

The Role of Electromagnetic Radiation in Information Communications



Chris Wang, Eddy Tang, Ajan Manoharan, Lasse Lundberg, Alex Tiu, Kevin Teo
The League of Eurasians || Blackett Laboratory, Imperial College London

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

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

Advantages Unlike traditional forms of communication which rely on electromagnetic radiation, neutrinos are affected only by the weak force and gravity; they can pass messages through virtually anything. This can be utilised to transmit information across vast expanses in space, or for a more present-day application, to send messages to nuclear submarines, as seawater can obstruct electromagnetic radiation.

Disadvantages The uninteractive nature of neutrinos causes them to be difficult to detect. Neutrinos also oscillate between 3 flavours - electron, muon, and tau. This can be represented by a neutrino switching between waves of different frequencies as it travels through space, 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

[1] Christopher C Davis. Fiber optic technology and its role in the information revolution. *Retrieved June, 5:2014*, 2013.

[2] S Smiley. NFC facts and applications that will broaden your mind. *RFID Insider*, 2015. Retrieved on November 8, 2019.

[3] DD Stancil, P Adamson, M Alania, L Aliaga, M Andrews, C Araujo Del Castillo, L Bagby, JL Bazo Alba, A Bodek, D Boehnlein, et al. Demonstration of communication using neutrinos. *Modern Physics Letters A*, 27(12):1250077, 2012.

Wi-Fi

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. 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**
- Remote access for convenience
 - Can support multiple simultaneous connections
 - Uses AFH, as explained on the left side of this poster
- Disadvantages**
- Limited by router location
 - Subject to interference
 - Slow speed compared to wired connections

Optical Fibres

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 absorbs light of matching frequencies.

Dispersion An optical phenomenon that causes light of different wavelengths to travel at different velocities through an optical medium. This creates a disparity in the time of a single pulse of light at the receiving end, which can corrupt the transferred data

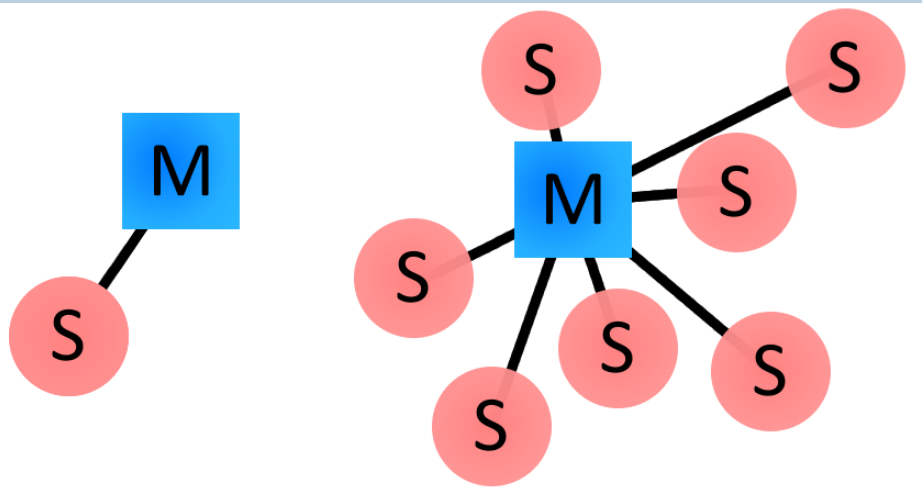
Rayleigh Scattering An atom or molecule reradiates incident light in any direction except the incident direction.

Bluetooth

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

Li-Fi involves the use of light emitters that modulate light intensity and a photo detector that receives the signal and converts it back into an electrical data stream.

Advantages

- High bandwidth compared to mobile signals
- Minimal maintenance and setup costs

Disadvantages

- Can be obstructed easily
- Prone to interference from other light sources
- Limited to point-to-point transfer at very high frequencies.

Near Field Communication

Near Field Communication (NFC) uses small chips to enable data transfer between active and passive devices. Active devices are powered externally and can both send and receive data. Passive devices do not require a power source and can only send data. In close proximity, active devices will induce small currents in passive ones.

Stats

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

Advantages

- Power Efficiency
- Control and Security
- Convenience

Disadvantages

- Low transfer speed

