CIFS Acceleration Techniques

How to improve SMB traffic
Plan

- Introduction
- Before Acceleration
- CIFS Acceleration Overview
- CIFS Acceleration Methods
- CIFS Acceleration Experience
- Platforms
- Q & A
Introduction
Introduction

- Company
  - Visuality Systems Ltd.
  - NQ - Embedded/Mobile CIFS solution
  - CAX – CIFS Accelerator
- Speakers
  - Mark Rabinovich – Project Manager
  - Igor Gokhman – Lead Developer
Before Acceleration
CIFS Issues

- CIFS is redundant
  - Multiple requests for the same information
  - Repeating transactions
    - Multiple reads of the same file
- Very limited multiplexing
- SMB2 addresses some of the issues but does not solve them all
**When CIFS runs over WAN?**

- From a branch office…
  - connected through a satellite link
  - connected through an overseas link
- VPN connection
  - an employee connected from home
CIFS over WAN (cont.)

- **Latency**
  - Satellite networks introduce 1 second of RTT
  - Overseas links may introduce 0.5 second RTT

- **Limited Bandwidth**
  - SMB almost never considers bandwidth
  - SMB2 considers bandwidth on Read/Write only
Some Numbers

- Opening a 1.5 MB Word document over SMB(1) involves about 630 SMB packets and requires more than 5 minutes open time (with 0.8 sec round trip).
- Starting a 440KB EXE single file (no more files in the folder) from Vista over SMB2 takes about 225 seconds and involves about 340 SMB2 packets when the Symantec Antivirus is involved. This mostly includes repeating file reads.
- When there are more EXE files in the same folder – it takes significantly longer.
Conclusions

Latency and limited bandwidth of WAN dramatically reduce the CIFS performance due to the protocol nature.

This makes basic scenarios unbearable:

- MS Office Open/Save/SaveAs
- Running remote executable
- File uploading/downloading
CIFS Acceleration Overview
- Shadow copy of the server file system.
- Both-sides solution
CIFS Acceleration

- CIFS Proxy
- Client-side (LAN side) solution
VFS versus CIFS Acceleration

Performance + Functionality

- **VFS**
  - Solutions shared by NFS, CIFS, etc.
  - Performance boosts:
    - data compression
    - entire file cache
  - Cache coherency – low, especially when accessing server from out of VFS scope

- **CIFS Acceleration**
  - CIFS solution only
  - Performance boosts:
    - Optimization of CIFS conversations
    - Separate data and meta-data cache
  - Cache coherency - high
Saving on Round Trips

Non accelerated CIFS model

Accelerated CIFS model
How to Save on Round Trips?

- Send less requests to server
- Send requests to server concurrently
Responding to Client Instantly

Non accelerated CIFS model

Accelerated CIFS model
How to Respond to Client Instantly?

- By predicting responses

This ensures more consistent load of the WAN link
CIFS Acceleration Methods
Three Acceleration Techniques

CIFS Acceleration techniques fall into the following categories

- **Caching**
  
  We can respond to repeating client requests without accessing the server

- **Predicting**
  
  We can recognize well-known sequences and perform actions in advance

- **Aggregating**
  
  We can bring the same information with less requests
Caching

Time without acceleration – two roundtrips, with acceleration – one roundtrip
Caching What?

- File Information
- Share Information
- Server Information
- File data
- File nonexistence
- Stream-full/stream-less file
Predicting

Time without acceleration – three roundtrips, with acceleration – one roundtrip
Predicting What?

- Pre-fetching
- Force requests for complex scenarios
- Some SMBs (almost) always succeed
Aggregating data

Time without acceleration – two roundtrips, with acceleration – less then one roundtrip
Aggregating When?

- Sequential file read
- Always issue queries with the most comprehensive info level
Accelerating Single Command

- Caching responses:
  - NTCreateAndX, Trans2.QueryPathInformation

- Caching SMB_STATUS_OBJECT_NOT_FOUND:

- Caching - folder is fully cached:
  - Trans2.FindFirst/FindNext

- Caching:
  - Trans2.QueryPathInformation with level STREAM_INFO
Accelerating Single Command

- **Predicting** - always succeeds:
  - The following commands are assumed to always succeed: Close, TreeDisconnect, LogOff

- **Predicting** - generate concurrent requests:
  - Trans2.QueryPathInformation with any level triggers another one with level INTERNAL_INFO
  - TreeConnect request triggers two Trans2.QueryFSInformation requests

- **Aggregating**:
  - Issue Trans2.FindFirst/FindNext with level 262 when possible even if less informative level was requested
  - Read at least 60K of data even if less data was requested
Accelerating Entire Scenario

- Recognize a beginning of a well-known sequence of SMBs
  - Usually starts with NtCreateAndX with a specific access mask
  - Continues with an information request
    - Common IOCTL functions
    - Common SRVSVC and WKSSVC calls
    - File delete sequence
  - Ends with Close
- Follow the sequence and try answering locally if this information was already cached
SMB1 Example: IOCTL
We can locally answer on the following SMB sequence
- “NtCreateAndX” with access mask – 0x100080
- “NtTrans.Ioctl” with function 0x30
- “Close”

This scenario, when accelerated, completes in zero round-trips
SMB2 Example:
Deleting a file
We can locally answer on the following SMB sequence

- “Create” with access mask – 0x10080
- “SetInfo” with type FILE_INFO and with level: FILE_DISPOSITION_INFO
- “Close”

This scenario, when accelerated, completes in just one round-trip
CIFS Acceleration Experience
CAX – CIFS Accelerator

- For any network with latency and/or limited bandwidth from satellite and long-range networks...
  ... to DSL/Cable links
- Transparent to user – preserves file sharing namespace semantics
- VPN supported on some platforms
- SMB2 support pending
- Signed traffic support pending
CAX – CIFS Accelerator (cont.)

- Embedded solution
  - Can be integrated into complex appliance
- Scalable solutions
  - Considers resource limitations
  - Disk or memory only cache
- Client-side solution
  - CAX works on the LAN side only
  - Seamless maintenance
Macro scenarios

CAX accelerates any SMB scenario

CAX is optimized for the most common scenarios

- Folder browsing
  - The very first show of the share root folder
  - Drill-down inside a subfolder
  - Stepping back to the parent folder
- Big file upload/download
  - Copying files using Windows Explorer
- MS Office document Open/Save/SaveAs
  - MS Word
  - MS Excel
  - MS PowerPoint
MS Word File Open

Scenario:

Client-side capture taken on satellite link simulator (RTT: 800 msec):

Upper graph: ~200 sec without acceleration

Lower graph: ~50 sec with acceleration
MS Excel 2003 SaveAs scenario:
Server-side capture taken on satellite link simulator (RTT: 1 sec).
The capture shows high multiplexing - several SMBs are packed into one TCP frame.
### Performance In Numbers

<table>
<thead>
<tr>
<th>Case</th>
<th>No acceleration</th>
<th>VFS</th>
<th>CAX</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Word 2003</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><em>Open</em></td>
<td>126 sec</td>
<td>40 sec</td>
<td>44 sec</td>
</tr>
<tr>
<td><strong>Excel 2007</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><em>Save</em></td>
<td>795 sec</td>
<td>45 sec</td>
<td>48 sec</td>
</tr>
<tr>
<td><strong>PowerPoint 2007</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><em>SaveAs…</em></td>
<td>794 sec</td>
<td>104 sec</td>
<td>43 sec</td>
</tr>
</tbody>
</table>

Measured on satellite link simulator:
- Latency – 1 second RTT
- Bandwidth – 1Mbit/sec
- Cold start, ~1Mbyte files
## Performance In Numbers (VPN)

<table>
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<tr>
<th>Case</th>
<th>No acceleration</th>
<th>CAX for Windows</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Word 2003</strong></td>
<td>56 sec</td>
<td>20 sec</td>
</tr>
<tr>
<td><em>Open 2.3MB document</em></td>
<td></td>
<td></td>
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</tbody>
</table>

Measured on DSL home network with bandwidth:
- **Client:**
  - Download – 4,000 Kb/s
  - Upload – 400 Kb/s
- **Server:**
  - Download – 3,000 Kb/s
  - Upload – 1,000 Kb/s
- Latency ~0

<table>
<thead>
<tr>
<th>Case</th>
<th>No acceleration</th>
<th>CAX for Windows</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Word 2003</strong></td>
<td>240 sec</td>
<td>25 sec</td>
</tr>
<tr>
<td><em>Open 2.3MB document</em></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Measured on SNIA Conf. network with server in VS headquarters, Israel.
- **Client:**
  - Download – 3,000 Kb/s
  - Upload – 3,000 Kb/s
- **Server:**
  - Download – 3,000 Kb/s
  - Upload – 1,000 Kb/s
- Latency ~250ms
Platforms
Platforms

- CAX embedded into communication equipment
  - Router
  - L2 switch/bridge
  - More
- Personal solution - CAX for Windows
  - Runs on client machine
  - Supports VPN
## Differences Between Platforms

<table>
<thead>
<tr>
<th></th>
<th>Embedded into communication equipment</th>
<th>Personal solution</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Shared cache</strong></td>
<td>V</td>
<td></td>
</tr>
<tr>
<td><strong>VPN support</strong></td>
<td></td>
<td>V</td>
</tr>
<tr>
<td><strong>Source transparency</strong></td>
<td>V</td>
<td>Not applicable</td>
</tr>
</tbody>
</table>

- Source transparency requires switching ports
Q & A
Thank you