from the space network community. Therefore, this paper restricts itself to the classification and comparison of *spot-beam* handover and *network layer* handover schemes.

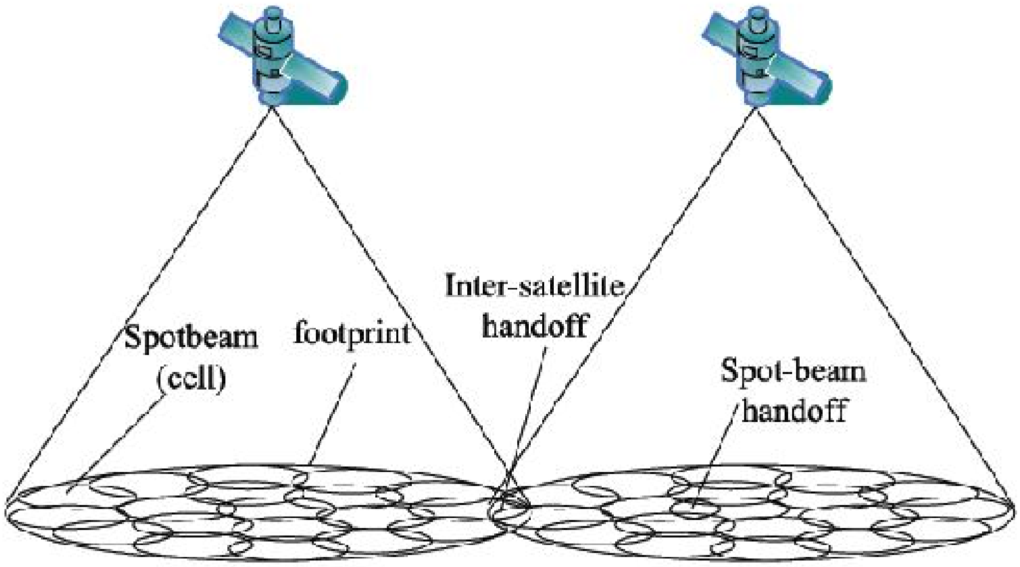


Figure 2-4:Scenes of handoff

2.7 Spotbeam Handover

Dividing the footprint of an individual satellite into smaller cells or spot-beams result in better frequency utilization through the use of identical frequencies in non-adjacent spot-beams which are geographically well separated to limit interference [3]. To ensure uninterrupted ongoing communications, a current communication link should be handed off to the next spot-beam if needed. A spot-beam handover involves the release of the communication link between the user and the current spot-beam and acquiring a new link from the next spot-beam to continue the call. Since both spot-beams are served by the same satellite, no other satellite is involved in the handover process, spot beam handover scenario shown in figure 2-5.

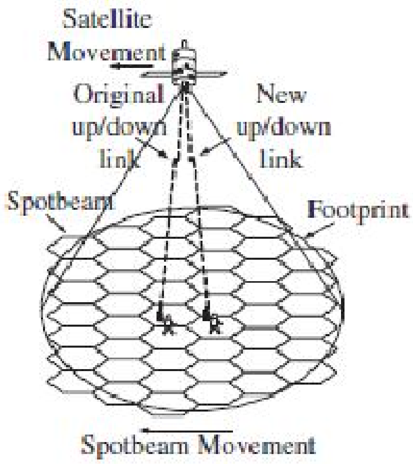


Figure 2-5 Spotbeam handover scenario

Due to small spotbeams and high satellite speed, spot-beam handovers are the most common type of handoversexperienced in LEO satellite systems [1]. We can consideruser mobility negligible compared to high satellite speed.As a result, the deterministic and constant movement of thesatellites makes the solving of the spot-beam handover problemseasier.

During the handover process, if a new link orchannel cannot be found in the next spot-beam, the ongoingcall should be dropped or blocked. From the user viewpoint,the interruption of a call is less desirable than the blocking of a newly arrived call [1]. It will be the best for a user if handovers can be guaranteed, ensuring smooth ongoing calls.Again, the selection of a suitable policy in resource management(channel allocation) can ensure new channel availabilityduring handover. Thus, the channel allocation strategiesand the handover guarantee are the prime issues in managinghandover requests.

2.8 Spotbeam Handover Classifications

To solve spot-beam handover problem, several handoverpolicies/schemes are proposed in the literature. We can classify the spot-beam handover schemes according to two differentcriteria: (a) channel allocation strategies, and (b) handoverguarantee.

2.8.1 Classification based on Channel AllocationStrategies

Various channel allocation strategies can be used to assign a channel to a call. Handover requests can also be considered a transferred call for the next cell, requiring allocationof a channel. Based on channel allocation strategies,handover schemes can be divided into three broad categories[10] as follows: (a) Fixed Channel Allocation (FCA) based handover schemes, (b) Dynamic Channel Allocation (DCA) based handover schemes, and (c) Adaptive Dynamic ChannelAllocation (ADCA) based handover schemes. Table [1] comparesdifferent channel allocation schemes based on severallink layer QoS criteria.

- **FCA based Handover Schemes**

In FCA schemes, a set of channels is permanently assignedto each cell, according to frequency reuse distance [10]. A handover call can only be given a channel if any channel belongingto the set of the cell is available. If no channel isavailable, the call is blocked or, in the worst case, dropped.Fixed channel allocation schemes have a very simple implementation due to fixed predefined channel distribution [10].

An interesting variation of FCA based handover scheme isChannel Sharing Handover [8]. Channel Sharing Handoveruses a channel allocation scheme called channel sharing [8],where channels can be shared between adjacent cells. A pair of adjacent cells is called a meta-cell. Two adjacent cells that form a meta-cell are called the component cells [8]. Inchannel sharing scheme, channels are shared between componentcells to carry on the connection during handover. Thisscheme offers a significantly lower call blocking probability(P_b) for the same handover dropping probability (P_f) whencompared to FCA based schemes [8].

- **DCA based Handover Schemes**

DCA based handover schemes use dynamic channel allocation,where channels are grouped together in a *central pool*.Any cell requiring a channel use a channel from the poolsatisfying the channel reuse distance [10]. Allocated channelsare removed from the common channel pool during calltime. When the call is terminated, the channel is transferredto the central pool for future reuse. DCA based schemes provide important advantage of coping up with traffic variations and overload conditions in different cells. This adaptabilityof DCA schemes makes it a fundamental channel allocationstrategy in third generation cellular networks. It is concludedthat there is a reduction of$P_b$and$P_f$in DCA compared to
FCA based schemes under same conditions.

- **ADCA based Handover Schemes**

Adaptive Dynamic Channel Allocation (ADCA) is an extensionof DCA scheme. It uses guard channelduring handover (Handover with Guard Channel HG). A handover scheme with guardchannel technique has to deal with the tradeoff between the number of guard channels and the number of normal channels. Excessive guard channels will create new call blocking,and fewer guard channels may block handover calls. Hence,ADCA keeps track of the current traffic load, and dynamicallyadapts the optimal number of guard channels according to user location information [3]. ADCA thus tries to makeappropriate use of the guard channels. Cho et al. [3] proposeda new connection admission control scheme based onADCA, called *Geographical Connection Admission*

Control(GCAC), for LEO satellites to limit the handover blockingprobability.

Table 2-1: Comparison among channel allocation schemes

Criteria	FCA	DCA	ADCA
Complexity	For uniform traffic conditions, complexity is low	High	High
P_b	High	Low	Low
P_f	High	Low	Low
Non-uniform Traffic conditions	Complex network planning required for non-uniform traffic conditions	Network planning always same	Network planning always same
Frequency reuse/Resource management	No	Yes	Yes

2.8.2 Classification based on Handover Guarantee

A number of handover schemes provide guaranteed handoverto prevent calls from being blocked or dropped duringhandover. Other schemes try to ensure best service by prioritizinghandover over the new calls, but do not ensure anyhandover guarantee. Based on handover guarantee, handoverschemes can be classified as: (a) Guaranteed Handover (GH)schemes, and (b) Prioritized Handover schemes.

I. Guaranteed Handover Schemes

In a guaranteed handover (GH) scheme, a new call is assigneda channel only if there is an available channel simultaneouslyin the current cell and the next transit cell. If suchchannels cannot be found immediately, the call is blocked. As the name indicates, this scheme guarantees each handover to be successful. Maral et al. [12] proposed a guaranteed handover scheme. In that scheme, when the first handover occurs, new channel reservation request will be issued to thenext candidate transit cell. If all the channels in the candidatetransit cell are busy, the handover request is queued ina FIFO queue until the next handover. Thus, this schemeprovides almost zero $P_f$while the value of $P_b$is unacceptablyhigh. This is due to the early channel reservation (alsoknown as channel locking in GH) for a call which is still nottransferred to the cell, exhibiting bad resource management.

To improve resource allocation, a few modified GH schemes are proposed: (a) Elastic Handover Scheme, (b) TCRA Handover Scheme, and (c) DDBHP Scheme.

- **Elastic Handover Scheme:** The elastic handover scheme is based on Elastic Channel Locking (ECL) scheme [6]. The idea behind the ECL scheme is that an entering call does not issue a channel locking request to the next cell immediately; instead it postpones the request for a period of time until *Ta* [6]. The time *Ta* is decided by the QoS requirement for handover failure probability.
- **TCRA based Handover Scheme:** Boukhatem et al. [2] proposed a Time based Channel Reservation Algorithm (TCRA) to improve GH performance and resource utilization. TCRA locks a channel in the next candidate cell with the cell movement. TCRA is a variation of ECL except that the time instant to send the channel reservation request (*Ta* in ECL) is calculated using the estimated user location in the current cell, instead of the QoS parameters in ECL.
- **Dynamic Doppler Based Handover Prioritization (DDBHP) Scheme:** DDBHP is yet another variation ofGH scheme proposed by Papapetrou et al. [13]. This methoduses Doppler Effect in order to determine the terminallocation, and to reserve channels at the estimated time in thenext servicing cell. The system must reserve channel for thenext cell in the corresponding time interval, called

handoverthreshold (ttH) [13]. Clearly, different values of ttHwillprovide different level of service [13].

Table 2-2: Comparison among Guaranteed Handover (GH) schemes

Criteria	Elastic	TCRA	DDBHP
Degree of guarantee	Varies with T_a	Varies with T_a	Varies with T_a
P_b	Increases if T_a decreases	Depends on number of users in a predefined area	Depends on T_a
P_f	Decreases if T_a increases	Null	Practically zero
T_a selection criteria	QoS requirement of handover	Expected crossing time of the user in the next cell	Doppler effect

II. Prioritized Handover Schemes

Probability of handover failure is a common criterion forperformance evaluation of handovers in satellite networks. In non-prioritized schemes, handover requests are treatedequally as new calls, thereby increasing the probability ofcall dropping during handover [10]. As discussed in Sec. 3,ongoing call dropping is less desirable than new call blocking from user viewpoint. Thus, handover prioritization schemeshave been proposed to decrease handover failure at the expenseof increased call blocking [10]. These prioritized handovertechniques can be used along with the channel allocationstrategies defined in Sec. 3.1 to increase handover performance.Table 3 compares different prioritized handoverschemes based on $P_b$andP_f. The following are differenthandover prioritization categories:

- **Handover with Guard channel (HG):** HG scheme [7] provides successful handover by reserving a set of channels (either fixed or dynamically adjustable) exclusively forhandovers [10]. This reduces the probability of forced termination of calls during handover, while increasing new call blocking probability as fewer channels are available for new calls. Therefore, an important design issue is carefully choosing the number of guard channels [10].

- **Handover with Queuing (HQ):** HQ scheme takes advantageof the overlapping area between adjacent cells [14] where a mobile host can be served by any of the cells. This makes provision of queuing the handover requests for a certain time period equal to the time of mobile host's existence in the overlapping area [10]. When a new channel becomes available, the cell checks the queue for waiting requests and grants the channel to the longest waiting request. Several schemes, depending on the strategy to order the handover requests in the queue, have been proposed. First in first out (FIFO) scheme [14] is the most common queuing discipline where handover requests are ordered according to their arrival times. A more complex scheme called MBPS (*Measurement Based Priority Scheme*), is based on dynamic priority, where the handover priorities are defined by the power levels of the corresponding calls (received from the satellite) from their current spot-beam [11]. The objective is to first serve the call with the most degraded link. Another alternative priority scheme is called LUI (*Last UsefulInstant*) scheme [14] where a handover request with a longer residual queuing time is queued ahead of other requests.
- **Channel Rearrangement based Handover:** This scheme is only used with dynamic channel allocation schemes [14] and manages handover requests in exactly the same manner as new call attempts. Whenever a call termination occurs in a cell, the scheme performs a channel rearrangement to deallocatethe channel which becomes available in the greatest number of cells.

- **HQ+HG Handover:** HQ+HG scheme takes advantages of both guard channel and queuing schemes.

Table 3-3: Comparison among prioritized handover schemes

Criteria	HQ	HG	Channel Rearrangement	HQ+HG
P_b	Good queueing strategy decreases P_b	Depends on guard channel management	Depends on efficient channel rearrangement	Efficient uses of HQ and HG decrease P_b
P_f	Depends on queueing strategy	Depends on guard channel management	Depends on efficient channel rearrangement	Depends on efficient use of HQ and HG

CHAPTER

THREE

Chapter Three

Physical Model and Surveying

3.1 Introduction

In this chapter we will study the geographical area stretching from (Rofaa) to (Shendi) and our study will focus on the coverage and the attendant the geographic area (24126.482 km^2) andits perimeter is given about (647.358 km) andis an enormous area of population and contain residential streets and traffic and buildings, so we will need three satellites to cover and to ensure a delivery process.

We assume the existence of three satellites to cover the area and each satellite will cover the geographical area of approximately 8045 km^2, and therefore the geographical area will be divided into three regions (x, y, z) is covered by three satellites (a, b, c).This system consists of three satellites and subscriber units (SUs).

This system relates generally to satellite cellular communications and, in particular, to an emergency handoff method of performing emergency handoff from one channel to another channel.

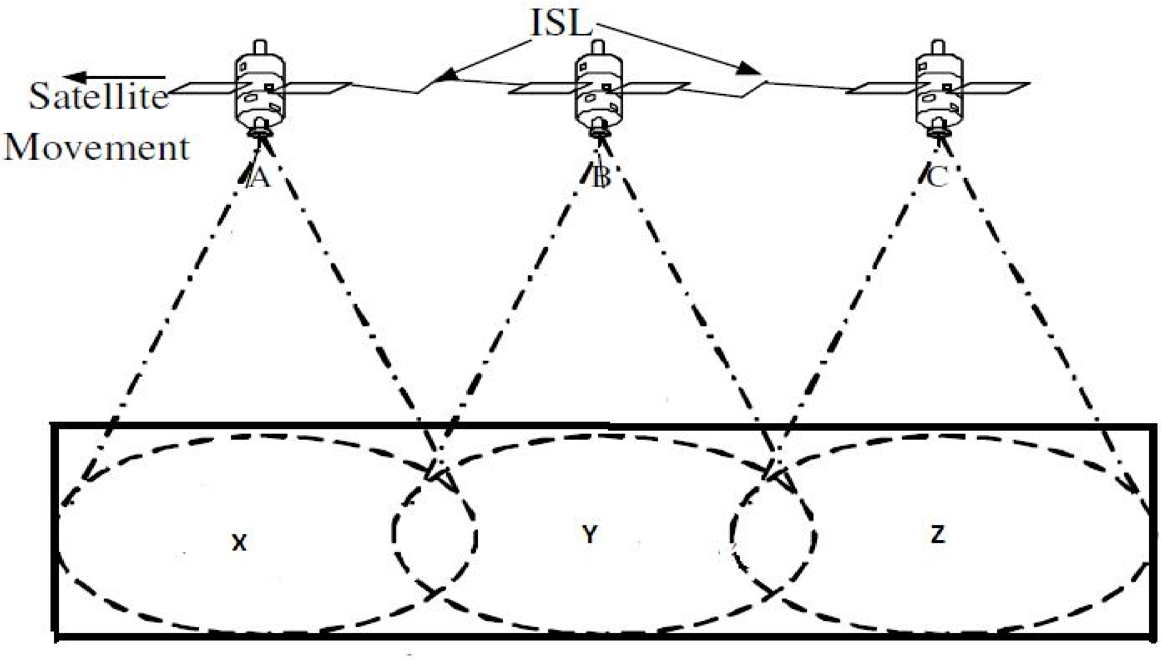


Figure 3-1: Geographical survey

3.2 Background of the System

A cellular communication system projects a number of cells onto the earth at diverse locations. A frequency spectrum is allocated in frequency, time, coding or a combination of these to the cells so that communications occurring in nearby cells use different channels to minimize the chances of interference. Communications taking place in cells located far apart may use the same channels, and the large distance between communications in common channels prevents interference. Over a large pattern of cells, a frequency spectrum is reused as much as possible by distributing common channels over the entire pattern so that only far apart cells reuse the same spectrum. An efficient use of spectrum results with no interference among the different communications.

In an urban environment, movement of a subscriber unit (e.g., a cellular phone) or a satellite can cause an abrupt change in the path loss characteristics, such as losing the signal from the servicing satellite. If a second satellite is in view of the user, the sudden loss of the first satellite will not allow the user to handoff the call to the second satellite. Thus, the call will be dropped or lost.

This abrupt loss of the communication signal can also occur from cell to cell on the same satellite. The fall-off rate of the inner cells of a satellite is such that the subscriber unit may not react fast enough to perform a normal handoff before the path from the original cell degrades to uselessness. Communications can also be lost for some period of time due to environmental conditions. After this period of time, changes in the spatial relationship between the subscriber and the system may make it impossible for the subscriber to perform a normal handoff.

Accordingly, there is a significant need for an emergency handoff method which permits each of the Subscriber Units (SUs) to determine when a new channel is necessary and to select a new channel that will receive its communications.

3.3 Satellite Selection Criteria

Satellite selection criteria should be defined when thereexist overlapping coverage areas among satellites.Three criteria were defined. For the sake of completeness, these criteria are described in brief below.

3.3.1 Maximum Available Capacity Criterion This criterion is based on the rule that the satellite that has the maximum available capacity should be selected. It aims to uniformly distribute the traffic over the LEO satellite network.

3.3.2 **Maximum Service Time Criterion**This criterion is based on the rule that a terminal should be connected to the satellite that provides the maximum serving period. The aim of this criterion is to minimize the number of handovers experienced by a user.

3.3.3 **Minimum Distance Criterion**This criterion is based on the rule that a terminal should be connected to the satellite that offers the highest elevation angle, that is, the closest satellite. This criterion aims to mitigate channel impairments.

3.4 Call Admission Control

A new *Class I* call will be admittedinto the network only if at least the minimum capacity requiredby the source is available in the visible satellite. Concerninguser terminals that are located in the overlapping area thatcontiguous satellites share, they will first check the availablecapacity in the satellite that is indicated by the satelliteselection criterion that is employed for new calls. If they donot manage to reserve the required capacity in that satellite,then the second visible satellite will be checked. The call willbe blocked only if the minimum capacity that is required for this type of service cannot be reserved in one of the visiblesatellites. If a call is admitted into the network, then a handoverrequest is immediately sent to the satellite (or satellites) towhich the call may be handed over. Concerning *Class II* calls,the procedure is slightly different since these calls are subjectto looser QoS constraints. A new *Class II* call is admitted intothe network provided that there exists some residual capacity,even lower than the minimum required capacity, in one of thevisible satellites.At this point we should stress the importance that theknowledge of the terminal’s location has to the proposedtechnique. The satellite should be aware of the terminal’slocation in order to be able to estimate the time instantof the forthcoming handover occurrence and the candidatesatellites for serving the call. A low-complexitytechnique based on the Doppler Effect was employed in orderto estimate the terminal’s position and the time instant of theupcoming handover occurrence. This technique, nevertheless,necessitates satellites with on-board processing capabilities, arequirement that should be met by most of the future satellitenetworks.

3.5 Analysis of the System

1. A method of handing-off a call from a current channel to one of a plurality of available channels in a satellite cellular communication system, the call being between a first subscriber unit SU and a second SU, the current channel being projected onto earth by a first satellite, the available channels being projected onto earth by a second satellite, a third satellite servicing the second SU, the method comprising the steps of:

a) The first SU determining that an emergency handoff is needed, wherein synchronization is not lost.

b) The first SU acquiring an available channel from the available channels and providing a logical channel number to the second satellite.

c) The second satellite creating a new logical channel number.

d) The second satellite receiving a path-end from the first satellite.

e) The second satellite transmitting the new logical channel number to the path-end, the path-end being the third satellite.

f) The third satellite rerouting the call from the first satellite to the second satellite.

g) The third satellite rerouting the call from the first satellite to the second satellite so that the second satellite can redirect the call to the available channel.

2. A method of handing-off a call from a current channel to one of a plurality of available channels in a satellite cellular communication system, the call being between a first subscriber unit (SU) and a second SU, the current channel being projected onto earth by a first satellite, the available channels being projected onto earth by a second satellite, a third satellite servicing the second SU, the method comprising the steps of:

(a) The first SU determining that an emergency handoff is needed, wherein synchronization is not lost.

(b) The first SU identifying an available cell from a list of available cells.

(c) The first SU acquiring an available channel from the available cell.

(d) The second satellite creating a new logical channel number.

(e) The second satellite receiving a path-end from the first satellite.

(f) The second satellite transmitting the new logical channel number to the path-end, the path-end being the third satellite.

(g) The third satellite rerouting the call from the first satellite to the second satellite.

(h) The second satellite redirecting the call to the available channel.

3. A method of handing-off a call from a current channel to one of a plurality of available channels in a satellite cellular communication system, the call being between a first subscriber unit (SU) and a second SU, the current channel being projected onto earth by a first satellite, the available channels being projected onto earth by the first and a second satellite, a third satellite servicing the second SU, the method comprising the steps of:

(a) The first SU determining that an emergency handoff is needed, wherein synchronization is not lost.

(b) The first SU identifying an available cell from a list of available cells.

(c) The first SU acquiring an available channel from the available cell.

(d) The first SU providing a logical channel number to one of the first and second satellites.

(e) The first satellite rerouting the call to the available channel if the logical channel number matches a logical channel number of the first satellite.

(f) The third satellite rerouting the call from the first satellite to the second satellite if the logical channel number does not match a logical channel of the second satellite.

(g) The second satellite redirecting the call to the available channel if the logical channel number does not match the logical channel of the second satellite.

4. A method of handing-off a call from a current channel to one of a plurality of available channels in a satellite cellular communication system, the call being between a first subscriber unit (SU) and a second SU, the current channel being projected onto earth by a first satellite, the available channels being projected onto earth by a second satellite, the second satellite servicing the second SU, the method comprising the steps of:

(a) The first SU determining that an emergency handoff is needed, wherein synchronization is not lost.

(b) The first SU acquiring an available channel from the available channels.

(c) The second satellite determining whether it handled the call before the first SU acquired the available channel.

(d) The second satellite requesting and receiving a path-end from the first satellite.

(e) The second satellite determining that the path-end is the second satellite.

(f) The second satellite rerouting the call to the available channel.

3.6 Problems of the System

There are two major problems faced this system

3.6.1 Handover Request

Each satellite has two queues where handover requests, thatis, capacity reservation requests, are placed. The first queueis named *NR* and contains the requests of *Class I* calls, whilethe second queue, which is called *NQ*, contains the requests of *Class II* calls.

Let us first assume a new *Class I* call that has beenadmitted into the network. Immediately after the admissionof the call the serving satellite derives the time instant of thefirst handover occurrence as well as the potential satellites towhich the call may be handed over. Then, capacity reservationrequests are sent to them. These requests are stored in the *NR*queues of those satellites. Capacity may have beenreserved in both candidate satellites for serving the call. The decision on which of them will serve the call is taken at the time instant of the handover occurrence. Thus, the capacity that has been reserved in the other satellite is then released without being used. In this paper we propose a technique thatrelies on a different approach. Capacity reservation requests are sent to both candidate satellites. Notwithstanding, as soon as capacity has been reserved in one satellite, the capacityreservation request that is stored in the *NR* queue of the othersatellite is deleted. Hence, the proposed scheme does not wastethe limited bandwidth of the satellite channel.In essence, it is highly unlikely that capacity will be available at the sametime instant in both satellites, therefore the employment of asatellite selection criterion for handover calls is not required.In the rare case that capacity is available inboth satellites, the satellite to which the call will be handed over is randomly selected.

As far as the management of *Class II* handover requests isconcerned, the procedure is more or less similar to the onethat is followed for *Class I* handover requests. As soon asa *Class II* call is admitted into the network, or successfullyhanded over to a satellite, the serving satellite estimates thetime instant of the next handover occurrence and derivesthe candidate satellites for relaying the call. Then, capacityreservation requests are sent to them. Each one of the requestsis placed in the *NQ* queue of each satellite. The only differencebetween the two procedures lies in the amount of bandwidththat should be reserved so that the call is not dropped. A *ClassII* call will not be dropped as long as some residual capacity,which can be lower than the minimum capacity that is requiredby the source, has been reserved in a satellite. Evidently, ifcapacity has been reserved in one satellite, then the handover request is removed from the *NQ* queue of the other candidatesatellite.

As mentioned before, *Class I* calls have more stringent QoS requirements than *Class II* calls and thus, priority should be given to requests of *Class I* calls over requests of *Class II* calls. Towards this end, the satellite first serves the requests of the *NR* queue and then the requests that are contained in its *NQ* queue.

3.6.2Handover Failure

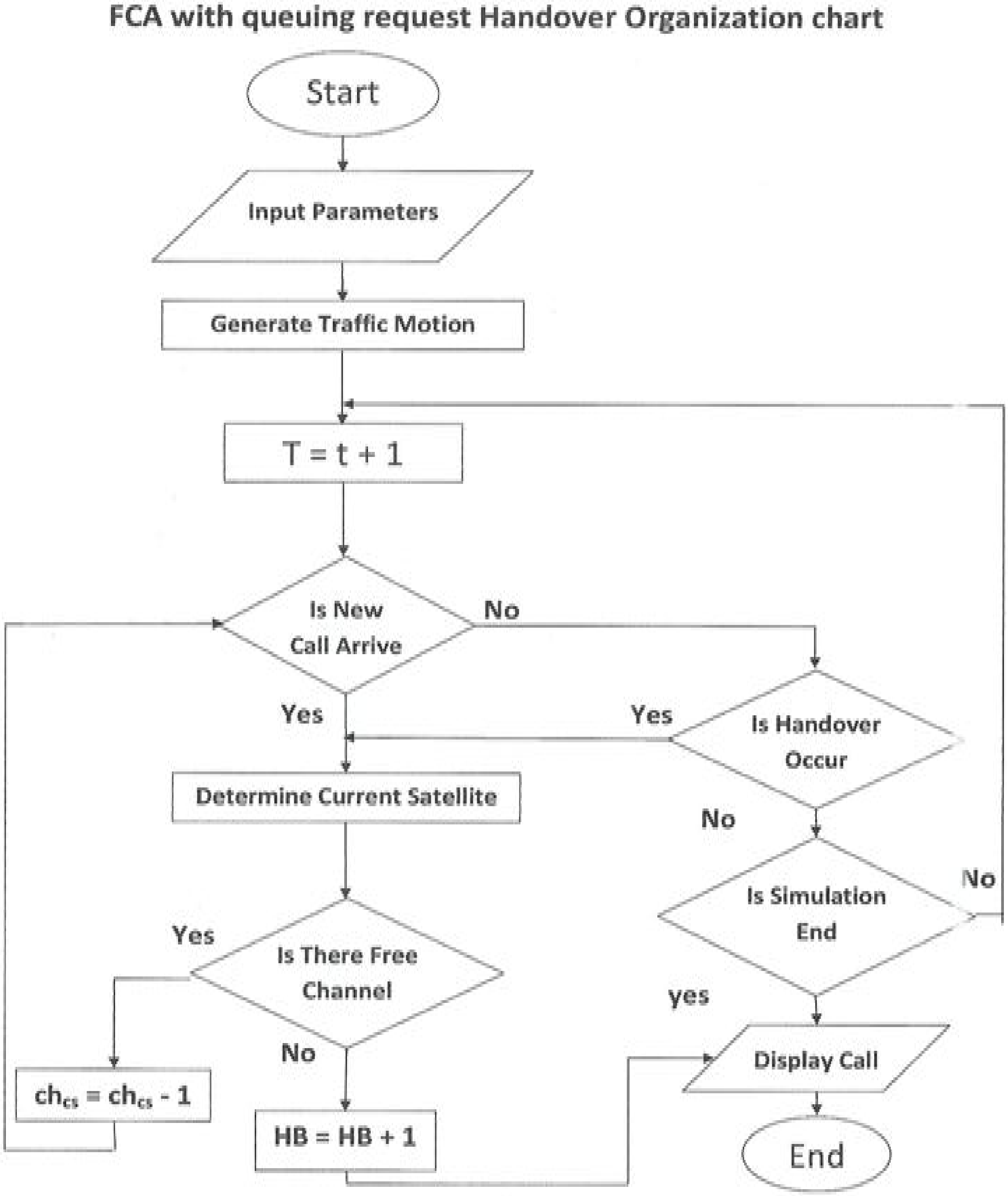
-If handover fails from some few cells to this cell, check the handover data and see whether there is co-channel and co-BSIC problem.

-If handover fails from all other cells to this cell, check the data of thiscell.

-If data cause is ruled out, check the hardware carefully. Check thealarm or perform drive test to locate uplink fault or downlink fault. Check step by step and find out the cause.

To solve this problem we have to:

Register the incoming inter cell handover measurement function and find that the successful rate of handover from all other cells to this cell is low, although it is not always 0 percent. Based on careful data checking, the data of this cell is correct.



Figure(3 – 2):traffic generation and handover request process flow chart.

CHAPTER

FOUR

Chapter Four

Results and Discussions

By using MATLAB language simulation presented in the following figures Using the **Poisson distribution**, this program calculates the **probability of blocking** occurring a given number of times.

We consider that the arrival of new calls forms a Poisson process with an average λ . The intensity of the Poisson process services is μ . The arrivals of handover requests form a Poisson process of average λ_h . If a mobile channel in the cell, the call duration (with mean $1 / \mu$) is equal to the time during which the call is in progress without having under gone a forced termination due to failure of the handover. If a channel has been allocated to a mobile, it will be released at the end of the call is due to a handover to a neighboring cell. So the channel occupation time is the minimum duration of the call.

We found out the handover process results and also calculated the requests of handover and decrease the number of call requests by applying FCA algorithm.

At labmda=10

The Result Became :

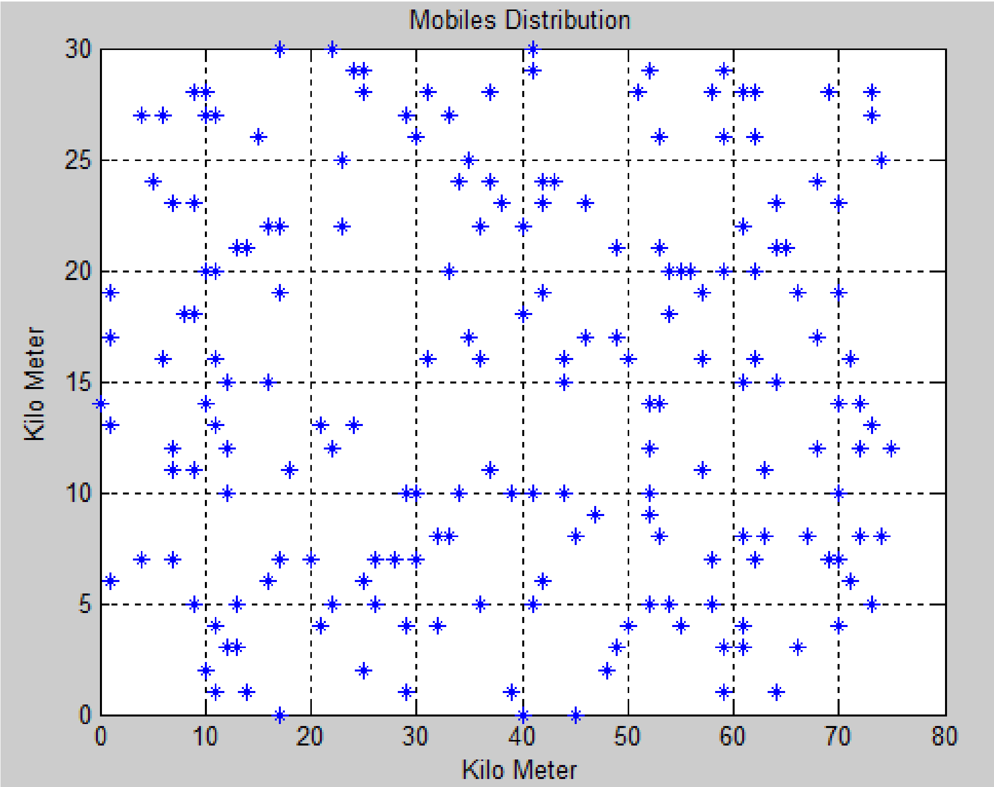


Figure 4-1: Mobile Distribution

This figure shows the mobile distribution in a specific area.

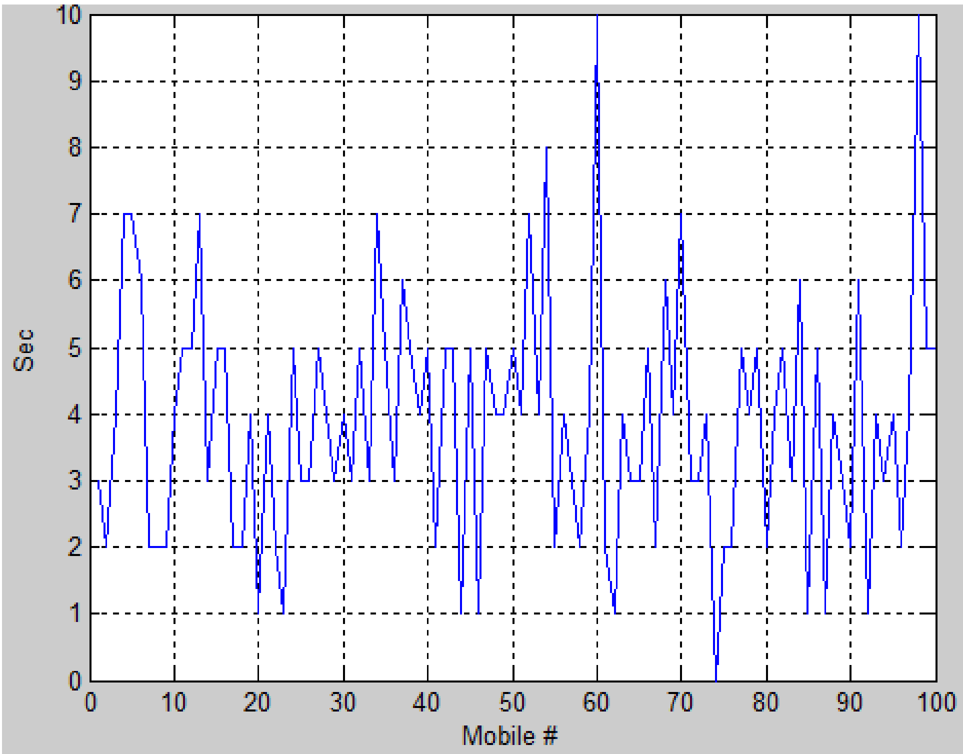


Figure 4-2: Call Arrival

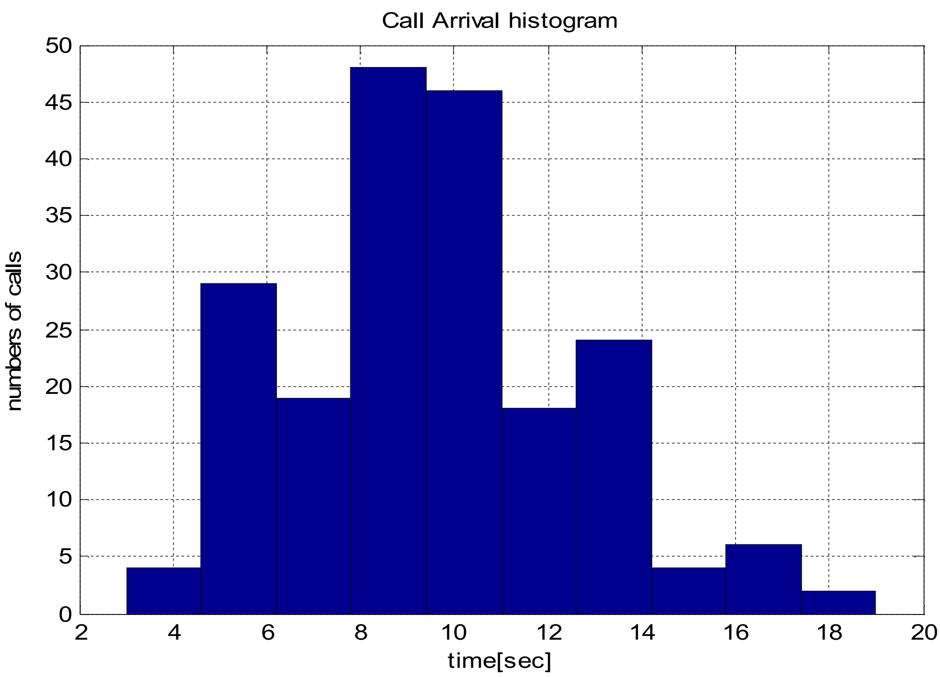


Figure 4-3: Call Arrival Histogram

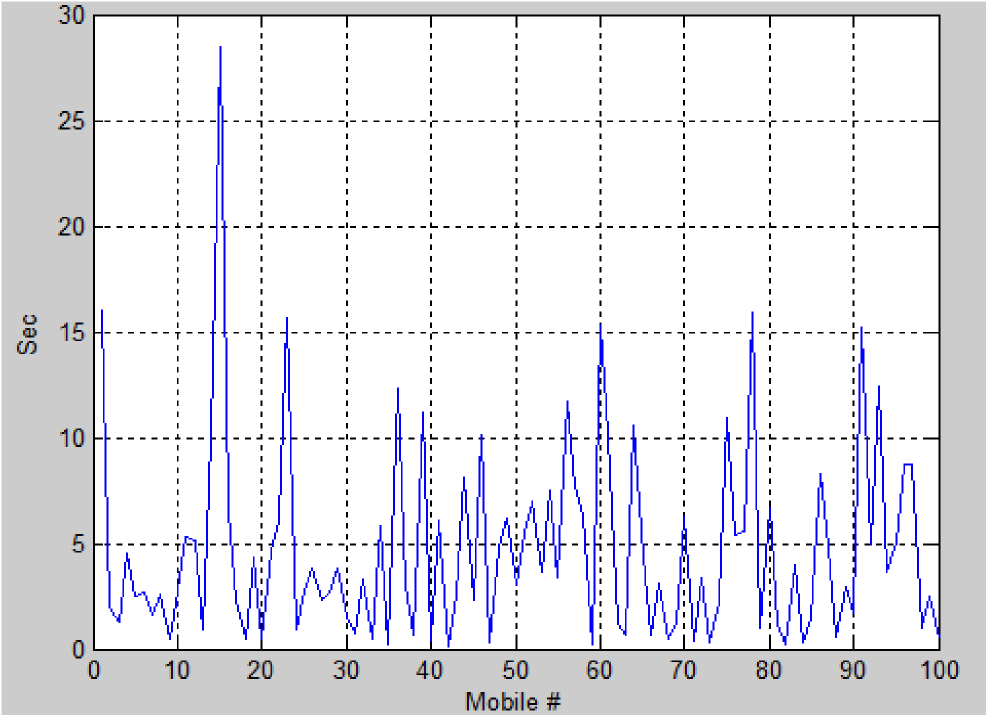


Figure 4-4: Call Duration

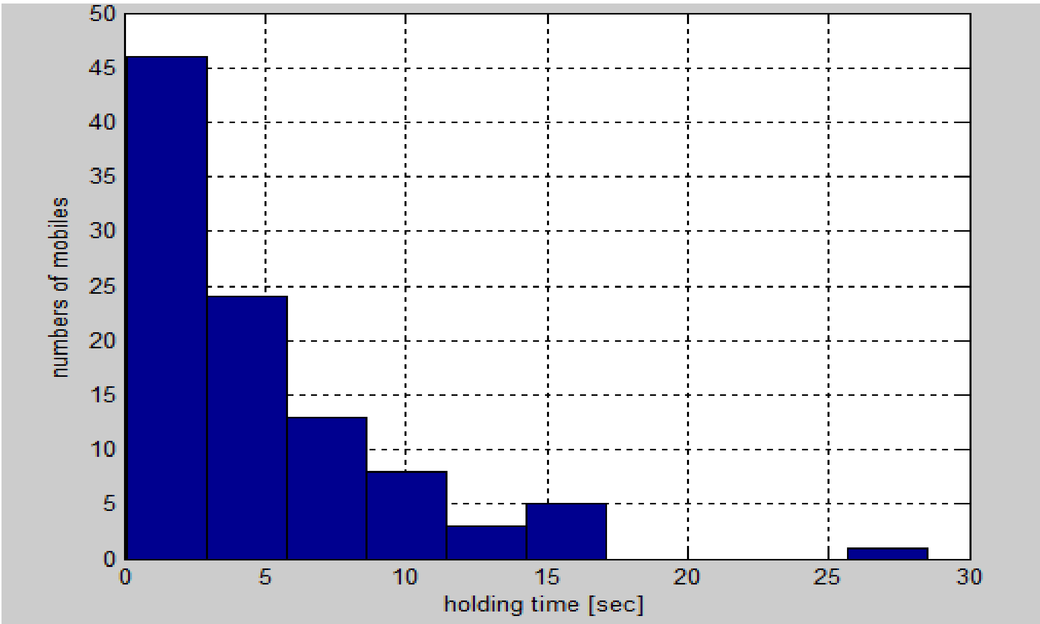


Figure 4-5: Call Duration Histogram

Above figures show the call duration probabilities & histogram.

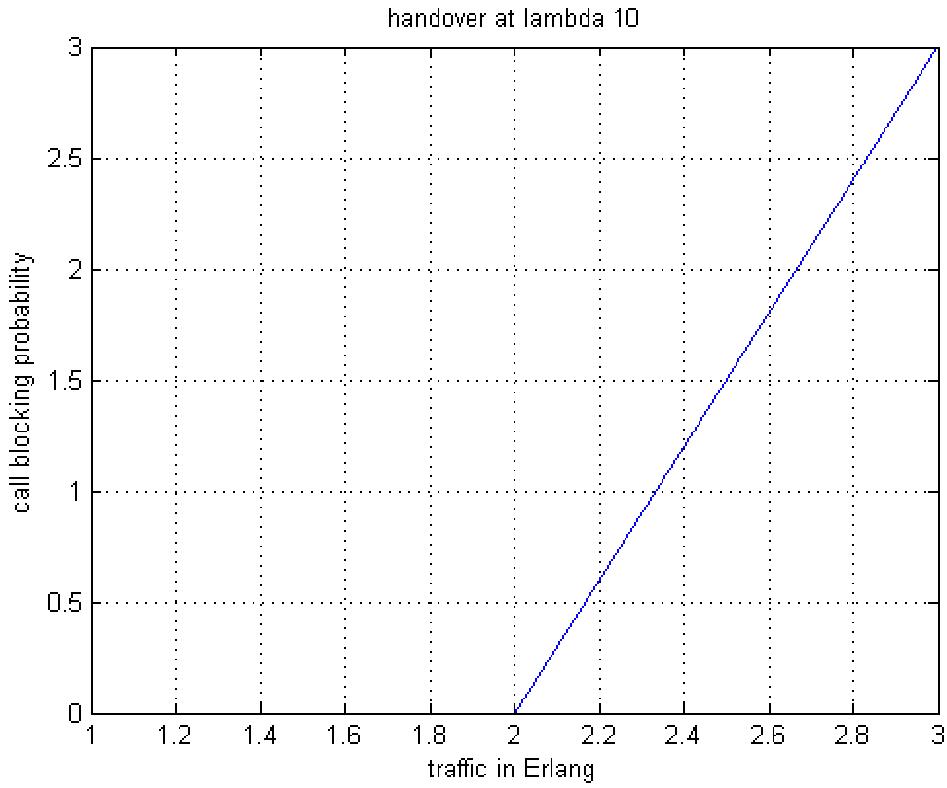


Figure 4-6: Handover

Above figure show the handover process from one satellite to another if the power of the signal of the first satellite is less than specified power.

At labmda=20

The Result Became :

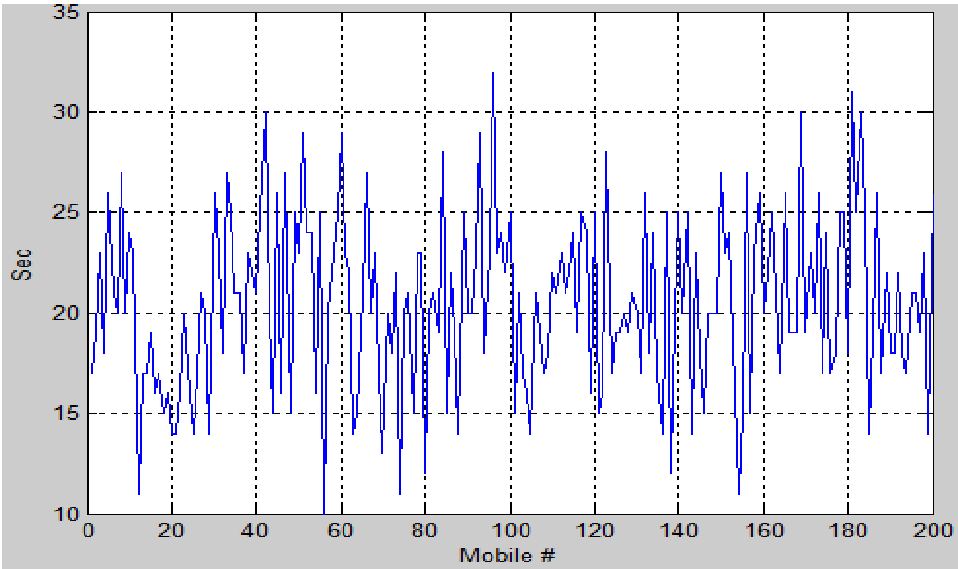


Figure 4-7: call arrival

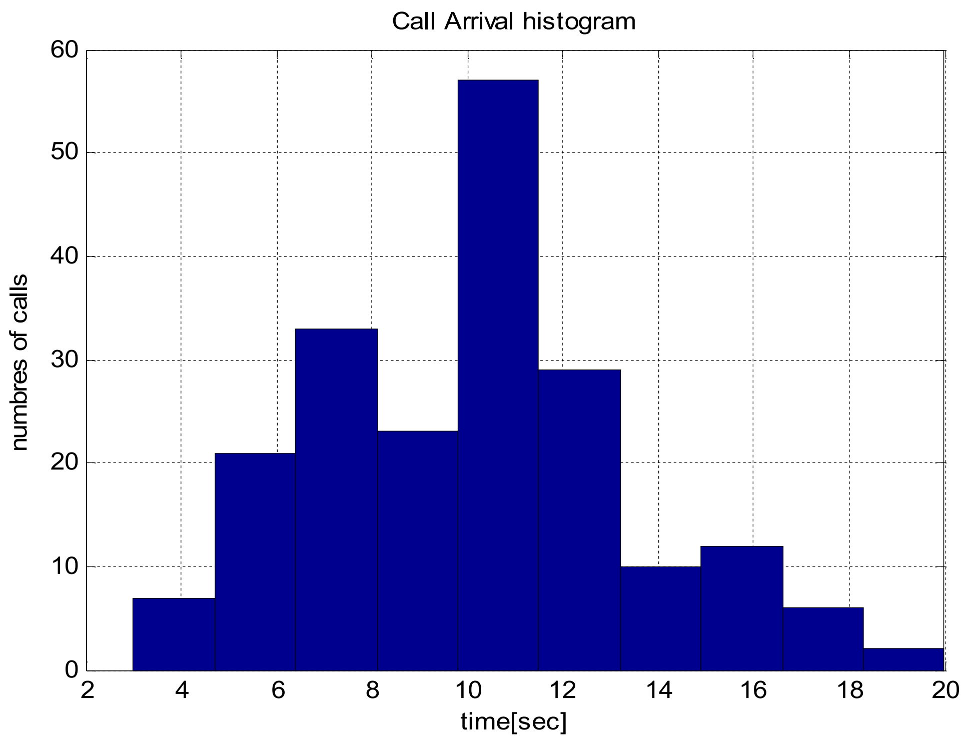


Figure 4-8: Call Arrival Histogram

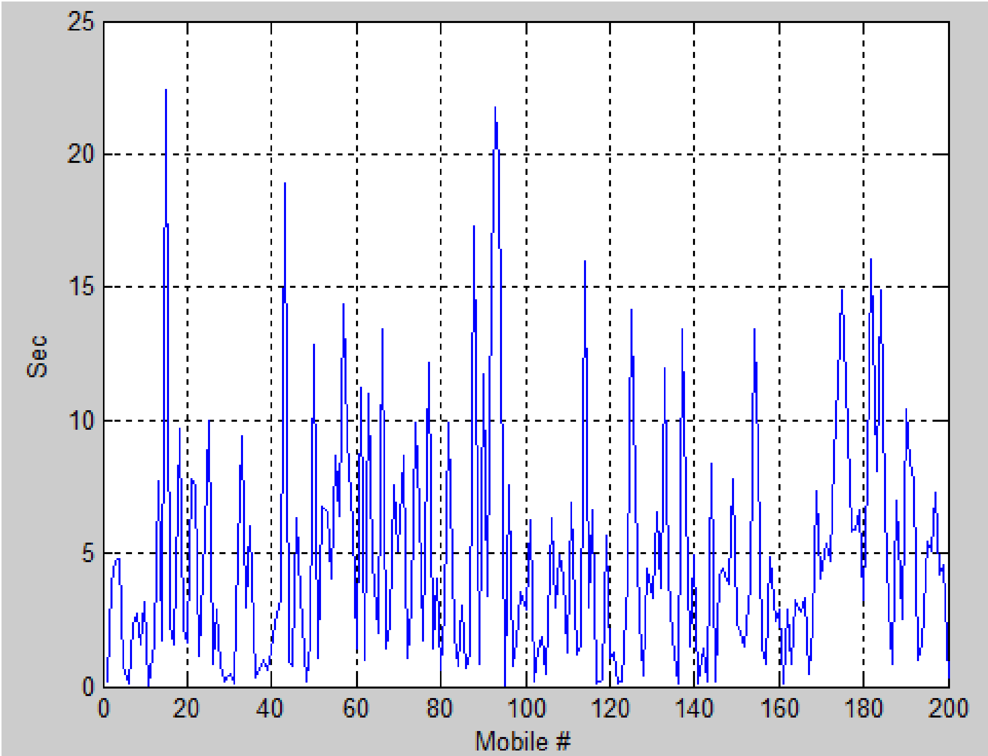


Figure 4-9: Call Duration

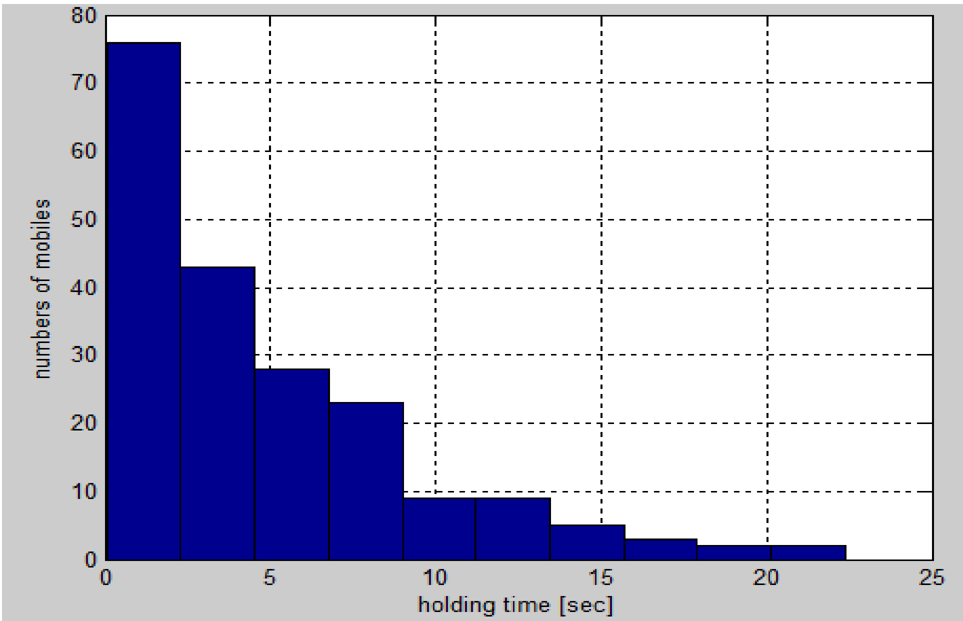


Figure 4-10: Call Duration Histogram

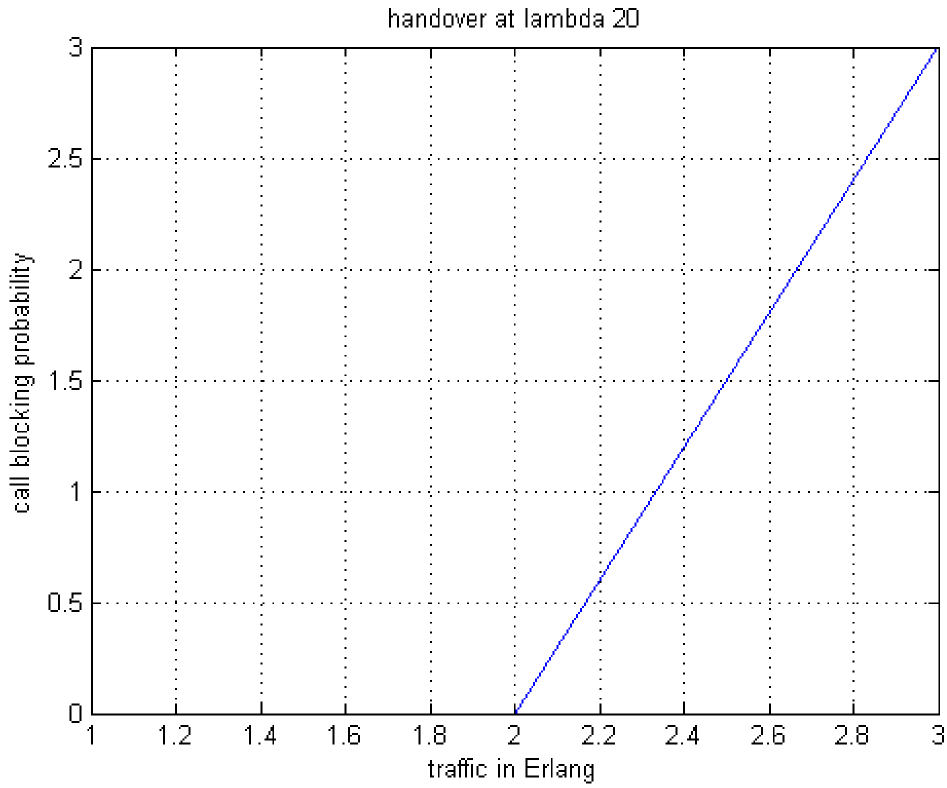


Figure 4-11: Handover

CHAPTER FIVE

Chapter Five
Conclusion and Recommendation

5.1 Conclusion

In this project, we proposed and evaluated the performanceof an inter-satellite handover technique, and also the evaluation of fixed and dynamic channel allocation techniques with handoverqueuing has been addressed. The mainmechanism behind the proposed scheme is the queuing of handover requests, which results in extremely low Call Dropping Probabilities. Two channel allocation schemes have been evaluated considering the case where handoverrequests are queued using a FIFO strategy. Furthermore, it has been assumed that the system supports different categories of fixed and mobile users.Performance evaluations and comparisonshave been carried out in terms of blocking probabilities of the different classes of users.

Moreover, in order to provide a good trade-offbetween Call Blocking and Call Dropping Probabilities, in thiswork a dynamic bandwidth deallocation scheme is introduced.According to this scheme, capacity reservation requests arecountermanded when the capacity that they strive to reserveis unlikely to be used. We also showed that the proposedtechnique can take advantage of the footprint's overlappingarea in order to enhance network performance.

In order to decrease a probability of handover failure an emergency bridge has been built.

5.2 Recommendations

Research team recommend establishing a link between iridium satellites and GEO satellites (inter-orbital link) that link would be useful as a backup. To achieve global coverage area and to reduce the blocking probability to minimum value as much as possible.

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Appendices

Appendix A

```
clear,clc,clf,close all
%%%%%%%%%%%%%%
%traffic generation
%-------------------
xpos_max=75;
ypos_max=30;

m=200;mu=5;sat=3;chn=100;
sat_pos=10*round(rand(1:10));
lamda=10;
s=5;
xpos=round(xpos_max*rand(1,m));
ypos=round(ypos_max*rand(1,m));

inta=poissrnd(lamda,1,m);

arrival=cumsum(inta);
call_dur=exprnd(mu,1,m);
%plotting of mobile desterbution station
figure
for i=1:m
plot(xpos(1,i),ypos(1,i),'*b');title(' Mobiles
Distribution ')
xlabel('Meter'),ylabel('Meter')
hold on
end
grid
figure
plot(inta)
grid,title('Call Arrival')
xlabel('Mobile #'),ylabel('Sec')
figure
plot(call_dur)
grid,title('Call duration')
xlabel('Mobile #'),ylabel('Sec')
```

```
figure
hist(inta)
grid
title('Call Arrival histogram')
figure
hist(call_dur)

grid
xlabel('Mobile #'),ylabel('Sec')
title('Call duration histogram')
xlabel('holding time [sec]'),ylabel('numbers of
mobiles')
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
%%%%
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
%%%%%%%%%%%%%%
```

Appendix B

```
%fca algorithm
%-------------
ave_speed=50;
for i=1:sat
chnn(1,i)=chn;
end
for k=1:m
    status(1,k)=1;
end
for i=1:s
    volx=ave_speed*rand(1,m)
    voly=ave_speed*rand(1,m)

for k=1:m
if status(1,k)==0
     dd=2000;
for gg=1:sat
            dm(1,k)=sqrt((xpos(1,k)+volx(1,k)-
sat_pos(gg,1)^2)+(ypos(1,k)+voly(1,k)-
sat_pos(gg,2))^2);
if dm(1,k)<dd
```

```
                dd=dm(1,k);
                index(1,k)=gg;
end
end

if (arrival(1,k)==i)&&(status(1,k)==0)
        chnn(1,index(1,k))=chnn(1,index(1,k))-1;
        status(1,k)=1;
        channel_location(1,k)=index(1,k);
elseif (arrival(1,k)+call_dur(1,k))>=i
        status(1,k)=0
        channel_location(1,k)=0
      Handover
%----------
end
end
end
end
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
for j=1:k
        handover_request(sat,j)=0;

end

p_max=40;
p0=1;
 p=(p_max).*(rand(1,m));

for i=1:sat
if p(m)>p0

handover_request(sat)=handover_request(sat)+1;
else
    handover_request(sat)=handover_request(sat);
end
end
%%%%%%%%%%%%%%

for k=1:m
if status(1,k)==0

for gg=1:sat
```

```
            dmn(1,k)=sqrt(((xpos(1,k)+volx(1,k)-
sat_pos(gg,1))^2)+(ypos(1,k)+voly(1,k)-
sat_pos(gg,2))^2);
if dmn(1,k)<dm(1,k)
                indexn(1,k)=gg;
else
                indexn(1,k)=index(1,k);
end
end
if channel_location(1,k)== indexn(1,k)
            handover_request(st,k)=0;
else

handover_request(s,k)=handover_request(s,k)+1;
          channel_location(1,k)= indexn(1,k);
          chnn(1,index(1,k))=chnn(1,index(1,k))+1;
          chnn(1,indexn(1,k))=chnn(1,indexn(1,k))-
1;
end

end


end
figure
plot(handover_request)
grid

%-------------------
xpos_max=75;
ypos_max=30;

m=200;mu=5;sat=3;chn=100;
sat_pos=10*round(rand(1:10));
lamda=10;
s=5;
xpos=round(xpos_max*rand(1,m));
ypos=round(ypos_max*rand(1,m));

inta=poissrnd(lamda,1,m);

arrival=cumsum(inta);
call_dur=exprnd(mu,1,m);
```

```
%plotting of mobile desterbution station
figure
for i=1:m
plot(xpos(1,i),ypos(1,i),'*b');title(' Mobiles
Distribution ')
xlabel('Meter'),ylabel('Meter')
hold on
end
grid
figure
plot(inta)
grid,title('Call Arrival')
xlabel('Mobile #'),ylabel('Sec')
figure
plot(call_dur)
grid,title('Call duration')
xlabel('Mobile #'),ylabel('Sec')
figure
hist(inta)
grid
title('Call Arrival histogram')
figure
hist(call_dur)

grid
xlabel('Mobile #'),ylabel('Sec')
title('Call duration histogram')
xlabel('holding time [sec]'),ylabel('numbers of
mobiles')
ch_fc=chnn;
 figure
plot(ch_fc)
grid
```