JoFRISE 3 (1) (2025)
Journal of Frontier Research in Science and Engineering
Publisher :
Andester Riau Edutech
Pusat Inovasi Pendidikan dan Teknologi
ISSN : 3032-0348

Transformation Of Electronic Communication Systems Into Optical Communication Systems

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Submitted: 10/02/2025
Accepted: 20/03/2025
Published: 26/03/2025
Vol. 3
No. 1

Abstract- Transformasi is an Indonesian word that means "change" or "transition". This word refers to the process of switching 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 state or condition. It involves the adoption of new technology, new methods, or new paradigms that fundamentally change the way something operates or functions. Transformation can occur in a variety of contexts, including technological, business, cultural, social, and environmental. The goals of transformation can be various, such as increasing efficiency, improving quality, adapting to change, or achieving certain goals. In the world of rapidly developing 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, greater bandwidth capacity reaching 60 Tbps or more, and more stable network use because optical fiber does not carry electrical currents, meaning there is no possibility of signal interference. The use of infrared light as an information transfer medium is the main reason why optical fiber can transfer data quickly. The glass fiber core in optical fiber can carry information as fast as 69% 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 (AC Sari, R Hartina, R Awalia, H Irianti, 2018). Communication can also be interpreted as conversation, notification, exchange of ideas or relationships. Communication in terms of delivery is divided into several forms, namely oral, written and electronic communication (Tri Indah Kusumawati, 2016).

As human civilization develops, communication methods and technology also progress (Harry Dhika, 2020). Starting from Morse code which sends electrical signals with meaning from one distant location to another, to the development of wired telephones, and currently, wireless cellular communications.

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

Understanding the differences between electronic and optical communications systems is critical to understanding the transformation from one system to another. An electronic communication system is a type of communication that uses electronic signals to send and receive data, such as in cell phones, radio and television (Aksenta, A., Irmawati, I., Ridwan, A., Hayati, N., Sepriano, S., Herlinah, H., ... & Ginting,

How to Cite :
Winda Pratiwi. *et al* (2025). Transformation Of Electronic Communication Systems Into Optical Communication Systems. *Journal of Frontier Research in Science and Engineering(JoFRISE)*, 3(1), 1-6.

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). Communication is successful if it can accommodate a lot of information in one sender per second and also the signal distance so that the signal can be received. One of the solutions offered is fiber optics as a communication medium, because it has advantages over other media (Haryadi, 2018). This is a new breakthrough in communications technology. How is the transformation of an electronic communication system into an optical communication system?. This article explains the entire transformation of an electronic communication system into an optical communication system.

2 Research Methodology

In optical communication systems, what is called optical fiber or also known as optical fiber is used. Fiber optics 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. Sender Source
   The sending source is a component in a fiber optic communication system that converts electrical signals into light signals.
2. Receiver Detector
   The photodetector in an optical communication system functions as a receiver. A photodetector does the opposite of what the sending part does, namely the optical source.
3. Fiber Optic Connector
   Optical connectors which act as fiber optic cables have the function of connecting fibers. This connector is needed when the fiber is removed when replacing the transmitter or receiver or for maintenance activities.
4. Fiber Optic Cable
   The structure of optical fiber consists of core, cladding and coating.

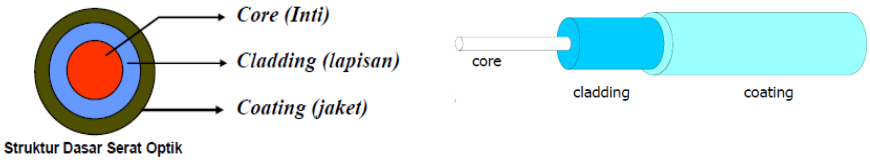

Figure 1: fiber optic section structure

The basic concept used in making it is the laws of ordinary optics, and there are also other theories.

2.1 Optical Theory

There are three kinds of light characteristics, namely:

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

2.1.1 Light in a medium operates straight forward

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

- The angle of incidence is the same as the angle of reflection

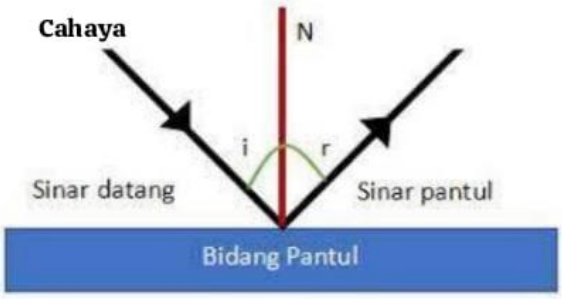

Figure 2: Reflection of Light in a Mirror (Evy Aldiyah, 2023)

In a 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 ratio factor of the speed of light in the medium

- Snell's Law

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

  The ray's angle of incidence divided by the angle of refraction is constant

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

Light that comes from a less dense medium to a denser medium, then the light is bent 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 into a medium is reflected, not just refracted. By adding the angle of incidence, it is possible for the light beam to be totally reflected, which is called total internal reflection. This usually happens for fiber optic light transport (Ananto, Bayu and Darjat, Darjat and Setiyono, 2011).

Based on Snell's law, light in a transparent medium uses waveguides for propagation. The waveguide consists of a core and cladding. (Naufal Hafizh Santoso, 2022).

2.1.2 Light can be thought of as an electromagnetic transport of energy that acts like a wave

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

2.1.3 Light consists of packets of energy called photons

Photons are the energy that makes up light. Photons are converted into particles or packages of energy whose color is determined. The wavelength will determine the color of the wave. So it can be concluded that there is a strong connection 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 communications infrastructure (Gushevinalti Gushevinalti, Panji Suminar, 2020)(H Haqqi, 2019). With the adoption of optical technology, the use of electrical signals was replaced by light, especially laser light, to transmit information (Z Lubis, 2001). This transformation process involves research and development of new technology, development of optical components such as lasers and optical fibers, efficient optical network design, as well as the construction of supporting physical infrastructure (Naulia Silalahi, 2023). Integration with existing electronic systems, user training, increased data security, and routine maintenance are also important parts of this process. This transformation aims to increase the speed, capacity and reliability of communications networks, opening up new opportunities

in areas including telecommunications, computing and sensory. With the right steps, this transformation can provide significant benefits to organizations and society as a whole.

The transformation from an electronic communications system to an optical communications system is a complex process that involves several steps, including assessing the current system, planning implementation, and considering the impact on existing infrastructure. According to a study conducted by the Optical Society of America, careful planning and execution are necessary to ensure a smooth and successful implementation. It can be seen in Figure 3 the flow of transformation between an electronic communication system into an optical communication system.

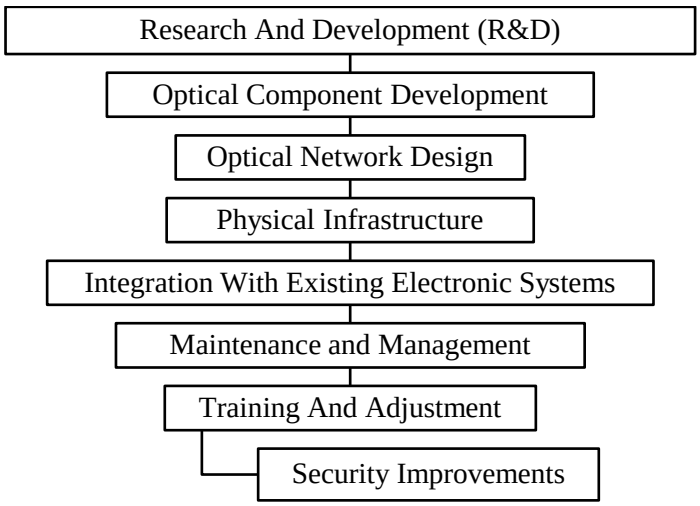

Figure 3: The flow of transformation of an electronic communication system into an optical communication system.

Based on Figure 3.1, the process begins with research and development of new technology to support optical communication systems. This includes development of the necessary hardware, software, and optical components. Important components such as lasers, optical fibers, and light detectors were developed and refined so they could be used in optical communications systems. The team designs optical communications networks, including planning fiber optic transmission routes, placement of repeaters or signal boosters, and power management strategies.

The transformation process involves building physical infrastructure to distribute optical fiber to the desired locations. This could include installing fiber optic cables on roads, underground, or in the ocean (Nur Ihsani Fitria D, Nurisnaini Putri, 2022). Optical communication systems must be integrated with existing electronic systems. This requires 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, intrusion detection and remediation, and infrastructure upgrades as needed. Operators and end users are provided with training to use optical communications systems effectively. Possible adjustments in operations and procedures are also taken into account. System security is enhanced to protect data transmitted via this optical medium. This includes the development of strong encryption technology and effective data protection strategies.

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

After the transformation, of course, there are changes to the existing communication system. To find out whether the transformation that is taking place provides convenience compared to the previous system, we

need to look at the differences between electronic communication systems and optical communication systems. This has been explained in table 1.

Table 1. Difference between Electronic Communication Systems and Optical Communication Systems (Iswan Umaternate, M Zen Saifuddin, Hidayat Saman, 2016)

Difference	Electronic Communication Systems	Optical Communication Systems
Transmission Media	➢ Copper cable: Used to transmit electrical signals. ➢ Coaxial cable: Has additional insulation to reduce electromagnetic interference. ➢ Twisted pair cable: Uses two wires twisted together to reduce the signal.	➢ Optical fiber: Made of a thin glass core surrounded by a protective layer. ➢ Optical signals are transmitted through the core in the form of light pulses.
Signal Form	Voltage or Electric Current	Electromagnetic Waves (Light)
Speed and Capacity	Limited, but can be high with the latest technology	Higher with larger capacity
Bandwidth	➢ Limited, generally in the Mbps (megabits per second) range. ➢ 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	➢ High, the signal takes longer to move from one point to another. ➢ May 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. ➢ Delivering a more responsive real-time experience.
Immunity Disorders	➢ Low, easily affected by EMI and RFI. ➢ Signals may be distorted or lost, causing data errors.	➢ High, resistant to EMI and RFI. ➢ The signal remains stable and reliable, minimizing data errors.
Security	➢ Vulnerable to eavesdropping, signals can be easily tapped and intercepted. ➢ Higher security risks for sensitive information.	➢ More secure, light pulses are difficult to tap and intercept without being detected. ➢ Improve data security and protect sensitive information.
Transmission Distance	➢ Short, generally a few kilometers. ➢ Requires a repeater to strengthen the signal over longer distances.	➢ Far, can reach hundreds of kilometers without a repeater. ➢ Reduce infrastructure costs and network complexity.
Cost	Relatively cheap, the cost of installing and maintaining copper cables is affordable.	Expensive, fiber optic installation and maintenance costs are higher.
Application	Telephone, radio, television, local area network (LAN).	High-speed internet, cloud computing, long-distance networks, telecommunications backhaul.

Based on Table 1, we can see that optical communication systems have several advantages that electronic communication systems do not have. However, this does not mean that optical communication systems can be said to be perfect because several aspects are still hampered by their implementation, for example the cost is more expensive than electronic ones.

The transition from electronic communication systems to optical communication systems is a significant progress that offers many benefits (Melinda, Syahrial, 2022). As we have discussed, electronic communications systems have evolved over time, but now face limitations that can be overcome with the superior capabilities of optical communications systems. The benefits of optical communication systems

include higher data transfer rates, greater bandwidth capacity, and more efficient energy use (Iswan Umaternate, M Zen Saifuddin, Hidayat Saman, 2016). In addition, the main components of optical communication systems, such as lasers, optical fibers and photodetectors, contribute to their high performance and reliability. (Winda Friandawa, Akhmad Hambali, 2017)

4 Conclusion

Each manuscript should contain a conclusion section in 250-450 words that may contain the main results of the work, highlighting its importance, limitations, relevance, application and recommendations. Conclusions should be written continuously with running sentences that usually include the main results of the research work, its application, limitations and recommendations. Do not use subheadings, quotations, references to other parts of the manuscript, or bulleted lists in the conclusion

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