
COMPUTER NETWORKS

- Chapter 1.1: Introduction

王昊翔

WANG Haoxiang

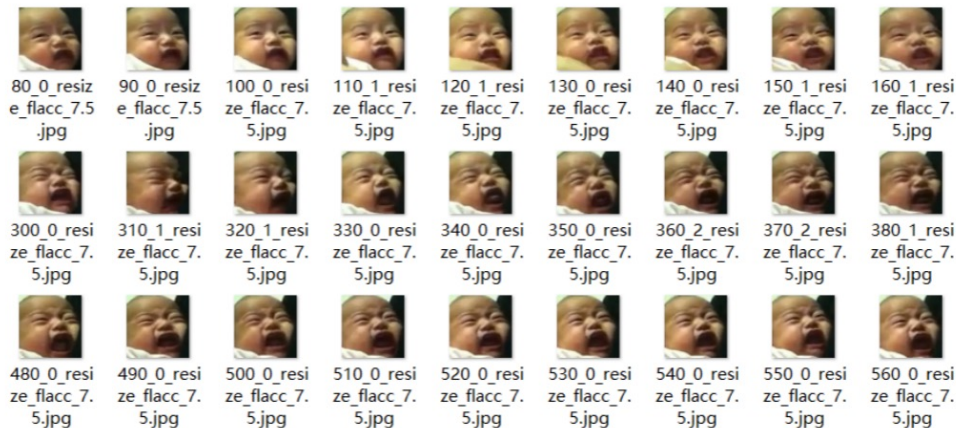
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School of Computer Science & Engineering

国家双语教学试点项目 广东省精品课

About me

- Research
 - Deep learning - Affective Computing: Facial emotion - Speech emotion - EEG - etc.
 - Big data analysis - Recommender Systems
 - Neonatal Pain Recognition
- Teaching
 - Computer networks
 - Intro 2 CS
 - etc.



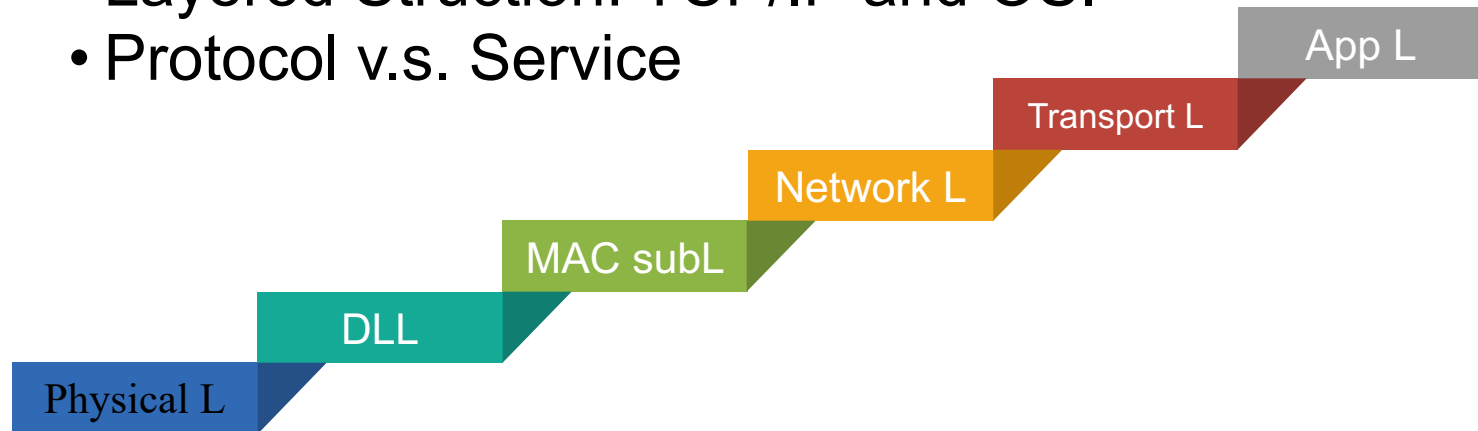
Syllabus 课程大纲

| | |
|--------------------------|----------------------------------------------------------------------------|
| Course Title | Computer Networks |
| Course Category | Disciplinary Basic Course |
| Course Nature | Compulsory Course |
| Class Hours | 64 teaching sessions, including 16 lab sessions |
| Credits | 3.5 |
| Semester | The fifth semester |
| Institute | School of Computer Science and Engineering |
| Program Oriented | Computer science and technology, network engineering, information security |
| Teaching Language | English |
| Prerequisites | Foundations of Computer Science, Computer Organization and Architecture |

Roadmap-Intro

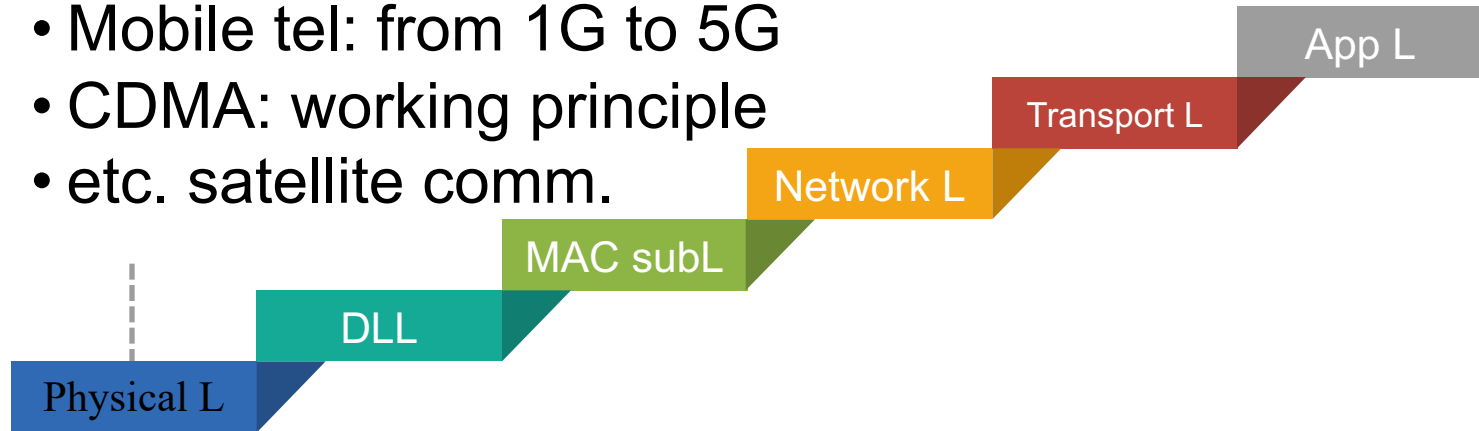
INTRO.

- Defs: networks, Computer networks
- History
- Classification
- Layered Struction: TCP/IP and OSI
- Protocol v.s. Service



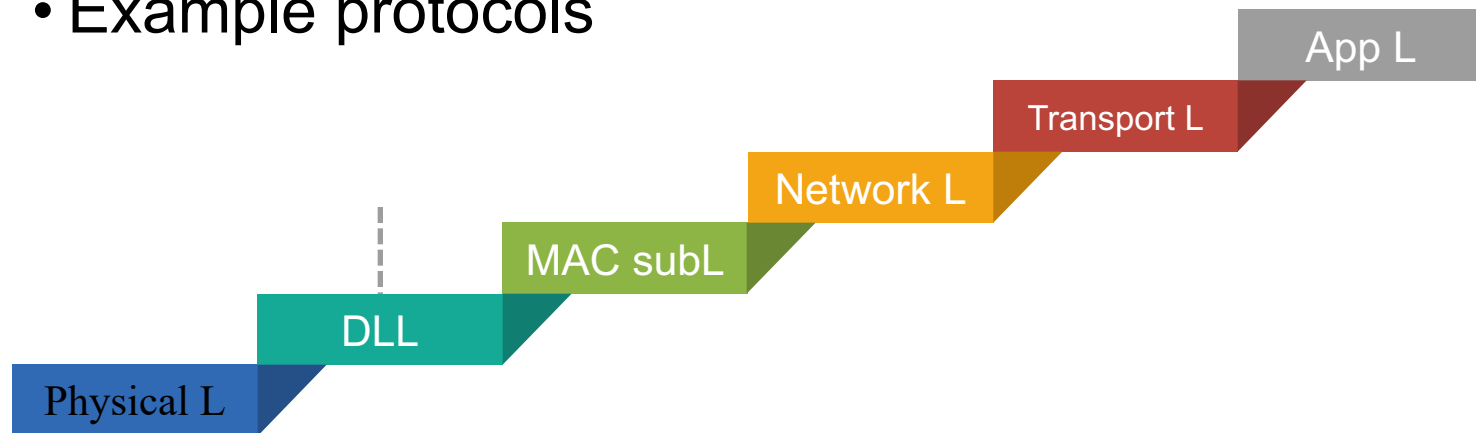
Roadmap-Physical Layer

- Theoretical basis: 3 theorems
- Transmission medium: wire and wireless
- Tel systems: 3 main components
- Mobile tel: from 1G to 5G
- CDMA: working principle
- etc. satellite comm.



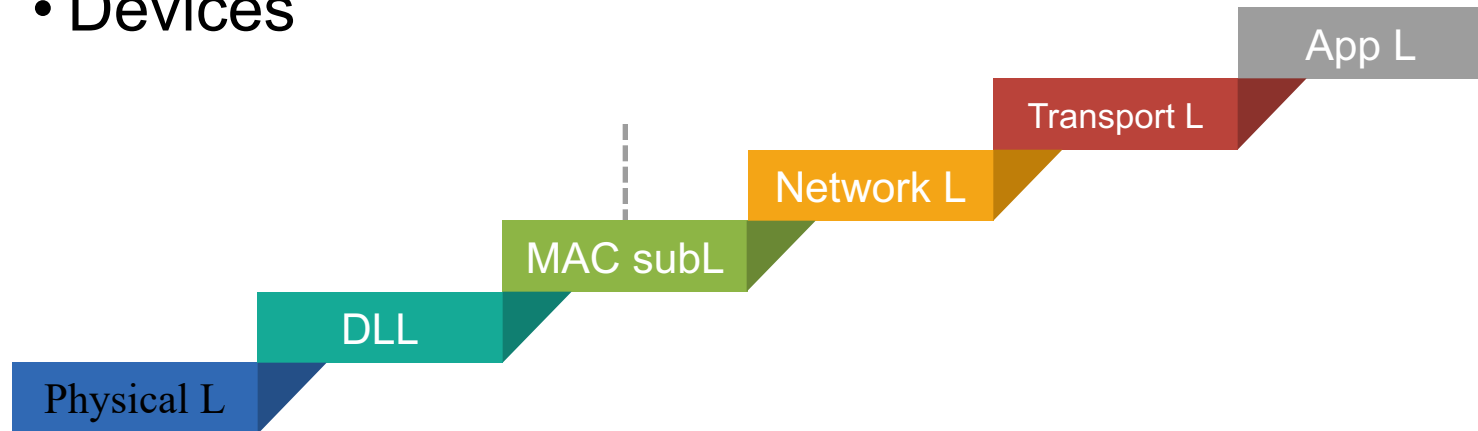
Roadmap- DLL

- Error process: Detection & Correction
- 6 elementary DLL protocols
- Piggybacking, sliding windows
- Example protocols



Roadmap-MAC Sub-layer

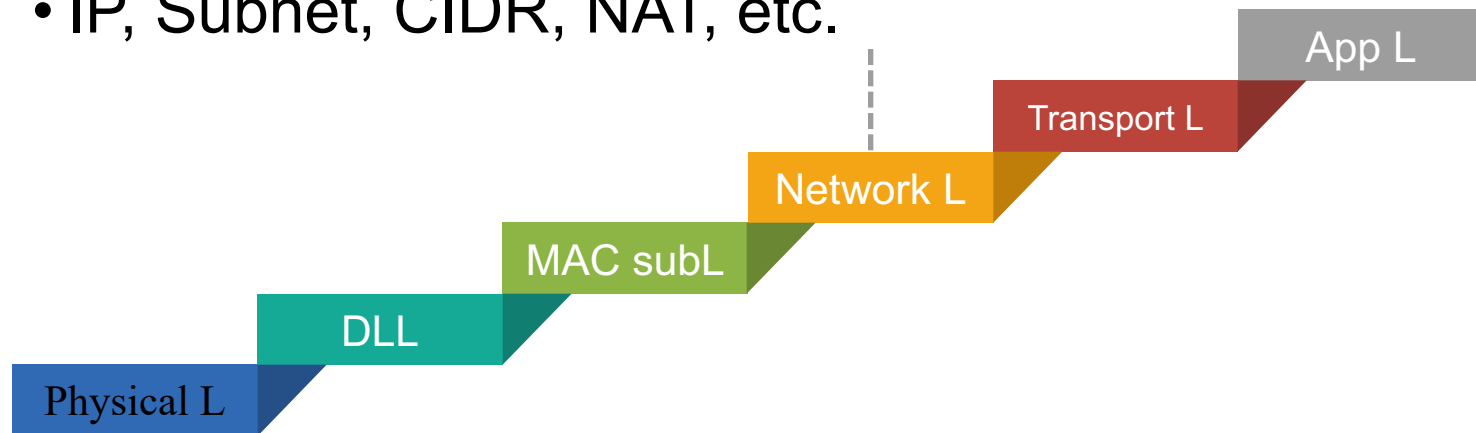
- Multiple access protocols: static & dynamic
- CSMA family
- Ethernet & IEEE802.3
- Devices



Roadmap–Network Layer

Network Layer

- Routing: algorithms - static, dynamic-DV, LS
- Routed: IP protocols - v4, v6
- IP, Subnet, CIDR, NAT, etc.



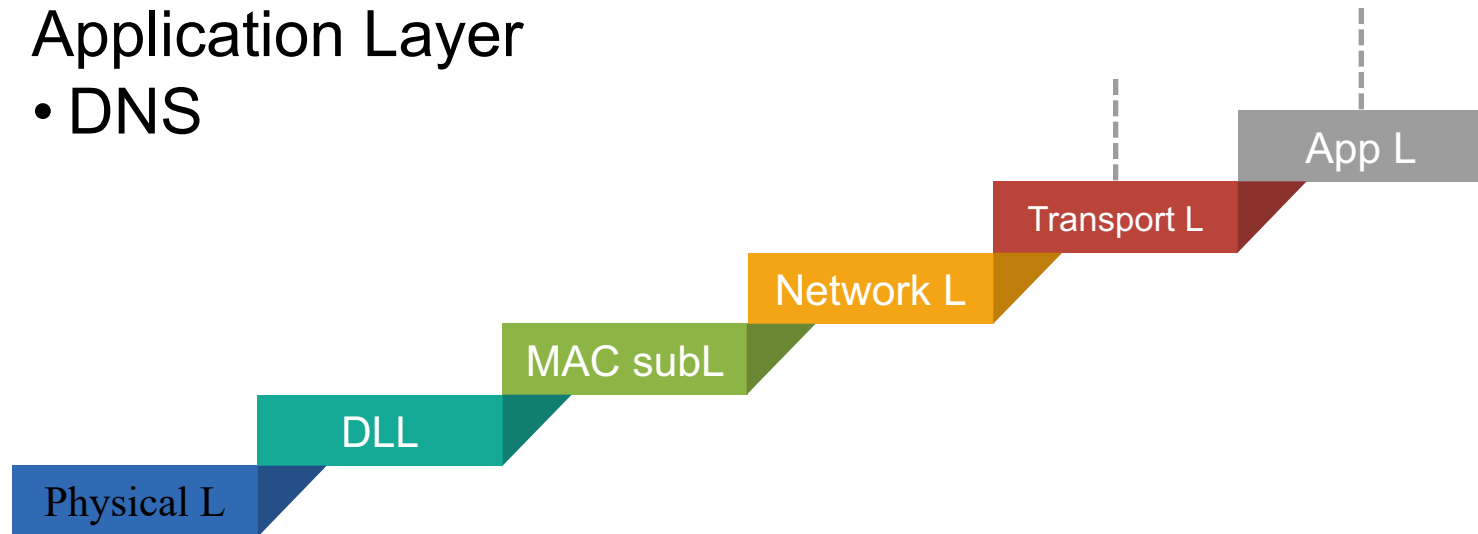
Roadmap-Trans & App Layers

Transport Layer:

- TCP, UDP

Application Layer

- DNS



Very IMPORTANT!!!

Marking scheme (评分标准)

- Participation (30%)
- Lab (30%)
- Exam (40%)



Very IMPORTANT!!! - marking scheme

- Participation(30%)
 - Attendance 5
 - MOOC 10
 - Presentation, Q&A 15
- Lab(30%)
 - Attendance 5
 - Demo 10
 - Report 15
- Exam(40%)
 - 40/100



学生评语

| 序号 | 评语 |
|----|---------------------------------------------------------------------|
| 4 | 老师担任课程教师,认真负责,有很强的敬业精神,和蔼可亲,幽默风趣,课堂气氛十分活跃。 |
| 5 | 老师细心负责, 讲课生动有趣, 课后乐于解答同学问题 |
| 6 | 老师授课内容认真细致, 而且还有很多互动 |
| 7 | 教师通过独到深入的讲解, 达到了很好的教学效果, 能结合多种教学手段, 使学生对知识的掌握更深刻。教学内容重点突出, 教学目的十分明确 |
| 8 | 老师讲课耐心细致, 很好沟通, 课业安排合理。 |
| 9 | 老师讲的很好 |
| 10 | 课堂很轻松, 实验很有趣, 老师也对我们很好, 压力不大 |
| 11 | 老师讲课非常认真, 英语口语非常好, 学到了很多东西 |
| 12 | 老师教学认真负责, 课堂生动有趣, 作业安排布置合理 |
| 13 | 上的课很好, 我很喜欢 |

1

共 4 页

15

1 - 15 共 54 条

关闭

Very IMPORTANT!!!

For **international** students:

A rough idea

If (online course == true)

 Thesis-based assess;

else


 Final exam(40%) + CW(40%)+ ATT(20%);

SPOC

SCUT Yuketang: 雨课堂? 长江雨课堂?

<https://scut.yuketang.cn>

← → ↻ scut.yuketang.cn/pro/courselist



教学管理

课程建设

我的资源

我教的课 我听的课

Computer Networks [编辑课程信息](#)

2021秋-19计科全英创新班,19计科全英联合班

59

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2021秋-19计科全英创新班,19计科全英联合班

59 2021-2022学年第一学期 开课时间: 2021-09-01 00:00 至 2022-01-31 00:00

教学内容

讨论区

公告

成绩单

成员管理

设置

输入关键字或按类型检索



目 录

42

Chapter1 Introduction

5

Chapter2 Physical Layer

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Chapter 3 Data Link L...

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Chapter4 Medium Acc...

6

Chapter 5 Network Layer

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Chapter 6 Transport L...

5

Chapter 7 Application ...

2

内容总览 收起

▼ Chapter1 Introduction

▼ 1.1 Introduction to Computer Networks



Introduction to Computer Networks



Introduction to Compute

▼ 1.2 Reference Models



ISO Model



TCP/IP Model



Reference Models

▼ Chapter2 Physical Layer

▼ 2.1 Theoretical basis

MOOC

For international students: (if you have problem of using Yuketang, very likely)

<https://next.xuetangx.com/course/scut08091001002intl/3994979>

The screenshot shows the Xuetangx MOOC platform interface for the 'Computer Networks' course. The header includes navigation links: 学堂在线 (Xuetangx), 首页 (Home), 全部课程 (All Courses), 合作院校 (Cooperating Institutions), 计算机学院 (School of Computer Science and Technology), 职场商务 (Career Business), Online MBA项目 (Online MBA Program), 考研/四六级 (Postgraduate Entrance Exam/TEM), and 更多 (More). A search bar is located on the right. The main banner features a cityscape background with the course title 'Computer Networks' and the South China University of Technology logo. Below the banner, there is a 'Self-Paced' dropdown menu, the start date '开课时间: 2020-04-12', and the number of registrants '103人已报名'. A '去学习' (Go to Study) button is also present. The '课程介绍' (Course Introduction) section states: 'The Internet is making life easier and faster. How is this magic happening? This course will show you the secrets behind computer networks.' A video thumbnail for the course is shown, featuring the title 'Computer Networks' and the instructor's name 'Haoxiang WANG 王昊翔'. Below the video, there are three icons representing '开课时间: 2020-04-12' (Start Date), '教学时长' (Teaching Duration), and '学习投入' (Learning Investment). A '详细介绍' (Detailed Introduction) link is provided. At the bottom, a paragraph describes the course objectives: 'Students should master the basic knowledge of computer network, basic principles and some important protocols. These include network-related terms and protocols(TCP/IP protocol), network standards, OSI reference model, LAN technology(Ethernet is the emphasis), physical layer, data link layer, network layer, transport layer and basic functions of Application layer, the study of network layer is the emphasis which includes routing principles and'.

Oversea/Home students

- All course materials are exactly the same!
 - same videos
 - same slides
 - same quizzes
- xuetangx.com Self-paced/public access
- <https://scut.yuketang.cn>
 - Syn with offline class
 - Private access. I can monitor you
 - Chinese interface
 - Working on creating accounts for overseas stu

Presentations, Q&A

- 59 home students
 - 4 students / group, with one exception
 - 12 + 3 topics
 - ~15-20 mins talk, ~5 mins discussion
 - Prepare discussion questions for your audience.
 - Q&A (Bonus for raising questions?)
 - Kick off in week 2
-
- Keep improving
 - Need your understanding, cooperation or even tolerance

Presentations

| No. | Ch. | Topics |
|-----|-----|------------------------------------------------|
| 01 | 2 | Wires for data transmission |
| 02 | 2 | Wireless communication |
| 03 | 2 | Mobile telephone system |
| 04 | 3 | Error correction & Hamming encoding |
| 05 | 4 | Ethernet and IEEE802.3 |
| 06 | 5 | OSPF protocol |
| 07 | 5 | IPv6 and comparisons with IPv4 |
| 08 | 5 | ICMP: Internet Control Message Protocol |
| 09 | 6 | Intro to TCP - working principles and examples |
| 10 | 6 | Intro to UDP, and comparisons with TCP |
| 11 | 7 | Belief of DNS: Domain name system |
| 12 | 7 | DNS Hijacking |

Presentation

| No. | Ch. | Topics |
|-----|-----|-------------------------------------|
| 13 | L1 | Network traffic analysis(wireshark) |
| 14 | L2 | Basic router config |
| 15 | L3 | Networking |

About lab?

CN and CN (课程思政)



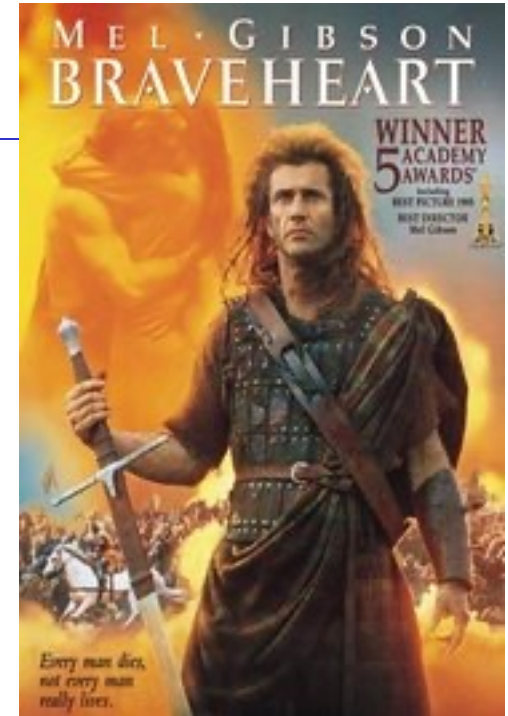
- 1986/08/25 11:11am first email
- 1994 CERNET national-wide TCP/IP network
- 1998 CERNET IPv6 testbed
- 2003 CNGI project
- 2008 world first Live on IPv6 network
- Tsinghua, IPv6 research, on the cutting edge
- SAVI、SAVA
- IPv4OverIPv6
- Address translation
- SCUT
- IPv9?



Before we kick off...

Rules for this module:

FREEDOM



Brave heart

BUT

Before we kick off...

Computer Networks?

Technology? Applications?

What you really want from this module?

Reference

- Andrew S. Tanenbaum , 《 Computer Networks 》
- 谢希仁等著, 《计算机网络》
- Vito Amato (美) , 《思科网络技术学院教程》
- James F. Kurose, Keith W. Ross, 《Computer Networking: A Top-Down Approach Featuring the Internet》
- Larry L. Peterson, Bruce S. Davie, 《Computer Networks: A Systems Approach》
- Just for recommendation... :-P

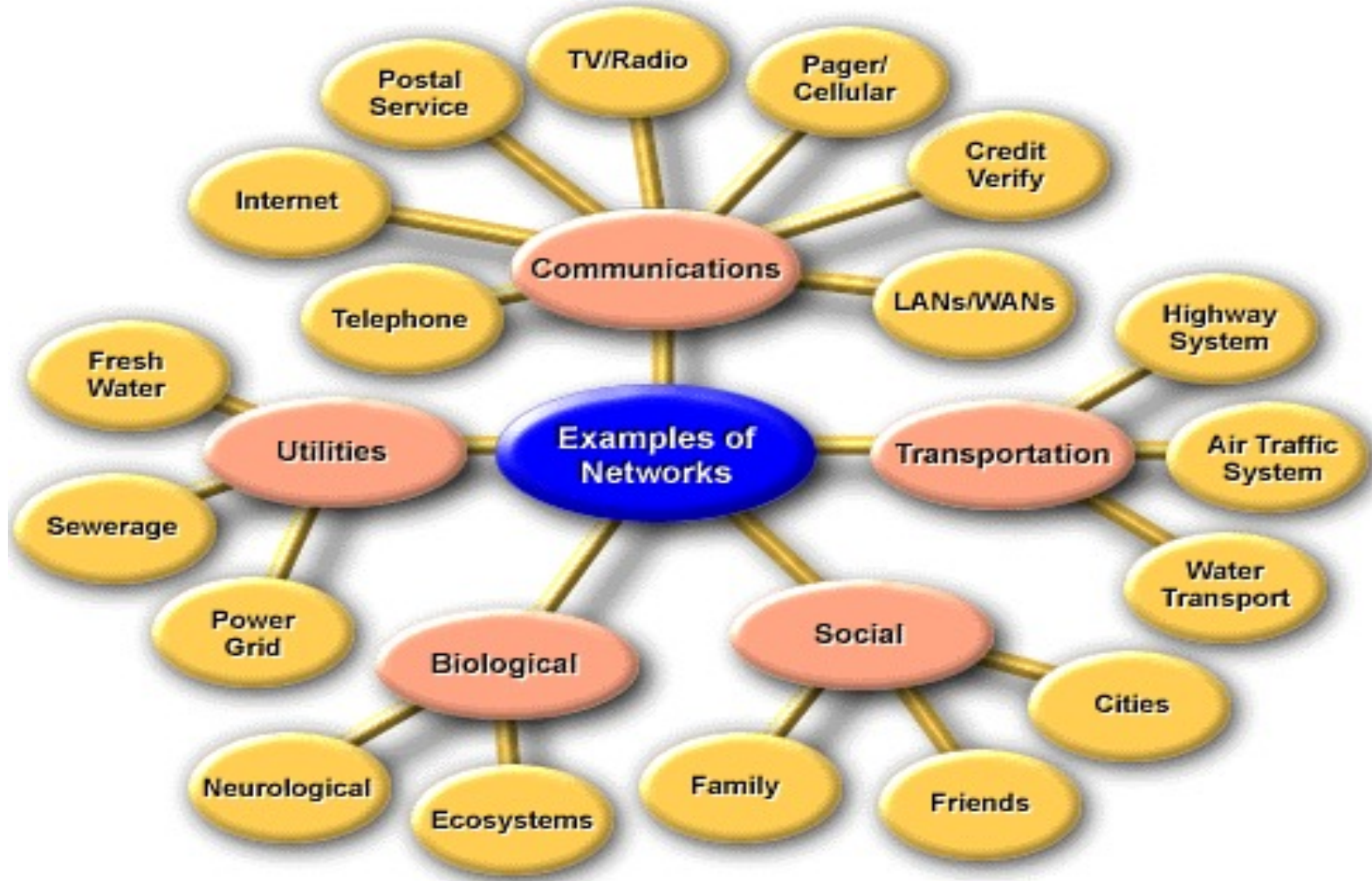
Treasure

- Collaboration of Profs across the nation.
- Might be the best CN self-learning slides in this country.
- <https://cloud.tsinghua.edu.cn/d/4b12b05d30dc435688c3/>

Session 1

- What is the Networks
- Classify Computer Networks

What is the networks in general ?



© Cisco Systems, Inc. 1999

What is “Computer Networks”

- Computer: CPU + MEM + Peripherals.
- Basic Concept of Computer Networks:
 - A collection of autonomous computers interconnected.
 - Interconnected: Be able to exchange information
 - Autonomous: Be able to handle independently
- Host/Computer toward Distributed System:
 - Multi – Tasks, Multi-Users, Multi-Cores...
- In modern and broad sense of CN:
 - Network is the Computer (Complicated & Ind.)

Network History

An example work from previous students

Pros & Cons

Communication networks ?



Digital/Data Communication

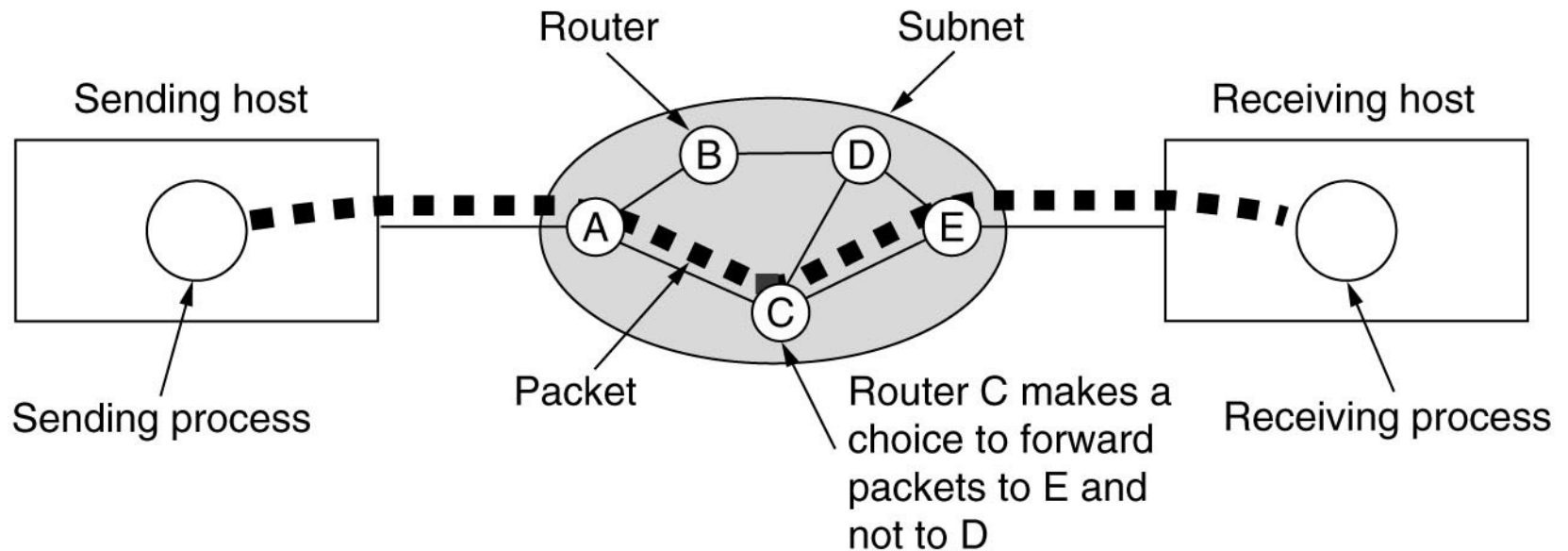
Computer Networks

Data Networks

Internet: NGI,NGN

Sensor Networks

Computer networks:















A stream of packets from sender to receiver

So many different:

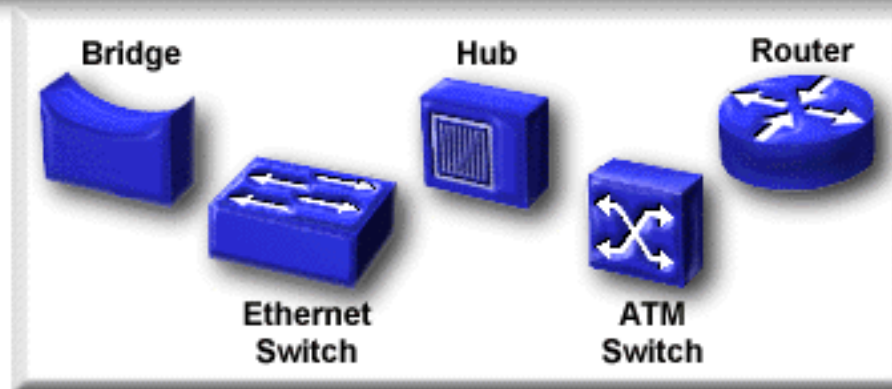
1. Variety of Size
2. Variety of Topology
3. Variety of Speed/Bandwidth
4. Variety of Transmission Medium
5. Variety of Communication Tech.
6. Variety of Communication mode/BD
7. Variety of Services
8. Variety of Applicants/Usage

研究方法: **Think about Library ?**

Networks Classify in Size

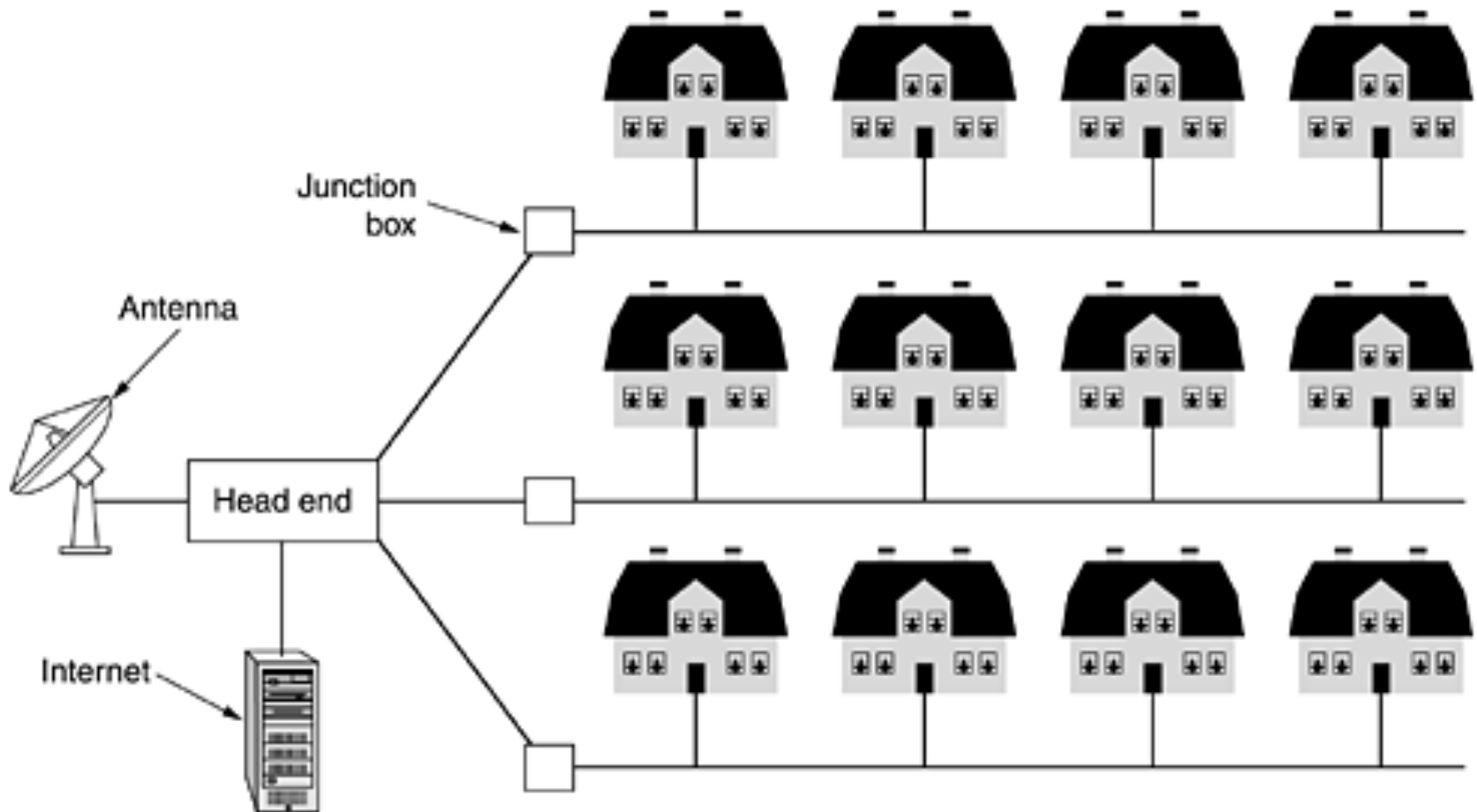
| Distance Between CPUs | CPUs are in the same | Icon | Name |
|-----------------------------|----------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------|
| 0.1 m | Printed circuit board Personal data asst. |   | Motherboard Personal Area Network (PAN) |
| 1.0 m | Millimeter Mainframe |    | Computer System Network |
| 10 m | Room |  | Local Area Network (LAN) Your classroom |
| 100 m | Building |  | Local Area Network (LAN) Your school |
| 1000 m = 1 km | Campus |  | Local Area Network (LAN) Stanford U. |
| 10,000 m = 10 km | City |  | Metropolitan Area Network (MAN) San Francisco |
| 100,000 m = 100 km | Country |  | Wide Area Network (WAN) Cisco Systems, Inc. |
| 1,000,000 m = 1,000 km | Continent |  | Wide Area Network (WAN) Africa |
| 10,000,000 m = 10,000 km | Planet |  | Wide Area Network (WAN) The internet |

- Operate within a limited geographic area
- Allow multiaccess to high-bandwidth media
- Control the network privately under local administration
- Provide full-time connectivity to local services
- Connect physically adjacent devices



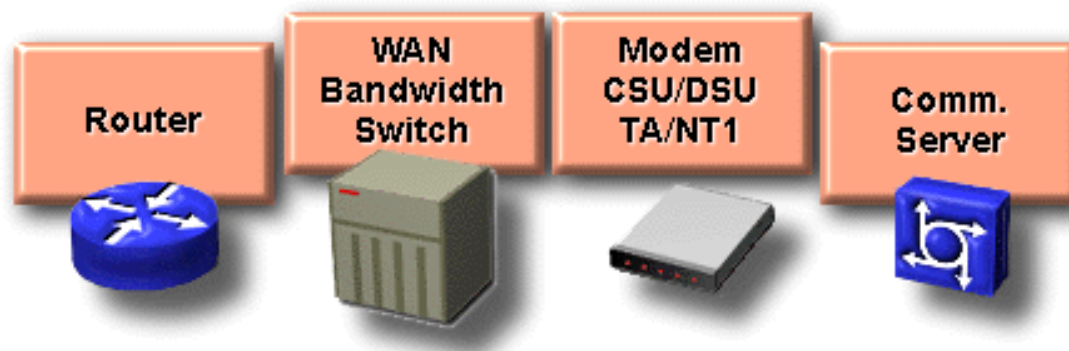
Widely used to connect pc and workstations in company offices and factories to share resources (e.g., printers) and exchange information

Local/Metropolitan Area Networks



WANs are designed to:

- Operate over large geographical area
- Allow access over serial interfaces operating at lower speeds
- Provide full-time and part-time connectivity
- Connect devices separated over wide, even global areas



Some common WAN technologies are:

- **Frame-Relay/ATM** (Asynchronous Transfer Mode) : 64Kbps – 155Mbps
- **E/T-Carrier Series** (in U.S.:T1, T3, etc.) : 1.5Mbps/2Mbps – 155Mbps
- **SONET/SONET** (Synchronous Optical Network) : 155Mbps- 10G+

Discussion(1)

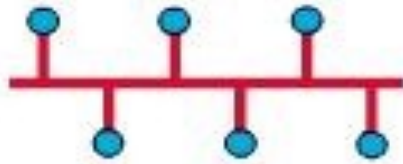
Networks on this island (High Edu Mega City)

LAN or MAN

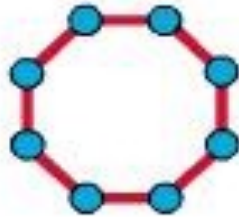


Network Topology:

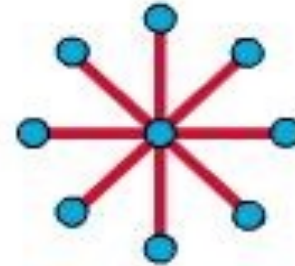
Layout of inter-connections (信道的分布方式)



Bus Topology



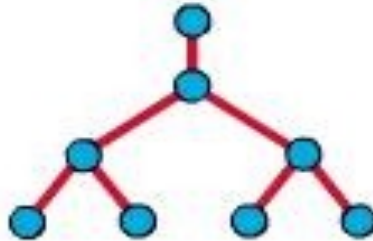
Ring Topology



Star Topology



Extended Star Topology



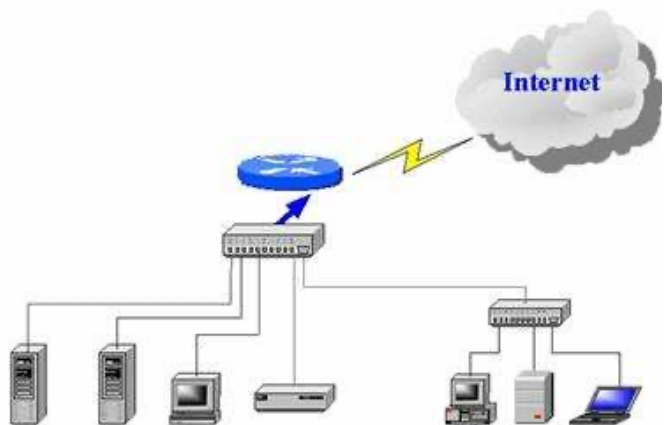
Hierarchical Topology



Mesh Topology

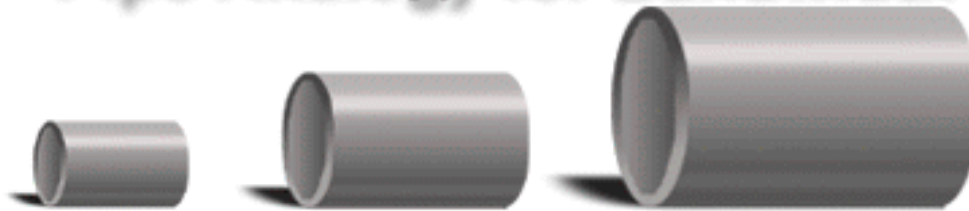
Discussion(2)

LAN in a house



Network Bandwidth-I:

Pipe Analogy for Bandwidth

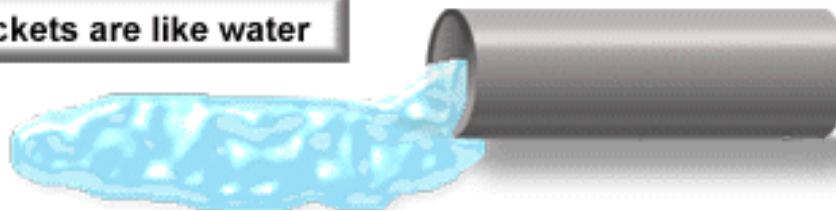


Bandwidth is like pipe width

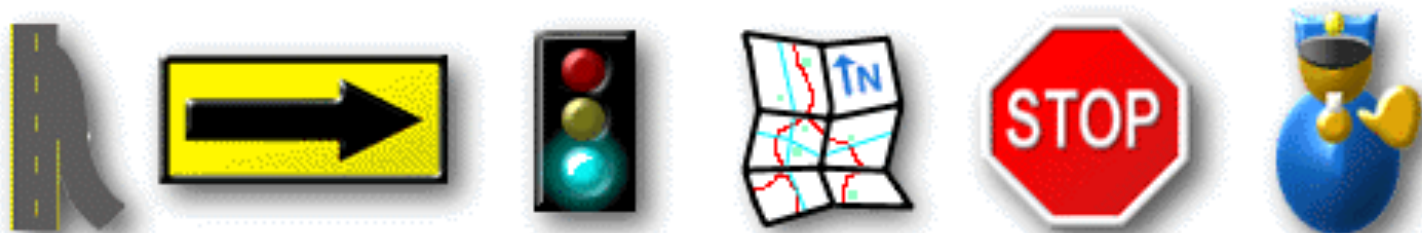
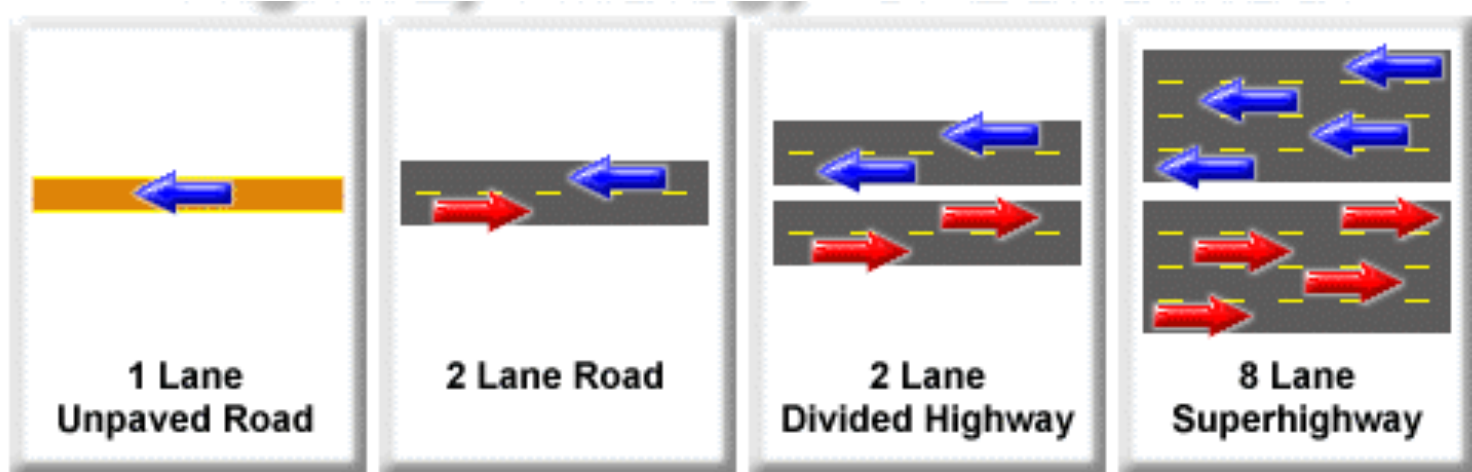


Network devices are like pumps, valves, fittings, and taps

Packets are like water



Highway Analogy for Bandwidth:



Networking devices are like: on ramps, traffic signals, signs, maps, and police.



Packets are like vehicles

© Cisco Systems, Inc. 1999

Measurement-I:

| Unit of Information | Definition | Approximate Bytes | Approximate Bits | Examples |
|---------------------|-------------------------------------------------------------|-------------------|------------------|------------------------------------------------------------------------------------|
| Bit (b) | Binary digit, a 1 or 0 | 1 bit | 1 bit | On/Off; Open/Closed +5 Volts or 0 Volts |
| Byte (B) | Usually 8 bits | 1 byte | 8 bits | Represent the letter "X" |
| Kilobyte (KB) | 1 kilobyte = 1024 bits | 1000 bytes | 8,000 bits | Typical Email = 2 KB 10-page report = 10 KB Early PCs = 64 KB of RAM |
| Megabyte (MB) | 1 megabyte = 1024 kilobytes = 1,048,576 bytes | 1 million bytes | 8 million bits | Floppy disks = 1.44 Mb Typical RAM = 32 MB CDROM = 682 MB |
| Gigabyte (GB) | 1 gigabyte = 1024 megabytes = 1,073,741,824 bytes | 1 billion bytes | 8 billion bits | Typical Hard Drive = 2 GB |
| Terabyte (TB) | 1 terabyte = 1024 gigabytes = 1,099,511,627,778 bytes | 1 trillion bytes | 8 trillion bits | Amount of data theoretically transmittable in optical fiber in one second |

Measurement-II:

| Unit of Bandwidth | Abbreviation | Equivalence |
|---------------------|--------------|-----------------------------------------|
| Bits per second | bps | 1 bps = fundamental unit of bandwidth |
| Kilobits per second | kbps | 1 kbps = 1000 = 10^3 bps |
| Megabits per second | Mbps | 1 Mbps = 1,000,000 bps = 10^6 bps |
| Gigabits per second | Gbps | 1 Gbps = 1,000,000,000 bps = 10^9 bps |

The fundamental unit of bandwidth:

- A unit of information (lets say the bit) per unit of time (lets say a second) is the bit per second,

Throughput:

Usually refers to actually measured bandwidth, at a specific time of day.

Throughput \leq digital bandwidth of a medium

Why?

- Your PC (client)
- The server
- Other users on your LAN
- Routing within the "Cloud"
- The design (topology) of all networks involved
- Type of data being transferred
- Time of day

The Importance of Bandwidth:

- It is finite
- It is worth money
- It is a key measure of network performance
- It is a key factor in network design
- It is key to understanding the information age
- Everyone wants more

Transmission medium:

| Some Typical Media | Maximum Theoretical Bandwidth | Maximum Physical Distance |
|----------------------------------------------------------------------------------|-------------------------------|---------------------------|
| 50-Ohm Coaxial Cable (Ethernet 10Base2, ThinNet) | 10-100 Mbps | 200m |
| 75-Ohm Coaxial Cable (Ethernet 10Base5, ThickNet) | 10-100 Mbps | 500m |
| Category 5 Unshielded Twisted Pair (UTP) (Ethernet 10BaseT, 100Base-TX) | 10 Mbps | 100m |
| Category 5 Unshielded Twisted Pair (UTP) (Ethernet 100Base-TX)(Fast Ethernet) | 100 Mbps | 100m |
| Multimode (62.5/125um) Optical Fiber 100Base-FX | 100 Mbps | 2000m |
| Singlemode (10um core) Optical Fiber 1000Base-LX | 1000Mbps (1.000 Gbps) | 3000m |
| Other technologies being researched | 2400 Mbps (2.400 Gbps) | 40km = 40,000m |
| Wireless | 2.0 Mbps | 100m |

No matter how you send your messages, no matter which physical medium you use, bandwidth is limited. This is due both to the laws of physics and to current technological advances.

Communication Technology:

- For twisted-pair cable:
 - Modem:
 - 300bps, 1200bps, 9600bps, 28kbps, 33kbps, 56kbps
 - XDSL:
 - 128Kbps, 1Mbps, 4Mbps, 6Mbps
 - Ethernet:
 - 10Mbps, 100Mbps, 1000Mbps...
- For Fiber:
 - Ethernet: 10/100Mbps, 1/10Gbps +
 - SDH: 155Mbps, 2.5Gbps, 1.6Tbps +

Communication Mode:

- Point-to-Point
- Multicast
- Broadcast

Type of Services

| Connection-oriented | Service | Example |
|---------------------|-------------------------|----------------------|
| | Reliable message stream | Sequence of pages |
| | Reliable byte stream | Remote login |
| Connection-less | Unreliable connection | Digitized voice |
| | Unreliable datagram | Electronic junk mail |
| | Acknowledged datagram | Registered mail |
| | Request-reply | Database query |

So many different:

1. Variety of Size (Location)
2. Variety of Topology
3. Variety of Speed/Bandwidth
4. Variety of Transmission Medium
5. Variety of Communication Tech.
6. Variety of Communication mode/BD
7. Variety of Services
8. Variety of Applicants/Usage

Think about telephone network ?

Many thanks:

Cisco Academy

Coursework: yuketang videos and
questions