IEEE 802.11

802 LAN Access Method for Wireless Physical Media

A Review of MAC Requirements + Proposed Decomposition Method for Selecting a WLAN MAC Protocol

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1. Decomposition of MAC Proposals as a Method of Making Comparisons between them

In the author's opinion there are some key aspects that a successful WLAN Access Control (AC) Protocol must meet.

Access Control protocol (AC) is used to distinguish the protocol that decides which frame is transmitted next (or the sequence of available frames transmitted) on the Wireless media, from other aspects of the general MAC protocol needed for WLAN.

The author suggests that the immediate job of the 802.11 MAC SG is to select a basic AC protocol, and then enhance it as required, to meet unique WLAN medium access requirements.

Many of these broader MAC aspects eg. Security, Compression & Management are clearly separable from the AC protocol, in that any reasonable AC protocol can support them.

The author recommends that, to focus the MAC SGs deliberations, the these issues, which are peripheral to the AC protocol, be discussed after the basic AC protocol is agreed.

Even discussion of some requirements which are unique to WLANs such as:

routing traffic from WLAN nodes to nodes on wired LANs (via Portals),

reconfiguration/reallocation of PHY layer resources (channels, spreading codes, FH patterns, Tx power levels)

registration of nodes with APs and hand-off of roaming nodes,

are best treated as a checklist of requirements that each AC protocol must be able to support.

Focusing The MAC SG's discussions initially on Fundamental AC requirements, will allow us to make progress at the very fast rate that is necessary in today's political climate.

2. Background

Fig. 1 shows the authors interpretation of the heavily discussed (& mostly agreed) 802.11 architecture.

Fundamental Medium Access Requirements & possible Consensus MAC Protocol Requirements

802.11 and MAC SG discussions and the Issues Log indicate the following key AC requirements

These requirements apply for situations where all the WLAN stations within "interference range" are part of a single "administration" or multiple administration or were brought together in an "ad-hoc" manner (no administration).

R1. Allow reliable (= to wired LANs) conveyance of the maximum amount of end user data traffic per Hectare/Bandwidth

- the very limited allocations proposed by the FCC indicate that bandwidth will be a "precious commodity" for the foreseeable future

R1.1 at high burst rates for Asynchronous traffic

R1.2 at the regular periods requirements for Synchronous traffic - when present

R2. Minimize collisions on the wireless media

- since collisions:

1. always involve a loss of bandwidth
2. will also cause loss of data in some cases (broadcast messages & repeated collisions)

R2.1 Primarily with known standardized WLAN nodes - eg. 802.11, Cellular, etc.

R2.2 With know Primary or Co-primary occupants of the wireless band in use
- eg. microwave ovens at 2.4-2.5 GHz

R3. Provide a mechanism to enhance the reliability of traffic delivery on the WLAN to something equal to approaching that on wired LANs)

- inherent errors rates on WLANs are several orders of magnitude worse than those on wired LANs

- this is requirements some type of retry mechanism and may requirements a segmentation function,

3.1 The overhead of using an Ack frame for each User Data frame violates R1

{ Connections (ala. HDLC & Fieldbus) allow reliable detection of lost frames and selective retries of only those frames that have been lost. }

3.2 Transmission of frames shorter than typical LLC-data frames will significantly enhance throughput under high error rate conditions

R4. Prevent unintentional delivery of traffic between "administrations"

4.1 the author recommends that AC only pass-up LLC-data-frames with a registered "Network number" to perform this function, as per several proposals

R5. Allow simple (low cost), battery-operated (low power consumption) nodes

R6. Allow the same simple node (same AC protocol subset) to participate in both ad-hoc and infrastructure networks

- this is a market requirements both to achieve large volume (lowest cost) and to avoid confusing users

R6.1 The CODIAC proposal seems to be unique in (its elegance of) meeting this requirements

3. Derivative Solution Constraints & Proposed MAC Protocol Features

The author believes that the following additional constraints can be derived from the above requirements.

C1. When no infrastructure is present, nodes must be able to establish an "ad hoc" network using a Point or Distributed Coordination Functions (CF).

- use of AC Conformance Classes (CC) would allow nodes in higher CCs to take a lead role, (possibly as the sole PCF) in the ad-hoc network, while nodes of the lowest (simplest) class could join in

C2. When multiple CFs are "present" (can communicate with each other) (& possibly in same ESS) they must coordinate their actions to meet R1, R2

C2.1 when there is a non wireless communication path available between the CFs, they shall use this path for coordination, unless this is preclude by incompatible administrations,

- to meet R1, R2 & to achieve more reliable coordination due the lower loss rate on a non-WLAN path

- CFs connected by non-wired infrastructure are normally Point CFs (PCFs) -

- a PCF can be thought of as a CF that performs any required coordination of wireless transmissions via the CFP rather than the AC

C2.2 when the wireless media is the only communication path available to overlapped CFs, or are owned by incompatible administrations, they shall use this path for coordination

C3. When infrastructure connected PCFs are "present", any ad hoc network CF must coordinate with the PCFs with which it can communicate per C2.

C3.1 The simplest & most efficient method of accomplishing this coordination is for the CFs in the ad-hoc network to gracefully coalesce with the PCFs

- the coalescence is done using the same CFP described in section 2.

- this approach partly satisfies R1, R2 and satisfies C2.1 & C2.2.

C3.2 For a variety of reasons, it is sensible to apply the same approach when any two CFs can communicate, but only via the wireless media

-the coalescence is done using the same CFP described in section 2.

C3.2.1 the AC protocol can be greatly simplified, since

1) there is no need for a Distributed CF (DCF) - ad-hoc networks operate by electing one the CF capable nodes as the PCF using the CFP

2) the bulk of the nodes in many systems can be very simple, and very "power stingy", since they need no CF

3) it is possible to design a AC (like that in Fieldbus) that allows these simple nodes to be "Responders" that (almost) never generate collisions

4) this approach satisfies R1, R2.1, C2.1 & C2.2

C4. R1 implies that "minimum overhead" is needed. This can be accomplished in several ways:

C4.1 minimize frame lengths by for example:

1) use short temporary IDs (network + association or connection) (~32 bits) where possible - instead of full 96 bit 802 SA+DA

2) only transmit MAC information in frames where it is needed - eg. power management, etc.

C4.2 minimize number of frames transmitted

C5. Satisfaction of the periodic requirements of time based service (TBS) users implies a need for negotiation of their QoS needs with the "Time Scheduling" (PCF) function

C5.1 several classes of users with different transmission time and frequency needs and different priorities exist

- thus a fixed allocation per TBS user is not practical

C6. Provisions to reliably support power saving modes, especially in battery operated nodes

- reliable implies possible loss of performance, but no loss of function

C7. must be able to cope reliably with (many) nodes being in inconsistent states

Current WLAN Architecture 93-53