

Chapter 76

Performance Studies of Integrated Network Scenarios in a Hospital Environment

Nurul I. Sarkar

*School of Computer and Mathematical Sciences,
Auckland University of Technology, New Zealand*

Kashif Nisar

*InterNetWorks Research Laboratory, School of
Computing, University Utara Malaysia, Malaysia*

Anita Xiao-min Kuang

*School of Computer and Mathematical Sciences,
Auckland University of Technology, New Zealand*

Angela Amphawan

*InterNetWorks Research Laboratory, School of
Computing, University Utara Malaysia, Malaysia*

ABSTRACT

Hospital network is evolving towards a more integrated approach by interconnecting wireless technologies into backbone networks. Although various integrated network scenarios have been published in the networking literature, a generic hospital model has not yet been fully explored and it remains a challenging topic in practice. One of the problems encountered by network practitioners is the seamless integration of network components into healthcare delivery. A good understanding of the performance of integrated networks is required for efficient design and deployment of such technologies in hospital environments. This research paper discuss on the modelling and evaluation of integrated network scenarios in hospital environments. The impact of traffic types (e.g. data, voice and video), traffic load, network size and signal strength on network performance is investigated by simulation. Three piloted case studies look at client performance in radiology Accident and Emergency (A & E and Intensive Care Unit (ICU)) scenarios. Each scenario reflects the need for various traffic types that end up distinct network behaviours. In the radiology scenario, email and File Transfer Protocol (FTP) traffic is found to perform well for medium-to-large networks. In the A & E scenario, Voice over Internet Protocol (VoIP) traffic is shown to generate very limited jitter and data loss. The performance is aligned with the Quality of Service (QoS) requirements. In the ICU scenario, the performance of video conference degrades with network size, thus, a QoS-enabled device is recommended to reduce the packet delay and data loss. IEEE 802.11a suits in hospital environment because it mitigates interference on the 2.4GHz band where most wireless devices operate.

DOI: 10.4018/978-1-4666-6339-8.ch076

1. INTRODUCTION

A misconception as to hospital model development is to replace the entire wired backbone with the wireless architecture. This opinion is not realistic. Since the radio signal strength varies constantly with the surrounding environment, such as distance, source of interference (interior and exterior), and the protocol being used etc., its performance is not as stable as the wired networks. Literatures also reveal that Quality of Service (QoS) is not supported in current mainstream Wireless Local Area Network (WLAN) protocols (namely, 802.11a (Latkoski, Hadzi-Velkov, & Popovski, 2005), 802.11b (Banitsas, Song & Owens, 2004) and 802.11g (Wijesinha, Song, Krishnan, Mathur, Ahn, & Shyamasundar, 2005)). Although 802.11e (Xiao, 2004). is introduced as an emerging standard to provision QoS features on a contention-based channel access scheme, extensive testing is still required for the deployment in medicine areas. Hence, a more integrated approach is expected to incorporate wireless technology into the existing backbone network, ensuring that the centralised service are maintained by wired architecture, while cable free flexibility and escalated bandwidth still satisfy the peripheral mobile service as well as emerging medical services (e.g. heart monitor and telemetry).

A number of researchers (Varshney, 2007) have made effort in designing an intellectual Emergency Unit (EU) model that extends accessibility and interoperability against the legacy system, yet a generic hospital model is not fully developed. The complexity is due to the characteristics of hospital scenarios. Unlike the commercial and educational networks (Fang, Hong, Yu-heng, & Li 2007), a standard hospital normally involves life-critical application, multimedia application and office-oriented application, and therefore the network model requires more specific performance metrics to evaluate data, audio and video traffic under different conditions. Especially, in the emergency

units, timely response to the biomedical signals or alarm is highly critical to saving lives, so mean packet delay and packet loss are sensitive at this point. As the network scenario switches to radiology room or intensive care units, the tolerated range for mean packet delay and packet loss must be varied. The patterns of transmitting data, audio and video traffic are fully specified in Chigan and Oberoi (2006). Researchers can observe the network behaviours by means of simulation tools for data validity and verification purposes.

Out of the numerous design and modelling issues, the main ones encountered network practitioners include validity and feasibility of network architecture, network protocol and the strategies that figure out performance metrics, user capacity, and propagation environment. Presumably, the network architecture offers fast and reliable connectivity for hospital-wide applications. However, different traffic demands on different security and quality-based provision. Explicitly, voice and video traffic requires a robust gateway to maintain authentication and sufficient bandwidth for each session, while data traffic tends to more rely on backup, security policy and Virtual Private Network (VPN) technology dedicated for the remote users. Therefore, a preliminary feasibility research is required for deploying such technologies in the hospital scenarios. The network architecture is not validated until cost, availability, scalability and all performance data have met the predefined standards. Likewise, the prospective WLAN protocols (802.11a and 802.11g) need to be fully justified in terms of throughput, mean packet delay and packet drop, etc. This research paper aims to develop a generic hospital network model and evaluate its performance for the integrated network scenarios, including radiology room, and Emergency (A & E). This research makes use of computer simulation and discusses various aspects of the network design, so as to discover the performance behaviour pertaining to effect of traffic type, traffic load and network

26 more pages are available in the full version of this document, which may be purchased using the "Add to Cart" button on the publisher's webpage:

www.igi-global.com/chapter/performance-studies-of-integrated-network-scenarios-in-a-hospital-environment/116285

Related Content

The Potential of System Dynamics to Model Patient-Aided Healthcare

(2020). *Managing Patients' Organizations to Improve Healthcare: Emerging Research and Opportunities* (pp. 93-115).

www.irma-international.org/chapter/the-potential-of-system-dynamics-to-model-patient-aided-healthcare/246996

Artificial Intelligence in Medical Science

Shashwati Mishra and Mrutyunjaya Panda (2019). *Intelligent Systems for Healthcare Management and Delivery* (pp. 306-330).

www.irma-international.org/chapter/artificial-intelligence-in-medical-science/218126

The Future

(2015). *Flipping Health Care through Retail Clinics and Convenient Care Models* (pp. 226-234).

www.irma-international.org/chapter/the-future/115803

Medical Practical Knowledge Circulation Based on Purpose-Oriented Service Modeling

Taisuke Ogawa, Mitsuru Ikeda, Muneou Suzuki and Kenji Araki (2015). *Healthcare Administration: Concepts, Methodologies, Tools, and Applications* (pp. 484-509).

www.irma-international.org/chapter/medical-practical-knowledge-circulation-based-on-purpose-oriented-service-modeling/116230

Articulations of Care

Colleen R. Greer and Sally J. McMillan (2024). *Perspectives on Social and Material Fractures in Care* (pp. 1-32).

www.irma-international.org/chapter/articulations-of-care/339011