Computer Communications: All you should know (should have known!)

- Data Transmission vs Data Communication

Data Link Layer
Network Layer
Transport Layer
Application Layer

Physical Layer

Its only function: Transmission of bits on a transmission medium =

Propagation!

Basic Concepts of Data Communications

- Data are stored inside a computer and transmitted on a communications path in the form of bits, either 1 or 0

represented by the level of polarity of electrical signals; for example high-level for 1, low-level signal for 0

between computer oriented devices using electrical signals (wire), light signals (optic fibers); for example, by placing a stronger electrical signal on the line for a fraction of a second to represent 1, low-level for 0

More About Signals Transmitted

- An ***analog signal*** is a continuously varying electromagnetic wave that can be propagated over a variety of media: twisted pair, coax cable, fiber-optic cable, and atmosphere or space propagation.
- A ***digital signal*** is a sequence of discrete, discontinuous voltage pulses that may be transmitted over a wire medium: for example, a constant positive voltage level may represent binary 1, and negative level a binary 0.
- Please note something important above: some transmission media will only transmit analog signals!!!!

Signals and Data

- Analog signals may represent analog data (think of voice on telephone lines)
- Digital signals may represent digital data (trivial!)
- Digital data may be represented by analog signals (your computer exchanging data via modem hooked up to your telephone): ***Modulation***, Lecture 4, slide 5!
- Modulation simply means that the data stream changes=modulates the (carrier) signal on the comm. path to represent those data

Signals on a Transmission Path = Signal Propagation

- Transmission of a signal requires use of a ***transmission medium***:
  - On a wire path, signal propagation is a flow of electrical current
  - Radio transmission between computers : signal propagation is achieved by emitting an electrical signal that propagates as an electromagnetic wave through a free space
  - Beam of light guided by a glass fibre

What is in a Signal

- Most signals consist of oscillating wave forms as shown in Lecture 5/slide 2.
- The oscillating signal can be described in the time domain and frequency domain
- The time domain representation is a picture of how the signal varies with time

FOURIER

- Frequency domain representation shows how the signal is made up of varying frequencies: we call them ***frequency components*** of a signal

How Do We Look at a Signal (in computer communications)

- The representation of a signal in the frequency domain is most interesting to us since channel characteristics are given in terms of ***frequency***.
- ***Bandwidth*** *(expressed in terms of highest and lowest frequency on a channel)*, for instance, limits the amount of data a channel can carry (Nyquist, Shannon, Lecture5, slides 3 &4)

there is more …….

Why Look at Frequency Domain Representation

- Some transmission impairments such as ***<u>delay distortion</u>*** are frequency dependent in that they distort different frequency components of a signal differently
- Moreover, the oscillating signal has 3 characteristics that can be varied in order for it to convey computer-generated data:
  - ***<u>amplitude, frequency, and phase</u>***

  (***<u>Modulation or Shift Keying</u>***, see Lecture 4, slide5)

Problems with Signal Propagation: Transmission Impairments

- Back to bullet 1 on the previous slide: delay distortion is just one of the transmission impairments
- The data in a frame, message, etc. do not always arrive at the destination correctly: a bit or several bits may arrive garbled
- Major transmission impairments are signal ***attenuation, dispersion, delay distortion and noise***.
- Some impairments corrected through devices such as equalizers, amplifiers, etc. inserted on transmission paths
- Other transmission errors corrcted through error correction/detection at layer above Physical, Lecture 7&8!

Propagation is never Enough - Being Efficient Matters

- The previous discussion concerned about what, how, and how much can be propagated on transmission media
- However, transmitting bits is not sufficient, since communications resources are limited
- We use multilevel coding, multiplexing and switching techniques to efficiently utilize transmission channels and paths

Being Efficient Matters

- Multilevel coding not within the scope of this class
- ***Multiplexing*** is best described as channel sharing: ***Frequency Division*** ("horizontally" slicing the bandwidth available on the channel); ***Time Division*** ("vertically" slicing by allocating discrete time slots); and variants.
- More in Lecture 5, slides 6,7,8

Being Efficient Matters: Part II

- ***Switching*** takes on various forms: Tanenbaum gives a nice overview, also Lecture 6, slides 2,3,4
- A simple issue: save on the interconnection path explosion by placing switches on the transmission path
- Granularity of switching at circuit, message, packet levels
- Examine the effect of granularity on the total time needed for a particular scenario (Lecture 6, slides 5&6)

Goals of the lectures so far

- Describe the different types of physical transmission media that are used to transmit data
- Appreciate the characteristics (how propagation affects the signal) and limitations (Shannon, Nyquist) of each type of medium
- Appreciate the switching and multiplexing technologies in the context of the efficient usage of the resources at the Physical Layer

The Road Ahead