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E-mail :
editor.ijpast@gmail.com
editor@ijpast.in

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ENERGY EFFICIENT POWER ALLOCATION WITH BUFFER CONSTRAINT FOR HIGH SPEED RAILWAYS

MR.R.VINAY KUMAR[1],Ms. MOILLA SAI LAKSHMI[2]

ABSTRACT:

The rapid development of high-speed railways (HSRs) all over the world is drawing much more attention on high mobility wireless communication. For the wireless links that connect the passengers on the train to the cellular network, it is very essential to employ an appropriate power allocation strategy to guarantee the reliability and efficiency of information transmission. So, this paper concentrates on evaluating the transmission performance of wireless links in the HSRs and attempting to derive an optimal power allocation strategy of this scenario. It is proved that traditional water-filling algorithm and channel inverse algorithm can be regarded as two specifical cases of this new algorithm.

INTRODUCTION

HIGH speed railways (HSRs) is developing rapidly all over the world in recent years, especially in China, where twenty-two thousand kilometers of HSRs have been already built by the end of January 2017. Consequently, how to provide reliable and efficient information transmission service to connect the passengers on the high-speed train to the cellular network is an important problem that significantly deserve to investigate . HSR communication has been considered as a typical scenario in future 5G systems, as shown in Figure 1, where the HSR users desire the reliable and high data rate wireless communication service to support their various information applications including online shopping, online video, online games and file downloading. Many key technologies in wireless communication system need to be reconsidered under high mobility scenario, such as channel estimation, synchronization, multiple antenna technique, resource allocation, etc . For instance, in , the authors proposed a pilot aided joint estimation technique for carrier frequency offsets and doubly selective channels , and a low complexity turbo equalization scheme for orthogonal frequency division multiple access (OFDMA) uplink systems with high mobility users.

[1]Associate Professor, International School of Technology and Sciences for Women, Rajanagaram, Andhra Pradesh-533294.

[2]Assistant Professor, International School of Technology and Sciences for Women, Rajanagaram, Andhra Pradesh-533294.

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Among them, power allocation, one of the most important methods to guarantee the reliability and efficiency of infor-mation transmission, is the main problem that this paper will concentrate on. There are a large amount of literatures in this research field. As we know, constant transmit power strategy is optimal in a time-invariant additive white Gaussian noise channel (AWGN) environment . If the channel is timevarying, water-filling algorithm is a better choice in terms of throughput maximization . On the other hand, if the information is sensitive to transmission delay, channel inversion algorithm presented in is optimal. Effective capacity is another powerful method to describe the channel transmission capability for delay limited information transmission .

• High mobility. The dramatic increase of train speed will cause frequent handover. Given a cell size of 1-2 km, a high-speed train of 350 km/h experiments one handover every 10-20 seconds . To solve the frequent handover problem is one of the main functions of RRM in HSR wireless communications. Moreover, the fast relative motion between the ground and the train will lead to large Doppler shift and small coherence time. The maximum speed of HSR in China is currently 486 km/h, which induces a Doppler shift of 945 Hz at 2.1 GHz . Thus, when implementing resource allocation for HSR communications, it is necessary to consider.

• Unique channel characteristics. The moving train encounters diverse scenarios (e.g. cuttings, viaducts and tunnels) with different channel propagation characteristics which causes that a single channel model could not depict features of HSR channels accurately. It brings a big challenge to RRM schemes, which should be adaptive to diverse scenarios along the rail with different channel models. Furthermore, the line-of-sight (LOS) component is much stronger than the multipath components especially in viaduct scenario, which implies that the propagation loss mainly depends on the distance between the base station (BS) and the train . Since the distance varies with the train's position, the power control along the time has a large influence on system transmission performance .

LITERATURE SURVEY

The architecture of LTE has two major components: (1) Access Network - Evolved Universal Terrestrial Radio Access Network (E-UTRAN) and (2) Packet Switched Core Network - Evolved Packet Core (EPC). The E-UTRAN Network consist of interconnected Evolved NodeBs (eNBs), whereas EPC contains Mobility Management Entity (MME), Serving Gateways (S-GW), and Packet Data Network Gateway (PGW) which provide various services like signalling, handover, security etc. These eNBs are interconnected using X2 interface and are further connected to EPC through S1 interface. Fig. depicts in detail the Network Architecture of the system 3GPP Technical Report 36.836 elaborated in detail about Mobile Relay Nodes (MRN) for enhancing the communication on High Speed Trains. These nodes are mounted on Trains, which act as intermediate relay units between User Equipments (UE) and LTE. Further, handling all the connectivity of passengers in a high speed train from a single interface would limit the bandwidth utilization

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and increase the failure rates. A two link architecture based on Distributed Antenna System (DAS) and Mobile Relay was proposed in . The system is developed by multiple RAUs which are interfaced to remote station using RoF. In the propose system the handover is performed with the support of antenna selection and power allocation across antennas. Lin Tian et al. has also introduced a HO scheme based on dual link architecture. The system employs antennas in the front and rear of train to carryout handover. However, both these models have neglected the period of HO, which affects performance in real network implementation .

EXISTING SYSTEM

A survey on high mobility wireless communications: challenges, opportunities and solutions Providing reliable broadband wireless communications in high mobility environments, such as high-speed railway systems, remains one of the main challenges faced by the development of the next generation wireless systems. This paper provides a systematic review of high mobility communications. We first summarize a list of key challenges and opportunities in high mobility communication systems, then provide comprehensive reviews of techniques that can address these challenges and utilize the unique opportunities. The review covers a wide spectrum of communication operations, including the accurate modeling of high mobility channels, the transceiver structures that can exploit the properties of high mobility environments, the signal processing techniques that can harvest the benefits (e.g., Doppler diversity) and mitigate the impairments (e.g., carrier frequency offset, intercarrier interference, channel estimation errors) in high mobility systems, and the mobility management and network architectures that are designed specifically for high mobility systems. The survey focuses primarily on physical layer operations, which are affected the most by the mobile environment, with some additional discussions on higher layer operations, such as handover management and control-plane/user-plane decoupling, which are essential to high mobility operations. Future research directions on high mobility communications are summarized at the end of this paper.

PROPOSED SYSTEM

SYSTEM STRUCTURE AND PARAMETERIZATIONS

Fig. illustrates the system structure diagram for a high speed railway wireless communication system, where BSs are uniformly deployed along one side of the railway with equal interval. The distance between BS and railway is d0, the height of antenna equipped at each BS is h0, and the coverage radius of each BS along railway is L. It is assumed in the most parts of this paper that a high-speed train is traveling along the line railway with a constant velocity, denoted as v0. And the performance under a non-uniform motion scenario will be investigated in detail in Section avoid serious penetration loss caused by metal carriage and large amounts of handoff operations between adjacent cells, users on the train usually connect to the BS in cellular network with the help of access point (AP), which is installed on the roof of train to construct a two-hop structure. Since transmission process between AP and users on the train is that exchanges information between high-speed train and base station.The same as traditional network, some well-developed technologies, such as Wi-Fi, can solve this problem very well. Thus, this paper concentrates on the transmission process between the mobile AP and BS.

OPERATION

However, when the number of available channels is equal to or below the fixed number of reserved channel, only M1 handoff can use the remaining channels, whereas new calls enter into the queue when there is an available entry in the queue, otherwise they are blocked. The queued calls may initiate M2 handoffs to other cells during their wait for free channels. The priority of the M2 handoff arrival is identical to the priority of the new call arrivals. However, the presence of M2 handoffs may increase the blocking probability of the system depending upon the traffic load conditions of the heading cell. Moreover the waiting time in the queue can be reduced by reducing the queue length but it causes only a limited improvement in performance. In Parekh and Gallager proposed a packet service discipline based on generalized processor sharing and leaky bucket rate control to provide flexible, efficient and fair use of the links. This is an idealized discipline which assumes that the server can serve multiple sessions simultaneously. The authors present a simple packet-by-packet transmission scheme as an approximation to their scheme even when the packets are of variable length. It is a rate-based flow control in which average rate, maximum rate and burstiness are used as parameters of the source's traffic. The user also requests a certain QoS such as the tolerance of worst case or average delay. The network checks to see the accommodation of a new source and if succeeded, reserve transmission links or switching capacity ensure the desired QoS for the new source. The authors concentrate on providing guarantees on throughput and packet delay. However, if the number of sessions sharing the server or the packet sizes are small then it is better to approximate the scheme by weighted round robin.

QoS Issues in 4G Technologies

The different potential challenges in 4G technologies are identified in this section. The user mobility, mobility management, integration and interoperability of diverse networks, streaming multimedia based services, QoS mapping between heterogeneous networks, and call admission control are some of the QoS issues for future 4G technologies. In this section the potential research challenges, the already published works and possible research directions related to 4G technologies are considered for discussion. User mobility In 4G eras users must get a convenient access to the services needed at any given situation. In this context user mobility has become an important aspect in the design of 4G wireless communication systems. Researchers have focused on three models of mobility defined in . The terminal mobility deals with mobility of users having a single device. The session mobility deals with users in a public access network (PAN) having multiple personal devices to provide a live session. The personal mobility concentrates on provision of personalized operating environments for users along with user movements. In personal mobility a service required by the user will be delivered instantaneously, irrespective of the user's location, device/device location, operator/provider domain, and type of network. So unlike terminal mobility, session and personal mobility

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concentrate more on user movements rather than terminal movements. Wang and Abu-Rgheff in discuss the disadvantages in the single-layer mobility approach that maintains strict layer modularity when applied to the emerging wireless systems and argue that such an approach can only provide incomplete mobility functionality.

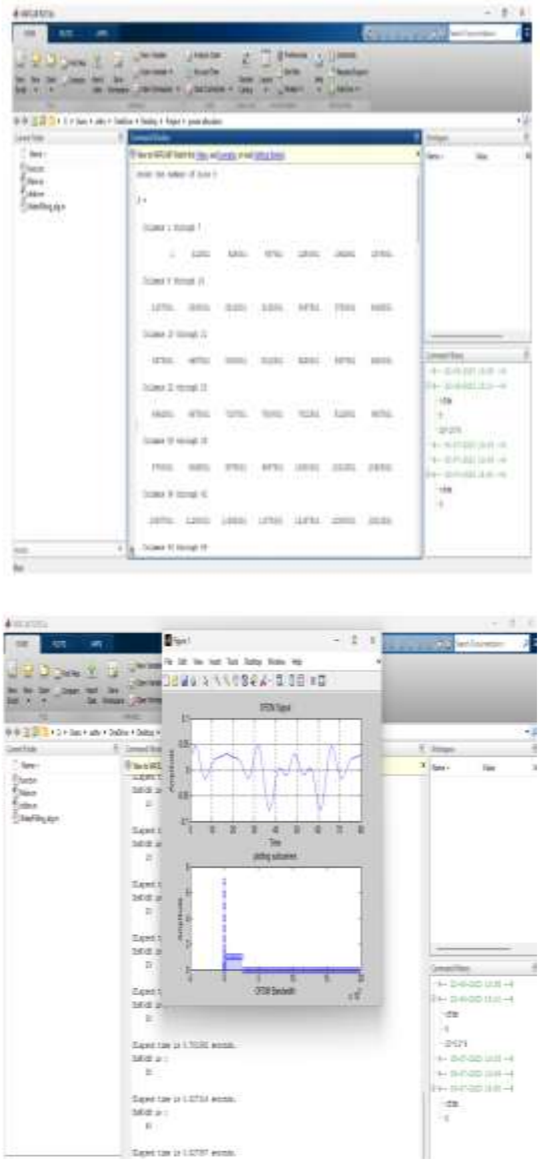

Fig.1. output results.

Optimization objectives: The primary objective is to minimize the energy consumption of the communication system while satisfying the buffer constraint. The optimization problem may involve formulating an objective function that considers factors such as signal quality, interference, and power consumption. Channel and traffic characteristics: The performance of the power allocation scheme depends on the specific characteristics of the communication channel and traffic patterns in high-speed railways. Factors such as channel fading, Doppler shift, and time-varying traffic loads need to be considered to achieve optimal power allocation. Trade-offs: Energy-efficient power allocation with a buffer constraint involves trade-offs between energy consumption, buffer occupancy, and communication reliability. The result of the optimization process will provide a power allocation scheme that balances these trade-offs based on the specific requirements and constraints of the high-speed railway system. Simulation and evaluation: Researchers typically employ simulations or analytical models to evaluate the performance of the proposed power allocation schemes. Metrics such as energy efficiency, buffer occupancy, throughput, or bit error rate can be used to assess the effectiveness of the solutions.

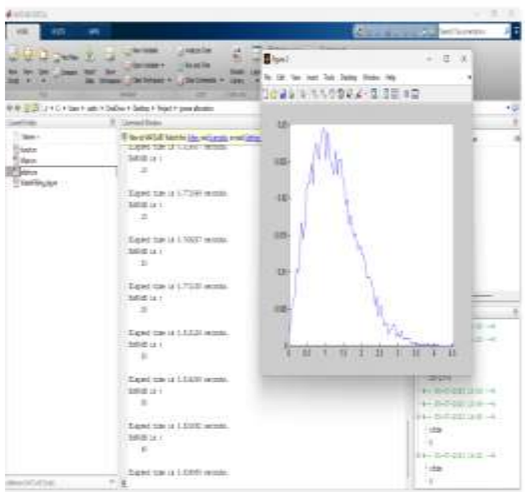

Fig.2 Results at signal strength.

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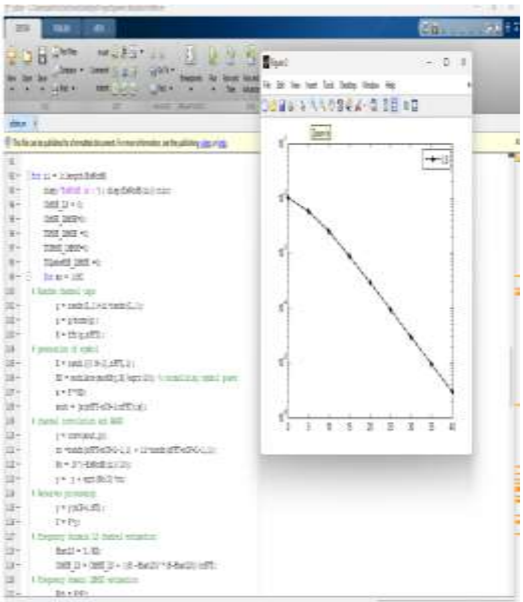

Fig.3. Final output.

CONCLUSION

This paper investigated the transmission problem for the wireless links that connects highspeed train and the cellular network. Since the information transmitted between them has diverse QoS requirements, differentiated service should be provided to improve the overall performance. As a result, a QoS-based achievable rate region is utilized as a metric in this paper to measure the system performance after we have divided the hybrid information into two sub streams. The corresponding service-oriented power allocation algorithm was also derived to achieve the largest achievable rate region, which can bridge the gap between traditional water-_lling algorithm and channel inverse algorithm. In the non-uniform motion scenario, we discussed the robust performance of the new proposed allocation algorithm. The performance loss of it was evaluated in terms of both achievable rate region and energy consumption minimization. Lastly, a typical implementation was presented in detail to show how to employ these results developed by this paper into practical system.

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