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Transformation of Electronic Communication System into Optical Communication System

Nur Wahyu Indah Yani*[1], Winda Pratiwi[1], Reikeisya Dwi Arimbi Putri Nabira[1], Dea Eliza Desri[1]

[1] *Physics Education, Faculty of Teacher Training and Education, University of Riau*

*Corresponding author's email: nur.wahyu1149@student.unri.ac.id

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ABSTRACT

Transformation is a word in Indonesian that means "change" or "transition". This word refers to the process of going from one form to another. Transformation is the process of significant change or alteration in a system, organization, or entity from one state or condition to another. It involves the adoption of new technologies, new methods, or new paradigms that fundamentally change the way things operate or function. Transformation can occur in a variety of contexts, including technology, business, culture, social, and environmental. The goals of transformation can vary, such as increasing efficiency, improving quality, adapting to change, or achieving certain goals. In the rapidly evolving world of technology, the transition from electronic communication systems to optical communication systems is a significant milestone. Because optical communication systems have several advantages that electronic communication systems do not have, such as high data transfer speeds, larger bandwidth capacities of 60 Tbps or more, and more stable network use because optical fibers do not carry electricity that may not be signal interference. The use of infrared light as an information transfer medium is the main reason why fiber optics can transfer data quickly. The glass fiber core on the optical fiber can carry information as fast as 69% of the speed of light.

Keywords : *Transformation, Communication, Technology, Electronic Communication, Optical Communication*

1 Introduction

Communication is a very fundamental activity in human life, it has existed since the beginning of human existence on earth(AM Sari, R Hartina, R Awalia, H Irianti, 2018). Communication can also be interpreted as conversations, notifications, exchange of thoughts or relationships. Communication in terms of delivery is divided into several forms, namely verbal, written communication and also electronic communication(Tri Indah Kusumawati, 2016)(Irawan, Ramadhan, & Azhar, 2022).

As human civilization develops, communication methods and technologies also progress(Harry Dhika, 2020). Starting from Morse code that transmits electrical signals with meaning from one location to another far away, to the development of wired telephones, and today, wireless cellular communications.

In the rapidly evolving world of technology, the transition from electronic communication systems to optical communication systems is a significant milestone. This transformation has great potential to revolutionize the exchange of information and enable faster and more efficient communication networks(Hasanah, 2012).

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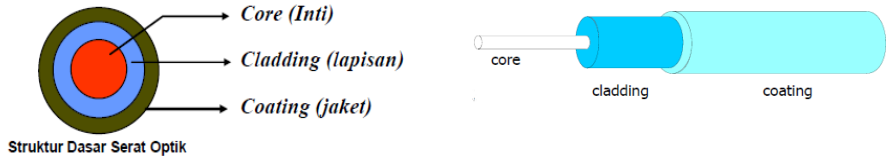
Understanding the differences between electronic and optical communication systems is essential for understanding the transformation from one communication system to another. Electronic communication systems are a type of communication that uses electronic signals to send and receive data, such as on cell phones, radios, and televisions(Aksenta, A., Irmawati, I., Ridwan, A., A., Hayati, N., Sepriano, S., Herlinah, H., ... &ginting, 2023). On the other hand, optical communication systems use light waves to send and receive data and are widely used in telecommunications, internet networks, and other high-speed data transmission applications(Iswan Umaternate, M Zen Saifuddin, Hidayat Saman, 2016)(Rizkananda M.I, Nur Sulistyawati., S.T., 2016).

Successful communication if it can accommodate a lot of information in one transmitter per second and also the signal distance so that the signal can be received. One of the solutions offered is optical fiber as a communication medium, because it has advantages over other media(Haryadi, 2018)(Irawan, Azhar, & Ramadhan, 2022). This is a new breakthrough in communication technology. How to transform an electronic communication system into an optical communication system? This article presents the whole story about the transformation of electronic communication systems into optical communication systems(Irawan, Ramadhan, Saktioto, & Marwin, 2022).

2 Research Methodology

In optical communication systems, what is called optical fiber or also known as optical fiber is used. Fiber optics (*Fiber optic*) is a medium that can convey information using light waves.(Sugeng Purbawanto, 2020). There are several components of a fiber optic communication system, namely:

1. Source Sender
   The sender source is a component contained in a fiber optic communication system that converts electrical signals into light signals.
2. Receiver Detector
   Photodetectors in optical communication systems function as receivers. A *photodetector* does the opposite of what the sender does, i.e. the optical source.
3. Automatic Optical Connector
   Optical connectors that act as fiber optic cables have a function as fiber connectors. This connector is needed when the fiber is removed when replacing *the transmitter* or *receiver* or for maintenance activities.
4. Fiber Optic Cable
   The constituent structure of optical fiber consists of core, cladding and coating.



(a) (b)

Figure 2.1 Fiber optic part structure

The basic concept used in its manufacture is the ordinary law of optics, and there are also other theories.

2.1 Optical Theory

There are three types of light characteristics, namely:

- Light in a medium is propagated straight forward.
- Light can be thought of as an electromagnetic transport of energy that acts like a wave.
- Light is made up of energy packets called photons

2.1.1 Light in a medium operates straight forward

The direction of light can be changed by using glass. The light that comes is reflected by the glass. This property is the second law of optics:

- The magnitude of the angle of occurrence is equal to the angle of reflection

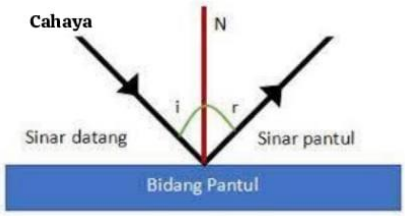


Figure 2.2 Reflection of Light on a Mirror(Evy Aldiyah, 2023)

Inside the medium, the speed of light is not constant but depends on the substance of the medium. The refractive index of the medium can determine the factor ratio of the speed of light in the medium.

2.1.2 Snelius' Law

Snellius' Law was formulated by W. Snellius, namely:

The beam from the angle coming in divided by the angle of refraction is constant

$$n(i).\sin(i)=n(r).\sin(r) \quad (2.1)$$

The light coming from a less dense medium to a tighter medium, then the light is deflected closer to the normal line(Elsa Nadhifa Putri, Masri'ah, Syahditawisma Kunti Wulan Meysi, Muhammad Irham Maula, 2023)(Murniati, 2023). This means that some of the light that comes on a medium is reflected, not only refracted. By adding the angle of incidence it is possible that the light beam can be reflected totally, which is called *total internal reflection*. It is common for fiber optic light transportation(Ananto, Bayu and Darjat, Darjat and Setiyono, 2011)(Irawan, Ramadhan, Saktioto, Fitmawati, Widiyatmoko, et al., 2022).

According to Snellius' law, light in a transparent medium uses a waveguide for its propagation. The waveguide consists of a core (*Core*) and also blankets (*cladding*).(Naufal Hafizh Santoso, 2022)

2.1.3 Light as an electromagnetic transport of energy that propagates like waves

Natural light (natural light) has no color, but when the prism is passed by white light, it will be decomposed into different colors, namely red, orange, blue, green, yellow, indigo and purple.(Ananto, Bayu and Darjat, Darjat and Setiyono, 2011)

2.1.4 Image formats

Photons are the constituent energy of light. Photons are transformed in a packet or energy packet whose color is determined. The wavelength will determine the color of the wave. So it can be concluded that there is a strong relationship between light waves and photons.(Ananto, Bayu and Darjat, Darjat and Setiyono, 2011)

3 Results and Discussion

The transformation of electronic communication systems into optical communication systems is a significant change in modern communication infrastructure(Gushevinalti Gushevinalti, Panji Suminar, 2020)(H Haqqi, 2019). With the adoption of optical technology, the use of electrical signals is replaced by light, specifically laser light, to transmit information(Z Lubis, 2001)(Irawan, Ramadhan, Saktioto, Fitmawati,

Hanto, et al., 2022). This transformation process involves research and development of new technologies, the development of optical components such as lasers and optical fibers, efficient optical network design, and the construction of supporting physical infrastructure(Naulia Syllabus, 2023). Integration with existing electronic systems, user training, improved data security, and regular maintenance are also important parts of this process. This transformation aims to improve the speed, capacity, and reliability of communication networks, opening up new opportunities in various fields including telecommunications, computing, and sensors. With the right steps, this transformation can provide significant benefits to the organization and society as a whole.

The transformation from electronic communication systems to optical communication systems is a complex process that involves several steps, including assessing existing systems, planning implementation, and considering their impact on existing infrastructure. According to a study conducted by the Optical Society of America, careful planning and execution are necessary to ensure smooth and successful implementation. It can be seen in Figure 3.1 the flow of transformation between electronic communication systems to optical communication systems.

Figure 3.1 The transformation flow of an electronic communication system into an optical communication system.

Based on Figure 3.1 the process begins with the research and development of new technologies to support optical communication systems. This includes the development of the necessary hardware, software, and optical components. Critical components such as lasers, optical fibers, and light detectors are developed and refined for use in optical communication systems. The team designs optical communication networks, including fiber optic transmission route planning, repeater or signal amplifier placement, and power management strategies.

The transformation process involves the construction of physical infrastructure to distribute fiber optics to desired locations. This can include laying fiber optic cables on the streets, underground, or in the ocean(Nur Ihsani Fitria D, Nurisnaini Putri, 2022). Optical communication systems must be integrated with

existing electronic systems. This entails the development of compatible interfaces and communication protocols between optical systems and electronic systems.

After implementation, the system requires regular maintenance and management to ensure optimal performance. This includes network monitoring, fault detection and remediation, and infrastructure upgrades as needed. Operators and end-users are trained to use optical communication systems effectively. Possible adjustments in operations and procedures are also taken into account. The security of the system is enhanced to protect the data transmitted through this optical medium. This includes the development of strong encryption technologies and effective data protection strategies.

Through this flow, electronic communication systems can gradually and efficiently transform into optical communication systems, opening up new opportunities in terms of communication speed, capacity, and reliability.

After the transformation occurs, of course, it provides changes to the existing communication system, to find out whether the transformation that takes place provides convenience from the previous system, we need to look at the difference between the electronic communication system and the optical communication system. This has been described in table 3.1

Table 3.1 Differences between Electronic Communication Systems and Optical Communication Systems(Iswan Umaternate, M Zen Saifuddin, Hidayat Saman, 2016)

Difference	Electronic Communication System	Optical Communication System
Transmission Media	‣ Copper cable: Used to transmit electrical signals. ‣ Coaxial cable: Has additional insulation to reduce electromagnetic interference. ‣ Twisted pair cables: Uses two wires braided together to reduce the signal.	Fiber optics: Made of a thin glass core surrounded by a protective layer. Optical signals are transmitted through the core in the form of pulses of light.
Signal Form	Voltage or Current	Electromagnetic Waves (Light)
Speed and Capacity	Limited, but can be high with the latest technology	Higher with greater capacity
Bandwidth	‣ Limited, generally in the Mbps (megabits per second) range. ‣ It cannot support data-intensive applications such as video streaming and cloud computing.	Very high, it can reach Gbps (gigabits per second) or even Tbps (terabits per second). Support data-intensive applications with ease.
Latency	The higher the signal, the longer it takes to move from one point to another. It can cause noticeable delays in real-time applications such as video conferencing and online gaming.	Low, the signal takes less time to move from one point to another. Provides a more responsive real-time experience.
Impaired immunity	Low, easily affected by EMI and RFI. The signal can be distorted or lost, causing data errors.	High, resistant to EMI and RFI. The signal remains stable and reliable, minimizing data errors.
Security	Susceptible to eavesdropping, signals can be intercepted and intercepted easily.	More securely, light pulses are difficult to tap and intercept without being detected.

	Higher security risks for sensitive information.	Improve data security and protect sensitive information.
Transmission Distance	Short, generally several kilometers. Requires a repeater to amplify the signal over longer distances.	Away, it can reach hundreds of kilometers without a repeater. Reduce infrastructure costs and network complexity.
Cost	Relatively cheap, the installation and maintenance cost of copper cables is affordable.	It is expensive, the installation and maintenance cost of fiber optics is higher.
Application	Telephone, radio, television, local computer network (LAN).	High-speed internet, cloud computing, long-distance networking, telecommunications backhaul.

Based on Table 3.1, we can see that optical communication systems have several advantages that electronic communication systems do not have. However, it does not mean that the optical communication system can be said to be perfect because some aspects are still constrained in its implementation, for example, the cost is more expensive than electronics.

4 Conclusion

The switch from electronic communication systems to optical communication systems is a significant advancement that offers many benefits(Melinda, Syahrial, 2022). As we have discussed, electronic communication systems have evolved over time, but now they face limitations that can be overcome with the superior capabilities of optical communication systems. The benefits of optical communication systems include higher rates of data transfer rates, greater bandwidth capacity, and more efficient use of energy(Iswan Umaternate, M Zen Saifuddin, Hidayat Saman, 2016). In addition, the main components of optical communication systems, such as lasers, fiber optics, and photodetectors, contribute to their high performance and reliability.(Written by Akhmad Hambali, 2017)

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