IEEE 802.11

Wireless Access Method and Physical Layer Specifications

Wireless Local Area Network Requirements

IEEE Project 802.11

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Abstract

The development of an effective,consensus wireless LAN standard requires agreement on the service requirements that the wireless LAN should provide to its using entities.

This document presents an integrated set of wireless LAN MAC and PHY requirements. The document is a "living" IEEE 802.11 one and will evolve through comment and modification. These requirements will be used to guide and evaluate subsequent development of wireless LAN MAC and PHY standards.

Examination of education, financial,office, industrial, retail, warehousing and medical application areas is used to derive MAC and PHY service requirements.

This version is a first draft for comment. It has not been fully reviewed by all contributors and does not as yet represent a common consensus of the authors or of the committee.

1. Introduction

1.1Charter

The development of an effective,consensus wireless LAN (WLAN) standard requires agreement on the service requirements that the wireless LAN should provide to its using entities.

This document presents an integrated set of wireless LAN MAC and PHY requirements. The document is a "living" IEEE 802.11 one and will evolve through comment and modification. These requirements will be used to guide and evaluate subsequent development of wireless LAN MAC and PHY standards.

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1.2Methodology

The chosen method is to investigate a set of market areas, identifying in each characteristic applications and wireless network configurations. We have defined editors/chairs for each market section of the document. They have the responsibility for developing, from existing 802.11materials as well as unique contributions, MAC and PHY service requirements typical for each market area.

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This ad hoc group has produced this "living"requirements document describing typical applications of wireless LANs and deriving MAC and PHY service requirements from the following market areas.

Education	The use of wireless LANs in support of educational computing.
Meetings	The use of wireless LANs in support of meetings.
Financial	The use of wireless LANs in support of financial applications.
Office	The use of wireless LANs in support of office applications.
Medical	The use of wireless LANs in support of medical applications.
Industrial	The use of wireless LANs in support of industrial applications.

Retail	The use of wireless LANs in support of retail applications.
Warehousing	The use of wireless LANs in support of warehousing applications.

While there is substantial crossover of applications, in particular office applications are common in almost every market area, the following analysis has focussed on applications unique to each area.

We enthusiastically solicit additional input.

1.3 Market Areas

We use as the starting point for the document the output of the adhoc "vocational" working groups of the July 1991 802.11 meeting. For each such market area we develop archetypal applications and system configurations. Each of these were edited, massaged, augmented and integrated into this single document.

1.4 Application Characteristics

For each market area, we define an anticipated set of applications. For example:

- data collection
- self-service
- point-of-entry machines
- tele-control
- tele-command
- paging
- real time voice (POTS and/or intercom/walkie-talkie)
- file transfer
- data base access
- file access/sharing
- terminal emulation
- server and printers access
- program access/sharing
- real time video
- e-mail store and forward text, graphics, image, voice and video
- wide area network access
- attachments/interworking with other LANs
- collaborative computing
- time distribution/synchronization

For each such identified application we characterize the expected MAC traffic generated by an instance of that application via the following criteria.

MSDU Size Distribution	Define probability distribution of MSDU size in octets.
MSDU Arrival Distribution	Define MSDU interarrival time probability distribution. Later we may wish to augment this description to describe specific, deterministic,request-response traffic models.
Nominal Transfer Delay	Transfer delay measures the time from when an MSDU is submitted for transmission at the source MAC interface until the completion indication is given by the destination MAC interface. This is measured in milliseconds and by definition includes the transmission time for the MSDU itself as well as access delay to a shared wireless medium as well as (possible) additional delay due to MAC level ARQ.
Transfer Delay Variance	The tolerated variance in transfer delay of this application. This is measured in milliseconds.
MSDU Loss Rate	Percentage lost MSDUs during an application session that the application can tolerate without unacceptable user performance. It is expected that higher layer protocols (e.g. transport) will provide additional, comprehensive end-to-end reliability.
Service Initiation Time	The amount of time this application can tolerate in order to initiate communication between source and destination. This is measured in milliseconds.
Station Speed	The possible movement speed of a station providing this application.
Destination Distribution	The percentage of this application's traffic that will typically be directly destined for wireless stations rather than stations on an interconnected wired backbone.

1.5 System Configurations

For each market area, we describe anticipated applications as above and describe typical wireless network configurations by supplying the following information.

Number of stations	The typical number of stations for this configuration.
Station density	The number of stations per hectare.
Dimension	The typical linear dimension of the wireless service area. Measured in units of meters.
Application List	The list of applications that this configuration would typically use.It is our intention to construct traffic load models using this information.

1.6 Global Considerations

In addition to the above applications and configuration dependent issues, we will be require certain global features including the following.

- o Internetworking.
- o Graceful degradation.
- o Privacy.
- o Integrity and denial of service.
- o Power management.

2. General Requirements

This section summarizes overall requirements common to most application/market areas. These requirements are consistent with the market area requirements and the802.11 PAR.

No end user license	The end user need not obtain a license to operate his wireless equipment. Licensing is inconsistent with unrestricted portability.
Independent network operation	The standard shall support two or more networks in geographical proximity to operate independently, and without the need for external coordination. For example, two companies who share an office building should be able to operate their wireless networks independently without the need for coordination. This does not mean that one or more of the networks has to change to a different channel. It may mean that the performance may degrade. The degradation needs to be graceful.
Optional distribution system	The standard shall allow two or more stations to communicate wirelessly without the need for a wired distribution system. The same station implementation works in a system with and without a distribution system. Users may add a distribution system based on standard IEEE 802 LAN systems to extend the range and capacity of the wireless LAN.
Station mobility	The standard shall support moving stations. The supported velocity required is "pedestrian speeds".
Optimized for local area data	Today's primary market need is 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 that 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.
Low power drain	Battery operation is a requirement, the standard must be designed to minimize power consumption.
Small size	The size of portable computers continues to decrease. The standard must be designed such that wireless LAN adaptors within portables can be implemented in very small sizes. A future goal is the support of credit card size devices.
Low cost	The standard shall allow the production of low cost components for providing wireless networking.

Self contained standard	The standard defined by 802.11 shall be complete and self contained. It must be possible to implement the 802.11 MAC and PHY and utilize all functionality contained in the standard. The 802.11 standard shall not be dependent on parts from other committees or organizations that are not completed or already in existence.
Time is of thre essence	There is a clear immediate need for wireless LANs. We must aim for the simplest standard that meets the requirements above in the shortest possible time.

3.Education

3.1Introduction

Education encompasses three substantially-different environments.

Classroom — which resembles an office LAN with two exceptions: 1) high station density with 30-40 stations in a small classroom and 100-500 stations in a large lecture hall; and 2) exceedingly bursty due to synchronization of activity shifts in the class (e.g., everyone accessing files on a new topic simultaneously).

Campus — Mobility,while mobile or stationary, anywhere on campus providing information access to the electronic library, and E-mail, including faculty/student conferencing.

Field Study — (aka "The Field Trip") providing 1) information access via a mobile database server in an accompanying van 2) real-time collaboration(with others in the group) - may include voice, image and video and3) data collection, including bulk transfer to a central repository.

The classroom environment is dominated by the need for large (1 MByte) simultaneous file transfers from server to user station. This is dominated by large packet sizes and will be a broadcast mode with individual stations requesting retransmission of lost MSDUs at the completion of the transfer. Traffic will be primarily from servers directly attached to the WLAN.

The campus internet covers a large (5 km x 5 km)area consisting of many subnets. Traffic over the wireless portion of the internet will be typical of normal LAN traffic except that a high percentage (80%) will be destined for and received from off-wireless network servers.

3.2Applications

	Collaboration	Data Collection	File Transfer
MSDU Size Distribution	90% 600byte 10% 80 byte	40% 600 byte 60% 80 byte	40% 600 byte 60% 80 byte
MSDU Arrival Distribution	Poisson distribution 30 msec average	Poisson distribution 100 msec average	Poisson distribution 40 msec average
Nominal Transfer Delay	5 msec	5msec	5 msec
Transfer Delay Variance	20 msec	20 msec	20 msec
MSDU Loss Rate	10^{-3}	10^{-3}	10^{-3}
Service Initiation Time	400 msec	400 msec	400msec
Station Speed	2m/s	2 m/s	4 m/s
Destination Distribution	80%	95%	20%

3.3Configurations

	Field Study	Classroom	Campus Internet
Number of stations	50	200	5000
Station density	50/hectare	2000/hectare	2 /hectare
Dimension	100 m	30 m	5000 m
Application List	o Collaboration o Data Collection o File transfer	o Collaboration o Data Collection o File transfer	o Collaboration o File transfer

4. Finance

4.1Introduction

The principal users are banks and stock or commodity trading floors. They can be viewed as a special class of offices. Their specific requirements are:

- o emphasis on interactive / transaction processing
- o require a quick response to requests
- o 802.10-like confidentiality, integrity and data origin authentication are mandatory. Digital signatures and non-repudiation are also important security services. Immunity to jamming/denial of service is important.
- o small packet sizes of about 80 octets buyer, seller, quantity, price
- o peak request rate 1/10 sec or 1/15 sec per user
- o low to moderate overall system throughput
- o mobility at pedestrian speed
- o Platforms: Pen-based, palmtop computers small weight,power, size
- o small cost desirable
- o Robust.
- o High station density,where the distance between adjacent transceivers can be quite small(< 30 cm). Density can be very crowded (e.g., 40 people per $10m^2$).
- o Station population of between 200 to 4000 stations on a trading floor
- o Power consumption is important. Devices must operate continuously for 8 hours; traders don't take breaks.
- o logging of all voice and data traffic is required today
- o a mobile station may need to be in a circumscribed location (the proper trading pit) for a specific application operation.
- o Links to a back-end system are required. The Chicago Board of Trade (CBOT) permits up to20 seconds of delay in reporting to the back-end system, but all transactions must be time-stamped. Explicit standards support required for (802.3, 802.5) - 802 LAN backbones

Data flows between wireless stations and the wired LAN. No appreciable traffic directly between stations using wireless media.

The description below is for a financial terminal station used by a trader in an open-outcry, crowded environment. It requires a small,handheld, tetherless computer. Battery power is critical for this application--the computer has to be able to operate 8 (or more) hours without recharging.

Data flow is between the traders and clearinghouses. Current scenarios do not include data exchange between traders, but that is a future possibility.

A transaction involves the following steps:

1) An order to buy or sell a financial instrument is communicated to the trader on the floor from the brokerage firm --OR-- the trader decides to trade for him/herself.
2) The trader checks the current price for the type of instrument
3) The trader negotiates(through gestures) with another trader to agree on price/quantity/delivery.
4) The transaction is logged on both trader's computers and then transmitted to a clearinghouse for resolution (make sure that they both agreed to the same thing).
5) A notification of the trade is also sent to the brokerage firm, if that was the origin of the transaction.

A high degree of reliability is required for the entire system. Orders must be received in a timely(within 5 seconds) and current trade prices must be available. There is much less pressure to resolve trades, but it is still deemed to be very important.

Fault tolerant, multiple redundancy systems are frequently specified for this type of application.

4.2Applications

Only two types of applications are common - Transaction processing and File transfer. Their characteristics are listed below:

	Transaction Processing	File Transfer
MSDU Size Distribution	80 octets	60% 1024 octets 40% 80 octets
MSDU Arrival Distribution	Poisson 10 sec mean	Poisson 5 msec mean
Nominal Transfer Delay	100 msec	10msec
Transfer Delay Variance	1000 msec	< 30 msec
MSDU Loss Rate	10^{-3}	10^{-3}
Service Initiation Time	1000 msec	1000msec
Station Speed	< 2 m/s	< 2 m/s
Destination Distribution	0%	0%

4.3Configuration

	Small Trading Floor	Large Trading Floor
Number of stations	200	8000
Station density	20000/hectare	8000/hectare
Dimension	10 m	100 m
Application List	o Trading o Order entry o File transfer	o Trading o Order entry o File transfer

5. Industrial Automation/Manufacturing

5.1Introduction

The anticipated set of applications which fall into the Industrial Automation category have been divided as follows:

- o Service areas and remote sites
- o Service and mobile equipment
- o Production (assembly)-line carriers
- o Monitoring/controlling dispersed or inaccessible process equipment
- o Material handling
- o A mobile terminal requiring access to an existing LAN
- o Computer Aided Manufacturing (CAM) download

The issues of privacy, authenticity, and security are generally much less of a concern for this set of applications than for other market segments. The jurisdiction is owned and controlled by network owner and physical or wireless intrusion is much more unlikely.

As with other network installations, the issue of integrity and denial of service is of concern. The data must be able to get through correctly and not be able to be shut down by accidental or purposeful jamming. As for other markets and applications, it is assumed that higher layer protocols, in particular transport protocols, have the responsibility for end-to-end reliability. The responsibility of the link level MAC protocols is to provide a reasonably robust environment so that the likely mechanisms of the transport layer can be effective.

Distances in an industrial LAN are, in general, much larger than atypical office environment. "Local" may be inside a 1 kilometer long by 1/2 kilometer wide building. The WLAN may require an extended system reach (range) and may need to function in a high-noise environment.

The wireless solution to the LAN problem is attractive because it is the only solution, not just the most convenient or cost effective

For the applications in the industrial sector the data generally flows between wireless stations and a wired enterprise LAN. There is no appreciable traffic between stations using wireless media.

Membership in this setting varies between 1 and1500 stations per wireless LAN. The distribution of the applications tends towards one end of the range or the other.

Most data is time-critical with a time constant typically on the order of 1 second, but different remedies are required for late packets. In some cases"late" data must be destroyed (e.g.sensors), in other cases it must not be lost (e.g. control). Some of the data is real-time, most of the data is human-time, and a small portion of the data is batch.

Graceful degradation is required. Predictability of effective data rates is often more important than high burst-rate speed.

For each such identified application, the following data characterize the expected MAC traffic and constraints.

5.2 Service areas and remote sites

Offices or service areas which are not physically connected to the plant information system will use wireless connections to close that gap. These applications will typically use many of the same applications as the specified for the Office market area.

Application	Service and remote sites
Description	Office or maintenance area which is disjoint from information infrastructure
Platform	Work stations, PCs,laptops,notebooks
Stations/installation	5-10
Station Density	5-10/hectare
Land speed of station	0
Range of travel	0
Data rate per station	Application dependent:slow scan video (19.6kbit/s); data base access (100 bytes/5sec), MS-Windows or X-Windows display (1kbit/s)
Dist. of data traffic	(noted above)
Transfer Delay	Effective response rate must not be greater than 2X wired LAN (802.3, 802.5)
Variance	Same as wired LAN
Special constraints	Reliability is very important; system will be viewed as an extension of wired LAN

	Slow-Scan Video	Transaction Processing	Terminal Emulation
MSDU Size Distribution	600 octets	50% 600octets 50% 80 octets	90% 80 octet 10% 600 octet
MSDU Arrival Distribution	Poisson 200 msec mean	Poisson 2 sec mean	200 msec
Nominal Transfer Delay	100msec	< 5 msec	5 msec
Transfer Delay Variance	100msec	< 10 msec	< 10 msec
MSDU Loss Rate	10^{-2}	10^{-3}	10^{-3}
Service Initiation Time	1000 msec	1000msec	1000 msec
Station Speed	0	0	0
Destination Distribution	0%	0%	0%

	Service & Remote Sites
Number of stations	5-10
Station density	5-10/hectare
Dimension	100 m
Application List	o Slow scan video o Terminal emulation (X-Windows) o Transaction processing (Data Base Access)

5.3 Service and mobile equipment

Large mobile equipment such as a crane or tug boat are not able to physically connect to the local information infrastructure. They have the need to send and receive control and sensor information as well as some operator information.

Application	Jerry Car in a steel mill
Description	Mobile materials handler needing to monitor weight of material currently gathered.
Platform	Terminal attached to/integrated with machine
Stations/installation	2-3
Station Density	1-2
Land speed of station	20 mph
Range of travel	20 feet path
Data rate per station	80 bit/s
Transfer Delay	1/10 sec
Variance	1/10 sec
Special constraints	Losing 1 packet is acceptable(up to perhaps10%) but 2 in a row is unacceptable

Application	Strap Crane
Description	Mobile scale connected wirelessly to mobile crane.Operator input (button push); receiving screen of data.
Platform	Terminal attached to/integrated with machine
Stations/installation	?
Station Density	?
Land speed of station	20 mph
Range of travel	400 feet path
Data rate per station	1 bit/s transmit/9600 bit/s receive
Traffic periodicity	infrequent
Transfer Delay	1/2 sec
Variance	1/2 sec
Special constraints	Transmitted data must be received by host

Application	Pit Crane

Description	Heap profile video image.
Platform	Terminal attached to/integrated with machine
Stations/installation	1
Station Density	1
Land speed of station	>5mph
Range of travel	400 feet path
Data rate per station	3 Mbit / sec
Dist. of data traffic	Constant rate
Transfer Delay	0
Variance	0
Special constraints	Real-time video(system was not fielded because of wireless bandwidth constraints)

Application	Scrap Crane
Description	voice channel
Platform	Terminal attached to/integrated with machine
Stations/installation	
Station Density	
Land speed of station	20 mph
Range of travel	.5 mile
Data rate per station	<64kbit/s
Dist. of data traffic	Constant
Transfer Delay	
Variance	
Special constraints	POT quality desired

	Jerry Car	Strap Crame	Pit Crane Video (Uncompressed)	Scrap Crane Voice (Uncompressed)
MSDU Size Distribution	128 octets	50 % 600 octets 50% 80 octets	100% 600 octets	100% 32 octet
MSDU Arrival Distribution	Poisson 10 sec mean	Poisson 1 sec mean	Constant 2 msec mean	Constant 4 msec mean
Nominal Transfer Delay	100 msec	100msec	< 30 msec	< 30 msec
Transfer Delay Variance	100 msec	100msec	4 msec	4 msec
MSDU Loss Rate	10^{-3}	10^{-3}	10^{-2}	10^{-2}
Service Initiation Time	1000 msec	1000msec	1000 msec	1000 msec
Station Speed	10 m/s	10m/s	2.5 m/s	10 m/s
Destination Distribution	100%	100%	100%	100%

	Jerry Car	Strap Crane	Pit Crane	Scrap Crane
Number of stations	2-3	?	1	?
Station density	1-3/hectare	?	1/hectare	?
Dimension	10 m	100 m	100 m	1000 m
Application List	Jerry Car	Strap Crane	Pit Crane Video	Strap Crane Voice

5.4 Production-line carriers

Unmanned vehicles which transport parts or assemblies in a discrete manufacturing environment receive their orders from a centralized control facility via the WLAN and the enterprise wired LAN. They tend to "clump" in a small area in groups of 30 to 40 units. When members of the "clump" get orders to go to another area, they are usually all told at nearly the same time.

Application	AGV
Description	Automated Guided Vehicle delivers material to assembly sites
Platform	Terminal attached to/integrated with machine
Stations/installation	1500
Station Density	up to 40/.01 hectare
Land speed of station	60 fpm on well defined paths
Range of travel	1500 sq ft area
Data rate per station	100 bits/sec, every 100 millisec; 1Mb downloads
Dist. of data traffic	clusters of 32 bursts typical in 1 min.
Transfer Delay	
Variance	500 ms
Special constraints	Packet sent to vehicle must eventually get it, order must be preserved. I t is assumed that the responsibility for reordering and end-to-end reliability lies with the transport layer.

	AGV Control	AGV Downloads
MSDU Size Distribution	80 octets	50% 600 octets 50% 80 octets
MSDU Arrival Distribution	Poisson 100 msec mean	Poisson 5 msec mean
Nominal Transfer Delay	10msec	< 30 msec
Transfer Delay Variance	50msec	30 msec
MSDU Loss Rate	10^{-3}	10^{-3}
Service Initiation Time	1000 msec	1000 msec
Station Speed	.5 m/s	.5 m/s
Destination Distribution	0%	0%

	AGV Control
Number of stations	1500
Station density	4000/hectare
Dimension	15 m
Application List	o Control o File transfer and download

5.5 Monitoring and controlling

Applications such as a storage tank farm or very hostile or mobile sensors require a wireless connection. Two classes of these devices are summarized: the simple transducer and the Programmable Logic Controller (PLC). They differ mostly in the amount of data produced/consumed.

Application	Transducers
Description	Sensors on production lines
Platform	Terminal attached to/integrated with machine
Stations/installation	20-30 per line
Station Density	100/hectare
Land speed of station	0
Range of travel	0
Data rate per station	5 bytes/sec
Dist. of data traffic	
Transfer Delay	20 ms
Variance	50 ms max delay
Special constraints	

Application	Programmable Logic Controller (PLC)
Description	If data can't be delivered on time, it must be destroyed. Can afford to lose radio link censor and the controlling entity
Platform	Terminal attached to/integrated with machine
Stations/installation	10-15 per line
Station Density	100/hectare
Land speed of station	0
Range of travel	0
Data rate per station	100 byte/sec; 1 Mbyte burst
Dist. of data traffic	Constant 100 bit/s; 1-3 /day of 1 Mbyte
Transfer Delay	20 ms
Variance	50ms delay max.
Special constraints	If not delivered on time, packet must be destroyed. Can not afford to lose radio link sensor and the controlling entity

	Transducer Data Collection	PLC Control	PLC Download
MSDUSize Distribution	10octets	80 octets	50% 600 octets 50% 80 octets
MSDU Arrival Distribution	Poisson 1000 msec mean	Poisson 500 msec mean	Poisson 5 msec mean
Nominal Transfer Delay	20 msec	20 msec	< 30 msec
Transfer Delay Variance	< 50 msec	< 50msec	30 msec
MSDU Loss Rate	10^{-3}	10^{-3}	10^{-3}
Service Initiation Time	1000 msec	1000 msec	1000 msec
Station Speed	0	0	0
Destination Distribution	100%	100%	100%

	Transducer Data Collection	PLC Control
Number of stations	20-30	10-15
Station density	100/hectare	100/hectare
Dimension	100 m	100 m
Application List	o Collection	o Control o File transfer and download

5.6 Material Handler

Human-operated material handlers,such as forklifts, must be scheduled from a central material-flowcontrol function. The central control may either be another human or a computer-based scheduling system. Information to the operator is the bulk of what must be transported. Information from the operator is essentially acknowledgment of receipt of order and confirmation of completion.

Application	Material handler
Description	Delivers material to production line, distribution center, warehouse. Usually operates a fork lift. Accurate, timely,delivery of materials is often critical. In some industries proper rotation of stock is also critical so that accuracy may defined as transporting a specific pallet.
Platform	Terminal attached to forklift
Stations/installation	50-100
Station Density	5/.01 hectare
Land speed of station	10-15 mph
Range of travel	1 Km
Data rate per station	80 bytes/sec
Dist. of data traffic	1-5 min
Transfer Delay	1-3 sec

Variance 1-3 sec
Special constraints

	Material Handler Control
MSDU Size Distribution	80 octets
MSDU Arrival Distribution	Poisson 180000 msec mean
Nominal Transfer Delay	500msec
Transfer Delay Variance	< 1500 msec
MSDU Loss Rate	10^{-3}
Service Initiation Time	1000 msec
Station Speed	7 m/s
Destination Distribution	0%

	Material Handler Control
Number of stations	50-100
Station density	500/hectare
Dimension	1000 m
Application List	

5.7 Mobile Terminal

Two classes of roving operator are characterized in the mobile terminal category. The process control supervisor travels from line to line and monitors the state of each one. This is combined with physical inspection of the process assures correct operation of the facility.

When problems are identified with a line, a maintenance person is called to correct the situation. In the majority of cases (90%) the maintenance repair person needs little or no assistance from the information infrastructure.When such help is needed, however, often takes the form of downloads current schematics and diagnostic procedures.

Application	Process control supervisor
Description	Responsible for overall functioning of a manufacturing line or lines in a process (or batch process) industrial environment.
Platform	Portable graphical display terminal
Stations/installation	10
Station Density	10/hectare
Land speed of station	1-2 mph
Range of travel	1 Km
Data rate per station	1-2 kbit bursts
Dist. of data traffic	2-5 sec intervals
Transfer Delay	1-3 sec
Variance	1-3 sec
Special constraints	Battery powered; 3-4 hour battery life required

Application	Maintenance and repair person.
Description	Responsible for preventative maintenance of complex equipment and repair of failed or malfunctioning equipment. Failures are usually on equipment which the person has had no recent experience and which costs hundreds or thousands of dollars per minute of downtime.
Platform	Portable graphical display computer
Stations/installation	3-5
Station Density	3-5/hectare
Land speed of station	1-2 mph
Range of travel	1 Km
Data rate per station	1-20 kbit bursts
Dist. of data traffic	5-60 sec intervals
Transfer Delay	1-3 sec
Variance	1-3 sec
Special constraints	Battery powered; 6-8 hour battery life required. Computer is required because interactive diagnostics or highly detailed schematics may be downloaded.

	Process Control Supervisor	Maintenance and Repair Technician
MSDU Size Distribution	40% 600 octet 60% 80 octet	40% 600 octet 60% 80 octet
MSDU Arrival Distribution	Poisson distribution 5 msec	Poisson distribution 5 msec
Nominal Transfer Delay	5 msec	5 msec
Transfer Delay Variance	< 30 msec	< 30 msec
MSDU Loss Rate	10^{-3}	10^{-3}
Service Initiation Time	100 msec	100 msec
Station Speed	< 1 m/s	< 1 m/s
Destination Distribution	0%	0%

	Process Control Supervisor	Maintenance and Repair Technician
Number of stations	10	3-5
Station density	10/hectare	2/hectare
Dimension	1000 m	1000 m
Application List		

5.8 Computer Aided Manufacturing

CAM communications consist of program downloads to a robot or numerically controlled manufacturing device and uploads of a record of the work done.

Application	Welder robot
Description	When AGV brings chassis to welderstation, the welder robot performs a complex series of movements and welds. QC information about the welds is communicated to base
Platform	Integrated with device.
Stations/installation	1000
Station Density	
Land speed of station	effective 0
Range of travel	30' radius
Data rate per station	100 byte/sec; 1Mbit downloads
Transfer Delay Variance	not time critical
Dist. of data traffic	constant
Special constraints	

	Welder Robot Control	Welder Robot Download
MSDU Size Distribution	80 octets	50% 600octets 50% 80 octets
MSDU Arrival Distribution	Poisson 500 msec	Poisson 5 msec
Nominal Transfer Delay	100 msec	< 30 msec
Transfer Delay Variance	100 msec	30 msec
MSDU Loss Rate	10^{-3}	10^{-3}
Service Initiation Time	1000 msec	1000 msec
Station Speed	0	0
Destination Distribution	0%	0%

	Welder Robot
Number of stations	1000
Station density	100/hectare
Dimension	100 m
Application List	o Control o Download

6. Medical

6.1 Introduction

Two major application areas are considered: diagnostic imaging and patient care information systems.

6.2 Applications

	Imaging	Patient Care Information System
MSDU Size Distribution	60% 2048 Octets 40% 80 octets	80% 80 Octets 20% 600 Octets
MSDU Arrival Distribution	Poisson 5 msec	Poisson 1000 msec
Nominal Transfer Delay	< 30 msec	< 10msec
Transfer Delay Variance	30 msec	30 msec
MSDU Loss Rate	10^{-2}	10^{-2}
Service Initiation Time	5000 msec	5000msec
Station Speed	90 % 0m/s 10% 3 m/s	90 % 3 m/s 10% 0 m/s
Destination Distribution	30%	90%

6.3 Configurations

	Imaging	Patient Care Information Systems
Number of stations	100	1000
Station density	10/hectare	100/hectare
Dimension	500 m	500 m
Application List	o Medical Image Management System o X-Rays o Ultra-sonograms o CT Scan o MRI Scan o Digital Subtraction Angiography o Intensive/Emergency Care	o Patient Care Systems o Appointments o Record storage and retrieval o Diagnostics o Tests o Medicine dispensing o Prescription o Billing

7. Meetings

7.1 Introduction

Four different types of meetings were identified:

1. Conference (such as IEEE 802)

2. Conference room

   - o Business or Board meeting, with a structured agenda
   - o Technical meeting, more ad hoc than B1

3. Sales meeting

   - o on-site meeting
   - o off-site meeting

4. Spontaneous meeting(e.g., a hallway meeting)

A conference meeting is typically a large structured group (e.g., seating, chairman, secretary) with the following requirements

- large transfers of text and graphics, and image data in some applications(e.g., a WLAN replacement for the "pigeon hole" system of document distribution)

- communications back to home office

- the following application services

  - o file distribution and retrieval
  - o database access, both intra-conference and off-site
  - o E-mail
  - o file sharing
  - o print server
  - o image distribution (real-time image?)
  - o access to WANs
  - o electronic "conferencing"
  - o voting

- platforms

  - o personal computers luggables and portables, laptops, notebooks This is truly a multi-vendor environment, with a wide range of capabilities.
  - o PC-based servers print,file,communications.

- connection types

  - o point-to-point delegate/delegate and delegate/chair

- o point-to-multipoint delegate/delegates and chair/delegates
- o point-to-servers

- transient population, but very limited mobility

- 802.10-like confidentiality and data origin authentication

- acknowledged (local) broadcast, with a high peak/mean traffic ratio

- communication between separate work-groups [e.g.,multicast]

The need for an access point to a(wired) backbone network was questioned. Access points are not necessarily required for a small room, but are useful to extend coverage in large rooms or to provide inter-room communications.

A voice capability, simulating a chairman-controlled wireless microphone, would be useful. A voice capability could also assist simultaneous translations.

7.2Applications

	Meeting Journal	Information Distribution	Information Retrieval
MSDU Size Distribution	50% 600octets 50% 80 octets	90% 600 octets 10% 80 octets	60% 600 octets 40% 80 octets
MSDU Arrival Distribution	Poisson 500 msec	Poisson 5 msec	Poisson 5 msec
Nominal Transfer Delay	< 20 msec	5 msec	5msec
Transfer Delay Variance	< 50 msec	< 20 msec	<20 msec
MSDU Loss Rate	10^{-3}	10^{-3}	10^{-3}
Service Initiation Time	1000 msec	250 msec	250 msec
Station Speed	0	0	0
Destination Distribution	100%	100%	100%

7.3Configurations

	working group	semi formal	lecture
Number of stations	<10	10-100	100-500
Station density	1200 stations/hectare	600stations/hectare	2500 stations/hectare
Dimension	< 10 m	10 m	50 m
Applications	o Journal o Info Retrieval	o Journal o Info Retrieval o Info Distribution	o Info Distribution

8.Office

8.1Introduction

8.2 Applications

8.2.1 Application Services

The following applications have been currently identified as present in the office. The anticipated network traffic of many applications can be generally represented by a subset of these applications.

File access/sharing	Shared,block demand file access. Unit of access is a random access datablock - about 1K bytes.
Program paging	Block demand backing store swap of program execution images. Unit of access is the page - about 1K bytes.
Program access/sharing	Shared program file access. Performance is often similar to either file transfer or file access (paged access).
File transfer	Bulk file copy- unit of access is the entire file as a stream of packets.
Printer/Facsimile sharing	Sharing of common network resource. Traffic model is often similar for file transfer with bulk file copy of a disk buffered file image to the network resource.
Electronic mail	File transfer of compound documents consisting of text, voice, image, graphics, video. Often two file transfers are required - one from the originating station's e-mail agent to the post office, and the second from the post office to the destination station's agent.
Terminal emulation	These applications includes advanced terminal emulation services such as X-terminal as well as more mundane modem sharing.
Data entry	Low volume entry of forms information. The traffic model is assumed to be a low volume transaction processing application.
Environmental control	Distributed control of building facilities HVAC, etc. It is speculated that this application's traffic can be generally represented by a low volume distributed computation application.
Database access	A specialized case of transaction processing and/or file access in which requests for database access are made of database servers by database client stations.The transaction processing traffic model is anticipated to adequately model this application.
Transaction Processing	A class of applications in which client stations request services of server stations using a Remote Procedure Call paradigm(e.g.request/response).
"Collaborative" computing	A class of applications in which multiple stations simultaneously manipulate shared objects. These applications will likely be implemented as high resolution access to common shared

	storage objects. It is speculated that their traffic model will resemble high utilization file access.
Image manipulation	Shared manipulation of digitized images. It is speculated that this application can be modelled by the file access traffic model for very large files.
CAD/CAM	CAD/CAM contains a number of applications within its broad scope. Design can be modelled as image manipulation. Evaluation and modelling can be modelled as distributed computation using compute servers. And distribution of results can be modelled as file transfer.
Distributed computation	A class of generalized applications in which an application is distributed across a number of nodes communicating via a Remote Procedure Call protocol. It is speculated that the traffic model will resemble transaction processing.
Real-time voice (POTS)	Digitized packet voice. Anticipates requirements where a portable data station integrates a real-time voice service.
Real-time video (TV)	Digitized packet television. Anticipates requirements where a portable data station integrates a real-time video service.

These applications can be abstracted to a smaller set of archetypal applications:

File acces	A random access file service providing for block-at-a-time access to shared network files. A common base for many applications including: word processing, program paging, "collaborative computing", shared database access, etc.
File transfer	A bulk data transfer service copying entire files from one station to another. Such transfer is often pipelined minimizing end-to-end connection management. A common base for many applications including: program loading, electronic mail, CAD/CAM, etc. Non-real-time voice and video can be transferred using a file transfer service underlying an electronic mail service.
Terminal Emulation	An interactive data transfer service providing terminal emulation between clients and servers. Generally transactions occurs at human interaction rates.
Transaction Processing	A Remote Procedure Call service serving as the foundation for data entry, environmental control, client/server applications including shared database management, and some distributed/collaborative applications.
Real-time Voice	Areal-time digitized, packetized voice service providing POTS quality service.
Real-time Video	

8.2.2 Explicit Standards Support

Office wireless LANs must support transparent interworking with other, wired, industry standard local area networks including IEEE802.3, 802.4, 802.5, 802.6, 802.9 and FDDI. In addition, services common to all these networks such as 802.1, 802.2 and 802.10 must be supported.

8.2.3 Implicit Market Requirements

Successful office LANs, in addition to the de jure support of standards, must support de facto network standards. Of particular importance is the support of industry standard network operating systems including:

- o Novell Netware
- o TCP/IP/NFS
- o AppleTalk
- o LAN Manager;
- o SNA; and
- o DECNET

Privacy/Security

Integrity/Denial of Service

Fairness

Seamless application portability in relation to 802.3, 802.5, and other office networks.

Maintain voice, video, and data connections while moving (e.g. Pen-based computers, wireless device can complete its communications session while user is moving/not entering data into his laptop).

Efficient Broadcast Mechanism for Electronic Mail, Distributed Database Applications, and Teleconferencing(receive-only, interactive).

8.2.4 Platforms and Configurations

The applications identified above will be implemented on arrange of user stations including the following.

Desktop PC	
Workstations	
Portables	
Handhelds	Ranging from notebooks -> palmtops
Bridges/gateways	
Servers	
Network peripherals	with built-in network attachments (FAX, printers, communication servers,etc.)

Telephones (portable,stationary)
TVs, Graphics Terminals (portable, stationary)

8.2.5 Node Population

- Small Company or workgroup: ^{2} 10 nodes
- Medium Company or department: 20-50 nodes
- Large Company or office floor: 100-200 nodes
- Campus Environment: 200-5000 nodes

8.2.6 Node Distribution

- High Density (e.g. back office worker layout or small business): 1 station/ 30 sq.ft.
- Average Office Density: 1 station/ 100sq.ft.

- Campus/Enterprise Density: 1 station/1000 sq. ft.

8.2.7 MAC Service Requirements

	File Access	File Transfer Windowed Protocol	Transaction Processing	Real-Time Voice	Real-Time Video	Terminal Emulation
MSDUSize Distribution	60% 80 octet 40% 600 octet	30% 80 octet 70% 1K octet	60% 80 octet 40% 600 octet	32 octet	600 octet	90% 80 octet 10% 600octet
MSDU Arrival Distribution	20 msec	2 msec	200msec	30 msec	30 msec	200 msec
Nominal Transfer Delay	2 msec	2 msec	5 msec	< 30 msec	< 30 Msec	5msec
Transfer Delay Variance	< 10 msec	< 20 msec	< 10msec	4 msec	4 msec	< 10 msec
MSDU Loss Rate	$< 10^{-3}$	$< 10^{-3}$	$< 10^{-3}$	$< 10^{-2}$	$< 10^{-2}$	$< 10^{-3}$
Service Initiation Time	1000 msec	1000 msec	1000 msec	1000 msec	1000msec	1000 msec
Station Speed	< 2 m/s	< 2 m/s	< 2m/s	< 2 m/s	0 m/s	0 m/s
Destination Distribution	100% (Small) 10% (Campus)	100% (Small) 10% (Campus)	100% (Small) 10% (Campus)	0	0	100% (Small) 10% (Campus)

8.3 Configurations

	Small Business	Department	Enterprise
Number of stations	5	50	1000
Station density	1000/hectare	300stations/hectare	30 stations/hectare
Dimension	10 m	100 m	1000 m
Application List	o File access o Transaction o File transfer o Terminal emulation	o File access o Transaction o File transfer o Terminal emulation	o File access o Transaction o File transfer o Terminal emulation o Voice o Video

9. Retail

9.1 Introduction

Retail includes two main application domains POS (point of sale) and hand-held (for pricing and receiving).

9.2 Applications

Hand-held stations require a sub-second response time from servers that are likely resident on an enterprise wired LAN. They can be moving while transmitting, and may move between access point coverage ranges while waiting for a reply to a previous request. They power-up only while transmitting. Their critical need is low response delay; they have only very small throughput requirements.

Normally services are provided by a client/server configuration with communications initiated by the client stations. Many services are provided locally by a POS server,while some require remote access to distant services.

POS (point of sale) applications include:

- Data collection
- Price lookup
- Credit card check, both of a local "hot card" file and via WAN
- Program load
- Financial point-of-sale transactions (e.g., debit card)

	Department store	Discount checkout	Supermarket checkout (UPC-code scanner)
peak transaction rate for N items	1/3 min for 2.5 items	1/min for 7 items	1/3 min for 50 items
number of enquiries/responses per transaction [==N+1 /sec.]	3.5	8	51
network area	0.25/2 hectare	clustered	clustered
user response delay			
desired within	1 sec	1 sec	50 msec
required within	5 sec	5 sec	200 msec
Message size per transaction (in octets)			
sent by POS terminal	120	120	25
sent to POS terminal	50	50	50
total	170	170	170
number of terminals	60 /hectare	20	20

POS stations are movable but not mobile. They need not work while being moved, but a move must not necessitate any user reconfiguration.

A department store thus requires 26.4bit/s/terminal = 1.6 kbit/sec/hectare.

Supermarket checkout requires 167 bit/s/terminal =3.3 kbit/sec/hectare.

Download to a diskless terminal requires512 koctets/min = 68 kbit/sec + overhead. With multicast (e.g.,802.1E), a total system load requires only 68 kbit/sec. 60 POS terminals loaded individually require 60 x 68 kbit/sec = 4+ Mbit/sec when a multicast protocol is not used.

Most POS terminals have an associated telephone, used primarily for in-store intercom. This gives rise to a small voice requirement. There may also be an in-store announcement channel [e.g., "Attention K-Mart shoppers"] requiring voice. And some stores may add a few graphics displays whose controllers are on the WLAN.

The environment changes with the change in the merchandise content creating variable propagation environments. Same in the airports with luggage check and airplanes movement.

Some applications are both indoors and outdoors: shipping/receiving, sidewalk sales, rental car check out,baggage match with travellers on the plane.

Most of the traffic with the exception of the file transfers is initiated by the remote stations. There is almost no peer to peer traffic but rather primarily client to server traffic.

Data security and integrity important.

Robustness required in mall or airport environment.

Most transactions are short 30 to 200 bytes. In the future it is foreseeable to have 1 kbyte records. This does not include resident software downloading which consists of a small percentage of the daily traffic. Downloaded software could be as big as 4 Mbytes.

Subsecond response time on the screen required by most customers. Customers would accept slower response time in the initial stage of downloading which happens normally once a day.

Battery life is very important. Users would prefer no battery change or charge during an eight hours shift.

Access point antenna location is important and could be limited by considerations other than optimal propagation.

Safety considerations could affect access point antenna location.

	Financial POS	Program Download	Real-time Voice
MSDU Size Distribution	120 octets	90% 600 octets 10% 80 octets	32 octets
MSDU Arrival Distribution	Poisson 30000 msec	Poisson 50 msec	30 msec
Nominal Transfer Delay	100 msec	50msec	< 30 msec
Transfer Delay Variance	500 msec	100msec	4 msec
MSDU Loss Rate	10^{-3}	10^{-3}	$< 10^{-2}$
Service Initiation Time	500 msec	500 msec	1000msec
Station Speed	< 2 m/s	< 2 m/s	< 2 m/s
Destination Distribution	80%	100%	100%

9.3Configuration

	Department Store	Discount Checkout	Supermarket Checkout
Number of stations	60/hectare	20	20
Station density	60/hectare	2000/hectare	2000/hectare
Dimension	100 m	100m	100 m
Application List	o POS o Price check o Program download o Inventory o Shipping	o POS o Price check o Program download o Inventory o Shipping	o POS o Price check o Program download o Inventory o Shipping

10. Warehousing

10.1Introduction

Warehousing overlaps other"vocational" uses. Offices in warehouses are like other offices. Manufacturing Automation and Process Control aspects of warehousing are like other Manufacturing Automation / Process Control uses. In addition to these,warehouses have some distinctive aspects

1. Areas of elatively-low user density, so it is possible to have more access points than users.

2. Greater mobility - speeds of at least 30 km/hr or 20 miles/hr will require active changing of access points.

3. Voice, which replaces or complements traditional voice (now almost entirely walkie-talkie). The emphasis is on local communication, not PSTN(Public Switched Telephone Network) access.

4. In some cases, a willingness to reduce raw data rates to extend the reach of the wireless system.

5. A harsh environment, in which it may be hard to wire access points.

10.2Applications

Applications are similar to those in the office environment. Mobile communications in warehousing is relatively simple today, but functionality would grow if higher data rates were available. 1 - 2 Mbit/s seems adequate.

Package handling and racking systems are similar, but include a good deal of down-loading and up-reading. This may also be true of AGVs (automated guided vehicles).

Warehousing overlaps other vocational uses. Offices in warehouses are like other offices. Manufacturing Automation and Process Control aspects of warehousing are like other Manufacturing Automation / Process Control uses.

The main application addressed in the table below is the handheld or vehicle mounted terminal used throughout the warehouse. Short transactions are a main characteristic of warehouse applications. The numbers presented below are indicative of present and near future installations. Robotics and highly automated applications, which require limits on the maximum delay have not been considered.

1. The overall application response delay to the user should be less than 0.25 second for the large majority of transactions. Delays up to several seconds are acceptable for a small percentage of cases (< 2%?). For most handheld terminals it is acceptable to require re-initiation of the transaction in a very small percentage of cases(< 0.1 %?) .

2. Applications in warehousing

Present:
- Data collection
- Data Base Access
- Terminal emulation (limited)
- Voice

If Robotics are included:
- Real Time video
- Tele-control
- Tele-command

	Data Collection	Data Base Access	Real-time Voice
MSDU Size Distribution	50% 120 octets 50% 80 octets	50% 600 octets 50% 80 octets	32 octets
MSDU Arrival Distribution	Poisson 20000 msec	Poisson 20000 msec	30 msec
Nominal Transfer Delay	50 msec	50 msec	< 30 msec
Transfer Delay Variance	100 msec	100msec	4 msec
MSDU Loss Rate	10^{-3}	10^{-3}	10^{-2}
Service Initiation Time	50 msec	50 msec	1000 msec
Station Speed	<10 m/s	< 10 m/s	< 10 m/s
Destination Distribution	0	0	0

10.3Configuration

Number of stations	10-40
Station density	3-15 hectare
Dimension	100 m
Application List	o Data collection o Database access o Real-time voice

11. Integrated MAC Service Requirements

This section to be completed.

11.1 Archetype Applications

11.2 MAC Service Requirements

MSDU Size Distribution			
MSDU Arrival Distribution			
Nominal Transfer Delay			
Transfer Delay Variance			
MSDU Loss Rate			
Service Initiation Time			
Station Speed			
Destination Distribution			

11.3Configuration

Number of stations			
Station density			
Dimension			
Application List			

11.4 Traffic Model

12. Integrated PHY Service Requirements

12.1Introduction

The physical medium over which an instance of an IEEE 802.11 MAC Layer Entity must operate is a broadcast medium. The properties of IEEE 802.11 medium differ from those of the traditional coax cable based broadcast media of IEEE 802.3and IEEE 802.4. These differences have an impact on MAC Layer Entity design. The characteristics detailed in this section of the requirements document relate to what a wireless MAC Layer Entity can and cannot assume when it requests service from a PHY Layer Entity or receives indications from a PHY Layer Entity.

This section of the document is divided into four sections. The first section provides definitions. The definitions are intended to provide a self-consistent framework in which to address the issues of concern to this section of the requirements document and as such take precedence over all other definitions in this context. Thre second section deals with generic statements that apply to all PHY signalling techniques currently under consideration. These generic statements are modified in the third and fourth sections to reflect differences that have been noted between the different PHY signalling techniques currently under discussion.

In order to adequately quantify a particular MAC's capability to deal with the generic requirements imposed by the PHY Layer Entity a significantly more complex model that provides a probablistic picture of the degree to which the various restrictions imposed by the generic requirements apply is needed. The data needed to evelop a model of this type would require a substantial effort on the part of the committee to obtain. Although benchmark models may need to be developed in the future it is doubtful whether a large scale effort to quantify the probability distributions associated with the generic PHY requirements would yield results that are more useful than heuristic evaluations of the impact of the generic requirements. The following articles in the technical literature provide an indication of the current state of the art in this area:

1) P.E.Mckenney, P.E. Bausbacher, "Physical- and Link-Layer Modeling of Packet-Radio Network Performance," IEEE JSAC vol. 9, pp 59-64, Jan.1991

2) E. Sousa,J.Silvester, T.D. Papavassiliou, "Computer-Aided Modeling of Spread Spectrum Packet Radio Networks," IEEE JSAC, vol.9, pp. 48-56, Jan.1991.

12.2 PHY Definitions

signal A detectable disturbance.

good signal A signal that passes all the tests that an IEEE 802.11 PHY Layer Entity can perform on it to assure that the signal has been generated by an IEEE 802.11 conformant PHY Layer Entity.

nfra red signal A signal that consists of an electromagnetic disturbance with a wavelength in the range from 750 nm to 1 mm. This corresponds to frequencies between 40000 GHz and 300 GHz.

microwave signal
A signal that consists of an electromagnetic disturbance with a wavelength in the range from 1 mm to 30 cm. This corresponds to frequencies between 300 GHz and 1 GHz.

radio frequency signal
A signal that consists of an electromagnetic disturbance with a wavelength in the range from 10 m to 1 cm. This corresponds to frequencies between 30 MHz and 30 GHz. (Note: This definition deliberately excludes signals that might be considered radio frequency in other environments in order to maintain a reasonable relationship between the physical size of objects in the environments in which the IEEE 802.11 standard is expected to operate and the wavelength of a signal)

medium
Anything upon which a signal is impressed or from which a signal is received. The term media is used only as the plural of medium.

guided medium
A medium that consists of a physical waveguide that confines signals impressed upon it to propagate only in the physical space occupied by the waveguide. A guided medium can only deliver signals to stations that are physically located along the path of the waveguide. Examples of guided media are coaxial and fiber optic cables. Signals propagating on a guided medium can be considered to be immune to interference from signals not intentionally imposed on the medium on which they are propagating.

restricted medium
A medium that consists of a physical cavity in which all signals that originate within the cavity are contained and from which all signals that originate outside of the cavity are excluded. A room without openings through which nfra red signals can pass is an example of a restricted medium. Signals propagating on a restricted medium can be considered to be immune to interference from signals not intentionally imposed on the medium on which they are propagating.

directed medium
A medium that propagates signals along a path that is primarily(although not entirely) confined to a solid angle that is small compared to 4^{1} steradians. An example of a directed medium is a point-to-point microwave link. Signals propagating on a directed medium cannot be considered to be immune to interference from signals not intentionally imposed on the medium on which they are propagating.

undirected medium
A medium that propagates signals in a manner that is not confined to a known physical path. An example of an undirected medium is cluttered free space in the vicinity of radio frequency signals emitted from common dipole antennaes. Signals propagating on undirected medium cannot be considered to be immune to interference from signals not intentionally imposed on the medium on which they are propagating.

station. Any entity that imposes signals that conform to the IEEE 802.11 PHY specification on a medium in a manner that conforms to the IEEE802.11 MAC specification and receives signals that conform to the IEEE 802.11 PHY and MAC specifications from a medium is considered a station whether or not it has any functionality beyond the reception and transmission of signals.

local area network(LAN) A group of stations that can communicate with each other through the use a common medium.

premises local area network (PLAN) A group of stations under the control of a single administration that desires the ability to communicate exclusively with members of this group of stations.

PLAN user An entity that desires access to the services of a specific **PLAN.**

native station A station that is a member of the specific instance of a premises local area network of concern to a specific **PLAN** user.

off premises local area network (OPLAN). A group of stations not under the administrative control of the specific instance of a **PLAN** of concern to a specific **PLAN** user.

alien station A station that is a member of an instance of an off premises local area network in the view of a specific **PLAN** user.

obsequious station A station that cooperates with alien stations for the purposes of sharing a single medium.

recalcitrant station. A station that does not cooperate with alien stations for the purposes of sharing a single medium.

jammer An entity that places signals that are observable by entities implementing an IEEE 802.11 PHY Layer Entity but do not conform to the IEEE 802.11 PHY Layer Specification.

pernicious jammer An entity that places signals that conform to the IEEE 802.11 PHY Layer Specification but do not conform to the IEEE 802.11 MAC Layer Specification.

Euclidean distance The classical measure of spatial separation that is calculated as Sqrt[x^2+y^2+z^2] and is denominated in meters.

attenuation distance The path loss between stations experienced by a signal that conforms to the IEEE 802.11 PHY specification as it propagates between a transmitter and a receiver. This distance is measured in dB and it is typically a time varying quantity.

12.3 GENERICS Characteristics Common to All PHYs

1. Stations are connected in parallel to the medium. Thus, when a station transmits, its signals have the potential to be received (or "heard")by some or all of the other stations on the medium. Other stations on the medium can interfere with the transmission of a station but cannot predictably alter its contents.

2. A station may not assume that any other station will receive (or "hear") its transmissions when it transmits.

3. Stations can not be guaranteed to have a common perception of what other stations are participating in the network at any instant in time.

4. There is some attenuation distance at which the transmissions from a station will not be received (or "heard") by other stations that are beyond this distance.

   Attenuation distance is non-Euclidian and as such individual sets of stations that are the same Euclidian distance apart can not be assumed to be the same attenuation distance apart.

5. If a station receives (or "hears") a particular transmission from another station it may not assume that it will be able to "hear"the next transmission from that same station.

6. If a station receives (or "hears") a particular transmission from another station it may not assume that the transmitting station can "hear" transmissions that the receiving station originates.

7. If a station detects a signal it may not assume that any station has transmitted that signal.

8. If a station detects a good signal it may not assume that any station has transmitted that signal.

9. A measurement of interference level at one station is not are liable indicator of the interference level at another station.

10. When a native station transmits it can not be assured that an alien station will not receive its transmission.

12.4 Special Considerations for Infrared Signals

1. The propagation characteristics of Infrared signals make it possible that through reasonable effort on the part of the administrator of a premises local area network item 10 above can be removed from the list of PHY Characteristics. In other words it is possible to design a restricted medium using IR signaling.

2. It is also possible to design a directed medium using IR signalling techniques.

3. Euclidean distance is more closely associated with attenuation distance if IR signalling is used than if RF signalling is used

12.5 Special Considerations above 10 GHz

1. It is possible to design a directed medium using RF signalling at 18 GHz.

2. Due to absorption characteristics of the atmosphere, propagation at 60 GHz, attenuation distance is strongly related to Euclidean distance if this type of signalling is used.

13. Summary

14. References