EFFECTS OF TRANSFERRING DATA TRAFFIC ON VIDEO TRAFFIC IN WIRELESS ATM CHANNELS

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ABSTRACT

Wireless ATM (WATM) aims at providing transmission of different type of traffics such as voice, data and video over wireless medium. It takes advantage of high bit rate and Quality of Service (QoS) guaranteed data transfer that is already well achieved by ATM technology in wired medium. A WATM MAC layer is employed to effectively utilize the shared wireless medium resources by multiple users. The MAC layer must provide support for standard ATM services including UBR, ABR, VBR and CBR traffic classes with QoS. In this work, a WATM MAC protocol called MAC–GB using TDMA/FDD technique is utilised and a comparative simulation study of video transfer applications together with data transfer applications are presented, followed by analysis of effects of transferring data traffic on video traffic in shared WATM channels.

I. INTRODUCTION

In the last years the importance of wireless/mobile data communication has increased along with the developments in wireless computers with high performance and other mobile communication systems. Nowadays, support of high bandwidth, low cell loss ratio, low delay and delay variation requirements of real time multimedia applications such as video, voice, interactive services has been exactly expected from the underlying wireless communication infrastructure [1-3].

Providing wireless communications requirements is quite difficult compared to wire communication due to radio signal noise, interference, multipath fading, low bandwidth, protection of connection continuity, high data loss ratio. At the present time, classic wireless technologies are insufficient for QoS support requirements of real-time multimedia applications.

QoS requirements of multimedia applications have been provided by ATM technologies accepted as the standard for B-ISDN in wired medium. ATM supports multimedia traffics from a few Kbit/s to a few Mbit/s bandwidths, continuous, constant rate (such as file transfer) and high burst (interactive data and video etc.) necessities. Success of ATM in wired networks with wide bandwidth and operation at high data rates (155─600 Mbit/s) has resulted in an important acceleration for its applicability research in WATM.

WATM is applicable in fixed base station and also can be applied in relatively more complex systems with mobile base stations or more simple systems without any base station. WATM network components differ from each other according to employed system. Usually a WATM system consists of mobile terminals and fixed base station that controls the communication between mobile terminals (Figure 1).

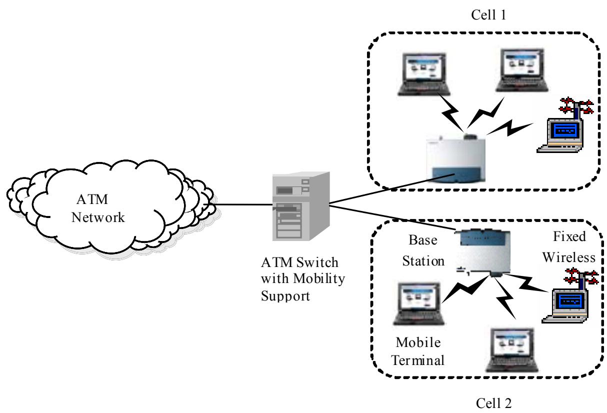


Figure 1. WATM network structure.

WATM protocol architecture requires additional features to the existing protocol structure of ATM such as radio access and mobility features due to requirements of wireless communication medium. A MAC (Medium Access Control) layer providing effective allocation of medium resources shared by many different users and a

DLC (Data Link Control) layer providing flow and error control for wireless communication medium, physical layer and wireless control layer are inserted into the ATM protocol structure as shown in Figure 2.

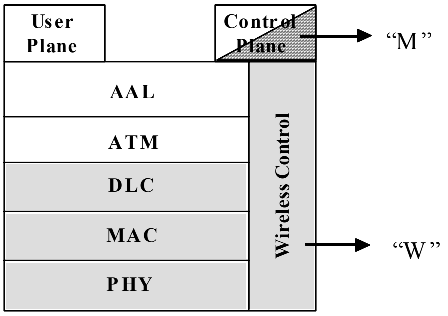


Figure 2. WATM protocol architecture.

WATM technology has aimed at offering multimedia applications a QoS guaranteed data transfer. For this reason a MAC protocol has to be employed for multimedia applications for the required level of QoS. For a WATM MAC layer, any standard has not been accepted by the ATM Forum. Nowadays, there are a lot of studies about this issue. Well-known MAC techniques are classified according to three different parameters (Figure 3). These are the transmission medium duplex usage, channel sharing and multiplexing [1-6].

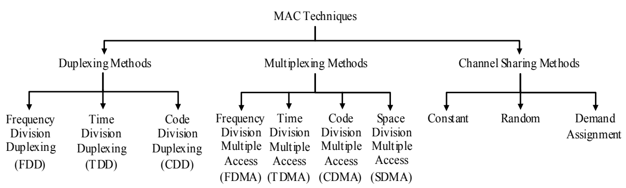


Figure 3. Classification of MAC techniques.

WATM must provide QoS parameters such as cell transfer delay, delay variation and cell loss ratio. Therefore MAC protocol uses a demand assignment method. In this method, the wireless terminal uses an uplink control channel to demand or reserve for access channel. Considering this demand the base station allocates required bandwidth to the wireless terminal. Several MAC protocols have been defined for WATM such as; MAC-GB, DQRUMA, E–PRMA, MASCARA, MDR–TDMA, DSA++, PRMA/DA etc. in literature [2, 6, 7].

In this work, we have examined the effects of transferring data traffic on video traffic using the MAC-GB (Medium Access Control-Guaranteed Based) WATM protocol based on TDMA/FDD (Time Division Multiple Access/Frequency Division Duplexing) technique [4].
The paper is organized as follows. Section 2 provides an overview of MAC-GB protocol for the underlying WATM network. Section 3 includes the characteristics of the multimedia application traffics. Section 4 explains a WATM network utilizing the MAC-GB technique, which has been modeled and simulated under different data and video traffic loads using a commercially available program called OPNET Modeler with Radio Module, followed by final remarks in Section 5.

II. MAC-GB PROTOCOL

A MAC protocol in wireless communication should be used to allocate the limited bandwidth to wireless terminals (WTs) efficiently. Several MAC schemes have been proposed in the literature for managing multimedia traffics in WATM systems. WATM technology promises to provide QoS guarantees for multimedia applications together with traditional services. A demand assignment MAC technique for WATM should be considered to maintain the bursty traffic natures of such applications. In such technique a user terminal needs a control channel in uplink direction to request access channel from a BS and then the BS assigns bandwidth for this request if there is enough resource which can support required level of QoS [4].

In MAC-GB protocol, a demand assignment scheme is employed to support real-time multimedia applications. As a multiplexing technique, TDMA is preferred due to its superiority and suitability for multimedia traffics. In the MAC-GB protocol, radio spectrum is divided into time slots that are assigned to different connections where a user application can send data only in its own dedicated slots. Due to the FDD duplexing technique utilized, two distinct carrier frequencies are used for the uplink and downlink channels (Figure 4). When a WT needs to communicate with any other, initially it asks for a transmission channel from the BS. According to the QoS requirements of this connection request, the BS assigns adequate number of time slots for this connection using a dynamic Slot Allocation Table (SAT) that is scheduled with an algorithm based on ATM service classes. If there are not enough slots for the request, a connection can not be established with required QoS guarantees [4].

III. MULTIMEDIA APPLICATION TRAFFICS

Data, voice and video are applications with diversely changing characteristics. These characteristics are determined with respect to the QoS parameters. Main parameters effecting QoS are cell loss ratio (CLR), cell transfer delay (CTD) and cell delay variation (CDV). Sensitivity of the different types of applications to these parameters is shown in Table 1. Voice and video traffics are real-time applications and therefore in this type of traffics continuity of transmission and delay variation between cells are of high importance. On the other hand, regardless of high delays, for a data transmission the less the data loss the better the overall result is [3-7].

Video transfer is an application sensitive to cell loss, cell delay, cell loss variation and bandwidth requirement, which may show sudden variations and fluctuations in frame sizes. Therefore it requires a VBR (Variable Bit Rate) service support. Also data transmission uses UBR (Unspecified Bit Rate) service support where no QoS guarantee is required.

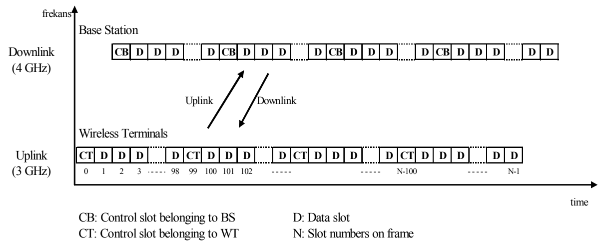


Figure 4. MAC-GB protocol frame structure.

Table 1. QoS parameters for various applications.

Traffic Type	Cell Loss Ratio (CLR)	Cell Transfer Delay CTD)	Cell Delay Variation (CDV)
Data	Very sensitive	Not sensitive	Not sensitive
Voice	A little sensitive	Very sensitive	Very sensitive
Video	A little sensitive	Very sensitive	Very sensitive

IV. MODELLING AND SIMULATION

In this section, we present the simulation model of the WATM network utilizing the MAC-GB protocol, which is mainly used to evaluate the effects of transferring data traffic on video traffic in shared WATM channels.

The WTs in the example scenario implemented using OPNET Modeler (Figure 5), employ the TDMA/FDD based MAC-GB protocol briefly explained in Section 2 to communicate with each other in the same wireless environment.

In the simulation model, there are 20 WTs on which two different kinds of applications (namely pure data and compressed video) operate to generate and receive traffics. There is only one type of application running at the same time on each WT. The data traffic introduced to the network by any WT is randomly destined to another WT. One of these applications is set to create data transfer traffic requiring ATM UBR service while the other is set to produce compressed video transfer traffic requiring ATM VBR service. For example, a compressed video application traffic originated from the K1 is transferred to the H9 over a connection with a VBR service support sensitive to delay and delay variation (jitter). Similarly, a data application traffic originated from the K6 is transferred to the H1 over a connection offering a UBR service with no QoS guarantees. It should be noted that in a real-life situation every WT will not generate data or video sources at a given time. Simulation parameters are given in Table 2.

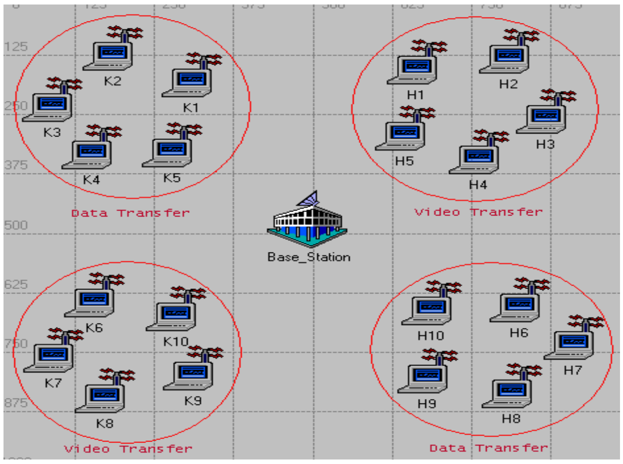


Figure 5. WATM network simulation model.

Table 2. Simulation parameters.

Traffic Sources	50000—350000* (Byte/s)
Uplink/Downlink Bit Rate	25 Mbit/s
Frequency Band	Uplink = 3 GHz and Downlink = 4 GHz
Transmitter Power	BS = 100 mW and WTs = 100 mW
Modulation Scheme	QPSK
UBR Parameters	PCR = 50 Kbyte/s
VBR Parameters	SCR = 85 KByte/s, PCR = 110 KByte/s, CTD = 100 ms, CDV = 1 ms
Channel Model	Free Space Propagation Model (LoS)
** Generated using Exponential Distribution Function; Exp (**Mean**).*	

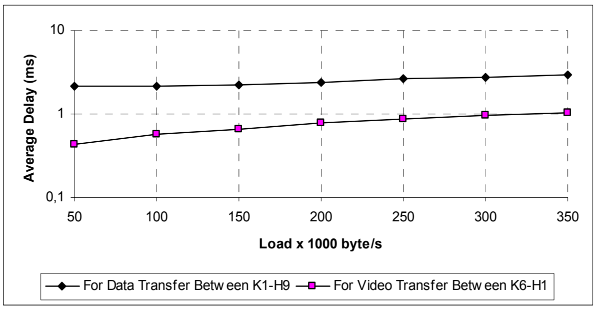
V. SIMULATION RESULTS AND PERFORMANCE ANALYSIS

Simulation results of WATM model described above are presented under varying network load conditions introduced by the pure data and compressed video traffic sources, followed by performance comparisons and evaluation.

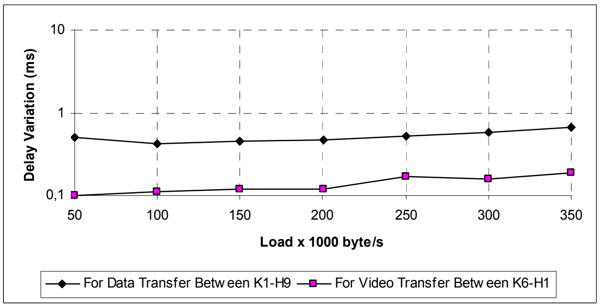
To examine the QoS support including UBR and VBR service classes of MAC-GB protocol, under varying data and video traffic loads end-to-end average delay, delay variation, and maximum delay parameters are of interest. Simulation results have been obtained for the wireless communication of the K1-H9 and K6-H1 terminals varying the data and video traffic loads from 50000 byte/s to 350000 byte/s.

End-to-end average delay results of data traffic transfer between K1-H9 and of video traffic transfer between K6-H1 are shown in Figure 6-a. At the minimum load amount (50000 byte/s) the average delay for UBR service supported traffic (i.e., data traffic between K1-H9) is 2.15 ms and for VBR service supported traffic (i.e., video traffic between K6-H1) is 0.44 ms. At the maximum load amount (350000 byte/s) average delay for VBR traffic service supported is measured as 1.05 ms while for UBR traffic service supported is 3 ms. According to these results at the minimum load amount, end-to-end average delay of data traffic transfer is about 5 times greater than that of video traffic transfer. This ratio lessens to 3 at the maximum load of 350000 byte/s.

Figure 6-b shows end-to-end delay variation results of data traffic transfer between K1-H9 and of video traffic transfer between K6-H1. At the minimum load amount (50000 byte/s) the delay variation ration between UBR service supported traffic (i.e., data traffic between K1-H9) and VBR service supported traffic (i.e., video traffic between K6-H1) is almost 5 and it is decreased to 3.5 as the load reaches maximum level.



(a)



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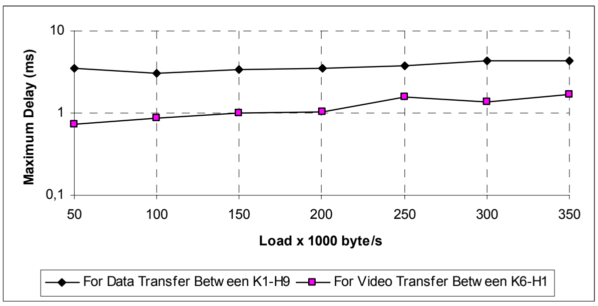

(c)

Figure 6.a) End-to-end average delay results under varying data and video traffic loads.
b) End-to-end delay variation results under varying data and video traffic loads.
c) Maximum delay results of UBR and VBR traffics under varying traffic loads.

Figure 6-c illustrates end-to-end maximum delay results of data traffic transfer between K1-H9 and of video traffic transfer between K6-H1. As shown, in all load conditions end-to-end maximum delay of VBR service supported traffic (i.e., video traffic between K6-H1) is always smaller that of UBR service supported traffic (i.e., data traffic between K1-H9).

From the simulation results presented in Figure 6, a simple conclusion can be easily driven that considering the different natures of the data and video traffic transfers in a wireless channel offering QoS support through ATM service classes, all average delay, delay variation and maximum delay results of VBR service supported traffic are better than those of the same loads of UBR service supported traffic. As the main focus of this work, also the study is extended to include the simulation results to analyse effects of the data traffic transfer on video traffic. For this purpose keeping the video traffic load constant (i.e., 200000 byte/s), data traffic load is varied from 50000 byte/s to 350000 byte/s in the wireless terminals. Figure 7 depicts the obtained average delay, delay variation and end-to-end maximum delay results of video traffic transfer between K6-H1, which are normalized with of those of their counterparts given in Figures 6-a, 6-b, and 6-c respectively. From the graphs it can be worked out that varying data traffic load has somewhat affected all end-to-end delay results of the video traffic. This is especially recognizable in delay variation results; for example, when the data traffic load is 100000 byte/s, increase in video traffic delay variation is about 33%. Thus, an important conclusion has to be pointed out that while data traffic and video traffic are transferred with UBR and VBR services respectively, changes in data traffic load have still negative effects on delay characteristics of the other. However, the video traffic has been transferred under the required level of delay remains true as the results meet the real-time criterion.

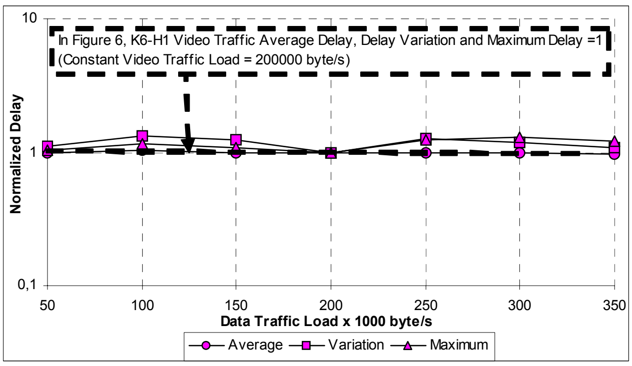

Figure 7. Normalized delay results for VBR traffics under varying UBR traffic loads.

VI. CONCLUSION

In this work, a WATM network model utilising the MAC-GB medium access control protocol has been constituted to transfer data and compressed video traffics using OPNET Modeler software. Having examined the effects of extremely changeable loads of data traffic transfer on video traffic transfer in wireless channels, two main conclusions are driven. The first is that use of a different service class for each traffic type improves the overall delay results of the video traffic transfer naturally. The second is that changing the data traffic loads has a very limited effect on end to end delay results of the video traffic.

REFERENCES

1. Raychaudhuri D., Wireless ATM Networks Technology Status and Future Directions. In Proceedings of IEEE, Vol 87 (1999) 1790-1805.
2. Ayanoglu E., Wireless Broadband and ATM Systems. Computer Networks, Vol 31, (1999) 395-409.
3. Hac A., Multimedia Applications Support for Wireless ATM Networks. Prentice Hall (2000).
4. Ceken C., Erturk I., Bayilmis C., A New MAC Protocol Design for WATM Networks, Lecture Notes in Computer Science, LCNS 3261 (2004), 564-574.
5. Sanchez J., Martinez R., and Marcellin M. V.: A Survey of MAC Protocols Proposed for Wireless ATM. IEEE Network, Vol 11, No 6 (1997) 52-62.
6. Akyıldız I. F., McNair J.: Medium Access Control Protocols for Multimedia Traffic in Wireless Networks. IEEE Network Magazine, Vol 13, No 14 (1997) 39-47.
7. Ceken C., Erturk I., Bayilmis C.: Non-Real Time Data Transferring With WATM. University of Suleyman Demirel, Journal of Science Institute (2004) 102–108.