

Local Area Networks

Part 12d of
“Electronics and Telecommunications”
A Fairfield University E-Course
Powered by LearnLinc

Section 11: Broadcast Systems

- Frequency Division Multiplexing
- AM
 - Modulation
 - Demodulation (The Envelope Detector)
- FM
 - Modulation
 - Demodulation (The Phase-Locked-Loop)
- Super Heterodyne Receivers
- Television
- Sampling

Section 12: Transmission and Networks

- Transmission Lines
 - Twisted pair
 - Coaxial Cable
 - Optical Fiber
- Microwave Systems
- Satellite Links
- Telephone Systems
- Local Area Networks
- Cellular Phone Systems

Section 12 Schedule

Session 12a	09/24	Transmission Lines, Radio, Microwave & Satellites	Bigelow: 36-42; WWW, notes
Session 12b	09/29	POTS	Bigelow: 1-36, 47-78, WWW, notes
Session 12c (No Class 10/06)	10/01	Telephone Systems & the CO	Bigelow: 79-106, 211-251
Session 12d (No class 10/13)	10/08	LANs	WWW, notes
Session 12e	10/15	Cell Phone Systems	Bigelow: 332-341; WWW, notes
Session 12f (Lab - 10/25, Sat.) (Quiz 12 due 10/26)	10/20	Review for Quiz 12	
Session 12g	10/27	Quiz 12 Results	
Session 12h	10/29	MT 6 Q&A	
MT6 (Sat, Cheshire)	11/01	MT 6	
MT6 Results	11/03	MT 6 Results	

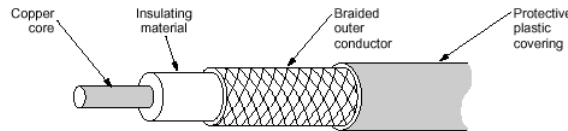
References

- <http://www.privateline.com/TelephoneHistory/History1.htm>
 - An early history of the telephone by Tom Farley
 - Also on the DoctorD Web Server under EE357
- http://www.comlab.hut.fi/opetus/423/2002/2_pstn1.ppt
 - An overview of the Public Switched Telephone Network (PSTN) by Timo O. Korhonen
 - A Power Point presentation
 - Available on the LearnLinc Server

Transmission Media: Get signals from here to there

- Copper

- Unbalanced, open wire line
- Pair (*used in telephone cables)
 - Untwisted or Twisted*
 - Unbalanced or Balanced*
- Coaxial cable

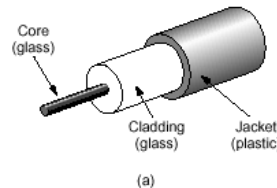


- Radio

- Free Space: Antennas
- Microwave:
 - Free Space
 - Wave Guides
- Satellite

- Optical

- Free Space (Laser)
- Fiber



- Transmission Lines

- Characteristic Impedance

- Termination

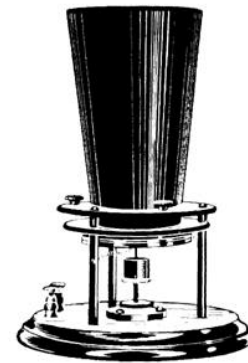
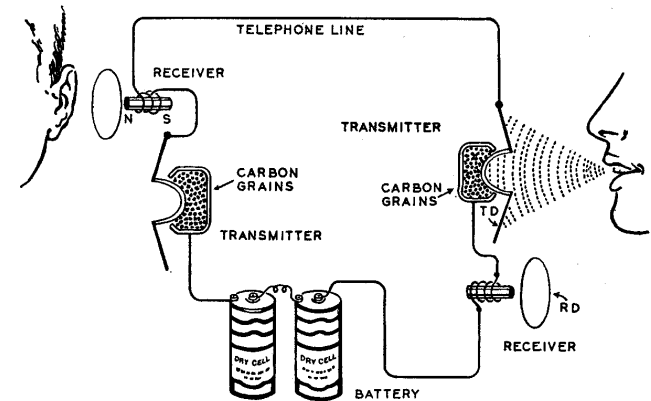
- = Z_0 : matched, energy absorbed
- $\neq Z_0$: mismatched, energy reflected

- Bridge Taps

- Mismatch at tap location
- Any reflection at end of bridging line \Rightarrow reflection returns to bridged line with a delay

Plain Old Telephone Service

- Phone Facts
 - Bell's liquid phone - 1876
 - Variable resistance transmitter
1877 – Edison, Blake
 - Battery feed current
 - Electromagnetic receiver
 - Switchboard
1878 – New Haven CT!!
 - Two-wire Circuit
1881- Bell (Tip & Ring)
 - First Coin Phone
1889- Hartford CT!!



1876 - Bell's original telephone



Cord switchboard

Signaling & Supervision

- Ringing
 - “Crank delivered low frequency AC
 - ~ 20 Hz
 - High Voltage (90 V - ring a bell at the other end)
- “On-Off Hook”
 - Off Hook
 - completes the circuit
 - battery current flows (line resistance, 24 volts)
- “Dial Tone”
 - Supports user protocol
 - Tells the user that the other end is ready to receive dialing



Signaling and Supervision 2

- Dialing

- Dial pulses

- (Strowger Rotary Telephone Switch – next session)

- Formed by momentary interruption of battery current
 - 10 per second rate
 - One through ten pulses send a digit (1-9,0)

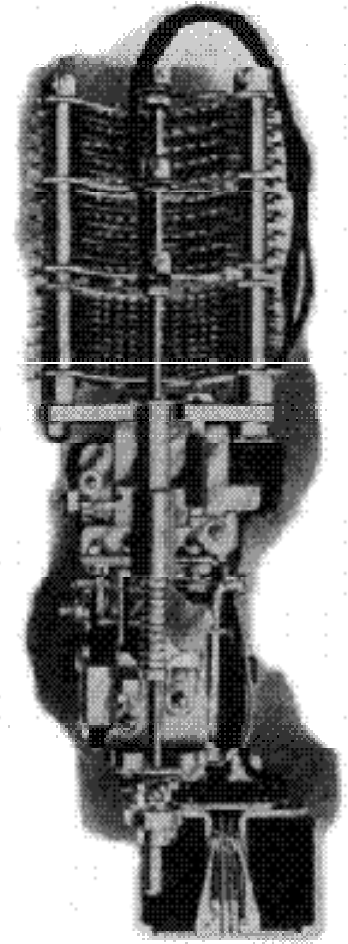
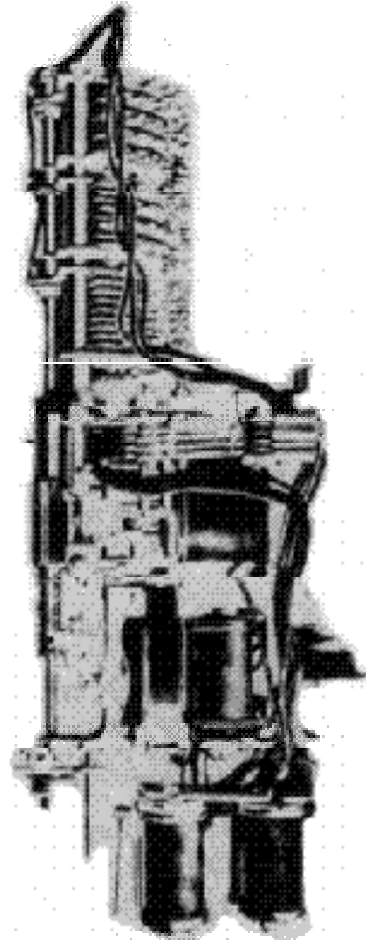
- Touch Tones (1950's)

- Two simultaneous tones
 - One from low freq. group
 - One from high freq. group
 - 16 codes

	1209	1336	1477	1633
697	1	2	3	A
770	4	5	6	B
852	7	8	9	C
941	*	0	#	D

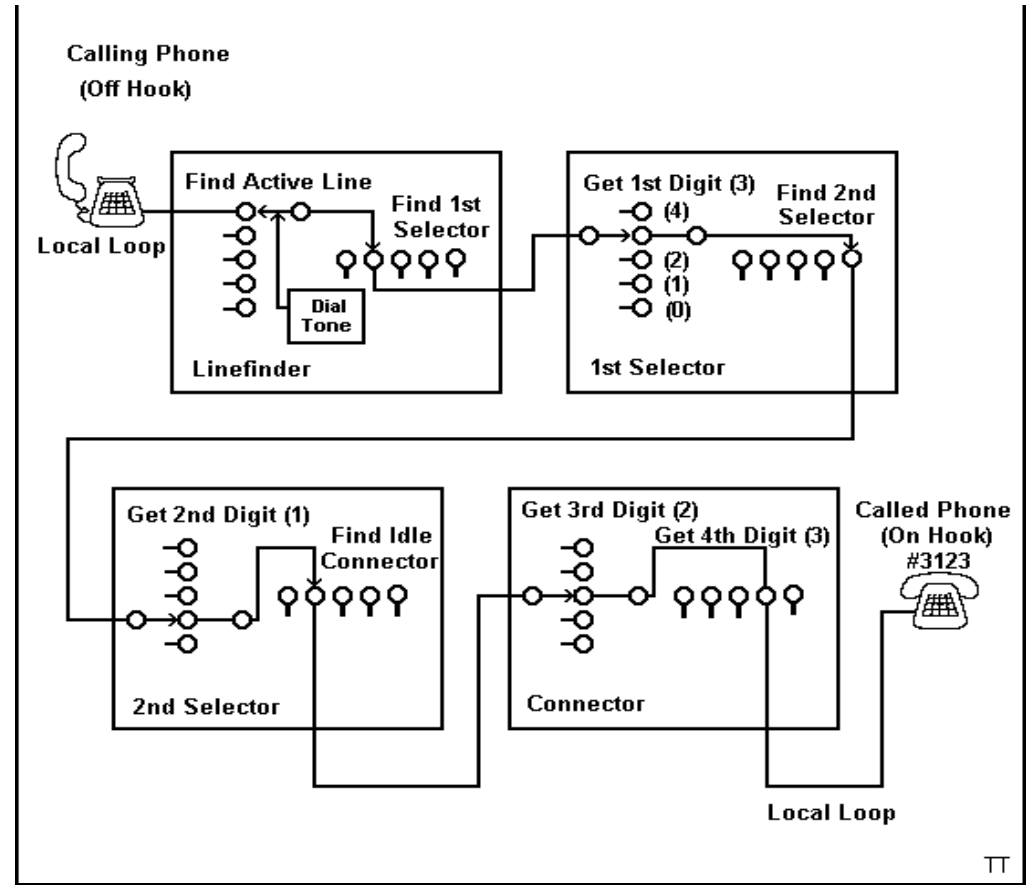
Strowger Rotary Switch

- Undertaker in Kansas City
- System to replace an operator (1891)
- A two-pole, 100-throw switch
 - 1 through 10 pulses for vertical movement
 - 1 through 10 pulses for rotational movement
- Three types
 - Linefinder:
 - Finds active (off-hook) line
 - Finds a free selector
 - Selector:
 - accepts a digit,
 - finds next free selector
 - Connector: accepts two digits



Strowger: Routing a call

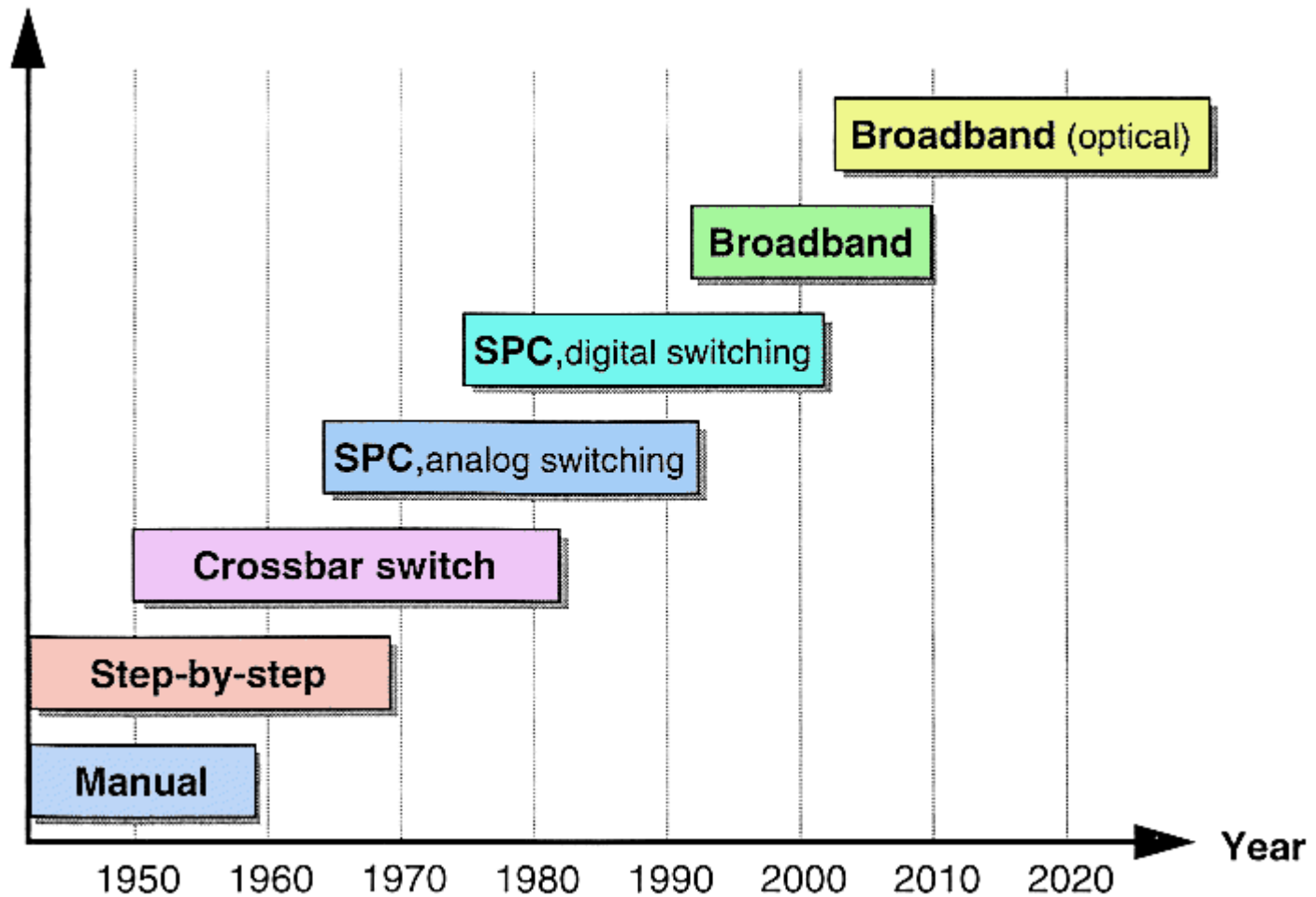
- Phone goes off-hook
 - Linefinder locks on and finds free 1st selector
- 1st Digit Dialed (3)
 - 1st Selector 3 steps up
 - 1st selector rotates to find free 2nd selector
- 2nd digit dialed (1)
 - 2nd selector 1 step up
 - 2nd selector rotates to find free connector
- 3rd, 4th digits dialed (2,3)
 - Connector 2 steps up
 - Connector rotates 3 steps to connect to called party



Subscriber Line Interface: Borscht

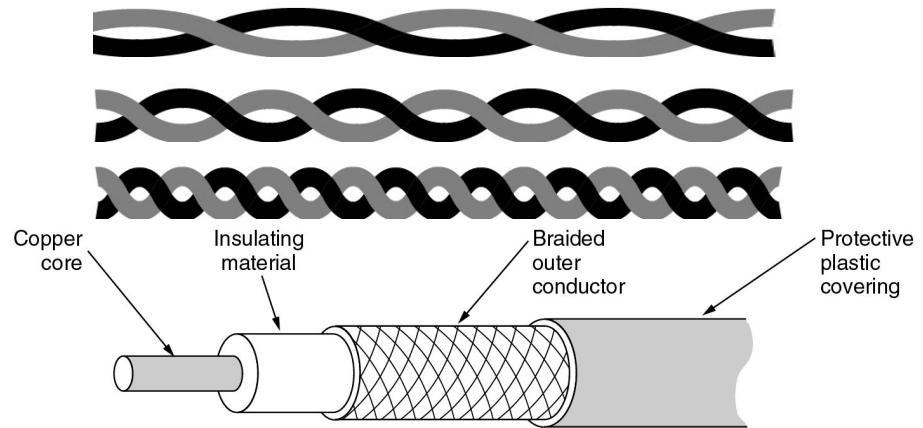
- **Battery Feed (24 VDC)**
- **Over voltage protection (Surge suppression)**
- **Ringling (90 volts AC 20 Hz)**
- **Supervision (on-off hook)**
- **Codec (A/D and Filter)**
- **Hybrid (2-4 wire conversion)**
- **Testing**

Telephone Switch Evolution



LAN Cabling

- Copper
 - Twisted Pair
 - Cat 1: Telephone
 - Cat 3: 10 MHz
 - Cat 5: 100 MHz
 - Coaxial cable (old)
- Radio 802.11(a,b,g)
- Optical Fiber

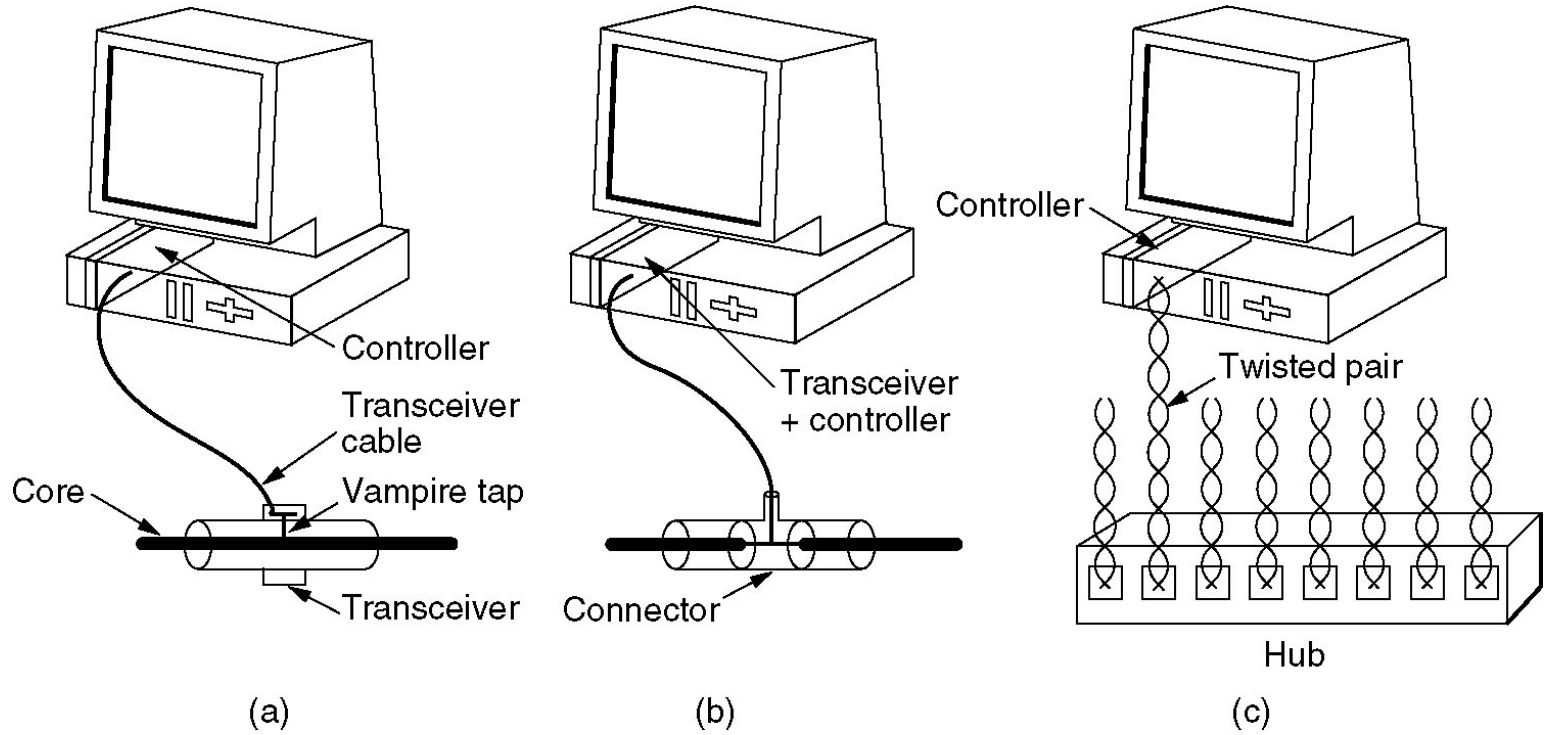


Ethernet (802.3) Cabling

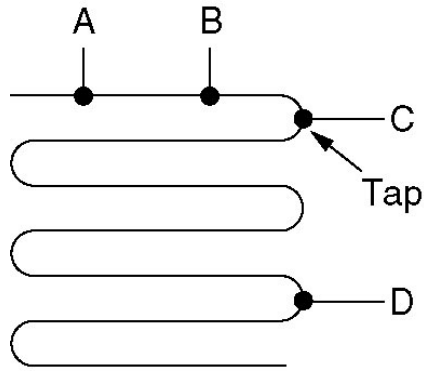
The most common kinds of Ethernet cabling.

Name	Cable	Max. seg.	Nodes/seg.	Advantages
10Base5	Thick coax	500 m	100	Original cable; now obsolete
10Base2	Thin coax	185 m	30	No hub needed
10Base-T	Twisted pair	100 m	1024	Cheapest system
10Base-F	Fiber optics	2000 m	1024	Best between buildings

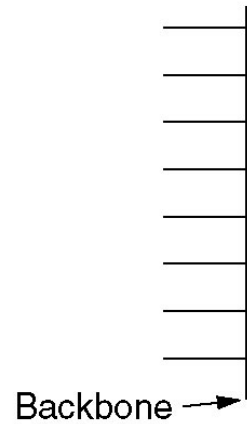
Ethernet Cabling (2)



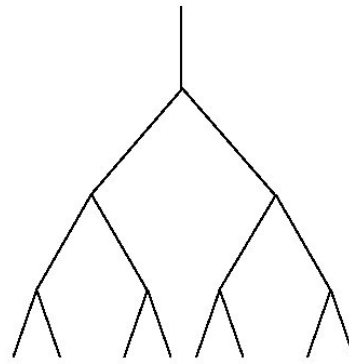
Ethernet Cabling (3)



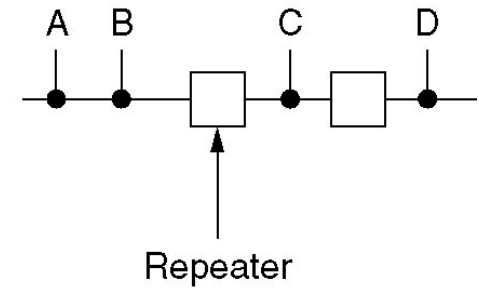
(a)



(b)

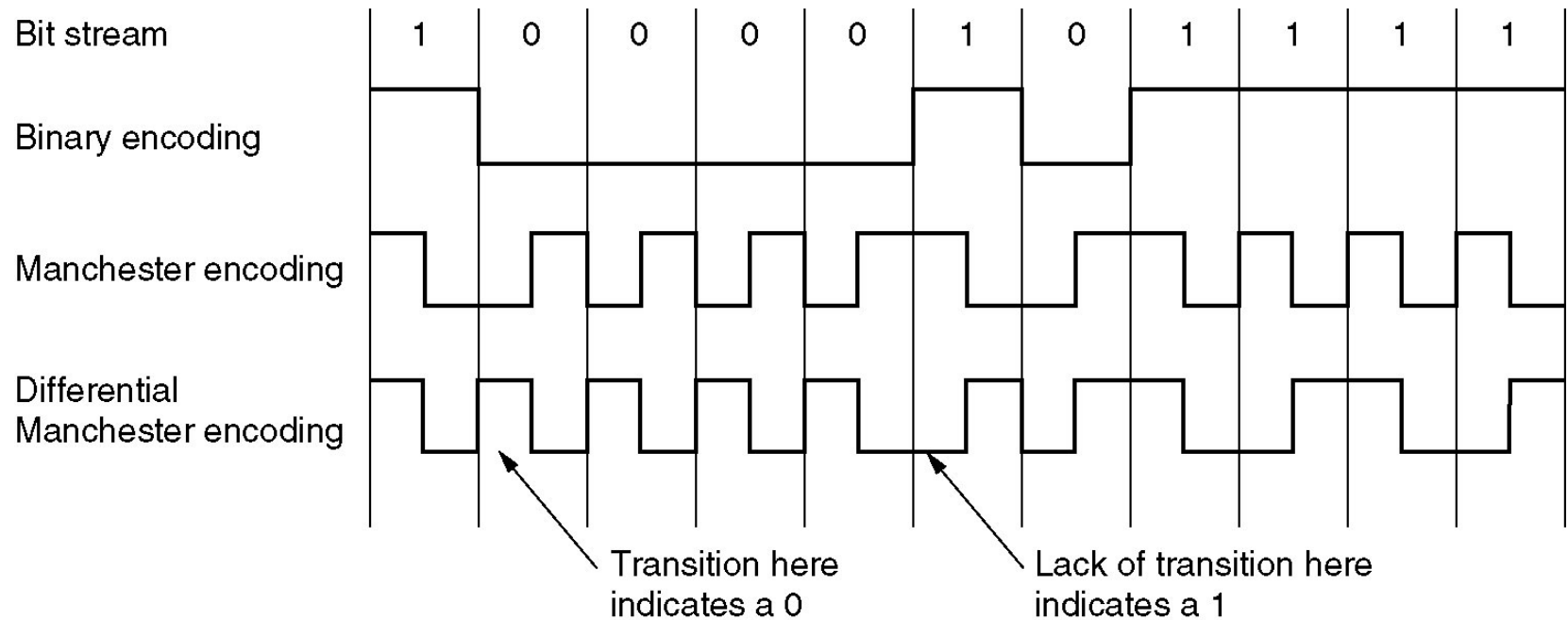


(c)



(d)

Ethernet Cabling (4)



Fast Ethernet

The original fast Ethernet cabling.

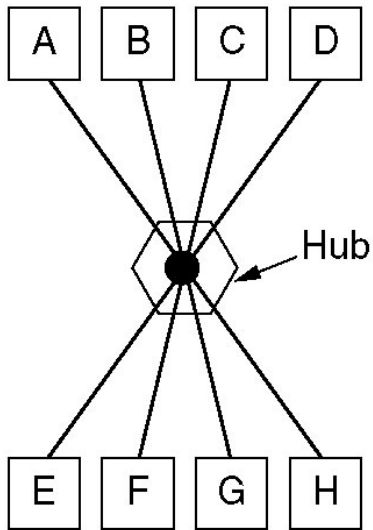
Name	Cable	Max. segment	Advantages
100Base-T4	Twisted pair	100 m	Uses category 3 UTP
100Base-TX	Twisted pair	100 m	Full duplex at 100 Mbps
100Base-FX	Fiber optics	2000 m	Full duplex at 100 Mbps; long runs

Gigabit Ethernet (2)

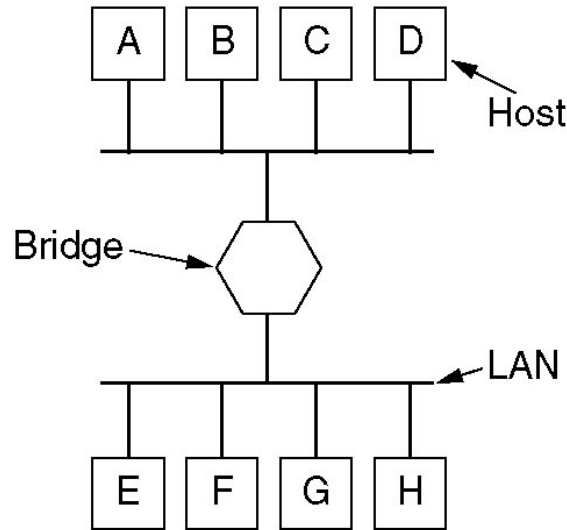
Gigabit Ethernet cabling.

Name	Cable	Max. segment	Advantages
1000Base-SX	Fiber optics	550 m	Multimode fiber (50, 62.5 microns)
1000Base-LX	Fiber optics	5000 m	Single (10 μ) or multimode (50, 62.5 μ)
1000Base-CX	2 Pairs of STP	25 m	Shielded twisted pair
1000Base-T	4 Pairs of UTP	100 m	Standard category 5 UTP

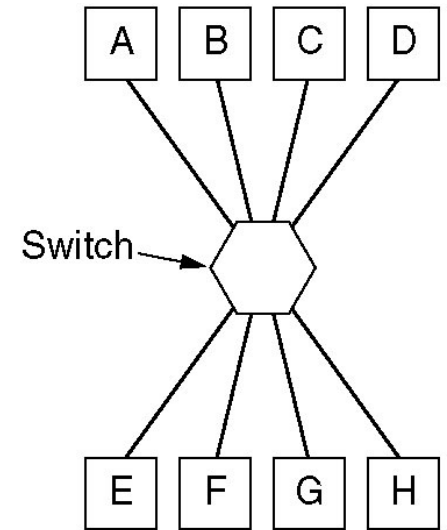
Repeaters, Hubs, Bridges, and Switches



(a)

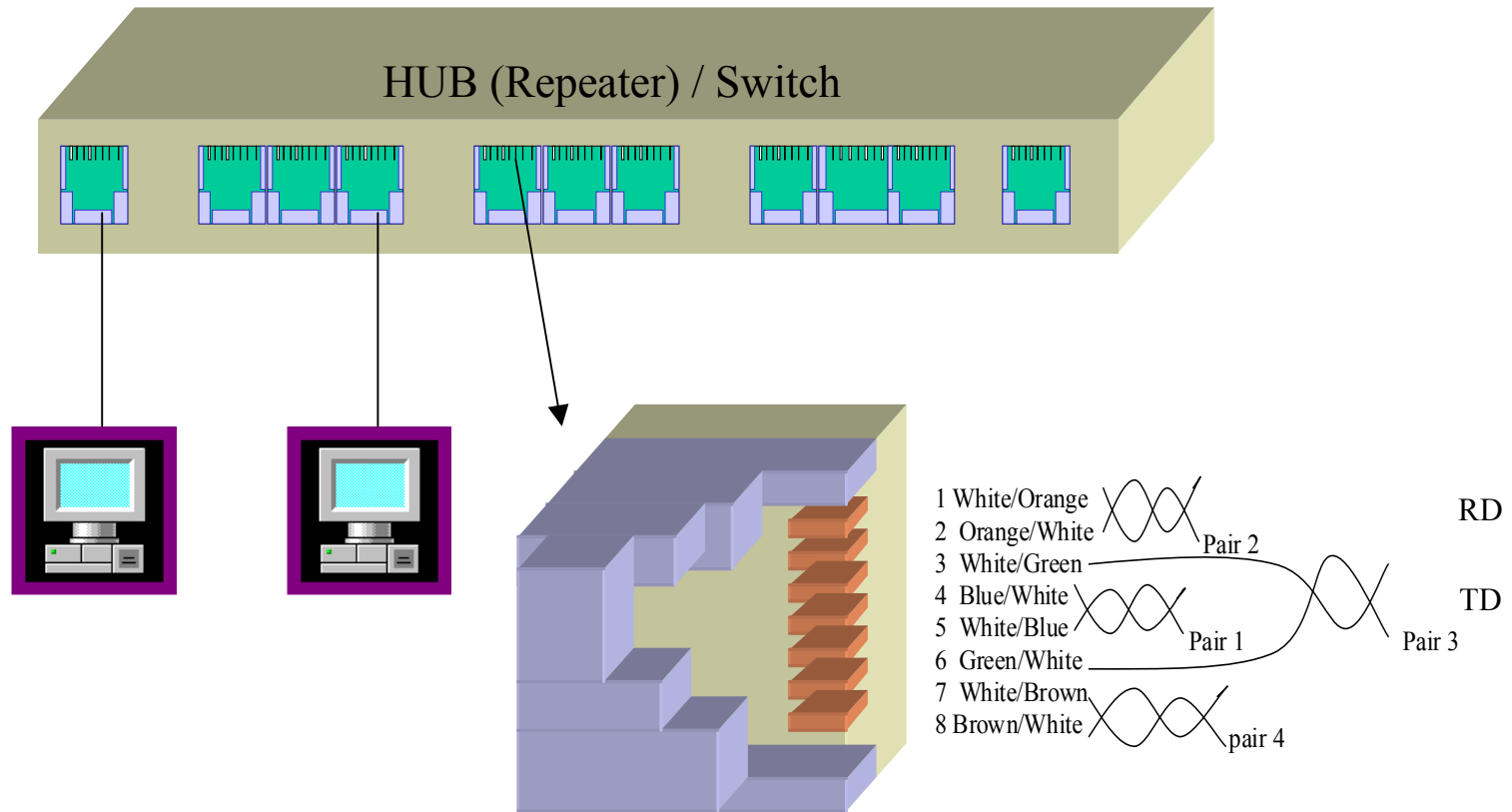


(b)



(c)

LAN Interconnect



Routers

- We'll go to <http://computer.HowStuffWorks.com/Router.htm> for this section

Wireless: 802.11(a,b,g) Access Point (Bridge)

- 802.11b (2.4 GHz)
 - 11Mbit/sec
 - Up to 300 ft
- 802.11g (2.4 GHz)
 - 54 Mbit/sec (but compatible with 802.11b)
 - Up to 300 ft
- 802.11a (5 GHz)
 - 54 Mbit/sec
 - Up to 100 ft

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