Update on NADA

draft-ietf-rmcat-nada-01

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Outline

• Update on draft and algorithm
• Update on evaluation results in NS2 (wired test case and AQMs)
• Additional test results:
  • NADA evaluation in NS3
  • Impact of rate update parameters
• Open Issues and next steps
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Overview of Changes in Draft -01

• Algorithm change: revised equation for gradual rate update (more details to follow)

• Structure change:
  • NADA congestion control algorithm in Sec. 4
  • Recommended practical implementation in Sec. 5
  • All discussions on open issues in Sec. 7

• More clear descriptions:
  • List of all variables and parameters in Sec. 4.1
  • Receiver procedure in Sec 5.1: 15-tap minimum filter for queuing delay estimation
  • Rate shaping behavior in Sec 5.2 as recommended (optional) feature
List of Notations for Gradual Rate Update

Input/Algorithm Parameters:

- **PRIO**: weight of priority of the flow
- **RMAX**: maximum rate of the flow
- **RMIN**: minimum rate of the flow
- **XREF**: reference value of aggregated congestion signal
- \(\kappa, \eta\): scaling parameters for gradual rate update calculation
- \(\tau\): upper bound of RTT in gradual rate update calculation

Variables:

- \(r_n\): reference rate based on network congestion control
- \(x_n\): reported aggregated congestion level
- \(x_{prev}\): previous value of aggregated congestion level
- \(\delta\): observed interval between current and previous feedback report

See full list of notations in the updated draft
Revised Equation for Gradual Rate Update

Calculate offset and change in aggregate congestion signal $x_n$:

$$x_{offset} = x_n - PRIO \times XREF \times \frac{RMAX}{r_n}$$

$$x_{diff} = x_n - x_{prev}$$

Update rate in proportion to both offset and change in $x_n$:

$$r_n = r_n - \kappa \frac{\delta x_{offset}}{\tau} r_n - \kappa \eta \frac{x_{diff}}{\tau} r_n$$
Tradeoff Between Rate and Queuing Delay at Equilibrium

Old Version:

\[ x_{eq} = PRIO \times XREF \times \frac{RMAX - RMIN}{r_{eq} - RMIN} \]

New Version:

\[ x_{eq} = PRIO \times XREF \times \frac{RMAX}{r_{eq}} \]
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• Open Issues and next steps
Updated Eval Results on RMCAT Test Cases in NS2

• 5.1 Variable Available Capacity with Single RMCAT flow
  • 5.1.a: Low Available Capacity with UDP Background Traffic
• 5.2. Variable Available Capacity with Multiple RMCAT flows
• 5.3. Congested Feedback Link with Bi-directional RMCAT flows
  • 5.3.a: Congested Feedback Link with TCP Flow along Backward Path
• 5.4. Competing Flows with Same RMCAT Algorithm
• 5.5. Round Trip Time Fairness
• 5.6. RMCAT Flow Competing with a Long TCP Flow
• 5.7. RMCAT Flow Competing with Short TCP Flows
• 5.8. Media Pause and Resume
5.1 Variable Available Capacity with Single RMCAT Flow

Old Version: draft-nada-00

New Version: draft-nada-01
5.1.a: Low Available Capacity with UDP Background Traffic

Old Version: draft-nada-00

New Version: draft-nada-01
5.2 Variable Available Capacity with Multiple RMCAT Flows

Old Version: draft-nada-00

New Version: draft-nada-01
5.4. Competing Flows with Same RMCAT Algorithm

Old Version: draft-nada-00

New Version: draft-nada-01
5.4. Competing Flows with Same RMCAT Algorithm

Old Version: draft-nada-00

New Version: draft-nada-01
5.5. Round Trip Time Fairness

Old Version: draft-nada-00

New Version: draft-nada-01
5.5. Round Trip Time Fairness

Old Version: draft-nada-00

New Version: draft-nada-01
5.6. RMCAT Flow Competing with a Long TCP Flow

Old Version: draft-nada-00

New Version: draft-nada-01
NADA Interaction with AQM: RED

Old Version: draft-nada-00

New Version: draft-nada-01

Avg. delay = 90.14ms

Avg. loss ratio = 0.81%

Avg. delay = 88.31ms

Avg. loss ratio = 0.50%
NADA Interaction with AQM: PIE

Old Version: draft-nada-00

- Avg. delay = 88.72 ms
- Avg. loss ratio = 0.91%

New Version: draft-nada-01

- Avg. delay = 88.36 ms
- Avg. loss ratio = 0.45%
NADA Interaction with AQM: Summary

Old Version: draft-nada-00

New Version: draft-nada-01
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5.1 Variable Available Capacity with Single RMCAT flow
(Using UDP as Background Traffic, No Additional Delay Jitter)

NS-2 result

NS-3 result
Impact of Parameter Values — Accelerated Ramp-Up

**Gamma Max**: Upper bound on multiplicative rate increase ratio

- Determines aggressiveness of rate acceleration
- Default value: 50%

**QBound**: Upper bound on self-inflicted queuing delay;

- Determines aggressiveness of rate acceleration
- Default value: 50ms

$$\gamma = \min(\text{GAMMA}_\text{MAX}, \frac{\text{QBOUND}}{\text{rtt} + \Delta})$$

$$r_n = \max(r_n, (1+\gamma) r_{recv})$$
5.1 Variable Available Capacity with Single RMCAT Flow

QBOUND=20ms

QBOUND=100ms
Impact of Parameter Values — Gradual Rate Update

- **TAU**: Upper bound of RTT for guaranteed stability of congestion control feedback loop
  - Default value: 500ms

- **ETA**: Dictates relative influence between \( x_{\text{offset}} \) and \( x_{\text{diff}} \) to rate change
  - Default value: 2.0 (leading to a 10:1 influence between \( x_{\text{diff}} \) and \( x_{\text{offset}} \) when ACK interval \( \delta \) = 100ms)

- **KAPPA**: Scaling factor for rate update
  - Determines overall aggressiveness of rate adaptation, trade-off between responsiveness and stability
  - Typical choices: 0.2 ~ 2.0; Default value: 0.2
5.1 Variable Available Capacity with Single RMCAT Flow

KAPPA=0.1: Slow recovery from loss

KAPPA=2.0: Noisy rates at steady state
Summary of Open Issues

• Choice of delay metric: relative OWD vs. RTT
  • Drawback of using relative OWD (current scheme): later comer may confuse standing queue as part of path propagation delay
  • Drawback of using RTT: susceptible to noise along the feedback path
• Method for estimating delay, loss and marking ratio
• Impact of parameter values on algorithm performance
• Sender-based vs. receiver-based calculation of congestion signal and rate
  • Current scheme calculates $x_n$ at receiver
  • Shifting the calculation to sender: simpler receiver yet slightly higher feedback overhead
• Incremental deployment: Droptail Queue -> ECN -> Advanced virtual queuing
Next Steps

- Algorithm analysis and improvement:
  - Impact of parameter choice in the presence of loss/marking
  - BW sharing between NADA and TCP flows
  - Fix issue with getting stuck in loss-based mode

- Evaluation efforts:
  - NS3-based evaluations for wired and wireless test cases
  - Evaluations driven by synthetic video traces and live video
  - Performance comparison against GCC and/or SCReAM
Backup Slides
Errata in Current Draft (-01)

• Section 4.1 Mathematical Notations:
  • In Figure 3: X_REF => XREF
  • In Figure 3: Default value of QTH: 100ms => 50ms
  • In Figure 3: Default value of GAMMA_MAX: 20% => 50%

• Section 4.3 Sender-Side Algorithm:
  • Change Eq. (4) to: $r_n = \max(r_n, (1+\gamma) \times r_{recv})$

See presentation in IETF-93: