Alternative Security Solutions for MPTCP

Christoph Paasch <christoph.paasch@uclouvain.be>
IP Networking Lab - UCLouvain

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draft-paasch-mptcp-ssl-00

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A low-overhead, low-security MPTCP for data centers

Motivation

- Need for low-overhead MPTCP handshake
  - Data centers
  - Non security-critical traffic

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Goals:

- Reduce chances of token collision
- Avoid extensive HMAC-calculations
- Allow stateless SYN+JOIN handling

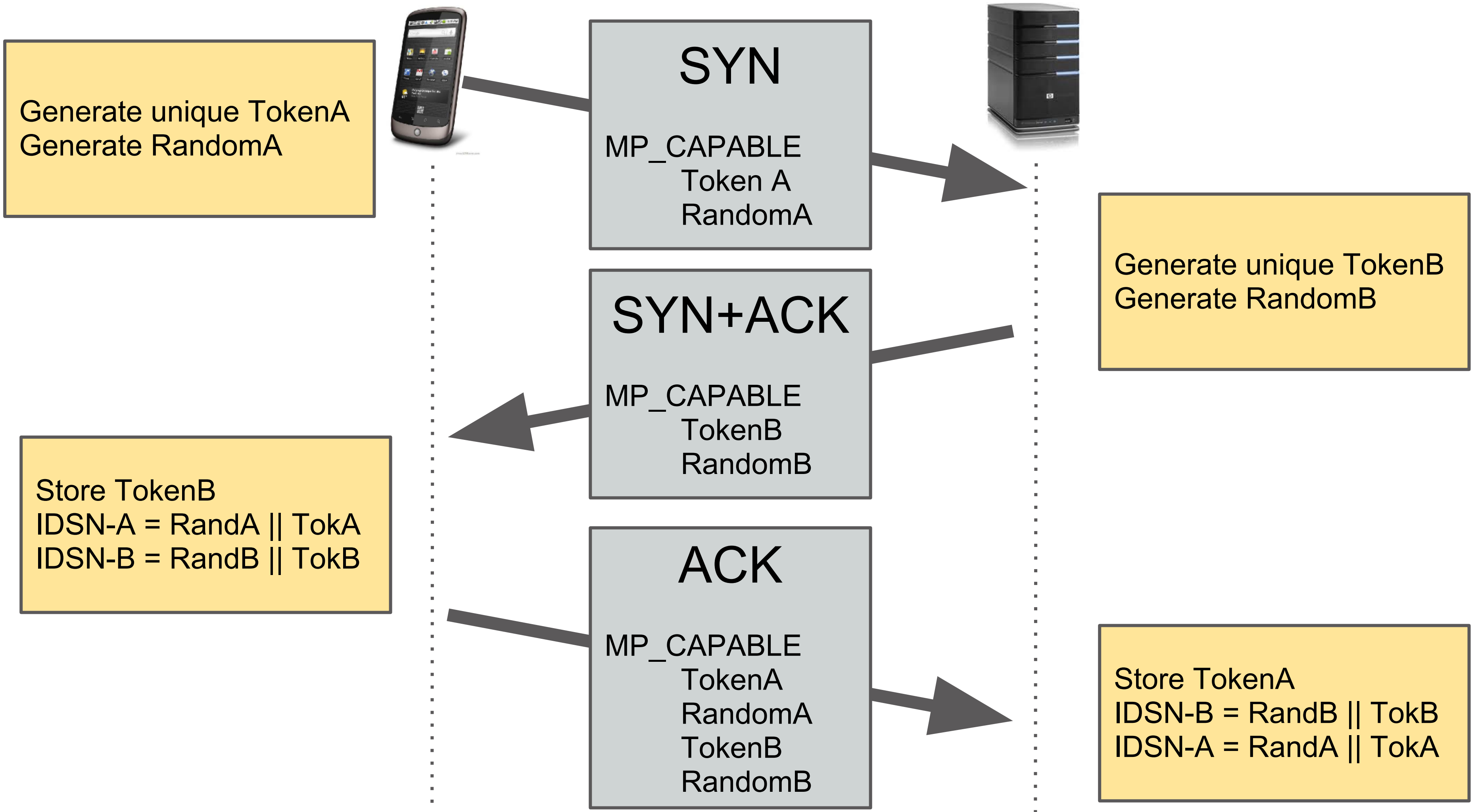
Non-goal:

- Authenticate new subflows

Low overhead initial handshake

- Purposes of the initial handshake:
  - Detect whether the peer supports MPTCP
  - Exchange a connection identifier (Token)
  - Agree on the Initial Data Sequence Number

Low overhead initial handshake



Low overhead initial handshake

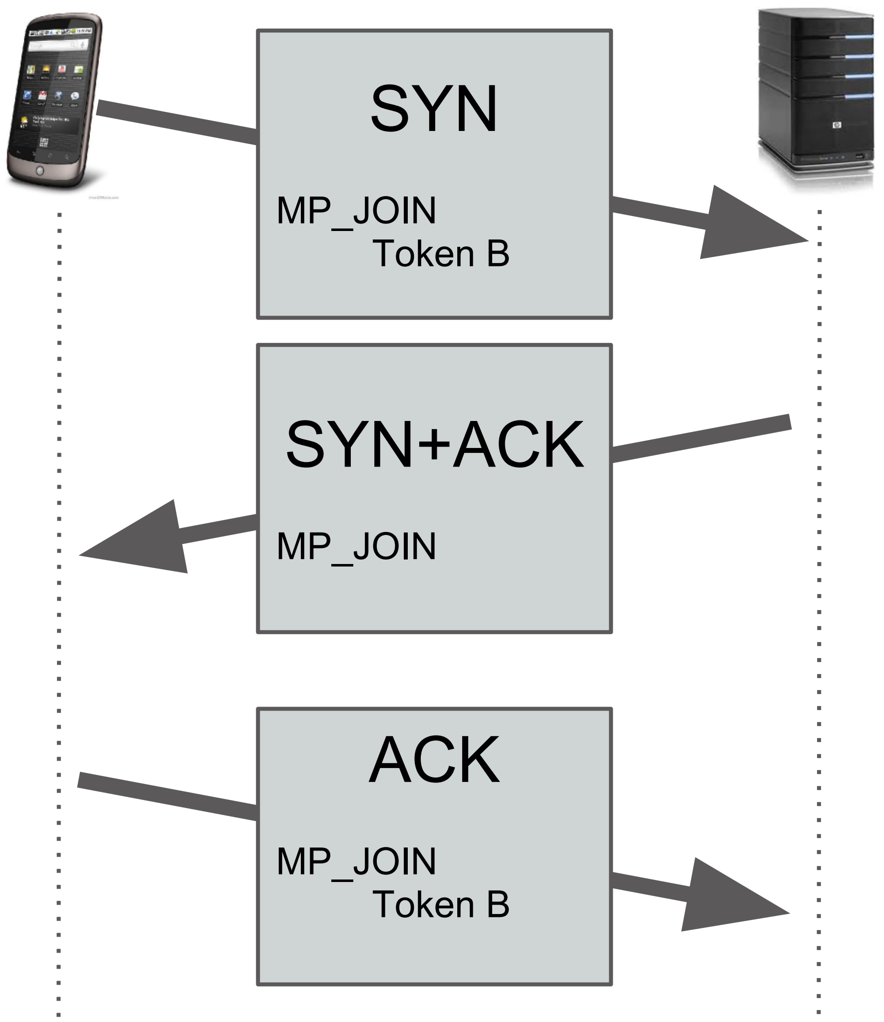
Generating the token:

- Could be a simple counter
- Better: block-cipher (RC5) of the counter plus a local secret

Benefits:

- Guarantees a high probability of uniqueness
- No need to compute a SHA-1

Low overhead additional subflows



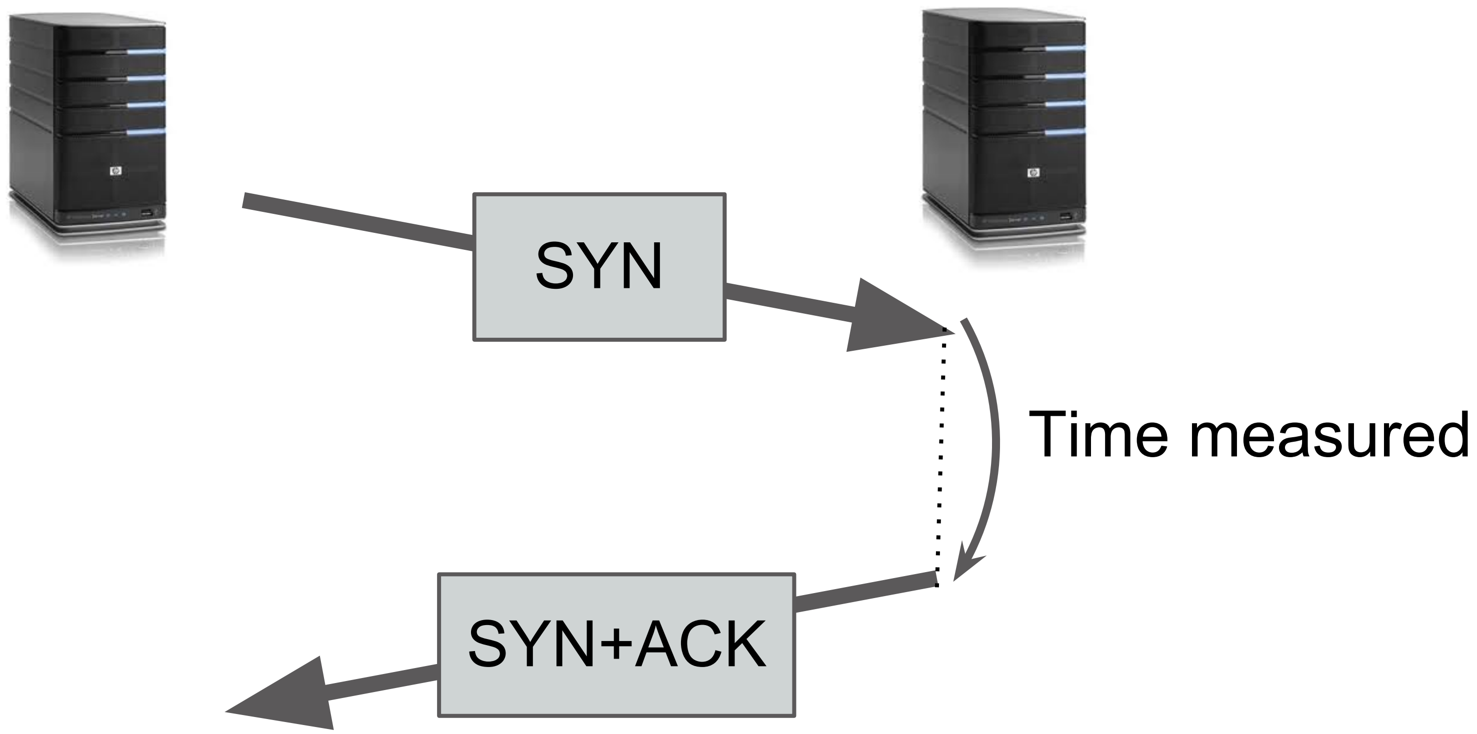
Low overhead additional subflows

Benefits:

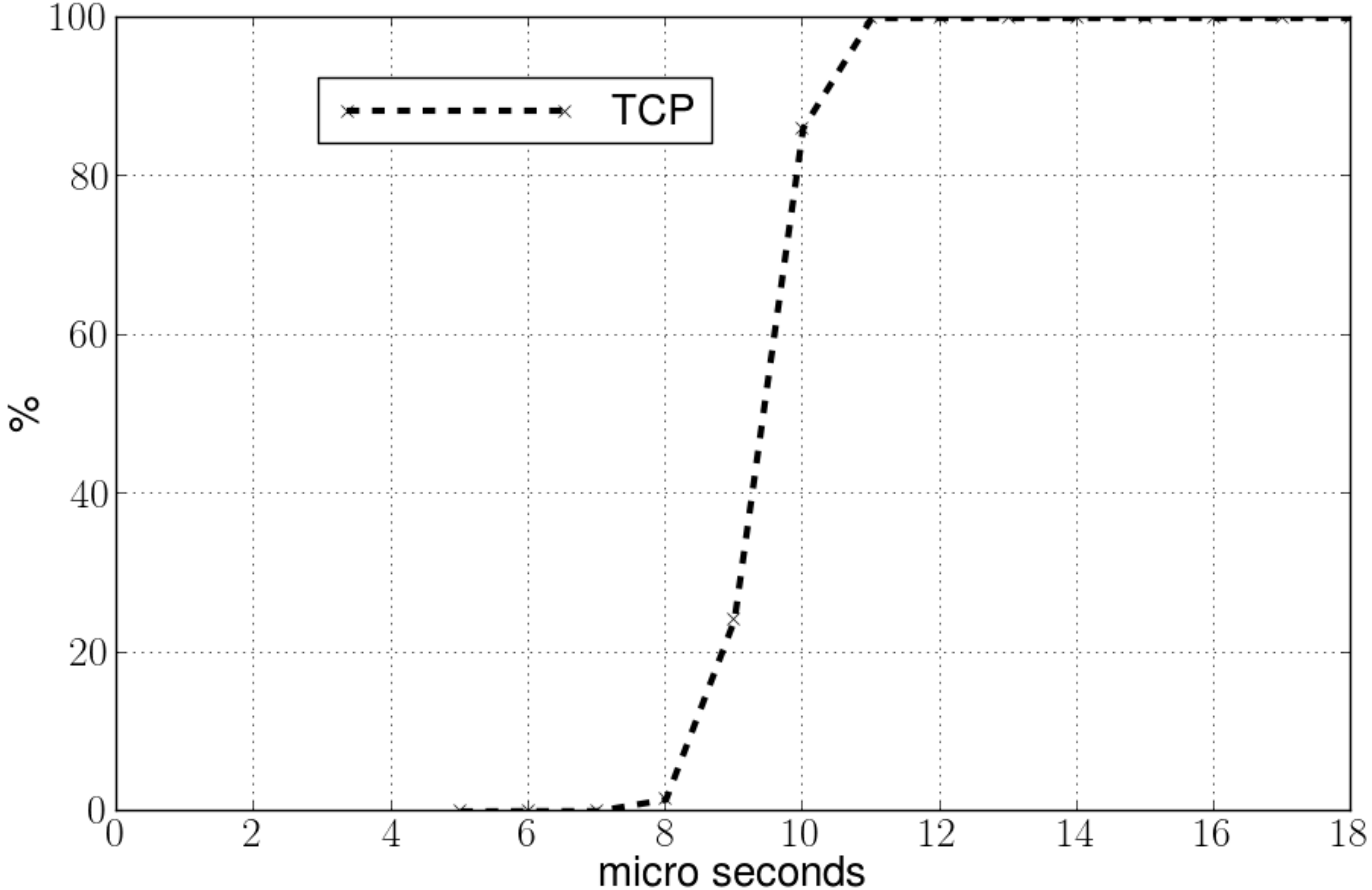
- No need to generate an HMAC
- Allows stateless handling of SYN+JOIN

Performance evaluation of MPTCP low overhead

SYN/ACK with MP_CAPABLE



SYN/ACK with MP_CAPABLE



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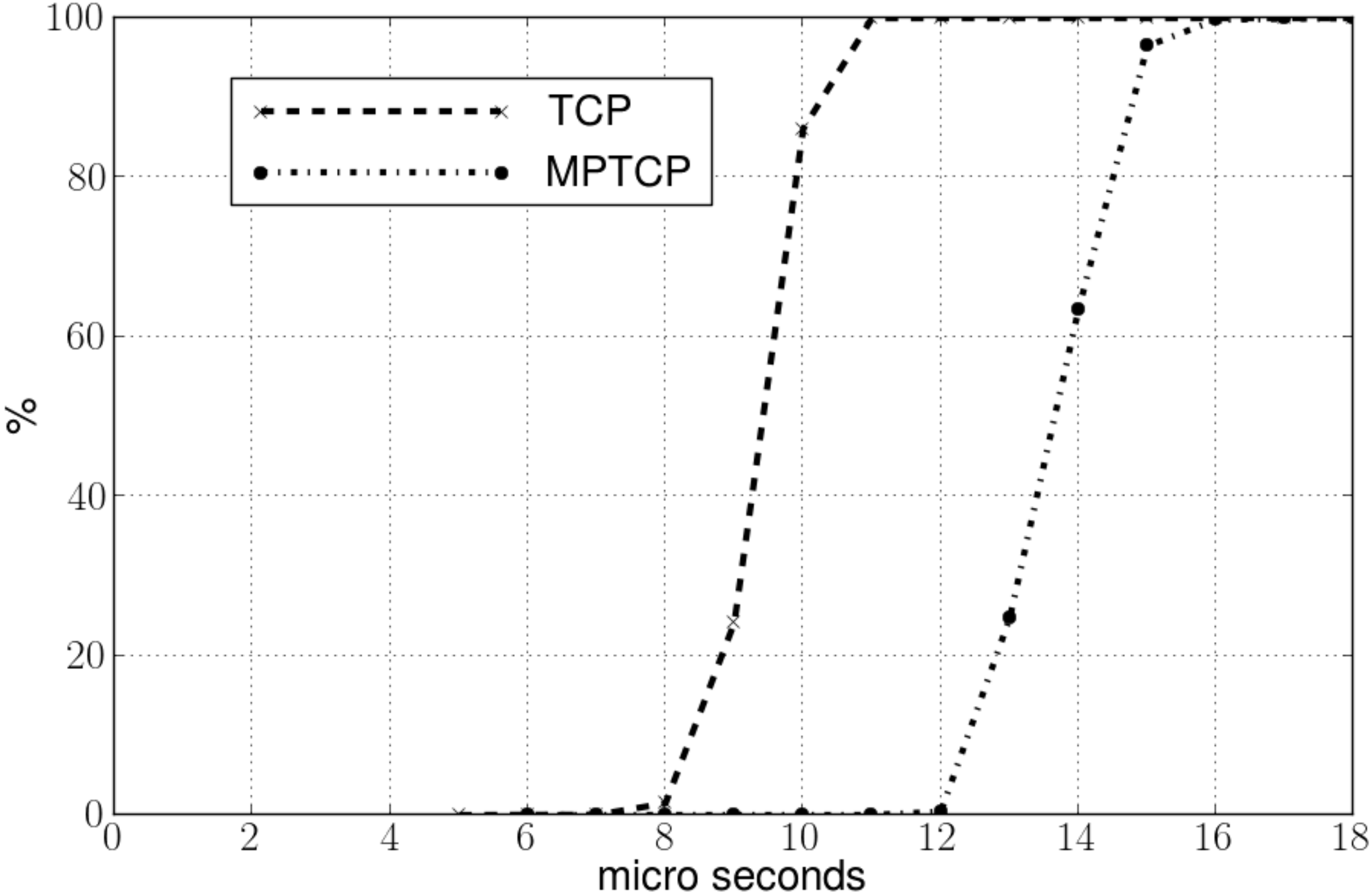
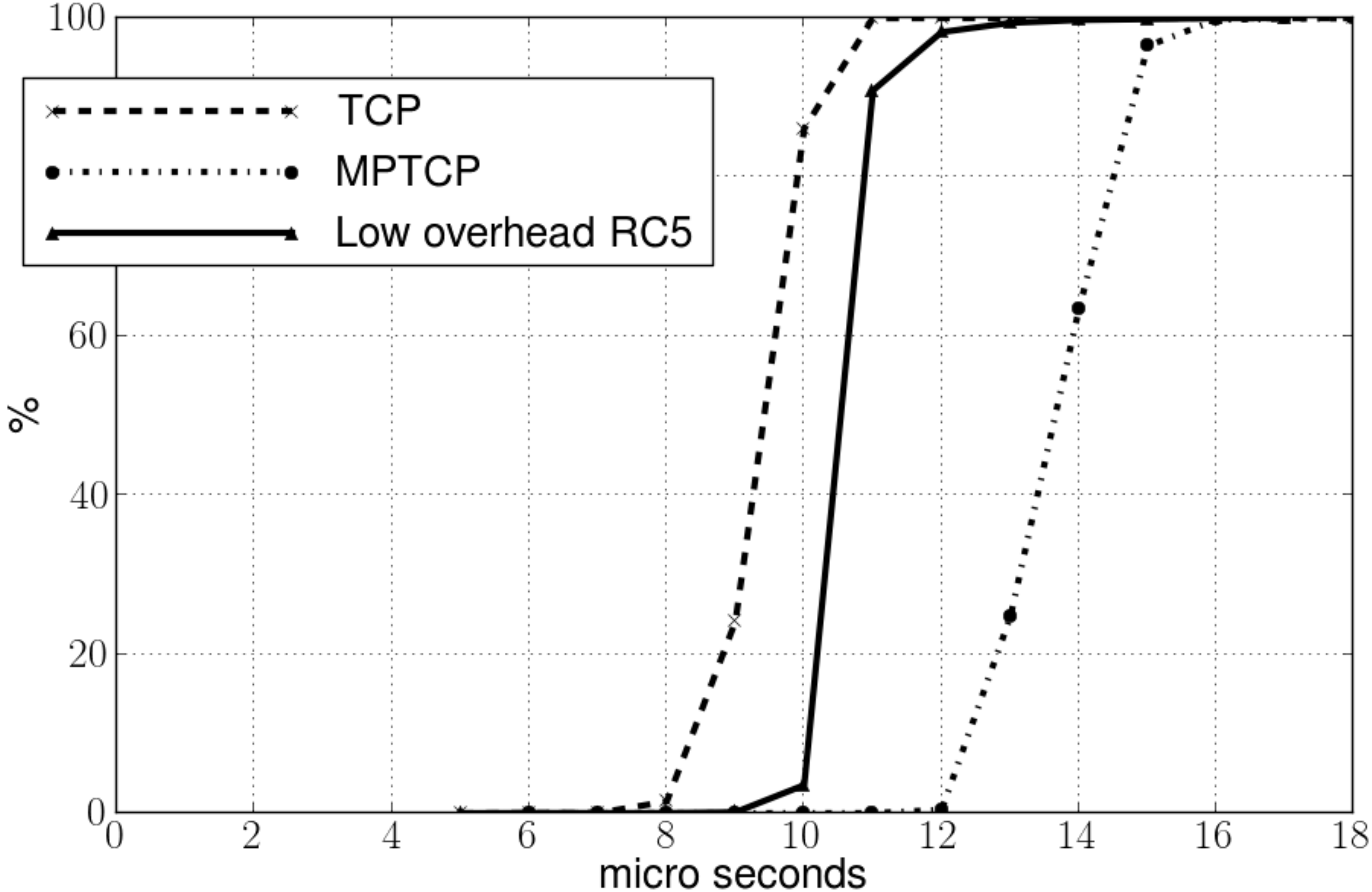


SYN/ACK with MP_CAPABLE



Random Number Generation

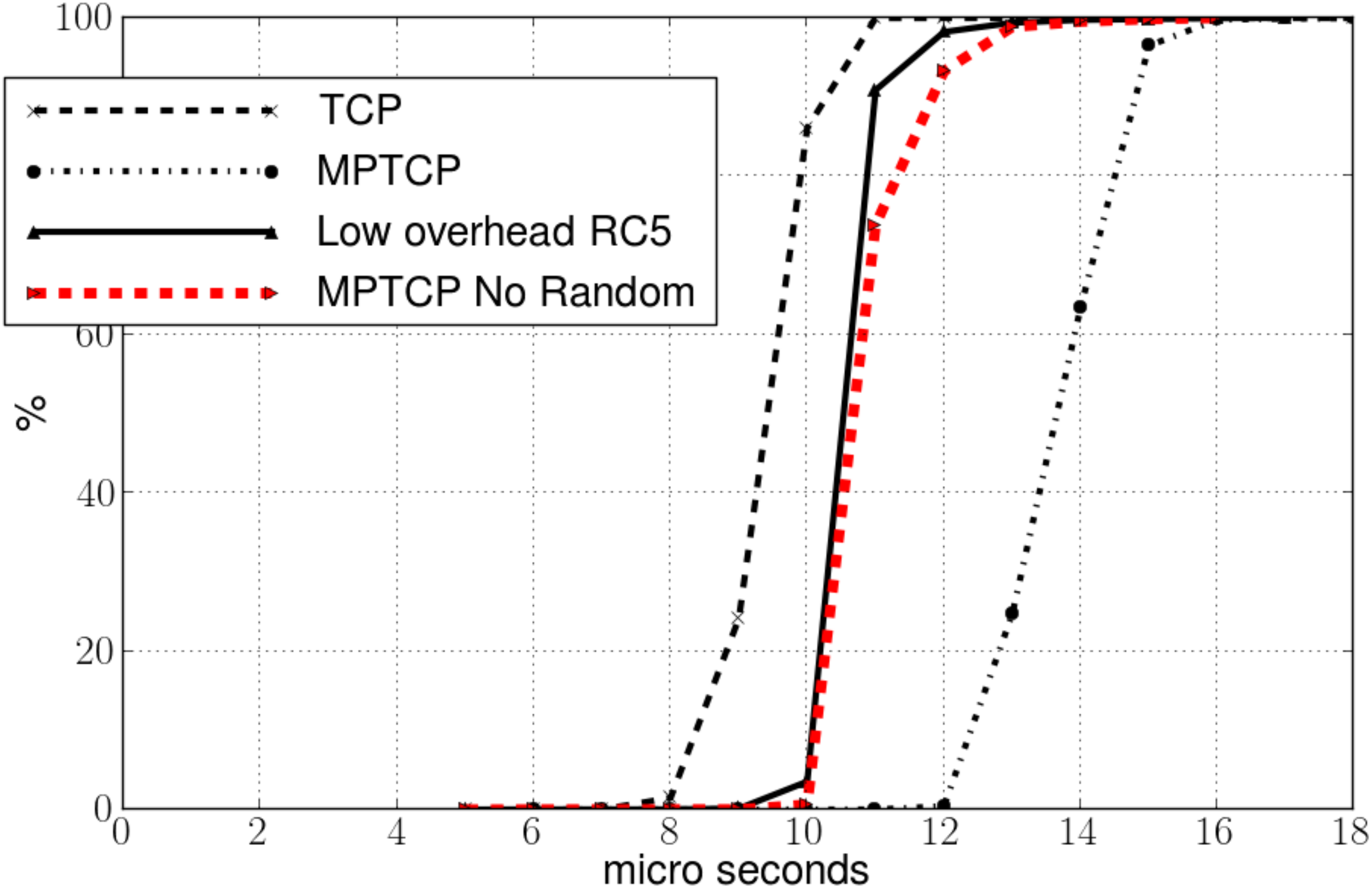
- MPTCP v0 generates random numbers:
  - Key (64-bits)
  - Random Number for MP_JOIN (32-bits)
- Generating these random numbers accounts for ~20% of the time

Random Number Generation

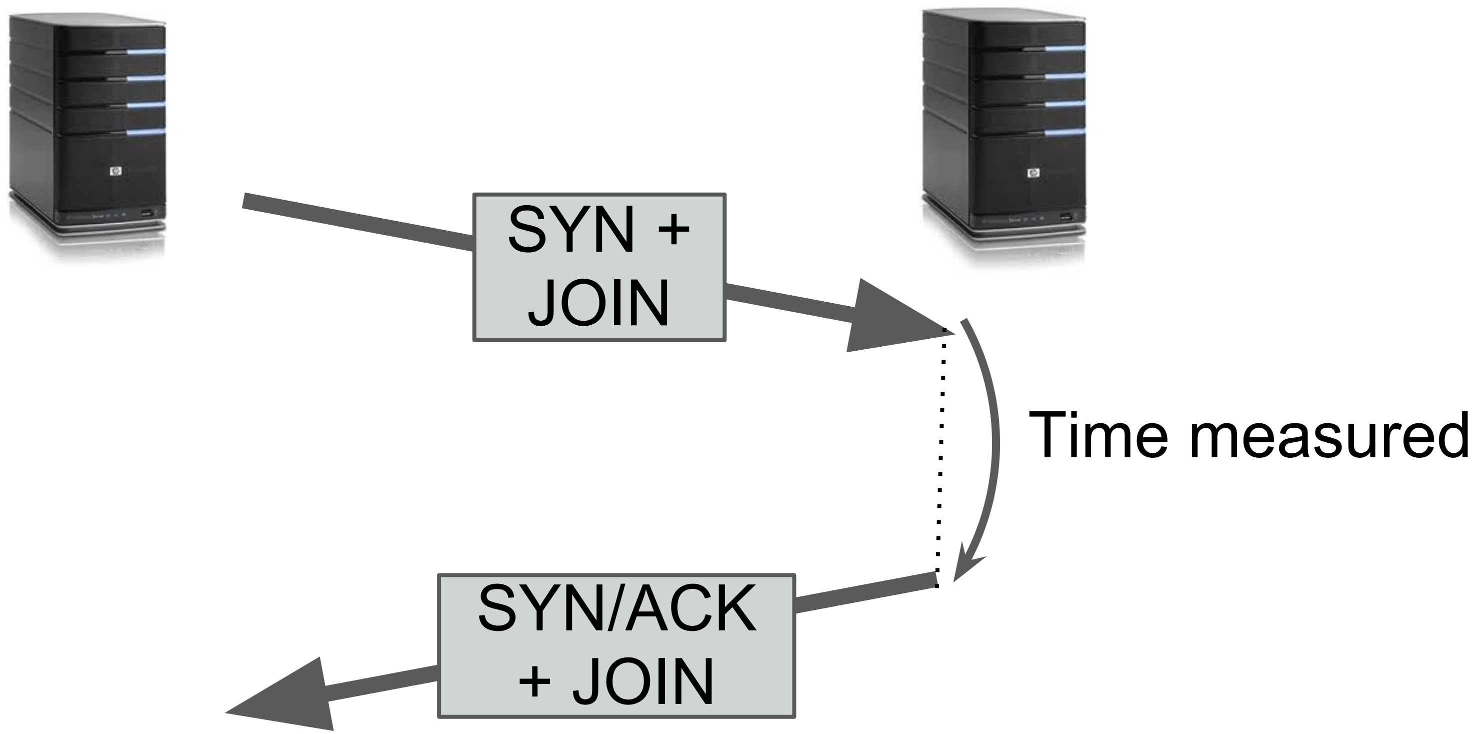
- RFC 6258: Generating the TCP sequence number:
  - ISN = MD5(5-tuple + secret)

- MPTCP Proposal:
  - Key = Hash(5-tuple + secret + counter)
  - Join-Nonce = Hash(5-tuple + secret + seqNo)

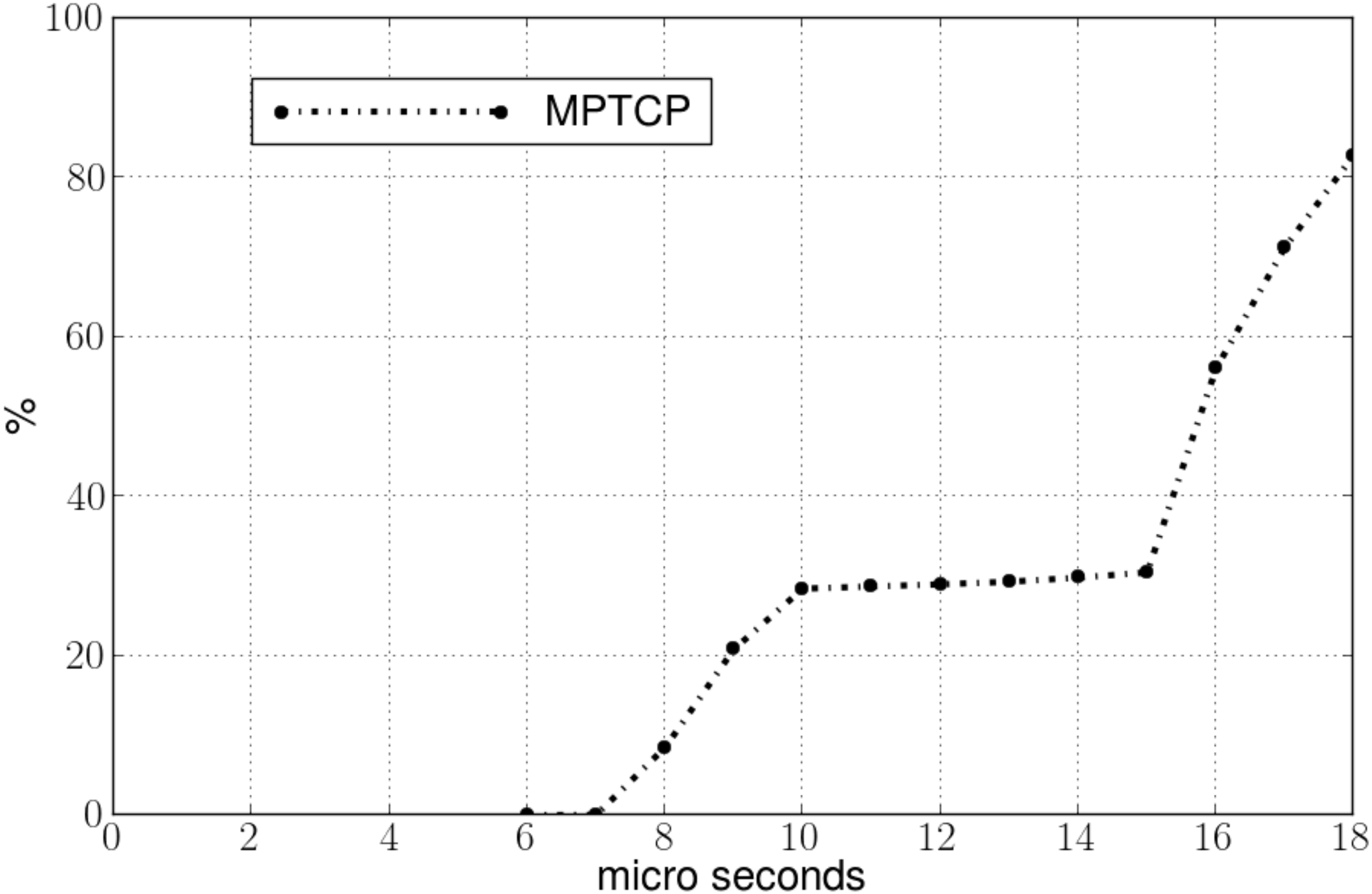
SYN/ACK with MP_CAPABLE



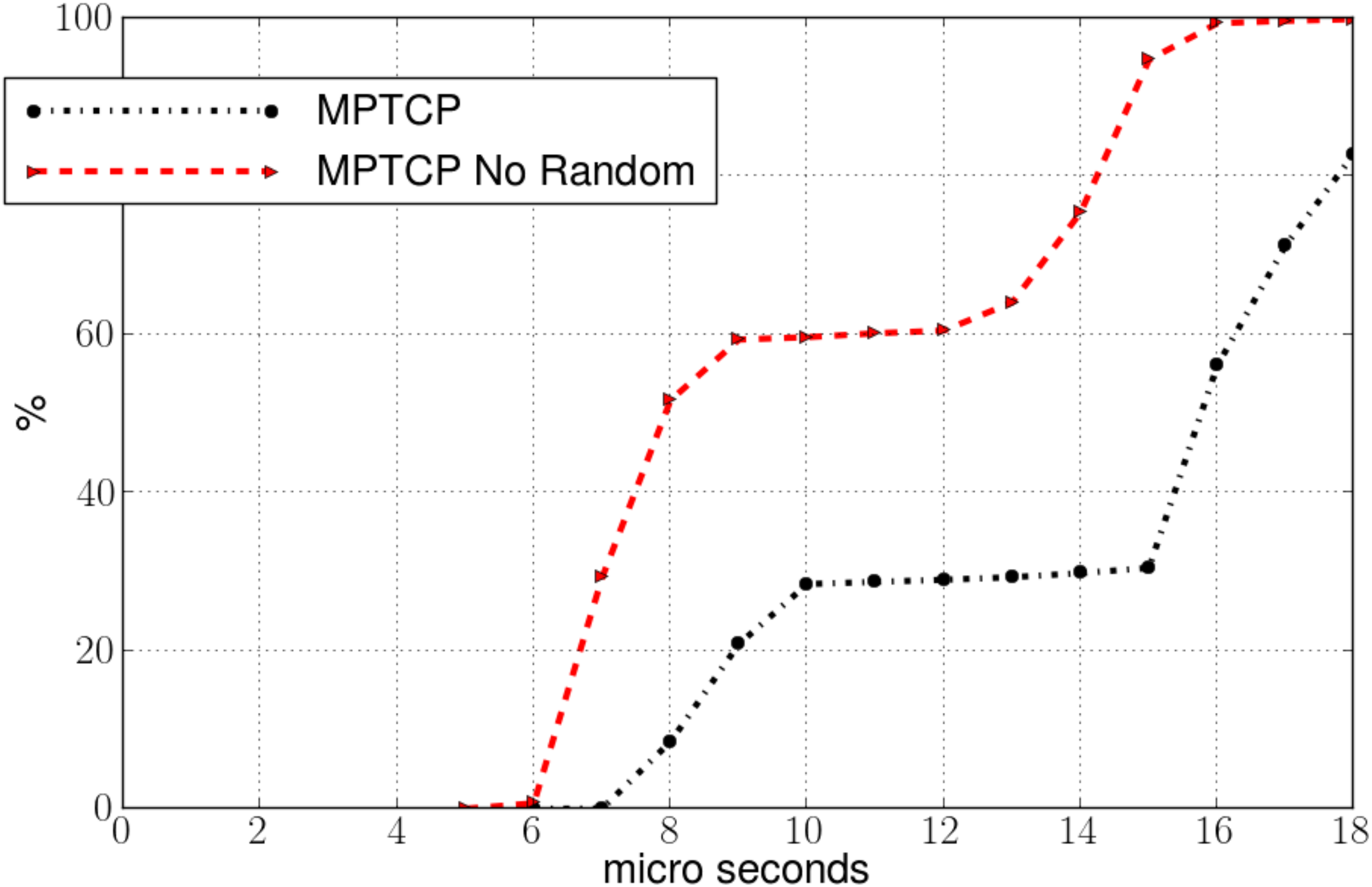
SYN/ACK with MP_JOIN



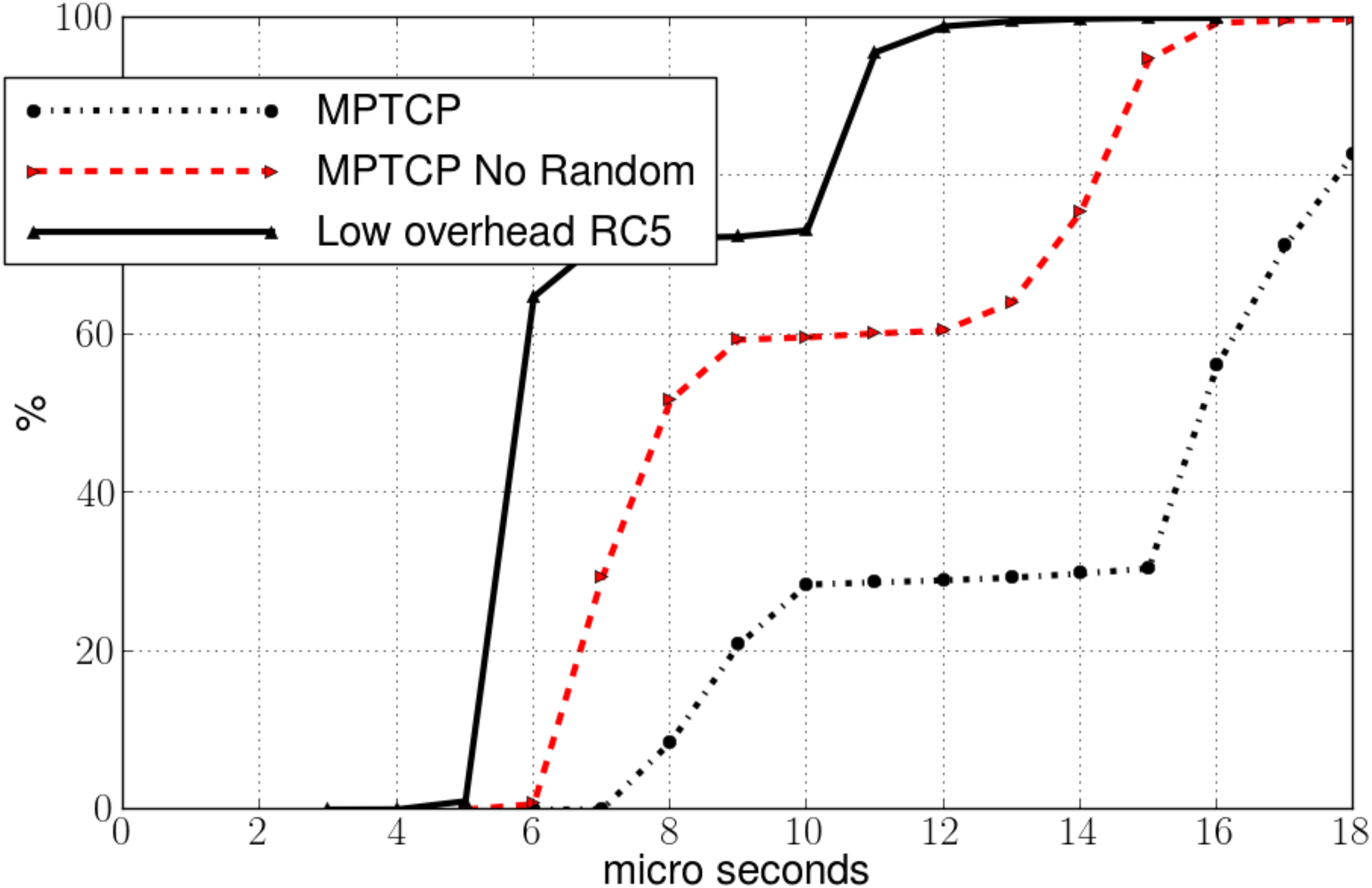
SYN/ACK with MP_JOIN



SYN/ACK with MP_JOIN



SYN/ACK with MP_JOIN

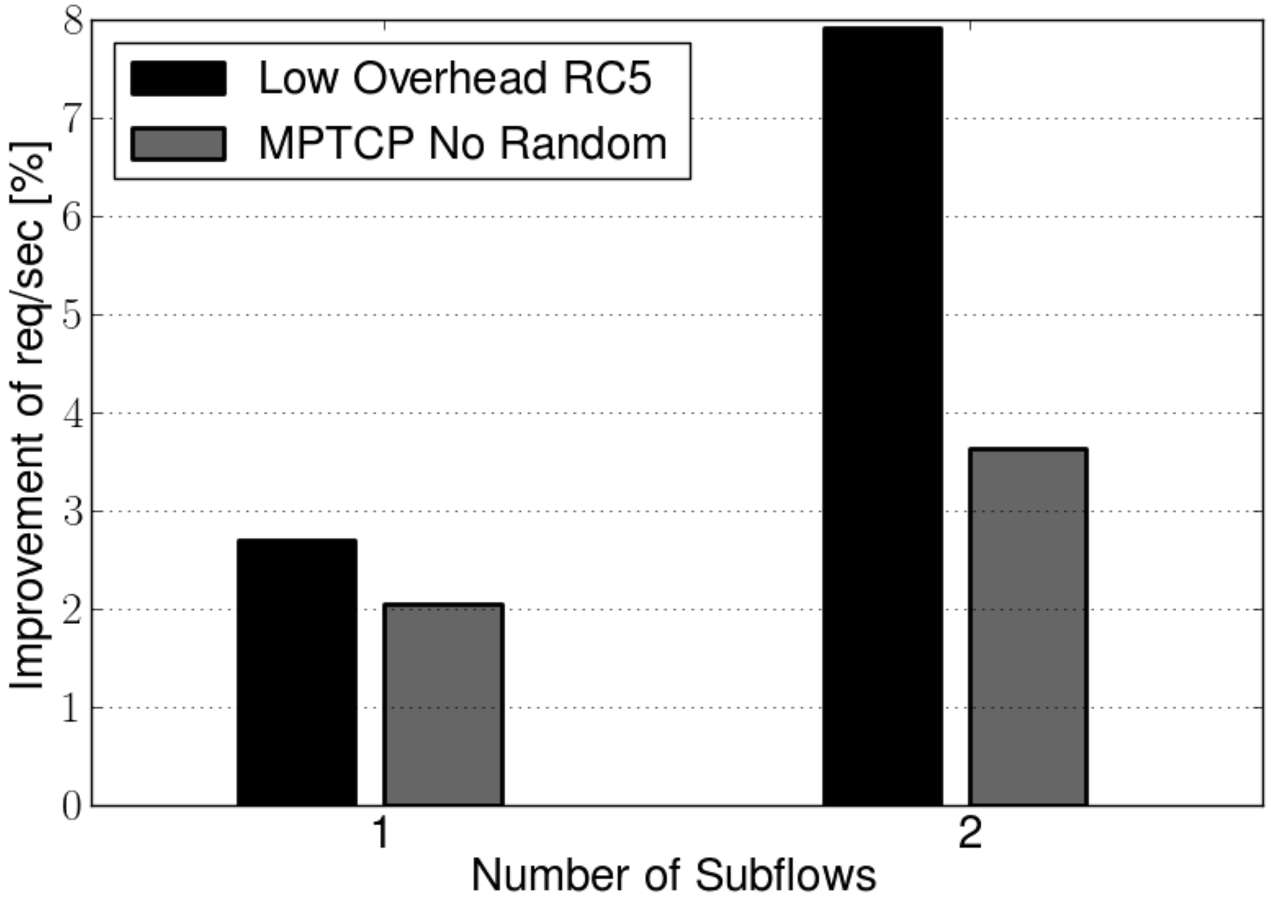


Impact on "real" traffic

- 250 simultaneous HTTP-requests
- File-size: 1KB
- Increasing number of MPTCP-subflows

- Measuring Requests/Second
- Baseline: Regular MPTCP

Impact on "real" traffic



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Securing the MultiPath TCP handshake with external keys

Motivation

- MPTCP v0 sends the keys in clear
  - Attacker who sees the initial handshake can hijack an MPTCP session
  - Integrate application-level security into MPTCP to benefit from the app-security

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Goals:

- Do not send MPTCP's key in clear
- Application-level protocols already do negotiate a key (cfr. SSL)

  We should use these keys!

- Extend the socket-API to allow keys from the application

SSL initial handshake

setsockopt(MPTCP_ENABLE_APP_KEY)

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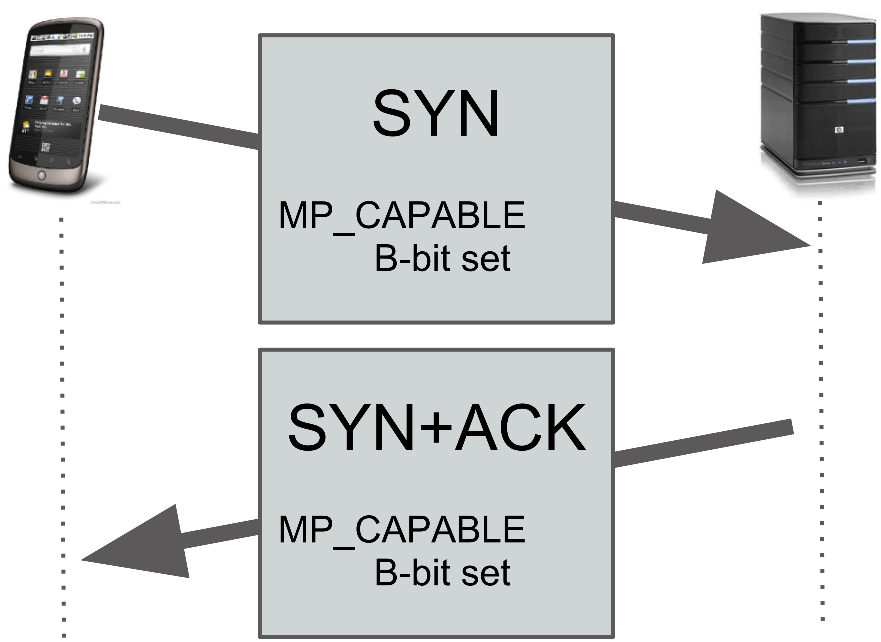
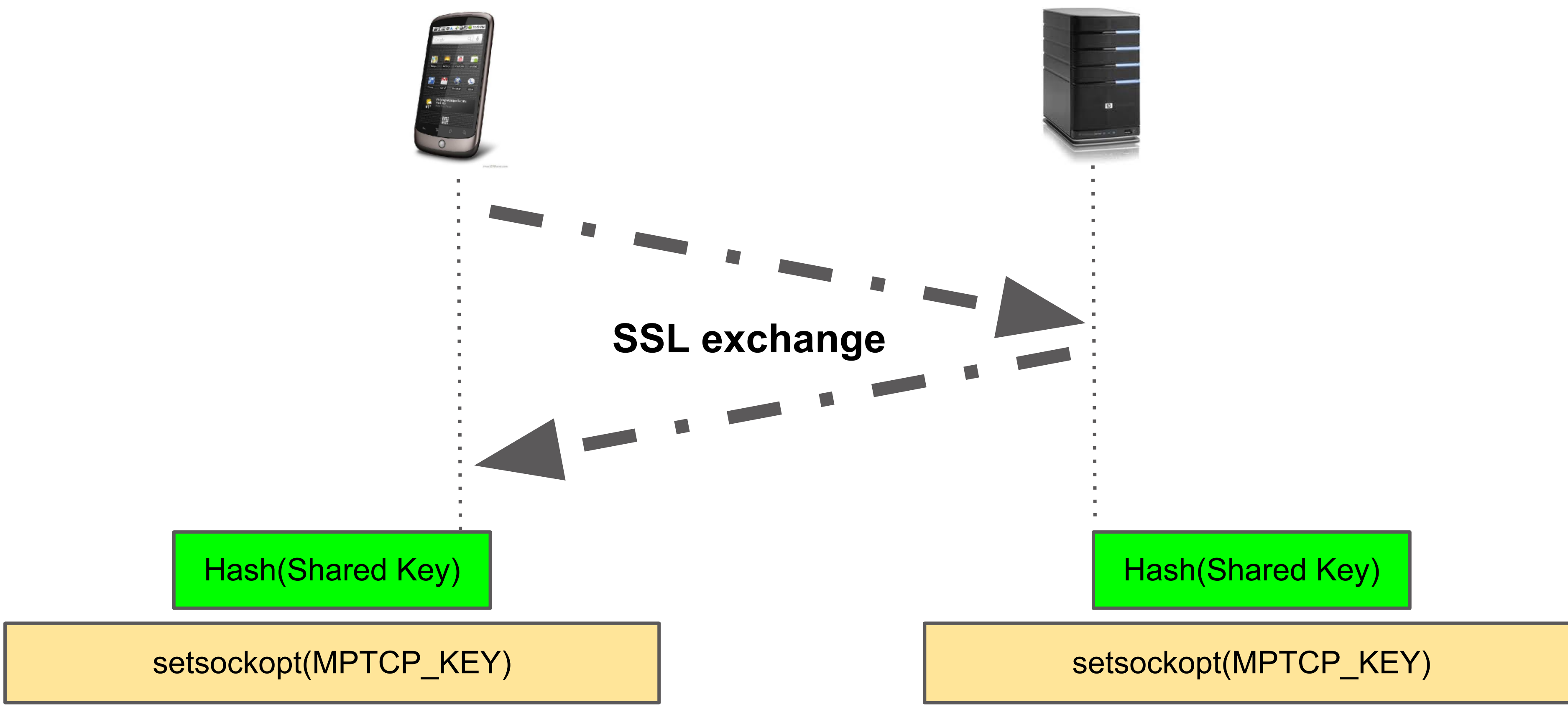
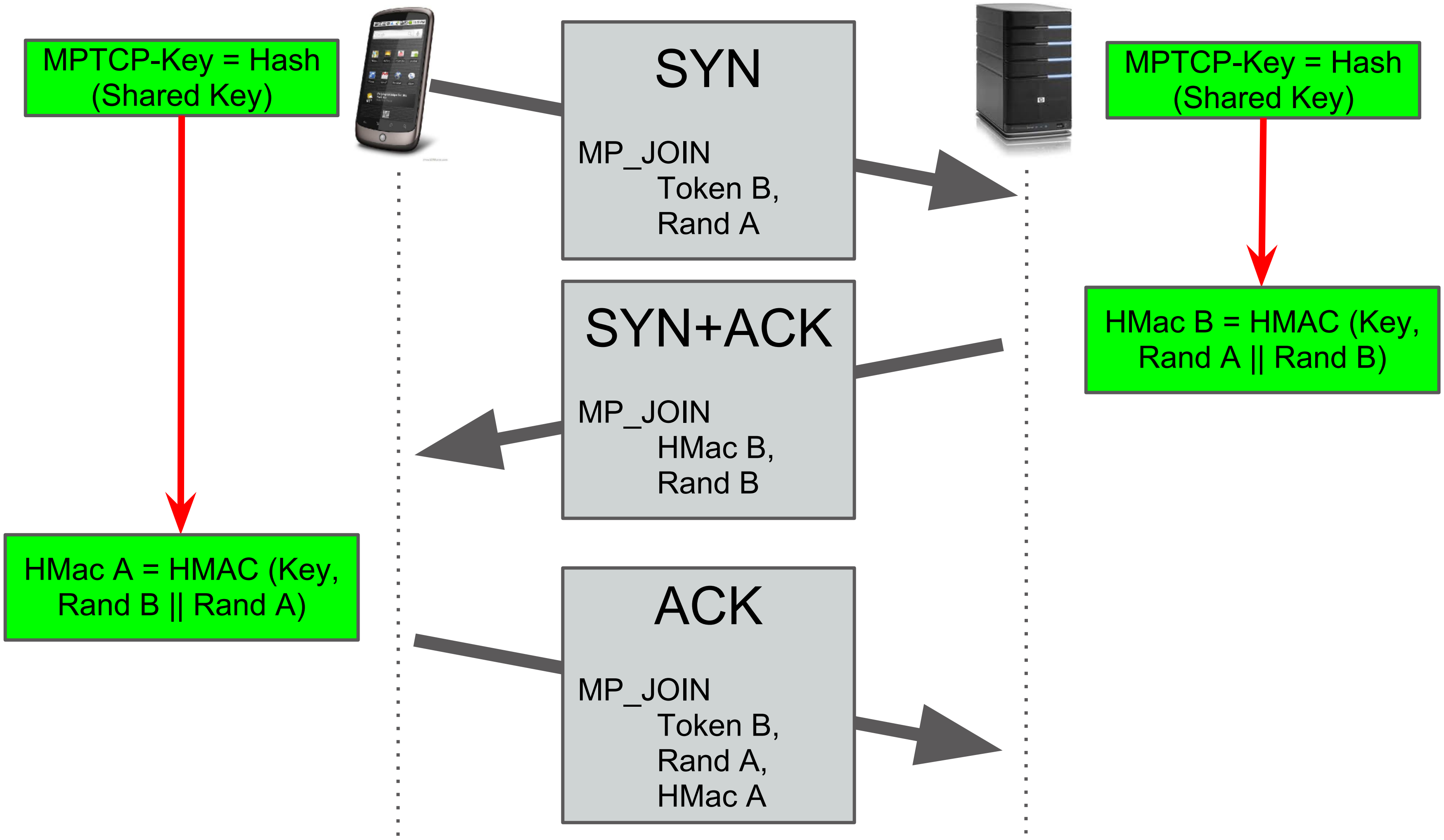


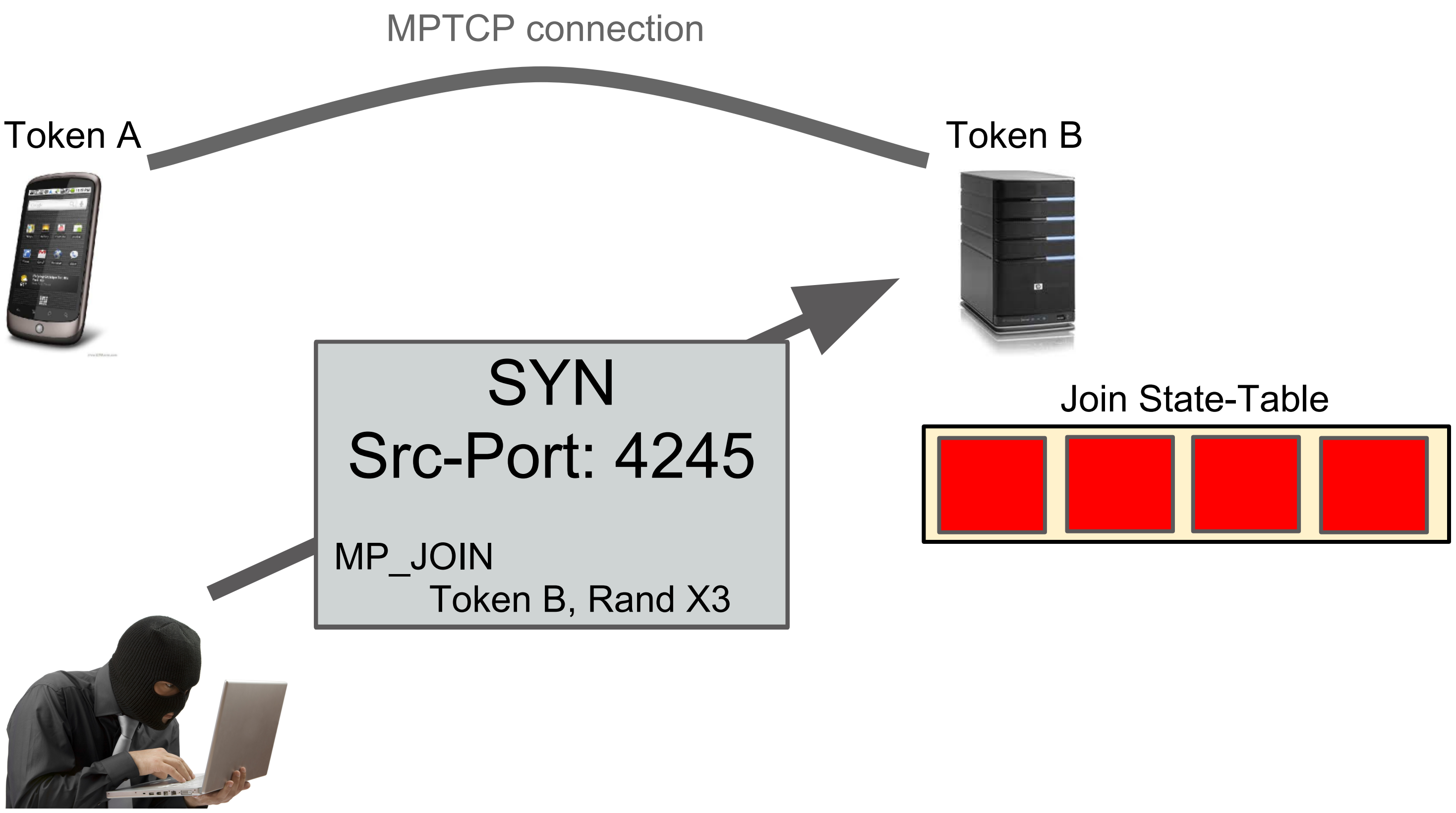
SSL initial handshake



SSL additional subflow



JOIN-flooding Attack



Stateless JOIN-handling

- Prevents JOIN-flooding attacks
- Based on the mechanism of TCP SYN-Cookies

Stateless JOIN

Possible thanks to the modified JOIN-format:

MP_JOIN
HMAC - truncated to 128-bits
Random A
Token B

Server must generate his random number in a verifiable fashion:

Rand B = Hash(5-tuple + secret)

Conclusion

MPTCP low overhead

- Performance improvement

MPTCP external keys

- Keys are no more exchanged in clear