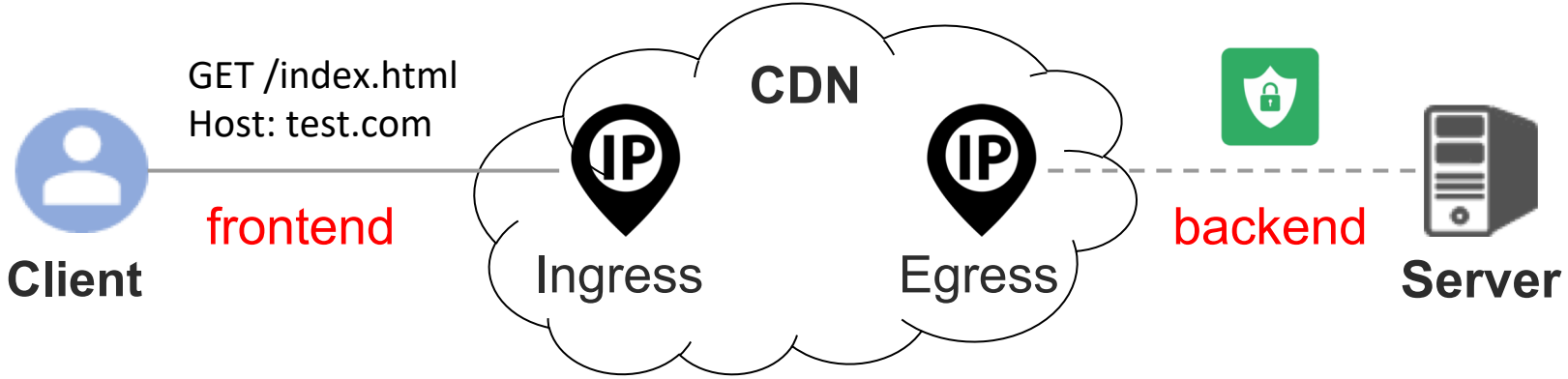
CDN Backfired: Amplification Attacks Based on HTTP Range Requests

Weizhong Li, Kaiwen Shen, Run Guo, Baojun Liu, Jia Zhang,
Haixin Duan, Shuang Hao, Xiarun Chen, Yao Wang (**Chaoyi Lu**)

DSN 2020 - June 30, 2020

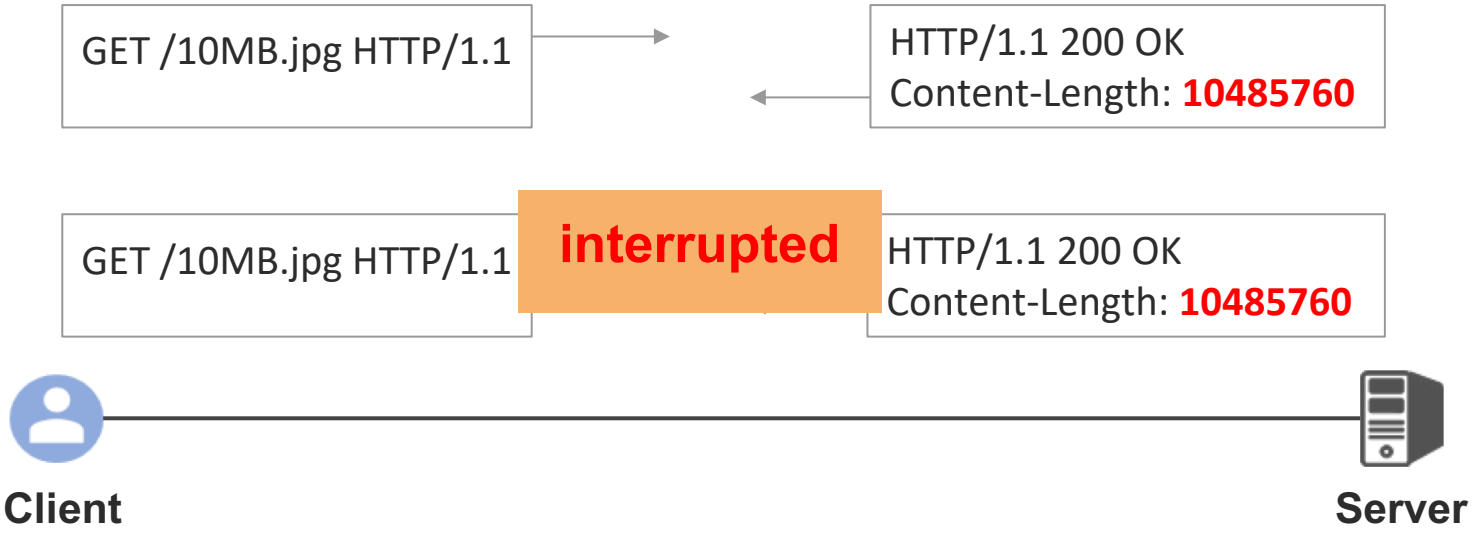
Content Delivery Network

- Infrastructure for performance and security.
  - Cache → Access acceleration.
  - DDoS defence.
- Adoption: 39.0% of Top 10K websites.



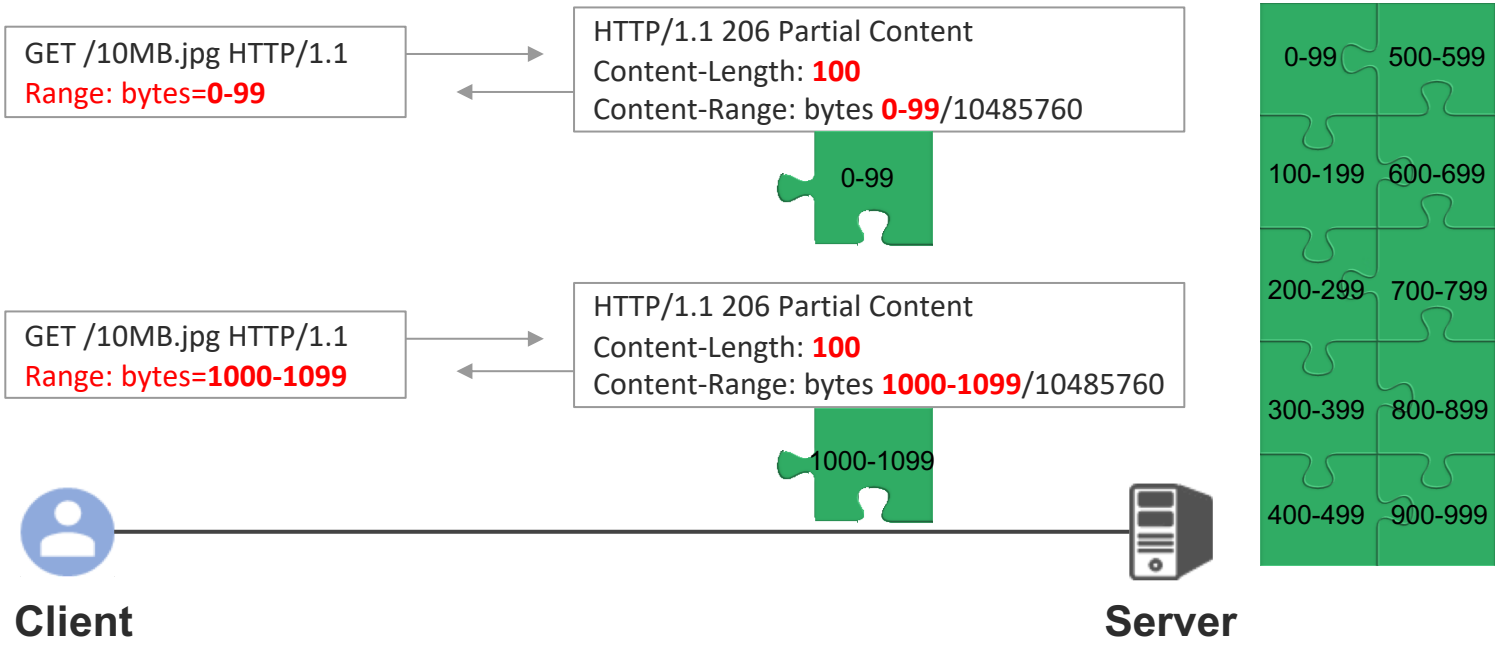
HTTP Range Request Mechanism

- HTTP is a stateless application protocol.
  - Interrupted transfer → Re-obtain the entire file.



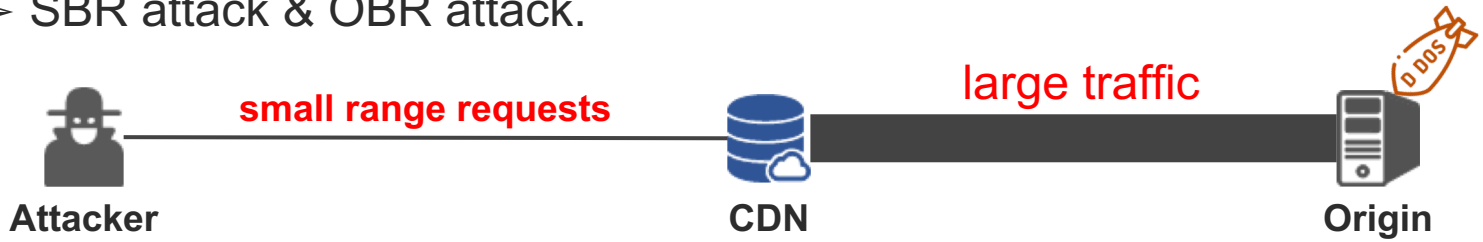
HTTP Range Request Mechanism

- To reduce unnecessary network transmission.
- Resuming from breakpoint & multi-thread transfers.



Our Work

- Range-based Amplification (**RangeAmp**) Attacks.
  - CDN turns into an amplifier when meeting range requests.
  - SBR attack & OBR attack.



(1) Small Byte Range (**SBR**) Attack

(2) Overlapping Byte Ranges (**OBR**) Attack

Measurement and Evaluation in the Wild

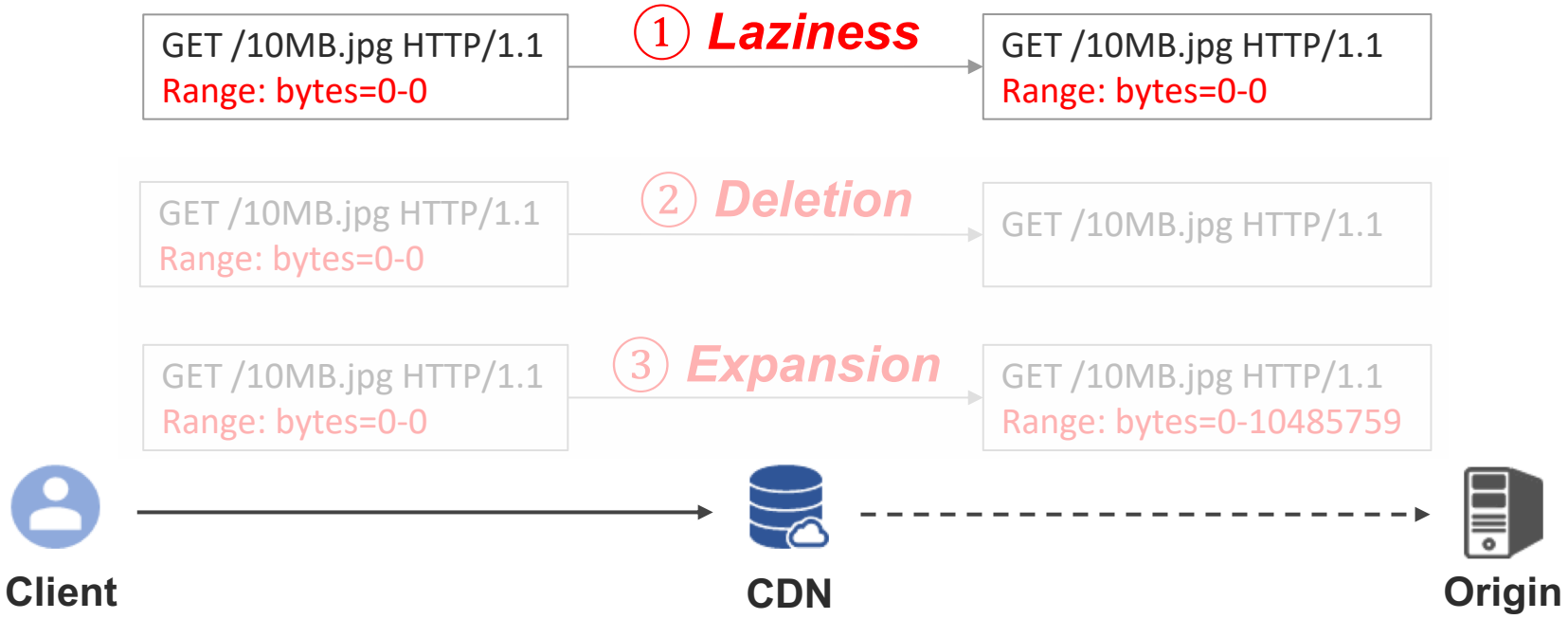
- **13 popular CDN vendors** we tested were vulnerable.
- The amplification factor far exceeds most traditional attack methods.

Attack-1

Small Byte Range (SBR) Attack

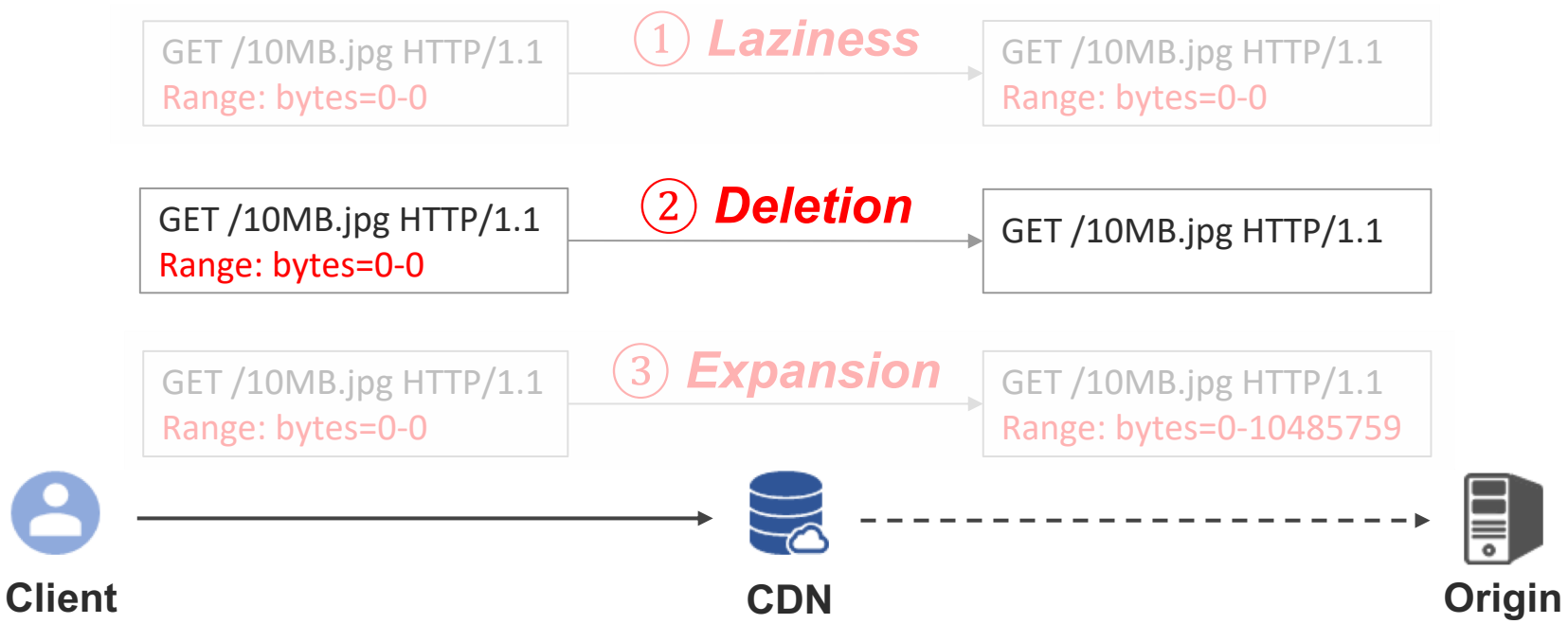
CDN's Range Forwarding Policies

- Different policies for malformed Range header.
  - ***Laziness***, *Deletion*, *Expansion*.



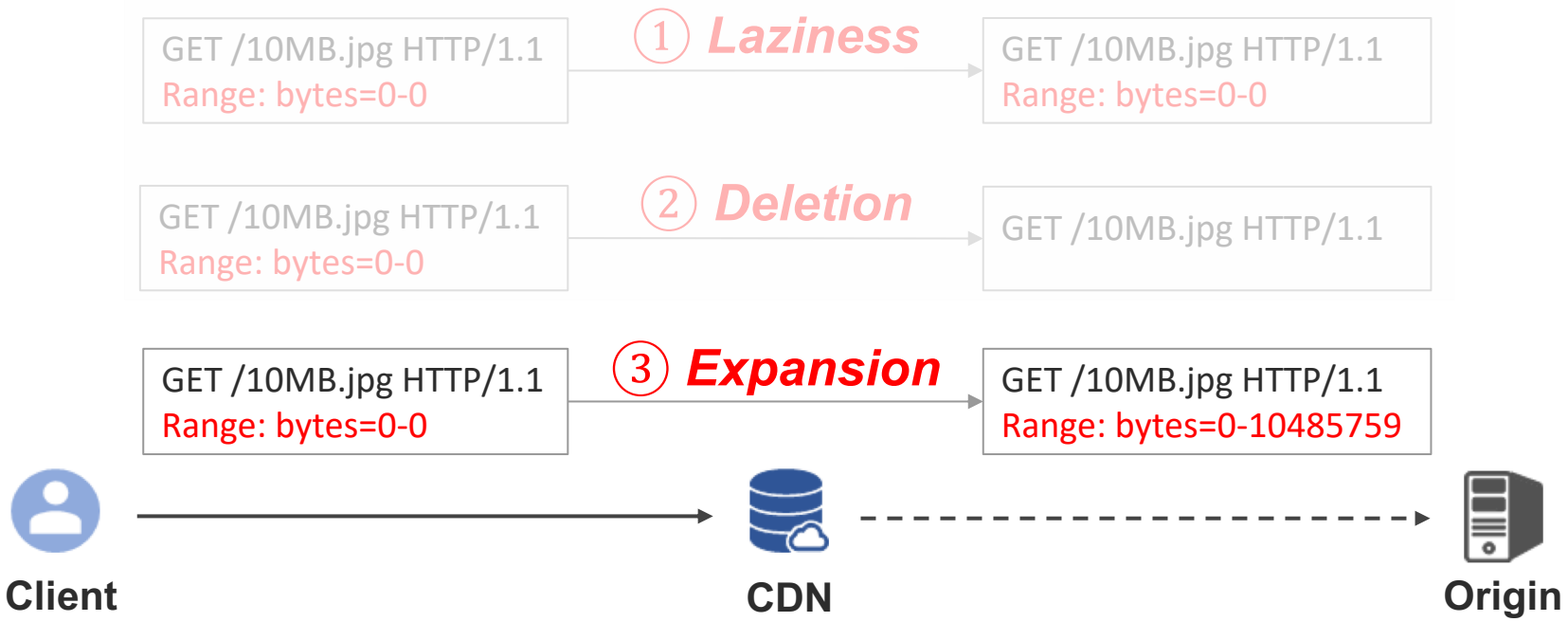
CDN's Range Forwarding Policies

- Different policies for malformed Range header.
  - *Laziness*, ***Deletion***, *Expansion*.



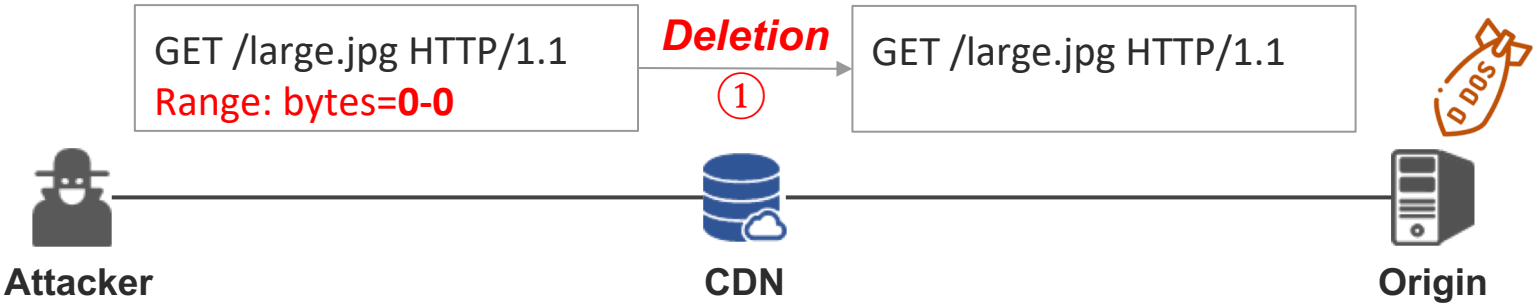
CDN's Range Forwarding Policies

- Different policies for malformed Range header.
  - *Laziness*, *Deletion*, ***Expansion***.



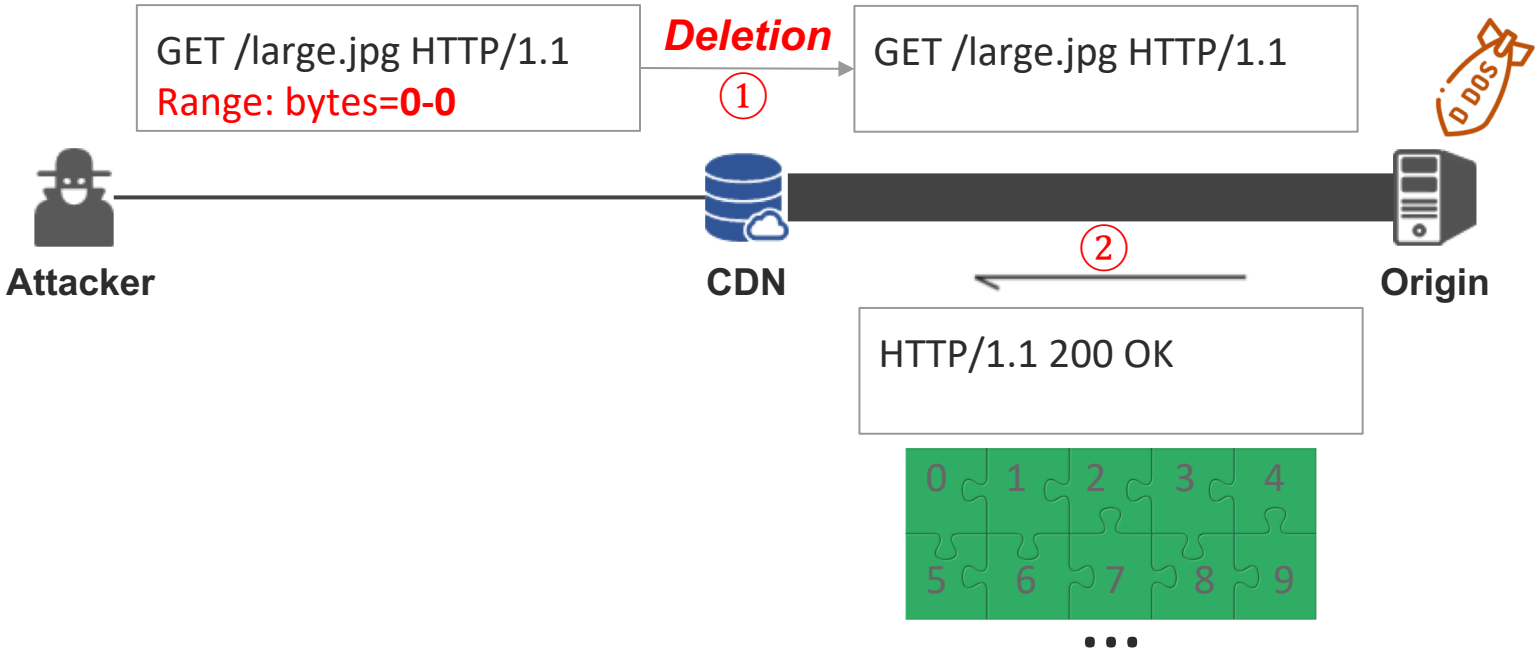
Small Byte Range (SBR) Attack

- The ***Deletion*** and ***Expansion*** policies will cause SBR attack.
  - Increasing bytes requested from the origin server.



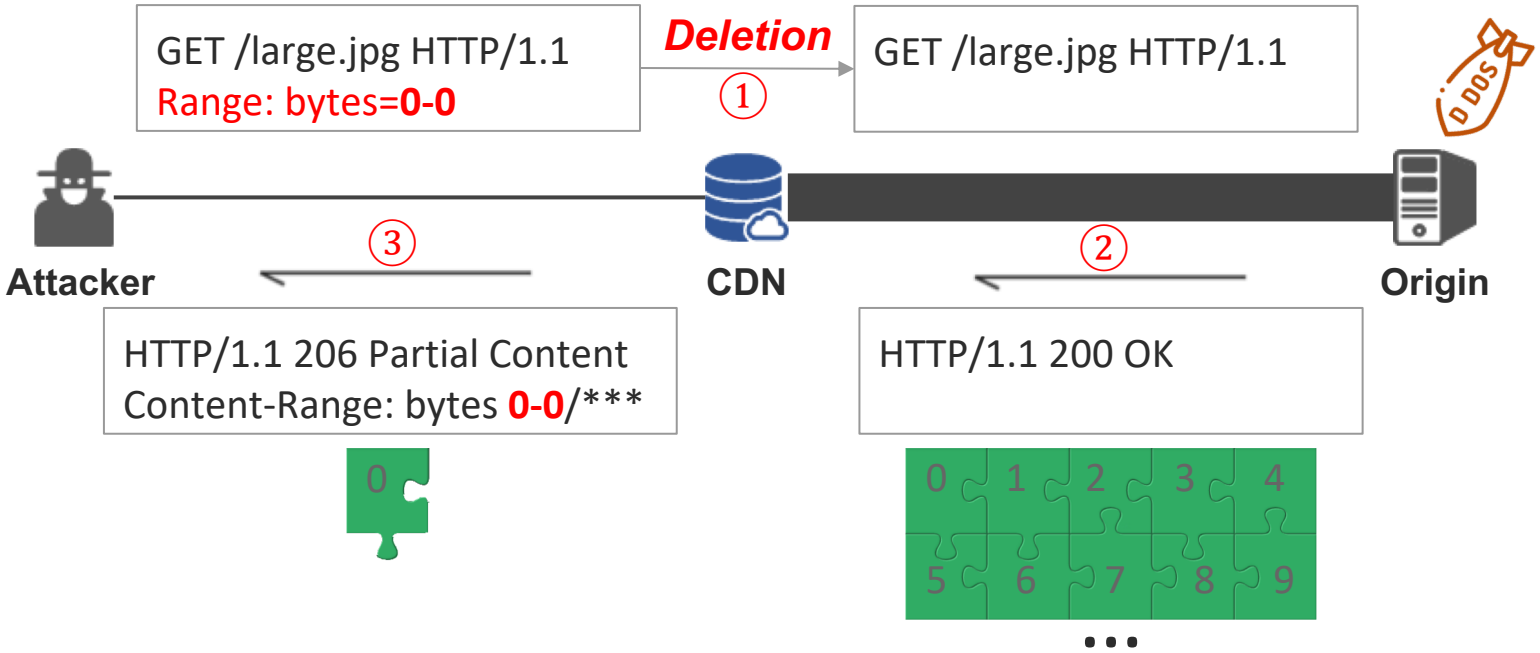
Small Byte Range (SBR) Attack

- The ***Deletion*** and ***Expansion*** policies will cause SBR attack.
  - Increasing bytes requested from the origin server.



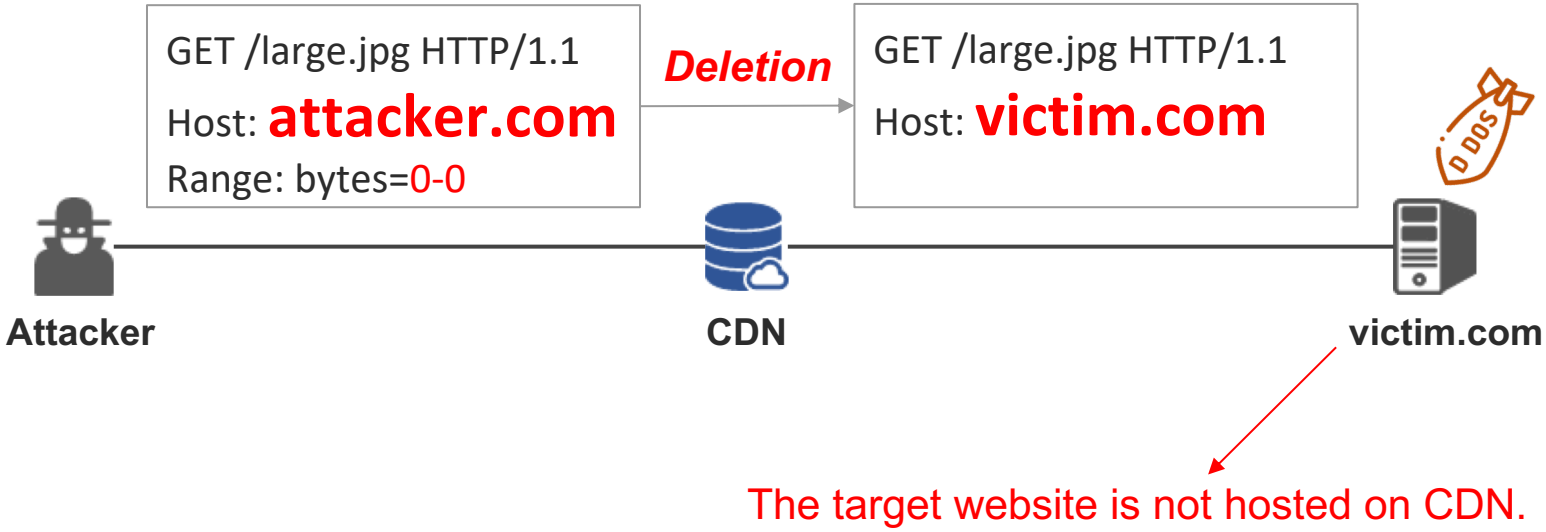
Small Byte Range (SBR) Attack

- The ***Deletion*** and ***Expansion*** policies will cause SBR attack.
  - Increasing bytes requested from the origin server.



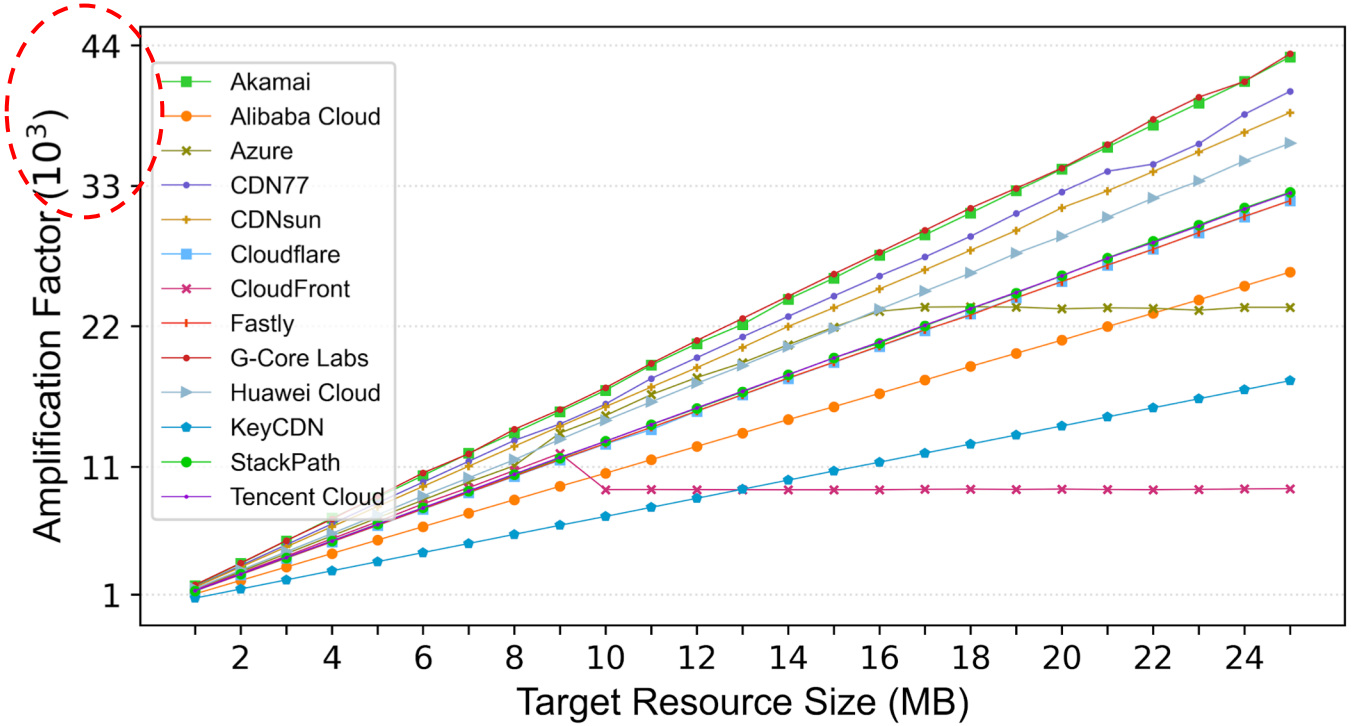
Victims Include Websites Not Hosted on CDN

- Most CDN vendors do not validate the origin servers.
  - Almost all websites are potentially affected.



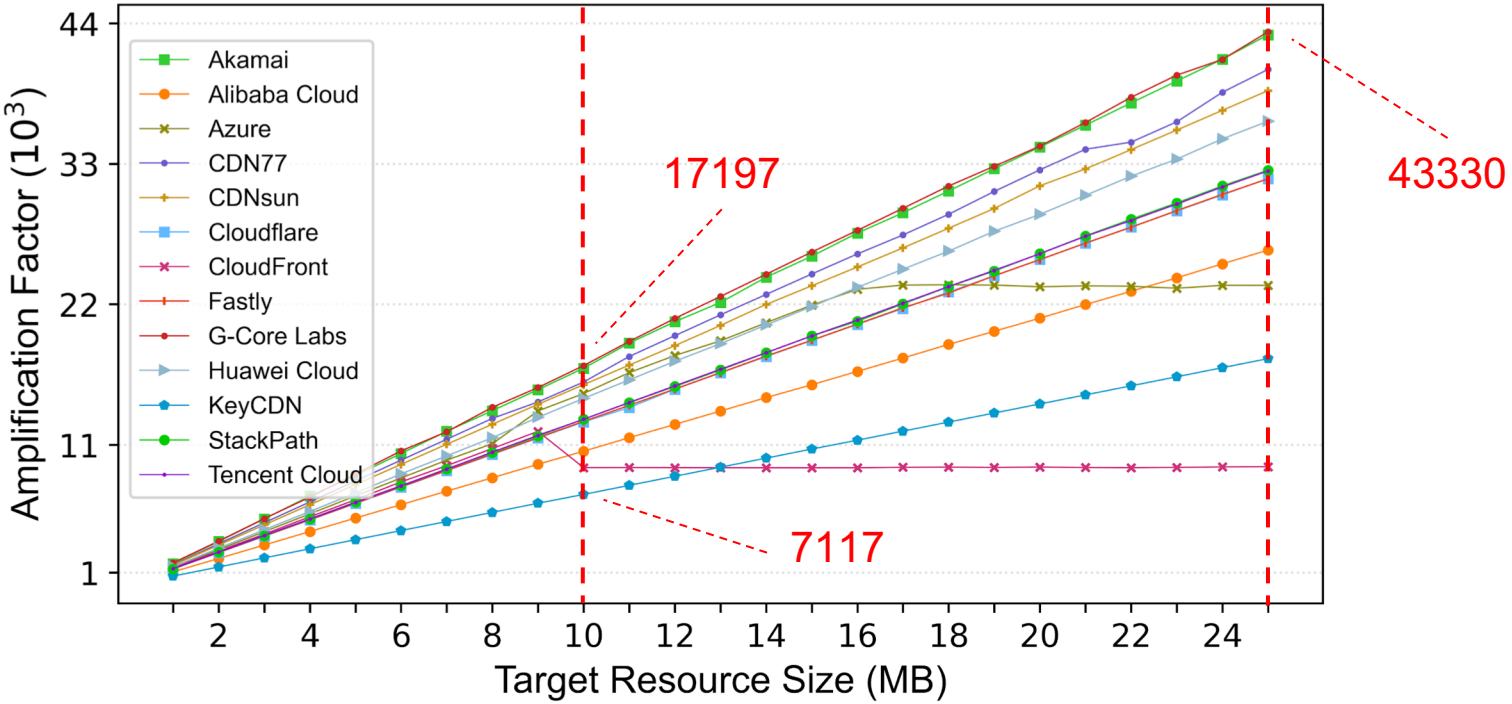
Evaluation of SBR Attack

- 13 popular CDN vendors we tested were vulnerable.
  - The amplification factor exceeds most traditional attack methods.



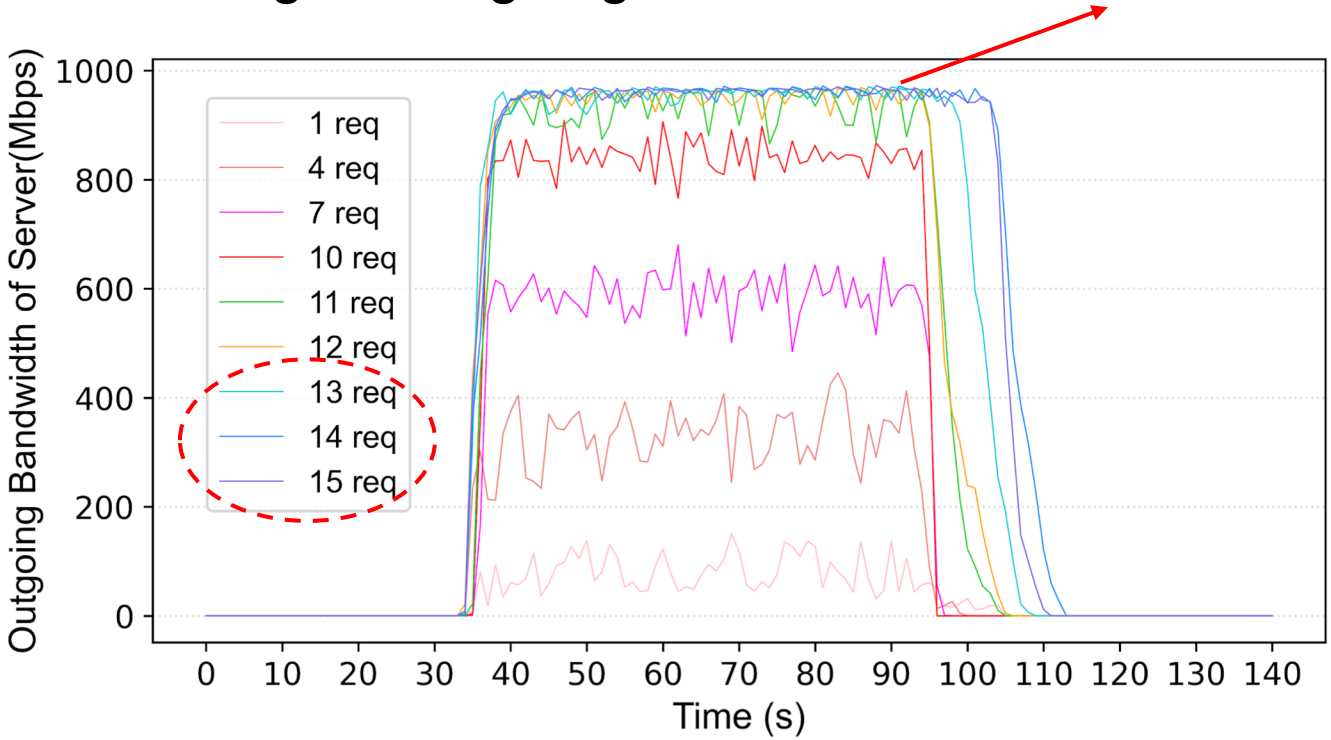
Evaluation of SBR Attack

- 13 popular CDN vendors we tested were vulnerable.
  - The amplification factor exceeds most traditional attack methods.



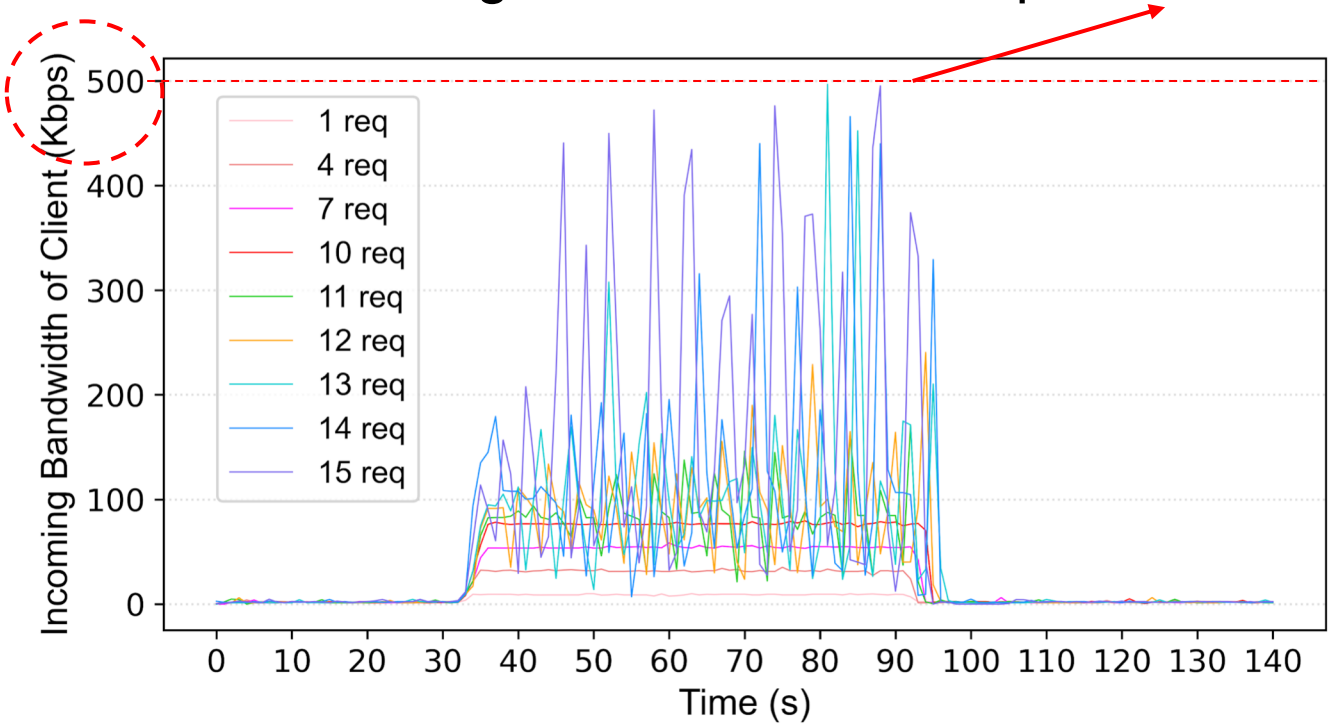
Demo of SBR Attack

- Experiment setup: bandwidth (1000Mbps), target file (10MB).
- Result: The origin's outgoing bandwidth was exhausted.



Demo of SBR Attack

- All CDNs raised no alert under the default configuration.
- The Client's incoming bandwidth consumption < 500Kbps

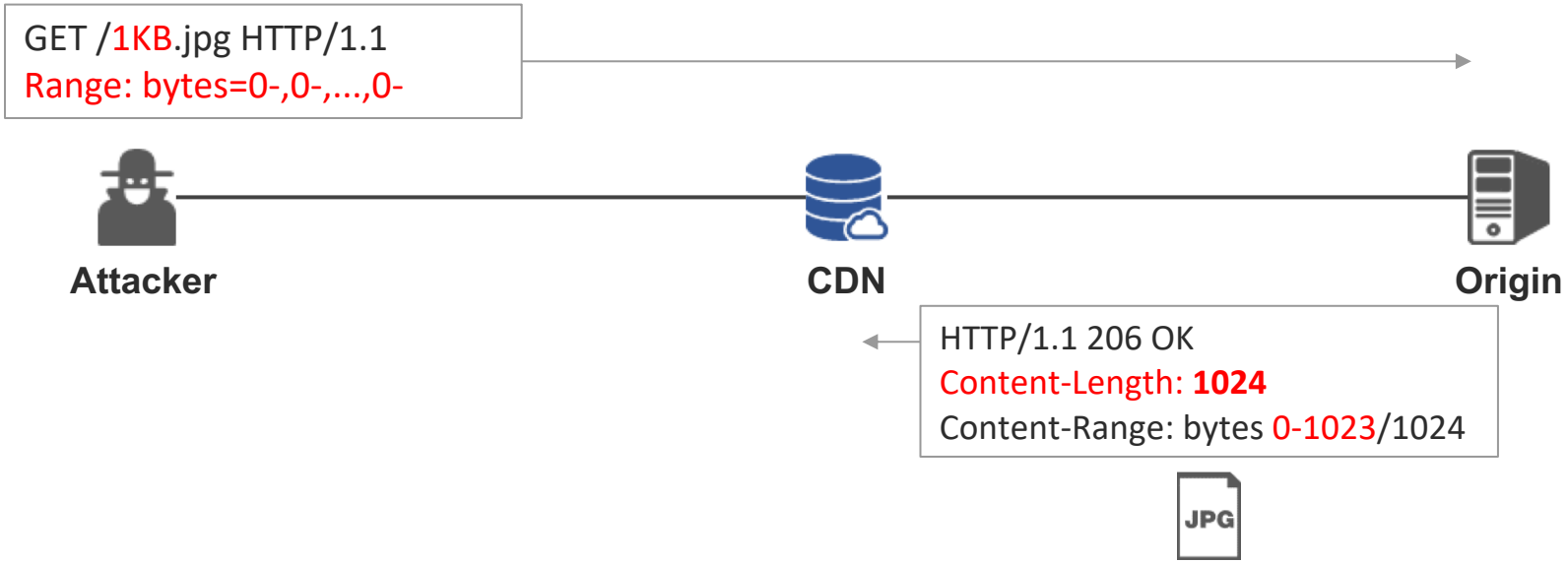


Attack-2

Overlapping Byte Ranges (OBR) Attack

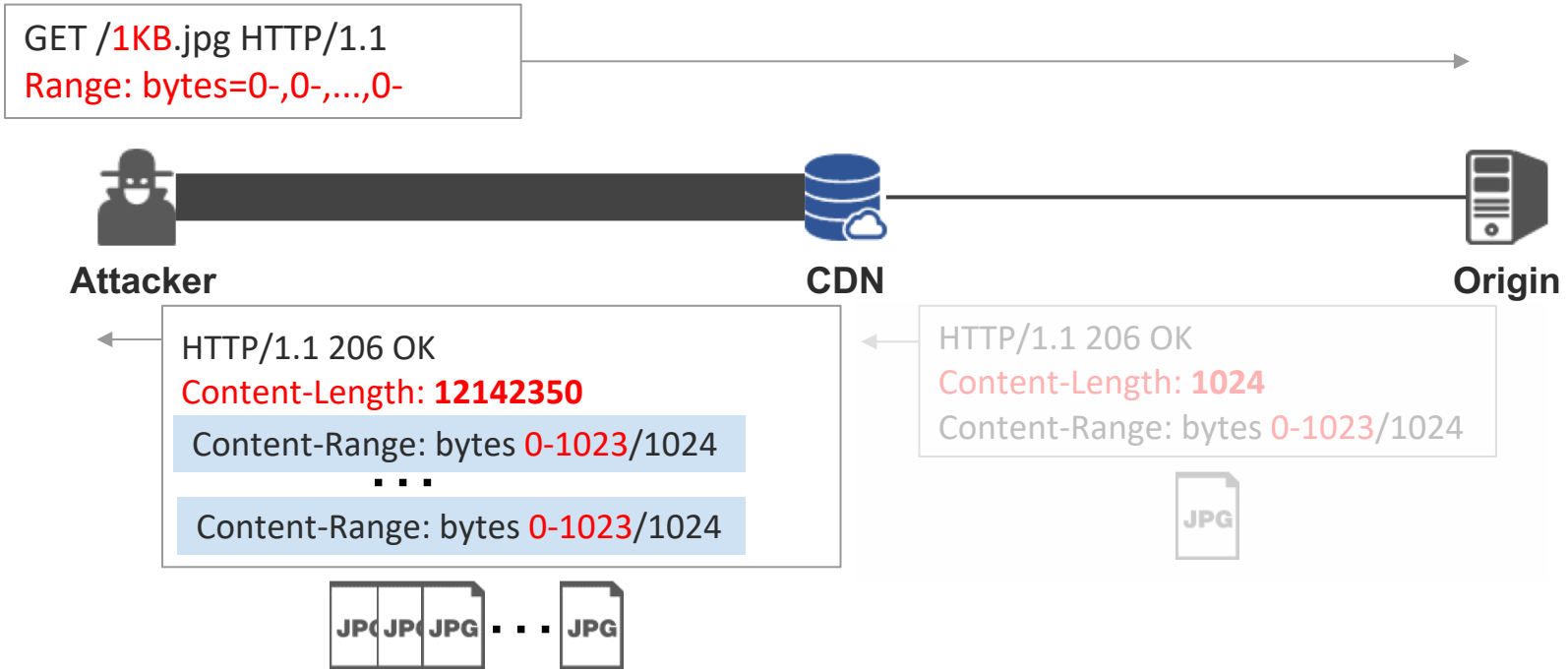
Overlapping Multi-range Requests

- RFC7233 suggests to **coalesce** overlapping multi-range requests.



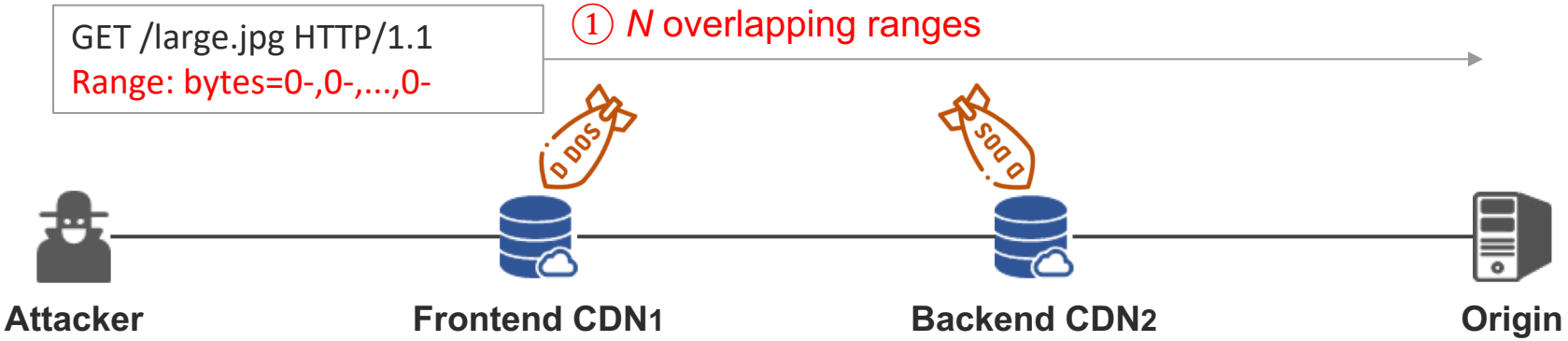
Overlapping Multi-range Requests

- RFC7233 suggests to **coalesce** overlapping multi-range requests.
  - Some CDN vendors ignore this security suggestion.



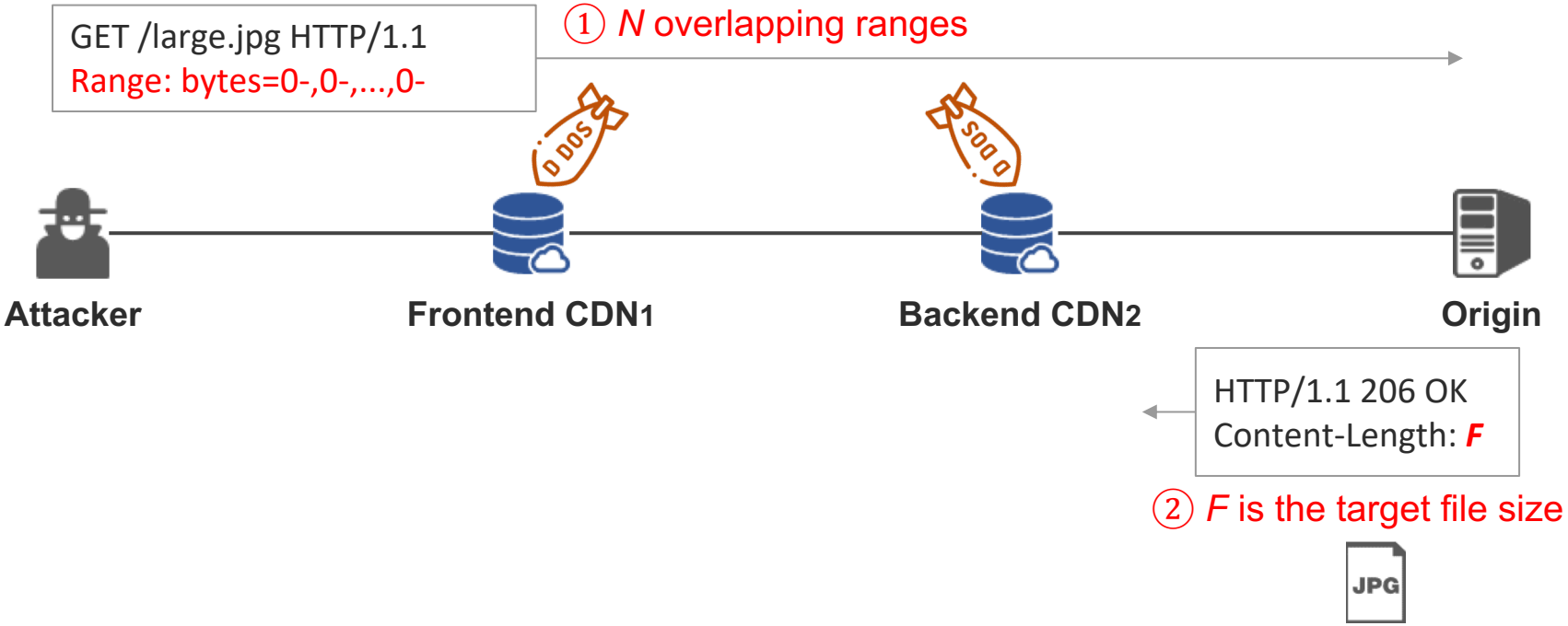
Overlapping Byte Ranges (OBR) Attack

- Two CDNs can be cascaded together.
- The Backend CDN returns overlapping multi-part responses.



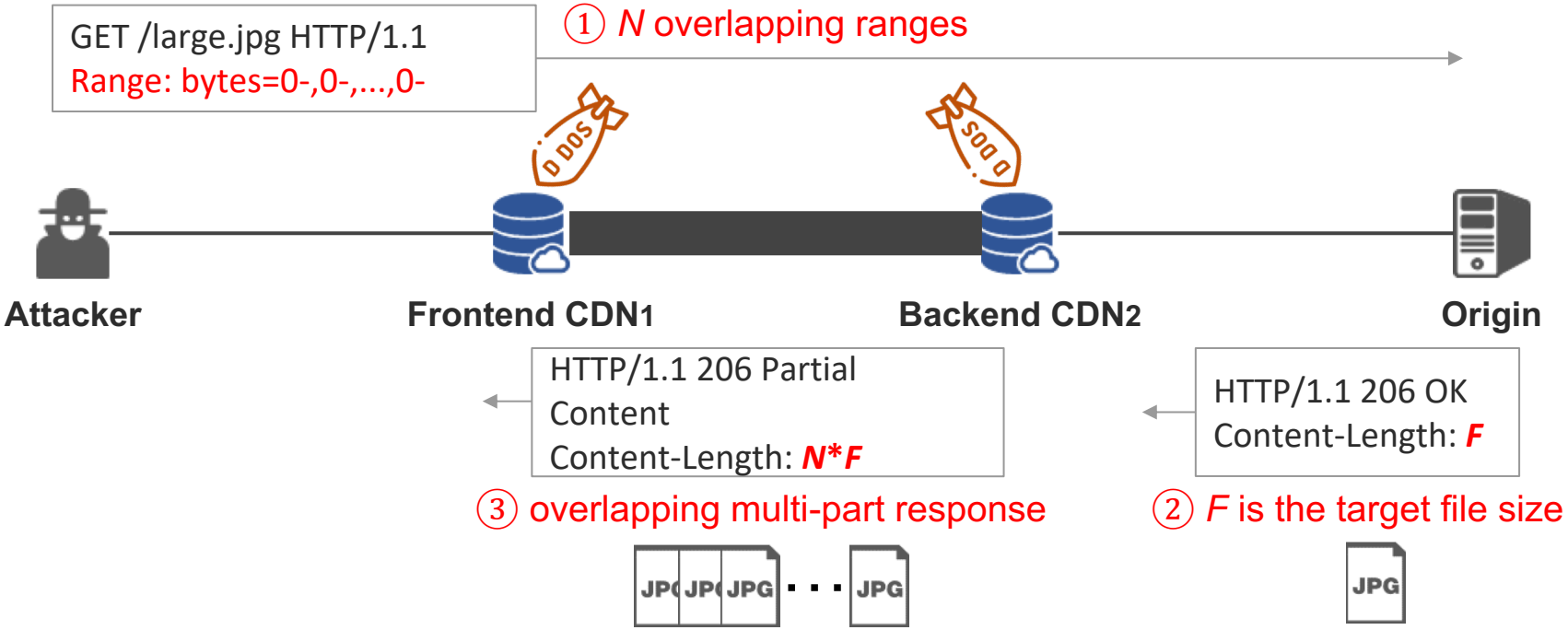
Overlapping Byte Ranges (OBR) Attack

- Two CDNs can be cascaded together.
- The Backend CDN returns overlapping multi-part responses.



Overlapping Byte Ranges (OBR) Attack

- Two CDNs can be cascaded together.
- The Backend CDN returns overlapping multi-part responses.



Evaluation of OBR Attack

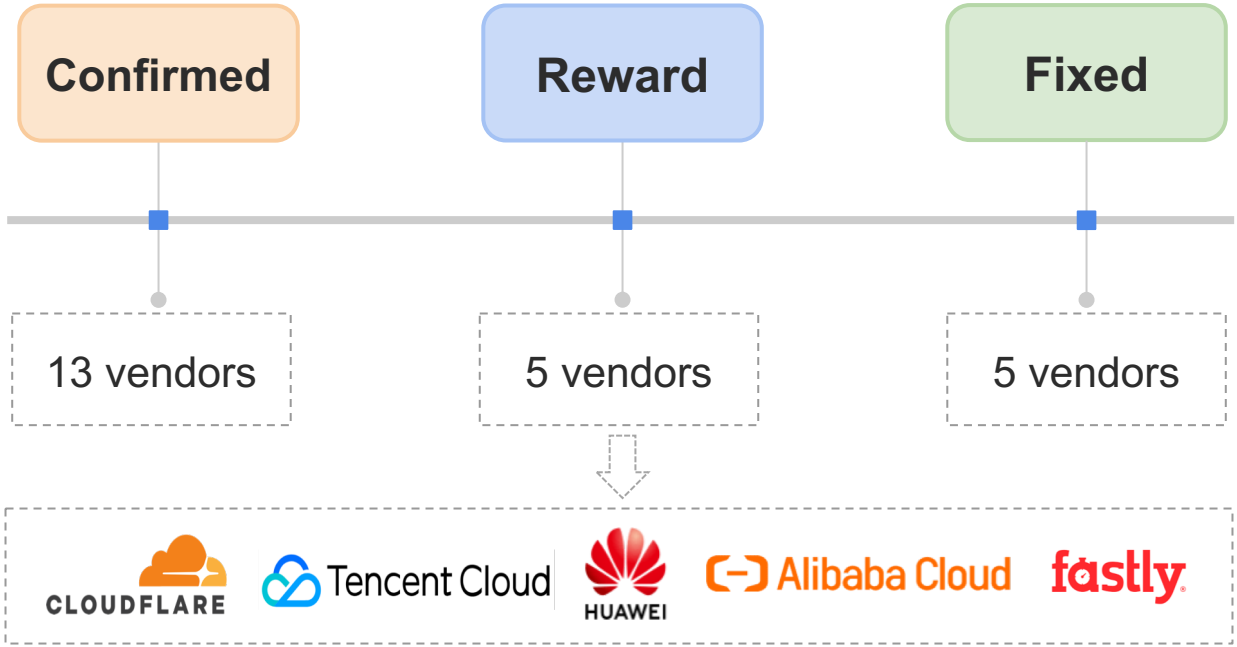
- Totally 11 combinations of cascaded CDNs are affected.
  - The amplification factor far exceeds traditional attack methods.

FCDN	BCDN	Traffic from Orign to Backend CDN	Traffic from Backend CDN to Frontend CDN	Amplification Factor
CDN77	Akamai	1676B	6350944B	**3789.35**
Cloudflare	Akamai	1676B	12456915B	**7432.53**
StackPath	Akamai	1676B	12522091B	**7471.41**
CDN77	StackPath	1808B	6413097B	**3547.07**
...	...	...	...	**...**
Traditional NTP reflection attack				**4670**

Discussion & Summary

Responsible Disclosure

- Helping CDN vendors eliminate the detected threats.
  - Vendors have 7 months to mitigate it before this paper is published.



Mitigation and Solution

- Proposing mitigation and solution at different levels.

CDN

- Adopt a secure Expansion policy
- Coalesce or reject overlapping ranges
- Add RangeAmp detection

Website

- Check its hosting CDN vulnerable or not
- Block traffic from CDN

Media Coverage

- ZDNet, iTnews, GovCERT.HK, DOSarrest, SecNews, …

GovCERT.HK

Weekly IT Security News Bulletin, 2020-W22
25 May – 31 May 2020

ZDNet

RangeAmp attacks can take down websites and CDN servers

Twelve of thirteen CDN providers said they fixed or planned to fix the problem.

By Catalin Cimpanu for Zero Day | May 25, 2020 -- 21:28 GMT (05:28 GMT+08:00) | Topic: Security

MORE FROM CATALIN CIMPANU

Security
Slovak police seize

DOSarrest

How the RangeAmp attack works

itnews

RangeAmp attacks turn CDNs into giant DoS cannons

By Juha Saarinen
May 26 2020
10:14PM

No botnet needed, just a laptop.

RangeAmp attacks turn CDNs into giant DoS cannons

Chinese researchers have outlined a way to abuse small requests to web servers hosted through content delivery networks that allows attackers to generate DDoS attacks.

Named RangeAmp [pdf] the attack exploits the hyper text transfer protocol (HTTP) Range Requests attribute to ask for a random, small amount of data from a large file on a server, like a byte out of gigabyte and terabyte sized resources.

Since a CDN is unlikely to have the small amount of data cached, it will have to request the entire large file from the origin server it is stored on, just to serve up a byte of it.

Summary

RangeAmp Attacks (SBR & OBR)

- Turn CDN into a DDoS cannon
- No botnet needed, just a laptop
- Affect most CDNs and websites
- Nullify CDN's DDoS protection