MobiVoD: A Video-on-Demand System Design for Mobile Ad hoc Networks*

Duc A. Tran
Department of Computer Science
University of Dayton
Dayton, OH 45469
duc.tran@notes.udayton.edu

Minh Le, Kien A. Hua
School of EECS
University of Central Florida
Orlando, FL 32816
{mle, kienhua}@cs.ucf.edu

Abstract

We present a design for a system that provides video-on-demand (VOD) services to mobile ad hoc clients. Such a system allows the clients to access video information anytime anywhere. MobiVoD, the proposed solution, overcomes many difficulties currently challenging video streaming in a mobile ad hoc network. The new environment includes a three-tier architecture, in which the mobile VOD system employs a periodic broadcast protocol to achieve maximum scalability; and the clients leverage an ad hoc network caching technique to minimize the service delay. This system can sustain client failure and mobility, and provide true VOD services to most clients.

1. Introduction

As people tend to work beyond their office desk, we can expect the next generation of wireless communication networks to include rapid deployments of independent mobile users. With the emergence of wireless technologies such as IEEE 802.11 [12] and Bluetooth [4], mobile users are enabled to connect to each other directly without any networking infrastructure such as the Internet and infrastructure-based wireless LANs. In other words, the users form a *mobile ad hoc network* (MANET) [7]. A MANET is an autonomous network of mobile nodes that communicate with each other only via direct wireless links. No fixed topology exists in such a network and nodes can join and leave freely.

MANETs can find many applications due to its appealing working environment. Popular examples include establishing survivable, efficient, dynamic communication for emergency/rescue operations, disaster relief efforts, and military networks. In this paper, we focus on another kind of application that can run in a MANET: *we design a technique that provides* video-on-demand *(VOD) services to mobile users*. A VOD system is an interactive multimedia system working like cable television, the difference being that the client can select a movie from a large video database stored at a distant video server. Individual clients in an area are able to watch different programs when they wish to, making the system a realization of the video rental shop brought into the home.

VOD has been on a rise on the Internet in recent years. According to an In-stat/MDR[1] report in 2002, the market for VOD would reach 1.9 billion USD and the number of online VOD users would reach 17 million by 2006. As VOD becoming an integrated part of an increasing number of applications and wireless networks emerging to dominate the communication environment of the future, it is interesting and worthwhile to design a VOD system for MANETs. Such a system has many practical applications. For instances, airlines could provide VOD services in airport lounges to entertain passengers on their own PDA (personal digital assistant) while they are waiting for a flight; a museum could provide video information on the exhibits on demand over the wireless network; in education, a university could also install such a system on campus to allow students to watch video recorded earlier from lectures they were not able to attend.

Despite the promising future of a system for mobile VOD, implementing it, at least, needs to answer the following main questions:

1. What should be the architecture for a mobile VOD system?
    - Challenge: The coverage of wireless transmission is limited. An 802.11-enabled host can only reach other devices within 100m of its radius, while that radius is 10m for Bluetooth. These

---

* This research is partially funded by the National Science Foundation under grant No. ANI-0088026.

[1] http://www.instat.com/

limits set a threshold on the communicability between two mobile hosts. If two mobile hosts are too far away from each other, they cannot communicate directly but must go through multiple intermediate hosts. In the case of video transmission, if a video goes through multiple hops from the source to the destination, significant amounts of bandwidth and energy of the intermediate mobile hosts are consumed. The architectural design should allow the system to cover clients within a distance long enough from the video server so the effectiveness of the system is increased.

2. What should be the communication protocol for a client to download a video from the video server?
    - Challenge: The wireless bandwidth is limited whereas a video is typically large. 802.11g, 802.11b, and Bluetooth provide maximum bandwidths of 54Mbps, 11Mbps and 1Mbps, respectively. A video server enabled with 802.11g, therefore, would not be able to deliver more than 36 1.5Mbps MPEG1 video streams simultaneously to its wireless clients. The situation is worse for 802.11b, which can only support at most seven concurrent such video streams. Consequently, how to transmit a video via wireless to a large number, say 100, of clients is challenging. We need a communication paradigm for video dissemination so the system can scale well with the size of client population.
3. How to ensure that a client can receive a video *truly* on demand?
    - Challenge: Under a significantly constrained network like a MANET, where many clients compete for limited wireless bandwidth, it is an impossible mission to satisfy all client requests instantly. However, keeping the service delay close to zero is always desired by any VOD system. A traditional way to shorten service delay in computer systems is use *cache*. The question then is what is cached, where to cache, and how to use cache, which we need to address.

It is also desirable to address other technical issues such as “is the designed system open to future wireless technologies?” and “is the system extendable to to support mobile clients with heterogeneous capabilities?” In this paper, we propose *MobiVoD*, a design for mobile VOD systems, which takes into account the aforementioned issues. Specifically, we propose to use: (1) a three-tier architecture for mobile VoD, which allows deployment of the system in a wide area, (2) a broadcast protocol based on Periodic Broadcast as the way to disseminate videos to clients, and (3) client selective-caching schemes, called *Dominating-Set*