FLEXIBLE VERTICAL HANDOVER DECISION ALGORITHM
FOR HETEROGENEOUS WIRELESS NETWORKS IN 4G

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https://doi.org/10.26782/jmcms.2019.12.00005

Abstract

Everyone around the globe would like to be linked flawlessly anytime, anywhere through the best network. The 4G network must have the capability to offer high information move rates, a premium of services and also smooth movement. In 4G, there is a sizable range of heterogeneous networks. The users for a variety of treatments would like to use different networks on the manner of their desires like a living, higher schedule and higher transmission capacity. When relationships need to shift in between various systems for performance as well as more top accessibility causes, the seamless vertical handoff is essential. To provide a systematic comparison, lately released VHD formulas have been categorized right into four significant classes depending upon the vital handover decision standard made use of, i.e. RSS located protocols, bandwidth located methods, cost feature-based algorithms, as well as the combination algorithms.

Keywords : 4G network, heterogeneous networks, handover decision, combination algorithms

I. Introduction

The term 4G is used extensively to consist of many forms of broadband cordless get access to communication systems, not only cellphone systems. Some of the terms made use of to explain 4G is actually MAGIC-- Mobile interactives media, anytime anywhere, Worldwide mobility support, included cordless remedy, as well as tailored personal solution. As a promise for the future, 4G units, that is actually, cellular broadband wireless gain access to devices, have actually been actually attracting much rate of interest in the mobile communication field. The 4G bodies not just will assist the next generation of mobile phone service, however additionally will assist the taken care of wireless networks. This paper offers an overall vision of the 4G features, structure, and also assimilation of mobile phone communication.
In heterogeneous wireless network environment, several networks can operate independently. These networks can either be of IEEE standard (WiMAX, WiFi) or 3GPP standard (UMTS, 4G LTE, WCDMA). All these networks provide mobile users connection as they move freely within the network coverage area. According to (Bijwe et al, 2015) we have mobile nodes which have multiple transceivers that can connect to multiple wireless networks at the same time. The objective of this system is to provide continuous connection with network that provide the best service for the user[II]. There are several wireless networks available to users based on their needs. In an heterogeneous network environment where users are authorized to make use of any of the accessible networks, there is need to disconnect from one access point (AP) and connect to another as the user moves.

The method of disconnecting coming from an offering AP to brand-new get access to aspect is called handover. Previously, the traditional way of handover utilizes acquire indicator durability (RSS) as the only specification for handover within systems of the same modern technology. RSS is undoubtedly not ample when handover entails numerous cordless network of various criteria. Example of specifications utilized for vertical handover include Little bit Mistake Price( BER), Mobile velocity, Bandwidth, Jitter, Network insurance coverage area, Record rate, Protection and so on.

4g networks were proposed to deal with numerous concerns experienced through 2G as well as 2.5 G systems, like low rates and also irreconcilable innovations (TDMA/CDMA) in various nations. Desires for 4g consisted of increased transmission capacity: 128 Kbps in an auto, and 2 Mbps in repaired uses. In theory, 4g will persuade Northern American in addition to European as well as Asian cordless air interfaces. The outlook for 4g is not either crystal clear nor specific. Part of the issue is that network service providers in Europe as well as North America presently sustain separate standards' physical bodies (3GPP for Europe and Asia; 3GPP2 for The United States And Canada). The criteria' physical bodies represent differences in sky interface modern technologies[III]. Additionally, there are financial inquiries also that cast doubt over 4g's worth. There is a worry that in several nations, 4g will indeed never be released. This problem is bared, partially, in the developing tourist attraction of 4G wireless modern technologies.

A 4G or 4th creation network is the name given to an IP-based mobile phone unit that provides gain access to through a selection of broadcast user interfaces [I] A 4G network guarantees smooth roaming/handover and also ideal hooked up service, integrating numerous broadcast accessibility user interfaces (like HIPERLAN, WLAN, Bluetooth, GPRS) in to a solitary network that users may make use of. Through this component, customers will possess access to different solutions, increased insurance coverage, the benefit of a solitary gadget; one costs with decreased full accessibility.
price, as well as other reputable cordless access despite the breakdown or even reduction of several networks.

At the best general degree, 4G construction will include three key locations of connection: Personal Region Networking (like Bluetooth), neighbourhood high-speed gain access to points on the network consisting of cordless LAN technologies, and cell connection. Under this sunshade, 4G calls for a broad range of cell phones that support global roaming. Each unit will certainly have the capacity to connect along with Web-located details that are going to be tweaked on the fly for the network is made use of due to the gadget at that moment. In other words, the roots of 4G networks hinge on the tip of pervasive computing.

### I. Short History of Mobile Telephone Technologies

| Technology     | 1G  | 2G  | 2.5G | 3G  | 4G  |
|----------------|-----|-----|------|-----|-----|
| Design: Begin  | 1970| 1980| 1985 | 1990| 2000|
| Implementation | 1984| 1991| 1999 | 2002| 2010|
| Service        | Analog voice, synchronous data to 9.6 kbps | Digital voice, short messages | Higher capacity, packetized data | Higher capacity, broadband data up to 2 Mbps | Higher capacity, completely IP-oriented, multimedia data to hundreds of megabits |
| Standards      | AMPS, TACS, NMT, etc. | TDMA, CDMA, GSM, PDC | GPRS, EDGE, 2xRTT | WCDMA, CDMA2000 | Single standard |
| Data Bandwidth | 1.9 kbps | 14.4 kbps | 384 kbps | 2 Mbps | 200 Mbps |
| Multiplexing   | FDMA | TDMA, CDMA | TDMA, CDMA | CDMA | CDMA |
| Core Network   | PSTN | PSTN | PSTN, packet network | Packet network | Internet |

### II. Features of Fourth Generation Technology

There are actually several sources which suffice to deal with a quick and easy question- why perform our firm need to have to make use of 4G modern-day technology? Below are actually a variety of the functions of 4G which make it an "most significantly" technology.

**Quality**

Industry pros state that consumers are going to undoubtedly surely not possess the ability to make use of affluent multimedias product throughout cordless get in touch with 4g. Instead of this 4G are actually heading to feature quite extraordinary on-line
video clip of top quality comparable to HD (hd) TELEVISION. Wireless downloads at rates reaching one hundred Mbps, i.e. fifty times of 4g, are manageable along with 4G.

**Interoperability and likewise effortless roaming**

A number of standards of 4g make it tough to walk along with interoperate around various units, whereas 4G gives an international criterion that gives worldwide movement. Many a variety of cordless receive accessibility to bodies normally differ in regards to insurance policy coverage, info rate, latency, as well as loss fee. Because of that, each of every one of them is really basically helped make to support a different set of details companies as well as likewise systems[IV], 4G will certainly deal with different kinds of terminals, which might should provide regular answers independently of their performances. This suggestion is referred to as solution customization.

**Totally converged options.**

If a consumer want to possess the capacity to access the network coming from tons of different devices: cellular telephone, notebooks, Pda he is totally free of charge to accomplish thus in 4G which offers relationship smart along with flexible sufficient to assist streaming online video, VoIP telephone devices, still or moving photographes, e-mail, Internet looking, shopping, and also location-based solutions using a variety of units. That suggests Independence for consumers.

**Economical**

4G units will definitely affirm more affordable than 4g, considered that they may be actually produced atop existing systems in addition to will not need to have operators to entirely reconstruct as well as likewise will not need companies to buy costly included realm. Alongside being actually a great deal a lot more expense reliable, 4G is really spectrally reliable, thereby carriers can do a lot additional together with a lot a lot less.

![Figure 1 : Key features of 4G](image-url)
Enriched GPS Solutions

In addition to finding people, a 4G model of FAMILY DOCTOR technology could be able to allow folks be practically existing in a wide array of locations.

Scalability

It is very most demanding element of the mobile networks. It pertains to capability to handle ever increasing amount of users and also solutions. Considering that an all IP center coating of 4G is actually effortlessly scalable, it is actually essentially suited to meet this difficulty.

III. Vertical Handoff (VHO)

Vertical handoff pertains to a network node altering the form of connectivity it utilizes to access a sustaining facilities, commonly to aid node variety of movement. As an instance, a correctly equipped laptop may have the ability to use both a high speed cord-less LAN as well as likewise a tissue technology for Net accessibility. Wireless LAN connections generally offer a lot higher costs, while mobile developments generally give a lot more omnipresent protection. Therefore the laptop customer can desire to make use of a cord-less LAN hookup whenever one is actually quickly on call, as well as to 'fall over' to a mobile connection when the cordless LAN is actually not readily available. Vertical handovers illustrate the automated fallover arising from one advancement to an extra if you want to maintain communication. The vertical handoff mechanism enables an incurable device to modify systems in between numerous kinds of networks (e.g., between 4g as well as 4G bodies) in a way that is entirely clear to final user procedures.

The vertical handoff treatment consists of three main stages, particularly system breakthrough, vertical handoff decision, and also VHO execution. During the course of the training program of the system invention stage, the smart phone terminal establishes which devices can be taken advantage of. These systems may additionally promote the supported data rates as well as also High quality of Service (QoS) rules. In VHO decision stage, the mobile phone incurable creates whether the relationships need to have to continue taking advantage of the present network or perhaps be in fact switched to an extra network. The decision may depend on various standards or metrics featuring the form of the procedure (e.g., informal, streaming), minimal information transactions and likewise concern asked for due to the treatment, availability price; show energy, and also the consumer's preferences[V]. Throughout the VHO fulfillment stage, the hookups in the cellphone terminal are actually re-routed arising from the existing network to the brand-new network in a seamless method. This stage in addition is composed of the authorization, consent, in addition to relocation of a user's instance applicable information.
Handoff tracking intends for managing the correction of an access point (AP) if you want to maintain the link with the transferring resource during the course of the spirited documents transmission. The difficulty is actually exacerbated as a result of the visibility of APs utilizing different technologies. For this reason vertical handoffs, that is actually, handoff approaches in between APs of heterogeneous present day technology, require to be taken into account.

![Vertical Handoff in heterogeneous networks](image)

**Figure 2** : Vertical Handoff in heterogeneous networks

IV. Mobility Management Issues in 4G Networks

Mobility is actually an important aspect of 4G. There are actually 3 main concerns concerning flexibility administration in 4G systems:

The 1st concern take care of superior selection of gain access to innovation, or even exactly how to be greatest hooked up. Dued to the fact that a customer might be actually provided connection coming from more than one present day technology at any kind of sort of once, one must examine precisely how the terminal as well as likewise an overlay network select the radio get access to to present day innovation suited for remedies the consumer is really accessing.

![Image of network layers](image)

**Figure 3**
There are numerous network developments available today, which may be looked at as equivalent. As an example, WLAN is actually biggest matched for higher data rate inside insurance coverage. GPRS or UMTS, on the other hand, are actually better suitable for nation large insurance coverage as well as likewise may be actually deemed large location networks, providing a much higher amount of mobility device. Therefore a customer of the mobile phone incurable or the network requires to have to create the optimal alternative of program accessibility modern-day technology amongst all those supplied. A handover algorithm ought to each set up which network to connect to alongside when to do a handover between the a variety of systems. Basically, the handover algorithm are going to assure that the most ideal standard cordless internet link is really decided on. The network assortment procedure have to deal with the type of ask for being managed because of the customer at that time of handover. This guarantees dependability in addition to optimum bandwidth for included and also past history firms.

The 2nd trouble involves the idea of a range of motion allowed Internet Process creating connects with layout, which consists of the functionality to take care of wheelchair in between obtain access to present day innovations. This contains quickly, hassle-free vertical (in between numerous present day innovations) handovers (IP micro-mobility), top quality of service (QoS), protection along with analysis.

Real-time plans later will undoubtedly call for fast/seamless handovers for hassle-free feature.

Wheelchair in IPv6 is actually not optimised to capitalize on particulars units that could be in fact put together in numerous supervisory domain names. Rather, IPv6 offers range of motion in a fashion that corresponds to just basic transportability. To enhance Activity in IPv6, 'micro-mobility' approaches have really been actually created for smooth handovers i.e. handovers that result in extremely little bit of handover hold-up, extremely little bit of deal loss, as well as likewise marginal reduction of communication state.

The third issue concerns the adaptation of multimedias gear box all over 4G networks. Absolutely multimedias will certainly be a major solution function of 4G devices, along with changing broadcast get access to systems could in particular lead to extreme modifications in the network condition. Thereby the system for interatives media gear box should be actually adaptable.

In cell devices such as UMTS, clients total for uncommon as well as likewise expensive transmission capacity. Flexible little bit of rate services give a strategy to make certain business provisioning at lessened costs. In addition the broadcast environment has technicians that provides it challenging to give a certain network solution. This needs
that the solutions are actually adaptive and also tough versus varying radio health problems.

Higher variations in the network Quality of Service (QoS) results in substantial assortments of the interactives media premium. The end result may sometimes be actually unwanted to the consumers. Stopping this calls for going for an adaptive inscribing structure for mixeds media gear box. The network must imply QoS varieties to make it possible for the treatment to be informed directly of the network conditions. Consumer communications will certainly assist to ensure tailored adjustment of the mixeds media discussion.

V. Handover Decision Algorithm

The recommended algorithm makes use of mobile measured vertical handover, considering that merely mobile possesses the expertise regarding unplanned Wi-Fi networks. Due to limited resources in mobile devices, the decision algorithm must be easily determinable and ought to be power dependable using lower processing opportunity. Even more over it ought to have the capacity of making decision on numerous attributes for smart decision. Various features treatment concern ratings, user interface plan score and user unprejudiced scores.

To help make handover decision based on the situation, the proposed algorithm uses circumstance conscious plan by collecting current network attributes featuring RSSI, QoS specifications, electric battery condition and also mobile velocity. These accumulated metrics are actually appointed with the predefined weights and afterwards passed to unclear based various characteristic decision making system. These accumulated analog values from different networks are normalized into popular scale (away from 10 scales) and entered the fuzzy reasoning unit. Analog market value can easily certainly not be actually refined due to the blurry logic bodies (Mehbodniya et cetera, 2012); it must be actually transformed to etymological worths.

![Figure 4: Handover information gathering](image)

*Figure 4: Handover information gathering*
Figure 5: Working flow of intelligent vertical handover decision algorithm

So these input specifications from the mobile phone module are actually supplied right into a fuzzifier as well as changes all of them right into blurry collections based subscription features. These etymological values are supplied right into the fuzzy inference engine. Then a set of blurry IF-THEN guidelines are actually put on secure the unclear decision collections. Fuzzy output decision collections consist of etymological values like Strongly Yes, Yes, Uncertain, No and Definitely No. The outcome fuzzy decision sets are incorporated into a solitary fuzzy collection and passed onto the defuzzifier to be converted into handover decision measurement worth. Based upon this worth, handover decision are going to be created. Fuzzy located tactic executes handover decision through selecting the necessary time and also one of the most suited gain access to network depending on to consumer preferences.

VI. Results and Discussion

The proposed method has actually been actually applied in Ubuntu located maker for determining precise performance and efficiency of the designed algorithm. The planned algorithm uses signal durability, top quality of service, company price, energy demands, mobile speed, place info, record fee, network latency as well as consumer preferences. The designed algorithm utilizes indicator strength, top quality of service, solution and safety and security possibilities. The decision algorithm makes use of common criteria to sup- slot assimilation of all high data fee innovations. Yet currently, many of the smart phones and notebook makers have the assistance for
merely Wi-Fi as well as 4g connection. Therefore for implementation, only these pair of innovations have been actually taken in to account.

Figure 6 shows the application of information through mobile terminal through information acquired utilizing tool analyzer application. If our company check out the overall data made use of, information from 4g is actually much higher also in visibility of totally free Wi-Fi hotspot. It utilizes 4g network even if it possesses inadequate connectivity. Also in the presence of numerous free Wi-Fi hotspots, the mobile phone was relied on the 4g network for its data usage. Also under inadequate received signal, the mobile phone has transferred higher data amount in 4g, which leads to heavy power drain.

Figure 6 : Utilization of resources in mobile terminal

Figure 7 shows that when variety of handover increases the packet reduction likewise increases due to higher signaling bunch. Yet still the planned algorithm reveals it

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possesses high throughput with minimum variety of packet reduction. Figure 8 show that when variety of handover boosts, the Big salami Opportunity (RTT) additionally increases. Yet it has really minimal deviation (< 4ms). The average handover problem for this practice has been noted as 30-40 ms.

Figure 8 : Average RTT analysis of proposed algorithm

X. Conclusion

The components of 4G devices may be outlined with one word-Integration. The 4G devices have to do with effortlessly incorporating terminals, systems, and also functions to please enhancing customer requirements. The continual growth of mobile interaction as well as even wireless networks shows documentation of remarkable growth in the places of the mobile consumer, cordless network get to, mobile solutions, as well as functions. The designed algorithm categorizes the request source demands to live and non-actual time. If request information criteria are classified precisely based on the market utilizing software substances after that, the algorithm will conduct better.
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