

Introduction And Features

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NetStress is a benchmarking tool used to measure network performance -- both wired and wireless. It is a simple tool that employs bulk data transfer using layer 3 protocols TCP and UDP. Network performance is reported in terms of throughput -- that is, bits (or bytes) per second.

In order to test and troubleshoot networks we need tools that allow us to generate network traffic and analyze the network's throughput performance. This is true for both wired and wireless networks. Three common scenarios: (a) The network is performing below expectations and you wish to measure the current throughput and compare that against the network's theoretical specifications; (b) You are installing a new network, everything is working great and you wish to benchmark current performance as a reference point you can later refer back to -- either on a regular basis or if performance begins to degrade at some point in the future; and (c) You are making modifications to the network and need to know whether or not the modifications make a difference in the network's performance. This is where NetStress fits in. By quantifying the network's throughput performance, NetStress provides a valuable metric to assist you in monitoring the health of the network or assist you in troubleshooting network problems.

NetStress has an advantage over tools like FTP (File Transfer Protocol) - which transfers data to and from disks. If you have a high performance network, then using FTP may be insufficient for real network testing -- since data transfer is occurring to/from disks. NetStress achieves high performance testing by filling buffers in memory with data, then repeatedly transmitting this data using the TCP and/or UDP protocols. Since everything is running from memory, then we have a traffic transmitter and receiver that can operate at true network speeds. In the case of wireless networks -- whose theoretical bandwidth is significantly less than wired networks -- this may not be an issue.

By comparing actual throughput with the theoretical bandwidth between the transmitter and receiver or with a measurement taken at an earlier date, you can tell whether the network is operating as expected. Variations in throughput may indicate a significant amount of other traffic, overloaded network equipment, communication errors which cause

packets to be lost or, in the case of wireless networks, interference from other wireless devices. By performing tests using different machines on the network then you begin to gain clues as to where the problem lies and which areas should be examined in greater detail.

NetStress runs on the following Windows operating systems: WinXP (SP3), Vista and Windows 7 (32-bit and 64-bit).

Features:

Single Instance of the Application (i.e. each instance can be used as receiver or receiver plus transmitter):

NetStress follows a transmitter / receiver model. In the previous version a user would launch an instance of the transmitter on one machine and an instance of the receiver on another machine. The new version also follows a transmitter / receiver model, but you don't have to be concerned with this when you first launch the application. Now, every instance of the application includes a built-in receiver --that receiver may lie dormant or respond to transmissions from a transmitter. Also, every instance of the application can act as a transmitter. So, this provides a lot more flexibility since each instance can act as a receiver and, optionally, as a transmitter. When you launch NetStress you'll see that the charts have been separated as Transmitter and Receiver. When the built-in receiver receives transmissions from a transmitter then the results are displayed in the receivers charts, and when NetStress is transmitting then the results are displayed in the transmitter's charts.

TCP and/or UDP -- plus multiple data streams:

Supports TCP transmissions, UDP transmissions or both (concurrently). Furthermore, you can specify from 0 to 8 data streams for each protocol. These are configured using the Settings dialog. In addition, the timecourse results are broken down accordingly:

Total: The chart labeled Timecourse (Total) shows (a) the total throughput (both TCP plus UDP), (b) TCP alone (total of all the TCP data streams), and (c) UDP alone (total of all the UDP data streams).

TCP: The chart labeled Timecourse (TCP) shows the throughput results for each of the TCP data streams.

UDP: The chart labeled Timecourse (UDP) shows the throughput results for each of the UDP data streams.

The default setting is to test throughput performance using a single TCP data stream -- this is the most common scenario.

Packet Size:

Supports TCP and UDP packet size. Using the Settings dialog you can configure the packet size of the TCP and UDP data streams. Turns out this can have a dramatic effect on throughput.

Rate of Packet Transmission

Supports Packets Per Second (PPS) "throttle" for the transmission side. Using the Settings dialog you can configure 'packets per second' for both TCP and UDP data streams. This is useful in emulating voice and other timed applications.

Maximum Transmission Unit (MTU): NOTE: This feature is not supported on WinXP

Using the Settings dialog you can configure the MTU for the current interface adapter. Typically, the operating system will optimize this value when it first boots. This is not a parameter that Microsoft readily exposes since a bad value can dramatically degrade network performance -- so, experiment with it at your own risk. Though NetStress allows you to change this parameter while the application is running, it will restore the MTU to its original value when the application exits. Microsoft Windows computers default to an MTU of 1500 bytes for broadband connections and 576 bytes for dialup connections. To verify the MTU setting (e.g. while NetStress is running) here is a useful link:

<http://www.speedguide.net/analyzer.php>

Uplink and Downlink Modes:

Supports "Uplink" or "Downlink" data flow. "Uplink" is the normal mode -- where the instance of NetStress in front of you is the transmitter and data traffic moves away from you (that is, from the local transmitter to a remote receiver). In "Downlink" mode, the instance of NetStress in front of you swaps roles with the remote receiver and data traffic moves toward you (that is, from a remote transmitter to the local receiver).

Auto Node Discovery:

Each instance of NetStress sends periodic beacons that are used to notify other instances of NetStress that a new receiver is available. This makes it much simpler and less error prone when selecting a remote

node.

Display Units:

Using the Settings dialog you can configure the which units NetStress should use when displaying the data: e.g. KBps (KBytes per sec), Kbps (Kbits per sec), MBps (MBytes per sec) or Mbps (Mbits per sec).

Support for Multiple Network Adapters:

When NetStress is launched a dialog box entitled "Select Network Interface (local host)" appears. One or more local IP addresses will appear, depending on the number of network interface adapters installed on that particular machine. Select from the available network interfaces for your current NetStress session.

Using NetStress

In order to measure throughput performance between two nodes on a network we need a transmitter and receiver. The transmitter transmits packets to the receiver -- and the receiver, in turn, sends the result back to the transmitter. The results represent a quantifiable metric that reflects the performance of the path between the transmitter and receiver machines. By selecting the transmitter and receiver machines at various points within the network one can analyze critical portions of the data path.

Each instance of NetStress can run as both a transmitter and receiver, or just as a receiver. If you wish for a particular instance of NetStress to run just as a receiver then it is not necessary to specify a remote receiver IP address. On the other hand, if you wish for a particular instance of NetStress to run as both a transmitter and receiver, then use the 'Remote Receiver IP' button along the main menu to select or enter the IP address of a remote receiver. NetStress uses a UDP broadcast mechanism to automatically discover other instances of NetStress on the network that can act as a remote receiver. If no remote receivers are listed below this is probably because NetStress is not running on another machine. You can also manually enter the IP address of a remote receiver. There is one requirement -- the remote receiver must be reachable from the transmitter using ICMP (i.e. ping).

Running NetStress:

- 1) Launch NetStress on machine A -- call this "Node A". A dialog appears with a list of available network interfaces -- choose one.
- 2) Launch NetStress on machine B -- call this "Node B". A dialog appears with a list of available network interfaces -- choose one. Be aware that in order for the two instances of NetStress to be able to communicate then the interfaces you've selected must be on the same network. If there is only one network and each machine has only one NIC, then that is not a

problem. But in the case of multiple networks and/or NICs then it is necessary to pay attention to this detail.

3) Let's say "Node A" will be a transmitter -- then it is necessary to select a remote receiver node. Along the menu bar you'll see the label "Remote Receiver IP" and an IP address of 0.0.0.0. The star that moves from side-to-side is a visual cue that a remote receiver needs to be selected if this instance of NetStress is to act as a transmitter. Select the blinking '0.0.0.0' and the 'Select Remote Receiver dialog box will appear. Select the IP address of one of the remote receivers and press 'OK'.

4) Once a remote receiver has been selected, then the 'Settings' and 'Start' buttons along the top menu are activated. The 'Settings' dialog box allows you to control the following parameters:

- TCP vs UDP
- Number of data streams
- TCP Packet Size
- UDP Packet Size
- Rate of Packet Transmission (Packets Per Second)
- Data Flow
- MTU
- Display Units

5) While transmitting, certain buttons on the main menu change state -- e.g. the Stop button now becomes active. The Settings, Start, and 'Remote Receiver IP' buttons are temporarily deactivated.

6) To stop transmitting, press the Stop button.

7) Below the main menu there are two main windows -- 'Transmitter' and 'Receiver'. When NetStress is acting as a transmitter then the timecourse charts in the upper window will display the results. When NetStress is acting as a remote receiver then the lower window will display the results.

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Additional Notes

1) In our hands TCP / UDP packet size can have a dramatic effect. For example, here are typical results using NetStress on an Ethernet network and 802.11 g network:

Effect of TCP Packet Size (1 Data Stream):

Sec)		Throughput (KBytes /	
Packet Size (bytes)		<i>Ethernet</i> (100 Mbps)	<i>802.11 g</i>
8192		1400	680
65536		10000	680
131072		11000	680
262144		11000	680
1048576		11500	---

Effect of UDP Packet Size (1 Data Stream):

Sec)		Throughput (KBytes /	
Packet Size (bytes)		<i>Ethernet</i> (100 Mbps)	<i>802.11 g</i>
8192		180	200
16384		325	350
32768		600	600
49152		900	900
65507		1200	1100

2) When mixing TCP and UDP data streams, then TCP wins. That is, when adding TCP data streams then UDP rates drop dramatically compared to what they were in the absence of TCP data streams. It appears that Windows gives priority to TCP data streams.

3) The maximum 'Packets Per Second' depends on the network rating. The maximum ethernet frame payload is 1500 bytes (not considering Jumbo frames), which yields a frame that consists of 1526 bytes plus a 12-byte inter-frame gap, for a total Maximum Frame size of 1538 bytes.

Here's an example for a 100-Mb/s ethernet link:

100,000,000 bits/sec divided by (1538 bytes * 8 bits/byte) equals 8127 packets.

Network Rating	Maximum Packets Per Second
11-Megabits / sec	896
54-Megabits /sec	4392
100-Megabits / sec	8127
150-Megabits / sec	12,192
300-Megabits / sec	24,384
1-Gigabits / sec	81,272

In the dialog box used to set Packets Per Second the maximum value for Packets Per Second is adjusted according to the network rating and may be rounded up or down such that it is divisible by 8.

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Interpreting The Results

Below are three 802.11 (i.e. Wi-Fi) scenarios we'll consider:



1. Both the transmitter and receiver use a wired connection to the network. We connected our two machines to a wireless router that included 4 100-Mbps ports. The important point about this scenario is the path between the two nodes is wired on both sides. When we ran NetStress our results reported a throughput of a little over 7,750,460 bytes-per-second. A 100-Mbps port is capable of a theoretical, maximum throughput of 13,107,200 bytes-per-second ($100 \times 1024 \times 1024 \text{ bits} / 8 \text{ bits / byte}$). Considering that various factors (including the TCP protocol) contribute to an overhead that causes the actual throughput to deviate from the theoretical, then this type of result is reasonable and to be expected.



2. Either the transmitter or receiver communicates wirelessly -- the other uses a wired connection to the network. We setup a wireless network and configured the wireless router's Network Mode to use Wireless-G only. When we ran NetStress our results reported a throughput of approximately 2,500,000 bytes-per-second. So, how does this compare with the theoretical maximum of 54 Mbps? 54 Mbps is equivalent to 7,077,888 bytes-per-second ($54 \times 1024 \times 1024 \text{ bits} / 8 \text{ bits / byte}$). So, is our actual throughput (which is roughly 35% of the theoretical) reasonable? The short answer -- yes. The 54 Mbps is the theoretical

maximum of what the hardware and medium are capable of. There are numerous factors that can contribute to the difference -- including network traffic, interference from other wireless devices and, equally important, the overhead of the 802.11 and TCP protocols. The throughput we measure doesn't take into account that every 802.11 packet includes additional bytes besides the data payload. Also, the TCP protocol takes a big chunk out of the performance

(<http://repository.cs.aueb.gr/getdoc.php?papercode=CPWR-18-2006>).

Taking into account throughput and coverage factors, others

(http://www.atheros.com/pt/whitepapers/Methodology_Testing_WLAN_Ch

have determined a theoretical maximum user-level performance for the 802.11 standards -- and for 802.11 g this turns out to be 24.4 Mbps (approximately 3,200,000 bytes / sec). Our measured throughput of 2,500,000 bytes / sec compares favorably with the theoretical maximum user-level throughput of 3,200,000 bytes / sec.



3. Both transmitter and receiver machines communicate wirelessly. A setup similar to (2) above, except both nodes use a wireless connection to the network. When we ran NetStress it reported a throughput rate of 1,300,000 bytes-per-second -- roughly one-half of that reported by scenario (2). The explanation is that each wireless "hop" takes its toll on the overall throughput -- so, this result is reasonable and expected.

Conclusion:

We've presented some of our results here to serve as a guideline to help you with interpreting yours. Your throughput benchmarking results will likely differ from ours but, in general, for similar setups we'd expect the results to be roughly comparable. That is, of course, unless there is something critical going on that is impacting the performance of your network.

Just to be clear, you should not use our results as a reference. The best

reference values are those you record during the lifetime of your network. Only in that way will you know for sure whether things are working normally or whether a problem has arisen which now requires further investigation.

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