Distributed access procedures for supporting real-time traffic:
Blackburst
Motivation

- Wish to support real-time applications with QoS guarantees, e.g., voice, video
- Basic access method - CSMA/CA
  - Does not provide QoS guarantees
- Centralized access method - polling
  - Cannot operate simultaneously in adjacent cells
  - Requires an access point
Requirements

• Three interframe spacings, as in the IEEE 802.11 standard
  – $T_{SHORT}$ - acknowledgment minipackets
  – $T_{MED}$ - real-time (RT) stations
  – $T_{LONG}$ - data stations
• Sensing capabilities, as in CSMA/CA
• Ability of RT stations to send *black bursts*
Basic operation

• RT station has an access instant
  – Transmits for at least $T_{PKT}$ s.
  – Schedules the next access instant to $D_{MIN}$ s. in the future

• RT station has a scheduled access instant
  – If channel has been idle for $T_{MED}$ s., it transmits
  – Otherwise, waits until channel has been idle for $T_{MED}$ s. and enters into black burst contention
Black burst contention

- Length of black burst is proportional to delay in accessing the channel
- Access instants of distinct stations differ by at least $T_{\text{PKT}} \Leftrightarrow$ black bursts differ by at least a black slot
- Unique winner after a black burst contention period - the station that has been waiting the longest
Example of operation

$T_{PKT}$

RT 1   RT 2

$T_{MED}$

DATA

RT 1   RT 2

$D_{MIN}$

Delay

RT 1

$D_{MIN}$

Delay

RT 2
Negative Acknowledgment

• Upon reception of an RT packet, a receiver knows when to expect the next packet

• Possibility of using a negative acknowledgment scheme
  – Reduced overhead
  – Robustness against hidden stations (implied RTS scheme)
Properties

- Compatible with IEEE 802.11
- RT traffic has priority over data traffic
- RT stations access the channel in round-robin order
- RT packets are not subject to collisions
- Supports RT stations with distinct bandwidth requirements
- Robust against hidden stations
Voice over 802.11 DS - Performance

2 Mbps 802.11 DS
Average data packet delay = 10 ms

Data Load = 22%

# of voice stations @ 64 Kbps = 14
@ 32 Kbps = 21

Data load = 41%

# of voice stations @ 64 Kbps = 8
@ 32 Kbps = 12
Publications on Blackburst

• João L. Sobrinho and A.S. Krishnakumar, Real-Time Traffic over the IEEE 802.11 Medium Access Control Layer, Bell Labs Technical Journal, Autumn 1996

• João L. Sobrinho and A.S. Krishnakumar, Quality-of-Service in Ad Hoc Carrier Sense Multiple Access Wireless Networks, IEEE Journal on Selected Areas in Communications, Vol. 17, No. 8, August 1999