An Efficient Resource Management Algorithm for Next Generation Networks Using Multi Network Data Path

V.Senthil Kumaran, E.D.Kanmani Ruby, Ms G.Deepa

***Abstract*—**The integration of mobile communications together with computer internet network is the main focus of Information technology industry. The user anticipations are swelling with regard to a huge range of services and applications with unalike point of quality of service (QoS), which is related to bandwidth, throughput, energy and delay. LAS-CDMA (Large Area Synchronized Code Division Multiple Access) covers global area, enables high-speed data transmission and increases voice capacity. MC-CDMA (Multi-Carrier Code Division Multiple Access) is designed for running on wide area, called macro cell. The LMDS (Local Multipoint Distribution System) designed for micro cell, enables wireless broadband technology used to carry voice, data and video services in 25GHz. 4G network integrates all access networks resulting in overlap coverage area. This may cause network resources wasted in the overlap coverage area. Therefore, it is necessary to propose a solution for this situation through utilizing multi network radio frequencies.

This paper focuses on Network Resource Management and Energy efficiency through Multi Network Data Path; considering mobility between the nodes. The Network Resource Management Algorithm is designed using bandwidth management which includes bandwidth monitoring and selection. The performance is evaluated by assigning different paths to the mobile nodes. Simulation results shows that Network Resource Management Algorithm improves the energy efficiency by 23%. This algorithm considers movement pattern of the mobile nodes which varies the buffer size by 0.1%.

***Keywords*—**Multi-network, 4G, Mobile Multimedia

I. INTRODUCTION

The next generation networks, Information Technology (IT) industry and media industry must be combined with telecommunication to support multimedia service for the mobile users. As a result, mobile communication together with computer internet networks will penetrate into the various fields of our society. Thus, the user anticipations are aggregate with esteem to a huge range of services and applications with poles apart degree of quality of service (QoS), which is related to delay, data rates and bit error requirements [1].

V.Senthil Kumaran, Department of ECE, Kongu Engineering College, Perundurai, Tamil Nadu, India, (Mobile: +919994969644)
e-mail: ervsenthilkumaran@gmail.com

Dr.E.D.Kanmani Ruby, Department of ECE, Kongu Engineering College, Perundurai, Tamil Nadu, India, e-mail: bewin_santhkumar@yahoo.com

MS G.Deepa, Department of ECE, Kongu Engineering College, Perundurai, Tamil Nadu, India, e-mail: mitdeeps@gmail.com

At this moment, many countries have established projects for next generation system development. However, DARPA (Defense Advanced Research Projects Agency) first started this project, who developed the wired internet [2]. The success of distributed architecture in wired internet leads to adapt the same distributed architecture for 4G wireless mobile internet. 4G is still developing in laboratories, all the aspects of 4G wireless networks was not agreed by all experts and policy makers [3]. 4G integrates with LMDS, LAS- CDMA, OFDM, IPv6, MC-CDMA and UWB [4].

4G networks has an issue addressed in basic protocol IPv6. Radio wave can transmit large amount of digital data using OFDM. Simultaneous transmission in OFDM occurs by piercing the radio signal into numerous lesser sub-signals at diverse frequencies to the receiver. LAS-CDMA increases voice capacity and enables high-speed data, which is designed for global area. MC-CDMA is designed for running on wide area, called macro cell.

4G integrates all access networks resulting in overlap coverage area [5]. This may cause network resources wasted in the overlap coverage area. This leads to overutilization of network resources in one particular network and underutilization of network resources in the other network. Therefore, it is necessary to propose a solution for this situation through utilizing multiple network radio frequencies in 4G.

Consider any two network radio frequencies for utilization. This paper focuses on Network Resource Management and Energy efficiency through Multi Network Data Path. The Network Resource Management Algorithm is designed using bandwidth management which includes bandwidth monitoring and selection. The performance is evaluated by assigning different paths to the mobile nodes. One of the network path carries the data request, and reply for that request from any other network path. Thus, mobile node gets services from two networks simultaneously.

Considering Mobile Node (MN) is communicating Correspondent Node (CN). Request is sent through Packet Data Service Node (PDSN). Correspondent Node (CN) is responding to Mobile Node (MN). Reply is done through Packet Data Interworking Function (PDIF). Multi network data path communication between MN and CN is done by Bandwidth Management. Bandwidth management implement bandwidth monitor in both network paths and based on the monitored output, bandwidth selection is done. The main objective of this paper is network resource management using resource management algorithm.

II. LITERATURE REVIEW

Xichun Li, et al., (2009) [6] proposed Multi-network Data Path. Multi-network data path design is based on MC-CDMA and WLAN networks, which focuses on network resource management. For session management and radio resource management, they made an assumption, under the overlapping area CDMA connection is already established, and a new connection is set up for available WLAN radio resource. The new proposed Multi-network data path distributes data request through MC-CDMA network and gets reply through WLAN network. Under the overlay area; when a mobile node enters, it gets services from both networks simultaneously. The new Multi-network data path does not consider issues such as movement pattern of the mobile node, re-negotiated QoS and congestion relief.

Harri Paloheimo, et al., (2006) [7] put forward interoperability of MANET and 4G RAN Routing, which provide operator radio coverage and flexible solutions for the 4G RAN. Insight of 4G RAN design is provided by combining these differing communication technologies. 4G requirements in terms of energy conservation against MANET is analysed in this paper. Their conceptual level analysis shows that MANET routing is possible but with strong limiting conditions due to the evident differences in the design emphasis. From energy conservation standpoint, both 4G RAN and MANET suffer from somewhat ambiguous requirements, which makes it difficult to compare them.

Navrati Saxena, et al., (2013) [8] put forward advances in 4G wireless along with special issues demonstrates research outcomes in different aspects of 4Gwireless, like resource allocation, cognitive and cooperative communications, scheduling, multicast services, coverage and planning of small cells. Contingent on the diverse aspects of 4G, special issue are classified into four diverse classes: (a) cognitive, opportunistic, and cooperative communications, (b) scheduling and resource allocation, (c) coverage and planning of small cells, and (d) multicast services.

Engr. Muhammad Farooq, Engr. Muhammad Ishtiaq Ahmed and Engr. Usman M Al (2013) [9] researched the future picture of mobile communication. They present the study of several generations which are being used 1G, 2G, 3G, and 4G, and try to find some future generations which are under research like 5G, 6G, and 7G. Satellite network will be used from 6G mobile communication systems and onwards.

III. CONVERGENCE NETWORK

Convergence architecture for 4G was issued by CDMA Development Group (CDG). Figure 1 shows the mishmash of micro cell, macro cell, pico cell and global area.

The architecture clearly shows that four wireless networks are covered in pico-cell area, and there are three wireless networks covered in the micro cell area; in macro cell area, at least there are two wireless networks covered. At a definite place or at a certain time, one network supplies wireless services for a user and remaining wireless network resources gets wasted is the major problem.

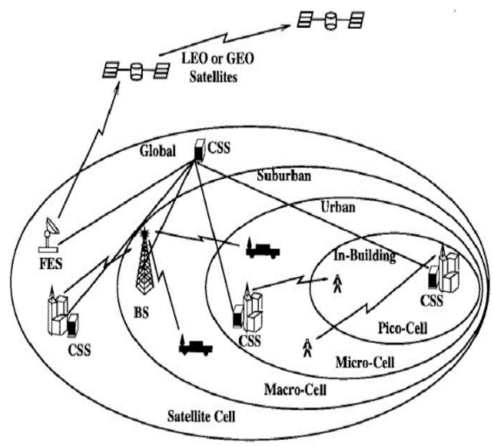

Figure 1: 4G Convergence Network

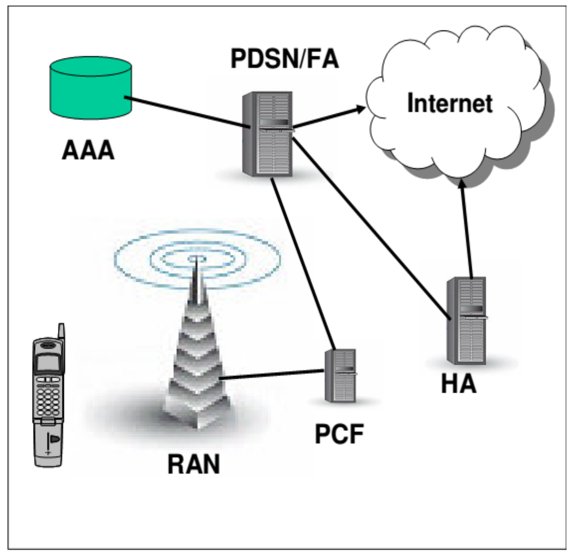

Figure 2: Communication Network

3.1 Packet Control Function (PCF)

- Maintains connection state between PDSN and BSC
- It is aware of mobile's air link status (dormant, active)
- Collects air time accounting from BSC and forwards it to PDSN

3.2 Packet Data Serving Node (PDSN)

- Establishes data session with MS
- Supports Foreign Agent (FA) capability for Mobile IP service
- Route packets
- Collects accounting information
- Acts as a client for authentication and accounting

3.3 Authentication, Authorization, Accounting Server (AAA)

- Performs authentication, authorization, and accounting in conjunction with PDSN
- Provides proxy functions to relay these services to other AAA servers

3.4 Home Agent (HA)

- Works in conjunction with FA to provide Mobile IP service

- Provides the "anchor point" for Layer 3 mobility

3.5 Packet Data Interworking Function (PDIF)

- It uses IKEv2 as signalling interface for allowing mobile equipment to access the Internet over an all - IP WLAN.
- IPSec tunnel is established by PDIF.
- For protecting CDMA network resources and data, PDIF acts as a security gateway.
- Collocated Foreign Agent (FA) service has a tight integration with PDIF, and PDIF/FA a denotation of PDIF.
- For handsets that do not support mobile IP, PDIF supports proxy mobile IP.
- If the MS is not suitable for proxy mobile IP registration, it may still be allowed to establish a simple IP session, in which case the traffic is directly routed to the Internet or corporate network from the PDIF.
- MS operates as a normal mobile phone by transferring voice, data over CDMA if the subscriber is mobile.
- When the FMC subscriber encounters a WiFi hotspot, then the WiFi network is automatically detected by MS, and it establishes an IPSec session automatically with the PDIF/FA.
- PDIF/FA works with other network elements after the establishment of secure connection and successful registration of mobile IP to afford MS with access to packet data services.

IV. MULTI-NETWORK DATA PATH DESIGN

The theoretical focus of this paper is on the 4G real wireless multimedia mobile internet to provide data services within integrating of MC-CDMA-WLAN network.

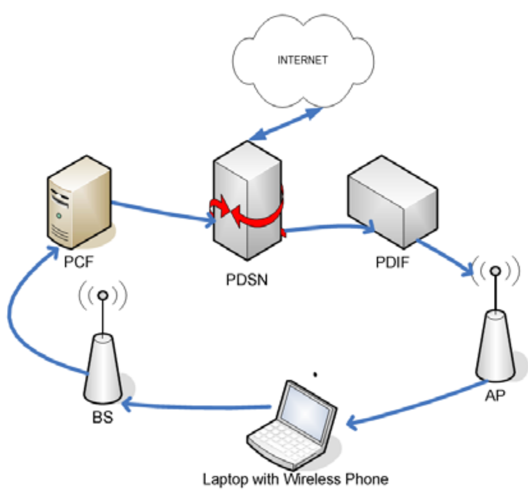

Figure 3: The Main System Components

Figure 3 shows remodeled main system component architecture of CDMA-WLAN. The architecture consists of the Access Point (AP), the Packet Control Function (PCF), the Base Station (BS), the Mobile Node (MN), the Packet Data Interworking Function (PDIF), and the Packet Data Service Node (PDSN).

The mobile node can work on the full TCP/IP protocol with data/multimedia application models. It can be handset, laptop, and personal digital assistant, etc. The wireless link and interface controlling functionality for the mobile node was provided by the Access Point (AP) and the Base Station (BS).

Packet Control Function (PCF) gets connection from BS and Packet Data Interworking Function (PDIF) with AP. For more information about Packet Control Function (PCF) is in [3]. 3GPP2, the standardization organization of CDMA2000 has specified the function of PDIF in [10].

IP interface to the internet was provided by Packet Data Service Node (PDSN). Pretentious CDMA link is already there under the overlapping area for session management and radio resource management. To set up a new connection, the available WLAN radio resource is utilized.

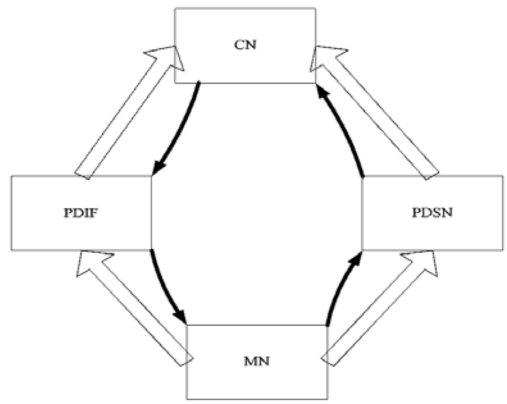

Figure 4: Multi-Network Data Path Model

The new proposed Multi-network data path distributes data request through MC-CDMA network and gets reply through WLAN network. The model design and Multi-network data path design overview will be presenting in following sections.

In order to design Multi-network data path, a new data model is proposed as shown in Figure 4. Any two networks overlay area is considered for this model. The dual networks supply services to the mobile node simultaneously, when it enters into an overlay area. Any one of the network carries data request, and other network respond for that request.

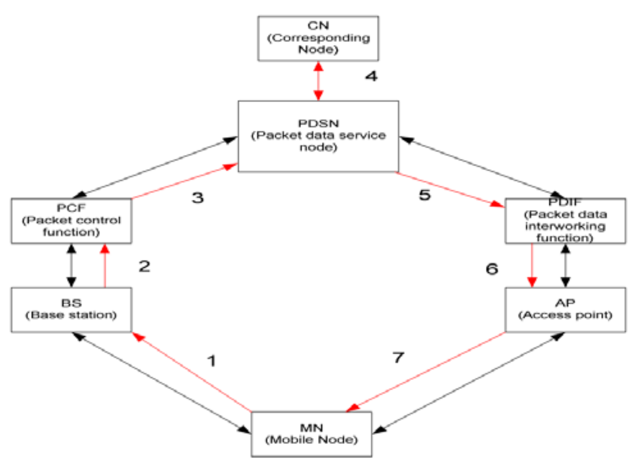

Figure 5: Multi-Network Data Path

In Multi-Network Data path model, the MN request go through first connection,

$$MN \rightarrow BS \rightarrow PDSN \rightarrow CN$$

and the subsequent reply can be from the second connection,

$$CN \rightarrow PDIF \rightarrow AP \rightarrow MN$$

Thus mobile node gets serviced by two networks simultaneously. The Proposed design working model is shown in figure 5.

Following this multi-network data path model, multi-network data path design is proposed as shown in Figure 6. Multi-network data path contains four components. They are bandwidth monitor, bandwidth management, bandwidth selection and packet receiver. In Figure 6, Dynamic installation and deletion of bandwidth monitor is carried by bandwidth management, after IPv6 protocol sends the indication message. Both sender and receiver has bandwidth management. Bandwidth monitor is installed on each network path. Monitoring the vacant bandwidth and estimate the appropriate transmission rates on the corresponding route is the primary function of the bandwidth monitor. After installing/deleting each bandwidth monitor, bandwidth management informs the current existing path.

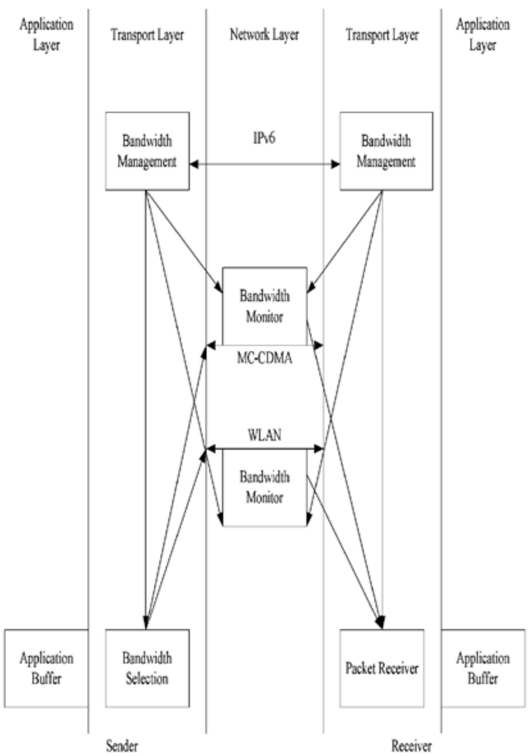

Figure 6: Multi-Network Data Path Design

After receiving the current existing path information from bandwidth management, bandwidth monitor will provide the rate of information. Encoder receives the input from bandwidth selection as calculated and encoding rates, and then IPv6 claims will be encrypted to suitable paths. Bandwidth monitor sends packet to the packet receiver, in which it accepts, filters and reorders before sending them to the decoder.

V. RESOURCE MANAGEMENT ALGORITHM

Step 1: *Initialization*: MN = BS, PDSN, PDIF and BS is transmitting signal at regular intervals along with BS (ID).
Step 2: for i = 1 to U do,
MN (IDi) = BS (IDi)
Step 3: If MN (IDi+1 > IDi)
Step 4: then MN = CN
Step 5: else MN = MN
Step 6: Route MN → BS → PDSN → CN
Step 7: Reroute CN → PDIF → AP → MN
Step 8: Stop the Process.

5.1 System Design

To evaluate the performance of the Multi-network data path scheme, we have designed a simulation system. The Multi-network data path simulation system design is based on two ideas:

- The Multi-network data path is supported by any two simultaneous different networks, which can work on a mobile node; and
- When a mobile nodule gets response from its correspondent nodule, the bandwidth optimization is done through bandwidth reselection, which results in rerouting from one network to another.

The application desired bandwidth is less than the response bandwidth [11].

5.2 System Testing

The performance of the Multi-network data path scheme is evaluated through extensive simulation using Network Simulator (Version 2). The objective of the simulation is to verify the establishment of multi-network data path.

Simulation developed that consists of the Mobile Node (MN), the Correspondent Node (CN), the Packet Data Interworking Function (PDIF) and the Packet Data Service Node (PDSN) as shown in Figure 4.

5.3 Simulation Parameters

In order to investigate the impact of Multi-network data path scheme the following network parameters are evaluated:

- Buffer Requirements
- Energy Efficiency
- Packet Delivery Ratio
- Average Residual Energy

5.4 Performance Analysis

5.4.1 Buffer requirement analysis

According to International Telecommunication Unit (ITU) standards, for a non-real-time internet session, the time taken to release the packets from the current route to a fresh route is defined as buffer time Tb, which is recognised and calculated as follows [12]:

$$T_b = R_t\ (CN, MN) \qquad (1)$$

During the course of simulation, the IPv6 packets were transmitted to MN from CN, the buffer time for IPv6 packets; which is from CN to MN is calculated using any two nodes distances by the packet rate. In the formula above, one can denote the buffer time as R_t (CN, MN) which is shown in the equation (1).

Representation shows that the time controlled-load traffic is buffered by CN. Then, the required buffer size Bs, is calculated as follows:

$B_s = T_b * R_p$ (2)

$R_p = b_r * P_s$ (3)

From the formula, the buffer size (B_s) is equal to packet rate (R_p) with buffer time (T_b), and the packet rate (R_p) is equivalent to packet size (P_s) with bit rate (b_r). Thus, we can get buffer size (B_s) as follows:

$B_s = Tb * br * Ps$ (4)

VI. SIMULATION RESULTS AND DISCUSSIONS

TABLE 1: SIMULATION PARAMETERS

Parameters	Values
No. of nodes	50
Propagation	TwoRayGround
MAC	802.11
Queue	Drop tail/PriQueue
Area	1000 X 1000
Packet size	512
Antenna	Omni-directional antenna

6.1 Buffer size without bandwidth selection

Figure 7: No. of Active Session Vs Buffer Size without BW Selection

Figure 7 illustrates bandwidth resources are not utilized uniformly in which buffer size requirement changes depending on number of active sessions.

6.2 Buffer size with bandwidth selection

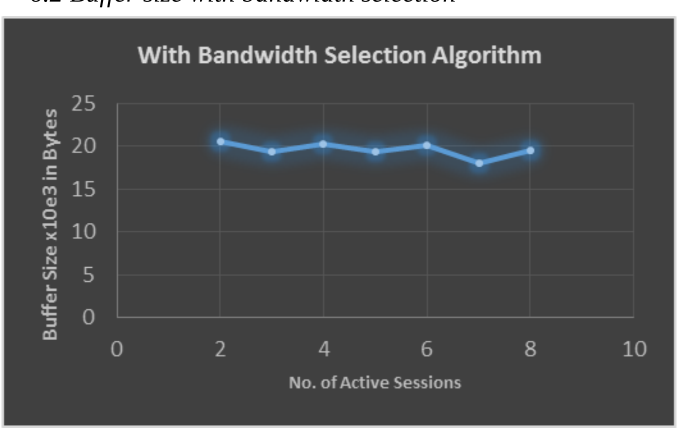

Figure 8: No. of Active Session Vs Buffer Size with BW Selection

Hence, with bandwidth selection, the resources are utilized uniformly. Figure 8 illustrates that buffer size requirement changes depending on number of active sessions.

6.3 Average Energy Consumption

TABLE 2: AVERAGE ENERGY CONSUMPTION

No. Active Sessions	Average Energy Consumption		
	With BW	***Without BW***	***Percentage***
10	0.0670768	0.1903	35
15	0.0749644	0.441886	17
20	0.0871457	0.459124	19
25	0.092515	0.472975	20
30	0.108908	0.498567	22
35	0.117654	0.537937	22
40	0.131127	0.525466	25
		Average	23

Table 2 shows that average energy consumption with bandwidth selection decreases by 23% compared to without bandwidth selection. Thus energy efficiency is improved by implementing multi network data path resource management algorithm.

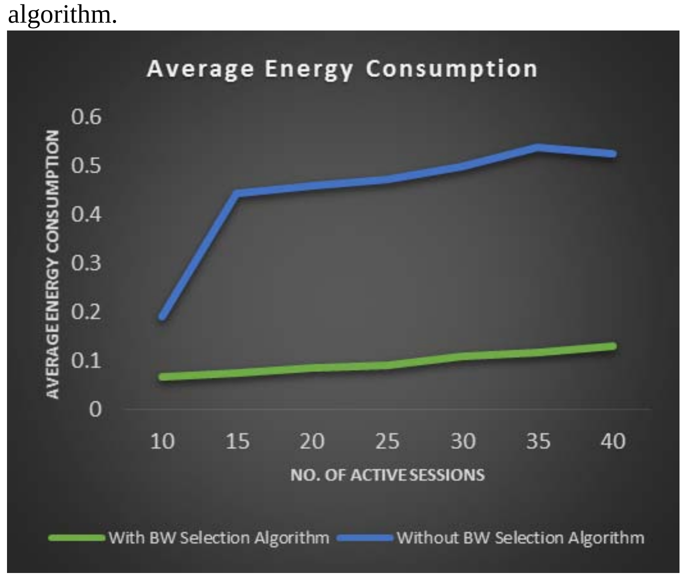

Figure 9: No. of Active Session Vs Average Energy Consumption

Figure 9 shows that resource management algorithm provides 23% improved energy consumption with bandwidth selection compared to without bandwidth selection.

6.4 Packet Delivery Ratio

TABLE 3: PACKET DELIVERY RATIO

No. Active Sessions	Packet Delivery Ratio	
	With BW	***Without BW***
10	99.7867	99.808
15	99.8197	62.1922
20	99.7776	51.6345
25	96.8303	20.4233
30	94.4454	16.6491
35	92.0667	7.779
40	92.7604	12.5811

Table 3 shows that packet delivery ratio with bandwidth selection algorithm gets improved when compared to without bandwidth selection algorithm. Thus packet drop is reduced considerably by implementing multi network data path resource management algorithm.

ISBN: 978-1-61804-235-4

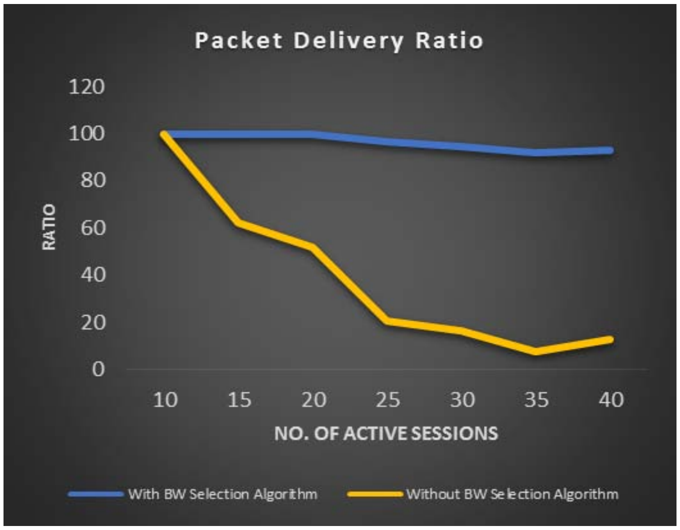

Figure 10: No. of Active Session Vs Packet Delivery Ratio

Figure 10 shows that resource management algorithm improves packet delivery ratio with implementation of bandwidth selection algorithm when compared to without bandwidth selection algorithm.

6.5 Average Residual Energy

TABLE 4: AVERAGE RESIDUAL ENERGY

No. Active Sessions	Average Residual Energy	
	With BW	*Without BW*
10	99.9329	99.8097
15	99.925	99.5581
20	99.9129	99.5409
25	99.9075	99.527
30	99.8911	99.5014
35	99.8823	99.4621
40	99.8689	99.4745

Table 4 shows that average residual energy with bandwidth selection algorithm is more when compared to without bandwidth selection algorithm. Thus average residual energy is more implementing multi network data path resource management algorithm.

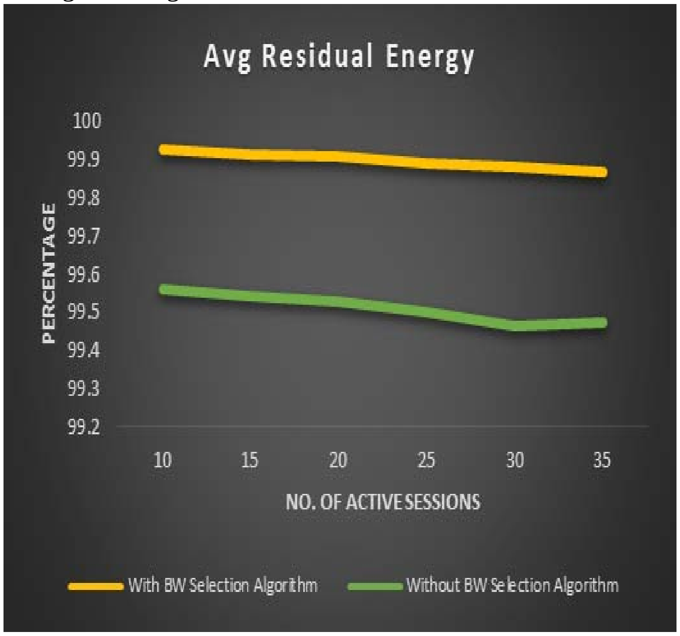

Figure 11: No. of Active Session Vs Average Residual Energy

Figure 11 shows that implementation of resource management algorithm provides average residual energy greater compared to without bandwidth selection algorithm.

VII. CONCLUSION AND FUTURE WORK

In this paper Multi-network data path; Data requests will be controlled by PDSN (Packets Data Service Node) and PDIF (Packet Data Interworking Function) controls the data reply. Data traffic is rerouted through PDSN to PDIF. For efficient utilization of network resources, the Multi-network data path has been well-defined to do bandwidth reselection for rerouting of networks. The performance is evaluated by assigning different paths to the mobile nodes. Simulation results shows that Network Resource Management Algorithm improves the energy efficiency by 23%, reduced packet drop and effective utilization of bandwidth. The resource management algorithm for Multi-network data path does not consider issues such as QoS and congestion relief. In future, there is a necessity to change a different revealing algorithm that can upkeep the wide-ranging level of network incorporation assured by the Next generation wireless system.

REFERENCES

[1] Abdullah Gani, Xichun Li, Lian Yang, Omar Zakaria, “Radio Frequency Combination for TCP/IP Suite Protocol Improvement in 4G Mobile Internet Networks”. International Journal of Communications, Pp.27-36, Issue 1, Volume 2, 2008.

[2] Frederic Paint, Paal Engelstad, Erik Vanem, Thomas Haslestad, Anne Mari Nordvik, Kjell Myksvoll, Stein Svaet, “Mobility aspects in 4G Networks- White Paper”

[3] Abdullah Gani, Xichun Li, Lian Yang, Omar Zakaria, (2008) “TCP/IP Suite Significant Enhancement for 4G Mobile Multimedia Internet Networks”, Proceedings of the 8th WSEAS International Conference on Multimedia System and Signal Processing (MUSP ’08). Vol. 586, pp. 229-235. April 6-8, 2008. Hangzhou, China.

[4] Shih-Lian Huang (Max Huang), “Evolution from 3G to 4G and beyond (5G)”, ITN-620 Enterprise Network Design, June 23, 2005.

[5] Rosli Salleh, Xichun Li, Lina Yang, Zhiyuan Li, (2008), “Radio Frequency Convergence Protocol for 4G Networks”, Proceedings of the 8th WSEAS International Conference on Multimedia System and Signal Processing (MUSP ’08). Vol. 586, pp. 287-293. April 6-8, 2008. Hangzhou, China.

[6] Xichun Li, Rosli Salleh, Abdulla Aani and Omar Zakaria (2009), “Multi-network Data Path for 5G Mobile Multimedia”, 978-0-7695-3522-7/09 $25.00 © 2009 IEEE, DOI 10.1109/ICCSN.2009.107

[7] Harri Paloheimo, Sudhir Dixit and Antti Yla Jaaski (2006), “Energy aware interoperability of MANET and 4G RAN Routing”, Springer, Wireless Personal Communications (2006) 37: 291–303, DOI: 10.1007/s11277-006-9032-y

[8] Navrati Saxena, Shamik Sengupta, Kai-Kit Wong and Abhishek Roy (2013), “Special issue on advances in 4G wireless and beyond”, EURASIP Journal onWireless Communications andNetworking2013,2013:157

[9] Engr. Muhammad Farooq, Engr. Muhammad Ishtiaq Ahmed and Engr. Usman M Al (2013) “The Future Picture of Mobile Communication”, Academy of Contemporary Research Journal V II (I), 15-21, ISSN: 2305-865 © Resource Mentors (Pvt) ltd (Publisher)

[10] 3GPP (2002). Feasibility study on 3GPP system to Wireless Local Area Network (WLAN) interworking (Release 6). 3GPP, TR 22.934 V6.1.0. http://www.3gpp.org/ftp/Specs/2002-12/Rel-6/22_series/22934-610.zip

[11] Lucent technologies, “Wireless Network Systems-3G Engineering Guidelines”. June 2001.

[12] Al-Shawabkeh, M; Salleh, R; Li, X, (2007) “Bandwidth optimization control protocol for 4G wireless mobile internet”, Proceedings of the 11th WSEAS International Conference on Communications, Vol. 3, pp. 279-284. July 23-25, 2007. Agios Nikolaos, Greece.

[13] Hui.S.Y and Yeung.K.H., “Challenges in the migration to 4G mobile systems”. IEEE Communications, vol. 41, No. 12, Dec. 2003.
[14] Lucent technologies, “Wireless Network Systems-3G Engineering Guidelines”. June 2001.
[15] McNair, Janise Yvete. “Handoff Techniques for Next Generation Wireless Network”. Pages 31-35, November 2000.
[16] Xichun Li, Rosli Salleh, (2007), “Handoff techniques for 4G wireless mobile Internet”, Information Technology Journal 6 (5), pp. 745-750.
[17] Xichun Li, Abdullah Gani, Lina Yang, Omar Zakaria, Badrul Jumaat, (2008), “Mix-Bandwidth Data Path Design for 5G Real Wireless World”, 12th WSEAS CSCC Multiconference. Heraklion, Crete Island, Greece, July 22-25, 2008. Pp.316-320.
[18] 3GPP (2002). Feasibility study on 3GPP system to Wireless Local Area Network (WLAN) interworking (Release 6). 3GPP, TR 22.934 V6.1.0. http://www.3gpp.org/ftp/Specs/2002-12/Rel-6/22_series/22934-610.zip.
[19] Iqbal Hussain and Rabiullah Khattak “Handover between 2G, 3G and WLANs”, Ericsson Review No. 1, 2003.