QoS support on IEEE 802.11a (IEEE 802.11e)

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PART one

QoS support on WLANs: basic principles

QoS principles 1/4

3 MAIN TECHNIQUES

- Integrated Services
  - CONNECTION ORIENTED Technique
  - RSVP (Reservation protocol)
  - Telecom philosophy
- Differentiated Services
  - Connection-less Technique
  - DIFSERV (Differentiated Services) Protocol
  - Local network
- Application Level Framing

QoS Basic principles 2/4

3 various approaches of the multimedia traffic over a network

- Integrated Services approach : Quality of Service (QoS) technology
  - each application produces a reservation per traffic flow based on a signalling protocol (e.g. RSVP)
  - each element of the network applies a per flow scheduling (id est connection-oriented)
  - the network service is guaranteed by the mean of the reservation

QoS principles 3/4

3 various approaches of the multimedia traffic over a network

- *Differentiated Services approach : Class of Services (CoS) or "soft QoS" technology*
  - *each packet is tagged (TOS field) and classified by the network (e.g. Diffserv)*
  - *the network components apply a per packet class scheduling*
  - *the network service is prioritised (statistical guarantee)*

QoS principles 4/4

3 various approaches of the multimedia traffic over a network

- *Application Level Framing approach : Adaptive streaming*
  - *the application*
    - *Continously assesses the network service properties (RTCP)*
    - *produces an adaptive streaming (bit rate & redundancy) (RTP)*
  - *the network is Best Effort (generally with no packet scheduling, QoS is often controlled a-posteriori –e.g. error level control)*

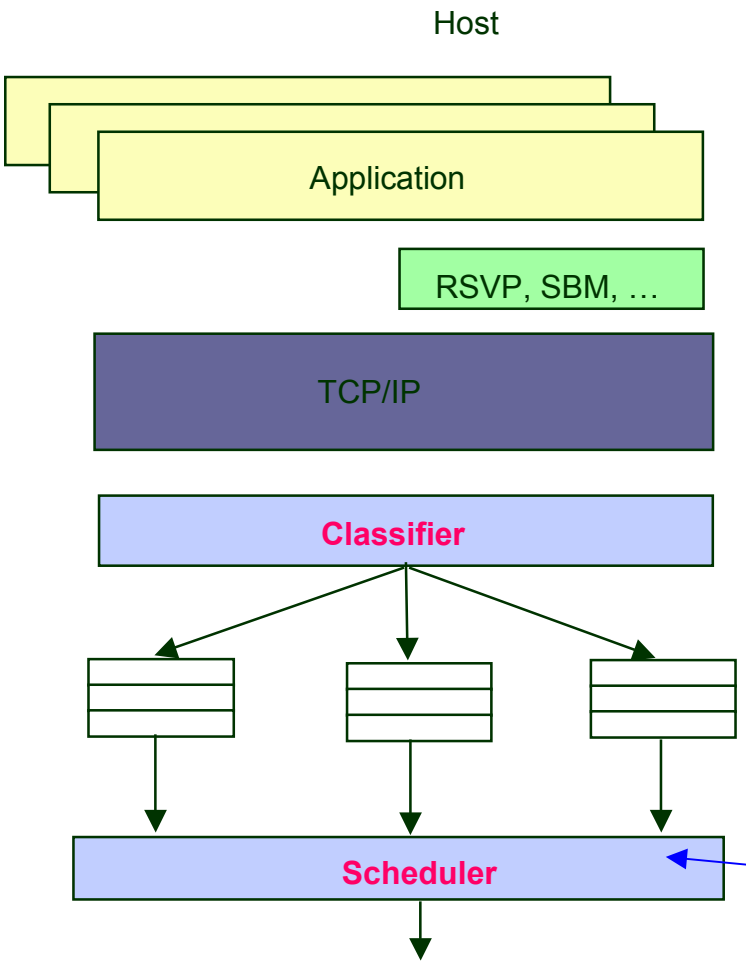
QoS policy on BWLAN

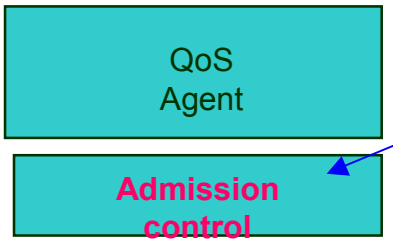
QoS at WLAN cell level :

Algorithms (distributed and or Centralized), *Resources* and *Set of parameters* to dynamically monitor and manage:

- *Medium access* on a prioritized /reservation scheme
- Across the *air "data" transport* (Streams/packets/connexions) with more or less guaranteed performance in term of Bandwidth, bounded time, latency and gitter, (packet) error rate
- … (security, integrity check, sequencing conservation, …)

QoS implementation in WLANs





- Negociation:
  - With appli,
  - With/between terminals
  - Between Access Points,
  - ….
- Queuing,
- Aging control
- Dynamic priority reallocation
- Medium access control
- Centralized (often TDMA),
  - with polls
- Distributed (often CSMA CA)
  - with backoff draw,
  - contention algorithms etc…

REVAMPING IEEE 802.11 for QoS

- *Disclaimer : the new std (802.11e MAC enhancements) is still on debate and unstable. Current presentation based on November 2001 draft version plus IEEE papers.*
- *Both DCF and PCF are enhanced to support QoS*
- *Backward compatible*
- *RESERVATION (PCF) and SCHEDULING (DCF) (Unspecified algorithms)*
- *Packet aggregation capability (Burst ACK)*

What is required for the QoS enhancements (initial list from IEEE-EARLY 2000)

- *Dynamic Bandwidth Management*
- *Stream Synchronization Support*
- *Reliable Multicast Streaming*
- ***Admission Control***
  - *Priority Assignment*
  - *Bandwidth allocation/reservation*
  - *Guaranteed Latency Bounds*
- *Selectable Acknowledgement Types*
- *Roaming and Connection Handling*
- *BSS Overlap Management*
- *FEC/Channel Protection*
- *Direct STA-to-STA Communication*
- *Dynamic Frequency Selection and TPC*

- **Initial work was covered by:**
- **AT&T (MediaPlex)**
- **ShareWave (WhiteCap)**
- **Lucent (Blackburst)**

IEEE 802.11 Medium Access Model

- STD EVOLUTION(802.11e) :
  - DCF => EDCF (Enhanced)
  - PCF => HCF (Hybrid coordination Function)
- 802.11E STD (QoS extension) status:
  - (private to IEEE workgroup) draft version 2.0 Nov. 2001
  - Claimed to be stabilized in Q3 2002

QoS hooks but no fixed policy

- *Can be elaborated in PCF mode or DCF mode*
- *802.11 does not specify resource allocation schemes:*
  - *Admission control*
  - *Buffer management*
  - *Scheduling*
  - *How polling list is created in PCF mode*
  - *When to poll which mobile in PCF mode*
- *802.11e specifies medium access policies, algorithms and timing parameters*
- *2 main mechanisms (simplified)*
  - *EDCF : concurrent CSMA/CA for up to 8 queues in one STA*
  - *HCF : "super-super frame" : STA can send a series of packets in one slot, Ack can be grouped (burst ACK), delayed etc…*

Enhanced DCF medium access algorithm

(simplified description)

-Same basic algo. as for genuine MAC, but

-Several simultaneous message queues in one station

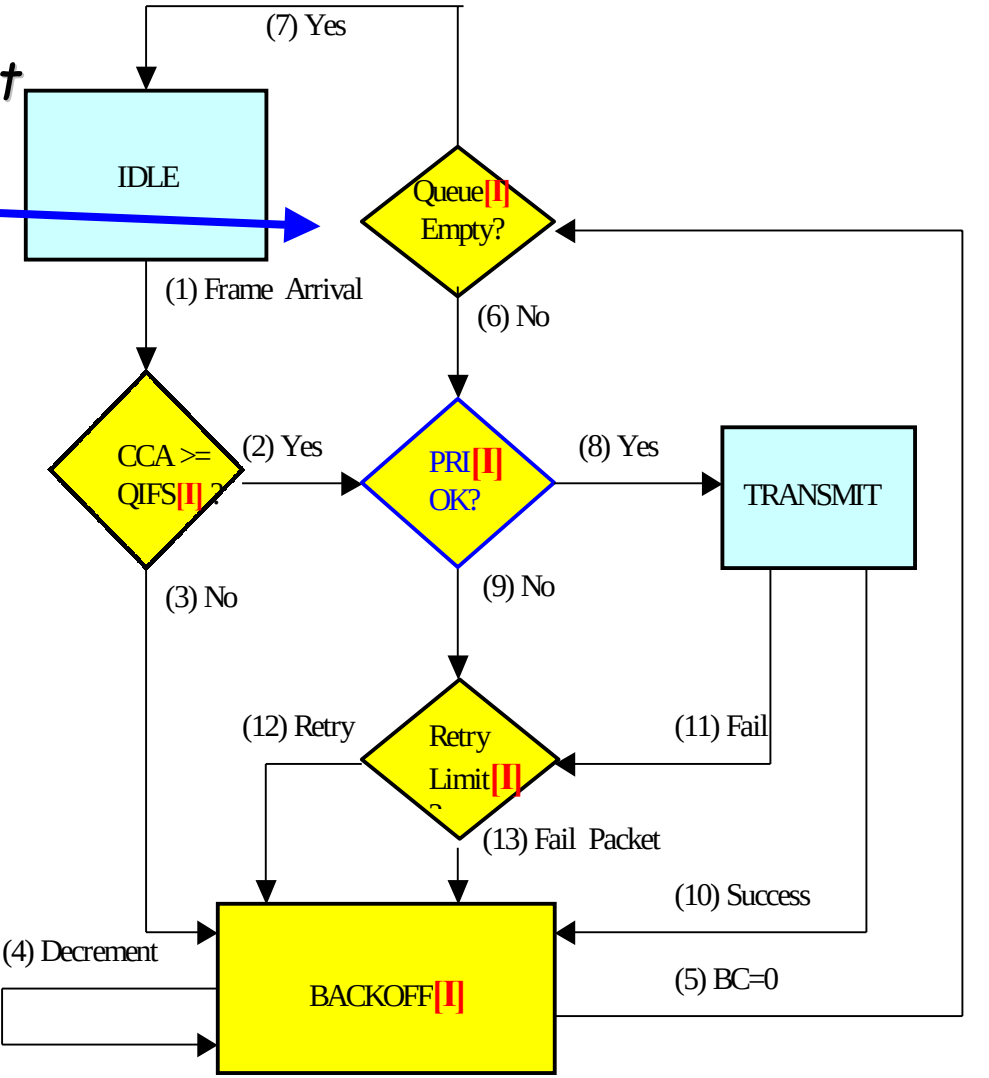
-All contending together for medium access

-Contention based on priority attributes (packet tags or bandwidth reservation)

-ONE DCF state machine per queue

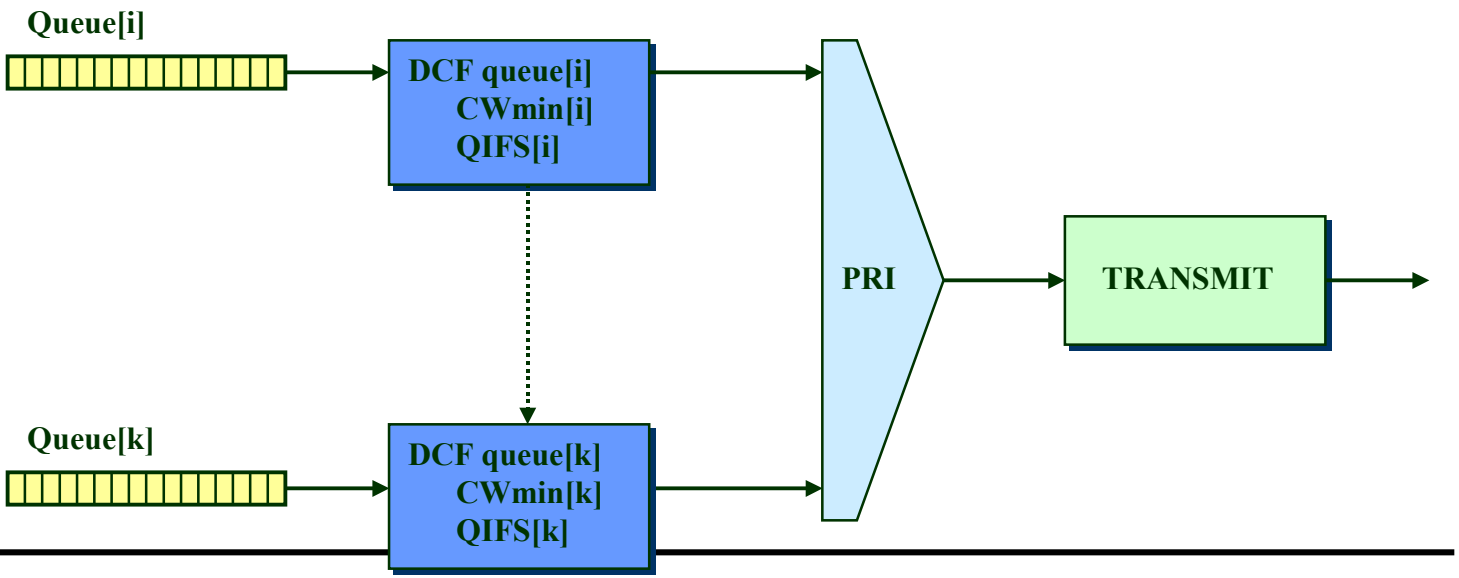
-For one queue, other internally contending queues act the same way as other contending stations

-Simultaneous backoff algorithms performed in parallel for each queue/priority



EDCF properties

- *Same state machine as DCF*
- *Prioritized access to MAC services per Traffic Category (TC)*
- *Controls relative bandwidth, latency, jitter per TC*
- *Based on 3 main parameters : Queue[I], Cwmin[I], QIFS[I](=DFS)*



CW and QIFS properties 2/2

- *Contention Window (CW)*
  - *TCs select random backoff counters from CWs, on average Lower-priority TC get higher delay count thus fewer TxOPS than higher-priority TCs Imposes bandwidth and access delay differentiation between TCs*
  - *Contention windows expand/contract*
    - *Local adaptation: binary exponential backoff in response to collision*
    - *Also controllable by EAP in Beacon*
    - *CWmin[i] in QoS Parameter Set Element updates aCWmin[i]*
- *Inter-Frame Space (IFS)*
  - *Different IFS per TC: TxQIFS[i] = SIFS + aQIFS[i] x aSlotTime*
  - *Imposes bandwidth and latency differentiation between TCs*
  - *Controllable by EAP*
    - *QIFS[i] in QoS Parameter Set Element updates aQIFS[i]*

CW and QIFS properties 2/2

- *Both controls should help providing effective differentiation*
  - *CWmin*
    - *Affects TxOP probability, collision probability*
    - *average backoff delay*
  - *QIFS*
    - *Low-priority traffic defers to high-priority traffic*
    - *Slower backoff counting rate for lower-priority traffic*
- *Complementary when used together*
  - *Claimed to achieve differentiation with better latency/jitter*

(proprietary algorithms to set and assess)