IP-based Handover Management over heterogeneous wireless Networks

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Abstract

Mobile users are facing the fact that many heterogenous radio access technologies coexist, ranging from wireless LANs to cellular systems. No technology has emerged as a common and universal solution which makes the current trends today toward design of All-IP wireless networks, where radio cells are under the control of IP Access Routers for signalling and data transmission. In such as networks, an IP-device with multiple radio interfaces or software radio can roam between different radio networks regardless the heterogeneity of their radio access technologies. The design of an All-IP wireless network requires an efficient and flexible handover management. A major issue in handover control is reducing data losses and avoiding additional end to end transmission delays. In this paper we propose mechanisms to handle soft-handover management in the IP layer which can coexist with Mobile IPv6 and allow efficient micro mobility management.

1. Introduction

One of the most important issues in IP-mobility protocols design is the IP handover performance. IP handover occurs when a mobile node changes its network point of attachment from an Old Access Router (AR1) to a New Access Router (AR2). If not performed efficiently, end-to-end transmission delay, jitters and packet loss directly impact and disrupt applications perceived quality of services. Because Soft handover enables same data receiving from multiples Access Router, it allows mobile station's session to progress without interruption when a MN moves from one radio cell to another. This can be achieved, if and only if 1.MN is able to communicate simultaneously with multiple ARs at the same time. 2. The network can duplicate and correctly merge the IP-flows from the correspondent node to the MN through different access routers. If the two conditions are verified, it is possible to eliminate packet losses and reduce end-to-end transmission delays, which provides a clear advantage to traffic requiring real time transmission. This paper presents pure IPv6 Soft Handover mechanisms [2], based on IPv6 flows duplication and merging in order to offer pure IP-based mobility management over heterogeneous networks. The Proposed solution does not impose any change to the Mobile IPv6 standard [3]. It is an extension to support an efficient Soft handover and micro mobility management, for Mobile Node (MN) with multiple radio interfaces (802.11) or with single CDMA interface. This solution requires the introduction of new component called "Duplication & Merging Agent" (D&M) agent. It is a conventional router located at the core network, which duplicates and merges IPv6 flows.

2. IPv6 Soft handover mechanisms

The IP Soft handover approach is based on four main processes, the registration process, the duplication process, the merging process, and the handover process. They allow duplication and merging of IP flows without the need to synchronise duplicated-flows transmission.

2.1. Mobile registration process

In order to be connected to several ARs, the MN must be associated with several Care of Addresses (CoA), since each CoA identifies a link to MN through a unique AR. If we consider a special case of MN with data connection with two ARs in an IPv6 network, and when a CN decides to send IP packets to our MN, the sending device has to know all the addresses of the MN in all sub networks. To perform such a thing, Mobile IPv6 allows MN to have a primary CoA (PCoA), which is the temporary address obtained by the MN for the first time it connects to the network. It is registered within home agent and D&M agent in the reference link of MN and it is the Address used by the different CN, which are likely to communicate with MN. Two additional local CoAs are used for packets transmission from D&M agents to MN through the two ARs. Those LCoAs are obtained by MN using IPv6 stateless addresses auto-configuration mechanism [3] and registered within the D&M agent.

2.2. Duplication Process

In order to duplicate packets, the D&M intercepts packets sent by CN, extracts from each packet the destination Address (PCoA) and finds all corresponding LCoAs. Using those LCoAs, the D&M agent creates new IPv6 packets with same payload information, but with substitute LCoA as new destination address. A sequence number field is inserted in each IPv6 packets header, it is used to number all packets sent to the tunnel. Same duplicated packets will be identified by same sender, same receiver and same sequence number. Duplicated and numbered packets are then tunnelled to the MN via corresponding ARs (Figure1).

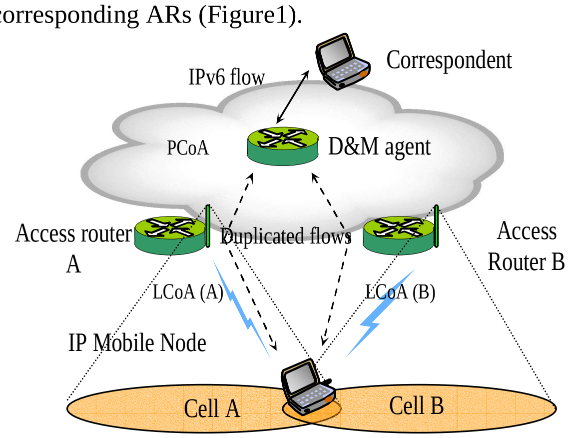

Figure1: IPv6 flow duplication and merging

Conversely, the MN does the same thing with the uplink stream. It duplicates all packets and sends them to the D&M agent via the two ARs.

2.3. Merging process

The use of the D&M agent (respectively MN) duplication process to send separate copies of same data via multiple ARs to the MN (respectively D&M agent), introduces the need to filter the duplicated packets. To perform efficiently such a thing, MN or D&M agent needs to match those multiples streams in IP layer at reception. In case of uplink traffic, D&M agent intercepts all tunnelled packets, checks if the sequence number is included in the IP packet. If there is no sequence number, which means that this IP packet was not duplicated, process will route normally the payload information. If sequence number is included in the packet and source-address has an entry in D&M table, the packet has been duplicated. Thus if the sequence number is listed as received packet in table, IP packet will be discarded (it has already been received).

2.4. Handover Process

We assume that the MN has two interfaces: primary and secondary, the interfaces priority choice is dynamic; we assume that the primary interface is always the interface with the better connexion quality. We suppose that the MN must be always connected through the primary interface and uses the secondary one to perform handover. Two signal quality thresholds are defined, gold_conn_shold and poor_conn_shold. First, the MN is connected on primary interface with AR1, it has its PCoA and LCoA1, and both of them are registered with in D&M agent. When MN discovers AR2, and if quality of the primary connexion is less then gold_conn_shold, secondary interface connexion is established with AR2, LCoA2 is registered within D&M, duplication and fusion process will be UP. In this case: 1. the interface with better connexion quality will be assigned dynamically to be the primary one. 2. If signal strength of secondary connexion became worse than poor_conn_shold, the secondary connexion is closed and active scanning is initiated to connect it to new AR. 3. When the Signal strength quality becomes better than gold_conn_shold (very good connexion quality), MN closes the secondary connexion, shuts down duplication and merging process.

3. Conclusions

We have presented a pure IPv6 Soft handover mechanism. It exploits IPv6 protocols futures and coexist with MIPv6. It provides data transmission continuity for delayed constrained applications. There is no need to synchronize distributed copies of data, since the MN routes the first received duplicated packets and simply ignore the others. Mobile Node (MN) can use existing radio technologies without changes.
Intensive simulations works are in progress and further studies are undertaken to address radio resource management and Quality of Service management when performing Handover.

4. References

[1] Yan Moret & All, European Patent "*Process and apparatus for improved communication between a mobile node and a communication network*", Patent No. 02368057.2-

[2] Charles Perkins, editor, "*IP mobility support for IPv4*", RFC 3220, January 2002.

[3] D. Johnson and C. Perkins. IETF Internet Draft "*Mobility Support in IPv6*", draft-ietf-mobileip-ipv6-12.txt. April 2000