The Impact of Network Delay on Applications

Summary

This white paper describes the impact of network delay on applications and how to stress your application before deployment to gain predictability of application success or growth potential. Even a relatively small delay in a network can result in a significant increase in application response times which will lead to user dissatisfaction, rebroadcasts and possible application failure. In today's networks significant stress can be caused by the many application turns and larger payload needed in today's communications environments. More data and delay presses the network bandwidth limits and can cause router congestion. Larger packets studies have shown to significantly increase loss and delay. These factors can effectively slow down your network and application response times.

Background

Network delay is the total time from the moment the user makes a request until a response is received by the user. Network delay consists of many delay components: propagation, transmission, routing or queuing, processing, and application turns. Propagation delay is the time required to cross a distance in a particular transmission medium (fiber, copper, air). Transmission delay is the time for the information (frame, packet, byte) to enter the link. Routing or queuing delay is the total time that the information sits in routing queues. Processing delay is the combined time required for the two end devices, typically a client and a server, to process the information and provide a response or action. In addition, network delay varies over time due to the following items: delay variations of router queues, amount of other traffic, infrastructure changes (either outages or new links), routing changes, and congestion effects from bursts of other streams.

A response time formula was developed by Peter Sevcik and Rebecca Wetzel of NetForecast to align response time with network delay factors:

R ~ (Payload / Bandwidth) + AppTurns (RTT) + Cs + Cc

R = response time between a user's action and the network's response to the user's request

Payload = information content in bytes that must be delivered to/from the user

Bandwidth = minimal link bandwidth between the user and network server

AppTurns = number of interactions needed between the client and network server to provide a response to the user

RTT = round trip time (seconds) between the user and application server

Cs = processing time (seconds) required by the server

Cc = processing time (seconds) required by the client device

This white paper describes the impact of network delay on applications and how to stress your application before deployment. Even a relative small delay in network delay can result in a significant increase in application response.

Network Delay

As described above, network delay is comprised of a number of delays. Each of these delays contribute to the round trip time of an application turn. Most applications require between five and a hundred application turns. In addition, as multimedia becomes mainstream, larger payloads are required to carry video and other content.

All of the delay factors tend to feed off each other and exasperate the network application delay issue. More application turns causes more data to be sent over the network. Larger payloads create more data. More data stresses the bandwidth of each network link and the routing capability of network devices.

A common practice to solve network issues in the past was to throw more bandwidth at the problem. More bandwidth may solve the problem if a particular link bandwidth is the bottleneck. However, more bandwidth will not solve the problem if the number of AppTurns and the propagation delay are both high. In addition, more bandwidth will not solve the problem if a router is over utilized and is causing queuing delays.

Pre-Deployment Testing

To optimize application implementation into the production network, applications should be stressed with WAN conditions before deployment. Below is a simple two server and two client example (Figure 1). Each client–server pair has a different WAN with their respective impairments listed in Table 1.

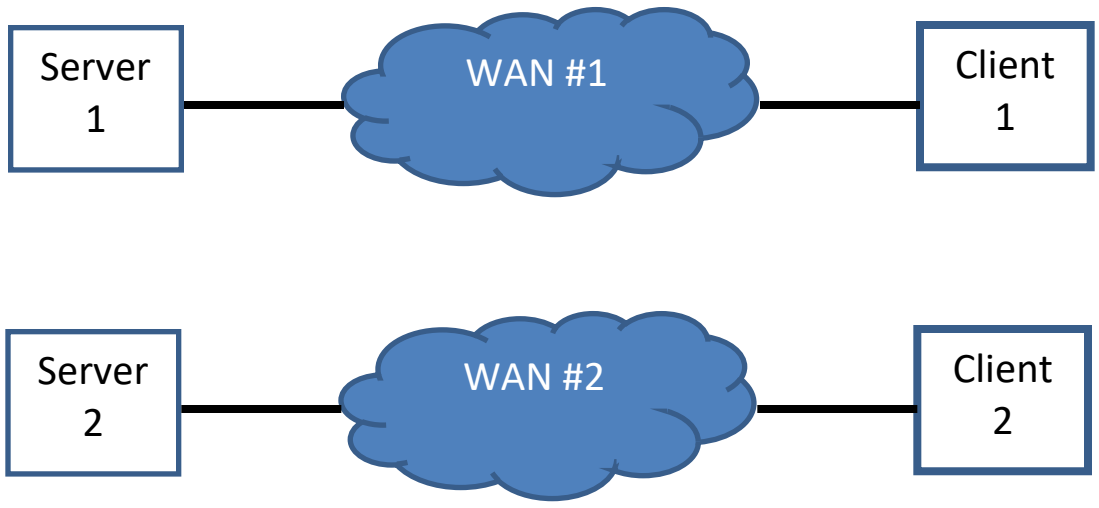


Figure 1. – Two Client-Server Example

	WAN #1	WAN #2
Delay	100 ms	180 ms
Packet Loss	2 %	1.2 %
Bandwidth Limit	1.5 Mbps	45 Mbps

Table 1 – WAN Impairment

By using a WAN emulator, different network conditions can be emulated to see what are the breaking points for the application. Test labs typically have their servers and clients on separate networks and in that case the emulator would be connected into one port of each network (Figure 2).

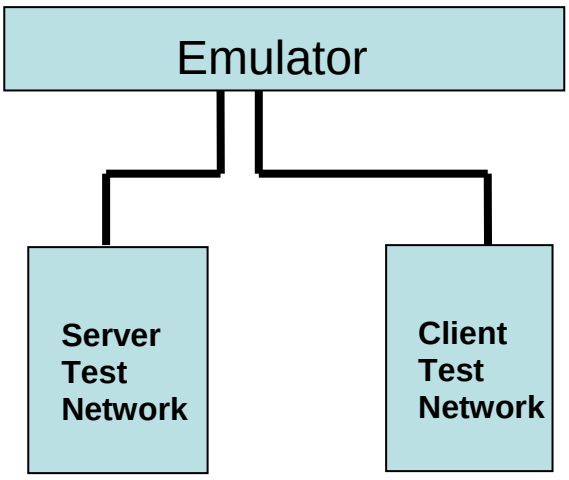
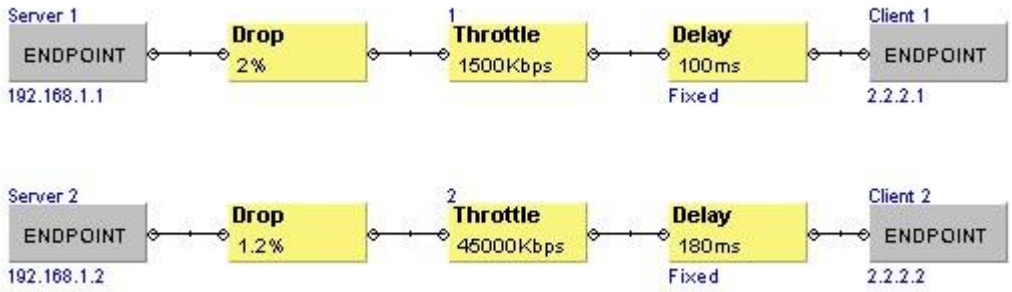


Figure 2 – Two Port Emulator Configuration – Test Networks

Figure 2 demonstrates the potential of a large number of concurrent independent Client-Server test networks.

Following is a GUI network configuration of a PacketStorm emulator for two Client–Server networks. Each network has its independent WAN impairments of packet drop, bandwidth throttle, and delay. The number of Client-Server pairs using the same emulator ports can be expanded to many more such that the aggregate bandwidth is below the maximum bandwidth of the emulator port.



Review

This paper examined the causes of delay and the equation needed to quantify delay measurements. Delay is the most basic network and application measurement needed to benchmark the network functionality and ability to successfully handle the network applications. Today's networks are business elements and without a successful network one will have to struggle to have a successful business. Networks need to be measured and tested regularly as comparative analysis is a great troubleshooting indicator for maintaining a successful business solution.

Pre-deployment testing is becoming an essential method to predict the effects of new or expansion of old applications or users. This "What If" testing will help one predict issues for new deployments or expansions before they have to take down the network and lose precious business time in repairing something after it has happened. With "What If' testing, one can prepare the network before deployment and avoid those dreaded Network outages. Network outages or applications being down can cost many $$ to a company, so avoid them by predictability testing scenarios. Always know the delay of your network and application to have a successful business network.

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About PacketStorm Communications

PacketStorm Communications, Inc. develops IP Network Emulators that allow users to emulate various IP Network conditions. By developing proprietary hardware and software, PacketStorm has created emulators that can be used to extensively test networking applications that are available today as well as future technologies that have yet to be deployed

PacketStorm is a privately held company founded in 1998 by a team of engineers and managers from the prestigious Bell Laboratories. With extensive backgrounds and experience in both network development and testing, PacketStorm continues to focus on the needs of IP developers and network managers. PacketStorm's world headquarters in New Jersey handles product engineering, marketing, and customer support.

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