Transparent TCP Timestamps

draft-scheffenegger-tcpm-timestamp-negotiation-01

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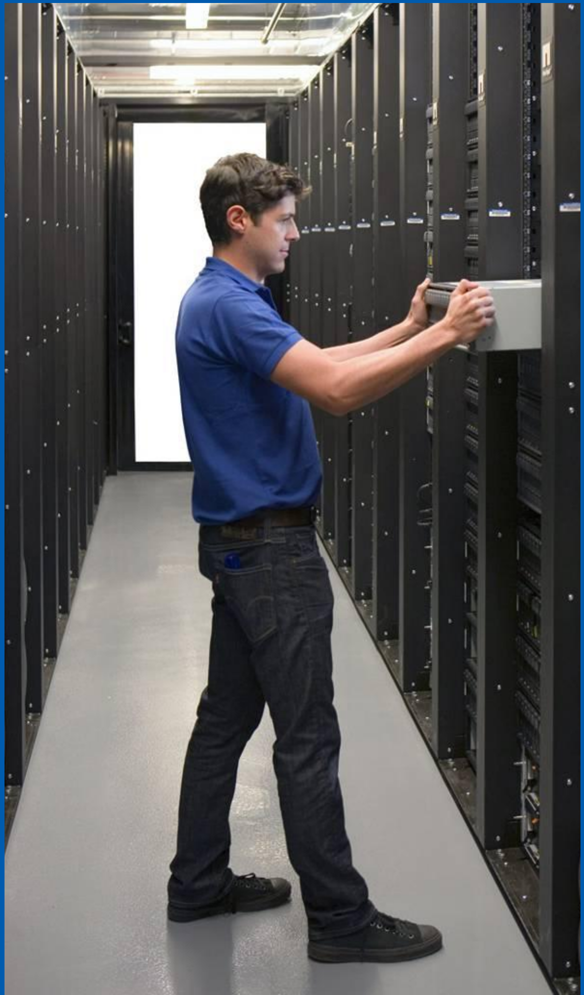


Agenda

Timestamps revisited

Problem statement

Use case examples

- One way delay (variation)
- TS+SACK synergy
  - Early spurious retransmission detection
  - Early lost retransmission detection
- TS integrity

Explicit signaling

TCP Timestamp Option

```
+-------+-------+---------------------+---------------------+
|Kind=8 |   10  |  TS Value (TSval)   |TS Echo Reply (TSecr)|
+-------+-------+---------------------+---------------------+
    1       1              4                     4
```

- Sender sets current timestamp in **TSval**
- Receiver echos the opaque **TSval** field in **TSecr** of <ACK> and provides an own timestamp TSval on sending of the acknowledgement
- **Round-Trip Time** (specified in RFC1323):

  RTT = curr_time() – TSecr

- **Unless reordering / loss is detected**
- Receiver: **PAWS** Test (imposes some restrictions)

Challenges

- TCP Timestamp Option does not ensure certain resolution

  “The timestamp value to be sent in TSval is to be obtained from a (virtual) clock that we call the "timestamp clock". Its values must be at least approximately proportional to real time, in order to measure actual RTT.”

- But in fact the receiver is just supposed to echo whatever is written in the TSval field
- Cases when more than one timestamp is available to echo (delayed ACK)
- Special treatment by receiver during loss / reorder events

Problem statement

- RFC1323 gives little guidance for timestamps
- New congestion control schemes (LEDBAT, TCP-RAPID, TCP-LP) require one-way delay (variation) as input
  - **One-Way-Delay estimate:** OWD = TSecr – TSval
- RFC1323 too restrictive to allow additional use
- Entire timestamps opaque to opposite host

Proposed Solution

Negotiate the sender and receiver TS capabilities

Use Case 1: OWD for Congestion Control

- One-way delay estimate

  C(t) = TSecr(t) - TSval(t)
- Increase of one-way delay is a sign for congestion
- Monitoring of one-way delay variation relative to an previous measurement

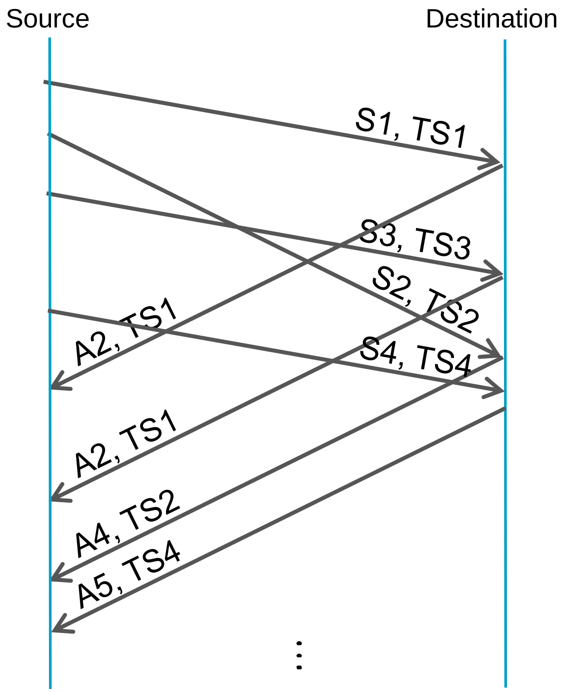
  V(t) = C(t) - C(t-n)

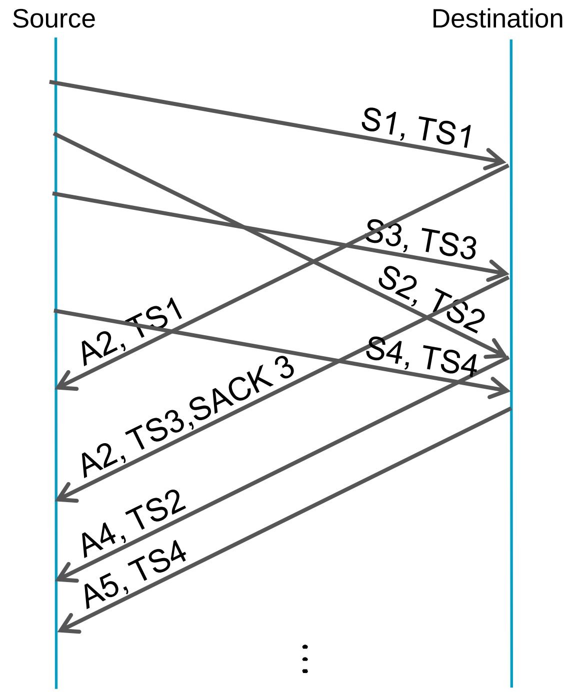
Problems

- remote timestamp clock rate is unknown
  - can be learnt if clock rate is related to a real clock
  - network conditions don‘t change
  - whole TSval field is used for a timestamp
- Delayed ACKs: OWD measurement includes delay outside the network

Use case 2: TS+SACK synergy

- Receivers echo TS of last in-sequence, unacked segment





Problems:

- Overly conservative if SACK is also enabled
- Delayed ACK behavior impacts sender RTTM calculation

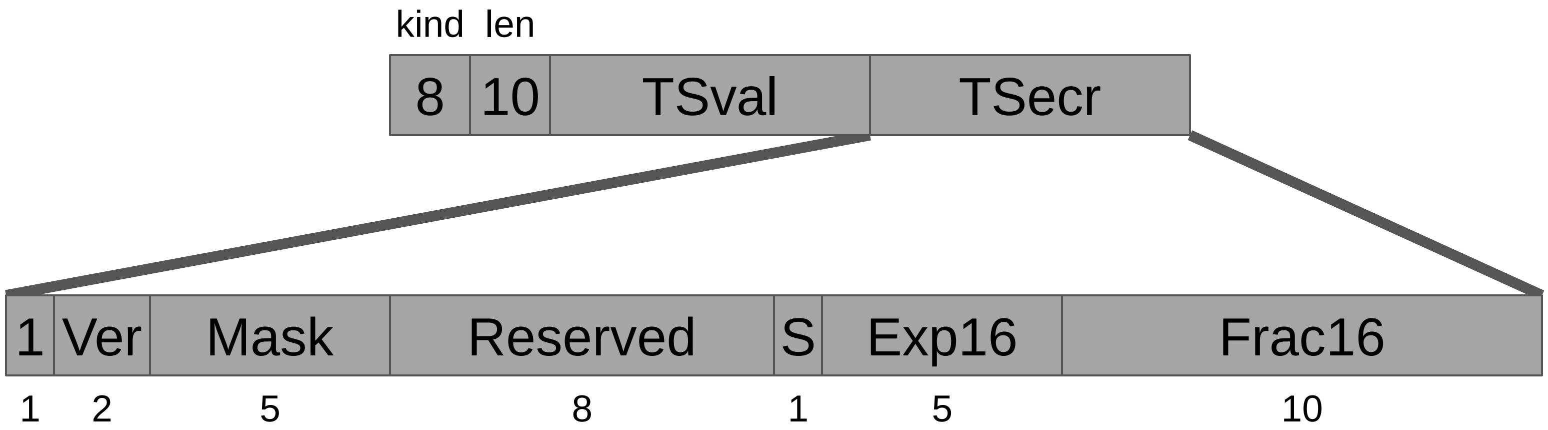
Use case 3: Timestamp integrity

- Use of transparent TS value for CC is creating incentive for malicious receivers to meddle with TSecr value (ie. early versions of Linux BIC, CUBIC)
- Current approach:
  - Use a limited number of LSB bits in TSval to (secure) fingerprint the value (limited by TSval constraints)
  - Sender tracks RTTM independent of TSecr (per-segment state kept)
- Proposed solution:
  - Announce the number of opaque LSB bits in TSval
  - Exclude opaque bits in receiver-side calculations (ie. PAWS)
  - breaking strict monoton increasing values
    - only required for transparent part of Tsval
    - better fingerprinting possible (less constraint)
  - No per-segment state on sender side

Explicit signaling of TS capabilities

- Use TSecr in <SYN> to signal local capabilities
  - Update to RFC1323
- In <SYN,ACK> need to **XOR** received TSval and local capabilities
  - Minimal state required in sender during handshake
  - Interaction with TCP Cookies / TCPCT
- Enable direct mirroring of TSval when SACK is also negotiated (supported by both)
- Allows further research opportunities

Proposed TS capabilities



- MSB: always 1 to signify TS capabilities field
  – enable direct echo of TSval if SACK is also enabled
- Ver(sion): must be 0
  – future use
- Reserved: must be 0
- Mask: # of LSBs for opaque use
  – secure hash
  – slow running TS clocks
- S, Exp16, Frac16: TS clock rate
  – range between ~16s ... 8ns (8ps with reduced precision)

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Thank you for your attention!

Questions?

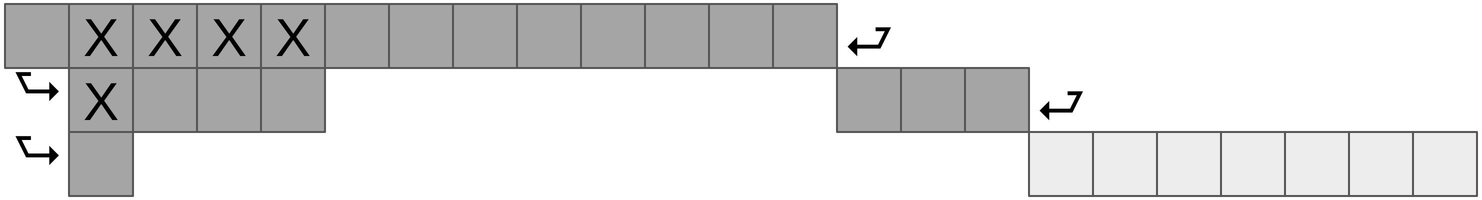
Backup Slides

Early spurious retransmission detection

- Based on TSecr aka Eifel detection (RFC3522)
- Requires different timestamp for retransmitted segment than original segment
  - Doesn‘t work if TS clock slower than ~RTT
  - Only works if first segment is delayed
- Senders using „slow“ TS clocks could use opaque masked least significant bits to differentiate retransmissions

Early lost retransmission detection

- SACK requires new segments to detect lost retransmissions
  - Unknown if SACKed segment is delayed original or retransmission



- Direct echo of TS would allow disambiguation