

A Feasibility Study of Cache in Smart Edge Router for Web-Access Accelerator

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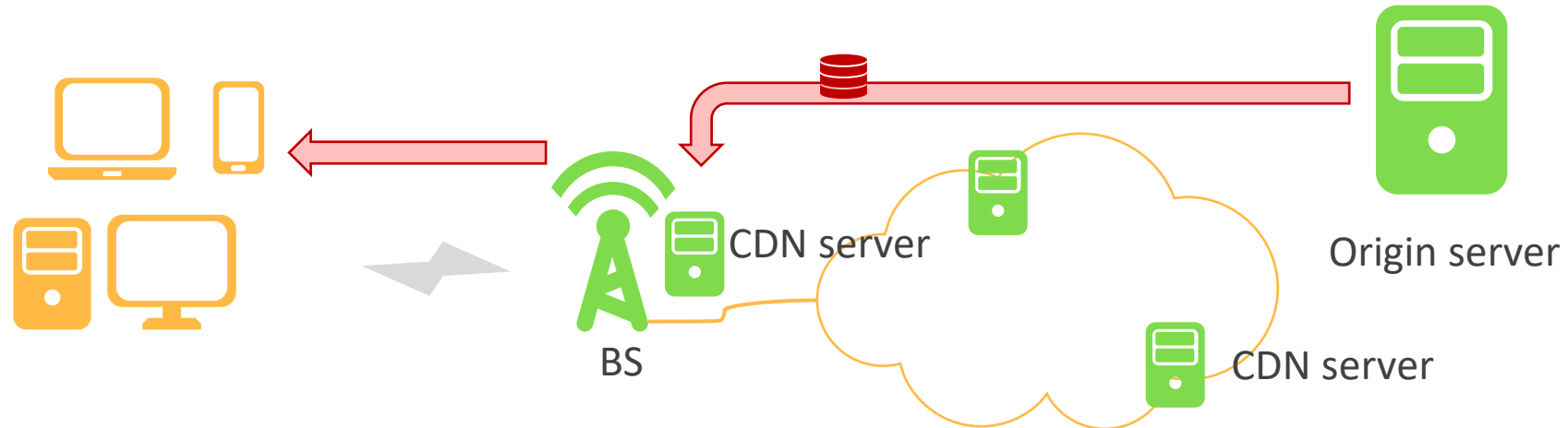
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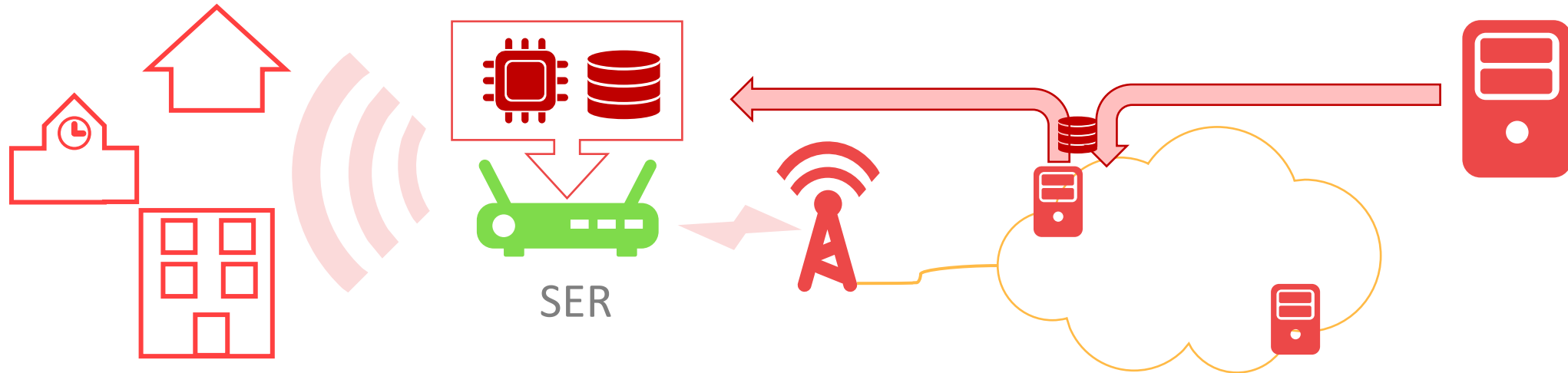
Content Delivery Networks (CDNs) with telecommunication operators

- Edge infrastructure: Reduce latency of streaming video content to users
- Deployed in telecommunication networks



Smart Edge Routers (SERs)

- Set-top boxes or WiFi routers to share internet access.
- Closer end-point to the user



Industry products of SERs

CacheBox

- A product for a network administrators which supports cache and networking functions

NightShift

- Collaboration between an internet service provider (ISP) and Netflix

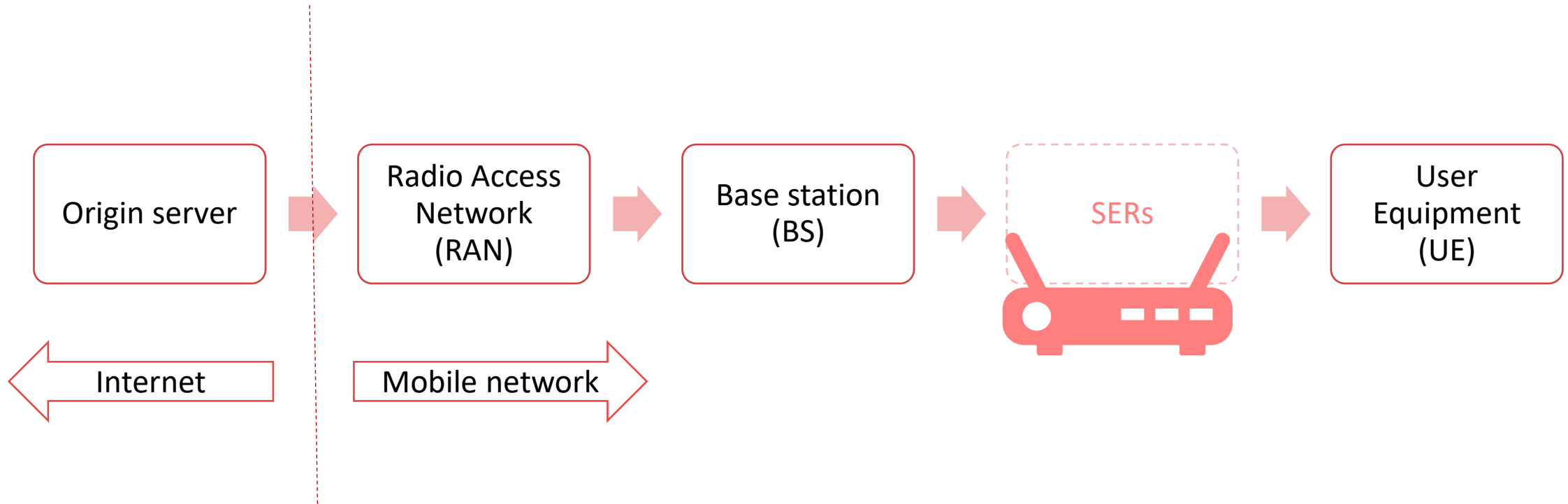
Smart Home Gateway

- A router that connects and manages all smart devices in a house.

Mobile Routers:

- Wi-Fi hotspots from Mobile Network Operator which connects to the internet via the mobile network.

Caching locations of SERs



Cache location in a survey paper ("*On mobile edge caching*," *IEEE Commu. Sur. Tut.*, 2019)

Problem of SERS

What is the appropriate point between an end-user and origin server?

Are SERs viable for an e-commerce CDN?

Objective

Study of Cache in Smart Edge Router
for Web-Access Accelerator

STUDY Scenarios

Small Scale

- 3–5 users
- Room or home

Medium Scale

- 10–200 users
- Cafe, restaurant, school

Large Scale

- ≥ 500 users
- Public parks, concert hall

Viability Questions

- What is the appropriate level to place a SER cache?
- How much traffic can a SER cache reduce in the network?
- How much can a SER cache decrease the latency to access content?
- How much storage does a SER cache require?

SIMULATION

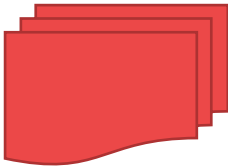
GOAL:

- Proof of concept of using a smart edge router for a particular service.
- A preliminary indicator of the appropriateness

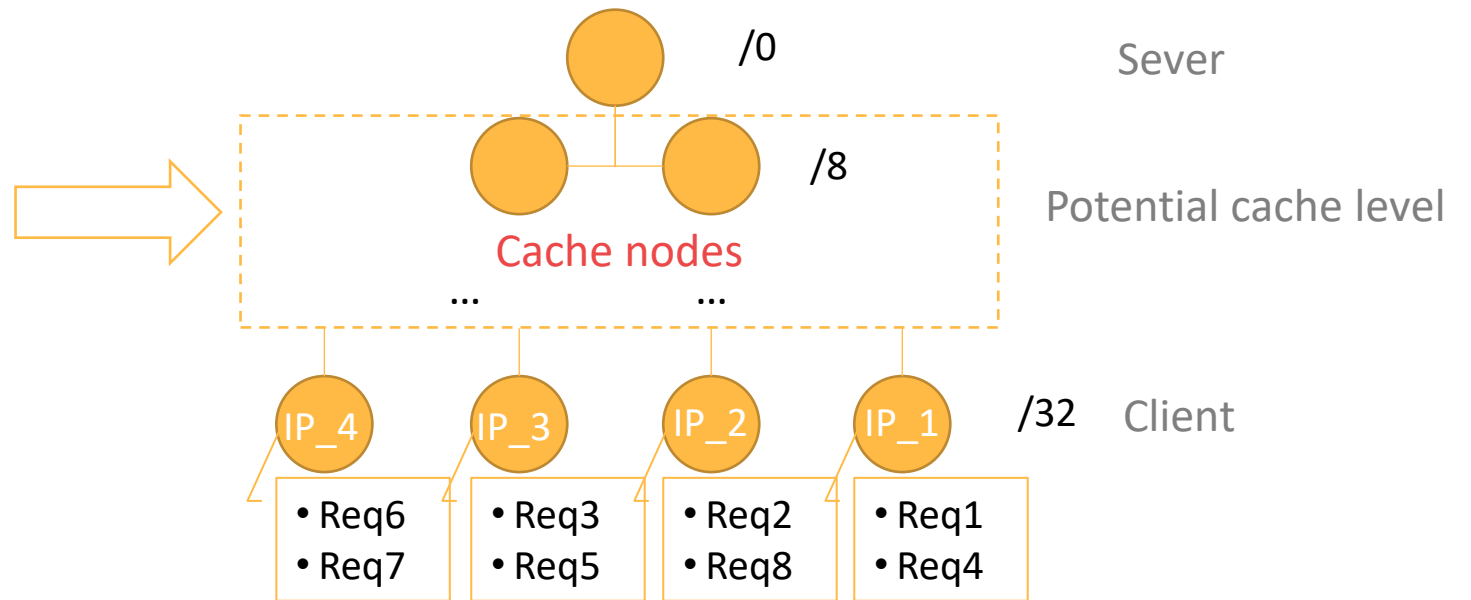
Design & Implementation

- Python
- Topology creation
- Event-based simulation.

Topology creation



- Req1 (IP_1, content A, size, ...)
- Req2 (IP_2, content B, size, ...)
- Req3 (IP_3, content A, size, ...)
- Req4 (IP_1, content B, size, ...)
- ...



How to group IP address by subnet mask (example)

IP	/32	/24	/16	/8	/0
	255.255.255.255	255.255.255.0	255.255.0.0	255.0.0.0	0.0.0.0
192.168.210.156	192.168.210.156	192.168.210.0	192.168.0.0	192.0.0.0	0.0.0.0
192.168.210.32	192.168.210.32	192.168.210.0	192.168.0.0	192.0.0.0	0.0.0.0
192.168.212.44	192.168.212.44	192.168.212.0	192.168.0.0	192.0.0.0	0.0.0.0
192.167.218.178	192.167.218.178	192.167.218.0	192.167.0.0	192.0.0.0	0.0.0.0
192.167.218.200	192.167.218.200	192.167.218.0	192.167.0.0	192.0.0.0	0.0.0.0
127.58.212.44	127.58.212.44	127.58.212.0	127.58.0.0	127.0.0.0	0.0.0.0

Group IP address - consider number of hosts

Home family

1 ~ 5

Restaurant/Café

10 ~ 50

Bus/Train

20 ~ 100

Public area/ School/office

50 ~ 200

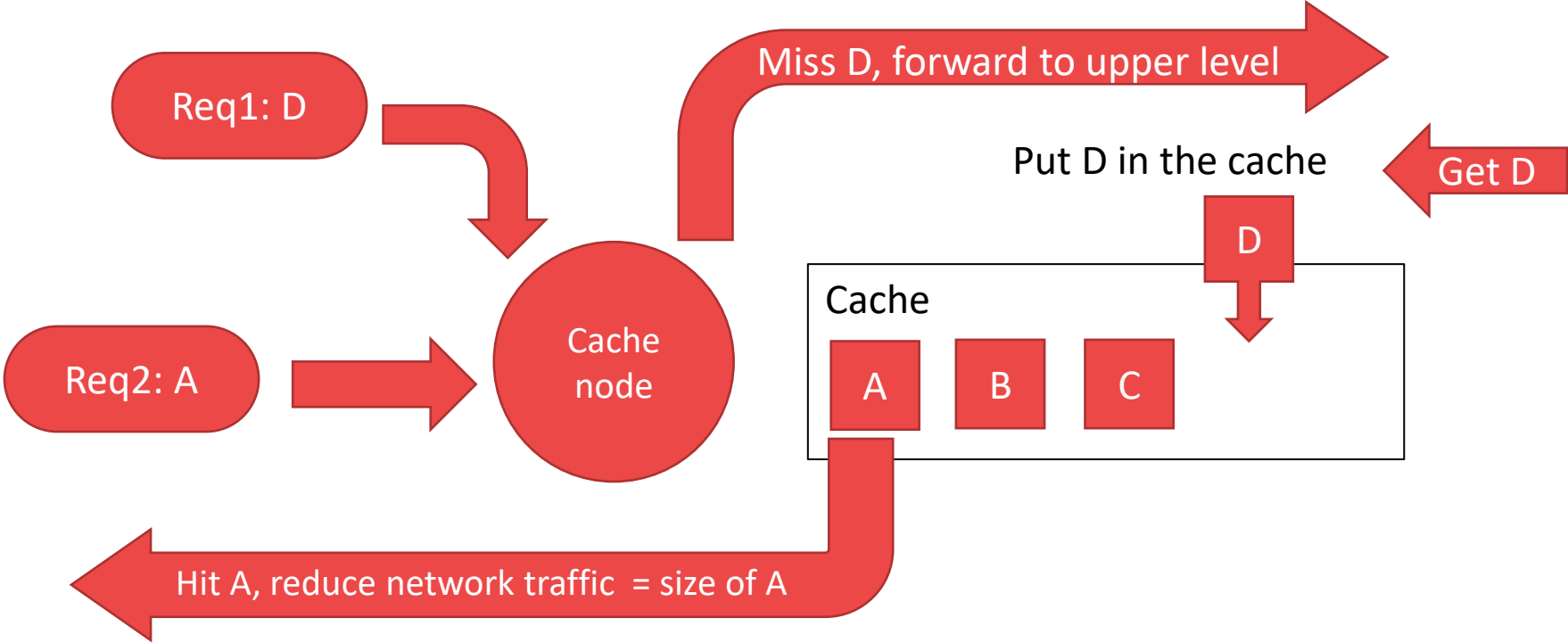
Hotel/ Mansion

30 ~ 200

Event/ Concert/ Centre hall

100 ~ 500 (~ 1000)

Event-Based Simulation



Traffic reduction in the network

Total traffic = \sum size of request.

Reduced traffic = \sum size of duplicated content in the same group

First request \rightarrow Miss

2nd, 3rd, ... \rightarrow Hit = Traffic can be reduced here

Experimental Setup - Dataset

Public data	Internal data	
Harvard Dataset* - HTTP	HTTP	HTTPS
<ul style="list-style-type: none">• Online Shopping Store - Web Server Logs• 5-day log	<ul style="list-style-type: none">• CDN log of Access of Rakuten Ichiba server• Image content• Sample	

*<https://doi.org/10.7910/DVN/3QBYB5>, Harvard Dataverse

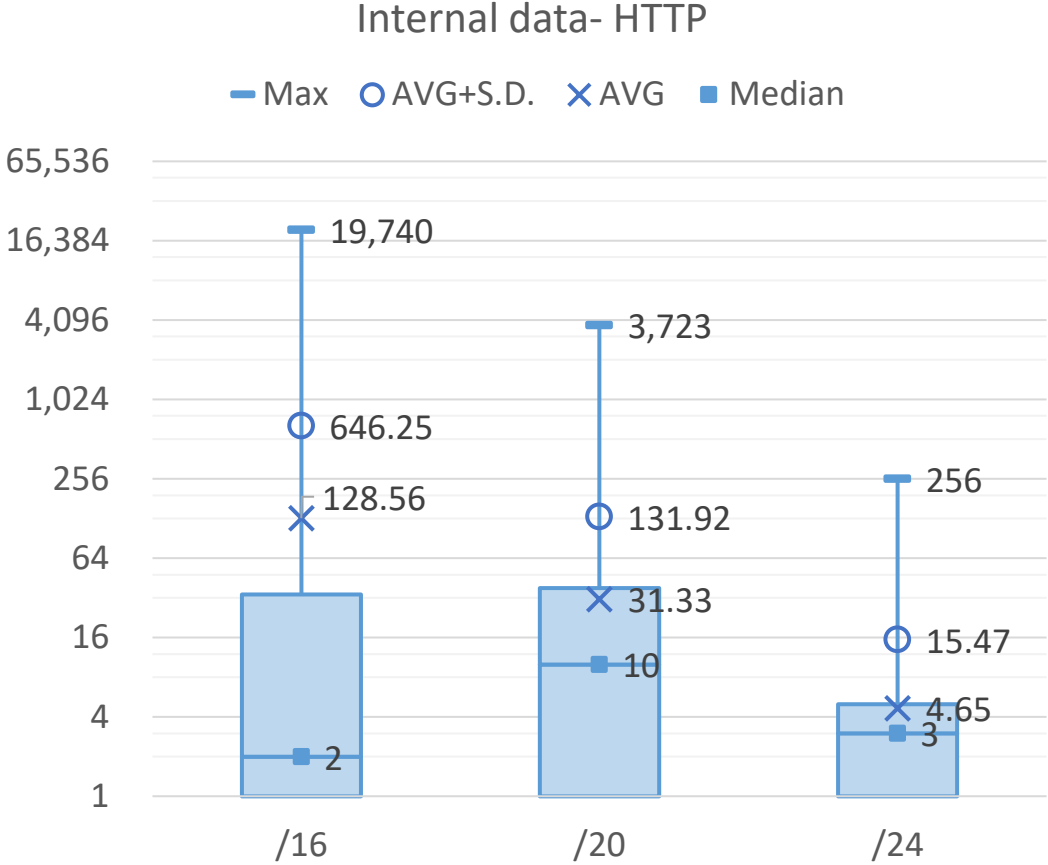
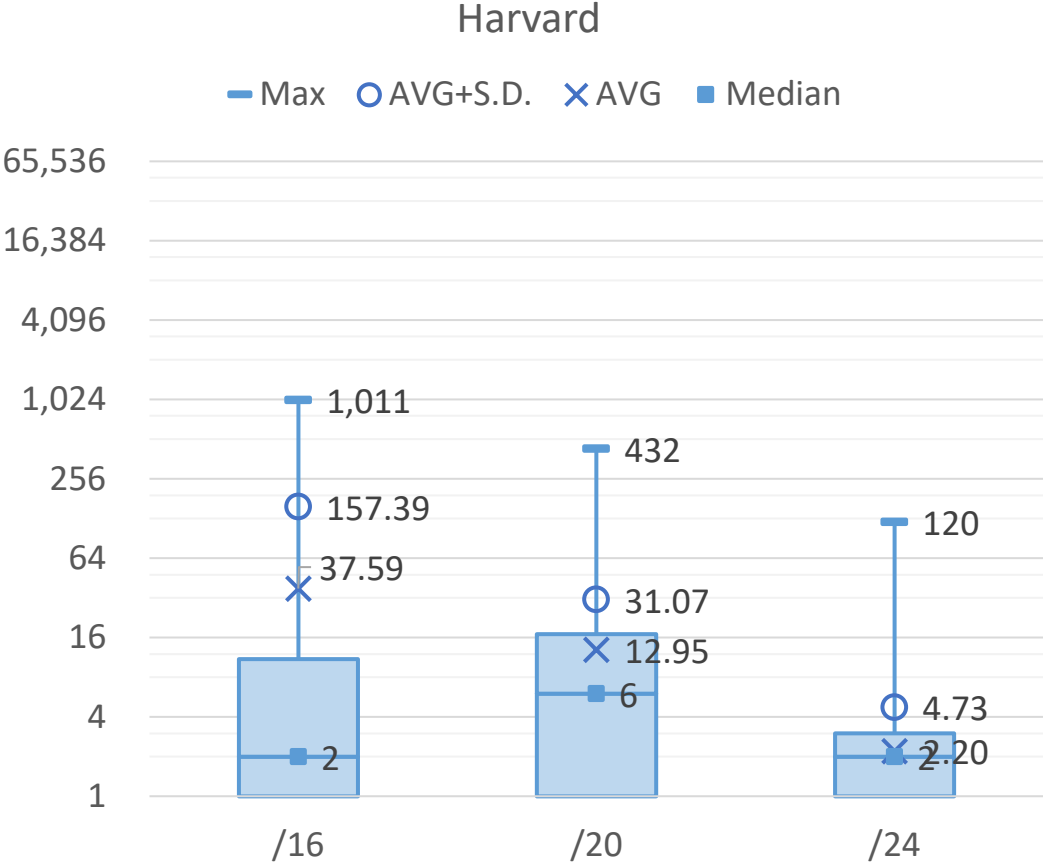
Simulation Results

- What is the appropriate level to place a SER cache?
- How much traffic can a SER cache reduce in the network?
- How much can a SER cache decrease the latency to access content?
- How much storage does a SER cache require?

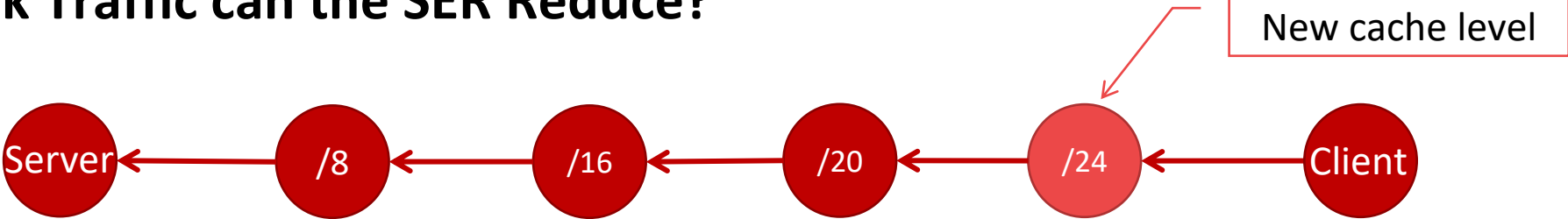
What is the Appropriate (Subnet) Level for the SER?

Chose “/24” level for the new cache level
However, most request were sent from different areas, with a few server interaction

Distribution of hosts per subnet



How Much Network Traffic can the SER Reduce?

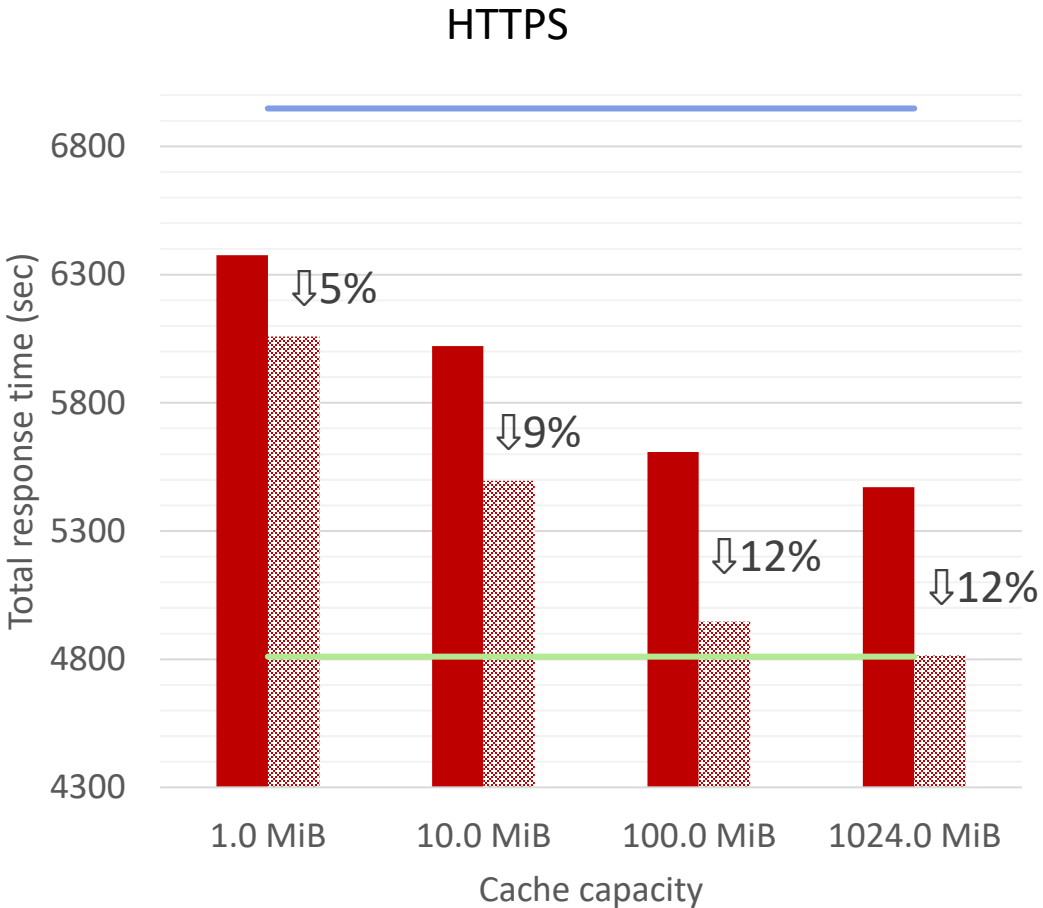
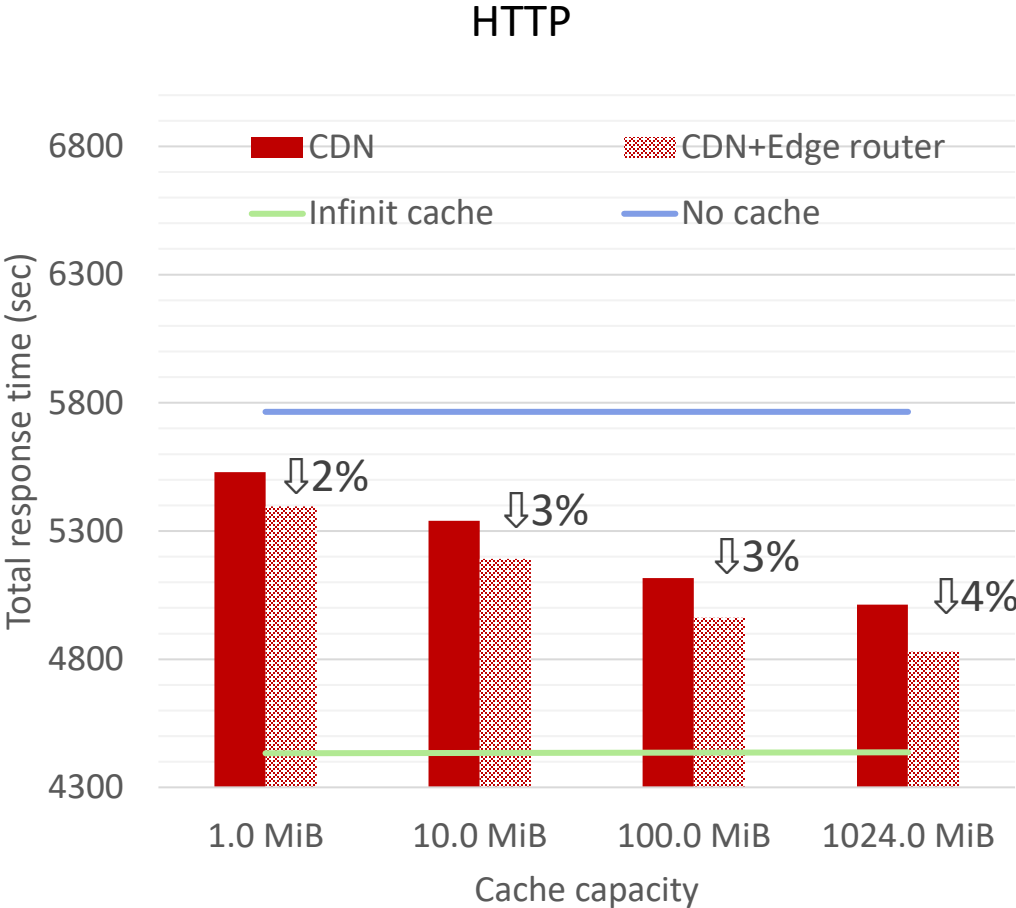


HARVARD	Seen	28%	47%	64%	80%	100%	100%
	Cache	0%	18%	16%	17%	20%	0%
HTTP	Seen	55%	74%	81%	86%	100%	100%
	Cache	0%	19%	12%	5%	7%	0%
HTTPS	Seen	48%	57%	59%	61%	100%	100%
	Cache	48%	9%	2%	2%	39%	0%

Reasonably good caching in /24

How Much Latency Decrease can the SER Provide?

Good on the overall response time, higher capacity → better response

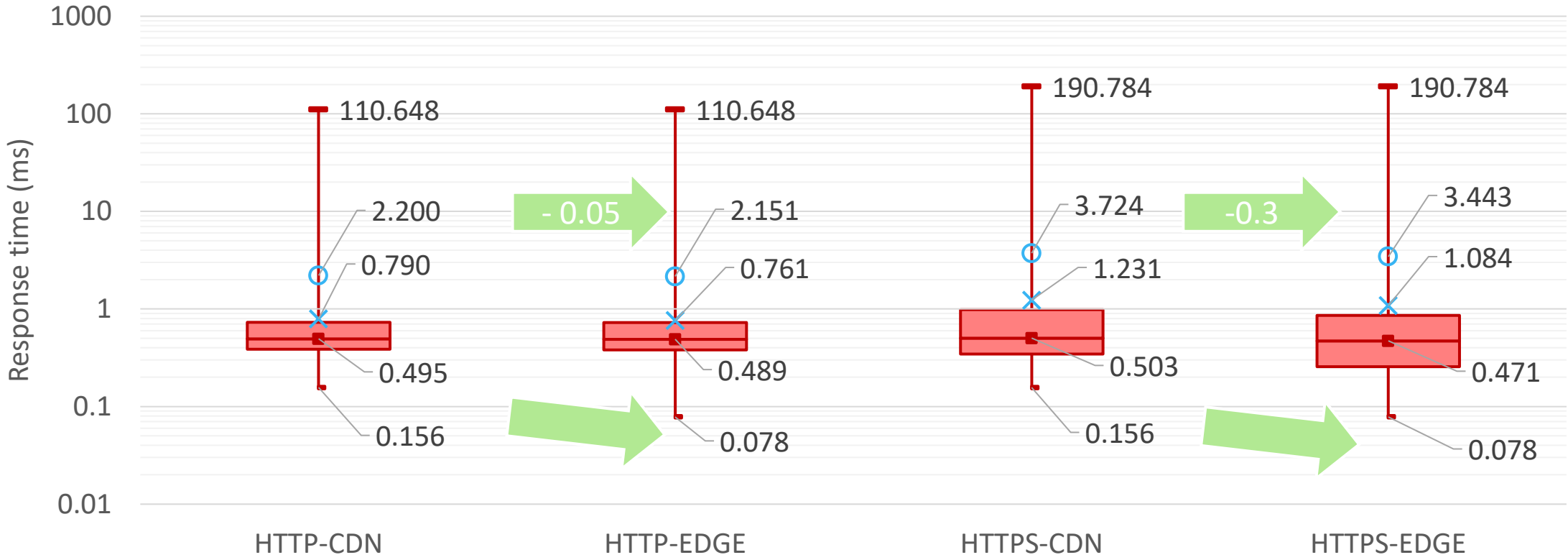


How Much Latency Decrease can the SER Provide?

Distribution of response time of request, Capacity = 1GB

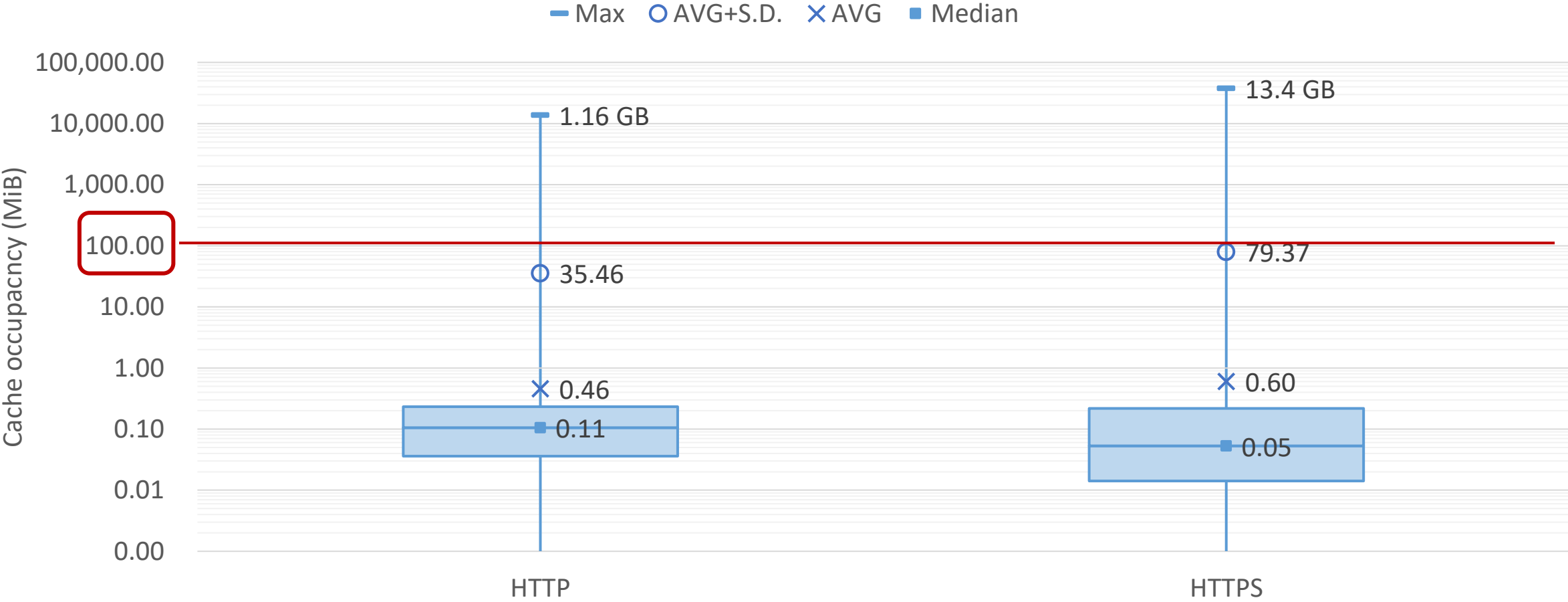
Not significant improvement for ecommerce

Max AVG+S.D. AVG Median MIN



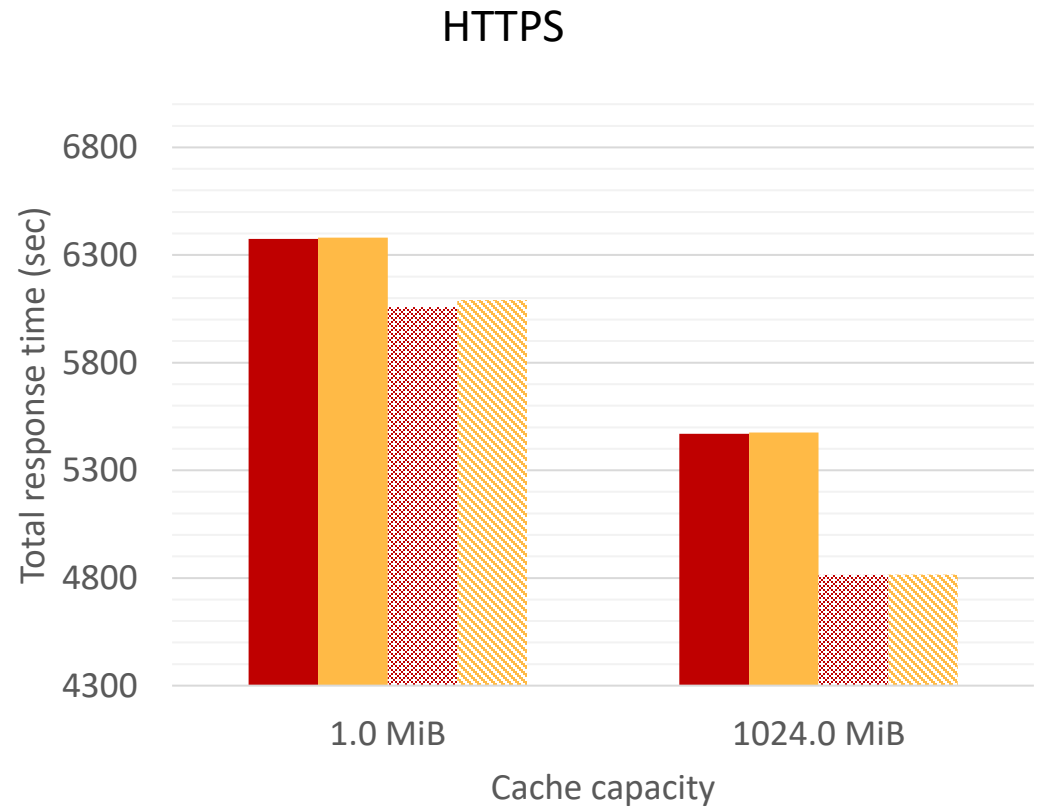
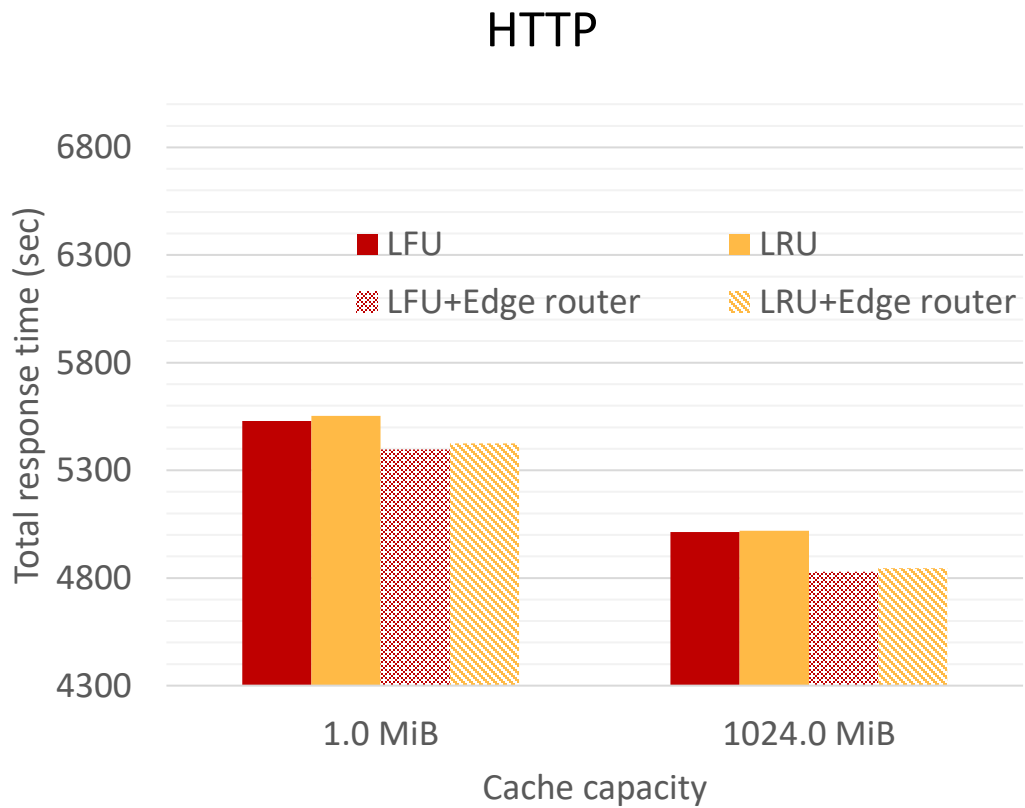
How Much Storage is Necessary for a SER?

100 MB is enough



What is the Effect of Cache Replacement Policies on the SER?

Not significant different



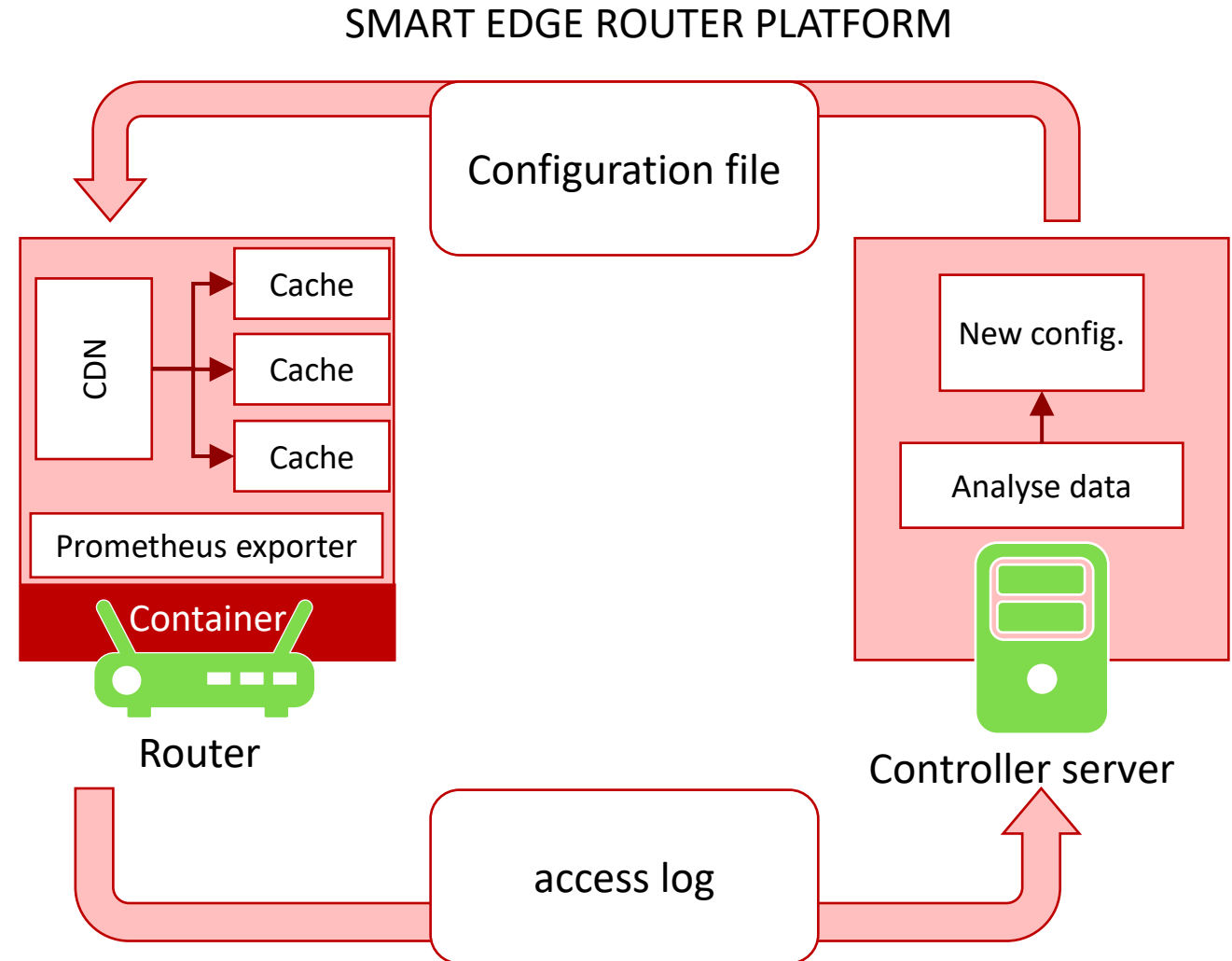
Summary – Simulation results

- What is the appropriate level to place a SER cache?
 - /24 level fits → but a small group of users
- How much traffic can a SER cache reduce in the network?
 - 7% ~ 39% from client access, good on overall
- How much can a SER cache decrease the latency to access content?
 - On average, ~0.3 ms → not significant improvement
- How much storage does a SER cache require?
 - 100 MB is enough for caching one-day contents

The SER is **not a viable option** in term of user response times or network load reduction.

Conclusion and Future work

- Work in Progress Study
- Simulation has a limitation
- Create a real edge router platform for caching
- Plan to verify other services and investigate autonomous operation of CDN.





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