A Comparative Study of User Centric Vertical Handoff Decision Strategies

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Abstract— Rapid development in the advancement of wireless technologies and mobile user demands requires future wireless communication to be a conjunctive working of a few heterogeneous systems with their integral characteristics. A boundless difference of services over the accessible radio access systems is guaranteed by the cutting edge wireless systems for consumers with multi-homed cell gadgets. Numerous customer driven vertical handoff models were proposed in this area, aiming to benefit the end user. In this paper, we furnish comparison of two most recent user centric vertical handoff decision strategies. Implementation of these strategies is done utilizing OM Net++ and MATLAB and the results are presented with talk and dissection.

Index Terms— *Consumer Surplus Value, Expert Opinions, Heterogeneous Networks, User Preferences, Vertical Handoff Decision*

I. INTRODUCTION

The development of wireless technologies supporting high information rate, multimedia services and brilliant versatile terminals with interoperable air interfaces and adaptable programming segments, and IP based requisitions generated at whatever time, anyplace, any sort service connectivity stages for portable clients. Worldwide remote connectivity is pointed by the fourth era (4G) wireless systems [1] [2]. Quintessence worldwide wandering and high information rate services hoisted 4G from the previous forms of Wireless systems [3] [4]. To a great degree propitiatory and versatile meeting of a few portable terminals and system innovations sponsorship implicit probability for consistent remote access drives the design objectives of 4G frameworks. It is likewise vital to understand that the entry and arrangement of additional wireless innovations offering adaptable services can add to the multifaceted nature of hand off procedure.

Mobility management is the mix of location management and handoff management. Change of point of contact while upholding coherence of services of a mobile terminal throughout its meandering, is guaranteed by handoff management [1]. The occasions that impact handoff are versatility situations, system conditions, client inclination, system determination techniques (handoff choice strategies) for the determination of best system and execution conventions. Consistent system exchanging is the test of vertical handoff administration. Assessment of received signal strength (RSS) will be deficient for settling on vertical handoff choice. Additional parameters, for example, system conditions, administration sort, system scope, expense, power utilization, and client inclination ought to be taken into attention [5]. Discovering the perfect time for handoff to happen is exceptionally urgent for handovers. Handoff systems might be controlled in two ways, either system controlled or mobile terminal controlled components. System controlled handover arrangements can't focus the opportune time for handoff to occur on the grounds that they can't have the most recent data of the current circumstances of the portable terminal. Additionally system controlled components won't be suitable for execution of vertical handovers on the grounds that a system can't be mindful of the qualities of all different systems. Mobile controlled handoff choice plans will be ideal for vertical handovers since a portable terminal realizes a better way of its current circumstances.

II. RELATED WORK

The network quality of service (QoS) parameters and handover measures carry a significant role in choosing the most effective network. Handover measures information is gathered from the handoff induction phase and QoS parameters are thought of by the particular application [7]. In [8] vertical handover algorithm for conveyance communications was projected. In this they used intelligent transit to boost the safety policies. In [9] Ishizaka Alessio et al. projected edges and limitations of skilled decisions. The advantage of AHP is it follows the structural hierarchy of criteria, sub criteria and alternatives. And the disadvantage is - pair wise comparisons are written as positive reciprocal matrix however it's not appropriate for a few applications that involves currency.

In [10], SAW was planned for person selection problem. The limitation of SAW is within the higher cognitive process throughout judgment section, it ignores the fuzziness of the executives. However the advantage of SAW is that the relative order of magnitude scores remains same [6]. In [11] sensitivity analysis was performed to determine the sensitive attributes. In [12], merging of multiple parameters like user parameters, terminal parameters, and network parameters so as to pick out the most effective network was projected. In [13] context aware higher cognitive process model was instructed. This model takes context data from terminal aspect and network aspect so as to pick out the optimum network. In [14] a milling tool system for complicated issues like road and railway infrastructure was suggested. In this they used SAW for comparing attribute values of latest product to the attribute values of leader in this branch.

III. MATERIALS AND METHODS

In this section gives a concise explanation of the user centric vertical handoff decision strategies considered for comparative study.

A. User Preferences And Expert Opinions Based Strategy

User preferences and expert opinions based approach considers both users' preferences along with expert's opinions. The reason for considering expert's opinions is to prevent the users from experiencing unwanted performances. It works in accompaniment with AHP with consistency ratio which is a proven mathematical framework for multi criteria decision making models [7]. It ranks all the candidate networks based on users' preferences and expert's opinions. The network with highest rank will be the chosen network for vertical handoff to take place. The whole process is carried out in five steps which are given below.

Step 1: Forms structural hierarchy among the chosen criteria.
Step 2: Develops users' preferences matrix for the chosen criteria.
Step 3: Computes weights for the criteria based on users' preferences.
Step 4: Computes weights of the candidate networks over the criteria based on expert's opinions.
Step 5: Ranks are computed for the candidate networks.

A complete exploration of this strategy can be found in the paper entitled 'User preferences and Expert opinions Based Strategy' proposed by Dhanaraj Cheelu et al. [15].

B. A Fuzzy Based Intelligent Strategy

Fuzzy logic is the effective way to deal with the imprecise information of some of the attributes of the network and user preferences. Fuzzy logic based systems take into account human experts' innovative distinctions based on qualities to be commuted as algorithms to ameliorate the overall efficiency. Also handoff decision algorithms which are driven by multiple attributes can be tuned up for better performance by fuzzy logic strategies. Many such strategies were already proposed. Since selection of the best network is dependent on multiple criteria, concluding that one network is absolutely better than other networks is not possible always. Choosing the best network will definitely involve some kind of compromising or finding a balance among the many criteria evolving the best network out. Because of the uncertainty involved we have designed a Mamdani style fuzzy system for the selection of the best network. The fuzzy system takes two inputs, one from the multi criteria decision module (MCDM) module and the other from the CS module. The CS module computes the consumer surplus of each network based on the constraints set by the network providers. The MCDM module computes ranks for each of the candidate networks based on the experts' opinions. The result of the fuzzy system is selection factor (SF). The inputs are first fuzzified and are evaluated by the fuzzy rules. The individual outputs of each of the member functions are aggregated. Finally the aggregated output is defuzzified by calculating center of gravity, which is basically selection factor for a network. The network with the highest SF will be the chosen one for vertical handoff to take place.

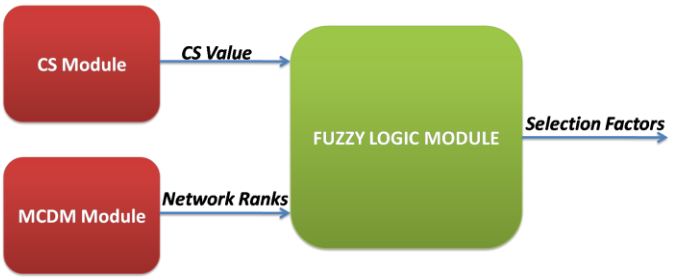

Figure 1: Block diagram of the Fuzzy System

A complete exploration of this strategy can be found in the paper entitled 'A Fuzzy Based Intelligent Vertical Handoff Decision Strategy with Maximized User Satisfaction' proposed by Dhanaraj Cheelu et al.[15].

IV. SIMULATION SETUP

The setting studied for the above two models comprises of three overlapping WLANs. Each WLAN comprises a number of affiliated downplay traffic developing wireless terminals. The three WLANs are adhered to a wired network which deploys the sink for the whole application information. We start with one smart client terminal established in the overlap locality which has the alternative to choose any of the three radio access networks for downloading a file. Subsequently added intelligent users are supplemented to make the vying traffic more sensible and thus the form and conclusions more unquestionable. All through the successive tests, the file dimensions used is 20MB. For each transmission two decision schemes are maintained: User preferences and expert opinions based strategy and fuzzy–based intelligent vertical handoff decision strategy. The simulation structure was constructed by OMNet++, version 4.1 with IEEE 802.11b WLAN contexts. Speeds are set to 144 kbps, 196 kbps and 226 kbps for WLAN 1, WLAN2 and WLAN 3 respectively. The topology utilized comprises of a wired network attached to three access points. Each access point has 25 affiliated wireless nodes. Application coded simulates two multi-homed nodes in the overlap locality of the wireless access systems, each inbuilt with CSINS and SCSNS respectively. The wired connections have trifling delay such that end-to-end hold up is mostly reliant on the performance of the chosen wireless access network. The sink acts as the server. After a moderately warm-up time span of 60 seconds, one of wireless terminals which is in the overlapped locality attempts to download a file of dimensions 20 MB. Throughout this the radio access network assortment is based on the User preferences and Expert opinions Based Strategy. The same file is then demanded by another intelligent mobile terminal in which case fuzzy–based intelligent vertical handoff decision strategy.

V. RESULTS AND DISCUSSION

This section contains a detailed study on the results. The results clearly demonstrate that the objectives of the two strategies have met in picking out the optimum network among many alternatives. The UPEOS picks the best network based on the ranks which are computed by the preferences given by the user. It can be seen that WLAN has the best rank hence it is the target network for vertical handoff. The FIVHDS picks the best network by finding balance between network speed and the consumer surplus value offered by the candidate networks. It can be easily noted down that WLAN 3 is offering the best transfer completion time for files of various sizes and WLAN 1 is the poorest. On comparison of the three networks considered WLAN 1 offers highest savings for the end user whereas WLAN 3 is the poorest. It can be easily established from figure 2 that WLAN 2 has the highest selection factor for files of any size over the other two networks.

A. Numerical Results For The Upeos

In terms of bandwidth, delay and jitter, pair-wise comparisons determine the preferences of each alternative over another.

BANDWIDTH

$$A_b = \begin{array}{c} \\ WLAN1 \\ WLAN2 \\ WLAN3 \end{array} \begin{array}{c} \begin{array}{ccc} \text{WLAN1} & \text{WLAN2} & \text{WLAN3} \end{array} \\ \begin{bmatrix} 1 & 1/3 & 1/2 \\ 3 & 1 & 2 \\ 2 & 1/2 & 1 \end{bmatrix} \end{array}$$

DELAY

$$A_d = \begin{array}{c} \\ WLAN1 \\ WLAN2 \\ WLAN3 \end{array} \begin{array}{c} \begin{array}{ccc} WLAN1 & WLAN2 & WLAN3 \end{array} \\ \begin{bmatrix} 1 & 4 & 3 \\ 1/4 & 1 & 2 \\ 1/3 & 1/2 & 1 \end{bmatrix} \end{array}$$

JITTER

$$A_j = \begin{array}{c} \\ WLAN1 \\ WLAN2 \\ WLAN3 \end{array} \begin{array}{c} \begin{array}{ccc} WLAN1 & WLAN2 & WLAN3 \end{array} \\ \begin{bmatrix} 1 & 1 & 1 \\ 1 & 1 & 1 \\ 1 & 1 & 1 \end{bmatrix} \end{array}$$

The Eigen values for the above alternatives are as follows.

$$E_b = \begin{bmatrix} 0.6483 \\ 0.2296 \\ 0.1220 \end{bmatrix} \quad CR=0.034 \leq 0.1$$

$$E_d = \begin{bmatrix} 0.6298 \\ 0.2186 \\ 0.1515 \end{bmatrix} \quad CR=0.10 \leq 0.1$$

$$E_j = \begin{bmatrix} 0.3333 \\ 0.3333 \\ 0.3333 \end{bmatrix} \quad CR=0 \leq 0.1$$

The weights of alternatives on each criteria is

$$E_a = \begin{array}{c} \\ \text{WLAN1} \\ \text{WLAN2} \\ \text{WLAN3} \end{array} \begin{array}{c} \begin{array}{ccc} B & D & J \end{array} \\ \begin{bmatrix} 0.6483 & 0.6298 & 0.3333 \\ 0.2296 & 0.2186 & 0.3333 \\ 0.1220 & 0.1515 & 0.3333 \end{bmatrix} \end{array}$$

$$E_c = \begin{bmatrix} 0.1634 \\ 0.5396 \\ 0.2969 \end{bmatrix}$$

Finally the ranks of the networks are computed are
$R1$=0.5447, $R2$=0.2544, $R3$=0.2006

The network with highest Eigen value is considered as the best network which is WLAN 1 in this case. Refer to [15] for complete details on the data and numerical computations.

B. Numerical Results For The Fivhds

Table 1 contains the consumer surplus values as computed by the CS module of the FIVHDS.

Table 1: Consumer Surplus Values

Networks	Consumer Surplus Values
WLAN 1	0.404371414
WLAN 2	0.365572514
WLAN 3	0.230056073

Ranks of the networks computed by the MCDM module are given below.

$$R = \begin{array}{c} WLAN1 \\ WLAN2 \\ WLAN3 \end{array} \begin{bmatrix} 0.9999 \\ 0.6271 \\ 0.7908 \end{bmatrix}$$

Refer to [16] for complete details on the data and numerical computations.

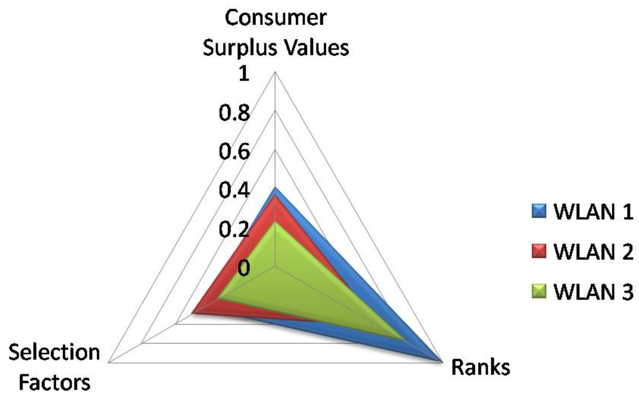

Figure 2: Comparison of various criteria of the networks

The consumer surplus values and ranks of the networks are given as inputs to the FIVHDS to compute selection factors for every network based on which best network will be selected. From the figure 2, it can be seen that WLAN 1 is offering best consumer surplus value as well as best rank over WLAN2 and WLAN3 respectively. But WLAN2 has the best selection factor over the other two networks. Since user satisfaction is solely dependent neither on money savings nor on transfer completion times. It is important to find a balance between these two criteria. It is achieved by fuzzy based approach which chooses WLAN 2. From figure 2, it can be seen that selection factor calculated by the fuzzy module is larger for WLAN 2 than the other two networks. Hence WLAN2 is selected for handoff.

CONCLUSION

In this paper, we have done a comparative study of user centric vertical handoff decision strategies. The two strategies considered for comparison are: User Preferences and Expert Opinions based Strategy (UPEOS) and a Fuzzy-based Intelligent Vertical Handoff Decision Strategy (FIVHDS) with maximized user satisfaction for next generation communication networks. The UPEOS strategy gives its users a complete opportunity to express their preferences over the decision criteria. But it is confined only to a group of users who are aware the network technologies. And also, the UPEOS strategy does not consider the cost parameter in the decision process. The FIVHDS considers user preferences as well as cost parameter promising the users money savings based the quality of services offered. Thus, intuitively it can be concluded that FIVHDS maximizes user satisfaction over UPEOS.

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