



Communication Museum

The Morse Telegraph

Samuel Morse, 1791-1872



First electrical telegraph demonstrated in 1837



CREATE THE NEXT WAVE

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1895 Guglielmo Marconi

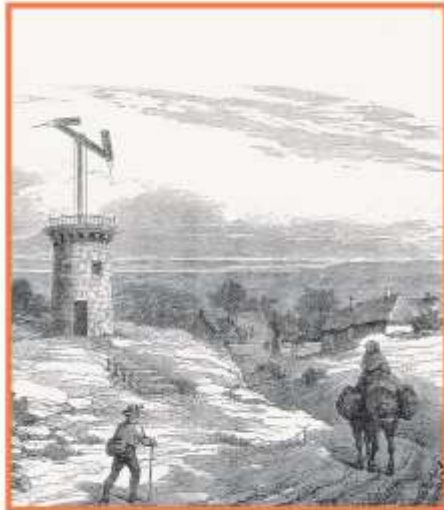
- ❑ first demonstration of wireless telegraphy (digital!)
- ❑ long wave transmission, high transmission power necessary ($> 200\text{kw}$)



H. Hertz (1857-94):
demonstrates with an
experiment the wave character
of electrical transmission
through space (1886, in
Karlsruhe, Germany, at the
location of today's University of
Karlsruhe)

The Chappe Telegraph

(Claude Chappe, 1763-1805)



**92 out of
256 (= $4 \times 8 \times 8$) positions
represented characters.**

**Integrity of message could be
restored at each relay station**

**In 1844,
534 relays linked Paris with
29 cities, covering in total
5000 Km.**

Alexander Graham Bell

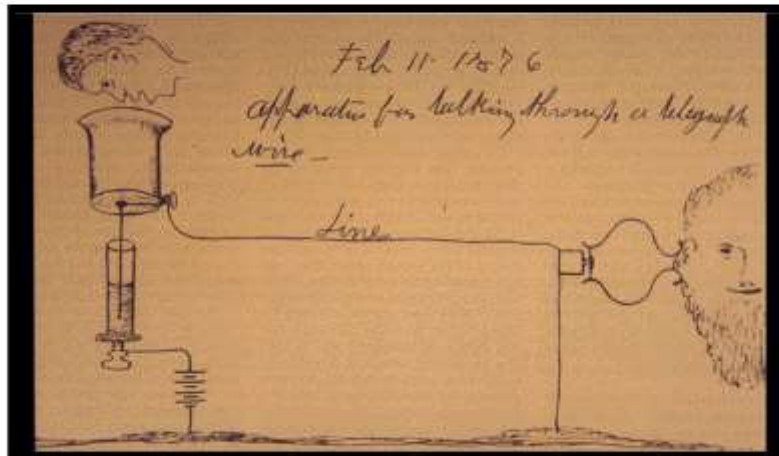


*Alexander
Graham Bell*



1876 - Bell's original telephone

Graham Bell , 1876



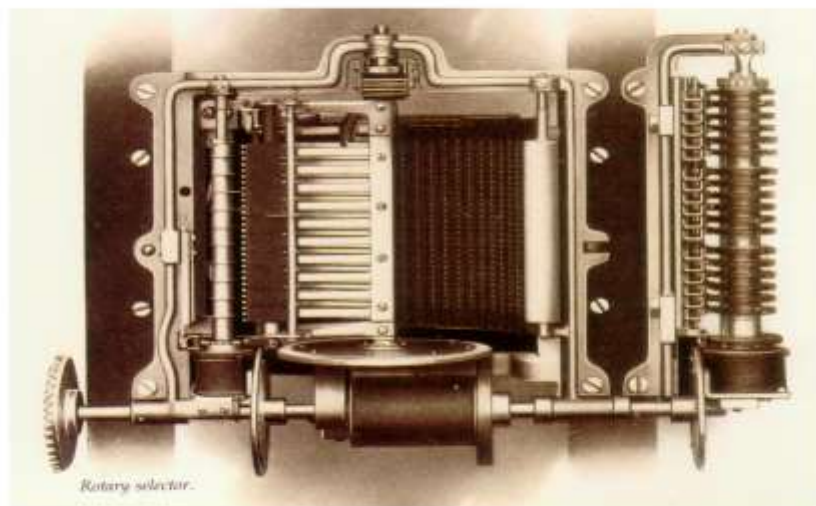
Telephone Instrument Evolution



Local battery Phone



Rotary Selector



Manual Exchange



$$\text{DataRate} \leq B \cdot \log_2(1 + S/N)$$

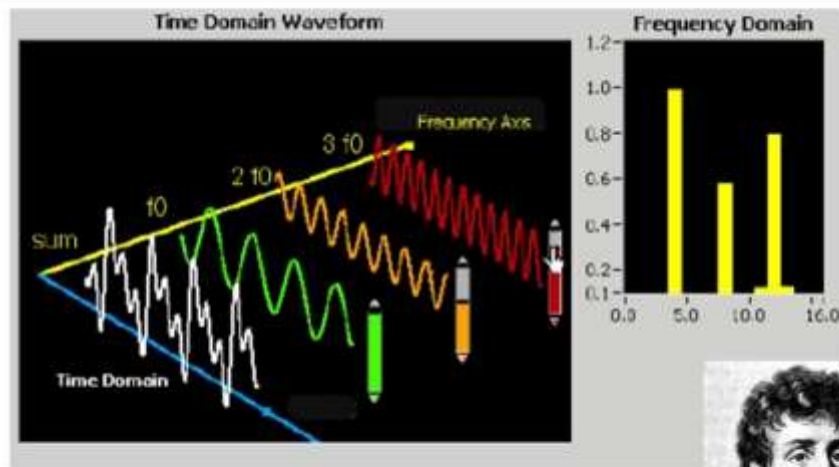
B : Channel Bandwidth (in Hertz)
S/N : Signal to Noise ratio



Example:
Telephone channel,
B = 3000 Hz, S/N = 1000

$$\text{DataRate} \leq 30\,000 \text{ b/s}$$

Fourier

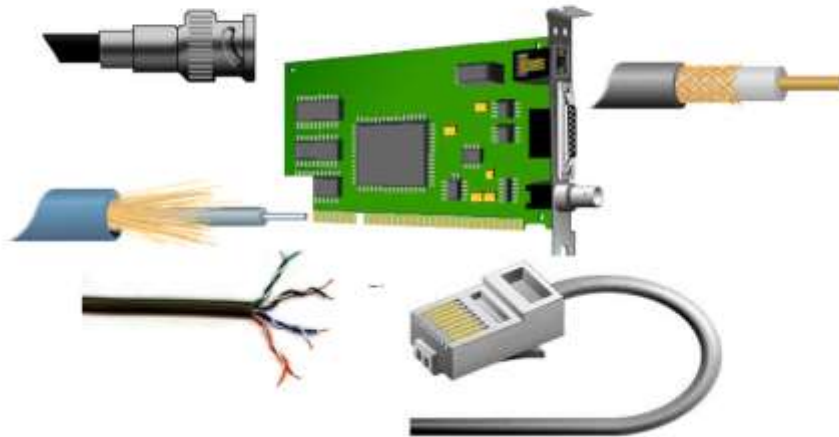


$$F(\omega) = \frac{1}{\sqrt{2\pi}} \int_{-\infty}^{\infty} f(t) e^{-i\omega t} dt$$

Fourier



Computer Network: NUTS and BOLTS



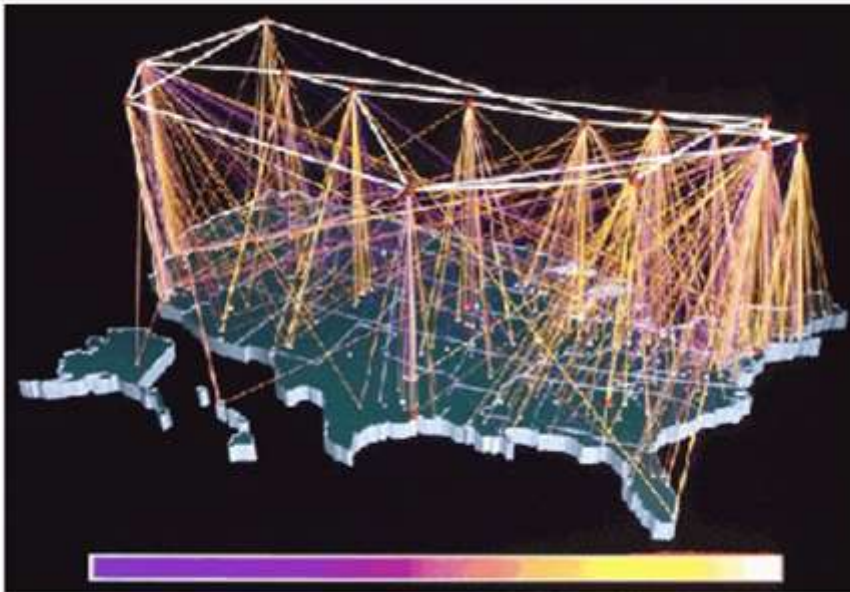
CREATE THE NEXT WAVE

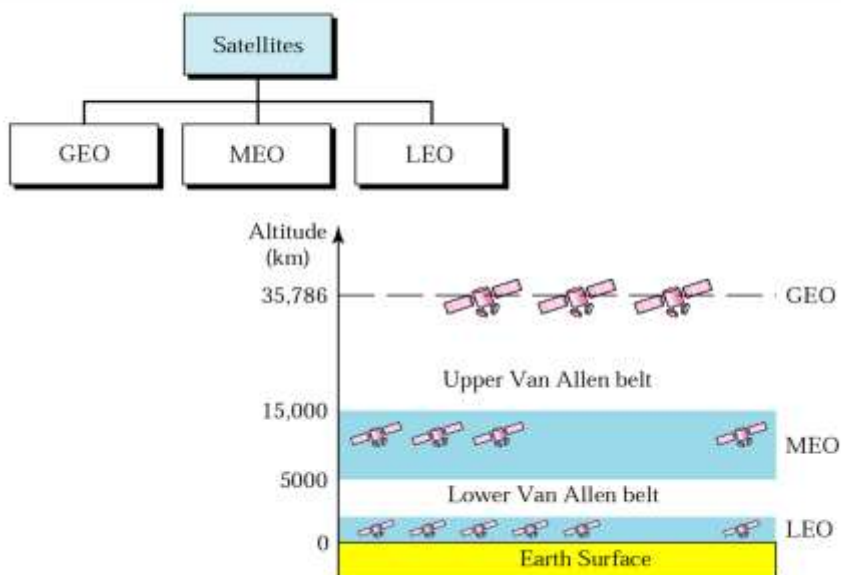
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Hubs, Switches, Access Point



Internet USA structure





History of satellite communications



- 1945: Arthur C. Clarke publishes an essay about „Terrestrial Relays“
- 1957: first satellite SPUTNIK
- 1960: first reflecting communication satellite ECHO
- 1963: first geostationary satellite SYNCOM
- 1965: first commercial geostationary satellite "Early Bird"
- (INTELSAT I): 240 duplex telephone channels or 1 TV channel, 1.5 years lifetime

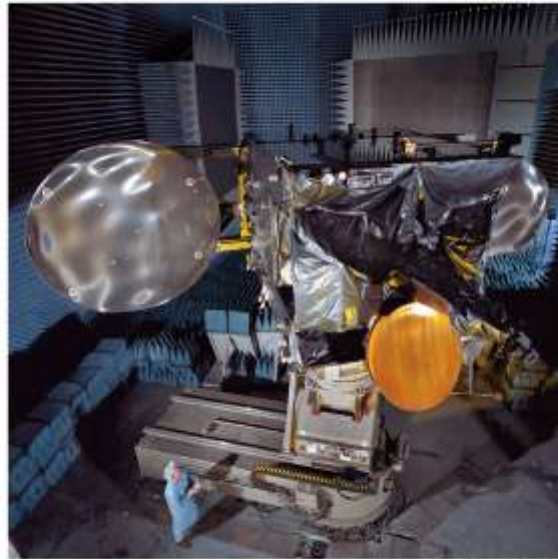


History of satellite communications



- 1976 : three MARISAT satellites for maritime communication
- 1982: first mobile satellite telephone system INMARSAT-A
- 1988: first satellite system for mobile phones and data communication INMARSAT-C
- 1993: first digital satellite telephone system
- 1998: global satellite systems for small mobile phones

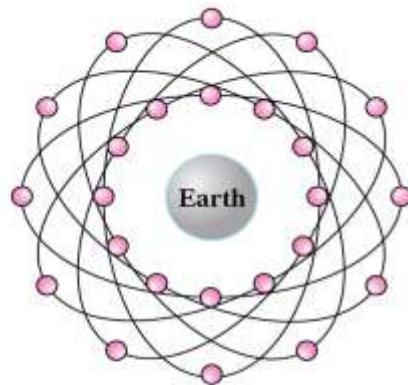




INTELSAT 806
satellite

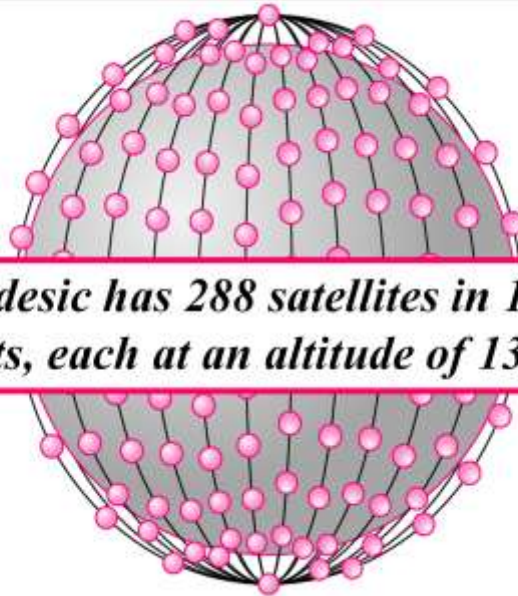
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GPS and Iridium



The Iridium system has 66 satellites in six LEO orbits, each at an altitude of 750 km.

Iridium is designed to provide direct worldwide voice and data communication using handheld terminals, a service similar to cellular telephony but on a global scale.



Teledesic has 288 satellites in 12 LEO orbits, each at an altitude of 1350 km.

Comparison of Satellite Network



	Iridium	Globalstar	ICO	Teledesic
# satellites	66 + 6	48 + 4	10 + 2	288
altitude (km)	780	1414	10390	ca. 700
coverage	global	±70° latitude	global	global
min. elevation	8°	20°	20°	40°
frequencies [GHz (circa)]	1.6 MS 29.2 ↑ 19.5 ↓ 23.3 ISL	1.6 MS ↑ 2.5 MS ↓ 5.1 ↑ 6.9 ↓	2 MS ↑ 2.2 MS ↓ 5.2 ↑ 7 ↓	19 ↓ 28.8 ↑ 62 ISL
access method	FDMA/TDMA	CDMA	FDMA/TDMA	FDMA/TDMA
ISL	yes	no	no	yes
bit rate	2.4 kbit/s	9.6 kbit/s	4.8 kbit/s	64 Mbit/s ↓ 2/64 Mbit/s ↑
# channels	4000	2700	4500	2500
Lifetime [years]	5-8	7.5	12	10
cost estimation	4.4 B\$	2.9 B\$	4.5 B\$	9 B\$

A Mobile Station

- Front of Circuit board



- Back of Circuit board



A Mobile Station

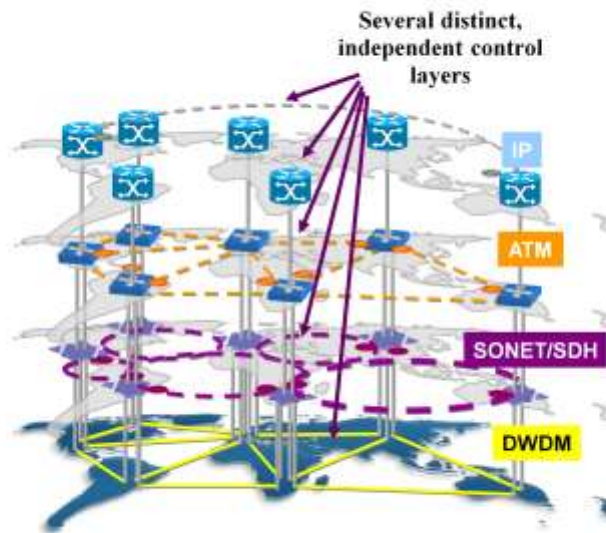
Circuit board containing the brains of the phone

- Microprocessor
- DSP
- A to D Converter
- D to A Converter
- Memory



- Antenna
- RF & Power sections
- Liquid Crystal Display
- Keyboard
- Microphone
- Speaker

Present Network Architectures





Thank you