CHAPTER 4

SIMULATION TOOL

OPNET MODELER

Problems can be effectively solved through, by running a computer simulation program since that would be more time efficient than actually doing the calculations by hand. OPNET is a graphically based package which allows to measures the performance of communication networks. These communication networks are available in vide variety, they are from simple links to complex enterprise wide systems to be analyzed and predicted. OPNET supports a building block approach where the blocks are well-known objects in the real world. The design tool has a library of these network objects and each network object represents one or more real world object. Every object has different parameters. These parameters are easily changed according to real world objects. These parameters are capable for performing analysis of both computer and communication network according to the type of a network, it also control algorithm and workload, it perform the simulation on the operation of the network and take a measurement of network performance [59]. One of the first steps before the beginning of the Project is to register with the OPNET simulation package. This will be done through the OPNET [59] website. In order to learn the capabilities of the OPNET simulation package, there are several online models which were contributed by users, and also there are tutorials on the Program that will be very helpful to succeed in a quick understanding on how the programs works and how to model the required network for this project. [60].
4.1 OVERVIEW OF OPNET

OPNET is the network technology development environment. OPNET provides simulation environment to study and formulate various communication network, devices used in network, network protocols, and different applications with greater functionality. OPNET Modeler is used by the industries and research labs to boost up the research & development process. OPNET Modeler [59] is based on object oriented modeling technique. Graphical editor reflect the design of real network and various network elements. So OPNET modeler naturally maps the actual network to OPNET model. Every network type and technologies support by OPNET modeler. When OPNET Modeler is used to simulate a network it is beneficial to an organization by:

- **Enhancing Network Research and development Productivity**: For design a network, specialized editors, analysis tools, and off the shelf models are delivered with OPNET Modeler. These special functions are used to focus on the various unique parts of the project [59].

- **Increasing Product Quality**: To improve product quality, test product or service designs perform in practical customer scenarios prior to production [59].

- **Decreasing Time to Market**: To decrease the time to launch new design in market develop and validate the designs in advance due to competition. Models are utilized to express the value of the solutions to different customers and partners [60].

OPNET (14.5) simulator is used for deploying UMTS network architecture by using different nodes (mobile & fixed) from object palette. OPNET MODELER is used for design and study different communication networks along with devices there protocols and various applications.

It provides a graphical user interface to build simulation models for various network parts from physical layer modulator to application processes. Figure 4.1 shows OPNET Modeler and the steps needed to create a network model and execute simulations. It centers on the project editor. In this workspace a network model can create, gather
statistics directly from every network object or from the complete network, execute the simulation and also get the results.

Fig 4.1 Steps to build a network in OPNET Modeler

The OPNET Modeler gives the facility of the graphical user interface in which the users can model and simulate their networks. For developing different communication structures and implementing different scenarios, different hierarchal layers are present in the environment of the modeling. Users can build a detail model according to the requirement to do the analysis of the system. The systems are designed in the object oriented way, on compilation of the model its produces a discrete event simulation in the C language. Fig. 4.2 shows the OPNET [59] modeler view. After performing the simulation, the results are analyzed with the different statistics related to the performance provided by the OPNET [60]. The following are the different layers in the OPNET which are explain below.
4.1.1 The Network Layer:

On the graphical map the network layer enables to specify the network topology. Different elements of the network can be placed on the network layer. Through different links these network elements can be connected. To perfume the mobility of the user equipment the trajectories can be created through the radio links. So it being the useful facility as the mobile UMTS users can be simulated. Fig. 4.3 shows the network editor screen shot. The sub network can be merging together in this layer. Using the network layer the network project can be built up. OPNET [59] contains the wide library of node model having different technologies like UMTS, ETHERNET, and ATM etc.
4.1.2 The Node Layer:

The nodes are built up in the node layer. The nodes are made up in the node editor using different transmitter, receiver, processor etc. These blocks are called as modules. These modules allow implementing the different node specific characteristics. The figure 4.4 below shows the node level implementation of the UMTS Node B.
4.1.3 The Process layer:

This layer makes the possibility of programming the various modules which are utilized in the node layer to design and implement various protocols or the required behavior of the node. The OPNET has a wide kernel of standard procedures that are mostly used in the communication networks but it is possible to write the C++ codes which are the user’s specific function. The process editor uses Proto-C, which is the programming language which makes the combination of the C/C++ language and the state transition diagram.
4.2 OPNET UMTS MODEL

OPNET Modeler presents the specialized models that cover the specific needs for the simulating and modeling the networks that poured on certain technology area. UMTS is the one of those models which is based on the 3GPP specification. Fig. 4.5 shows the UMTS model architecture.

Fig 4.5 UMTS Model Architecture

4.2.1 Available Node Models

The node models of universal mobile telecommunication system specialized model library are grouped in the universal mobile telecommunication system and universal mobile telecommunication system advanced object palettes. Fig. 4.6 shows the UMTS object palette.
The OPNET UMTS model suite contains two groups of node types:

- **Station models**: These models are used to model raw traffic at particular bit rates. Fig. 4.7 shows the UMTS station models.

- **Full stack models**: These models are used to model application traffic that goes over the full IP stack via an IP network. Fig. 4.8 shows the UMTS full stack models.
Fig 4.7 UMTS station models

Fig 4.8 UMTS full-stack models
The following model focuses on UE-UTRAN-CN architecture as shown in the figure 4.9

![UE-UTRAN-CN architecture](image)

Fig. 4.9 UE-UTRAN-CN architecture

The User equipment model gives the functionality of the mobile equipment. It is responsible for the radio link termination. The UTRAN model is developed by base station (Node B) and the radio network controller (RNC). The CN is not fully implemented. The SGSN and the GGSN are included. Fig. 4.10 shows a simple UMTS network using application traffic in OPNET simulator.

![Simple Network using application traffic](image)

Fig. 4.10 Simple Network using application traffic

The UMTS model supports wide range of a feature which resembles the real network. The four different traffic classes are defined in the model which is conversation, interactive, background and streaming. Different QoS profiles are defined for each traffic
class. This allows studying various effects in the network. The overall features of the UMTS OPNET Model are discussed below [60].

- It is based on WCDMA.
- It supports the four QoS classes.
- It supports the user equipment UE, Node B, RNC, Repeater, GGSN and SGSN.
- It supports the hard, soft and the softer handovers.
- It supports the outer loop power control.
- It offers the facility of the set up, release and negotiation of the radio access bearers.
- It supports for the dedicated and the common control channels.
- It supports for the different modes like acknowledge, unacknowledged and the transparent RLC.
- It supports for the multiplexing of logical channel to the transport channel.