Study on Prioritization of Network Traffic for Wireless Traffic Monitoring Systems

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Abstract

Wireless transmission, a rising computer science field, has brought numerous applications and attracted the attention of many researchers in the past few years. For traffic monitoring systems, wireless transmission extends the traffic monitoring area more diffusely. Due to high demand in wireless traffic monitoring systems, how to optimize the system, to ensure timely and accurate data transmission in every possible way, becomes a much more serious question. In this paper, we make a careful review of current wireless traffic monitoring systems: Econolite Control Products and Smart Zone System, and analyze the core issue: prioritization of network traffic in wireless transmission.

Keywords: Wireless Transmission, QoS, Real- time Transport Protocol, Network Prioritization

1. Introduction

Due to many advantages, wireless technologies apply to a lot of areas widely, particularly in data transmission, which can help increase the flexibility and reliability. Video monitoring systems based on wireless technology are adopted successfully for traffic control. Moreover, some people are working on more integrative and functional systems. For example, during the 2008 Olympic Games, Beijing's urban traffic management and the traffic organization need a distinct improvement. Therefore, intelligent traffic management system, reflecting advanced management and technology, should be instituted by 2008 [1]. As a sub-function of traffic management systems, traffic monitoring systems perform an important role as an investigator. From this point, the basic issue of monitoring systems is how to provide an efficient data transmission against some problems such as low speed wireless channels and limited bandwidth. Hence, the rest of the paper is organized as follows. In section 2, we give a general introduction about current wireless traffic monitoring systems. Section 3 describes the core problem for wireless transmission, and section 4 points out some feasible solutions. We then provide concluding comments and a discussion of future work in the final section.

2. Wireless Traffic Monitoring Systems

There has been a great deal of research and applications on wireless traffic monitoring systems. Some products like Econolite Control Products, Inc. of Anaheim, California manufactures 2.4GHz and 5.8 GHz Wireless Video and Data Transmission Systems, which provide high-resolution, real-time video and data for long or short range transmissions and work in conjunction with transportation systems, surveillance [2]. Another famous system is Smart Zone System. ADDCO, Inc. delivers the Smart Zone System, which is also a portable traffic management system that incorporates video, sensors, wireless communications, and dynamic message signs integrated throughout the work zone. Smart Zone gives (Traffic Management Center) TMC operators the ability to monitor changing traffic patterns and weather-related road conditions and immediately inform motorists via dynamic message signs. Traffic managers can use the Smart Zone to monitor and regulate work zone traffic remotely, greatly reducing the need for on-site supervision. Smart

Zone takes on the responsibility of providing driver communication updates and lets workers proceed with their jobs at hand. Motorists can look to Smart Zone messages for up-to-the-minute changes in driving conditions delivered on-site. The result is a faster, smoother flow of traffic and reduced frustration among drivers [3].

However, currently the main problem for wireless transmission is the low speed wireless channels and limited bandwidth that makes too much constraint on the transmission of growing traffic video data [4]. It is generally believed that data is generated unpredictably for various applications, and no one can guarantee that particular data will reach the destination on time. The reason is that the existence of several data flows may result in network congestion and unpredictable delays. Moreover, if all sources of the video data are downgraded uniformly, that also would degrade the video quality received from all sources. This is why we consider the issue of prioritization to address this problem. Suppose there is an accident, investigators might be interested in that particular video source where the accident occurred, and require this particular video to be of high quality for the purpose of investigation. Therefore, the normal way is to increase the frame rate and decrease the compression ratio to improve the video quality. On the contrary, this will result in increased bandwidth requirement for that particular video source. At this time, since the quality of other video sources is not really concernful, we can degrade these video sources and provide higher bandwidth to the video source where the accident occurred.

One feasible way against the problem of limited bandwidth is to adopt compression techniques at the source camera side after collecting data. Recently, there exist many commercial products for image compression, such as JPEG2000 and WaveLet. Some of them claim they can reach high compression ratio (even over 100:1) with extremely small data loss. However, there is little empirical evidence to support these high radio compression techniques for real-life traffic image/video data [5] [6]. In real wireless traffic monitoring system, high compression ratio, which achieved on test bed only, may not be practical with real traffic data. In the case of real networking circumstance, it is supposed to consider the networking hardware quality and external conditions like weathers. Also end users may find that the quality of delivered compressed data is not the same as the products claiming. The more compressed, the less pressure on the bandwidth. We can't deny the advantage of compression techniques which can decrease the huge volume of data before transmitting through wireless LANs. But, for wireless traffic monitoring systems, the most important issue is how good quality and fast image/video data users can get. Therefore, based on strict requirements of image/data quality in wireless traffic monitoring systems, we should consider other techniques to incorporate with compression techniques to improve the data transmission.

3. Network Prioritization for Wireless Traffic Monitoring Systems

Obviously, in a typical IP based computer network, congestion is unavoidable when the network bandwidth is limited, particularly in the case of wireless networks. For wireless traffic monitoring systems, this issue comes into much more focus during transmission of video or image data, which require greater bandwidth.

Prioritization of Network Traffic, as a subset of QoS, means the delivery service has different levels of priority. This can be done by assigning high priority to that particular video source. That means, all other video sources will be downgraded to provide QoS to the high priority source. It is essential to address QoS techniques into wireless LANs, which can optimize the transmission in 802.11 wireless LANs.

Firstly, we explain the IEEE 802.11 logical architecture simply. Generally, 802.11 networks consist of four main physical components: distribution system (DS), access point (AP), wireless medium (WM), and stations, which interact to support wireless LANs. IEEE 802.11 working group just defined MAC and (Physical) PHY layers (Figure 1). The objective of the MAC layer is to provide access control functions, such as, addressing, access coordination, frame check generation and checking [7]. For Kinesis system, it implants DSSS at the 2.4 GHz band, using a single spreading sequence.

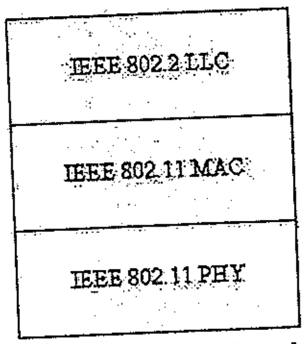

Figure 1: IEEE 802.11 Logical Architecture

The 802.11 PHY layer specifies three different transmission technologies: direct sequence spread spectrum (DSSS), frequency hopping spread spectrum (FHSS) and diffused infra red (DIR) [8]. Kinesis, a transmission system on wireless packet switching networks, is a software architecture that organizes the functionality of these basic building blocks into a unifying software application. The Real- time Transport Protocol (RTP) is a deliberately incomplete protocol framework. And any complete specification for a particular application will require, at least, a profile and a payload format specification [9] [10]. RTP has been used widely for multi-participant real-time applications over packet switched networks. As a recent style of protocol, RTP follows the principles of application level framing and integrated layer processing, and provides end-to-end network delivery services for the transmission of real-time data. RTP is network and transport-protocol independent, though it is often used over UDP. According to the requirements of wireless traffic monitoring systems, TMC always need the real time data transmission for the camera. Hence, RTP is a suitable protocol for real time transmission systems. However, if we consider the wireless LANs environment, there still some other factors which can improve the transmission greatly, for instance, the following solution: network prioritization.

4. Possible Solutions for Network Prioritization

It is necessary to introduce priority on MAC layer for different types of network traffic to wireless transmission. In other words, the possible solutions is to allocate sufficiently high priority or QoS parameters to the traffic data on MAC layer, in order to ensure its real-time delivery over the wireless network infrastructure. Since the network infrastructure is shared by many classes of traffic, it is important to treat different traffic sources based on the policies that can be customized for different types of applications. The main research issue here is to investigate the trade off between the image/video quality and real-time delivery to end users for realistic networking configuration. In a typical computer network, there are different types of data flowing simultaneously. Due to unpredictable nature of data generated by various applications, there is no guarantee that a particular data will reach the destination on time. This is because the existence of several data flows may result in network congestion and unpredictable delays [11]. Therefore, it is necessary to provide certain assurance or guarantee to ensure that a particular data will always reach the destination within a given time interval. Lots of works have been done in order to solve these problems, which concern much more with efficient compression techniques and how to incorporate QoS techniques into the network.

Based on the destination IP address and port number, we can assign different priorities to different network connections. So, we need to configure the application in such a way that a particular video source receives higher priority than other sources during congestion. Under such a configuration during congestion the high priority traffic is allocated more bandwidth in order to get the particular good quality video. Also, considering the Carrier Sense Multiple Access with Collision Avoidance (CSMA/CA), this mechanism is needed to ensure that mission-critical data reaches the destination on time since a delayed transmission may render them useless. CSMA/CA or the Distributed Coordination Function (DCF) provides an equal transmission opportunity for the stations which are ready to transmit a frame. CSMA/CA makes attempts to avoid packet collisions by using explicit packet acknowledgement (ACK), which means that an ACK packet is sent by the receiving station to confirm that a packet arrived intact. In wireless transmission system, package error rate (PER) depends on the distance and the obstructions between the transmitter and receiver. The IEEE.802.11 wireless LAN devices support multiple data rate with dynamic rate switching capability to improve the performance. And if the multiple mechanisms are used under the CSMA/CA, the system capacity will be decreased because the low rate transmission consumes such amount of time. Therefore, the time for high rate transmissions will be decreased as the number of low rate transfer method for 802.11 wireless LANs that support multi-rate capability by using a priority control mechanism. Therefore, in such situations, Quality of Service techniques play a key role in providing reliable and quality service. This is made possible by incorporating Quality of Service techniques in the network.

5. Conclusions

This paper investigates the wireless transmission, which is the core issue for wireless traffic monitoring system. Through reviewing several current traffic monitoring systems,analysing network prioritizations and 802.11 wireless structures, we propose possible solutions on a mechanism with priority control on MAC layer, which can improve the performance of wireless transmission.

6. References

[1] *Transport Construction and Traffic Management Plan,*

http://en.beijing-2008.org/04/48/article211614804.shtml,

Beijing 2008 Olympic Games.

[2] *Say Goodbye to Wires: Traffic Video and Data Transmission Systems Cut Loose,*

http://www.itsa.org/itsnews.nsf/0/354c069e8502c42885256bc200542ca9?OpenDocument,

Anaheim, Calif, May 2002.

[3] *Smart Traffic Management Relies on Your Ability to Manage the Bigger Picture.*

http://www.addcoinc.com/t_smart.htm,
ADDCO, Inc.

[4] *Wireless LANs: How feasible?*

http://www.zdnetindia.com/biztech/services/whitepapers/stories/17979.html,
Tele.com Bureau, March 2001.

[5] D.S. Taubman. and M. Marcellin, *Jpeg2000: Image Compression Fundamentals, Standard, and Practice,* Kluwer, 2001.

[6] Amara Graps, *An Introduction to Wavelets*, IEEE Computational Science and Engineering, vol.2, no.2, 1995.

[7] ISO/IEC, and ANSI/IEEE, "ISO/IEC 8802-11; ANSI/IEEE Std. 802.11, 1999 edition, Information Technology – Telecommunications and Information Exchange Between Systems – Local and Metropolitan Area Networks – Specific Requirements – Part 11: *Wireless LAN Medium Access Control (MAC) and Physical Layer (PHY) Specifications*, 1999.

[8] J. Ala-Laurila, J. Mikkonen. and J. Rinnemaa, *Wireless LAN access network architecture for mobile operators, IEEE Communications Magazine*, vol. 39, no. 11, pp. 82 – 89, Nov 2001.

[9] H. Liu. and M. El Zarki, *Performance of H.263 Video Transmission over Wireless Channels Using Hybrid ARQ*, IEEE JSAC, vol 15, no.9, pp.1775-1786, Dec 1997.

[10] H.Schulzrinne, S.Casner, R. Frederick. and V. Jackson, *RTP: A transport protocol for real-time application*", RFC1889, July 1997.

[11] Y. Charfi, R. Hamzaoui. and D. Saupe, *Model-based real-time progressive transmission of images over noisy channels*, Proc. WCNC-2003 IEEE Wireless Communications and Networking Conference, New Orleans, LA, March 2003.

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