Advanced Internet and IoT Technologies

- Network Economy and Social Impact -

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Agenda

Introduction

Service Infrastructure

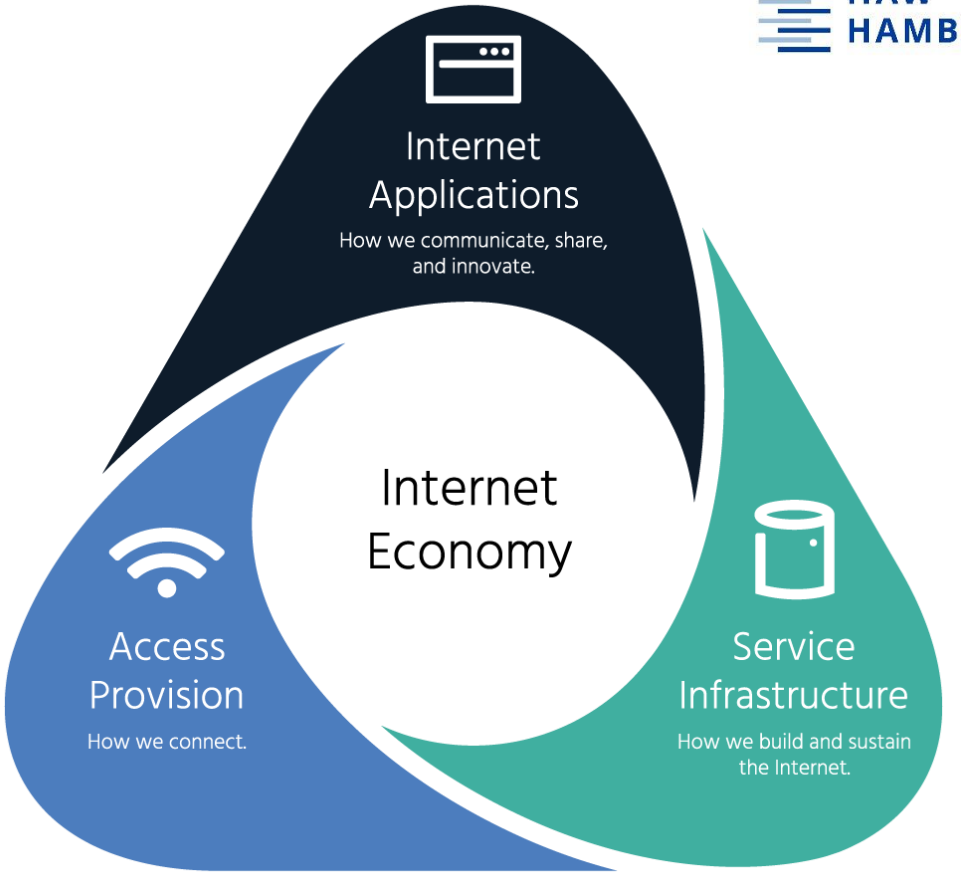
Network Access

Internet Applications

Social Impact

INTRODUCTION

Economic activities that either support the Internet or are fundamentally dependent on the Internet existence



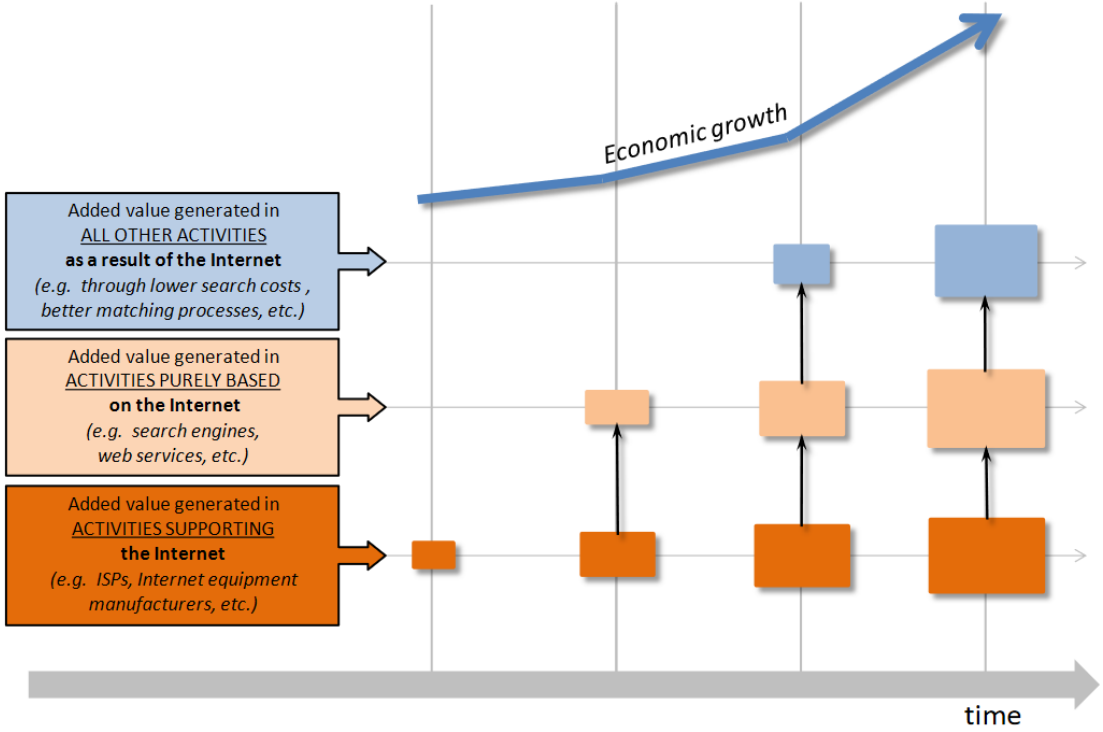
Internet Society 2019

Contributions to the Growth Domestic Product

Indirect effects s.a.

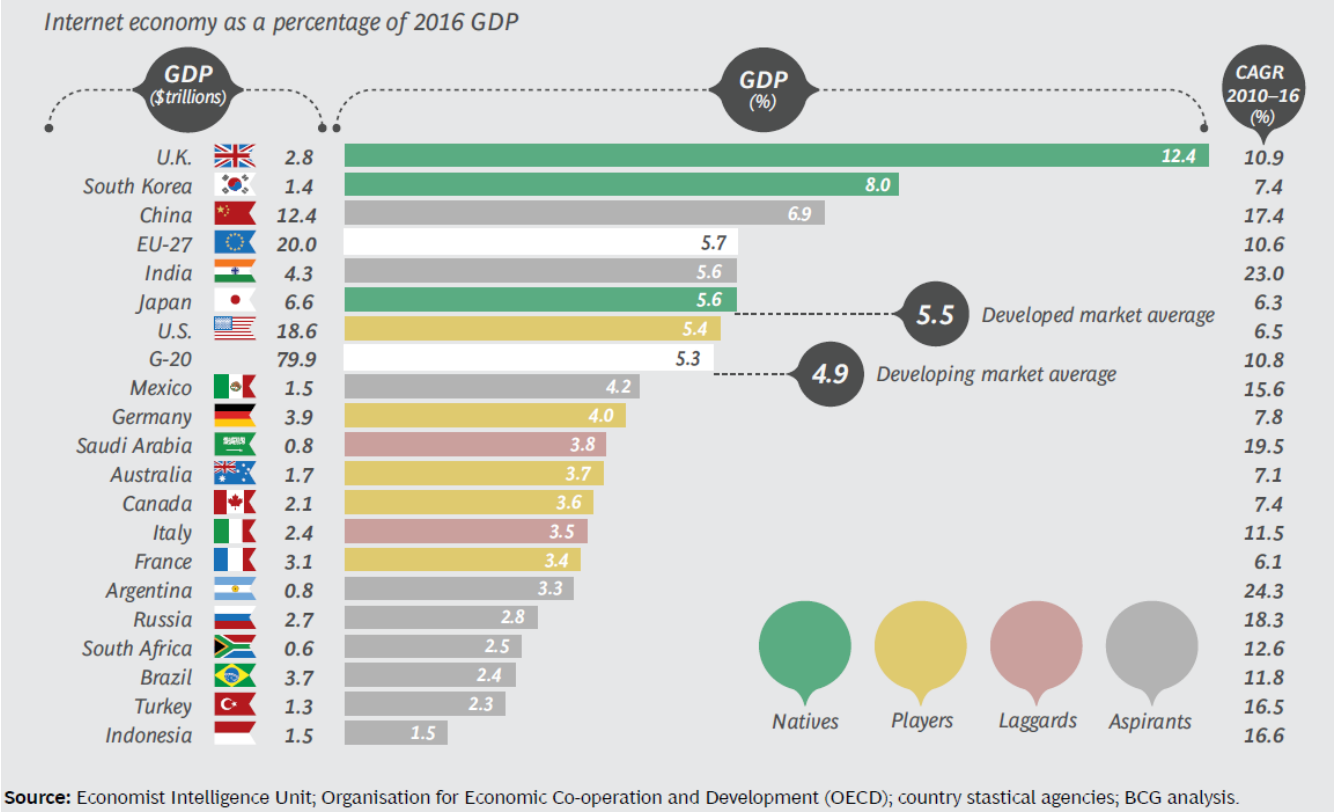
- information density
- operational synergies
- efficiency gains
- online marketing

start to dominate



OECD 2013

Internet Economy: Relative Sizes



Source: Economist Intelligence Unit; Organisation for Economic Co-operation and Development (OECD); country stastical agencies; BCG analysis.

An Economic Theory of Communication

Rohlfs' seminal paper observed 1974:

"Larger is better for communication systems"

A theory of interdependent demand for a communications service

Jeffrey Rohlfs

Bell Laboratories
Murray Hill, New Jersey

The utility that a subscriber derives from a communications service increases as others join the system. This is a classic case of external economies in consumption and has fundamental importance for the economic analysis of the communications industry. This paper analyzes the economic theory of this kind of interdependent demand. We begin by defining "equilibrium user set" as a set of users consistent with all individuals' (users and nonusers) maximizing their utilities. There are typically multiple equilibria at any

The Bell Journal of Economics and Management Science, vol. 5, no. 1, pp. 16–37, 1974.

Consequences

Highly scalable communication systems

- either follow open standards
- or tend to become monopolies

As of today, closed applications have created
huge “winner-takes-all” markets
that stimulated consolidation even for areas, in which open standards dominate(d)

Consequences

> Like the oil barons at the turn of the 20th century, the data barons are determined to extract as much as possible of a resource that's central to the economy of their time. The more information they can get to feed the algorithms that power their ad-targeting machines and product-recommendation engines, the better.
>
> —MIT Technology Review, 2018

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SERVICE INFRASTRUCTURE

Tier 1 and Transit

Two key services

1. Global connectivity at very high speeds
2. Global prefix reachability (DFZ)

Operationally related fields

- Transnational/subsea cable infrastructure
- Access provisioning

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Main business competitors

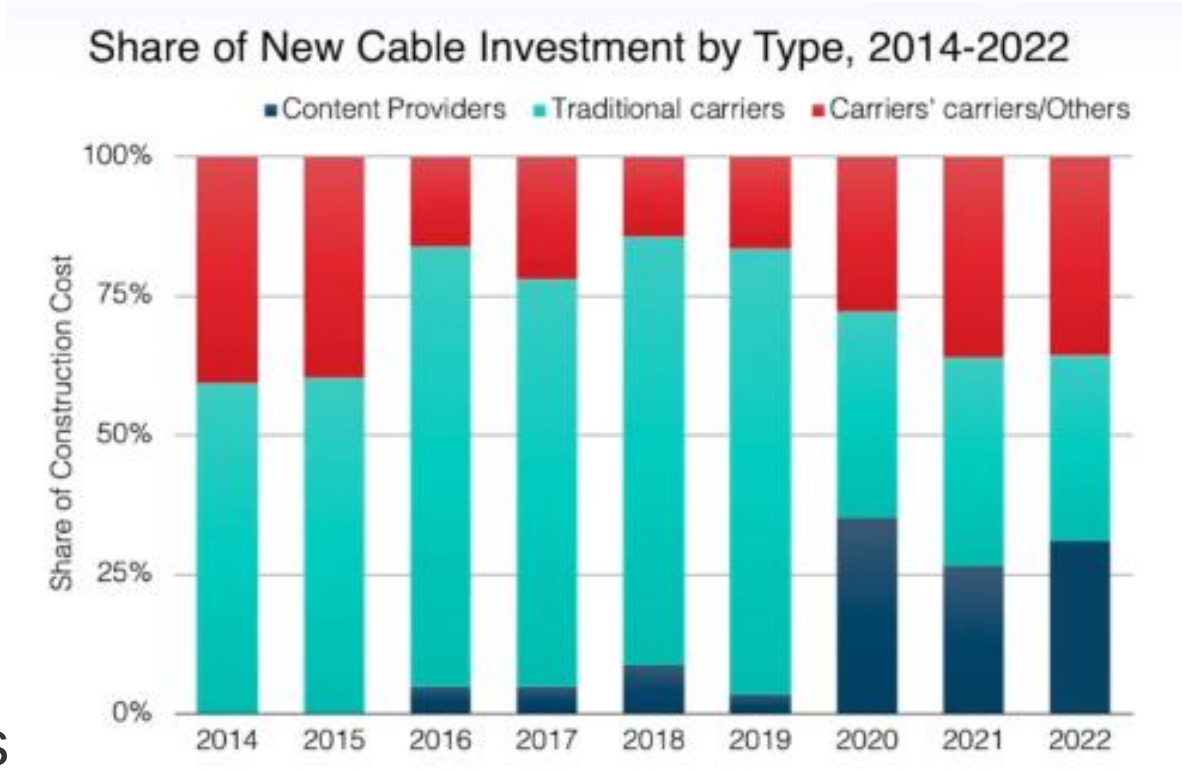
- IXPs and NSPs
- OTTs and CDNs

Cable Infrastructure

Traditional carriers reduce investment

Content providers increasingly invest in fiber

Focus: subsea cables



telegeography.com

Recent Trends

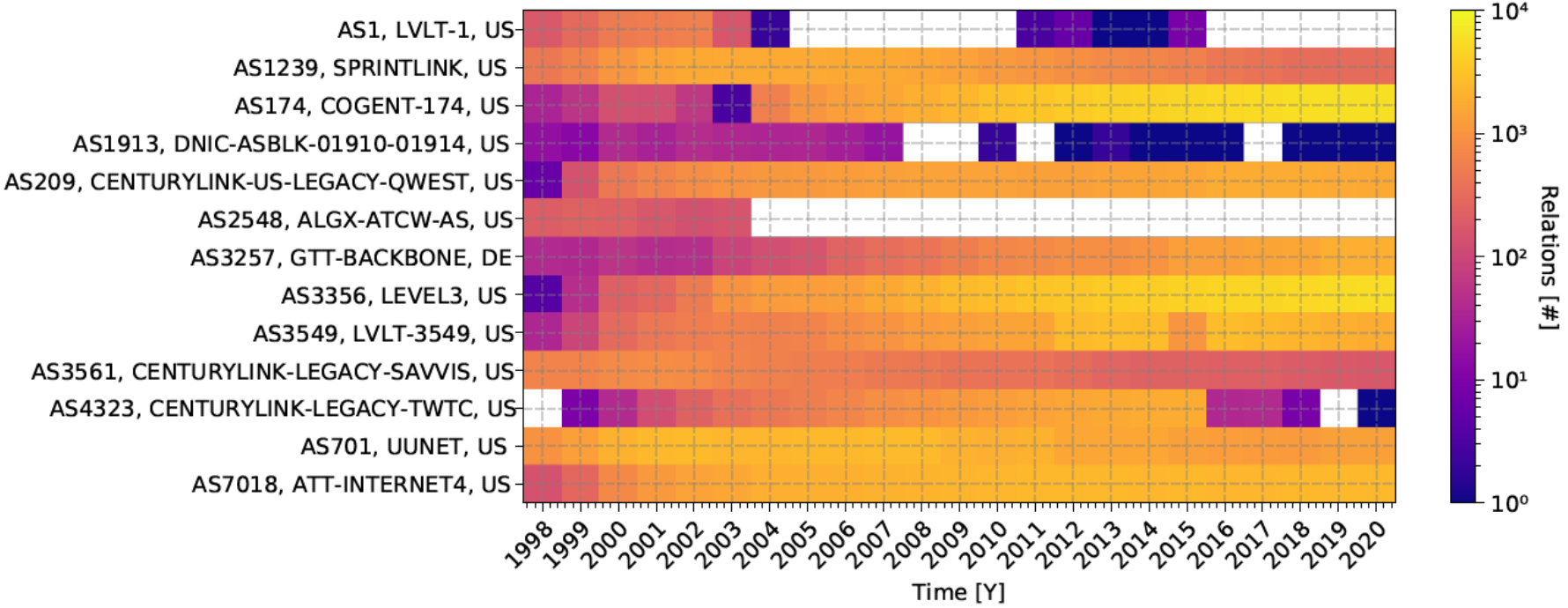
Reduce CAPEX in physical infrastructure

Merge with other Tier-1 or large IXPs

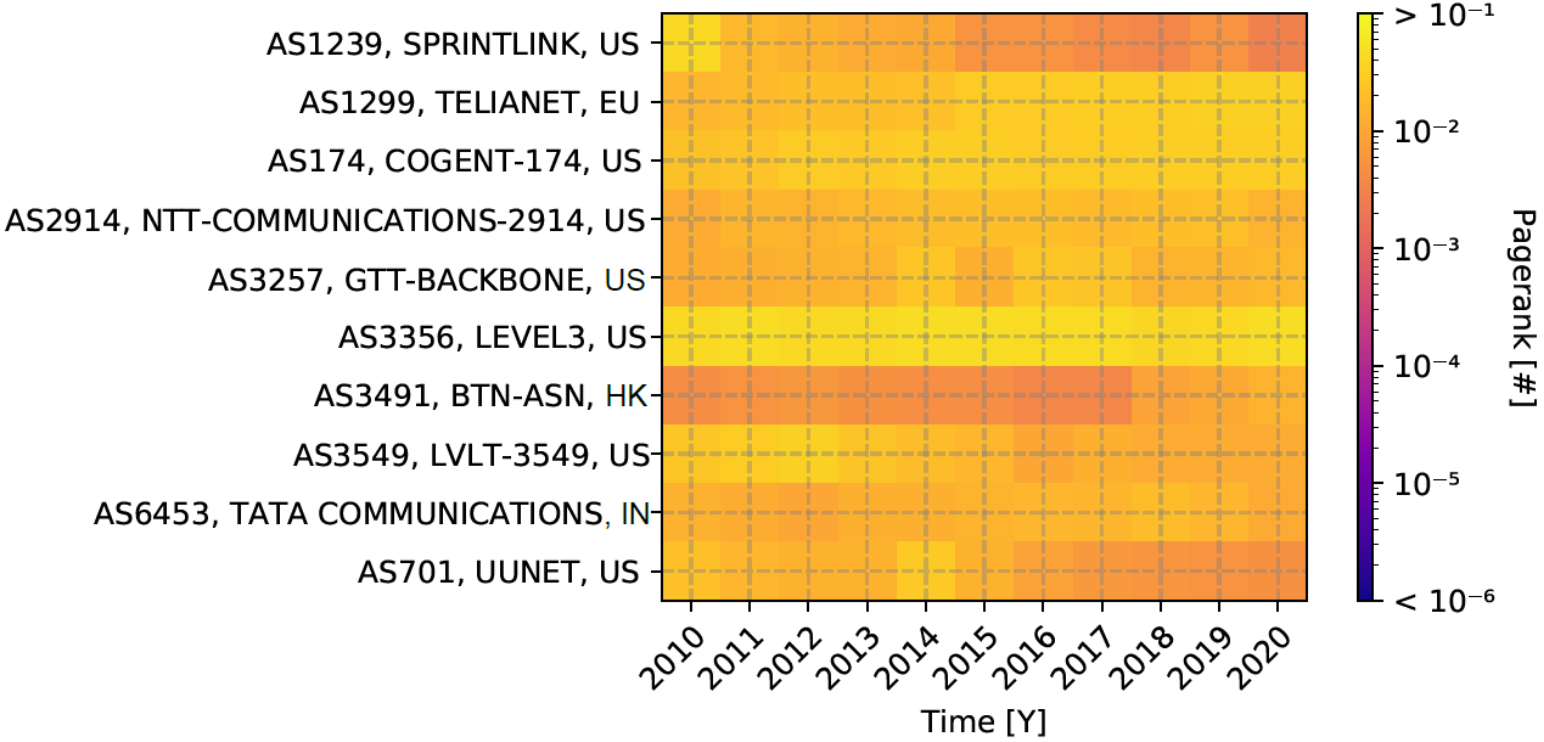
Increase presence in national access, enlarge consumer base

USP: Exclusive customer access

Customer Cones: Accumulated Top 5 ASes

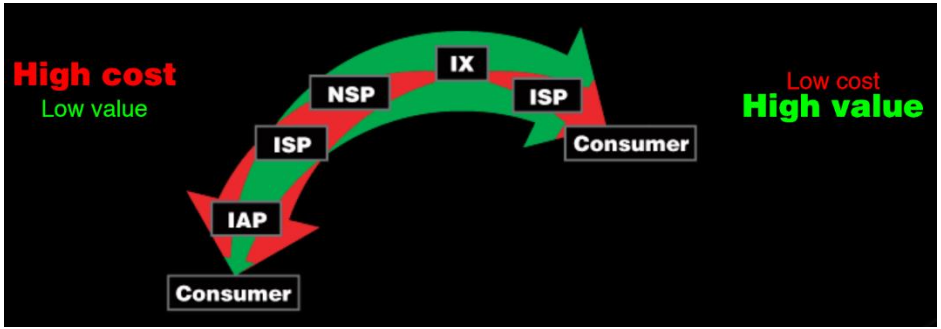


C2P Pagerank: Accumulated Top 5 ASes



Internet Exchange Points (IXPs)

IXPs exploit locality – they have highest gain, where neighbors shortcut transit



Utility of an IXP is larger the closer to consumers

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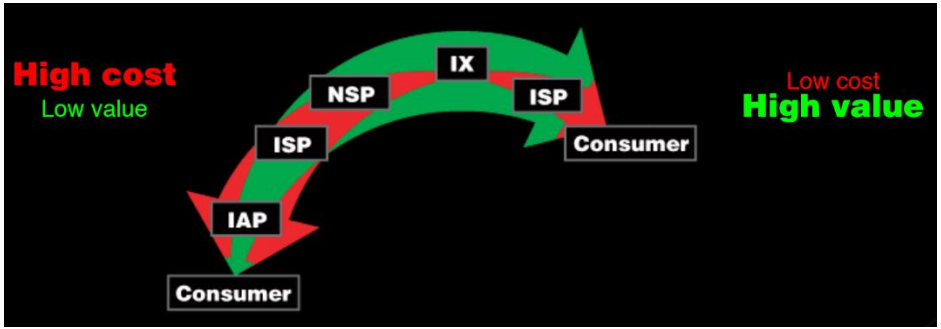
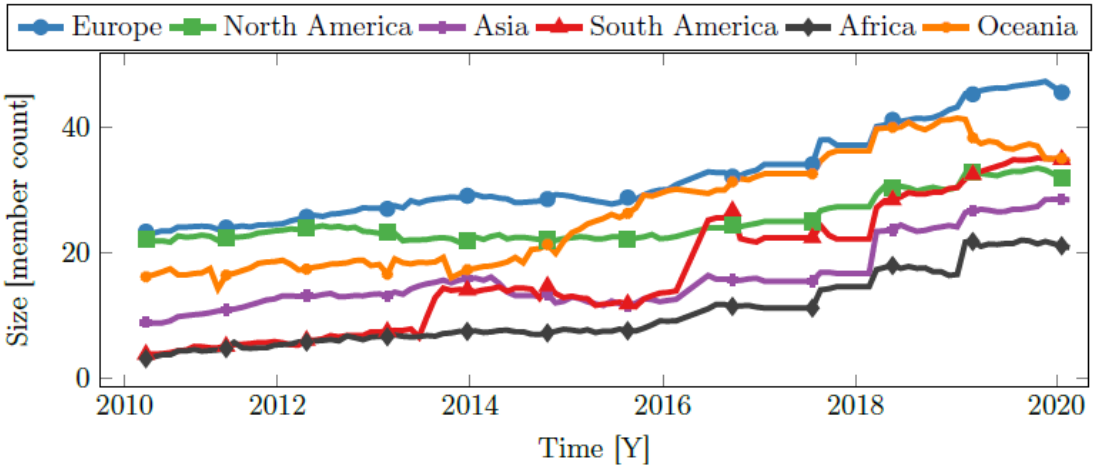


Utility of an IXP is larger the closer to consumers

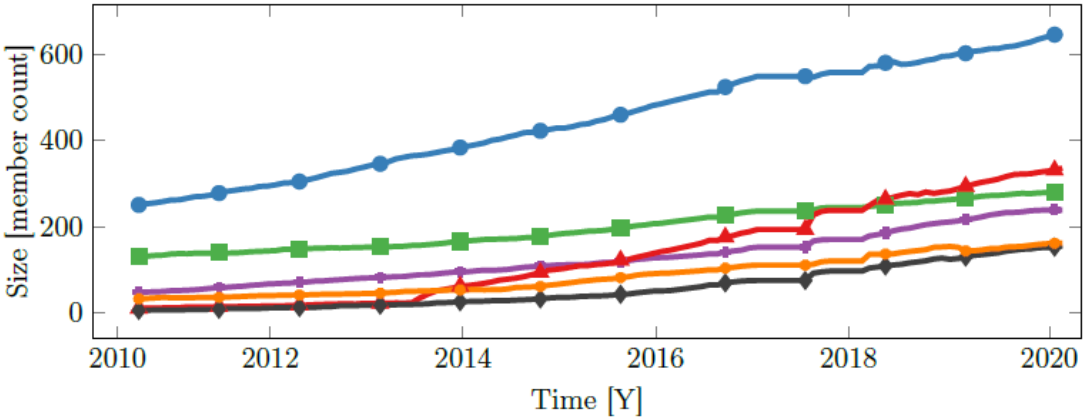
“A cheap IX is probably a successful one.
An expensive IX is always a failure.”
-- Bill Woodcock, PCH

Global IXP Growth

In Europe, a small number of very large IXPs has emerged, which grow well above average



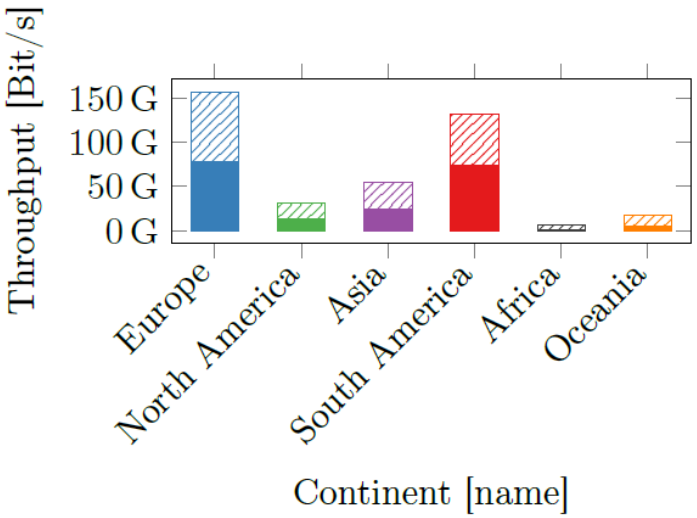
(a) All IXPs



(b) Top five IXPs

Global IXP Throughput

Europe and South America (Brazil) take a different scale than the other continents



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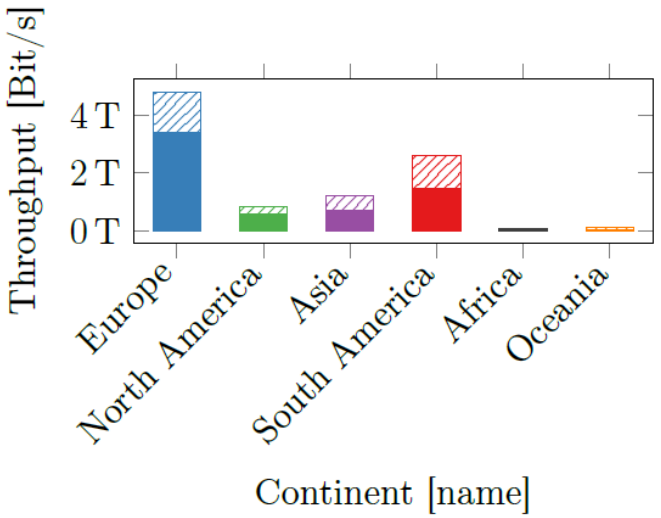
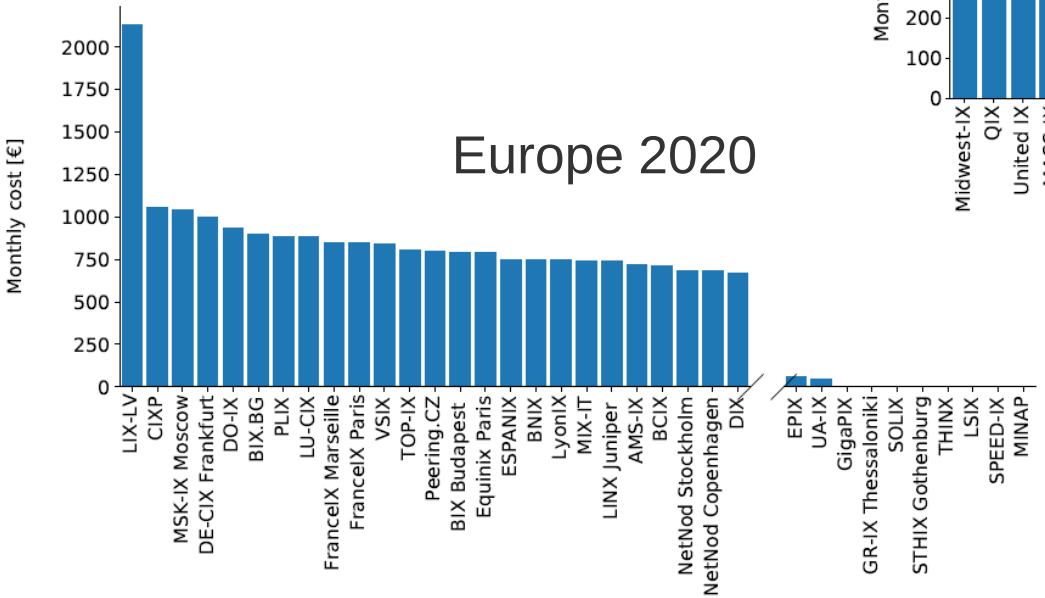
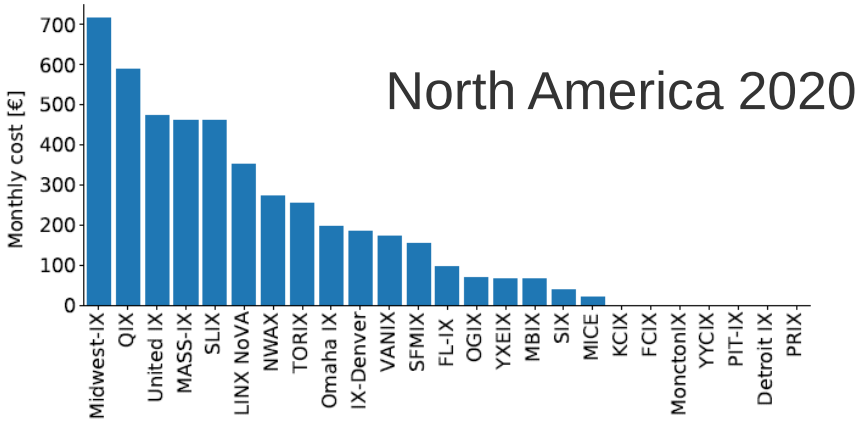


(b) Top five IXPs by throughput

Global IXP Costs





NETWORK ACCESS

The Problem of Coverage & Competition

Provisioning of network access infrastructure is a challenging business outside metropolitan areas

Traditionally, public telephone monopolies provisioned basic network services – those were split up in the western countries

Network infrastructure w/ last mile coverage remains monolithic

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Network infrastructure w/ last mile coverage remains monolithic

How to organize a provider market that

- continuously invests into state-of-the-art access technologies?
- maintains and develops network coverage also in rural areas?
- allows for plurality in the last mile without replicating infrastructure?

The US Case

The US telephone monopolist AT&T was split up in 1984

- Seven independent regional Bell Operating Companies (Baby Bells)
- AT&T remained as long distance telephone company

➔ Geographic split w/o competition at consumers

Since then

- Southwestern Bell bought three other Baby Bells and later AT&T
- Atlantic Bell bought the remainders and formed Verizon

➔ Two large companies monopolize area-wise most of the US

Today, 50M households (40 %) only have a single provider choice

The German Case

Deutsche Telekom (DTAG) lost the network monopoly in 1996

Per law, the access to cable infrastructure was regulated

- DTAG kept its cables, but had to open access at regulated prices
- DTAG had to sell the TV cable network (CATV)

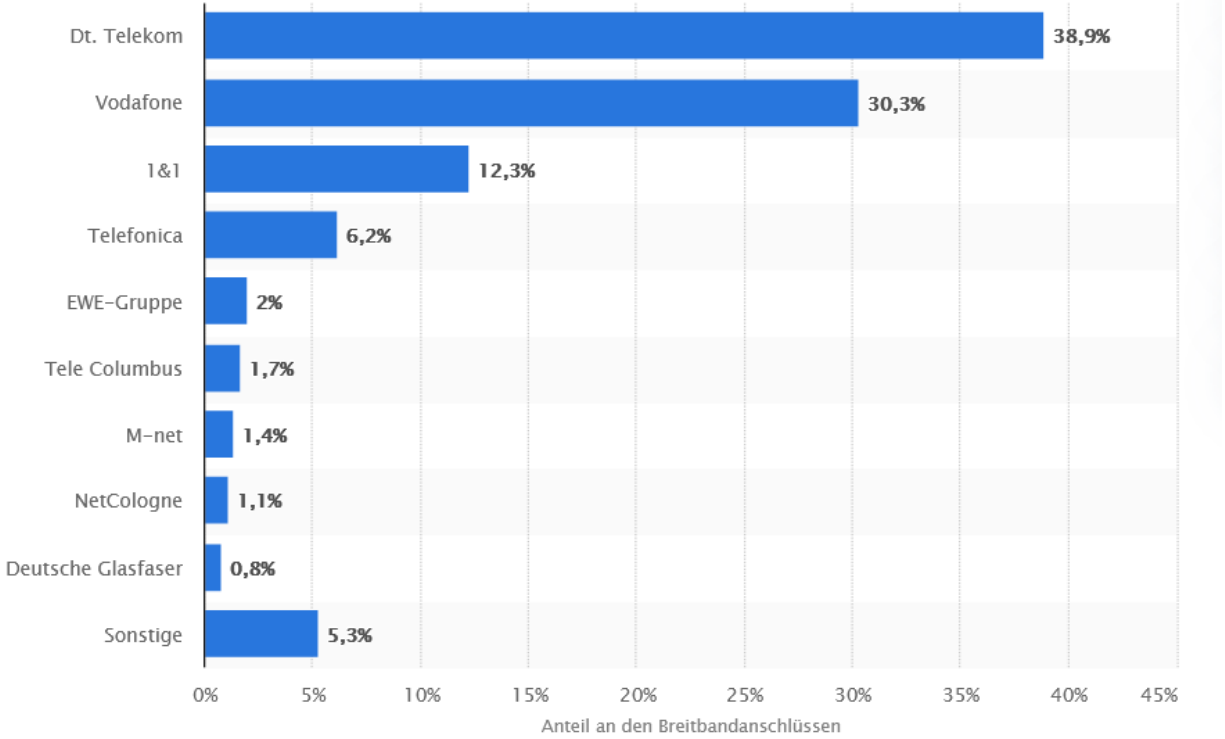
➔ Horizontal split across all last miles, competition at consumers

Since then

- Pluralistic network access at nation-wide prices
- TV cable network partly monopolized with Vodafone

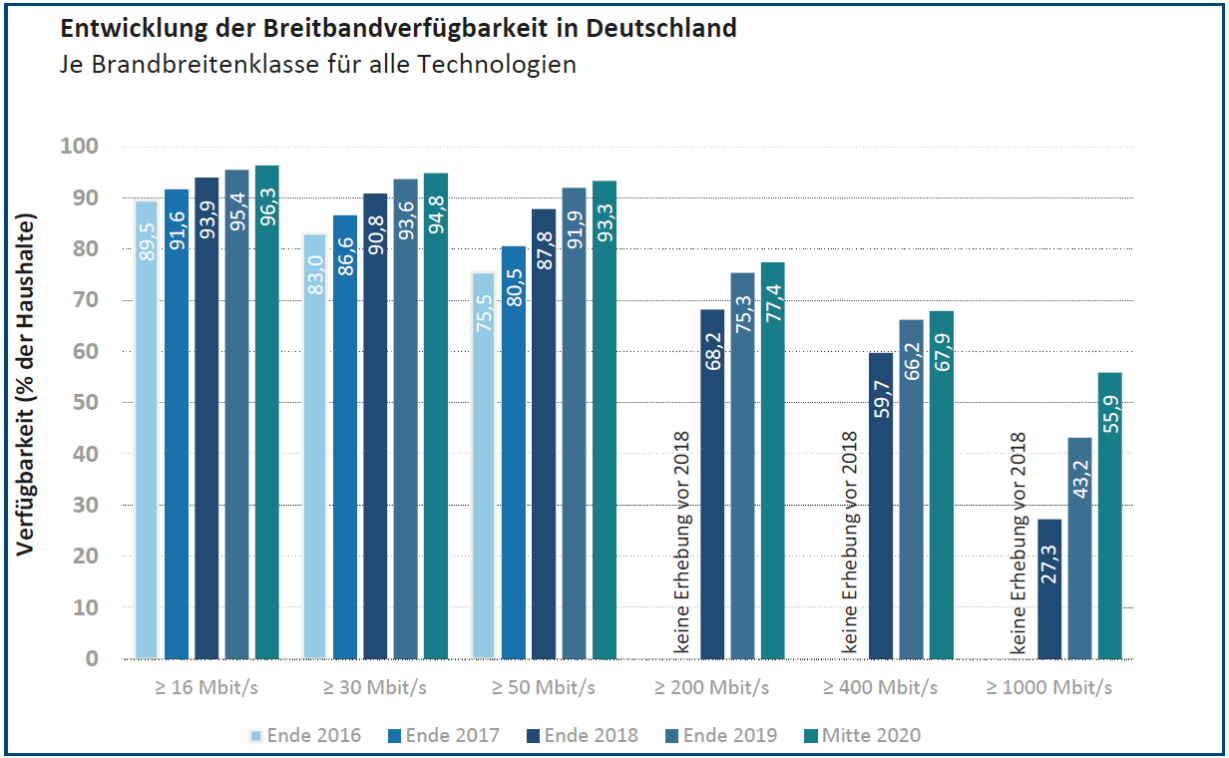
➔ Diverse ecosystem of (partly regional) providers, relevant newcomers

Broadband Access: German Market Shares (2020)



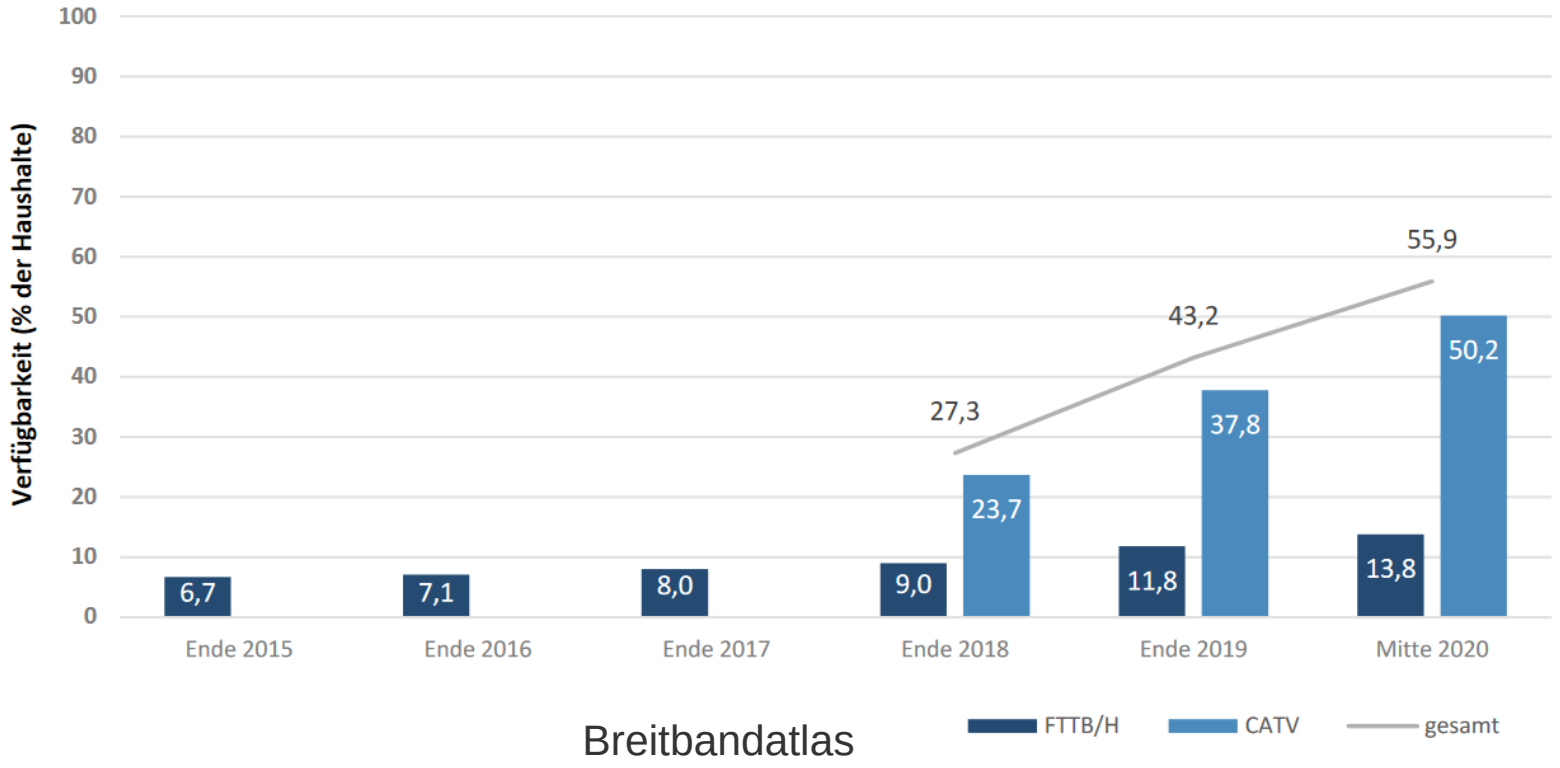
Statista

Broadband Access



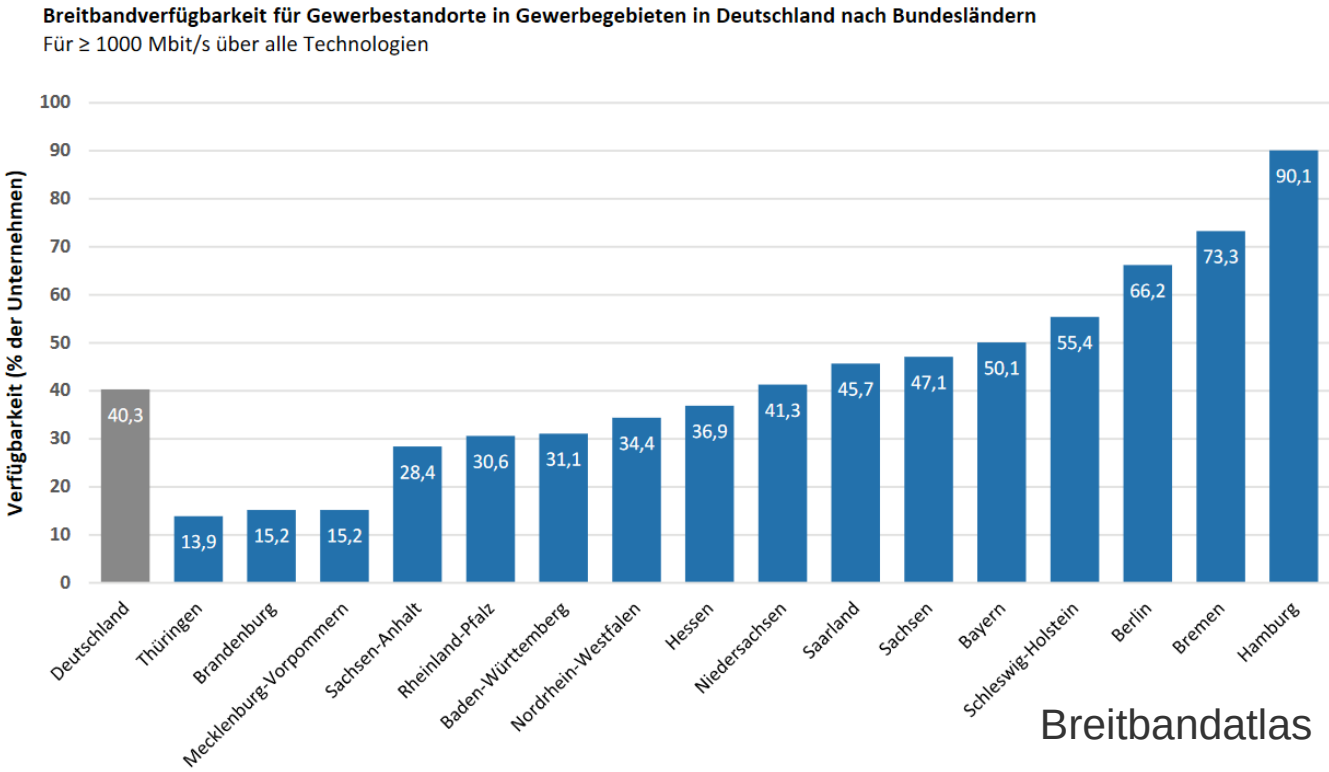
Breitbandatlas

Gigabit Access



Breitbandatlas

Gigabit Access in Industrial Zones



INTERNET APPLICATIONS

Content Delivery Networks (CDN)
Cloud Infrastruktur Platform Services (CIPS)

CDNs and CIPS manifest the concept of global centralization

- Akamai dominates revenue
- Google and Tencent dominate growth
- Emerging competition: CIPS for IoT – currently dominated by Amazon

In 2019, 43% of the global Internet traffic was delivered by Google, Netflix, Facebook, Microsoft, Apple, or Amazon

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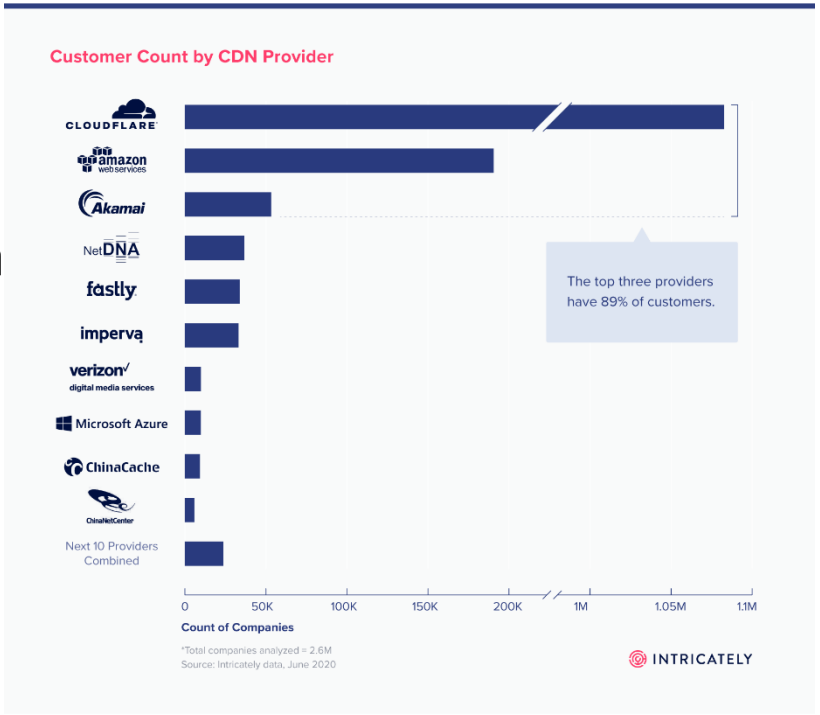

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End Systems

Operating Systems hold a key role in shaping the user interaction with the Internet

- First realized by Microsoft (late 90es) to kill Netscape
- Sophisticated by Apple's App store 2007
- Rebuilt by Google: Android, Google Play, Chrome ... Gmail, Quic, DNS, CT, ...

CAVEAT: The (pseudo-)HAL and its APIs of the OS may enforce undesired network use

Proprietary Applications and APIs

> The growing use of APIs puts more of the Internet innovation, functionality, and interoperability into the hands of the dominant Internet platforms, whose interests may not always align with those of the broader technical community and other players.
>
> - Internet Society

Digital Gatekeepers:

platforms to dominate markets

Social Networks & Media:

platforms to tie in users

Proprietary Communication Services:

platforms to monopolize user data

APIs owned by end systems or application platforms abstract open Internet standards away

SOCIAL IMPACT

Internet Access as Basic Service

Continuous access to the Internet has become essential in many areas of our lives:

- Information, education, social participation
- Various commercial & professional activities
- eGovernment & international exchange

Broadband Internet access today is limited in many countries, rural areas, and by social, economical, and age factors: Lack of options, knowledge, or interest leads to a ‘digital illiteracy’ in parts of our world.

Society faces a Digital Divide with increasing tension

Digital Divide

Children in urban areas are exposed to the digital world almost from the time they are born. However, children in tribal, rural communities may never even have access to primary education, let alone the digital world.

- Amit Chakravarty, ICRISAT

A significant number of people have no access to the Internet. Main reasons are:

- Lack of provider access
- Service cost
- Lack of end systems

Majority without Internet are children and young adults in rural areas

- Strongly correlated with educational deficits
- Excludes from public participation
- Leads to social marginalization

Economical, Political, and Social Divide

Broadband access opens business potentials

- Increased access boosts economy of rural places and neighboring regions

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- Brexit voting in Britain showed this pattern

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Successful careers most often require broadband Internet, leaving undersupplied regions behind:

- Separating the elderly and the deprived

Safety and Disaster Management in an IP World

Emergency calls and safety alerting are integral, protective contributions of a country

- Traditional infrastructure was dedicated and vertically integrated
- Today, this is replaced by a horizontally structured all-IP-world

The horizontal, pluralistic IP system makes vertical infrastructure assurances difficult

New standards are needed to enable an integrated emergency management

Internet Architecture for Emergency Calls

An incoming emergency call requires

- Locating the caller
- Mapping location to the responsible first responder
- Setting up the call with the local authority

All without active assistance of the emergency caller

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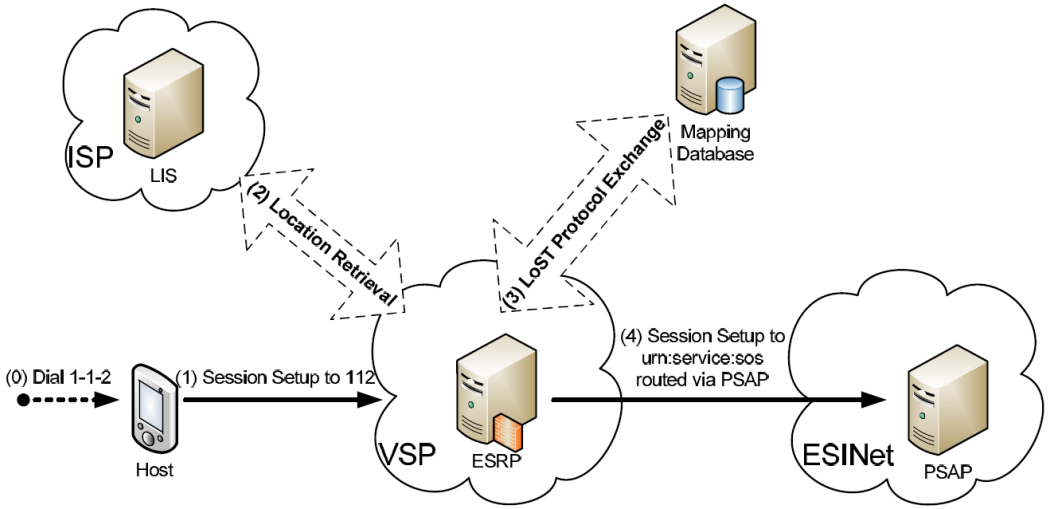


Hannes Tschofening

Security of Alerting Authorities

A horizontally integrated, pluralistic system requires effective security measures on each layer

This calls for thought- and careful operative procedures

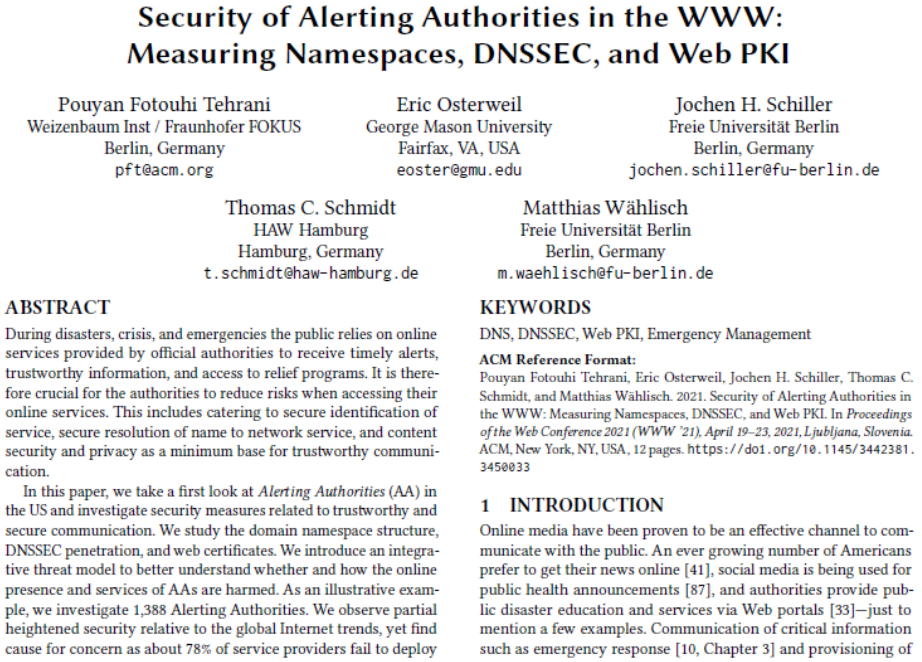
Unfortunately, reality does not reflect these demands: alerting authorities are run as sloppy as any Internet service

DNS		Certificate			
Restricted delegation	Supports DNSSEC	DV	O/EV	Assurance profile[1]	# Names
✓	✓	–	✓	●	29 (≈ 2%)
✓	✓	✓	✘	◐	11
✘	✓	–	✓	◐	2
✓	✘	–	✓	◐	132
✘	✘	–	✓	◐	117
				Total:	262 (≈ 20%)
✓	✘	✓	✘	○	354
✘	✘	✓	✘	○	482
✘	✓	✓	✘	○	3
✓	✓	✘	✘	○	2
✓	✘	✘	✘	○	67
✘	✓	✘	✘	○	2
✘	✘	✘	✘	○	126
				Total:	1036 (≈ 78%)
				Grand Total:	1327

[1] ● strong, ◐ weak, ○ inadequate (see Table 1)

Analysis of Alerting Authorities

Pouyan Fotouhi Tehrani, Eric Osterweil, J. Schiller, T. C. Schmidt, M. Wählisch, **Security of Alerting Authorities in the WWW: Measuring Namespaces, DNSSEC, and Web PKI**, **In:** *30th The Web Conference (WWW'21),* p. 2709–2720, ACM : New York, USA, April 2021.



Security of Alerting Authorities in the WWW: Measuring Namespaces, DNSSEC, and Web PKI

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ABSTRACT

During disasters, crisis, and emergencies the public relies on online services provided by official authorities to receive timely alerts, trustworthy information, and access to relief programs. It is therefore crucial for the authorities to reduce risks when accessing their online services. This includes catering to secure identification of service, secure resolution of name to network service, and content security and privacy as a minimum base for trustworthy communication.

In this paper, we take a first look at *Alerting Authorities* (AA) in the US and investigate security measures related to trustworthy and secure communication. We study the domain namespace structure, DNSSEC penetration, and web certificates. We introduce an integrative threat model to better understand whether and how the online presence and services of AAs are harmed. As an illustrative example, we investigate 1,388 Alerting Authorities. We observe partial heightened security relative to the global Internet trends, yet find cause for concern as about 78% of service providers fail to deploy

KEYWORDS

DNS, DNSSEC, Web PKI, Emergency Management

ACM Reference Format:
Pouyan Fotouhi Tehrani, Eric Osterweil, Jochen H. Schiller, Thomas C. Schmidt, and Matthias Wählisch. 2021. Security of Alerting Authorities in the WWW: Measuring Namespaces, DNSSEC, and Web PKI. In *Proceedings of the Web Conference 2021 (WWW '21), April 19–23, 2021, Ljubljana, Slovenia.* ACM, New York, NY, USA, 12 pages. https://doi.org/10.1145/3442381.3450033

1 INTRODUCTION

Online media have been proven to be an effective channel to communicate with the public. An ever growing number of Americans prefer to get their news online [41], social media is being used for public health announcements [87], and authorities provide public disaster education and services via Web portals [33]—just to mention a few examples. Communication of critical information such as emergency response [10, Chapter 3] and provisioning of

Content Consolidation: The Rabbit Whole

Content platforms aim at maximizing user participation time

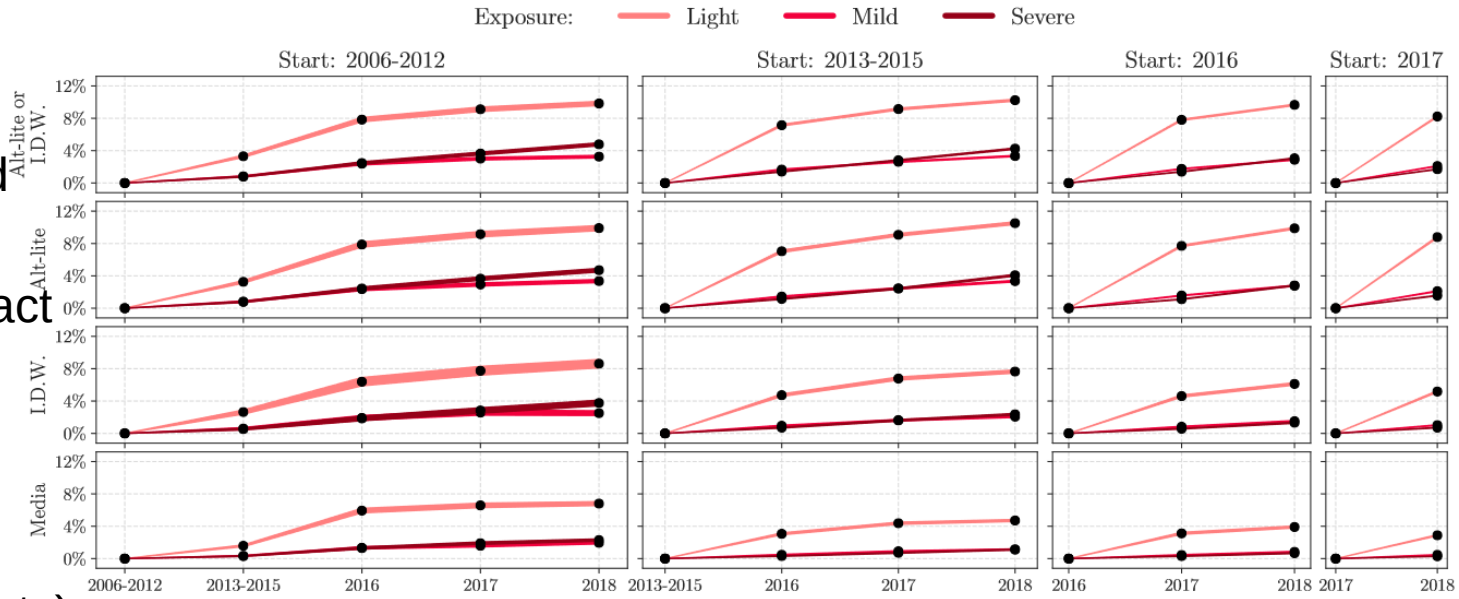
- Use recommender systems to keep people interested
- Use larger content jumps to avoid boredom
- Use reinforcement learning to maximize excitement

This is reported to cause severe lock-ins of users – into a ‘Rabbit Whole’

Recommender Impact

Transitions of different content consumers toward alt-right content after the first contact with this content.

Differentiated between intensity levels:
Light (1-2 comments), Mild (3-5 comments); Severe (6++ comments). Effectiveness of recommendation system seems established in 2016.

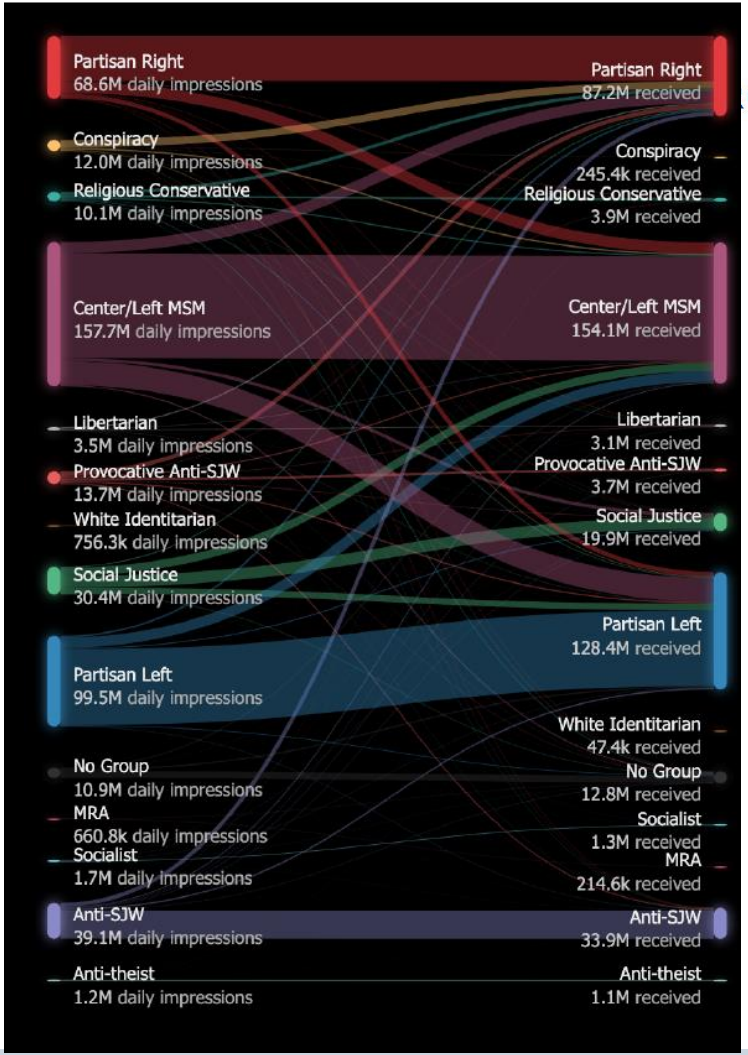


Youtube Recommender Flows

A 2019 study by Ledwich and Zaitsev analyzed user transitions between 800 categorized political channels

Authors observed a theme-specific recommendation avoiding dubious channels s.a. Conspiracy

The contrast to previous studies suggests Google’s manual interference



Network Neutrality

Principle that Internet service providers (ISPs) must treat all Internet communications equally

Non-discriminatory forwarding of traffic, no blocking or slowing down, no specific charging

Regulatory issue:

US: “Save the Internet Act” (pending)

EU: “Regulation for laying down measures concerning open internet access and retail charges for regulated intra-EU communications” (2015/2020)

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