Open Connect Everywhere: A Glimpse at the Internet Ecosystem through the Lens of the Netflix CDN

Timm Böttger, Felix Cuadrado, Gareth Tyson, Ignacio Castro, <u>Steve Uhlig</u>

steve.uhlig@qmul.ac.uk

Queen Mary University of London, UK





Agenda

Motivation

- Background
- Methodology
- Server deployment
- Traffic
- Conclusion







- Where did Netflix choose to deploy servers?
- What does this tell us about the Internet Ecosystem?



World-Wide Content Availability



original kids series -- available at the same time to members everywhere.



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Architectural Decisions





Concentrate Your Resources

Americas

Berkeley County, South Carolina Council Bluffs, Iowa Douglas County, Georgia Jackson County, Alabama Lenoir, North Carolina Mayes County, Oklahoma Montgomery County, Tennessee Quilicura, Chile The Dalles, Oregon

Asia

Changhua County, Taiwan Singapore

Europe

Dublin, Ireland Eemshaven, Netherlands Hamina, Finland St Ghislain, Belgium





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Try to be Everywhere

- 216,000 servers
- In over 120 countries
- Within more than 1,500 networks





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The Old Netflix

• Netflix used to rely on datacentres plus CDN partners









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Today's Netflix Architecture

• "Datacentre-free" since January 2016

• Many services on Amazon Web Services



• Netflix deployed its own CDN: OpenConnect





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Netflix OpenConnect Delivery Options





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Out of scope: Netflix Client Redirection





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Deployment: Exploiting the Naming Scheme

- DNS names of servers used by Netflix:
 - ipv4_1-lagg0-c020.1.lhr001.ix.nflxvideo.net
 - ipv4_1-cxl0-c045.1.fra001.ix.nflxvideo.net
 - ipv6_1-lagg0-c002.1.lhr005.bt.isp.nflxvideo.net

- Using a DNS crawler, we discovered
 - 4,777 servers
 - 243 locations
 - 48 countries
 - 123 ISPs











Traffic: Exploiting IPID

• IPID

- Field of the IPv4 header
- Originally used for fragmentation
- Can be incremented arbitrarily, though often incrementally [RFC6864]
- All Netflix caches run FreeBSD 10
- Checked that consistent values of the IPID field returned
- 1 sample per server every 30 mins to reduce overhead



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Global Netflix deployment (locations)





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Global Netflix deployment (size)





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Deployment according to Netflix



ISP Locations Internet Exchange Point (circles are sized by volume)



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Servers deployed at IXP locations





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Map of IXP locations worldwide





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Servers deployed at ISP locations





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Global relative IXP/ISP deployment

- Few IXP locations
- Many ISP locations



- More servers at IXPs than ISPs overall
- Though continents differ





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Server deployment in North America





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Server deployment in Europe





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Northern Europe

Country	Network (IXP/ISP)	# of servers			
Denmark	TDC (ISP)	24			
	Stofa (ISP)	5			
	Comx (ISP)	3			
	Nianet (ISP)	3			
	Hi3g (ISP)	2			
	Telenordk (ISP)	2			
	Trefor (ISP)	2			
	Waoo (ISP)	2			
Finland	IXP	13			
	Dna (ISP)	8			
	Fne (ISP)	2			

Country	Network (IXP/ISP)	# of servers		
Norway	Telenor (ISP)	40		
	Altibox (ISP)	13		
	Getas (ISP)	10		
	Broadnet (ISP)	5		
	Bkk (ISP)	2		
	Ntebredband (ISP)	2		
	Signal (ISP)	2		
Sweden	IXP	60		
	Comhem (ISP)	22		
	Telenor (ISP)	16		
	Bahnhof (ISP)	5		
	Bredband2 (ISP)	4		
	Alltele (ISP)	3		
	Nordunetas (ISP)	2		
	Telecom3 (ISP)	2		



USA		Canada		United Kingdom		Brazil		Mexico	
AT&T	-	Bell Aliant	22	BT	63	Algar	4	Axtel	10
Bright House	-	Bell Canada	32	\mathbf{EE}	-	GVT	43	Totalplay	7
Cablevision	28	Cogeco	14	Plusnet	6	Live TIM	5	izzi	36
CenturyLink	6	Distributel	-	\mathbf{Sky}	71	Net Virtua	-	Cablevision Mont.	-
Charter	-	$\operatorname{Eastlink}$	22	TalkTalk	37	Oi Velox	28	Cablemás	_
Comcast	-	MTS	18	Virgin	41	Vivo	-	Telnor	-
Cox	-	Rogers	43					Megacable	2
Frontier	13	SaskTel	12					Telecable	1
Mediacom	-	Shaw	125					Telmex	64
$\operatorname{Suddenlink}$	50	TekSavvy	12						
TWC	-	Telus	54						
Verizon	2	Videotron	-						
Windstream	20								

ISP deployment in largest markets worldwide

- USA: Tier-1 ISPs do not deploy...they have their own CDN agenda.
- Canada: Significant ISP deployment due to no IXP deployment (US-based Equinix is used)
- UK: Significant ISP deployment, because it's a large enough market to require ISP deployment
- Mexico: Significant deployment, absence actually means ISP merging



Deployment: take-home message

- Still a datacentre-based approach (through IXPs)
 - Few IXP locations with significant number of servers
 - Complemented by ISP deployment
- Every region/market is different, though many share similarities



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Estimated global traffic pattern

- North America dominates
- Followed by Europe (UK mostly)
- Central/South America unexpectedly third (Mexico and Brazil)





Traffic per country

- Total traffic:
 - Expected: US, CA, GB, AU
 - Interesting: MX, BR
- Share of IXP/ISP traffic reflects server deployment figures





Traffic: take-home message

- North America dominates, as expected
- Strong Central/South American market
- IXP traffic dominates, reflecting server deployment figures
- Peak traffic dominates, though evidence of limited back-end traffic



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Conclusion

- First ever mapping of Netflix's OpenConnect CDN
 - Physical server distribution
 - Traffic estimation
- Different markets require region-specific deployments
 - Differences between the local Internet Ecosystems
 - Marked contrast/complementarity in IXP/ISP deployments
- Exposing Netflix' overall server placement strategy
 - Appears focused on utilising IXP footprint
 - Complemented by ISP deployment
 - Actually: deploying within ISPs takes time, so importance of IXP deployment reflects the phase in the ongoing process of deploying within ISPs
- Full paper at arXiv <u>http://tiny.cc/netflix-maps</u>

