Chapter 19
Cross-Layer Multimedia QoS Provisioning over Ad Hoc Networks

Raad Alturki
Imam Mohammed Bin Saud University, Saudi Arabia

Rashid Mehmood
Swansea University, UK

ABSTRACT

Multimedia applications are becoming the main driver for the advancements in the telecommunications industry. Increased demand for anytime anywhere mobility has given rise to the development of ad hoc networks. Supporting multimedia applications over ad hoc networks is extremely challenging due to the stringent Quality of Service (QoS) requirements and the lack of infrastructure. In recent years, cross-layer design techniques have emerged as a potential solution to address these challenges.

This chapter takes a cross-layer design approach and presents the design and analysis of wireless ad hoc networks that support multimedia applications with scalable Quality of Service (QoS). The chapter has contributed in two areas. Firstly, a novel, cross-layer, Hierarchical Clustering, Provisioning, and Routing (HCPR) scheme for ad hoc networks is proposed, implemented, and analysed. Secondly, a novel methodology is developed for multimedia network analysis and its effectiveness is demonstrated by the analysis of the HCPR scheme and other well-known protocols.

The HCPR scheme is implemented as an extension to the OPNET simulation software and is analysed in detail for its QoS performance to deliver multimedia applications over ad hoc networks. It is compared with three well-known and widely used routing protocols: Ad Hoc On Demand Distance Vector (AODV), Optimised Link State Routing (OLSR), and Geographic Routing Protocol (GRP). Several networking scenarios have been carefully configured with variations in networks sizes, applications, codecs, and

DOI: 10.4018/978-1-4666-0960-0.ch019

routing protocols to extensively analyse the proposed scheme. The HCPR enabled ad hoc network outperforms the well-known routing schemes, in particular for relatively large networks and high QoS network loads. These results are promising because many QoS schemes do work for small networks and low network loads but are unable to sustain performance for large networks and high QoS loads. Several directions to extend this research for future work are given.

INTRODUCTION

Multimedia applications have been the key driving force behind the convergence of fixed, mobile, and IP networks. The current trends suggest that, in the future, multimedia services will be delivered over multiple heterogeneous network platforms all employing IP-based technologies. The Internet is a loosely coupled distributed collection of autonomous networks, which delivers traffic of different types on a best effort basis. In contrast, multimedia applications usually have stringent QoS (Quality of Service) requirements. Various IP-based heterogeneous wired/wireless networking technologies are being connected to the ever-growing Internet infrastructure, which is now being referred to as 'internet of things.' However, it is still a significant challenge for such an infrastructure to support QoS requirements of various applications particularly those involving real time media (such as voice and video). Moreover, increased demands for mobility and anytime anywhere communications have given rise to the concept of ad hoc networks[1], and this has exacerbated the QoS support challenges due to certain unique features of ad hoc networks namely its autonomic and multi-hop nature and the lack or scarcity of infrastructure. It is, therefore, of paramount importance to manage networks for scalable end-to-end QoS provisioning, and understand the QoS requirements of multimedia applications and the performance of heterogeneous networks carrying such multimedia traffic.

Cross-layer design techniques have emerged in the recent years as a potential solution to address the multimedia QoS provision challenges plaguing the development of heterogeneous networks. The traditional approach for network design is based on the OSI (Open Systems Interconnection) model, which divides a communication system into multiple layers where each layer carries out a specific job, receives services from the layer below and provides services to its upper layers. For several reasons this layered architecture provides excellent modularity for networks, such as the Internet, to scale. However, a disadvantage of such layered architecture is its inability to provide service differentiation and QoS, as, for example, is required for multimedia delivery over ad hoc networks. The cross-layer ideology is to optimise the design and performance by increased and effective interaction between layers and optimisation at a global level (multiple layers) rather than at the local level (single layer).

Chapter Aims and Contributions

The aim of our research is the design and analysis of wireless ad hoc networks that support multimedia applications with scalable QoS. We are convinced that cross-layer approaches have the potential to address these QoS provisioning challenges. In this context, this chapter proposes HCPR (Hierarchical Clustering, Provisioning, and Routing), a cross-layer scheme to address QoS challenges to deliver multimedia over ad hoc networks. The HCPR scheme is based on an intelligent protocol that optimises multimedia QoS provisioning by enabling and exploiting interactions between Application, Transport and Network layers. The cross-layer aspects of the HCPR are explained further in Section 4 where the Scheme is described in detail. The motivation and novelty for this work have been established through a state of the art