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Design Of Efficient Network Controlled Vertical Handoff Mechanisms for Heterogeneous Wireless Network

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Abstract: Fourth Generation (4G) wireless systems include the integration of many wireless technologies including Wi-Fi, WiMAX, and cellular networks in order to meet the rising need for mobile and always-on access to communication services. Higher data rates, increased speed, and international roaming across many wireless access networks are key benefits of 4G wireless systems. One of the most important aspects of providing effective ubiquitous computing in a heterogeneous wireless environment is the creation of a smart vertical handoff algorithm that ensures the quality and continuity of service. particular significant issues within the larger field of vertical handoff are tackled here, with a focus on making effective use of the system characteristics to accomplish particular application-specific goals. This research presents a fresh method for developing a vertical handoff algorithm that takes into account many criteria in heterogeneous wireless networks.

Keywords: Wi-Fi, WiMAX , vertical handoff, Fourth Generation (4G).

Introduction

Wireless network technology has made some fascinating advancements in recent years. The current trends and requirements in wireless communications are shown in Figure 1, which include the need to assure Quality of Service (QoS) for real-time multimedia applications over heterogeneous wireless networks. Communication technology advances are racing to incorporate various wireless access technologies into what are being referred to as Fourth Generation (4G) wireless networks as more and more people expect to be able to use these types of apps and services whenever and wherever they please. Now a days, 4G wireless networks with high speeds and capacities are accessible. These wireless technologies provide smooth mobility across a broad range of heterogeneous wireless networks and global roaming. Mobile Stations (MS) in an ordinary 4G network will have many interfaces and the appropriate hardware to connect to different Access Networks (AN) and offer sophisticated multimedia services. intelligence to make better judgements.

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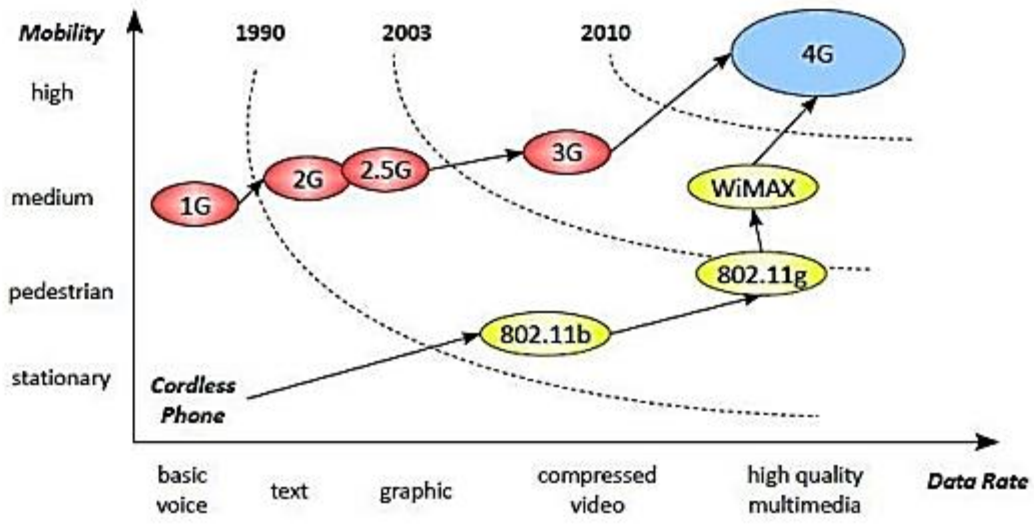

Figure 1. Evolution of Wireless Communications

A homogeneous wireless network uses a variety of wireless technologies, many of which are substantially different from one another. The bandwidths as well as the frequency they provide, the costs they charge, the geographies they cover, and the delay they impose are just a few of the many ways they differ. No wireless technology currently exists that can provide affordable services, large bandwidths, and fast latencies to a large number of mobile users. In this situation, Vertical Handoffs (VHO) across various wireless network types become crucial. The transition that takes place when a mobile device switches its connection to a new Base Station or channel is referred to as a "handoff" or "handover." One such instance is switching a phone or video call between two core network channels. Switching the underlying channel of communication (frequency, data rate, modulation scheme, spreading code, or a combination of these) while a call or session is active is known as handoff. The handoff method is how a mobile station maintains a live connection when transferring from one network connection point to another. In wireless LANs and cellular voice and data networks, this a connector is referred to as an Access Point (AP) and a Base Station (BS), respectively.

Network Discovery - The procedure through which an MS looks for available wireless networks to connect to. To pick up on service ads broadcast by various wireless technologies, a mobile station (MS) having numerous interfaces must first turn on those interfaces. Leaving all interfaces enabled is the quickest approach to find nearby wireless networks. However, even if no packets are being received or sent, keeping an interface active will still drain the battery. When evaluating the effectiveness of system discovery techniques, power efficiency and the speed with which a system is discovered are of paramount importance. In order to receive service announcements, the interface might be periodically engaged. The time it takes for the system to "wake up" depends directly on the activation frequency. The MS with the most frequent interface activation will likely find the accessible network first, but it will also likely run out of juice first. A low-frequency interface-activating MS may improve power efficiency, but it may take longer to learn about nearby wireless networks. Power efficiency and speed of system discovery are opposing factors.

Handoff Decision - The ability to choose when and to which access network to complete a handoff is known as "handoff decision." A mobile station's choice to perform a vertical handoff may be affected by a number of factors unique to both the current and target networks. A vertical handoff agent, located in the mobile station, may make decisions about mobile-controlled handoffs based on criteria like network capacity, load, coverage, cost, security, quality of service, or even user preferences.

Handoff Execution - In this last step of the vertical handoff procedure, the active session is actually transferred to the new attachment point. For this reason, the existing network must promptly tell the newly chosen network of the MS's route and other relevant contextual information. Algorithms for Vertical Handoff Decision (VHD) aid mobile stations in selecting the most suitable network for establishing a connection. Cost of services, power consumption, and mobile station speed may need to be considered by VHD algorithms in addition to Received signal strength (RSS) in order to maximise user satisfaction, in contrast to horizontal handoff decision algorithms.

Vertical Handoff Criteria and Metrics

The received signal strength is the most used metric since it is simple to assess and immediately relates to the quality of the service being provided. RSS readings and the distance between the mobile station and the point of attachment are highly correlated. RSS is a crucial requirement for VHD algorithms, and it is used by the vast majority of currently available horizontal handoff methods. The amount of time a mobile station spends connected to a certain access network is referred to as its "network connection time." In order to keep the service quality at an acceptable level, it is crucial to accurately predict when a network connection will be made. A handoff from a WLAN to a cellular network, for instance, might waste network resources if performed too early or fail altogether if performed too late. To further reduce the amount of handoffs that aren't essential, it's helpful to know how long it takes for a network to connect to the one you're trying to connect to. The mobile station's RSS is affected by its location and speed, both of which influence the time it takes to establish a network connection. The length of time a mobile station remains connected to a given network is then based on the RSS's fluctuation. Since heterogeneous networks often have varying amounts of network coverage, the network connection time is very crucial for VHD algorithms. For a mobile station (MS), the handoff delay is the amount of time between the end of packet reception on the old AN and the beginning of packet reception on the new AN after a successful handoff. Interactivity is severely impacted by the fact that handoff latency varies greatly across systems. Bandwidth, measured in bits per second (bit/s), is the capacity of a network to transfer data. It's a reliable measure of the access network's traffic load. Handoff with assured Quality of Service requires managing a mobile station's bandwidth needs while it is in motion. There will be less call failures and fewer blocked calls with more available bandwidth. Any handoff method should include bandwidth management. Internet traffic: The capacity constraints are established in accordance with the available bandwidth. This metric accurately depicts the base station's comms capacity. When a mobile station's battery life is threatened, power consumption becomes an urgent concern. When this occurs, it's best to transfer control to a fixed point so that the battery life may be preserved for as long as possible. We need to figure out how to reduce power consumption in 4G networks. Mobile switching and handoffs can have an energy cost. Handoffs may significantly deplete batteries due to the constant usage of interfaces. Because needless interface activation might increase power consumption, power efficiency is also a concern in network discovery. Therefore, the issue of power consumption must be taken into account while making a handoff choice. Money involved: Handoff choices may sometimes need to factor in the cost of a network service due to variations in billing practises among networks.

There has been a lot of effort done to provide smooth mobility for a mobile station (MS) while it hops across many heterogeneous wireless networks. However, the primary emphasis of this study is on the choices and initiations of vertical handoffs, an essential part of seamless mobility. The Received Signal Strength is the primary metric used in deciding when and how to do a horizontal handoff between two otherwise identical wireless networks. Typically, many network characteristics, including RSS, MS-Velocity, Security, Cost, and QoS, are considered while making decisions on vertical handoffs. The preferences of network users and the rules of network operators are often taken into account when making such choices. Unlike in homogeneous wireless networks, where handoff choices may be automated with relative ease, doing so in a diverse environment presents a number of challenges. There are a few distinct phases to a handoff: handoff initiation, choosing a destination network, and processing the handoff signal. The timing of a handoff is determined by its beginning. Accurately initiating the handoff is essential for its completion. A false handoff results from an early handoff, whereas a handoff failure results from a handoff that occurs too late. The second step, selecting the target network, would be less effective if the handoff was faulty, and the third step, processing the handoff signal, would be overburdened if the handoff failed. There are a plethora of suggested handoff algorithms in the literature, all of which aim to improve the accuracy of the handoff decision. However, these methods do not take into account network selection, which is independent of the network's static properties. Although handoff initiation and need assessment are just as crucial, most existing studies focus on selecting a target network. For optimal customer happiness, it's best to mix the two.

Literature Review

Zhengguo Sheng et.al (2018) This study proposes a 5G wireless network architecture that employs Dedicated Short Range Conversation (DSRC) for Vehicle-to-Vehicle (V2V) communication and millimetre wave (mmWave) for Vehicle-to-Infrastructure (V2I) communication. The proposed architecture utilises reinforcement learning (Q-learning) for both types of communication. Our study indicates that to achieve optimal vertical handoff decisions across different access radios, it is essential to create crucial vehicular connection management elements and a context-aware central intelligent wireless optimisation unit. Our commitment is demonstrated through a performance evaluation that is backed by extensive simulation and field testing.

Nasser M. Alotaibi et.al (2015) This study suggests a novel approach based on the use of several classifiers to address the challenging VHO decision problem. We want to provide a thorough review of the most recent research in this field and talk about the possibility of employing statistical classifiers to satisfy the strict VHO condition. The architectural design of the recommended technique is shown. The procedures used to develop the VHO system based on several classifiers are described.

Shuai Fu et.al (2014) Next-generation wireless networks incorporate several wireless access techniques to guarantee that mobile nodes (MNs) always have dependable wireless connectivity. For mobile nodes (MNs) operating in wireless heterogeneous networks, selecting an access point (AP) at random may dramatically reduce received signal strength (RSS) and subsequently quality of services (QoS). We manage vertical handoff using game theory, allowing MNs to start the handoff and choose a suitable network from a range of wireless access technologies. Conventional vertical handoff techniques, however, fall short because they do not account for the combined behaviours of MNs and APs. We propose a vertical handoff approach based on a set of repeated games to overcome this problem. The uncooperative strategy game among the MN and the AP that that makes up each of the sub-games has a solution known as the Nash equilibrium. By identifying its ideal equilibrium, the proposed recursive game aims to maximise the utility of the whole network. Our performance analysis shows that the recommended method increases throughput and network capacity utilisation when compared to a collection of wireless access points (APs) chosen at random..

Weights for Conversational Traffic Class

Table 1 provides a view of the AHP decision matrix for level-one parameters. These weights are only an example of how users could rate their own importance, and they might be adjusted if necessary.

Table 1 AHP decision matrix for level-1 parameters

Parameters	RSS	QoS	Velocity	Network loading	Security	Cost
RSS	1	1	3	4	5	7
QoS	1	1	3	4	5	7
Velocity	1/3	1/3	1	2	3	5
Network loading	1/4	1/4	½	1	3	5
Security	1/5	1/5	1/3	1/3	1	3
Cost	1/7	1/7	1/5	1/5	1/3	1

Table 2. Operating ranges of the parameters

Parameters	WLAN	WMAN	WWAN
RSS (dbm)	-110 – -55	-160 – -100	-150 – -90
Delay (ms)	100-150	10-50	10-75
Jitter (ms)	10-30	3-12	5-15
PLR per 10^6 bytes(%)	3-7	1-8	1-5
Throughput (Mbps)	50-150	20-100	0.1-3
Network Range (m)	0-100	0-350	0-750
Velocity (mps)	0-10		
Traffic load (%)	0-100		
Security	1-10		
Cost	1-10		

The range from -120 dBm to -90 dBm is used to create the "Low" fuzzy set for WLAN. Between -100 and -60dbm, the "Medium" fuzzy set is established, while the "High" fuzzy set is defined between -70 and -55dbm. The range of -160 dB to -135 dB is used to create the "Low" fuzzy set for WMAN. The range of "Medium" fuzzy set values is specified as -140 to -115dbm, whereas "High" values range from -120 to -100dbm. WWAN's "Low" fuzzy set spans -125 dBm to -150 dBm. A range of -130 to -105dbm is used to create the "Medium" fuzzy set, whereas the range of -110 to -90dbm is used to establish the "High" fuzzy set. WLAN network coverage, or the distance between WLAN and MS, is often discussed in terms of distances between 0 and 100m, such as 0-40 (Near), 20-80 (Medium), and 60-100 (Far). WMAN network coverage, or the distance between WMAN and MS, is often described in increments of 100 metres, such as 0-150 (Near), 100-300 (Medium), and 250-350 (Far). WWAN network coverage, or the distance between the WWAN and the MS, is often discussed in terms of distances between 0 and 750 metres, such as between 0 and 300 metres (Near), 200 to 600 metres (Medium), and 500 to 750 metres (Far). The MS-Velocity definitional universe spans 0–10m. The values 0–4 define the "Low" fuzzy set.

By comparing the scores, the network selection algorithm determines which networks are most capable of maintaining the availability and quality of the already provided service. In Figure 5.3, we can see the four types of traffic and their respective score values generated by the algorithm. It has been determined that a mobile station travelling at a speed of 2m/s favours WLAN for streaming and background traffic and WMAN for interactive and conversational traffic based on the network characteristics and their related weights. Although WLAN has a lower RSS, the algorithm favours it due to other considerations like speed, network load, and cost.

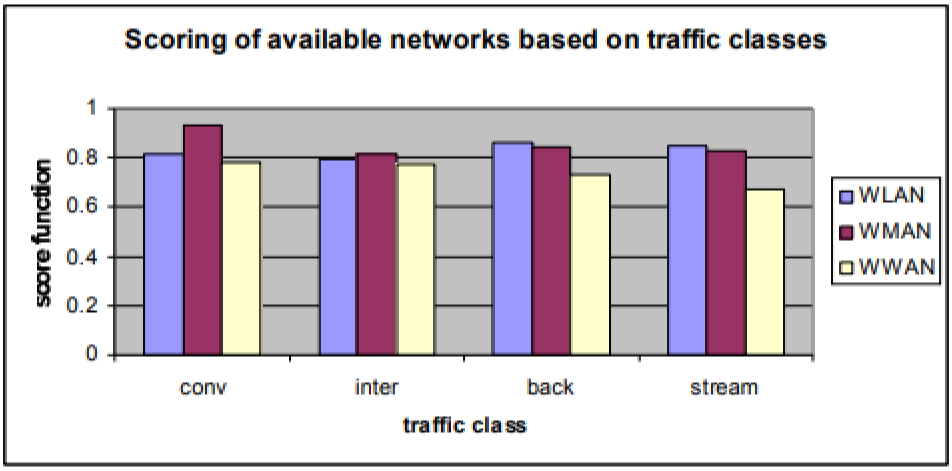

Figure 3 Scoring of available networks based on traffic classes (Velocity 2m/s)

The effectiveness of the suggested method is tested at velocities between 0 and 10m/s. Each velocity has a standard average call rate of 10 calls per second. Comparisons are made between the EVHD and the HMM based algorithms and the proposed Vertical handoff initiation and decision algorithm (VHIDA). Figure 4 shows that the VHIDA method, thanks to its accurate prediction and dynamic weights of the numerous factors, leads to a lower number of vertical handoffs and a lower handoff failure rate than the other algorithms. The amount of handoffs is shown to be little influenced by the MS's speed. Therefore, the suggested approach may be used in highly mobile, rapidly fading settings.

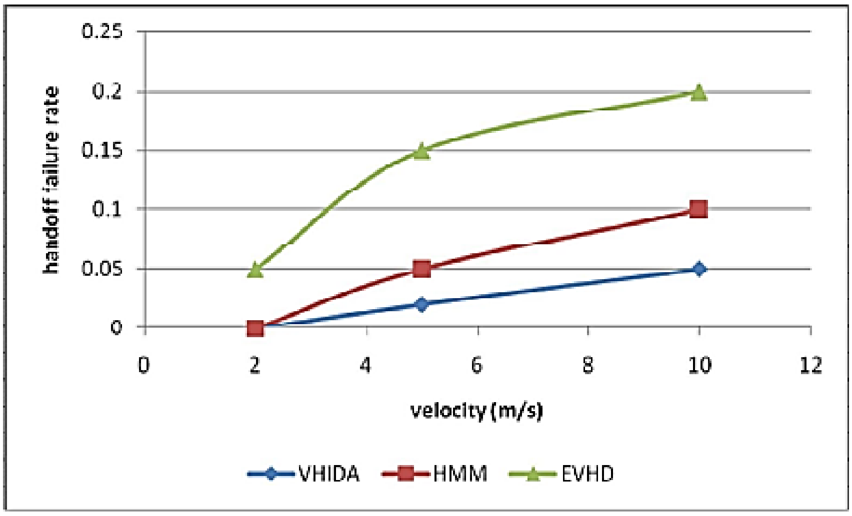

Figure 4 Handoff failure rate under various velocities

Conclusion

This study contributes to the theory and practise of vertical handoff by addressing key issues in this context, which is a highly integrated ubiquitous heterogeneous wireless environment. This thesis focuses on developing and implementing methods for intelligent and efficient vertical handoffs between nodes in heterogeneous wireless networks. The primary goal of the proposed systems is to reduce the amount of unwanted handoffs while simultaneously increasing the user's time spent on their chosen network.

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