Analysis of Route Optimization Mechanism for Distributed Mobility Management

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***Abstract*—the mobile data traffic has been extremely expanded for years and will remains the high growth rate in a long term. It is believed that distributed mobility management has been developed to be a new trend of designing mobility management scheme to solve the problem caused by the increasing traffic volume. Based on reviewing the characters of distributed mobility management schemes as a model of "access router distributed but location management centralized", this paper introduces a distributed mobility management scheme called D-PMIPv6 and its route optimization mechanism. A performance analysis will be given, and numerical results show that the route optimization mechanism this paper proposed has a less signaling cost compared with route optimization mechanism for PMIPv6, but reduces the packets delivery cost as the same as route optimization mechanism for PMIPv6.**

***Index Terms*—distributed mobility management, route optimization, signaling cost, packets delivery cost**

I. INTRODUCTION

Nowadays people use Internet resource more aggressively than ever before, resulting in much data traffic volume. Especially for mobile environment, people desire ubiquitous mobile service all the time. It is believed that more and more people would access Internet via wireless connectivity [1]. According to a survey of Cisco, it shows that the data traffic of global mobile grew 2.3-fold in 2011, more than doubling for the fourth year in a row, and over the next few years it would remain such high growth as shown in Table 1[2].

Considering the situation discussed above, the traditional mobility management scheme obviously cannot satisfy the demands. Host based and network based mobility management schemes such as Mobile IPv6 (MIPv6) and Proxy Mobile IPv6 (PMIPv6) both have one single mobility anchor [3][4], which means all the traffic should be forwarded by this anchor reducing the whole system scalability and overall reliability dramatically.

Distributed mobility management that refers to an architecture in which the mobility anchor is distributed across multiple levels of hierarchy in a deployment is considered to address the problem caused by increasing traffic volume. And recently it has been a main purpose that the IETF Distributed mobility management (DMM) workgroup is working on [5]. The approaches and issues to achieve distributed mobility management are described in [6][7].

Till now many efforts put emphasis on separating data traffic forwarding from traditional mobility anchor. That is the access level routers are distributed in a large scale, and a centralized location management entity takes charge of mobility supporting. Thus the data plane packets from Mobile Node (MN) can be transmitted to Corresponding Node (CN) from the access router level directly [8][9][10][11]. We call such schemes as "access router distributed but location management centralized" model. The paper will summarize the general characters of such model of distributed mobility management scheme. A route optimization mechanism for D-PMIPv6 will be introduced, as well as a performance analysis. Such route optimization mechanism is not only for D-PMIPv6, but also applicable to other so-called "access router distributed but location management centralized" model.

TABLE I.
THE GLOBAL MOBILE DATA TRAFFIC GROWTH IN RECENT YEAR AND ESTIMATION

Year	Global Mobile Data Traffic Growth Rate
2009	140%
2010	159%
2011	133%
2012 (estimate)	110%
2013 (estimate)	90%
2014 (estimate)	87%

The remainder of this paper is organized as follows. Section I reviews the current development situation of distributed mobility management. Section II introduces the related work including the basic distributed mobility management schemes and traditional route optimization mechanism. Section III describes the basic idea of route optimization mechanism for distributed mobility management schemes in details. Section IV evaluates the performance analysis of such general route optimization mechanism. Section V shows the numerical results, and Section VI concludes the paper finally.

II. RELATED WORK

In this section, we will first introduce the basic idea of distributed mobility management scheme of "access router distributed but location management centralized"

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model as we called. Then we review the D-PMIPv6 which is an effort on this way and the traditional route optimization mechanism.

A. Distributed Mobility Management

As mentioned earlier many efforts have been made to achieve the model of "access router distributed but location management centralized" as we called. The schemes such as signal-driven PMIP in [8] and D-PMIPv6 in [9] are mainly followed the basic architecture of PMIPv6. In the context of these two schemes, Mobile Access Gateway (MAG) still manages the mobility related signaling messages for MN and tracks the movement of MN just as it does in PMIPv6. By a separation of control and data plane of traditional Local Mobility Anchor (LMA), LMA or Control Plane Local Mobility Anchor (CLMA) as defined in [9] as the unique control plane point holds Binding Cache Entries (BCE) information for MNs but avoiding from forwarding data plane traffic. The difference of these two schemes is that in the context of D-PMIPv6, the traffic destined to the CN outside of domain will be forwarded by Data plane Local Mobility Anchor (DLMA) which is considered as edge router for a domain.

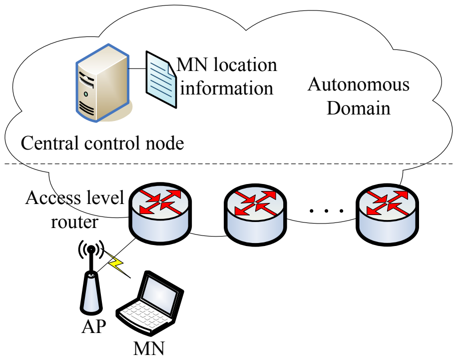


Figure 1. The basic architecture of so-called "access router distributed but location management centralized" model

The same idea is adopted by other distributed mobility management schemes such as [10][11]. So-called Mobility capable Access Router (MAR) or Mobility Anchor and Access Router (MAAR) can be seen as the access level router used for tracking the movement of MN just as MAG as well as allocating MN the prefix. The main difference from the previous two schemes is that, such first level access router is also the topological anchor point for MN. To avoid disturbing the route of whole domain, each first level access router would just forward the traffic with the prefix in its charge. That means the packets from MN would be forwarded to CN directly without encapsulation by such entities. And as MN moves on, handover would occur involving in allocating MN multiple prefixes.

Through the above discussion, we can conclude the basic architecture of such "access router distributed but location management centralized" model of distributed mobility management schemes. As shown in Fig.1, the access level routers which MN attaches to are distributed in an autonomous domain, and a centralized control node can maintain the location information of quite a number of MNs.

B. Overview of D-PMIPv6

The architecture of D-PMIPv6 is to make an improvement as shown in Fig.2. It borrows several key terms from PMIPv6 to support mobility management. It split the data and control plane of LMA by the new defined CLMA and DLMA. In the context of D-PMIPv6, two kinds of LMA's function are described as follows. CLMA has to manage the signaling messages of binding registration. It allocates DLMA to MN as well as home network prefix (HNP), and maintains the BCE for MN. However, DLMA takes charge in forwarding the data plane packets.

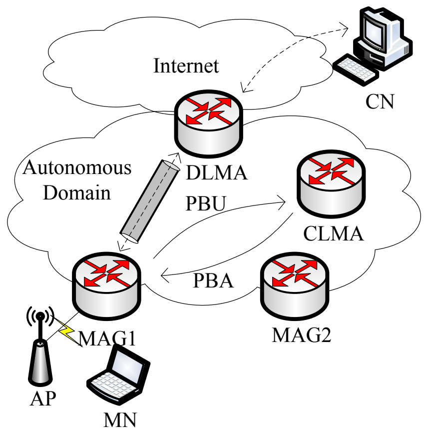


Figure 2. The basic architecture of D-PMIPv6

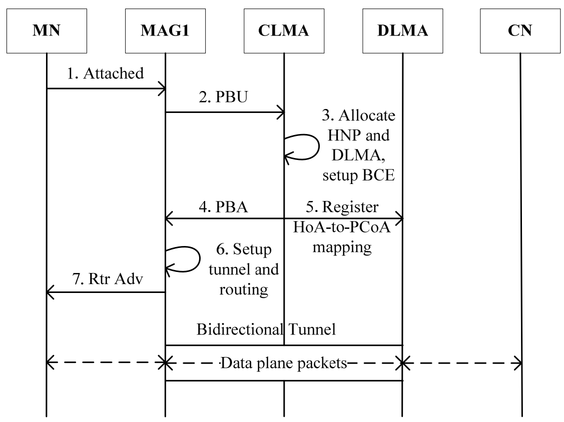


Figure 3. The basic design of D-PMIPv6

The basic design of D-PMIPv6 is shown in Fig.3. D-PMIPv6 does not introduce extra steps compared to the attachment of PMIPv6. After MN attaches to the domain successfully through an authentication procedure, MAG would send Proxy Binding Update (PBU) to CLMA for binding registration. Meanwhile MAG is also asking for the DLMA address for MN. When CLMA receives the PBU message it would build the BCE for this MN and allocate MN a DLMA by a DLMA decision procedure [9]. Then CLMA sends back Proxy Binding Acknowledgement (PBA) to MAG including the DLMA address information which is defined as a new mobility option. Finally the bidirectional tunnel will be set up between MAG and the determined DLMA. It is noted that the DLMA is the topology anchor of MN.

In context of D-PMIPv6, signaling messages will be exchanged between CLMA and MAG as illustrated by solid lines. The data plane packets will be forwarded to CN by DLMA as illustrated by dotted line.

C. Route Optimization Mechanism

In this paper the route optimization mechanism mainly refers to PMIPv6 localized routing [12]. There are four scenarios for PMIPv6 route optimization [13]. Here we just consider the scenario that MNs attach to different MAGs which are belonged to the same LMA.

There are two modes of route optimization mechanism for PMIPv6, direct mode and proxy mode [14]. The performance of these modes is throughout discussed in [15]. The purpose of this protocol is to set up bidirectional tunnel between MAGs for MNs to communicate with each other directly. A new defined entity called Route Optimization Controller (RO controller) which is advised to be assigned on LMA is introduced to set up and maintain the route optimized path.

In Direct Mode, MAGs can exchange signaling messages with each other to set up and maintain route optimization paths for MNs, but such mode needs sharing Security Association (SA) between MAGs [16]. Then in the Proxy Mode, LMA takes charge in exchanging signaling messages with MAGs to set up and maintain route optimization paths.

III. Overview of Route Optimization for Distributed Mobility Management Schemes

In this section, we first introduce the basic design of route optimization of D-PMIPv6. A security consideration is also included at last.

A. Basic Design

The route optimization mechanism in this paper is mainly designed for D-PMIPv6, but it is also available to so-called "access router distributed but location management centralized" model of distributed mobility management schemes as we summarized early. The basic idea is that, at first the route optimization related MNs have already attached to the domain. Before MN initials a communication session, MAG would trigger the optimization procedure on behalf of MN to establish the bidirectional tunnel between MAGs for the direct data plane traffic. Here we make reuse of Proxy Binding Query (PBQ) and Proxy Query ACK (PQA) messages format described in [8]. As shown in Fig.4, we assume MN1 accesses to MAG1 and MN2 accesses to MAG2 respectively, the details of process are discussed as followed.

Step 1 and 2: route optimization related MNs both attach to the domain. This procedure is illustrated by Fig.3. After the attachment succeeds, MN will obtain the HNP to generate Home Address (HoA).

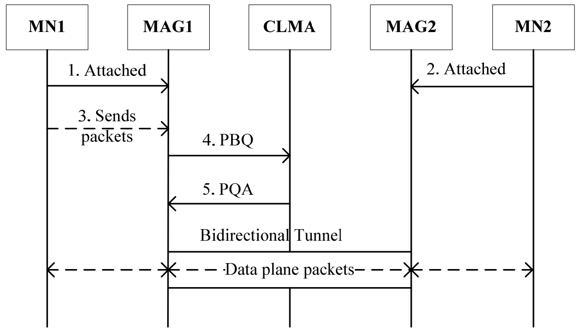
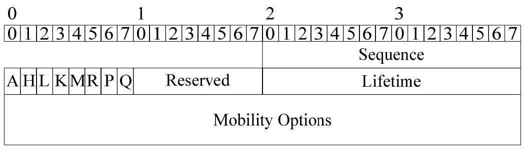


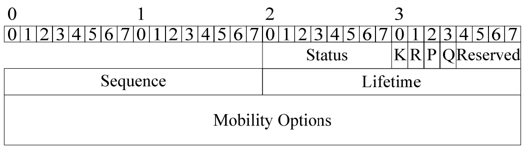
Figure 4. Route optimization for D-PMIPv6

Step 3: MN1 sends data plane packets to MN2. MAG1 trigger the route optimization mechanism by this time. These packets will be buffered in MAG1 in a while until MAG2 obtains the Proxy Care-of Address (PCoA) of MN2.

Step 4: MAG1 first extract the destination address of packets from MN1. Here we suppose this address is HoA2. Then MAG1 sends PBQ message whose format is shown in Fig.5 (a) to CLMA to inquire the HoA-to-PCoA mapping information of MN2. Mobility options must contain HNP option and MAG address option with value 0 in the field which is defined in [13].



(a) the Format of PBQ



(b) the Format of PQA

Figure 5. The format of signaling messages used in route optimization

Step 5: CLMA looks up its BCE for HoA-to-PCoA mapping of MN2, and sends the PQA message whose format is shown Fig.5 (b) back to MAG1. This message contains the PCoA of MN2.

Thus, the data plane traffic can be exchanged between two MNs through the bidirectional tunnel. It is noted that, before MAG1 sends data plane packets to MAG2, there are not any messages exchanging between two MAGs. One may doubt how MAG2 can process the encapsulated packets from MAG1. Our solution is that, the corresponding MAG should stripe the outer encapsulation directly, and records such HoA-to-PCoA mapping for sending back packets. It is very similar to the process of Egress Tunnel Router (ETR) receiving packets from Ingress Tunnel Router (ITR) in LISP [17].

According to the basic architecture of PMIPv6, every MN attached to the domain must accomplish the binding registration. That is CLMA as the unique control plane point is considered to hold all the HoA-to-PCoA mapping information of the domain. Since there may be quite a number of MNs in the domain, we advise to use LDAP to store the HoA-to-PCoA mapping [18]. Thus CLMA can find the exact matched entry for a quick response among massive records of mapping information.

B. Security Consideration

The basic design adopts the idea of direct mode for route optimization of PMIPv6. That is the signaling messages are exchanged between LMA and MAG. Such approach has an advantage that SA has been established in the binding registration procedure [4]. So the mechanism does not be involved in extra security issues.

IV. Performance Analysis

In this section we analyze the performance of route optimization mechanism of D-PMIPv6. The analysis is mainly based packets delivery cost and signaling cost. We will compare the performance of PMIPv6 [4], the route optimization of PMIPv6 [14] and the route optimization of D-PMIPv6 [9]. Though there are two modes of optimization mechanism for PMIPv6, we just consider the proxy mode to be on behalf of the performance of route optimization for PMIPv6.

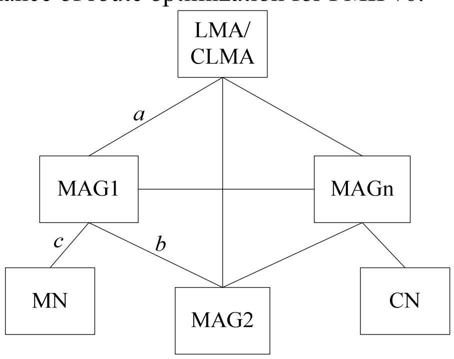


Figure 6. The format of signaling messages used in route optimization

The network topology of PMIPv6 used for performance analysis is introduced in [15]. We suppose the number of MAGs in the domain is n. In this paper, we assume there are 20 MAGs in the domain. The topology is shown in Fig.6. We assume that the distance between LMA and MAG is *a* with the default value 5 as we defined. The distance between MAGs is *b*, whose value is √20 as described in [20]. And the distance between MN and MAG is *c* with the default value 1. CLMA is in the same location just as LMA.

A. Mobility Model

In this paper, we use Fluid Flow (FF) for analysis. That is the movement of MN is uniformly distributed in the direction of (0, 2π). Each MAG has a circular shape for MN to access with the area size S_{AR}, $S_{AR} = \pi \times R^2$, where R is the radius with the default value of 100m as we defined. Let ρ be the density of MN on this area, and l is the area border length. Here we can easily figure out the value of l, that is $l = 2\pi R$. Thus, the rate of border crossings per hour (CR) out of the area can be calculated as follows [19].

$$CR = \frac{\rho \cdot v \cdot l}{\pi} \tag{1}$$

For a single MN, let μ_c and μ_d be the border crossing rate of an MN out of a MAG and out of a domain respectively, and υ is the average velocity of the MN. We can calculate them as follows.

TABLE II
The definition and default value of related parameters

Category	Description	Default value
R	the radius of area that MAG covers	100m
n	the number of MAGs in this the domain	20
L_s	the size of signaling message	76 Bytes
L_p	the average size of data packets	10 Bytes
τ	bidirectional tunnel header size	40 Bytes
α	unit transmission cost over the wired link	1
β	unit transmission cost over the wireless link	1.5
PC_R	process cost on the regular router	8
PC_M	process cost on MAG	12
PC_L	process cost on LMA	24
a	the distance between LMA and MAG	5
b	the distance between MAGs	√20
c	The distance between MN and MAG	1
v	velocity of MN	10m/s
λ_s	MN's session arrival process	0.5

$$\mu_c = \frac{2 \cdot v}{\sqrt{\pi \cdot S_{AR}}}, \mu_d = \frac{2 \cdot v}{\sqrt{\pi \cdot n \cdot S_{AR}}} \tag{2}$$

Let μ_l be the cell crossing rate that MN moves within the same domain. We can calculate μ_l as follows.

$$\mu_l = \mu_c - \mu_d = \mu_c \cdot \frac{\sqrt{n} - 1}{\sqrt{n}} \tag{3}$$

Then we assume MN's session arrival process follows a Poisson distribution with rate λ_s. Based on (2) and (3), the average number of location binding updates during an inter-session time interval under MAG crossing $E\ (N_c)$ and domain crossing $E\ (N_d)$ can be calculated as follows.

$$E(N_c) = \frac{\mu_c}{\lambda_s}, E(N_d) = \frac{\mu_d}{\lambda_s} \tag{4}$$

Thus we can finally conclude the average number of movements during an inter-session arrival within domain $E\ (N_l)$ as follows.

$$E(N_l) = \frac{\mu_l}{\lambda_s} = \frac{(\mu_c - \mu_d)}{\lambda_s} \tag{5}$$

The other related parameters for cost analysis are shown in Table 2. In this paper we make use of default value of parameters defined in [21][22]. It is noted that, we do not distinguish the different type of signaling messages, since the format of PBQ and PQA are quite similar to the PBU and PBA messages of PMIPv6. Thus in this paper these four types of signaling messages are all 76 Bytes.

B. Signaling Cost

The signaling cost of PMIPv6 is defined as SC_{PMIP}. In the context of PMIPv6, when MN accesses to MAG, MAG would exchange PBU and PBA messages with LMA. Let C_{PBU} and C_{PBA} be the signaling cost of PBU and PBA respectively. As mentioned early, the average number of movements within a domain is $E\ (N_l)$, we can figure out the signaling cost of PMIPv6 as follows.

$$SC_{PMIP} = E(N_l)\cdot(C_{PBU} + C_{PBA}) \tag{6}$$

The cost of PBU and PBA would be the sum of the cost on transmission wired link and the processing cost on other entities such as routers and mobility management related MAG and LMA. The process cost of regular router, MAG and LMA are 8, 12 and 24 respectively as we defined. And the unit transmission cost over the wired link α is 1. Thus C_{PBU} and C_{PBA} can be calculated as follows.

$$\begin{aligned} C_{PBU} &= \alpha\cdot a\cdot L_s + (a-1)\cdot PC_R + PC_L \\ C_{PBA} &= \alpha\cdot a\cdot L_s + (a-1)\cdot PC_R + PC_M \end{aligned} \tag{7}$$

Then let $SC_{PMIP\text{-}RO}$ be the signaling cost of route optimization mechanism for PMIPv6. We should add the cost of route optimization $C_{PMIP\text{-}RO}$ to signaling cost based on (6). $SC_{PMIP\text{-}RO}$ can be calculated as follows.

$$SC_{PMIP-RO} = E(N_l)\cdot(C_{PBU} + C_{PBA} + C_{PMIP-RO}) \tag{8}$$

According to [14], $C_{PMIP\text{-}RO}$ is the sum of transmission cost on wired link from MAG to LMA and the processing cost on MAG and LMA. Thus the value of $C_{PMIP\text{-}RO}$ can be calculated as follows.

$$\begin{aligned} C_{PMIP-RO} &= 2(3\cdot\alpha\cdot a\cdot L_s + (a-1)\cdot PC_R) \\ &\quad +3\cdot PC_M + 3\cdot PC_L \end{aligned} \tag{9}$$

At last, let $SC_{DPMIP\text{-}RO}$ be the signaling cost of route optimization mechanism for D-PMIPv6. Just like the scenario in PMIPv6, $C_{DPMIP\text{-}RO}$ denotes the signaling messages related cost. Thus $SC_{DPMIP\text{-}RO}$ can be calculated as follows.

$$\begin{aligned} SC_{DPMIP-RO} &= E(N_l)\cdot(C_{PBU} + C_{PBA} \\ &\quad + C_{DPMIP-RO}) \end{aligned} \tag{10}$$

As described in III.A, $C_{DPMIP\text{-}RO}$ is the sum of transmission cost on wired link from MAG to CLMA and the processing cost on MAG and CLMA. We can easily figure out the value of $C_{DPMIP\text{-}RO}$ as follows.

$$\begin{aligned} C_{DPMIP-RO} &= 2(\alpha\cdot a\cdot L_s + (a-1)\cdot PC_R) \\ &\quad + PC_M + PC_L \end{aligned} \tag{11}$$

C. Packets Delivery Cost

There are two scenarios for the packets delivery cost. One scenario is the delivery cost for optimized path, and the other scenario is the delivery cost for regular path. We define them as PC_{NRO} and PC_{RO} respectively. The average size of data packets are 10 Bytes in this paper. Let $E\ (S)$ be the average number of packets during a session. The value of β which is defined as unit transmission cost over the wireless link is 1.5. PC_{NRO} means that all the traffic from MN should be forwarded by LMA through a bidirectional tunnel. PC_{NRO} can be calculated as follows.

$$\begin{aligned} PC_{NRO} &= 2\beta\cdot E(S)\cdot L_p\cdot c \\ &\quad +2E(S)\cdot(\tau + L_p)\cdot a \\ &\quad +2(a-1)\cdot PC_R \\ &\quad +2PC_M + PC_L \end{aligned} \tag{12}$$

While, PC_{RO} means that all the traffic would be exchanged between MAGs. PC_{RO} can be calculated as follows.

$$\begin{aligned} PC_{RO} &= 2\beta\cdot E(S)\cdot L_p\cdot c \\ &\quad +E(S)\cdot(\tau + L_p)\cdot b \\ &\quad +(a-1)\cdot PC_R \\ &\quad +2\cdot PC_M \end{aligned} \tag{13}$$

The packets delivery cost of PMIPv6 is PC_{PMIP}, which is the sum of cost on wireless link from MN to MAG, the processing cost on the MAG, LMA as well as router, and the delivery cost on wired link within the domain. Let $E\ (S)$ be the average number of packets during a session. Base on (12) PC_{PMIP} can be calculated as follows.

$$\begin{aligned} PC_{PMIP} = PC_{NRO} &= 2\beta\cdot E(S)\cdot L_p\cdot c \\ &\quad +2E(S)\cdot(\tau + L_p)\cdot a \\ &\quad +2(a-1)\cdot PC_R \\ &\quad +2PC_M + PC_L \end{aligned} \tag{14}$$

Let ω be ratio that packets are not transited by route optimized path. So it is easy to know the ratio that packets are transited by route optimized path is (1-ω). In the scenario of route optimization mechanism of PMIPv6, the whole process should be triggered by LMA. That is after the first packet from MN arrives at LMA, LMA would trigger the route optimization. Thus we can figure the value of ω in route optimization of PMIPv6.

$$\omega = \frac{L_p}{E(S)\times L_p} = \frac{1}{E(S)} \tag{15}$$

The packets delivery cost of route optimization which is described as $PC_{PMIP\text{-}RO}$ for PMIPv6 can be divided into two parts. One part is the delivery cost for optimized path, and the other part is the delivery cost for regular path. Based on (12), (13) and (15) $PC_{PMIP\text{-}RO}$ can be calculated as follows.

$$\begin{aligned} PC_{PMIP-RO} &= \omega\times PC_{NRO} + (1-\omega)\times PC_{RO} \\ &= 2\beta\cdot E(S)\cdot L_p\cdot c \\ &\quad +(\tau + L_p)\cdot(2a + b\cdot E(S) - b) \\ &\quad +\frac{(a-1)\cdot(E(S)+1)}{E(S)} \\ &\quad +\frac{PC_L + 2PC_M\cdot E(S)}{E(S)} \end{aligned} \tag{16}$$

The packets delivery cost of route optimization of D-PMIPv6 is $PC_{DPMIP\text{-}RO}$ as we defined in this paper, which is the sum of cost on wireless link between MN and MAG, the processing cost on the MAGs, and the delivery cost on wired link within this domain. It is noted that, unlike the route optimization mechanism for PMIPv6, the route optimization mechanism for D-PMIPv6 does not involve in the delivery cost on LMA. That is because such mechanism is not triggered by the first data plane packet as the route optimization mechanism for PMIPv6, and by a serial of signaling messages exchanging all of traffic will be forwarded by MAGs directly. Thus based on (13) the value of $PC_{DPMIP\text{-}RO}$ can be calculated just as follows.

$$\begin{aligned} PC_{DPMIP-RO} = PC_{RO} &= 2\beta \cdot E(S) \cdot L_p \cdot c \\ &+ E(S) \cdot (\tau + L_p) \cdot b \\ &+ (a-1) \cdot PC_R \\ &+ 2 \cdot PC_M \end{aligned} \qquad (17)$$

D. Total Cost

The total cost is the sum of signaling cost and packets delivery cost. The total cost of PMIPv6, route optimization for PMIPv6 and route optimization for D-PMIPv6 are defined as TC_{PMIP}, $TC_{PMIP\text{-}RO}$ and $TC_{DPMIP\text{-}RO}$ in this paper. Based on the discussion above, we can easily figure out these three values as follows.

$$\begin{aligned} TC_{PMIP} &= SC_{PMIP} + PC_{PMIP} \\ TC_{PMIP-RO} &= SC_{PMIP-RO} + PC_{PMIP-RO} \\ TC_{DPMIP-RO} &= SC_{DPMIP-RO} + PC_{DPMIP-RO} \end{aligned} \qquad (18)$$

V. Numerical Results

In this section, based on the performance analysis described earlier we will present the impact of several factors such as velocity, session arrival rate, session to mobility ratio (SMR) on the signaling cost, the packets delivery cost and the total cost. The numerical results provide a quantitative compare among PMIPv6, route optimization for PMIPv6 and route optimization for D-PMIPv6.

A. Signaling Cost

We first illustrate the impact of velocity on signaling cost. In this paper, velocity varies from 5 m/s as human walk to 30 m/s as vehicle moves. From (6), (8) and (10), we can calculate the signaling cost of PMIPv6, route optimization for PMIPv6 and route optimization for D-PMIPv6 as shown in Fig.7.

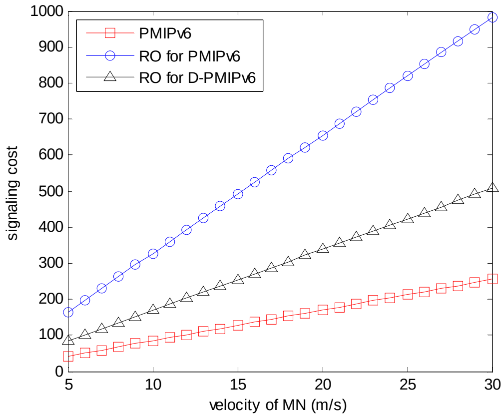


Figure 7. The impact of velocity on signaling cost

Then we illustrate the impact of session arrival rate λ_s on signaling cost. Here, we assume the value of λ_s varies from 0.1 to 1. Thus the signaling cost is shown Fig.8.

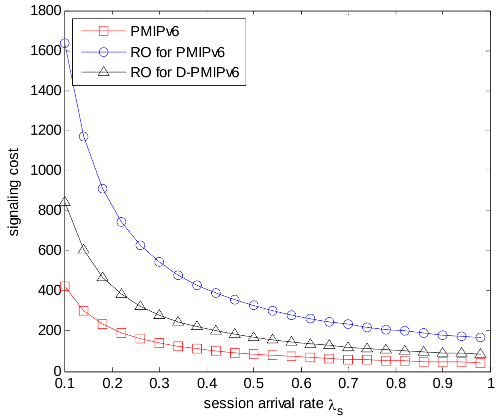


Figure 8. The impact of session arrival rate on signaling cost

From Fig.7 and Fig.8 we can see that the route optimization mechanisms would involve in extra signaling burden, since they both need several signaling to trigger the whole process. As velocity of MN increases the signaling will increases linearly and as session arrival rate increases the signaling will decreases linearly. But the route optimization for D-PMIPv6 roughly has a lighter burden compared with route optimization for PMIPv6.

B. Packets Delivery Cost

We illustrate the impact of average number of packets during a session *E (S)* on packets delivery cost. In this paper, we assume the value of *E (S)* varies from 10 to 100. The packets delivery cost is shown in Fig.9.

From Fig.9 we can see that, as *E (S)* increases packets delivery cost will also increase linearly. The packets delivery cost of PMIPv6 has a much heavier burden than route optimization mechanism. And the two type of mechanism almost have the same performance.

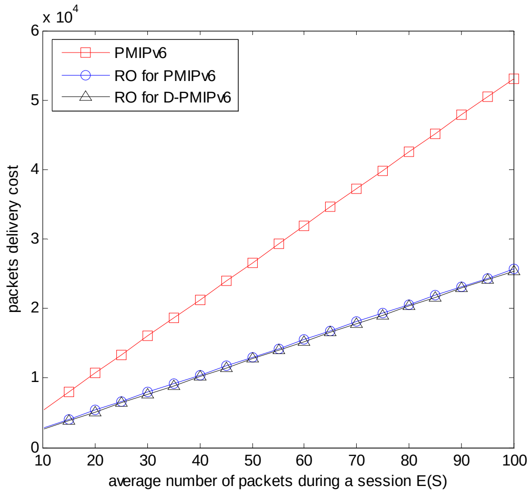


Figure 9. The Impact Of Average Number of Packets During A Session on Packets Delivery Cost

C. Total Cost

We consider the impact of SMR on total cost. The value of SMR is λ_s/μ_c. We assume that the value of *E (S)* is 1. Since velocity varies from 5m/s to 30m/s and λ_s varies from 0.1 to 0.75. Thus the value of SMR can be supposed to vary from 0.05 to 1.2. The packets delivery cost is shown in Fig.10.

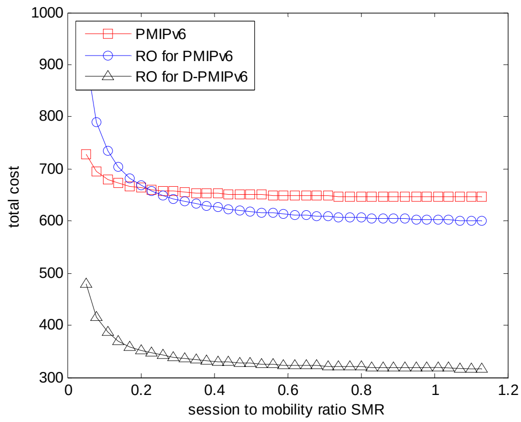


Figure 10. The Impact Of Session To Mobility Ration (SMR) on Total Cost

From Fig.10 we can see as session to mobility ratio increases, the total would decrease. And the route optimization mechanism for D-PMIPv6 has a better performance than route optimization mechanism for PMIPv6 and the traditional PMIPv6.

VI. Conclusion

This paper reviews the most discussed distributed mobility management schemes, and summarizes the characters of "access router distributed but location management centralized" model. Then a route optimization mechanism for D-PMIPv6 is introduced. Such mechanism is also applicable to other schemes of the model. A performance analysis and numerical results show that to signaling cost the route optimization that we proposed has a better performance compared to route optimization mechanism for PMIPv6. In the analysis of packets delivery cost, the route optimization for D-PMIPv6 has a performance just as good as route optimization for PMIPv6. And for total cost it does even better.

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