

The Role of Electromagnetic Radiation in Information Communications



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Introduction

This poster outlines a variety of technologies which use waves as a means to transfer information. These are both waves in the conventional sense of electromagnetic radiation, as well as the particle/wave duality sense of neutrinos.

Adaptive Frequency Hopping

What Is Frequency Hopping? Adaptive Frequency Hopping (AFH) is a technique where rather than using a single radiofrequency to transfer data, the frequency is constantly changing between a number of channels. This allows for faster transfer speeds and makes it harder for intruders to interfere with the signal.

Why Is It Adaptive? The transmitting device monitors different channels to estimate their quality. If one frequency is busy or being jammed, it will simply switch channels.

Neutrino Messaging

History A hypothetical form of communication that is currently undergoing research. The presence and absence of neutrino pulses are represented as 1 and 0 respectively to encode messages. This was experimentally verified in 2012.

Advantages

- Neutrinos are affected only by the weak force and gravity; they can pass messages through virtually anything.
- Can send information across vast expanses in space
- A present-day application is sending messages to nuclear submarines, as seawater can obstruct electromagnetic radiation.

Disadvantages

- The uninteractive nature of neutrinos results in difficult detection
- Neutrinos oscillate between 3 flavours - electron, muon, and tau (can be thought of as switching between waves of different frequencies as it travels), which can be a problem for detection.

Conclusion

These technologies have changed the world, allowing us to be interconnected to a much greater extent than any time before. Many people's livelihoods, and some of the largest industries on the planet, revolve around wave-based communication. In the future, neutrino messaging may solve electromagnetic radiation-based communication's range and interference issues.

References

idk if we need this

- [1] Christopher C Davis. Fiber optic technology and its role in the information revolution. *Retrieved June, 5:2014, 2013.*
- [2] R Paschotta. article on 'Rayleigh Scattering'. *RP Photonics Encyclopedia*. Retrieved on November 8, 2019.

Wi-Fi

Principles Wi-Fi is defined as any "wireless local area network (WLAN) products that are based on the IEEE 802.11 standards." It is usually a wave of frequency between 2.4GHz to 5GHz. **Uses** Networks are created through Wi-Fi where multiple devices can connect to one source of Wi-Fi and thus access the internet as well as communicate with other devices connected to the network.

Advantages

- Users are connected even when moving around
- Wireless networks can serve a suddenly increased number of clients with the existing equipment

Disadvantages

- The typical range of a 802.11g network is on the order of tens of meters
- Wireless networking signals are subject to a wide variety of interference, as well as complex propagation effects
- The speed on most wireless networks (typically 1-54 Mbps) is far slower than even the slowest common wired networks

Optical Fibres

Introduction Optical fibres utilise total internal reflection to confine light rays within its core. Modern fibre technologies are limited by physical phenomena of light travelling in an optical medium.

Residual Absorption Fundamental vibration frequencies of the particles that make up the glass absorb light with matching frequencies.

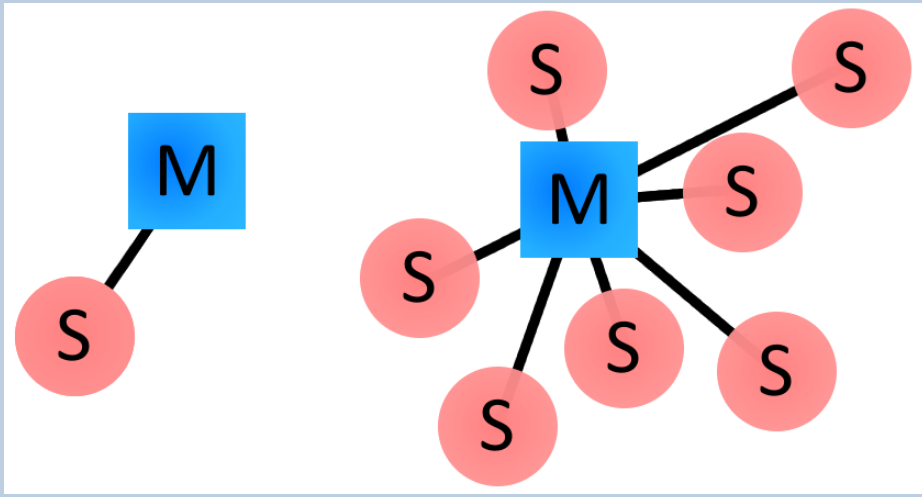
Dispersion Dispersion is an optical phenomenon where light of different frequencies travel at different velocities through an optical medium. In optical communications, data is coded in binary form and transmitted as pulses of light. As a laser pulse emits more than a single frequency of light, it is critical that the gap in time at the receiving end is not greater than the time period of the wave group, otherwise the original data would be lost.

Rayleigh Scattering An atom or molecule reradiates incident light in any direction except the incident direction. This effect is magnified at shorter wavelengths, and is increased by imperfections in the composition of the silica glass on a molecular level.

Bluetooth

History Bluetooth was developed by the Swedish telephone company Ericsson AB in 1990

Master/Slave Topology Bluetooth follows a master/slave topology where there is a master device broadcasting data to a maximum of seven slave devices. This network of 8 devices is known as a piconet. The master will always default to being the device which initialised the connection, however master and slave roles can be exchanged given that both devices agree upon this.



AFH Bluetooth uses a technique known as AFH, which is explained on the left side of this poster.

Li-Fi

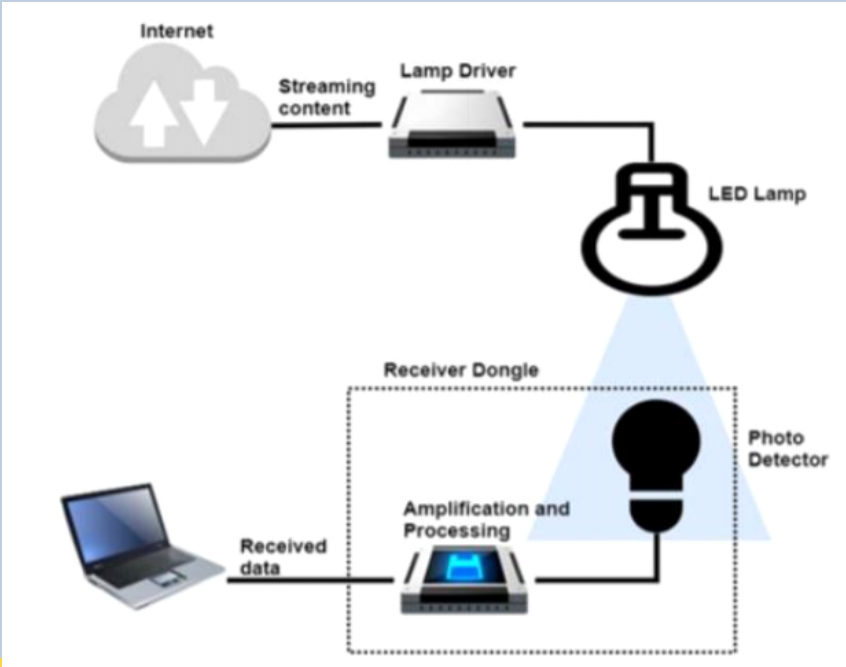
Principle A light emitter, a photo detector; Modulate light intensity faster than eyes can follow; Receiver dongle converts changes electrical signals; Signals converted back into a data stream and transferred to a mobile device.

Advantages

- Bandwidth of the visible spectrum is 10,000 times more than that of the radio spectrum
- Implementation and maintenance costs are minimal compared to Wi-Fi
- Elimination of health problems
- Enabling of the Internet of Things on a large scale

Disadvantages

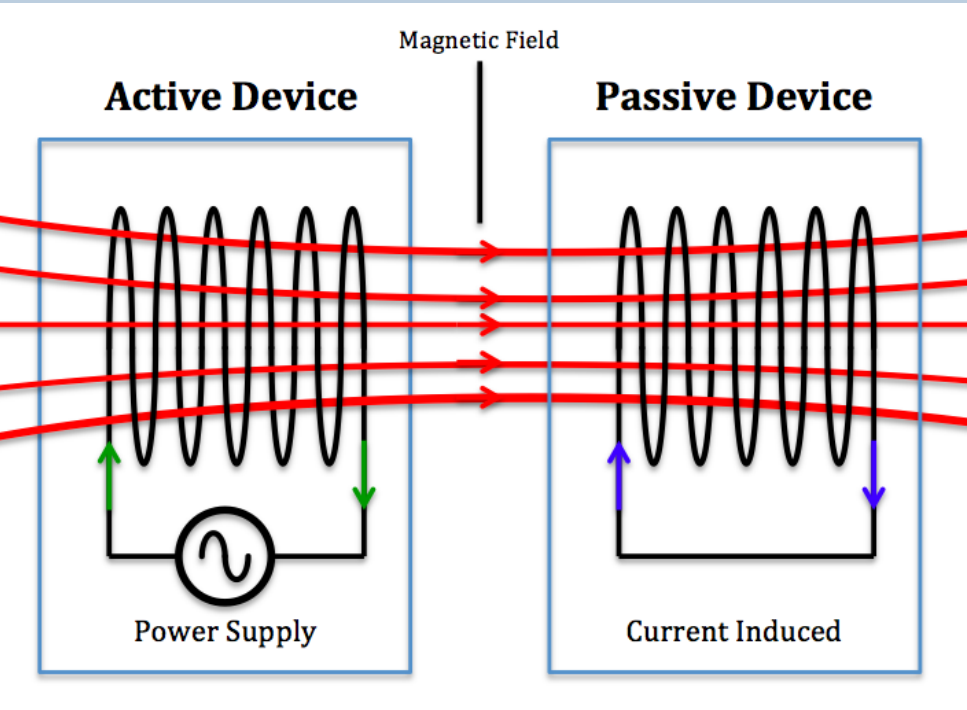
- Light can't pass through objects
- Interference from other light sources can cause interruption in communication
- Communication is limited to point-to-point transfer when implemented at very high frequencies.



Near Field Communication

How It Works Near Field Communication (NFC) works off of small chips enabling data transfer between devices, of which there are active and passive ones. Active NFC devices are powered by an external source, and are able to both send and receive data. Passive devices can only send data, but do not require a power source of any kind. In close proximity with one another, the electromagnetic field of the active device will induce a small current in the passive one.

«««< **HEAD Stats** Max Range = 20cm. Max Speed = 424kbit/s. Transmission Frequency =



13.56MHz =====

wStats

- Max Range = 20cm - Max Speed = 424kbit/s - Transmission Frequency = 13.56MHz »»»>
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Advantages

- Power Efficiency. The passive devices do not require a power source, only active ones do.
- Control. Since the range is small, users will mostly be aware and be able to determine when exactly information transfer occurs.
- Convenience. NFC does not require any prior setup or pairing to be able to transfer data. Detection of nearby NFC devices is automatic, and the data transfer is initiated by the user.