

Panel 1

Last Time:
not much!
Nyquist:
Nyquist-Shannon:

1

Panel 2

Quiz 3 (1)
Questions removed to allow
makeups

2

Panel 3

Quiz 3 (2)

Questions removed to allow
makeups

3

Panel 4

Quiz 3 (3)

Questions removed to allow
makeups

4

Panel 5

If $f(t) = \sin(1200t)$, then what - really -
is the frequency?

HW - send me email!!

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Panel 6

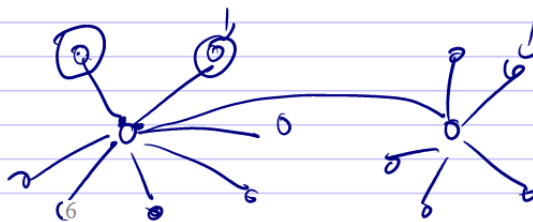
The Telephone System

Alexander Graham Bell: 1876 just hours ahead of
rival Elisha Gray

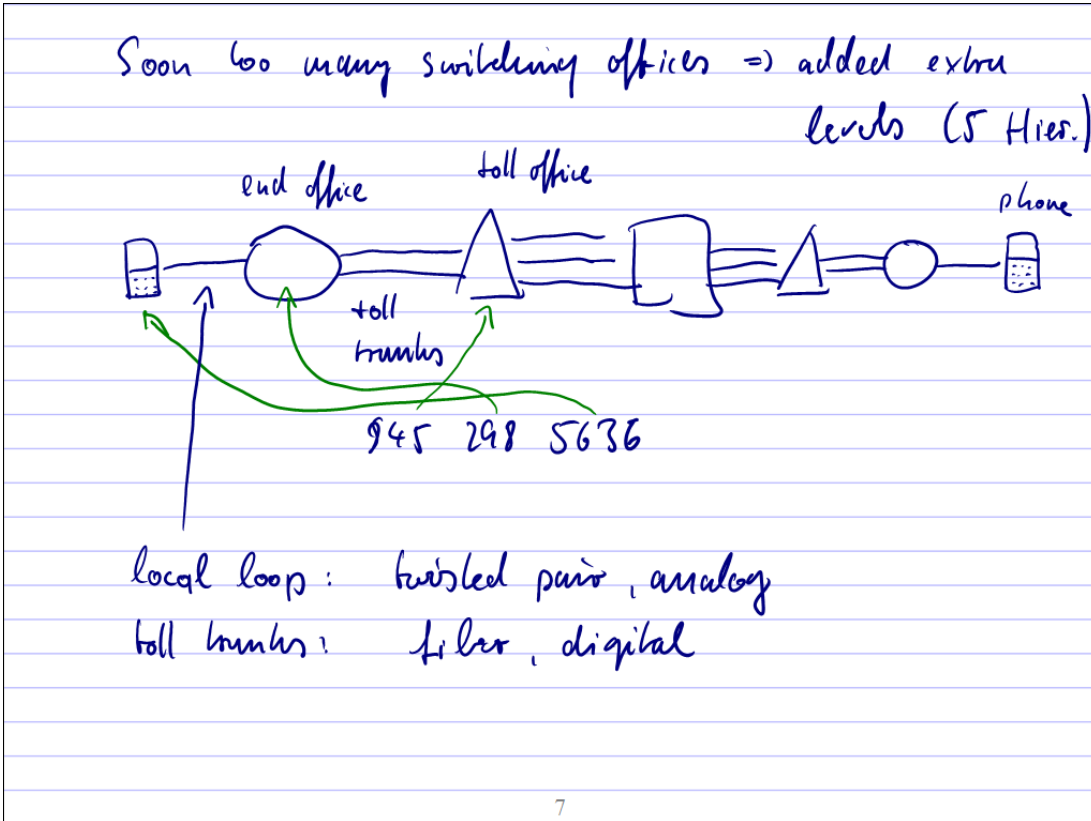
Telephones were sold in pairs, customers
provided wires.

⇒ wires everywhere!

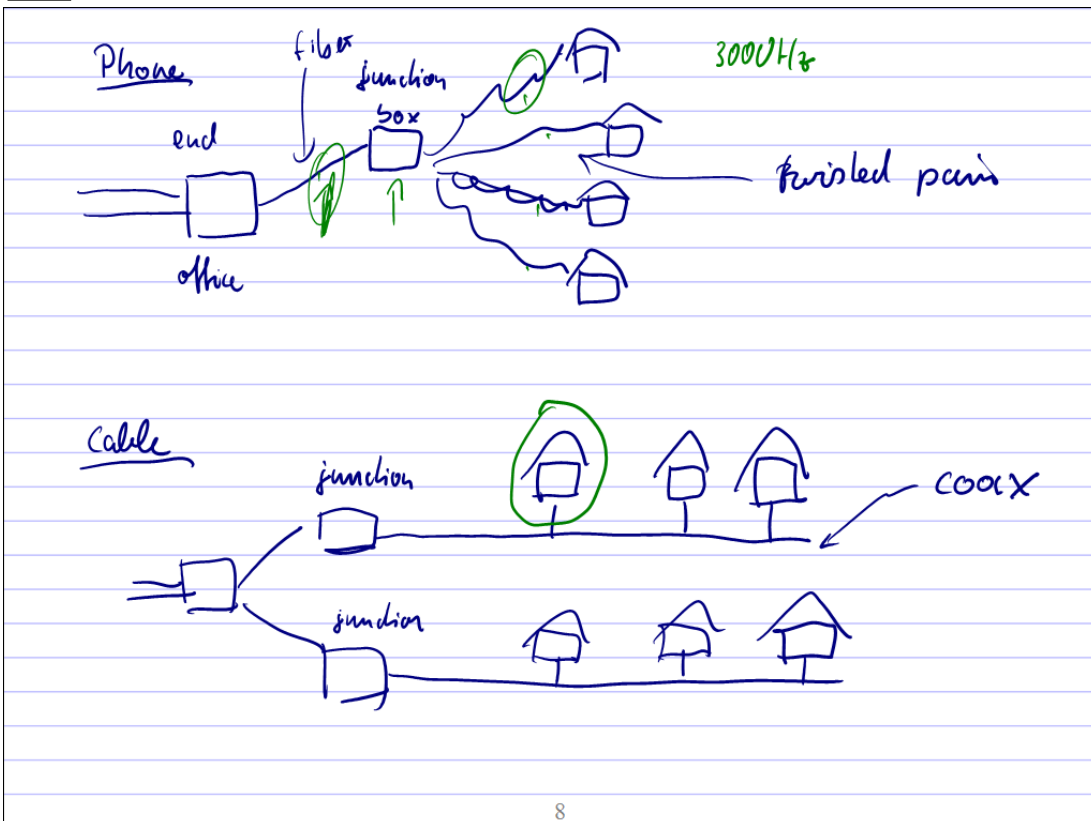
Bell formed Bell Telephone to provide
switching services: ~ 1878



Panel 7



Panel 8



Panel 9

Multiplexing
 combining multiple channels onto one line

$\left\{ \begin{array}{l} \text{FDM} \\ \text{TDM} \end{array} \right.$

Frequency Division Multiplexing (FDM)

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Panel 10

Time Division Multiplexing (TDM)

Signal is sampled 8000 times per sec.

⇒ 24 8-bit channels combined into "frame"

$24 \cdot 8 + 1 \text{ bits}$
 every $\frac{1}{8000} = 125 \mu\text{s}$

$(24 \cdot 8 + 1) = 193 \text{ bits per } 125 \mu\text{sec} = 1.544 \text{ Mbps}$

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Panel 11

Multi-Multiplexing

24 voice grades is T1 line (1.544 Mbps)

4 × T1 = T2 ~ 6.312 Mbps

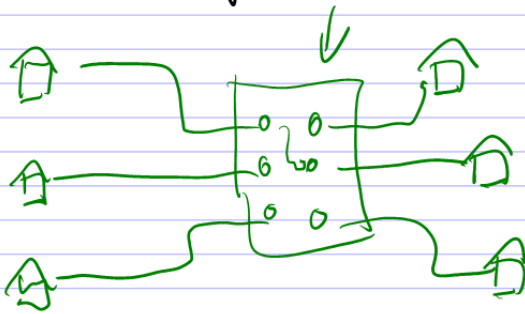
7 × T2 = T3 ~ 44 Mbps

6 × T3 = T4 ~ 274 Mbps

Since 1995 SONET (Synchronous Optical NETwork)
governs all long distance traffic in
the US

11

Panel 12

Switching

Slower gear 100 years old
now phased out!

12

Panel 13

$$f(t) = \# + \# \cos(\#t) + \# \sin(\#t) + \dots$$

Annotations:

- Two upward arrows from the first and second '#' point to the text '#FT' below them.
- Two upward arrows from the first and second '#' inside the trigonometric terms point to a bracket labeled 'period' below them.
- Small superscripts '1.' and '2.' are placed above the first and second '#' inside the trigonometric terms, respectively.