

# A Smart Decision Algorithm for Handover

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## ABSTRACT

There has been a continuous demand, of smartphone users, for high bandwidth and the least usage cost of the network. The smart phone users require high bandwidth for the use of multiple mobile applications. Vertical handover (VHO) becomes necessary for hassle-free running of these mobile applications while smartphone users are traveling. In this research paper, we present an intelligent decision algorithm for vertical handover which decide the best network among the available candidate networks. The decision is based on the calculation of the score value of the networks. The parameters considered are the cost of the usage, bandwidth and battery consumption. We have considered two networks scenario i.e., 3G & wireless local area network (WLAN).

**Keywords:** Received Signal Strength, Vertical Handover, Vertical Handover Decision Algorithm.

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## INTRODUCTION

With the current growth and development in the area of mobile computing, mobile handsets need to switch connectivity to the various Radio Access Technologies (RATs).<sup>[1,2]</sup> This results in an interesting issue of deciding the "best network" among the available candidate networks in the given area. The decision for the network selection is based on various parameters such as network usage cost, bandwidth and battery consumption.<sup>[3,4]</sup>

This research paper has been organized as follows: Section II provides Literature Review. Theoretical framework is explained in Section III. Section IV provides the design of the proposed system model. Section V gives the experimental scenario. Section VI provides Simulation & Results followed by Conclusion & future scope in Section VII.

## LITERATURE REVIEW

The authors have reviewed the papers written by researchers in the area of Vertical Handover (VHO). In<sup>[5]</sup> a performance analysis of mobile IPv6 and proposed improvements is presented. The simulation has been performed using NS-2 network simulator. In<sup>[6]</sup> the author has presented a policy-enabled handover. The main aim of this proposed model is to check the possibility of balancing the load of bandwidth across various networks. In<sup>[7]</sup> the link capacity measurement considering queuing delay and packet loss is presented. The estimation of the link capacity is done using a technique

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called CAPPROBE. In<sup>[8]</sup> the authors have presented an architecture for creating cluster-based scalable networks. In<sup>[9]</sup> the authors have presented an evaluation of structures of the cost functions and the optimization of the decision process. In<sup>[10]</sup> the authors have proposed an architecture known as Transport Layer Mobility. In this architecture, the change of the point of attachment is allowed for the mobile user. In<sup>[11]</sup> the authors have presented a mobile handover approach that uses a combination of the hierarchical approach, fast approach, and software-based movement monitoring methods. In<sup>[12]</sup> the authors have developed an app which is able to deliver seamless music while the occurrence of vertical and horizontal handover. In<sup>[13]</sup>, the authors have presented an approach for handover based on handover server and mobile node. In<sup>[14]</sup> the authors have implemented vertical handover among overlapping wireless networks. In<sup>[15]</sup> the authors have

presented an algorithm for selecting the network for vertical handover. The algorithm uses the approach combining the Analytical Hierarchy Process (AHP) & fuzzy logic. The research papers have explored various techniques for seamless handover across networks<sup>[11][16-19]</sup> The classification for VHO can be divided into two approaches - network layer approach & upper layer approach. The network layer approach focuses on IP V6 or IP V4 standards<sup>[3]</sup> The main requirement is network layer approach requires deploying the various agents for the purpose of the redirection of the data to Mobile Host (MH).<sup>[3]</sup> While in the upper layer approach, a session layer is implemented over the transport layer to establish the connection changes in the layers below the application layer.<sup>[10][12]</sup>

The solutions for the handover, whether it is using a network layer or transport layer, involve complexity. The solutions have complexity in implementation as well as operation. While using the network layer solutions, the implementation refers to the up gradation of every router that does not have mobile IP features. There is a substantial cost associated with this approach and hence acts as a barrier in the implementation of the solution. In the approach using upper layer solutions, a new session layer needs the updation for all present applications, systems & ecosystems. This requires substantial cost which hinders the deployment. As a result, while there are solutions for handover which have reduced latency (delay) and packet loss, the implementation becomes difficult due to the cost associated with the solution.<sup>[3]</sup>

Considering the present scenario of the use of the various application by the smartphone users the need exists for a handover solution which does not change the existing telecom infrastructure.

### Theoretical Framework

#### VHO – Parameters

The primary function of Vertical Handover (VHO) is to ensure that the mobile user is latched on the best network among the available candidate networks. Also the Quality of Service should be guaranteed.<sup>[20-22]</sup>

Vertical Handover Decision Algorithms (VHDAs) make the decision for VHO on the basis of the input parameters.<sup>[23-25]</sup> Received Signal Strength (RSS) is considered one of the most important parameters for deciding handover.<sup>[26-32]</sup>

Score Value (SV)

The Score Value (SV) for each and every network is calculated and then the handover is performed to the network with the highest score value.

Let us consider

n: total number of networks

m: number of parameter being considered for making decision

Then the Score Value of the network is given by the following equation

$$SV_n = \sum_{i=1}^m w_i f_{i,n} \tag{1}$$

Where

$$0 < SV_n < 1 \tag{2}$$

And

$$\sum_{i=1}^m w_i = 1 \tag{3}$$

In the above equation

$w_i$  denotes the weight of the parameter i

$f_{i,n}$  denotes the normalized value of network n for parameter i

The score value for the parameters is captured below as below :

$$SV_n = w_c f_{c,n} + w_d f_{d,n} + w_b f_{b,n} \tag{4}$$

Where

$w_c$  denotes weight for usage cost for network n

$w_d$  denotes weight for bandwidth for network n

$w_b$  denotes weight for battery status for network n

The values of  $f_{c,n}$ ,  $f_{d,n}$  and  $f_{b,n}$  are normalized between the values of 0 and 1.

The equations are represented as under:

$$f_{c,n} = \frac{1}{e^{x_n}} \tag{5}$$

Where

$$x_n \geq 0 \tag{6}$$

$$f_{d,n} = \frac{e^{y_n}}{-T} \tag{7}$$

Where

$$T \geq y_n \geq 0 \tag{8}$$

T is the maximum bandwidth required by the mobile user

$$f_{b,n} = \frac{1}{e^{z_n}} \tag{9}$$

Where

$$z_n \geq 0 \tag{10}$$

The coefficients  $x_n$ ,  $y_n$  and  $z_n$  are obtained through practical measurement.<sup>[3]</sup>

### PROPOSED SYSTEM MODEL DESIGN

In this section, the authors have described the design of the proposed system model. The connection between the various RATs and upper layer applications is provided by Handover Control Center (HCC). Figure 1 denotes the system model.

As shown in Figure 1, the HCC comprises of the following four parts. Device Monitor (DM): It is a device monitor which is used for monitoring a device. The main function of the DM is to monitor and report the status of each and every network. The parameters like Received Signal Strength (RSS), bandwidth and cost are monitored.

System Monitor (SM): The main function is to monitor and report the information and details pertaining to the system. The parameters monitored by SM are the battery status of

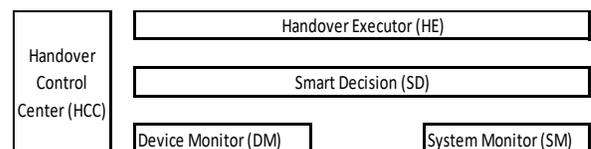


Figure 1: System Model

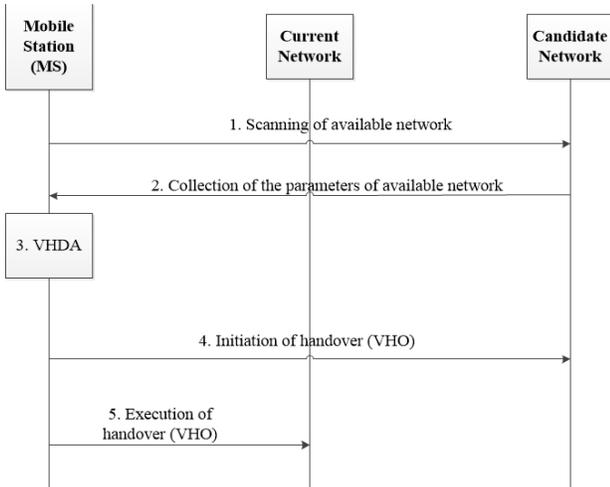


Figure 2: Handover process

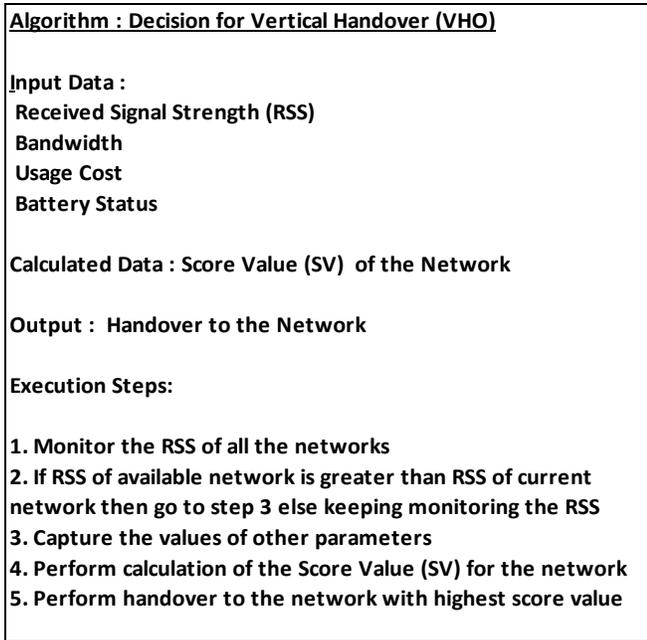


Figure 3: Algorithm for Vertical Handover

the handset.

**Smart Decision (SD):** The main function of this component is to perform integration of the details provided by the components like DM, SM along with the user preferences for making the decision for vertical handover. The component named Smart Decision selects the network on the basis of the Score Value (SV) of the network.

**Handover Executor (HE):** The main function of the Handover Executor is to perform handover to the selected network. The handover is performed in case the selected network is different from the current network.

The RSS of all the available networks is monitored. Once RSS criteria is satisfied, the value of the other parameters is fed into the algorithm and the output obtained is the Score Value (SV) of the network. Figures 2 & 3 represent the handover process and vertical handover decision algorithm

Scenario 1

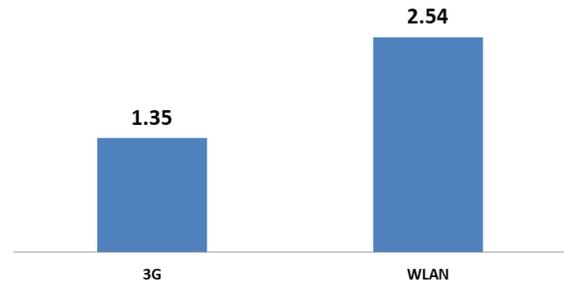


Figure 4: Score Value for Scenario 1

respectively.

### EXPERIMENTAL SCENARIO

In this section, the authors have described the experimental scenario. The authors have considered a practical and real-life scenario in which a mobile user (3G) is entering a café. The café has its own Wireless Local Area Network (WLAN). The user has two options

- To continue on to 3G network
- To latch on to WLAN.

The authors have considered various scenarios with different weightage of the parameters. The RSS criterion is checked before calculating the score value for both the networks and making decision on the handover. Practical values of network parameters have been considered.

### SIMULATION AND RESULTS

The simulation has been performed by considering two networks (3G & WLAN). The parameters for simulation are captured in table 1.

The cost of 3G has been taken as 0, since the mobile user has already subscribed for the monthly plan. For using WLAN of the café, the mobile user has to pay for the wifi Voucher (for using the WLAN deployed at cafe). The values of the cost for both the networks have been normalized on the scale of 0 to 1.

The maximum bandwidth available for 3G user is taken as 2 Mbps and the maximum bandwidth for WLAN is taken as around 4 Mbps. The available bandwidth for 3G is taken as 1 Mbps. The available bandwidth for WLAN is taken as 2 Mbps. The battery consumption in 3G will be less than WLAN. The battery of the mobile user is around 8 hours. The mobile battery will be available for 8 hours if user is latched on to 3G and the mobile battery will be available for 4 hours if the mobile user latches on WLAN. This is normalized on the scale of 0 to 1.

#### Scenario 1

$$w_c = 0.3$$

$$w_d = 0.3$$

$$w_b = 0.4$$



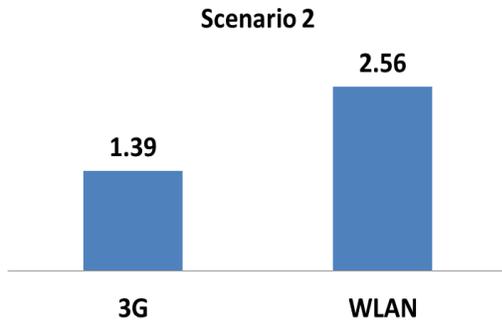


Figure 5: Score Value for Scenario 2

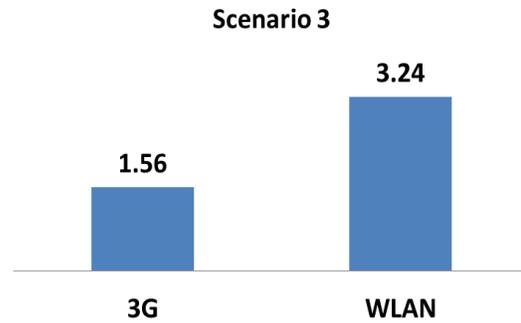


Figure 6: Score Value for Scenario 3

The values of simulation parameters are shown in table 1. Basis the values of the simulation parameters and weightages, the Score Values (SV) of both the networks is calculated. Figure 4 depicts the Score values for Scenario 1.

$$SV_{3G} = 1.35$$

$$SV_{WLAN} = 2.54$$

Observation from Figure 4 – The authors observe from above figure that the score value for WLAN is greater than 3G. Hence the handover should be performed to WLAN.

Remark: Perform handover to WLAN.

**Scenario 2**

$$w_c = 0.4$$

$$w_d = 0.3$$

$$w_b = 0.3$$

The values of simulation parameters are shown in table 1. Basis the values of the simulation parameters and weightages, the Score Value (SV) for both the networks is calculated. Figure 5 depicts the Score value for Scenario 2.

$$SV_{3G} = 1.39$$

$$SV_{WLAN} = 2.56$$

Observation from Figure 5 – The authors observe from above figure that the score value for WLAN is greater than 3G hence the handover should be performed to WLAN.

Remark: Perform handover to WLAN.

**Scenario 3**

$$w_c = 0.3$$

$$w_d = 0.4$$

$$w_b = 0.3$$

The values of simulation parameters are shown in table 1. Basis the values of the simulation parameters and weightages, the Score Value (SV) for both the networks is calculated. Figure 6 depicts the Score value for Scenario 3.

$$SV_{3G} = 1.56$$

$$SV_{WLAN} = 3.24$$

Observation from Figure 6 – The authors observe from above figure that the score value for WLAN is greater than 3G hence the handover should be performed to WLAN.

Remark: Perform handover to WLAN.

**CONCLUSION & FUTURE SCOPE**

In this research paper, the authors have presented Vertical Handover Decision Algorithm (VHDA) which considers parameters like Received Signal Strength (RSS), bandwidth, usage cost and battery status. The authors have performed the implementation for a practical and real-life scenario.

The VHDA is implemented using measured values of parameters on the field. The calculations of the score values for all the available networks have been performed. The selection of network for handover is performed on the basis of the calculated score values.

In future, the authors intend to design the algorithm for vertical handover using the Least Squares Weighting techniques. The authors also intend to establish the relationship between handover value and parameters using a polynomial regression model. The authors also intend to improve the algorithm for vertical handover by using more parameters like Quality of Service (QoS) and velocity of the user.

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Table :1 Simulation parameters

Parameter	Unit	3G	WLAN
x (Usage Cost)	INR	0	0.5
y (Available Bandwidth)	Mbps	1	2
z (Battery Consumption)	hrs	0.5	1
T (Max. bandwidth required by user )	Mbps	2	4

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