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NEOTERIC MITIGATION SCHEME FOR PILOT CONTAMINATION IN TDD MASSIVE MIMO

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Abstract: A future generation wireless networks have rapidly grown that's demand more power efficiency and spectral efficiency. With This Demand In The Current Scenario, Massive MIMO Have Capable Technology. A Massive MIMO Can Support The Aerials in A Huge Quantity On Each Base Station. For Avoid Interference within & between the cells, All User Should Be Allocated With An Orthogonal Pilot Sequence. Practically Pilot Sequences Are Limited in Number and Therefore as the Number of Users Increases, It's Not Capable for Each User to Have a Different Pilot Sequence. So, The Same Pilot Sequences Are Reused In Different Cells Which Caused Inter-Cell Interference. This Phenomenon is known as 'Pilot Contamination". In This Work we have propose to mitigate pilot contamination by adjoining the soft pilot reuse and weighted graph coloring algorithm to get the maximum achievable rate in uplink massive MIMO system. Simulation results shows that proposed combine method is provide better achievable rate in uplink compare to existing soft pilot and weighted graph coloring pilot decontamination..

Keywords: *5G, Massive MIMO, Time Division Duplexing, Pilot Contamination, Soft Pilot Reuse*

I. INTRODUCTION

In Current Network, numerous Technologies were created to induce most knowledge Rates to achieve High Spectral efficiency, more Spectrums. New Technologies like Carrier Aggregation, MIMO and Heterogeneous Networks Are Features to satisfy overcome back Demand of grown Proficiency [1]. Thus Current Network situation is also troublesome to unravel of High data Traffic Demand in coming to Next Era of 5G.

MIMO (Multiple Input Multiple Output) allow to Transmit data Between Base Station and User Terminal. Single User MIMO Was utilized in LTE to urge Higher Spectral efficiency in both Time and Frequency - Division Multiplexing Mode. Later LTE Advance used multiuser MIMO system with most 8x8 MIMO that is best in offer a lot of Cell Coverage, dependability Then Single User MIMO [2]. However, With Growing Requirement of higher data Rate, a new advanced version of MIMO is required to boost Spectral efficiency In Current growing Time Technologies Comparable to internet of Things, Machine to Machine Communication.

Massive MIMO is Propitious Technology In On-Going plus up Coming Generation of Wireless Communication. Fig.1 mentions An Graphic of large MIMO, Where BS Connected through More Antennas. A Different Study Are Being been Carried out to Research Challenges and Limitations through. Analysis and Simulation.

When Massive MIMO are used with Time Division Duplexing. The utilization of Pilot Signal in Assessing Channel State Information in TDD approach Acquaint the difficulty of Pilot Contamination in a very large MIMO system. In Multi-Cell Systems, Pilots need to be Re-used To some extent from different Cell, that Contaminates Channel Estimations within the Home-based Cell with Channels From different Cells. This effect referred to as "Pilot Contamination". Author [13-15] has Shown That Pilot Contamination Can Reduce In large MIMO System. As An outcome, many strategies are anticipated to ease the result of Pilot Impurity In large MIMO.

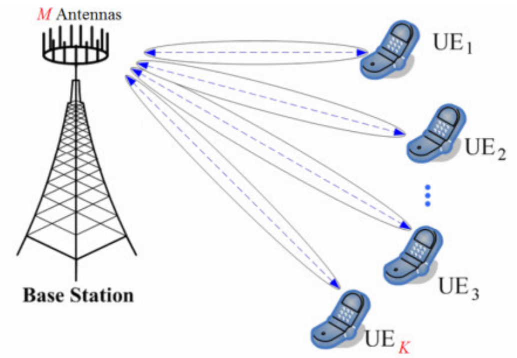

Figure 1: Massive MIMO System

II. UTILITY OF MULTICELL MIMO SYSTEM

Massive Multiple Input-Multiple Output Can aid In Various Prospects Which Is Given as Follow:

- Spectral Efficiency: the immense variety Of Provision Antennas In large MIMO & Multiplexing to several Users To individual User delivers the accumulated Ethereal Effectiveness [3].
- When Spatial Multiplexing Used, Capacity of Massive MIMO Increase 10 Times [4].
- Energy Efficiency: The High Antenna Arrays Are Help To Increased Energy Efficiency In Which Radiated Energy Can Be Concentrated On UE [3].
- Multiplexing Gain: Aggressive spatial Multiplexing utilized in huge MIMO Makes It in theory attainable to extend the capability 10 Times more.
- Improved strength & Consistency: an outsized variety Of Antennas permits more Multiplicity Gains That The Propagation Channel can provide. When The Number Of

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Antennas Increases Without Bound, Data Rate And Reliability Is Increased [5].

- Reduce Cost: Because of the Lessening in Energy utility, a huge antenna with array permits to be used Of inexpensive RF Amplifiers [5].

However, Some Limitations Have Been Identified Like Hardware Impairment and Pilot Contamination Problem [6]. Although Various Implementation Of Massive MIMO Make Like Pilot Sequence Design, Channel Estimation, Theoretical Limits In Massive MIMO.

III. TDD OR FDD SCHEME

TDD is more efficient than FDD because TDD requires estimation, which can be done in one direction and used in both directions; while FDD requires estimation and feedback for forward and reverse directions, respectively [10]. So we consider TDD Scheme in This paper to examine the sources of pilot contamination.

A TDD approach with Huge MIMO, the pilot signals that are wont to estimate the channels will be polluted as an outcome of the re-use of non-orthogonal pilot signals in multi-cell [9]. This development effects intrusion between inner cells that are proportional to the quantities of base station antennas, that successively reduces the achievable rates within the system and have an effect on the spectrum efficiency.

Some pilot Signal for CSI estimate is taken into account in [7], the lowest quantity of UL pilot ciphers adequate the quantity of UTs, while in [8], if data control and pilot are needed to be equal, an emblem the optimal number of a pilot is larger than numbers of aerials.

In the mainstream of studies administered on pilot contamination, it's presumed that the identical size of pilot signals is employed all expressed cells.

IV. PILOT CONTAMINATION

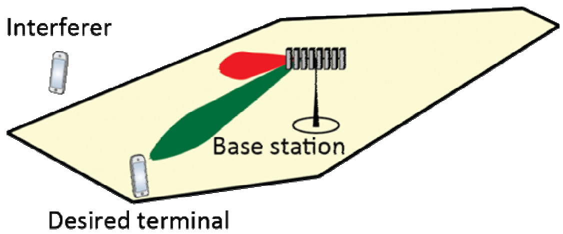

Figure 2: Pilot Contamination

Fig.2 Shows the Pilot-Contamination Scenario in Multi cell MIMO. In Multi-Cell Systems, Pilots Have to Be Reused to Some Degree from Cell to Cell, Which Contaminates Channel Approximations In intra Cell with Networks from Additional Cells. This Occurrence, defined as “Pilot Contamination”. It Does Not Remove Even When the Number of BS Antennas Increases. PC Decreases The Achievable Rates In Massive MIMO System.

In Practical Scenario, Massive MIMO Must Have Accurate CSI At Every BS By Channel Reciprocity Or Feedback Schemes. To Gain The Benefit Of Massive MIMO In Practice, Every BS Needs Perfect Estimation Of ‘Channel State Information (CSI)’, Either Through Feedback Or Channel Reciprocity Schemes [3].

(1) Source of Pilot Contamination

1) Non-Orthogonal Pilot Schemes: when the same frequency is communal thru entirely cells in a multicellular system, the intracell intrusion is reflected insignificant as the pilots remain assumed to be mutually orthogonal. The pilot signals are affected by inter-cell interference when the frequency reuse factor is used; leading to pilot contamination from end-to-end cell carried obsessed by the scheme. Every Base station associates its conventional pilot signals with its particular orthogonal pilot signals whereas all terminals within the different cells cause the pilot contamination. [11].

2) Hardware Impairment: Various Study has taken on the effect of Hardware Impairment. The hardware components in RF are prone to hardware deficiencies i.e. phase noise, quantization error, and amplifier non-linearity. Then after study of [12] shows how hardware deficiency indications to a gap among the generated signal and the intended transmitted signal. It disturbs the channel estimation correctness and it causes pilot contamination.

V. PROPOSED WORK

This Paper, an uplink Massive MIMO is considered with TDD scheme. The system includes Q cells. Every Base Station has each cell which is encumbered with N antennas give a facility to U (U << N) particular aerial user. In the base station of u^{th} cell is connected with user l^{th} of q^{th} cell via channel vector impulse response which can be elaborate as

$$h_{u,l,q} = W_{u,l,q}\sqrt{v_{u,l,q}} \qquad (1)$$

Where, $W_{u,l,q}$ shows the large-scale fading and $v_{u,l,q}$ define the small-scale fading factor individually. In the similar Base Station $v_{u,l,q}$ is equivalent amongst different aerials.

Base Station channel info may be no inheritable by pilot-aided Channel Estimation. But, first assets are restricted, the analogous set of orthogonal pilot orders with length l should be used once more which no such pilots use over in one explicit cell must be certain. Therefore, the existing Y (Y≥K) pilots’ matrix is $\omega = [\varpi_1, \varpi_2, ..., \varpi_y]$ whose column paths are extraneous to each other i.e. $\omega^H \omega = I$ .To indication the pilot assignment, $a_i \in \{1.., y\}$ variable is Presented to signify that $\varpi_{a_{uk}}$ pilot order are allocated to $l_{k,u}$ user, Then, $A = [a_{u,k}]$.

Hence, the uplink communiqué scheme can be shown as

$$X_u^N = \sqrt{\alpha_p}\sum_{y=1}^{Y} H_{u,q}\varpi + N \qquad (2)$$

Where the signal of pilot sequences received at the u^{th} BS, Channel Matrix expression under control of equation (1), the transmission power (α_p) and noise standard mention with N.

Because of the similar pilot the estimate, contains the pilot sequence of the former cells’ users, this termination approach as pilot contamination problem. Therefore, if a pilot batch matrix A is implicit, Signal Interference Noise

Ratio of $l_{k,u}$ is described as:

$$SINR = \frac{\left\| h^H_{<q,l>,q} \right\|^4}{\sum_{<q',l'>\in\Gamma<q,l>} \left\| h^H_{<q,l>,q} \right\|^4 + \tau^2_{<q,l>} / \beta^2} \approx \frac{v^2_{<q,l>,q}}{\sum_{<q',l'>\in\Gamma<q,l>} v^2_{<q,l>,q}} \quad (3)$$

Here, $<q',l'>\Gamma<q,l>$ signifies the users in different cells using the similar pilot as $U_{l,u}$, $\tau^2_{<q,l>}$ represents the noise and intrusion, & $\sum_{<q',l'>\in\Gamma<q,l>} v^2_{<q,l>,q}$ symbolize as pilot contamination. So the correlated typical achievable rate R of $U_{l,u}$ is expressed by:

$$R = (1 - \partial_0) E \log_2 (1 + SINR) \quad (4)$$

Where ∂0 indicate loss of spectral efficiency in fraction through allotted channel estimation.
our goal is to maximize the entire communication rate R. So, the optimal issue G1 stands

$$\max_{a_{k,q}} \left\{ \sum < q,l > \log_2^{(1+SINR)} \right\} \quad (5)$$

Fortunately, G1 can be rewritten as P2 approximately

$$\max_{a_{k,q}} \left\{ \sum < q,l > \log_2^{\left(1+\frac{v^2_{<q,k>,q}}{\sum_{<q',k'>\in\Gamma<q,k>} v^2_{<q,k>,q}}\right)} \right\} \quad (6)$$

If Achievable rate is high then Signal Interference noise ratio is also high so performance of cell will increase due to reduction of pilot contamination.

Let's u^{th} cell have total k_u user which is split in two groups: cell center users and cell edge users based on $v_{u,l,q}$ constant, it is given as:

$$v^2_{q,u,l} \overset{?}{>} o_i \rightarrow \begin{cases} Yes \rightarrow center\ users, \\ No \ \rightarrow edge\ users. \end{cases} \quad (7)$$

And here o_i value represented the threshold which is formulated as:

$$o_i = \frac{\theta}{l} \sum_{l=1}^{l} \gamma^2_{q,u,l} \quad (8)$$

Where θ is modifiable rendering to the existent configuration. So, a modest illustration of the separation is show in Figure 3.

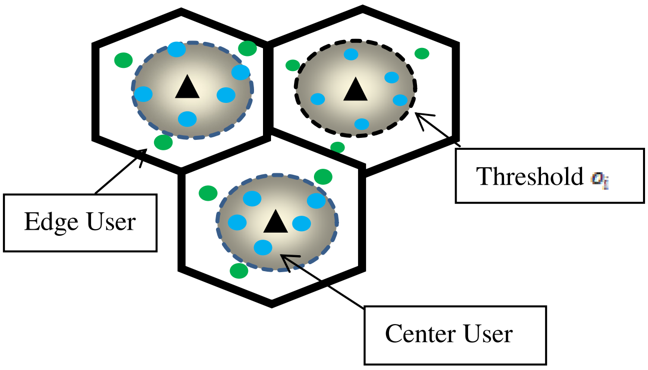

Figure 3: An illustration of the users' division

Hence, we tend to acquaint with the SPR-edge during which the entire orthogonal pilot source sets are torn apart into two subgroups, which is cell edge and cell center users individually. Also, in all cell, cell center user is reused in step with (7),

$$J_u = J_{u,c} + J_{u,e} \quad (9)$$

Where in the u^{th} cell, shows the quantity of cell center user & elaborate user of cell edge. Describe $J_{CS} = \max\{J_q, q = 1,2,...,L\}$ and $J_{ed} = \sum_{q=1}^{L} J_{q,e}$. Consequently, in this strategic method, the overall quantity of the required orthogonal pilot sequences is

$$J_{all} = J_{ct} + J_{ed} \quad (10)$$

Then the available ϖ can be assigned as

$$\varpi_{all} = [\varpi^T_{ct} \varpi^T_{ed}]^T \quad (11)$$

Here ϖ^T_{ct} show pilots of cell center and ϖ^T_{ed} describe cell edge user. Also ϖ_{ed} will be separated in K division. Consistent to user of edge "$J_{u,e}$".so cell edge user have assurance with pilots of it's orthogonal to each other hence the standard of communication will increase expressively. Therefore pilot contamination problems in the cell edge area are removed due to the orthogonal nature of pilots. Now in the cell center area, the intrusions will occur due to use same pilots so we initially evaluate the strength of pilot contamination of some two users by $\zeta_{<q,l><q',l'>}$ variable.it is given as:

$$\zeta_{<q,l><q',l'>} = \frac{v^2_{<q',l'>q}}{v^2_{<q,l>q}} + \frac{v^2_{<q,l>q}}{v^2_{<q',l'>q}} \quad (12)$$

When the same pilot uses again then Pilot contamination problem become more consequential when the value of is greater.so in mathematics, this MIMO intrusion can be interpreted as graph theory problem: WG=(C, P), here C show all users present in cell and p determine the effect of pilot contamination in the cell.in this method we only apply on cell center side to the reduction of pilot effluence so-called WGC-center PD.it is based on the greedy algorithm which chooses cell users with having minimum pilot effluence.so proposed algorithm as mention as below :

Input : Parameters : $L, Q,$ and E
WG=(C,P)
Output : Pilot Allocation: $\{a_{q,l}\}$
$1 \leq q \leq Q, 1 \leq l \leq L$

Initialization:
1: $\{q_1, l_1, q_2, l_2\} = arg\ max_{\{q,l,l',q \neq q'\}} \tau_{<q,l><q'l'>}$
2: $\{a_{q,l}\} = 0, a_{q_1,l_1} = 1, a_{q_2 l_2} = 2$
3: $\Psi = \{< q_1, l_1 >, < q_2, l_2 >\}$
While $\exists a_{q,l} = 0$ do:
4: $\varsigma_{j,k} = \Sigma_{\{q',l'\} \epsilon \Psi j \neq j'} \tau_{<q,l><q',l'>}$
5: $< q_0 l_0 >= arg\ max_{<q',l'>} \{\varsigma_{q,l} : \{q,l\} \in \Psi\}$
6: $Y = \{q : \forall l, a_{q_0,l} \neq q, 1 \leq q \leq Q\}$
7: $n_q = \Sigma_{\{q,l\} \epsilon a_{q,l} = s} \zeta_{<q_0 l_0><q,l>}$
8: $a_{q_0 l_0} = \arg\ min_q \{n_q : q \in Y\}$
9: $\Psi = \Psi \cup \{(q_0 l_0)\}$

End and return $\{a_{q,l}\}$

As stating of step 1 shows the any two users with highest weight are designated &step 2 show selected users. It is unite into set Ψ as show in step 3.this loop of allocating pilot with further user carried out till $\forall a_{q,l} \neq 0$.

Now in step 4 $\varsigma_{j,k}$ are user selection parameters which show the addition of weighted edge linking $u_{l,q}$ through other cell. In step 5 a user will selected with maximum pilot contamination which is not belonging to set Ψ.

Step 6 mention available pilot set Y which indicate available resources without reuse of pilots within same cell.in step 7, n_q show potential Pilot Contamination strength among the users with pilots in Ψ and the user & step 8 show which select minimum pilot contamination user. And this is add in pilot set Ψ as mention in step 9 and finally, return $\{a_{q,l}\}$ at the end of the loop.
By joining two significant schemes a serious problem of pilot contamination will be overcome which is supported with our next chapter of simulation results.

VI. SIMULATION RESULTS

In our simulation result, we analysis the performance of the soft pilot reuse, weighted graph and soft-edge and WGC-center PD via Monte Caro Algorithm. The performance parameter is given below:

Name	**Value**
Number of users in one cell	10
Number of cells	19
Radius of cell	1000 m
The threshold parameter θ	0.05≤θ≤1 0.1 if fixed
Transmission power	30 dB

Table 1: Simulation Parameter

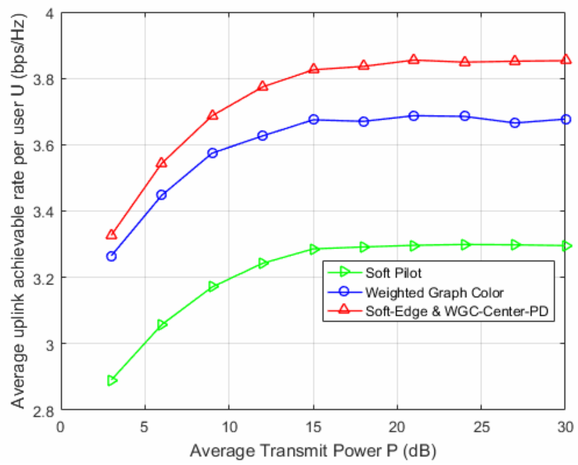

Figure 4: Average Achievable Rate U against Number of Antennas for Different Methods

In figure shows simulation analysis of Typical Achievable Degree U vs. P of Various Method. When numbers of antenna have minimum then the performance will be degraded but if we increase the number of antenna we get fast result. Our proposed method shows very fast response with compare to other two methods which we can see in the graph with Red line.

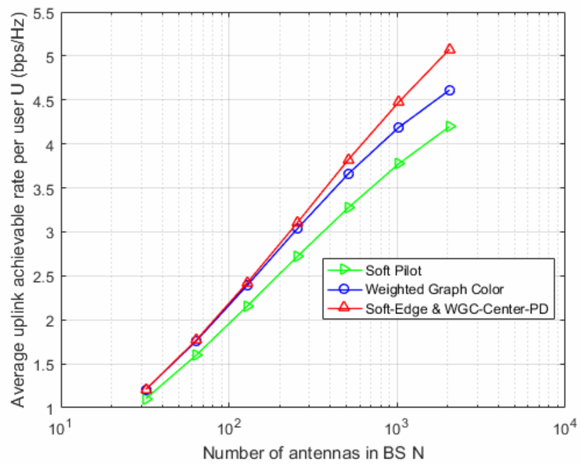

Figure 5. Typical Achievable Rate U vs. P of Various Methods

In figure shows that the average transmits power verses Achievable Rate per user U. All method can improve with the value of U when p increases so of course, our method shows better result compare to other methods.

VII. CONCLUSION

We derive effective Neoteric Mitigation Scheme of Pilot Decontamination in TDD Massive MIMO. With Proposed Effective Approach Pilot Contamination Problem Is Solved by Combination of Soft Pilot and Weighted Graph pilot decontamination Scheme For large MIMO Systems. By Using Softer Pilot Reuse Pilot Decontamination Method We Can Reduce The Pilot Contamination In Cell Edge Area. However Some Of Pilot Contamination Still Present In The Cell Center.by Applying Weighted Graph Algorithm On Cell Center Area We Mitigate Pilot Contamination Problem and Combination of soft edge and WGC center based pilot decontamination method gives better performance than individual soft PD and WGC PD.

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