

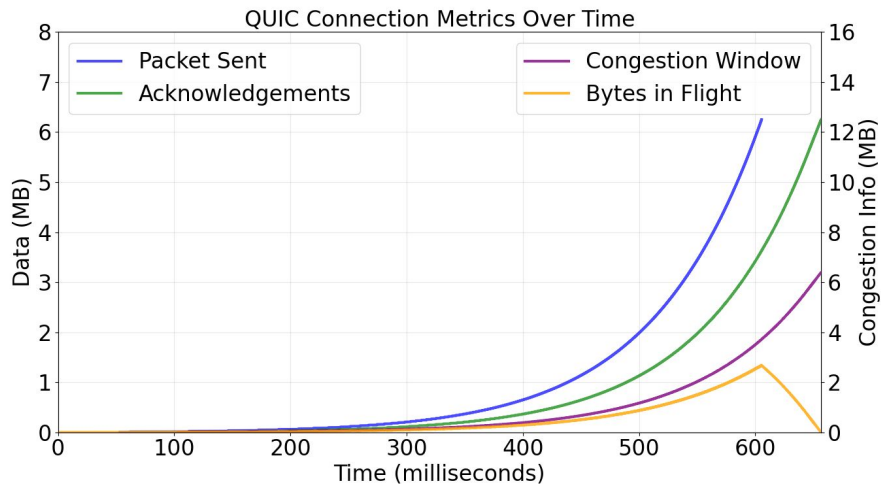
Getting up to Speed with Neqo and Careful Resume

Nicolai Fischer, Matthias Hofstätter, Jörg Deutschmann, Reinhard German
Friedrich-Alexander-Universität Erlangen-Nürnberg

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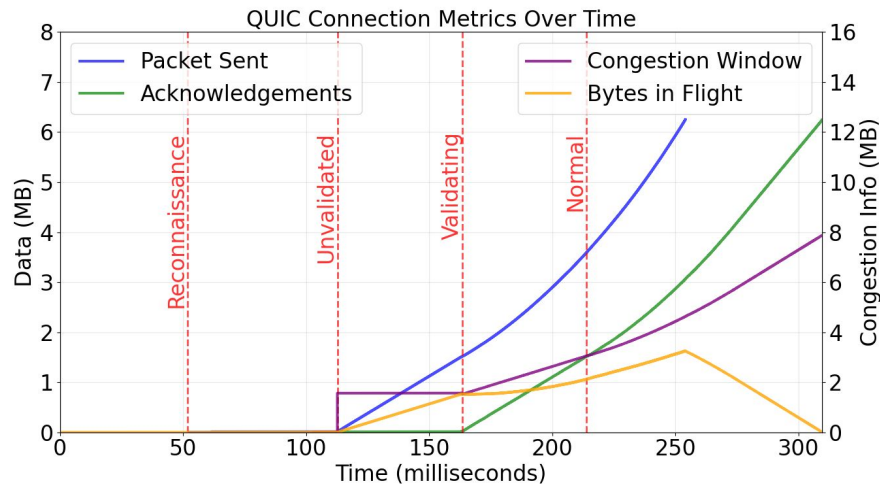
Slow-Start vs Careful Resume

6.25 MB transfer over 500 MBit/s, 50 ms RTT



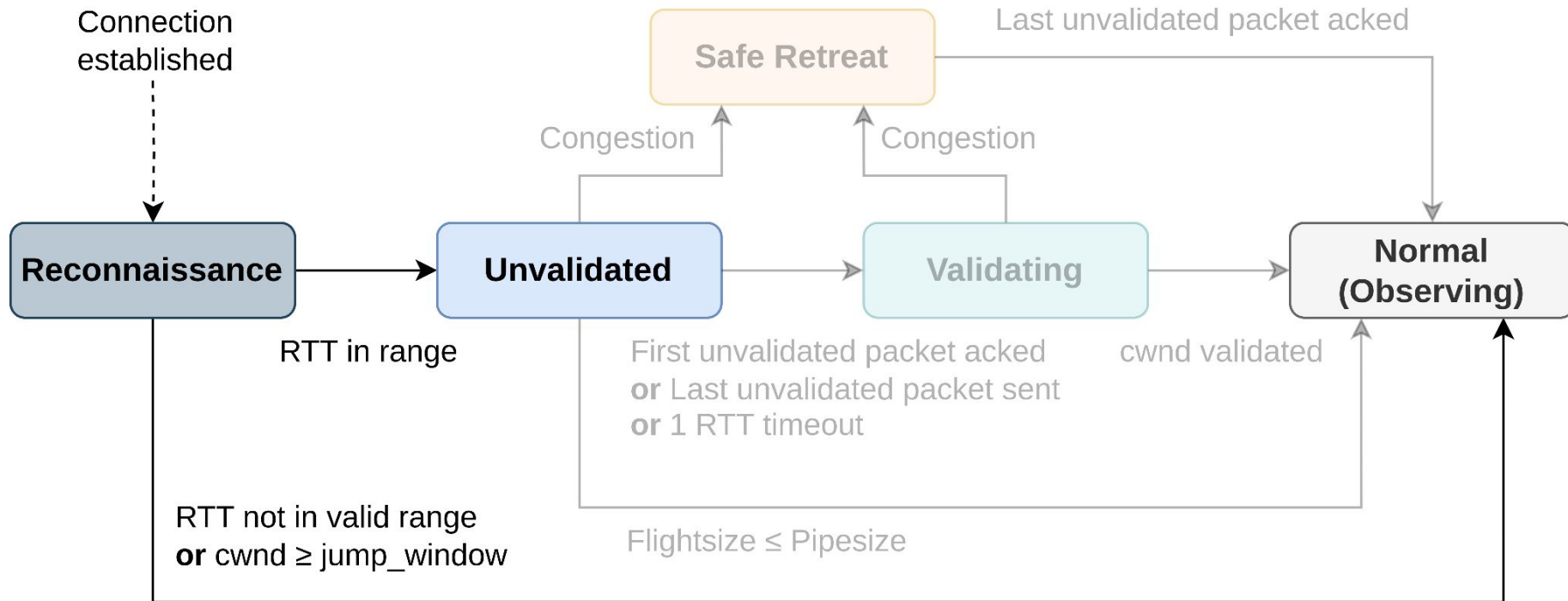
Slow-Start

TTLB: 657 ms



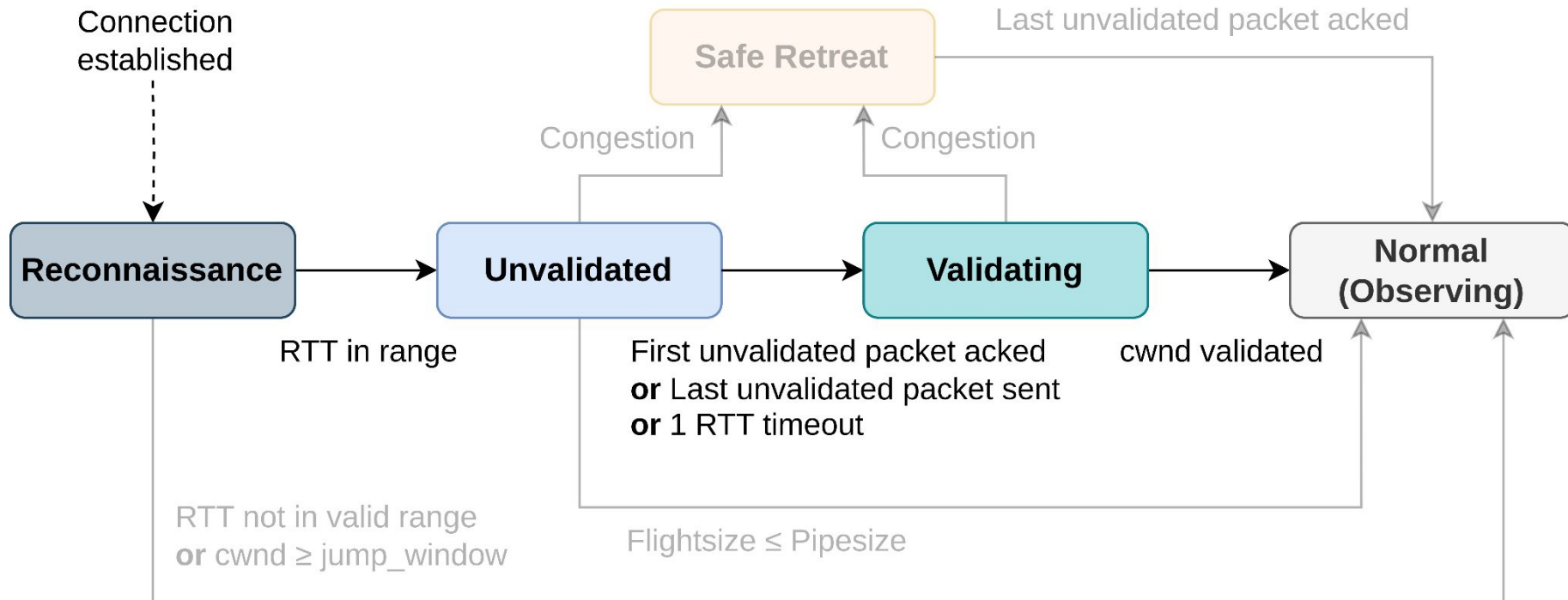
Careful Resume

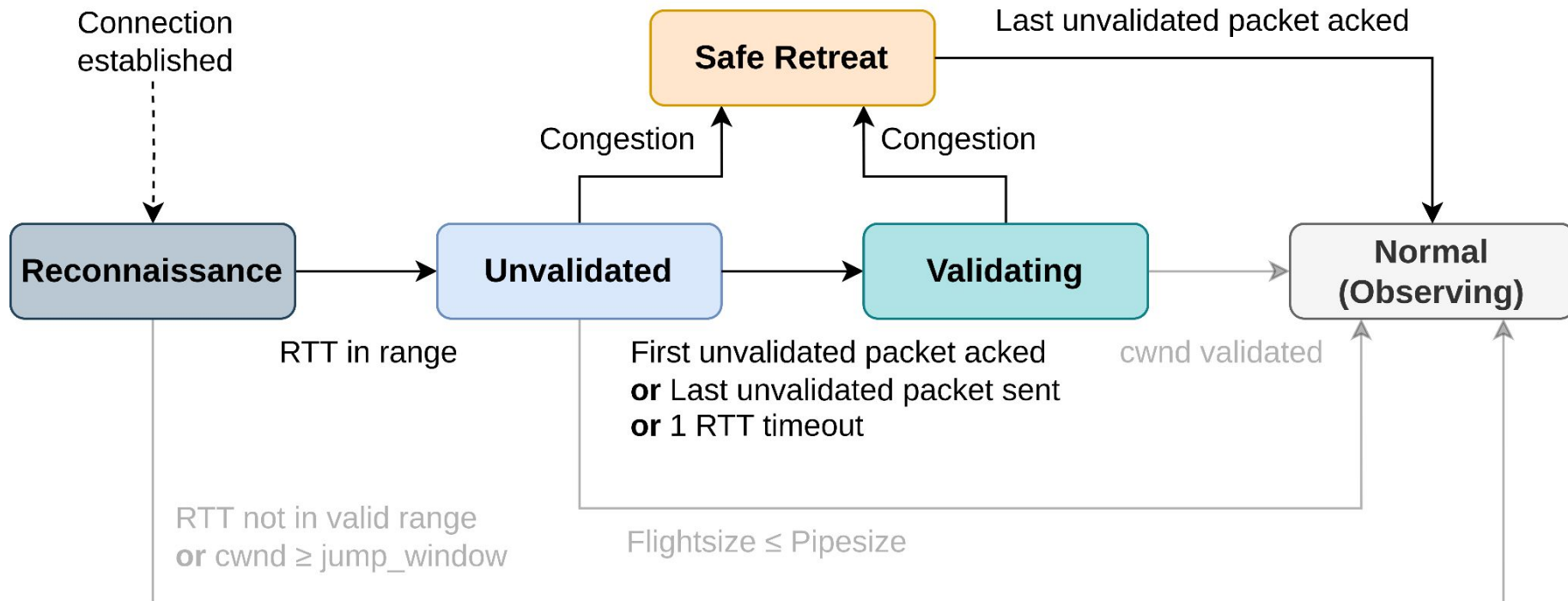
TTLB: 310 ms



Careful Resume

Validating Phase





Our Implementation

Neqo: QUIC Implementation in Rust by Mozilla, used to Power Firefox

<https://github.com/Finic8/neqo>



Buffer management

Default UDP socket buffer size small

No good insight into buffer utilization

👉 I-D: [Source Buffer Management](#)

draft-cheshire-sbm

Pacing

No ACK-clocking during Unvalidated Phase

Accurate timers needed: `SO_TXTIME`, `timerfd`

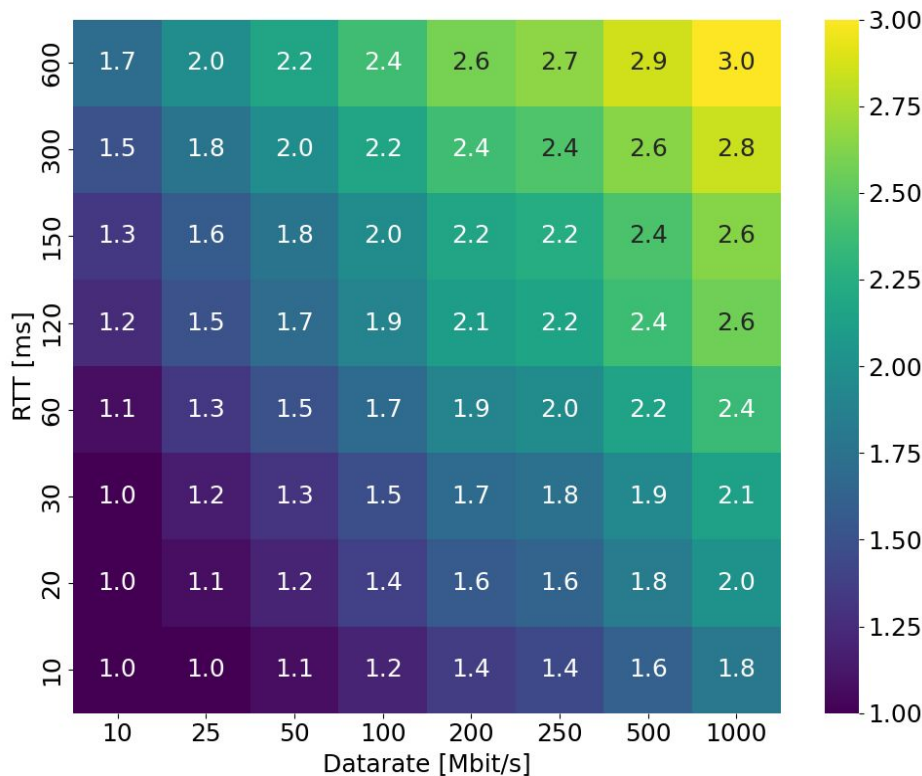
Reduced overhead: `sendmmsg(2)`, `GS0`

👉 I-D: [Pacing in Transport Protocols](#)

draft-welzl-iccrp-pacing

Speedup Careful Resume over Slow-Start

Transfer of BDP-sized object



Testsetup

Neqo HTTP/3 client, server

Transfer of BDP-sized object over NetEm bottleneck

$$\text{Speedup} = \frac{t_{\text{Slow-Start}}}{t_{\text{Careful Resume}}}$$

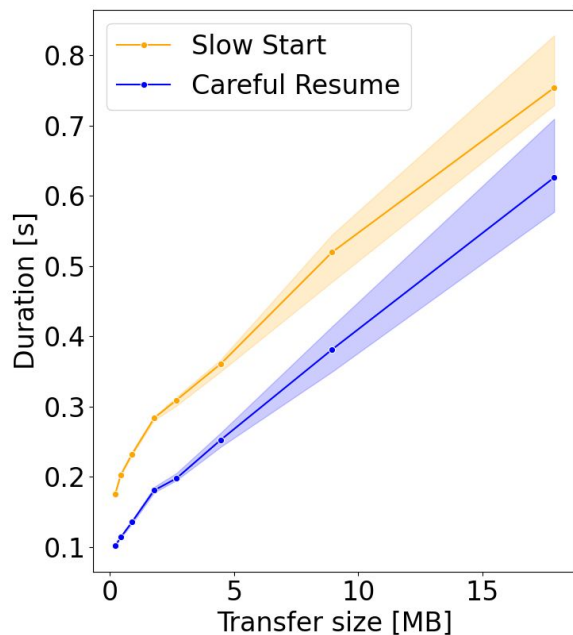
Results

Large benefit for high BDP paths

Careful Resume saves several RTTs

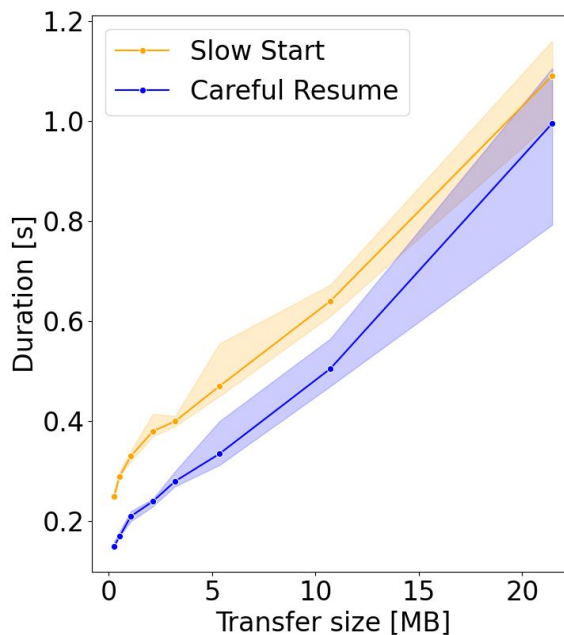
Validation over Internet Paths

Transfers of $0.25 \times \text{BDP}$ to $20 \times \text{BDP}$



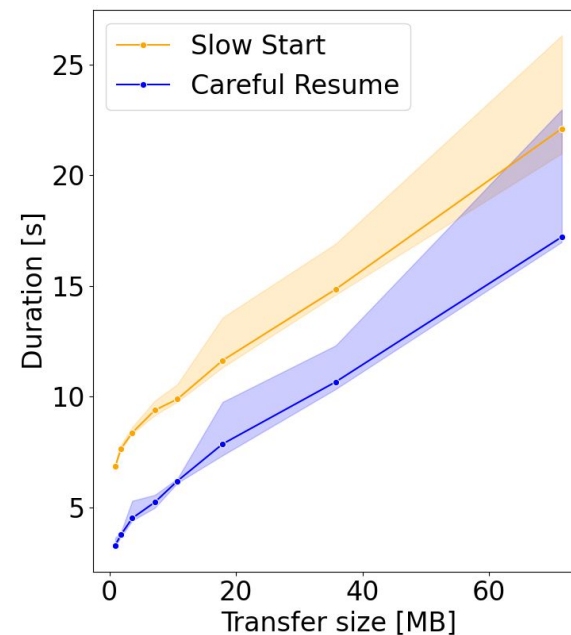
Fiber (1&1 Versatel)

BDP = $375 \text{ Mbit/s} \times 20 \text{ ms} = 0.9375 \text{ MB}$



5G Cellular (Telekom)

BDP = $300 \text{ Mbit/s} \times 30 \text{ ms} = 1.125 \text{ MB}$



Geostationary Satellite (Konnect)

BDP = $50 \text{ Mbit/s} \times 600 \text{ ms} = 3.75 \text{ MB}$

Fairness to Background Traffic

Losses suffered by background flows

Baseline

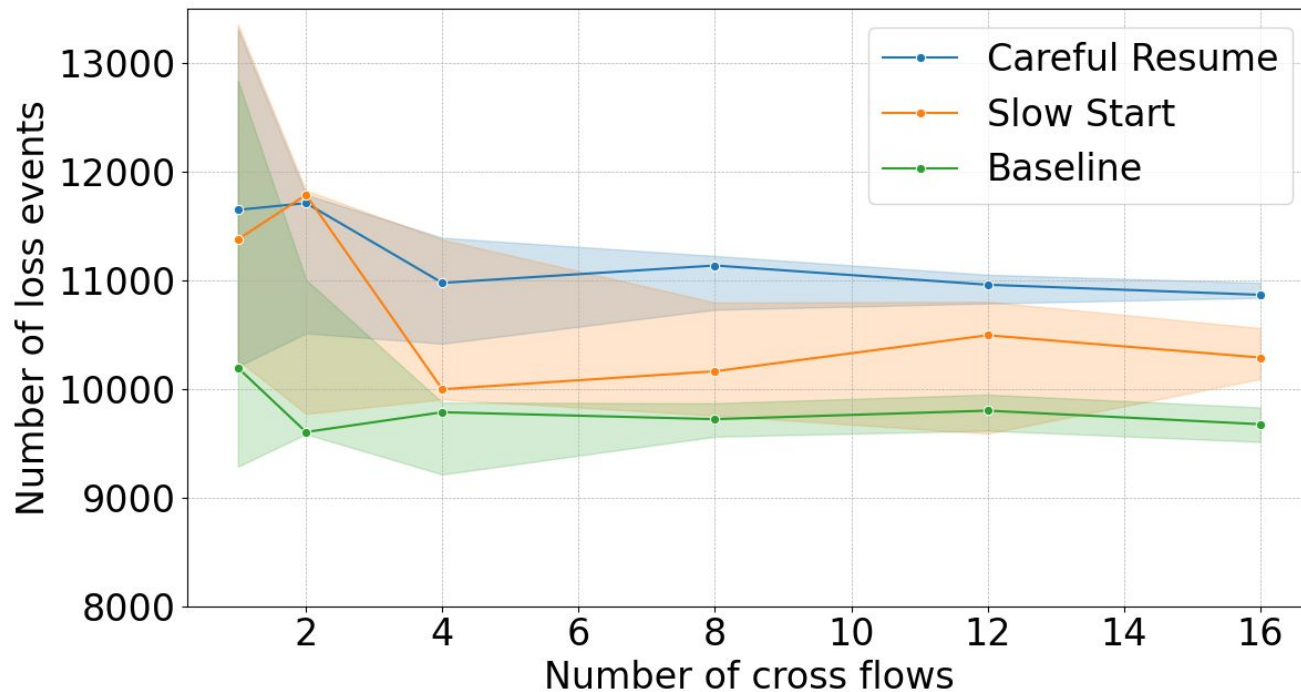
100 × BDP of data
Distributed over 1 - 16 flows
Neqo HTTP/3 Server/Client

Slow Start

40 × BDP of data

Careful Resume

40 × BDP of data
Assumes empty Path



Careful Resume enhances Slow-Start mechanism

Reconnaissance to validate saved path parameters

Safe Retreat to handle congestion

Accurate pacing challenging to implement

Code: <https://github.com/Finic8/neqo>

[draft-ietf-tsvwg-careful-resume](#)

[draft-ietf-tsvwg-careful-resume-qlog](#)

Works on a wide range of real Internet paths

Higher BDP paths benefit more (saved RTTs)

Not significantly more harm than Slow-Start

