SharkFest'21 Virtual Europe

# Introduction to WAN Optimization Traffic
# *** Updated Session***

Using Wireshark to assess the effectiveness of your WAN OPT features & deployment

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# Updated Session

- This is an update to the US v2020 session of same title
- Due to time constraints, we’re going to skip some of the background and intro material so we can get straight into Wireshark
- You can find the additional background and concepts in the US v20 session (Links on next slide)

# Links to v20 US

- https://sharkfestvirtual.wireshark.org/sf20v
- https://www.youtube.com/watch?v=IyvlvmdbvZM

# About me?

#sf21veu

- SharkFest Instructor since 2017
- Practicing Performance Engineering since 1980
- Protocol Analysis since 1991
- Professional Services with OPNET / Riverbed since 2005
- Love the mystery of a complicated performance issue
- Shaved off beard in 2003…

# Why this session…?

- WAN OPT technologies modify / enhance protocol behavior
- You will see protocol behavior in Wireshark that might look confusing / questionable
- The more background you have, the more effective you will be interpreting Wireshark to determine the benefits of your WAN OPT deployment

# Why this session…?

- Some of this behavior is similar to other tunnelling and proxy technologies
- You will gain knowledge that will help you in a variety of special technology situations

# Agenda

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- Why WAN Optimization
- Overview of Features (Subset)
- Wireshark Capture & Analysis Examples
- Wrap-up with Q & A

IT'S GO TIME

# Why WAN-OPT?

# Benefits of WAN OPT

- Improve User Productivity
- Reduce WAN bandwidth usage

# Benefits of WAN OPT

- Improve User Productivity
- Reduce WAN bandwidth usage
- Reduce Cloud Egress Costs

# Concepts to Baseline / Level Set

# Application Performance

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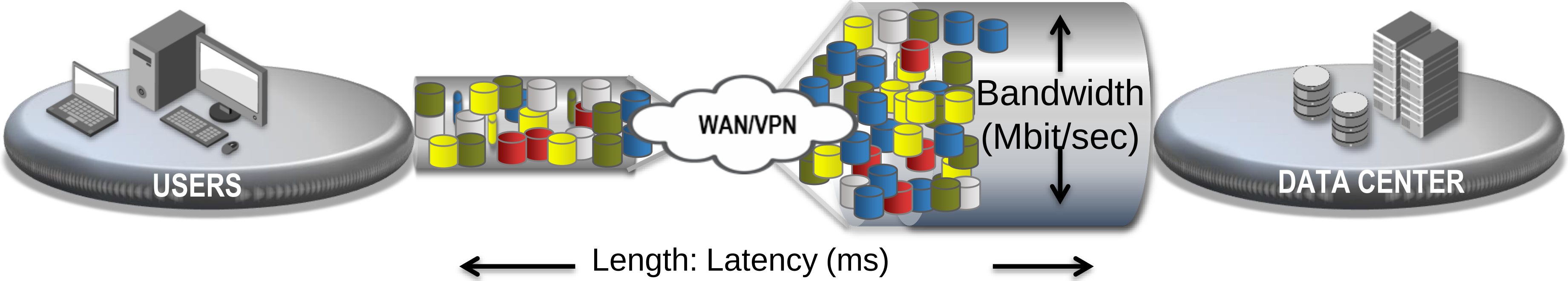
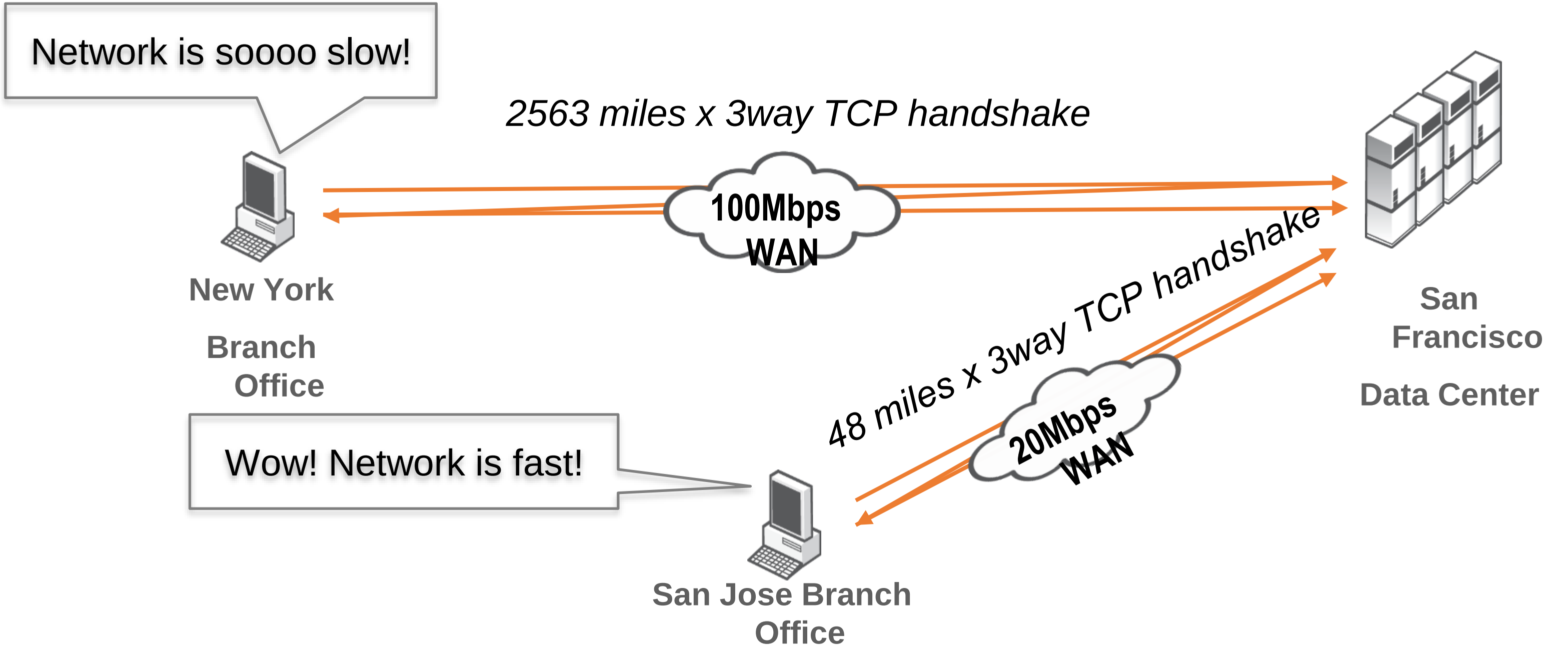
- Application networking performance is primarily dependent on…
    - Latency – due to distance
    - End to End Network Health (Packet Loss / Protocol Effects)
    - Bandwidth - smallest link rate (physical or subscribed)
    - Congestion - busy devices, congested links, QoS Policies



# Focus on Latency

Latency has a direct relationship with physics and distance



# Round Trip Time

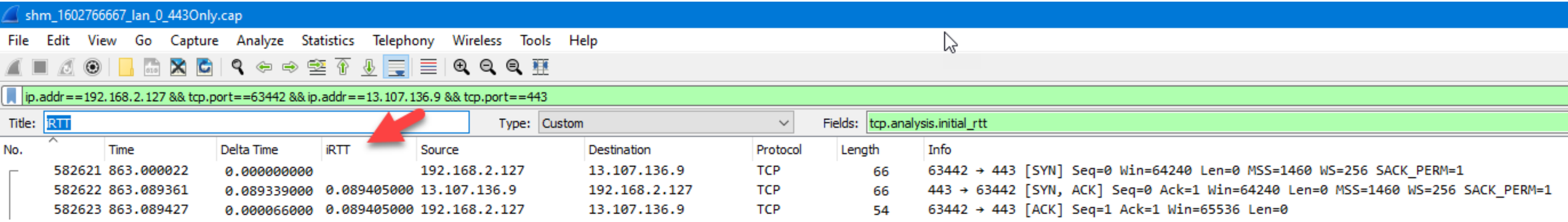
- Time required to send packets between two hosts (request from A to B, followed by response from B back to A)
- Function of Latency + Congestion + Protocol Delay
- More / Faster Bandwidth will **not** improve latency

# Related Wireshark Metrics

- tcp.analysis.initial_rtt
  - Time from SYN to SYN+ACK (plus ‘x’ factor)
  - Static value for the life of a connection
- tcp.analysis.ack_rtt
  - Time to ACK a particular segment
- tcp.analysis.acks_frame
  - The frame being acknowledged

# iRTT

- Sample from Decode Summary



shm_1602766667_lan_0_443Only.cap

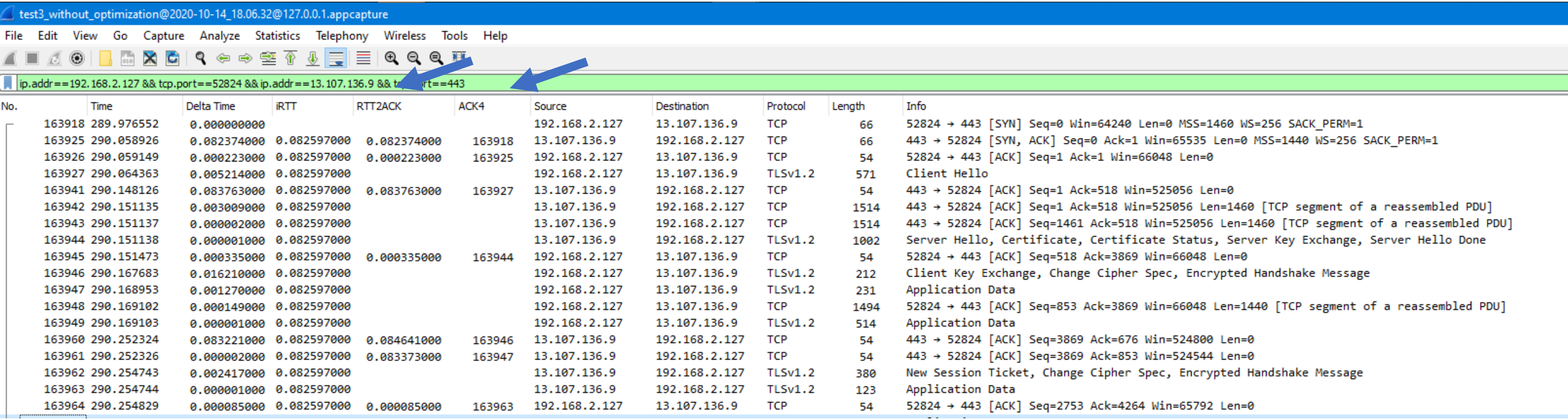
ip.addr==192.168.2.127 && tcp.port==63442 && ip.addr==13.107.136.9 && tcp.port==443

Title: iRTT Type: Custom Fields: tcp.analysis.initial_rtt

```
No.          Time        Delta Time   iRTT        Source         Destination     Protocol   Length   Info
   582621 863.000022  0.000000000              192.168.2.127  13.107.136.9   TCP          66   63442 → 443 [SYN] Seq=0 Win=64240 Len=0 MSS=1460 WS=256 SACK_PERM=1
   582622 863.089361  0.089339000  0.089405000 13.107.136.9   192.168.2.127  TCP          66   443 → 63442 [SYN, ACK] Seq=0 Ack=1 Win=64240 Len=0 MSS=1460 WS=256 SACK_PERM=1
   582623 863.089427  0.000066000  0.089405000 192.168.2.127  13.107.136.9   TCP          54   63442 → 443 [ACK] Seq=1 Ack=1 Win=65536 Len=0
```

# RTT2ACK and ACK4

#sf21veu



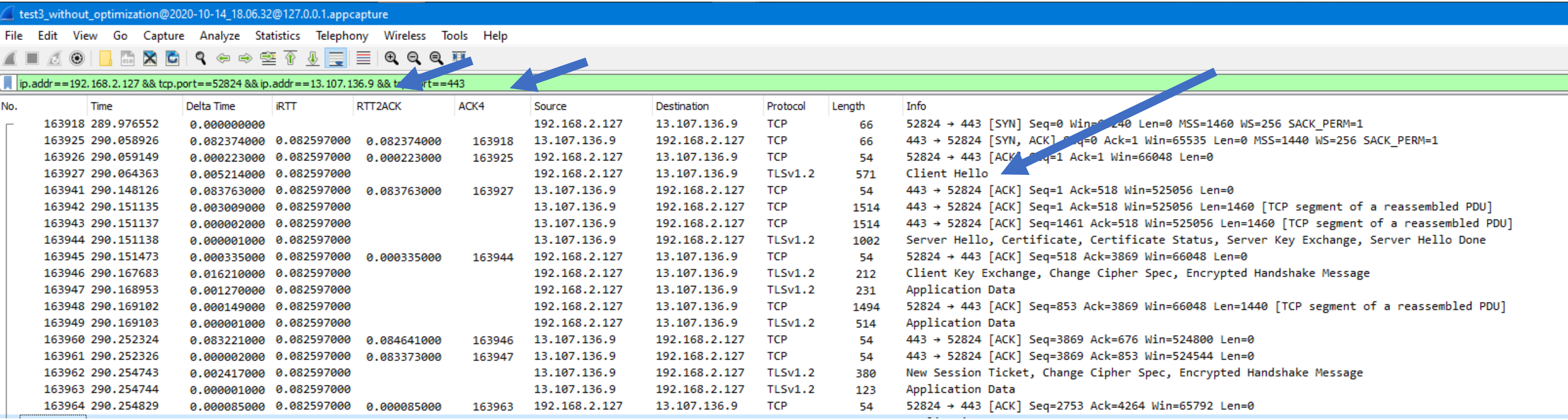
test3_without_optimization@2020-10-14_18.06.32@127.0.0.1.appcapture
File
Edit
View
Go
Capture
Analyze
Statistics
Telephony
Wireless
Tools
Help

```
ip.addr==192.168.2.127 && tcp.port==52824 && ip.addr==13.107.136.9 && tcp.port==443
```

```
No.     Time       Delta Time   iRTT         RTT2ACK      ACK4    Source         Destination    Protocol  Length  Info
163918 289.976552  0.000000000                                    192.168.2.127  13.107.136.9   TCP       66      52824 → 443 [SYN] Seq=0 Win=64240 Len=0 MSS=1460 WS=256 SACK_PERM=1
163925 290.058926  0.082374000  0.082597000  0.082374000  163918  13.107.136.9   192.168.2.127  TCP       66      443 → 52824 [SYN, ACK] Seq=0 Ack=1 Win=65535 Len=0 MSS=1440 WS=256 SACK_PERM=1
163926 290.059149  0.000223000  0.082597000  0.000223000  163925  192.168.2.127  13.107.136.9   TCP       54      52824 → 443 [ACK] Seq=1 Ack=1 Win=66048 Len=0
163927 290.064363  0.005214000  0.082597000                       192.168.2.127  13.107.136.9   TLSv1.2   571     Client Hello
163941 290.148126  0.083763000  0.082597000  0.083763000  163927  13.107.136.9   192.168.2.127  TCP       54      443 → 52824 [ACK] Seq=1 Ack=518 Win=525056 Len=0
163942 290.151135  0.003009000  0.082597000                       13.107.136.9   192.168.2.127  TCP       1514    443 → 52824 [ACK] Seq=1 Ack=518 Win=525056 Len=1460 [TCP segment of a reassembled PDU]
163943 290.151137  0.000002000  0.082597000                       13.107.136.9   192.168.2.127  TCP       1514    443 → 52824 [ACK] Seq=1461 Ack=518 Win=525056 Len=1460 [TCP segment of a reassembled PDU]
163944 290.151138  0.000001000  0.082597000                       13.107.136.9   192.168.2.127  TLSv1.2   1002    Server Hello, Certificate, Certificate Status, Server Key Exchange, Server Hello Done
163945 290.151473  0.000335000  0.082597000  0.000335000  163944  192.168.2.127  13.107.136.9   TCP       54      52824 → 443 [ACK] Seq=518 Ack=3869 Win=66048 Len=0
163946 290.167683  0.016210000  0.082597000                       192.168.2.127  13.107.136.9   TLSv1.2   212     Client Key Exchange, Change Cipher Spec, Encrypted Handshake Message
163947 290.168953  0.001270000  0.082597000                       192.168.2.127  13.107.136.9   TLSv1.2   231     Application Data
163948 290.169102  0.000149000  0.082597000                       192.168.2.127  13.107.136.9   TCP       1494    52824 → 443 [ACK] Seq=853 Ack=3869 Win=66048 Len=1440 [TCP segment of a reassembled PDU]
163949 290.169103  0.000001000  0.082597000                       192.168.2.127  13.107.136.9   TLSv1.2   514     Application Data
163960 290.252324  0.083221000  0.082597000  0.084641000  163946  13.107.136.9   192.168.2.127  TCP       54      443 → 52824 [ACK] Seq=3869 Ack=676 Win=524800 Len=0
163961 290.252326  0.000002000  0.082597000  0.083373000  163947  13.107.136.9   192.168.2.127  TCP       54      443 → 52824 [ACK] Seq=3869 Ack=853 Win=524544 Len=0
163962 290.254743  0.002417000  0.082597000                       13.107.136.9   192.168.2.127  TLSv1.2   380     New Session Ticket, Change Cipher Spec, Encrypted Handshake Message
163963 290.254744  0.000001000  0.082597000                       13.107.136.9   192.168.2.127  TLSv1.2   123     Application Data
163964 290.254829  0.000085000  0.082597000  0.000085000  163963  192.168.2.127  13.107.136.9   TCP       54      52824 → 443 [ACK] Seq=2753 Ack=4264 Win=65792 Len=0
```

Q. What is the RTT2ACK for the Client Hello Message?

# RTT2ACK and ACK4



test3_without_optimization@2020-10-14_18.06.32@127.0.0.1.appcapture
File Edit View Go Capture Analyze Statistics Telephony Wireless Tools Help

```
ip.addr==192.168.2.127 && tcp.port==52824 && ip.addr==13.107.136.9 && tcp.port==443
```

| No. | Time | Delta Time | iRTT | RTT2ACK | ACK4 | Source | Destination | Protocol | Length | Info |
|---|---|---|---|---|---|---|---|---|---|---|
| 163918 | 289.976552 | 0.000000000 | | | | 192.168.2.127 | 13.107.136.9 | TCP | 66 | 52824 → 443 [SYN] Seq=0 Win=64240 Len=0 MSS=1460 WS=256 SACK_PERM=1 |
| 163925 | 290.058926 | 0.082374000 | 0.082597000 | 0.082374000 | 163918 | 13.107.136.9 | 192.168.2.127 | TCP | 66 | 443 → 52824 [SYN, ACK] Seq=0 Ack=1 Win=65535 Len=0 MSS=1440 WS=256 SACK_PERM=1 |
| 163926 | 290.059149 | 0.000223000 | 0.082597000 | 0.000223000 | 163925 | 192.168.2.127 | 13.107.136.9 | TCP | 54 | 52824 → 443 [ACK] Seq=1 Ack=1 Win=66048 Len=0 |
| 163927 | 290.064363 | 0.005214000 | 0.082597000 | | | 192.168.2.127 | 13.107.136.9 | TLSv1.2 | 571 | Client Hello |
| 163941 | 290.148126 | 0.083763000 | 0.082597000 | 0.083763000 | 163927 | 13.107.136.9 | 192.168.2.127 | TCP | 54 | 443 → 52824 [ACK] Seq=1 Ack=518 Win=525056 Len=0 |
| 163942 | 290.151135 | 0.003009000 | 0.082597000 | | | 13.107.136.9 | 192.168.2.127 | TCP | 1514 | 443 → 52824 [ACK] Seq=1 Ack=518 Win=525056 Len=1460 [TCP segment of a reassembled PDU] |
| 163943 | 290.151137 | 0.000002000 | 0.082597000 | | | 13.107.136.9 | 192.168.2.127 | TCP | 1514 | 443 → 52824 [ACK] Seq=1461 Ack=518 Win=525056 Len=1460 [TCP segment of a reassembled PDU] |
| 163944 | 290.151138 | 0.000001000 | 0.082597000 | | | 13.107.136.9 | 192.168.2.127 | TLSv1.2 | 1002 | Server Hello, Certificate, Certificate Status, Server Key Exchange, Server Hello Done |
| 163945 | 290.151473 | 0.000335000 | 0.082597000 | 0.000335000 | 163944 | 192.168.2.127 | 13.107.136.9 | TCP | 54 | 52824 → 443 [ACK] Seq=518 Ack=3869 Win=66048 Len=0 |
| 163946 | 290.167683 | 0.016210000 | 0.082597000 | | | 192.168.2.127 | 13.107.136.9 | TLSv1.2 | 212 | Client Key Exchange, Change Cipher Spec, Encrypted Handshake Message |
| 163947 | 290.168953 | 0.001270000 | 0.082597000 | | | 192.168.2.127 | 13.107.136.9 | TLSv1.2 | 231 | Application Data |
| 163948 | 290.169102 | 0.000149000 | 0.082597000 | | | 192.168.2.127 | 13.107.136.9 | TCP | 1494 | 52824 → 443 [ACK] Seq=853 Ack=3869 Win=66048 Len=1440 [TCP segment of a reassembled PDU] |
| 163949 | 290.169103 | 0.000001000 | 0.082597000 | | | 192.168.2.127 | 13.107.136.9 | TLSv1.2 | 514 | Application Data |
| 163960 | 290.252324 | 0.083221000 | 0.082597000 | 0.084641000 | 163946 | 13.107.136.9 | 192.168.2.127 | TCP | 54 | 443 → 52824 [ACK] Seq=3869 Ack=676 Win=524800 Len=0 |
| 163961 | 290.252326 | 0.000002000 | 0.082597000 | 0.083373000 | 163947 | 13.107.136.9 | 192.168.2.127 | TCP | 54 | 443 → 52824 [ACK] Seq=3869 Ack=853 Win=524544 Len=0 |
| 163962 | 290.254743 | 0.002417000 | 0.082597000 | | | 13.107.136.9 | 192.168.2.127 | TLSv1.2 | 380 | New Session Ticket, Change Cipher Spec, Encrypted Handshake Message |
| 163963 | 290.254744 | 0.000001000 | 0.082597000 | | | 13.107.136.9 | 192.168.2.127 | TLSv1.2 | 123 | Application Data |
| 163964 | 290.254829 | 0.000085000 | 0.082597000 | 0.000085000 | 163963 | 192.168.2.127 | 13.107.136.9 | TCP | 54 | 52824 → 443 [ACK] Seq=2753 Ack=4264 Win=65792 Len=0 |

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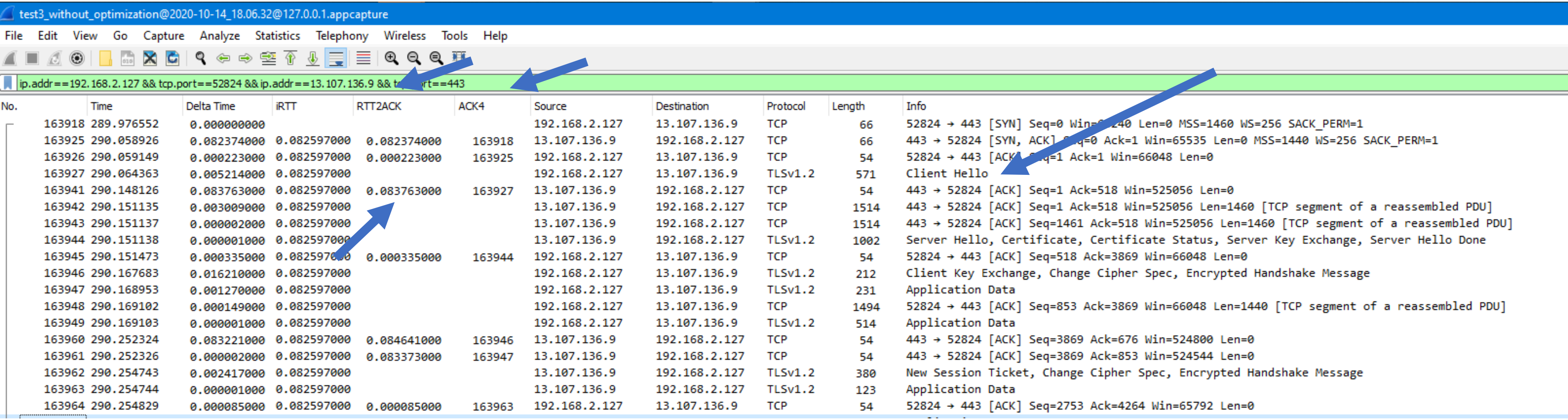

test3_without_optimization@2020-10-14_18.06.32@127.0.0.1.appcapture

ip.addr==192.168.2.127 && tcp.port==52824 && ip.addr==13.107.136.9 && tcp.port==443

| No. | Time | Delta Time | iRTT | RTT2ACK | ACK4 | Source | Destination | Protocol | Length | Info |
|---|---|---|---|---|---|---|---|---|---|---|
| 163918 | 289.976552 | 0.000000000 | | | | 192.168.2.127 | 13.107.136.9 | TCP | 66 | 52824 → 443 [SYN] Seq=0 Win=64240 Len=0 MSS=1460 WS=256 SACK_PERM=1 |
| 163925 | 290.058926 | 0.082374000 | 0.082597000 | 0.082374000 | 163918 | 13.107.136.9 | 192.168.2.127 | TCP | 66 | 443 → 52824 [SYN, ACK] Seq=0 Ack=1 Win=65535 Len=0 MSS=1440 WS=256 SACK_PERM=1 |
| 163926 | 290.059149 | 0.000223000 | 0.082597000 | 0.000223000 | 163925 | 192.168.2.127 | 13.107.136.9 | TCP | 54 | 52824 → 443 [ACK] Seq=1 Ack=1 Win=66048 Len=0 |
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| 163945 | 290.151473 | 0.000335000 | 0.082597000 | 0.000335000 | 163944 | 192.168.2.127 | 13.107.136.9 | TCP | 54 | 52824 → 443 [ACK] Seq=518 Ack=3869 Win=66048 Len=0 |
| 163946 | 290.167683 | 0.016210000 | 0.082597000 | | | 192.168.2.127 | 13.107.136.9 | TLSv1.2 | 212 | Client Key Exchange, Change Cipher Spec, Encrypted Handshake Message |
| 163947 | 290.168953 | 0.001270000 | 0.082597000 | | | 192.168.2.127 | 13.107.136.9 | TLSv1.2 | 231 | Application Data |
| 163948 | 290.169102 | 0.000149000 | 0.082597000 | | | 192.168.2.127 | 13.107.136.9 | TCP | 1494 | 52824 → 443 [ACK] Seq=853 Ack=3869 Win=66048 Len=1440 [TCP segment of a reassembled PDU] |
| 163949 | 290.169103 | 0.000001000 | 0.082597000 | | | 192.168.2.127 | 13.107.136.9 | TLSv1.2 | 514 | Application Data |
| 163960 | 290.252324 | 0.083221000 | 0.082597000 | 0.084641000 | 163946 | 13.107.136.9 | 192.168.2.127 | TCP | 54 | 443 → 52824 [ACK] Seq=3869 Ack=676 Win=524800 Len=0 |
| 163961 | 290.252326 | 0.000002000 | 0.082597000 | 0.083373000 | 163947 | 13.107.136.9 | 192.168.2.127 | TCP | 54 | 443 → 52824 [ACK] Seq=3869 Ack=853 Win=524544 Len=0 |
| 163962 | 290.254743 | 0.002417000 | 0.082597000 | | | 13.107.136.9 | 192.168.2.127 | TLSv1.2 | 380 | New Session Ticket, Change Cipher Spec, Encrypted Handshake Message |
| 163963 | 290.254744 | 0.000001000 | 0.082597000 | | | 13.107.136.9 | 192.168.2.127 | TLSv1.2 | 123 | Application Data |
| 163964 | 290.254829 | 0.000085000 | 0.082597000 | 0.000085000 | 163963 | 192.168.2.127 | 13.107.136.9 | TCP | 54 | 52824 → 443 [ACK] Seq=2753 Ack=4264 Win=65792 Len=0 |

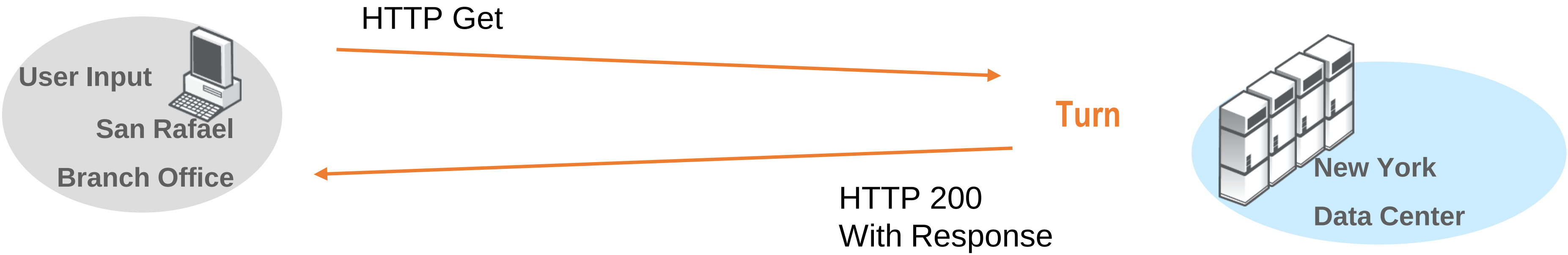
Q. What is the RTT2ACK for the Client Hello Message?
A. 83.7ms

# Key Concept Ahead

# Application Turn

- Request Message / Response Message Pair
  - Request Message can be multiple packets
  - Response Message can be multiple packets
- Request/Response Pair == 1 Turn
- Time duration is at least 1 RTT
- 10 Turns @ 100ms RTT >= 1 Second Duration

# HTTP Example



HTTP Get

User Input

San Rafael

Branch Office

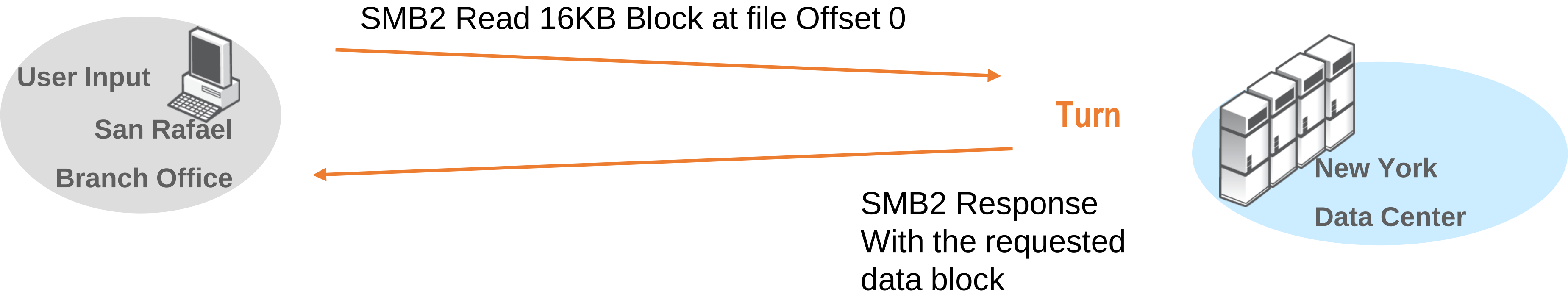
Turn

New York

Data Center

HTTP 200
With Response

# SMB2 Example



SMB2 Read 16KB Block at file Offset 0

User Input

San Rafael

Branch Office

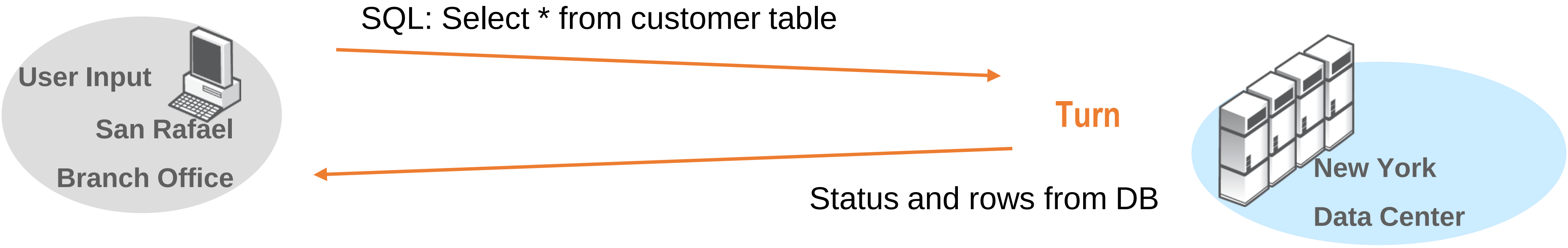
Turn

New York

Data Center

SMB2 Response
With the requested
data block

# SQL Example



SQL: Select * from customer table

User Input

San Rafael

Branch Office

Turn

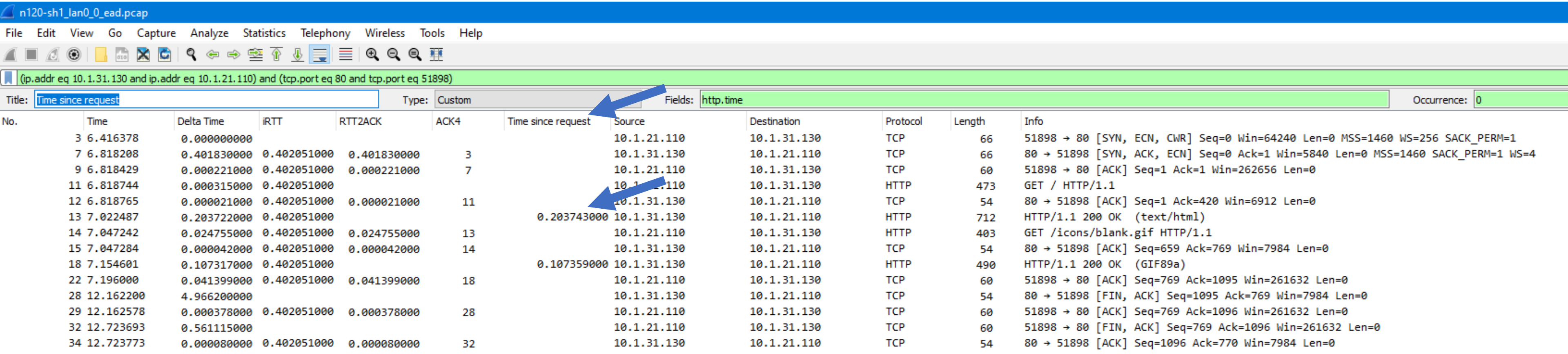
New York

Data Center

Status and rows from DB

# One more useful metric

- Some decodes measure delta between request / response



n120-sh1_lan0_0_ead.pcap

File Edit View Go Capture Analyze Statistics Telephony Wireless Tools Help

(ip.addr eq 10.1.31.130 and ip.addr eq 10.1.21.110) and (tcp.port eq 80 and tcp.port eq 51898)

Title: Time since request   Type: Custom   Fields: http.time   Occurrence: 0

```
No.   Time       Delta Time   iRTT         RTT2ACK      ACK4  Time since request  Source       Destination  Protocol  Length  Info
    3 6.416378   0.000000000                                                      10.1.21.110  10.1.31.130  TCP       66      51898 → 80 [SYN, ECN, CWR] Seq=0 Win=64240 Len=0 MSS=1460 WS=256 SACK_PERM=1
    7 6.818208   0.401830000  0.402051000  0.401830000  3                         10.1.31.130  10.1.21.110  TCP       66      80 → 51898 [SYN, ACK, ECN] Seq=0 Ack=1 Win=5840 Len=0 MSS=1460 SACK_PERM=1 WS=4
    9 6.818429   0.000221000  0.402051000  0.000221000  7                         10.1.21.110  10.1.31.130  TCP       60      51898 → 80 [ACK] Seq=1 Ack=1 Win=262656 Len=0
   11 6.818744   0.000315000  0.402051000                                         10.1.21.110  10.1.31.130  HTTP      473     GET / HTTP/1.1
   12 6.818765   0.000021000  0.402051000  0.000021000  11                        10.1.31.130  10.1.21.110  TCP       54      80 → 51898 [ACK] Seq=1 Ack=420 Win=6912 Len=0
   13 7.022487   0.203722000  0.402051000                     0.203743000         10.1.31.130  10.1.21.110  HTTP      712     HTTP/1.1 200 OK  (text/html)
   14 7.047242   0.024755000  0.402051000  0.024755000  13                        10.1.21.110  10.1.31.130  HTTP      403     GET /icons/blank.gif HTTP/1.1
   15 7.047284   0.000042000  0.402051000  0.000042000  14                        10.1.31.130  10.1.21.110  TCP       54      80 → 51898 [ACK] Seq=659 Ack=769 Win=7984 Len=0
   18 7.154601   0.107317000  0.402051000                     0.107359000         10.1.31.130  10.1.21.110  HTTP      490     HTTP/1.1 200 OK  (GIF89a)
   22 7.196000   0.041399000  0.402051000  0.041399000  18                        10.1.21.110  10.1.31.130  TCP       60      51898 → 80 [ACK] Seq=769 Ack=1095 Win=261632 Len=0
   28 12.162200  4.966200000                                                      10.1.31.130  10.1.21.110  TCP       54      80 → 51898 [FIN, ACK] Seq=1095 Ack=769 Win=7984 Len=0
   29 12.162578  0.000378000  0.402051000  0.000378000  28                        10.1.21.110  10.1.31.130  TCP       60      51898 → 80 [ACK] Seq=769 Ack=1096 Win=261632 Len=0
   32 12.723693  0.561115000                                                      10.1.21.110  10.1.31.130  TCP       60      51898 → 80 [FIN, ACK] Seq=769 Ack=1096 Win=261632 Len=0
   34 12.723773  0.000080000  0.402051000  0.000080000  32                        10.1.31.130  10.1.21.110  TCP       54      80 → 51898 [ACK] Seq=1096 Ack=770 Win=7984 Len=0
```

# What about TCP? (Transport)

- Is it sensitive to Latency?

- Does it have Turns too?

# What about TCP?

- Is it sensitive to Latency?
- Does it have Turns too?
- Consider Congestion Window Mechanisms, Slow-Start, Delayed-ACK, Retransmits, etc.
- You pay a RTT Penalty for some of these

# !!! Please Read !!!

If you remember only one key point from this entire session…

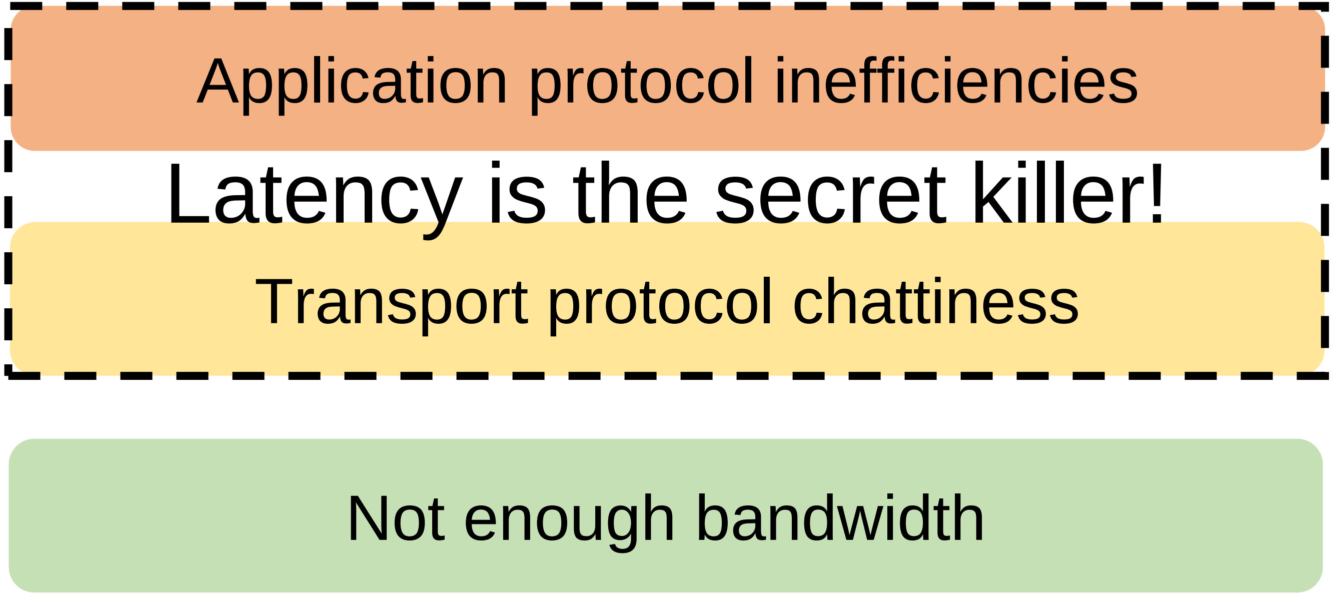
# Key Point

- Latency * Turn Rate == User Pain

# Key Point

- Latency * Turn Rate == User Pain
- Reduce Turn Rate == Reduced User Pain
- Reduce Latency == Reduced User Pain

# Review



Application protocol inefficiencies

Latency is the secret killer!

Transport protocol chattiness

Not enough bandwidth

**You have to solve all three to see performance benefits**

# SteelHead Features Overview

# Optimization Features

- Transport Optimization
  - TCP Proxy / ACK Spoofing
  - Intelligent Caching
  - Compression / Deduplication
  - WAN Connection Pooling
  - Overrides for sub-optimal TCP Options
  - Enhanced WAN Packet Loss Recovery Mechanisms
  - High Latency Detection / Optimizations

# Optimization Features

- Application Protocol Specific Optimizations
  - Override sub-optimal settings / behavior
  - Pre-Fetch
  - Read Ahead / Immediate Write
  - Object Caching
- Policy and QoS based Traffic Shaping
- App Recognition to Drive Traffic Mgmt Policies
- Secure traffic between sites

# Common Themes

- ✓ Reduce Turns
- ✓ Reduce Payload
- ✓ Reduce User Pain

# Wireshark Analysis & Timing Samples

# Scenarios

#sf21veu

- Scenario #1 – Virtual Lab Environment
  - Enhanced Auto Discovery
  - Transport Optimization

- Scenario #2 - Client Accelerator (John’s Laptop)
  - Transport Optimization
  - Improve Response Times

# Scenario #1

- Riverbed Training - Lab Environment
- Virtual Everything (SH, Client, Server, WAN, etc.)
- Explore Enhanced Auto Discovery & Transport Optimization

# Lab Scenario Topology

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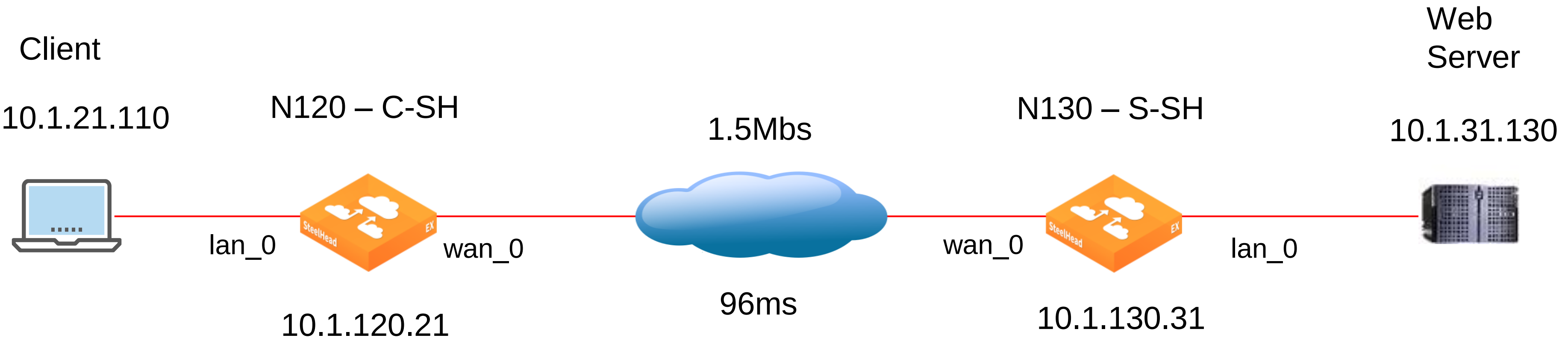
All Components are Virtualized

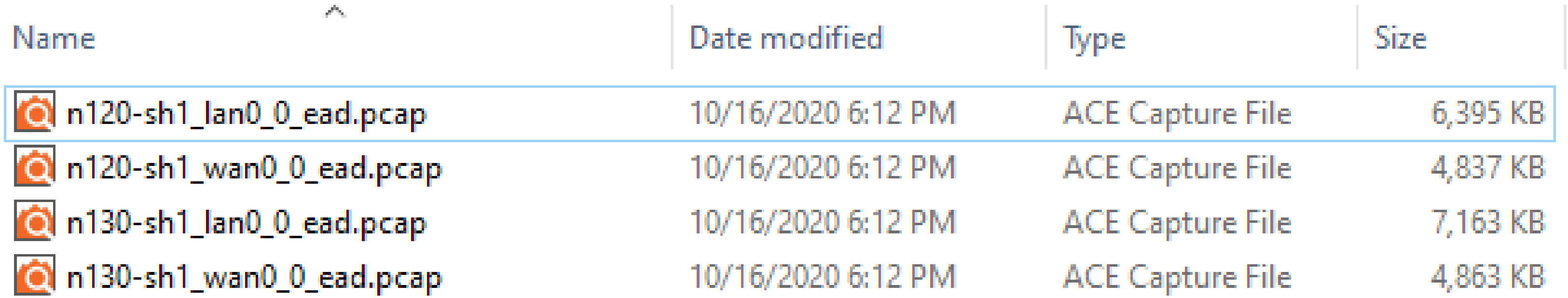


- Transactions, all HTTP, of note (from cfe LAN perspective):
  - ○ Open 10.1.31.130
  - ○ Click public folder (srcprt: 51902)
  - ○ Click High-Res Images folder (srcprt: 51904)
  - ○ R-click > save as: wallpaper-1871712.png (srcprt: 51907)
  - ○ R-click > save as: wallpaper-1985738.png (srcprt: 51910)

R-click > save as: wallpaper-1985738 (1).png (srcprt: 51915)

# Four Capture Files

- TCPDumps controlled from the SteelHead Web UI



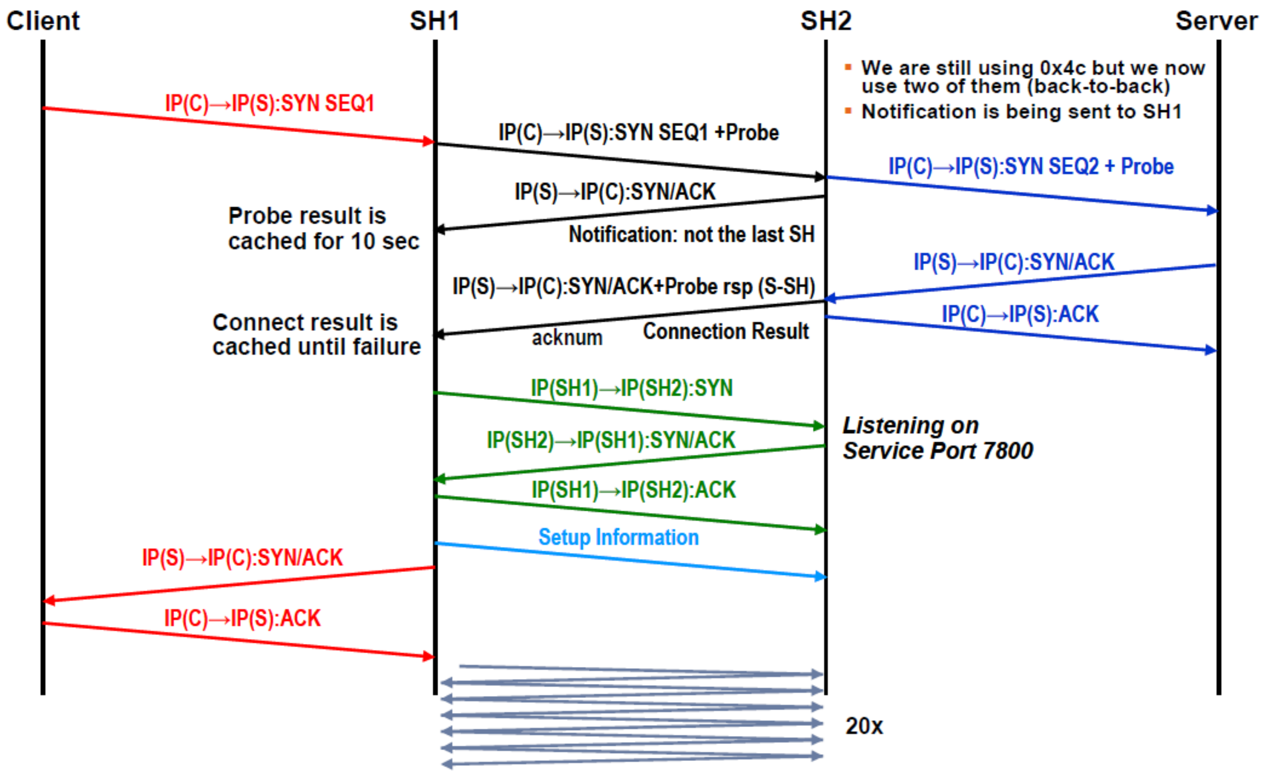
| Name | Date modified | Type | Size |
|---|---|---|---|
| n120-sh1_lan0_0_ead.pcap | 10/16/2020 6:12 PM | ACE Capture File | 6,395 KB |
| n120-sh1_wan0_0_ead.pcap | 10/16/2020 6:12 PM | ACE Capture File | 4,837 KB |
| n130-sh1_lan0_0_ead.pcap | 10/16/2020 6:12 PM | ACE Capture File | 7,163 KB |
| n130-sh1_wan0_0_ead.pcap | 10/16/2020 6:12 PM | ACE Capture File | 4,863 KB |

# Purpose of Auto Discovery

- Initiated by Client side SteelHead
- Discover possible SteelHeads in the path that are closest to Server
- If an appropriate SH is discovered, then client SH will establish peering relationship if one does not already exist
- Transparent to both the client and the server end points

# EAD - Bounce Chart

#sf21veu

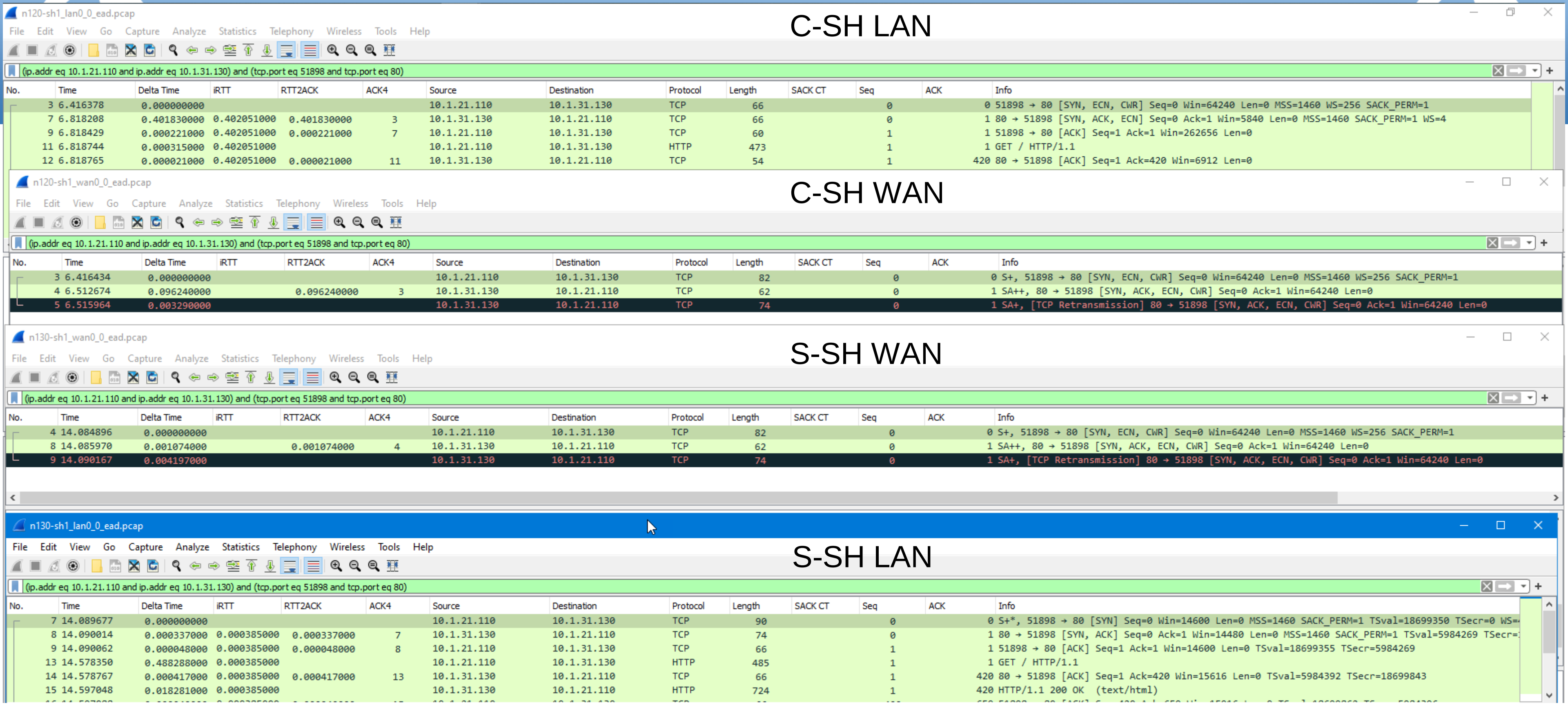


- We are still using 0x4c but we now use two of them (back-to-back)
- Notification is being sent to SH1

*Listening on Service Port 7800*

# Be on the “lookout”

- Decode Labels: SYN+, SYN++, SYN+*
- SYN-ACK Retransmission
- iRTT higher than expected
- TCP Options being modified



n120-sh1_lan0_0_ead.pcap
File Edit View Go Capture Analyze Statistics Telephony Wireless Tools Help

C-SH LAN

(ip.addr eq 10.1.21.110 and ip.addr eq 10.1.31.130) and (tcp.port eq 51898 and tcp.port eq 80)

| No. | Time | Delta Time | iRTT | RTT2ACK | ACK4 | Source | Destination | Protocol | Length | SACK CT | Seq | ACK | Info |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 3 | 6.416378 | 0.000000000 | | | | 10.1.21.110 | 10.1.31.130 | TCP | 66 | | 0 | 0 | 51898 → 80 [SYN, ECN, CWR] Seq=0 Win=64240 Len=0 MSS=1460 WS=256 SACK_PERM=1 |
| 7 | 6.818208 | 0.401830000 | 0.402051000 | 0.401830000 | 3 | 10.1.31.130 | 10.1.21.110 | TCP | 66 | | 0 | 1 | 80 → 51898 [SYN, ACK, ECN] Seq=0 Ack=1 Win=5840 Len=0 MSS=1460 SACK_PERM=1 WS=4 |
| 9 | 6.818429 | 0.000221000 | 0.402051000 | 0.000221000 | 7 | 10.1.21.110 | 10.1.31.130 | TCP | 60 | | 1 | 1 | 51898 → 80 [ACK] Seq=1 Ack=1 Win=262656 Len=0 |
| 11 | 6.818744 | 0.000315000 | 0.402051000 | | | 10.1.21.110 | 10.1.31.130 | HTTP | 473 | | 1 | 1 | GET / HTTP/1.1 |
| 12 | 6.818765 | 0.000021000 | 0.402051000 | 0.000021000 | 11 | 10.1.31.130 | 10.1.21.110 | TCP | 54 | | 1 | 420 | 80 → 51898 [ACK] Seq=1 Ack=420 Win=6912 Len=0 |

n120-sh1_wan0_0_ead.pcap
File Edit View Go Capture Analyze Statistics Telephony Wireless Tools Help

C-SH WAN

(ip.addr eq 10.1.21.110 and ip.addr eq 10.1.31.130) and (tcp.port eq 51898 and tcp.port eq 80)

| No. | Time | Delta Time | iRTT | RTT2ACK | ACK4 | Source | Destination | Protocol | Length | SACK CT | Seq | ACK | Info |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 3 | 6.416434 | 0.000000000 | | | | 10.1.21.110 | 10.1.31.130 | TCP | 82 | | 0 | 0 | S+, 51898 → 80 [SYN, ECN, CWR] Seq=0 Win=64240 Len=0 MSS=1460 WS=256 SACK_PERM=1 |
| 4 | 6.512674 | 0.096240000 | | 0.096240000 | 3 | 10.1.31.130 | 10.1.21.110 | TCP | 62 | | 0 | 1 | SA++, 80 → 51898 [SYN, ACK, ECN, CWR] Seq=0 Ack=1 Win=64240 Len=0 |
| 5 | 6.515964 | 0.003290000 | | | | 10.1.31.130 | 10.1.21.110 | TCP | 74 | | 0 | 1 | SA+, [TCP Retransmission] 80 → 51898 [SYN, ACK, ECN, CWR] Seq=0 Ack=1 Win=64240 Len=0 |

n130-sh1_wan0_0_ead.pcap
File Edit View Go Capture Analyze Statistics Telephony Wireless Tools Help

S-SH WAN

(ip.addr eq 10.1.21.110 and ip.addr eq 10.1.31.130) and (tcp.port eq 51898 and tcp.port eq 80)

| No. | Time | Delta Time | iRTT | RTT2ACK | ACK4 | Source | Destination | Protocol | Length | SACK CT | Seq | ACK | Info |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 4 | 14.084896 | 0.000000000 | | | | 10.1.21.110 | 10.1.31.130 | TCP | 82 | | 0 | 0 | S+, 51898 → 80 [SYN, ECN, CWR] Seq=0 Win=64240 Len=0 MSS=1460 WS=256 SACK_PERM=1 |
| 8 | 14.085970 | 0.001074000 | | 0.001074000 | 4 | 10.1.31.130 | 10.1.21.110 | TCP | 62 | | 0 | 1 | SA++, 80 → 51898 [SYN, ACK, ECN, CWR] Seq=0 Ack=1 Win=64240 Len=0 |
| 9 | 14.090167 | 0.004197000 | | | | 10.1.31.130 | 10.1.21.110 | TCP | 74 | | 0 | 1 | SA+, [TCP Retransmission] 80 → 51898 [SYN, ACK, ECN, CWR] Seq=0 Ack=1 Win=64240 Len=0 |

n130-sh1_lan0_0_ead.pcap
File Edit View Go Capture Analyze Statistics Telephony Wireless Tools Help

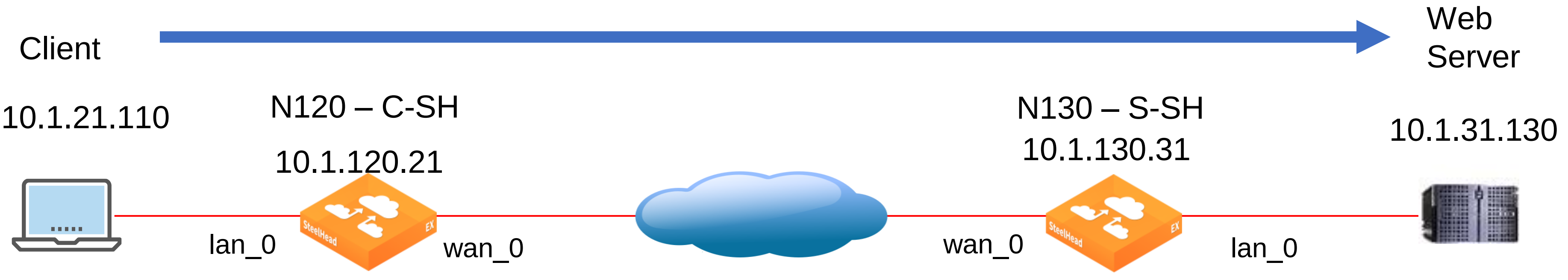
S-SH LAN

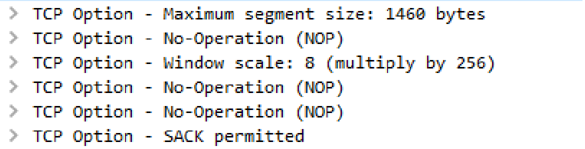
(ip.addr eq 10.1.21.110 and ip.addr eq 10.1.31.130) and (tcp.port eq 51898 and tcp.port eq 80)

| No. | Time | Delta Time | iRTT | RTT2ACK | ACK4 | Source | Destination | Protocol | Length | SACK CT | Seq | ACK | Info |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 7 | 14.089677 | 0.000000000 | | | | 10.1.21.110 | 10.1.31.130 | TCP | 90 | | 0 | 0 | S+*, 51898 → 80 [SYN] Seq=0 Win=14600 Len=0 MSS=1460 SACK_PERM=1 TSval=18699350 TSecr=0 WS= |
| 8 | 14.090014 | 0.000337000 | 0.000385000 | 0.000337000 | 7 | 10.1.31.130 | 10.1.21.110 | TCP | 74 | | 0 | 1 | 80 → 51898 [SYN, ACK] Seq=0 Ack=1 Win=14480 Len=0 MSS=1460 SACK_PERM=1 TSval=5984269 TSecr= |
| 9 | 14.090062 | 0.000048000 | 0.000385000 | 0.000048000 | 8 | 10.1.21.110 | 10.1.31.130 | TCP | 66 | | 1 | 1 | 51898 → 80 [ACK] Seq=1 Ack=1 Win=14600 Len=0 TSval=18699355 TSecr=5984269 |
| 13 | 14.578350 | 0.488288000 | 0.000385000 | | | 10.1.21.110 | 10.1.31.130 | HTTP | 485 | | 1 | 1 | GET / HTTP/1.1 |
| 14 | 14.578767 | 0.000417000 | 0.000385000 | 0.000417000 | 13 | 10.1.31.130 | 10.1.21.110 | TCP | 66 | | 1 | 420 | 80 → 51898 [ACK] Seq=1 Ack=420 Win=15616 Len=0 TSval=5984392 TSecr=18699843 |
| 15 | 14.597048 | 0.018281000 | 0.000385000 | | | 10.1.31.130 | 10.1.21.110 | HTTP | 724 | | 1 | 420 | HTTP/1.1 200 OK (text/html) |

# Journey of SYN

# SYN-LAN_0

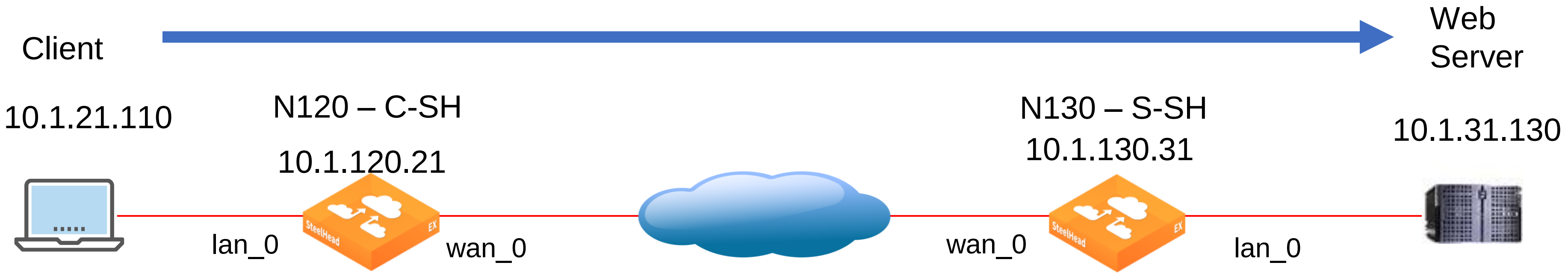


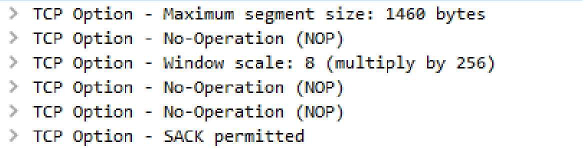


```
> TCP Option - Maximum segment size: 1460 bytes
> TCP Option - No-Operation (NOP)
> TCP Option - Window scale: 8 (multiply by 256)
> TCP Option - No-Operation (NOP)
> TCP Option - No-Operation (NOP)
> TCP Option - SACK permitted
```

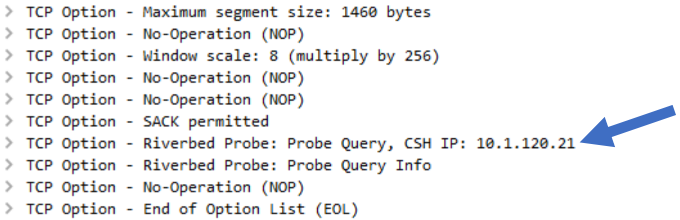
# SYN-WAN_0

#sf21veu



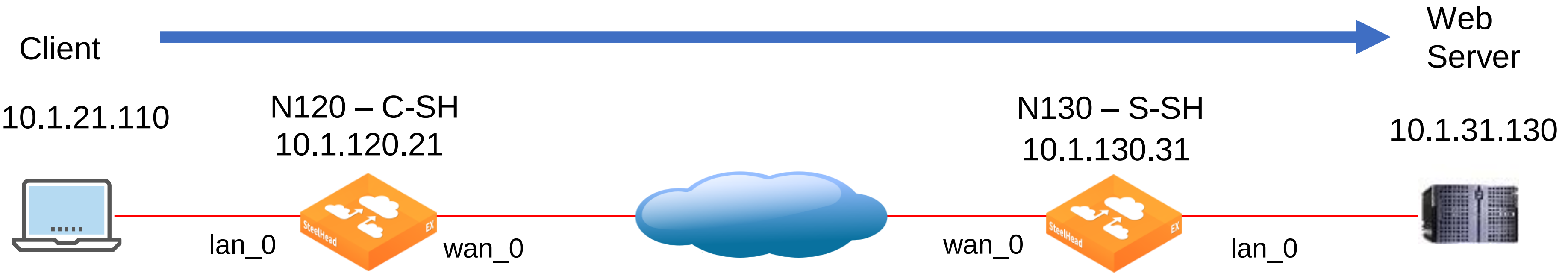


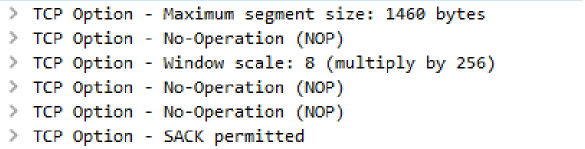
```
> TCP Option - Maximum segment size: 1460 bytes
> TCP Option - No-Operation (NOP)
> TCP Option - Window scale: 8 (multiply by 256)
> TCP Option - No-Operation (NOP)
> TCP Option - No-Operation (NOP)
> TCP Option - SACK permitted
```



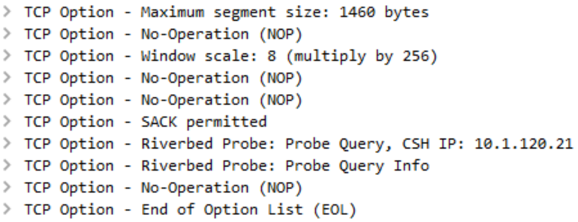
```
> TCP Option - Maximum segment size: 1460 bytes
> TCP Option - No-Operation (NOP)
> TCP Option - Window scale: 8 (multiply by 256)
> TCP Option - No-Operation (NOP)
> TCP Option - No-Operation (NOP)
> TCP Option - SACK permitted
> TCP Option - Riverbed Probe: Probe Query, CSH IP: 10.1.120.21
> TCP Option - Riverbed Probe: Probe Query Info
> TCP Option - No-Operation (NOP)
> TCP Option - End of Option List (EOL)
```

# SYN-WAN_0 DC

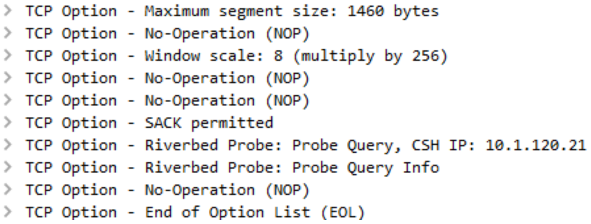




```
> TCP Option - Maximum segment size: 1460 bytes
> TCP Option - No-Operation (NOP)
> TCP Option - Window scale: 8 (multiply by 256)
> TCP Option - No-Operation (NOP)
> TCP Option - No-Operation (NOP)
> TCP Option - SACK permitted
```

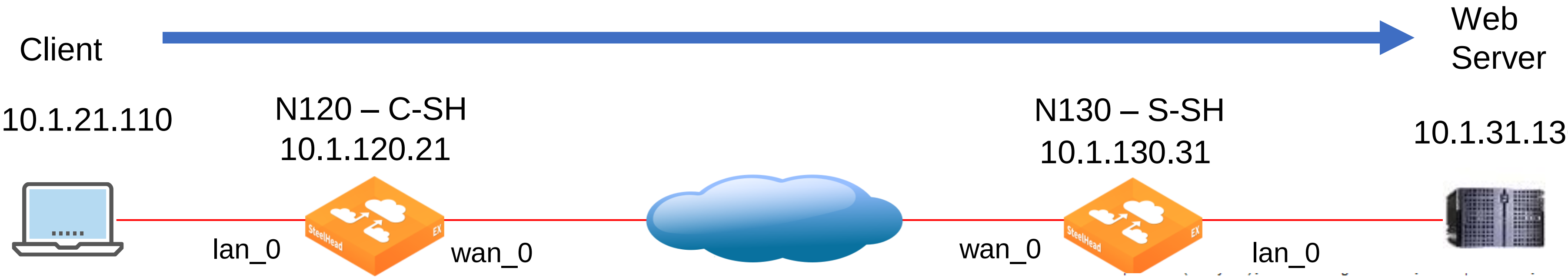


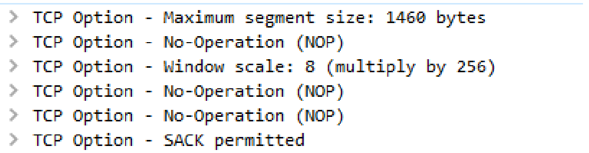
```
> TCP Option - Maximum segment size: 1460 bytes
> TCP Option - No-Operation (NOP)
> TCP Option - Window scale: 8 (multiply by 256)
> TCP Option - No-Operation (NOP)
> TCP Option - No-Operation (NOP)
> TCP Option - SACK permitted
> TCP Option - Riverbed Probe: Probe Query, CSH IP: 10.1.120.21
> TCP Option - Riverbed Probe: Probe Query Info
> TCP Option - No-Operation (NOP)
> TCP Option - End of Option List (EOL)
```



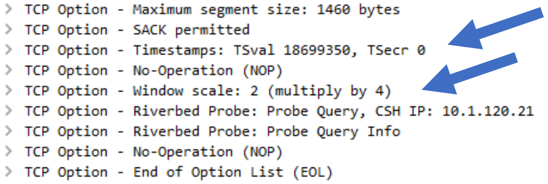
```
> TCP Option - Maximum segment size: 1460 bytes
> TCP Option - No-Operation (NOP)
> TCP Option - Window scale: 8 (multiply by 256)
> TCP Option - No-Operation (NOP)
> TCP Option - No-Operation (NOP)
> TCP Option - SACK permitted
> TCP Option - Riverbed Probe: Probe Query, CSH IP: 10.1.120.21
> TCP Option - Riverbed Probe: Probe Query Info
> TCP Option - No-Operation (NOP)
> TCP Option - End of Option List (EOL)
```

# SYN-LAN_0 DC

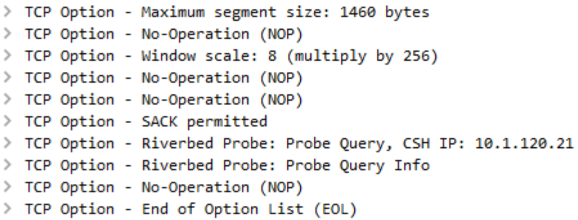




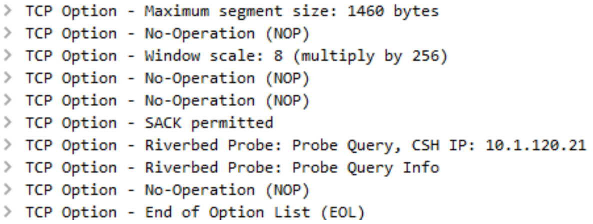
```
> TCP Option - Maximum segment size: 1460 bytes
> TCP Option - No-Operation (NOP)
> TCP Option - Window scale: 8 (multiply by 256)
> TCP Option - No-Operation (NOP)
> TCP Option - No-Operation (NOP)
> TCP Option - SACK permitted
```



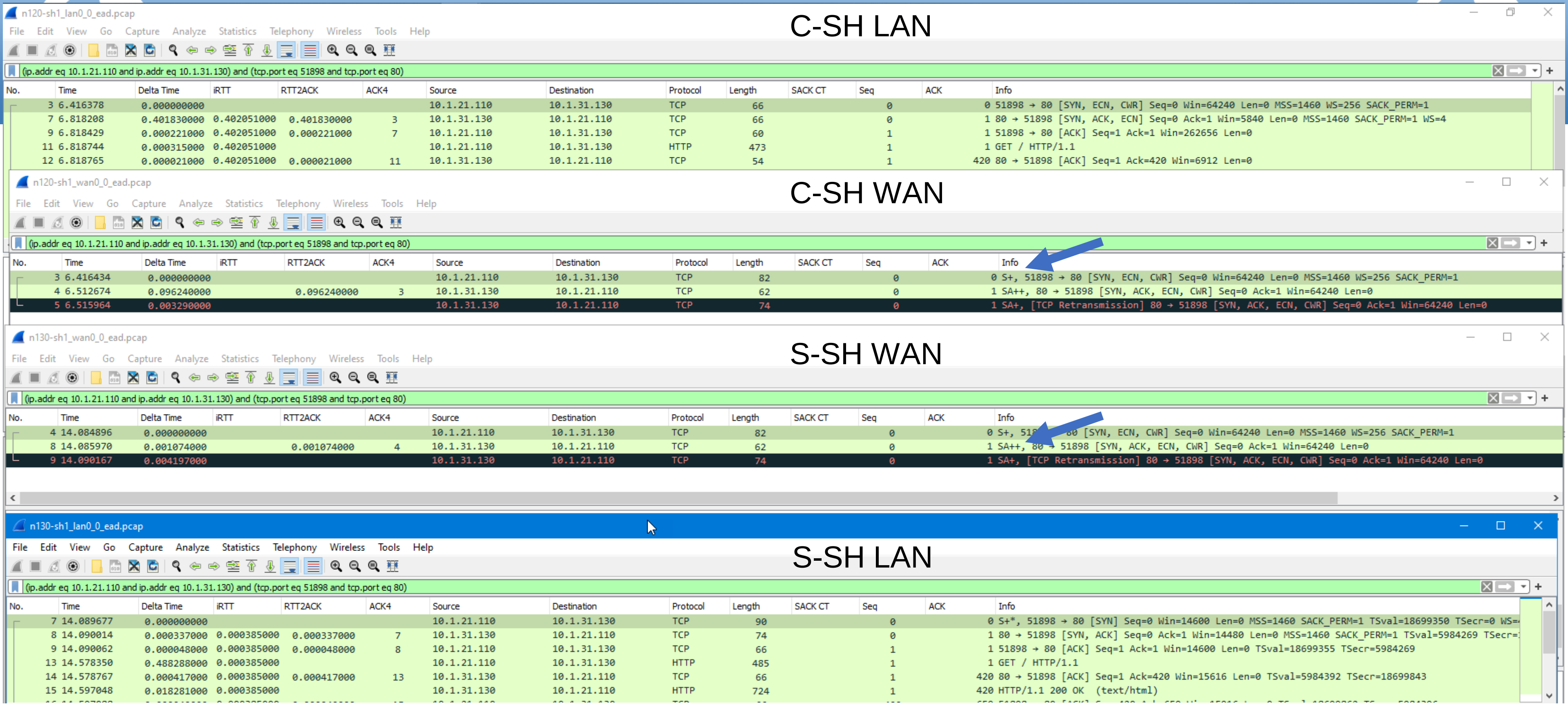
```
> TCP Option - Maximum segment size: 1460 bytes
> TCP Option - SACK permitted
> TCP Option - Timestamps: TSval 18699350, TSecr 0
> TCP Option - No-Operation (NOP)
> TCP Option - Window scale: 2 (multiply by 4)
> TCP Option - Riverbed Probe: Probe Query, CSH IP: 10.1.120.21
> TCP Option - Riverbed Probe: Probe Query Info
> TCP Option - No-Operation (NOP)
> TCP Option - End of Option List (EOL)
```



```
> TCP Option - Maximum segment size: 1460 bytes
> TCP Option - No-Operation (NOP)
> TCP Option - Window scale: 8 (multiply by 256)
> TCP Option - No-Operation (NOP)
> TCP Option - No-Operation (NOP)
> TCP Option - SACK permitted
> TCP Option - Riverbed Probe: Probe Query, CSH IP: 10.1.120.21
> TCP Option - Riverbed Probe: Probe Query Info
> TCP Option - No-Operation (NOP)
> TCP Option - End of Option List (EOL)
```



```
> TCP Option - Maximum segment size: 1460 bytes
> TCP Option - No-Operation (NOP)
> TCP Option - Window scale: 8 (multiply by 256)
> TCP Option - No-Operation (NOP)
> TCP Option - No-Operation (NOP)
> TCP Option - SACK permitted
> TCP Option - Riverbed Probe: Probe Query, CSH IP: 10.1.120.21
> TCP Option - Riverbed Probe: Probe Query Info
> TCP Option - No-Operation (NOP)
> TCP Option - End of Option List (EOL)
```



C-SH LAN

n120-sh1_lan0_0_ead.pcap

(ip.addr eq 10.1.21.110 and ip.addr eq 10.1.31.130) and (tcp.port eq 51898 and tcp.port eq 80)

| No. | Time | Delta Time | iRTT | RTT2ACK | ACK4 | Source | Destination | Protocol | Length | SACK CT | Seq | ACK | Info |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 3 | 6.416378 | 0.000000000 | | | | 10.1.21.110 | 10.1.31.130 | TCP | 66 | | 0 | 0 | 51898 → 80 [SYN, ECN, CWR] Seq=0 Win=64240 Len=0 MSS=1460 WS=256 SACK_PERM=1 |
| 7 | 6.818208 | 0.401830000 | 0.402051000 | 0.401830000 | 3 | 10.1.31.130 | 10.1.21.110 | TCP | 66 | | 0 | 1 | 80 → 51898 [SYN, ACK, ECN] Seq=0 Ack=1 Win=5840 Len=0 MSS=1460 SACK_PERM=1 WS=4 |
| 9 | 6.818429 | 0.000221000 | 0.402051000 | 0.000221000 | 7 | 10.1.21.110 | 10.1.31.130 | TCP | 60 | | 1 | 1 | 51898 → 80 [ACK] Seq=1 Ack=1 Win=262656 Len=0 |
| 11 | 6.818744 | 0.000315000 | 0.402051000 | | | 10.1.21.110 | 10.1.31.130 | HTTP | 473 | | 1 | 1 | GET / HTTP/1.1 |
| 12 | 6.818765 | 0.000021000 | 0.402051000 | 0.000021000 | 11 | 10.1.31.130 | 10.1.21.110 | TCP | 54 | | 1 | 420 | 80 → 51898 [ACK] Seq=1 Ack=420 Win=6912 Len=0 |

C-SH WAN

n120-sh1_wan0_0_ead.pcap

(ip.addr eq 10.1.21.110 and ip.addr eq 10.1.31.130) and (tcp.port eq 51898 and tcp.port eq 80)

| No. | Time | Delta Time | iRTT | RTT2ACK | ACK4 | Source | Destination | Protocol | Length | SACK CT | Seq | ACK | Info |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 3 | 6.416434 | 0.000000000 | | | | 10.1.21.110 | 10.1.31.130 | TCP | 82 | | 0 | 0 | S+, 51898 → 80 [SYN, ECN, CWR] Seq=0 Win=64240 Len=0 MSS=1460 WS=256 SACK_PERM=1 |
| 4 | 6.512674 | 0.096240000 | | 0.096240000 | 3 | 10.1.31.130 | 10.1.21.110 | TCP | 62 | | 0 | 1 | SA++, 80 → 51898 [SYN, ACK, ECN, CWR] Seq=0 Ack=1 Win=64240 Len=0 |
| 5 | 6.515964 | 0.003290000 | | | | 10.1.31.130 | 10.1.21.110 | TCP | 74 | | 0 | 1 | SA+, [TCP Retransmission] 80 → 51898 [SYN, ACK, ECN, CWR] Seq=0 Ack=1 Win=64240 Len=0 |

S-SH WAN

n130-sh1_wan0_0_ead.pcap

(ip.addr eq 10.1.21.110 and ip.addr eq 10.1.31.130) and (tcp.port eq 51898 and tcp.port eq 80)

| No. | Time | Delta Time | iRTT | RTT2ACK | ACK4 | Source | Destination | Protocol | Length | SACK CT | Seq | ACK | Info |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 4 | 14.084896 | 0.000000000 | | | | 10.1.21.110 | 10.1.31.130 | TCP | 82 | | 0 | 0 | S+, 51898 → 80 [SYN, ECN, CWR] Seq=0 Win=64240 Len=0 MSS=1460 WS=256 SACK_PERM=1 |
| 8 | 14.085970 | 0.001074000 | | 0.001074000 | 4 | 10.1.31.130 | 10.1.21.110 | TCP | 62 | | 0 | 1 | SA++, 80 → 51898 [SYN, ACK, ECN, CWR] Seq=0 Ack=1 Win=64240 Len=0 |
| 9 | 14.090167 | 0.004197000 | | | | 10.1.31.130 | 10.1.21.110 | TCP | 74 | | 0 | 1 | SA+, [TCP Retransmission] 80 → 51898 [SYN, ACK, ECN, CWR] Seq=0 Ack=1 Win=64240 Len=0 |

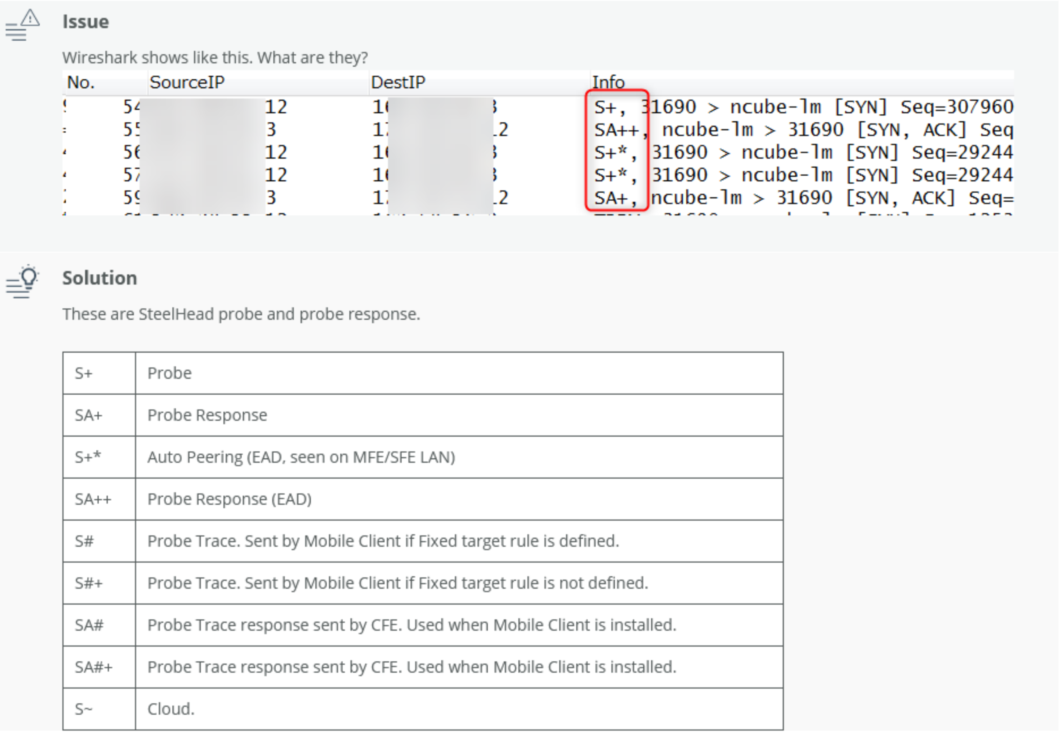
S-SH LAN

n130-sh1_lan0_0_ead.pcap

(ip.addr eq 10.1.21.110 and ip.addr eq 10.1.31.130) and (tcp.port eq 51898 and tcp.port eq 80)

| No. | Time | Delta Time | iRTT | RTT2ACK | ACK4 | Source | Destination | Protocol | Length | SACK CT | Seq | ACK | Info |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 7 | 14.089677 | 0.000000000 | | | | 10.1.21.110 | 10.1.31.130 | TCP | 90 | | 0 | 0 | S+*, 51898 → 80 [SYN] Seq=0 Win=14600 Len=0 MSS=1460 SACK_PERM=1 TSval=18699350 TSecr=0 WS= |
| 8 | 14.090014 | 0.000337000 | 0.000385000 | 0.000337000 | 7 | 10.1.31.130 | 10.1.21.110 | TCP | 74 | | 0 | 1 | 80 → 51898 [SYN, ACK] Seq=0 Ack=1 Win=14480 Len=0 MSS=1460 SACK_PERM=1 TSval=5984269 TSecr= |
| 9 | 14.090062 | 0.000048000 | 0.000385000 | 0.000048000 | 8 | 10.1.21.110 | 10.1.31.130 | TCP | 66 | | 1 | 1 | 51898 → 80 [ACK] Seq=1 Ack=1 Win=14600 Len=0 TSval=18699355 TSecr=5984269 |
| 13 | 14.578350 | 0.488288000 | 0.000385000 | | | 10.1.21.110 | 10.1.31.130 | HTTP | 485 | | 1 | 1 | GET / HTTP/1.1 |
| 14 | 14.578767 | 0.000417000 | 0.000385000 | 0.000417000 | 13 | 10.1.31.130 | 10.1.21.110 | TCP | 66 | | 1 | 420 | 80 → 51898 [ACK] Seq=1 Ack=420 Win=15616 Len=0 TSval=5984392 TSecr=18699843 |
| 15 | 14.597048 | 0.018281000 | 0.000385000 | | | 10.1.31.130 | 10.1.21.110 | HTTP | 724 | | 1 | 420 | HTTP/1.1 200 OK (text/html) |

# Enhanced SYN Decodes



### Issue

Wireshark shows like this. What are they?

```
No.        SourceIP               DestIP                Info
     54[redacted]12          1[redacted]3          S+, 31690 > ncube-lm [SYN] Seq=307960
     55[redacted]3           1[redacted]2          SA++, ncube-lm > 31690 [SYN, ACK] Seq
     56[redacted]12          1[redacted]3          S+*, 31690 > ncube-lm [SYN] Seq=29244
     57[redacted]12          1[redacted]3          S+*, 31690 > ncube-lm [SYN] Seq=29244
     59[redacted]3           1[redacted]2          SA+, ncube-lm > 31690 [SYN, ACK] Seq=
```

### Solution

These are SteelHead probe and probe response.

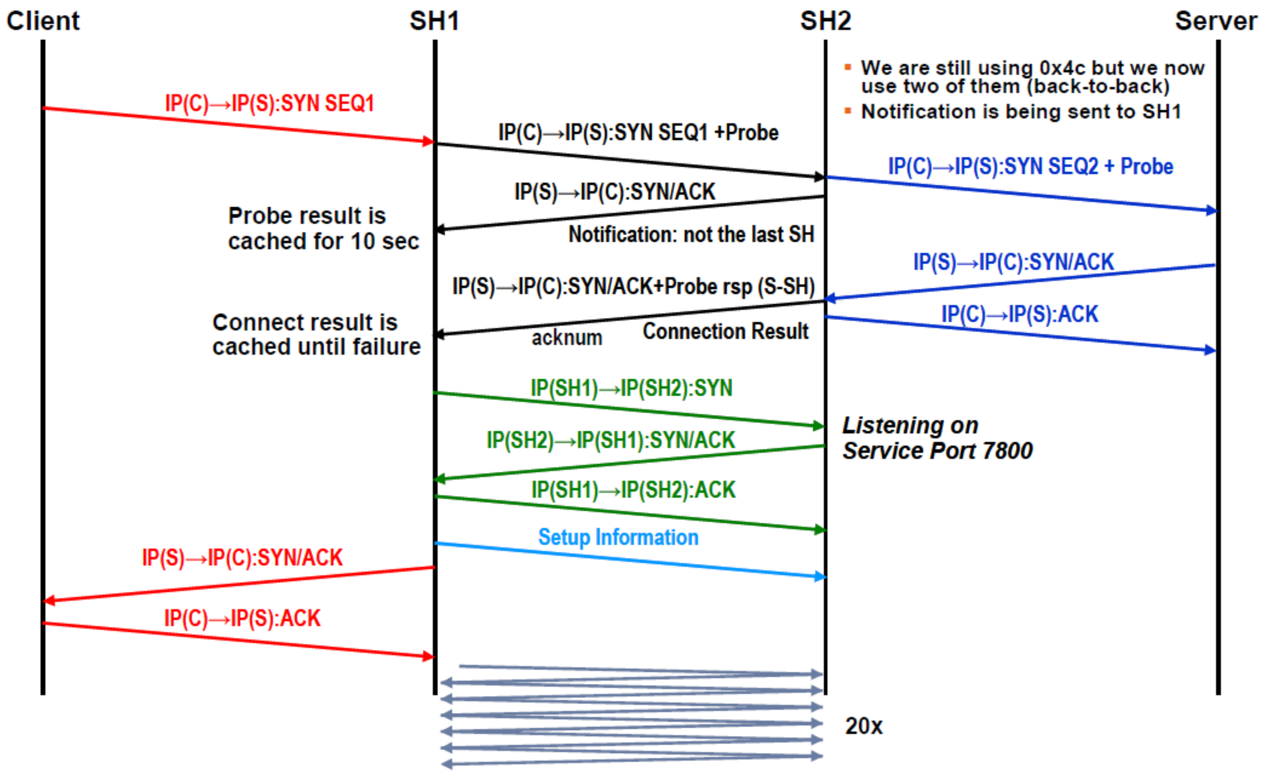
| | |
|---|---|
| S+ | Probe |
| SA+ | Probe Response |
| S+* | Auto Peering (EAD, seen on MFE/SFE LAN) |
| SA++ | Probe Response (EAD) |
| S# | Probe Trace. Sent by Mobile Client if Fixed target rule is defined. |
| S#+ | Probe Trace. Sent by Mobile Client if Fixed target rule is not defined. |
| SA# | Probe Trace response sent by CFE. Used when Mobile Client is installed. |
| SA#+ | Probe Trace response sent by CFE. Used when Mobile Client is installed. |
| S~ | Cloud. |

# Questions you might have…

- Why does S-SH SYN to server have SYN+*?
- Why don't we see any HTTP traffic on the WAN interface captures?
- Why did the S-SH change the Scaling Factor?
- Why did the S-SH introduce TCP Timestamps?
- Why is iRTT greater than expected latency?

# Why iRTT can be higher…

#sf21veu



- We are still using 0x4c but we now use two of them (back-to-back)
- Notification is being sent to SH1

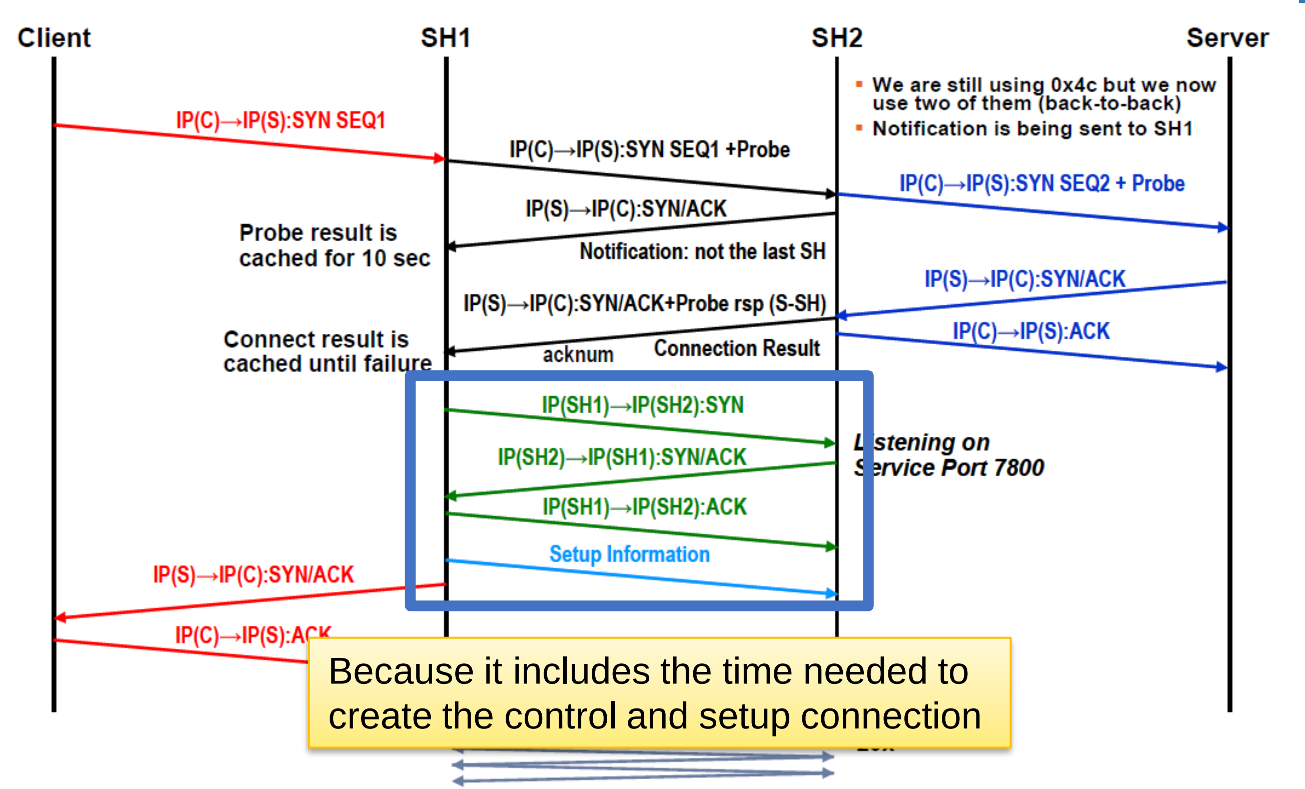
Probe result is cached for 10 sec

Connect result is cached until failure

*Listening on Service Port 7800*

# Why iRTT can be higher…

#sf21veu



Client

SH1

SH2

Server

- We are still using 0x4c but we now use two of them (back-to-back)
- Notification is being sent to SH1

IP(C)→IP(S):SYN SEQ1

IP(C)→IP(S):SYN SEQ1 +Probe

IP(C)→IP(S):SYN SEQ2 + Probe

IP(S)→IP(C):SYN/ACK

Notification: not the last SH

Probe result is cached for 10 sec

IP(S)→IP(C):SYN/ACK

IP(S)→IP(C):SYN/ACK+Probe rsp (S-SH)

IP(C)→IP(S):ACK

acknum

Connection Result

Connect result is cached until failure

IP(SH1)→IP(SH2):SYN

IP(SH2)→IP(SH1):SYN/ACK

IP(SH1)→IP(SH2):ACK

Setup Information

*istening on*
*ervice Port 7800*

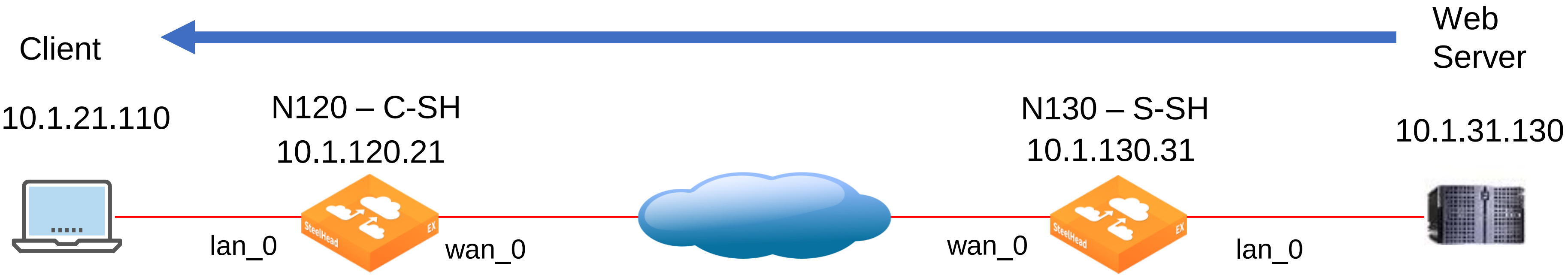
IP(S)→IP(C):SYN/ACK

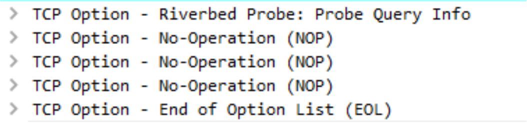
IP(C)→IP(S):ACK

Because it includes the time needed to create the control and setup connection

# Journey of SYN+ACK

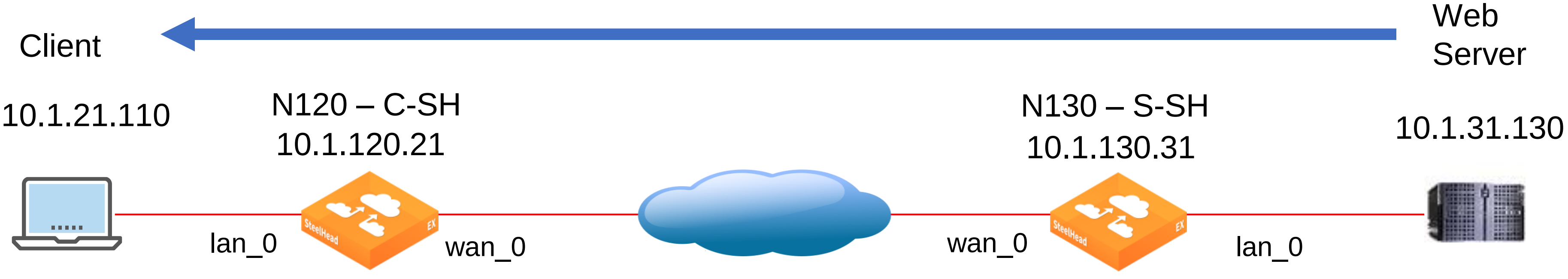
# SYN+ACK (#1) -WAN_0 DC

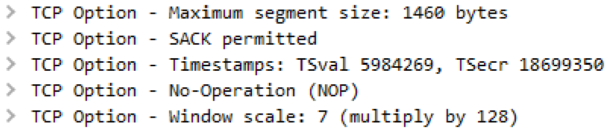




```
> TCP Option - Riverbed Probe: Probe Query Info
> TCP Option - No-Operation (NOP)
> TCP Option - No-Operation (NOP)
> TCP Option - No-Operation (NOP)
> TCP Option - End of Option List (EOL)
```

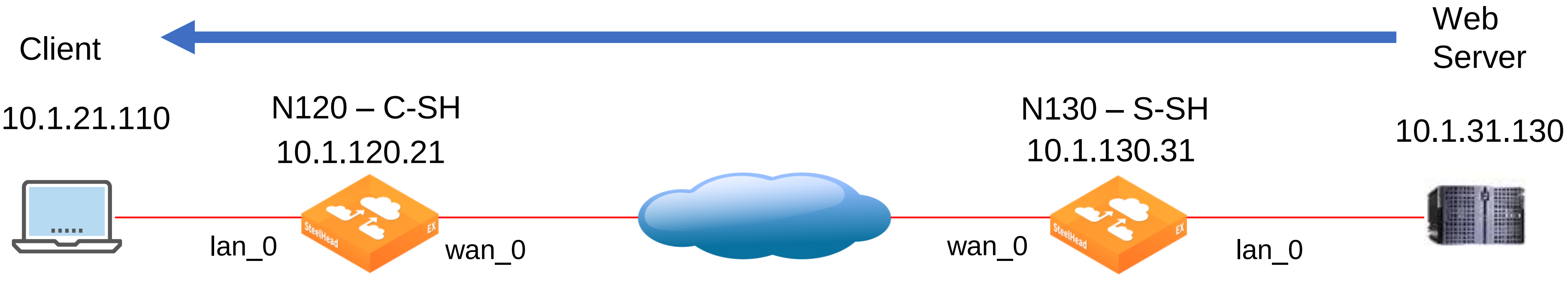
# SYN+ACK-LAN_0 DC

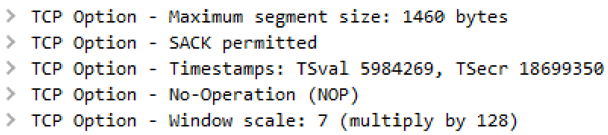




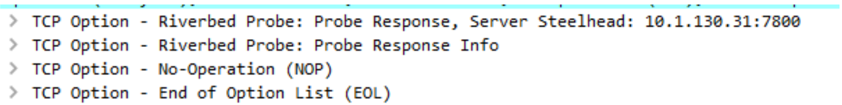
```
> TCP Option - Maximum segment size: 1460 bytes
> TCP Option - SACK permitted
> TCP Option - Timestamps: TSval 5984269, TSecr 18699350
> TCP Option - No-Operation (NOP)
> TCP Option - Window scale: 7 (multiply by 128)
```

# SYN+ACK (#2) -WAN_0 DC



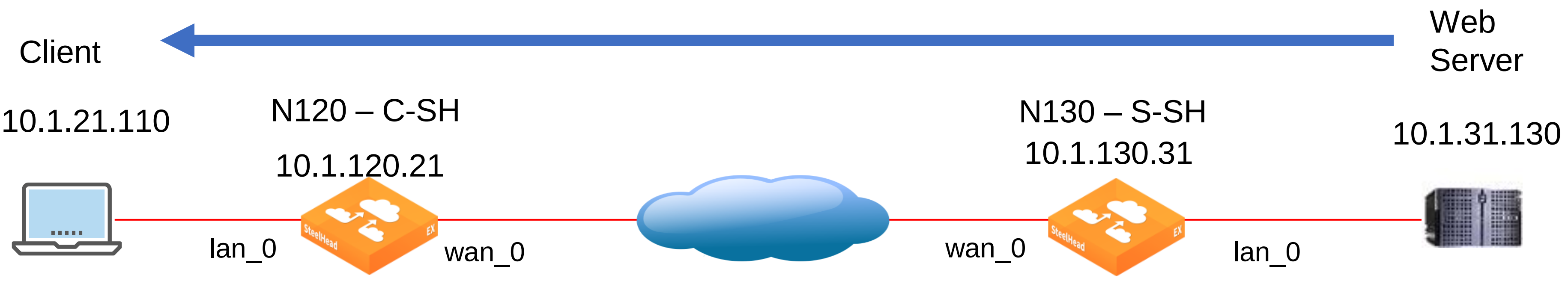


```
> TCP Option - Maximum segment size: 1460 bytes
> TCP Option - SACK permitted
> TCP Option - Timestamps: TSval 5984269, TSecr 18699350
> TCP Option - No-Operation (NOP)
> TCP Option - Window scale: 7 (multiply by 128)
```



```
> TCP Option - Riverbed Probe: Probe Response, Server Steelhead: 10.1.130.31:7800
> TCP Option - Riverbed Probe: Probe Response Info
> TCP Option - No-Operation (NOP)
> TCP Option - End of Option List (EOL)
```

# SYN+ACK-WAN_0



Client

10.1.21.110

N120 – C-SH

10.1.120.21

lan_0

wan_0

Web Server

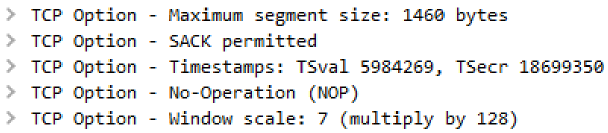
10.1.31.130

N130 – S-SH

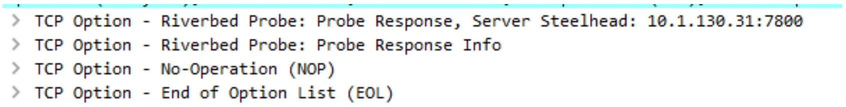
10.1.130.31

wan_0

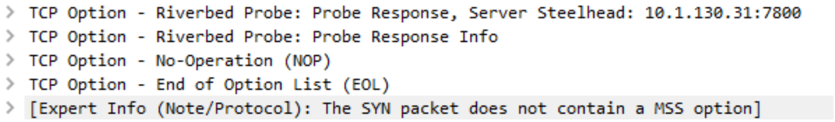
lan_0



```
> TCP Option - Maximum segment size: 1460 bytes
> TCP Option - SACK permitted
> TCP Option - Timestamps: TSval 5984269, TSecr 18699350
> TCP Option - No-Operation (NOP)
> TCP Option - Window scale: 7 (multiply by 128)
```



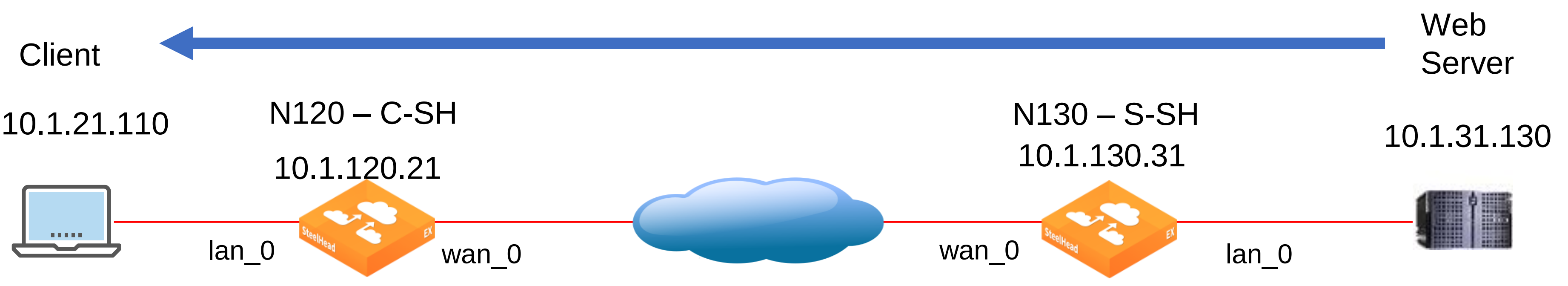
```
> TCP Option - Riverbed Probe: Probe Response, Server Steelhead: 10.1.130.31:7800
> TCP Option - Riverbed Probe: Probe Response Info
> TCP Option - No-Operation (NOP)
> TCP Option - End of Option List (EOL)
```

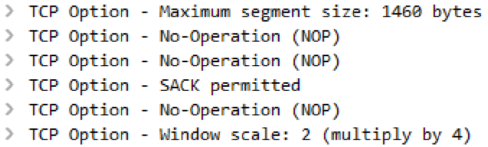


```
> TCP Option - Riverbed Probe: Probe Response, Server Steelhead: 10.1.130.31:7800
> TCP Option - Riverbed Probe: Probe Response Info
> TCP Option - No-Operation (NOP)
> TCP Option - End of Option List (EOL)
> [Expert Info (Note/Protocol): The SYN packet does not contain a MSS option]
```

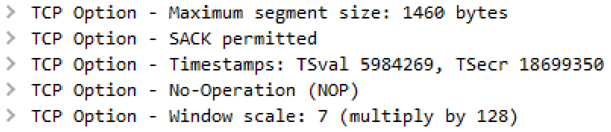
# SYN+ACK-LAN_0

#sf21veu

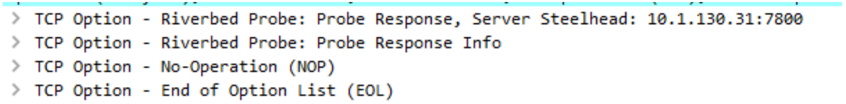




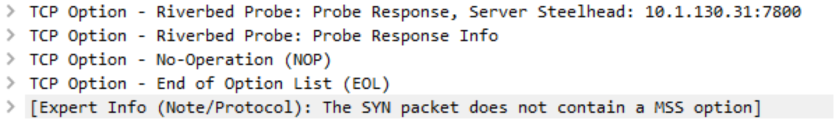
```
> TCP Option - Maximum segment size: 1460 bytes
> TCP Option - No-Operation (NOP)
> TCP Option - No-Operation (NOP)
> TCP Option - SACK permitted
> TCP Option - No-Operation (NOP)
> TCP Option - Window scale: 2 (multiply by 4)
```



```
> TCP Option - Maximum segment size: 1460 bytes
> TCP Option - SACK permitted
> TCP Option - Timestamps: TSval 5984269, TSecr 18699350
> TCP Option - No-Operation (NOP)
> TCP Option - Window scale: 7 (multiply by 128)
```



```
> TCP Option - Riverbed Probe: Probe Response, Server Steelhead: 10.1.130.31:7800
> TCP Option - Riverbed Probe: Probe Response Info
> TCP Option - No-Operation (NOP)
> TCP Option - End of Option List (EOL)
```



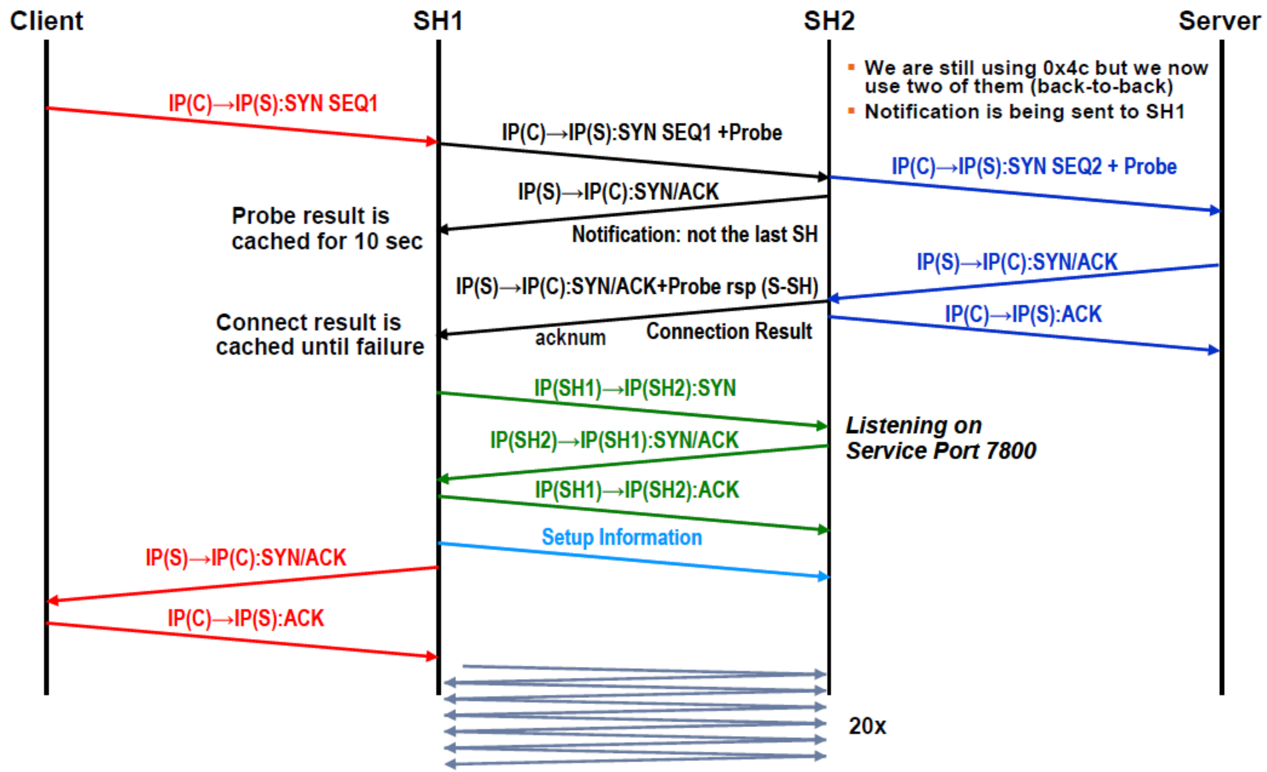
```
> TCP Option - Riverbed Probe: Probe Response, Server Steelhead: 10.1.130.31:7800
> TCP Option - Riverbed Probe: Probe Response Info
> TCP Option - No-Operation (NOP)
> TCP Option - End of Option List (EOL)
> [Expert Info (Note/Protocol): The SYN packet does not contain a MSS option]
```

# Q++

- Why are there two SYN+ACKs on the WAN interface captures
- Why did S-SH change the server's scaling factor?

# Discovery Complete

#sf21veu



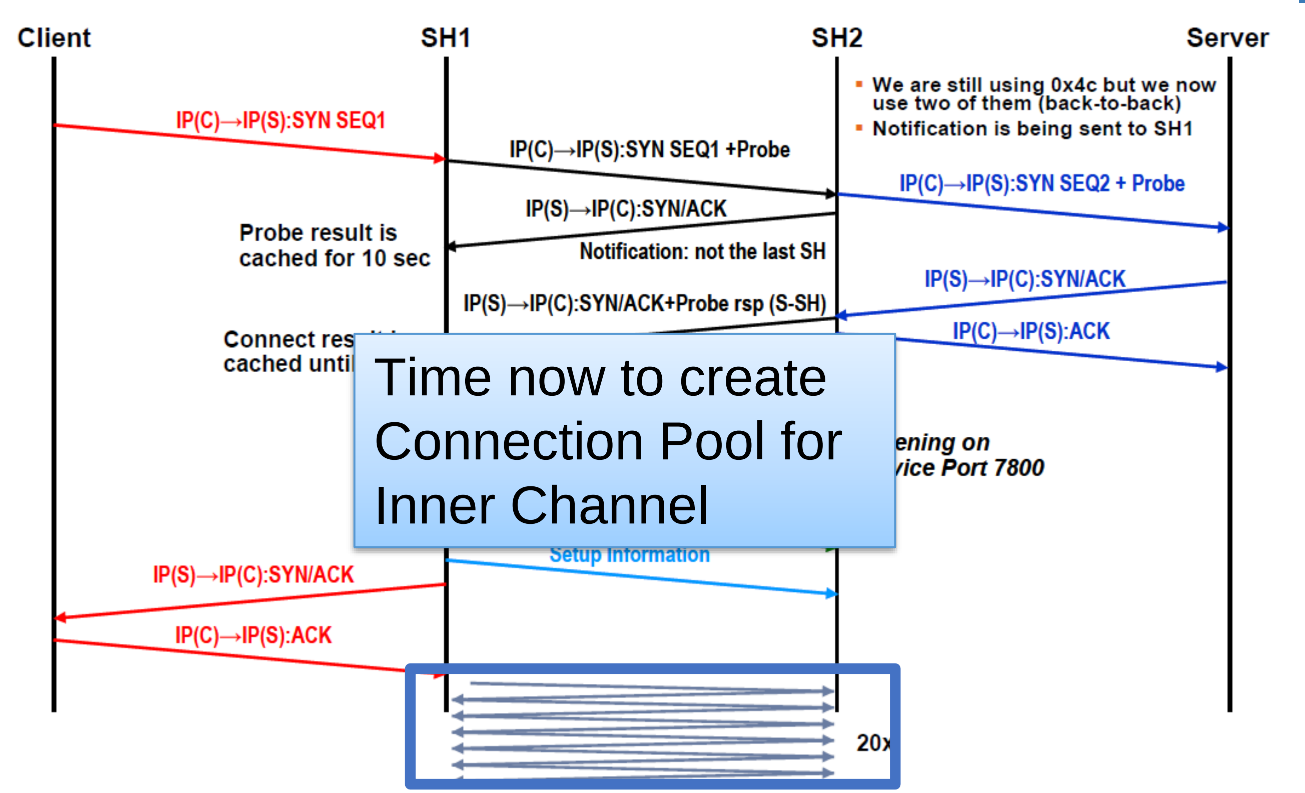
- We are still using 0x4c but we now use two of them (back-to-back)
- Notification is being sent to SH1

Probe result is cached for 10 sec

Connect result is cached until failure

*Listening on Service Port 7800*

# Discovery Complete

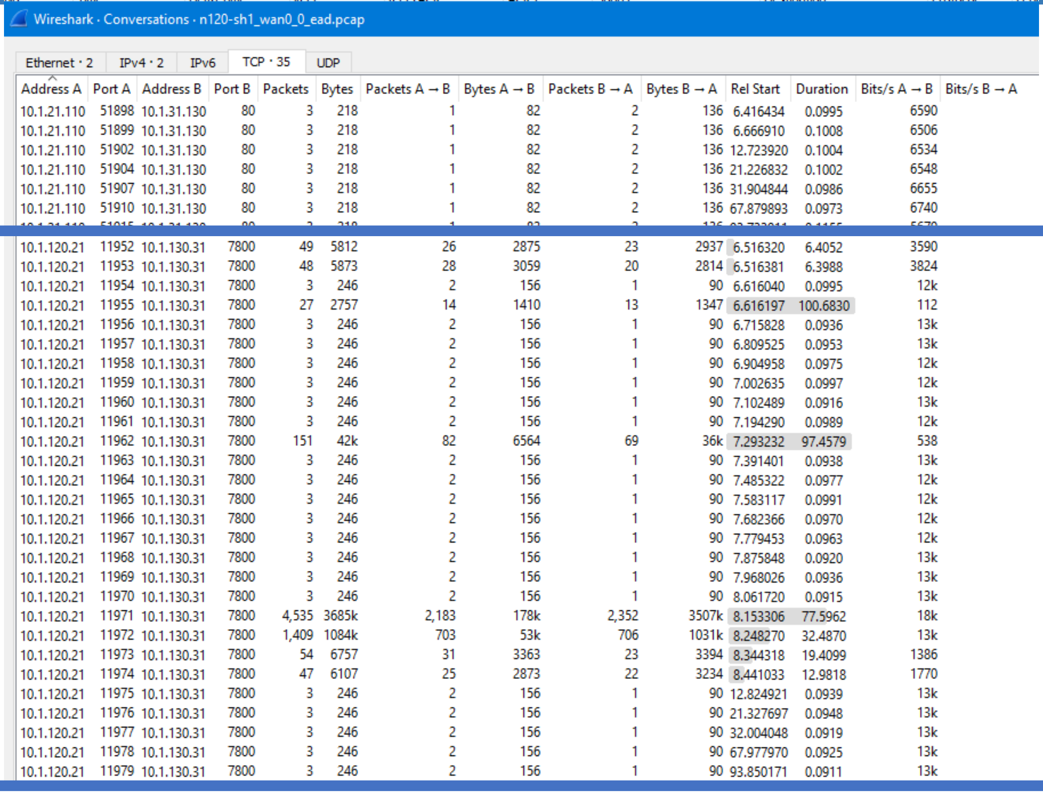


- We are still using 0x4c but we now use two of them (back-to-back)
- Notification is being sent to SH1

Time now to create Connection Pool for Inner Channel

# 28 Connections on Port 7800

#sf21veu



Wireshark · Conversations · n120-sh1_wan0_0_ead.pcap

| Address A | Port A | Address B | Port B | Packets | Bytes | Packets A → B | Bytes A → B | Packets B → A | Bytes B → A | Rel Start | Duration | Bits/s A → B | Bits/s B → A |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 10.1.21.110 | 51898 | 10.1.31.130 | 80 | 3 | 218 | 1 | 82 | 2 | 136 | 6.416434 | 0.0995 | 6590 | |
| 10.1.21.110 | 51899 | 10.1.31.130 | 80 | 3 | 218 | 1 | 82 | 2 | 136 | 6.666910 | 0.1008 | 6506 | |
| 10.1.21.110 | 51902 | 10.1.31.130 | 80 | 3 | 218 | 1 | 82 | 2 | 136 | 12.723920 | 0.1004 | 6534 | |
| 10.1.21.110 | 51904 | 10.1.31.130 | 80 | 3 | 218 | 1 | 82 | 2 | 136 | 21.226832 | 0.1002 | 6548 | |
| 10.1.21.110 | 51907 | 10.1.31.130 | 80 | 3 | 218 | 1 | 82 | 2 | 136 | 31.904844 | 0.0986 | 6655 | |
| 10.1.21.110 | 51910 | 10.1.31.130 | 80 | 3 | 218 | 1 | 82 | 2 | 136 | 67.879893 | 0.0973 | 6740 | |
| 10.1.120.21 | 11952 | 10.1.130.31 | 7800 | 49 | 5812 | 26 | 2875 | 23 | 2937 | 6.516320 | 6.4052 | 3590 | |
| 10.1.120.21 | 11953 | 10.1.130.31 | 7800 | 48 | 5873 | 28 | 3059 | 20 | 2814 | 6.516381 | 6.3988 | 3824 | |
| 10.1.120.21 | 11954 | 10.1.130.31 | 7800 | 3 | 246 | 2 | 156 | 1 | 90 | 6.616040 | 0.0995 | 12k | |
| 10.1.120.21 | 11955 | 10.1.130.31 | 7800 | 27 | 2757 | 14 | 1410 | 13 | 1347 | 6.616197 | 100.6830 | 112 | |
| 10.1.120.21 | 11956 | 10.1.130.31 | 7800 | 3 | 246 | 2 | 156 | 1 | 90 | 6.715828 | 0.0936 | 13k | |
| 10.1.120.21 | 11957 | 10.1.130.31 | 7800 | 3 | 246 | 2 | 156 | 1 | 90 | 6.809525 | 0.0953 | 13k | |
| 10.1.120.21 | 11958 | 10.1.130.31 | 7800 | 3 | 246 | 2 | 156 | 1 | 90 | 6.904958 | 0.0975 | 12k | |
| 10.1.120.21 | 11959 | 10.1.130.31 | 7800 | 3 | 246 | 2 | 156 | 1 | 90 | 7.002635 | 0.0997 | 12k | |
| 10.1.120.21 | 11960 | 10.1.130.31 | 7800 | 3 | 246 | 2 | 156 | 1 | 90 | 7.102489 | 0.0916 | 13k | |
| 10.1.120.21 | 11961 | 10.1.130.31 | 7800 | 3 | 246 | 2 | 156 | 1 | 90 | 7.194290 | 0.0989 | 12k | |
| 10.1.120.21 | 11962 | 10.1.130.31 | 7800 | 151 | 42k | 82 | 6564 | 69 | 36k | 7.293232 | 97.4579 | 538 | |
| 10.1.120.21 | 11963 | 10.1.130.31 | 7800 | 3 | 246 | 2 | 156 | 1 | 90 | 7.391401 | 0.0938 | 13k | |
| 10.1.120.21 | 11964 | 10.1.130.31 | 7800 | 3 | 246 | 2 | 156 | 1 | 90 | 7.485322 | 0.0977 | 12k | |
| 10.1.120.21 | 11965 | 10.1.130.31 | 7800 | 3 | 246 | 2 | 156 | 1 | 90 | 7.583117 | 0.0991 | 12k | |
| 10.1.120.21 | 11966 | 10.1.130.31 | 7800 | 3 | 246 | 2 | 156 | 1 | 90 | 7.682366 | 0.0970 | 12k | |
| 10.1.120.21 | 11967 | 10.1.130.31 | 7800 | 3 | 246 | 2 | 156 | 1 | 90 | 7.779453 | 0.0963 | 12k | |
| 10.1.120.21 | 11968 | 10.1.130.31 | 7800 | 3 | 246 | 2 | 156 | 1 | 90 | 7.875848 | 0.0920 | 13k | |
| 10.1.120.21 | 11969 | 10.1.130.31 | 7800 | 3 | 246 | 2 | 156 | 1 | 90 | 7.968026 | 0.0936 | 13k | |
| 10.1.120.21 | 11970 | 10.1.130.31 | 7800 | 3 | 246 | 2 | 156 | 1 | 90 | 8.061720 | 0.0915 | 13k | |
| 10.1.120.21 | 11971 | 10.1.130.31 | 7800 | 4,535 | 3685k | 2,183 | 178k | 2,352 | 3507k | 8.153306 | 77.5962 | 18k | |
| 10.1.120.21 | 11972 | 10.1.130.31 | 7800 | 1,409 | 1084k | 703 | 53k | 706 | 1031k | 8.248270 | 32.4870 | 13k | |
| 10.1.120.21 | 11973 | 10.1.130.31 | 7800 | 54 | 6757 | 31 | 3363 | 23 | 3394 | 8.344318 | 19.4099 | 1386 | |
| 10.1.120.21 | 11974 | 10.1.130.31 | 7800 | 47 | 6107 | 25 | 2873 | 22 | 3234 | 8.441033 | 12.9818 | 1770 | |
| 10.1.120.21 | 11975 | 10.1.130.31 | 7800 | 3 | 246 | 2 | 156 | 1 | 90 | 12.824921 | 0.0939 | 13k | |
| 10.1.120.21 | 11976 | 10.1.130.31 | 7800 | 3 | 246 | 2 | 156 | 1 | 90 | 21.327697 | 0.0948 | 13k | |
| 10.1.120.21 | 11977 | 10.1.130.31 | 7800 | 3 | 246 | 2 | 156 | 1 | 90 | 32.004048 | 0.0919 | 13k | |
| 10.1.120.21 | 11978 | 10.1.130.31 | 7800 | 3 | 246 | 2 | 156 | 1 | 90 | 67.977970 | 0.0925 | 13k | |
| 10.1.120.21 | 11979 | 10.1.130.31 | 7800 | 3 | 246 | 2 | 156 | 1 | 90 | 93.850171 | 0.0911 | 13k | |

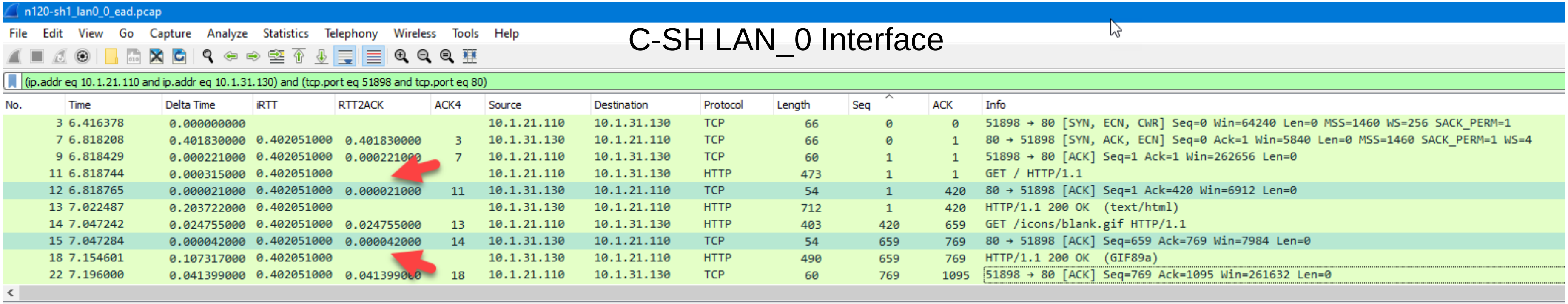
# Transport Optimization

✓ Override TCP Options

✓ Connection Pooling

- ACK Spoofing

# RTT2ACK is sub-ms vs. 400ms of iRTT



C-SH LAN_0 Interface

(ip.addr eq 10.1.21.110 and ip.addr eq 10.1.31.130) and (tcp.port eq 51898 and tcp.port eq 80)

| No. | Time | Delta Time | iRTT | RTT2ACK | ACK4 | Source | Destination | Protocol | Length | Seq | ACK | Info |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 3 | 6.416378 | 0.000000000 | | | | 10.1.21.110 | 10.1.31.130 | TCP | 66 | 0 | 0 | 51898 → 80 [SYN, ECN, CWR] Seq=0 Win=64240 Len=0 MSS=1460 WS=256 SACK_PERM=1 |
| 7 | 6.818208 | 0.401830000 | 0.402051000 | 0.401830000 | 3 | 10.1.31.130 | 10.1.21.110 | TCP | 66 | 0 | 1 | 80 → 51898 [SYN, ACK, ECN] Seq=0 Ack=1 Win=5840 Len=0 MSS=1460 SACK_PERM=1 WS=4 |
| 9 | 6.818429 | 0.000221000 | 0.402051000 | 0.000221000 | 7 | 10.1.21.110 | 10.1.31.130 | TCP | 60 | 1 | 1 | 51898 → 80 [ACK] Seq=1 Ack=1 Win=262656 Len=0 |
| 11 | 6.818744 | 0.000315000 | 0.402051000 | | | 10.1.21.110 | 10.1.31.130 | HTTP | 473 | 1 | 1 | GET / HTTP/1.1 |
| 12 | 6.818765 | 0.000021000 | 0.402051000 | 0.000021000 | 11 | 10.1.31.130 | 10.1.21.110 | TCP | 54 | 1 | 420 | 80 → 51898 [ACK] Seq=1 Ack=420 Win=6912 Len=0 |
| 13 | 7.022487 | 0.203722000 | 0.402051000 | | | 10.1.31.130 | 10.1.21.110 | HTTP | 712 | 1 | 420 | HTTP/1.1 200 OK (text/html) |
| 14 | 7.047242 | 0.024755000 | 0.402051000 | 0.024755000 | 13 | 10.1.21.110 | 10.1.31.130 | HTTP | 403 | 420 | 659 | GET /icons/blank.gif HTTP/1.1 |
| 15 | 7.047284 | 0.000042000 | 0.402051000 | 0.000042000 | 14 | 10.1.31.130 | 10.1.21.110 | TCP | 54 | 659 | 769 | 80 → 51898 [ACK] Seq=659 Ack=769 Win=7984 Len=0 |
| 18 | 7.154601 | 0.107317000 | 0.402051000 | | | 10.1.31.130 | 10.1.21.110 | HTTP | 490 | 659 | 769 | HTTP/1.1 200 OK (GIF89a) |
| 22 | 7.196000 | 0.041399000 | 0.402051000 | 0.041399000 | 18 | 10.1.21.110 | 10.1.31.130 | TCP | 60 | 769 | 1095 | 51898 → 80 [ACK] Seq=769 Ack=1095 Win=261632 Len=0 |

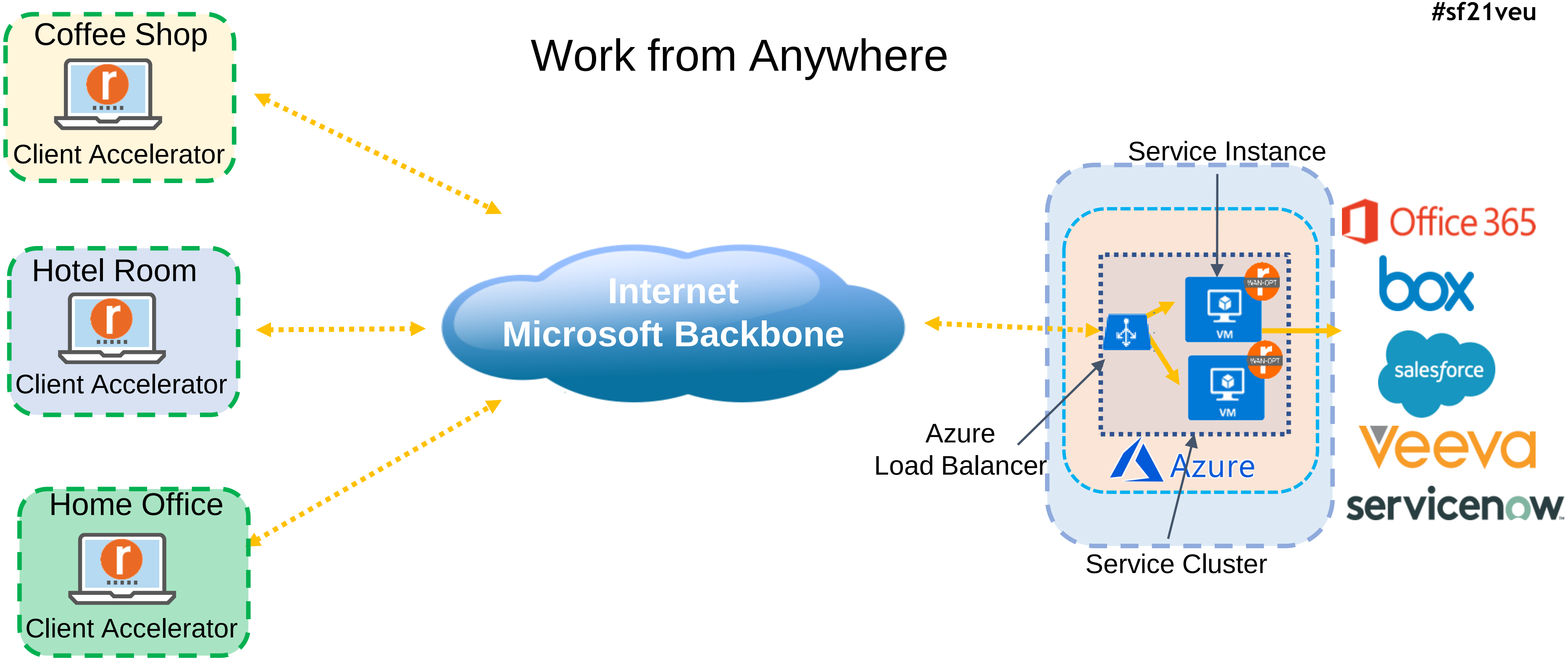
- RTT2ACK for GET in #11 is < 1 ms
- RTT2ACK for GET in #14 is < 1 ms

# Scenario #2 – SaaS Accelerator

# Help for my SaaS Apps?

#sf21veu

## Work from Anywhere



# Scenario #2

- Client Accelerator on my laptop in Orlando
- SaaS Accelerator provisioned for Rvbd O365
- O365 Apps in the cloud (likely to be West Coast)
- Cloud SteelHeads running in a "Service Cluster" behind an Azure Load Balancer

# Scenario #2 – Test Plan

- Test script planned out in advance
- Multiple copies of 56MB PPT test files with different file names
- Before and After Test Runs
- Packet Captures and Screen Video Captures

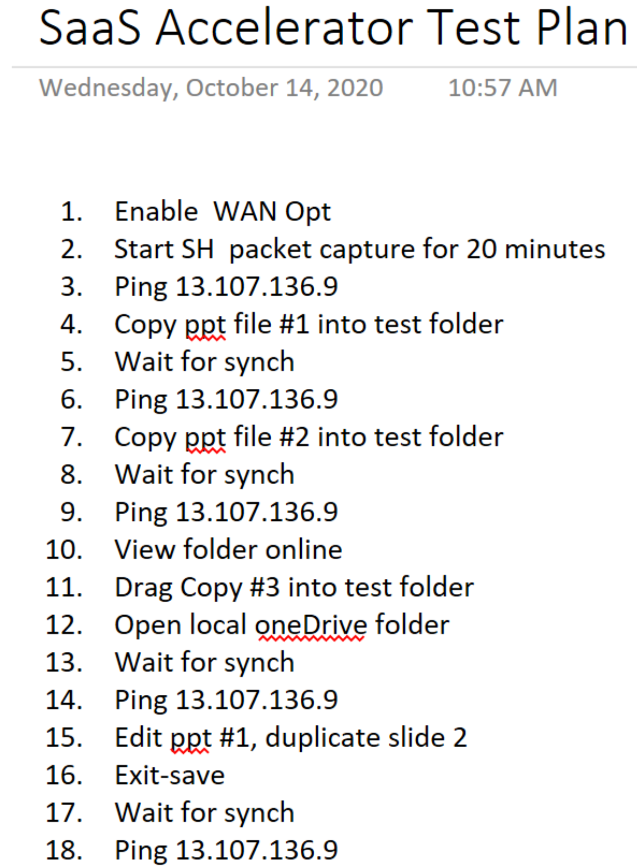
# Scenario #2 - Actions

- Copy 56MB PPT from Desktop to local OneDrive via File Explorer, watch Synch
- Copy 56MB PPT to OneDrive via Browser
- Edit PPT on local OneDrive and watch Synch
- Edit PPT with SharePoint Online and watch Synch
- Capture packets for all steps

# Why this activity was chosen

- Demonstrate time savings
- Caching based on byte patterns, not file names
- Measure optimization time savings for both local copy / edit, as well as browser-based copy / edit / synch

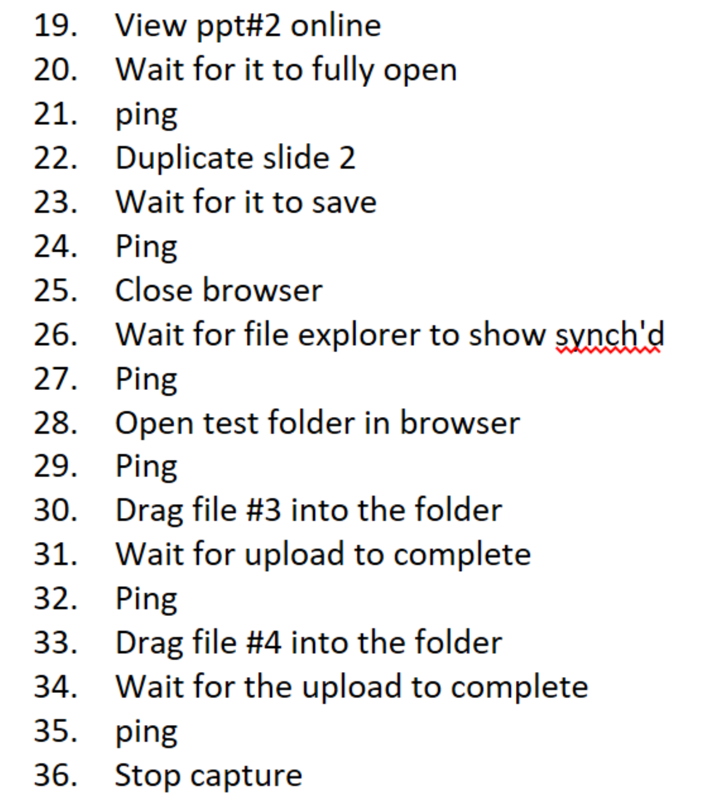
# Test Script



## SaaS Accelerator Test Plan

Wednesday, October 14, 2020 10:57 AM

1. Enable WAN Opt
2. Start SH packet capture for 20 minutes
3. Ping 13.107.136.9
4. Copy ppt file #1 into test folder
5. Wait for synch
6. Ping 13.107.136.9
7. Copy ppt file #2 into test folder
8. Wait for synch
9. Ping 13.107.136.9
10. View folder online
11. Drag Copy #3 into test folder
12. Open local oneDrive folder
13. Wait for synch
14. Ping 13.107.136.9
15. Edit ppt #1, duplicate slide 2
16. Exit-save
17. Wait for synch
18. Ping 13.107.136.9

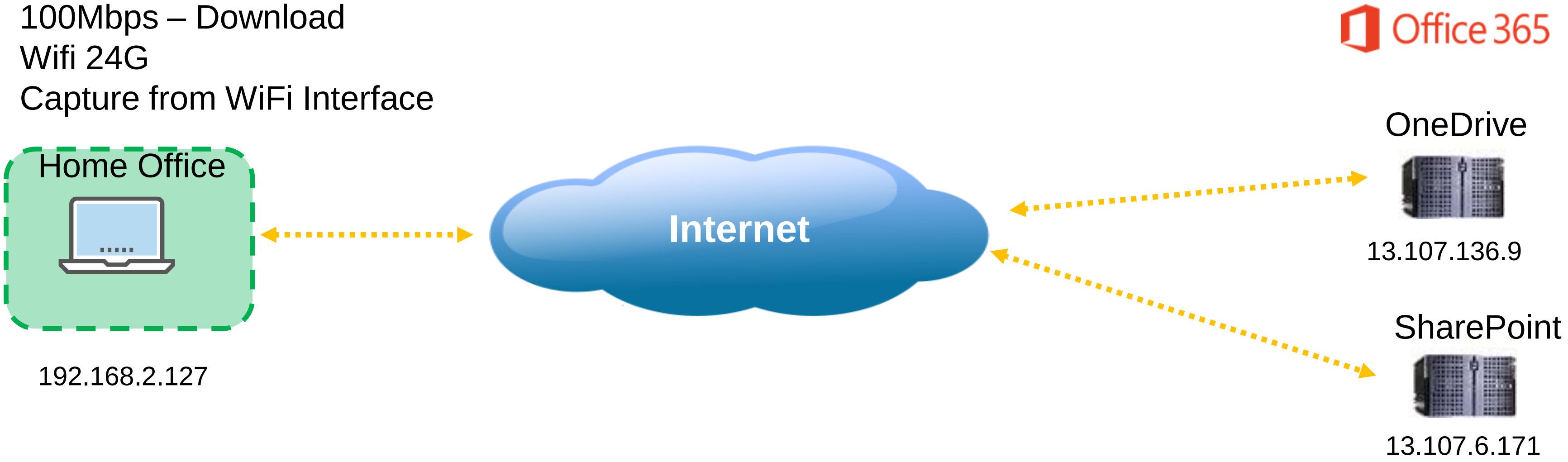


19. View ppt#2 online
20. Wait for it to fully open
21. ping
22. Duplicate slide 2
23. Wait for it to save
24. Ping
25. Close browser
26. Wait for file explorer to show synch'd
27. Ping
28. Open test folder in browser
29. Ping
30. Drag file #3 into the folder
31. Wait for upload to complete
32. Ping
33. Drag file #4 into the folder
34. Wait for the upload to complete
35. ping
36. Stop capture

# 1st Test - WAN OPT Disabled

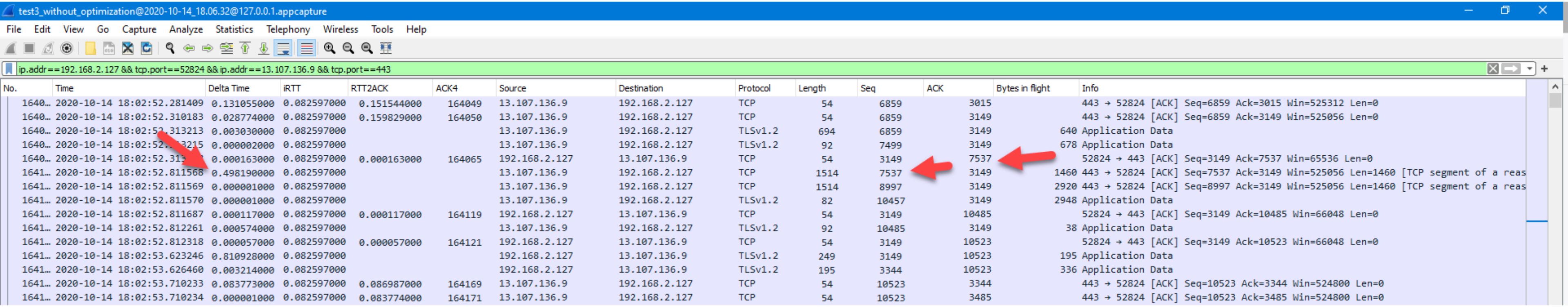
# Topology: WAN OPT Disabled

11Mbps – Upload
100Mbps – Download
Wifi 24G
Capture from WiFi Interface



# Evidence of RTT Cost

- Client ACK says “ready for stream bytes @ 7537”
- 498ms later that segment arrives

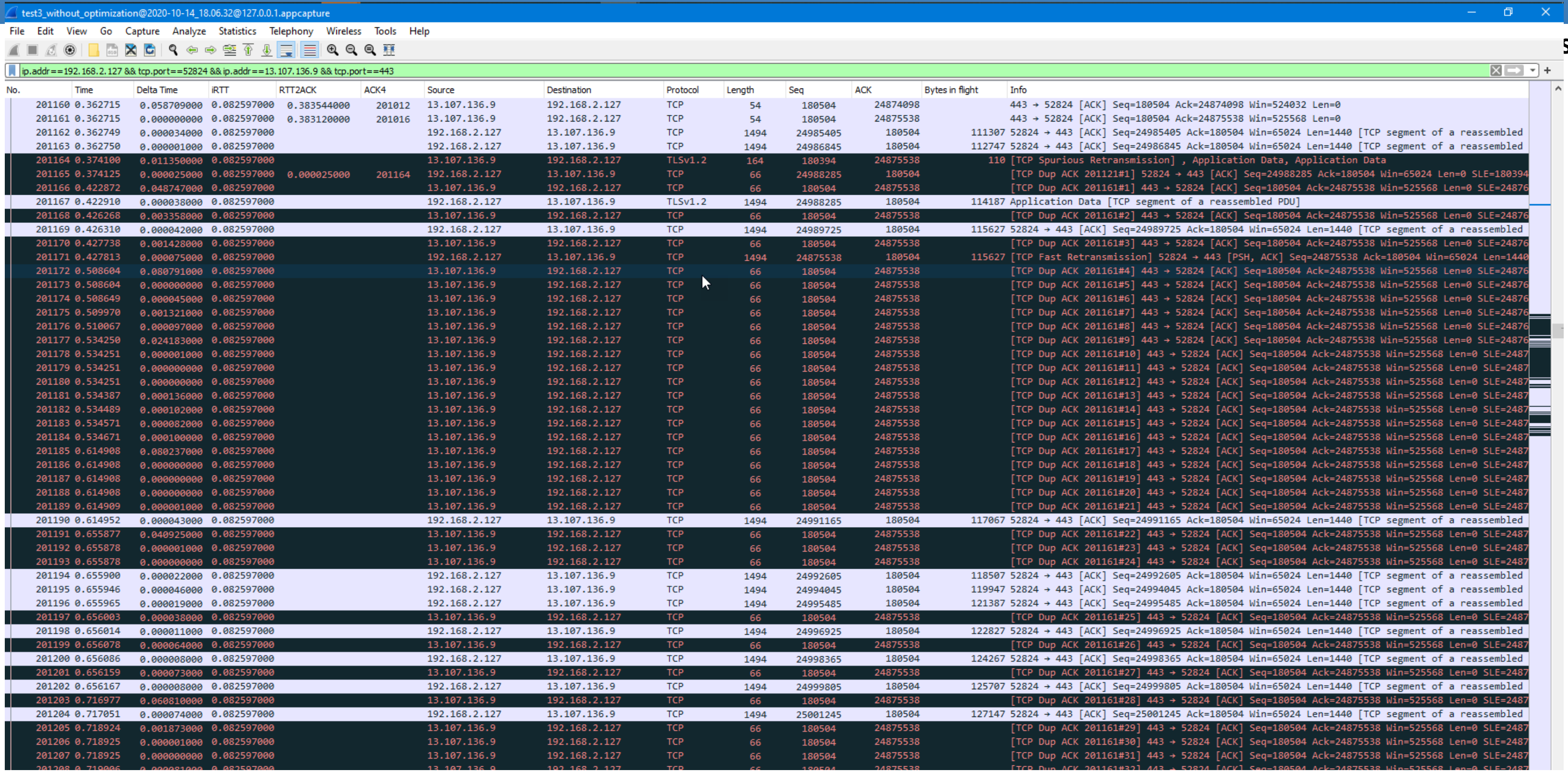


test3_without_optimization@2020-10-14_18.06.32@127.0.0.1.appcapture

ip.addr==192.168.2.127 && tcp.port==52824 && ip.addr==13.107.136.9 && tcp.port==443

| No. | Time | Delta Time | iRTT | RTT2ACK | ACK4 | Source | Destination | Protocol | Length | Seq | ACK | Bytes in flight | Info |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1640… | 2020-10-14 18:02:52.281409 | 0.131055000 | 0.082597000 | 0.151544000 | 164049 | 13.107.136.9 | 192.168.2.127 | TCP | 54 | 6859 | 3015 | | 443 → 52824 [ACK] Seq=6859 Ack=3015 Win=525312 Len=0 |
| 1640… | 2020-10-14 18:02:52.310183 | 0.028774000 | 0.082597000 | 0.159829000 | 164050 | 13.107.136.9 | 192.168.2.127 | TCP | 54 | 6859 | 3149 | | 443 → 52824 [ACK] Seq=6859 Ack=3149 Win=525056 Len=0 |
| 1640… | 2020-10-14 18:02:52.313213 | 0.003030000 | 0.082597000 | | | 13.107.136.9 | 192.168.2.127 | TLSv1.2 | 694 | 6859 | 3149 | 640 | Application Data |
| 1640… | 2020-10-14 18:02:52.[illegible]3215 | 0.000002000 | 0.082597000 | | | 13.107.136.9 | 192.168.2.127 | TLSv1.2 | 92 | 7499 | 3149 | 678 | Application Data |
| 1640… | 2020-10-14 18:02:52.313[illegible] | 0.000163000 | 0.082597000 | 0.000163000 | 164065 | 192.168.2.127 | 13.107.136.9 | TCP | 54 | 3149 | 7537 | | 52824 → 443 [ACK] Seq=3149 Ack=7537 Win=65536 Len=0 |
| 1641… | 2020-10-14 18:02:52.811568 | 0.498190000 | 0.082597000 | | | 13.107.136.9 | 192.168.2.127 | TCP | 1514 | 7537 | 3149 | 1460 | 443 → 52824 [ACK] Seq=7537 Ack=3149 Win=525056 Len=1460 [TCP segment of a reas |
| 1641… | 2020-10-14 18:02:52.811569 | 0.000001000 | 0.082597000 | | | 13.107.136.9 | 192.168.2.127 | TCP | 1514 | 8997 | 3149 | 2920 | 443 → 52824 [ACK] Seq=8997 Ack=3149 Win=525056 Len=1460 [TCP segment of a reas |
| 1641… | 2020-10-14 18:02:52.811570 | 0.000001000 | 0.082597000 | | | 13.107.136.9 | 192.168.2.127 | TLSv1.2 | 82 | 10457 | 3149 | 2948 | Application Data |
| 1641… | 2020-10-14 18:02:52.811687 | 0.000117000 | 0.082597000 | 0.000117000 | 164119 | 192.168.2.127 | 13.107.136.9 | TCP | 54 | 3149 | 10485 | | 52824 → 443 [ACK] Seq=3149 Ack=10485 Win=66048 Len=0 |
| 1641… | 2020-10-14 18:02:52.812261 | 0.000574000 | 0.082597000 | | | 13.107.136.9 | 192.168.2.127 | TLSv1.2 | 92 | 10485 | 3149 | 38 | Application Data |
| 1641… | 2020-10-14 18:02:52.812318 | 0.000057000 | 0.082597000 | 0.000057000 | 164121 | 192.168.2.127 | 13.107.136.9 | TCP | 54 | 3149 | 10523 | | 52824 → 443 [ACK] Seq=3149 Ack=10523 Win=66048 Len=0 |
| 1641… | 2020-10-14 18:02:53.623246 | 0.810928000 | 0.082597000 | | | 192.168.2.127 | 13.107.136.9 | TLSv1.2 | 249 | 3149 | 10523 | 195 | Application Data |
| 1641… | 2020-10-14 18:02:53.626460 | 0.003214000 | 0.082597000 | | | 192.168.2.127 | 13.107.136.9 | TLSv1.2 | 195 | 3344 | 10523 | 336 | Application Data |
| 1641… | 2020-10-14 18:02:53.710233 | 0.083773000 | 0.082597000 | 0.086987000 | 164169 | 13.107.136.9 | 192.168.2.127 | TCP | 54 | 10523 | 3344 | | 443 → 52824 [ACK] Seq=10523 Ack=3344 Win=524800 Len=0 |
| 1641… | 2020-10-14 18:02:53.710234 | 0.000001000 | 0.082597000 | 0.083774000 | 164171 | 13.107.136.9 | 192.168.2.127 | TCP | 54 | 10523 | 3485 | | 443 → 52824 [ACK] Seq=10523 Ack=3485 Win=524800 Len=0 |

# The cost of retransmissions



test3_without_optimization@2020-10-14_18.06.32@127.0.0.1.appcapture

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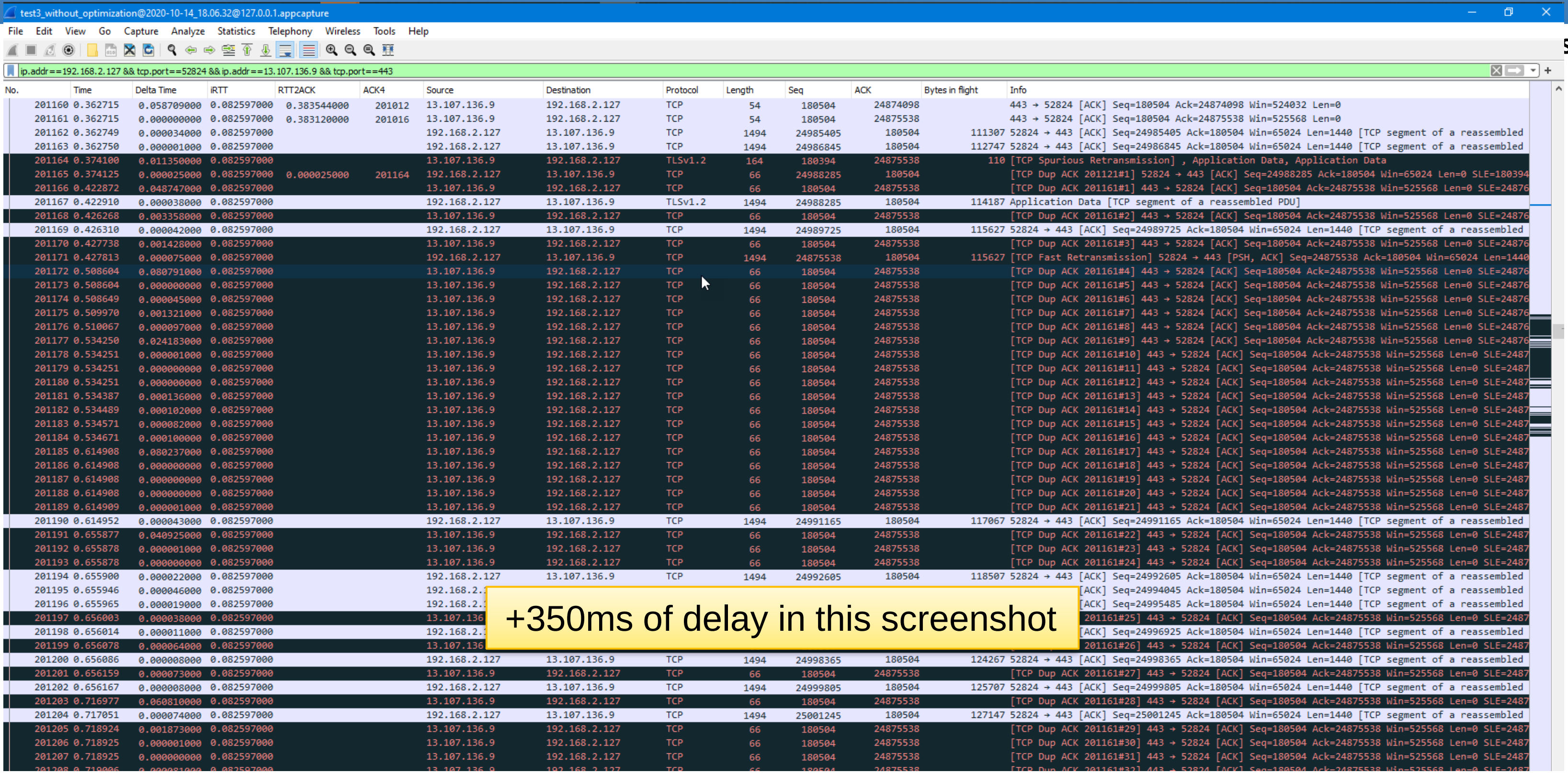
ip.addr==192.168.2.127 && tcp.port==52824 && ip.addr==13.107.136.9 && tcp.port==443

| No. | Time | Delta Time | iRTT | RTT2ACK | ACK4 | Source | Destination | Protocol | Length | Seq | ACK | Bytes in flight | Info |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 201160 | 0.362715 | 0.058709000 | 0.082597000 | 0.383544000 | 201012 | 13.107.136.9 | 192.168.2.127 | TCP | 54 | 180504 | 24874098 | | 443 → 52824 [ACK] Seq=180504 Ack=24874098 Win=524032 Len=0 |
| 201161 | 0.362715 | 0.000000000 | 0.082597000 | 0.383120000 | 201016 | 13.107.136.9 | 192.168.2.127 | TCP | 54 | 180504 | 24875538 | | 443 → 52824 [ACK] Seq=180504 Ack=24875538 Win=525568 Len=0 |
| 201162 | 0.362749 | 0.000034000 | 0.082597000 | | | 192.168.2.127 | 13.107.136.9 | TCP | 1494 | 24985405 | 180504 | 111307 | 52824 → 443 [ACK] Seq=24985405 Ack=180504 Win=65024 Len=1440 [TCP segment of a reassembled |
| 201163 | 0.362750 | 0.000001000 | 0.082597000 | | | 192.168.2.127 | 13.107.136.9 | TCP | 1494 | 24986845 | 180504 | 112747 | 52824 → 443 [ACK] Seq=24986845 Ack=180504 Win=65024 Len=1440 [TCP segment of a reassembled |
| 201164 | 0.374100 | 0.011350000 | 0.082597000 | | | 13.107.136.9 | 192.168.2.127 | TLSv1.2 | 164 | 180394 | 24875538 | 110 | [TCP Spurious Retransmission] , Application Data, Application Data |
| 201165 | 0.374125 | 0.000025000 | 0.082597000 | 0.000025000 | 201164 | 192.168.2.127 | 13.107.136.9 | TCP | 66 | 24988285 | 180504 | | [TCP Dup ACK 201121#1] 52824 → 443 [ACK] Seq=24988285 Ack=180504 Win=65024 Len=0 SLE=180394 |
| 201166 | 0.422872 | 0.048747000 | 0.082597000 | | | 13.107.136.9 | 192.168.2.127 | TCP | 66 | 180504 | 24875538 | | [TCP Dup ACK 201161#1] 443 → 52824 [ACK] Seq=180504 Ack=24875538 Win=525568 Len=0 SLE=24876 |
| 201167 | 0.422910 | 0.000038000 | 0.082597000 | | | 192.168.2.127 | 13.107.136.9 | TLSv1.2 | 1494 | 24988285 | 180504 | 114187 | Application Data [TCP segment of a reassembled PDU] |
| 201168 | 0.426268 | 0.003358000 | 0.082597000 | | | 13.107.136.9 | 192.168.2.127 | TCP | 66 | 180504 | 24875538 | | [TCP Dup ACK 201161#2] 443 → 52824 [ACK] Seq=180504 Ack=24875538 Win=525568 Len=0 SLE=24876 |
| 201169 | 0.426310 | 0.000042000 | 0.082597000 | | | 192.168.2.127 | 13.107.136.9 | TCP | 1494 | 24989725 | 180504 | 115627 | 52824 → 443 [ACK] Seq=24989725 Ack=180504 Win=65024 Len=1440 [TCP segment of a reassembled |
| 201170 | 0.427738 | 0.001428000 | 0.082597000 | | | 13.107.136.9 | 192.168.2.127 | TCP | 66 | 180504 | 24875538 | | [TCP Dup ACK 201161#3] 443 → 52824 [ACK] Seq=180504 Ack=24875538 Win=525568 Len=0 SLE=24876 |
| 201171 | 0.427813 | 0.000075000 | 0.082597000 | | | 192.168.2.127 | 13.107.136.9 | TCP | 1494 | 24875538 | 180504 | 115627 | [TCP Fast Retransmission] 52824 → 443 [PSH, ACK] Seq=24875538 Ack=180504 Win=65024 Len=1440 |
| 201172 | 0.508604 | 0.080791000 | 0.082597000 | | | 13.107.136.9 | 192.168.2.127 | TCP | 66 | 180504 | 24875538 | | [TCP Dup ACK 201161#4] 443 → 52824 [ACK] Seq=180504 Ack=24875538 Win=525568 Len=0 SLE=24876 |
| 201173 | 0.508604 | 0.000000000 | 0.082597000 | | | 13.107.136.9 | 192.168.2.127 | TCP | 66 | 180504 | 24875538 | | [TCP Dup ACK 201161#5] 443 → 52824 [ACK] Seq=180504 Ack=24875538 Win=525568 Len=0 SLE=24876 |
| 201174 | 0.508649 | 0.000045000 | 0.082597000 | | | 13.107.136.9 | 192.168.2.127 | TCP | 66 | 180504 | 24875538 | | [TCP Dup ACK 201161#6] 443 → 52824 [ACK] Seq=180504 Ack=24875538 Win=525568 Len=0 SLE=24876 |
| 201175 | 0.509970 | 0.001321000 | 0.082597000 | | | 13.107.136.9 | 192.168.2.127 | TCP | 66 | 180504 | 24875538 | | [TCP Dup ACK 201161#7] 443 → 52824 [ACK] Seq=180504 Ack=24875538 Win=525568 Len=0 SLE=24876 |
| 201176 | 0.510067 | 0.000097000 | 0.082597000 | | | 13.107.136.9 | 192.168.2.127 | TCP | 66 | 180504 | 24875538 | | [TCP Dup ACK 201161#8] 443 → 52824 [ACK] Seq=180504 Ack=24875538 Win=525568 Len=0 SLE=24876 |
| 201177 | 0.534250 | 0.024183000 | 0.082597000 | | | 13.107.136.9 | 192.168.2.127 | TCP | 66 | 180504 | 24875538 | | [TCP Dup ACK 201161#9] 443 → 52824 [ACK] Seq=180504 Ack=24875538 Win=525568 Len=0 SLE=24876 |
| 201178 | 0.534251 | 0.000001000 | 0.082597000 | | | 13.107.136.9 | 192.168.2.127 | TCP | 66 | 180504 | 24875538 | | [TCP Dup ACK 201161#10] 443 → 52824 [ACK] Seq=180504 Ack=24875538 Win=525568 Len=0 SLE=2487 |
| 201179 | 0.534251 | 0.000000000 | 0.082597000 | | | 13.107.136.9 | 192.168.2.127 | TCP | 66 | 180504 | 24875538 | | [TCP Dup ACK 201161#11] 443 → 52824 [ACK] Seq=180504 Ack=24875538 Win=525568 Len=0 SLE=2487 |
| 201180 | 0.534251 | 0.000000000 | 0.082597000 | | | 13.107.136.9 | 192.168.2.127 | TCP | 66 | 180504 | 24875538 | | [TCP Dup ACK 201161#12] 443 → 52824 [ACK] Seq=180504 Ack=24875538 Win=525568 Len=0 SLE=2487 |
| 201181 | 0.534387 | 0.000136000 | 0.082597000 | | | 13.107.136.9 | 192.168.2.127 | TCP | 66 | 180504 | 24875538 | | [TCP Dup ACK 201161#13] 443 → 52824 [ACK] Seq=180504 Ack=24875538 Win=525568 Len=0 SLE=2487 |
| 201182 | 0.534489 | 0.000102000 | 0.082597000 | | | 13.107.136.9 | 192.168.2.127 | TCP | 66 | 180504 | 24875538 | | [TCP Dup ACK 201161#14] 443 → 52824 [ACK] Seq=180504 Ack=24875538 Win=525568 Len=0 SLE=2487 |
| 201183 | 0.534571 | 0.000082000 | 0.082597000 | | | 13.107.136.9 | 192.168.2.127 | TCP | 66 | 180504 | 24875538 | | [TCP Dup ACK 201161#15] 443 → 52824 [ACK] Seq=180504 Ack=24875538 Win=525568 Len=0 SLE=2487 |
| 201184 | 0.534671 | 0.000100000 | 0.082597000 | | | 13.107.136.9 | 192.168.2.127 | TCP | 66 | 180504 | 24875538 | | [TCP Dup ACK 201161#16] 443 → 52824 [ACK] Seq=180504 Ack=24875538 Win=525568 Len=0 SLE=2487 |
| 201185 | 0.614908 | 0.080237000 | 0.082597000 | | | 13.107.136.9 | 192.168.2.127 | TCP | 66 | 180504 | 24875538 | | [TCP Dup ACK 201161#17] 443 → 52824 [ACK] Seq=180504 Ack=24875538 Win=525568 Len=0 SLE=2487 |
| 201186 | 0.614908 | 0.000000000 | 0.082597000 | | | 13.107.136.9 | 192.168.2.127 | TCP | 66 | 180504 | 24875538 | | [TCP Dup ACK 201161#18] 443 → 52824 [ACK] Seq=180504 Ack=24875538 Win=525568 Len=0 SLE=2487 |
| 201187 | 0.614908 | 0.000000000 | 0.082597000 | | | 13.107.136.9 | 192.168.2.127 | TCP | 66 | 180504 | 24875538 | | [TCP Dup ACK 201161#19] 443 → 52824 [ACK] Seq=180504 Ack=24875538 Win=525568 Len=0 SLE=2487 |
| 201188 | 0.614908 | 0.000000000 | 0.082597000 | | | 13.107.136.9 | 192.168.2.127 | TCP | 66 | 180504 | 24875538 | | [TCP Dup ACK 201161#20] 443 → 52824 [ACK] Seq=180504 Ack=24875538 Win=525568 Len=0 SLE=2487 |
| 201189 | 0.614909 | 0.000001000 | 0.082597000 | | | 13.107.136.9 | 192.168.2.127 | TCP | 66 | 180504 | 24875538 | | [TCP Dup ACK 201161#21] 443 → 52824 [ACK] Seq=180504 Ack=24875538 Win=525568 Len=0 SLE=2487 |
| 201190 | 0.614952 | 0.000043000 | 0.082597000 | | | 192.168.2.127 | 13.107.136.9 | TCP | 1494 | 24991165 | 180504 | 117067 | 52824 → 443 [ACK] Seq=24991165 Ack=180504 Win=65024 Len=1440 [TCP segment of a reassembled |
| 201191 | 0.655877 | 0.040925000 | 0.082597000 | | | 13.107.136.9 | 192.168.2.127 | TCP | 66 | 180504 | 24875538 | | [TCP Dup ACK 201161#22] 443 → 52824 [ACK] Seq=180504 Ack=24875538 Win=525568 Len=0 SLE=2487 |
| 201192 | 0.655878 | 0.000001000 | 0.082597000 | | | 13.107.136.9 | 192.168.2.127 | TCP | 66 | 180504 | 24875538 | | [TCP Dup ACK 201161#23] 443 → 52824 [ACK] Seq=180504 Ack=24875538 Win=525568 Len=0 SLE=2487 |
| 201193 | 0.655878 | 0.000000000 | 0.082597000 | | | 13.107.136.9 | 192.168.2.127 | TCP | 66 | 180504 | 24875538 | | [TCP Dup ACK 201161#24] 443 → 52824 [ACK] Seq=180504 Ack=24875538 Win=525568 Len=0 SLE=2487 |
| 201194 | 0.655900 | 0.000022000 | 0.082597000 | | | 192.168.2.127 | 13.107.136.9 | TCP | 1494 | 24992605 | 180504 | 118507 | 52824 → 443 [ACK] Seq=24992605 Ack=180504 Win=65024 Len=1440 [TCP segment of a reassembled |
| 201195 | 0.655946 | 0.000046000 | 0.082597000 | | | 192.168.2.127 | 13.107.136.9 | TCP | 1494 | 24994045 | 180504 | 119947 | 52824 → 443 [ACK] Seq=24994045 Ack=180504 Win=65024 Len=1440 [TCP segment of a reassembled |
| 201196 | 0.655965 | 0.000019000 | 0.082597000 | | | 192.168.2.127 | 13.107.136.9 | TCP | 1494 | 24995485 | 180504 | 121387 | 52824 → 443 [ACK] Seq=24995485 Ack=180504 Win=65024 Len=1440 [TCP segment of a reassembled |
| 201197 | 0.656003 | 0.000038000 | 0.082597000 | | | 13.107.136.9 | 192.168.2.127 | TCP | 66 | 180504 | 24875538 | | [TCP Dup ACK 201161#25] 443 → 52824 [ACK] Seq=180504 Ack=24875538 Win=525568 Len=0 SLE=2487 |
| 201198 | 0.656014 | 0.000011000 | 0.082597000 | | | 192.168.2.127 | 13.107.136.9 | TCP | 1494 | 24996925 | 180504 | 122827 | 52824 → 443 [ACK] Seq=24996925 Ack=180504 Win=65024 Len=1440 [TCP segment of a reassembled |
| 201199 | 0.656078 | 0.000064000 | 0.082597000 | | | 13.107.136.9 | 192.168.2.127 | TCP | 66 | 180504 | 24875538 | | [TCP Dup ACK 201161#26] 443 → 52824 [ACK] Seq=180504 Ack=24875538 Win=525568 Len=0 SLE=2487 |
| 201200 | 0.656086 | 0.000008000 | 0.082597000 | | | 192.168.2.127 | 13.107.136.9 | TCP | 1494 | 24998365 | 180504 | 124267 | 52824 → 443 [ACK] Seq=24998365 Ack=180504 Win=65024 Len=1440 [TCP segment of a reassembled |
| 201201 | 0.656159 | 0.000073000 | 0.082597000 | | | 13.107.136.9 | 192.168.2.127 | TCP | 66 | 180504 | 24875538 | | [TCP Dup ACK 201161#27] 443 → 52824 [ACK] Seq=180504 Ack=24875538 Win=525568 Len=0 SLE=2487 |
| 201202 | 0.656167 | 0.000008000 | 0.082597000 | | | 192.168.2.127 | 13.107.136.9 | TCP | 1494 | 24999805 | 180504 | 125707 | 52824 → 443 [ACK] Seq=24999805 Ack=180504 Win=65024 Len=1440 [TCP segment of a reassembled |
| 201203 | 0.716977 | 0.060810000 | 0.082597000 | | | 13.107.136.9 | 192.168.2.127 | TCP | 66 | 180504 | 24875538 | | [TCP Dup ACK 201161#28] 443 → 52824 [ACK] Seq=180504 Ack=24875538 Win=525568 Len=0 SLE=2487 |
| 201204 | 0.717051 | 0.000074000 | 0.082597000 | | | 192.168.2.127 | 13.107.136.9 | TCP | 1494 | 25001245 | 180504 | 127147 | 52824 → 443 [ACK] Seq=25001245 Ack=180504 Win=65024 Len=1440 [TCP segment of a reassembled |
| 201205 | 0.718924 | 0.001873000 | 0.082597000 | | | 13.107.136.9 | 192.168.2.127 | TCP | 66 | 180504 | 24875538 | | [TCP Dup ACK 201161#29] 443 → 52824 [ACK] Seq=180504 Ack=24875538 Win=525568 Len=0 SLE=2487 |
| 201206 | 0.718925 | 0.000001000 | 0.082597000 | | | 13.107.136.9 | 192.168.2.127 | TCP | 66 | 180504 | 24875538 | | [TCP Dup ACK 201161#30] 443 → 52824 [ACK] Seq=180504 Ack=24875538 Win=525568 Len=0 SLE=2487 |
| 201207 | 0.718925 | 0.000000000 | 0.082597000 | | | 13.107.136.9 | 192.168.2.127 | TCP | 66 | 180504 | 24875538 | | [TCP Dup ACK 201161#31] 443 → 52824 [ACK] Seq=180504 Ack=24875538 Win=525568 Len=0 SLE=2487 |
| 201208 | 0.719006 | 0.000081000 | 0.082597000 | | | 13.107.136.9 | 192.168.2.127 | TCP | 66 | 180504 | 24875538 | | [TCP Dup ACK 201161#32] 443 → 52824 [ACK] Seq=180504 Ack=24875538 Win=525568 Len=0 SLE=2487 |

sf21veu

# The cost of retransmissions

sf21veu



test3_without_optimization@2020-10-14_18.06.32@127.0.0.1.appcapture

ip.addr==192.168.2.127 && tcp.port==52824 && ip.addr==13.107.136.9 && tcp.port==443

| No. | Time | Delta Time | iRTT | RTT2ACK | ACK4 | Source | Destination | Protocol | Length | Seq | ACK | Bytes in flight | Info |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 201160 | 0.362715 | 0.058709000 | 0.082597000 | 0.383544000 | 201012 | 13.107.136.9 | 192.168.2.127 | TCP | 54 | 180504 | 24874098 | | 443 → 52824 [ACK] Seq=180504 Ack=24874098 Win=524032 Len=0 |
| 201161 | 0.362715 | 0.000000000 | 0.082597000 | 0.383120000 | 201016 | 13.107.136.9 | 192.168.2.127 | TCP | 54 | 180504 | 24875538 | | 443 → 52824 [ACK] Seq=180504 Ack=24875538 Win=525568 Len=0 |
| 201162 | 0.362749 | 0.000034000 | 0.082597000 | | | 192.168.2.127 | 13.107.136.9 | TCP | 1494 | 24985405 | 180504 | 111307 | 52824 → 443 [ACK] Seq=24985405 Ack=180504 Win=65024 Len=1440 [TCP segment of a reassembled |
| 201163 | 0.362750 | 0.000001000 | 0.082597000 | | | 192.168.2.127 | 13.107.136.9 | TCP | 1494 | 24986845 | 180504 | 112747 | 52824 → 443 [ACK] Seq=24986845 Ack=180504 Win=65024 Len=1440 [TCP segment of a reassembled |
| 201164 | 0.374100 | 0.011350000 | 0.082597000 | | | 13.107.136.9 | 192.168.2.127 | TLSv1.2 | 164 | 180394 | 24875538 | 110 | [TCP Spurious Retransmission] , Application Data, Application Data |
| 201165 | 0.374125 | 0.000025000 | 0.082597000 | 0.000025000 | 201164 | 192.168.2.127 | 13.107.136.9 | TCP | 66 | 24988285 | 180504 | | [TCP Dup ACK 201121#1] 52824 → 443 [ACK] Seq=24988285 Ack=180504 Win=65024 Len=0 SLE=180394 |
| 201166 | 0.422872 | 0.048747000 | 0.082597000 | | | 13.107.136.9 | 192.168.2.127 | TCP | 66 | 180504 | 24875538 | | [TCP Dup ACK 201161#1] 443 → 52824 [ACK] Seq=180504 Ack=24875538 Win=525568 Len=0 SLE=24876 |
| 201167 | 0.422910 | 0.000038000 | 0.082597000 | | | 192.168.2.127 | 13.107.136.9 | TLSv1.2 | 1494 | 24988285 | 180504 | 114187 | Application Data [TCP segment of a reassembled PDU] |
| 201168 | 0.426268 | 0.003358000 | 0.082597000 | | | 13.107.136.9 | 192.168.2.127 | TCP | 66 | 180504 | 24875538 | | [TCP Dup ACK 201161#2] 443 → 52824 [ACK] Seq=180504 Ack=24875538 Win=525568 Len=0 SLE=24876 |
| 201169 | 0.426310 | 0.000042000 | 0.082597000 | | | 192.168.2.127 | 13.107.136.9 | TCP | 1494 | 24989725 | 180504 | 115627 | 52824 → 443 [ACK] Seq=24989725 Ack=180504 Win=65024 Len=1440 [TCP segment of a reassembled |
| 201170 | 0.427738 | 0.001428000 | 0.082597000 | | | 13.107.136.9 | 192.168.2.127 | TCP | 66 | 180504 | 24875538 | | [TCP Dup ACK 201161#3] 443 → 52824 [ACK] Seq=180504 Ack=24875538 Win=525568 Len=0 SLE=24876 |
| 201171 | 0.427813 | 0.000075000 | 0.082597000 | | | 192.168.2.127 | 13.107.136.9 | TCP | 1494 | 24875538 | 180504 | 115627 | [TCP Fast Retransmission] 52824 → 443 [PSH, ACK] Seq=24875538 Ack=180504 Win=65024 Len=1440 |
| 201172 | 0.508604 | 0.080791000 | 0.082597000 | | | 13.107.136.9 | 192.168.2.127 | TCP | 66 | 180504 | 24875538 | | [TCP Dup ACK 201161#4] 443 → 52824 [ACK] Seq=180504 Ack=24875538 Win=525568 Len=0 SLE=24876 |
| 201173 | 0.508604 | 0.000000000 | 0.082597000 | | | 13.107.136.9 | 192.168.2.127 | TCP | 66 | 180504 | 24875538 | | [TCP Dup ACK 201161#5] 443 → 52824 [ACK] Seq=180504 Ack=24875538 Win=525568 Len=0 SLE=24876 |
| 201174 | 0.508649 | 0.000045000 | 0.082597000 | | | 13.107.136.9 | 192.168.2.127 | TCP | 66 | 180504 | 24875538 | | [TCP Dup ACK 201161#6] 443 → 52824 [ACK] Seq=180504 Ack=24875538 Win=525568 Len=0 SLE=24876 |
| 201175 | 0.509970 | 0.001321000 | 0.082597000 | | | 13.107.136.9 | 192.168.2.127 | TCP | 66 | 180504 | 24875538 | | [TCP Dup ACK 201161#7] 443 → 52824 [ACK] Seq=180504 Ack=24875538 Win=525568 Len=0 SLE=24876 |
| 201176 | 0.510067 | 0.000097000 | 0.082597000 | | | 13.107.136.9 | 192.168.2.127 | TCP | 66 | 180504 | 24875538 | | [TCP Dup ACK 201161#8] 443 → 52824 [ACK] Seq=180504 Ack=24875538 Win=525568 Len=0 SLE=24876 |
| 201177 | 0.534250 | 0.024183000 | 0.082597000 | | | 13.107.136.9 | 192.168.2.127 | TCP | 66 | 180504 | 24875538 | | [TCP Dup ACK 201161#9] 443 → 52824 [ACK] Seq=180504 Ack=24875538 Win=525568 Len=0 SLE=24876 |
| 201178 | 0.534251 | 0.000001000 | 0.082597000 | | | 13.107.136.9 | 192.168.2.127 | TCP | 66 | 180504 | 24875538 | | [TCP Dup ACK 201161#10] 443 → 52824 [ACK] Seq=180504 Ack=24875538 Win=525568 Len=0 SLE=2487 |
| 201179 | 0.534251 | 0.000000000 | 0.082597000 | | | 13.107.136.9 | 192.168.2.127 | TCP | 66 | 180504 | 24875538 | | [TCP Dup ACK 201161#11] 443 → 52824 [ACK] Seq=180504 Ack=24875538 Win=525568 Len=0 SLE=2487 |
| 201180 | 0.534251 | 0.000000000 | 0.082597000 | | | 13.107.136.9 | 192.168.2.127 | TCP | 66 | 180504 | 24875538 | | [TCP Dup ACK 201161#12] 443 → 52824 [ACK] Seq=180504 Ack=24875538 Win=525568 Len=0 SLE=2487 |
| 201181 | 0.534387 | 0.000136000 | 0.082597000 | | | 13.107.136.9 | 192.168.2.127 | TCP | 66 | 180504 | 24875538 | | [TCP Dup ACK 201161#13] 443 → 52824 [ACK] Seq=180504 Ack=24875538 Win=525568 Len=0 SLE=2487 |
| 201182 | 0.534489 | 0.000102000 | 0.082597000 | | | 13.107.136.9 | 192.168.2.127 | TCP | 66 | 180504 | 24875538 | | [TCP Dup ACK 201161#14] 443 → 52824 [ACK] Seq=180504 Ack=24875538 Win=525568 Len=0 SLE=2487 |
| 201183 | 0.534571 | 0.000082000 | 0.082597000 | | | 13.107.136.9 | 192.168.2.127 | TCP | 66 | 180504 | 24875538 | | [TCP Dup ACK 201161#15] 443 → 52824 [ACK] Seq=180504 Ack=24875538 Win=525568 Len=0 SLE=2487 |
| 201184 | 0.534671 | 0.000100000 | 0.082597000 | | | 13.107.136.9 | 192.168.2.127 | TCP | 66 | 180504 | 24875538 | | [TCP Dup ACK 201161#16] 443 → 52824 [ACK] Seq=180504 Ack=24875538 Win=525568 Len=0 SLE=2487 |
| 201185 | 0.614908 | 0.080237000 | 0.082597000 | | | 13.107.136.9 | 192.168.2.127 | TCP | 66 | 180504 | 24875538 | | [TCP Dup ACK 201161#17] 443 → 52824 [ACK] Seq=180504 Ack=24875538 Win=525568 Len=0 SLE=2487 |
| 201186 | 0.614908 | 0.000000000 | 0.082597000 | | | 13.107.136.9 | 192.168.2.127 | TCP | 66 | 180504 | 24875538 | | [TCP Dup ACK 201161#18] 443 → 52824 [ACK] Seq=180504 Ack=24875538 Win=525568 Len=0 SLE=2487 |
| 201187 | 0.614908 | 0.000000000 | 0.082597000 | | | 13.107.136.9 | 192.168.2.127 | TCP | 66 | 180504 | 24875538 | | [TCP Dup ACK 201161#19] 443 → 52824 [ACK] Seq=180504 Ack=24875538 Win=525568 Len=0 SLE=2487 |
| 201188 | 0.614908 | 0.000000000 | 0.082597000 | | | 13.107.136.9 | 192.168.2.127 | TCP | 66 | 180504 | 24875538 | | [TCP Dup ACK 201161#20] 443 → 52824 [ACK] Seq=180504 Ack=24875538 Win=525568 Len=0 SLE=2487 |
| 201189 | 0.614909 | 0.000001000 | 0.082597000 | | | 13.107.136.9 | 192.168.2.127 | TCP | 66 | 180504 | 24875538 | | [TCP Dup ACK 201161#21] 443 → 52824 [ACK] Seq=180504 Ack=24875538 Win=525568 Len=0 SLE=2487 |
| 201190 | 0.614952 | 0.000043000 | 0.082597000 | | | 192.168.2.127 | 13.107.136.9 | TCP | 1494 | 24991165 | 180504 | 117067 | 52824 → 443 [ACK] Seq=24991165 Ack=180504 Win=65024 Len=1440 [TCP segment of a reassembled |
| 201191 | 0.655877 | 0.040925000 | 0.082597000 | | | 13.107.136.9 | 192.168.2.127 | TCP | 66 | 180504 | 24875538 | | [TCP Dup ACK 201161#22] 443 → 52824 [ACK] Seq=180504 Ack=24875538 Win=525568 Len=0 SLE=2487 |
| 201192 | 0.655878 | 0.000001000 | 0.082597000 | | | 13.107.136.9 | 192.168.2.127 | TCP | 66 | 180504 | 24875538 | | [TCP Dup ACK 201161#23] 443 → 52824 [ACK] Seq=180504 Ack=24875538 Win=525568 Len=0 SLE=2487 |
| 201193 | 0.655878 | 0.000000000 | 0.082597000 | | | 13.107.136.9 | 192.168.2.127 | TCP | 66 | 180504 | 24875538 | | [TCP Dup ACK 201161#24] 443 → 52824 [ACK] Seq=180504 Ack=24875538 Win=525568 Len=0 SLE=2487 |
| 201194 | 0.655900 | 0.000022000 | 0.082597000 | | | 192.168.2.127 | 13.107.136.9 | TCP | 1494 | 24992605 | 180504 | 118507 | 52824 → 443 [ACK] Seq=24992605 Ack=180504 Win=65024 Len=1440 [TCP segment of a reassembled |
| 201195 | 0.655946 | 0.000046000 | 0.082597000 | | | 192.168.2. | | | | | | | [ACK] Seq=24994045 Ack=180504 Win=65024 Len=1440 [TCP segment of a reassembled |
| 201196 | 0.655965 | 0.000019000 | 0.082597000 | | | 192.168.2. | | | | | | | [ACK] Seq=24995485 Ack=180504 Win=65024 Len=1440 [TCP segment of a reassembled |
| 201197 | 0.656003 | 0.000038000 | 0.082597000 | | | 13.107.136 | | | | | | | 201161#25] 443 → 52824 [ACK] Seq=180504 Ack=24875538 Win=525568 Len=0 SLE=2487 |
| 201198 | 0.656014 | 0.000011000 | 0.082597000 | | | 192.168.2. | | | | | | | [ACK] Seq=24996925 Ack=180504 Win=65024 Len=1440 [TCP segment of a reassembled |
| 201199 | 0.656078 | 0.000064000 | 0.082597000 | | | 13.107.136 | | | | | | | 201161#26] 443 → 52824 [ACK] Seq=180504 Ack=24875538 Win=525568 Len=0 SLE=2487 |
| 201200 | 0.656086 | 0.000008000 | 0.082597000 | | | 192.168.2.127 | 13.107.136.9 | TCP | 1494 | 24998365 | 180504 | 124267 | 52824 → 443 [ACK] Seq=24998365 Ack=180504 Win=65024 Len=1440 [TCP segment of a reassembled |
| 201201 | 0.656159 | 0.000073000 | 0.082597000 | | | 13.107.136.9 | 192.168.2.127 | TCP | 66 | 180504 | 24875538 | | [TCP Dup ACK 201161#27] 443 → 52824 [ACK] Seq=180504 Ack=24875538 Win=525568 Len=0 SLE=2487 |
| 201202 | 0.656167 | 0.000008000 | 0.082597000 | | | 192.168.2.127 | 13.107.136.9 | TCP | 1494 | 24999805 | 180504 | 125707 | 52824 → 443 [ACK] Seq=24999805 Ack=180504 Win=65024 Len=1440 [TCP segment of a reassembled |
| 201203 | 0.716977 | 0.060810000 | 0.082597000 | | | 13.107.136.9 | 192.168.2.127 | TCP | 66 | 180504 | 24875538 | | [TCP Dup ACK 201161#28] 443 → 52824 [ACK] Seq=180504 Ack=24875538 Win=525568 Len=0 SLE=2487 |
| 201204 | 0.717051 | 0.000074000 | 0.082597000 | | | 192.168.2.127 | 13.107.136.9 | TCP | 1494 | 25001245 | 180504 | 127147 | 52824 → 443 [ACK] Seq=25001245 Ack=180504 Win=65024 Len=1440 [TCP segment of a reassembled |
| 201205 | 0.718924 | 0.001873000 | 0.082597000 | | | 13.107.136.9 | 192.168.2.127 | TCP | 66 | 180504 | 24875538 | | [TCP Dup ACK 201161#29] 443 → 52824 [ACK] Seq=180504 Ack=24875538 Win=525568 Len=0 SLE=2487 |
| 201206 | 0.718925 | 0.000001000 | 0.082597000 | | | 13.107.136.9 | 192.168.2.127 | TCP | 66 | 180504 | 24875538 | | [TCP Dup ACK 201161#30] 443 → 52824 [ACK] Seq=180504 Ack=24875538 Win=525568 Len=0 SLE=2487 |
| 201207 | 0.718925 | 0.000000000 | 0.082597000 | | | 13.107.136.9 | 192.168.2.127 | TCP | 66 | 180504 | 24875538 | | [TCP Dup ACK 201161#31] 443 → 52824 [ACK] Seq=180504 Ack=24875538 Win=525568 Len=0 SLE=2487 |
| 201208 | 0.719006 | 0.000081000 | 0.082597000 | | | 13.107.136.9 | 192.168.2.127 | TCP | 66 | 180504 | 24875538 | | [TCP Dup ACK 201161#32] 443 → 52824 [ACK] Seq=180504 Ack=24875538 Win=525568 Len=0 SLE=2487 |

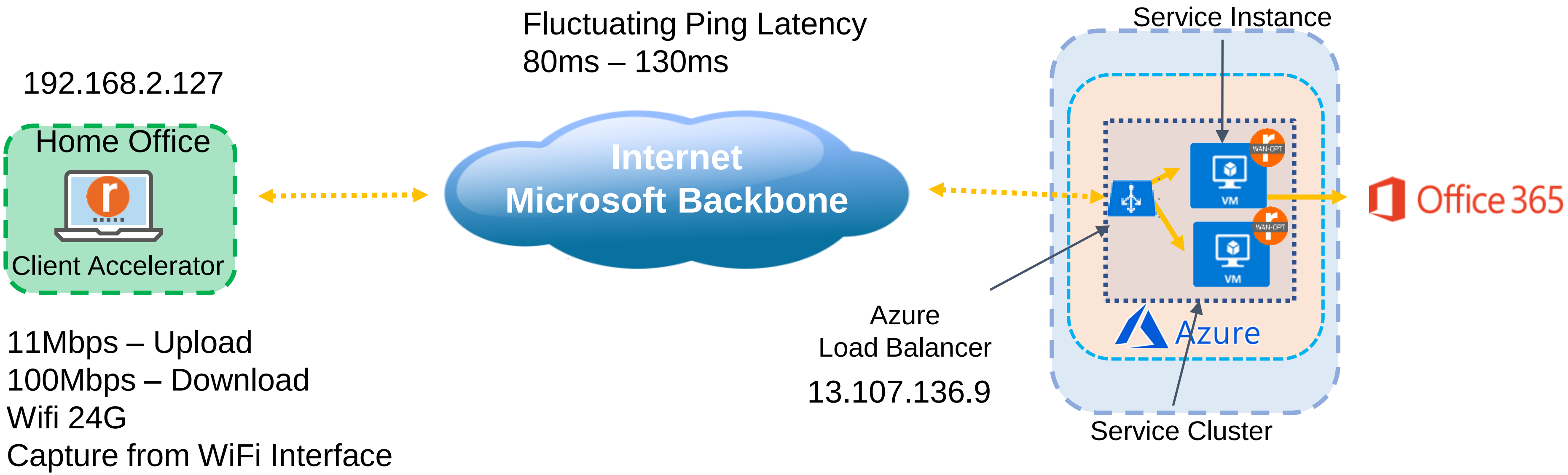
+350ms of delay in this screenshot

# Turning Optimization On

- Now we’ll run the script navigation with Optimization Turned on

# OneDrive & SharePoint

## Work from Home



Fluctuating Ping Latency
80ms – 130ms

192.168.2.127

Home Office

Client Accelerator

Internet
Microsoft Backbone

Service Instance

Azure
Load Balancer

13.107.136.9

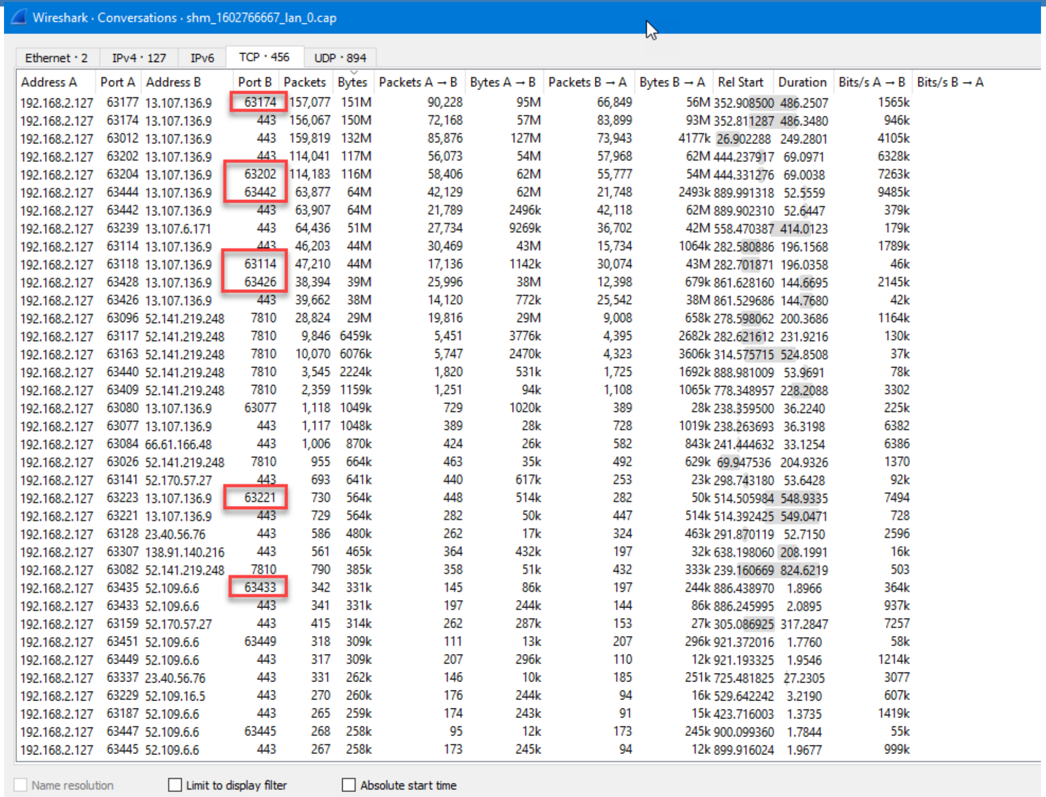
Service Cluster

11Mbps – Upload
100Mbps – Download
Wifi 24G
Capture from WiFi Interface

# Be on the “lookout”

- Phantom TCP Connections in LAN_0 TCPDUMP
- RTT Timing evidence that incoming data is served from “nearby” cache
- No retransmissions
- Faster transfer times

# With Client Accelerator Enabled

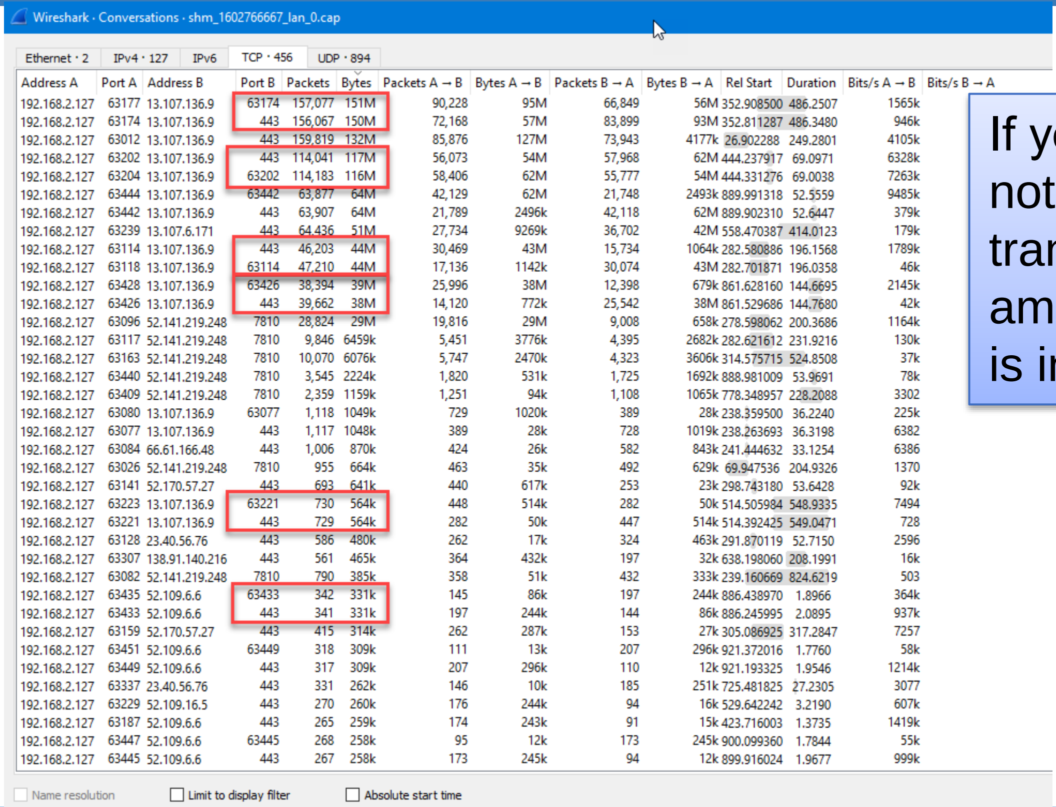


| Address A | Port A | Address B | Port B | Packets | Bytes | Packets A → B | Bytes A → B | Packets B → A | Bytes B → A | Rel Start | Duration | Bits/s A → B | Bits/s B → A |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 192.168.2.127 | 63177 | 13.107.136.9 | 63174 | 157,077 | 151M | 90,228 | 95M | 66,849 | 56M | 352.908500 | 486.2507 | 1565k | |
| 192.168.2.127 | 63174 | 13.107.136.9 | 443 | 156,067 | 150M | 72,168 | 57M | 83,899 | 93M | 352.811287 | 486.3480 | 946k | |
| 192.168.2.127 | 63012 | 13.107.136.9 | 443 | 159,819 | 132M | 85,876 | 127M | 73,943 | 4177k | 26.902288 | 249.2801 | 4105k | |
| 192.168.2.127 | 63202 | 13.107.136.9 | 443 | 114,041 | 117M | 56,073 | 54M | 57,968 | 62M | 444.237917 | 69.0971 | 6328k | |
| 192.168.2.127 | 63204 | 13.107.136.9 | 63202 | 114,183 | 116M | 58,406 | 62M | 55,777 | 54M | 444.331276 | 69.0038 | 7263k | |
| 192.168.2.127 | 63444 | 13.107.136.9 | 63442 | 63,877 | 64M | 42,129 | 62M | 21,748 | 2493k | 889.991318 | 52.5559 | 9485k | |
| 192.168.2.127 | 63442 | 13.107.136.9 | 443 | 63,907 | 64M | 21,789 | 2496k | 42,118 | 62M | 889.902310 | 52.6447 | 379k | |
| 192.168.2.127 | 63239 | 13.107.6.171 | 443 | 64,436 | 51M | 27,734 | 9269k | 36,702 | 42M | 558.470387 | 414.0123 | 179k | |
| 192.168.2.127 | 63114 | 13.107.136.9 | 443 | 46,203 | 44M | 30,469 | 43M | 15,734 | 1064k | 282.580886 | 196.1568 | 1789k | |
| 192.168.2.127 | 63118 | 13.107.136.9 | 63114 | 47,210 | 44M | 17,136 | 1142k | 30,074 | 43M | 282.701871 | 196.0358 | 46k | |
| 192.168.2.127 | 63428 | 13.107.136.9 | 63426 | 38,394 | 39M | 25,996 | 38M | 12,398 | 679k | 861.628160 | 144.6695 | 2145k | |
| 192.168.2.127 | 63426 | 13.107.136.9 | 443 | 39,662 | 38M | 14,120 | 772k | 25,542 | 38M | 861.529686 | 144.7680 | 42k | |
| 192.168.2.127 | 63096 | 52.141.219.248 | 7810 | 28,824 | 29M | 19,816 | 29M | 9,008 | 658k | 278.598062 | 200.3686 | 1164k | |
| 192.168.2.127 | 63117 | 52.141.219.248 | 7810 | 9,846 | 6459k | 5,451 | 3776k | 4,395 | 2682k | 282.621612 | 231.9216 | 130k | |
| 192.168.2.127 | 63163 | 52.141.219.248 | 7810 | 10,070 | 6076k | 5,747 | 2470k | 4,323 | 3606k | 314.575715 | 524.8508 | 37k | |
| 192.168.2.127 | 63440 | 52.141.219.248 | 7810 | 3,545 | 2224k | 1,820 | 531k | 1,725 | 1692k | 888.981009 | 53.9691 | 78k | |
| 192.168.2.127 | 63409 | 52.141.219.248 | 7810 | 2,359 | 1159k | 1,251 | 94k | 1,108 | 1065k | 778.348957 | 228.2088 | 3302 | |
| 192.168.2.127 | 63080 | 13.107.136.9 | 63077 | 1,118 | 1049k | 729 | 1020k | 389 | 28k | 238.359500 | 36.2240 | 225k | |
| 192.168.2.127 | 63077 | 13.107.136.9 | 443 | 1,117 | 1048k | 389 | 28k | 728 | 1019k | 238.263693 | 36.3198 | 6382 | |
| 192.168.2.127 | 63084 | 66.61.166.48 | 443 | 1,006 | 870k | 424 | 26k | 582 | 843k | 241.444632 | 33.1254 | 6386 | |
| 192.168.2.127 | 63026 | 52.141.219.248 | 7810 | 955 | 664k | 463 | 35k | 492 | 629k | 69.947536 | 204.9326 | 1370 | |
| 192.168.2.127 | 63141 | 52.170.57.27 | 443 | 693 | 641k | 440 | 617k | 253 | 23k | 298.743180 | 53.6428 | 92k | |
| 192.168.2.127 | 63223 | 13.107.136.9 | 63221 | 730 | 564k | 448 | 514k | 282 | 50k | 514.505984 | 548.9335 | 7494 | |
| 192.168.2.127 | 63221 | 13.107.136.9 | 443 | 729 | 564k | 282 | 50k | 447 | 514k | 514.392425 | 549.0471 | 728 | |
| 192.168.2.127 | 63128 | 23.40.56.76 | 443 | 586 | 480k | 262 | 17k | 324 | 463k | 291.870119 | 52.7150 | 2596 | |
| 192.168.2.127 | 63307 | 138.91.140.216 | 443 | 561 | 465k | 364 | 432k | 197 | 32k | 638.198060 | 208.1991 | 16k | |
| 192.168.2.127 | 63082 | 52.141.219.248 | 7810 | 790 | 385k | 358 | 51k | 432 | 333k | 239.160669 | 824.6219 | 503 | |
| 192.168.2.127 | 63435 | 52.109.6.6 | 63433 | 342 | 331k | 145 | 86k | 197 | 244k | 886.438970 | 1.8966 | 364k | |
| 192.168.2.127 | 63433 | 52.109.6.6 | 443 | 341 | 331k | 197 | 244k | 144 | 86k | 886.245995 | 2.0895 | 937k | |
| 192.168.2.127 | 63159 | 52.170.57.27 | 443 | 415 | 314k | 262 | 287k | 153 | 27k | 305.086925 | 317.2847 | 7257 | |
| 192.168.2.127 | 63451 | 52.109.6.6 | 63449 | 318 | 309k | 111 | 13k | 207 | 296k | 921.372016 | 1.7760 | 58k | |
| 192.168.2.127 | 63449 | 52.109.6.6 | 443 | 317 | 309k | 207 | 296k | 110 | 12k | 921.193325 | 1.9546 | 1214k | |
| 192.168.2.127 | 63337 | 23.40.56.76 | 443 | 331 | 262k | 146 | 10k | 185 | 251k | 725.481825 | 27.2305 | 3077 | |
| 192.168.2.127 | 63229 | 52.109.16.5 | 443 | 270 | 260k | 176 | 244k | 94 | 16k | 529.642242 | 3.2190 | 607k | |
| 192.168.2.127 | 63187 | 52.109.6.6 | 443 | 265 | 259k | 174 | 243k | 91 | 15k | 423.716003 | 1.3735 | 1419k | |
| 192.168.2.127 | 63447 | 52.109.6.6 | 63445 | 268 | 258k | 95 | 12k | 173 | 245k | 900.099360 | 1.7844 | 55k | |
| 192.168.2.127 | 63445 | 52.109.6.6 | 443 | 267 | 258k | 173 | 245k | 94 | 12k | 899.916024 | 1.9677 | 999k | |

☐ Name resolution ☐ Limit to display filter ☐ Absolute start time

These "phantom" connections on port 63xxx occur only within the laptop.
Part of internal WAN-Opt processing.

# 63xxx paired with 443



Wireshark · Conversations · shm_1602766667_lan_0.cap

| Address A | Port A | Address B | Port B | Packets | Bytes | Packets A → B | Bytes A → B | Packets B → A | Bytes B → A | Rel Start | Duration | Bits/s A → B | Bits/s B → A |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 192.168.2.127 | 63177 | 13.107.136.9 | 63174 | 157,077 | 151M | 90,228 | 95M | 66,849 | 56M | 352.908500 | 486.2507 | 1565k | |
| 192.168.2.127 | 63174 | 13.107.136.9 | 443 | 156,067 | 150M | 72,168 | 57M | 83,899 | 93M | 352.811287 | 486.3480 | 946k | |
| 192.168.2.127 | 63012 | 13.107.136.9 | 443 | 159,819 | 132M | 85,876 | 127M | 73,943 | 4177k | 26.902288 | 249.2801 | 4105k | |
| 192.168.2.127 | 63202 | 13.107.136.9 | 443 | 114,041 | 117M | 56,073 | 54M | 57,968 | 62M | 444.237917 | 69.0971 | 6328k | |
| 192.168.2.127 | 63204 | 13.107.136.9 | 63202 | 114,183 | 116M | 58,406 | 62M | 55,777 | 54M | 444.331276 | 69.0038 | 7263k | |
| 192.168.2.127 | 63444 | 13.107.136.9 | 63442 | 63,877 | 64M | 42,129 | 62M | 21,748 | 2493k | 889.991318 | 52.5559 | 9485k | |
| 192.168.2.127 | 63442 | 13.107.136.9 | 443 | 63,907 | 64M | 21,789 | 2496k | 42,118 | 62M | 889.902310 | 52.6447 | 379k | |
| 192.168.2.127 | 63239 | 13.107.6.171 | 443 | 64,436 | 51M | 27,734 | 9269k | 36,702 | 42M | 558.470387 | 414.0123 | 179k | |
| 192.168.2.127 | 63114 | 13.107.136.9 | 443 | 46,203 | 44M | 30,469 | 43M | 15,734 | 1064k | 282.580886 | 196.1568 | 1789k | |
| 192.168.2.127 | 63118 | 13.107.136.9 | 63114 | 47,210 | 44M | 17,136 | 1142k | 30,074 | 43M | 282.701871 | 196.0358 | 46k | |
| 192.168.2.127 | 63428 | 13.107.136.9 | 63426 | 38,394 | 39M | 25,996 | 38M | 12,398 | 679k | 861.628160 | 144.6695 | 2145k | |
| 192.168.2.127 | 63426 | 13.107.136.9 | 443 | 39,662 | 38M | 14,120 | 772k | 25,542 | 38M | 861.529686 | 144.7680 | 42k | |
| 192.168.2.127 | 63096 | 52.141.219.248 | 7810 | 28,824 | 29M | 19,816 | 29M | 9,008 | 658k | 278.598062 | 200.3686 | 1164k | |
| 192.168.2.127 | 63117 | 52.141.219.248 | 7810 | 9,846 | 6459k | 5,451 | 3776k | 4,395 | 2682k | 282.621612 | 231.9216 | 130k | |
| 192.168.2.127 | 63163 | 52.141.219.248 | 7810 | 10,070 | 6076k | 5,747 | 2470k | 4,323 | 3606k | 314.575715 | 524.8508 | 37k | |
| 192.168.2.127 | 63440 | 52.141.219.248 | 7810 | 3,545 | 2224k | 1,820 | 531k | 1,725 | 1692k | 888.981009 | 53.9691 | 78k | |
| 192.168.2.127 | 63409 | 52.141.219.248 | 7810 | 2,359 | 1159k | 1,251 | 94k | 1,108 | 1065k | 778.348957 | 228.2088 | 3302 | |
| 192.168.2.127 | 63080 | 13.107.136.9 | 63077 | 1,118 | 1049k | 729 | 1020k | 389 | 28k | 238.359500 | 36.2240 | 225k | |
| 192.168.2.127 | 63077 | 13.107.136.9 | 443 | 1,117 | 1048k | 389 | 28k | 728 | 1019k | 238.263693 | 36.3198 | 6382 | |
| 192.168.2.127 | 63084 | 66.61.166.48 | 443 | 1,006 | 870k | 424 | 26k | 582 | 843k | 241.444632 | 33.1254 | 6386 | |
| 192.168.2.127 | 63026 | 52.141.219.248 | 7810 | 955 | 664k | 463 | 35k | 492 | 629k | 69.947536 | 204.9326 | 1370 | |
| 192.168.2.127 | 63141 | 52.170.57.27 | 443 | 693 | 641k | 440 | 617k | 253 | 23k | 298.743180 | 53.6428 | 92k | |
| 192.168.2.127 | 63223 | 13.107.136.9 | 63221 | 730 | 564k | 448 | 514k | 282 | 50k | 514.505984 | 548.9335 | 7494 | |
| 192.168.2.127 | 63221 | 13.107.136.9 | 443 | 729 | 564k | 282 | 50k | 447 | 514k | 514.392425 | 549.0471 | 728 | |
| 192.168.2.127 | 63128 | 23.40.56.76 | 443 | 586 | 480k | 262 | 17k | 324 | 463k | 291.870119 | 52.7150 | 2596 | |
| 192.168.2.127 | 63307 | 138.91.140.216 | 443 | 561 | 465k | 364 | 432k | 197 | 32k | 638.198060 | 208.1991 | 16k | |
| 192.168.2.127 | 63082 | 52.141.219.248 | 7810 | 790 | 385k | 358 | 51k | 432 | 333k | 239.160669 | 824.6219 | 503 | |
| 192.168.2.127 | 63435 | 52.109.6.6 | 63433 | 342 | 331k | 145 | 86k | 197 | 244k | 886.438970 | 1.8966 | 364k | |
| 192.168.2.127 | 63433 | 52.109.6.6 | 443 | 341 | 331k | 197 | 244k | 144 | 86k | 886.245995 | 2.0895 | 937k | |
| 192.168.2.127 | 63159 | 52.170.57.27 | 443 | 415 | 314k | 262 | 287k | 153 | 27k | 305.086925 | 317.2847 | 7257 | |
| 192.168.2.127 | 63451 | 52.109.6.6 | 63449 | 318 | 309k | 111 | 13k | 207 | 296k | 921.372016 | 1.7760 | 58k | |
| 192.168.2.127 | 63449 | 52.109.6.6 | 443 | 317 | 309k | 207 | 296k | 110 | 12k | 921.193325 | 1.9546 | 1214k | |
| 192.168.2.127 | 63337 | 23.40.56.76 | 443 | 331 | 262k | 146 | 10k | 185 | 251k | 725.481825 | 27.2305 | 3077 | |
| 192.168.2.127 | 63229 | 52.109.16.5 | 443 | 270 | 260k | 176 | 244k | 94 | 16k | 529.642242 | 3.2190 | 607k | |
| 192.168.2.127 | 63187 | 52.109.6.6 | 443 | 265 | 259k | 174 | 243k | 91 | 15k | 423.716003 | 1.3735 | 1419k | |
| 192.168.2.127 | 63447 | 52.109.6.6 | 63445 | 268 | 258k | 95 | 12k | 173 | 245k | 900.099360 | 1.7844 | 55k | |
| 192.168.2.127 | 63445 | 52.109.6.6 | 443 | 267 | 258k | 173 | 245k | 94 | 12k | 899.916024 | 1.9677 | 999k | |

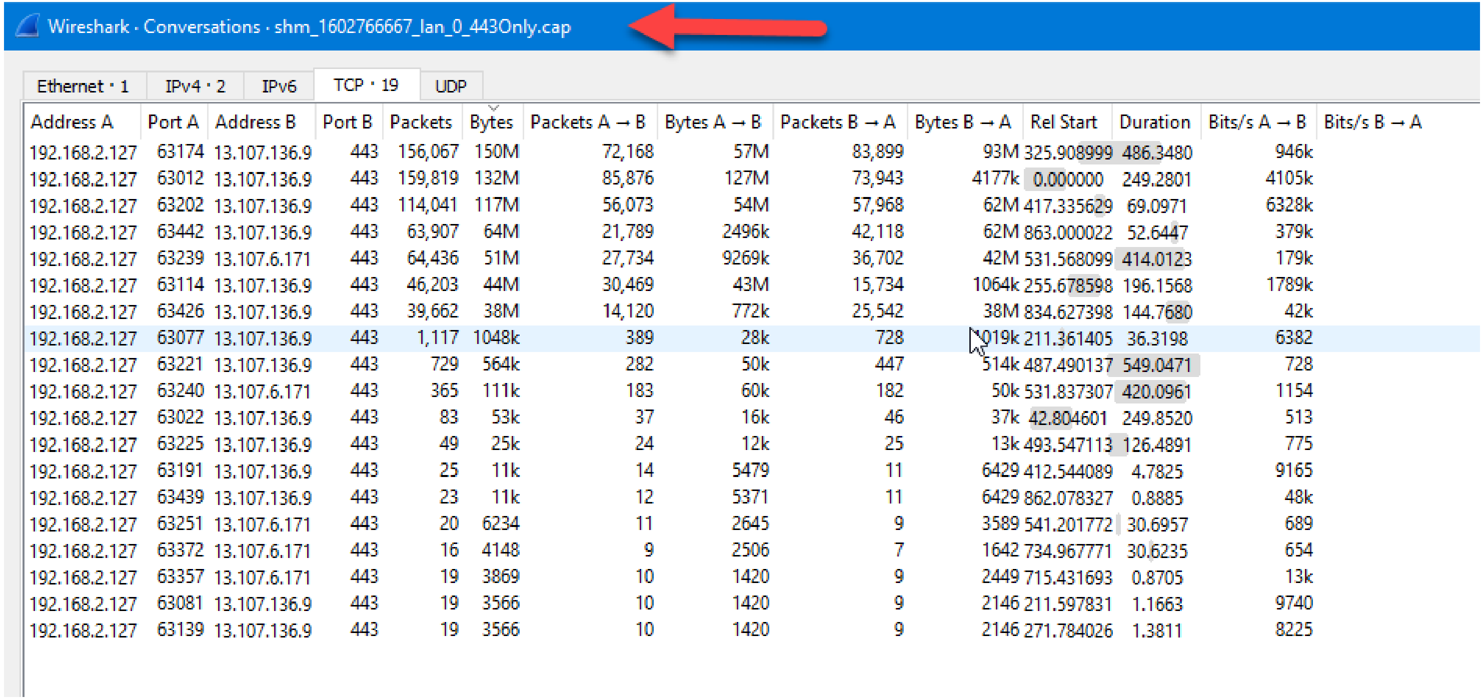
☐ Name resolution ☐ Limit to display filter ☐ Absolute start time

If you look closely, you'll notice connection pairs that transfer roughly the same amount of traffic. Again, this is internal processing.

We'll use display filter and "export specified packets…" to create a new pcap with tcp.port==443 only

# New PCAP with 443 Only

#sf21veu

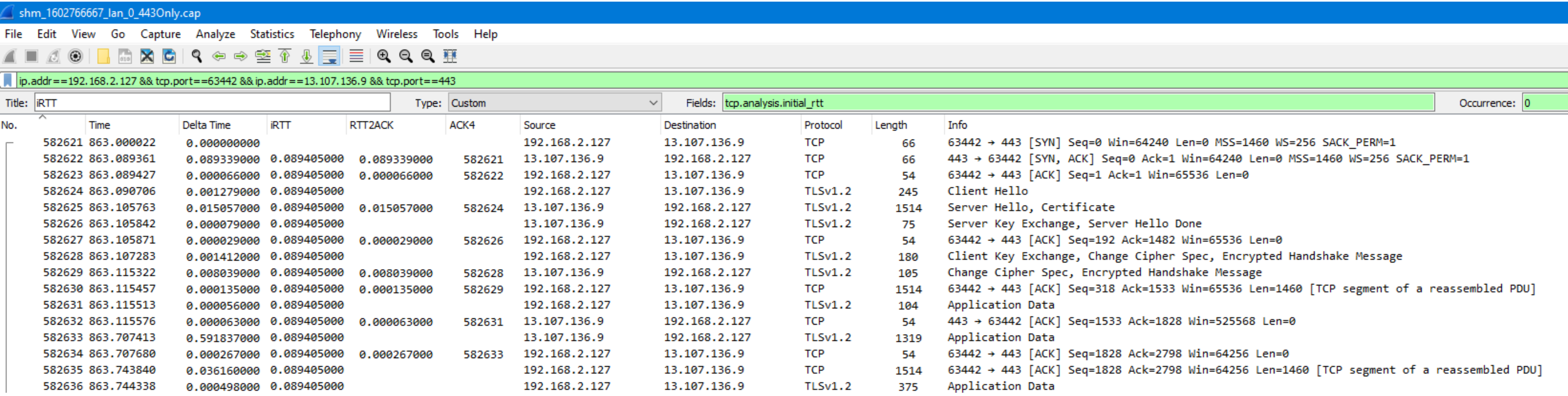


Wireshark · Conversations · shm_1602766667_lan_0_443Only.cap

| Address A | Port A | Address B | Port B | Packets | Bytes | Packets A → B | Bytes A → B | Packets B → A | Bytes B → A | Rel Start | Duration | Bits/s A → B | Bits/s B → A |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 192.168.2.127 | 63174 | 13.107.136.9 | 443 | 156,067 | 150M | 72,168 | 57M | 83,899 | 93M | 325.908999 | 486.3480 | 946k | |
| 192.168.2.127 | 63012 | 13.107.136.9 | 443 | 159,819 | 132M | 85,876 | 127M | 73,943 | 4177k | 0.000000 | 249.2801 | 4105k | |
| 192.168.2.127 | 63202 | 13.107.136.9 | 443 | 114,041 | 117M | 56,073 | 54M | 57,968 | 62M | 417.335629 | 69.0971 | 6328k | |
| 192.168.2.127 | 63442 | 13.107.136.9 | 443 | 63,907 | 64M | 21,789 | 2496k | 42,118 | 62M | 863.000022 | 52.6447 | 379k | |
| 192.168.2.127 | 63239 | 13.107.6.171 | 443 | 64,436 | 51M | 27,734 | 9269k | 36,702 | 42M | 531.568099 | 414.0123 | 179k | |
| 192.168.2.127 | 63114 | 13.107.136.9 | 443 | 46,203 | 44M | 30,469 | 43M | 15,734 | 1064k | 255.678598 | 196.1568 | 1789k | |
| 192.168.2.127 | 63426 | 13.107.136.9 | 443 | 39,662 | 38M | 14,120 | 772k | 25,542 | 38M | 834.627398 | 144.7680 | 42k | |
| 192.168.2.127 | 63077 | 13.107.136.9 | 443 | 1,117 | 1048k | 389 | 28k | 728 | 1019k | 211.361405 | 36.3198 | 6382 | |
| 192.168.2.127 | 63221 | 13.107.136.9 | 443 | 729 | 564k | 282 | 50k | 447 | 514k | 487.490137 | 549.0471 | 728 | |
| 192.168.2.127 | 63240 | 13.107.6.171 | 443 | 365 | 111k | 183 | 60k | 182 | 50k | 531.837307 | 420.0961 | 1154 | |
| 192.168.2.127 | 63022 | 13.107.136.9 | 443 | 83 | 53k | 37 | 16k | 46 | 37k | 42.804601 | 249.8520 | 513 | |
| 192.168.2.127 | 63225 | 13.107.136.9 | 443 | 49 | 25k | 24 | 12k | 25 | 13k | 493.547113 | 126.4891 | 775 | |
| 192.168.2.127 | 63191 | 13.107.136.9 | 443 | 25 | 11k | 14 | 5479 | 11 | 6429 | 412.544089 | 4.7825 | 9165 | |
| 192.168.2.127 | 63439 | 13.107.136.9 | 443 | 23 | 11k | 12 | 5371 | 11 | 6429 | 862.078327 | 0.8885 | 48k | |
| 192.168.2.127 | 63251 | 13.107.6.171 | 443 | 20 | 6234 | 11 | 2645 | 9 | 3589 | 541.201772 | 30.6957 | 689 | |
| 192.168.2.127 | 63372 | 13.107.6.171 | 443 | 16 | 4148 | 9 | 2506 | 7 | 1642 | 734.967771 | 30.6235 | 654 | |
| 192.168.2.127 | 63357 | 13.107.6.171 | 443 | 19 | 3869 | 10 | 1420 | 9 | 2449 | 715.431693 | 0.8705 | 13k | |
| 192.168.2.127 | 63081 | 13.107.136.9 | 443 | 19 | 3566 | 10 | 1420 | 9 | 2146 | 211.597831 | 1.1663 | 9740 | |
| 192.168.2.127 | 63139 | 13.107.136.9 | 443 | 19 | 3566 | 10 | 1420 | 9 | 2146 | 271.784026 | 1.3811 | 8225 | |

# SSL Handshake Acceleration

- TLS Server Hello arrives 15ms after Client Hello, but server iRTT == 89ms?



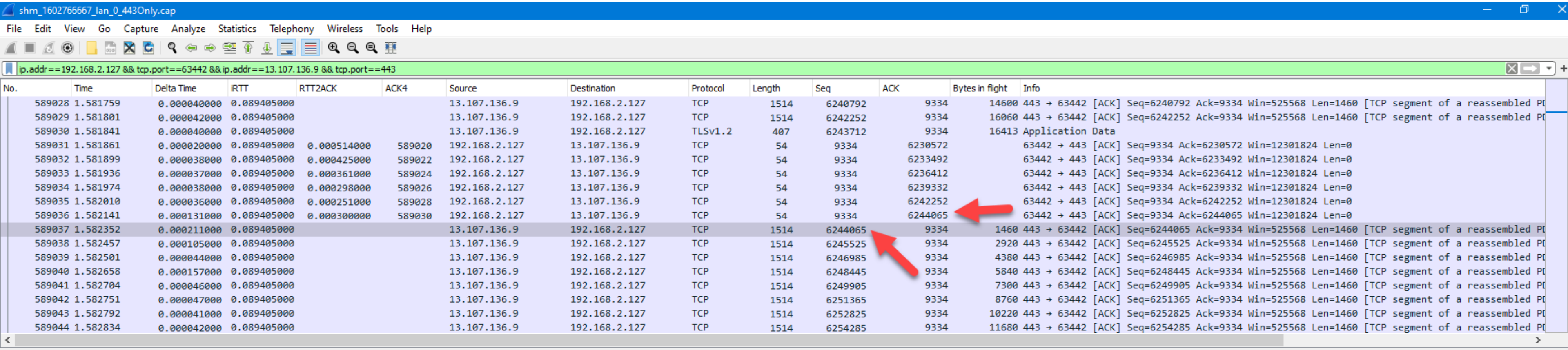
ip.addr==192.168.2.127 && tcp.port==63442 && ip.addr==13.107.136.9 && tcp.port==443

Title: iRTT Type: Custom Fields: tcp.analysis.initial_rtt Occurrence: 0

| No. | Time | Delta Time | iRTT | RTT2ACK | ACK4 | Source | Destination | Protocol | Length | Info |
|---|---|---|---|---|---|---|---|---|---|---|
| 582621 | 863.000022 | 0.000000000 | | | | 192.168.2.127 | 13.107.136.9 | TCP | 66 | 63442 → 443 [SYN] Seq=0 Win=64240 Len=0 MSS=1460 WS=256 SACK_PERM=1 |
| 582622 | 863.089361 | 0.089339000 | 0.089405000 | 0.089339000 | 582621 | 13.107.136.9 | 192.168.2.127 | TCP | 66 | 443 → 63442 [SYN, ACK] Seq=0 Ack=1 Win=64240 Len=0 MSS=1460 WS=256 SACK_PERM=1 |
| 582623 | 863.089427 | 0.000066000 | 0.089405000 | 0.000066000 | 582622 | 192.168.2.127 | 13.107.136.9 | TCP | 54 | 63442 → 443 [ACK] Seq=1 Ack=1 Win=65536 Len=0 |
| 582624 | 863.090706 | 0.001279000 | 0.089405000 | | | 192.168.2.127 | 13.107.136.9 | TLSv1.2 | 245 | Client Hello |
| 582625 | 863.105763 | 0.015057000 | 0.089405000 | 0.015057000 | 582624 | 13.107.136.9 | 192.168.2.127 | TLSv1.2 | 1514 | Server Hello, Certificate |
| 582626 | 863.105842 | 0.000079000 | 0.089405000 | | | 13.107.136.9 | 192.168.2.127 | TLSv1.2 | 75 | Server Key Exchange, Server Hello Done |
| 582627 | 863.105871 | 0.000029000 | 0.089405000 | 0.000029000 | 582626 | 192.168.2.127 | 13.107.136.9 | TCP | 54 | 63442 → 443 [ACK] Seq=192 Ack=1482 Win=65536 Len=0 |
| 582628 | 863.107283 | 0.001412000 | 0.089405000 | | | 192.168.2.127 | 13.107.136.9 | TLSv1.2 | 180 | Client Key Exchange, Change Cipher Spec, Encrypted Handshake Message |
| 582629 | 863.115322 | 0.008039000 | 0.089405000 | 0.008039000 | 582628 | 13.107.136.9 | 192.168.2.127 | TLSv1.2 | 105 | Change Cipher Spec, Encrypted Handshake Message |
| 582630 | 863.115457 | 0.000135000 | 0.089405000 | 0.000135000 | 582629 | 192.168.2.127 | 13.107.136.9 | TCP | 1514 | 63442 → 443 [ACK] Seq=318 Ack=1533 Win=65536 Len=1460 [TCP segment of a reassembled PDU] |
| 582631 | 863.115513 | 0.000056000 | 0.089405000 | | | 192.168.2.127 | 13.107.136.9 | TLSv1.2 | 104 | Application Data |
| 582632 | 863.115576 | 0.000063000 | 0.089405000 | 0.000063000 | 582631 | 13.107.136.9 | 192.168.2.127 | TCP | 54 | 443 → 63442 [ACK] Seq=1533 Ack=1828 Win=525568 Len=0 |
| 582633 | 863.707413 | 0.591837000 | 0.089405000 | | | 13.107.136.9 | 192.168.2.127 | TLSv1.2 | 1319 | Application Data |
| 582634 | 863.707680 | 0.000267000 | 0.089405000 | 0.000267000 | 582633 | 192.168.2.127 | 13.107.136.9 | TCP | 54 | 63442 → 443 [ACK] Seq=1828 Ack=2798 Win=64256 Len=0 |
| 582635 | 863.743840 | 0.036160000 | 0.089405000 | | | 192.168.2.127 | 13.107.136.9 | TCP | 1514 | 63442 → 443 [ACK] Seq=1828 Ack=2798 Win=64256 Len=1460 [TCP segment of a reassembled PDU] |
| 582636 | 863.744338 | 0.000498000 | 0.089405000 | | | 192.168.2.127 | 13.107.136.9 | TLSv1.2 | 375 | Application Data |

# Segment from Local Cache

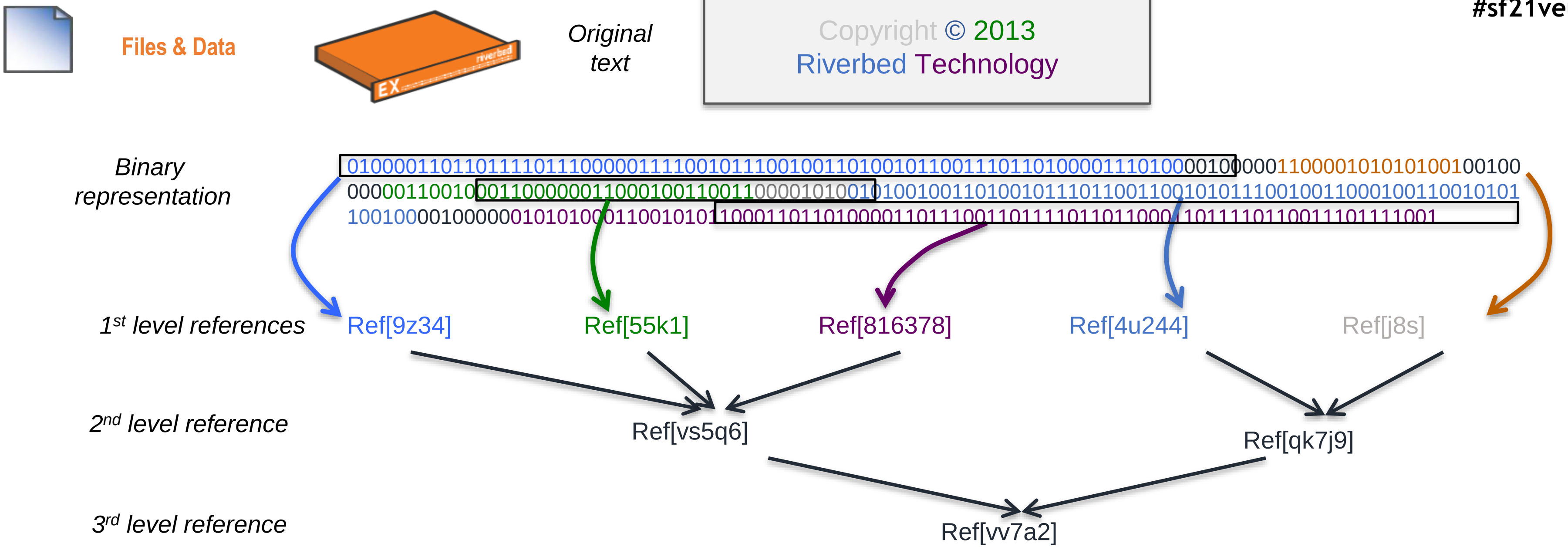
- Segment arrives immediately after ACK, no RTT delay from me to O365



ip.addr==192.168.2.127 && tcp.port==63442 && ip.addr==13.107.136.9 && tcp.port==443

| No. | Time | Delta Time | iRTT | RTT2ACK | ACK4 | Source | Destination | Protocol | Length | Seq | ACK | Bytes in flight | Info |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 589028 | 1.581759 | 0.000040000 | 0.089405000 | | | 13.107.136.9 | 192.168.2.127 | TCP | 1514 | 6240792 | 9334 | 14600 | 443 → 63442 [ACK] Seq=6240792 Ack=9334 Win=525568 Len=1460 [TCP segment of a reassembled PD |
| 589029 | 1.581801 | 0.000042000 | 0.089405000 | | | 13.107.136.9 | 192.168.2.127 | TCP | 1514 | 6242252 | 9334 | 16060 | 443 → 63442 [ACK] Seq=6242252 Ack=9334 Win=525568 Len=1460 [TCP segment of a reassembled PD |
| 589030 | 1.581841 | 0.000040000 | 0.089405000 | | | 13.107.136.9 | 192.168.2.127 | TLSv1.2 | 407 | 6243712 | 9334 | 16413 | Application Data |
| 589031 | 1.581861 | 0.000020000 | 0.089405000 | 0.000514000 | 589020 | 192.168.2.127 | 13.107.136.9 | TCP | 54 | 9334 | 6230572 | | 63442 → 443 [ACK] Seq=9334 Ack=6230572 Win=12301824 Len=0 |
| 589032 | 1.581899 | 0.000038000 | 0.089405000 | 0.000425000 | 589022 | 192.168.2.127 | 13.107.136.9 | TCP | 54 | 9334 | 6233492 | | 63442 → 443 [ACK] Seq=9334 Ack=6233492 Win=12301824 Len=0 |
| 589033 | 1.581936 | 0.000037000 | 0.089405000 | 0.000361000 | 589024 | 192.168.2.127 | 13.107.136.9 | TCP | 54 | 9334 | 6236412 | | 63442 → 443 [ACK] Seq=9334 Ack=6236412 Win=12301824 Len=0 |
| 589034 | 1.581974 | 0.000038000 | 0.089405000 | 0.000298000 | 589026 | 192.168.2.127 | 13.107.136.9 | TCP | 54 | 9334 | 6239332 | | 63442 → 443 [ACK] Seq=9334 Ack=6239332 Win=12301824 Len=0 |
| 589035 | 1.582010 | 0.000036000 | 0.089405000 | 0.000251000 | 589028 | 192.168.2.127 | 13.107.136.9 | TCP | 54 | 9334 | 6242252 | | 63442 → 443 [ACK] Seq=9334 Ack=6242252 Win=12301824 Len=0 |
| 589036 | 1.582141 | 0.000131000 | 0.089405000 | 0.000300000 | 589030 | 192.168.2.127 | 13.107.136.9 | TCP | 54 | 9334 | 6244065 | | 63442 → 443 [ACK] Seq=9334 Ack=6244065 Win=12301824 Len=0 |
| 589037 | 1.582352 | 0.000211000 | 0.089405000 | | | 13.107.136.9 | 192.168.2.127 | TCP | 1514 | 6244065 | 9334 | 1460 | 443 → 63442 [ACK] Seq=6244065 Ack=9334 Win=525568 Len=1460 [TCP segment of a reassembled PD |
| 589038 | 1.582457 | 0.000105000 | 0.089405000 | | | 13.107.136.9 | 192.168.2.127 | TCP | 1514 | 6245525 | 9334 | 2920 | 443 → 63442 [ACK] Seq=6245525 Ack=9334 Win=525568 Len=1460 [TCP segment of a reassembled PD |
| 589039 | 1.582501 | 0.000044000 | 0.089405000 | | | 13.107.136.9 | 192.168.2.127 | TCP | 1514 | 6246985 | 9334 | 4380 | 443 → 63442 [ACK] Seq=6246985 Ack=9334 Win=525568 Len=1460 [TCP segment of a reassembled PD |
| 589040 | 1.582658 | 0.000157000 | 0.089405000 | | | 13.107.136.9 | 192.168.2.127 | TCP | 1514 | 6248445 | 9334 | 5840 | 443 → 63442 [ACK] Seq=6248445 Ack=9334 Win=525568 Len=1460 [TCP segment of a reassembled PD |
| 589041 | 1.582704 | 0.000046000 | 0.089405000 | | | 13.107.136.9 | 192.168.2.127 | TCP | 1514 | 6249905 | 9334 | 7300 | 443 → 63442 [ACK] Seq=6249905 Ack=9334 Win=525568 Len=1460 [TCP segment of a reassembled PD |
| 589042 | 1.582751 | 0.000047000 | 0.089405000 | | | 13.107.136.9 | 192.168.2.127 | TCP | 1514 | 6251365 | 9334 | 8760 | 443 → 63442 [ACK] Seq=6251365 Ack=9334 Win=525568 Len=1460 [TCP segment of a reassembled PD |
| 589043 | 1.582792 | 0.000041000 | 0.089405000 | | | 13.107.136.9 | 192.168.2.127 | TCP | 1514 | 6252825 | 9334 | 10220 | 443 → 63442 [ACK] Seq=6252825 Ack=9334 Win=525568 Len=1460 [TCP segment of a reassembled PD |
| 589044 | 1.582834 | 0.000042000 | 0.089405000 | | | 13.107.136.9 | 192.168.2.127 | TCP | 1514 | 6254285 | 9334 | 11680 | 443 → 63442 [ACK] Seq=6254285 Ack=9334 Win=525568 Len=1460 [TCP segment of a reassembled PD |

# RiOS: Scalable Data Reference (SDR)



*Original text*

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*Binary representation*

0100001101101111011100000111100101110010011010010110011101101000011101000010000011000010101010010010 0
000001100100011000000110001001100110000101001010010011010010111011001100101011100100110001001100 10101
1001000010000001010100011001010110001101101000011011100110111101101100001011110110011101111 1001

*1st level references*

Ref[9z34] Ref[55k1] Ref[816378] Ref[4u244] Ref[j8s]

*2nd level reference*

Ref[vs5q6] Ref[qk7j9]

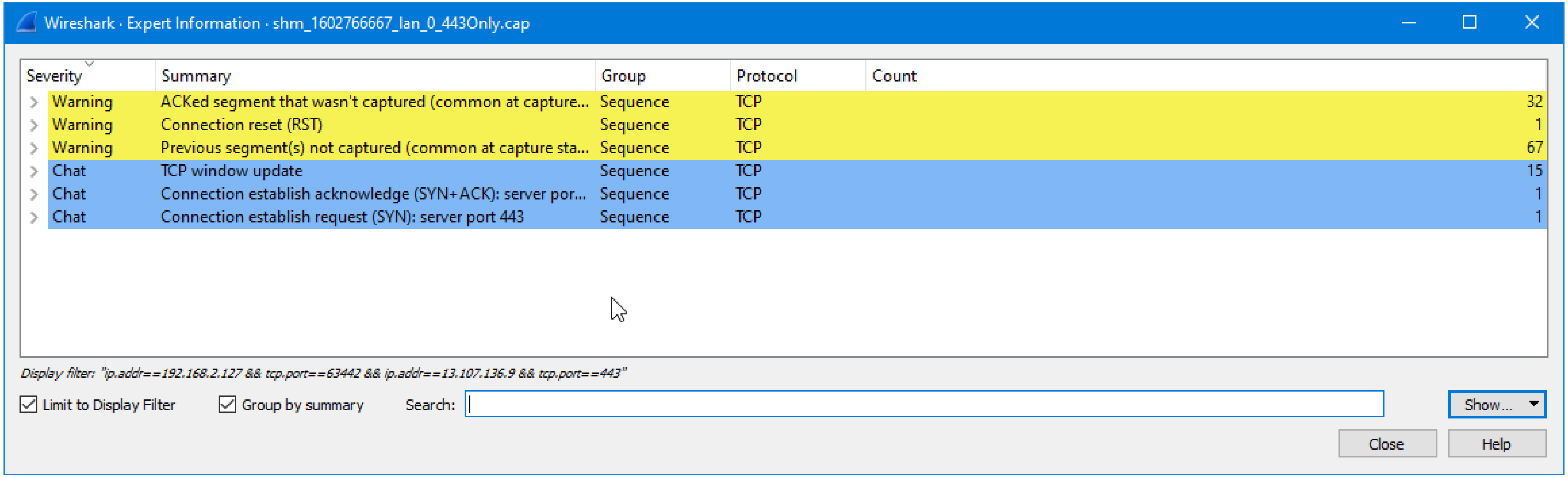
*3rd level reference*

Ref[vv7a2]

16-Byte references communicate megabytes of existing data (128Byte average chunk size)

# No Retransmissions

- Stream Bytes Served Locally



Wireshark · Expert Information · shm_1602766667_lan_0_443Only.cap

| Severity | Summary | Group | Protocol | Count |
|---|---|---|---|---|
| Warning | ACKed segment that wasn't captured (common at capture... | Sequence | TCP | 32 |
| Warning | Connection reset (RST) | Sequence | TCP | 1 |
| Warning | Previous segment(s) not captured (common at capture sta... | Sequence | TCP | 67 |
| Chat | TCP window update | Sequence | TCP | 15 |
| Chat | Connection establish acknowledge (SYN+ACK): server por... | Sequence | TCP | 1 |
| Chat | Connection establish request (SYN): server port 443 | Sequence | TCP | 1 |

Display filter: "ip.addr==192.168.2.127 && tcp.port==63442 && ip.addr==13.107.136.9 && tcp.port==443"

☑ Limit to Display Filter ☑ Group by summary Search:

# Significant Increase in User Productivity

- Over 30 hours since running initial script test
- Cache is still warm on laptop and in the cloud
- Video captures for upload and download scenarios
- Upload 16s vs. 64s
- Download 9s vs. 24s

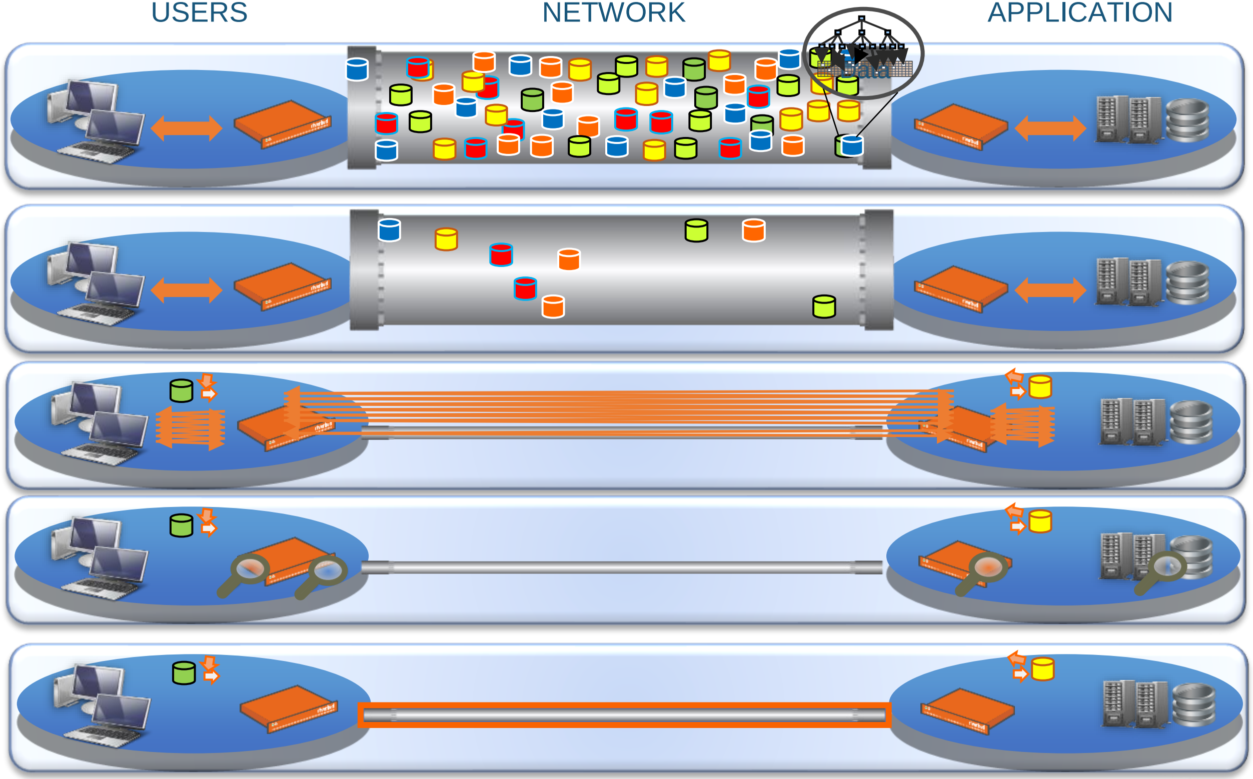
# Session Recap

#sf21veu

- Expect your captures to contain some unusual side effects if WAN Optimization is in path
- Client accelerator running inside laptop provides significant user productivity improvements to support WFA employees
- Remediates latency, retransmissions, home WiFi issues

# WAN Optimization Features

#sf21veu



DE-DUPLICATE DATA

OPTIMIZE NETWORK TRANSPORT

ELIMINATE APPLICATION LATENCY

INSPECT, REPORT & CAPTURE

SHAPE, DIRECT & PROTECT

# Your Feedback is Important

#sf21veu

- Please take a moment to complete the session feedback form

- Help us to keep SharkFest relevant and interesting

- https://forms.gle/GGRAzkJcEuDkx5r36

# End of Session

#sf21veu

# Q & A

#sf21veu