Chapter 1: Introduction

1.1. History and Development of Internets and Intranets

Internet

Internet is a communication infrastructure useful in exchanging information. It consists of millions of smaller business, academic, domestic, and government networks, which together carry various information and services, such as electronic mail, online chat, and the interlinked web pages and other documents of the World Wide Web.

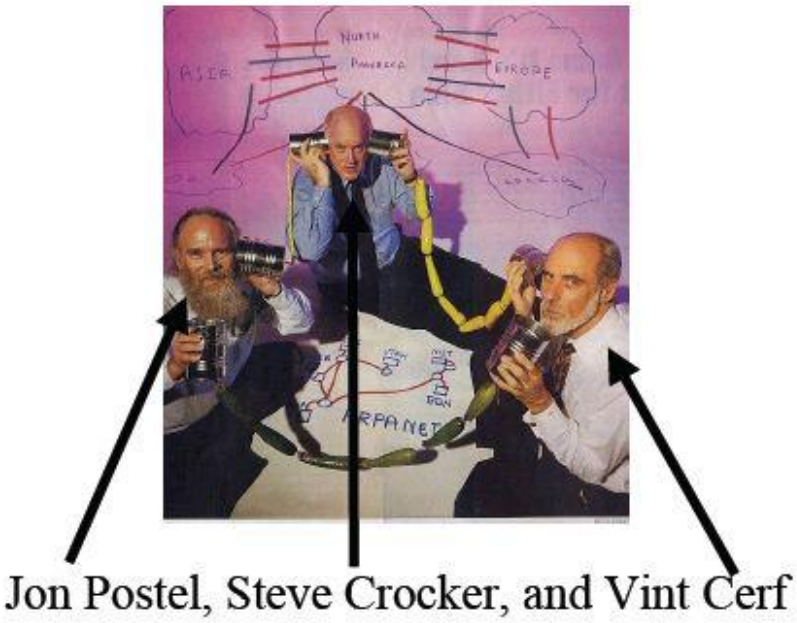
Intranet

Intranet is a private enterprise network that uses internet and web technologies for information gathering and distribution within an organization.

Extranet

Extranet is a community of interest created by extending an intranet to selected entities external to an organization.

History of Internet and Some Internet Applications



Jon Postel, Steve Crocker, and Vint Cerf

Newsweek Aug 8, 1994

- 1950s - Advanced Research Project Agency.
- Late 1960s - ARPA (think tank of Department of Defense (DOD)) introduced ARPANET.
- 1971- Universities added to net, Telnet and FTP are available.
- 1972 - First electronic mail sent.
- 1974 - TCP starts being used for communicating across a system of networks.
- 1982 - US DOD starts building defense data networks based on ARPANet Technology.
- 1983 - ARPANET split into ARPANet and MILNet, Internet now in place, TCP/IP Standardized.
- 1985 - First .com domain name registered.
- 1986 - National Science Foundation (NSF) implements NSFNet, Six supercomputer centers established by NSF.
- 1988 - OSI Reference Model released
- 1991 - Archie and Gopher released.
- 1992 - Internet links more than 17000 networks in 33 countries, 3 million hosts.
- 1993 - World Wide Web released. (Mosaic web browser)
- 1995 - IPv6 proposed.
- 1996 - Hotmail free web-based e-mail.
- 1998 - Google Search, Yahoo! Clubs, Paypal.
- 2001 - Wikipedia.
- 2003 - LinkedIn, MySpace, Skype, iTunes Store.
- 2004 - Facebook, Flicker.
- 2005 - YouTube, Google Earth.
- 2006 - Twitter.
- 2007 - Wikileaks, Google Street View.
- 2008 - Amazon Elastic Compute Cloud, Dropbox.
- 2009 - Bing.
- 2011 - Google++.

1.2. Internet Number Management

Internet Assigned Numbers Authority (IANA)

IANA is broadly responsible for the allocation of globally unique names and numbers that are used in Internet protocols that are published as RFC documents. These documents describe methods, behaviors, research, or innovations applicable to the working of the Internet and Internet-connected systems. IANA also maintains a close liaison with the Internet Engineering Task Force (IETF) and RFC Editorial team in fulfilling this function. It is also responsible for administrating global IP addresses.

Regional Internet Registry (RIR)

A regional Internet registry (RIR) is an organization that manages the allocation and registration of Internet number resources within a particular region of the world. Internet number resources include IP addresses and autonomous system (AS) numbers. Within the Internet, an Autonomous System (AS) is a collection of connected Internet Protocol (IP) routing prefixes under the control of one or more network operators that presents a common, clearly defined routing policy to the Internet.

The Regional Internet Registry system evolved over time, eventually dividing the world into five RIRs:

- African Network Information Centre (AfriNIC) for Africa
- American Registry for Internet Numbers (ARIN) for the United States, Canada, several parts of the Caribbean region, and Antarctica.
- Asia-Pacific Network Information Centre (APNIC) for Asia, Australia, New Zealand, and neighboring countries
- Latin America and Caribbean Network Information Centre (LACNIC) for Latin America and parts of the Caribbean region
- Réseaux IP Européens Network Coordination Centre (RIPE NCC) for Europe, Russia, the Middle East, and Central Asia

National Internet Registry (NIR)

A National Internet Registry (or NIR) is an organization under the umbrella of a Regional Internet Registry with the task of coordinating IP address allocations and other Internet resource management functions at a national level within a country or economic unit.

NIRs operate primarily in the Asia Pacific region, under the authority of APNIC, the Regional Internet Registry for that region.

The following NIRs are currently operating in the APNIC region:

- APJII (Asosiasi Penyelenggara Jasa Internet Indonesia), Indonesian ISP Association
- CNNIC, China Internet Network Information Center
- JPNIC, Japan Network Information Center
- KRNIC, National Internet Development Agency of Korea
- SGNIC, Singapore Network Information Centre
- TWNIC, Taiwan Network Information Center
- VNNIC, Vietnam Internet Network Information Center

The following NIRs are currently operating in the Latin-American (LACNIC) region:

- NIC Argentina
- NIC Bolivia
- NIC Chile
- NIC Mexico
- NIC Brazil

Local Internet Registry (LIR)

A local Internet registry (LIR) is an organization that has been allocated a block of IP addresses by a regional Internet registry (RIR), and that assigns most parts of this block to its own customers. Most LIRs are Internet service providers, enterprises, or academic institutions. Membership in an RIR is required to become an LIR.

Internet Services Providers (ISP)

An Internet service provider is an organization that provides access to the Internet. ISPs directly connect clients to the Internet using copper wires, wireless or fiber-optic connections. Hosting ISPs lease server space for smaller businesses and other people.

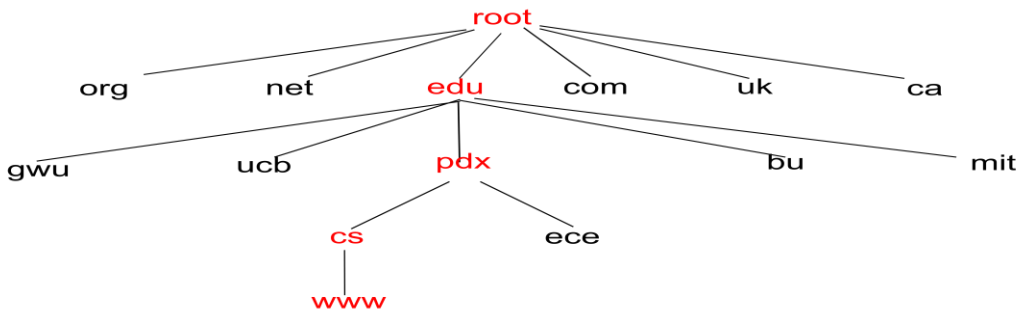
Classified into three tiers, based on size and capacity:

- Tier 1: Big, national backbones of multiple OC-12 - 48; UUNet.
- Tier 2: Large, metropolitan backbones.
- Tier 3: Local ISPs

1.3. Internet Domain and Domain Name System

Internet Domain

Internet domain is a group of end systems on a network that share something in common, such as the function they serve, the organization type they belong to, or their location. Top-level domains include .com for commercial organizations, .edu for educational institutions, .gov for government organizations, or others specifying foreign countries.



Domain Name System

The Domain Name System is a hierarchical distributed naming system for computers, services, or any resource connected to the Internet or a private network. It associates various information

with domain names assigned to each of the participating entities. A Domain Name Service (DNS) resolves queries for these names into IP addresses for the purpose of locating computer services and devices worldwide. By providing a worldwide, distributed keyword-based redirection service, the Domain Name System is an essential component of the functionality of the Internet.

An often-used analogy to explain the Domain Name System is that it serves as the phone book for the Internet by translating human-friendly computer hostnames into IP addresses. For example, the domain name 'www.example.com' translates to the addresses 192.0.43.10 (IPv4) and 2620:0:2d0:200::10 (IPv6).

e.g. http://74.125.224.72/

Ex- Client wants IP for www.amazon.com:

- Client queries a root server to find com DNS server
- Client queries com DNS server to get amazon.com DNS server
- Client queries amazon.com DNS server to get IP address for www.amazon.com

1.4. Internet Access Overview

Accessing the internet

Internet access is the means by which individual terminals, computers, mobile devices, and local area networks are connected to the global Internet. Internet access is usually sold by ISPs that use many different technologies offering a wide range of data rates to the end user. Dial-up connections were popular techniques for accessing internet in the 1980s and 1990s. By the first decade of the 21st century, many consumers had switched away from dial-up to dedicated connections.

Via a standard telephone line, a maximum of two computers can communicate using a modem, in the same way that it is impossible to call two people simultaneously using the same telephone line. This is thus called a point to point link, i.e. a link between two machines reduced to its most simple expression: there is no need to share the line between several machines, each one speaks and responds in turn.

So, many modem protocols have been developed. The first of them allowed a single transmission of data between two machines, then some of them were equipped with error control and with the growth of the Internet, were equipped with the ability to address machines. In this way, there are now two main modem protocols:

- Serial Line Internet Protocol (SLIP): an old protocol, low in controls

- Point to Point Protocol (PPP): the most widely used protocol for accessing the Internet via a modem, it authorizes addressing machines

Serial Line Internet Protocol (SLIP)

It is a simple Internet link protocol conducting neither address or error control, this is the reason that it is quickly becoming obsolete in comparison to PPP.

Data transmission with SLIP is very simple: this protocol sends a frame composed only of data to be sent followed by an end of transmission character (the *END* character, the ASCII code of which is 192). A SLIP frame looks like this:

Data to be transmitted	END

For more information on SLIP protocol, please refer to RFC 1055.

Point to Point Protocol (PPP)

PPP is a much more developed protocol than SLIP (which is why it is replacing it), insofar as it transfers additional data, better suited to data transmission over the Internet (the addition of data in a frame is mainly due to the increase in bandwidth).

In reality, PPP is a collection of three protocols:

- a datagram encapsulation protocol
- an LCP, Link Control Protocol, enabling testing and communication configuration
- a collection of NCPs, Network Control Protocols allowing integration control of PPP within the protocols of the upper layers

Data encapsulated in a PPP frame is called a *packet*. These packets are generally datagrams, but can also be different (hence the specific designation of *packet* instead of datagram). So, one field of the frame is reserved for the type of protocol to which the packet belongs. A PPP frame looks like this:

Protocol (1-2 bytes)	Data to be transmitted	Padding data

The padding data is used to adapt the length of the frame for certain protocols.

A PPP session (from opening to closure) takes place as follows:

- Upon connection, an LCP packet is sent
- In the event of an authentication request from the server, a packet relating to an authentication protocol may be sent (PAP, *Password Authentication Protocol*, or CHAP, *Challenge Handshake Authentication Protocol* or Kerberos)

- Once communication is established, PPP sends configuration information using the NCP protocol
- Datagrams to be sent are transmitted as packets
- Upon disconnection, an LCP packet is sent to end the session

Features supported by PPP

Demand dial: Brings up a PPP interface and dials the phone when packets are queued for delivery; and brings the interface down after some period of inactivity.

Redial: Brings up a PPP interface whenever it goes down, to keep a line up.

Scripting: Negotiates through a series of prompts or intermediate connections to bring up PPP link.

Paralleling: Configures several PPP lines to the same destination and do load sharing between them.

Filtering: Selects which packets to send down a link or whether to bring up a demand-dial link based on IP or TCP packet type.

Header Compression: TCP header compression. Useful on high-speed lines, essential for low-speed lines.

Tunneling: Builds a virtual network over a PPP link across a TCP stream through an existing IP network.

For more information on PPP protocol, please refer to RFC1661.

PPP versus SLIP

- Header compression can be implemented over both. (when SLIP is run with header compression, it is often called CSLIP)
- Since it has no option-negotiation phase during link start-up, SLIP can get under way more quickly and therefore makes better use of connectivity time.
- SLIP has a simpler framing scheme compared to PPP's approach, so its per-packet overhead is lower, which means that the percentage of the link bandwidth devoted to paying transmission is much higher.
- Since SLIP's framing scheme is simple, and since it specifies no finite-state machine to implement and no error checking, it absorbs fewer system resources than PPP.
- Since SLIP is so minimalist in its approach to the problem, it is much quicker to implement and verify than PPP. But the current engineering effort invested in PPP for IP

will pay off in the future, when it will be much easier to plug in support for other protocol families.

Accessing the internet Historic Note

The Internet began as a network funded by the U.S. government to support projects within the government and at universities and research laboratories in the US - but grew over time to include most of the world's large universities and the research arms of many technology companies. Use by a wider audience only came in 1995 when restrictions on the use of the Internet to carry commercial traffic were lifted.

In the early to mid-1980s, most Internet access was from personal computers and workstations directly connected to local area networks or from dial-up connections using modems and analog telephone lines. LANs typically operated at 10 Mbit/s and grew to support 100 and 1000 Mbit/s, while modem data rates grew from 1200 and 2400 bit/s in the 1980s, to 28 and 56 kbit/s by the mid to late 1990s. Initially dial-up connections were made from terminals or computers running terminal emulation software to terminal servers on LANs. These dial-up connections did not support end-to-end use of the Internet protocols and only provided terminal to host connections. The introduction of network access servers (NASs) supporting the Serial Line Internet Protocol (SLIP) and later the Point-to-point protocol (PPP) extended the Internet protocols and made the full range of Internet services available to dial-up users, subject only to limitations imposed by the lower data rates available using dial-up.

Broadband Internet access, often shortened to just broadband and also known as high-speed Internet access, are services that provide bit-rates considerably higher than that available using a 56 kbit/s modem. In the U.S. National Broadband Plan of 2009, the Federal Communications Commission (FCC) defined broadband access as "Internet access that is always on and faster than the traditional dial-up access", although the FCC has defined it differently through the years. The term broadband was originally a reference to multi-frequency communication, as opposed to narrowband or baseband. Broadband is now a marketing term that telephone, cable, and other companies use to sell their more expensive higher data rate products.

Most broadband services provide a continuous "always on" connection; there is no dial-in process required, and it does not “hog” phone lines. Broadband provides improved access to Internet services such as:

- Faster world wide web browsing
- Faster downloading of documents, photographs, videos, and other large files
- Telephony, radio, television, and videoconferencing
- Virtual private networks and remote system administration
- Online gaming, especially massively multiplayer online role-playing games which are interaction-intensive

In the 1990s, the National Information Infrastructure initiative in the U.S. made broadband Internet access a public policy issue. In 2000, most Internet access to homes was provided using dial-up, while many businesses and schools were using broadband connections. In 2000 there

were just fewer than 150 million dial-up subscriptions in the 34 Organisation for Economic Co-operation and Development (OECD) countries and fewer than 20 million broadband subscriptions. By 2004, broadband had grown and dial-up had declined so that the numbers of subscriptions were roughly equal at 130 million each. In 2010, in the OECD countries, over 90% of the Internet access subscriptions used broadband, broadband had grown to more than 300 million subscriptions, and dial-up subscriptions had declined to fewer than 30 million.

The broadband technologies in widest use are ADSL and cable Internet access. Newer technologies include Very-high-bit-rate digital subscriber line (VDSL) and optical fiber extended closer to the subscriber in both telephone and cable plants. Fiber-optic communication, while only recently being used in premises and to the curb schemes, has played a crucial role in enabling broadband Internet access by making transmission of information at very high data rates over longer distances much more cost-effective than copper wire technology.

In areas not served by ADSL or cable, some community organizations and local governments are installing Wi-Fi networks. Wireless and satellite Internet are often used in rural, undeveloped, or other hard to serve areas where wired Internet is not readily available.

Newer technologies being deployed for fixed (stationary) and mobile broadband access include Worldwide Interoperability for Microwave Access (WiMAX), Long Term Evolution (LTE), and fixed wireless.

Starting in roughly 2006, mobile broadband access is increasingly available at the consumer level using "3G" and "4G" technologies such as High Speed Packet Access (HSPA), Evolution-Data Optimized (EV-DO), Evolved High-Speed Packet Access (HSPA+), and LTE.

1.5. Internet Backbone Networks

A backbone network is a part of computer network infrastructure that interconnects various pieces of network, providing a path for the exchange of information between different LANs or sub-networks. A backbone can tie together diverse networks in the same building, in different buildings, in a campus environment, or over wide areas. Normally, the backbone's capacity is greater than the networks connected to it.

- Optical Backbone
- Marine Backbone
- Teleports
- Satellite
- Terrestrial Links