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Femtocell Stationed Flawless Handover In High Agility Trains

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***Abstract*—The development of high-speed railway makes people's lives more and more convenient; meanwhile, handover is the major problem on high-speed railway communication services. In order to overcome that drawback the architecture of Long-Term Evolution (LTE) femtocell networks is used to improve network performance, and the deployment of a femtocell is a key for bandwidth limitation and coverage issues in conventional mobile network system. To increase the handover performance this paper proposed a multiple input multiple output (MIMO) assisted handoff (MAHO) algorithm. It is a technique used in mobile telecom to transfer a mobile phone to a new radio channel with stronger signal strength and improved channel quality.**

Keywords— High-speed train, Home evolved Node B, LTE, Mobile Femtocell, RSSI, Flawless handover.

I. INTRODUCTION

Due to the lower energy consumption, less environmental pollution, larger transmission capacity, economical and higher safety, high-speed railway has been playing an important role in mass transportation. In the last 25-30 years, wireless communications have become an essential part of people's lives all over the globe. The development of high-speed railway makes people's lives more and more convenient. Meanwhile, handover is the major problem on high-speed railway communication services. Moreover, new challenges in train-to-ground communication with high mobility cause some problems i.e frequent handover, long handover latency and poor quality of service. Rapid changing of radio channel and over-frequent handovers make mobile communication access much more difficult. Therefore, it has practical significance to design fast and smooth handover mechanisms which have high speed adaptively. In order to provide reliable communication service in high-speed train, the several handover scheme is introduced.

When a train moves along the track, its mobile station (MS) would need to switch from one AP to the next frequently to guarantee continuous data transmissions between the train and roadside devices, since the coverage of each AP is quite limited[1].In general during basically a small cellular base station, which is mostly used in a home or small business. It is designed to improve indoor coverage of 3G and future mobile communication systems. The range of a micro cell is less than two kilometers wide, a picocell is 200 meters or less, andafemtocell is on the order of 10 meters. A femtocell generally connects to the service providers network through a broadbandsuch as DSL or CABLE. A femtocells job is that it allows the service providers to extend the service coverage indoors, especially in the areas where the access is almost negligible or where the access is limited or unavailable. Not only it increases coverage capacity but also it provides better voice quality and battery life. The concept of Mobile Femtocell is motivated by the concepts of mobile relays and Femtocell technology. It is a small cell which can move around and dynamically change its connection to the operator's core network. It adopts LTE's standard radio interface to communicate with the serving base station (eNodB) and the group of users that are served by that particular MFemtocell. A MFemtocell and its associated users are all viewed as a single unit to the eNodB. From a user point of view, a MFemtocell can be seen as Home eNodB. Home eNodB is the base station that used inside building, commercially known as Femtocell, and from here the name Mobile Femtocell is suggested. The Mobile Femtocells can be deployed on vehicles such as public transport buses, trains and even private cares[2].When a mobile user moves from coverage area of one Base Station to the coverage area of another while engaging in active call then the transfer of call from one Base Station to the other or from one channel to other is known as Handover. Handover procedure is classified into following categories depending on the network structure soft handover and hard handover .If the handoff is between two Base Stations which operates on different channel sets then the handoff is called Hard handoff. It is the handoff procedure primary in GSM network but also occurs in CDMA network. If the handoff is between two base stations but operating channel of the call remains the same then this type of handoff is called soft handoff. In this type of Handoff, only the Mobile Base station handling the call changes but the operating channel remains same. This type of handover is found in CDMA network. Several factors are considered before initiating handoff procedure viz. signal strength, velocity of the user, interference, type of radio network. These handoff can be done efficiently by using MIMO assisted handover.

The remainder of this paper is organized as follows. Section I, contains Introduction, Section II , provides a review of related works on network mobility design and multiple egress network interfaces. In Section III, we describe the operations of the proposed scheme. In Section IV, we discussed about Performance analysis. Section VI , contains some conclusion and future works.

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II. Related Work

A. Multiple Egress Network Interfaces

Multiple egress network interfaces improve the link quality and handover performance of mobile devices in vehicles. For example, the Mobile Access Router (MAR) infrastructure integrates multiple wireless access technologies and exploits network diversity to provide a high quality communication channel for MNNs. However, a single egress network interface for each wireless access technology is still not sufficiently robust or reliable. The equivalent egress network interfaces use to share the communication load and perform handovers cooperatively. The System/Core Network Architecture is shown in Fig. 1, an enhanced femtocell base station (enhanced HeNB) is deployed on a train to serve the user equipment (UE) on the train. The Mobility Management Entity (MME) and the Serving Gateway (S-GW) handle the UE's mobility events and packet forwarding.[4],[5].

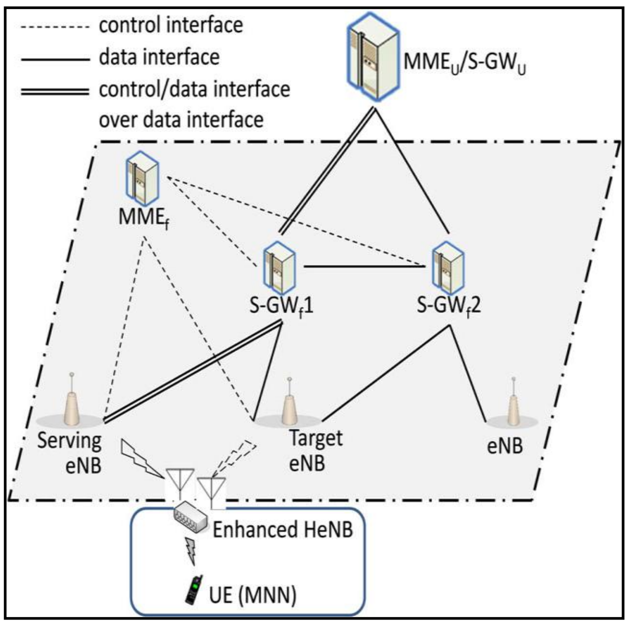

Fig.1. The MEM-NEMO architecture.

Under the LTE standard, a HeNB connects to the operators core network via a public network over a secure IP-based connection. configures the egress interface(s) of the enhanced HeNB to communicate with the MME*U* and S-GW*U* via the IP connection in an LTE wireless access network. In other words, the enhanced HeNB's acts as a UE that connects to the serving eNB and is served by the MME*f* and the S-GW*f* 1.Then forwarded from the MME*U*/S-GW*U* to the enhanced HeNB via the S-GW*f* 1 and the serving eNB.

B. Seamless Handover Procedure

The design of the seamless MME/S-GW handover procedure of MEN-NEMO is based on the 3GPP network. Here the movement trajectory of the train is fixed in high speed rail environment. The enhanced HeNB periodically sends a measurement Report to the serving eNB. The report contains signaling information, such as the received signal strength indication (RSSI) of the head antenna for handover decisions. The serving eNB prepares to perform the handover procedure. when it receives the RSSI report of the target eNB from the head antenna. Based on the information in the Measurement Report and Radio Resource Management (RRM), the serving eNB makes decisions about handoff to the enhanced HeNB. The serving eNB issues a Handover Request with the necessary information to prepare for handover to the target eNB, and Admission Control is used to increase the likelihood of a successful handover. The target eNB replies to the serving eNB with a Handover Request Acknowledgement message to confirm the handover. The serving eNB sends an Radio Resource Control (RRC) Connection Reconfiguration to the enhanced HeNB. The message contains the channel access parameters that can be used to attach to the target eNB. When the enhanced HeNB receives the RRC Connection Reconfiguration, it synchronizes with the target eNB and uses the head antenna to access the target cell. After the head antenna is attached to the target eNB, the enhanced HeNB forwards uplink traffic to the target eNB via the head antenna. Meanwhile, the serving eNB continues sending packets to the enhanced HeNB via the tail antenna, and the SN Status Transfer is cancelled[7].

C. Discussion of Handover Failure

The tail antenna will handle the handover failure of the head antenna situation. Generally head antenna reapeatedly performs handover procedure until it become successful. At this time, the tail antenna still connects to the serving eNB. In high traffic , the tail antenna takes over the handover procedure of the head antenna, when the tail antenna will handle the coverage of the serving eNB and the head antenna still cannot connect to the target eNB. But also some of drawback occur they are as follows signal loss, data rate, hand over latency, less security[1].

III. Objectives & Overview Of The Proposed Scheme

A. Objectives

Next, we present the system architecture of MAHO Technique for high-speed trains. It is based on LTE femtocell technology with MAHO interfaces. We Solved the handover latency, interference problem. This is main problem in the previous work LTE femtocell technology using MEN-NEMO. We used the MAHO technique for reducing the handover delay and MIMO technique for reducing the interference. In this paper, we focus on the seamless handover procedure between the serving eNB and the target eNB.

B. Process Flow

Handover procedure for the proposed architecture as follows,

1) During the usage of high-quality telecommunication and Internet access services on high-speed trains the transmission signal which produces is connected to the nearest femtocell access point.

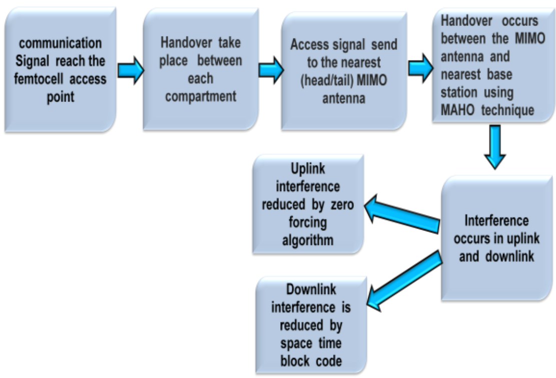

Fig .2. Process Flow

2) During the usage of high-quality telecommunication and Internet access services on high-speed trains the transmission signal which produces is connected to the nearest femtocell access point.
3) The handover which takes place between the each compartment of the train at that time, transmission signal produces in particular compartment passes to the nearest femtocell access point in that compartment.
3) The access signal from each femtocell access point is connected with Enhanced HeNB (home evolved nodeB).It is connected between the head and tail MIMO antenna which is placed at the engine and the end compartment of the train.
4) During this transmission of the signal from MIMO antenna to the nearest base station ISI (Inter Symbol Interference) occur this can be cancelled using Zero forcing algorithm for uplink.

C. The System/Core Network Architecture

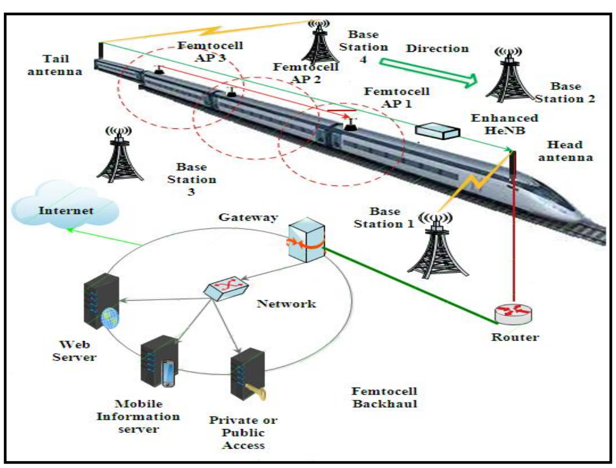

Fig .3.The Proposed System Architecture

D. Multiple Input Multiple Output

It is an antenna technology for wireless communications in which multiple antennas are used at both the source (transmitter) and the destination (receiver). The antennas at each end of the communications circuit are combined to minimize errors and optimize data speed. The main function of MIMO is precoding, spatial multiplexing, diversity coding. MIMO has become an essential element of wireless communication standards including IEEE802.11n (WiFi), IEEE802.11ac (WiFi), HSPA+ (3G), Wi MAX (4G), and Long Term Evolution (4G). More recently,MIMO has been applied to power-line communication. In this paper MIMO antenna is placed at both engine and last compartment of the train.Depending upon the enhanced HeNB router decision the signal which is sent to either front or rear MIMO antenna

Fig .4. Different Types Of MIMO Antenna

E. MAHO

MIMO Assited handover (MAHO) is better option as it releases the pressure from Mobile Switching Centre. MAHO scheme with 2_2 antennas configuration be applied in the paper, and the method can be easily expanded to the case of four antennas as defined in 802.11n standard [7].Also, it enables the call to be handover between base stations at a much faster rate than in 1G analog systems. It is because the measurements are made by each mobile. The handoff procedure includes identification of new channel belonging to new base station where the call is to be transferred and transfer of voice and control channels that must be allocated to channels associated to new base station. Also, the handoff is to be prioritized before call initiation process. At first, optimum signal level at which handoff is to be initiated is determined. Then a particular signal level is specified as minimum usable signal for acceptable voice quality at the base station receiver. A slightly signal is used as a threshold at which a handoff is made. The difference between handoff power and minimum usable power, cannot be too large or too small because if it is too large, lot of handoff occurs which burdens MSC and if it is too small there may in sufficient time to complete the handoff before call is dropped due to weak signal. It is important for the mobile to accurately measure channel quality and report it to the serving base station, so that it can hand over before the performance becomes unacceptable leading to a dropped call. Measures such as received signal strength and symbol/bit error rates do not correlate well with the frame error rate (FER) which is widely accepted as the meaningful measure of performance in wireless systems. Also, received signal strength measurements are often coarse and

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inaccurate. The SINR is a more appropriate handoff metric near the cell boundary. The base station then directs the mobile to handoff when the SINR reported by the mobile drops below a threshold [3].

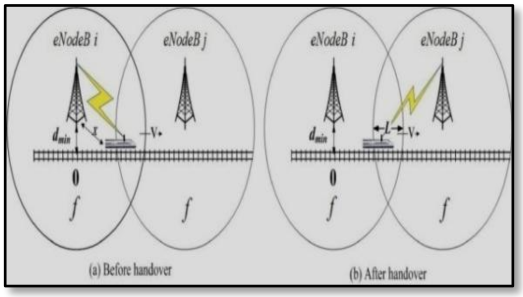

Fig.5.Handoff using MAHO

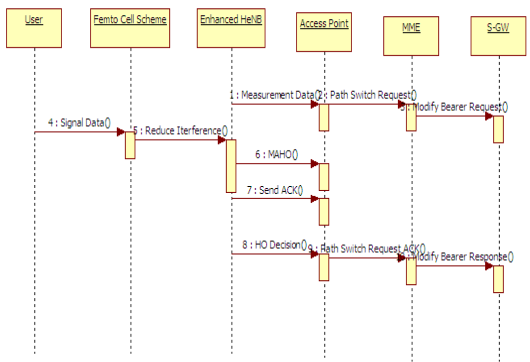

Fig.6.Proposed MAHO Handover Procedure

IV. INTERFERENCE CANCELLATION ALGORITHM

A. Zero Forcing Algorithm

It aims to eliminate the inter symbol interference (ISI) at decision time instants (i.e. at the center of the bit/symbol interval) or frequency domain. The names zero forcing corresponds to bringing down to inter-symbol interference to zero in a noise free case. This will be useful when ISI is significant compared to noise. Zero-forcing equalizers ignore the additive noise and may significantly amplify noise for channels with spectral nulls. This equalizer removes all ISI, and is ideal when the channel is noiseless. At some frequencies the received signal may be weak. To compensate, the magnitude of the zero-forcing filter ("gain") grows very large. As a consequence, any noise added after the channel gets boosted by a large factor and destroys the overall signal-to-noise ratio.Thus zero forcing algorithm is used in this paper to reduce interference in uplink.

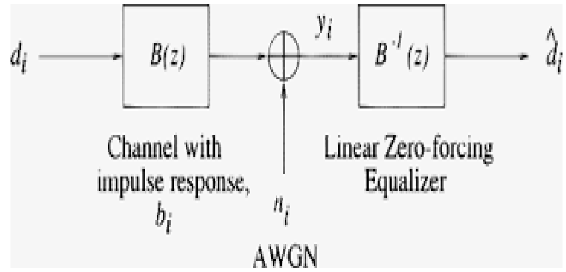

Fig .7.Block diagram of Zero Forcing Algorithm

B. Space–Time Block Coding

It is a technique used in wireless communications to transmit multiple copies of a data stream across a number of antennas and to exploit the various received versions of the data to improve the reliability of data-transfer. The transmitted signal must traverse a potentially difficult environment with scattering, reflection, refraction and so on and may then be further corrupted by thermal noise in the receiver means that some of the received copies of the data will be 'better' than others. This redundancy results in a higher chance of being able to use one or more of the received copies to correctly decode the received signal. Space–time coding combines all the copies of the received signal in an optimal way to extract as much information from each of them as possible An STBC is usually represented by a matrix. Each row represents a time slot and each column represents one antenna's transmissions over time.

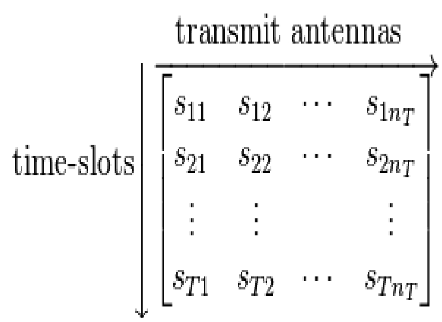

Fig 8. Space Time Block Code Matrix

Here Sij is the modulated symbol to be transmitted in time slot i from antenna j. Here T timeslot and nT transmit antennas as well as nR receive antenna. This block is usually to be considered of length T. Code rate of STBC measures as,

$$r = k/T \quad (1)$$

Here k is symbol , T is the length.

In the downlink the APs transmit packets to the train, since there does not exist orthogonal STBC for complex signal transmission, a quasiorthogonal STBC (QOSTBC) transmission for the AP in the downlink can be implemented, where the MS on the train can cancel the interference of other APs through array processing.

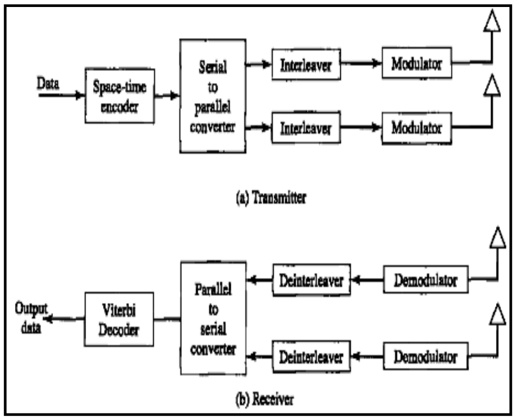

Fig 9.Block Diagram Of Space Time Block Code

V. PERFORMANCE ANALYSIS

In this section we reduce the handover latency , reducing the interference during the uplink and downlink from MIMO antenna to the base station, coverage is increase by femtocell, Improve received signal strength (RSS), Improve channel quality, Frame error rate is decrease.

Performance Metrics

The performance metrics are summarized as follows

1) Handover latency

The disruption time is computed from the time when the train begins the handover procedure from its serving eNB to the target eNB. The handover latency is an important indicator of whether the designed handover procedure is effective. Therefore, the average handover latency of the LTE can be formulated as follows:

$$\text{THO latency} = (1 - \text{Pfr})^{8} \_ (\text{Tho sig} + \text{mChTime}) + \text{Pfr} \_ (1 - \text{Pfr})^{7} \_ ((\text{Tho sig} + \text{Nbackof} \_ \text{Tslot}) \_ (0 + 1 + \ldots + 7) + \text{mChTime} + \text{Twait}) \quad (2)$$

Tho sig of one single handoff signaling packet in systems is calculated as follows:

$$\text{Tho sig} = \text{TP} + \text{Ttx} + \text{TDIFS} + \text{TCCA} + \text{TRxTx} + \text{T Preamble} + \text{TPLCP} + \text{Nbackof} \_ \text{Tslot} \quad (3)$$

where *mChTime*- maximum time to spend on each channel, *Pfr*-frame error rate.TP-propagation latency, Ttx–transmission latency, TDIFS-distributed inter Frame space (DIFS),TCCA-time to sense the channel, TRxTx-latency, TPreamble and TPLCP are the time to transmit preamble and physical layer convergence protocol (PLCP) packet respectively .N back of - number of back off slots before transmitting data, *Tslot*-slot length in 802.11.

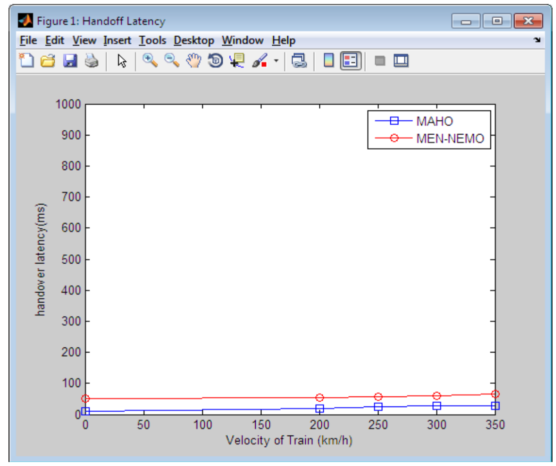

Fig.10. Latency Performance of the MIMO Assisted Handover

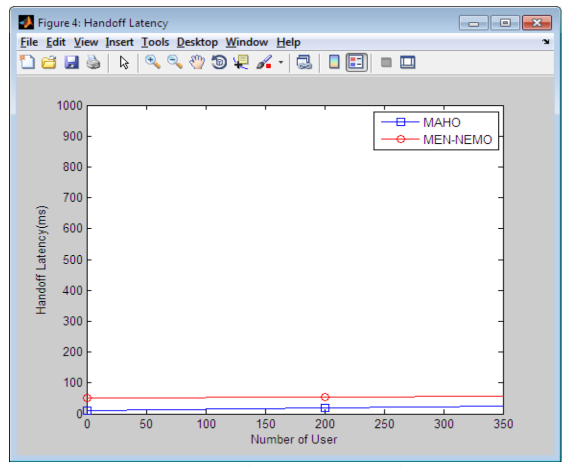

Fig. 11.Handoff latency vs No of User

2) User satisfaction

The satisfaction score function utilizes reward and punishment to evaluate the satisfaction levels of UEs on a train.

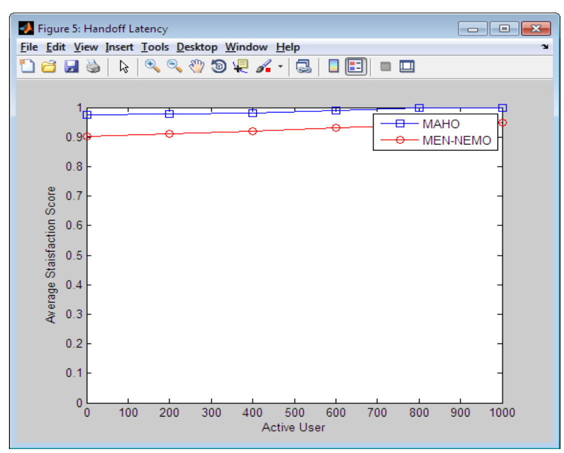

Fig.12.Satisfication Score

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3) Data Rate

The speed at which data is transferred within the computer or between a peripheral device and the computer, measured in bytes per second.

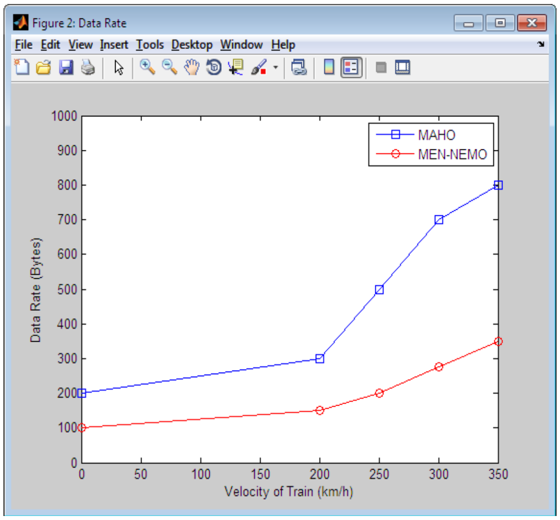

Fig.13.Data Rate using MAHO

4) RSS

RSS(Received signal strength) is a generic radio receiver technology metric, which is usually invisible to the user of the device containing the receiver, but is directly known to users of wireless networking of IEEE 802.11 protocol family.

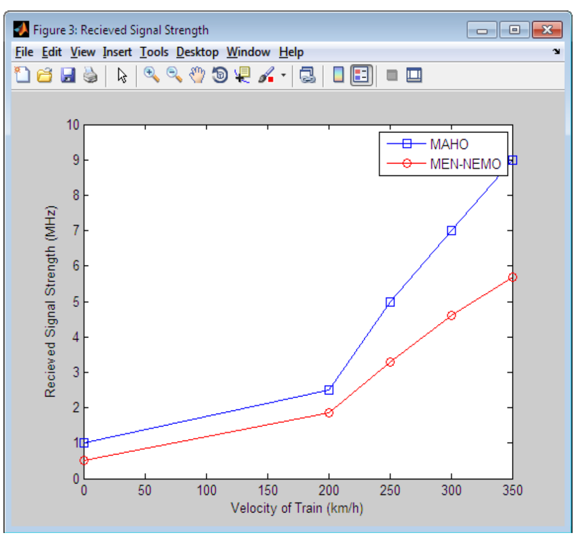

Fig.14.RSS using MAHO

5) Interference

Interference is anything which modifies, or disrupts a signal as it travels along a channel between a source and a receiver.

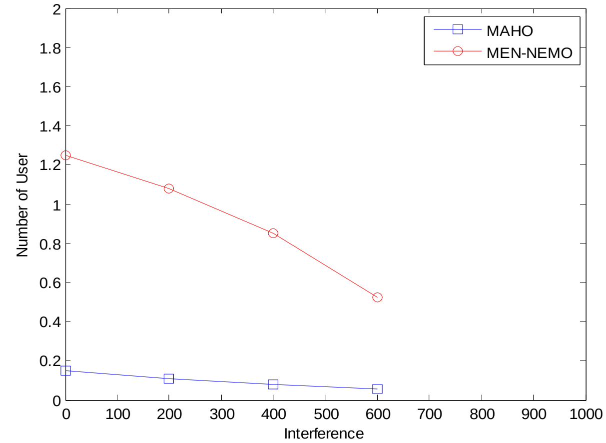

Fig.15.Interference

VI. Conclusion And Future Work

The wireless cellular network for high speed train is designed in this paper that can be deployed in the high speed environment. Two different network architectures are designed for inside and outside the train respectively. Inside the train, the MS's are connected to the wireless femtocell access points and the AP's are connected to any one transceiver MIMO antenna on the top of the train via enchaned HeNB by wired connections. In the outside of the train the BS's for railway is designed with Omni-directional antennas for less energy consumption. Finally an algorithm for handover procedure is proposed that is MIMO assisted handoff scheme, unlike existing handoff algorithms, we use location based method to initiate the probe procedure. Handoff signaling and normal data packets are transmitted by different antennas, so that the handoff procedures can proceed without interrupting normal data transmissions. Simulation results show that the proposed MAHO scheme can reduce the handoff latency than MEN-NEMO. Therefore in future work we will consider more efficient resource management algorithm for different types of traffic (eg:voice,audio,data,video) to maximize the resource utilization in high speed trains.

References

[1]. Cheng-Wei Lee, Ming-Chin Chuang, Meng Chang Chen and Yeali S. Sun"Seamless Handover for High-Speed Trains Using Femtocell-Based Multiple Egress Network Interfaces" IEEE TRANSACTIONS ON WIRELESS COMMUNICATIONS", VOL. 13, NO. 12, DECEMBER 2014.

[2]. Fourat Haider, Mehrdad Dianati, Rahim Tafazolli "A Simulation Based Study of Mobile Femtocell Assisted LTE Networks" Center for Communication Systems Research University of Surrey Guildford GU2 7XH, Surrey, U.K.

[3]. Krishna Balachandran, Member, IEEE, Srinivas R. Kadaba, Member, IEEE, and Sanjiv Nanda, Member, IEEE " Channel Quality Estimation and Rate Adaptation for

Cellular Mobile Radio" IEEE JOURNAL ON SELECTED AREAS IN COMMUNICATIONS, VOL. 17, NO. 7, JULY 1999 S. Buchegger and J. Boudec, "Performance Analysis of the Confidant Protocol," Proc. Int'l Symp. Mobile Ad Hoc Networking and Computing, 2002.

[4]. C.-W. Lee, M. C. Chen, and Y. S. Sun, "A novel network mobility management scheme supporting seamless handover for high-speed trains," Comput.Commun., vol. 37, pp. 53–63, Jan. 2014.

[5]. C.-W. Lee, T.-Y. Lee, M. C. Chen, and Y. S. Sun, "An integrated network mobility management and call admission control scheme for Internet access on high-speed trains," Inst. Inf. Sci., Acad. Sinica, Taipei, Taiwan, Tech. Rep. TR-IIS-11-004, Jul. 2011.

[6]. 3rd Generation Partnership Project (3GPP), Overall description; Stage 2, Sophia-Antipolis, France, 3GPP TS 36.300: V11.2.0, Jun. 2012.

[7]. Part 11: "Wireless LAN Medium Access Control (MAC) and Physical Layer (PHY) Specifications Amenment 5: Enhancements for Higher Throughput", IEEE Std. 11n, 2009.

[8]. L.Tian, J. Li, Y. Huang, J. Shi, and J. Zhou, "Seamless dual-link handover scheme in broadband wireless communication systems for high-speed rail," IEEE J. Sel. Areas Commun., vol. 30, no. 4, pp. 708–718, May 2012.

[9]. O. B. Karimi, J. Liu, and C. Wang, "Seamless wireless connectivity for multimedia services in high speed trains," IEEE J. Sel. Areas Commun., vol. 30, no. 4, pp. 729–739, May 2012.

[10]. M.-C. Chuang and J.-F. Lee, "A light weight mutual authentication mechanism for network mobility in IEEE 802.16e wireless networks," Comput. Netw., vol. 55, no.16, pp. 3796–3809, Nov. 2011.

[11]. 3rd Generation Partnership Project (3GPP), Home Enhanced NodeB (HeNB) Operations, Administration, Maintenance and Provisioning(OAM&P); Procedure flows for Type 1 interface HeNB to HeNB Management System (HeMS), Sophia-Antipolis, France, 3GPP TS 32.593:V11.0.0, Sep. 2011.99-302.

[12]. C. Sue, S. Sorour, Y. Yuk, and S. Valaee, "Network coded information raining over high-speed rail through IEEE 802.16j," in Proc. IEEE, PIMRC, Sep. 2009, pp. 1138–1142.

[13]. D. Huang, P. Fan, and K. B. Letaief, "An optimal antenna assignment strategy for information raining," IEEE Trans. Wireless Commun., vol. 7, no. 4, pp. 1134–1139, Apr. 2008.

[14]. Y.-C. Tseng, J.-J. Chen and Y.-L. Cheng, "Design and implementation of a SIP-based mobile and vehicular wireless network with push mechanism," IEEE Trans.Veh.Technol., vol. 56, no. 6, pp. 3408–3420, Nov. 2007.

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