Chapter 10

On the Use of Home Node Bs for Emergency Telemedicine Applications in Various Indoor Environments

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ABSTRACT

The use of emergency telemedicine applications at the site of a medical emergency event provides a multitude of benefits, both from the perspective of the patient and the emergency care providers. Innovations in rich multimedia telemedicine solutions further enhances the aforementioned benefits, but places more stringent quality-of-service demands on the underlying mobile networks. In this paper, the authors present a proposal for a complementary solution for rapid provisioning of mobile broadband data connectivity for emergency telemedicine applications in indoor environments. The proposed solution relies on the exploitation of existing femtocellular network resources available at emergency sites in various residential building types. Simulations carried out for a UMTS network environment demonstrate significant improvements in terms of achievable throughput for the emergency mobile terminal device when access to UMTS Home Node Bs available in the building is allowed for emergencies compared to macro Node B access only.

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INTRODUCTION

Emergency telemedicine refers to the information and communication technology solutions utilized by Emergency Medical Service (EMS) personnel (e.g., paramedics) throughout a medical emergency event cycle (Keane, 2009; Sluyter, 1979). Emergency telemedicine applications have proved to be particularly useful for transferring patient information and measurements gathered at an emergency site or during transportation via ambulance to emergency departments and data repositories in targeted care centres. The advances in underlying technologies, particularly broadband mobile communications (Pattichis, Kyriacou, & Voskaride, 2002), make emergency telemedicine a key contributing factor in overall improvement of quality emergency care services. This is due to the fact that the improved resolution and clarity of real-time audio-visual interaction between field ambulance teams and supervising physicians in remote medical facilities enhances decision making, improves diagnostic accuracy and provides remote supervision on complicated prehospital care procedures. Additionally, the enhanced data handling capacity for emergency telemedicine improves the way in which Electronic Patient Record (EPR) data and other multimedia medical content are rapidly updated, distributed and shared within the EMS ecosystem. Moreover, effective utilization of emergency telemedicine solutions enables the EMS provider to optimise resource requirements (on-site physicians, hospital beds etc.) throughout the emergency cycle.

Past statistical studies by various EMS providers (e.g., Accident and Emergency Department of Queen Mary Hospital, Hong Kong; Leung, Lo, & Tong, 2000) noted that typically over two thirds of routine medical emergency events occur in indoor residential environments. The indoor environment would therefore be the likely location of the first point of contact between paramedics and the patient. The need to provide preliminary or urgent prehospital care at first contact with patient means that paramedics expect to have automatic access to their complete suite of emergency telemedicine applications regardless of the location of the emergency site. Moreover, any noticeable performance degradations of the emergency telemedicine applications should not compromise the overall quality of the care provided.

However, in practice, the underlying legacy broadband wireless networking technologies that provide bearer connectivity services to support the emergency telemedicine applications have inherent limitations in terms of end-to-end link performance, availability, service accessibility and so on. These limitations may in turn reduce the usefulness (hence, clinical value) of the telemedicine applications during the critical emergency situations. For instance, throughput degradations in a radio link may enforce further stringent compression measures (e.g., reduced frame rate, lowered spatial resolution etc.) on real-time medical video streams resulting in video quality that falls below the tolerable levels for medical purposes (Kim, Yoo, & Kang, 2004).

This paper reviews some of the limitations of existing broadband wireless solutions for supporting emergency telemedicine applications in indoor environments and proposes a complementary solution based on the emerging femtocellular approach for indoor emergency telemedicine scenarios. The rest of the paper is organized as follows. The next section provides a brief review of the limitations of current broadband wireless solutions and introduces our proposed femtocellular emergency telemedicine approach. A more detailed system overview is then presented, focusing on key aspects, such as, system architectural viewpoints, service quality and access control strategies. This followed by discussions on system modelling and essential assumptions for performance studies carried out in this paper. The simulation setup and results are then discussed in the following section, from which conclusions and envisioned future work on subject is outlined.
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