

Packet Losses Interpretation in Mobile Internet

Hossam el-ddin Mostafa, and Pavel Čičák

Abstract—The mobile users with Laptops need to have an efficient access to i.e. their home personal data or to the Internet from any place in the world, regardless of their location or point of attachment, especially while roaming outside the home subnet. An efficient interpretation of packet losses problem that is encountered from this roaming is to the centric of all aspects in this work, to be over-highlighted. The main previous works, such as *BER-systems*, *Amigos*, and *ns-2 implementation* that are considered to be in conjunction with that problem under study are reviewed and discussed. Their drawbacks and limitations, of stopping only at monitoring, and not to provide an actual solution for eliminating or even restricting these losses, are mentioned. Besides that, the framework around which we built a Triple-R sequence as a cost-effective solution to eliminate the packet losses and bridge the gap between subnets, an area that until now has been largely neglected, is presented. The results show that, in addition to the high bit error rate of wireless mobile networks, mainly the low efficiency of mobile-IP registration procedure is a direct cause of these packet losses. Furthermore, the output of packet losses interpretation resulted an illustrated triangle of the registration process. This triangle should be further researched and analyzed in our future work.

Keywords—Amigos, BER-systems, ns-2 implementation, packet losses, registration process, roaming.

I. INTRODUCTION

THE newfound freedom of mobility with Laptops was recently carried over into the computer world [1], [2]. The need of many mobile users utilizing Laptops to have an efficient access to i.e. their home personal data or to the Internet from any place in the world, regardless of their location or point of attachment (POA), especially during traveling through a town or a country, *roaming*, has made

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macro-mobility outside home subnet (HS), to a foreign subnet (FS), to the centric of all aspects in this work. In contrast to the nomadic user, the term mobile in this context implies that a user, such as a business traveler, with a portable computer of some sort (ex, Laptop), is connected to one or more decentralized applications across the Internet, that the user's POA changes dynamically and that all connections are automatically maintained despite the change, without reconfiguring his computer, changing his IP address or rebooting his system. This need for roaming through macro-mobility has driven companies, standards bodies, and industry forums [3]-[5] to spend millions of dollars on the research and development (R&D) of Laptops and protocols to create a seamless connection through and to the HS, which is affordable, efficient, and transparent to the basic mobile-IP (MIP) standards [6], [7]. However, this one of the main themes is not successfully achieved up-till-now. The following questions remain unsolved: How is it possible to roam outside the HS while having access to the Internet or home personal resources without packet losses (PLs)? What are the costs for this luxury? The idea is, to offer suitable functionality and protocol-extension to the basic MIP to let the communication believe that, the mobile host (MH) is still at its HS while it roams and receives the forwarded traffic on time, correctly and without delay or PLs through a secure roaming process. In summary, the goal is determined by the fact to achieve a higher degree of macro-mobility, while roaming, with similar functionality of the basic mobile-IP protocol. A second aspect is, companies' deal with the use of Internet technology and additional ways to do business with minimum costs while serving the user to support remote-access will make the most concerning of our interpretation is handling that roaming functionality without PLs, to bridge the gap between subnets, an area that until now has been largely neglected.

II. RESEARCH OVERVIEW

The previous works that are considered to be in conjunction with our PLs problem under study, besides the framework where we started to design our Triple-R sequence (RRR: requesting, registration, and then roaming) are discussed in the two subsections that follow:

A. Related Work

2.1.1. In all the previous works, which handled the PLs problem in networks with a wireless channel as the physical layer, ended with BER-systems [1] and [8]-[10], the reason for PL was that the bit error rate (BER) of transmission control protocol (TCP) in wireless channel is as high as 10^{-3} .

- It operated under conditions where the radio-coverage of the two subnets is overlapped. Whereas, this may not always be the case, where the conditions for the handover could also be significantly worse. The longer one is without overlapped radio-coverage

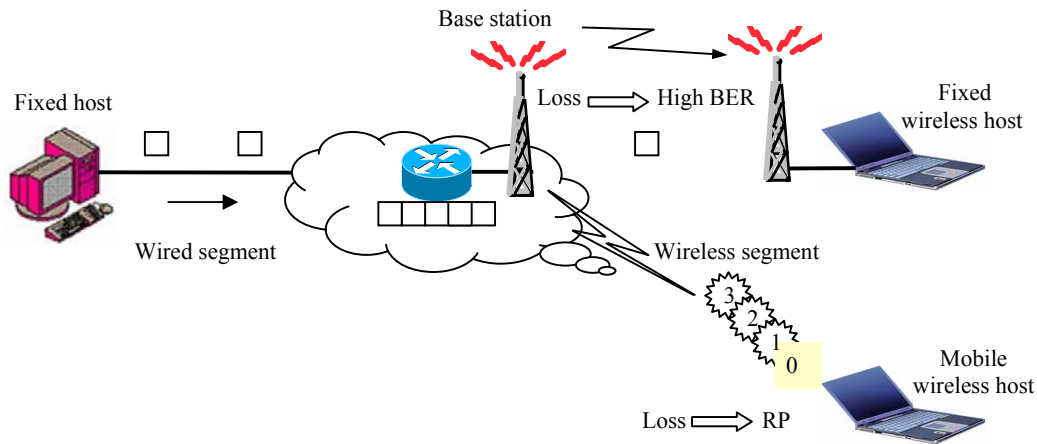


Fig. 1 Mobile wireless network versus fixed wireless network loss interpretations

However, these works have the following drawbacks:

- It considered the wireless hosts as fixed points with wireless channels and did not consider the mobility features of those clients.
- It concentrated on the high BER of transmitting the data itself as an only reason for PL in wireless networks, whereas neglected the procedure of delivering these packets between subnets as another usual reason for the PL in wireless mobile networks. Fig. 1 illustrates this misinterpretation.

2.1.2. One of the efficient works in describing the PLs between two subnets in wireless mobile network was, in part, *Amigos* [11]:

- It presented a mobile network prototype, of two mobile laptops under a wireless network of an already built network called *Amigos* as a HS and three FSs.
- It measured the PL, that comes from the mobile node's (MN) registration with the foreign agent (FA) and home agent (HA), using the "Ping" and "Netperf" programs, to estimate the influence of switching subnets on normal TCP performance.

However, this work has the following limitations:

- It reported a PL only of 7 packets under their test-conditions whereas that number may be worse in other settings, to sense the actual problem.
- Its' results mainly based on using "Ping" program, which does not send out a lot of packets, for example, another application that transmits more packets (stream) may lose more.

where more packets are lost.

- It estimated the PL on normal TCP, which normally considers PL as a sign of congestion and begins to transmit packets at a lower rate to help the congested subnet to recover. This strategy is not optimal if packets are lost due to subnets switch.
- It used MIP as a standard, to place the mobility support in the network layer. It means that it discarded the failures in the kernel of MIP itself.
- It sufficed at measuring the PL presence between subnets, not to provide an actual solution for eliminating or even restricting it.

2.1.3. The most recent work in describing the PLs between two subnets in wireless mobile networks was, in part, the implementation of route optimization extension [12] using *ns-2* [13], [14] simulation:

- It employed *ns-2* network simulator to implement the route optimization extension in MIP, during which it illustrated simulations of the PLs between subnets.
- It reported that PL begins at approximately 35 sec, when MN moves out of the wireless HS. Packet flow resumes when the MN successfully registers in the FS-1. PL occurs again at approximately 65 sec when the MN leaves FS-1 and enters FS-2. Packet flow resumes again at approximately 70 sec, as in Fig. 2.

However, this work also stopped at monitoring and illustrating the PL existence between subnets, not to provide any solution for solving this problem.

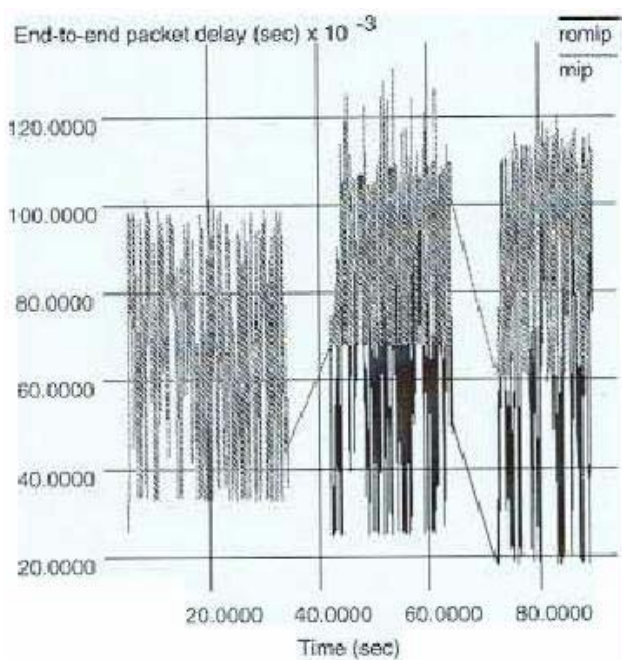


Fig. 2 End-to-end packet delay with (solid) and without (dashed) route optimization in mobile IP

We have to mention that the above-related works are considered to be in conjunction with the PLs problem under study and they are only comparable from the views of defining the source of PLs and the contributions in handling these losses.

B. Framework of the Triple-R Sequence

The original MIP introduced in the (Internet Engineering Task Force - Request For Comments) IETF RFC 2002 encountered some inefficiencies, basically within three main categories according to each step of the mobility resource management (MRM) process: location management, routing management, and handoff management. Adding to which here, in the registration process (RP), one of the MIP three basic capabilities, that the MN uses an authenticated registration procedure to register its current location with a FA in order to acquire a new IP address, Care-of Address (CoA), and to inform its HA of its CoA in order that the HA forwards its IP traffic. In this registration procedure is the gap, which causes our problem under study.

This led to specify the registration procedure of the original MIP protocol as a framework for us around which we previously built a Triple-R sequence. The RP involves four steps, shown in Fig. 3:

1. The MN requests the forwarding service by sending a registration request to a selected FA that the MN will use.
2. The FA relays this request to the MN's HA.
3. The HA either accepts or denies the request and sends a registration reply to the FA.
4. The FA relays this reply to the MN.

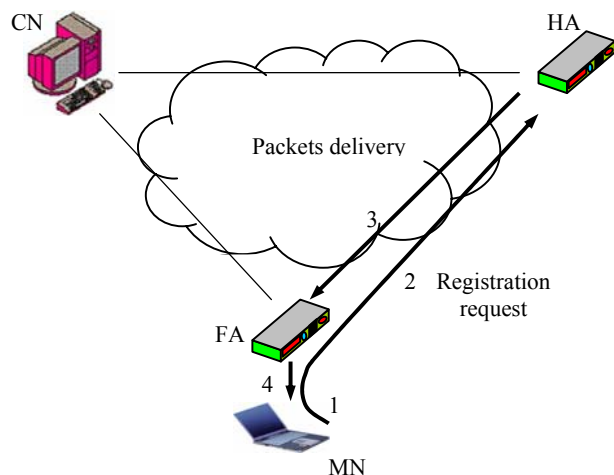


Fig. 3 Packets flow in a mobile IPv4 network

III. PLs INTERPRETATION AND RESULTS

The following Fig. 4 represents the output from our PLs interpretation, which is the triangle of RP (point B-FA-point C). In our this work:

- The low efficiency of MIP-RP in wireless mobile networks is a direct cause of the fact that MIP misinterprets the PL mainly because of the RP, in addition to the high BER.
- Rather than only measuring or monitoring the PLs, something that is a clear actuality nowadays, our work provided the Triple-R sequence on the principle of HA-based registration [15], to avoid the traditional sequence of MIP that shown in Fig. 4 (from point A to B, from point B to a FA, from the FA back to the HA, from the HA again forward to the FA, then finally from the FA to the MN at point C), as a cost-effective solution to eliminate the PLs and bridge the gap between subnets.

In contrast to the previous related works in which the registration capability may be inefficient, since all the registration steps take place whereas the MN already moved into the destined FS with no forwarding service yet and just waiting until performing a successful registration, the Triple-R sequence based on performing the registration with the FA while the MN is still inside the HS.

In [15] we presented this Triple-R sequence, however as a hint, the Triple-R sequence encounters that the registration request experience unnecessary delay (from the FA back to the HA, from the HA again forward to the FA, then finally from the FA to the MN at point C) in initiating forwarding service and in turn causes access interruption.

- A more efficient approach would be to initiate the registration with the FA within the HS, before a change in subnet connectivity is detected.
- That is, the nearest HA (i.e. HA-based) performs the choosing process of a FA, on behalf of the MN, according to the equilibrium policy, directly from its updated mobility binding cache (MBC) entry.

- These steps take place while the MN stills in the way to the FS, without any loss of time.

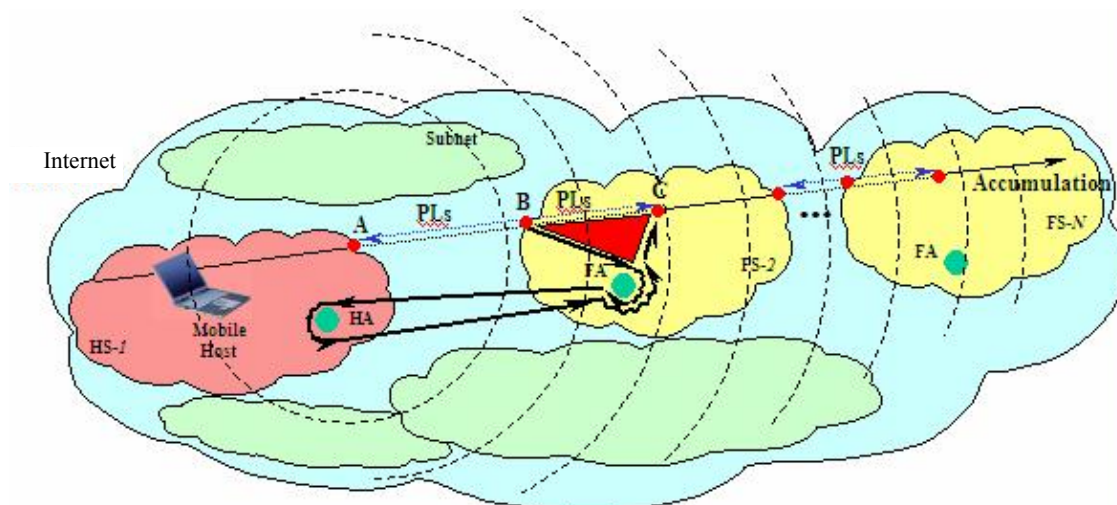


Fig. 4 Packet losses interpretation in mobile Internet

The scheme requires only minimal changes to nodes S/W. Consequently, servers' providers will practicalize it as a new update-function or routine in the initial configuration of the basic MIP protocol, to be pre-defined for all nodes. Such management, if properly engineered via modern vendors components, can provide improved quality of service (QoS).

IV. CONCLUSION AND FUTURE WORK

The PLs problem that is encountered while roaming outside the HS was to the centric of all aspects in this work, to be over-highlighted.

The main previous works that are considered to be in conjunction with PLs problem under study were reviewed and criticized. Besides that, the inefficiencies of the RP in the kernel of original MIP protocol have led to specify the registration procedure as a framework for our work to bridge the gap between subnets, an area that until now has been largely neglected.

The paper provided a novel architecture for efficient interpretation of these PLs in wireless mobile networks.

The results showed that the low efficiency of the MIP-RP is a direct cause of the fact that MIP misinterprets the PLs mainly because of the RP, in addition to the high BER. Furthermore, the PLs interpretation output resulted a triangle of RP. This triangle should be further researched and analyzed as our future work.

REFERENCES

- [1] A. Jamalipour, *The Wireless Mobile Internet: Architectures, Protocols and Services*, John Wiley & Sons Ltd, England, 2003, pp. 325-384.
- [2] W. Son, *Mobile IP*: <http://williamson.cx/>, 2003.
- [3] *Cisco website*: http://www.cisco.com/go/mobile_ip/, 2006.
- [4] *Microsoft website*: <http://www.microsoft.com/technet/mobility/>, 2006.
- [5] *Verizonwireless website*: http://www.verizonwireless.com/mobile_ip, 2006.
- [6] C. Perkins (Ed.), *IP mobility support*, IETF RFC 2002, Oct. 1996.

- [7] C. Perkins (Ed), *IP mobility support for IPv4*: <http://www.ietf.org/rfc/rfc3220.txt>, Jan. 2002.
- [8] G. Xylomenos, GC. Polyzos, P. Metri, P. Mahonen & M. Saaranen, "TCP performance issues over wireless links", *IEEE Communications Magazine*, 39(4), 52-58, 2001.
- [9] W. Ding & A. Jamalipour, "A new explicit loss notification with acknowledgment for wireless TCP", *the 12th IEEE International Symposium on Personal, Indoor and Mobile Radio Communication (PIMRC 2001)*, San Diego, Calif., Sep. 30-Oct. 3 2001.
- [10] W. Ding & A. Jamalipour, "Delay performance of the new explicit loss notification TCP technique for wireless networks," *Proceeding of IEEE Globecom 2001*, San Antonio, Tex., Nov. 2001.
- [11] A. Svendsen & R. Niel, *Mobile Networks*, Master Thesis, project: Devices on the Net (Apparater på Nettet), Department of Computer Science at the University of Copenhagen (DIKU), Denmark, May 2001.
- [12] H. Chen and L. Trajkovic, "Simulation of Route Optimization in Mobile IP," *proceedings of 27th annual IEEE conference on local computer networks (LCN'02), workshop of wireless local networks*, Tampa, FL, USA, Nov. 2003.
- [13] *The network simulator - ns-2*: <http://www.isi.edu/nsnam/ns>, Aug. 2002.
- [14] K. Fall and K. Varadhan (Eds.), *The ns Manual*: <http://www.isi.edu/nsnam/ns/doc/index.html>, Aug. 2002.
- [15] H. Mostafa, P. Čičák, "Home agent-based decentralized user-mobility with EPA-selection," *IIT.SRC-2005 student research conference proceedings*, FiiT-STU, Bratislava, Slovakia, Apr. 2005, pp. 103-107.



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