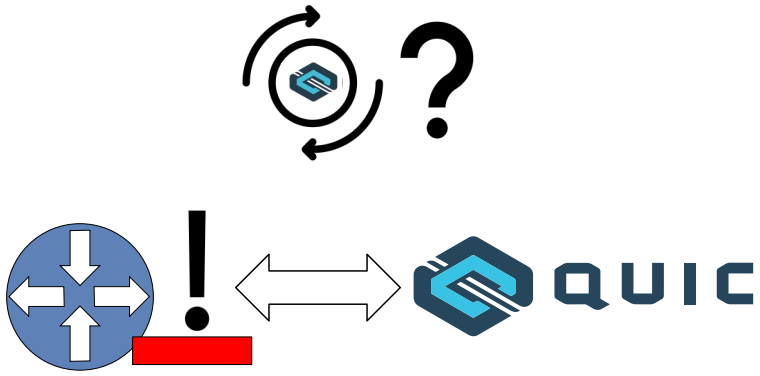


Using the Spin Bit and ECN with QUIC

Adoption and Challenges in the Wild

Ike Kunze[12*], Constantin Sander[12*], Leo Blöcher[2*], Mike Kosek[2†], and Klaus Wehrle[12*]

* RWTH Aachen University
† TU Munich

1 Does It Spin? On the Adoption and Use of QUIC's Spin Bit
2 ECN with QUIC: Challenges in the Wild

https://www.comsys.rwth-aachen.de/

IRTF MAPRG, Nov. 2023 ~~ACM IMC '23, Oct. 2023~~

Methodology

- Large scale longitudinal QUIC web measurements (Apr. 2022 – May 2023)



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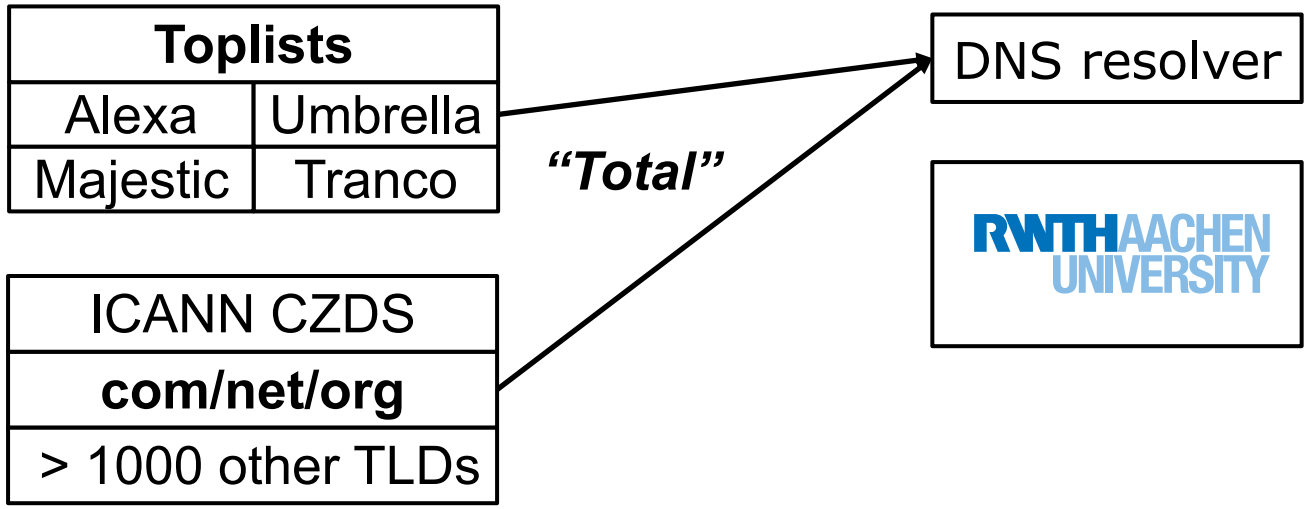
Toplists	
Alexa	Umbrella
Majestic	Tranco

ICANN CZDS
com/net/org
> 1000 other TLDs

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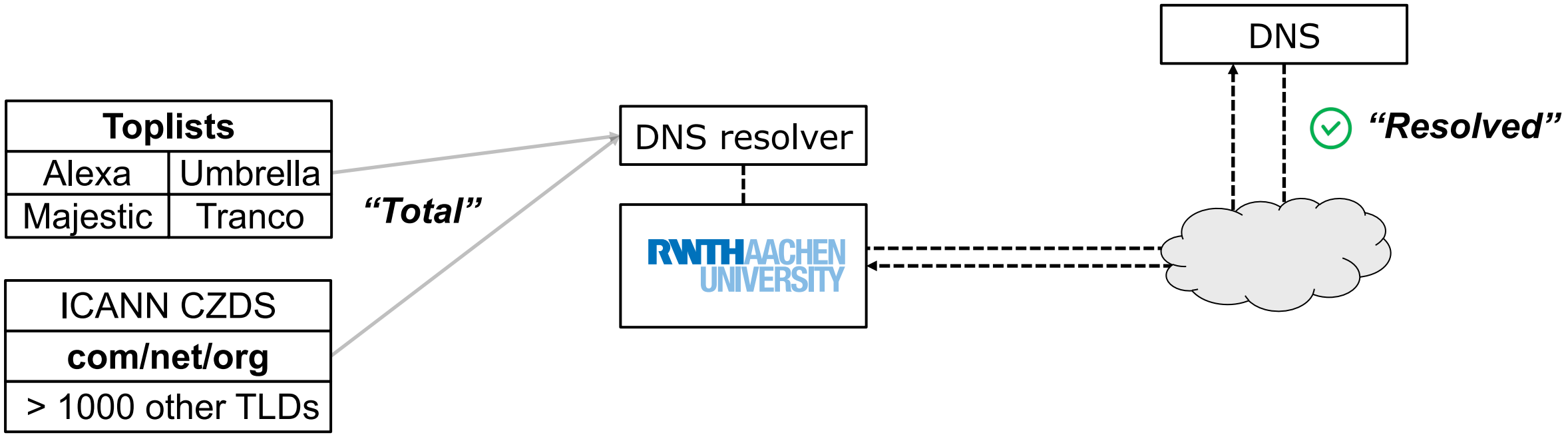
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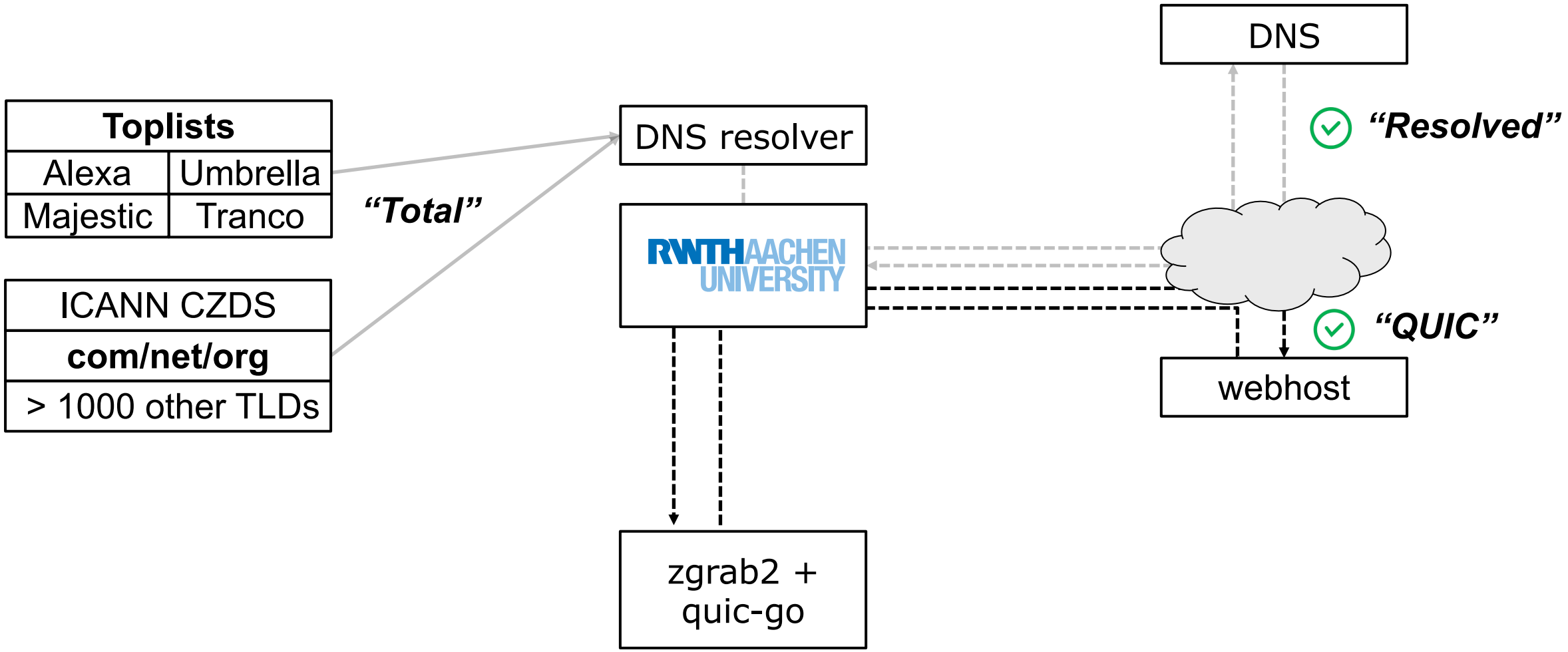
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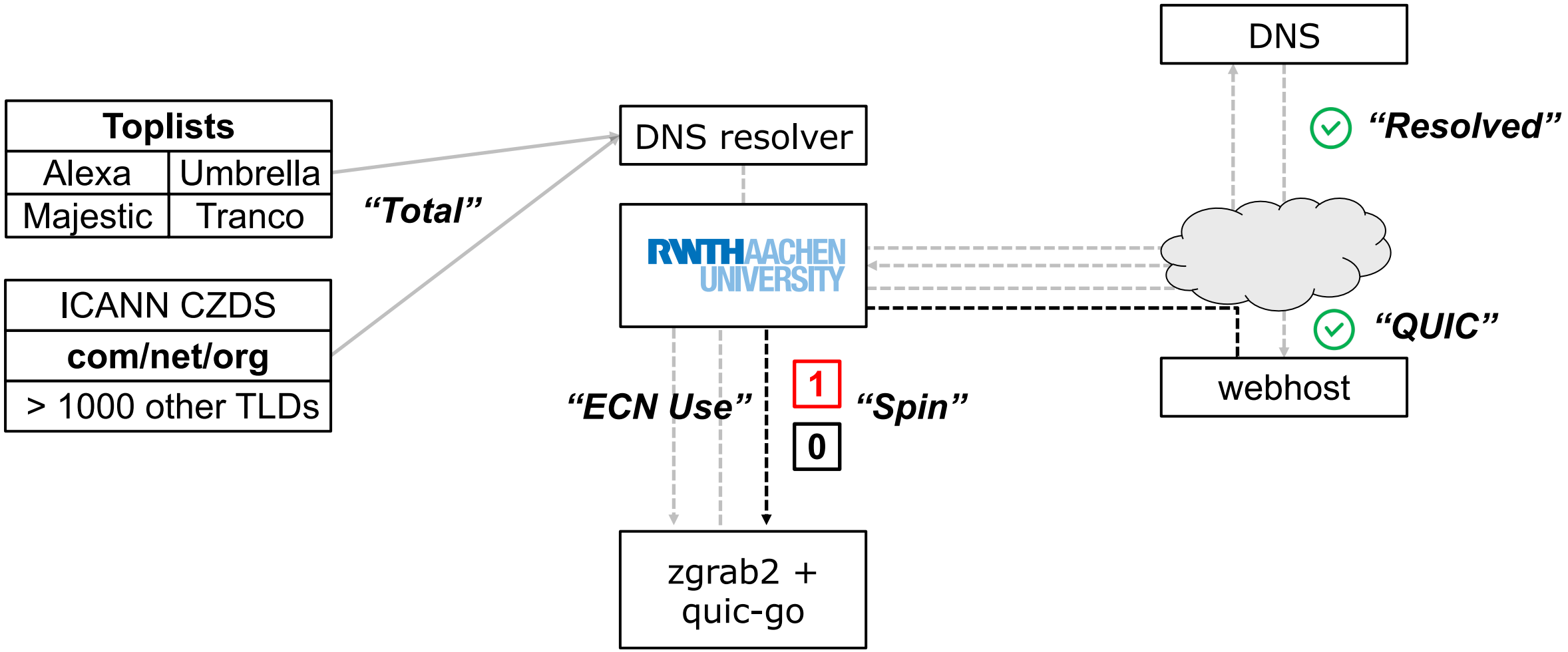
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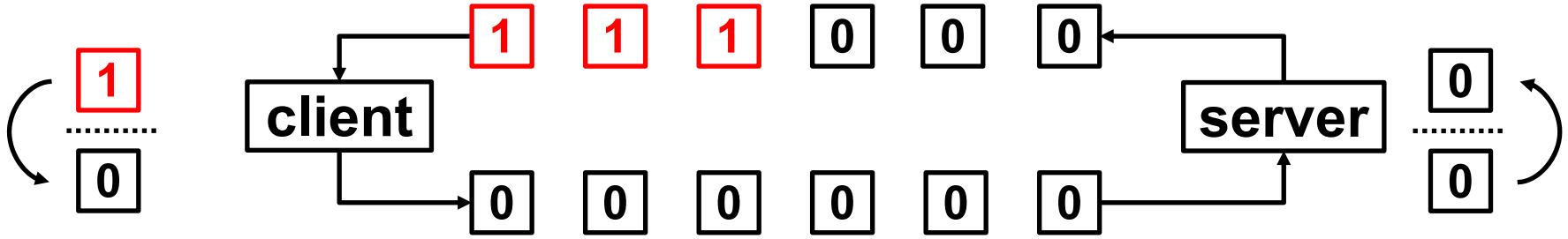
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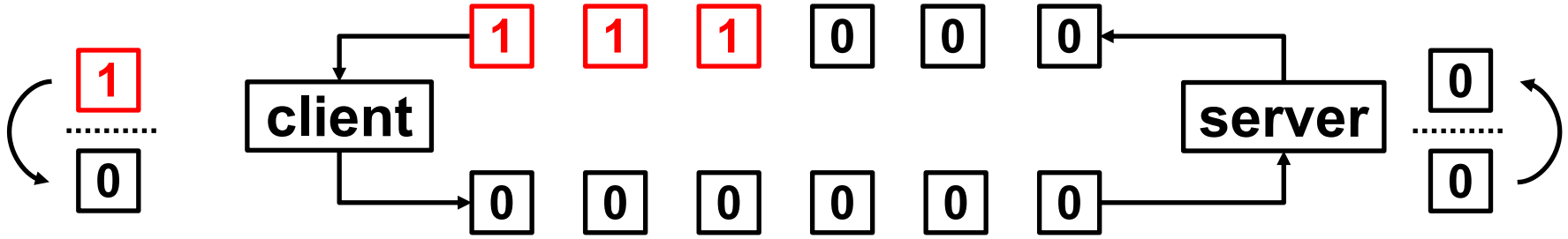
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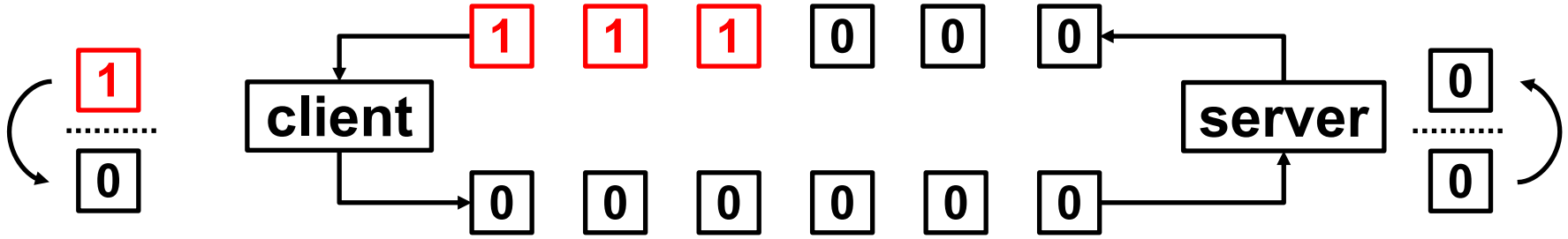


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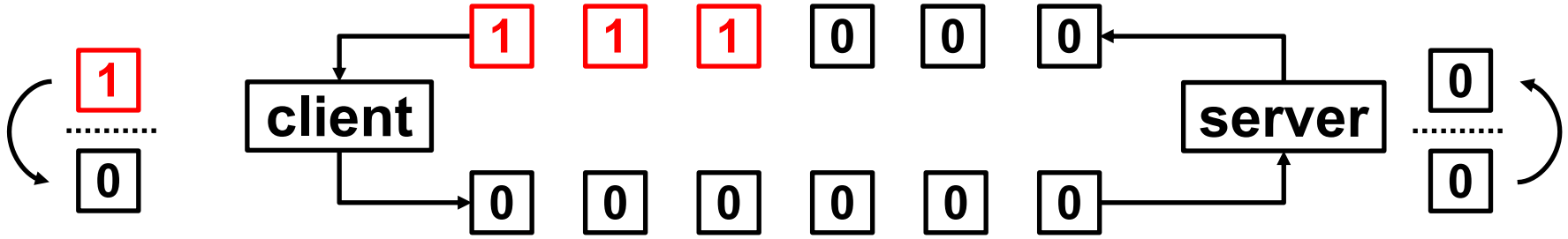
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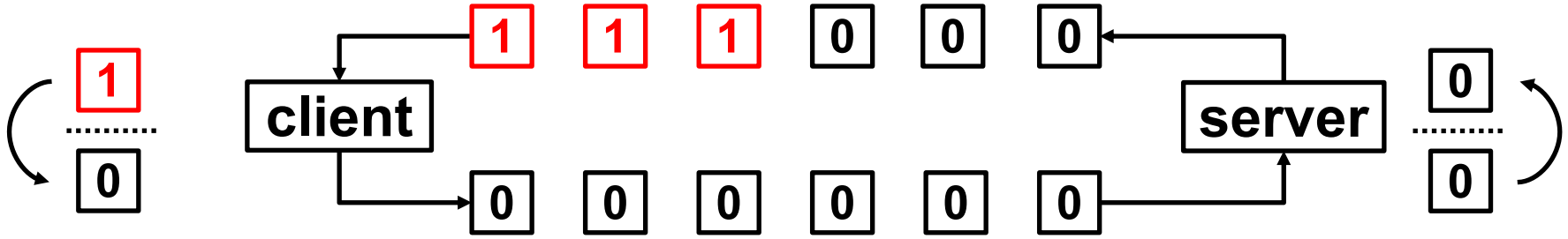
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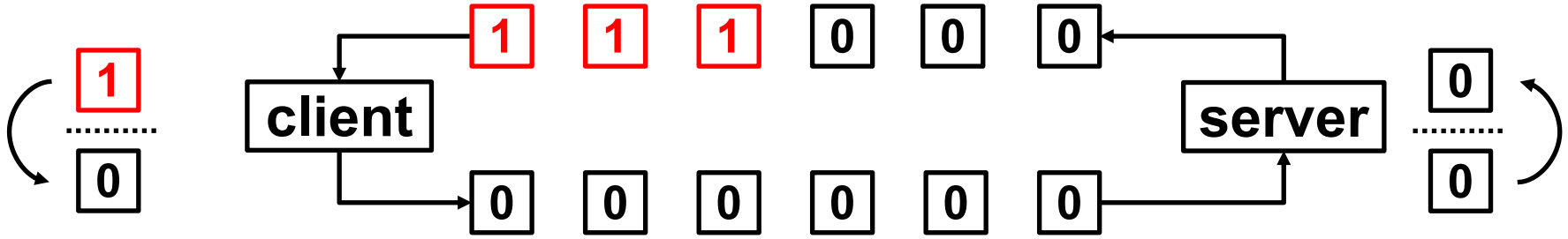
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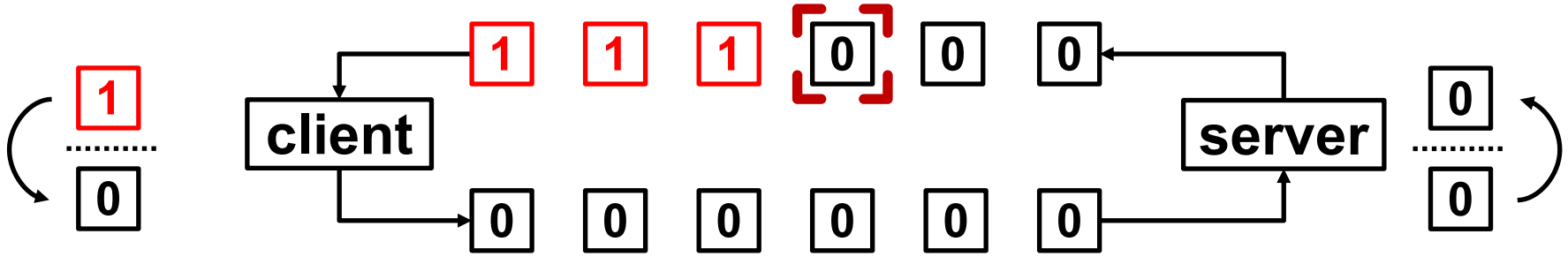
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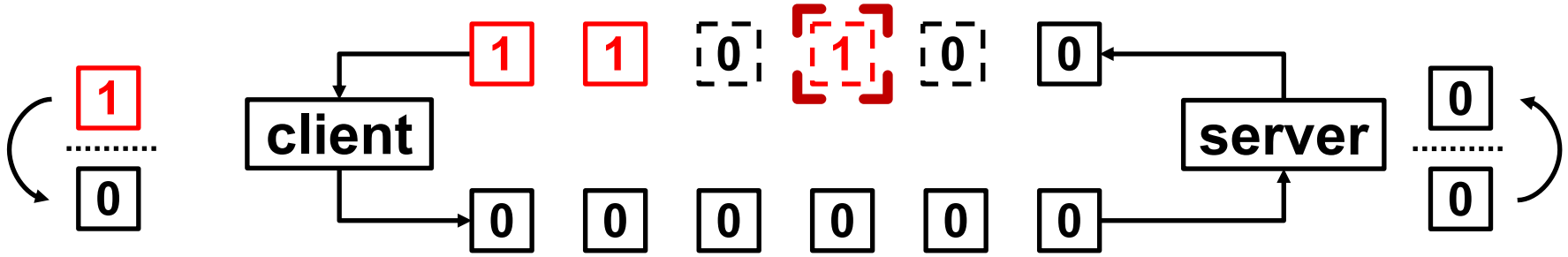
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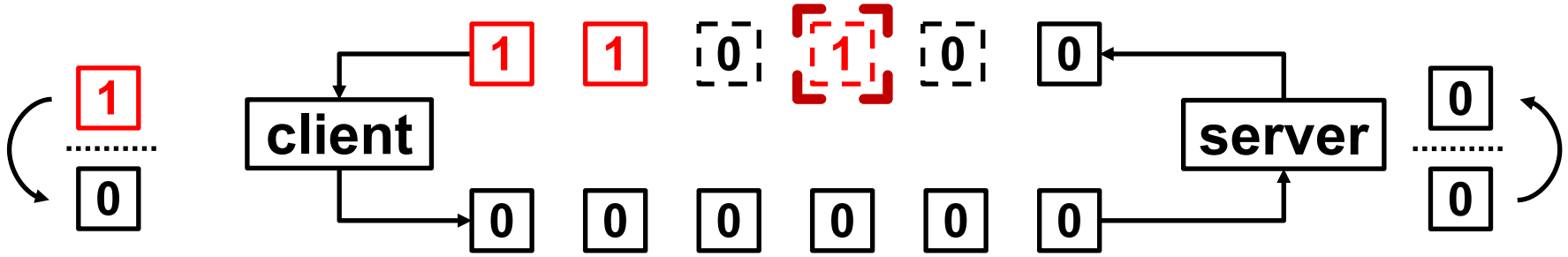
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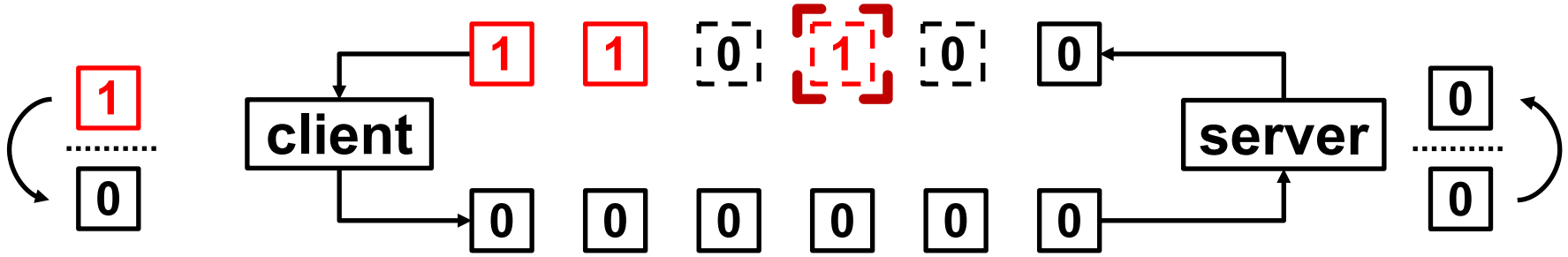
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Spin Bit Adoption (IPv4)

Q1: **Is the spin bit used** and by whom?

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com/net/org	#Domains	183.05 M	158.89 M	18.42 M	11.1 %

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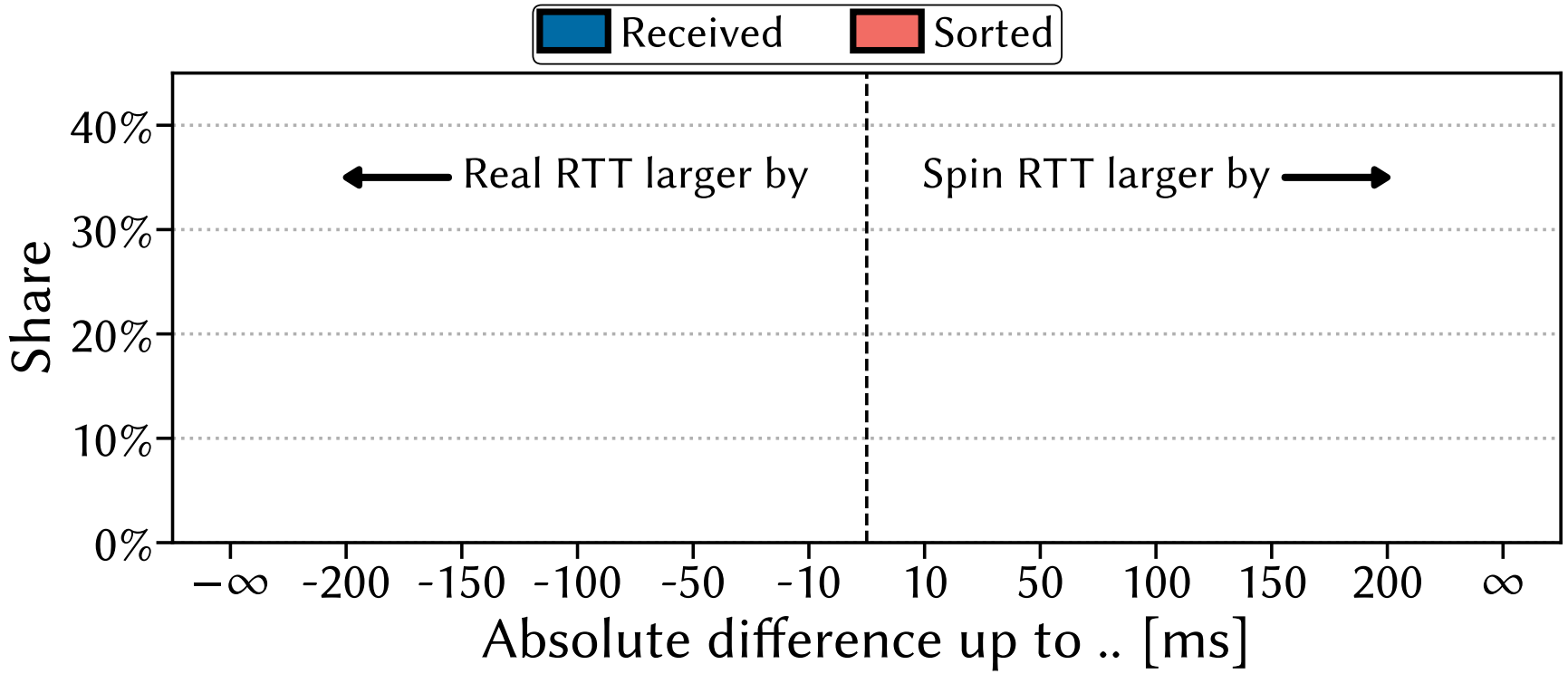
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RTT Measurement Accuracy

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  - **R**eceived packet order / **S**orted by packet numbers

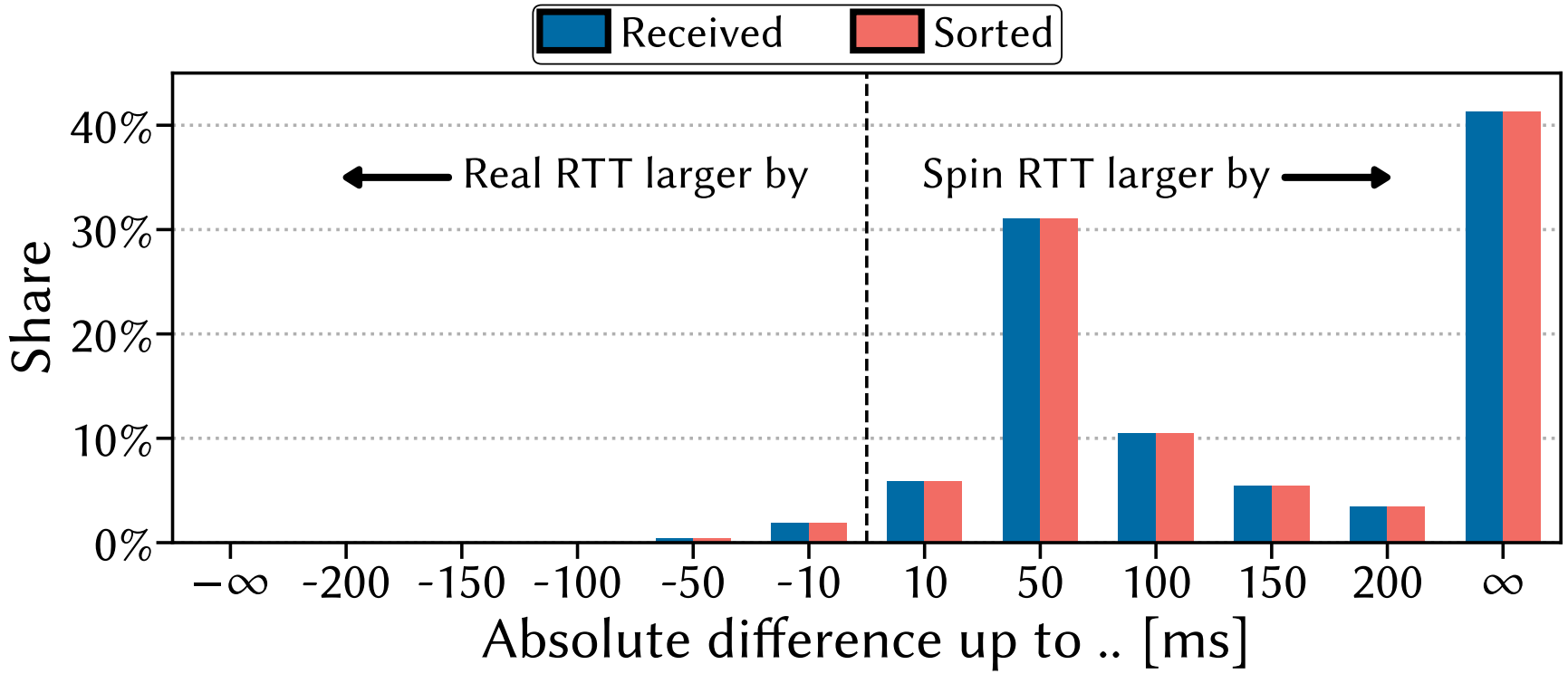


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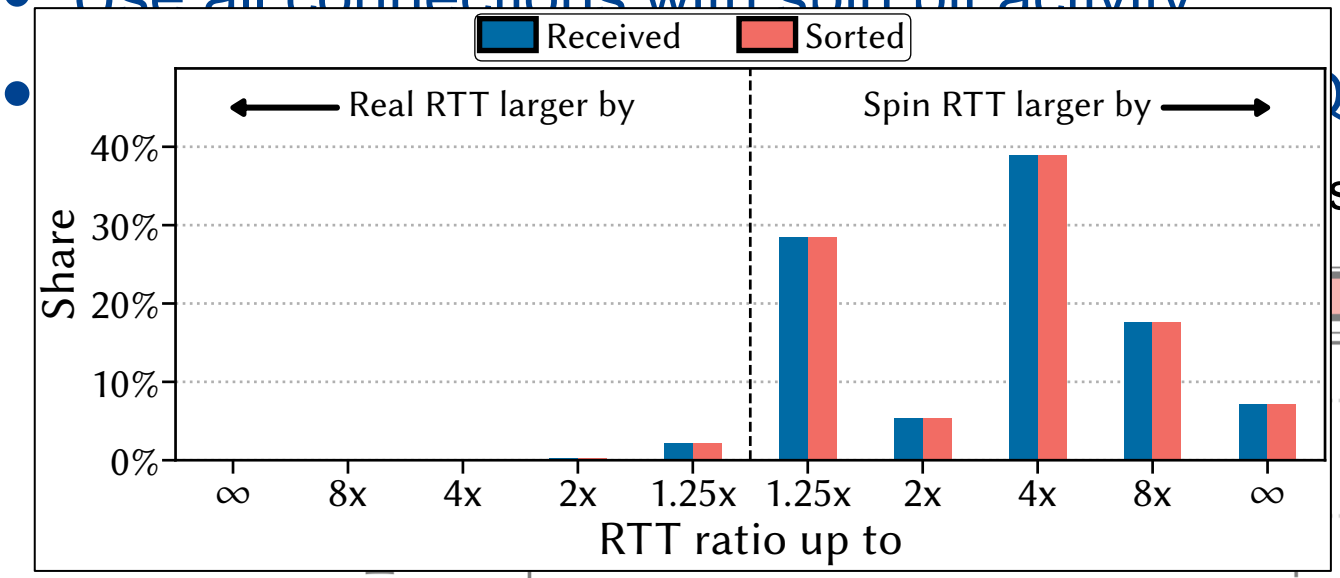


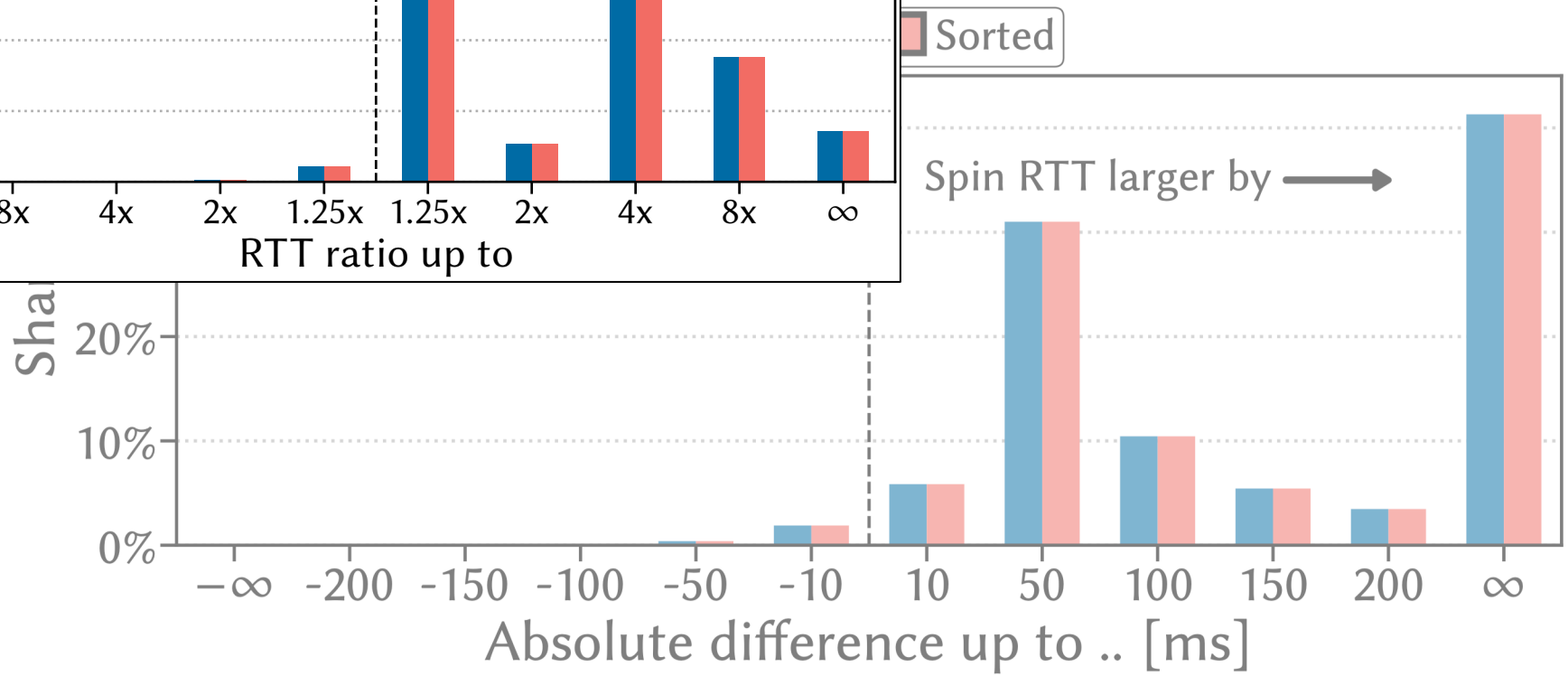
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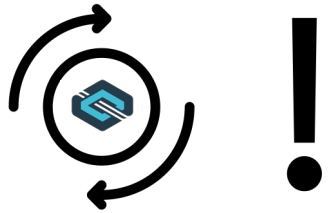




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Spin Bit – Takeaways

- The spin bit indeed sees use in the wild
  - ~10 % of domains with QUIC support use it
  - 50 – 60 % of underlying hosts



- RTT measurements draw an ambiguous picture
  - Often quite accurate
  - More often large overestimation
  - Some underestimation

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Visible QUIC ECN Support

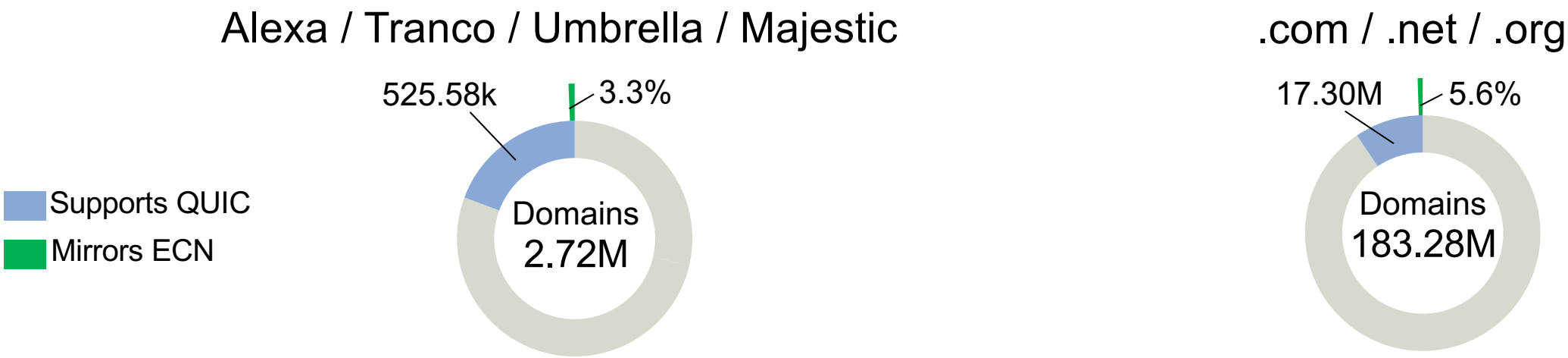
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- **Visit websites via HTTP/3 / QUIC and log ECN counters (from Germany in CW15)**

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RFC Erratum exists

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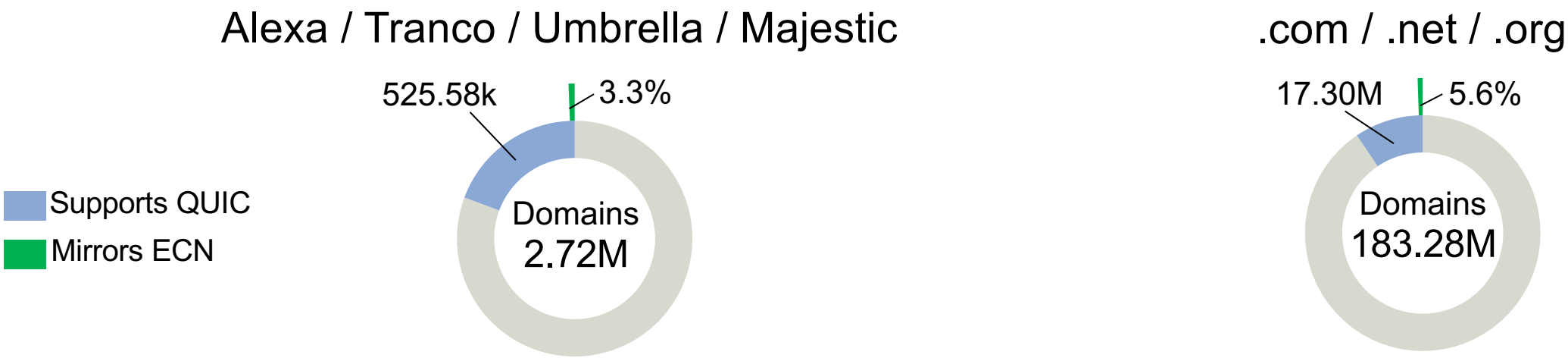
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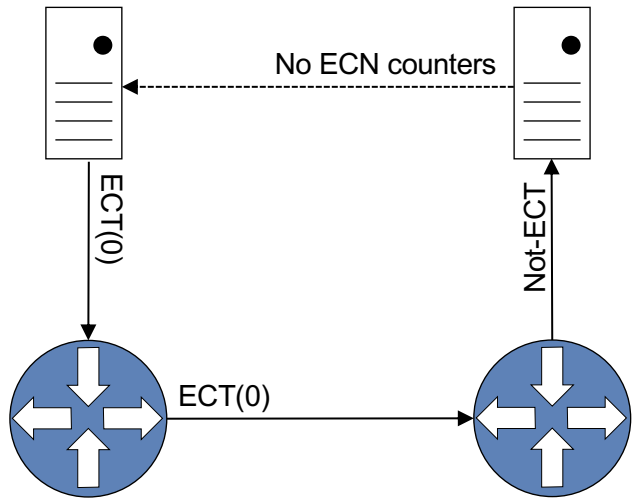
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- Mainly LiteSpeed HTTP/3 server, Amazon Cloudfront and tests by Google mirror ECN
  - Again low support by hyperscalers and content providers

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Clarifying Missing Support

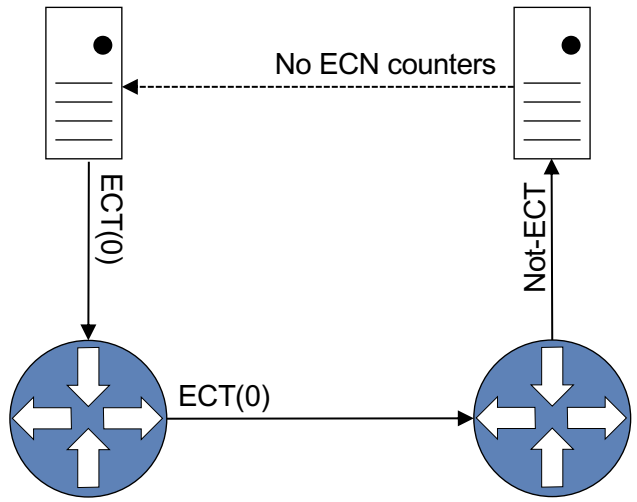
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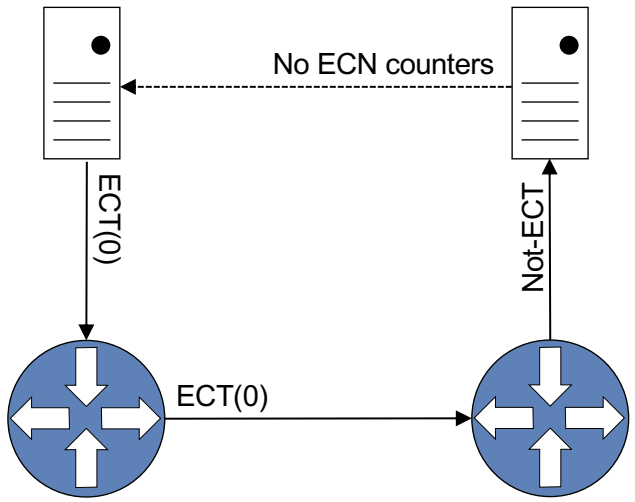
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- **No visible ECN clearing for 97.5% of domains**
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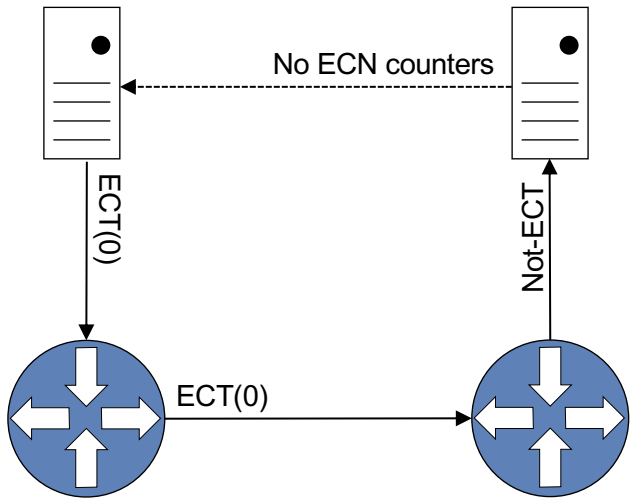
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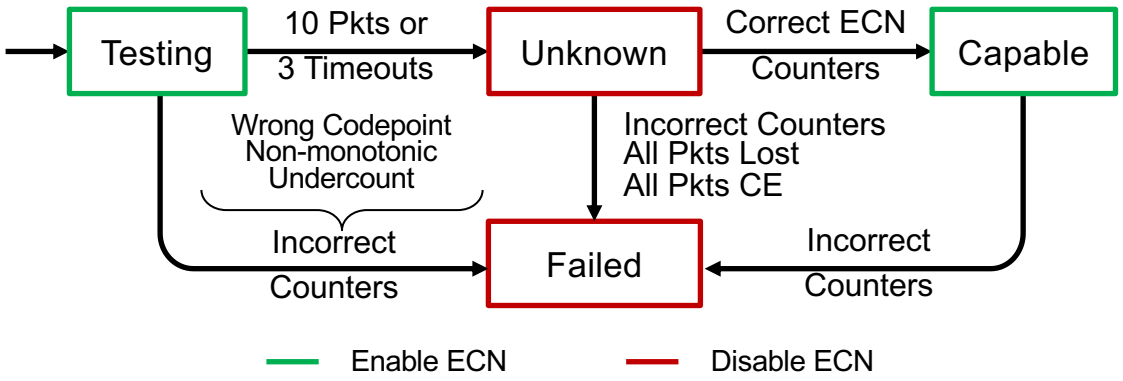


- **Single Tier 1 ISP impacts 98.6% of affected domains**
  - Affects smaller hosters, especially after route changes in December 2022
- **Missing support by content providers not due to clearing**
  - Support ECN via TCP, QUIC stacks or undiscovered middleboxes ignore ECN

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ECN Validation Challenges

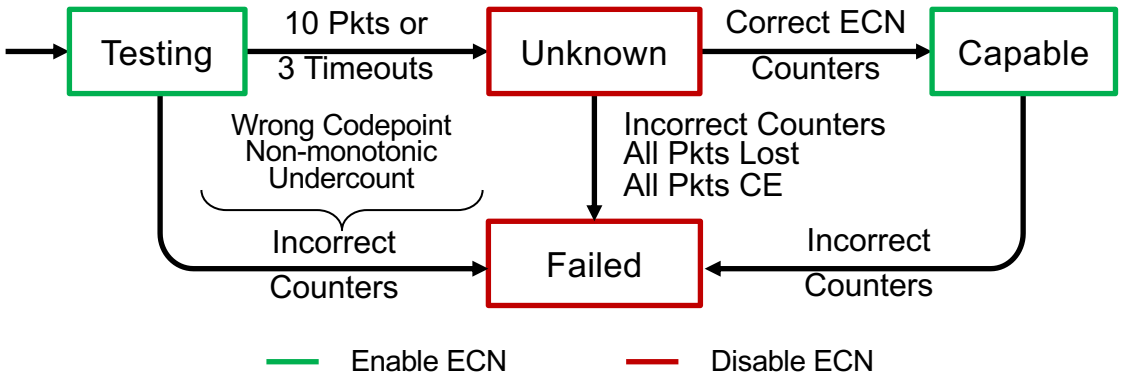
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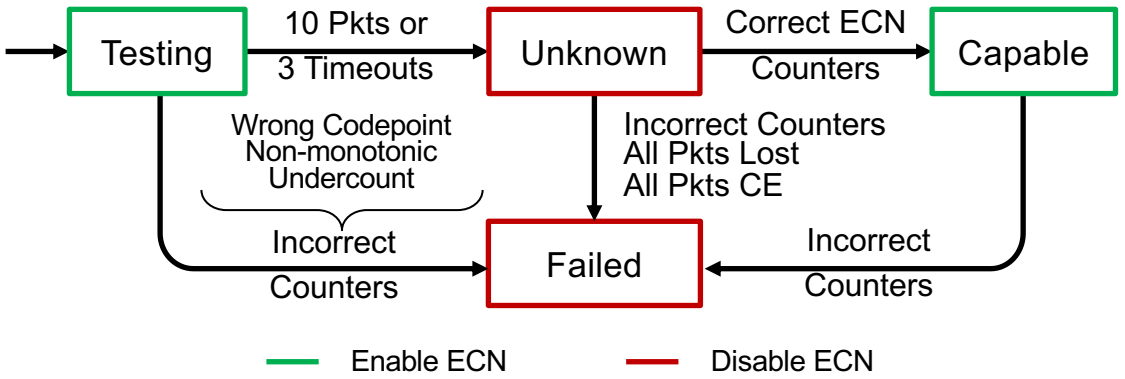


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ECN Validation Challenges

- **QUIC requires ECN validation to use ECN**
  - Checks for the first packets whether
    - Timeouts occur with ECN
    - Wrong codepoints
    - Missing / undercounted codepoints



- **0.2% of com/net/org pass validation ⇔ 96% of mirroring domains fail due to**
  - Undercounting
    - Google AS
      - Related work suspects DCTCP
    - LiteSpeed Server
      - Packetno. switch can disable ECN
  - Re-marking
    - Again network elements of Tier 1 ISP
      - Also rewriting of codepoints
    - Again Google's AS
      - Potentially again DCTCP usage

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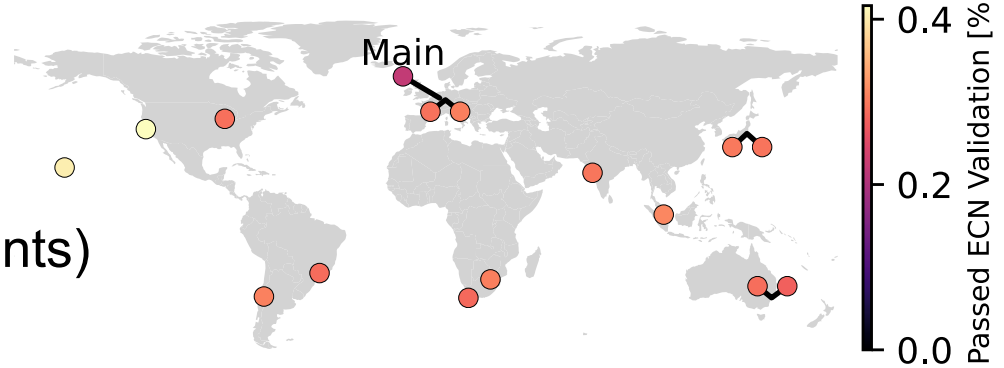
ECN with QUIC – Takeaways

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  - 1. Several QUIC stacks do not mirror ECN
  - 2. Some network elements clear signals
  - 3. Often ECN validation fails (stack + network impairments)

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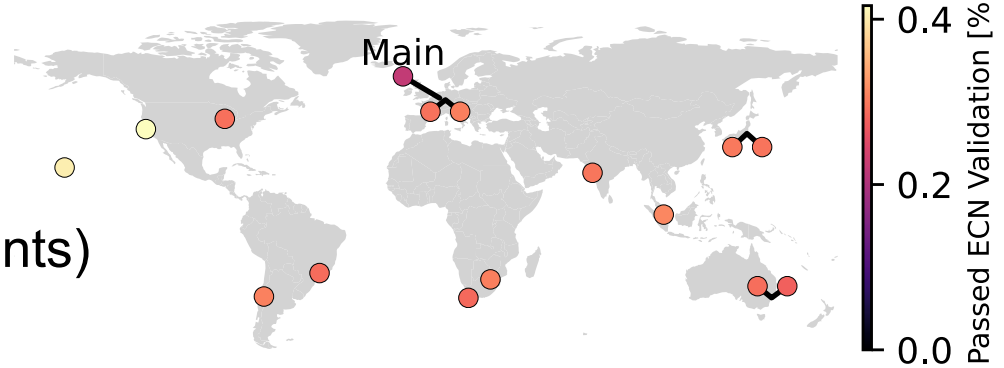
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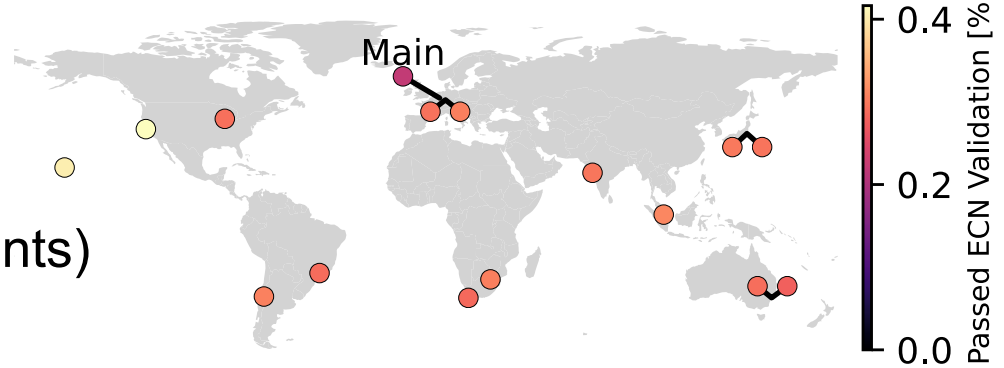


- **Beyond QUIC: significant impact for novel ECN mechanisms such as L4S**
  - ECT(0) → ECT(1) re-marking detrimental for L4S and traditional traffic on L4S routers

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- **Beyond QUIC: significant impact for novel ECN mechanisms such as L4S**
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- **Trend is probable to be increasing, changes over time visible**
  - QUIC RFC Erratum on ECN may trigger rework of stacks
  - Open ticket with stack vendor and in touch with ISP for debugging ECN issues

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Conclusion

- **Large scale longitudinal QUIC web measurements**
- **Spin bit**
  - Optional, yet sees use in the wild
  - How useful is the provided measurement accuracy?
- **ECN**
  - Mandatory, yet significantly limited on a global scale
  - Many challenges (stack support to faulty network devices)
- **Check out papers for more details**

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