

TECC: Towards Efficient QUIC Tunneling via Collaborative Transmission Control

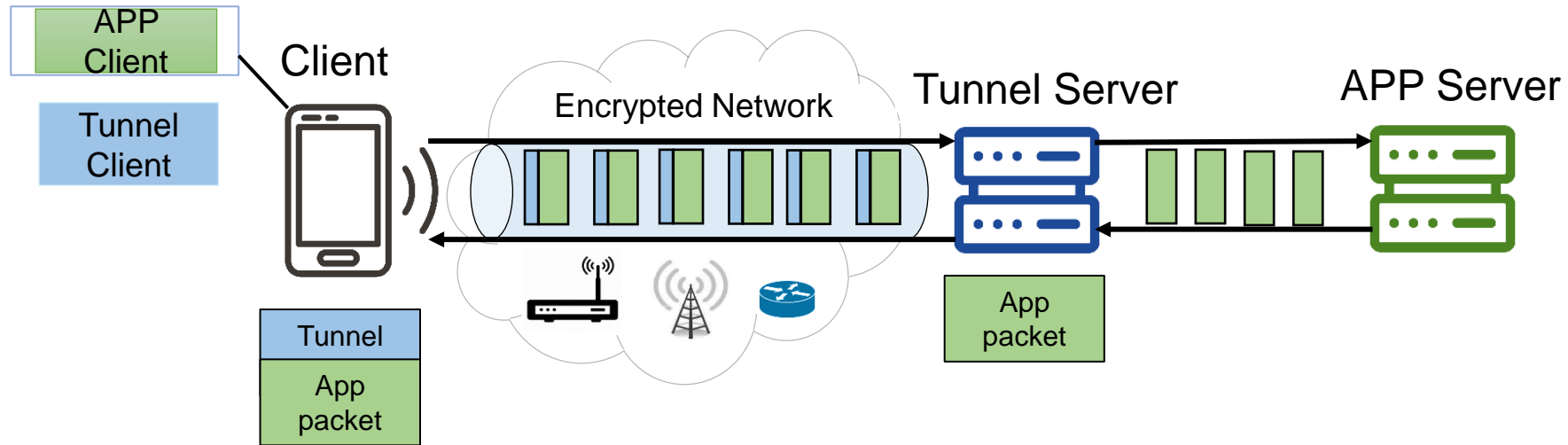
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Alibaba Group, University of Chinese Academy of Sciences,
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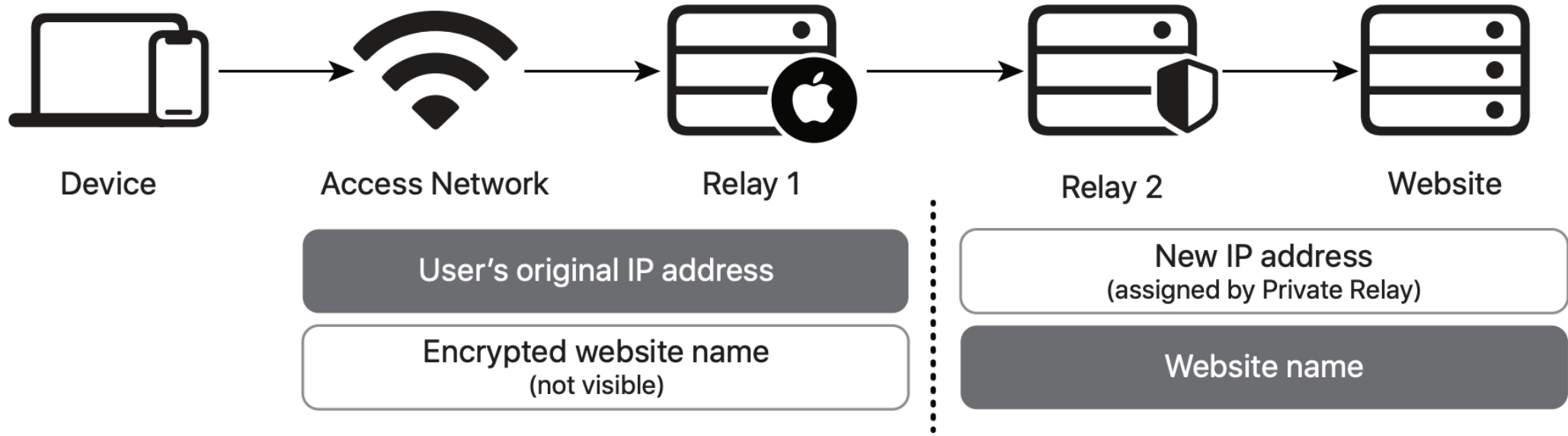
➤ Masque QUIC Tunnel Overview

Multiplexed Application Substrate over QUIC Encryption(Masque)



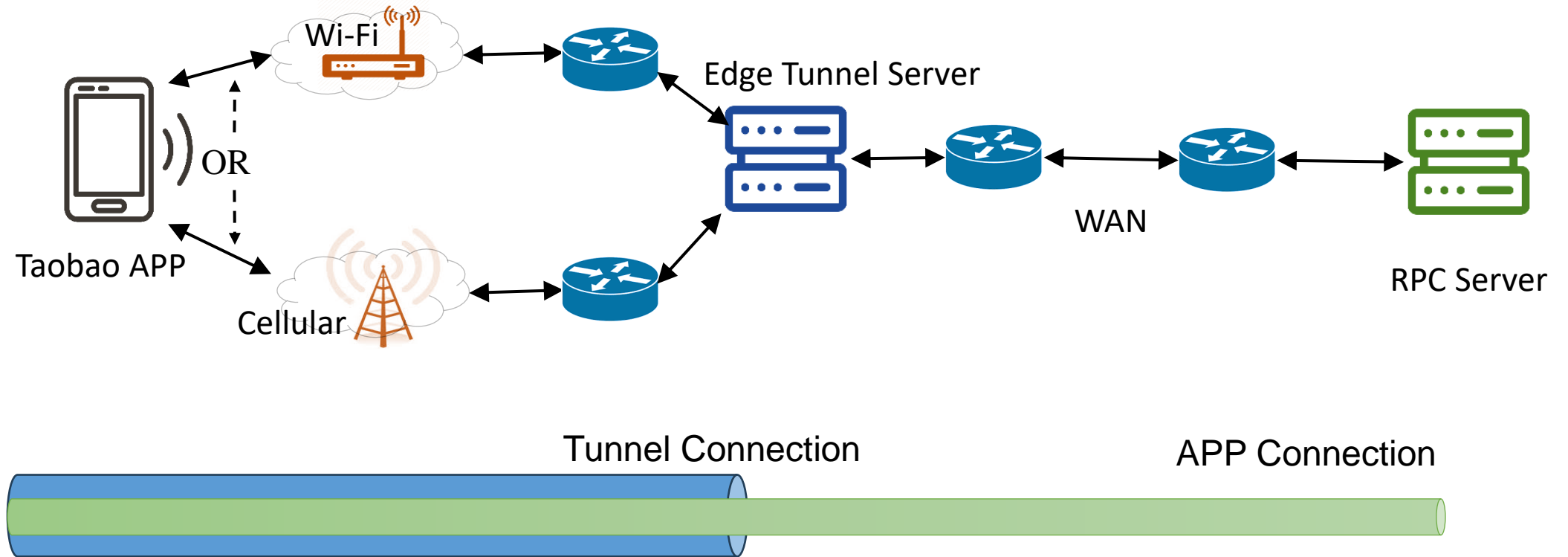
QUIC in QUIC communication pattern

➤ Privacy Protection



QUIC tunnel between user device and relay

➤ Transmission Optimization in Taobao



Loss can be recovered by the tunnel connection

➤ Masque Tunnel Type

Head of Line
Blocking

Stream

Masque Stream Tunnel(**MST**)

Masque Stream Group Tunnel(**MSGT**)

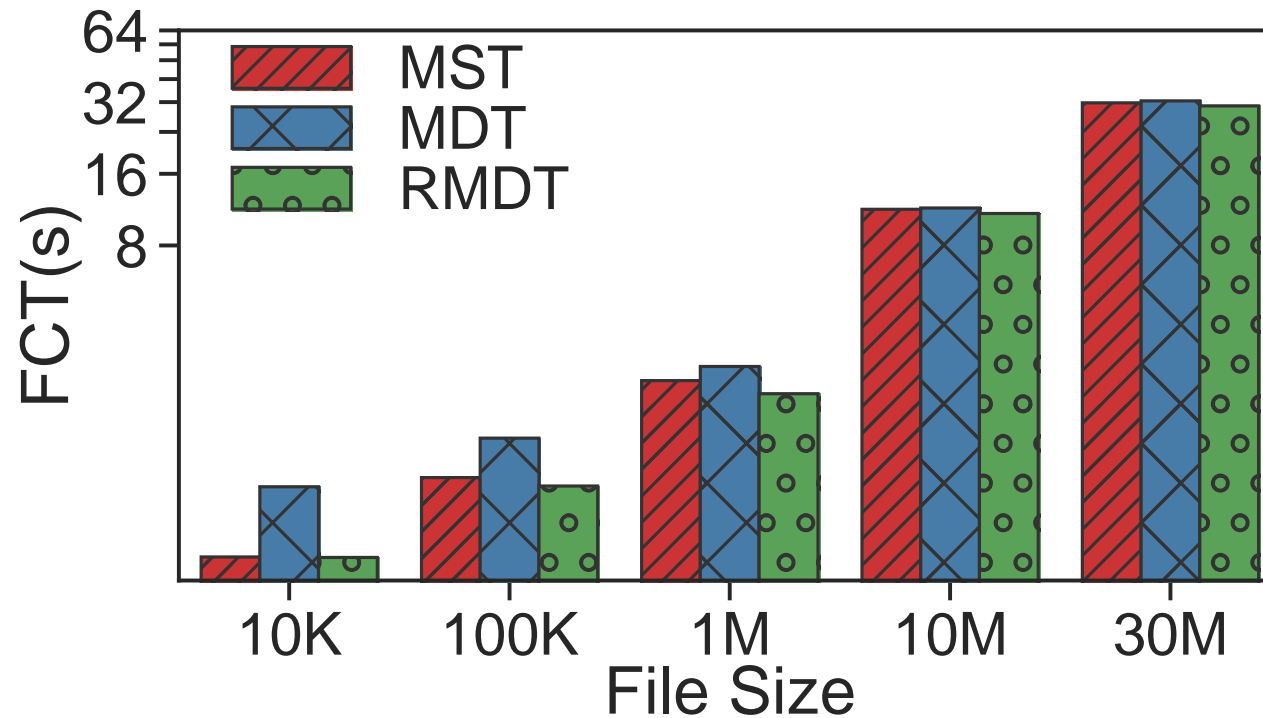
QUIC

Datagram

Masque Datagram Tunnel(**MDT**)

Masque Datagram Tunnel
with Retransmission(**RMDT**)

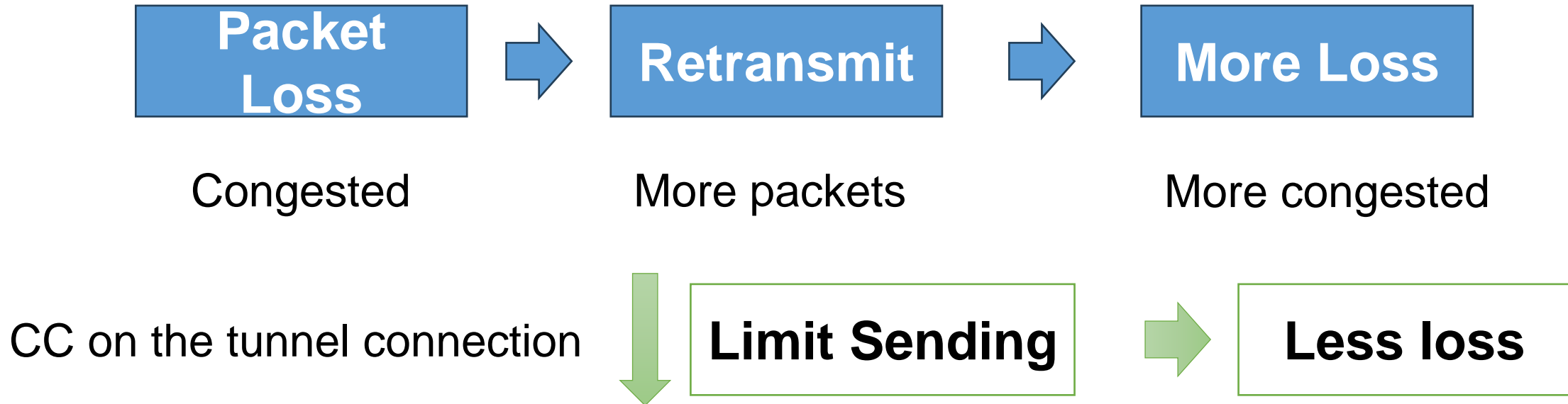
➤ Performance Comparison



Retransmission leads to better performance

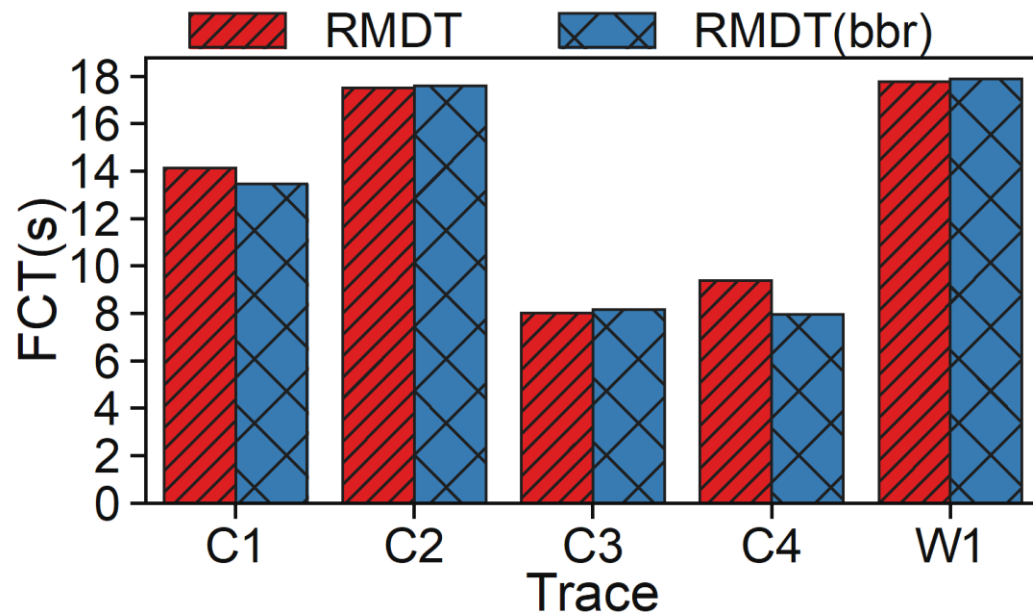
➤ The Cost of Retransmission

Congestion may be exacerbated

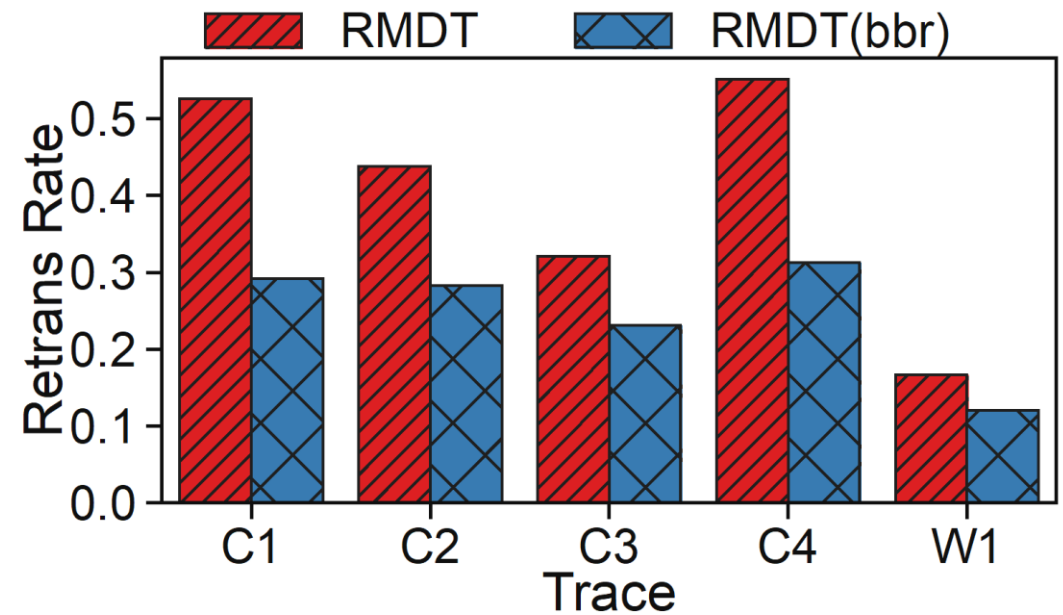


➤ Comparison with/without CC

Mobile Trace with Mahimahi

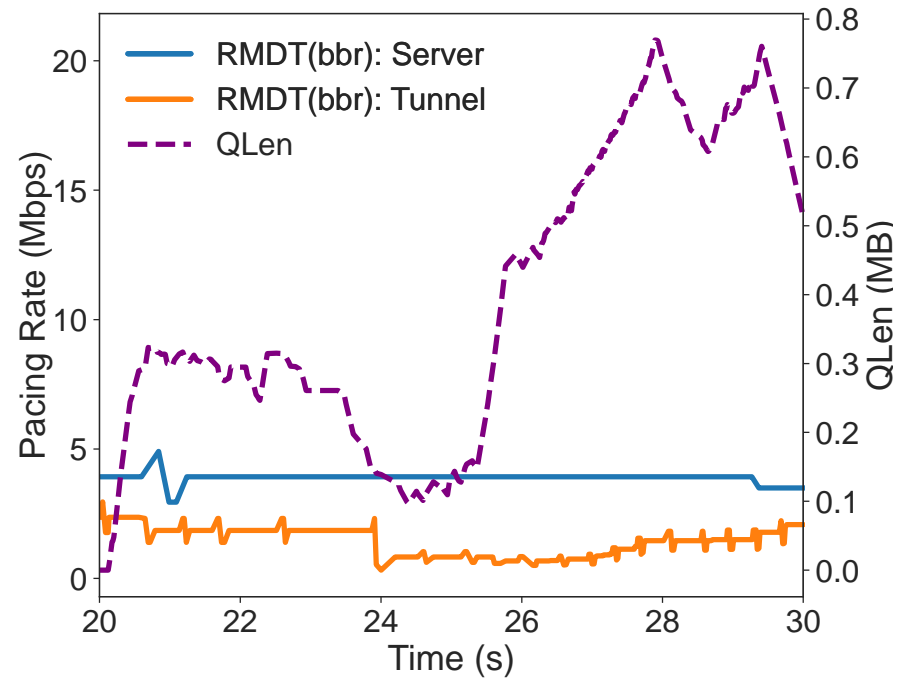


Frequent Bandwidth Changes

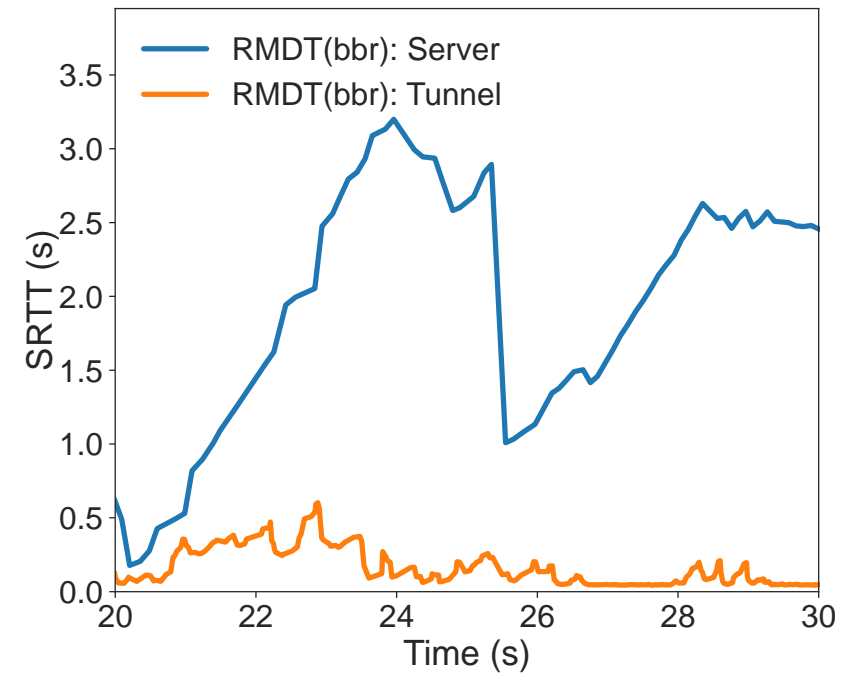


Why FCT(s) are similar?

➤ Nested CC



Mismatch of CCs

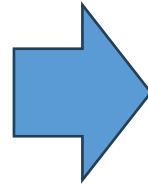


Packet Queue Accumulation

➤ TECC Solution

**Nested CC State
Synchronization**

**Offload CC to
Tunnel Server**



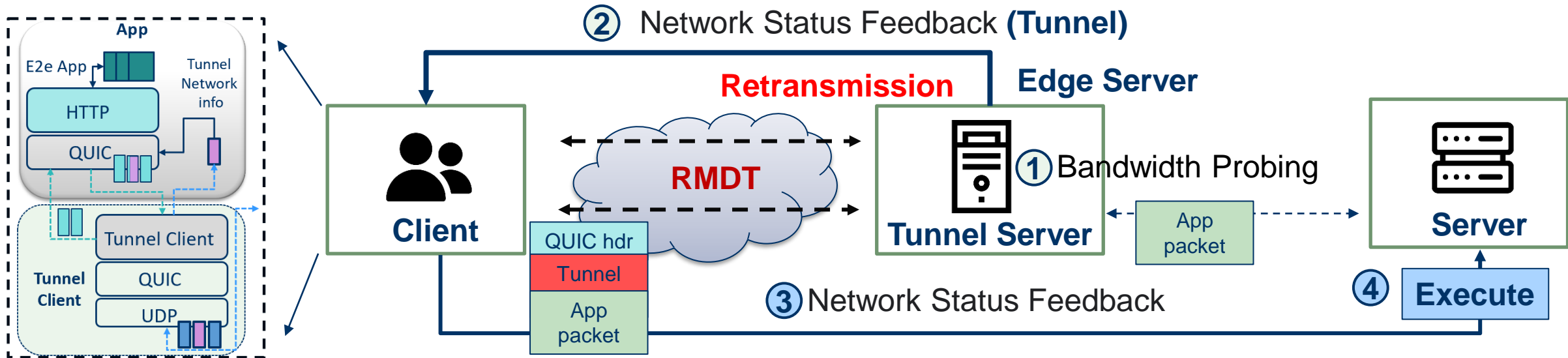
**Monitor Network Status
at Tunnel Server**



**Synchronize Network
Status to Server**

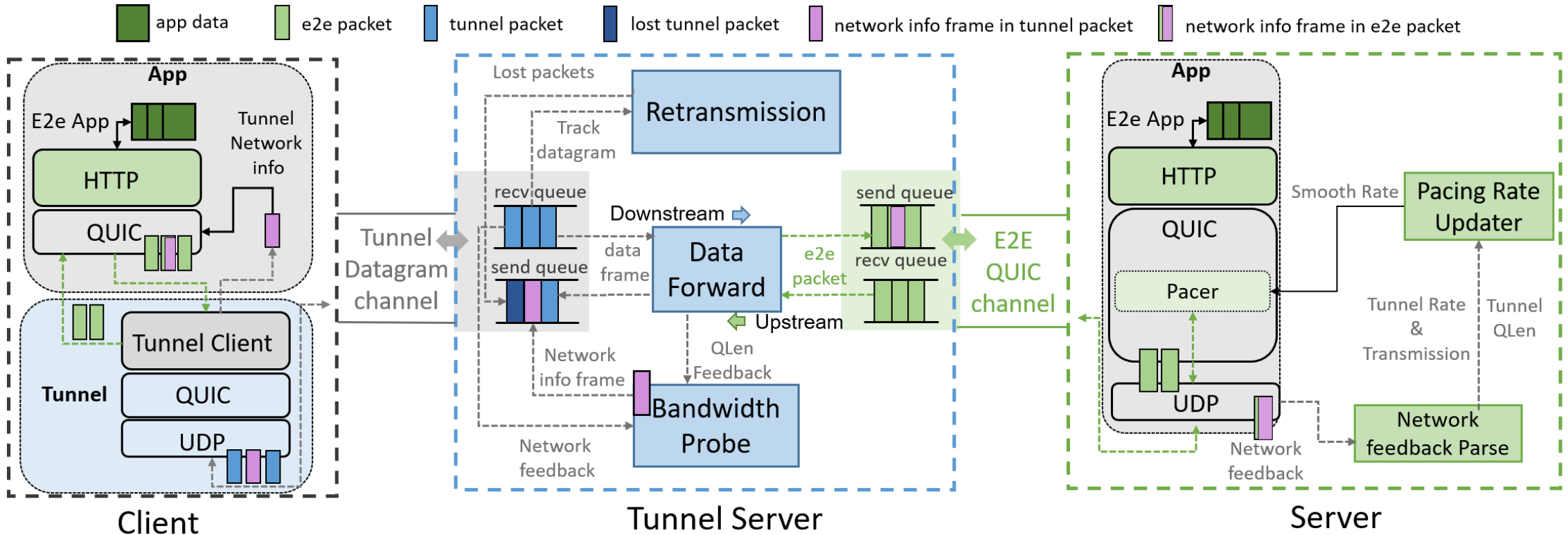
Shorter control loop

➤ TECC Overview



Path: Tunnel Server → Tunnel Client → Client → Server

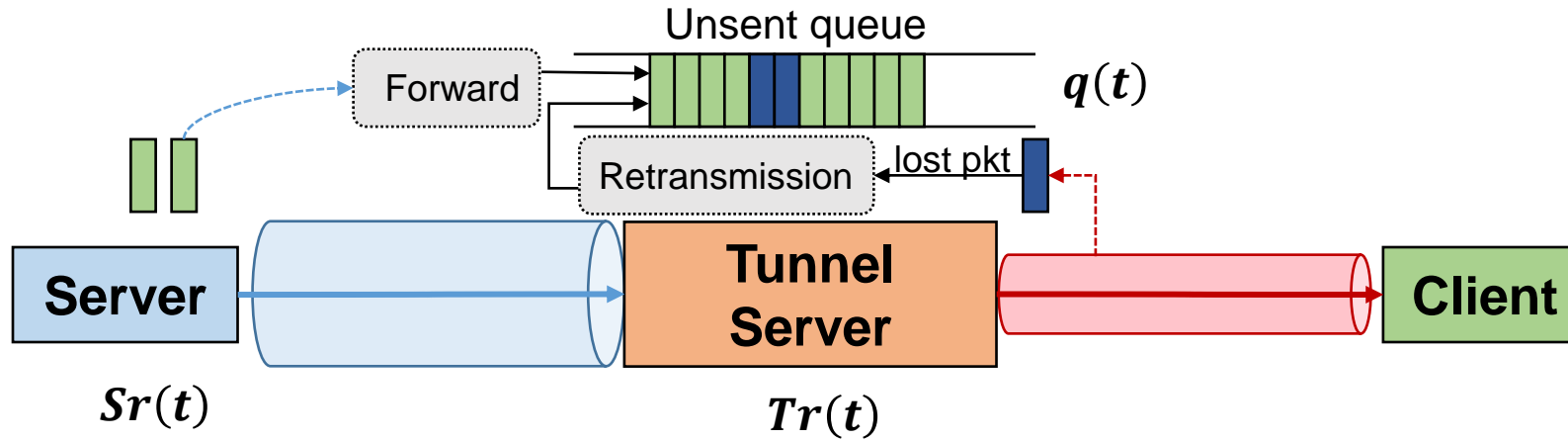
TECC Feedback Loop



Server Sending Rate Calculation

➤ Sending Rate - Queue length

$$Sr(t) = U(t) \times Tr(t), U(t) \in [0, 1]$$



$$q(t) \uparrow \quad Sr(t) \downarrow \quad q(t) \downarrow \quad Sr(t) \uparrow$$

$$Sr(t) = Tr(t) - \frac{q(t)}{\theta}$$

$Sr(t)$: sending rate of server
 $Tr(t)$: sending rate of tunnel
 $q(t)$: queue length of tunnel
 θ : time to clear the queue

After extensive experiments, we set θ to $\frac{2}{3}RTT_{(\text{tunnel})}$

➤ Sending Rate – Retransmission

● Tunnel Retransmission → Packet Queue

$$Sr(t) = Tr(t) - \frac{q(t)}{\theta} \quad \rightarrow \quad Sr(t) = Tr(t) - \frac{q(t) + \delta r(t)Tr(t)}{\theta}$$

$\delta r(t)$: retransmission rate

$$U(t) = 1 - \frac{q(t) + \delta r(t)Tr(t)}{\theta Tr(t)} \quad \leftarrow \quad Sr(t) = U(t) \times Tr(t), U(t) \in [0, 1]$$

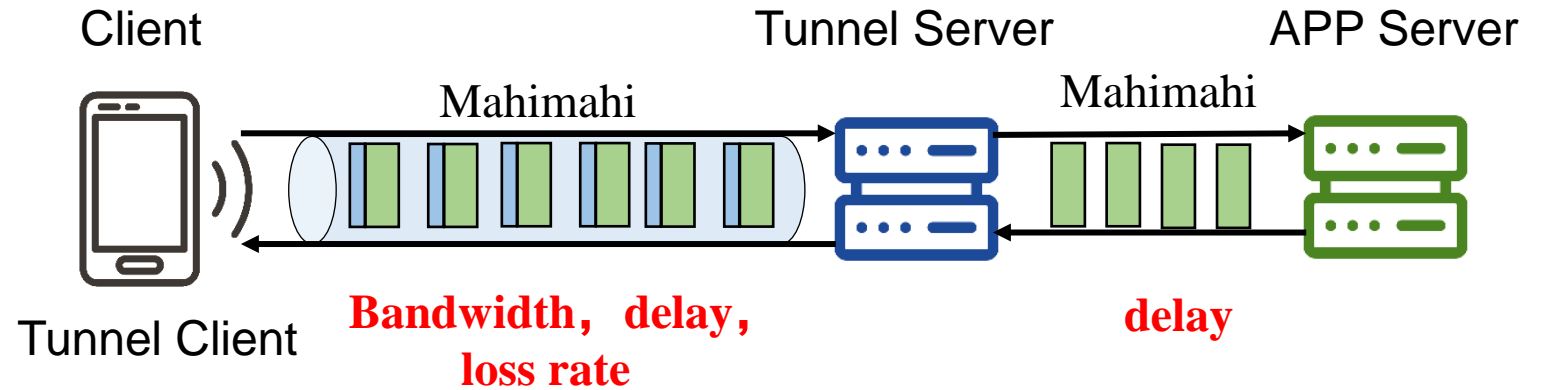
When $U(t)$ is too small? ?

$$U(t) = \max\left\{1 - \frac{q(t) + \delta r(t)Tr(t)}{\theta Tr(t)}, 1 - \text{max_pf}\right\}$$

max_pf: maximum percentage of rate reduction

➤ Evaluation

Emulated Networks



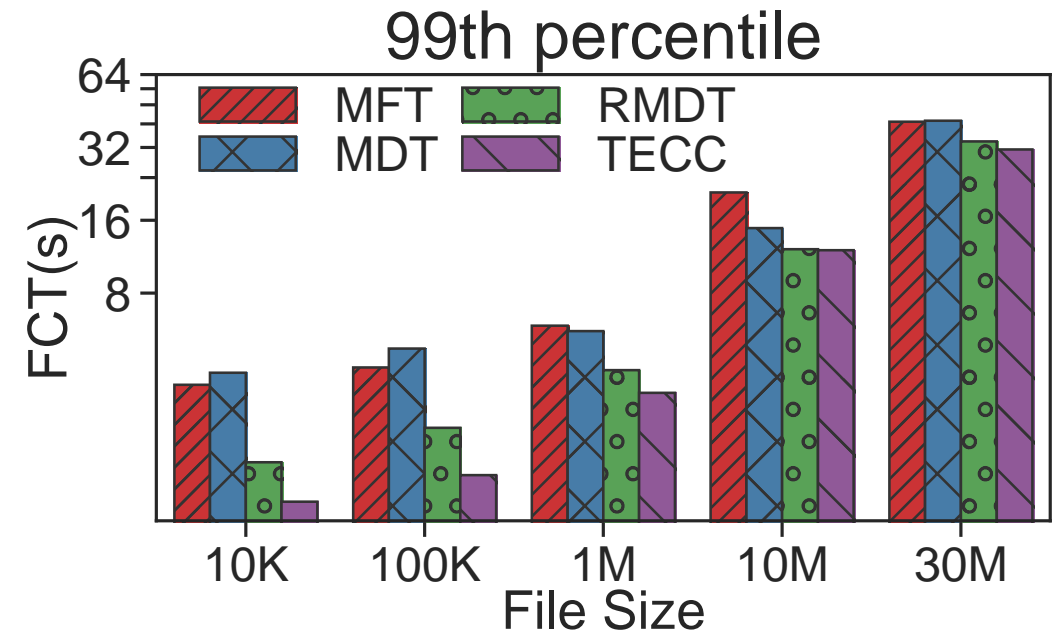
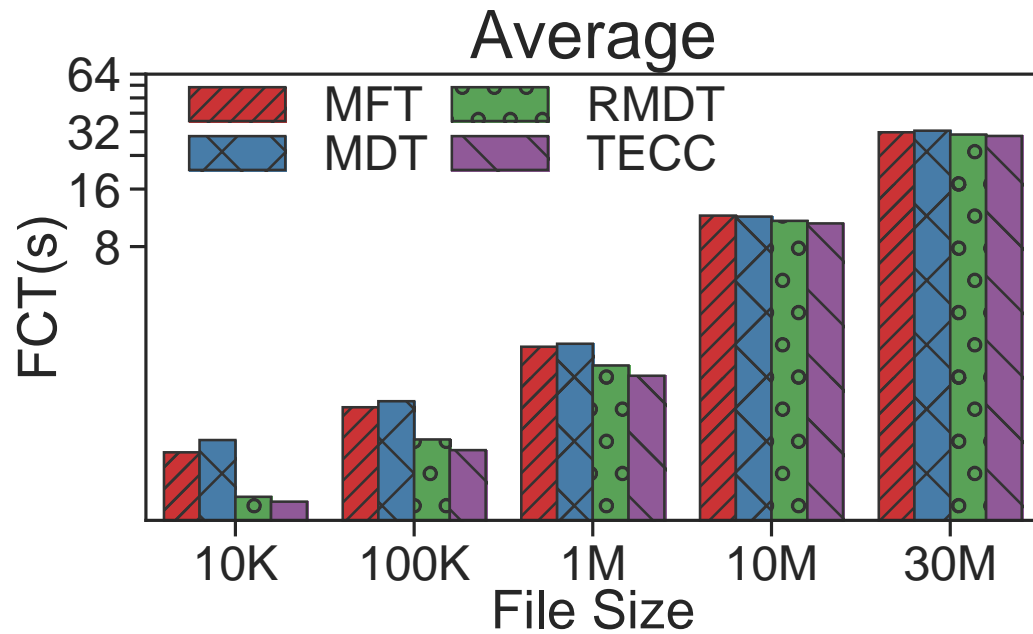
MFT: Non-tunnel

MDT: Masque Datagram Tunnel

RMDT: Masque Datagram Tunnel with Retransmission

➤ Evaluation: Performance

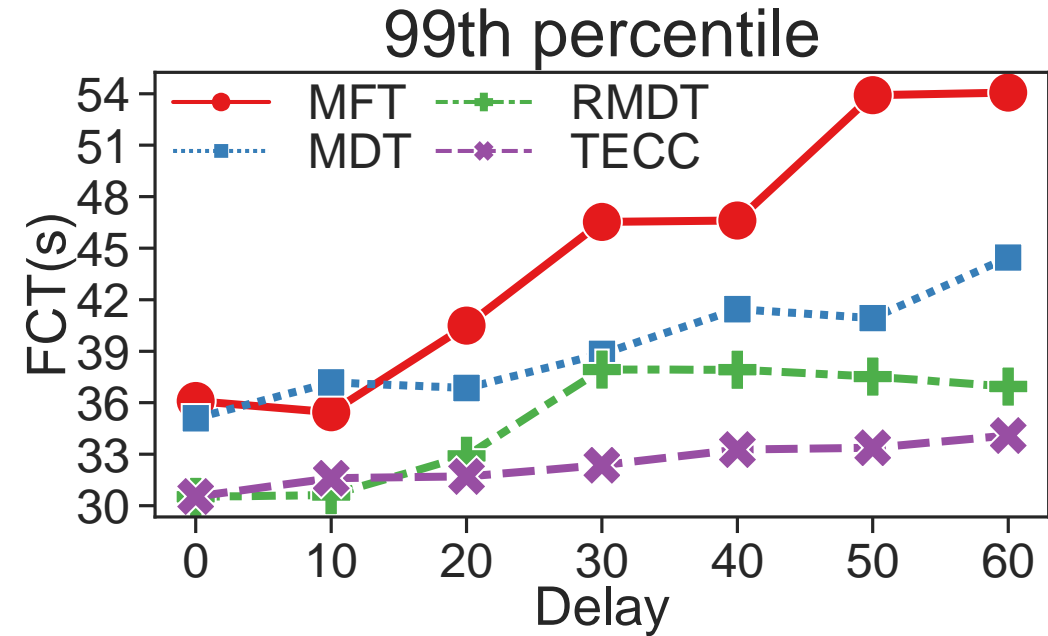
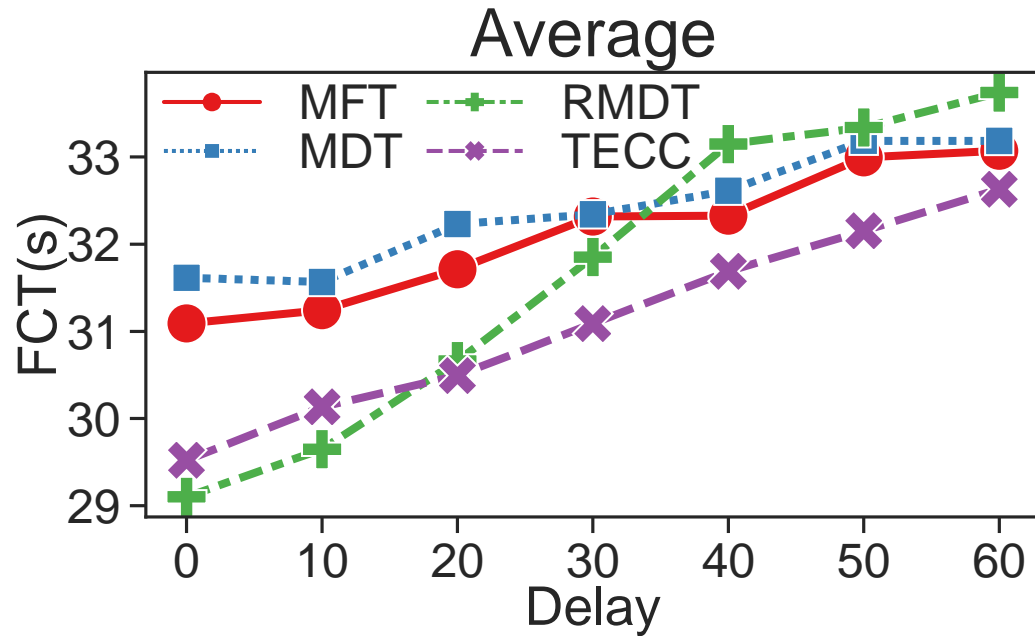
Different file size



TECC reduces FCT, particularly for short flow.

➤ Evaluation: Performance

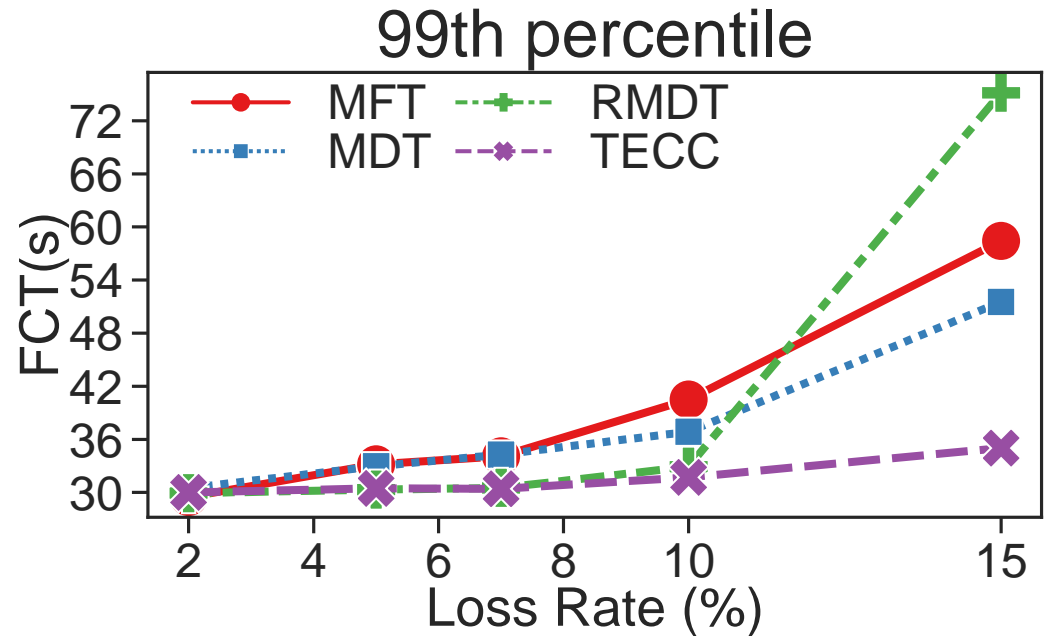
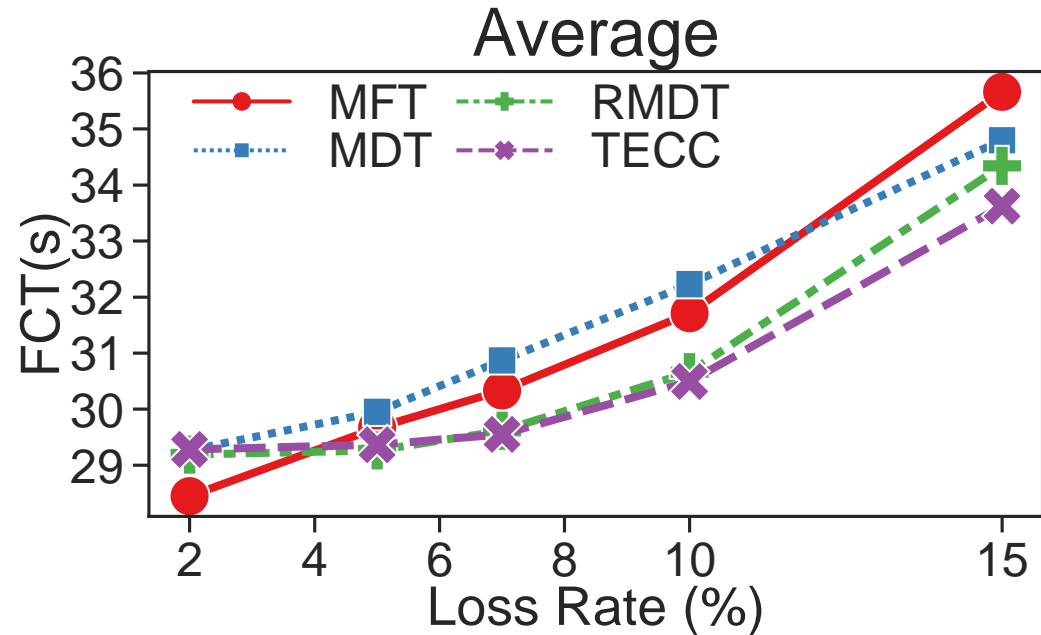
Different client-tunnel delay



Lower delay -> More benefits

➤ Evaluation: Performance

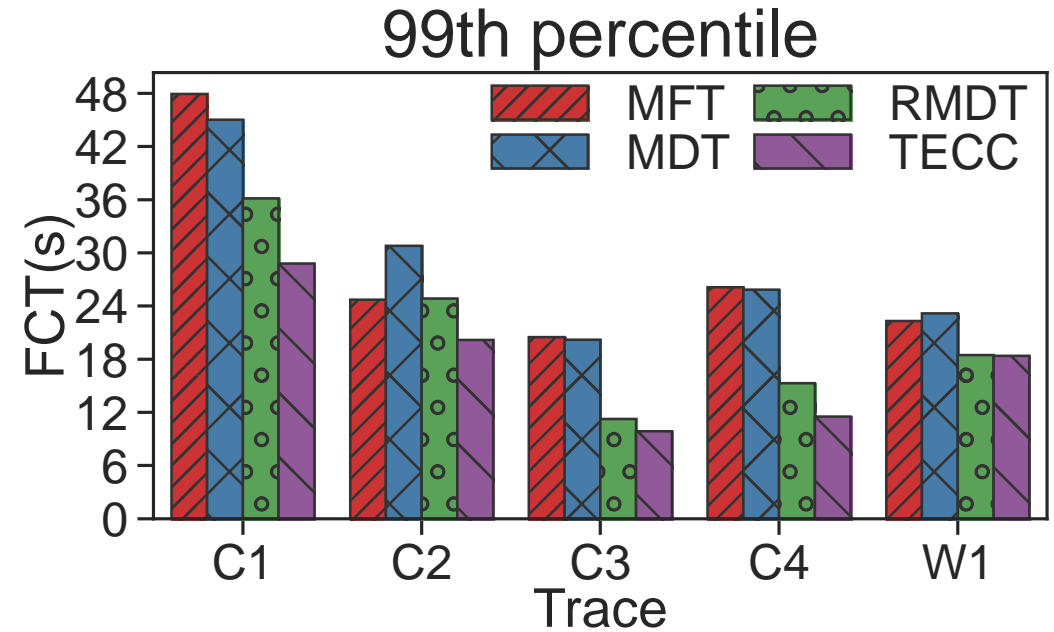
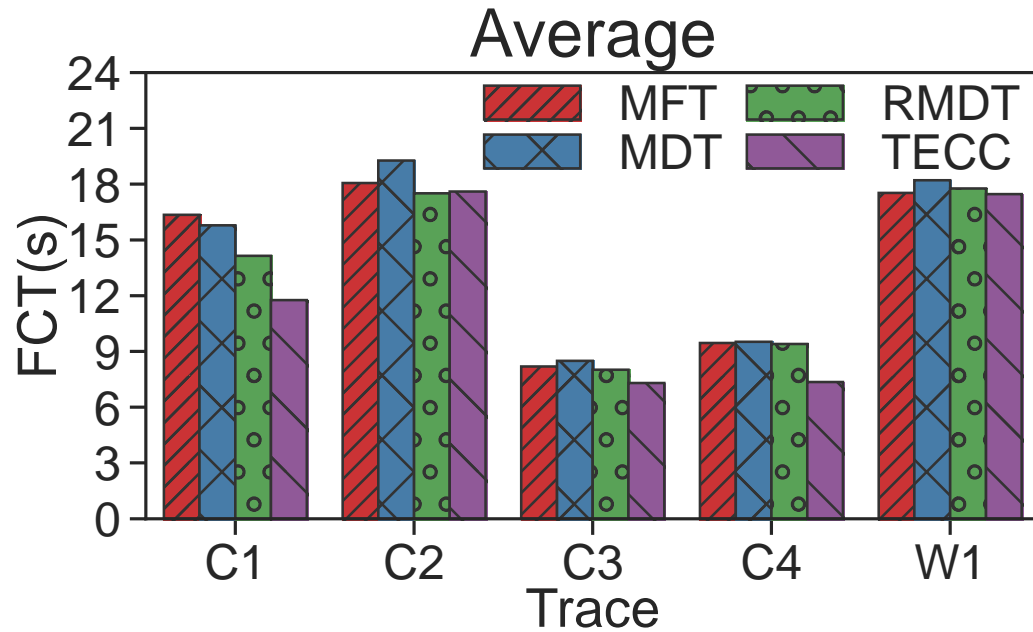
Different loss rate



Higher loss rate -> More benefits

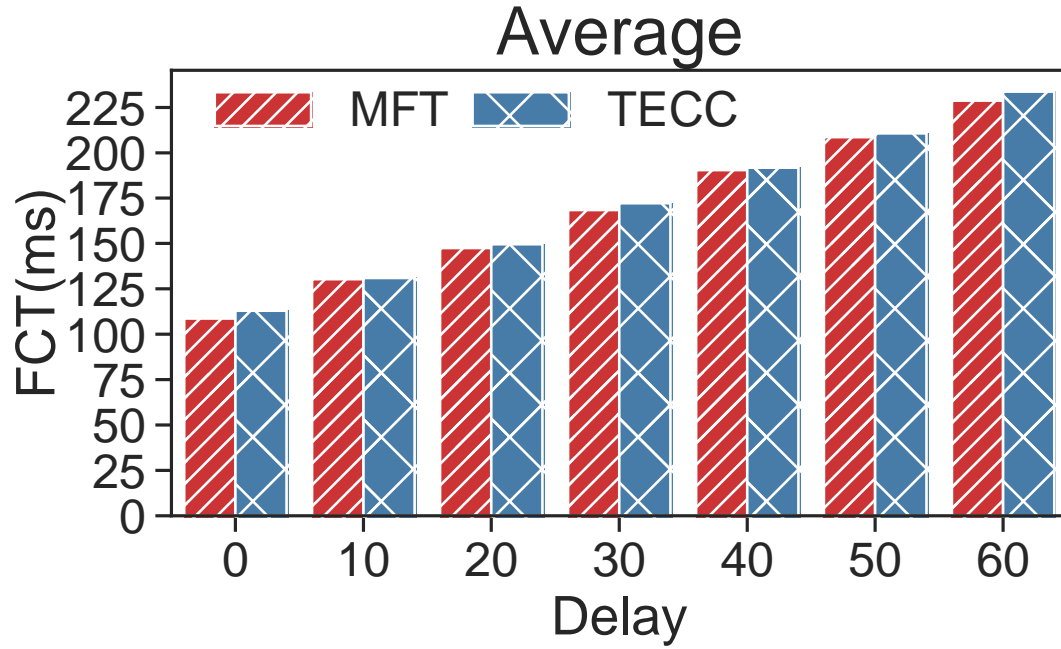
➤ Evaluation: Performance

Different network traces

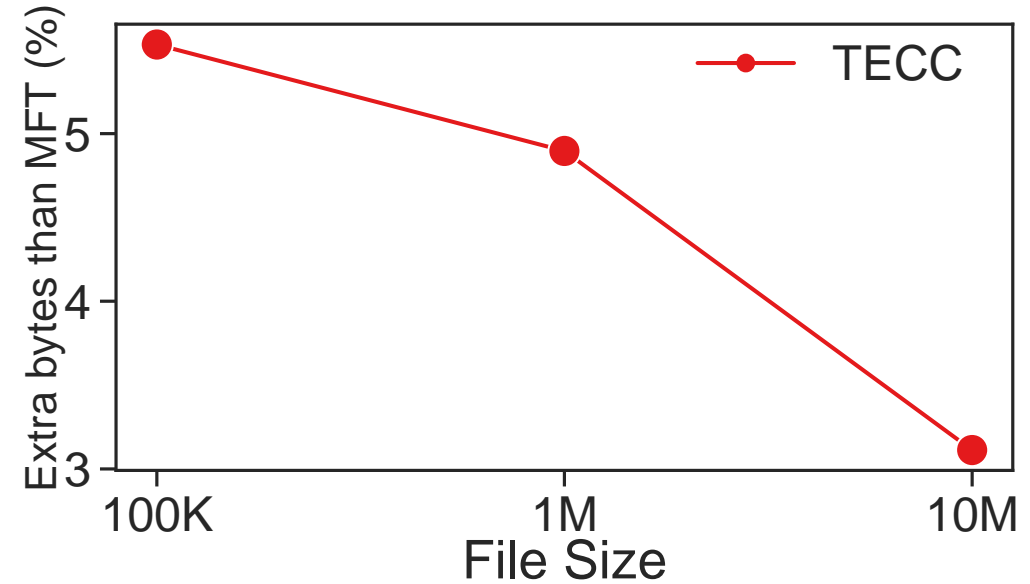


More performance gain at the 99th percentile

➤ Evaluation: Overhead

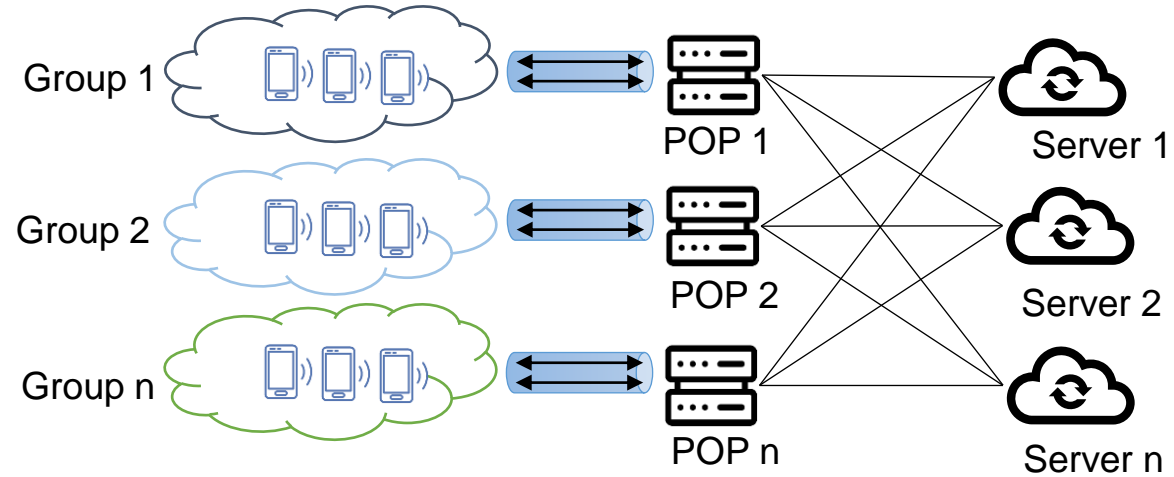


The setup delay increases no more than **2%**.



Overhead is reduced as flow size increases.

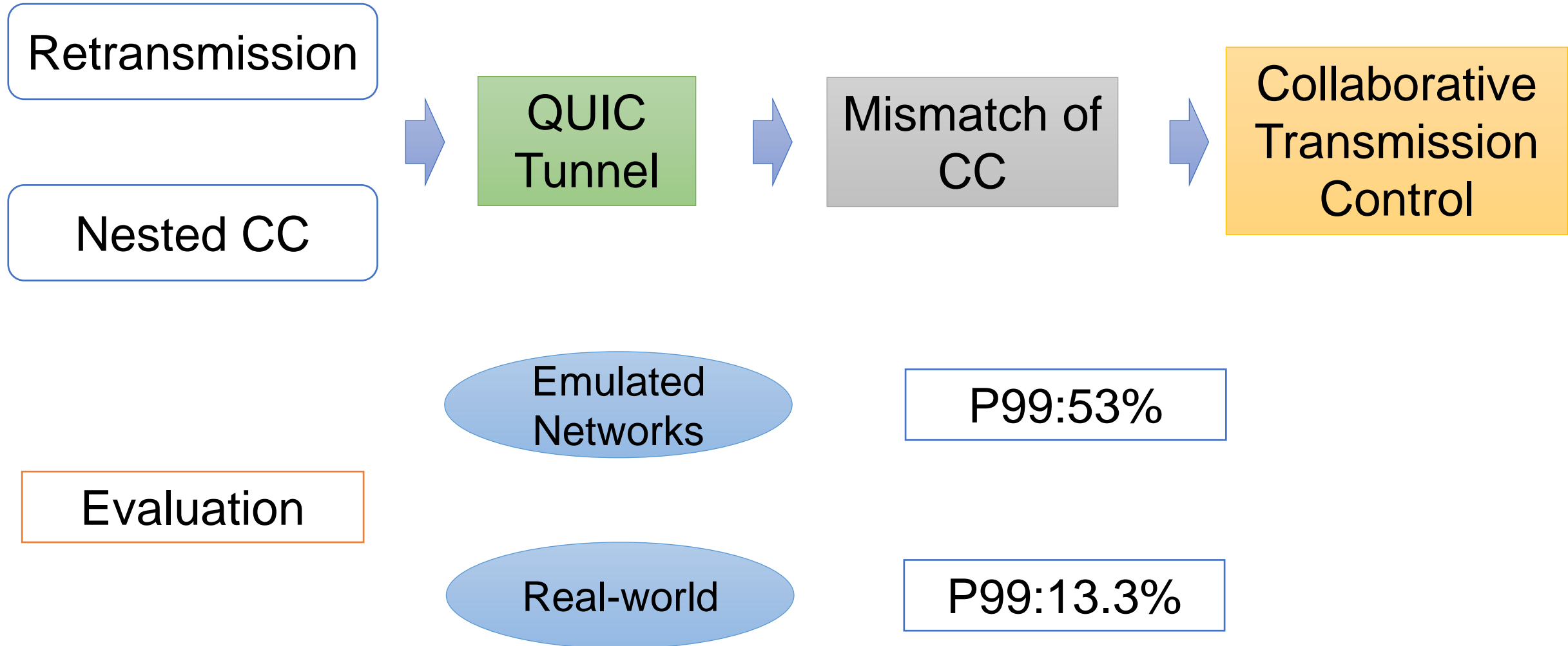
➤ Evaluation: Real-world A/B Tests



Baseline: MDT

	mean	p95	p99
MST	2.7%	1.9%	6.0%
TECC	3.9%	4.5%	13.3%

➤ Conclusion



Thank You

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