

SIMULATION OF NETWORK CONGESTION RATE BASED ON QUEUING THEORY USING OPNET

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ABSTRACT

Most University networks are built to accommodate the needs of a single organization or group. So in current era, analysis of network simulation is very costly with real equipments, so by using some simulation tools which helps to simulate the data on mathematical view and generate the accurate results. To understand the total data transfer time from user to server and back in the network with network congestion. In this problem the queuing theory application in time especially M/M/1 method is used to define the network congestion and buffer time to provide the output of the query. Network simulation helps to examine problems with much less work and of much larger scope than are possible with experiments on real hardware. An invaluable tool in this case is the free OPNET network simulator that offers the tools for modeling, design, simulation, data mining and analysis. OPNET can simulate a wide variety of different networks which are linked to each other.

I. INTRODUCTION

As the technology is improving now days, demands of end users and their applications also increasing. A wide variety of new applications are being invented daily. These Applications have different demands from the underlying network protocol suite. High Bandwidth internet connectivity has become a basic requirement to the success of almost all of these areas. Network simulation with queuing theory explains the various related technologies like Simulation of network and OPnet technology, and also the how to use Queuing theory.

II. OPTIMUM NETWORK PERFORMANCE (OPNET)

A simulation and analysis software for:

Applications
Protocols
Architecture
Devices

OPNET Modeler is the industry's leading network development software first introduced in 1986 by MIT graduate. OPnet allows you to design and study communication networks, devices, protocols, and applications. Modeler is used by the world's most prestigious technology organizations to accelerate the R&D process. Some of the customers include Pentagon, MIT, UIC, and many more.

The virtual network environment represents a network. It can have a slew of components in every salient category. OPnet defines a topology as a “collection of links, nodes and its Configuration”. By “**nodes**” OPnet means to include networking hardware of all kinds (routers, workstations, switches, hubs etc). By “**links**” the underlying connectivity technology (Ethernet, ATM, etc) and relevant characteristics (latency, bandwidth) are meant. In “**configuration**” things like routing protocols, addressing, are included.[3]

III. SIMULATION PROCESS IN OPNET

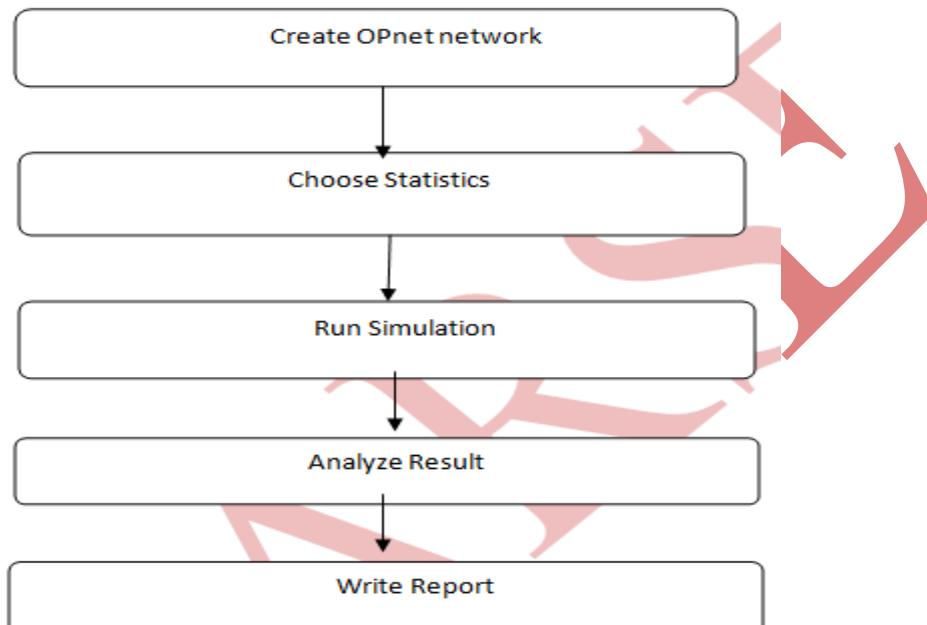


Figure 1 DFD Of Simulation Process

IV. SIMULATION CONFIGURATION

In **OPnet** common setting Tab of Simulation we performed with the following features:

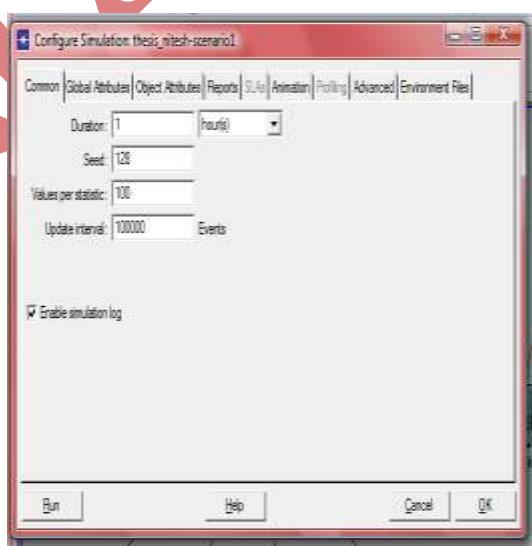
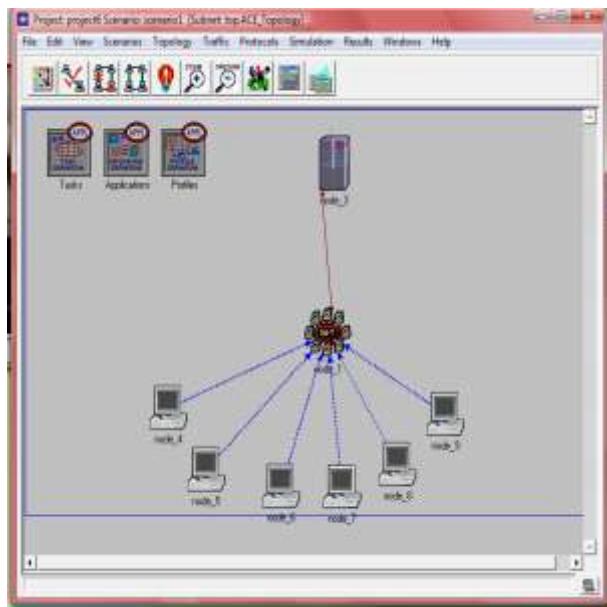


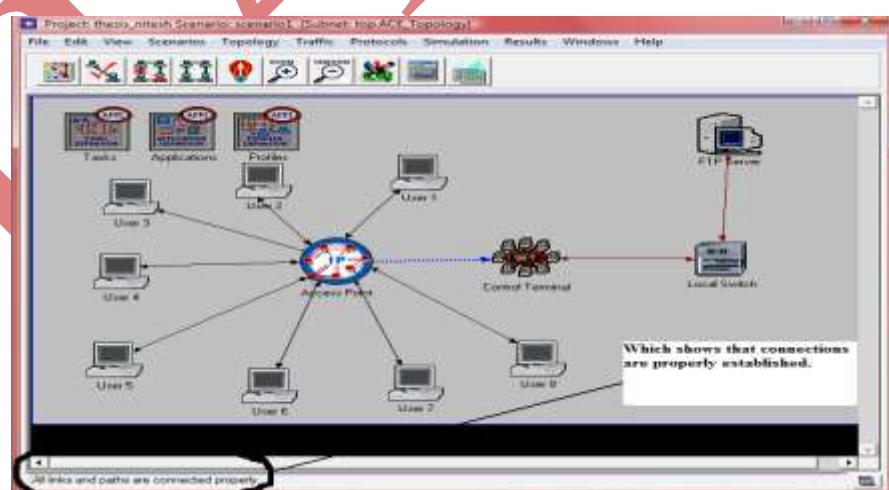
Figure 2 Common Attributes Data Filling In Thesis_Nitesh-Scenario1

V. HOW THE SERVER AND CLIENT WORKS



1. Clients send “Short” requests to Control Servers. (node4, 5, 6, 7, 8, 9)
2. Control Servers compose and send “Long Request” to Data Servers. (Node 1)
3. Data Servers reply by sending the “Large Files”. (Node 3)
4. Control Servers broadcast the “Large Files” to all clients. (Node 1)

VI. OPNET MODEL FOR SIMULATION



The verification of the link between different devices has been checked for proper data connectivity:

Simulation of network contained with the given Attributes

Duration: 2 hours (~=8000 sec)

Seed value: 128 (Random number generation seed).

Value per static: 100(collected for each).

Update Interval: 100,000(In simulation events between simulation performances updates sent back to the GUI).

VII. CONGESTION RATE

Network congestion rate is changing all the time [2], the instantaneous congestion rate is used to analysis the network traffic in network monitor. The instantaneous rate $A_c(t)$ is the congestion rate at the moment of t, the $A_c(t)$ can be obtained by solving the system length of the queue's probability distributing, which is called $P_{n-1}(t)$. According to some properties of Markov Process, we know that $P_i(t)$ ($i=0 \dots C+1$) satisfies the following equation and by solving this equation, we get the network congestion rate $A_0(t)$ [5]

$$A_0(t) = P_1(t) = \frac{\lambda}{\mu+\lambda} (1 - e^{-(\mu+\lambda)t}) \quad \dots (1)$$

The results observed during the simulation are:

Simulated Time: 2 hrs

Total elapsed time for simulation: 3 sec

Event Happens: 442037 in 2 hrs

Speed average: 200197 events /sec

Speed current: 230971 events /sec

In the given results,

Event Happens: 442037 in 2 hrs = 2 sec

Therefore in 1 sec = $442037/2 = 221019$ is arrival time in 1 second.

Average speed for 1 second is = 200197 is service time in 1 second.

Exponential inter arrival times with mean $1/\lambda = 221019$ (2)

Exponential service times with mean $1/\mu = 200197$ (3)

Then we calculate,

$$\rho = \frac{\lambda}{\mu} < 1$$

$$\rho = \frac{1/\mu}{1/\lambda} = 200197/221019$$

$$\rho = \frac{\lambda}{\mu} < 1$$

The Value of λ, μ are calculated from equation (5) and (6) as

$$\lambda = 1/221019, \quad \mu = 1/200197.$$

For $t \leq 0$, the probability density function is

$$f(t) = \lambda e^{-\lambda t}$$

Then the probability density function of arrivals time with mean $1/\lambda$ is

$$f(t) = 1/221019 e^{-1/221019 t} \quad \dots (4)$$

Similarly

For $0 \geq t$, the probability density function is

$$g(s) = \mu e^{-\mu t}$$

Then the service time t is $g(s) = 1/200197e^{-1/200197t}$ (5)

To getting μ and λ we calculating the value of

$$A_0(t) = P_1(t) = \frac{\lambda}{\mu+\lambda} (1 - e^{-(\mu+\lambda)t})$$

$$A_0(t) = P_1(t) = \\ 0.5263(1 - e^{-(1/221019 + 1/200197)t})$$

$$A_0(t) = P_1(t) = 0.5263(1 - e^{-0.000095t})$$

For $t = 1$, for first congestion in 1 sec i.e. 1 hours

$$A_0(1) = 0.5263(1 - e^{-0.000095})$$

From table the value of $e^{-0.000095} = 0.999905005$

$$A_0(1) = 0.5263$$

It is observed from the above calculation that the congestion rate increased by 0.5263 percent in 1 hour is predicted in network. If the more number of switches are added in a network then it reduces the network congestion and increase the performance of network.

VIII. CONCLUSION AND FUTURE SCOPE

OPnet simulator environment was used by experimenting with different network traffic data available with this tool kit. The simulation was performed using the M/M/1 model of queue theory. The congestion rate observed during the simulation is 0.5263 percent in 1 hour without increasing a single node in network. If number of switches in a network increased then it only reduces the network congestion and increase the performance of network. But due to using of this process model, network performance is increased and service is available for longer times. In traffic received by switch in sending the data is same, but this type of observation is not measure in long period (In case of packet transfer). It is also observed that the loss of network simulation data i.e. the difference between received and sent data are $14701 - 14602 = 99$ bytes at 1 hours duration of given data. This all states shows that in network environment, congestion is always possible but it can be reduced by apply Queuing theory approach in modeling. Otherwise use the extra switches in the network, which will reduce the congestion on particular server and increase the speed of server and overall speed in the network will increase.

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