Web Systems

Lecture 2

Web System Infrastructure, Protocols, and Applications

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Web System Infrastructure, Protocols, and Applications

- **Computer Systems**:
  - Client and Server computers, Mobile Devices
  - Client/Server Computing
  - Cloud computing
- **Communications and Networking**
  - Wired, Wireless, Cellular communications
  - Internetworking
  - TCP/IP Protocols and Application Programs
  - Internets, Extranet
- **The Internet Technology**
  - Internet, Web, Packet Switching, TCP/IP Architecture, IP Addresses; Domain Names, DNS, and URLs;

Web System Infrastructure, Protocols, and Applications

- **The Development of Web**
  - Web Browsers & Web Servers
    - Search Engine
    - Online Forums and Chat
    - Streaming Media (audio, video, images and pictures)
    - E-commerce, E-business Enterprise app, Social media
    - E-mail, Text Messaging, Multimedia messaging

Web System Infrastructure, Protocols, and Applications

- **The Development of Web**
  - Web Browsers & Web Servers
  - **Web 2.0 and Services**
    - Participative Web and Social Web
    - User create contents and interact with sites and with each other through social media
    - Use: Blogs, Social Networking, Social Collaborative Tools
    - May Offer: Podcasting, Wikis, Music and Video Services, VoIP, IPTV, Online software, Web Services

Web System Infrastructure, Protocols, and Applications

- **Web 3.0 (2006.. Now)**
  - **Five Main Features of Web 3.0, https://www.expertsystem.com/web-3-0/**
    - **Semantic Web –** generate, share, and connect content through search and analysis based on the ability to understand the meaning of words.
    - **Artificial Intelligent –** can understand the information like humans in order to provide faster and more relevant results.
    - **3D Graphics**
    - **Connectivity**
    - **Ubiquity**

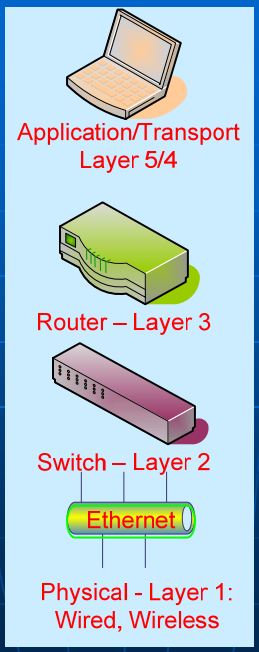
The Internet

- **Internet**
  - **A TCP/IP networked, distributed information system**
    - **A collection of computer networks spread around the world**
    - **The name for a group of worldwide client/server-based information system for sharing resources and for communications**
    - **A global, interactive, dynamic, cross-platform, distributed, hypertext and hypermedia information system**
- **Examples of Internet-enabled Services**
  - Email, File downloading and uploading, WWW Client/Server applications

TCP/IP Protocol Stacks

- TCP/IP RFC (Request for Comments – Standards) - Internet Engineering Task Force, https://www.ietf.org/
- System Administration Guide: IP Services, http://docs.oracle.com/cd/E19253-01/816-4554/ipov-10/index.html
- TCP/IP Protocol Architecture, https://technet.microsoft.com/en-us/library/cc958821.aspx
- TCP/IP Tutorial and Technical Overview - IBM Red Book, 1004 pages https://www.redbooks.ibm.com/redbooks/pdfs/gg243376.pdf
- Connecting all the Things in the Internet of Things, May 2017, https://www.ibm.com/developerworks/library/iot-lp101-connectivity-network-protocols/index.html

TCP/IP Protocol – Five Layers

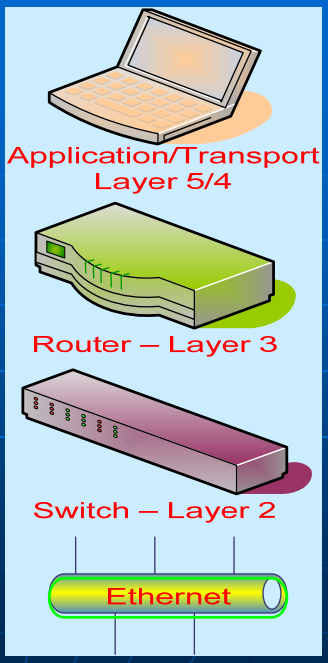


TCP/IP Layer Model

- **Five Layers**

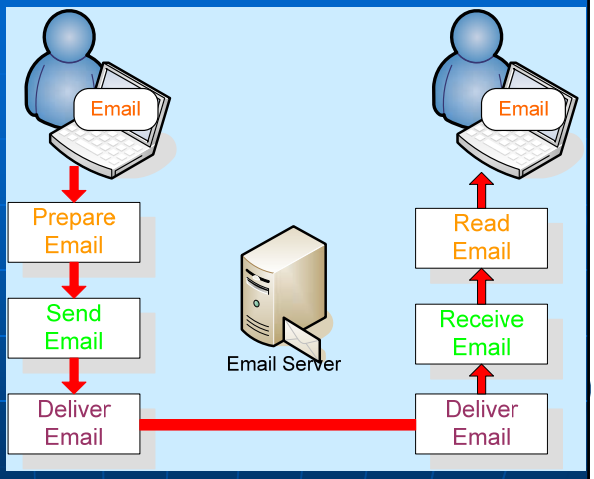
(Encapsulation of data units)

- Layer 5: **Application Layer**
  - **Message**
- Layer 4: **Transport Layer**
  - **Segment or User Datagram**
- Layer 3: **Network Layer**
  - **Datagram**
- Layer 2: **Frame**
  - **Data Link Layer**
- Layer 1: **Physical Layer**
  - **Bits**



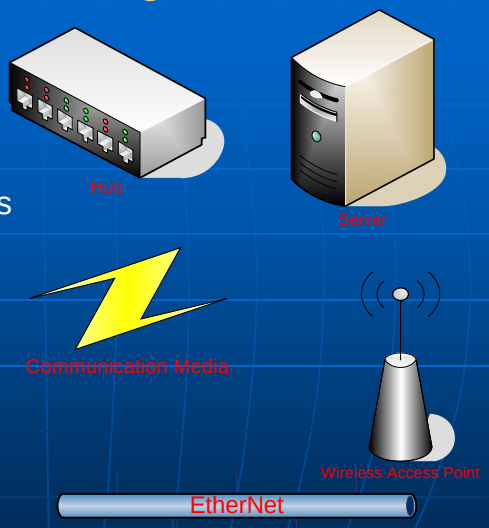
Layered Tasks

- **Sender, Receiver, Carrier**
- **Hierarchy**
  - **Preparation**
  - **Sending**
  - **Delivering**
- **Services**
  - **Higher layer uses lower layer service**



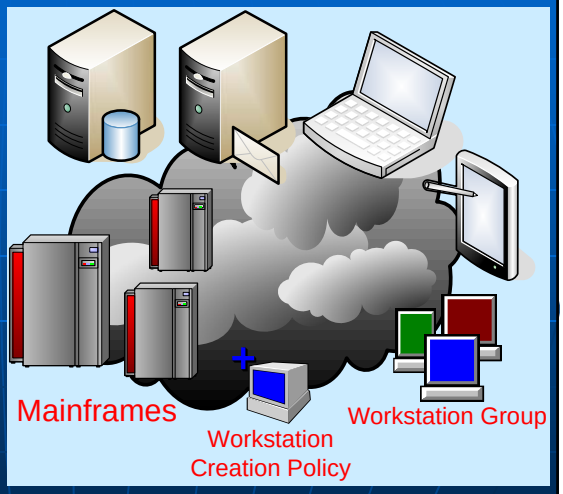
Networking

- Involves
  - Applications
  - Connections of Computers
  - Networking Protocols
  - Transmission Media
  - Networking Devices

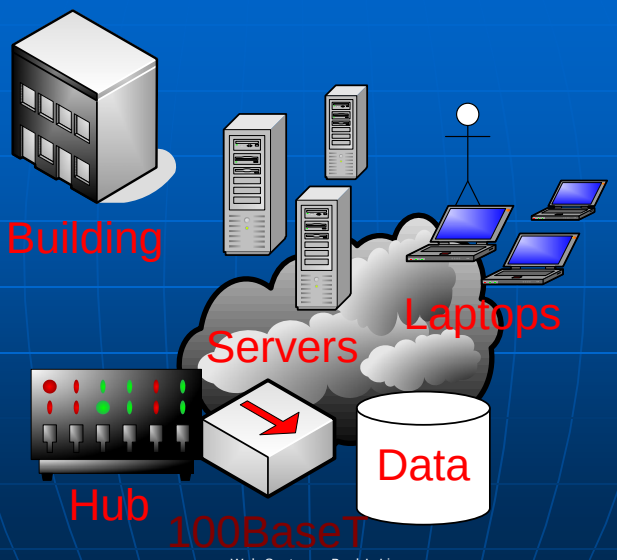


Computer Networks & Distributed Computer Systems

- **Distributed Processing**
  - **Loosely connected computer networks**
  - **Many computers collaborating with each other**
  - **Client-Server Computing**

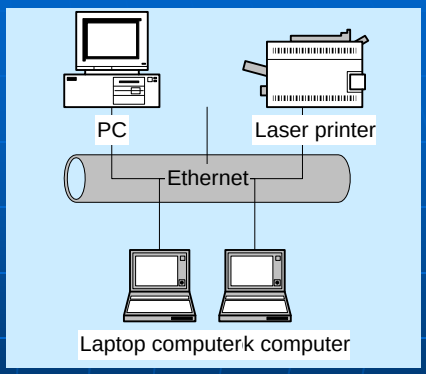


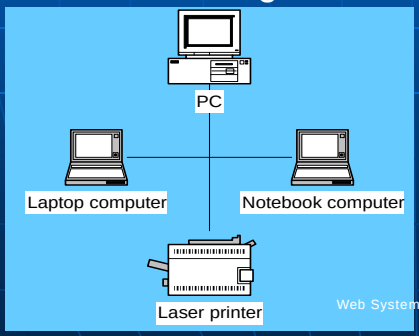
Local Area Networks



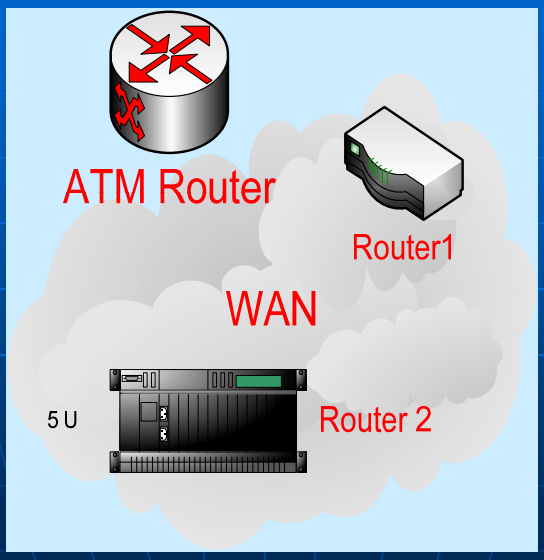
Multipoint Line Configuration

- **Multi-drops**
- **Sharing a single link:**
  - Spatially
  - Time sharing





Wide Area Networks (WANs)



TCP/IP Protocol Stack

TCP / IP Layers	TCP / IP Protocol Examples
5 – Application Layer	Standard TCP/IP services: ftp, tftp, telnet, ping commands, etc Linux/Unix commands: rlogin, rsh Name services: NIS, DNS (domain name system), Directory services: LDAP File services: NFS Network administration/management: SNMP (simple network management) Route management: RDISC (router discover server protocol), RIP (routing information protocol)
4 – Transport Layer	TCP UDP – User Datagram Protocol SCTP – Reliable connection-oriented transport protocol (for supporting connections between systems with more than one address)
3 – Internet Layer	IPv4, IPv6 ARP – Address Resolution Protocol IMCP – Internet Control Message Protocol
2 – Data Link Layer	PPP – point-to-point protocol IEEE 802.3 (Ethernet) Token Ring
1 – Physical Layer	RS 232, 485, ADSL (Asymmetric Digital Subscriber Line), DSL FDDI (Fiber Distributed Data Interface)

TCP/IP Protocol Suite

- TCP/IP (Transmission Control Protocol/Internetworking Protocol) Layering Model
- TCP/IP Applications
- Domain Names
- TELNET
- FTP (File Transfer Protocol)
- HTTP (HyperText Transfer Protocol)
- HTTPS (secure)
- And more

Internet Applications and Addressing

- Email addressing
- Web server addressing (domain name, IP address)
- TELNET addressing (Web)
- FTP address

Internet Content/File Types

- **Email text**
- **HTML** (Hypertext Markup Language) document
- **Hypertext** -- a technique used to link one word or phrase to another word or phrase in a virtual digital publishing system
- **Hypermedia** -- a technique used in the Web documents to link one media to another media in the forms of words, color graphics, video clip, etc

Internet Content/File Types

- **RTF** (Rich Text) - a super ASCII format established by Microsoft in 1980, can be imported to many other systems such as all Windows word processors, and Macs.
- **Postscript** - a highly sophisticated and precise page description language that is used for formatting and typesetting the print media. It is a proprietary format owned by Adobes

Internet Content/File Types

- MIME (Multipurpose Internet Mail Extension) for sending binary data
- Color Graphics File
  - GIF – Graphics Interchange Format
  - JPEG – Joint Photographic Experts Group
- Video – Digital motion video
  - .mov – QuickTime Movie (plug-in player)
  - .avi – Audio/Video Interleaved (1992, Microsoft)
  - .mpg – a multimedia standard supporting video, audio, and streaming by Moving Picture Expert Group
- Embedded Programs: JavaScript, Java Applet

Internet Content/File Types

Audio File formats:

- wav – Waveform Audio File for PC (uncompressed, CD-quality sound file)
- mp3 – the MPEG Layer 3 format (Moving Picture Experts Group)
- aiff – Audio Interchange File Format for the MAC
- avi – Audio, Video Interleaved
- au – standard audio file format used by Sun, Unix and Java
- midi: Music Instrument Digital Interface, non-streaming audio file
- Real Audio/Video (not-in-real-time audio/ video) - steaming audio/video

Enterprise Applications

- E-commerce
  - high availability and security
- Messaging/Groupware
- Content monitoring
- Security
- Network Management
- Servers:
  - Web server
  - File and Print server
  - Database server
  - Mail server

Enterprise Applications

- Intranet:
  - A network within an enterprise uses TCP/IP, HTTP, and other Internet protocols
- Extranet:
  - A private secure extension of an enterprise via a corporate intranet that allows you and your customer, vendors, and other business partners to communicate and do business using standard Internet technology.
- Virtual Private Network (VPN)
  - A private network uses public telecommunication infrastructure. Privacy is maintained by the use of tunneling protocol, encryption, and other security procedures.

Internet Web-Enabled Applications

- E-Commerce: B2C (Business to Customer), B2B (Business to Business)
- E-Health
- Smart Power Grid
- Electronics publishing with multimedia technology
- Database applications
- Application Service Provider
- Customer Relationship Management (CRM)
- Supply Chain Management (SCM)
- Enterprise Management (ERP)
- Connected smart infrastructure (smartphone, IoTs, smart cities, etc)

Internet Web-Enabled Applications

- Distance Education
- Email/Messaging
- Teleconferencing
- Entertainment
- Content Delivery/Advertisement
- Machine Control and Monitoring
- Cloud-based Services

TCP/IP and Internet

- **Internet**
  - **A virtual network system that is formed by using routers to connect physical networks around the world**
- **Routers**
  - **Special purpose computers dedicated to interconnecting heterogeneous networks**
- **Internet Activities Board (IAB)**
  - The Internet Engineering Task Force (IETF)
  - The Internet Research Task Force (IRTF)
  - Request For Comments (RFC) process
  - Proposed Standard - Draft Standard - Full-fledged Standard
  - http://www.w3.org

TCP/IP Applications

- **Ping** (echo service)
- **Telnet** (RFC 854)
  - Remote Login terminal emulation protocol that enable clients to log on to remote hosts on the network
  - Provide access to a computer connected to the network
- **FTP** – File Transfer Protocol, (RFC 959)
  - RFC 959
  - File transfer applications that enables users to transfer files between hosts across network
  - Provides two virtual connections:
    - Data transfer or exchange (port 20, TCP)
    - Control (commands, replies, process updates; port 21, TCP)
- **SMTP** (Simple Mail Transfer Protocol, RFC 821)
  - Mail service

Ping – An Echo Service Example

C:\Users\Administrator>**ping www.mit.edu**

Pinging e9566.dscb.akamaiedge.net [23.63.195.47] with 32 bytes of data:
Reply from 23.63.195.47: bytes=32 time=17ms TTL=53
Reply from 23.63.195.47: bytes=32 time=91ms TTL=53
Reply from 23.63.195.47: bytes=32 time=99ms TTL=53
Reply from 23.63.195.47: bytes=32 time=16ms TTL=53

Ping statistics for 23.63.195.47:
Packets: Sent = 4, Received = 4, Lost = 0 (0% loss),
Approximate round trip times in milli-seconds:
Minimum = 16ms, Maximum = 99ms, Average = 55ms

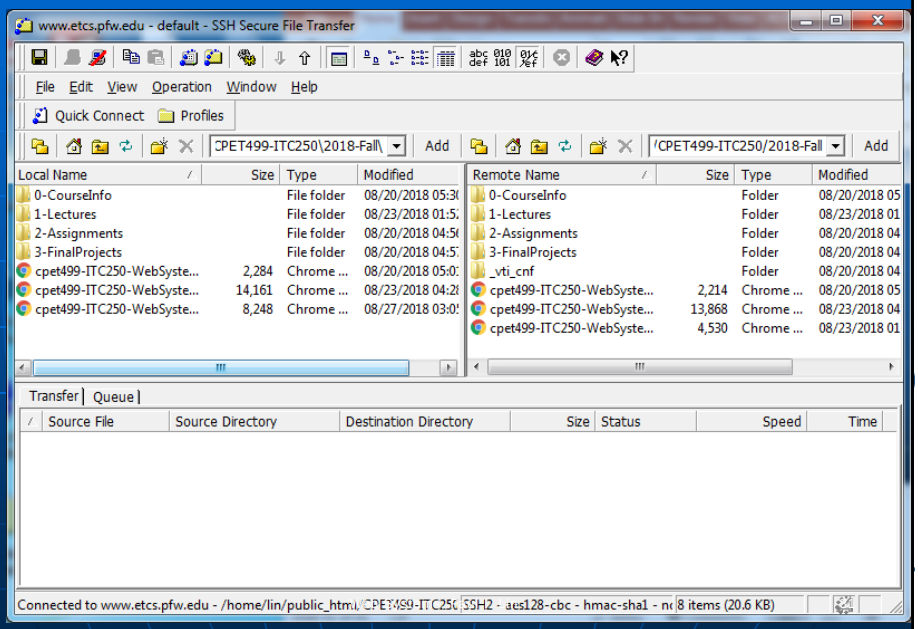
Ping – An Application Example

C:\Users\Administrator>**ping www.microsoft.com**

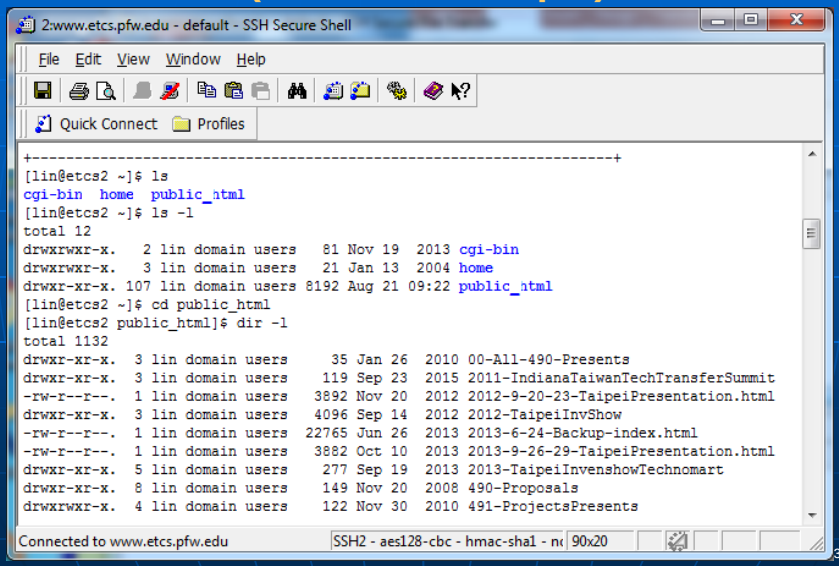
Pinging e13678.dspb.akamaiedge.net [23.53.232.243] with 32 bytes of data:
Reply from 23.53.232.243: bytes=32 time=15ms TTL=57
Reply from 23.53.232.243: bytes=32 time=20ms TTL=57
Reply from 23.53.232.243: bytes=32 time=16ms TTL=57
Reply from 23.53.232.243: bytes=32 time=16ms TTL=57

Ping statistics for 23.53.232.243:
Packets: Sent = 4, Received = 4, Lost = 0 (0% loss),
Approximate round trip times in milli-seconds:
Minimum = 15ms, Maximum = 20ms, Average = 16ms

SSH Application – A FTP Application



SSH Secure Shell – Terminal Window (A Telnet Example)



TCP/IP Applications

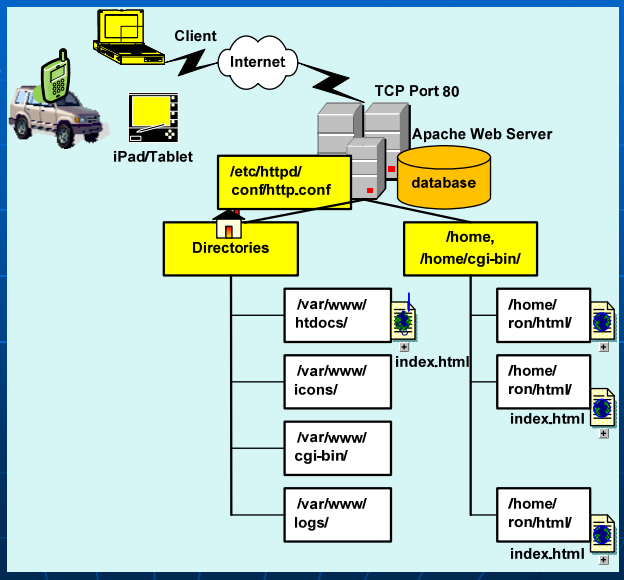
- **SNMP** (Simple Network Management Protocol)
  - RFC 821
  - Simple Network Management Protocol) - used to remotely manage and monitor network devices
- **DNS** (Domain Name Services) - domain names to IP address translation

TCP/IP Applications

- **HTTP** (HyperText Transfer Protocol)
  - Establish a connection between the client and server
  - For transferring hypertext (mixed media) documents through WWW
  - Use TCP/IP to support communications between Web servers and Web clients
  - HTTP Communications:
    - A Request from a Web client (client → Server)
    - A Response from the Web server (server → client)
    - Close or terminate the connection

HTTP Web Server

- HTTP Port 80
- HTTPs Port 443



TCP/IP Applications

- NFS (Network File System) - File Access Protocol
- POP (Post Office Protocol)
- Network News Transfer Protocol
- RPC (Remote Procedure Call) - Transfer Procedure (function) Call to another machine
- TFTP (Trivial File Transfer Protocol))

Transport Layer

- Transport Layer
  - Specify how to ensure reliable transfer
  - Defines two protocols
    - Transmission Control Protocol (connection oriented, reliable)
    - User Datagram Protocol (connectionless, not reliable)

Domain Names

- Human-friendly reference names associated with IP address
- For TCP/IP based network system
- Standardized in hierarchical fashion
- An example:

  www.purdue.edu

  edu - Top level domain name

  purdue - main or network specific domain name

  www - Web server

Domain Name System (DNS)

- DNS identifies each host on the Internet
- Similar to the Telephone Number System (country code, area code, number)
- A Name Server using Client-Server model
- Tree Structure (Root, Leaves):
  - Organization (Generic) domain
  - Country domain
  - Reverse
- Unique Domain Name → Unique IP address

Domain Organizations

- **ICANN (Internet Corporation for Assigned Names and Numbers), http://www.icann.org/**
  - The authority governs global Internet domain name system

com	Commercial Organization
edu	Educational Institution
gov	Government Institution
int	International Organization
mil	Military Groups
net	Network Support Center
org	Non-profit Organizations

- gTLD (Generic Top-Level Domain) Program, http://www.icann.org/en/registries/

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Domain Organization

- November 16, 2000: ICANN, the authority that governs global Internet domain name system, has approved seven new domains extensions, in addition to .com, .net and .org:

  biz, info, name, pro, aero, coop, museum
- **New gTLD (Generic Top-Level Domains)**, http://newgtlds.icann.org/en/

Summary