IEEE 802.11
Wireless LANs

802.11 MAC Layer - Some Proposed Characteristics

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Introduction

This submission proposes some baseline characteristics for the 802.11 MAC layer. The intention here is not to present a complete MAC layer architecture, as we feel this would be premature. Instead, we discuss some issues that strongly influence the MAC layer, and also propose directions that we believe would be useful to pursue. The purpose is to stimulate discussion, and resolution, of these issues in the committee. The committee's decisions in these areas can then serve as the basis for further work.

The MAC layer characteristics developed in this submission take into account the MAC layer requirements put forth in the contribution '**Market Driven Functional Requirements**' by D.Bagby, R.Dayem, and R.Rom, submitted at this session.

Operation of Autonomous Collocated Networks

A crucial issue in the development of the MAC layer is the need to accommodate **autonomous, collocated** networks. Such networks will be commonplace. A typical case would be different companies sharing an office building, each operating an IEEE 802.11-based network.

> **Autonomous networks** are defined here to be networks operated by independent entities, that are not actively coordinating with each other.
>
> **Collocated networks** are defined here to be networks operating on the same physical channel in the same vicinity.

The system design must permit the operation of high data rate, autonomous, collocated, networks[1]. However, it is unrealistic to expect such networks to operate with complete disregard for each other's existence without risking considerable degradation of service.

It is therefore essential that the standard incorporate explicit mechanisms to accommodate operation of these networks.

The properties of these networks are a factor in several of the proposed MAC layer characteristics.

Proposed MAC Layer Characteristics

1. Class of service

In this first round of standardization, the MAC layer should not support isochronous traffic, but should be designed for the transfer of packetized, digital data. Voice messaging, and other non-real-time applications, have the same characteristics as packetized digital data and therefore require no special treatment.

One reason for this position is explained in a section of the contribution "Market Driven Functional Requirements", reproduced here.

> "We perceive today's primary need to be wireless LAN data networks. The need is significant and there are no standard bodies addressing this specific requirement except for 802.11. While we understand the longer term attractiveness of isochronous services, our markets will not withstand additional complexity in the standard for isochronous services, nor delay of the standard to obtain such services."

Another factor governing this position is that no proof of concept exists for a wireless system that combines isochronous traffic with the low-latency, bursty, high-bandwidth, traffic that is characteristic of data networks.

2. Addressing

The 802.11 MAC layer should use standard 802 addressing conventions, supporting globally unique 48 bit addresses, multicast and broadcast.

Since it is necessary that addresses be unique over autonomous networks, it is proposed that locally administered addresses not be supported by 802.11.

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[1]Operation of autonomous, collocated networks would not be an issue were an adequate amount of radio spectrum available to guarantee that each such network had an independent physical channel available to it. Given the high data rates targetted for 802.11 wireless LANs, we believe this is not a realistic assumption.

3. Administrative Bounding of a LAN

Unlike a wired network, a radio LAN cannot be physically bounded. In particular, some of the traffic on the medium may be generated by stations that are not part of the same autonomous network[2].

It is necessary that such traffic be filtered out, and not be presented to the higher layer protocols. Failure to do so may result in failure of the internet of which the LAN is a part. For instance, it is imperative that router traffic that is generated in a different autonomous network not be mis-delivered.

Administrative bounding of the LAN is therefore required.

It is proposed that **globally unique LAN IDs** be used for administrative bounding of the LAN. The LAN ID would be a part of the MAC frame header, and would be used by the MAC layer to filter incoming traffic.

It is important to realize that, while the mechanism resides in the MAC layer, the motivation for this mechanism lies in higher protocol layers. In this respect, the LAN ID is similar to LLC Service Access Points.

Since the need for this function is a direct consequence of the physical layer characteristics, and since it is important that 802.11 use the standard 802 LLC layer, it is proposed that this function reside in the MAC layer rather than in the LLC layer.

The Appendix describes one possible approach for generating globally unique LAN IDs.

4. Channel Access Mechanism

When autonomous collocated networks exist, it will typically be the case that transmissions occuring in the context of one network are capable of causing interference to the operations of other collocated networks. It is essential that the effect of this interference be minimized.

To this end, **Carrier Sense Multiple Access** is proposed as the channel access mechanism.

The principal advantages of CSMA are that it is a simple, distributed algorithm that is extremely robust, while requiring only a very low level of coordination between stations. These properties are important for controlling the transmissions of stations in autonomous LANs, in the absence of other coordination. These properties also contribute to considerable robustness in the face of dynamic LAN membership - nodes joining and leaving the LAN do not disrupt LAN operation. The principal drawbacks of CSMA are that

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[2] As stated earlier, this situation arises because it cannot be assumed that the degree of channelization available from the physical layer will be adequate to guarantee that autonomous networks will operate on seperate channels.
Spectrum availability is the dominant, but not the only, factor.
Other factors include
- coordination of channel use
- cost of components such as programmable correlators if Spread Spectrum is used in the PHY

etc

it is inefficient at high utilization levels, and that it degrades in the presence of hidden nodes. However, we believe that the benefits outweigh the drawbacks.

Since Collision Detect is difficult to implement in a wireless LAN, the algorithm should be p-persistent or non-persistent, rather than 1-persistent. (The IEEE 802.3 algorithm is Carrier Sense Multiple Access with Collision Detect and is 1-persistent.)

5. Broadcast and Multicast

802.11 LANs must support broadcast and multicast. This is an existing 802 requirement, which may require additional mechanisms in 802.11.

6. Security

Security is desired, but not at the MAC level.

7. Strawman MAC header

Based on the preceding points, a strawman MAC header is proposed

• LAN ID	globally unique
• MAC Control Bits	To be developed
• Destination address	48 bit globally administered IEEE address
• Source address	48 bit globally administered IEEE address
• Length	16 bits

Conclusion

In this submission, some baseline MAC layer characteristics have been proposed. Decisions made in the areas discussed here fundamentally influence the design of the MAC layer, so it is important that the committee deal with these issues early in the design cycle. The committee's decisions in these areas will serve as the basis for further work.

Appendix

Globally Unique LAN IDs

Many mechanisms are possible to generate globally unique LAN IDs. The specific mechanism is less important than the principle that a LAN ID is necessary, and that it should be globally unique. It is desirable that LAN IDs be generated without creating any new administrative mechanisms within the 802 committee.

One approach to meeting these requirements is to derive the LAN ID of a network from the 48 bit globally unique address of one of the nodes on the LAN.

If this approach is used, the LAN ID may take the form

48 bit 802 address [+ additional bits]

This method would be suitable for use both in the presence of a distribution system, as well as with ad-hoc networks, that operate in the absence of any infra-structure.

An algorithm to distribute the LAN ID within the LAN is also needed.

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Key Requirements

(Condensed from Market-Driven Requirements submission)

- **Unrestricted portability -**
  the network goes with the computer + unlicensed
- **No distribution system required**
- **Optimized for local area data**
- **Autonomous, collocated networks -**
  ie: using a *shared spectrum* ~~X~~ physical channel

MAC Layer - Some Proposed Characteristics

Key Characteristics

- Class of service
- Administrative Bounding
- Channel Access Mechanism
- Addressing
- Broadcast and multicast
- Security
- Strawman MAC Header

Class of service

- Need for wireless data is immediate
- 802.11 only standards body with data as immediate priority
- Focus on data now
- Isochronous later

- we recognize isochronous cannot be piggybacked after the fact.

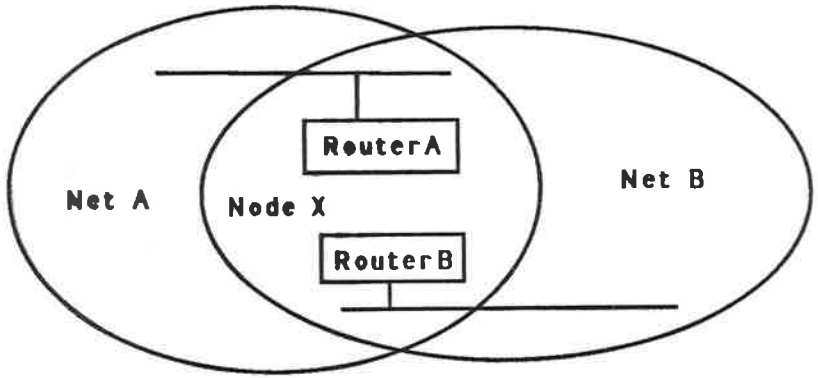
Administrative Bounding

Physical bounding not possible

- To filter traffic not generated on that autonomous LAN issue not interference
- Use a globally unique LAN ID
- LAN ID in MAC layer to permit use of standard LLC header

MAC Layer - Some Proposed Characteristics

Example - Administrative Bounding



Net A and Net B are autonomous, collocated networks

Router A and Router B should not accidentally exchange Routing information

Node X on Net A should not communicate with Router B

MAC Layer - Some Proposed Characteristics

Channel Access Mechanism

Two channel access issues - can be solved independantly

- To regulate access within an autonomous net
- To regulate access between autonomous networks on the same physical channel

Additionally:

- To allow robust operation with dynamic LAN membership [portable]

[redacted]

[redacted]

MAC Layer - Some Proposed Characteristics

Channel sharing within the autonomous net

- dynamic LAN membership needs to be accommodated.

CSMA proposed here as well

But note again there are two issues.

Addressing

- Standard 802 addressing
- 48-bit, globally unique node ids
- Don't support 16-bit local addresses

MAC Layer - Some Proposed Characteristics

Broadcast & Multicast

- Existing 802 requirement
- Support on 802.11 LANs probably requires additional mechanisms

Security

- Market will demand security
- Not at MAC level

Strawman MAC Header

• LAN ID	Globally unique ID
• MAC control bits	To be developed
• Destination address	48-bit IEEE address
• Source address	48-bit IEEE address
• Length	16-bit frame length

MAC Layer - Some Proposed Characteristics

Channel sharing by autonomous nets:

- Minimal coordination required

CSMA proposed.

Important:

Can be combined/overlayed with a different protocol within the autonomous net.