

Multipath TCP



Breaking Today's Networks
With Tomorrow's Protocols

Speakers - Who are we?

- Catherine (Kate) Pearce
 - Security Consultant / Pentester
 - New Zealand transplant.
 - Loves her wine the way she likes her RFCs (Dry)
- Patrick Thomas
 - Senior Security Consultant / Pentester
 - Application Security focus





MPTCP changes
fundamental assumptions
about
*how TCP works**

*Use it to break
things today*

*Adapt to it for
tomorrow*

 *Well... kinda

Not Layer 4?
Totally the same.

Layer 4?
Buckle Up.

2 Simple Examples: #1



192.168.88.165 - PuTTY

```
root@deb7min2:~# curl 192.168.88.164
<html><body><h1>It works!</h1>
<p>This is the default web page for this server.</p>
<p>The web server software is running but no content has been
</body></html>
root@deb7min2:~#
```

2 Simple Examples: #1

Snorby - Dashboard - Chro... [Terminal - pst@pst-virtual-... Terminal - pst@pst-virtual-... Capturing from Pseudo-dev...

Capturing from Pseudo-device that captures on all interfaces [Wireshark 1.6.7]

File Edit View Go Capture Analyze Statistics Telephony Tools Internals Help

Filter: tcp.port == 80 Expression... Clear Apply

No.	Time	Source	Destination	Protocol	Length	Info
80	12.278794	192.168.88.165	192.168.88.164	TCP	88	34668 > http [SYN] Seq=0 Win=29200 Len=0 MSS=1460 SACK_PERM=1 TSval=12490003
81	12.278839	192.168.88.164	192.168.88.165	TCP	88	http > 34668 [SYN, ACK] Seq=0 Ack=1 Win=28560 Len=0 MSS=1460 SACK_PERM=1
82	12.278924	192.168.88.165	192.168.88.164	TCP	96	34668 > http [ACK] Seq=1 Ack=1 Win=0 Len=0 TSval=12490113 TSecr=1247
83	12.279003	192.168.88.165	192.168.88.164	HTTP	166	GET / HTTP/1.1
84	12.279256	192.168.88.165	192.168.88.165	TCP	76	http > 34668 [ACK] Seq=1 Ack=1 Win=0 Len=0 TSval=12474351 TSecr=124
85	12.280095	192.168.88.165	192.168.88.164	TCP	88	39757 > http [SYN] Seq=0 Win=29200 Len=0 MSS=1460 SACK_PERM=1 TSval=12490003
86	12.280111	192.168.88.164	192.168.88.165	TCP	92	http > 39757 [SYN, ACK] Seq=0 Ack=1 Win=28560 Len=0 MSS=1460 SACK_PERM=1
87	12.280222	192.168.88.165	192.168.88.164	TCP	92	39757 > http [ACK] Seq=1 Ack=1 Win=0 Len=0 TSval=12490113 TSecr=1247
88	12.280338	192.168.88.164	192.168.88.165	TCP	76	[TCP Window Update] Seq=1 Ack=1 Win=0 Len=0 TSval=12490114 TSecr=1247
89	12.283984	192.168.88.164	192.168.88.165	HTTP	548	HTTP/1.1 200 OK
90	12.284014	192.168.88.165	192.168.88.164	TCP	76	39757 > http [ACK] Seq=1 Ack=1 Win=0 Len=0 TSval=12490114 TSecr=1247
91	12.284045	192.168.88.165	192.168.88.164	TCP	88	[TCP Dup ACK 90] Seq=1 Ack=1 Win=0 Len=0 TSval=12490114 TSecr=1247
92	12.284064	192.168.88.164	192.168.88.165	TCP	88	[TCP Dup ACK 89] Seq=0 Ack=1 Win=85696 Len=0 TSval=12490114 TSecr=1247
93	12.284073	192.168.88.165	192.168.88.164	TCP	76	39757 > http [ACK] Seq=1 Ack=1 Win=0 Len=0 TSval=12490114 TSecr=1247
94	12.284077	192.168.88.165	192.168.88.164	TCP	76	34668 > http [ACK] Seq=1 Ack=1 Win=0 Len=0 TSval=12490114 TSecr=1247
95	12.284086	192.168.88.165	192.168.88.164	TCP	76	[TCP Dup ACK 93] Seq=1 Ack=1 Win=0 Len=0 TSval=12490114 TSecr=1247
96	12.284091	192.168.88.164	192.168.88.165	TCP	76	http > 39757 [ACK] Seq=0 Ack=1 Win=0 Len=0 TSval=12474352 TSecr=1247
97	12.284099	192.168.88.165	192.168.88.164	TCP	76	39757 > http [ACK] Seq=1 Ack=1 Win=0 Len=0 TSval=12490114 TSecr=1247
98	12.284103	192.168.88.164	192.168.88.165	TCP	76	http > 34668 [ACK] Seq=0 Ack=1 Win=0 Len=0 TSval=12474352 TSecr=1247
99	12.284126	192.168.88.165	192.168.88.164	TCP	76	34668 > http [ACK] Seq=1 Ack=1 Win=0 Len=0 TSval=12490114 TSecr=1247

Mark Packet (toggle)
Ignore Packet (toggle)
Set Time Reference (toggle)
Manually Resolve Address
Apply as Filter
Prepare a Filter
Conversation Filter
Colorize Conversation
Follow TCP Stream
Follow UDP Stream
Follow SSL Stream
Copy
Decode As...
Print...
Show Packet in New Window

Frame 83: 166 bytes on wire (1328 bits), 166 bytes captured (1328 bits)
Linux cooked capture
Internet Protocol Version 4, Src: 192.168.88.165 (192.168.88.165), Dst: 192.168.88.164 (192.168.88.164)
Transmission Control Protocol, Src Port: 34668 (34668), Dst Port: http (80), Seq: 1, Ack: 1, Len: 78
Hypertext Transfer Protocol

2 Simple Examples: #1

Snorby - Dashboard - Chro... [Terminal - pst@pst-virtual-... Terminal - pst@pst-virtual-... Capturing from Pseudo-dev... Follow TCP Stream

Capturing from Pseudo-device that captures on all interfaces [Wireshark 1.6]

File Edit View Go Capture Analyze Statistics Telephony Tools Internals Help

Filter: tcp.stream eq 2 Expression... Clear Apply

No.	Time	Source	Destination	Protocol	Length	Info
80	12.278794	192.168.88.165	192.168.88.164	TCP	88	34668 > http [SYN] Seq=0 Win=29200 Len=0 MSS=1460 SACK
81	12.278839	192.168.88.164	192.168.88.165	TCP	88	http > 34668 [SYN, ACK] Seq=0 Ack=1 Win=28560 Len=0 MS
82	12.278924	192.168.88.165	192.168.88.164	TCP	96	34668 > http [ACK] Seq=1 Ack=1 Win=58432 Len=0 TSval=1
83	12.279003	192.168.88.165	192.168.88.164	HTTP	166	GET / HTTP/1.1
84	12.279256	192.168.88.164	192.168.88.165	TCP	76	http > 34668 [ACK] Seq=1 Ack=79 Win=57152 Len=0 TSval=
94	12.284077	192.168.88.165	192.168.88.164	TCP	76	34668 > http [FIN, ACK] Seq=79 Ack=1 Win=88576 Len=0 T
98	12.284103	192.168.88.164	192.168.88.165	TCP	76	http > 34668 [FIN, ACK] Seq=1 Ack=80 Win=85696 Len=0 T
99	12.284126	192.168.88.165	192.168.88.164	TCP	76	34668 > http [FIN, ACK] Seq=80 Ack=1 Win=85696 Len=0 T

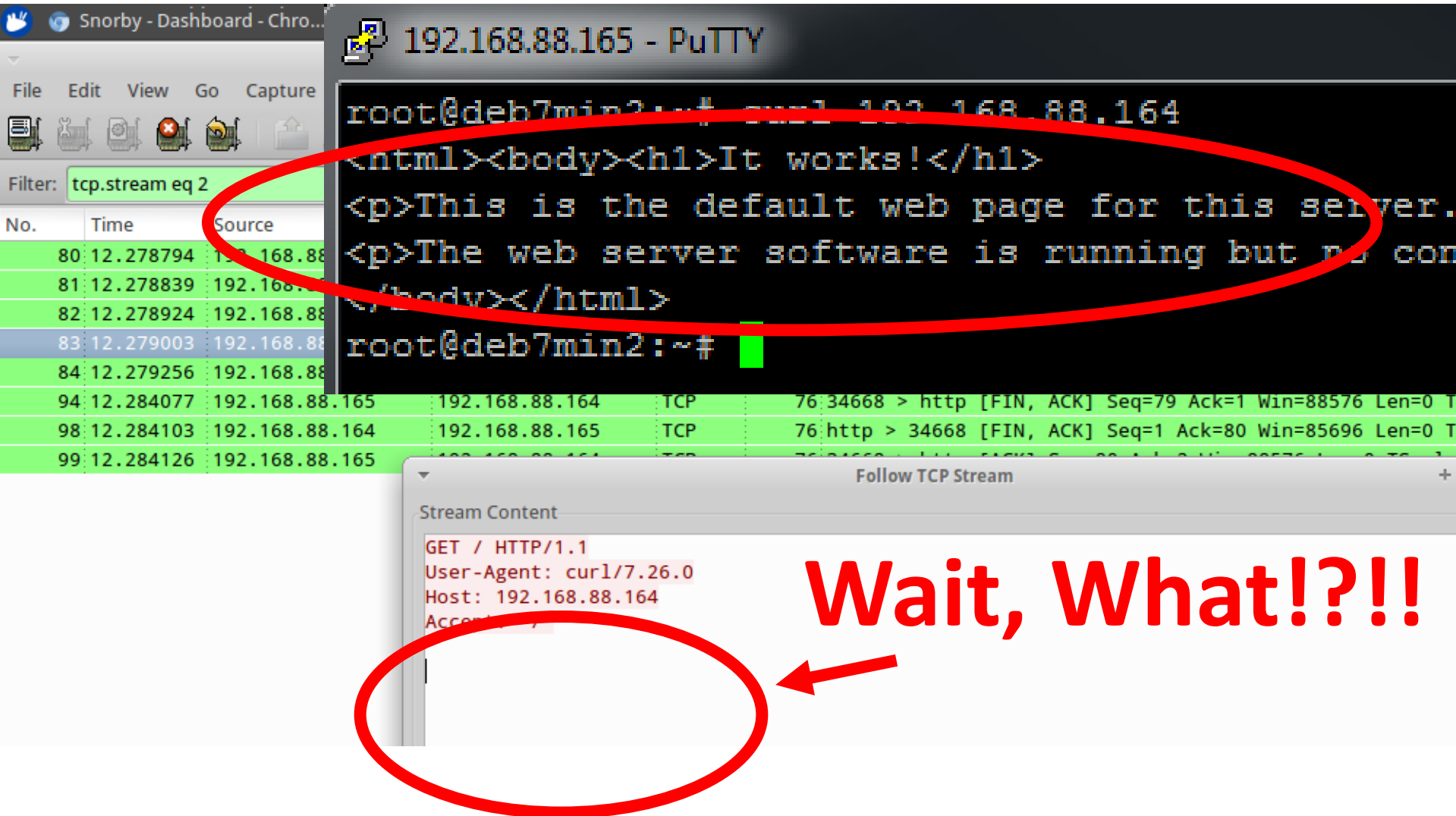
Follow TCP Stream

Stream Content

GET / HTTP/1.1
User-Agent: curl/7.26.0
Host: 192.168.88.164
Accept: */*

Wait, What!?!?

2 Simple Examples: #1



The image shows a network capture in Wireshark and a terminal session in PuTTY. The terminal session shows a user running a curl command to fetch a web page from 192.168.88.164. The output of the curl command is an HTML document. The network capture shows the corresponding HTTP traffic. A red circle highlights the curl output, and another red circle highlights the 'Host' field in the HTTP request.

Terminal Output:

```
root@deb7min2:~# curl 192.168.88.164
<html><body><h1>It works!</h1>
<p>This is the default web page for this server.
<p>The web server software is running but no con
</body></html>
root@deb7min2:~#
```

Network Capture (Filter: tcp.stream eq 2):

No.	Time	Source	Destination	Protocol	Length	Info
80	12.278794	192.168.88.164	192.168.88.165	TCP	76	34668 > http [FIN, ACK] Seq=79 Ack=1 Win=88576 Len=0
81	12.278839	192.168.88.165	192.168.88.164	TCP	76	http > 34668 [FIN, ACK] Seq=1 Ack=80 Win=85696 Len=0
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83	12.279003	192.168.88.165	192.168.88.164	TCP	76	http > 34668 [FIN, ACK] Seq=1 Ack=80 Win=85696 Len=0
84	12.279256	192.168.88.164	192.168.88.165	TCP	76	34668 > http [FIN, ACK] Seq=79 Ack=1 Win=88576 Len=0
94	12.284077	192.168.88.165	192.168.88.164	TCP	76	http > 34668 [FIN, ACK] Seq=1 Ack=80 Win=85696 Len=0
98	12.284103	192.168.88.164	192.168.88.165	TCP	76	34668 > http [FIN, ACK] Seq=79 Ack=1 Win=88576 Len=0
99	12.284126	192.168.88.165	192.168.88.164	TCP	76	http > 34668 [FIN, ACK] Seq=1 Ack=80 Win=85696 Len=0

Follow TCP Stream (Stream Content):

```
GET / HTTP/1.1
User-Agent: curl/7.26.0
Host: 192.168.88.164
Accept: */*
```

Wait, What!?!?

2 Simple Examples: #2

```
# nc 192.168.1.25 3000
```

2 Simple Examples: #2

```
root@deb7min-LEFT:/home/username# netstat --tcp
Active Internet connections (w/o servers)
Proto Recv-Q Send-Q Local Address           Foreign Address         State
tcp      0      1 10.2.2.111:43272        192.168.1.25:3000      SYN_SENT
tcp      0      1 10.3.3.111:33145        192.168.22.145:3000    SYN_SENT
tcp      0      1 10.1.1.111:43769        192.168.1.25:3000      SYN_SENT
tcp      0      1 10.1.1.111:52605        192.168.22.145:3000    SYN_SENT
tcp      0      0 192.168.1.34:50818      192.168.1.25:3000      ESTABLISHED
tcp      0      1 192.168.1.34:34095      192.168.22.145:3000    SYN_SENT
tcp      0      1 10.3.3.111:36916        192.168.1.25:3000      SYN_SENT
tcp      0      1 10.2.2.111:40284        192.168.22.145:3000    SYN_SENT
tcp6     0      0 2601:6:1700:168:2:40378 2601:6:1700:168:20:3000 ESTABLISHED
tcp6     0      0 2601:6:1700:168:2:41599 2601:6:1700:168:20:3000 ESTABLISHED
```

Err?



Sense
This makes none



Why did we see that?

→ *Let's talk about MPTCP*

...but first, why change TCP?

Current TCP is rather limited

Doesn't support use cases for:

- High Availability
- Link Aggregation
- Multihoming
- Mesh networking

Multipath TCP

Multipath TCP is an extension to TCP that adds the above functionality

AND: it works over existing infrastructure

- (it *IS* TCP... just more so)

BUT: nothing much else understands it
– including security tools

 **TO BE CLEAR:**

MPTCP is more culture shock than security vulnerability

We like MPTCP

We want MPTCP to succeed

Network security isn't ready



Background

Technical Introduction

Key Security Effects

Perimeter Security

Network Management

MPTCP Future

What got us thinking about this?

■ Kate saw this...

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👤 Apple seems to also believe in Multipath TCP ([uclouvain.be](#))
10 points by [rhapsodyv](#) 278 days ago | [discuss](#) | [save to pocket](#)

What got us thinking about this?

- Which led to this...

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Olivier Bonaventure
Homepage and blog

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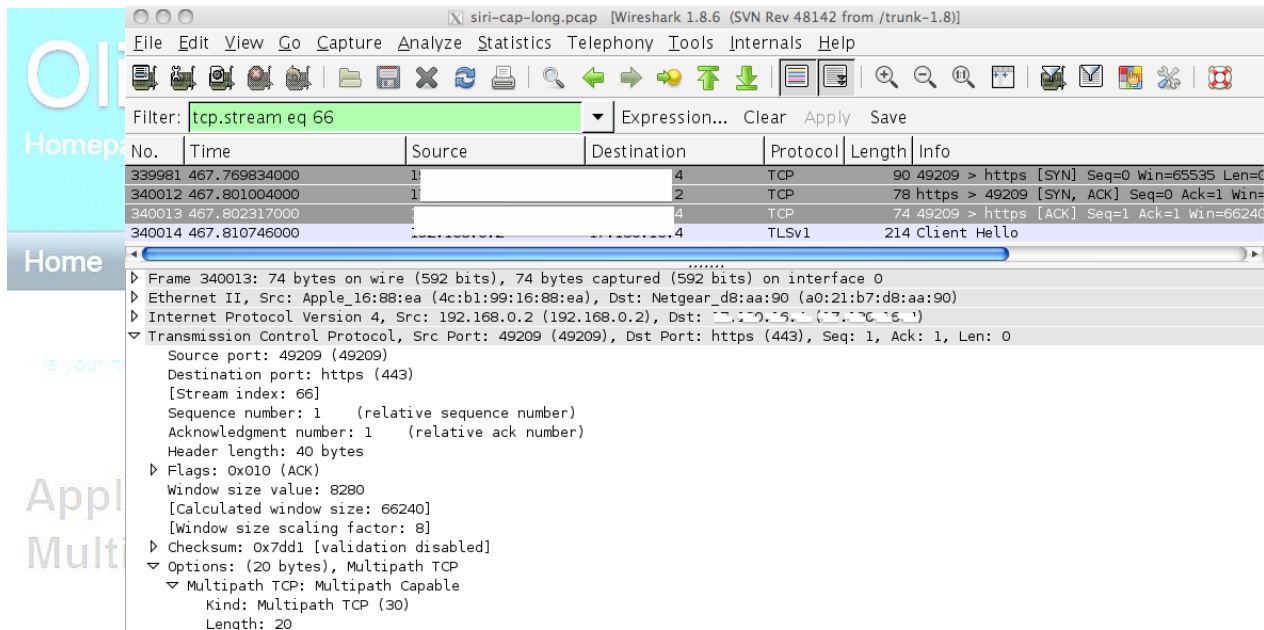
September 18, 2013

Apple seems to also believe in Multipath TCP

What got us thinking about this?

■ Which contained this...

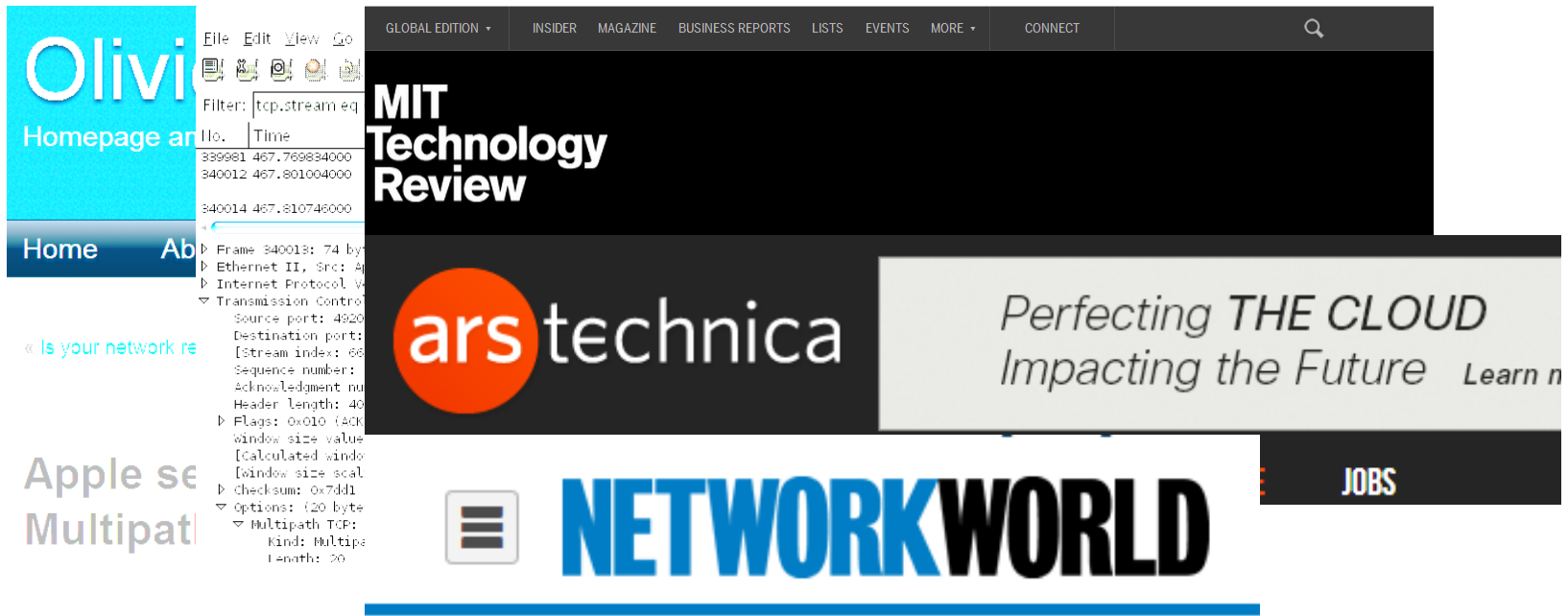
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What got us thinking about this?

- Then other media outlets started covering it...

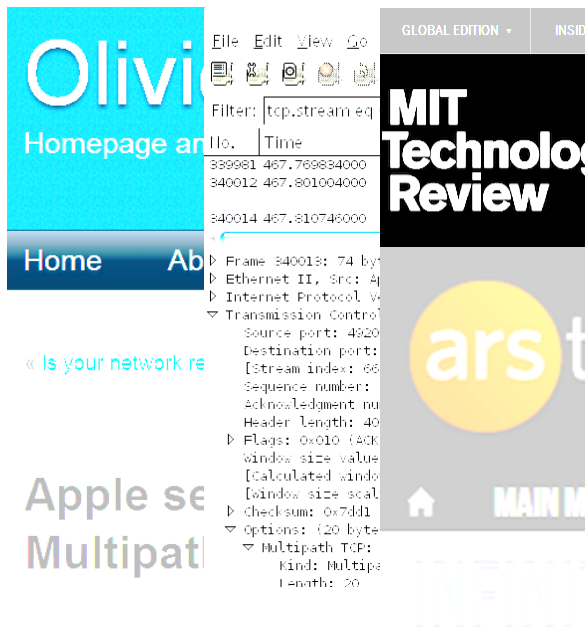
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What got us thinking about this?

- Then other media outlets started covering it...not always positively

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Collage of tech-related images including Olivio, MIT Technology Review, and network packet analysis data.



The Register

Data Center Software Networks Security Policy Business Hardware Science Bootnotes Col

Servers HPC Cloud Storage **Data Networking** Virtualisation BOFH

DATA CENTER > DATA NETWORKING

Multipath TCP: Siri's new toy isn't a game-changer

This experiment is an alpha and carriers could swat it like a bug

By Richard Chirgwin, 1 Oct 2013  2,485 followers

 What got us thinking about this?

- And then...

SILENCE

- BUT, the rate of progress was unprecedented for a major change to TCP

Was anyone thinking about security?

- The security of MPTCP itself



- What changes like this *could mean* for network security



... not so much

That's what this session is about

- What does multipath TCP mean for security *today*?
- What could it (or similar tech) mean to network security *a decade from now*?
- With a couple of PoCs and tools...



Background

Technical Introduction

Key Security Effects

Perimeter Security

Network Management

MPTCP Future

Motivations and Advantages

- TCP implements connections between IP:PORT & IP:PORT
- NOT between endpoint A and endpoint B
- In the past this was a distinction without a difference, but not any more

Riding on top of TCP

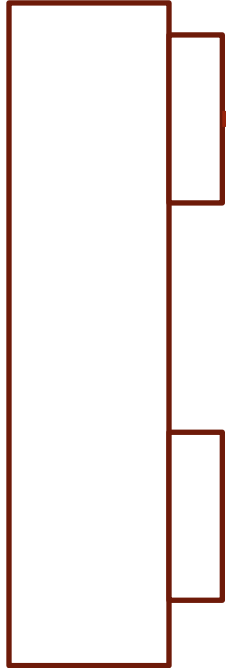
- **An MPTCP Connection** is defined by a connection ID
- It is composed of multiple *streams*, where each stream is a regular TCP connection (with an option strapped on)

MPTCP Characteristics

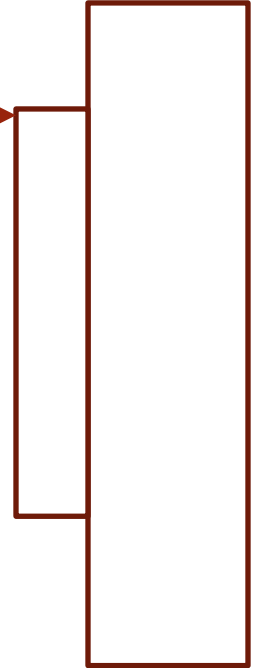
- Backwards compatibility
- Performance \geq now
- Security \geq now

MPTCP – Simple Case

Client



Server

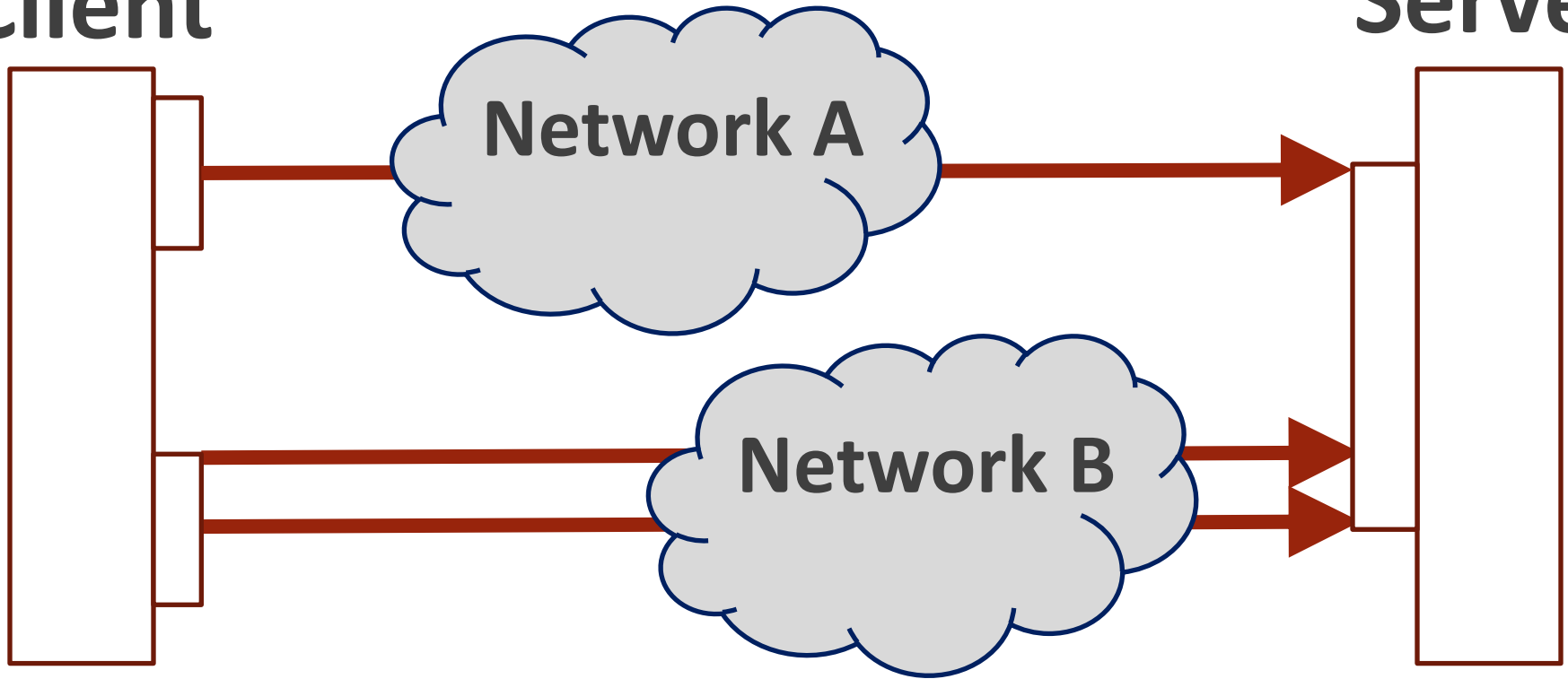


MPTCP connection looks like TCP so far...

MPTCP – Simple Case

Client

Server

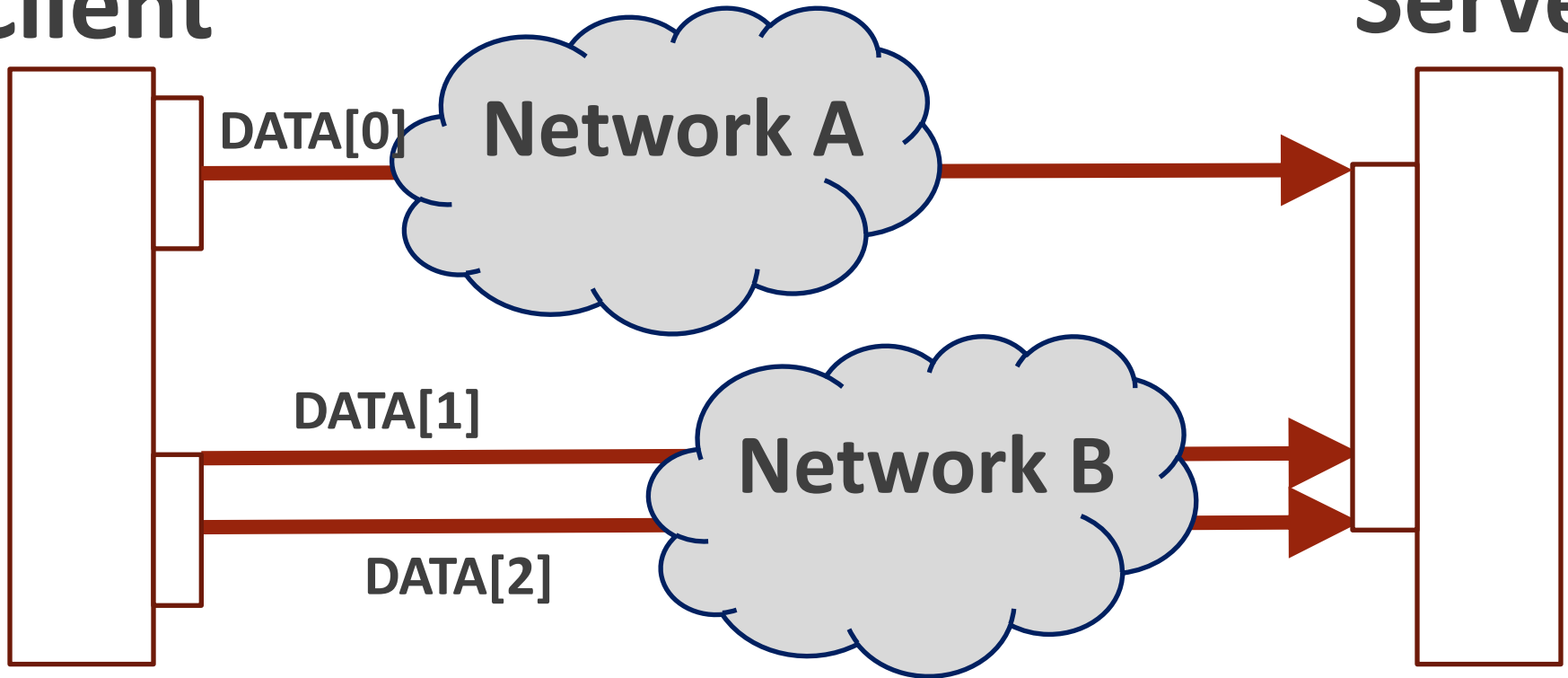


N different TCP connections, contributing to ***ONE*** logical data flow

MPTCP – Simple Case

Client

Server

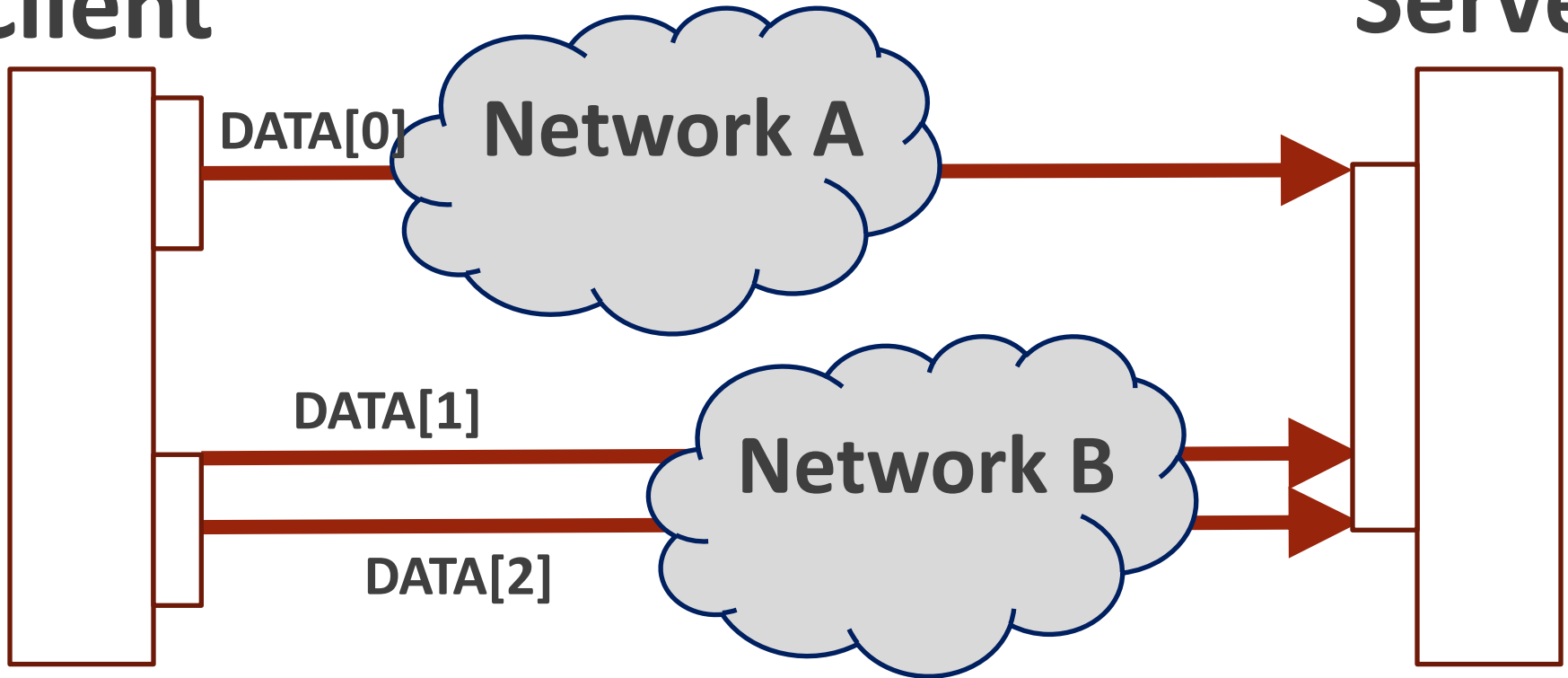


N different TCP connections, contributing to **ONE** logical data flow... data flows through any/all

MPTCP – Simple Case

Client

Server

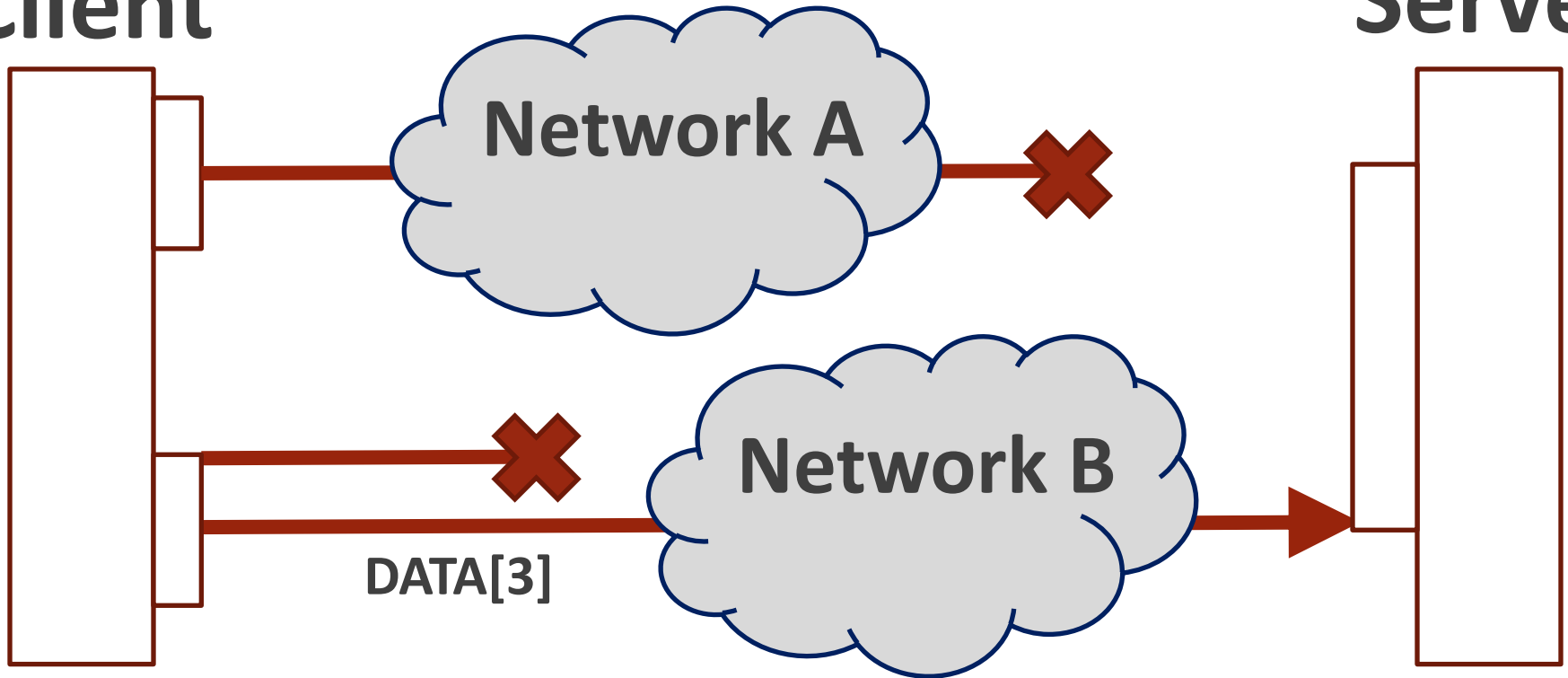


Sender of a packet can choose to use
any flow *(this will be important)*

MPTCP – Simple Case

Client

Server

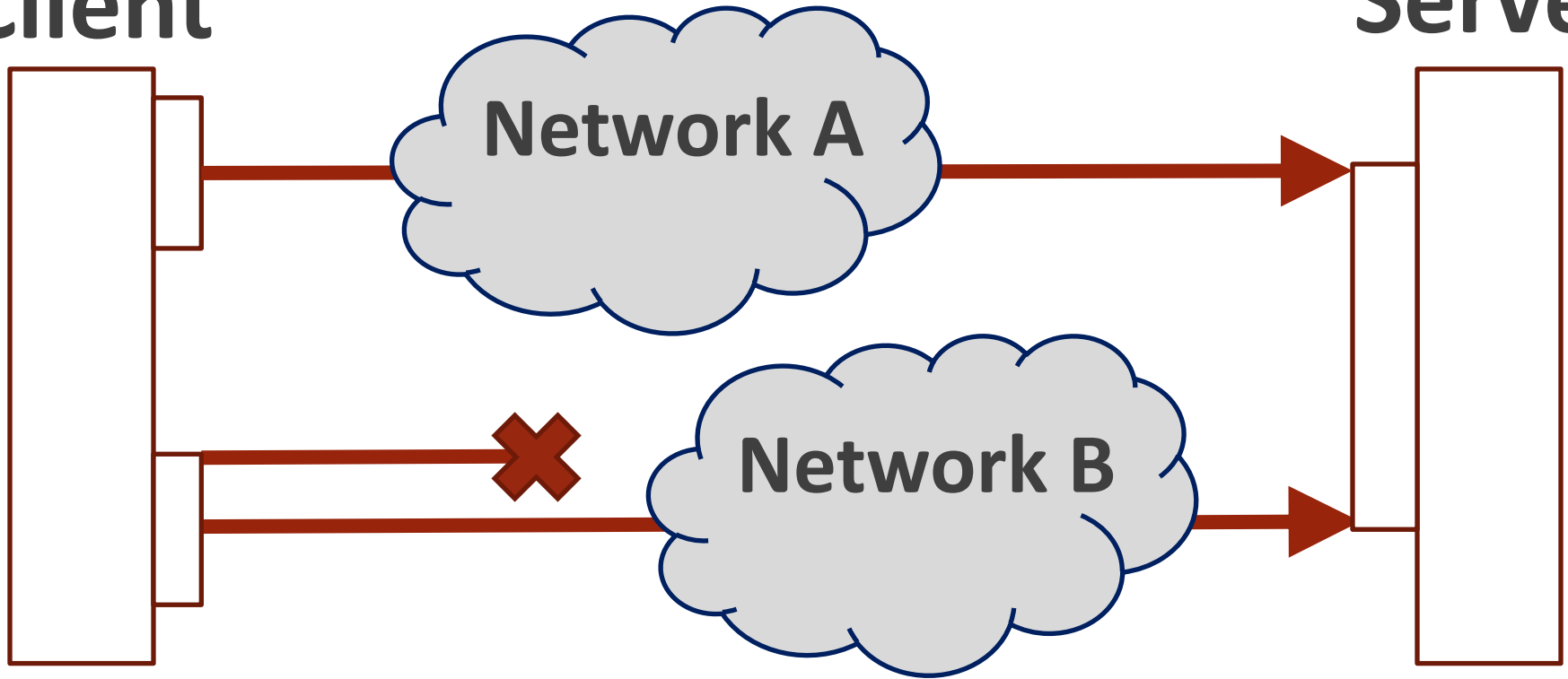


Any subset of connections can drop,
overall flow continues.

MPTCP – Simple Case

Client

Server

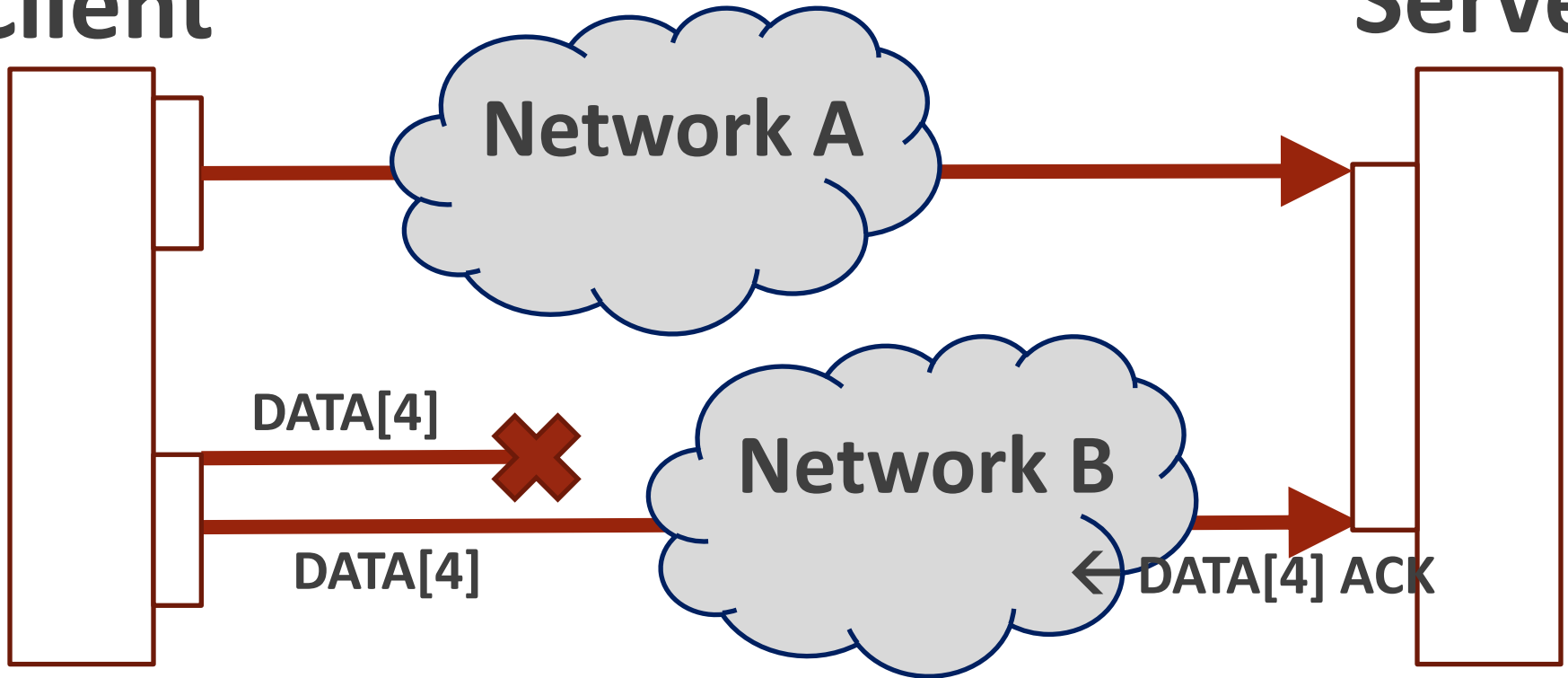


Connections can be re-added at any time

MPTCP – Simple Case

Client

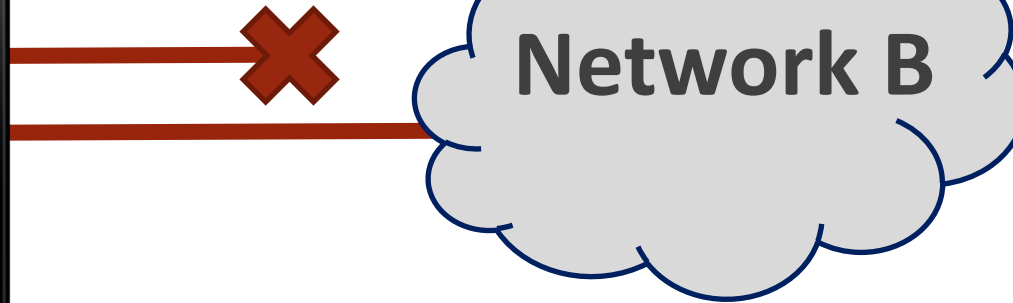
Server



Un-ACK'd data can be quickly resent over a different flow... first ACK is good enough!

MPTCP – Basic Use Cases

Client



For seamless roaming

Server



For high availability

MPTCP – Basic Use Cases

Client

Server



For seamless roaming



How is MPTCP implemented? – TCP Option

Bits 0 - 7		Bits 8 - 15		Bits 16 - 23		Bits 24 - 31	
Source Port				Destination port			
TCP Sequence Number							
TCP Acknowledgement Number (if Ack Set)							
Data Offset	Reserved	TCP Flags (Ack, Syn etc)			Window Size		
Checksum				Urgent Pointer (if URG Set)			
0x1e (MPTCP Option Type)		Length		Subtype	MPTCP Ver	MPTCP Flags	
Remaining MPTCP Subtype Data							
Packet DATA							



What does it look like?

■ Packet Breakdown - WireShark

Filter: tcp

No.	Time	Source	Destination	Protocol	Length	Info	MPTCP
7	26.231	192.168.110.10	192.168.110.30	TCP	86	41974 > qip-msgd [SYN] Seq=0 Win=5120 Multipath Capable	
8	26.231	192.168.110.30	192.168.110.10	TCP	86	qip-msgd > 41974 [SYN, ACK] Seq=0 Ack= Multipath Capable	
9	26.231	192.168.110.10	192.168.110.30	TCP	94	41974 > qip-msgd [ACK] Seq=1 Ack=1 Win= Multipath Capable, Data Sequen	

Checksum: 0x6c1b [validation disabled]

Options: (32 bytes), Maximum segment size, SACK permitted, Timestamps, No-Operation (NOP), Window scale, Multipath TCP

- Maximum segment size: 256 bytes
- TCP SACK Permitted Option: True
- Timestamps: TSval 39509940, TSecr 0
- No-Operation (NOP)
- Window scale: 7 (multiply by 128)
- Multipath TCP: Multipath Capable
 - Kind: Multipath TCP (30) ← Option 30 (0x1E)
 - Length: 12
 - 0000 = Multipath TCP subtype: Multipath Capable (0)
 - 0000 = Multipath TCP version: 0
- Multipath TCP flags: 0x81
 - 1... = Checksum required: 1
 -1 = Use HMAC-SHA1: 1
- Multipath TCP Sender's Key: 376768013894042967

0000 00 0c 29 3d 01 86 00 0c 29 4d e0 21 08 00 45 00 ..)=....)M.!...E.

TCP Options field





How is MPTCP implemented? – MPTCP Subtypes

- 8 currently defined (ones relevant in **bold**)
- **MP_CAPABLE** - Signals MPTCP support
- **ADD_ADDR** - This address is also a way to reach me
- **MP_JOIN** - Add incoming subflow to the connection
- **REMOVE_ADDR** - Please stop using [address] to reach me
- **DSS** - How to map this stream's data against the overall data flow
- MP_PRIO
- MP_FAIL
- MP_FASTCLOSE

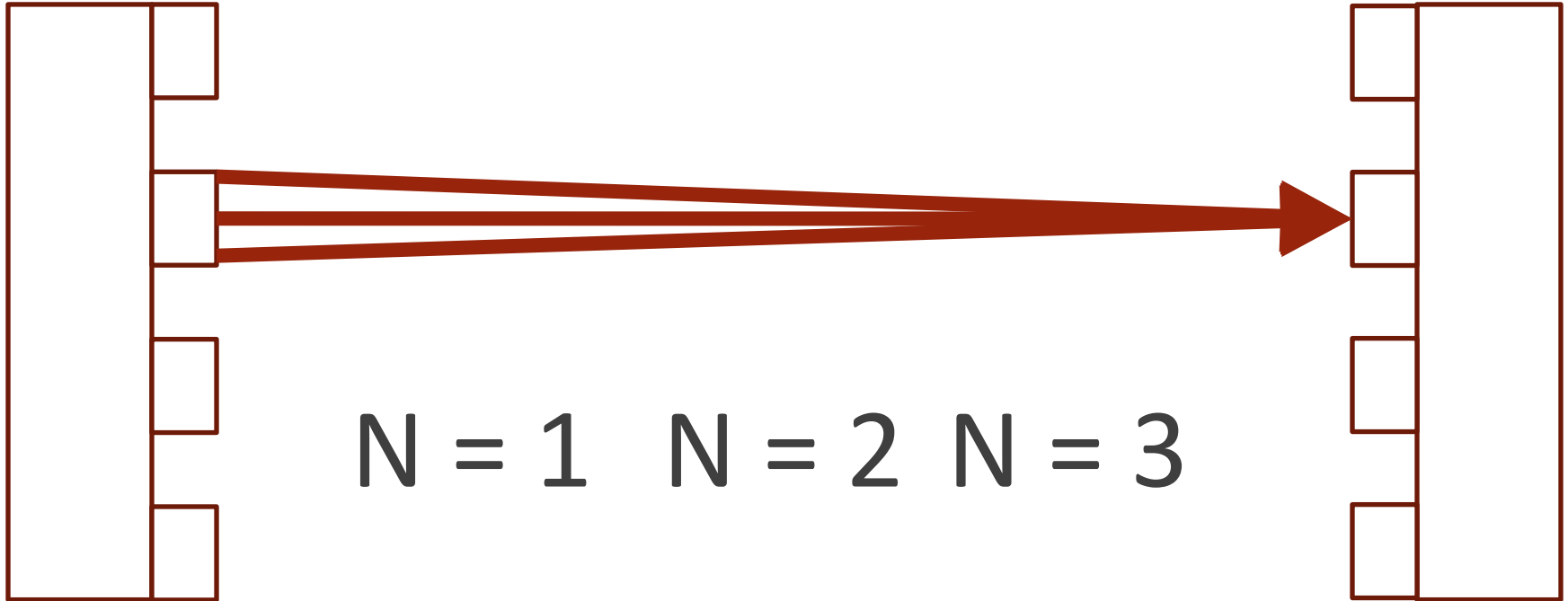
Path Management - Linux

- The Linux Path Manager has two primary path managers at present
 - Fullmesh – n:n (all to all)
 - Ndiffports – 1-1 interfaces, n-1 ports
- This is in the **TCP stack**... application layers get MPTCP for free (mostly)

Path Management - ndiffports

Client

Server

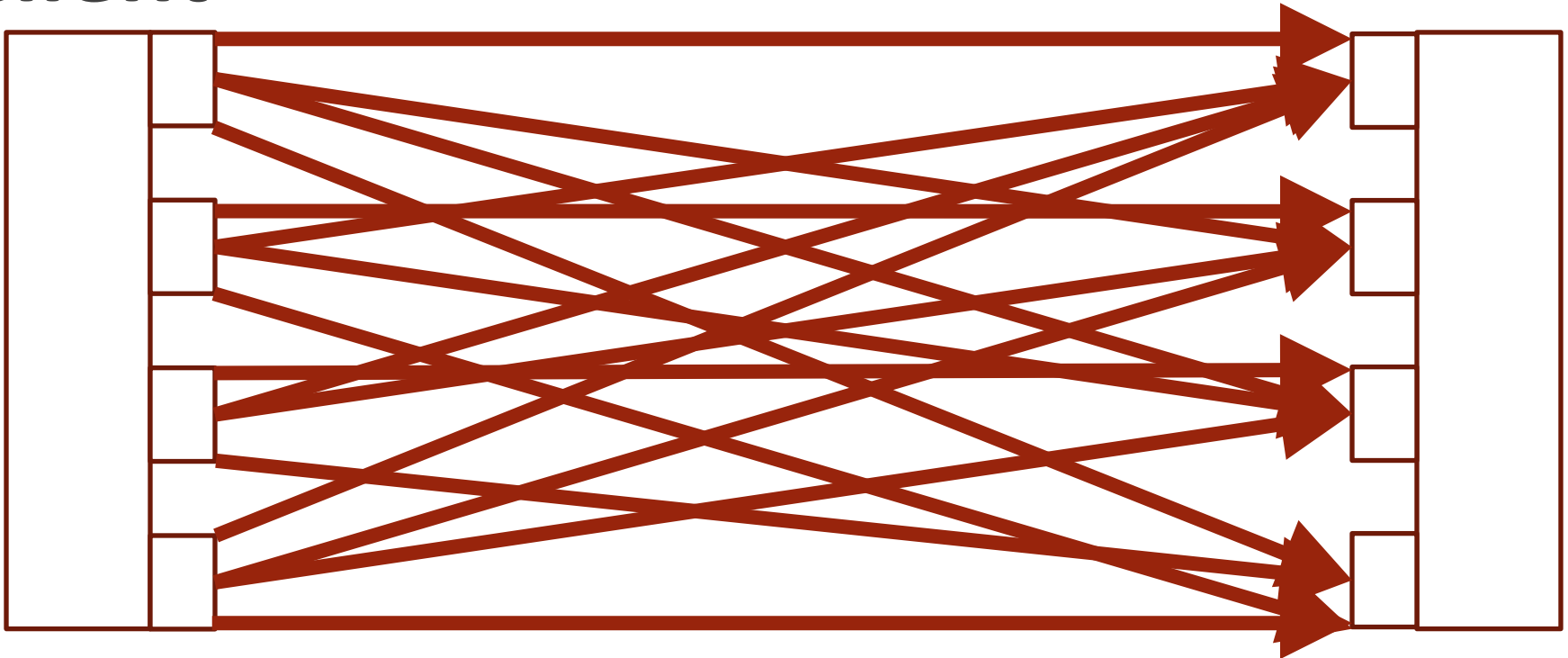


N different source ports,
1 destination port

Path Management - fullmesh

Client

Server



All possible paths used

Deeper technical details

- TCP Handshake with additional details
- Data sequence numbering
 - Truncation of SHA1 of host key
- Authentication
 - MP_JOIN - Challenge-response HMAC of other host's key, Nonce, AddressID
 - MP_FASTCLOSE – Other party's key in plaintext
- Routing
 - Packet **sender** decides which data goes down which path

More on this later...

Cheatsheet!

MPTCP Cheatsheet

MPTCP Header:

Bits 0 - 7		Bits 8 - 15		Bits 16 - 23		Bits 24 - 31	
Source Port				Destination port			
TCP Sequence Number							
TCP Acknowledgement Number (if Ack Set)							
Data Offset	Reserved	TCP Flags (Ack, Syn etc)		Window Size			
Checksum		Urgent Pointer (if URG Set)					
MP_Capable		Length		Subtype	MPTCP Ver	MPTCP Flags	
Remaining MPTCP Subtype Data							
Packet DATA							

MPTCP Subtype	HEX	Flags?	Other Likely fields of interest
MP_CAPABLE	0x0		
MP_JOINS	0x1		
DSS	0x2		
ADD_ADDR	0x3		
REMOVE_ADDR	0x4		
MP_PRIO	0x5		
MP_FAIL	0x6		
MP_FASTCLOSE	0x7		

Getting the MPTCP Sequence Numbers:

Key	64 Bit number supplied by host	
Initial DSN (ISDN):	SHA1(key)[-64:]	Binary mode hash, network byte order

Initial DSS		
Subflow DSS	mapping likely starts at ISDN[0:32] + TCP ISN + 1	TCP Seq is 32 bits, + 1 for the SYN
MP_JOIN		

MP_JOIN Authentication (RFC 6824 Fig 8)

A	B
TCP_SYN, MP_JOIN (TokenB, NonceA) ->	
<- TCP_SYN_ACK, MP_JOIN(HMAC(Key=KB+KA, Msg = NonceA + NonceB), NonceB)	
TCP_ACK, MP_JOIN(HMAC(Key=KA+KB,Msg=NonceB+NonceA) ->	
<- TCP_ACK	
Token = ConnectionID = SHA1(Key)[0:32] of Other Party's key. (Capture from either steps 2 or 3 in the first handshake)	

Detecting MPTCP things

Passive:	Usage	Inbound Connection Attempts	Detect inbound connection attempts - Look for the SYN packets with MPTCP Header	TCP(SYN) TCP Option= 30 ** 00 ...
		Successful Handshake	(Pre-viability) Look for Ack Packets with MPTCP Option header	TCP(ACK) TCP Option = 30 ** 00 ...
		Valid Handshake	MPTCP Option header Look for Ack Packets with the MPTCP Option Header	TCP(ACK) TCP Option = 30 ** 00 ...
		MPTCP Joins	TCP SYN Packets with MPTCP TCP Option and an MP_JOIN subtype	TCP(SYN) TCP Option = 30 ** 01 ...
	Attacks	MPTCP Simple	Non look for non sequential last	

So who's using it?

- Nearly no one is using it large scale (yet), with a few exceptions
 - Apple iOS7 (Siri) → enabled by default in Yosemite (?)
 - Some other experimental stuff?
- Given that, there's a surprising number of implementations
 - Implementations available for several OS's (including Linux, BSD, Android), and baked in some way into commercial kit (Citrix, Cisco, Apple, Oracle, F5)
 - **NOT Windows**

Availability – Getting it working

- Linux
 - Linux reference implementation via apt-get (multipath-tcp.org) -- best way right now
 - Can work in Kali, but ... challenges
- Nicolas Maître made *a ridiculously useful*, near complete, SCAPY implementation
 - We're based some tools on this code, and fixed some bugs along the way
 - <https://github.com/nimai/mptcp-scapy>



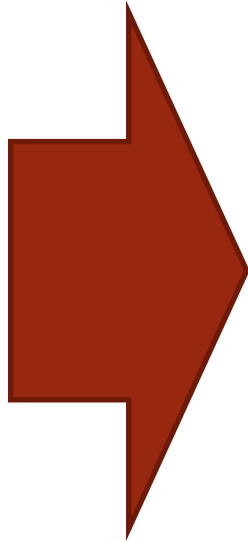
Background
Technical Introduction
Key Security Effects
Perimeter Security
Network Management
MPTCP Future

MPTCP's Key Security Effects

- Cross-path traffic fragmentation
 - That's the whole point!
- Moving target
 - Ability to change source and destination addresses in the middle of a connection
- Connection Resilience
 - Has additional checksums that require capture of the initial packet to reliably fake
 - Until every subflow is dead the overall connection keeps going
- “Reverse” connections

Because of these...

- Cross-path
- Moving target
- Connection Resilience
- Reverse connections



... if your approach to security requires *any* of these...

- See all app layer data in a TCP stream
- Associate logical sessions to IP addresses
- Tamper with or close "bad" connections mid-stream
- Differentiate clients from servers based on connection direction

...then something is probably going to break

How practical are these attacks?

- Today? Extremely.
 - But only if both endpoints speak MPTCP
 - Of which... there aren't many. Yet.
- In an MPTCP world, a bit less
 - But we have to change the way we do things in network security

Practicality Going Forward

- All of those things can be *partially* mitigated with MPTCP aware infrastructure and security tools.
- But overall, there remain some interesting shifts in how network flows work – especially if we go in with “well meaning” intent

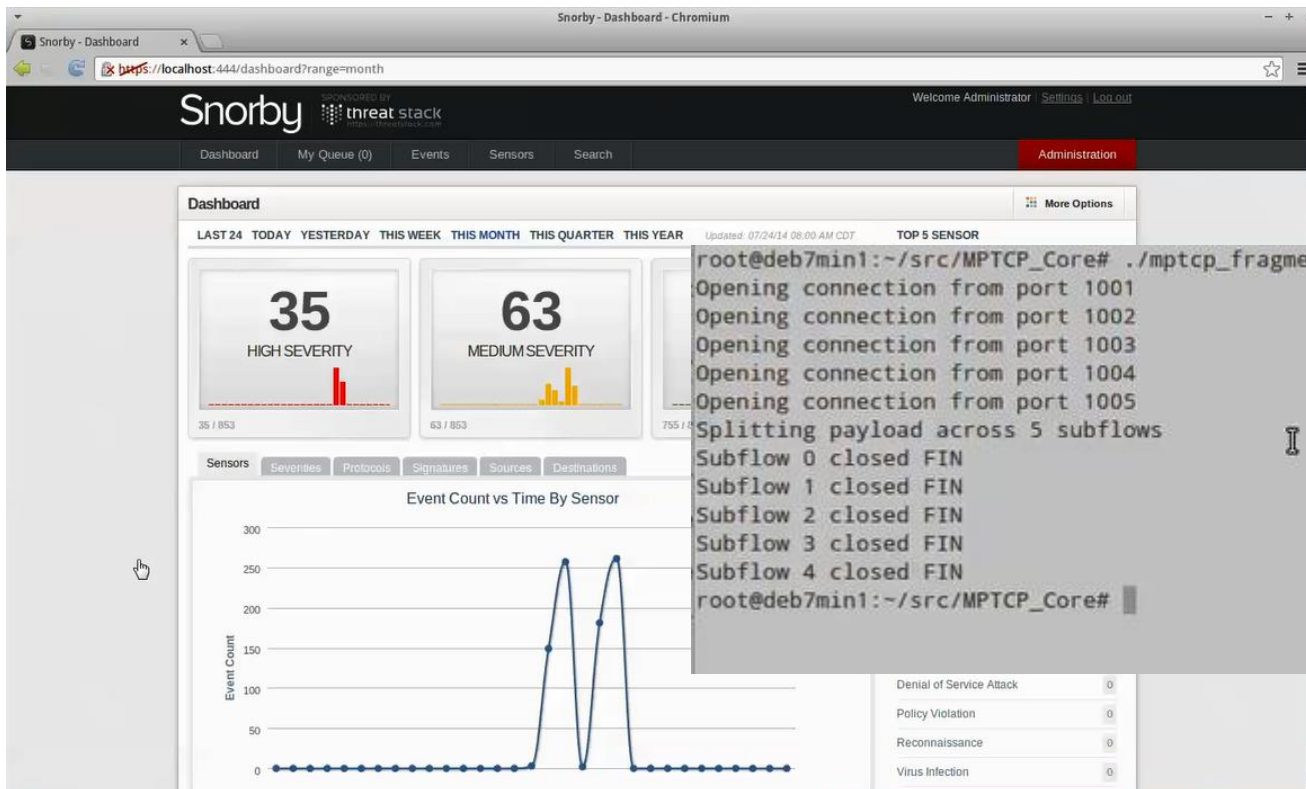
MPTCP's Key Security Effects

A few slides back...

- The **packet sender decides** which data goes down which path.
- Normal/benign clients won't choose pathological fragmentation schemes
 - But there's nothing stopping us...

PoC tool for MPTCP IDS Evasion

■ Demo!



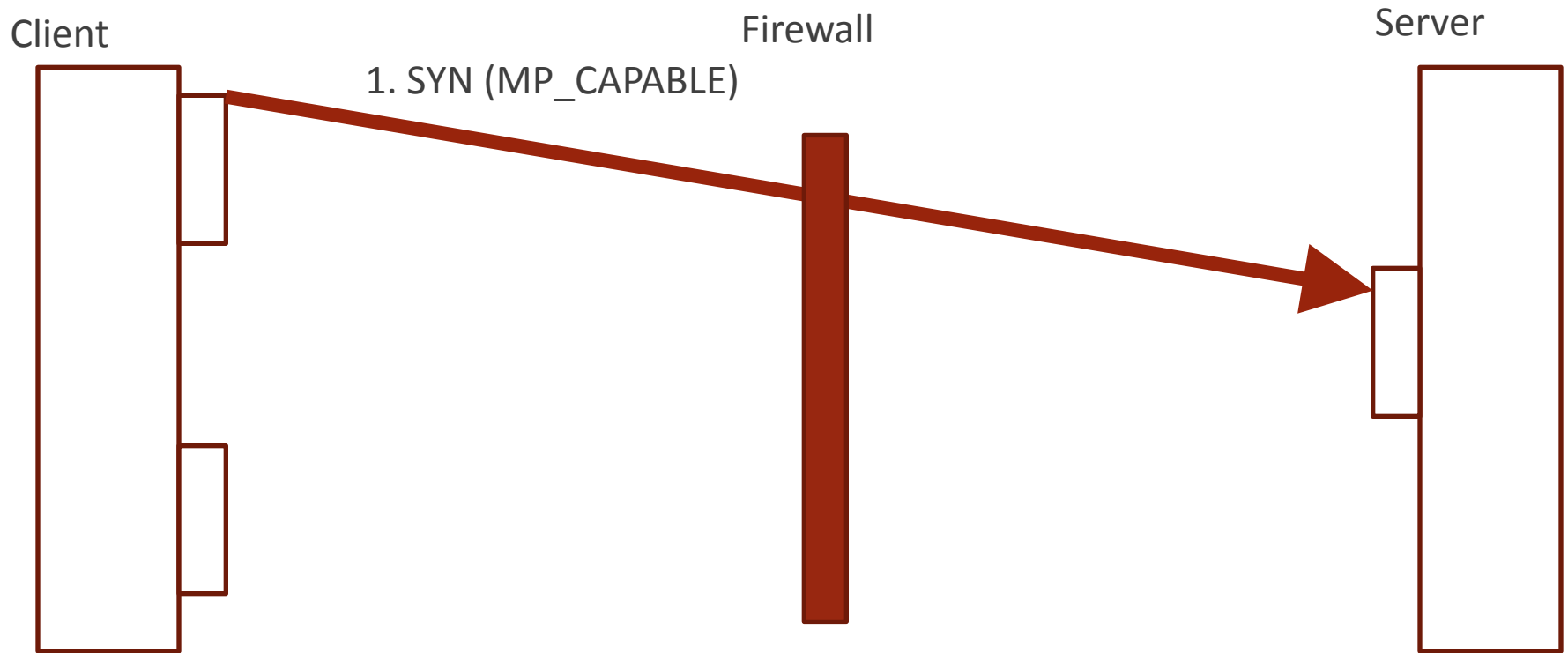


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MPTCP and ... Firewalls

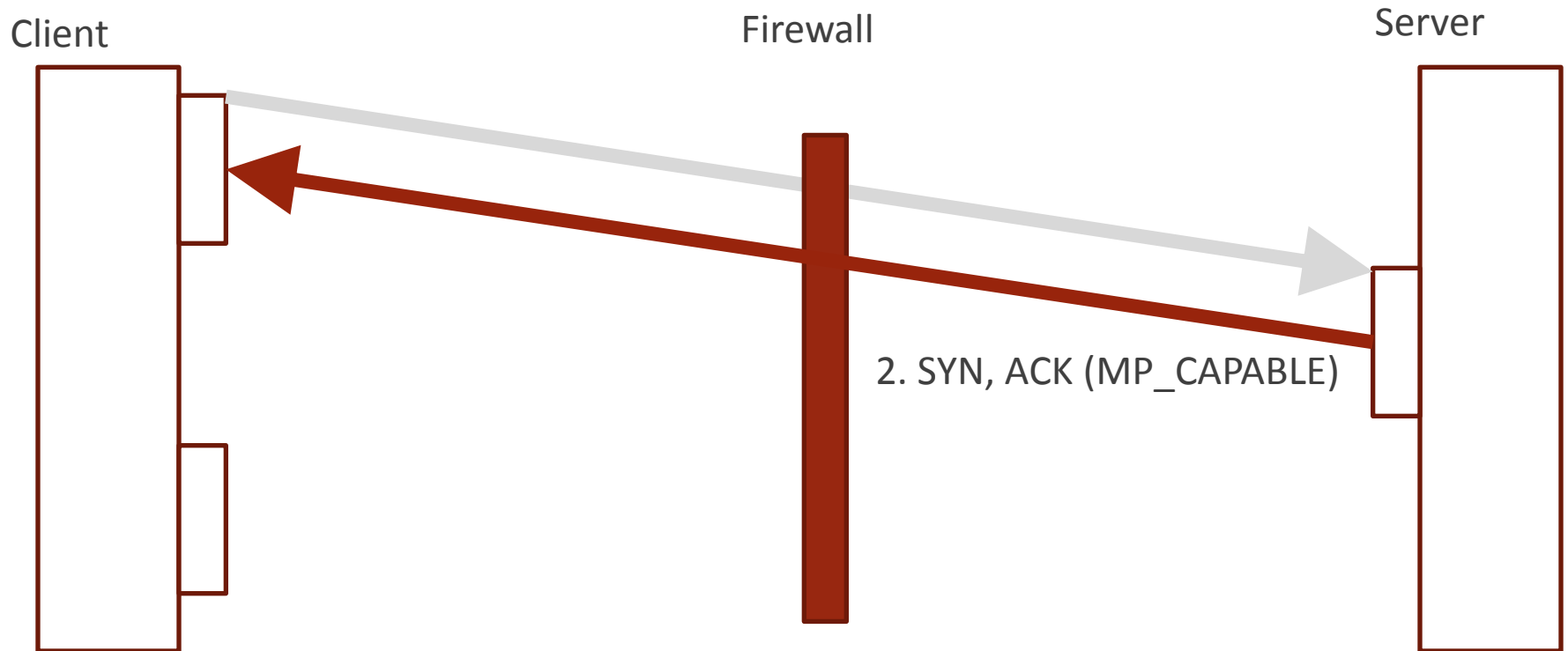
- MPTCP changes things for perimeters
- How'd you like an outbound incoming connection?

MPTCP and ... Firewalls



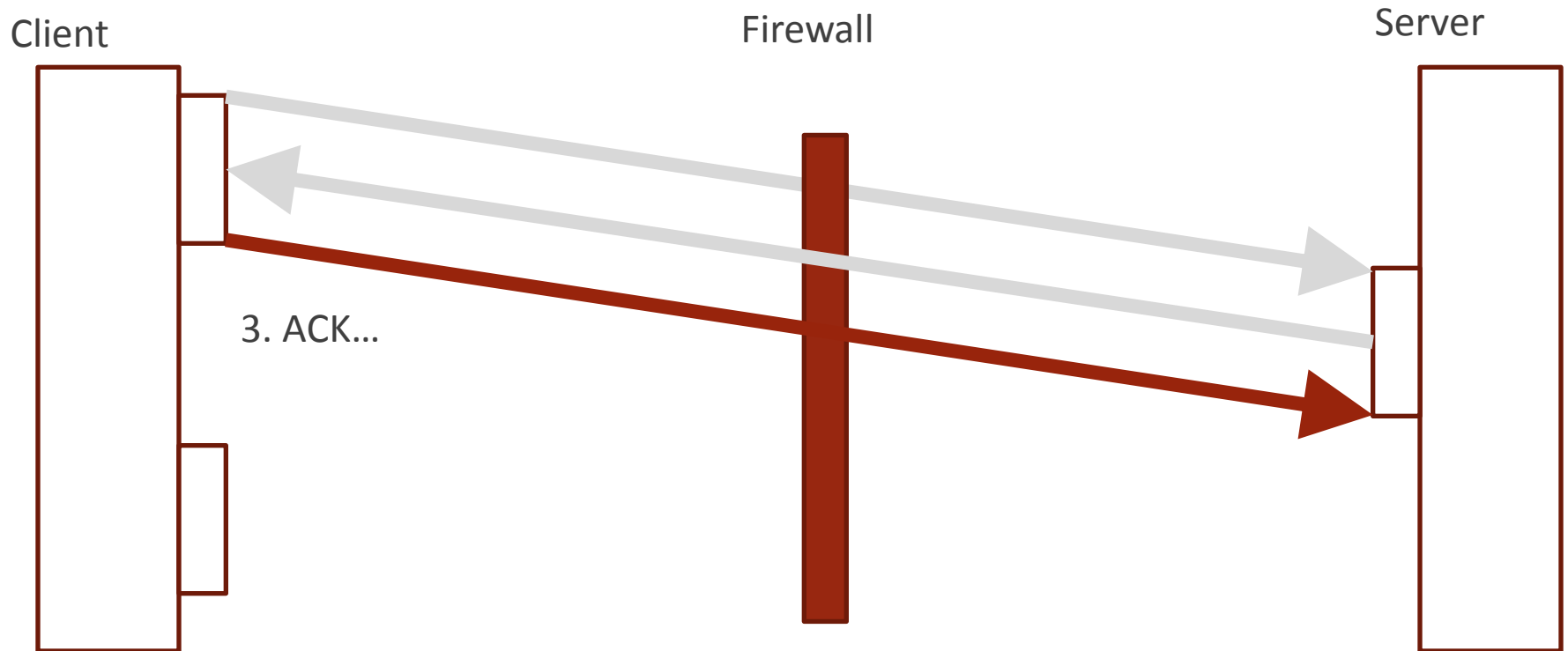
- MPTCP connection looks like TCP so far...

MPTCP and ... Firewalls



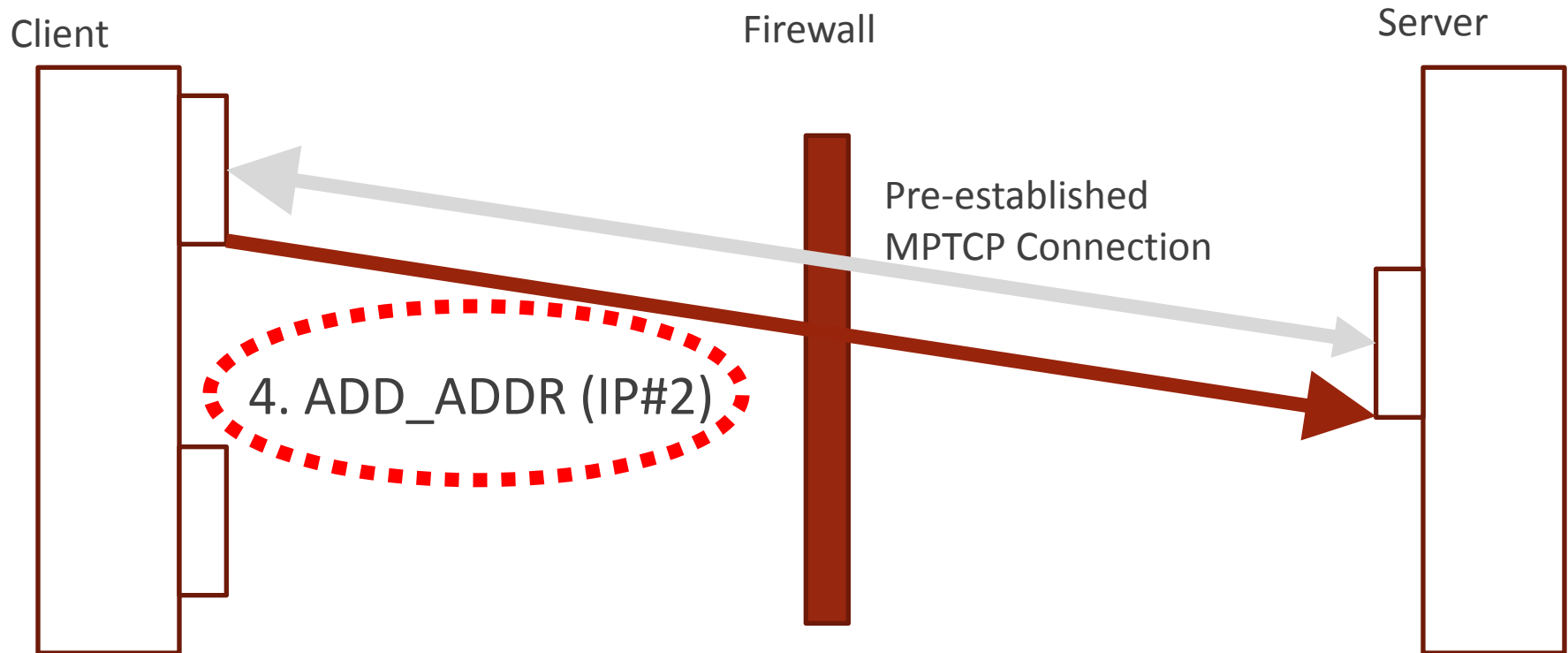
- Still seems pretty standard, albeit with extra TCP OPTIONS

MPTCP and ... Firewalls



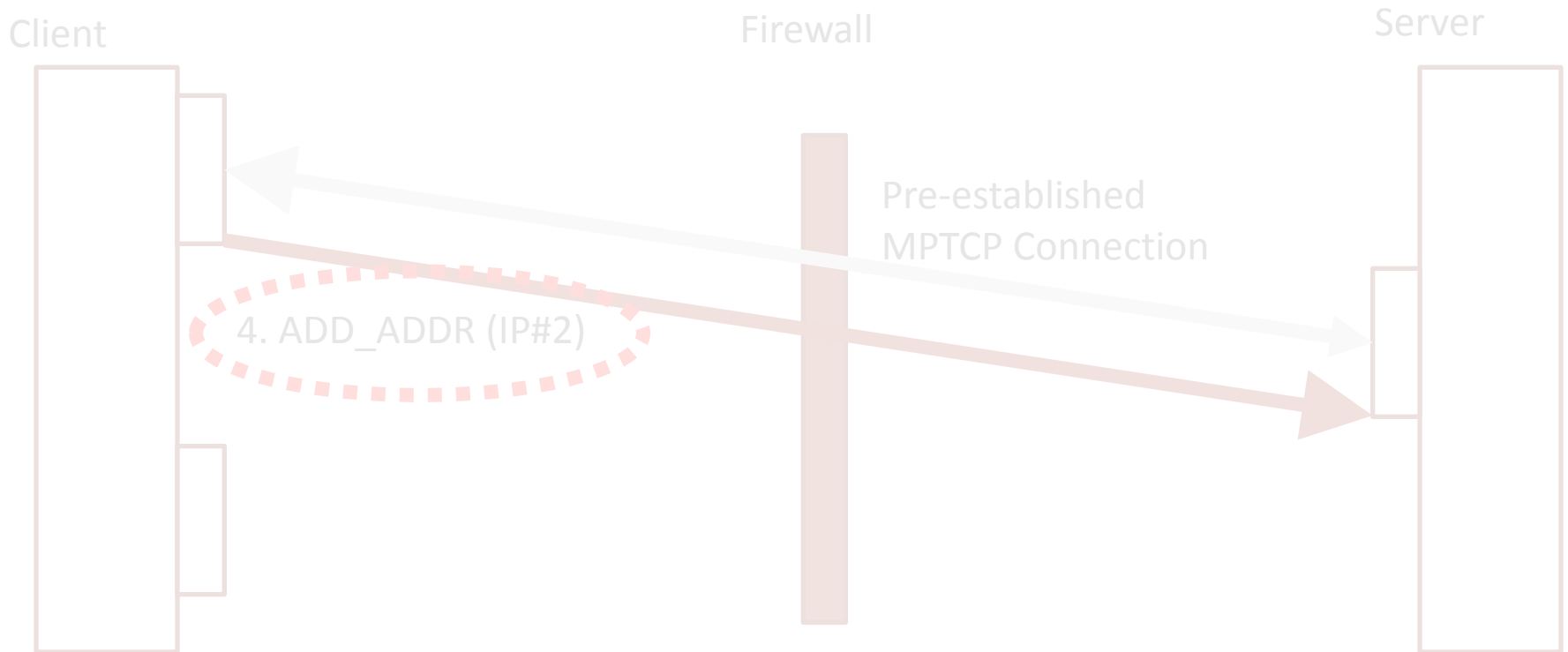
- OK, so it's a TCP connection with an additional options... so what?

MPTCP and ... Firewalls



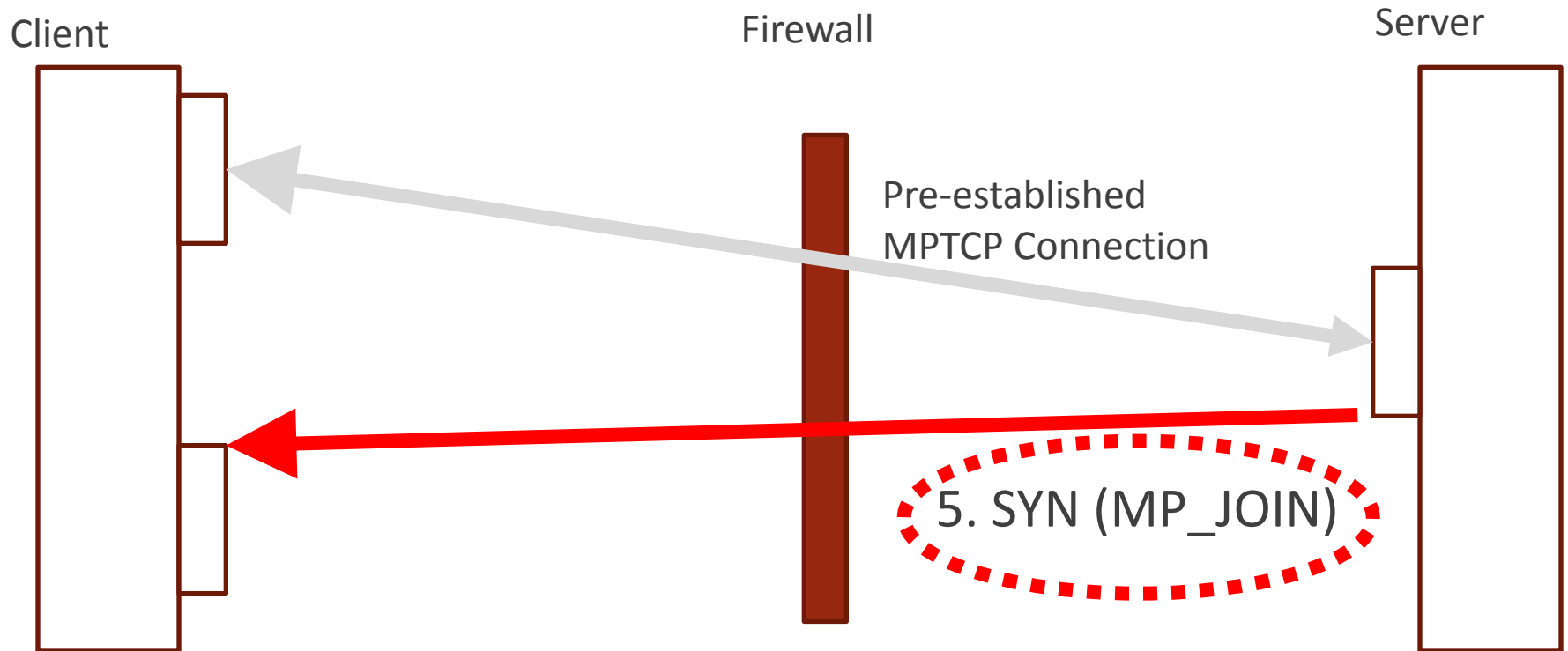
- Well, what if the client tells the server about a new address?

MPTCP and ... Firewalls



- Now, the “Internal” host may set up a connection to the advertised address

MPTCP and ... Firewalls



- Is this new connection **incoming** or **outgoing**?

MPTCP and ... Firewalls



- Is this new connection **incoming** or **outgoing**?



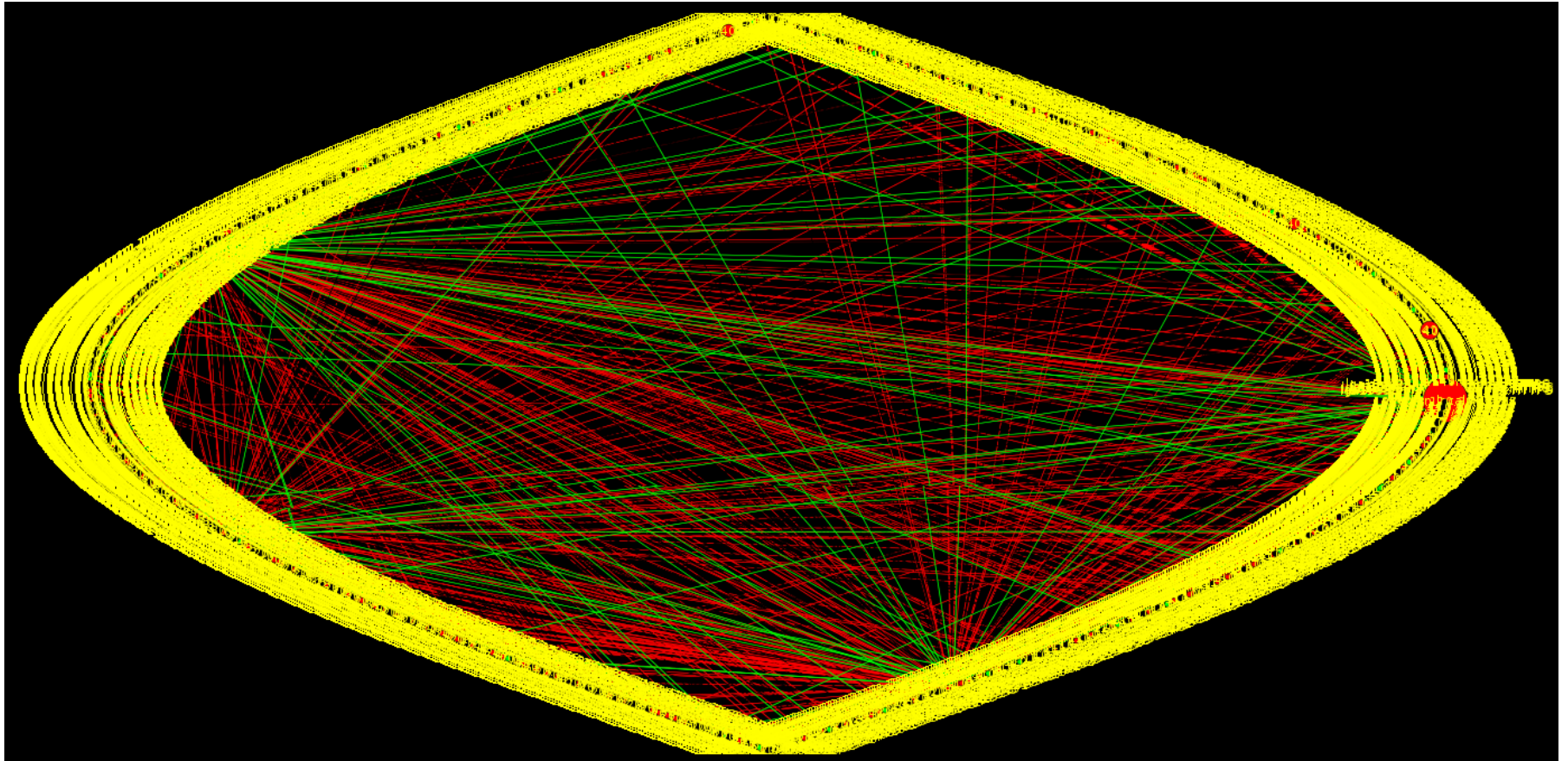
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MPTCP and ... Network monitoring

- If tool doesn't understand MPTCP, flows look like unrelated TCP streams

What does it look like?

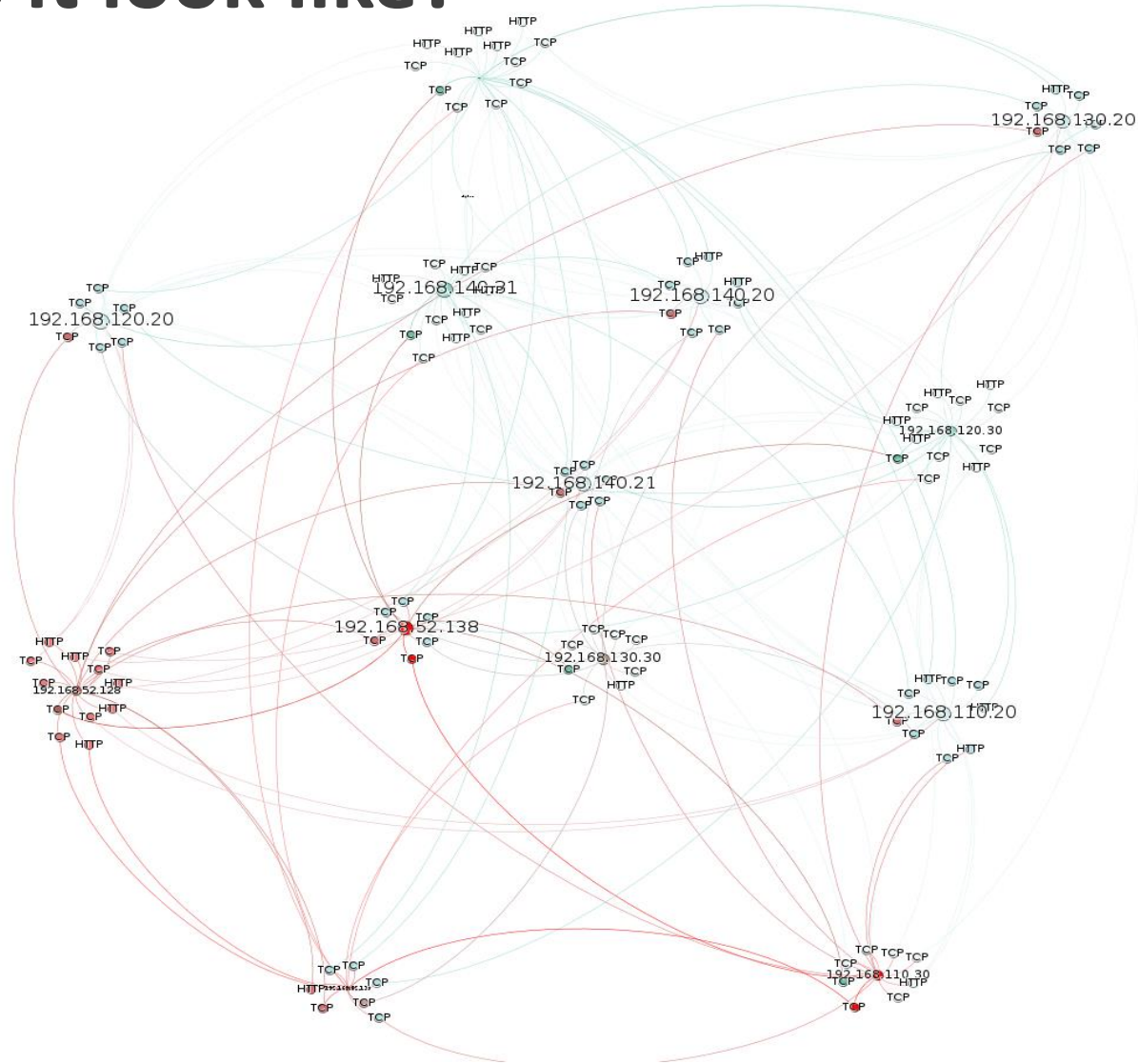
- On the network: If you don't understand



Each yellow blob is actually part of an address label

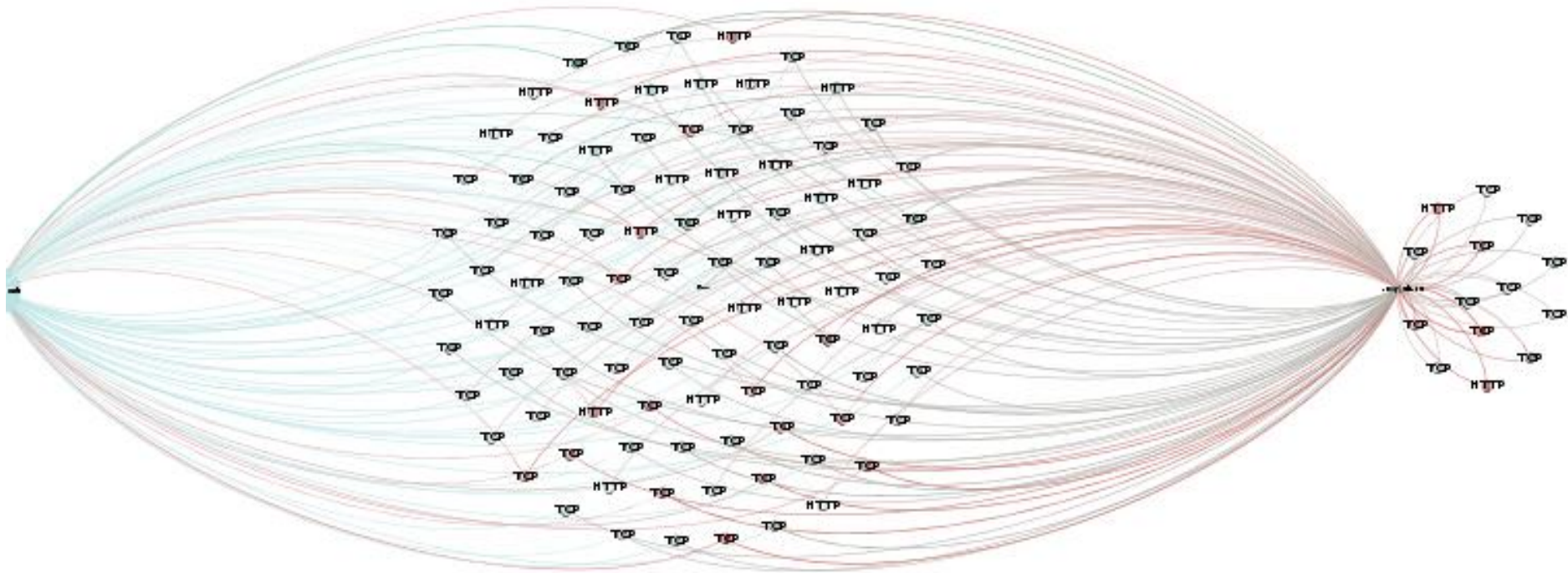
What does it look like?

- On the network: If you don't understand it, but you cluster IPs



What does it look like?

- On the network: If you do understand



- But you can only do this when you can see & correlate **all** related flows...

MPTCP Defense - Awareness

- People
- Technology
 - Check support
 - Look for use
- Architecture
 - Terminate it where you terminate SSL

MPTCP Support Scanner

```
root@psthomas-neo-dev:~/mptools# ./scanner.py
usage: scanner.py [-h] [--ip SRC_IP] host port
```

Network scanner to test hosts for multipath TCP support. Requires root privileges for scapy.

positional arguments:

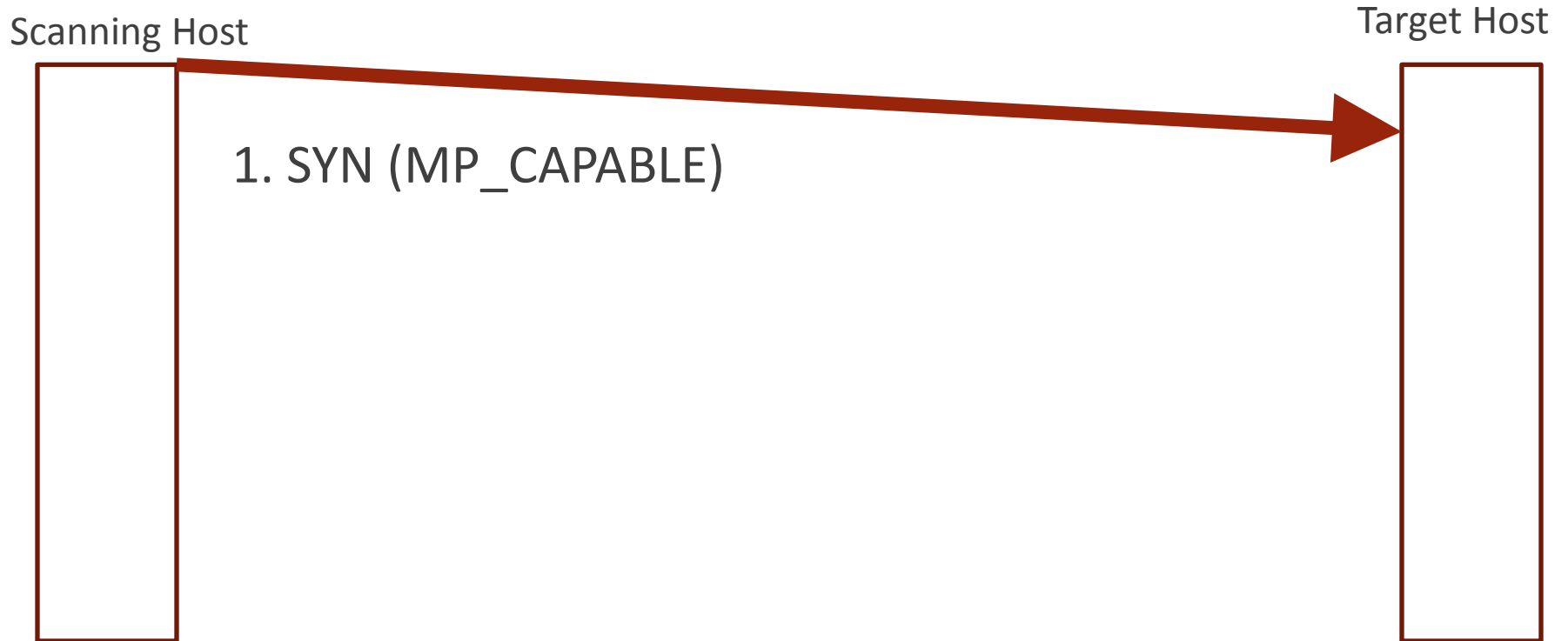
host	comma-separated IPs or ranges (globs allowed), eg "127.0.0.1,192.168.1-254,203.0.113.*"
port	comma-separated port(s) or port ranges, eg "22,80,8000-8999"

```
root@psthomas-neo-dev:~/mptools# ./scanner.py 192.168.88.164 22,80
Testing: 192.168.88.164 ... on local network... at ARP: 00:0c:29:c8:8a:61
got MPTCP Response from 192.168.88.164 : 22 !... 20
RST Test indicates MPTCP support
got MPTCP Response from 192.168.88.164 : 80 !... 20
RST Test indicates MPTCP support
****Results:****
    192.168.88.164
                        {22: 'MPTCP (MP_JOIN Verified)'}
                        {80: 'MPTCP (MP_JOIN Verified)'}
```

MPTCP Support Scanner

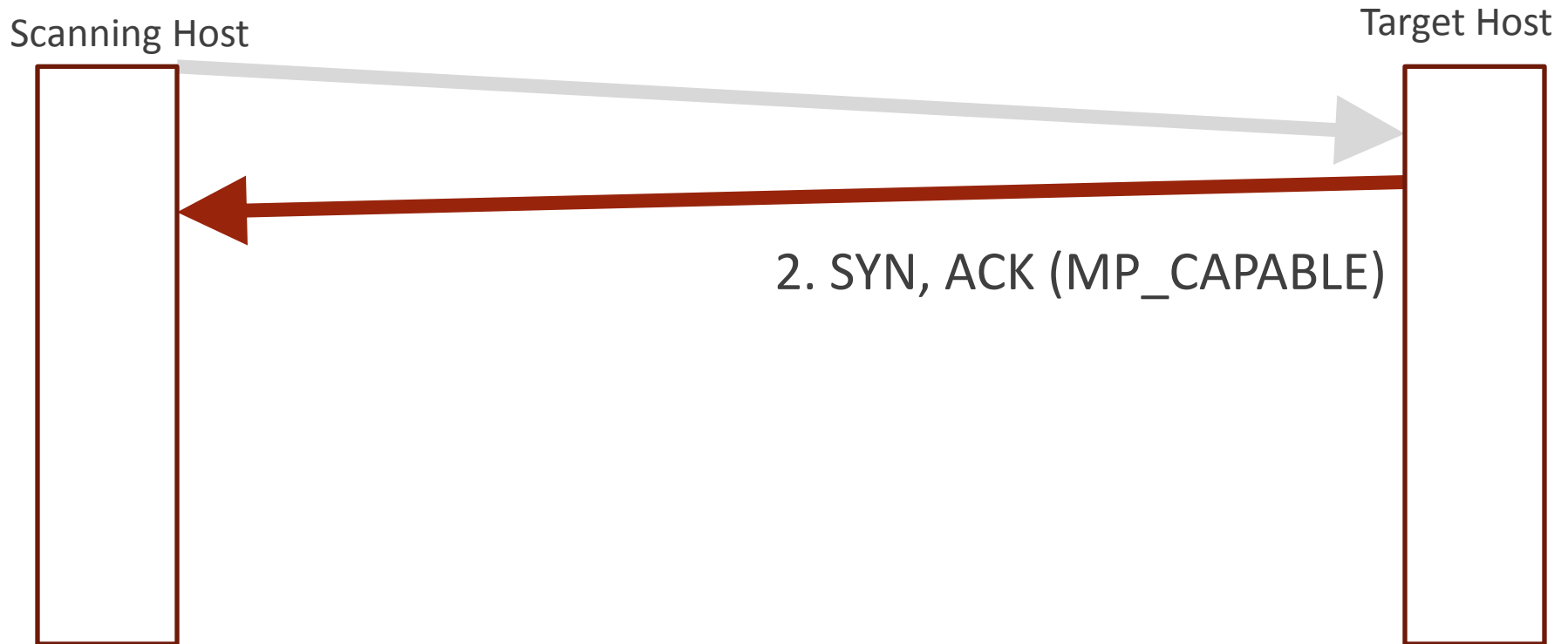
- Accomplishes three things
 - Test device for *apparent* support
 - Test for *actual* support (as opposed to repeating the option blindly)
 - Test network path allows it to get there

MPTCP Scanner



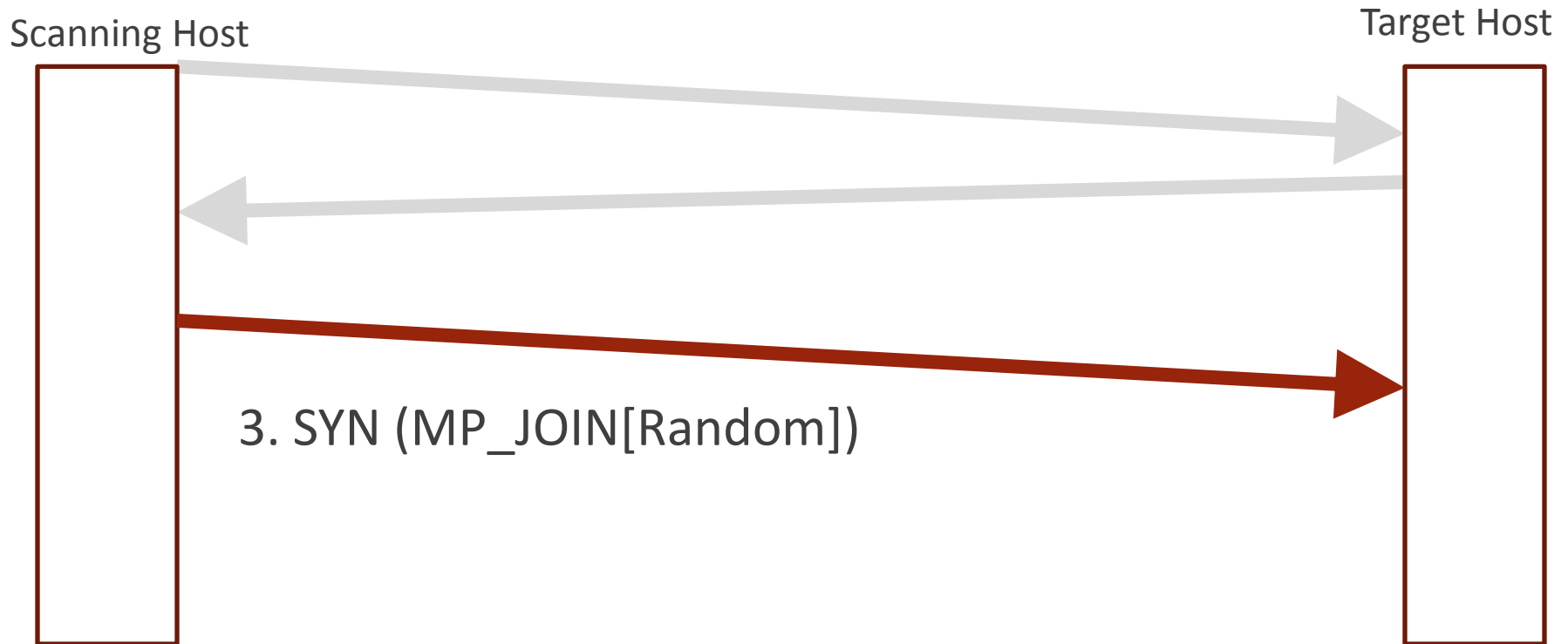
- Send an MP_CAPABLE syn

MPTCP Scanner



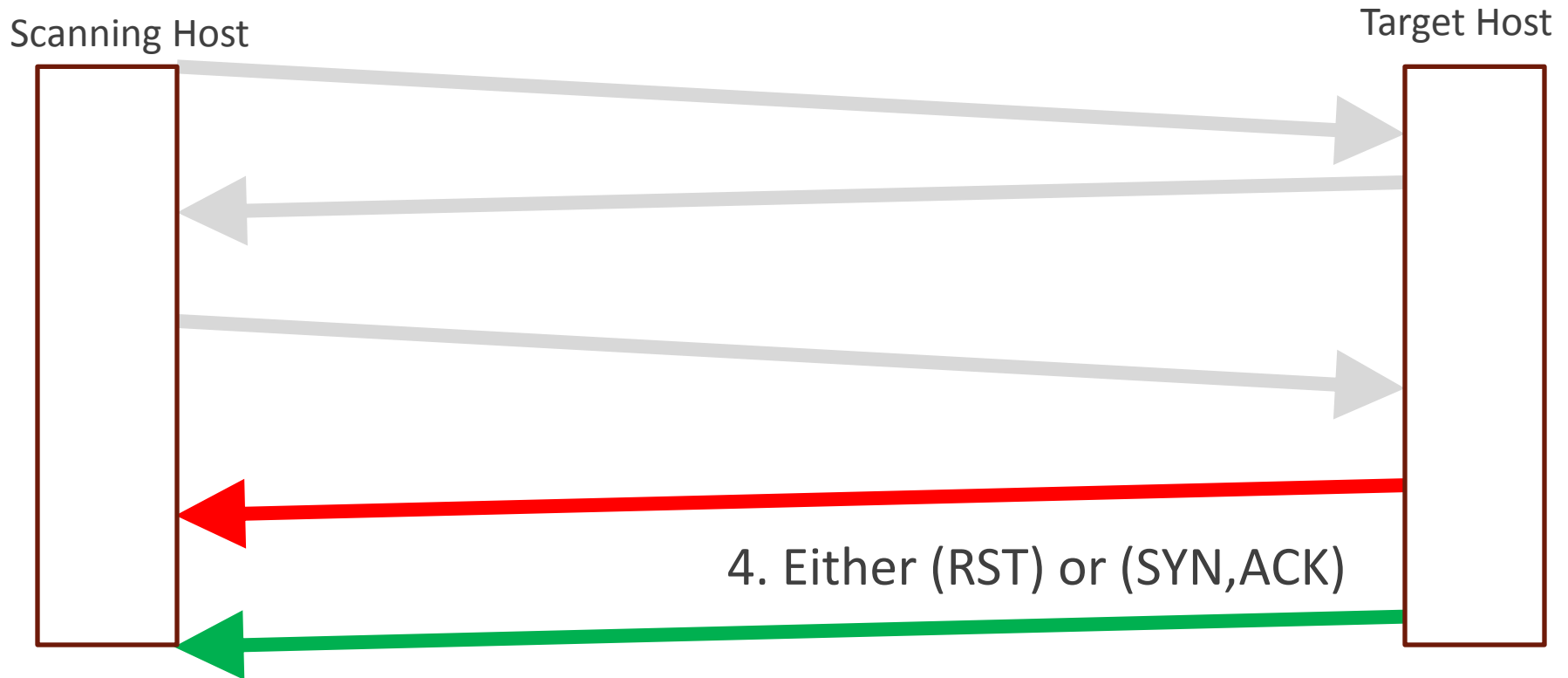
- We got an MP_CAPABLE response.. But is it genuine?

MPTCP Scanner



- Send a join to an invalid connection ID

MPTCP Scanner



- An MPTCP host will RST an invalid join,
- An ACK reply indicates TCP only

MPTCP Stripping

- Transparent proxy on primary path
 - Either no MPTCP support, or only on the one interface
- Firewall rules:

strip-options 30 - iptables,

tcp-options 30 30 clear - Cisco IOS

MPTCP and Active Network Security

- To track & modify MPTCP, you must

1. Capture the initial handshake

2. Perform non-trivial calculations to determine

- Connection membership
- Correct checksum or modified traffic



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MPTCP and ... Privacy

- MPTCP shifts power towards endpoints, and away from infrastructure & ISP's
- I don't trust my ISP or Cellular company...
- But they probably don't trust each other either!

The MPTCP Future

- What will change in a multipath future that simply cannot work with most existing security models?
 - Split trust crypto
 - Multipath agility
- Some research into privacy effects already underway

Conclusions

- Multipath communications are awesome, and they're coming
- Multipath communication confounds business & security models relying on inspection
- Now is the time for network security to prepare



PCAP Challenge (with solution) @
<http://bit.ly/MPTCPTROOPERS15>



Questions?

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Downloads:

<https://github.com/Neohapsis/mptcp-abuse>

More stuff will be released @

<http://labs.neohapsis.com>