



Computer Networks

-An Engineering Design Approach

Lecture-1: Introduction

January 8, 2010

Rahul Banerjee, *PhD (CSE)*

Networking & Distributed Systems Research Group

Computer Science & Information Systems

Birla Institute of Technology & Science, Pilani, INDIA

Email: rahul@bits-pilani.ac.in / Rahul.Banerjee.CSE@gmail.com

Home Page: <http://www.bits-pilani.ac.in/~rahul/>



Interaction Points

- About the focus of the course
- How shall this course be conducted?
- Resources & Timelines for the course
- What is a Computer Network and why do we need it?
- Basic types of Computer Networks and Internetworks
- Select References to the literature
- Questions and Answers / Summary



About the Focus of the Course

■ Focus of the course:

- Learning about the basics of Computer Networking
- Developing an ability to:
 - Conceptualize a simple network,
 - Design an elementary network,
 - Simulate and build a multi-protocol network,
 - Configure a simple network,
 - Analyze a give network design &
 - Diagnose issues / problems associated with a simple state-of-the-art Network / Internetwork



The Course Plan

- Methodology to be used:
 - About 38-42 Classroom lectures (three per week, as per the provided course handout)
 - Tutorial or Case-study session (as per need)
 - Structured laboratory sessions (in February and March at SDETU and IPCU Laboratories)
 - Four assignments <all assignments and their deadlines and defense schedules already up at the course-page!>
 - Two tests <closed book>
 - Surprise Quizzes <any FIVE to be evaluated randomly>
 - Comprehensive Examination <Open Book>



Resources for the Course

■ **Course Home Page:**

- ❑ <http://discovery.bits-pilani.ac.in/rahul/CompNet>
- ❑ This page shall have the original slides developed by me for a group of lectures on related topics <to be updated after lectures on a particular topic are over>.
- ❑ This page may also have my topic-wise lecture notes in electronic form (PDF / html) hereafter referred as online lecture notes <to be updated at the end of every month>.

■ **IntraBITS Page for Course:**

- ❑ <http://intraBITS.bits-pilani.ac.in> <to be operational around January 21, 2009 and updated before every lecture / evaluation component and after each phase of completed evaluation>
- ❑ This page shall carry my lecture-wise slides, additional external reference material for exclusive internal use by students, notices, assignment announcement and upload facility, Mid-Sem marks and grades and End-Sem Marks (End-semester grading shall not be published here until approved by the Examination Committee)
- ❑ Indicative Solutions to Test / Quiz / Compre. Exam papers
- ❑ **Laboratory sheets developed with the help of student volunteers**
- ❑ Indicative solutions to at least one earlier Compre. Exam. Paper
- ❑ **Reading advisories**
- ❑ Occasional Links to News items of contemporary relevance to the topic under discussion
- ❑ **Challenges for bright students <meant for self-learning, no evaluation weightage>**



Resources for the Course

■ Digital Library resources:

- As accessible from the <http://library.bits-pilani.ac.in> < including relevant online IEEE / ACM journals / magazines / standards & e-books as advised through Reading Advisories>>

■ Laboratory resources:

- Fixed and Mobile Networking equipments located in
 - IBM Laboratory for Open Source Computing,
 - Microsoft Laboratory for Mobile Computing and
 - Media Laboratory of the Centre for Software Development at the SDET Unit +
 - Relevant networking apparatus as and when allowed by the IPC Unit at the Cisco Advanced Networking Laboratory

■ Chamber Consultation Hours:

- Monday: 1500 – 1600 Hrs.



What is a Computer Network?

- A *Computer Network* is an interconnected group of *autonomous computing nodes* which can *meaningfully* and (preferably) *controllably communicate with one-another*.
- Such communication *requires* presence of *one or more sets of rules and conventions* which are *encoded as commands and their corresponding responses*.
- Such *rules and conventions* that allow meaningful and unambiguous *communication between members of a Computer Network* are collectively called *Network Protocols*.
- In real-life networks, often a *set of related functions* are handled by a *group of closely tied protocols* which constitute a *Protocol Family* (also known as a *Protocol Suite*).



Defining a Computer Network

- Defining a Computer Network
 - A Computer Network is an interconnected group of autonomous computing nodes which:
 - Use a well-defined, mutually-agreed set of rules and conventions known as Protocols,
 - Interact with one-another, if duly authenticated and authorized, meaningfully;
 - Allow resource-sharing preferably in a predictable and controllable manner.
- Autonomous computing node
 - A computer / node that has its own processing capabilities and that does not act under the control of any other computer / is known as an Autonomous Computer or an Autonomous Computing Node.
 - It should NOT be confused with the traditional Dumb Terminals in centralized computing environments.



Elements involved in a Network / Internetwork

■ Nodes

- ❑ Regular computing nodes
- ❑ Network extension / interconnection devices

■ Network Interfaces

- ❑ NICs / On-board Chips
- ❑ Wireless interfaces
- ❑ Wireline interfaces

■ Links

- ❑ Wireline links
- ❑ Wireless links

■ Strategies, Algorithms & Protocols: H/W, S/W, F/W level implementations

Nodes: where processing and communication capabilities co-exist

Hosts: end / intermediate nodes where all levels / layers including those belonging to applications exist



Applications of Computer Networks

- Numerous applications of computer networking are possible.
- Some of the most popular ones include:
 - ❑ Electronic Mail
 - ❑ Web-browsing
 - ❑ Digital Libraries
 - ❑ Video-on-Demand
 - ❑ File Transfer
 - ❑ Video / Audio Conferencing



Types of Computer Networks (1 of 2)

- Spread, size, inter-node-distance and purpose based classification:
 - Personal Area Networks (PANs): Often, Wireless: Wireless Personal Area Networks (WPANs)
 - Local Area Networks (LANs): Wireline LANs (LANs) & Wireless LANs (WLANs)
 - Metropolitan Area Networks (MANs): Wireline and Wireless MANs
 - Wide Area Networks (WANs): Wireline / Wireless, Fixed / Mobile, Planet-wide / Interplanetary
 - Sensor Networks (SNs) & Wireless Sensor Networks (WSNs)
 - Storage Area Networks / System Area Networks (SANs)
 - Body Area Networks (BANs)
 - Car Area Networks (CANs)



Types of Computer Networks (2 of 2)

- **Virtualization-based classification:**
 - Virtual Local Area Networks (VLANs)
 - **Virtual Private Networks (VPNs)**
- **Node-Organization based classification**
 - **Mobile Ad-hoc Networks**
 - **Regular Mobile Networks**
 - **Infrastructure WLANs**
 - **Cellular Networks**
 - **GSM**
 - **CDMA**
 - **3G variants**



Classes of Computer Networks 1 of 2

- **Class One: Function-based classification**
 - Data Networks
 - Voice Networks
 - Multimedia Networks

- **Class Two: Location-and-Distance-based classification**
 - Personal Area Networks (PANs)
 - Local Area Networks (LANs)
 - Metropolitan Area Networks (MANs)
 - Wide Area Networks (WANs)



Classes of Computer Networks 2 of 2

- **Class Three: Forwarding-based classification**
 - Switched Networks
 - Circuit-Switched Networks
 - Packet-Switched Networks
 - Shared Networks
 - Hybrid Networks

- **Class Four: Ownership-based classification**
 - Public Networks
 - Private Networks
 - Virtual Private Networks



Local Area Networks (LANs)

- The term LAN stands for Local Area Network.
- The term 'local area' in the world of networking usually refers to:
 - a geographically contiguous area
 - in which the inter-node distance is lesser than or equal to one kilometer.
- LANs are always owned by a single entity (an organization or individual)
- Examples of popular LAN technologies include the Ethernet in wired (wireline) category and Wi-Fi in the wireless category



Local Area Networks ...

- A LAN is local in the sense that it is installed in a local location like a local office, a laboratory, a building or a campus.
- Although, normally, in a LAN, the inter-node distance does not exceed a kilometer; in most of the real-life situations, it is far less than this ceiling.



Interconnection of nodes / interfaces / networks

- **Media-based interconnection perspective**
 - Guided / Unguided
 - Noisy / Noiseless
 - Broadcast / Non-broadcast
- **Link-based interconnection perspective**
 - Secure / Insecure
 - Logical / Physical
 - Point-to-Point / Multi-point
- **Physical Links**: those entities that provide physical path (direct paths between neighbouring nodes (point-to-point / point-to-multi-point) for data delivery over guided or unguided media
- **Logical Links**: an abstraction showing the logical path of data delivery at layers higher than the physical layer



Personal Area Networks (PANs)

- The term PAN stands for Personal Area Network.
- Typically these networks are small in size, belong to a single person and are limited to his / her environment within a small area *like* his room, body or garden etc.
- PANS mostly use short-range wireless technologies for interconnecting various nodes that comprise them.



Local Area Internetwork

- Traditionally, a Campus Internetwork is a campus-wide internetwork of individual LANs which may be geographically spread over the part or whole of a single campus. This sometimes called campus intranet.
- In common practice, the entire campus internetwork including its communication subnet is wholly owned by a single organization or institution.
- Usually, the campus internetworks use LAN technology; however, it is possible to use WAN technology, when so desirable.
- The latter may be desirable in some cases when the campus is very large and comprises of a vast set of buildings spread over it. Protocols used in both of these cases at the lower layers, are, generally, different.



Metropolitan Area Networks (MANs)

- The term MAN stands for Metropolitan Area Network.
- A computer network that is not usually owned by a single organization / entity and that is spread over a metropolitan city area is called a Metropolitan Area Network.
- Normally, in a MAN, the inter-node distance does not exceed ten kilometers. This, however, is not a hard-and-fast rule.



Wide Area Networks (WANs)

- The term WAN stands for Wide Area Network.
- A computer network that is not usually owned by a single organization / entity and that is spread over an area larger than that of any city of operation is called a Wide Area Network .
- *A WAN may be spread over several cities / towns, a state, a country or even a continent.*
- In many a cases, when people say WAN, they actually mean Wide Area Internetwork (WAI), however!

Summary of the Concepts & Terms learnt so far



Communication Media / Interconnection Links / Logical Links

- **Media-based interconnection perspective <basic form>**
 - Guided
 - Unguided

- **Physical Links**
 - These are the entities that provide physical path (direct paths between neighbouring nodes (point-to-point / point-to-multi-point) for data delivery over guided or unguided media.

- **Logical Links**
 - These are abstractions showing the logical path of data delivery at layers higher than the physical layer.



Comparing Computer Networks with Distributed Systems

- **Terms Computer Network and Distributed System must NOT be used interchangeably since:**
 - In the former, locations and elements of network remain visible to the user;
 - In the latter, the underlying network remains transparent to the user who sees the system as a uni-processor.
- Similar differences can be cited in case of Network Operating Systems and Distributed Operating Systems.



Concluding remarks

- Networking support of some kind is already inside most of the operating systems we use today in variety of forms on Notebooks, Laptops, Workstations and Servers. All Smart-phones and several set-top boxes support it too.
 - **Subsequent lecture shall introduce you to the following topics:**
 - Internetworks
 - Network Architectures
 - Performance
 - Quality of Service
 - Reliability
 - Security
-

Any question please?

Thank you for your kind attention!

For further details, you may contact at:

E-mail: rahul@bits-pilani.ac.in / rahul.banerjee.cse@gmail.com

or visit:

Home: <http://www.bits-pilani.ac.in/~rahul/>

References

- Larry L. Peterson & Bruce S. Davie: Computer Networks: A Systems Approach, Fourth Edition, Morgan Kaufmann / Elsevier, New Delhi, 2007. <System design approach>*
- S. Keshav: Computer Networking: An Engineering Approach, Pearson Education, New Delhi, 1997.*
- A. S. Tanenbaum: Computer Networks, Fourth Edition, Pearson Education, New Delhi, 2003. <Conceptual Approach>*
- Y. Zheng and S. Akhtar: Networks for Computer Scientists and Engineers, Oxford University Press, New York, 2002. <Structural approach>*
- A. Leon Garcia and I. Widjaja: Communication Networks: Fundamental Concepts and Key Architectures, Second Edition, Tata McGraw-Hill, New Delhi, 2004.*
- Mohammed G. Gouda: Elements of Network Protocol Design, Wiley Student Edition, John Wiley & Sons (Pte.) Ltd., Singapore, 2004.*
- Thomas G. Robertazzi: Computer Networks and Systems: Queuing Theory and Performance Evaluation, Third Edition, Springer-Verlag, New York, 2000. <Analytical approach>*