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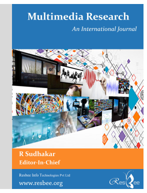

Mobility Management and Mode Switching using Support Vector Machine

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Abstract: In the communication fields, the service provides by the cellular networks received huge interest among researchers. Hence, mobile industries handle significant technological rivalry as regard service quality. On the basis of superiority, consistency, and a rapid service the quality, is determined, and finally, it is distributed to the user. Hence, one of the major factors here is mobility management because it is coping with the crucial information in order to manage the user's mobility. Nevertheless, because of the increase of linked devices, the users establish heavily motivates the researchers to formulate the new mode switching technique. Therefore, this work formulates a new mode switching technique by exploiting the Support Vector Machine (SVM). Based on numerous parameters quality such as bandwidth, link consumption, delay, energy utilization and signal strength, the mode switching depends. The parameter quality should maintain during the network switches communication connect to user mode from the cellular mode. A model for mobility management is formulated to enhance network performance in that user mobility is calculated. Hence, the adopted technique is important to aid the enhanced user mobility at the time of communication. By exploiting the adopted SVM model attains better performance with minimum delay, maximum power, link utilization ratio, and throughput correspondingly.

Keywords: Mode Switching, Mobility Management, Cellular Network, SVM, Classifier

Nomenclature

Abbreviation	Description
EAs	Evolutionary Algorithms
GA	Genetic Algorithm
MMS	Mobility Management System
CGAs	Cellular GA
PMIP-MIVH	Proxy MIPv6-based Mobile Internal Vertical Handover
ILP	Integer Linear Problem
HMWNs	Heterogeneous Multi-Hop Wireless Networks
HVN	Heterogeneous Vehicular Networks
LOOCV	Leave-One-Out Cross-Validation

1. Introduction

In the communication field, the accessibility and popularity of services offered by cellular networks and considered them as leaders. In 2017, on the basis of GSM1 connection, approximately half of the planet is exploited by mobile communication services. Here, service quality is considered as the main module, and it has performed the mobile industry with remarkable economical and technical competitions [1].

The quality can be calculated by means of rapid, consistency, and better service is requested, delivered from, or to a user. The needful information is handled by using the MMS which is a sensitive core, for the user's mobility management [3]. Using the MMS the research has exhibited that messages produced while attempting to place a mobile user make higher than the signaling traffic transistor by means of bandwidth. Moreover, the bandwidth is considered as one of the important economical value resources like overhead outcomes in numerous problems like failure of service, network congestion and the failure of communication which is offensive by both the consumers' and operators. Hence, the optimization of the users is considered as one of the chaotic tasks in nowadays 2G, 3G, and 4G networks [2].

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In a grid, EAs comprise of CGAs, are arranged systematically the population in which every node comprises an individual, and the communications among them, are prohibited using the neighbourhood. Identical to the CGAs, there are numerous other approaches which are typically exploited to solve issues such as MMP that is based upon the obstruction else incidence. The MMP result is based upon the fineness of parameter tuning. For creating the MMP model that experiences numerous procedures it is more suitable to identify the problem. In addition, the superior knowledge of techniques requires parameter tuning that is to be used to solve the issues. Hence, the lower effectual of the technique happens due to disparities in properties of techniques. New loop tuning is used thus to recuperate the efficiency of the issue is addressed without using an external agent. In addition, many research works exploited the deep learning methods [11] for mobility management.

The major aim of this paper is to develop a Mode switching by exploiting the SVM classifier for mobility management. Moreover, to attain the possible communication, the cellular mode is formed by the network switches mode for communication to user mode. The mode switching is performed on the basis of switching metrics that use particular constraints such as signal strength, bandwidth, delay, energy, mode, and utilization of the link.

2. Literature Review

In 2018, Zakaria Abdelmoiz Dahi et al [1], addressed the issue in user tracking procedures for cellular networks. Here, a novel minimum complexity adaptive cellular GA was proposed to address this issue. A torus-like structured population for candidate solution was proposed which controls the communication inside by exploiting the dimensional neighbourhood. In 2018, Sajal K. Das [2], worked on the mobility management topic. An information model was proposed for mobility learning and prediction which possess for the application in a diverse setting that included activity identification and smart services. The significance for privacy preservation in position-based services and mobility models was also worked. In 2018, Sanjay Kumar Biswash and Dushantha Nalin K. Jayakody [3], developed a user-centric performance-based cellular communication. The adopted method was considered as the key to mode switching and it aids a maximum degree of user's mobility at the time of the communication. On the basis of the quality parameters like utilization of link, utilization of energy, and delay the mode switching methods dependent. In 2008, Abraham George et al [4], worked on mobility management in HMWNs which was very significant in both single andmulti-hop communication models. Here, an innovative HMWN was proposed whereas heterogeneous networks, operating in single- and multi-hop modes were combined to present raised capability and improved coverage for users. In 2020, Livinus Tuyisenge et al [5], worked on the HVN paradigm it comprises in the integration of vehicular network and cellular networks. It creates the vertical handover, and it was considered as the main technologies for the IoV deployment. Hence, a vertical handover model was proposed and it was PMIP-MIVH that exploits logical interface and a Distributed PMIPv6 model to enhance the performance of the handover and as a result of the whole network's performance.

3. System Model

For bypassing cellular target nodes, the communication among devices assists users positioned in close immediacy and it linked to each other thus, entrust the traffic from the cellular communications. One of the most important problems in cellular network designers, the recycling of spatial frequencies is improved by device-centric communication. This problem is considered sensitive by means of the maximum population of cellular traffic and users. In a cellular network, to increase the spatial frequency and enhance the cellular network throughput to facilitate device-centric communication. The main objectives of this are to permit the transmitter-receiver pairs to create enduring peer-to-peer links.

If the transmitter chooses the receiver within the transmission, remove the target node while the transmitter is allowed and it swaps the information in device-centric mode. The device-centric communication assists short-range, minimum power connection to subsist by means of cellular connection and improve recycling of available spectrum and reduce power utilization and also it enhances the network throughput. Nevertheless, device-centric communication comprises a lot of problems such as resource allocation in cellular connections, interference supervision and mode is chosen. A new technique is formulated for the switching model to address this problem the switching factors such as bandwidth, switching factors, utilization of link, energy, and delay.

Consider device-centric communication which enables cellular network [6] in that, the target node is bypassed by the user equipment and swap information by means of the predictable receiver if the receiver is situated within device-centric proximity D_{max}. The utmost transmits the power Q_l of a UE, and receiver sensitivity, q_{min} is exploited to detect the device-centric proximity. Here,

$D_{max} = \left(\frac{q_1}{Q_{min}}\right)^{\frac{1}{G}}$ represents device-centric proximity, G indicates the path loss exponent for device-centric links.

In the device-centric proximity, the user apparatus possess an anticipated receiver situated and it is indicated as an impending device-centric transmitter. For communication, impending device-centric transmitter do not essentially select device-centric mode. In order to attain efficient mobility management, the communication mode is chosen based on the selection model it is considered as the research motivation.

4. Mobility Management using SVM Classifier in Cellular Network

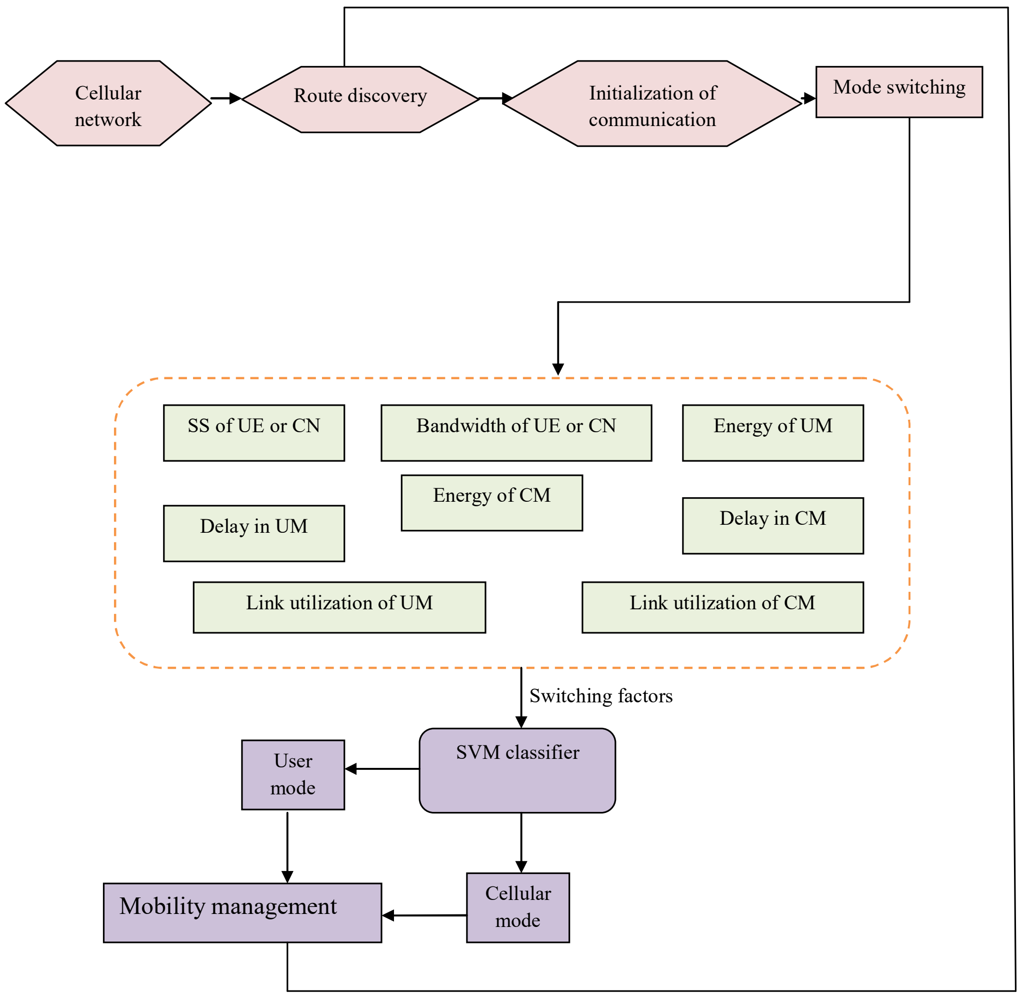

Fig 1. *Developed mobility management model exploiting SVM classifier in a cellular network*

The main objective of this paper is to formulate the devise mode switching method to establish mobility management in cellular networks. For further communication, at the initial stage, to set up a route, the initialization of the cellular network took place. After the set up of the route, the optimal routing algorithm [8] is carried out. Subsequently, the selection of optimal route, a dynamic mode switching model [7] is used for the initialization of communication. Fig 1 portrays the proposed mobility management model.

In order to attain reliable communication, to operate either in UM or UM, the network switches communication for every user.

On the basis of switching factor, the switch mode is decided that use measures such as Bandwidth consumption of CN or UE, Signal strength of UE or CN, UM or CM energy, UM or CM delay, and link exploitation of UM or CM.

To the SVM classifier [10], in order to choose CM or UM, the performance measures are subjected as input. Subsequent to the switching mode, for maintaining the route, mobility management is performed.

4.1 Initialization of Network

As a connected graph $M=(K,L)$, the network is designed whereas $K=(K_1,K_2\ldots K_s)$ indicate a cluster of content routers in the network and $L\subseteq(K\times K)$ indicates the cluster of bidirectional connects to devices that are linked in the network. Presume $N=(N_1N_2\ldots N_T)$ exhibit the cluster of a content object that is attainable in the network. In the network servers, these objects are chiefly detached that is unwaveringly linked to edge content routers.

Here, the restricted capability caches problem in the network is solved thus the main objective of least network latency is attained.

Hence, optimal routing problem is designed as an ILP and devised as,

$$\min_{u,v}:\sum_{x=1}^{S}\sum_{y=1}^{T}m_x^y\sum_{r=1}^{S}t_{x,r,y}n_{x,r,y} \tag{1}$$

In eq. (1), m_x^y signifies request rate for object N_y at node x, $t_{x,r,y}$ signifies distance utilized by node x to request content object N_y from node r. Moreover, $n_{x,r,y}$ signifies an element that uses value one if node x downloads a replica of content object y from node r, that is devised as follows:

$$\sum_{r=1}^{s}n_{x,r,y}=1,\forall x,y \tag{2}$$

$$n_{x,r,y}\le W_{r,y},\forall x,r,y \tag{3}$$

$$\sum_{y=1}^{T}z^yW_{x,y}\le X_x,\forall x \tag{4}$$

In eq. (4), X_x signifies utmost cache size at the router x, and z^y signifies content object size N_y. where, $W_{x,y}=1$, if node x caches a replica of the element y and0 else and is scientifically formulated as,

$$n_{x,r,y}\in\{0,1\} \text{ and } W_{x,y}\in\{0,1\},\forall x,r,y \tag{5}$$

4.2 Route Discover

The optimal routing algorithm is used to perform the route discovery [9]. Initially, the update and network information is observed by the controller in a particular time period.

The number of users and real-time loading conditions can be attained during the observations. Each time the content is demanded by the mobile customer; hence the content name and request are covered and transmit to the network edge device. Subsequently, the collected information is used by the controller in order to compute the best routing path by means of minimum network cost between the providers that save the user request content. Then, based on the number of the user request and cache replacement it customizes in-network cache condition. In order to obtain least network latency in control circumstance, optimal routing and the virtual network is set up by examining the content status and vibrant storage.

4.3. Mode Switching Exploiting Performance Measure by SVM Classifier

Here, the dynamic mode switching process is illustrated using the SVM classifier [10].

To select the UM or CM, to the classifier in order to obtain reliable communication, the switching factors are subjected as an input. In network infrastructure, the user-centric mode possesses minimum trust, an da related improved node, which has the examination over the performance metrics. The switching mode process is stated as follows:

A. Steps for Mode Switching Exploiting Switching Factors

The concise description of the developed switching mode procedure is stated as follows:

i) A call is initiated by the UE, and the allied improved node overtakes the call.

ii) The position of cell and caller is computed by the improved node and the position of the target node is also determined.

iii) The switching metrics such as delay, link consumption, signal strength, energy, and bandwidth are calculated by the improved node for each CN and UE and it is considered as the target mobile user.

iv) In order to decide the user to work either in CM or UM, the attained switching metrics are subjected to an SVM classifier.

v) For each mobile user, the QoS parameter is evaluated by the improved node in UM. Suppose, the value of the threshold is higher than the value of the QoS subsequently, it attaches the relay node to enhance the network performance.

vi) The system performance is controlled by the improved node which possesses the user-centric pairing to provide the suitable QoS.

The performance is monitored by the network, and certain actions are adapted to provide superior services to mobile users.

This phase contains two secondary modules.

At first, the caller information is adapted by the network, andit is implemented an analysis on them. Subsequently, the SVM classifier [10] is used to decide in order to switch the modes based on the performance metrics, when switching among CM and UM.

In mode switching, in order to attain the enhanced performance, the bandwidth, signal strength, energy, delay, and link consumption are calculated and they are explained as follows:

B. Performance Measures for Evaluating Mobile Users

The mobile network infrastructure namely improved nodes is exploited in cellular networks, thus a mobile node has the ability to swap the information to another device. In cellular networks, this approach is called user-centric or device-centric communication. The user-centric pairs are used to enhance the performance of the network, whereas the switching metrics [7] such as bandwidth, signal strength, energy, delay, and link consumption is exploited and it is explained as follows:

4.3.1 Signal Strength

It is indicated as the output power, and by exploiting the reference antenna, the output power is attained using the transmitter at a certain distance from the transmitting antenna. In communication, UE signal strength is computed as below:

$$R_{(\vartheta)} = \sum_{j=0}^{Z} g_e \eta_e \rho_h \prod_k^i \pi J + \sum_{j=0}^{z/2} g_e \eta_{e\pm1} \rho_{h\pm1} \prod_k^i \pi J \tag{6}$$

g_e indicates the probabilities formulated based on the departure and call arrival, e indicates position index, k indicates call departure conditions, η signifies the call arrival per unit area, ρ signifies the rate of traffic, π signifies link consumption, $\prod$ signifies condition change, J signifies per-hop link consumption cost, and j denotes the movement direction.

4.3.2 Bandwidth

It indicates the utmost data transfer rate in the specified path during computation. Moreover, it utilizes among source and target node and it is devised as follows:

$$B = \sum_{j=0}^{Z} \eta_e \rho_h \prod_k^i BC + \sum_{j=0}^{z/2} g_e \eta_e \rho_h \prod_k^i BC \tag{7}$$

In eq. (7), B denotes bandwidth allocation and C denotes service area.

4.3.3 Energy

In a cellular network, energy utilization is portioned into hardware and network energy. On the basis of the 3 modules, the network energy is focused, which are packet transmission, packet binding, and network update energies. Moreover, based upon the mobility factor and hop count these modules are dependent and it is formulated based on the UM and CM. Hence, in CM the energy utilization are devised as follows:

$$\varepsilon_{CM} = \prod_k^i \sum_{e=1}^{\gamma} \sum_{h=1}^{U} (\alpha + \beta + \chi) + \prod_k^i \sum_{e=1}^{\gamma} \sum_{h=1}^{U} \chi \tag{8}$$

In eq. (8), α signifies unit energy, χ signifies signaling cost, γ signifies hop count so that $1 \le e \le \gamma$, and U simplifies user mobility factor so that $1 \le h \le U$, and β simplifies network update energy. In UM, energy utilization is formulated as,

$$\varepsilon_{UM} = \prod_k^i \sum_{e=1}^{\gamma} \sum_{h=1}^{U} (\alpha + \beta + \chi) + \prod_k^i \sum_{h=1}^{U} \chi \tag{9}$$

4.3.4 Delay

Based on the network performance the communication mode is formulated, here, the delay in communication is formulated based on the propagation and processing time as it makes delay. Hence, in CM delay is calculated as follows:

$$P_{CM} = U g_e \left(\prod_k^i \sum_{e=1}^{\gamma} \sum_{j=0}^{\partial J} \rho + \pi_i^k \sum_{j=0}^{\partial J} \rho \right) \tag{10}$$

In eq. (10), ρ denotes communication delay and U denotes movement coefficient.

In UM, the delay is formulated as below:

$$P_{UM} = Ug_e\left(\prod_k^i \sum_{e=1}^{\psi}\sum_{j=0}^{\partial J}\rho + \pi_i^k \sum_{j=0}^{\partial J}\rho\right) \tag{11}$$

In eq. (11), $\psi = 2$ that shows 2 hop communications.

4.3.4 Link utilization

By means of total link capability percentage evaluation of link utilization is performed, which indicates the average traffic in a particular link.

The link efficiency is used in minimum frequent manner that is explained as ratio of time utilized to transmit data to total time used to acknowledge data. In CM, the consumption of link is devised as,

$$\pi = \max_{p_c, B_c}\left(\frac{A_c E_c}{I_c + I_{min}}\right) \tag{12}$$

p_c denotes the percentage of resource allocation in CM, I_{min} denotes minimum power allocation in CM, A_c denotes the energy dissipated in CM, and B_c denotes bandwidth consumption in CM and E_c denotes transmission rate in control mode, I_c denotes power owed in CM.

In UM, utilization of link is devised as,

$$\pi = \max p_u B_u\left(\frac{A_u E_u}{I_u + I_{min}}\right) \tag{13}$$

p_u denote resource allocation percentage in UM, E_u denote rate of transmission in UM, I_u denote power due in UM, and B_u denote utilization of bandwidth in UM and I_{min} denote least power allocation in UM, A_u denotes the energy dissipated in UM.

C. Adopted Mode switching method exploiting SVM classifier to switch modes

SVM is a classifier with outstanding performance and has a better result in terms of the analysis of nonlinear, least-sample, and high-dimensional data sets. By transforming data into a superior space in terms of the attendance of a kernel function, the SVM technique has the ability to identify a nonlinearly separable issue. The suitable kernel function is selected; hence a good classification effect is attained by SVM.

There are 4 general kernel functions:

a)The linear kernel function expression is stated as below:

$$K(Y_i, Y_j) = Y_i^T, Y_j \tag{14}$$

b) The polynomial kernel function expression is stated as below:

$$K(Y_i, Y_j) = (\gamma Y_i^T, Y_j + r)^d, \gamma > 0 \tag{15}$$

c) The radial basis function is expression is stated as below:

$$K(Y_i, Y_j) = \exp(-\gamma \mid\mid Y_i^T, Y_j \mid\mid^2), \gamma > 0 \tag{16}$$

d) The Sigmoid kernel function is expression is stated as below:

$$K(Y_i, Y_j) = \tanh(\gamma Y_i^T, Y_j + r) \tag{17}$$

Amongst them, Y_i, Y_j indicate the two common sample data vectors, γ indicates gamma parameter setting of kernel function r indicates parameter of the coefficient in kernel function Set, and d indicates polynomial degree parameter. The technique of LOOCV is used to SVM classifier by means of 4 kernel functions.

D. In Cellular Network Mobility Management Scheme

In any direction, mobile users have the ability to move freely in the cellular model regarding its communication infrastructures. On the basis of the mobility model, in all directions of cells, the users are permitted to move. To improve network performance measures, the mobility management efficiency procedure helps. The performance of the allied can degrade, suppose any node changes its positions throughout communication, hence, the QoS impact occurs. Based on the communication, in order to manage the user mode or cellular model mobility management is responsible. In addition, suppose it is minimum than threshold value subsequently communication is returned to existing mode. In order to attain cellular communication, node mobility is considered as one of the important factors as it permits the user to explore in every direction for superior QoS. In particular coverage area, A the mobile user travels in which, the starting position of the user in a 3D plane is presumed as $p_1(\kappa_1, \lambda_1, \upsilon_1)$ and the present position as $p_2(\kappa_2, \lambda_2, \upsilon_2)$. The distance between the starting location and the present location is stated as,

$$\text{Dist} = | p_1 p_2 | \tag{18}$$

$$\text{Dist} = \sqrt{(\kappa_2 - \kappa_1)^2 + (\lambda_2 - \lambda_1)^2 + (\upsilon_2 - \upsilon_1)^2} \tag{19}$$

5. Result and Discussion

In this section, the efficiency of the developed technique was described by demonstrating the techniques by means of existing techniques regarding the throughput, delay, link consumption, and power exploiting 50, 100, and 150 users.

Table 1: *Performance analysis of the proposed model with the conventional model*

Nodes	Metrics	LM model	Adaptive CGA model	User-centric communication model	Proposed model
50 nodes	Delay (sec)	0.677	0.669	0.666	0.667
	Power (dbm)	65.539	19.377	37.756	77.776
	Ratio of Link utilization	0.69	0.696	0.691	0.715
	Throughput (bps)	1701571	1667135	956677	1956173
100 nodes	Delay (sec)	0.19	0.196	0.179	0.167
	Power (dbm)	69.777	33.909	36.766	59.796
	Ratio of Link utilization	0.76	0.766	0.767	0.767
	Throughput (bps)	1139576	1550009	936396	1671763
150 nodes	Delay (sec)	0.179	0.173	0.176	0.169
	Power (dbm)	79.33	19.117	35.176	50.669
	Ratio of Link utilization	0.713	0.713	0.719	0.76
	Throughput (bps)	1050966	1306099	963960	1663606

The evaluation of techniques exploiting 50, 100 and 150 nodes regarding the power, throughput, delay, and link utilization ratio is summarized in Table 1. The evaluation is carried out by changing the experimentation time from 1 sec to 475 sec. Here, delay, power, ration of link utilization and throughput is used to analyze the performance of the proposed method. The overall analysis exhibits the proposed method performs better than the conventional models.

5. Conclusion

The main aim of this paper was to propose a new mode switching model for mobility management in cellular networks. This technique combines dynamic QoS-based mode switching andmobility management in a network. Moreover, the evaluation took place in energy utilization, bandwidth, link utilization, delay, and Signal strength for every mobile user. To process either in user-centric or cellular mode, the SVM classifier was utilized to switch the mode for the user. Here, the switching factors were considered as an input by the SVM classifier for switch the modes. For route maintenance, mobility management was performed subsequent to the mode switching. For cellular communication, the mobility among nodes was considered as an important factor that permits the user to explore in any direction for enhanced QoS. The adopted switching mode by exploiting the SVM classifier performs better than the other techniques.

Compliance with Ethical Standards

Conflicts of interest: Authors declared that they have no conflict of interest.

Human participants: The conducted research follows the ethical standards and the authors ensured that they have not conducted any studies with human participants or animals.

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