Introduction to the Internet and Data Networking

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Goals of the Course

- **Week 1:** Gain a basic understanding of how the Internet was formed.
- **Week 2:** Understand the following networking concepts: LAN/WAN, Seven Layer OSI Model, TCP/IP.
- **Week 3:** Gather an overview of the various core technologies of Data Networking
- ***Week 4:* Finish Core Data Networking Technologies and Understand what companies, agencies, and organizations are helping to build the Internet today.**
- **Week 5:** Have an ability to discuss the pros/cons of the Internet and why it will change the way we work, live, play, and learn.

Routing – Algorithms

- The goal of a routing algorithm is to route a packet from one point in the network to another point in the network through some set of intermediate routers without "looping," a situation in which a packet is forwarded across the same link several times.
- There are two general algorithms for computing: *distance-vector* and *link-state*.

Distance Vector Routing Protocols

- Distance Vector Algorithms are based on the "*Bellman-Ford*" Algorithm (page 172 of text).
- **RIP** – Routing Information Protocol Version 1
  - Derived from Xerox Network System's (XNS) routing protocol, which was also called RIP. It was bundled with BSD UNIX in 1982 as part of the TCP/IP protocol suite and became the de facto standard for IP routing.
- **RIPv2** - Routing Information Protocol Version 2
  - The following features were added: Authentication, Interpretation of IGP and BGP Routes, Next Hop Field, Multicasting.

RIP uses a distance-vector algorithm that determines the best route by using hop metric. When used in small, homogeneous networks, RIP is a very efficient protocol and its operation is fairly simple. RIP keeps all routing tables within a network updated by transmitting routing table update messages every 30 seconds. After a RIP-enabled device receives an update, it compares its current information with the information contained in the update message.

RIP imposes a maximum hop count of 15 – more than 15 hops away – RIP classifies the network as "unreachable." In router jargon, the destination network's cost goes to infinity.

Other strategies to resolve misinterpretations of update information are:

1. split-horizon – ensures that a router never sends routing info back in the direction in came from
2. split-horizon with poison-reverse – similar to split-horizon but routes back were it came from are sent to 15 (unreachable)
3. Hold-down – forces routers to periodically update based on set time.

Link-State Routing Protocols

- Link-State Algorithms are based on Dijkstra's Shortest Path First Algorithm (page 174 of text).
- Link State Advertisements (LSA) are sent as updates to all other devices including names and cost-metric value of its neighbors.
- Protocols Include: OSPF (Open Shortest Path First), OSI's IS-IS, and Netware's Link Services Protocol.

Differences between OSPF vs. RIP

RIP is a DV protocol best operated in a homogeneous environment with major limitations

OSPF designed for large, heterogeneous IP networks. Allows 16-bit for metrics (very flexible & feature rich

-- more difficult to implement

Common Circuit Speeds

DIGITAL

- DS-0: 64kbps
- DSL: 144k, 384k, 768k, 1.5M, others
- ISDN(BRI): 192kbps
- ISDN(PRI): 1.544Mbps
- T1(DS-1): 1.544Mbps
- T3(DS-3): 44.736Mbps (30 x T1)

SONET

- *OC-n: 51.84Mbps x n*
- OC-3: 155.52Mbps
- OC-12: 622.08Mbps
- OC-48: 2.49Gbps
- OC-192: 9.95Gbps

DS-0 (one channel)

ISDN(BRI) = 2xB channels (64kbps) + D channel (16kbps) + framing/error correction(~48)

ISDN(PRI) = 24xB channels (64kbps) + 8kbps (overhead)

DS-1 vs. T1?

Today they're often used interchangeably … However, the distinction is DS-1 is the bit format used for transmission on a T1 data communication link. DS-1 is a format used on copper, fiber, and broadband medium.

T1 (digital Transmission rate) is a point-to-point communication circuit that carries 24x64kbps channels that can be used for both data and digitized voice across a copper medium.

Common WAN Technologies

- Asynchronous Transfer Mode (ATM)
- Integrated Services Digital Network (ISDN)
- Point-to-Point Protocol (PPP)
- Frame Relay
- X.25
- Switched Multimegabit Data Service (SMDS)
- High-Speed Serial Interface (HSSI)
- Synchronous Data Link Control (SDLC)

ATM: Asynchronous Transfer Modes is a method for the dynamic allocation of bandwidth using a fixed-size packet (called a cell). The ATM Forumis an international non-profit organization aiming to encourage the user of Asynchronous Transfer Mode through interoperability specifications and to promote cooperation and awareness. The ATM Forum consists of a worldwide Technical Committee, three Marketing Committees for North America, Europe and Asia-Pacific as well as the User Committee, through which ATM end-users participate. Worldwide Headquarters: 2570 West El Camino Real, Suite 304 Mountain View, CA 94040-1313 USA.

ISDN: Integrated Services Digital Network (ISDN) refers to a set of communication protocols proposed by telephone companies to permit telephone networks to carry data, voice, and other source material. In general, ISDN provides a set of digital services that concurrently deliver voice, data, text, graphics, music, video, and information to end users. ISDN was developed to permit access over existing telephone systems. ISDN services are offered by many carriers under tariff. ISDN is generally viewed as an alternative to Frame Relay and T1 wide-area telephone services (WATS). In practical terms, ISDN has evolved into one of the leading technologies for facilitating telecommuting arrangements and internetworking small, remote offices into corporate campuses.

ISDN (BRI) = 2x64kbps (B-channel) + 16kbps (D-Channel) = 192kbps

ISDN (PRI) = 23x64kbps (B-channel) + 64kbps (D-Channel) = 1.544Mbps

PPP: The Point-to-Point Protocol (PPP) is generally viewed as the successor to the Serial Line IP (SLIP) protocol. PPP provides router-to-router and host-to-network connections over both synchronous and asynchronous circuits.

PPP emerged in the late 1980s in response to a lack of encapsulation protocols for the Internet that was blocking growth of serial-line access. PPP was basically created to solve remote Internet connectivity problems. PPP supports a number of network layer protocols, including Novell IPX and DECnet.

Frame Relay: is a high-performance wide-area network (WAN) protocol that operates at the physical and data link layers of the OSI Model. Frame Relay was originally designed for use across (ISDN) interfaces. Today, it is used over a variety of other network interfaces as well. Typical communication speeds for Frame Relay are between 56 Kbps and 2 Mbps (although lower and higher speeds are supported). Frame Relay is considerably more efficient than X.25, the protocol for which it is often considered a replacement.

X.25: is an International Telecommunication Union Telecommunication Standardization Sector (ITU-T) protocol standard for WAN communications. The X.25 standard defines how connections between user devices and network devices are established and maintained. X.25 is designed to operate effectively regardless of the type of systems connected to the network. It is typically used in the packet switched networks (PSNs) of common carriers (the telephone companies). Subscribers are charged based on their use of the network. The development of the X.25 standard was initiated by the common carriers in the 1970s. At that time, there was a need for WAN protocols capable of providing connectivity across public data networks (PDNs). X.25 is now administered as an international standard by the ITU-T.

SMDS: Switched Multimegabit Data Service (SMDS) is a high-speed, packet-switched, datagram-based WAN networking technology used for communication over public data networks (PDNs). SMDS addresses two important trends in WAN technology: the proliferation of distributed processing and other applications requiring high-performance networking, and the decreasing cost and high-bandwidth potential of fiber media, which can support such applications over a WAN. SMDS can use fiber- or copper-based media. It supports speeds of 1.544 Mbps over Digital Signal level 1 (DS-1) transmission facilities, or 44.736 Mbps over Digital Signal level 3 (DS-3) transmission facilities. In addition, SMDS data units are large enough to encapsulate entire IEEE 802.3, IEEE 802.5, and Fiber Distributed Data Interface (FDDI) frames.

HSSI: is a network standard for high-speed (up to 52 Mbps) serial communications over WAN links. HSSI employs a DTE/DCE interface developed by Cisco Systems and T3plus Networking. HSSI was originally offered to the ANSI EIA/TIA TR30.2 committee review. It has since been moved to the ITU-T standardization sector for acceptance.

SDLC: protocol is a bit-synchronous data-link layer protocol developed by IBM Corp. SDLC was developed by IBM during the mid-1970s for use in Systems Network Architecture (SNA) environments. Subsequent to the implementation of SDLC by IBM, SDLC formed the basis for numerous similar protocols, including HDLC and LAPB. In general, bit-synchronous protocols have been successful because they are more efficient, more flexible, and in some cases faster than other technologies. SDLC is the primary SNA link layer protocol for wide-area network (WAN) links.

Internet Organizations & Societies

- Internet Society (ISOC)
- Internet Architecture Board (IAB)
- Internet Engineering Steering Group (IESG)
- Internet Engineering Task Force (IETF)
- Internet Assigned Number Authority (IANA)
- RFC Editor
- InterNIC

Internet Society (ISOC) - is a professional society that is concerned with the growth and evolution of the worldwide Internet, with the way in which the Internet is and can be used, and with the social, political, and technical issues which arise as a result. The ISOC Trustees are responsible for approving appointments to the IAB from among the nominees submitted by the IETF nominating committee. (RFC 1718) ISOC maintains a web page at http://www.isoc.org/. The ISOC Executive Directory can be contacted at amr@isoc.org.

Internet Architecture Board (IAB) - is a technical advisory group of the ISOC. It is chartered to provide oversight of the architecture of the Internet and its protocols, and to serve, in the context of the Internet standards process, as a body to which the decisions of the IESG may be appealed. The IAB is responsible for approving appointments to the IESG from among the nominees submitted by the IETF nominations committee. (RFC 1718) The IAB can be contacted at iab-contact@isi.edu.

Internet Engineering Steering Group (IESG) - is responsible for technical management of IETF activities and the Internet standards process. As part of the ISOC, it administers the process according to the rules and procedures which have been ratified by the ISOC Trustees. The IESG is directly responsible for the actions associated with entry into and movement along the Internet "standards track," including final approval of specifications as Internet Standards. The IESG can be contacted at iesg@cnri.reston.va.us.

Internet Engineering Task Force (IETF) - is a loosely self-organized group of people who make technical and other contributions to the engineering and evolution of the Internet and its technologies. It is the principal body engaged in the development of new Internet standard specifications. Its mission includes:

•Identifying, and proposing solutions to, pressing operational and technical problems in the Internet;

•Specifying the development or usage of protocols and the near-term architecture to solve such technical problems for the Internet;

•Making recommendations to the Internet Engineering Steering Group (IESG) regarding the standardization of protocols and protocol usage in the Internet;

•Facilitating technology transfer from the Internet Research Task Force (IRTF) to the wider Internet community; and

•Providing a forum for the exchange of information within the Internet community between vendors, users, researchers, agency contractors and network managers.

The IETF is divided into eight functional areas. They are: Applications, Internet, Network Management, Operational Requirements, Routing, Security, Transport and User Services. Each area has one or two area directors. The area directors, along with the IETF/IESG Chair, form the IESG. Each area has several working groups. A working group is a group of people who work under a charter to achieve a certain goal. That goal may be the creation of an Informational document, the creation of a protocol specification, or the resolution of problems in the Internet. Most working groups have a finite lifetime. That is, once a working group has achieved its goal, it disbands. As in the IETF, there is no official membership for a working group. Unofficially, a working group member is somebody who is on that working group's mailing list; however, anyone may attend a working group meeting. (RFC 1718) IETF and its various working groups maintain numerous mailing lists. To join the IETF announcement list, send a request to ietf-announce-request@cnri.reston.va.us. To join the IETF discussion list, send a request to ietf-request@cnri.reston.va.us.

Internet Assigned Number Authority (IANA) - Many protocol specifications include numbers, keywords, and other parameters that must be uniquely assigned. Examples include version numbers, protocol numbers, port numbers, and MIB numbers. The IAB has delegated to the Internet Assigned Numbers Authority (IANA) the task of assigning such protocol parameters for the Internet. The IANA publishes tables of all currently assigned numbers and parameters in RFCs titled "Assigned Numbers". (RFC 1602)

The IANA maintains a web page at http://www.isi.edu/iana/ and can be contacted at iana@isi.edu.

RFC Editor - Each distinct version of a specification is published as part of the "Request for Comments" (RFC) document series. This archival series is the official publication channel for Internet standards documents and other publications of the IESG, IAB, and Internet community. RFCs are available for anonymous FTP from a number of Internet hosts. The RFC series of documents on networking began in 1969 as part of the original ARPA wide-area networking (ARPANET) project (see Appendix A for glossary of acronyms). RFCs cover a wide range of topics, from early discussion of new research concepts to status memos about the Internet. RFC publication is the direct responsibility of the RFC Editor, under the general direction of the IAB. (RFC 1602). The RFC Editor maintains a web page at http://www.isi.edu/rfc-editor/ and can be contacted at rfc-editor@isi.edu.

InterNIC - the Internet Network Information Center, has two major components. AT&T provides Directory and Database Services, most importantly the Internet White Pages, used by the Whois program to locate people, networks, and domains. Network Solutions, Inc. provides Registration Services, including domain name registration. Originally funded by NSF, InterNIC is becoming self-sufficient.

InterNIC maintains a web page at http://www.internic.net/.

Conclusion:

- Routing Algorithms
- Common Routing Protocols: DV & LS
- Common Circuit Speeds
- Common WAN Technologies
- Internet Organizations & Societies

- PROJECT FOR NEXT WEEK

PROJECT: Prepare a 2-5 presentation about the Internet and how it has (or has not) significantly changed the way we work, live, play, AND/OR learn. Be prepared to discuss the pros and cons of this significant change (or lack there of) with the entire class