International Journal of Scientific & Engineering Research Volume 3, Issue 4, April-2012
ISSN 2229-5518

Modulation Error as QoS Trigger for Optimum Vertical Handover : Analysis for Adhoc Network

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ABSTRACT
Next generation network is envisaged to be a heterogeneous network with integration of different radio access network (RAN) technology (4G) i.e circuit switched and IP centric. To maintain a better Quality of Service (QoS) during a seamless transfer of a session from one RAN to another is termed as Vertical Handover. One of the key wireless network is Adhoc network which is a decentralized wireless network. This paper proposes a Measurement report comprising of minimum signal power (Eb/No) for different frames at different sublayers of PHY and MAC Layer. Here Error Vector Measurement (EVM rms %) at the receiver point is obtained which is exposed to hostile environment i.e impaired with AWGN channel with frequency offset and non-linear propagation (George) model. Measurement suggests De/authentication and RTS frames needs to be transmitted at higher SNR for achieving better QoS (i.e Zero FCS-error).

KEYWORD
AWGN,BER,CTS,EDGE,EVM,FCS,GSM,MAC,OFDM,RTS,SSID,SNR

1. INTRODUCTION

An ad hoc wireless network is a collection of wireless nodes that self-configure to form a network without the aid of any established infrastructure. Some or possibly all of these nodes are mobile.[2]
In this paper, Adhoc network is simulated on WiLANTA software which strictly adheres to IEEE802.11 b/g norms. Here the figure of merit for the modulation accuracy is the Error Vector Magnitude (EVM), which represents the distance between the measured and the perfect modulated signals[Fig.1]. EVM is used instead of the typical figure of merit, bit-error-rate (BER), because BER suffers from some limiting factors, such as the requirement for dedicated equipment, long measurement intervals (QoS) metrics on which network selection and connection is based and a limited diagnostic value. BER, Delay, Bandwidth etc are treated as Quality of Service metrics. Here EVM is used as a proposed QoS trigger to initiate a Handover. Therefore EVMrms is observed for different frames of Adhoc network and a comparative study of different frames/layers is done.

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2. AD HOC WIRELESS LOCAL AREA NETWORK STANDARDS

IEEE Std 802.11g.-2003 was introduced in 2003.
Modulation format: It uses OFDM, CCK(Complimentary Code Keying), and BCC (Packet Binary Convolution Coding) modulation schemes.
Max data rate : 54 Mbps.

Operating frequency : 2.4 GHz .
Max power output : 1000 mw.
Compatibility : compatible with 802.11b .
No of Channels : 14 (3 non overlapping)

3. AD HOC NETWORK,MAC FRAME TYPE AND SUBFRAME TYPE

3.1 Adhoc Network : An Adhoc wireless network is a collection of wireless nodes that self-configure to form a network without the aid of any established infrastructure. Some or possibly all of these nodes are mobile. These networks are extremely compelling for applications where a communications infrastructure is too expensive to deploy, cannot be deployed quickly, or is simply not feasible. There are numerous potential applications for ad hoc wireless networks, ranging from multihop wireless broadband Internet access, to sensor networks, to building or highway automation, to voice, image, and video communication for disaster areas.[2]

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3.2 Management Frames : Management Frames contain information for the receiving MAC management entity. Management Frame type has the following Sub frame types.[1]

3.2.1. Probe request Frame : A station sends a probe request frame when it needs to obtain information
from another station. For example, a radio NICs/station would send a probe request to determine which access points are within range.

3.2.2. Probe response Frame : A station will respond with a probe response frame, containing capability information, supported data rates, etc., when after it receives a probe request frame.

3.2.3. Beacon Frame : The access point periodically sends a beacon frame to announce its presence and relay information, such as timestamp, SSID, and other parameters regarding the access point to radio NICs/stations that are within range. Radio NICs/stations continually scan all 802.11 radio channels and listen to beacons as the basis for choosing which access point is best to associate with.

3.2.4. Authentication Frame : A station sends an authentication frame to another station if it wishes to begin secure communication.

3.2.5. Deauthentication Frame : A station sends a deauthentication frame to another station if it wishes to terminate secure communication.

3.3 Control frames : Control frames contain information to control access to the wireless medium and assist in the delivery of data frames. Control frames type has the following Sub frame types.[1]

3.3.1. Power Save (PS)-Poll : When a station wakes up from a power save mode it transmits a Power Save Poll Frame to the access point to retrieve any frames buffered while it was in power save mode.

3.3.2. Request to Send (RTS) : A station sends a RTS frame to another station as the first phase of a two-way handshake necessary before sending a data frame.

3.3.3. Clear to Send (CTS) : A station responds to a RTS with a CTS frame, providing clearance for the requesting station to send a data frame.

3.4 Data frame : Data frames contain data from higher protocol layers as indicated by their name, but not always.

They can contain only data, data with control information; contain only PCF control information or sometimes no data at all.[1]

3.4.1. Data : Frames of the data subtype are used for the purpose of just transmitting the frame body or data from 802.11bg transmitter to 802.11bg receiver.

4. RF FRONT-END NON IDEALITIES or SIGNAL IMPAIRMENTS

4.1. AWGN (Additive White Gaussian Noise) : It is a common wideband channel thermal noise impairment, on which SNR (Signal to Noise Ratio) is typically based. If SNR is high, we can decode the transmitted signal easily. On the other hand, If SNR is low, decoded the noisy signal becomes difficult and prone to errors.

4.2. Frequency Offset : Frequency offset is the difference between the frequency of a source and a reference frequency/carrier frequency. The frequency offset occurs due to a mismatch of oscillator frequencies or Doppler shift which results from a relative movement between transmitter and receiver in a mobile environment. The frequency offset must be specified in Hz in the range (-125 KHz to 125 KHz) according to IEEE 802.11b/g standard.

4.3.Memoryless Nonlinearity : Memoryless Nonlinearity block applies a memoryless nonlinearity to a complex, baseband signal. It models radio frequency (RF) impairments to a signal at the receiver. George Model is used for modelling the nonlinearity.

5. ERROR VECTOR MAGNITUDE

3GPP standards provide the following definition of EVM: "The Error Vector Magnitude is a measure of the difference between the reference waveform and the measured waveform as illustrated by Figure 1. This difference is called the error vector[5]. EVM gives the measure of modulation error. The modulation error indicates the deviation of In phase and Quadrature phase (I/Q) values from ideal signal states and thus provides a measure of signal quality[1].

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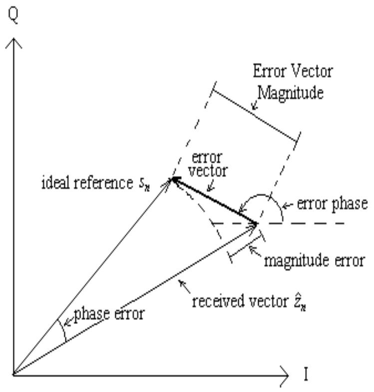


$$EVM_{RMS} = \sqrt{\frac{\sum_{n \in N} |\hat{z}_n - s_n|^2}{\sum_{n \in N} |s_n|^2}}$$

--- (1)

Figure 1: Error Vector Magnitude and related quantities.

The instantaneous error vector is subtracting the ideal reference from the modified version of the measured waveform. The root mean square EVM is obtained by above eq (1).

IEEE 802.11g Standard EVM Limits

$$Error_{RMS} = \frac{\sum_{i=1}^{N_f} \sqrt{\frac{\sum_{j=1}^{L_p} \left[\sum_{k=1}^{52} \{(I(i,j,k) - I_0(i,j,k))^2 + (Q(i,j,k) - Q_0(i,j,k))^2\} \right]}{52 L_p \times P_0}}}{N_f}$$

--- (2)

Lp: Length of the packet
Nf: Number of frames for the measurement
Io(I,j,k),Qo(I,j,k) : ideal symbol point of i^{th} frame, j^{th} OFDM symbol of the frame, k^{th} subcarrier of the OFDM symbol in the complex plane
I(I,j,k),Q(I,j,k) : observed point of the i^{th} frame, j^{th} OFDM symbol of the frame, k^{th} subcarrier of the OFDM symbol in the complex plane
Po :average power of the constellation. [10]

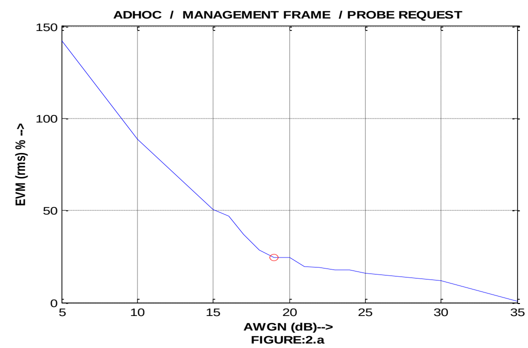
6. SIMULATION CONFIGURATION

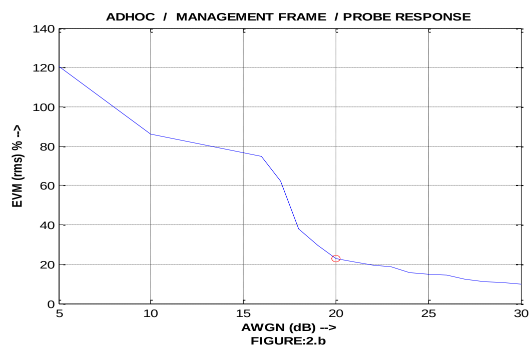
The simulation is done using the WiLANTA IQ generator and analyser software.The different parameters selected are as follow.

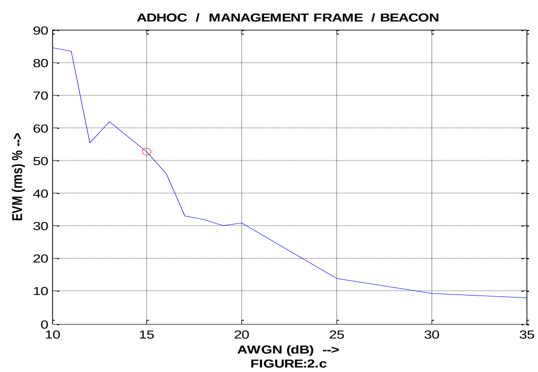
Parameter selected:

Software : Wilanta IQ Generator IEEE 802.11 g;
Standard : IEEE 802.11g
Modulation scheme : OFDM
Data Rate : 9 Mbps
Scrambler : on
Data Payload : 10Kbps
Symbol/frame : 285
Pre designed pattern : 00001111
Packet count : 1
MAC Parameters :
Network type : Adhoc
Frame type : Management / Control / Data
More fragment : not required
Power management : Active mode
WEP Encryption : WEP not enabled
Duration : 20 ms
Impairments :AWGN
Frequency offset : 10 KHz
Memoryless Nonlinearity: George model

7. SIMULATION RESULT AND DESCRIPTION







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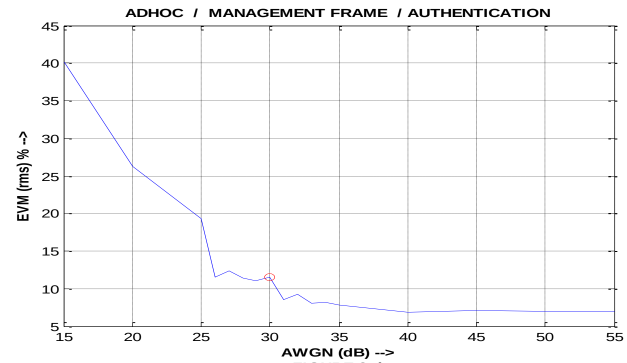

FIGURE:2.d

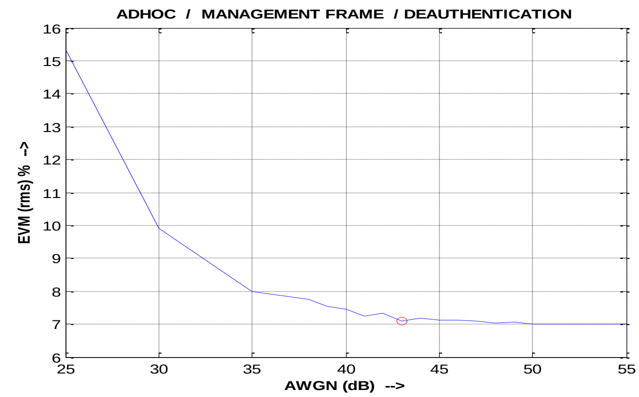

FIGURE:2.e

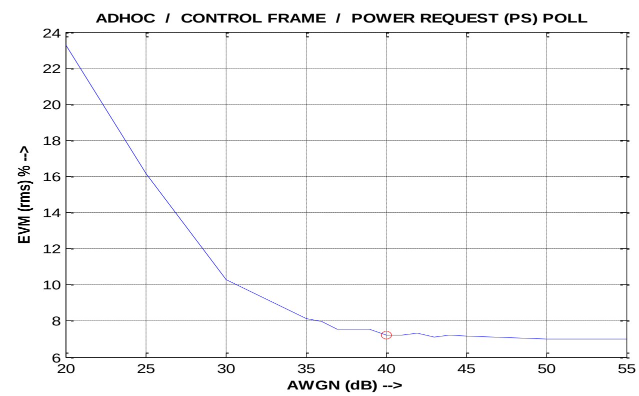

FIGURE:3.a

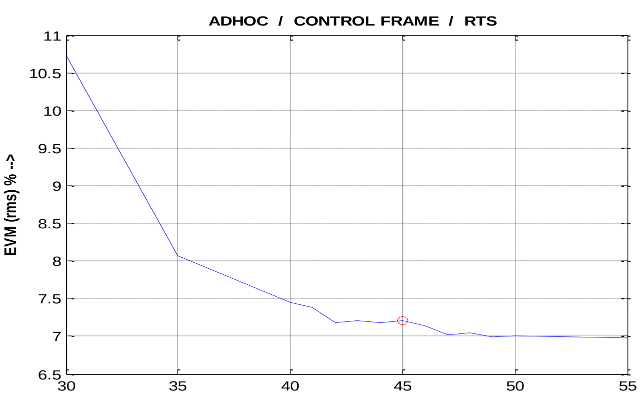

FIGURE:3.b

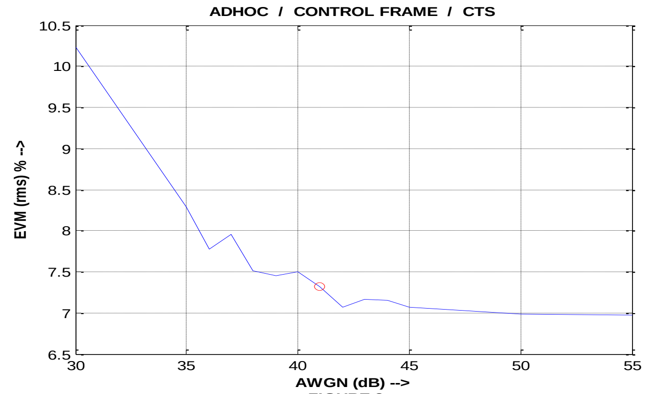

FIGURE:3.c

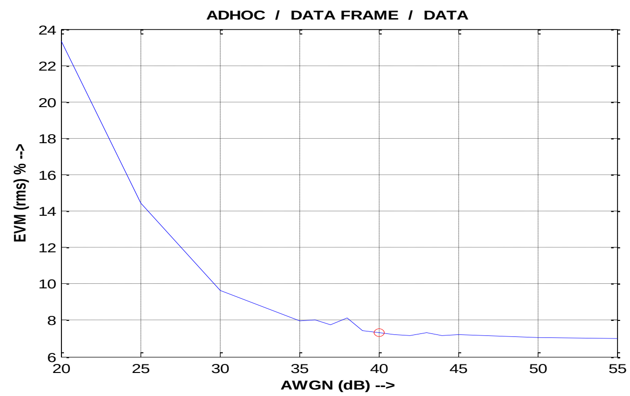

FIGURE:4.a

1. An attempt has been made to obtain EVM rms, by varying AWGN. Management,Control and Data frames are usedfor the analysis as user has to associate with a new Access point for VHO decision. It can be observed that we get low EVMs when AWGN(dB) are slightly increased. Here we are testing our proposed metric in fading environment.

2. Eb/No (AWGN) dB for successful transmission (Zero FCS error) for different frames :

Network / Frame / Subtype	Min. Eb/No (dB)	EVMrms%
Adhoc / Management / Probe request	19	24.6124
Adhoc / Management / Probe response	20	22.6645
Adhoc / Management / Beacon	15	52.6606
Adhoc / Management / Authentication	30	11.4837
Adhoc / Management / Deauthentication	43	7.07913
Network / Frame /	**Min.**	**EVMrms%**

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Subtype	Eb/No (dB)	
Adhoc / Control / Power save poll	40	7.2273
Adhoc / Control / RTS	45	7.2063
Adhoc / Control / CTS	41	7.3242
Adhoc / Data / Data	40	7.3333

3. Under management frame for the probe request(fig 2.a) with SNR 19 dB with respective EVM rms of 24.6124% the signal can be successfully transmitted while for probe response (fig 2.b) EVM rms i.e. 22.6645% followed with an increase in SNR that is 20dB . Comparatively for beacon (fig 1.c) a less SNR (15dB) can give successful reception with a very high value of EVM rms reached (52.6606%).i.e. a large error can be tolerated with maintenance of signal power in between 15 to 20 dB. Similarly comparing the Authentication (fig 2.d) and Deauthentication (fig 2.e) subtype .The deauthentication require large signal power for somewhat similar EVM rms fall. That is to connect a call with reference to fig 2.a ,2.b ,2.c a signal strength between 15 dB to 20 dB required that is feasible variation but EVMrms is getting to large due to the impairments .

4. As we gone through the management frame the max strength required noticed is for deauthentication frame (fig 2.e) in comparative study of 5 subtypes considered while it can be observed with the simulation result of control frame that the minimum SNR required is 40dB while there is great decrement in EVMrms in comparison of management frame. Here maximum it is only 7.3242 i.e for 'clear to send' (fig 2.c) subtype.

5. The DATA subtype used for the purpose of just transmitting the frame body or data from 802.11bg transmitter to 802.11bg receiver. As per simulation result analysis it require a high SNR of 40dB while the respective EVMrms recorded is 7.3333% i.e by maintaining a low EVMrms it requires a tough maintained SNR of 40dB (fig 4.a).

8.CONCLUSION

EVM should be minimized in order to enhance the performance of data networks .So it could be better parameter to analyse the desired QoS. In the work it is observed that different frame-type (Management, Control or data) responds differently to AWGN enabled channel impairment i.e. require different power level for maintaining QoS.

1. Management frames can be paged at a lower power level with the possibility of large EVMrms (24.612 %) Fig. 2.a

2. The control and data frames require large signal power to over come the hostile fading environment by Keeping Eb/No above 40 dB.

3. Control and data frames are very susceptible to fading environment and can not tolerate Modulation error beyond 7 % .

4. Adhoc network require a large signal strength for successful transmission of a signal frame and minimum possible EVMrms is 7.20633.So if we are capable of maintaining a power level between 15dB to 40 dB.

5. Measurement report suggest that EVM is a better candidate to measure Quality of Service of a given network. EVM obtained from different Networks in the proximity of Mobile node will help Mobile node to connect to a new target network bearing better QoS. This report is also helpful during a Network failure or poor QoS offered by existing Service provider or network.

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