IEEE 802.11
802 LAN Access Method for Wireless Physical Media

MAC Architecture Proposal
MAC Protocol Proposal & Evaluation
for
BPF MAC- Best Features of Proposals

July 26, 1993
Robert S Crowder
SHIP STAR Associates, Inc.
36 Woodhill Dr, Suite 19
Newark, DE, 19711 USA
Voice: 1 (302) 738-7782
FAX: 1 (302) 738-0855
EMAIL: SHIP STAR @mci.com

I. MAC Architecture Proposal

See Figure 1 for the proposed MAC Architecture
Most of these concepts, but perhaps not this terminology, are included in the Draft Standard and recent MAC discussions
Items marked * are mostly new concepts introduced in this paper.
Items marked # are relatively new concepts introduced by others.
NOTES:
1.All comparisons below are to the MAC criteria outlined in 93/53
2.A WLAN user resides above LLC. IT is identified by Station Address (48bits) + LASP (8 bits)

II. BPF MAC Protocol Proposal

NOTES:
1. This is a high-level (as seen from X thousand feet) overview of a MAC Proposal that attempts to combine the best features of MAC proposals to 802.11 with those of the Fieldbus Data Link protocol, which is designed for use over both wired and wireless LANs.
It is both incomplete and subject to revision.
Choices between possible alternative were made on the basis of the Requirements and Constraints given in 93/53.

P1 Three forms of Data Transfer Service will be offered:

1.1 UnConfirmed Connectionless

0. No Setup beyond WLAN user registration with CF.

1. LLC-data=MAC-SDU is transferred once on the WLAN by WLAN user

a. an AP repeats MAC-SDU when it is active (User-AP-User)

2. Delivery QoS

a. no MAC protection against lost or duplicate LLC-data

b. error recovery is by layers above Data Link

3. each frame uses Net-ID + 112 bit 802 addresses

= 2x(48+8) bit (DA+DSAP & SA+SSAP per 802

4. Time allocation is on demand

5. must be used for Multicast and Broadcast traffic

1.2 Confirmed Connectionless

0. No Setup beyond WLAN user registration with CF

1. Operation: full LLC-data=MAC-SDU is transferred on the WLAN by the Source WLAN user, with an Ack & possibly one retry by the MAC

a.- the Destination WLAN user must Ack if it receives the data

b. lack of an Ack is passed causes a single retransmission of the same LLC-data=MAC-SDU by the Source WLAN user

c. an AP may repeat both Data & Ack but takes no active error control role

2. Delivery QoS

a. A short transaction-sequence-# protocol lets the WLAN user detect duplicates

b. Some protection exists against lost frames - eg. but a 2nd missed or corrupted frame is lost

c. the WLAN user's upper layers must do error recovery in the case of lost frame

3. each frame uses Net-ID + 112 bit 802 address

= 2x(48+8) bit addresses (DA+DSAP & SA+SSAP per 802

4. Time allocation is on demand

EVALUATION
Meets R3, partly meets R1.1
Fails R1, R1.2, R3.2, C4, C5
Better for R5
Worse for R3.1
May fail R6 - except in the CODIAC proposal

1.3 Connections (context maintenance) between WLAN Users (ala. HDLC & Fieldbus)

0. Setup

a. WLAN users exchange Connect Establish frames to establish context (desired QoS) & Connect-ID

(with 56 bit addresses = DA+DSAP & SA+SSAP)

b. The initial Connection Establish request routed via the PCF, which can participate in negotiating the connection QoS

c. Connection QoS

LLC-data & MAC-PDU sizes (time reqd/frame)

Priority (for time allocation & maximum MAC-PDU size)

Access desired

1) Async (on demand)

2) Time Based + frequency & duration of frames + sporadic (for voice)

Error control

1) Group Ack + Selective Retries of missing data-segments - for most LLC-data

2) Order received data-segments - for Isochronous

3) None - for repetitive (state) data - industrial, pager, fire-alarm, etc

Power Savings required by this node

1. Operation - Source WLAN users send LLC-data-segments

(1 segment per MAC-SDU if MAC-PDU > LLC-data=MAC-SDU)

a. Destination WLAN user Acks groups of good segments or requests Selective Retries of missing segments

b. AP may also request retransmission of missing uplink segments, but it never Acks segments

2. Breakdown at end of Call / Session - frees bandwidth

3. uses Net-ID + Connect-ID (16 bit) + Connect Control

(16-24 bits = Seq.#, Retry Request, etc.)

4. Time allocation is fixed & negotiated with the PCF at Setup

5. when a WLAN user is communicating with a user on a wired LAN (WLAN user) the Portal becomes a proxy WLAN user

a. the Portal converts between the WLAN Connect-ID (16bit) & the 112 bit 802 addresses on the WLAN

EVALUATION

... Meets R1, R1.2, R3, R3.1, R3.2, C4, C4.1, C4.2
Worse for R1.1
R5 - Good for low power, Bad for simplicity
Better for R6

P1A - Other uses of short addresses local to an ESS - same form as Connect-IDs

1A.1 to pass tokens

1A.2 to provide "well known" addresses for common functions

- servers
- CF of BSS o& all CF
- base PCF of ESS - often a/the Portal
- AP for BSS, all AP
- Portal N, all Portals
- redundant but inactive copies of any of the above
- registration addresses for nodes newly entering an ESS or an isolated BSS
- Registration MIB
- WLAN MIB
- Security MIB
- Closed user groups
- many more

P2. Access Control (AC) - uses a PCF to allocate time (permission to transmit for know or maximum time) to all WLAN users

NOTE: - this procedure assumes that each WLAN user is associated to one & only one PCF - see C2 in 93/53 and MP1 below

2.1 the PCF passed a "token" at Priority X to each WLAN user on a regular basis

a) the designated User can send a frame of Priority X to another user

b) the designated User may also include a "More" request for additional time at some Priority to the PCF

- the procedure a) & b) can be repeated at will to send any amount of traffic

c) if the WLAN user has no traffic to send, it sends an short "None" frame, which may include a More indication if the WLAN node has additional, but non qualified - eg. too long or from another WLAN user (LSAP) in the same node, traffic to send

d) if the PCF hears no response in the PCF's "Slot time", it reclaims the token

1.- during the round-robin portion of the schedule, it immediately sends a token to the next user

2.- during the periodic portion of the schedule, it can search for another frame that fits the schedule and send the token to the next user

or it can do nothing - as in a Super-frame system

2.2 The PCF establishes its schedule based on Connection requests and registered Nodes (at the one or more APs scheduled by the PCF)

a. If this is TBS Connection, X, frame duration & start time, & frequency are negotiated at Setup

1) since these frames will be sent on a periodic basis and their (maximum) duration is known, the PCF enters these time slots in the periodic portion of its schedule

2) if a TDMA Superframe is used for transmissions on the wireless media, these periodic requests can be mapped to one or more SF "slots"

- these slots do not have to be contiguous - since Connections allow reliable segmentation of LLC-data

3) if a TDMA Superframe is used for transmissions on the wireless media, each of these periodic tokens can be mapped to one SF "slot"

b. If this is an Async Connection, X & frequency are negotiated at Setup

- since these frames will be sent on a irregular basis, the PCF enters the maximum possible time slots in the round-robin portion of its schedule

c. If this User has no Connections, X is by default & frequency is round-robin in available time

- since these frames will be sent on a irregular basis, the PCF enters the maximum possible time slots in the round-robin portion of its schedule

4.1 this protocol feature satisfies two needs & has two modes of operation:

a. low power nodes that "turn off" during known idle periods - see 1.3.0

1) The PCF creates known "Dead times" for each low power node, by buffering frames received for that Connection during the Dead time

- Connections allow flow control & thus prevent flooding of the PCFs buffers

2) Stored frames are transmitted during commanded "Awake times for the node

b. to allow roaming nodes to move seamlessly between BSSs in an ESS

1. If both BSS are controlled by the same PCF,

this is not an issue if the AP & PCF coincide

a. the PCF finds the new AP & then reassigns the AP that communicates with the node based on feedback from the PHY &/or MAC Error statistics

b. Connections will correct errors due to dropped frames during temporary outages while passing between APs

c. For longer outages or Connectionless services, Frames stored & then passed to, and transmitted by, the new AP when the transition is complete

2. If the BSS are controlled by different PCFs

a. the old & new PCFs find the new AP and loss of the old AP based on feedback from the PHY &/or MAC Error statistics

b. the old and new PCFs manage the transition between APs and reassign the AP that communicates with the node & the Time Scheduling function for the roaming WLAN users using the CFP - see MP1

b. Connections will correct errors due to dropped frames during temporary outages while passing between APs

c. For longer outages or Connectionless services, Frames stored & then passed to, and transmitted by, the new AP when the transition is complete

EVALUATION

Meets R3, R5, R? = support of Roaming nodes

Added function for PCFs

P5. Low Power Operation

- PCFs support this feature for simple (subscriber) nodes

5.1) P1.3, P2.2, P3 & P4a allow a node to turn off for a large fraction (> 90% in large or TBS networks)

5.2) PCFs are assumed to be line powered & to perform the Store & Forward function for low powered nodes

5.3) Low power nodes will be assigned a fixed slot to listen during each periodic schedule

a. if the PCF has anything to send the node, it will either

1. send the stored frame if the slot is long enough for the complete frame

2. send a next time to listen if the frame is too long or there is a backlog of Stored frames

3. send a "Next time to send" if the node sent a "More" indication previously

both 2 & 3 take place during the round-robin portion of the schedule

b. If the low powered node has nothing to send it will merely send a Connection status message

1. if it has something to send it will assert a "More" frame

EVALUATION

Meets R5, R6,

P6. Bootstrapping a WLAN Network

P6.1 when a WLAN node is turned on, it listens for X seconds for a CF

P6.2 if it hears none, it assumes the CF function

- for the simplest form of CF

- it is technically feasible to include the simplest CF function in all nodes, but this involves both a cost and power (when operating) constraint

a. the CF polls the preassigned registration IDs at a frequency determined by its power source & WLAN Management

b. If a WLAN node registers with the CF, it sends it a token and begins operation -using round-robin scheduling

eg. per P2.1a, P2.1c, P2.1d, P2.2c & P2.2d

Proposed WLAN Architecture 93-50