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SYN Flood Defense in Programmable Data Planes

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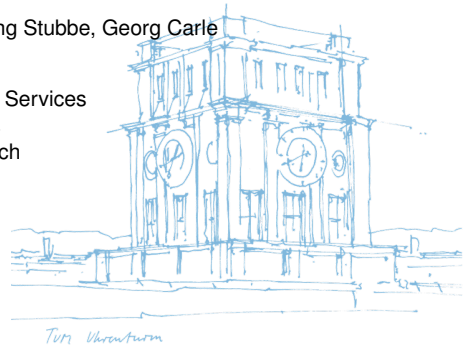


Motivation

SYN Floods are (Still) a Serious Problem

Flaw in TCP handshake protocol

- "top-placed SYN flooding, whose share [...] reached a record high of 92.6"[1]
- problem will always exist

→ networks/end nodes always need protection

- volume of attacks increases

→ solutions need to scale

→ **Move mitigation to the data plane**
Anywhere in your network, efficiently, flexible

Available solutions

- network stacks

→ do not scale

- using your favorite packet processing framework

→ not portable

- commercial solutions (e.g. traffic scrubbing centers)

→ closed-source

[1] Kaspersky: "DDoS attacks in Q1 2020", [Online] `https://securelist.com/ddos-attacks-in-q1-2020/96837/`

Outline

SYN Flood-specific Mitigation

SYN Flood Mitigation with P4

Teaser & Conclusion

SYN Flood-specific Mitigation

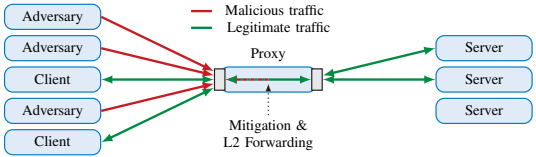
Deployment Scenarios

On the endhost

- does not scale
- takes away resources from server

SYN proxy

- in network or in cloud
- protect multiple servers or whole network(s)
- intercepts TCP flows



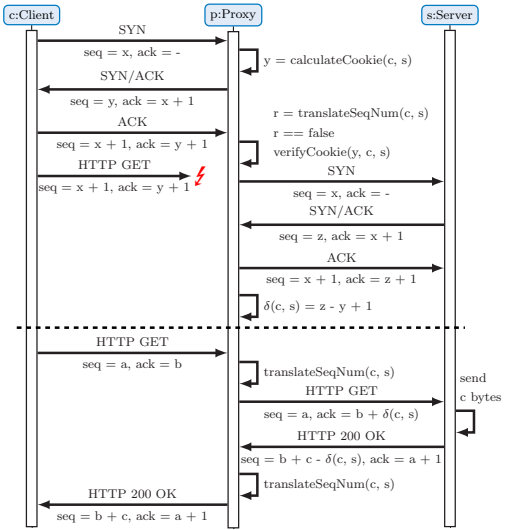
Several challenges when implementing mitigation strategies as SYN proxy in data plane
We focus on SYN cookies and SYN authentication

SYN Flood-specific Mitigation

Protecting Against SYN Floods

SYN cookies

- cryptographic hash (cookie) bound to flow
- no state maintained by proxy until handshake finished
- two connections
  - client – proxy
  - proxy – server
- proxy needs to translate between both connections
- initial data segments might be lost

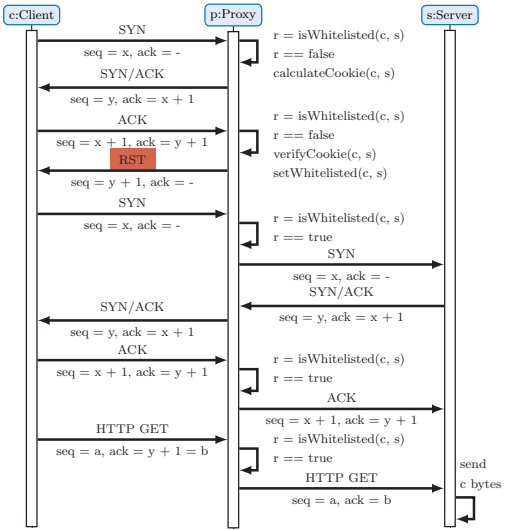


SYN Flood-specific Mitigation

Protecting Against Syn Floods

SYN authentication

- interrupt initial connection attempt
- whitelist client/subnet once challenge completed
  - reset
  - full handshake
  - higher-layer connection
- combined with cookie
- one connection, no translation



SYN Flood-specific Mitigation

Comparison

	SYN Cookies	SYN Authentication
Packet modification	every segment	handshake
Transparent	yes	no
Option support	limited (encoded)	full
State		
State per	flow	flow/subnet
Lookup for	not SYN	every segment

Program core

- parse up to and including TCP header
- essentially L2 forwarder
- received packet is modified according to strategy used
- state (e.g. whitelist) maintained in match-action table

https://bit.ly/36IDtQP

Target-specific changes

- architecture model
- cryptographic hash for cookie

SYN Flood Mitigation with P4

Challenges

Cryptographic hash

- possible for several targets [2]
- add extern (DPDK, NPU)
- modify architecture (FPGA)
- offload to another node (ASIC)

→ portability issue

Whitelisting

- maintaining state requires control plane
- e.g. evicting outdated entries
- alternative: bloom-filter using register extern

→ architecture specific (resources, performance)

[2] Scholz, Dominik, et al. "Cryptographic Hashing in P4 Data Planes." 2019 ACM/IEEE Symposium on Architectures for Networking and Communications Systems (ANCS). IEEE, 2019.

Teaser & Conclusion

What else is in the paper?

- performance figures
  - t4p4s/DPDK
  - Agilio SmartNIC
  - NetFPGA SUME
- case study: SYN flood mitigation in Linux
- comparison with software implementation based on libmoon/DPDK
  - time: 6 months vs. 2 weeks
  - LoC: 1.000 vs 100
  - targets: DPDK vs DPDK, NPU, FPGA

Conclusion

- easy to implement
- scales
- portable
- but requires cryptographic hashing
- targets still require domain-specific knowledge