Internet scale mobility service: a case study on building a DHT based service for ISPs

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Abstract

Mobility in packet networks has become a critical issue in the last years. Mobile IP and NEMO are the IETF proposals to provide mobility. However, both of them introduce performance limitations, due to the presence of an entity, the Home Agent (HA), in the communication path. A family of solutions solves the problem by allowing mobile devices to use several geographically distributed HAs with the goal of making shorter the communication path. These techniques require a method to discover a close HA to the mobile node among those geographically distributed. This position paper proposes a DHT based peer-to-peer solution, called *Peer-to-Peer Home Agent Network (P2PHAN)*, in order to discover a close HA. The proposed solution is simple, fully global, and dynamic. It constitutes an starting point for discussion of how DHT based p2p services can provide a Internet scale mobility service that could constitute a new business model for ISPs.

1 INTRODUCTION

The basic solution of Mobile IP and NEMO presents the well known and deeply studied triangular-routing as the main performance limitation: the communication path of the Mobile Node (MN) must pass through an entity, called the Home Agent (HA). This non optimal routing may cause problems to delay sensitive applications. The research community has proposed several solutions to solve the routing problems of basic NEMO and Mobile IP.

One family of solutions proposes to reduce and limit the distance between the HA and the MN by minimizing the total path length. Basically, a MN always tries to use a close HA which lets it to fulfill the specific requirements of its communications. Therefore, this family of solutions needs a mechanism to efficiently discover a close HA.

This paper presents a mechanism which solves that problem by proposing the use of a DHT based overlay peer-to-peer network (P2PHAN), formed by HAs, in order to discover a close HA to a certain MN. The novelty of this approach is that we exploit the versatility of p2p not only in a well know scenario like file sharing but for a Internet scale HA dynamic discovery. An extended version of the architecture described in this paper is [1].

In a nutshell, a MN detects that its current HA is too far away. Then, it asks its current HA, which belongs to the P2PHAN network, for a close HA. The P2PHAN, based on information provided by the BGP protocol, discovers the HAs located in the same Autonomous System (AS) where the MN belongs. This information is received by the current HA. After that, it sends the list of HAs to the mobile node which finally associates with one of the HA in the list. The proposed solution is simple, fully global, and dynamic and it can be deployed in both IPv4 and IPv6 scenarios.

2 P2PHAN Architecture

We propose the use of an overlay p2p network formed by HAs in order to discover a close HA to a certain Mobile Router (MR). Information about the location of each HA (its AS) will be available within the P2PHAN.The basic idea is that an MN is always associated to a HA belonging to the P2PHAN. Eventually, the MN realizes that its current HA is too far away to fulfill the requirements of some kind of communication (e.g. real time ones as voice or video). Then, the MN launches the mechanism to discover a closer HA. It sends its location information (i.e. the MN’s CoA) to its current HA. After that, this HA runs a search process, based on the MN’s CoA, within the P2PHAN in order to discover a closer HA. The search result is the IP addresses of the close HAs. Finally, the current HA informs to the MN and this one connects to one of those HAs.

The following description of the architecture focuses on the development of P2PHAN over NEMO, but the solution works also on both Mobile IP and NEMO.

P2PHAN is a self-organized, fully decentralized, with semantic free indexes and with a Chord –like ring structure.. In our scheme the search key is hash(AS number). When one node joins the P2PHAN, it chooses an identifier (Peer-ID) from the ids pool. Its position in the ring is determined by the chosen id and it is placed between the two nodes with the most similar id to its own id. Each peer has direct references to its two neighbours and also with other peers (crossing the ring) so as to make faster the routing within P2PHAN. Each peer uses these references to create its P2PHAN routing table.
On the other hand, each peer must store its AS number within P2PHAN. The peer obtains a key by computing the hash(AS number). Then, it looks for the peer with the most similar Peer-ID to that key and sends to this peer the key and its IP address. The destination peer stores the pair <key, IPaddress>.

The HA discovery mechanism could be initiated by both the MR or the HA.

a) MR initiated approach
An MR connected to a HA1 detects that the delay to this HA is higher than desired (e.g. by measuring a Round Trip Time -RTT- to HA1 higher than a given threshold). Then, it launches the procedure to discover a closer HA. The MR sends its current CoA to HA1. At this point, HA1 discovers (using BGP) the CoA’s AS number. Afterwards, it computes hash(AS number) which is the search key. The search method within the P2PHAN is as follows. HA1 sends a query with the search key. It compares the search key with the Peer-IDs stored in its P2PHAN routing table and chooses the IP address of the closest Peer-ID to the search key as next hop. The next hop operates similarly. By doing so, the last hop will be the destination peer for the query (it looks for a closer Peer-ID to the search key in its P2PHAN routing table but there is not any other node with a closer Peer-ID. This peer (e.g. HA2) stores the IP addresses of all the Has located in the AS where the MR is currently attached to. Then, HA2 sends the IP addresses of the HAs to HA1, which

sends them to the MR. The MR decides the preferred HA based on any criterion (e.g. minimum measured RTT). Figuew 1 shows theP2PHAN functionality explained above.
In order to make the P2PHAN dynamic and adaptive, every HA periodically checks if the peers, which it has direct references to, are still reachable and running. If it is necessary, the HA reconfigures its P2PHAN routing table and establishes new references.
On the other hand, to make the solution more robust and reliable, redundancy must be added. Therefore, each peer stores the information of its two neighbours and the MR shaves a list with the IP addresses of the HAs received in the last query. Both techniques permit to avoid the loss of connectivity of one MR if its HA fails. The MR would choose one of the HAs present in its list, and neighbours of the fallen HA would restructure the ring.
Finally, the peer departure procedure is quite simple. The HA which desires to leave the P2PHAN only has to inform its MRs and its neighbours about its leaving. Then, its neighbours change the references to properly close the ring and MRs connect to a new HA.

b) HA initiated approach
It differs from the previous case because now it is the HA who initiates the search, within the P2PHAN, when it receives a new CoA from the MR. After that, it sends the result (the IP addresses of the HAs in the MR's current AS) to the MR. In this case, the MR decides whether it prefers to change the HA or not.

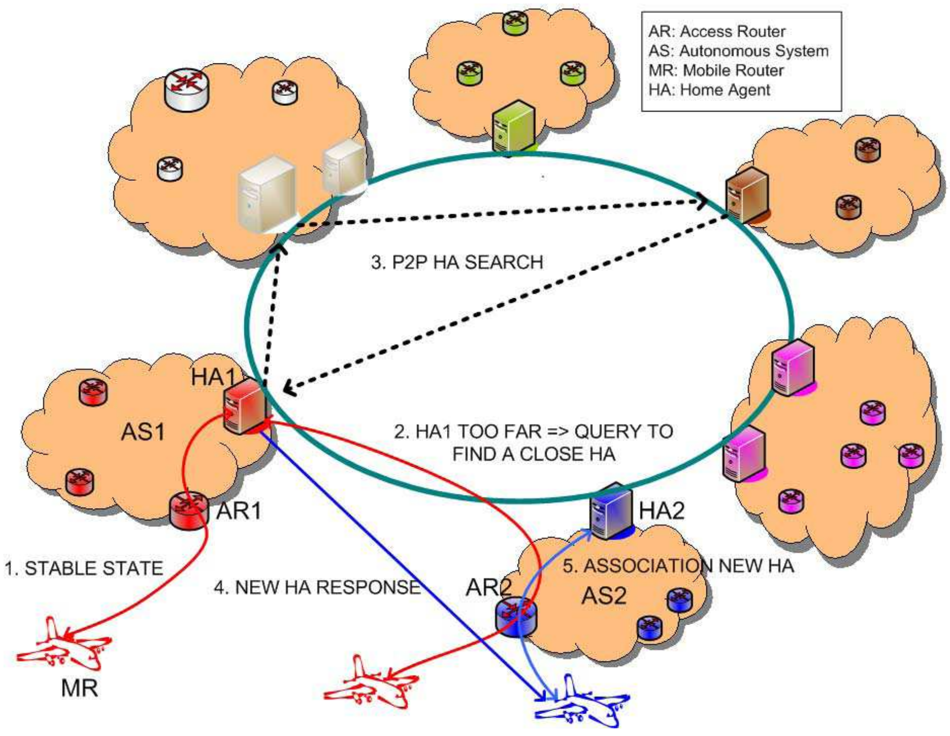

Figure 1. P2PHAN Scheme

3 RELATED WORK

Some solutions have been proposed for dynamic HA discovery. A global dynamic HA discovery solution, Global Dynamic Home Agent Discovery on Mobile IPv6 [2] proposes a very complex approach which needs major changes in the network infrastructure, it demands changes in devices like Border Routers or Access Routers. Besides, it proposes the use of new IPv6 anycast addresses which are not routable by routers currently deployed in the Internet.

There are also other solutions focused on local dynamic HA discovery, which involve DHCP servers [3] or Access Routers [4]. These solutions are not globally applicable. With regard to local discovery, Dynamic Home Agent Address Discovery (DHAAD) [5] also proposes a solution based on an anycast address for Home Agents in the Home Network, then the MN asks for this address in order to dynamically find a HA. These solutions are designed as local HA discovery and there are no proposals to migrate them to a global scenario.

In a nutshell, very few solutions have been proposed to solve the global dynamic HA discovery, and the proposed ones are more complex than ours. Other solutions were proposed for dynamic local HA discovery but they are not useful in a global scenario. On the other side, our proposal offers a simple and global solution. It includes redundancy and techniques which make the solution more stable and robust to failures. The p2p search method assures a quick answer in the HA discovery. Besides, our solution does not require infrastructure changes in devices different than HAs and MRs.

4 CONCLUSION AND FURTHER WORK

Due to the sub-optimal routing introduced by the NEMO Basic Support Protocol, there are several solutions which try to solve this problem by means of finding a closer HA to the MR. This paper proposes a based p2p architecture to solve the key point of these solutions that is the dynamic and global discovery of a close HA. Several solutions have been proposed so far. Some of them are not global, and those that are global require major infrastructure changes and complex mechanisms in order to dynamically discover a closer HA. On the other side, the solution proposed in this paper offers a dynamic and fully global mechanism to discover a close HA. P2PHAN provides a reliable and quick search method based on p2p techniques. The solution is quite simple, and therefore it could be easily implemented and deployed. Another important advantage is that our proposal works both in both IPv4 and IPv6 scenarios.

Finally, it must be highlighted the great adaptability offered by our solution. It can be easily migrated to any service discovery scenario in a mobility environment where the objective is dynamically discovery a close server offering a particular service. Some clear examples of applying this kind of approach presented in the position paper are: discovery of NAT trasversal, sip servers or wifi hotpots.

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