EE673: Digital Communication Networks

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Department of EE, IIT Kanpur
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Lecture 01: Tue, 1 Aug 2006

Course Contents

- Internet design principles
- Layering
- Encoding
- Framing
- Error detection, correction
- Medium Access Control

- Addressing
- Routing
- Congestion Control
- Flow Control
- Application Protocols
- Security
- Socket Programming
- Network Simulator

Related Courses

- EE679: Queuing Theory

- EE629: Digital Switching

- CS425: Computer Networks

- CS625: Advanced Computer Networks

- CS725: Topics in Networking

- CS698t: Wireless Networks – Principles and Practice

- CS628: Computer Systems Security

Course Structure

- 1 + 1.5 hour lecture

- 1.5 hour tutorial once in two weeks
  - Batches of ~30 each

- Tutorials & lectures possibly combined with CS425

- Proposed timings:
  - Lectures: Mon & Wed 5-6:30pm
  - Tutorials: Thu 5-6:30pm, Fri 3-4:30pm & 5-6:30pm
  - Office hours: Thu 11am-12noon [ACES-305B]
  - Class time discussion: Tue 01 Aug 7:30pm, CSE-101

Evaluation Plan

Class Participation	5%
Quizzes	2x5=10%
MidSem2	20%
EndSem	45%
Project	20%

Project Plan

- To be done in groups of three
- On socket programming
- Will be assigned before Mid-Sem break
- Due in one month

Reference Material

- Papers

- Web material

- Textbooks

  - *Computer Networks – A Systems Approach*, by Peterson and Davie, 3rd Edition, published by Morgan Kaufmann

  - *Data Networks*, by Bertsekas and Gallager, 2nd Edition, published by Prentice Hall of India

Values

- Sincerity, hard-work: committed learning

- Time management: methodical learning

- Discussion & participation: group learning

- Straightforwardness, honesty, no short-cuts: ethical learning

Enter the World of Communication Networks
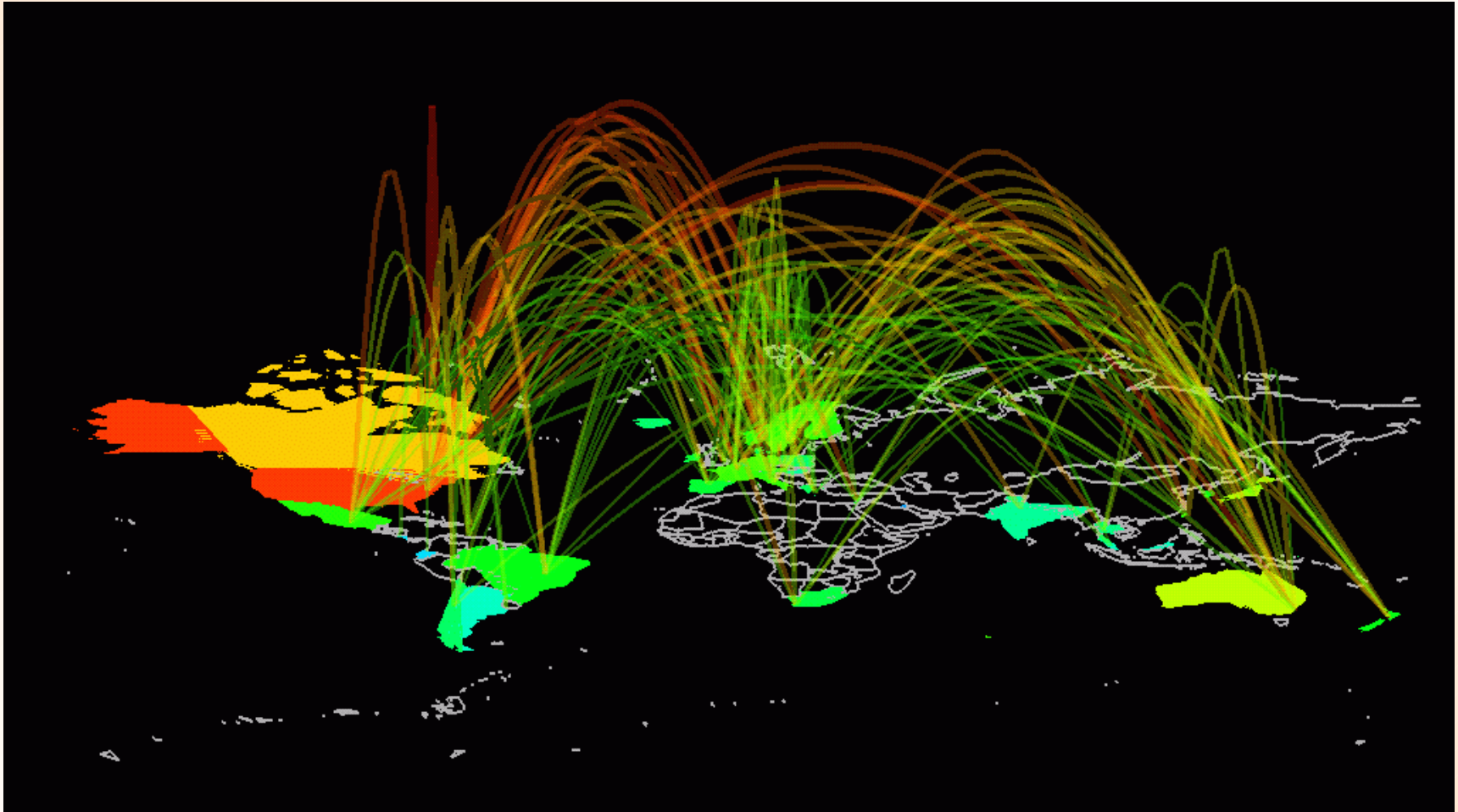

Picture of the Internet, from the Internet

Communication: what and how?

- *Communication: The exchange of thoughts, messages, or information, as by speech, signals, writing, or behaviour.*

- Requirements for communication
    - Medium + Energy, Protocol

Communication networks

- Before the electronic age
  - Using doves/pigeons
  - Smoke signals
- Postal system
- Telegraph
- Telephone network
- Internet
- Cellular/Wireless

What is a Communication Network?

Communication Network
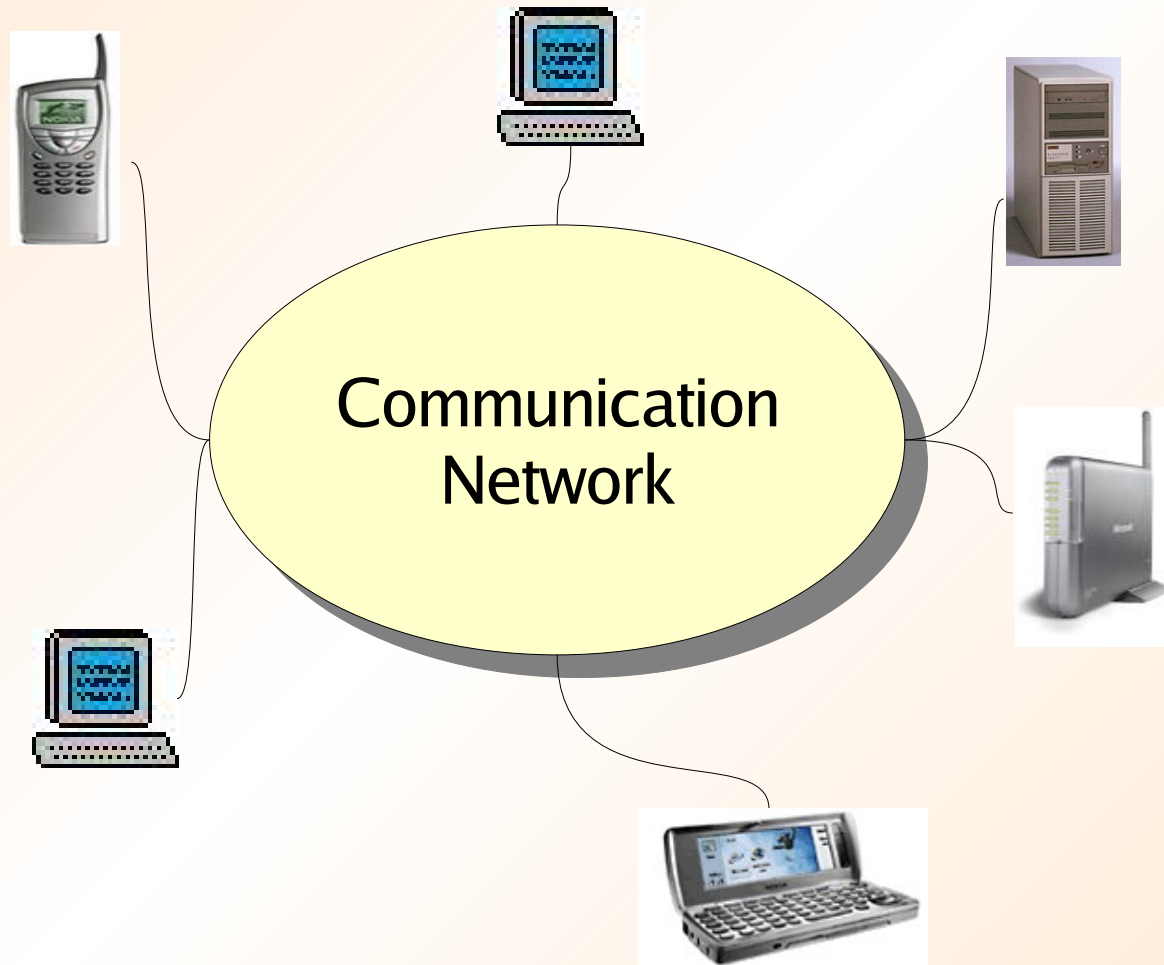
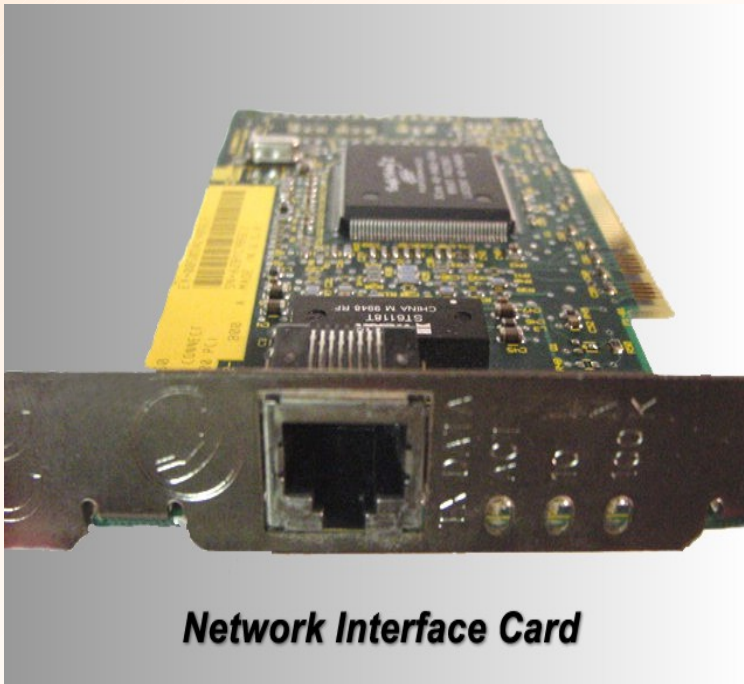Icons courtesy Google

Network Components: Hosts

Communication end-points

– PCs, Workstations, PDAs, Cellphones, Servers

Pictures courtesy Google
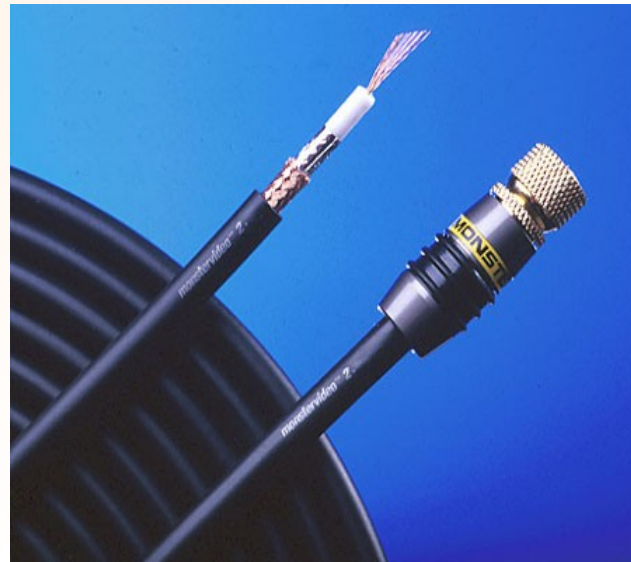
Interface Cards

Attach the host to the link

Network Interface Card
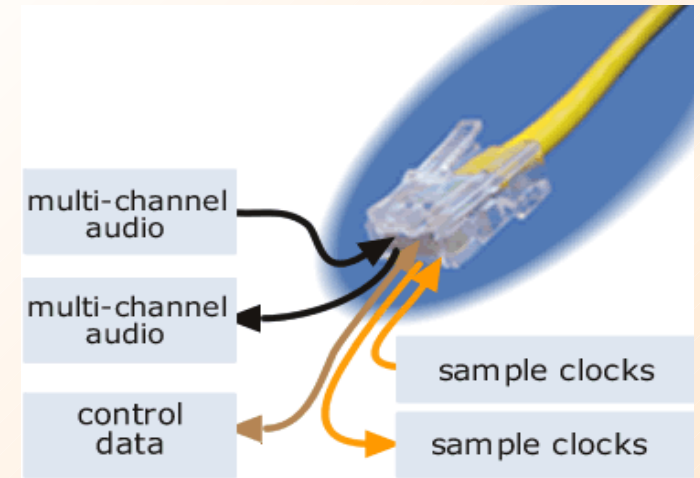
Pictures courtesy Google

Links

Carry signals from one place to other place(s)

Fiber Optics

Co-axial

Cat5-twisted pair

Pictures courtesy Google
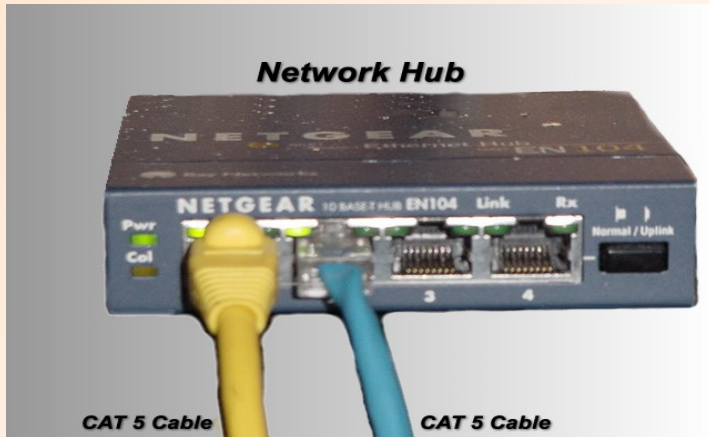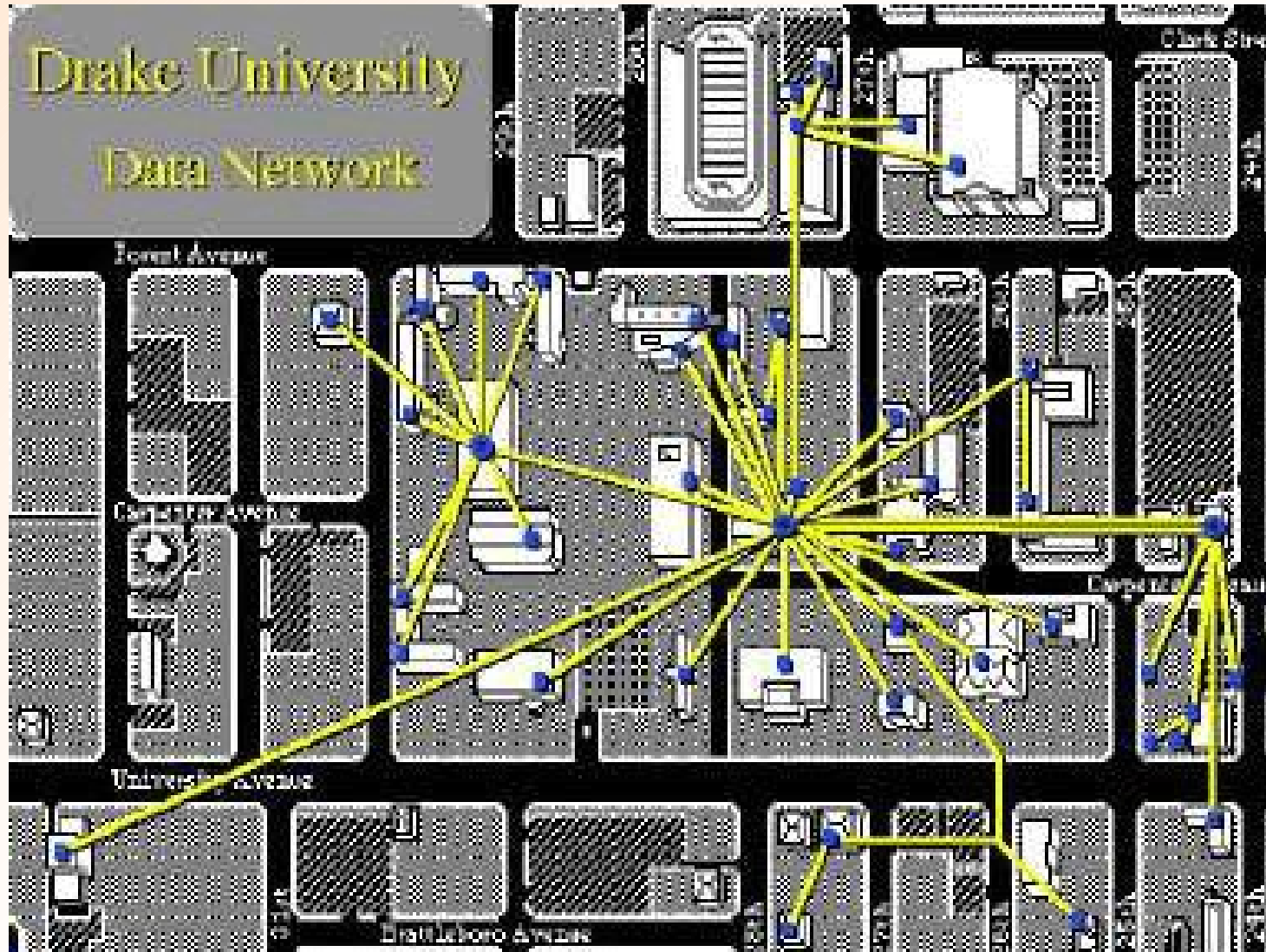
Hubs/Switches/Routers

Hub

Switch

Router

Pictures courtesy Google

Types of Networks

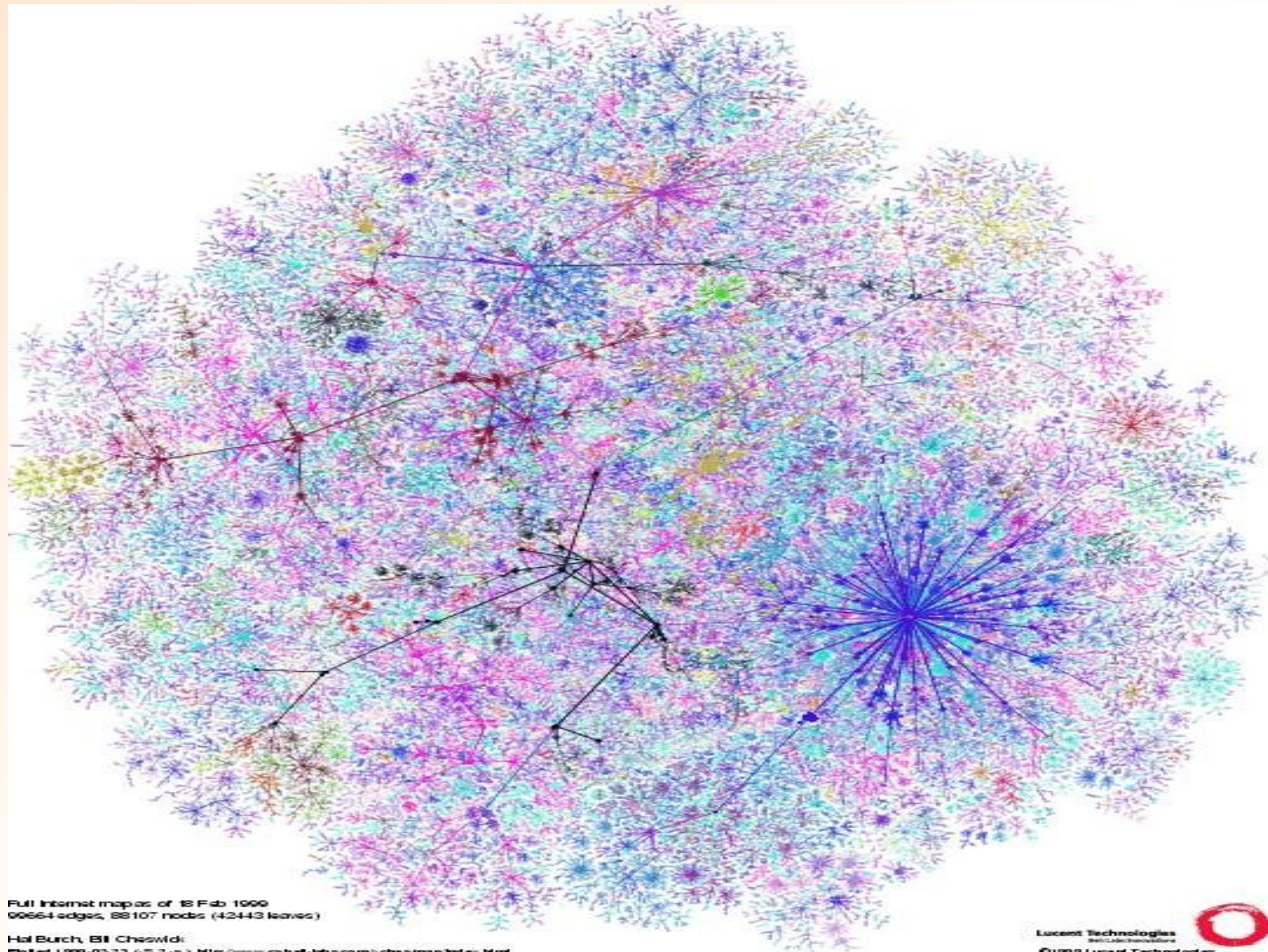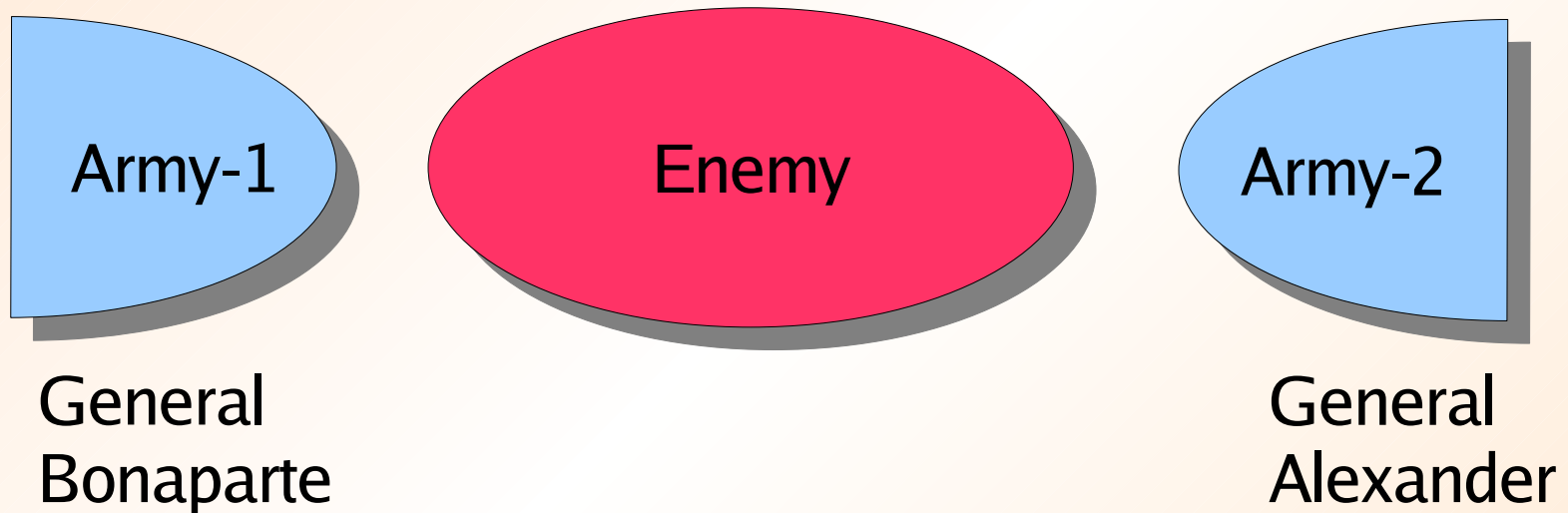| Inter-node distance	Type of network
<1m	Multi-processor network
1-10m	Personal Area Network
10m-1km	Local Area Network
10-100km	Metropolitan Area Network
100-1000km	Wide Area Network
10000-100000km	Internet
>100000km	Inter-planetary Internet

Local Area Network

Picture courtesy Google

Wide Area Network
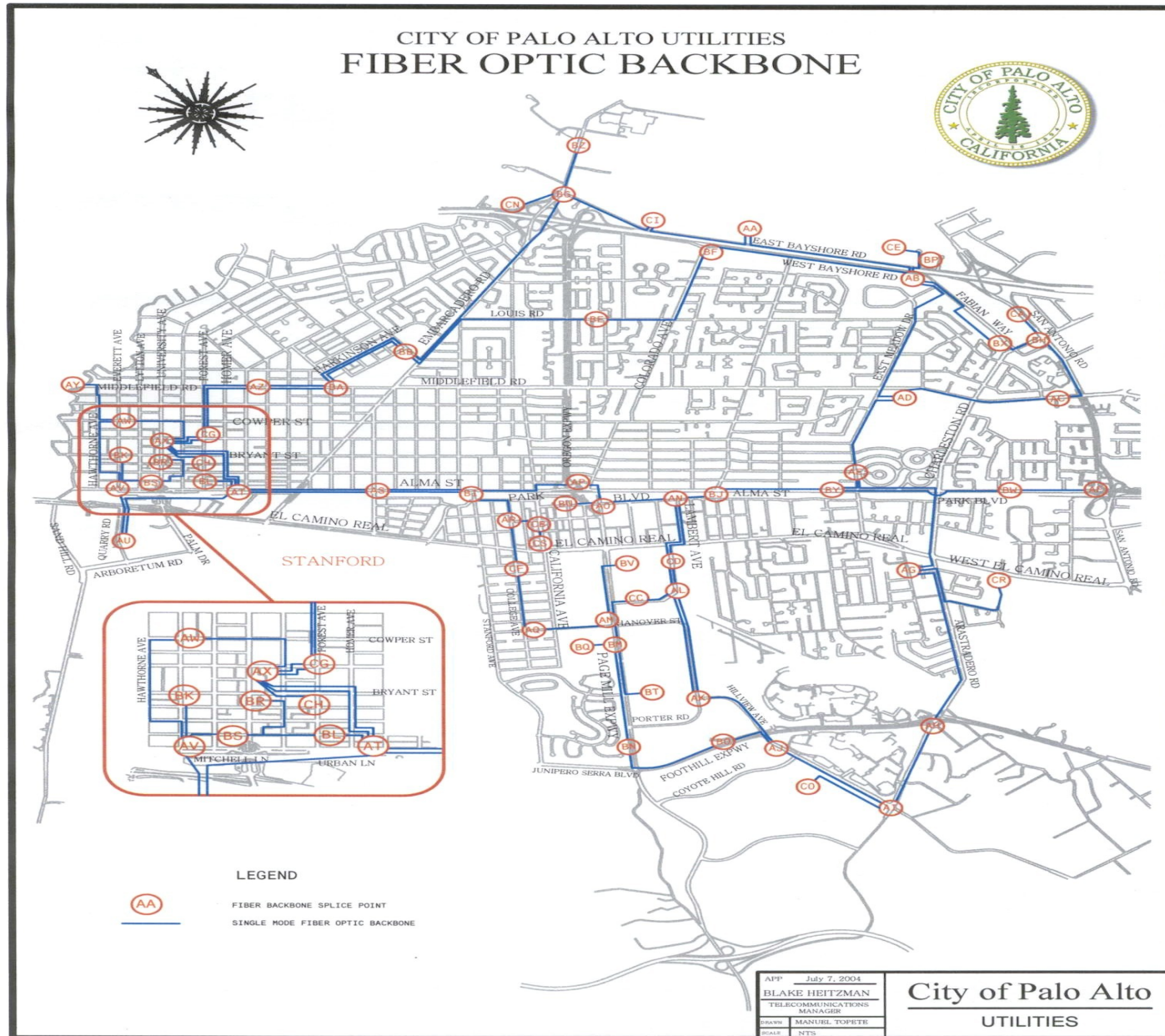
Picture courtesy Google

Internet as of 1999

Full Internet map as of 18 Feb 1999
90664 edges, 88107 nodes (42443 leaves)

Hal Burch, Bill Cheswick
Plotted 1999-03-23 (-S 2 -s) http://www.cs.bell-labs.com/~ches/map/index.html

Lucent Technologies
Bell Labs Innovations
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Picture courtesy Google

The Two-Army Problem

Army-1

Enemy

Army-2

General
Bonaparte

General
Alexander

The attack will succeed *if and only if* both
armies attack the enemy at the same time

What strategy to adopt?

Designing a Protocol

- **What** information to send?

  - Sequence Numbers, CRC etc

- **When** to send?

  - Define possible message sequences

Metrics for Protocol/Network Design

- Efficiency
  - Time, cost, energy, etc.
 - Throughput versus latency
- Reliability
- Security

Several Levels of Issues

- How do two computers communicate on a single link?

- How do several computers share a common medium?

- The notion of a network: when not all computers are connected to each other directly

Communication on a Single Link

- Depends on the physical medium in use
    - Ethernet: converted to electrical signals
    - SONET: optical signals
    - Satellite, WLAN: RF modulation in some frequency
- Framing
- Error Detection/Correction

Sharing a Medium
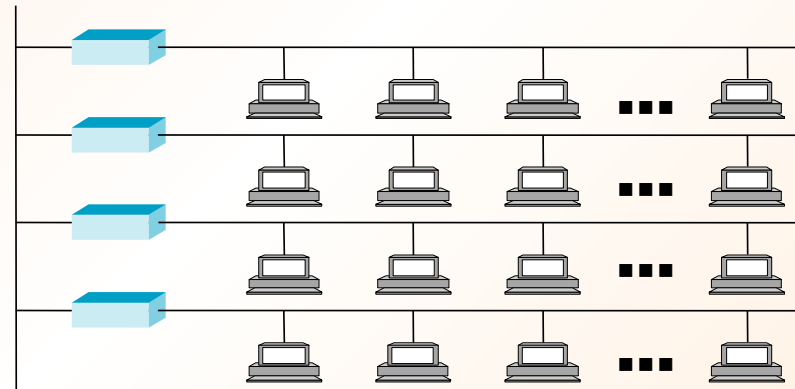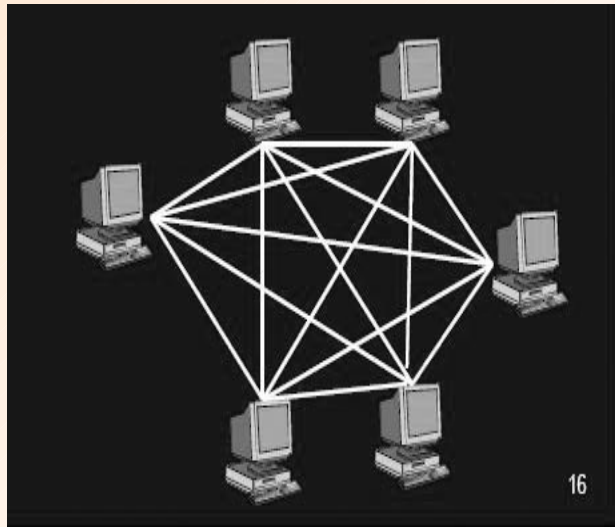
- Notion of Medium Access Control (MAC) protocol

- Possibilities: central control vs. distributed control
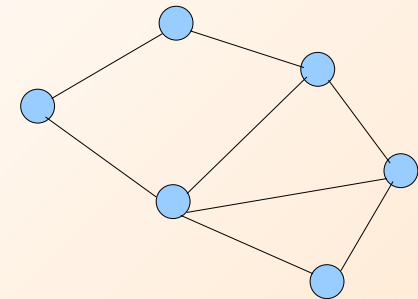
Pictures courtesy Peterson & Davie

Medium Access Control (MAC)

- Time-division multiple access (TDMA)
  - Satellite link, T1, SONET
- CSMA/CD
  - Ethernet
- CSMA/CA (RTS/CTS optional)
  - Wireless LAN
- Other possibilities: FDMA, CDMA
  - GSM uses TDMA + central control

Beyond Direct Communication

Network cloud
and network nodes (switches/routers)

Picture courtesy Peterson & Davie
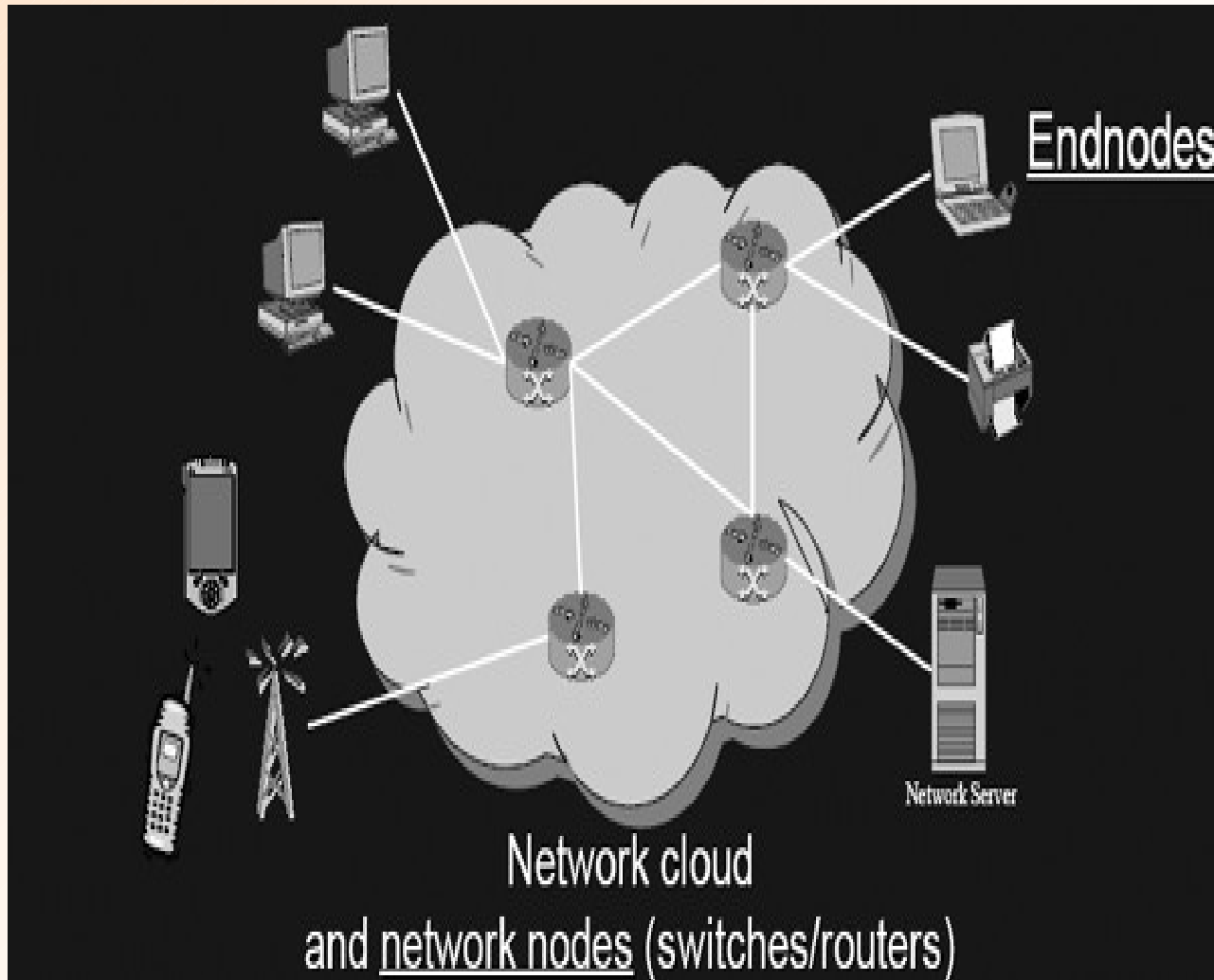
- Need naming

- Network topology:
  - All-to-all
  - Star
  - Intermediate, e.g.

- This is natural:
  - Roads, railway, airlines

Beyond Direct Communication

- Notion of routing
  - Centralized vs. distributed routing
- Distributed routing:
  - Source routing vs. destination-based routing
- Destination-based routing:
  - Each "node" has a routing table
    - Send packets to node 5 via node 2
    - Send packets to node 6 via node 3 etc

Other Issues

- Transport
  - Reliability
  - Flow/Congestion Control
- Applications
  - HTTP, Email
- Network Security
  - Cryptography fundamentals
  - Public key/ private key management

Impact

- Personal
  - Emails, chat, VoIP, video, entertainment
- Business
  - Online purchases, information availability
- Health
  - Tele-medicine
- Education
  - Distance education, easy research/publication