A Platform for Unobtrusive Measurements on PlanetLab

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http://www.cs.umd.edu/projects/sidecar

Need for Measurements

Measurements benefit many applications:

- Performance optimization [OASIS]
- Overlay construction [i3]
- Network diagnosis [PlanetSeer],[CoMoN],[iPlane]

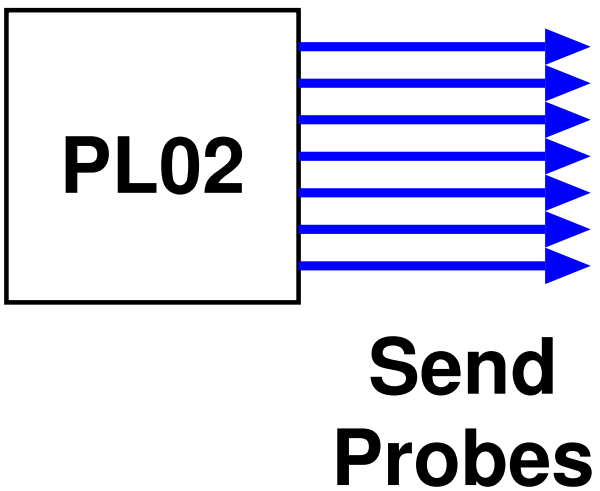
Grand Challenge:

- Collect a "Day in the Life"
  - CSTB *Looking Over the Fence* report

Why Not Just Measure Everything?

for src in PlanetLab **do**
  ssh to src
  for dst in All Addresses **do**
    Traceroute dst
    Ping dst
    Pathchar dst
    Other measurements ...

Why Not Just Measure Everything?



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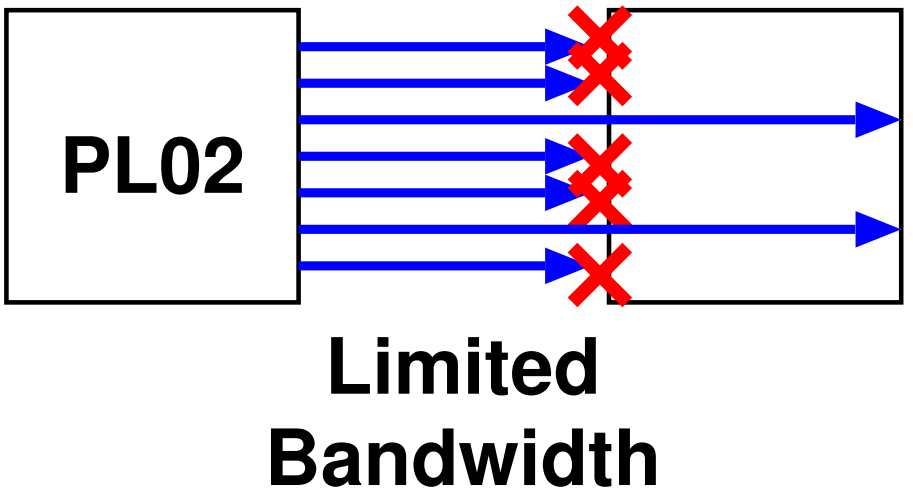

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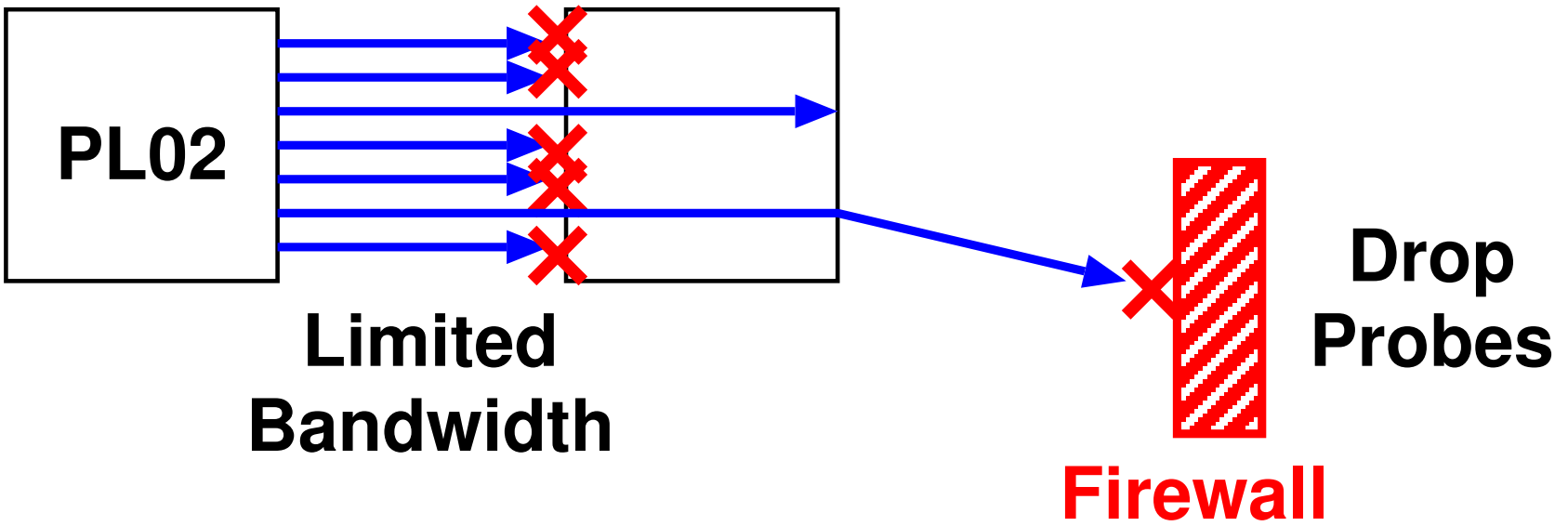

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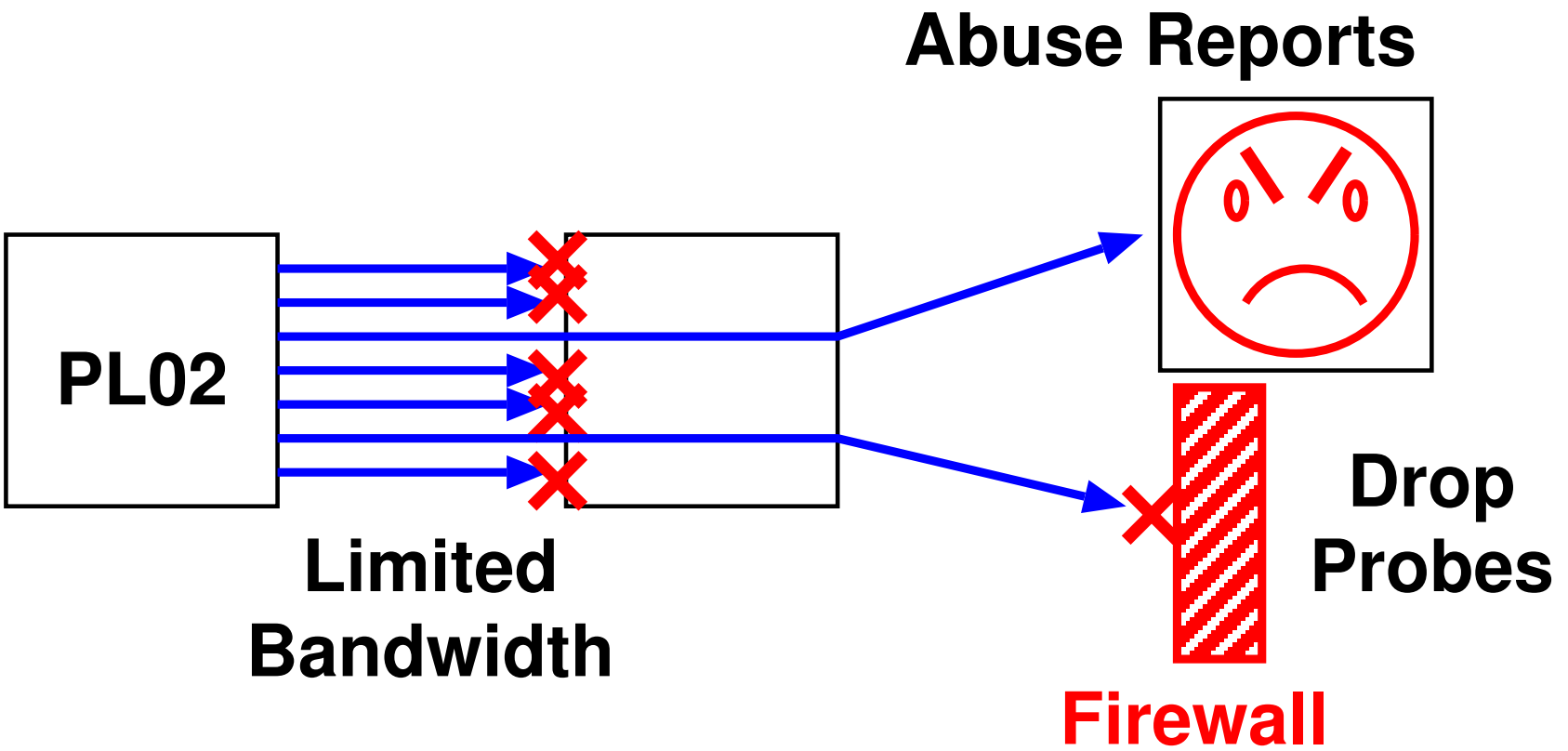

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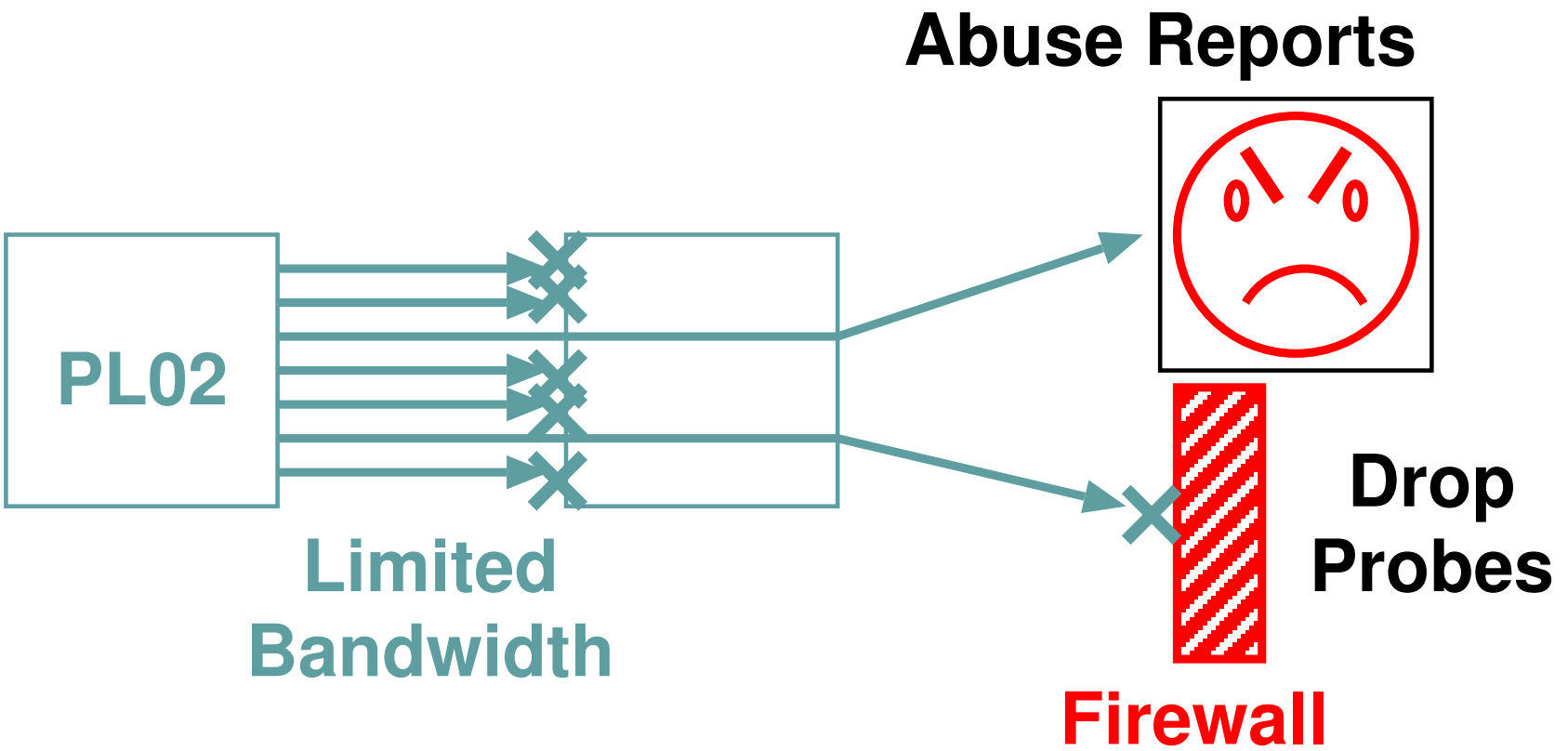

Abuse Reports

- Measurement traffic exceptional
- Exceptional == suspicious
- Reports of network abuse are handled with care
  - Thank you Mark Huang and PL Staff!
- Curtails experiment scope

Measurement Platform: Sidecar

Inject probes into normal traffic:

- Probes are retransmissions
- Avoids abuse report
- Allows firewall/NAT traversal

General measurement platform:

- Latency — Sideping
- Bottleneck location — Artrat
- Topology — Passenger [IMC06]

Talk Overview

- How Sidecar works
- Learning from Sidecar
- What Sidecar can do

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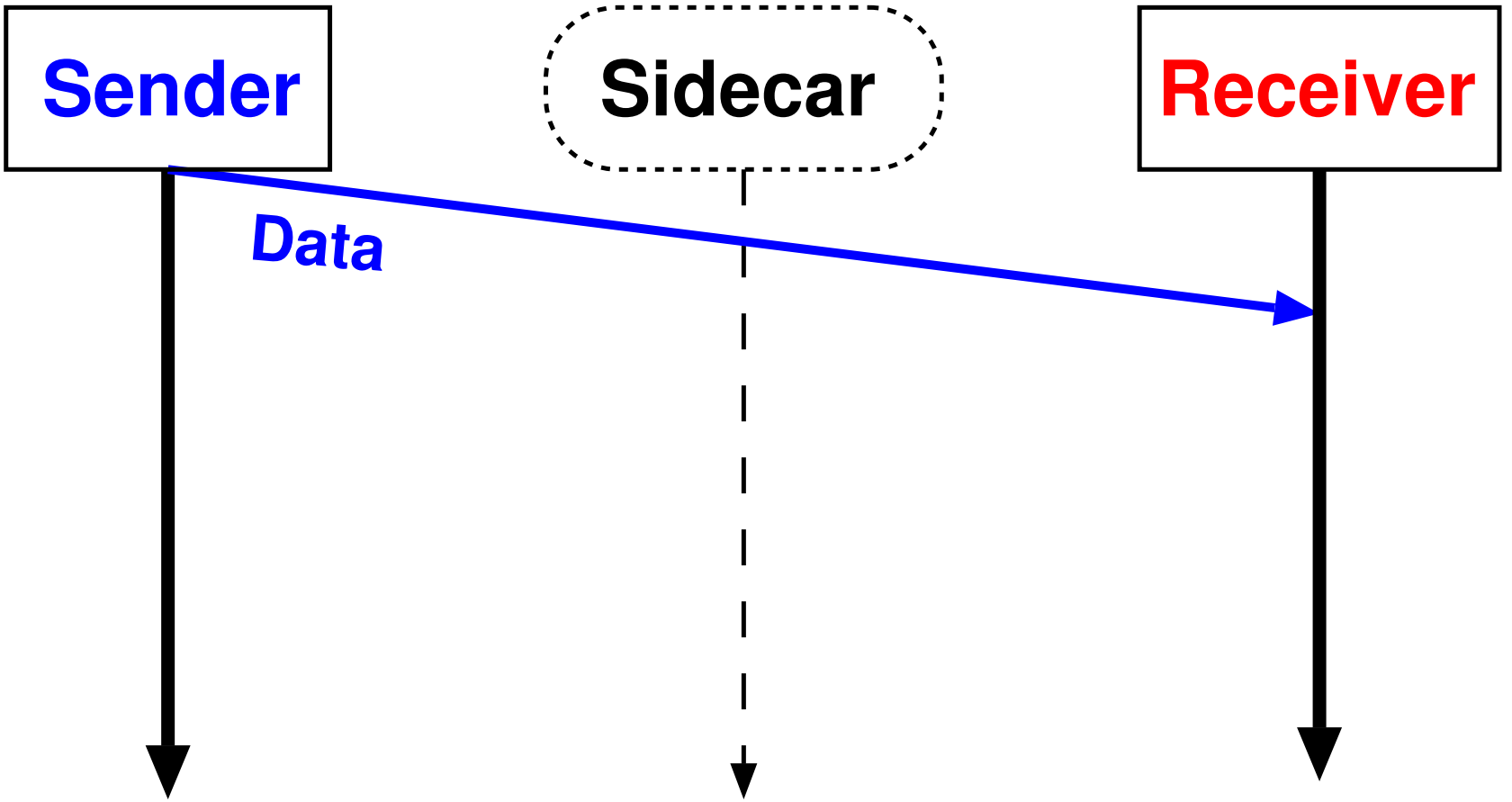
Sidecar Probes



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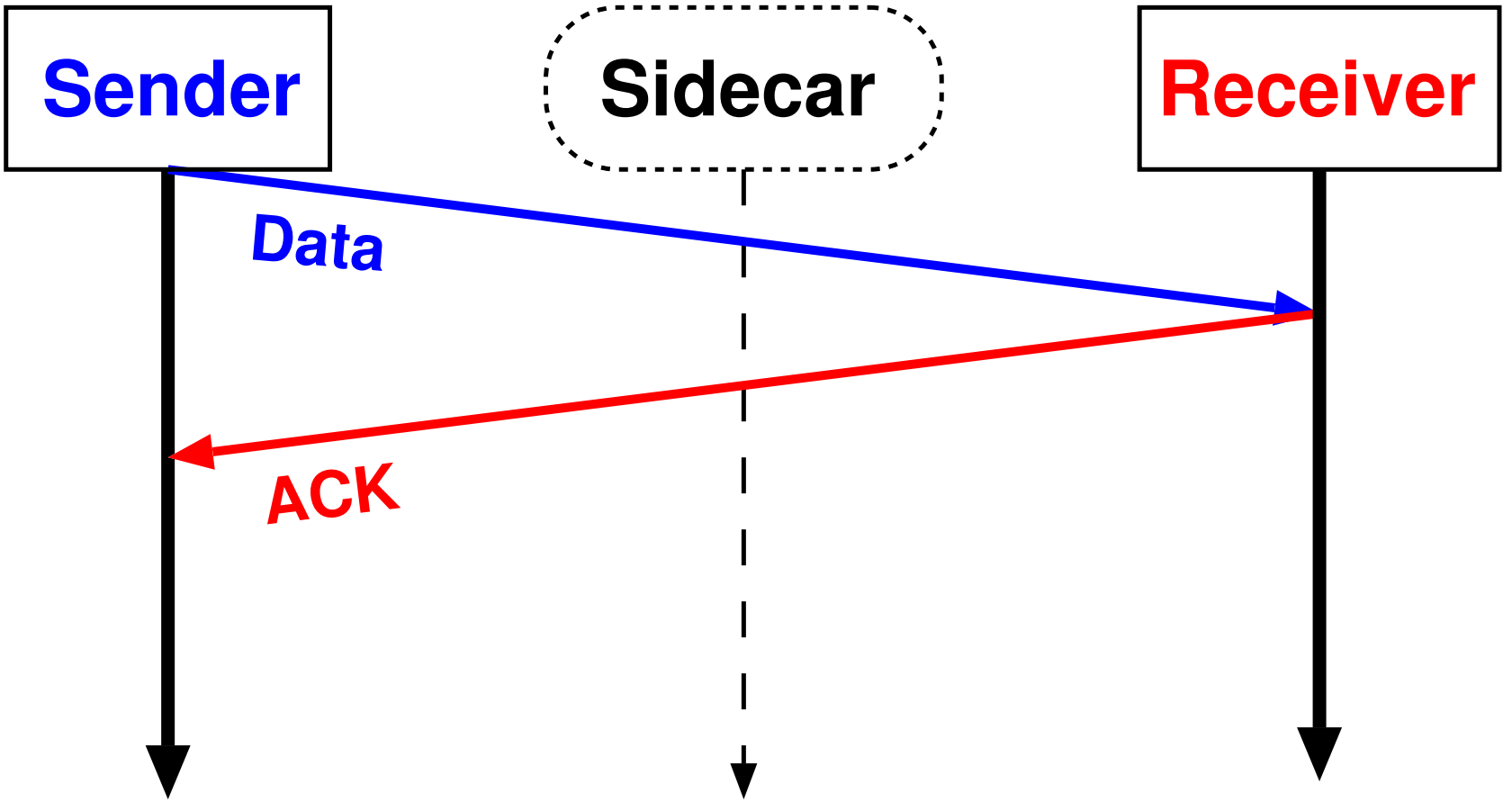

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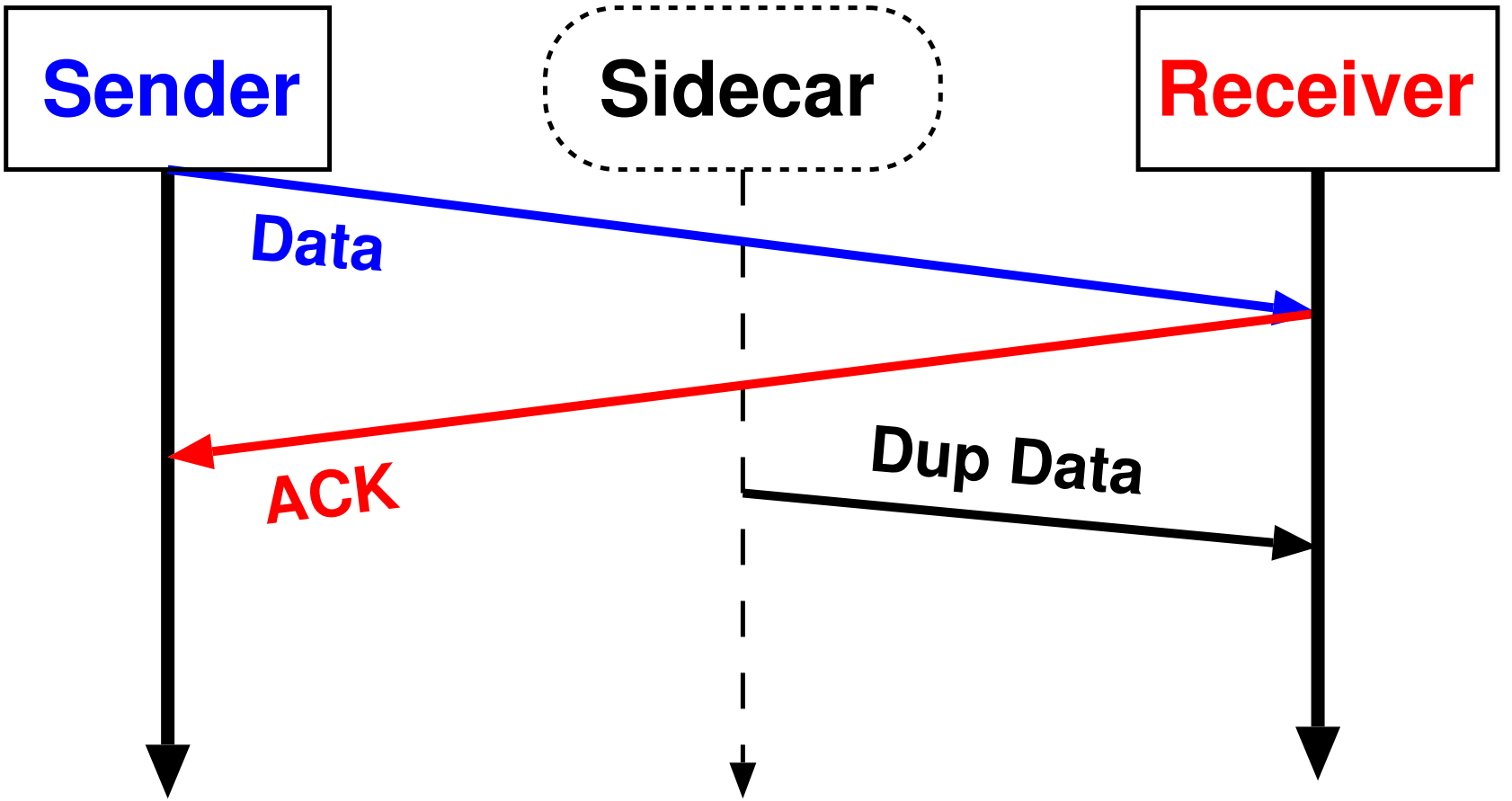

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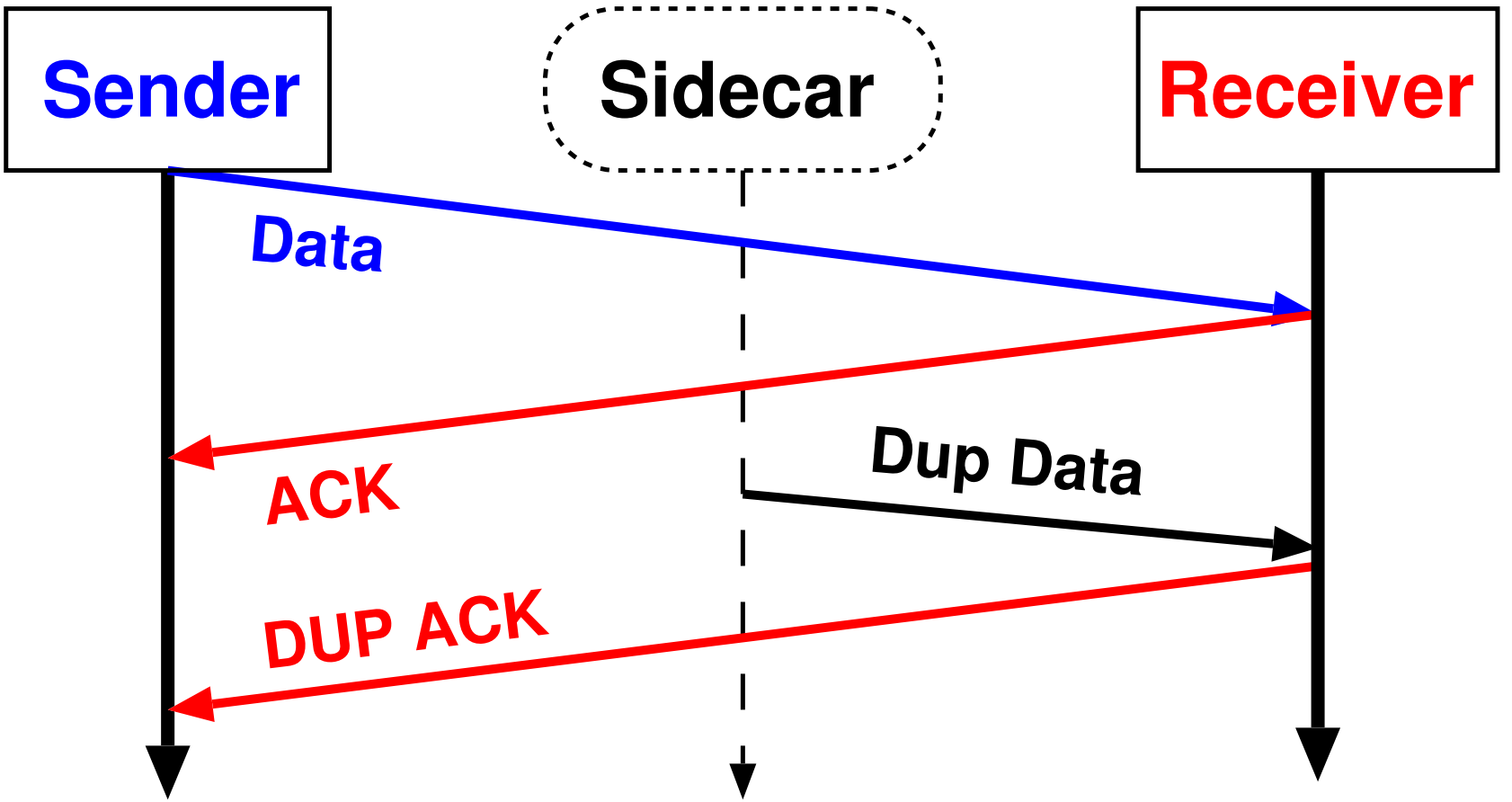
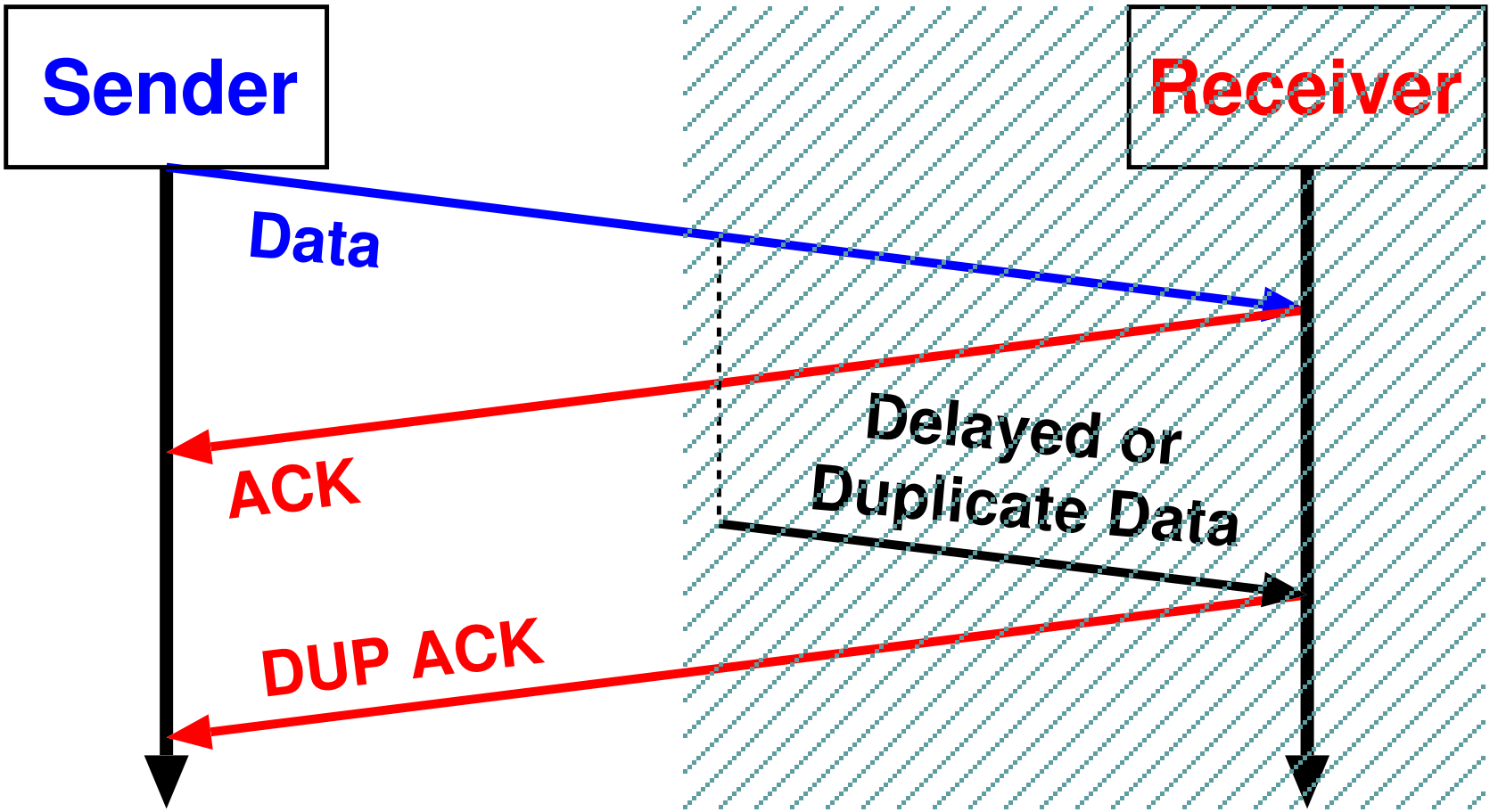
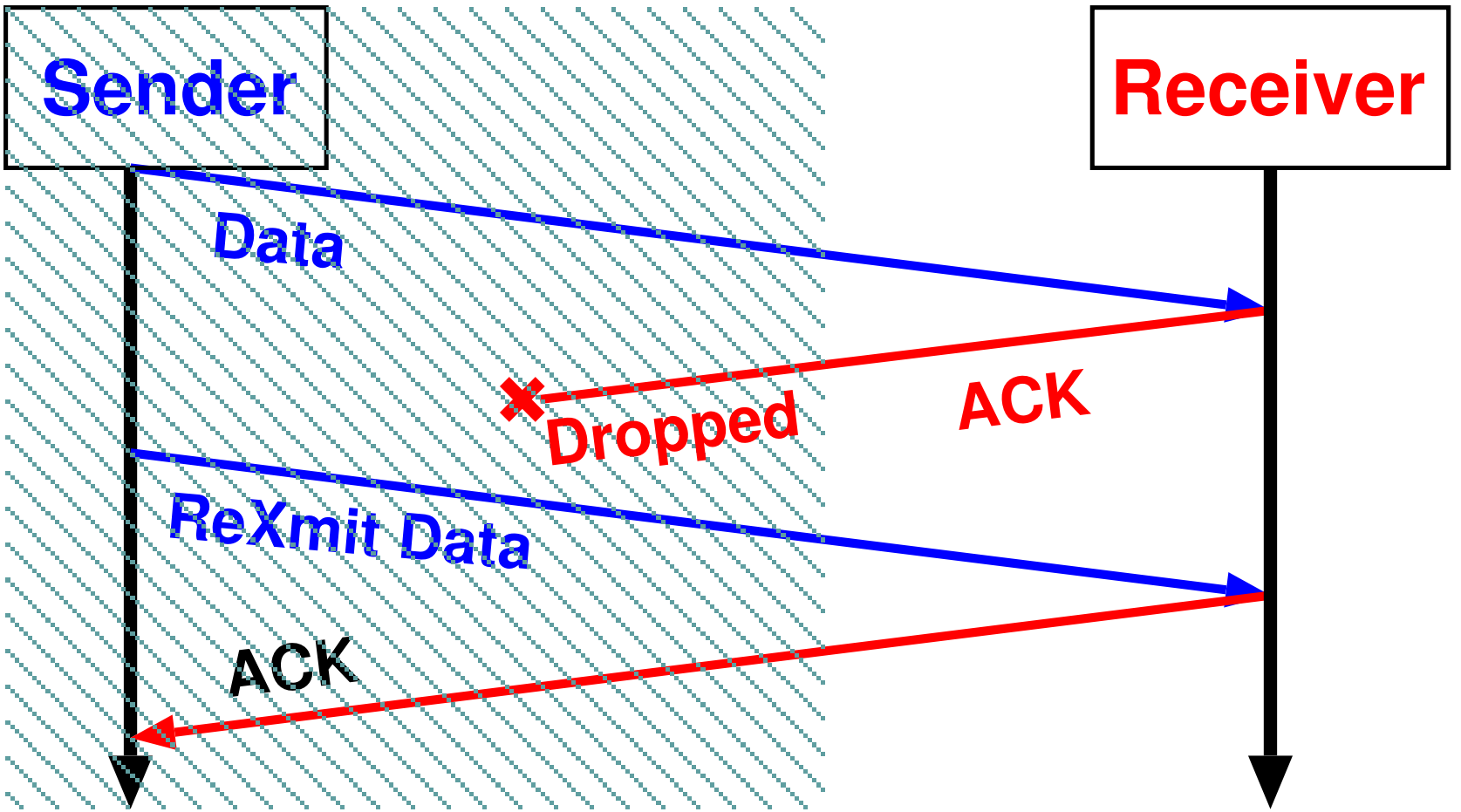


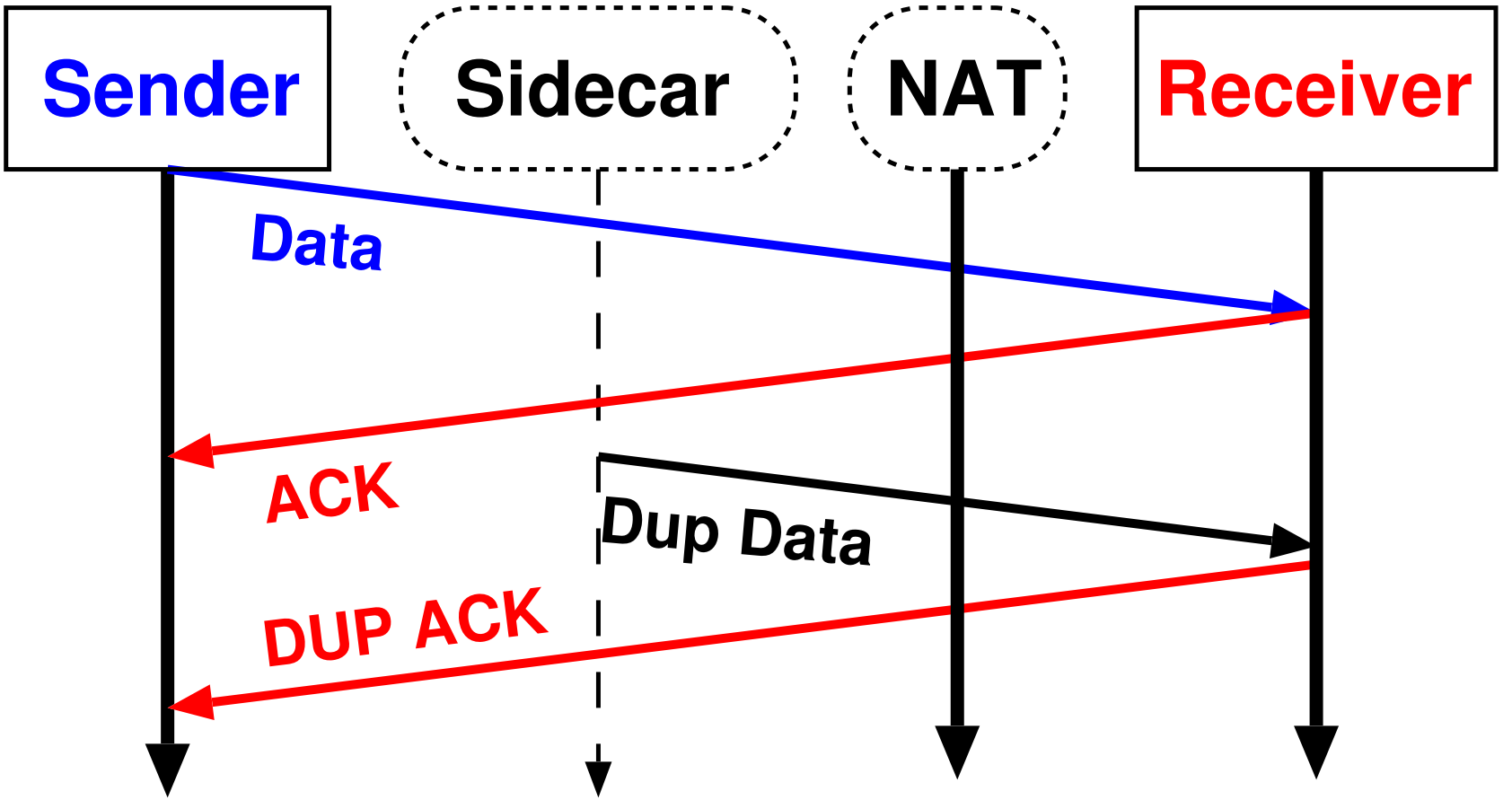
Sidecar Probes: Sender's View



Sidecar Probes: Receiver's View



Firewall and Nat Traversal

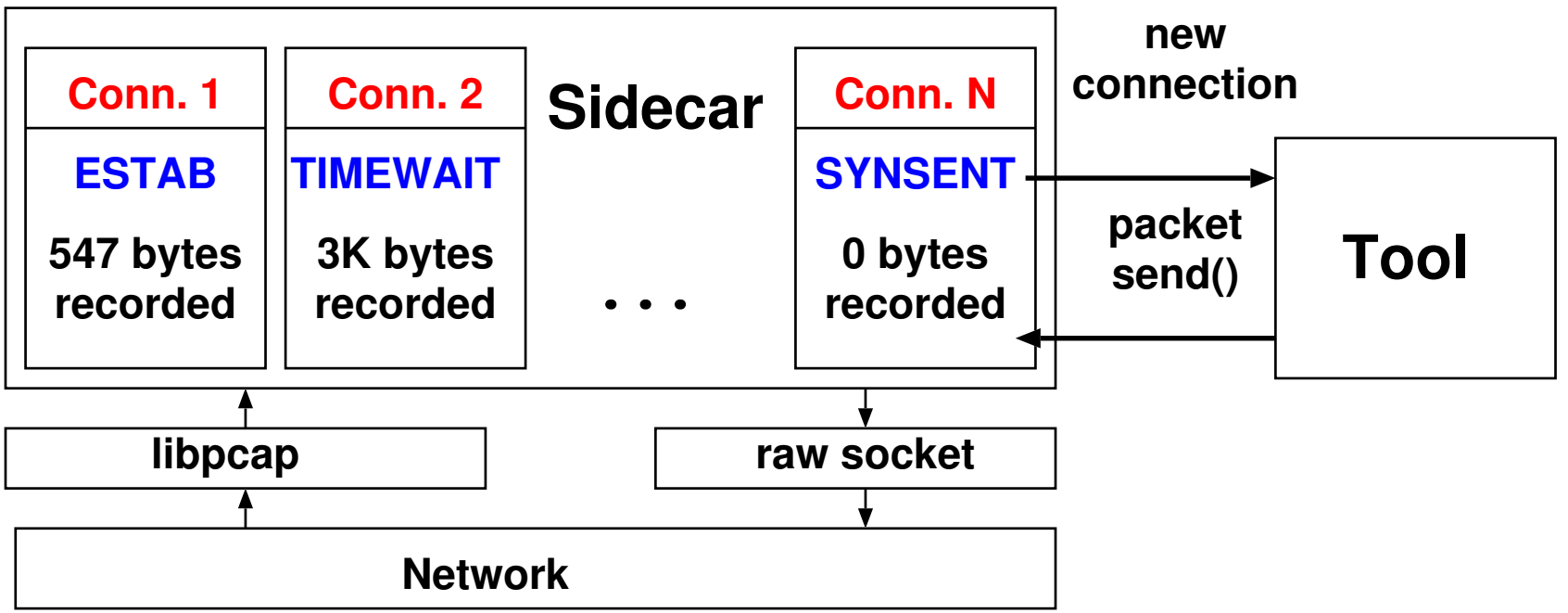


Sidecar Probes

- Probes are retransmissions
  - Requires no end-point support
  - Send probes when connection is idle
- Modify probes for specific measurement
  - Reduce TTL
  - Send probes in train
  - Add IP options
- Can send probes after connection closes
  - Receiver in TIME_WAIT state

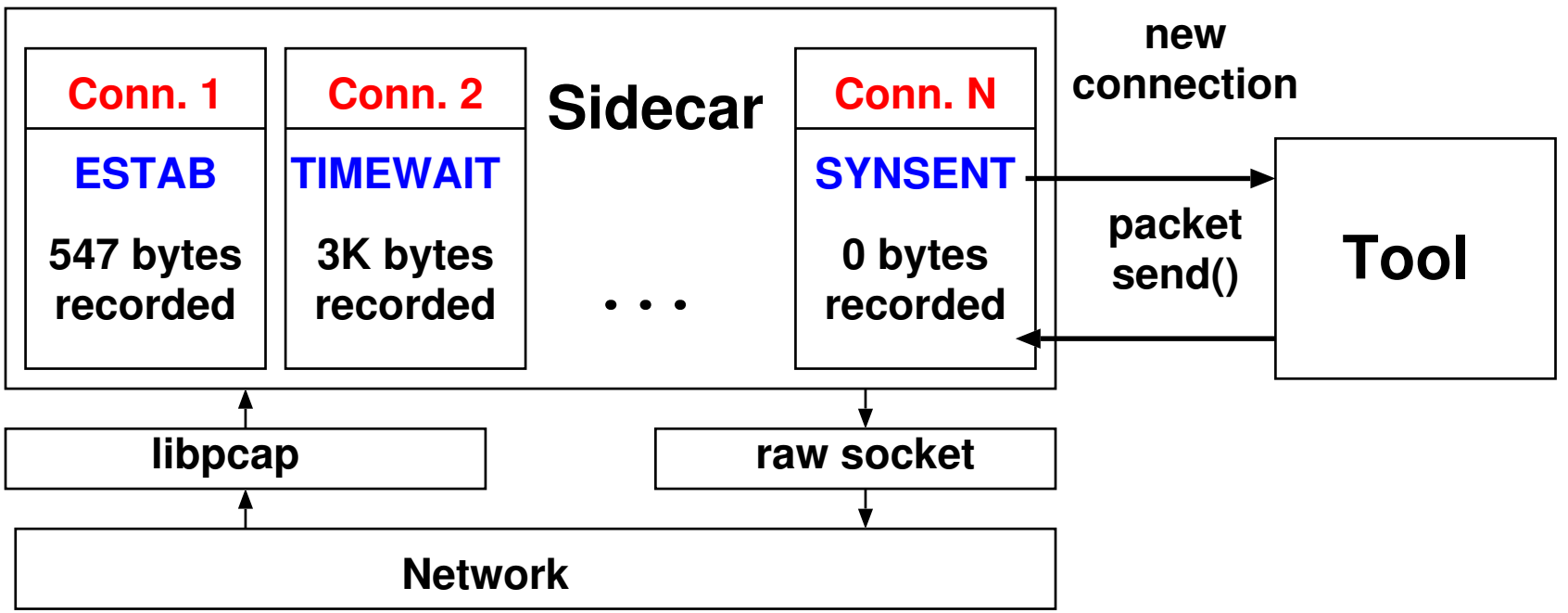
Sidecar API

- libpcap filter: "tcp port 80"



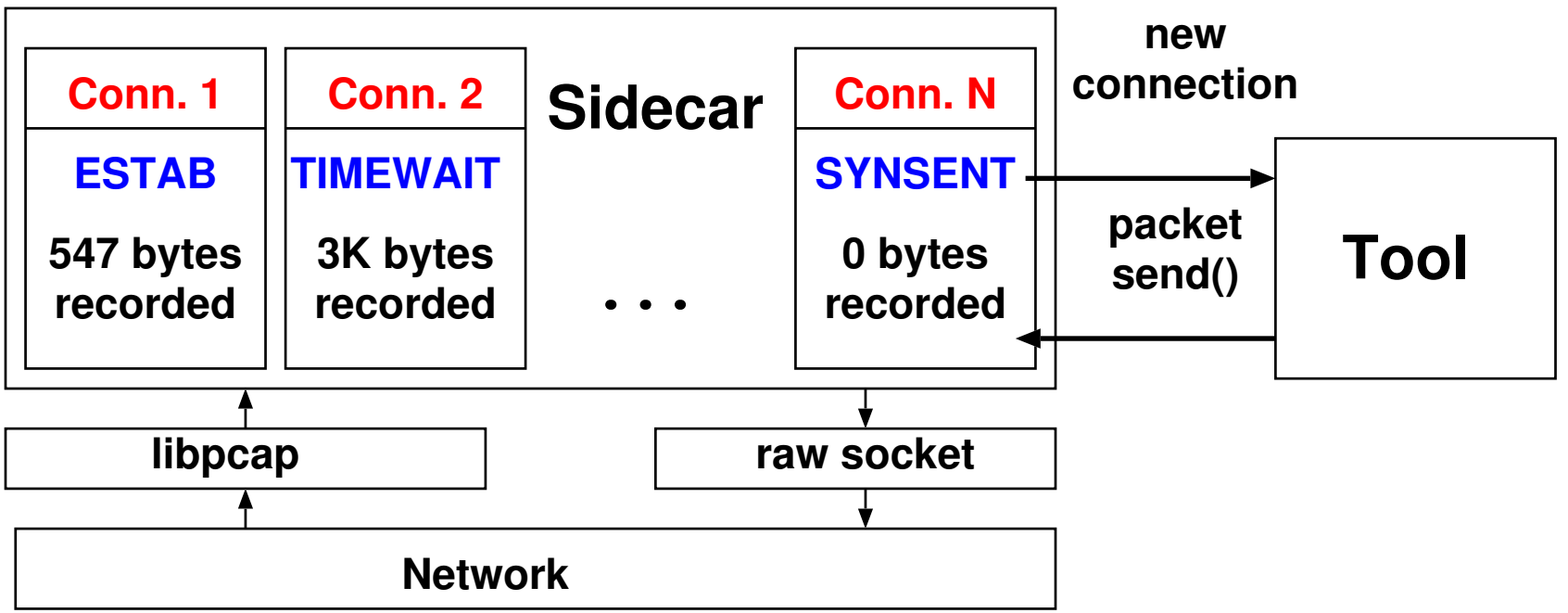
Sidecar API

- Tracks connection state and data



Sidecar API

- Applications register callbacks
  - Events: new connection, probe returned, idle, close, timeout



Example Code for Sidecar Tool

1. sc_register_connection(connectCB);
2. sc_init("tcp port 80");
3. connectCB(conn *c){
   sc_register_idle(c,idleCB);
   sc_register_in(c,inCB);}
4. idleCB(conn *c){send_probe(c);
   sc_register_timeout(c,timeoutCB) }
5. inCB(conn *c, packet *p){
   print "Response@"+calcRTT(p)}

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What We Learned: Overview

- Sidecar generates no abuse reports
- Generate traffic carefully
- Clocks are not accurate
- Causally related packets are reordered
- Firewalls unset DF bit
- IO systems calls lag

No Abuse Reports

- Probed all traffic to CoDeeN clients
- Experiment ran for 1 week
- Sidecar traceroute to each client
- 13.4M hosts probed
- No abuse reports generated

Generate Traffic Carefully 2/6

- Instrument custom web crawler with Sidecar probes
  - 168K web servers $\times$ PL Nodes
  - Caused ten abuse reports
  - . . . but from web crawler, not Sidecar
- Correct User-Agent, Virtual hosts
- Crawlers synchronized $\longrightarrow$ traffic spikes

N1: AAABBCD
N2: AAABBCD
N3: AAABBCD
N4: AAABBCD

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N1: ABCD
N2: BACD
N3: ADBC
N4: DCAB

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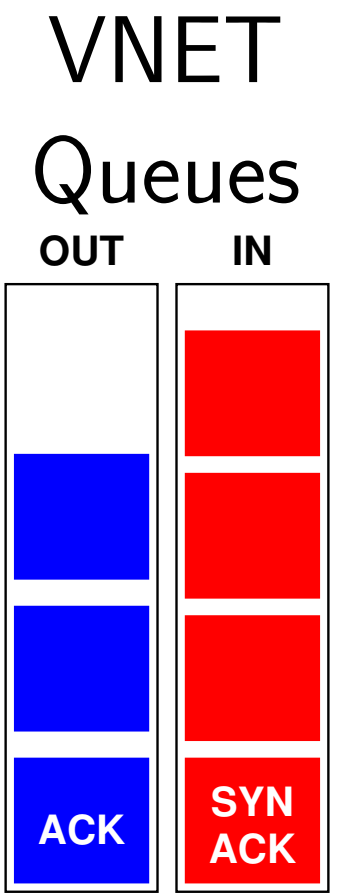
- Crawlers synchronized $\longrightarrow$ traffic spikes
- Application logs

Clock Irregularities

- Clocks would change rate, jump backwards
  - Similar to [Myths05]
- PlanetLab nodes have diverse hardware
- Future work: add RDTSC sanity check
  - Signal tool that clock jumped

Causal Packets Reordered 4/6

- VNET + libpcap interaction caused causally related packets to arrive out-of-order
  - e.g., ACK before SYN|ACK
  - Replicated by other researchers
- Time stamps correct
- Made state transition logic more robust
- Future: patch VNET code



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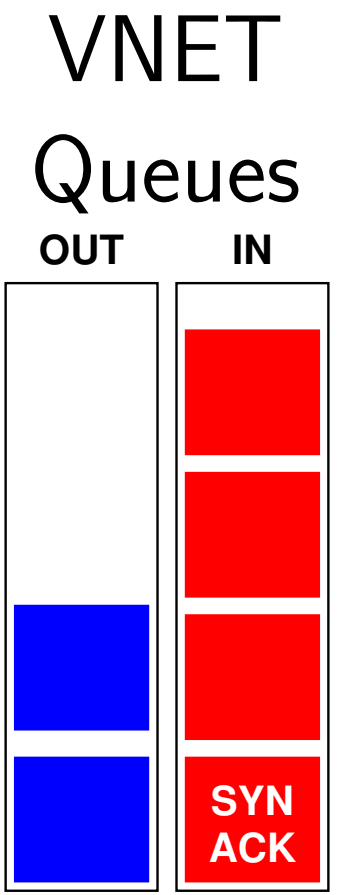

Firewalls Unset DF Bit

- Recursive packet train measurements overflowed libpcap [Sigcomm04]
- Tried to use DF bit to ignore payload
  - Some firewalls unset DF on incoming packets
- Implications for MTU discovery measurements

Lag in IO Systems Calls 6/6

- Many concurrent writes
- *strace -T* showed that *open()* and *write()* calls took 1-3 seconds to return
- Intermittent; could not diagnose

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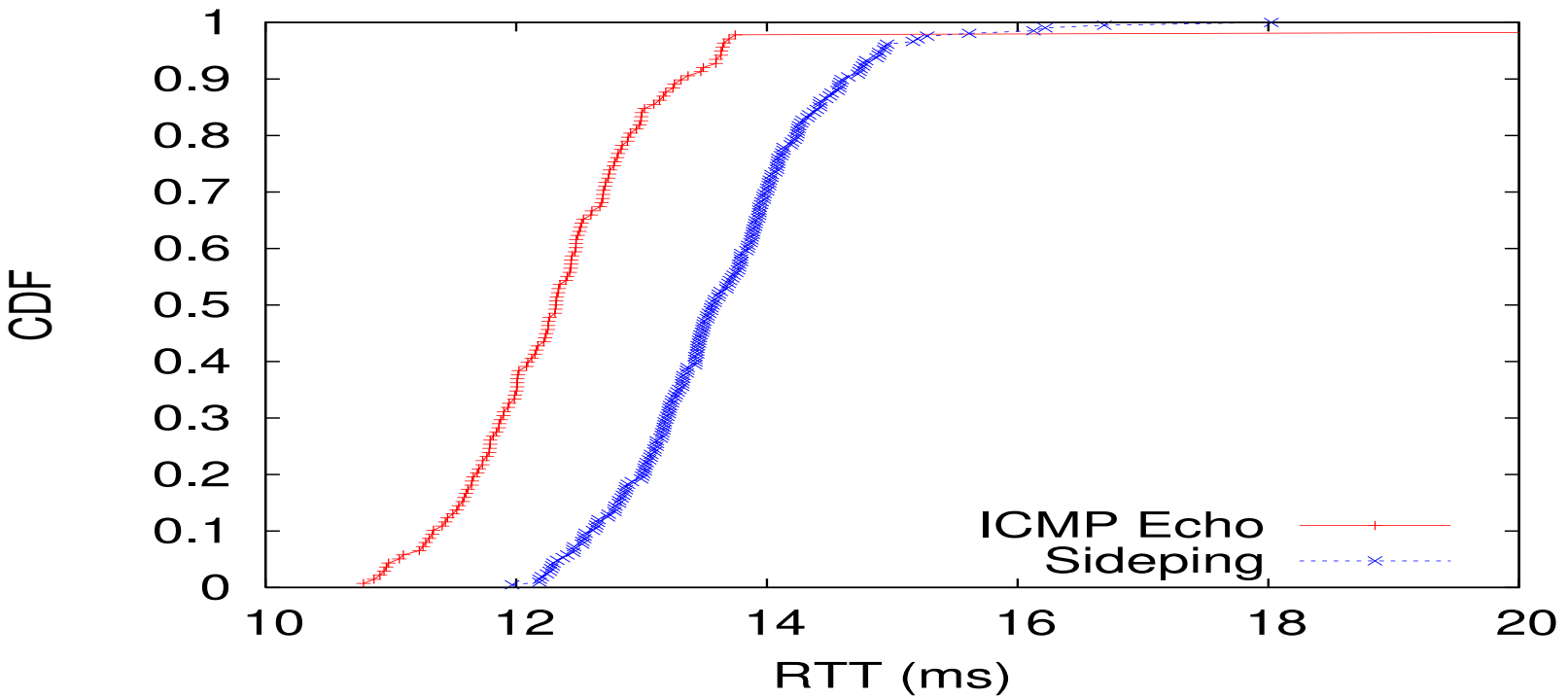
Sideping

- 24/482 PL nodes drop ICMP Echo
  - All nodes allow Sidecar probes
- Sideping traverses firewalls and NATs
  - Exposes higher latency extra hop

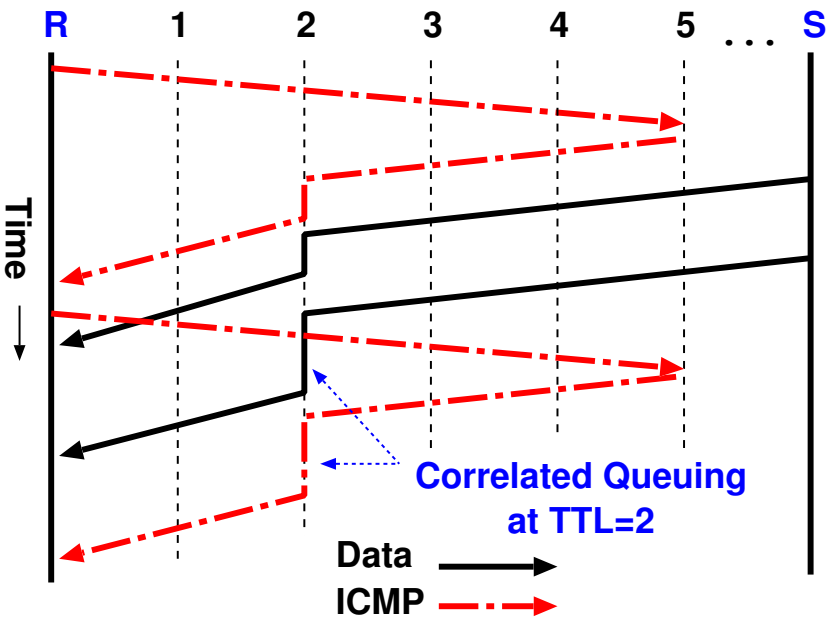


Artrat

- Artrat: Active Receiver-side TCP Rate Analysis Tool
- Locate bandwidth bottleneck from receiver
- Sanity check PlanetLab experiment conditions

Artrat: Technique

- Use IP timestamp option with ICMP echo to measure queuing delay
- Router with highest correlated delay is bottleneck



Conclusion

- Sidecar is a technique and API/package for unobtrusive probing
- Probes caused no* abuse reports
- Symbiotic relationship between service and measurement projects
  - Measurements $\Leftrightarrow$ application traffic
- Download API and tools from

  `http://www.cs.umd.edu/projects/sidecar`

Bibliography 1/2

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5. [iPlane]
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2. [Myths05] "Using PlanetLab for Network Research: Myths, Realities, and Best Practices." Neil Spring, Larry Peterson, Andy Bavier, and Vivek Pai
3. [Sigcomm04] "Locating Internet Bottlenecks: Algorithms, Measurements and Implications". Ningning Hu, Li Erran Li, Zhuoqing Morley Mao, Peter Steenkiste, Jia Wang