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SOHO NETWORK MODELING AND SIMULATION USING OPNET

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ABSTRACT

The rapidly growing Internet is driving the demand for higher transmission capacity and high-speed networks. Designing an efficient network to achieve desirable performance is a challenging task, requiring designers to balance user performance expectations with costs and capacities. The study is based on the OPNET simulation tool focusing on the question of whether faster connections are worth higher prices for the Small Office/Home Office network. The paper simulated 3 different scenarios comparing application performance with different connection speeds between a SOHO LAN and the ISP, to evaluate application performance and server capacity planning for web browsing, E-mail, video conferencing, database and FTP. It also examined how response times, throughput, utilization on the WAN link and other network performance measured. Use numbers to justify our recommendation. The investigation results reveal that upgrading a link data rate will not necessarily be economically feasible with the performance improvement that it gives, and solve them cost-effectively by understanding the impact of changes.

Keywords: *Simulation, Modeling, SOHO LAN, OPNET*

1. INTRODUCTION

With the developing of network technology, the network structure and environments are more and more complicated, and the applications of network are also more and more diverse. It is already not adapt to the development of network simply rely on the experience to design and plan network. So we need a scientific method to reflect and predict the performance of network. Network simulation technology appears.

Three basic activities of network simulation are system modeling, simulation modeling and simulation experiment, which associate system, model with computer (including hardware and software) closely[1]. OPNET software is a very useful network simulation software.

OPNET is developed by OPNET Technologies Company. OPNET software contains professional knowledge of how to operate network equipments, network protocols, applications and servers, which make the technology provide an objective and reliable quantitative basis for network. OPNET can reduce the construction period of network, improve the decision scientific and reduce the investment risk of network construction [2].

With the rapid development and the popular applications of computer technology, SOHO network is becoming an important part of network, and SOHO become a popular work style. The issue of how to construct a suitable SOHO network is discussed in this paper.

Section 2 presents modeling and designing of SOHO network. Section 2 shows the topology of SOHO network and details configuring of applications and profiles. In section 3, we analyze the simulation results. Section 4 gives a conclusion to the whole paper.

2. SOHO NETWORK DESIGNING AND RUN THE SIMULATION

2.1 SOHO Network Designing

The network design process is a challenging task, requiring designers to balance user performance expectations with costs and capacities. Network is so ubiquitous in modern business that it is hard to develop an overall strategic vision and detail enough to be useful at the same time. In order to achieve a good design, it is often essential to build a network model and apply certain tools to evaluate different scenarios. Network design is also

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achieving design goals by applying the trade-off with constraints to parts of the whole network.

2.1.1 Design the Topology of SOHO Network

A company contains several departments. So A SOHO network contains several subnets, each subnet is on behalf of a department and contains several PCs connected to a switch. Today laptop is more and more popular, so there should be a wireless AP connected to some laptops. Most companies have their servers, so a SOHO network also contains several local servers, for examples, email server and print server. Those subnets and local servers connect to a switch. The switch and the AP should connect to a router, a router connects to ISP. So the logic topology of SOHO network is shown in Fig1.

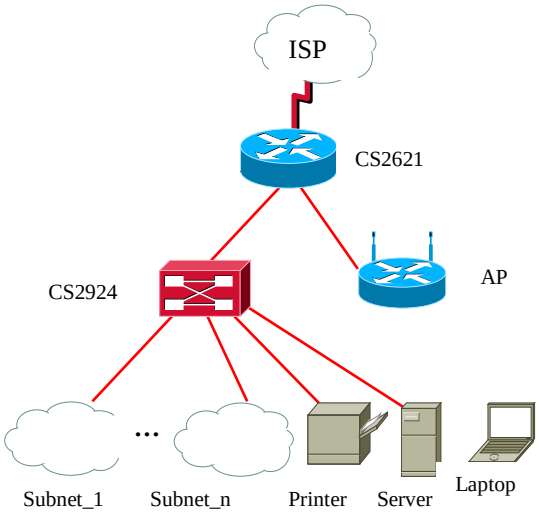


Fig1 Soho Network Logic Topology

Start OPNET and build a project. Name the project SOHO, and the scenario 2M.

Add to the project workspace the following objects from the Object Palette: Application Config, Profile Config, an ip_32Cloud, three ppp_servers, two ethernet_servers, three 100BaseT_LANs, a ethernet_wkstn, a wlan_ethernet_router and two wlan_wkstns, four CS_2924XL_ls_ae24 switchs, a CS_2621_3s_a2_fe2_slip2 router,

Rename and connect the objects as shown in Fig2.

Pay attention to the links connected devices, the links must be correctly chosen. Ethernet links must be chosen between PC, switch and router, for example, 10BaseT, 100BaseT, 1000BaseX. PPP links must be chosen between router, IP cloud and servers, for example, PPP_T1, PPP_E3.

Save the project[3,4].

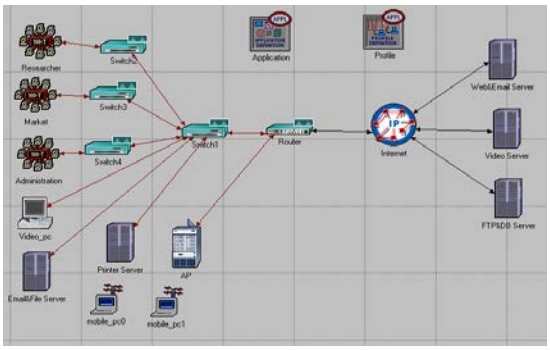
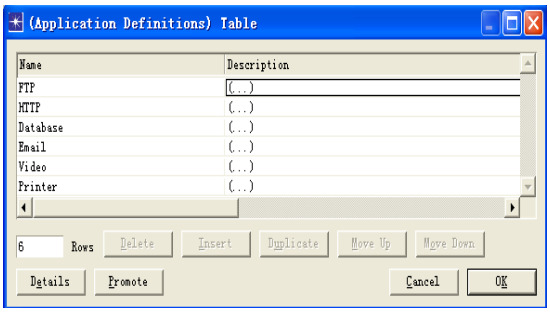


Fig2 Soho Network Topology

2.1.2 Configure the Network

2.1.2.1 Configure the Applications and Profiles

Right_click on the Application node, choose Edit Attributes and set Application Definitions to Default as shown in Fig 3.



Edit description of FTP to High Load. Edit description of HTTP to Heavy Browsing. Edit description of Database to High Load. Edit description of Email to High Load. Edit description of Video to Low Resolution Video. Edit description of Printer to Color Prints.

Right_click on the Profile node, choose Edit Attributes and set Application Definitions as shown in Fig 4[5].

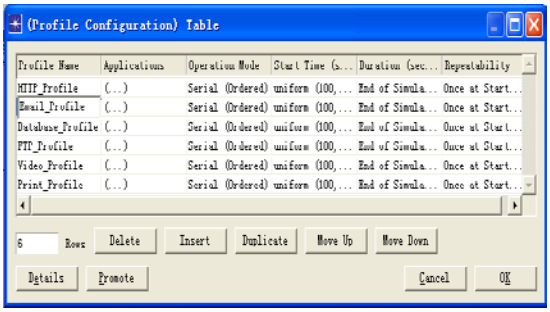


Fig3 Profile Configuration

Application of HTTP_Profile is shown in Fig5.

Application of Email_Profile is shown in Fig6.

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Application of Database_Profile is shown in Fig7.

Application of FTP_Profile is shown in Fig8.

Application of Video_Profile is shown in Fig9.

Application of Print_Profile is shown in Fig10.

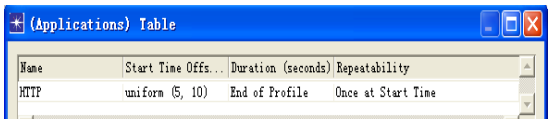

Figure5 Http_Profile Configure

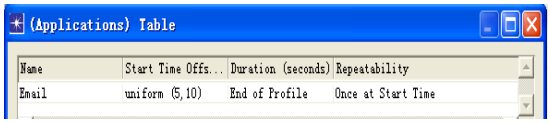

Figure6 Email_Profile Configure

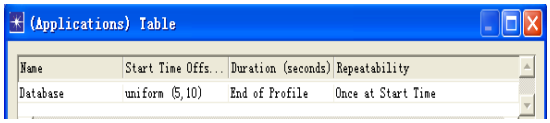

Figure7 Database_Profile Configure

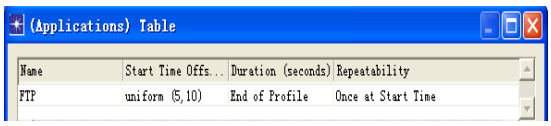

Figure8 Ftp_Profile Configure

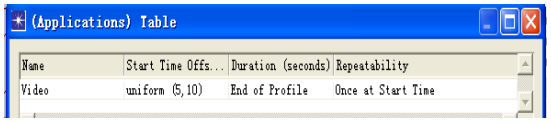

Figure9 Video_Profile Configure

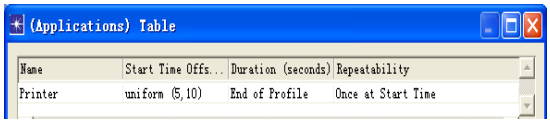

Figure10 Print_Profile Configure

2.1.2.2 Configure the servers and the workstations

Right_click on the Web & Email Server, set its Supported Services to HTTP and Email. Right_click on the Video Server, set its Supported Services to Video. Right_click on the FTP&DB Server, set its Supported Services to FTP and Database. Right_click on the Email&File Server, set its Supported Services to Email and Database. Right_click on the Printer Server, set its Supported Services to Printer.

Right_click on the Researcher, set its Supported Profiles to HTTP_Profile, Email_Profile, Database_Profile, FTP_Profile and Print_Profile. Right_click on the Market, set its Supported Profiles to HTTP_Profile, Email_Profile and Print_Profile. Right_click on the Administration, set its Supported Profiles to HTTP_Profile, Email_Profile, Database_Profile and Print_Profile, set its Number of Workstations to 5. Right_click on the mobile_pc0 and mobile_pc1, set their Supported Profiles to HTTP_Profile and Email_Profile. Right_click on the mobile_pc0 , mobile_pc1 and AP, edit Wireless LAN Parameters and set Data Rate (bps) to 11Mbps[5, 6].

2.1.3 Choose the statistics

Right_click on the workspace and select Choose Individual Statistics from the pop-up menu.

In the Choose Results dialog box, choose the following statistic[6,7]:

Global Statistics → HTTP → Page Response Time

Global Statistics → Video Conferencing → Packet End-to-End Delay

Global Statistics→FTP→Download Response Time(sec)

Right_click on the link between Router and Internet and select Choose Individual Statistics from the pop-up menu, and then choose point-to-point→utilization <-- and throughput (bit/sec) <--.

Click OK.

2.2 Run the simulation

Right_click on the link between router and internet select Edit Attributes, change the data rate to 2000000 as shown in Fig11.

Click on  and the Configure Simulation window should appear. Set the duration to be 60 minutes. Then click OK and save the project.

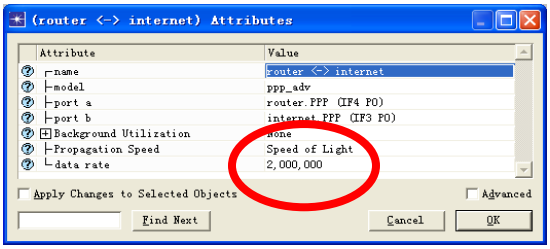

Fig11 Link Attributes

In the network we only set the link speed between a SOHO LAN and its ISP to 2Mbps, we should have some other different data rate to investigate applications performance.

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Select Duplicate Scenario from the Scenarios menu, name it 4M and set the link between router and internet to 4000000.

Select Duplicate Scenario from the Scenarios menu, name it 10M and set the link between router and internet to 10000000.

To run the simulation for the three scenarios simultaneously. Select Manage Scenarios and change the values as shown in Fig12. Click OK to run the three simulations.

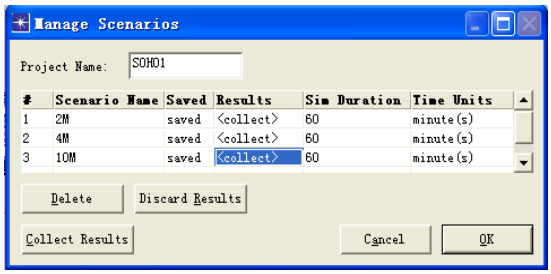

Fig12 Manage Scenarios

3. Analyze the Results

Select View Result from the Scenarios menu. Fully expand the Global Statistics and the Object Statistics.

Select the Download Response Time (sec) under Ftp, then click Show and the result is shown in Fig13.

Fig13 shows the FTP Download Response Time of different data rate. When the data rate is 2Mbps, the FTP download response time is in the range of 0.75 to 1.25 second. When the data rate increases to 4Mbps and 10Mbps, the download response time decreases to about 0.25 second and 0.12 second The result shows download response time decreases very fast with the increasing of bandwidth, but it decreases slow when the bandwidth increase from 4Mbps to 10Mbps. The reason is the largest contributing factor to the Ftp download response time is protocol/congestion. Only about 30 percent of the download response time is caused by bandwidth[8]. So for FTP，increasing bandwidth is not the most efficient way to decrease download response time.

Select the Page Response Time (seconds) under HTTP, then click Show and the result is shown in Fig14.

Fig14 shows the page response time is in the range of 0.1 to 0.2second when the data rate is 2Mbps. When the data rate increases from 2Mbps to 4Mbps and 10Mbps, the page response time go down to about 0.03 and 0.015 second. It is obvious that the page response time decrease when the data rate increases from 2Mbps to 4Mbps and 10Mbps. But it has little difference when the data rate increases from 4Mbps to 10Mbps.

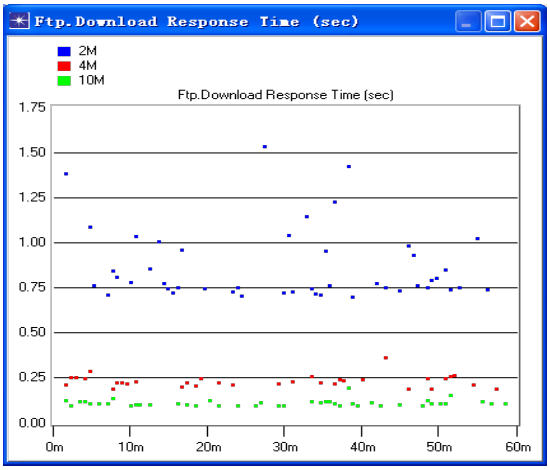

Fig13 Download Response Time

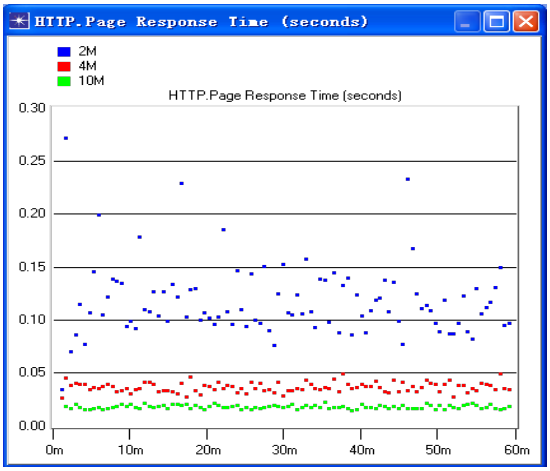

Fig14 Page Response Time

Select the Packet End-to-End Delay (sec) under Video conferencing, and then click Show and the result is shown in Fig15.

Fig15 shows the video conferencing packet end-to-end delay is about 0.075 second, 0.036second and 0.015second when the data rate is 2Mbps, 4Mbps and 10Mbps. Video conferencing extremely emphasize synchronism, so it's better when delay is smaller. 10Mbps is best for the video conferencing application.

Select the throughput <-- and utilization <-- between router<->internet [0], then click Show and the result is shown in Fig16 and Fig17.

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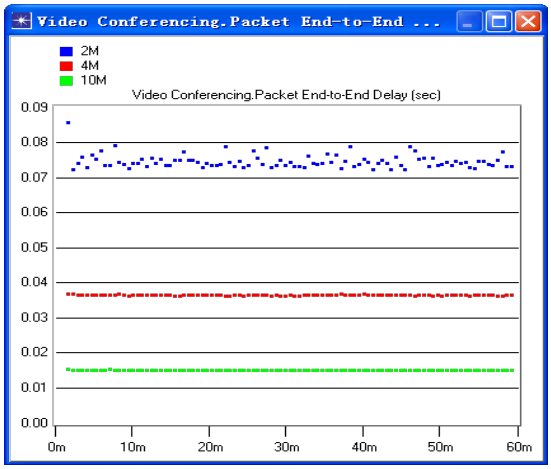

Fig15 Packet End-To-End Delay

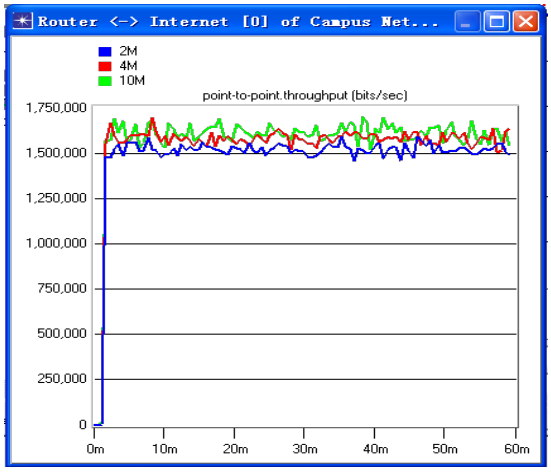

Fig16 Download Throughput

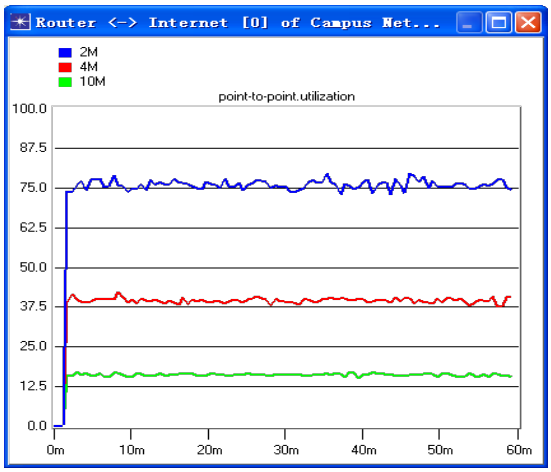

Fig17 Download Utilization

Fig 16 shows the throughput is about 1530000bit/sec, 1600000bit/sec and 1640000bit/sec when the bandwidth is 2Mbps, 4Mbps and 10Mbps. It does not change a lot under different data rate. The reason is that the applications of three scenarios are same, only the bandwidth of the router and internet changes. When the bandwidth is big enough for all applications, bandwidth has little effect on throughput. The bandwidth of those three scenarios is big enough, the load of three scenarios is nearly same, so the throughput is approximately equal.

The download link utilization can roughly calculate using download throughput divided by bandwidth, which is approximately equal with the results shown in Fig17. The utilization <-- is about 77%, 49% and 16% when the date rate is 2Mbps, 4Mbps and 10Mbps.

When the date rate is 2Mbps, the download link utilization is about 77%, which is a little large. So there isn't much available bandwidth for potential users or applications. For example, Select and copy the Video_pc. Set the simulation duration to be 35 minutes and run the simulation. The result is shown as Fig18. Fig18 shows that the download link utilization is nearly 100% when the data rate is 2Mbps, which is too large and against the advanced of SOHO network.

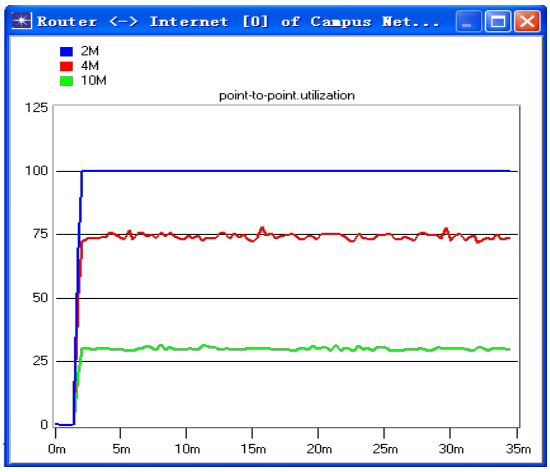

Fig18 Download Link Utilization

The results of global statistics are shown in Table1.

The cost of different bandwidth is shown in Table2.

From Table1 and Table2, when the bandwidth is 10Mbps, the network performance is the best, but the cost is also the most expensive. The performances don't change obviously when the bandwidth increases from 4Mbps and 10Mbps, but the cost is much cheaper. The cost is cheapest when the bandwidth is 2Mbps, but it's against the

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development of SOHO network from previous analysis.

Table1 Results

	Page Response Time(sec)	Packet End-to-End Delay(sec)	Download Utilization	Throughput (bit/sec)
2M	0.1-0.2	0.075	77%	1530000
4M	0.03	0.036	40%	1600000
10M	0.015	0.015	16%	1640000

Table2 Cost

	2M	4M	10M
Cost(Yuan/month)	210	388	900

So considering the network performance and the cost, bandwidth of 4Mbps is the most appropriate.

4. CONCLUSION

The paper supplies a method to choose a suit bandwidth considering performance and cost at the same time. It can realize the network performance and reduce the investment risk and cost of network construction by simulation before building a real network.

It isn't the most appropriate when the data rate is the largest from previous simulation. We should consider many different factors, for example, performance, cost, development, to choose the best suitable bandwidth.

The topology of SOHO network in the paper maybe not very appropriate for today's SOHO network. And maybe you have some other applications and profiles. You can use the method to simulate your true SOHO network and choose suit bandwidth.

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