Physical Layer

radios, coaxial cable, optical fibers

bits "on the wire"

spread spectrum	reduces narrowband interference by spreading a signal's frequency to create a wider bandwidth
DSSS	direct sequence spread spectrum
FHSS	frequency hopping spread spectrum

DSSS and FHSS require time synchronization between sender and receiver.

Maximum (Data) Bandwidth

Shannon Channel Capacity

> data rate = Wlog2(1 + S/N)

(theoretical) maximum number of bits that can be transmitted per second by a physical channel

data rate = **bps**
W = frequency range = bandwidth = **Hz**
S/N = signal noise ratio = **no unit**

Variables

Signal	sending signal
Noise	thermal noise, background radiation (aka AWGN - additive white gaussian noise)
Interference	signals from other transmitting sources
SINR or SNR	S/(N + I)

Path Loss Formulas

free space model

> --

two-ray ground reflection model

> --

Effects on Signal Propagation

path loss, shadowing, reflection, refraction, scattering, diffraction, fading

Multiplexing

space, time, frequency, code
TODO: pros/cons of each

Modulation

AM, FM, PM
amplitude modulation, frequency modulation, phase modulation
TODO:
pros/cons of each

Link Layer

WiFi, Ethernet

data transfer btwn neighboring network elements

IEEE 802.11 DCF CSMA/CA

CSMA/CA	carrier sensing medium access / collision avoidance
DCF	distributed coordination function - appropriate for multi-hop ad hoc networks
RTS/CTS	request to send, clear to send
hidden terminal problem	A and C want to send to B but A and C cannot see each other. both send to B and msg collides. solved by RTS/CTS

Security

TODO WEP insecure as heck

Network Layer

IP, routing protocols

routing of datagrams from src to dest

knows addresses, routes from src to dest, elems = hosts and routers

LS	link state
DV	distance vector
types of networks	MANET (mobile ad hoc network), mesh network, sensor network, DTN (delay tolerant network)

MANET

DSR	destination source routing
AODV	ad hoc on-demand distance vector
DSDV	destination-sequenced distance vector

DSR can be used for wireless mesh networks

Mesh Networks

ETX	expected transmission count
	= 1/(df * dr) ... where df = fwd delivery rate, dr = rev delivery rate
ETT	estimated transmission time TODO: this is some combo of SETT and something right???

Sensor Network

GPSR	greedy perimeter stateless routing
BVR	beacon vector routing

TODO: study implementation and write in chart in word or something

DTN

ALGORITHM	WHO	WHEN	TO WHOM
flood	all nodes	new contact	all new
direct	src only	dest	dest

DTN (cont)

simple replication (r)	src only	new contact	r first contacts
history (r)	all nodes	new contact	r highest ranked
erasure coding (ec-r)	src only	new contact	kr (k >= 1) first contacts (k is related to coding algorithm)

TODO: review history and erasure coding

Mobile IP

TO mobile system

> CN -> HA -> FA -> MN

FROM mobile node

> MN -> FA -> CN

CN = correspondent node (aka FN = fixed node??)
HA = home agent
FA = foreign agent
MN = mobile node

Transport Layer

TCP, UDP

host-host data transfer

UDP	user datagram protocol
TCP (wired)	transmission control protocol

Mobile TCP

TCP - not pipelined

Stop and wait

TCP - pipelined

GBN	go-back-N

selective repeat

Questions

Why can't we just use NACK?

Formulas

Transmission

> T = L/R

Utilization - fraction of time sender is busy sending

> U = (L/R) / (RTT + L/R)

Speed of light (to convert distance to propagation delay)

> 3E8 m/s

Don't forget to use proper units (convert)
T = transmission time in **seconds**
L = pack length in **bits**
R = transmission rate in **bps**
U = utilization **no unit**
RTT = round trip time **seconds**
= propagation delay * 2