Dynamic Security Orchestration for CDN Edge-Servers

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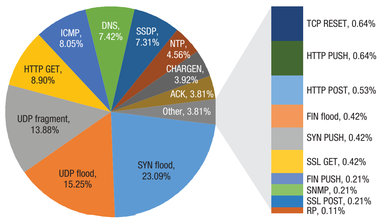
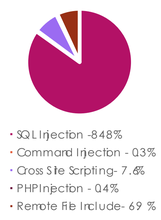
Introduction and Motivation

- Content Delivery Networks (CDNs) provide high QoE in delivering digital content
- CDNs cache content in *edge-servers* in the vicinity of end-users
- Attacks against CDN edge-servers deteriorate QoE
- Limitations of current defense mechanisms
  - Hardware security functions
    - Expensive, not elastic, not flexible
  - Scrubbing centers
    - Redirection latency, proprietary mechanisms
  - Current software solutions
    - Massive changes in infrastructure, not-automated deployment, exclusive to DDoS

Denial of Service Attacks
Distribution by Type



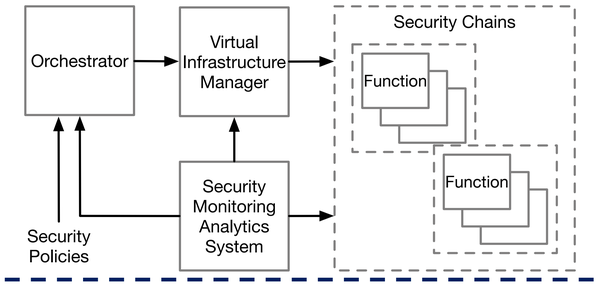
Application Layer Attacks
Distribution by Type



- SQLInjection -848%
- Command Injection - 03%
- Cross Site Scripting- 7.4%
- PHPInjection - 04%
- Remote File Include- 69 %

Dynamic Security Orchestration

- **Automatic** and **dynamic** deployment and **flexible** modification of security services
  - Instantiating and modifying **security chains** in reaction to **events**
- Inspecting only **suspicious** traffic by security services
  - **Classifying** traffic at the beginning of the chains



Demo 1: Network Layer Rate Limiting

Context

- **Attack**
  - TCP flooding attacks
- **Impacts**
  - Exhausting bandwidth resources
  - Making service unavailable
- **Defense**
  - Per IP traffic rate-limiting

Security Policy

too_many_con **initiates** $create\_chain(r:$
<"not src net 129.97.124.0/24", 1, 2>,
$\{f{:}Rate\text{-}Lim.\})$
if not $chain(r)$
lim **after** $create\_chain(r)$
if true
lim **initiates** $run(f, \text{“}rate\_limit.sh\text{”})$
if true

Demo Setup

- A cluster of machines
  - 16~GB RAM
  - 8-cores 3.30~GHz Xeon CPU
  - 10~Gbps NIC.
- Device under test
  - Hosting security chains
  - Hosting our system
- Traffic generators: `iperf client`
- Traffic sink: `iperf server`

Demo 2: Application Layer Rate Limiting

Context

- **Attack**
  - HTTP flooding attacks
- **Impacts**
  - Exhausting processing resources
  - Degrading quality of experience
- **Defense**
  - Per IP, per request rate-limiting

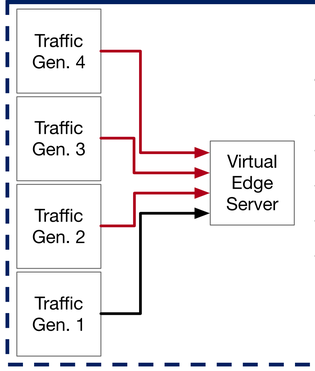
Security Policy

$suspicious\_ip$ **initiates** $create\_chain(l:$
"not src net 99.231.0.0/16", 1, 2,
$\{t : TLS\text{-}Term, w : WAF\}$)
if not $chain(l)$

Demo Setup

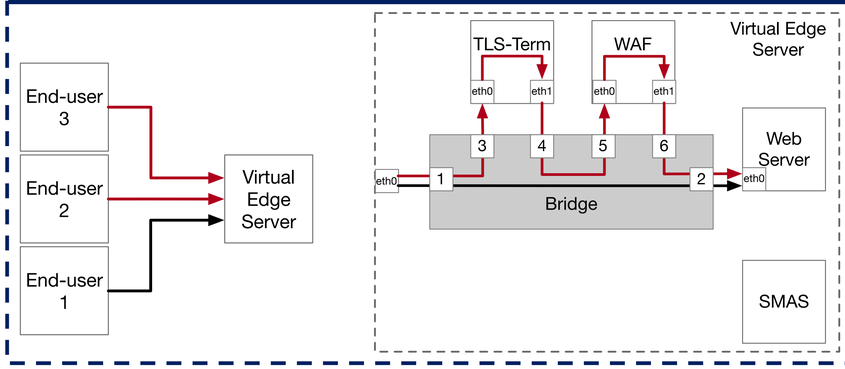
- A cluster of machines
  - 16~GB RAM
  - 8-cores 3.30~GHz Xeon CPU
  - 10~Gbps NIC.
- Device under test
  - Hosting security chains
  - Hosting our system
- Traffic generators: `VLC`, `curl`
- Traffic sink: `Apache server`

Attack Emulation



Stage	Flooding traffic share	Active traffic generators
1	0%	Traffic Gen. 1
2	50%	Traffic Gen. 1 and 2
3	66.6%	Traffic Gen. 1, 2, and 3
4	75%	Traffic Gen. 1, 2, 3, and 4

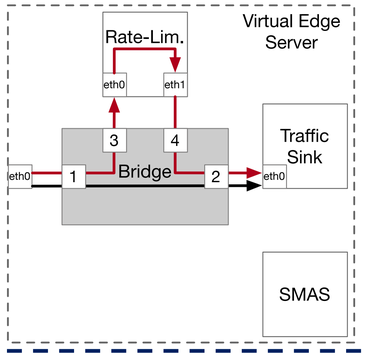
Attack Emulation and Mitigation Chain

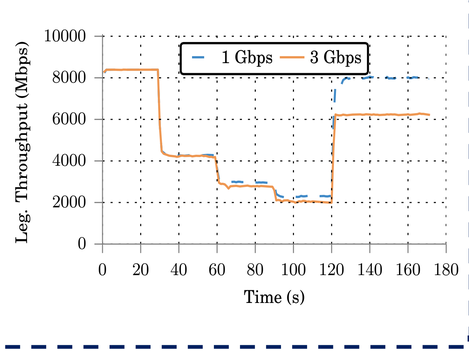


Architecture Components

- **Orchestrator**
  - Programed by policies scripted in an adapted version of $\mathcal{L}_{active}$ language
  - Reacts to environment states and threats
- **Virtual Infrastructure Manager (VIM)**
  - Manages the resources of a virtual edge-server
  - Provides a north-bound API for Orchestrator and SMAS
- **Security Monitoring Analytics System (SMAS)**
  - Monitors and analyzes the collected data
  - Feeds the orchestrator with alerts that may trigger security actions

Mitigation Chain





Conclusion

- We demonstrated a configurable security system that protects CDN edge-servers
- This system behavior is governed by high-level policies
- The deployment of security function chains is dynamic and automatic
- We illustrated how our system can be flexibly programmed to mitigate real-world threats
- In first demonstration, our system mitigates a network layer flooding attack
  - Deploying a chain of a rate-limiting function recovering legitimate traffic
- In second demonstration, an application layer abusive behavior is rate-limited
  - Deploying a chain of a TLS termination and a WAF to rate-limit abusive requests