



An Introduction to Internet Interconnection Concepts and Actors

Briefing Paper

Introduction

The Internet is sometimes referred to as the “network of networks.” This expression reflects the very origin of the Internet as the interconnection between existing networks. The possibility of easily generating new interconnections with high bandwidth at a reasonable cost has been one of the key elements that allowed the fast evolution of the Internet in the last twenty years and it is central to the continuous growth of the network. A good interconnection not only has technical benefits, but it also allows innovation, attracts investments, and fosters the local ICT (Information and Communications Technologies) community.

In the past, Internet interconnection for most developing countries consisted of only an international link (normally to the United States or Europe) that needed to be upgraded on a regular basis. Today, local networks in developing countries have matured, not only in their infrastructure, but also in their integration in the global Internet. Diverse and reliable interconnections can give these networks benefits such as: reducing costs by avoiding the use of expensive international links for purely local communications, improving users’ experience by reducing the time needed to obtain content (improving the responsiveness of the network), and helping to attract new investments in the ICT sector. Achieving a successful interconnection plan for any organization involves skills in network engineering, telecommunication business, regulations, negotiation, and entrepreneurship.

Before embarking on the opportunities and challenges of interconnection, it is important to identify the different actors that are involved:

- **Internet service providers (ISPs):** These companies normally own last-mile networks that bring Internet access to the end-users. They use a great diversity of technologies such as wireless, digital subscriber line (DSL), or cable-modem. ISP residential customers both consume and generate Internet content.
- **Content providers (CPs):** CPs act as content factories. A CP may have presence only in a small number of data centers around the globe. However, in the last 5 years, many CPs have decided to increase traffic distribution by installing new nodes in different countries or using Content Delivery Networks. Examples of CPs include media companies (distributing films, music, or videos), streaming services, e-Government, e-learning, e-commerce, social networks, or software companies that use the Internet to distribute their products.
- **Regional/global transit providers:** These networks are usually global providers of connectivity. They normally provide access to the global Internet for ISPs, allowing them to access distant networks.



- **Content delivery networks (CDN):** CDNs act as local warehouses for content. CDNs have servers in many data centers distributed around the globe and their main customers are CPs. An example of how CDNs are used is when a software company is about to release a new version of popular software. By hiring a CDN to distribute its content, CPs can cope with very high, short-term demand from end-users without needing to own infrastructure around the world.
- **Internet exchange points (IXPs):** IXPs are meeting points for all entities to facilitate interconnection. At the IXPs, everybody shares a common infrastructure, thus it is simple and, in most cases, inexpensive to access high speed connections at an IXP. The availability of IXPs is central to allowing more affordable local, regional, or international interconnection, particularly for the smaller networks.
- **Infrastructure operators:** Interconnections need availability of infrastructure such as datacenters and data transport (local, regional, or intercontinental).
- **Private companies and/or universities:** These organizations normally interconnect in order to improve their Internet access by adding multiple providers and reducing their access costs.

These definitions may not suit every environment as organizations may take more than one of the defined roles. As an example, an organization may act as both an ISP and an Infrastructure Operator.

These actors have different strategies when searching for the best partners to interconnect with. For example, when a CP, or a CDN, interconnects with an ISP, a more direct and efficient path is established between the end-user and the content thereby reducing network latency (delay). In the case of Peer-to-Peer (P2P) traffic, where content is originated by end-users, direct interconnection of ISPs ensures that the most cost efficient and optimal route is used.

Two questions arise in any interconnection negotiation: How will the data be transported between the two parties? And what will be the commercial terms of the relationship?

The first question normally involves agreements between the ISPs and Infrastructure Operators. The abundance of Infrastructure Operators, providing diverse options for metropolitan, regional, and international transport capacity has been shown to have a significant impact in increasing the availability of Internet interconnection at lower costs. It is worth mentioning that the price paid for the international transport is not proportional to the distance that the information needs to travel. There are cases where the short distance over a national network to

access the undersea cables (called back-haul) can be more expensive than the international long-haul.

The commercial terms of an interconnection relationship fall into two broad categories: transit and peering. Some transit providers, are international networks that have the ability to move packets across the globe. At the time of this writing, there are at least 30,000 different organizations that could be interconnected. As direct interconnections are not feasible, networks normally pay a third party (a transit provider) for the service of accessing the networks to which they are not directly interconnected. This defines a “transit” relationship. The price that ISPs pay for transit has been steadily dropping in the last 20 years. However, cost varies from one region to another based on many factors, including the effort of moving the traffic to that region.

The alternative to the transit relationship is the “peering” relationship, where separate networks voluntarily interconnect to exchange traffic to and from their own customers. Peering may have no cost to both parties (settlement-free or bill-and-keep) or may have a cost that’s lower than transit (fee-based peering). There are some other special commercial relationships that define the scope of traffic to be exchanged, such as partial transit, regional or local transit, and regional or local peering, but it is beyond the scope of this paper to describe these in detail.

Opportunities and challenges

Identifying efficient interconnection options, which focus more on peering and less on transit, provides a more resilient growth model. Without diversifying interconnectivity through peering interconnections, service providers would be limiting their growth to their transit link. New Internet applications such as video streaming, P2P, e-learning, and social networks require a more connected Internet. All in all, interconnections today for an ISP or a CP are no longer a desire but a necessity to sustain the 300% growth of the Internet user base in the last decade.

In tandem, the increased interconnection and lower costs encourage content innovation targeted at the growing online audience. The net effect becomes an increased demand for local and regional hosting solutions and services such as datacenters and collocation facilities. As a result, a complete ecosystem comes into being, with all the main actors creating abundant opportunities for the social and economic growth of the region. However, this is often not always realized due to policy and regulatory challenges.

In countries with expensive Internet services and scarce interconnections, the challenge for governments is to generate an environment that fosters interconnection. Where appropriate,



governments can provide leadership to do so: for example, by ensuring their regulatory and legislative frameworks create an enabling, rather than restrictive, environment. The availability of a competitive metropolitan and national data transport market, the availability of diverse international connection paths, and the availability of datacenters and IXPs are important factors to improve a country's local and regional interconnection. Public policies that help provide ISP choices for technologies and infrastructure operators have been very effective in reducing access costs. On the other hand, public policies that encourage a closed market in any of these areas, or that force traffic to take a particular route, will normally restrict the growth of the interconnection.

In order to initiate this virtuous circle, governments can play an active role in boosting the local creation and localization of content. With an adequate and well-interconnected local content industry or by attracting foreign CPs and/or CDNs, local ISPs will reduce their access costs to content and users' Internet experiences will be improved. Some of the possible public policies in this area could include financial incentives (for example, tax rebates) that favour the creation of local content and local datacenters, promoting a local content industry and the hosting of CDNs.

A well-interconnected Internet market is attractive for investments in the broader ICT sector, particularly from foreign companies looking to serve that area. Regional interconnection is a key component in generating growth as it creates a larger market for local and foreign investors. A well-interconnected region is also an attractive location for hosting critical Internet resources such as DNS infrastructure.

The way forward

A widely interconnected Internet is central for the growth and stability of the network. When the interconnection happens near the end-users, they receive significant benefits in terms of the cost of the Internet access and their overall Internet experience.

In countries at an earlier stage of Internet development, governments can have an important role to play in creating a favorable environment for organizations (and particularly ISPs) to interconnect. The key action for governments is to create regulatory environments that provide choices and flexibility for interconnecting, while also removing artificial barriers, particularly on commercial agreements. The main government tools should be general and permissive in nature, rather than narrow and restrictive. An important lesson learned over the past 20 years is that technology moves fast, so policy, legislation, and regulation have to be as generic and technology-neutral as possible.

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Some considerations may include:

1. Ensuring adequate choice and flexibility for Service Providers in accessing the physical infrastructure necessary for interconnections. Some of the possible action areas may be:

- diversifying the availability of international and regional infrastructure
- ensuring that ISPs have fair and competitive access to the international capacity
- ensuring flexibility in the technology that they use (such as fiber or wireless infrastructure)
- ensuring the availability of adequate datacenter infrastructure, especially neutral datacenters (those that are not run by an ISP or transit provider).

2. Eliminating restrictions and barriers that prevent network operators from entering into robust Interconnection relationships. Particularly not requiring traffic to take a specific path and acting against monopolized environments.

3. Encouraging the deployment of IXPs, which help decrease interconnection costs and keep local traffic local. The importance of IXPs is described in reference [2],[3],[4] and [5].

4. Engaging in regional and sub-regional discussions to help develop policies for the regional interconnections, particularly between neighboring countries referred to as cross-border interconnections.

5. Promoting the localization of content. Either by fostering the local content industry, or by creating the conditions for hosting CPs and/or CDNs.

In conclusion, it has been widely noted that the majority of the next billion Internet users will be from the emerging Internet markets and developing countries. In this regard, the Internet Society believes that interconnection will play a crucial role in enabling access to this next group of users. Further, as the Internet continues to evolve by the emergence of new technologies and becomes more internationalized, efficient interconnections will contribute to its increased resilience, lower latency, lower costs of access, and better end user experiences as a whole.



For further information

The Internet Society has published a number of papers and reports related to Internet Interconnection. These are available for free download on the Internet Society website:

1. The Bandwidth Bandwagon, by Mat Ford, *IETF Journal*, Volume 5, Number 3, January 2010

English: <http://www.isoc.org/tools/blogs/ietfjournal/?p=1488#more-1488>

2. Promoting the Use of Internet Exchange Points: A Guide to Policy, Management, and Technical Issues, by Mike Jensen.

English: <http://www.isoc.org/educpillar/resources/docs/promote-ixp-guide.pdf>

French: <http://www.isoc.org/educpillar/resources/docs/promote-ixp-guide-fr.pdf>

Spanish: <http://www.isoc.org/educpillar/resources/docs/promote-ixp-guide-es.pdf>

3. A Summary Report Promoting the Use of Internet Exchange Points: A Guide to Policy, Management, and Technical Issues (short summary of the article above).

English: <http://www.isoc.org/educpillar/resources/docs/promote-ixp-summary.pdf>

French: <http://www.isoc.org/educpillar/resources/docs/promote-ixp-summary-fr.pdf>

Spanish: <http://www.isoc.org/educpillar/resources/docs/promote-ixp-summary-es.pdf>

4. Report from the IGF Rio Best Practices Session Internet Traffic Exchange in Less Developed Internet Markets and the Role of Internet Exchange Points.

English: <http://www.isoc.org/educpillar/resources/docs/igf-ixp-report-2007.pdf>

French: <http://www.isoc.org/educpillar/resources/docs/igf-ixp-report-2007-fr.pdf>

Spanish: <http://www.isoc.org/educpillar/resources/docs/igf-ixp-report-2007-es.pdf>

5. Briefing paper: Internet Exchange Points (IXPs).

English: <http://www.isoc.org/pubpolpillar/docs/ixps-20090514.pdf>

Arabic: <http://www.isoc.org/pubpolpillar/docs/ixps-20090514-ar.pdf>

Chinese: <http://www.isoc.org/pubpolpillar/docs/ixps-20090514-cn.pdf>

French: <http://www.isoc.org/pubpolpillar/docs/ixps-20090514-fr.pdf>

Russian: <http://www.isoc.org/pubpolpillar/docs/ixps-20090514-ru.pdf>

Spanish: <http://www.isoc.org/pubpolpillar/docs/ixps-20090514-es.pdf>

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