Start notes "week 7".

Some Definitions:

Simplex Line:

Traffic possible in only one direction.

(Silly? Maybe Meter reader?)

OR: Broadcast. (Radio).

Half Duplex:

Traffic possible in both directions, only one direction at a time.

(Needs protocol to establish "ownership"). "Over".

Full Duplex:

Traffic possible in both directions simultaneously.

Hidden Assumption:

Hidden Assumption:

Two parties.

Multiple Access Protocols.

1. Old Fashioned Ethernet:

- 10 Base 5 (Thick ethernet) co-ax
  10 Mb/sec, 500 m between bridges/repeaters
  Obsolete. (≤100 nodes)
- 10 Base 2 (Thin ethernet) co-ax
  10 Mb/sec, 200 m (185 m) between
  (≤30 nodes) bridges/repeaters
- 10/100 Base T Twisted wire, 4 pairs. 8 strands.
  (Category 5) my lab.
  ≤100 M ~~between repeaters~~ From Hub to unit. ≤1024 nodes. (??)
- 10/?? Base-F Optical Fiber.
  ≤2000 m From Hub to unit.
  ≤1024 nodes. (??)

Also:
Fast Ethernet. (Tanenbaum, p 284)

100 Base-T4 (Twisted, 100 m, Cat 3)
100 Base-TX (Twisted, 100 m, Cat 5)
100 Base-FX (Fiber, 2000 m)

=

Gbit Ethernet (Tanenbaum, p 288).

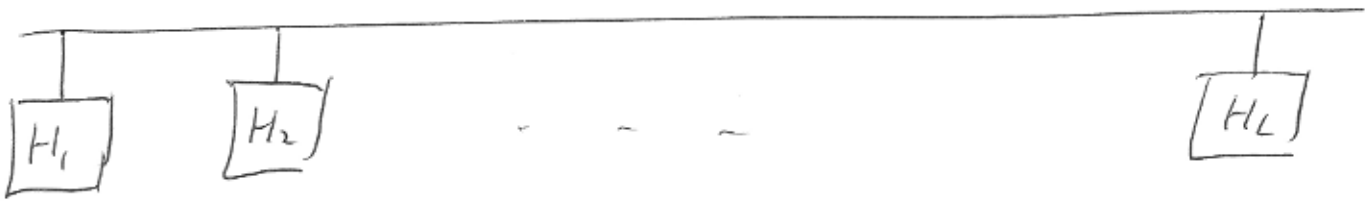
4 versions.
1000 Base ---.
2 use fiber
2 use twisted wire, various kinds.

All use the same
ethernet frame format.

Also: 802.1Q. ~~Later 10/100 Base T.~~
"slightly different ethernet frame format."
VLAN. (my lab has 802.1Q over 10/100 Base T).

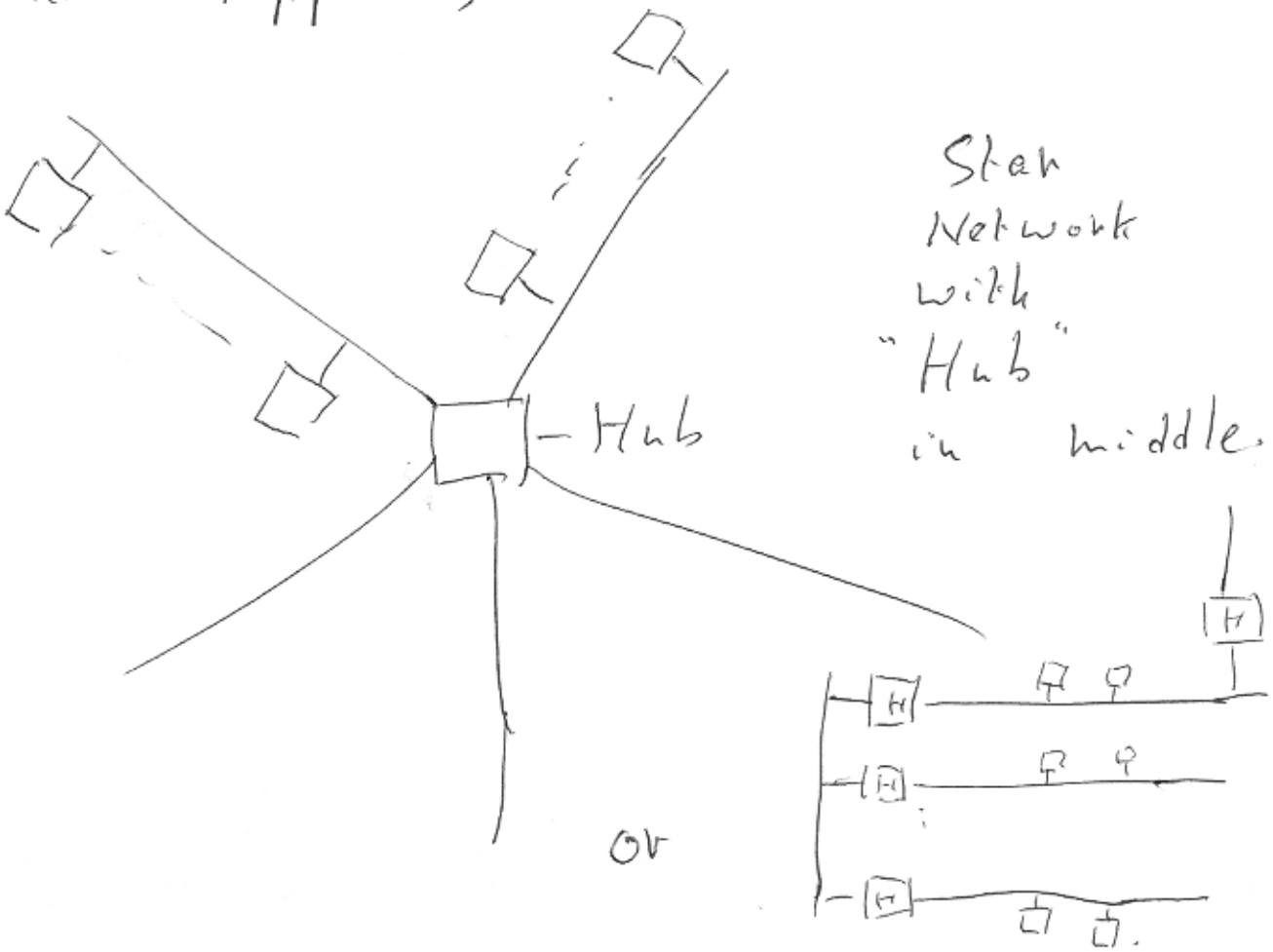
First Approxmation:

10 Base 5, 10 Base 2 :



"Every body Listens".

Second Approx, 10 Base 5, 10 Base 2 :



10/100 Base T : Always Hub.

10/?? Base F : Always Hub.

What is a "Hub" ?

1. Dumb Repeater. decibels: dB.
   ("Amplifier").
   Amplifies Noise and Signal.
2. Bridge (soon)
3. Ethernet switch (soon).

Related: 802.1Q.
"Ethernet with VLAN".
(my lab).

Other Multiple Access LANs:

All wireless LANs.

(Wireless LAN 802.11, Bluetooth 802.15, ~~WMAN~~ Wireless LAN 802.16 "Fixed Wireless")

Plus some systems for cellular phone.

All multiple access systems have the problem of collissions.

Strictly speaking,

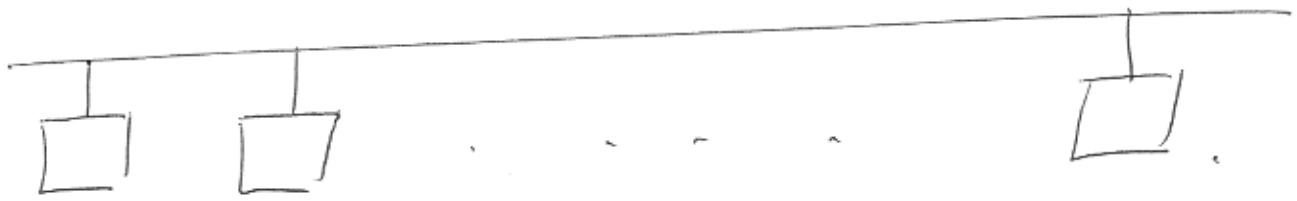
?? Base T,
?? Base F,
802.1 Q

} As long as the "~~Hub~~" is a bridge or switch.

Do not have collissions.

Simplest Ethernet:

Co-ax, one segment.



Multiple Access.

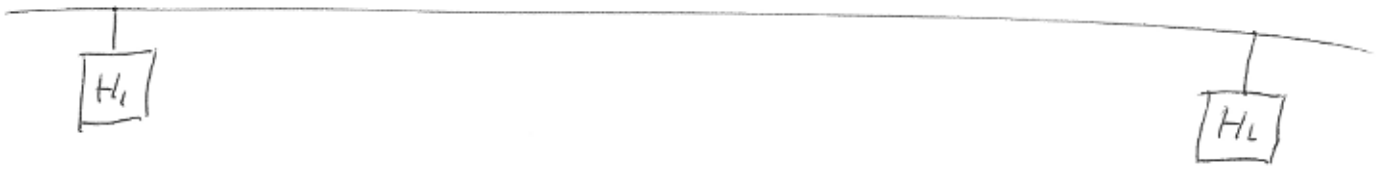
1. ~~Carie~~ Carrier Sense.
2. Collission Detection.
3. Random BackoFF.

First: in ~~twiketf~~ wireless Packet Radio Aloha.

~~Our~~ Access.

Assume "Old Fashioned" Ethernet.

Co-ax.



H_1 has ~~ethernet~~ frame to send.

(1) Listens. ~~("Collision Det~~ ("Carrier Sense").

(2) IF nobody there:
Start sending.

(Is this garanteed to work$?)

(3) Keep listening.
("Collission Detection").

How long?

At least 2τ.

What does this say about Framesize?

Framesize : F (bits)

Bitrate : B bits/sec.

Speed : v ($v \sim \frac{2}{3} c$).

Simple cable: length L.

$$\tau = \frac{L}{v}$$

Time to send frame : $\frac{F}{B}$.

Wanted: $\frac{F}{B} > 2 \cdot \frac{L}{v}$ (This is not math!).

$$F > 2 \frac{LB}{v}$$ (minimal frame size)

$$L < \frac{Fv}{2B}$$ (maximal length).

$$\frac{L}{F} < \frac{v}{2B}$$ (??)

We must make sure that

$$\frac{L}{F} < \frac{V}{2B} \qquad \text{or} \qquad \left(\frac{F}{L} > \frac{2B}{V} \right)$$

so collissions will be detected. (1)

IF H_1 detects collission ("itself with somebody else"):

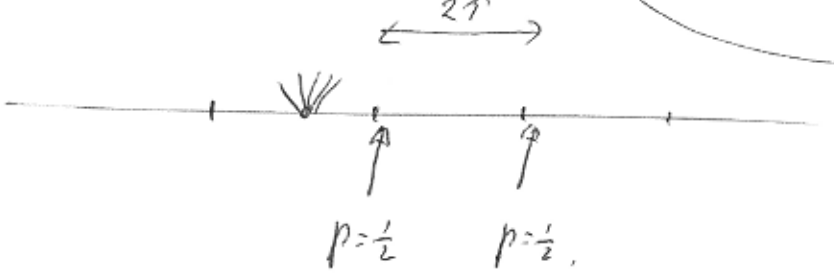
(i) Send short burst of noise. (To make sure everybody knows).

(ii) Try again.

Try again when? Right Away?

Randomize. !

First collission:



"2τ = 64 Bytes = 512 bits"

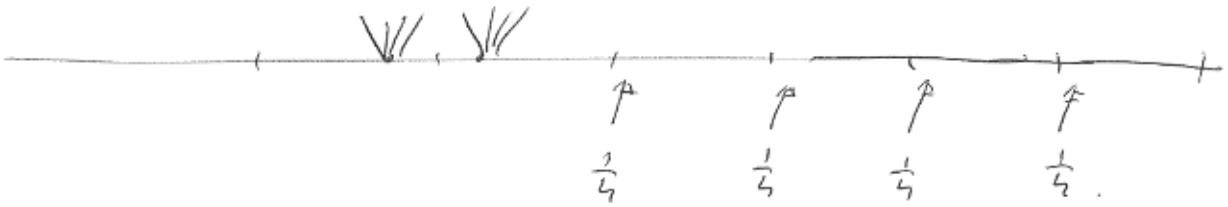
sloppy!

Try "right away" : prob. $\frac{1}{2}$

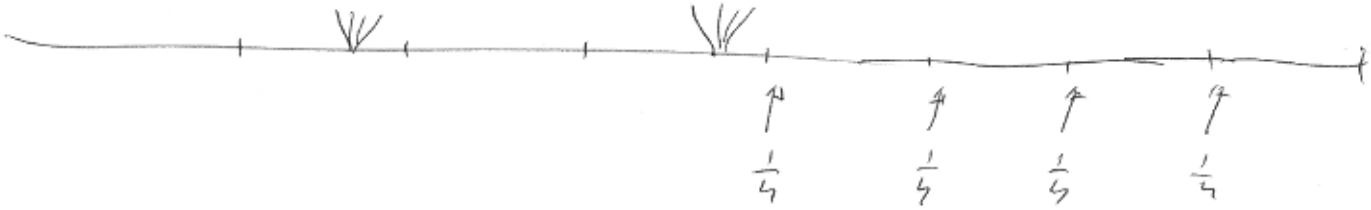
Try "after ~~one~~ $1 * (2\tau)$" : prob $\frac{1}{2}$.

// Ok: Ok!

// Not Ok.



or



Sloppy: here 2τ is the <u>backoff</u> length

"The worst possible value of 2τ, rounded up".

Binary Exponential Backoff.

After k collisions:

Unif $\{0*(2T), 1*(2T), 2*(2T), \cdots, (2^k-1)*(2T)\}$

each probability (2^{-k}).

Eg: With max of $k=10$.

if ≥ 10 collisions have occurred:

Unif $\{0*(2T), \cdots, 1023*(2T)\}$.

each prob $2^{-10} = \frac{1}{1024}$

After 16 collisions: give up.

Q: Why not high. away ~~1024~~ $\{0*(2T), \cdots, (2^{10}-1)*(2T)\}$?

Q: Why not right away "very small p"?

A: Long Delay.

Waste of time.

Waste of Bandwidth.

Thought experiment:

Suppose we know there are exactly n stations that want to send.

Best p?

Criteria:

Maximize probability of one attempt in slot zero.

(May not be best objectives
Good enough!)

Nobody : Failure!

> 1 : Failure!

$= 1$: Good!

$$P\{\underline{\text{one}} \text{ attempt}\} = n p (1-p)^{n-1}$$

Make this large :

$$\frac{d}{dp}\left(np(1-p)^{n-1}\right) = n(1-p)^{n-1} - np(n-1)(1-p)^{n-2}$$

$$= n(1-p)^{n-2}\left(\underbrace{(1-p) - (n-1)p}\right)$$

$$1 - p - np + p = 1 - np$$

$$\frac{d}{dp}\left(np(1-p)^{n-1}\right) = n(1-p)^{n-2}(1-np)$$

$= 0$: $\quad p = \frac{1}{n}$.

(for max)

IF only we knew!

First: guess $n=2$.
(only 1 "other party").

IF collission: "guess" $n>2$.
why not $n=4$?

More collissions:
"guess" n to be larger.

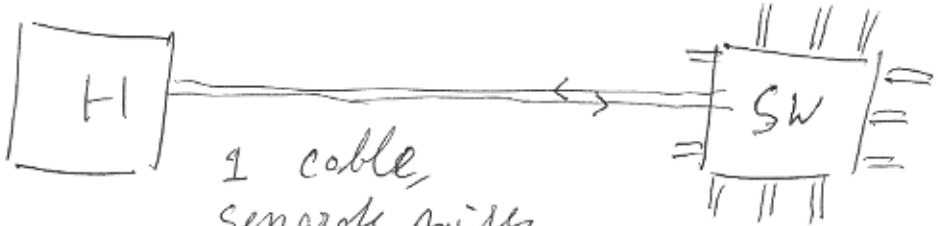
Start Tue 10/24/2003

1975 - 1990: Lots of papers on more sophisticated schemes.

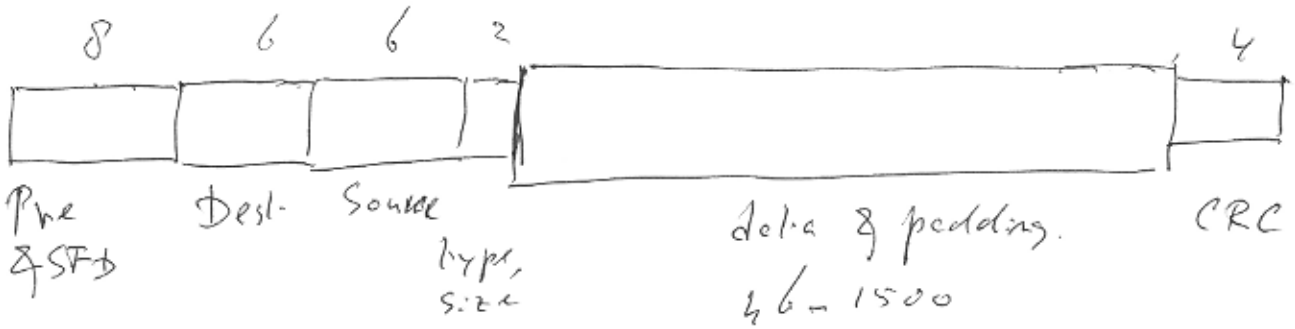
With ethernet ~~bridge~~ switch:
problem went away.

~~Soon.~~

Cat 5 cable between switch and host:
Bidirectional, Full duplex, only 2 parties: Never Collisions!



1 cable,
separate wires
(4 pairs: 8 wires).



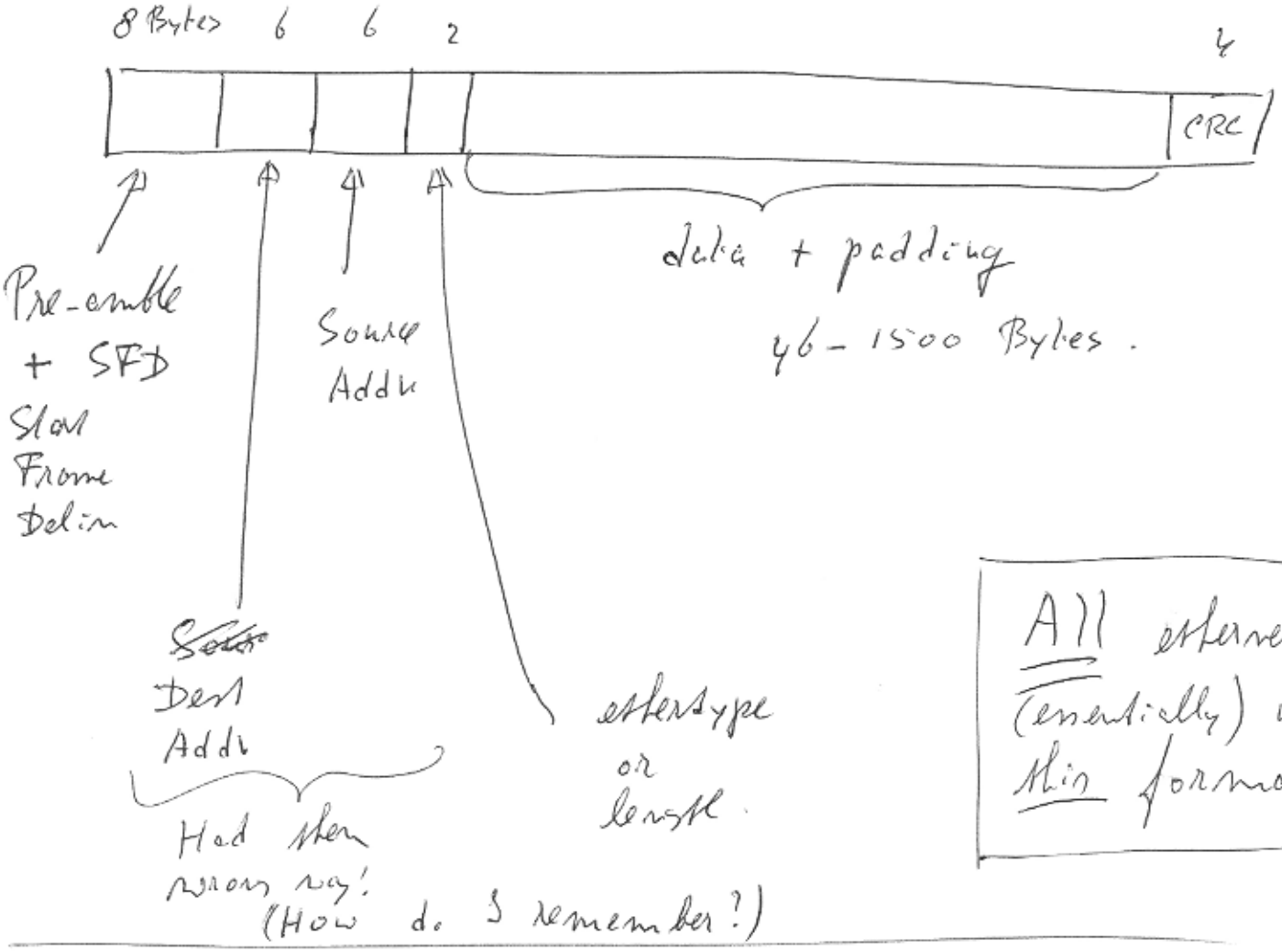
"Direction of Travel".

"Big - Endian".

(most significant bit first).

Ethernet Frame. Layout

(p 89 of notes)



All ethernets (essentially) use this format

Why the minimum of 46 data bytes (& padding)?

~~46 + (8~~

46 + (6 + 6 + 2 + 4) = 64 Bytes = "25"

(Pre-amble does not count).