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A NEMO-ENABLED SOLUTION TO THE SSM SOURCE MOBILITY PROBLEM

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EXTENDED ABSTRACT

Multicast mobility has been a concern for about ten years and has led to numerous proposals, but no generally accepted solution. Significant effort has already been invested in protocol designs for mobile multicast receivers; only limited work has been dedicated to multicast source mobility, which poses the more delicate problem. Multicast communication divides into Any Source Multicast (ASM) and Source Specific Multicast (SSM). One of the benefits of SSM is the avoidance of many of the router protocols and algorithms that are needed to provide the ASM service model. Despite of the complexity of the requirements, multicast mobility management should seek lightweight solutions with easy deployment.

SSM has been designed for static addresses of multicast senders. The source addresses in a client subscription to an SSM group is directly used for route identification. Any SSM subscriber is thus forced to know the topological address of the contributor to the group it wishes to join. The SSM source identification invalidates when topological source addresses change under mobility. SSM has been designed as a light-weight approach to group communication. When adding mobility management, it is desirable to preserve the principle leanness of SSM by minimizing additional signalling overheads.

IPv6 network mobility - NEMO Protocol

Let us assume a small local IP network interconnecting a laptop, a PDA and a cellular phone. These devices share a common local network, usually in a wireless environment. In NEMO, the mobility of these IP devices is assured by a Mobile Router (MR) that extends the Mobile Node (MN) functionalities defined in MIPv6. Broadly speaking, this Mobile Router can be the laptop that enables connecting all the IP devices in the local network to the Internet. The laptop can thus change dynamically its point of access to the Internet (for example, during a travel by car or train), keeping intact the IP addresses and network connections of the mobile nodes during the mobility periods. One can say that the network moves itself as a whole without a separate move of each of the nodes. This paradigm can be seen as Network Mobility and be implemented by NEMO protocol. This idea confronts the Node Mobility support from previous mobility protocols, such as MIPv6.

The NEMO-enabled SSM source proposal

In this proposal the SSM sources are also NEMO-enabled nodes. In this way it is possible to keep the source IP address unchanged during mobility. A virtual network is created in the source device. This network contains the multicast source (S in Fig. 1) with its own IP address and a mobile router (MR) which implements NEMO protocol.

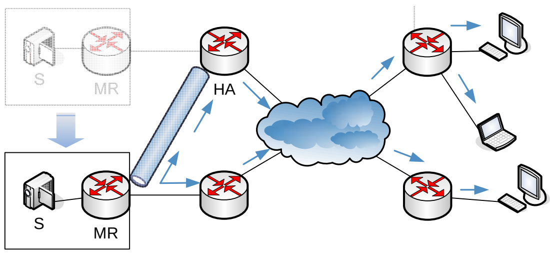

Fig. 1. The proposed architecture.

The mobile source device comprises therefore two independent processes: the multicast source process (S) and the mobile router process (MR). The multicast source process has its own IP address (virtual mobile IP network) and may be responsible for real-time video signal acquiring and processing. Video signal processing may include a multimedia layered encoding system for adaptation to the available bandwidth and light weight encryption for security. The mobile router process assures the device's connection to the home network or to a visited network, granting the mobility of the device by implementing the NEMO protocol.

When the MR moves, it informs the HA about its new location and they establish an IPv6/IPv6 tunnel and all the multicast traffic is send through this tunnel. At the other side of the tunnel, traffic follows the pre-existing SPT. In this way, initially, the source device mobility is hidden from the source process, from the network and from the receivers. At the same time, multicast traffic is also transmitted non-encapsulated through the new AR, starting the creation of a new SPT which should reuse part of the previous established tree. In what respects to multicast routing, the tunnel virtual link cost will be high enough in order that the new optimized path is preferred to the path including the tunnel. During this phase there is a traffic overhead: the multicast traffic is duplicated in the physical links used by the tunnel (an encapsulated version and a non-encapsulated one) and somehow may lead to inefficient link utilization.

Preliminary tests and results

This new NEMO-enabled SSM source proposal involves four main technologies: Multicast, MIPv6, FMIPv6 and NEMO. In order to test and assess existing implementations for these technologies, a testbed has been built. To test the global architecture here proposed, putting together these technologies, NS-2 simulation tool has been used.

A simple architecture has been deployed to test NEMO protocol main functionalities, using unicast communication. A simple set of tests has been performed in order to achieve two major goals: (1) to validate the selected NEMO implementation, NEPL - NEMO Platform for Linux, according to the specification and (2) to analyze, with both TCP and UDP based applications, the continuity of established network connections, during the transit of the mobile network from the home to the visited network. The tests showed the robustness of the NEPL implementation of NEMO. During the transition of the mobile node from the home to the visited network, the existing sessions were kept while the whole network was moving.

Seamless handover scenarios are expected to limit disruptions or delay to less than 100 ms. In IPv6 networks there are some handover expediting schemes that reduce the process duration time, such as Fast Handover for Mobile IPv6 (FMIPv6) and Hierarchical Mobile IPv6 (HMIPv6). A set of MIPv6 and FMIPv6 tests have been carried out. The results proved FMIPv6 efficiency, having a clearly faster handover when compared with MIPv6. The return handover is always faster than the initial one, because deleting the tunnel is always faster than building it.

In order to test the operation of the overall architecture tests had to be conducted in Network Simulator 2 (NS2). Nevertheless, once there is still no known NEMO available implementation in NS-2, the wanted functionality is only simulated. Fig. 2 presents the testbed architecture and pictures the first one of the four phases characterizing the source mobility process. The source device may be multi-interface or single-interface and these interfaces may use different technologies, e.g., wired and wireless. The source device moves between different access networks.

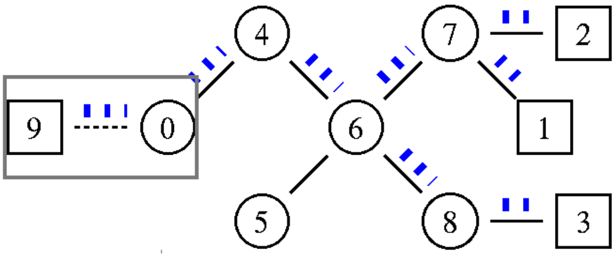

Fig. 2: Testbed architecture - before the handover

Conclusions

An SSM multicast channel (S, G) subscription includes the source IP address. In general, source mobility leads to source IP address change, creating a critical problem to the SSM multicast model.

In our proposal the SSM source devices are NEMO-enabled nodes, thus allowing for the source to keep unchanged its IP address, eliminating the above stated problem.

A testbed was implemented and tests with the four main technologies involved, Multicast, MIPv6, FMIPv6 and NEMO, have been performed, with positive results. In order to validate the proposal, overall architecture preliminary tests were performed in the NS-2 network simulator.

The presented proposal allows keeping SSM simplicity without the need for Rendez-vous Points, as it is the case of the shared tree approach of. SSM is also important because most of the multicast applications are Quality of Service (QoS) sensitive in nature, thus will need from QoS support too, if available. SSM will certainly enable us to build a multicast tree (or a set of multicast trees) to deliver multicast data, from source to receivers, assuring that QoS requirements are satisfied, even when the source is itself mobile. Furthermore, RP-based multicast distributions do not suit as well as SSM whenever security and authentication issues arise.

The SSM design permits trust in equivalence to the correctness of unicast routing tables. Our NEMO SSM mobility solution preserves this degree of confidence.

SSM has been designed as a light-weight approach to group communication. Our mobility management solution does not need additional signalling overheads, preserving the principle leanness of SSM.