TCP Friendly Rate Control (TFRC): Protocol Specification RFC3448bis

draft-ietf-dccp-rfc3448bis-02.txt

S. Floyd, M. Handley, J. Padhye, and J. Widmer

July 2007,

DCCP Working Group

Reported in previous IETFs:

- Changes from RFC 3448, in draft-ietf-dccp-rfc3448bis-00.txt
- Changes in draft-ietf-dccp-rfc3448bis-01.txt
- Reported for me in March 2007:
  - Changes in draft-ietf-dccp-rfc3448bis-02b.txt, (never submitted).
  - A slide on “things that could be done”.

Changes from draft-ietf-dccp-rfc3448bis-01.txt:

- The initial feedback packet after an idle period.
  - The mechanism for dealing with this has changed.
- Response to idle and data-limited periods.
  - The sender is not limited by the receive rate if the sender has been idle or data-limited for an entire feedback interval.
- Use of unused send credits:
  - The sender may keep unused sent credits up to one RTT.
- Many clarifications and some small changes, listed in the draft.

The initial feedback packet after an idle period:

- The mechanism for dealing with this has changed.
- The new mechanism:
  - Keep X_recv_set, with X_recv from the last two RTTs.
  - If (the entire interval covered by the feedback packet was a data-limited interval)
    - Replace X_recv_set contents by Infinity;
- Older mechanisms in older revisions:
  - If (not the first feedback packet, and not the first feedback packet after a nofeedback timer)
  - If (feedback packet reports Limited Receive Rate or sender has been data-limited over period covered by the last feedback packet)

Response to Idle and Data-Limited Periods:

Protocol	Long idle periods	Long data-limited periods
Standard TCP:	Window -> initial.	No change in window.
TCP with CWV:	Halve window (not below initial cwnd).	Reduce window half way to used window.
Standard TFRC:	Halve rate (not below 1 pkt/64 sec). One RTT after sending pkt, rate is limited by X_recv.	Rate limited to twice receive rate.
Revised TFRC:	Halve rate (not below initial rate).	Rate not limited to twice receive rate.

Response to Idle Periods:

- The initial version of RFC3448bis:
  - After a long idle period, the sender doesn't reduce the allowed rate below the initial rate.
  - From RFC4342.

- This is still true.
  - But the mechanisms have changed.

Response to Idle Periods:

- Current pseudocode:
  - If (X_recv < recover_rate, and sender has been idle ever since nofeedback timer was set)
    - Don't use X_recv to reduce sending rate.
- Initial versions of the draft (-00 and -01):
  - The code for dealing with idle or data-limited periods was in response to feedback packets, not in response to the nofeedback timer.
  - If (sender has been idle or data-limited)
- Later versions of the draft (-02c):
  - The code for dealing with idle or data-limited periods was moved to be in response to the nofeedback timer (as it is now).
  - If (X_recv < 4 packets per round-trip time, and sender has been idle since nofeedback timer was set)
    - Don't use X_recv to reduce sending rate.

Response to Data-Limited Periods:

- This draft:
  - Follow Standard TCP, and don't be limited by receive rate during data-limited periods.
  - If (the entire interval covered by the feedback packet was a data-limited interval) {

        Replace X_recv_set contents by Infinity;

- Earlier -00, -01, and -02c revisions:
  - During idle or data-limited periods, do be limited by receive rate, but not below the initial sending rate.
  - If (sender has been idle or data-limited within last two round-trip times)

        min_rate = max(2*X_recv, W_init/R);

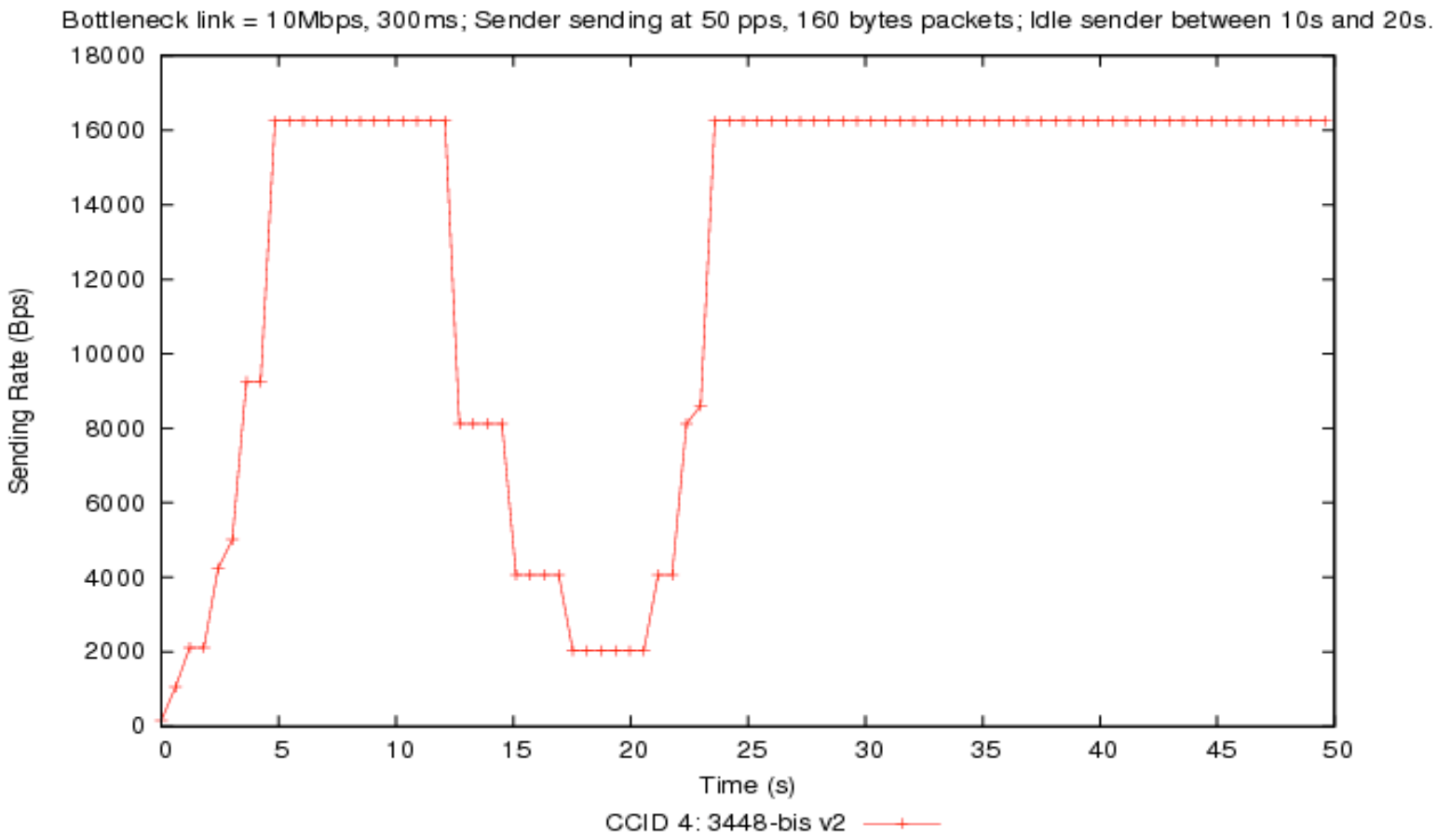
Unused send credits:

- Specified that the sender may maintain unused sent credits up to one RTT.
  - This gives behavior similar to TCP.
  - A TFRC implementation MAY limit bursts to less than one RTT, if desired.

- This was not explicitly addressed in RFC 3448, or in earlier revisions of this draft.

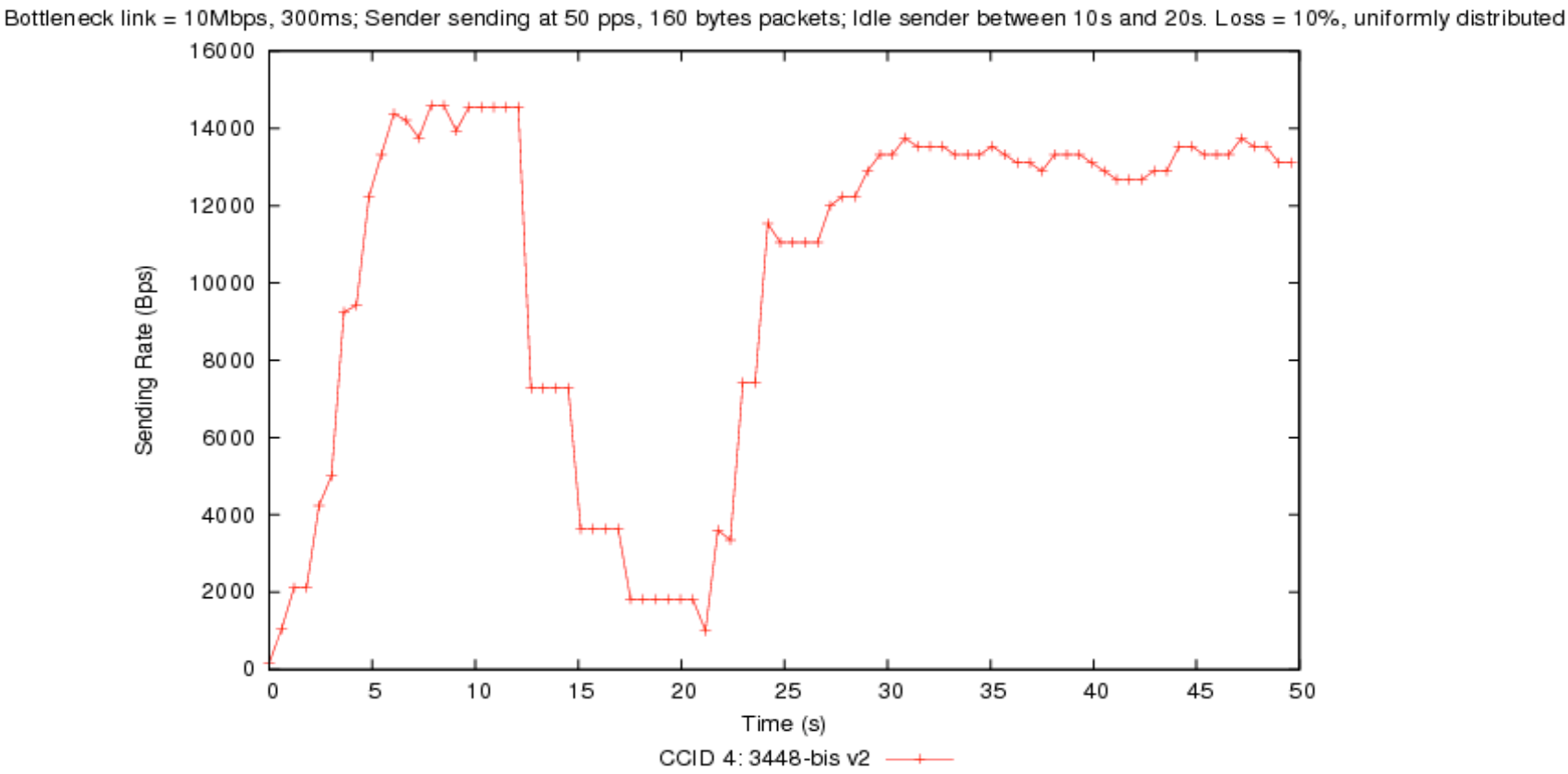
Basic Simulation Results - I

- Long idle period behaviour.
- Sending rate never reduces below recover_rate
- Low receiver rate after idle period and initial startup rectified.



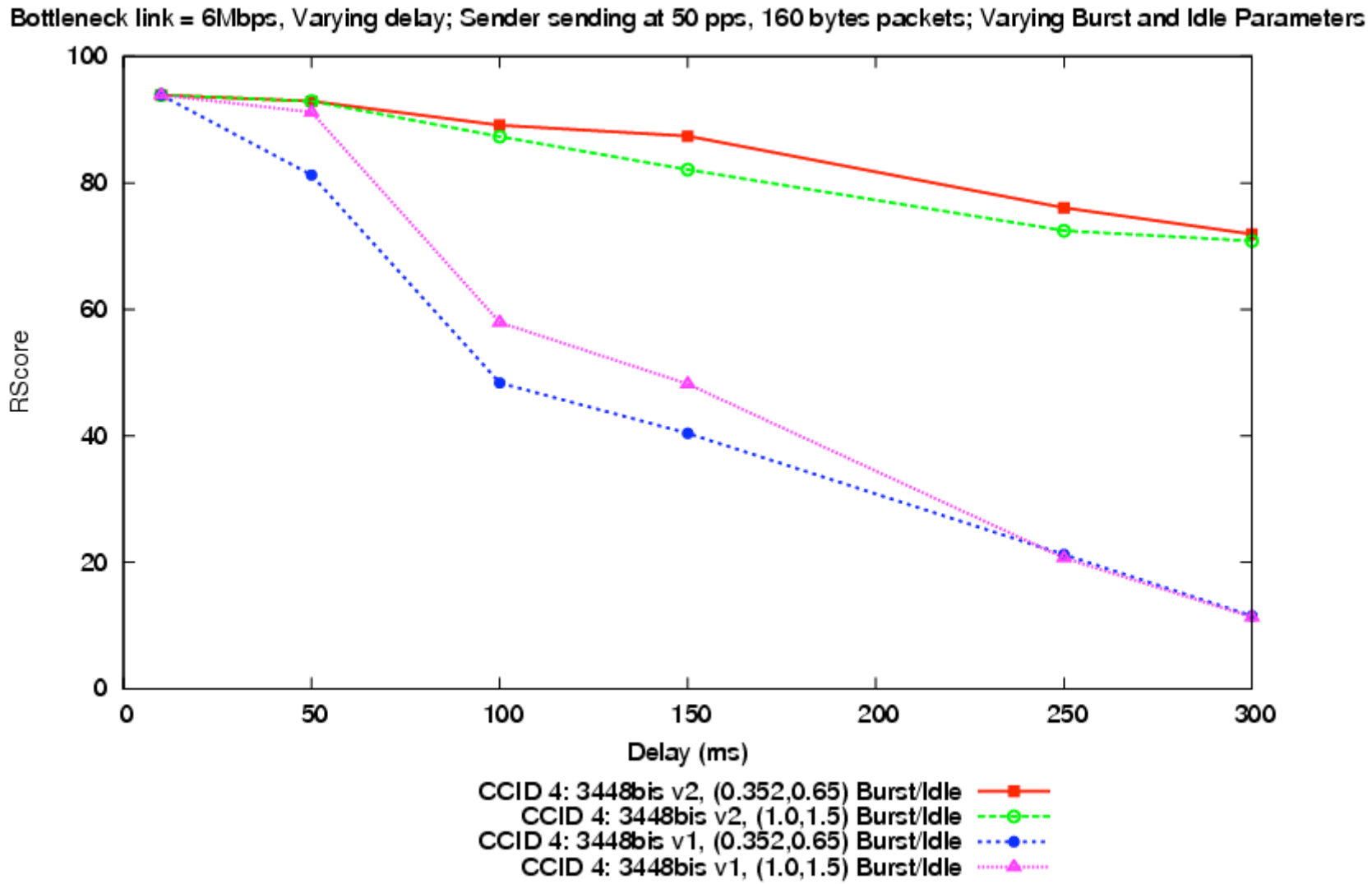
Basic Simulation Results - II

- Long idle period behaviour.
- With loss, the sending rate is limited by the throughput equation after the idle period.



Basic Simulation Results - III

- **Datalimited behaviour**
- Low receiver rate problem rectified.
- 3448-bis now good for bursty traffic : gives high perceived quality.



Change #1 to make:

- For reducing sending rate during idle periods during initial slow-start.
- Old:

Else if (X_recv < recover_rate, and
sender has been idle ever since nofeedback timer was set)
Timer_limit is not updated;

- New:

Else if (((p>0 && X_recv < recover_rate) or
(p==0 && X < 2 * recover_rate)), and
sender has been idle ever since nofeedback timer was set)
Timer_limit is not updated;

Problem reported by Arjuna. (Fix not yet tested.)

Change #2 to make:

- When datalimited and p = 0, the sender still doubles the allowed sending rate after each feedback packet.
- Old code, for when (p==0):

```
Else if (t_now - tld >= R)    // initial slow-start
        X = max(min(2*X, recv_limit), initial_rate);
        tld = t_now;
```

- New code, for when (p==0):

```
Else if (t_now - tld >= R) and
   (sender was not data-limited over entire feedback interval)
        // initial slow-start
        X = max(min(2*X, recv_limit), initial_rate);
        tld = t_now;
```

Problem reported by Arjuna. (Fix not yet tested.)

Future work (in a separate document):

- "Future work could explore alternate responses to using the receive rate during a data-limited period."
  - E.g., more like TCP with Congestion Window Validation.
- At a minimum, we could have more limits on *increasing* the allowed sending rate during a data-limited period.