WMAC Protocol

93/96

Comparison against MAC Criteria

Doc: IEEE P802.11-93/96

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Supported Services:

* **Asynchronous Service:**
    - Full 802 LLC service with unicast/multicast capability.
    - Broadcast/Multicast reliability depend on medium load.
    - LLC-1 service only mode without Broadcast available for extreme low Power Devices.

* **Isochronous Service:**
    - Available as an option, and can mix with Async only implementations.
    - Support mixed Voice/Data applications.
    - Higher speed or Video support depends on PHY speed.
   - BSS overlap dependent on PHY channel isolation.

Supported configurations:

* **Infrastructure based network (Async Service)**
    - Default all traffic via AP but Direct Station-to-Station possible.
    - Single NID per ESA, and unique APID per BSA.
    - Multiple BSS's can overlap using same channel.
    - Can overlap with an Ad-Hoc Network on same channel.
    - Distribution system can be any 802 LAN, also 802.11.

* **Services provided by AP+Distribution System.**
    - AP contains forward function to other BSS and or a wired Network. This is an expanded "Bridge" function.
    - (Re-)Association Service provided.
    - "Initial" and "Previous APID" parameters exchanged to support Re-Association across Routers.
    - Station to initiate Re-Association process based on "Link Quality".
    - Synchronization and Power Management provisions included in AP.

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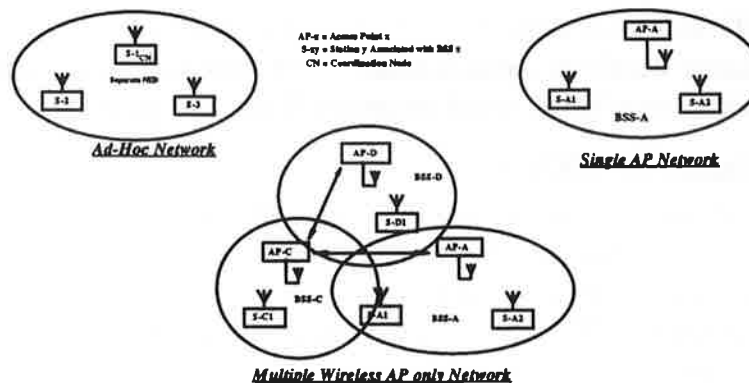

Supported Configurations: (cont'd)

* **Wireless AP configuration possible.**
    - Single AP without Distribution System connection to expand range.
    - Allows Wireless AP interconnections (Wireless DS).

* **Ad-Hoc Networks:**
    - All traffic Direct Station-to-Station.
    - Assumption that all stations can see each other.
    - Use separate NID and fixed APID.
    - Can overlap with Infrastructure Network sharing the same channel.
    - A Station can be associated with Infrastructure and Ad-Hoc Network at the same time (on a non-Hopping PHY).
    - Synchronization and Power Management provisions included.
    - Stations "Listen for Timing Coordinator", and will assume this function when nothing is found.

Wireless Architecture:

Wireless Network Architecture
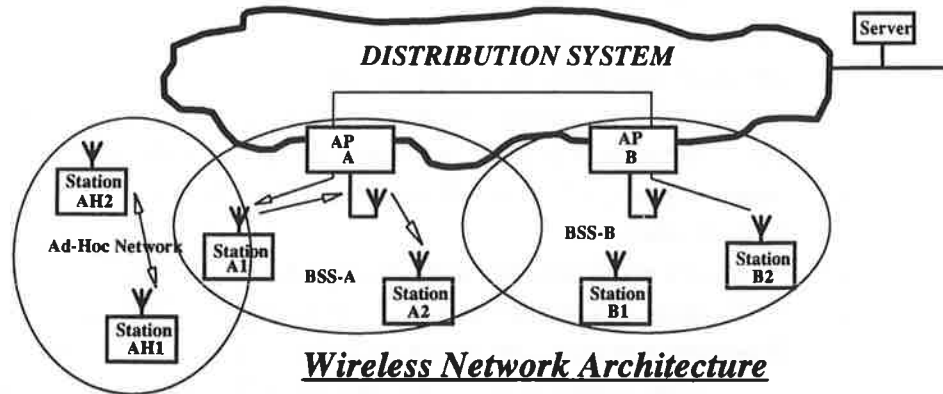
*   **Allows single and multiple channel overlapping BSA's.**

*   **Station can be part of Ad-Hoc and Infrastructure NW.**

Other Configurations:

Ad-Hoc Network   *Single AP Network*

Multiple Wireless AP only Network

*   **Multiple BSS Wireless only networks possible when using the same "Channel".**

Supported Configurations: (cont'd)

* **Infrastructure Network** (Isochronous Service)
    - Can operate with mixed Async/Isochronous devices.
    - Isochronous traffic in multiple overlapping BSA's require sufficient channel isolation (limited recovery possible).
    - Reserved but unused Isochronous Bandwidth is available for Asynchronous traffic without control overhead.
    - Need separate "Time Bounded" Distribution System to meet time constraints.
    - Support variable bitrate (Video, ATM backbone).
    - "Wireless segment" delay depending on PHY speed <=25 msec.
    - Random service sequence provision allows for time in Station to "Scan for a better AP" during each Frame interval, when "Link Quality" is deteriorating.
    - Same provision allows for Power Management.

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Performance Characteristics:

* **Basic CSMA/CA+Ack Access Protocol**
    - Short access delay ideal for Bursty traffic.
    - Efficient stable throughput at High loads (Ref doc P802.11-92/51)
    - Shares medium automatically, without additional control overhead.
    - Ack allows MAC level recovery from lost packets.

* **Overlapping BSA's**
    - Medium is shared when the same channel is used.
    - Sharing medium while multiple FH channels collide.
    - Tx-Power Control provision allows improved spectrum re-use.
    - Multiple BSA's can not overlap the same channel for Time Bounded Services.

* **Performance over Distribution System.**
    - Depend on DS access delay, speed and number of segments.
    - Performance may depend on Power Save Mode used.

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Performance Example (Asynchr):

CSMA/CA + Ack Throughput versus Load

23 usec Slot time
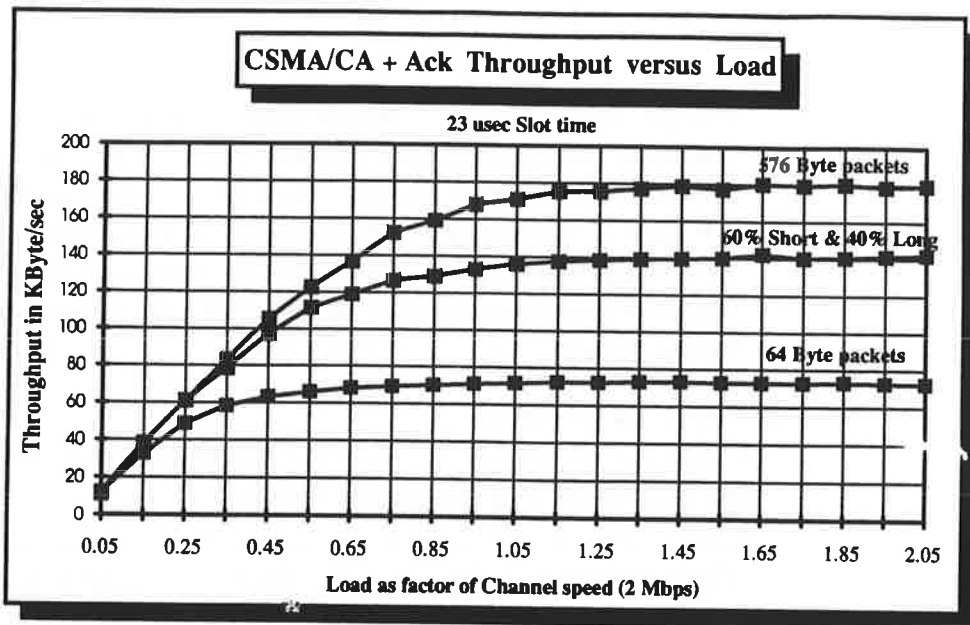
Performance Example (Isochr):

*   **Assumption:**   **32Kbps ADPCM Voice**

                              15 Byte MAC + Wavelan PHY Overhead

*   **Example: @ 2 Mbps Modem speed:**

Voice only:	**28 FDX** (using talkspurt)
Voice/Data 576 Byte:	**23 FDX** (using talkspurt)
Voice/Data 1500 Byte:	**18 FDX** (using talkspurt)
Voice/Data 1500 Byte:	**9 FDX** (100% load)
Async Data throughput:	**> 75 KByte/sec** (assuming max Isoc load)
Async Data throughput:	**>130 KByte/sec** (assuming 9 FDX Talkspurt channels)
Async Data throughput:	**>200 KByte/sec** (no Isoc connection active)

Power Management

* **Basic Provisions (Infrastructure):**
   - Synchronization provisions within one BSS.
   - Power Management is application independent.
   - Stations can operate in different Power Save modes (PM mode indication in Frame Header, and maintained in the AP).
   - AP provides temporary buffering while Stations sleep.
   - AP frequently announces buffering status at predictable times.
   - Stations can dynamically switch PM modes to operate at desired Power/Throughput operating point.

* **Services provided:**
   - Full LLC service with variable "Initial Response" delays depending on PM mode and parameterization.
   - LLC-1 service only for Extreme Low Power devices.
   - Very diverse applications can share the same infrastructure.

Power Management (cont'd)

* **Ad-Hoc Network**

   - All stations may choose to operate in Power Save mode.
   - One station to assume the "Timing Coordination" function using a tbd algorithm, to allow synchronization of the Network.
   - Transmitters send short traffic announcement frames in a time window where all stations are awake.
   - Stations receiving a traffic announcement stay awake to receive the data.
   - Stations can dynamically change PM mode to allow high speed data exchange.

Power Management (cont'd)

* **Performance:**
    - Very low Power operation possible during "Idle mode", which is the dominant factor for low power operation.
    - Increased delay for the initial frame of a session.
    - Dynamic PM mode switching allows high speed operation for subsequent frames.
    - Another "Idle mode" Power consumption component that needs to be considered will depend on the re-association frequency and the power consumed during "Scan for a better AP" activity.
    - A WMAC can be configured to operate at different Speed/Power trade-off points, by controlling the PM mode and timing parameters.

* **Re-Association speed / Power consumption.**
    - Speed will depend on PHY type and "Scan for better AP" algorithm.
    - Stations can switch to PSP mode during scan to prevent frame loss.

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Idle Power Consumption example:

* **Assumptions: 600/150 mA Tx/Rx Power consumption**
    - 20/100 msec TIM/DTIM interval
    - 50 ppm Xtal accuracy (The worst case is shown)
    - 2 Mbps channel (with 64/1088 Byte frame size 60/40% duty cycle)

	Sleep interval		
Avg. Power in mA	**100 msec**	**1 sec**	**30 sec**
CAM mode:	150	150	150
PSNP mode synchronized:	3	--	--
PSNP mode (no synchr):	12	--	--
PSP mode synchronized:	3	.3	.016
PSP mode (no synchr):	12	1.2	.041

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Multiple PHY support:

* WMAC can be configured for different speeds.
    - IFS and Backoff protocol parameters are PHY speed dependent (Symbol rate).
    - WMAC does support mixed bitrates (on same symbol rate).
* WMAC can support ISM band PHY's.
    - Includes provisions for FHopper control.
    - Basic Synchronization for FHopper already present.
* WMAC support for 1.9 GHz PCS band.
    - LBT and Backoff is very similar to Etiquette, and compliance is achieved by parameter set.

Multiple PHY support (cont'd):

* WMAC support for others (Wide-Band and IR).
    - IR: No limitations known.
    - ETSI 5.2 GHz: Is proposed as MAC candidate.
* Basic PHY requirements to support WMAC.
    - Fast Carrier Detect function.
    - Fast Rx-Tx turnaround times improve efficiency.
* MAC provisions to support multiple PHY's.
    - Synchronization provisions provides FH timing.
    - Conditional State Machines allow dedicated functions.
    - Parameters can be PHY dependent.
    - Intelligence is in the MAC.

MAC Access Function:

- Same Distributed Access Coordination Function for Infrastructure and Ad-Hoc.
- No limit on number of stations.
- Access mechanism is fair, but close by stations have capture advantage during access collisions.
- Good High load stability (use exponential Backoff).
- Throughput efficiency similar to CSMA/CD, but depend on Rx-Tx turnaround times and CS delays.
- Ack provisions allow MAC level recovery from ISM and co-channel interference sources.
- Graceful medium sharing when Networks (and Hops) overlap.

MAC Access Function:

- Async/Time Bounded mix by high priority level.
- Reserved but unused Isochronous bandwidth can be fully used by Asynchronous traffic.
- Only overhead for mixed operation is one extra slot access delay after a defer to allow Isochronous priority.
- Gradual Asynchronous throughput decrease when Time Bounded traffic is active.
- Isochronous robustness can be improved when needed by MAC level recovery.
- Asynchronous standard can be defined first without the need to fully specify the Time Bounded standard.

Other MAC Features:

- Security on MSDU payload only.
- Encryption only on Wireless segment, so no existing network impact.
- Allows adoption of basic 802.10 SDE mechanisms.

- Element structure in Frame Format allows flexibility for future and proprietary extensions in a transparent way.
- Fragmentation provisions are being included.
- WMAC supports mixed bitrate, assuming bitrate detection function in the PHY. (allows migration).