UNIVERSITI PUTRA MALAYSIA

SOFTWARE DEVELOPMENT FOR CONVERSION OF IP TO WIRELESS ATM (WATM)

SWARNAPPA CLEMENT SUDHAKAR

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By

SWARNAPPA CLEMENT SUDHAKAR

Thesis Submitted to the School of Graduate Studies, Universiti Putra Malaysia, in Partial Fulfillment of the Requirements for the Degree of Master of Science

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To my Dear parents who taught me to talk
And my Beloved Teachers who taught me to walk

Abstract of thesis presented to the senate of Universiti Putra Malaysia in fulfillment of the requirements for the degree of Master of Science

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SWARNAPPA CLEMENT SUDHAKAR

September 2002

Chairman : Associate Professor Borhanuddin Mohd. Ali, Ph.D.

Faculty : Engineering

To meet the anticipated and high demand for wireless access to the broadband Asynchronous Transfer mode (ATM) network, the concept of wireless ATM has been proposed in 1994. One of the main challenge in the design of the Wireless ATM network resides in the formation of the Wireless MAC protocol, that could handle various services with a considerable QoS and providing efficient utilization of the Wireless Channel.

In this thesis, we propose the conversion algorithm that leads to a WATM packet assuming to use the TCP/IP protocol as the source. The project considers the various aspects of carrying IP over a WATM channel, by retransforming the IP data to a WATM cell, ready to be transmitted over a wireless channel.

Analysis and simulation shows various advantages and disadvantages in the above-mentioned method when performed using software. Furthermore, discussion about the hardware methods of implementing communication protocols shows a way for the engineer to choose the right method for his future development of the protocols for implementation.

Finally, this algorithmic approach is proposed to integrate this approach to simulate the methodology of IP to WATM conversion.

Abstrak tesis yang dikemukakan kepada Senat Universiti Putra Malaysia sebagai memenuhi keperluan untuk ijazah Master Sains

PEMBANGUNAN PERISAN BAGI PERTUKARAN IP KEPADA WAYARLES ATM (WATM)

Oleh

SWARNAPPA CLEMENT SUDHAKAR

September 2002

Pengerusi : Profesor Madya Borhanuddin Mohd. Ali, Ph.D.

Fakulti : Kejuruteraan

Sebagai memenuhi jangkaan yang tinggi bagi capaian jalur lebar wayarles rangkaian ATM, konsep wayarles ATM telah diketengahkan pada tahun 1994. Satu daripada cabaran utama di dalam rekaentuk rangkaian ATM tanpa wayar ialah pembentukan protokol MAC tanpa wayar yang dapat mengendalikan berbagai jenis kemudahan dengan QoS yang munasabah dan juga memberi penggunaan saluran wayarles yang cekap.

Di dalam tesis ini, kami mengutarakan algoritma tukaran bagi menuju paket WATM dengan menggunakan protokol TCP/IP sebagai asas. Projek ini menimbangkan berbagai aspek bagi membawa IP di atas WATM dengan pertukaran data IP kepada sel WATM, yang untuk dihantarkan di atas saluran tanpa wayar.

Analisa dan simulasi menunjukkan berbagai kebaikan dan keburukan bagi cara di atas apabila dikendalikan dengan perisian. Tambahan pula, perbincangan mengenai cara-cara perkakasan bagi menjayakan protokol komunikasi dapat menunjukkan cara terbaik bagi para jurutera untuk memilih bagi pembangunan masa depan protokol yang hendak dijayakan akhit sekali, pendekatan algorithma ini diketengahkan untuk menyepadukan cara ini sebagai satu simulasi tentang cara penukaran IP kepada WATM.

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Last, but not the least, my dear wife, parents and the rest in family, your support was never less than discrete, thank you all.

I certify that an Examination Committee met on 5th September 2002 to conduct the final examination of Swarnappa Clement Sudhakar on his Master of Science thesis entitled "Software Development for Conversion of IP to Wireless ATM (WATM)" in accordance with Universiti Pertanian Malaysia (Higher Degree) Act 1980 and Universiti Pertanian Malaysia (Higher Degree) Regulations 1981. The Committee recommends that the candidate be awarded the relavant degree. The members of the Examination Committee are as follows:

ABDUL RAHMAN RAMLI, Ph.D.,
Lecturer,
Department of Computer and Communication Systems Engineering.
Faculty of Engineering.
Universiti Putra Malaysia.
(Chairman)

BORHANUDDIN MOHD ALI, Ph.D.,
Associate Professor,
Department of Computer and Communication Systems Engineering
Faculty of Engineering
Universiti Putra Malaysia
(Member)

VEERARAGHAVAN PRAKASH, Ph.D.,
Lecturer,
Faculty of Engineering
Universiti Putra Malaysia.
(Member)

NOR KAMARIAH NORDIN
Lecturer,
Department of Computer and Communication Systems Engineering
Faculty of Engineering
Universiti Putra Malaysia.
(Member)

SHAMSHER MOHAMAD RAMADILI, Ph.D.
Professor/Deputy Dean
School of Graduate Studies,
Universiti Putra Malaysia

Date: 9 OCT 2002

This thesis submitted to the Senate of Universiti Putra Malaysia has been accepted as partial fulfillment of the requirements for the degree of Master of Science. The members of the Supervisory Committee are as follows.

BORHANUDDIN MOHD ALI, Ph.D.,
Associate Professor,
Department of Computer and Communication Systems Engineering
Faculty of Engineering
Universiti Putra Malaysia
(Chairman)

VEERARAGHAVAN PRAKASH, Ph.D.,
Lecturer,
Faculty of Engineering
Universiti Putra Malaysia.
(Member)

NOR KAMARIAH NORDIN
Lecturer,
Department of Computer and Communication Systems Engineering
Faculty of Engineering.
Universiti Putra Malaysia.
(Member)

AINI IDERIS, Ph.D.,
Professor/Dean,
School of Graduate Studies,
Universiti Putra Malaysia

Date:

DECLARATION

I hereby declare that the thesis is based on my original work except for quotations, and citations which have been duly acknowledged. I also declare that it has not been previously or currently submitted for any other degree at UPM or other institutions.

Swarnappa Clement Sudhakar

Date: 09. 10 . 2002

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AP	Access Point
ARP	Address Resolution Protocol
ABR	Available Bit Rate
ACK	Acknowledge
ATM	Asynchronous Transfer Mode
B	
B-ICI	Broadband Intercarrier Interface
BSA	Basic Service Area
BSS	Basic Service Set
C	
CBR	Constant Bit Rate
CBO	Continuous Bit Stream Oriented Services
CCITT	Commite' Consultatif International de Telecommunications
CF	Contention Free Period
CIDR	Class InterDomain
CSMA/CA	Carrier Sense Multiple Access/ Collision Avoidance
CSMA/CD	Carrier Sense Multiple Access/ Collision Detection
CTS	Clear to Send
D	
DBPSK	Differntial Binary Phase Shift Keying
DCF	Distributed coordination Function
DCF-IFS	Distributed coordination Function –IFS (Refer IFS)
DSSS	Direct Sequence Spread Spectrum
DTBS	Distributed Time Bounded Services
DLC	Data Link Control
DXI	Data Exchange Interface
DQPSK	Differential Quadrature PSK (Refer PSK)
E	
ESS	Extended Service Set

ESTI	European Telecommunication Standards Institute
F	
FCC	Federal Communications Commission
FHSS	Frequency Hopping Spread Spectrum
G	
GMSK	Gaussian Minimum Shift Keying
H	
HLEN	Header Length
I	
IP	Internet Protocol
IBSS	Independent BSS (Refer BSS)
ICMP	Internet Control Message Protocol
IEEE	Institution of Electrical and Electronics Engineers
ISM	Industrial, Scientific and Medical Board
IFS	Intra Frame Space
L	
LAN	Local Area Network
M	
MAC	Medium Access Control
MBS	Mobile Broadband Systems
N	
NAV	Network Allocation Vector
NNI	Network Node Interface
O	
OS	Operating System
OSI	Open System Interconnection
OFDM	Orthogonal Frequency Division Multiplexing
P	
PC	Point Coordinator
PCF	Point Coordination Function
PDU	Protocol Data Unit

PHI	Physical Layer Interface
Q	
QoS	Quality of Service
R	
RFC	Request for Comment
RTS	Request to Send
S	
SAR	Segmentation and Reassembly Sublayer
SIFS	Short IFS (Refer IFS)
SN	Sequence Numbering
STM	Synchronous Transfer Mode
T	
TCP	Transmission Control Protocol
TDMA	Time Division Multiple Access
TTL	Time to Live
U	
UDP	User Datagram Protocol
UNI	User Node Interface
UMTS	Universal Mobile Telecommunication System
V	
VBR	Variable Bit Rate
VCI	Virtual Channel Identifier
VPI	Virtual Path Identifier
W	
WATM	Wireless ATM (Refer ATM)
WLAN	Wireless LAN (Refer LAN)

CHAPTER 1

INTRODUCTION – A PROPOSED SCHEME FOR IP PACKET TO WATM CELL CONVERSION ALGORITHM

1.1 Introduction

In recent years, we have seen the development of two major trends in the telecommunication world: the evolution of the wireline network to support broadband multimedia services and the increasing success of personal communication systems. We can thus expect an increasing demand in the future to connect mobile services to the broadband wired network.

Asynchronous Transfer Mode (ATM) [6] has been proposed by CCITT to be the transfer protocol of the current Broadband Integrated Services Digital Network (B-ISDN) [46]. To extend the capabilities of ATM over the wireless channel, the concept of wireless ATM (WATM) [22] was first proposed in 1994. In order to remain compatible with the wired ATM network, the wireless hop must support the standard ATM service classes. Namely, Constant Bit Rate (CBR), Variable Bit Rate (VBR), and Available Bit Rate (ABR) traffic [42], which will be discussed later in Chapter 2. However, the development of ATM assumed a fixed wireline network with characteristics that are not shared with the hostile wireless environment.

For example, Asynchronous Transfer Mode is characterized by a high bandwidth, low error rate and time- invariant channel while Wireless ATM has to considered to provide a limited bandwidth, is error prone and has to face a time varying broadcast

radio medium. Some of the most crucial issues in the conception of an efficient WATM network are the design of the physical layer, data link layer, medium access control (MAC) [22],[28], protocol and mobility management functions [34],[37],[41]. In this project, we mainly consider the discussion on the WATM technology and the formation of the Wireless ATM cell which will be transmitted through a wireless medium.

The project assumes that IP transmitted over a wireless medium is noise free and hence, does not cover the discussions on noisy environments. Furthermore, as explained in the later chapters, the project assumes the availability of TCP/IP [4] as a standard Internet protocol for obtaining packets, which are further converted to WATM packet for transmission.

1.2 Motivation

In wired networks, adjacent nodes are joined by point-to-point communication links. Thus the received message at one end of the link only depends on the transmitted message at the other end. On the other hand, in a Wireless Local Area Network (WLAN), the signal that is received at the base station consists of the transmitted message from a set of mobiles. There is a need in such an environment for a Medium Access Control Protocol (MAC) [28] to efficiently and equitably allocate the multi access scarce radio medium among the competing mobile nodes. In a wireless ATM environment, the MAC protocol must support, at reasonable QoS levels, mobiles transmitting heterogeneous ATM traffic while maintaining high radio channel utilization. Furthermore, the required bandwidth for many ATM services is

time varying; the wireless ATM MAC protocol must therefore adapt the channel allocation to these traffic variations.

In the past couple of years, several projects have developed MAC protocols for WLANs. Among those, we can highlight the IEEE 802.11 WLAN [15] and HIPERLAN [27] standard MAC protocols. However, they cannot be used, as they are to provide a WATM service. Their main problem is the lack of priority of delay sensitive packets. Other MAC protocols have been specifically designed to implement WATM technology [22].

Three major WATM types were developed by Lucent [13], NEC [3] and the Magic Wand [3],[58] Project. Most of these prototypes used centrally control demand assignment MAC protocols and is designed to support CBR, ABR and VBR traffic. However, only a few resource allocation schemes that efficiently integrate these ATM traffic classes have been proposed.

It is necessary to note that the current situations use ATM technology at the UNI of the WATM network and WATM technology at the NNI [53] of the WATM network. This involves a mix of both the ATM and WATM technologies considering the whole network. This of course increases the cost and complexity of the whole problem. If one realizes the situation, the design and implementation of a WATM card can obtain a more cost-effective solution. This gives way to transmit and receive WATM packets at the UNI [52] of the WATM network thereby avoiding the usage of a ATM switch and handover circuits which is necessary for the conversion of the wired ATM cell to a wireless ATM cell. However, it is to be accepted that the

Wireless ATM technology has a slow pace of development due to its increased cost of implementation and limitations. Some of the reasons of this slow pace in research could be summarized as follows

- Some of the obstacles to realizing the full benefit of WATM include the present lack of standards, cost and complexity in implementation, and the amount of overhead. It is believed that increased radio bandwidth allocation, emerging reliable and QOS-oriented protocols, along with error-control protocols for wireless ATM, will help in deploying wireless ATM to support mobile applications.

- Since ATM is a connection-oriented technology, rerouting has to be performed after a mobile user moves to a new location. The connection rerouting schemes can be based on, setting up a new connection, providing multiple paths to a mobile user, forwarding ATM cells, or dynamically rerouting the connection. The wireless ATM network should have the information about the current location of mobile hosts to route or reroute ATM connections. Any change in location information should be reflected in the storage system, a location database, and the new location information should be available to the network when a connection to a mobile host needs to be set up or rerouted.

- When ATM cells are transmitted over wireless links, a high rate of cell loss may occur. Possible ways to counteract the cell loss include the use of forward error-correction algorithms or the use of an error detection scheme such as cyclic redundancy control. This should be followed by buffering and

selective retransmission of ATM cells. The retransmission and possible re-sequencing of ATM cells will require the use of sequence number in ATM cells. It may be possible to package sequence number, error-control overhead, and a 53-byte ATM cell together in a larger WATM cell..

However an attempt is being made in the implementation of WATM from IP that would possibly reduce cost and solve various other implementation issues. The first step in such a realization could be to implement an algorithm that would aim to implement a WATM cell at the UNI of the network. This in the future could be converted to a single chip solution for a WATM card. This could be observed as a very cost-effective solution to implement a WATM network, and could also pave way to a Wireless Personal Area Network (WPAN) [16]. This thesis proposes such a software algorithm to implement a WATM cell construction from IP. It could also be simply explained as a IP over a WATM [58] channel. To achieve this task, a series of objectives need to be fulfilled. They have been summarized below.

- To capture IP packets, which would be used as the base, source data for the Algorithm – This would involve the development of a packet capture algorithm, which sniffs the presently available Ethernet and captures packets in a real time mode.

- To convert the IP to ATM cells - This is achieved in two stages. This thesis proposes to use the IP over ATM method. Hence, as the first stage, it is required to form the ATM Adaptation Layer 5 (AAL5) Common Part Convergence Sub Layer (CPCS) PDU in order to ensure that the ATM PDU formed is all of equal

length. This AAL5 CPCS PDU is then spliced to a 48 byte ATM PDU. The 5-byte ATM header is formed and appended to the ATM packet thereby forming the ATM cell. However this is only an intermediate stage, which is not necessary for the proposal.

- To design a Cell conversion algorithm that would be used to form the WATM cell involves the conversion of a ATM cell to a WATM cell. The algorithm mainly concentrates in stripping the ATM header, and forms a new WATM header and appends to the ATM cell.

In order to meet these objectives, it is necessary to use C++ language for object program development. Support tools like the Microsoft Developers Network library, Microsoft Software Development Kit is used. Furthermore, the algorithm has been developed using Microsoft Visual C++ V6.0 and operates on the Windows 2000 OS environment.

1.3 The Organization Of This Thesis

This thesis is subdivided into various chapters. Chapters 1 and 2 discuss the evolution of the wireless technology and wireless LANs. It also shows some clear definitions about IP in networking, packet formation that forms the basic data source of this project.

Chapter 2 also summarizes the extensive work done in the literature study. Various concepts of IP packet, various algorithms and techniques in IP networks are discussed. During the course of the literature review work, we also cover the areas

of ATM, its challenges to the future, and its future based on the introduction of WATM networks.

Chapter 3 summarizes the various methodologies involved in the work to convert the IP packets to WATM cells. The chapter covers the algorithms involved in the capture of an IP packet for conversion, conversion of IP to ATM and conversion of ATM to WATM. There is also a highlight of the general structure of the algorithm using diagrams, which clearly explains the concept trying to be achieved.

Chapter 4 includes the software routines used in the thesis in the form of modules. The codes are implemented using Microsoft C++ Version 6 with the Microsoft Software Development Kit installed on a computer running Windows 2000 operating system.

Chapter 5 discusses the results of the study conducted and analyses the advantages and disadvantages of this method. It also reports the summary of the project and recommends a future work plan.

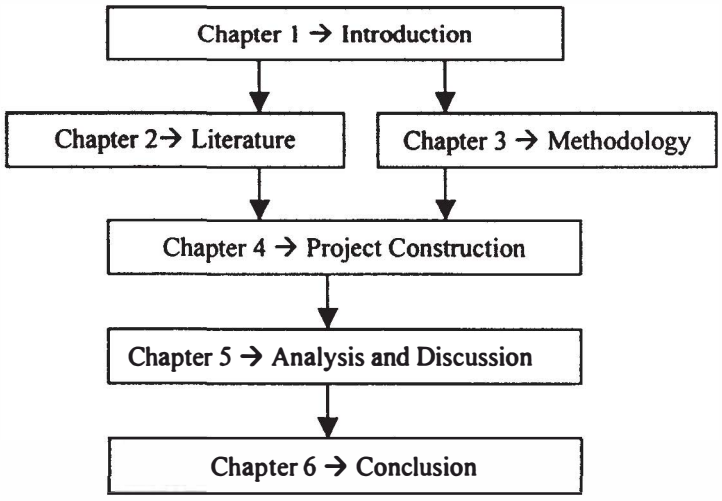

Figure 1.1: The Structure of this Thesis