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An 3GPP Spatial Channel Model for Urban Micro

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Abstract— **In this paper, MIMO spatial channel has been implement for outdoor environments – Urban Micro using MATLAB for finding various parameter like angle of arrival of the user, user route and the space between user and access point. Except the "far scattered clusters" attribute and the intercellular interference the system has been evaluate. These features were left out of the realization because they make certain restrict assumptions about the set of connections layout. The present implementation has no built-in assumptions on network geometry and is hence usable for a variety of simulation purposes. The results were analyzed for various numbers of users and graph has been plotted.**

Index Terms—**MIMO, Urban Micro, Scattered Clusters, Spatial Channel.**

I. Introduction

MIMO tools was consistent in 2004 for 3G mobile phone network to accomplish superior data rates [1]. Later, in organize to increase the data rates even further, [2] proposed MIMO known as (MIMO-OFDM) for WiMAX as an option to cellular standards [2]. WiMAX is based on the 802.16e set and uses MIMO-OFDM to deliver speeds up to 138 Mbit/s. The more superior 802.16m set enable download speed up to 1 Gbit/s [3].

Recently, MIMO has been extensively acknowledged as the boss means to recover mobile broadband services and to maintain wider transmission bandwidths. In theory, MU-MIMO can provide throughput gains that scale linearly with the number of antennas [4]. MU-MIMO is already supported in LTE Release 8 via transmission mode 5 (TM5). In LTE, specifications provide downlink rates up to 300 Mbit/s and uplink rates up to 75 Mbit/s [5].

Therefore, MIMO processing techniques - such as spatial multiplexing, space-time coding and diversity schemes - have gained much attention. Spatial multiplexing can be used for the development of data rates [6-8]. Whereas space-time coding and MIMO diversity technique can be used for improvement Signal to Noise Ratio (SNR) while custody the data rate high. Overall, MIMO meting out techniques appear very hopeful for future wireless systems. In this paper, we implement (MU-MIMO) spatial channel model for different outdoor environments: urban micro, and urban macro. Simulations are carried in MATLAB for finding various parameters like angle of arrival, user direction and the space between user and access point (AP).

Procedure for Paper Submission

II. Development of Spatial Channel Model

For model and design of smart antenna systems, spatial channel model is needed that reflect the measured uniqueness of a mobile radio channel. There should be a specific circulation channel model which plays a role as a presentation evaluator and comparator. Spatial channel model (SCM) is called algebraic or ray based model which is based on stochastic modeling of scatterers. In Spatial Channel Model these environments such as, urban micro and urban macro are consider. Urban micro is also further defined into LOS and NLOS broadcast.

Every situation is being given permanent number of paths which can be adapted in channel parameter configuration function and every path has further separated with twenty spatially sub paths. This channel model is used to generate the matrices for desired number of links by using different parameters in the input structures, Such as channel configuration parameters, antenna-parameters and link-parameters. This SCM channel model gives output the MU-MIMO channel matrices while having the input of link-parameter, antenna-parameter and channel configuration-parameter. Channel impulse answer for pre-defined number of links is given by a multi-dimensional array output.

III. Environments Considered for MU-MIMO SCM

Four environments considered in MU-MIMO spatial channel model are as under.

A. Urban Environments:

An urban area is described as greatly built up area within a city. Tall building along street act as reflectors of radio waves and LOS path normally does not exist because of investigation of nearby buildings. Both the base station and mobile antennas presumably use an Omni-directional antenna.

B. Sub-Urban Environments:

A sub-urban area is described as a less built up outskirts of a city. These areas may be open farmlands and there may also be some visible mountains off in the distance. In sub-urban areas nearby buildings cause most of the multi-path with small time delays, but the large stutterers such as large buildings and mountains, generate significant multi-path components with large time delays.

C. Macro cell Environments:

In case of macro cell environment, stutterers surrounding MS are at same height or higher than MS, hence BS antenna is placed above stutterers.

D. Micro cell Environment:

In micro cell environment, BS antenna may be at same height as surrounding objects. In this case the scattering spread of received signal at BS is greater than that of macro cell environment and delay spread is less due to smaller coverage area.

IV. Spatial Channel Model (SCM) Parameter Set

A. Antenna Parameter Set (ANTPARSET):

The angular spread model for spatial channel model has been defined for systems with 5MHz bandwidth and 2GHz center frequency.

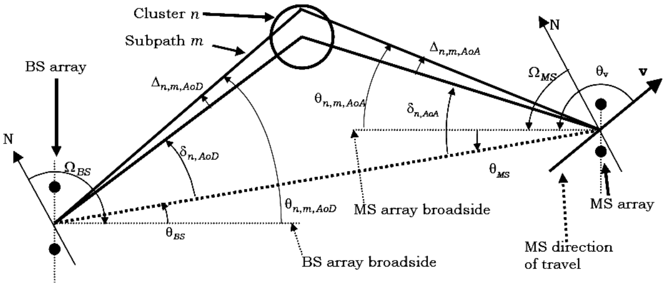

Figure 1 : Angular spread model of SCM

Each of the N received paths has M subpaths (cluster). In 3GPP SCM model, each resolvable path is characterized by its own spatial direct parameters: angular spread (AS), angle of departure (AoD), angle of arrival (AoA), and power azimuth spectrum (PAS). In practice, the cumulative distribution function (CDF) of outage capacity is often used [6]; it is defined as the threshold below which the structure capacity will be with a given outage probability *Pout*:

$$P_{out}(C_{th}) = \Pr[C \leq C_{th}]$$

where C_{th} is the threshold capacity and C is the capacity. It is clear that the smaller is the spatial association between antennas the larger is the system capacity. This is an input structure used to define various parameters. Main fields of this structure are defined in Table 1.

Table 1: SCM Parameter Set.

1. NumAPElements : Number of antenna array elements used in access point (AP)
2. NumUserElements: Number of antenna array elements used in user station.
3. Environment: Scenarios which could be, urban micro or urban macro.
4. Sample density Value: It states the number of samples per half wavelength. Also defined as sampling interval of channel. As the Doppler analysis is required so a value greater than one '1' i.e 3 in this case is selected.
5. APUrban-MacroAS: Average Angle Spread (Mean) of User: 80° and 150° are selected which are only possible values for Urban-macro environment.
6. No Paths: Total number of paths available which can be changeable according to scenario.
7. S paths per path: Total number of sub paths available in each path which are fixed to 20 as it is only value supported by Spatial Channel Model (SCM). Table 2 is given for the offset AoD/AoA for every sub path.
8. CF: Central frequency (2.0 GHz) which can affects the time sampling interval and path loss.
9. Chan-Options SCM channel Options which can be urban canyon, polarized, LOS or none. All of these are mutually exclusive options.

Table 2: S-path offsets of AoA and AoD.

S-path No.	**2o Angle Spread at AP (Urban-Macro cell)**	**5o Angle Spread at AP (Urban-Micro cell)**	**35o Angle Spread at User station**
1&2	0.0784	0.3012	1.4985
3 &4	0.3197	0.7573	5.1425
5 & 6	0.5013	1.1989	9.0190
7 & 8	0.8014	1.9147	12.8045
9 & 10	1.1348	2.6524	15.8562

B. Antenna Parameter Set (ANTPARSET):

This is also being used for defining the input antenna parameter configuration for MU-MIMO SCM. The identical behavior of antenna pattern is not necessary, it only supports the linear arrays in this case.. The main fields of the antenna parameter set(ANTPARSET) are given in Table 3.

Table 3: Antenna Parameter Set.

1. AP-G-Pattern This is an argument which defines Access Point gain pattern. All the elements have uniform and identical gain so the value is set to '1'.
2. AP-Azimuth- This input argument is a vector which contains the information of Azimuth angles for the field angles pattern values of Access Point (AP). Its value is set in the range of $-\pi$ (-180) to $+\pi$ (+180).
3. AP-Elem-Pos It defines the Access Point's position of linear antenna array in wavelength, 0.5 is selected as a uniform spacing between the elements.
4. User-G-Pattern This is an argument which defines User (Mobile station) gain pattern. All the elements

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have uniform and identical gain so the value is set to '1'.

5. User-Elem-Pos It defines the User's position of linear antenna array in wavelength, 0.5 is selected as a uniform spacing between the elements.
6. User-Azimuth- This input argument is a vector which contains the information of Azimuth angles for the field Angles pattern values of User. Its value is set in the range of –π (-180) to +π (+180).

C. *Link Parameter Set (LINKPARSET):*

This is also being used for defining the input Link parameter configuration for MU-MIMO SCM. Every parameter is a vector of length 'N', where N are the no. of links. The main fields of the antenna parameter set (LINKPARSET) is given in Table 4.

Table 4: Link Parameter Set.

1. AP-USER- This input argument is a vector which contains the information of the distance between User and AP, Distance as the users are uniformly distributed in a circular cell so every user is 35 to 500 m away from the AP.
2. ΘAP It contains the angle of arrival of the signals for AP in degree.
3. ΘUser It contains the angles of User in degree.
4. VUser Velocity of the user in meter/sec. (m/s)
5. User-Direct It contains the information of direction of the User with respect to Broadside of User antenna array.
6. User-Height Height of the user from the ground surface, it is set to 1.5m.
7. AP-Height Height of AP from the ground surface, it is set to 32m.
8. User-No It is a vector of 1….N, where N is the number of links available. It defines the number of users available in each simulation run.

V. Simulation Result

Lifetime MU-MIMO Spatial channel model has been used to indicate the angle of different users operating from different locations in addition to following:
Angle of Arrival of signal
Direction of movement of User. c. Distance between User and AP. The resultant output values calculated in the Link-parameter structure are as under:

1. User-AP Distance=498.5580m and 374.4319m all users.
2. Angles of Arrival = -40o and 40o
3. User-Direction = 104.8044o and 113.3827o all users

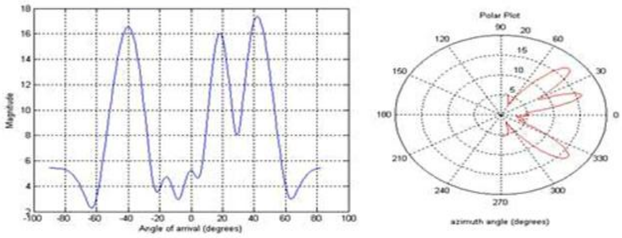

Figure 2:AoA of 3x Mobile Users.

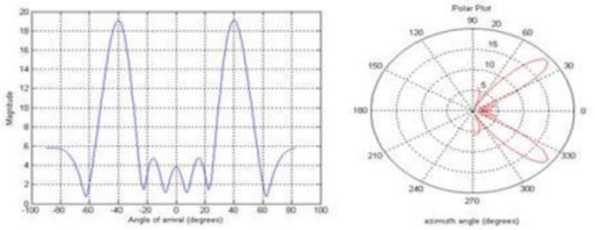

Figure 3:AoAs of 2x Mobile Users.

Complete simulation results of simulation are given in Table.

Input Parameters											Output Results								
	antenna elements		Scenarios			Option					AoAs (degrees)			MS-BS Distance (meters)			MS Direction (degrees)		
No of Users	BS	MS	S-urban macro	Urban macro	Urban-micro	LOS	None	Urban canyon	MS velocity	Cha-nnel samples/link	1	2	3	1	2	3	1	2	3
1	8	1	-	-	Y	Y	-	-	5	10	30	-	-	174.33	-	-	-157.3	-	-
2	8	1	-	Y	-	Y	-	-	5	10	-40	40	-	498	375	-	105.00	113.0	
3	8	1	-	-	Y	Y	-	-	5	10	-40	20	40	349	422	423	109.0	147.0	-96.0

VI. Conclusion

In this paper, a simulation environment for outdoor channel model for MU-MIMO was created in MATLAB. Three different scenarios were considered: urban, micro, and urban macro. Simulation results were obtained for these scenarios for input link, antenna, and SCM parameters. Simulation results demonstrate that user parameters – AoA, user direction and distance between user and AP - in a MU-MIMO system in an outdoor environment that may fall in any of above scenarios can be accurately extracted using the proposed adaptive algorithm.

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