

# Networks, Standards & Interoperability

The speed of innovation in the next 5-10 years will challenge the general purpose, global reach and interoperability of the Internet.



## Overview

The Internet has always evolved, both in its technologies and how we use it. The standards that define its shared protocols also change, and produce freely available specifications. Yet, these same standards will be challenged in the future by the sheer speed of innovation.

As the Internet has evolved and grown — with some parts optimised for certain traffic patterns or expected uses — it has always retained several key properties including general purpose, global reach and interoperability, and absence of central authority.<sup>1</sup> This notion of general purpose means that the Internet is not designed for just one application, but as a general infrastructure on which new applications could be conceived — without permission.<sup>2</sup> As wireless platforms become the access technologies of the future, these basic properties of the Internet will be under pressure.

This “general purpose” Internet is facing three growing pressures: ubiquitous connectivity; significant changes at the edge of the network (including the devices and applications that generate and use traffic); and the decline of traffic that is passed between backbone networks operated by different entities.

Taken together, the evolving edge, the dominance of wireless access, and the decline in transit may put pressure on the general-purpose, open Internet and its ability to support ongoing evolution and

innovation. These developments demand attention to ensure they do not create conditions that forestall industry competition and reduce the choices and opportunities available to Internet users.

**The proliferation of connected systems and wireless devices will bring ubiquitous connectivity, letting users roam seamlessly across networks, without even being aware of it.**

**The network edge will become more complex, with many and varied devices connecting to new services using specialised networks. These new technologies and services — such as IoT — are reshaping and putting pressures on the general-purpose Internet.**

**The nature of transit will change due to the increasing use of Content Delivery Networks (CDNs), caching and other specialised services that flatten the network hierarchy. This may lead to reduced competition and lack of innovation in the core of the network.**

**Increasingly, developers are relying on proprietary standards which will be a barrier to innovation and interoperability. Open standards development will need to evolve to ensure standards are still relevant in a world of competing proprietary systems.**

<sup>1</sup> <https://www.internetsociety.org/internet-invariants-what-really-matters>

<sup>2</sup> <http://www.internetsociety.org/internet/what-internet/history-internet/brief-history-internet>



## Ubiquitous Connectivity

Mobile access is already the primary way people connect to the Internet in many parts of the world. Emerging technologies and use cases promise to accelerate that trend. Devices that hop seamlessly from WiFi to cellular networks, and technologies such as 5G, will be optimised for uses that put a premium on continuous connectivity no matter where we are. Connected systems and devices — such as actuators and sensors — that comprise the mushrooming Internet of Things (IoT), will increase the number of connections and demand for bandwidth. At the same time, increases in bandwidth will spur the deployment of HD and 4K video, and encourage new uses that have yet to be imagined.

**Overall, our community sees the future trending towards ISPs being able to better meet the bandwidth demands of their users.<sup>3</sup>**

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Connectivity and ubiquitous coverage are the backbone of an inclusive new digital world and a prerequisite for a successful further innovation of services online.

Private Sector, Europe

These increases in scope and scale follow well-established patterns of Internet growth. From an end-user perspective, ubiquitous and increasingly robust connectivity will simply be part of the environment most of the time and for many people. Increasingly, the state of being *offline* will be the exception and may need to be actively sought out.

The future of ubiquitous connectivity is not without challenges. For people to roam seamlessly across different wireless technologies, we will need continued development and deployment of open standards that facilitate interoperability. To ensure that the Internet remains an open, global communications system, network operators will need to stay committed to deploying of core technologies (e.g., IPv6) and best operational practices.

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Will I still be seeking out wireless zones, or having to tote around my own hotspot?

Technologist, North America

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<sup>3</sup> Future of the Internet Survey 2 - Question 2: “How well are Internet service providers (ISPs) able to meet the demand for bandwidth in [RESPONDENT’S REGION]?”



## Evolution of the Edge

Broadly defined, the edge of the Internet includes both the networks and devices within homes and enterprises, as well as the Internet service provider networks that connect those homes and enterprises to the global Internet. The Internet was originally conceived as an end-to-end network connecting peer devices, but services are emerging that are delivered by finely-tuned infrastructure that includes specialised networks and purpose-built services made available via those networks. This evolving edge is rapidly changing how individuals interact with the Internet. It offers the potential of new and exciting interactive applications and services, but also raises challenges for the current general purpose architecture of the Internet.

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The Internet will change from end-to-end to edge-to-edge.

Technologist, Europe

Home networks are supporting a growing number of services that extend far beyond the home and the traditional edge of the network. For example, an individual's home appliances can participate as part of the regional electric power management

system. Health devices in the home can be connected into remote health monitoring systems. Entertainment and personal application data can be stored remotely and accessed seamlessly on demand. These systems are completely independent of each other while using the same underlying network infrastructure of the home. We are only at the cusp of what this new networked environment will mean for innovation and new services.

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The proliferation of “private” IP-based networks that don't use the “public Internet” is going to increase by orders of magnitude. Real-time and other applications (voice, video etc.) are latency intolerant and need a certain quality of service. Think “all bits are created equal, but some bits are more equal than others”. Unless the “public Internet” can incorporate and adapt to other use and applications, private networks (IP networks that are not end to end and don't use BGP or DNS) will continue to be deployed — and its already happening.

Technologist, North America



These new services are changing what we traditionally considered to be the edge of the network. They often run on special hardware, and are typically delivered using cloud infrastructures and CDNs connected via customised connections. Connected sensors or devices, part of the IoT, make use of intermediary hubs or proprietary protocols. They are also tied to dedicated back-end services rather than being individually addressable on the network. This evolving edge, and its growing complexity of specialised networks and purpose-built services, may create independent islands of connectivity. This could lead to fragmentation of the open, global Internet. If specialised networks dominate the connectivity environment, this will create obstacles for innovation and the deployment of new services and technologies.

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Parastatals (and normal businesses) try to protect their IT infrastructure at the perimeter but BYOD is interfering with their ability to do so and many networks have become porous as a result.

Internet Society Member, Africa

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Businesses want to protect their business models as much as possible – they want to use TCP/IP but not the “public Internet”. Instead, they are establishing private networks and private domains to create control for their own business structures.

Technologist, Asia-Pacific

Related to: [The Internet & the Physical World;](#)  
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## Decline of Transit

Complementary to the evolving network edge, the traditional hierarchy of backbone, access and enterprise networks is flattening. In the past, this hierarchy meant that backbone networks would exchange, or transit, traffic destined for access networks they did not directly connect. However, the increasing use of CDNs and the continuous growth of Internet Exchange Points (IXPs), where traffic is often passed directly to access networks, have reduced the need for transit traffic. Geoff Huston, Chief Scientist at APNIC, referred to this as “the death of transit”.<sup>4</sup>

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There is going to be a gradual scaling up of networks to carry the increasing traffic being generated by users, especially video content.

Government, Africa

While these changes improve performance — by reducing latency and jitter — for end-users and lower costs for large-scale service providers, the

cost of implementing capabilities such as CDNs and other close-to-the-edge service points puts smaller or emerging service providers at a disadvantage. For example, large on-demand video providers can establish caches close to their users to provide better quality service. This trend may lead to consolidation and reduced competition in service offerings.

The potential implications include reduced innovation in long haul networks and lack of choice for consumers. Ensuring a healthy competitive ecosystem is crucial to ensure that we have the necessary infrastructure for the next generation of permissionless innovation.

Respondents from Africa and Asia reported a significant trend toward greater use of the global, public internet, while respondents from Europe and North America see a significant trend toward greater use of closed, access-limited, or private IP networks.<sup>5</sup>

Related to: [The Internet Economy](#)

<sup>4</sup> Geoff Huston, APNIC, is widely credited for identifying the “death of transit” and its implications for the global architecture of the Internet. <https://blog.apnic.net/2016/10/28/the-death-of-transit/>

<sup>5</sup> Future of the Internet Survey 2 - Question 36: “To what extent are private or closed Internet Protocol-based networks being deployed or used for services in contrast to IP-based networks that are fully connected to the global, “public” Internet?”



## Innovation and Standardisation

Open and voluntary standards have long been at the core of the Internet's success. They will, however, be challenged in the future by the speed of Internet innovation, the complexity of the emerging infrastructure and services, and the emergence of proprietary systems and walled gardens. Standards development processes are also under increasing threat from companies that can use their powerful market presence to create de facto standards, bypassing open standards processes and risking fragmentation.

Established approaches to formulating Internet standards must evolve if they are to remain relevant going forward. Simply put, the challenge for established standards organisations and processes includes engaging the innovators who either do not see the benefits of standardisation, or for whom the process of standardisation is too cumbersome.

Related to: [The Internet & the Physical World](#); [The Internet Economy](#)

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Optimistically the (so-called) “Internet of Things” (so-called) will have faded in significance, as the Internet itself simply continues to expand with increasing numbers and varieties of connected devices. Successful manufacturers of these devices will have embraced the Internet ecosystem, in terms of open standards, Internet best practices, and appropriate measures to ensure security and longevity of their devices.

Technologist, Asia-Pacific