http://ansinet.com/itj

ITJ

ISSN 1812-5638

INFORMATION TECHNOLOGY JOURNAL

ANSInet
Asian Network for Scientific Information
308 Lasani Town, Sargodha Road, Faisalabad - Pakistan

Information Technology Journal 11 (5): 596-604, 2012
ISSN 1812-5638 / DOI: 10.3923/itj.2012.596.604

Improving the Performance of Packet Transfer in Network Mobility

[1]M. Dinakaran and [2]P. Balasubramanie
[1]School of Information Technology and Engineering, VIT University, South India
[2]Department of Computer Technology, Kongu Engineering College, South India

Abstract: Uninterrupted connectivity to Internet services during mobility is an increased demand now-a-days. When, a user is traveling through a vehicle like car or train, it is important to have a continuous Internet connection without connection break-ups and data losses. This vehicular Internet connectivity is enabled by establishing connectivity to nearby networks. N-PMIPv6 (Network-Proxy Mobile Internet Protocol Version 6) Novell Architecture enables seamless and efficient integration of mobile networks. Users moving through vehicles access Internet through the mobile networks. In case the user access multimedia data such as audio, video, graphics and animation, this type of data requires high bandwidth in mobile networks. Accessing such high proportion of data through wireless networks may degrade the quality of data through data loss. The quality of audio or resolution of the downloaded video may get affected due to significant data loss in mobile wireless networks. This study proposes a solution to avoid the data loss issue by simultaneous binding. The proposal is implemented using NS2 simulation tool and the results are analyzed.

Key words: NEMO, PMIPv6, simultaneous binding, vehicular networks

INTRODUCTION

Uninterrupted continual flawless Internet service is the demand of the user in today's environment. The most required Internet service is the download or transfer of multimedia data. It is obvious that any data or packet loss that occurs during data transmission affects the quality of the multimedia data (Velmurugan and Rajaram, 2005). Today the usage of internet is increasing and quality of data transmission is the critical issue under consideration. Many techniques are currently being implemented to provide Internet through vehicular networks however, lossless data transfer is the key factor to be considered. Mobile network is a sub network which may have a frequent mobility between multiple networks from its home (Jalil and Dunlop, 2009). Mobile IP is the Internet Protocol for wireless mobile networks developed by Internet Engineering Task Force (Nada, 2007). As the Internet user count is high using IPv6 (Internet protocol version 6) address will provide huge amount of IP addresses (Bahaman *et al*., 2011). When a node changes its point of attachment, this protocol informs the network about the details regarding the switching of host to a new access network. It provides location-independent access to Internet. Each mobile host is assigned a home address when it is present inside the home network. When the mobile host moves out of the home network, it is identified by the Care of Address (CoA) which is registered with the Home Agent (HA) (Nada, 2007). Mobile IP specifies the procedure of how a mobile node registers its CoA with the home agent and how the home agent routes the packets to the mobile node through an authenticated procedure (Costa and Hartenstein, 2002). Mobile IP is mostly used in wireless networks where mobile devices traverses across multiple LANs. A vehicular network is an important service request from mobile users (Kuang *et al*., 2011). It is one of the most challenging research areas in Mobile Ad Hoc Networks (Sharma *et al*., 2011).

NETWORK MOBILITY (NEMO)

To support the movement of a complete network which changes its point of attachment to the fixed infrastructure and to maintain the sessions of the mobile nodes uninterrupted, the concept of NEMO was developed by the IETF (Sharma *et al*., 2011). This provides the mobility management at the network layer (Mangues *et al*., 2004). When the mobile node moves out of the home network, it sends a request for a care of address from the new access router. After receiving the new CoA, mobile router has to register this CoA to the home agent. After the successful registration of new CoA with the home agent, a bi-directional tunnel is established between the HA and the Mobile Router (MR) with one end point as HA's Home Agent's address and the other end point being the MR's Care of Address. This concept is called as tunneling and all the messages to the mobile

Corresponding Author: M. Dinakaran, School of Information Technology and Engineering, VIT University, South India

node are sent through this tunnel. In case of network in a network, a phenomenon called nested tunneling is established (Senan *et al*., 2011). In nested tunneling though multiple tunnels are established in between the mobile node and home agent based on level of nesting, the ultimate tunnel end points are the home agent and the present CoA of mobile node (McCarthy *et al*., 2008). The advantage of using NEMO is less power consumption for connecting to a particular device outside the vehicle. MR Flag (R) is added in message format of NEMO BS protocol. This flag used to intimate to Home Agent that the respective Mobile Node is acting as Mobile Router, if it is set to 0 (Noor and Edwards, 2011). The mobility of many users can be tracked using a single gateway, as it provides mobility management for them (Gundavelli *et al*., 2009). Routing mechanism, hand off management and security are the three important QoS parameters for mobile networks (Alrashdan *et al*., 2011). In order to judge the routing QoS the packet delivery ratio, average end-to-end delay and protocol load parameters can be considered (Lakshmi and Sankaranarayanan, 2006).

PROXY MOBILE IPv6

PMIPv6 is a protocol devised by IETF to support mobility for a large network (Soto *et al*., 2010). This protocol makes use of Mobile Access Gateway (MAG) (Gundavelli *et al*., 2009) whose functionality is similar to that of access routers. MAG helps in providing connectivity to the mobile terminals present within its range. This protocol makes use of Localized Mobility Anchor (LMA) (Chang *et al*., 2009). LMA acts as a proxy and takes care of several mobile access gateways within its coverage area. The following Fig. 1 illustrates PMIPv6 concept.

When a mobile terminal reaches a new mobile network, it requests a new CoA to the MAG within its range.

MAG allocates the corresponding prefix to the mobile terminal and the information regarding the new mobile terminal along with its allocated prefix is registered and stored in LMA in the form of table. LMA acts as proxy and takes up the responsibility of informing the new CoA to the mobile terminal’s HA. After CoA binding, a tunnel is established between the LMA and HA. If the mobile terminal starts moving and reaches a new MAG which is under the control of same LMA as the previous MAG, new CoA is updated only in LMA table and details regarding this localized mobility are not informed to the home agent. This is because MAG acts as proxy and takes the responsibility of tracking and updating the location of the mobile node to the central authority. However when the mobile terminal moves to a MAG under the control of a different LMA, this movement has to be informed to the home agent and registered. This protocol acts as an existing mechanism to control mobility of terminals in a large network (Soto *et al*., 2009).

SIMULTANEOUS BINDING

Simultaneous bindings is an extension of FMIPv6 (Perkins, 2002). This particular technique minimizes the packet loss to MN. The traffic of the MN is sent to its

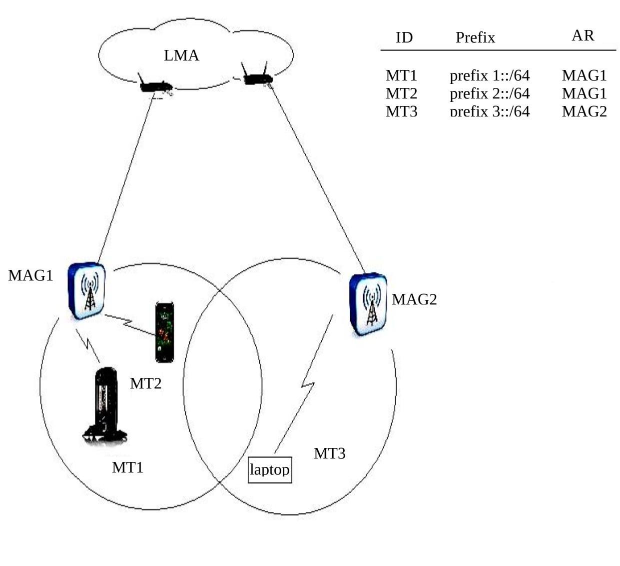

Fig. 1: Concept of PMIPv6, LMA: Localized mobility anchor, MAG: Mobile access gateway, MT: Mobile terminal, AR: Access router

current location and the next expected location (Lam and Liew, 2007). In vehicular networks, the terminals are in continual motion and hence it is complex to track the location of the terminals at specified point of time. Under many circumstances the mobile terminal moves to a new location and receives a new CoA while the packets are still delivered to the previous access routers. This problem is due to the binding delay of the new CoA to the home agent.

A simple solution for the above problem is to bi-cast or n-cast the data packets for a short period of time from OAR (old access router) to one or more future locations before the node reaches it.

Figure 2 is the sequence diagram which illustrates the concept of simultaneous binding using three gateways and one mobile node. The above sequence diagram (Fig. 2) shows the concept of simultaneous binding using three gateways and one mobile node. Consider a scenario where the data transmission takes place between the mobile terminal and corresponding node. Let us assume that the mobile terminal moves out of the coverage area of MAG1 and reaches the range of MAG2. In normal conditions, the packets are still transmitted to the old MAG without the knowledge of change in location. However in case of simultaneous binding, the packets are transmitted to the present and nearby future locations with a short life time (Perkins, 2002). According to this concept, the packet is first transmitted to MAG1, MAG2 and MAG3. Only the current AP accepts the packets while the rest AP's discard the packets at the expiry of the life time. Unlike other techniques which demands more information to be processed at each component like storing the address, location and other details of the user, this technique requires the storage of less bandwidth table information. When the network tries to reduce the latency, fast handover and HMIPv6 are good (Costa *et al*., 2002). To avoid packet loss, simultaneous binding is a better solution (El-Malki and Soliman, 2005).

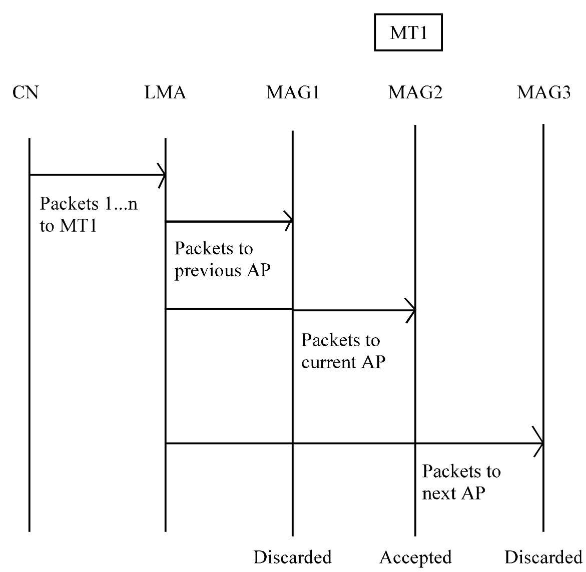

Fig. 2: Simultaneous binding flow

NEMO ENABLED PMIPv6

In this approach, network mobility is integrated with the usage of MAG and LMA (Soto *et al*., 2009). Using this approach, users can obtain connectivity either from fixed locations or mobile platforms (e.g., vehicles) and obtain continual data transmission irrespective of the change in location. N-PMIPv6 architecture exhibits two remarkable characteristics. First, N-PMIPv6 is totally network-based therefore no mobility support is required in the terminals. This means that the mobility of terminals within the network is transparent. Second, the handover performance is improved, both in terms of latency and signaling overhead.

NEMO Basic Support protocol requires MR to manage their mobility; this is not required in N-PMIPv6. N-PMIPv6 makes use of LMA and MAG to manage the mobility of entire network and hence mobile routers to manage the individual mobile terminals are not required. The LMA-localized mobility anchor adds the new binding cache entry associating the id of MT with prefix. LMA table also contains details regarding the MAG to which the MT is being attached. The MAG acts as a proxy for the mobile node and so only one control message is sent to the LMA. The disadvantage of this approach is the nested tunneling that in turn leads to packet loss. This packet loss degrades the quality of multimedia data that is transmitted.

Problems in the existing architecture: Though this architecture provides connectivity for the vehicular networks, there is a security issue regarding the authentication of CoA given by MAG to LMA table. Providing the optimized route to the vehicular networks is another big challenge for this existing architecture. The major drawbacks are:

- Nested tunnels while delivering packets to the mobile nodes
- The major concern is about packet loss which degrades the performance especially in terms of multimedia data transmission
- Mobile access gateways should be authenticated by LMA's

PROPOSED ARCHITECTURE

The proposed architecture integrates N-PMIPv6 protocol with simultaneous binding. N-PMIPv6 uses MAG and LMA to provide continuous connectivity while simultaneous binding eliminates packet loss during mobility of terminals by n-casting the data packets to many access routers.

The proposed architecture which is in Fig. 3 can be explained as follows. Let us consider an ongoing data transmission between a CN and a mobile terminal. Data packets from CN are first transmitted to the home agent of the mobile terminal. The packets are then transmitted from HA to corresponding LMA through the bi-directional tunnel. The concept of simultaneous binding is integrated during the transmission of packets from LMA to MT (Dinakaran and Balasubramanie, 2011). For this purpose, the nodes that are under constant motion are identified. Simultaneous binding concept is applied to these terminals under constant motion. LMA transmits the packets to current MAG and future MAG's within its coverage. These data packets are provided with a short life time. This approach makes sure that packet loss to MT is prevented. This is because even if MT reaches a nearby MAG, packets are delivered since the packets are n-casted by LMA to present and nearby MAGs. Only the MAG which contains the MT within its range accepts the packets while the remaining MAGs discard the packets. Duplication of the packet is being avoided by the usage of life time. Each and every packet is sent along with its life time. In case the packet is not delivered to the destined node within the given life time, the packet gets discarded. Thus packet loss as well as packet duplication is being eliminated in this approach. The problem of packet loss in N-PMIPv6 is eliminated that makes reception of good quality video and audio files.

This is the main table (Table 1) maintained at LMA and acts as a root for all the data transfer. The parameters in the table are id of the particular node, address of the node IPv6, access router which it comes under and the m flag for indication that the user is constantly moving using the vehicle. This information inside the table is maintained at the LMA-local mobility anchor and the other node constantly updates it with the necessary information whenever a little change is made to the network. The information is shared by the trusted node or MAG-mobile access gateway. If the CN needs to send data to the particular node which comes under the LMA then it verifies the table and sends the packet exactly to the destination node using the MAG. MAG plays a vital role in filling up the above table. If a mobile node comes under the particular MAG, it sends its IPv6 address to the

Table 1: LMA table

ID	PREFIX	AR	M-FLAG
MT1	Pref1::/64	MAG1	No
mMAG1	Pref2::/64	MAG1	No
MT2	Pref3::/64	MAG3	No
MT3	Pref4::/64	mMAG1	Yes

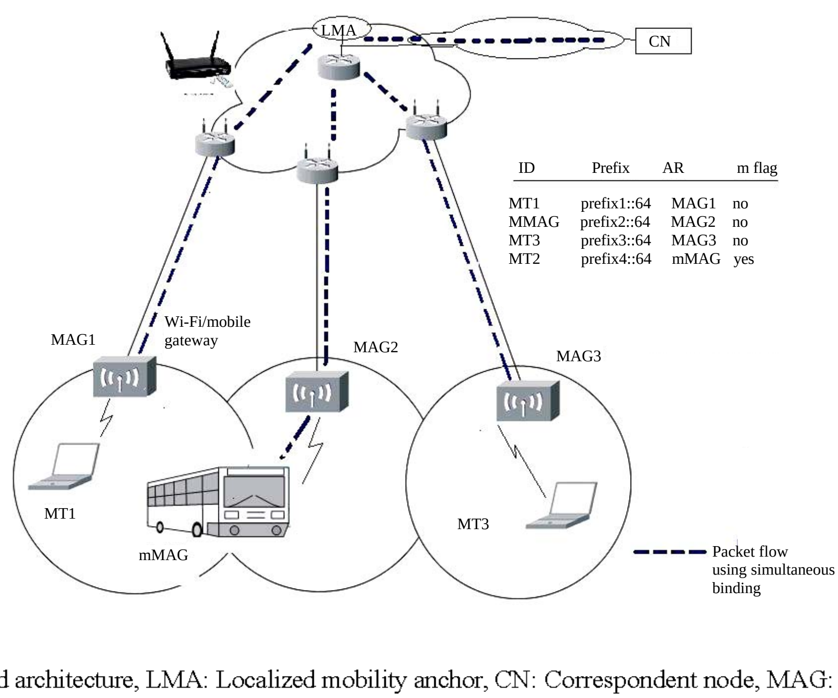

Fig. 3: Proposed architecture, LMA: Localized mobility anchor, CN: Correspondent node, MAG: Mobile access gateway, MT: Mobile terminal, mMAG: Moving MAG

LMA without the usage of bandwidth from the node. So that the proxy updating concept is implemented and the node in the network gets the more connectivity.

If the node is constantly moving in the vehicle at some speed in such cases the m-flag is set as true and rest for all the cases the m-flag is false. Using m-flag the mobility of the node can be tracked and also the data transfer is much simpler than before.

The Table 2 is maintained at the mobile node itself so that it can avoid the duplicate packets. When the mobile node is between the two MAG's it may get many duplicate packets and it makes the node congested. The parameters are packet id and lifetime, using lifetime alone the mobile node rejects the duplicate packets.

Advantages: The proposed system enhances the performance of internet access in the vehicular network:

- The system guarantees continuous data transmission without packet loss which is eliminated using the concept of simultaneous binding
- Packet duplication is avoided by the maintenance of a separate MN table consisting of the packet ID and its life time
- Handoff latency is greatly reduced by the usage of N-PMIPv6 which makes use of LMA that acts as localized home agent and performs packet reception on behalf of the mobile terminal
- The proposed architecture consumes only lesser bandwidth and hence the traffic is greatly reduced
- The time taken for reverse tunneling in the proposed architecture is very low when compared to other existing systems

Table 2: MN table

Packet ID	Life time (S)
P1	34
P2	20
P3	10

PERFORMANCE ANALYSIS

The Packet loss, bandwidth, traffic/congestion, latency and reverse tunneling are the parameters that are used for the performance analysis. After every simulation, trace file (with tr extension) is generated by the simulator. On comparing the existing system trace files with the proposed system trace file it is evident that the proposed system is far better than the existing system.

Packet loss: The number of packets dropped is counted from the trace files of existing system and proposed system. The dropped packets are mentioned by-d in the trace file. Those lines are alienated and counted. A graph is plotted with simulation time in X-axis and number of packet loss in Y-axis. The overall simulation of existing system and the proposed system are same so as to make the comparison easier. The packets dropped at particular time interval is marked and connected. The existing system has more packet loss whereas the proposed system has fewer packet losses. The values from the trace file are plotted as points in the graph (Fig. 4).

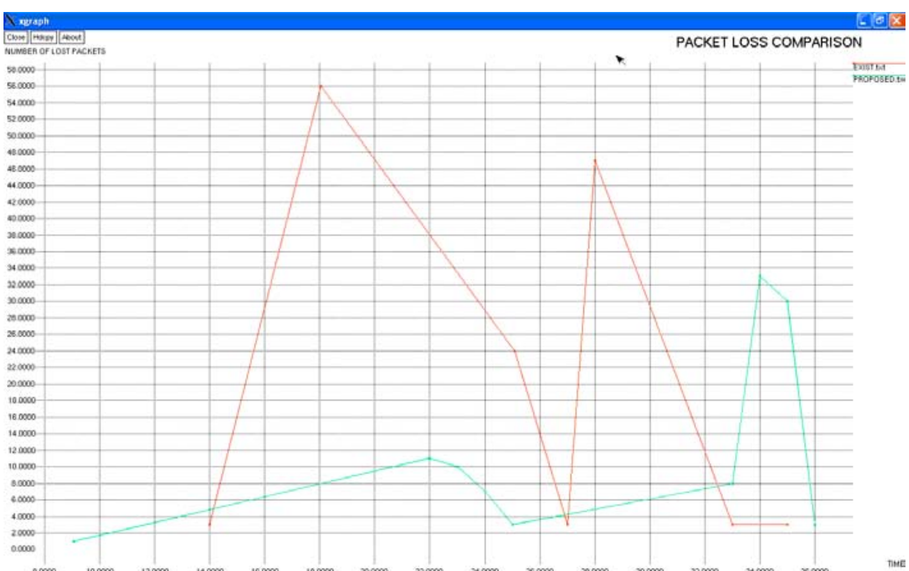

Fig. 4: Comparison graph for packet loss

Both the systems are validated with their number of highest packet losses. The existing system shows highest packet loss of 56 packets at time 18, the proposed system shows highest packet loss of 33 packets at time 34 (at worst case scenario-occurs rarely). Thus, the integrity and efficiency of new system is proved. The comparison graph is shown below.

The red color line in the graph represents the existing system/architecture and the green color line represents the proposed system/architecture.

Bandwidth: The bandwidth is the overall capacity/channels in the particular network. In this case the bandwidth utilization for single data transfer through the network is considered for plotting the graph. During data transfer some packets are dropped. Those packets are resend by the source on receiving negative acknowledgement. These additional packets are also taken into consideration. Here the graph is plotted with time in X-axis and packets in Y-axis. Both existing and proposed architecture are plotted in the same graph. From the trace file all categories of packets such as sent and received packets are counted using the word count command.

As mentioned in the Fig. 5, red line is used to indicate the existing architecture and the green line is used to indicate the proposed architecture. In the proposed system bandwidth consumption is less which means the remaining bandwidth can be used for other purposes. Due to lower bandwidth consumption, the traffic is also greatly reduced.

Congestion/traffic at each node: Congestion of packets denotes the overcrowding of the packets at the nodes. In both the existing and proposed architecture, the same numbers of packets are transferred between two nodes. The number of packets handled at each node is taken for plotting the graph. The congestion at each node is taken in X-axis and packets is taken in Y-axis. The X-axis is the number of nodes involved in the simulation (1 to 5). Even in congestion graph (Fig. 6) the proposed system proved to be efficient.

Hence the proposed system can handle more number of users in its network than the old one and also can manage all the data transfers between them efficiently.

Reverse tunneling: In vehicular network, the user moves frequently. When some node wants to send packets to user who is constantly moving, the home network sends the packets to the access point which is nearer to the user. When the packets are being transferred, the user moves from one access point to another access point. At

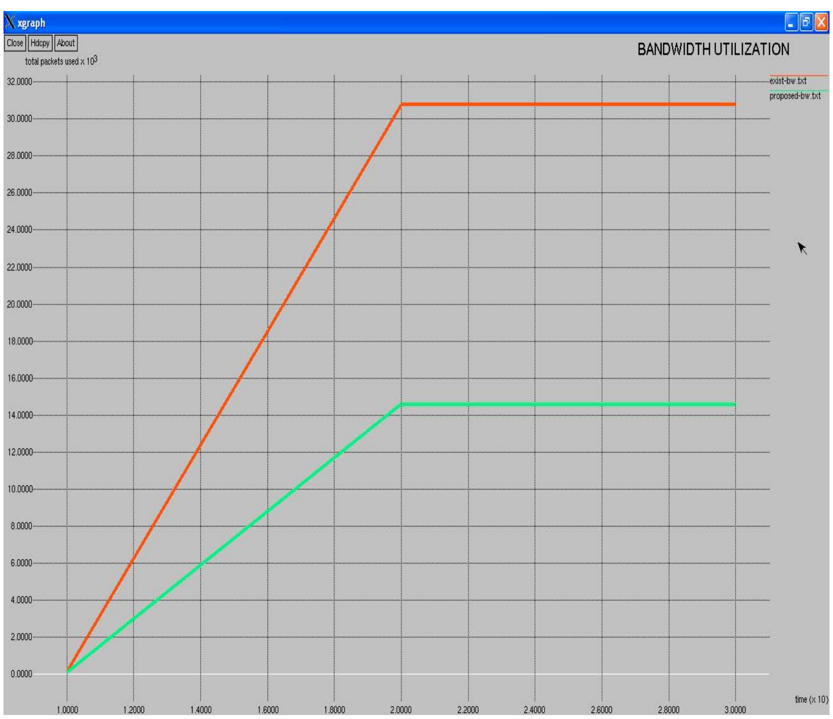

Fig. 5: Bandwidth utilization comparison graph

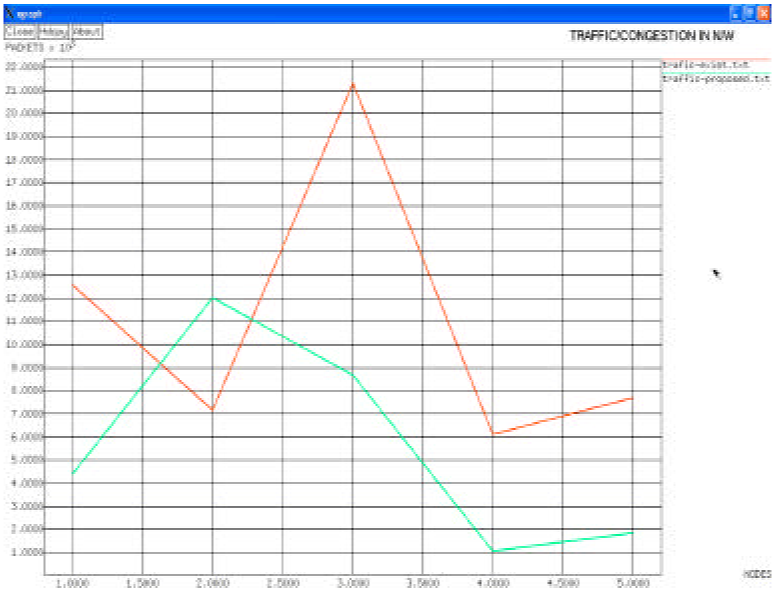

Fig. 6: Traffic/congestion in the network

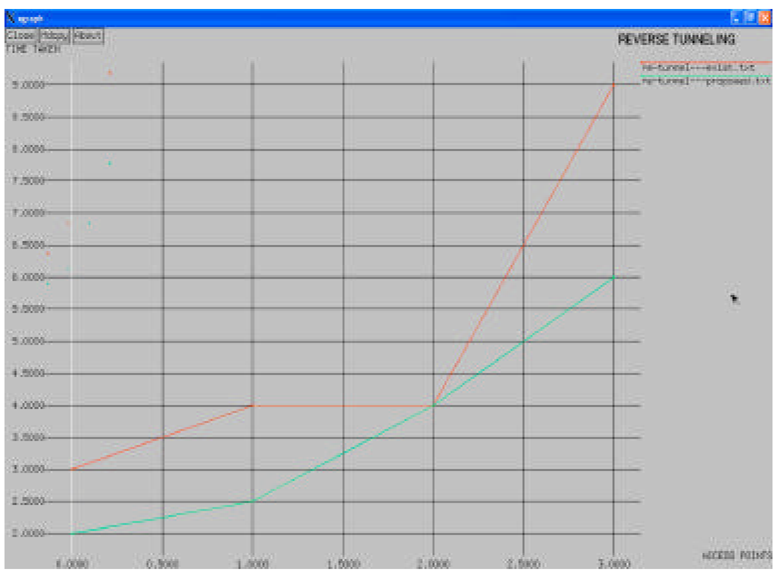

Fig. 7: Reverse tunneling graph comparison

this situation, the packets from the previous access point are redirected back to the home network. The home network redirects the packets to the new access point which is nearer to the user. This is called reverse tunneling. Reverse tunneling occupies more bandwidth and causes more packets lose and so on. In the new system, the occurrence of reverse tunneling is very less or no reverses tunneling. So there will be little packet loss and uses less bandwidth, hence it performs well in terms of data transfer. The access points (0, 1, 2 and 3) are taken in X-axis and the time taken by the nodes for re-tunneling the packets is taken in Y-axis. The time is considered in seconds. The graph (Fig. 7) shows the difference between the two systems. For example, user moves at some certain high speed inside the vehicle, it has to travel across many access points. If more packet loss happens, the quality of data will be reduced. Now-a-days multimedia data are having high demand and used frequently. For exchange of multimedia data more precision in data exchange is needed. Packet losses must be negligible so that it doesn't affect the sensitivity of the data. Providing a qualitative data exchange is possible with the new system. Reverse tunneling is a rare event in the proposed system, assuring that the multimedia data is transferred with higher integrity.

CONCLUSION

The proposed method improves the performance of the vehicular networks in terms of data transfer. The packet loss is minimized, thus improving the quality of data transfer especially transferring multimedia data which is frequently used by the users. Our architecture will provide route optimization for the vehicular networks. In future, the security problems like authenticating the access points in order to prevent falsifying the table information can be addressed. This new architecture may be implemented in other type of networks.

REFERENCES

Alrashdan, M., M. Ismail, K. Jumari, G.A. Abed and S. Hassan, 2011. Performance comparison analysis of SSHMIPv6 and HMIPv6 lost packets using network simulator NS-2. Infor. Technol. J., 109: 1989-1993.

Bahaman, N., A.S. Prabuwono and M.Z. Masud, 2011. Implementation of IPv6 network testbed: Intrusion detection system on transition mechanism. J. Applied Sci., 11: 118-124.

Chang, C.C., C.Y. Lee and Y.C. Chiu, 2009. Enhanced authentication scheme with anonymity for roaming service in global mobility networks. Comput. Commun., 32: 611-618.

Costa, X.P. and H. Hartenstein, 2002. A simulation study on the performance of Mobile IPv6 in a WLAN-based cellular network. Comput. Networks, 40: 191-204.

Costa, X.P., R. Schmitz, H. Hartenstein and M. Leibsch, 2002. MIPv6, FMIPv6 and HMIPv6 handover latency study: Analytical approach. Proceedings of the IST Mobile and Wireless Telecommunications Summit, June 16-19, 2002, Thessaloniki, Greece, pp: 100-105.

Dinakaran, M. and P. Balasubramamie, 2011. Integrating N-PMIPv6 and simultaneous bindings to avoid packet loss in NEMO. Int. J. Comput. Appl., 15: 33-36.

El-Malki, K. and H. Soliman, 2005. Simultaneous bindings for mobile IPv6 fast handovers. Network Working Group, Internet-Draft, http://tools.ietf.org/html/draft-elmalki-mobileip-bicasting-v6-05

Gundavelli, S., G. Keeni, K. Koide and K. Nagami, 2009. Network mobility (NEMO) management information base. IETF, RFC 5488, April 2009. http://tools.ietf.org/html/rfc5488

Jalil, K.A. and J. Dunlop, 2009. Performance evaluation of mobile sub-networks convergence approaches in a personal distributed environment. Inform. Technol. J., 8: 657-667.

Kuang, L., Z. Wang, M. Xu and Y. Chen, 2011. Performance study of IEEE 802.11 broadcast protocols in vehicular networks. Infor. Technol. J., 10: 2060-2067.

Lakshmi, M. and P.E. Sankaranarayanan, 2006. Agent based power aware on demand distance vector routing protocol for wireless mobile ad hoc network. Inform. Technol. J., 5: 944-950.

Lam, P.P. and S.C. Liew, 2007. Nested network mobility on the multihop cellular network. IEEE Commun. Mag., 45: 100-104.

Mangues, J., A. Cabellos, R. Serral, J. Domingo and A. Goomeza *et al*., 2004. IP mobility. Macromobility, micromobility, quality of service and security. J. Council Eur. Profession. Inform. Soc., 5: 49-55.

McCarthy, B., M. Jakeman, C. Edwards and P. Thubert, 2008. Protocols to efficiently support nested NEMO (NEMO+). Proceedings of the 3rd international workshop on Mobility in the evolving internet architecture (MobiArch), August 17-22, 2008, Kyoto, pp: 43-48.

Nada, F., 2007. Performance analysis of mobile IPv4 and mobile IPv6. Int. Arab J. Inform. Technol., 4: 153-160.

Noor, R.M. and C. Edwards, 2011. A comparative performance analysis on NEMO-QoS and MIPv6-QoS in heterogeneous environments. J. Applied Sci., 11: 3130-1341.

Perkins, C., 2002. IP mobility support for IPv4. Network Working Group, Request for Comments: 3344, http://www.javvin.com/protocol/rfc3344.pdf

Senan, S., A.H.A. Hashim, A.S. Rashid and J.I. Daoud, 2011. Evaluation of nested network mobility approaches. J. Applied Sci., 11: 2244-2249.

Sharma, N., N. Sharma and D. Malik, 2011. Problems of inefficient routes in network mobility in wireless multihop gateway networks and their resolution. Int. J. Electr. Eng., 3: 29-31.

Soto, I., C. Bernardos, M. Calderon, A. Banchs and A. Azcorra, 2009. Nemo-enabled localized mobility support for internet access in automotive scenarios. IEEE Commun. Mag., 47: 152-159.

Soto, I., C.J. Bernardos, M. Calderon and T. Melia, 2010. PMIPv6: A network-based localized mobility management solution. Internet Protocol J., 13: 1-32.

Velmurugan, A. and R. Rajaram, 2005. Mobile Ad-hoc network internetworking with Next generation internet. Inform. Technol. J., 4: 398-404.