IEEE P802.11
802 LAN Access Method for Wireless Physical Medium

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TITLE: **SELECTION BASIS FOR ARCHITECTURAL, MODULATION, CHANNELIZATION AND FREQUENCY REUSE METHODS**

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INTRODUCTION

It will be necessary for the IEEE 802.11 Committee to make choices before work on a draft Standard can progress. Some of these choices are generic and are addressed in **Part I**. Most of the same questions reappear in any attempt to define a specific system, but the terms and conclusions are in a different descriptive form. This is illustrated in **Part II** where modulation, channelization and access method possibilities are more specifically described.

Part III is an overview of the access methods that would support these choices.

No final conclusion is offered, however an attempt is made to show the reasons why some possibilities and combinations should not be selected, and to point out invalid reasons sometimes given for rejection of a possibility. This paper is introductory for three further contributions each describing one of three access methods referenced in Part III.

Where subjective judgments are made, an effort is made to present the reasons leading to those preferences.

It is a premise of this contribution that <u>an adequate access method can be found for any of the selectable combinations of data rate, channelization and use of infrastructure</u>.

A need for both a low rate service for portable computers and a high rate service for high function Stations is also assumed.

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No final conclusion is offered, however an attempt is made to show the reasons why some possibilities and combinations should not be selected, and to point out invalid reasons sometimes given for rejection of a possibility.

A substantial effort is made to present the reasons where subjective judgments are made.

An assumption is that an adequate access method can be found for any of the selectable combinations of channelization and use of infrastructure. A need for both a low and a high rate service is also assumed.

PART I--GENERIC CHOICES

OVERVIEW

Much or the proposal work has been focused on particular aspects of the perceived goals for 802.11 with the benefit that many viewpoints are now known. From this work, the generic possibilities about which fundamental decisions are needed have become apparent. There are many commonalities among the proposals that are disguised by differences in jargon and descriptive technique. Generic choices must be made in the following areas:

1) **Centralized to Distributed Control Logic (gray scale)**

2) **Deterministic to Contention-based Access Method (gray scale)**

3) **Channelized or Non-channelized Medium (binary choice)**

4) **Time-slotted or Header-based Space Allocation (binary choice)**

The preferred solutions cannot be arrived at one-issue-at-a-time, because these possibilities are not wholly independent choices. Only certain combinations lead to usable systems.

Externally Defined Limitations

Some possibilities cannot be considered further because of physical limitations from the rate and delay parameters in the 802 "Functional Requirements" or from the more detailed limitations of the 802 PAR.

Layer Discipline

It is important to keep separated physical medium design, access method and higher layer functions. This is particularly difficult with respect to channelization and modification of error prone wireless to achieve the low error rates on which the upper layers of 802 are based.

CENTRALIZED AND DISTRIBUTED CONTROL LOGIC

The argument for distributing all logic to the Stations using a common medium is often confused on whether it is about access method or avoidance of common equipment. The strong functional arguments for infrastructure include the possibility of a deterministic access method but there are many others.

It is NOT TRUE that the use of an infrastructure precludes operation without it or communication between Stations directly. The usefulness of these functions is not questioned, but they can be accomplished within an infrastructure utilizing plan.

Infrastructure Functions

Infrastructure is required for the workgroup to be linked beyond its own members, and for them to be reached from the outside. The degree to which this requirement is ubiquitous is arguable, but it is large enough that support is required.

There are three separate functions for infrastructure:

1) To provide access and accessibility for external communication by the Stations on the LAN.

2) To increase the radio coverage available to a Station with minimal radio capability.

3) To provide organized access control that considers and resolves overlapping radio coverage from the access-points.

There is no absolute requirement that a Station be able to reach another Station that is beyond the unassisted radio range, or even entirely outside of the originator's system, but the usefulness of a system is greater without these limitations. This leads to a decisive inducement to provide an infrastructure capability.

Infrastructure for external access does not necessarily provide any kind of central control. These are two distinct and separate functions.

Centralization of Access Control

The minimum scope of central control is determined by the following factors:

4) the number of access-points which must take into account the status of other surrounding access-points before transmitting.

5) the number of access-points required to serve the area in which each Station must have MAC layer bridging of LAN access to other Stations.

It is not an absolute requirement that Stations be inhibited from transmitting when interference would be created for other coinciding communication, but it is certainly undesirable and probably inefficient.

Distributed Access Control

There is a strong philosophical orientation in 802 to distribute the system access function over the using Stations independently of shared/common equipment. This concept is becoming less practiced as local bridges and active hubs become an accepted part of networks.

The 802.11 requirement that all Stations be alike regardless of system size or type in which they are used, complicates (or makes impossible) the use of a wholly distributed access method. There could be material differences in the physical layer to accommodate various sizes and capacities. The exact level of compatibility and access method dependence between Station designs for various environmental assumptions remains to be seen.

There may be differences in channel assignment methods, prioritization and even message structure which would be chosen differently in small and autonomous systems and in those which are desktop services extensions for an entire Company. It is important to keep those differences out of the Station logic and the air-interface defined by 802.11.

Optional Infrastructure Functions

An infrastructure that provides orderly access control does not necessarily provide any of the other functions for which it could also be useful. The other possible functions include those given above, and also:

6) time and protocol efficient backbone services

7) central operation of directories, status registers, maintenance and management information

8) common points of interconnection to other LAN, Public Telephone Network and private wide area facilities

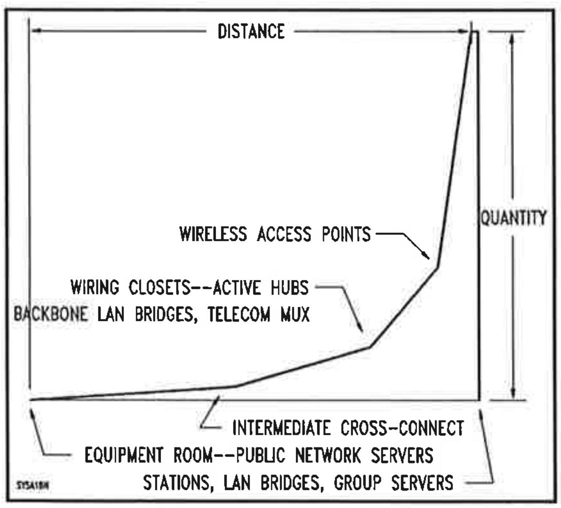

Figure 1 Centralization Levels Shown on a Plot of Quantities of Instances vs. Distance

Conclusion on Degree of Centralization

The system plan is dependent on critical functional requirements. Figure 1 above is meant to illustrate the role that distance and quantity play in selecting the network position of various functions. For example, the public network interface and slowly changing transaction records can be in an Equipment Room common for the whole Company, but <u>the function of granting access must be as close as possible to the Stations affected because of propagation time</u>.

Neither extreme of centralization is general and suitable.

The access control logic cannot be as centralized as in a PBX, though there are infrastructure functions (see 7) and 8) above) which could be shared at this high level.

The access control logic cannot be totally distributed to the Stations without great loss in the utilization of channel time and statistical possibility of great delay. The station does not know enough about what is happening in other parts of the system to correctly make the access decisions that it must.

The simple consequences of propagation delay preclude decisions being made at any great distance from the Stations involved. <u>Access management must be closer to the Station the higher the medium signaling rate</u>.

Registration, short address assignment and usage accounting functions can be handled in a highly centralized management equipment, but medium access regulated by infrastructure must make its decisions at a hub common to a limited number of interfering access-points.

PERMISSIBLE CONTENTION WITHIN AN ACCESS METHOD

A completely distributed access method can be used based on contending use of a setup or a common signaling channel. It is not true that access based on presence/absence of signal or on the 802.3 packet frame is the only or even a preferred way of getting this result.

A distinction must be drawn between possible contention and a means of resolving it, and the use of carrier detection as a criteria for enabling transmission. These are two different matters.

There have been several contributions on various aspects of the use or objections to use of "CSMA/CD." The first aspect is that the meaning must be defined in the context of application to the 802.11 problem.

Carrier (or Signal) Sensing Access Method

In a radio system with overlapping coverages from many Access-points and Stations, the presence of signal does not indicate that a transmitted message will not be received, and is therefore undependable as an indication of channel availability.

Similarly, absence of signal at the transmitting point is not a dependable indication that the transmission will be received.

There is a difference in results if the criteria of signal present is not a radio carrier but valid data format for the system. The difficulty with the latter criteria is that it takes a receiver much more time to decide that data is valid than to decide that a radio signal is present.

Better methods are available than either form of "CSMA".

Recovery from Failed Messages

A significant proportion of transmissions will be unsuccessful without contention due to inadequate radio path. If this is so, the remedy would apply equally to contention loss if it is of the same order of magnitude.

There are both analog and logical methods for creating and using redundancy to reduce missed message probability. In combination with other methods, automatic repetition of flawed data transmissions is a method of recovery which would apply equally to messages lost from contention.

There can also be contention on resend unless measures for desynchronization of multiple users are included.

Contention in Common Channel and Multichannel Plans

In a multichannel system, it is possible to dedicate one channel to the setup (Request-Grant) procedure. One benefit is that the contention possibility can be limited to setup messages and avoided for data transfers with a minimal central control. Without central control, contention is also possible on the data transfer channels but at a reduced probability.

With a common channel system for setup and data transfer, contention can still be restricted to the setup procedure if there is central control.

In a common channel system without central control, the contention possibility will be proportional to transmission duration for both setup and data transfer. Longer transmissions have increased probability of error from multiple simultaneous use of the channel.

It would seem that the common channel system is at a serious disadvantage in this respect, particularly for systems not using a central control. This conclusion might be accurate if both common and multichannel systems operated at the same data signaling rate per channel, but typically the common channel system will operate at a multiple of the channelized signaling rate which makes the aggregate capacity of both systems equal (e.g 10 channels at 1 Mb/s is the same capacity as 1 channel at 10 Mb/s).

The increased speed of the common channel system reduces overlapping transmission probability to a similar level when both common and multichannel systems are carrying the same amount of aggregate traffic.

CHANNELIZED OR COMMON CHANNEL RADIO SYSTEM

The channelized system is particularly attractive with spread spectrum modulation where the channels are derived by code division in a way that does not increase occupied spectrum over that required to get good multipath resolution. It is possible to select channels with logic circuits rather than by choice of operating frequency.

Channelization is much less attractive using frequency division which creates a need for fast-stepping synthesized local oscillators and a higher degree of accuracy and stability in oscillators and filters.

This choice is greatly influenced by implementation factors.

Relative Range and Power

When correctly done, the spread spectrum processing gain reduces the noise bandwidth of the receiver from that occupied by the signal to that required for the information transfer rate derived. There should be little difference between the code and frequency division methods for the same derived channel data rate.

If the data rate is increased tenfold (10X), then the signal bandwidth is increased by the same factor and a 10 dB increase in transmitter power would be required to maintain the same signal-to-noise ratio at the receiver for the same modulation technology.

If the high data rate is obtained by operating a number of low data rate channels in parallel (e.g. 10 x 1 Mb/s) there would not be a range difference between high and low rate, though there would be the same power and occupied spectrum difference.

If the high data rate is obtained by using the same modulation at a higher rate, changes in the multipath limitations on range would have to be considered.

Preference Basis

The range of the radio system will have a proportionality to the transmission rate. The 1 Mb/s channels of a channelized system would tend to have greater range than a common channel 10 Mb/s system--normally. This would result in the following application factors for a preference:

Channelized 10 x 1 Mb/s:

- area coverage
- less capacity per unit area
- fewer access-points per unit area

Common channel at 10 Mb/s:

- high usage
- more capacity per unit area
- more access-points per unit area

Layering Considerations

The implications of interlayer communication required especially for channelized systems should be considered.

TIME-SLOTTED AND HEADER-BASED FRAME STRUCTURES

Within a time-division frame structure, an assigned slot is a type of address the parameters of which are implementation dependent. The difficulty created by this parameter is increased if it takes many frames to pass allotment changes.

The public network is entirely based on time-slot derived channels and tandem switches with slow data intercommunication. The setup of a connection involves a negotiation between the ends of each link on the path to be used. This process is inevitable with regular time division. The difficulty that LAN users have with incorporation of switches in the data path are directly derived from this characteristic.

A fast network must propagate setup information at least as fast as the data to be transferred which is an important part of the insight and advantage of the common channel LAN.

The medium must be used at its full rate and sequentially for setup information and data transfer. Each packet of data must have a header with all needed handling and routing information.

Proposals to 802.11 have used a time-slotted frame structure with reserved fields for management of payload space within the frame. The alternative is to incorporate this space management function into the header which is already part of the payload use of the managed space.

The means for serializing the frames on a common medium is the function of the access method. The time at which the frames appear on the medium should be determined by the transmitting end. The receiver should look at the header of each frame obtaining the information necessary to handle it appropriately. The receiver should not measure the time of arrival as a factor in forwarding the frame.

PART II -- SPECIFIC METHODS

OVERVIEW

There are a number of choices to be made before drafting of a standard can begin. Most of these choices are tradeoffs which are much dependent on selection of the area of optimization. It is now assumed that there are two distinct and separate groups of requirements as shown in Table I below.

Requirements Addressed

To attract markets by fulfilling user functional requirements (those of 802 LAN are taken as given). it is assumed that the 802.11 Standard must accommodate both views.

There are important functional needs which are different combinations of the above elements. E.g. industrial is more like "portable" except that battery drain and deterministic capacity are more like "high function."

It is now accepted that the needs of all of the referenced groups are sufficiently important that the Standard must accommodate them.

Use of Frequency Space

It is assumed that operation in ISM bands at 2.45 and 5.8 GHz are the main possibilities for the immediate future. A preferred technology would also operate in 10 and 20 MHz segments of the USA 1710 to 1990 MHz point-to-point microwave bands.

Major Choices

It will be necessary to choose methods for the following technical functions:

1) Radio frequency modulation of bits or chips
2) Channelization method for channelized systems
3) Reuse method for the channel or channels in larger multiple access-point system plans.

TABLE I – MAJOR FUNCTIONAL REQUIREMENT GROUPS

PORTABLE COMPUTER GROUP	HIGH FUNCTION GROUP
• Low battery drain, small size	• battery drain and size limits greater
• 1-2 Mb/s physical medium data rate	• 8-16 Mb/s physical medium data rate
• Reach through some walls to 75 meters, much more when path is clear	• Reach through a wall to 15 meters, more when path is clear
• For the required signaling rates, additional frequency space for the system bandwidth required for spread spectrum is probably available	• For the signaling rates required, the frequency space required for spread spectrum is probably unavailable except at microwave frequencies
• Efficient operation without infrastructure, but increased function with infrastructure	• Always operated with at least one access-point of infrastructure
• If connection support, limited to one POTS or 64 Kb/s only	• Support of ISDN connections including BRI, 384 Kb/s and PRI if possible
• Indeterminate capacity and delay acceptable if delay is small at less than 25% air time loading	• Capacity and delay must be determinable with efficient operation up to 80% air time loading

The main subjects of this paper are the possibilities and proposed preferred choice for some of these technical functions. It is not easy to decide which is first because all possibilities interlock. The weighting of pro and con points can be subjective.

Access Method

There will also be three variations of access method to fit the combinations of these choices which are as follows:

1) Sequential use of a single channel
2) Channelized system with primary access-point control
3) Channelized system with primary contention setup channel, and with no infrastructure required but supported

The choices to be proposed depend on the availability of these types of access method. The channelized schemes can use either type 2) or 3) above.

RADIO FREQUENCY MODULATION

This selection must be made early weighting relatively perceptions of size, battery drain and cost. So many existing systems and proposals for PCN and other functions have chosen some form of PSK that this type of modulation must be the default choice. The main possibilities are laid out in Table II following.

The selected modulations are 2) and 3), QAM/NRZST in Table II which are described in some detail in a separate contribution. NRZST is an a baseband modulation optimized for transmission through a no dc medium and to compensate distortion encountered in filters and transmission lines at high rates.

TABLE II -- RF MODULATION METHOD

1) PSK with NRZST--Unchannelized (phase reference is previous bit--no quadrature channel)
+ a) easy and fast rf phase reference recovery
+ b) occupied spectrum of 0.8 bits/Hz
+ c) AM envelope is bit clock
+ d) simple modulator/demodulator with polar detection with minimum battery drain
+ e) least error extension from phase discontinuity in medium
– f) analog delay lines or resonators may be required in receiver
– g) requires linear amplification, implying:
  i) in the transmitter power amplifier, lower power efficiency and greater complexity
  ii) in the receiver, fast automatic gain control but less total gain

2) QPSK or QAM/NRZST--Unchannelized
+ a) Occupied spectrum of 1.6 bits/Hz
+ b) Usable for either direct or chipped (SS) modulation
+ c) minimum noise bandwidth and required transmitter power
+ d) maximizes attainable rate and capacity within narrow bandwidth spectrum allocation
+ e) division into I and Q channels is inherent in modulator and demodulator so simplest transport and processing is two parallel channels at half composite rate
+ f) rf phase lock in receiver avoidable with DSP at baseband
– g) requires linear amplification same as in 1g) above

3) PSK, QPSK or QAM/NRZST--Channelized
  a) Inherits advantages and disadvantages of unchannelized identical modulation
+ b) Occupied spectrum of 0.8 and 1.6 bits/Hz
+ c) Minimal system guard band required
– d) Greater accuracy and frequency stability required

4) Direct Frequency Modulation with NRZST
+ a) quieting is analog equivalent of SS processing gain
+ b) no receiver AGC function
+ c) lesser frequency accuracy
– e) at least 4 times BW of QAM system
– f) out-of-band spectrum hard to reduce

CHANNELIZATION METHOD

Channelization is an important part of implementing complex area coverage, and of increasing the parallel capacity of systems.

A subtle consideration is that <u>a channelized plan is not readily convertible to a cabled medium</u>.

In the radio LAN context, the use of channels is not to multiplex more than one simultaneous user on a common radio access-point as it is in mobile telephone, but to enable independent and simultaneous operation of Access-points that have overlapping coverage and the mobile Stations that use each of them.

Two well-known methods of deriving channels are considered and each has advantages/disadvantages in various contexts as shown below:

TABLE III – CHANNELIZATION METHOD

1) Code-division with spread spectrum
+ a) Inherits advantages of modulation type
– b) Inherits disadvantages of modulation type
+ b) RF channel switching not required
+ c) No RF phase lock required
+ d) Fast bit clock acquisition
+ e) Logically derived channelization
– f) Relative to direct digital modulation, processing speed, dynamic range and power drain increase by chipping ratio
– g) Derived channels not suitable for negative signal-to-interference ratios limiting system design

2) Frequency-division with PSK/NRZST or QAM/NRZST
(particular case of minimized BW)
+ a) Inherits advantages of modulation type
– b) Inherits disadvantages of modulation type
+ c) Permits once-removed adjacent channel signal levels to be higher than desired signal
– d) Synthesizer channel stepper has high power drain, and it is difficult to realize when rapid switching required
– e) narrower fractional-bandwidth for radio increases required accuracy and cost relative to unchannelized radio with the same modulation at proportionally higher rate

REUSE METHOD

Accepting that channelization is possible and available, there is a question on whether or not to use it. The desirability of channelization contains many diverse considerations in both radio system planning, protocol and implementation hardware.

An unarranged radio system will have overlapping coverages from both Stations and Access-points. There must be some method of dealing with this.

The "reuse factor" assumes that a regular pattern of N coverages is laid out each with its own assigned channel derived by one of the above methods. N is the number of different channels that must be used before it can be assumed that multiple uses of the same channel will be spaced sufficiently to be non-interfering when used simultaneously. The minimum value for N depends upon capture ratio or required signal/interference ratio inherent in a selected modulation. For this evaluation N = 9 is assumed consistently, though smaller or possibly larger values might be chosen after further study and experimental work.

Reuse separation can be obtain by channelization as described above, or by time division. Sequential use of Access-points and stations in a reuse group is also a separation possibility. Its main disadvantage is that signaling speed must be proportionately higher to carry the same traffic as the same number of Access-point used simultaneously. A comparison of these approaches is shown below:

TABLE IV – REUSE METHOD

1) Sequential
   a) Peak capacity = Signaling rate
   b) Inherits advantages and disadvantages of unchannelized modulation type
   + c) High yield on time-space utilization
   + d) No problem from mislocated Stn use of APt
   + e) Multiple APt reception gives space diversity
   – f) Shorter $\text{range}_{\text{sequential}}$ = $\text{range}_{\text{channelized}}$/reuse-factor
   – g) Larger system guard band required

2) Channelized
   a) Peak capacity = per point capacity
   b) Inherits advantages and disadvantages of channelized modulation type
   c) Fixed partitioning of setup and data transfer capacity, (1/10th of 1/17th typical)
   d) Greater range and lower frequency reusability
   + e) Access request non-blocking relative to packet length
   + f) Signal processing speed at (1/reuse-factor) relative to sequential, and therefore lower power drain

MENU OF THE MAIN POSSIBILITIES

Not all combinations of the above elements are usable together. The most suitable combinations (4) are shown below in Table V on the following page along with certain overall radio parameters that are implied.

TABLE V – RADIO CHANNEL PARAMETERS

System Model: 9-BSA square reuse pattern		SINGLE CHANNEL SETUP & DATA SEQUENTIAL USE	ONE SETUP & 9 DATA CHANNELS PARALLEL USE
ANALOG MODULATION –QAM/NRZST–1.6 B/HZ			
SYSTEM BANDWIDTH	MHZ	15	10
CHANNEL SIGNALING RATE	MB/S	12	1.2
CHANNEL BANDWIDTH @ -6 DB	MHZ	7.50	0.75
NUMBER OF FREQUENCY-DIVISION CHANNELS		1	10
CHANNEL SPACING	MHZ	na	0.75
INTERSYSTEM GUARDBAND (100% TYP)	MHZ	7.50 (100%)	2.50 (25%)
REACH IN OPEN OFFICE/RETAIL	MTR	20 CLEAR	50 CLUTTERED
SPREAD SPECTRUM MODULATION –1.6 Chip/HZ			
SYSTEM BANDWIDTH	MHZ	15	40
CHANNEL SIGNALING RATE	MB/S	1.1	1.2
CHANNEL CHIPPING RATE	MB/S	12.1 (11)	37.2 (31)
CHANNEL BANDWIDTH @ -6 DB	MHZ	7.56	23.25
NUMBER OF CODE-DIVISION CHANNELS		1	10
INTERSYSTEM GUARDBAND	MHZ	7.44 (98%)	26.75 (72%)
REACH IN OPEN OFFICE/RETAIL	MTR	30 CLUTTERED	100 CLUTTERED

PREFERRED CHOICES

Two types must be chosen now called "Portable" and "High Function."

Further study on the tradeoffs for directly transmitted high rate and various higher chipping rate redundancy forms is needed.

Any of these plans can be implemented with/without infrastructure support. That is a separate issue.

Portable Parameters

For the 1.2 Mb/s system, the channelized spread spectrum system is suggested. Only in this way can the code-division property be used to advantage. Without the code-division channelization, spread spectrum gives too little capacity relative to the occupied bandwidth. The gain results from the possible simultaneous use of overlapping Access-points.

High Function Parameters

For the 12 Mb/s system, sequential use of a common channel is preferred. Spread spectrum cannot realize the signaling rate within a 20 MHz band, but it might in an 80-120 MHz band (ISM at 2.45/5.9 GHz).

Part III -- Access Methods

OVERVIEW

It has been possible to define a methodology for access method which has commonality between many of the possible choices for the physical medium. The inherently burst nature of the inward transmission from Stations requires that each burst contain:

a) start synchronization,
b) overhead,
c) payload,
d) end delimiting.

If the absolute requirement for infrastructure and Access-points is to be avoided, then the same applies to transmissions toward the Station.

There is now a question of whether these bursts are:

1) fitted within a uniform timed frame structure within which all transmissions are fitted, or
2) allotted within a dynamically dimensioned timed frame structure, or
3) asynchronously timed dependent on the presence of a preceding message, except for sequence initiation.

Notwithstanding the arguability, the third case is assumed. It is asserted that this provides necessary flexibility and independence of the detail of the physical medium. It is elsewhere asserted that this also provides high relative efficiency in the use of channel time, but this is aside from the present generic issues.

Each of the possible sequences has its own defined overhead structure within a message format containing the elements a)-d) above. It has been found that the same or only slightly modified message set can be used for all of the forms of physical medium and access method as follows:

i) Common Channel--no infrastructure
ii) Common Channel--infrastructure controlled
iii) Channelized--no infrastructure
iv) Channelized--infrastructure controlled

Contribution Identification

Three contributions have been prepared to describe specifically the four types of Access-methods in i)-iv) above. The two types for a common channel system are both described in one contribution. These papers are identified as follows:

IEEE P802.11/91-95 (File: 11APS18F)
Sequentially-used Common Channel Access Method

With and without infrastructure, sequential use of one channel at all Access-points within one reuse group. (Revision of IEEE 802.11/91-19)

IEEE P802.11/91-96 (File: 11CTN18A)
Access Method for Channelized system Using Distributed Logic and Not Requiring Infrastructure

Independent of infrastructure and without virtual circuit support, random contention use of a common setup channel and distributed channel selection for following use of one of several data transfer channels.

IEEE P802.11/91-97 (File: 11API18D)
Channelized System Access Method Using Infrastructure Control

With infrastructure control, sequential use of a common setup channel and parallel use of a number of data transfer channels derived by code-division spread spectrum or otherwise.

Earlier relevant contributions include:

IEEE P802.11/91-19 (File: 11AP12J)
Access Protocol for IVD Wireless LAN

The basis of the protocol is a single channel binary data link used alternately by the fixed common control network and a number of fixed or moving STATIONs. All protocol elements are data messages which do not depend in any way on special properties of the physical medium apart from requiring rapid switching between ON and OFF states.

There are many ACCESS-POINTS in the fixed network each of which serves one or a small number of the total number of user STATIONs in an indefinitely large network. The possibility of direct STATION-to-STATION transfer is provided.

An infrastructure independent mode might be supported by a default Access-point simulation incorporated in Stations.

IEEE P802.11/91-80 (File: 11AP16K)
Access Protocol for IVD Wireless LAN--Part II

"A short summary of the main changes (relative to P802.11-19) and current Message/Field List is given ..."

BRIEF DESCRIPTION OF ACCESS METHODS

All of the current contributions depend on use of the common message set and field definition contained in contribution -80 above referenced.

Insofar as possible, the access methods do not depend on specific implementation of the physical medium. The minimum required degree of channelization is dependent on required signal-to-interference ratios from overlapping coverage, and this may be different for various modulation and radio frequency techniques. The reuse pattern assumed is conservative enough to work with most technical choices.

All of the described access methods fit within the generic classifications shown above.

Sequentially-used Common Channel Access Method (P802.11/91-95)

This access method uses a single high-data-rate channel sequentially at overlapping and interfering Access-points (one reuse group) all under the control of a single Access Manager within a multi-port Hub Controller. In general, the capacity can be equal to the parallel use of a lower rate at the same number of Access-points in a channelized system.

The primary plan requires infrastructure, but permits direct Station-to-Station transfers when it is possible. The plan provides connection-type service consistent with IEEE 802.6 cell format.

A secondary version of the plan is given for operation without infrastructure and without support of connection-type services.

The previous contribution (IEEE 802.11/91-19) on access method is superseded in detail use of messages by the current contribution (IEEE 802.11/91-95), however, the original contribution contains material on calculated efficiency and compatibility with 802.6 ATM cell transfer which remains relevant though slightly inaccurate because of increases in message lengths to allow channelization and multiple simultaneous connections at one Station. The purpose of this revision is to present the single time-shared channel concept consistently with channelized systems elsewhere presented, and to incorporate the common message set for all of the methods.

**Access Method for Channelized System Using Distributed Logic and Not Requiring Infrastructure
(P802.11/91-96)**

This medium access method uses one setup and nine (or N) data transfer channels in which any Station can transmit at any time on the setup channel without reference to whether or not signal is present. The channelization is assumed to be code-division within a spread spectrum modulation, but is not limited to this possibility.

The main assumption is that there is always a probability of a lost message or transmission from uncontrollable factors like path obstruction and multipath. Contention may be allowed within the system as long as its relative probability is less than or the same order of magnitude as other message loss mechanisms.

This access method is optimized for peer-to-peer communication without use of infrastructure. Infrastructure may be used as a means of providing communication in the same network but not within radio range of each other, and to provide a means for each Station to reach destinations outside of the local network.

This access method is not suitable for a virtual circuit service.

Channelized System Access Method Using Infrastructure Control (P802.11/91-97)

This access method is based upon a system plan with code-division-spread-spectrum channelization of 10 or 17 channels which is optimized for large-scale, wide area use. The method depends upon infrastructure access control.

Contention is allowed for Stations requesting access within a limited set of contenders; however, allotment of a data transfer channel is exclusive within one reuse cluster.

The protocol is implemented with sequential message transfers using the referenced message set.

Full provisions have been made for direct peer-to-peer communication and virtual circuits with demand-assigned bandwidth.

It is possible that the access method could be expanded to include the non-infrastructure mode of -96 above when there is no infrastructure available.

MESSAGE SUMMARY

The following is a summary listing of messages used in the above access methods as given in greater detail in -80.

TABLE VI

Type#	Function	Oct lgth
001	Segment Data Frame--short address	10+PDU
003	Packet Data Frame--long address	25+PDU
005	Invitation-to-request	8
007	Poll or Invitation-to-register	8
009	Set Channel/Power	8
011	Acknowledgment	8
013	NACK--repeat	8
015	Grant	9
100	Segment Data Frame--short address	10+PDU
102	Register	13
104	De-register	13
106	Request--short address	11
108	Request--long address	23
110	Acknowledgment	7
112	NACK-repeat	7
114	Packet Data Frame	10+PDU
115	Grant Stn-Stn	9

CONCLUSION

It is possible to classify access methods generically. Access methods are possible which have high commonality for many different physical mediums and system optimization factors. Multiple operating modes for different environments may be considered within one implementation.

TRANSMISSION FORMAT		APPLICATION & ACCESS METHOD REFERENCE			
		NO INFRASTRUCTURE		WITH INFRASTRUCTURE	
CHANNELS	MODULATION	LOW RATE	HIGH RATE	LOW RATE	HIGH RATE
SINGLE CHANNEL	SPREAD S	*-95	NR	*-95	*-95
	NARROW B	NR	*-95	*-95	*-95
MULTI-CHANNEL	SPREAD S	*-96	NA	*-97	NA
	NARROW B	NR	*-96	NR	*-97

NA = NOT APPLICABLE
NR = NOT RECOMMENDED
* = IEEE 802.11/91