RTT-Based Congestion Control for the Internet of Things

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Reference

- **Author**
  1. Emilio Ancillotti
  2. Simone Bolettieri
  3. Raffaele Bruno
- International Conference on Wired/Wireless Internet Communication (WWIC), Boston, United States
- August 23, 2019
- **Link to paper:** *RTT-based congestion control for the Internet of Things*

Motivation

- The design of scalable and reliable transport protocols for IoT environments
- Increasing the packet delivery ratios in presence of congestion-unaware traffic
- Ensuring a significant improvement of fairness

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Overview

- TCP has been primarily designed to efficiently deliver a large bulk of data over a long-lived connections without strict latency requirements.
- However, IOT systems often employ low-energy communication technology and request low network delays.
- In this work, an alternative approach for congestion control has been investigated that employs measurements of round trip times to infer network state and to determine the flow rate that would prevent network congestion.

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Algorithm : Pseudo code

Algorithm 1 RTT-CoAP CONGESTION CONTROL

function UPDATERATE($\mathbf{S}$, $SRTT_L$, $SRTT_S$, $RTTVAR_L$,μ)

    if ($\mathbf{S} \in \mathbf{LC}$) **then**
        $R = R + \text{COMPRATE}(R, SRTT_L, fast)$;
    else if ($\mathbf{S} \in \mathbf{NO}$) **AND** ($\mu < L_{high}$) **then**
        $R = R + \text{COMPRATE}(R, SRTT_L, slow)$;
    else if ($\mathbf{S} \in \mathbf{MV}$) **AND** ($\mu \geq L_{low}$) **then**
        $R = R - \text{COMPRATE}(R, SRTT_L, slow)$;
    else if ($\mathbf{S} \in \mathbf{HV}$) **AND** ($\mu \geq L_{low}$) **then**
        $R = R - \text{COMPRATE}(R, SRTT_L, fast)$;
    end if
end function

function COMPRATE(R, $SRTT_L$, $speed$)

    if ($speed = fast$) **then**
        $\omega = 0.2$
    else if ($speed = slow$) **then**
        $\omega = 0.05$
    end if

    $R_b = \frac{1}{SRTT_L}$
    if ($R < R_b$) **then**
        $\delta = \omega \times (R_b - R)$
    else
        $\delta = \omega \times R_b$
    end if
    return δ
end function

Algorithm : Variables

$$SRTT_S = \alpha_S r + (1 - \alpha_S) \times SRTT_S$$
$$SRTT_L = \alpha_L r + (1 - \alpha_L) \times SRTT_S$$
$$RTTVAR_L = \beta_L |SRTT_L - r| + (1 - \beta_L) \times RTTVAR_L$$

Here, $SRTT_S$ and $SRTT_L$ are obtained by applying exponential smoothing to RTT and $RTTVAR_L$ is smoothed RTT variance. α_S, α_L and β_L are smoothing factors.

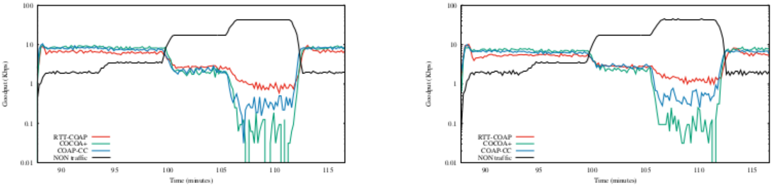
Algorithm : Decision Boundary

$T(\gamma) = SRTT_L + RTTVAR_L X \gamma$

- (**LC**): $SRTT_S < T(1)$ (Low Congestion)
- (**NO**): $T(-1) \leq SRTT_S < T(1)$ (Normal Operating Point)
- (**MV**): $T(1) \leq SRTT_S < T(2)$ (Medium Variability)
- (**HV**): $SRTT_S \geq T(2)$ (High Variability)

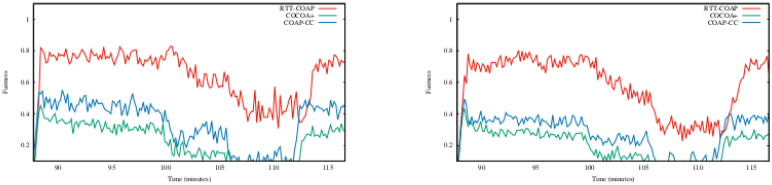
Algorithm : Decision Boundary

1. $S \in LC$ and there is a *fast increase* of sending rate
2. $S \in NO$ and there is a *slow increase* of sending rate
3. $S \in MV$ and there is a *slow decrease* of sending rate
4. $S \in HV$ and there is a *fast decrease* of sending rate



(a) $n = 57$ (b) $n = 112$

Fig. 1. Goodput under mixed traffic scenario for two network deployments.



(a) $n = 57$ (b) $n = 112$

Fig. 2. Fairness under mixed traffic scenario for two network deployments.

Thank You