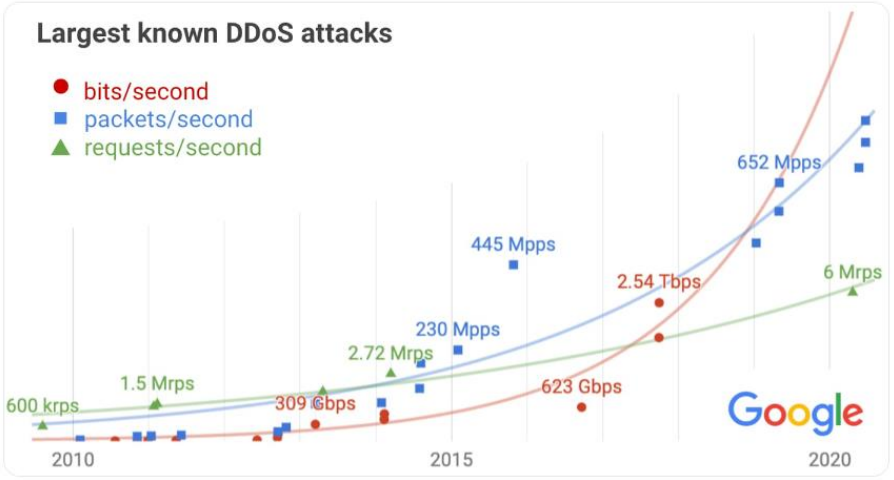
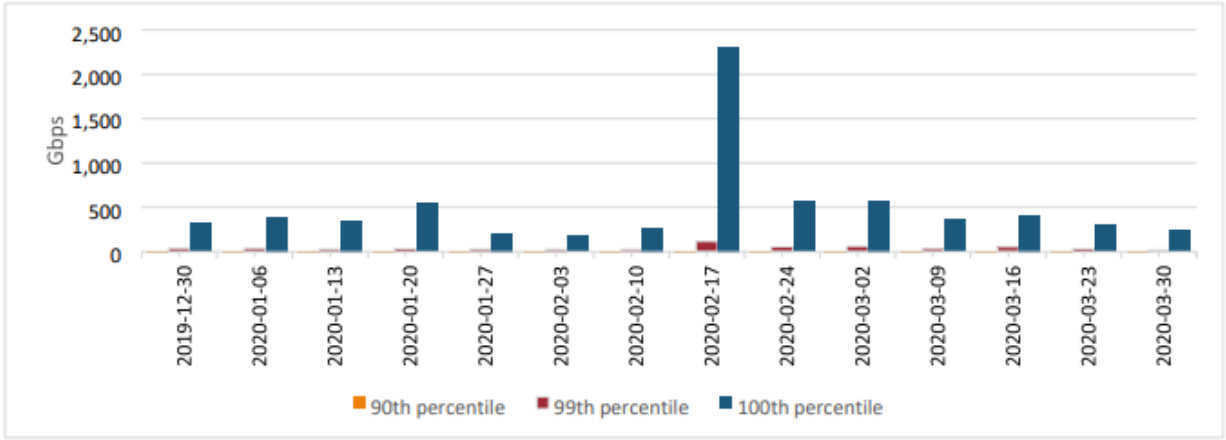
Denial of Service (DoS) and Distributed DoS (DDoS) Attacks

Denial of Service Attack (DoS)

- A Denial of Service (DoS) attack aims to render a server or a device unavailable to legitimate users by interrupting the device's normal services[1]
- A Distributed DoS (DDoS) is a type of DoS that originates from multiple distributed sources (e.g., botnet DDoS attack), thus, amplifying the effect of DoS



Largest known DDoS attacks in Google Cloud between 2010 and 2020. [Figure taken from Google Cloud blogs. https://tinyurl.com/bdzuupb6]

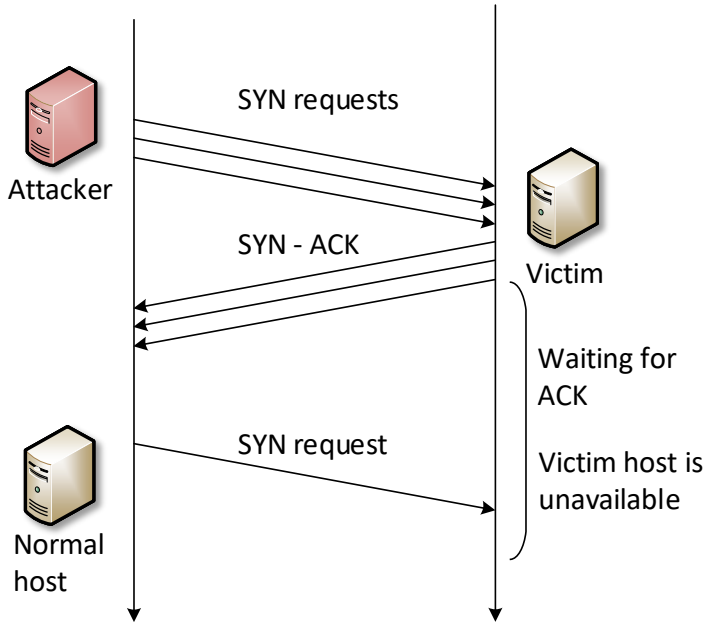


Packet volume of the largest network volumetric events observed by AWS in Q1 2020. [Figure taken from AWS Shield Report. https://tinyurl.com/yd3ehx47]

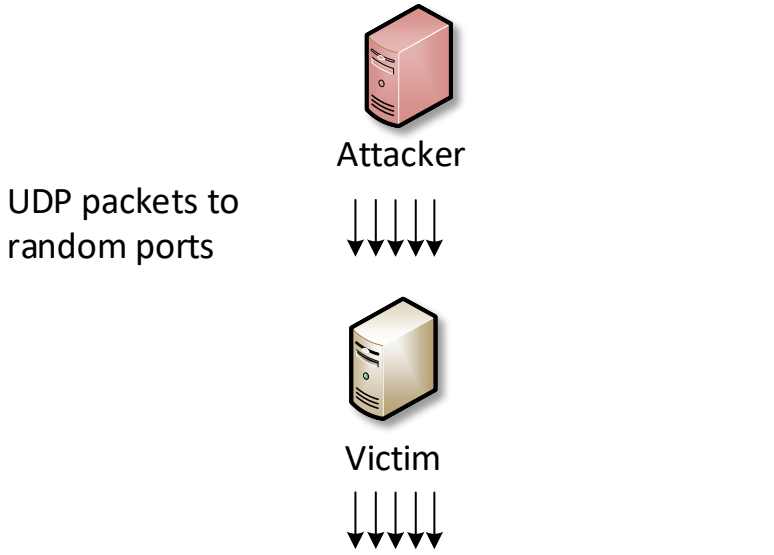
[1] Cloudflare, "What is a denial-of-service (DoS) attack?", [Online]. Available: https://www.cloudflare.com/learning/ddos/glossary/denial-of-service/

Types of DoS Attacks

- DoS attacks can be classified as volumetric, reflected, and stealthy DoS attacks
- Volumetric DoS attacks flood the target machine with traffic, depriving legitimate users from downloading the target's resources
- DoS attacks can be performed at various levels of the protocol stack (e.g., TCP, UDP)



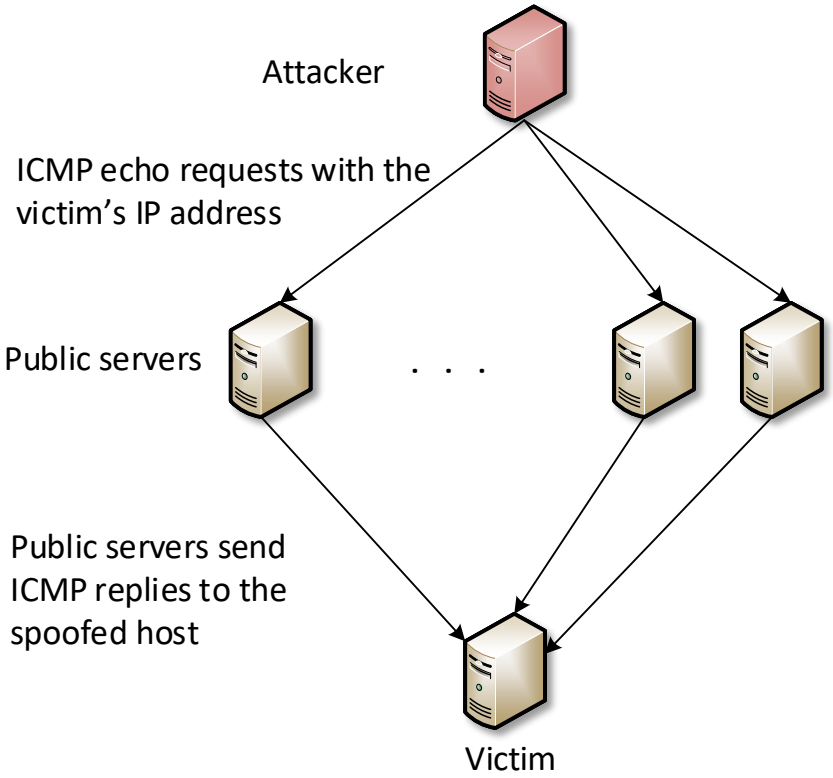
TCP SYN flood attack



UDP flood attack

Types of DoS Attacks

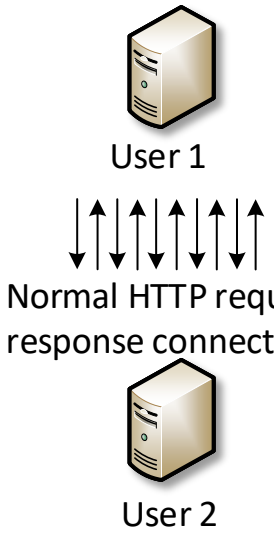
- Reflected DoS attacks (amplification attacks) make use of a third-party component to send the attack traffic to a victim, ultimately hiding the attacker's own identity
- In a reflected DoS attack
  - The attacker spoofs the source IP address of the target victim machine
  - The reflector sends response packets that overwhelm the victim
- *Smurf* reflected DoS attack uses ICMP echo requests and public servers to overwhelm a target victim



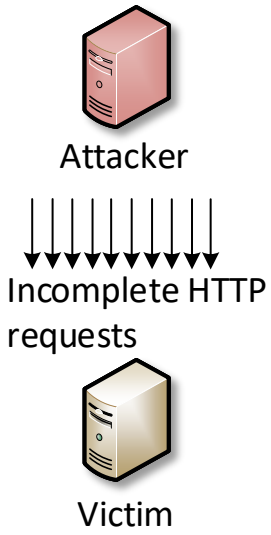
Smurf reflected DDoS attack

Types of DoS Attacks

- Stealthy DoS attack (slow DoS) use low bandwidth rates when targeting a victim
- *SlowLoris* attack establishes many connections to a target server and holds them as long as possible
- *SlowLoris* sporadically sends partial requests to keep the session active



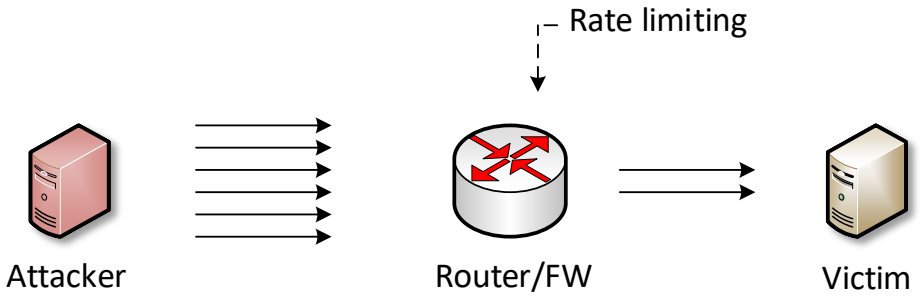
Normal connection: complete HTTP request/response connections



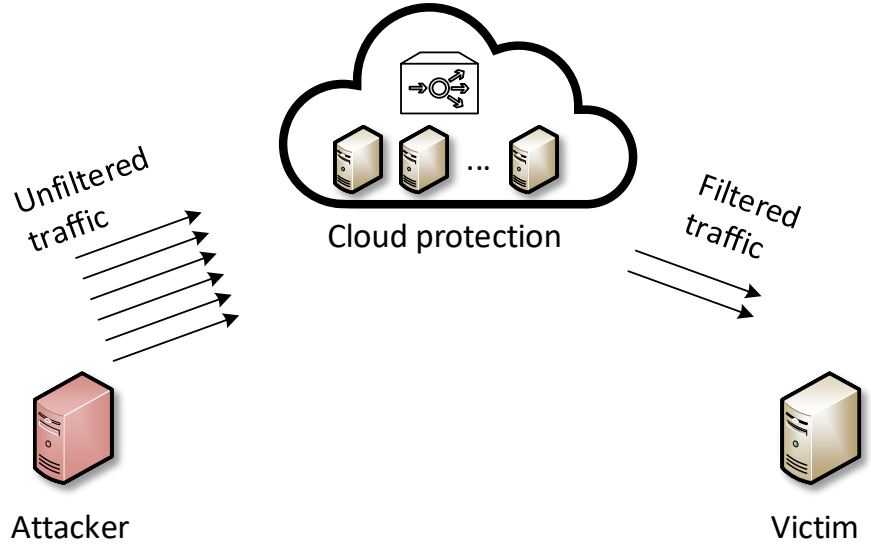
SlowLoris attack: incomplete HTTP requests

DoS Mitigation

- DoS mitigation refers to the process of successfully protecting a targeted server or network from a DoS attack
- Traditional DoS mitigation strategies include purchasing and maintaining expensive equipment
- Modern infrastructure rely on cloud providers to provide DoS mitigation services[1]



Rate limiting against DoS attacks



Cloud-based DoS protection

[1] Cloudflare, "What is DDoS mitigation?", [Online]. Available: https://www.cloudflare.com/learning/ddos/ddos-mitigation/

DoS Mitigation

- Additionally, operating systems provide some level against DoS attacks
  - In Linux, the following techniques are implemented:
    - Reverse path filtering: prevents IP spoofing associated with DoS attacks
    - SYN cookie: prevents against SYN flood attacks
    - Session's caching: allows for rapid recent TCP sessions to