PROTOCOL DESIGN FOR REAL TIME MULTIMEDIA COMMUNICATION OVER HIGH-SPEED WIRELESS NETWORKS

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ABSTRACT

The growth of interactive multimedia (IMM) applications is one of the major driving forces behind the swift evolution of next-generation wireless networks where the traffic is expected to be varying and widely diversified. The amalgamation of multimedia applications on high-speed wireless networks is somewhat a natural evolution. Wireless local area network (WLAN) was initially developed to carry non-real time data. Since this type of traffic is bursty in nature, the channel access schemes were based on contention. However real time traffic (e.g. voice, video and other IMM applications) are different from this traditional data traffic as they have stringent constraints on quality of service (QoS) metrics like delay, jitter and throughput. Employing contention free channel access schemes that are implemented on the point coordination function (PCF), as opposed to the numerous works on the contending access schemes, is the plausible and intuitive approach to accommodate these innate requirements. Published researches show that works have been done on improving the distributed coordination function (DCF) to handle IMM traffic. Since the WLAN traffic today is a mix of both, it is only natural to utilize both, DCF and PCF, in a balanced manner to leverage the inherent strengths of each of them. We saw a scope in this technique and develop a scheme that combines both contention and non-contention based phases to handle heterogeneous traffic in WLAN. Standard access scheme, like 802.11e, improves DCF functionality by trying to emulate the functions of PCF. Researchers have made a multitude of improvements on 802.11e to reduce the costs of implementing the scheme on WLAN. We explore improving the PCF, instead, as this is more stable and implementations would be less costly. The initial part of this research investigates the effectiveness of the point coordination function (PCF) for carrying interactive multimedia traffic in WLAN. The performance statistics of IMM traffic were gathered and analyzed. Our results showed that PCF-based setup for IMM traffic is most suitable for high load scenarios. We confirmed that there is a scope in improving IMM transmissions on WLAN by using the PCF. This is supported by published researches on PCF related schemes in carrying IMM traffic on WLAN. Further investigations, via simulations, revealed that partitioning the superframe (SF) duration according to the need of the IMM traffic has considerable impact on the QoS of the WLAN. A theoretical model has been developed to model the two phases, i.e., PCF and DCF, of WLAN medium access control (MAC). With this model an optimum value of the contention free period (CFP) was calculated to meet the QoS requirement of IMM traffic being transmitted. Treating IMM traffic as data traffic or equating both IMM and non-IMM together could compromise a fair treatment that should be given to these QoS sensitive traffic. A self-adaptive scheme, called MAC with Dynamic Superframe Selection (MDSS) scheme, generates an optimum SF configuration

according to the QoS requirements of traversing IMM traffic. That particular scheme is shown to provide a more efficient transmission on WLAN. MDSS maximizes the utilization of CFP while providing fairness to contention period (CP). The performance of MDSS is compared to that of 802.11e, which is taken as the benchmark for comparison. Jitter and delay result for MDSS is relatively lower while throughput is higher. This confirms that MDSS is capable of making significant improvement to the standard access scheme.

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LIST OF PUBLICATIONS

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List of Abbreviations

AC – Access Categories

ACK – Acknowledgment

AID – Association Identifiers

AP – Access Point

ARQ – Automatic Repeat Request

BER – Bit Error Rate

BSS – Basic Service Set

CBR – Constant Bit Rate

CFP – Contention-Free Period

CFPri – CFP Repetition Interval

CODEC – Compressor/Decompressor

CP – Contention Period

CSMA – Carrier Sense Multiple Access

CSMA/CA – CSMA with Collision Avoidance

CW – Contention Window

DCF – Distributed Coordination Function

DCF/CD – Distributed Coordination Function with Collision Detection

DES – Discrete-Event Simulation

DIFS – DCF Interframe Space

DRR – Deficit RR

DS – Distribution System

DTIM – Delivery Traffic Indication Message

EBA – Early Backoff Announcement

EDCA – Enhanced Distributed Channel Access

EIFS – Extended Interframe Space

FQ – Fair Queuing

GHz – Gigahertz

HCCA – HCF Controlled Channel Access

HCF – Hybrid Coordination Function

HTML – Hypertext Markup Language

IEEE – The Institute of Electrical and Electronics Engineers

IFS – Interframe Space

IMM – Interactive Multimedia

IP – Internet Protocol

ITU – International Telecommunication Union

Kbps – Kilobits per second

MAC – Medium Access Control

Mbps – Megabits per second

MDSS – MAC with Dynamic Superframe Selection

MPEG – Moving Pictures Expert Group

MPLS – Multiprotocol Label Switching

MSDU – MAC Service Data Unit

Msec – Milliseconds

MWN – Multimedia Wireless Network

NAV – Network Allocation Vector

NIC – Network Interface Card

nRT – non Real Time

OPNET – Optimized Network Engineering Tool

OSI – Open Systems Interconnection

PC – Point Coordinator

PCF – Point Coordination Function

PCM – Pulse-Code Modulation

PER – Packet Error Rate

PHY – Physical (Layer)

PIFS – PCF Interframe Space

QoS – Quality of Service

RF – Radio Frequency

RR – Round-Robin

RT – Real Time

Sec – Seconds

SF – Superframe

SIFS – Short Interframe Space

STA – Workstation

TCP – Transmission Control Protocol

TCP/IP – TCP/Internet Protocol

TS-MP – Two-step Multipolling

TXOP – Transmission Opportunity

UBR – Unspecified Bit Rate

VBR – Variable Bit Rate

WFQ – Weighted FQ

WLAN – Wireless Local Area Network

WRR – Weighted RR

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