

IEEE 802.4L
Through-the Air Physical Media, Radio
Running
Objectives and Directives
Document

Third 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.

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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

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

Directions

System plan

The radio system plan for one community of users is proposed to be a dual frequency bus mode with head end, but will accommodate 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 4L/89-02

In the dual frequency bus mode with head end normal token rotation shall be used, only for stations in the outskirts, immediate response mode will be considered. (see issue 5)

May 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 accommodated in the band

May 89

To separate transmissions of stations of nearby networks. the preamble will contain a Network Identification.

May 89

Modulation

We will consider modulation methods and bandwidths which are within the frequency allocation and spectral power density limits of FCC 15.126.

Jul 88

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:

May 89

- 0 and 1 from MSK like DOQPSK,
- Non-data (for the delimiters) from intentional code violations (multiple errors) from omitting a single phase change, and later another single phase change within an octet.

Direct Sequence Spread Spectrum shall be used.

Nov 88/2 4L/88-02

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Directions (cont..d)

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 correlator output and frequency spectrum: Jan 89 4L/89-02
 01001000111.

Scrambler

For the scrambler the following two polynomials will be considered for their properties in conjunction with the encoding and FCS polynomials: May 89

- First choice: $1+X^{**4}+X^{**7} (1+X^{**3}+X^{**7})$
- Second choice: $1+X^{**6}+X^{**7} (1+X^{**1}+X^{**7})$

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

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.

Definition of Bit Error Ratio

Jan 89

The working definitions are as follows:

- * undetectable frame errors must be below 1 in 10^{*15} frames.
- * Undetected bit errors must be below 1 in 1^{*E9} bits
- * Detected bit errors must be below 1 in 1^{*E8} bits

where:

~~bits are to be read as bits transmitted between SD and ED, an undetected error is defined as a frame containing an FCS error (so may have been caused by a burst) and no bad signal reported.~~

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Directions (cont..d)

~~— a detected error is defined as a frame containing 1 or more bad signal hits,~~
~~— the frame length being equal to the smallest frame used by the MAC.~~
~~— an undetectable frame error is defined as a frame in error that has no FCS error and no bad signal reported.~~

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 than one MSDU with undetected errors per year at 200 bit data units.

The frame loss rate shall be less than 1 per 10⁸ frames transmitted.

Bit Error Ratio

Jul 88

~~Since the radio medium is known to have a bit error ratio of the order 10E-3 the system shall incorporate the level of diversity and forward error coding required to support the detected error rate of 10E-8 and undetected error rate of 10E-9.~~

For forward error correction the following measures are under considerations:

May 89 4L/89-07

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.

Outage

Jul 88

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.

Velocity ranges

Jan 89

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

- | | |
|-----------|------------------|
| 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)

Error correction codes

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

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

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

Meeting Plan

Type	Dates	Place	Objective
Plenary	Jul 9-14, 89 4 half day sessions: start Sunday 9 July 13.00 h Monday AM Tuesday AM Wednesday PM	Vancouver	Draft 1 to 802.4
Interim	Sep 11-15, 89 8 half day sessions	Toronto	Next draft
Plenary	Nov 6-10, 89	Ft Lauderdale	Draft 2 to 802.4
Interim	Jan - , 90	?	Next draft
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	Phoenix	Final Draft out

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

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 delimiter encoding, e.g. use a combination of an alternative constellation and correlation.
- 4 What is the characteristic of the impulse noise in the various media.
- 5 What are the implications 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.

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 Prediction 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 Communications Magazine. May 1989.
- A differential offset QPSK modulation/demodulation technique for point-to-multipoint radio systems. By Tho Le-Ngoe. GLOBECOM 87.