International Journal of Engineering Research & Technology (IJERT)
ISSN: 2278-0181
Vol. 2 Issue 6, June - 2013

Design Of Secured Handoff Mechanism For WiMAX & 3GPP LTE

Pragati T. Kene, Managala S. Madankar
Department of Wireless Communication & Computing , G.H.Raisoni College of Engineering.
Department of Computer Science & Engineering , G.H.Raisoni College of Engineering.

Abstract

A key issue that aids in providing seamless vertical handoff in Next Generation Wireless Networks is, the ability to correctly decide at any given time whether or not to carry out vertical handoff and determine the best handoff candidate access network. This paper mainly deals with a network selection mechanism based on Fuzzy Multiple Attribute Decision Making which takes into account Received Signal Strength (RSS), Available Bandwidth, Network coverage , QoS and User preference as the decision parameters. With the help of simulation result the handoff between the two network (WiMAX and 3GPP LTE) has been shown. The proposed mechanism avoids unnecessary handoff and assures successful handoff mechanism. Security is a big question in case of WiMAX. Hence the 128 bit key based AES (Advance Encryption Standard) encryption is implemented to encrypt communication so that no one can hack the data while the communication between the source and destination node is going on . Enhancement in the security by using AES, increases overhead and hence RLE algorithm which provides lossless data transfer, is implemented for compressing the data before sending and decompressing the data after receiving. So as to achieve fast data transfer.

Keywords: *Handoff, WiMAX, 3GPP LTE, Fuzzy, AES, RLE*

1. Introduction

The proliferation of wireless and mobile technologies have revolutionized the world of communications. . During the evolution a range of wireless systems have been developed. All these systems were designed independently targeting different data rates, service types and user requirements. There is no single system that is good enough to replace all the other technologies. Instead of putting efforts into developing new radio interfaces and technologies for 4G systems, establishing 4G systems that integrate existing and newly developed wireless systems is a more feasible option [1].

The coexistence of cellular, 3GPP LTE and WiMAX access networks is termed as heterogeneous wireless networks [2]. The integration and inter operation of these heterogeneous networks pose several challenges. One of the important issues is the design of intelligent network selection algorithms that provide better performance to the multiinterface terminals in the integrated networks [3] [4] [5]. The IEEE 802.21 standard only provides the capability and possibility of allowing a mobile node to select a suitable network to handover. However, IEEE 802.21 does not have defined the way of how the networks selection process should be performed. A handoff algorithm must be capable of making a decision based on incomplete information and in a region of uncertainty. Here an adaptive multi-criteria handoff decision algorithm that incorporates fuzzy logic has been designed because of the inherent strength of fuzzy logic in solving problems exhibiting imprecision and the fact that many of the terms used for describing radio signals are fuzzy in nature [6] [7] [8].

2.Review Literature

Handoff algorithms can be classified based on handoff criteria and their processing, These algorithms are categorized as below

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Signal Strength Based Algorithms: The RSS is used as the main criterion to perform handoffs [9]. Different variations of this category exist as follows:

- *Relative Signal Strength Algorithms*: This is based on the comparison of RSS of the current Access Point with that of the target network. . A variation of this algorithm incorporates hysteresis [10], where a handoff is initiated only if the RSS measured from the target BS exceeds the

RSS from the current BS by an amount of hysteresis.

- *Absolute Signal Strength Algorithms*: In this type of algorithm, a handoff is requested as soon as the measured RSS drops below a certain threshold level.[11]
- *Combined Absolute and Relative Signal Strength Algorithms*: These algorithms must satisfy two conditions to perform handoffs [12]. The average RSS of the current BS must fall below an absolute threshold value and the average RSS of the target BS must exceed the average RSS of the current Base Station by an amount of hysteresis.

Bandwidth Based Algorithms: The available bandwidth offered by the Access Point to the mobile terminal is used as the main criterion for these algorithms [9]. Handoff can also be initiated based on both criteria, i.e., available bandwidth and RSS [13].

Distance Based Algorithms: In this category, the mobile terminal is always connected to the *nearest* Base Station.

Signal to Interference Ratio (SIR) Based Algorithms: These algorithms trigger the handoff when the SIR of the current Base Station drops below a certain threshold and another Base Station is available to provide a better SIR

Velocity Adaptive and Direction Biased Algorithms: Handoffs to the Base Stations, towards which an mobile station is moving, are encouraged in this category of algorithms [14].

Cost Function Based Algorithms: In this category, several performance metrics (usage cost, available bandwidth, delay, security offerings and power consumption, etc.) are used to calculate an overall network cost for all available candidate networks. Handoff is then performed to the network with the smallest calculated cost [15].

Pattern Recognition Based Algorithms: These algorithms can identify meaningful regularities in uncertain environments. The handoff problem is studied as a pattern recognition problem in [16] [17].

Prediction Based Algorithms: Estimated future values of different handoff metrics are used to predict the behaviour of the system [18].

Fuzzy Logic and Neural Network Based Algorithms: These algorithms are suitable for multi-criteria handoffs. Fuzzy logic based techniques allow us to model the qualitative aspects of human experts' knowledge and reasoning behind the handoff process to be encoded as handoff algorithms [19]. While, Neural Networks, using a comprehensive set of inputs and desired output(s), can be trained to perform optimal handoff decisions [20].

In [21], the vertical handoff decision is designed as a fuzzy MADM (Multiple Attribute Decision Making) problem. Fuzzy logic represents the imprecise information of some attributes and user preferences. The fuzzy MADM method consists of two steps. The first step is to convert the fuzzy data into a real number. The second step is to use classical MADM methods to determine the ranking order of the candidate networks. Two classical MADM methods are proposed: SAW (Simple Additive Weighting) and TOPSIS (Technique for Order Preference by Similarity to Ideal Solution).In SAW, the overall score of a candidate network is determined by the weighted sum of all the attribute values. The score of each candidate network is obtained by adding the normalized values from each metric multiplied by the importance weight assigned .In TOPSIS, the selected candidate network is the one which is the closest to the ideal solution (and the farthest from the worst case solution). The ideal solution is obtained by using the best values for each metric.

In [22], the network selected is based on Analytic Hierarchy Process (AHP) and Grey Relational Analysis (GRA). AHP decomposes the network selection problem into several subproblems and assigns a weight value for each sub-problem. GRA is then used to rank the candidate networks and selects the one with the highest ranking. The ranking of GRA is performed by building grey relationships with a positive ideal network. The selected network is the one which has highest similarity to the ideal network.

The Multiplicative Exponent Weighting (MEW) is another MADM method [23]. The vertical handoff decision problem is expressed as a matrix form, where each row corresponds to the candidate network and each column corresponds to an attribute (e.g., bandwidth, delay). The score of network is determined by the weighted product of the attributes (or metrics).The importance weights required for MEW and other vertical handoff decision algorithms are calculated by using the eigenvector method. The weight values depend on the QoS requirements of the traffic classes.

3. Methodology

Following are the requirement for the Handoff mechanism for Heterogeneous Wireless Network .

- A handoff mechanism based on multiple handoff parameter is required to reduce call drop probability and un-necessary handoff.
- The handoff operation or execution should be fast in order to reduce packet loss.
- The security and privacy of the user data should be considered .

Here the objectives are divided in two parts, the first part is to implement a Handoff mechanism using Fuzzy logic for efficient handoff decision and the second part is to achieve secured and fast Handoff using AES and RLE algorithms.

The vertical handoff decision function is triggered when any of the following events occur: (a) when the availability of a new attachment point or the unavailability of an old one is detected, (b) when the user changes his/her profile, and (c) when there is severe signal degradation or complete signal loss of the current radio link A Mamdani FIS can be used for computing accurately the handoff factor which determines whether a handoff initiation is necessary between an 3GPP LTE and WiMAX. The decision to handoff between 3GPP LTE and WiMAX network or vice-versa is dependent upon the five input parameters. QoS consideration is must since user satisfaction depends on it. User Preference is important as service requirement of user are indicated by it. RSS is an important factor for handoff . Available Bandwidth is required for handoff from current network to target network. Network Coverage is required to be connected to the target network. Hence these five factors are considered in the proposed mechanism,Figure1 indicates the same.. For data security AES is proposed while for data compression RLE is proposed.

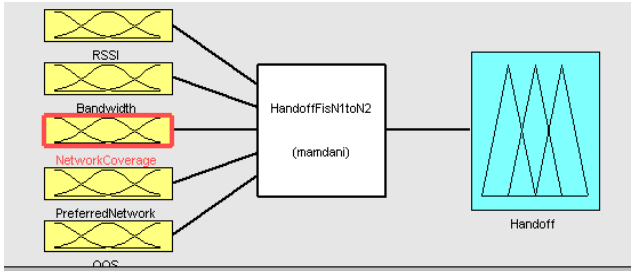

Figure 1 : Fuzzy Interface System

Each of the input parameters is assigned to one of the three fuzzy sets for every parameter; like , the RSSI fuzzy set values consist of the linguistic terms: Strong, Medium, and Weak. For bandwidth and QoS the linguistic terms are: low, medium and high. While that for the Network Coverage it is Bad, Medium and Good .And for preferred network there are only two values Network1 and Network2. The output linguistic variables of fuzzy inference handoff decision are given as {Yes, Preferably Yes, Uncertain, Preferably No, No} = {Y, PY, UC, PN, N}.

The crisp values of the input parameters are fed into a fuzzifier in a Mamdani FIS, which transforms them into fuzzy sets by determining the degree to which they belong to each of the appropriate fuzzy sets via membership functions (MFs). Next, the fuzzy sets are fed into a fuzzy inference engine where a set of fuzzy IF-THEN rules is applied to obtain fuzzy decision sets. The total number of rules is calculated as

$$[\text{No. of sets}]^{\text{No. of parameters}}.$$

There are five parameters, four (RSSI, Network Coverage, QoS, Bandwidth)of which have three sets of values for each parameter and one(User preference) have two sets of values for its representation. Thus, the number of rules in this case is given as

$$[x]^m . [y]^n = 162 \text{ rules},$$

Where' x' is the number of sets used in User preference representation, that is, 2,' y' is the number of sets used in other four parameters that is, 3.' m' is the number of parameters having' x' sets and' n' is the number of parameters having y sets. Figure 2 shows some of the rules.

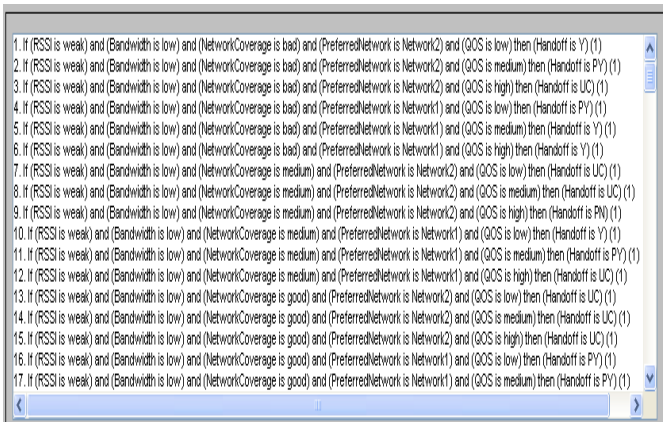

Figure 2 : Fuzzy Based Rules

The crisp handoff factor computed after defuzzification is used to determine when a handoff is required as follows:

if *handoff factor* > 0.5, then initiate handoff; otherwise do nothing.

Despite of so many advantages that WiMAX provides, security has been considered as the main issue during the design of the protocol [24]. From the point of view of an end user, the primary security concerns are privacy and data integrity. Users needs that no one can eavesdrop on their sessions and that the data sent across the communication link is not tampered. This is achieved through the use of encryption. WiMAX encrypts neither the MAC headers nor the MAC management messages, with the purpose to enable various operations of the MAC layer. Therefore, an attacker, as a passive listener of the WiMAX channel, can retrieve valuable information from unencrypted MAC management messages [25].Hence Advanced Encryption Standard (AES) can be used for encrypting the data which is transferred between the nodes during handoff.

AES is based on the principle known as Substitution Permutation network (SP-network) which means there will be a series of linked mathematical operations in the block cipher algorithm.AES encrypts one data block of 128- bits which is fixed with three different key sizes 128,192,256 bits. The input of AES algorithm is 128-bit or 16 byte data which can be specified as a block. AES operates on a fixed number of bytes AES as well as most encryption algorithms is reversible. Which means that almost the same steps are performed to complete both encryption and decryption in reverse order. AES algorithm operates on bytes, due to which it becomes simpler to implement and explain. As mentioned before AES is an iterated block cipher. That means the same operations are performed many times on a fixed number of bytes.

The rapid growth of multimedia and networking technologies gives rise to numerous multimedia applications such as mobile, desktop, internet and video surveillance and has made the extensive use of the text data unavoidable. Compression is useful because it helps reduce resources usage, such as transmission capacity or data storage space . Since compressed data must be decompressed to use, this extra processing imposes computational or other costs through decompression. The text compression techniques are broadly classified into two categories: Lossless techniques and Lossy techniques. In lossless compression techniques, the original image/data can be perfectly recovered from the compressed (encoded) image/data.

Here the basic lossless compression technique named as Run Length Encoding (RLE) is considered. The Idea behind this algorithm is, If a data item d occurs n consecutive times in the input data we replace the n occurrences with the single pair nd.ie .Run-length encoding (RLE) is a very simple form of data compression in which runs of data (that is, sequences in which the same data value occurs in many consecutive data elements) are stored as a single data value and count, rather than as the original run [26].

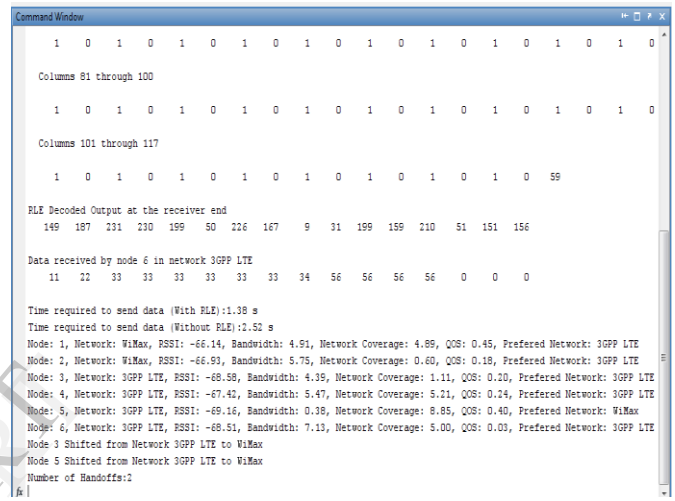

Figure 3 : Output Showing Handoff

RLE compression recognizes sequences of a repeating value, and replaces every sequence by a code, representing the value and the repeat count. The degree of compression depends on how much repetition is found in the data.

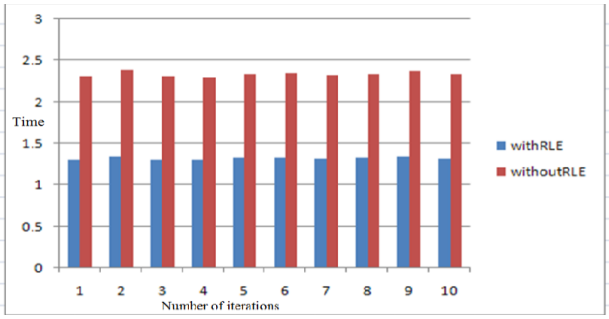

Figure 4 : Graph showing time required for Data transfer with and without RLE

4. Conclusion

Here Fuzzy based mechanism is proposed which takes in to account User preference, QoS, RSSI, Available Bandwidth, Network Coverage . Compared with single factor handoff decision the proposed algorithm subsequently reduces the ping-pong effect which drains heavily on resources; thus reduced number of unnecessary vertical handoffs save resources and time. The large number of input parameters increases the computational complexity, but reduces ping-pong effect. The simulation results in figure 4 shows that time required for the data transmission between the source node and destination is less when the RLE algorithm is used . The AES algorithm used for secured data transmission gives desired output that is the data send by the source node and the data received at the destination node is same which can be seen in figure 3.Thus a secured handoff mechanism is achieved using AES.

5.References

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