The Saigon CTT

Chapter 4
ELECTRICITY
AND
SIGNAL

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ELECTRICITY

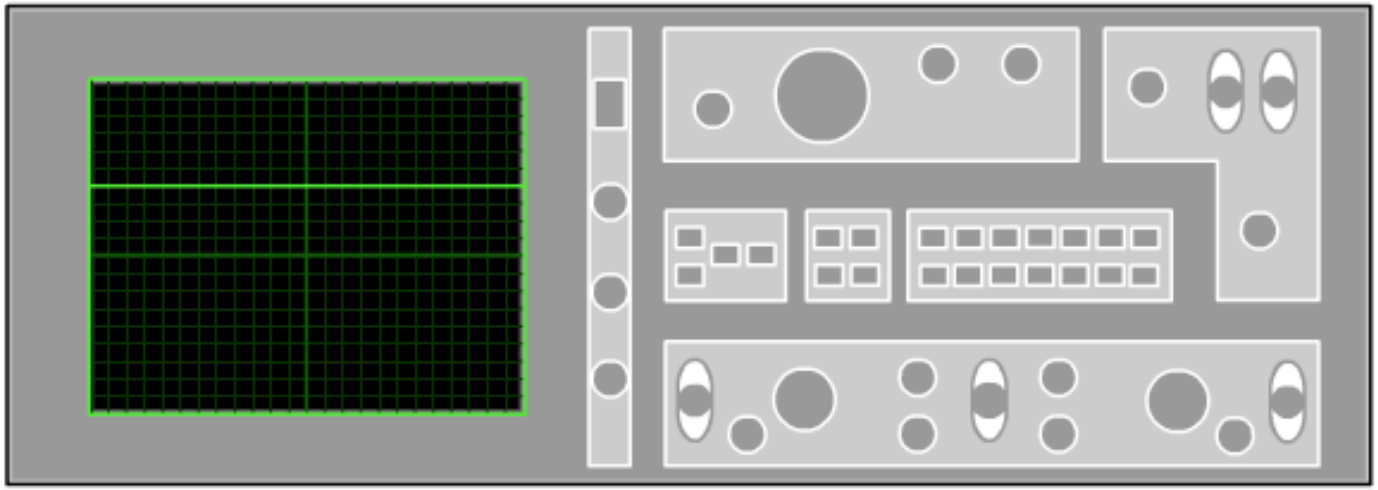
Static electricity

- **Electrons have been loosened from the atom and stay in one place, without moving.**
- **Electrostatic discharge (ESD).**
  - ***ESD, though usually harmless to people, can create serious problems for sensitive electronic equipment.***
  - ***How to handle the printed circuit boards ?***

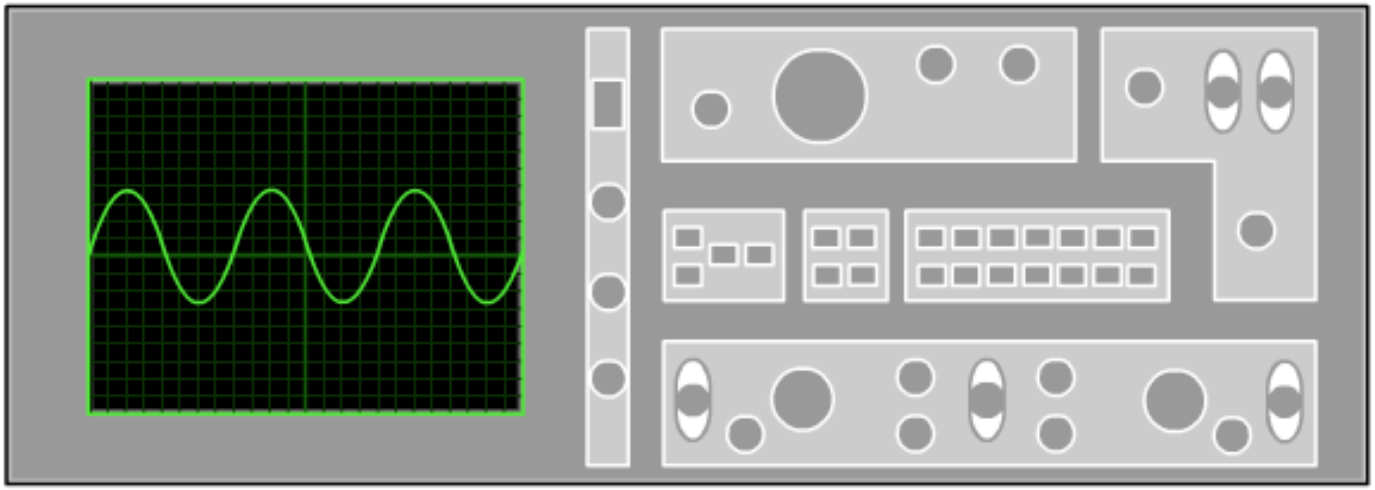
Electrical definitions: AC and DC

- **Alternating Current (AC):**
  - **Electrical current flows in both directions; positive and negative terminals continuously trade places (polarity).**
- **Direct Current (DC):**
  - **Electrical current flows in one direction; negative to positive.**

Oscilloscope



DC

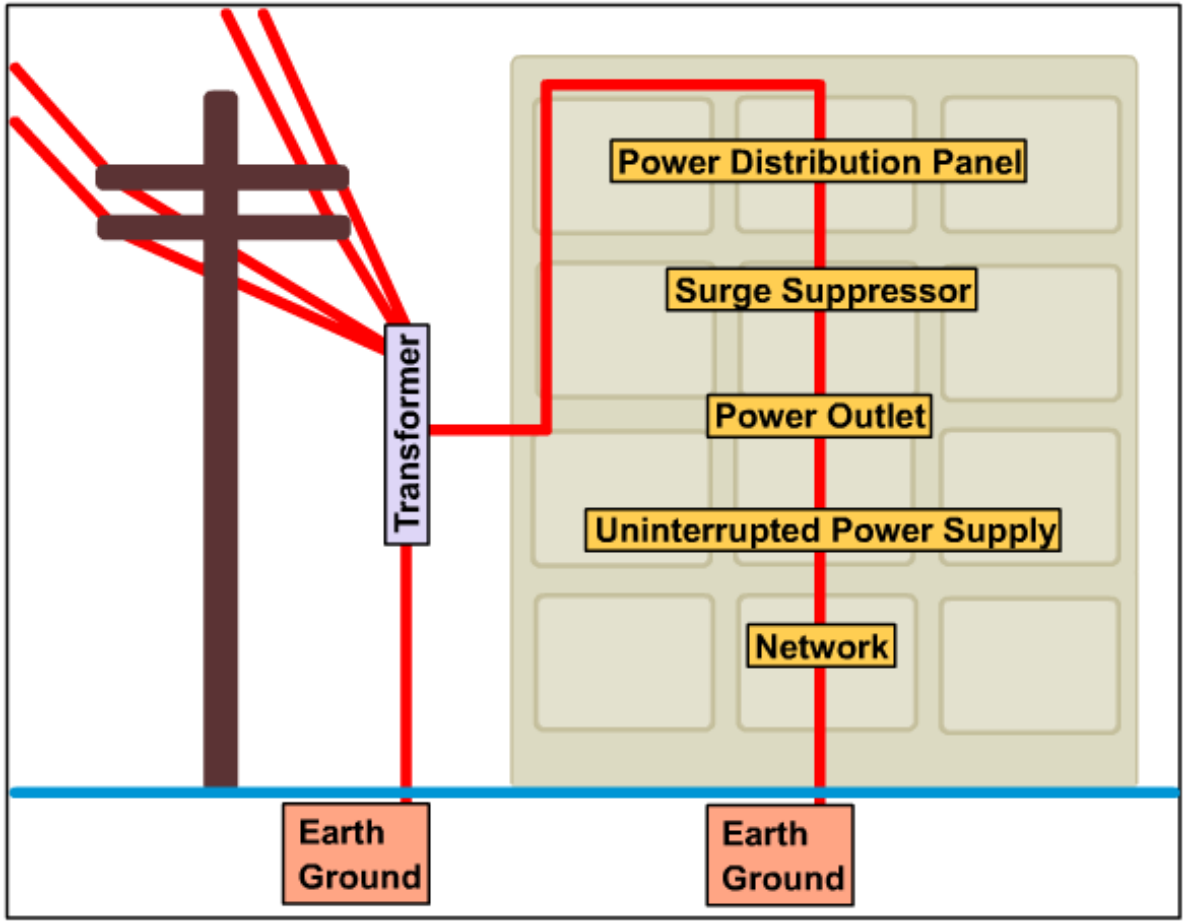


AC

Electrical definitions: Ground

- Ground can refer to the place on the earth.
- Ground can also mean the reference point, or the 0 volts level, when making electrical measurements.

Safety ground wire (SGW)



- **SGW prevents electrons from energizing metal parts of the equipments.**

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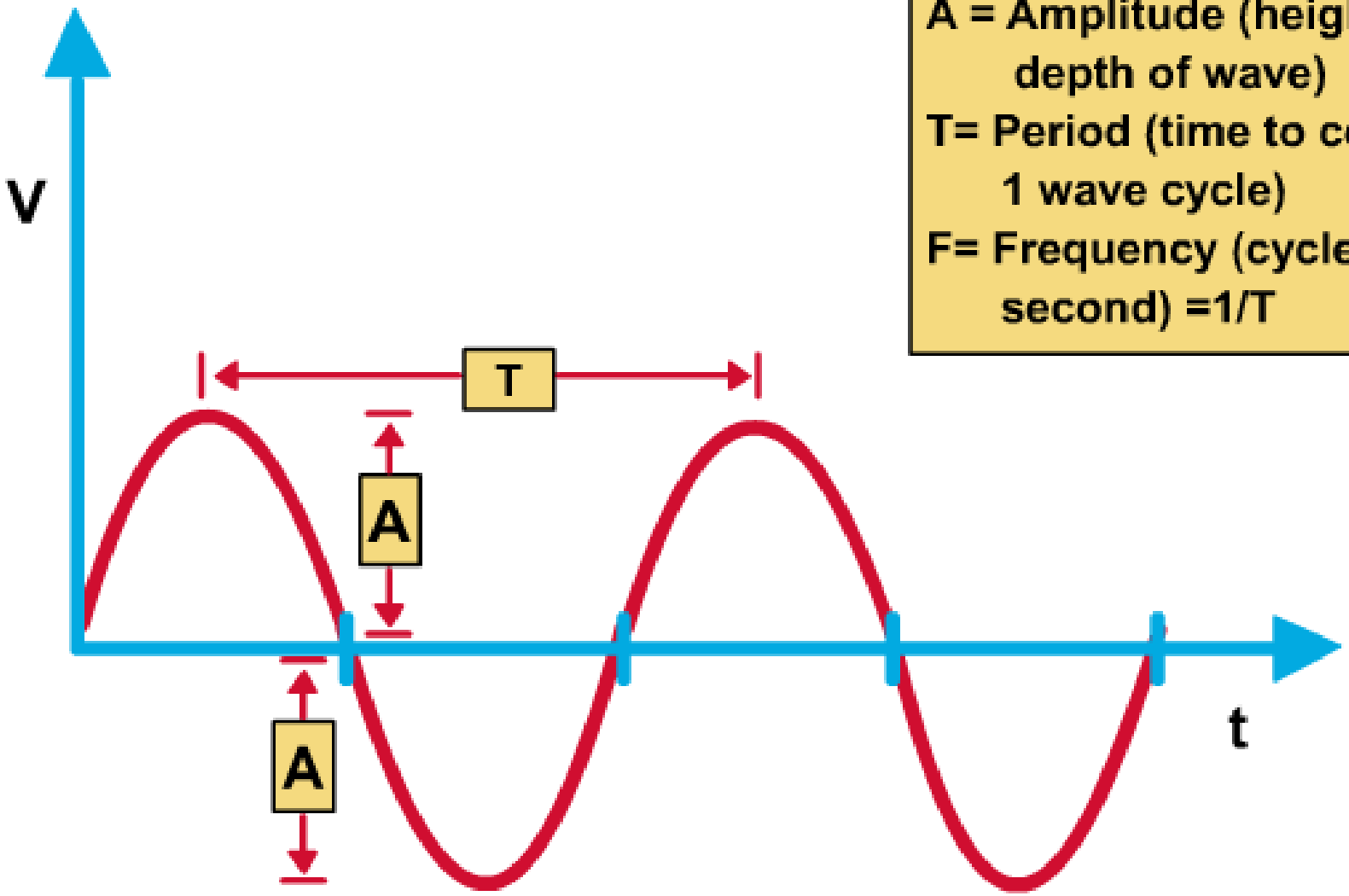
SIGNALS AND NOISE

Signals

- Signal refers to a form to carry information.
- Example:
  - A desired electrical voltage.
  - A light pattern.
  - A modulated electromagnetic wave.

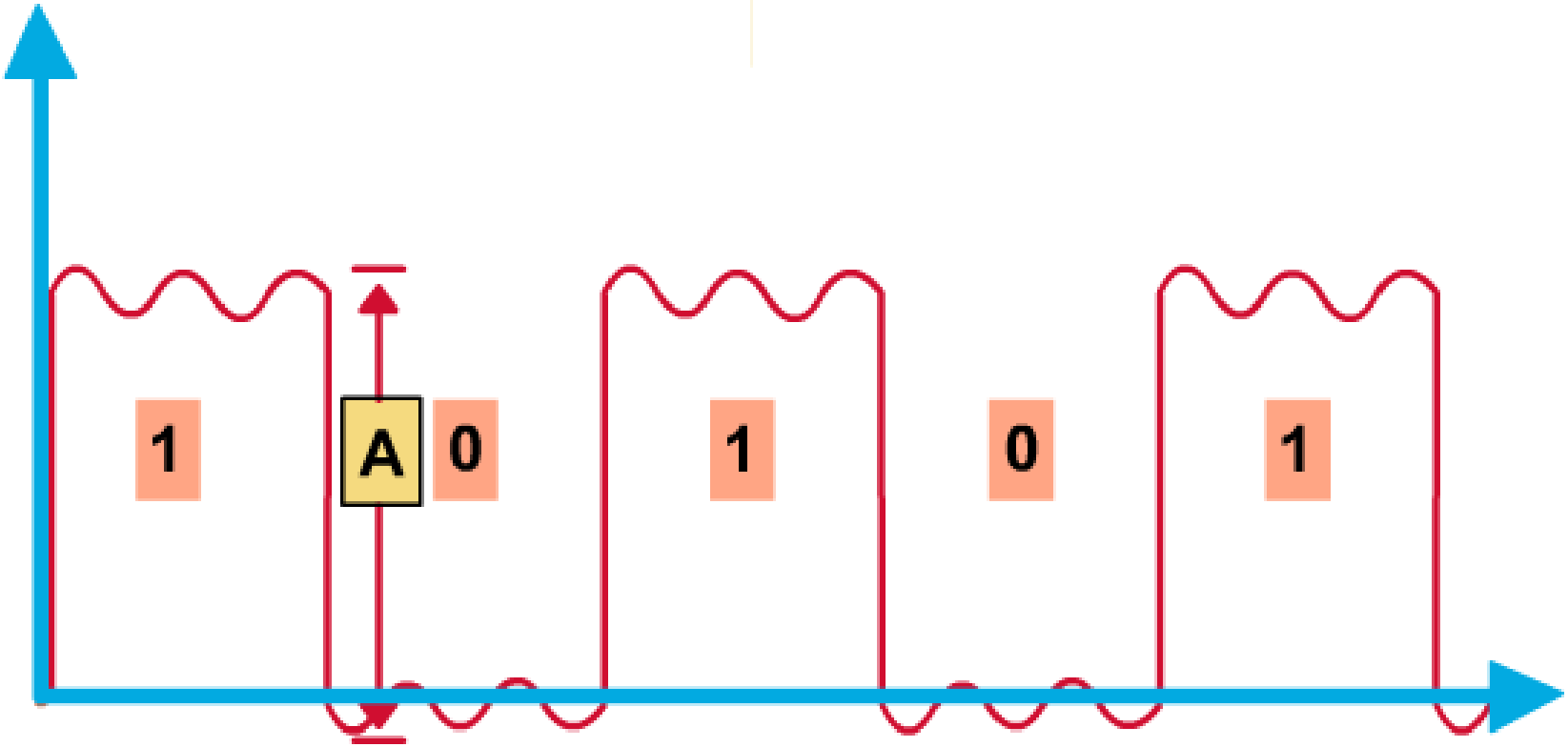
Analog signals



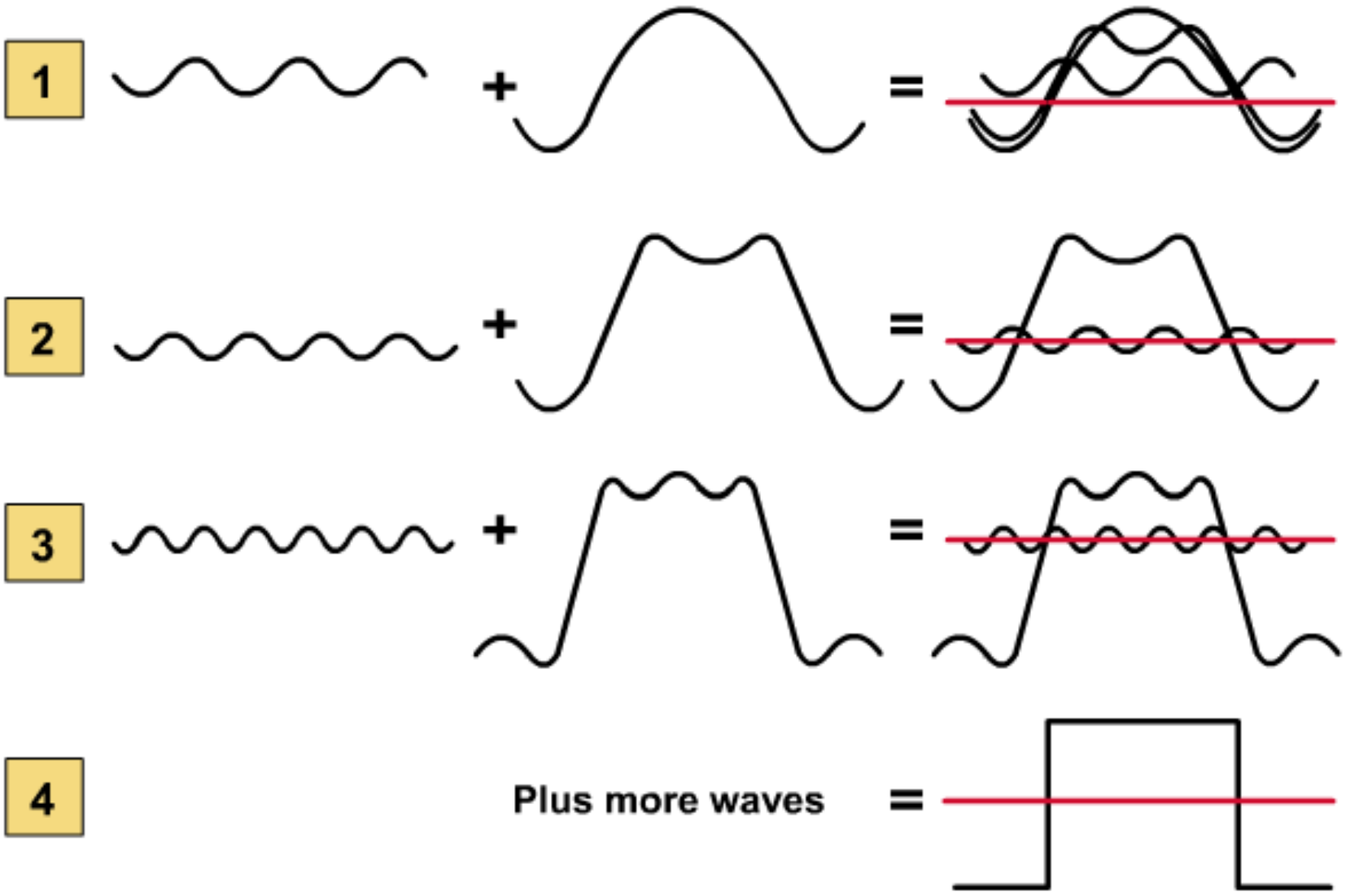
A = Amplitude (height or depth of wave)
T= Period (time to complete 1 wave cycle)
F= Frequency (cycles per second) =1/T

Digital signals

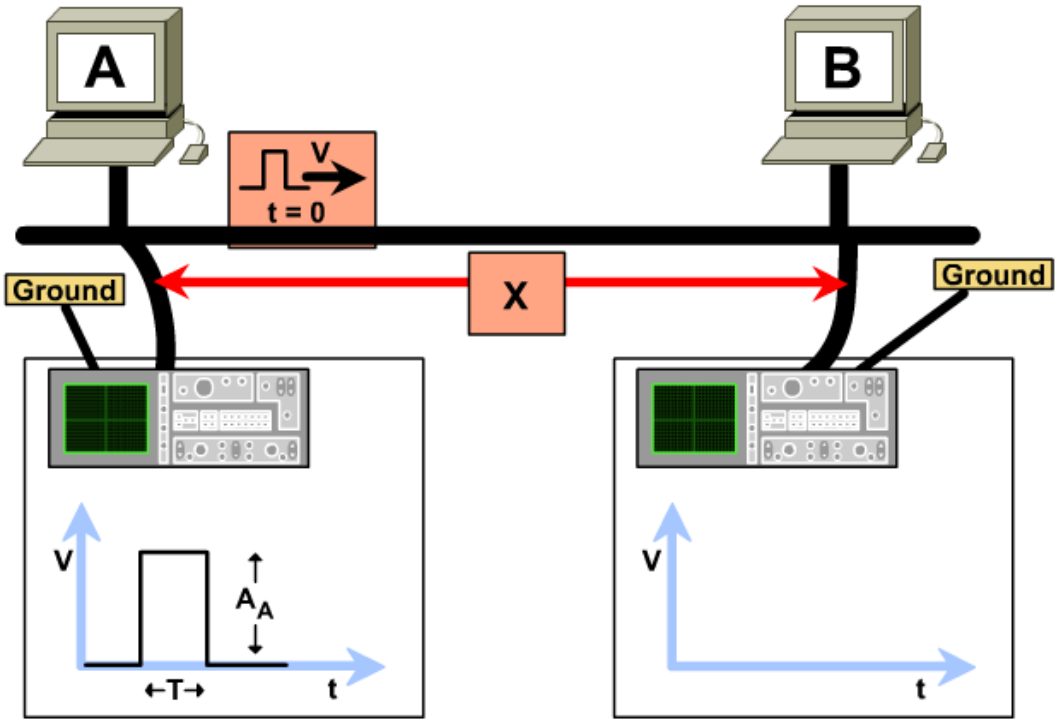
A = Amplitude (height of pulses)



Fourier synthesis



One bit on physical media



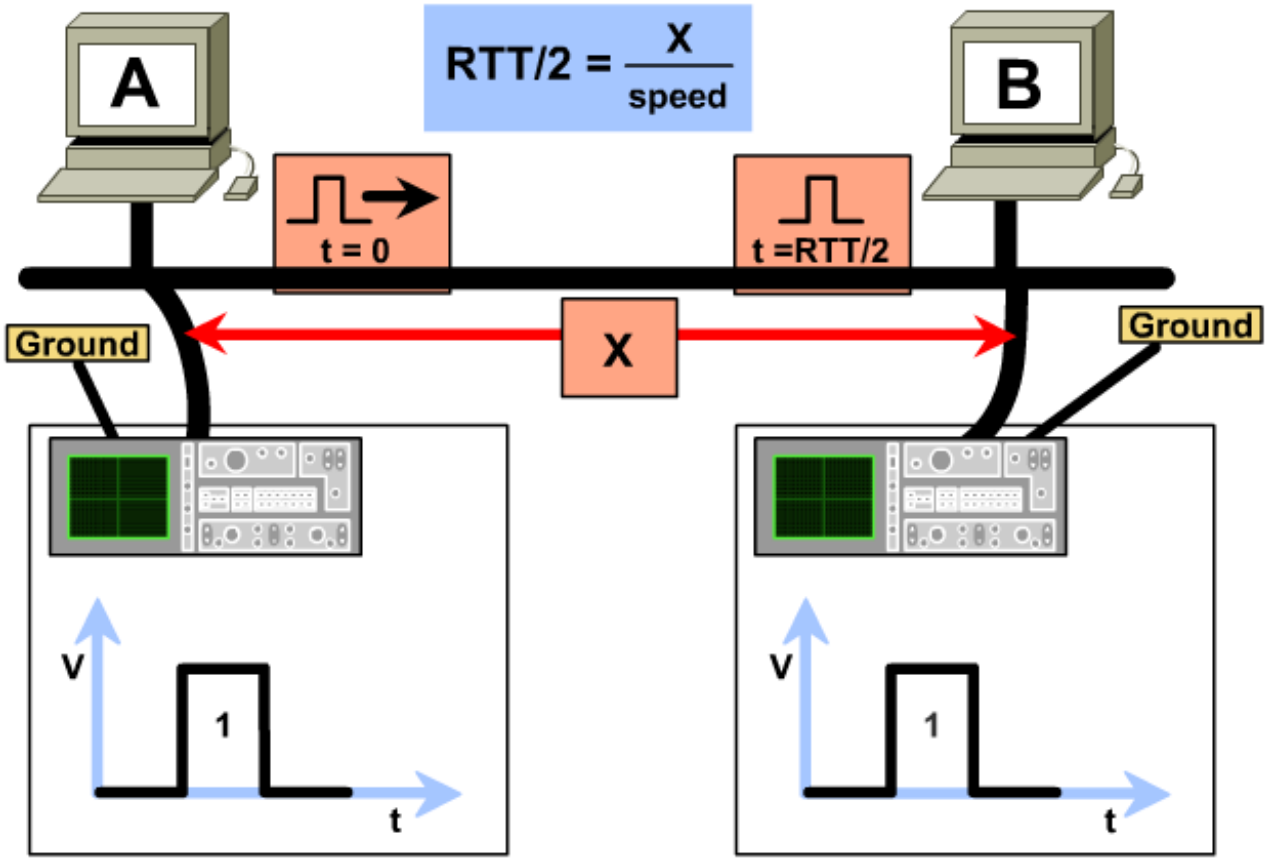
- Voltage level
- Light intensity
- Burst of waves

- ***Bits must arrive at the destination undistorted in order to be properly interpreted.***

Bits on travel

- Propagation
- Attenuation
- Reflection
- Timing Problems
- Collisions
- Noise

Propagation

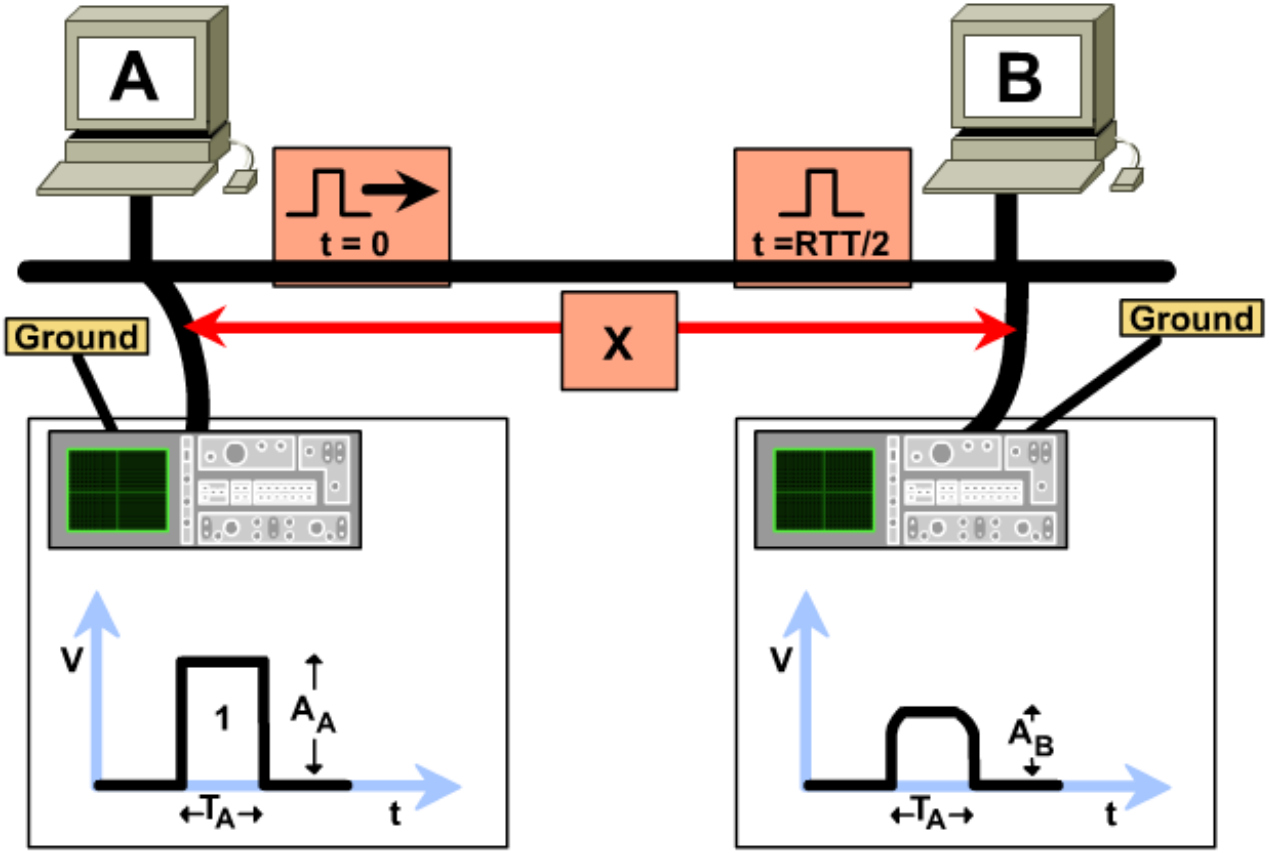


- **A bit takes at least a small amount of time to travel (propagate) down the wire.**

Propagation (cont.)

- If the receiving device cannot handle the speed of the arriving bits, data will be lost.
- To avoid data loss, the device either...
  - Buffers the arriving bits into memory for later processing, or.
  - Sends a message to the source to slow down the speed of propagation.

Attenuation

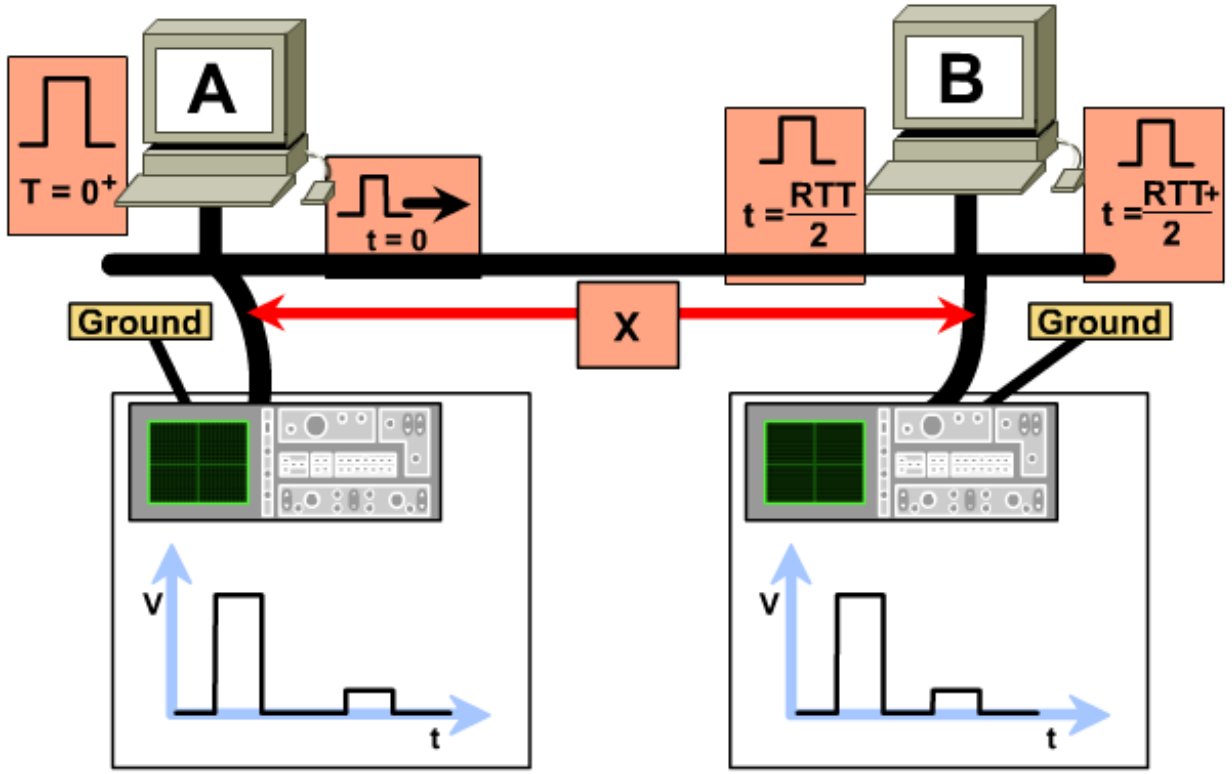


- **The signal degrades or losses amplitude as it travels along the medium.**

Attenuation (cont.)

- Loss of amplitude means that the receiving device can no longer distinguish a 1 bit from a 0 bit.
- Attenuation is prevented by:
  - Not exceeding a medium's distance requirement (100 meters for Cat 5 cable).
  - By using repeaters that regenerate the signal.

Reflection

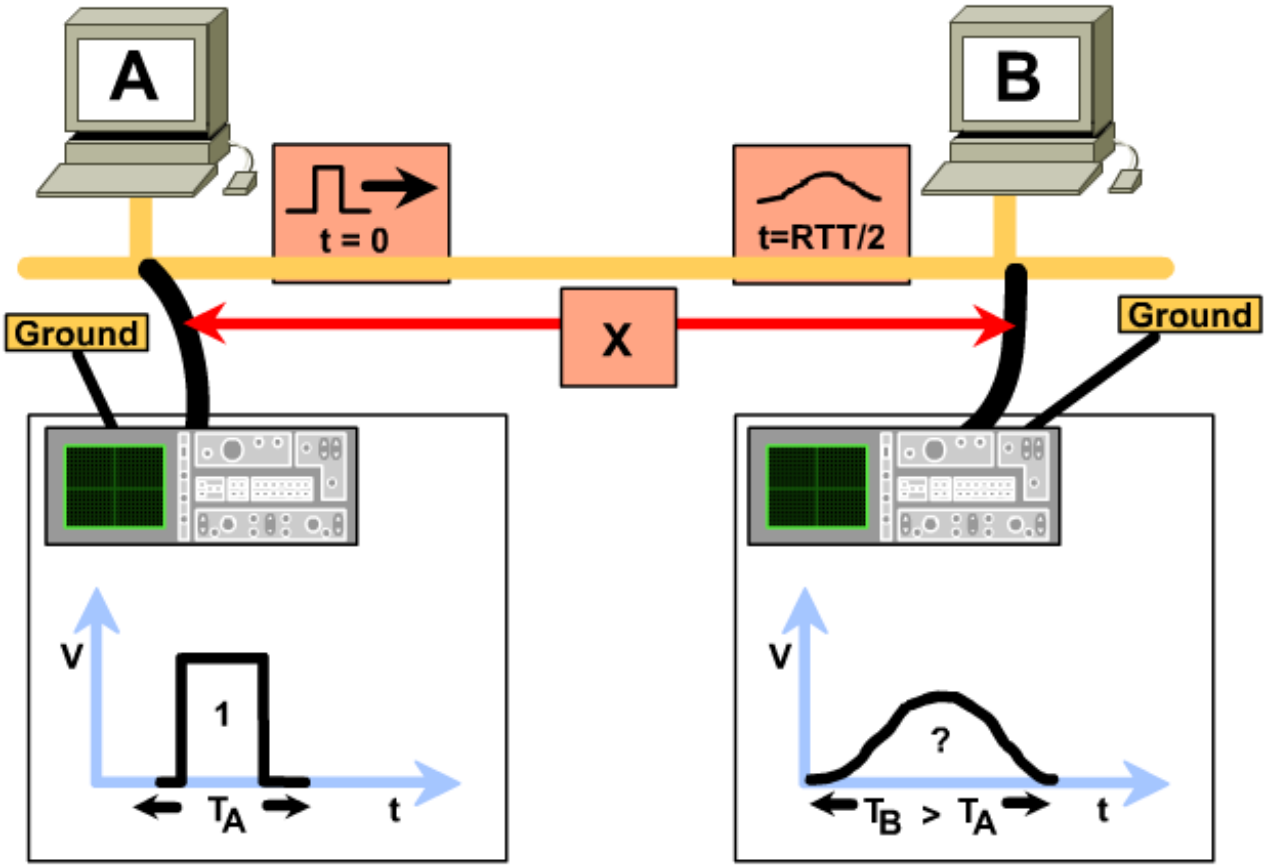


- Reflection refers to reflected energy.

Reflection (cont.)

- When impedance is mismatched, the digital signal can “bounce back” (reflect) causing it to be distorted as bits run into each other.
- If enough energy is reflected, the binary, two-state system can become confused by all the extra energy bouncing around.

Timing problems

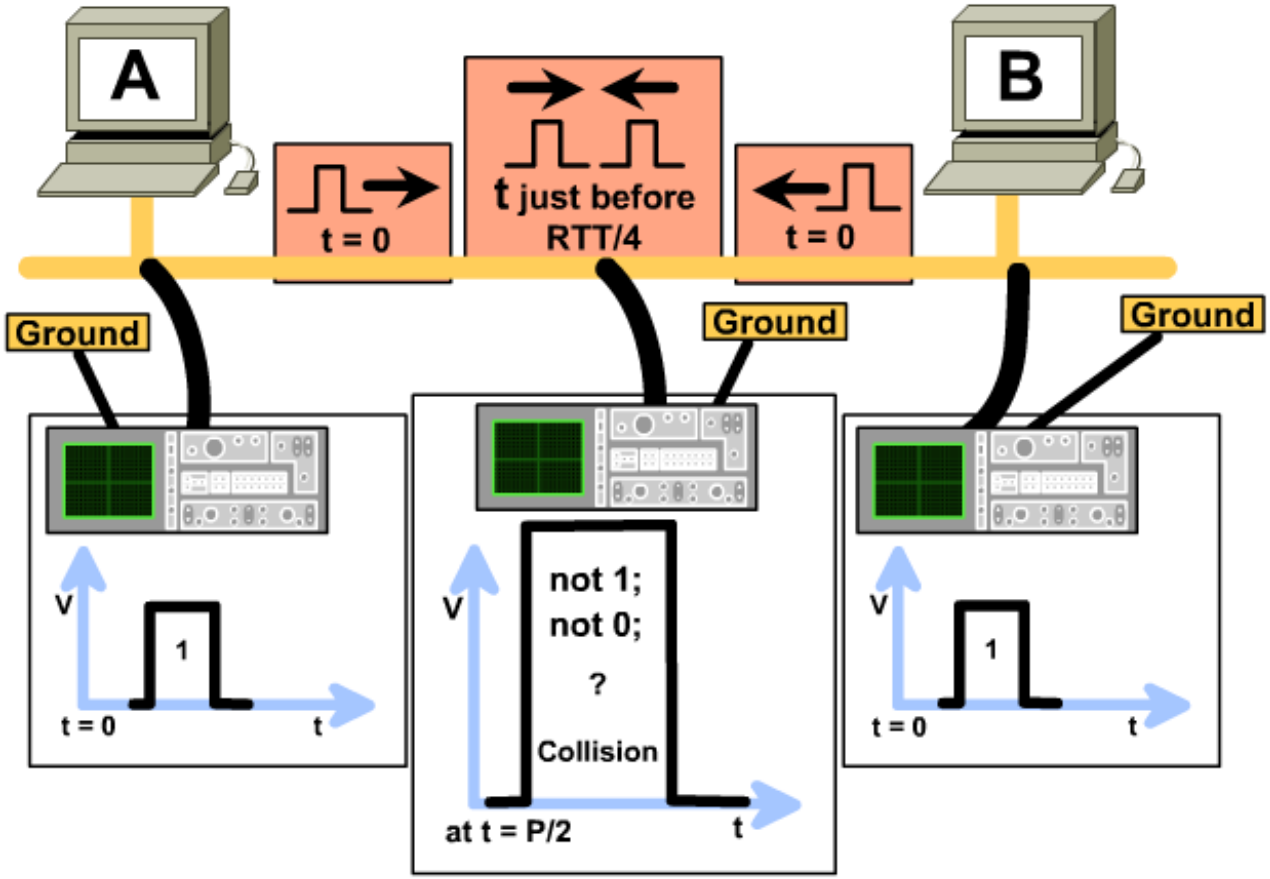


- **Dispersion, Jitter, Latency**

Timing problems (cont.)

- **Dispersion:** similar to attenuation, is the broadening of a signal as it travels down the media.
- **Jitter:** caused by unsynchronized clocking signals between source and destination. This means bits will arrive later or earlier than expected.
- **Latency:** is the delay of a network signal.

Collisions

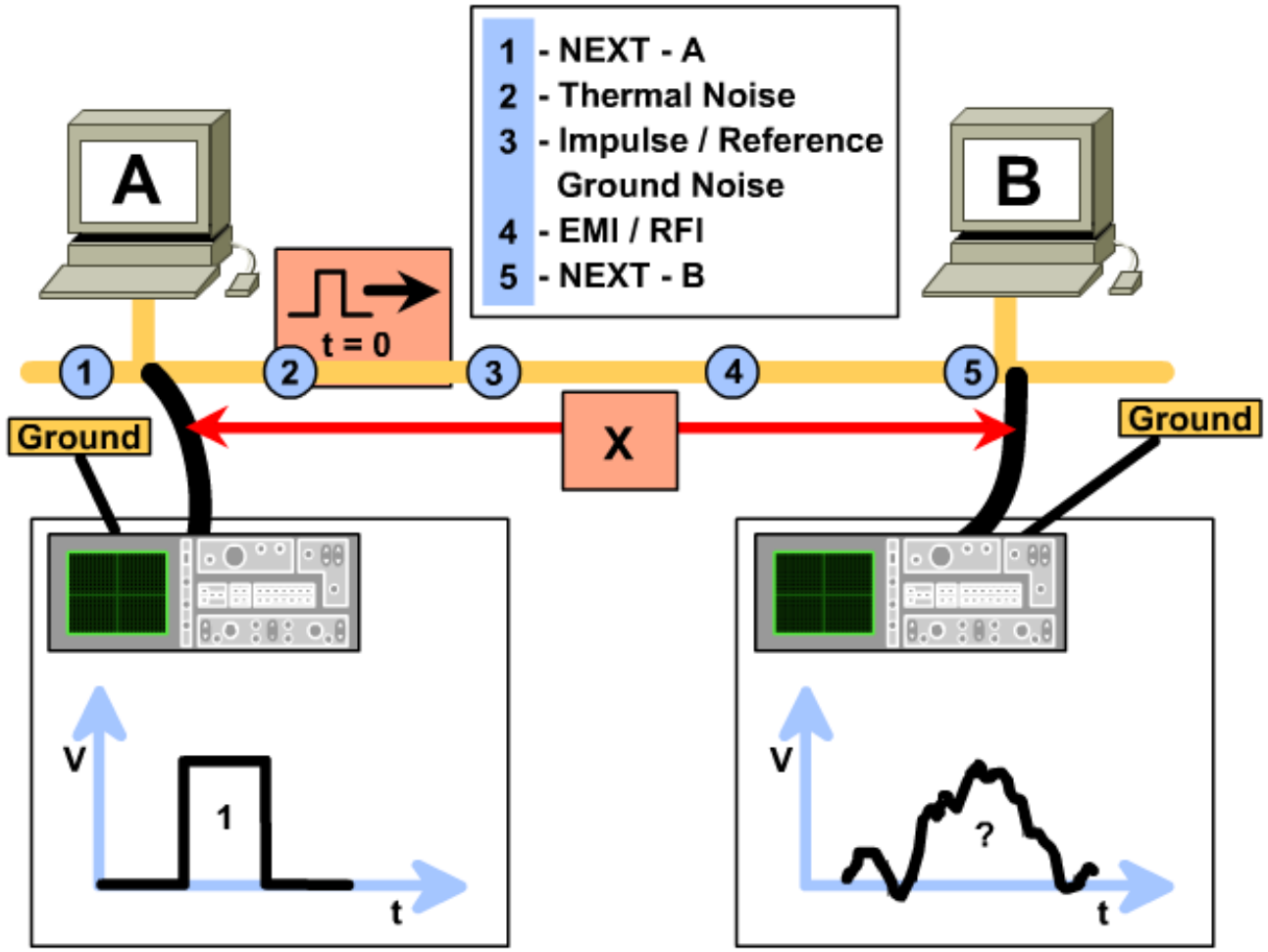


- A collision happens when two bit are on a point of media at the same time.

Collisions (cont.)

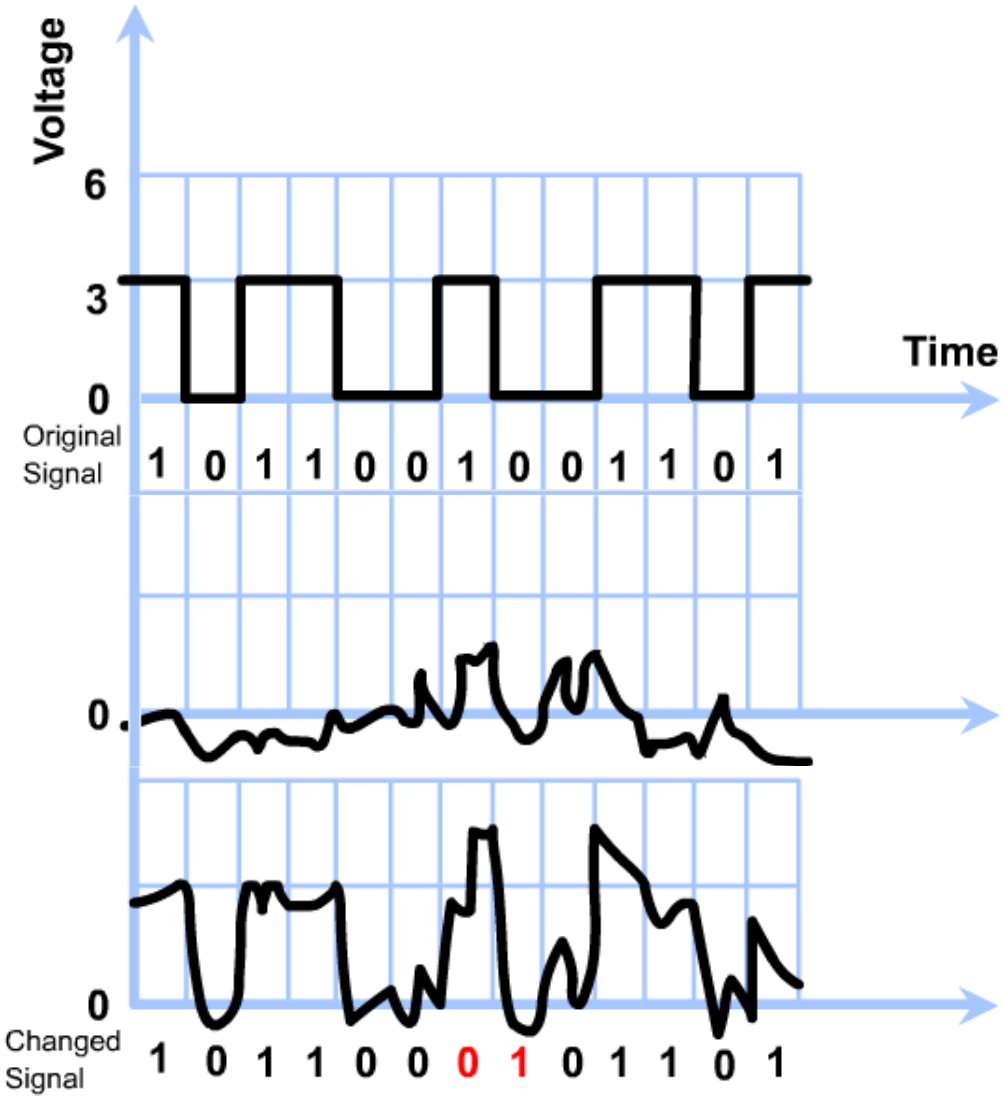
- Collisions occur in broadcast topologies where devices share access to the network media.
- A collision happens when two devices attempt to communicate on the shared-medium at the same time.
- Collisions destroy data requiring the source to retransmit.

Noise



- **Noise is unwanted additions to the signal.**

Noise (cont.)


Voltage
6
3
0
Time
Original Signal
1 0 1 1 0 0 1 0 0 1 1 0 1
0
0
Changed Signal
1 0 1 1 0 0 0 1 0 1 1 0 1

Noise (cont.)

- Too much noise can corrupt a bit, thus destroying the message.
- Noise is unavoidable.
- Kinds of noise:
  - Thermal Noise.
  - Near end cross talk.
  - AC Power/Reference Ground Noise.
  - Electromagnetic Interference (EMI).
  - Radio Frequency Interference (RFI).

Noise: Thermal

- Due to the random motion of electrons, thermal noise is unavoidable.
- Our signaling is usually strong enough to override the effects of thermal noise.

Noise: NEXT

- Near end cross talk (NEXT) : when two wires are near each other, energy from one wire can wind up in an adjacent wire and vice versa.
- Cross talk is avoided by a network technician using proper installation procedures including:
  - Strict adherence to RJ-45 termination procedures (chapter 5).
  - Using high quality twisted pair cabling.

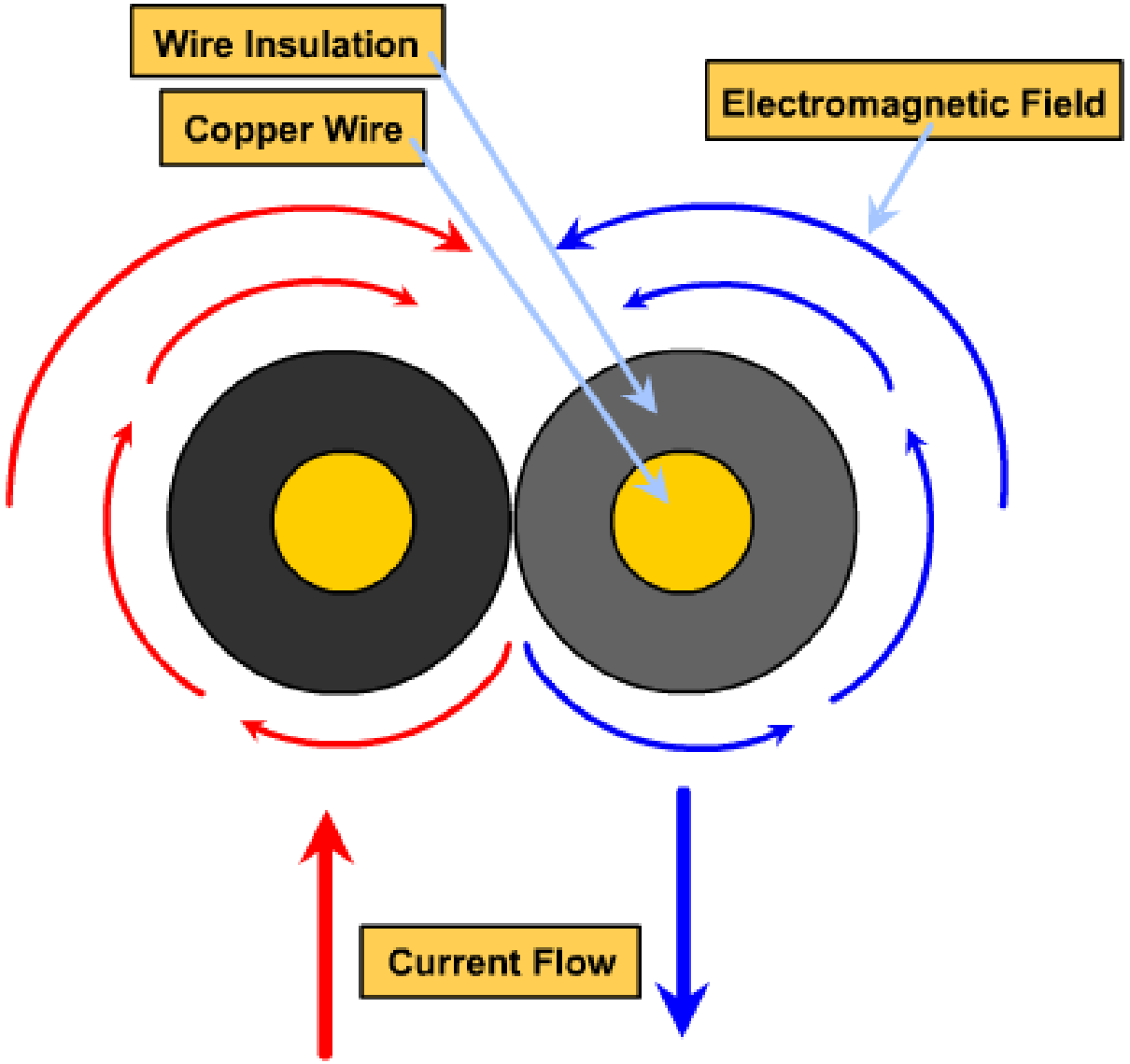
Noise: AC Power/Reference ground

- The signal reference ground is not completely isolated from the electrical ground.
- AC power line act as an antenna for electrical noise interferes with the digital signals.

Noise: EMI/RFI

- **Sources of EMI/RFI include:**
  - **Fluorescent lighting (EMI).**
  - **Electrical motors (EMI).**
  - **Radio systems (RFI).**
- **Two ways to prevent EMI/RFI Noise:**
  - **Through shielding the wires in the cable with a metal braid or foil.**
  - **Through cancellation the wires are *twisted* together in pairs to provide self-shielding.**

Cancellation



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BASIC OF ENCODING

Encoding

- **Encoding is the process of converting information into a form that can travel on a physical link.**
- **Example:**
  - **Smoke signals.**
  - **Morse mode.**
  - **Telephone.**
  - **TV/Radio.**

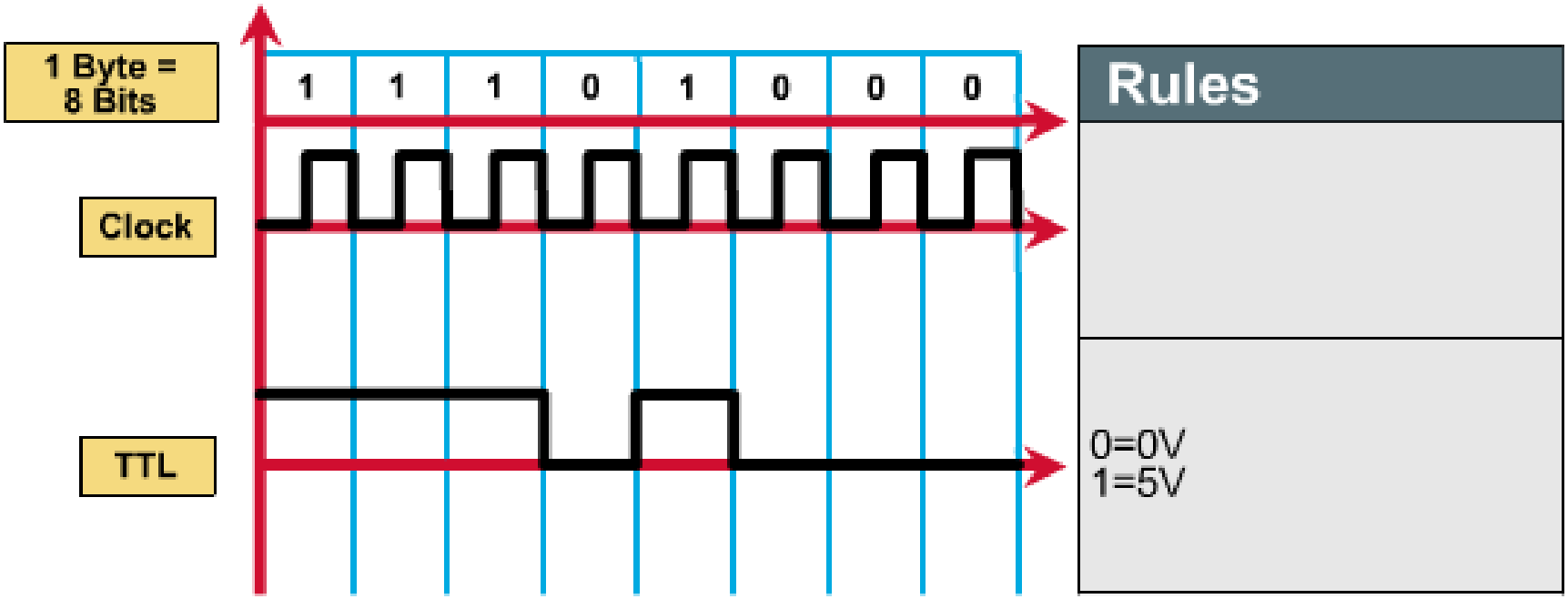
Signal modulation

- ***AM (amplitude modulation):*** **the amplitude, or height, of a carrier sine wave is varied to carry the message.**
- ***FM (frequency modulation):*** **the frequency, or wiggly-ness, of the carrier wave is varied to carry the message.**
- ***PM (phase modulation):*** **the phase, or beginning and ending points of a given cycle, of the wave is varied to carry the message.**

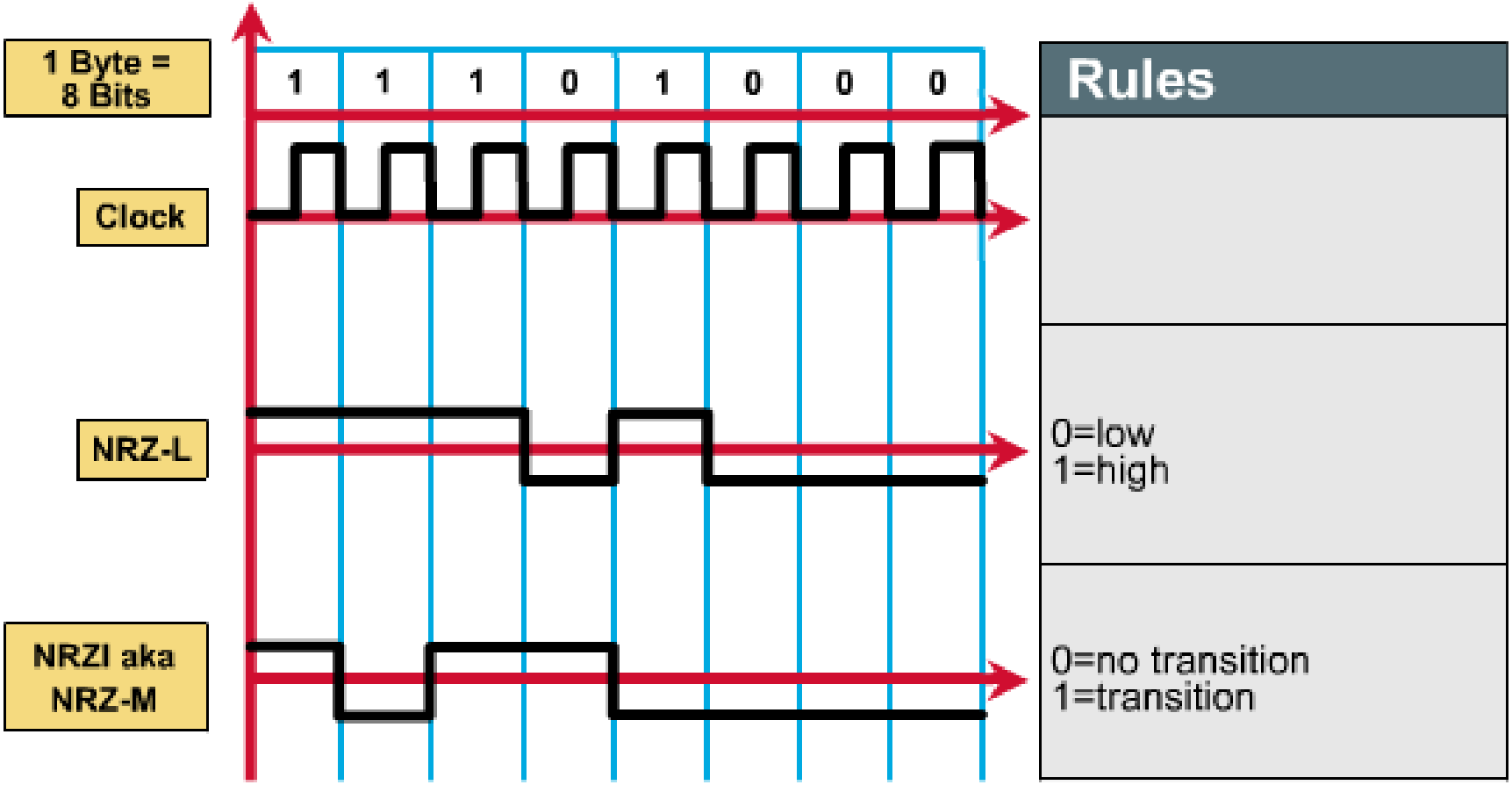
Binary encoding

- **TTL**: Transistor-Transistor logic
- **NRZ-L**: Non-Return to Zero-Level
- **NRZI**: Non-Return to Zero-Inverted
- **NRZ-M**: Non-Return to Zero-Mark
- **Manchester Tx** (Transmit)
- **MLT3**: Multi-Level Threshold-3

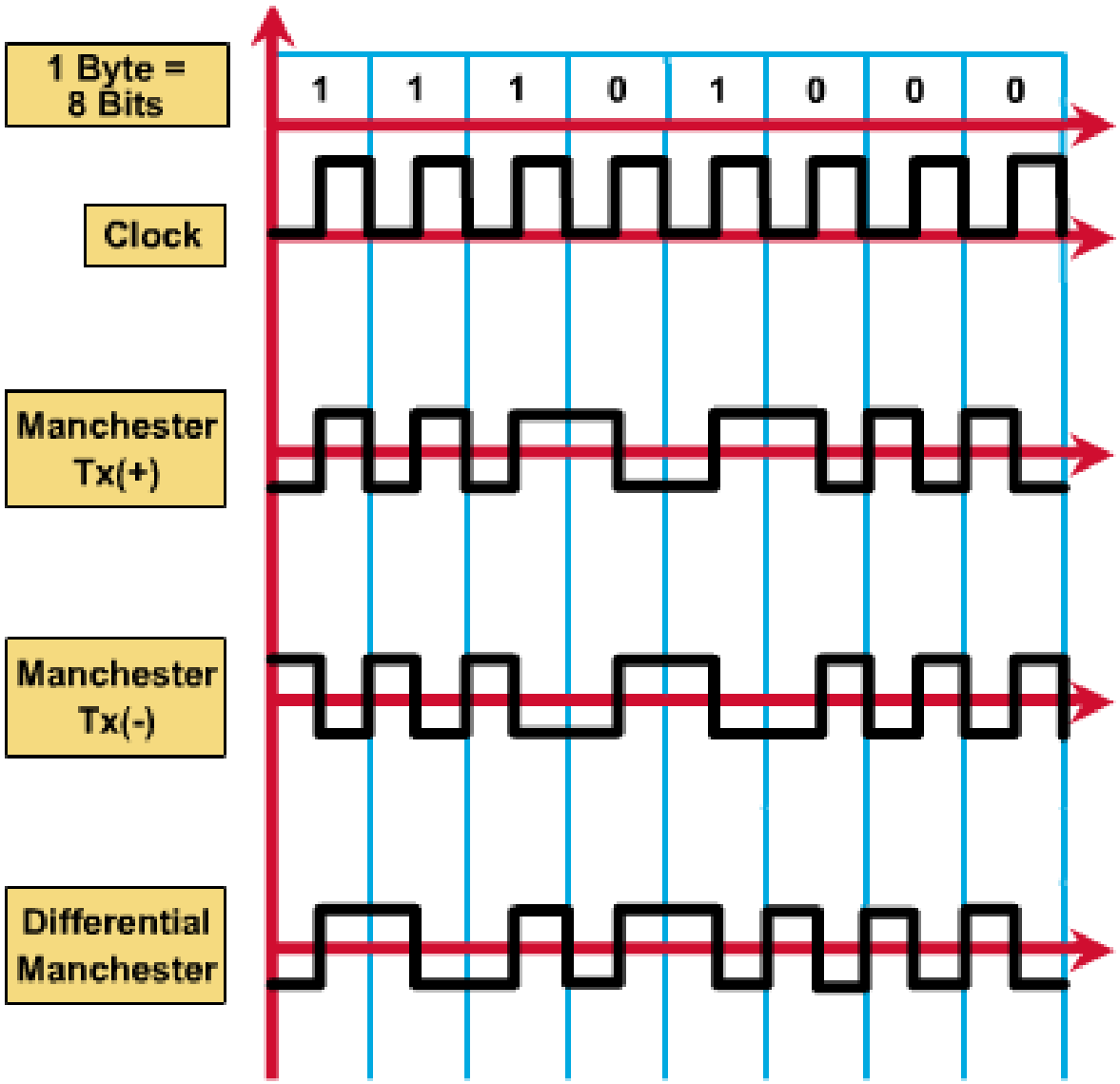
Binary encoding: TTL



Binary encoding: NRZ-L, I

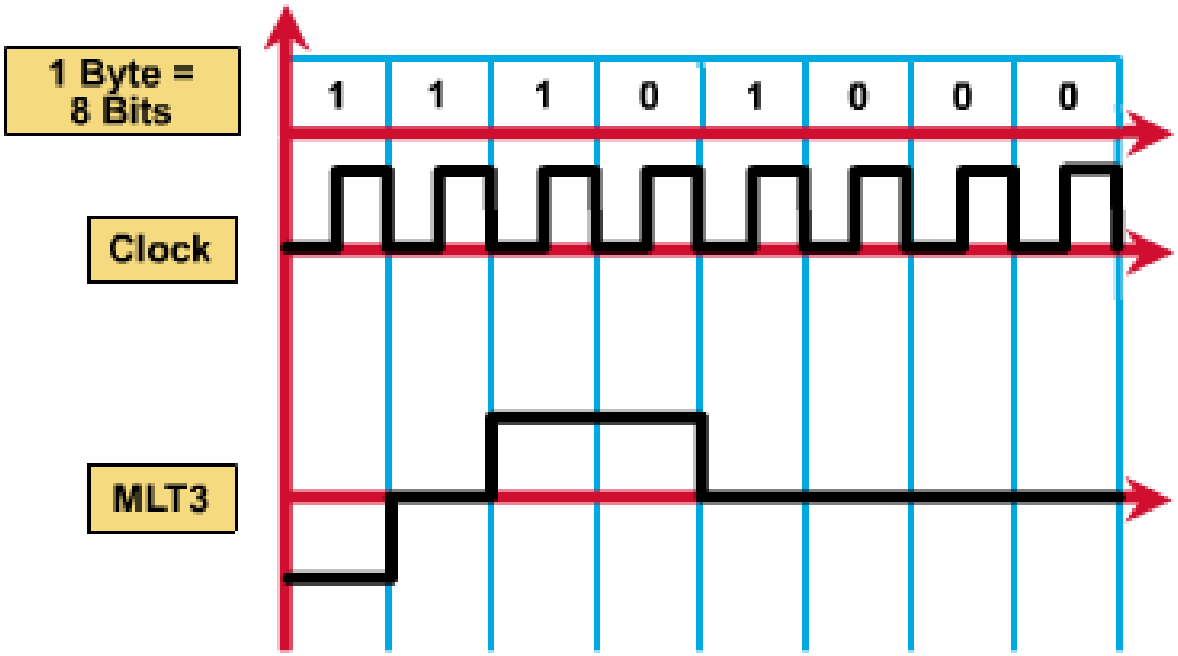


Binary encoding: Manchester



Rules
0= begin high, transition to low in middle 1= begin low, transition to high in middle
0= begin low, transition to high in middle 1= begin high, transition to low in middle
Always a transition in middle of interval 0 = transition in beginning of interval 1 = no transition in beginning of interval

Binary encoding: MLT3



Rules

3 level amplitude,
Level = -1V, 0V, +1V, 0V, -1V, etc...
0 = no transition
1 = transition to next level in cycle

Binary encoding: Used

- **Ethernet:**
  - Manchester Tx+, Tx-
- **Token-ring:**
  - Differential Manchester
- **Fast Ethernet:**
  - MLT-3