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Handover Latency and Interoperability in Future Generation Wireless Mobile Heterogeneous Environment

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Abstract

Continuous striving in the development of wireless mobile networks maximizes the possibility of user services and provides experience context rich and personalized services. In this way, for the development towards fully integrated 4G-all IP network architecture, the interoperability between future generation wireless networks and seamless vertical handover (VHO) has become a crucially important issue. The proposed work is mainly focusing on exploring interoperability issues in heterogeneous networks considering development towards 4G and emphasizing one merging IEEE 802.21 standard. Further, Simulation results were presented to showcase vertical handover (VHO) performance using IEEE 802.21. Simulation Analysis is done using Network Simulator (NS-2) with seamless mobility package extension.

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4G;
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Abbreviations and Symbols used in this Paper

- 3G Third Generation
- 4G Fourth Generation
- AP Access Points
- AAAC Authorization, Accounting and Charging
- BS Base Stations
- CN Corresponding Node
- GPRS General Packet Radio Service
- IEEE The Institute of Electrical and Electronics Engineers
- IP Internet Protocol
- LAN Local Area Network
- MIH Media Independent Handover
- MIHF Media Independent Handover Function
- MN MobileNode
- RAT Radio Access Technology
- SOH Service Oriented Handover
- WiMA World wide Interoperability for

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Microwave Access

- Wi-Fi Wireless Networking Technologies
- WCDMA Wide band Code Division Multiple Access
- WLAN Wide Area Network
- UMTS Universal Mobile Telecommunications System
- VHO VerticalHandovers

Introduction

The integration of wireless network solutions such as 3G, 4G and beyond, WiMAX and Wi-Fi has become a crucial need of pervasive and ubiquitous networks with their own features and characteristics able to support seamless and transparent user roaming with the design of new devices to handle various network platforms and protocols. The 4G wireless communication systems is open, all IP based, seamless connectivity system embraced with user friendly features of being simple, operable and personalized to the user needs and cost effective. The 4G is considered as an integrator among all existing wired and wireless networks.[1] Integration and Convergence are the major goals towards 4G development.[2] The 4G integration technology is defined to offer seamless interoperability for different wireless networks whereas, 4G convergence is defined to converge various traffic types such as voice, data and multimedia traffic on single IP based platform, different technologies, different media and different services.[3-5] The work is mainly focused on measuring handover latencies in heterogeneous environments to evaluate the user traffic on tolerating latency. The investigation is done for handover effects between three wireless networks UMTS, IEEE 802.16 (WiMAX) and IEEE 802.11 (Wi-Fi). The scenario consists of a node generating traffic towards mobile node (MN) which moves freely throughout the coverage area to perform vertical handovers (VHO) assuming channel as ideal, two intermediate routers were placed with IEEE 802.11 access points (AP) and IEEE 802.16 base stations (BS). UMTS node covers an area of 2000mx2000m where as IEEE802.16 and IEEE802.11 covers an area of 500m and 40m inside respectively.

The paper is organized as follows: Section II will discuss the interoperability benefits along with aspects of Interoperability towards 4G and emerging IEEE802.21 technology and works prior to it will be discussed. Section III elaborates the IEEE 802.21 standards and Section IV concludes the paper and finally, some preliminary results on the proposed work will be discussed.

Interoperability Benefits and its Aspects

Due to the rapid development of wireless communication systems and market needs. It has yielded the necessity of interoperability as it brings benefits for network providers and user services and at the same time facilitates user seamless and transparent service management.[6] The reconfigurable interoperability at the network level will offer network operators to opt between alternative wireless networks based on selection of access resources availability, service Requirements such as quality of service requirements, channel availability, context awareness, vertical handovers, load sharing and distribution between different wireless networks, efficient spectrum sharing, gateway selection, network discovery and congestion control.[7, 8] Hence, any dynamic variations in the network resource availability due to crashes or network saturations will be bypassed by the network components and terminals. Hence, this will lead to more user choices and market needs. The interoperability at the user level in heterogeneous environments will provide optimized end to end connectivity, service delivery easy roaming, and dynamic response to regional context, enhanced personalization services.[9] Based on the usage capabilities of available resources such as providing information through navigation and localization systems, agile spectral capabilities, cognitive levels, service cost minimization and user contexts and preferences anticipation, the user devices will be reconfigured.[10] Several literatures have been found on the attempts of deploying heterogeneous interoperable environment. The first experimental test bed efforts was LCE-CL test bed which is basically a loosely coupled, MIPv6 based GPRS/WLAN/LAN heterogeneous network. As per the results, it is shown that MIPv6 protoco l is designed for mobility management. However, MIPv6 when dealing with vertical handovers yields latency and cannot support real time applications.[11, =12] The authors in[13] have proposed a seamless vertical handover solution which has decreased number of authentication messages and handover latency as well. However, the model has found to be very sensitive to packet loss. Authors in[14] have proposed vertical authentication method which provides security against denial of service attacks. Moby Dick Project, another integrated architecture that continued 3rd generation wireless mobile infrastructure[15] which developed, implemented, evaluated IPv6 based mobility enabled network architecture provides services such as Authentication, Authorization, Accounting and Charging (AAAC) and supports Quality of Service requirements. Interactive and distributed multimedia applications are used as a representative set such as interactive and distributive multimedia applications to verify, validate and demonstrate integrated architecture comprising different access technologies such as WCDMA, IEEE 802.11 and ETHERNET.[16, 17] The service oriented handover (SOH) unleash the VHO's in upward and downward to create proper conditions to add handover process the eco-system awareness in which the event is embedded. The system is basically versatile information structure, an ontology which is shared by users and providers through common terms and relationships.[18, 19]

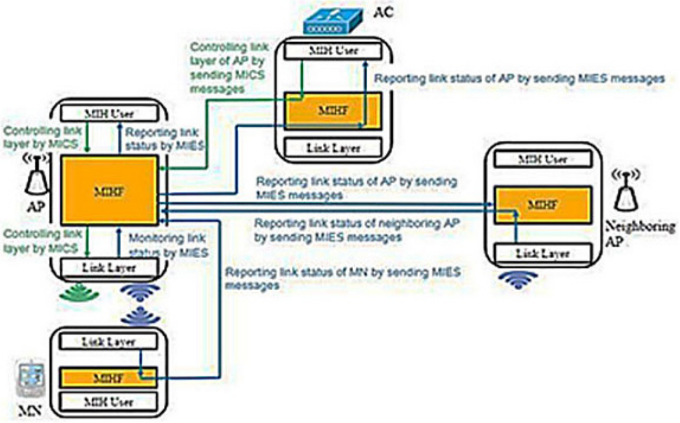

Fig. 1: Media Independent Handover Function (MIHF).[20]

IEEE Technology and Standards

This section is mainly focusing on emerging IEEE 802.21 technology and standards. The IEEE 802.21 provides handover between different wireless networks in the heterogeneous environments regardless of the medium type. This handover is called Media Independent Handover (MIH). The motive of IEEE 802.21 is to facilitate the users with easy and uninterrupted handover in heterogeneous networks. Due to this the information is collected from mobile terminals and network infrastructure for handover procedures. Below, Fig.1 shows the Media Independent Handover Function (MIHF) which acts as an intermediate layer between upper and lower layer whose function is to exchange information between devices that are involved in handover decision and executions.

There are three different services defined by MIHF: Media Independent Event Service (MIES) generates events due to changes in links and status, Media Independent Command Service (MICS) gives commands to control and manage handover functions, and Media Independent Information Service (MIIS) gives the information about the neighboring networks and capabilities.[21] IEEE 802.21 is expected to be the key enabler for providing seamless and transparent roaming in heterogeneous networks. Additionally, IEEE 802.21 has the features of delivering lower VHO disconnection times, QOS, Mobility management. Hence IEEE802.21 technology will make an outstanding contribution to future generation wireless communication system in providing re-configurability and interoperability.[22, 23]

Methodology

The work is mainly focused on measuring handover latencies in heterogeneous environments to evaluate the user traffic on tolerating latency. The investigation is done for handover effects between three wireless networks UMTS, IEEE 802.16 (WiMAX) and IEEE 802.11 (Wi-Fi). The scenario consists of a node generating traffic towards mobile node (MN) which moves freely throughout the coverage area to perform vertical handovers (VHO) assuming channel as ideal, two intermediate routers were placed with IEEE 802.11 access points (AP) and IEEE 802.16 base stations (BS). UMTS node covers an area of 2000mx2000m where as IEEE802.16 and IEEE802.11 covers an area of 500m and 40m inside respectively. In the simulation environment, two nodes were assumed- Corresponding node (CN) and Mobile Node (MN). Handover Latency is the time difference between the link detected by MN and reception of acknowledgement packet from CN. Figure 2 shows the handover latency of UMTS and WiMAX. From the graph, it is obvious that the handover latency increases with the MN speed. One major consideration is MN and CN connection will be continuous and will not be required to reset during actual vertical handover. Figures 3 and 4 show handover latencies for UMTS and Wi-Fi, Wi-Fi and WiMAX handover. These two vertical handover provides low latency and subsequent benefits to RAT operators (Radio Access Technology Operators) allowing seamless and transparent switching. Hence, users transparent load sharing is allowed between various RAT's and transparent switching to preferable RAT's. The simulation results shown are at the preliminary levels, however unleashes the potential of IEEE802.21 technology in providing interoperability towards 4G. First of all, 802.11 physical and Media Access Layer is setup in the MATLAB which consists of Transmission, Channel Modelling, and Reception. Similarly, the 802.16 is setup. The transmission starts with Wi-Fi and the link is brought down, and hand over occurs from 802.11 to 802.16. The transmission starts for 802.16, and the performance measures are calculated, using the Hyper threading algorithm the performance measures are better.

Simulation Results

The proposed work contributes the development towards 4G by providing a solution compatible to IEEE802.21 standard and exploits various wireless access technologies. The proposed implemented work demonstrates IEEE 802.21 based platform that are subjected to use for multimedia services for transportation and distribution through any type of wireless access networks to end users. Real time experiments are executed to demonstrate the system functionalities. The simulation results shows VHO performance using IEEE802.21. Simulation analysis is done using MATLAB with seamless mobility package extensions.[24]

The comparison is shown below:

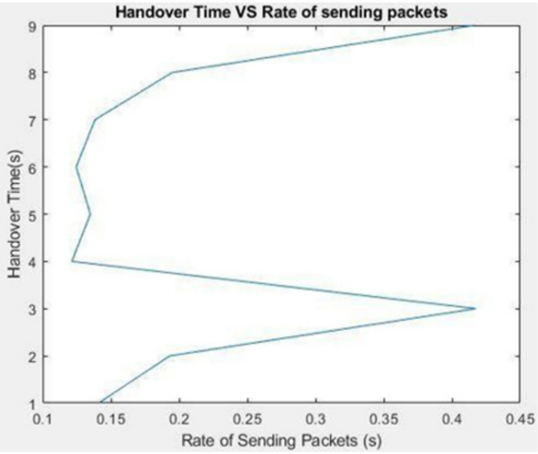

Fig. 3: Packet size (Mbytes) vs hand over Time (s) (Percentage improvement: 62%)

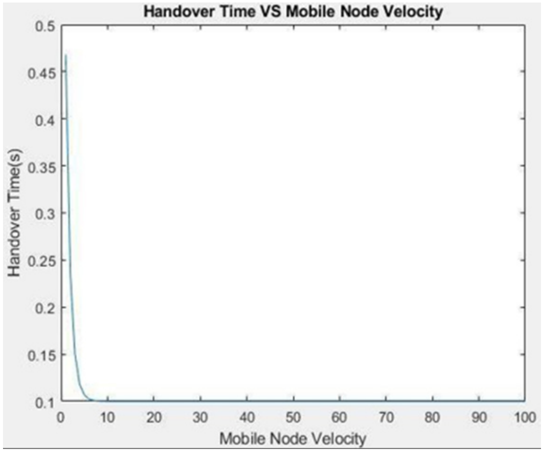

Fig. 4: Packet size (Mbytes) vs hand over Time (s) (Percentage improvement: 62%)

Conclusion

Future generation wireless communication systems unleashes the potential of offering several benefits such as high transmission speeds, seamless and high mobility communication support. They would have to use a common platform where all the access technologies, multimode user terminals, interoperability solutions are integrated and unified. The proposed work has detailed interoperability issues in 4G development and provided simulation analysis of three different wireless networks and showed IEEE 802.21 yields low VHO latencies with more seamless and transparent VHO's. From the simulations conducted, It is clearly shown that there is a 50% improvement in transmitting packets whereas 62% improvement is shown in mobile node velocity and packet size with respect to Hand over time.

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Conflict of Interest

Both of the authors declare that there is no conflict of interest.

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