Transparent TCP Timestamps

draft-scheffenegger-tcpm-timestamp-negotiation-03

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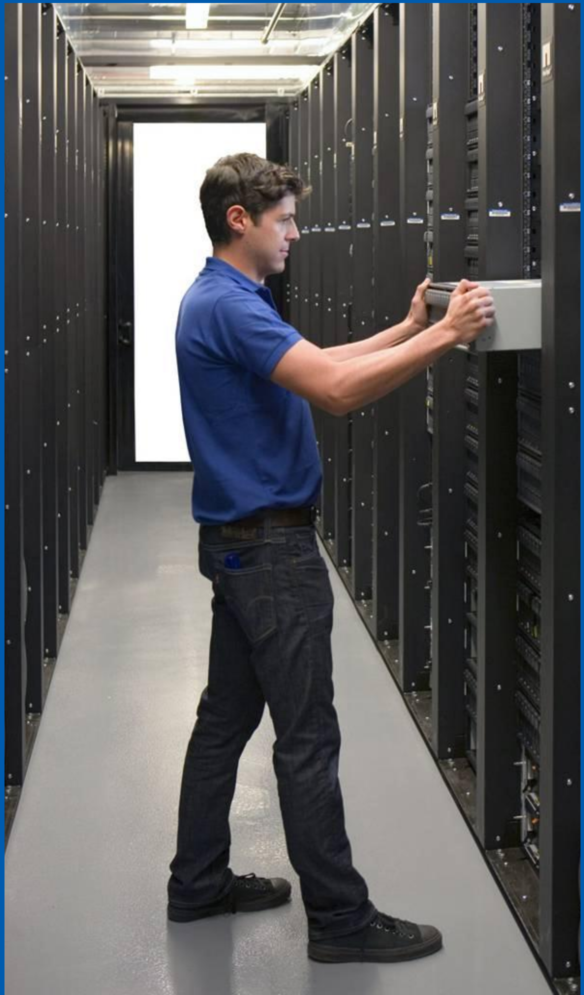


Agenda

Timestamp Echo on SYN
TCP RTO calculation
Changes since -02 draft

TCP Timestamp Echo on SYN

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

- Some senders set TSecr != 0 on [SYN]
- RFC1323 states, a sender SHOULD set TSecr to zero, if no valid timestamp is known
- Investigated this issue against Waikato Dataset (IP Header trace) covering 1. Jan. 2005 – 17. Aug. 2005

TCP Timestamp Echo on SYN

- 1 016 245 629 [SYN] packets in trace
  - 878 264 323 (86.4%) unique [SYN]

- 3 634 [SYN] && TSecr != 0 (3.6 ppm)
  - 3 613 (99.4%) unique
  - 586 unique host pairs
  - 457 unique senders
  - 1 953 unique TSecr values

TCP Timestamp Echo on SYN

- Majority of TSecr values sent on [SYN] is seen in at least one preceeding packet – always from a different TCP session between the two hosts
- 1 783 (of 1 953; 91.3%) [SYN] && TSecr != 0 preceeded by
  - 1 191 [FIN, ACK]
  - 5 [FIN, PSH, ACK]
  - 573 [ACK]
  - 13 [PSH, ACK]
- Remaining 171 [SYN] have no packet from opposite side (unidirectional flow captured)

TCP Timestamp Echo on SYN

- passive OS signature on [SYN] && TSecr != 0

- MSS SACK TS NOP WS 3520 (96.86%)
- NOP NOP TS 56 (1.54%)
- MSS NOP WS NOP NOP TS 22 (0.61%)
- MSS NOP NOP TS 16 (0.44%)
- MSS NOP NOP TS WS 9 (0.25%)
- MSS SACK TS 8 (0.22%)
- MSS NOP WS NOP NOP TS NOP 1 (0.03%)
- MSS NOP WS NOP NOP TS NOP NOP 1 (0.03%)
- MSS NOP WS NOP NOP TS NOP WS 1 (0.03%)

TCP Timestamp Echo on SYN

- passive OS signature on [SYN] && TSecr != 0
  - p0f fails to identify senders (stringent heuristics)
  - SinFP uses “relaxed” heuristics

```
   1 IPv4: HEURISTIC0/P2: BSD: Darwin: 8.6.0
   2 IPv4: BH0FH0WH1OH0MH1/P2: BSD: FreeBSD: 4.4
   4 IPv4: HEURISTIC0/P2: BSD: FreeBSD: 4.10
  12 IPv4: BH0FH0WH0OH0MH1/P2: BSD: Darwin: 8.6.0

 106 IPv4: unknown

   4 IPv4: BH0FH0WH1OH0MH1/P2: GNU/Linux: Linux: 2.2.x
   5 IPv4: BH0FH0WH0OH1MH0/P2: GNU/Linux: Linux: 2.4.x
   5 IPv4: BH0FH0WH1OH0MH1/P2: GNU/Linux: Linux: 2.4.x
   6 IPv4: BH0FH0WH1OH0MH0/P2: GNU/Linux: Linux: 2.4.x
  49 IPv4: BH0FH0WH0OH0MH1/P2: GNU/Linux: Linux: 2.6.x
 217 IPv4: HEURISTIC0/P2: GNU/Linux: Linux: 2.6.x
 409 IPv4: BH0FH0WH0OH0MH1/P2: GNU/Linux: Linux: 2.4.x
2814 IPv4: HEURISTIC0/P2: GNU/Linux: Linux: 2.4.x
```

TCP Timestamp Echo on SYN

- 3509 sessions initiated from Linux (96.5%)
- 106 sessions initiated from unknown Host OS
- 19 sessions identified as BSD derived

- Known feature of Linux, when either **sysctl_tcp_tw_reuse** or **sysctl_tcp_tw_recycle** are enabled. This is used to shorten the TimeWait interval before sockets may be reused between two hosts.
- Observed TSecr values are not random, but preceeded in all observable instances by identical TSval (in a different TCP session), clearly indicating some kind of per-host timestamp cache.

TCP Timestamp Echo on SYN

- As timestamp values represented uptime in some way, values are not random distributed. Would lead to **reduced** false positive negotiation with current proposal.

- Most TSecr values are seen in [FIN] segments (61.3%). As [FIN] packets are closing a TCP session, small semantic change to send TSval = 0 on [FIN] would further alleviate this issue. As with timestamp offset randomization (draft-gont-tcpm-tcp-timestamps), may break linux feature - revert to regular timewait session closure.

TCP RTO calculation

Defined in RFC6298:

$RTO = sRTT + \max(G, k * RTTvar)$; $k = 4$

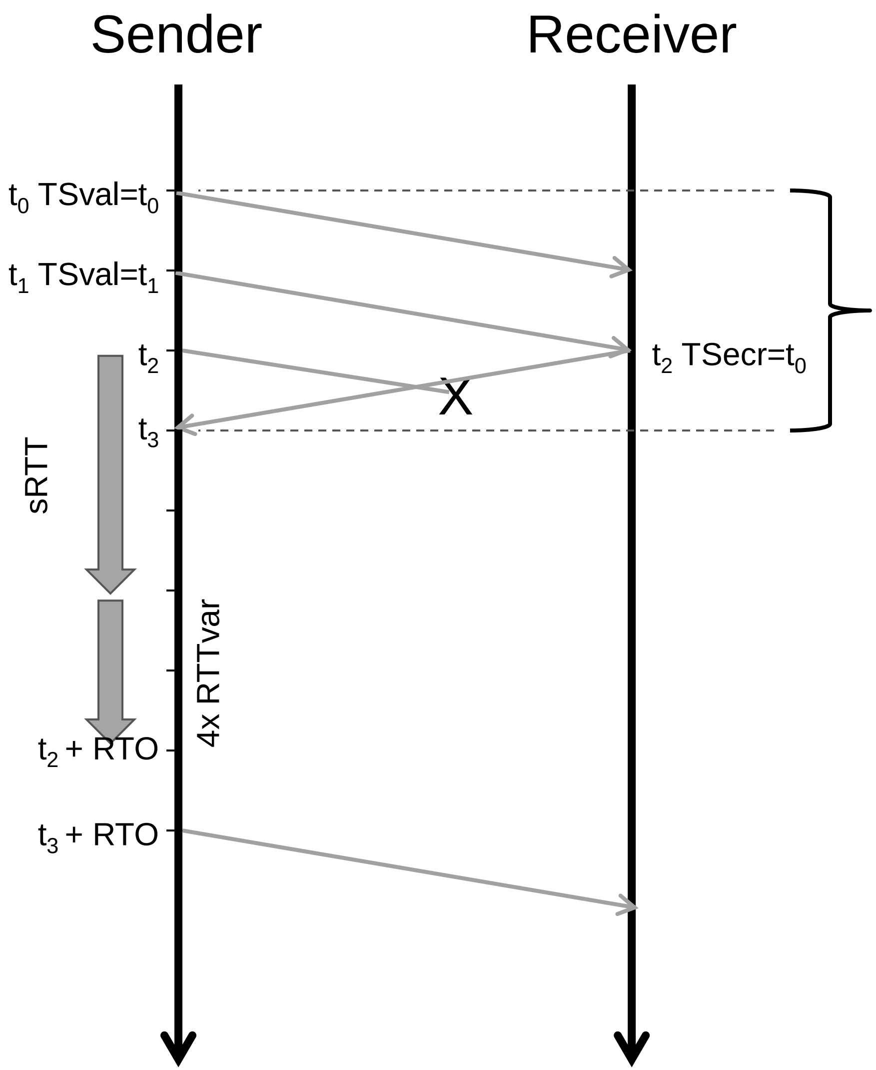
$RTTvar = (1-\beta) * RTTvar + \beta * | sRTT – R´ |$; $\beta = 1/4$

$sRTT = (1-\alpha) * sRTT + \alpha * R´$; $\alpha = 1/8$

- The sampled RTT (R´) no longer includes delACK processing variability
- RTTvar will become smaller
- RTT represents primarily represents network delay

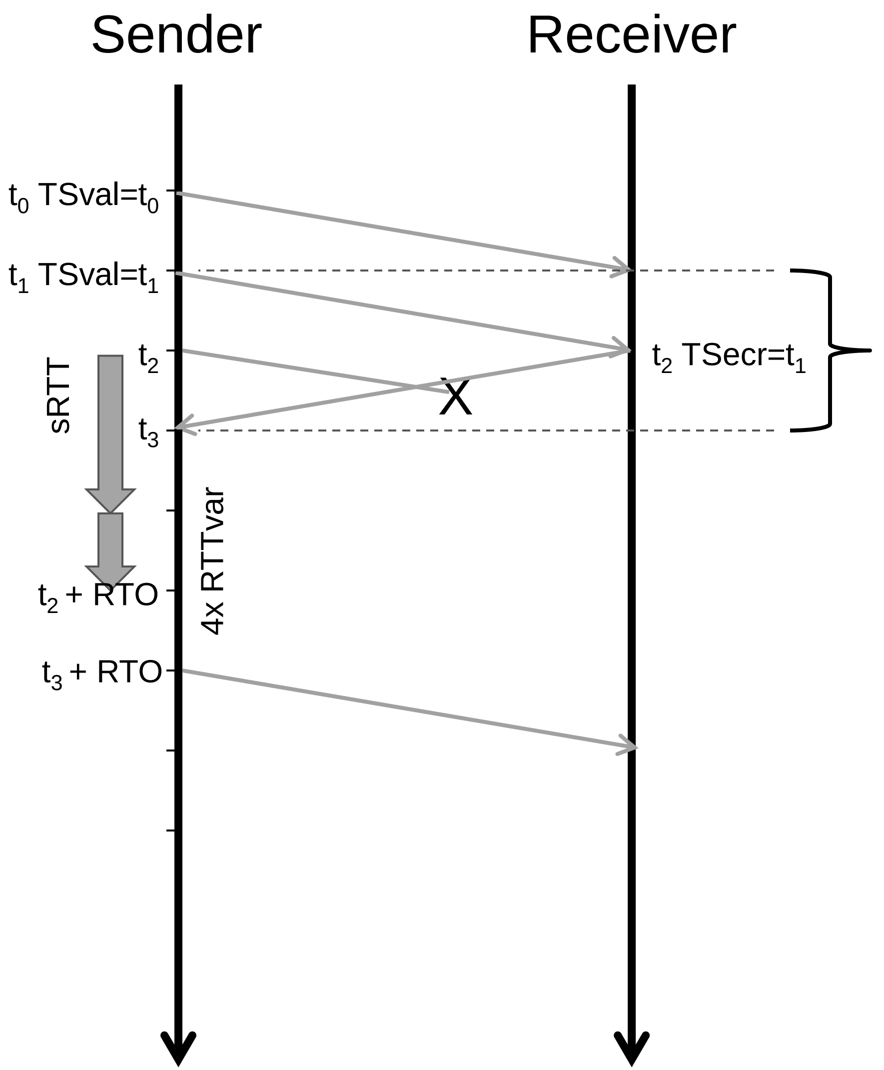
- One RTT extra delay before RTO expires added by restarting the RTO timer for each seen ACK

TCP RTO calculation – RFC1323 / 6298



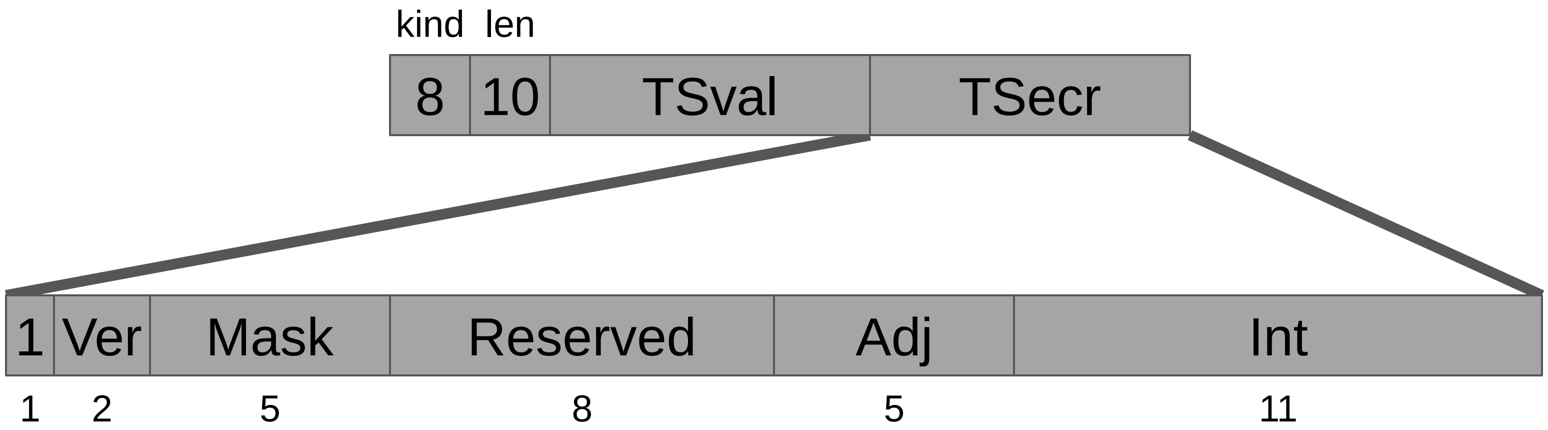
- RTT includes delayed ACK delay
- Retransmission permitted after t_2 + RTO
- Typically at t_3 + RTO

TCP RTO calculation – new semantic



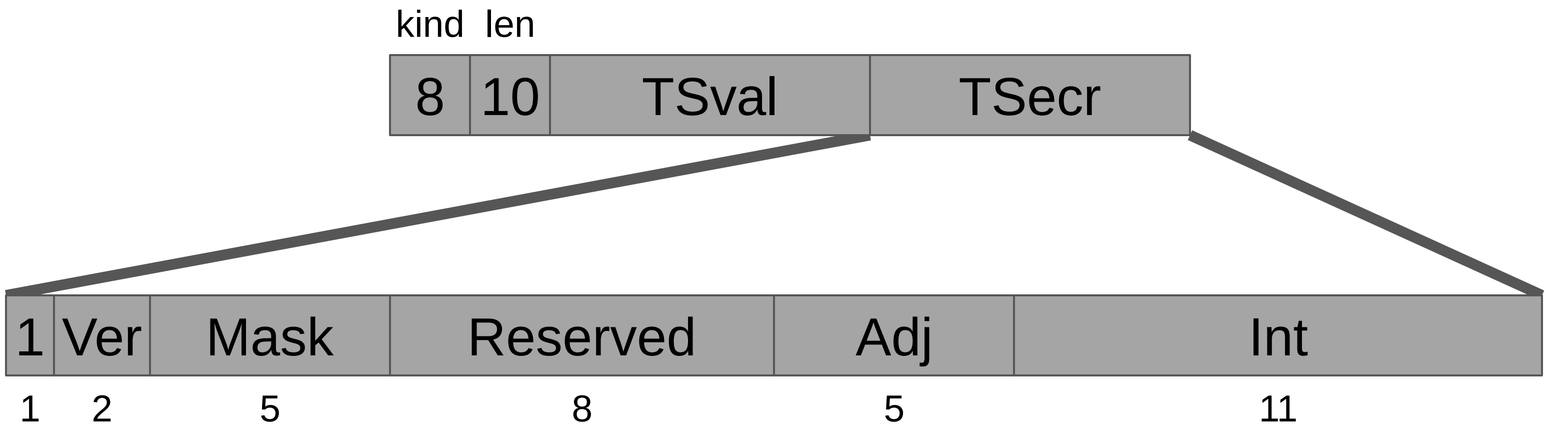
- RTT excludes delayed ACK delay
- Retransmission permitted after t_2 + RTO – too fast?
- Explicitly stipulate max(t_2,t_3) + RTO (last received ACK + RTO)?

Major Change since -01



- Redefined lower 16 bits
- No longer “alike” IEEE 754 floating point representation
  - No “special case” handling when evaluating Interval
  - Interval now signaled as scale/value pair like TCP window scaling
  - Conceptually, the Interval is a large integer, right-shifted “Adj” times to fit into “Int” with the most significant bit
  - Derived calculations stay identical (i.e. OWD) as with previous draft
  - Allows for implicit “clock source” quality signaling by leading zero bits in “Int”

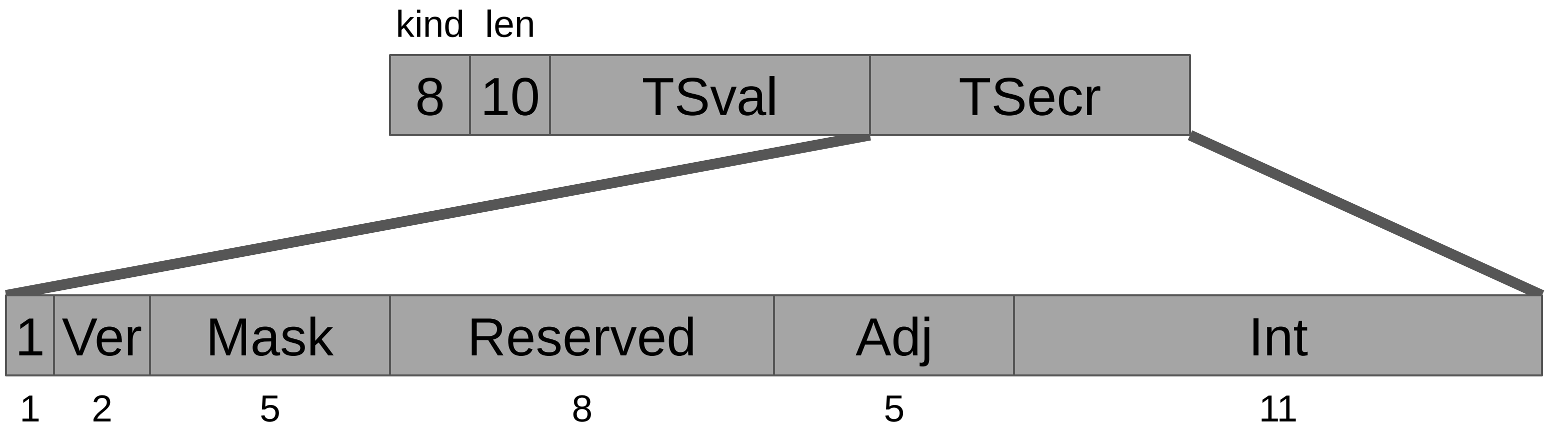
Major Change since -01



- Definition: 1 sec = 0x40 0000 0000 (39 bit length)
  - Right shifted 28 times, to fit into 11 bit
  - Int = 0x400, Adj=28

  Alternative representations:
  - Int=0x200, Adj=29;
  - Int=0x100, Adj=30;
  - Int=0x080, Adj=31
- Allows for clock tick intervals between ~16 sec and a few nanoseconds, each with up to 10 alternative representations (clock source quality levels)

Major Change since -01



- Expected to be (compile time) static value for current slow running TCP clock sources (100 µs or longer intervals)

Transparent TCP Timestamps

Questions:

- semantic change to timestamp to have TSval set to zero on [FIN]?

- Changed signaling of Interval (simple shift vs. IEEE-754 like float) less problematic?

- Ready for adoption as a WG Item?

Thank you!