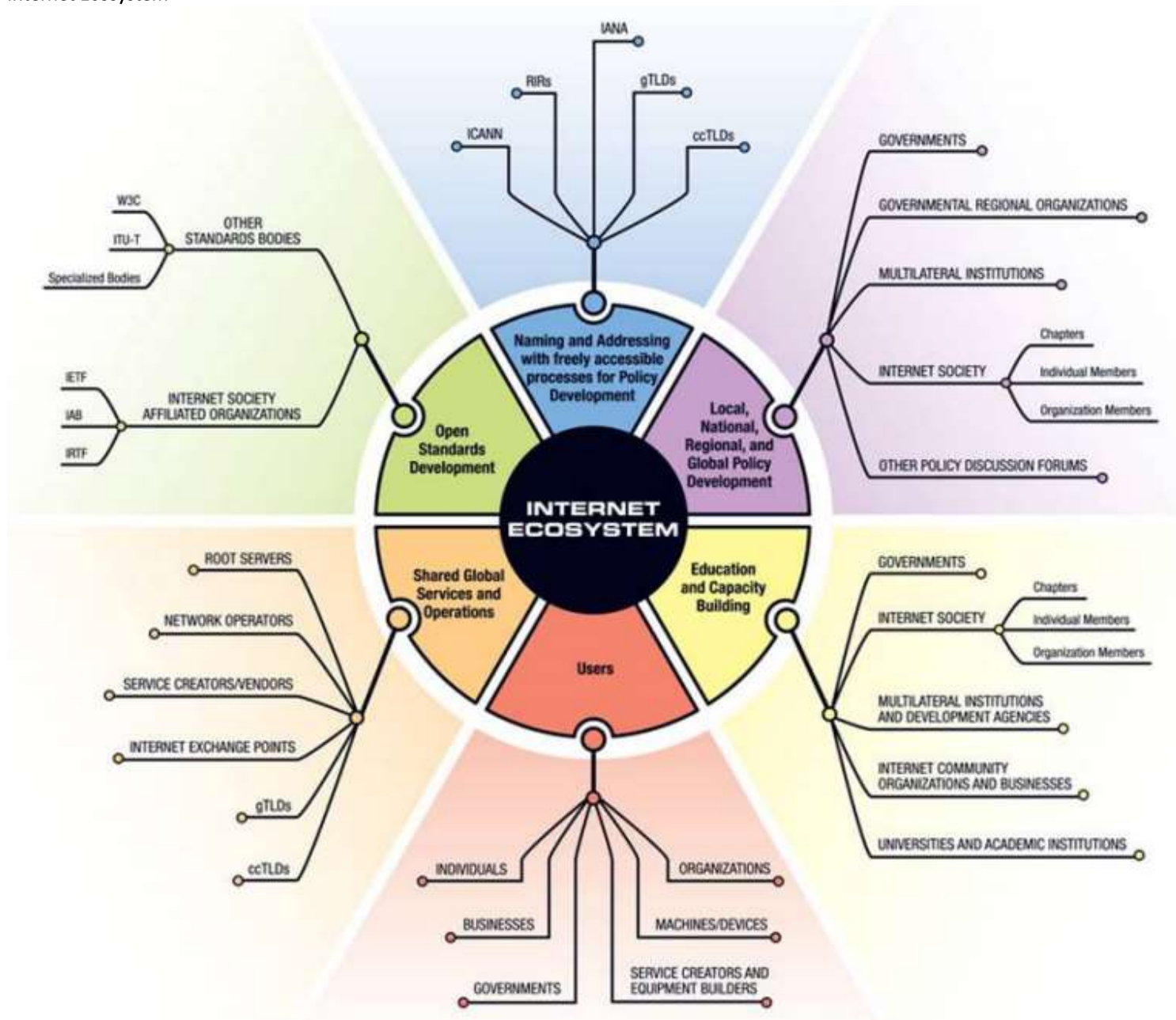


- 1.1. History and Development of Internets and Intranets
- 1.2. IANA, RIR/NIR/LIR and ISPs for internet number management
- 1.3. Internet Domain and Domain Name System
- 1.4. Internet Access Overview
- 1.5. Internet Backbone Networks: Optical Backbone, Marine Cables, Teleports, Satellite and Terrestrial Links

Introduction

Internet Ecosystem



Naming and Addressing: focuses on IP address and generic top-level domain (gTLD). Players are IANA, ICAAN, ASO(Address Supporting Organization), NRO(Number Resource Organization), RIR,NIR, LIR, ISPs.

Shared Global Services and Operations: focuses on Root Servers and Country Code Top Level Domains (ccTLDs). Players are ICAAN, IANA.

Open Standards Development: focuses on Internet Society affiliated organizations and other Internet standards bodies. Players are Internet Society (ISOC), Internet Engineering Task Force (IETF), IAB (Internet Architecture Board), IESG (Internet Engineering Steering Group), W3C (World Wide Web Consortium), IEEE (Institute of Electrical and Electronics Engineers), International Telecommunications Union (ITU), Organizations that comprise the Internet Ecosystem include:

- Technical standards bodies such as the Internet Engineering Task Force (IETF), the World Wide Web Consortium (W3C), and the Institute of Electrical and Electronic Engineers (IEEE)

- Organizations that manage resources for global naming and addressing capabilities such as the Internet Corporation for Assigned Names and Numbers (ICANN), including its operation of the Internet Assigned Numbers Authority (IANA) function, Regional Internet Registries (RIR), and Domain Name Registries and Registrars
- Companies that provide network infrastructure services such as Domain Name Service (DNS) providers, network operators, cloud and content delivery network providers, and Internet Exchange Points (IXPs)
- Individuals and Organizations that use the Internet to communicate with each other and offer services and applications, or develop content, and ! Organizations that provide education and build capacity for developing and using Internet technologies, such as multilateral organizations, educational institutions, and governmental agencies.

* **Internet (INTERNational NETwork) : “Network of Networks”** Internet is a **clustered system of interrelated computer networks** that uses a standard Internet protocol (IP) or transmission control protocol (TCP) network. It is a **global network** of millions of private, public and organizational network. It carries a massive range of informational resources and data in form of HTTP (Hypertext Markup language) documents and applications through World Wide Web (WWW). Common functions of sharing are: *email, file sharing, telephony and p2p networks*. Internet has totally reshaped the entire professions of the world. TV channels, cellular companies, newspapers, books, retailer are using website technology to expand their services. Nothing is impossible today. *All kinds of verbal communication, social networking, online shopping and financial services are being performed through Internet.*

* **Intranet (INTRA NETwork) :** Intranet is a computer network system in which *a specific organizational systems share information, computing services and operational systems with each other by using an Internet (IP) technology.* This term basically refers to the network of a specific organization. You can also say it a **private network**. *Authenticated users* of the organization can access the database system, search engines, directory and can distribute documents and workflow. Employees can make *interactive communication in shape of chatting, audio and videoconferencing, groupware and teleconferencing.* The benefits of Intranet is that low development and maintenance cost arises on this setup. It is also a means of friendly environment and speedy sharing of secret information on time.

* **Extranet (EXTRA NETwork) :** The term Extranet is linked with Intranet. Extranet is a kind of computer network that *allows the outside users to access the Intranet of organization.* This network system is basically used for business to business (B2B) purposes. This system *basically allows the outside users of an organization, like partners, suppliers, vendors and other stakeholders to remain in touch with the activities of organization.* Information and data access performed through a proper account or link system. This is a best network system to keep in touch with market position and share a large amount of data to partners in a timely manner.

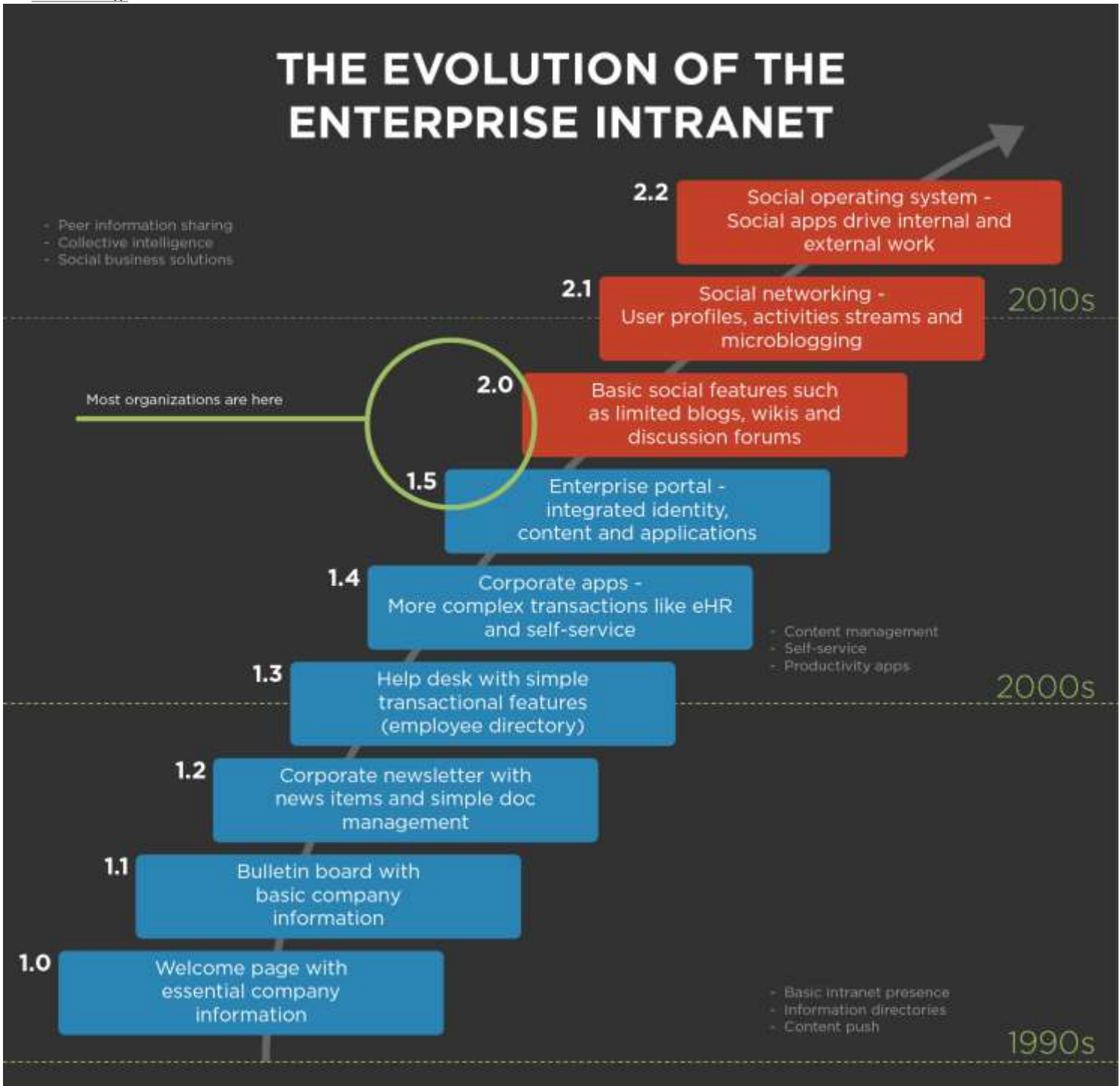
Comparison between Internet, Intranet and Extranet.

- **Availability:** Internet is a *global network system* and is available to all while Intranet and Extranet are available to *limited inside and outside* users of the organization.
- **Secure:** Intranet and Extranet are *more secure* than Internet because having Intranet or Extranet network system means organization has created a firewall against outsiders. Accessing any information on Internet is not *much difficult today.*
- **Accessible :** General public is the user of Internet so it can be called as *public network* while business persons and organization are the users of Intranet and Extranet and can be called as *private networks.*
- **Authenticity :** Internet can be access through *without having user account.* While user account is the first important condition in case of Intranet and Extranet.
- **Policy :** Internet has *no hard and fast policies* while there is a complete organization policy behind the setup of Intranet and Extranet.

1.1 History and Development of Internets and Intranets

- **1950s :** development of electronic computers in the. Initial concepts of packet networking originated in several computer science laboratories in the United States, United Kingdom, and France.
- as early as the **1960s :** The US Department of Defense awarded contracts for packet network systems, including the development of the ARPANET. The first message was sent over the ARPANET from computer science Professor Leonard Kleinrock's laboratory at University of California, Los Angeles (UCLA) to the second network node at Stanford Research Institute (SRI).
- late 1960s : Packet switching networks such as ARPANET, NPL network, CYCLADES, Merit Network, Tymnet, and Telenet, were developed
- **1982,** the Internet protocol suite (TCP/IP) was introduced as the standard networking protocol on the ARPANET.
- early 1980s the NSF funded the establishment for national supercomputing centers at several universities, and provided interconnectivity
- in **1986** with the NSFNET project, which also created network access to the supercomputer sites in the United States from research and education organizations.
- very late 1980s : Commercial Internet service providers (ISPs) began to emerge. The ARPANET was decommissioned in **1990**. Limited private connections to parts of the Internet by officially commercial entities emerged in several American cities **by late 1989 and 1990**.
- In the **1980s**, research at CERN in Switzerland by British computer scientist Tim Berners-Lee resulted in the World Wide Web, linking hypertext documents into an information system, accessible from any node on the network.

- **Since the mid-1990s**, the Internet has had a revolutionary impact on culture, commerce, and technology, including the rise of near-instant communication by electronic mail, instant messaging, voice over Internet Protocol (VoIP) telephone calls, two-way interactive video calls, and the World Wide Web with its discussion forums, blogs, social networking, and online shopping sites.
- **1993**: Increasing amounts of data are transmitted at higher and higher speeds over fiber optic networks operating at 1-Gbit/s, 10-Gbit/s, or more. The Internet's takeover of the global communication landscape was almost instant in historical terms: it only communicated 1% of the information flowing through two-way telecommunications networks
- already 51% by **2000**, and more than 97% of the telecommunicated information by **2007**.
- **Today** the Internet continues to grow, driven by ever greater amounts of online information, commerce, entertainment, and social networking.



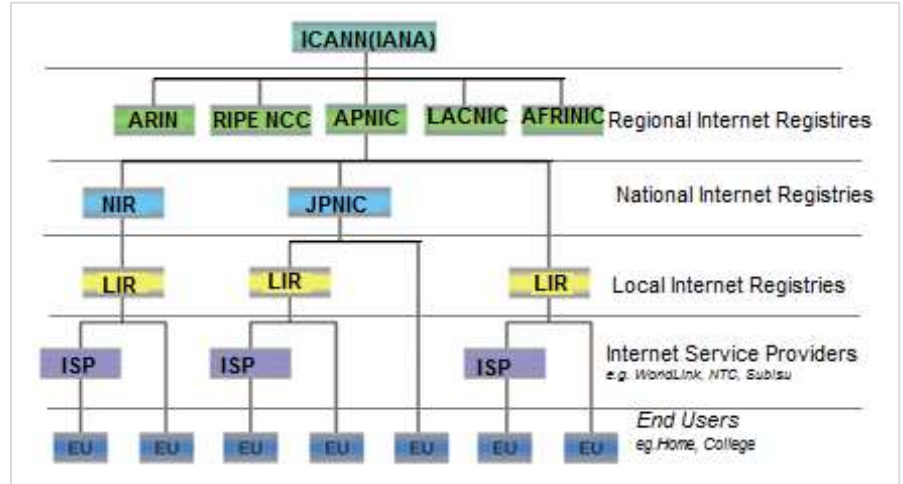
1.2 IANA, RIR/NIR/LIR and ISPs for internet number management

***IANA** : The **Internet Assigned Numbers Authority (IANA)** is a department of **ICANN (Internet Corporation for Assigned Names and Numbers)** responsible for coordinating some of the key elements that keep the Internet running smoothly. While the Internet is famous for being a worldwide network free from central coordination, there is a technical need for some key parts of the Internet to be globally coordinated, and this coordination role is undertaken by IANA.

Specifically, IANA allocates and maintains unique codes and numbering systems that are used in the technical standards (“protocols”) that drive the Internet. An AS is a group of IP networks operated by one or more network operator(s) that has a single and clearly defined external routing policy. Exterior routing protocols are used to exchange routing information between Autonomous Systems.

Roles of IANA

- **Domain Names** : IANA manages the DNS Root, the .int and .arpa domains, and an IDN practices resource. Management of the root zone involves assigning the operators of top-level domains, such as .uk and .com, and maintaining their technical and administrative details. The root zone contains the authoritative record of all top-level domains (TLDs). See page 14 for more details.
- **Number Resources** : Management of Internet number resources involves the global coordination of the Internet Protocol addressing systems, commonly known as IP addresses. The allocation of blocks of autonomous system numbers (ASNs) to regional Internet registries (RIRs) is another part of this function. Providing Internet protocol version 6 (IPv6) and Internet protocol version 4 (IPv4)
- **Protocol Assignments** : Management of protocol parameters involves maintaining many of the codes and numbers used in Internet protocols. This is done in coordination with the Internet Engineering Task Force (IETF). IANA is also responsible for providing all specific codes, functions and protocols, including:
 - Services (e.g., routing)
 - E-mail protocols (e.g., POP3 and SMTP)
 - Special broadcasting and private addressing IP classes
 - Port numbering
 - Other common Ethernet network protocols



Internet Number Management

***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. Autonomous System (AS) Numbers are used by various routing protocols. IANA allocates AS Numbers to Regional Internet Registries (RIRs). The RIRs further allocate or assign AS Numbers to network operators in line with RIR policies. AS Numbers can be obtained from the registry in your region.

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

- African Network Information Center (**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*

***NIR**: A **National Internet Registry** (or NIR) is *an organization under the umbrella of a Regional Internet Registry (RIR) 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**, Korea Internet & Security Agency
- **TWNIC**, Taiwan Network Information Center
- **VNNIC**, Vietnam Internet Network Information Center
- **Indian** Registry for Internet Names and Numbers

The following NIRs are currently operating in the Latin American (LACNIC) region: **NIC Mexico, NIC Brazil**

NOTE : There are no NIRs operating in the RIPE NCC region

***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 Regional Internet registry is required to become an LIR.

***ISP** : An **Internet service provider (ISP)** is an organization *that provides services for accessing, using, the Internet.* Internet service providers may be organized in various forms, such as *commercial, community-owned, non-profit, or otherwise privately owned.*

Internet services typically provided by ISPs include Internet access, Internet transit, domain name registration, web hosting, Usenet service, and colocation.

- An ISP is an organization that connects business or residential customers to Internet (backbone).
- An Internet Service Provider (ISP) is a company that provides access to the Internet. Their customers can be businesses, individuals or organizations.
- The advent of ISPs has made connecting to the Internet an affordable and convenient option for general people
- Internet structure is roughly hierarchical
- In the public Internet, access networks situated at the edge of the Internet are connected to the rest of the Internet through a tiered hierarchy of Internet Service Providers (ISPs)

Mercantile was the first company to provide internet service in Nepal. Currently there are over 40 registered Internet Service Providers in our country. Most of the ISPs in Nepal are :-

1. Worldlink Communication
2. Subisu Cablenet Pvt. Ltd.
3. Nepal Telecom ADSL Broadband Internet Service
4. Vianet Communications
5. Broadlink Network & Communication

ISP Tiers

- a. **Backbone Providers / Tier-1 ISPs:** These ISPs are nationwide or multinational organizations that control Internet routing. They often own significant pieces of backbone itself
 - Also known as Internet Backbone
 - Exists at the center of the Internet Architecture
 - Directly connected to each of the other tier-1 ISPs
 - Connected to a large number of tier-2 ISPs and other customer networks
 - International in coverage: Two tier-1 ISPs can also peer with each other by connecting together a pair of POPs, one from each of the two ISPs.
 - The trend is for the tier-1 ISPs to interconnect with each other directly at private peering points.
 - Examples (e.g., UUNet, BBN/Genuity, Sprint, AT&T)
- b. **National Providers / Tier-2 ISPs:** These ISPs buy capacity (bandwidth) and routing services from backbone providers and run Points Of Presence (POP: location of access points to the Internet) across the country.
 - Provides smaller coverage as compared to tier-1 ISPs
 - National Coverage: Connect to one or more tier-1 ISPs
 - Connect to other tier-2 ISPs as well. Tier-2 ISPs typically have regional or national coverage and connects only to a few of tier-1 ISPs
 - A tier-2 ISP is said to be a customer of the tier-1 ISP to which it is connected, and the tier-1 ISP is said to be a provider to its customer.
 - The trend for tier-2 ISPs is to interconnect with other tier-2 ISPs and with tier-1 ISPs at NAPs
- c. **Local Providers / Tier-3 ISPs:** These ISPs operate in the same way as the national ISPs, but on a smaller geographical area.
 - last hop ("access") network (closest to end systems)
 - Local Coverage: Below tier-2 ISPs are the lower-tier ISPs, which connect to the larger Internet via one or more tier-2 ISPs
 - Users and content providers are the customers of lower-tier ISPs and lower-tier ISPs are the customers of higher-tier ISPs

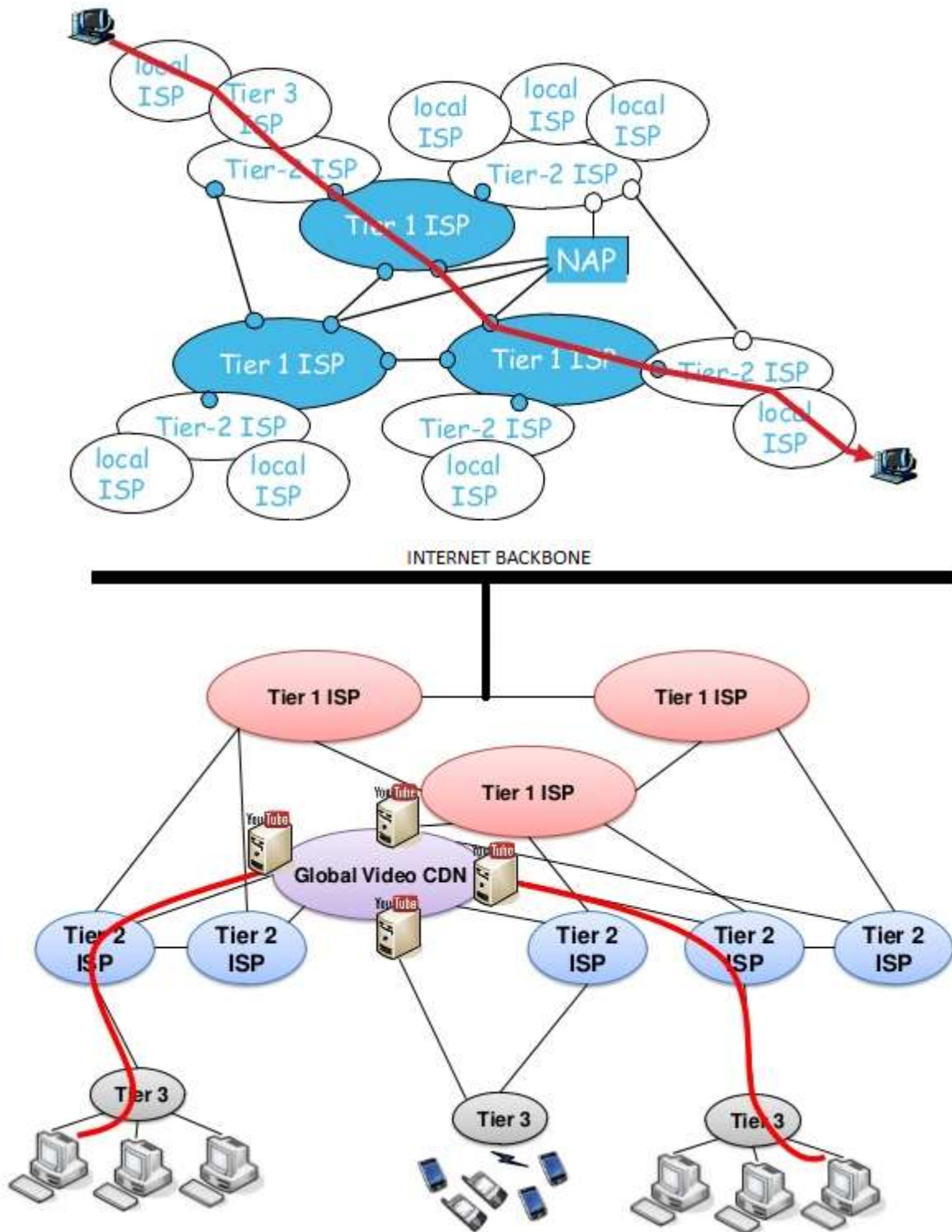


Fig. ISP 3-Tier Architecture

1.3. Internet Domain and Domain Name System

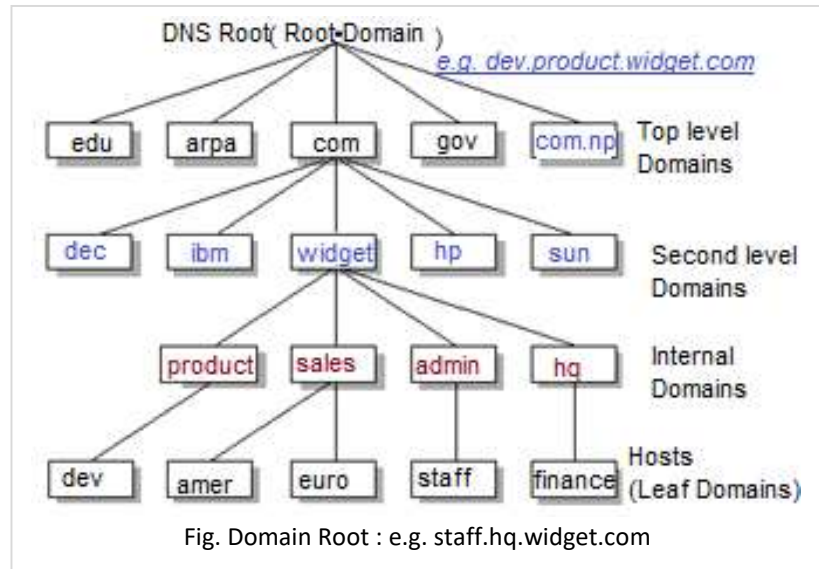
***Domain Name :** A **domain name** is an identification string that defines a area of administrative autonomy, authority or control within the Internet. *Domain names are formed by the rules and procedures of the Domain Name System (DNS)*. Any name registered in the DNS is a domain name. Domain names can also be thought of as *a location where certain information or activities can be found*.

Domain names are organized right to left, with general descriptors to the right, and specific descriptors to the left. It is like family surnames to the right, specific person names to the left.

Note: Most American servers use three-letter top level domains (e.g. ".com", ".edu"). Countries other than the USA commonly use two letters, or combinations of two letters (e.g. ".au", ".ca", ".co.jp")

As of 2015, IANA distinguishes the following groups of top-level domains:

- Infrastructure top-level domain (ARPA) "Address and Routing Parameter Area" Internet infrastructure TLD
- Generic top-level domains (gTLD)
.com commercial, .net network oriented, .org non-profit organization
- Restricted generic top level domains : (grTLD):
.edu accredited U.S. educational,
.gov U.S. government agencies,
.mil U.S. military, .int international treaties (1988)
- Sponsored top-level domains (sTLD) :
.aero global aviation community,
.jobs human resources/employment,
.travel travel industry
- Country code top-level domains (ccTLD) : two-letter suffix such as .np (Nepal), .ca (Canada) and .de (Germany)
- Test top-level domains (tTLD)



***Domain Name System :** Is used to resolve human-readable hostnames like `www.hcoe.edu.com` into machine-readable IP addresses like `182.185.35.17`. DNS also provides other information about domain names, such as mail services.

But why is DNS important? How does it work? What else should you know?

Why is DNS important?

DNS is like a phone book for the Internet. *If you know a person's name but don't know their telephone number, you can simply look it up in a phone book. DNS provides this same service to the Internet.*

When you visit `http://hcoe.edu.np` in a browser, your computer uses DNS to retrieve the website's IP address of `204.13.248.115`. Without DNS, you would only be able to visit our website (or any website) by visiting its IP address directly, such as `http://204.13.248.115`.

How does DNS work?

When you visit a domain such as `http://hcoe.edu.np`, your computer follows a series of steps to turn the human-readable web address into a machine-readable IP address. *This happens every time you use a domain name, whether you are viewing websites, sending email or listening to Internet radio stations like Pandora.*

Step 1: Request information : The process begins when you ask your computer to resolve a hostname, such as visiting `http://dyn.com`. The first place your computer looks is its local DNS cache, which stores information that your computer has recently retrieved.

If your computer doesn't already know the answer, it needs to perform a DNS query to find out.

Step 2: Ask the recursive DNS servers : If the information is not stored locally, your computer queries (contacts) your ISP's **recursive DNS servers**. These specialized computers perform the legwork of a DNS query on your behalf. Recursive servers have their own caches, so the process usually ends here and the information is returned to the user.

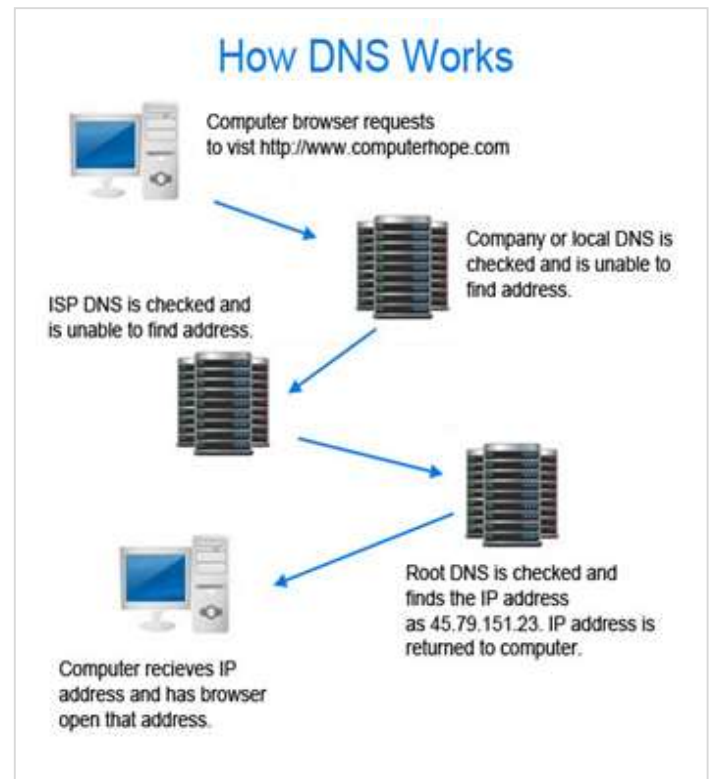
Step 3: Ask the root name servers : If the recursive servers don't have the answer, they query the root nameservers. A nameserver is a computer that answers questions about domain names, such as IP addresses. The thirteen root nameservers act as a kind of telephone switchboard for DNS. They don't know the answer, but they can direct our query to someone that knows where to find it.

Step 4: Ask the TLD name servers : The root nameservers will look at the first part of our request, reading from right to left — *www.dyn.com* — and direct our query to the Top-Level Domain (TLD) nameservers for *.com*. Each TLD, such as *.com*, *.org*, and *.us*, have their own set of nameservers, which act like a receptionist for each TLD. These servers don't have the information we need, but they can refer us directly to the servers that *do* have the information.

Step 5: Ask the authoritative DNS servers : The TLD nameservers review the next part of our request — *www.dyn.com* — and direct our query to the nameservers responsible for this *specific* domain. These authoritative nameservers are responsible for knowing all the information about a specific domain, which are stored in DNS records. There are many types of records, which each contain a different kind of information. In this example, we want to know the IP address for *www.dyndns.com*, so we ask the authoritative nameserver for the Address Record (A).

Step 6: Retrieve the record : The recursive server retrieves the A record for *dyn.com* from the authoritative nameservers and stores the record in its local cache. If anyone else requests the host record for *dyn.com*, the recursive servers will already have the answer and will not need to go through the lookup process again. All records have a time-to-live value, which is like an expiration date. After a while, the recursive server will need to ask for a new copy of the record to make sure the information doesn't become out-of-date.

Step 7: Receive the answer Armed with the answer, recursive server returns the A record back to your computer. Your computer stores the record in its cache, reads the IP address from the record, then passes this information to your browser. The browser then opens a connection to the webserver and receives the website.



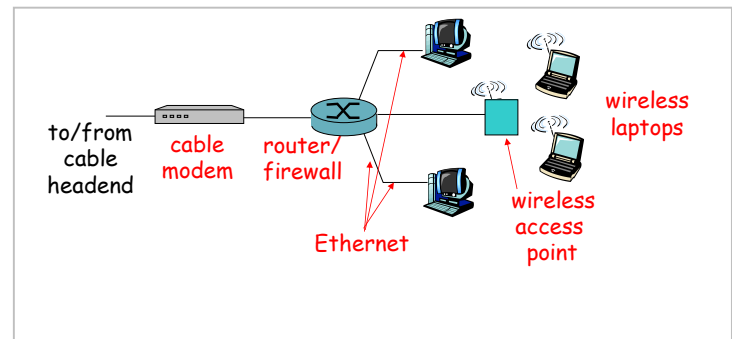
1.4 Internet Access Overview

Internet access connects individual computer terminals, computers, mobile devices, and computer networks to the Internet, enabling users to access Internet services, such as email, digital TV, and the World Wide Web. Internet service providers (ISPs) offer Internet access through various technologies that offer a wide range of data signaling rates (speeds).

Typical home network components:

- ADSL or cable modem
- router/firewall/NAT
- Ethernet
- wireless access point

Technically, any router with Wi-Fi onboard can be called a wireless access point, but that's not their only definition. For example, a router can be an access point, but an access point can't be a router.



Internet access technology :**1. Hardwired broadband access : Dial-Up, ISDN, Leased Line, Cable, DSL, Fibre, Power Line Internet**

-Dial-up : Point-to-point access Internet access uses a *modem and a phone call placed over the public switched telephone network (PSTN)* to connect to a pool of modems operated by an ISP. The modem converts a computer's digital signal into an analog signal that travels over a phone line's local loop until it reaches a telephone company's switching facilities or central office (CO) where it is switched to another phone line that connects to another modem at the remote end of the connection.

- up to 56Kbps direct access to router (often less)
- Can't surf and phone at same time: can't be "always on"

-Integrated Services Digital Network (ISDN) – Residential access: is a *switched telephone service capable of transporting voice and digital data, is one of the oldest Internet access methods. ISDN has been used for voice, video conferencing, and broadband data applications.*

-Leased lines : are *dedicated lines used primarily by ISPs, business, and other large enterprises to connect LANs and campus networks to the Internet using the existing infrastructure of the public telephone network or other providers. Delivered using wire, optical fiber, and radio, leased lines are used to provide Internet access directly as well as the building blocks from which several other forms of Internet access are created.*

- Cable – Residential access : *Internet access or cable modem access provides Internet access via hybrid fiber coaxial wiring originally developed to carry television signals. Either fiber-optic or coaxial copper cable may connect a node to a customer's location at a connection known as a cable drop. In a cable modem termination system, all nodes for cable subscribers in a neighborhood connect to a cable company's central office, known as the "head end." The cable company then connects to the Internet using a variety of means – usually fiber optic cable or digital satellite and microwave transmissions. Like DSL, broadband cable provides a continuous connection with an ISP.*

-Optical Fiber : The use of optical fiber offers much higher data rates over relatively longer distances. Most high-capacity Internet and cable television backbones already use fiber optic technology, with data switched to other technologies (DSL, cable, POTS) for final delivery to customers

-Power-line Internet : also known as *Broadband over power lines (BPL)*, carries Internet data on a conductor that is also used for electric power transmission

2. Wireless broadband access : Satellite, Mobile, WiMAX

-Satellite Internet service provides fixed, portable, and mobile Internet access. Data rates range from 2 Kbit/s to 1 Gbit/s downstream and from 2 Kbit/s to 10 Mbit/s upstream. Satellite antenna dishes require a clear line of sight to the southern sky. Service can be adversely affected by moisture, rain, and snow (known as rain fade). The system requires a carefully aimed directional antenna.

-Mobile broadband is the marketing term for wireless Internet access delivered through mobile phone towers to computers, mobile phones (called "cell phones" in North America and South Africa), and other digital devices using portable modems. Some mobile services allow more than one device to be connected to the Internet using a single cellular connection using a process called tethering. The modem may be built into laptop computers, tablets, mobile phones, and other devices, added to some devices using PC cards, USB modems, and USB sticks or dongles, or separate wireless modems can be used.

-Worldwide Interoperability for Microwave Access (WiMAX) is a set of interoperable implementations of the IEEE 802.16 family of *wireless-network standards certified by the WiMAX Forum. WiMAX enables "the delivery of last mile wireless broadband access as an alternative to cable and DSL".* The original IEEE 802.16 standard, now called "Fixed WiMAX", was published in 2001 and provided 30 to 40 megabit-per-second data rates. Mobility support was added in 2005. A 2011 update provides data rates up to 1 Gbit/s for fixed stations. WiMAX offers a metropolitan area network with a signal radius of about 50 km (30 miles), far surpassing the 30-metre (100-foot) wireless range of a conventional Wi-Fi local area network (LAN). WiMAX signals also penetrate building walls much more effectively than Wi-Fi. on a much larger scale and at faster speeds than Wi-Fi.

1.5. Internet Backbone Networks - Optical Backbone, Marine Cables, Teleports, Satellite and Terrestrial Links

A **backbone network** or **network backbone** 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 subnetworks.* 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.*

A large corporation that has many locations may have a backbone network that ties all of the locations together, for example, if a server cluster needs to be accessed by different departments of a company that are located at different geographical locations. The pieces of the network connections (for example: ethernet, wireless) that bring these departments together is often mentioned as network backbone.

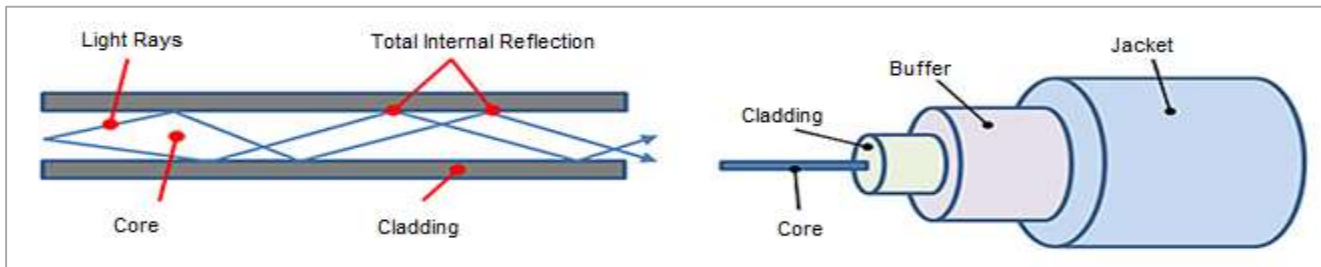
Network congestion is often taken into consideration while designing backbones

The **Internet backbone** may be defined by *the principal data routes between large, strategically interconnected computer networks and core routers on the Internet.* These data routes are hosted by commercial, government, academic and other high-capacity network centers, the Internet exchange points and network access points, that exchange Internet traffic between the countries, continents and across the oceans.

The Internet backbone is a composite of multiple, redundant networks owned by numerous companies. It is typically a fiber optic trunk line. The trunk line consists of many fiber optic cables bundled together to increase the capacity. The backbone is able to reroute traffic in case of a failure.

- Nearly all Web browsing, video streaming, and other common online traffic flows through Internet backbones.
- They consist of network routers and switches connected mainly by fiber optic cables (although some Ethernet segments on lower traffic backbone links also exist). **Each fiber link on the backbone normally provides 100 Gbps of network bandwidth.** Computers rarely connect to a backbone directly. Instead, the networks of Internet service providers or large organizations connect to these backbones and computers access the backbone indirectly.
- The Internet eventually became a network of **smaller backbones operated by Internet Service Providers** that tap into the biggest national and internal backbones owned by large telecommunications companies.

*Fiber Optics



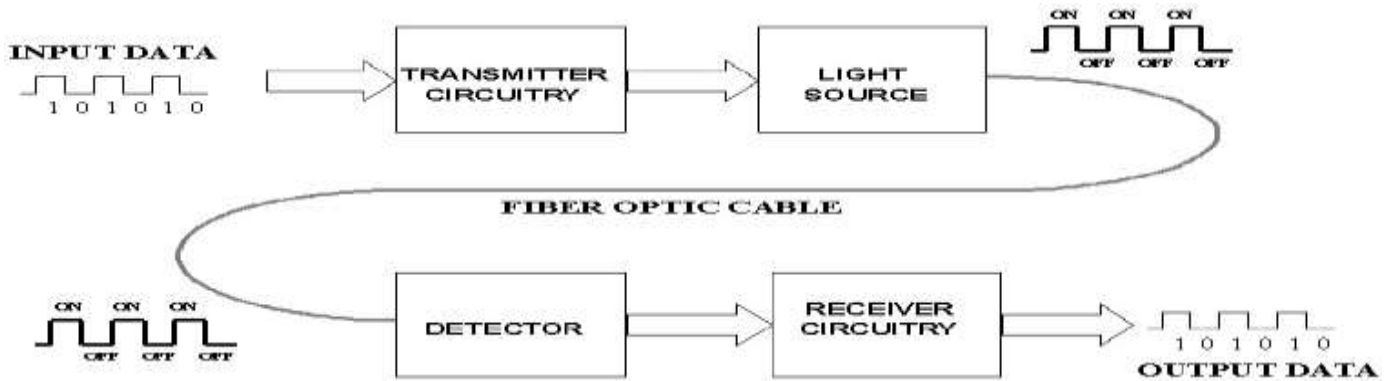
An optical fiber is a cylindrical dielectric (a poor conductor of electricity) waveguide that transmits light along its axis, by the process of total internal reflection. The fiber consists of a *core* surrounded by a cladding layer, both of which are made of dielectric materials. To confine the optical signal in the core, the refractive index of the core must be greater than that of the cladding. The boundary between the core and cladding may either be abrupt, in *step-index fiber*, or gradual, in *graded-index fiber*. Covering Distance may be of the order of 30,000 km.

Advantages

- **Bandwidth** - Fibre optic cables **have a much greater bandwidth** than metal cables. The amount of information that can be transmitted per unit time of fibre over other transmission media is its most significant advantage. **With the high performance single mode cable used by telephone industries for long distance telecommunication, the bandwidth surpasses the needs of today's applications and gives room for growth tomorrow.**
- **Low Power Loss** - An optical fibre offers low power loss. This allows for **longer transmission distances**. In comparison to copper; in a network, the longest recommended **copper distance is 100m while with fibre, it is 2000m.**
- **Interference** - Fibre optic cables are **immune to electromagnetic interference**. It can also be run in electrically noisy environments without concern as electrical noise will not affect fibre.
- **Size** - In comparison to copper, a fibre optic cable has nearly **4.5 times as much capacity as the wire cable** has and a cross sectional area that is 30 times less.
- **Weight** - Fibre optic cables are much **thinner and lighter** than metal wires. They also occupy less space with cables of the same information capacity. Lighter weight makes fibre easier to install.
- **Safety** - Since the fibre is a **dielectric**, it does not present a spark hazard.
- **Security** - Optical fibres are **difficult to tap**. As they do not radiate electromagnetic energy, emissions cannot be intercepted. As physically tapping the fibre takes great skill to do undetected, fibre is the most secure medium available for carrying sensitive data.
- **Flexibility** - An optical fibre has **greater tensile strength** than copper or steel fibres of the same diameter. It is flexible, bends easily and resists most corrosive elements that attack copper cable.
- **Cost** - The raw materials for glass are plentiful, unlike copper. This means glass can be **made more cheaply** than copper.

Disadvantages

- **Cost** - Cables are **expensive to install** but last longer than copper cables.
- **Transmission** - transmission on optical fibre **requires repeating at distance intervals.**
- **Breakable** - Fibres **can be broken or have transmission losses** when wrapped around curves of only a few centimetres radius. However by encasing fibres in a plastic sheath, it is difficult to bend the cable into a small enough radius to break the fibre.
- **Protection** - Optical **fibres require more protection** around the cable compared to copper.



*Teleports: Telecommunication Ports - Gateways for Global Transmission Services

A **telecommunications port**—or, more commonly, **teleport**—is a satellite ground station with multiple parabolic antennas (i.e., an antenna farm) that functions as a hub connecting a satellite or geocentric orbital network with a terrestrial telecommunications network e.g. Internet. Teleports may provide various broadcasting services among other telecommunications functions, such as uploading computer programs or issuing commands over an uplink to a satellite.

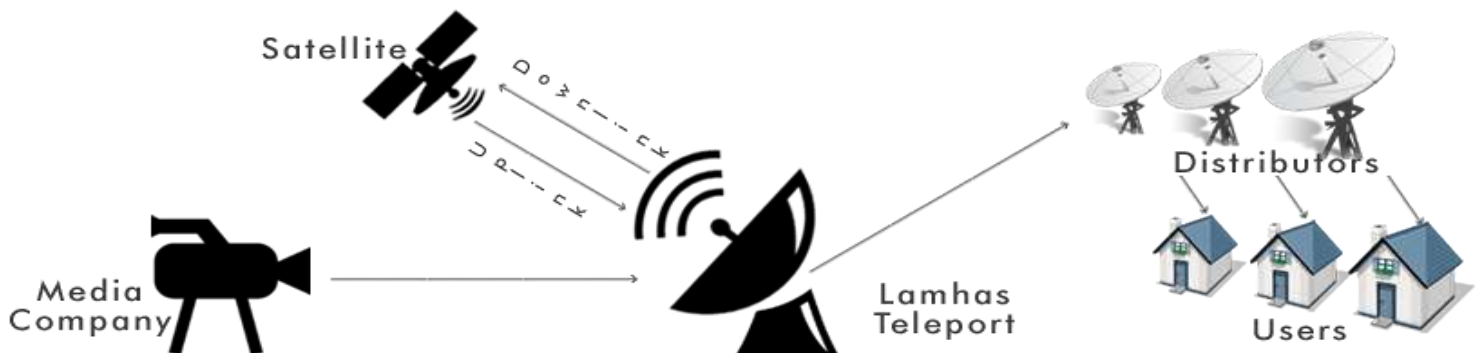
Satellite teleports are permanent satellite uplink facilities located throughout the world which are used for maintaining constant communication with the orbiting satellites (i.e. providing connectivity between the ground and the space segment). The teleport infrastructure is the critical link that facilitates seamless(all-in-one) transfer of information to and from the end user's computer network.

Perth Teleport

- 12 antennas ranging from 2.4 to 13 meters in size
- Up-linking to 9 geostationary satellites across C- & Ku-band
- Interconnected to terrestrial fiber networks and the Internet backbone
- 24 x 7 x 365 on-site Network Operations Centre

Adelaide Teleport

- 11 antennas ranging from 2.4 to 13 meters in size
- Up-linking to 8 geostationary satellites across C- & Ku-band
- Interconnected to terrestrial fiber networks and the Internet backbone
- Military Accredited Global Access Point
- 24 x 7 x 365 on-site Network Operations Centre



*Microwave

Microwave frequencies are used for wireless communication as they penetrate ionosphere. They get attenuated(weakened) when used as ground waves as well as surface waves. Due to this reason microwave communication is mainly LOS (Line of Sight) based communication.

Microwave communication systems are mainly classified into satellite systems and terrestrial systems. Both of these systems require transmit part and receive part. The transmit system converts baseband signal to microwave signal. The receive system converts microwave signal to baseband signal. The baseband signal is multiplexed signal which carries number of individual low bandwidth signals such as voice, data and video. Multiplexing is done either using TDM or FDM.

Microwaves are electromagnetic waves with a frequency greater than 1 GHz (1,000,000 Hz). Microwave signals, due to their inherently high frequencies, have relatively short wavelengths, hence the name "micro" waves. The wavelengths of microwave frequencies fall between 1 cm and 60 cm; slightly longer than the infrared energy.

Microwave communications requires the line-of-sight or space wave propagation method. There are some instances where barriers are presented which cause obstacles between the transmitter and receiver or power amplification of weak signals. This kind of problem is best resolved by repeaters placed on sender and receiver side must be line-of-sight of each other. The data signals are received, amplified, and re-transmitted by each of these stations.

Type of Microwave Transmission

*Terrestrial Links : Land based Communication

A communications line that travels on, near or below ground. Contrast with [satellite link](#). It is a land based link for transmission. Usually a terrestrial link **relies on broadcasting tower(s) (in TV case) to emit their channels info to end users who** receive them via antennas mounted on roof of on TV set, **this broadcasting requires line of site between transmitter and receiver**, thus the distance between the tower and antenna is kind of limited, the range can be extended via adding multiple towers in different locations, in data link, usually cables connect the transmitter link to end user

Microwave frequency gets attenuated due to buildings, trees, geographical locations, hence the ground distance (i.e. range) is limited from one part of earth to the other. In order to extend the range of terrestrial communication system, multi section relays or repeaters are used.

Difference between Satellite System and Terrestrial System

- Coverage area of a satellite based system is greater than that of a terrestrial based wireless communication system. A GEO satellite with one single antenna can cover about 1/4th of the earth.
- Satellite communications link will have more degradations compare to terrestrial communication link but quality of transmission is usually quite good.
- In a satellite link delay from earth to satellite to earth is about 240ms while in terrestrial link it will be far less. But transmission cost in a satellite system is independent of the distance within the area of coverage of the satellite antenna, while in terrestrial system it varies based on the distance.
- Very high bandwidths and very high data rates are achievable in a satellite based communication system.
- In case of satellite based systems all the earth stations/VSATs can receive their own transmissions and hence transmitted power should be carefully decided based on the RF link budget. But both transmitting and receiving frequencies are different and hence will not create much problem. Transmit reject filter should be good enough to overcome this problem.

*Marine Network

Submarine Cable : A submarine communications cable is **a cable laid on the sea bed between land-based stations to carry telecommunication signals across stretches of ocean**. The first submarine communications cables, laid in the 1850s, carried telegraphy traffic. Subsequent generations of cables carried telephone traffic, then data communications traffic. **Modern cables use optical fiber technology to carry digital data, which includes telephone, Internet and private data traffic**.

Modern cables are typically about 1 inch (25 mm) in diameter and weigh around 2.5 tons per mile (1.4 tones per km) for the deep-sea sections which comprise the majority of the run, although larger and heavier cables are used for shallow-water sections near shore. **Submarine cables connected all the world's continents** except Antarctica when Java was connected to Darwin, Northern Territory, Australia in 1871 in anticipation of the completion of the Australian Overland Telegraph Line in 1872 connecting to Adelaide, South Australia and thence to the rest of Australia.

A submarine cable is *designed to protect its information carrying parts from water, pressure, waves, currents, and other natural forces that affect the seabed and overlying water*. Most of the forces change with depth. Temperature becomes colder, pressure increases and wave effects lessen, but strong current action can occur at any depth.

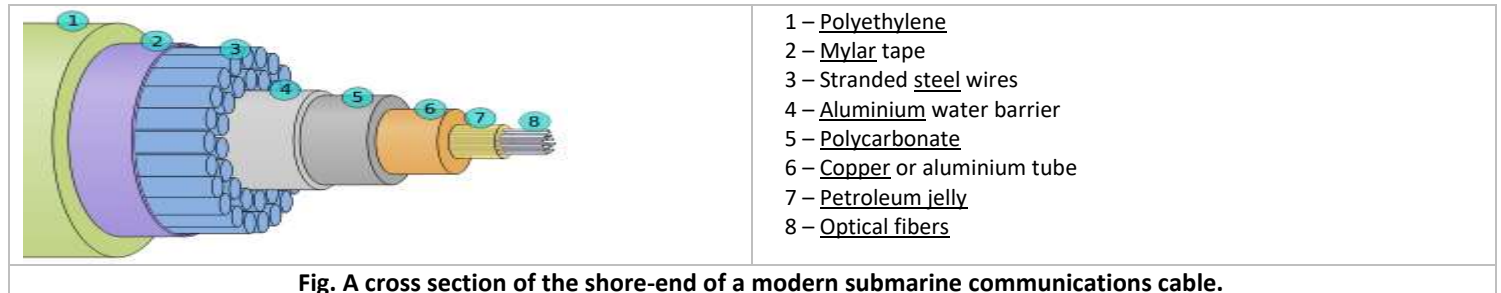


Fig. A cross section of the shore-end of a modern submarine communications cable.

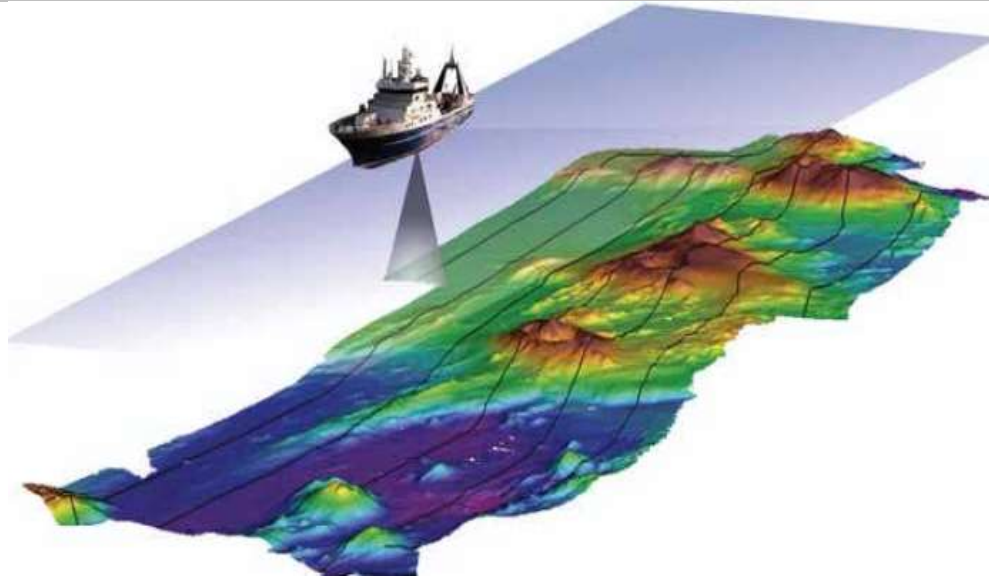


Fig. "Mowing the lawn": a survey ship equipped with a multibeam mapping system and guided by satellite navigation, charts the seabed to provide total coverage with depth surroundings along a swath of seabed that can be 20km wide.

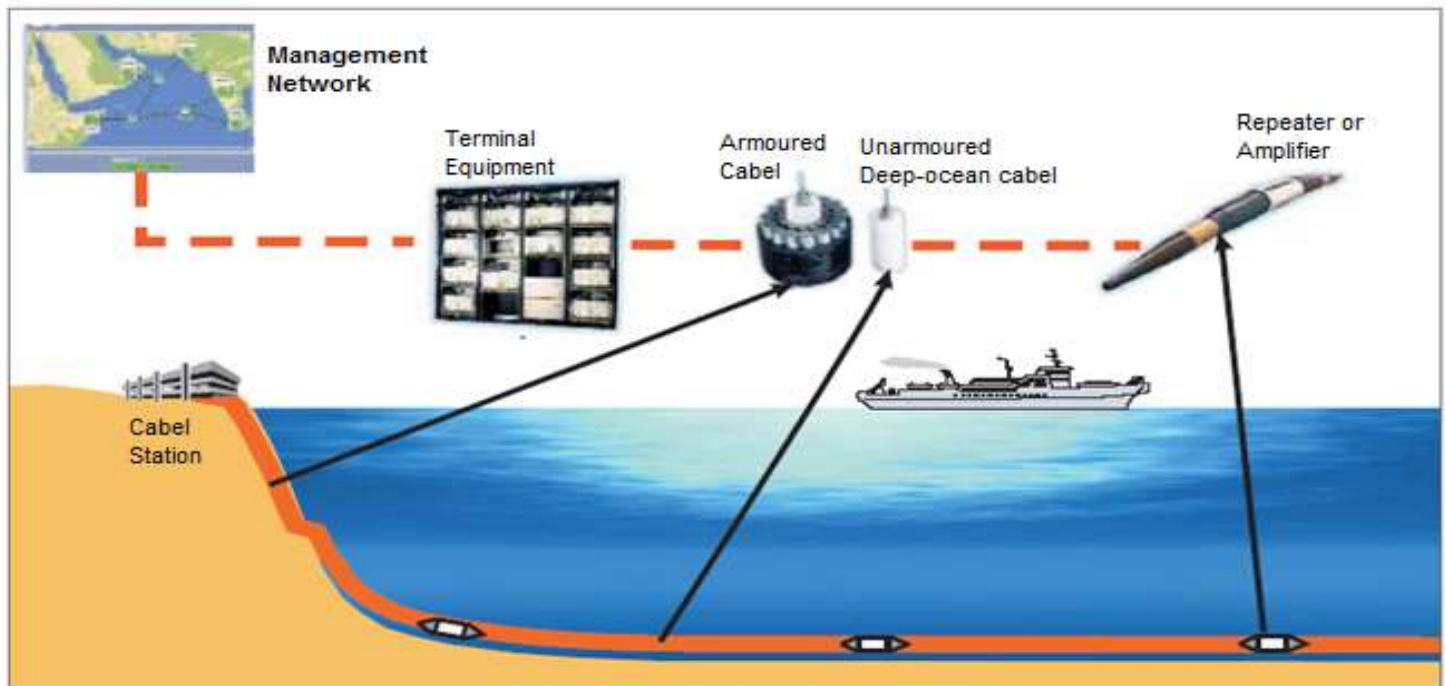


Fig : Submarine Cable System