

# Multipath TCP and its applications

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Multipath TCP enables unmodified applications to use multiple network paths in the same transport connection.

It is implemented and deployed on Apple IOS and high-end Android devices.

## Many devices have multiple connections to the Internet

- Mobile phones with Wifi, cellular and Bluetooth links
- CPE devices with DSL and cellular links
- Datacenter networks with many paths between servers

## Multipath TCP

- Looks like a set of regular TCP connections, but with some special TCP options in each packet.
- On connection startupp, each endpoint assigns a per connection identifier which is used to “glue” (many) subflows.
- Subflows can be added and removed freely.
- Needs both ends to support it: otherwise it falls back to using regular TCP

## Implementation and standardization

Standards: RFCs 6182, 6356, 6824, 7430  
Production-quality Linux kernel implementation  
Apple IOS implementation

## Applications of Multipath TCP

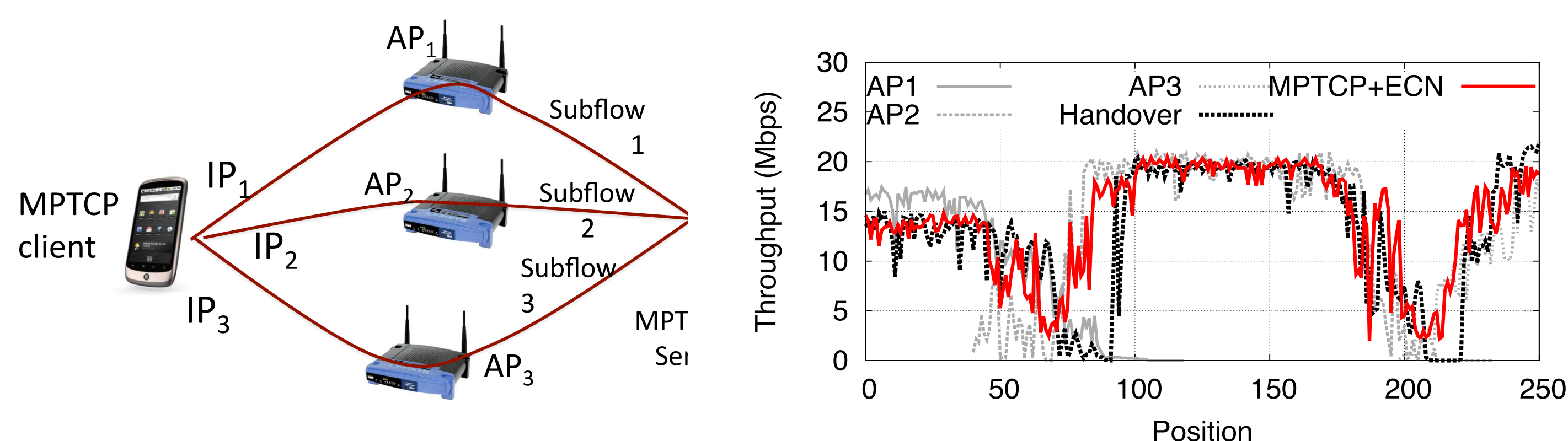
### Multipath TCP on mobile phones

4.5G deployments at Korea Telekom and Turkish Telekom: bond LTE and 802.11ac

Pilot deployment at Orange Romania (UPB)

### Wireless mobility [NSDI 2015]

Associate to all access points you see, balance traffic with Multipath TCP => smooth mobility experience.



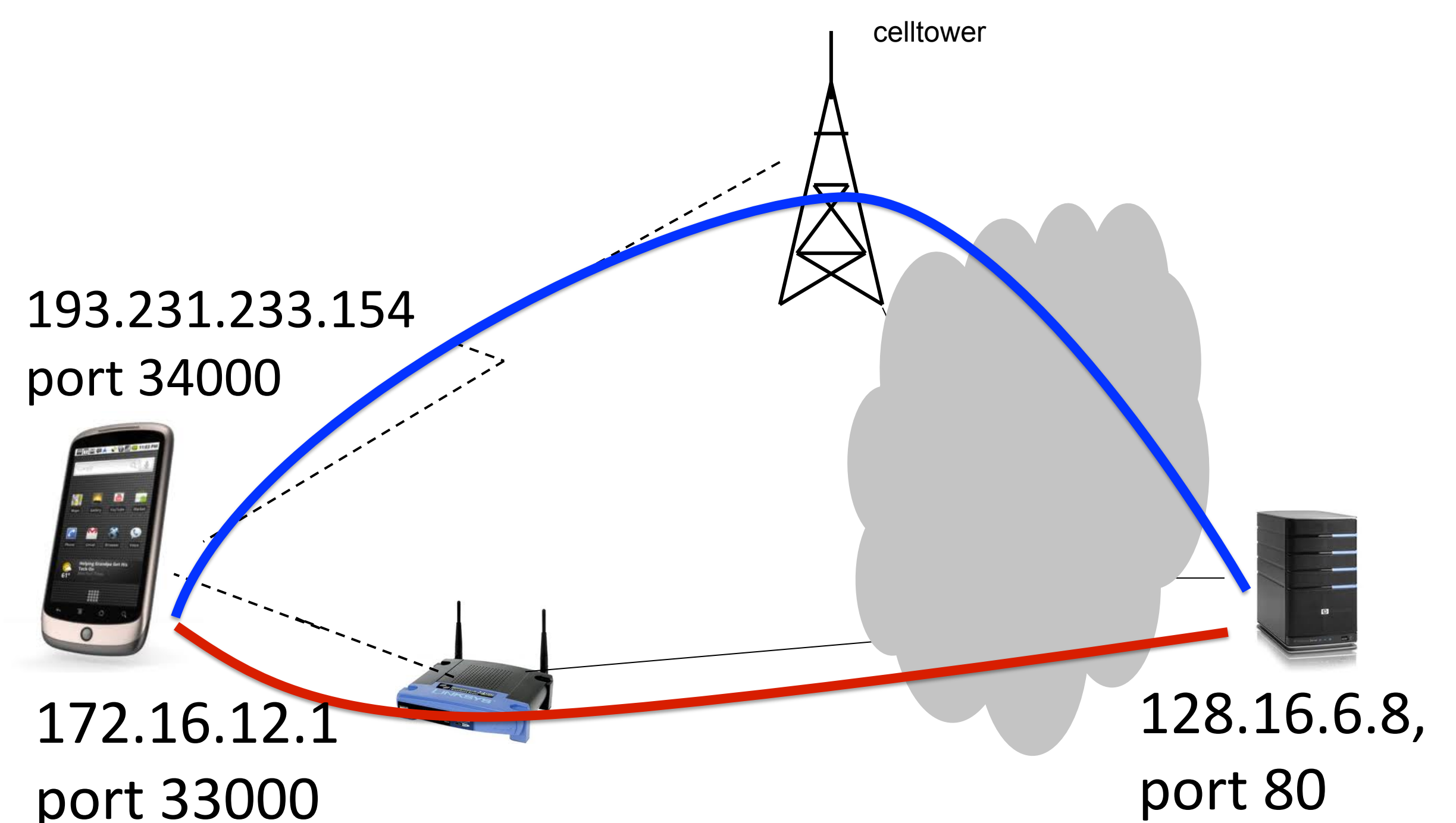
### Opportunistic encryption

SMKEX protocol performs DH exchange on multiple paths

MiTM attacker must be active and communicating on both paths to succeed.

## TCP is single-path and unable to utilize such links

- Connection breaks when switching between cellular and Wifi
- Any TCP connection limited to the speed of DSL or cellular.
- In the worst case, 55% of capacity is wasted.



## Publications

Congestion control – Usenix NSDI 2011 – best paper award  
Protocol – Usenix NSDI 2012 – community award  
Datacenter usage – ACM Sigcomm 2011

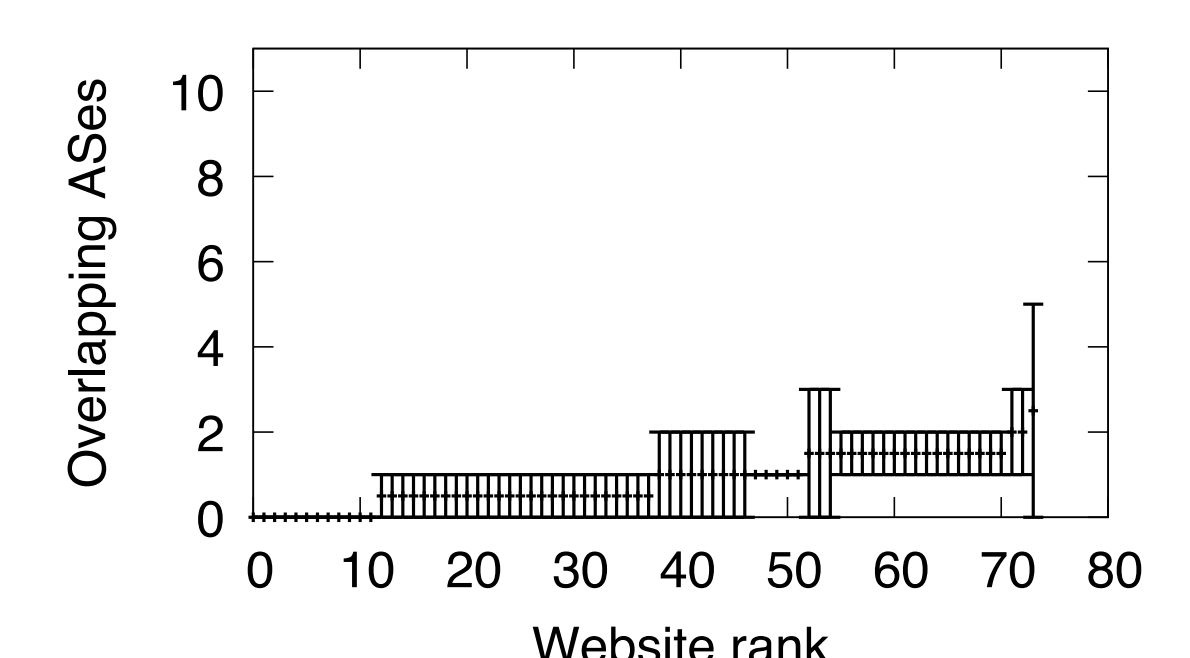
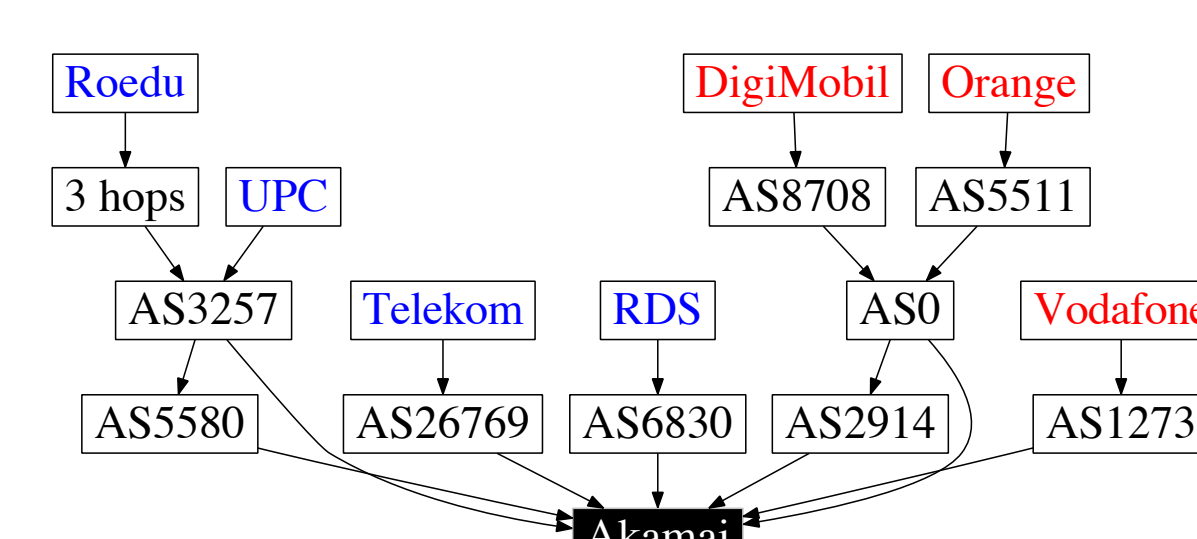
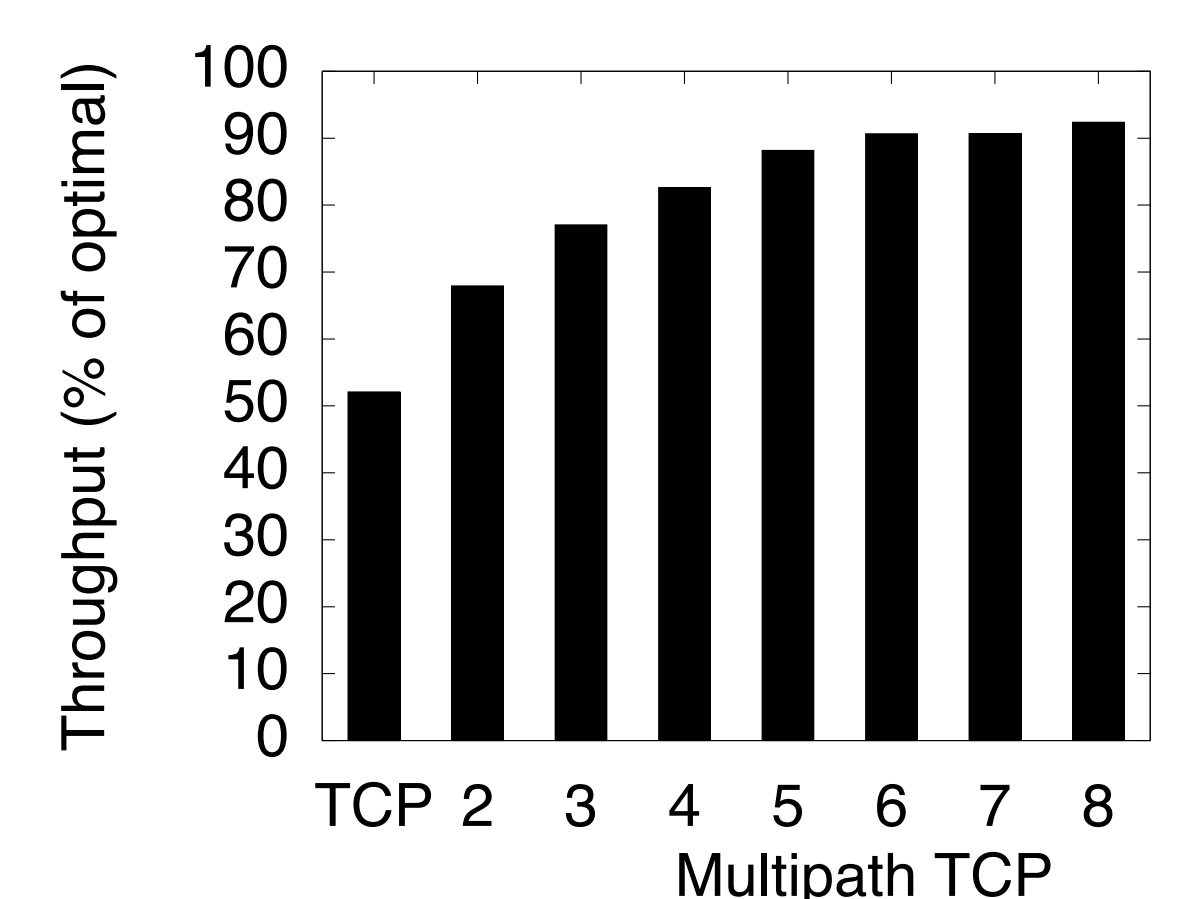
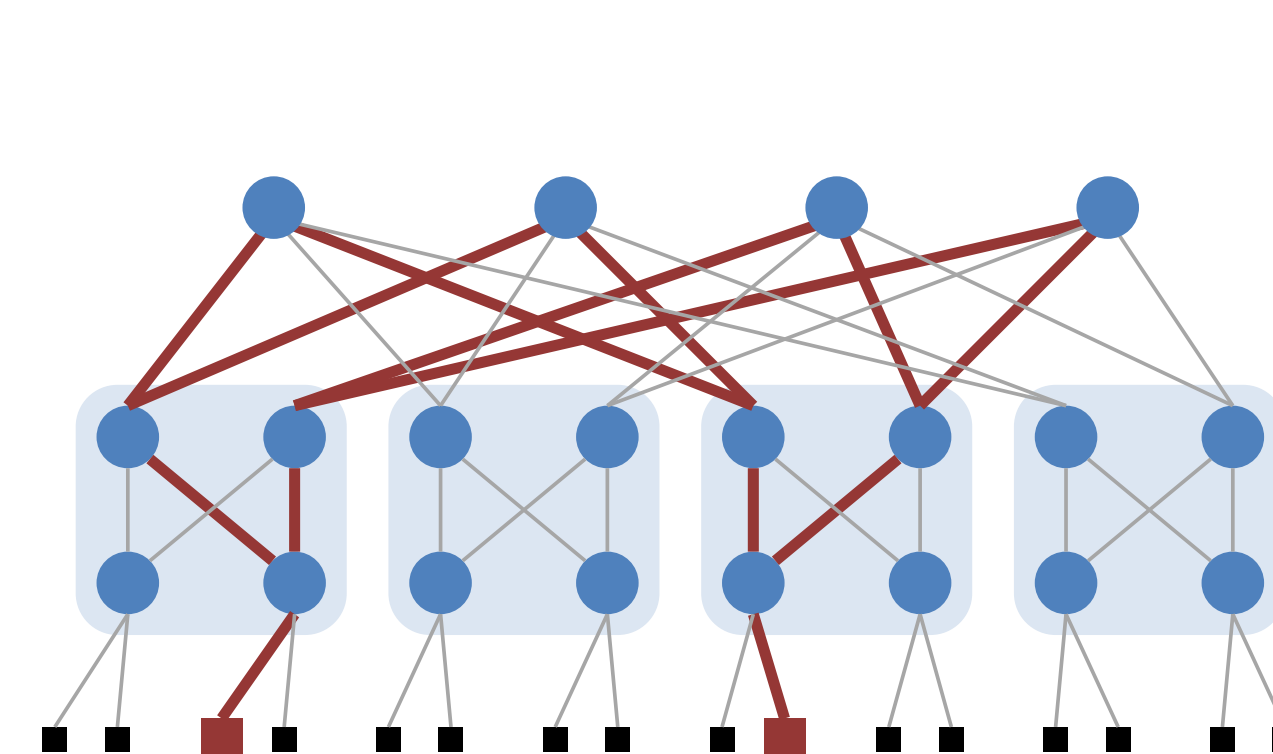
## Increasing broadband capacity

CPEs that use MPTCP to bond LTE and DSL

Pilot deployments at DT, BT, Vodafone

## Increasing datacenter utilization [Sigcomm2011]

Create multiple subflows for each connection to avoid collisions and utilize capacity in DCs networks.



## Funding

Trilogy, CHANGE, Trilogy 2 (FP7, European Comission) Mobil4 (UEFISCDI)