A Swift Communication Method For Railways

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Abstract- *The communication through railways is becoming a very important means of communication since the use of railways by people is increasing. So, to provide secure communication through railways many new technologies in a combined form is used here. LTE with Wi-Fi using PRP is introduced to provide secure and bandwidth demanding applications. Mobile hotspot network is introduced to provide the backhaul communication capacity in millimeter range. So a combination of LTE and Wi-Fi along with MHN is introduced to reduce the communication problems like handoff and other bandwidth requiring applications without compensating its speed.*

Keywords- Secure communication; Handoff, LTE, MHN, PRP, Wi-Fi.

I. INTRODUCTION

Wireless communication is used to incorporate device communication through a wireless signal using various wireless techniques. It enables people to communicate regardless of their location. Nowadays, more and more people use railway as their means of transport.

In some European countries even the government incite their people to use railway for travelling. Since the technology in railway is emerging the high speed trains help the busy world to meet their requirements in time. In most cases people spent their fraction of time in travelling and use this time for communication and entertainments which requires bandwidth applications. So the ability of providing a secure and unbroken communication is a major concern for railway environment. As the wireless communication technology is improving its efficiency by introducing new generation techniques the railway communication can also adapt it easily for providing smooth communication for its passengers.

The main aim of this paper is to provide the passengers to stay connected to the bandwidth demanding applications using LTE [1] and Wi-Fi combination using PRP [2] and to increase the backhaul capacity by using the mobile hotspot network [3].

Since the LTE [4] requires costly licensed spectrum and is lacking behind Wi-Fi in terms of economies of the scale a combination of LTE and Wi-Fi architecture [5] is used for the communication requirements. The parallel redundancy protocol is used to check the error in data communication. The mobile hotspot network based on millimetre range allows people to communicate without bothering about their location. The higher data rate and lower latency of the MHN network helps it to use in the railway environment.

II. RELATED WORKS

The higher technologies are implemented for the high speed railway communications for meeting the demands of the passengers. The communication through trains is a major difficulty since the train covers a number of cell clusters within few seconds. So the problem of handover frequencies and meeting required bandwidth needs is a major concern in railways.

The GSM-R [6] technology was the first communication network used by the railways. GSM-R networks are initially used to provide the railway voice communication only. As more of the GSM-R networks begin to support train signalling, the capacity of GSM-R turns out to be insufficient, because of the reduced number of channels and increase in the number of trains. Thus it has insufficient capacity and thus it limits the number of trains in a particular area. So as a solution to these problems GSM-R is replaced by the LTE. GSM-R uses circuit switching while the LTE is fully packet switched network. LTE has lower latency and high bandwidth and has improvements over 3G network. The LTE is implemented by several researches. It is as follows:

- In August 2011, the Department of Industry and Wireless Bureau of Zhengzhou Province approved Zhengzhou Metro Co., Ltd. to use the frequencies from 1,795 MHz to 1,805 MHz.
- From 2011 to 2012, the design institute determined detailed technical solutions.
- In 2012, tenders for commercial telecommunications equipment, train, and PIS equipment used in train and ground, as well as LTE equipment were complete.

- In 2013, equipment for LTE was installed in Metro line 1 in Zhengzhou.

The use of LTE alone for communication over the network is very much expensive since the LTE requires a costly licensed spectrum. So for using a combination of LTE with Wi-Fi provides efficient improvement in cost and by also including mobile hotspot network with this increases the backhaul capacity of the system in millimeter-wave range.

III. PROPOSED SYSTEM

The proposed system includes the LTE, Wi-Fi network and the mobile hotspot network.

The figure below shows the system architecture:

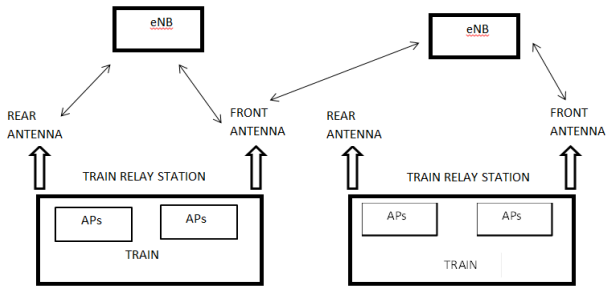

Fig 1: System Architecture

1. *Long Term Evolution (LTE)*

LTE is also known as the fourth generation network is developed by the Third Generation Partnership Project (3GPP) [7]. LTE enables faster and richer applications while streamlining the network infrastructure over IP. The 2G and 3G network architectures switches voice and data through two separate sub domains, that is, voice is transmitted through circuit switching and the data is transmitted through packet switching. The major advantage of LTE over other generation network is that it uses a complete IP architecture since the data and voice are unified and transmitted through the same IP network, which reduces the operational cost of the system. So LTE is fully a packet switched protocol.

LTE comprises of three sub units. The User Equipment (UE), the Evolved UMTS Terrestrial Radio Access Network (EUTRAN) [8] and the Evolved Packet Core (EPC). The UE is the terminal device in a network which can be directly used by the user. It is similar to the mobile station in the GSM network. The UE [9] is connected to the eNodeBs or to the base station. The UE handles the mobility management, call control, session management and identity management functions. The E-UTRAN is also known as eNBs or eNodeBs. It provides interaction between the UE and the EPC. It is similar to the BTS in the GSM. It is controlled by the Radio Network Controller (RNC). The EPC is the core network of the LTE. EPC is a framework for providing converged data and voice on 4G network.

LTE is used in various technologies and architectures for vehicle to vehicle communication or vehicle to infrastructure communication. Since LTE is used for long range communication it is mainly used in vehicle to infrastructure communication. Here the vehicle to infrastructure means the communication between train and the eNBs.

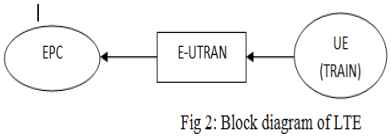

Fig 2: Block diagram of LTE

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The LTE has low latency, high bandwidth, higher network throughput, increased data rate wide coverage and has improvements over 3G network. It has the capability to provide speed of 100 Mbps – 1Gbps and has high QoS (Quality of service) and security. It also offers various kind of service at any time as per user requirements anywhere.

2. *Wi-Fi*

Wi-Fi or wireless fidelity is a technology for wireless communications. It is the IEEE 802.11 communication standard for wireless local area networking (WLAN). It provides the EDGE (Enhanced Data Rate for GSM Evolution) network connectivity to on-board users.

Wi-Fi works on the physical layer and data link layer. The EDGE is a speed and latency advancement in GSM technology. EDGE standard was designed to deliver multimedia applications like video streaming, television etc.

Wi-Fi offers a relatively high capacity at a low cost and high market penetration. But due to its lower coverage range it is used for on-board communication or vehicle to vehicle communication. Wi-Fi commonly uses 2.4 GHz UHF and 5.8GHz SHF ISM radio bands.

3. *Parallel Redundancy Protocol*

PRP is a network layer protocol which is introduced by the International Electro technical Commission (IEC). It is a redundancy technique which can counter balance any single network failures. For increasing timing behavior and data loss the PRP can be integrated along with Wi-Fi.

The PRP use two different networks for data transfer. Every network node is connected to the two of these networks for reducing the data loss. The two networks are not connected each other in any way, thus any failure in one network does not affect other node. So a reliable transmission of data is possible by using this technique. The data to be transmitted is duplicated in the transmitter side and sent through these two networks. These two networks carry these data to the receiver. In case of any congestion or packet loss problem in either node occurs it will not affect to the next network since in packet transmission through packet switching no fixed route is designed for the data transmission. The correct packet reaching at the receiver first is accepted while the second packet can be discarded by the receiver.

4. Mobile Hotspot Network

The Mobile Hotspot Communication system is a system which provides backhaul communication for large capacity in the millimeter wave range and compensates basic needs similar to 5G. For increasing wireless backhaul capacity and link reliability MHN is used with LTE and Wi-Fi.

Mobile hotspots are critical for anyone who travels or who needs to have constant access to the internet with multiple devices. For a secure dedicated connection mobile hotspot can be used. Mobile hotspot removes the problem of conducting business or personal work over an unsecured public connection. The main advantage of MHN is its faster connection speed and reliability for tethering to multiple devices.

The system uses LTE to reduce the handoffs [10] and increase bandwidth requiring applications. The Wi-Fi has high market penetration and of short range communication it is used by the on-board users inside the train. The mobile hotspot network is used to provide increased backhaul capacity in millimeter range wave. These all are introduced in the railway network by using several network layer protocols since these both can be easily implemented.

IV. CONCLUSION

This system provides a very smooth and secure communication for the passengers of the train. Here the combination of LTE and Wi-Fi employing PRP is used for reducing the handover problems and improving the quality of services. The mobile hotspot network provides backhaul communication capacity to the millimeter wave range. Since the Wi-Fi is of short range, it is used for on-board communication between the users in the train. The LTE provides long range communications, that is, the communication between user and the infrastructure nodes. The Wi-Fi provides vehicle to vehicle communication, that is, the communication inside the trains. The mobile hotspot network is integrated over the LTE network for increased capacity.

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