

Studying Twitch's CDN as an Ecosystem

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Twitch

Internet Video Genre

- Stored Video (a.k.a. VoD)
 - Netflix, Youtube
 - Delay and BW requirement low
 - Viewer # high



- Conversational Video
 - Zoom, Google Meet, Skype
 - Delay and BW requirement high
 - Viewer # low



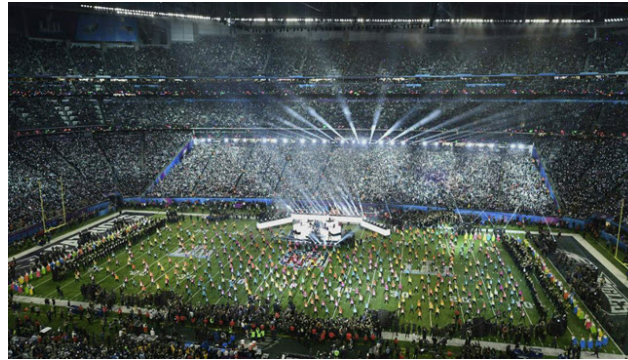
- Live Video
 - Twitch, Youtube Live
 - Delay and BW requirement high
 - Viewer # high



Viewership

- Host of
 - eSports events
 - Game streams and etc.
- In 2018
 - Super Bowl
 - 98M viewers
 - TV commercial time the most expensive!
 - League of Legends World Championship finals
 - 99.6M viewers
 - Twitch

Super Bowl



LoL World Championship



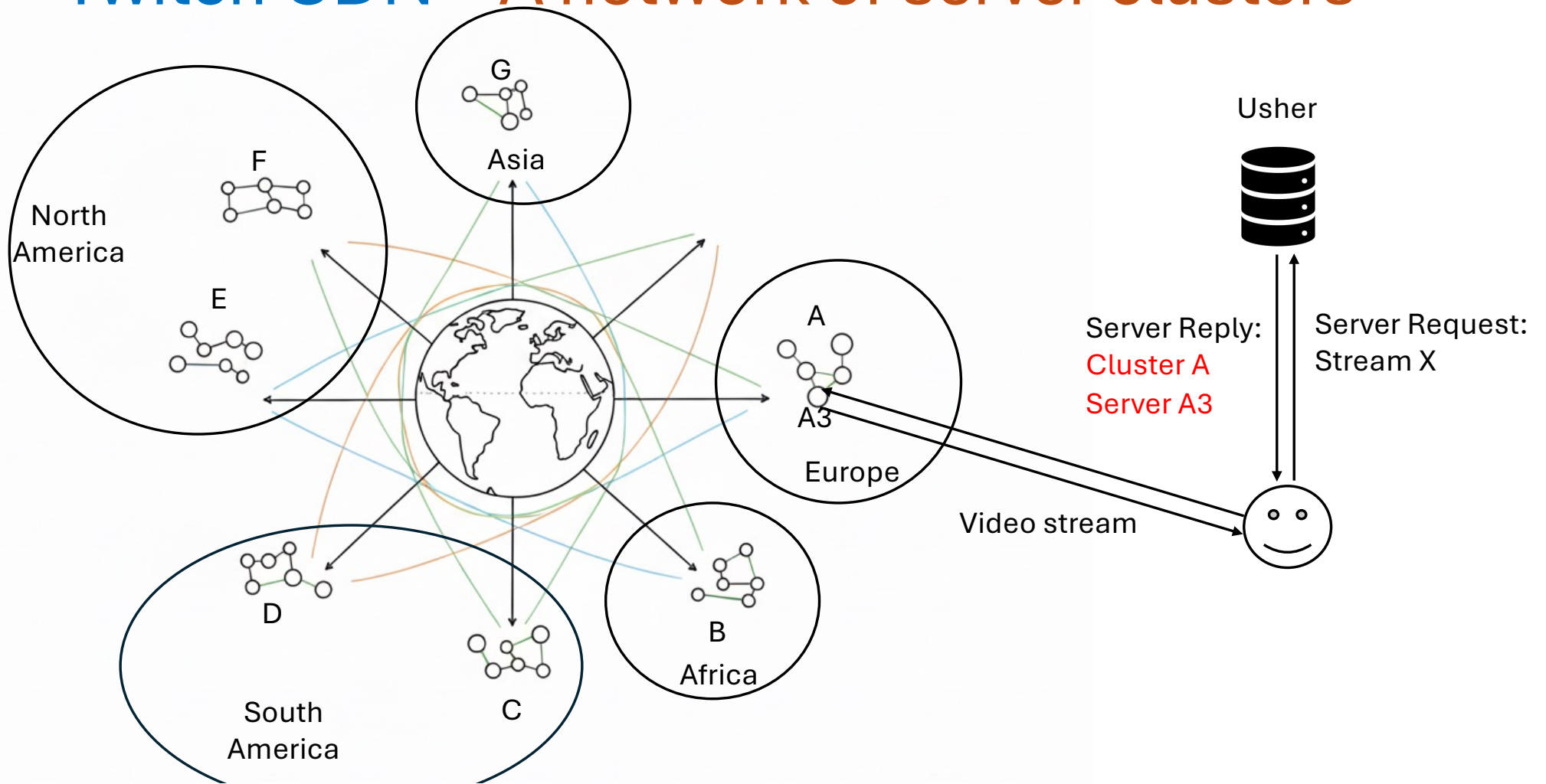
Twitch's CDN

1. Most successful
2. Yet, [little's known](#)

Half a Decade of Work

- A series of Twitch work on AINTEC
 - 2021 **Twitch's CDN** as an Open Population Ecosystem
 - Long-term observation in 2 phases
 - Phase 1: **statistical sampling to discover change**
 - Phase 2: full scan upon detection of a change
 - 2022 **Jujuby**: Design and Deployment of a Crawler for Twitch CDN
 - A **crawling platform** to discover the video servers
 - 2023 **Best-Effort Scan** of Twitch's CDN in Europe
 - Best scan of **Twitch's CDN in Europe**
 - 2025 **Global-Scale CDN – Locality, Dynamics, and Load Balance**

Twitch CDN – A network of server clusters

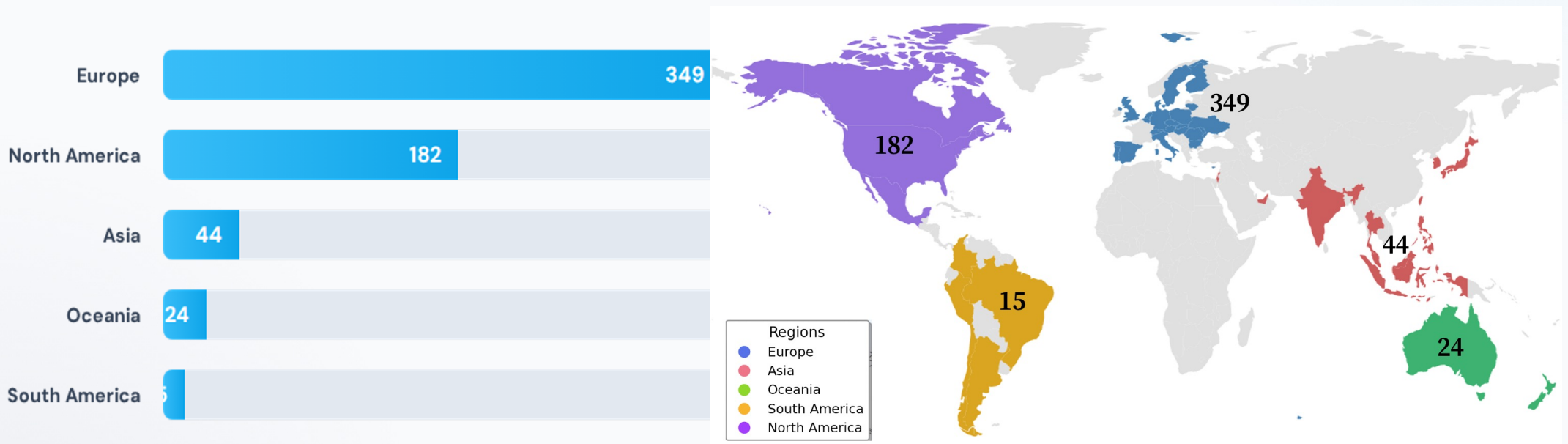


Contribution

- Measurement methodology
- Result
 - Twitch's global CDN
 - Validation
- Analysis
 - Viewer-server co-locality
 - Server dynamics
 - Load balance

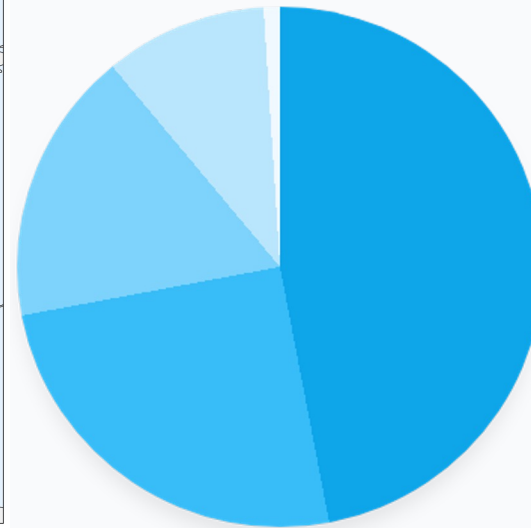
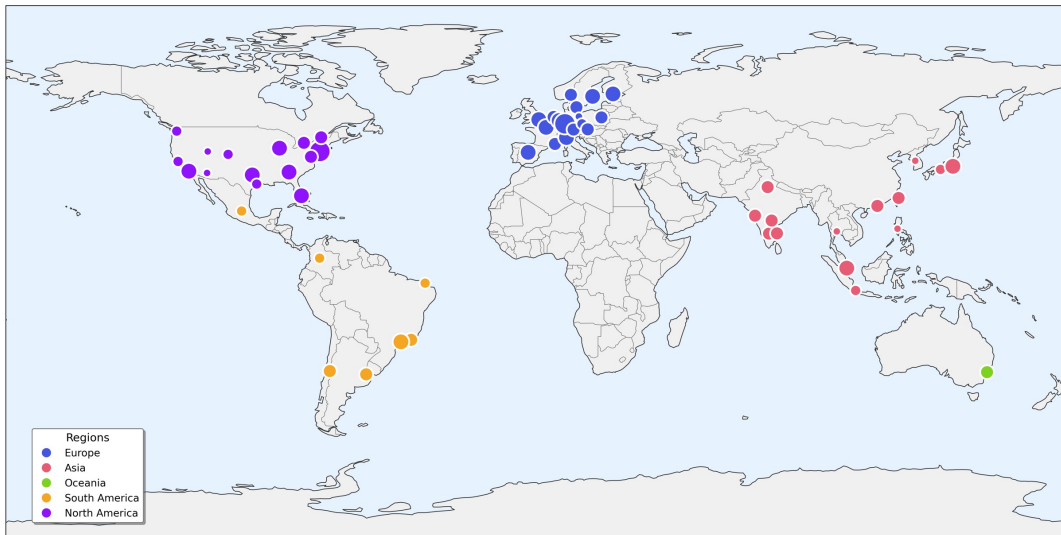
Measurement Vantage Points

Distribution of 686 VPN nodes used for the global crawl



Partial credit: Gemini

Global Server Discovery



- Europe (1,022 Servers)
- North America (537 Servers)
- Asia (363 Servers)
- South America (216 Servers)
- Oceania (28 Servers)

A total of 2,166 edge servers were mapped across 64 clusters. Europe and North America host the majority of the active infrastructure.

Partial credit: Gemini

Validation

Ad hoc scan missing out?

Asia

Country	City	Cluster	IPinfo	Kukudy
IN	Bangalore	blr01	23	21
	Chennai	maa01	31	30
	Delhi	del01	23	23
	Hyderabad	hyd01	26	26
	Mumbai	bom01	28	26
TH	Bangkok	bkk01	32	0
		bkk02	25	0
ID	Jakarta	jkt01	17	0
		jkt02	18	18
CN	Hong Kong	hkg01	35	0
		hkg06	24	24
PH	Manila	mnl01	19	0
SG	Singapore	sin01	54	40
		sin04	42	41
TW	Taoyuan	tpe01	49	26
		tpe03	33	0
JP	Osaka	osa01	18	14
		tyo01	17	0
	Tokyo	tyo03	41	37
		tyo05	50	37
KR	Seoul	sel01	15	0
		sel03	157	0
		sel04	73	0

South America

Country	City	Cluster	IPinfo	Kukudy
AR	Buenos Aires	bue01	29	27
BR	Fortaleza	for01	28	19
		Rio de Janeiro	rio01	51
		rio03	126	47
		rio04	27	0
	São Paulo	sao01	98	0
	sao03	32	23	
	sao05	62	48	
CL	Santiago	scl01	29	21
CO	Bogotá	bog01	22	16
MX	Queretaro	qro01	23	0
		qro02	45	0
		qro03	18	15
		qro04	26	0

Validation I

Parameter Choices

1VPN per subnet → All VPNs on NordVPN

2,000 channels → 20,000 channels

Scan TH, ID, PH, KR, BR, MX again

Matching the best effort scan (AINTEC23)?

AINTEC 23 – May 2023

Country	City	Cluster	IPinfo	Kukudy
ES	Madrid	mad01	130	66
		mad02	23	23
GB	London	lhr03	42	41
		lhr04	51	0
		lhr08	16	16
		cdg02	170	103
FR	Paris	cdg10	47	45
	Marseille	mrs02	18	46
NL	Amsterdam	ams02	148	25
		ams03	31	28
NO	Oslo	osl01	30	25
IT	Milan	mil02	49	78
DK	Copenhagen	cph01	32	29
	Dusseldorf	dus01	53	51
DE	Frankfurt	fra02	112	57
		fra05	206	98
		fra06	147	31
	Munich	muc01	27	25
	Berlin	ber01	71	42
CZ	Prague	prg02	10	0
		prg03	15	11
AT	Vienna	vie02	48	50
SE	Stockholm	arn03	127	64
		arn04	27	30
PL	Warsaw	waw01	30	0
		waw02	27	27
FI	Helsinki	hel01	31	0
		hel03	37	34
Sum			1755	1045

AINTEC 25 – August 2024

Europe				
Country	City	Cluster	IPinfo	Kukudy
ES	Madrid	mad01	120	71
		mad02	31	28
GB	London	lhr03	45	45
		lhr04	36	0
		lhr08	20	20
		lhr05	1	0
FR	Paris	cdg02	108	29
		cdg10	53	48
		Marseille	mrs02	50
NL	Amsterdam	ams02	134	19
		ams03	29	20
NO	Oslo	osl01	30	25
IT	Milan	mil02	84	84
DK	Copenhagen	cph01	33	30
DE	Dusseldorf	dus01	55	53
		Frankfurt	fra02	193
		fra05	164	97
		fra06	94	34
	Munich	muc01	29	27
	Berlin	ber01	59	0
CZ	Prague	prg02	1	0
		prg03	20	17
AT	Vienna	vie02	52	50
SE	Stockholm	arn03	95	55
		arn04	107	44
PL	Warsaw	waw01	30	0
		waw02	29	29
FI	Helsinki	hel01	15	0
		hel03	76	72
Sum			1793	1022

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FR	Paris	cdg02	170	103
		cdg10	47	45
	Marseille	mrs02	18	46
NL	Amsterdam	ams02	148	25
		ams03	31	28
NO	Oslo	osl01	30	25
IT	Milan	mil02	49	78
DK	Copenhagen	cph01	32	29
DE	Dusseldorf	dus01	53	51
		fra02	112	57
		fra05	206	98
	Frankfurt	fra06	147	31
	Munich	muc01	27	25
Berlin	ber01	71	42	
CZ	Prague	prg02	10	0
		prg03	15	11
AT	Vienna	vie02	48	50
SE	Stockholm	arn03	127	64
		arn04	27	30
PL	Warsaw	waw01	30	0
		waw02	27	27
FI	Helsinki	hel01	31	0
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1 year later

Europe				
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		lhr08	20	20
		lhr05	1	0
FR	Paris	cdg02	108	29
		cdg10	53	48
	Marseille	mrs02	50	50
NL	Amsterdam	ams02	134	19
		ams03	29	20
NO	Oslo	osl01	30	25
IT	Milan	mil02	84	84
DK	Copenhagen	cph01	33	30
DE	Dusseldorf	dus01	55	53
		fra02	193	75
	Frankfurt	fra05	164	97
		fra06	94	34
	Munich	muc01	29	27
	Berlin	ber01	59	0
CZ	Prague	prg02	1	0
		prg03	20	17
AT	Vienna	vie02	52	50
SE	Stockholm	arn03	95	55
		arn04	107	44
PL	Warsaw	waw01	30	0
		waw02	29	29
FI	Helsinki	hel01	15	0
		hel03	76	72
Sum			1793	1022

Stay mostly the same

Country	City	Cluster	IPinfo	Kukudy
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		mad02	23	23
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		lhr04	51	0
		lhr08	16	16
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		cdg10	47	45
	Marseille	mrs02	18	46
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DE		fra02	112	57
	Frankfurt	fra05	206	98
		fra06	147	31
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		lhr05	1	0	
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		cdg10	53	48	
	Marseille	mrs02	50	50	
NL	Amsterdam	ams02	134	19	
		ams03	29	20	
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DK	Copenhagen	cph01	33	30	
DE	Dusseldorf	dus01	55	53	
		Frankfurt	fra02	193	75
			fra05	164	97
		fra06	94	34	
	Munich	muc01	29	27	
CZ	Prague	prg02	1	0	
		prg03	20	17	
AT	Vienna	vie02	52	50	
SE	Stockholm	arn03	95	55	
		arn04	107	44	
PL	Warsaw	waw01	30	0	
		waw02	29	29	
FI	Helsinki	hel01	15	0	
		hel03	76	72	
Sum			1793	1022	

Significant ↓

Move?

Significant ↑

Validation II

Comparison to best-effort Scan

1. Mostly the same
2. Some moves from a cluster to another
3. Some increases significantly
4. Some decreases significantly



Similar, overall

Why null clusters?

- KR
 - Twitch clusters in Korea were shutdown in February 2024 due to high network access fee.
 - The Korean clusters are off because of a **change in operation cost**.
- TH
 - Unknown and perhaps Thai users know better...
- PH
 - Unknown and perhaps Filipino users know better...

Country	City	Cluster	IPinfo	Kukudy
IN	Bangalore	blr01	23	21
		Chennai	maa01	31
	Delhi	del01	23	23
	Hyderabad	hyd01	26	26
	Mumbai	bom01	28	26
TH	Bangkok	bkk01	32	0
		bkk02	25	0
ID	Jakarta	jkt01	17	0
		jkt02	18	18
CN	Hong Kong	hkg01	35	0
		hkg06	24	24
PH	Manila	mnl01	19	0
SG	Singapore	sin01	54	40
		sin04	42	41
TW	Taoyuan	tpe01	49	26
		tpe03	33	0
JP	Osaka	osa01	18	14
	Tokyo	tyo01	17	0
		tyo03	41	37
		tyo05	50	37
KR	Seoul	sel01	15	0
		sel03	157	0
		sel04	73	0

Q&A