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Mushr00m - May 17, 2010, 1:53 pm

Introduction to Networking (Part 3)

By: Mushr00m

The Physical Layer

Analog and Digital Data

A fundamental physical layer distinction is between digital and analog forms of data.

Signals that vary continuously over time are called Analog Data.

Ex. Sound waves, image, and video.

Discrete signals are called Digital Data.

Ex. Square waves, impulses, digital data in binary form.

[img]http://www.brainbell.com/tutors/A+/Hardware/images/f12xx05.jpg[/img]

(Image Source: <http://www.brainbell.com/tutors/A+/Hardware/images/f12xx05.jpg>)

Analog vs. Digital Transmission

Transmission is the propagation through a medium over a carrier wave.

Transmission can be analog or digital.

Analog Transmission: Transmission using continuous waves as a carrier.

Analog Transmission: Transmission using square waves as a carrier.

-In analog data all details must be reproduced accurately.

Ex. AM, FM, TV transmission

In digital data only discrete levels need to be reproduced.

Ex. Digital telephone, CD Audio

There are more advantages when you use digital transmission as opposed to analog transmission.
Some advantages are: Fewer errors

Higher transmission rates

More efficient

More secure

Easier to combine or separate transmission (Multiplexing, Demultiplexing, Inverse Multiplexing)

Note: These will be explained later in the tutorial.

Network Circuits

There are two basic circuit configurations, they are:

- Point-to-point
- Multipoint(also called a shared media)

Point-to-point circuits connect just one sender and one receiver together.

Multipoint circuits connect a number of senders and receivers together.

Note: In a multipoint circuit, only 1 computer can access the media at one time.

Data Flow

Data can move in one direction or in both directions. Simplex-Data moves in one direction only.

Half Duplex-Data can only move in either direction. However, data can only move in one direction at one time.

Full Duplex-Data can move in both directions simultaneously.

[img]<http://upload.wikimedia.org/wikipedia/id/7/7a/Simplex-Duplex.png>[/img]

(Image Source: <http://upload.wikimedia.org/wikipedia/id/7/7a/Simplex-Duplex.png>)

Communications Media

A Medium is the physical material that carries the transmission.

There are 2 types of media:

Guided Media

Ex. Twisted pair wiring, coaxial cable, fiber optic cable

Wireless Media

Ex. Radio, infrared, microwave

In wireless media the waves are not guided, they just flow through space.

Twisted Pair Wires

- Commonly used for telephones and LANs
- Twisting 2 wires together reduces electro magnetic interference
- May have a number of pairs of wires

Coaxial Cable

- Expensive, however it is less prone to interference because it is shielded
- Used for cable TV
- Not as common on LANs as it used to be
- Has an inner conductor, an insulator, an outer conductor (wired mesh), and a protective outer jacket

Fiber Optic Cable

- Very high capacity
- Has a glass or plastic fiber core, cladding, and a protective outer jacket
- Guided through: multimode, graded index multimode, and single mode
- The light source is from an LED or a laser

Wireless Media

-The main forms are:

Radio 3KHz – 300 GHz(including Microwave 300MHz-300GHz): cellular network, Wi-Fi, Wi-Max, two-way radio, police/military radio, ISM (Industrial, Scientific, Medical) unlicensed band, RFID, Satellite, terrestrial microwave, etc.

Infrared

Microwave Communications

-Terrestrial microwave

-Satellite communications

between the ground station and a satellite

usually in geosynchronous orbit (about 23,000 miles above the earth)

Advantage: high coverage

Disadvantage: long propagation delay.

Media Selection

You should select your media based on the:

Type of network

Cost

Transmission distance

Security

Error rates

Transmission speeds

Coding

EBCDIC

-Extended Binary Coded Decimal Interchange Code

-Used by IBM mainframes and midrange systems such as the AS/400

-Designed for ease of use on punched cards

ASCII

-American Standard Code for Information Interchange

-Originally used a 7-bit code (128 combinations)

-Now in use is an 8-bit version

Unicode

-16-bit

Transmission Modes

Data can be sent in either serial or parallel.

Parallel Mode uses several wires. Each wire sends one bit at the same time as the others. Ex. A parallel printer cable or a computer's processor or motherboard

Serial Mode sends bit by bit over one line. Serial mode is slower than parallel. The advantage of using serial mode is the use over long distances. The bits stay in order when they are sent, while bits in parallel mode that are sent over long distances tend to spread out.

Digital Transmission

- Digital signals are sent as square waves (a series of them)
- Can be + or - voltage
- The voltage can be anywhere from +3/-3 and +24/-24, all depending on the type of circuit that is used.
- Voltage levels have a corresponding 0 or 1 which is defined by the digital transmission.
- Unipolar can vary from a 0 and a 1, and can be + or -.
- Bipolar signals are sent with both + and - voltages
- Return to Zero (RZ) means that after a bit is sent, the voltage returns to a value of 0.
- Non Return to Zero (NRZ) is the opposite of RZ. The voltage stays the same after the bit is sent.
- Biphase->Ethernet uses Manchester Encoding. In Manchester Encoding, the value of the bit can only be determined by a mid-bit transition. High->Low voltage transition=binary 0. Low->High mid-bit transition=binary 1

[IMG][http://i44.\[censored\].com/2j516l0.jpg](http://i44.[censored].com/2j516l0.jpg)[IMG]

Digital Transmission of Analog Data

PAM/PCM

- Phone systems use PAM/PCM
- >PAM has 2 steps: 1. Measure the signal and 2. Take samples of the signal
- >PCM has 1 step: 1. Encode the signal into a binary data sample

PAM

- Stands for Pulse Amplitude Modulation
- Quantizes the signal into 128 pulse amplitudes (PAM)

PCM

- Stands for Pulse Code Modulation
- PCM takes samples at specific points to produce amplitude modulated pulses, then the pulses are coded.

Codecs

- A codec (which stands for coder/decoder) can be used to convert an analog voice signal into a digital signal.
- >Coder: analog data to digital transmission
- >Decoder: digital transmission back to analog data.
- Used for audio/video digital storage/transmission
- PAM/PCM is the fundamental technology for analog/digital conversion.
- Raw bitrate is very high, compression is critical for "high quality and low bitrate"
- MPEG (Moving Picture Experts Group)

MPEG

- The Moving Picture Experts Group (MPEG) was formed by the ISO to set standards for audio and video compression and transmission. It was established in 1988
- MPEG-1: was designed to deliver 30 frame per second video from bandwidth limited sources such as CD-ROM.
- MPEG-2: The MPEG2 standard builds upon MPEG1 to extend it to handle the highest-quality video applications. MPEG2 is a common standard for digital video transmission. Broadcast distribution equipment, digital cable head-ends, video DVDs, and satellite television all employ MPEG2.
- MPEG-4: It's designed to scale down – down to dial-up internet bandwidths and to tiny devices like cell phones and PDAs; as well as still remain viable for high-quality desktop streaming up to 1Mbps.

-MP3: part of MPEG-1, its magical ability to squeeze the 1.4Mbps audio stream from a standard audio CD down to 128kbps that has made MP3 the de facto standard for digital music distribution.

Multiplexing

What is Multiplexing?

Multiplexing is when you break up a high speed circuit into a group of slower circuits.

-Multiplexing is cheap

-There are 4 types of multiplexing:

Frequency division multiplexing (FDM)

Time division multiplexing (TDM)

Statistical time division multiplexing (STDM)

Wavelength division multiplexing (WDM)

*For time and space sake I am not going to explain each one of those. If you would like to know more about each you can PM me, but they are pretty simple to grasp.

Inverse Multiplexing

-Rather than using a single line, an IMUX (Inverse Multiplexer) can be used to send the data over multiple lines.

Analog Transmission of Digital Data

Carrier Waves

-Used by modems to send information.

-There are 4 characteristics of a carrier wave: Amplitude-height of the wave

Frequency-# of waves that pass in 1 second (cycles/second). Measured in Hertz

Wavelength-Length of wave from crest to crest

Phase-The cycle where a wave begins

Modulation

-The change in a carrier wave's characteristics (analog) in order to encode information (digital).

-There are 3 ways in which you can modulate a carrier wave: Amplitude Modulation (changing the height of the wave to encode data)

Frequency Modulation (changing the frequency to encode data)

Phase Modulation (changing the phase to encode data)

Some of this may be confusing and weird to some readers. I urge you to pick up a networking book and begin reading. You will not learn everything you need to know about networking in my tutorials,

and you may not even understand it, but hey, I'm trying right? ?

Spectrum and Bandwidth

Spectrum is the range of frequencies in a signal

Bandwidth is the width of the spectrum

Attenuation

-When the signal strength is lower due to the distance

-All depending on the media that is used

-An increasing function of frequency

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Also, this isn't nearly everything included in the physical layer, more will be discussed in future tutorials that apply to the physical layer.

phybe? - May 17, 2010, 2:28 pm

Very nice and detailed introduction once again, you posted all three of these so quickly with only 7 posts. Awesome, you must know a lot. :)

Mushr00m - May 17, 2010, 2:36 pm

Thanks, I just hope they are helping people. The other two seem to have gotten buried already, starting to think maybe I should try to find other topics to write about. The plan was write tutorials on an introduction to networks, then write about network security. I will continue with the series and see what happens...lol

phybe? - May 17, 2010, 2:39 pm

(May 17, 2010 02:36 PM)Mushr00m Wrote: [CITE](#) Thanks, I just hope they are helping people. The other two seem to have gotten buried already, starting to think maybe I should try to find other topics to write about. The plan was write tutorials on an introduction to networks, then write about network security. I will continue with the series and see what happens...lol

Well just find some stuff lots of people have questions on and what not and Im sure you will be one of HF's most helpful contributors.

AndyKLovin - May 17, 2010, 4:30 pm

Hehe, don't worry. I am copying them to a txt file.

Your tutorials are REALLY useful!

I wish you good luck in here.

You are a high quality member. ~Andy

the rofler - May 18, 2010, 12:08 pm

I'm bookmarking all of your tutorials :)

This one is a bit harder to take in than the others, but I'll get it eventually, thanks.

AndyKLovin - May 18, 2010, 9:28 pm

:P Some of the stuff here is more related to electronics than to networking.

You only missed the capacitor wave as long as I am concerned.

joey213 - October 12, 2011, 12:19 pm

So detailed you seem to be an expert at this. I did not understand everything of the 3 tutorials , because idont know some hard english words but i will read this over a few times en hope i understand. Thanks for the shares!

-joey

dgdgdgd - *October 12, 2011, 1:18 pm*

very good tut's i relay like them :)

S?mbra - *October 12, 2011, 2:19 pm*

Very nice done, but for some reason I feel like its stolen from somewhere else, could have sworn I saw this before..

But if it is your's, good job.

ThatGoatherd - *October 12, 2011, 2:37 pm*

Very nice tutorial! Explains stuff very well and you even took the time to reference the content. Keep up the HQ work!