Internet Technology

CSC - 402

Credit hours: 3 **Full Marks**: 60+20+20 **Pass Marks**: 24+8+8

BSc. CSIT 7th Semester

Objective:

This course deals on the practical application of internetworking technologies to private intranets for information management and public Internets for electronic commerce students will learn theoretical details, strategies for designing sites, techniques for creating their technical infrastructures, methods for developing content, and techniques for site deployment and management.

Reference Books:

1. ***Computer Networks***: Andrew S. Tanenbaum, Prentice Hall India Limited, New Delhi, 2010

2. ***Internet and Intranet Engineering***: Daniel Minoli, MGraw-Hill India Limited, New Delhi, 2009

3. ***Internetworking with TCP/IP***: Comer, D.E. and Stevens

CHAPTER 1

1. Introduction 5 Hrs.

1.1 History and Development of Internets and Intranets

1958	President Eisenhower requests funds to create ARPA. Approved as a line item in Air Force appropriations bill.
1961	Len Kleinrock, Professor of Computer Science at UCLA, writes first paper on packet switching, "Information Flow in Large Communications Nets." Paper published in RLE Quarterly Progress Report.
1962	•J.C.R. Licklider & W. Clark write first paper on Internet Concept, "On-Line Man Computer Communications." • Len Kleinrock writes Communication Nets, which describes design for packet switching network; used for ARPAnet
1964	Paul Baran writes, "On Distributed Communications Networks," first paper on using message blocks to send info across a decentralized network topology(Nodes and Links)
1965	First Network Experiment: Directed by Larry Roberts at MIT Lincoln Lab, two computers talked to each other using packet-switching technology.
1966	ARPA project begins. Larry Roberts is chief scientist.
1968	ARPANet contract given to Bolt, Beranek & Newman (BBN) in Cambridge, Mass.
1969	First ARPANet node installed at UCLA Network Measurement Center. Kleinrock hooked up the Interface Message Processor to a Sigma 7 Computer.
	Second node installed at Stanford Research Institute; connected to a SDS 940 computer. The first ARPANet message sent: "lo." Trying to spell log-in, but the system crashed!
	Third node installed at University of California, Santa Barbara. Connected to an IBM 360/75.
	Fourth node installed at University of Utah. Connected to a DEC PDP-10.
1970	Fifth node installed at BBN, across the country in Cambridge, Mass.
	Alohanet, first packet radio network, operational at University of Hawaii.
1972	First basic e-mail programs written by Ray Tomlinson at BBN for ARPANET: SNDMSG and READMAIL. "@" sign chosen for its "at" meaning.
1973	First ARPANET international connections to University College of London (England) and NORSAR

	(Norway).
1974	Intel releases the 8080 processor. • Vint Cerf and Bob Kahn publish "A Protocol for Packet Network Interconnection," which details the design of TCP.
1976	Apple Computer founded by Steve Jobs and Steve Wozniak. • Queen Elizabeth II sends out an e-mail. Vint Cerf joins ARPA as program manager.
1978	TCP split into TCP and IP.
1979	Bob Metcalfe and others found 3Com (Computer Communication Compatibility).
1980	Tim Berners-Lee writes program called "Enquire Within," predecessor to the World Wide Web.
1981	IBM announces its first Personal Computer. Microsoft creates DOS.
1983	Cisco Systems founded.
	Domain Name System (DNS) designed by Jon Postel, Paul Mockapetris, and Craig Partridge. .edu, .gov, .com, .mil, .org, .net, and .int created.
1984	• William Gibson writes "Neuromancer." Coins the term "cyberspace". • Apple Computer introduces the Macintosh on January 24th.
1985	Symbolic.com becomes the first registered domain.
1986	5000 hosts on ARPAnet/Internet.
1987	• 10,000 hosts on the Internet. • First Cisco router shipped. • 25 million PCs sold in US.
1989	• 100,000 hosts on Internet. • McAfee Associates founded; anti-virus software available for free. Quantum becomes America Online.
1990	ARPAnet ends. Tim Berners-Lee creates the World Wide Web.
1992	"Surfing the Internet" is coined by Jean Armour Polly.
1993	Mosaic Web browser developed by Marc Andreesen at University of Illinois, Champaign-Urbana. InterNIC created.

	• Web grows by 341,000 percent in a year.
1994	Netscape Communications founded. • Jeff Bezos writes the business plan for Amazon.com. Java's first public demonstration.
	Microsoft licenses technology from Spyglass to create Web browser for Windows 95.
1995	Sun Microsystems releases Java.
	Windows 95 released.
1996	Domain name tv.com sold to CNET for $15,000. Browser wars begin. Netscape and Microsoft two biggest players.
1997	business.com sold for $150,000.
1998	Microsoft reaches a partial settlement with the Justice Department that allows personal computer makers to remove or hide its Internet software on new versions of Windows 95. Netscape announces plans to give its browser away for free.
	US Depart of Commerce outlines proposal to privatize DNS. ICANN created by Jon Postel to oversee privatization. Jon Postel dies.
1999	•AOL buys Netscape; Andreesen steps down as full-time employee. • Browsers wars declared over; Netscape and Microsoft share almost 100% of browser market. • Microsoft declared a monopoly by US District Judge Thomas Penfield Jackson. •Shawn Fanning creates Napster, opening the possibilities of peer-to-peer file sharing and igniting a copyright war in the music industry.
2000	Fixed wireless, high-speed Internet technology is now seen as a viable alternative to copper and fiber optic lines placed in the ground.
2000	• AOL Merges with Time-Warner. AOL shareholders take 55% stake in newly formed company.
	. A large-scale denial of service attack is launched against some major Web sites like Yahoo! and eBay, alerting Web sites to the need for tighter security measures. . 10,000,000 domain names have been registered.
	There are 20,000,000 websites on the Internet, numbers doubling since February 2000.

2001	A federal judge rules that Napster must remain offline until it can prevent copyrighted material from being shared by its users. The Code Red worm and Sircam virus infiltrate thousands of web servers and email accounts, respectively, causing a spike in Internet bandwidth usage and security breaches.
	The European Council adopts the first treaty addressing criminal offenses committed over the Internet. First uncompressed real-time gigabit HDTV transmission across a wide-area IP network takes place on Internet2.
2002	.name begins resolving
2003	• The SQL Slammer worm causes one of the largest and fastest spreading DDoS attacks ever, taking only 10 minutes to spread worldwide. • The Internet celebrates its 'unofficial' 20th birthday. • Apple launches iTunes and Safari browser. • MySpace, Linkedin, Skype and Wordpress launched.
	The RIAA sues 261 individuals for allegedly distributing copyright music files over peer-to-peer networks
	The Research project "How much information 2003" finds that Instant messaging generates five billion messages a day (750GB), or 274 Terabytes a year and that e-mail generates about 400,000 terabytes of new information each year worldwide.
2004	Google's IPO – Market Cap £23BN. Facebook, Flickr and Vimeo launched. Mozilla launches Firefox Browser.
2005	YouTube.com launches
2006	There are an estimated 92 million Web sites online
2006	A massive DDOS assault on Blue Security, an anti-spam company, is redirected by Blue Security staff to their Movable Type-hosted blog. The result is that the DDOS instead knocks out all access to over 1.8 million active blogs.
	AOL announces that they will give for free virtually every service for which it charged a monthly fee, with income coming instead from advertising.

	There are an estimated 92 million Web sites online (some stats say over 100 million) Google Inc. acquires YouTube for $1.65 billion in a stock-for-stock transaction.
2007	Microsoft launches its various consumer versions of Microsoft Vista.
	Apple surpasses one billion iTunes downloads.
	1.114 billion people use the Internet according to Internet World Stats.
	Search engine giant Google surpasses Microsoft as "the most valuable global brand," and also is the most visited Web site.
Development of Internet Continues… Refer to the Info-graphics provided herewith. ***Note: It's your job now to dig till 2014.***	

Internet Network Information Center, a registered service mark of the U.S. Department of Commerce and now a obsolete entity. InterNIC began as a collaborative project between AT&T and Network Solutions, Inc. (NSI) supported by the National Science Foundation. When active, the project offered four services:

· InterNIC Directory and Database Services - online white pages directory and directory of publicly accessible databases managed by AT&T.

· Registration Services -- domain name and IP address assignment managed by NSI.

· Support Services -- outreach, education, and information services for the Internet community managed by NSI.

· Net Scout Services -- online publications that summarize recent happenings of interest to Internet users (managed by NSI).

The InterNIC is currently an informational Web site established to provide the public with information about domain name registration. ICANN now oversees the domain name registration industry.

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

IANA

The **Internet Assigned Numbers Authority** (**IANA**) is a department of ICANN, a nonprofit private American corporation, which oversees global IP address allocation, autonomous system number allocation, root zone management in the Domain Name System (DNS), media types, and other Internet Protocol-related symbols and numbers.

Prior to the establishment of ICANN primarily for this purpose in 1998, IANA was administered at the Information Sciences Institute (ISI) of the University of Southern California (USC) situated at Los

Angeles, under a contract USC/ISI had with the United States Department of Defense, until ICANN was created to assume the responsibility under a United States Department of Commerce contract.

The **Internet Corporation for Assigned Names and Numbers** (**ICANN**) is a nonprofit organization that coordinates the Internet's global domain name system. The Internet Assigned Numbers Authority (IANA) is a department of ICANN responsible for managing the DNS Root and the numbering system for IP addresses.

The Internet Assigned Numbers Authority (IANA) is responsible for the global coordination of the DNS Root, IP addressing, and other Internet protocol resources. It is a set of functions that is currently contracted out by the National Telecommunications and Information Administration (NTIA), an agency in the U.S. Department of Commerce. The IANA function is currently carried out by ICANN.

With regard to Internet number resources, IANA's role is to allocate IP addresses and AS Numbers from the pools of unallocated resources to the Regional Internet Registries (RIRs) according to their needs, and to document protocol assignments made by the IETF. When an RIR requires more IP addresses for allocation or assignment within its region, IANA makes an additional allocation to the RIR.

IANA does not make allocations directly to ISPs or end users except in specific circumstances, such as allocations of multicast addresses or other protocol-specific needs.

Responsibilities

IANA is broadly responsible for the allocation of globally unique names and numbers that are used in Internet protocols that are published as Request for Comments (RFCs) 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.

In the case of the two major Internet namespaces, namely IP addresses and domain names, extra administrative policy and delegation to subordinate administrations is required because of the multi-layered distributed use of these resources.

IP addresses

IANA delegates allocations of IP address blocks to Regional Internet Registries (**RIRs**). Each RIR allocates addresses for a different area of the world. Collectively the RIRs have created the Number

Resource Organization formed as a body to represent their collective interests and ensure that policy statements are coordinated globally.

The RIRs divide their allocated address pools into smaller blocks and delegate them in their respective operating regions to Internet service providers and other organizations.

Domain names

IANA administers the data in the root name servers, which form the top of the hierarchical DNS tree. This task involves liaising with top-level domain operators, the root name server operators, and ICANN's policy-making tools.

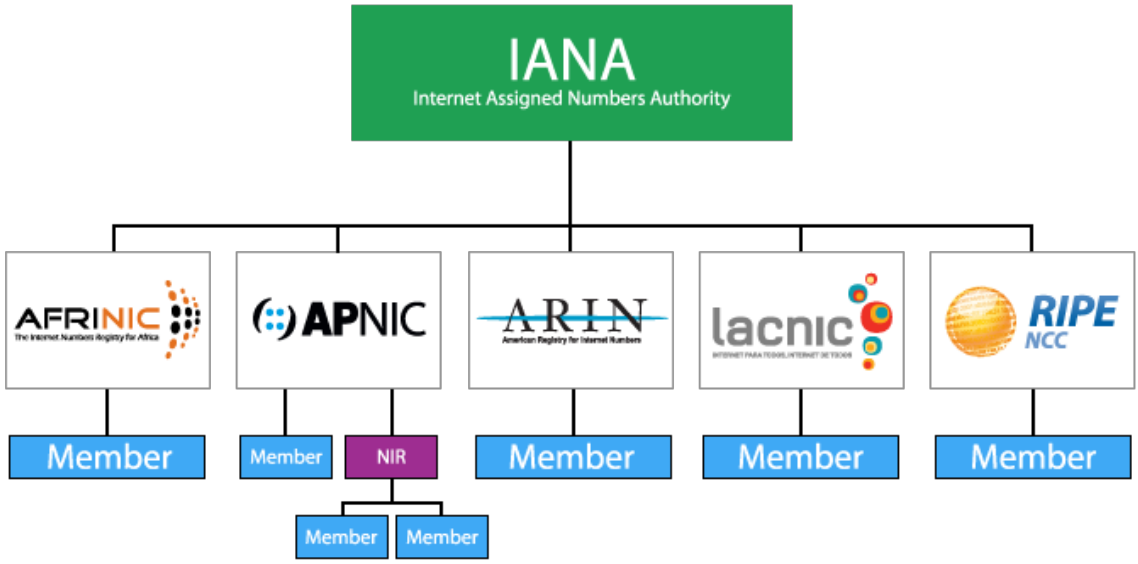
ICANN also operates the .int registry for international treaty organizations, the .arpa zone for Internet infrastructure purposes, including reverse DNS service, and other critical zones such as root-servers.

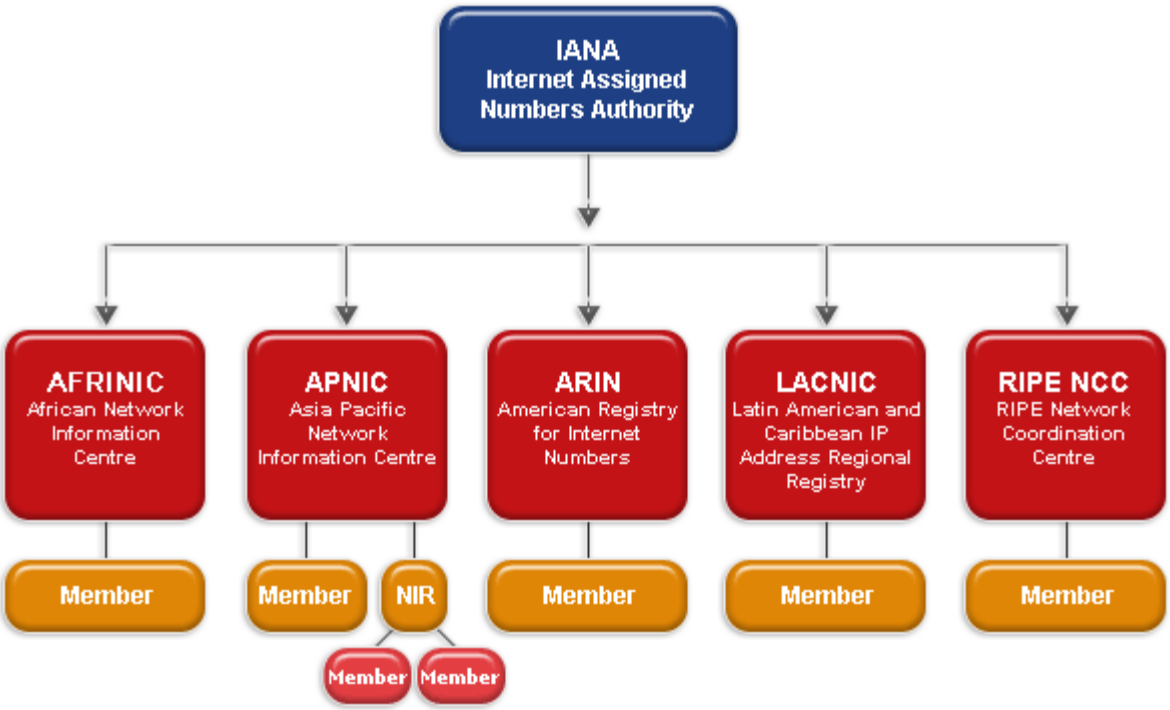
Protocol parameters

IANA administers many parameters of IETF protocols. Examples include the names of Uniform Resource Identifier (URI) schemes and character encodings recommended for use on the Internet. This task is undertaken under the oversight of the Internet Architecture Board, and the agreement governing the work is published in RFC 2860.

Time zone database

The IANA time zone database holds the time zone differences and rules for the various regions of the world and allows this information to be mirrored and used by computers and other electronic devices to keep accurate track of time zones through the Internet.

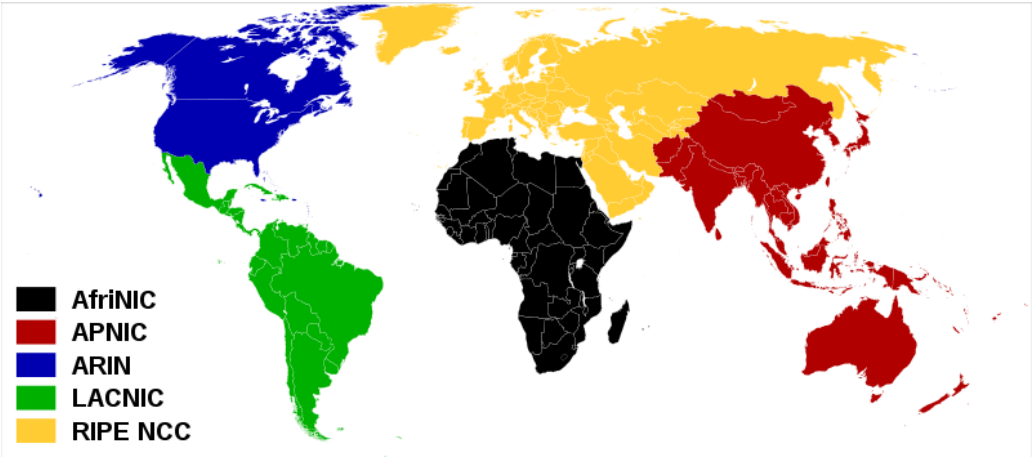




RIR

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.

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



Registry	Geographic Region
AFRINIC	Africa, portions of the Indian Ocean
APNIC	Portions of Asia, portions of Oceania
ARIN	Canada, many Caribbean and North Atlantic islands, and the United States
LACNIC	Latin America, portions of the Caribbean
RIPE NCC	Europe, the Middle East, Central Asia

The relationship between RIRs and IANA

Regional Internet Registries are components of the Internet Number Registry System, which is described in IETF RFC 7020. The Internet Assigned Numbers Authority (IANA) delegates Internet resources to the RIRs who, in turn, follow their regional policies to delegate resources to their customers, which include Internet service providers and end-user organizations. Collectively, the RIRs participate in the Number Resource Organization (NRO), formed as a body to represent their collective interests, undertake joint activities, and coordinate their activities globally. The NRO has entered into an agreement with ICANN for the establishment of the Address Supporting Organization (ASO), which undertakes coordination of global IP addressing policies within the ICANN.

> The Number Resource Organization (NRO) is a coordinating body for the five Regional Internet Registries (RIRs) that manage the distribution of Internet number resources including IP addresses and Autonomous System Numbers. Each RIR consists of the Internet community in its region.

List of Country Codes and RIRs

http://ripe.net/internet-coordination/internet-governance/internet-technical-community/the-rir-system/list-of-country-codes-and-rirs

NIR

National Internet Registries - As the RIR for the Asia Pacific, APNIC provides Internet number resource distribution, registration, and many other services to organizations across the region. In some cases APNIC provides services through approved National Internet Registry (NIR) organizations to meet particular geographical needs. NIRs perform Internet number delegations and registrations in line with APNIC policies. There are seven NIRS that exclusively serve their respective Internet communities in the local languages:

- APJII (Indonesia)
- CNNIC (China)
- IRINN (India)
- JPNIC (Japan)
- KISA (Republic of Korea)
- TWNIC (Taiwan)
- VNNIC (Vietnam)

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

- NIC Mexico
- NIC Brazil
- NIC Chile

There are no NIRs operating in the RIPE NCC region.

NIR quick facts

- Each economy may only have one NIR. There are seven NIRs in the APNIC region.
- NIRs have their own fee schedules in local currency for their members, and they pay membership fees to APNIC.
- Government endorsement is required to establish an NIR, although this is not an ongoing requirement.
- NIRs can have their own policies that apply only to their members, but those policies must not conflict with regional and global policies.

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 a Regional Internet registry is required to become an LIR.

Local Internet Registry (LIR) is a term used to describe the members of the RIPE NCC. They are called LIRs because they are responsible for the distribution of address space and registration of the address space on a local level. LIRs also ensure that policies and procedures are followed on the local level. Organizations that become LIRs are mainly Internet Service Providers (ISPs) that assign and allocate address space on to their customers, telecom and enterprise organizations, as well as academic institutions.

Understanding Domain Registration

There are a large number of companies that provide domain name registration services. The prices to register a domain name for a web site vary widely, from the budget domain name registration outlets to the premium companies that charge quite a bit more. All too often, people new to the world of registering domain names make the mistake of choosing the first domain name registration company (known as "registrars") that comes along - not fully realizing the importance of it all.

How Domain Name Registration Works

First, though, it's important to understand the role a domain registrar plays. How it works is that you pay for your own domain name (such as *bigskyfishing.com*). The registrar then "holds" the domain name for you. You then assign what are known as DNS numbers to the particular domain name (these DNS numbers are provided by your web host - a web host is where your actual web site is stored). These DNS numbers point the way to where your actual web site is located - and are used throughout the entire Internet to locate your site. If the DNS numbers are incorrect or something else doesn't work, your site cannot be found - even by typing in the domain name of your site.

So why do you need DNS numbers to point the way to your actual web site? The reason is because the Internet locates web sites by IP addresses (or the DNS number) and not by actual domain names. Thus, when you type in, say, ***www.bigskyfishing.com*** into the address bar of a browser, a very quick lookup is then launched behind the scenes that finds what DNS numbers that bigksyfishing.com is associated with. This is done because it is far easier for *users* to locate web sites by domain names (bigskyfishing.com) instead of DNS numbers (which is what the computers use).

Thus, any problem with the DNS numbers will lead to a web site that cannot be found by anyone - including you! As such, registering a domain name with a company that will not mess things up is crucial. If they mess up the DNS numbers or something else related to it, your web site is essentially out of business.

My first domain names, including *bigskyfishing.com*, were registered with the cheapest registrar I could find. For "holding" domain names, known as "parking" (where you buy a domain name but do not right away associate a web site to it), this is ok, since if the domain name registration company messes things up, you're not really out anything.

1.3 Internet Domain and Domain Name System

The Domain Name System (DNS) is a global database that translates domain names (such as www.internetsociety.org) to Internet addresses that are used by computers to talk to each other.

Domain names are fundamental to the Internet. Every Internet-connected device, whether a personal computer, smart phone, or gaming console, looks up each name in the global DNS, and uses the resulting Internet address to connect to the web server, send the e-mail or use the World Wide Web.

When you visit http://www.internetsociety.org in a browser, your computer uses DNS to retrieve the website's IP address.

What is a URL?

URL stands for Uniform Resource Locator and refers to the entire address used to visit a website, including all those colons and slashes. This address includes the domain name.

The URL for the Netregistry website would be 'http://www.netregistry.com.au'. This contains the 'hypertext transfer protocol' (http), telling the browser that you are using a domain name instead of an IP Address. This is followed by the domain name itself (www.netregistry.com.au or netregistry.com.au — both are valid). This points to the server where the website is hosted and the particular files on that server to be accessed.

What are top level and second level domain names?

Dot Com (.com) was the first domain type to be introduced and is considered a top level domain or TLD. Top level domains include any that contain only one suffix — for example; .net, .info, .biz and so on.

Second level domains or 2LDs are domain names containing another level after the .com or .co suffix. For example; .com.au is a second level domain style as it contains an additional suffix after the .com that shows the website originates in Australia.

How do domain names work?

Registering a domain name does not automatically activate a website that displays when visitors enter your domain name into a Web browser. The domain name must have a hosted website that includes a numeric address, called an IP address, for visitors to access the website using your domain name.

Your domain name and its associated IP address are stored in a common database along with every other domain and associated IP addresses that are accessible via the Internet. When visitors enter your domain name into a Web browser, the browser request uses your domain name to find the domain name's associated IP address and, therefore, the website. People use domain names instead of IP addresses because it is easier to remember a name rather than a series of numbers.

‘When you register a domain name, you do not have to host a website.’

For new domain names and updates, allow up to eight hours for changes to become effective. Allow up to 48 hours for changes made to all other domain name extensions to become effective. This delay is because of the number of networks and agencies involved in the Internet structure. Delays apply to all domain names and registrars.

List of Internet top-level domains

http://en.wikipedia.org/wiki/List_of_Internet_top-level_domains

What is an IP Address?

An IP (Internet Protocol) address is a unique identifying string of numbers, like **216.27.61.137**, given to every individual computer, server, and network on the Internet. Like a license plate is used to help identify vehicles, an IP address is used to identify and locate information online. Additionally, they allow for communication over the internet between devices and networks connected to the internet.

What is a domain name?

A domain name, like **www.coolexample.com**, is a lot like a street address for a house or business.

Let's use the White House as an example. The street address, 1600 Pennsylvania Avenue, is an exact location — like an IP address. You might not know the exact street address, but when you visit Washington, D.C., you can tell your cabbie that you want to visit the White House and still get there. This is how a domain name is used: It's an easy way to reach the exact location of a website without having to remember its numeric address.

A domain name consists of, at least, a top-level and a second-level domain. A top-level domain (TLD) is the part of the domain name located to the right of the dot ("."). The most common TLDs are .com, .net, .org etc.

Many domains, also called extensions, can be registered by anyone, like .com, .net, and .org. A second-level domain (SLD) is the portion of the domain name that is located immediately to the left of the dot and domain name extension.

Advanced Domain Name Description: A domain name represents a physical point on the Internet — an IP address. The Internet Corporation for Assigned Names and Numbers (ICANN) governs coordination of the links between IP addresses and domain names across the Internet. With this standardized coordination, you can find websites on the Internet by entering domain names instead of IP addresses into your Web browser.

What is the 'www' before my domain name?

The **www** before your domain name is a subdomain, not part of the domain name itself. Therefore, if you set up your **www** CNAME record to point to your primary A record, your site will resolve both at **www.coolexample.com** and **coolexample.com**.

If you can reach your website by typing in your domain without the **www** but cannot reach it when you type the **www**, then your CNAME might be set up incorrectly.

How do domains work?

When visitors enter your domain name into a Web browser, the browser request uses your domain name to find the domain name's associated IP address and, therefore, the website. People use domain names instead of IP addresses because it is easier to remember a name rather than a series of numbers.

Your domain name and its associated IP address are stored in a common database along with every other domain and associated IP addresses that are accessible via the Internet.

What is a URL?

A URL, or Uniform Resource Locator, is the address of an Internet website or webpage. Think of a URL as a street address for the location of information on the Internet. For instance, a complete URL like http://coolexample.com/music, points you to the music page of the coolexample.com website.

Take a look at the anatomy of this URL to better understand how they direct online users to specific information:

http://coolexample.com/funky/music.html

http:// = protocol
coolexample.com = domain name
/funky/music.html = path
/funky/ = directory
/music.html = file name

What is a nameserver?

Nameservers are the Internet's equivalent to phone books. A nameserver maintains a directory of domain names that match certain IP addresses. The information from all the nameservers across the Internet is gathered in a central registry.

Nameservers make it possible for visitors to access your website using a familiar domain name, instead of having to remember a series of numbers.

What can you do with domain once it's been registered?

Registering a domain name does not automatically activate a website that displays when visitors enter your domain name into a Web browser. The domain name must have a hosted website that includes a numeric address, called an IP address, for visitors to access the website using your domain name.

Besides setting up a website, there are a number of things you can do with your domain name once you register it.

- **Sell it** — Domain names can be a great investment. If you have registered a domain name that you are not using, maybe someone else can.

- **Protect your brand online** — The more domain names you register, the better. Prevent others from registering a similar domain name to yours. These similar domain names can steal your customers or confuse them.

- **Hold on to it** — Maybe you haven't decided what to do with your new domain name. Don't worry — there's no rush.

Why should I register more than one domain name?

If you're thinking about registering more than one domain name, you've got the right idea. Registering and using multiple domains names is great for building your business, protecting your brand name, and creating a dynamic online identity.

When you register multiple domain names, you can:

- Keep your competition from registering a similar domain name drawing customers to them instead of you
- Promote the different products and services you offer
- Drive more traffic to your website
- Enjoy more opportunities to market to — and be listed in — search engines
- Create distinct advertising strategies reaching different target markets
- Provide customers more ways to find you when searching the Internet
- Capture common misspellings of your domain name, instead of sending visitors to an error page
- Protect your brand and online identity

When can I register an expired domain name?

Usually, a domain name is not available for re-registration as soon as it expires. Most registrars allow a grace period that can be as short as one or two weeks or as long as a year for registrants to renew expired domain names. The actual grace period can be different for each individual registrar and domain name extension. That is, the grace period for a .com domain name might be different from the grace period for a .us domain name, even at the same registrar.

After the registrar's grace period, most domain names have a redemption period. This period can last from two weeks to 30 days, and, during this time, the current registrant can renew the domain name by paying a redemption fee along with the domain name's renewal fee.

If the current registrant does not renew or redeem the domain name, it might be auctioned. When a domain name is released to a public auction, you can participate and possibly capture the domain name by placing a bid on it.

If the domain name is not renewed, redeemed, or purchased through an auction, it is returned to its registry. The registry determines when the domain name is released again for registration. Once it's released, you can register the domain name through us.

1.4 Internet Access Overview

[SELF STUDY]

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

Optical Backbone

The fiber optic backbone can mean different things depending on the service being used. Generally, however, it simple refers to that fiber optic cable traversing the main path or route in that part of the overall network. It differs with a lateral, which would run from a backbone splice point to typically an end use premise (i.e. building or cell site). Backbone cables will typically be built with high fiber counts and laterals will have relatively fewer fibers in the cable since it will have less use.

Fiber optic cables are replacing copper wiring to increase the speed of digital information transmission. These cables are bundles of extremely pure glass threads that have been coated in two layers of reflective plastic.

> The use of optical fiber and laser technology ensures that connections can be made over very long distances (e.g. more than 100 km (60 miles) between 2 nodes, network size >2000km (1200 miles)) with excellent transmission quality.

Fiber optics (optical fibers) are long, thin strands of very pure glass about the diameter of a human hair. They are arranged in bundles called **optical cables** and used to transmit light signals over long distances.

If you look closely at a single optical fiber, you will see that it has the following parts:

- **Core** - Thin glass center of the fiber where the light travels
- **Cladding** - Outer optical material surrounding the core that reflects the light back into the core

- **Buffer coating** - Plastic coating that protects the fiber from damage and moisture

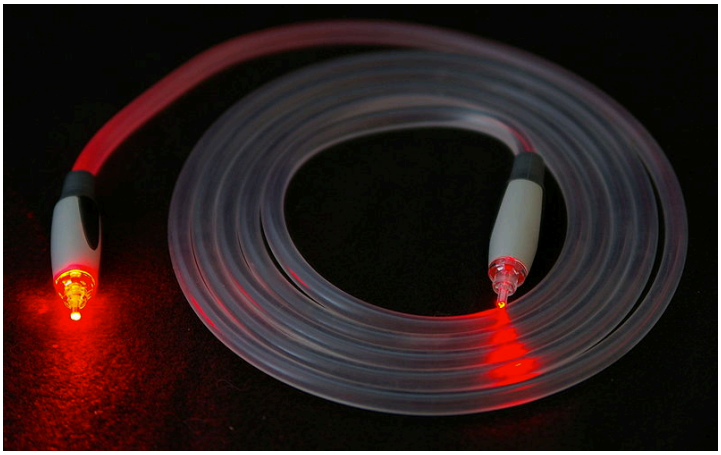
Hundreds or thousands of these optical fibers are arranged in bundles in optical cables. The bundles are protected by the cable's outer covering, called a **jacket**.

Optical fibers come in two types:

- **Single-mode fibers**
- **Multi-mode fibers**

Single-mode fibers have small cores (about 3.5 x 10^{-4} inches or 9 microns in diameter) and transmit infrared laser light (wavelength = 1,300 to 1,550 nanometers). **Multi-mode fibers** have larger cores (about 2.5 x 10^{-3} inches or 62.5 microns in diameter) and transmit infrared light (wavelength = 850 to 1,300 nm) from light-emitting diodes (LEDs).

- Fiber optic cables have a much greater bandwidth than metal cables. This means that they can carry more data.
- Fiber optic cables are less susceptible than metal cables to interference.
- Fiber optic cables are much thinner and lighter than metal wires.
- Data can be transmitted digitally (the natural form for computer data) rather than analogically.



OC-1 = 51.85 Mbps

OC-3 = 155.52 Mbps

OC-12 = 622.08 Mbps

OC-24 = 1.244 Gbps

OC-48 = 2.488 Gbps

OC-192 = 9.952 Gbps

OC-255 = 13.21 Gbps

Submarine communications cable (**Marine Cables**)

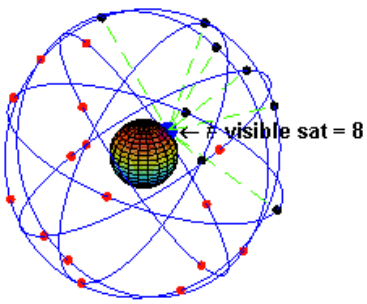
A **submarine communications cable** is a cable laid on the sea bed between land-based stations to carry telecommunication signals across stretches of ocean. The first submarine communications cables, laid in the 1850s, carried telegraphy traffic. Subsequent generations of cables carried telephone traffic,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

[Reference: Videos]

S**atellite** is an artificial object, which has been intentionally placed into orbit. Such objects are sometimes called **artificial satellites** to distinguish them from natural satellites such as the Moon.

Satellites are used for a large number of purposes. Common types include military and civilian Earth observation satellites, communications satellites, navigation satellites, weather satellites, and research satellites. Space stations and human spacecraft in orbit are also satellites. Satellite orbits vary greatly, depending on the purpose of the satellite, and are classified in a number of ways. Well-known (overlapping) classes include low Earth orbit, polar orbit, and geostationary orbit.

About 6,600 satellites have been launched. The latest estimates are that 3,600 remain in orbit. Of those, about 1,000 are operational; the rest have lived out their useful lives and are part of the space debris. Approximately 500 operational satellites are in low-Earth orbit, 50 are in medium-Earth orbit (at 20,000 km), the rest are in geostationary orbit (at 36,000 km).



1. **Low-Earth orbits (LEO)** — LEO satellites occupy a region of space from about 111 miles (180 kilometers) to 1,243 miles (2,000 kilometers) above Earth. Satellites moving close to the Earth's surface are ideal for making observations, for military purposes and for collecting weather data.

2. **Medium-Earth orbits (MEO)** — These satellites park in between the low and high flyers, so from about 1,243 miles (2,000 kilometers) to 22,223 miles (36,000 kilometers). Navigation satellites, like the kind used by your car's GPS, work well at this altitude. Sample specs for such a satellite might be an altitude of miles (20,200 kilometers) and an orbital speed of 8,637 mph (13,900 kph).

3. **Geosynchronous orbits (GEO)** — GEO satellites, also known as geostationary satellites, move around Earth at an altitude greater than 22,223 miles (36,000 kilometers) and at the same speed of rotation. As a result, satellites in these orbits are always positioned over the same spot on Earth. Many geostationary satellites fly above a band along the equator, which has led to significant congestion in this region of space. Several hundred television, communications and weather satellites all use geostationary orbits.

A *telecommunications port*—or, more commonly, *teleport*—is a satellite ground station that functions as a hub connecting a satellite or geocentric orbital network with a terrestrial telecommunications network, such as the 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.