

# Multipath TCP: Seamless WiFi/Cellular Handover

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inspired by <http://multipath-tcp.org/data/MultipathTCP-netsys.pdf>

# A Connection

- For users, a connection is something like my phone  $\leftrightarrow$  [www.facebook.com](http://www.facebook.com)
- For TCP, a connection is (src IP, src port, dst IP, dst port)

# A Connection



10.0.0.1



10.0.0.2

When TCP was designed, a computer usually had one network interface and hence one IP address

# A Connection

- Now, mobile devices are there with multiple interfaces:

100.105.176.193



192.168.2.29

3G

(either or)

WiFi



10.0.0.1



When you switch from WiFi to cellular network or vice-versa, all connections are shut down and must be re-established.

Let's restore the end-  
to-end principle

# Multipath TCP

- TCP has got an option field that was intended for extensions
- TCP Option 30 dedicated to Multipath TCP
- Idea: Introduce a “connection token” that can be used to dynamically add/remove IP addresses (“subflows”) to/from a TCP session

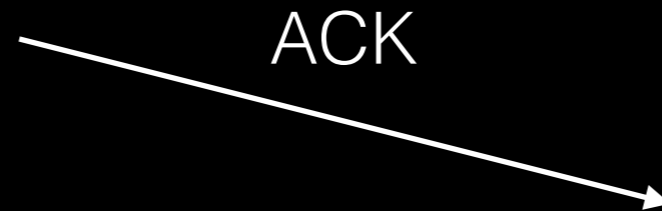
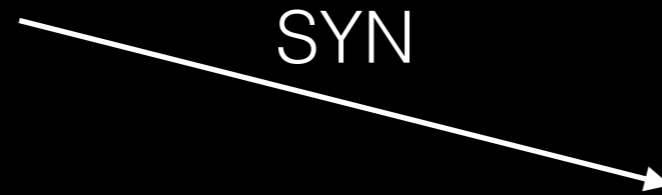
# Challenges

- TCP Options get eaten by many middleboxes: NAT, Carrier-Grade NAT, Firewalls, ... 6% of all tested MPTCP connections fail
- Prevent Session Hijacking (be as good [read: bad] as TCP)
- Be backward compatible



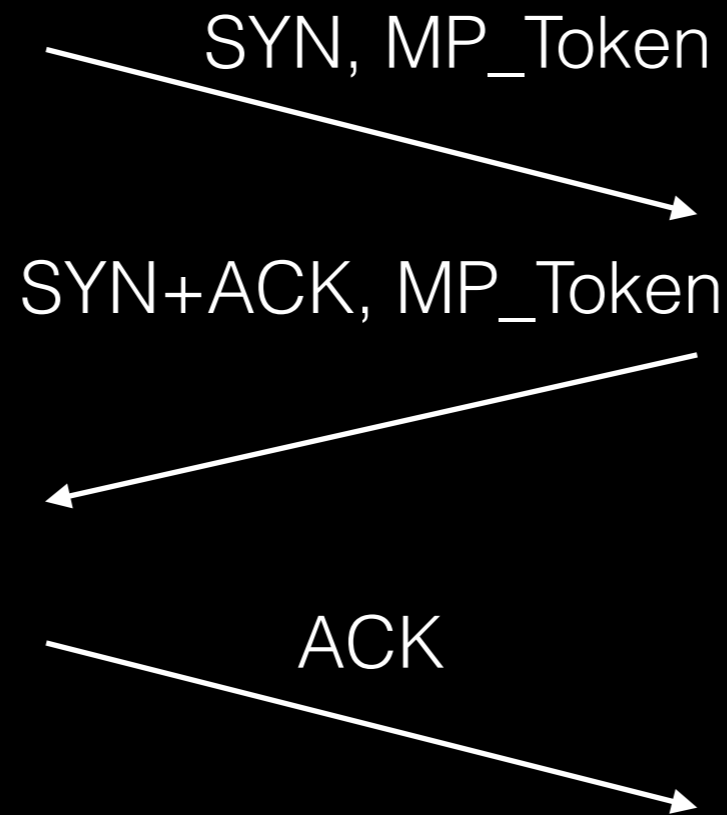
# Backward Compatibility

Regular TCP Handshake



# Backward Compatibility

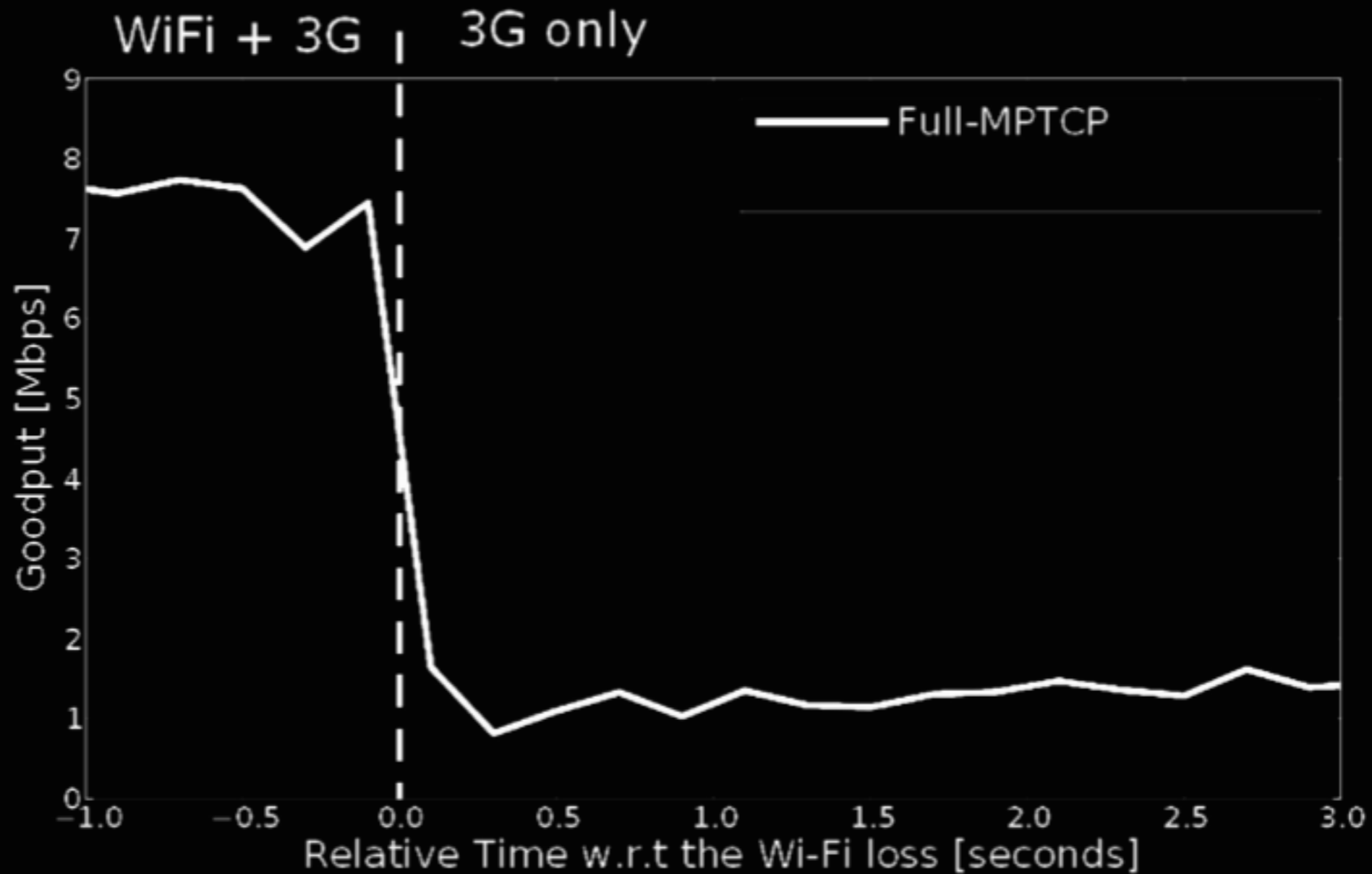
## Multipath TCP Handshake



# Protocol features

- Add subflow: When initiated by the client, the server's token and the client's old IP address is sent (with some HMAC stuff) on the new flow and the new address on the old flow (security, NAT)
- Change Subflow Priority (actually: backup or not)
- Remove subflow: Just reset subflow (TCP RST)

# Benefits



C. Paasch, et al. , "Exploring mobile/WiFi handover with multipath TCP," presented at the CellNet '12: Proceedings of the 2012 ACM SIGCOMM workshop on Cellular networks: operations, challenges, and future design, 2012.

# Benefits

- Use Multipath TCP as a backup link for seamless handover (Siri)
- Use Multipath TCP to bond connections (interesting for landlines)

# Multipath TCP for Seamless Handover

- Mobile device knows when the WiFi connection goes down
- When the subflow is taken down, all unacknowledged data is retransmitted immediately on remaining subflows
- If this “connection lost” detection does not work, a timeout will kick in and take the subflow down

# OS Support

- Linux
- FreeBSD
- iOS 7 (yay!)

# iOS Support

- Multipath TCP is currently used by Siri
- No SDK access yet
- There is a support page that does not say much (<http://support.apple.com/kb/HT5977>)
- Let's wait for it!



Thank you for your attention.  
Ask your question now.

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Backup Slides

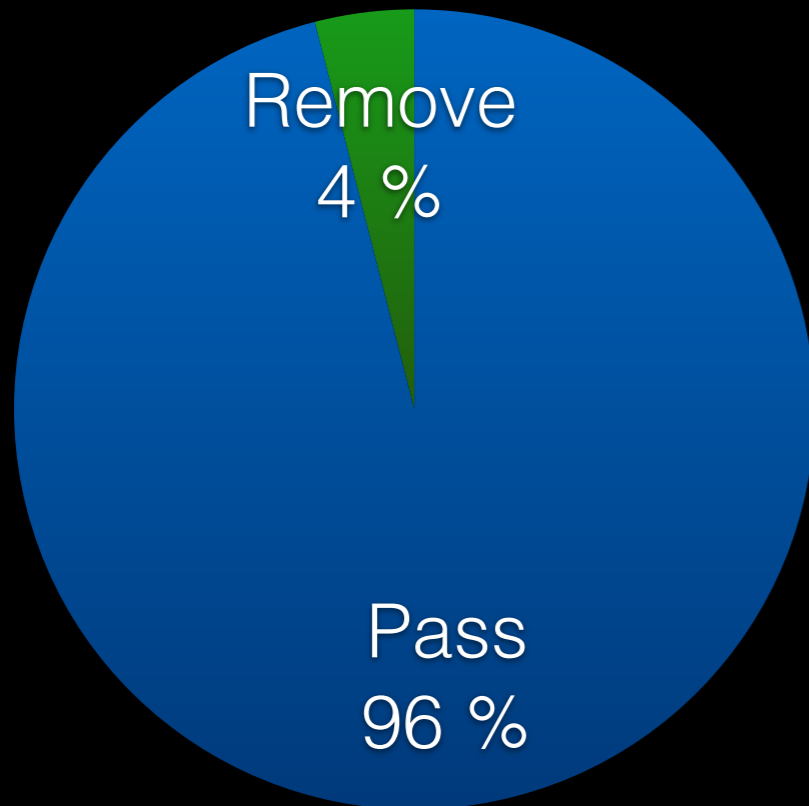
# Security

- Connection Setup with MP\_CAPABLE: Client and server insert 64-bit random keys
- MP\_JOIN: Carry a MAC of the keys from original subflow. Generate a connection identifier derived as hash from recipient's key
- Further reading: A. Ford, C. Raiciu, M. Handley, and O. Bonaventure. TCP extensions for multipath operation with multiple addresses, Jan 2012

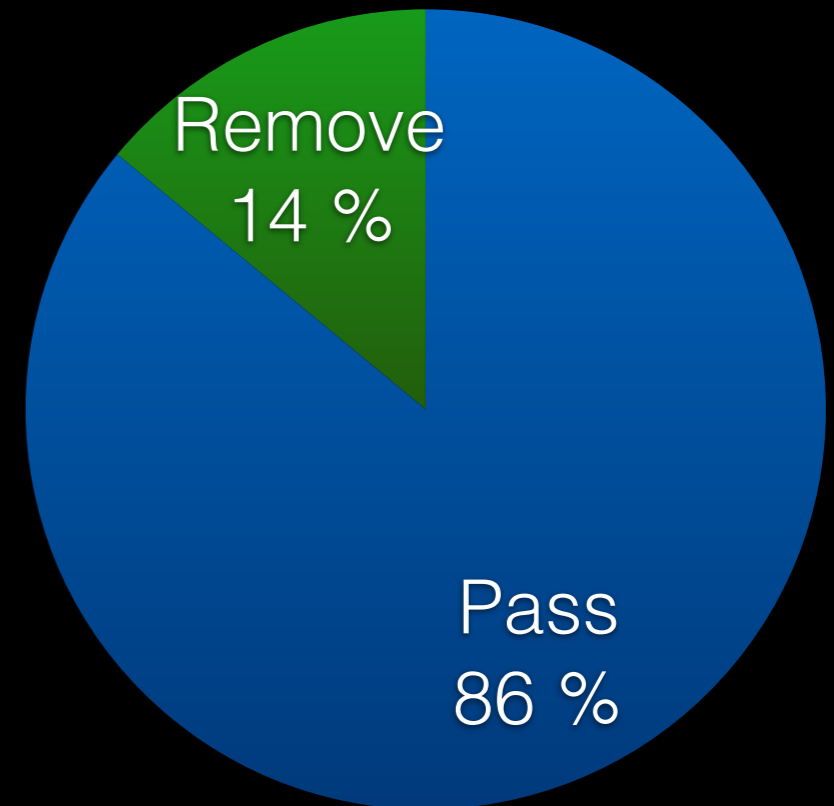
# Evil Middleboxes

TCP Options in SYN packets

port 34443



port 80



# Evil Middleboxes

- Web Security Appliance, VPN Concentrator, SSL Terminator, NAT, ...
- TCP connections must be opened with SYN
- NAT can change IPs and ports
- No gaps in sequence numbers allowed (hence MPTCP maintains its own sequence numbers)
- Middlebox may coalesce/split segments
- Middlebox may change data payload -> own checksum