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Improving Windows® Performance with TCP/IP Offload Engine (TOE) on IBM® System x® Servers

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Abstract

This paper discusses the performance of Microsoft® Windows® when TCP/IP Offload Engine (TOE) is used on IBM System x® servers. TOE provides offloaded processing of the TCP/IP stack from the main system processor to the network controller. This offloading can provide performance advantages for certain configurations and network loads. The results presented will show which configurations can benefit the most from using TOE on IBM System x servers.

Introduction

TCP/IP (Transmission Control Protocol / Internet Protocol) has become the standard protocol used by computers throughout the world. IP contains the information needed to connect two computers and routes data from one computer to another.TCP segments data for transmission and reassembles the data at the receiving end, making sure the data is error-free. TCP requires a great deal of processing to perform these tasks. In the past, attempts have been made to shorten path lengths of the software code making up the TCP stack. An alternative is to offload the TCP stack to the network device itself, thus allowing more processing cycles for the main system CPU(s). TCP/IP Offload Engine (TOE) is the technology that addresses this issue.

Overview of TCP/IP Offload Engine (TOE)

Because TCP is a connection-oriented protocol, there is a great deal of processing required by the protocol. This processing must establish a connection, acknowledge packets, provide sequence number and checksum calculation, provide congestion control, and terminate the connection. TCP Offload Engine frees the server's CPU(s) for other tasks. There are at least three types of TCP/IP offload: Parallel Stack Full Offload, HBA Full Offload, and TCP Chimney Offload. TCP Chimney Offload is the type of offload discussed in this paper. At this time, TOE is supported on Windows 2003 and 2008. TOE is generally not supported on the various versions of Linux® because The Linux Foundation does not support implementation of TOE.

TOE does not offload every connection. Only older connections are offloaded to the network adapter. The Windows operating system determines which connections will be offloaded. TOE applies only to TCP connections. Other protocols, which are not offloaded, are processed normally by the operating system.

Requirements

The following are required for using TOE with IBM System x servers:

- Microsoft Windows Server™ 2003 Service Pack 1 or later plus the Scalable Networking Pack or Windows 2008
- IBM System x server with Integrated dual Gigabit Ethernet with TCP/IP Offload Engine (TOE) and associated IBM network driver

Receive Side Scaling

IBM System x servers also support Receive Side Scaling (RSS). With RSS, incoming packets are balanced across multiple processors. This is most beneficial for any application with heavy network traffic running on a multi-processor system such file or Web servers.

Configuration for Analysis

The configuration for the system under test was an IBM System x3650 M2 server with two Intel®
Xeon® X5570 (2.93GHz) processors with 12GB (6 x 2GB DIMMs) of memory.

TOE vs non-TOE Windows 2008 100% Client Writes

Data was gathered for 2- and 4-port TOE and non-TOE configurations for both throughput and
CPU utilization. TOE shows lower CPU utilization for most data sizes; however, TOE shows lower
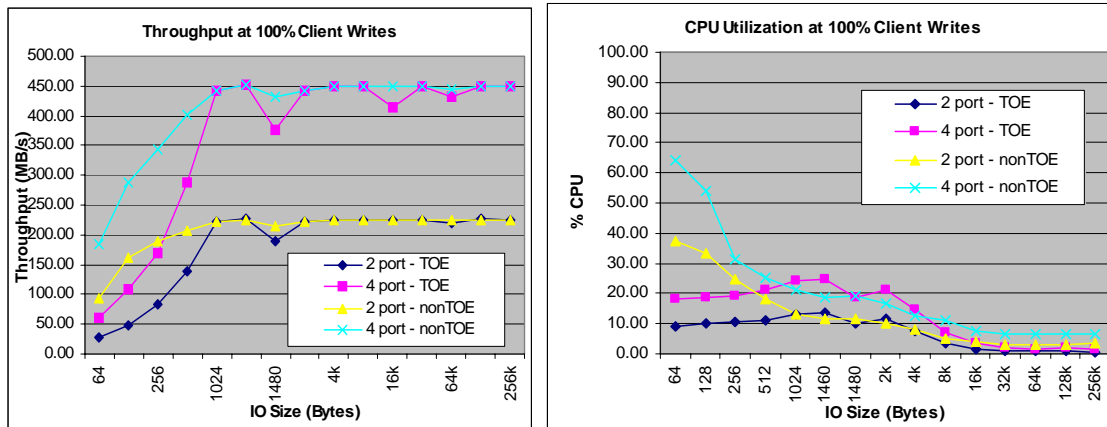throughput for smaller data sizes.

Figure 1: TOE vs non-TOE Windows 2008 100% Client Writes

TOE vs non-TOE Windows 2008 100% Client Writes Efficiency

Perhaps a better comparison for TOE is the efficiency. Efficiency is the throughput per CPU
utilization. TOE shows greater efficiency for large data sizes but very little difference in efficiency
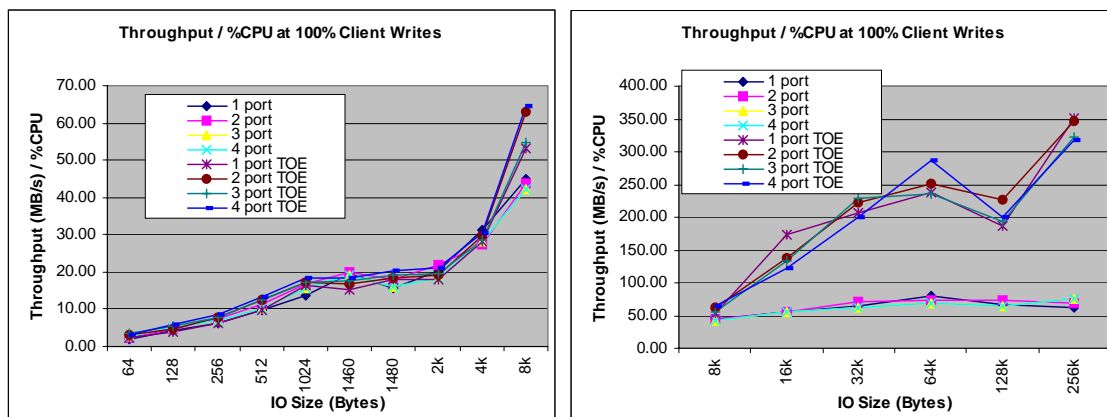for small data sizes.

Figure 2: TOE vs non-TOE Windows 2008 100% Client Writes Efficiency

TOE vs non-TOE Windows 2008 70% Client Reads/30% Client Writes

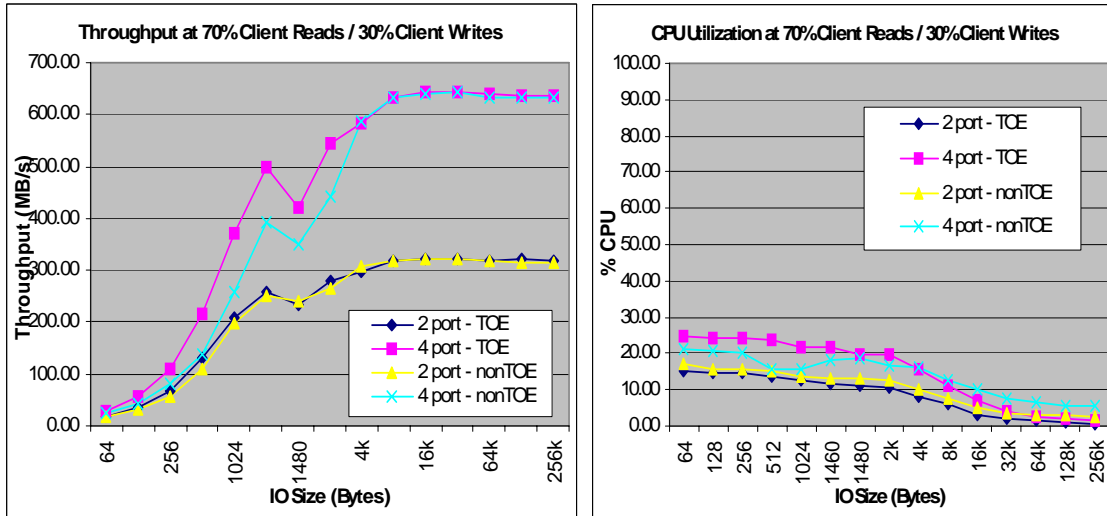TOE vs non-TOE shows little difference for 70% client reads/30% client writes.

Figure 3: TOE vs non-TOE Windows 2008 70% Client Reads/30% Client Writes

TOE vs non-TOE Windows 2008 70% Client Reads/30% Client Writes Efficiency

It is more useful to look at efficiency for 70% client reads/30% client write configurations. Just as with 100% client writes, it is more useful to look at efficiency. TOE shows greater efficiency for large data sizes and very little difference in efficiency for small data sizes.
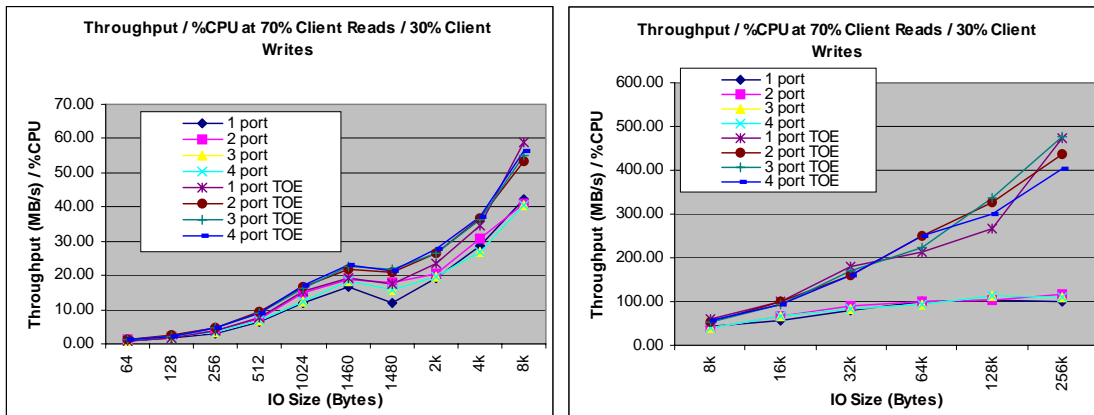

Figure 4: TOE vs non-TOE Windows 2008 70% Client Reads/30% Client Writes Efficiency

TOE vs non-TOE Windows 2003 100% Client Writes Efficiency

TOE on Windows 2003 shows similar efficiencies to Windows 2008. TOE shows greater
efficiency for large data sizes and very little difference in efficiency for small data sizes.
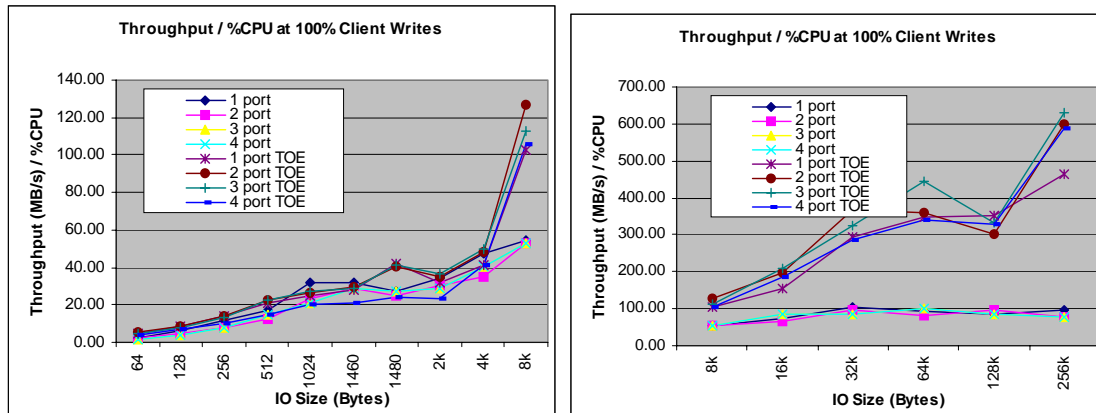

Figure 5: TOE vs non-TOE Windows 2003 100% Client Writes Efficiency

Conclusion

TCP/IP Offload Engine provides greater efficiency for large data sizes for a mix of traffic of 70%
Client Read/30% Client Write. Additionally for 100% client writes, TOE shows lower CPU
utilization for most data sizes. TOE also shows greater efficiency for large data sizes. The
benefits in performance are similar for both Windows 2003 and 2008.

TCP/IP Offload Engine does not increase wire speeds, but does improve server efficiency.
If packets are small and TCP/IP connections do not last long, it does not pay to offload the
protocol.

Network performance benefits when the TCP/IP stack is offloaded to an adapter that supports
TOE. With IBM System x servers and adapters running TOE, the server's efficiencies can be
increased significantly.

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