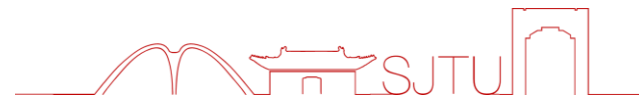




上海交通大学  
SHANGHAI JIAO TONG UNIVERSITY



# 流撕裂者 StreamRipper

一种自适应的分布式局域网缓存

陈文迪，游灏溢，陈文浩

2021年12月13日

饮水思源 · 爱国荣校

# 01

## 项目简介



# 02

## 设计架构



# 03

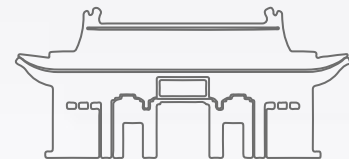
## 运行流程

请输入文字



# 04

## 实验及结果





HIGHLIGHT



Red team has stolen the Rift Herald!

EDG Jiejie

9

EDG Viper

9

Meiko

EDG Flandre

12

EDG Scout

10



正在缓冲... 0.00KB/s

DK Ghost

9

DK ShowMaker

11





- **卡顿**在互联网流媒体中常常出现，这极大地影响用户体验。
- 相同地区内的人们的网络需求往往**类似**。
- 用户访问互联网的带宽与局域网内部的带宽**有差距**。



- 缓存技术已经应用于网络基础设施中，能有效地加速网络传输效率。
- 但是缓存技术应用具有局限性，目前无法应用于小范围机器集群中，如寝室，教室等。
- 并且使用缓存技术往往需要额外的网络缓存机器，这导致缓存技术应用常常被设备所限制。



- 缓存的思想给予了我们启发。
- 本项目组设计了一个**自适应的分布式局域网缓存。**



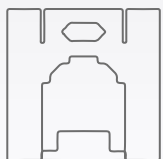


# 本方案的优势

- 对用户透明，用户的访问体验与直接从服务器访问一致，无需离开浏览器。
- 去中性化的设计，不需要设立一个单独的主机用作缓存服务器。

01

项目简介



02

设计架构



03

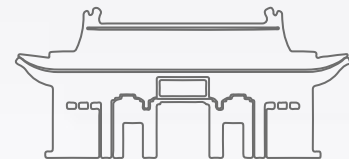
运行流程

请输入文字



04

实验及结果







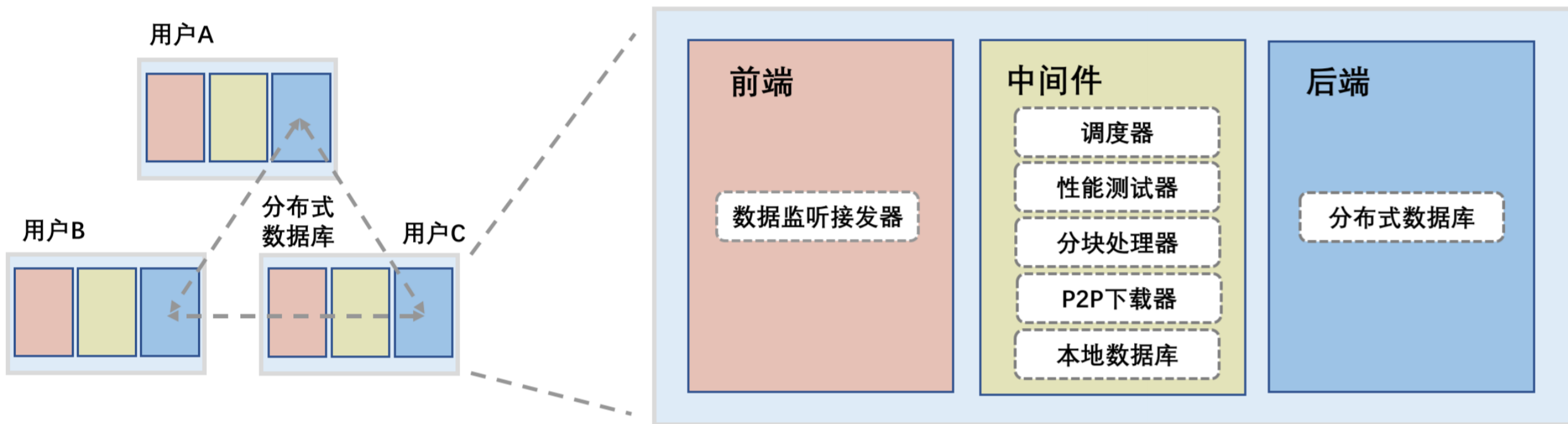
- 请求拦截
- 分布式存储
- 性能调优（下载节点的选择与流媒体碎片）

——攻破！



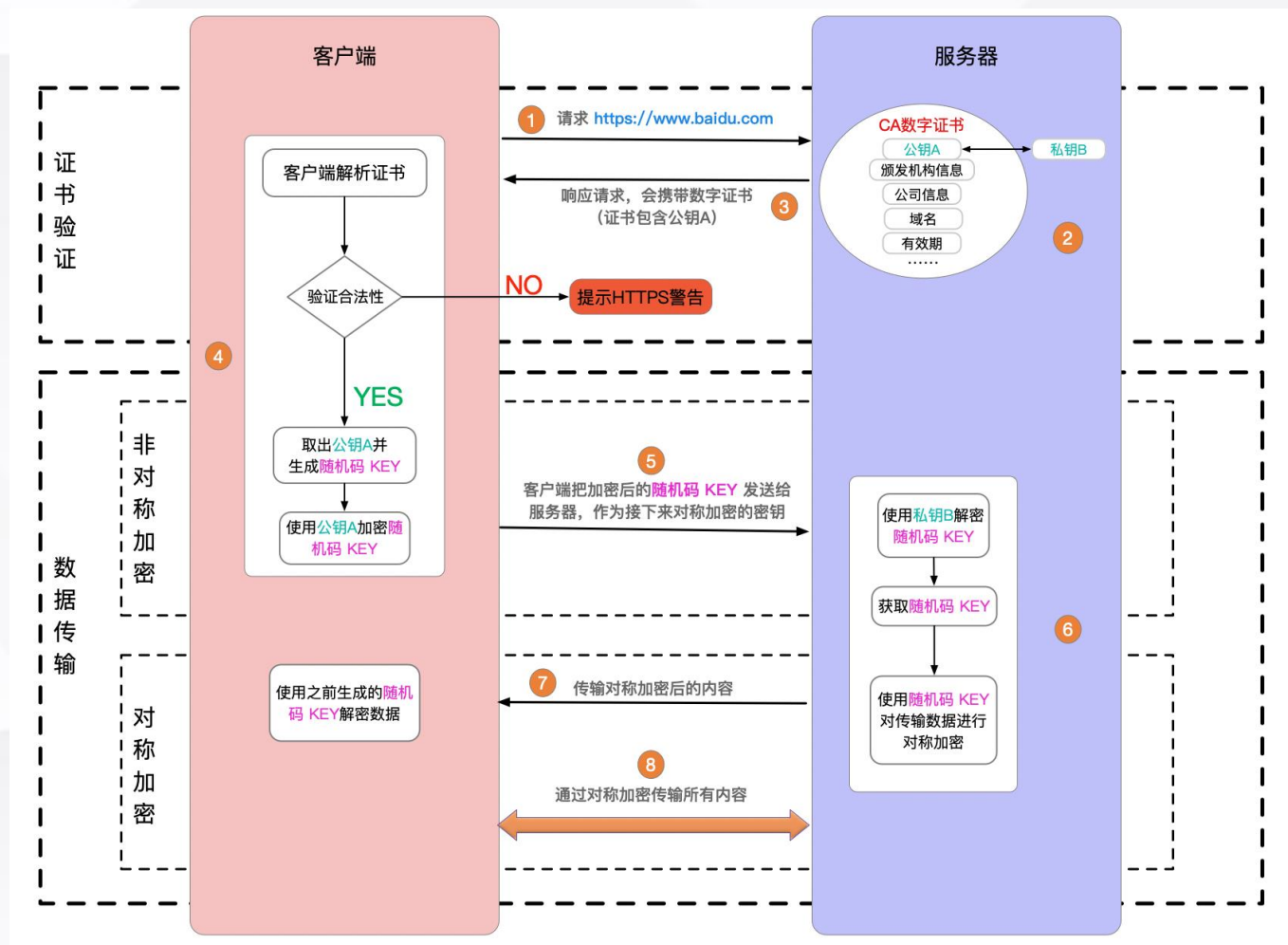
# 整体框架

## 整体采用分层设计思想





## 方案一：使用代理拦截HTTP请求



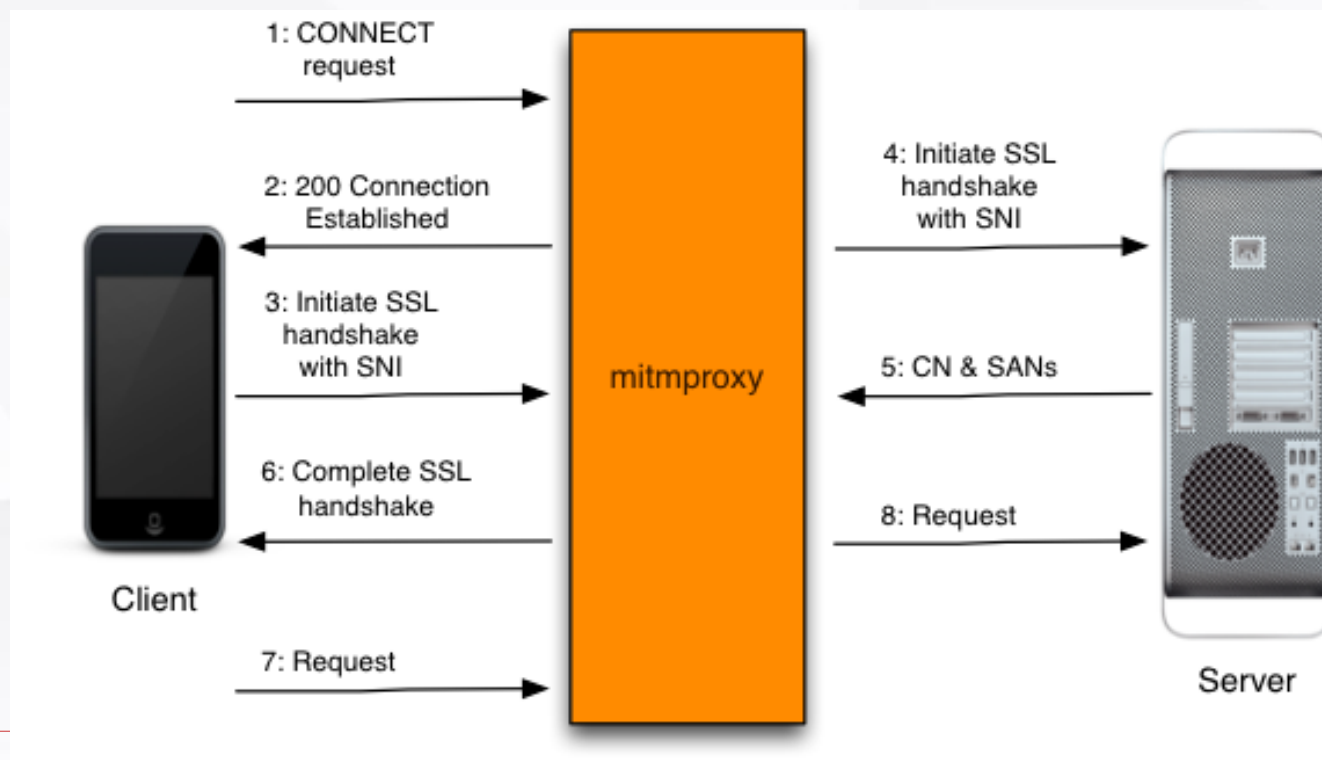


方案二：类似现有互联网代理的方式，拦截TCP报文

同样不可行，因为HTTP报文仍然是无法解密的。

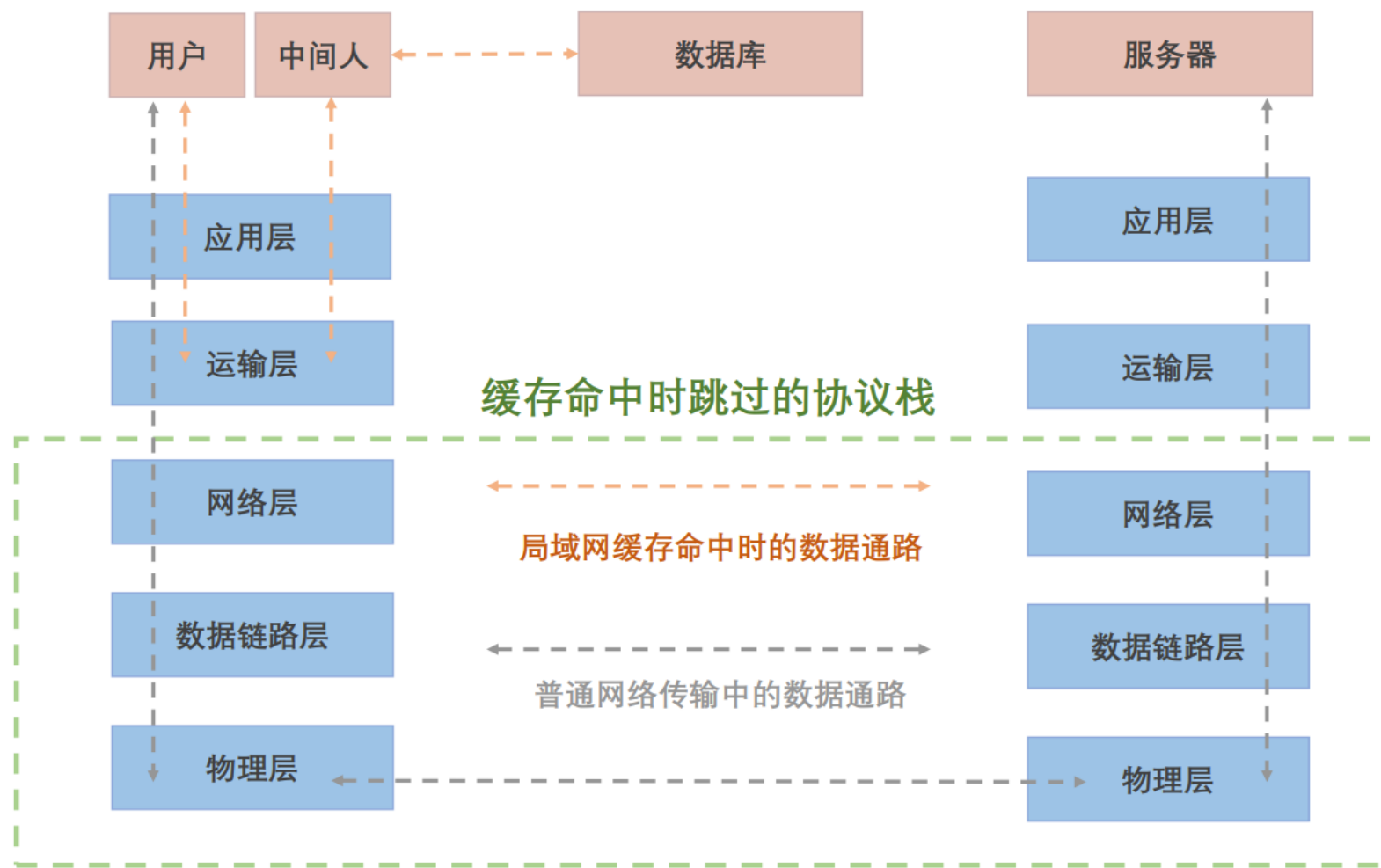
## 方案三：HTTPS真的无法攻破？中间人攻击！

通过伪造CA证书来实现中间人攻击，利用中间人攻击的来实现HTTP报文的截取。





## 最终方案: 使用mitmproxy利用中间人攻击来实现代理





- 委托下载  
将自己的下载任务委托给别人  
等待别人下载完成
- 死锁：A->B, B->A  
避免死锁：区分server, client





- 性能测试

$$score(i) = speed(i) + \frac{\alpha}{delegation(i)}$$



- 服务器分块的不确定性减少缓存命中率

不同截止range的数据大量存在

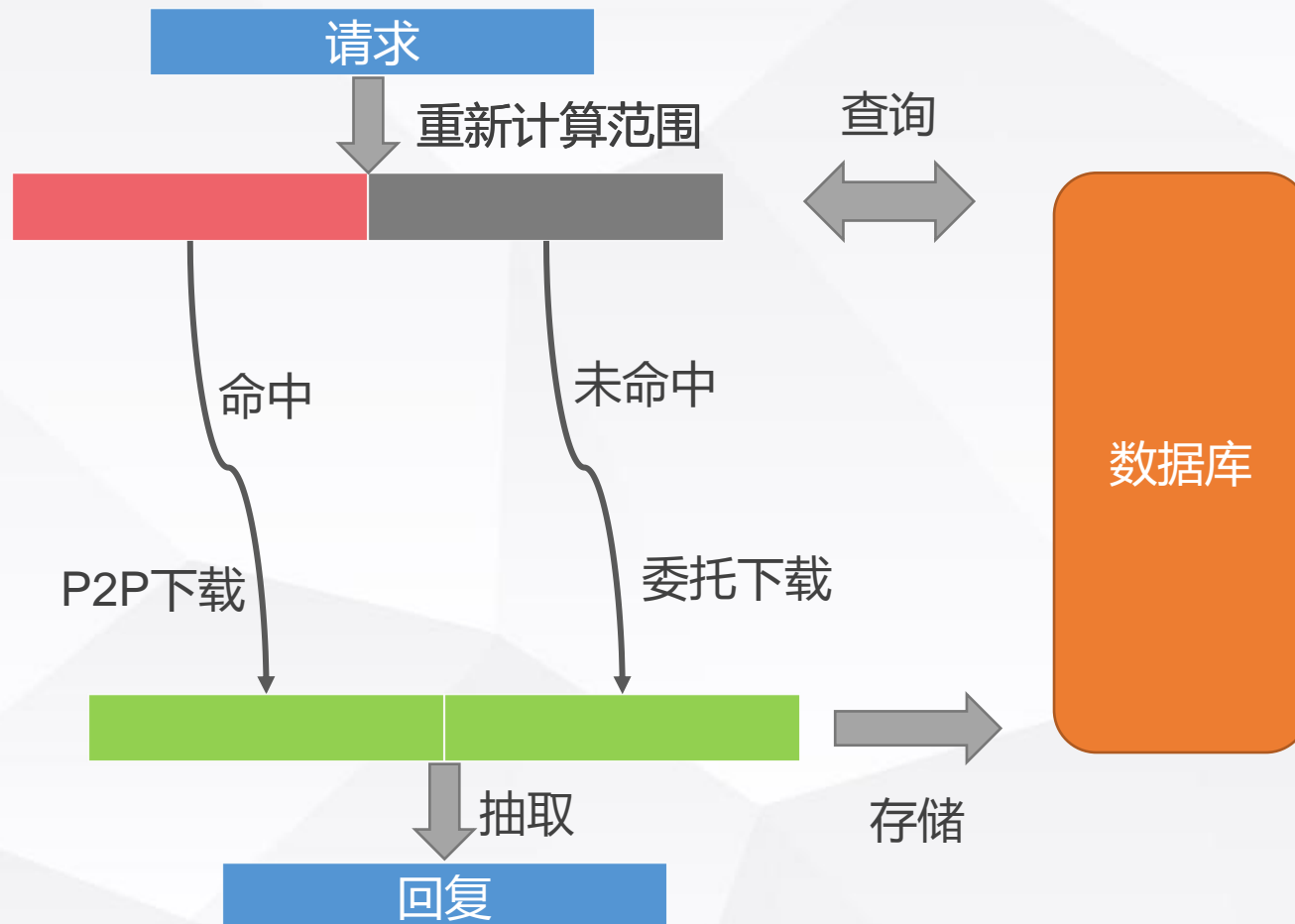
A: [0, 100]

B: [0, 101]



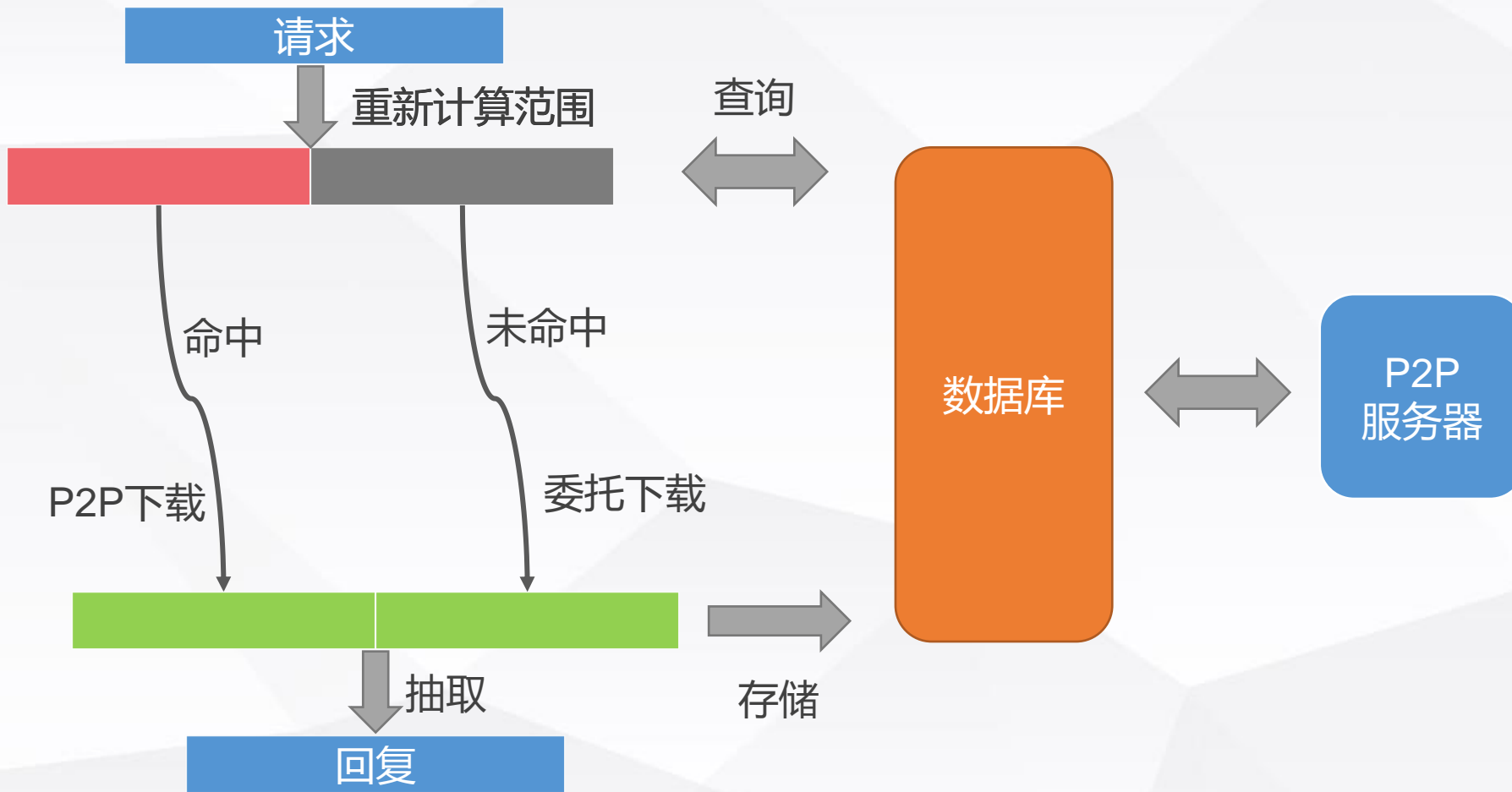
# 中间件：分块处理器

- 整流
- 分块处理
- 合并
- 抽取



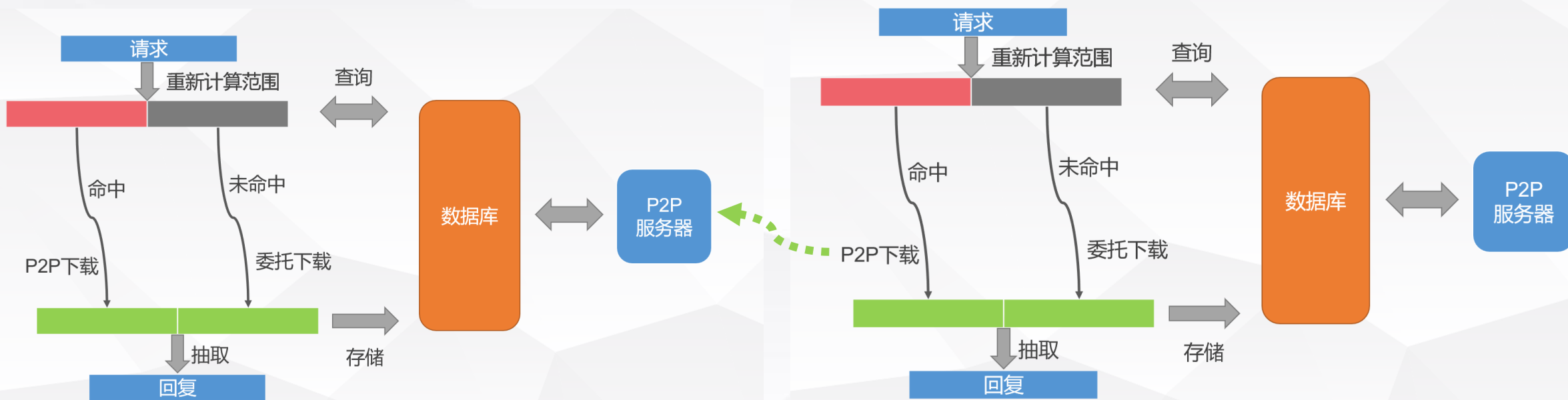


# 中间件：数据库和P2P下载器





# 中间件：数据库和P2P下载器

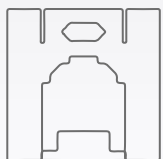




- 基于Raft的rqlite
- 保持节点数据一致性 + 一定的错误容忍能力
- 根据ID自组织集群，sqlited形式python API

01

项目简介



02

设计架构



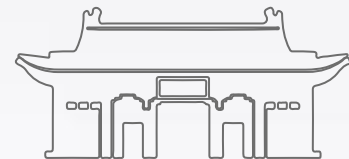
03

运行流程



04

实验及结果







用户

加入集群

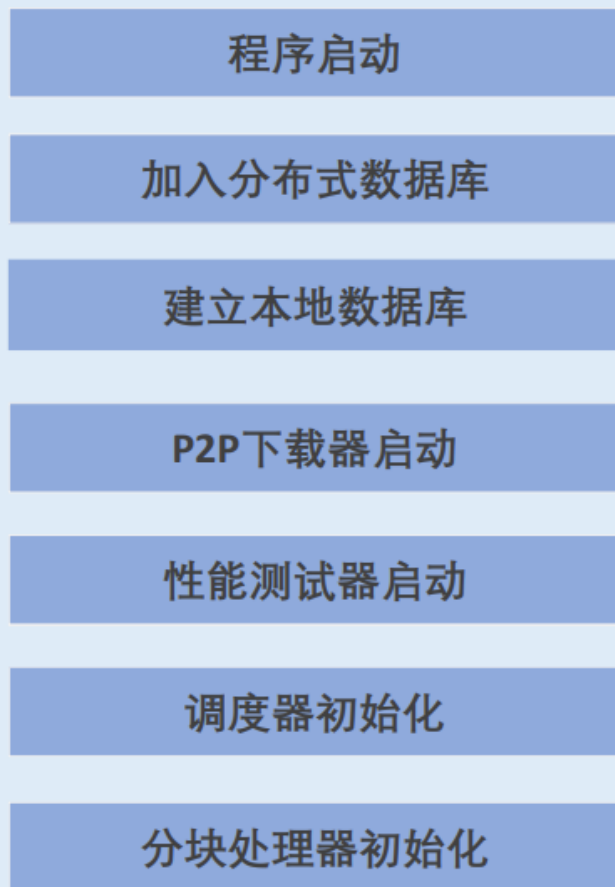
运行代理  
服务器

离开集群

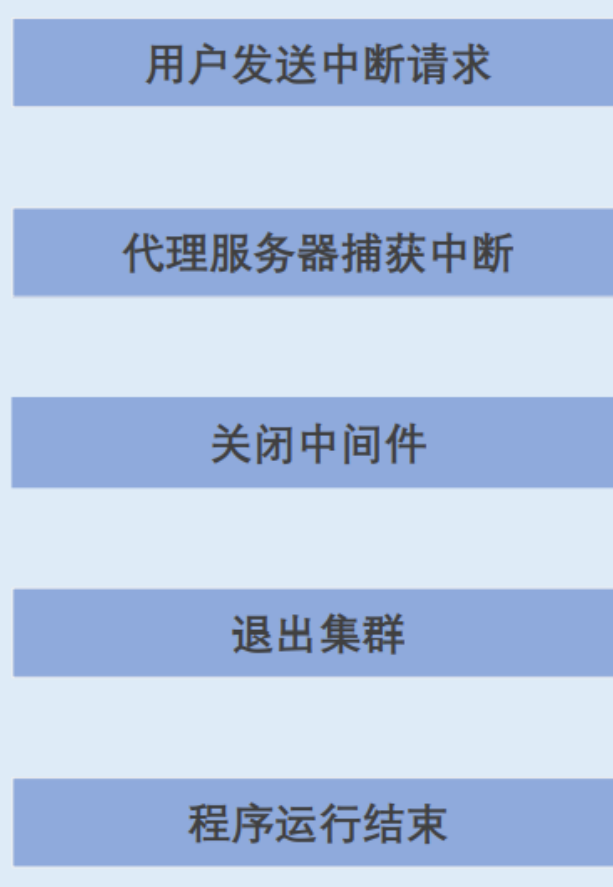


# 加入与离开集群

## 加入集群流程

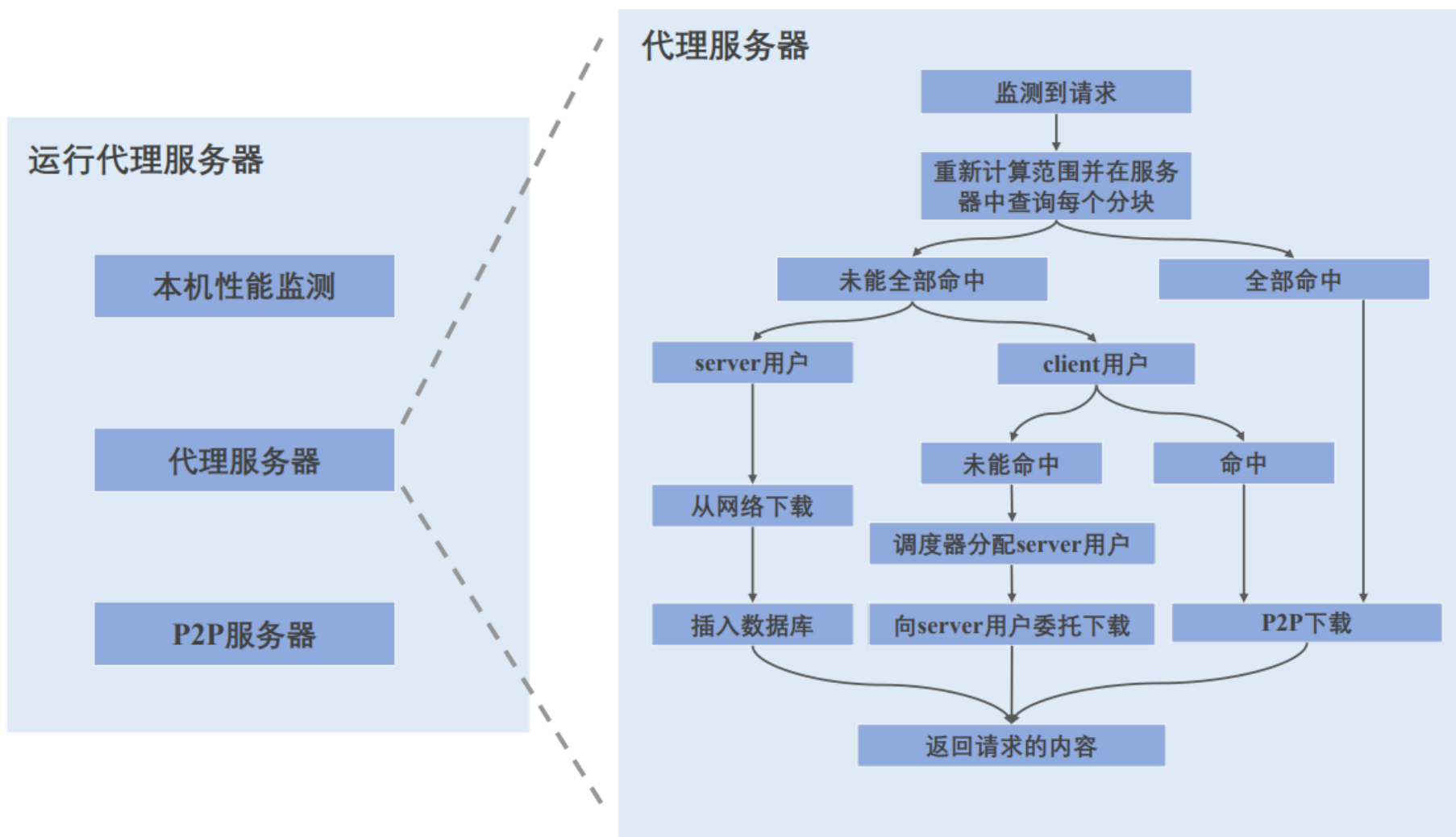


## 离开集群流程





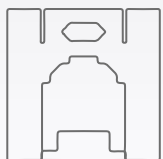
# 程序运行过程





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# 04

实验及结果





# 正确性验证：视频正常播放

```
tion is strongly advised. See: https://urllib3.readthedocs.io/en/1.26.x/advanced-usage.html#ssl-warnings
warnings.warn(
[INFO]: get_data b'\x80\x04\x95\x80\x10\x00\x00\x00\x00'
[INFO]: frontend hit or partial hit
127.0.0.1:50506: server connect upos-sz-mirrorcoso1.bilibili.com:443 (120.253.247.35:443)
[WARN]: status: Error
[WARN]: status: Error
[INFO]: status: OK
[INFO]: query Key: BV1pL4y1q7mu-30032-{}, (1000, 4043)
[INFO]: query BV1pL4y1q7mu-30032-0-524287
Download: BV1pL4y1q7mu-30032-0-524287
Close the connection
[INFO]: block hit
[INFO]: get_data b'\x80\x04\x95\x82\x10\x00\x00\x00\x00'
[INFO]: frontend hit or partial hit
[INFO]: status: OK
[INFO]: query Key: BV1pL4y1q7mu-30280-{}, (908, 3951)
[INFO]: query BV1pL4y1q7mu-30280-0-524287
Download: BV1pL4y1q7mu-30280-0-524287
Close the connection
[INFO]: block hit
[INFO]: get_data b'\x80\x04\x95\x82\x08\x00\x00\x00\x00'
[INFO]: frontend hit or partial hit
[WARN]: status: Error
[WARN]: status: Error
[INFO]: status: OK
[INFO]: query Key: BV1pL4y1q7mu-30032-{}, (0, 999)
[INFO]: query BV1pL4y1q7mu-30032-0-524287
Download: BV1pL4y1q7mu-30032-0-524287
Close the connection
[INFO]: block hit
[INFO]: get_data b'\x80\x04\x95\x82\x08\x00\x00\x00\x00'
[INFO]: frontend hit or partial hit
[INFO]: status: OK
[INFO]: query Key: BV1pL4y1q7mu-30280-{}, (0, 907)
[INFO]: query BV1pL4y1q7mu-30280-0-524287
Download: BV1pL4y1q7mu-30280-0-524287
Close the connection
[INFO]: block hit
[INFO]: get_data b'\x80\x04\x95\x82\x08\x00\x00\x00\x00'
[INFO]: frontend hit or partial hit
[INFO]: status: OK
[INFO]: query Key: BV1pL4y1q7mu-30032-{}, (4044, 28239)
[INFO]: query BV1pL4y1q7mu-30032-0-524287
Download: BV1pL4y1q7mu-30032-0-524287
Close the connection
```

【IGN】《艾尔登法环》

mitproxy

微信 - Search


交大云盘

https://www.bilibili.com/video/BV1pL4y1q7mu?from=search&seid=8206

bilibili 主站 番剧 游戏中心 直播 会员购 漫画 赛事 BLS 下载APP 登录 大会员 消息 动态 收藏 历史

【IGN】《艾尔登法环》实机演示视频

112.4万播放 · 总弹幕数1.1万 2021-11-04 23:33:59



这里就是游戏的舞台——“交界地”

30 人正在看,已装填 6000 条弹幕 请先 登录 或 注册 弹幕礼仪 发送

3.8万 1.7万 1.3万 4.1万 稿件投诉 笔记

在今晚的直播活动上，万代南梦宫放出了《艾尔登法环》的实机演示视频，里面为我们展示了游戏的世界「交界地」、任务、Boss战等内容。《艾尔登法环》将于2022年2月25日发售，登陆PS5、PS4、Xbox及PC平台。

IGN中国 发消息 玩游戏也就图一乐 + 关注 28.9万

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【学徒】反重光 大湿的学





# 正确性验证：回复报文被代理所修改

Firefox Developer Tools Network Panel

Filter URL:

所有 HTML CSS JS XHR 字体 图像 媒体 WS 其他

状态	方法	域名	文件	发起者	类型	传输	大小
206	GET	cn-sh...	436425743-1-30280.m4s?e=ig8	sentry-5...	m...	195.26 KB	1...
206	GET	cn-sh...	436425743-1-30032.m4s?e=ig8	sentry-5...	m...	301.24 KB	3...
206	GET	cn-sh...	436425743-1-30280.m4s?e=ig8	sentry-5...	m...	196.14 KB	1...
200	P...	data....	web?0000151639321899652ht	log-repo...	pl...	511 字节	2 ...
200	P...	api.bi...	heartbeat	sentry-5...	json	650 字节	3...
200	P...	api.bi...	heartbeat	sentry-5...	json	650 字节	3...
200	GET	api.bi...	total?aid=848964774&cid=4364	sentry-5...	json	871 字节	1...
200	P...	api.bi...	heartbeat	sentry-5...	json	650 字节	3...
200	P...	api.bi...	heartbeat	sentry-5...	json	650 字节	3...
200	GET	api.bi...	total?aid=848964774&cid=4364	sentry-5...	json	870 字节	1...
200	P...	data....	web?0000161639321960180ht	log-repo...	pl...	513 字节	2 ...
200	P...	data....	web?0000171639321960931ht	log-repo...	pl...	513 字节	2 ...
200	P...	api.bi...	heartbeat	sentry-5...	json	650 字节	3...

191 个请求 | 已传输 5.69 MB / 2.36 MB | 完成: 1.45 分钟 | DOMContentLoaded: 1.44

消息头

过滤消息头

alt-svc: h3-29=":443"; ma=900, h3-Q050=":443"; ma=900, h3-27=":443"; ma=900, h3-T051=":443"; ma=900, h3-T050=":443"; ma=900, h3-Q046=":443"; ma=900, h3-Q043=":443"; ma=900, quic=":443"; ma=900; v="46,43"

content-length: 199070

content-range: bytes 801080-1000149/50035005

content-type: video/mp4

date: Sun, 12 Dec 2021 15:06:07 GMT

debug: Reorganization

last-modified: Fri, 12 Nov 2021 10:24:22 GMT

server: StreamRipper

X-Firefox-Spdy: h2

x-server: cn-sh-fx-bcache-03

x-service-module: bvc-h2-server

x-upsig-version: 20200423

请求头 (1.100 KB)

Accept: \*/\*







# 正确性验证：委托的请求与处理

```
yuri@yuri-virtual-machine: ~/network/StreamRipper/src
[INFO]: start main
Web server listening at http://127.0.0.1:8081/
Loading script frontend.py
Proxy server listening at http://*:8080
[INFO]: join cluster 6bd2da3c-5b59-11ec-ac7e-01531b592756
Serving on 192.168.31.33:4003
[INFO]: download speed 56.9062
192.168.31.65:43780: client connect
192.168.31.65:43780: server connect cn-sh-fx-bcache-07.bilibili.com:443 (202.120.193.8:443)
[INFO]: receive a delegation
[INFO]: Insert Key: BV1pL4y1q7mu-30032-(), (0, 524287)
[INFO]: Insert BV1pL4y1q7mu-30032-0-524287
192.168.31.65:43780: client disconnect
192.168.31.65:43780: server disconnect cn-sh-fx-bcache-07.bilibili.com:443 (202.120.193.8:443)
192.168.31.65:43782: client connect
192.168.31.65:43782: server connect cn-sh-fx-bcache-03.bilibili.com:443 (202.120.193.4:443)
[INFO]: receive a delegation
[INFO]: Insert Key: BV1pL4y1q7mu-30280-(), (0, 524287)
[INFO]: Insert BV1pL4y1q7mu-30280-0-524287
192.168.31.65:43782: client disconnect
192.168.31.65:43782: server disconnect cn-sh-fx-bcache-03.bilibili.com:443 (202.120.193.4:443)
Received BV1pL4y1q7mu-30032-0-524287 from ('192.168.31.65', 35846)
[INFO]: server hit
Close the connection
Received BV1pL4y1q7mu-30280-0-524287 from ('192.168.31.65', 35848)
[INFO]: server hit
Close the connection
Received BV1pL4y1q7mu-30032-0-524287 from ('192.168.31.65', 35850)
[INFO]: server hit
Close the connection
Received BV1pL4y1q7mu-30280-0-524287 from ('192.168.31.65', 35852)
[INFO]: server hit
Close the connection
Received BV1pL4y1q7mu-30032-0-524287 from ('192.168.31.65', 35854)
[INFO]: server hit
Close the connection
Received BV1pL4y1q7mu-30280-0-524287 from ('192.168.31.65', 35856)
[INFO]: server hit
Close the connection
Received BV1pL4y1q7mu-30032-0-524287 from ('192.168.31.65', 35858)
[INFO]: server hit
Close the connection
Received BV1pL4y1q7mu-30280-0-524287 from ('192.168.31.65', 35860)
[INFO]: server hit
Close the connection
```

```
活动 Firefox 网络浏览器 12月12日 22:55
cwher@ubuntu: ~/Desktop/main/StreamRipper/src
(network) cwher@ubuntu: ~/Desktop/main/StreamRipper/src$ python start.py
Please input your node type:([1] server [2] client):2
Please input disco ID (empty for the first node):6bd2da3c-5b59-11ec-ac7e-01531b592756
[INFO]: Init Router
[INFO]: type: client
[INFO]: start main
Web server listening at http://127.0.0.1:8081/
Loading script frontend.py
Proxy server listening at http://*:8080
127.0.0.1:50498: client connect
127.0.0.1:50498: client connect
127.0.0.1:50498: server connect cn-sh-fx-bcache-07.bilibili.com:443 (202.120.193.8:443)
127.0.0.1:50498: server connect cn-sh-fx-bcache-03.bilibili.com:443 (202.120.193.4:443)
[WARN]: status: Error
[INFO]: status: OK
[INFO]: join cluster 6bd2da3c-5b59-11ec-ac7e-01531b592756
[INFO]: query Key: BV1pL4y1q7mu-30032-(), (1000, 4043)
[INFO]: query BV1pL4y1q7mu-30032-0-524287
Serving on 192.168.31.65:4003
[INFO]: best score 106.9062
[INFO]: use other host:192.168.31.33 to download
/home/cwher/anaconda3/envs/network/lib/python3.8/site-packages/urllib3/connectionpool.py:1013: InsecureRe
questWarning: Unverified HTTPS request is being made to host '192.168.31.33'. Adding certificate verifica
tion is strongly advised. See: https://urllib3.readthedocs.io/en/1.26.x/advanced-usage.html#ssl-warnings
warnings.warn(
[INFO]: get data b'\x00\x04\x95\x02\x10\x00\x00\x00\x00\x00'
[INFO]: frontend hit or partial hit
127.0.0.1:50500: client connect
[INFO]: status: OK
[INFO]: query Key: BV1pL4y1q7mu-30280-(), (908, 3951)
[INFO]: query BV1pL4y1q7mu-30280-0-524287
[INFO]: best score 81.9062
[INFO]: use other host:192.168.31.33 to download
/home/cwher/anaconda3/envs/network/lib/python3.8/site-packages/urllib3/connectionpool.py:1013: InsecureRe
questWarning: Unverified HTTPS request is being made to host '192.168.31.33'. Adding certificate verifica
tion is strongly advised. See: https://urllib3.readthedocs.io/en/1.26.x/advanced-usage.html#ssl-warnings
warnings.warn(
[INFO]: get data b'\x00\x04\x95\x02\x10\x00\x00\x00\x00\x00'
[INFO]: frontend hit or partial hit
127.0.0.1:50500: server connect upos-sz-mirrorcoso1.bilibili.com:443 (120.253.247.35:443)
[WARN]: status: Error
[WARN]: status: Error
[INFO]: status: OK
[INFO]: query Key: BV1pL4y1q7mu-30032-(), (1000, 4043)
[INFO]: query BV1pL4y1q7mu-30032-0-524287
Download: BV1pL4y1q7mu-30032-0-524287
Close the connection
[INFO]: block hit
[INFO]: get data b'\x00\x04\x95\x02\x10\x00\x00\x00\x00\x00'
[INFO]: frontend hit or partial hit
[INFO]: status: OK
[INFO]: query Key: BV1pL4y1q7mu-30280-(), (908, 3951)
[INFO]: query BV1pL4y1q7mu-30280-0-524287
Download: BV1pL4y1q7mu-30280-0-524287
Close the connection
```

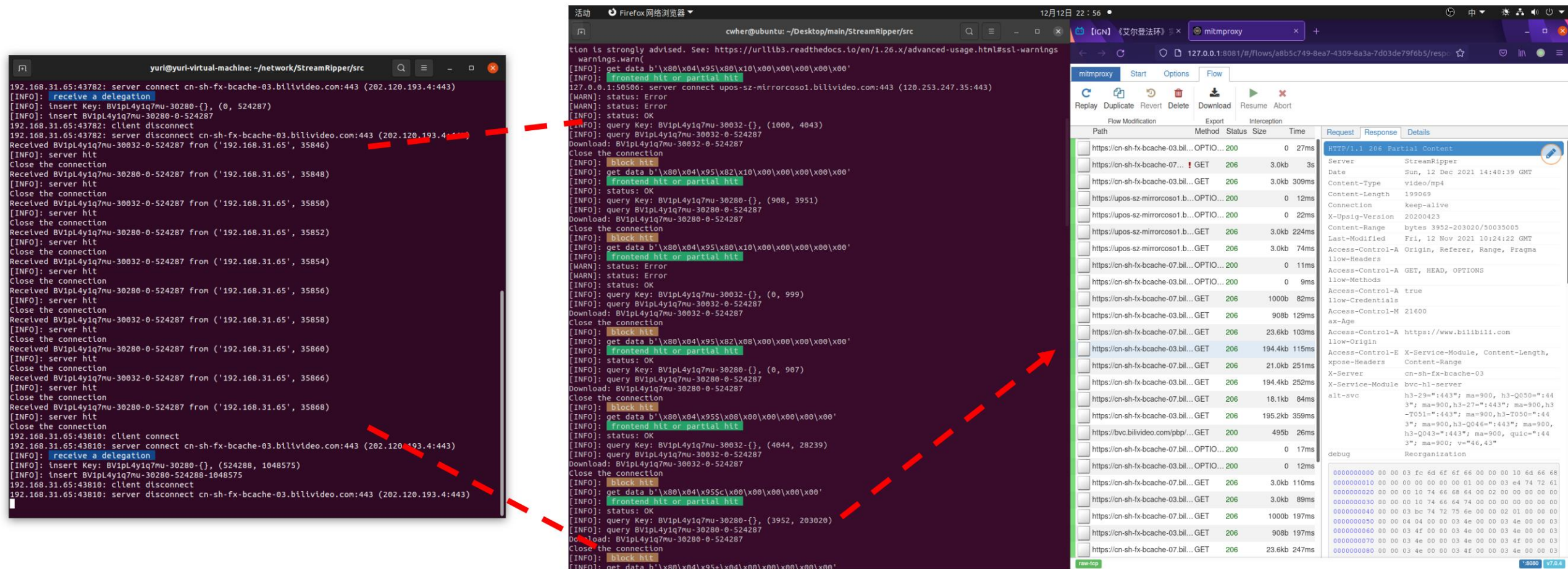
Path	Method	Status	Size	Time	Request	Response	Details
https://cn-sh-fx-bcache-03.bil...	OPTIO...	200		0 27ms	HTTP/1.1 204 Partial Content		
https://cn-sh-fx-bcache-07...	GET	206	3.0kb	3s	Server	StreamRipper	
https://cn-sh-fx-bcache-03.bil...	GET	206	3.0kb	309ms	Date	Sun, 12 Dec 2021 14:40:39 GMT	
https://upos-sz-mirrorcoso1.b...	OPTIO...	200		0 12ms	Content-Type	video/mp4	
https://upos-sz-mirrorcoso1.b...	OPTIO...	200		0 22ms	Content-Length	3044	
https://upos-sz-mirrorcoso1.b...	GET	206	3.0kb	224ms	Connection	keep-alive	
https://upos-sz-mirrorcoso1.b...	GET	206	3.0kb	74ms	X-Upsig-Version	20200423	
https://cn-sh-fx-bcache-07.bil...	OPTIO...	200		0 11ms	Last-Modified	Sun, 12 Dec 2021 12:57:27 GMT	
https://cn-sh-fx-bcache-03.bil...	OPTIO...	200		0 9ms	Access-Control-A	Origin, Referer, Range, Pragma	
https://cn-sh-fx-bcache-07.bil...	GET	206	1000b	82ms	Access-Control-A	GET, HEAD, OPTIONS	
https://cn-sh-fx-bcache-03.bil...	GET	206	908b	129ms	Access-Control-A	true	
https://cn-sh-fx-bcache-07.bil...	GET	206	23.6kb	103ms	Access-Control-A	https://www.bilibili.com	
https://cn-sh-fx-bcache-03.bil...	GET	206	194.4kb	115ms	Access-Control-E	X-Service-Module, Content-Length,	
https://cn-sh-fx-bcache-07.bil...	GET	206	21.0kb	251ms	xpose-Headers	Content-Range	
https://cn-sh-fx-bcache-03.bil...	GET	206	194.4kb	252ms	X-Server	cn-sh-fx-bcache-07	
https://cn-sh-fx-bcache-07.bil...	GET	206	18.1kb	84ms	X-Service-Module	bvc-hl-server	
https://cn-sh-fx-bcache-03.bil...	GET	206	195.2kb	359ms	alt-svc	h3-29="443"; ma=900, h3-Q050="443"; ma=900, h3-27="443"; ma=900, h3-Q051="443"; ma=900, h3-Q050="443"; ma=900, h3-Q046="443"; ma=900, h3-Q043="443"; ma=900, quic="443"; ma=900; v="46,43"	
https://bvc.bilibili.com/ppp/...	GET	200	495b	26ms	debug	Reorganization	
https://cn-sh-fx-bcache-07.bil...	OPTIO...	200		0 17ms			
https://cn-sh-fx-bcache-03.bil...	OPTIO...	200		0 12ms			
https://cn-sh-fx-bcache-07.bil...	GET	206	3.0kb	110ms			
https://cn-sh-fx-bcache-03.bil...	GET	206	3.0kb	89ms			
https://cn-sh-fx-bcache-07.bil...	GET	206	1000b	197ms			
https://cn-sh-fx-bcache-03.bil...	GET	206	908b	197ms			
https://cn-sh-fx-bcache-07.bil...	GET	206	23.6kb	247ms			







## 正确性验证：P2P的请求与处理





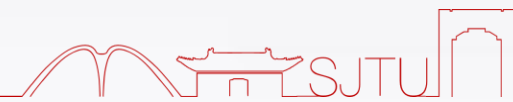
# 缓存性能测试

Flow Modification					Export		Interception		
Replay	Duplicate	Revert	Delete	Download	Resume	Abort			
Path	Method	Status	Size	Time	Request	Response	Details		
https://cn-sh-fx-bcache-03.bil...	GET	200	3.0kb	371ms	HTTP/2.0 206	server openresty			
https://cn-sh-fx-bcache-03.bil...	GET	206	3.0kb	388ms	date Sun, 12 Dec 2021 15:06:07 GMT				
https://cn-sh-fx-bcache-07.bil...	GET	206	1000b	31ms	content-type video/mp4				
https://cn-sh-fx-bcache-03.bil...	GET	206	908b	32ms	content-length 199921				
https://cn-sh-fx-bcache-07.bil...	GET	206	23.6kb	41ms	x-uptsig-version 20200423				
https://cn-sh-fx-bcache-03.bil...	GET	206	194.4kb	44ms	content-range bytes 402090-602010/50035005				
https://cn-sh-fx-bcache-07.bil...	GET	206	21.0kb	33ms	last-modified Fri, 12 Nov 2021 10:24:22 GMT				
https://cn-sh-fx-bcache-03.bil...	GET	206	194.4kb	35ms	access-control-allow-headers Origin, Referer, Range, Pragma				
https://cn-sh-fx-bcache-07.bil...	GET	206	18.1kb	17ms	access-control-allow-methods GET, HEAD, OPTIONS				
https://cn-sh-fx-bcache-03.bil...	GET	206	195.2kb	684ms	access-control-allow-credentials true				
https://cn-sh-fx-bcache-07.bil...	GET	206	17.8kb	33ms	access-control-max-age 21600				
https://cn-sh-fx-bcache-03.bil...	GET	206	1000b	6ms	access-control-allow-origin https://www.bilibili.com				
https://cn-sh-fx-bcache-07.bil...	GET	206	10.6kb	36ms	access-control-expose-headers X-Service-Module, Content-Length, Content-Range				
https://cn-sh-fx-bcache-03.bil...	GET	206	194.4kb	53ms	x-server cn-sh-fx-bcache-03				
https://cn-sh-fx-bcache-03.bil...	GET	206	194.4kb	22ms	x-service-module bvc-h2-server				
https://cn-sh-fx-bcache-03.bil...	GET	206	195.3kb	716ms	alt-svc h3-29=":443"; ma=900, h3-Q050=":443"; ma=900, h3-27=":443"; ma=900, h3-T051=":443"; ma=900, h3-Q046=":443"; ma=900, h3-Q043=":443"; ma=900, quic=":443"; ma=900; v="46,43"				
https://cn-sh-fx-bcache-07.bil...	OPTIO...	200	0	11ms	debug Reorganization				
https://cn-sh-fx-bcache-03.bil...	OPTIO...	200	0	11ms					

来自服务器的请求延迟

Flow Modification					Export		Interception		
Replay	Duplicate	Revert	Delete	Download	Resume	Abort			
Path	Method	Status	Size	Time	Request	Response	Details		
https://cn-sh-fx-bcache-03.bil...	GET	206	195.2kb	684ms	HTTP/2.0 206	server StreamRipper			
https://cn-sh-fx-bcache-07.bil...	GET	206	17.8kb	33ms	date Sun, 12 Dec 2021 15:06:06 GMT				
https://bvc.bilibili.com/pbp/...	GET	200	495b	92ms	content-type video/mp4				
https://cn-sh-fx-bcache-07.bil...	GET	206	10.6kb	36ms	content-length 199921				
https://cn-sh-fx-bcache-03.bil...	GET	206	194.4kb	53ms	x-uptsig-version 20200423				
https://cn-sh-fx-bcache-03.bil...	GET	206	194.4kb	22ms	content-range bytes 402090-602010/50035005				
https://cn-sh-fx-bcache-03.bil...	GET	206	195.3kb	716ms	last-modified Fri, 12 Nov 2021 10:24:22 GMT				
https://cn-sh-fx-bcache-07.bil...	OPTIO...	200	0	11ms	access-control-allow-headers Origin, Referer, Range, Pragma				
https://cn-sh-fx-bcache-03.bil...	OPTIO...	200	0	11ms	access-control-allow-methods GET, HEAD, OPTIONS				
https://cn-sh-fx-bcache-07.bil...	GET	206	3.0kb	13ms	access-control-allow-credentials true				
https://cn-sh-fx-bcache-03.bil...	GET	206	3.0kb	14ms	access-control-max-age 21600				
https://cn-sh-fx-bcache-07.bil...	GET	206	1000b	6ms	access-control-allow-origin https://www.bilibili.com				
https://cn-sh-fx-bcache-03.bil...	GET	206	908b	9ms	access-control-expose-headers X-Service-Module, Content-Length, Content-Range				
https://cn-sh-fx-bcache-07.bil...	GET	206	23.6kb	20ms	x-server cn-sh-fx-bcache-03				
https://cn-sh-fx-bcache-03.bil...	GET	206	194.4kb	21ms	x-service-module bvc-h2-server				
https://cn-sh-fx-bcache-07.bil...	GET	206	21.0kb	12ms	alt-svc h3-29=":443"; ma=900, h3-Q050=":443"; ma=900, h3-27=":443"; ma=900, h3-T051=":443"; ma=900, h3-Q046=":443"; ma=900, h3-Q043=":443"; ma=900, quic=":443"; ma=900; v="46,43"				
https://cn-sh-fx-bcache-07.bil...	GET	206	18.1kb	27ms	debug Reorganization				
https://cn-sh-fx-bcache-03.bil...	GET	206	195.2kb	30ms					
https://cn-sh-fx-bcache-07.bil...	GET	206	17.8kb	17ms					

来自局域网缓存的延迟





- 设计了一种自适应的分布式局域网缓存。
- 针对分布式存储、请求拦截和性能调优这三个挑战分别给出了我们的解决方案。
- 根据互联网流媒体服务的特点，我们设计了一种分块处理器，有效地减少了数据库冗余并降低了系统整体负载。
- 实验显示，本项目在对外流量管理上具有明显优势，可以很好地解决低质量网络环境下的重复请求问题。



- 如定期交换分块的存储位置，可以实现更好的局部性。
- 通过对 P2P 下载请求的合并，我们更好地解决局域网内的性能冗余，提升 P2P 传输性能。
- 可以设计浏览器插件在加密前获取 HTTP 原始报文，从而避免中间人攻击所带来的风险与性能损失





上海交通大學

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感谢聆听

饮水思源 爱国荣校