On the Performance of Middleboxes

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(Work done while with BBN Technologies)

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"Holly came from Miami, FLA; Hitch-hiked her way across the USA"

Middleboxes

- "Middleboxes" have cropped up all over the Internet for a variety of reasons:
  - security (firewalls, normalizers, etc.)
  - performance (PEPs, TCP snoopers, etc.)
  - address translation (NATs)
- Many have espoused the virtues and evilness of these entities.
- But, little quantitative information about their impact in real networks.
- We conducted a preliminary evaluation of one middlebox setup.

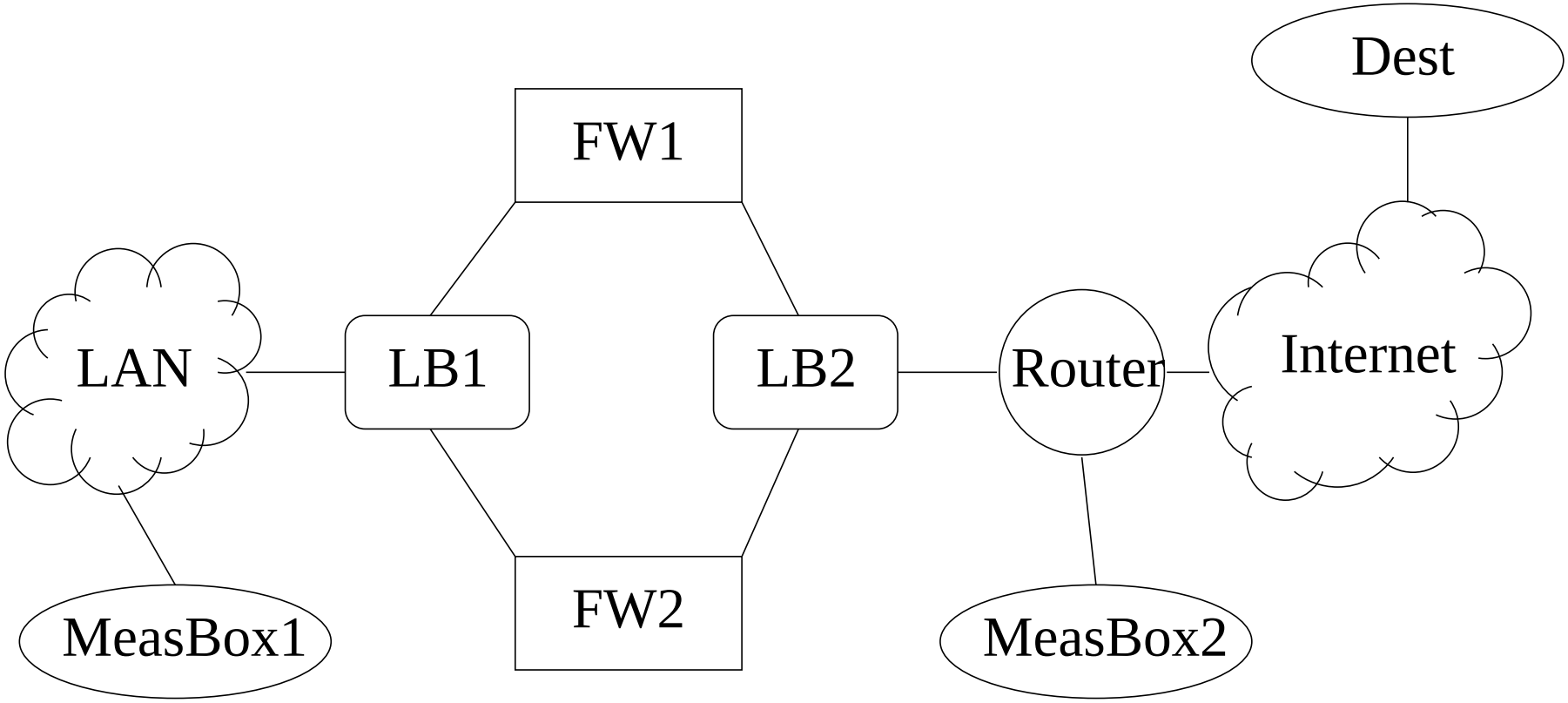
Experimental Setup

- Application measurements
  - Packet tracing and matching is future work
- Measurement period: 10/14/2002 - 1/27/2003
- Conducted in a production setting
  - A network serving thousands of users

Experimental Setup (cont.)

- Measured:
  - Transaction delay
  - Feedback time (aka "RTT")
  - Bulk transfer
  - FTP performance
    - See the paper
- Also, failures.

Experimental Setup (cont.)



- Firewalls + Load Balancers = MBI

Transaction Delay

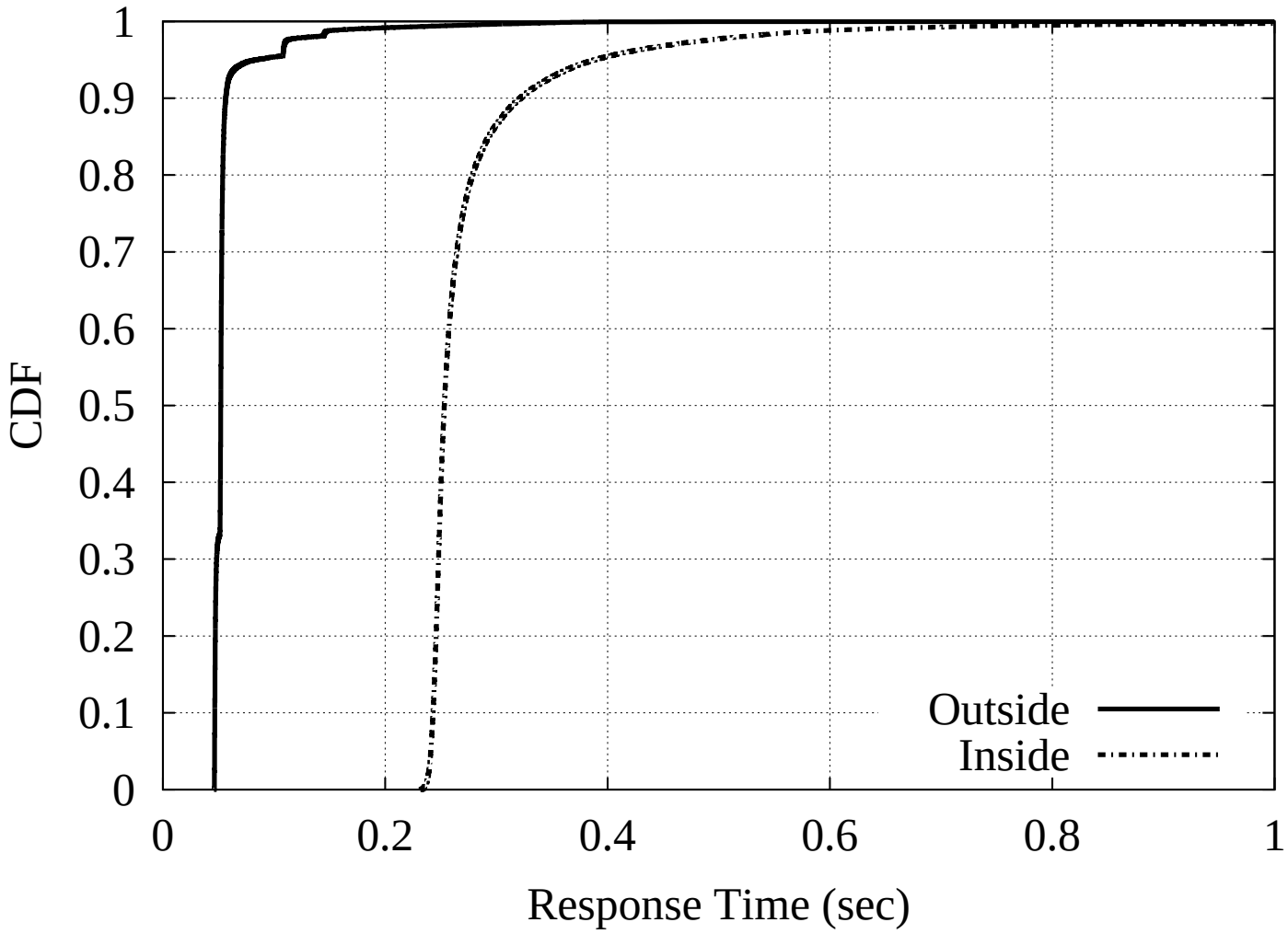
- How long does it take to start from nothing and run a transaction between a client and the server?

- Procedure:
  - A finger transaction between the client and server
  - Time the entire transaction at the application layer

- Conduct a transaction from each client roughly every 2 minutes.

- Over 75,000 transactions from each client.

Transaction Delay (cont.)



- 42 failures inside the MBI; 12 failures outside the MBI

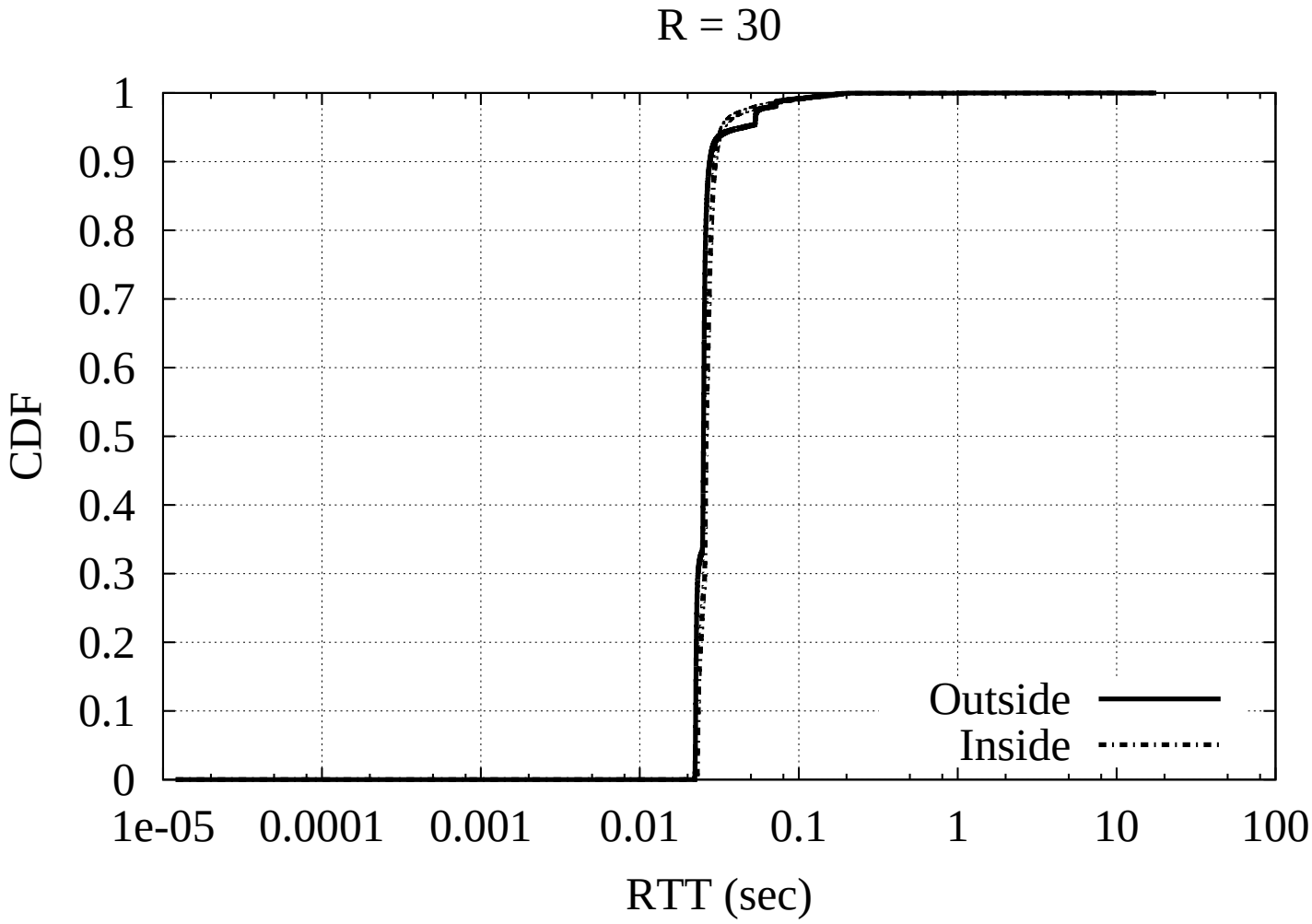
Feedback Time

- Once established, how long does it take to send a message across a TCP connection?

- Procedure:
  - Open a TCP connection between the client and server
  - Send "pings" from the client; echoed by the server
    - Every (roughly) N seconds
      - We only consider N = 30 seconds -- others are similar
    - Until one of the pings does not come back in 20 seconds
    - Then, start a new TCP connection and start over

- Over 303,000 pings from each client.

Feedback Time (cont.)



- Failed to setup connection: 51 from inside; 46 from outside

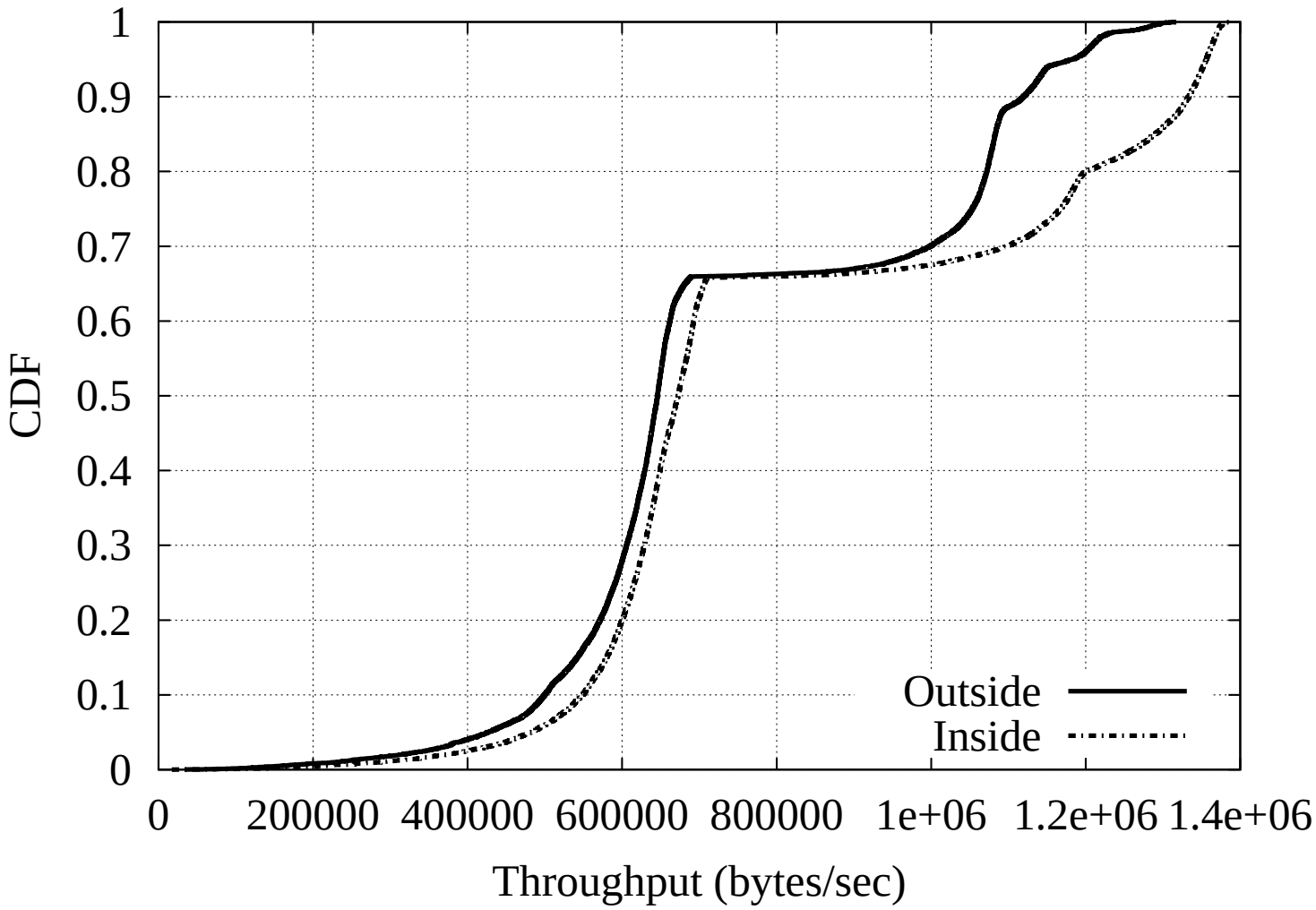
Feedback Time (cont.)

- Connection lengths are roughly twice as long from the outside as from the inside client
  - On mean and median

Bulk Transfer

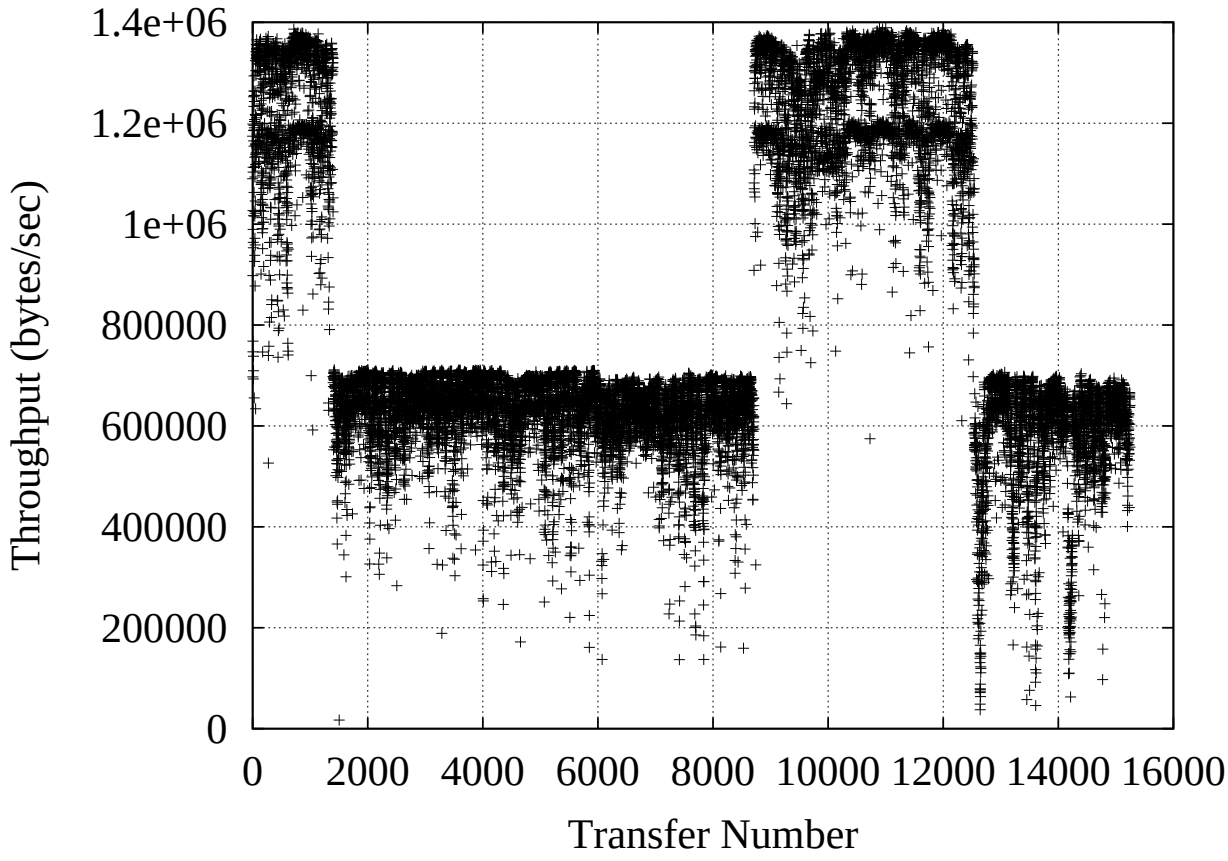
- Open a TCP connection
- Send 1 MB
  - Last 4 bytes are a random number
  - The server echos the random number back to the client
  - Measurement stops when the "ACK" arrives
- Conduct a transfer from each client roughly every 10 minutes.
- 15,000 transfers from each client

Bulk Transfer (cont.)



Bulk Transfer (cont.)

- Why the bi-model distribution?
  - Routing or provisioning changes



Bulk Transfer (cont.)

- Why the difference in performance?
  - Possibility #1: Concatenated TCP connections
    - shorter control loop
    - isolate drops
  - Possibility#2: Maybe a difference in TCP's congestion control algorithms inside and outside the MBI.

Conclusions

- Performance comparison is a muddle of contradictions
  - Bulk transfer performance is enhanced by the middleboxes
  - Transaction times increase roughly 5 times when going through the middleboxes
- Failures increase when going through the middleboxes
  - But, failures are very low in all the cases (over 99.9% across all measurements).

Future Work

- Tons
- Lots of questions can be better answered if we had packet traces from various points throughout the middlebox infrastructure.
  - Requires lots of analysis and correlation that may be non-trivial
- We can pin down why the performance is different
  - E.g., are the MBI elements getting out of sync?
  - E.g., are the firewalls dropping state?
  - Etc.
- Gather data from more locations and different kinds of middleboxes