

Hospital Networks

Author-Up2120303/Harry Miller

Abstract

This project examines the continued use of outdated communication devices, such as pagers and fax machines, in hospital networks and compares them to modern smart devices and applications. The aim is to determine the best network system by evaluating security, usability, quality of service [QoS], costs, implementation, reliability and fault tolerance. Simply put, the best system will not just save time and money, it will save lives.

Alternatives to pagers and fax machines include secure messaging apps and voice over internet protocol [VoIP] phones, offering enhanced features and security. These modern methods enable real-time communication, data security, and integration with databases.

Challenges with smart technology include poor mobile and WiFi coverage in hospitals, the cost of new equipment, staff training, and network security risks. Solutions involve using boosters, implementing separate networks for staff and patients, and ensuring secure medical staff networks through two-factor authentication, cybersecurity education, regular audits, firewalls, end-to-end encryption, and registered devices. [QoS] is crucial for managing data traffic but must be implemented correctly across the entire network. Transitioning to smart technology can enhance efficiency, security, and communication in healthcare, despite the initial challenges.

Introduction

This project is looking into hospital networks and why they are still using outdated communication devices. It will investigate the advantages and disadvantages of Pagers and Fax Machines against modern Smart devices and address any issues that may arise from modernising the equipment. The project aims to find solutions to these issues and ask the question, which network system is better (through qualitative research and results)? To reach a conclusion I intend to look into the security, usability, [QoS], costs and implementation, reliability, fault tolerance along with any other relevant factors.

In 2023 the NHS was still using 79,000 pagers and hundreds of fax machines; the figure equates to 10% of all pagers in the world. Whilst this is a reduction from the 130,000 being used in 2019, the figure still represents an unwillingness to move to smarter technology (Kent) (Davies, 2023). The Department of Health [DoH] banned hospitals from using pagers from 2021, but this is still to materialise (Ercole et al, 2023). Approximately 80% of hospitals still use pagers in some capacity ('Why the Hospital' 2019). A pilot project in 2017 found that switching to smart devices saved doctors 48 minutes per shift and nurses 21 minutes (Mitchell, 2019). Purchase of new fax machines and their use was banned by the DoH from 2020. Again, this is a target that is not being met ('What happened' 2020).

Critical Analysis

Advantages of pagers

They are reliable, relatively cheap to operate and have a battery life that can last several weeks ('Why are pagers'). Unlike mobile phones and tablets, they are very robust and can be used in harsh environments, such as A & E departments, with little risk of being damaged. They remove any bias as recipients do not have sender details. The frequency they use is similar to FM radio; it can penetrate thick walls and barriers, and it is not affected by computer network traffic, and does not affect hospital equipment (Kent, 2021). Hospital staff are used to using pagers and they are familiar with the systems they have in place for their use.

Limitations of pagers

Pagers are a one-way communication system which can lead to misunderstandings that can't be discussed. They require a separate network infrastructure which will increase running costs. You cannot see patients' medical records or message groups or individuals. Recipients are unaware who contacted them or the level of urgency. Pagers have a limited range and tracking capabilities, which can lead to lost messages. There isn't an automated way to escalate unanswered messages to the next available provider. Pagers are not secure and can be vulnerable to a number of attacks ('5 Reasons'). Anyone who gains physical access to a device can tamper with it. They were designed before cybersecurity was an issue.

There is only one provider of pagers left in the UK and this has pushed the price up to £400 per unit (Department of Health and Social Care, 2019); this alongside with the DoH ban means they have limited scalability. By continuing to use pagers, NHS staff are being trained on hardware that will be subject to change.

Advantages of fax machines

Fax machines are very simple to use, and they are a relatively quick way to distribute a paper document. Hospital staff are used to using them and do not require further training. Traditional fax machines do not require an internet connection, they communicate over a phone line, so are not affected by network traffic.

Limitations of fax machines

The DoH ban means they have very limited to no scalability. They are slow as communication requires printing. They are not environmentally friendly as all correspondence requires a paper copy from both ends. Fax machines send messages over phone lines, which are not encrypted. Fax machines can spread malware by embedding a specially crafted file within an image and faxing it to a recipient machine (Etemadieh, 2018). Human error can lead to faxes being sent to the wrong number which can breach a patient's confidentiality and therefore the Data Protection Act 2018. They are likely to go missing as they are physically insecure in that they can be picked up by anyone. These examples of poor communication can lead to medical mistakes. Even if everything happens correctly, the sender doesn't get a receipt that the receiver (physical person) received the message. With all these underlying issues there is simply too much space for user errors or attacks. With a secure network in place, there seems to be very little reason for fax machines to remain in existence within the health service.

Proposed Solutions

With the rise of smartphones and other mobile devices, should all hospitals now adopt modern communication methods?

The shift away from pagers is driven by their limitations. They can only handle simple text messages, lacking the ability to transmit images or videos, which is crucial in medical settings for accurate diagnoses and treatment plans.

So, what are the alternatives? Many hospitals are switching to secure messaging apps as an alternative to pagers ('What do hospitals' 2023). These apps enable staff to send and receive messages and alerts on smartphones, tablets, or other devices. They often include features like group

chat, file sharing, and the capability to send alerts to specific teams or individuals. Secure messaging also eliminates the need for fax machines as long as a printer is available when a paper copy of a document is required. Smart devices equipped with VoIP, could directly replace pagers in hospitals for staff communications. VoIP enables staff to make and receive calls via the internet ('What do hospitals' 2023). VoIP has many advantages over traditional phone lines such as cost, scalability, flexibility and the ability to support both audio and video communications. VoIP can also facilitate migration from office to home or any connected internet device with authorisation. Unlike with pagers, staff with non portable devices would also be able to communicate. Internet calls have come on leaps and bounds in recent years as the speed of internet connections has increased leading to better call quality and excellent reliability.

Issues that may arise with smart technology

Hospitals are notorious for poor mobile and WiFi coverage due to their large campuses and long corridors. Constructed with concrete, steel, and glass, these buildings also feature walls lined with insulated foil and double-glazed "K glass" windows. These materials almost entirely block mobile phone signals, making connectivity a challenge ('Why are pagers'). This can make smart technology less reliable in emergency situations. Another issue would be dealing with parts of the network being down and how this would be tackled.

There would be cost implications associated with changing systems. Like all government departments, hospitals work to a fixed budget. Changing systems will involve the purchase of new equipment and staff training. The implementation would require the running of both the new and old system whilst transition takes place.

The networks used for staff and patients would also need to be addressed. There would be a higher density of users affecting speed and reliability. The security would be a risk as patients files and records would be available to hackers on the network.

VoIP can be very secure but this depends on configurations. The security of the network and its reliability would need to be addressed. Also how would staff use VoIP? Staff bring in their own phones? company phones? specialised devices or applications?

Addressing the issues

Boosters can be used to help eliminate dead spots. If a booster still does not produce a strong enough signal (x-ray room for example) an ethernet cable can be used.

Whilst the initial outlay may be an additional expense; the money spent will be recuperated from only running one staff network instead of two.

To help with security two networks would need to be installed, one for patients and one for medical staff.

You would need a system that allows the network to continue operating without interruption when one

or more of its components fail (fault tolerance). This would prevent disruptions arising from a single point of failure allowing critical systems to continue. This could be achieved by using an identical server running in parallel for hardware issues or operating a second database for software issues ('Fault Tolerance'). Power failure could also be an issue but hospitals run with backup power supply's anyway as they have critical lifesaving equipment.

Staff would carry mobile phones equipped with secure messaging apps. They would either be supplied with devices or use their own. This would be contractual and therefore, not covered in this report. The network used for staff communications would need to be made fully secure. This could be done by implementing the following:-

- Implementing Two-Factor Authentication for all medical staff.
- Educating staff on cyber security threats such as phishing emails.
- Carrying out regular audits to identify and fix any vulnerabilities found.
- Installation of firewalls to monitor network traffic for suspicious activity.
- Implementation of end to end encryption for any data transferred within the network.

• Allowing only registered and authenticated devices to access the network. You would need a good QoS to manage data traffic to ensure that high-priority applications get the performance they need. This is to try and ensure the most important apps get bandwidth over less urgent tasks like file downloads. QoS isn't a cure-all; WLAN design is equally crucial. Often, configuring QoS on the WLAN alone isn't sufficient; it needs to extend throughout the entire LAN to be fully effective. Integrating QoS across both LAN and WLAN networks can be complex. (Badman, 2020)

QoS configuration operates by marking packets to identify their service types and configuring routers to create separate virtual queues for each application based on priority. There are 4 main techniques that can be used to ensure high performance of the most critical applications, prioritising, resource reservation, queuing and traffic marking ('What Is Quality').

You would finally need to introduce a failsafe if the network fails. This could be to send the message to an SMS or email message if the in-app alert cannot go through.

Related Works

Since 2014, Cambridge University Hospitals (CUH) NHS Foundation Trust has utilised a comprehensive Electronic Health Record (EHR). CUH, a large tertiary referral centre in the East of England, boasts over 1,100 beds and approximately 16,000 staff. Their information-governance compliant messaging solution, Epic Secure Chat, gives users the ability to send secure instant messages either in one-on-one settings or within groups. These messages can be general or specifically related to a patient. Additionally, users can link a patient's clinical documentation to a message, enabling recipients to easily access the patient's chart. (Ercole et al, 2023). Humber River Hospital in Canada showcases the immense potential of fully integrated digital systems in healthcare. In 2015, the hospital transitioned from outdated operations to becoming North America's first fully digital hospital. Its digital infrastructure now encompasses a fibre network, structured cabling, building automation systems, and various patient-centric technologies, including unified communications and nurse call systems.

Bouygues UK, the company behind Humber River Hospital, is currently constructing Oriel, a state-of-the-art eye care, research, and education centre in Camden. They are integrating technologies used in Humber River Hospital, into Oriel (Boyd, 2023).

Conclusion

The delay in implementing smart technology within the NHS can be attributed, in part, to the impact of COVID-19. Although the pandemic is no longer the issue it once was, hospitals are still working through the backlog of cases it created. Furthermore, there is a notable reluctance among medical staff to embrace newer, smarter technologies, preferring to rely on traditional methods instead. Another issue will be the costs involved in changing systems. Like all government departments, hospitals work to a fixed budget.

Nevertheless, the security of hospital networks can be effectively managed to create a safe secure system, and by implementing QoS measures, it is possible to prioritise urgent information, ensuring it is given precedence across the network. Not only are smart devices more cost-effective, but they are also more efficient and secure compared to the systems currently in use. The technology required for this transformation already exists, having been thoroughly tried and tested.

Fully adopting smart devices in hospitals would result in cost savings by consolidating the staff network system into a single, unified platform instead of maintaining two separate systems.

Implementation would need to be included in a hospital's budget as the initial set-up would be costly. Any reliability issues associated with smart applications can be overcome by installing boosters and using ethernet cables in areas with weak signals. Fault tolerance can be achieved by using an identical server running in parallel to address hardware failures, or by operating a secondary database

to handle software issues. Smart technology can also be used to manage medications, schedule appointments, and utilise various healthcare services directly from a smart device. This heightened usability and engagement will continue to revolutionise healthcare, making it more personalised and centred around the patient's needs. Smart devices also facilitate staff communication through sending and receiving messages and alerts on smartphones, tablets, and other devices using VoIP. These tools often feature group chat, file sharing, and the ability to send alerts to specific teams or individuals.

Despite the government's attempts to enforce these changes without much success, the reality is that this shift towards smarter technology should be happening now to improve the efficiency and security of healthcare services.

Kent, C. How will UK hospitals let go of the pager?. medical-technology.
https://medical-technology.nridigital.com/medical_technology_jan21/uk_hospitals_pager

Ercole, A. Tolliday, C. Gelson, W. Rudd, JHF. Cameron, E. Chaudhry, A. Hamer, F. Davies, J. (2023, 20 April). Moving from non-emergency bleeps and long-range pagers to a hospital-wide, EHR-integrated secure messaging system: an implementer report. informatics.
<https://informatics.bmj.com/content/30/1/e100706>

Why the Hospital Pager Withstood the Test of Time. (2019, 21 june). healthtechmagazine
<https://healthtechmagazine.net/article/2019/06/why-hospital-pager-withstood-test-time>

Mitchell, G. (2019 25 february). Ditching old pagers will save nurses 21 minutes per shift. nursingtimes.
<https://www.nursingtimes.net/digital-and-technology/ditching-old-pagers-will-save-nurses-21-minutes-per-shift-25-02-2019/>

Davies, J. (2023, 21 may). FOR FAX SAKE Hundreds of NHS hospitals still using archaic fax machines despite orders to bin them. thesun.
<https://www.thesun.co.uk/health/22431913/nhs-hospitals-still-using-fax-machines/>

What happened to 'axe the fax' in the NHS?. (2020, 10 september). practicebusiness
<https://practicebusiness.co.uk/what-happened-to-axe-the-fax-in-the-nhs>

Why are pagers still used in hospitals and what is the alternative? stelladoradus.
<https://www.stelladoradus.com/blog/why-are-pagers-still-used-in-hospitals-and-what-is-the-alternative/>

Kent, C. (2021, 26 january). How will UK hospitals let go of the pager?. medicaldevice-network.
<https://www.medicaldevice-network.com/features/how-will-uk-hospitals-let-go-of-the-pager/?cf-view>

5 Reasons to Ditch Pagers. onpage. <https://www.onpage.com/5-reason-to-ditch-pagers/>

Department of Health and Social Care. (2019, 23 february). Health and Social Care Secretary bans pagers from the NHS. gov.
<https://www.gov.uk/government/news/health-and-social-care-secretary-bans-pagers-from-the-nhs>

Etemadieh, A. (2018, 5 september). Danger alert: Criminals can spread malware through fax machines. paubox. <https://www.paubox.com/blog/faxexploit-fax-machine-hack-malware>
[Danger alert: Criminals can spread malware through fax machines](https://www.paubox.com/blog/faxexploit-fax-machine-hack-malware)

What do hospitals use instead of pagers?. (2023, 4 may). hypercare.
<https://www.hypercare.com/blog/what-do-hospitals-use-instead-of-pagers>

Fault Tolerance. Imperva. <https://www.imperva.com/learn/availability/fault-tolerance/>

Badman, L. (2020, 2 november). How and why to implement Wi-Fi QoS. techtarget
<https://www.techtartget.com/searchnetworking/answer/Can-you-tell-me-about-wireless-LAN-QoS-and-what-are-the-pros-and-cons-of-implementing-this>

What Is Quality Of Service (QoS) In Networking?. fortinet

<https://www.fortinet.com/uk/resources/cyberglossary/qos-quality-of-service>

Boyd, C. (2024, 11 July). Exploring Smart Systems that Enhance the Patient Experience.

Bouygues.

<https://www.bouygues-uk.com/exploring-smart-systems-that-enhance-the-patient-experience/>