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MIMO-STBC a superb combination to increase spatial diversity

Farha siddiqui

Abstract— Several wireless communication system include radio propogation(cellular and wireless LAN),satteite communication ,televissin communication needless to say mobile communication a are in terms of design quite challenging though the attributes of wireless communication and them attractive yet still the challenging task was the propogation environment which is time varying.The outmost requirement of the systems are high data rate,portable ,mobility ease of connectivity,must provide privacy and security ease of connectivity in wireless environment and of coure reliability without requiring extra power or providing additional bandwidth.MIMO with STBC(orthogonal structured codes) proves to be an outrageous combination to improve spatial diversity.In this paper work i would like to make you familiar with wireless propogating environment,MIMO(a smart antenna technology) and diversity techniques,which proves to be a key soution to wireless fading channel.

Index Terms— MIMO(mutiple input multiple output),STBC(space time block codes),diversity,smart antenna technology etc

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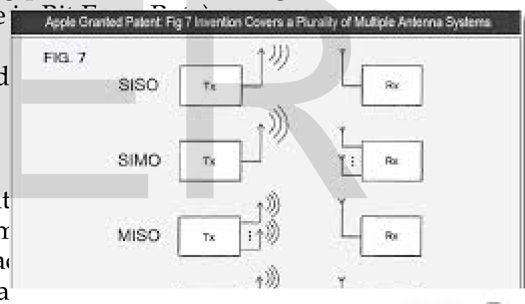
1 Introduction

other.thus resuts in higher spectral effeciency improve data rate with consequent saving of spectrum space.

As the signal reaches the receiver via number of propogating path therefore the signals which arrives at the receiver will interfere with each other their quality also degerate(increase



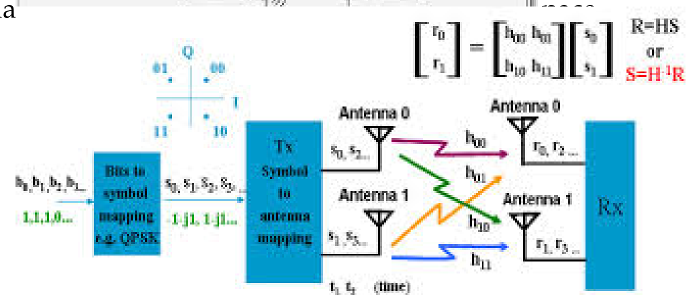
The above diagram depicts the curve between throughput and ... tems.

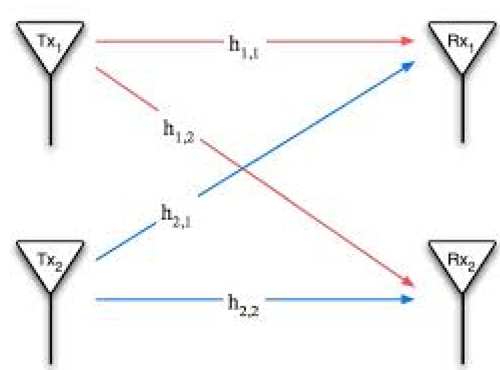
MIMO a smart antenna technology which increases the performance and spectral effeceiency of wireless communication system by pacing multiple transmitter and receiver antenna at both the end of the link.thus a multiple data coud be transmitted at the same time which aso results in large coverage area and effecient and eminent utilization of spectrum resource.biggest wireless challenge is to maximize data rate(channel capacity maximum utilization),low power requirement less complecated design circuits with low equipment cost with excellent voice quality(low BER) in adiition which can adapted to cellular coverage that means must be accessable in rural ass urban areas.hot spots also.

AS the radio communication system is finite therefore higher data rate prblem can be solved by higher order modulation scheme(eg,QPSK,PSK etc) as quadrarture

increases the bit rate so we can send more information

bit ... ; interference an ... rthogonal to ea ... ncy improve da ...





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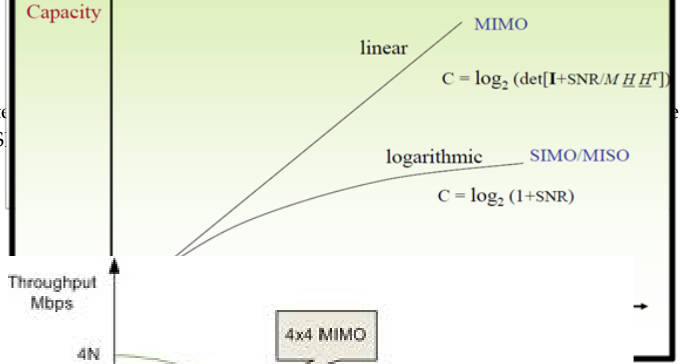
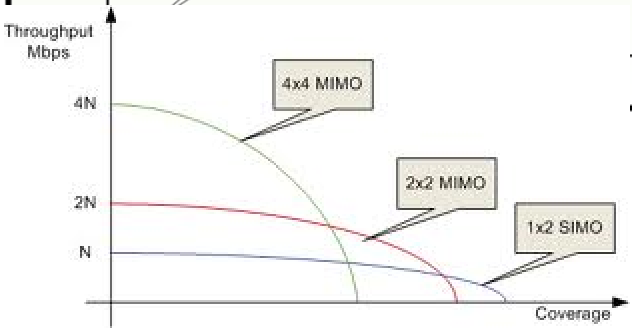


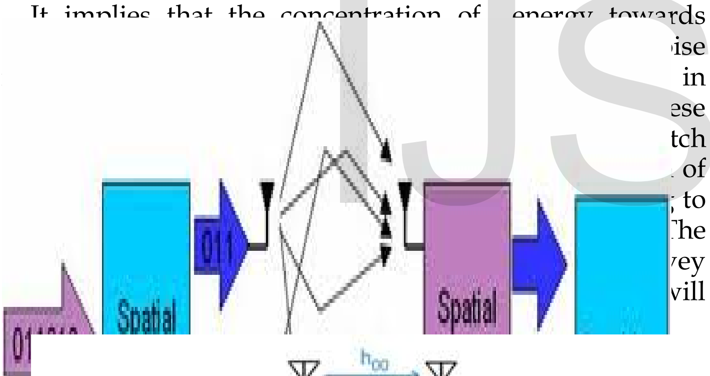


The above diagram depicts the curve between throughput and coverage. For various multilple antenna systems.

2 FUNCTIONS OF MIMO

2.1 Mimo-beamforming

It implies that the concentration of energy towards … ise … in … ese … tch … of … to … The … vey … will



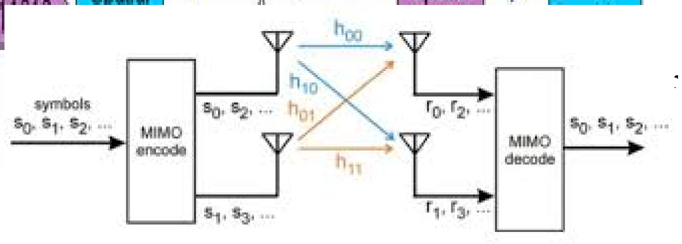


Figure 3. Simplified 2x2 MIMO block diagram.

$$r1 = h11\ t1 + h21\ t2 + h31\ t3$$

$$r2 = h12\ t1 + h22\ t2 + h32\ t3$$

$$r3 = h13\ t1 + h23\ t2 + h33\ t3$$

Where data stream from transmitting antenna t1,t2 and t3 are being transmitted from antenna first ,second and third.there are several paths from transmitter to receiver antenna.h11 is path from transmitting antenna 1 to receiver antenna 1, simiarly h12 is the path from transmitting antenna 1 to receiver antenna 2.where r1,r2,r3 are rexceived signal on firsdt ,second and third antnna respectrivey.

$$[R] = [H] \times [T]$$

$$[T] = [H]^{-1} \times [R]$$

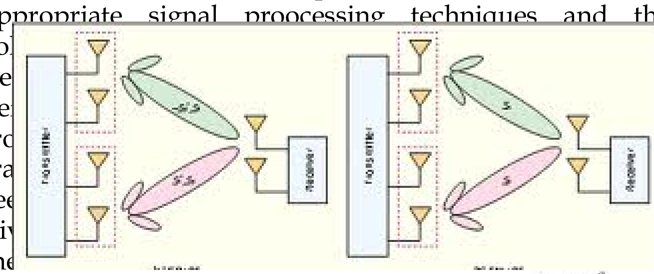
Where hij is channe transfer charachteristics firsty comput e the channel transfer matrix then mutiply with receive signal matrrix in order to estimate transmitter signal matrix.

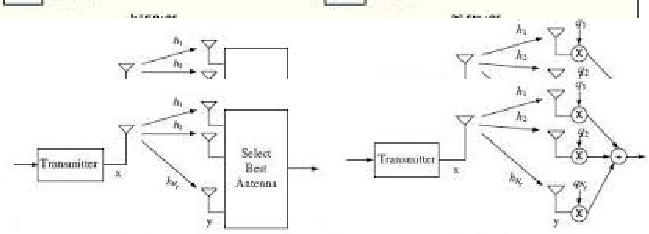
Ns=min(Nt,Nr)

Where Nt are the transmitter antenna Nr are the receiver antenna .Ns stremas could be transmitted in parrel increasing the data transmission rate.spatia multiplexing is used to increase channel capacity at high SNR

2.3 Spatial diversity

multiple antenna are seperatewd in space whose spacing must be at least 10 wave length when location is at the base station) and less than 10 when location is some where othet than base station namely at mobile unit. and the receiver can select the qantenna with best SNR which appropriate signal proocessing techniques and then co… he de… an be… ed fro… en tra… he ree… ut div… he me…





selection combing maximal ratio combing

.In selection combining:in simple language pick up that signal which have high SNR .thus simple andd easy to implement needs a singe switch and power measuring technique.

Maximun ratio combinbing: in this cxombinng techniques signa are combined coherently soa s the signa is aximised.it takes both the phase and amplitude inf

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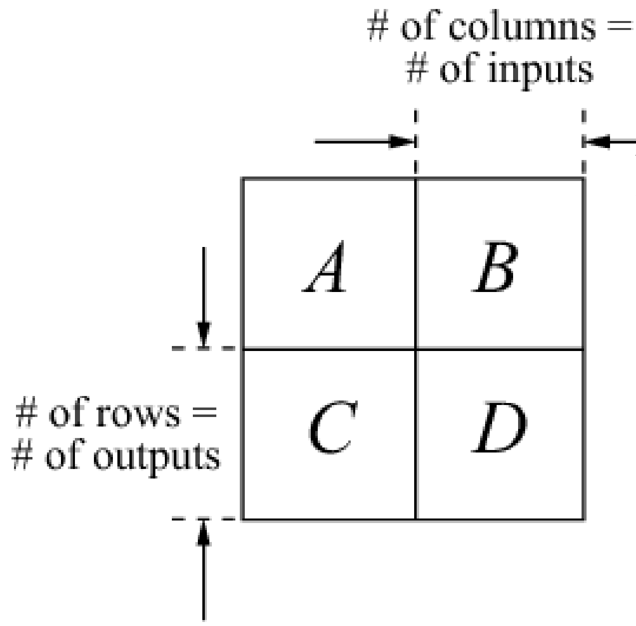
A.



Example of a system with two inputs two outputs"

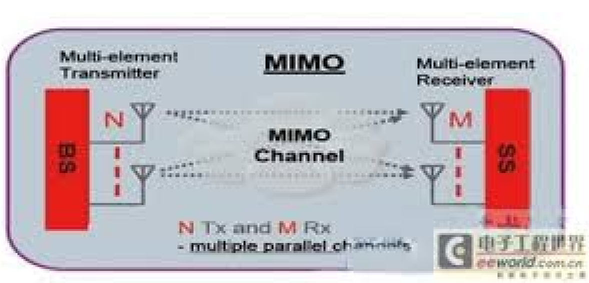
Lets us assume we have two input and two output y_1 and y_2, and also assume two inputs u_1 and u_2. They are inter related through following equations:

$$y_1'' + a_1 y_1' + a_0(y_1 + y_2) = u_1(t)$$
$$y_2' + a_2(y_2 - y_1) = u_2(t)$$

State variable are assign as follows:

$$x_1 = y_1$$
$$x_4 = y_2$$
$$x_1' = y_1' = x_2$$
$$x_2' = -a_1 x_2 - a_0(x_1 + x_4) + u_1(t)$$
$$x_4' = -a_2(x_4 - x_1) + u_2(t)$$

Assemble these state -space equations



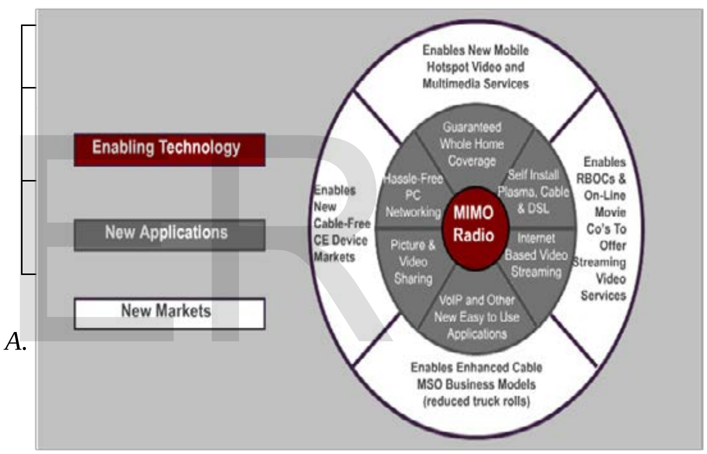
The channel with N_r outputs and N_t inputs is denoted as a $N_r \times N_t$ matrix:

$$H = \begin{pmatrix} h_{1,1} & h_{1,2} & \cdots & h_{1,N_t} \\ h_{2,1} & h_{2,2} & \cdots & h_{2,N_t} \\ \vdots & \vdots & \ddots & \vdots \\ h_{N_r,1} & h_{N_r,2} & \cdots & h_{N_r,N_t} \end{pmatrix} \quad (2)$$

In MIMO systems Using multiple natenna at the transmitter allow several users can access the base station simultaneously.

TABLE I

	Comparrison based on different attributes		
	Attributes	**SISO**	**MIMO**
1	Spectral effeciency	Lower than mimo	Higher than siso
2	Channel capacity	$B\log_2(1+SNR)$	M $B\log_2(1+SNR)$



A.

MIMO is used in IEEE 802.16 and IEEE 802.11 N "High throughput standards,future mobile communication systems also supporting MIMO eg LTE(long term evoution) beyong 3G Technology a promising technology for next generation mobile platform.

MULTIPATH PROPOGATION:

Wireless environment:As the signal propogates from transmitter to receiver via number of propogating path besides lOS(line of sight) which gives the strongest and the most dominating signa as receiver and transmitter are in ine of sight to each other.An incoming eectromagnetic wave when travel from transmitter to rceiver may refect from arge bjects which occurs in the vicinity of the propogating path.thus the wave which arrives at the

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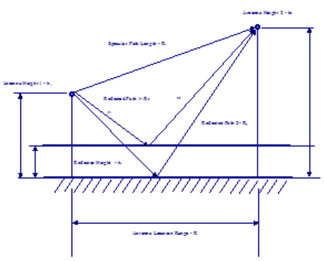
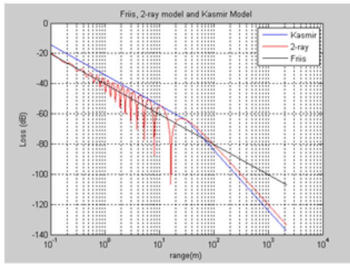
receiver wil have different phase shift delays time of arrival etc





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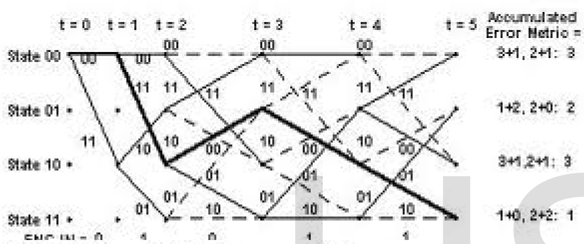

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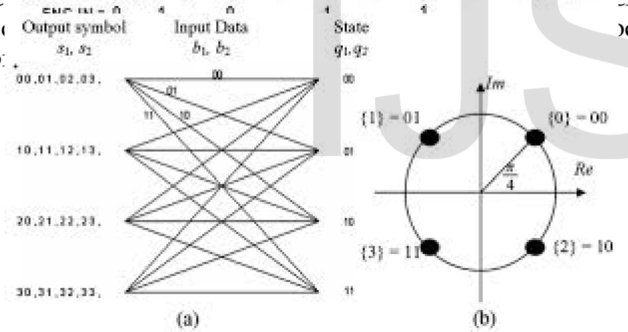


C. Space time coding:

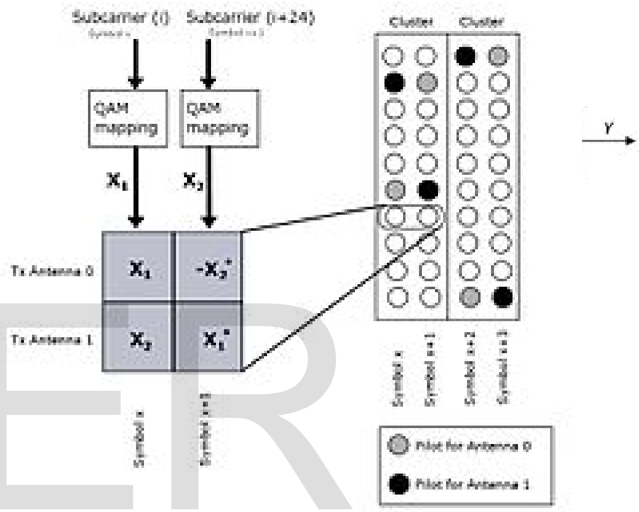
A space time coded system uses multiple transmitting and receiving antenna at both the end of the link creatte spatial diversity(redundancy is added in space) spacing between the antenna .thus the signal become un correlated which leads to ease in decoding complexity and decoding at the receiver.which is based on rank and determinant criterion.the difference between the determinant of the square matreices of the code must be non zero (non vanishing determinant) which ensure the full diversity, a condition of golden codes(perfect STBC).SRBC is quite simple to decode and its orthogonal structure is quite eye catching.,which reduces the decoder complexity. Space time code can provide diversity gain and effective capacity .the first STBC desighn was given by Amouti

$$X = \begin{bmatrix} s_1 & -s_2^* \\ s_2 & s_1^* \end{bmatrix}$$

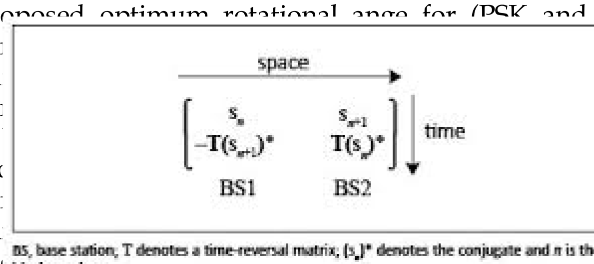
$$\mathbf{G}_2 = \begin{matrix} t_1 \\ t_2 \end{matrix} \left\{ \overbrace{\begin{bmatrix} s_1 & s_2 \\ -s_2^* & s_1^* \end{bmatrix}}^{\mathrm{Tx}_1 \quad \mathrm{Tx}_2} \right.$$

...matrices have rows wh... r which signal gets tra... ch antenna signal got tra... structured codes for wi...

$$C = \overset{\text{Space}}{\longrightarrow}\begin{bmatrix} s_1 & s_2 & s_3 & s_4 \\ -s_2^* & s_1^* & -s_4^* & -s_3^* \\ -s_3^* & -s_4^* & s_1^* & s_2^* \end{bmatrix} \Big\downarrow \text{Time,}$$

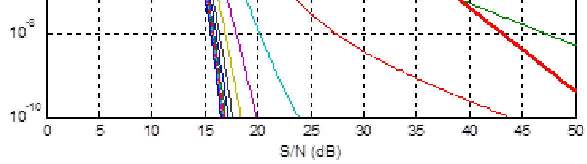


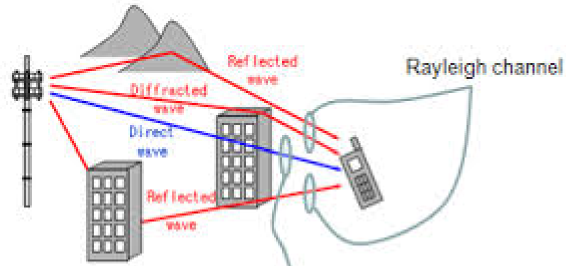
The orthgona STBC desighn given by Amoutui provide fu rate ful diversity the code can be decoded lineary due to its orthogona structure design.Tarokh another author proved that this scheme of fu rate and fu diversity was appicable ony for two antnnas.Hamid.Jafarkhani proposed Quasi orthognal STBC(QO-STBC) for four antennas they take almouti 2*2matrix of coeffecients (1&2)on diagonol term and matrix (3&4) on off diagonol term.which gives full rate but the the diversity gain was not full and with additional decoding compexity which increases linearly.TBHalso propossed a scheme which can aso acheive full rate but not the ful diversity,autors come aong with the schemne to rotate the constellation they also proposed optimum rotational ange for (PSK and QAM) co... work na... ept of co... ...ty for mo... duced co... mbols .Si... mbos su...



BS, base station; T denotes a time-reversal matrix; $(s_n)^*$ denotes the conjugate and n is the block number.

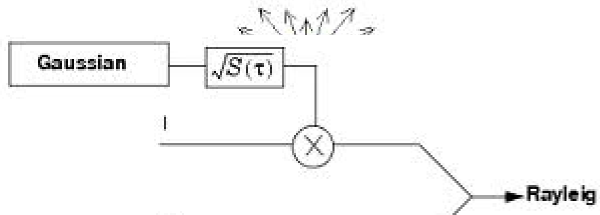
FIGURE 2: A block transmission of the time-reversed block form of Alamouti's scheme.

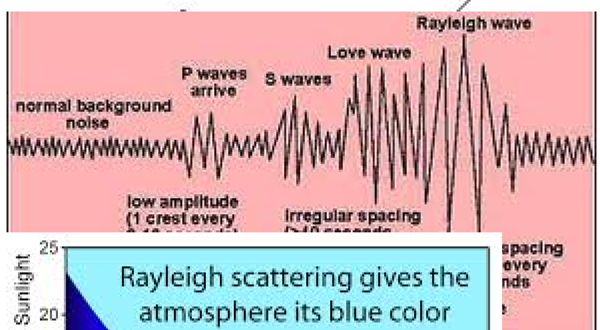




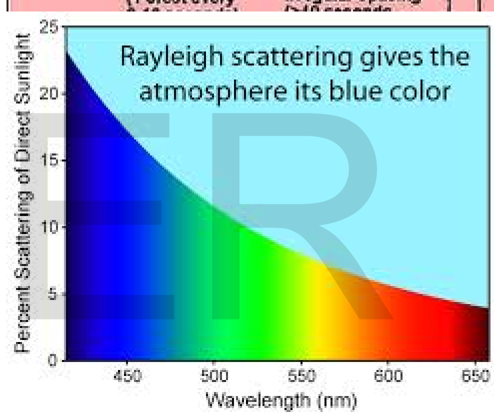
r fading

Serial no	scheme	Merits
01	Spectral effeciency	Which describes the multiplexing gain in MIMO.
02	link reliability	Depicts the diversity gaiun
03	coverage	Diversity gain and array gain
04	Cellular capacity	Which depends on Co-channel interference reduction factor

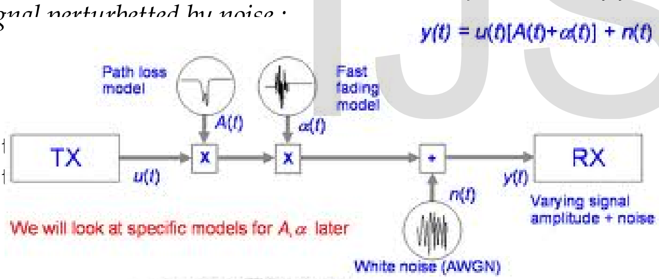




D. TRANSMISSION MODELS FOR MULTIPLE INPUT MULTIPE OUTPUT CHANNELS



Consider a transmitting scenario in which a systerm transmitt (N) transmuitting antenna) and receiver equippped with (M) receiver antenna therfore each each output of the channel when reaches the receiver antenna is is a inear supersosition of faded signal perturbetted by noise :



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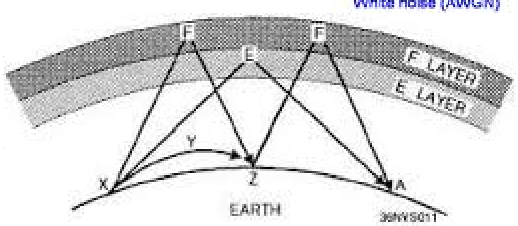


s to receiver.

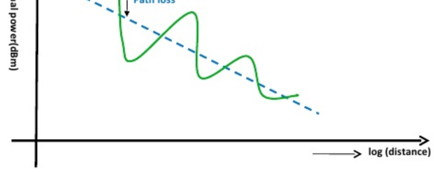
As the signal travels from transmitter to receiver via number f multiple path due to the interlacing objects(in the vicinity)of the transmitter and receiver the signal get reflected ,scattered,diffracted,experience path loss,have a shaddowing effect and thus reached the receiver via multiple path reffered to as multi path .additionay when signal traves from one ayer to another it experience a fading due to variation in transmitting medium(reffered to as scintilation) results from variation in electron density within the layer.the the signal which reaches the receiver will have a reduced strength of the signal thus resultant signal is said to be fadded ,because of different time of

LARGE SCALE FADING"

Large scae fading manifest attenuation in signal power and path loss which occurs due to motion of the signa over arge area,induced by the channel. Large scale fading occurs due to terrain contoure interacing bjects(in the vicinity of path) between the transmitter and recxeiver,shadowing is aso occurs .we can measure path loss as a funcion of distance.

SLOW FADING:

Smal changes in signals amplitude and phase occurs such fading is reffered to as small scale fading when sifgna travels between transmitter and receiver .is said to be manifested in two ways signal disperssion and time varient behavoir of the channel.smal scxale fading is called RAYLEIGH fading when there are multiple reflected path between transmitter when the line of sight component is bocked.



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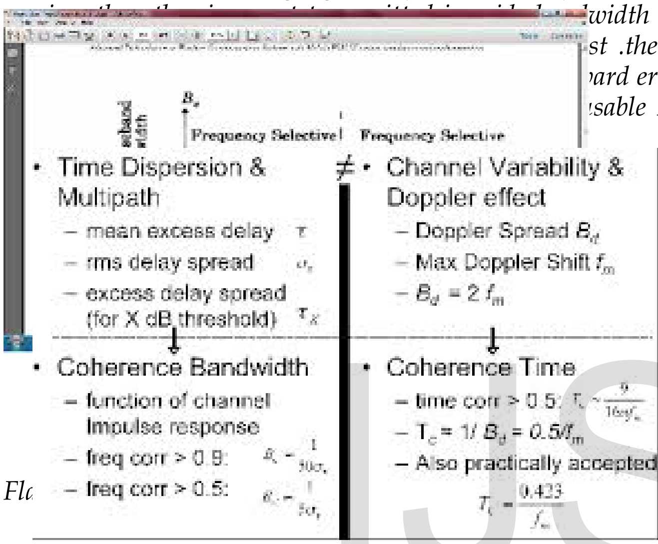
Frequency selective fading: in wireless radio communication systems the responce of the signal is not flat it sudders from fades and dips as it travel along its path as the signal got reflected in the vicinity f transmitter-receiver path and thus thus resuts in cancellation of certain frequency. In narrow band transmission of the signa l it the deep fadding occurs at the transmission frequency entire signal would have been corrupted due to correlation. There are two ways to sort out this problem (i)by wideband signal just as in the case of spread spectrum signal. Spread spectrum is a tehnique in which an already modulated signa is modulated second time in such a way theat the signa which is transmitting in the same frequency band will rarely interfere with this signa) Example in CDMA(ii)the transmitiing signa is split into multiple small sub ... width thus ... st .the lost ... ard error - ... sable BER



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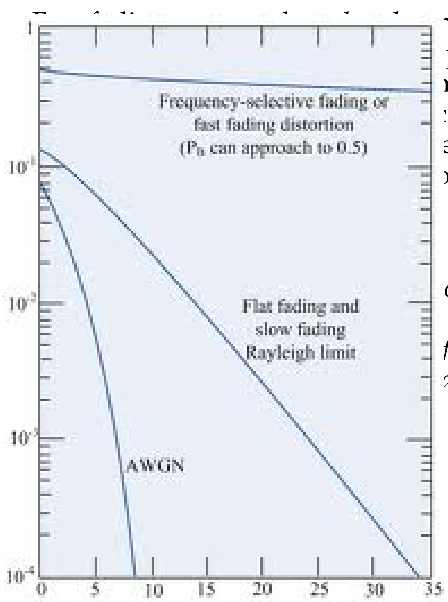
E. Fast fading:

... nel coherence time(the ... predicatble) is shorter ... nitted signal.therefore ... channe changes many ... e symbl which was ... on in the shape of the

... on cxhannels is said to ... time of the channel(the ... f the channel remain ... atin .thus the state of the ... duration in which the



Causes of fading:

(a) Reflection:when an incoming electrmagnetic wave strikes an object whose size is much greater than signals wavelength such as wall etc then this coming elctromagnetic wave strikes at the boundry and changes its propogating direction.

(b) Refraction:When an incoming elctromagnetic wave travel from one medium to another ithere seems to diverted in its path due to different refracted indices of the medium.for example the propogation of wave from wall to air.

(c) Diffraction:when an incoming electromagnetic wave strikes an edge of an object whose size is much larger than its wavelength.for example in the outdoor environment the edges of the walls and in indoor invironment the edges of the furniture.

(d) Scattering:When an incoming electromagnetic wave hits at the object whose size is much smaller than signal wavelength then scattering occurs.example in the outdoor environment when wave strikes the rain drop whose size is much smaller than signal wavelength.

(e) Adjacent channel interference:which is a type of interference caused at the adjacent channels due to extra power from the transmiitting signal which produces the side lobes which interfere with the signal next to main signal.

(f) Co channel interference:co means same that means when working on the same channel or cell the interference occurs amongst the signals.

(g) Path loss:Which occurs when the signal transmitted power is loss when transmit from the transmitting antenna and in addition to it due to loss caused by propogation path.

(h) Shadowing:Which occurs when the obstacles present in the vicinity of the transmitter receiver path absorb power thus the provide which reaches at the receiver have rduced power level in it.When the objects fully absorb power the signal is said to be blocked.

There are diversity techniques are available which are used to mitigate fading used commonly.:

(a)Time diversity: In time diversity also called temporaral diversity same signal is transmitted from all the antenna in different time slots with seperation between the slots will be greater than coherence time(frequency domain representation of coherence bandwidth) it is defined as the timeduration over which statae of the channel remain predicatable.therefore all the copies of same signal will undergoes independent fading .thus they could be easily summed up at the receiver by appropriate diversity combining techniques)

(b)Space diversity:This diversity scheme also called antenna diversity which uses multiple antenna ,when multiple antennas are used at transmitter it is called Transmitter diversity .when multiple ante nna are used at the receiver is called receiver diversity.here redundancy is added in space(spacing between the antenna element) therfore no extra bandwidth is nedded thus consiquent saving of spectrum space.

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(c)Frequency diversity: frequency diversity by transmitting the same signa n different carrier which have a frequency seperation of (fo)coherence bandwidth,a bandwidth over which the state of the channel remains predictable.

(d)poarization d iversity: a diversity scheme to get uncorrelated copies of the signal of interest.

3.CONCLUSSION:

Mimo when used in STBC reveals outrageouserformance in wireless environment.MIMO is consedered to be a key technology for next generation systems,STBC (an orthogonal structured codes for wireless fading environment)

ACKNOWLEDGMENT

I would like to thank almighty the creator for his mercy on me.and my family members.

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