Performance Analysis of Modern Handoff Techniques Provide QoS in Mobile Networks

Mr. Selvan.C[1] and Dr. R.Shanmugalakshmi[2]

[1]Department of CSE, Government College of Technology, Anna University of Technology, Coimbatore, Tamil Nadu, India
[2]Department of CSE, Government College of Technology, Coimbatore, Tamil Nadu, India

Summary
Modern Wireless Mobile Network offers higher data rate, Quality of Service (QoS) and ability to roam across multiple heterogeneous wireless networks; several issues to be considered for further research and development. A handoff technique is the one of the several issues in Modern wireless mobile networks. An analytic model has been previously developed for evaluating the performance of handoff algorithms based on (i) Relative Signal Strength(RSS) measurements, i.e., the difference of signal strength from two Base Stations (BSs) (ii) Absolute Signal Strength(ASS) which is the averaged value of the received signal level from current serving BS measured by the mobile unit. In this paper we have extended this analysis by including an additional criterion based on the speed of the Mobile Node (MN) which reduces handoff latency in Mobile Networks. Better Base Station has been identified by using Better Base Station Selection Protocol (BBSSP). Based on the estimated round trip time, handoff signaling delay has been calculated. The information obtained from above and using speed of the MN, handoff is initiated in prior to support seamless communication. The model is compared with Double threshold points, BBSSP, IA and IA with BBSSP. The simulation results are sufficiently accurate by comparison studies of simulation.

Key words:
Handoff, Mobility Management, Better Base Station Selection Protocol, Modern Mobile Networks, Intelligent Agent

1. Introduction

In Modern Mobile Networks, mobile users are connected to the best available networks that suit their service requirements and switch between different networks based on their service needs. Efficient mobility management protocols are required to support mobility across heterogeneous access network. A challenging issue in Mobile Networks is to support seamless mobility management.

Mobility Management (MM) contains two components: Location Management (LM) and Handoff Management (HM)[1]. LM enables the system to track the locations of mobile users between consecutive communications. In Location Management, there are two methods, one is paging another is updation. Base Station (BS) will track the mobile nodes and mobile node will send the updation to the BS. Using Dynamic load balancing, unused channels will be used by introducing frequency reuse methods. On the other hand, Handoff Management is the process by which users keep their connections active when they move from one Base Station (BS) to another. Handoff may also be requested if the capacity of current network site is insufficient to serve the existing users. Because of the frequency reuse, the service providers able to give service more than 5crore people even though shortages of spectrum. This achievement is reached because of the technological advancement. HM protocols will operate from different layers of the TCP/IP protocol stack.

Mobile IP [2] that operates from the network layer is proposed to support mobility management in IP-based networks. It forwards packets to mobile users that are away from their home networks using IP-in-IP tunnels [2]. Transport layer mobility management protocols eliminate the need for tunneling of the data packets. TCP-Migrate [3] an architecture called MSOCKS [4] is proposed to support transport layer handoff management.

Mobile node requests the handoff procedure based on the received signal strength from Current Base Station (CBS) and New Base Station (NBS). There are four main handoff initiation techniques based on (i) Relative Signal Strength (ii) Relative Signal Strength with threshold (iii) Relative Signal Strength with hysteresis (iv) Relative Signal Strength with hysteresis and threshold. Handoff decision is made either by mobile node or the network.

The classification of handoff is shown below.

Classification of handoff
1.Horizontal handoff
i)Link layer handover
ii) Intrasystem handover
2. Veridical handoff

Manuscript received August 5, 2010
Manuscript revised August 20, 2010

Handoff between two Access Points(APs) that uses the same technology is said to be the Horizontal handoff which is further classified into **(i) Link layer handoff:** Handoff between two BSs that are under the same Foreign Agent (FA) **(ii) Intra system handoff:** Handoff between two BSs that belongs to two different FAs and both use the same technology. Vertical handoff refers to the handoff between two BSs that uses different technologies. The efficient intra and inter system handoffs depend on the following characteristics for seamless handoff and are:

- **Minimum handoff latency**
- **Low packet loss**
- **Limited handoff failure**
- **Intelligent Agent's computation**
- **Better Base Station Selection**

Handoff latency is the time duration between handoff initiation and handoff completion. At present the use of Link Layer information to reduce the handoff requirement detection delay has gained attention. The Link Layer information is used to anticipate the possibility of inter and intra system handoff in advance so that the handoff procedures can be carried successfully before the Mobile Terminal(MT) moves out of the coverage area of the serving BS. Hence very low packet loss and very limited handoff failure is tolerable. The IA's reply is used to take correct decision and to provide QoS in Mobile Networks.

The use of Link Layer information significantly reduces the handoff latency and handoff failure probability of handoff -management protocols.

2. Proposed System

In the proposed system we have used the following architecture for the Physical and Data link layer transmission. Physical layer comprises of two units namely **(i) Speed Estimation unit (ii) RSS measurement unit**. In Data link layer unit, we have **(a) Neighbour discovery unit** and **(b) Handoff signaling delay estimation unit**. Information collected from the above mentioned layers are used to carry out the handoff procedures, handoff trigger and handoff execution unit. The units are explained below.

Hence Intelligent Agent (IA) processes users' history of the handoff and predict the much possibility of the handoff. Hence failure rate and success of the event probability computed. This computation work will be performed depends upon the availability of the users' history. Before introducing Intelligent Agent, profile based and movement based data mining process processed to provide Quality of Service and to avoid failure of the connection while communicating between mobile nodes. Finally we compared Double Threshold Protocol with IA, BBSSP, and IA with BSSSP.

2.1 Neighbor Discovery Unit

It is used to identify the neighbouring stations through queries imposed to the selection router from mobile nodes or by using Better Base Station Selection Protocol (BBSSP). The operation of BBSSP is described below. In wireless networks mobile nodes need every now and then to change their Selection Router (SR). To make this handover seamless there is a need to know in advance where to connect.

BBSS Protocol is used to find those Selection Routers to which the Mobile Node (MN) could connect. All routers do not have equal capabilities and in order to be able to make a decision where the mobile node could get the service it needs, BBSS Protocol finds out selection routers' capabilities.

The Mobile Station (MS) learns about the neighbour BSs using the neighbour discovery protocol and determines the type of handover in the movement to the new Base Station (BS). Once the neighbouring BS is learnt, the Handoff Signalling Delay Estimation Unit estimates the signalling delay associated with the neighbouring BS. The RSS monitoring unit starts to monitor the RSS of the serving BS and anticipates a handoff when the RSS decreases continuously and in the selection of the next BS

2.2 Handoff Signalling Delay Estimation Unit

During change in location, it is difficult to predict to which particular BS the MS will move. The main objective of the proposed system is to estimate the handoff signalling delay in advance without knowing to which BS the MS will move. In the proposed one, we estimate the handoff signalling delay using the following steps. We have used invalid authentication extension to learn the handoff signalling delay without changing the mobility binding.

The handoff signalling delay is estimated based on the difference between the transmission time of the HMIP registration request message and the reception time of the handoff registration reply message.

2.3 Handoff Anticipation

This stage requires information from the Received Signal Strength (RSS) measurement unit. If the RSS of the serving Base Station decreases continuously, it shows the handoff is anticipated and hence the handoff trigger learns

the signalling delay for the particular Base Station from the handoff signalling delay estimation unit.
Thus the anticipated handoff is executed ultimately by transferring the user profile from one Base Station to the other. RSS measurement is estimated in separate unit.

2.4 Handoff Initiation Unit

Once the mobile node learns about the neighbouring Base Station it is going to move, it estimates the right time to start the HMIP registration. The handoff trigger unit uses the speed and handoff signalling delay information to estimate the threshold T1. When the RSS of the serving Base Station drops below T1, the handoff trigger unit sends the trigger to the handoff execution unit to start the HMIP handoff procedure. According to the RSS of the incoming mobile node the handoff is executed.

2.5 Handoff Execution Unit

The handoff execution unit receives the handoff trigger from the handoff trigger unit. It starts the handoff registration. Once the handoff registration is completed, the Mobile Terminal is switched to the new base station. The MS keeps its registration with the old base station for a specified time period to avoid the ping-pong effects during handoff using the binding method.

The mobile station binds the Care of Address (CoA) of the old Foreign Agent and new FA at the Gateway Foreign Agent (GFA) in intrasystem handoff and at Home Agent (HA) in intersystem handoff. Thus GFA and HA forwards packets destined for the MS to both CoAs during this time interval [2].

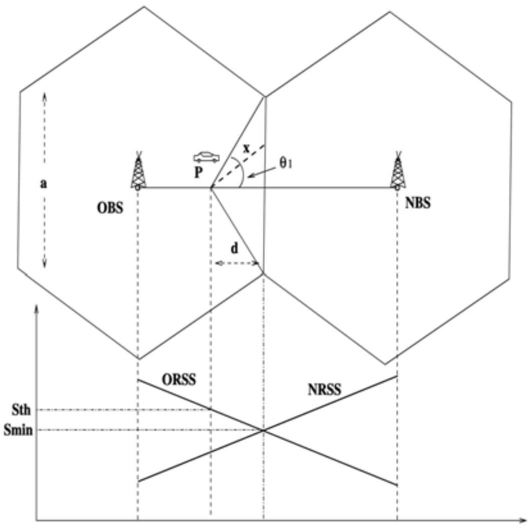

Fig. 1. Handoff Process

The operation of handoff management [7] is explained with the diagram shown figure 1.
In this handoff process, we design an analytical framework that Fig. 1, which shows a handoff from the current BS, referred as old BS (OBS), to the future BS, referred as new BS (NBS). We consider a scenario where an MT is currently served by OBS. We consider that the MT is moving with a speed v. During its course of movement, the MT discovers that it is going to move into the coverage area of the NBS [7].

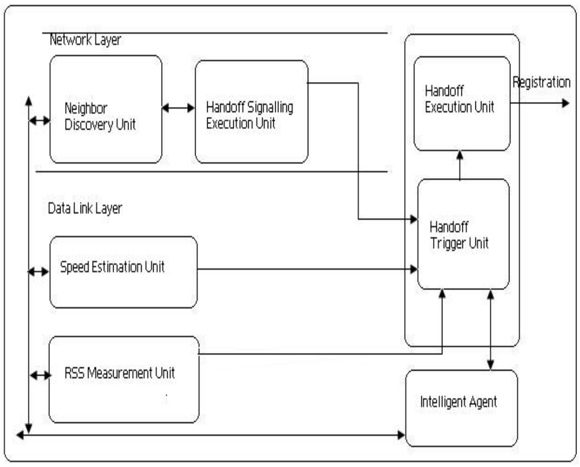

Fig.2. Modules of Handoff Architecture.

2.6 Intelligent Agent

An agent is a thing that can be viewed as perceiving its environment through sensors and acting upon that environment through effectors. Hence, we know how to couple an agent to an environment and what kind of data will be issued. At last, how do we produce quality of service through Intelligent Agent? There are three cases in Intelligent Agent. Such as,

Case1: To find best base station between two BSs for successful handoff, it uses the Binomial distribution. This method for when we have very limited data about the user's (new user) history.

Case 2: To find best base station between two BSs for successful handoff, it uses the Poisson distribution. This method for when we have indefinite data about the user's (long time user) history.

Case 3: After finding the probability, rarely the decision may be wrong, here negative binomial distribution is used to find failure rate. This history also noted by IA for future use.

3. Modern Handoff Algorithm

In our proposed algorithm, the mobile node receives a beacon signal from the access point through activating the 802.11 card. Hence IA and BBSSP provide Qos in Modern mobile networks. This is explained in the figure below.

```
/* In Modern Mobile Networks */
Label1:
advertisement from AP()
measurement-of-SNR()
if(best AP!=AP)
registration()
establish-IP-connectivity()
transfer-operational-parameters()
setup-a-new-data path()
Label2:
Intelligent-Agent-BBSSP()
handoff-notice()
path-management()
if(MN-ID-SA-me !=True)
bandwidth-selected()
else
goto Label2:
else
goto Label1:
```

Fig. 3 Modern Handoff Algorithm

If the mobile node receives an agent advertisement message from the MAP3, it sends a handoff ready request message to the MAP2 which is the currently serving cellular network. Then the MAP1 transmits in-bound packets to the MAP3. After that, the mobile node checks the received beacon signals continuously to determine whether to handoff or not. If the conditions for the handoff are satisfied, then the handoff procedure is performed. At this point, mobile node requests to keep the channel that is currently allocated to the cellular network and transmits a reassociating request message to the Access Point in the Modern Mobile Networks. Soft handover is supported by CDMA-based systems where several Access Points can receive the same signal at the same time. So the mobile node is using two base stations at the same time. Every Mobile node receives signal from its current Base Station continuously. It checks its Received Signal Strength (RSS) periodically. If the RSS decreases, then the handoff anticipation and next Base Station (BS) should be selected. Hence neighbourhood discovery and handoff signalling delay estimation should be done in prior.

Depending on the location of the target Base Station, the corresponding handoff should be executed. The different types of handover as follows:

i) Link Layer Handoff: If the associated handoff to the next BS is link layer handoff, the existing algorithm can be used.

ii) Intrasystem handoff: If the associated handoff to the next BS is an intrasystem handoff, the handoff trigger unit estimates the dynamic RSS threshold t_1.When the RSS of the current BS drops below t_1, the MS starts the proposed mechanism with the next BS.

iii) Intersystem handoff: If the associated handoff to the next BS is an intersystem handoff, the handoff trigger unit estimates the dynamic RSS threshold t_2.When the RSS of the current BS drops below t_2, the MS starts with the intersystem handoff procedure that we have proposed.

The typical handoff scenario in the Modern Mobile Networks is shown Fig. 3.

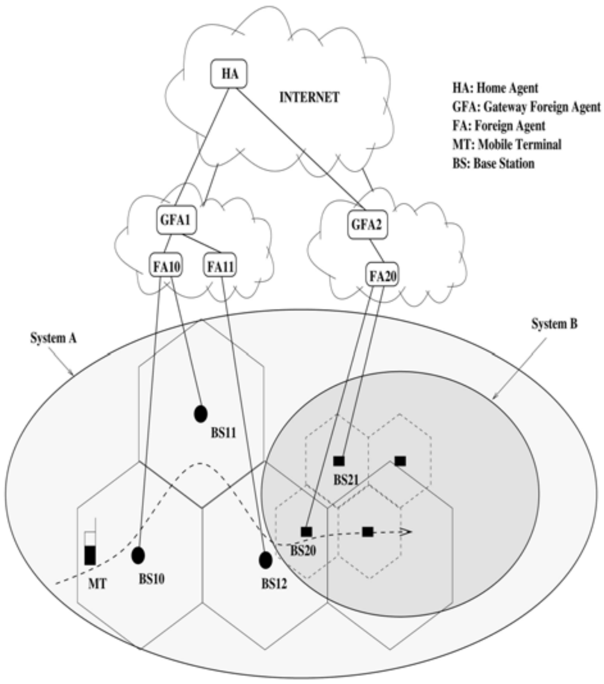

Fig.3. Handoff Scenario of Modern Mobile Networks

4. Performance Analysis of Handoff Techniques

To evaluate the performance of TCP during handoff, a simulation is done. Handoff takes from the current BS referred as old (OBS), to the future BS, referred as (NBS).

4.1 Setting Parameters

We have used the following parameters,

T_{avg} : The threshold value of the RSS (Received Signal Strength) to initiate the proposed handoff process.

t_2 : The minimum value of RSS required for successful communication between MN and OBS.

a : Cell size.

In the simulation, we have considered that the MN is served by the OBS and is moving with a speed v. During the movement of the Mobile Node (MN) it is to move into the coverage area of the NBS and the proposed registration procedure is needed to register with the FA of the serving NBS known as NFA. The MN can learn about the possibility of moving to another cell when the RSS of OBS decreases continuously. Once the MN knows that it can move into the coverage area of NBS, the next step is to determine the right time to decide registration to the NFA.

4.2 Setting Parameters Relationship between RSS Threshold T_{avg} and speed

For different values of handoff signaling delay, we analyzed the relationship between T_{avg} and MS speed (v). Taking different values of speed, we calculated the required value of d and using all we found the required value of T_{avg}. The relationship T_{avg} between and speed in microcellular system is shown in Table 4. The graph implies that, for an MT moving at high speed the handoff should be initiated earlier as compared to a slow-moving MT to guarantee the desired handoff failure probability independent of MTs speed. When τ is large, the handoff must start earlier compared to when τ is small.

The small and large values of τ correspond to intra and inter handoffs respectively and so calculation of T_{avg} is adaptive v and τ.

The architecture is implemented in tcl and the output is viewed as a visual simulation in the network animator. After the registration of the MN with the BSs, communication between two MNs starts.

The parameters we assumed are:

Base Station Transmitter Power (Pt) =33 dBm
Path Loss Component (n) =3
Shadow Fading parameter (S) = 8 dB
Distance between two MNs = 1.5
Path Loss (PL) = 10nlog(d)+S
=10(3)log(1.5) +8
=13.28 dBm
The Received Signal Strength (Pw) = Pt-PL
= 33-13.28
=19.7dBm
=20 dBm (approx.)
MN starting time =10 sec
Handoff Signaling Delay =30 ms
Time taken by the MN to reach the destination =10.89 sec
Speed of the MN =280 units/sec
Handoff Initiation Time
=starting time+|(delay+[log(speed)]$^{-1}$)|
=10.89+|(0.03+log(280)$^{-1}$)
=10.45sec

The Simulation results are tabulated below.

Table 4: Measurement and analysis of Handoff

Speed of the Node (Units/sec)	Time Taken To reach the destination (sec)	Handoff Initiation Time (sec)
30	18.33	17.62
60	14.16	13.56
125	12	11.49
280	10.89	10.45
300	10.83	10.3
380	10.65	10.23

The value of RSS with respect to the distance between the Access Point and Mobile Node is shown in the table 4.1 and the graphical results have been shown. By analyzing this, its found that RSS varies inversely with the distance.

Table 4.1: RSS vs. Distance

Distance between MN and AP(units)	RSS (dBm)
150	-40.28
205	-44.35
210	-44.66
369	-52.01

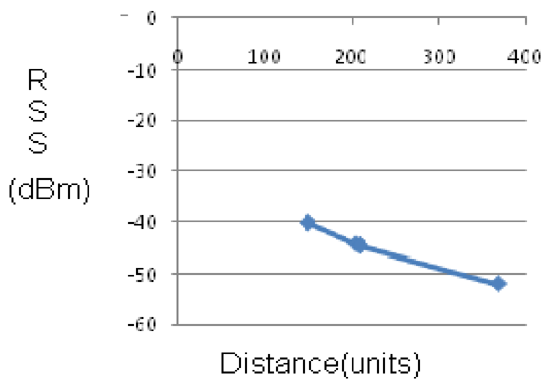

Figure 4.1: RSS vs. Distance

The value of RSS with respect to the speed of the mobile Node is shown in the table 4.2 and the graphical results have been shown. By analysing this, its found that RSS varies directly with the speed.

Table 4.2: Speed vs. RSS threshold

Speed (Units/sec)	RSS Threshold (dBm)
60	-80
150	-27
250	-1
280	5

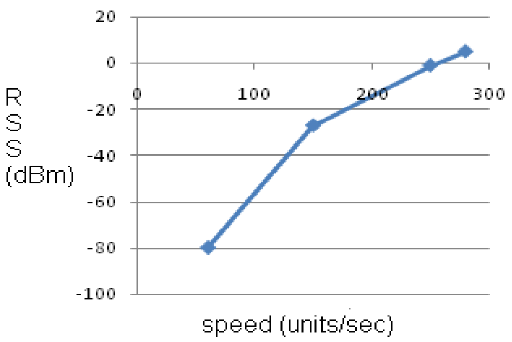

Figure 4.2 Speed Vs. RSS threshold

The Handoff Initiation time with respect to the speed of the mobile Node is shown in the table 4.3 and the graphical results have been shown. By analysing this, it is known that Handoff initiation is done in accordance with the speed.

Table 4.3: Speed vs. Handoff Initiation Time

Speed (Units/sec)	Handoff Initiation time(sec)
60	13.56
125	11.49
280	10.45
300	10.39

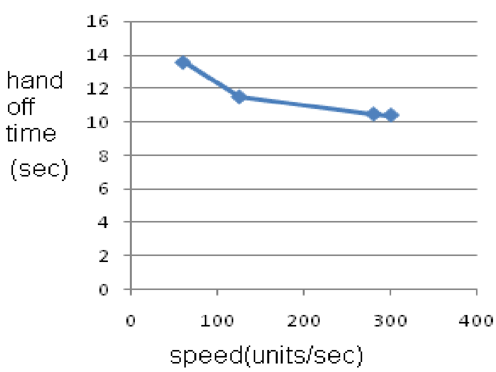

Figure 4.3: Speed vs. Handoff Initiation Time

4.3 Comparison of Handoff Techniques

After the careful analysis of Handoff techniques, we have tabulated here, the different modern Handoff techniques to reduce the delay. The Intelligent Agent (IA) with BBSS protocol will provide Qos but the system complexity is high. Complexity of the system is tolerable when consider the Qos of the mobile service. IA with BBSS reduces the handoff delay to avoid the failure of the connection between Mobile Terminals (MTs). Speed of the mobile node is 10km/s is measured and tabulated in Table 4.4 using different protocols for comparison studies.

Table 4.4: Comparison of modern-handoff techniques

Protocol / Parameter	Double Threshold Protocol	BBSSP using RSS	Intelligent Agent	Intelligent Agent & BBSP
Delay(ms)	2.8	2.1	1.8	1.6
Failure rate (%)	10%	8%	8%	7%
System complexity	Medium	Medium	Low	High

5. Conclusion

In this work different types of handoff mechanisms are demonstrated in mobile environment. Speed estimation unit is a mandatory unit which finds the speed of different user irrespective of their distance. RSS invariably varies with the distance. Based on the user's speed handoff is done in prior. No static RSS is used, only dynamic updating of RSS is calculated and handoff is done. Hence Intelligent Agent and BBSSP assisted the handoff operation to provide Quality of Service. This enhanced handoff is designed for 4G wireless systems hence scalability of the product is also taken into account and this work can be even extended to support the fore coming technical advancement.

6. Future Enhancement

In coming years, Intelligent Agent will add existing protocols to take much care providing QoS in Mobile Networks. It may increase the software maintenance cost/system complexity, but there is no room for failure of the handoff.

Acknowledgments

We would like to express our cordial thanks to Dr. V. Lakshmi Prabha for her full support and valuable suggestions to continue our research work.

References

[1] I.F. Akyildiz et al., “Mobility Management for Next Generation Wireless Systems,” Proc. IEEE, vol. 87, no. 8, pp. 1347-1384, Aug. 1999.

[2] C. Perkins et al.,” IP Mobility Support for IPv4”, IETF RFC 3344, Aug. 2002.

[3] A.C. Snoeren and H. Balakrishnan, “An End-to-End Approach to Host Mobility,” Proc. MobiCom, Aug. 2000.

[4] D. Maltz and P. Bhagwat, “MSOCKS: An Architecture for Transport Layer Mobility,” Proc. INFOCOM, pp. 1037-1045, Mar. 1998.

[5] Ning Zhang and Jack M.Holtzman ”Analysis of Handoff algorithms using absolute and Relative measurements” IEEE transactions on vehicular technology, vol. 45, no. 1, February 1996.

[6] Liebsch, M., A. Singh, H. Chaskar, D. Funato and E. Shim, Candidate Access Router Discovery, Internet Draft, Internet Engineering Task Force, draft-ietf-seamoby-card-protocol-07.txt, 2004.

[7] Shantidev Mohanty and Ian F.Akyildiz, Fellow, IEEE ”A Cross-Layer (Layer 2 + 3) Handoff Management Protocol for Next-Generation Wireless Systems” October 2006.

[8] Matz, D. and P. Bhagwat,. Msocks: “An Architecture for Transport layer mobility”. Proceeding IEEE Infocom 98, 29 March-2 April 1998, IEEE Xplore London, pp: 1037-1045.

[9] Perkins, C. et al., 2002. “IP Mobility support for Ipv4”. Internet Engineering Task force RFC 3344.

[10] Snoeren, A.C. and H. Balakrishnan, “An end-to-end approach to host mobility”. Proceeding of the 6th ACM/IEEE International Conference on Mobil Computing and Networks, 2000 New York, USA, ISBN: 1-58113-197-6.

Selvan.C is doing his research in the area of Mobile Computing in the Department of Computer Science and Engineering in Government College of Technology, Coimbatore, Tamil Nadu, India. This research work is supported by University Grant Commission, New Delhi, India. He has registered his research in Anna University of Technology, Coimbatore, Tamil Nadu, India. His area of interest is Mobile Computing and Mobile Communication. He is the student member of IEEE.

Dr. R.Shanmugalakshmi is working as an Assistant Professor in the Department of Computer Science and Engineering in Government College of Technology, Coimbatore, Tamil Nadu, India. She has published more than 40 International / National Journals. Her research area includes Image processing, Neural Networks and Mobile Computing. She has received Vijya Ratna Award from India International Friendship Society in the year of 1996. She has received Mahila Jyothi Award from Integrated Council for Socio-Economic Progress in the year 2001 and she has received Eminent Educationalist Award from International Institute of Management, New Delhi in the year of 2008. She is a member of Computer Society of India, ISTE and FIE.