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BE Computer,

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ABSTRACT

In heterogeneous wireless networks, the context-awareness is more advantageous offering the user with different services and network capacity. In order to select the appropriate network such as coverage area, RSS, available bandwidth, delay, response time, jitter, security, user preference, cost, etc there is an increasing need for context-awareness. Consequently, there is a necessity to investigate context-aware methods that characterize the roaming from any access network to any other access network (For an example: migrating from GPRS to Wi-Fi and Wi-Fi to 3G ,vice versa).

We implement an intelligent handover decision policy able to classify the candidate's point of attachment based on their provided context and the required mobile user context. The decision policy will be realized using an algorithm to choose the appropriate context to be used for making decision for mobility management and handover process. Also, evaluate tradeoffs between the wireless technologies.

Abbreviations

Abbreviated	
CN	Cellular Network
Wi-Fi	Wireless Fidelity
3G	3rd Generation
GPRS	General Packet
HO	Handover
HHO	Horizontal Handover
VHO	Vertical Handover
QoS	Quality of parameter
RSS	Received Signal Strength
MT	Mobile terminal
MN	Mobile Node
MH	Mobile Host
BS	Base Station
MADM	Multiple Attribute Decision Method
GRA	Grey Relational Analysis
TOPSIS	Technique for Order Preference by Similarity to Ideal Solution
AHP	Analytic Hierarchy Process
FL/AI	Fuzzy Logic/ Artificial Intelligence
CA	Context Aware
SAW	Simple Additive Weighting
MIH	Media Independent Handover
RTT	Round Trip Time
MEW	Multiplicative Exponent Weighting
RA	Relaxed Atomicity
ACID	Atomicity Consistency Integrity Durability
dBm	Decibel in mill watt
VN	Vehicular Network

List of Tables

List of Figures

Introduction

Chapter 1

Introduction

1.1 Motivation

Mobile network is made up of cells, each served by at least one fixed location transceiver called as base station. In a cellular system as distributed mobile transceivers move from cell to cell during an ongoing continuous communication mobile unit automatically switches from current channel to new channel and communication continues. With diverse wireless technologies there has been an evolution of wireless network towards heterogeneous infrastructure; users thus demand for the freedom to roam globally among multitude POA of different access networks as per service requirements. Such heterogeneity calls for a system to adapt to different execution conditions at different contexts, hide the heterogeneity from application and transparently and dynamically switch between network technologies. Heterogeneous wireless networks incorporate different radio access technologies. Future wireless networks are expected to consist of different types of wireless networks, each providing different access bandwidth and coverage level. Example, to utilize high bandwidth in Wi-Fi resource for mobile users in hotspots and switch to cellular networks (CN) when the coverage of Wi-Fi is not available or the network condition in one is not good enough. The challenge in internetworking of these heterogeneous networks is to provide high performance by achieving high data rate with high QoS levels. Wireless access networks vary greatly by nature, for example, with regard to data rate, coverage, supported mobile velocity, anti-interference, and suitable transmitting environment [1]. Usually networks with bigger coverage are of lower data rate, and vice versa. It has been well recognized that no single access technique can fulfill all the requirements. Parameters can be categorized as static and dynamic. Static parameters are battery, application parameters, etc, whereas, dynamic parameters are network parameters, user preferences, velocity etc. Moreover, the QoS parameters of each single wireless network vary dynamically over time as well, in terms of reliability and availability, bandwidth, delay, jitter, RTT, and packet-loss rate. User mobility leads to continuous changing of location and environment, network operator and service provider, and access networks . These highly dynamic factors in mobile devices, wireless networks, and end users have led to the demand for adaptive seamless connectivity management, so that diverse networking resources can be optimally utilized in a simultaneous, collaborative, and complementary way [17]. Thus principle objective is to design a model which involves simple mathematical calculations and yet select the optimum resources considering multiple criteria maintaining seamlessness.

1.2 Aim

Implement an intelligent handover which provides the user application, flexibility between active interfaces that best suit them based on application, user requirements and interface capabilities

1.3 Objectives

- Attain seamless connectivity
- Convenience for user

1.4 Minimum Requirements

The minimum requirements are:

1. Device supporting Android 4.1 (Jellybean)
2. Wi-Fi access, GSM connectivity(GPRS, Wi-Fi, HSPDA)

1.5 Mathematical model for existing system

Let us consider **'S'** as a system for vertical handover system.

S={..........

- **Identify the inputs**

Let '**I**' is a set of inputs.

I={N,AT,MT,M,NT,A}

N={N_0 U N_1 U N_2 U.....N_n}

AT={ AT_0 U AT_1 U AT_2 U.....AT_n }

MT={ MT_0 U MT_1 U MT_2 U.....AT_n }

NT={ NT_0 U NT_1 U NT_2 U.....NT_n }

A={type of application}

- **Output**

Let **'O'** be the set of output

O={ N_0 **}**

Where

N_0={Final network selected for switching}

1.6 Functions performed

Let **'F'** is a set of Functions.

F={Discover_network(), Detect_network_parameter(), Detect_mobile_parameter(), take_user_prefernce(), select_algorithm(), get_applicationthreshold(), get_networkthreshold(), compare_network_QoS(), Sort_network(), compare_current_network(), swich()}

- discover_network() =N capture the incoming network type.
- detect_network_parameter(N)=N capture network parameter.
- detect_mobile_parameter()=M capture mobile parameter.
- take_user_prefernce()=A application running.
- select_algorithm(N_{0_RSS},$N_{0\_Bandwidth}$,mobility(),$AT_{RSSthreshold}$,$AT_{Bandwidththreshold}$) = {AHP,Reflex} will select AHP or Reflexive algorithm.
- get_applicationthreshold(AT,type) = AT_i will return values based on currently running application.
- get_ networkthreshold(NT,type) = NT_i will return values for given network .
- compare_network_QoS(NT_i,AT_k,N) = N will return if it satisfies the condition.
- sort_ network(N) = N will return network in Sorted order.
- compare_current_ network(N_0,N_1) = N_0 will return the best network between current network and highest priority network.
- switch(N_0) = will switch to selected network.

1.7 Data Structure to be used.

For each input and output set we can use the appropriate data structure as follows.

Table 1: Data Structures

Sr. no	Set	Data Structure
1	N	ArrayList
2	NT	ArrayList
3	AT	ArrayList
4	A	String
5	MT	ArrayList
6	M	ArrayList

1.8 Product Scope

It's an efficient and user friendly mobile application. User needs to install this system in his mobile before using its services. It enables user application to switch automatically between active interfaces that best suit them based on an application requirements, user requirements and interface capabilities. It is a research project on vertical handover between 3G, Wi-Fi and GPRS.

1.9 Organization of Report

This report is categorized in 8 main chapters. The first chapter is a brief introduction to the topic. The second chapter is, Project planning management, it comprises of Software requirement specification, risk analysis, estimation facts. Third chapter is Literature Survey, covers the background of the concept, strategies and feasibility study. Fourth chapter covers the system overview, this focuses on the main concepts of the title. Fifth is, Design; contains mathematical model, class diagram, activity, sequence and deployment diagram. Sixth, comprises of Testing, various tests as unit testing, integration testing and validation testing are done. Seventh chapter confers the results attained through readings, graphs etc. Eighth chapter contains a conclusion and future approach to the project. Towards the end of the report; synopsis, paper published at Journal Of Harmonized Research is enclosed.

Project Planning and Management

Chapter 2

Project Planning and Management

2.1 Software Requirement Specification

2.1.1 Purpose

A system with an intelligent handover decision policy which considers all necessary metrics to evaluate the best suited interface based on application requirements, user requirements and interface capabilities ensuring optimum usage of network resources available to the terminal. It chooses the appropriate context for making decisions for mobility management and handover process to ensure seamless connectivity.

2.1.2 Intended Audience

This documentation is intended for user. The rest of the SRS is organized in systematic manner covering all necessary topics like project scope, references and overall description of project, system features and non functional requirements. For best understanding of usage and functionality of the project for any reader it can be read in the same given flow of description.

2.1.3 Implementation Constraint

1. Network interface selection

This is to ensure that the best connection is used by the application at any time. Some rules must exist for the determination of "the best" connection, in which information about user, device, net- works, and applications has to be examined.

2. Connection switching

When the application is operating on data transmission, network status is subject to change. At some point a better connection may be available to the application or the used one is lost. Then the connection should be automatically and seamlessly switched to the new one while maintaining the connection's continuity.

3. Disconnection treatment

During the period that no valid network connection is available, I/O requests of the application should be suspended. The operations have to be resumed later when one qualified interface becomes available.

4. Perception of application

Network-aware applications need to be aware of connectivity contextual information (such as chosen interface, connection status, available bandwidth, delay, etc.), so that application may adjust its activities accordingly. Threshold based approach is sensitive to changes in devices, network environments and user behaviors.

2.1.4 Operating Environment

A device which supports Android 4.1 (jellybean) and more is required.

2.1.5 Assumptions and Dependencies

1.Network Interfaces should be available.

2.If system gets corrupted then reinstallation is needed.

3.Thresholds for application, network and mobile are assumed on basis of test cases.

2.1.6 Software Requirement

1. Android 4.1 (jellybean)
2. Java SDK (Eclipse 7.1)

2.1.7 Factors responsible for handover

The desired features of handovers are listed as follows:

• Wireless technology:

The wireless technology used in the wireless network also decides the cell size and cell topology and the traffic model. Nowadays networks may employ multiple wireless technologies simultaneously such as: Bluetooth, Wi-Fi, GSM and UMTS. This leads to a new requirement of handover procedures between two different wireless technologies; this is called vertical handover.

• Cellular structure:

The cellular structure determines the handover due to cell size. There are five types of cells ordered by size: umbrella cell, macro-cell, micro-cell, pico-cell, and femtocell. When the cell size decreases, for a given MS mobility scenario, handover is more frequent and the time constraint will also be more stringent.

• Topographical features:

Topography is an important element of the design of a wireless network. Part of this is the selection of the antenna locations. This together with the trajectories of the users' movement determines the performance of the handover.

• Mobility:

The speed and direction of the user also affects the handover. When the user moves fast, time for handover is shorter and hence the handover algorithms should deal with this requirement.

• QoS:

Whenever the QoS decreases such as the bandwidth or packet loss, the handover may be requested to connect with another BS that can guarantee the QoS.

2.1.8 Other Nonfunctional Requirements

1)Performance Requirements

1.1) Response Time

The terminal should perform network discovery in minimum possible time.

2)Recoverability Requirements

System should be able to maintain a specified level of performance in cases of software faults or when all the resources are not available.

3)Learnability Requirements

The operation of the product can be rapidly mastered by the intended user.

4)Portability Requirements

The system must adhere to standards or conventions relating to portability.

5)Installability Requirements

Other software's of terminal should not be affected by installation of system. System should be removed cleanly when uninstalled.

6)Compatibility Requirements

The system shouldn't unnecessarily hog memory, storage, or other system resources. It should maintain operating system compatibility.

2.1.9 Business Rules

1. User needs to successfully install system in mobile
2. If current network interface is not the best option then automatically will switch to the best network interface without interrupting the working application.
3. The latency of the handover must be low. The handover should be fast enough so that the user cannot detect any degradation of service or interruption during a handover.

4.Given a particular trajectory of a MS, the total number of handovers should be minimal while the ratio of successful handovers to total attempted handovers should be maximized.

5. Multiple Wi-Fi should be discovered, if exists.

2.1.10 System Feature

This handover decision policy nconsiders all required metrics to evaluate the best suited network interface based on application requirements, user requirements, interface capabilities as well as the previous handovers ensuring optimum usage of network resources available to the terminal. It chooses the appropriate context for making decisions for mobility management and handover process to ensure seamless connectivity. This provides seamless connectivity with convenience to the user.

2.1.11 Efforts and Estimation

1. Efforts (usually in person-months)
2. Project duration (in calendar time)

LOC is the number of lines of delivered source code of the software, excluding comments and blank lines, commonly known as LOC. Although LOC is programming language independent, it is most widely used software metric. However, exact LOC can only be obtained after the project has been completed. Estimating the code size of the program before it is actually built is almost as hard as estimating the cost of the program.

Table 1: LOC based estimation

Sr. No.	**File**	**Estimated LOC**
1	Main Activity	30
2	Network	354
3	Network Manager	207
4	Application	34
5	Threshold	30
6	ExecuteSwitch	50
7	Terminal	50
8	WifiThreshold	10
9	NonrealThreshold	10
10	RealThreshold	10
11	MobileNetworkThreshold	05
12	HSPDAThreshold	10
13	EDGEThreshold	10
Total	**Estimated LOC**	810

2.12 Risk Analysis

Table 2: Risk Analysis

Sr. No.	Risk (Description of risk)	Category	Probability	Impact	Risk Management
1	Customer will change requirements.	PS	30%	4	Buffer time is kept in schedule to implement the changes.
2	Lack of training on tools	DE	30%	2	Training is scheduled well before the implementation starts
3	Large amount of memory required by the system.	PS	40%	2	Reduce number of history records.
4	User may not adapt to the system easily.	CC	20%	4	Redesign User Interface to make it more user friendly.
5	Lack of sufficient hardware resource.	CC	40%	2	Upgrade resources in order to meet minimum specified hardware requirements.
6	Lack of wireless networks environment.	CC	10%	1	Use system in sufficient wireless environment.

Impact values can be decided as:

1 – Catastrophic

2- Critical

3- Marginal

4 – Negligible

The risk categories are as follows:

- PS – Product Size
- BI - Business Impact
- CC – Customer Characteristics
- PD – Process Definition
- DE – Development Environment
- TB – Technology to be Built
- SS – Staff Size and Experience

2.13 Task Set

Table 3: Task Set

Phase	**Task**	**Description**
Phase 1	Literature Survey	Gather IEEE papers, Springer & ACM papers about the mobility management, handover and approaches for handover, etc.
Phase 2	Analyze	Sort information required for our system, decide methodology, algorithms, resources needed, software and hardware requirements.
Phase 3	Design	Deciding flow of the system ,parameters to considered, interfaces, creating UML diagrams.
Phase 4	Implementation	Deciding flow of the system ,parameters to considered, interfaces, creating UML diagrams.
Phase 5	Testing	Test the code and overall process , approach for unit testing , acceptance testing, system testing.
Phase 6	Documentation	Prepare documents for this project.

2.14 Functional Decomposition

The system requirements are defined in as much detail as possible. This usually involves interviewing a number of users representing all the external or internal users and other aspects of the existing system. The six functions may basically be viewed as follows.

Task 1: Handover Information Gathering

Here, this task collects all the network information, terminal information as well as application information.

- Network information consists of throughput, cost, packet loss ratio, HO rate, RSS, jitter, location, and QoS parameters.
- Mobile Terminal information about battery status, resources, speed, and service class.
- User preferences information such as application services required.

Task 2: Maintain Context Repository

A context aware service senses the user's current context and changes to that context and adapts its behavior to the user's needs accordingly. It provides flexible and context-aware services, a system must be able to know at any given time the network status, user location, profiles of various entities(user, MT, network equipment and services) involved , and system policies, i.e., able to cope with a large amount of context information.

Task 3: Handover Decision Making

Based on the gathered information, this phase is responsible for deciding 'When' and 'Where' to trigger the handover. The 'When' decision refers to the precise instant in time to make an optimal handover, while the 'Where' refers to selecting the best network achieving the requirements for the switching. This is done by collecting and comparing contextual information. Determining whether a handover is needed (i.e., handover initiation) and how to perform it by selecting the most suitable network (i.e., network selection) based on decision criteria appropriate decision algorithm.

Task 4: Handover execution

Execution phase performs the handover itself; besides performing the handover, the phase should also guarantee a smooth session transition process.

2.15 Software sizing

The constructive cost model (COCOMO) is generally used for estimation of cost, project duration, man power etc. Like all estimation models, the COCOMO model requires sizing information. the information can be specified in the form of :

- Object points
- Function points (FP)

  A function point is a rough estimate of a unit delivered functionality of a software project. FP measure size in terms of amount of functionality in a system. Function points are computed by first calculating an unadjusted function point count (UFC).

  Counts are made for the following categories :

- Number of inputs
- Number of outputs
- Number of handovers
- Number of external interfaces

The counts for each level of complexity for each type of component can be entered into a table such as the following one. Each count is multiplied by the numerical rating shown to determine the rated value. The rated values on each row are summed across the table, giving a total value for each type of component. These totals are then summed across the table, giving a total value for each type of component. These totals are then summoned down to arrive at the Total Number of Unadjusted Function Points.

Table 4: Unadjusted function points

Type of Component	**Complexity of Component** (no of components * rating of particular level)			
	Low	**Average**	**High**	**Total**
External inputs	2* 3=6	2* 4=8	0 * 6=0	14
External Output	0 * 4=0	0 * 5=0	1 * 7=14	7
External Inquiries	0*3=0	4*4=16	0 *6=0	16
Internal Logic files	0*7=0	4*10=40	0*15=0	40
External interface files	0*5=0	0*7=7	1*10=10	10
	Total number of unadjusted function points			87

The value adjustment factor (VAF) is based on 14 general system characteristics (GSC's) that rate the general functionality of the application being counted. Each characteristic has associated descriptions that help determine the degrees of influence of the characteristics. The degrees of influence range on a scale of zero to five, from no influence to strong influence. The IFPUG Counting Practices Manual provides detailed evaluation criteria for each of the GSC'S, the table below is intended to provide an overview of each GSC.

Table 5: Overview of GSC

Sr. no	**General system characteristics**	**Description**	**Rating**
1	Data communications	How many communication facilities are there to aid in the transfer or exchange of information with the application or system?	4
2	Distributed data processing	How are distributed data and processing functions handled?	4
3	Performance	Was response time or throughput required by the user?	5
4	Heavily used configuration	How heavily used is the current hardware platform where the application will be executed?	3
5	Transaction rate	How frequently are transactions executed daily, weekly, monthly, etc.?	4
6	On-Line data entry	What percentage of the information is entered On-Line?	2
7	End-user efficiency	Was the application designed for end-user efficiency?	5
8	On-Line update	How many ILF's are updated by On-Line transaction?	2
9	Complex processing	Does the application have extensive logical or mathematical processing?	3

10	Reusability	Was the application developed to meet one or many user's needs?	2
11	Installation ease	How difficult is conversion and installation?	2
12	Operational ease	How effective and/or automated are start-up, back-up, and recovery procedures?	3
13	Multiple sites	Was the application specifically designed, developed, and supported to be installed at multiple sites for multiple organizations?	4
14	Facilitate change	Was the application specifically designed, developed, and supported to facilitate change?	3
	Total		**46**

Once all the 14 GSC's have been answered, they should be tabulated using the IFPUG Value Adjustment Equation (VAF)

1) VAF = ∑ 0.65 + [(Ci) / 100] , i = is from 1 to 14 representing each GSC.
2) Ci = degree of influence for each General System Characteristic
3) In this system, VAF= 9.56.
4) The final Function Point Count is obtained by multiplying the VAF times the Unadjusted Function Point (UAF).
5) FP = UAF * VAF
6) FP=87* 9.56=831.72 function points.

LITERATURE SURVEY

Chapter 3

Literature Survey

3.1 Background

Vertical handover, or intersystem handover, involves handover between different types of networks. Traditional handover algorithms were based only on RSS or a combination of RSS and available bandwidth to decide the handover time. A combination algorithm was introduced where, available bandwidth, network traffic were considered based on neural networks. Later a cost based function was introduced to manage handover such that user's active applications are individually handed over to target networks with minimum cost. A handover decision is performed based on a perception of channel quality reflected by the received signal strength and other measurements, and the availability of resources in the new cell. The base station usually measures the quality of the radio link channels being used by mobile nodes in its service area. This is done periodically so that degradations in signal strength below a prescribed threshold can be detected and handover to another radio channel or cell can be initiated. Under network-controlled handover (NCHO) or mobile-assisted handover (MAHO), the network makes the decision for handover, while under mobile-controlled handover (MCHO), the mobile node takes its own signal strength measurements and makes the handover decision on its own [15]. While performing handover, the mobile node's connection may be created at the target base station before the old base station connection is released. This is referred to as a make before break handover. On the other hand, the new connection may be set up after the old connection has been torn down, which is referred to as a break before make handover. In either case, the mobile node executes a hard handover, which means that the mobile node can only communicate on a channel with one base station at time.

3.2 Handover Decision Scheme

3.2.1 Reflexive – A RSS based strategy

Reflexive methodology, a vertical handover decision algorithm designed for dynamic environments where RSS and available bandwidth are compared to their threshold values and a rapid decision is taken in a dynamic situation. Vehicular environments, latency issues must be addressed in this algorithm.

3.2.2 User Centric

A handover is specified from the perspective of the user, as per cost and QoS. With this handover performance of some user application running on user terminal improves (HTTP, FTP and telnet) while others become worse [21].

3.2.3 Multiple Attribute Decision Making (MADM) Strategy

After referring we conclude that the decision making algorithm considers the QoS parameters required for the applications (e.g. the bandwidth required). Each candidate network is compared with the previous best network. The chosen network is the one which provides the best optimized results.

3.3 MADM Strategies

3.3.1 Simple Additive Weighting (SAW):

In SAW, the network scores are given by a weighted sum of the considered metrics. The normalized value of each attribute is multiplied with weights assigned to those attributes. Then the total score of each attribute is calculated by considering all the considered metrics selecting the highest score [17].

3.3.2 Multiplicative Exponent Weighting (MEW):

In MEW, the matrix considered has N number of alternative and M number of criteria against them. The selected network is the best value of each matrix. The highest value is considered as preferred one and the lower value is considered as the last option available [17].

3.3.3 Technique for Order Preference by Similarity to Ideal Solution (TOPSIS):

In TOPSIS, the selected network is closest to the ideal solution. This selected network is obtained by considering the best value for all the considered metrics.

TOPSIS has two artificial alternatives:

1) Ideal alternative: It is the best option to be considered that represents the best value for each metric.

2) Negative alternative: It is possibly the last option to be considered is no other option satisfies the policy. It probably has the worst attribute value.

TOPSIS makes the decision of alternative that is very near to the best result and very far from Negative option alternative [17].

3.3.4 Grey Relational Analysis (GRA):

GRA is used to rank the networks and selects the one with the highest rank. Ranking is performed by considering the grey relationships with the ideal network. A normalization process is required to deal with the cost and benefit metrics required. The Grey Relational Coefficient (GRC) of each network is calculated which describes the score of similarity between each network and the ideal network. The selected network has the highest GRC score [17].

3.3.5 Context Aware (CA)

Context-Aware strategy not only considers mobile terminal information, and network information, but also considers user preference, that is, the information about the application that is running. It supports multi criteria consideration, real time support and high user consideration. Medium implementation complexity, medium throughput and high delay are its short comings. Research states the comparisons of various methodologies and algorithms. In this experiment we implement Context

Aware methodology through AHP and a reflexive algorithm, which is a RSS based algorithm as per the handover scenario for seamless connectivity.

3.3.6 Analytic Hierarchy Process (AHP) - A Context Aware methodology

In AHP, list of threshold values and a list for the set of attributes attained from various contexts as per an application. A comparison list is generated that represents the pair-wise comparison between both the lists. Then the networks are prioritized and best valued network is approached.AHP avoids the process of fuzzification and defuzzification, it involves user consideration and has medium implementation complexity. It decomposes the network selection problem into sub problems. The candidate networks are then ranked and the best one is selected.

3.3.7 Fuzzy Logic and Artificial Intelligence (FL/AI) Strategy

Fuzzy logic can be viewed as a theory for dealing with uncertainty about complex systems, and as an approximation theory. Fuzzy logic has two objectives,

a) to develop computational methods that can perform reasoning and problem solving tasks

b) to explore an effective trade-off between precision and the cost in developing an approximate model of a complex system.

Fuzzy logic is used to represent the imprecise information of some attributes and user preferences. For example, in fuzzy logic, the sojourn time can be represented as {short, long, very long}. A fuzzy logic based algorithm adopts the RSS threshold and hysteresis values as input parameters. FL includes fuzzification and defuzzification which increases the implementation complexity.

Table 1: VHO Decision Strategies[21]

VHO decision strategy	**Traditional (RSS- based)**	**UC**	**MADM**	**FL/NN**	**CA**
Multi –criteria	No	Yes	Yes	Yes(FL) No(NN)	yes
User consideration	No	High	Medium	Medium	High
Efficiency	Low	Medium	High	High	High
Flexibility	Low	High	High	Medium	High
Implementation complexity	Low	Low	Medium	high	Medium
Service type supported	Non-real-time	Non-real time	Non-real time and real-time	Non-real time and real-time	Non-real time and real time

Table 2: Comparison of various VHO decision strategies

Sr. No.	VHO Decision Strategy	Advantages	Disadvantages
1)	RSS Based	Low implementation Complexity	No multimedia Criteria
			No user consideration
2)	UC	High user consideration	No real time support
		Low implementation complexity	
3)	FL/AI	Multi Criteria Consideration	Weak user consideration
		Real time support	Medium Implementation Complexity
4)	MADM	Real time support	High Implementation Complexity
		Multi Criteria Consideration	
5)	CA	Multi Criteria Consideration	Medium Implementation Complexity
		Real time support	Medium Throughput
		High user consideration	High Delay

MEW, SAW, and TOPSIS provide similar performance to traffic classes. GRA provides a slightly higher bandwidth and lower delay for interactive and background traffic classes.

3.4 IEEE 802.21 MIH

The IEEE 802.21 group is developing standards to enable handover and interoperability between heterogeneous network types. The IEEE 802.21 Media Independent Handover standards (IEEE 802.21 MIH) address that requirement by enabling handover between IEEE 802 networks and non-IEEE 802 networks through a MIH framework. MIH service access points (MIH SAPs) has been a media independent interface common to all technologies MIH function enhances the handovers across heterogeneous access networks, i.e. vertical handover, and to optimize the session continuity during handover[19].

3.5 Feasibility Study

The feasibility for vertical handover system can be

```
DecisionAlgo(N,NT,AT,MT,M,A)    // Core algorithm for handover decision
{
        If(decideAlgo(N[0,RSS],N[0,Bandwidth],mobility,NT[k,RSS],NT[k,Badwidth)!=0)
        {       // Perform AHP
                compareQOS(N,NT[i],AT[j]);
                comapeParameters(M,MT);
                prioritiseNetwork(N);
                if(compareNetworks()==N[1])
                        switch(N[1]);
        }
        Else            // Perform Reflexive
        {
                compareQOS(N,NT[i],AT[j]);
                switch(N[i]);
        }
}
```

The network parameters are compared with their threshold values and applications threshold value this can be done in polynomial amount of type. For sorting is done using ArrayLists' inbuilt function and SJF technique of scheduling. This sorting is done in polynomial amount of time. Also in last function we are comparing current networks parameters with best selected networks parameters. This can be done in polynomial amount of time.

As we are not using backtracking technique and all the functions can be solved in polynomial amount of time we can say that our problem lies in **P domain and not in NP domain**.

System Overview

Chapter 4
System Overview

4.1 Mobility Management

Tracking the location of the mobile subscribers, allowing continuity of calls and other services is the objective of mobility management. Various queuing modeling techniques have been developed to manage mobility and handover processes. For instance, the basic queuing discipline for handover requests is based on the First in First out (FIFO) scheme. In this scheme, handover requests remain in the queue until channels become available or the signal of the requests drops to a very low level. In the latter situation, the requests are blocked. For example, in the user transaction, if a channel is available and the users are still in the handover area, the channel is allocated to the requests with the highest priority, depending on the type of queuing techniques used. As new requests are not given service until the queue is empty, this guarantees high priorities for handover requests. This prioritization reduces the probability of forced termination of handover requests at the expense of an increased request blocking probability [14]. In order to access a wide range of services which are distributed across pervasive and mobile cyberspace, we need to maintain the following relaxed atomicity (RA), consistency, context, and durability (RACCD) properties.[15]

1) RA

It is possible that all transactions may commit unilaterally and failure of nonvital transactions may not result in the abortion of the transactions. RA requires that all vital transactions commit successfully. Thus, either all or none of the vital transactions will be executed in to maintain the RA property.

2) Consistency

Consistency requires that the data remain consistent after the execution of transactions. However, with RA, the consistency property can be enforced only at the component service level. The traditional notion of consistency and isolation of ACID criteria cannot be enforced in pervasive and mobile cyberspace.

3)Context

It requires that transactions must fulfill the requirements of the service context. That is, transactions can be committed only if all its (vital) transactions are successfully executed and their contextual requirements are met.

4)Durability

It requires that the effects of committed transactions must be made permanent in the respective data sources even in the case of failures [14].

Mobility management is categorized as

1) Location management
2) Handover Management

4.2 Location Management

Location Management deals with how to keep track of an active mobile station within a cellular network. An MT is active if it is powered on. There are two basic operations,

1) Location Update

2) Location Paging

Location update is the activity of updating the location of the mobile node. It is performed by active mobile station. It is global when all subscribers update their location at the same set of cells and local if an individual subscriber is allowed to decide when and where to perform location update.

Paging operation is performed by cellular network when incoming call arrives for a MT, the cellular network will page the MT in all possible cells to find cell in which it is located so the incoming call is routed to corresponding BS.

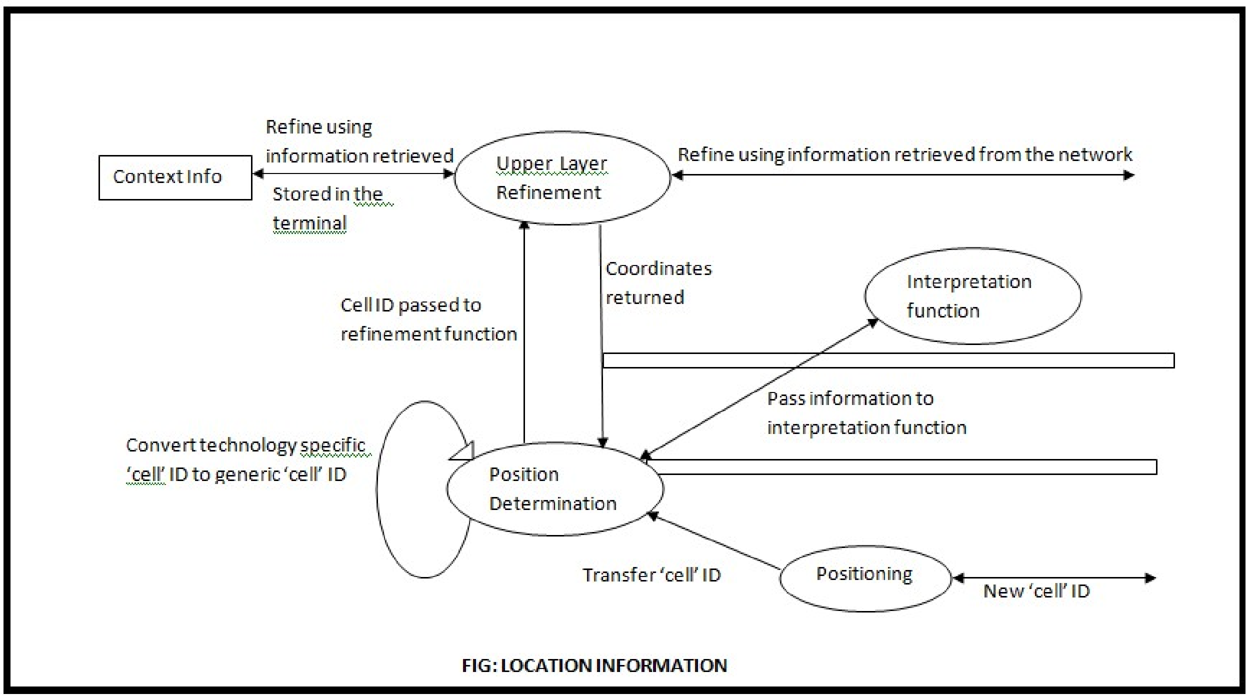


Figure 1 : Use case for location management

An example use of specific location technique:

1) The new cell ID is received at the link layer. The exact format of the cell received is specific the interface technology in use.

2) The position determination function will receive it from the interface specific positioning function.

3) The interface specific cell ID is converted to a generic format of cell ID.

4) The cell ID is given to the upper layer refinement function.

5) The refinement function uses information either from the terminal's database or retrieved from the network to convert the cell ID into a two dimensional coordinate.

6) The two dimensional coordinates are passed back to position determination coordinate. The two dimensional coordinates are passed back to the position determination function.

7) The two dimensional coordinates are given to the application requesting the information, for interpretation.[20]

A basic API would include the following basic functionalities:

1) Query

   This functionality is used by application to determine what positioning information is available in abstract terms, i.e., what 'type' of information is available, what the accuracy is etc.

2) Notify

   This functionality is used by the positioning functions to indicate to applications that different positioning information has become available e.g. if a different network support finer granularity of information.

3) Request

   This functionality is used by applications to request position information. The request should include the required format and accuracy needed by the application, and whether the position information is needed now, periodically, or when some event happens etc

4) Report

   This functionality is used by positioning information to report to application, including a timestamp of when the positioning information is determined.

There are two main approaches to interpretation location information that can be adopted by the MT. Firstly, use locally stored information to interpret the location information, and secondly, each decision, or some useful grouping of a set of decisions, query the network dynamically for associated context.

4.3 Handover Management

Handover is the action of moving a mobile terminal from one wireless cell/technology to another. It refers to change in radio channel as user moves in or out of the cells. An efficient handover algorithm is thus essential for better resource utilization as well as improvement in quality of service (QoS).When such an action takes place between different cells, it is called, horizontal handover (HHO). Similar action between access technologies with different capabilities and characteristics, it is termed as vertical handover (VHO). Example, if mobile moves to Wi-Fi coverage from GSM network, intersystem or vertical handover will be necessary. This is divided in two categories: upward VHO is a handover to wireless overlay with a larger cell size(but lower bandwidth per unit area) and downward VHO is a handover to a wireless overlay with a smaller sized cell(high bandwidth per unit area). When heterogeneity of a wireless environment comes into picture it reflects issues namely, mobility, resource allocation, high QoS support, seamless handover. Seamless handover is a major issue which requires mobility decisions and mobility protocols [1].

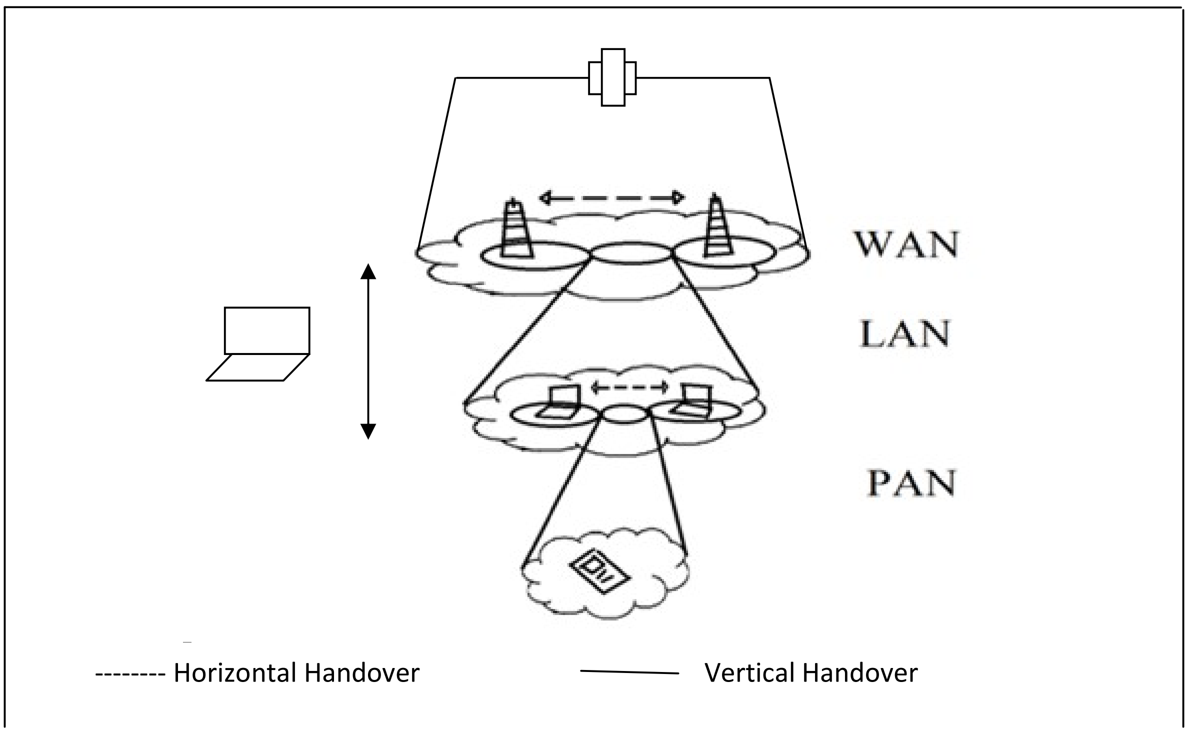


Figure 2: Handover

Table 1: Vertical and Horizontal Handover [13]

Sr No.	Parameters	HHO	VHO
1.	Access Technology	Not changed	Changed
2.	QoS Parameters	Not changed	May be changed
3.	IP Address	Changed	Changed
4.	Network Interface	Not changed	May be changed
5.	Network Connection	Single	More than one connection

- **Classification of Requests For Handover**

1) Handover transaction requests (HTRs):

These requests are part of an ongoing transaction, i.e., the requests generated by roaming users from cell to another. For example, when a user moves from a cell to another while processing the transaction, the requests are called handover requests.

2) New transaction requests (NTRs):

These are requests that belong to newly created transactions.

For example, if user starts a new transaction, in this case, both HTR and NTR have access to the (wireless network) channels which are available for the processing of transactions. Both HTR and NTR are treated equally once they occupy the channels. That is, both requests have the same service rate but distinct arrival rates [13].

4.4 Vertical Handover Scheme

In interworking system, mobile user experiences horizontal handovers with similar network, also vertical handovers between different networks. The vertical handovers from Wi-Fi to CN are different from those from CN to Wi-Fi. Similar to horizontal handover, vertical handover from Wi-Fi to CN are mainly initiated when the user is not in coverage area. As Wi-Fi user is moving away from AP, RSS decreases. When user detects that RSS from Wi-Fi is below threshold, mobile will initiate a handover request. If CN has sufficient resources to accommodate it will accept the request, otherwise it will drop the request. In this case, user is totally disconnected from interworking system. The handovers from CN to Wi-Fi are triggered to seek low-cost or high-speed services or to reduce CN congestion. Since Wi-Fi has rather small coverage and usually locates within a single CN cell, the user requesting a vertical handover from CN to Wi-Fi is always within the coverage area of CN. If Wi-Fi accepts the handover request, the user will break the connection with CN and start to communicate with Wi-Fi. Even if Wi-Fi denies the handover request, the user can still remain in the original connection with CN as it is still within the coverage of CN cell [13]. That is, user is always connected to the interworking system. There is no real blocking for the vertical handover from CN to Wi-Fi.

The primary challenges in the design of the vertical handover are:

• Low latency handoff – to switch between networks as seamless as possible with as little data loss as possible.

• Power savings – minimizing power drain due to simultaneously active multiple network interfaces.

• Bandwidth Overhead – minimizing the load of the additional information used to implement the handover.

• Triggering times – determining the exact time to trigger handovers in a wireless channel.

4.5 Handover Stages

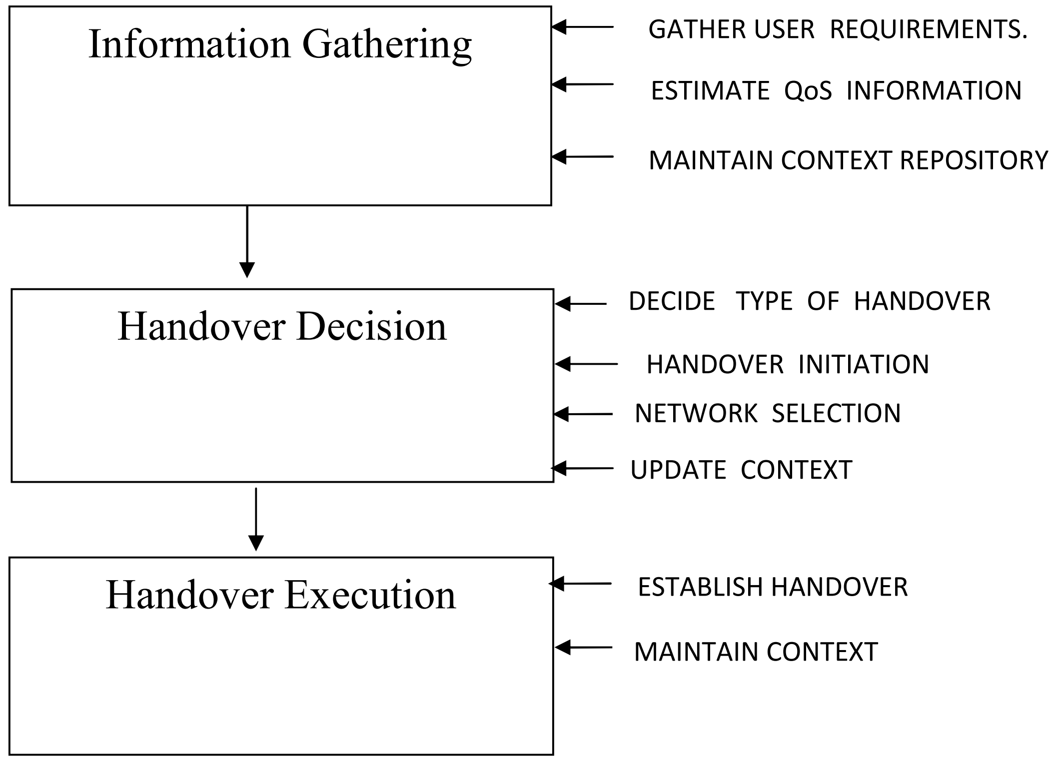


Figure 3: Stages Of Handover

1) **Handover Information Gathering**

Description

The handover information gathering phase collects not only network information, but also information about the rest of the components of the system such as network properties, mobile devices, access points, and user preferences.

- Availability of neighboring network links is collected by offering information such as throughput, cost, packet loss ratio, HO rate, RSS, distance, location, and QoS parameters.
- The MT's state by gathering information about battery status, resources, speed, and service class.
- User preferences information such as budget and services require

Stimulus/Response Sequences

System accepts application and network interface from user, monitors and discovers networks and its parameters.

2) Maintain Context Repository

Description

A context aware service senses the user's current context and changes to that context and adapts its behavior to the user's needs accordingly. In order to provide flexible and context-aware services, a system must be able to know at any given time the network status, user location, profiles of various entities(user, MT, network equipment and services) involved , and system policies, i.e., able to cope with a large amount of context information.

(i) Network context:

QoS parameters (bandwidth, delay, jitter, packet loss), link quality as RSS of the current access network and its neighbors. Also threshold values for network parameters are stored in the context.

(ii) Terminal context:

Terminal status (battery, power consumed and network interfaces) are considered comparing them to the terminal thresholds stored in context.

(iii) Application context:

Application type (real services or non real time services) are considered comparing them to threshold values stored in context.

(iv) Handover context:

Maintains and updates latency (discovery, initiation, decision, handover, execution and dwell time), number of VHO's, VHO success rate and VHO packet loss.

3) Handover Decision

Description

Based on the gathered information, this phase is responsible for deciding 'When' and 'Where' to trigger the handover. The 'When' decision refers to the precise instant in time to make an optimal handover, while the 'Where' refers to selecting the best network achieving the requirements for the switching. This is done by collecting and comparing contextual information. Determining whether a handover is needed (i.e., handover initiation) and how to perform it by selecting the most suitable network (i.e., network selection) based on decision criteria appropriate decision algorithm. It also specifies 'How' to perform them giving instructions to execution phase.

Stimulus/Response Sequences

Considering gathered information and context information suitable decision algorithm is performed.

4) Handover execution

Description

Execution phase performs the handover itself; besides performing the handover, the phase should also guarantee a smooth session transition process. The execution of the VHO must be carefully controlled to achieve accuracy by considering the geographical location, the selected network and the precise time.

Stimulus/Response Sequences

On basis of the selected decision algorithm network switching needs to be performed seamlessly. A need for seamless connection is sensed when a user moves in different geographical areas, maintaining a continuous session during his movement without any disruption or loss of information. Tracking the location of the user and evaluating his movements is a major task. Mobility decisions are based on VHO decision criteria and algorithms aiming to ensure automated, rapid and right decision for suitable network selection.

4.6 Vertical Handover Mechanism

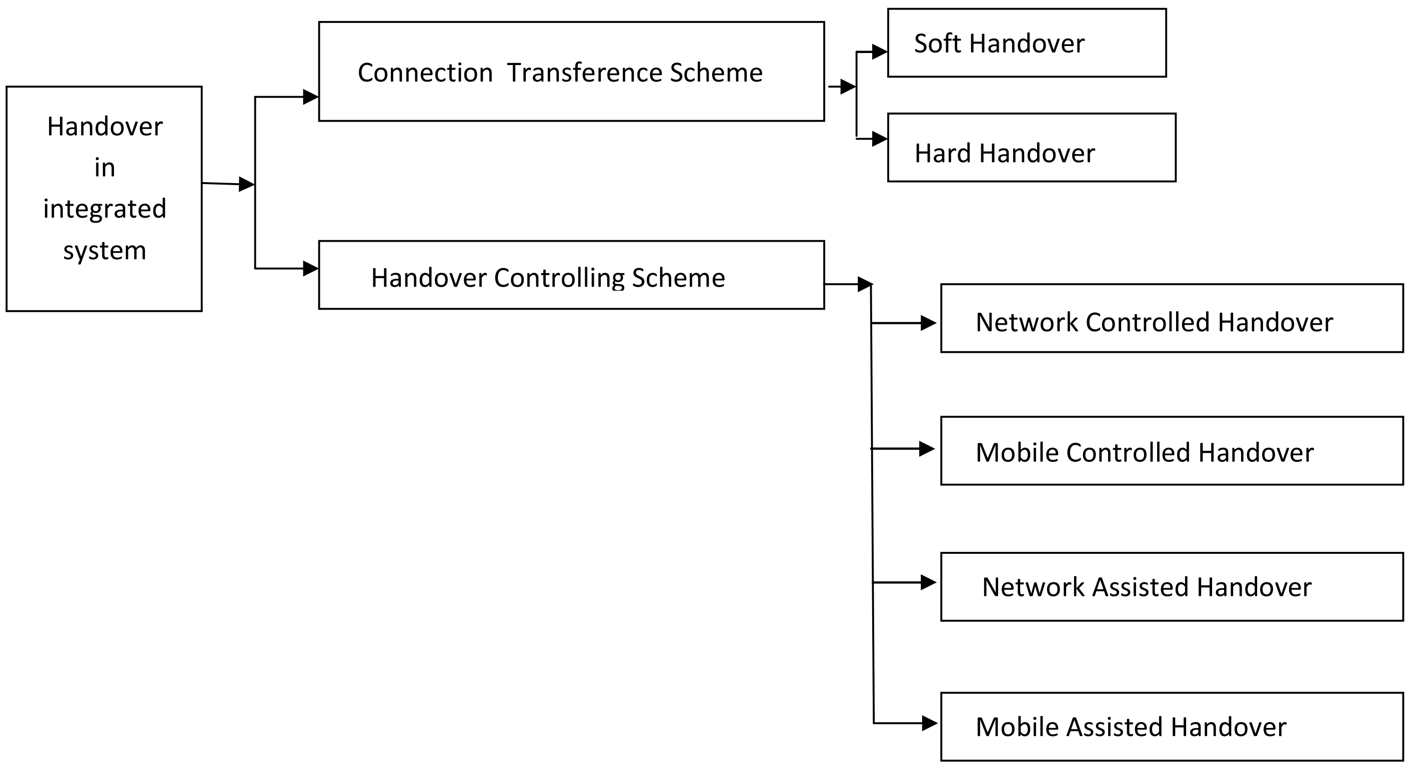


Figure 4: Mechanisms for HO

When the mobile node switches to the target network only after the disconnection from current network is called as hard handover or **break before make.** On the other hand, in soft handover a mobile node maintains the connection with the previous base station till its association with the new base station is completed. This process is also termed as **make before break**.

A handover controlling scheme is based on who controls the handover decision. In **network controlled handover,** network decides whether handover should be taken or not depending upon networks parameter, not the mobile terminal. In **mobile controlled handover**, mobile decides whether handover should be taken or not depending upon mobile parameters, not the network. In **Network assisted handover**, the mobile terminal takes the decision about the handover considering network parameters. **Mobile assisted handover**, the network takes the decision about the handover considering the mobile parameters.

In this project we have implemented an algorithm considering the network, terminal, user parameters as per need for an application, based on**, Network assisted handover mechanism**.

4.7 Context Aware Vertical Handover

Context means data collected through monitoring and measurement, required to identify the need for handover for handover and to apply handover decision. This information is monitored periodically and updated accordingly. It is characterized by a high degree of complexity due to challenges,

1) Decisions may be made quickly

2) Situations and devices evolve dynamically overtime.

Context awareness demands systems to obtain real-time information using available resources in a way, i.e., useful for the applications at hand. The derived context can either be immediately used for triggering actions or perform further computations required to relate the contexts to the situations, leading to what is termed as, situation awareness. This information may include capacity, location, user preferences, network QoS, coverage, QoS requirements, and service type e.g. real-time, interactive or Real time traffic [13]. The selection is based on optimizing QoS requirements and entails satisfying multiple objectives such as user preference, maximizing throughput, and minimizing jitter, delay, packet loss and bandwidth fluctuations.

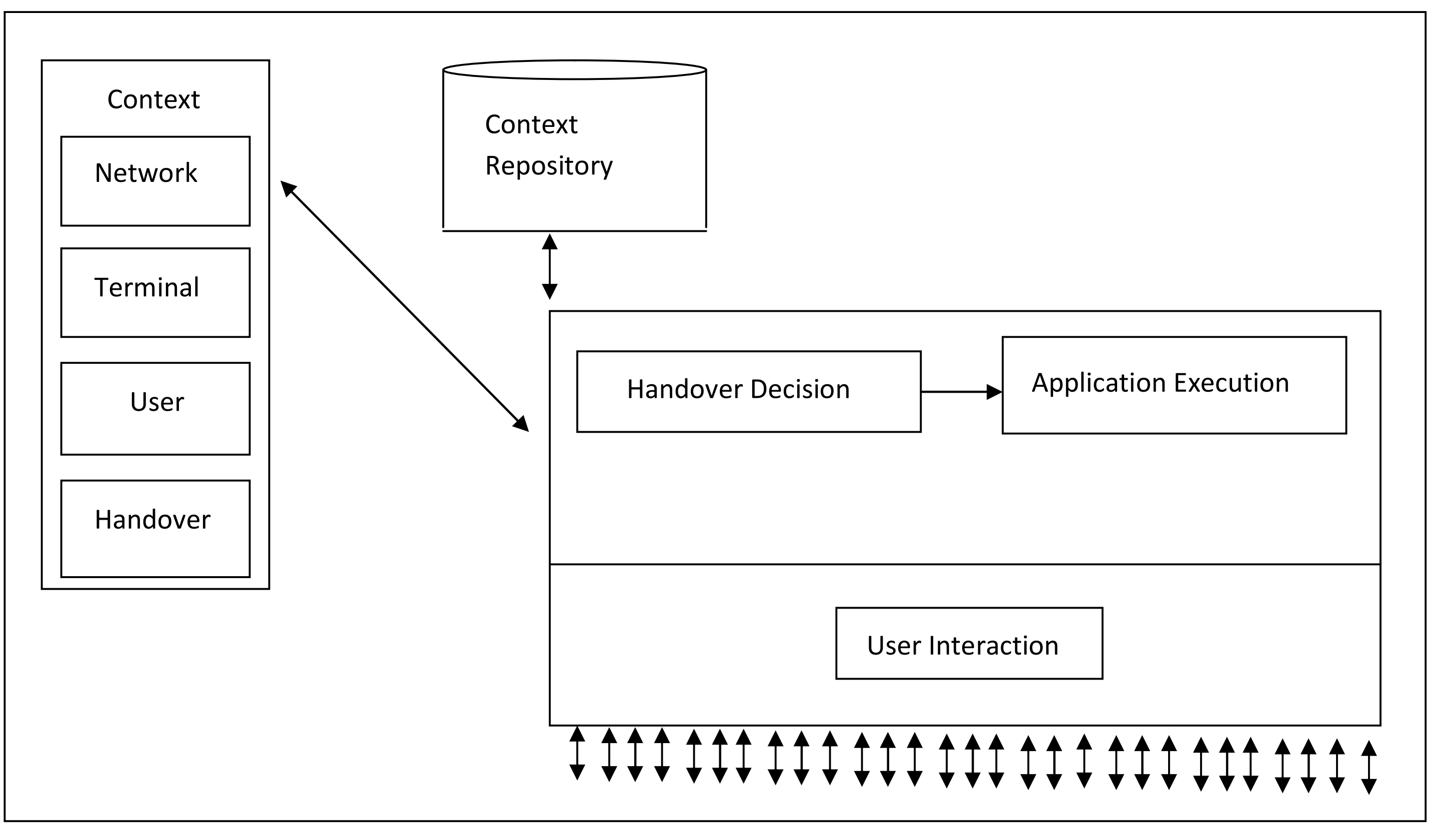


Figure 5: Context Management

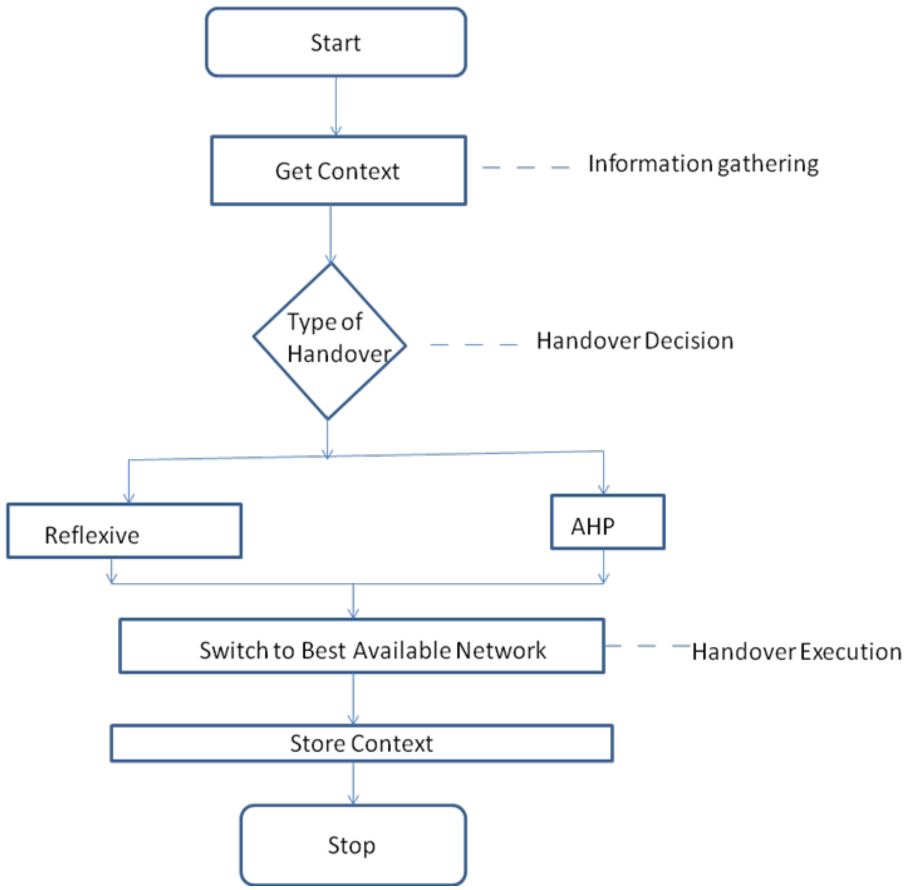


Figure 6: Procedure For Handover

4.8 Analytic Hierarchy Process - A Context Aware methodology:

In AHP, list of threshold values and a list for the set of attributes attained from various contexts as per an application. A comparison list is generated that represents the pair-wise comparison between both the lists. Then the networks are prioritized and best valued network is approached.AHP avoids the process of fuzzification and defuzzification, it involves user consideration and has medium implementation complexity. It decomposes the network selection problem into sub problems. The candidate networks are then ranked and the best one is selected.

4.9 Reflexive – A RSS based algorithm

A scenario where users within vehicular networks demands to access content from the Internet at high speeds while travelling, that is, switching among multiple access points with heterogeneous coverage areas, as well as with different Quality of Service (QoS) levels.[1] To maintain connectivity seamlessly in such dynamic conditions, a rapid vertical handover technique is required. Reflexive methodology, a vertical handover decision algorithm designed for dynamic environments where RSS and available bandwidth are compared to their threshold values and a rapid decision is taken in a dynamic situation. Vehicular environments, latency issues must be addressed in this algorithm.

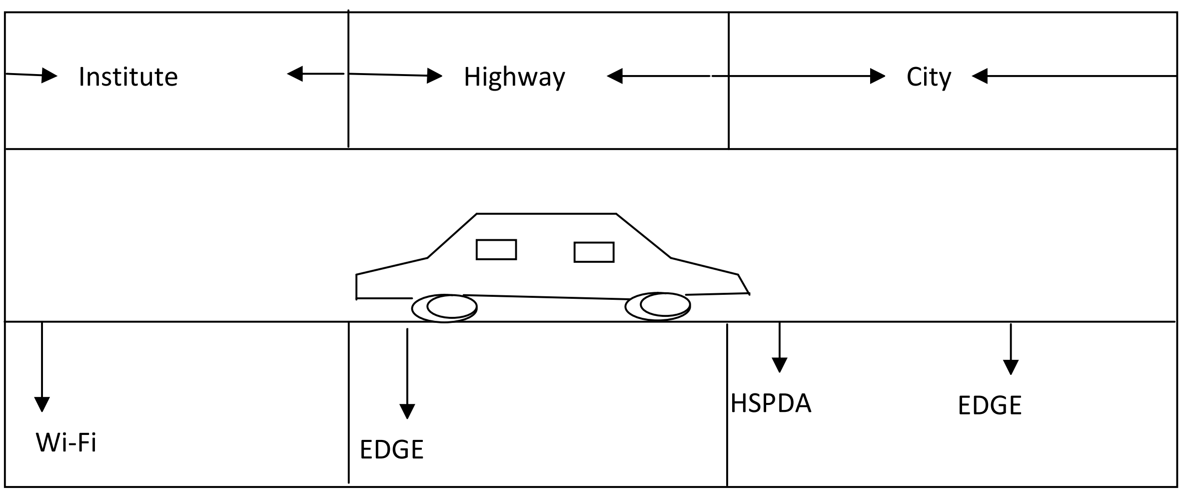


Figure 7 : Scenario for Reflexive

Whenever the user moves with velocity greater than the threshold, the system makes sure to connect to the best available network considering the parameters as per the application used by user. It takes into consideration the number of handovers in order to connect to the best network for the in use application. This ensures efficiency and performance while maintaining convenience with connectivity.

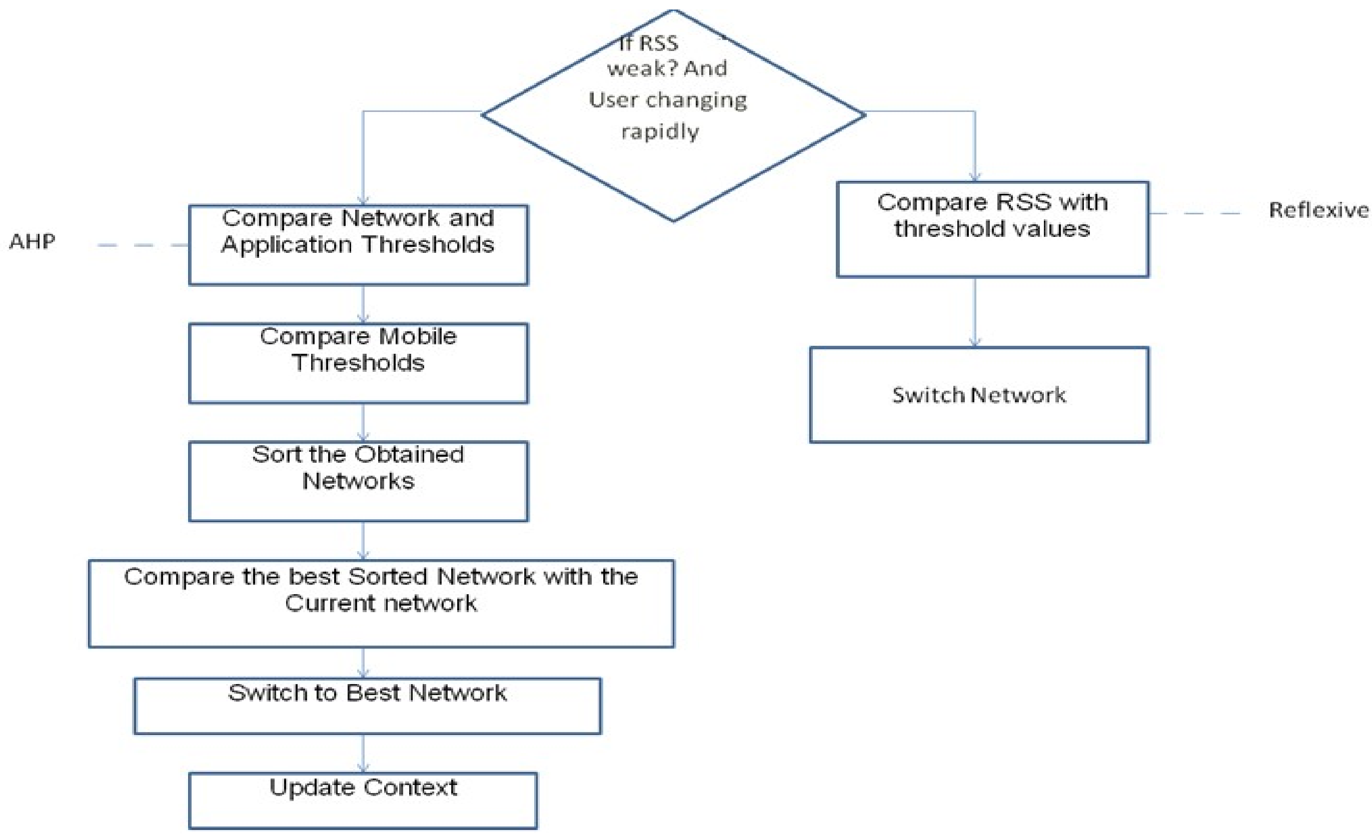


Figure: Handover Algorithm

This flowchart elucidates the state, when a handover is required and which handover needs to be performed. When the RSS drops and user moves with speed we need a rapid handover, thus we opt for reflexive handover. Whereas, when user is immobile or a new network with higher data rate comes into scenario an AHP is preferred.

4.10 VHO Decision Making Parameters

In heterogeneous networks, Vertical handovers can be initiated for convenience and connectivity reasons. A decision algorithm gives a better performance when several parameters are considered, more so when a combination of static and dynamic parameters are considered. But the trade off is with the increase in decision time and complexity of the algorithm.

4.11 Network QoS Parameters

1) Received Signal Strength (RSS)
RSS depicts the power present in a received signal.

2) Available bandwidth
Available bandwidth, refers to the width of a range of frequencies in the available network. It measures, how much data can be sent over a specific connection in a given amount of time.

3) Latency
It is total period taken to perform a handover. It is calculated as,
Total latency = latency for information gathering + handover decision latency + handover execution latency.

4) Throughput
Throughput refers to the average data rate of successful data or message delivery over a specific communication links.

1) Packet Loss
Packet loss occurs when one or more packets of data travelling across a computer network fail to reach their destination.

2) Jitter
Jitter refers to variation in time, in the arrival of packets.

3) RTT
RTT refers to time taken for a packet to travel from a specific source to a specific destination and back again.

Table 2: Priority for Parameters

Sr. No.	**Profile**	**Parameters**	**Priority**
1.	User Profile	1.1 User location	**Low**
		1.2 User mobility	**High**
		1.3 Application type	**High**
2.	Terminal Profile	2.1 Battery Life	**Medium**
		2.2 Power Consumption	**Medium**
		3.2 Number of VHO events successful	**Medium**
		3.3 VHO latency	**High**
4.	Network Profile	4.1 Received Signal Strength (RSS)	**High**

		4.2 Bandwidth	**High**
		4.3 Latency	**High**
		4.4 Throughput	**Medium**
		4.5 Packet Loss	**Medium**
		4.6 Jitter	**Medium**
		4.7 RTT	**Medium**

Table 3: Application specific network parameters[8]

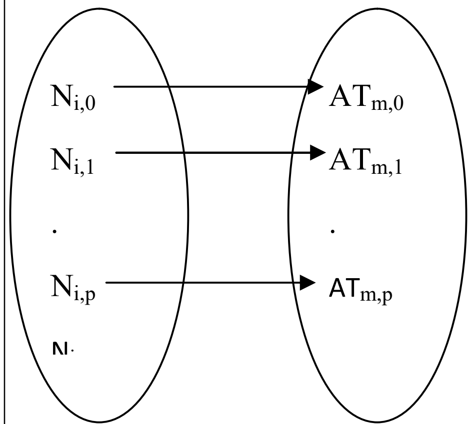
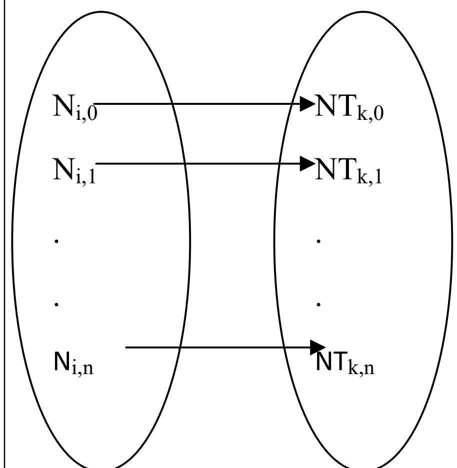
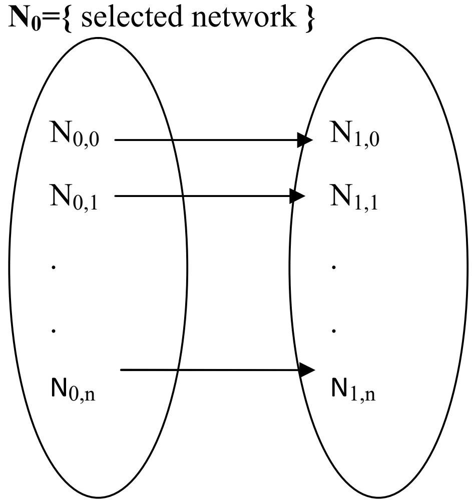
Sr. No.	**Application**	**Parameters**	**Threshold value**
1.	Web Non real time	RSS	Less than -95 dBm
		Available bandwidth	< 30.5 Kbps
		Delay	< 400 ms
		Response time	2-5 sec
2.	Video Real time	RSS	Less than -95 dBm
		Delay	< 150 ms
		Jitter	< 100 ms
		Available bandwidth	28.8- 500 Kbps
3.	Email	RSS	Less than -95 dBm
		Delay	10 Kbps
		Data rate	< 10Kbps
		Available bandwidth	< 10 Kbps

Design

5.1 Mathematical Model

Table 1: Mathematical Model

Sr. No	**Mathematical Model**	**Description**	**Observations**
1	Discover_network() =N	**N**={ N_0 U N_1 U N_2 U.....N_n |**'N_i** 'is type of network}	Discover the networks available in the Mobile area.
2	Detect_network_parameter(N)= N	**N**={ N_0 U N_1 U N_2 U.....N_n |**'N_i**' is a network parameter with its type"}	Catch parameters of all the networks Obtain in last function.
3	Detect_mobile_parameter()=M	**M**={**M_0 U M_1 U ....,M_k**|'M' is a mobile parameter}	Detects mobile parameters like battery Life.
4	take_user_prefernce()=A	**A**={ 'A' is a type of application running}	Take application preference from user.
5	select_algorithm($N_{0,RSS}$, $N_{0,Bandwidth}$,mobility(),NT_{RSS}, $NT_{Bandwidth}$)={c1}	**C1=**{AHP,Reflex **}**	Selects which algorithm to choice for handover decision.
6	get_applicationthreshold (AT,type)=AT_i	**AT_i={ |'AT_i'** is application threshold**}**	Get threshold values of all Q0S parameters for the running application.
7	get_ networkthreshold (NT,type)=NT_i	**NT_i={ |'NT_i'** is network threshold**}**	Get threshold values of all Q0S parameters for the selected network.

8	compare_network_QoS(NT_k,AT_m,N_i)=P	**P={0,N_i | N_i** is Network Parameter**}**   	Compares networks QoS parameters With threshold values ie. application, Network threshold.
9	Sort_ network(P)=N	**N={** Sorted network array}	Sort all the networks obtain depending on their QoS like RSS, bandwidth, delay.
10	Compare_current_work(N_0,N_1)= N_0	**N_0={** selected network **}**  	Compare QoS values of current network with selected network.

11	Switch(N_0)	Switch to selected network.	Perform switch operation depending Upon the network obtain.

5.2 Class Diagram

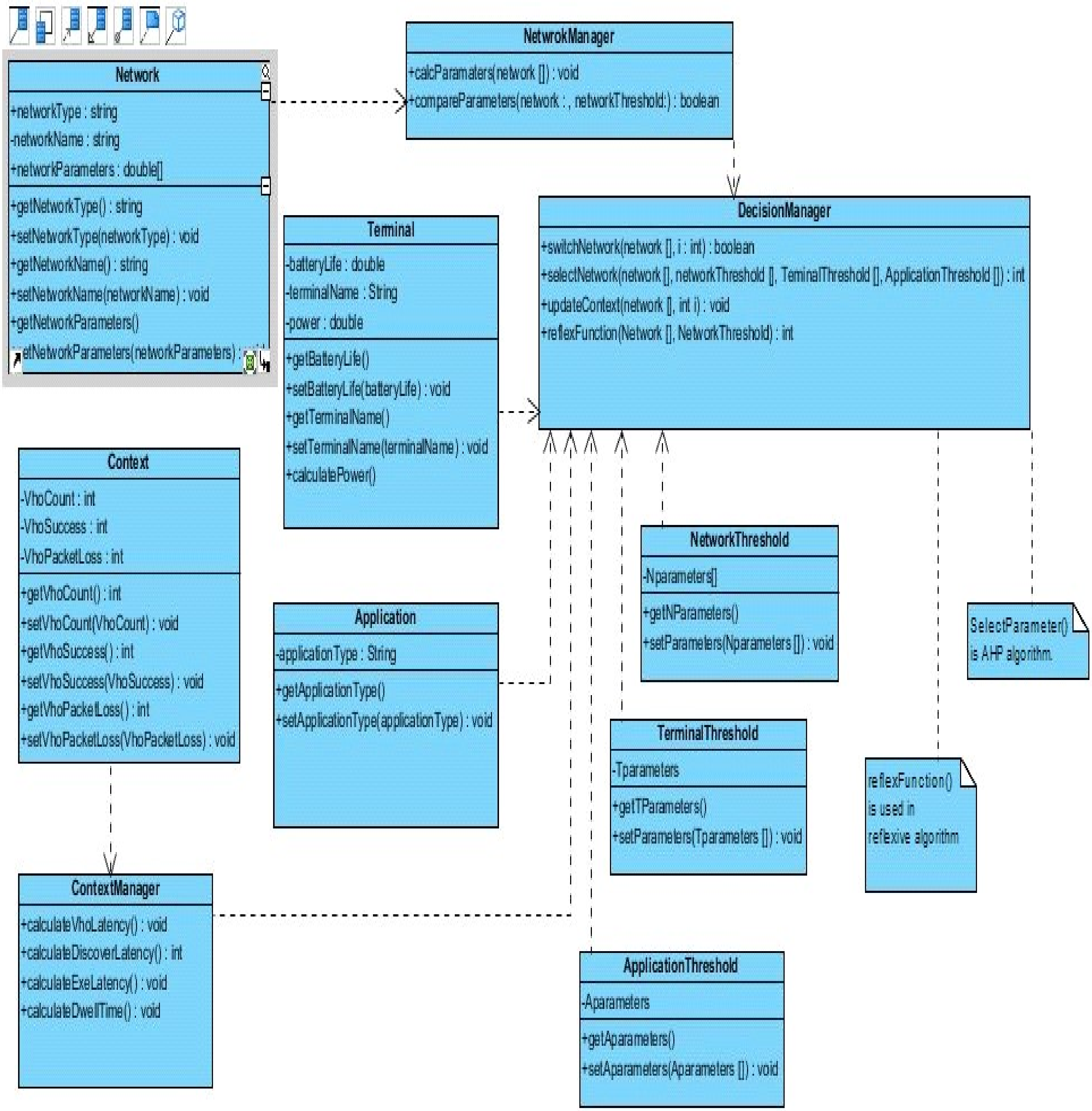


Figure 1: Class Diagram

5.3 Sequence Diagram

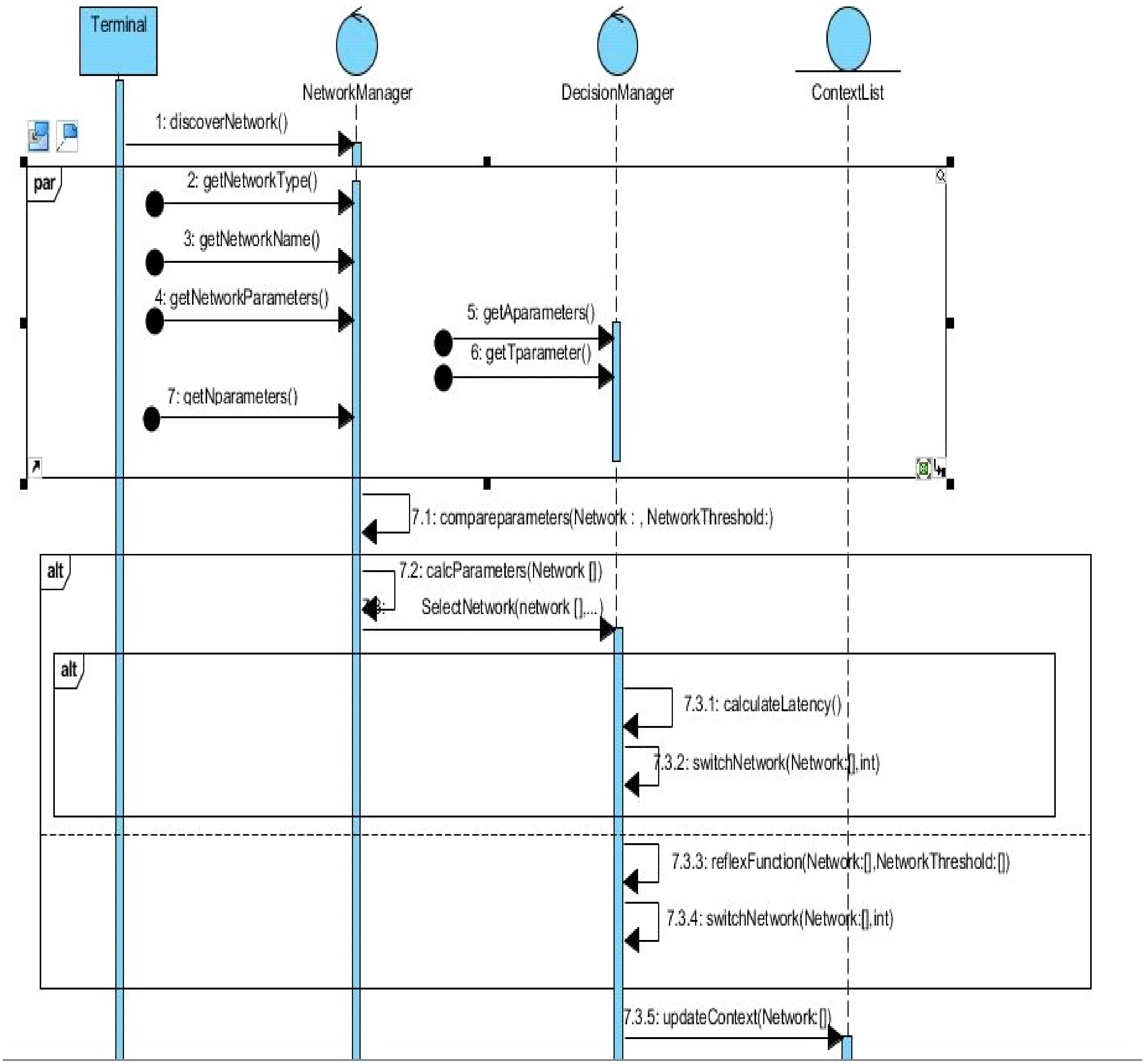


Figure 2: Sequence Diagram

5.4 Activity Diagram

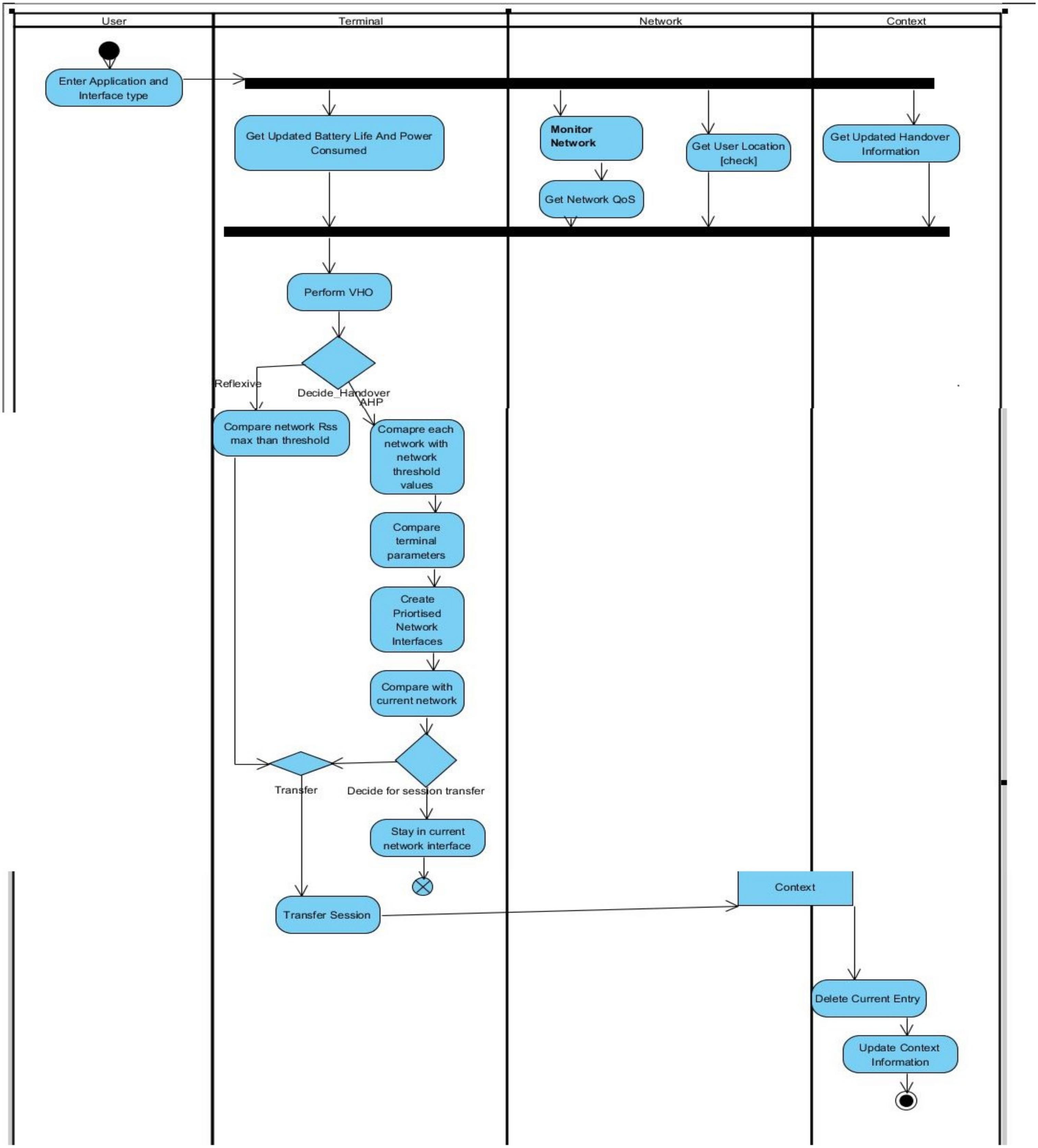


Figure 3: Activity Daigram

5.5 Deployment Diagram

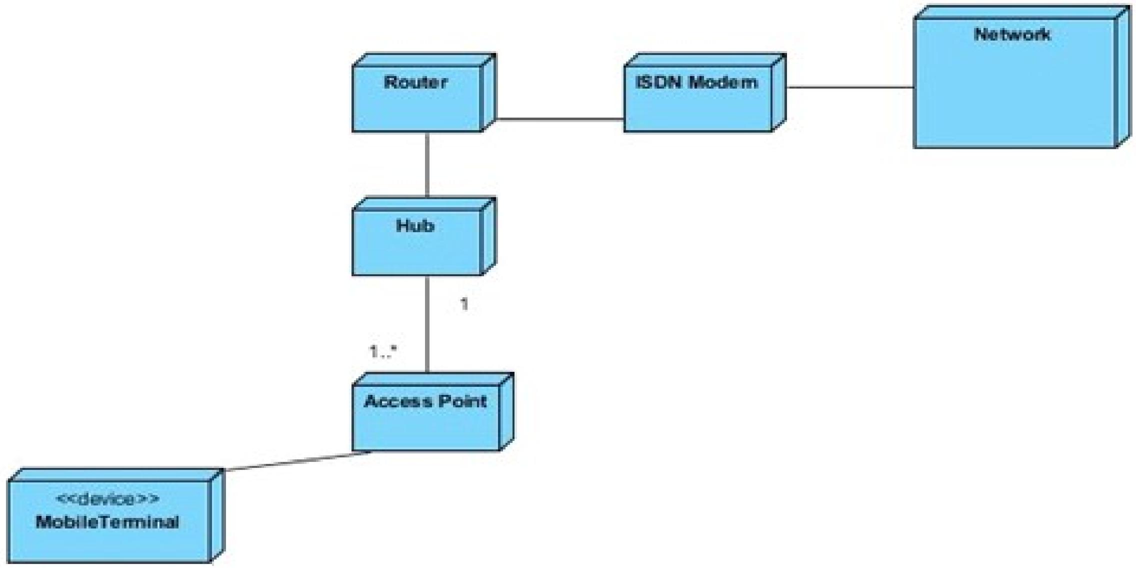


Figure 4: Deployment Diagram

Testing

6.1 Scenarios To Be Tested

1) MN Stationary and starts a new session.

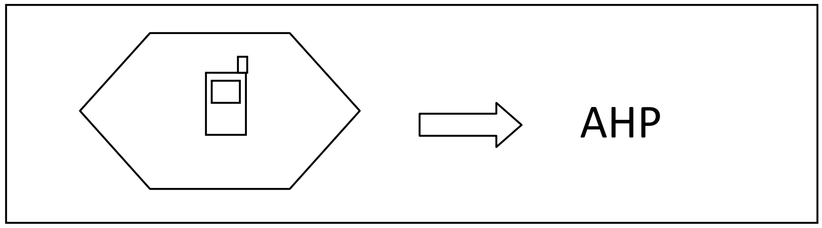


Figure 1: Scenario 1

2) MN stationary within session but changes network interfaces.

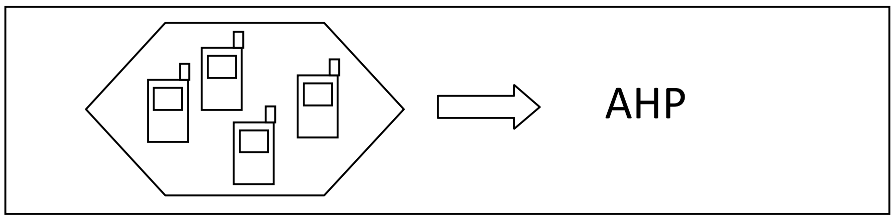


Figure 2: Scenario 2

3) MN is moving within session and selects the best available network interface with services as per user requirements with velocity less than threshold.

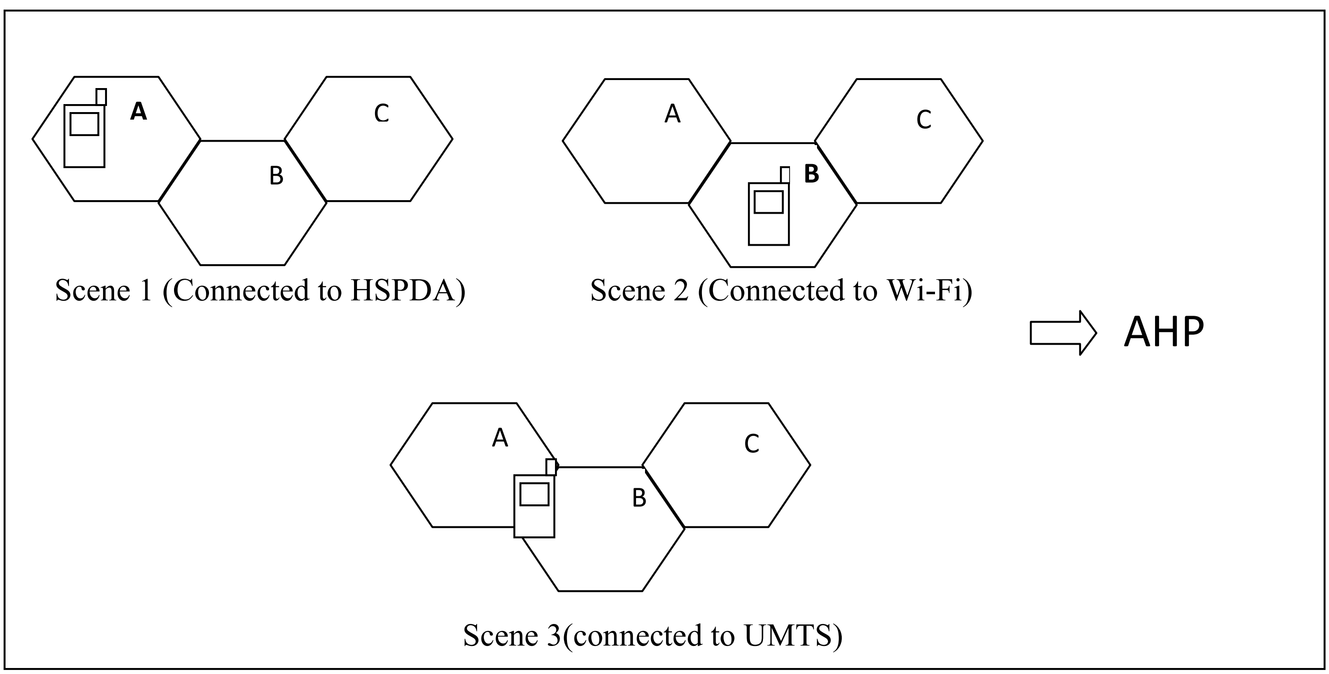


Figure 3: Scenario 3

4) MN moves with velocity greater than threshold values

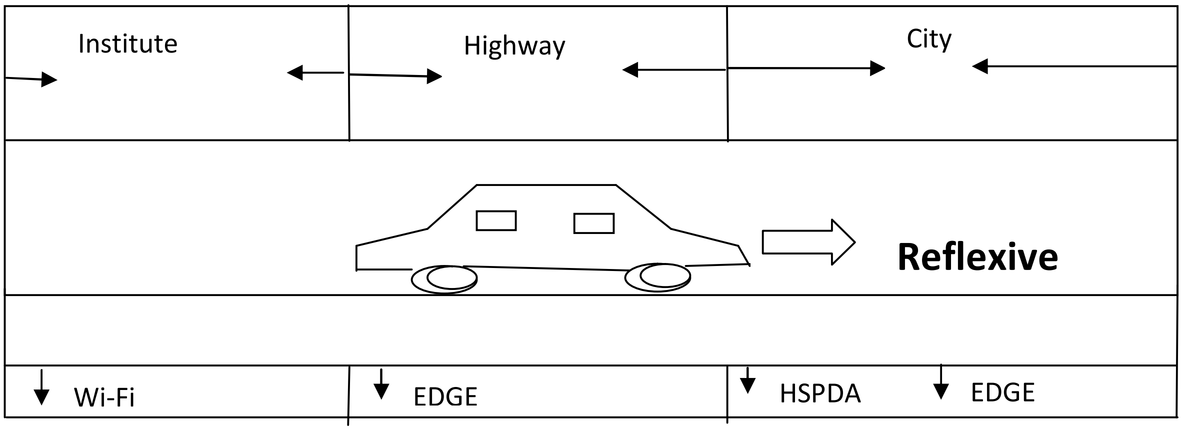


Figure 4: Scenario 4

6.2 Features To Be Tested

1) Seamless connectivity
2) Convenience
3) Compatibility
4) Recoverability

Table 1: Features of system

Sr. No.	Features to be tested	Level of testing required
1	Seamless connectivity	H
2	Convenience	H
3	Compatibility	M
4	Recoverability	M

H: High

M: Medium

L: Low

6.3 Unit Testing

Table 2: Unit test cases

Sr. No.	Module	Expected	Actual
1	Information Gathering	Various context gathered	Context as per application gathered
2	HO Decision	Decision of whether a handover is to be taken and which AHP, Reflexive	Necessary handover takes place
3	HO Execution	Make before Break as connection scheme; switch to new network.	Switches to best available network
4	Context Repository	Maintains context history	Maintains number of handovers, HO success and failure

6.4 Integration Testing

Table 3: Integration test cases

Sr. No.	System	Expected Result	Actual Result
1	Whole system	Information gathered, context required as per application is taken and evaluated and necessary HO is performed	Gathered information is evaluated as per application type, HO history is considered and a liable HO is performed.

6.5 Validation Testing

Table 4: Validation test cases

Sr. No.	Activity	Technology	Algorithm	Expected Results	Actual Results	Pass/ Fail
1	Non real time	Wi-Fi to EDGE	AHP	Switch when in between -95 to -125	RSS=-119 HO takes place	Pass
2	Non real time	Wi-Fi to EDGE	AHP	Switch when in between -95 to -125	RSS=-120 No HO takes place	Fail
3	Non real time	Wi-Fi to Wi-Fi	Cont AHP[No handover]	Switch when in	RSS > -95	Pass

				between -95 to -125		
4	Real time	EDGE-Wi-Fi	Reflexive	Velocity changes constantly	Switch to strong constant network as per handover history	Pass
5	Non real time	EDGE (start session)	AHP	Connect to best network	Initially connects to mobile data	Pass
6	Real time	EDGE	Reflexive	Switch rapidly to best suited as per application	Switching successful, but the number of handover is greater than expected	Fail
7	Non real time	HSPDA	AHP	Switch to best suited network	Switching successful	Pass
8	Real time	HSPDA	Reflexive	Best network with minimum handovers	Maintains proper number of handovers	Pass

Results and Discussion

7.1 Experimental Results

There are two major categories that have been performed are going to be presented. The first one focuses on the operation of the previously described system in real and non-real applications experiments performed are concerned on session continuation and handover times.

1) **Real time application**
2) **Non-real time application**

Table 1: Application based mechanism

Sr. No.	Application	Mechanism
1	Real Time	Reconnect, buffer, concurrency, session
2	Non Real Time	Reconnect, session, caching concurrency

Table 2: Assumed Application Threshold Values

Sr. No	Parameters	Non real time	Real time
1	RSS	>= (-95)	>= (-95)
2	Bandwidth	>=6.62 E^{-4}	>=0.0101 ~ 0.01469 Mbps
3	Jitter	<=300	<=850
4	Packet Loss	<=25	<=50
5	RTT	<=800	<=5500

Table 3: A Comparison Handover In Wi-Fi, GSM[19]

Sr. No.	Technology / Features	GSM	Wi-Fi
1	Handover Process	Information gathering, Handover decision, Handover Execution	Information gathering, Handover decision, Handover Execution, Reauthentication, Reassociation
2	Handover Type	Hard handover; UMTS: soft handover	Hard handover
3	Handover Controlled	Network (rarely at MS)	MS

7.2 Data Set

Table 4: Dataset

Access Tech	Switching time (ms)	Total HO Latency
Wi-Fi - EDGE	15	36
EDGE – Wi-Fi	83	6106
Wi-Fi – Wi-Fi	77	2174
Wi-Fi - HSPDA		
HSPDA – Wi-Fi	72	5139

7.3 Weights Assigned

Table 5: Weights assigned for parameters

Sr. No.	Application	Weights
1	Bandwidth	Wt+ 9
2	Packet loss	Wt+ 8
3	RTT	Wt+ 7
4	Jitter	Wt+ 6

7.4 Results for Tested Scenarios

Version 1: RSS and Velocity

Table 6: Version 1

Sr. No.	Algorithm	Access Technology (switched to)	Activity	RSS	Velocity	Switch Latency	Latency (ms)
Test 1:							
1	Reflexive	EDGE (Start)	Browsing	-95	0	15	37
2	Reflexive	EDGE – WiFi	Browsing	-91	0	86	144
3	Reflexive	EDGE – WiFi	Browsing	-87	0	81	154
4	Reflexive	Wi-Fi –EDGE	Browsing	-91	0	15	36
5	Reflexive	Wi-Fi –EDGE	Browsing	-91	0	18	37
Test 2:							
1	Reflexive	EDGE (start session)	Browsing	-91	0	11	31
2	Reflexive	Wi-Fi – Wi-Fi	Browsing	-87	0	26	67
3	Reflexive	Wi-Fi – Wi-Fi	Browsing	-95	0	48	61
4	Reflexive	Wi-Fi – Wi-Fi	Browsing	-90	0	47	81
5	Reflexive	Wi-Fi – Wi-Fi	Browsing	-91	0	63	114

Version 2: RSS, velocity and bandwidth

Table 7: Version 2

Sr. No.	Algorithm	Access Technology	Activity	RSS	Bandwidth	Latency (ms)
Test 1						
1	AHP	EDGE	Non real time	-59	6.6186E-^{4}	519
2	AHP	Edge - Wi-Fi	Real time	-51	0.00687	4096
3	AHP	Wi-Fi	Real time	-75	0.002	3955
4	AHP	Wi-Fi	Real time	-83	0.0585	3902
Total Number Of Handovers					**2**	

Version 3: RSS, velocity, packet loss and bandwidth

Table 8: Version 3

Sr. No.	Algorithm	Access Technology	Activity	RSS	Packet Loss	Bandwidth
1	AHP	EDGE	Browsing	-57	25	141.39
2	AHP	Wi-Fi	Streaming	-55	0	45000
3	AHP	HSPDA	Streaming	-83	0	248
4	AHP	Wi-Fi	Browsing	-71	0	5980

Version 4: RSS, velocity, packet loss, jitter and bandwidth

Table 9: Version 4

Sr. No.	Algorithm	Access Technology	Activity	RSS	Packet loss	Jitter	Bandwidth
1	AHP	EDGE	Browsing	-55	0	72.66	4500
2	AHP	EDGE	Browsing	-59	25	38	131.3
3	AHP	EDGE	Browsing	-55	25	763	10120
4	AHP	EDGE	Browsing	-52	0	258	6870
Test for 3 mins							
5	AHP	HSPDA(start)	Streaming	-83	0	50.73	290
6	AHP	HSPDA(No handover)	Streaming	-83	0	151.82	595
7	AHP	HSPDA(No handover)	Streaming	-91	0	86	70
Number of Handovers :						**0**	

Version 5: RSS, velocity, packet loss, jitter, RTT and bandwidth

Table 10: Version 5

Sr. No.	Access Technology	Activity	RSS	Bandwidth	Packet Loss	Jitter	RTT	Velocity
Test 1								
1	EDGE	Browsing	-57	141.39	25	8.231	271	0
2	EDGE	Browsing	-59	661.86	0	105.71	365.2	0
3	EDGE	Browsing	-55	4500	0	72.66	445.75	0
4	EDGE	Browsing	-59	131.3	25	38	348	0
5	EDGE	Streaming	-55	14110	25	156	380.250	0
6	EDGE	Streaming	-55	10120	25	763	1973.3	2.6
7	EDGE	Streaming	-51	6870	50	258	2060.	2.3

							23	
8	HSPDA	Browsing	-80	667	0	201.6	241.96	2.6
9	HSPDA	Browsing	-91	570	0	86	487.27	2.6
10	HSPDA	Browsing	-91	383.5	0	651.12	39.31	2.6
Test 4								
11	HSPDA	Streaming	-83	50658	0	437.65	50.73	2.6
12	HSPDA	Streaming	-83	56368	0	144.245	61.256	2.6
13	HSPDA	Streaming	-83	10192	0	513.9	87.9	2.6
14	Wi-Fi	Browsing	-79	839	25	120	138	0
15	Wi-Fi	Browsing	-80	690	0	356	221	0
16	Wi-Fi	Browsing	-78	631	0	25	46	0
17	Wi-Fi	Streaming	-75	16000	0	45	81	0
18	Wi-Fi	Streaming	-83	56000	0	40	478	0
19	Wi-Fi	Streaming	-71	58500	25	41	396	0

7.5 Memory and Space Consumed

RAM Consumed by system: 5.4 MB

Space Consumed by system: 728 KB

7.6 Graphs

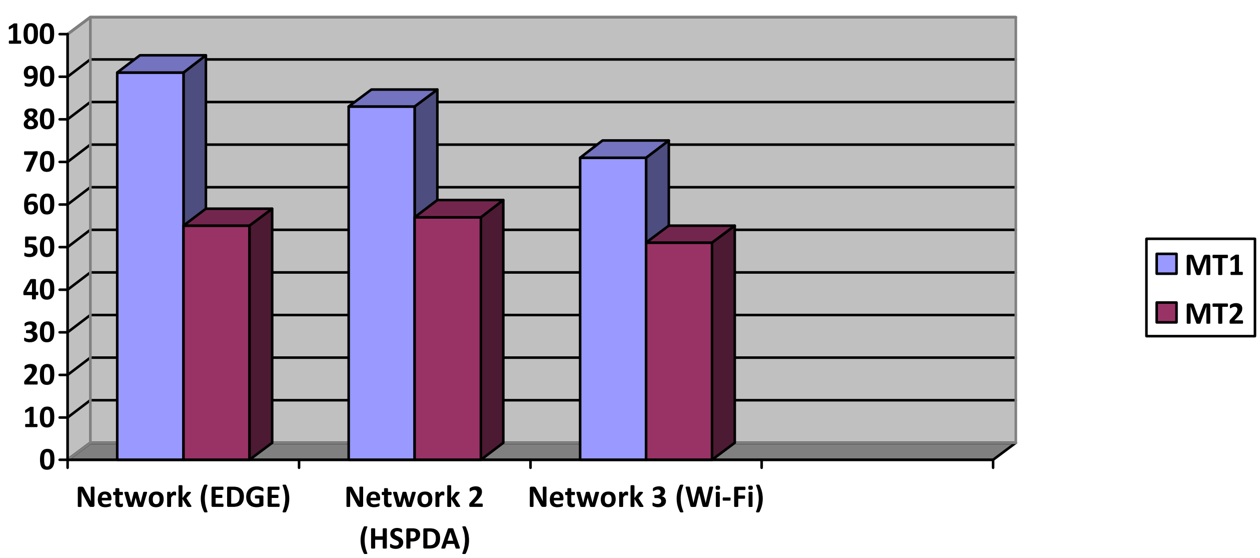


Figure 1: Monitored RSS for Networks

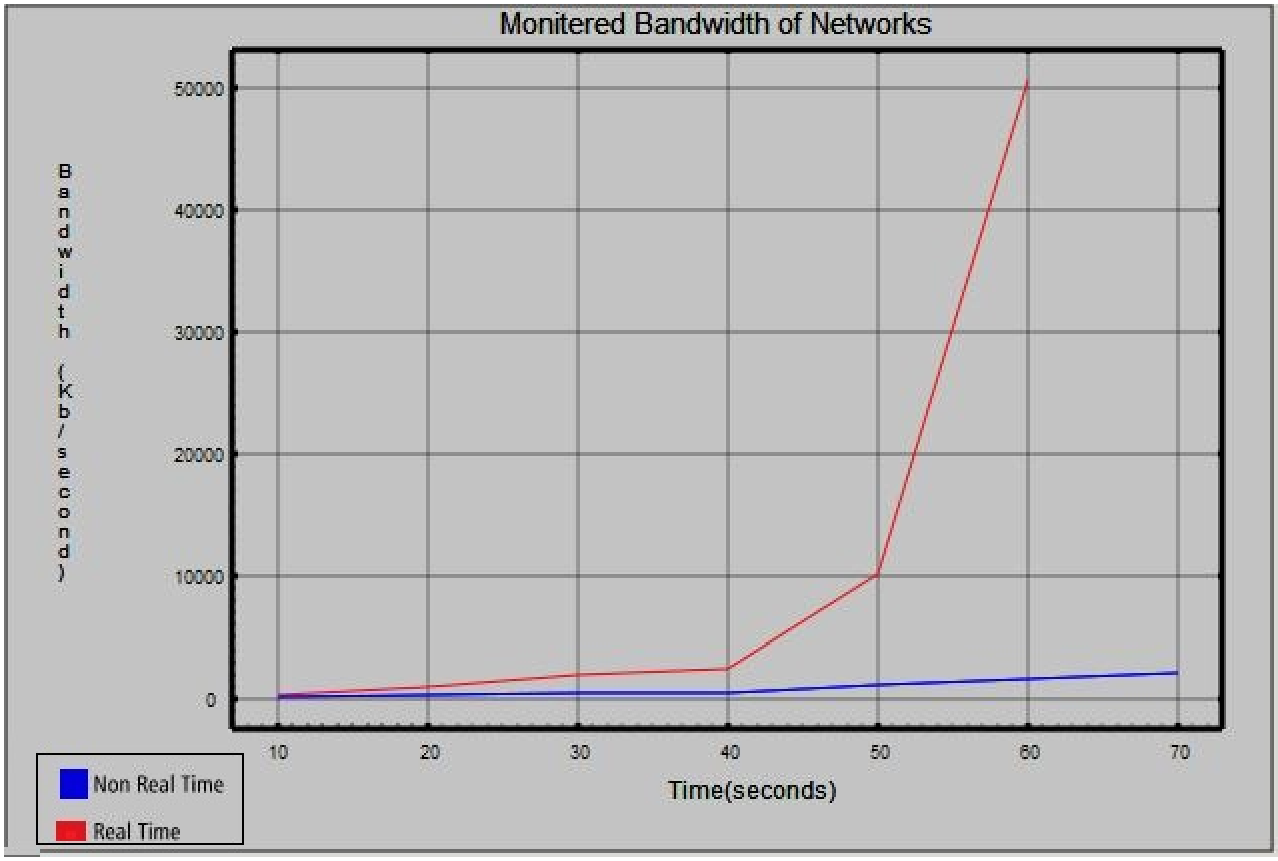


Figure 2: Monitored Bandwidth For Networks

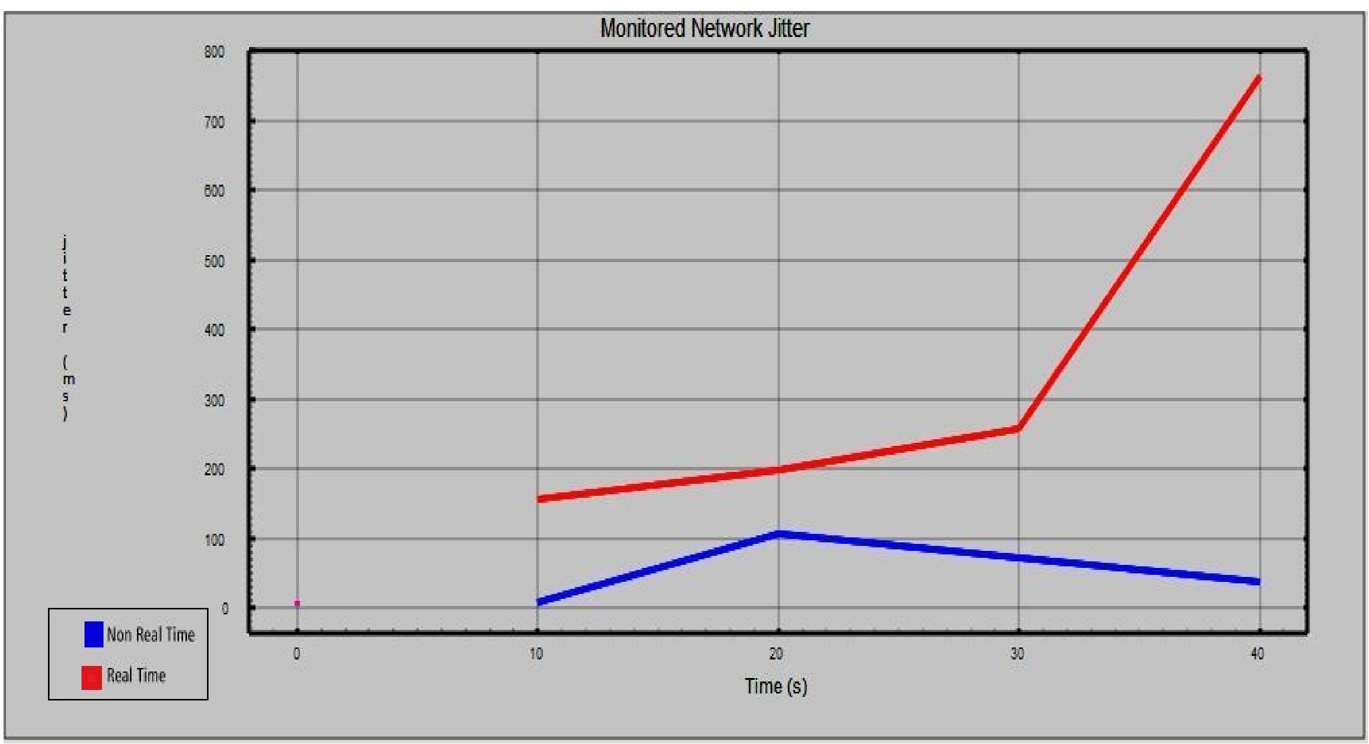


Figure 3: Monitored Jitter for networks

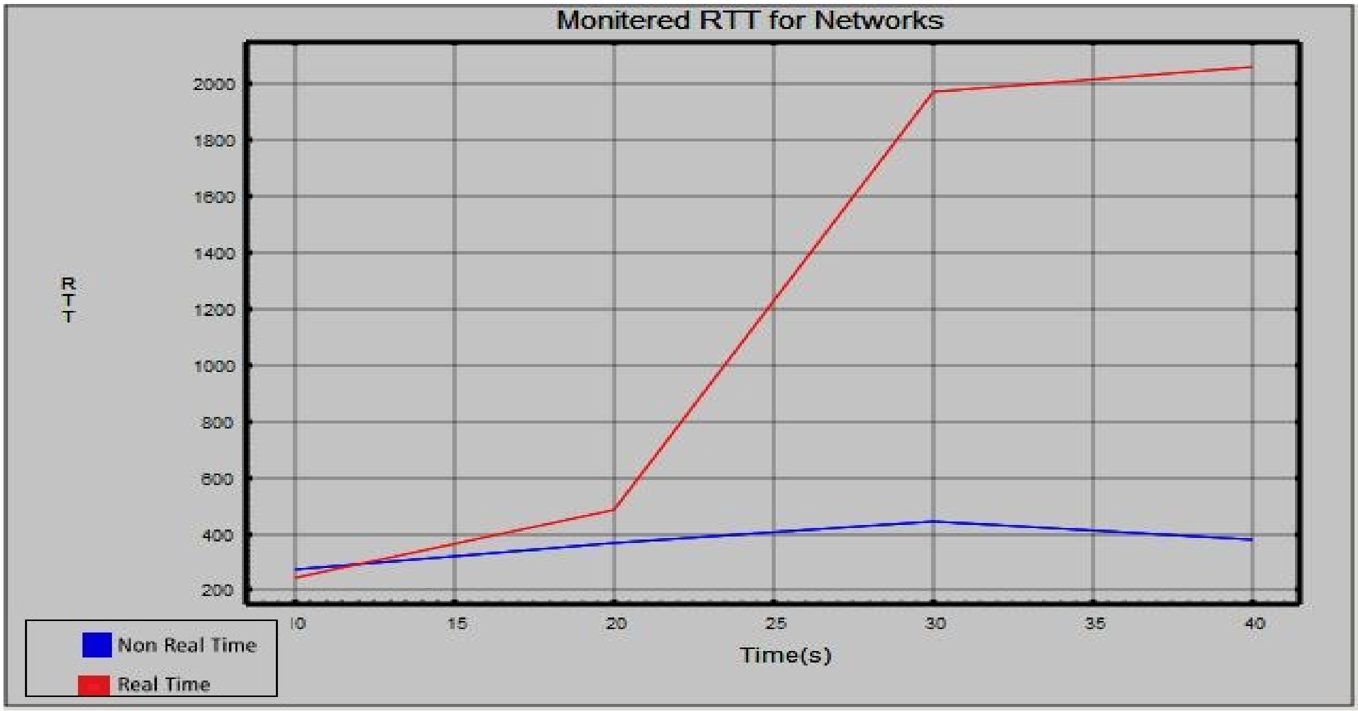


Figure 4: Monitored RTT for Networks

Conclusion and Future Work

8.1 Conclusion

Nowadays, users demand high service availability to access network infrastructure not only under the anywhere, anytime but also under the always best connected paradigm. This system brings up an intelligent handover which provides the user application, flexibility between active interfaces that best suit them based on application, user requirements and interface capabilities. Moreover we have analyzed VHO process from vehicular network (VN) perspective to evaluate solutions that conjunction of wireless technologies and VHO technologies and VHO techniques offers to satisfy the connectivity needs on road. Multiple-parameters-based algorithms must be used should be used to select information, in order to take most of context environment and further using the AHP method for handover-decision making.

When gathering information in VN we take into account velocity with which the user moves and RSS of networks. When AHP is implemented, it considers parameters as per the required application, monitoring the environment continuously for best suited network. With this improves the selection effectiveness in presence of highly dynamic channel conditions. Application based context model improves robustness and efficiency.

8.2 Future Work

This system focuses on the action of handover from one heterogeneous network to another network as per the priority of context considered with respect to current running application. It classifies the applications as real and non real applications only; this brings in a need for a handover that can suffice diversified applications, as every day a new application is launched. However, a handover should also minimize the battery consumption of MT, currently; battery consumption is more, which leads to a drop in the performance. The security aspect as per applications needs to be measured and considered. This system is centered to android platform only, we propose that by adding a java coded MIDP patch, system can be made device independent. We propose this system with the proposed concept for the remote patient tele-monitoring service in the (mobile) m-health domain aiming to achieve a better perceived performance for healthcare professionals, while optimizing battery usage.

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Annexure A:

Synopsis

VERTICAL HANDOVER IN HETROGENOUS WIRELESS NETWORKS

The evolving trend of network convergence and mobile accessibility in the Internet is a crucial call to the connectivity management of end hosts. As for mobile accessibility, seamless handover between diverse access points is a challenging issue. Most of the previous handover mechanisms show inadequacy when making handover decision by considering a few metrics related to different radio access technologies. In such an environment, an intelligent handover decision, beyond traditional ones which are based only on received signal strength, is needed so that terminals can select the best option available from diverse networks. This would enable user applications to switch automatically between active interfaces that best suit them based on application requirements and interface capabilities using multiple radio interfaces simultaneously ensuring the optimum usage of the network resources available to the terminal.

In heterogeneous wireless networks, the context-awareness will be more advantageous offering the user with different services. In order to select the appropriate network, network based metrics such as RSS, available bandwidth, data rate, delay, user preferences, device and application capabilities are taken into consideration .Thus, there is a necessity to investigate context-aware methods that characterize roaming from any access network to any other access network (Example: migrating from GPRS to Wi-Fi and Wi-Fi to 3G, vice versa).

We implement an intelligent handover decision policy, able to classify the candidate's point of attachment based on their provided context and the required mobile user context. The decision policy will be realized using an algorithm to choose the appropriate context to be used for making decision for mobility management and handover process. Also, evaluate tradeoffs between the wireless technologies.

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Annexure B:

Paper Published

Details of the paper :

Name of journal : Journal of Harmonized Research (July 2014 edition)

User Manual

9.1 Overview

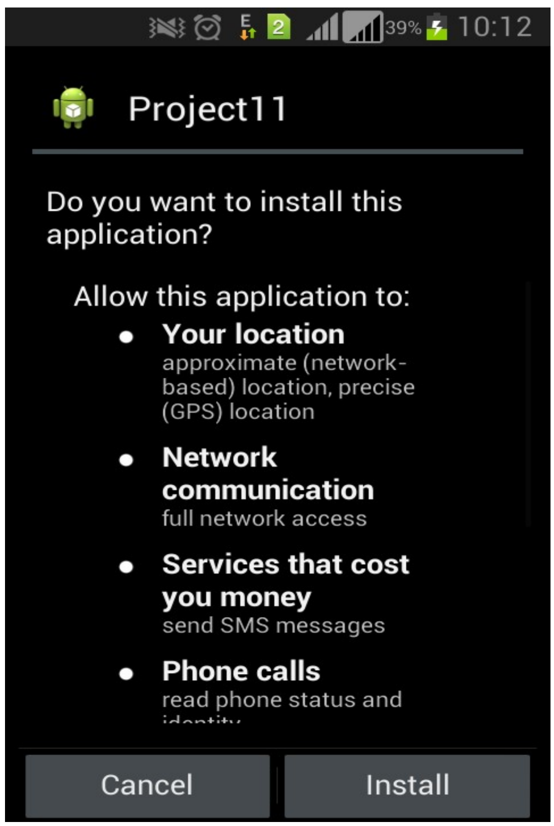
This document describes about steps to install the system.

9.2 System Requirements

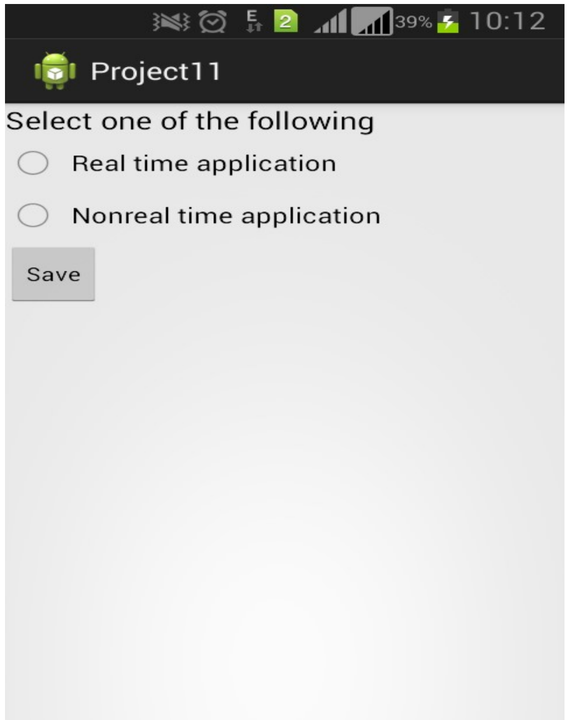
Android 4.1(jellybean)

9.3 Instructions with snapshots

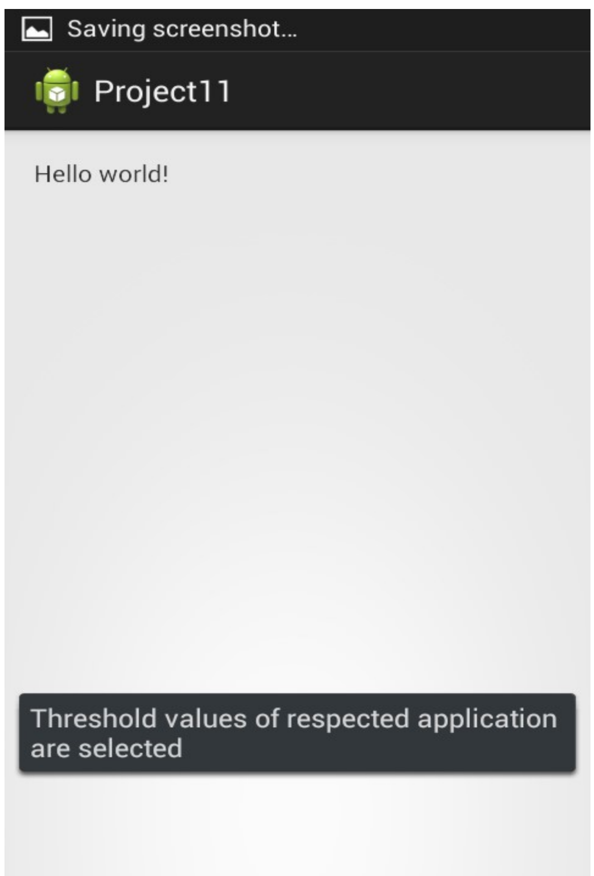
1. Switch on the data connectivity
2. Install the app in your device as external install.
3. Open and run the app.
4. Start working on browser.



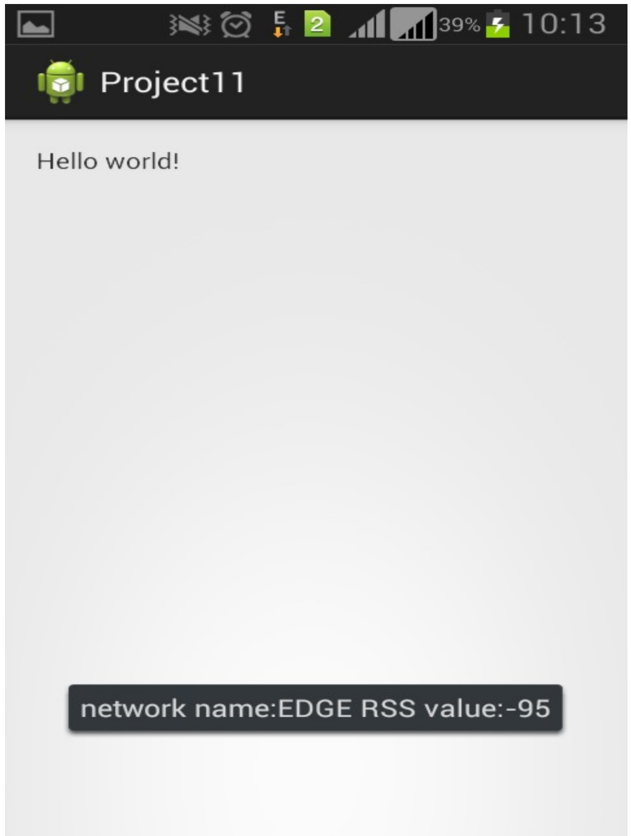
Click on Install in order to install app to your MT.



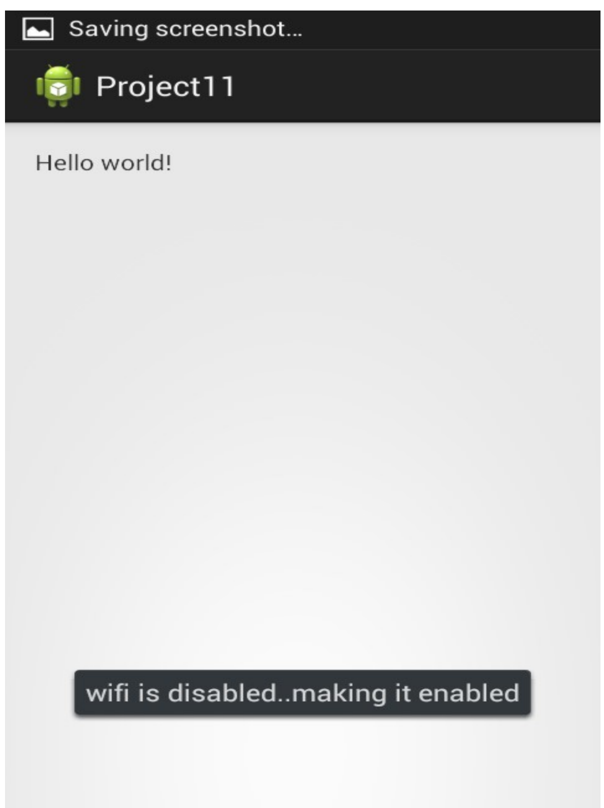
This demonstration has been set up in order to picture how and what the system reacts to various contexts. User thus selects type of the application.



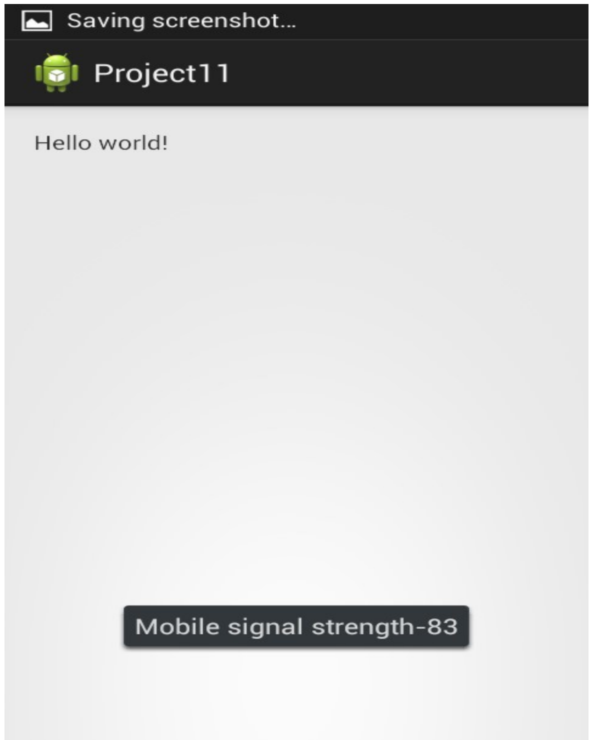
System starts monitoring the network, thresholds for various contexts relevant to the type of application is collected.



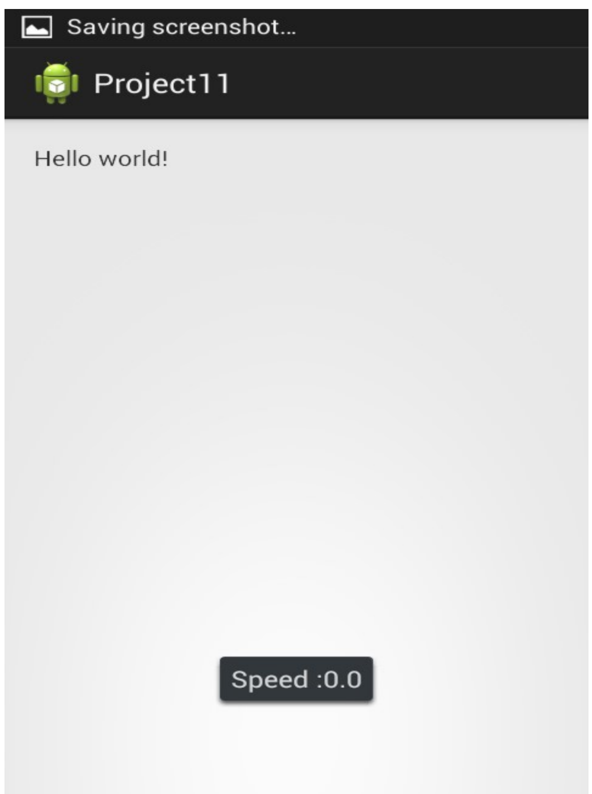
System calculates the network parameters, name RSS value.



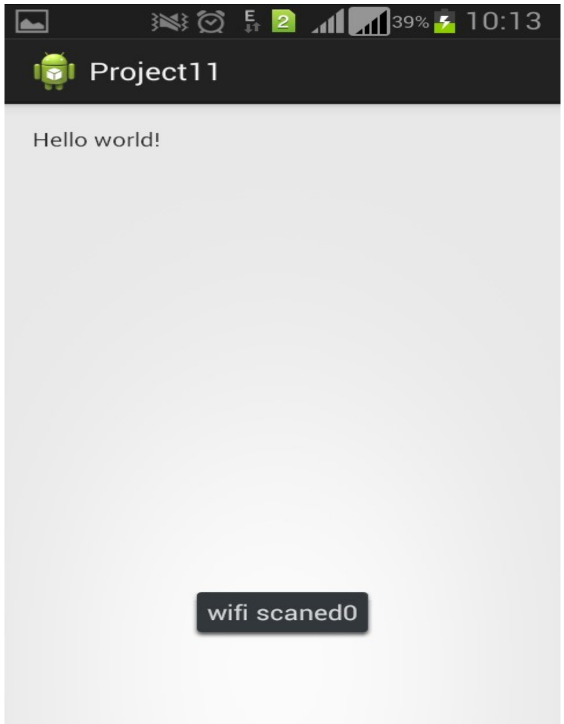
System switches Wi-Fi capability on.



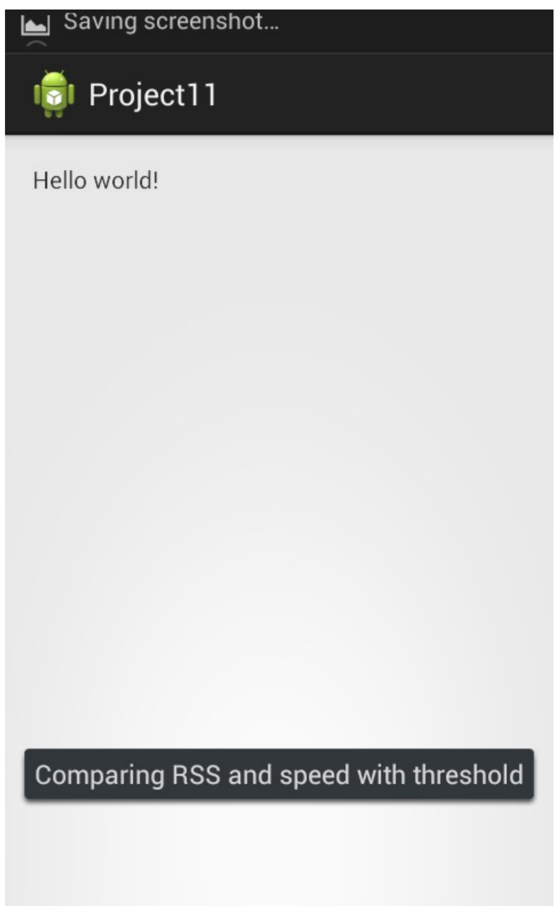
System calculates the MT parameters.



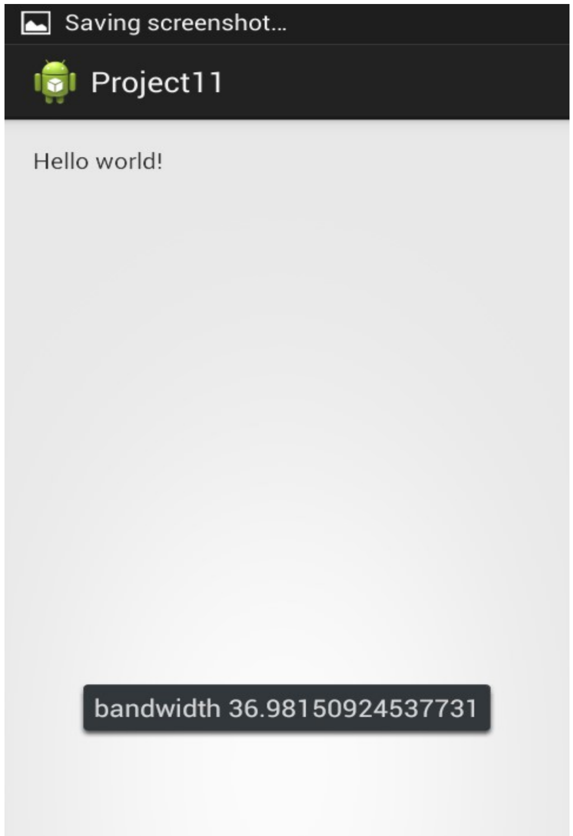
Speed is the velocity with which the user is moving.



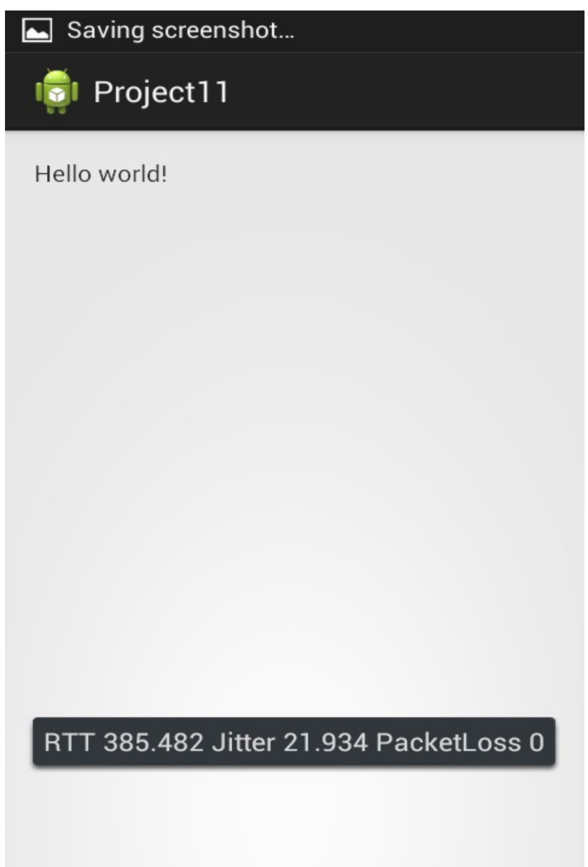
System calculates and displays all the scanned open Wi-Fi available then.



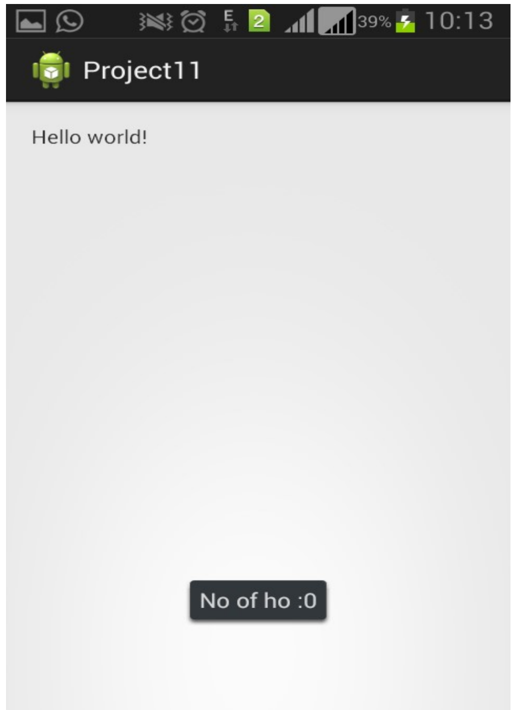
System compares network parameter, RSS which is a crucial parameter, the system decides on basis of RSS and velocity whether HO needs to be taken, if yes then which HO.



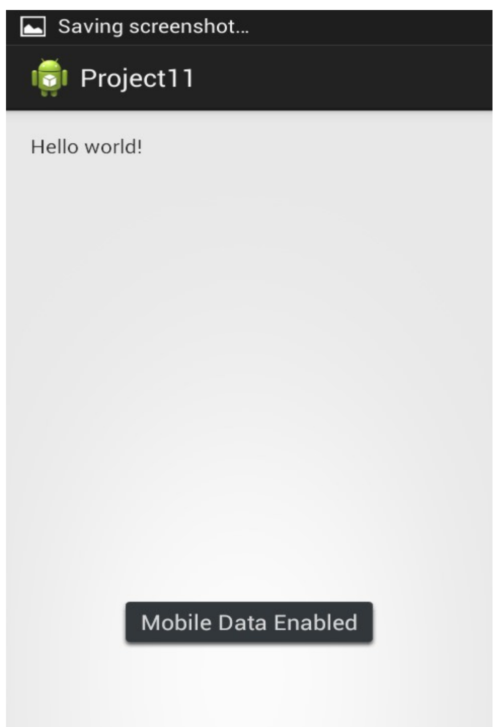
Bandwidth is calculated for the particular application by the system.



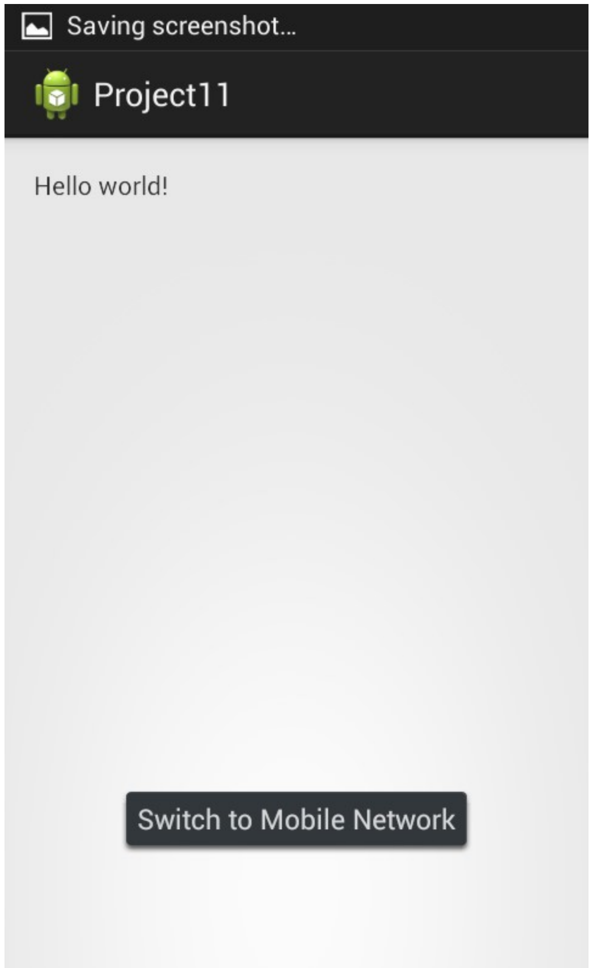
RTT, jitter and packet loss for the application is calculated.



There has been no HO in the history for considered session. This the information retrieved from the HO profile



System enables the mobile data.



A HO takes place to Mobile network.