

# **HISTORY OF TELECOMMUNICATION AND INVENTIONS**



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# History of Telecommunications

- Using sunlight
  - **Heliograph** (using the reflection of sunlight from a mirror for information transmission)
- Using fire or lamp light
  - Fire tower
  - Lighthouse
  - Using signal lights for ship-to-ship communication

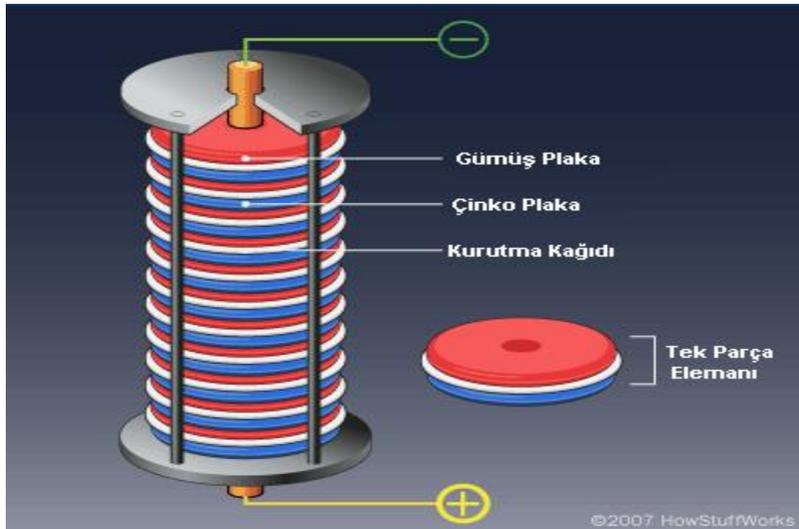


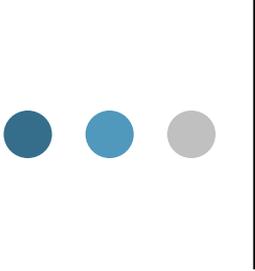
# History of Telecommunications

- The first foundations of electrical communication has been established by Italian origin scientist Alessandro Volta in 1776 with the invention of the battery.



**Alessandro Volta**  
1747-1827  
İtalyan asıllı





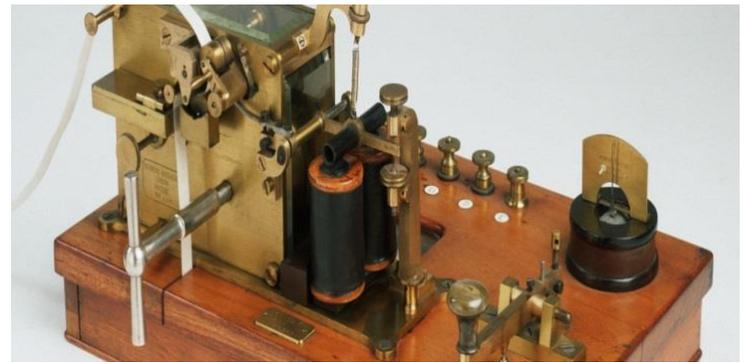
## History of Telecommunications

- As it is known, when the battery is applied to the input of an electrical circuit, a constant electric current starts to flow from this circuit.
- As in light communication, if we cut (0) or flow (1) this current for a certain period of time and according to the information we want to send, then the information can be transmitted electrically from one place to another.



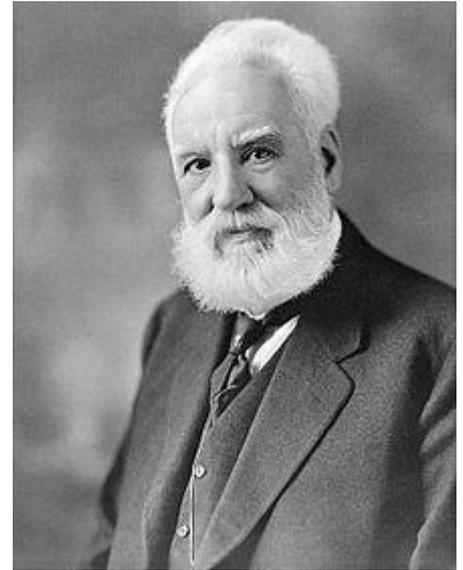
## History of Telecommunications

- Morse called this device Telegraph. He then established a 60 km telegraph line between Baltimore and Washington and this line was used to convey news about the American presidential elections.
- Mors received his first **telegraph patent** from **Sultan Abdülmecid in Istanbul** in 1874.



## History of Telecommunications

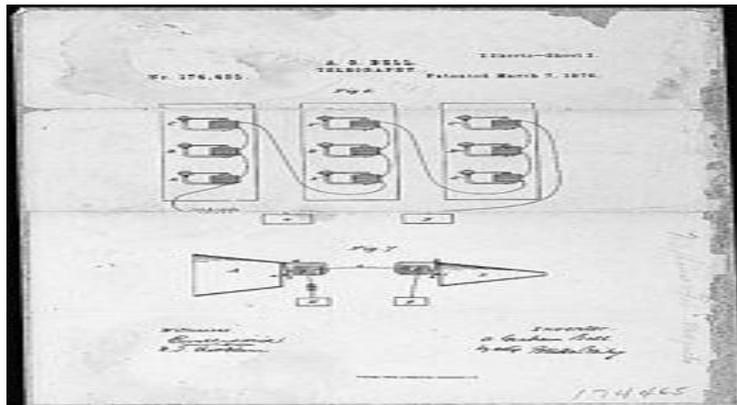
In my opinion, the real developments in communication technology started with the invention of the telephone in 1876 by Alexander Graham Bell.

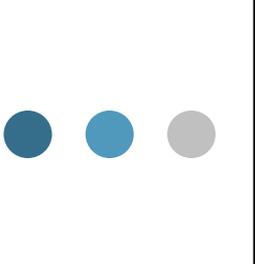


Alexander Graham Bell  
1847-1922  
İskoç

## History of Telecommunications

In 1876, Alexander Graham Bell, together with electrical engineer Thomas Watson, invented a device that transmits sound over a pair of copper wires and calls it a **telephone**. They both apply to patent the phone separately, but immediately after these applications, Graham Bell is entitled to receive the telephone patent on March 7, 1876.





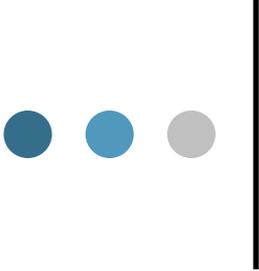
## History of Telecommunications

After the invention of telephone, first meaningful phone conversation between Graham Bell and his assistant was as follows:

Graham Bell pours acid from his battery into his pants while working in the lab, and calls Watson for help in the other room.

"Mr.Watson- come here- I want to see you."

Watson hears this on the phone and understands what is said by Graham Bell.



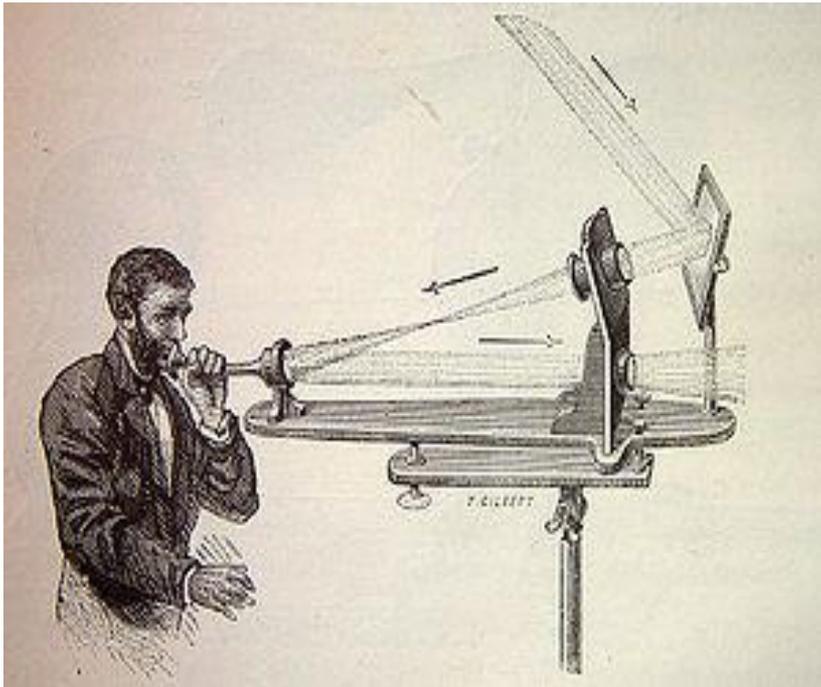
## History of Telecommunications

Second important invention of Graham Bell's in 1880, which is not known as much as telephone, is based on transmitting voice over **sunlight** called **Photophone**. He claimed that photophone is most important invention in his life even more than Telephone. Bell was very proud of this invention, such that he wanted to name his new second daughter "Photophone", which was rejected by his wife and they instead chose "Marian", with "Daisy" as her nickname.

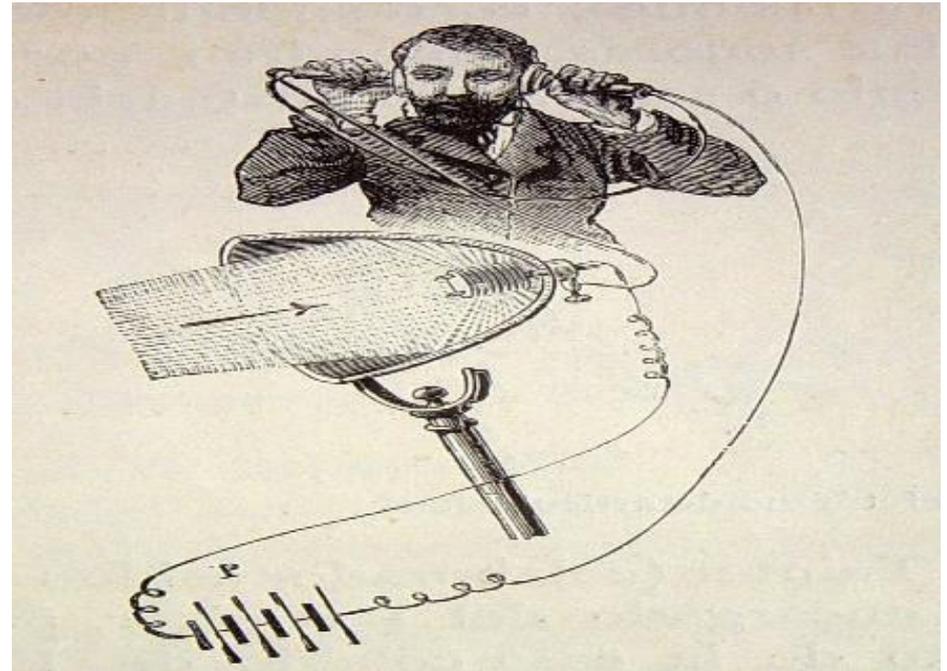
# History of Telecommunications

## Photophone

### Transmitter



### Receiver



In 1873 Willoughby Smith, found that the element called **selenium** can convert the incoming light into electrical current.

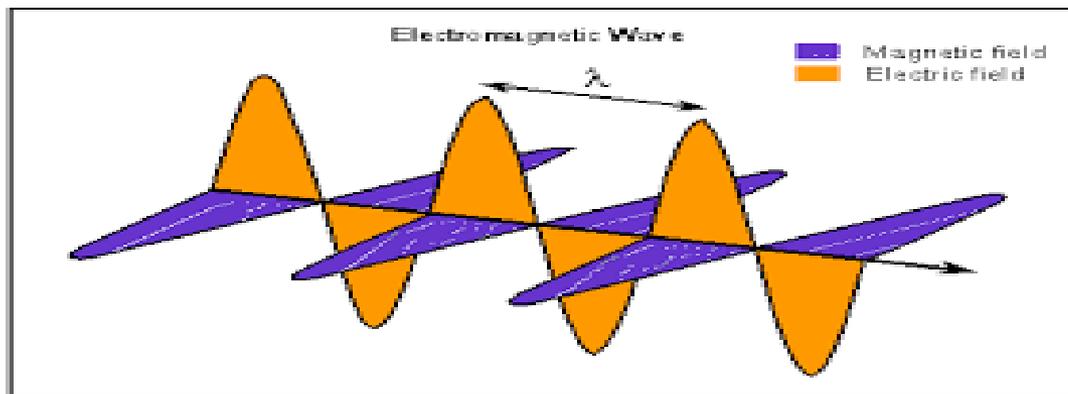


## History of Telecommunications

Photophone has initiated today in the developments of video, mobile phones, live broadcast communication over the Internet and visible light communications

## History of Telecommunications

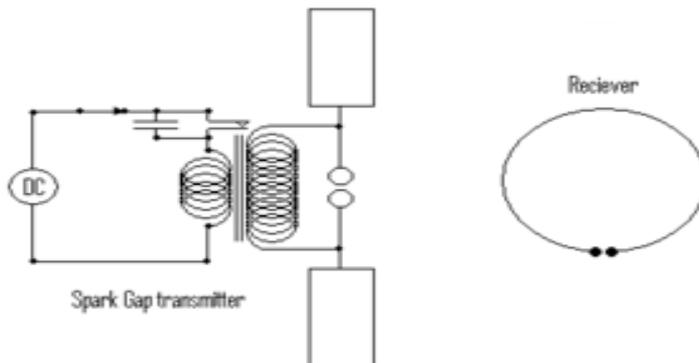
On the other hand, in 1865 James Clerk Maxwell, a Scottish-based theoretical physicist and mathematician, created the mathematical foundations for **Electromagnetic waves** and their propagation in space with the help of famous **Maxwell's equations**.



James Clerk Maxwell  
1831- 1878  
Iskoçyalı

# History of Telecommunications

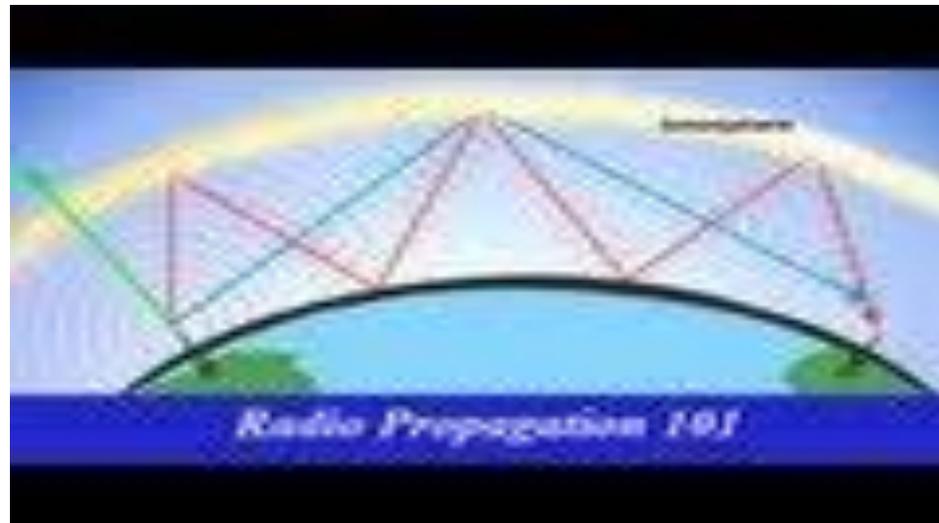
H. Hertz, in 1888, using Maxwell's theory, was able to experimentally demonstrate that, the **electrical signals** can be transmitted by electromagnetic waves at the **speed of light** in space was possible.



Henric R. Hertz  
1857- 1894  
Alman asıllı

## History of Telecommunications

In the field of electrical engineering, electromagnetic waves and their propagation in space have resulted in the emergence of both **radio** and **wireless mobile communication** systems that are developing day by day.

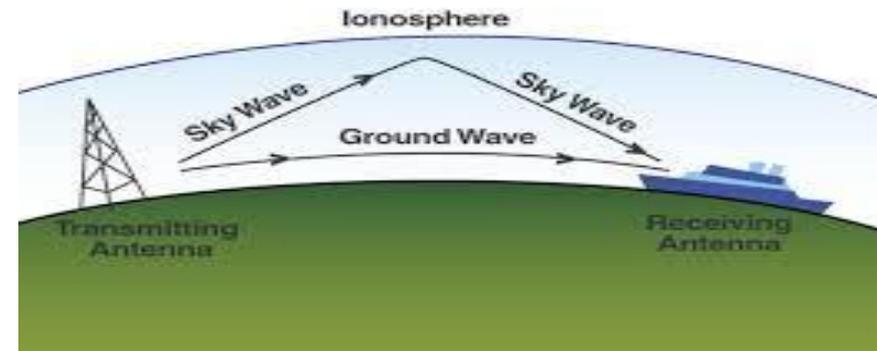


## History of Telecommunications

- ▶ After the propagation properties of electromagnetic waves are understood, the first **short wave radio** communication is carried out by Marconi in 1889.
- For the first time, the transmission of the message to a distant place in a wireless environment was then described a science fiction.

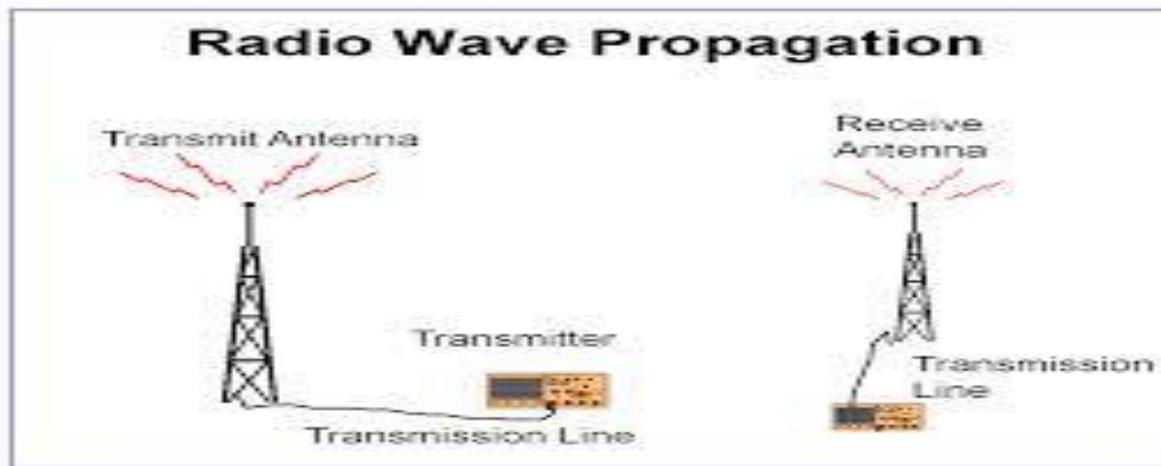


Guglielmo Marconi  
1874-1937  
İtalyan asıllı Fizikçi



## History of Telecommunications

- Marconi was able to send the first radio signal from England to Canada in 1891.
  - The first radio broadcast was made in the USA in 1906.
- Whole world met with regular radio in the 1920 and radio broadcasts in Turkey It started in 1927.



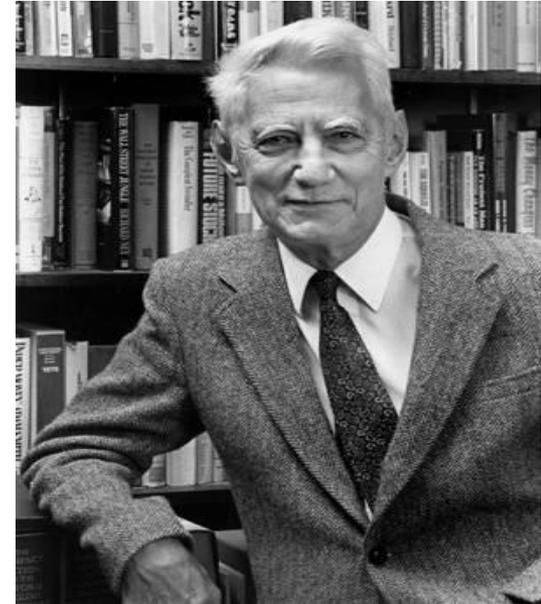
## History of Telecommunications

When Marconi died, all the world's radios  
Became silent for the last time for two minutes



# History of Telecommunications

- The foundation of modern communication (**digital**) technologies was laid with Claude Shannon in 1948 and developed rapidly until our days.
- Shannon's established the foundations of **Information theory** and showed that the Information is a measurable size and called its unit as '**bits**'.



**Claude Shannon**  
**1916-1999**  
**ABD'li Matematikçi**

## History of Telecommunications

**Shannon**, showed that the information of a Message ( $M$ ) is directly proportional to the probability of this message  $P(M)$  **and he has proved that** the amount of message carried by this message **is given by**

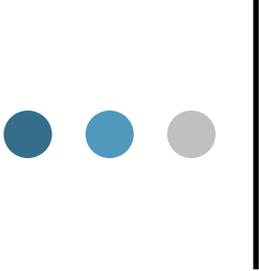
$$I = -\log_2 P(M) \quad \text{bit}$$

And his information unity he defined as bit.

**For example,**

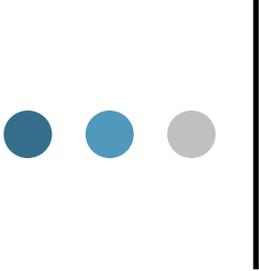
$$P(M) = 1 \quad \text{ise} \quad I = 0 \quad \text{bit} \quad P(M) = 0.95 \quad \text{ise} \quad I = 0.074 \quad \text{bit}$$

$$P(M) = 0 \quad \text{ise} \quad I = \infty \quad \text{bit} \quad P(M) = 0.05 \quad \text{ise} \quad I = 4.32 \quad \text{bit}$$



## History of Telecommunications

- In this way, any communication to be transmitted through a communication system how many bits of information the written text, sound or picture contains became calculable.
- For example “A picture is worth a thousand words”  
The accuracy of the Chinese proverb with the help of this formula of Shannon can be easily proved.

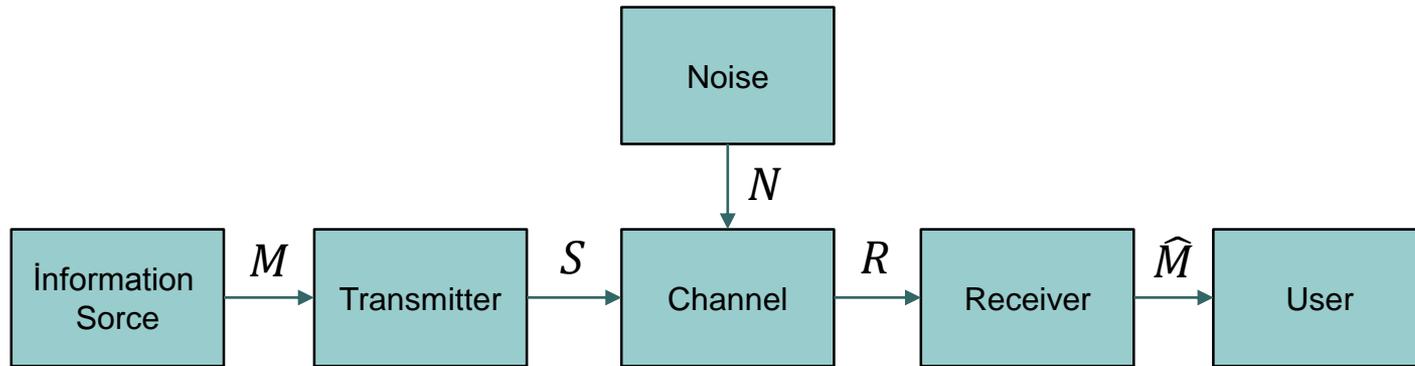


## History of Telecommunications

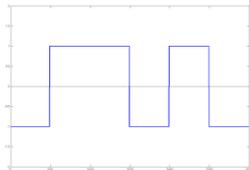
Most important contribution of Claude Shannon in the field of telecommunications in 1948 was that **regardless of noise level in a communication channel, information can be transmitted without any error.**

This situation according to the telecommunication technology of the time was described as AMAZING.

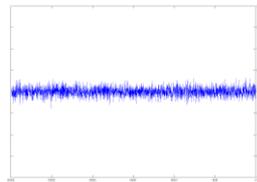
# History of Telecommunications



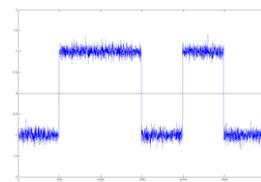
$S$   
0 1 1 0 1 0



$N$



$R=S+N$



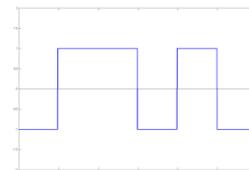
$\hat{M} = 011010$

**GÜRÜLTÜ**  
=10dB

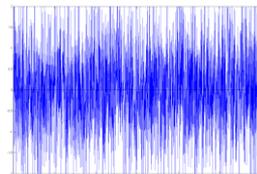
$M = 011010$

+

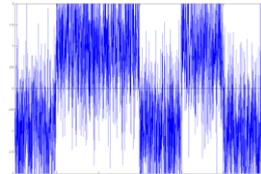
=



+



=



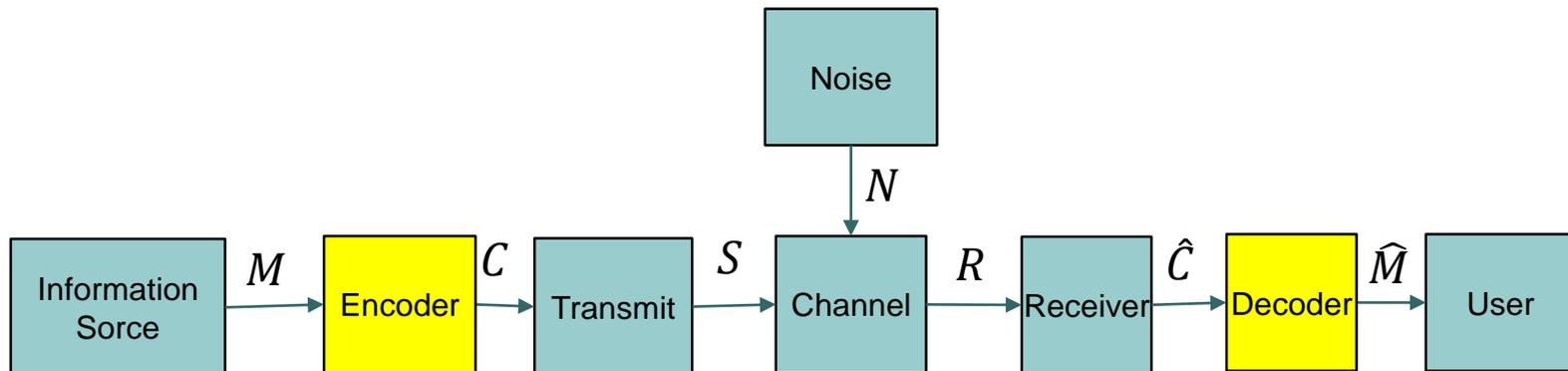
$\hat{M} = 101100$

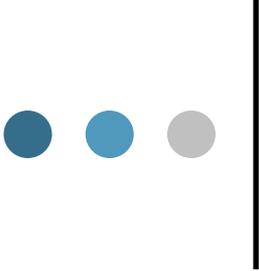
**GÜRÜLTÜ**  
=1dB

$M = 011010$

# History of Telecommunications

In 1948, Shannon mathematically proved that information can be transmitted from the channel without any errors, regardless of the SNR occurring in the channel, using a suitable **encoder** at transmitter and a **decoder** at the receiver of a **digital communication system**.





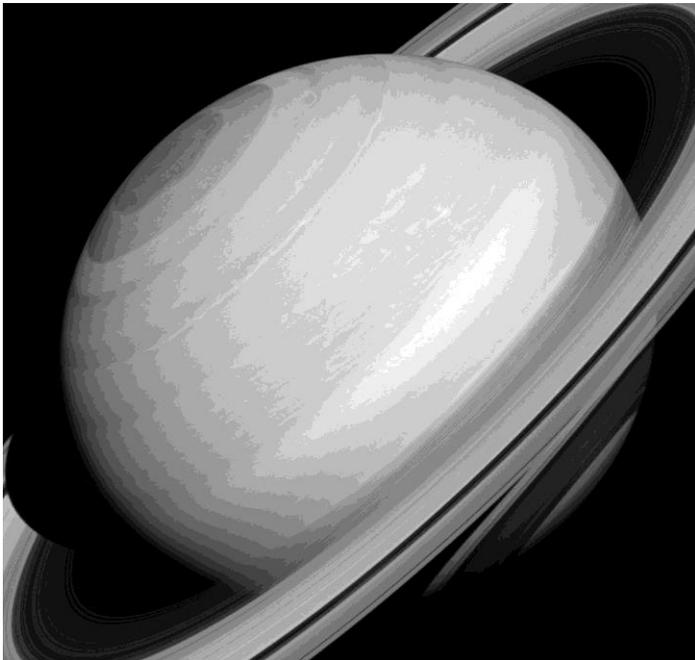
## History of Telecommunications

- After this date, big steps have been taken especially in the development of **wireless digital communication systems**

## History of Telecommunications

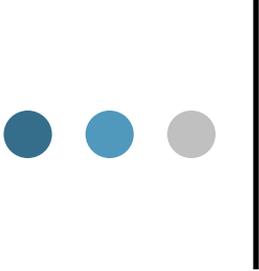
The images sent by Cassini spacecraft from SATURN 1,658,500,000 km away sent by NASA

**Saturn**



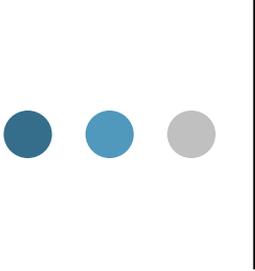
Rhea, the second largest moon in Saturn





# **Wireless Mobile Communications**

## ***Recent Developments in Telecommunications Technology***



## Wireless Mobile Communications

Next generation Electrical wireless technologies are confronted with challenges such as

► **Need High data rates :**

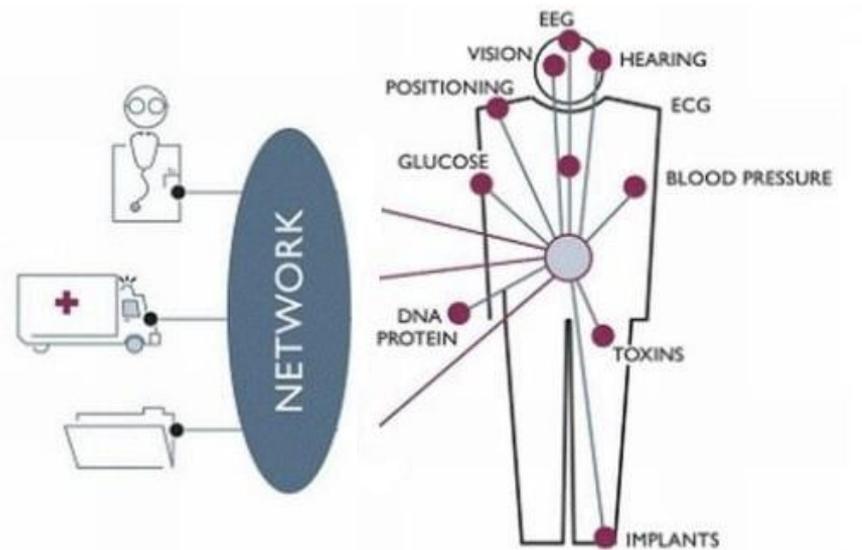
Data traffic and capacity are increasing in time.

Next 10 years, it is predicted that 1000-fold increase in data traffic.



# Wireless Mobile Communications

- ▶ Things can be any device, an object, and anything in our life.



# Wireless Mobile Communications

► By 2025, while the world population approached 8 billion, 50 billion wireless devices with the Internet of Things will be connected and communicated over the communication Networks.



# Wireless Mobile Communications

- ▶ This huge data and information needs to be a **secure** and **accurate processing** for **storing** and **transmitting**.
- ▶ For this purpose, in recent years, a new information processing tool and technique, called **Big Data**, began to be widely used.



# Wireless Mobile Communications

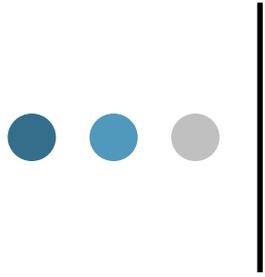
- ▶ Also, a number of very large capacity servers away from the users are employed for storage and processing of the data and information, called **Cloud Computing**



## Wireless Mobile Communications

2. We need to go to **higher mobility**. The speeds that are being used today are up to 460 km/h. We need to have new communication systems to work for such high-speed trains and planes.





***G's Times***

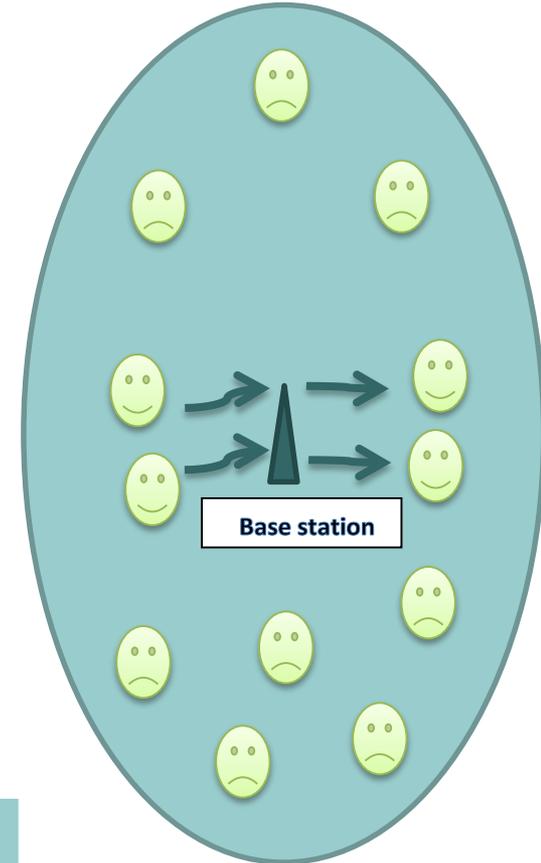
# G's Times

► The main reason for this technology:

In a given geographic area, if there is  $N$  telephone channel in a given frequency band allocated to this area, maximum  $2N$  person can communicate each other

.

Telephone Channel 1	Telephone Channel 1	Telephone Channel 1	.....	.....	Telephone Channel $N$
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## G's Times

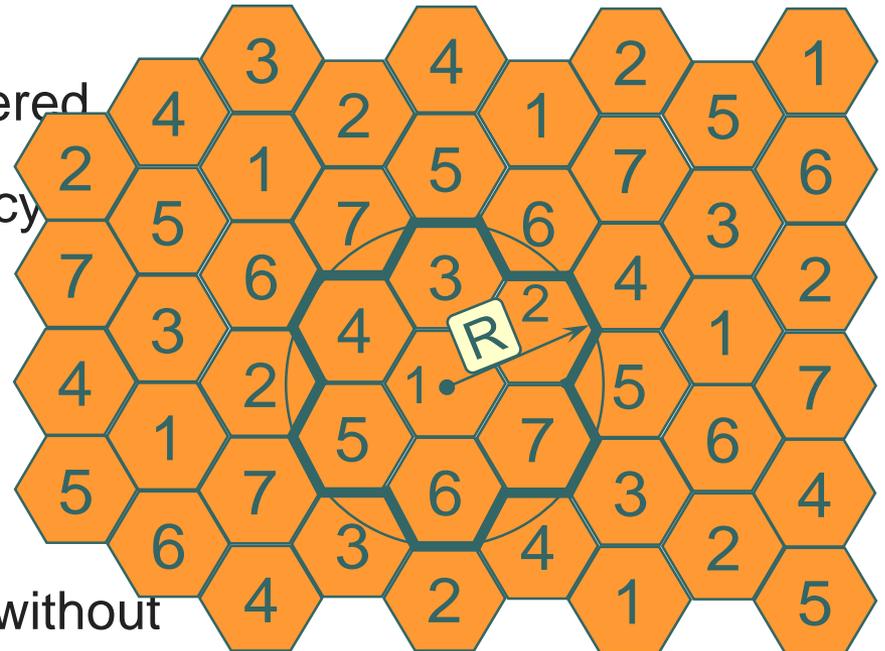
- ▶ To increase the telephone capacity, in the early 1980s, we have witnessed a new breakthrough in telecommunications called **Cell-based (cellular) Wireless Mobile communication technology.**

This was the beginning of the **G's**.

For example, for a given area covered by 7-cell cluster, different frequency

bands were assigned to each of the 7 cells. The same frequencies were repeated for each cluster.

Thus, the capacity was increased without increasing the allocated frequency band.



● ● ● | AMPS: **A**dvanced **M**obile **P**hone **S**ystem  
TACS: **T**otal **A**ccess **C**ommunication **S**ystem  
Analog technology, limited only to telephone communications

# Mobile communications: from 1G to 5G

Generation	Device	Specifications
<b>1G</b> 		<b>1G</b> <b>Year</b> early 80s <b>Standards</b> AMPS, TACS <b>Technology</b> Analog <b>Bandwidth</b> – <b>Data rates</b> –

GSM: **G**lobal **S**ystem for **M**obile Communications  
GPRS: **G**eneral **P**acket **R**adio **S**ervice  
EDGE: **E**nhanced **D**ata rates for **G**SM **E**valuation  
Veri Hızı: **10 kbits/sec** (GSM); **100kbits/sec** (GPRS)  
Ses +SMS



UMTS: **U**niversal **M**obile **T**elephone **S**ystem

HSPA: **H**igh **S**peed **P**acket **A**ccess

W-band CDMA

Veri Hızı: **1 Mbits/sec**

Ses+ SMS+Internet +Mobil TV+ Video Calls



The graphic is divided into three vertical panels. The left panel features a large blue '3G' logo and an illustration of a woman in a green top and white skirt sitting on a bench, looking at her phone. The middle panel shows a black smartphone with a grid of colorful app icons on its screen. The right panel is a light green box containing technical specifications and service icons.

3G	
Year	2001
Standards	UMTS / HSPA
Technology	digital
Bandwidth	Broad Band
Data rates	up to 2 Mbit/s

Service icons: SMS / MMS, Internet access, Video calls, Mobile TV

LTE: **L**ong **T**erm **E**valuation

LTE-A: High Mobility (Hızlı trenler ve uçaklar)

Veri speed: **1 Gbits/sec**; Higher Mobil **100 Mbits/sec**

Delays: **100 ms**

Voice+SMS+ internet + Cloud Computing+  
Mobile TV+ Games+Video Calls



**4G**

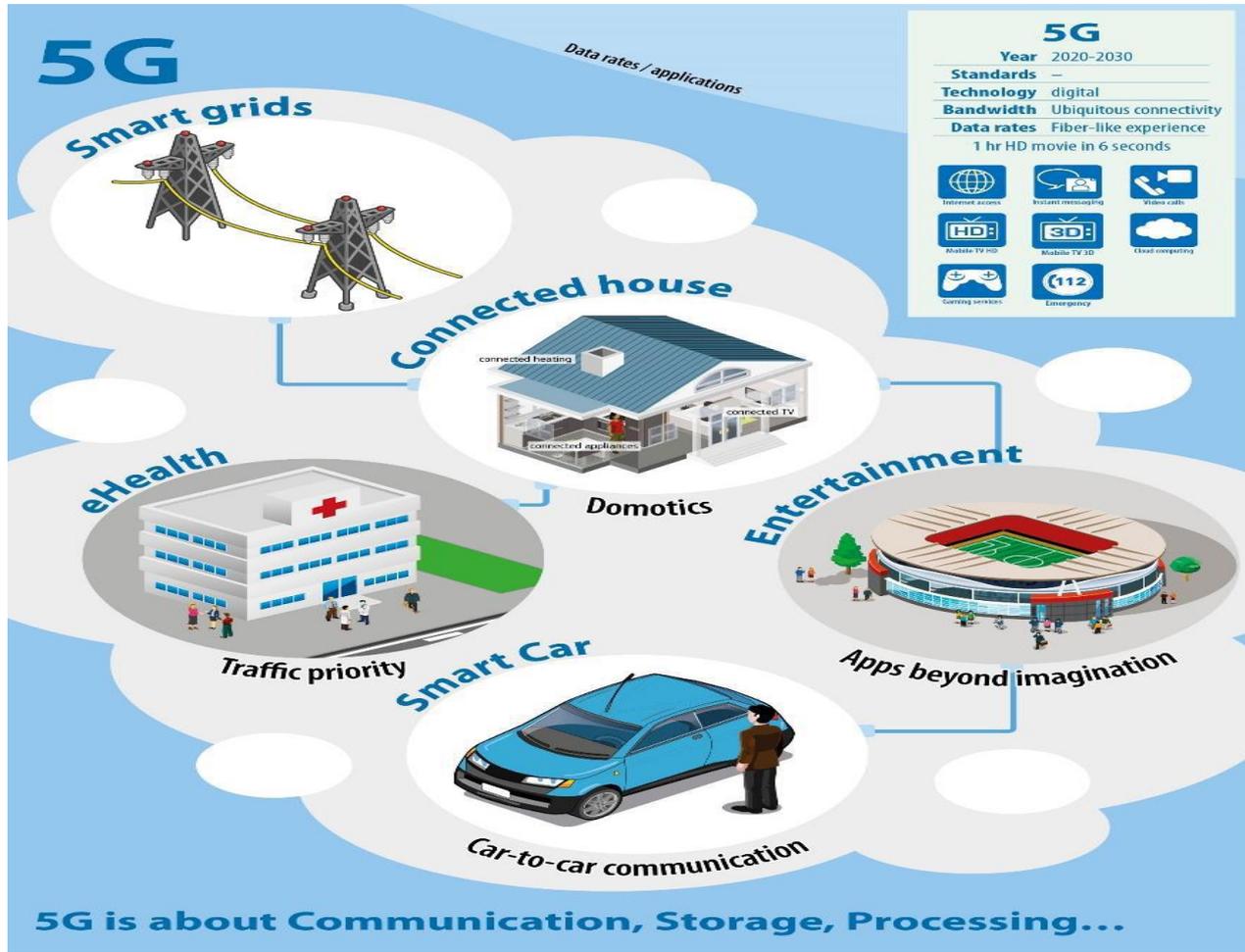
Year 2010

Standards	LTE, LTE Advanced
Technology	digital
Bandwidth	Mobile Broad Band
Data rates	xDSL-like experience

1 hr HD movie in 6 minutes

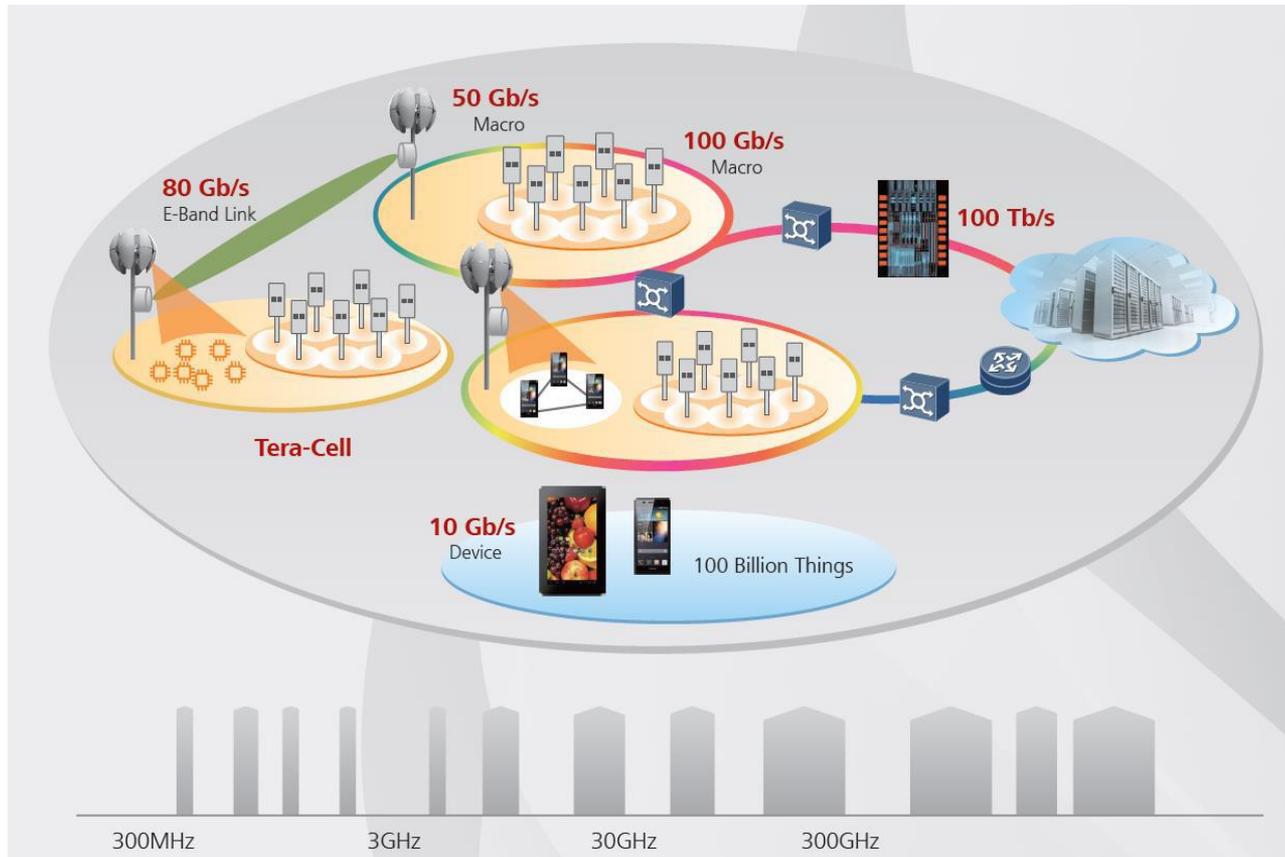
- SMS / MMS
- Internet access
- Video calls
- Mobile TV
- Gaming services
- Cloud computing

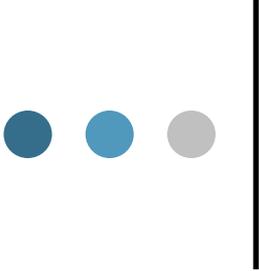
Max veri rate: **100 Gbits/sec.**  
Delay: **1 ms**



People & Things

# 5G Spektrumu:

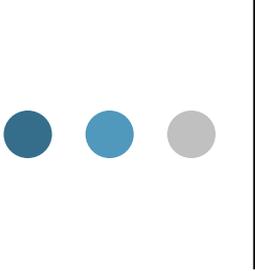




## Optical wireless Communications

As mentioned before, note that every 10 years amount of information generated by human beings and things increase **1000 fold**. In order to keep up with the increase in information rate, we have to increase the frequency of the electromagnetic waves that we use up to 1000 times every 10 years.

➤ **BUT UP TO WHERE !!**



# Optical wireless Communications

In 5G systems, we have now reached the upper limit of frequencies that can be used with radio waves.

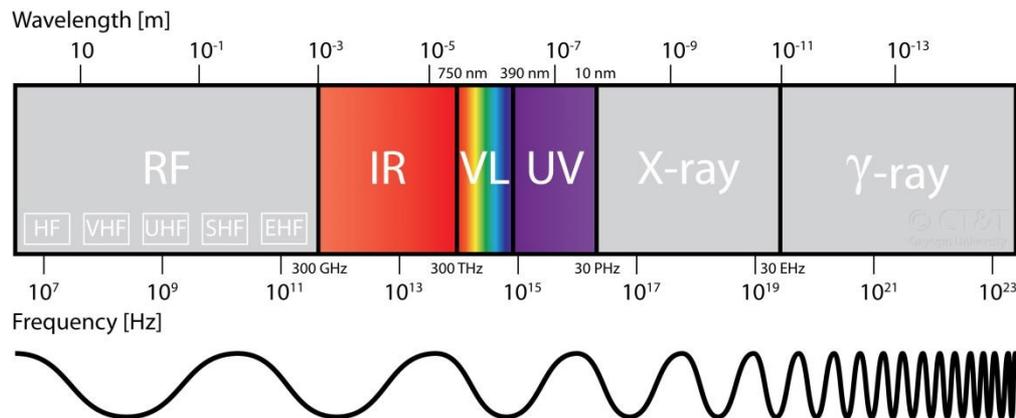
▶ The only thing to do next is to switch to using light or optical frequency bands that will carry us to much, much higher frequency.

▶ At this point, we come across Communication with Visible Light, a communication structure in which Alexander Graham Bell laid the first foundations.

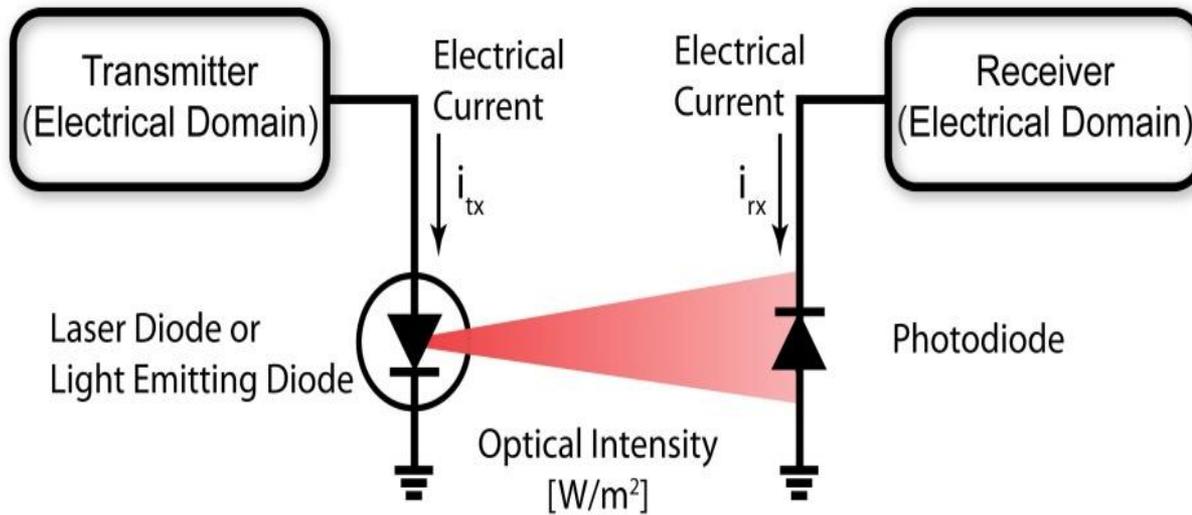
# Optical wireless Communications

- Optical wireless communications uses three frequency bands.

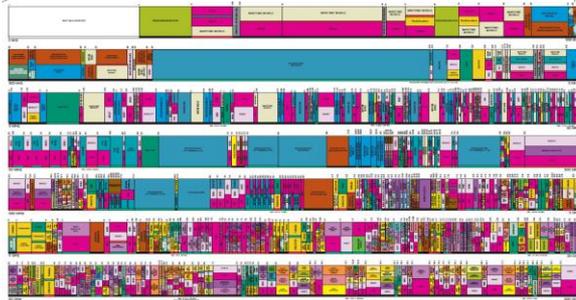
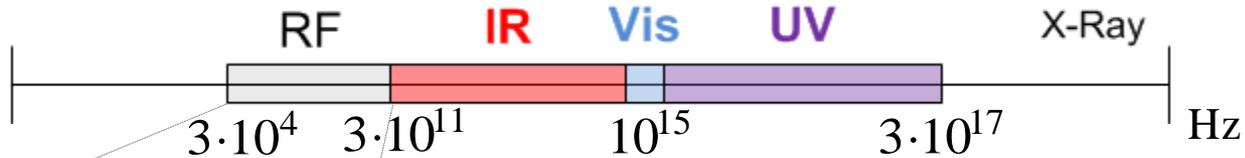
infrared (IR) :	[300 GHz-430]	THz
visible light) (VL) :	[430 THz-790]	THz
ultraviolet) (UV):	[790 THz- 30]	PHz



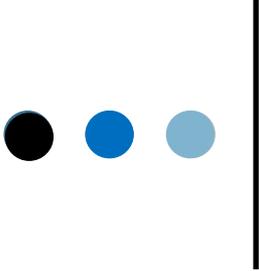
# Optical wireless Communications



# Advantages of Visible Light Communications



- 1) It has an information transmission capacity 1000 times larger than RF
- 2) Since the use of the Visible Light frequency band is not restricted by certain laws, it can be freely used by anyone.
- 3) Since the information is transmitted to the other side by a very narrow and thin beam of light, it is much easier to protect and secure the information.
- 4) The advantage of being used in hospitals, aircraft, industrial areas where radio waves are dangerous

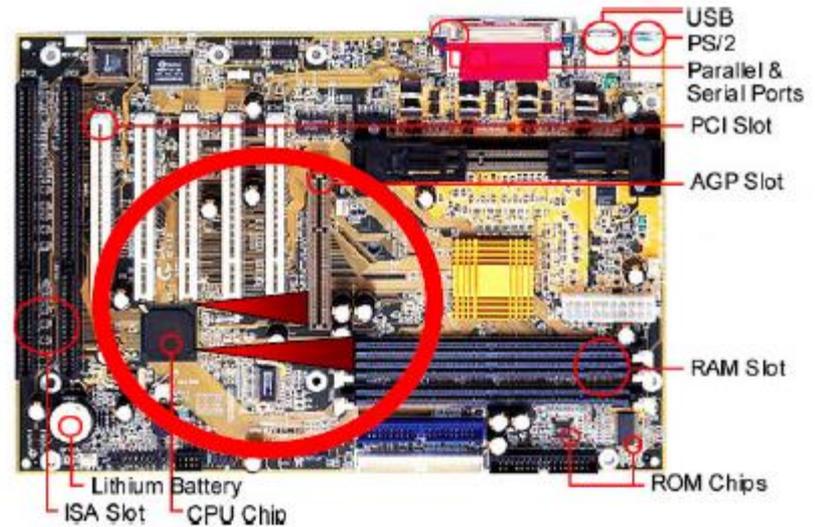
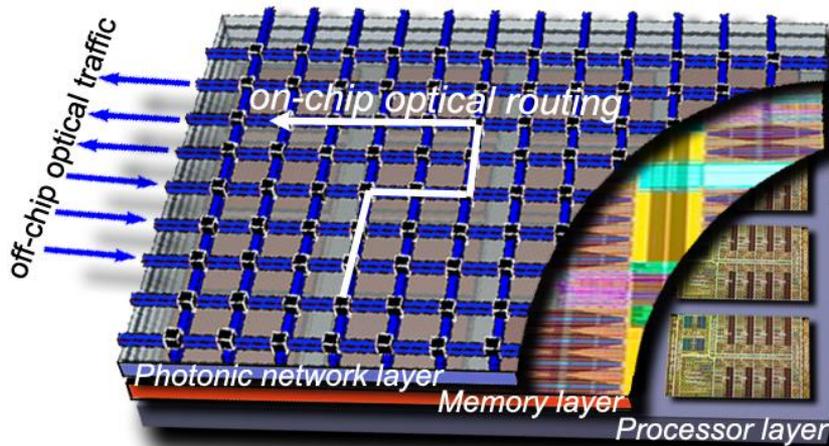


## Applications of visible light communications

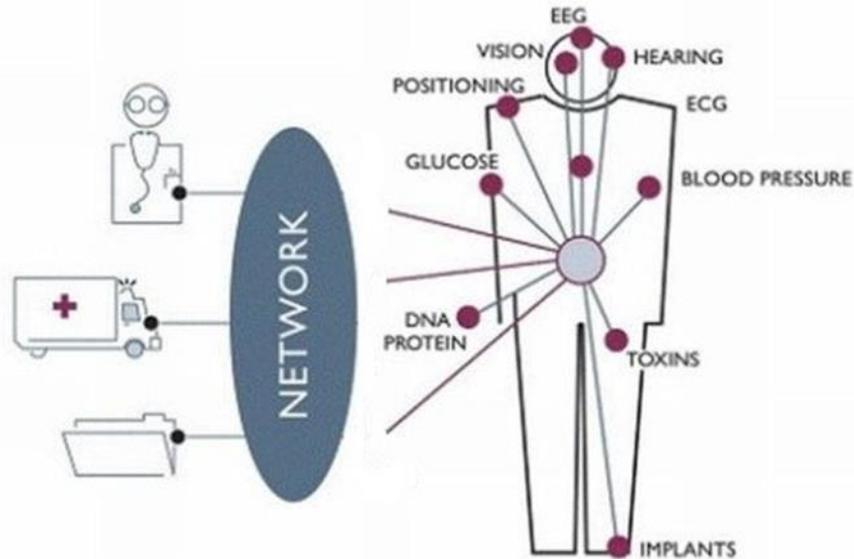
- In visible light communications, applications are classified according to their communication distance:

# Very Short Length Applications

- High speed interchip communications
- Chip-to-chip communications

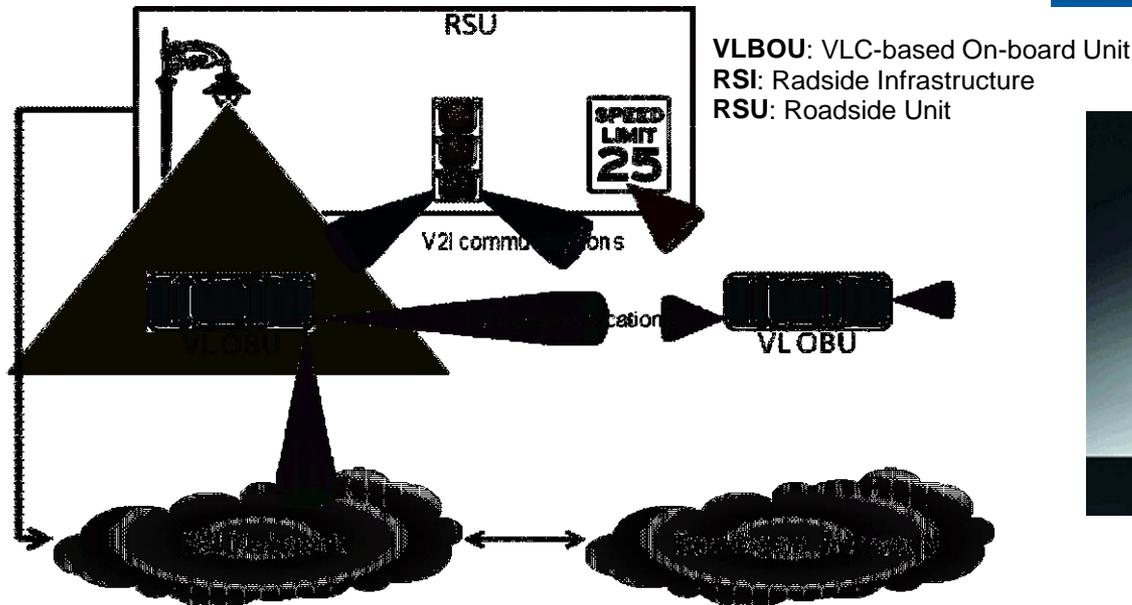


# Short Length Applications



# Medium Length Applications

- Using the headlights of vehicles
- communication between vehicles
- Communication with vehicles, traffic lights and street lights



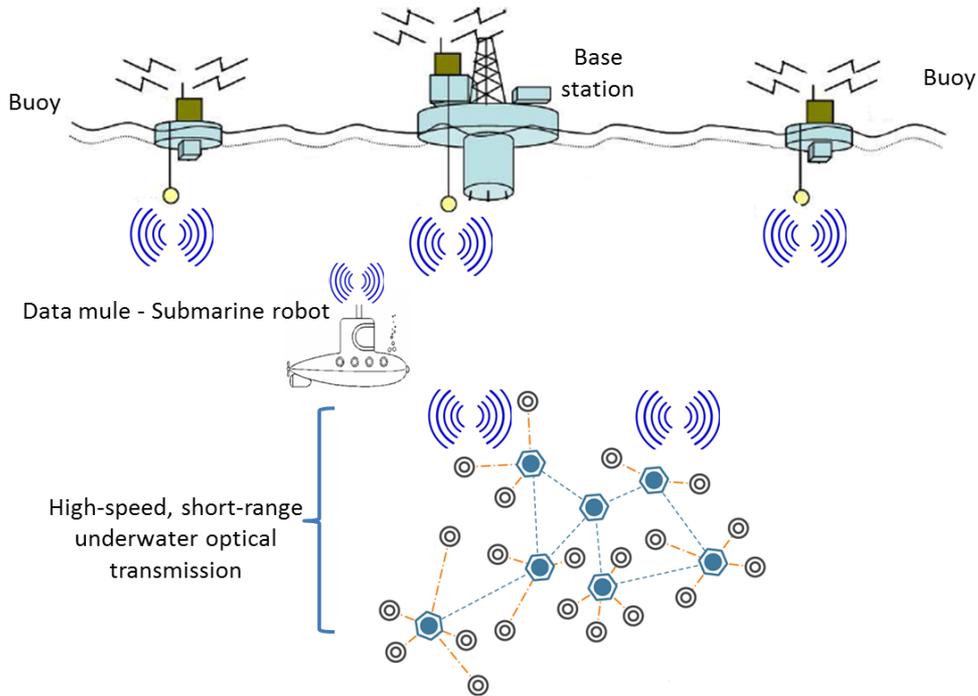
# Medium Length Applications

## ○ Underwater communications

⦿ Acoustic Links

⦿ Hybrid acoustic/optic cluster head

⦿ Underwater optical sensor node



# Long Length Applications

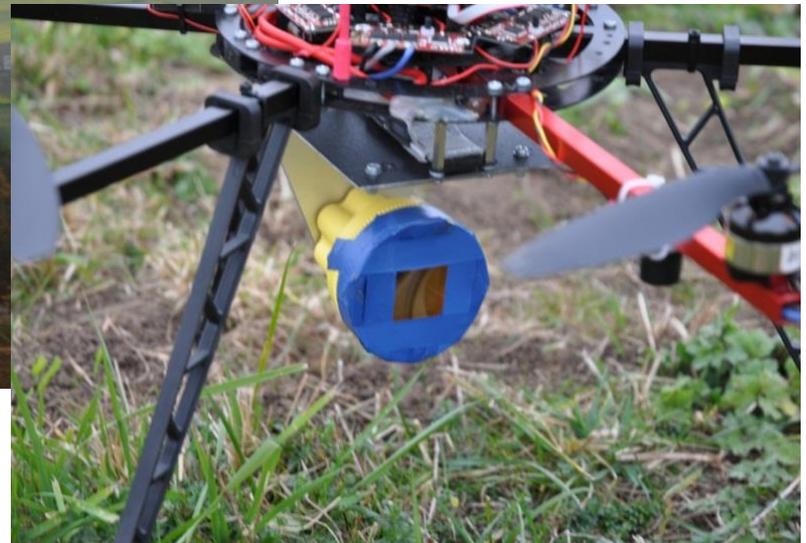
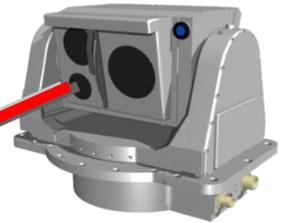
Communications between buildings



# Long Length Applications

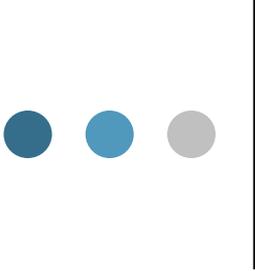


Ground station  
@ 4 km



© CASSIDIAN

Corner Cube reflector  
2 cm diameter



## Conclusions

- We now understand that, after Alexander Graham Bell invented the phone, we have witnessed incredible developments in electrical communication technologies as well in optical communications provided by the light.
- Especially, visible light communications and related technologies will be a part of our life as a new and large branch of industry.
- In addition, there will be much need for the trained manpower to work on these issues.

