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InfoBrief 2

Understanding the Internet

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The Internet has become one of the buzzwords of the late 1990's. The buzz has also penetrated the development community, leading to numerous projects and initiatives to harness the power of the 'Net.' This InfoBrief explains what the Internet actually is, giving development policy makers and practitioners a grasp of the basic technical concepts. By understanding the basic terminology, practitioners can interact intelligently with cyber-technicians, asking the right questions and distinguishing between 'cyberhype' and what can feasibly be done with the Internet.

Young and often visionary professionals are developing the Internet into the first global *public* data communication network. As more and more people get connected, they are working out new ways in which information can be shared, expertise exchanged and services and products sold through the Internet. They are also developing a new and often confusing language. For example: Some computers are called *servers*, others are *hosts* or *clients*. To complicate matters, they are concocting hundreds of acronyms – TCP/IP, POP, PPP, Kbps, HTTP, HTML, W3, LAN, WAN and so on. As bewildering as the Internet's terminology may be, it is key to understanding the new *cyberspace* that is emerging from millions of linked computers across the world.

Computers, switches, routers, wires and satellites

The Internet is often talked about as if it is only hardware – large numbers of computers, switches, routers, wires, intercontinental cables and satellites. Indeed, the Internet consists of various national and international data communication networks – the high-speed core – and many sub-networks connecting the computers of individuals to Internet service providers. However, the Internet has no physical or organisational form. It is defined solely by the protocols that allow the computers and networks to communicate with each other.

A key feature is that no central organisation runs this hotchpotch of networks. Of course, there are firms who build and exploit them and others that register all the unique Internet addresses. However, all the structures to exploit and manage these networks are loosely organised, and there is no central control. What is more, new sub-networks can be added without reconfiguring the whole system.

Successive *layers of protocols and applications* actually make this jumble of networks work. Using the same data communication 'backbone,' suites of protocols have been developed for various groups. Thus, the basic suite of Internet protocols plays an important role for most of us. Banks and credit card companies, however, use other suites of protocols to operate a global network of automatic teller machines.

Internet protocols

Every form of communication – whether between people or between computers – requires *protocols* to support it. Within the Internet, dozens of such protocols operate simultaneously. The strength of the Internet protocol suite is that it can be placed on top of a wide variety of data communication networks, each with its own different protocols. The key Internet protocols are Transmission Control Protocol (TCP) and Internet Protocol (IP). TCP splits large messages into smaller packets or ‘datagrammes’ that can easily be sent from one computer to another. It also attaches labels to each datagramme so that, on arrival, they can be re-assembled into the original message. IP creates ‘envelopes’ around each datagramme and ‘stamps’ them with the addresses of the sending and receiving computers. Once released, each envelope finds its own way to the destination. The datagrammes and envelopes are helped on their way by routers – ‘intelligent’ computers with maps of the network. The key ideas are that datagrammes travel through the jumble of national and international communication networks independently, and that there is no lasting connection between the two communicating computers.

Communication among computers

What do computers communicate, and how? Data communication networks are organised to handle digital signals. Through the Internet, the sender can share anything with other people – text messages, formatted documents, data sets, graphics, sound and video – as long as they are in digital form.

On the Internet, files are transmitted through *client-server application software*. Normally, information resources and applications are stored on a dedicated computer (*server*). These can be copied, downloaded or accessed from another ‘remote’ computer by using *client* programmes stored on the remote ‘client’ computer (see figure 1). Instead of each computer containing all the resources or applications it requires, the means of accessing them is distributed. This is efficient because the remote client is tiny compared with the total resources and software it can access. What is more, the exchanges of requests and responses between the client computer and the server happen so fast and seamlessly that the two communicating computers actually seem to be connected, even if they are physically far apart.

E-mail

Thus, when a user wants to send an electronic mail, or e-mail, he or she uses an e-mail ‘client’ software (such as Outlook Express, Eudora or Pegasus) to compose the message, to attach an e-mail address to it, and to send it. Then an e-mail server takes over, splits the message into datagrammes, and sends them on their way. The datagrammes finally arrive at another e-mail server where the addressee has a mailbox. After reassembling the datagrammes into the original message, the receiving server holds the message until it is collected.

Electronic mail is the most basic and most-used Internet application. Today, e-mail client software supports basic text formatting as well as MIME (Multipurpose Internet Mail Extension). This allows us to attach files to our messages. The files can contain documents, spreadsheets, powerpoint presentations, sounds and movies – anything in a digital format. E-mail messages are passed through the Internet using a Simple Mail Transfer Protocol (SMTP). E-mail servers receive and store messages using a protocol called Post Office Protocol (POP) – ‘cyber-technicians’ therefore call them POP-servers or just POP’s. Most people do not have a computer that is permanently attached to the Internet – instead, they dial in and connect to the e-mail server of an Internet Service Provider (ISP), which keeps their mailbox.

Besides e-mail, Internet users will encounter many other Internet applications such as mailing lists, online chat, voice- and video-conferencing and the World Wide Web (WWW), usually shortened to

'Web'.

The web: A killer application

While e-mail, mailing lists, newsgroups, file transfer, telnet and others have been around since the mid-1970s, the Web has totally transformed the way the Internet is being used.

Retrieving information from the Internet used to be a lengthy process to determine the location of the file and its format, starting an application to display the file, logging into the right server, opening and reading the file, and logging out. The Web has collapsed all these steps into a single click of the mouse. What in the early days of the Internet took minutes or sometimes hours, now takes only seconds. However, one should never forget that the apparent simplicity of web 'browsing' software (such as Netscape or Internet Explorer) conceals enormous technical power.

How is this possible? The inventors of the Web took a hypertext concept, which had been used for many years in publishing software applications, and designed a HyperText Markup Language (HTML). This software marks text so that it can display formatting and graphics, and make 'hyperlinks' to other documents, data files, or images. They also developed a HyperText Transfer Protocol (HTTP) so that clients and servers can exchange hypertext documents over the Internet. For this, they devised a universal resource locator (URL) that specifies the exact location of the HTML document on the Internet and the type of service requested. They recognised that, if such documents were made available on servers scattered across the Internet, they would create a 'web' of interconnected information that would stretch around the globe. Hence the name World Wide Web.

Within the Web, the URL directs a client's request to a specific web server. The most common URL format for retrieving files is `http://name-server`. Using web servers, any Internet user with a web browser can gain access to information, usually stored on a *web site*. All web sites have an opening menu, a *home page*, which serves as the entry point to the whole site. It normally provides information on the contents of the site and hyperlinks to various directories or folders. The files themselves are usually referred to as *web pages*. It is possible to skip the home page and retrieve a particular web page by adding its exact file name and folder to the URL (`http://name-server/directory-path/folder/filename.ext`).

Since the launch of the Web, both the number of Internet (or, better, Web) users and the technology behind it have developed rapidly and continue to do so. The arrival of web programming languages such as Java and XML have made it possible for Internet users to search for content online, to query databases, and to 'interact' with web pages (online forms). The Web and the avalanche of applications it has engendered have also consigned most early Internet applications to oblivion. In fact, things will change even faster now that computer manufacturers and software companies have started to build powerful Internet 'hooks' into their operating systems and software (such as in Windows '98).

Connecting to the Internet

To use these smart Internet applications, both to offer information (through a server) and to access information (from a client or with a browser), one has to be 'connected' to local, national or international data communication networks. Typically, ISPs arrange the hook-up of institutional servers and Local Area Networks (LANs) that need to be connected continuously to the Internet, mostly via leased lines. They also provide dial-up connections for individuals, usually via the public telephone network using a modem.

A major concern with respect to the connections within and to the Internet is the 'connection speed' or, as it is often called, the 'bandwidth'. In particular, efficient use of the Web requires lots of bandwidth. This is because Web users are 'online', they are directly connected to the Internet.

Five Internet Applications (out of many)

Application	Protocol	Software	What is does
E-mail	Simple Mail Transfer Protocol (SMTP)	Mail server; E-mail client (Eudora, Pegasus, etc.)	Transfers messages and files from one computer to another.
Mailing lists	Management (MLM)	MLM programmes (Listserv, Majordomo, etc)	Enables groups of Internet users to communicate by e-mail.
Newsgroups	Net News Transfer Protocol (NNTP)	News server, news reader (web browser)	Transfers messages to a central server where many people can read them.
File Transfer	File Transfer Protocol (FTP)	FTP server FTP Utility	Copies files to and from a server. Files on a remote server can be changed.
World wide web	HyperText Transfer Protocol (HTTP)	Web server; Web browser	Automatically retrieves documents, graphics, sound, video, data from remote servers.

The user is, so to speak, 'watching' datagrammes being sent (with requests for web pages) and returning (with the requested web pages) to and from servers across the Internet as they happen in 'real time.' As they travel from source to destination, datagrammes pass through numerous devices and communication links, the one with the lowest bandwidth determines the actual connection speed. If this is fast, it seems as if the computers are actually connected and the interaction time is minimal. If the connection speed is slow, the user often waits for long periods before the interactions are complete and the information appears on the screen.

Connection speed is less important for other applications. With these, much of the writing, editing and other file manipulation is done 'offline,' while not actually connected to the Internet. For instance, most e-mail users connect to the Internet for small amounts of time to send and collect messages. The much longer time spent reading, writing, and filing e-mail messages does not require a 'live' connection to the Internet.

International data communication networks are very fast, passing data at rates of 622 megabits per second (Mbps) and higher. This is like transmitting the complete *Encyclopaedia Britannica* in the blink of an eye. Most ISPs have relatively fast Internet connections, ranging from 5 to 45 Mbps, and even higher. The speed of an Internet connection via a local area network depends mainly on the bandwidth of the line to the outside world. Individual users with dial-up connections normally use modems with low bandwidths of 14.4 or 28.8 kilobits per second (Kbps) to connect to their ISP. These bandwidths are sufficient for offline applications, but result in very low connection speeds on the Web. To work the Web comfortably, a minimum bandwidth of 56 Kbps is necessary for up- and downloading files containing text only, and of 128 Kbps or higher, if the files contain graphics or multimedia presentations such as sound and video.

The web is just the beginning

Current technological achievements in the Web arena are only the precursors to future applications of the Internet. Technological developments, the falling retail prices of computer hardware and software, and sharply declining telecommunications costs seem to feed on each other. For instance, the production of new multimedia web applications and web services is being fuelled by the introduction of very fast ISDN and cable connections for home computers.

Recent breakthroughs in glass fibre technology mean that it is now possible to use light to transfer digital files, data, graphics, voice and video. When this technology is introduced, the data load currently being shipped by the entire US Internet backbone could be channeled through a single glass fibre. The expectation is that practical and economically feasible applications of this revolutionary technology will become available in 5–10 years. Its introduction will transform the current Internet backbone into a network of 'fibre glass tunnels' and data paths transporting information at the speed of light.

We can expect the resulting glut in bandwidth at the international level to create a new avalanche of commercial and non-commercial graphics- and multimedia-intensive web services which will fundamentally change the way we currently make use of the Internet.

InfoBriefs focus on the information dimensions of international cooperation, illustrating how investments in 'knowledge' can strengthen the capacities of organisations. InfoBriefs present a mix of institutional case studies and illustrations of practical tools, approaches, and strategies. This brief is based on part of a report written by Rutger Engelhard for the Technical Centre for Agricultural and Rural Cooperation (CTA) in Wageningen. For further information on this brief or others in the series, please contact Peter Ballantyne (pb@ecdpm.org).

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