DFWMAC

Distributed Foundation Wireless Access Protocol

Basic access method and Contention Free Service support.

for

IEEE 802.11

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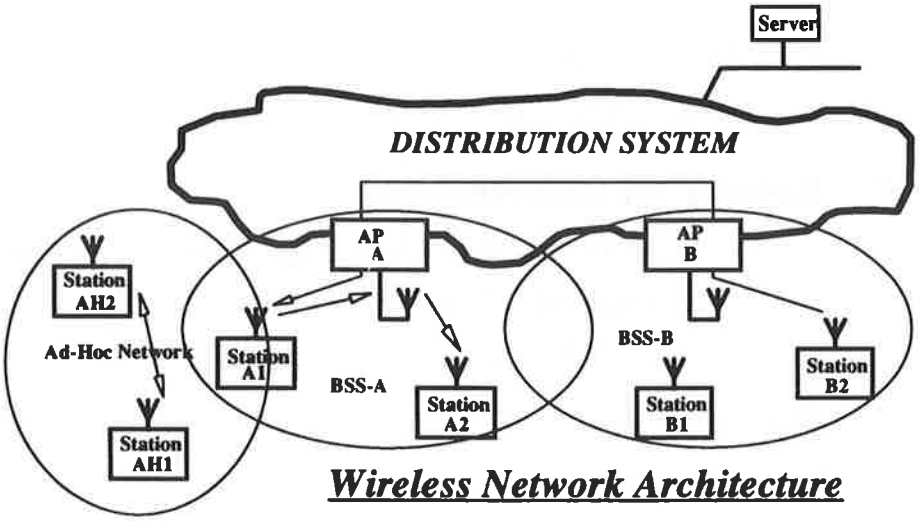
Wireless Network Architecture



Wireless Network Architecture

* Infrastructure mode can overlap with Ad-Hoc.
* Support single and multi-channel PHY's.

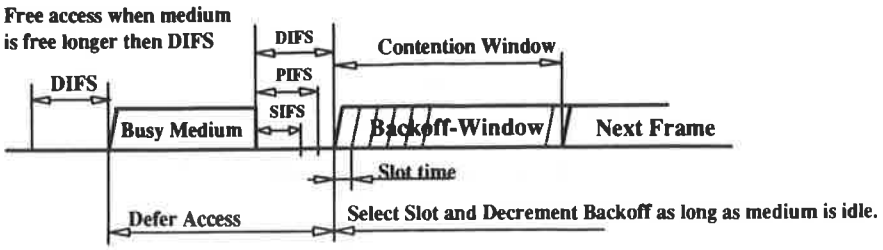
Supported Services:

* Asynchronous Data Service:
  - Short response time with high instantaneous Throughput, suitable for Bursty traffic.
  - No BSS isolation required
* Contention Free Service (Optional):
  - Time Bounded Service dimensioned for Voice.
    . Connection oriented reserves bandwidth.
    . Allows mixed Voice/Data.
    . Allows variable bitrates (frame sizes)
  - Asynchronous Contention Free Service
    . Supports the bursty nature.
  - Requires sufficient BSS isolation, (TDMA type access protocols have similar requirements).

Basic Access Protocol:

* Use Distributed Access Protocol for efficient medium sharing.
* Robust for interference.
  - CSMA/CA + Ack for unicast frames. With MAC level recovery
  - CSMA/CA for Broadcast frames.
* Optional RTS / CTS to provide a "Virtual CS" function to protect against Hidden Nodes.
* Supports Ad-Hoc operation seamlessly, so does not require any infrastructure.

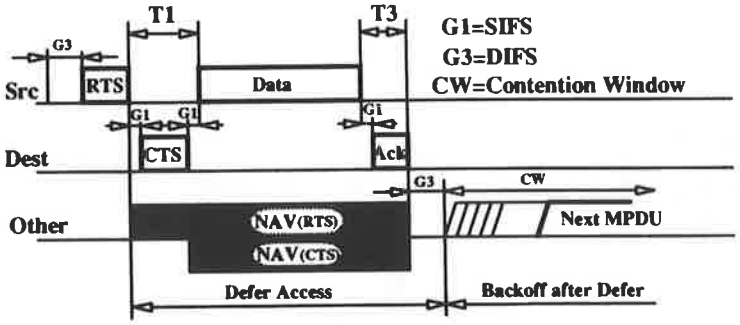
CSMA/CA explained:



CSMA/CA Access Methodology with PCF priority

* Reduce collision probability where mostly needed.
* Efficient Backoff algorithm stable at high loads.
  - Exponential Backoff for retransmissions.
* Implement different priority levels.
  (to allow immediate Ack and PCF coexistence)

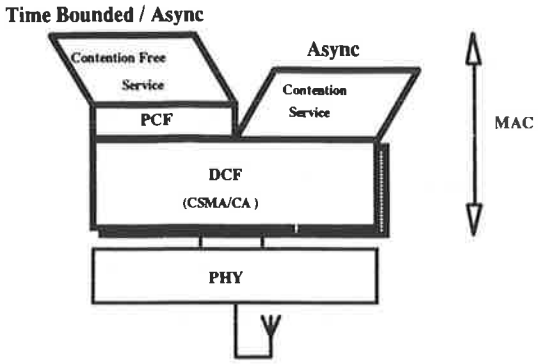
CSMA/CA+Ack Access Protocol



RTS/CTS/DATA/Ack MPDU

* With optional RTS / CTS provisions.
* Defer on NAV and "Carrier Sense", also for the Contention Free service.
* RTS / CTS use is controlled by a NoRTS parameter per station. Used for long inbound frames.

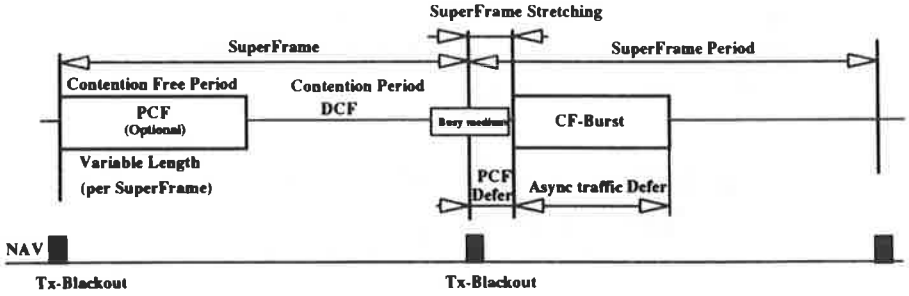
Contention Free Service Model:



MAC Service Model

* Contention Free Service uses Point Coordination Function (PCF) on a DCF Foundation.
* Async Data, Voice or mixed implementations possible.
* Contention Free capability does not burden the Async service implementation.

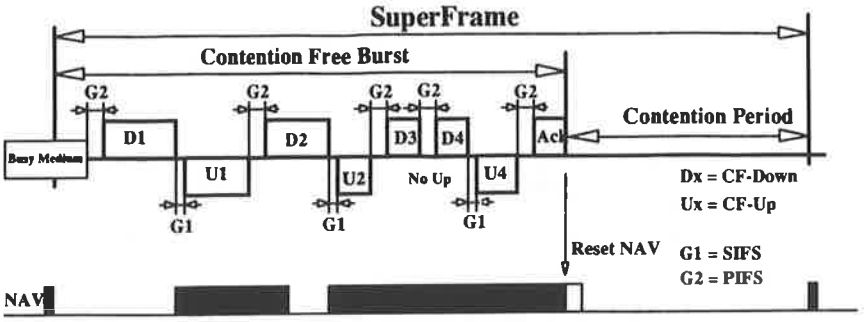
Point Coordination Function:



PCF SuperFrame Composition

* SuperFrame to allow mixed "Contention" and "Contention Free" operation.
* "Contention Free" period under PCF control.
* Both PCF and DCF Defer for each other causing SuperFrame Stretching.
* Tx-Blackout to prevent DCF with PCF collision.

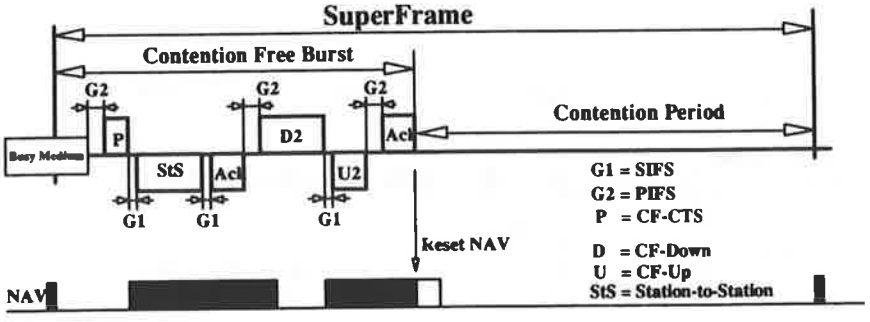
PCF Protocol:



PCF Protocol mechanism

* CF-Burst by Polling bit in CF-Down frame.
* Immediate response by Station on a Poll.
* Stations to maintain NAV to protect Up-traffic.
* Variable length or no response possible.
* Last frame from AP to reset the NAV in stations.
* "Ack Previous Frame" bit in Header.

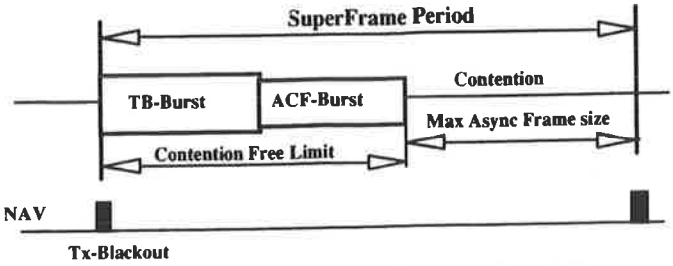
Station-to-Station PCF Protocol:



Station-to-Station PCF Protocol

* Poll from AP can start a "Station-to-Station" transfer with individual Ack.
* NAV update based on maximum frame duration.
* Works with both Time Bounded and Async frames.

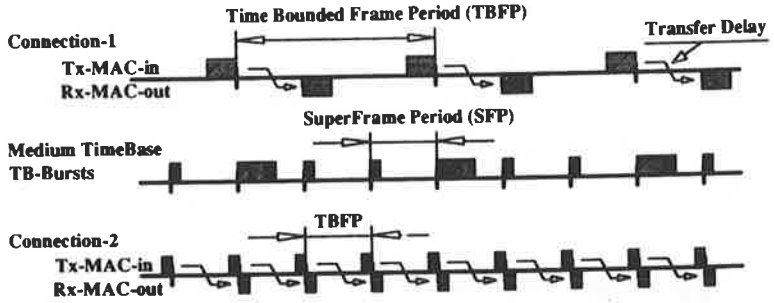
Contention Free Service Types:



PCF Contention Free Limits

* Time Bounded Service
  - Highest priority based on reservation.
* Async Contention Free Service
  - Dynamic Polling scheme to maintain Bursty characteristics.
* Contention Free limit based on max. Async frame size.

Time Bounded Service:



TBFP / SFP Relation

* Connection oriented repetitive traffic with low delay variance.
* Reservation for "Time Bounded Frame Period" and maximum frame size per TBFP per connection.
* Uses different Frame format based on "ConnID".
* "Connection Setup" uses Async service.

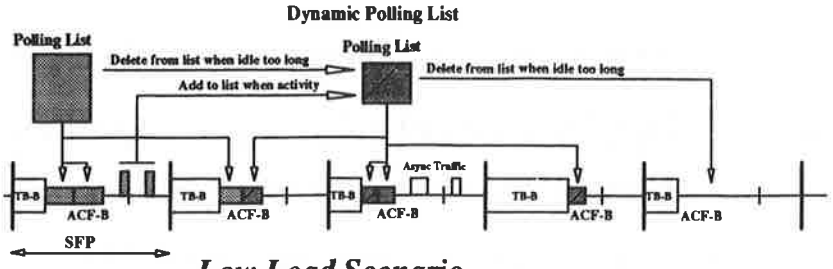
Time Bounded Characteristics:

* Built on Asynchronous Access method (DCF).
* Uses CSMA/CA + (Ack) with highest priority.
  - With limited recovery (QoS parameter)
* Dimensioned to support mixed Voice/Data.
* Video support possible at higher PHY rates.
* Time Bounded Framing Period is PHY speed dependent, but also depend on max. Async frame size.
  SFP= 20-30 msec for 1-2 Mbps, 5-10 msec at 10 Mbps.
* Unused reserved Time Bounded Bandwidth can be used for Asynchronous traffic.

Time Bounded Characteristics:

* Can support different PHY speeds (1-20 Mbps). Which will allow different TBFP's.
* Support variable frame size on a per SuperFrame basis, without control overhead.
  - Can take full advantage of "Talk Spurt" characteristics of Voice.
  - Allows flexible congestion control.
* Support direct Station-to-Station.
* Includes provisions for Power Consumption Management.
* Includes basic re-association provisions.

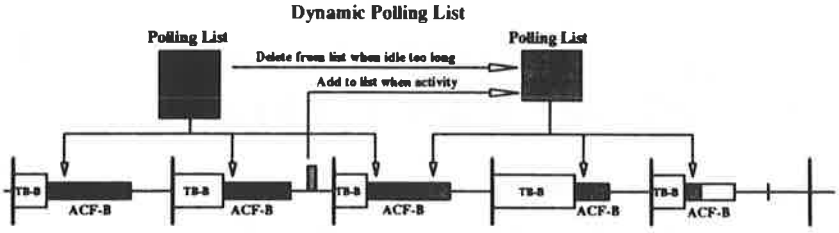
Async Contention Free service:



Low Load Scenario

* Stations "*Declare*" ACF capability to the AP during setup.
* AP maintains Dynamic Polling list for ACF-Burst
  - Request or traffic activity detection in Contention period can cause "*Add to Poll-list*"
  - n*SFP Inactivity can cause "*Delete from Poll-list*".
* Limit on max number of Polls per SFP.

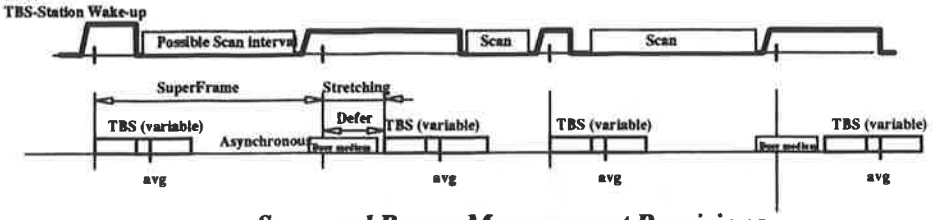
ACF Characteristics:



High Load Scenario

* ACF can provide stable throughput during High Loads.
* Is optimized for efficiency without reservation.
* Can increase response times when Load is low.
* Uses same Async frame format as in Contention Period.
* Dynamic Polling algorithm can be AP proprietary.
* Could also provide large population fixed polling service.

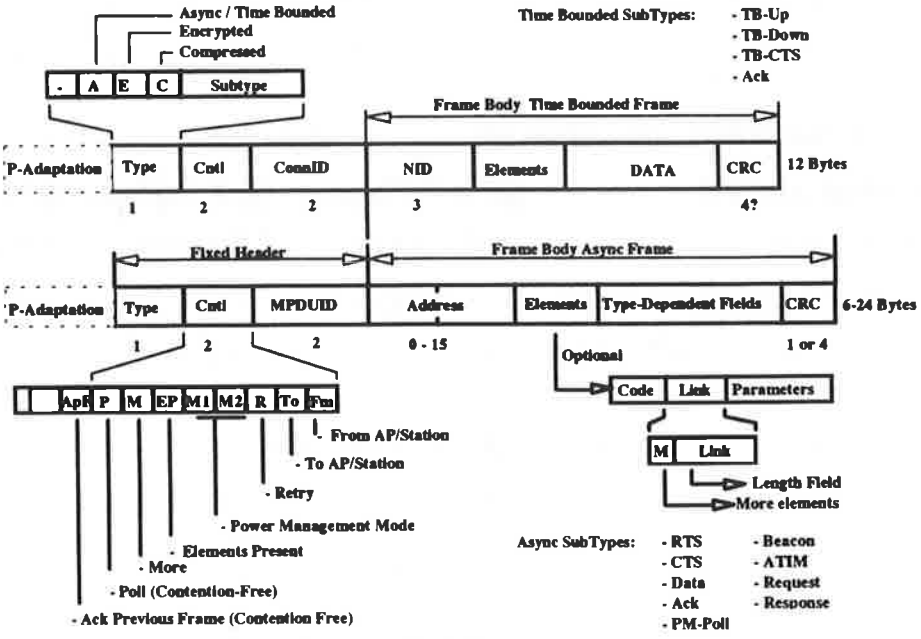
Scan and Power Management:



Scan and Power Management Provisions.

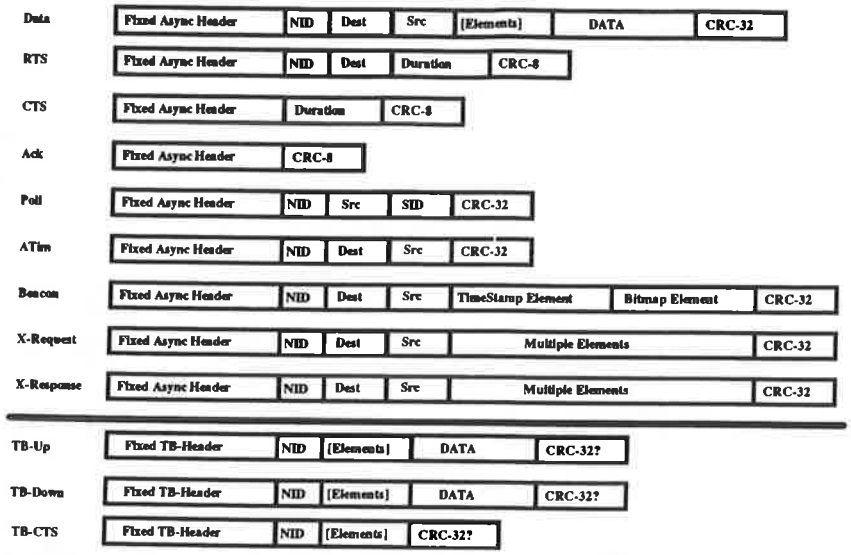
* Time Synchronization assumed by regular Beacon or TimeStamp embedded in TBS Frame Header.
* Random Polling Sequence allows equal average active time per station.
* CF-Burst stations are awake from beginning of SuperFrame until they are serviced.

Frame Formats:



Async and Time Bounded Frame structure

DFWMAC Frames:



Performance Example (TBS):

* **Assumption:** 32Kbps ADPCM Voice
  12 Byte MAC + Wavelan PHY Overhead

* **Example: @ SFP of:** 20 msec 30 msec

Modem speed	@ 2 Mbps	@1 Mbps	@2 Mbps	@1 Mbps
Voice only:	16 FDX	10 FDX	20 FDX	11 FDX
Voice/Data 576 Byte:	14 FDX	7 FDX	18 FDX	9 FDX
Voice/Data 1500 Byte:	11 FDX	3 FDX	15 FDX	6 FDX

The following is an estimate of the maximum Async throughput @ 2Mbps

Async Data throughput: > 75 KByte/sec (assuming max TBS load)
Async Data throughput: >130 KByte/sec (assuming 11 FDX Talkspurt channels)
Async Data throughput: >200 KByte/sec (no TBS connection active)

PCF limitations:

* PCF's can not overlap on the same channel.
  (Same restrictions as in any TDMA system)
* Application is therefore limited to:
  - Multi channel environment with sufficient BSS isolation.
  - In single BSS of single channel ESS.
* Only supported in Infrastructure Networks.
* Capability needed in both Station and AP.

Conclusion: Therefore the PCF should be an option.

Conclusion:

* A PCF on a CSMA/CA + Ack based DCF is an efficient access method which maintains the good medium sharing characteristics.
  - Hidden node vulnerability decreased through NAV.
* A very flexible Contention Free capability has been demonstrated, built on top of CSMA/CA.
  - Support both Time Bounded and Async services.
* Advantage over TDMA:
  - Frame size flexibility - allows variable bitrates.
  - Optimum capacity sharing between Asynchronous and Time Bounded services.
  - Dynamic allocation possible without reservation.
* Like TDMA it only works when there is no overlap.