# Deploying Microsoft Windows Server 2008 and Vista on a Cisco Network

Updated: 9/30/08

# Agenda

- Microsoft Windows Server 2008 and Windows Vista Network Overview
- IPv6 in Windows Server 2008 and Windows Vista
- Cisco Branch Network Impact - WAAS
- Cisco Data Center Network / Application Services Impact

  TCP Interoperability with Cisco ACE

  Windows Server 2008 Failover Clusters @ Layer 3

# Overview

- TCP/IP changes to Microsoft Windows Server 2008 and Vista are significant
- Network performance increase is substantial in many cases, but not all
- WAAS benefits still rule over OS-based TCP optimizations – Even in SMB 2.0 environments
- Network design considerations may change due to increased throughput performance
- Vista/Server 2008 interact just fine with Cisco ACE (with modifications)
- Layer 3 or Multisite clusters will offer a lot to our customers but not without some design considerations – mainly around DNS

# Microsoft Windows Server 2008 and Vista Network Overview

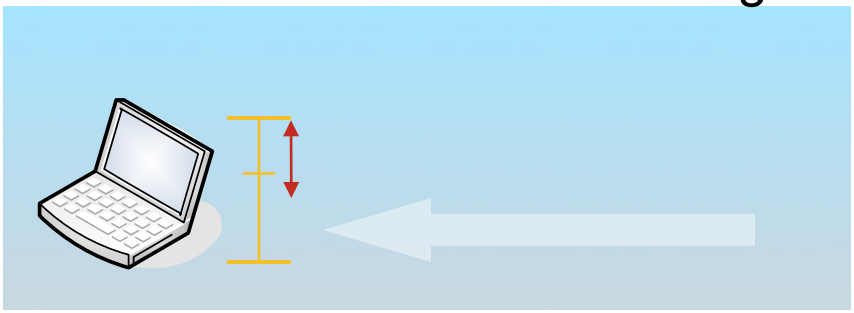
# TCP/IP Stack Features

http://technet.microsoft.com/en-us/library/bb726965.aspx

- IPv6 enabled by default and preferred
- Receive Window Auto-Tuning
- Compound TCP – Applicable in High BW/High Delay networks
- Enhancements for high-loss environments – RFC-based improvements for WLAN environments
- Neighbor Unreachability Detection for IPv4 – Equivalent to NUD for IPv6. Not applicable or beneficial in networks with real first hop routing protocol (HSRP/GLBP).
- Receive-Side Scaling – balance TCP flows across multiple CPUs (See findings from Maurizio Portolani/Christian Elsen EDCS:699210)
- Changes in dead gateway detection – Fail-back support has been added
- Changes to PMTU black hole router detection - http://tinyurl.com/677skq
- Network Diagnostics Framework support
- TCP extended statistics (ESTATS) – TCP Analyzer program (obtain via Vista SDK)
- Windows Filtering Platform
- Explicit Congestion Notification – Allows host to adjust TCP based on ECN notification from routers (IOS supports ECN notification as does Catalyst 4500)

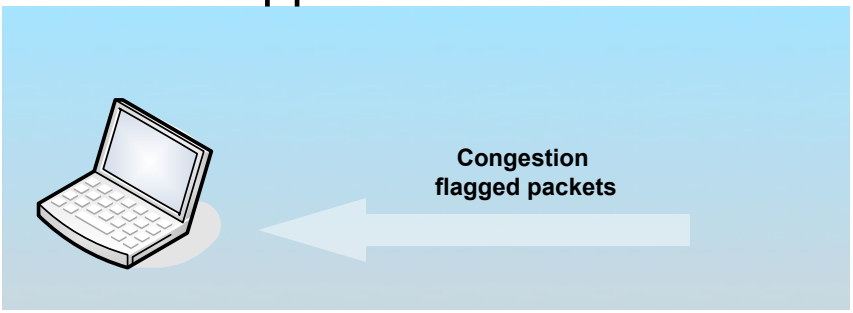
# Enhanced Capabilities Of 2008/Vista

- Receive Window Auto-Tuning



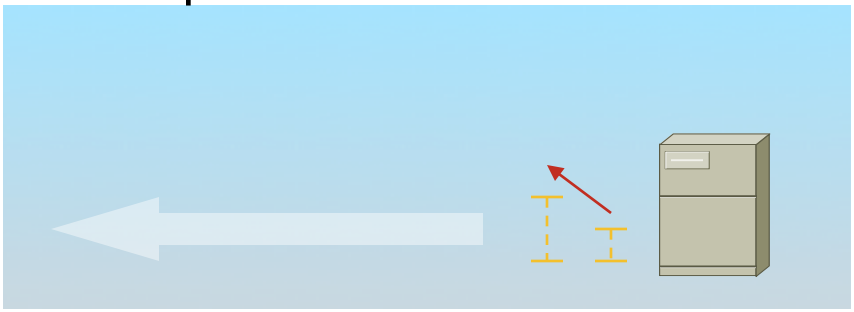
**Per application auto-scaled window (network buffer) size**

- ECN Support



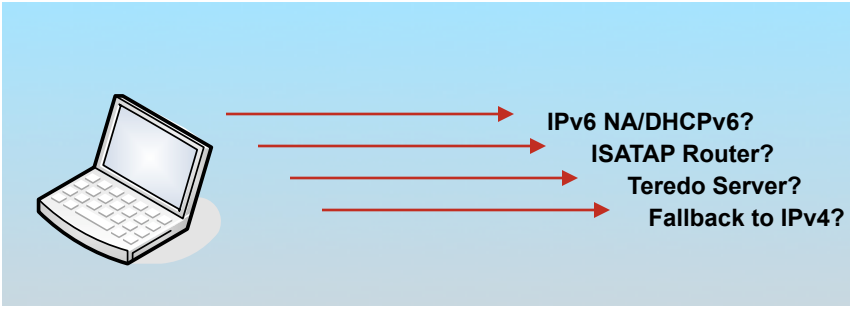

**Recognizes and controls data transfers based on network congestion being flagged**

- Compound TCP



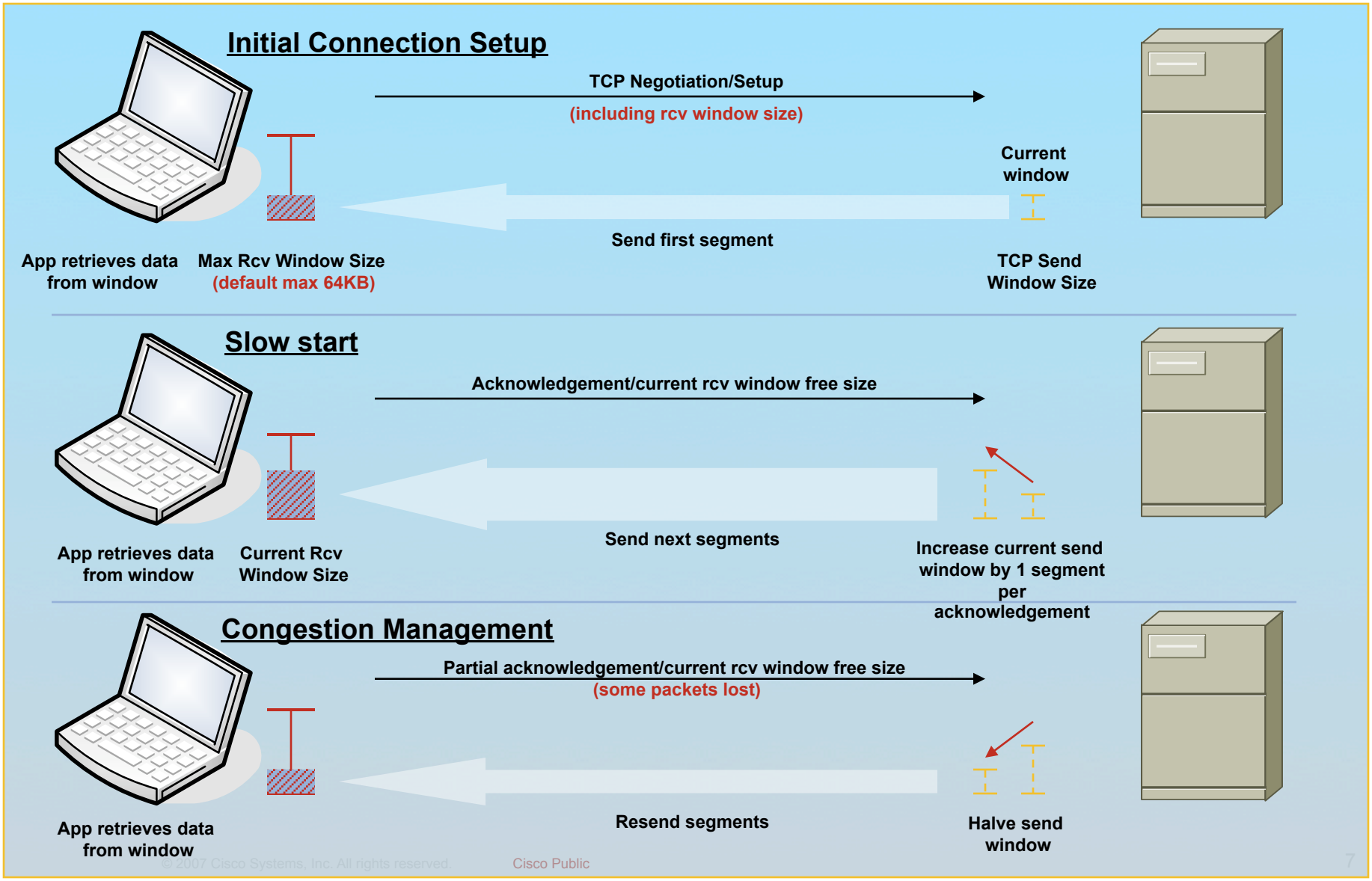
**Aggressive send window growth based on delay and loss (more aggressive on high delay connections after loss to quickly bring window size back up to optimal level**

- IPv6

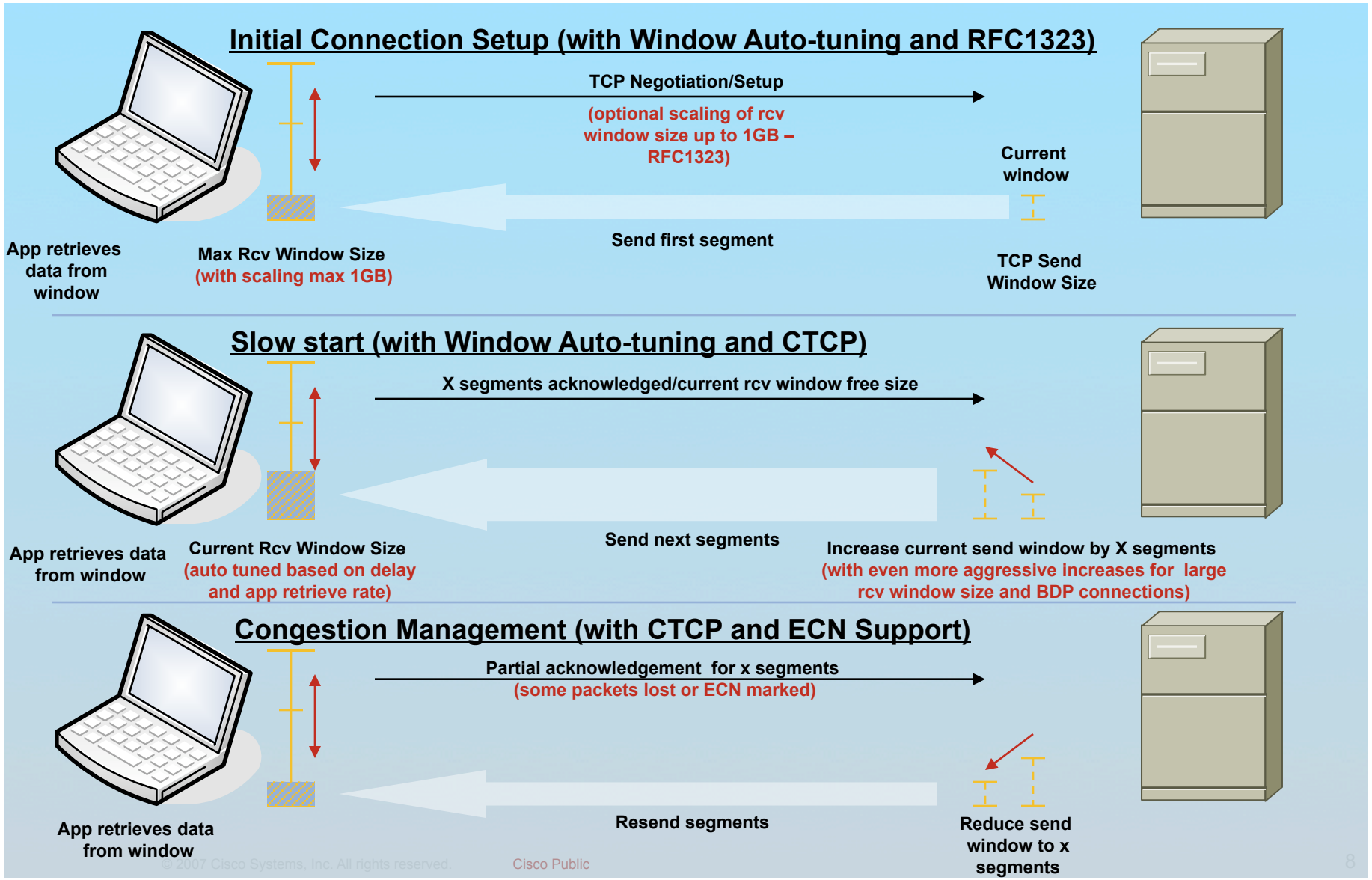



**IPv6 is preferred over IPv4**

# Standard TCP FTP to client



# Vista/2008 TCP FTP to client



# XP/2003 – Stack Behavior Review

- XP/2003 default TCP window size is 65535
- Sender's TX rate is limited by advertised RX window
- Window size backs off by 50% with packet loss
- Increases window size by one for every successful ACK
- Manual tuning of RX window size is often suboptimal (takes for all apps on all links)

# Microsoft Windows Server 2008/Vista
## Auto-tuning

- Flows may congest available WAN BW
- On by default
- Adjusts EACH TCP flow over time
- Increase throughput for long latency flows
- Auto-tuning automatically senses TCP environment to determine optimal window size

  RTT

  Application consumption capacity (some apps may not yield any performance improvements)

**MSFT-Stack-Overview**
**Todd Thorson - MSFT**

# Microsoft Windows Server 2008/Vista
## Auto-tuning Parameters

- Can be changed via GPO or CLI

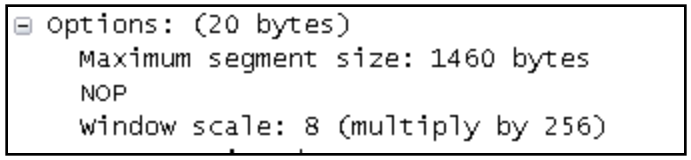
  **`netsh interface tcp set global autotuninglevel =`**

  **`disabled`** – scaling is turned off – XP-like performance (64-KB window)

  **`highlyrestricted`** – scaling limited to 2 (256 KB window)

  **`restricted`** – scaling is limited to 4 (1 MB window)

  **`normal`** (default on Vista) – scaling is limited to 8 (16 MB window)




  **`experimental`** (unlimited) – scaling up to 14 (1 GB window)

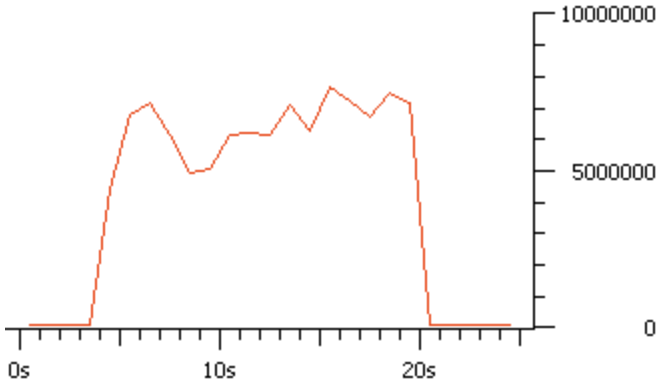
- Application can alter scaling value – Window Vista with IE7 and Firefox use “highlyrestricted”

**`Window scale: 2 (multiply by 4)`**

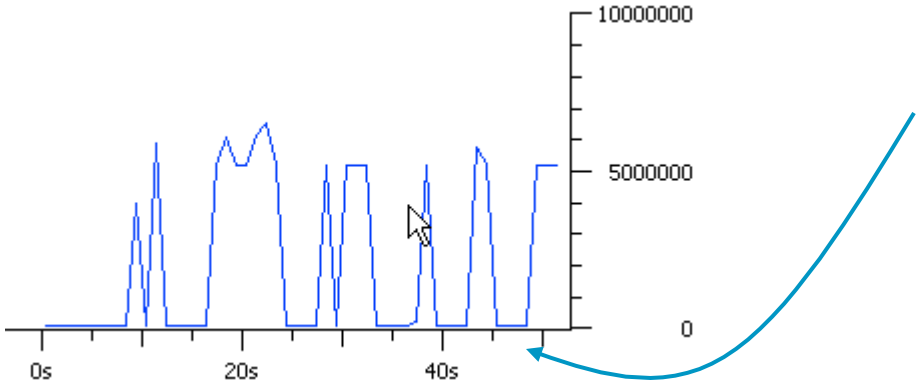
# Negotiated TCP Window Size Examples

- During some tests TCP Window sizes were as high as 7 Meg

**2053 51.46 10.6.1.1 10.6.1.2 TCP 63050 > http [ACK] Seq=132 Ack=633613893 Win=5058816 Len=0**




- The large window sizes can cause issues such as out-of-order segment errors




| No. | Sever. | Group | Protocol | Summary |
|---|---|---|---|---|
| 1930 | Warn | Sequence | TCP | Out-Of-Order segment |
| 1932 | Warn | Sequence | TCP | Out-Of-Order segment |
| 1934 | Warn | Sequence | TCP | Out-Of-Order segment |
| 1938 | Warn | Sequence | TCP | Out-Of-Order segment |
| 1941 | Warn | Sequence | TCP | Out-Of-Order segment |
| 1943 | Warn | Sequence | TCP | Out-Of-Order segment |
| 1945 | Warn | Sequence | TCP | Out-Of-Order segment |
| 1947 | Warn | Sequence | TCP | Out-Of-Order segment |
| 1949 | Warn | Sequence | TCP | Out-Of-Order segment |
| 1951 | Warn | Sequence | TCP | Out-Of-Order segment |
| 1953 | Warn | Sequence | TCP | Out-Of-Order segment |
| 1955 | Warn | Sequence | TCP | Out-Of-Order segment |
| 1957 | Warn | Sequence | TCP | Out-Of-Order segment |
| 1959 | Warn | Sequence | TCP | Out-Of-Order segment |
| 1961 | Warn | Sequence | TCP | Out-Of-Order segment |
| 1963 | Warn | Sequence | TCP | Out-Of-Order segment |
| 1965 | Warn | Sequence | TCP | Out-Of-Order segment |
| 1967 | Warn | Sequence | TCP | Out-Of-Order segment |
| 1969 | Warn | Sequence | TCP | Out-Of-Order segment |
| 1971 | Warn | Sequence | TCP | Out-Of-Order segment |
| 1973 | Warn | Sequence | TCP | Out-Of-Order segment |
| 1975 | Warn | Sequence | TCP | Out-Of-Order segment |
| 1977 | Warn | Sequence | TCP | Out-Of-Order segment |
| 1979 | Warn | Sequence | TCP | Out-Of-Order segment |
| 1981 | Warn | Sequence | TCP | Out-Of-Order segment |
| 1983 | Warn | Sequence | TCP | Out-Of-Order segment |
| 1985 | Warn | Sequence | TCP | Out-Of-Order segment |
| 1987 | Warn | Sequence | TCP | Out-Of-Order segment |
| 1989 | Warn | Sequence | TCP | Out-Of-Order segment |
| 1991 | Warn | Sequence | TCP | Out-Of-Order segment |
| 1993 | Warn | Sequence | TCP | Out-Of-Order segment |
| 1995 | Warn | Sequence | TCP | Out-Of-Order segment |
| 1997 | Warn | Sequence | TCP | Out-Of-Order segment |
| 1999 | Warn | Sequence | TCP | Out-Of-Order segment |
| 2001 | Warn | Sequence | TCP | Out-Of-Order segment |

# Microsoft Windows Server 2008/Vista
## Compound TCP (CTCP)

- More aggressive in increasing the send window for high BW, high latency flows
- Maximizes throughput by monitoring variations in delay and loss
- Works in conjunction with auto-tuning to improve performance
- Off by default on Vista and on by default on Server 2008

```
netsh interface tcp set global
congestionprovider =
```

`none` – CTCP is disabled

`ctcp` – CTCP is enabled

# ECN - Summary

- ECN is off by default in Microsoft Vista/Server 2008 due to possible support issues in legacy routers/firewalls where ECN flags are not supported

  Can be enabled/disabled by using **`netsh int tcp set global ecncapability=enabled`**

  Microsoft Vista/Server 2008 will have TCP backoff when ECN ECN-CE is set to "1"

- If "middle box" can support ECN, congestion could be better controlled from the endpoint by the OS participating in congestion control
- Middle boxes should support ECN so that packets with these flags set by other devices (endpoints, routers) can at least forward the packets even if they do not support setting the ECN flags when congestion is present
- Allows for Endpoint to help with congestion issues in the network – WRED can be used to mark traffic for ECN handling that would otherwise be a candidate for drop
- At this time ECN should be avoided

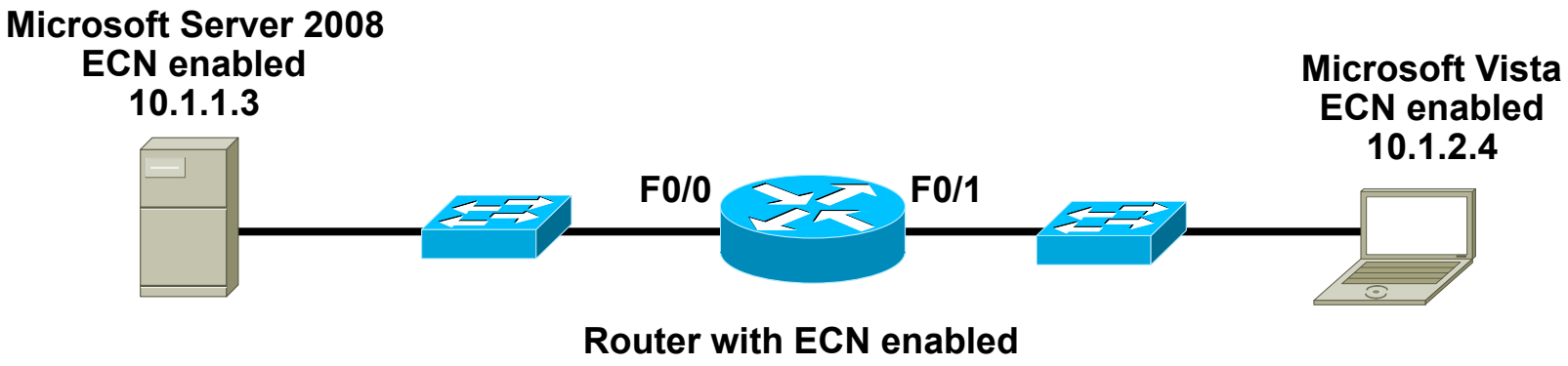
  ECN usages on the host nodes demonstrates erratic drops and rapid recovery at times and other times offers no change at all

  Standard WRED is the recommended method to achieve the original goal of ECN (as it pertains to the host)

# ECN IOS Example

```
policy-map ECN
 class class-default
  bandwidth percent 100
  random-detect
  random-detect ecn
policy-map MQC-SHAPING-5MBPS
 class class-default
  shape average 4750000 47500 0
  service-policy ECN
!
interface FastEthernet0/0
 ip address 10.1.1.1 255.255.255.0
 service-policy output MQC-SHAPING-5MBPS
```

```
#show policy-map interface f0/0
…OUTPUT SUMMARIZED FOR CLARITY
  Service-policy output: MQC-SHAPING-5MBPS

    Class-map: class-default (match-any)
              exponential weight: 9
             explicit congestion notification
             mean queue depth: 19

  class      ECN Mark
             pkts/bytes
      0       171/257053
      1         0/0
```



# ECN – View of a Packet

**Endpoints are ECN capable – ECT set to 1**

```
Internet Protocol, Src: 10.1.2.4 (10.1.2.4), Dst: 10.1.1.3 (10.1.1.3)
    Version: 4
    Header length: 20 bytes
    Differentiated Services Field: 0x02 (DSCP 0x00: Default; ECN: 0x02)
        0000 00.. = Differentiated Services Codepoint: Default (0x00)
        .... ..1. = ECN-Capable Transport (ECT): 1
        .... ...0 = ECN-CE: 0
```

**Congestion experienced by router – ECN-CE set to 1**

```
Internet Protocol, Src: 10.1.1.3 (10.1.1.3), Dst: 10.1.2.4 (10.1.2.4)
    Version: 4
    Header length: 20 bytes
    Differentiated Services Field: 0x03 (DSCP 0x00: Default; ECN: 0x03)
        0000 00.. = Differentiated Services Codepoint: Default (0x00)
        .... ..1. = ECN-Capable Transport (ECT): 1
        .... ...1 = ECN-CE: 1
```

# SMB 2.0 – Good news for the network

- SMB 2.0 Greatly Increases restrictive constants
  - •Number of open files on the server
  - •Number of shares on a server
- SMB 2.0 Protocol Improvements
  - •Packet compounding reduces “chattiness”
  - •Transactions are supported
  - •Message signing settings have been improved
  - •Client side encryption is supported
  - •Durable handles are supported
- SMB 2.0 Server and Client Requirements
  - •Server 2008 and Vista clients will support all SMB 2.0 features

# SMB 1.0 Negotiation
## XP to 2008 or Vista to 2003

```
No.     Time        Source              Destination         Protocol Info
   134 21.925052   10.124.2.18         10.121.10.14        SMB     Negotiate Protocol Request
…
Transmission Control Protocol, Src Port: can-ferret (1920), Dst Port: microsoft-ds (445), Seq: 687977853, Ack: 2938559479, Len: 137
NetBIOS Session Service
SMB (Server Message Block Protocol)
   SMB Header
   Negotiate Protocol Request (0x72)
      Word Count (WCT): 0
      Byte Count (BCC): 98
      Requested Dialects
         Dialect: PC NETWORK PROGRAM 1.0
         Dialect: LANMAN1.0
         Dialect: Windows for Workgroups 3.1a
         Dialect: LM1.2X002
         Dialect: LANMAN2.1
         Dialect: NT LM 0.12

No.     Time        Source              Destination         Protocol Info
   135 21.925724   10.121.10.14        10.124.2.18         SMB     Negotiate Protocol Response
…
Transmission Control Protocol, Src Port: microsoft-ds (445), Dst Port: can-ferret (1920), Seq: 2938559479, Ack: 687977990, Len: 197
NetBIOS Session Service
SMB (Server Message Block Protocol)
   SMB Header
   Negotiate Protocol Response (0x72)
      Word Count (WCT): 17
      Dialect Index: 5, greater than LANMAN2.1
      Security Mode: 0x03
      Max Mpx Count: 50
      Max VCs: 1
      Max Buffer Size: 16644
      Max Raw Buffer: 65536
….
```

# SMB 2.0 Negotiation
## Vista/2008 Only

```
No.     Time        Source              Destination         Protocol Info
   161 29.340781   10.124.2.5          10.121.10.14        SMB     Negotiate Protocol Request
…
Transmission Control Protocol, Src Port: 49396 (49396), Dst Port: microsoft-ds (445), Seq: 2713220216, Ack: 4127120, Len: 148
NetBIOS Session Service
SMB (Server Message Block Protocol)
   SMB Header
   Negotiate Protocol Request (0x72)
      Word Count (WCT): 0
      Byte Count (BCC): 109
      Requested Dialects
         Dialect: PC NETWORK PROGRAM 1.0
         Dialect: LANMAN1.0
         Dialect: Windows for Workgroups 3.1a
         Dialect: LM1.2X002
         Dialect: LANMAN2.1
         Dialect: NT LM 0.12
         Dialect: SMB 2.002

No.     Time        Source              Destination         Protocol Info
   162 29.341902   10.121.10.14        10.124.2.5          SMB2    NegotiateProtocol Response
…
Transmission Control Protocol, Src Port: microsoft-ds (445), Dst Port: 49396 (49396), Seq: 14127120, Ack: 2713220364, Len: 240
NetBIOS Session Service
SMB2 (Server Message Block Protocol version 2)
   SMB2 Header
      Server Component: SMB2
      Header Length: 64
      NT Status: STATUS_SUCCESS (0x00000000)
      Command: NegotiateProtocol (0)
      unknown: 0100
      Flags: 0x00000001
      Chain Offset: 0x00000000
      Command Sequence Number: 0
…
```

# Server Core – Feature Summary

## Roles

- AD Domain Services – ADDS
- AD Lightweight Directory Service – ADLDS
- Domain Name System Server - DNS
- Dynamic Host Configuration Protocol Server – DHCP
- File Services
- Print Server
- Streaming Media Services
- Internet Information Services (IIS7)
- Windows Server Virtualization – WSV (available within 180 days of RTM)

## Features

- BitLocker
- Client For NFS
- DFS Server & Replication
- Failover Cluster
- FRS
- LPD Print Service
- MultipathIO
- Network Load Balancing
- Removable Storage Management
- Server For NFS
- SNMP
- Subsystem for UNIX-based Applications
- Telnet Client
- Windows Server Backup
- WINS

# Branch Office Deployments

## Will the customer remove remote servers?

- Restart Active Directory without rebooting
  - Can be done through command line and MMC
  - Can't boot the DC to stopped mode of Active Directory
  - No effect on non-related services while restarting Active Directory
  - Several ways to process login under stopped mode
- RoDC – Read-only Domain Controller
  - Uni-directional Replication
  - Credential Caching
- Server Core
- TCP Window Auto-tuning and CTCP offer basic network BW optimization – sort of

# IPv6 in Vista/W2K8

http://www.microsoft.com/technet/network/ipv6/default.mspx

# Understand The Behavior Of Vista

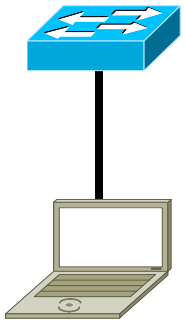
- IPv6 is preferred over IPv4
  - –Vista sends IPv6 NA/NS/RS upon link-up
  - – Attempts DHCP for IPv6
  - – If no DHCP or local RA received with Global or ULA, then try ISATAP
  - – If no ISATAP, then try Teredo
- Become familiar with Teredo

  http://www.microsoft.com/technet/prodtechnol/winxppro/maintain/teredo.mspx
- ANY application built on the Peer-to-Peer Framework REQUIRES IPv6 and will NOT function over IPv4 - http://www.microsoft.com/technet/network/p2p/default.mspx

# In More Detail – Vista on link-up
## No Network Services

| No. | Time | Source | Destination | Protocol | Info |
|---|---|---|---|---|---|
| 1 | 0.000000 | :: | ff02::1:ffae:4361 | ICMPv6 | Neighbor solicitation |
| 2 | 0.000030 | fe80::80aa:fd5:f7ae:4361 | ff02::2 | ICMPv6 | Router solicitation |
| 3 | 0.000080 | fe80::80aa:fd5:f7ae:4361 | ff02::16 | ICMPv6 | Multicast Listener Report Message v2 |
| 4 | 1.155917 | fe80::80aa:fd5:f7ae:4361 | ff02::1:3 | UDP | Source port: 49722 Destination port: 5355 |
| 5 | 1.156683 | 169.254.67.97 | 224.0.0.252 | UDP | Source port: 49723 Destination port: 5355 |
| 6 | 3.484709 | 169.254.67.97 | 169.254.255.255 | NBNS | Name query NB **ISATAP**<00> |
| 7 | 126.409530 | fe80::80aa:fd5:f7ae:4361 | ff02::1:2 | DHCPv6 | Information-request |
| 8 | 128.886397 | 0.0.0.0 | 255.255.255.255 | DHCP | DHCP Discover - Transaction ID 0x6c8d6efa |

1. Unspecified address :: -> Solicited node address NS/DAD
2. Looking for a local router -> ff02::2 RS
3. Looking for MLD enabled routers -> ff02::16 MLDv2 report
4. LLMNR for IPv6 – ff02::1:3 – advertise hostname
5. LLMNR for IPv4 – 224.0.0.252 from RFC 3927 address
6. No global or ULA received via step 1/2 – Try ISATAP
7. Try DHCP for IPv6 – ff02::1:2
8. Try DHCP for IPv4

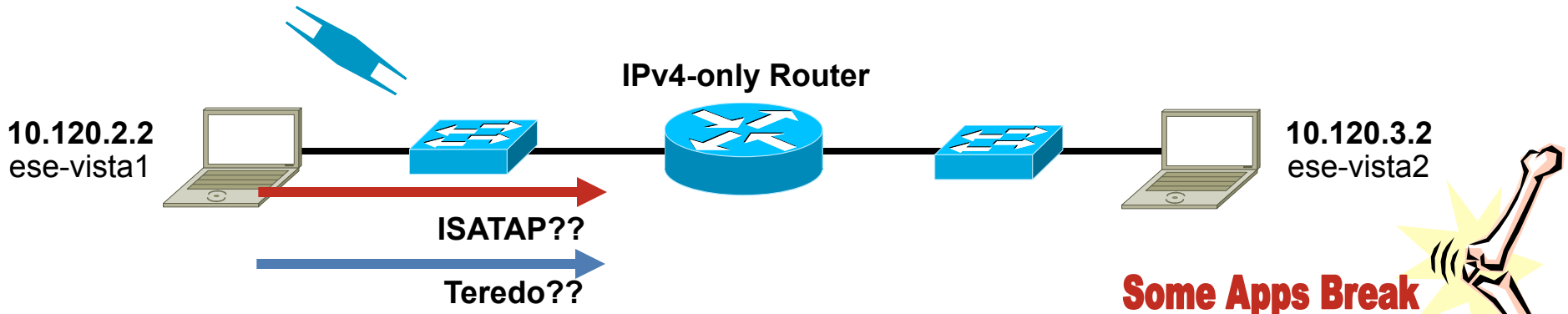


**fe80::80aa:fd5:f7ae:4361**
ese-vista1

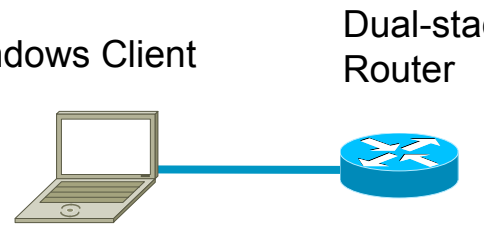
# IPv4 Network – No IPv6 Network Services

## What Does Vista Try To Do?

```
No.     Time        Source                Destination           Protocol Info
  13 8.813509    10.120.2.1            10.120.2.2            DHCP     DHCP ACK      - Transaction ID 0x2b8af443
....
Bootstrap Protocol
    ...
    Your (client) IP address: 10.120.2.2 (10.120.2.2)
    ...
    Option: (t=3,l=4) Router = 10.120.2.1
    Option: (t=6,l=4) Domain Name Server = 10.121.11.4
    Option: (t=15,l=9) Domain Name = "cisco.com"
    ..

No.     Time        Source                Destination           Protocol Info
    70 13.360756    10.120.2.2            10.121.11.4           DNS      Standard query A isatap.cisco.com

No.     Time        Source                Destination           Protocol Info
   138 25.362181    10.120.2.2            10.121.11.4           DNS      Standard query A teredo.ipv6.microsoft.com

No.     Time        Source                Destination           Protocol Info
   580 296.686197   10.120.2.2            10.120.3.2            TCP      49211 > epmap [SYN] Seq=0 Len=0 MSS=1460 WS=8
   581 296.687721   10.120.3.2            10.120.2.2            TCP      epmap > 49211 [SYN, ACK] Seq=0 Ack=1 Win=2097152
   582 296.687794   10.120.2.2            10.120.3.2            TCP      49211 > epmap [ACK] Seq=1 Ack=1 Win=65536 Len=0
   583 296.687913   10.120.2.2            10.120.3.2            DCERPC   Bind: call_id: 1, 2 context items, 1st IOXIDResolver V0.0
```



# Client Configuration - Dual-Stack




- Required

  Microsoft Windows XP (SP1 or higher), Server 2003, Vista, Server 2008

- IPv6 must be installed on XP/2003 (enabled by default on Vista /Server 2008)

  ```
  C:\>ipv6 install
  ```

- Have network (Routers/Switches) configured for IPv6

  Stateless autoconfiguration and/or DHCPv6

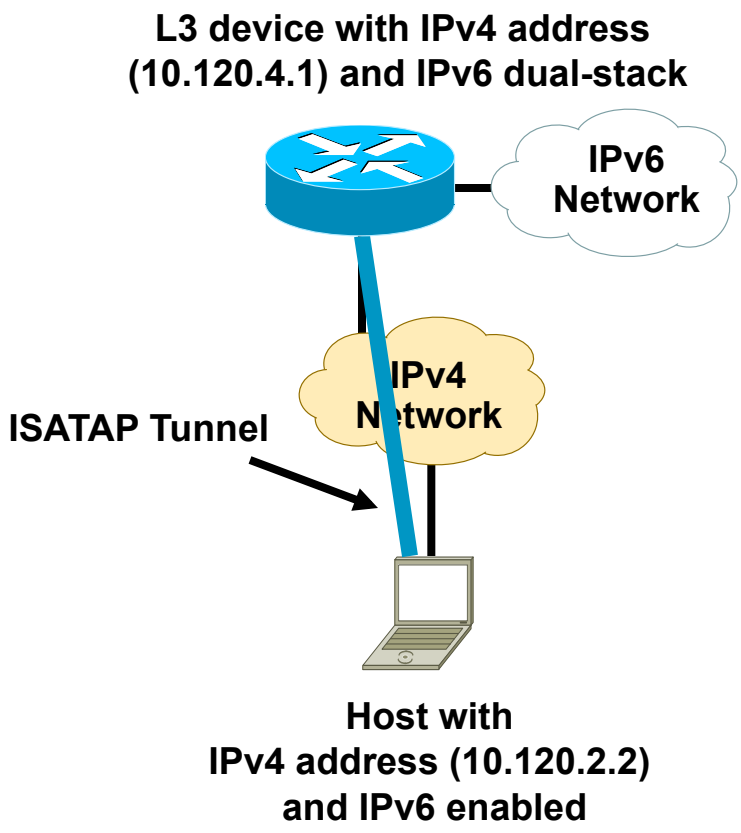
```
C:\>ipconfig

Windows IP Configuration

Ethernet adapter Local Area Connection 1:
        Connection-specific DNS Suffix  . :
        IP Address. . . . . . . . . . . . : 10.1.1.100
        Subnet Mask . . . . . . . . . . . : 255.255.255.0
        IP Address. . . . . . . . . . . . : 2001:db8:cafe:1122:203:ffff:fe81:d6da
        IP Address. . . . . . . . . . . . : fe80::203:ffff:fe81:d6da%4
        Default Gateway . . . . . . . . . : 10.1.1.1
                                            fe80::201:42ff:fe2d:9580
```

# ISATAP Refresher

- Intra-Site Automatic Tunnel Addressing Protocol
- RFC 4214
- Host-to-router Tunnel
- ISATAP connections look like one flat network
- Create DNS “A” record for “ISATAP” = 10.120.4.1
- Use Static Config if DNS use is not desired:

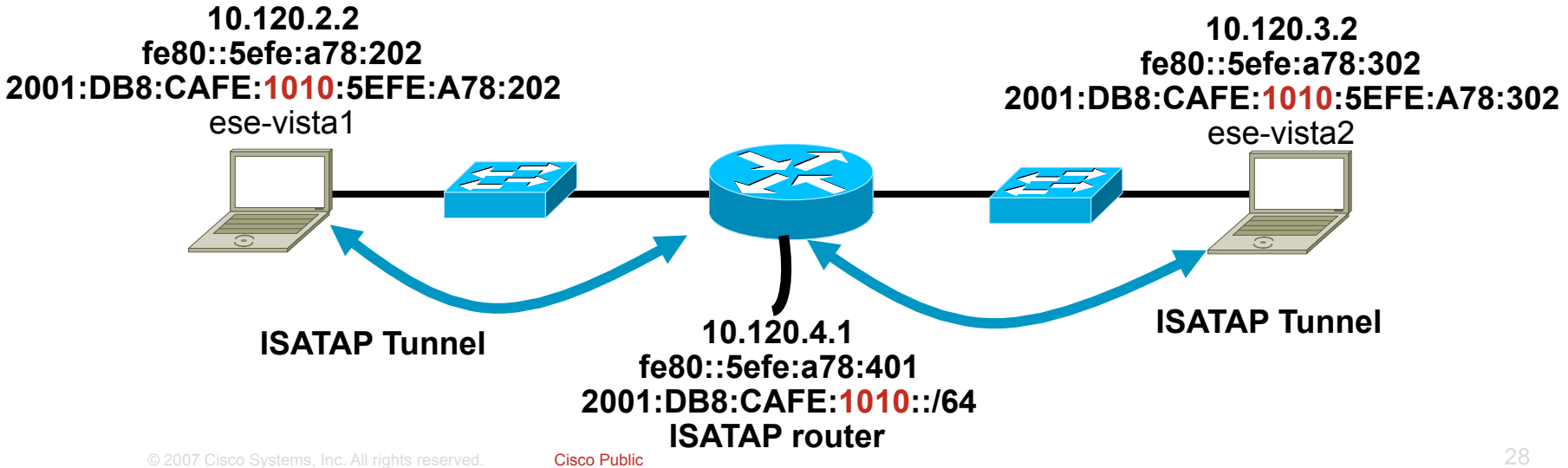
```
C:\>netsh interface ipv6
 isatap set router
 10.120.4.1
```

- Recommendation: Deploy ISATAP endpoints via policy distribution



# IPv4 Network – ISATAP Enabled Router

```
No.     Time          Source                Destination           Protocol Info
    302 48.129716   fe80::5efe:a78:202    fe80::5efe:a78:401    ICMPv6   Router solicitation
Internet Protocol, Src: 10.120.2.2 (10.120.2.2), Dst: 10.120.4.1 (10.120.4.1)

No.     Time          Source                Destination           Protocol Info
    871 480.607899  fe80::5efe:a78:401    fe80::5efe:a78:202    ICMPv6   Router advertisement
Internet Protocol, Src: 10.120.4.1 (10.120.4.1), Dst: 10.120.2.2 (10.120.2.2)

No.     Time          Source                                Destination                           Protocol Info
   1235 675.685012  2001:db8:cafe:1010:0:5efe:a78:302 2001:db8:cafe:1010:0:5efe:a78:202 ICMPv6   Echo request
Internet Protocol, Src: 10.120.3.2 (10.120.3.2), Dst: 10.120.2.2 (10.120.2.2)

No.     Time          Source                                Destination                           Protocol Info
   1236 675.685259  2001:db8:cafe:1010:0:5efe:a78:202 2001:db8:cafe:1010:0:5efe:a78:302 ICMPv6   Echo reply
Internet Protocol, Src: 10.120.2.2 (10.120.2.2), Dst: 10.120.3.2 (10.120.3.2)
```



# Client Configuration - ISATAP

Windows Vista will automatically attempt to resolve the name “ISATAP”

- Local host name
- Hosts file - *SystemRoot*\system32\drivers\etc
- DNS name query (“A” record)
- NetBIOS and Lmhosts

- Manual ISATAP router entry can be made

```
netsh interface ipv6 isatap set router 20.1.1.1
```

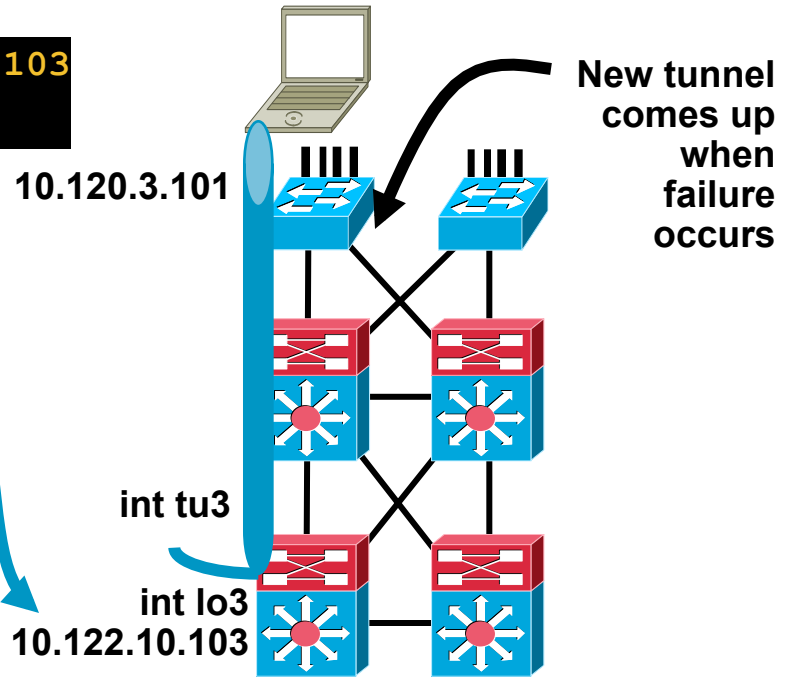
- Key fact here is that NO additional configuration on the client is needed again

# IPv6 Campus ISATAP Configuration
## ISATAP Client Configuration

**Windows XP/Vista Host**

```
C:\>netsh int ipv6 isatap set router 10.122.10.103
Ok.
```

```
interface Tunnel3
 ipv6 address 2001:DB8:CAFE:3::/64 eui-64
 no ipv6 nd suppress-ra
 ipv6 ospf 1 area 2
 tunnel source Loopback3
 tunnel mode ipv6ip isatap
!
interface Loopback3
 description Tunnel source for ISATAP-VLAN3
 ip address 10.122.10.103 255.255.255.255
```




```
Tunnel adapter Automatic Tunneling Pseudo-Interface:
Connection-specific DNS Suffix  . :
IP Address. . . . . . . . . . . . : 2001:db8:cafe:3:0:5efe:10.120.3.101
IP Address. . . . . . . . . . . . : fe80::5efe:10.120.3.101%2
Default Gateway . . . . . . . . . : fe80::5efe:10.122.10.103%2
```

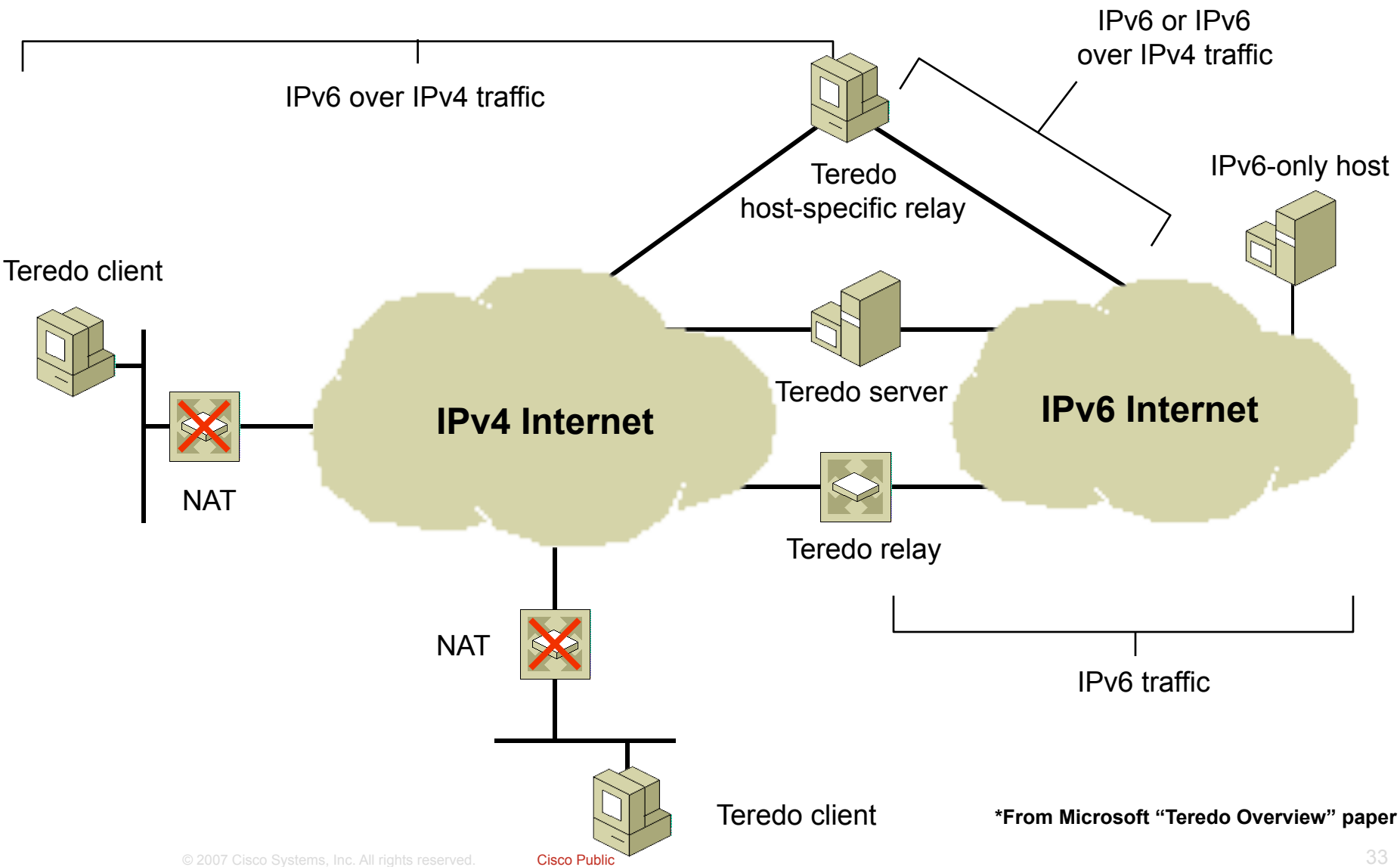
# What is Teredo?

- RFC4380
- Tunnel IPv6 through NATs (NAT types defined in RFC3489)
  - –Full Cone NATs (aka one-to-one) – Supported by Teredo
  - –Restricted NATs – Supported by Teredo
  - –Symmetric NATs – Supported by Teredo with Vista/Server 2008 if only one Teredo client is behind a Symmetric NATs
- Uses UDP port 3544
- Is complex – many sequences for communication and has several attack vectors
- Available on:
  - –Microsoft Windows XP SP1 w/Advanced Networking Pack
  - –Microsoft Windows Server 2003 SP1
  - –Microsoft Windows Vista (enabled by default – inactive until application requires it)
  - –Microsoft Server 2008
  - –http://www.microsoft.com/technet/prodtechnol/winxppro/maintain/teredo.mspx
  - –Linux, BSD and Mac OS X – “Miredo” - http://www.simphalempin.com/dev/miredo/

# Teredo Components

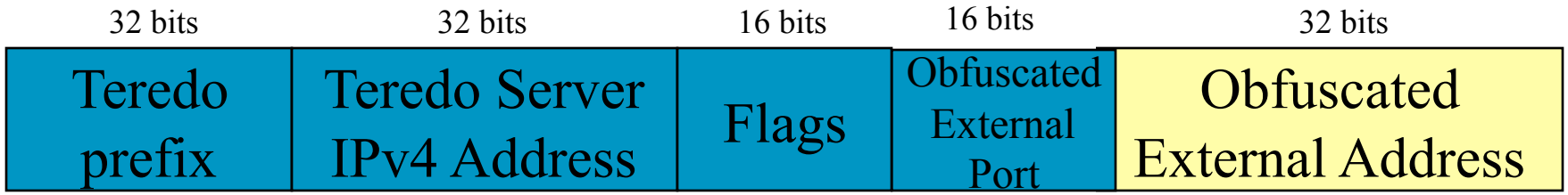
- Teredo Client - Dual-stack node that supports Teredo tunneling to other Teredo clients or IPv6 nodes (via a relay)
- Teredo Server – Dual-stack node connected to IPv4 Internet and IPv6 Internet. Assists in addressing of Teredo clients and initial communication between clients and/or IPv6-only hosts – Listens on UDP port 3544
- Teredo Relay – Dual-stack router that forwards packets between Teredo clients and IPv6-only hosts
- Teredo Host-Specific Relay – Dual-stack node that is connected to IPv4 Internet and IPv6 Internet and can communicate with Teredo Clients without the need for a Teredo Relay

# Teredo Overview




*From Microsoft "Teredo Overview" paper

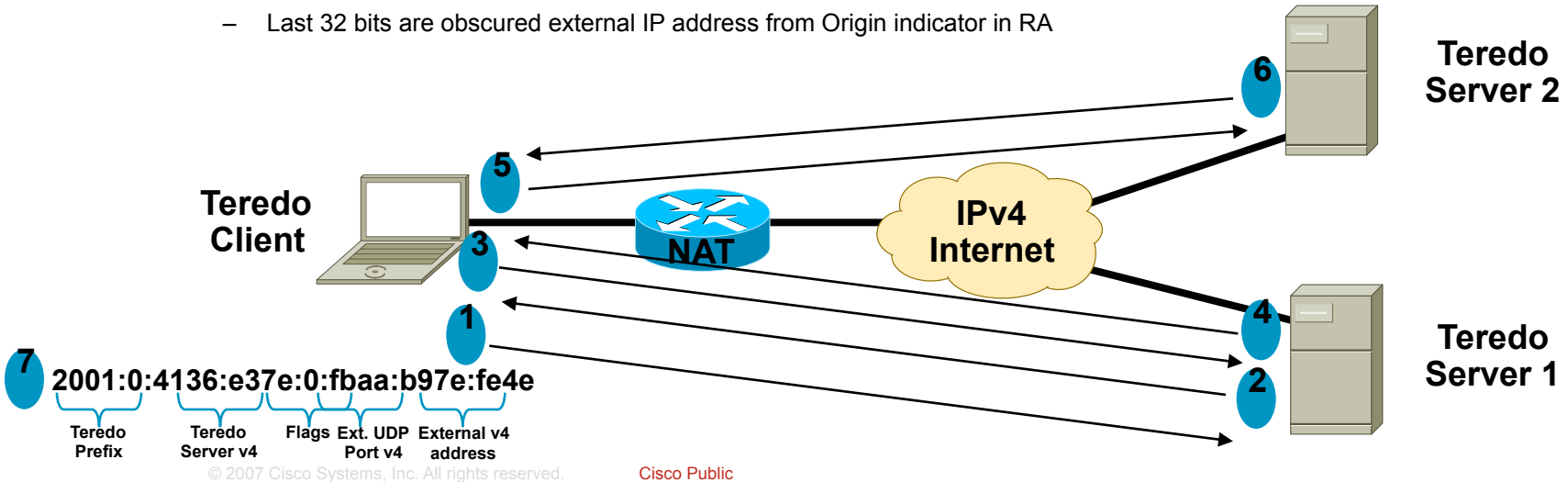
# Teredo Address




- Teredo IPv6 prefix (2001::/32 – previously was 3FFE:831F::/32)
- Teredo Server IPv4 address: global address of the server
- Flags: defines NAT type (e.g. Cone NAT)
- Obfuscated External Port: UDP port number to be used with the IPv4 address
- Obfuscated External Address: contains the global address of the NAT

# Initial Configuration for Client

1. RS message sent from Teredo client to server – RS from LL address with Cone flag set
2. Server responds with RA - RS has Cone flag set – server sends RA from alternate v4 address – if client receives the RA, client is behind cone NAT
3. If RA is not received by client, client sends another RA with Cone flag not set
4. Server responds with RA from v4 address = destination v4 address from RS – if client receives the RA, client is behind restricted NAT
5. To ensure client is not behind symmetric NAT, client sends another RS to secondary server
6. 2nd server sends an RA to client – client compares mapped address and UDP ports in the Origin indicators of the RA received by both servers. If different, then the NAT is mapping same internal address/port to different external address/port and NAT is a symmetric NAT
7. Client constructs Teredo address from RA
   - First 64 bits are the value from prefix received in RA (32 bits for IPv6 Teredo prefix + 32 bits of hex representation of IPv4 Teredo server address)
   - Next 16 bits are the Flags field (0x0000 = Restricted NAT, 0x8000 = Cone NAT)
   - Next 16 bits are external obscured UDP port from Origin indicator in RA
   - Last 32 bits are obscured external IP address from Origin indicator in RA



# What Happens on the Wire - 1

| No. | Time | Source | Destination | Protocol | Info |
|---|---|---|---|---|---|
| 15 | 25.468050 | 172.16.1.103 | 151.164.11.201 | DNS | Standard query A **teredo.ipv6.microsoft.com** |

| No. | Time | Source | Destination | Protocol | Info |
|---|---|---|---|---|---|
| 16 | 25.481609 | 151.164.11.201 | 172.16.1.103 | DNS | Standard query response A **65.54.227.126** A 65.54.227.127 A 65.54.227.120 A 65.54.227.124 |

```
netsh interface ipv6>sh teredo
Teredo Parameters
---------------------------------------------
Type                                    : client
Server Name                             : teredo.ipv6.microsoft.com
Client Refresh Interval                 : default
Client Port                             : default
State                                   : probe(cone)
Type                                    : teredo client
Network                                 : unmanaged
NAT                                     : cone
```

```
netsh interface ipv6>sh teredo
Teredo Parameters
---------------------------------------------
Type                                    : client
Server Name                             : teredo.ipv6.microsoft.com
Client Refresh Interval                 : default
Client Port                             : default
State                                   : qualified
Type                                    : teredo client
Network                                 : unmanaged
NAT                                     : restricted
```

# What Happens on the Wire - 2

No. Time Source Destination Protocol Info
28 33.595460 **fe80::8000:ffff:ffff:fffd** **ff02::2** ICMPv6 **Router solicitation**
Internet Protocol, Src: **172.16.1.103** (172.16.1.103), Dst: **65.54.227.126** (65.54.227.126)
User Datagram Protocol, Src Port: 1109 (1109), Dst Port: **3544** (3544)

No. Time Source Destination Protocol Info
29 37.593598 **fe80::8000:ffff:ffff:fffd** **ff02::2** ICMPv6 **Router solicitation**
Internet Protocol, Src: **172.16.1.103** (172.16.1.103), Dst: **65.54.227.126** (65.54.227.126)

No. Time Source Destination Protocol Info
31 45.546052 **fe80::ffff:ffff:fffd** **ff02::2** ICMPv6 **Router solicitation**
Internet Protocol, Src: **172.16.1.103** (172.16.1.103), Dst: **65.54.227.127** (65.54.227.127)
User Datagram Protocol, Src Port: 1109 (1109), Dst Port: 3544 (3544)

No. Time Source Destination Protocol Info
32 46.039706 **fe80::8000:f227:bec9:1c81** **fe80::ffff:ffff:fffd** ICMPv6 **Router advertisement**
Internet Protocol, Src: **65.54.227.127** (65.54.227.127), Dst: **172.16.1.103** (172.16.1.103)
User Datagram Protocol, Src Port: 3544 (3544), Dst Port: 1109 (1109)
Teredo Origin Indication header
Origin UDP port: **1109**
Origin IPv4 address: **70.120.2.1** (70.120.2.1)
Prefix: **2001:0:4136:e37e::**

No. Time Source Destination Protocol Info
33 46.093832 **fe80::ffff:ffff:fffd** **ff02::2** ICMPv6 **Router solicitation**
Internet Protocol, Src: **172.16.1.103** (172.16.1.103), Dst: **65.54.227.126** (65.54.227.126)
User Datagram Protocol, Src Port: 1109 (1109), Dst Port: 3544 (3544)

No. Time Source Destination Protocol Info
34 46.398745 **fe80::8000:f227:bec9:1c81** **fe80::ffff:ffff:fffd** ICMPv6 **Router advertisement**
Internet Protocol, Src: **65.54.227.126** (65.54.227.126), Dst: **172.16.1.103** (172.16.1.103)
Teredo Origin Indication header
Origin UDP port: **1109**
Origin IPv4 address: **70.120.2.1** (70.120.2.1)
Prefix: **2001:0:4136:e37e::**

**Send RS Cone Flag=1 (Cone NAT), every 4 seconds**

**If no reply, send Flag=0 (restricted NAT)**

**Receive RA with Origin header and prefix**

**Send RS to 2nd server to check for symmetric NAT**

**Compare 2nd RA – Origin port/address from 2nd server**

# What Happens on the Wire - 3

No. Time Source Destination Protocol Info
82 139.258206 172.16.1.103 151.164.11.201 DNS **Standard query AAAA www.kame.net**

No. Time Source Destination Protocol Info
83 139.530547 151.164.11.201 172.16.1.103 DNS **Standard query response AAAA 2001:200:0:8002:203:47ff:fea5:3085**

No. Time Source Destination Protocol Info
96 148.960607 **2001:0:4136:e37e:0:fbaa:b97e:fe4e** **2001:200:0:8002:203:47ff:fea5:3085** **ICMPv6 Echo request**
Internet Protocol, Src: **172.16.1.103** (172.16.1.103), Dst: 6**5.54.227.126** (65.54.227.126)
User Datagram Protocol, Src Port: **1109** (1109), Dst Port: **3544** (3544)

No. Time Source Destination Protocol Info
97 149.405579 **fe80::8000:5445:5245:444f** **2001:0:4136:e37e:0:fbaa:b97e:fe4e** IPv6 **IPv6 no next header**

Internet Protocol, Src: **65.54.227.126** (65.54.227.126), Dst: **172.16.1.103** (172.16.1.103)
Teredo IPv6 over UDP tunneling
**Teredo Origin Indication header**
Origin UDP port: **50206**
Origin IPv4 address: **66.117.47.227** (66.117.47.227)

No. Time Source Destination Protocol Info
98 149.405916 **172.16.1.103** **66.117.47.227** UDP Source port: 1109 Destination port: 50206

No. Time Source Destination Protocol Info
99 149.463719 **66.117.47.227** **172.16.1.103** UDP Source port: 50206 Destination port: 1109

No. Time Source Destination Protocol Info
100 149.464100 **172.16.1.103** **66.117.47.227** UDP Source port: 1109 Destination port: 50206

No. Time Source Destination Protocol Info
101 149.789493 **66.117.47.227** **172.16.1.103** UDP Source port: 50206 Destination port: 1109

**DNS lookup**

**Response**

**ICMP to host via Teredo Server**

**Relay sends Bubble packet to client via server – client receives relay address -port**

**Packets to /from IPv6 host and client traverse relay**

- **According to MSFT, if Teredo is the only IPv6 path, AAAA query should not be sent**

http://msdn2.microsoft.com/en-us/library/aa965910.aspx

# What Happens on the Wire – 3 continued

```
Interface 7: Teredo Tunneling Pseudo-Interface

Addr Type  DAD State  Valid Life   Pref. Life   Address
---------  ---------- ------------ ------------ ----------------------------
Public     Preferred      infinite     infinite 2001:0:4136:e37e:0:fbaa:b97e:fe4e
Link       Preferred      infinite     infinite fe80::ffff:ffff:fffd
```

```
C:\>ping www.kame.net

Pinging www.kame.net [2001:200:0:8002:203:47ff:fea5:3085] with 32 bytes of data


Reply from 2001:200:0:8002:203:47ff:fea5:3085: time=829ms
Reply from 2001:200:0:8002:203:47ff:fea5:3085: time=453ms
Reply from 2001:200:0:8002:203:47ff:fea5:3085: time=288ms
Reply from 2001:200:0:8002:203:47ff:fea5:3085: time=438ms
```

# Maintaining NAT Mapping

- Every 30 seconds (adjustable) clients send a single bubble packet to Teredo server to refresh NAT state
  - –Bubble packet = Used to create and maintain NAT mapping and consists of an IPv6 header with no IPv6 payload (Payload 59 – No next header)

```
No.     Time        Source                                Destination       Protocol Info
 35 46.399072   2001:0:4136:e37e:0:fbaa:b97e:fe4e      ff02::1           IPv6     IPv6 no next header

Frame 35 (82 bytes on wire, 82 bytes captured)
Ethernet II, Src: Foxconn_2d:a1:4e (00:15:58:2d:a1:4e), Dst: 01:00:5e:00:00:fd (01:00:5e:00:00:fd)
Internet Protocol, Src: 172.16.1.103 (172.16.1.103), Dst: 224.0.0.253 (224.0.0.253)
User Datagram Protocol, Src Port: 1109 (1109), Dst Port: 3544 (3544)
Teredo IPv6 over UDP tunneling
Internet Protocol Version 6
    Version: 6
    Traffic class: 0x00
    Flowlabel: 0x00000
    Payload length: 0
    Next header: IPv6 no next header (0x3b)
    Hop limit: 21
    Source address: 2001:0:4136:e37e:0:fbaa:b97e:fe4e
    Destination address: ff02::1
```

# Enterprise Recommendations

- Teredo - Disable via ACLs, refuse name resolution, and/or create a tunnel “honey pot” to black hole the traffic
- Teredo - ingress filters for expected internal ipv4 prefixes to prevent spoofing
- Teredo – Registry change to disable Teredo on interface -

  http://www.microsoft.com/technet/community/columns/cableguy/cg1005.mspx#EVF

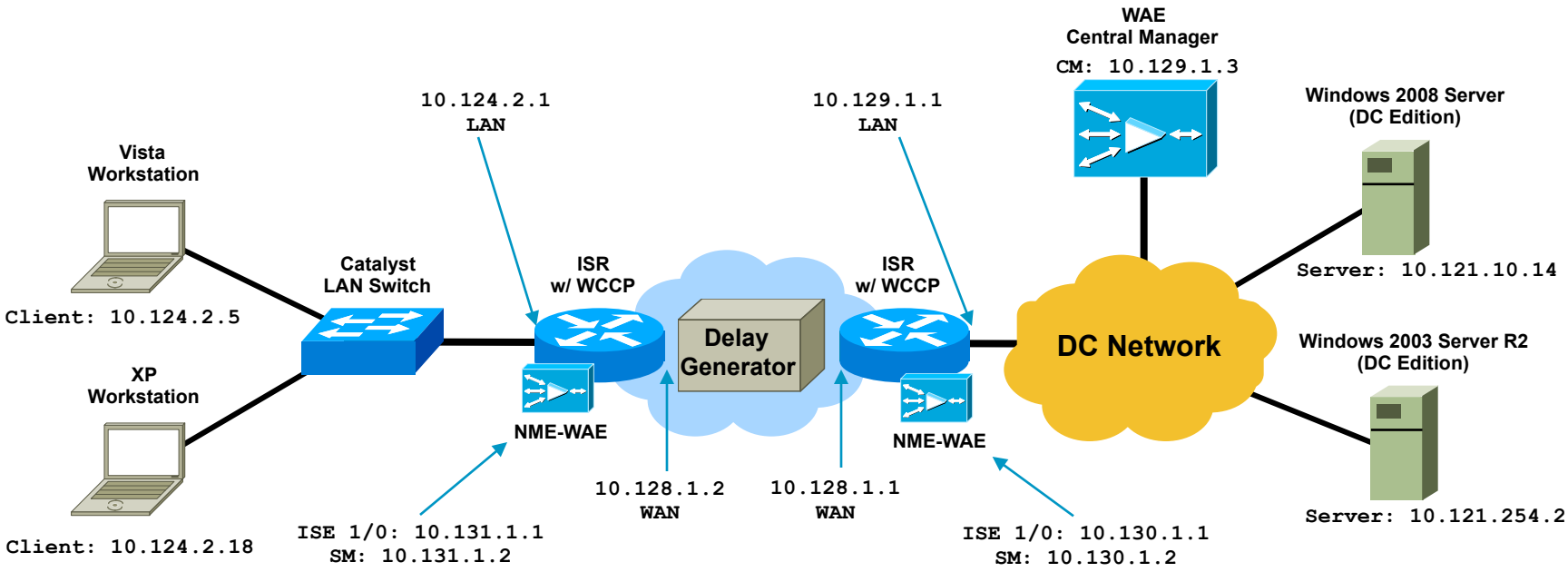
# Branch Impact - WAAS

# Purpose of Testing Vista in the Branch

- Validate if Windows Vista positively or negatively impacts a branch deployment – with or without WAAS
- Yield updated best practice recommendations, if needed, for the field and customers to use when deploying Windows Vista
- Provide Microsoft and Cisco product teams information about performance and, if found, issues related to Windows Vista TCP/IP stack

# Validation Setup & Methodology

# Branch Testing Diagram



# Cisco and Microsoft OS Specifics

- Cisco Gear
  - Cisco ISR 2851 – 12.4(15)T3
  - Cisco WAAS NME/CM – 4.0.15
  - Cisco Catalyst 3750 – Advanced IP Services 12.2.25-SEE4
- Microsoft OS Versions
  - Windows XP Professional SP2
  - Windows 2003 R2 Data Center Edition SP2
  - Windows Vista Enterprise Edition*
  - Windows Server 2008 Data Center Edition

***Note: Windows Vista SP1 was not yet available during this testing – post testing results shows that SP1 has issues with performance and causes a significant drop in both network performance and also "fairness" is not so fair with other non-SP1 hosts. These issues are under evaluation by MSFT.**

# Validation Tools – Overview

- SMB, HTTP (IIS 6.0 and 7.0) and FTP (6.0) were used
- Tools that are native to OS were used (browser, command-line tools)
- All Operating Systems and applications were using default settings (except when comparing TCP features such as CTCP)
- Sniffer was running during validation baseline test (with/without WAAS) to capture end-to-end behavior (sniffer did not run during performance cases)
- Output from all tests were captured to logs
- Windows performance monitoring tools were running during baseline testing to ensure consistency with BW reported from command-line tools
- Client and Server OS versions were tested in all combinations (Vista/2008, Vista/2003, XP/2008 and XP/2003) and traffic was transmitted from the client (TX) and to the client (RX)
- Routers/Switches run for connectivity only – meaning no QoS, MTU changes, ACLs, etc…

# Validation Tools and Methodology (1)
## Client/Server Tools - SMB

```
C:\>robocopy z:\waas-download c:\ iso-file-131m.iso /IS
------------------------------------------------------------------------------
   ROBOCOPY     ::     Robust File Copy for Windows
------------------------------------------------------------------------------
  Started : Wed Apr 16 12:52:34 2008
   Source : z:\waas-download\
     Dest : c:\
    Files : iso-file-131m.iso
  Options : /COPY:DAT /IS /R:1000000 /W:30
------------------------------------------------------------------------------
                           1    z:\waas-download\
100%        Same                  131.3 m        iso-file-131m.iso
------------------------------------------------------------------------------
               Total    Copied   Skipped  Mismatch    FAILED    Extras
    Dirs :         1         0         1         0         0         0
   Files :         1         1         0         0         0         0
   Bytes :  131.33 m  131.33 m         0         0         0         0
   Times :   0:06:23   0:06:23                       0:00:00   0:00:00
   Speed :              359206 Bytes/sec.
   Speed :              20.553 MegaBytes/min.
   Ended : Wed Apr 16 12:58:58 2008
```

- XCOPY and ROBOCOPY
- Scripts were created to map drives, TX/RX files, capture times/ throughput
- Report results into Microsoft Excel spreadsheet
- Test iterations were delayed between runs
- Does not report msec

# Validation Tools and Methodology (2)
## Client/Server Tools - HTTP

- HTTP transfers – Baseline used both IE browser and wget.exe
- wget.exe was used for bulk of testing as it was easy to script, allows for no client caching (good for automation) and reports both time to transfer and throughput accurately. Time was calculated from test start/end time.
- Results were reported into Microsoft Excel spreadsheet

```
C:\>wget --no-cache http://10.121.10.14/waas-download/doc-file-2.41m.doc
--13:36:32--  http://10.121.10.14/waas-download/doc-file-2.41m.doc
          => `doc-file-2.41m.doc.6'
Connecting to 10.121.10.14:80... connected.
HTTP request sent, awaiting response... 200 OK
Length: 2,529,792 (2.4M) [application/msword]

100%[====================================>] 2,529,792     10.52M/s

13:36:32 (10.52 MB/s) - `doc-file-2.41m.doc.6' saved [2529792/2529792]
```

# Validation Tools and Methodology (3)
## Client/Server Tools - FTP

- FTP transfers – Baseline used both IE browser and ftp.exe
- ftp.exe was used for bulk of testing as it was easy to script, allows for no caching (good for automation) and reports both time to transfer and throughput accurately. Results were reported into Microsoft Excel spreadsheet

```
C:\>ftp -A -s:ftp-rx-config.txt 10.121.10.14
Connected to 10.121.10.14.
220 Microsoft FTP Service
...
ftp> get doc-file-2.41m.doc
200 PORT command successful.
150 Opening BINARY mode data connection for doc-file-2.41m.doc(2529792 bytes).
226 Transfer complete.
ftp: 2529792 bytes received in 0.25Seconds 10119.17Kbytes/sec.
ftp>
```

# Validation Tools and Methodology (4)
## WAAS Specifics

- Test cases that included WAAS used different scripts than non-WAAS baseline tests
- WAAS stats and cache were cleared between non-repetitive test iterations (clear stat dre, stat tfo all, stat wccp, cache dre) – stats and cache were not cleared for iterations that were focused on cache/compression cases
- All WAAS testing included at least three transfers – Cold hit, 1st hit warm, 2nd hit warm
- A variety of logs and show output were gathered (show stat dre, stat tfo app, stat tfo sav, tfo conn summ)
- Transfer times were reported into Microsoft Excel

# Branch Test Cases

- 1.544 Mbps @ 50, 80, 150ms
- 3.0 Mbps @ 50, 150ms
- Delay generator was used between sites to induce delay – each test case was subject to fixed and variable loss percentages from zero loss to as high as 5% to compare TCP/IP stack performance

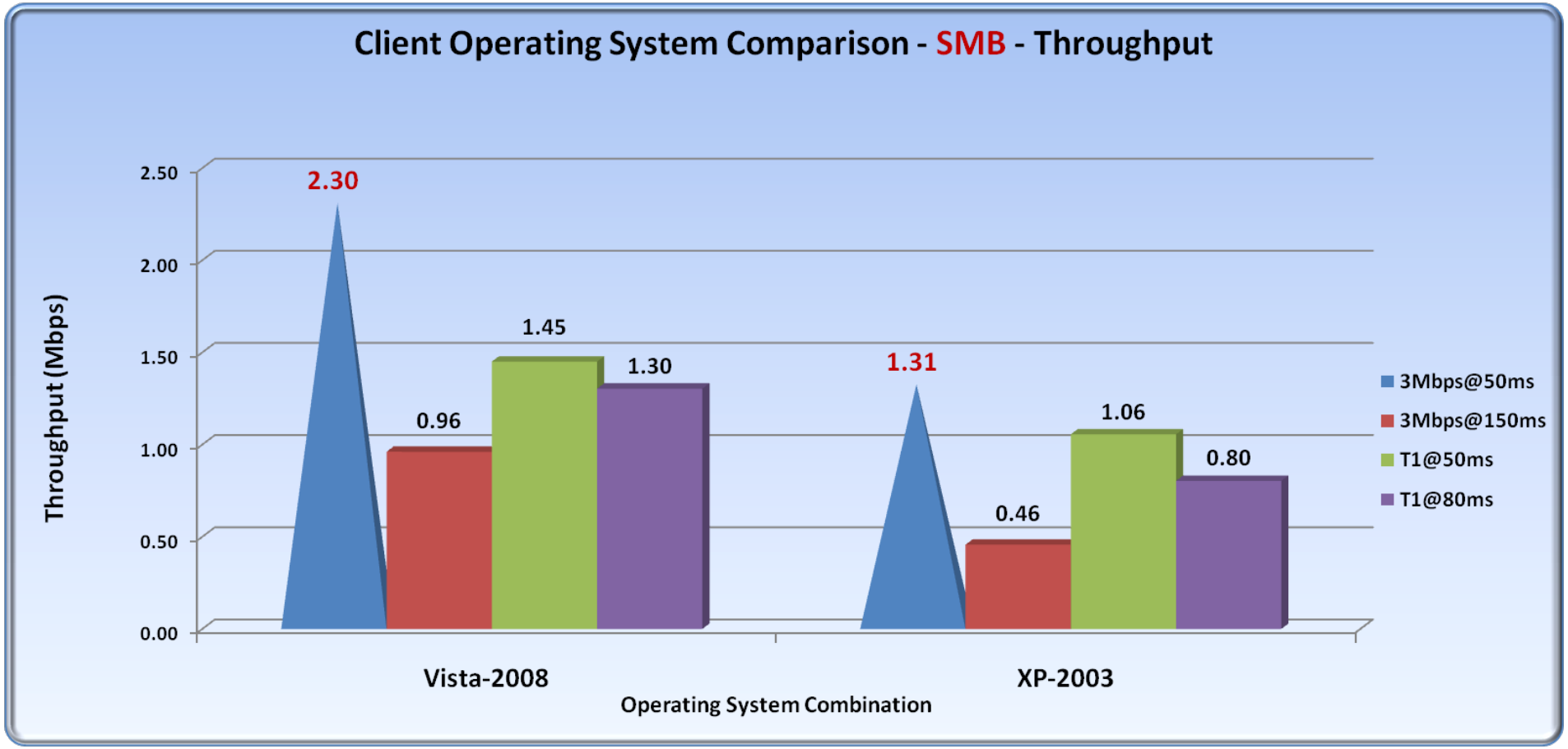
# Branch Testing Results - Summary

# Microsoft TCP/IP Performance Summary

- Windows Vista provides a massive improvement over Windows XP in transfer times and throughput in certain situations such as environments where there is high-bandwidth and high-delay
- In addition to TCP/IP improvements, additional gains are realized with the many improvements found in SMB 2.0
- The customer needs to carefully evaluate Windows Vista in the branch environment to ensure interoperability of the new TCP/IP features and network components such as Firewalls, Load-balancer and legacy devices

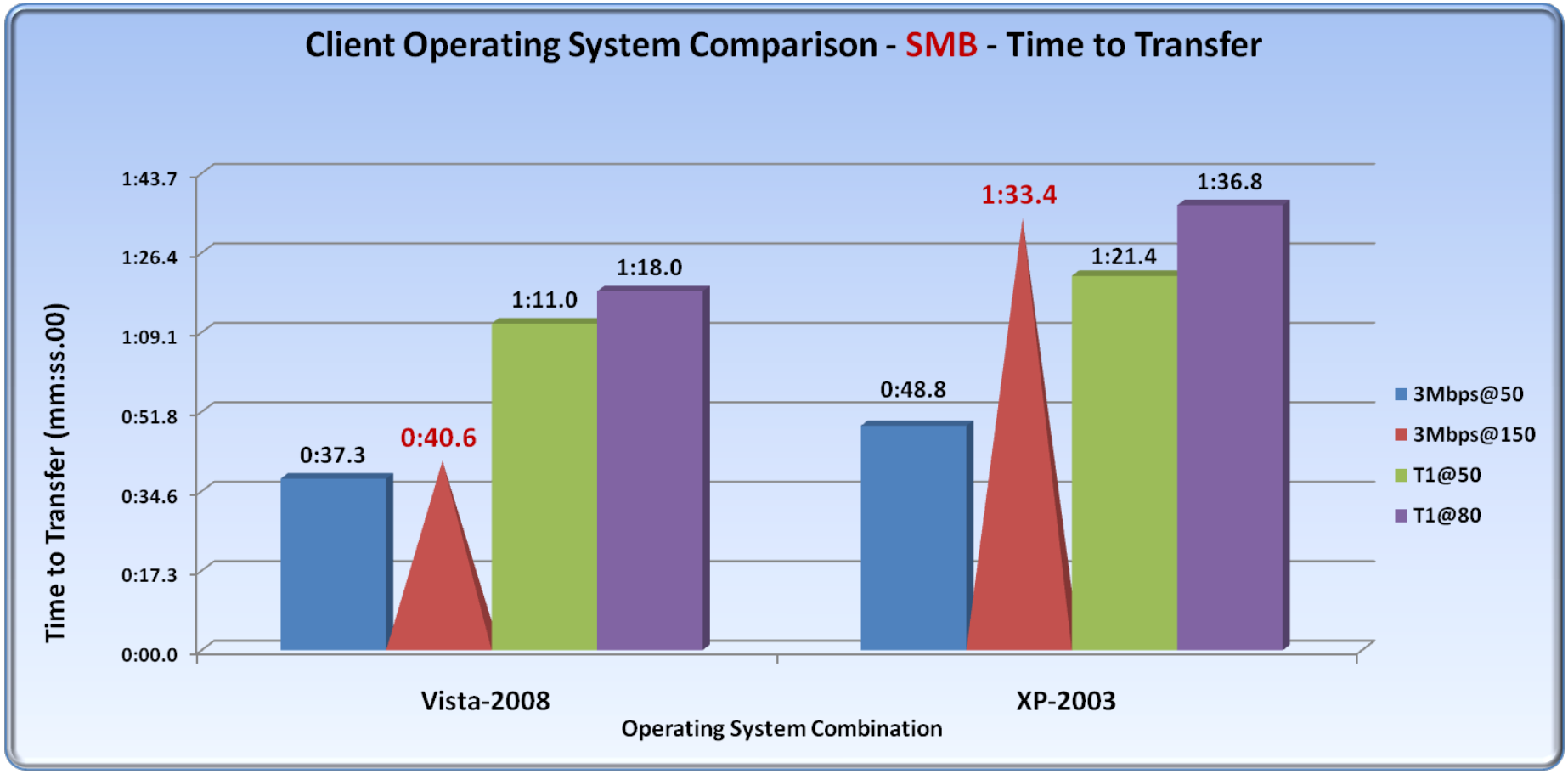
  TCP Auto-tuning, CTCP, ECN and RFC1323 can cause performance issues and even loss of connectivity in certain situations where the network device does not yet support large window size negotiation, the presence of ECN bits and other high-speed TCP functions

# SMB Throughput Test
## Variable BW, Delay

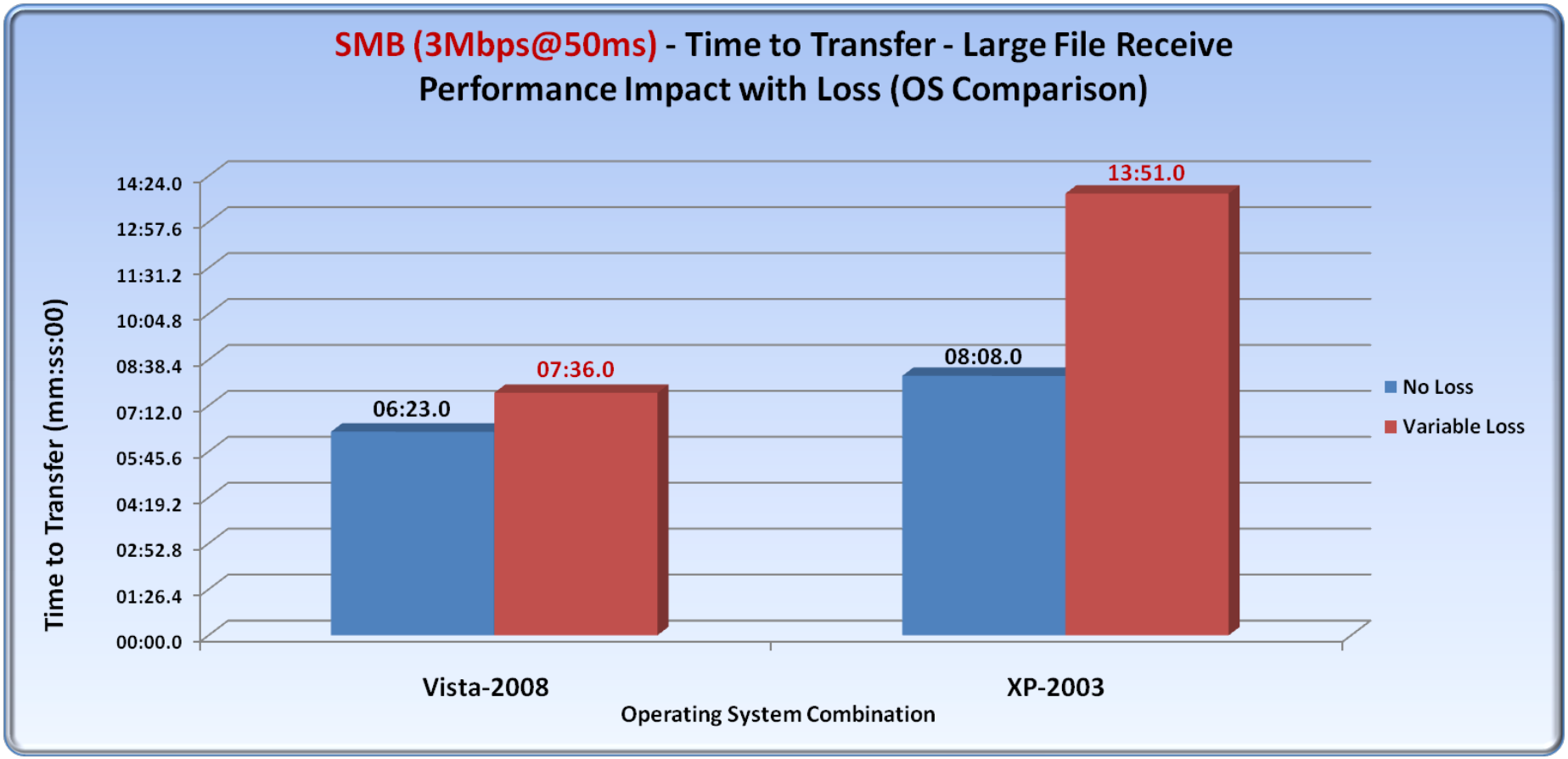



**Dramatic improvement in throughput via TCP optimization and also SMB 2.0 enhancement**

# SMB Time to Transfer
## Variable BW, Delay

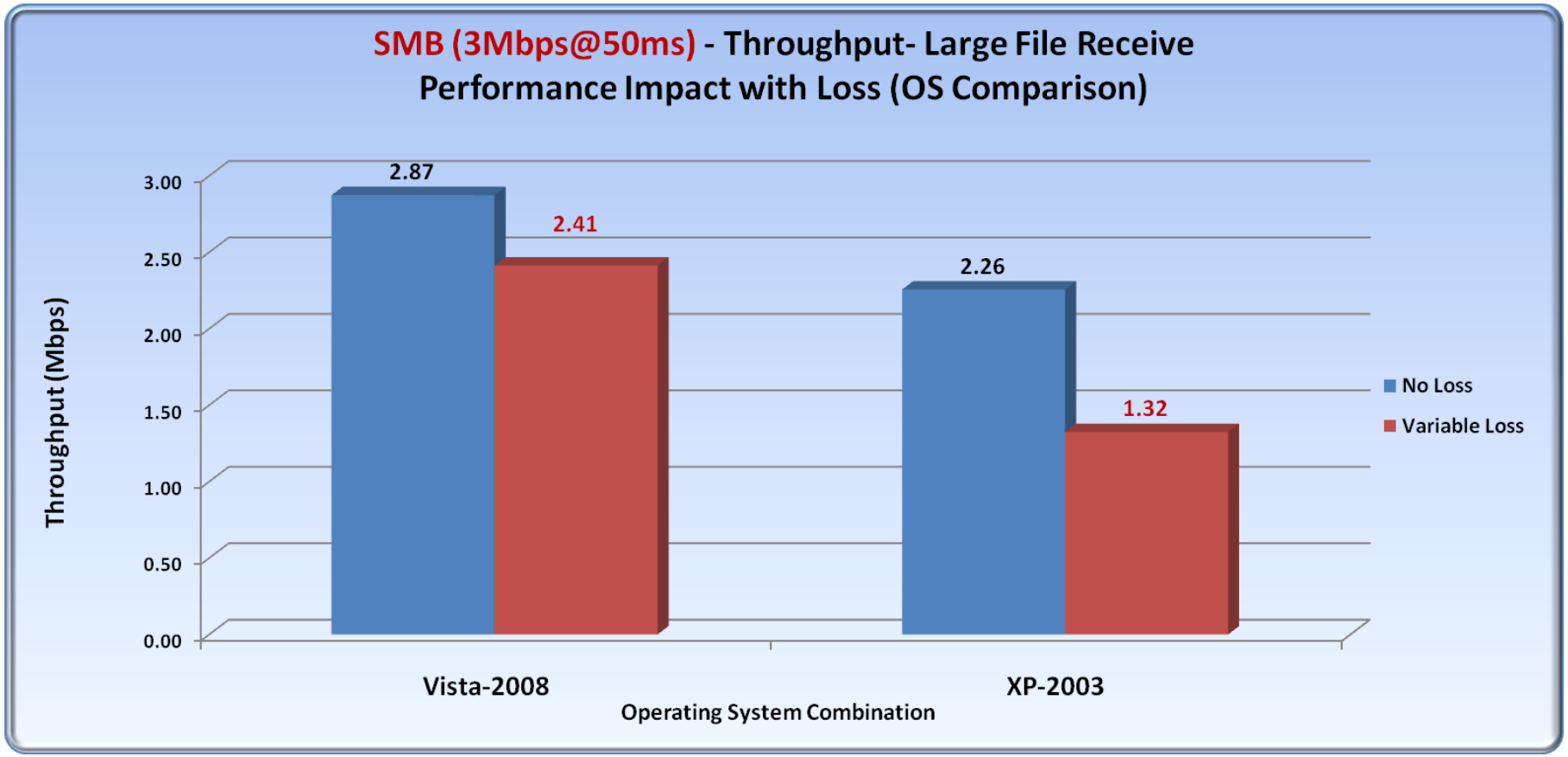


# SMB Time to Transfer
## Loss Comparison (Zero vs. Variable)

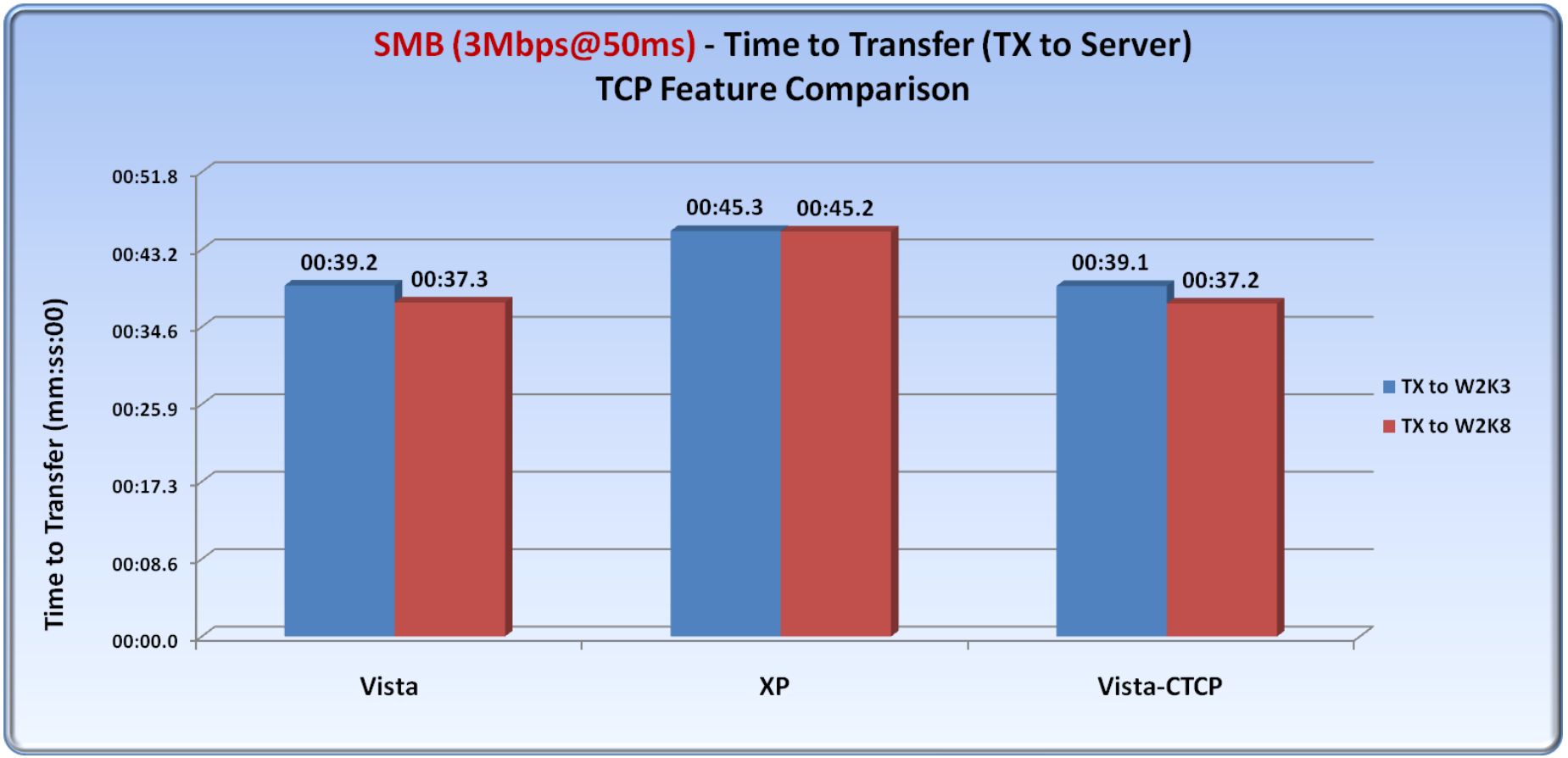



**Windows Vista is improved over XP not only as delay increases but also when loss is present**

# SMB Throughput
## Loss Comparison (Zero vs. Variable)

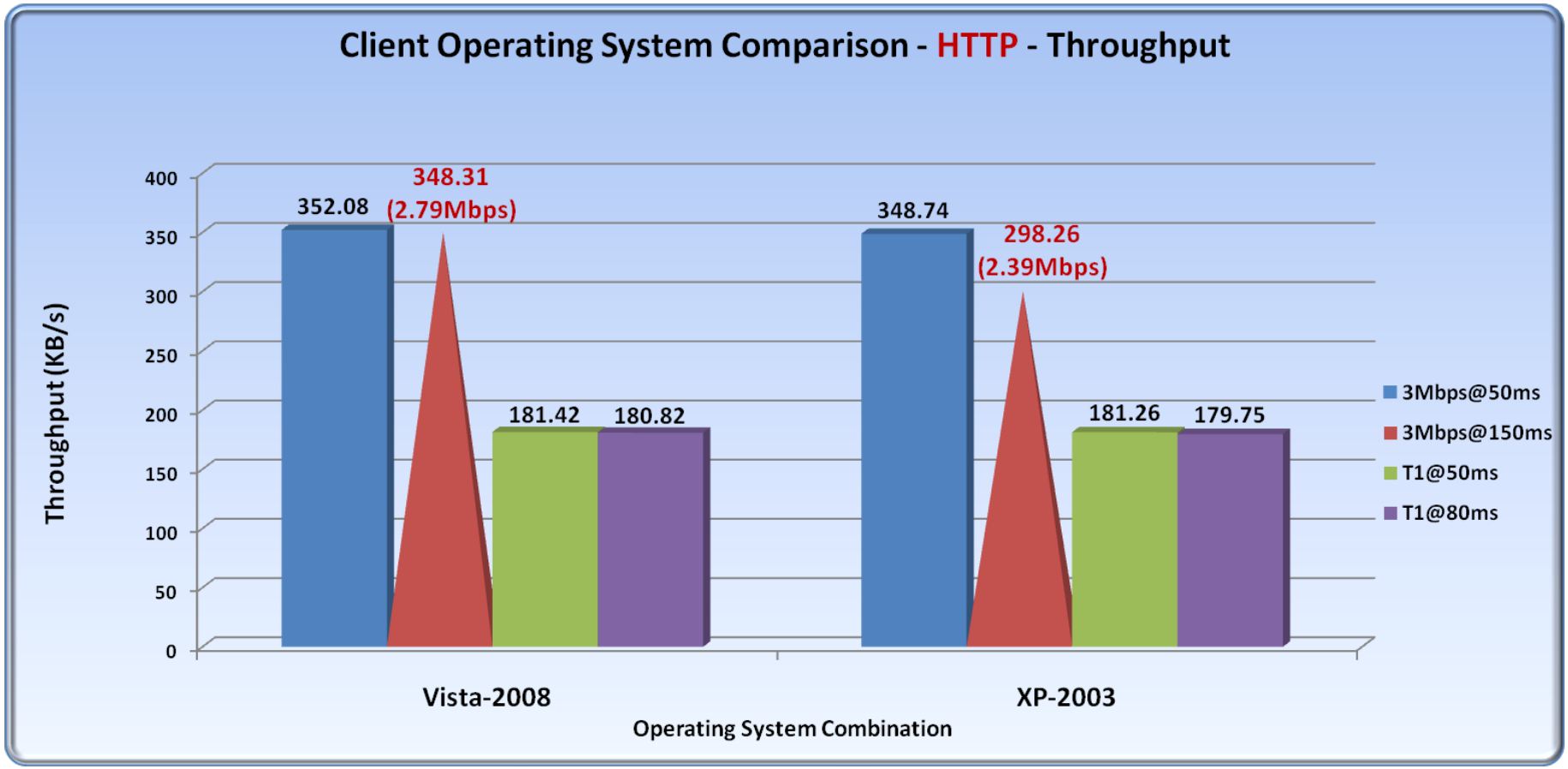


# SMB Time to Transfer
## TCP Feature Comparison



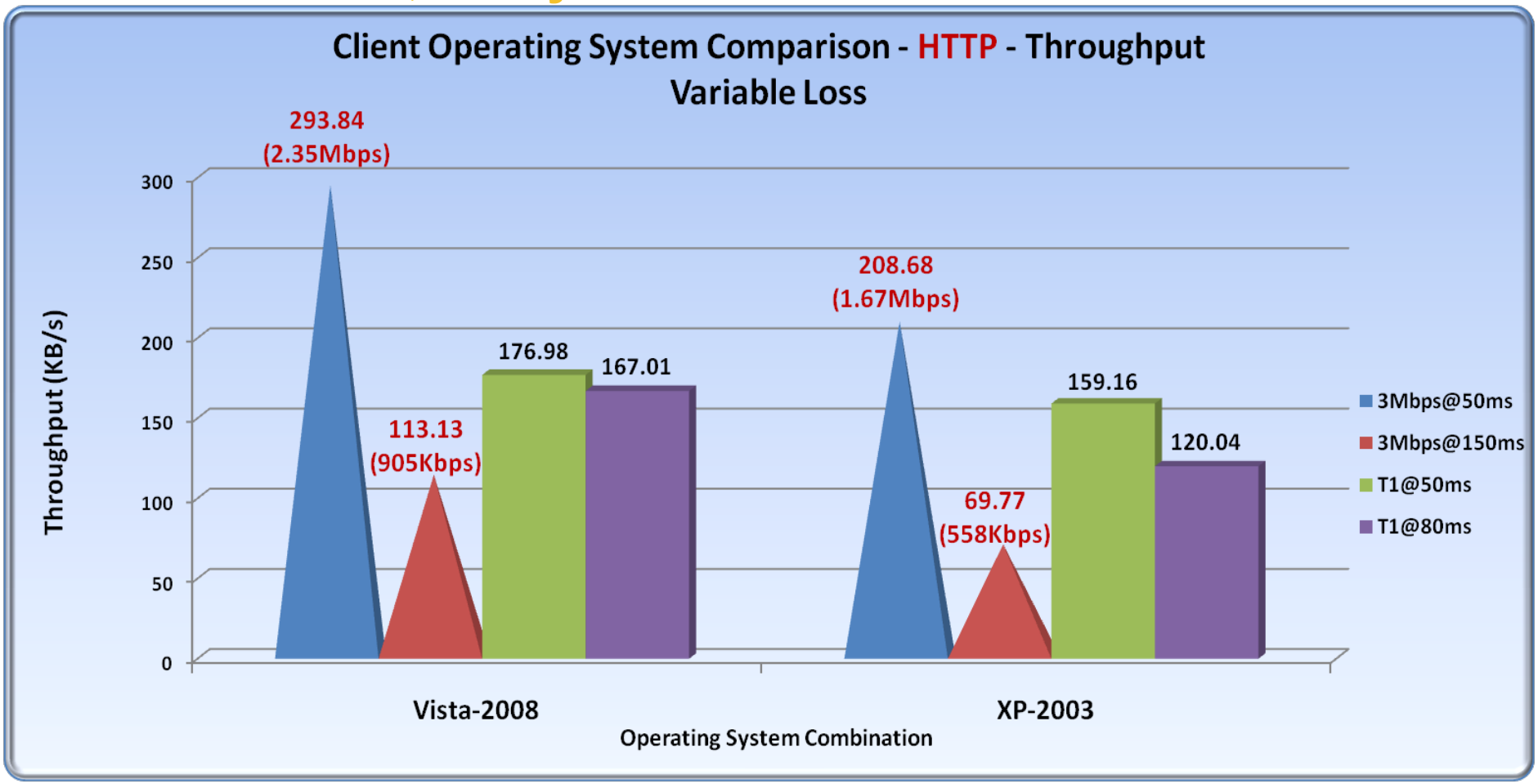

**Not all TCP optimization features show improvement in all cases – Here Vista with CTCP enabled (not the default) does not show any measurable improvement (conditions in this test were not suitable for CTCP gains)**

# HTTP Throughput
## Variable BW, Delay



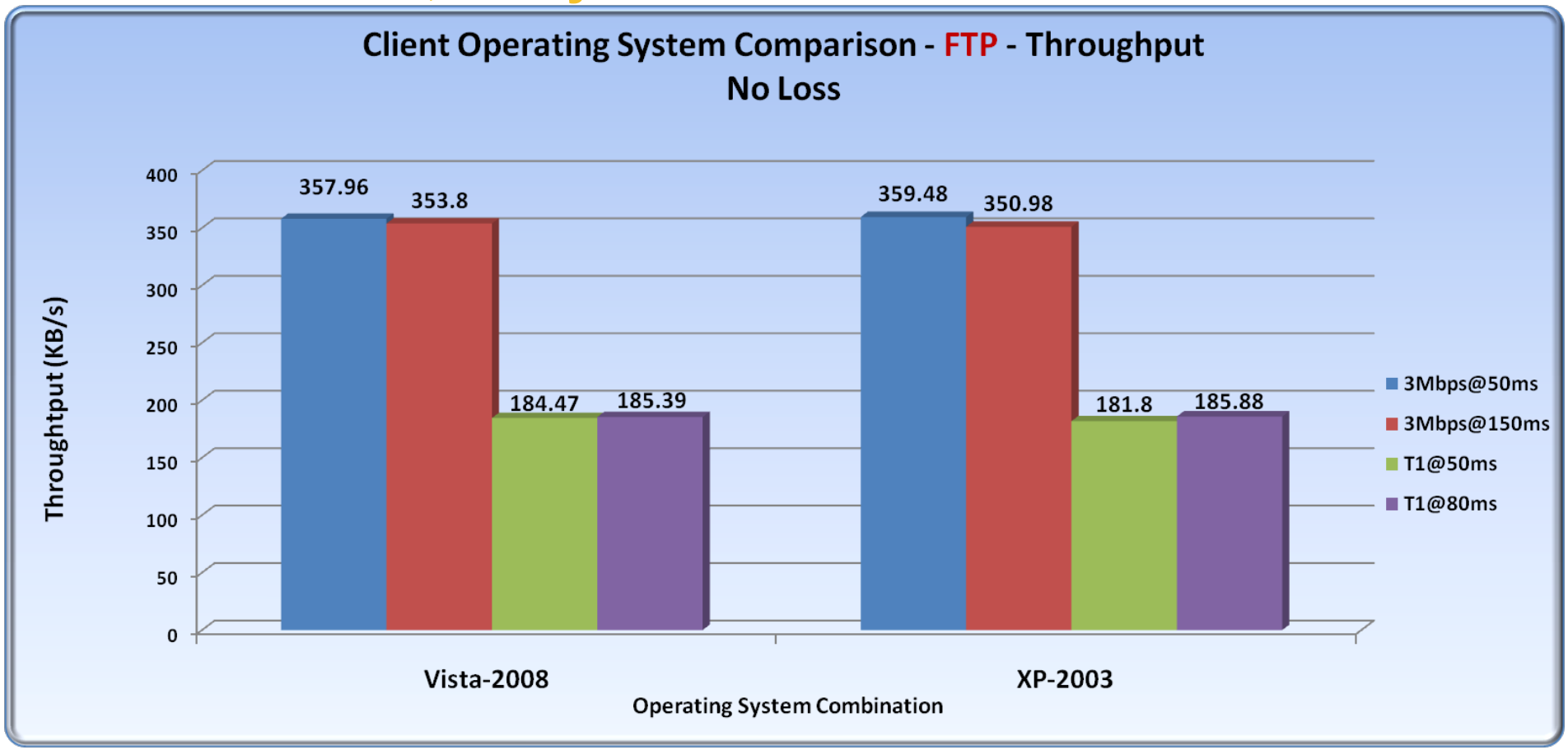

**Remember that the application can (and does) impact performance. For example the registry can be modified to override the default data buffer size used by HTTP.sys – Here we see that performance is similar at all BW rates but auto-tuning does help in high delay environments**

# HTTP Throughput
## Variable BW, Delay and Loss




**Same test as before only with loss added to the network – It is obvious to see how Vista/2003 can recover from loss compared to XP/2003**

# FTP Throughput
## Variable BW, Delay



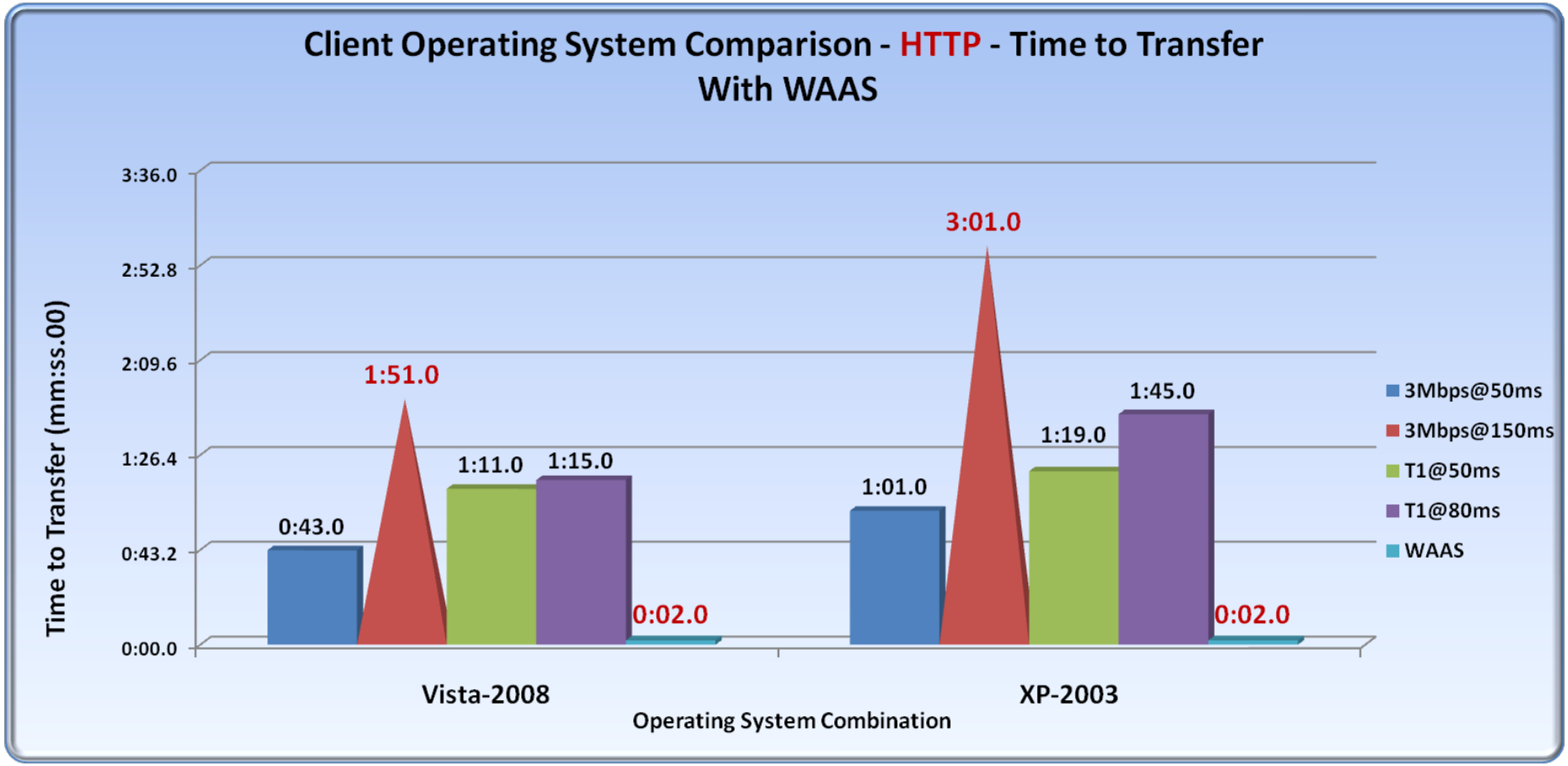

**Perfect example that shows how the application limits the network performance – here the default FTP settings limit how much data is pushed to the network thereby limiting overall performance**

# Microsoft Windows Vista + Cisco WAAS

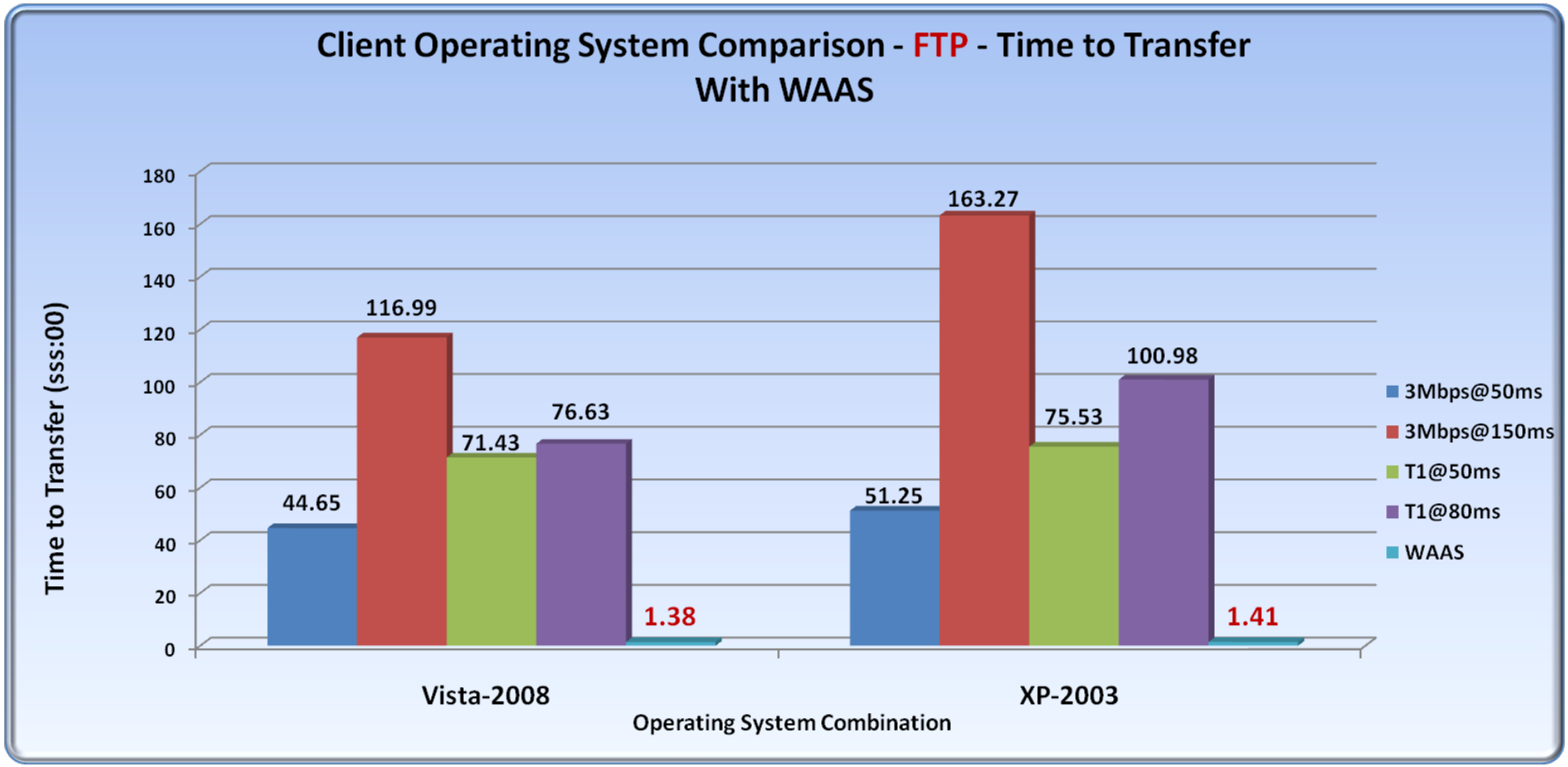
- Even with the great TCP performance improvements that come with Windows Vista and Windows Server 2008 there are distinct advantages to using WAAS in the network
- Windows Vista does NOT provide compression or caching – the following slides are a few of the many examples where both compression and caching prove to be very valuable in application performance

| | TCP Optimization | Caching | Compression |
|---|---|---|---|
| Microsoft Windows Vista/ Server 2008 | Auto-tuning, CTCP, RFC1323 | No | No |
| Cisco WAAS | Yes (TFO) | Yes (DRE) | Yes (LZ) |

# HTTP Time to Transfer
## WAAS Comparison – Variable BW, Delay



# FTP Time to Transfer
## WAAS Comparison – Variable BW, Delay



# Branch Performance Impact Summary

- Windows Vista alone or in combination with Server 2008 offer impressive network performance improvements when the conditions are right
- Time will tell if the constant “tuning” of every single TCP flow over a network connection that rarely changes (BW, Delay or Loss) ends up causing issues
- Some features of the new stack may cause issues with legacy or non-RFC compliant networking gear
- There is no substitute for the performance improvements offered by WAAS when TFO/DRE/LZ are used

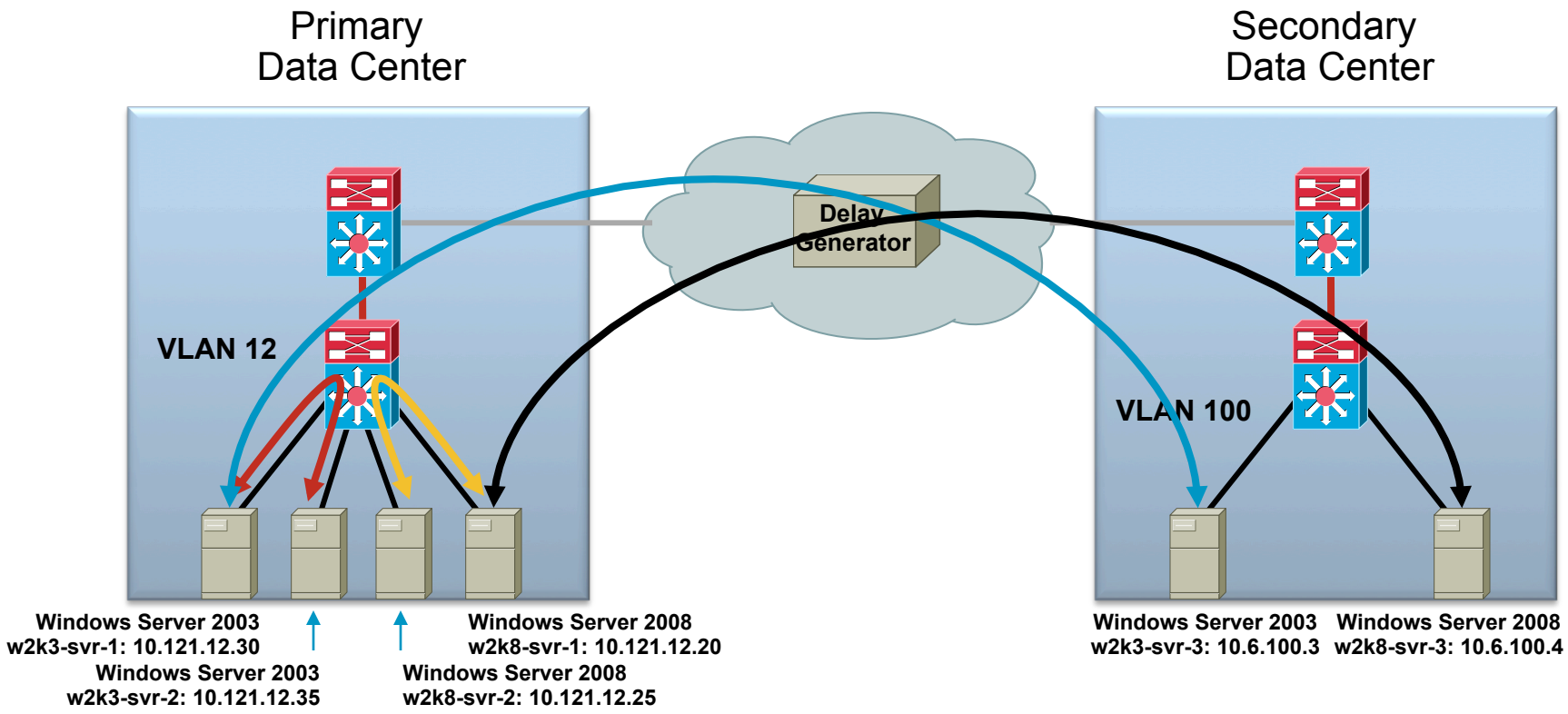
# Data Center Impact

# Purpose of Testing Windows Vista and Server 2008 in the Data Center

- Determine impact of new TCP/IP stack and Clustering on DC-related services and designs such as:
  - Interoperability with ACE
  - Impact on Data Center bandwidth requirements within and between DC sites
  - Design changes when using WSFC (Windows Server Failover Cluster) in a Layer 3 configuration (Local and GeoCluster)
- Yield updated best practice recommendations, if needed, for the field and customers to use when deploying Windows Vista and Server 2008
- Provide Microsoft and Cisco product teams information about performance and, if found, issues related to Windows Vista TCP/IP stack

# Validation Setup & Methodology – TCP Stack Performance

# Data Center TCP Stack Test Diagram



# Cisco and Microsoft OS Specifics

- Cisco Gear

  Cisco Catalyst 6509 with Supervisor 720 – Advanced Ent Services 12.2.18-SXF13

- Microsoft OS Versions

  Windows 2003 R2 Data Center Edition SP2

  Windows Server 2008 Data Center Edition

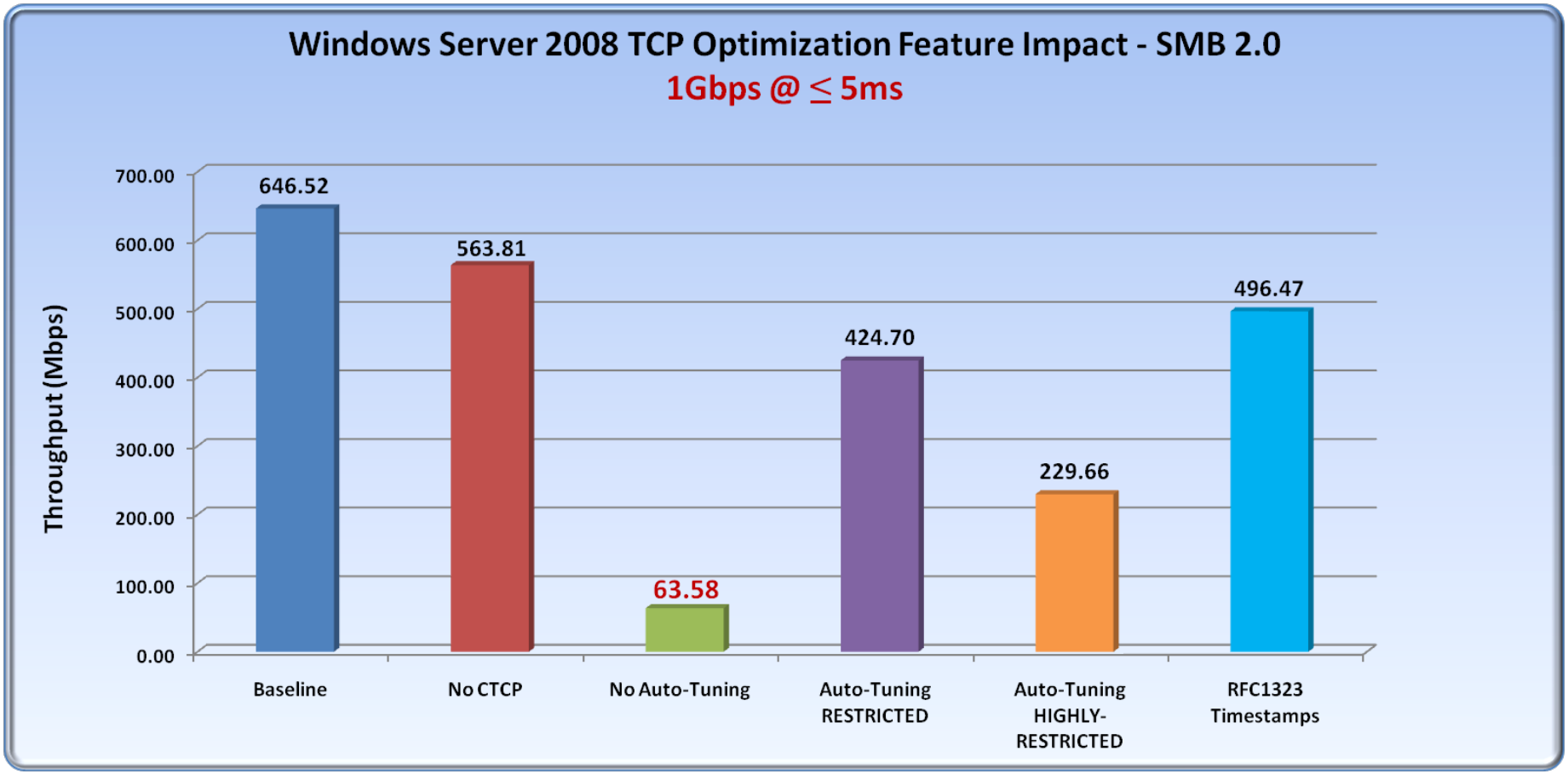
# Validation Tools – Overview

- SMB, HTTP (IIS 6.0 and 7.0) and FTP (6.0) were used
- Tools that are native to OS were used (browser, command-line tools)
- All Operating Systems and applications were using default settings (except when comparing TCP features such as CTCP)
- Sniffer was running during validation baseline test to capture end-to-end behavior (sniffer did not run during performance cases)
- Output from all tests were captured to logs
- Windows performance monitoring tools were running during baseline testing to ensure consistency with BW reported from command-line tools
- Client and Server OS versions were tested in all combinations 2008/2008, 2003/2003, 2003/2008
- Cisco switches are there for basic connectivity – no QoS, ACLs, default interface configuration (i.e. no jumbo frames)

# Data Center Test Cases

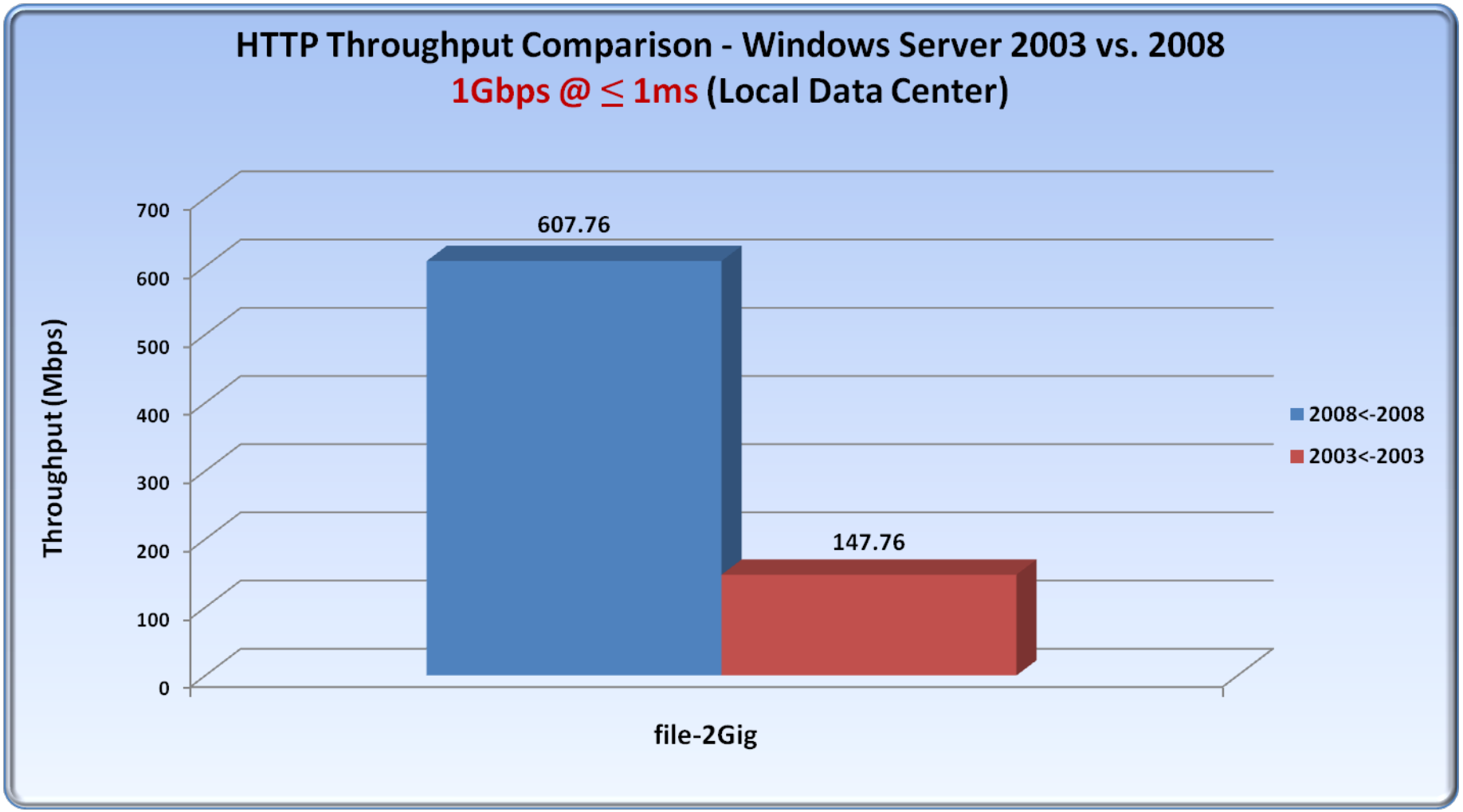
- 10, 100, Mbps @ <1ms, 5ms, 50ms, 150ms
- 1000 Mbps @ <1ms, 5ms, 50ms
- Delay generator was used between sites to induce delay – each test case was subject to fixed and variable loss percentages from zero loss to as high as 5% to compare TCP/IP stack performance
- Summary of results (following slides) had variable loss injected unless noted with “Zero Loss” (used as a baseline)

# Windows Server 2008 TCP Optimization
## TCP Feature Comparison – SMB 2.0

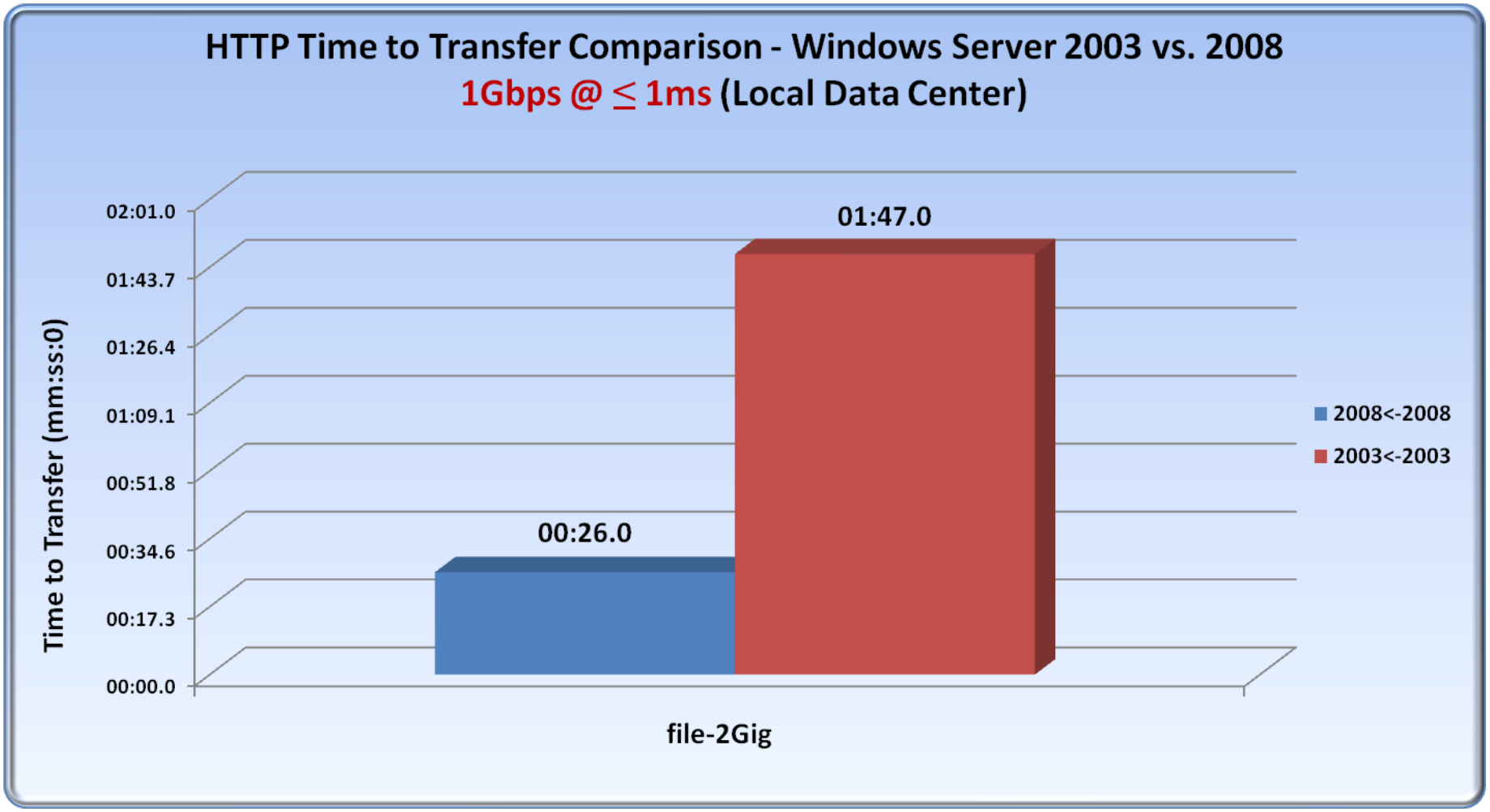



**Baseline – W2K8 defaults (Auto-tuning=Normal, CTCP=enabled)**
**No CTCP test only impacts transmit**
**No Auto-tuning – Basically reduces W2K8 to W2K3 performance**

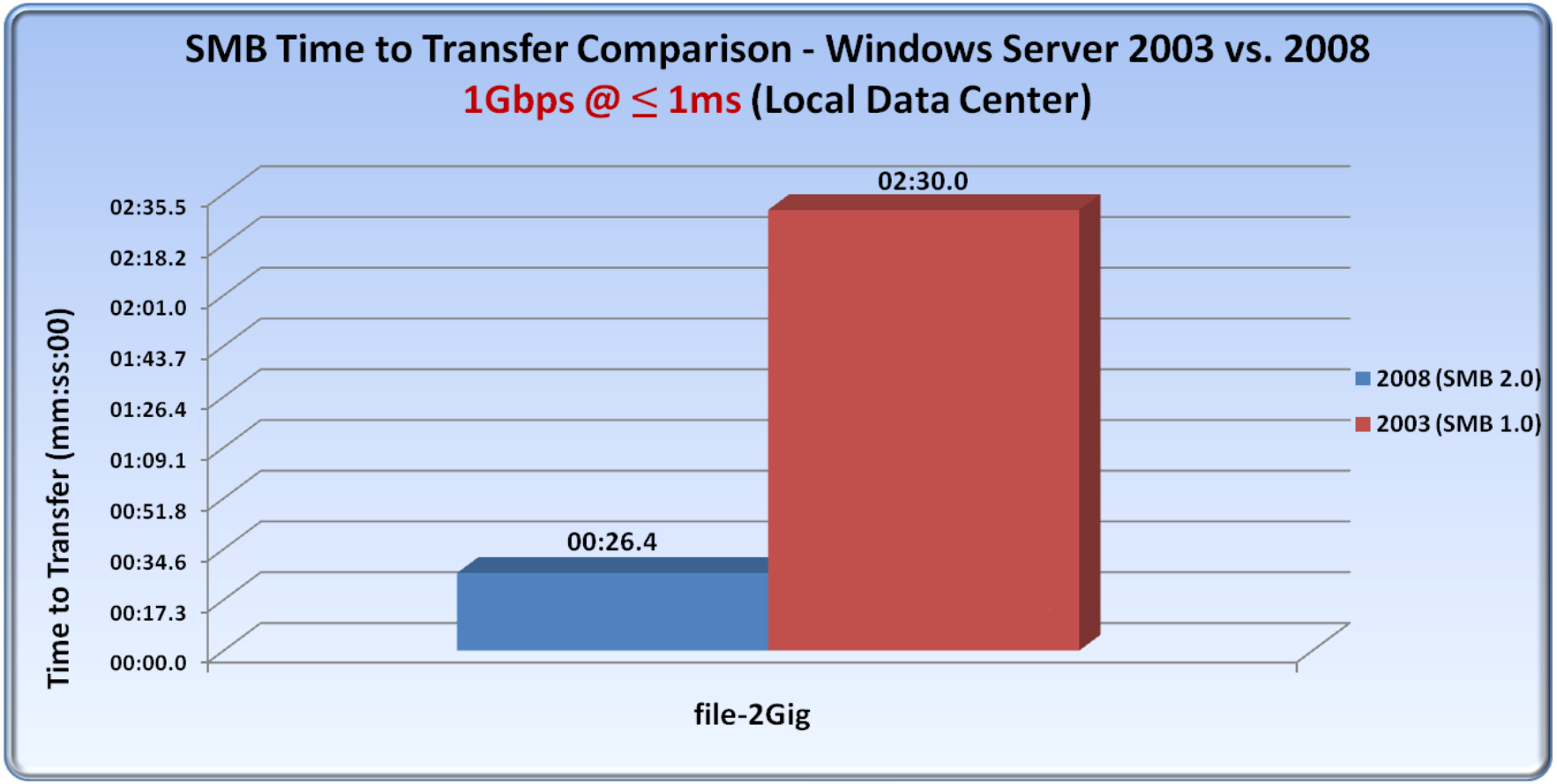
# HTTP Throughput
## Local DC Comparison – Zero Loss



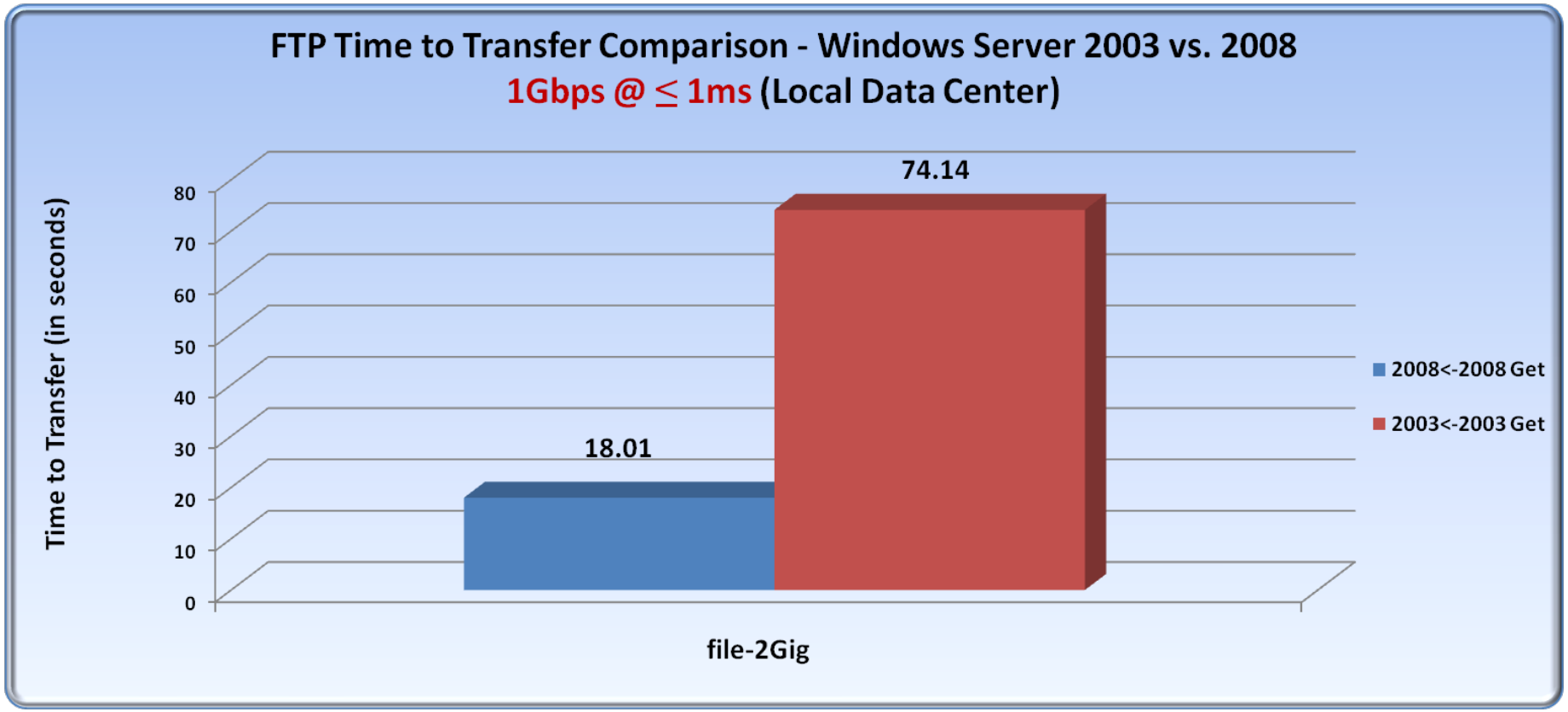
# HTTP Time to Transfer
## Local DC Comparison – Zero Loss



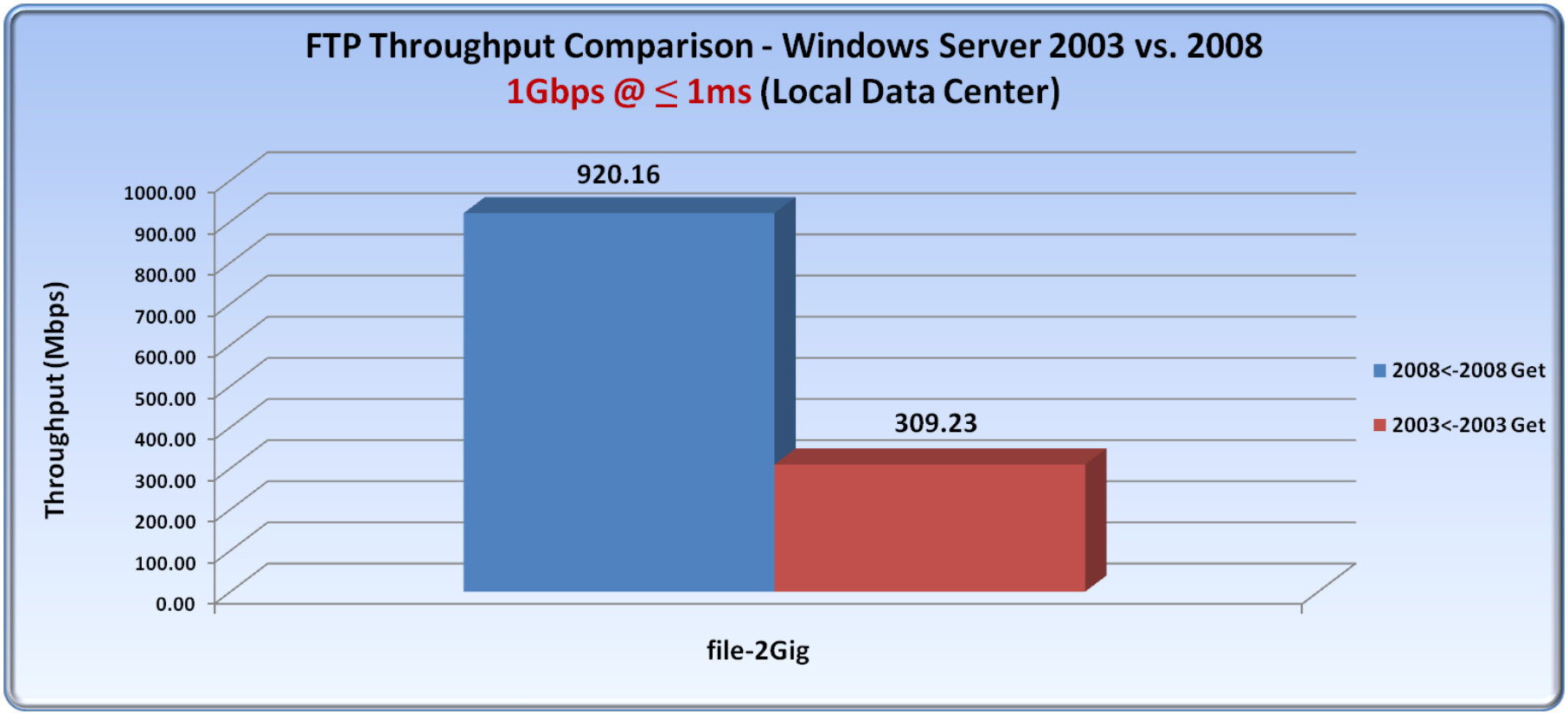
# SMB Time to Transfer
## Local DC Comparison – Zero Loss



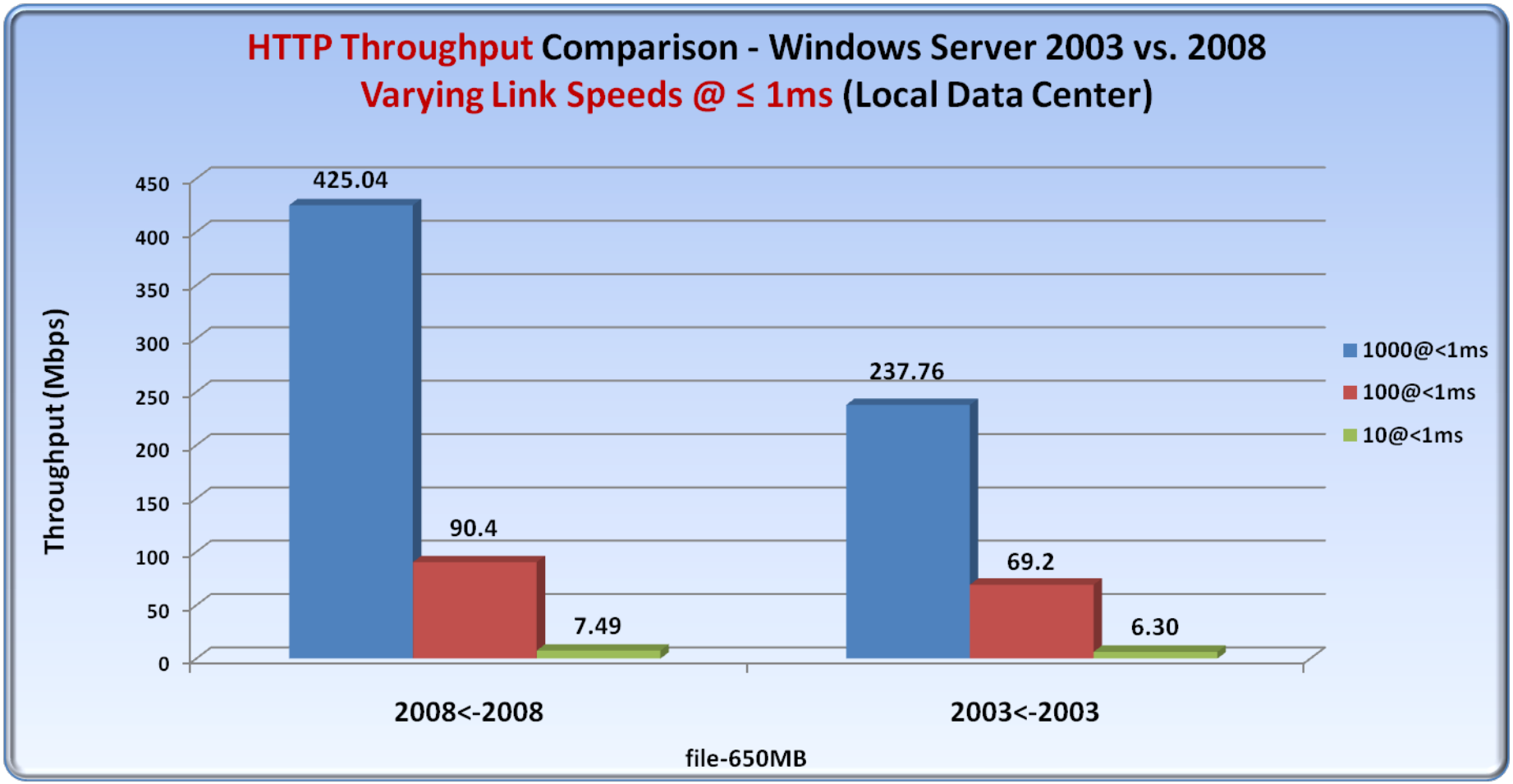
# FTP Time to Transfer
## Local DC Comparison – Zero Loss



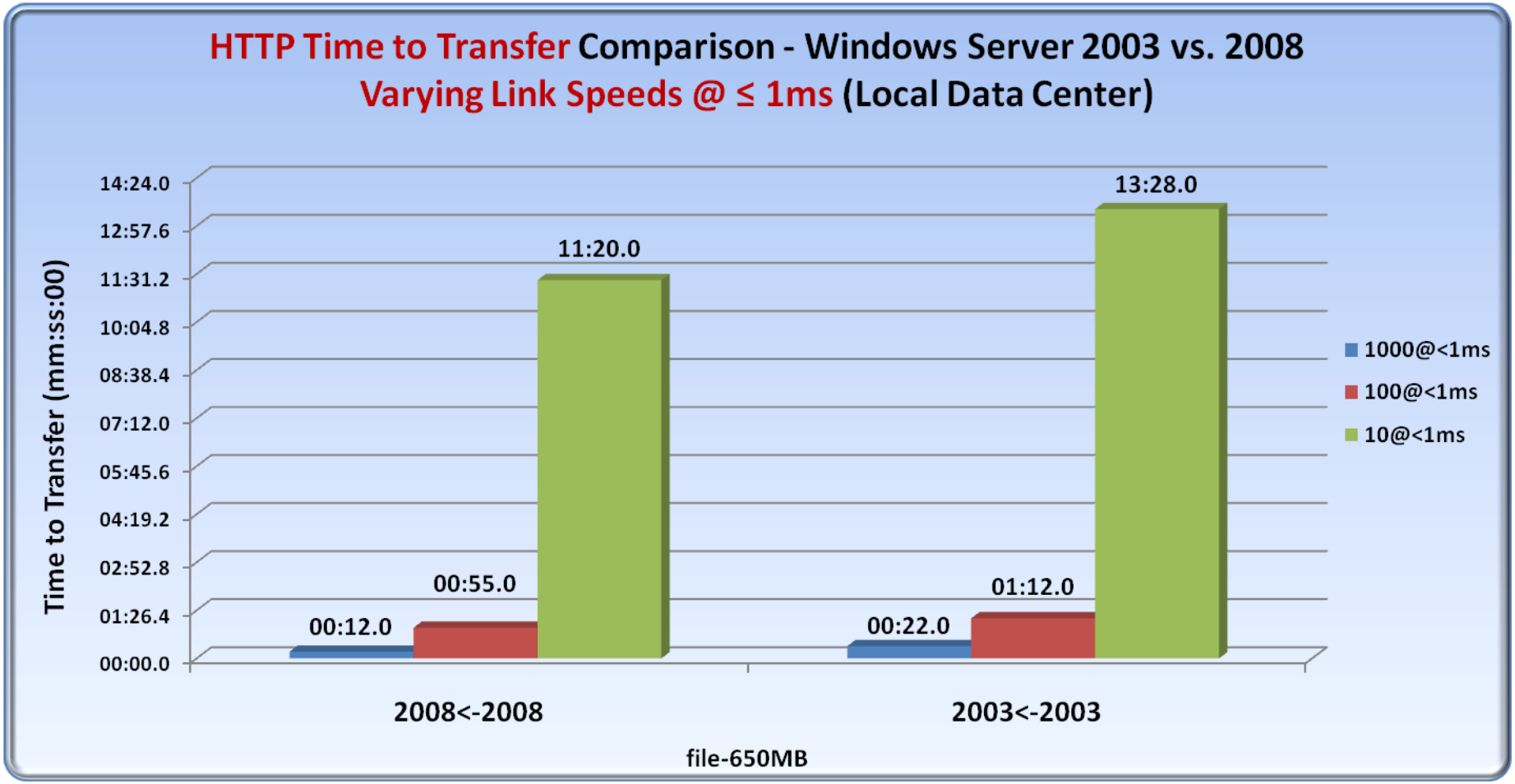
# FTP Throughput
## Local DC Comparison – Zero Loss



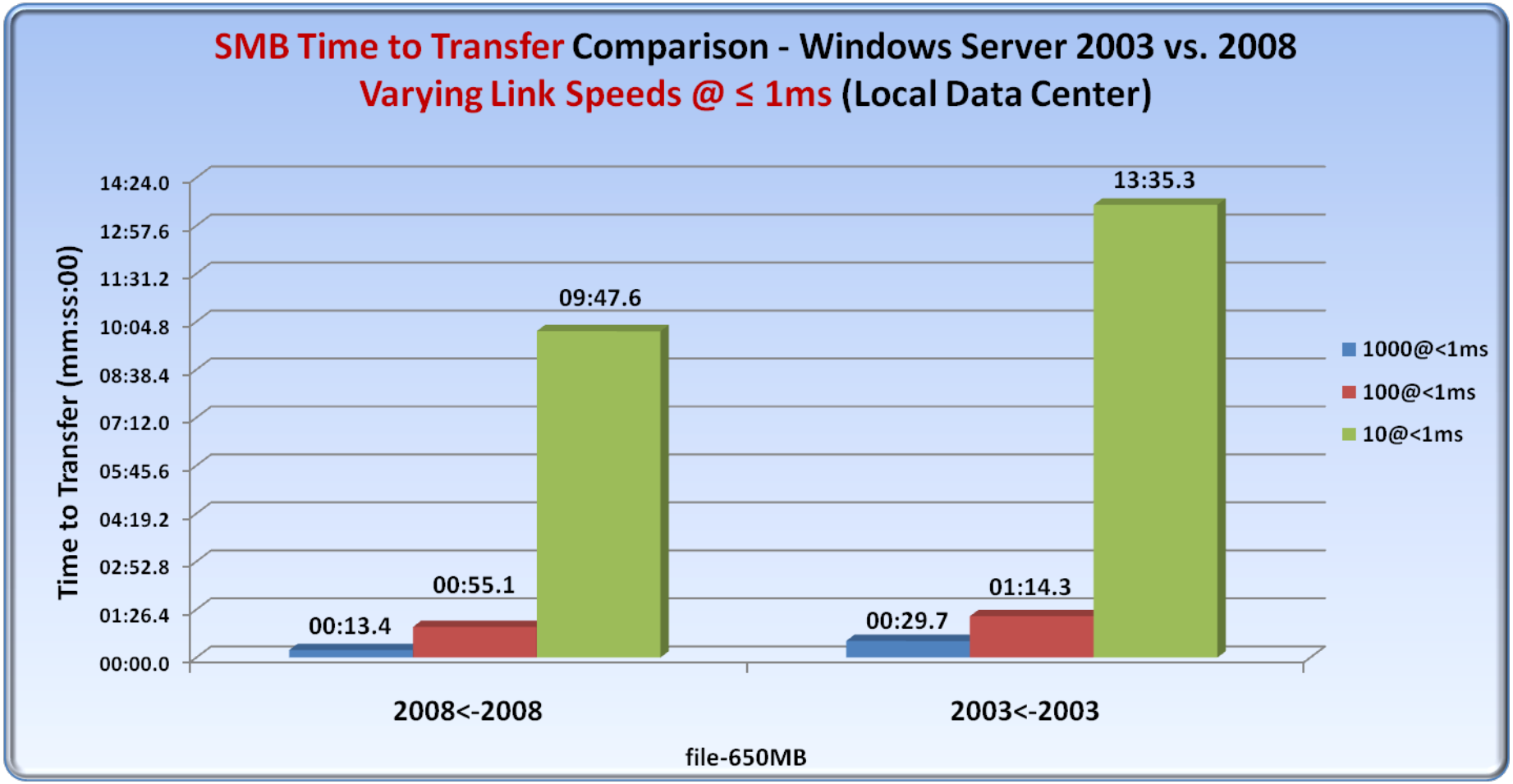
# HTTP Throughput
## Varying Link Speeds



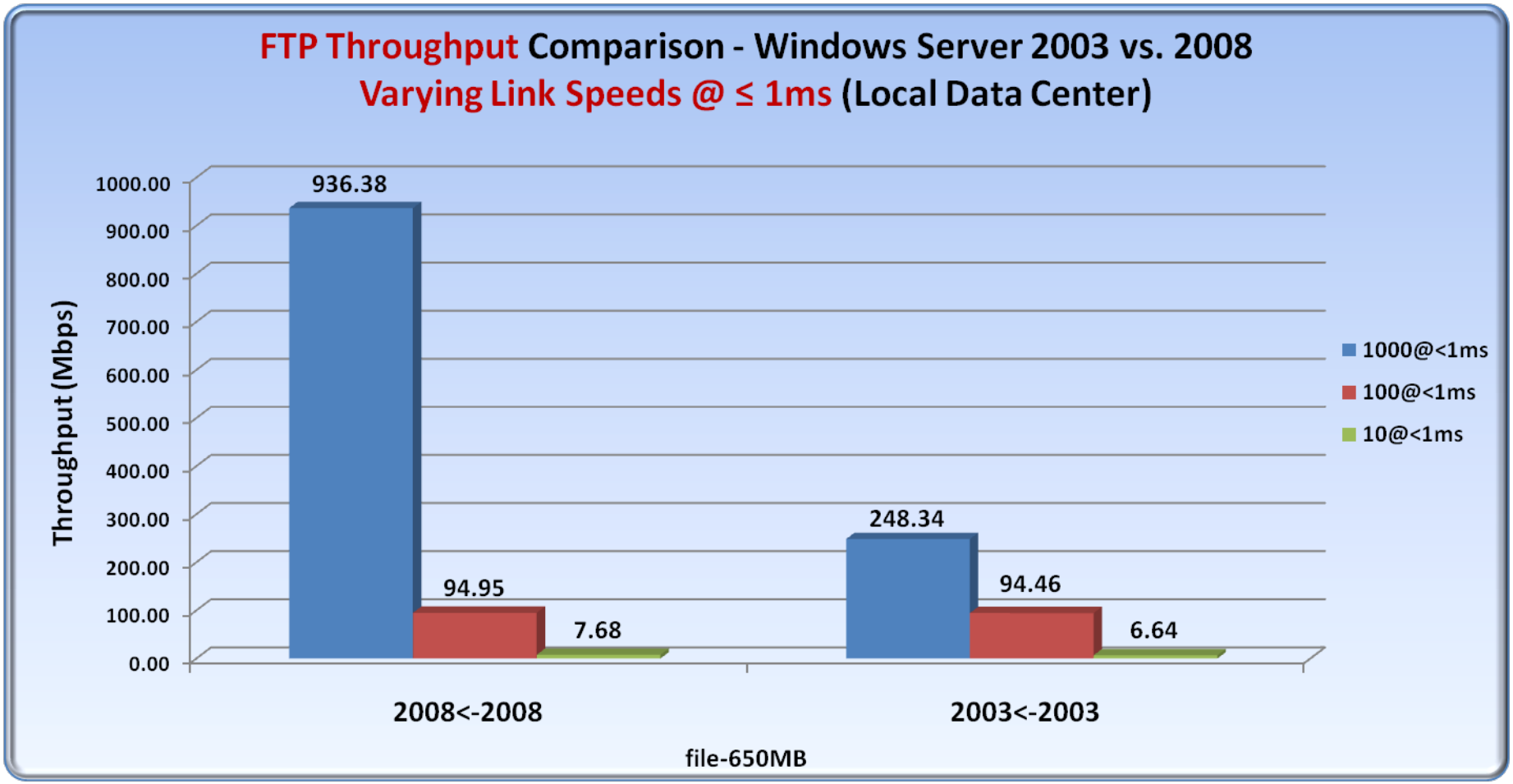
# HTTP Time to Transfer
## Varying Link Speeds



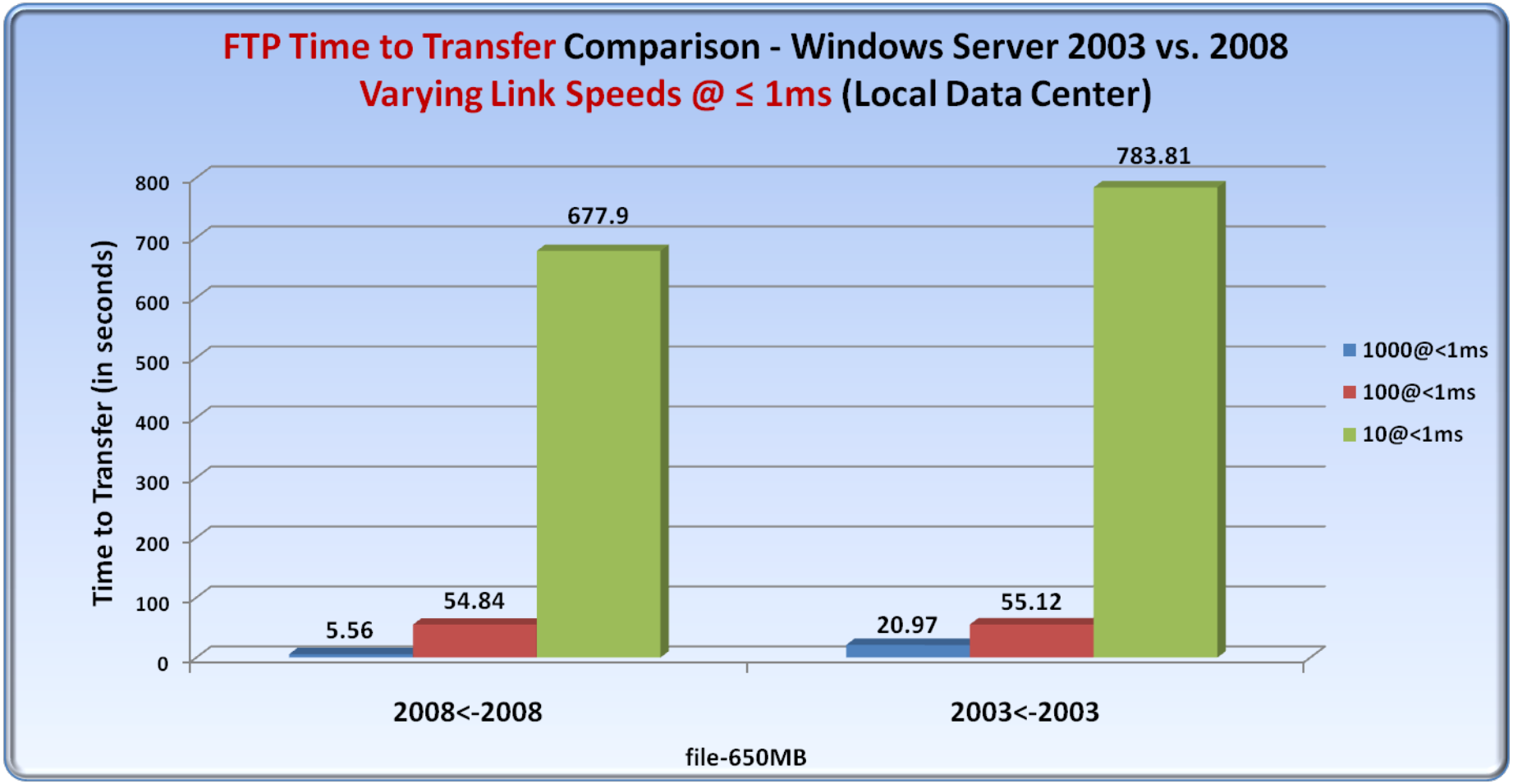
# SMB Time to Transfer
## Varying Link Speeds



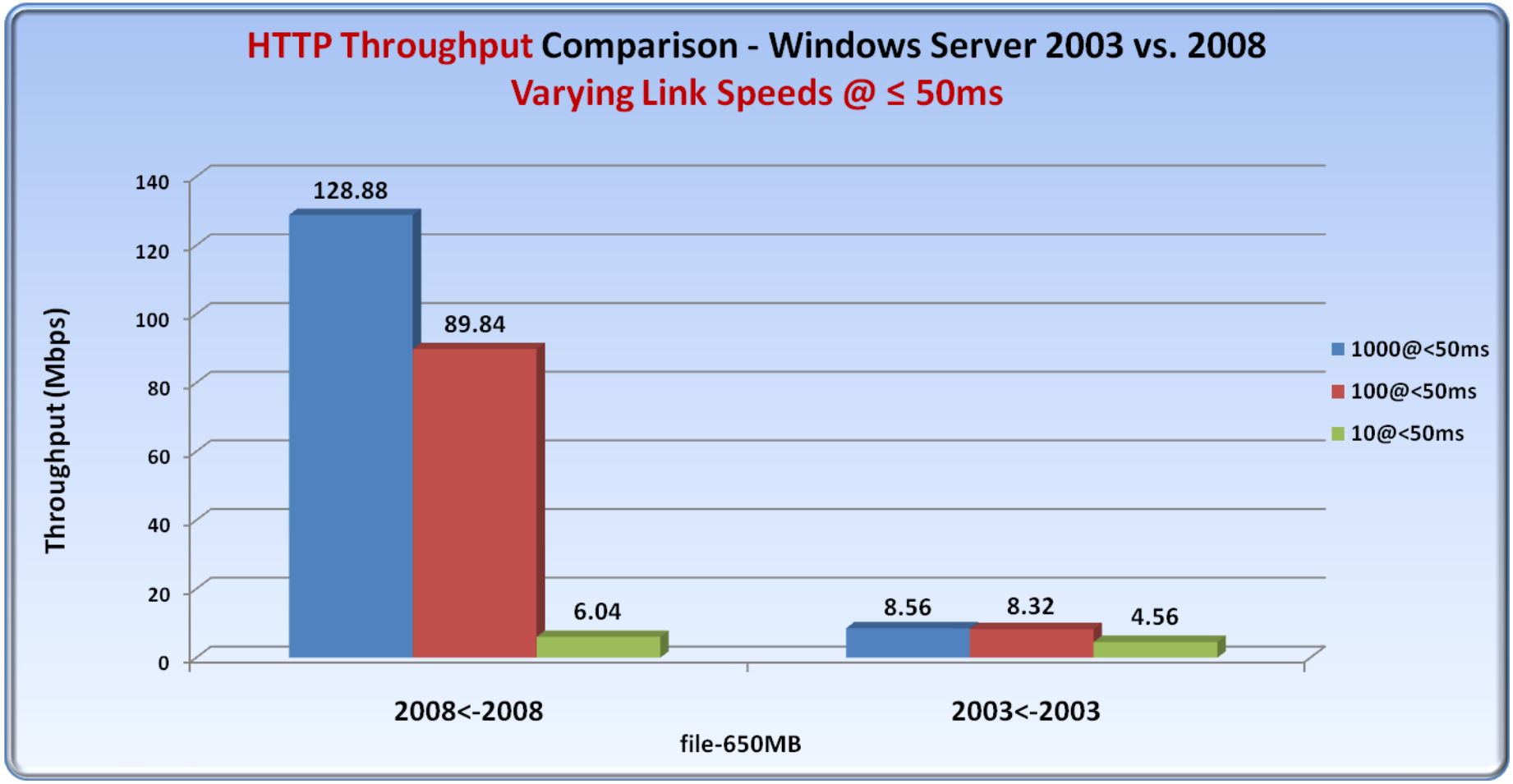
# FTP Throughput
## Varying Link Speeds



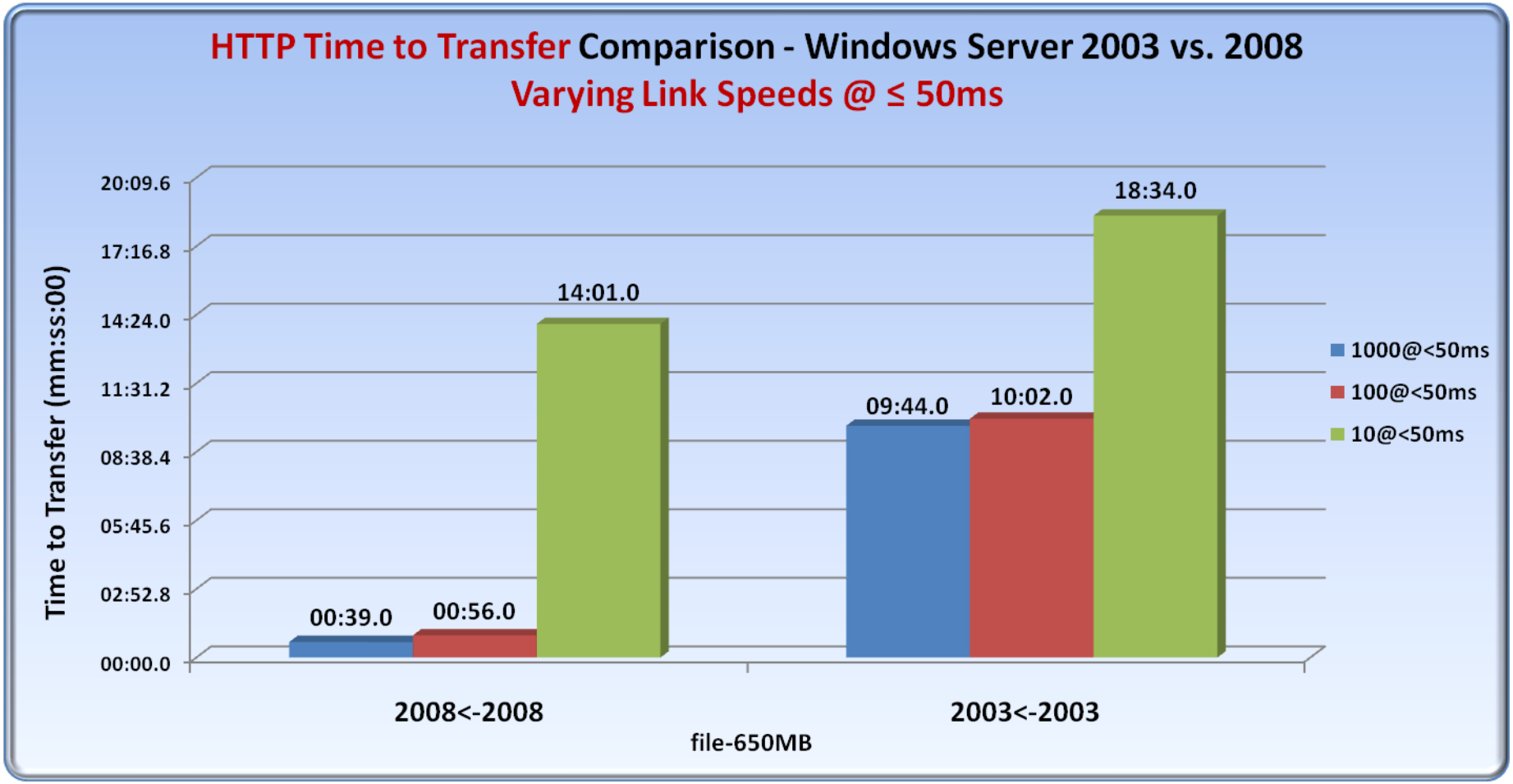
# FTP Time to Transfer
## Varying Link Speeds



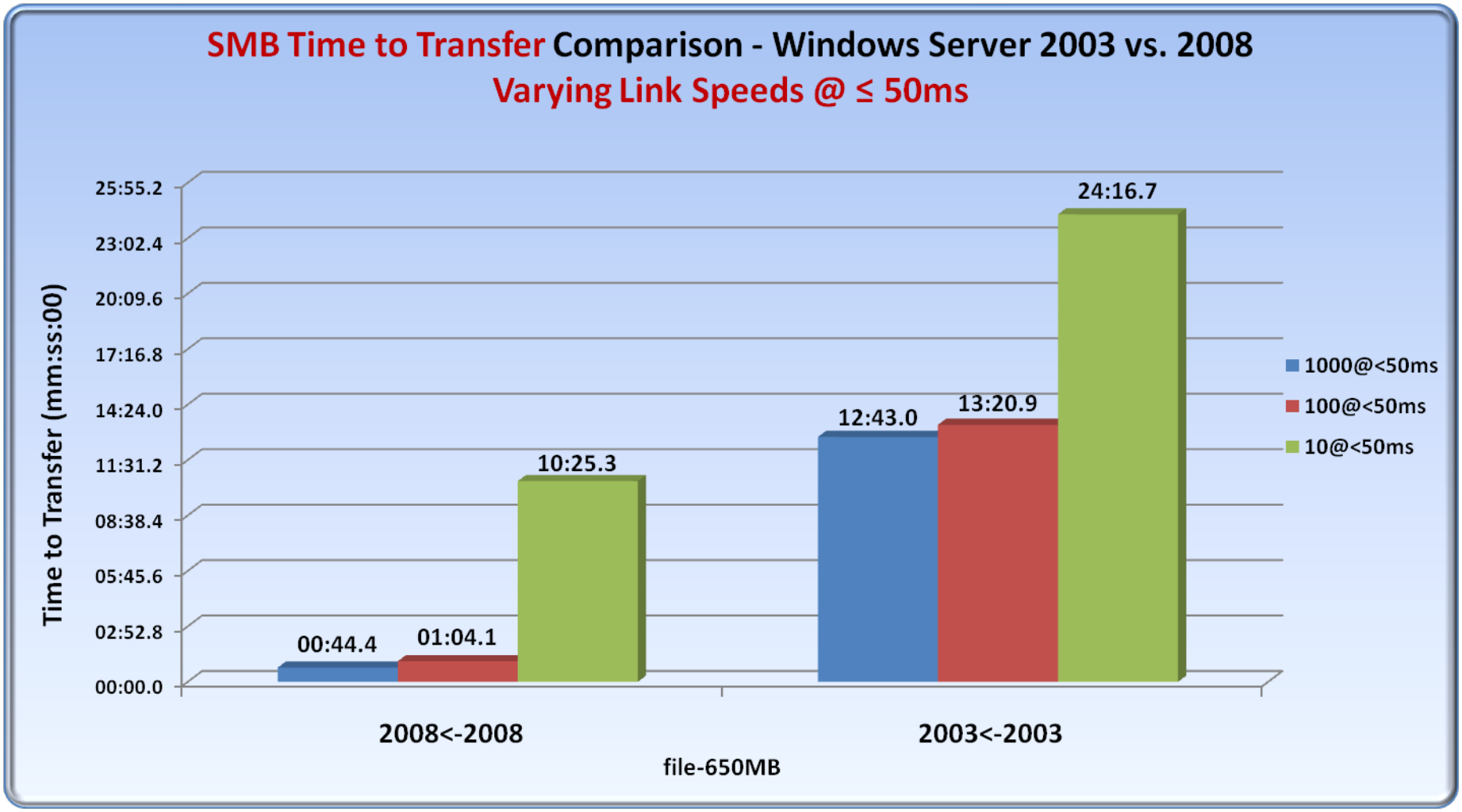
# HTTP Throughput
## Varying Link Speeds @ 50ms Delay



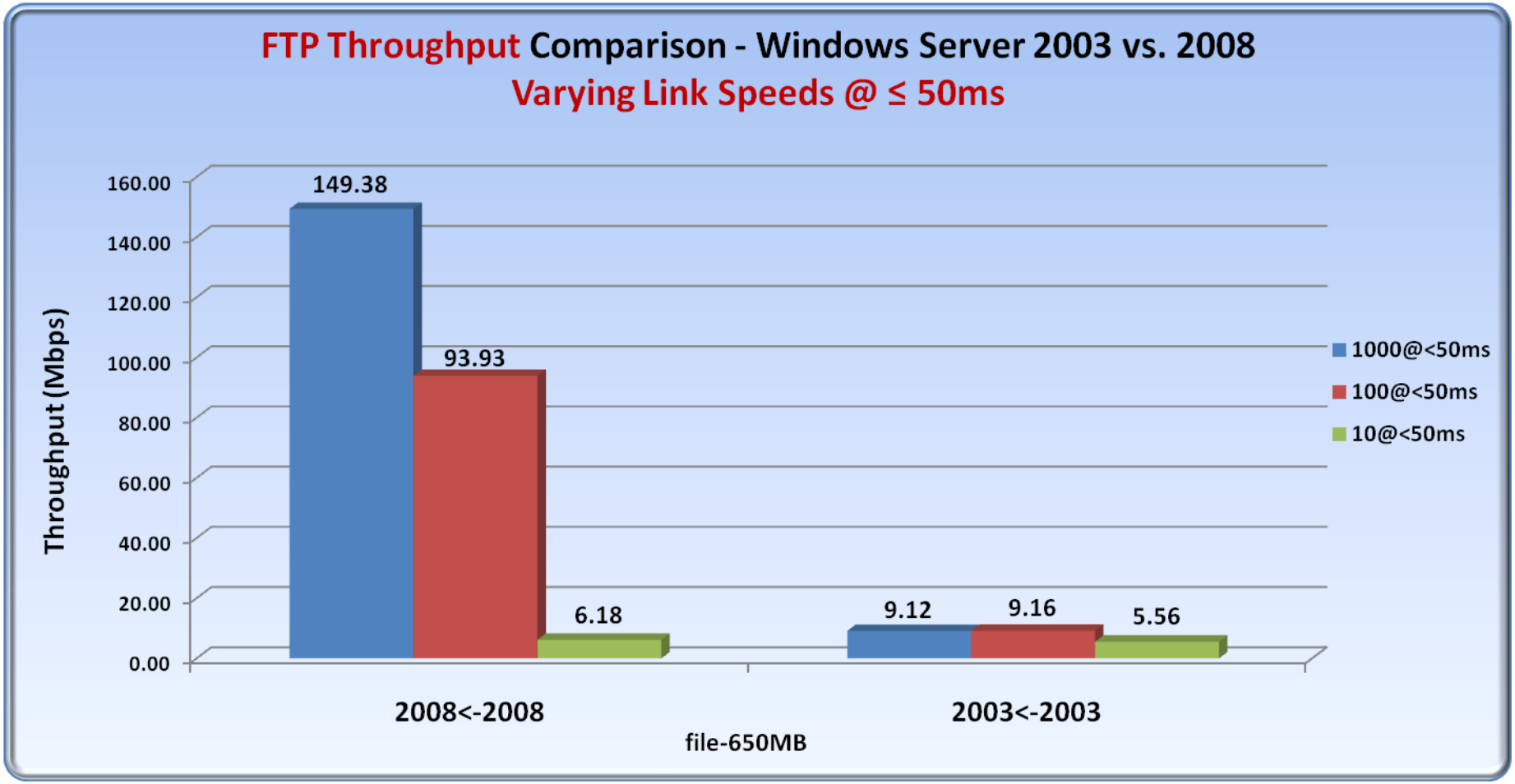
# HTTP Time to Transfer
## Varying Link Speeds @ 50ms Delay



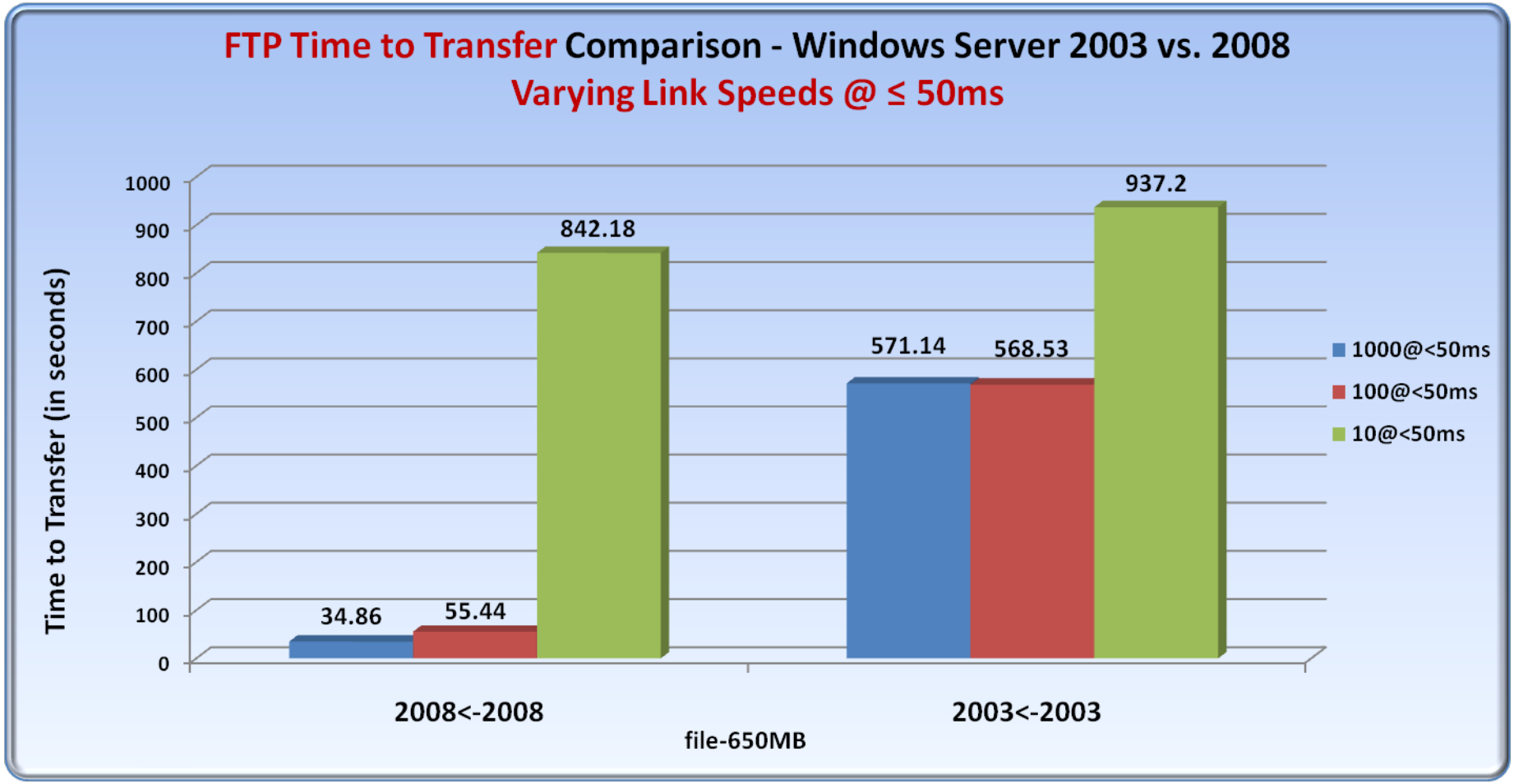
# SMB Time to Transfer
## Varying Link Speeds @ 50ms Delay



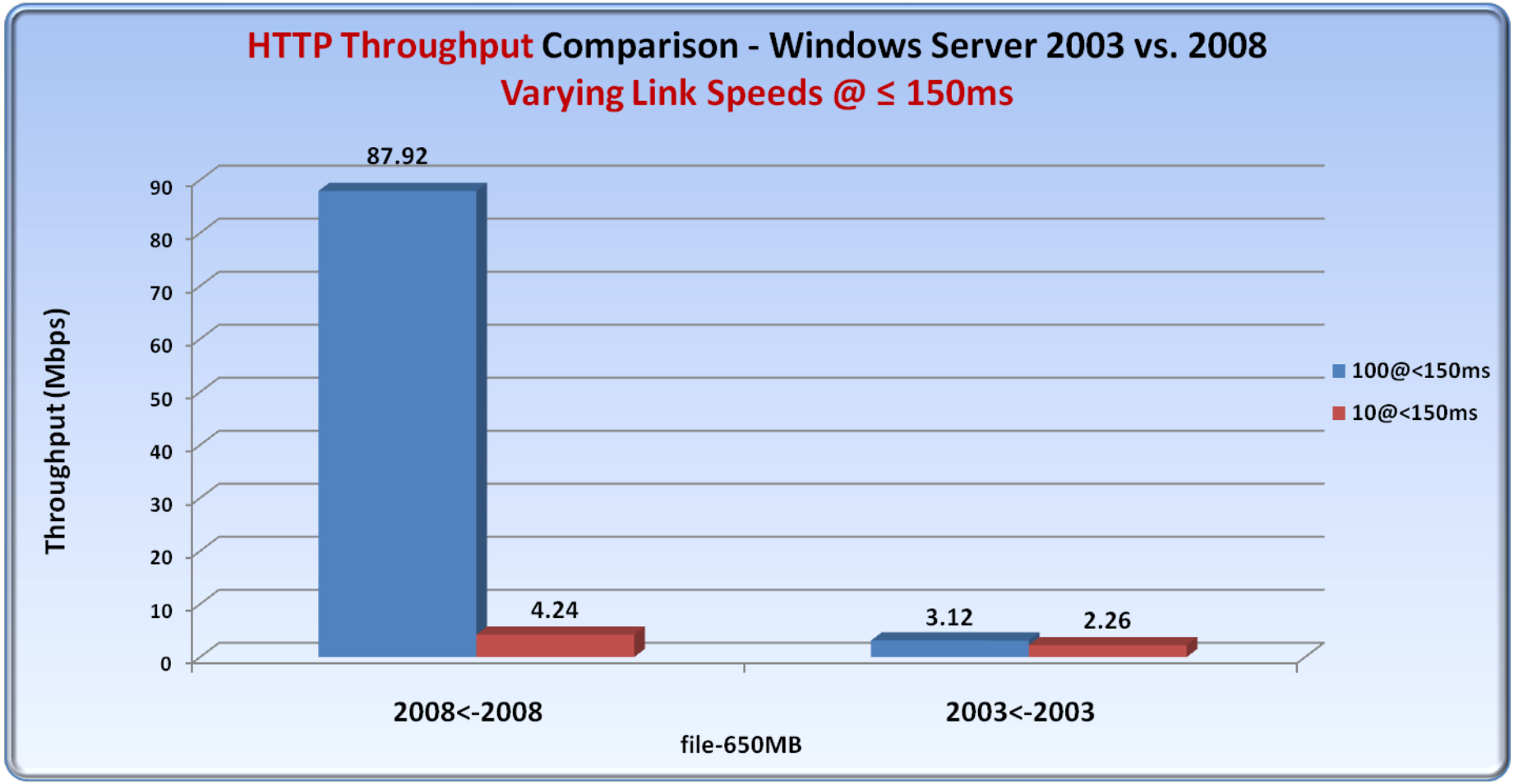
# FTP Throughput
## Varying Link Speeds @ 50ms Delay



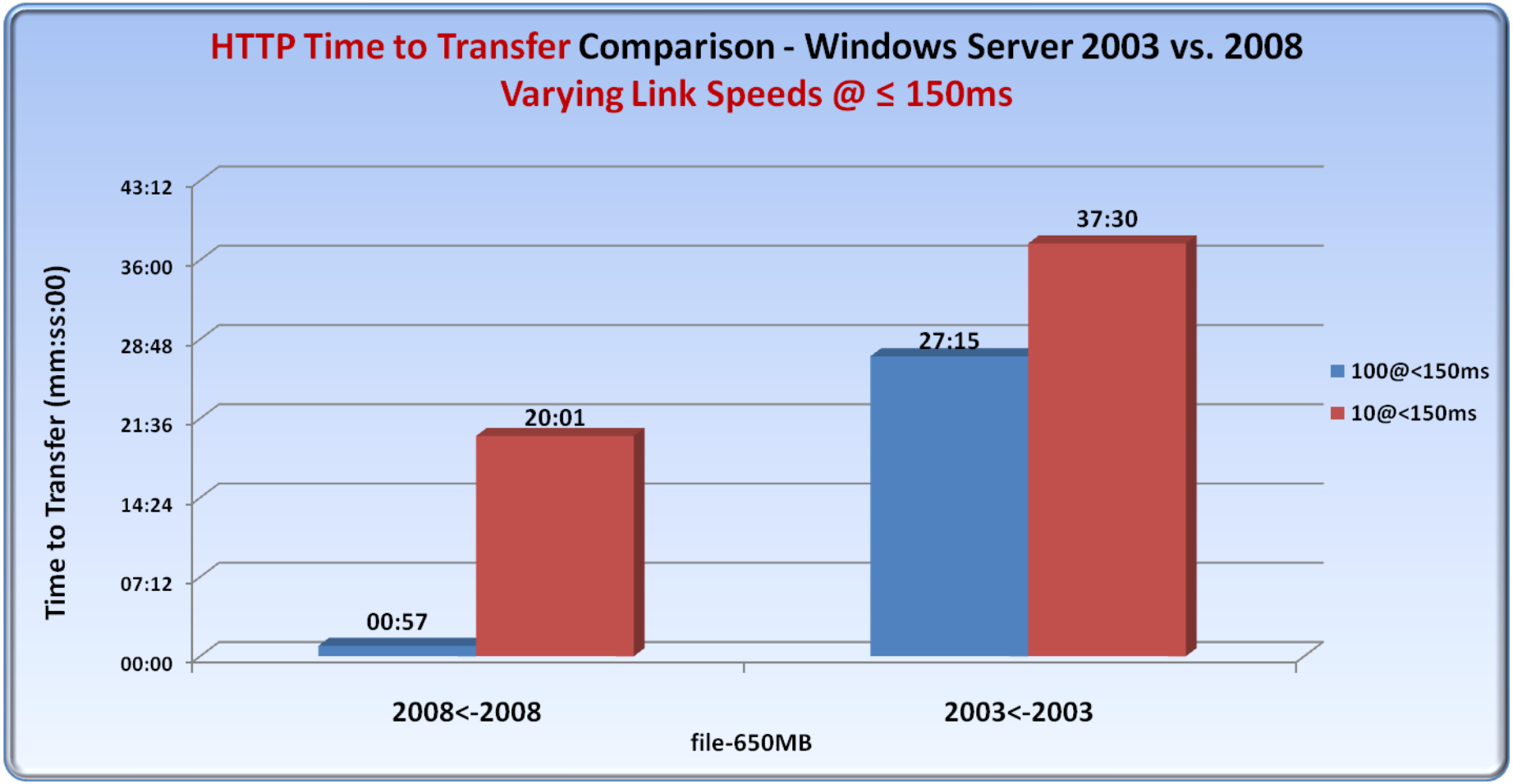
# FTP Time to Transfer
## Varying Link Speeds @ 50ms Delay



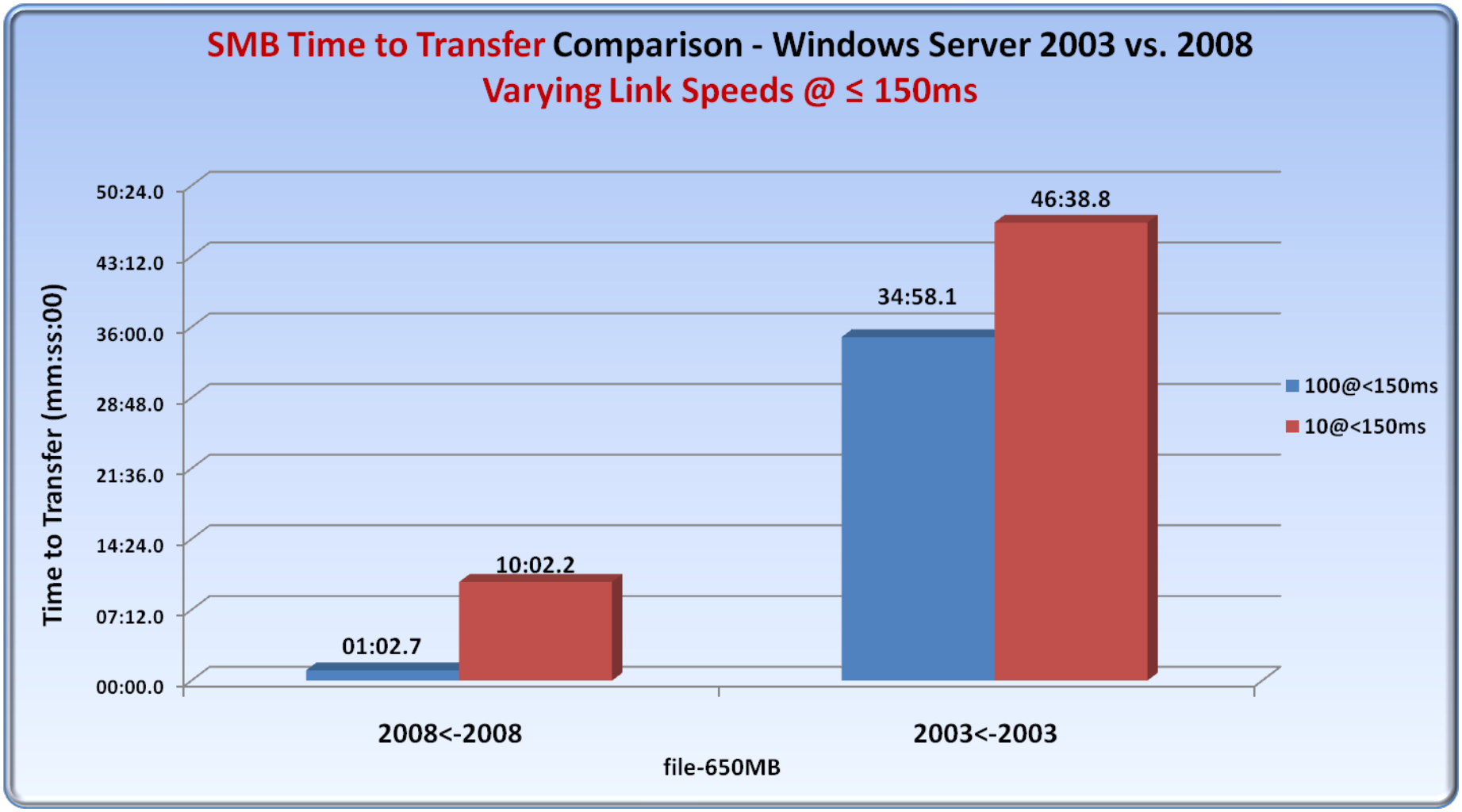
# HTTP Throughput
## Varying Link Speeds @ 150ms Delay



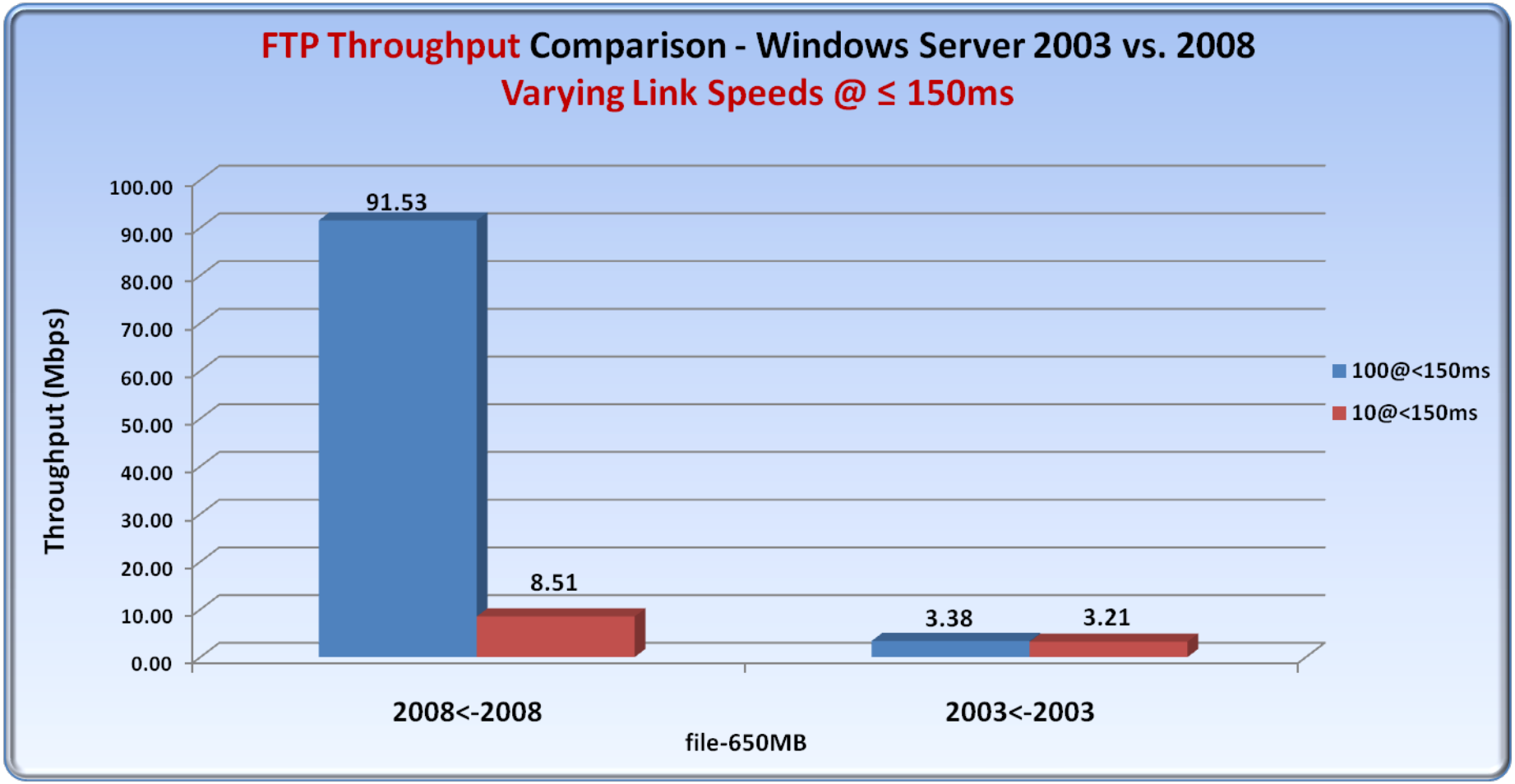
# HTTP Time to Transfer
## Varying Link Speeds @ 150ms Delay



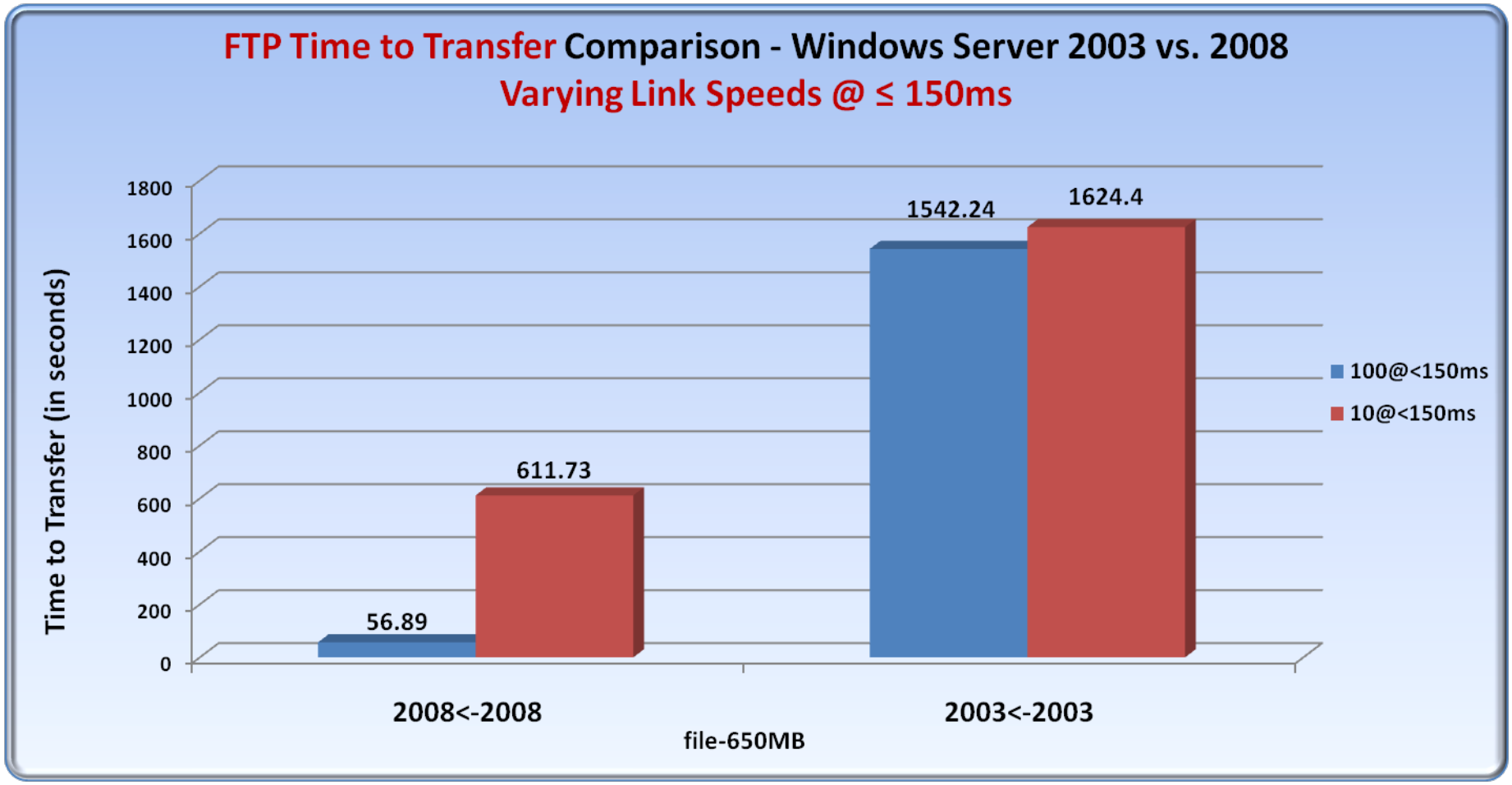
# SMB Time to Transfer
## Varying Link Speeds @ 150ms Delay



# FTP Throughput
## Varying Link Speeds @ 150ms Delay



# FTP Time to Transfer
## Varying Link Speeds @ 150ms Delay



# DC TCP Performance Impact Summary

- Windows Server 2008 with TCP and SMB 2.0 provides a massive performance improvement over Server 2003 within the DC and between DC locations
- Will the increase in throughput impact existing design recommendations? (related to oversubscription ratios, QoS settings or performance strain)
- Again, time will tell if the constant auto-tuning of each flow makes good sense in the DC vs. nailing the window to a specific value for a purpose-driven server (like we do with Server 2003 and Linux server today)

# TCP Interoperability with Cisco ACE

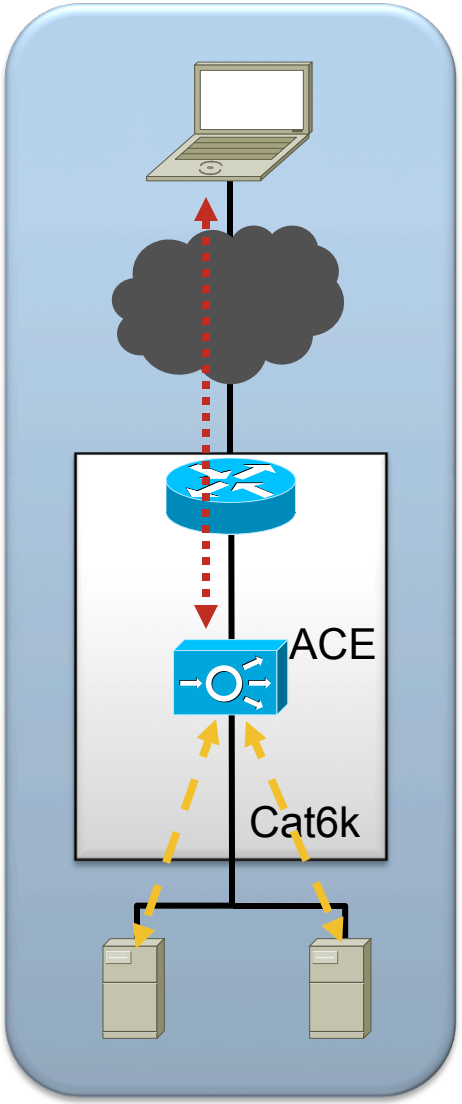
# Microsoft Windows Vista/2008 and Cisco ACE
## TCP Interoperability Summary

- By default the Cisco ACE TCP normalization feature prohibits Vista/2008 'advanced' TCP features (auto-tuning, RFC1323 Timestamps, SACKs, etc…)

  Configure parameter maps to allow options or clear them and set your own values

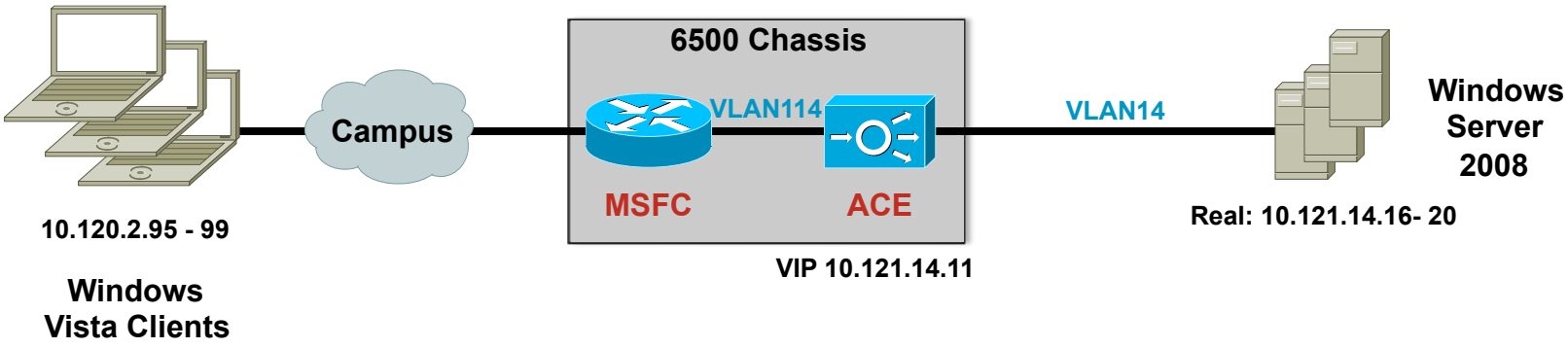
  Enabling the "buffer sharing" option on ACE can maximize TCP receive buffer operation between hosts and ACE – This should be extensively tested by customer before deploying in their environment

- Application probes to Server 2008 will fail if Windows Firewall is not configured to allow the probes



# Validation Setup & Methodology – TCP Stack Interoperability

# Windows Vista/2008 + ACE Validation
## Diagram



# Cisco and Microsoft OS Specifics

- Cisco Gear

  Cisco Catalyst 6509 with Supervisor 720 – Advanced Ent Services 12.2.18-SXF13

  Cisco ACE Service Module - Version A2(1.0a) [build 3.0(0)A2(1.0a)

  Cisco NAM (WS-SVC-NAM-2) - 3.6(1a-Patch3)

- Microsoft OS Versions

  Windows Vista Enterprise Edition

  Windows Server 2008 Data Center Edition

# Validation Tools – Overview

- HTTP (IE7 and wget) on client – IIS7 on Server

  IE7/Firefox uses a windows scaling factor of 2 by default

  wget uses the OS default of windows scaling factor of 8

- All Operating Systems and applications were using default settings (except when comparing TCP features such as RFC 1323 Timestamps)
- Cisco NAM was running during validation baseline test to capture end-to-end behavior
- Output from all tests were captured to logs
- Cisco switches are there for basic connectivity – no QoS, ACLs, default interface configuration (i.e. no jumbo frames)

# Data Center Test Cases

- Validation for interoperability and ACE operation impact was based on the following test cases:

  **Baseline with no VIP** - Determine impact of normalization, no normalization and parameter-map to allow TCP options (SACK, Timestamps, Windows Scaling)

  **VIP with L4 Policy** – Same validation as with baseline

  **VIP with L7 Policy** – Baseline + various buffer-share and windows scaling settings – parameter maps were enabled in different combinations towards client and/or towards server

**Note: Performance was not tested. Sniffer captures were taken on both sides of the ACE and on the ACE to ensure that the settings matched or could be altered correctly by the ACE and that the application functioned properly.**

# Cisco ACE TCP Normalization

- TCP Normalization is on by default – will clear TCP options (windows scale, timestamps, SACK, etc..)

```
10.120.2.99  10.121.14.16  TCP  54428 > http [SYN] Seq=0 Win=8192 Len=0 MSS=1460 WS=2
  Client       Server
```

**Window scale: 2 (multiply by 4)**

```
10.121.14.16  10.120.2.99  TCP  http > 54428 [SYN, ACK] Seq=0 Ack=1 Win=8192 Len=0 MSS=1460
```

- SYN, ACK has no options set as the options never reached the server because TCP normalization cleared them (WS is missing)
- Disabling normalization OR using a parameter map can allow options to be "allowed" through the ACE

```
interface vlan 114
  description North Side ACE VLAN
  bridge-group 1
  no normalization
```

```
parameter-map type connection TCP_PARAM_MAP
  tcp-options selective-ack allow
  tcp-options window-scale allow
```

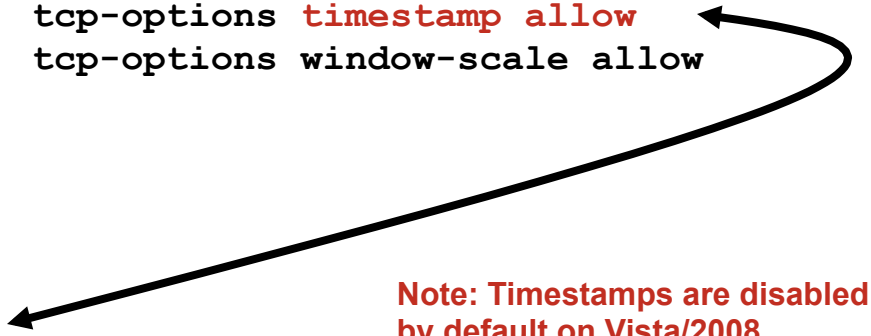
```
10.120.2.99  10.121.14.16  TCP  54564 > http [SYN] Seq=0 Win=8192 Len=0 MSS=1460 WS=2
10.121.14.16  10.120.2.99  TCP  http > 54564 [SYN, ACK] Seq=0 Ack=1 Win=8192 Len=0 MSS=1460 WS=8
```

**Window scale: 8 (multiply by 256)**

# Cisco ACE – RFC 1323 Timestamps

```
C:\>netsh int tcp sh gl
TCP Global Parameters
----------------------------------------------
Receive-Side Scaling State          : enabled
Chimney Offload State               : enabled
Receive Window Auto-Tuning Level    : normal
Add-On Congestion Control Provider  : none
ECN Capability                      : disabled
RFC 1323 Timestamps                 : enabled
```

```
parameter-map type connection TCP_PARAM_MAP
  tcp-options selective-ack allow
  tcp-options timestamp allow
  tcp-options window-scale allow
```



Note: Timestamps are disabled by default on Vista/2008

```
TCP 54190 > http [SYN] Seq=0 Win=8192 Len=0 MSS=1460 WS=2 TSV=6517994 TSER=0

Options: (20 bytes)
  Maximum segment size: 1460 bytes
  NOP
  Window scale: 2 (multiply by 4)
  SACK permitted
  Timestamps: TSval 6517994, TSecr 0
```

```
TCP  http > 54190 [SYN, ACK] Seq=0 Ack=1 Win=8192 Len=0 MSS=1460 WS=8 TSV=6716945 TSER=6517994

Options: (20 bytes)
  Maximum segment size: 1460 bytes
  NOP
  Window scale: 8 (multiply by 256)
  SACK permitted
  Timestamps: TSval 6716945, TSecr 6517994
```

# Modifying Buffer Sharing – Client Facing
## Should you do this? Probably not

- Cisco ACE supports increasing the TCP window RX buffer space – modifying this value will impact the advertised window size from the ACE in certain situations (see results table)
- Cisco ACE has a default buffer-space of 32768 and can be configured up to a max of 262143

```
parameter-map type connection TCP_OPTIONS_MAP
  set tcp buffer-share 262143
```

- Just because you have the capability to increase the buffer share value on the client side does not mean you should

  Only in rare cases would this be a good idea (increasing buffer share on the server side would be more appropriate)

  Negative performance if buffer-share + windows scaling is used on ACE and the ACE is receiving large volumes of connections and data transfers - Remember that the buffer share is per connection and with any vendor, a shared resource with a high number of connections on that resource will exhaust the buffer if the value is set too high

# Buffer Sharing + Window Scaling
## Advertised To Client

- Example with Windows Vista client and ACE with default buffer-share of 32768 (ACE sends window size of 128) X default WS=0 (multiplier=1)

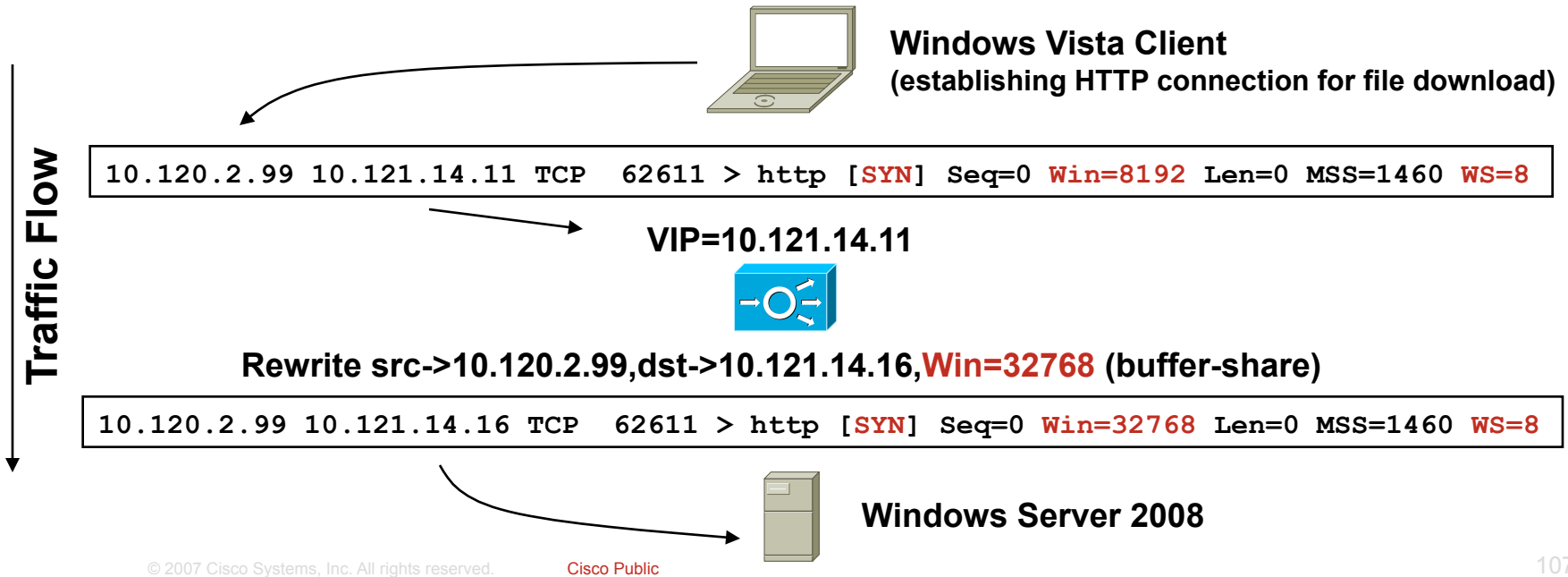
```
10.121.14.11 10.120.2.99  TCP  http > 62611 [SYN, ACK] Seq=0 Ack=1 Win=128 Len=0 MSS=1460…WS=0
```

- Extreme example with ACE with max buffer-share of 262143 (ACE sends window size of 255) X max WS=14 (multiplier 16,384) = 4177920

```
10.121.14.11 10.120.2.99  TCP  http > 59864 [SYN, ACK] Seq=0 Ack=1 Win=255 Len=0 MSS=1460…WS=14

                                                    Window scale: 14 (multiply by 16384)

15837 … 66560 10.120.2.99 10.121.14.11    TCP  59864 > http [ACK] Seq=1 Ack=1 Win=66560 Len=0
15838 … 66560 10.120.2.99 10.121.14.11    HTTP GET /3mfile.msi HTTP/1.0
15839 … 4177920 10.121.14.11 10.120.2.99  TCP  http > 59864 [ACK] Seq=1 Ack=129 Win=4177920 Len=0
```

# Modifying Buffer Sharing – Server Facing
## This may be a good idea in some cases

- Modifying the buffer-share for connections from server can help with high BDP situations such as a WAN (see Cisco Application Networking for SAP Design Guide http://www.cisco.com/go/srnd)
- By default, on L7 client-initiated connections, the server receives a modified advertised window size in the SYN from the ACE which is the buffer-share default of 32,768



# ACE Buffer-Share and Window Scale

## Impact on Advertised Window Size/WS – Client RX

| Vista Client RX file via HTTP | ACE-Advertised Window Size to Client | ACE-Advertised WS Value to Client | ACE-Advertised Window Size to Server | ACE-Advertised WS Value to Server | Note: |
|---|---|---|---|---|---|
| Client Policy Buffer-share/WS = Default | 128 | 0 | 32768 | 8 | Client/SVR SYN=8192/WS=8 |
| Client Policy Buffer-Share=Max | **255** | 0 | **8192** | 8 | No large windows |
| Client Policy Buffer-Share/WS=Max | **255** | **14 (x 16,384)** | **8192** | 8 | ACE sends 4MB window (4177920) |
| Server Policy Buffer-Share/WS=Default | 128 | 0 | 32768 | 8 | SVR sends window =8192/WS8 (2097152=256*8192) |
| Server Policy Buffer-Share=Max | 128 | 0 | 32768 | 8 | SVR sends window =8192/WS8 (2097152=256*8192) |
| Server Policy Buffer-Share/WS=Max | 128 | 0 | 32768 | 8 | SVR sends window =8192/WS8 (2097152=256*8192) |

**ACE Default buffer-share size: 32768**
**ACE Default Window Scale (WS): 0**

**ACE max buffer-share size: 262143**
**ACE max Window Scale (WS): 14**

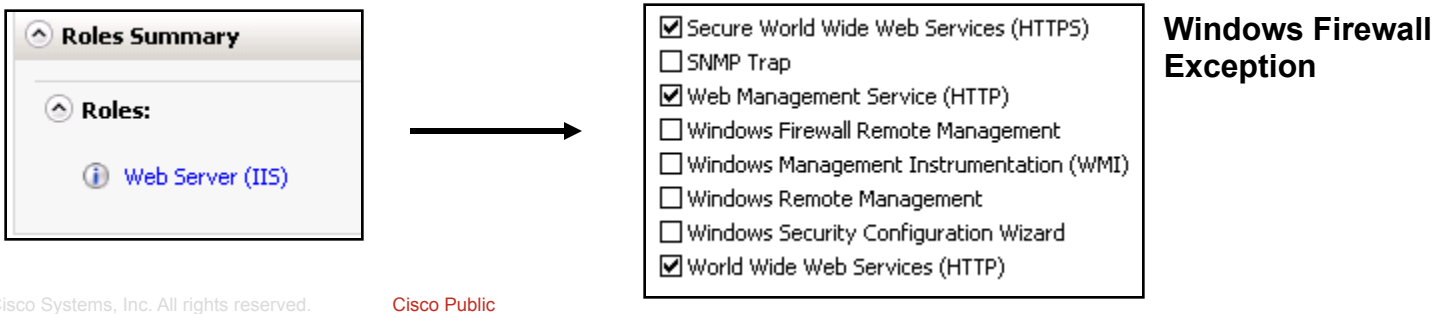
# ACE Buffer-Share and Window Scale

## Impact on Advertised Window Size/WS – Client TX

| Vista Client TX file via HTTP | ACE-Advertised Window Size to Client | ACE-Advertised WS Value to Client | ACE-Advertised Window Size to Server | ACE-Advertised WS Value to Server | Note: |
|---|---|---|---|---|---|
| Client Policy Buffer-share/WS = Default | 8192 | 8 | 8192 | 8 | Client/SVR SYN=8192/WS=8 |
| Client Policy Buffer-Share=Max | 8192 – **Vista Changes to 65535 Window Size** | 8 | 8192 | 8 | No large windows |
| Client Policy Buffer-Share/WS=Max | 8192 – **Vista Changes to 65535 Window Size** | 8 | 8192 | 8 | ACE sends 4MB window (4177920) |
| Server Policy Buffer-Share/WS=Default | 8192 | 8 | 8192 | 8 | SVR sends window =8192/WS8 (2097152=256*8192) |
| Server Policy Buffer-Share=Max | 8192 | 8 | 8192 | 8 | SVR sends window of (2097152) |
| Server Policy Buffer-Share/WS=Max | 8192 | 8 | 8192 | 8 | SVR sends window of (2097152) |

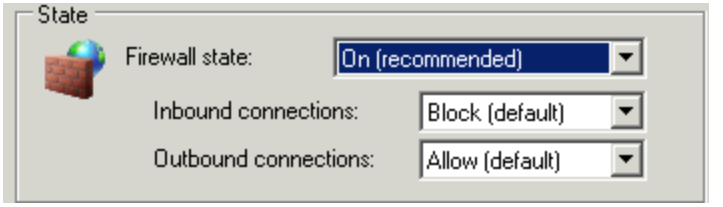
# Health Probes – Window Server 2008
## HTTP Probe

- In Windows Server 2008 the Windows Firewall is enabled by default
- Usually, at the time of installation of server “roles” or “features” certain Windows Firewall rules will be modified to allow inbound traffic – additionally rules may need to be created/modified depending on your needs
- For example, if the “Web Server (IIS)” role has been installed the system will modify the Windows Firewall rules for



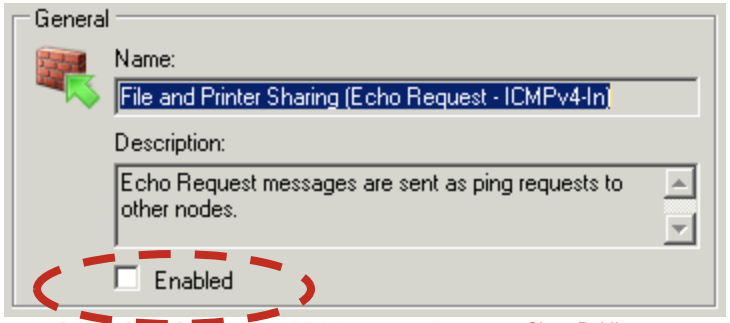
# Health Probes – Window Server 2008
## ICMP Probe

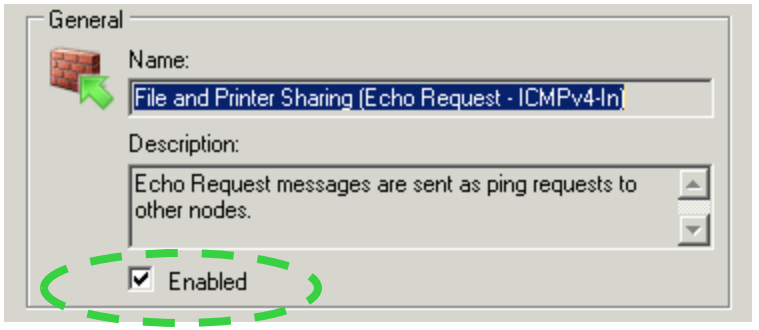
- By default Windows Firewall drops all traffic inbound to the server unless it first originates from the server or has been allowed via a rule – this includes ICMP




```
-------------------- probe results --------------------
   probe association    probed-address  probes      failed      passed      health
   ------------------- ---------------+----------+----------+----------+-------
   serverfarm   : WEB
     real       : w2k8-web-01[0]
                        10.121.14.16    300         300         0           FAILED
```

- If ICMP probes are used on the ACE, the Windows Firewall must either be disabled for the appropriate Network Profile (Domain, Private, Public) or the “ICMPv4-In” rule needs to be enabled to allow connections – optionally the ACE mgmt address for context can be permitted



# Windows Server Failover Clusters @ Layer 3

# Windows Server 2008 – Windows Server Failover Cluster (WSFC)

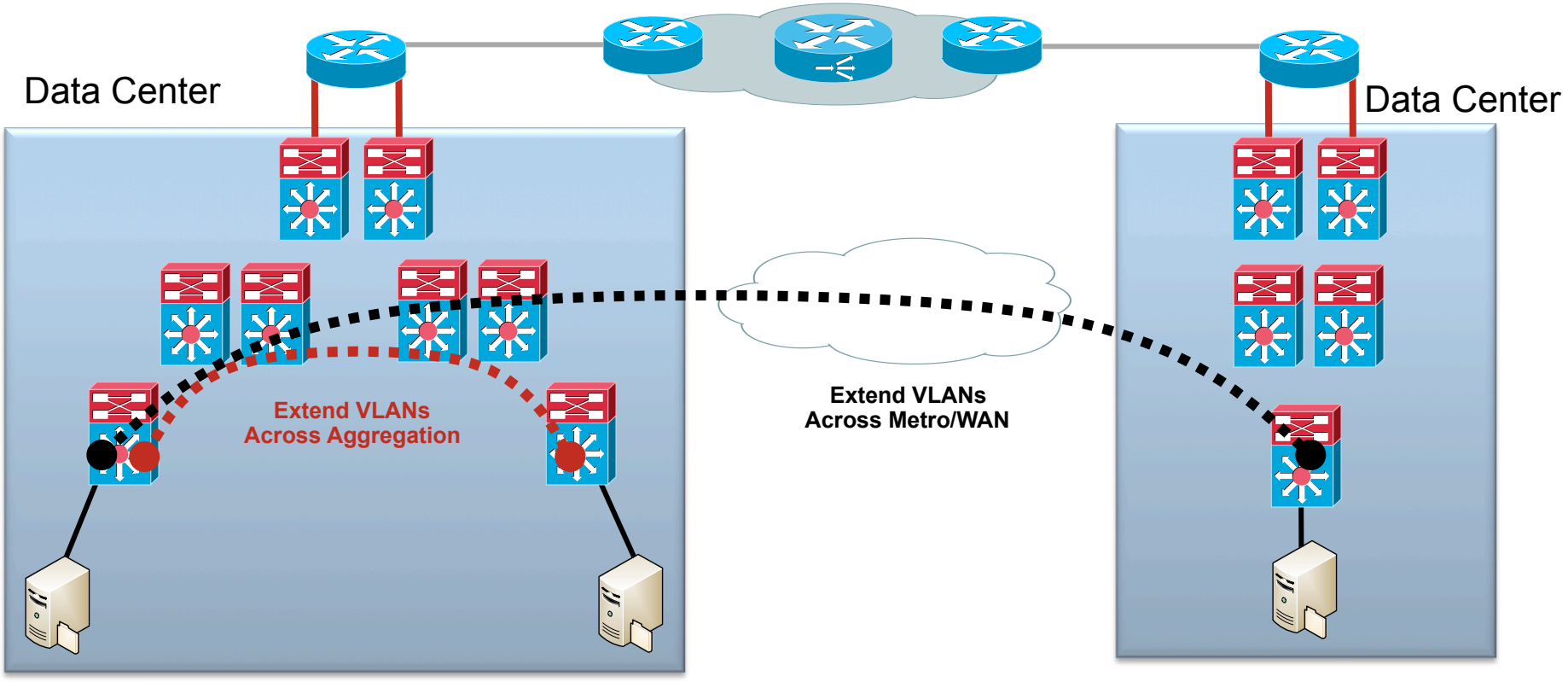
- Dramatically improves deployment and management of clusters
- Keeps existing support for Layer 2 based clusters
- Adds support for what Microsoft calls “Multisite” clusters (AKA: Layer 3 or GeoClusters)
- Offers the customer a way to have cluster nodes in different parts of the DC or across DC locations without stretching/extending VLANs
- Purpose of Cisco validation of the WSFC Multisite option is to ensure:

  Interoperability in the Data Center

  Offer support/improvements on the Layer 3 aspects of the cluster design

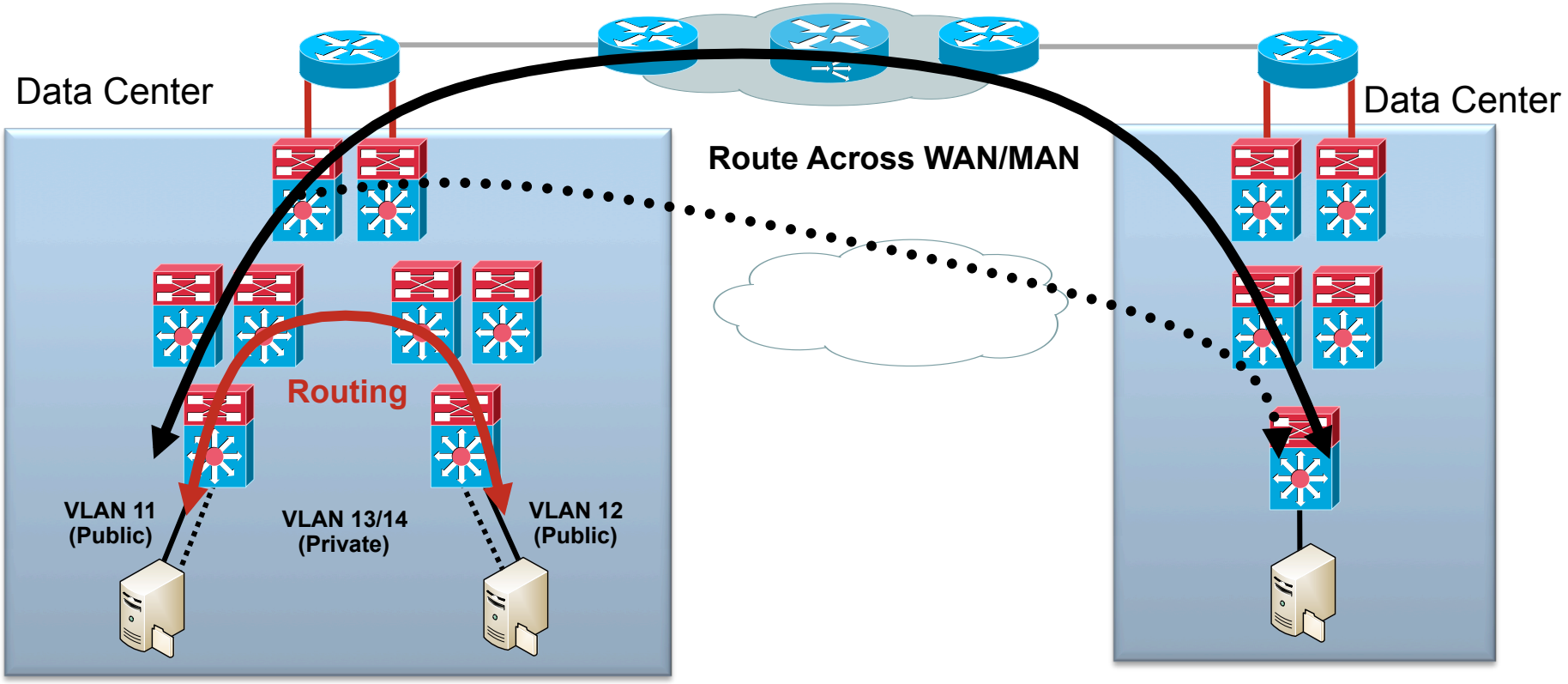
# Network Challenges with Layer 2 Failover Clusters

- L2 adjacency requirement restricts the proximity of nodes to the same aggregation switch pair unless there is support for extending VLANs beyond a single aggregation pair
- L2 adjacency also requires that VLANs be extended to other DC locations for the network and SAN connections if nodes are deployed in multiple locations



# Layer 3 Failover Cluster Solution

- Allows for both the private and public interfaces in the cluster to exist on different VLANs/Subnets within and/or between Data Centers
- Cluster nodes can be located in different racks/rows/rooms or cities without the requirement to stretch the two VLANs
- However, there is a price to pay by going this way – DNS propagation delays

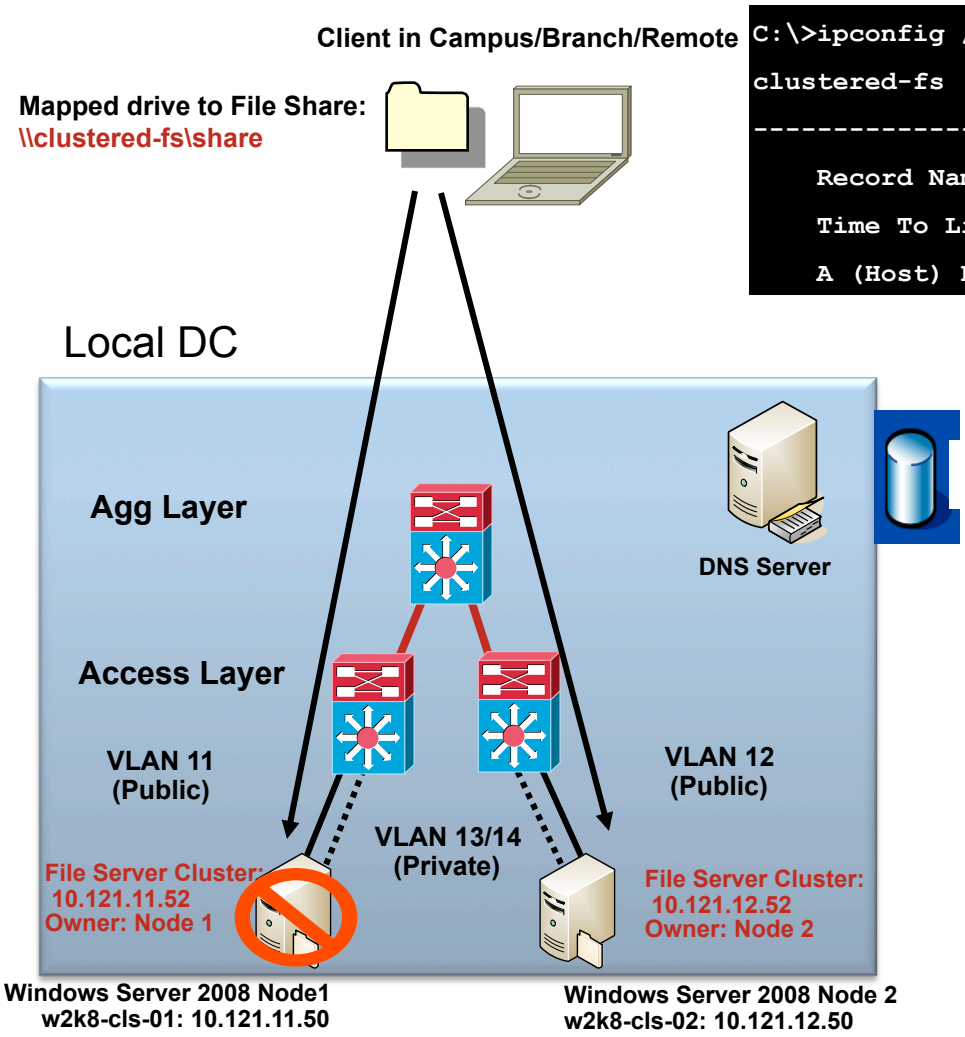


# Challenges with L3/Multisite Clusters

- All based on DNS updates for the change in address
- Relies on DNS registration so that records can be updated automatically (non-DNS registration still works but requires that the record be changed manually)
- **`HostRecordTTL`** value for the cluster resource in DNS is 20 minutes by default – this is the maximum time before the client expires the TTL for the record
- Microsoft has a recommendation of 5 minutes (based on recommendations for Exchange Server)
- But, we have additional solutions other than depending on DNS

# Multisite Clusters – Recovery Options

## Option 1:Default Behavior – 20 minute DNS setting




```
C:\>ipconfig /displaydns
clustered-fs
----------------------------------------
    Record Name . . . . . : clustered-fs.cisco.com
    Time To Live  . . . . : 1198
    A (Host) Record . . . : 10.121.12.52
```

Client DNS Cache expires for old entry (Default=20 minutes)

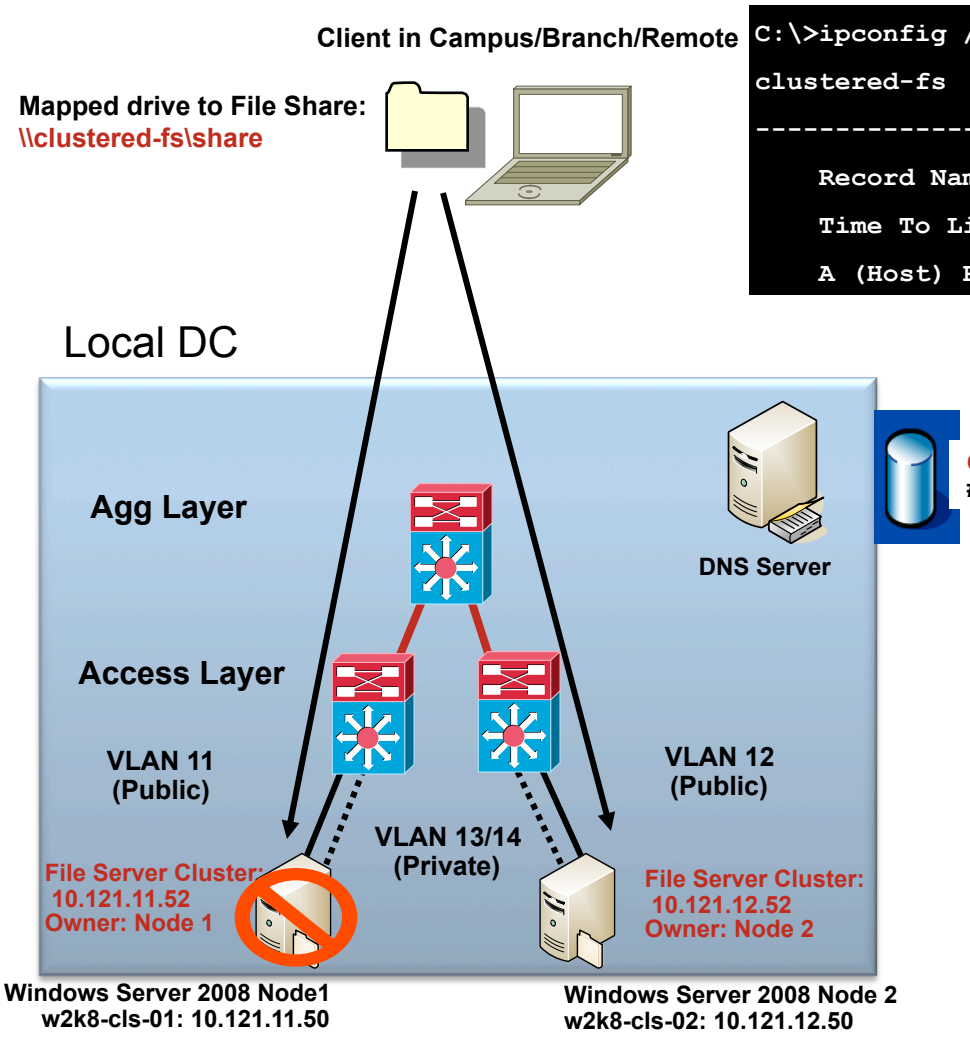
Clustered-FS Host(A) 10.121.11.52
#Default HostRecordTTL = 1200 Seconds

- Client has mapped drive to file share on cluster
- Node 1 fails
- Node 2 becomes active for cluster resource
- DNS is updated with the new IP address resource
- The client DNS cache entry waits until the TTL expires (default is 20 minutes) before reconnecting to the share on Node 2

Note: not a valid solution in static DNS environments

# Multisite Clusters – Recovery Options

## Option 2:Host TTL modified – 5 minute DNS setting




```
C:\>ipconfig /displaydns
clustered-fs
----------------------------------------
    Record Name . . . . . : clustered-fs.cisco.com
    Time To Live  . . . . : 272
    A (Host) Record . . . : 10.121.12.52
```

Client DNS Cache expires for old entry (manually set to 5 minutes in Cluster/DNS – MSFT recommended value)

Clustered-FS Host(A) 10.121.11.52
#Default HostRecordTTL = 300 seconds

- Cluster resource is modified to have a HostRecordTTL=300

```
C:\>cluster.exe res "Clustered-FS" /priv HostRecordTTL=300
```

- Client has mapped drive to file share on cluster
- Node 1 fails
- Node 2 becomes active for cluster resource
- DNS is updated with the new IP address resource
- The client DNS cache entry waits until the TTL expires (modified to 5 minutes) before reconnecting to the share on Node 2

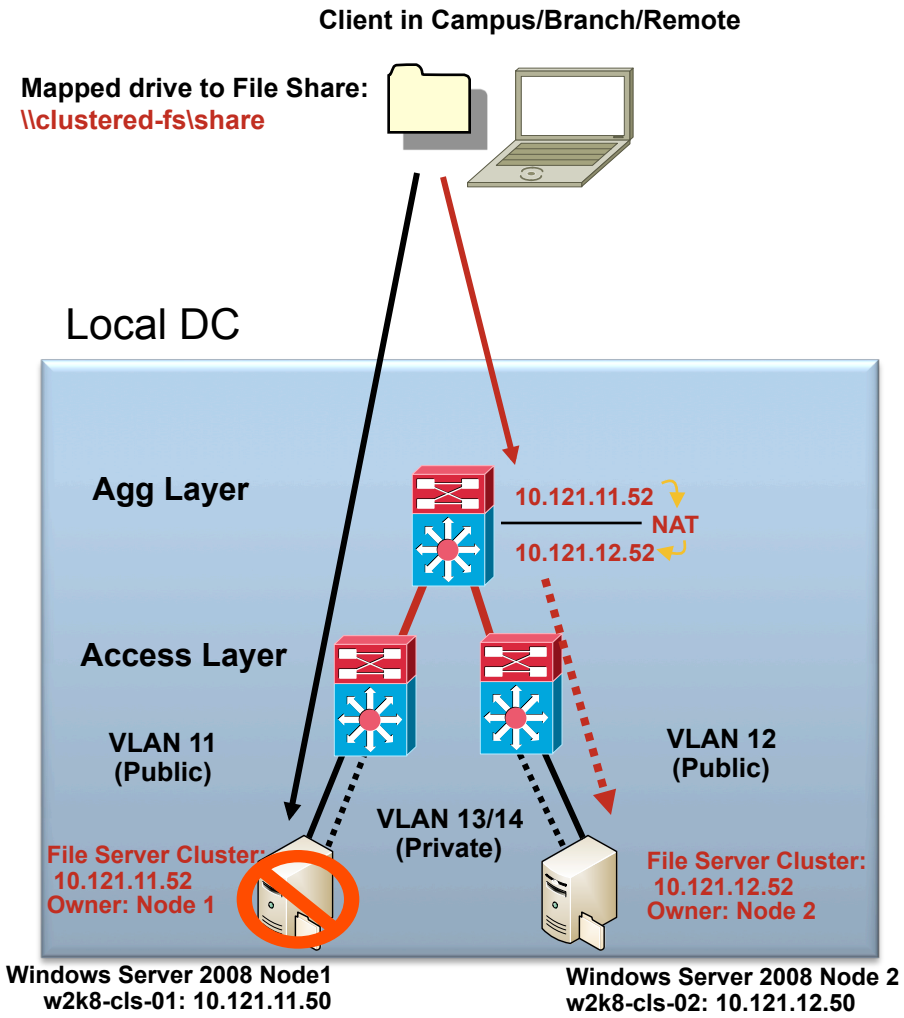
http://support.microsoft.com/kb/947048/en-us

# Network-based Options

- Mask the cluster IP address resource change from the client – NAT works great for this!
- Several options for doing this:
  - Do NAT at the Aggregation switch in front of the server farm
  - Allow for complete automation by using the Cisco ACE to monitor the cluster nodes and application availability and perform failover/recovery on behalf of the client
  - Do NAT on whatever you like but it must be able to perform well since there may be many clients/sessions connecting to the cluster resource
- Automation options
  - Network devices can be updated manually upon cluster IP address resource change (slowest recovery method and the one most prone to error – Good in a Multisite DC where the admin controls when/where the cluster recovery happens)
  - Basic script can be used to monitor the cluster resources/notifications (could even use RHI) and when the standby cluster node becomes active for the resource the script can activate the change on the network device (Similar to manual method above only automated – in a Multisite DC failure event the device running the script may not have access to the now active DC devices)
  - Poll the Microsoft Cluster for events using the Cluster API and run a script to make changes to the network device (Fully automated but slower failover event as this 'pull' model will work on a timer and the failure may occur between polling events)
  - Use a custom resource DLL and make the resource dependent on the Network Name and upon failure the Cisco resource DLL would come online and determine what to change on the network (Optimal method in all scenarios but has the custom resource DLL has to be written)
  - Cisco ACE (for multi DC sites add Cisco ACE GSS) will fully automate failure/recovery for connectivity to the nodes from the client

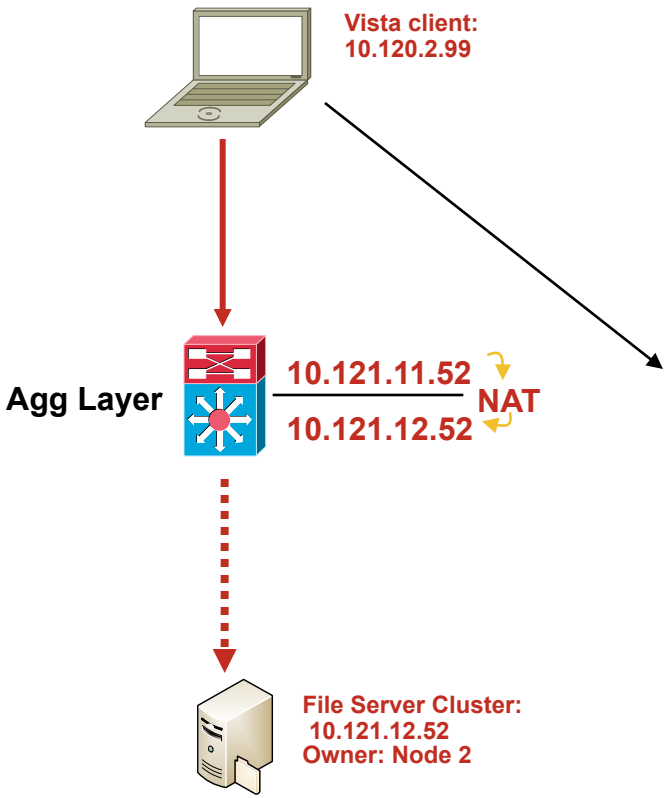
# Multisite Clusters – Recovery Options

## Option 3:NAT the Cluster IP Address on Failure




- Client has mapped drive to file share on cluster
- Node 1 fails
- Node 2 becomes active for cluster resource
- Original IP address used to connect to the share changes (now on node 2 – 10.121.12.52)
- NAT is used on the Agg switch (or some other device) to NAT the original 10.121.11.52 address to the now active 10.121.12.52 address on Node 2 – Prevents the client from having to wait for DNS to update
- Failover happens within seconds vs. minutes
- MANY NAT scenarios to choose from
  - NAT in DC only for Node 2 (This example)
  - NAT in DC for both Nodes (Use separate address for virtual address in DNS)
  - NAT any other place in the network you can think of…☺
- Reduces client recovery time from minutes to seconds!!!

# Option 3 Configuration Example



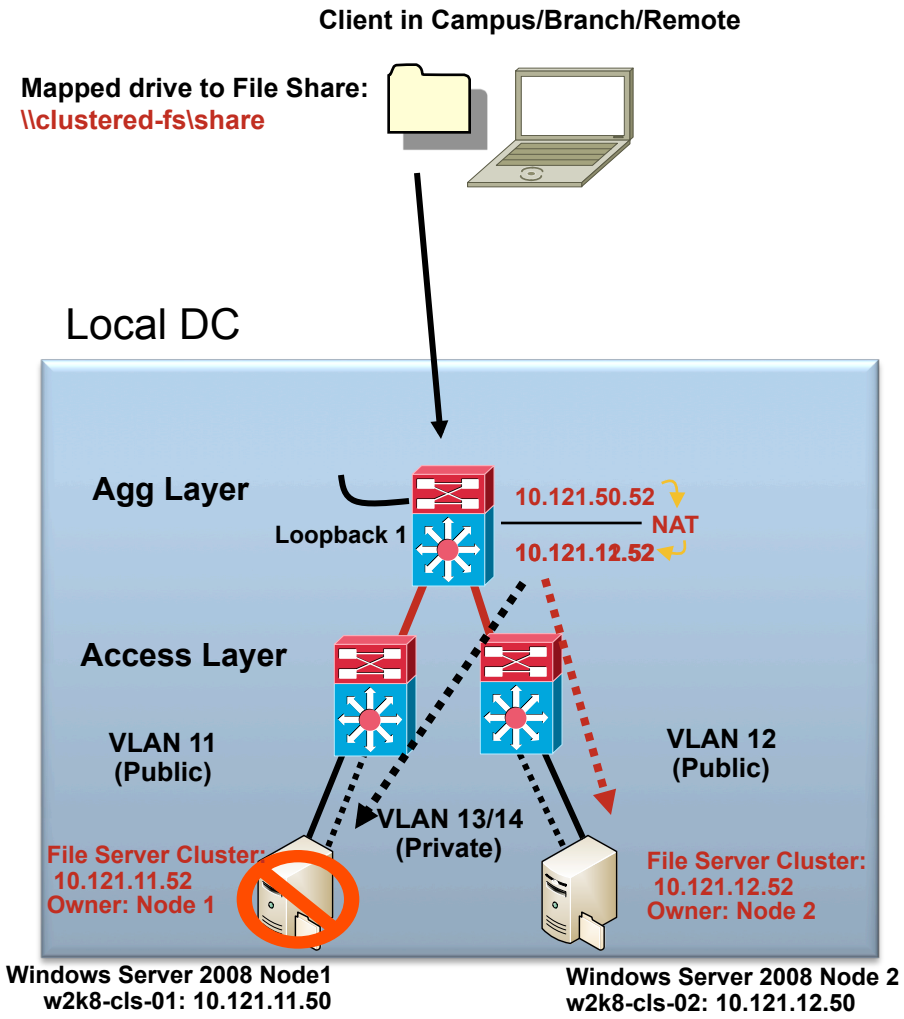

```
interface GigabitEthernet3/2
 description To DC Core
 ip nat outside
!
interface Vlan12
 description To Cluster-Node2
 ip nat inside
!
ip nat inside source static 10.121.12.52 10.121.11.52
```

```
Reply from 10.121.11.52: bytes=32 time<1ms TTL=125
Reply from 10.121.11.52: bytes=32 time<1ms TTL=125
Reply from 10.121.11.52: bytes=32 time<1ms TTL=125
Request timed out.
Request timed out.
Request timed out.
Reply from 10.121.11.52: bytes=32 time<1ms TTL=125
Reply from 10.121.11.52: bytes=32 time<1ms TTL=125
Reply from 10.121.11.52: bytes=32 time<1ms TTL=125
```

```
6k-agg-1#sh ip nat translations
Pro Inside global      Inside local       Outside local      Outside global
tcp 10.121.11.52:80    10.121.12.52:80    10.120.2.99:54605  10.120.2.99:54605
udp 10.121.11.52:137   10.121.12.52:137   10.120.2.99:137    10.120.2.99:137
tcp 10.121.11.52:445   10.121.12.52:445   10.120.2.99:54606  10.120.2.99:54606
```

# Multisite Clusters – Recovery Options

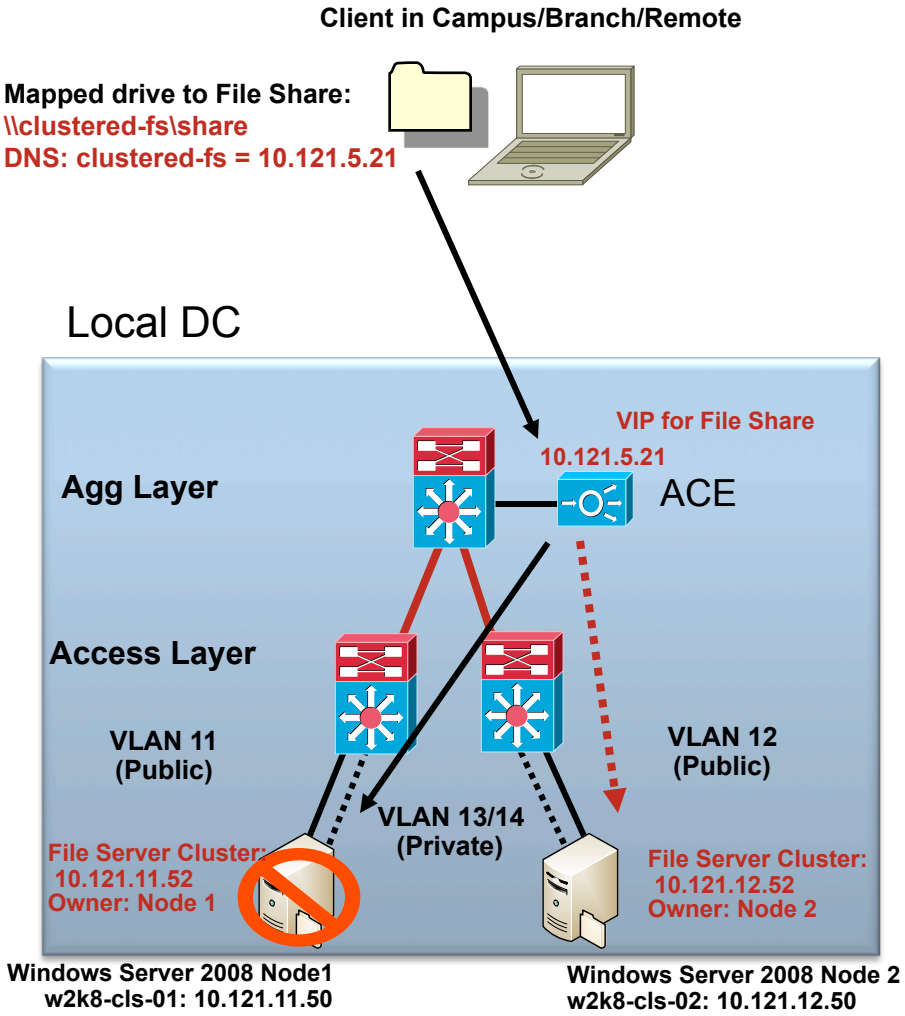
## Option 3.5:NAT the Cluster IP Address Full Time




- Same as Option 3 only NAT is used full time – meaning that a third IP address is used for the virtual IP (also used in DNS) and the clients connect to the Virtual IP rather than the node directly
- Create a third IP address (this example is from an IP address range on a Loopback interface (10.121.50.52)
- Change DNS to reflect: clustered -fs=10.121.50.52
- Client maps drive to clustered-fs (10.121.50.52)
- Once nodes change ownership the NAT configuration will change from: 10.121.50.52<->10.121.11.52 TO 10.121.50.52<->10.121.12.52
- Again, like in Option 3, this can either be done manually or via scripting/custom resource DLL

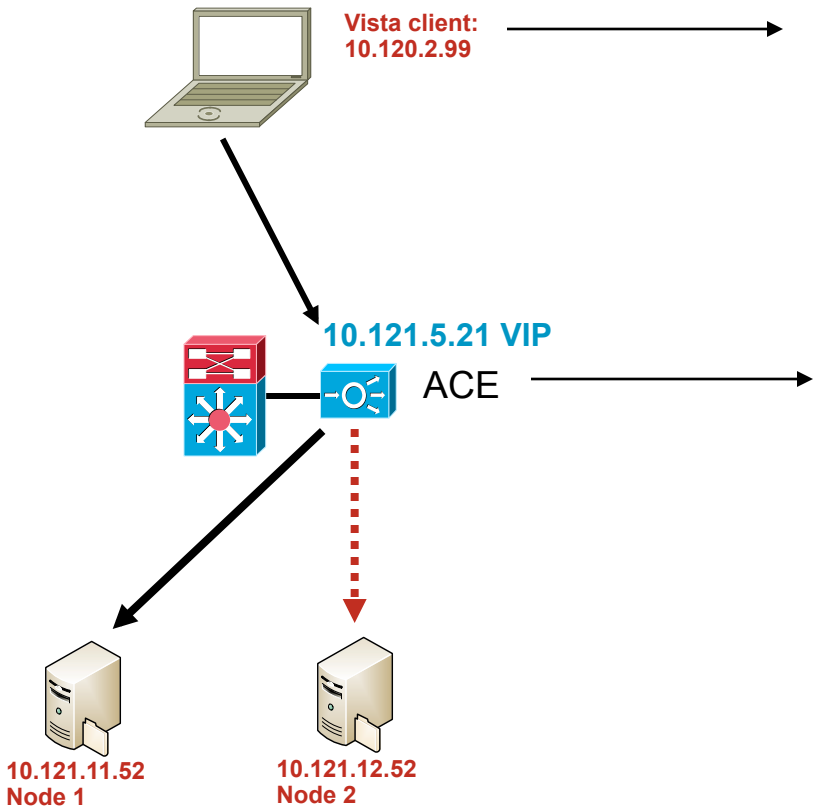
# Multisite Clusters – Recovery Options

## Option 4: Use a VIP on the ACE to Front-end the Cluster




- The Cisco ACE will have a VIP that is used by the client to connect to the FS resource
- The ACE will monitor the IP resources on the cluster and determine when a failure occurs
- When a node fails the IP address change (also DNS) is hidden from the user and the cluster DNS entry
- The ACE will switch over to the backup (second node) server and allow connections through the VIP to reach the cluster resource
- ACE must be in One-Arm or Routed mode for this to work as the ACE must connect to servers in multiple subnets
- Reduces client recovery times from minutes to seconds completely hands free!!!

# Option 4 Configuration Sample

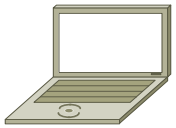



```
C:\>ipconfig /displaydns
clustered-fs
----------------------------------------
    Record Name . . . . . : clustered-fs.cisco.com
    Time To Live  . . . . : 1198
    A (Host) Record . . . : 10.121.5.21
```

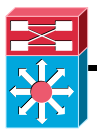
```
rserver host w2k8-cls-01
  ip address 10.121.11.52
  inservice
rserver host w2k8-cls-02
  ip address 10.121.12.52
  inservice
!
serverfarm host CLS-FARM
  probe CLS-ICMP
  rserver w2k8-cls-01
    backup-rserver w2k8-cls-02
    inservice
  rserver w2k8-cls-02
    inservice standby
!
class-map match-all CLS-VIP
  10 match virtual-address 10.121.5.21 any
```

Only ACE VIP/rserver configuration show

# Option 4 Results – Complete Automation



Vista client:
10.120.2.99



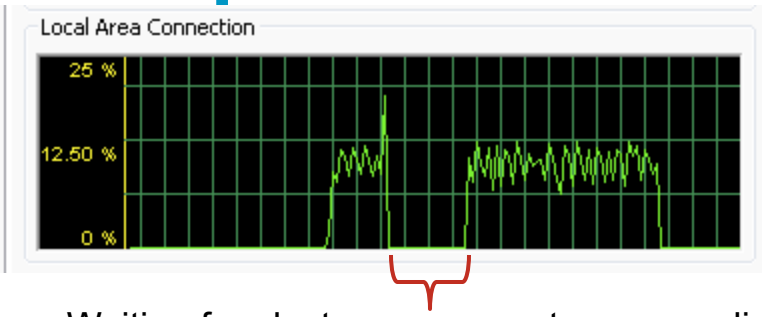
10.121.5.21 VIP

ACE

10.121.5.17 – inside NAT used for Server return

10.121.11.52
Node 1

10.121.12.52
Node 2




Waiting for cluster resources to come online
(650MByte File Transfer during Node failure)

```
Probe Results:

---------------------- probe results ----------------------
  probe association   probed-address  probes     failed     passed     health
------------------- ---------------+----------+----------+----------+-------
  serverfarm   : CLS-FARM
    real       : w2k8-cls-01[0]
                       10.121.11.52    1244       641        603        FAILED
    real       : w2k8-cls-02[0]
                       10.121.12.52    988        454        534        SUCCESS

Connection Results (summary):

8           2   in  TCP    5     10.120.2.99:51751      10.121.5.21:445        ESTAB
7           2   out TCP    5     10.121.12.52:445       10.121.5.17:1066       ESTAB
```

# Option 4 Summary

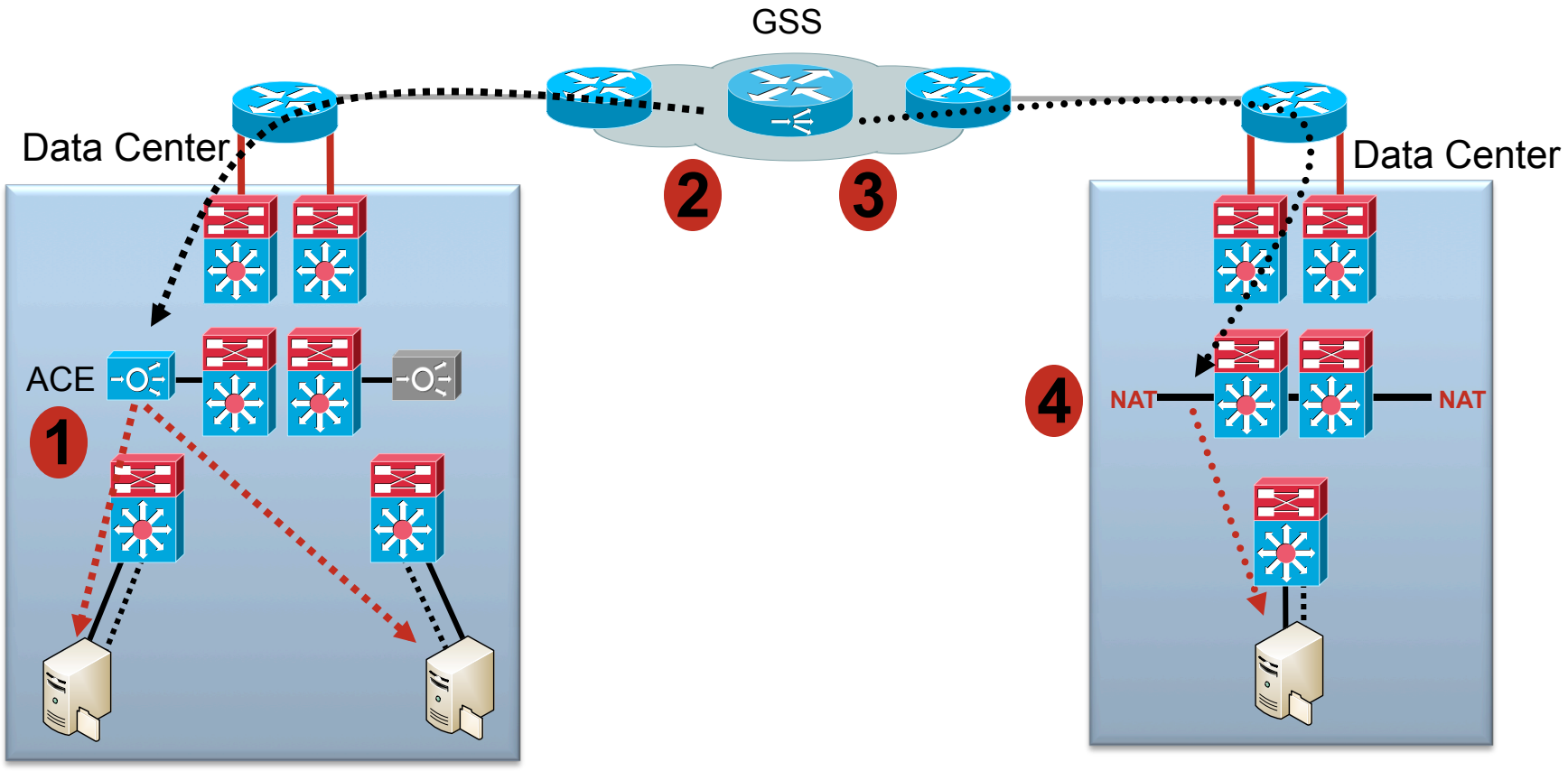
- To prevent DNS issues it is imperative that the cluster service name is not allowed to be updated upon node change
  - Ensures that the VIP address is always present for the record
  - One method is to use DNS record security so the cluster account cannot modify the record
- ACE in One-Arm or Routed mode can track and connect to servers in the local DC (across subnets) and also networks in other DC (multisite)
- The ACE solution offers complete tracking of the cluster resource IP address and allows for failure/recovery of the nodes to occur with no user /admin intervention
- If the primary DC goes down, therefore the ACE is gone, a 'Tiered Recovery' strategy can be used
  - Use Cisco ACE GSS (Global Site Selectors) to track the ACE VIP and if the VIP is down/unreachable, the GSS can modify DNS to allow clients to connect to cluster nodes in another DC location

  OR

  - A script or static configuration can be implemented for NAT in the network to allow the clients to maintain the same DNS information but the NAT device can map the DNS record entry to the cluster nodes that are active in the standby DC

# Tiered Recovery
## One of Many Options

1. ACE Monitors Cluster
2. GSS Monitors ACE VIP
3. GSS Redirects to 2nd DC
4. NAT or ACE used to 'hide' new Cluster Node



# Summary

- Windows Server 2008 and Vista are coming to a network near you or will be soon – understand what the new TCP/IP stack does
- IPv6 is on by default and preferred in both OS versions – this means that the OS can and will (in the right conditions) prefer IPv6 over IPv4 (even if it needs to use a tunnel)
- WAAS still rules even though there are ‘some’ TCP improvements with the new Windows OS
- Increased BW utilization of Vista/W2K8 will change the traffic profile on the network – be aware of this ahead of time
- Ensure the ACE (or any other product doing TCP normalization or inspection) allows for the RFC 1323 options
- L3/Multisite clusters are a great improvement – be aware of the default dependency on DNS and ensure the customer understands our solutions to the issue – we reduce client recovery time from minutes to seconds