Chapter 15
Replication Strategies for Video On-Demand over Wireless Mesh Networks: A Cross-Layer Optimization Approach

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ABSTRACT

To pervasively and diversely support a wide range of multimedia services, several traditional replication techniques have been considered for improving data accessibility in Wireless Mesh Networks (WMNs). The metrics used to evaluate data accessibility performance are often related to service integrity parameters of the lower layers such as the network, medium access control, and physical layers. However, these parameters cannot directly reflect the Quality of Experience (QoE) as perceived by end users. In contrast, QoE based parameters for video streaming applications are deduced from subjective tests and involve processing at the application layer including quality of playback in terms of spatial artifacts, smooth playback, and continuous playback.

In this chapter, dependencies between the different protocol layers and across the hops through WMNs will be exploited to deliver video streaming with high QoE. Specifically, a cross-layer optimization ap-

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proach is applied to a replication strategy for video on-demand over WMNs. Additionally, the authors consider a distributed implementation algorithm, namely Mod&Timer, to handle the placement of replicas for saving storage resources of the network. Simulation results are shown to demonstrate that the proposed cross-layer design outperforms many existing schemes in terms of QoE. More importantly, compared to other strategies without cross-layer interaction, the proposed cross-layer design satisfies the heterogeneous bandwidth constraint of end users.

INTRODUCTION

Wireless mesh networks (WMNs) (Akyildiz, et al., 2005) have gained an important role in broadband wireless networks to serve a large number of users having high demands for multimedia services. WMNs rely on multihop wireless backbones consisting of relatively stationary mesh routers and gateways as illustrated in Figure 1. The salient advantages of WMNs, such as self-organization, self-configuration, self-healing, reliability, and scalability, provide an easy and economical network deployment and management. With the rapid growth of multimedia applications, many studies have focused on how to improve the efficiency and the performance of delivering multimedia streaming over WMNs by using feasible techniques such as scheduling, dropping, routing, caching, replication, and cross-layer design.

Multimedia streaming applications allow the users to initiate and commence playback simultaneously instead of waiting for downloading to complete. In general, multimedia streaming applications can be subcategorized into three scenarios: 1) On-demand streaming of stored multimedia, e.g., Video on-Demand (VoD), 2) live streaming, e.g., Internet live sport networks, Internet radio stations, and 3) real-time interactive streaming, e.g., on-line games, video conference, E-education. These three scenarios have several QoE objectives in common such as small distortions in the reconstructed application at the receiver, smooth playback, and continuous playback. However, live and real-time interactive streaming

Figure 1. Components of a typical wireless mesh network