

ETSI STQ Workshop "Compensating for Packet Loss in Real-Time Applications", Feb 2003

VoIP on WLAN, QoS issues and VoIP specifics

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Agenda

- 802.11 standards overview
- Wireless QoS principles
- The draft 802.11e standard supplement
- Current situation and lessons from the past
- Summary





Introduction

- IEEE 802.11 wireless networking is the foundation for a whole new class of mobility and application scenarios
- The WLAN industry is in the midst of an exponential growth and as well in the midst of a transition (and turmoil) from 802.11b (Wi-Fi) and 802.11a (Wi-Fi5)





802.11 overview





Top-down perspective







802.11 standards

higher	supplements 802.11c and 802.11f
802.11 MAC	supplements 802.11d, 802.11e, 802.11i and 802.11h
802.11 PHY	supplements 802.11a, 802.11b and 802.11g





802.11 Stds and WGs

- 802.11a 5GHz OFDM PHY layer
- 802.11b 2.4GHz CCM PHY layer
- 802.11c bridging tables
- 802.11d international roaming
- 802.11e quality of service
- 802.11f inter-access point protocols
- 802.11g 2.4GHz OFDM PHY
- 802.11h European regulatory extensions
- 802.11i enhanced security



802.11 stds (trends) overview



Techincal summary 802.11a/b/g

- 802.11a
 - MAC Layer: Same CSMA/CA MAC as 802.11b
 - Modulation: Orthogonal Frequency Division Multiplexing (OFDM)
 - 20 MHz channels, multi-carrier
 - RF: UNI-II and ISM bands
- 802.11b
 - MAC Layer: Same CSMA/CA MAC as 802.11a
 - Modulation: Complementary Code Keying (CCK)
 - 22 MHz channels, single-carrier
 - RF: ISM bands (2.4 GHz)
- 802.11g
 - MAC Layer: Same CSMA/CA MAC as 802.11b
 - Modulation: Complementary Code Keying (CCK) and Orthogonal Frequency Division Multiplexing (OFDM)
 - 22 MHz channels, single-carrier (CCK) and multi-carrier (OFDM)
 - RF: ISM bands (2.4 GHz)





802.11 standard & supplements summary

- Base standard divided into two layers
 - medium access control (MAC) layer
 - physical (PHY) layer
- Standard supplements extend one of these layers or provide higher layer functions
- Supplements at different layers can be intermixed
 - 802.11e applies to 802.11b, 802.11a and 802.11g





Wireless QoS Principles





Wireless QoS Principles

- What works in a wired network doesn't necessarily work in a wireless network
 - too many broken assumptions
- System aspects
 - division of functions across layers
 - application expectations





Wireless QoS Principles

- Many previous attempts at WLAN QoS (and non-QoS channel access schemes), show that strategies that work well in a wired environment don't translate to WLAN
- Things that break assumptions:
 - Packet error rate can be in the range 10 20%
 - Bit rates vary according to channel conditions you can't do a bandwidth reservation at connection setup time and expect it to stick
 - The "rubber pipe problem" a bandwidth manager doesn't know how much bandwidth it has to manage, since a neighboring, unrelated bandwidth manager can take some of it at any time

• Questions:

- what does "guaranteed QoS" mean in a system with a 20% packet error rate?
- what does "connection admission control" mean in an unlicensed RF band?





CBR traffic in a wireless LAN

- Multimedia traffic is frequently modeled as predictable, constant bit rate
 - but CBR traffic acquires a significant bursty component in the presence of packet errors that force retries
 - constant slot allocation strategy alone does not work well any more





The draft 802.11e standard supplement





System aspects

- Not all functions need to be contained in the MAC layer
 - 802.11e targeting Ethernet equivalence
 - connection admission control considered a higher layer problem
 - MAC needs only to provide priority separation
- Different applications make different assumptions about connection admission control
 - 802.11e trying to target all of these applications



Division of functions accross layers

- MAC layer can only see its own network segment
- Connections are end to end, and not in the domain of the MAC
- Packets that are part of a stream are labeled with a priority and passed to the MAC







Example of usage

- Voice call is highest priority, gets lowest latency
- Video is next priority, will get sufficient bandwidth if it is there
- Data will get whatever bandwidth is left over







Implications for 802.11e

- 802.11e must support 802.1D priority marking
 makes its behavior identical to Ethernet
- 802.11e cannot assume that RSVP is present
 - but can be designed to take advantage of additional information if it is there





Application of 802.11e

Focus on two usage models:

- IP-based multimedia
 - Streaming protocols such as RTP/RTCP
 - Applications have been built on the assumption of very little guarantee of service from the network
 - Robust to sudden changes built in adaptability
 - Require only on 802.1D-based priority, where available
 - Seamless bridging across Ethernet and 802.11
- 1394 over 802.11a
 - Proposals under discussion in 1394 wireless working group
 - May run directly over the 802.11e MAC, or using IP encapsulation
 - Seamless interworking between 1394 and 802 LANs, particularly 802.11 is required
 - Attach PC and other IP devices to the 1394 bus
 - No brainer installation and configuration





Issues with 802.11e

- Not efficient for adhoc networks when load increases
- EDCF parameters are difficult to set (static) and can cope with change of conditions on the network
- EDCF is backwards compatible to DCF making it practicaly useless when DCF nodes present
- Collision number increases with increased number of stations (severely decreases network throughput and increases latency/jitter)





Lessons from the past and current situation



Previous Attempts for QoS on WLAN

• Hiperlan 1 (EY-NPMA)

- early (1996) fully distributed prioritized scheme
- focused on time bounds rather than 802.1p-style flow separation
- theoretically highly efficient and delivers on time bounds, but fragile in presence of errors and hidden stations

• Hiperlan 2 (Wireless ATM)

- fully centralized all scheduling pushed to the AP, which broadcasts time allocation for each 2ms superframe
- theoretically highly efficient, given a perfect scheduling algorithm (nearly all publicly available papers assume this)
- efficiency drops dramatically in adverse (bursty) traffic conditions, because efficiency is dependent on ability of scheduler to predict requirements
- immensely complex





Previous Attempts ... ctd

• HomeRF (DECT/802.11)

- combines CSMA/CA for data, slots with retransmission for voice
- works well within stated objectives efficient data transfer, good for voice, but not quite for video etc.
- let down by inadequate PHY layer





Issue with Frequencies

- 2.4 GHz ISM band is very congested
 - Everything from 2.4 GHz phones to microwave ovens to Bluetooth 1.1 transmit here
- 802.11a in the 5 GHz frequency band is a primary or co-primary user
 - Shared with navigation and satellite equipment, not other consumer equipment
 - Designed for wideband transmissions as opposed to narrowband (phones, garage door openers, etc.)
 - No guarantees it will stay this way; still unlicensed spectrum
- Reduces concerns over "co-existence" issues
 - 5 GHz is the best place for Radio LANs





Bonus Material - 802.11 at home



Bonus Material - 802.11 at home -issues

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46	00:02:D3:86:	Broadcast	00:02:B3:8	86:	11.0	10	249	+ 64	02:32:31	802.11 Beacon	FC=	5	Reply from	192.168.2.1	by
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GLOBAL IP SOUND



Internal test results







GIPS VoiceEngine[™] - PPC







Acoustic Echo Supression (AES)

Features

- Interoperability with different speech coders
- Handle both 8kHz and 16kHz sampled signals
- Suitable for small devices like PDAs
 - Play out and recording speech flows are not required to be synchronized
 - Can handle changing delay caused by soundcards and drivers in the PDA
 - Low complexity
- Comfort noise insertion
- High level API
- ITU G.167 compliant





Summary

- WLAN is ubiquitous technology and as well brings some ubiquitous QoS issues
 - If I run VoIP over WLAN at home, whose going to guarantee me QoS level?
- Usage of technology that can deal with some of WLANs intrinsic imperfections (or ones who are operating it) can accelerate its wide acceptance



Memory in kWord16