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The Effect of National Roaming for Service availability
(Case Study: Tracking Service in Sudan)

تاثير التجوال القومي علي توفر الخدمة (حالة الدراسة : خدمة التتبع الالي في السودان)

This thesis is submitted as a partial fulfillment for the degree of MSc in Information Technology

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الحمد

الحمد لله الذي بنعمته تتم الصالحات

الحمد لله حمداً كثيراً طيباً مباركاً فيه

الحمد لله الذي وفقنا لاكمال هذا البحث نرجو الله أن يجعله من العلم الذي ينتفع به

جهد بشري لا يخلو من خطأ فان أصبنا فذلك بفضل الله وأن أخطانا فمنا ومن الشيطان .

Dedication

To my mother who told me “you can do anything if you believe in yourself”, my father, family and friends. To everyone who taught me useful things in my life.

Acknowledgement

Thanks to Mighty Allah, for giving me the power to complete this research.

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To SUST and college of Computer Science and Information Technology family, and to my colleagues many thanks and respect to all.

ABSTRACT

National roaming is an important service that Facilitates can lead us to do the best utilization of available resources between different telecommunication providers in the same country.

Vehicle tracking services are important for vehicle protection in different businesses. But this service is limited with the limitation of cellular coverage area especially in rural areas. As a result, the vehicle is disconnected from the tracking server until it enters an area where cellular coverage is available.

To solve the limitation of coverage we propose to use a mobile IP roaming network . When the quality of service (QOS) is acceptable in one Access Point of a network and absent in another, The mobile device is allowed to roam in another network which provides coverage in that area .The device can therefore continue to transmit its location to the server .This improves resource utilization and increases system reliability.

المستخلص

التجوال القومى من الخدمات الهامة التي من شأنها أن تقود الي استغلال أفضل للموارد المتاحة بين مزودي خدمة الاتصالات داخل نفس القطر.

يعتبر التتبع الالي من الخدمات الهامة في التطبيقات المختلفة, لكن قد تقل كفاءة هذه الخدمة وتصبح محدودة بسبب محدودية تغطية الشبكة الخلوية وخاصة في المناطق الريفية. يؤدي ذلك إلي انقطاع الاتصال بين جهاز التتبع والمخدم حتي يصل جهاز التتبع لمنطقة بها تغطية ويعاود الاتصال بالمخدم.

لكي نتمكن من حل مشكلة التغطية المحدودة اقترحنا استخدام شبكة بروتوكول الانترنت بواسطة الجوال عندما تتوفر جودة مقبولة في نقطة اتصال تتبع لشبكة معينة وغير متوفرة لشبكة أخرى, يتم السماح لجهاز الموبايل بالتحول داخل الشبكة التي توفر الخدمة في المنطقة. ولذلك يستطيع الجهاز الاستمرار بارسال موقعه إلي المخدم, يؤدي هذا إلي استغلال أفضل للموارد ويزيد من اعتمادية النظام.

TABLES OF CONTENTS

LIST OF FIGURES

List of Abbreviations

• A-GPS	Assisted GPS
• AP	Access Point
• BTS	Base Transceiver Stations.
• Cell ID	Cell Identification.
• EDGE	Enhanced Data rate GSM Environment
• E-OTD	Enhanced Observed Time Difference.
• GSM	Global System for Mobile communications.
• GPRS	General Packet Radio Service.
• GPS	Global Positioning System.
• GGSN	Gateway GPRS Support Nod.
• GNSS	Global Navigation Satellite System.
• HLR	Home Location Register.
• LA	Location Area.
• MSC	Mobile Switching Centers.
• MS	Mobile Stations.
• OPNET	Optimization Network.
• PCU	Packet Control Unit.
• QOS	Quality of Service.
• RNC	Radio Networks Controller.
• RSS	Random Signal Strength.

• SGSN	Serving GPRS Support Node.
• SIM	Subscriber Identity Module.
• SMS	Short Message Service.
• UMTS	Universal Mobile Telecommunications System.
• VLR	Visitor Location Register.
• CEO	Chief Executive Officer

CHAPTER ONE

INTRODUCTION

CHAPTER ONE

INTRODUCTION

1.1 Background

The urgency of information delivery has become important to guarantee the reliability of today's applications. This urgency is not related to voice services alone, but data services as well.

Tracking services use mobile devices which allow the user to know the location of his valuable goods at any time. The tracking device includes a Global Positioning System (GPS) antenna and data Subscriber Identity Module (SIM) card. The role of the GPS antenna is to receive signals from the satellite so the device is located. But for the user to know the information collected by the GPS antenna the mobile device needs coverage of the mobile network to transfer data to the server by the (SIM) card.

1.2 Problem statement

When a vehicle moves out of the network coverage area, the tracking system is unable to send tracking data to the tracking server. However, there may be cellular coverage provided by another mobile network.

Information collection for tracking services is time sensitive, it needs to be collected when events occur. Delay in location information update happens due to the interruption of service in the absence of network coverage. This leads to the inefficiency of the tracking system by not having up to date information.

1.3 Proposed solution

National roaming can be utilized, where the user is transferred form one cellular system to another that provides coverage in that area. This ensures continues communication between the vehicle and the tracking server. Consequently, all time tracking is provided, improving the system reliability.

1.4 Objectives

The objective of this work are to:

1. Reduce network coverage limitations.
2. Increase Information transfer speed.
3. Provide continuous communication between the vehicle and the tracking server.

1.5 Methodology

We use OPNET Modeler 14.5 to simulate two scenarios. In the first scenario, the mobile device has no roaming capabilities, and in the second scenario the mobile device is allowed to roam in other system. We evaluate Throughput, traffic sent and Traffic received in HTTP and FTP to compare two scenarios.

1.6 Scope

The research uses national roaming to solve the problem of missing data due to lack of network coverage, it does not take into account voice services. The work considers a Mobile IP roaming scenario network.

1.7 Research importance

The research solves the problem of limitation of network coverage focusing on tracking services. Marinating connectivity guarantees up-to-date location information and improving the QOS. It utilizes the available resources of different cellular systems to maintain communication. This leads to the end user and service provider satisfaction.

1.7.1 Technical benefits

Utilization of available resources of different systems in different network areas to maintain communication.

1.7.2 Economical benefits

Good utilization of available network resources reduces the cost of services. More reliable services attract more paying customers.

1.8 Thesis organization

The rest of the thesis is organized as follows:

- Chapter Two: Overview of cellular mobile systems:-

  This Chapter overviews cellular systems including GSM, GPRS and UMTS. It also gives information regarding handovers and tracking.

- Chapter Three: Literature reviews and related work:-

  This chapter explains the Literature reviews and related work to this research.

- Chapter Four: Proposed System design and framework:-

  This chapter explains the tools that was used for the evaluation. It also illustrates the design of the system.

- Chapter Five: Results and discussion. :-

  This chapter explains the mobile IP network scenario and analysis of result.

- Chapter Six: Conclusions and future work:-

  This chapter explains the conclusions of this research and future work.

CHAPTER TWO

Cellular Mobile Systems

CHAPTER TWO

Cellular Mobile Systems

2.1 Introduction:-

This Chapter overviews cellular systems including GSM, GPRS and UMTS. It also gives information regarding handovers and tracking.

2.2GSM Network:-

The GSM (Global System for Mobile Communications) technology is a personal communication service to provide a connection between mobile devices.' It is standard set includes the traditional circuit-switched mobile communication, as well as the packet switched standards, like General Packet Radio Services (GPRS) and Enhanced Data rate GSM Environment(EDGE). The specification was extended in order to support location services. The GSM architecture is shown in Figure 2.1. [1]

2.2.1GSM Infrastructure and Operations:-

The coverage area of a GSM network is divided into cells. Every cell includes a Base Transceiver Station (BTS) which is equipped with a single or multiple antennas pointing in different directions. Each antenna controls a certain sector within each cell; each sector has a unique identifier, called Cell-ID. These cells are grouped into logical areas known as Location Area (LA).Figure 2.2 illustrates a location area, a cell and cell sectors. An LA has an integer identifier called Location Area Code (LAC) and has a Base Station Controller (BSC). The LA is an important means to control mobility in the network, as Mobile Stations (MS) are required to report their new position when moving from an LA to another .[1]

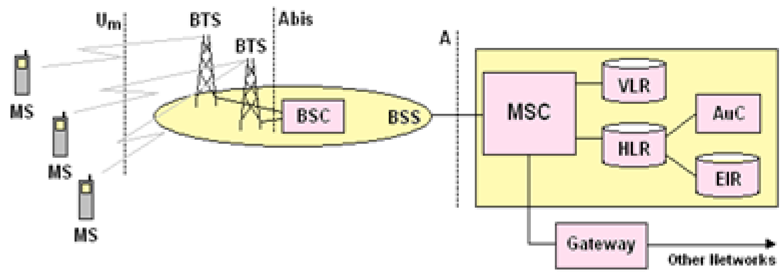


Figure 2.1The Basic Architecture of the GSM Network

MS with its SIM card is the smallest element of the GSM infrastructure. The MS connects to a BTSs by measuring the signal strength of the surrounding BTSs/cells. Neighboring BTSs are connected to a Base Station Controller (BSC). Each BSC usually belongs to a LA, and they are connected to the Mobile Switching Center (MSC) which is responsible for switching and service provision. The MSC has a database called Visitor Location Register (VLR) that records the MS's LAC and connected phones Cell-IDs within the area of MSC. In addition, the network has a global database that also contains the last known LAC and Cell-ID of MS, called Home Location Register (HLR). MSC uses HLR when the target MS is in another MSC. During a phone call the MS is in a mode called connected mode which is important to track MS movements at cell level; VLR and HLR record the MS's Cell-ID. When the moving user reaches the boundary of the cell, The MS measures lower signal strength compared to other (neighboring) base stations. Therefore, The MS sends a request to the network for changing its Cell-ID, and when the network confirms it, the Cell-ID will be changed and the new base station will serve the MS[1]

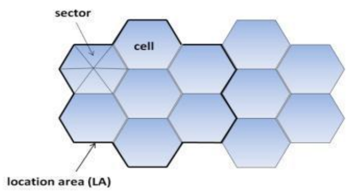


Figure 2.2 An example of a GSM location area

2.3 GPRS:-

General Packet Radio Services (GPRS) is a packet-based wireless communication service that promises data rates from 56 up to 114 Kbps and continuous connection to the Internet for mobile phone and computer users. The higher data rates allow users to enjoy their needs like video conferencing and similar applications using mobile handheld devices as well as notebook computers. GPRS is based on GSM and complements existing services such circuit-switched cellular phone connections and Short Message Service (SMS). [2]

2.3.1 GPRS Benefits:-

GPRS packet-based services cost user's less than circuit-switched services because communication channels are being used on a shared-use basis rather than dedicated to only one user at a time. It is also easier to make applications available to mobile users because the faster data rate means that middleware currently needed to adapt applications to the slower speed of wireless systems are no longer be needed. [2]

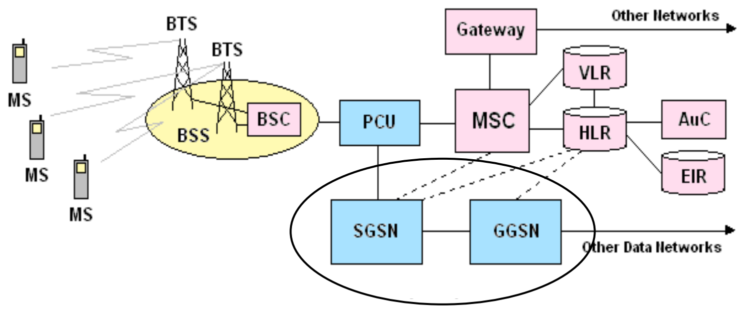


Figure 2.3: GPRS Network Architecture

2.3.2 GPRS Core Network:-

1. Serving GPRS Support Node (SGSN)

   The SGSN carries out functions related to communication, security and access control. It processes and retains registration and location information of GPRS subscribers. The MSC, VLR, HLR, and EIR of the GSM network support the SGSN.

2. Gateway GPRS Support Node (GGSN)

   The GGSN is the interface between GPRS users and external networks. It is responsible for routing incoming traffic to the correct SGSN. One GGSN may support multiple SGSNs.

3. Packet Control Unit (PCU).

   The interface between the BSS and SGSN. It separates packet traffic from voice traffic at the BSC and directs the packet data traffic to the GPRS network. [3]

2.4 UMTS:-

Universal Mobile Telecommunications System UMTS is a 3G packet-based mobile service based on the GSM standards. UMTS offers services such as text, voice, video, and multimedia to mobile users regardless of their location in the world. UMTS is also known as Wideband Code Division Multiple Access (WCDMA) because WCDMA is the air interface used by UMTS. [4]

2.4.1 UMTS Network Architecture:-

UMTS architecture consists of three main components:-

1. User Equipment (UE):-

- The main functions of the UE are:

- Display and user interface.
- To hold the authentication algorithms and keys.
- User end termination of the air interface.
- Application platform.

- The elements of the UE are:-

- The mobile equipment (ME): the radio terminal used for communication over the radio interface.
- The UMTS Subscriber Identity Module (USIM): a smartcard the holds the subscriber identity, authentication and encryption keys.
- The Terminal Equipment (TE): optionally to support Bluetooth for example.

2. UMTS Terrestrial Radio Access Network (UTRAN):-

-The main UTRAN functions are:-

- Provide radio requirements for users at QoS levels.
- System access control for active users.
- Security and privacy.
- Support for handover (soft, softer).

- Radio resource management and control (channel allocation, traffic handling, power control, load control, admission control).

-The basic elements:-

- Radio Network Controller (RNC): owns and controls radio resources. Manages radio allocation and congestion control in its cells (equivalent of the GSM BSC)
- Node B: the radio base station (equivalent to the GSM BTS).

3. Core Network (CN):-

- The functions of the CN are:
  - Switching.
  - Service provision.
  - Communications with other networks.
  - Mobility management.
  - Operations, administration, and maintenance.
- The major elements of the CN are:
  - Home Location Register (HLR).
  - Visitor Location Register (VLR).
  - Mobile Switching Center (MSC).
  - Gateway MSC (GMSC).
  - Serving GPRS Support Node (SGSN).
  - Gateway GPRS Support Node (GGSN).[4]

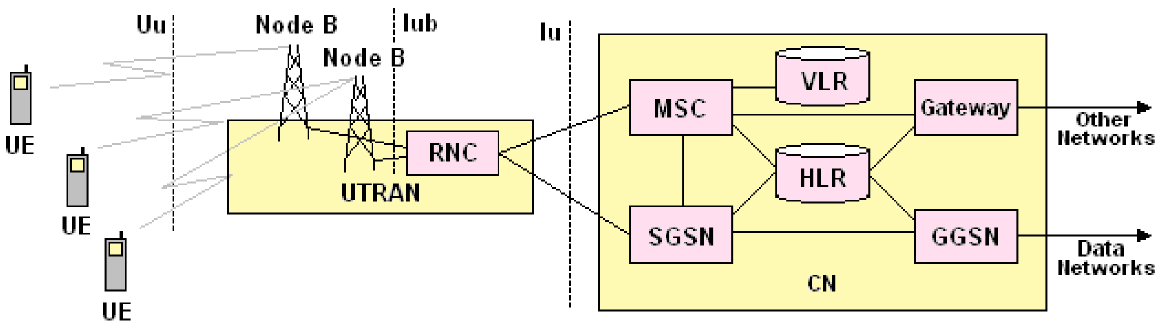


Figure2.4: UMTS Network Architecture

UMTS Services:-

UMTS provides users a guaranteed integrated personalized environment regardless of the mobile or network from which the service is accessed. The following are some of UMTS services:-

1) Virtual Home Environment

This service allows UMTS users to subscribe to their home services while roaming in other networks having the same home network environment.

2) Multimedia Services

The most attractive features in UMTS are multimedia services. UMTS supports video-streaming applications, video conferencing applications, on-line video sales catalogues and telemedicine applications.

3) Access to Internet-Intranet Services

With the development of mobile devices and the bandwidth UMTS provides, accessing the Internet and other networks is much more stimulating.

4) Voice Services

Voice services are services based on voice recognition. These types of services increase the usability of existing applications. [4]

2.5Handovers in cellular systems:-

Handover is the transfer of a mobile active connection between cells as the mobile moves from one cell to another cell while ensuring that an existing call is maintained. Handovers occur when the signal strength between the mobile and the serving base station BS falls below a certain level due to the mobile distance from the base station or the level of interference. [4]

2.5.1Handover objectives:-

1. Maintaining continuous connection for users whilst providing the network quality of service QoS at all times.
2. Decreasing the interference by reducing the transmitted power, and hence increasing the useful signal.
3. Insuring equal distribution of traffic among cells to administrate resources. Avoid congestion and balance the load between cells.
4. Clearing outlining of cells' boundaries and coverage areas. [4]

2.5.2Reasons for a Handover to be conducted:-

1. To avoid call termination.
2. When the capacity for connecting new calls of a given cell is used up.
3. When there is interference in the channels due to the different phones using the same channel in different cells.
4. When the user behavior changes.
5. Other reason due to interrupt in QoS in existing network. [4]

2.5.3 Importance of Handling Handovers:-

- Customer satisfaction is very important in cellular communication .To do that we need effective handovers to maintain good quality of service.

- Handovers are very important for managing radio resources in cellular systems. [4]
-

2.5.4 Design Considerations for handovers:-

The main goal of handover design is to reduce major changes to existing networks. Especially at lower levels. This will ensure that existing networks will continue to function as before without requiring current users to change to the new approach. [4]

2.5.5 Types of Handovers with respect to links:-

Handovers are classified into two categories- hard and soft handovers, which are further divided among themselves. [4]

2.5.5.1 Hard handover:-

Can be define as the status of connection when the radio links between the mobile and the base station in the old cell are released. Then the new links in the new cell are established. (The mobile has at most one set of radio links with one base station at any time). Also called "break-before-make" Hard handoff can be further divided into intra and inter-cell handovers. [4]

- Intra-cell handovers: In intra-cell handover, the source and target cell are the same cell and only the used channel is changed during the handover. The purpose of intra-cell handover is to change a channel, which may be interfered, or fading with a new clearer or less fading channel.
- Inter-cell handovers: In inter-cell handover, the source and the target cell are different cells. The purpose of the inter-cell handover is to maintain the call as the subscriber is moving out of the area of the source cell and entering the area of the target cell. [4]

2.5.5.2 Soft handover:-

Takes place in spread spectrum systems such as CDMA.One or more radio links from the nearest base station(s) is/are established without losing the radio link of the current base station. At this point, a decision is not yet made to specify the cell to which the mobile will be transferred. The mobile communicates through more than one channel simultaneously. The radio links which do not belong to the target cell are released. The mobile is always connected to at least one radio link at any time. Also called "make-before-break". [5]. Soft handovers can be classified as Multiways and softer handovers. [4]

- **Multi way handovers**:

A soft handover which involves using connections to more than two cells is a multi ways handover.

- **Softer handover:**

  Where a cell phone is simultaneously connected to two or more cell sectors during a call sectors are from the same physical cell site [7]

2.5.6 Types of Handovers with respect to systems:-

- Vertical handover :-

  This type accrues when mobile user's connectivity changes from one base station to another base station of a different networks.

- Horizontal handover:-

  This type accrues when mobile user transfers from one base station to another base station of the same network.[9]

2.5.7 Handover Prioritization:-

In wireless mobile networks, when available resources are not sufficient for users' requests, it is preferred not to accept new callers in the network than to force an existing call to terminate.

1. Guard Channels Method:

- A fixed or variable number of channels are reserved for handover requests.
- This method decreases the handover dropping probability, but at the same time increases the new call blocking probability.
- A problem with this method is channel utilization.

2. Queuing Handover Requests Method:

   A queue is used to reserve handover requests hoping for a channel to become available. The size of the queue should carefully be chosen. [3]

2.5.8 Types of protocols:-

There are four basic types of handover protocols which help in providing continuous and QoS-guaranteed service. And are discuss below:-

1. Network-controlled handover NCHO: is a centralized handover protocol, in which the network makes a handover decision based on measurements of the signal quality of mobile station (MS) at a number of based stations (BS). Sometimes the network sets up a bridge connection between the old and new BSs and thus minimizes the duration of handover. This type of handover is not suitable for a rapidly changing environment and a high density of users due to the associated delay.
2. Mobile-assisted handover MAHO: which is the protocol that distributes the handover decision process. The MS makes measurements, and the MSC makes decisions.
3. SHO is often used in conjunction with MAHO. Rather than immediately terminating the connection between an MS and a BS, the connection to the old BS is not broken until a connection to the new BS is made.
4. Mobile-controlled handover: in MCHO, the MS is completely under control of the handover process. This type of handover has a short reaction time and is suitable for microcellular systems. A MS keeps on measuring signal strength from all the surrounding base stations. If the MS finds that there is a new BS

which has a stronger signal than that of the old BS, it decides and initiates the handover process. [4]

2.5.9 Handover evaluation mechanisms:-

Handover can be seen as a blind procedure if it is only based on the comparison of measurements without the information of location. Efficient handover algorithms can enhance system capacity and service quality cost-effectively.

Three basic mechanisms are used to evaluate the performance of handover algorithms including:-

1. Analytical approach,
2. Simulation approach, and
3. Emulation approaches.

- An analytical approach can quickly give a preliminary idea about the performance of some handover algorithms for simplified handover scenarios. This approach is valid only under specified constraints. For real-world situations, this approach is complex and mathematically intractable.
- The simulation approach is the most commonly used handover evaluation mechanism. Several simulation models suitable for evaluation of different types of handover algorithms under different deployment scenarios have been proposed and used. Simulation models usually consist of one or more of the following components: the cell model, traffic model, and mobility model.
- The emulation approach uses a software simulator consisting of a handover algorithm to process measured variables. The main disadvantages are that this approach requires periodic measurement efforts and is not suitable for comparison of different handover algorithms on the same platform. [4]

2.6 National Roaming

2.6.1 Definition

The GSM World Association has defined roaming as "the ability for a cellular customer to automatically make & receive voice calls, send & receive data, or access other services when traveling outside the geographical coverage area of the home network, by means of using a visited network". If the visited network is in the same country as the home network, it is known as the national roaming service.

2.6.2 National Roaming Scenario

While roaming, a subscriber logs onto the network of a mobile operator in the visited service area with whom the home mobile operator of the roaming subscriber has a roaming agreement. A roaming agreement is a commercial agreement between the home mobile operator and a roaming partner mobile operator, that allows subscribers of the home mobile operator to access the roaming partner's network. When a roaming subscriber switches on his mobile device in the geographical area outside the service area of his mobile operator, the mobile device picks up the radio signals of one of the operators in the visited service area with whom the roaming subscriber's home mobile operator has a roaming agreement. This local operator (in the visited area) will then 'authenticate' the mobile number of the user with the home operator i.e. it will check whether the user is a valid subscriber, and is allowed to roam outside. Once the authentication is received, the user can make, and receive calls. [12]

2.6.3 Canadian example of national roaming:-

In Canada, the coverage area was extended to offer seamless roaming, soft handover, between carrier partners in areas with poor or absent service. As a result, fewer calls were dropped when transitioning between areas with good coverage and those without.

Their goal is to improve customer experience by allowing them to use their devices where they could not before, with no additional cost. [13]

2.6.4 Case study of Sudan for national roaming:-

In Sudan ,there are a number of telecom provider companies .In some areas ,the QoS for these companies is very different .For example the QoS might be acceptable for company X while very poor for company Y. In the case where company X and company Y sign national roaming agreement users can take advantage of this service leading to better resource utilization and uninterrupted communication.

2.7 Positioning, location-based applications and tracking

2.7.1 Positioning technologies can be divided into 3 categories:-

1. **Basic:**

   Basic methods are those which build their applications using cell identification. (Cell ID) cell ID can be used alone, or together with advanced timing and network measurement report.

2. **Enhanced :**

Enhanced positioning methods (E-OTD) is a technology for identifying the location of a cellular caller. Uses a mathematical algorithm to identify the location of the caller based on the time signal takes to reach a set of base stations and then through a triangulation scheme, determine the approximate area where the caller might be.

3. **Advanced:**

An advanced positioning method (A_GPS). It is Likely to be the standard of positioning in 3G worlds. Mobile Phone chip vendors, have built in the A-GPS feature together with their CDMA solution. A-GPS is a technology that uses an assistance server to cut down the time needed to determine a location using GPS. It is useful in urban areas. [6]

2.7.2 Location -based applications:-

When the location of the mobile is known, it can be used within the wireless systems to improve the system performance in the different layers for system enhanced applications and increase wireless system functionality for location-based commercial services. System Level Applications - Location information can be used to improve system performance. Some examples of applications which could make us to locate information are listed below. [7]

1. Intelligent Handover System: uses signal strength and MS location information to reduce unnecessary dropped calls as well as maintain the quality of service.

2. Efficient Channel Allocation Using location information: the velocity of the MS can be determined and dynamically allocate channel capacity by reserving channels in the target cell for each user.

3. Commercial Location Based Services: Tracking Services- Fleet management allows timely allocation of resources which help reduce response time to new calls. Car navigation can be linked with the portal map and also provide real-time, current users position and surrounding information.

4. Value Added Services: Mobile station requests the nearest ATM, cheapest gas station, local traffic information etc.

5. Messenger Services: Network notifies the user's current location to friends and also provides the location of friends to the user.[7]

2.7.3Tracking:-

Tracking services are important service and contain many categories depending on what the customer needs to track including kids, goods or vehicles.

Mobile commerce services may be part of tracking services such as smart traveling services, where the customer is interested of finding the nearest driver to request.

The challenge of these services is that the customer needs to immediately know the location and of the tracked item.

One major advantage of GSM-based positioning solution is that the position of the MS can be derived without any additional data exchange or application on the MS and there is no need of further hardware element installation on network side either. One potential positioning technology in GSM network is based on measuring the handover events. [1]

CHAPTER THREE

LITERATURE REVIEW AND RELATED WORK

CHAPTER THREE

LITERATURE REVIEW AND RELATED WORK

3.1 Mobility and mobility management

The authors of propose a conceptual framework for mobility and mobility management, with the emphasis on the key research issues involved in the effort of a graceful design of the mobility management schemes. The effects of the mobility on both architectures and protocols of networks and communications are presented. The diversity of the future mobile communication systems introduce new challenges, which lead to the definitions of mobility on various levels according to different granularities. Mobility management is defined as two complementary operations, i.e. location management and handover management. The authors of also describe the mobility management issues at the network layer. The processing stages of the two operations are introduced respectively, together with the analyses of key research issues and possible solutions. Finally, the issues about the performance evaluation of the mobility management schemes are discussed [5].

3.2 Tracking vehicle in GSM network to support intelligent transportation systems

The work illustrates the GSM network, GSM infrastructure and operation which illustrates the concept of LAU (Location Area Update) then leads to the handover concept to keep the best QoS to MS(Mobile station). GSM-based positioning techniques can be divided into two categories based on equipment requirements. Technologies in the first category do not need special equipment to determine MS's position (Cell-ID, RSS-based) on the network side. Those in the second category require hardware modules to support positioning.

3.2.1 handover-based technology for tracking vehicles:-

The novel GSM-based positioning method described can potentially support intelligent transportation systems. The method of mapping handover zones as network side data acquisition is easy to be implemented; there is no need for additional hardware deployment. Using probabilistic finite automata in handover zone pattern recognition enables improving route matching reliability and therefore, supports various traffic flow applications. A method for assessing zone geometry patterns has also been developed. It has been investigated how this mass positioning data acquisition technique can broaden the area of location-based services. Besides human mobility pattern mapping and potential commercial and intelligent transportation applications that could be based on origin-destination analysis. The paper provides detailed information on how this alternative technique positioning can be integrated into a cutting-edge ITS platform Safe TRIP, and can be efficiently used as an alternative ground-based positioning method when satellite-based technologies failure as a complementary method to improve accuracy or validate positioning information from Global Navigation Satellite System(GNSS) systems[1].

3.3 Mobile tracking and resource reservation scheme for cellular networks

The work in presents a new technique for resource reservation schemes for cellular networks using mobile tracking and also discusses the possible applications in mobile telecommunication network. Resources can be reserved in advance, if able to predict the motion of the user, using his current location. This requires mobile positioning. In the proposed method, the base stations transmit certain signals at different power levels that traverse different distances. These signals are used to partition each cell into Location Areas (LA), which lie at the intersection of various regions formed by the signals. The natural attenuation of the signals with distance is exploited to form the LA's [7].

3.4 Seamless data services for real-time communication in a heterogeneous networks using network tracking and management

The paper in mainly concentrates on framing a path in advance between the source and the destination based on the nature of the data being communicated, in this case mobile video conferencing.

The paper discusses the challenges involved in the mobility and handover technique. In heterogeneous wireless networks, traditionally handover is mainly classified as horizontal handover and vertical handover. Seamless and efficient Vertical Handover between different access technologies is an essential and challenging problem in the development of the next-generation wireless networks. Internally, as the handover process is considered, it can be further carried out using the following main steps: system discovery, handover decision, and handover execution.

The ultimate goal of the paper was to provide the services based on the saying "Any time Anything Anywhere and Everywhere Any state and Every state". The paper proposed a location tracking based solution that supports hybrid handovers without disruption of real-time multimedia communication services. The solution provided is that the mobility management using Location-based tracking and Network management [8].

3.5 Handoff implementation in IEEE 802.11 wireless local area network using riverbed modeler

The work in discussed handover detection when the signal quality reaches a minimal threshold, the station may take the decision to initiate a handover in order to connect to other APs offering a better quality of the signal. It considers handover phases of Scanning, Authentication, and Association.

The paper implements the handover in WLAN. They use the Riverbed Simulator to represent the various network performance results with mobile node handovers in

WLAN. The Access Point connectivity result shows the status of all mobile nodes in the wireless network. The network performance is measured with two different parameters to evaluate the network performance as Network Load and Throughput of WLAN. [9]

3.6 Performance and handoff evaluation of heterogeneous wireless networks (HWNS) using OPNET simulator

The need for coupling Heterogeneous Wireless Networks (HWNs) such as WLAN, WiMAX or UMTS, play a great role in developing towards the fourth generation of wireless networks. OPNET simulation results show that the superiors of WiMAX performance through the research on the WLAN and UMTS networks. The performance of WiMAX throughput beats the other networks in more than 30%. Also, the simulation results show the successful implementation and simulation of the deployment of WLAN into WiMAX and UMTS network by using multiple network interfaces. In this work, it was found that it is very difficult to successfully complete the vertical handover between WLAN-WiMAX and WLAN-UMTS without carefully and accurately, engineering the WLAN network due to highlighting the fundamental difference in HWNs. [10]

3.7 Implementation of Soft Handover in UMTS Using OPNET

Paper focused on handover parameter of UMTS network in various simulated environments using OPNET MODELER. It is based on modeling and simulating a UMTS scenario and it has been verified that UMTS handover performance can be improved by fine-tuning to Timer 3350. By varying the Timer time to a value other than the value specified in the standard gives "break free handover" in UMTS network.

The results show comparative performance of handover. After performing an animated view of the network, 42354 total requests are processed by the UMTS

network. Zig-Zag movements of UE's are implemented using Fixed Interval. Due to the long path, some UEs are unable to maintain connectivity with Cn_east By increasing the value of Timer to 3350 UE's are able to maintain a connection with Cn_East.[11]

CHAPTER FOUR

System Design and Framework

CHAPTER FOUR

System Design and Framework

4.1 Introduction

This chapter explains the tools that was used for the evaluation. It also illustrates the design of the system.

4.2 OPNET simulator

In this work, OPNET Network simulator (Modeler Educational version 14.5) was used as a tool to simulate the behavior and performance of the network. The main difference in OPNET Simulator compared to other simulators lies in its power and versatility. It Provides pre-built models of protocols and devices, and allows creating and simulating different network topologies. The set of protocols/devices are fixed, therefore, protocols cannot be created or modified. [14]

4.2.1 Advantages of OPNET Simulator

Following are the advantages of OPNET:

- It is an open free software (Educational version)
- It offers a large amount of project scenarios.

4.2.2 Uses of OPNET simulator

- Operational validation.
- Network planning and design.
- Validating hardware architecture.
- Protocol modeling.
- Traffic modeling of telecommunication networks.
- Evaluating performance aspects of complex software systems.

4.2.3 Discrete event simulation workflow in OPNET

- Create/import topology/configuration.
- Create traffic.
- Choose statistics
- Run simulation.
- View results.
- Duplicate or create a new scenario.
- Publish results.

4.2.4 Result categories:-

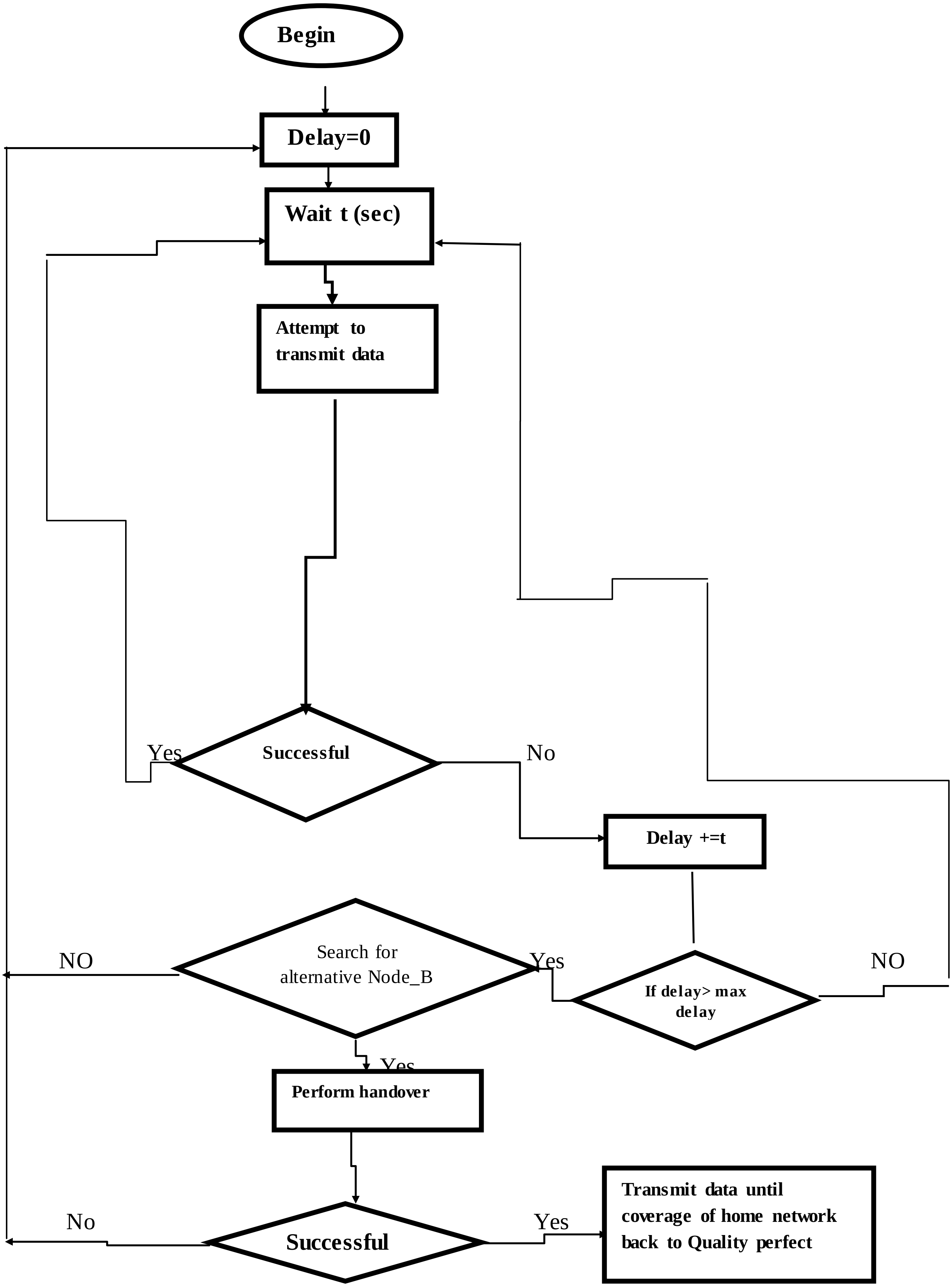
- **Global statistics:** measured at the network level.
- **Node statistics:** measured at the level of specific network element.

4.4 The system design of proposed scenario:-

The Flowchart in Figure 4.1 illustrates the steps Alogrthim of vehicle communication in tracking service . These steps are explained as follows:

1. Avehicle that is not moving transmit data every t seconds to the Node_B.
2. Moving vehicle transmit data every t seconds .
3. If transmission is successful , the vehicle will wait for its next transmission .

   If the transmission id unsuccessful for X times, delay > max delay .
4. Search for an alternative Node_B If it is available :
   - Perform handover and Transmit data until coverage of the original network (home network) is restored.
   - If handover is unsuccessful, transmit data every t2 seconds.
5. If no alternative Node_B is available go to step1.



Figur4.1 Flowchart of scenario

CHAPTER FIVE

Results and Discussion

CHAPTER FIVE

Results and Discussion

5.1Introduction:-

The problem of this research is the loss and delay of information due to limitation or degradation of coverage of mobile networks.

We use a scenario of 9 Access Points (AP) and 4 mobile nodes for each access point except AP 6 which has 5 mobile nodes, a mobile device is roaming around this setup.

Three mobile nodes move around AP areas, as these APs represent the total coverage area in perspective of Mobile node X. When the CEO is allowed roaming around the entire coverage area (CEO in solution scenario), it starts at AP1 and moves around from AP2 to AP9 then back to AP1, This scenario is compared with another scenario (CEO in problem scenario) where the mobile node moves out of the network coverage area and not have authorizations for national roaming. In this case the CEO is disconnected while outside network coverage area.

5.2Network implemention:-

5.2.1 Mobile IP components:-

To solve the research problem , we design mobile IP Roaming senario with the following components: -

1. 9 Access point .
2. 37 mobile nodes.
3. HTTP server.
4. FTP server.
5. IPV4.

5.2.2 Mobile IP Network senarios:-

5.2.2.1 Objective:-

To show the traffic overhead produced by Mobile IPv4 mechanisms in a network with 37 mobile nodes that are randomly moving across various access points.

5.2.2.2 Configuration:-

All nodes run two applications simultaneously: HTTP and FTP.

Nine access points are placed across the network. Initially each access point serves 4 mobile nodes, for which the initial access point will be their Home Agent.

Four wireless domains define the area of mobility for the mobile nodes. Each mobile node is restricted to move across four access points, maximum.

Three mobiles (MN_0A ,CEO and MN_6B), have been set to follow fixed trajectories across all nine access points. These two run a more heavy loaded version of the applications mentioned above.

5.3 Results:-

The statistics show three main aspects of the dynamics of the simulation:-

1-Application traffic.

-Performance of the applications can be observed.

2-Mobile IPv4 traffic.

-Control traffic generated by MIPv4 (mobile IPv4 mobility messages) can be observed.

-The time that takes to a mobile to bind with its Home Agent is measured.

-Overhead due to MIPv4 mechanisms also shown: route optimization and tunneled traffic.

3- Visited access points.

-The different networks (access points) visited by the mobile nodes can be observed (MN_0A, CEO and MN_6B visited access points shown).

5.4 Mobile IP Roaming Network Design:-

Figure 5.1 illustrates 9 Access points and 4 mobile nodes for all access points except AP 6 which has 5 mobile nodes. The IPV4, HTTP server, FTP server and Application are the network services and the Profile to saves which application we add. Mobility management sets the roles of authorization to mobile nodes if they move around. AP has coverage in the coverage area (mobile device roaming until back to home AP). We add trajectory (which means specifiying the way that the mobile moves) far away from the access point and see the effect in connection.

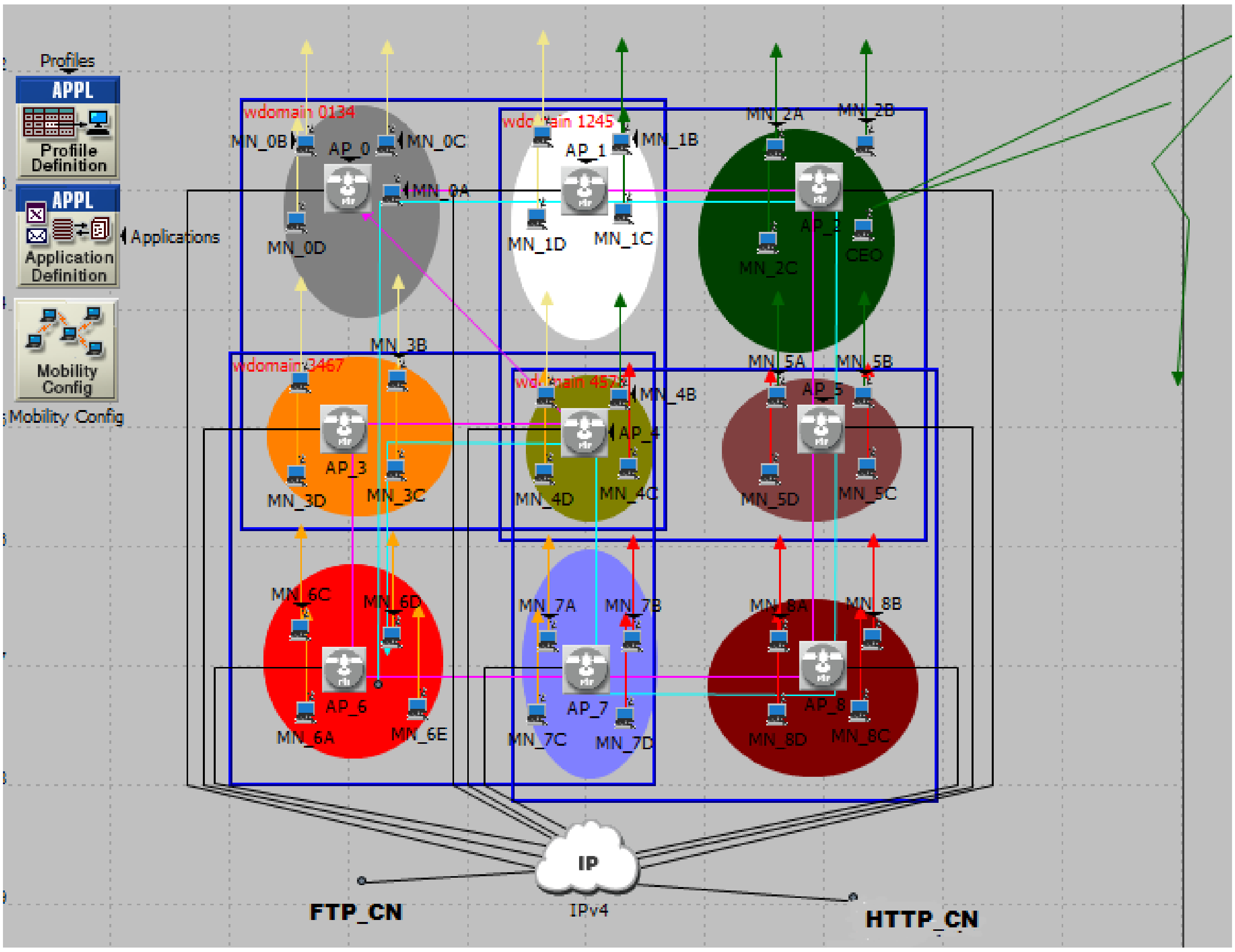


Figure 5.1 The design of the problem scenario

Figure 5.2 illustrates a design similar to the first scenario we add the authorization to mobile node CEO to move around 9AP and back to the home access point and see the effect in connection. The simulation is run 120 minutes. The results were displayed and the two scenarios are compared.

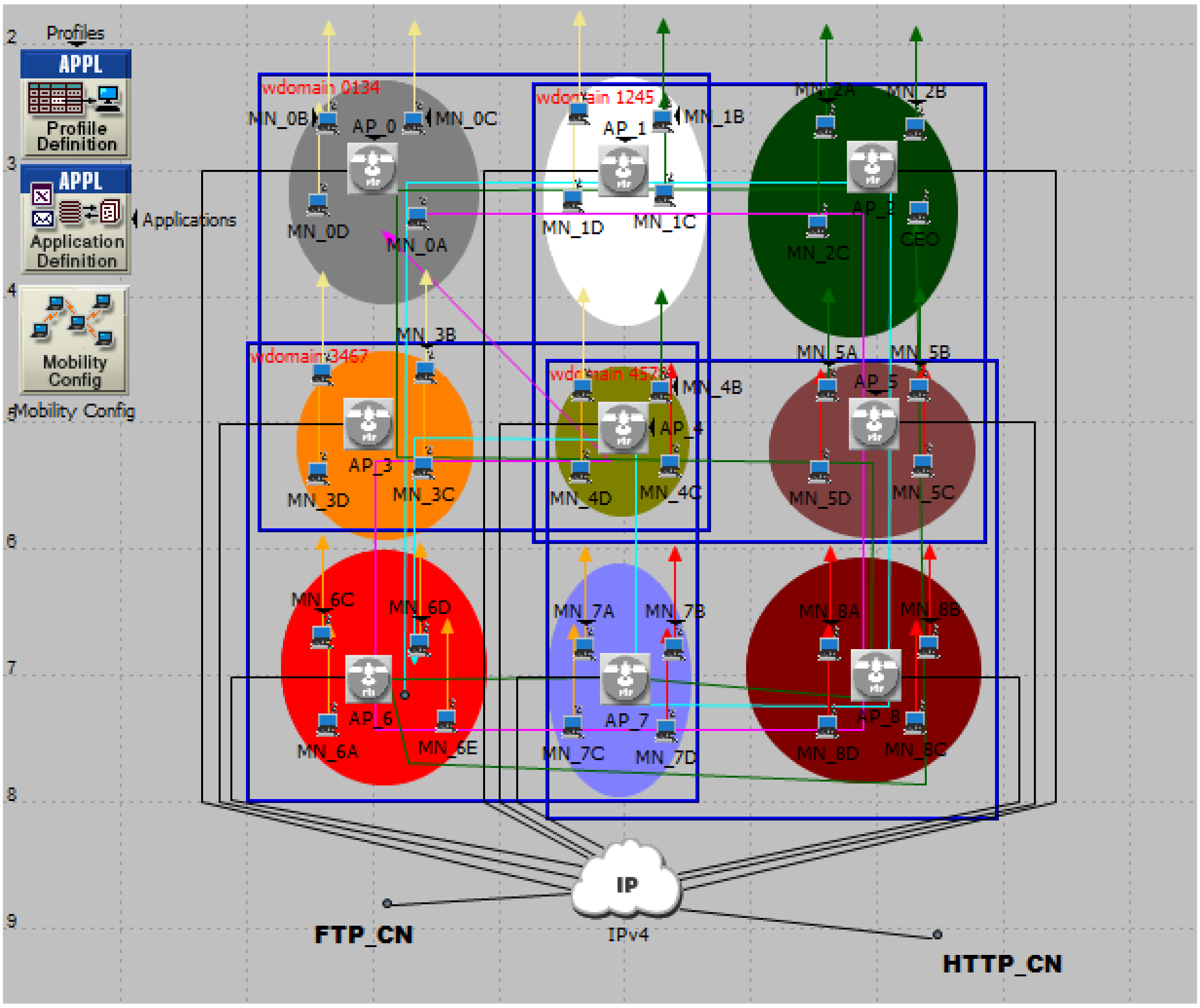


Figure 5.2: The design of the solution scenario

5.5 Analysis of Results:-

Figure 5.3 Illustrates shows received FTP traffic in solution scenario average bytes per second forwarded to all FTP applications by the transport layers in the network. And Traffic Received illustrates Average bytes per second submitted to the transport layers by all FTP applications in the network.

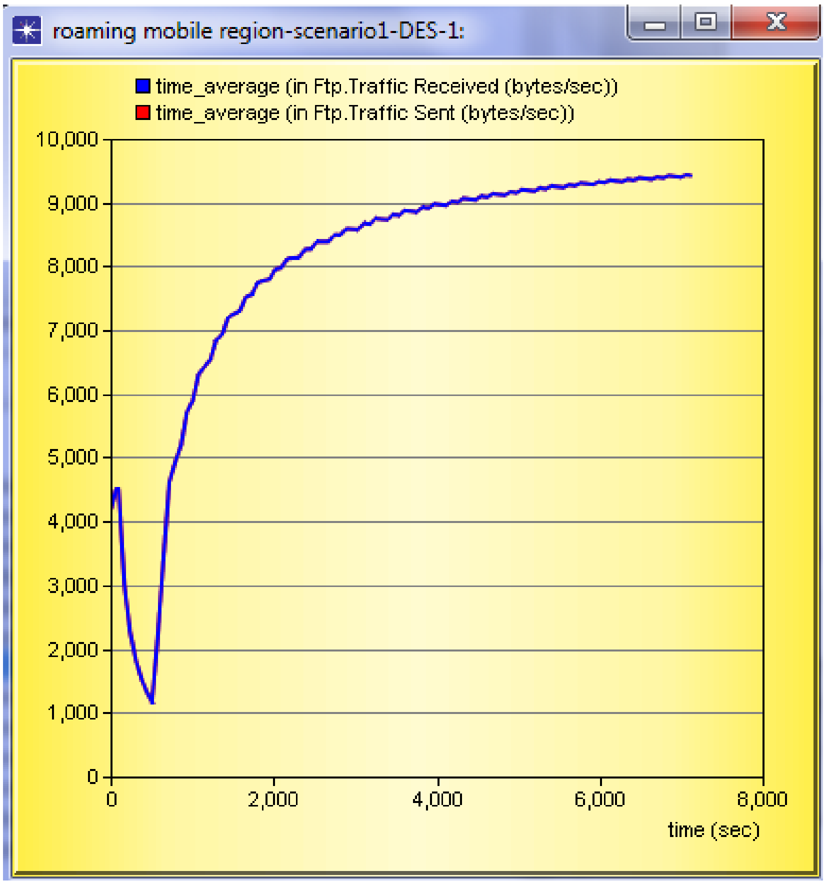


Figure 5.3 The FTP received traffic in solution scenario

Figure5.4 Illustrates Average Traffic Received (bytes per second) forwarded to the HTTP application by the transport layer in this node. And Traffic sent shows average bytes per second submitted to the transport layer by the HTTP application in this node.

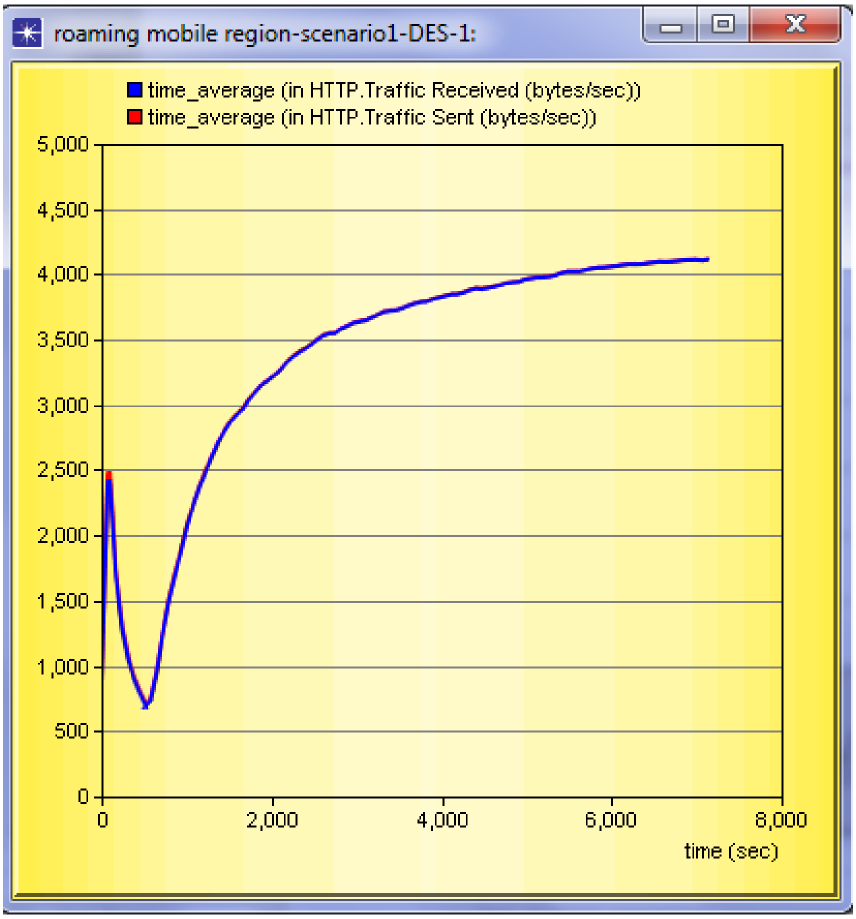


Figure5.4 the HTTP received traffic in solution scenario

Figure5.5 illustrates the throughput and delay .As we see the throughput increases over time and the delay was 0 in all time which means the network was very efficient.

Throughput (Represents the total number of bits (in bits/sec) forwarded from wireless LAN layers to higher layers in all WLAN nodes of the network.)Delay (Represents the end to end delay of all the packets received by the wireless LAN MACs of all WLAN nodes in the network and forwarded to the higher layer. This delay includes medium access delay at the source MAC, reception of all the fragments individually, and transfer of the frames via AP, if access point functionality is enabled.)

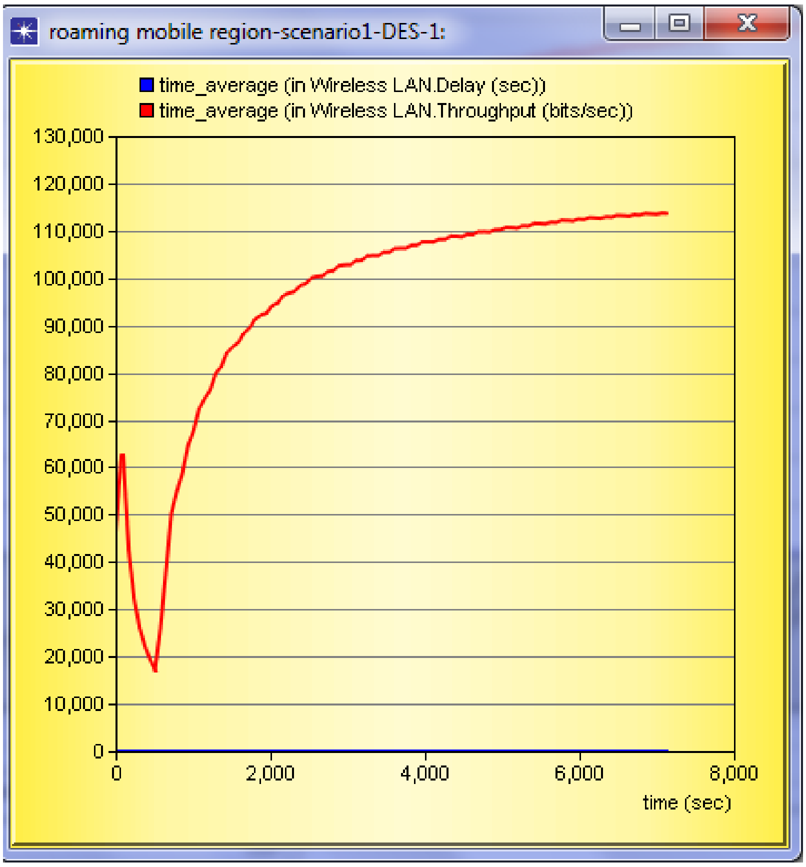


Figure 5.5 Wireless LAN in solution scenario

Figure 5.6 Illustrates Traffic Received (Average bytes per second forwarded to the application layer by the TCP layer in this node, for all connections. Calculation method: number of bytes forwarded divided by the current simulation time), and delay time per sec. As we can see that the traffic received increases with time because the mobile moves around the home AP and decreases because mobile move far away from home AP, the delay 0 at all simulation time indicates that the network is working well.

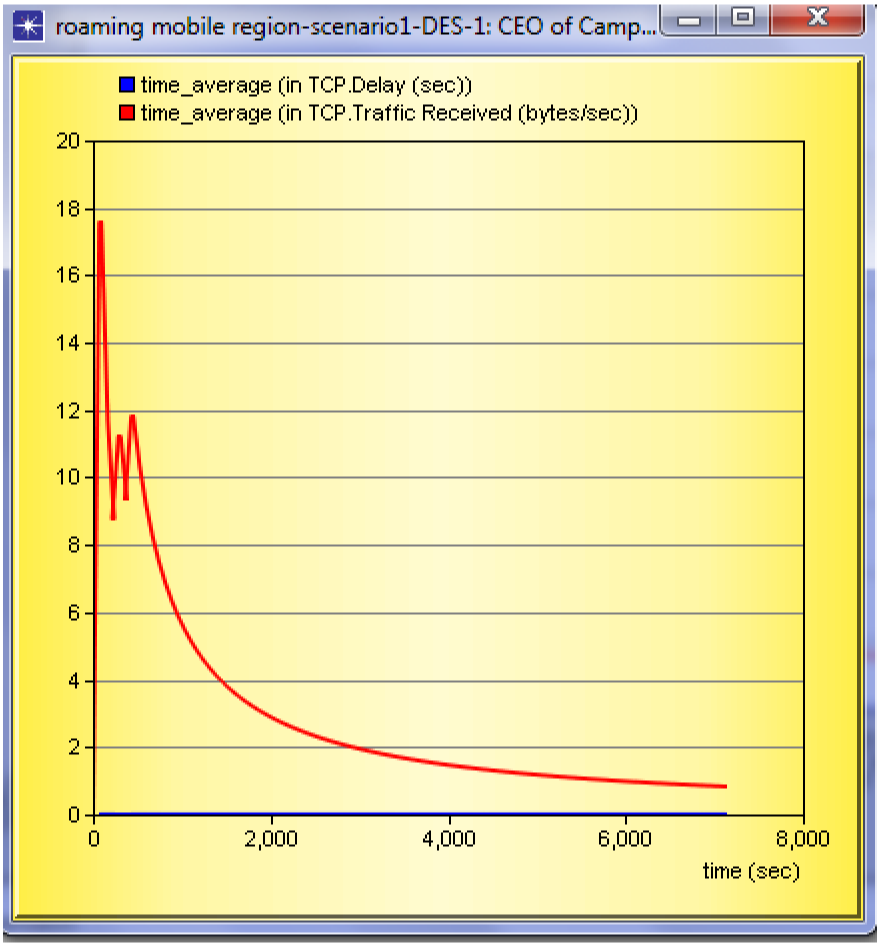


Figure 5.6 CEO mobile node connectivity status in solution scenario

Figure5.7 Compares the CEO connectivity in the two scenarios .The red color illustrates the solution scenario where the throughput was begin with high value because the mobile is near the AP and reduces because the mobile moves far away but still finds connection from another AP. the blue color illustrates the problem scenario where the throughput was begins with 0 because the mobile moved far away from the AP and when the mobile moves back to the home AP the throughput increases and then decreases again because the mobile moves far away again to an area with no coverage.

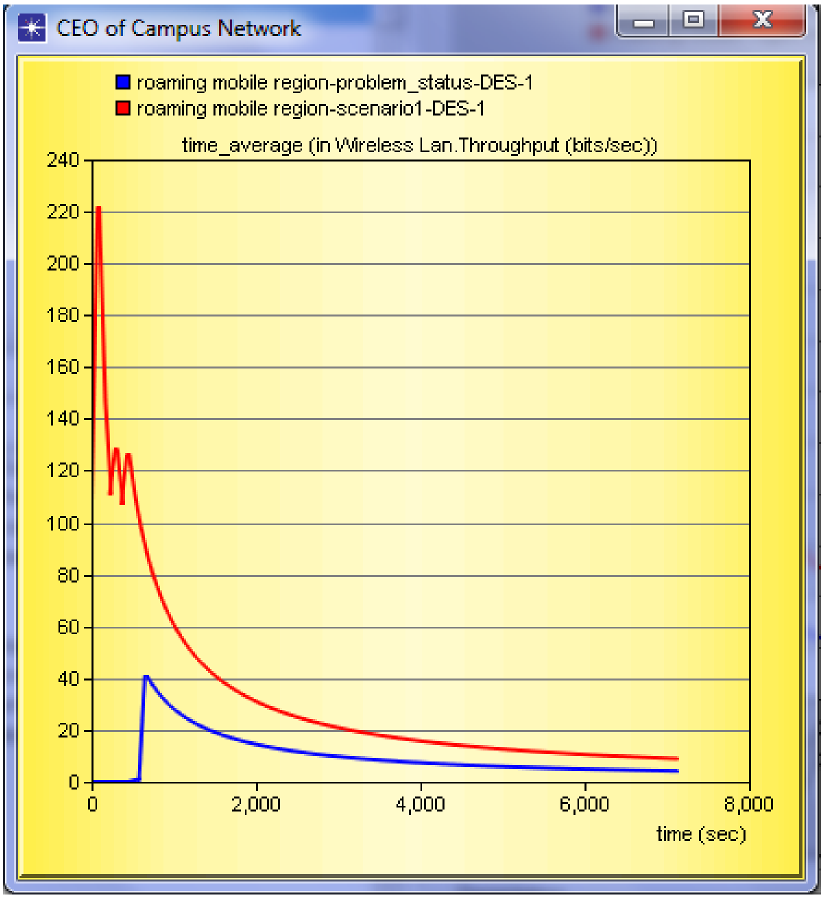


Figure 5.7 CEO mobile node connectivity status compared between problem scenario and solution scenario

Figure 5.8 shows received FTP traffic in the considered scenarios .The red color illustrates the solution scenario and blue illustrates the problem scenario. The difference between the two scenarios is not clear because the effect of the CEO mobile node is insignificant over all the network.

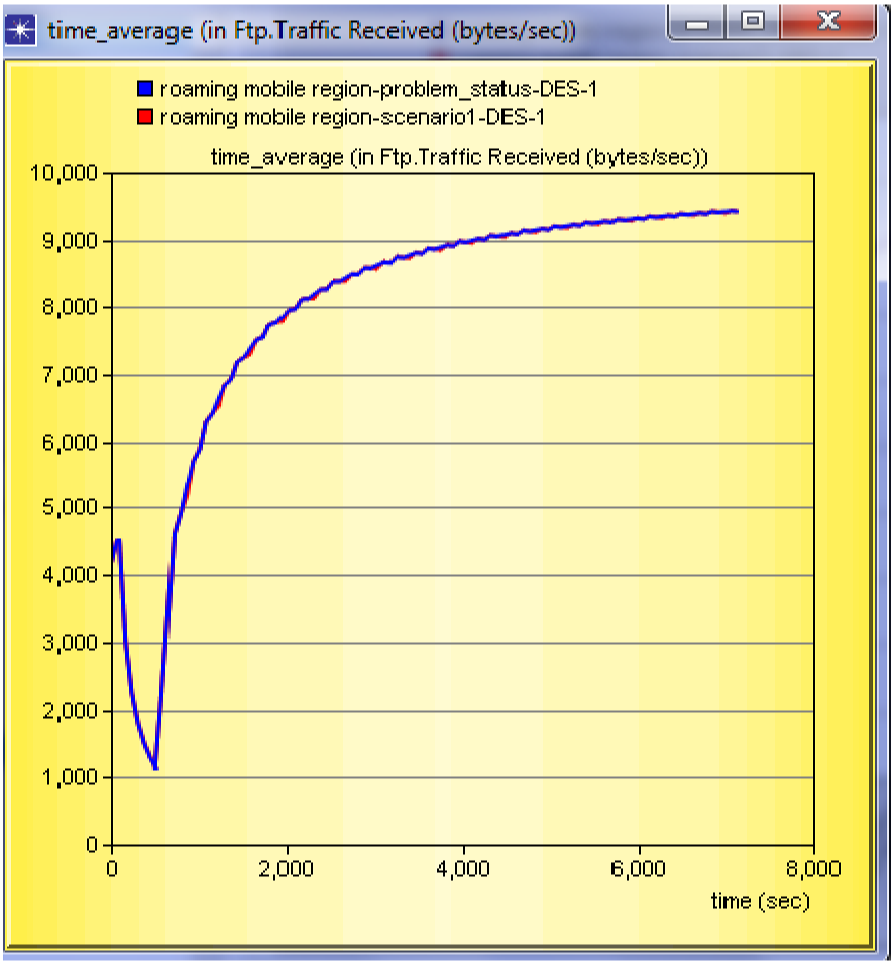


Figure 5.8 FTP the Traffic Received compared between two scenarios

Figure5.9 illustrates FTP sent traffic in the two scenarios. Similar to the received traffic, the two scenarios result in the same sent traffic.

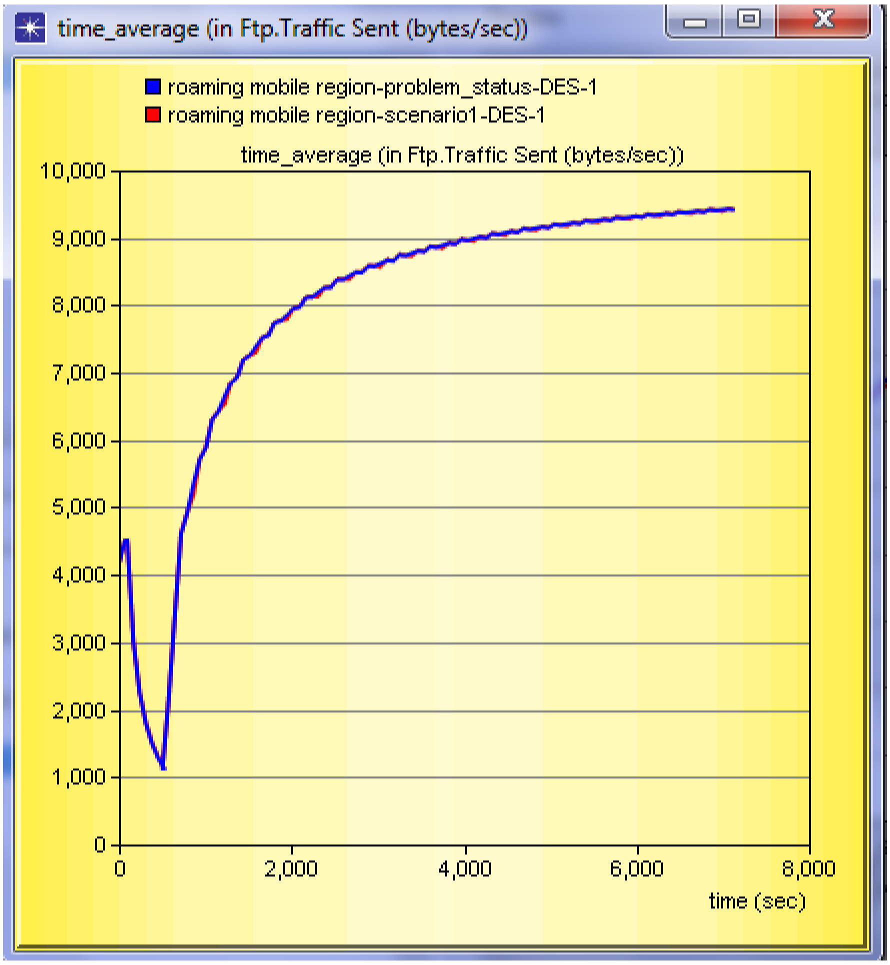


Figure 5.9 FTP The Traffic sent compared between two scenarios

Figure5.10 the sent and received HTTP traffic shows in Figure 5.10 is similar under both scenarios. The sent and received HTTP shown in Figure5.10 and Figure5.11, respectively are similar under the two considered scenarios.

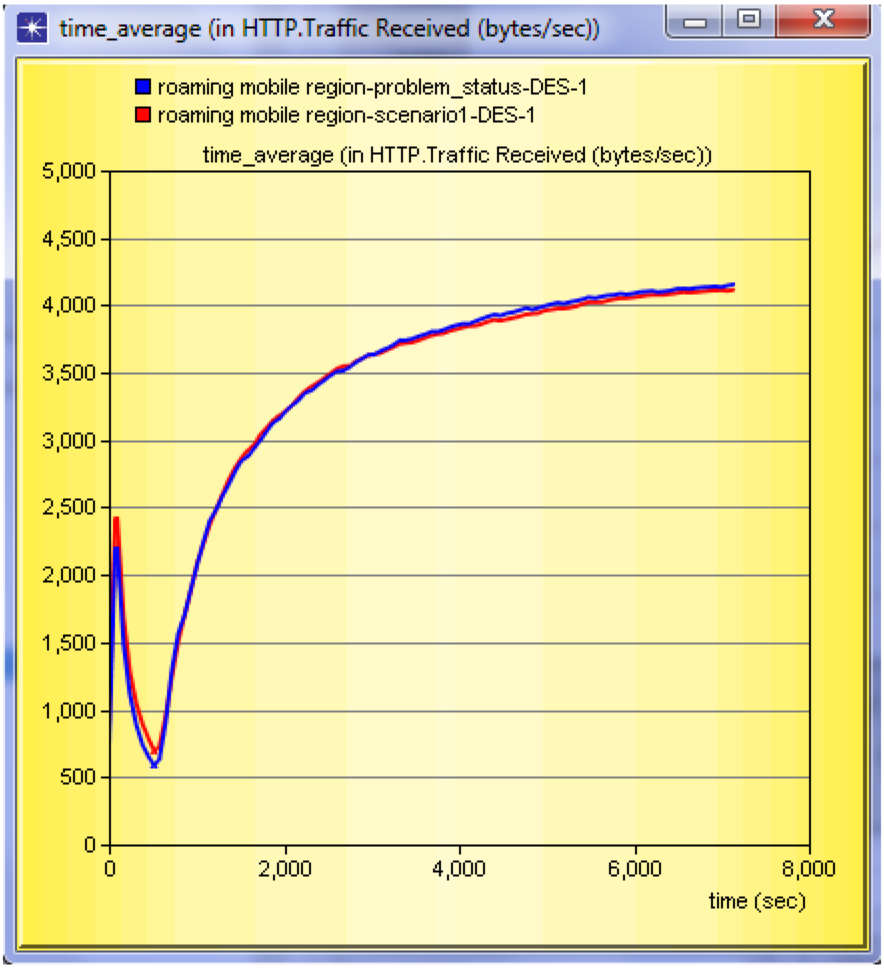


Figure 5.10 HTTP the Traffic Received compared between two scenarios

Figure 5.11. Similarly, the wireless LAN throughput is the same for both scenarios as can be seen in .

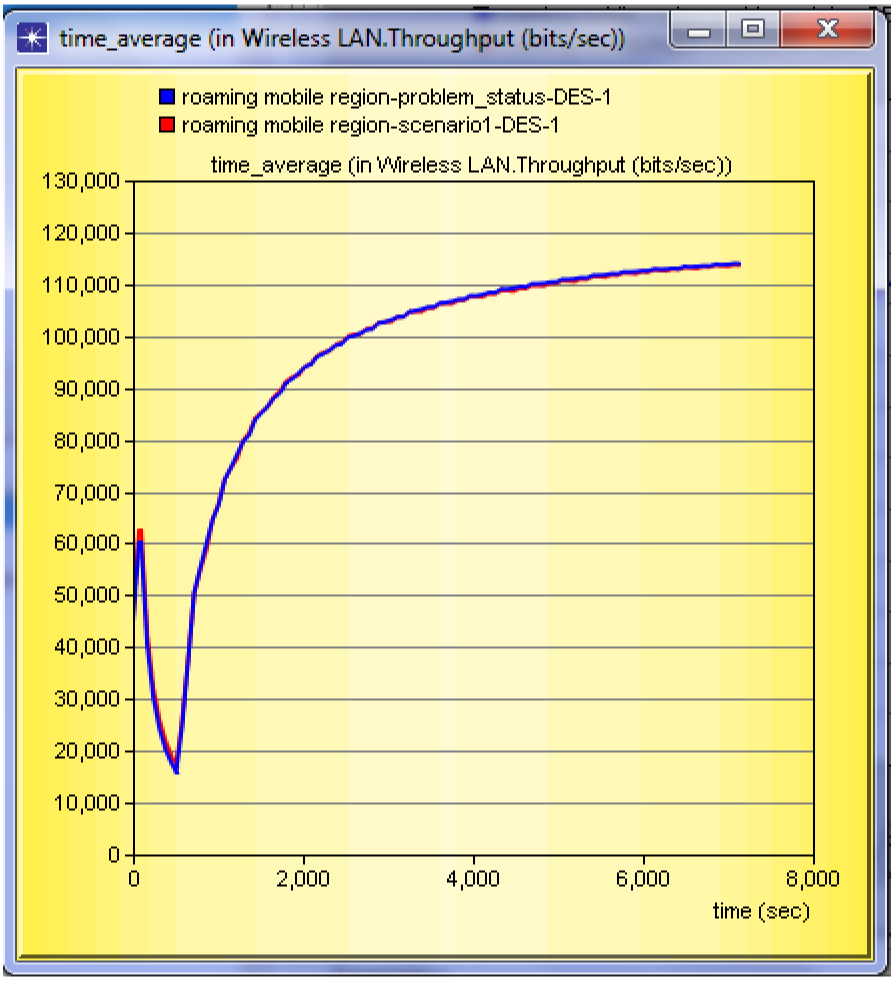


Figure 5.11 Wireless LAN throughput compared between two scenarios

Summary:-

We show in Figure 5.3 sent and received traffic in FTP to validate that network is working the same is shown in Figure 5.4 for HTTP traffic.

In Figure 5.5 we shown wireless LAN connectivity throughput and delay where see the throughput increases over time and the delay was 0 all the time which confirms the network efficiency.

Figure 5.6 shows the CEO mobile node connectivity (CEO is the mobile node which can move around all APs). We illustrated Traffic Received and delay time per sec where we see that traffic received increases with time because the mobile moves around the home AP and then decreases because the mobile moves far away from the home AP. The delay is 0 at all simulation time and this result indicates that the network is efficient.

Figure 5.7 compares the CEO mobile node connectivity status in the problem scenario and the solution scenario. The throughput begins with high values because the mobile is near the AP and then reduces because the mobile moves away but still finds connection from other APs in the solution scenario.

However in the problem scenario the throughput start at 0 because the mobile moves far away from the AP and when the mobile moves back to the home AP the throughput increases and then decreases again because the mobile move is far away again and no cellular coverage is available.

In Figures 5.8, 5.9, 5.10 and 5.11 the difference between the two scenarios is insignificant because the effect of the CEO mobile node is very small over the entire network.

CHAPTER SIX

Conclusions and Future work

CHAPTER SIX

Conclusions and Future work

6.1 conclusions:-

The thesis has presented work is about the Effect of National Roaming for Service Availability (Case Study: Tracking Service in Sudan).

We use the OPNET simulation tools using IP mobile Roaming scenario including mobile nodes, 9APs with authorization to move around some regions of coverage used IPv4 and the mobile movement authority to all access points. We then duplicate the scenario to see the effect if the mobile moves far away from the AP and coverage is not available.

We analyze the results of the solution scenario if the mobile has the authority to roam in the coverage area and see the effect in the network throughput and delay.

The result show that there is no difference in the whole network performance.

However, the effect is very clear for the (CEO) mobile node ,as it remains in the coverage area when national roaming is allowed ,but is out of coverage in the first scenario.

6.2 Future work:-

To improve the current work, the following is suggested:-

1. Adding more mobile devices and regions then give authority to more mobile devices to roam around areas and study the effect on QoS.
2. Identifying the exact number of APs required to get the best coverage and maintain a connection to give the customer the information needed efficiently.
3. Evaluating national roaming for more than two networks.

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