SHARKFEST '12

Wireshark Developer and User Conference

Mike Canney

Application Performance Analysis

Tektivity™

Welcome to Sharkfest '12

contact

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Agenda

agenda

- So why focus on the application?
- Creating a CDA (Capture to Disk Appliance)
- Using Pilot for "back in time" troubleshooting with your CDA and Wireshark
- Application QA Lifecycle
- Top Causes for Application Performance issues
  - Application Turns
  - TCP
  - Layer 7 Issues
  - TCP Retransmissions
- Using Wireshark to create custom profiles to troubleshoot CIFS/SMB

So why focus on the Application?

- In many cases it is the Network Engineers that have the tool set to help pinpoint where the problem exists.
- "It's not the Network!" - The Network is guilty until proven innocent.
- Application performance issues can impact your business/customers ability to make money.
- User Response time is "Relative".
- Intermittent performance issues (moving target).

focus

The "moving target"

- Analyzer placement - Two options
  - Move the analyzers as needed
  - Capture anywhere and everywhere

- To defend the Network multiple capture points of the problem is the best solution.

Commercial vs. Free Capture

capture

- Define your capture strategy
  - Data Rates
  - What are my goals? Troubleshooting vs. Statistical information.
  - Do I need to capture every packet?

Capture to Disk Appliance (on a budget)

budget

- What is needed?
  - dumpcap is a command line utility included with the Wireshark download to enable ring buffer captures.
  - Use an inexpensive PC or laptop (best to have 2 NICs or more).
  - Basic batch file to initiate capture.
  - Cascade Pilot (optional but recommended)

Dumpcap Example

example

cd \program files (x86)\wireshark

dumpcap -i 1 -s 128 -b files:100 -b filesize: 2000000 –w c:\traces\internet \headersonly1.pcap

This is a basic batch file that will capture off of interface 1, slice the packets to 128 bytes, write 100 trace files of ~2 Gigabytes, and write the trace file out to a pcap file.

So why did I write multiple 2 Gig trace files?

- Pilot!
- Pilot can easily read HUGE trace files.
- This allows us to utilize our CDA in ways no other analyzer can.
- I personally have sliced and diced 50 GB trace files in Pilot in a matter of seconds.

trace file

So how does this all work together?

practice

- Directory full of 2GB trace files, all time stamped based on when they were written to disk.
- User calls in and complains that “the network” is slow.
- Locate that trace file based on time and date and launch Pilot.

Instructor Demo

demo

Troubleshooting user “Network Issue”

Think about the possibilities…

hmmm

- From a multix GB trace file we were able to:
  - Look at the total Network throughput.
  - See what applications were consuming the bandwidth.
  - Identify the user that was responsible for consuming the bandwidth.
  - Identify the URI’s the user was hitting and what the response times were.
  - Drill down to the packets involved in the slow web response time in Wireshark.
- All in a matter of a few seconds.

Why are there so many application issues?

- Applications are typically developed in a “golden” environment
  - Fastest PCs
  - High Bandwidth/low latency
- When applications move from test (LAN) to production (WAN) the phone starts ringing with complaints coming in.

help

The Application QA Lifecycle

qa cycle

- In most organizations, applications go through a QA process
- Typical QA/App developers test the following:
  - Functional tests
  - Regression tests
  - Stress tests (server)
  - Rinse and Repeat
- What is often missing is “Networkability” testing
- All QA Lifecycles should include Networkability testing

Application Networkablility Testing

- Identify key business transactions, number of users and network conditions the application will be deployed in.
- Simulation vs. Emulation
  - Simulation is very quick, often gives you rough numbers of how an application will perform over different network conditions.
  - Emulation is the only way to determine when an application will “fail” under those conditions.
- A Combination of both is recommended.

Top Causes for Poor Application Performance

top 5

- Application Turns
- TCP
- Layer 7 Bottlenecks
- Congestion (network)
- Processing Delay

Causes for Slow Application Performance

turns

Application Turns

Application Turns

turns

- An Application Turn is a request/response pair
- For each “turn” the application must wait the full round trip delay.
- The greater the number of turns, the worse the application will perform over a WAN (latency bound).

App Turn

Begin

End

```
GET /assets/images/riverbed_logo.png HTTP/1.1
[TCP segment of a reassembled PDU]
[TCP segment of a reassembled PDU]
49222 > http [ACK] Seq=573 Ack=2921 Win=16060 Len=0
[TCP Window Update] 49222 > http [ACK] Seq=573 Ack=2921 Win=1
HTTP/1.1 200 OK  (PNG)
GET /assets/photos/Riverbed_Cascade_home_010211.png HTTP/1.1
```

Example in Wireshark

Display Filter:

Filter: smb.cmd

Time	Delta	Bytes	Source	Bytes in Flight	Destination	Protocol	Info
10.008388	0.096607	237	192.168.151.108	183	192.168.151.122	SMB	Read AndX Response, FID: 0xc00d, 61440 bytes
10.008935	0.000547	117	192.168.151.122	63	192.168.151.108	SMB	Read AndX Request, FID: 0xc00d, 61440 bytes at offset 61440
10.105423	0.096488	237	192.168.151.108	183	192.168.151.122	SMB	Read AndX Response, FID: 0xc00d, 61440 bytes
10.105972	0.000549	117	192.168.151.122	63	192.168.151.108	SMB	Read AndX Request, FID: 0xc00d, 61440 bytes at offset 122880
10.202297	0.096325	237	192.168.151.108	183	192.168.151.122	SMB	Read AndX Response, FID: 0xc00d, 61440 bytes
10.202691	0.000394	117	192.168.151.122	63	192.168.151.108	SMB	Read AndX Request, FID: 0xc00d, 61440 bytes at offset 184320
10.299228	0.096537	237	192.168.151.108	183	192.168.151.122	SMB	Read AndX Response, FID: 0xc00d, 61440 bytes
10.299569	0.000341	117	192.168.151.122	63	192.168.151.108	SMB	Read AndX Request, FID: 0xc00d, 16384 bytes at offset 245760
10.358427	0.058858	441	192.168.151.108	387	192.168.151.122	SMB	Read AndX Response, FID: 0xc00d, 16384 bytes
10.358662	0.000235	117	192.168.151.122	63	192.168.151.108	SMB	Read AndX Request, FID: 0xc00d, 45056 bytes at offset 262144
10.441337	0.082675	1373	192.168.151.108	1319	192.168.151.122	SMB	Read AndX Response, FID: 0xc00d, 45056 bytes
10.445493	0.004156	117	192.168.151.122	63	192.168.151.108	SMB	Read AndX Request, FID: 0xc00d, 61440 bytes at offset 307200
10.541826	0.096333	237	192.168.151.108	183	192.168.151.122	SMB	Read AndX Response, FID: 0xc00d, 61440 bytes
10.542163	0.000337	117	192.168.151.122	63	192.168.151.108	SMB	Read AndX Request, FID: 0xc00d, 61440 bytes at offset 368640
10.638633	0.096470	237	192.168.151.108	183	192.168.151.122	SMB	Read AndX Response, FID: 0xc00d, 61440 bytes
10.639010	0.000377	117	192.168.151.122	63	192.168.151.108	SMB	Read AndX Request, FID: 0xc00d, 61440 bytes at offset 430080
10.735377	0.096367	237	192.168.151.108	183	192.168.151.122	SMB	Read AndX Response, FID: 0xc00d, 61440 bytes

Packets: 22388 Displayed: 882

882 Application Turns in this trace

App Turns and Latency

latency

- It is fairly easy to determine App Turns impact on end user response time
  - Multiply the number of App Turns by the round trip delay:
    - 10,000 turns * .050 ms delay = 500 seconds due to latency
- Note, this has nothing to do with Bandwidth or the Size of the WAN Circuit

So what causes all these App Turns?

cause

- Size of a fetch in a Data Base call
- Number of files that are being accessed
- Loading single images in a Web Page instead of using an image map
- Number of bytes being retrieved and how they are being retrieved (block size)

Causes for Slow Application Performace

TCP

TCP Window Size

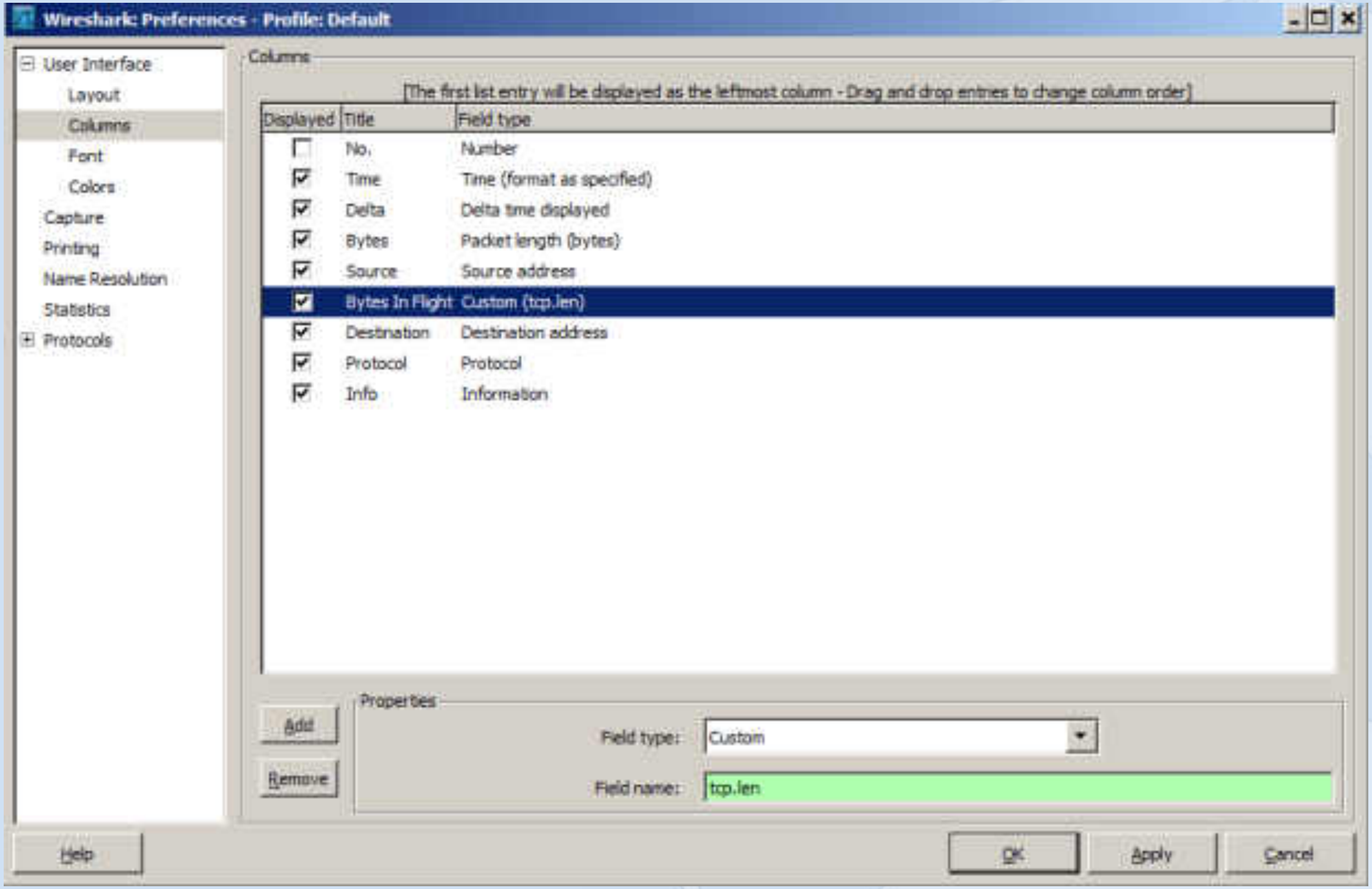
size

- The TCP Window Size defines the host's receive buffer.
- Large Window Sizes can sometimes help overcome the impact of latency.
- Depending on how the application was written, advertised TCP Window Size may not have an impact at all (more on this later).

TCP Inflight Data

- The amount of unacknowledged TCP data that is on the wire at any given time.
- TCP inflight data in limited by the following:
  - TCP Retransmissions
  - TCP Window Size
  - Application block size
- The amount of TCP inflight data will never exceed the receiving devices advertised TCP Window Size.

TCP Inflight Data in Wireshark



TCP Inflight Data in Wireshark

[illegible]	Delta	Bytes	Source	Bytes In Flight	Destination	Protocol	Info
4.888151	0.000170	130	192.168.151.108	76	192.168.151.122	SMB	NT Trans Response, NT NOTIFY
4.888215	0.000064	54	192.168.151.122	0	192.168.151.108	TCP	1041 > 445 [ACK] Seq=682 Ack=2514 Win=63969 Len=0
4.888499	0.000284	142	192.168.151.122	88	192.168.151.108	SMB	Trans2 Request, SET_FILE_INFO, FID: 0xc000
4.888828	0.000329	142	192.168.151.122	88	192.168.151.108	SMB	NT Trans Request, NT NOTIFY, FID: 0x4005
4.933909	0.045081	118	192.168.151.108	64	192.168.151.122	SMB	Trans2 Response, FID: 0xc000, SET_FILE_INFO
4.934090	0.000181	130	192.168.151.108	76	192.168.151.122	SMB	NT Trans Response, NT NOTIFY
4.934149	0.000059	54	192.168.151.122	0	192.168.151.108	TCP	1041 > 445 [ACK] Seq=858 Ack=2654 Win=63829 Len=0
4.939393	0.005244	142	192.168.151.122	88	192.168.151.108	SMB	NT Trans Request, NT NOTIFY, FID: 0x4005
5.197543	0.258150	60	192.168.151.108	0	192.168.151.122	TCP	445 > 1041 [ACK] Seq=2654 Ack=946 Win=63663 Len=0
5.197735	0.000192	142	192.168.151.122	88	192.168.151.108	SMB	NT Trans Request, NT NOTIFY, FID: 0x4006
5.243042	0.045307	130	192.168.151.108	76	192.168.151.222	SMB	NT Trans Response, NT NOTIFY
5.243344	0.000302	142	192.168.151.122	88	192.168.151.108	SMB	NT Trans Request, NT NOTIFY, FID: 0x4006
5.506404	0.263060	60	192.168.151.108	0	192.168.151.122	TCP	445 > 1041 [ACK] Seq=2730 Ack=1122 Win=63487 Len=0
6.736559	1.230155	144	192.168.151.122	90	192.168.151.108	SMB	Trans2 Request, FIND_FIRST2, Pattern: *
6.784039	0.047480	1514	192.168.151.108	1460	192.168.151.122	TCP	[TCP segment of a reassembled PDU]
6.784098	0.000059	314	192.168.151.108	260	192.168.151.122	SMB	Trans2 Response, FIND_FIRST2, Files: . .. .test.pc
6.784142	0.000044	54	192.168.151.122	0	192.168.151.108	TCP	1041 > 445 [ACK] Seq=1212 Ack=4450 Win=64240 Len=0
9.690081	2.905939	1514	192.168.151.122	1460	192.168.151.108	TCP	[TCP segment of a reassembled PDU]
9.690373	0.000292	1514	192.168.151.122	1460	192.168.151.108	TCP	[TCP segment of a reassembled PDU]
9.690457	0.000084	1514	192.168.151.122	1460	192.168.151.108	TCP	[TCP segment of a reassembled PDU]
9.690536	0.000079	1514	192.168.151.122	1460	192.168.151.108	TCP	[TCP segment of a reassembled PDU]
9.690620	0.000084	1514	192.168.151.122	1460	192.168.151.108	TCP	[TCP segment of a reassembled PDU]
9.690698	0.000078	1514	192.168.151.122	1460	192.168.151.108	TCP	[TCP segment of a reassembled PDU]
9.690777	0.000079	1514	192.168.151.122	1460	192.168.151.108	TCP	[TCP segment of a reassembled PDU]
9.690854	0.000077	1514	192.168.151.122	1460	192.168.151.108	TCP	[TCP segment of a reassembled PDU]
9.690932	0.000078	1514	192.168.151.122	1460	192.168.151.108	TCP	[TCP segment of a reassembled PDU]
9.691010	0.000078	1514	192.168.151.122	1460	192.168.151.108	TCP	[TCP segment of a reassembled PDU]
9.691089	0.000079	1514	192.168.151.122	1460	192.168.151.108	TCP	[TCP segment of a reassembled PDU]
9.691170	0.000081	1514	192.168.151.122	1460	192.168.151.108	TCP	[TCP segment of a reassembled PDU]

The Bytes in Flight Column shows us how much payload is in each packet.

TCP Inflight Data in Wireshark

	No.	Time	Delta	Bytes	Source	Bytes in Fl	Destinatio	Protocol	Info
2	98	9.79559	0	242	192.168.1	188	192.168.1	SMB	Write AndX Request, FID: 0xc000, 61440 bytes at offset 0
3	109	9.84588	0.05029	105	192.168.1	51	192.168.1	SMB	Write AndX Response, FID: 0xc000, 61440 bytes
4	162	9.91585	0.06998	242	192.168.1	188	192.168.1	SMB	Write AndX Request, FID: 0xc000, 61440 bytes at offset 61440
5	174	9.96369	0.04784	105	192.168.1	51	192.168.1	SMB	Write AndX Response, FID: 0xc000, 61440 bytes
6	227	10.0333	0.06963	242	192.168.1	188	192.168.1	SMB	Write AndX Request, FID: 0xc000, 61440 bytes at offset 122880
7	239	10.0822	0.04891	105	192.168.1	51	192.168.1	SMB	Write AndX Response, FID: 0xc000, 61440 bytes
8	291	10.1495	0.0673	242	192.168.1	188	192.168.1	SMB	Write AndX Request, FID: 0xc000, 61440 bytes at offset 184320
9	304	10.1974	0.04788	105	192.168.1	51	192.168.1	SMB	Write AndX Response, FID: 0xc000, 61440 bytes
10	356	10.2653	0.06785	242	192.168.1	188	192.168.1	SMB	Write AndX Request, FID: 0xc000, 61440 bytes at offset 245760
11	369	10.3201	0.0548	105	192.168.1	51	192.168.1	SMB	Write AndX Response, FID: 0xc000, 61440 bytes
12	420	10.3872	0.06709	242	192.168.1	188	192.168.1	SMB	Write AndX Request, FID: 0xc000, 61440 bytes at offset 307200
13	434	10.436	0.0489	105	192.168.1	51	192.168.1	SMB	Write AndX Response, FID: 0xc000, 61440 bytes
14	485	10.5012	0.0652	242	192.168.1	188	192.168.1	SMB	Write AndX Request, FID: 0xc000, 61440 bytes at offset 368640
15	499	10.5491	0.04783	105	192.168.1	51	192.168.1	SMB	Write AndX Response, FID: 0xc000, 61440 bytes
16	550	10.6142	0.0651	242	192.168.1	188	192.168.1	SMB	Write AndX Request, FID: 0xc000, 61440 bytes at offset 430080
17	564	10.6608	0.04659	105	192.168.1	51	192.168.1	SMB	Write AndX Response, FID: 0xc000, 61440 bytes
18	614	10.7235	0.06269	242	192.168.1	188	192.168.1	SMB	Write AndX Request, FID: 0xc000, 61440 bytes at offset 491520
19	629	10.7714	0.04797	105	192.168.1	51	192.168.1	SMB	Write AndX Response, FID: 0xc000, 61440 bytes
20	679	10.8337	0.06232	242	192.168.1	188	192.168.1	SMB	Write AndX Request, FID: 0xc000, 61440 bytes at offset 552960
21	694	10.8818	0.04804	105	192.168.1	51	192.168.1	SMB	Write AndX Response, FID: 0xc000, 61440 bytes
22	744	10.9457	0.06391	242	192.168.1	188	192.168.1	SMB	Write AndX Request, FID: 0xc000, 61440 bytes at offset 614400
23	759	10.9937	0.04797	105	192.168.1	51	192.168.1	SMB	Write AndX Response, FID: 0xc000, 61440 bytes
24	808	11.054	0.06031	242	192.168.1	188	192.168.1	SMB	Write AndX Request, FID: 0xc000, 61440 bytes at offset 675840
25	824	11.102	0.04803	105	192.168.1	51	192.168.1	SMB	Write AndX Response, FID: 0xc000, 61440 bytes
26	873	11.162	0.06005	242	192.168.1	188	192.168.1	SMB	Write AndX Request, FID: 0xc000, 61440 bytes at offset 737280
27	889	11.2088	0.04671	105	192.168.1	51	192.168.1	SMB	Write AndX Response, FID: 0xc000, 61440 bytes

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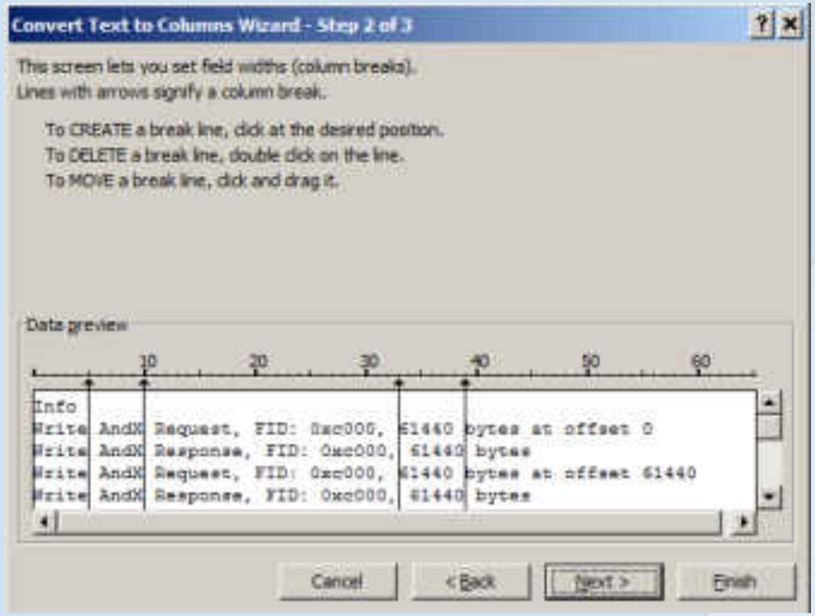
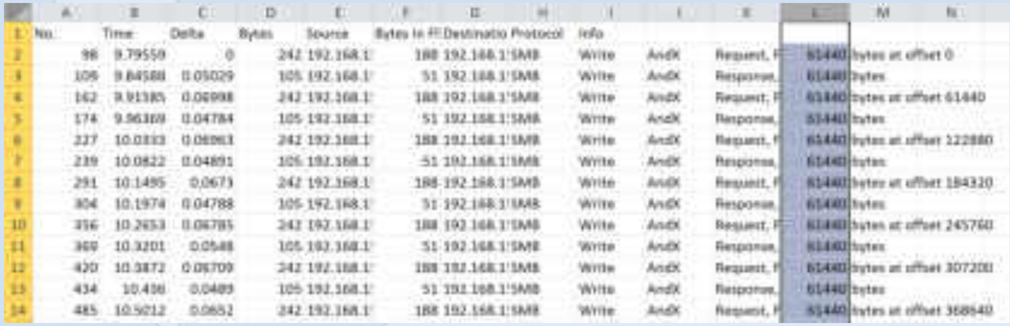
TCP Inflight Data in Wireshark





	A	B	C	D	E	F	G	H	I	J	K	L	M
1	No.	Time	Delta	Bytes	Source	Bytes In Fl	Destinatio	Protocol	Info				
2	98	9.79559	0	242	192.168.1	188	192.168.1	SMB	Write	AndX	Request, F	61440	bytes at offset 0
3	109	9.84588	0.05029	105	192.168.1	51	192.168.1	SMB	Write	AndX	Response,	61440	bytes
4	162	9.91385	0.06998	242	192.168.1	188	192.168.1	SMB	Write	AndX	Request, F	61440	bytes at offset 61440
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10	356	10.2653	0.06785	242	192.168.1	188	192.168.1	SMB	Write	AndX	Request, F	61440	bytes at offset 245760
11	369	10.3201	0.0548	105	192.168.1	51	192.168.1	SMB	Write	AndX	Response,	61440	bytes
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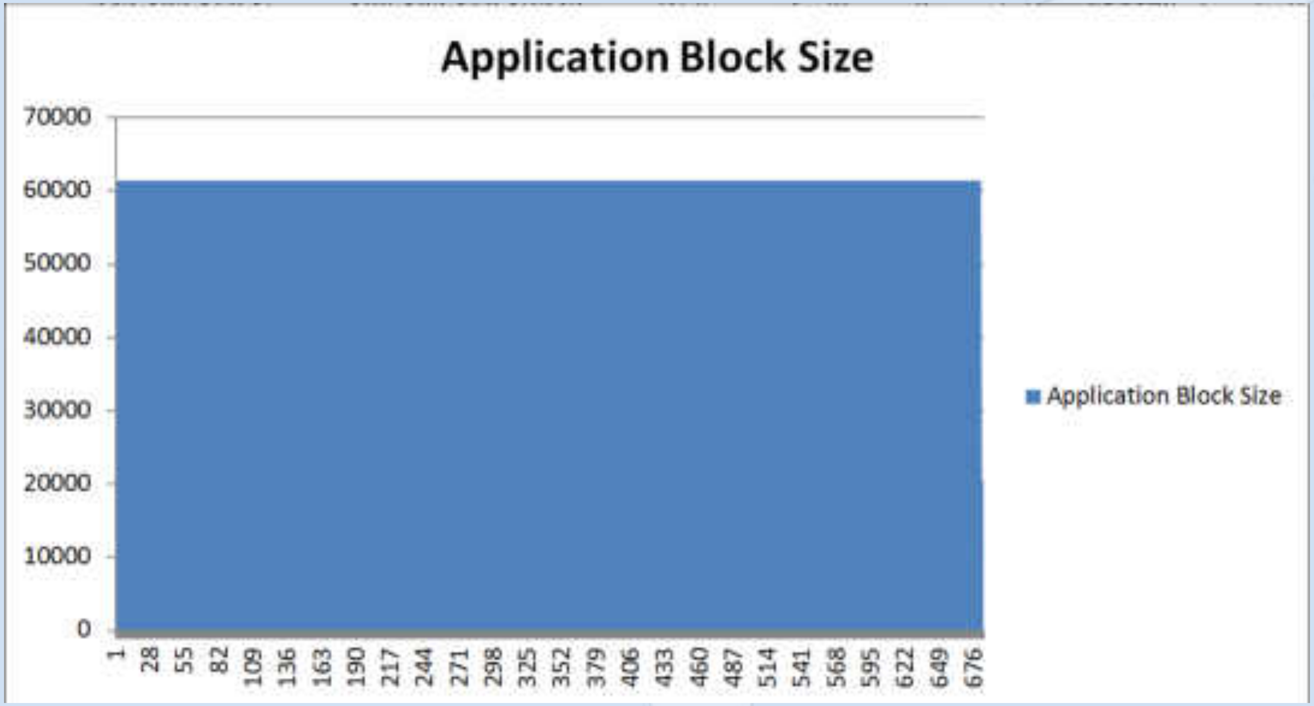
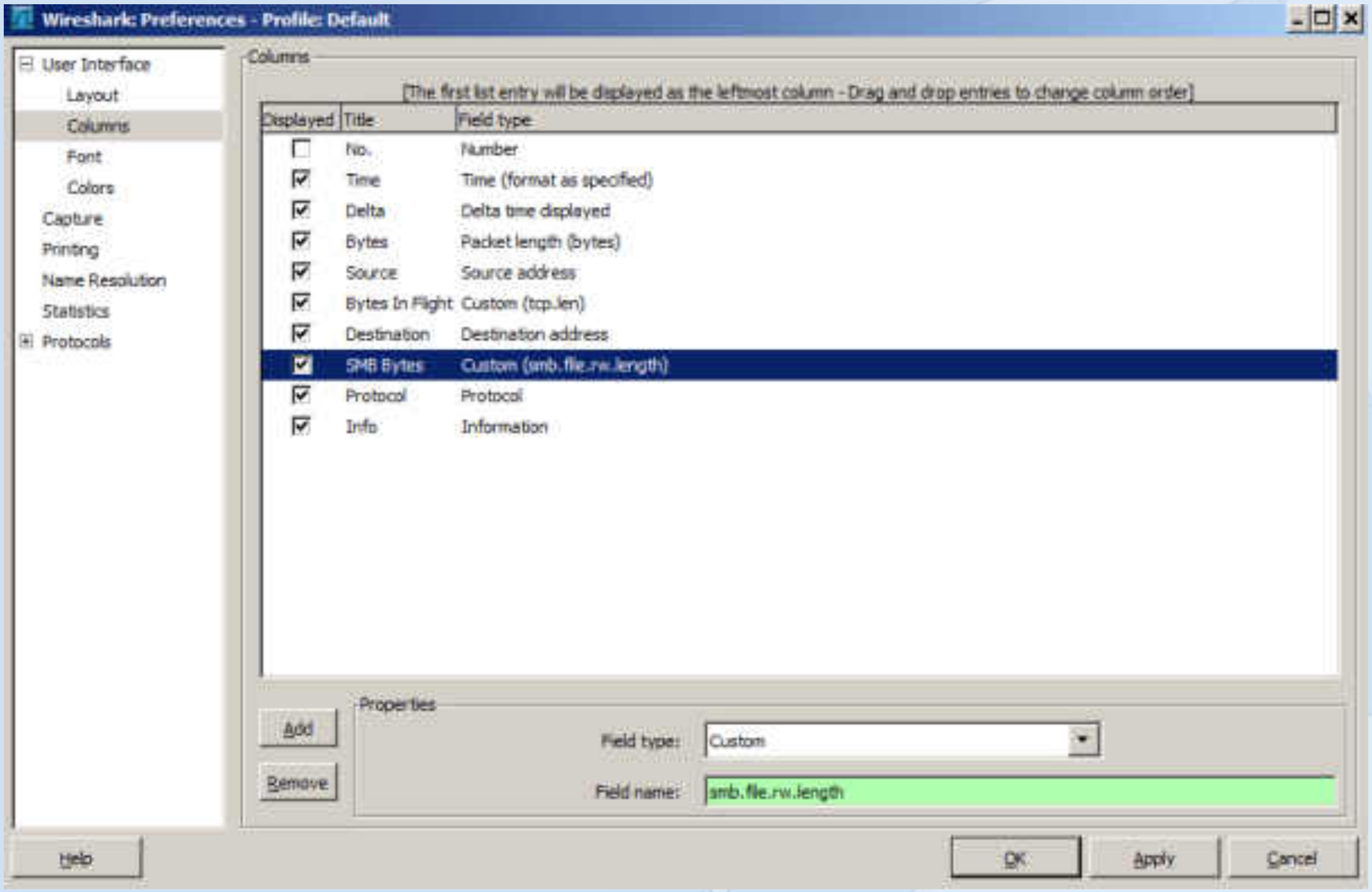
TCP Inflight Data in Wireshark



Graphed in Excel

Easier way for SMB/CIFS



TCP Retransmissions

- Every time a TCP segment is sent, a retransmission timer is started.
- When the Acknowledgement for that segment is received the timer is stopped.
- If the retransmission timer expires before the Acknowledgement is received, the TCP segment is retransmitted.

tcp

TCP Retransmissions

tcp flow

- Excessive TCP Retransmissions can have a huge impact on application performance.
- Not only does the data have to get resent, but TCP flow control (Slow Start) kicks into action.

Application Performance

demo

Layer 7 Bottlenecks

ULPs (upper layer protocols)

- TCP often gets blamed for the ULPs problem.
  - The application hands down to TCP amount of data to go retrieve (application block size)
  - TCP then is responsible for reliably getting that data back to the application layer
    - TCP has certain parameters in which to work with and can usually be tuned based on bandwidth and latency
    - Many times too much focus is put on “tuning” TCP as the fix for poor performance in the network

- If the TCP advertised receive window is set to 64K and the application is only handing down to TCP requests for 16K, where is the bottleneck?

ulp

ULPs (upper layer protocols)

ulp

Case in point: CIFS/SMB

Troubleshooting CIFS/SMB

cifs/smb

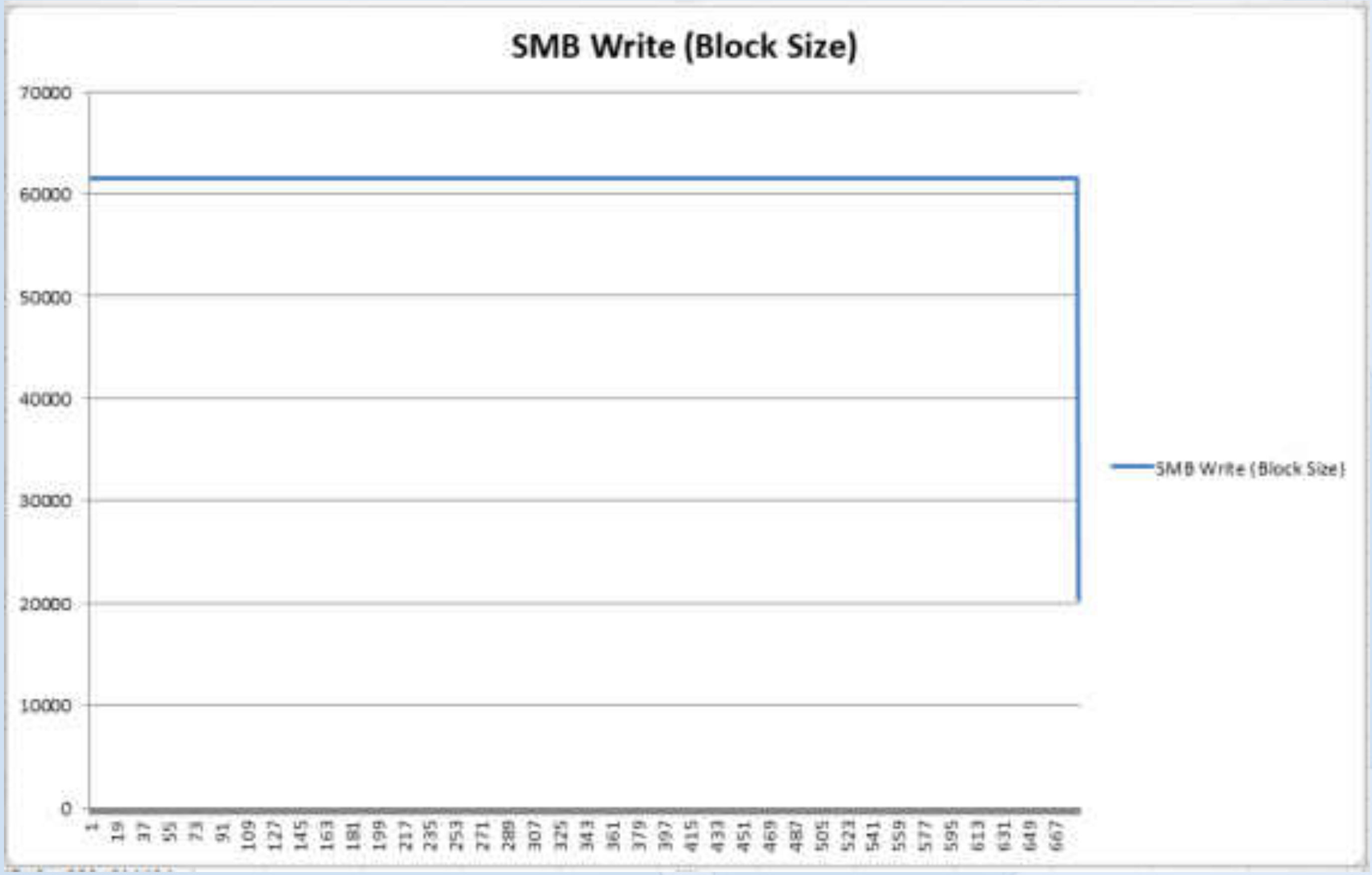
- Arguably the most common File Transfer method used in businesses today.
- SMB was NOT developed with the WAN in mind.
- One of the most “chatty” protocols/ applications I run into (with the exception of poorly written SQL).

CIFS/SMB Quiz

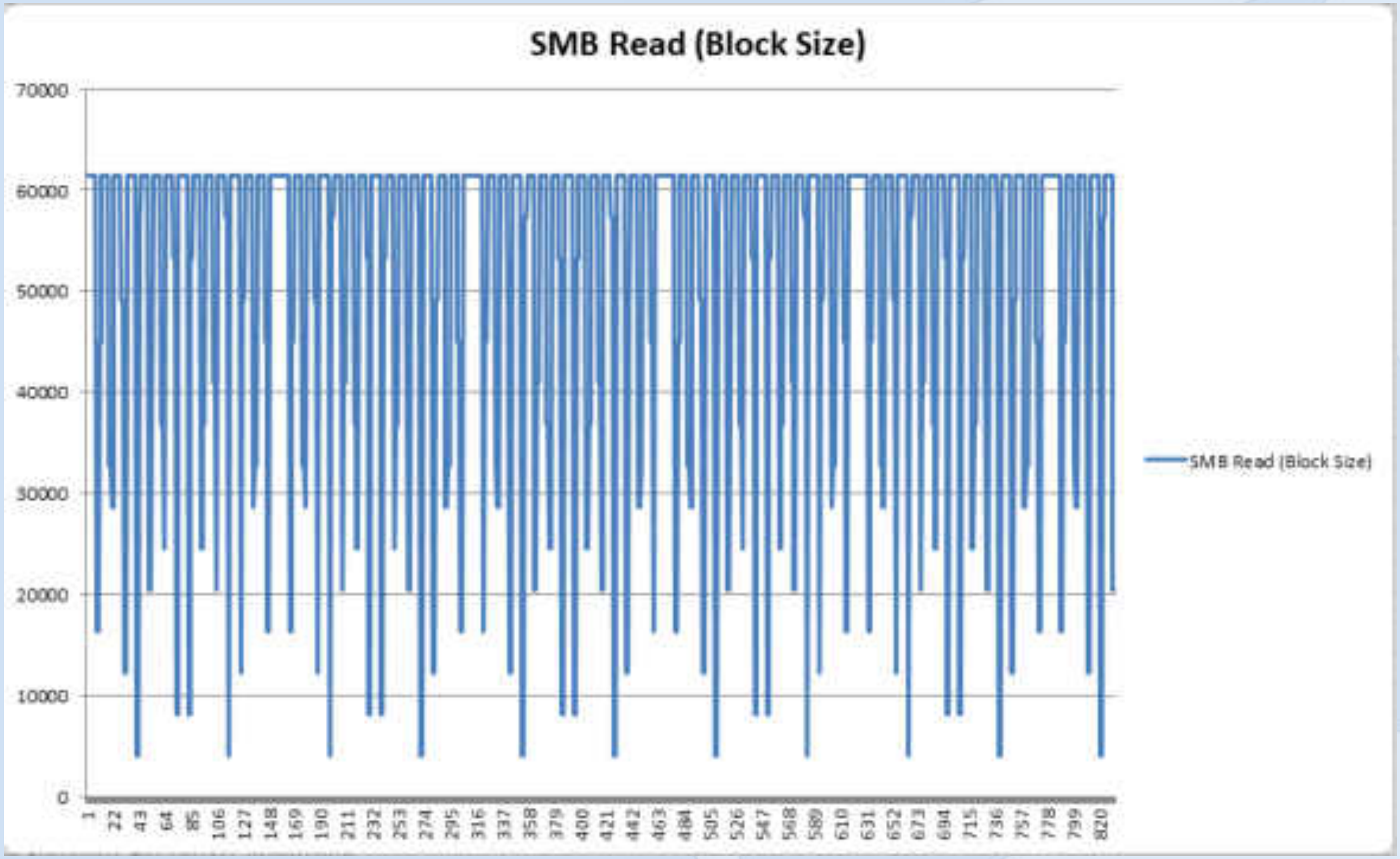
- What is faster using MS File Sharing?
  - Pushing a file to a file server?
  - Pulling a file from a file server?

quiz

ULPs (upper layer protocols)



ULPs (upper layer protocols)



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CIFS/SMB

cifs/smb

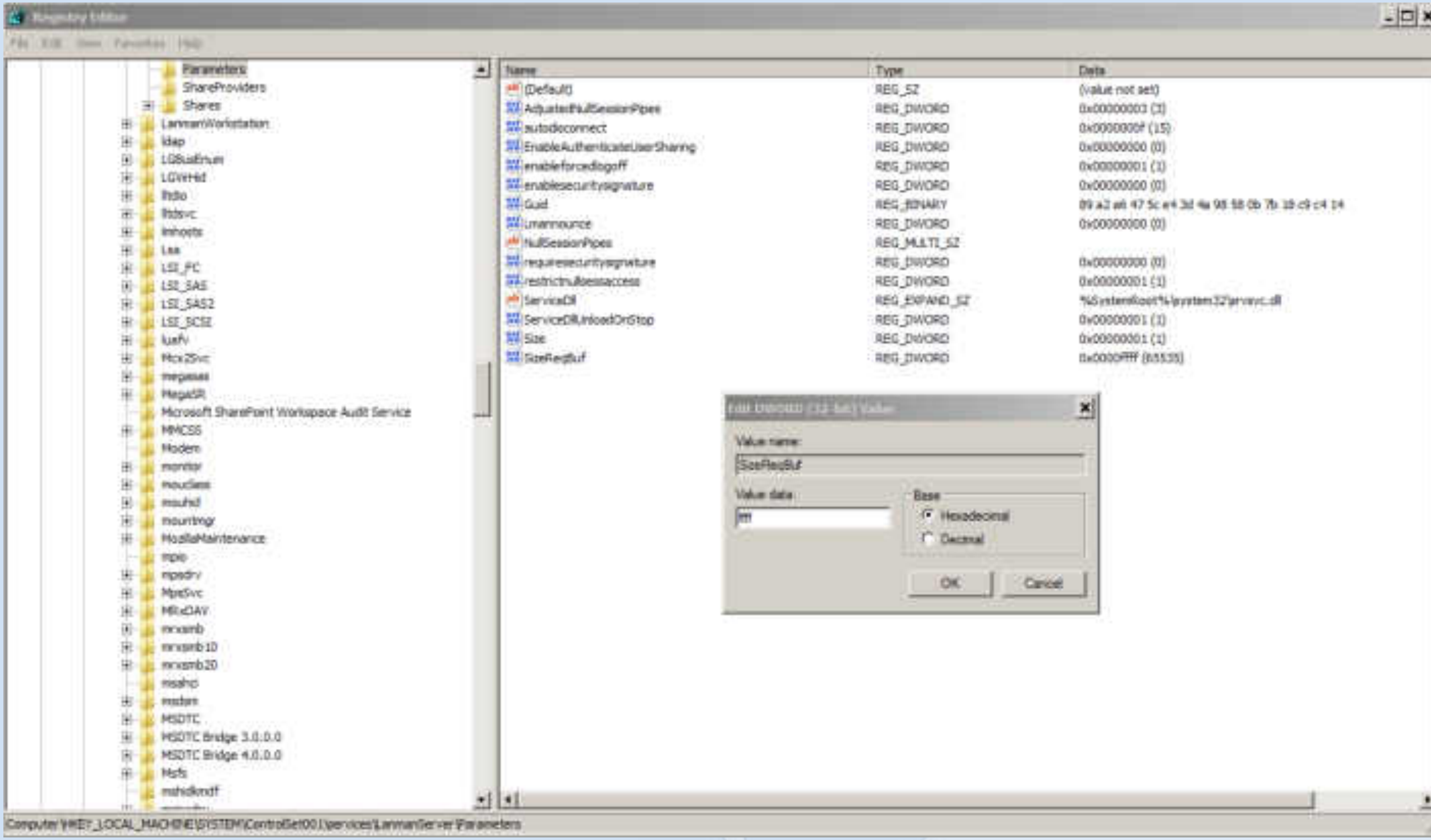
- What is faster using MS File Sharing?
  - Pushing a file to a file server?
  - Pulling a file from a file server?
    - SMB Write (Pushing the file) can almost be 2X as fast as pulling (SMB Read)
    - Depends on the Latency

CIFS/SMB Tuning

tuning

- SMB Maximum Transmit Buffer Size
  - Negotiated MaxBufferSize in the Negotiate Protocol response
  - Default for Windows servers is typically 16644 (dependent upon physical memory)
  - Client default typically 4356

CIF/SMB Tuning



CIFS/SMB Tuning

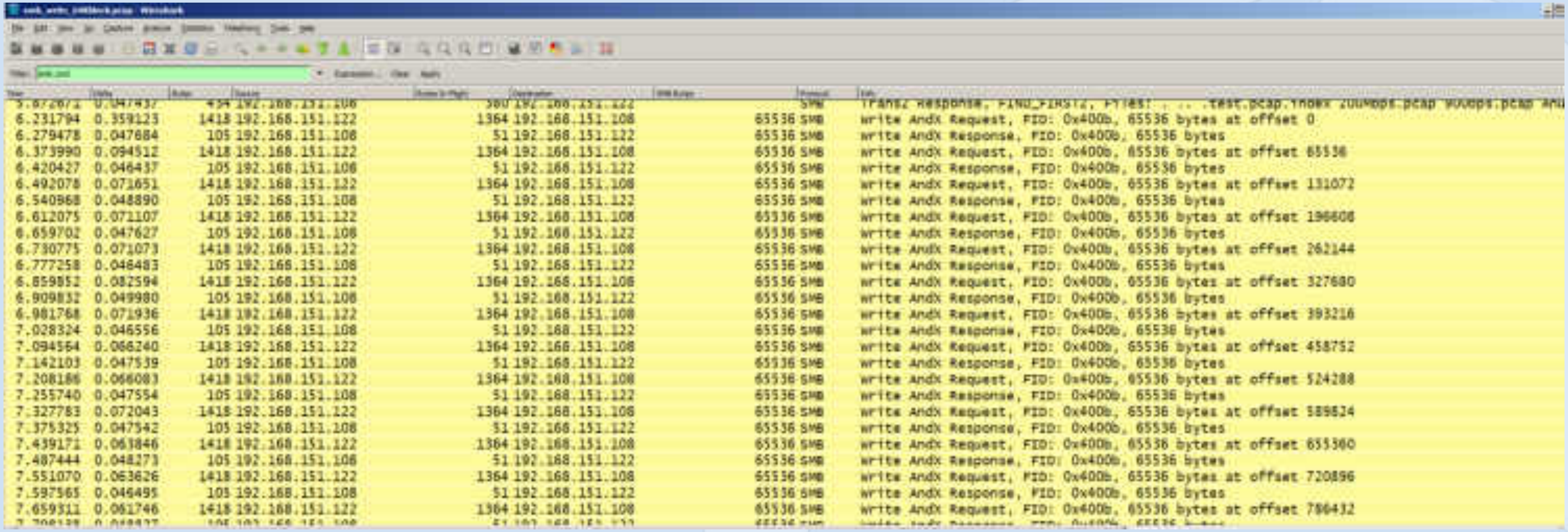
tuning

- Caveat:
  - SMB is extremely dependent upon the API
    - Even though you set the max buffer size to 64K, windows "share" data will always get truncated to 60K (61440) even though the server can support 64K

CIFS/SMB Tuning

- Custom SMB APIs
  - The Windows limitation can be exceeded by programs written to use SMB as they file transfer protocol

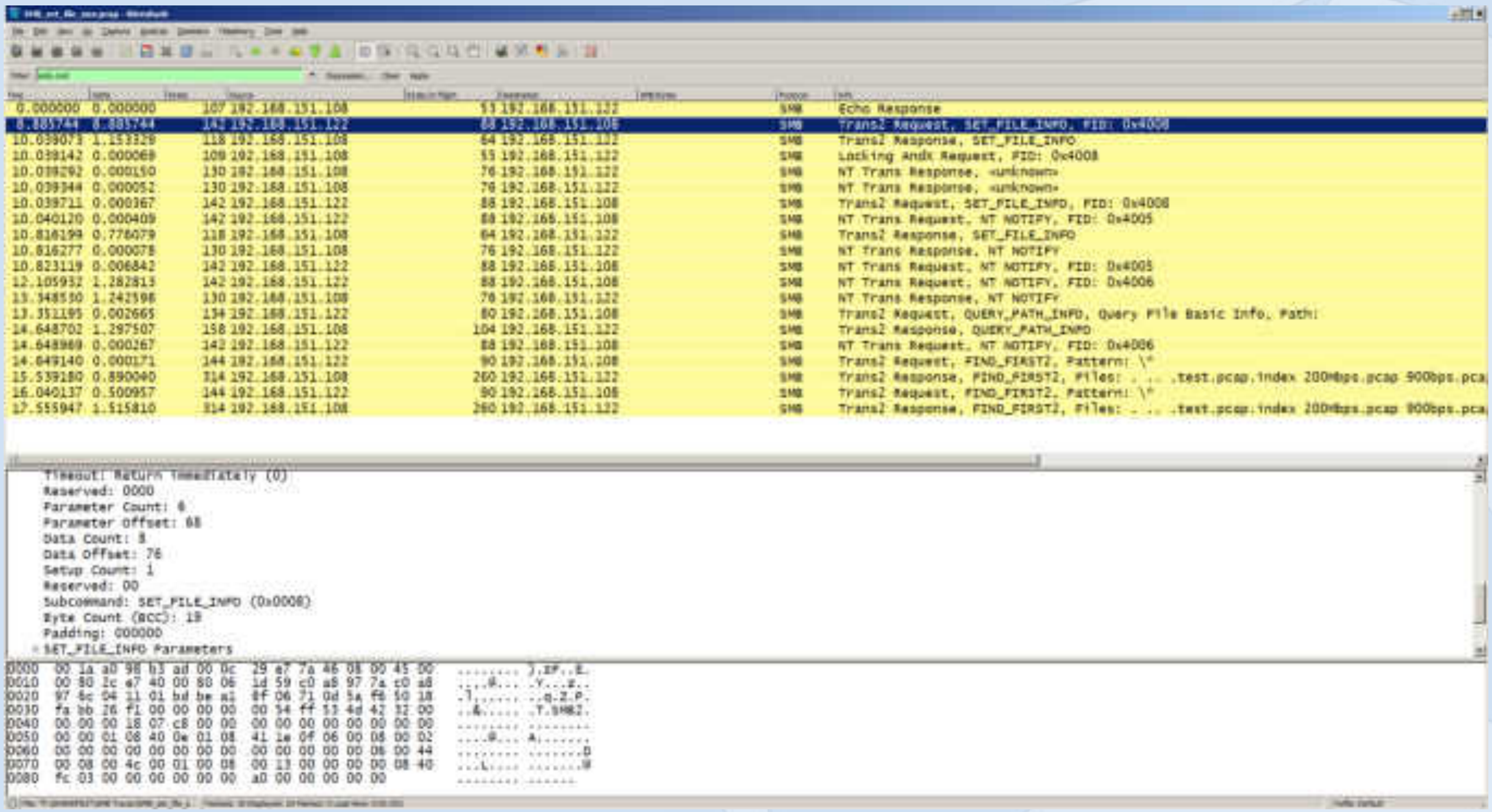
CIFS/SMB Tuning



Note the SMB writes of 65,536

This is a file transfer using a custom API on a Windows XP machine

CIFS/SMB Tuning (Preallocation)



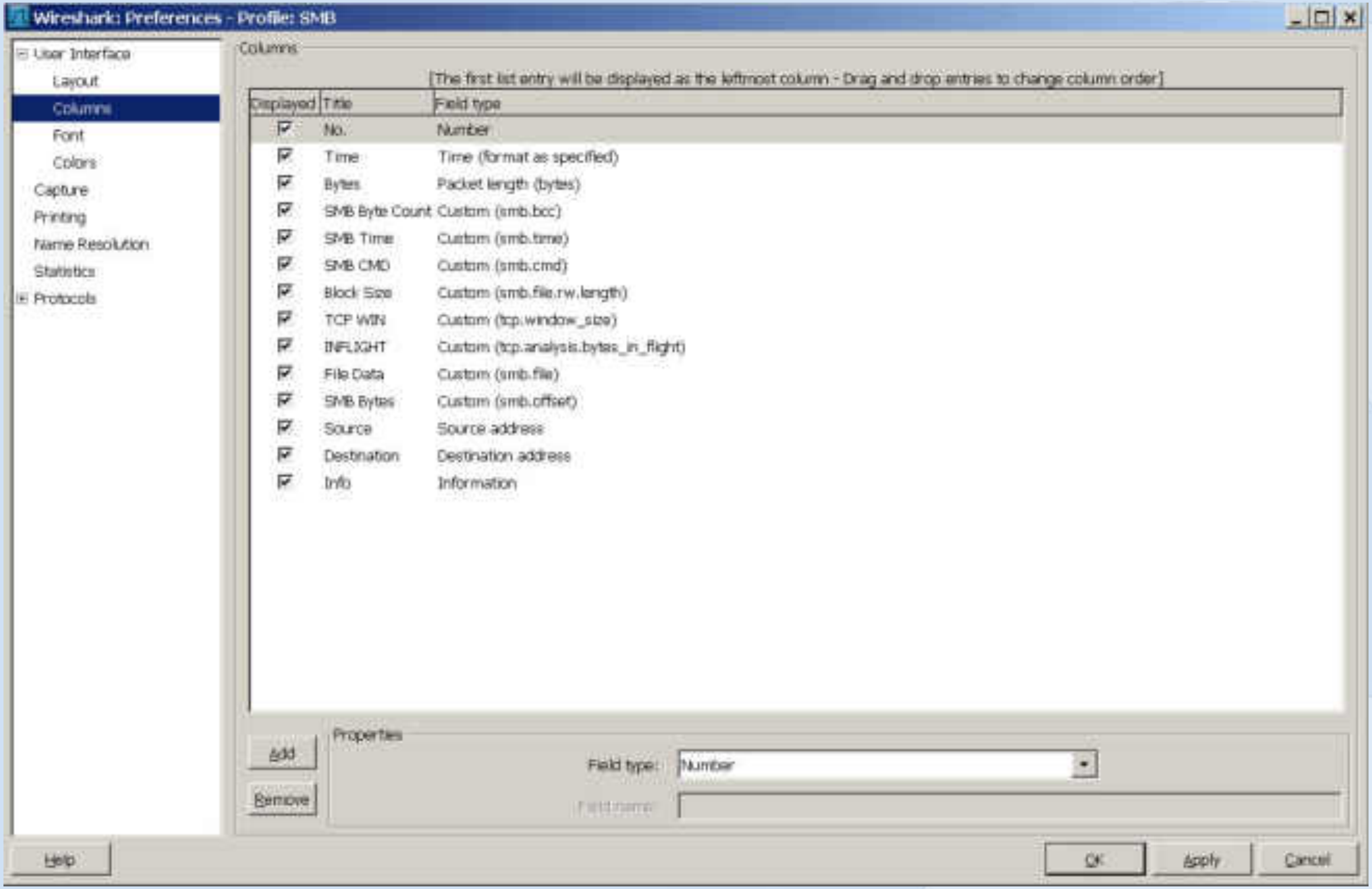
Preallocation sets the file info for SMB Writes and can drastically reduce some of the "chattyness" of SMB

Instructor Demo of SMB Profiles

demo

Demo of SMB Tracefiles

My personal SMB Profile



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Take Away Points

points

- Building your own CDA is easy to do and may fit in a majority of the areas you need to capture from
- Pilot, Pilot, Pilot, it's not just a fancy reporting engine for Wireshark!
- Test your applications "Networkability" before they hit production.
- Use the Wireshark Profiles, they will save you a ton of time.

SHARKFEST '12

Wireshark Developer and User Conference

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Tektivity™