IEEE 802.4L

Through-the-Air Physical Media, Radio

Running Objectives and Directives Document

Fourth issue

This document provides a base for the discussions of the IEEE 802.4L Working Group.
Each decision will be marked in this document along with the reference to the motion on which the decision has been based (column Base) and with the reference of the document on which the present decision is based (Doc no). After each meeting a new document will be prepared to reflect the decisions made at the meeting.

Table of Contents

Subject	Base	Doc no

1. scope

To define an alternative Physical Layer for Through-the-air communication, which is part of a local area network using 802.4 media access techniques and which is primarily for mobile environments.	PAR	4L/87-014

2. Purpose

To provide LAN access to moving automatic machines and other stations for which wireless attachment is appropriate. To add description of standards criteria for through-the-air transmission parameters to support Physical Layer Service. To prepare, if necessary, a petition to the FCC for rule making which authorizes use of radio spectrum for wireless LAN.	PAR	4L/87-014

3. Directions

3.1 Design Principles

- 1. Meet FCC rules - spreading, scrambling, power, etc.
- 2. Meet 802.4 requirements implicit in ISO DIS 8802-4 1-10
- 3. Economy
- 4. Permit adjacent 802.4L-conformant radio LANs
- 5. Provide for both single-channel (direct peer-to-peer) and dual-channel (head-ended) operation
- 6. Single-channel system size: The objective is to permit a system diameter of 300 m. The minimum acceptable system diameter is 100 m.
- 7. Modulation technique must support office, retail and industrial environments.

3.2 System plan

The radio system plan for one community of users is proposed to be a ~~dual~~ single frequency bus mode with head end, but will accomodate single frequency station-to-station operation for small systems. The physical layer including the head end and radio system shall support the existing 802.4 MAC. (Among other things, this implies that when any station is transmitting, all stations must hear something.)	Jan 89 Jul 89	4L/89-02 4L/89-011
In the ~~dual~~ single frequency bus mode with head end normal token rotation shall be used, only for stations in the outskirt, immediate response mode will be considered. (see issue 5)	May 89 Jul 89	
Whatever plan is evolved, it shall be suitable for use under current FCC part 15 regulations, in particular the three bands, 0.912, 2.45, and 5.9 GHz.	Jul 88	
The 0.912 GHz band will be used in the first standard. At least 2 channels will be accomodated in the band	May 89	

Subject	Base	Doc no
3.2 Directions (cont..d)		
To separate transmissions of stations of nearby networks.the preamble will contain a Network Identification.	May 89	

3.3 System Design Parameters

Relation to the Objective List in [3.1]

1. Use a 7-bit (length-127) scrambler if the adopted chip rate is < 127. [1] The preferred polynomial is $1 + X^{-4} + X^{-7}$.[1+3]
2. Choose a modulation technique that does not include an amplitude modulation component, for [3] and to lower technical risk.
3. Permit differential demodulation for fast acquisition, to provide robustness for the time-varying (fading) radio channel, and to simplify the receiver [3]. The primary disadvantage of this approach is a 2.3 dB (theoretical) loss in S/N.
4. Use some form of quaternary PSK as a reasonable means of decreasing signaling rate (for multipath) without excessively compromising S/N or [3,7].
5. Spread the minimum amount practical [1,3]. The preferred spreading code is + — ++ — + + + — — —. This is a known Barker code, with bounded auto-correlation, bounded periodic auto-correlation, and bounded odd periodic auto-correlation, and good spectral properties.
6. Filtering should consider adjacent-channel single-frequency (single-channel) and simultaneous dual-frequency (dual-channel) operation. [4,5]
7. Initial focus should be on 900 MHz band. [3]

3.4 Modulation

Subject	Base	Doc no
~~We will consider modulation methods and bandwidths which are within the frequency allocation and spectral power density limits of FCC 15.126.~~	~~Jul 88~~	see [1]
Differential Phase Modulation shall be used.	Nov 88/1	4L/88-02
~~The first modulation technique to be investigated is DOPQSK (Differential Offset Quadrature Phase Shift Keying) with greater-than-Nyquist filtering of the baseband signal.~~	~~May 89~~	
~~The encoding of the PHY symbols is as follows:~~ ~~0 and1 from MSK like DOQPSK,~~ ~~Non-data (for the delimeters) from intentional code violations (multiple errors) from omitting a single phase change, and later another single phase change within an octet.~~	~~May 89~~	
~~Direct Sequence Spread Spectrum shall be used.~~	~~Nov 88/2~~	~~4L/88-02~~
For the spreading sequence at least 10 and not more than 15 chips shall be used. This provides a processing gain of between 10 and 15 allowing frequency division multiplexing of co-located LANs	Nov 88/3	4L/88-02
~~The following 11 chip sequence is considered for its good characteristics in corrolator output and frequency spectrum:~~ ~~0 1 0 0 1 0 0 0 1 1 1.~~	~~Jan 89~~	~~4L/89-02~~ [3.2.5]

3.5 Scrambler

Subject	Base	Doc no
~~For the scrambler the following two polynomials will be considered for their properties in conjunction with the encoding and FCS polynomials:~~ ~~First choice: 1+X**-4+X**-7 (1+X**-3+X**-7)~~ ~~Second choice: 1+X**-6+X**-7 (1+X**-1+X**-7)~~	~~May 89~~ [3.2.1]	

Subject	Base	Doc no

Directions (cont..d)

3.6 Data Rate

The data rate for comparison purposes shall be 1 Mbit/s. We can only consider the IEEE data rates of 1 to 20 Mbit/s.	Jan 89	

3.7 Antenna

The design model shall assume a 16 antenna array in a square grid. For purpose of analysis, it will be assumed that the antenna array is driven by one power splitter with equal length loss less cable from the splitter to each antenna.

3.8 Performance definition

The performance of the Token Bus standard will be expressed in the number of MAC Service Data Units with undetected errors per time unit, at 0 frame overhead.

May 89

The performance requirement is: less then one MSDU with undetected errors per year at 200 bit data units.

The frame loss rate shall be less then 1 per 10^8 frames transmitted.

3.9 Bit Error Ratio

~~May 89~~ ~~4L/89-07~~

~~For forward error correction the following measures are under considerations:~~

1. ~~Intrinsic redundancy of DOQPSK to combat isolated errors,~~
2. ~~Multi-symbol interleaving of chips to combat impulse noise, and~~
3. ~~Extra redundancy in the form of an additional FEC precoding. This alternative is to be avoided.~~

3.10 Outage

MAC protocol assumes the communication channel is always available. Since the radio medium is known to have an outage rate on the order of 10E-2, a method is required to reduce outage rate to less than 10E-5.	Jul 88	

3.11 Velocity ranges

The following are the ranges for the velocity of the stations: Jan 89

0.912 GHz	0 - 53.7 miles/h	
2.45 GHz	0 - 20.0 miles/h	
5.9 GHz	0 - 8.3 miles/h	

Definable parameters

XMTR power output:	1 W max	Jan 89
Station antenna gain:	TBD	Jan 89
Station antenna directivity:	TBD	Jan 89
Receiver noise figure:	6 dB at 900 MHz	Jan 89
	8 dB at 2400 MHz	Jan 89
	10 dB at 5900 MHz	Jan 89

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Directions (cont..d)

3.12 Error correction codes

Allowable overhead:	1.2x	Jan 89	
Type: TBD		Jan 89	
Spectral efficiency:	TBD		

3.13 Propagation

Office/retail environment:	6 dB/octave under 10 meters	Jan 89	
11 dB/octave over 10 meters		Jan 89	
Factory environment:	TBD	Jan 89	
Delay spread parameter	TBD		
S/N minimum:	TBD		
Noise:		Jan 89	
at .9 GHz	10 dB above thermal		
at 2.5 GHz	thermal	Jan 89	

3.14 Antenna

If the antenna is located 7 to 10 feet above ground it has 25 dB antenna gain over an antenna in a pocket.	Jan 89	

4. Meeting Plan

Type	Dates	Place	Objective
Interim	Sep 11-15, 89 8 half day sessions	Chicago Demo simulation model „	Presentation Dr. Rappaport Measurements results Distributed Antenna system First draft generation
Plenary	Nov 6-10, 89	Ft Lauderdale	Draft 1 to 802.4
Interim	Jan - , 90	?	Next draft preparation
Plenary	Mar 12-16, 90	Newport Beach	802.4 Voting draft
Interim	May - , 90	?	Prepare TCCC draft
Plenary	Jul 9-13, 90	Denver (CO)	TCCC voting draft
Interim	Sep - , 90	?	Last comment
Plenary	Nov 12-16, 90	Maui, HI	Final Draft out?

5. Possible Document Outline

20. Radio Bus Physical Layer

  20.1 Nomenclature

  20.2 Object

  20.3 Compatibility Considerations

  20.4 Operational Overview Single Frequency System

  20.5 Operational Overview Dual Frequency System

  20.6 General Overview

  20.7 Application of Network Management

  20.8 Functional, Electrical and Mechanical Specifications

  20.9 Environmental Specifications

21. Radio Bus Medium

  21.1 Nomenclature

  21.2 Object

  21.3 Compatibility Considerations

  21.4 General Overview

  21.5 Functional, Electrical and Mechanical Specifications

  21.6 Environmental Specifications

  21.7 Transmission Path Delay Considerations

  21.8 Documentation

  21.9 Network Sizing

  21.10 Guidelines

6. Issues

1 Is a Bit Error Ratio (BER) of 10**-8 detected and 10**-9 achievable with operation with a dual frequency head-end distribution system.
2 Is the BER described in issue 1 achievable for direct station-to-station operation and what is the condition to achieve this BER.
3 What Forward Error Correcting Code (FEC) is suited for channels with burst errors characteristics.
4 Considering the agreement that non-data will not be encoded as a PHY symbol: Find a method of start and end delimeter encoding, e.g. use a combination of an alternative constellation and corrolation.
4 What is the characteristic of the impulse noise in the various media.
5 What are the implicatios on the LLC when the immediate response mode is required to communicate with stations in the outskirt?
6 How should a distributed antenna system be represented for ruling measurements.

7. Referenced papers.

The following papers are of interest to the taskgroup members:

Environmental Monitoring for Human Safety Part 1: Compliance with ANSI Standards. By John Coppola and David Krautheimer, Narda Microwave Corporation. - RF Design--.

RF Radiation Hazards: An update on Standards and Regulations. By Mark Gomez, Assistant Editor, and Gary A. Breed, Editor. - RF Design, October 1987

RF Radiation Hazards: Power Density Predeiction for Communications Systems. By Gary A. Breed, Editor. - RF Design, December 1987

Microprocessor Interference to VHF Radios. By Daryl Gerke, PE Kimmel Gerke & Associates, LTD. - RF Design, March 1988

Distributed Antennas for Indoor Radio Communications. By Adel A.M. Saleh, A.J. Rustako, Jr and R.S. Roman. - IEEE Transactions on Communications, Vol. Com-35, No12, December 1987

UHF Fading in Factories. By Theodore S. Rappaport and Clare D. McGillem. - IEEE Journal on selected Areas in Communications. Vol. 7. No 1. January 1989

Indoor Radio Communications for Factories of the Future. By Theodore S. Rappaport. - IEEE Commmunications Magazine. May 1989.

A differential offset QPSK modulation/demodulation technique for point-to-multipoint radio systems. By Tho Le-Ngoe. GLOBECOM 87.