

Norma: Towards Practical Network Load Testing

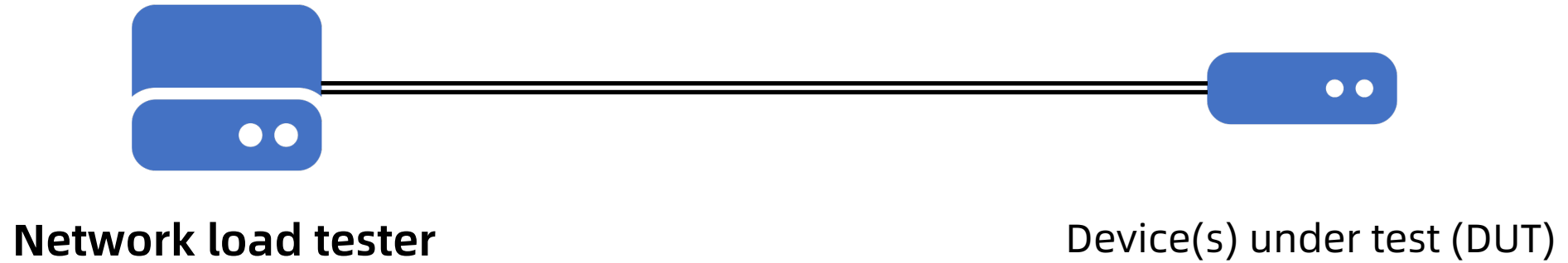
Yanqing Chen, Bingchuan Tian, Chen Tian, Li Dai, Yu Zhou, Mengjing Ma,
Ming Tang, Hao Zheng, Zhewen Yang, Guihai Chen, and Ennan Zhai



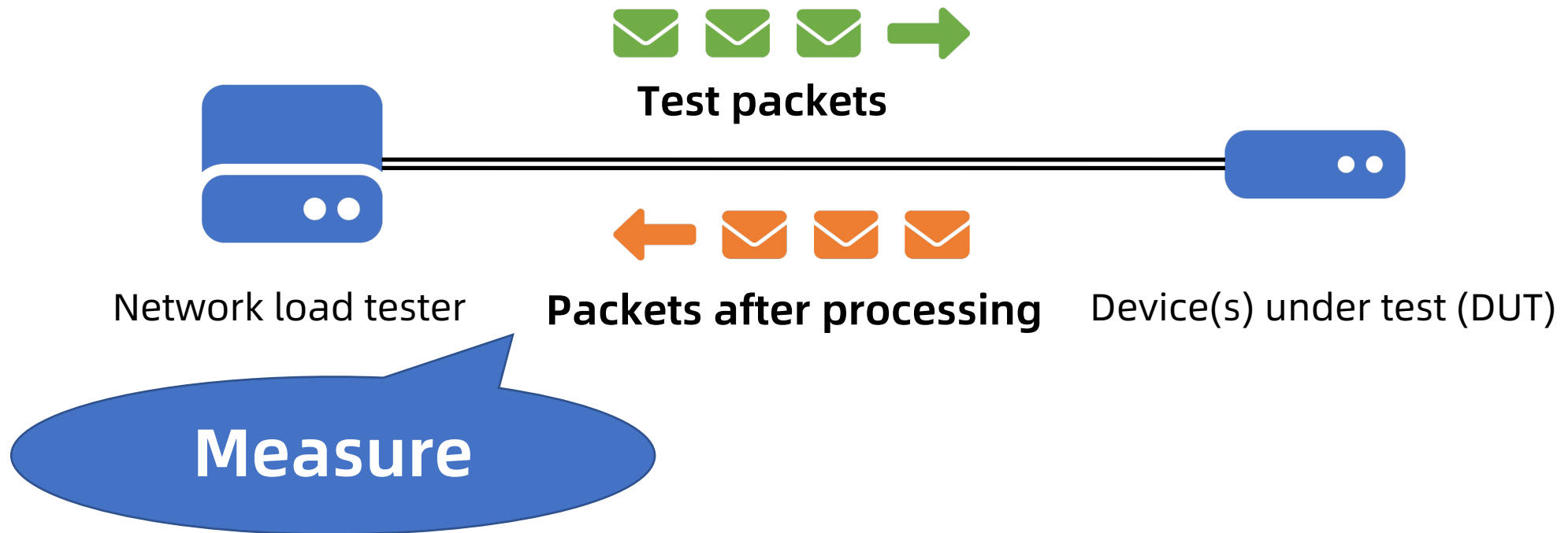
南京大學
NANJING UNIVERSITY



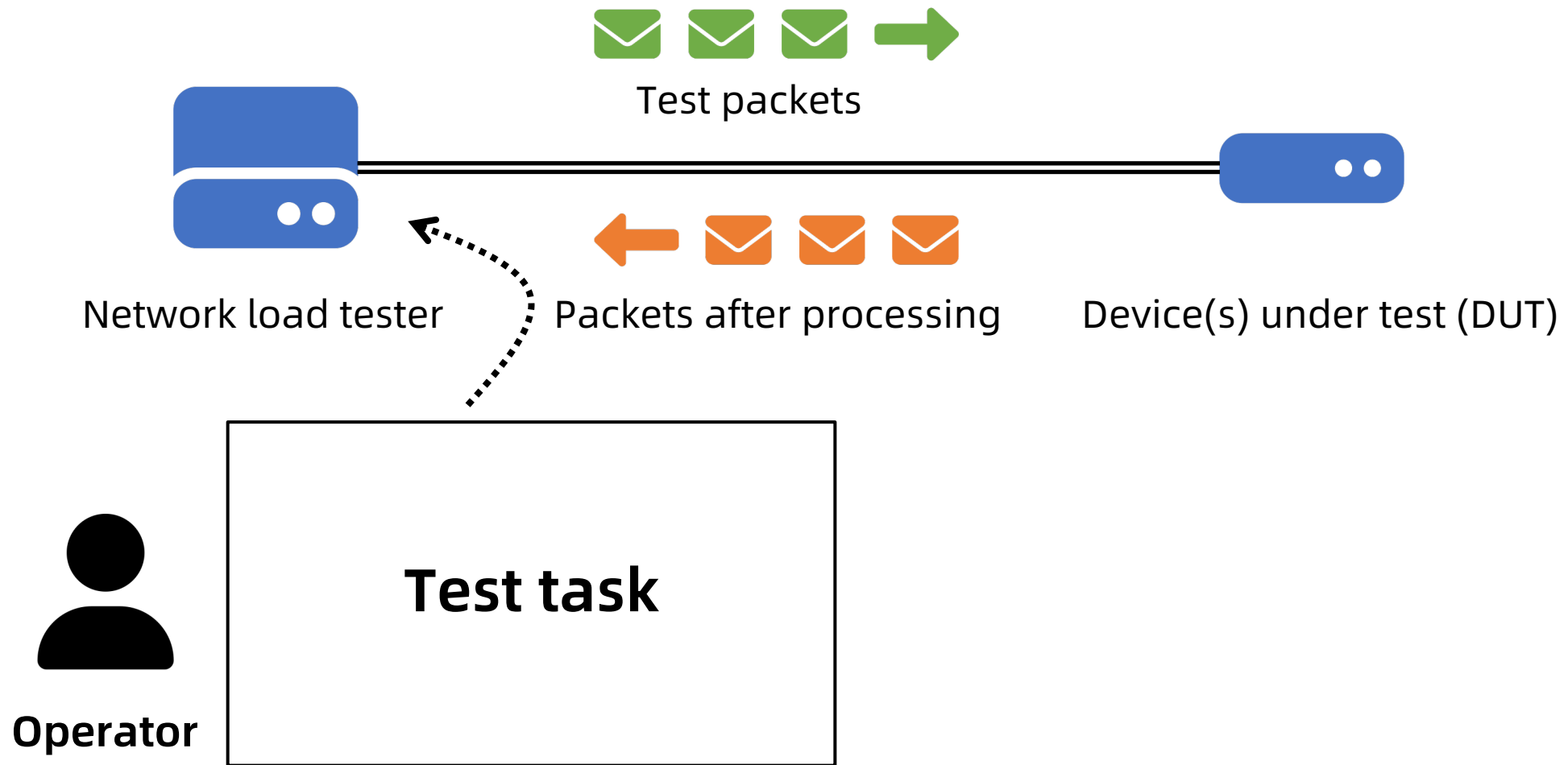
Network load tester



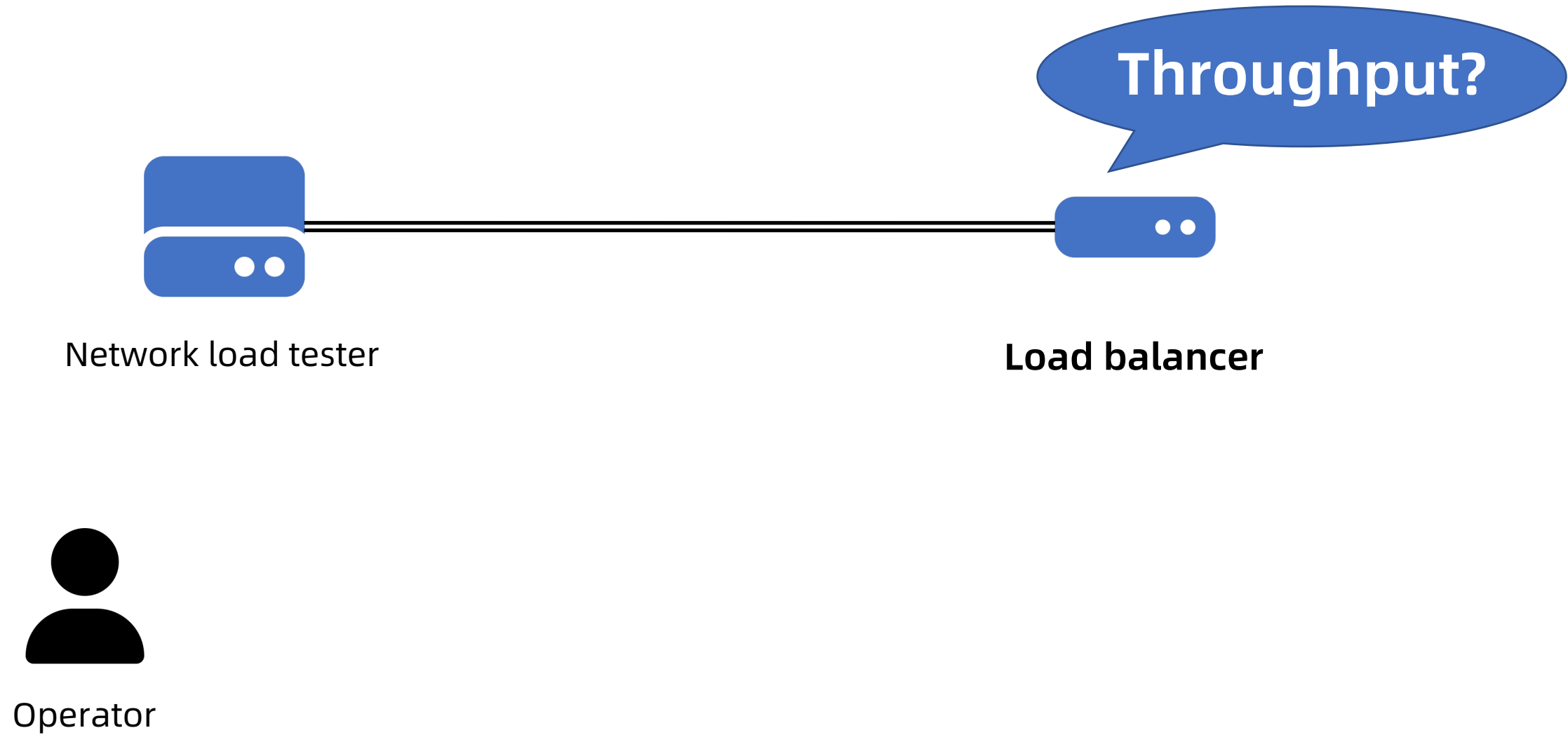
Network load tester



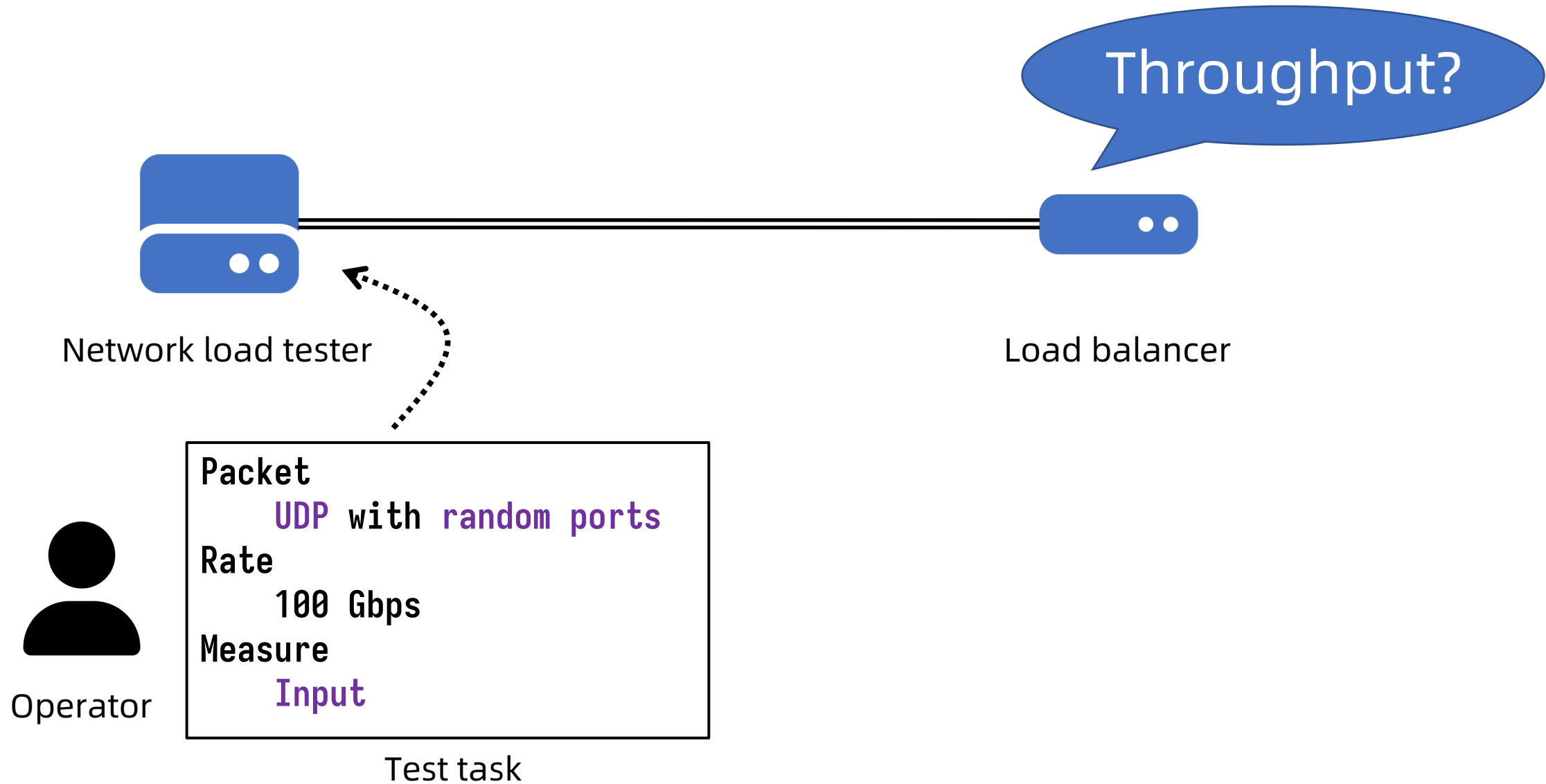
Network load tester



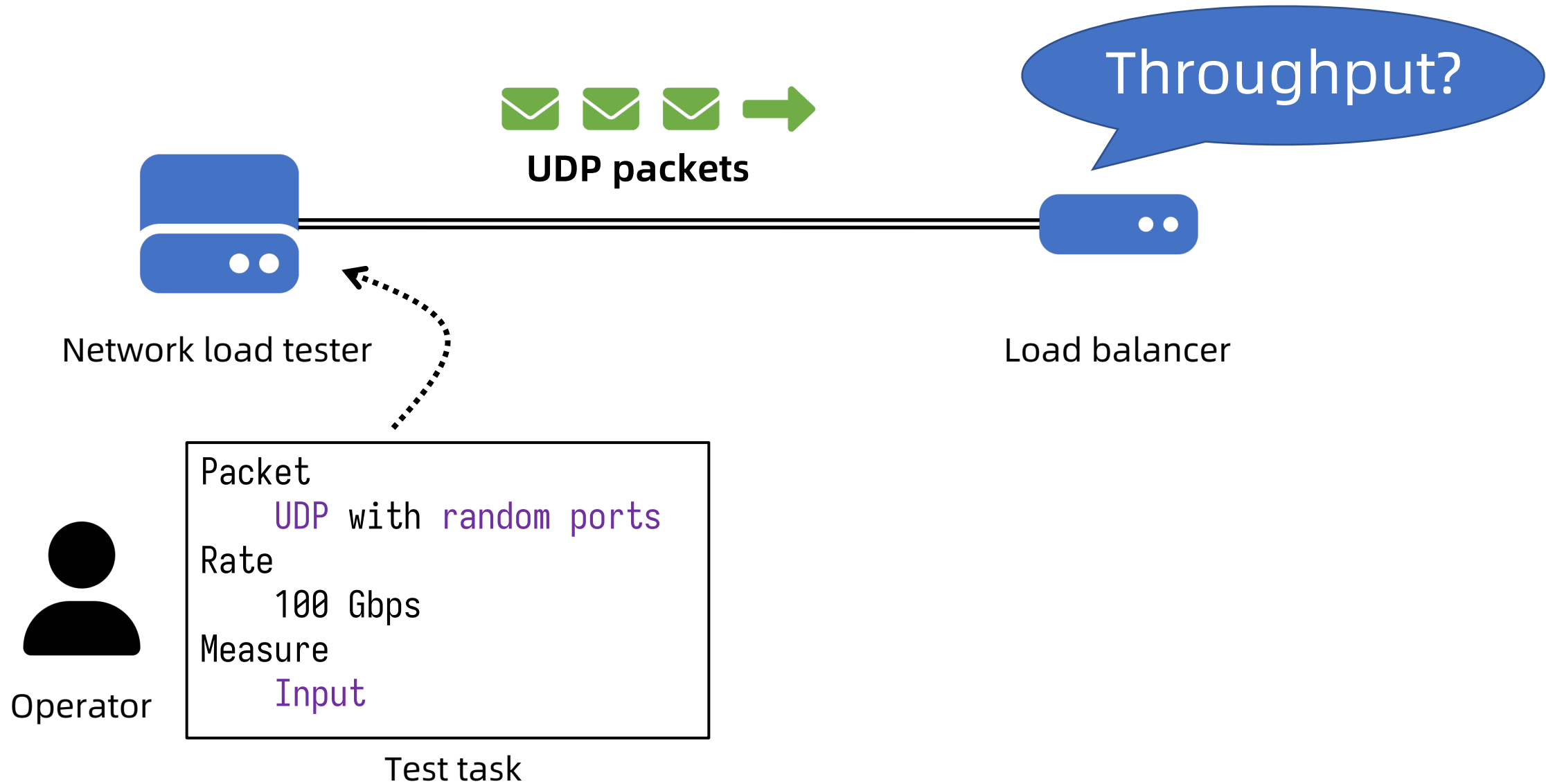
Network load tester



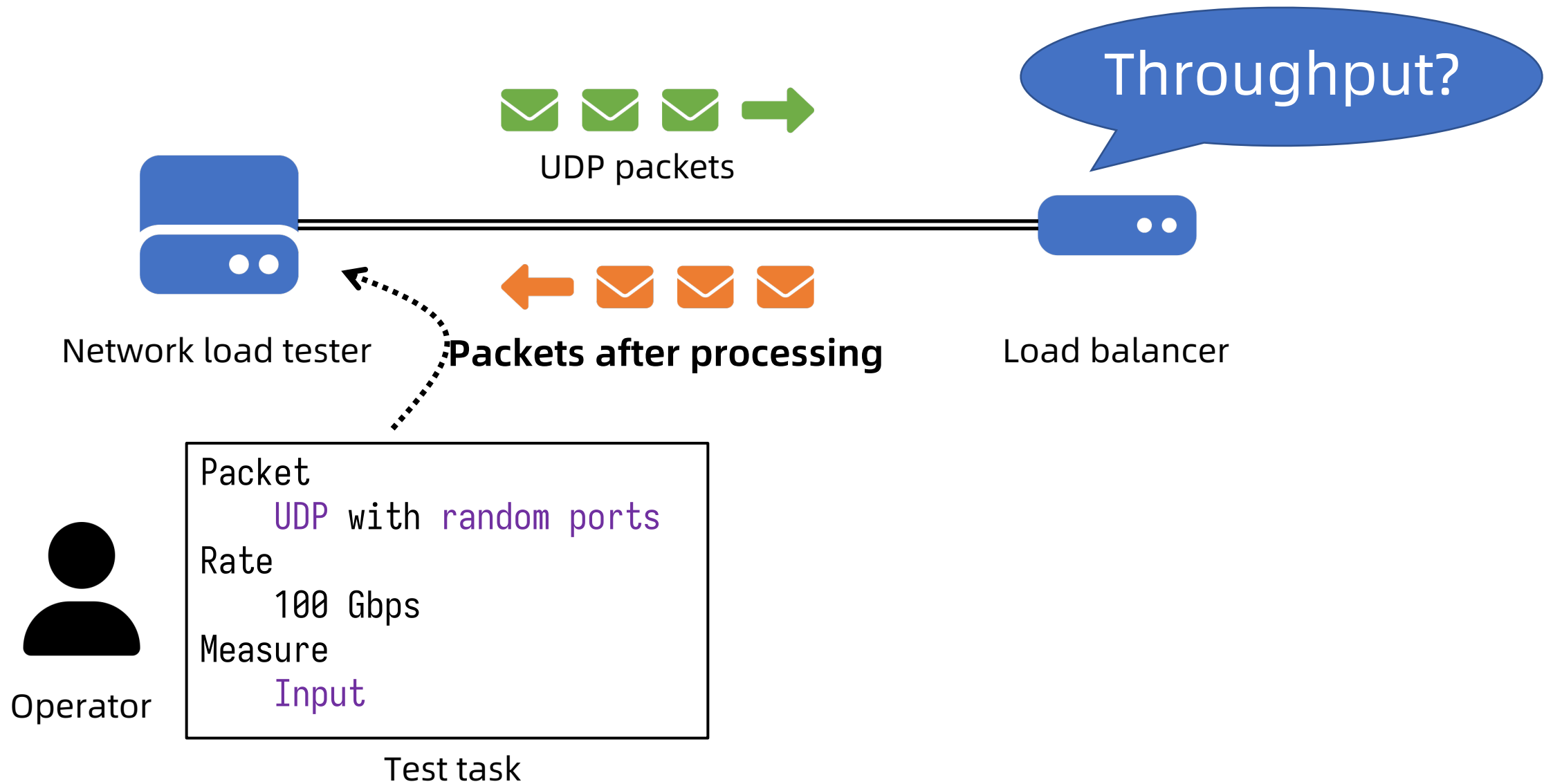
Network load tester



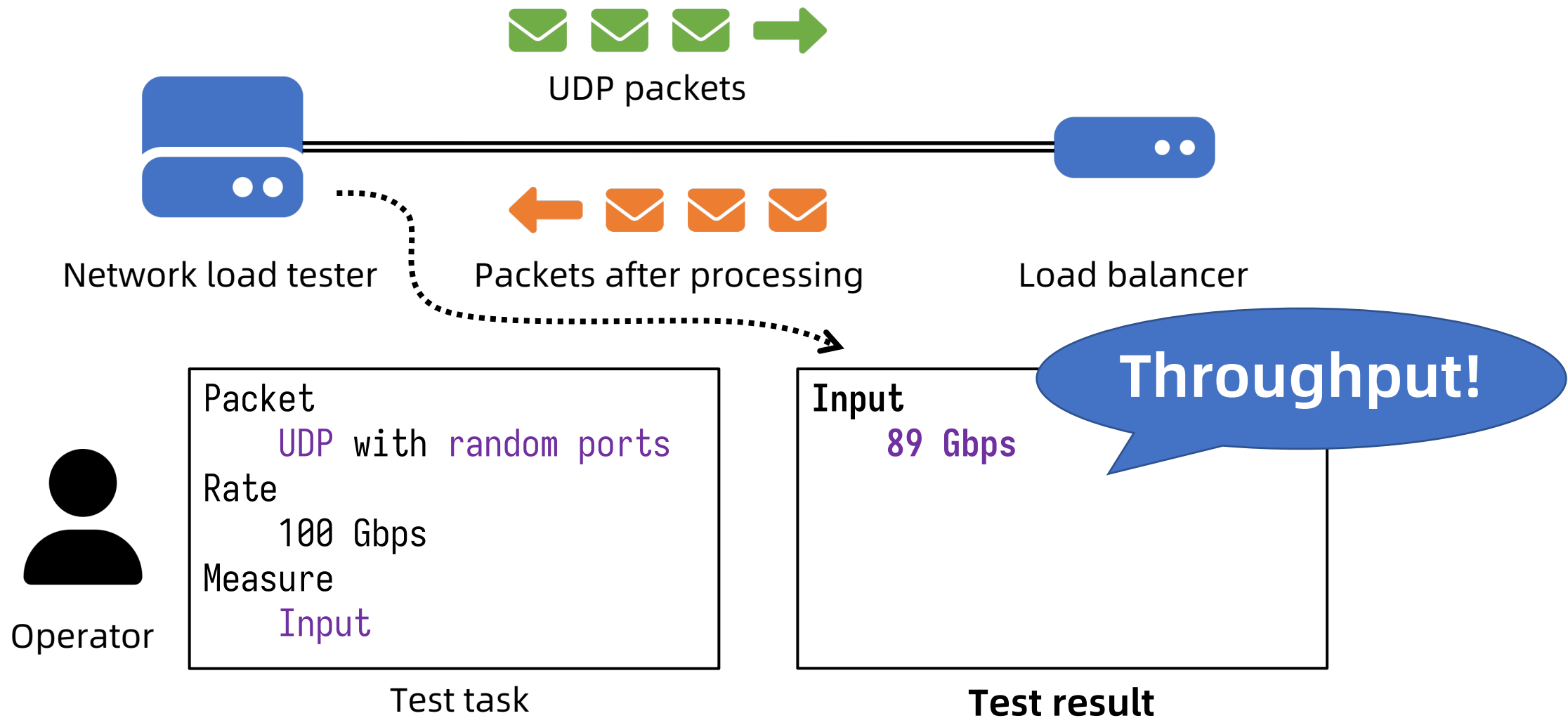
Network load tester



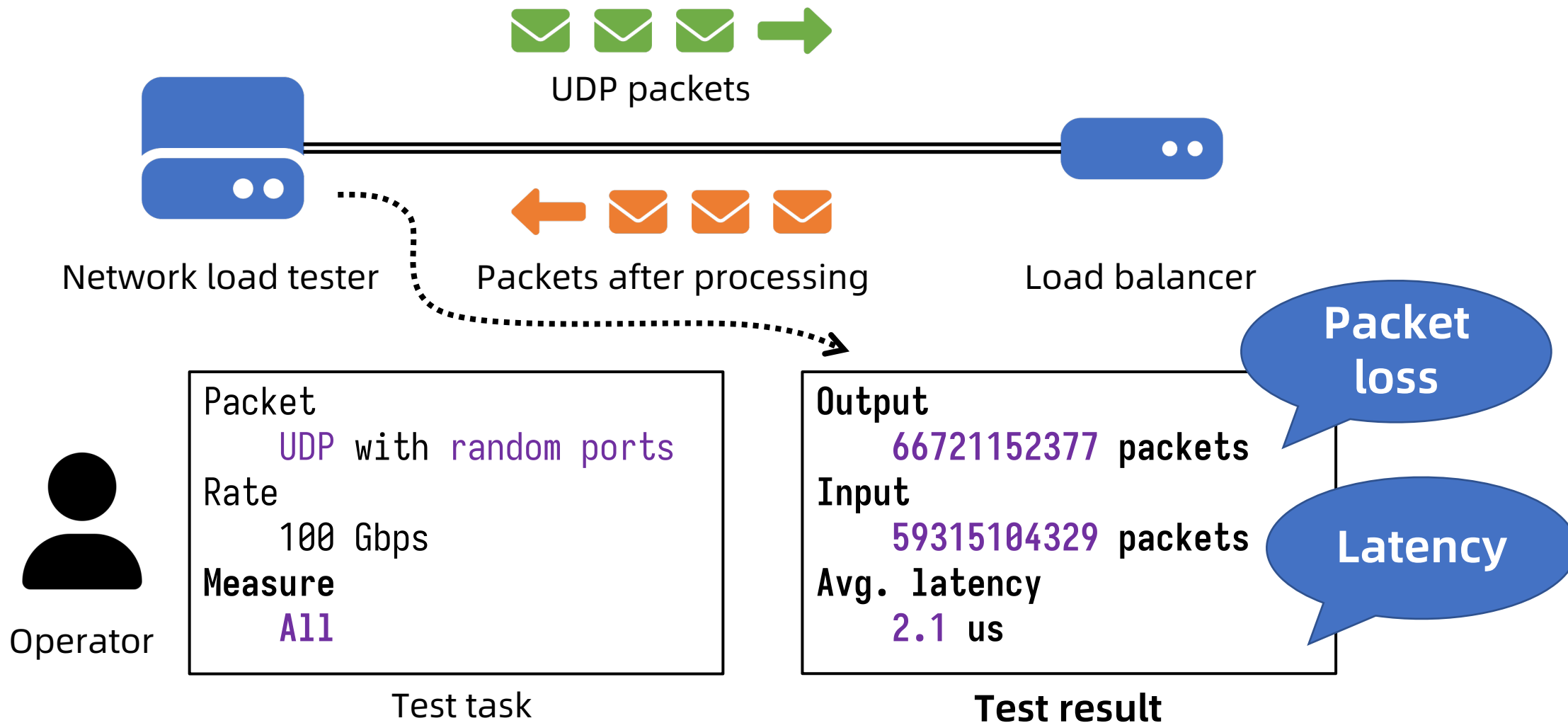
Network load tester



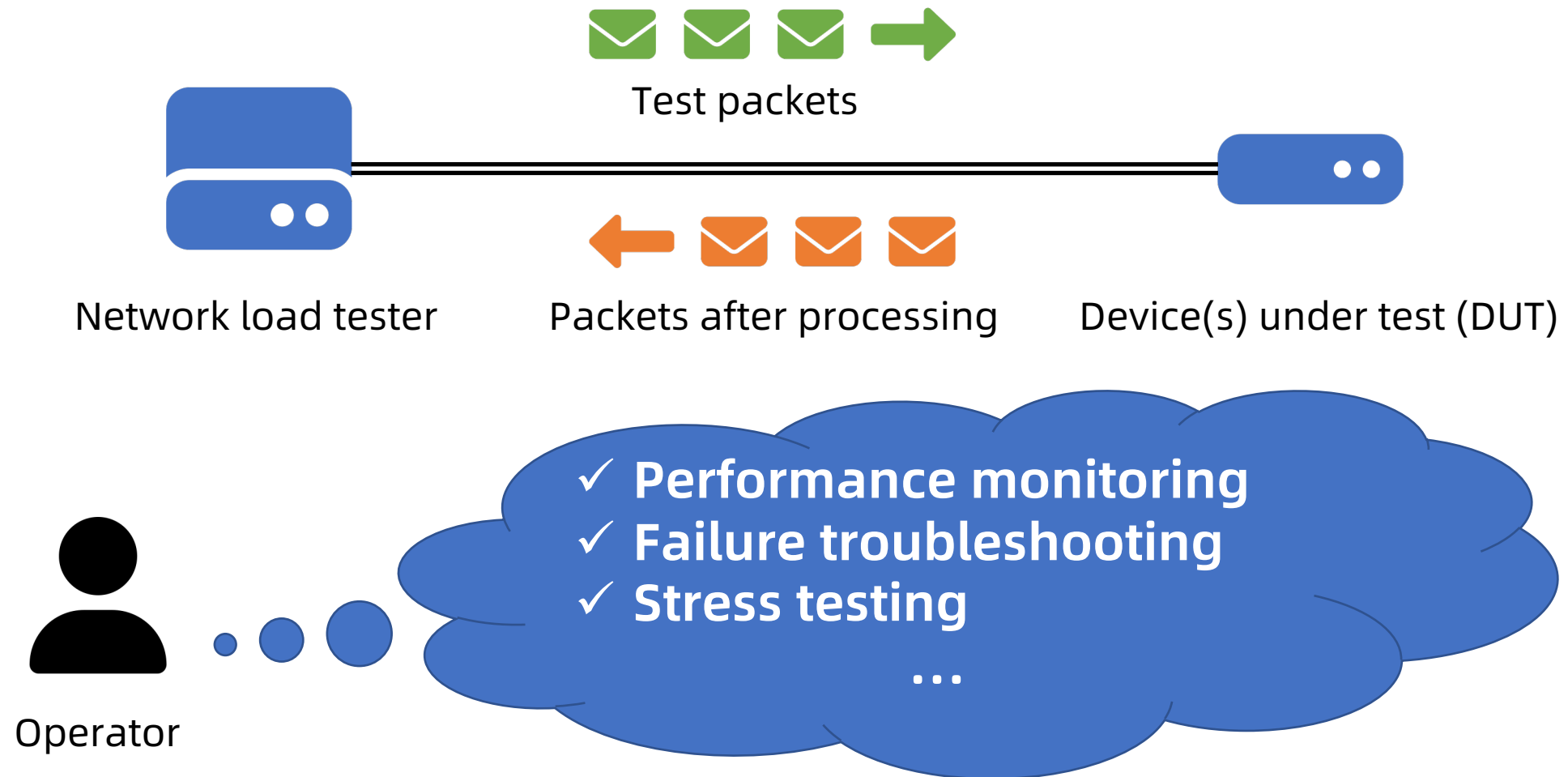
Network load tester



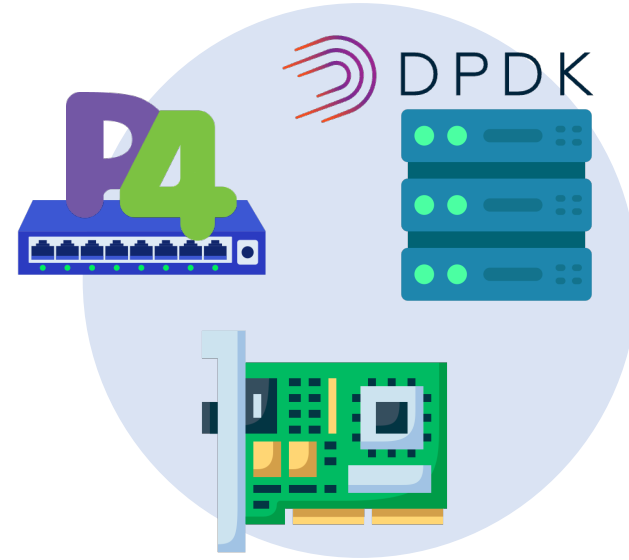
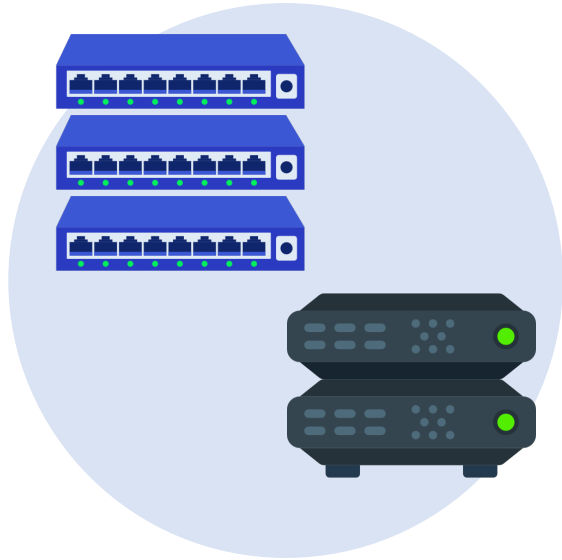
Network load tester



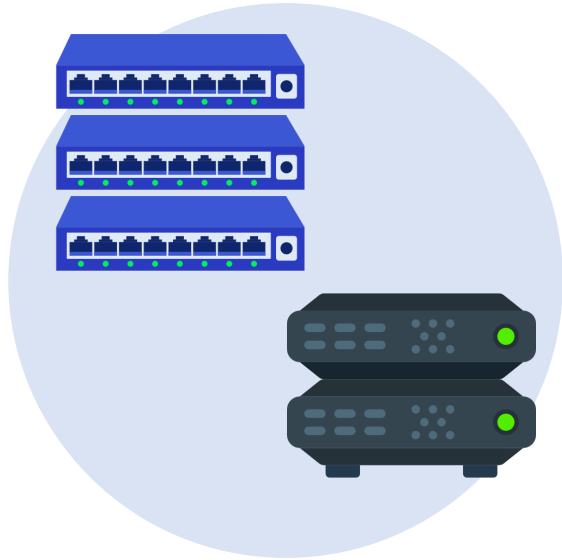
Network load tester



DUT we met

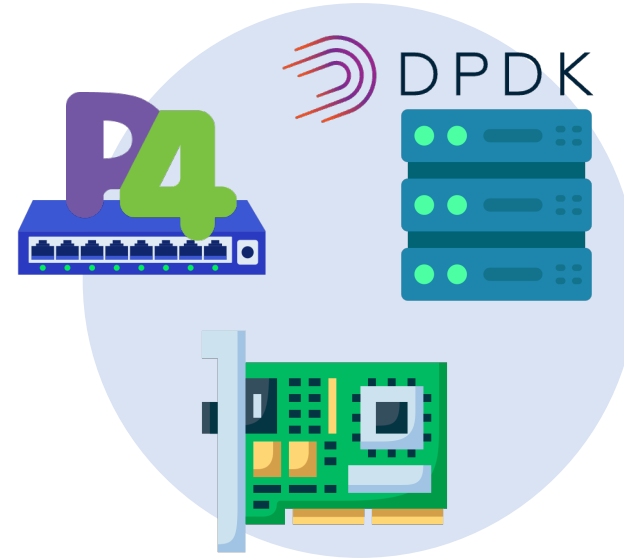


DUT we met

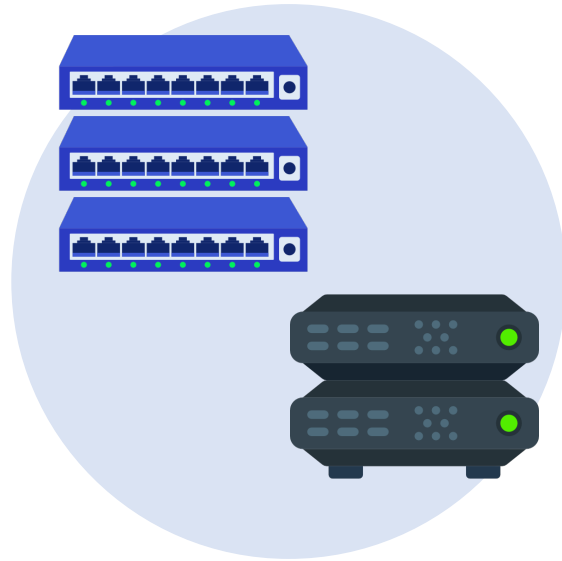


Fixed-function device

- Switch
- Router
- ...

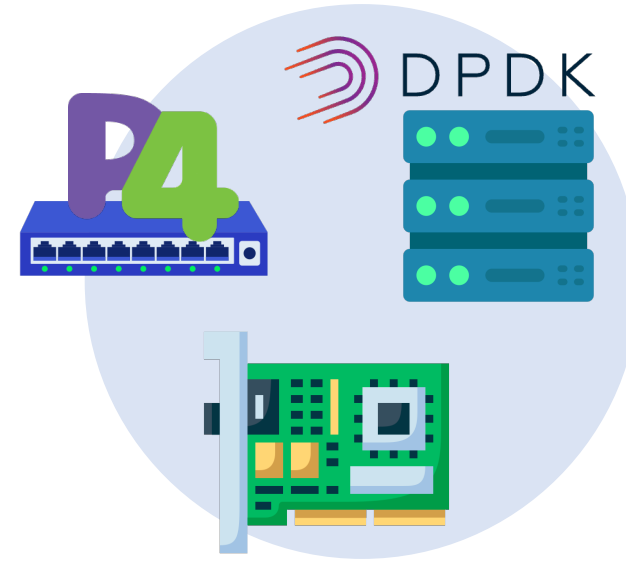


DUT we met



Fixed-function devices

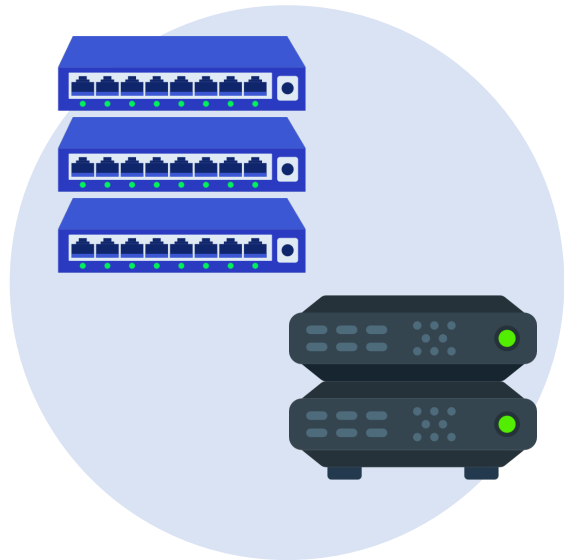
- Switch
- Router
- ...



Programmable device

- **P4 Programmable switch**
- **NetFPGA**
- **Software**
- ...

Functions we want



Fixed-function devices

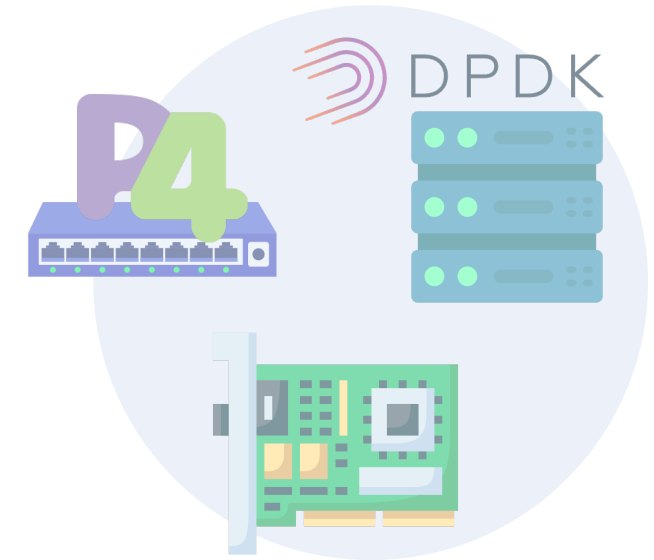
High-throughput traffic

Stateful protocols

Customized packet headers

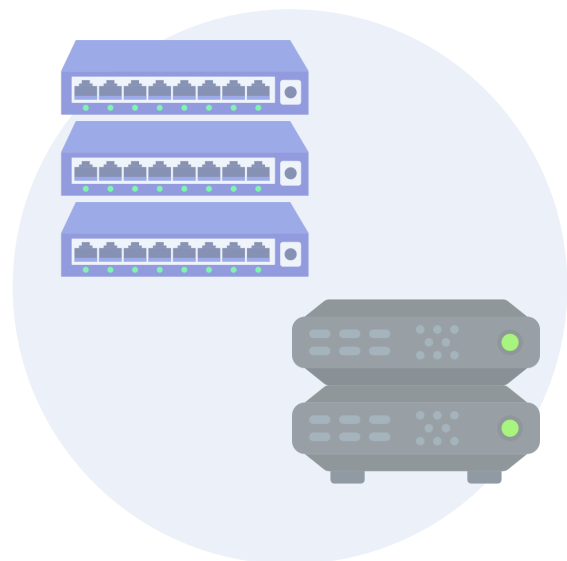
Precise rate/burst control

Accurate measurement



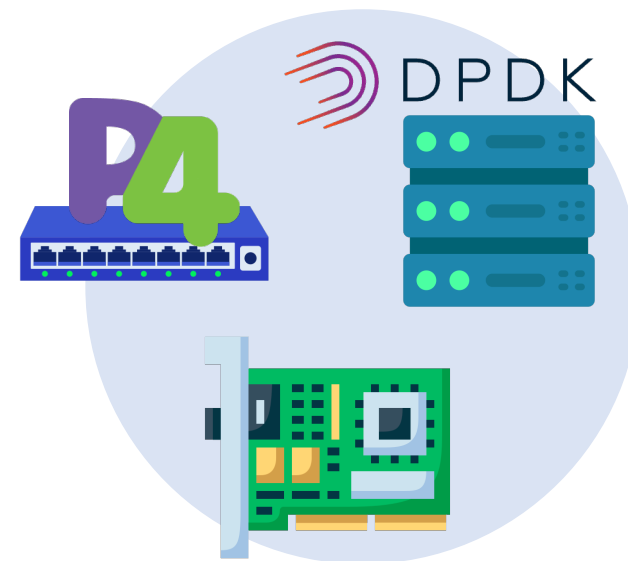
Programmable devices

Functions we want



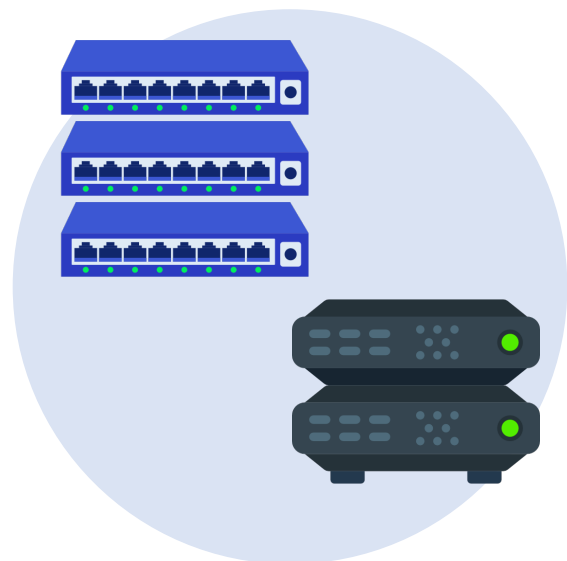
Fixed-function devices

- High-throughput traffic
- Stateful protocols**
- Customized packet headers**
- Precise rate/burst control
- Accurate measurement



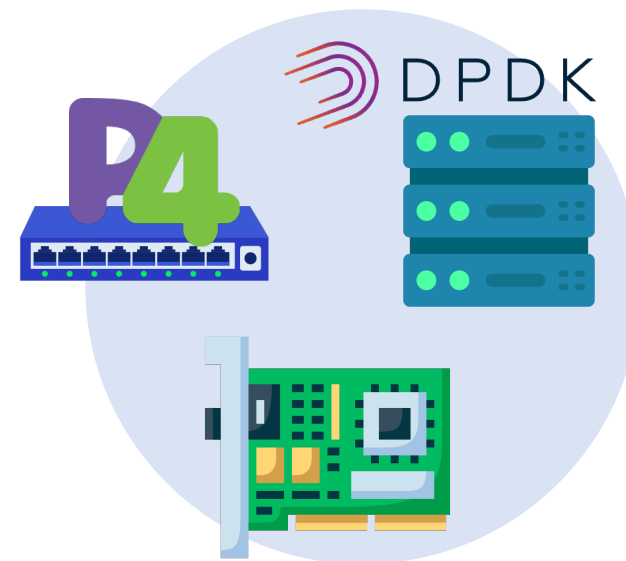
Programmable devices

Functions we want



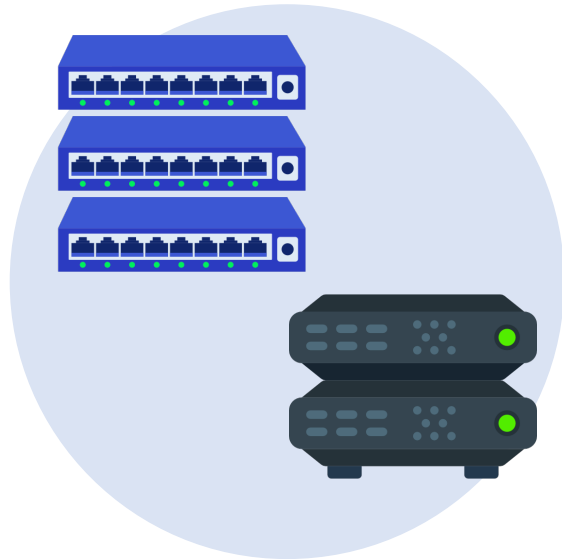
Fixed-function devices

- High-throughput traffic
- Stateful protocols
- Customized packet headers
- Precise rate/burst control**
- Accurate measurement



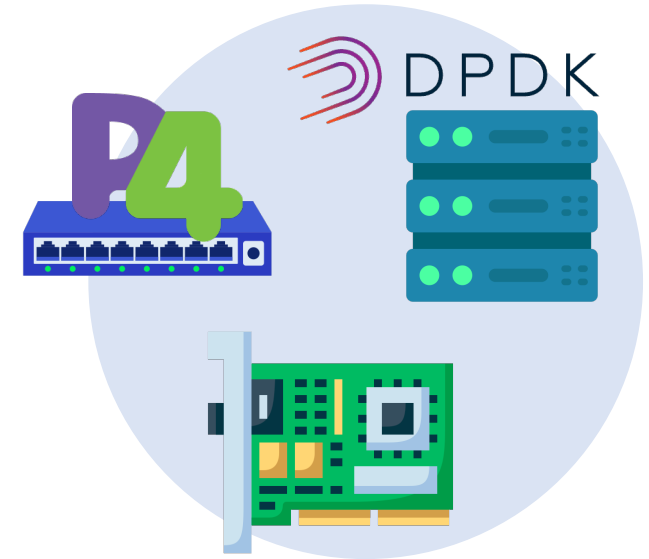
Programmable devices

Functions we want



Fixed-function devices

- High-throughput traffic
- Stateful protocols
- Customized packet headers
- Precise rate/burst control
- Accurate measurement**



Programmable devices

Issues of the existing works

Software testers

NetFPGA-based testers

Commercial testers

HyperTester

Tester

X High-throughput traffic

X Customized packet headers

X Stateful protocols

Failed to support

Issues of the existing works

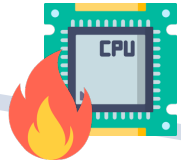
Software testers

NetFPGA-based testers

Commercial testers

HyperTester

Tester



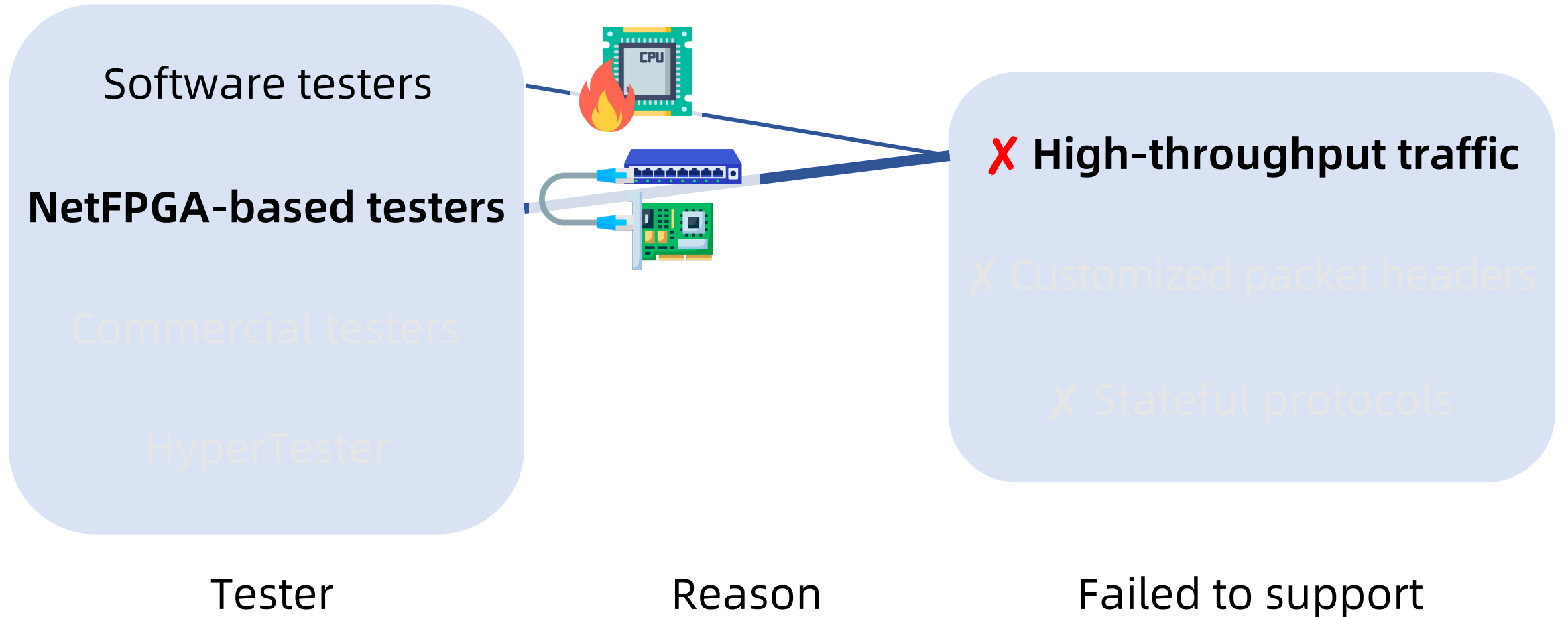
X High-throughput traffic

X Customized packet headers

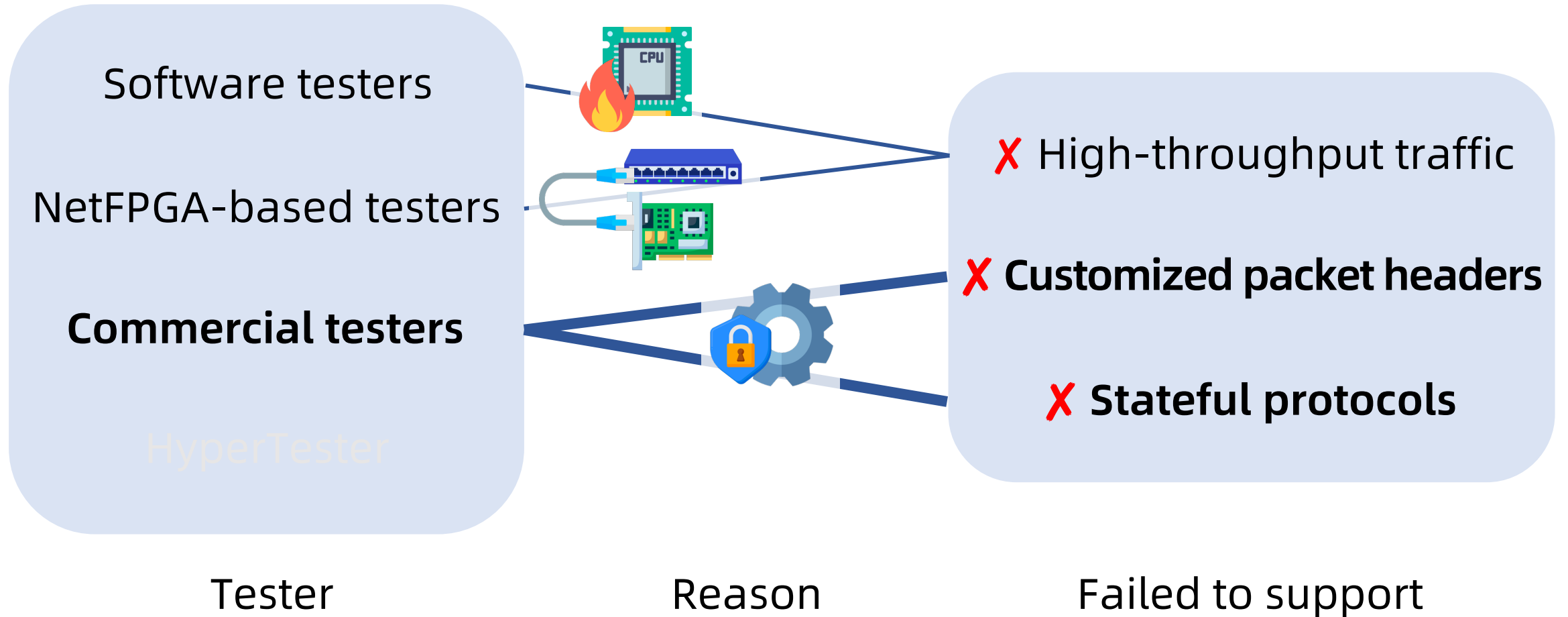
X Stateful protocols

Failed to support

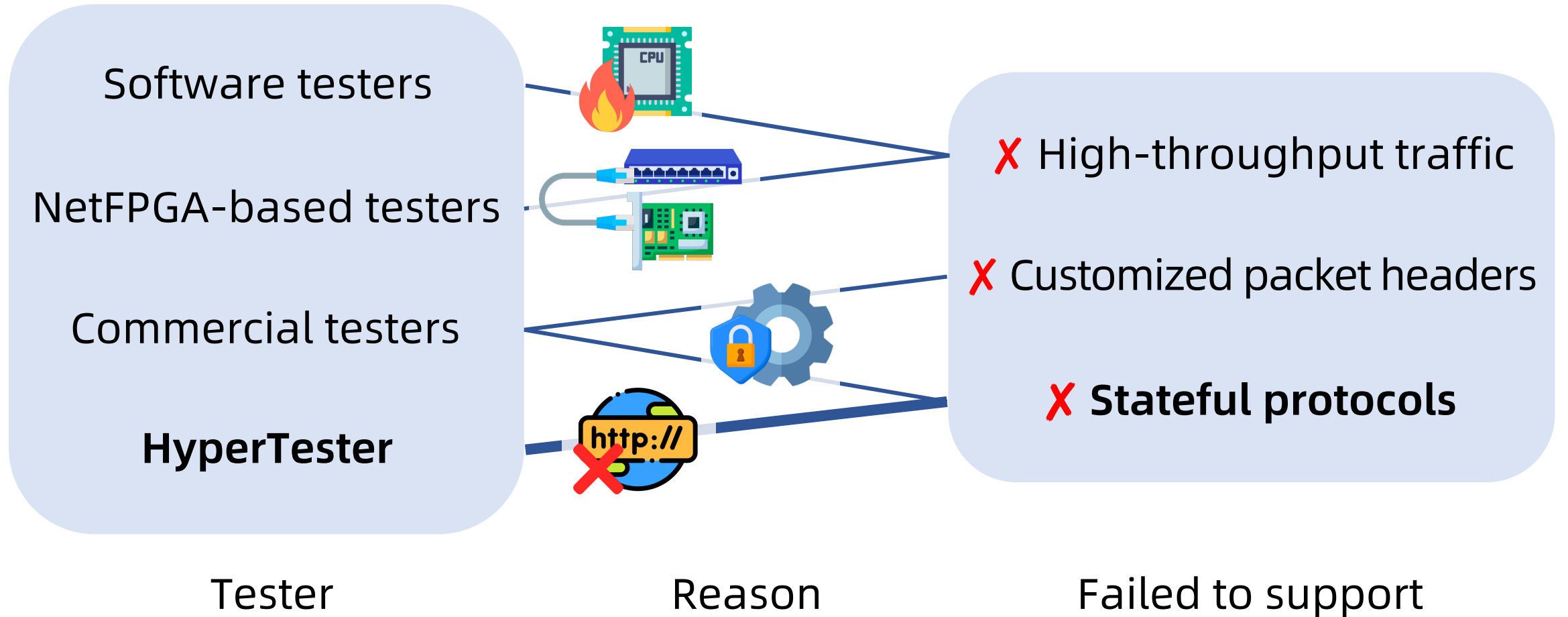
Issues of the existing works



Issues of the existing works



Issues of the existing works



Norma: Towards Practical Network Load Testing

Norma: Towards Practical Network Load Testing

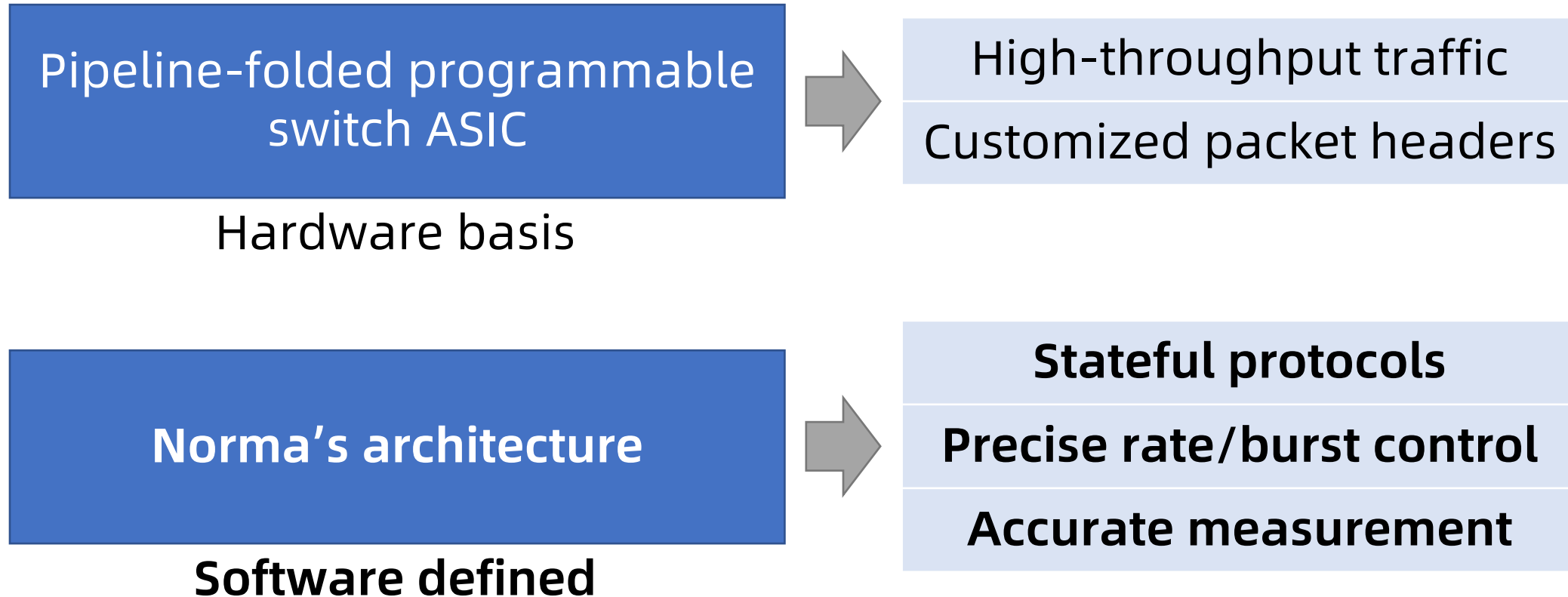
**Pipeline-folded programmable
switch ASIC**



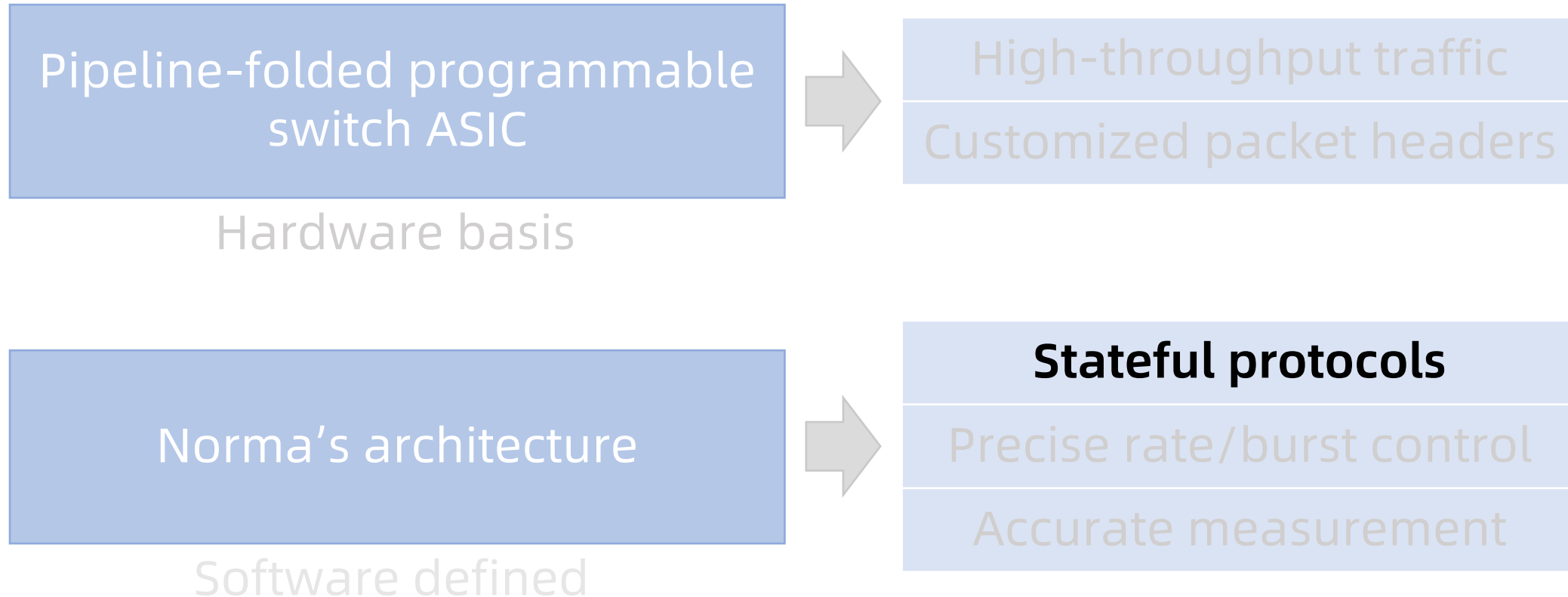
High-throughput traffic
Customized packet headers

Hardware basis

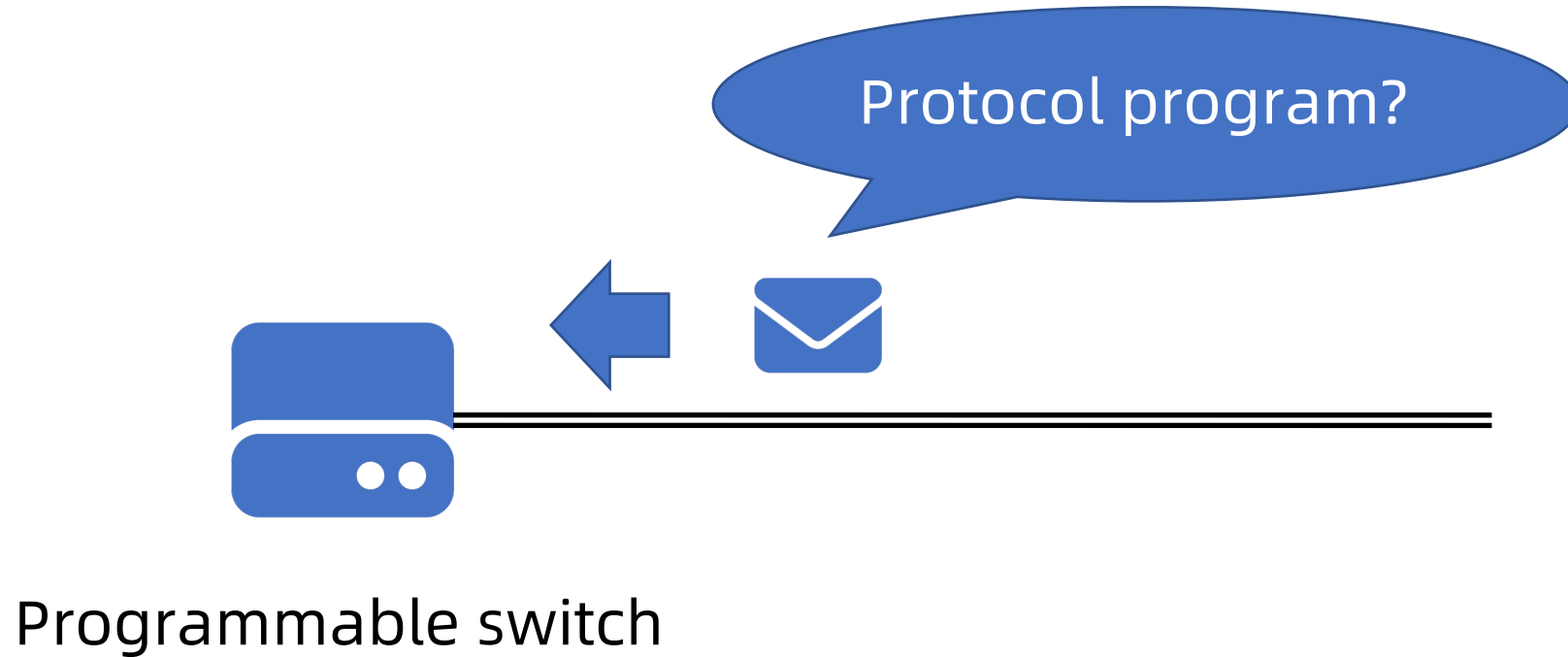
Norma: Towards Practical Network Load Testing



Norma: Towards Practical Network Load Testing



Supporting stateful protocols



Supporting stateful protocols

Protocol program \Rightarrow State transition table

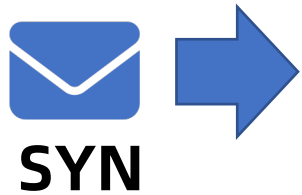
Supporting stateful protocols

Protocol program \Rightarrow State transition table

TCP client

Supporting stateful protocols

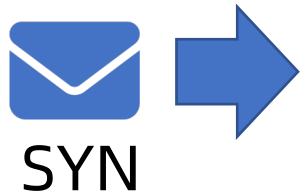
Protocol program \Rightarrow State transition table



TCP client

Supporting stateful protocols

Protocol program \Rightarrow State transition table

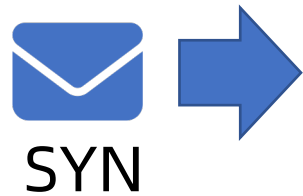


TCP client

Flow state ID: 0

Supporting stateful protocols

Protocol program \Rightarrow State transition table

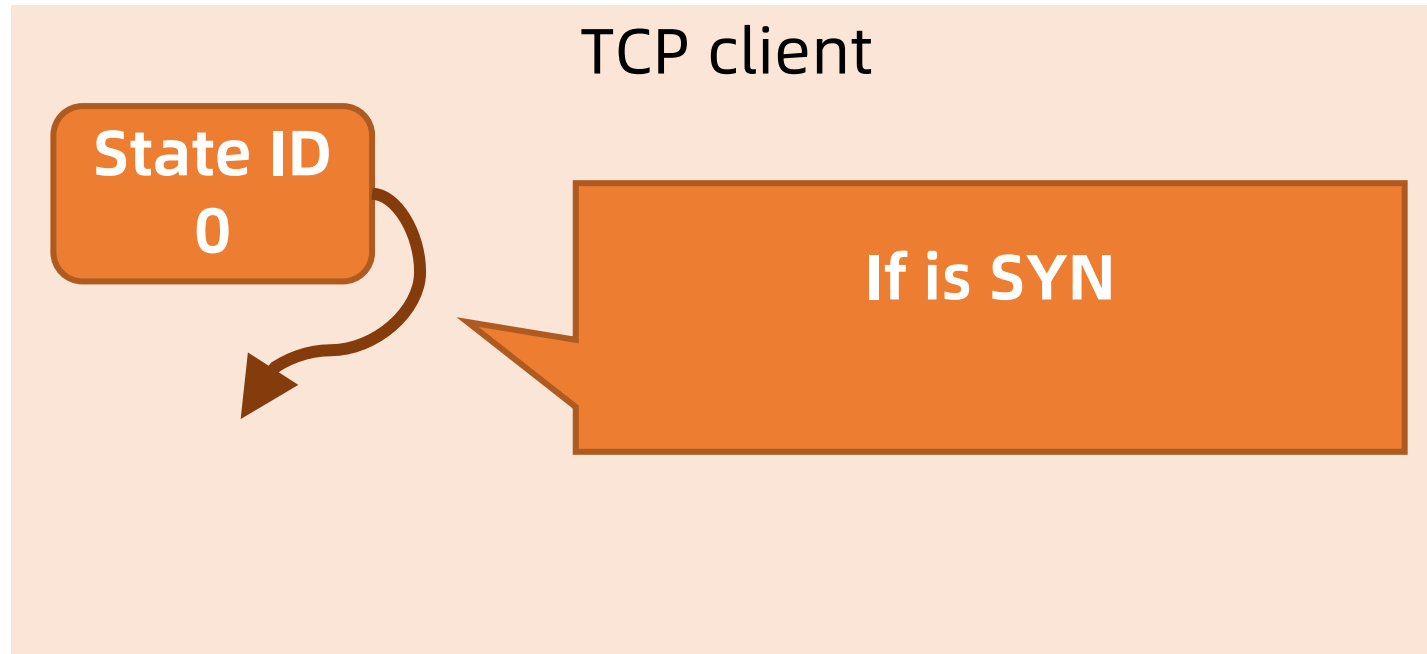
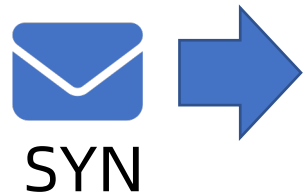


TCP client

Flow state ID: 0

Supporting stateful protocols

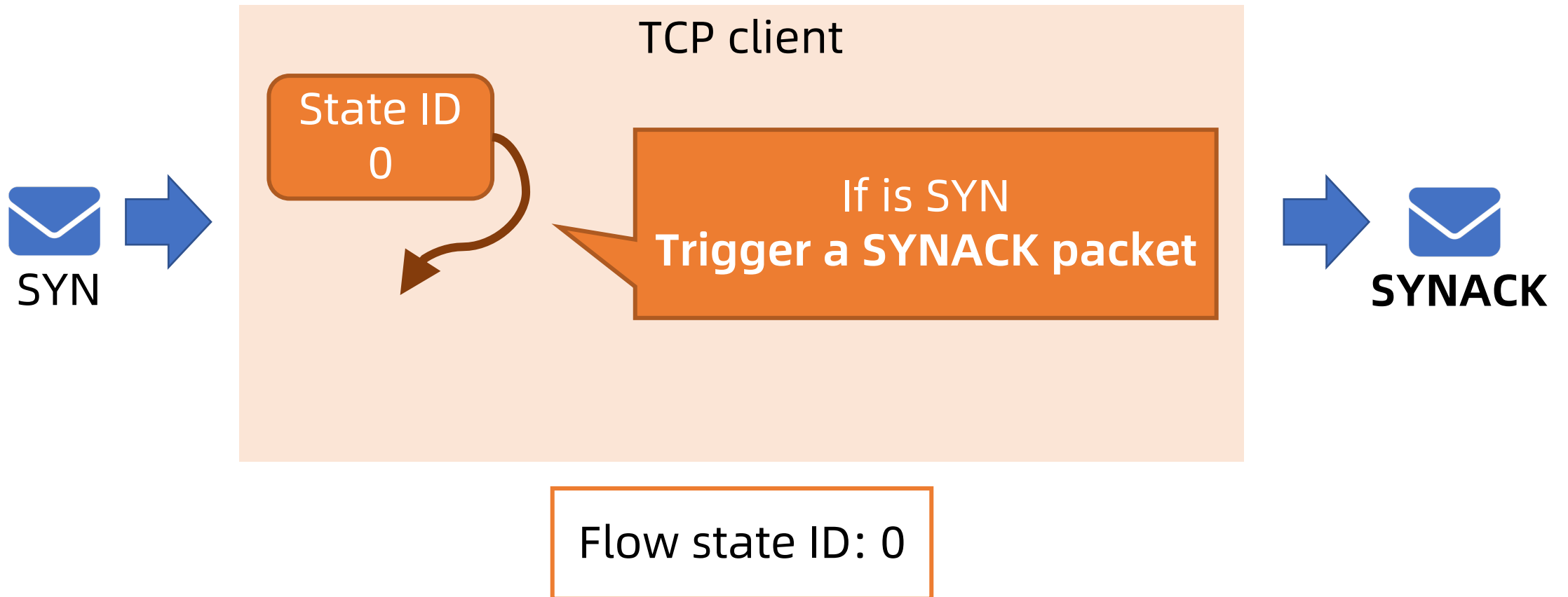
Protocol program \Rightarrow State transition table



Flow state ID: 0

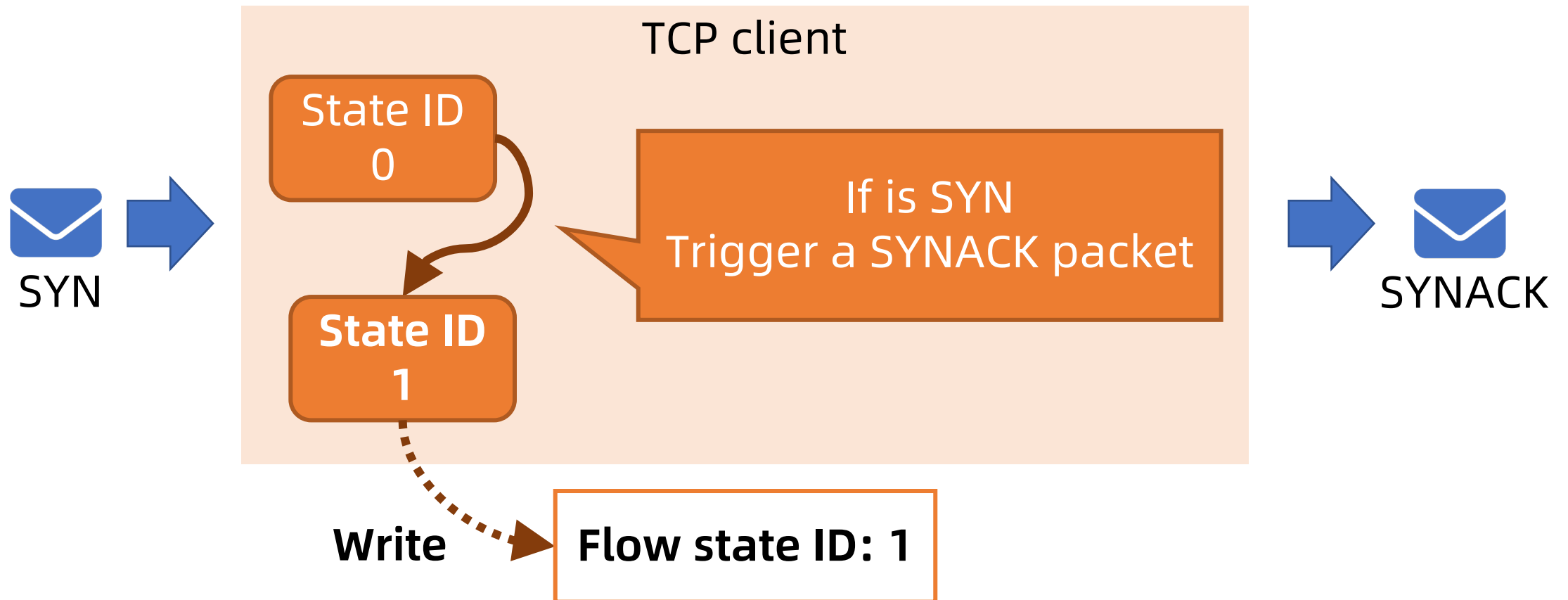
Supporting stateful protocols

Protocol program \Rightarrow State transition table

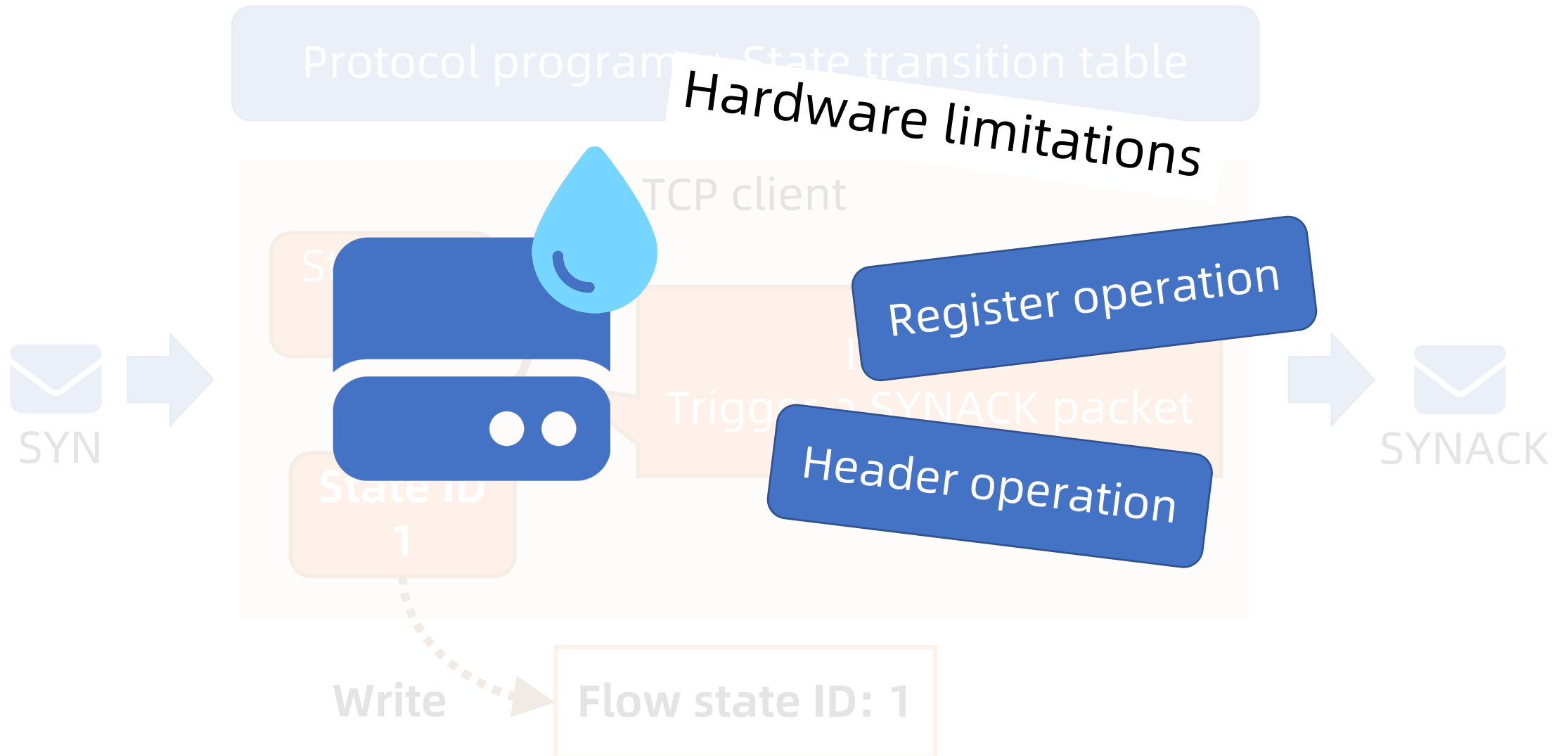


Supporting stateful protocols

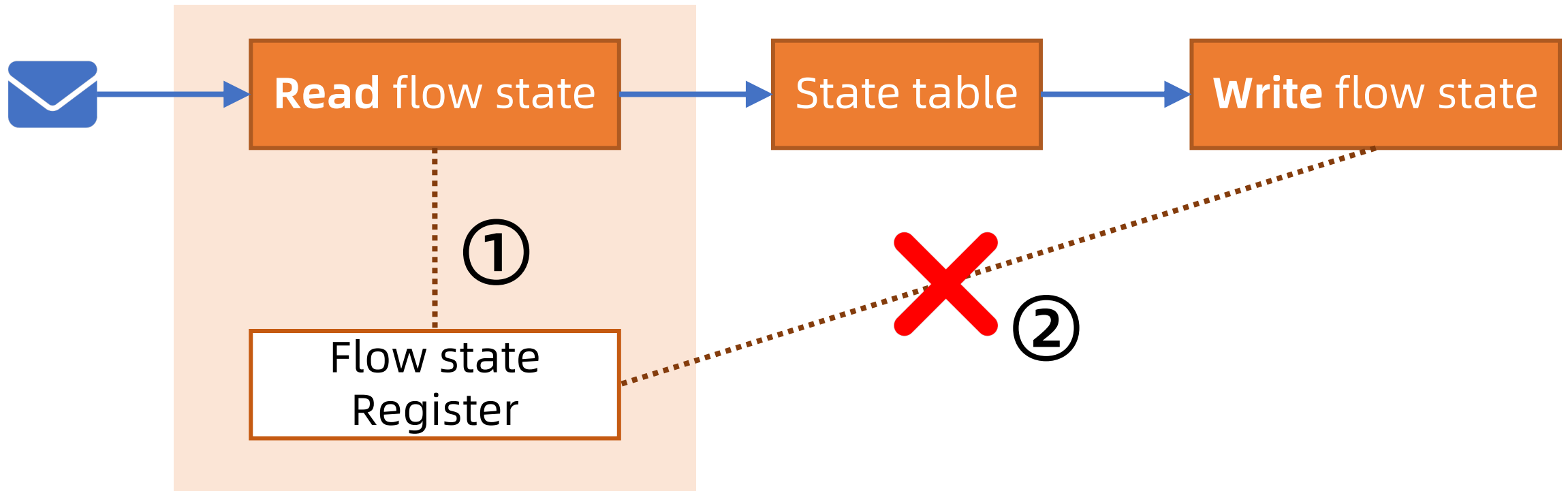
Protocol program \Rightarrow State transition table



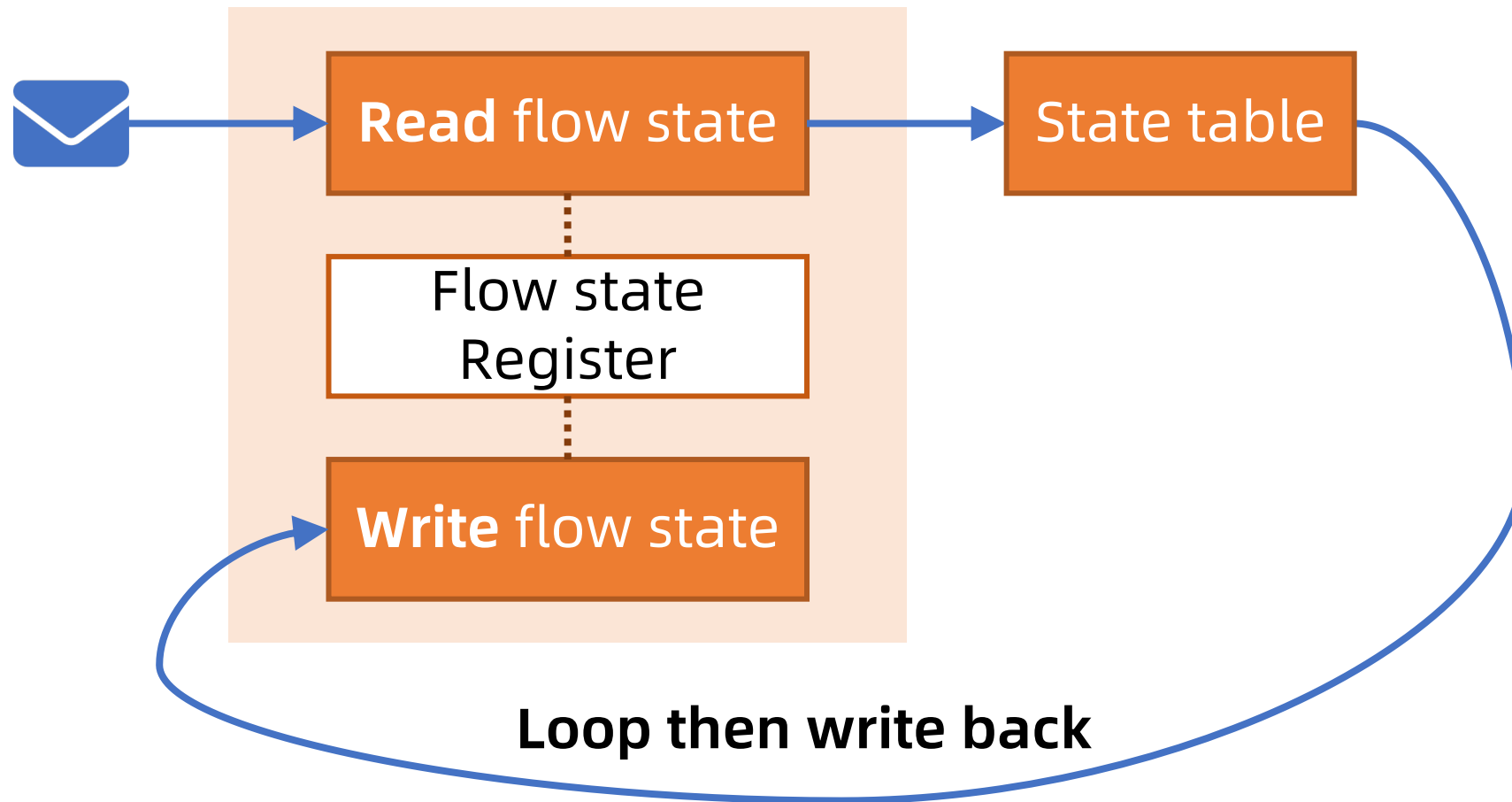
Supporting stateful protocols



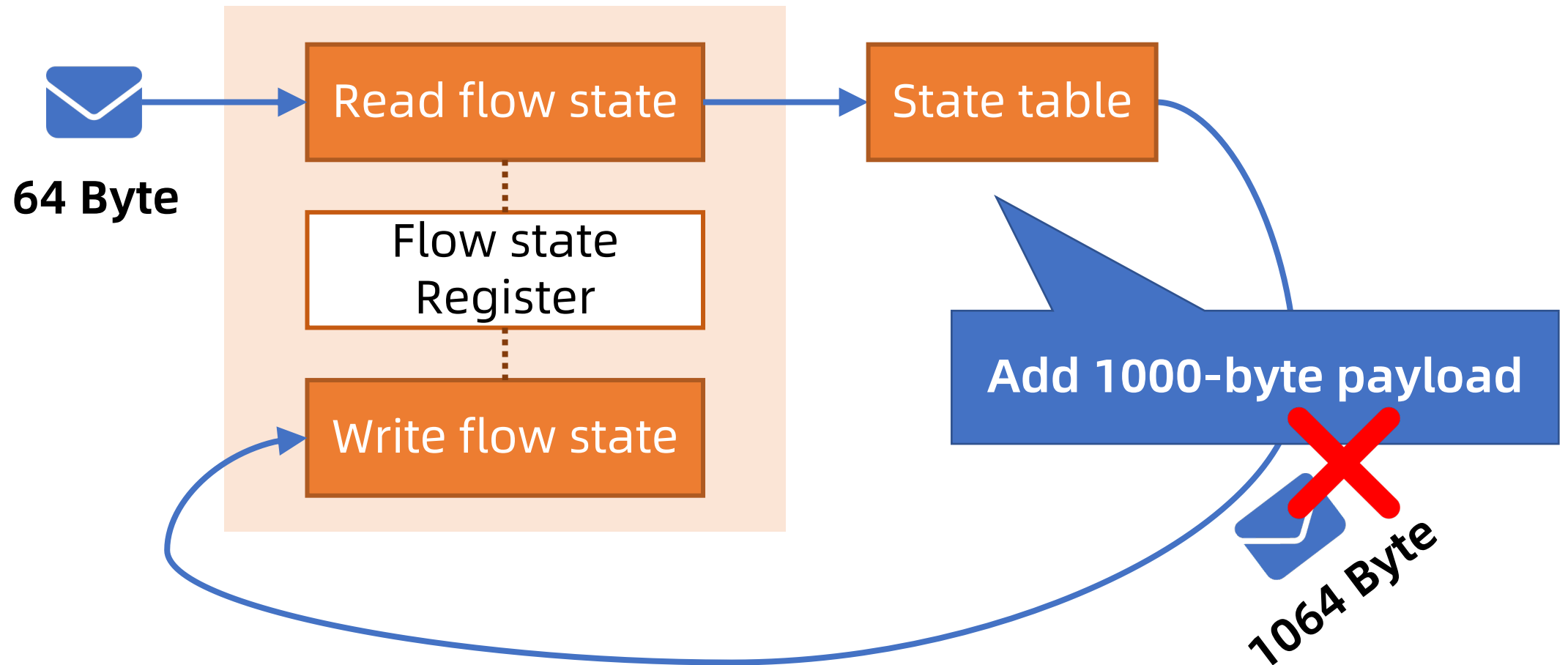
Supporting stateful protocols



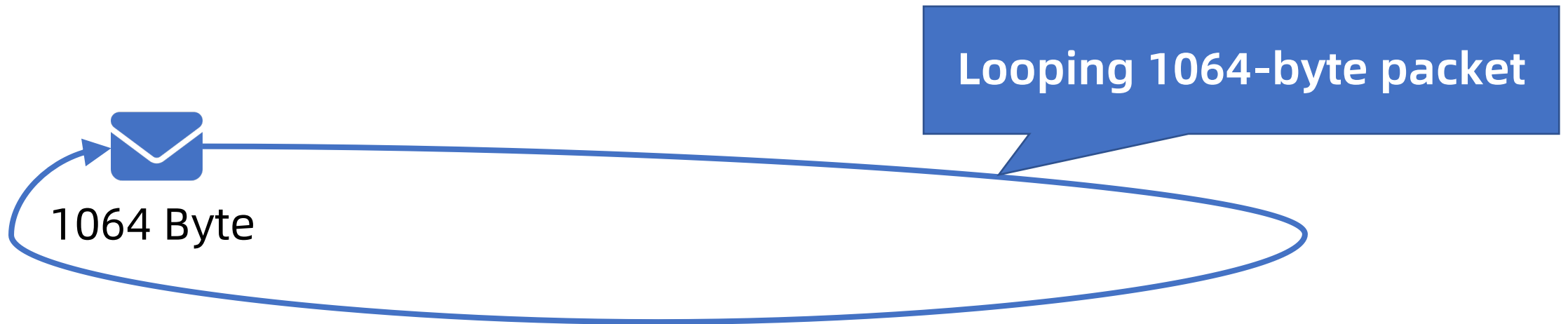
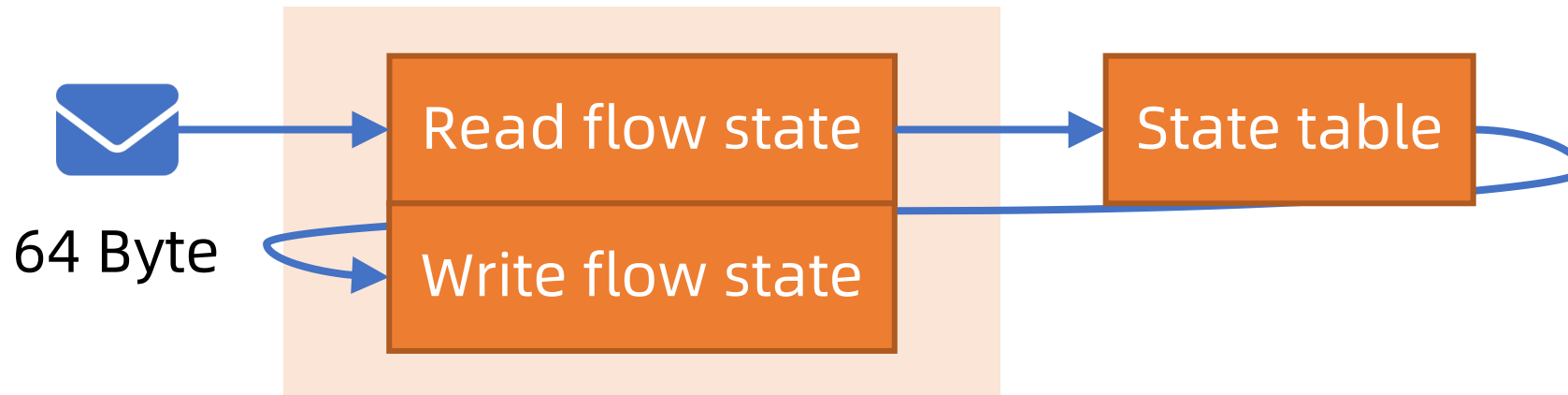
Supporting stateful protocols



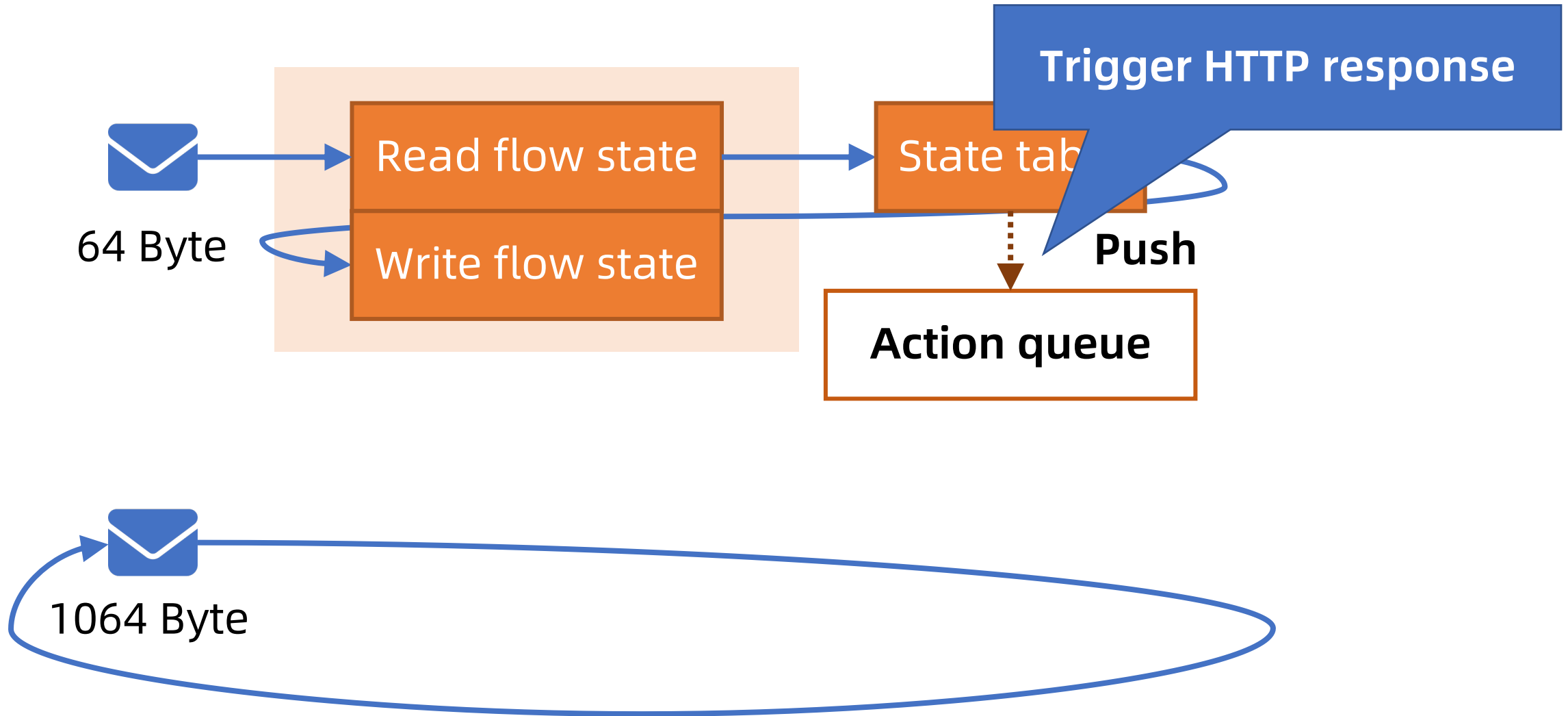
Supporting stateful protocols



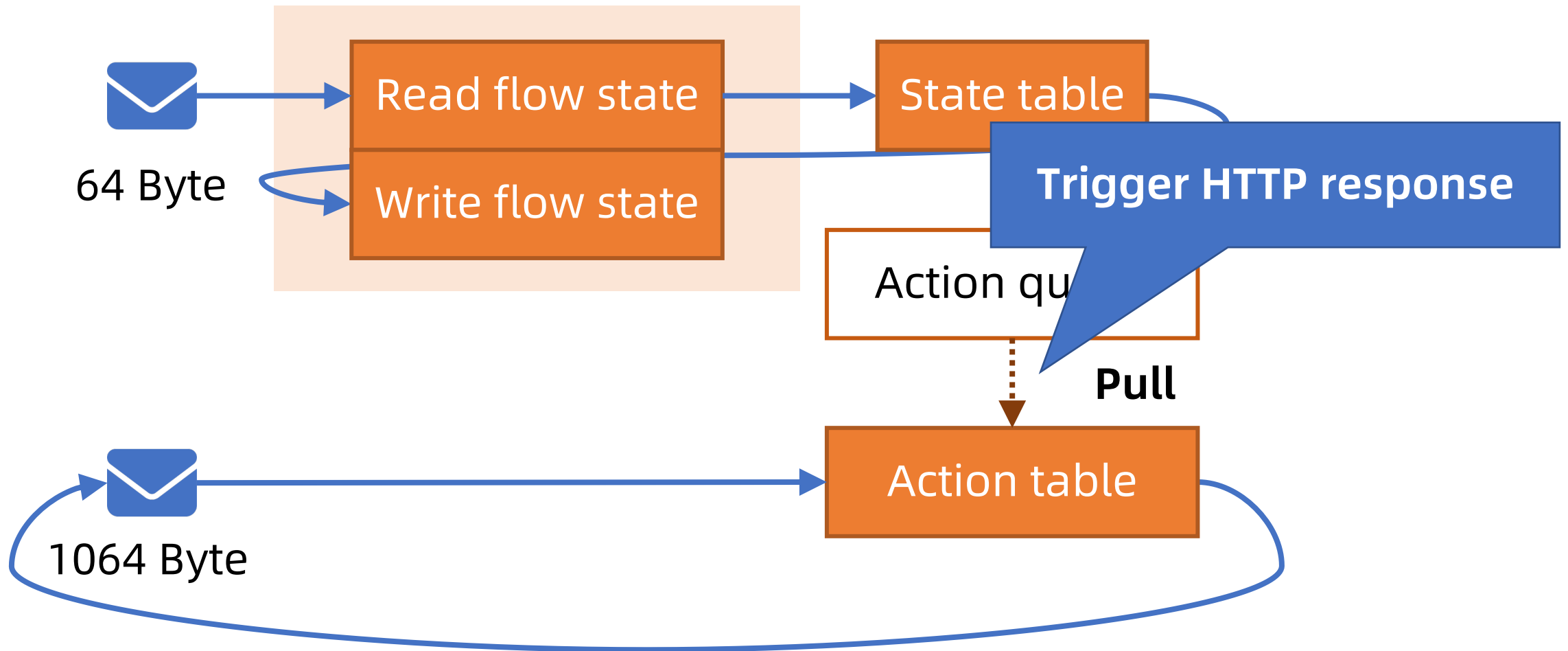
Supporting stateful protocols



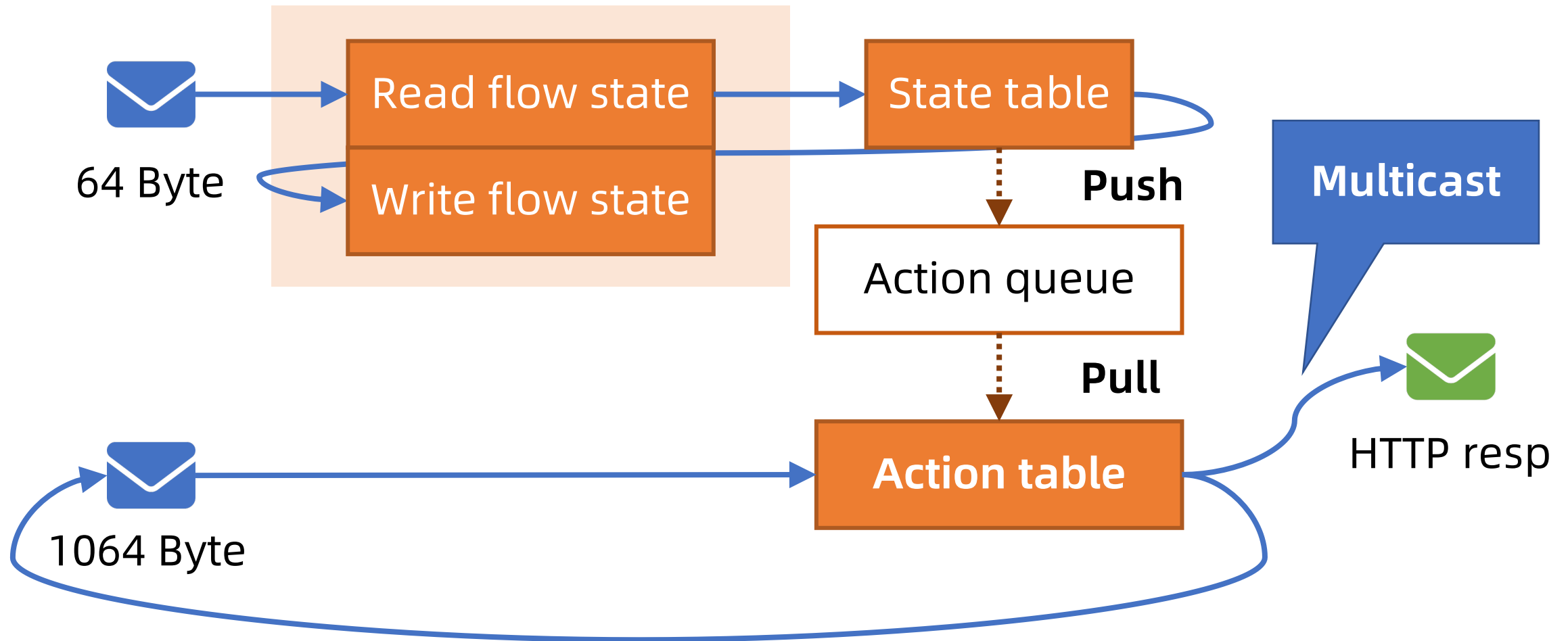
Supporting stateful protocols



Supporting stateful protocols



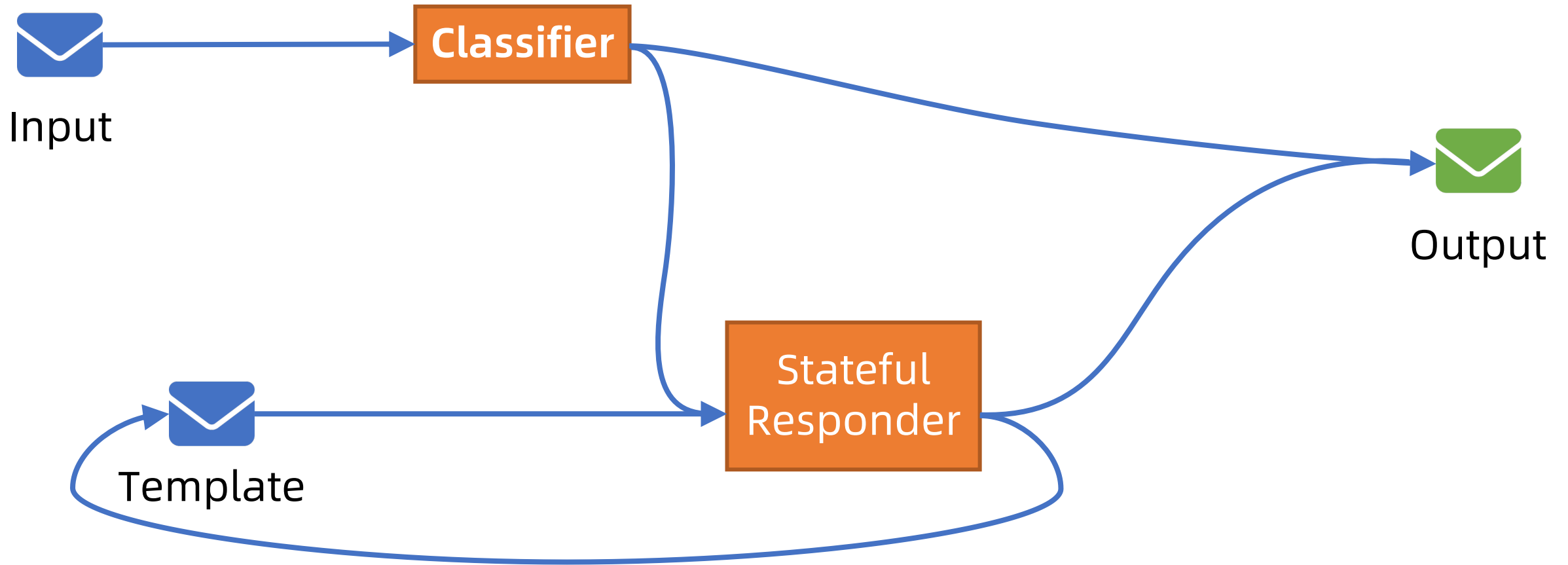
Supporting stateful protocols



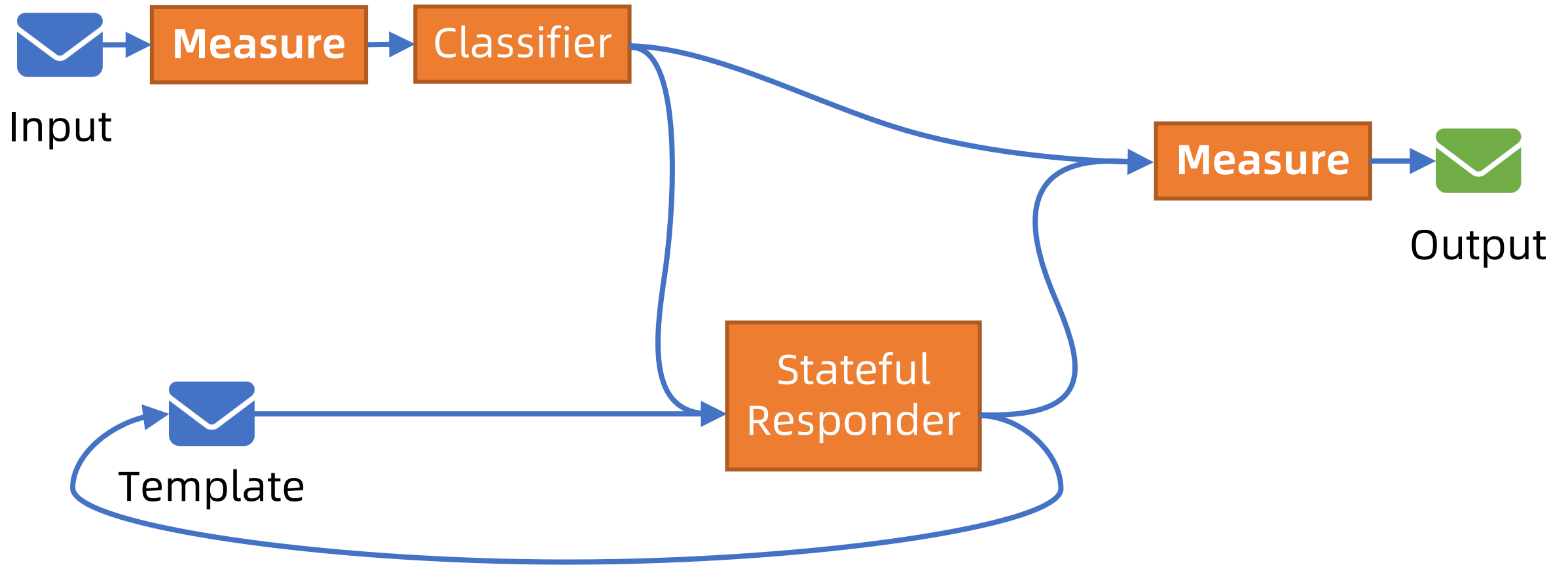
Supporting stateful protocols



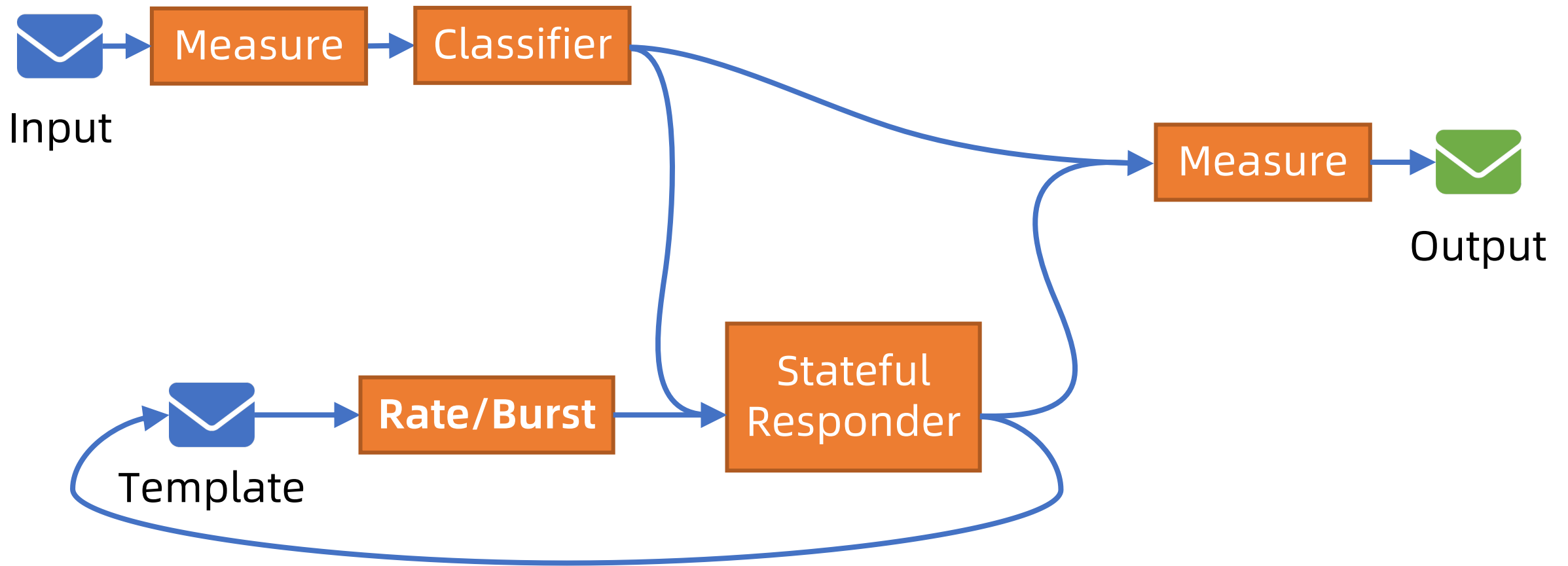
Norma's architecture



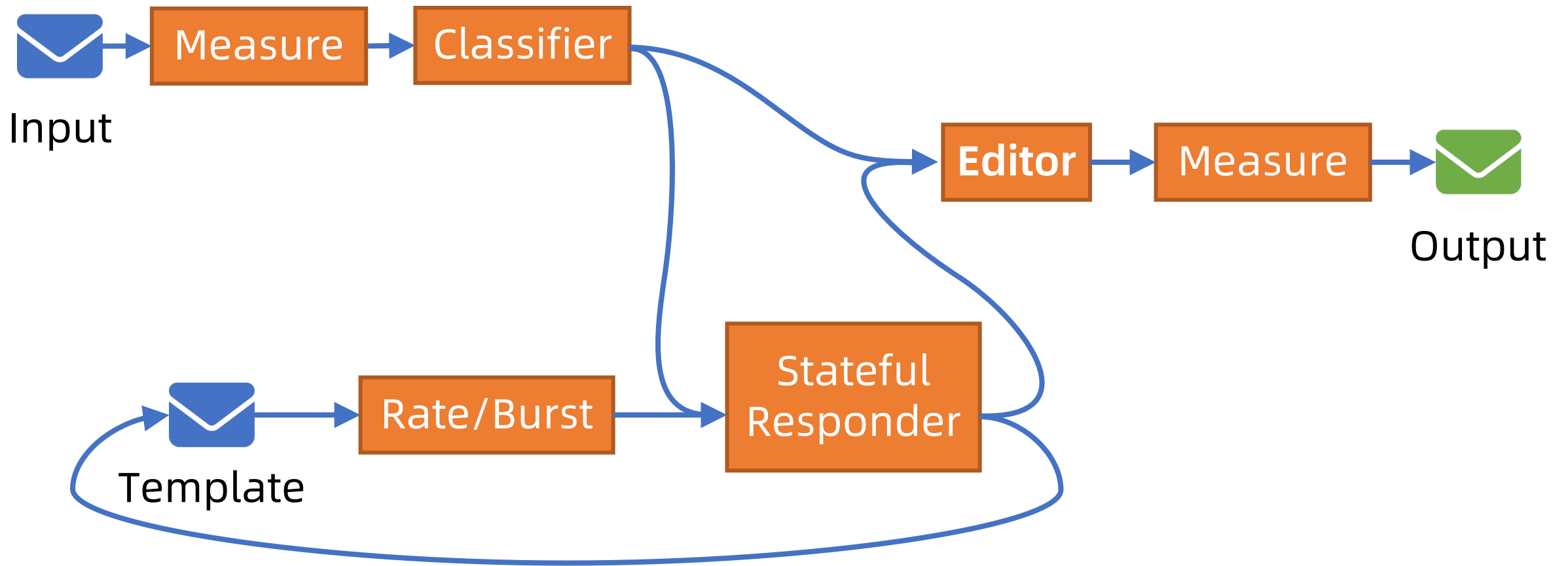
Norma's architecture



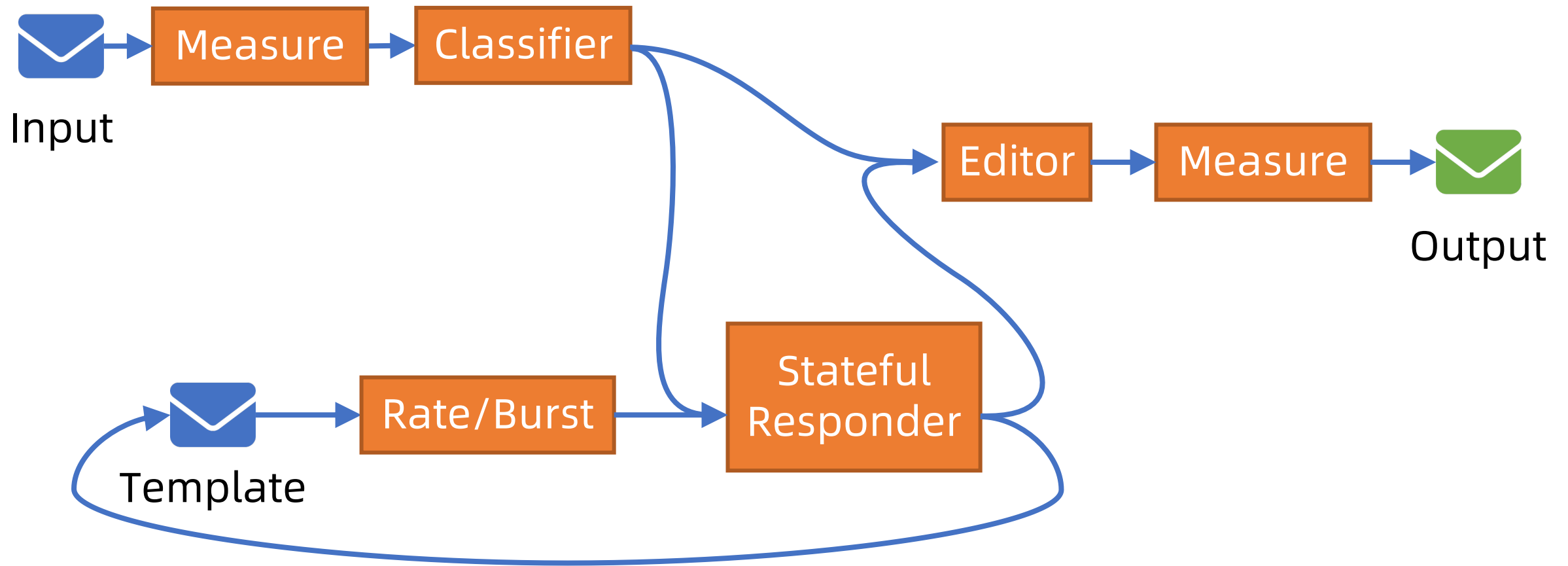
Norma's architecture



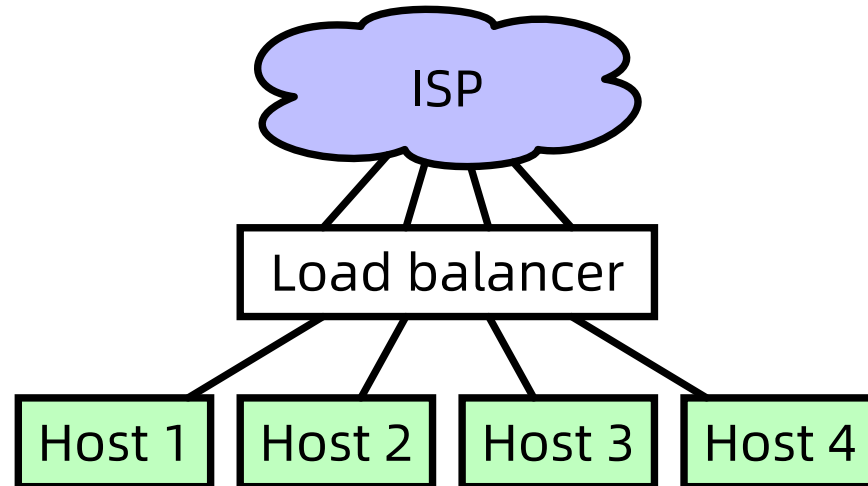
Norma's architecture



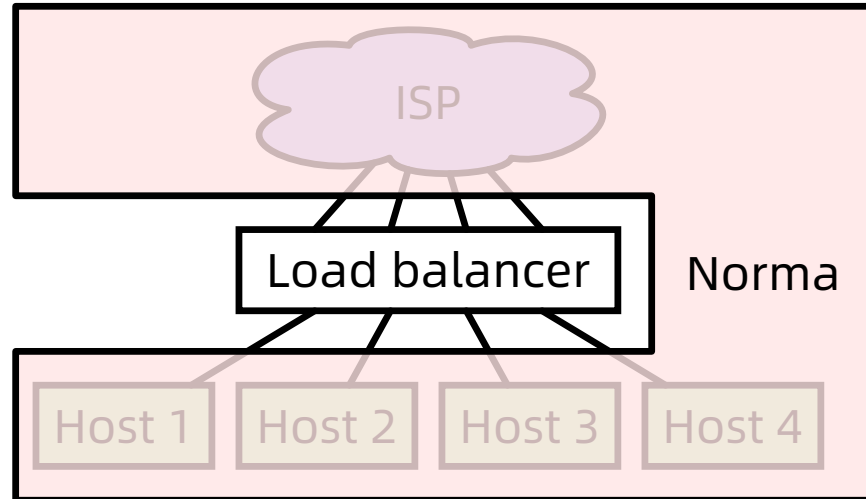
Norma's architecture



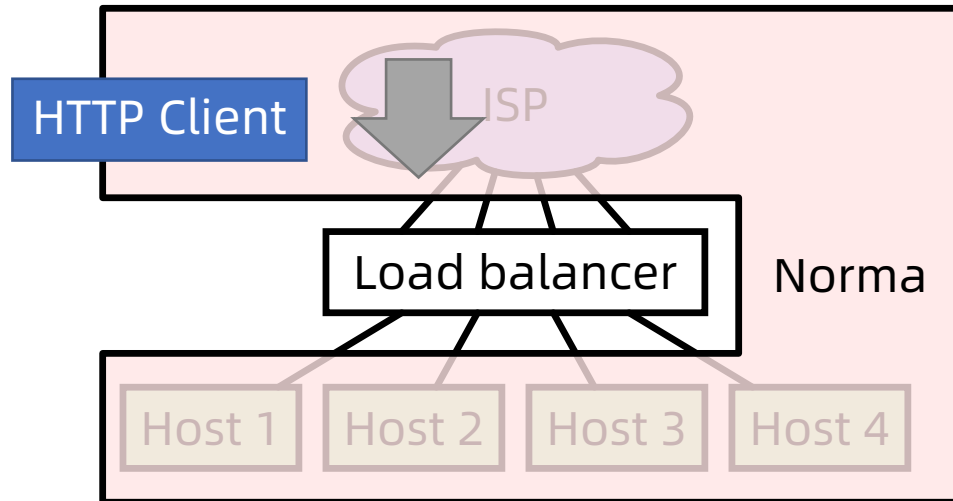
Case study: CDN load balancer stress test



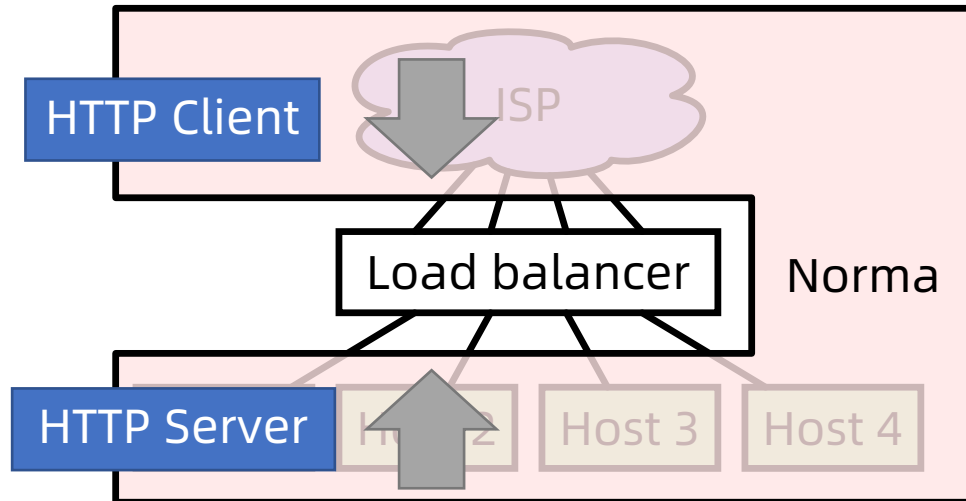
Case study: CDN load balancer stress test



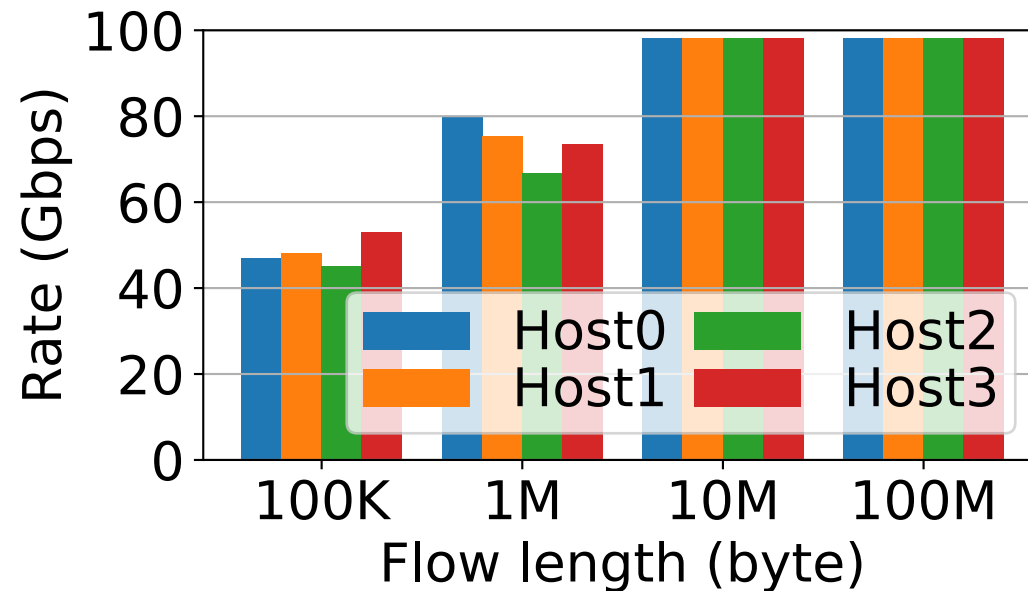
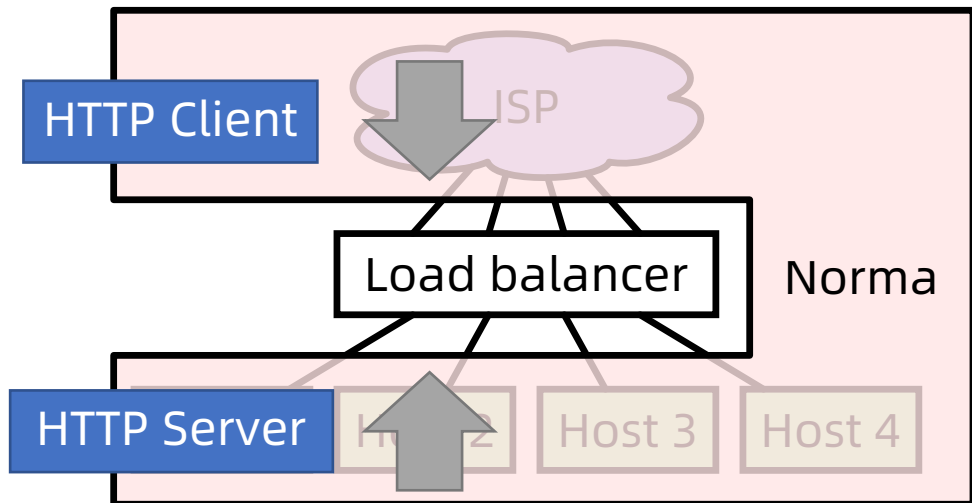
Case study: CDN load balancer stress test



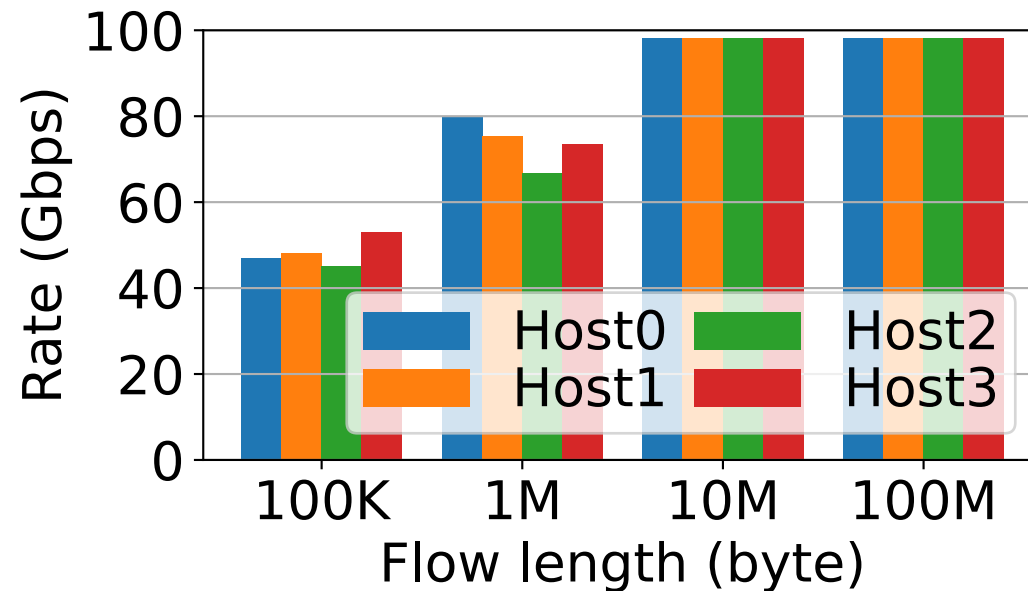
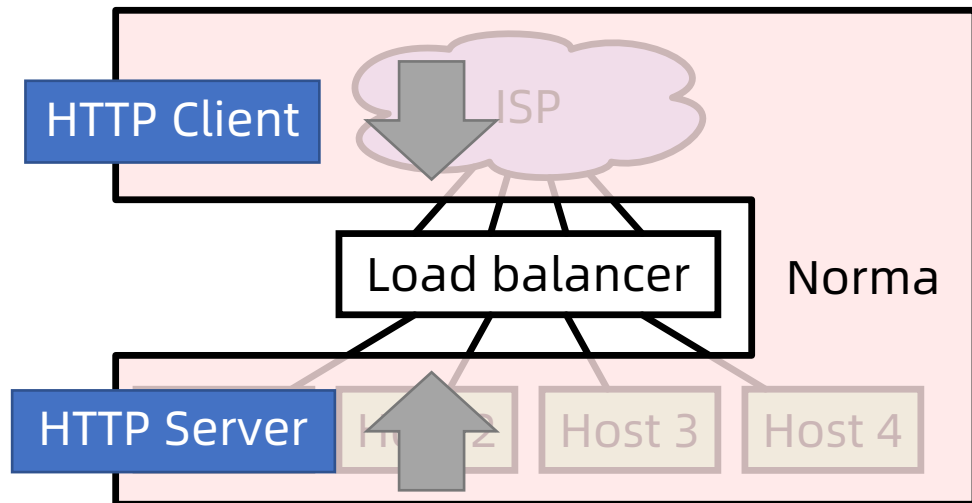
Case study: CDN load balancer stress test



Case study: CDN load balancer stress test

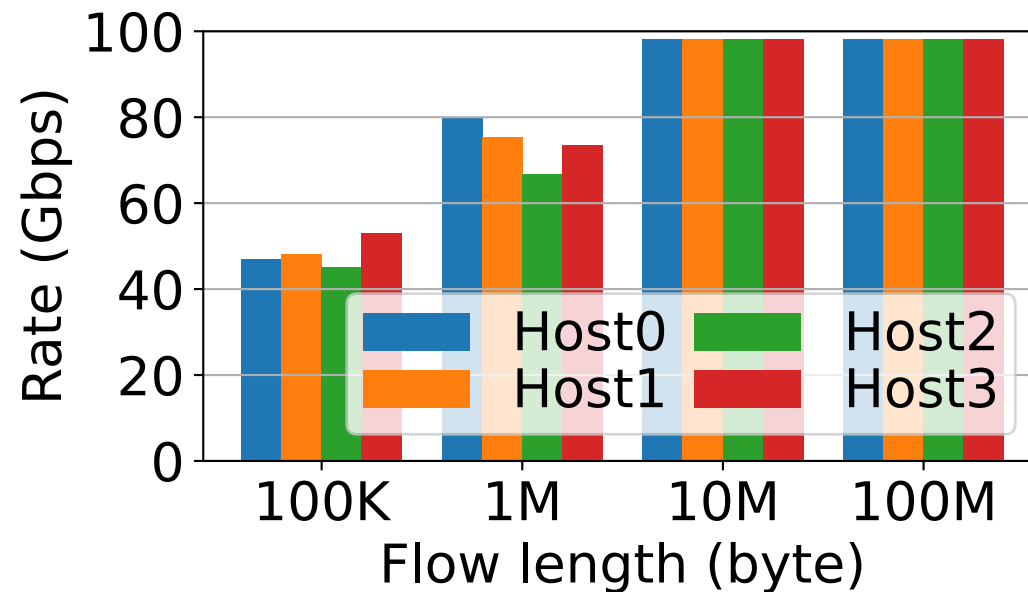
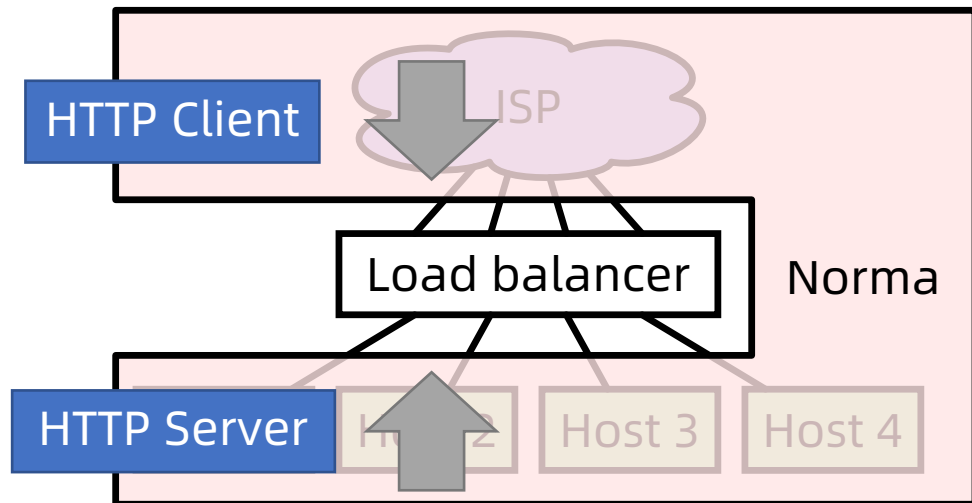


Case study: CDN load balancer stress test



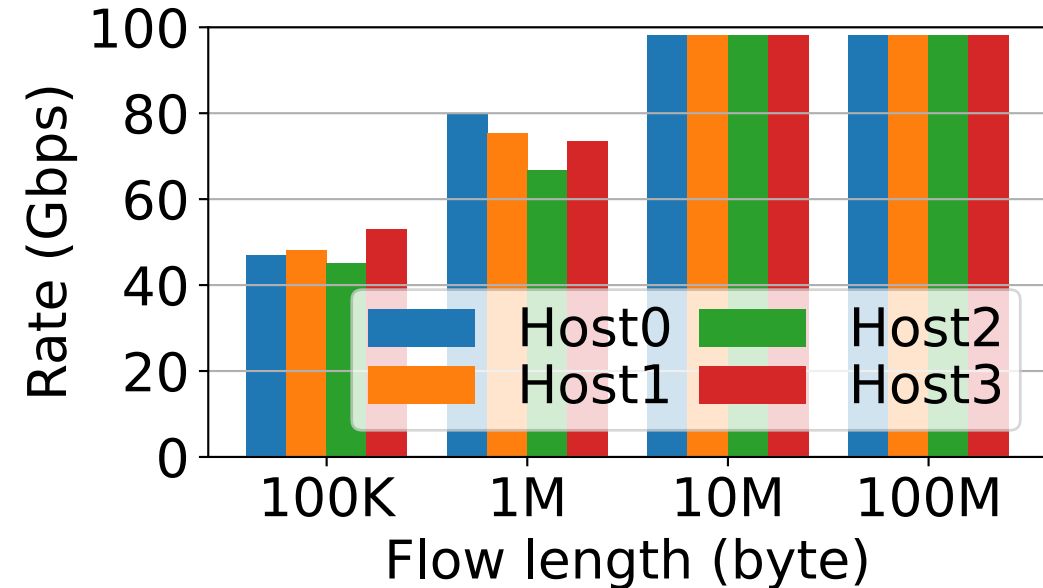
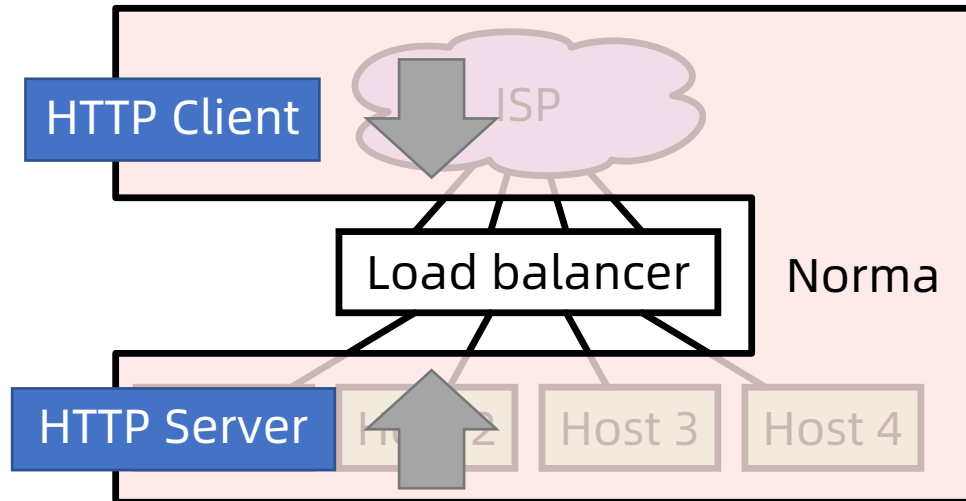
- Obtain the performance of the device

Case study: CDN load balancer stress test



- Obtain the performance of the device
- **Reference standard for later optimization**

Case study: CDN load balancer stress test



- Obtain the performance of the device
- Reference standard for later optimization
- **Potential bottlenecks before deploying to production**

Evaluation

Evaluation Overview

- Throughput
 - Stateless protocol (UDP)
 - Stateful protocol (TCP and HTTP)

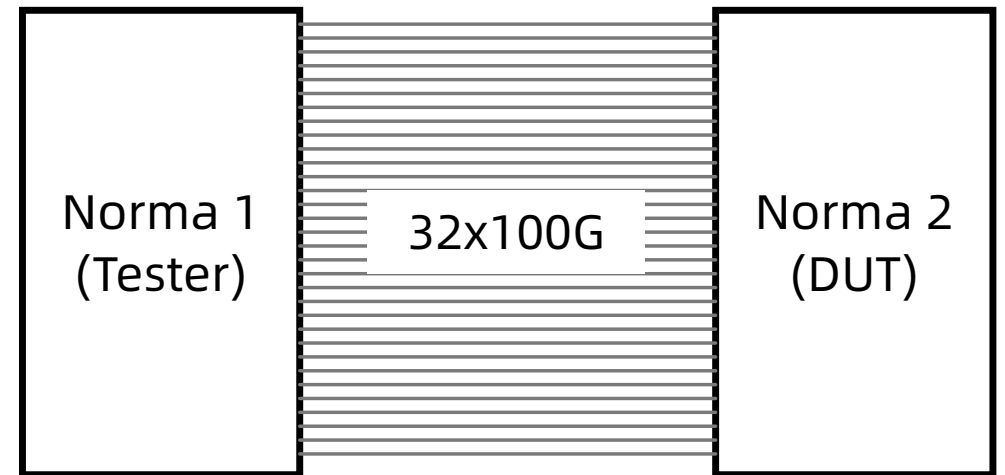
Evaluation

Evaluation Overview

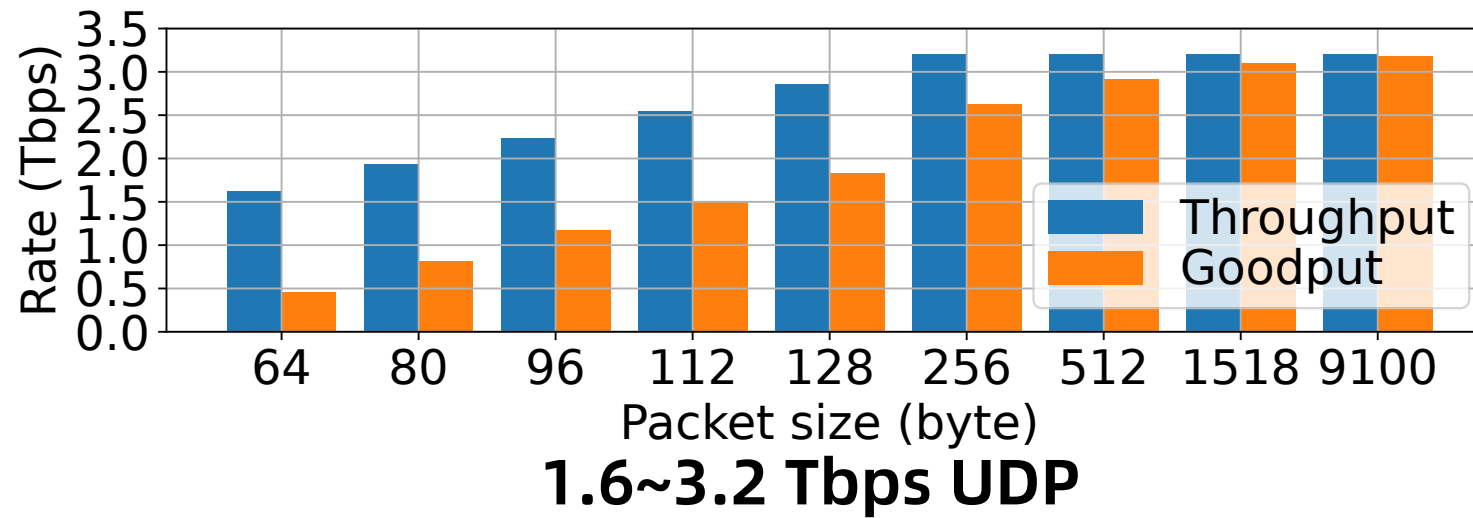
- Throughput
 - Stateless protocol (UDP)
 - Stateful protocol (TCP and HTTP)

Evaluation Setup

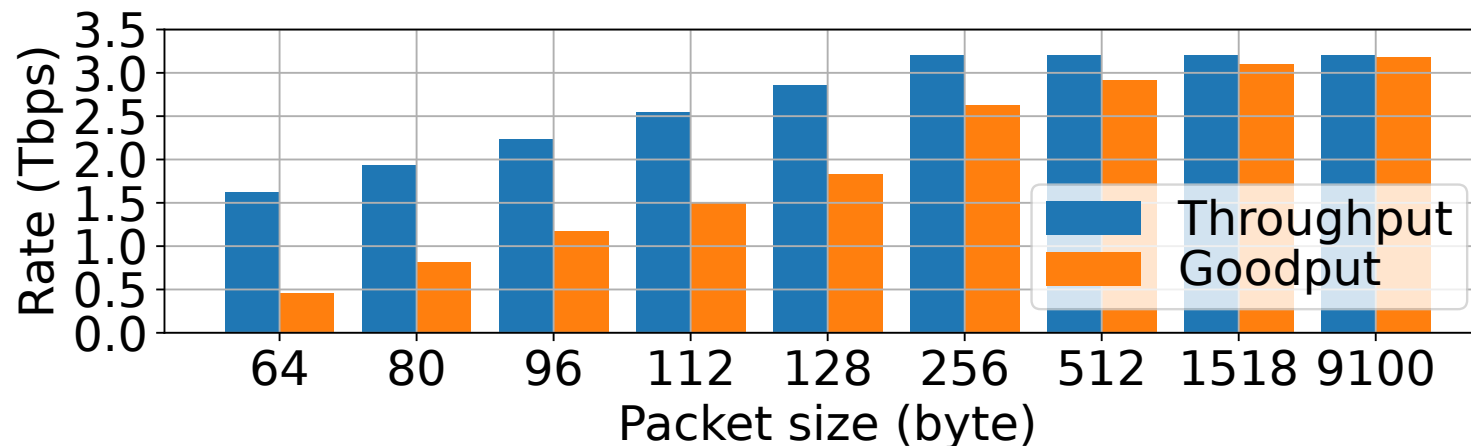
Two Tofino programmable switches connected via 32 100G links



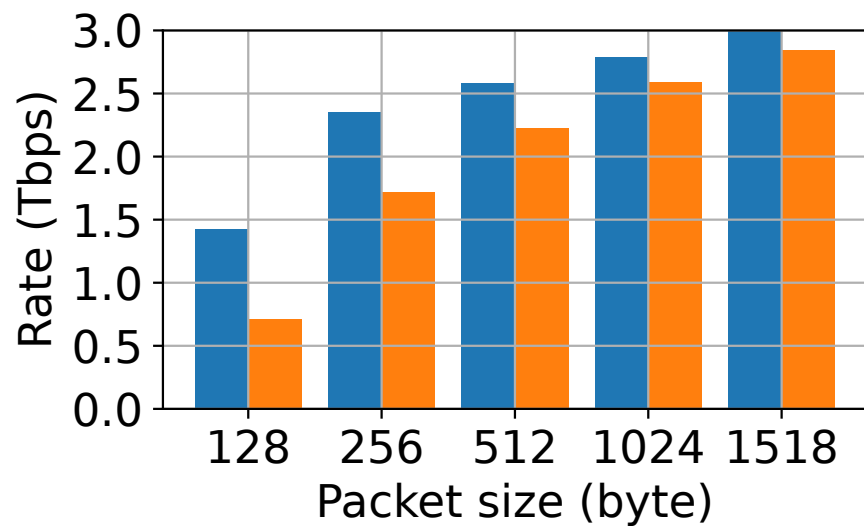
Evaluation



Evaluation

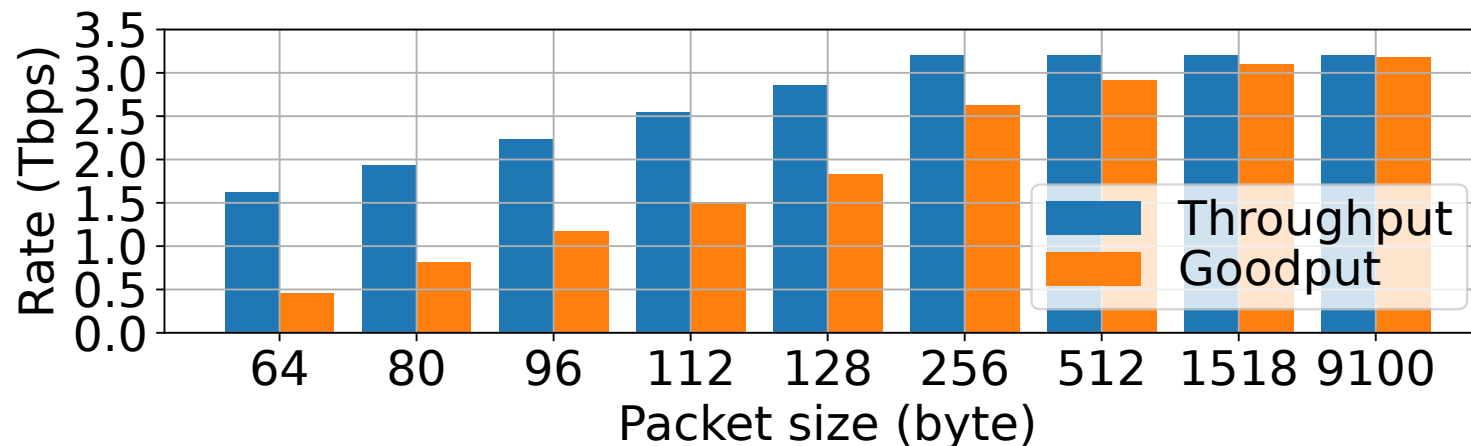


1.6~3.2 Tbps UDP

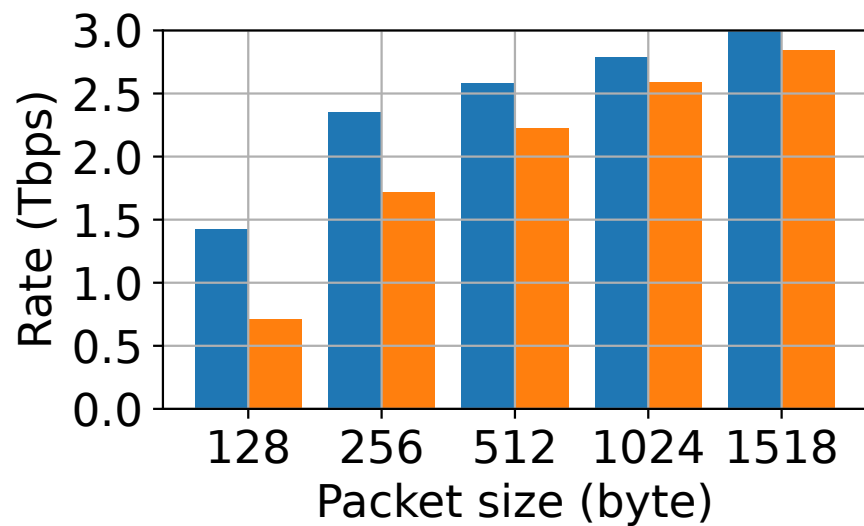


1.4~3.0 Tbps TCP

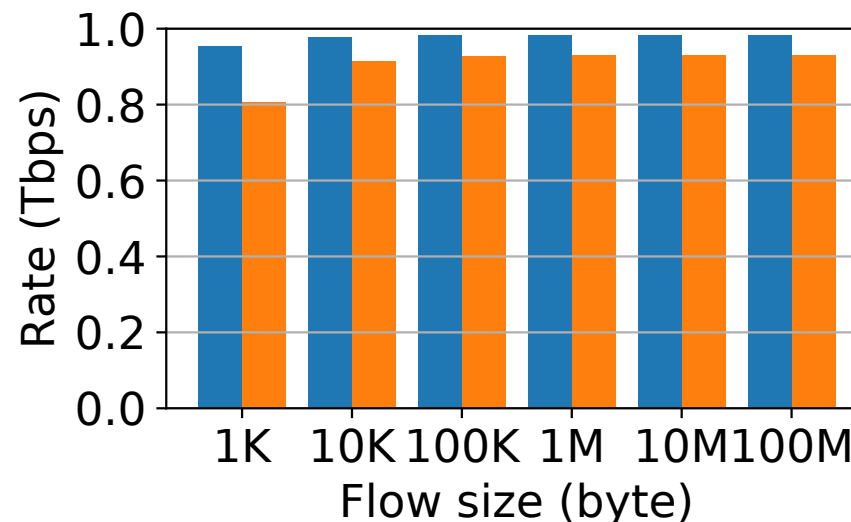
Evaluation



1.6~3.2 Tbps UDP



1.4~3.0 Tbps TCP



Near 1Tbps HTTP

Conclusion

Norma: a practical network load tester

- High-throughput traffic
- Stateful protocols
- Customized packet headers
- Precise rate/burst control
- Accurate measurement

Thank you!

