

# Fiber Optic Network Installation and Data Monitoring at Hospitals

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**Abstract—** In the fast-changing field of healthcare technology, the adoption of sophisticated communication infrastructure becomes crucial. This abstract examines the importance of installing and monitoring fiber optic networks in hospital environments. The incorporation of fiber optic networks in hospitals not only caters to the increasing need for fast and dependable data transmission but also improves the overall efficiency and efficacy of medical services. Deploying a fiber optic network in a hospital requires establishing a strong and adaptable communication infrastructure that can handle the growing amount of data produced by medical equipment, electronic health records (EHRs), and other digital systems. Fiber optics, renowned for its wide bandwidth and minimal latency, offers a robust option to support the varied and data-intensive applications crucial for contemporary healthcare operations.

**Index Terms—** fiber optic, Network, network installation, network monitori

## I. INTRODUCTION

Hospitals are increasingly using fiber optic networks due to their numerous advantages over old copper cable networks. Fiber optic networks utilize fiber optic cables composed of either glass or plastic to carry data through the use of light pulses. These networks are renowned for their ample capacity, rapidity, and dependability, rendering them optimal for transmitting massive amounts of data and facilitating high-speed internet connections.

Fiber optic networks in a hospital campus context can offer rapid and dependable internet connectivity to patients, academics, and staff, enabling the utilization of online learning platforms, research resources, and communication tools. In addition, they have the capability to facilitate high-data-rate tasks such as video conferencing, streaming media, and cloud computing services.

One further benefit of fiber optic networks is their capacity to span extensive regions with minimum signal loss. Fiber optic cables have the capability to carry data over greater distances

compared to conventional copper cables. This makes them well-suited for connecting various facilities, such as buildings, labs, and other structures within a hospital campus.

The telecommunications sector in Iraq has experienced multiple stages of transformation. Over the past decade, the industry has experienced rapid exponential growth. Efficient implementation and management of the infrastructure are crucial for sustaining this growth. Fiber optics technology has become the dominant network infrastructure and communication medium due to its superior bandwidth capacity and high-speed capabilities. Fiber optics technology provides a flexible and scalable network infrastructure that can accommodate an unlimited amount of capacity as the demand for new technology and services increases. Despite significant and strategic expenditures in fiber optic infrastructure by mobile network providers, the number of network outages caused by frequent failures in fiber optics networks, such as fiber cable cutting, has increased. Fiber cable cuts have become the primary cause of transmission failure or disruption to telecommunications services in Iraq, significantly affecting the experience of subscribers. This study intends to analyze the technical, governmental, and administrative challenges associated with laying fiber optic cables at Hospital in Baghdad. It also aims to propose feasible ways to overcome these challenges. The challenges created by frequent fiber cutting can be attributed to external factors such as dig-ups during road construction. An important risk to fiber management is the lack of regulatory standards and processes for the implementation and control of fiber.

Fiber optic networks are extensively used in several industries and sectors, including telecommunications, internet connectivity, industrial automation, and medical equipment. Fiber optic networks are frequently employed in the telecommunications sector to deliver fast internet, television, and phone services to residential and commercial establishments. In addition, they are utilized in long-distance communication networks, such as undersea cables, to convey data over vast bodies of water and landmasses. Fiber optic networks are employed in data centers to establish connections between servers and storage devices, facilitating rapid data

transfer rates and minimal latency. Fiber optic networks are utilized in industrial automation applications, including manufacturing and process management, to establish dependable and secure communication between equipment and systems. Fiber optic networks are utilized in the medical field to send high-resolution images and data from inside the body through endoscopes and surgical equipment. This application enhances patient outcomes and minimizes the likelihood of complications. Fiber optic networks are utilized in military and defense applications to establish secure communication systems and surveillance equipment. In general, fiber optic networks are a flexible technology with numerous uses, offering fast, dependable, and protected communication and data transfer.

In summary, fiber optic networks are a highly advantageous investment for hospitals seeking to offer their patients, faculty, and staff speedy, dependable, and high-capacity internet connectivity.

## II. BACKGROUND

In the past, a sole physician managed various illnesses that patients experienced, however nowadays, patients receive treatment from multiple doctors and clinics. Consequently, a multitude of healthcare organizations must securely share clinical and medical information. Data is efficiently and dependably communicated throughout the different elements of the system, encompassing process optimization and networked knowledge support. Many large hospitals are currently implementing expensive and inefficient network design infrastructures. The term "design infrastructure" in this thesis shall specifically denote the framework for network design. The successful execution of hospital operations relies on the performance of the network, while the overall reliability and functioning of the system depend on the prioritization of resources. Improper allocation of resources leads to a decrease in performance. Consequently, the management and maintenance of these complex networks might incur a substantial overall expense. The cost will undoubtedly increase as more resources are allocated to maintaining complex and inefficient network systems. It is evident that 85% of the network is now being utilized. The network of Mid-Western Hospital Medical Centre is now functioning at a capacity of 60% and has a wide area network (WAN) speed of 6 megabits per second (Mbps). This research illustrates that hospital networks are plagued by problems associated with network inefficiencies and latency. Several prominent healthcare organizations are currently experiencing network performance issues. To ensure optimal application performance, it is necessary to refresh the circuit. Based on this use case, we may deduce that the performance and overall business operations will be put at risk. Prior to granting approval, the CIO and CFO of Mid-Western Hospital demanded cost-benefit evaluations and enhancements in network performance. Increasing the bandwidth leads to a drop in the total cost of ownership. By

doing rid of expensive bundled T1 lines for parasite clinic hubs, this division alone will save over \$150,000 per year. The parasite centers consist of 20 clinics that are primarily operational from 8 a.m. to 5 p.m. Moreover, the new design will substantially enhance bandwidth by 60% for the various clinics, in comparison to the previous design. It is essential for hospital facilities to have full redundancy at every level due to the cumulative nature of costs. The adoption of the new dual MAN design will lead to cost savings by replacing the expensive and slow bundled T1 lines.

## III. RESEARCH PURPOSE

The fiber optic network in hospitals is designed to offer a dependable, fast, and secure communication infrastructure to facilitate essential tasks and services within the healthcare facility. Fiber optic cables provide the capacity to carry data at exceptionally high velocities, facilitating rapid and effective transfer of substantial amounts of information. This renders them indispensable for real-time applications such as electronic health records, medical imaging, and telemedicine consultations. Their dependability and immunity to signal interference guarantee consistent connectivity, facilitating continued functioning of medical systems and communication channels. Furthermore, the extensive data transfer capacity of fiber optic networks effectively supports the growing requirements of digital medical records, telemedicine, video conferencing, and other applications that require large amounts of bandwidth. This results in greater patient care and improved collaboration among healthcare teams. Fiber optic networks are utilized in medical imaging and diagnostics to facilitate the swift transfer of sizable picture data, hence facilitating prompt diagnosis and treatment planning. In addition, these networks enable telemedicine services, remote consultations with professionals, and ensure the secure transmission of sensitive patient data, guaranteeing compliance with privacy requirements. By investing in fiber optic infrastructure, the hospital ensures that its communication needs are prepared for the future. This allows for the smooth integration of Internet of Things (IoT) devices and readiness for potential improvements in medical technology and communication requirements. In general, a fiber optic network has a vital role in enhancing healthcare services, optimizing patient care, and guaranteeing the security and efficiency of hospital operations.

The purpose of implementing fiber optic connectivity in hospitals is to establish a resilient and high-speed network infrastructure that facilitates diverse healthcare operations and services. The main aims and purposes of incorporating fiber optic technology in hospitals are:

1. Improved Patient Care: Fiber optic networks provide rapid and secure access to crucial patient information for healthcare providers. This enhances the coordination of care, enables precise diagnosis, and guarantees prompt treatment decisions, ultimately resulting in improved patient outcomes.

Fiber optic cables provide efficient communication by providing high-speed and dependable communication channels within hospitals, facilitating effective collaboration among medical professionals. It facilitates smooth communication across various departments, physicians, nurses, and other healthcare personnel, hence improving the overall effectiveness of healthcare delivery.

Fiber optic connections provide efficient and rapid transport of substantial amounts of data, including medical imaging, electronic health records, and real-time monitoring data. This guarantees expedient access to information, enabling more rapid decision-making and minimizing delays in patient treatment.

Fiber optic link facilitates telemedicine and remote healthcare by enabling remote consultations, virtual examinations, and telemonitoring. It enhances the availability of healthcare services, especially in locations with limited access, and enables healthcare providers to collaborate remotely, resulting in better patient access and outcomes.

5. Fiber optic networks can meet the growing need for data-intensive applications and future technologies in healthcare, including artificial intelligence, machine learning, and IoT devices. These technologies possess the capacity to improve diagnoses, treatment planning, and personalized medicine.

Fiber optic cables provide enhanced dependability and signal integrity in comparison to conventional copper wiring due to its superior performance and redundancy. They exhibit higher resistance to electromagnetic interference and signal degradation, guaranteeing uninterrupted connectivity and minimizing the likelihood of network failures in crucial medical procedures or emergency situations.

7. Fiber optic infrastructure offers the capacity to adapt to future technological breakthroughs and growing data requirements in the healthcare industry, ensuring scalability and futureproofing. The enormous bandwidth capacity provided enables hospitals to seamlessly incorporate new equipment, applications, and services without the need for substantial infrastructure changes.

The primary objective of implementing fibre optic technology in hospitals is to establish a resilient, fast, and dependable network infrastructure that facilitates efficient communication, smooth data transmission, cutting-edge healthcare technologies, and ultimately improves patient care and outcomes.

#### IV. PROBLEM STATEMENT

The presence of fiber optic connectivity in hospitals offers numerous substantial benefits, improving multiple facets of medical services and operations. Fiber optic technology has made several significant contributions to hospitals:

1. Fiber optic connections provide extremely fast data transfer rates, guaranteeing swift and dependable communication among various hospital departments, medical devices, and systems. This allows healthcare practitioners to

rapidly access and exchange vital information, so promoting effective diagnoses, treatment, and patient care.

Fiber optic access facilitates uninterrupted video conferencing and instantaneous telemedicine consultations. Physicians have the ability to remotely assess patient records, do virtual examinations, and offer specialized guidance to healthcare professionals in distant locations. This facilitates prompt medical interventions, diminishes the necessity for patient transfers, and enhances access to specialized care.

Fiber optic networks facilitate the efficient and safe transmission of electronic health records (EHRs). By gaining access to patient records, updating information, and exchanging data across departments, the process becomes more efficient and organized, resulting in better care coordination, decreased errors, and increased patient safety.

4. Fiber optic connections facilitate the swift transmission of voluminous medical imaging files, such as MRI scans, CT scans, and X-rays, among various departments and healthcare establishments. This enhances the ability of radiologists to quickly read and analyze medical images, hence assisting in precise diagnosis and timely planning of therapy.

5. Fiber optics enables the incorporation of monitoring devices and sensors, facilitating the instantaneous gathering and transfer of essential physiological data, such as heart rate, blood pressure, and oxygen saturation. Continuous surveillance guarantees timely identification of alterations in a patient's state, prompting instant notifications for healthcare personnel and facilitating prompt actions.

6. A robust network infrastructure, consisting of fiber optic networks, offers hospitals a highly dependable and protected framework. Compared to standard copper cable, they have a lower susceptibility to electromagnetic interference, data loss, and signal degradation. This guarantees a steady and uninterrupted connection, minimizing the possibility of network malfunctions during crucial medical procedures and emergency situations.

7. The ability to scale and adapt to future needs: Fiber optic networks provide abundant bandwidth capacity and scalability, effectively meeting the growing need for data-intensive applications and developing technologies in the healthcare sector. With the ongoing progress in medical technology, fiber optics offer a reliable solution that can facilitate the incorporation of new healthcare technologies and Internet of Things (IoT) devices, ensuring compatibility with future developments.

In general, the use of fiber optic connectivity in hospitals improves communication, facilitates the interchange of information, and promotes the delivery of healthcare services. It enhances the effectiveness, precision, and cooperation among healthcare practitioners, leading to better results for patients, improved clinical processes, and superior healthcare provision.

### 1.5 Scope of Research

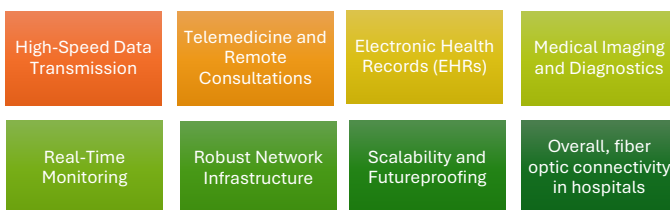
The research on fiber optic networks within hospitals is extensive and covers multiple crucial topics. The objective of this study is to investigate and evaluate the execution, advantages, and difficulties related to the installation of fiber optic communication infrastructure in healthcare facilities. The inquiry will prioritize comprehending the precise demands of hospitals regarding fast, dependable, and protected data transmission to facilitate crucial medical applications and services. The study will explore the technical elements of designing a fiber optic network, taking into account considerations such as bandwidth capacity, network topology, and scalability to meet the growing needs of medical data and developing technologies.

Furthermore, the study will examine the influence of fiber optic networks on improving patient care, medical diagnostics, and operational efficiency in hospitals. The study will investigate the impact of high-speed and reliable internet connections on the accessibility of electronic health records, medical imaging, and telemedicine services. The goal is to determine how improved connectivity might enhance decision-making and improve patient outcomes. In addition, the project will investigate the possibility of achieving seamless collaboration among healthcare teams, thereby enhancing communication and coordination in the delivery of medical services.

Moreover, the project will investigate the security and privacy consequences of implementing fiber optic networks in hospitals. The investigation will focus on the steps taken to protect sensitive patient information, assuring adherence to healthcare data protection rules and cybersecurity standards.

As part of the research, we will evaluate the economic viability of deploying fiber optic networks in hospitals. This assessment will consider the initial investment, maintenance expenses, and long-term advantages. Assessing the feasibility of implementing fiber optic infrastructure in healthcare settings would heavily rely on cost-effectiveness and return on investment.

In addition, the study may examine case studies and examples of hospitals that have effectively implemented fiber optic networks, offering useful insights and best practices for deployment.



The primary objective of the research on fiber optic networks

within hospitals is to contribute to the progress of healthcare technology and infrastructure. This research aims to provide evidence-based recommendations to hospital administrators, policymakers, and healthcare professionals. These recommendations will assist them in making well-informed decisions regarding the adoption of fiber optic communication solutions. The implementation of such solutions has the potential to enhance patient care, optimize medical processes, and improve overall hospital performance.

## V. RESULTS AND DISCUSSION

Deploying a server within a hospital network provides numerous essential benefits. Firstly, it consolidates data storage, offering a singular repository for vital patient information, such as records, photographs, and reports. This centralised solution guarantees expedited and safe access for authorised people. Furthermore, the server's strong security protocols, which include firewalls, encryption, and access controls, enhance protection against unauthorised access and potential cyber attacks, ensuring the safety of critical patient information. Moreover, the server can be set up to perform periodic backups, serving as a safeguard against data loss caused by unexpected incidents or hardware malfunctions. Redundant storage arrangements provide further assurance of data availability in the event of system or disc failures. In addition, the server promotes improved cooperation among healthcare providers, allowing for immediate access and modifications to patient records, which is especially important in urgent situations or when numerous specialists are engaged. The server optimises processes and enables smooth integration of different medical equipment and systems by hosting specialised healthcare software and applications such as Electronic Health Records (EHR) systems and diagnostic tools. Adhering to regulatory mandates, like HIPAA in the United States, becomes easier by implementing server configurations that enforce data encryption, access limits, and thorough audit trails. Finally, resource optimisation is accomplished by the server effectively allocating computing resources according to demand, enabling the ability to increase or decrease the size of applications and services. This improves performance while reducing hardware expenses.

### DHCP server version

Deploying a DHCP (Dynamic Host Configuration Protocol) server in a hospital network provides numerous notable advantages. First and foremost, it effectively handles IP addresses by automating the process of assigning them to devices on the network. This guarantees that every device is assigned a distinct and suitable IP address automatically, eliminating the need for manual setup. This reduces the possibility of conflicts and assures the efficient utilisation of available addresses. Additionally, DHCP significantly simplifies the process of connecting new devices to a network.



## Network Performance Monitoring Tools

Network management and network monitoring software and hardware solutions are also required since these fast optical Ethernet data connections require quick problem detection capabilities (Caisse, 2001). There are numerous Network Management Monitoring solutions available now, and this number will only increase as network switches and devices become more commonplace (Caisse, 2001). In this study, two incredibly potent and distinctive tools will be investigated and analyzed. Tools for network monitoring and reporting that give real-time results of network systems include NetQoS and Orion SolarWinds. "Other forces are at work conspiring to rob your WAN's performance and response time; latency, congestion, chatty applications, traffic contention, and the size of the pipe," claims Keith Schultz of InfoWorld, a reputable source of information on emerging enterprise technologies (Schultz, 2005, p. 39). Moreover, he continued, "Network latency could be a significant problem on the MAN/WAN it can kill the network performance, both in response time and overall throughput on the MAN/WAN; congestion occurs when no bandwidth allocation policy has been applied to traffic on the WAN" (Schultz, 2005, p. 40).

According to Argoces and Portolani (2004), p. 697, the Simple Network Management Protocol (SNMP) "is used to retrieve information about the configuration, state, and counters for hardware and software components from network devices and hosts (manage devices) and to set the value of those components for configuration purposes." From network devices to the application server, SNMP offers management information services.



## VI. CONCLUSION

In conclusion, implementing a hospital network based on fiber optic technology represents a significant leap forward in the provision of advanced healthcare services. The adoption of fiber optics offers unparalleled advantages, including high-speed data transmission, reliable connectivity, and support for bandwidth-intensive applications critical for modern medical practices. This technology not only enhances patient care through real-time monitoring and telemedicine but also facilitates seamless collaboration among healthcare

professionals. However, it is essential to acknowledge the associated considerations, such as initial investment costs and the need for specialized installation expertise. Despite these challenges, the long-term benefits of a fiber optic network in a hospital setting far outweigh the drawbacks. By prioritizing security, scalability, and adaptability, hospitals can establish a network infrastructure that is poised to meet the evolving demands of healthcare, ultimately leading to improved patient outcomes and the delivery of exceptional medical care. In embracing fiber optic technology, hospitals position themselves at the forefront of technological advancement, setting a foundation for the future of healthcare delivery.

## REFERENCES

1. AbroZA, HongC, ChenN, et al. A fiber Bragg grating based smart wearable belt for monitoring knee joint postures. *Text Res J* 2019;90:386–394.
2. PlumpeM, BeckersM, MecnikaV, et al. 9—Applications of polymer-optical fibres in sensor technology, lighting and further applications. In: BungeC-A, GriesT and Beckers M (eds) *Polymer optical fibres*. Cambridge: Woodhead Publishing, 2017, pp.311–335.
3. CarmoJP, DaSilvaAMF, RochaRP, et al. Application of fiber Bragg grating to wearable garments. *IEEE Sens J* 2012;12:261–266.
4. Mac-Thiong J-M, Petit Y, Aubin C-E, et al. Biomechanical evaluation of the Boston brace system for the treatment of adolescent idiopathic scoliosis: Relationship between strap tension and brace interface forces. *Spine (Phila Pa 1976)* 2004;29:26–32.
5. Massaroni C, Saccomandi P and Schena E. Medical smart textiles based on fiber optic technology: An overview. *J Funct Biomater* 2015;6:204–221.
6. RothmaierM, LuongMP and ClemensF. Textile pressure sensor made of flexible plastic optical fibers. *Sensors (Basel)* 2008;8:4318–4329.
7. LamPoTangS. Recent developments in flexible wearable electronics for monitoring applications. *Trans Inst Meas Control* 2007;29:283–300.
8. Leal-JuniorAG, DiazCAR, AvellarLM, et al. Polymer optical fiber sensors in healthcare applications: A comprehensive review. *Sensors (Basel)* 2019;19:3156.
9. Schneegass S and Amft O. Introduction to Smart Textiles. In: Schneegass and Amft O (eds) *Smart textiles*.
10. KoncarV. 1—Introduction to smart textiles and their applications. In: Koncar V (ed) *Smart Textiles and their Applications*. Oxford: Woodhead Publishing, 2016, pp.1–8.
11. DasSC and ChowdhuryN. Smart textiles—new possibilities in textile engineering. *J Polymer Text Eng* 2014;1: 1–4.
12. The Insight Partners. Smart textile market is expected to reach US\$13.63bn in 2027, [https://www.theinsightpartners.com/pr/smart-textile-market\(2020, accessed 11 April 2021\)](https://www.theinsightpartners.com/pr/smart-textile-market(2020, accessed 11 April 2021)).
13. VanLangenhoveL. Smart textiles: Past, present, and future. In: X Tao (ed.) *Handbook of smart textiles*. Singapore: Springer Singapore, 2015, pp.1035–1058.

14. AmeriResearchInc.Smarttextilesmarket to2024:Key productcategories(active,passive,ultrasmart),application(sensing,thermo-electricity,energyharvesting, luminescenceandaesthetics),end-use,regionalsegmentation, competitive dynamics,M&A insights, pricing analysis (OPP, IPP, RAP) and segment forecast, <https://www.ameriresearch.com/product/smart-textiles-market/> (2017,accessed7August2020).

15. GrilletA, KinetD, Witt J, et al. Optical fiber sensors embedded into medical textiles for healthcare monitoring. *IEEE Sens J* 2008;8:1215–1222.

16. Quandt BM, Scherer LJ, Boesel LF, et al. Body-monitoring and health supervision by means of optical fiber based sensing systems in medical textiles. *Adv Healthc Mater* 2015;4:330–355.

17. Erik V, Raul I and Inmaculada P. Sensing systems for respiration monitoring: A technical systematic review. *Sensors (Basel)* 2020;20:5446.

18. Roudjane M, Khalil M, Miled A, et al. New generation wearable antenna based on multimaterial fiber for wireless communication and real-time breath detection. *Photonics* 2018;5:33.

19. Costa JC, Spina F, Lugoda P, et al. Flexible sensors from materials to applications. *Technologies (Basel)* 2019;7:35.

20. Gong Z, Xiang Z, Ou Yang X, et al. Wearable fiber optic technology based on smart textile: A review. *Materials* 2019;12:3311.