CS 716: Introduction to communication networks

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Clicker Question

The time taken for a signal to travel from sender to receiver is: _____.

1. Round-Trip-Time	2. Transmission delay
3. Propagation delay	4. Transmission + Propagation

It is not sufficient to just pick an answer. You need to also think about how you will justify your answer!

Recall from last class (PHY): Bandwidth and Delay

Bandwidth:

- Amount of data that can be transmitted per unit time.
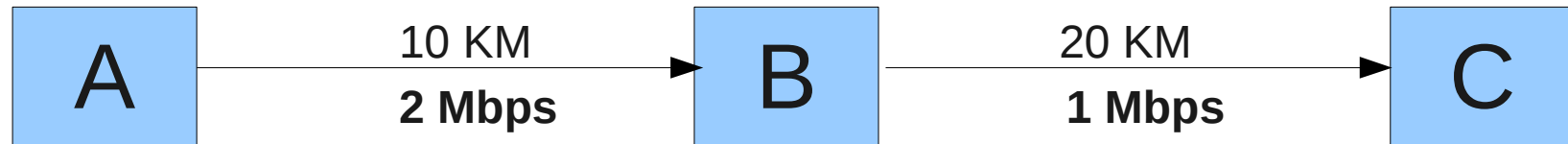
Delay (Latency):

- Time taken to send a message from point A to point B
    - Latency = Propagation + Transmit + Queue
    - Propagation = Distance / SpeedOfLight
    - Transmit = Size / Bandwidth
    - Queue = Waiting for Transmit

- Recall activity for components of End-to-End delay.

Delay X Bandwidth Product

- Relative importance of bandwidth and delay
    - Small message: 1ms vs 100ms dominates 1Mbps vs 100Mbps

    - Large message: 1Mbps vs 100Mbps dominates 1ms vs 100ms

- Example:
    - 100ms delay and 45Mbps bandwidth

    => 560 KB of data in the pipe

Activity: Pair-Solo

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┌─────┐      10 KM       ┌─────┐      20 KM       ┌─────┐
│  A  │ ───────────────→ │  B  │ ───────────────→ │  C  │
└─────┘     2 Mbps       └─────┘     1 Mbps       └─────┘
```

How long will it take to <u>successfully</u> transmit a 10MB file from A to C?

- Assume that the speed of light 300000 KM/sec, Queuing delays are zero and that there is no buffer at node B.

- Pair - Discuss the solution approach with your neighbour.

- Solo - Work out the answer by yourself.

Example: Linux PHY interface

PHY Interface definitions

- int phy_read(struct phy_device *phydev, u16 regnum);
- int phy_write(struct phy_device *phydev, u16 regnum, u16 val);
- Other functions such as print_status, enable_interrupt, ...

- Ethernet drivers in /usr/src/linux/net/inet/eth.c
  - http://www.kernel.org/pub/linux/kernel/v1.0
  - http://www.google.co.in/codesearch

Example PHY protocols

- Telephone Modems V.92, SONET/SDH, DSL, ISDN.

- Ethernet: 10BASE-T, 1000BASE-T.

- WiFi: 802.11 a/b/g

- GSM Um radio interface physical layer.

- Bluetooth Physical Layer.

- USB, RS-232.

- Firewire

- ....

- Quick reference:
  http://en.wikipedia.org/wiki/Category:Physical_layer_protocols

PHY configurable parameters

- Preset configurations are sufficient in most cases.

- GUI and text-based tools/utilities available to user:

  - ethtool, Mii-tool

- Common actions:

  - ifup eth0: Turn on the Ethernet
  - Ifdown eth0: Turn off the Ethernet
  - /etc/init.d/network [status | stop | start]

- Config parameters are stored in files typically in:

  - /etc/network/interfaces
  - /etc/sysconfig/network-scripts/ifcfg-eth0 /etc/network/
   – Actual file names may vary across Linux flavours/versions

More on Modulation schemes

- Fast Ethernet 100BASE-T and Gigabit Ethernet 1000BASE-T utilize Pulse Amplitude Modulation (PAM-5).

  - See Ethernet Working Group, IEEE 802.3

    http://www.ieee802.org/3/

- WiFi 802.11b uses Direct Sequence Spread Spectrum (DSSS) and 802.11g uses Orthogonal Frequency Division Multiplexing (OFDM)

  - See Wireless LAN Working Group, IEEE 802.11
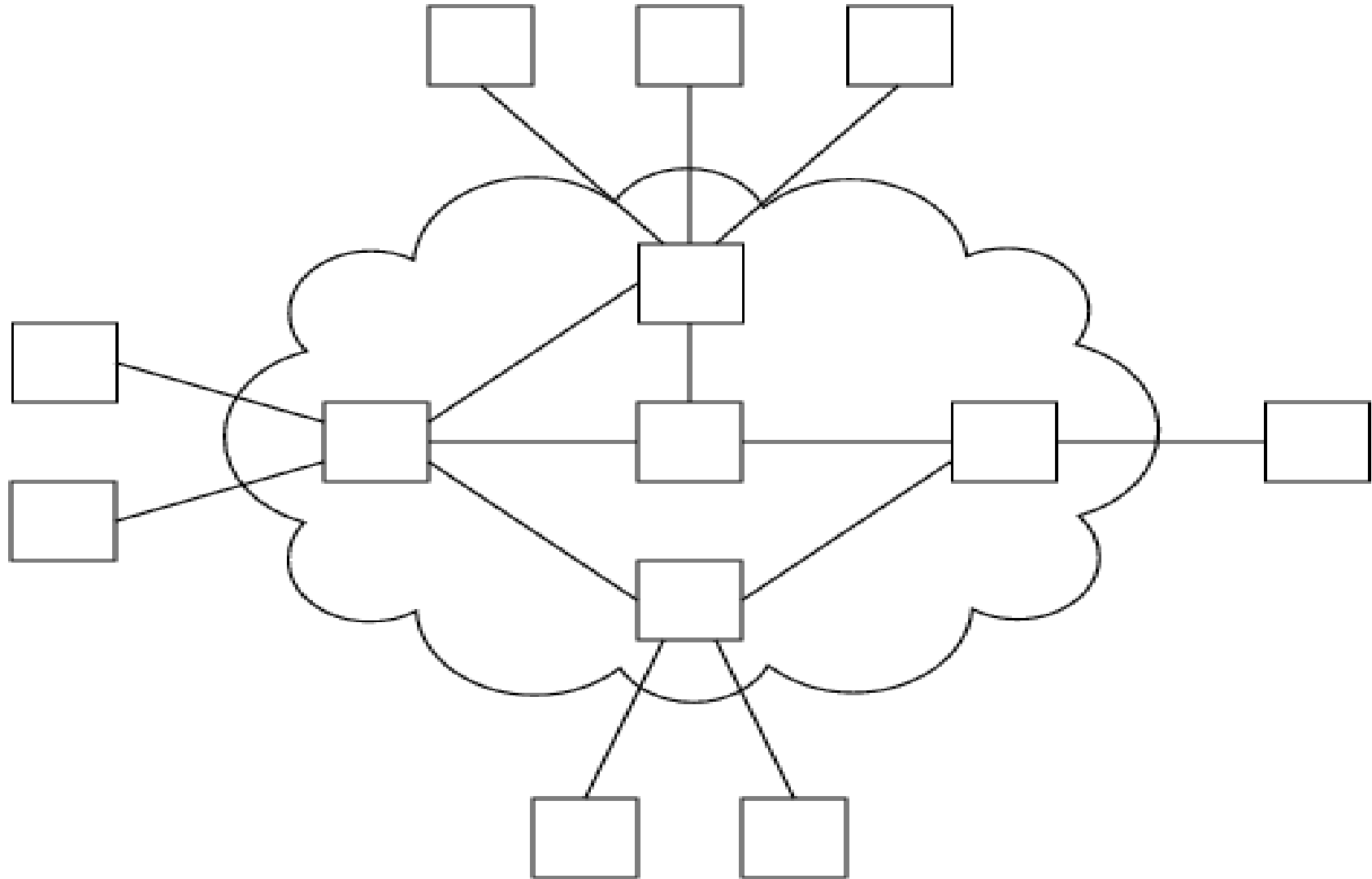
    http://www.ieee802.org/11/

More on PHY design

- Is beyond the scope of this course!

- Topics in PHY lead to research areas such as:
  - Design of Transmitters, Antennas and Receivers.
  - Modulation techniques.
  - Coding, error correction.
  - … and many more.

We will move from a single link to ...

Direct Links

Point-to-point connectivity

...

Shared Links

Multiple access network
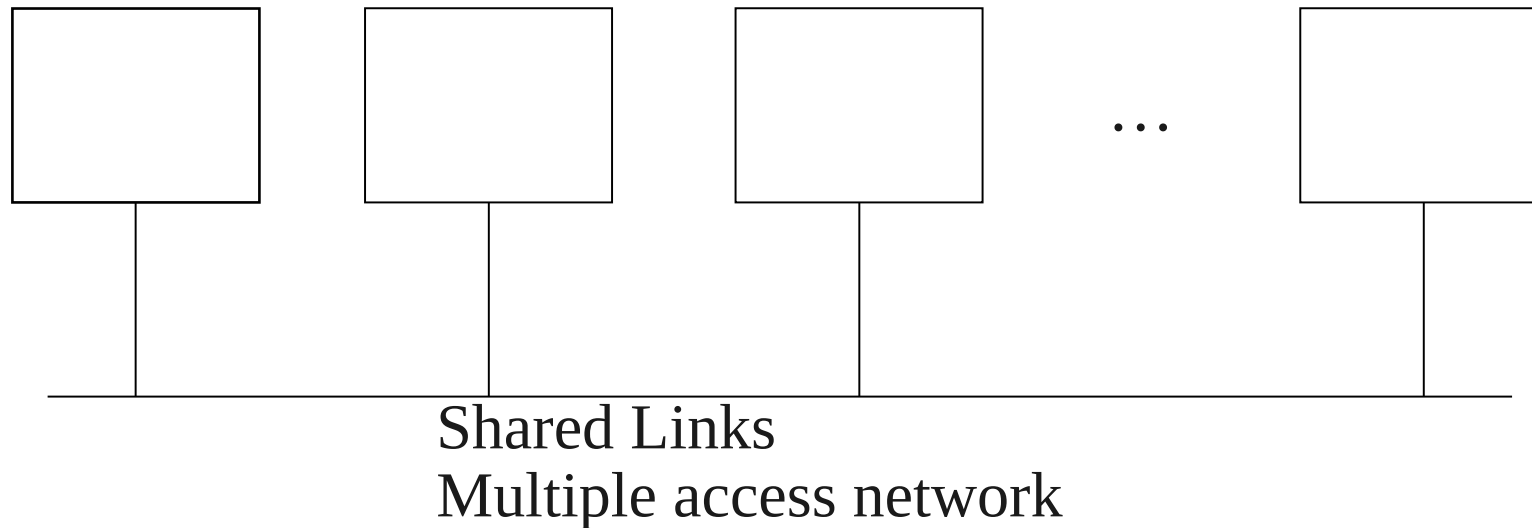
And then onto … switched networks

Today's class discussion

- Having seen the concepts in PHY, we will get into the Link layer (MAC and LLC), also known as Layer 2.

  - What should be the concerns of the Link layer?

  - What services should Link layer provide?

  - What are the pros and cons of sharing a link?

  - What are the issues in sharing a link (multiple-access; MAC – Medium Access Control)?

- Let us quickly put some answers on the board!

Multiple-access

- A PHY link may sometimes be shared among multiple senders and receivers.
  - Is this desirable? What are the pros and cons?
    - Tradeoffs: cost, utilization, security, …
    - Some student's answers that came up:
      - LAN is better for adding nodes without much increase # of links.
  - Do we have a choice?
    - Wireless is inherently a shared medium!
- Broad idea:
  - Sharing a given resource among multiple users.
  - Terms: Multiprocessing; Multitasking; Multiplexing.

Activity: Think-Pair-Share

Consider a room full of people (such as this class)

1. What are three different ways/modes in which communication can happen in this room?

   – Hint: Think about the different types of conversations.

2. For each of the above communication modes:

   1. Do we need any protocol between the entities?

      • If yes, why? If no, why not?

   2. If yes, suggest a protocol that could be used.

Activity: Think-Pair-Share (contd)

3. More Questions:

- What factors need to be considered for MAC protocol design?

- How does each factor influence the MAC protocol?

Example:

Factors	How they affect
Mode of communication	Duration of access to the medium; If all have equal priority, round-robin time-slots could be used.
Cost of medium	Licensed v/s unlicensed spectrum in wireless.

- Think – Individually

  - Add as many entries as you can to the above table.

- Pair - Discuss with your neighbour.

  - Copy answers from your neighbour's list that you have missed out!

- Share - Discuss with entire class.

Some points from last year

- Broadcast – if one person wants to talk to everyone.
- Priority – if one person is more important to be heard.
- Round robin – if equal opportunity to be given to all.
- Intra-group versus inter-group communication.
- ...

Key points to consider for MAC

- Types/Modes of communication:
  - Although the medium is shared, who is talking to whom?
    - 1-to-1: Conversation between two students in a corner.
    - One-to-Many: Instructor lecturing.
    - Many-to-One: Students responding to instructor's question.
    - Many-to-Many: Your group discussion!

- Protocols for each modes of communication:
    - 1-to-1: Separate space; Separate channel (language/frequency).
    - 1-to-Many: Broadcast; Often associated with notion of Priority.
    - Many-to-One: Polling; Round-robin; Some notion of taking turns.
    - Many-to-Many: Speak at will; Listen before talk; Handle collisions!