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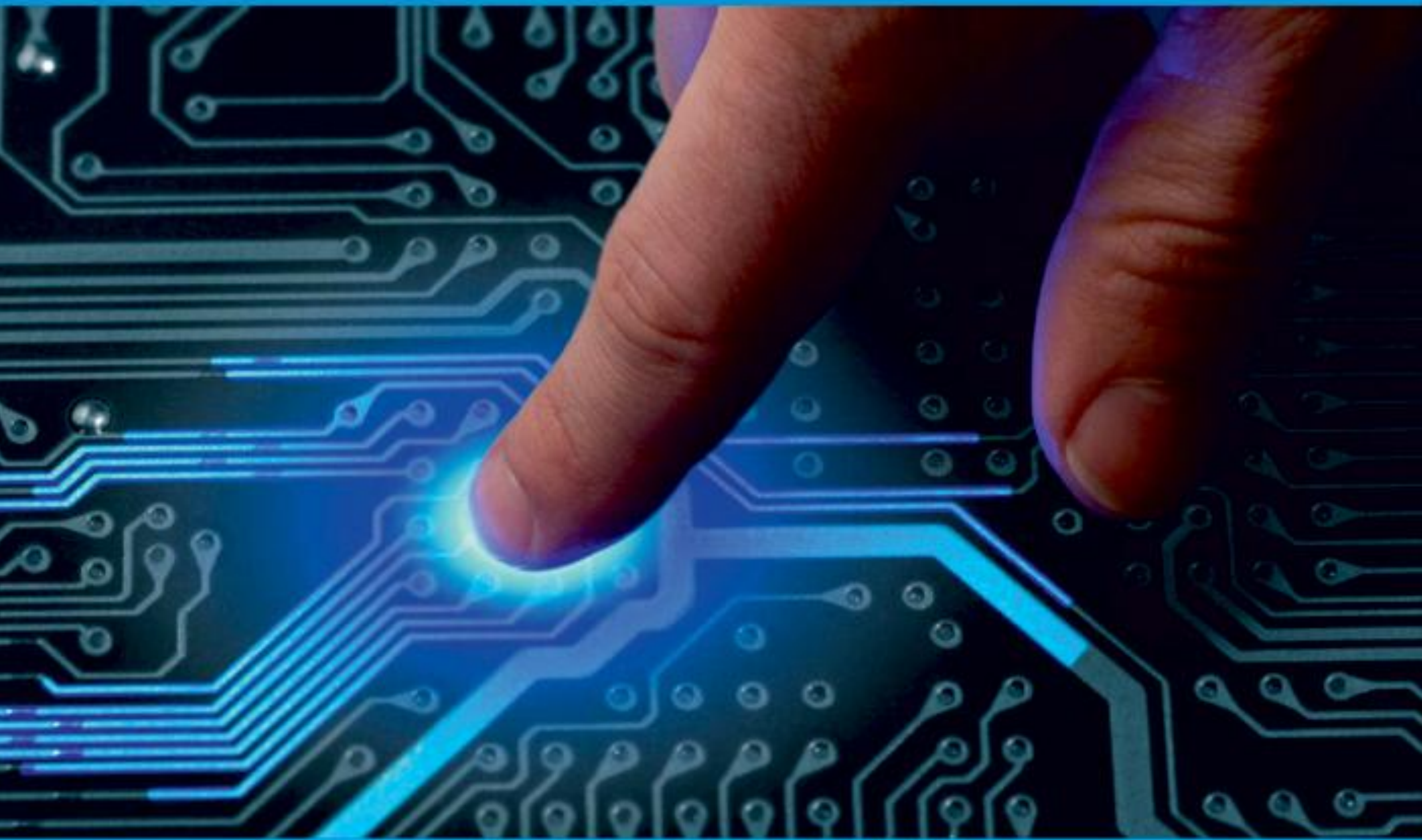

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High Speed Railway Communication Using Moving Relay in 5G

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ABSTRACT: The dramatic growth of railway mobile communication driven by wireless internet and smart devices has triggered the investigation of fifth generation (5G), for the next generation of terrestrial mobile telecommunications. Facing great challenges of future mobile network, the essential requirements for 5G which is mainly include higher traffic volume, energy, cost efficiency and signal strength are pointed out. Even in 5G the data rate is poor when we are travelling in train. which is due to lack of signal strength, to improve this the parameters that we have capacitor Vs average UE throughput, comparision of co-operative and non co-operative massive MIMO for relays of 1,2&4 with antennas of 15,25&50 respectively . Thus results fast communication occurs in high speed railways where co-operative MIMO has higher signal strength for 4 relay with 50 antenna compared to non co-operative MIMO

KEYWORDS: 5G Network ; High Speed Railway(HSR) ; mobile communication ; relay communication ; Long Term Evolution (LTE).

I.INTRODUCTION

High speed railway is playing an important role in mass transportation all over the world. The development of high speed railways makes it more convenient for people's lives and works. Meanwhile, it puts forward various higher requirements on services of high mobility (i.e. above 300km/h) users. On the one hand, information of the train operation, the system state monitoring need real-time transmission to the control center, as a real-time dynamic information transmission feature of the railway network. On the other hand, with the development of social informatization, people need to stay connected to the network (especially the Internet) through a variety of communication terminals. Nowadays, wireless communication has a wide range application in high speed rails. Wireless access networks like satellite, GSM/GPRS, 802.11, and special wireless access networks are being used for train operation and passenger application. However, these access methods cannot meet the current or future requirements through the development of railways and communications, i.e. the high mobility, high data rate, real-time, and more reliability. Many new wireless access technologies such as WCDMA, WiMAX, and LTE, etc. have emerged. Each method has its own features with higher Quality of Service (QoS). However, they are not vastly applied in the railway communications. These new access networks are under research and field test for applying to high speed train (HST) communications. However, which wireless method is the best suitable one for the high speed rails? Evaluations of these methods should be provided. Since the distribution nature of the high speed railway, the wireless access network for it also has the distribution feature, i.e. it covers the whole railway through a lot of cells. Therefore, the construction of distributive communication system is a huge project

a. Aim of the Project

It aims at demonstrating that CM-MIMO can improve the system performance of cell edge users significantly even if the cell average performance is very slightly degraded or maintanence caused by the power imbalance of received signal from different cooperative neighbouring cells.

Comparing the performance of cooperative massive MIMO and non-cooperative massive MIMO system performance is compared under the uniform framework of the LTE TDD system. Here MF precoding is adopted for comparison

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owing to the benefit of low complexity of MF precoding and also in order to reduce the impact on the backhaul since no channel state information needs to be exchanged among base stations.

b. Motivation for the project

These past years, data traffic (both mobile and fixed) has grown exponentially due to the dramatic growth of smartphones, tablets, laptops, and many other wireless data consuming devices. The demand for wireless data traffic will be even more in future. Global mobile data traffic is expected to be 77.49 exa bytes per month by 2022, which is about a 7-fold increase over 2017. In addition, the number of mobile devices and connections are expected to grow to 17.72 billion by 2024. New technologies are required to meet this demand. Related to wireless data traffic, the key parameter to consider is wireless throughput (bits/s) which is defined as: Throughput = Bandwidth (Hz) × Spectral efficiency(bits/s/Hz).Clearly, to improve the throughput, some new technologies which can increase the bandwidth or the spectral efficiency or both should be exploited.

c. Technical Approach

In CM-MIMO, user data as well as CSI (channel state information) is shared among base stations that will provide more degrees of freedom for communication. Also, precoding can take into account inter-cell interference and thus mitigate inter-cell interference, which is especially critical for cell edge users that typically suffer more inter-cell interference. Furthermore, CM-MIMO, where multiple base stations coordinate through the backhaul network, the bandwidth of the backhaul link and delay may create additional impairments on the system performance.

II. EXISTING METHODOLOGY

We investigated the performance of OFDMA systems under realistic conditions.The throughput increment happens between the carriers allocation retrieving form the receiver side systems.A transceiver structure is proposed to reduce the interference between transmitting subcarriers and receiving subcarriers.

a . MIMO System

MIMO is the use of multiple antennas at both the transmitter and receiver to improve communication performance.In wireless communication the propagation channel is characterized by multipath propagation due to scattering on different obstacle. MIMO exploits the space dimension to improve wireless systems capacity, range and reliability.

b . MIMO Channel model

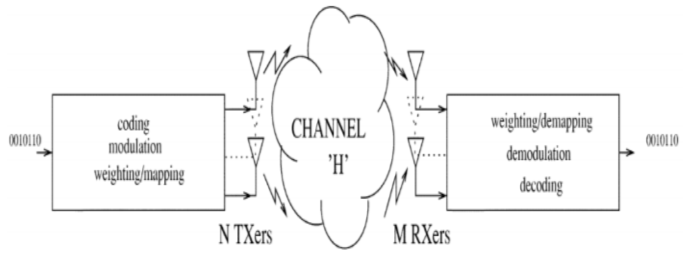

Fig 1 : MIMO wireless transmission system

The transmitter and receiver are equipped with multiple antenna elements. The transmit stream go through a matrix channel which consists of multiple receive antennas at the receiver. Then the receiver gets the received signal vectors by the multiple receive antennas and decodes the received signal vectors into the original information.

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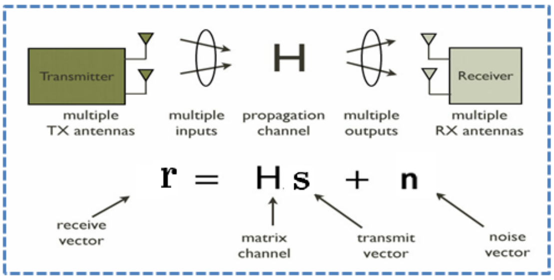

Fig 2 :MIMO system model

There are detail explains for denoted symbols:

- r is the Mx1 received signal vector as there are M antennas in receiver.
- H represented channel matrix
- s is the Nx1 transmitted signal vector as there are N antennas in transmitter
- n is the Mx1 vector of additive noise term

III . PROPOSED METHODOLOGIES

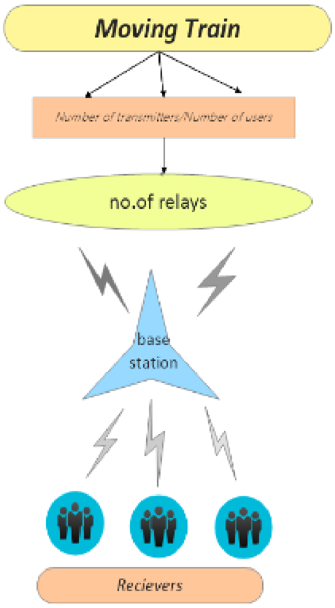

Fig 3 :block diagram for high speed railway communication using relay

Fig 3, shows the flow diagram of the propose system, the UE of the passengers in the high speed train are connected to the base station via relays and the base station transmits the signal to the receivers, in this paper we propose a 4 relay system which yields better output in 5G communication. From the base station the signal passes to the receivers. The user can establish a direct communication link to the base station without relay which leads to decrease in signal strength thereby leading to loss of signal. Relays receive and retransmit the signals between base stations and mobiles can be used to increase throughput extend coverage of cellular networks. In the proposed model the use of relay overcomes those issues.

Amplify-and-forward (AF),Here the relay simply amplifies its received signals and then forwards them to the destination.the relay receives a noisy version of the signal transmitted by the source and then amplifies its received signal and re-transmits it to the destination.**Decode-and-forward (DF),**Here the relay decodes the received signals and then forwards the re-encoded information to the destination. the relay decodes the noisy version of the signal transmitted by the source and then re-encodes and re-transmits to the destination.

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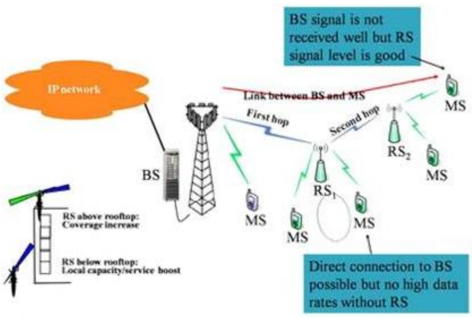
a .Relay Communication

Fig 4.: Relay Communication

Relays that receive and retransmit the signals between base stations and mobiles can be used to increase throughput



extend coverage of cellular networks. Infrastructure relays do not need wired connection to network thereby offering savings in operators' backhaul costs. Mobile relays can be used to build local area networks between mobile users under the umbrella of the wide area cellular networks

IV .SYSTEM LEVEL SIMULATION

The system level simulation is run using Matlab. The system simulation configuration is partly based upon LTE macro-cell system simulation baseline parameters .For system level simulation let us assume that seven omni-directional sites are simulated with 10 single-antenna UEs in each site equipped with 15, 25, and 50 transmit antennas with ULA (Uniform Linear Array) configurations respectively. The path loss model of 3GPP 36.942 urban model is used. The TDD duplex mode is assumed, where the downlink channel matrix can be obtained through TDD channel reciprocity from the uplink channel matrix. A system bandwidth of 20 MHz and all-user full bandwidth scheduling are used, which means all 10 users in each cell are scheduled at the same time to the full bandwidth. In the simulation, for simplification of illustration, we assume that all the system bandwidth is available for downlink data transmission in each sub-frame. The net system throughput for a specific TDD uplink-downlink configuration can be easily derived. In the simulation downlink MF precoding is utilized.

Table 1.Throughput Comparison table

Cases		5 % User Throughput (Mbps)	Cell average Throughput (Mbps)
15 Antennas	Non-cooperative	5.3	86.3
	Cooperative	8.2	77.1
25 Antennas	Non-cooperative	7.1	123.0
	Cooperative	9	112.2
50 Antennas	Non-cooperative	9.5	175.6
	Cooperative	12	175.9

The above three cases demonstrate that the cooperative massive MIMO can significantly improve cell edge users' system performance, whereas the cell average system performance is slightly degraded or maintained.

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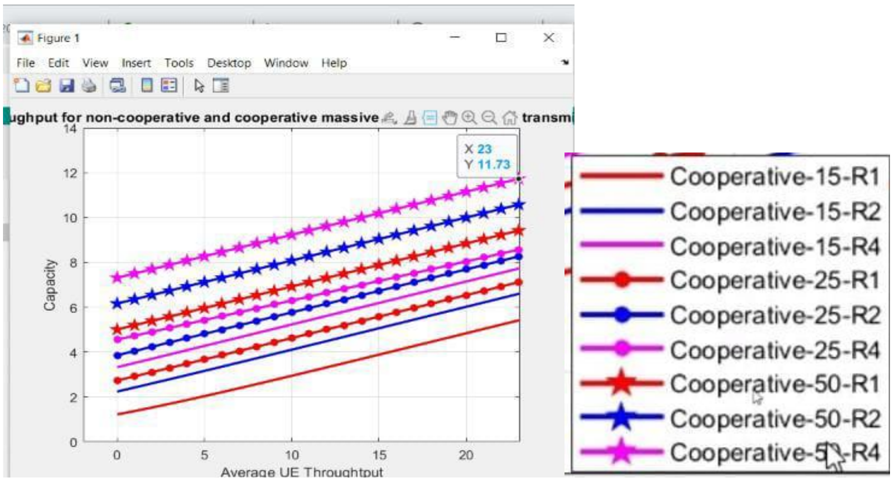

Fig 5: Comparision in terms of capacity in all 3 cases

In the Fig 5 ,the X- axis represents the average UE throughput and Y- axis represents the capacity. R1,R2,R4 represent the number of relays used that is 1,2 and 4 respectively.

Table 2 .Comparison table

No. of Antennas	No. of Relay	Throughput X axis	Capacity Y	Signal Strength
15	1	25	5.799	144.9
15	2	25	6.98	174.5
15	4	25	8.108	202.7
25	1	25	7.5	187.5
25	2	25	8.648	216.2
25	4	25	8.915	222.8
50	1	25	9.801	245.02
50	2	25	10.96	272.5
50	4	25	12.11	302.7

As we analyse the above table when the number of antennas are 15, number of relay used 1 the throughput achieved is 25 with capacity 5.799 and less signal strength of 144.5.Without changing the number of antennas by increasing the number of relays to 2 and 4, the throughput remains constant but the capacity increases to 6.98 and 174.5 and the signal strength increases to 174.5 and 202.7 respectively.When the number of antennas are 25, number of relay used 1 the throughput achieved is 25 with capacity 7.5 and signal strength of 187.5.Without changing the number of antennas by increasing the number of relays to 2 and 4, the throughput remains constant but the capacity increases to 8.648 and 8.915 and the signal strength increases to 174.5 and 202.7 respectively. From the two analysis we can observe that the number of antennas and relay plays a major role in increasing the signal strength. When the number of antennas is increased to 50, number of relay used 1 the throughput achieved is 25 with capacity 9.801 and signal strength of 245.02.Thus when we increase the number of relays, significantly the signal strength increases. Without changing the number of antennas by increasing the number of relays to 2 and 4, the throughput remains constant but the capacity increases to 10.96 and 12.11 and the signal strength increases to 272.5 and 302.7 respectively. From the table 1, we can conclude that when number of antennas and relays are increased the throughput remains constant but the capacity and signal strength increases.

IV .CONCLUSION AND FUTURE WORK

The requirements of critical communications are very strict, and currently can only be fulfilled by standard GSM-R technology and dedicated systems, but going towards the future, 5G technology will be a valid alternative to replace GSM-R for most critical services. In fact, 5G will fulfil most of the present and future requirements of railway services

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with high reliability and availability. Further, the techniques for improving capacity, coverage and diversity techniques are being experimented and open research areas are using more relays for forwarding the signal to destination in a given cell and hence the requirement of an efficient routing algorithm, power allocation algorithms and scheduling algorithms are being researched.

Thus the in-depth view of the co-operative communication technology using relays for 5G cellular networks was discussed. Particularly, how the utilization of cooperative massive MIMO with relay significantly improves cell edge users' system performance has been delineated. The current issues and challenges in the previous works were considered. The effect of cooperative and non-cooperative communication for multi-tier heterogeneous network is investigated. The cooperative communication is possible with the help of MR by using the concept of group mobility. Finally from this we executed strong signal strength for high speed coomunication with the help of 4 relays with 50 antennas in cooperative communication.

REFERENCES

1. T. L. Marzetta, "Non-cooperative Cellular Wireless with Unlimited Numbers of Base Station Antennas," IEEE Transactions on Wireless Communications, vol. 9, no. 11, pp. 3590–3600, Nov. 2010.
2. F. Rusek, D. Persson, BuonKiong Lau, E. G. Larsson, T. L. Marzetta, and F. Tufvesson, "Scaling Up MIMO: Opportunities and Challenges with Very Large Arrays," IEEE Signal Processing Magazine, vol. 30, no. 1, pp. 40–60, Jan. 2013.
3. Hien Quoc Ngo, E. G. Larsson, and T. L. Marzetta, "Energy and Spectral Efficiency of Very Large Multiuser MIMO Systems," IEEE Transactions on Communications, vol. 61, no. 4, pp. 1436–1449, Apr.2013.
4. C. He and R. D. Gitlin, "Limiting Performance of Massive MIMO Downlink Cellular Systems," in Information Theory and Applications Workshop (ITA), Feb. 2016.
5. R. W. Heath, T. Wu, Y. H. Kwon, and A. C. K. Soong, "Multiuser MIMO in Distributed Antenna Systems With Out-of-Cell Interference," IEEE Transactions on Signal Processing, vol. 59, no. 10, pp. 4885–4899, Oct. 2011.
6. R. Zakhour and S. V. Hanly, "Base Station Cooperation on the Downlink: Large System Analysis," IEEE Transactions on Information Theory, vol. 58, no. 4, pp. 2079–2106, Apr. 2012.
7. A.M. Tulino and S. Verdu, Random Matrix Theory and Wireless Communications. Hanover, MA: Now Publishers Inc, 2004.
8. J. C. Ikuno, M. Wrulich, and M. Rupp, "System Level Simulation of LTE Networks," 2010, pp. 1–5.
9. 3GPP, "TS 25.814 - V7.1.0 - Physical layer aspects for evolved Universal Terrestrial Radio Access (UTRA)."
10. 3GPP, "TS 36.942 - V12.0.0 - LTE; Evolved Universal Terrestrial Radio Access (E-UTRA); Radio Frequency (RF) system scenarios."
11. 3GPP, "TS 36.211 - V12.0.0 - Evolved Universal Terrestrial Radio Access (E-UTRA); Physical channels and modulation."

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