



## **GROWTH OF THE INTERNET AND KNOWLEDGE GRAPH IN EMERGING ECONOMIES STUDY**

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### **The idea of the Internet**

Distributed communications network with no single central point – dates back to the days of the telegraph; however, the real research base was conducted by the US Advanced Research Projects Agency (ARPA) in 1968 to develop a series of protocols or procedures that would allow computers to communicate with each other over a packet network. This set of protocols, published in 1974, is called the Transmission Control Protocol/Internet Protocol (TCP/IP) and is the computing foundation of the Internet.

Why packet networks? In circuit-switched networks, traditionally used for telephones, each time a connection is made, it is exclusive to that connection – it cannot be shared. This results in a waste of bandwidth (think about how much of your last phone call was silence). In a packet network, data is split into packets and sent over different connections (shared with other data packets for other communications) and reassembled in the correct form at the destination. This provides much greater capacity. In fact, with the rise of digital telephony, telephone networks are increasingly using packet networks for voice communications as well, better known as Voice over Internet Protocol (VoIP). Another important aspect of TCP/IP is its simplicity and how it can be layered on top of other digital communications methods, so that networks using different protocols can connect to each other using TCP/IP as an intermediary. This was a major factor in the early days of the Internet, when TCP/IP was used to connect regional networks that used incompatible communications standards.

### **The Growth of the Internet**

The first two nodes to go online were at the University of California, Los Angeles (UCLA) and the Stanford Research Institute. This was in 1969. The Internet initially ran on ARPANET, a small US government backbone network. The primary users were scientists and researchers working for the US government. However, in 1986, the US National Science Foundation (NSF) created NSFNET, greatly increasing the bandwidth to connect five US supercomputer centers. This increase in capacity and expansion of US academic networks effectively opened the Internet to non-governmental participation – first universities and then commercial interests.

This initial investment in the Internet backbone also gave the US a first-mover advantage in Internet usage and bandwidth, and the US still has the largest backbone network capacity in the world. However, other countries, including Norway and the Netherlands, have taken advantage of technology and their smaller size to provide Internet access to more of their populations than the US did. NSFNET's impact on the growth of the Internet can be easily seen in the growth of Internet hosts (i.e., connected computers): less than two thousand in 1985, two thousand three hundred in 1986, nearly twenty-five thousand in 1987, and nearly sixty thousand in 1988. The growth of the Internet continues to be astronomical; as of 2008, there are an estimated half a billion hosts.

### **Connecting Networks**

While the United States conducted much of the initial research into the Internet, other countries also built packet networks and, as those networks grew, connected them to the Internet. The first international connection, ARPANET, was established between the United States and Norway in 1973, followed shortly by a connection between the United States and the United Kingdom. When TCP/IP became the standard Internet protocol in 1982, international connection speeds increased rapidly. At this time, the network was called the "Internet," later shortened to "the Web." There was never any central, coordinated plan for how countries or regions would develop their networks and connect them. Thus, the global spread of the Internet was organic and haphazard—arguably, the very lack of a central organization was a blessing in disguise, allowing the Internet to expand so widely and quickly without being held back by strict standards or plans, or subject to the control of a single agency. Despite this, this rapid, organic growth also underlies many ongoing issues around security, reliability, safety, and information management. A country's ability to connect to the global Internet is dependent on the capacity of that country's own domestic network. For example, much of Africa lacked investment, and so data transmission technologies were very slow and sparse in the early 1990s, limiting international connectivity. This situation has improved; in 1996, the Leland Project, funded by the United States Agency for International Development (USAID), began upgrading parts of Africa's digital infrastructure and thus improving Internet connectivity. This is just one of many projects aimed at expanding Internet access in developing countries.

### **Using the Network**

One of the first applications of the Internet was electronic mail (e-mail), first adopted by ARPA in 1972. Email allowed remote users to send messages to each other, and the success of this application alone was enough to inspire further investment and development. Email was followed by the Telnet network, which allowed users to connect to other computers remotely, and the File Transfer Protocol (FTP), which allowed them to transfer files from one computer to another. These applications, which were initially difficult to use, developed standardized commands and thus became more widespread, especially among communities such as scientists, academics, and librarians. However, they were still not user-friendly in the sense that we understand the term, due to the lack of a graphical interface and mouse control. Another problem was the difficulty of finding and organizing information on the network. Essentially, you had to sift through a long list of UNIX files with truncated or ambiguous names. In 1991, Tim Berners-Lee proposed the concept of the World Wide Web, in which various forms of files located on computer hosts could be represented by a common language (Hypertext Markup Language - HTML) and linked together by a common protocol (Hypertext Transfer Protocol - HTTP). This would allow information to be presented in a more human-readable format, and would also allow information to be linked by semantic, hierarchical, or other relationships in accordance with the creator's intentions.

### **Emerging Economies**

The Internet is a global phenomenon, and much of its technology is distributed and accessible worldwide; however, some important elements, such as bandwidth and connectivity, remain bound by geography or nationality, with richer countries having greater bandwidth and denser networks. Consequently, emerging economies tend to connect to the Internet later than other countries, and in a more limited form.

China was one of the first emerging economies to connect to the Internet, with email connectivity established in 1987. Brazil and India connected in 1990, South Africa and Tunisia in 1991, Cameroon, Ecuador, and Venezuela in 1992, and in 1993 – the year that Mosaic exploded the popularity of the World Wide Web – Costa Rica, Egypt, Fiji, Ghana, Guam, Indonesia, Kazakhstan, Kenya, and Peru all connected. At that time, there were about two million hosts worldwide, and their number was doubling every year.

Internet penetration as a percentage of the population in emerging economies lags behind that of OECD countries, but the growth rate in emerging economies is significantly higher, and the total number of users in emerging economies now exceeds the total number of users in OECD countries. In other words, the Internet is quickly becoming an emerging economy phenomenon.

However, citizens of developing countries are often unable to take full advantage of the Internet's potential. Due to more limited access to computers and less available bandwidth, most citizens of emerging economies are unable to use a number of the everyday household functions available over the Internet (shopping, banking, finding directions, making appointments, and keeping track of current events) that OECD citizens enjoy. And, of course, one of the Internet's greatest strengths—its ability to foster communities of people

who are geographically distant but connected by shared interests and concerns—is denied to the very communities that could benefit most from it: citizens of emerging economies living in isolated towns and villages. This disparity, sometimes called the digital divide, is generally attributed to three factors:

1. **Bandwidth.** Most developing countries do not have the high bandwidth available to consumers in developed countries. The problem is only partly due to limitations of domestic telephone networks, and in fact the rollout of wireless telephone networks in many countries in Africa and Asia is reducing this barrier (and it is surprising how the idea of using a cell phone as a gateway to the Internet is more advanced in many emerging economies than in most OECD countries). However, the international gateways that connect developing countries and regions to the Internet often lack the capacity to support widespread consumer access to high-speed connections. It is important to remember that many of the most valuable information aggregates (health, finance, economics, human rights, etc.) maintained by governments and international organizations are located in OECD countries, and it is necessary to connect to these host networks to gain access to these resources. Without high-speed connections to OECD networks, even with adequate national infrastructure, the real availability of the Internet to developing countries will be limited.

2. **Computer hardware.** In October 2008, it was possible to purchase a high-quality Dell personal computer with monitor for less than US\$500. This is a surprisingly low price, but still far more than most citizens in developing countries can afford. A number of solutions are being used, such as recycling old equipment by donating it to developing countries, the \$100 laptop initiative, the custom of sharing, where one computer can be purchased by a group (for example, through microcredit) and used to serve groups, and the creation of Internet cafes. In addition, the increased use of cell phones and their increased data transmission and display capabilities are also creating a mobile alternative to personal computers.

3. **Education.** Access to education is limited in developing countries, and while generations of children in OECD countries are growing up with school and home life integrated with computer technology, children in developing countries are not having the same exposure. Again, developing countries are overcoming this obstacle by increasing funding and aid to support computers in the classroom and by sending students to study abroad. However, lack of training is perhaps the most significant factor in the digital divide, especially given the explosion of Web 2.0 software that is changing our interactions with the Internet from specific, niche activities to a constant accompaniment to everyday life. The extent to which children and young people become comfortable and comfortable with computer technology is an important social development in the developed world, and the impact that these social changes will have both nationally and internationally, and how they may act as a social divide, is still not clear

### **Internet Libraries**

A library is an access point; in the past it provided access to books and journals, now this access extends to the global information network. The role of libraries begins with providing access by providing computers with Internet connections to local residents. This is a crucial first step, and often the easiest to achieve: the challenges are almost entirely economic: how to obtain the equipment, Internet access, and how to finance the running costs. In developing countries, with a lack of infrastructure and a large rural population, new, lightweight satellite and battery technologies make it possible to equip mobile libraries with computers and Internet connections, and to travel and to isolated rural communities on a rotating basis. There are many examples, including Big Blue in Zimbabwe and the upcoming mobile telecentre in Ghana. Providing these access points is critical, but the needs of developing countries extend beyond providing access, and in many cases other services complement libraries by doing the same. These include commercial internet cafés or even mobile phone networks. The role of libraries extends much further and includes, both at the level of training and education and in the area of political advocacy, aspects that go beyond commercial interests.

For example, the Action for Development through Libraries Programme (ALP), one of the core activities of the International Federation of Library Associations and Institutions (IFLA), considers part of its mission to promote the use of information and computer technologies, including sponsoring training and workshops for librarians in developing countries. However, ALP goes beyond training: it also promotes and supports the creation of library associations to support advocacy and give libraries in developing countries a stronger voice. Like all disruptive technologies, as the Internet becomes more widely used, it is showing the potential

for social upheaval. The Internet as a source of knowledge needs advocates and supporters at the political level to achieve the goal of reducing the digital divide.

Many developing economies are benefiting from the rollout of new high-bandwidth backbones. A prime example is the Education and Research Network of India (ERNET). This network is used by universities, NGOs, government agencies, and other non-profit organizations to meet a variety of research needs. One of the latest projects to take advantage of this opportunity is the Digital Library of India, a portal with over a million books available for free reading to anyone with an Internet connection and the means to display electronic text.

Libraries everywhere are finding it increasingly difficult to cope with the costs of materials such as journals. One result of this increased financial pressure is a growing incentive for open access to journals. It would be wrong to assume that open access is primarily driven by developing economies – even the best-funded Western universities and organisations, such as Harvard University and the Max Planck Institute, support open access. It is equally wrong to assume that developing countries are primarily the recipients of open access research. In fact, in many research fields, such as medicine and social science, researchers from developing countries make significant contributions, and OECD countries also benefit. However, open access is a clear example of the enormous benefit that the Internet can bring to developing economies simply by making so much research accessible to scientists, professionals, government officials and ordinary people. One of the most significant efforts in this area is the World Health Organization's Network for Access to Research Initiative (HINARI), a portal of five thousand five hundred different journals in the biomedical and related sciences that is available at little or no cost to NGOs and other non-profit organizations in emerging economies. Libraries are not simply hosts or distribution points for open access and other digital content initiatives: an internet café can be a library as easily as any other structure. But libraries play a much more important role in advocating for the dissemination of information and the principles that guide content distribution. Just as the provision of low-cost pharmaceuticals in emerging economies required significant advocacy to counter the profit-driven arguments of Western drug makers, so open access requires that advocates confront the publishing industry and work with that industry to support new business models and new means of incentivizing content creators.

Advocacy is a challenging role for libraries in the Internet age. Not all issues are as concerning as open access. In some cases, the laws of the country itself make it difficult to take advantage of the global information network. These laws may be based on religion, cultural customs, or political restrictions designed to discourage dissent. The problem is that any filtering of the Internet is a blunt instrument, and blocking access to information available online will also block people from accessing useful content. Moreover, the rise of Web 2.0 has largely enabled the creation of virtual communities, and, following the usual trend of the Internet, new technologies initially used for casual purposes (such as social networking) are soon used for more serious purposes with real-world consequences. Just as libraries have evolved from traditional structures into databases of digital objects, so too are librarians evolving from custodians of books to prophets and implementers of the possibilities of information and knowledge management on the Internet. The role of the library in emerging economies is no longer simply to be a physical node of knowledge – there are now many nodes: internet cafés, bookstores with satellite TV, a group with a laptop, a person with a mobile phone. The librarian must be a teacher and a conduit for existing resources, and an advocate for keeping those resources available and for continually adding new ones. This presents a whole new challenge for librarians in emerging economies, where they must not only act as teachers, but also acquire the knowledge and experience to help develop knowledge networks.

### **Recommendations**

The Internet is not passive; it drives activity: technology firms, publishers and media companies, governments and non-governmental organizations. As many people have noted, ignoring the Internet is a mistake because it provides a fast, low-cost alternative to traditional models of research, consumption and communication. Moreover, many of the organizations that seek to shape the Internet are large corporations or public sector organizations. Libraries have traditionally seen themselves as independent service providers. There is still some disagreement among economists and productivity analysts about the measurable impact of the Internet on business and education, but it is clear that it has made a huge difference to society, especially in the developed world. There is also agreement that the Internet is a technology that can rapidly

close the development gap between developed and developing economies by enabling access to and exchange of useful information and by connecting virtual communities of interest. The International Telecommunication Union (ITU) lists numerous projects in developing countries that provide numerous examples: doctors sharing information about infectious diseases, teachers gaining information for use in the classroom, entrepreneurs using information about market conditions to help them optimize their businesses.

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