802_link.tex

A Spread Sheet for the IEEE802.11 Transmission Link Calculations

Jonathon Y.C. Cheah
Hughes Network Systems
10790 Roselle St.
San Diego CA92121
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Abstract:

This short note shows a typical communication links calculation pertaining to the IEEE802.11 use. It is envisaged that this link analysis or equivalence will be incorporated into the IEEE802.11 communications kernel that the users, the manufacturers, the installers nor the consultants need to worry about it. The link analysis provides the design transmit power dynamic range requirements. An expansion of this link calculation can take into account of other hardware/firmware design specifications for the transmission portion of this system.

I Introduction.

For the design of IEEE802.11 communication systems, the first hurdle is to specify the performance and the necessary design requirements of the communications blocks. Parameters such as noise figure of the receiver and transmit power of the transmitter. Other more detail parameters then follow such as filter bandwidths, gain chain analysis, phase noise specifications, intermodulations, interference model, implementation loss ...etc.

The purpose of this link calculation extract shown here is to highlight the important impact of the propagation model. It carries two initial implications. First, suitable FEC may be of advantage. Second, simplifying propagation paths may be of great interest (i.e. dont try to light up World Trade Center with two one-zillion-Watt light bulbs, two zillion one-Watt light bulbs work better).

It is also important to be realistic about man-made noise. Not every piece of equipment will be operating next to a Vehicular Identification System with its Kilo-Watt transmission, and thus this fact should not imply that every piece of equipment should survive this interference[1], and thus, the design will not price the equipment out of the consumer market (may be even the military one). This consideration also points to higher ISM bands where the problems are easier to solve.

For this note, only a basic transmission link analysis is provided.

II Link Analysis.

The following link design concept is straight forward. The analysis assumes only the simple manipulations of noise power, noise figure and propagation loss calculations. The modulation kernel is assumed to be M'ary DPSK which is a suitable choice. Spreading analysis in this fundamental form is transparent, other than it perhaps affects the propagation models. Two extreme propagation models are considered, to give a bound on the numbers. The spread sheet print-out given below is self explanatory, analytically simple and it needs no more descriptive effort in this note. One can change any or all of the parameters to suit one's design. There is an exception. The man-made noise number is given as 18 dB, This is a rule-of-thumb number. A more pessimistic one can be gotten from [1].

[1] This is a multi-facet question, a lot to do with marketing, human factors, and other non-engineering aspects.

IEEE 802.11 LAN Transmission Budget

System items:	Inputs:	Calculations:
Overall System Parameters		
Transmit Frequency:	915.00 Mhz	
Transmit Antenna Gain:	3.00 dB	
Receiver Antenna Gain:	3.00 dB	
System Noise Budget		
Antenna Noise:	18.00 dB	63.10
Passive Losses:	3.00 dB	2.00
LNA Noise Figure:	6.00 dB	3.98
LNA Gain:	20.00 dB	100.00
Post-LNA Noise Figure:	10.00 dB	10.00
System Noise Figure:		18.46 dB
System Noise Temp:		2.01E+04 Deg K
LAN coverage radius:		50.00 m
Path Loss:		65.65 dB
System Performance		
Level of DPSK:	4.00	
Information Bit Rate:	1000.00 kbps	
wanted raw BER:	2.56E-07	
Inv spectrum redundancy:	1.00	
Transmitted bit rate:		1000.00 Kbps
Transmitted Symbol Rate:		500.00 Ksps
Noise Bandwidth:		1000.00 Khz

Link Calculations		
Fading characteristics:	Rayleigh:	Gaussian:
Eb/No Required:	62.91 dB	11.61 dB
Noise power:	-125.57 dBW	-125.57 dBW
Received Carrier Power:	-59.66 dBW	-110.95 dBW
Transmit Carrier Power:	-0.01 dBW	-51.30 dBW
Transmit Power Required:	998.48 mWs	0.01 mWs

References

[1] W. C. Y. Lee, *Mobile Communications Design Fundamentals, Indianapolis:Howard W. Sams & Co, 1986.*