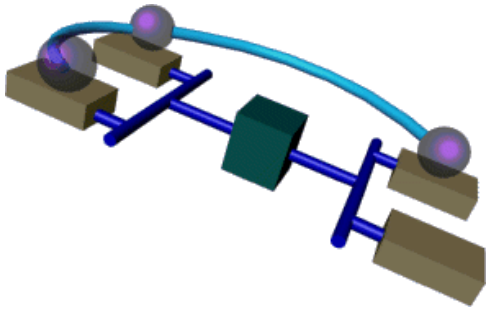
SMB 2.2

and

Real-World Data Networks



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Storage Architect, CIFS Geek
Founder and CTO

DTC Leading Edge Seminar

December 7, 2011

Introductions

Introductions

YOU

- Network Storage Administrators
- Network Storage Developers
- Students
- The Curious
- The Others

  (*you* know who you are)

Introductions

ME: Your Friendly Neighborhood CIFS Geek

- Samba Team member (since 1998-ish)
- jCIFS Project co-founder
- CIFS Author (shameless plug)
- Network Storage Geek
- Incurable Idealist
- Etc., etc., ad nauseum

A ruminant mammal (Geekus geekus) with long legs, humped shoulders, and broadly palmated antlers.

Introductions

SMB/CIFS and SMB2

- *The* Microsoft network file protocol
- Originally created by IBM for PC-DOS
- Ported and updated for OS/2, then W/NT
- SMB2 was introduced with Windows Vista
  - V2.1 with Windows 7, W2K8r2 Server
  - V2.2 with Windows 8 (next year)

A *de facto* (vs. *de jure*) standard.

Introductions

Terminology (real world)

SMB: Server Message Block protocol

A stateful network file system protocol originally created by IBM in the early 1980s for use with the PC-DOS operating system.

CIFS: Common Internet File System

A “marketing upgrade” to SMB. This new name for SMB was coined in the mid 1990's. The term “CIFS” is now often used as a name for the complete suite of protocols that include and provide support for SMB. Often written “SMB/CIFS”.

SMB2: Server Message Block protocol version 2

A complete rewrite of the SMB protocol, introduced with Windows Vista. SMB2 reduces the top-level command set from 75 commands to 19.

Introductions

Terminology (legal and regulatory world)

CIFS: The Server Message Block file sharing protocol as implemented in Windows NT 3.51, NT 4, and Windows 9x clients.

SMB: The Server Message Block file sharing protocol as implemented in Windows starting with Windows 2000, up to and including current versions of Windows.

SMB2: The Server Message Block protocol, v2 as defined on the previous slide.

The terminology changes depending upon who you talk to, when you talk with them, and the context of the conversation.

Introductions

The Competition: NFS

- *The* POSIX/Unix network file protocol
- Originally created by Sun
- Given to the IETF for standardization
- NFSv4.x specified over the past 10 years
  - pNFS == Parallel I/O (objects)
  - NFS over RDMA

A *de jure* (vs. *de facto*) standard.

Introductions

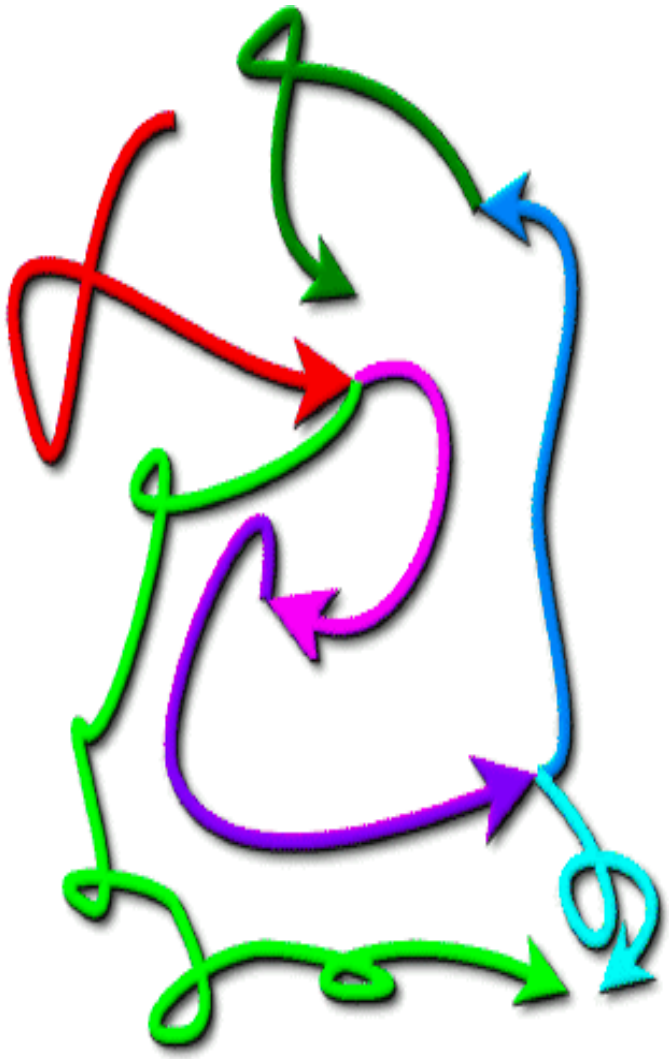
Samba Team:

World-Renowned SMB/CIFS and SMB2 Developers

Members of the Samba Team gather at the 10th annual Samba eXPerience conference in Göttingen, Germany.

Introductions

Whither Shall We Wander?



- Why do we care?
- Breaking into SMB
- SMB2.2 Features
- SMB vs. NFS
- SMB Internals
- “Real World” SMB

Why do we Care About SMB?

Why do we care about SMB?

There is little to love about SMB

- It is proprietary
  Protocol development is under Microsoft's control.
- It is somewhat closed
  The Windows NT version (still used today) was not documented until late 2009.
- It is bulky and inefficient
  SMB/CIFS supports DOS and OS/2 system calls. 75 primary commands plus pass-through RPC and system calls.

SMB is “Windows on the Wire”.

Why do we care about SMB?

SMB2 is only a slightly better

- It is still proprietary
  Protocol development is under Microsoft's control.
- It is still somewhat closed
  Specifications are available, including pre-release SMBv2.2 documentation, but these are not “standards”.
- It is leaner and cleaner
  No DOS or OS/2 support.
  SMB2 has only 19 primary commands.

SMB2 is still “Windows on the Wire”.

Why do we care about SMB?

Don't Laugh Yet...

- SMB has been built into every version of Windows since WfWG3.11

- SMB2 has been included since Vista
  - Microsoft is putting lots of effort into SMB2
- All major NAS vendors support SMB
  - 3rd party SMB2 adoption is accelerating

- NFSv4 “borrows” features from SMB

There are no hard numbers... but the SMB/CIFS community guestimates 90+% market share.

Why do we care about SMB?

In the Market: It's NFS vs. SMB/SMB2

- Other proprietary NAS protocols are gone
  - Apple, Novell, etc. now support NFS and SMB
- There's a new crop of specialized protocols
  - Object Storage is big, but diverse
  - Clustered storage is another big (crashing?) wave
  - FUSE makes it easy to create new file systems
- Specialized protocols are typically platform-specific (though there are exceptions)
- Windows 8 will include SMB2.2 client/server

Breaking Into SMB

Breaking Into SMB

At the start, *SMB was documented:*

- **1984:** IBM Personal Computer Seminar Proceedings, Volume 2, Number 8
- **1986:** OpenNET/Microsoft Networks FILE SHARING PROTOCOL EXTENSIONS, Version 1.9, Microsoft and Intel (XENIX extensions)
- **1988:** Microsoft Networks/OpenNet, Document Version 2, Microsoft and Intel (Core)
- **1988:** Microsoft Networks SMB File Sharing Protocol Extensions Version 2.0, Document Version 3.3, Microsoft Corporation (LAN Manager 1.0)
- **1989:** Microsoft Networks SMB File Sharing Protocol Extensions Version 3.0, Document Version 1.09, Microsoft Corporation (LAN Manager 1.2)
- **1990:** Microsoft Networks SMB File Sharing Protocol Extensions Version 3.0, Document Version 1.11, Microsoft Corporation (LAN Manager 2.0)
- **1992**: Microsoft Networks SMB File Sharing Protocol Extensions, Document Version 3.4, Microsoft Corporation (LAN Manager 2.1)

Breaking Into SMB

Then things started thinning out.

- **1992:** X/Open CAE Specification, Protocols for X/Open PC Interworking: SMB, Version 2, X/Open Company, Ltd. (Core through LAN Manager 2.0)
- **1996:** Microsoft Networks SMB File Sharing Protocol, Document Version 6.0p, Microsoft (Unfinished draft of NT LAN Manager 0.12 documentation.)
- **1997:** A Common Internet File System (CIFS/1.0) Protocol, IETF INTERNET-DRAFT, Paul J. Leach, Dilip C. Naik (Unfinished draft v2 of NT LAN Manager 0.12 specification.)
- **2002:** Common Internet File System (CIFS) Technical Reference, Revision: 1.0, Storage Networking Industry Association (SNIA)
- **2003:** Implementing CIFS, yours truly, Prentice Hall PTR

Breaking Into SMB

During this time...

- [MS|PC]-DOS
- OS/2
- Windows NT
- Windows 2000
- Windows XP
- Windows 2003
- Windows Vista

...and we already knew that the documentation we had was, in places,

- Incorrect
- Incomplete
- Incomprehensible

Never ascribe to malice that which is adequately explained by incompetence. — attributed to Napoleon Bonaparte, among others

Breaking Into SMB

This situation made people unhappy.

Breaking Into SMB

Open Source Credentials Notwithstanding...

Microsoft asked a member of the *Samba Team* to document SMB/CIFS!

Breaking Into SMB

Thus, SMB/CIFS is covered in two documents:

[MS-CIFS]

- Provides the base specification of the "NT LM 0.12" dialect.
- A "snapshot in time".
- Most of this stuff is still there in current Windows versions. Really.

[MS-SMB]

- "Extends" [MS-CIFS].
- Documents changes made to SMB starting in W2K.
- Still the same "NT LM 0.12" dialect.

Note: The naming is backwards!

Breaking Into SMB

Go here:
http://www.microsoft.com/openspecifications/

Over 400 documents have been published, covering:

- Authentication
- Windows Internals
- File Formats
- Client-Server Protocols
- Server-Server Protocols

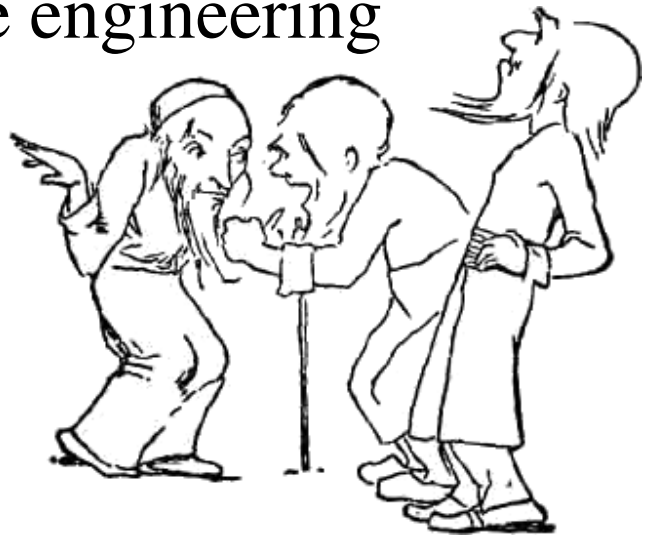
Overview docs provide starting points for understanding groups of docs.

Breaking Into SMB

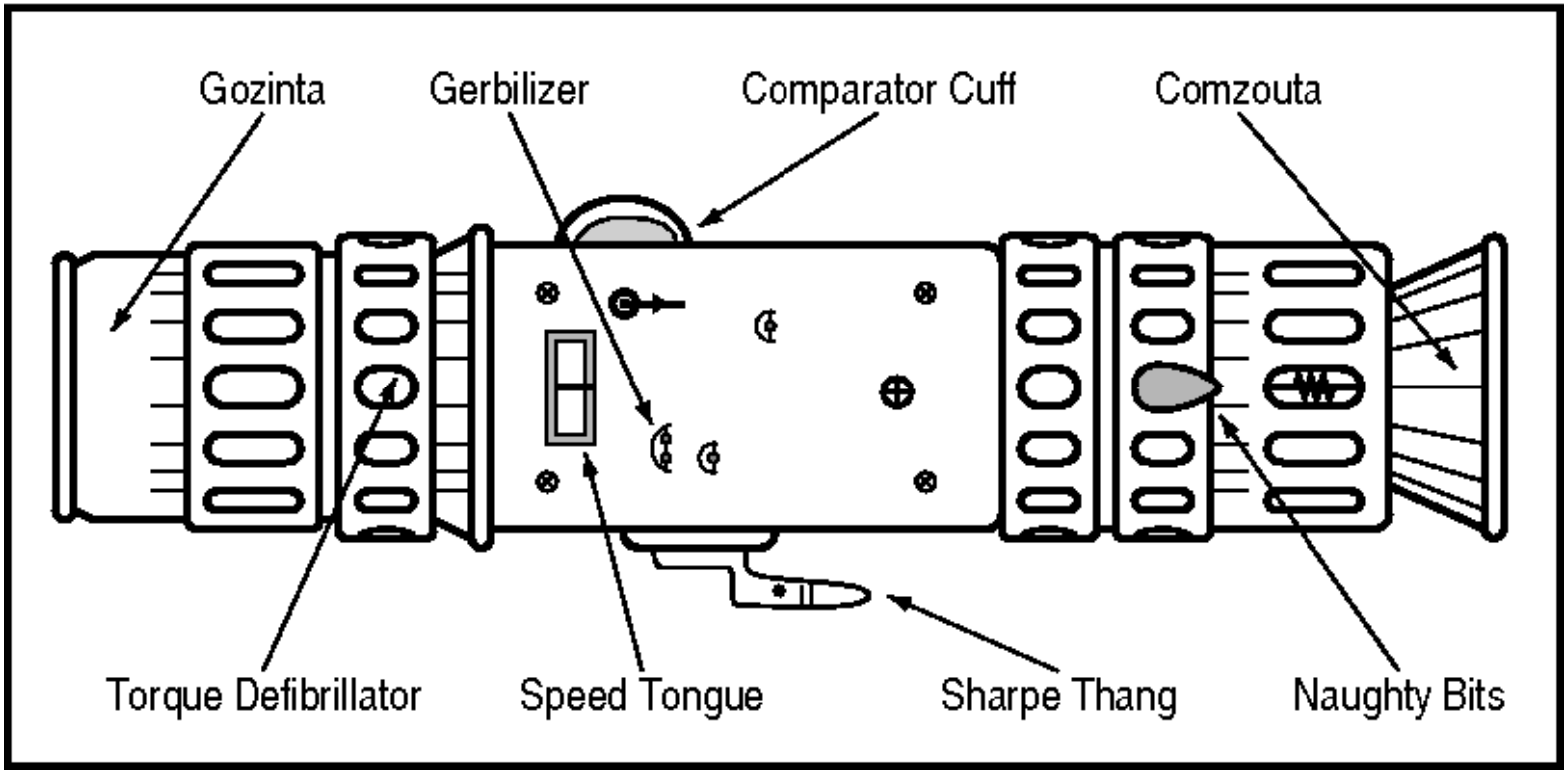
"We should implement them all."

— Tridge

- There is an opportunity here to leverage both the technology and the installed base.
- Preview specifications cover SMB2.2 and other features of Windows 8.
- This will feed the software engineering ecosystem for years.



SMB2.2 Features



SMB2.2 Features

SMB2.0 was a sleeper:

- No user-visible features
- Performance improvements were subtle
- The user did not even know when SMB2 was being used instead of SMB/CIFS

SMB2.1 offered little more, but 3rd parties started to notice.

SMB2.2 Features

Meanwhile...

- Samba/CTDB added cluster support
- NFS developments included:
  - NFS over RDMA
  - Parallel NFS (pNFS)

The competition was moving ahead.

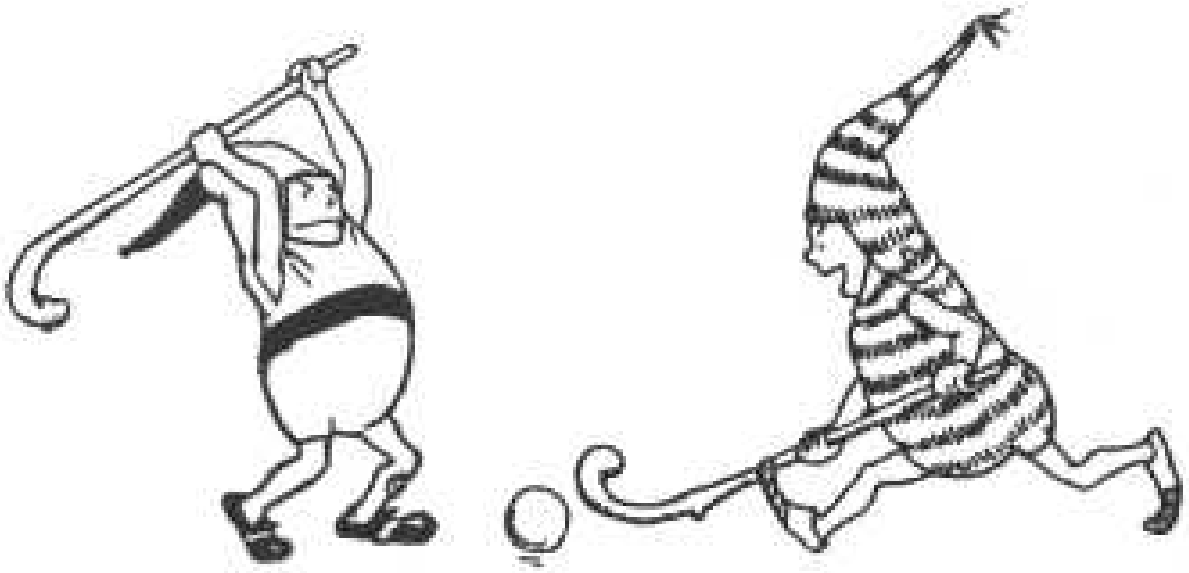
SMB2.2 Features

SMB2.2 Supports:

- Multipath Communication
- SMB-over-RDMA
- Scale-up and Failover Clusters
- Distributed content caching

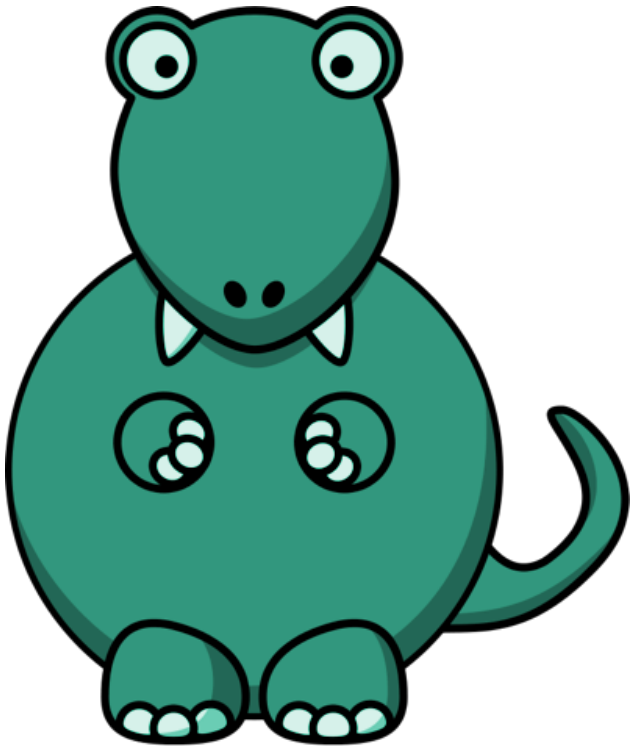
There is nothing “new” here, except that it is all in one place from one vendor.

SMB vs. NFS



SMB vs. NFS

The Battle of the Dinosaurs



With SMBv2.2 Microsoft is aiming to conquer datacenter storage, a traditional NFS stronghold.

SMB vs. NFS

SMB1

- Stateful
- Per-user connections
- Simple RPC-style mechanism
- Used as a transport
- Tuned for DOS/OS2 and Windows

NFSv3

- Stateless
- Per-system connections
- RPC-based protocol
- Not a transport
- Generally tuned for Unix/POSIX environments

SMB vs. NFS

SMB2.2

- Stateful
- SMB over RDMA
- Multipath
- Distributed caching and command chaining for improved WAN performance

NFSv4.1

- Semi-stateful
- NFS over RDMA
- Parallel NFS (pNFS)
- Improved authentication and Access Control support

SMB vs. NFS

SMB2.2

- Will simply “be there” in Windows 8 clients and servers
- It will simply “be there” in data centers and on desktops around the world

NFSv4.1

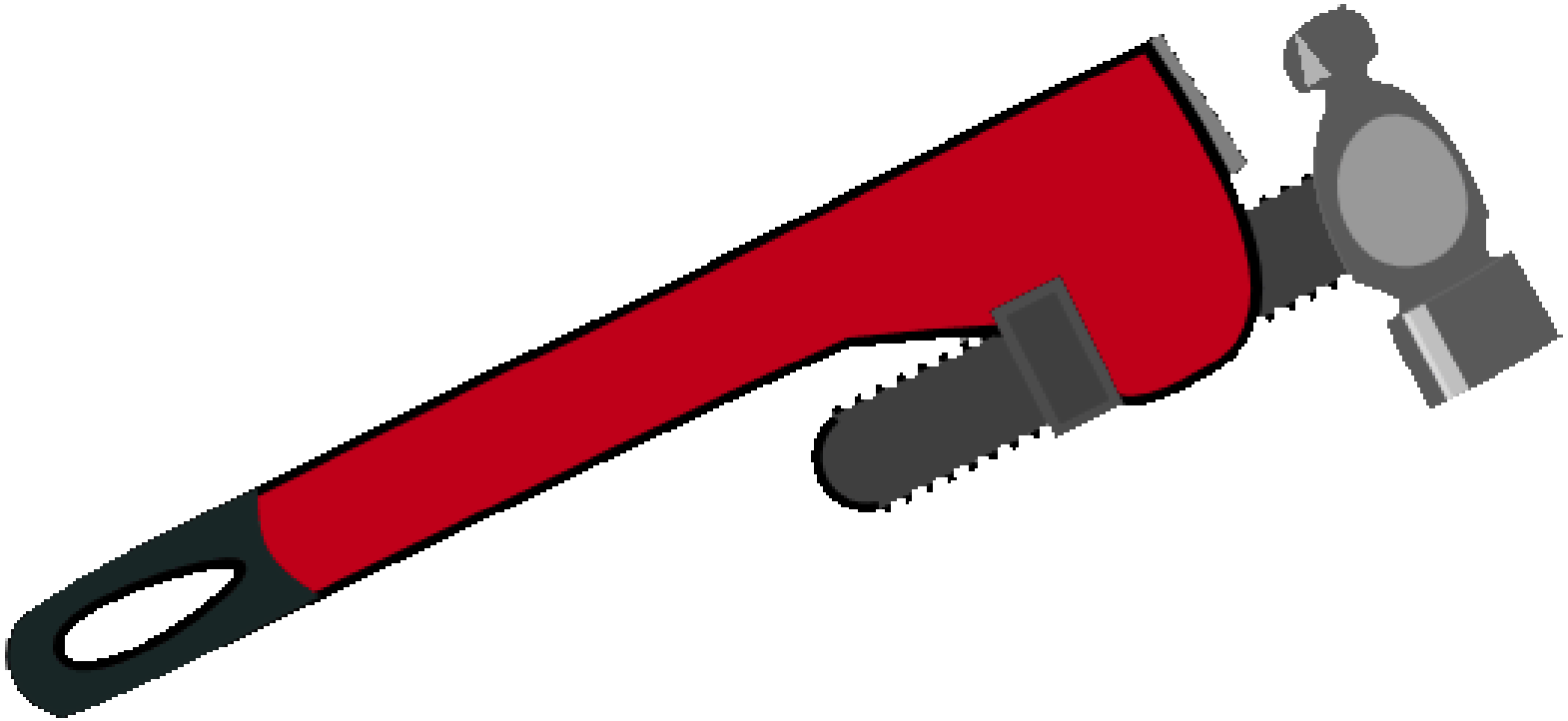
- Despite ten years of open specification development, it isn't “there” yet
- NFS developers appeared jolted by Microsoft's SMB2.2 presentation at the 2011 SNIA SDC

SMB Internals

SMB Internals

So... What do SMB and SMB2 look like?

Wireshark and NetMon are your friends...



SMB Internals

File Edit View Go Capture Analyze Statistics Telephony Tools Help

Filter: Expression... Clear Apply

No.	Time	Source	Destination	Protocol	Info
6	0.012509	192.168.101.21	192.168.101.54	NBSS	Session request, to PUGSLEY<20> from JCIFS0_2_30<20>
7	0.013053	192.168.101.54	192.168.101.21	NBSS	Positive session response
8	0.013578	192.168.101.21	192.168.101.54	TCP	38427 > netbios-ssn [ACK] Seq=73 Ack=5 Win=5840 Len=0
9	0.015232	192.168.101.21	192.168.101.54	SMB	Negotiate Protocol Request
10	0.016442	192.168.101.54	192.168.101.21	SMB	Negotiate Protocol Response
11	0.038718	192.168.101.21	192.168.101.54	SMB	Session Setup AndX Request, User: ?\CRH; Tree Connect AndX, Path: \\PUGSLEY\IPC$
12	0.059613	192.168.101.54	192.168.101.21	SMB	Session Setup AndX Response; Tree Connect AndX
13	0.061587	192.168.101.21	192.168.101.54	LANMAN	NetShareEnum Request
14	0.067041	192.168.101.54	192.168.101.21	LANMAN	NetShareEnum Response
15	0.069211	192.168.101.21	192.168.101.54	TCP	38427 > netbios-ssn [FIN, ACK] Seq=431 Ack=446 Win=7504 Len=0
16	0.070055	192.168.101.54	192.168.101.21	TCP	netbios-ssn > 38427 [FIN, ACK] Seq=446 Ack=432 Win=8330 Len=0

```
▷ Frame 11 (248 bytes on wire, 248 bytes captured)
▷ Ethernet II, Src: CameoCom_1f:82:43 (00:40:f4:1f:82:43), Dst: Vmware_40:00:85 (00:50:56:40:00:85)
▷ Internet Protocol, Src: 192.168.101.21 (192.168.101.21), Dst: 192.168.101.54 (192.168.101.54)
▷ Transmission Control Protocol, Src Port: 38427 (38427), Dst Port: netbios-ssn (139), Seq: 124, Ack: 98, Len: 194
▷ NetBIOS Session Service
▽ SMB (Server Message Block Protocol)
  ▽ SMB Header
      Server Component: SMB
      [Response in: 12]
      SMB Command: Session Setup AndX (0x73)
      Error Class: Success (0x00)
      Reserved: 00
      Error Code: No Error
    ▷ Flags: 0x18
    ▷ Flags2: 0x8001
      Process ID High: 0
      Signature: 0000000000000000
      Reserved: 0000
      Tree ID: 0
      Process ID: 46208
      User ID: 0
      Multiplex ID: 2
  ▽ Session Setup AndX Request (0x73)
      Word Count (WCT): 13
      AndXCommand: Tree Connect AndX (0x75)
      Reserved: 00
      AndXOffset: 142
```

```
0010  00 ea f2 36 40 00 40 06  fc 3a c0 a8 65 15 c0 a8   ...6@.@. .:..e...
0020  65 36 96 1b 00 8b 03 3a  e1 90 00 06 d4 c8 50 18   e6.....: ......P.
0030  16 d0 23 d4 00 00 00 00  00 be ff 53 4d 42 73 00   ..#..... ...SMBs.
0040  00 00 00 18 01 80 00 00  00 00 00 00 00 00 00 00   ........ ........
0050  00 00 00 00 80 b4 00 00  02 00 0d 75 00 8e 00 14   ........ ...u....
0060  05 0a 00 01 00 00 00 00  00 18 00 18 00 00 00 00   ........ ........
0070  00 14 00 00 00 51 00 45  68 ba ae f9 8e db f2 84   .....Q.E h.......
0080  17 90 03 a2 bc 4e 59 5e  d3 7d 3e 97 1a 1f ee 30   .....NY^ .}>....0
0090  f5 da 3e 3e 33 aa f4 18  99 e0 73 46 d6 16 42 ee   ..>>3... ..sF..B.
00a0  18 eb d5 c3 8f 2f 2c 00  43 00 52 00 48 00 00 00   ...../,. C.R.H...
00b0  3f 00 00 00 4c 00 69 00  6e 00 75 00 78 00 00 00   ?...L.i. n.u.x...
00c0  66 00 6f 00 6f 00 00 00  04 ff 00 00 00 00 00 01   f.o.o... ........
00d0  00 25 00 00 5c 00 5c 00  50 00 55 00 47 00 53 00   .%..\.\. P.U.G.S.
00e0  4c 00 45 00 59 00 5c 00  49 00 50 00 43 00 24 00   L.E.Y.\. I.P.C.$.
00f0  00 00 3f 3f 3f 3f 3f 00                            ..?????.
```

SMB (Server Message Block Protoc... Packets: 17 Displayed: 17 Marked: 0 Profile: Default

SMB Internals

SMB/SMB2 are "stateful"

… so what state is maintained?

In the Microsoft documentation:

- A state machine is presented, providing:
  - Different context levels in which state is kept
    - ...with constructors and destructors
  - A set of state variables per context level
  - A set of operations that change the state
  - Relationships between variables is maintained across documents
- This is in addition to basic packet formats, given in a separate section.

SMB Internals

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SMB Internals

Read the Docs

- Implementing CIFS is an Open Source book, freely available on the Web
- Microsoft's Documentation is also freely available from their website
- CIFS.Org is a Wiki site dedicated to capturing developer insights

Use the Source

- Samba provides a complete server suite, available for study
- jCIFS is an SMB client implementation in Java, also available for study

“Real-World” SMB

SMB in the "Real World"

We have established:

- SMB is difficult and annoying
  - SMB2 is a little better
- SMB/SMB2 are *de facto* standard protocols
  - ...and market leaders
- Adoption of NFSv4.x is slow
- SMB2.2 is feature–comparable to NFSv4.x

What are you going to do about it?

SMB in the "Real World"

Consider the Market for Storage Engineers

In Silicon Valley, you can put out a sign that says "NFS coders wanted", and a line will form. NFS is an open specification, studied in University classes. There are multiple books on the subject.

In comparison, the pool of SMB/CIFS/SMB2 engineers is very small indeed.

Scarcity == Opportunity

The End


Questions?
The Tacky Tie Show