Journal of Mobile Multimedia, Vol. 9, No.3&4 (2014) 253-272

PIM-SM PROTOCOL WITH GRASP-RP SELECTION ALGORITHM BASED ARCHITECTURE TO TRANSPARENT MOBILE SOURCES IN MULTICAST MOBILE IPV6 DIFFUSION

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Due to the progress of network multimedia technology, Internet research community has proposed many Different multicast routing protocols to support efficient real-time multimedia application such as, IPTV, videoconferencing, group games. These applications require a multicast routing protocol in which packets arrive to multicast receptors within a minimum delay and delay variation. Nevertheless, these protocols does not take into account that group members may be mobile and have not been designed for mobile members and roaming sources, and has not been tested in wireless and mobile environment since they were developed for multicast parties whose members and sources are topologically stationary. Recently, as the performance of mobile hosts rapidly improves and the bandwidth of wireless access networks grows up, the expectation for mobile multimedia communication services including many-to-many communications begins a big necessary. Studying and solving multicast issues in the stationary multicast infrastructure has been largely studied in the literature. However, fewer efforts have been spent in the specific problems of mobile members and sources caused by the frequent change of membership and point of attachment. The main problematic of the multicast IP protocols in a Mobile IP environment is the frequent change of membership and members location, this can rapidly affect quality of both routing protocol scheme and multicast tree used, especially, the scenario of handover where a mobile source moves from attachment point in one sub-network to another one in another sub-network is challenging. A multicast source is identified by its Home Address HA. Since IP mobility implies acquisition of a new topologically Care-of-Address CoA at each handoff resulting in a change of identity of the multicast source, however, the established multicast routing states are always based on the home address of the mobile source. This paper addresses the issue of mobile Multicast routing by presenting a PIM-SM based architecture with a GRASP-RP selection algorithm. The key idea of this work is to make the handover of multicast sources transparent and avoid the reconstruction of the entire multicast-based tree, by using an architecture based in PIM-SM multicast distribution trees to hide the mobility of a mobile multicast source from the main multicast delivery tree. To estimate and evaluate our scheme, we implement simulation based in many metrics, simulation results show that good performance is achieved in terms of handoff latency, end-to-end delay, tree construction delay and others metrics.

Key words: GRASP-RP, PIM-SM, Mobile IPv6, Multicast Routing, RP.

1 Introduction

Many Distributed real-time applications, such as audio- and video-conferencing, collaborative environments and distributed interactive simulation involve a source sending messages to a selected group of receptors; classic unicast and broadcast network communication is not optimal for this application kind. For this, in 1991 Steve Deering [1] has proposed a technique called Multicast IP. Which technique entrusts the task of data duplication to the network. In this model of communication source sends a data packet in a single copy and the network takes care of the duplication of the message to the receivers of the group. Consequently, Multicast protocols reduce the total number of packets flooded in a network.

Current protocols such as Protocol-Independent Multicast- Sparse Mode PIM-SM [2] and Distance Vector Multicast Routing Protocol DVMRP [3] are tree based. Multicast routing protocols are built using two kinds of multicast trees: source-based trees and shared trees. With source-based trees, a separate tree is built for each source. With a shared tree, one tree is built for the entire group and is shared among all the senders, shared trees have a significant advantages more than source-based trees such as only one routing table entry is needed for an entire group.

Multicast tree Construction is the first step to start a multicast session; existing multicast protocols implicitly assume that group members are topologically stationary. However, the arrival of Mobile IPv6 [4] networks generates other scenarios; the group members (receivers and senders) are mobile and may move regularly from one IP network to another. Consequently, the multicast in mobile environment deals with not only dynamic group memberships (member joining or leaving multicast group), but also dynamic member locations

The impact of member's and sources mobility is important for multicast routing protocols that use a pre-constructed multicast tress to realize the multicast distribution. These protocols may be lead to produce a higher multicast tree cost, higher number of data packets as well as larger delay for the receivers. Member's mobility may also impact the multicast tree distribution, because every time a member's location changes the multicast tree may need to be reconstructed, resulting in large overhead. Otherwise, it may result in incorrect multicast path.

In this paper we present proposal architecture based in PIM-SM [2] protocol with GRASP-RP [5] selection algorithm to avoid the reconstruction of the multicast tree when a mobile source moves from one sub-network to other and to make source handover transparent to multicast receivers.

This paper is organized as follows. Section 2 describes multicast routing protocol roles and an overview of multicast Trees. Section 3 introduces the mobile IPv6. Section 4 describes Multicast tree cost and fitness function used to evaluate optimal solution. Section 5 presents the existing related work in the literature. Section 6 details and discussed our proposal architecture. Section 7 reports the results of simulation study. Finally, Section 8 provides concluding remarks and perspectives.

2 Multicast Routing Protocols

The main role of a multicast routing protocol is the construction of an optimal multicast tree, which facilitates the operation of multicast packet replication, this problem of constructing an optimal unique multicast tree is known by the Minimum Steiner Tree MST problem [6]; this problem is NP complete [7–10], since it seeks to find a low-cost tree spanning all members of the group at a time by minimizing the cost of the tree and the transmission delay, which needs using a heuristic algorithm. Multicast routing protocols are divided in two categories (SBT and ST).

Source-based Tree SBT is composed of the shortest paths between the source and each receivers of the multicast group [11]. The main motivations behind the use of SBT are the simplicity of building in a distributed manner using only the unicast routing information [7, 11], and optimization of transmission delay between source and each receiver. The main drawbacks of SBT are: additional costs for maintaining the tree, and the statements to be stored in the nodes which complexity is O(S*G)

(S is the number of sources set and G is the number of groups set) [7, 12], the SBT is used by several multicast routing protocols such as Multicast Open Shortest Path First MOSPF [13], Protocol-Independent Multicast- Dense Mode PIM-DM [14] and DVMRP [3].

Shared tree ST can be constructed using a shared Rendezvous Point RP tree: It requires the selection of a central router called "Rendezvous point" RP in PIM-SM [14] protocol and “Core” in Core-Based Tree CBT [15] protocol. Shared tree is more appropriate when there are multiple sources in the multicast group. Under this approach, ST separates the concept of source from that of the tree root. One node in the network is chosen as the centre, and the sources forward messages to the centre [15]. Like SBT tree, a shortest path multicast tree is constructed rooted at the selected core. Only routers on the tree need to maintain information related to group members. It gives good performance in terms of the quantity of state information to be stored in the routers and the entire cost of routing tree [3, 13, 14]. Joining and leaving a group member is achieves explicitly in a hop-to-hop way along the shortest path from the local router to core router resulting in less control overhead, efficient management of multicast path in changing group memberships, scalability and performance [2, 15].Several multicast routing protocols in the literature use core-based tree: Protocol Independent Multicasting-Sparse mode PIM-SM [2] and CBT [15]. In this paper, we will focus on PIM-SM protocol using RP based tree construction.

PIM-SM [2] is regarded as the preferred intra-domain multicast routing protocol among current multicast protocols, because it does not depend on unicast routing protocols, group members join explicitly, and the multicast tree can switch from shared tree to shortest path tree. The complexity of PIM-SM realization and the high overhead of its control messages have impeded the wide deployment of PIM-SM [2] for long, which is also the focus of Internet researchers. Too many control messages lead to at least two problems, causing more router processing load and consuming more network bandwidth.

3 Mobile IPV6

The most widely employed network protocol IP (IPv6 and IPv4) is not designed to handle the issues of mobility. For this purpose, NEMO working group in Internet Engineering Task Force (IETF) develops a new protocol as an enhancement to the existing Internet Protocol called Mobile IP (MIP) [4]. The main objective of IP mobility support is to enable a mobile host to change its point of attachment to the Internet while still maintaining connectivity with its Correspondent Nodes (CNs) during its movement at the transport layer (i.e., TCP/UDP), which usually assumes that a host address is permanent [16].

Mobile IP addresses the problem by introducing two IP addresses for mobile hosts: regardless of its location in the Internet, the host is always identified by its permanent static home address, which it’s known globally across the network, when attached to different networks other than its home network so-called foreign network, the host obtains a temporary transient CoA. This address acquired through either two mechanisms [17], stateless [18] or state-full auto- configuration [19] mechanisms.

An operational overview of MIP as presented in RFC3775 [4]. In first step, when a mobile starts a transport connection (TCP or UDP) white CN in another network, it uses just its Home Address HA. In second step, the MN visits a new network and acquires a local care-of address. It then sends a binding update (BU) to its home agent. The home agent creates and stores a binding entry which associates the

MN's home address with its current CoA. However, the CN continues to send packets to the MN's Home Address, this packets intercepted by home agent are forwarded to the MN via the CoA by using a tunnel in next step. To overcome this indirect sub-optimal route between CN and MN passing by the home agent, the mobile node can send a new binding update to the CN to exchange packet using a direct optimal route between MN and CN.

4 Mathematical Modelling

A computer network is modelled as a simple directed and connected graph $\mathbf{G} = (\mathbf{N}, \mathbf{E})$, where $\mathbf{N}$ a finite set of nodes and $\mathbf{E}$ is the set of edges (or links) connecting the nodes. Let $|\mathbf{N}|$ be the number of network nodes and $|\mathbf{E}|$ the number of network links. An edge $\mathbf{e} \in \mathbf{E}$ connecting two adjacent nodes $\mathbf{u} \in \mathbf{N}$ and $\mathbf{v} \in \mathbf{N}$ will be denoted by $\mathbf{e}(\mathbf{u}, \mathbf{v})$, the fact that the graph is directional, implies the existence of a link $\mathbf{e}(\mathbf{u}, \mathbf{v})$ between $\mathbf{v}$ and $\mathbf{u}$. Each edge is associated with two positive real value: a cost function $\mathbf{C}(\mathbf{e}) = \mathbf{C}(\mathbf{e}(\mathbf{u}, \mathbf{v}))$ represents link utilization (may be either monetary cost or any measure of resource utilization), and a delay function $\mathbf{D}(\mathbf{e}) = \mathbf{D}(\mathbf{e}(\mathbf{u}, \mathbf{v}))$ represents the delay that the packet experiences through passing that link including switching, queuing, transmission and propagation delays. We associate for each path $\mathbf{P}(\mathbf{v}_0, \mathbf{v}_n) = (\mathbf{e}(\mathbf{v}_0, \mathbf{v}_1), \mathbf{e}(\mathbf{v}_1, \mathbf{v}_2), \cdots, \mathbf{e}(\mathbf{v}_{0n-1}, \mathbf{v}_n))$ in the network two metrics:

$$C(P(v_0, v_n)) = \sum_{0}^{n-1} C(e(v_i, v_{i+1})) \qquad (1)$$

$$And \quad D(P(v_0, v_n)) = \sum_{0}^{n-1} D(e(v_i, v_{i+1})) \qquad (2)$$

A multicast tree $\mathbf{T_M}(\mathbf{S}, \mathbf{RP}, \mathbf{D})$ is a sub-graph of $\mathbf{G}$ spanning the set of sources node $\mathbf{S} \subset \mathbf{N}$ and the set of destination nodes $\mathbf{D} \subset \mathbf{N}$ with a selected core $\mathbf{RP}$. Let $|\mathbf{S}|$ be the number of multicast destination nodes and $|\mathbf{D}|$ is the number of multicast destination nodes.

In Protocols using Core-based tree, all sources node needs to transmit the multicast information to selected core via unicast routing, then it will be forwarded to all receptors in the shared tree, to model the existence of these two parts separated by core, we use both cost function and delay following:

$$C(T_M(S, RP, D)) = \sum_{s \in S} C(P(s, RP)) + \sum_{d \in D} C(P(RP, d)) \quad (3)$$

And

$$D(T_M(S, RP, D)) = \sum_{s \in S} D(P(s, RP)) + \sum_{d \in D} D(P(RP, d)) \quad (4)$$

We also introduce a Delay Variation (7) function defined as the difference between the Maximum (5) and minimum (6) end-to-end delays along the multicast tree from the source to all destination nodes and is calculated as follows:

$$Max_{Delay} = Max(D(T_M(S, RP, D))) \quad (5)$$

$$Min_{Delay} = Min(D(T_M(S, RP, D))) \quad (6)$$

$$DelayVariation = Max_{Delay} - Min_{Delay} \quad (7)$$

Core selection problem tries to find an optimal node C in the network with an optimal function Opt_F by minimizing in the first time the cost function $C(T_M(S, RP, D))$ and in the second a Delay and delay variation bound as follows:

$$Opt_{F(RP,T_M)} \begin{cases} Min\, C(T_M(S,RP,D)) \\ Delay < \alpha \\ DelayVariation < \beta \end{cases} \quad (8)$$

5 Related Work

Two basic mechanisms have been proposed with Mobile IPv6 in RFC3775 [4] to ensure a multicast service and to handle multicast communications with mobile members (sources and receivers). Which are the remote subscription (RS) and the home subscription (HS) called also bi-directional tunnelling.

The home subscription or bi-directional tunnelling mechanism [4] relies on the Mobile IP architectural entity (HA) located on the home network; it is responsible for periodically forwarding multicast group membership control messages to its mobile receiver whenever the latter is away from home. To send and receive multicast packets, the MN establishes a bi-directional tunnel with his HA and tunnels its membership report message to the HA. This scheme requires that HA be also a multicast router and must add itself onto the distribution tree to receive and forward multicast packets. The HA maintain the list of MNs that have requested to join the multicast groups.

This approach hides host mobility from all mobile members of the group and avoids the reconstruction of the multicast tree when the member location changes: When a mobile receiver moves to a new foreign network, it does not need to re-join the multicast group since the HA is already informed about its membership. As advantages of the home subscription approach; it’s simple and shows the transparency of handover to the multicast operation since the mobile receiver does not need to re-join the multicast group whenever it moves from one foreign network to another.

The main disadvantage of this scheme is that the multicast routing path used between sources and receivers may be far from optimal and suffers from triangle routing across the home network, which may increase the join latency. This approach is based in a central point of failure, which is the HA. In the case where multiple MNs of the same HA want to join the same multicast group. The home agent may be greatly loaded as it must replicate and deliver the tunnelled multicast packets to all of its mobile hosts respectively. And there is no recovery mechanism on the HA side that ensures that the membership report message sent by the mobile receiver is correctly received by the multicast router

In remote subscription mechanism [4], each mobile host sends MLD [20] Membership Reports messages to re-join the multicast group when it enters a new foreign network via a local multicast router. The local router in each foreign network visited must be a multicast router and attached to the multicast tree, so the mobile host can receive and send packets directly from the foreign network through the shortest path. To join a multicast group, an MN sends its membership report message to the local multicast router located on the visited network. The local multicast router intercepts this membership report message and joins the requested multicast group.

The advantage of this mechanism is that the routes from source to all the group members are optimal and join latency is more reduced. This approach is more performance when the MN stays in the foreign network for a relatively long period of time. However, this approach assumes existence of a local router in each foreign network visited as a multicast router enabled and attached to the multicast tree, due to this, this approach is vulnerable to multicast service inactivity. Also in this approach, the multicast delivery tree reconstruction frequency depends on how often the Mobile node moves

Jelger and al [18] present a solution to support mobile multicast sources in mobile IPv6 by using a source-specific multicast mode. [18] Introduces a new binding message called SSM source handover notification and it is used to notify the multicast receivers to subscribe to the new channel when the handover occurs. A multicast mobile source initially serving a multicast group with a its Home address, When it moves into a foreign network , it receives a care of address CoA1, and when it moves and connects to new foreign network, it receives a new CoA2, which is different from the old CoA1. To avoid multicast disruption, the mobile source sends a SSM source handover notification binding update message, which contains the source handover notification, to all the receivers to inform them about the new CoA (CoA2). Getting this binding update message, multicast receivers initiate the reconstruction of the new source-specific tree by sending new MLD membership report messages that specify the new CoA (CoA2) instead of the old one (CoA1). The new multicast delivery tree will be built, and it will be referenced by (CoA2, G) states instead of (CoA1, G) states. Consequently, Receivers have to be kept informed about each change of the source's address. The main Limitation of this approach is the reconstruction of the entire source specific tree in each mobile source handover.

O'Neill [19] has proposed RPF redirection solution to overcome multicast mobile source handover in PIM-SM multicast routing protocol. In PIM-SM [2], when a new multicast mobile source starts sending multicast packets from its Home Network HN, it uses to be identified by de Rendezvous Point RP its HoA and group address (HoA, G), this state is used also by receivers choosing to use source-specific tree. When the source moves to a foreign network, all the previous state should be updated, Otherwise, all the multicast data sent by the source with the CoA will be dropped by the Rendezvous point and by multicast receivers using the source-specific tree, because the multicast data come from a "wrong direction" and failed the RPF check Consequently, the multicast session will be disrupted. To resolve this problem, the author in [19] has suggested extending the register message to inform the RP not to send PIM join messages back to the source's network. To pass the RPF check [19] has introduced a new IPv6 hop-by-hop option called RPF redirect option to update the RPF check point between the multicast mobile sources' in the home network and the visited network. This solution solves efficiently the RPF check failure problem in PIM-SM [2]. However, it introduces an overhead signalling cost and state refresh mechanism.

Romdhani et al. [21] proposed a tunnel–based backbone distribution of packets between newly introduced ”Mobility-aware Rendezvous Points” (MRPs) entity in order to handle the mobility of a multicast source in both intra-domain and inter-domain multicasting based in MSDP protocol. The MRP aims to make the handover of the source transparent to both on-tree routers and multicast receivers since the multicast routing states are built using the HoA and not the current CoA. These MRPs operate on extended multicast routing tables, which simultaneously hold HoA and CoA. This solution accounts for the ASM inter-domain source activation problem [22]. The main advantages of this solution the use of a new entity (MRP) where multicast receivers meet mobile source. However, this solution is based in MSDP to manage source in multi-domain topology network, a modified Register Message and an overhead to store (HoA, CoA) state of every source by a unique shared static entity.

Baddi and El Kettani [23] proposed a first version of PIM-SM Protocol based Architecture, this solution us a PIM-SM as a proxy between a mobile source and his Home Agent, after a first source movement away his home agent it build a Rendezvous point tree with PIM-SM protocol, each source move it use this Rendezvous point tree to hide his mobility. The main advantages of this solution is an efficient source transparent mobility. However, this solution don’t integer an optimal Rendezvous point selection mechanism.

6 PIM-SM Protocol Based Architecture

Many solutions exist for roaming receivers [24–27], but very few schemes have been detailed out for mobile multicast sources. The main objective of our proposal architecture is to avoid the re-computation of the primary multicast tree when a mobile source moves from one sub-network to other and to make sources handover transparent to multicast session. This objective allows the primary multicast delivery tree to be always built using the HoA wherever the multicast sources move.

In this section, we introduce our proposal architecture based in PIM-SM multicast routing protocol to manager the multicast mobile sources.

6.1 Overview

In order to support transparent multicast source mobility and avoid the re-construction of the multicast tree, we introduce a new architecture called PIM-SM Protocol based architecture to Mobile source in Multicast Mobile IPv6 diffusion.

our motivation to choose PIM-SM protocol is directly influenced by: using one node in the network as the centre, and the source forward messages to the centre when it’s in movement, it gives good performance in terms of the quantity of state information to be stored in the routers and the entire cost of routing tree [3, 14, 15].

PIM-SM Protocol based architecture construct a Rendezvous based tree RT with an RP as a centre router to manage mobile sources. The Rendezvous point router is the meeting point where multicast a mobile source sends data when it changes point of attachment.

As shown in figure 1, when a multicast source moves to a first new foreign network 1, it connect to multicast tree with address group constructed as detailed in section 5.7, this multicast group is based in Any Source Multicast ASM communication model [22] whit Home Agent as a member receiver and the source is the mobile source. To send multicast data, the mobile multicast source encapsulates its data packets, and then sends them in unicast routing to the Rendezvous Point RP, after the Rendezvous point forward data on multicast tree to the Home Agent. The Home Agent de-capsulate these packets, and then sends them using the (HoA, G) header to the multicast receivers. When the mobile source moves to a second new foreign network 2 it use the same RP point and the same multicast tree and all multicast mobile multicast receivers join the multicast group based in HoA of multicast source and not with CoA.

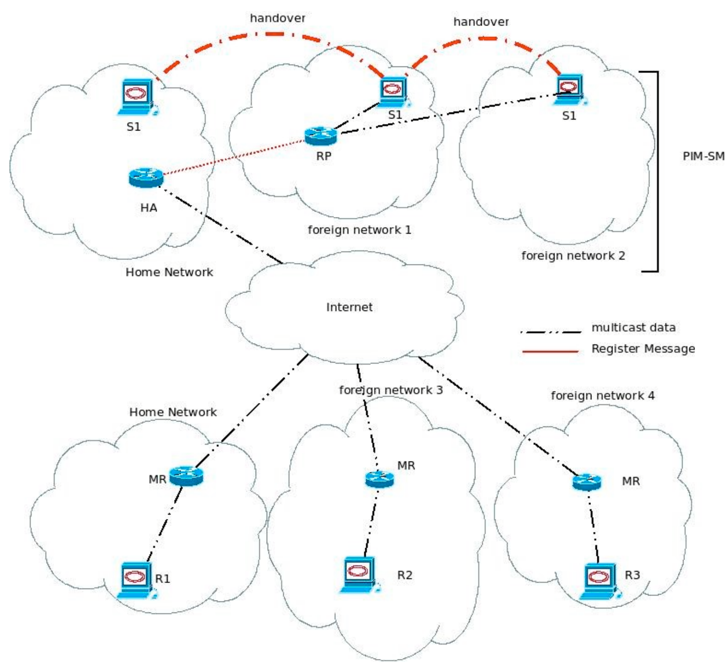

Figure 1 PIM-SM Based Architecture

6.2 Core Selection

Shared core trees separate the concept of source from receivers, Joining and leaving a group member is achieves explicitly in a hop-to-hop way along the shortest path from the local router to core router resulting in less control overhead, efficient management of multicast path in changing group memberships, scalability and performance [2, 15].

The main problem in this architecture is to select an optimal centre router, PIM-SM requires the selection of a central router called "Rendezvous point" RP.

As proposed in RFC 4601 [2], PIM-SM protocol select an RP router based in a hash function to produces an ordering set of RPs for each group. This selection scheme doesn't grantee selecting of an optimal set, especially in dynamic network whit mobile nodes. In our architecture we extend this mechanism and we integrate GRASP-RP [5] Algorithm based in GRASP [28] search algorithm with Opt_F as a fitness function.

Fundamentals of GRASP-RP [5] search are the use of flexible two phases, first a construction phase followed by a parallels local search processes to surmount local better solutions. Basic features that are needed to implement the GRASP-RP search are described briefly in this section. According to the features of RP selection, we take a first restricted candidate list (RCL) as the first set of candidate RPs.

Figure 2 presents the deferent execution phases of our proposal algorithm based on GRASP search algorithm [28]. Algorithm starts by collecting candidature requests explicitly sent by routers, these requests are stored in the restricted candidate list (RCL). GRASP-RP executes the two phases of algorithm in a loop by testing a stop condition, generally test not exceeding a max number of iteration, first phase, Randomized Greedy Construction, try to build a random initial solutions, each one of these solutions will be used by the second phase, local search algorithm, for selecting an alternative that minimizes the cost function declaration in formula (8).

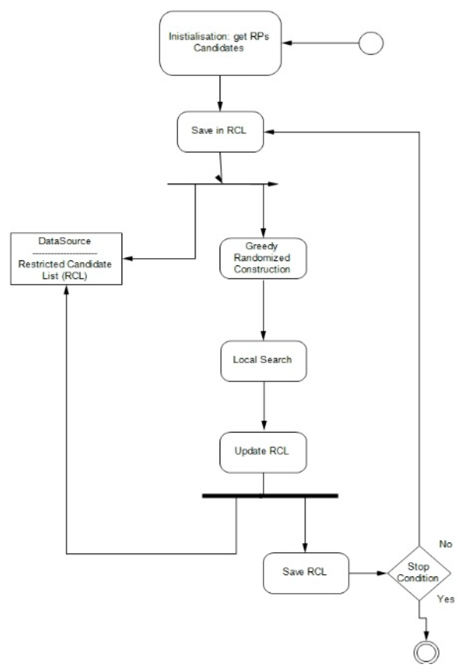

Figure 2 GRASP-RP algorithm

6.3 Greedy Randomized Construction Phase

Our goal is to extend standardized Rendezvous Point selection mechanism, BootStrap RP [29], in version 2 of multicast routing protocol PIM-SM [2]. We use as initial state the list of candidate RPs sent to BSR router, this list will be inserted initially in the restricted candidate list (RCL).

This phase contains two functions, first used to sort elements of the restricted candidate list (RCL) using the cost function defined in formula (6), this function is the greedy part of our algorithm. Followed by a random selection function, as a random part of the algorithm, this function selects a set of solutions that will be a set of initial solutions of the local search phase.

6.4 Restricted Candidate List (RCL)

The bootstrap RP uses a list of candidate RPs sent by each router wishing to act as a Rendezvous Point RP in the topology, the explicit request sent by each router candidate is associated with a priority value assigned by the router itself .

Unlike the static management of the list of candidate RPs proposed in Bootstrap RP, in our algorithm we use a restricted candidate list (RCL) dynamically powered by the phase of local search iteratively, this by adding the best local solution at each iteration.

6.5 Local Search Phase

In recent years, several local search algorithms have been proposed. In our proposition local search phase usually improves the constructed solution in an iterative fashion by successively replacing the current solution by a better solution in the neighborhood of the current solution. They proceed from an initial solution generated randomly from restricted candidate list (RCL) and trays to find an optimum local solution, which improve each time the value of the cost function defined in formula (8).

Our proposal architecture is independent of the local search algorithm used; it can work with hill climbing, adaptive multi-start, variable depth search, simulated annealing, Tabu search (TS), others such as genetic search.

6.6 Recovery Phase

RP router is a special and important node in a multicast network with several specialized responsibilities. RP selection is the first step in RPST multicast tree. Hence, a node which is a good RP node for the current multicast tree at a given time may not remain good in all multicast session.

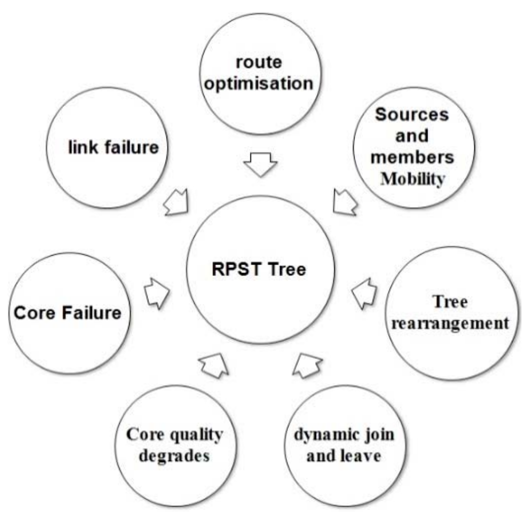

Figure 3 RP recovery mechanism initiator events

As presented in figure 4, the RP recovery mechanism in the multicast tree is triggered due to:

- RP router quality degrades: Due to membership dynamics as the dynamic nature of multicast group, RP quality degrades with time, consequently the multicast tree quality will degrades with time.
- Mobile IPv6: Due to unconstrained movement of nodes in mobile IPv6 networks, the topology of the network keeps changing. The main challenge to integrate multicast IP in mobile IPv6 networks is the rapidly changing environment. Hence, it's difficult to maintain an optimal Rendezvous point RP for all multicast group members and sources during the multicast session. Sources and members movement can be considered as a deletion of a node from the tree followed by addition of the node to the tree.
- RP router Failure: In core-based multicasting, RP is a single point of failure. If the RP fails, there is a large amount of packet loss as many of the receivers cannot receive the data sent by the senders.
- Node/link failure: multicast protocols are based in unicast protocol to forward multicast data, and to mention multicast tree, Node/link failure affect directly topology network and multicast tree structure
- Joine / leave: The recovery mechanism can be invoked when the current multicast tree has deteriorated due to dynamic join and leave of group members

When the RP fails, these responsibilities need to be locally transferred without causing too much disruption in service.

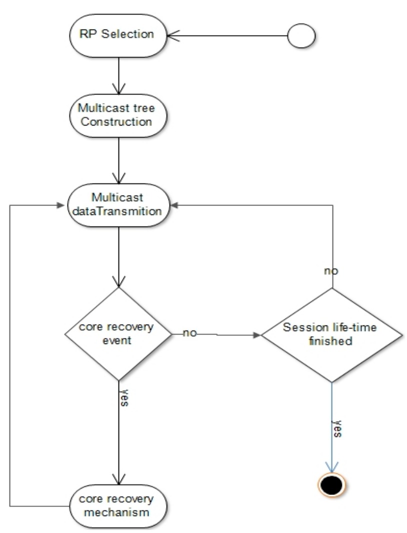

Figure 4 Recovery Mechanism

Hence as presented in figure 5, when one of this events occur or periodically a new node that can offer better performance than the current RP must be chosen. Reselection of a new RP node involves informing all the other nodes, affected and served by this RP, of the new RP node as well as modifying the multicast tree so that the new RP becomes the root of the multicast tree.

6.7 Multicast Addressing

Multicast IP use two communication models to manage multicast address allocation: Any-Source Model (ASM) [22] and the Source-Specific Model (SSM) [27]. PIM-SM based architecture as presented in Figure 1 is based in ASM [25] model for mobile sources. ASM model is used for mobile sources because it gives to sources the ability to join and serve the multicast group and leave it at will with movement.

Following the guidelines proposed by IETF [30] to assign and allocate IP multicast addresses for ASM and SSM models.

To allocate a multicast address, PIM-SM based architecture use the extension proposed in RFC 3306 [26], this proposed solution introduces a new format that incorporates 64 bits unicast prefix information in the multicast address (Figure 5).

It should be noted that the Interface Identifier requirements in Section 2.5.1 of [31] effectively restrict the length of the unicast prefix to 64 bits, hence the network prefix portion of the multicast address will be at most 64 bits.

8 bits	Flag (4 bits)	Scp	Reserved	plen	Network prefix	Group ID
FF	0RPT	4 bits	8 bits	8 bits	64 bits	32 bits

Figure 5 Multicast Addressing

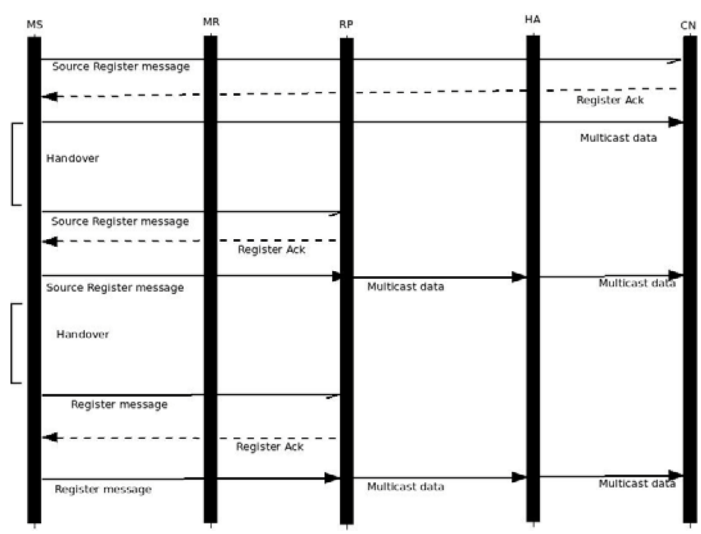

Figure 6 Source Registration processus

6.8 Source Registration

As defined in RFC 4601 [23] and presented in Figure 2, PIM-SM based architecture for mobile source use PIM-SM registration to connects and forwards multicast data from mobile sources to all multicast member group.

As defined in Figure 2, after each handover the mobile source registers with the selected Rendezvous Point RP by sending a Source Register message whit CoA as The source address and the destination address is set to multicast group created locally as mentioned in section 6.7.

The selected RP replies with a Register Ack message that it sends directly to the mobile source, and then orders the mobile source to send multicast data.

7 Simulation Results

7.1 Network Topology and Parameters

The studied scenario was designed in order to be large enough to provide realistic results and to be handled randomly and efficiently within NS2 [32].

Figure 3 shows the topology of studied scenario, the topology contains three independent parties.

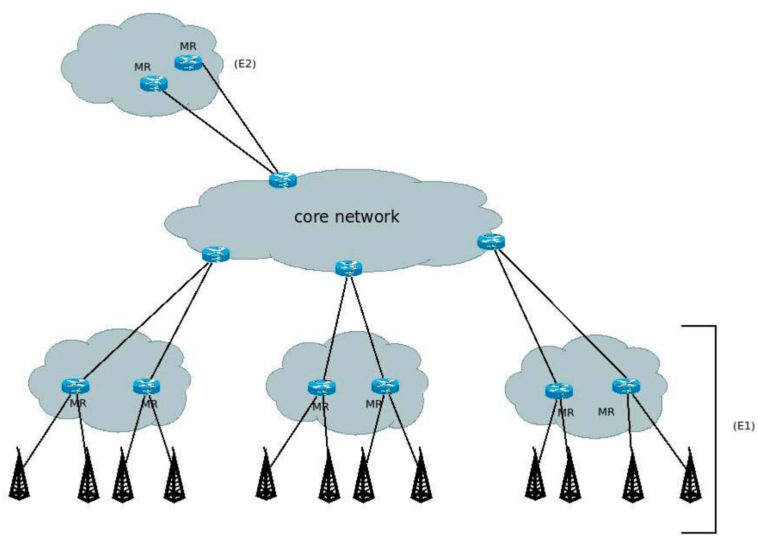

Figure 7: core network

The 'core network' illustrates an autonomous domain representing the 'internet network' generated randomly by GT-ITM [33] and two network extension E1 and E2.

An extension E1 has been added to a set of 'core network' edges router selected randomly, this extension shown in Figure 4 contains two multicast router (MR1 and MR2) everyone linked to an access point (AR1, AR2, AR3, AR4) each one representing a different IP subnet. An extension E2 with the same topology has been added to contain a set of mobile sources nodes of the multicast session.

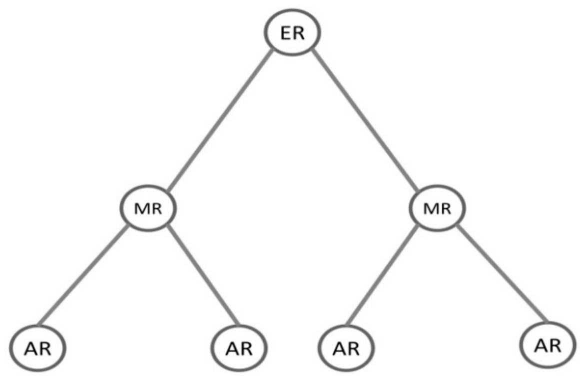

Figure 8: extension E1

Each four access routers have been positioned in a way to provide total coverage to an area of approximately 700 × 700 square meters considering a transmission range of 250 meters, see Figure 5. An area contains between 10 and 100 nodes, 20% of this node are member of multicast group.

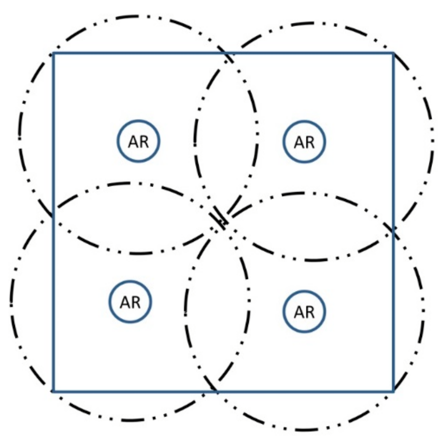

Figure 9: AR position

In order to simulate a realistic case where a Mobile receivers will receive packets from the multicast session and where a Mobile Node will also communicate with other MNs and with an AR to access the channel, 20% of the MNs receive data from the sources nodes and the other nodes communicate among themselves and send data to the sources nodes. In our simulations all sources sent UDP CBR traffic.

At the simulation starting all mobile nodes are uniformly distributed over the network areas. A long the simulation the observed receivers mobile nodes follow a deterministic path to visit more areas, while all other mobile nodes move randomly.

7.2 Simulation Results

In this section, we simulate and compare the performances of PIM-SM based architecture (PIM-SM arch) with SSM source handover (SSM) [18], RPF redirection (RPF) [19] and first version of PIM-SM based architecture (PIM-SM Arch V1) [23] solutions, we use for this metrics described above.

For simulation, we used NS2 (Network Simulator) [32] and we extend Mobiwan [34] extension to simulate home HS and remote RS subscription mechanisms. The random networks topologies are generated with random graph generator GT-ITM [33], and we adopt Waxman [35] as the graph model. Our simulation studies were performed on a set of 100 random networks. The values of $\alpha = 0.2$ and $\beta = 0.2$ were used to generate networks with an average degree between 3 and 4 in the mathematical model of Waxman.

Figure 10 shows the variation of Throughput Consumed with the number of nodes in the network topology, it shows that PIM-SM Architecture is the best scheme to integrate multicast IP with Mobile IPv6, it reduces the Throughput Consumed and the number of packet in the network, followed by PIM-SM Arch V1 [23], RPF and SSM, because RPF add more information in register message to inform the RP not to send PIM join messages back to the source's network, and SSM introduces a new binding message to notify the multicast receivers to subscribe to the new channel when the handover occurs.

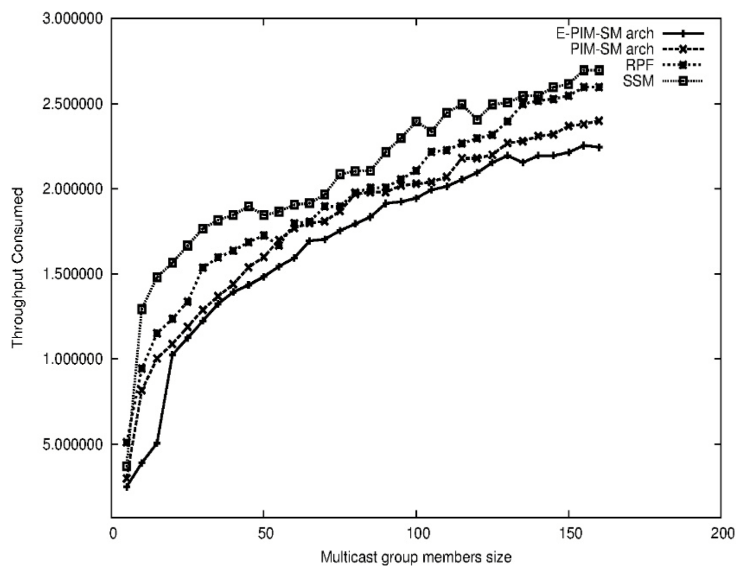

Figure 10: Comparison of Throughput Consumed

Packets lost is very important metrics in multicast session with a multimedia application, it's also a very important metrics in mobile environment with a mobile multicast members and sources. We have studied the packet losses due to the handoff of multicast sources and du to multicast events. Figure 11 shows the variation of Packets lost with the number of nodes in the network topology, it shows that PIM-SM based architecture reduce more the Packets lost followed by PIM-SM Arch V1 [23], RPF and SSM.

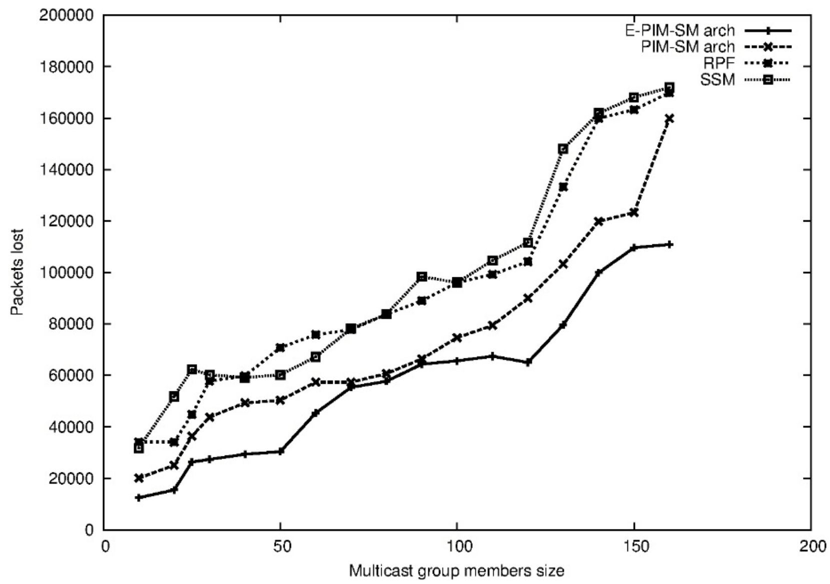

Figure 11: Comparison of Packets lost

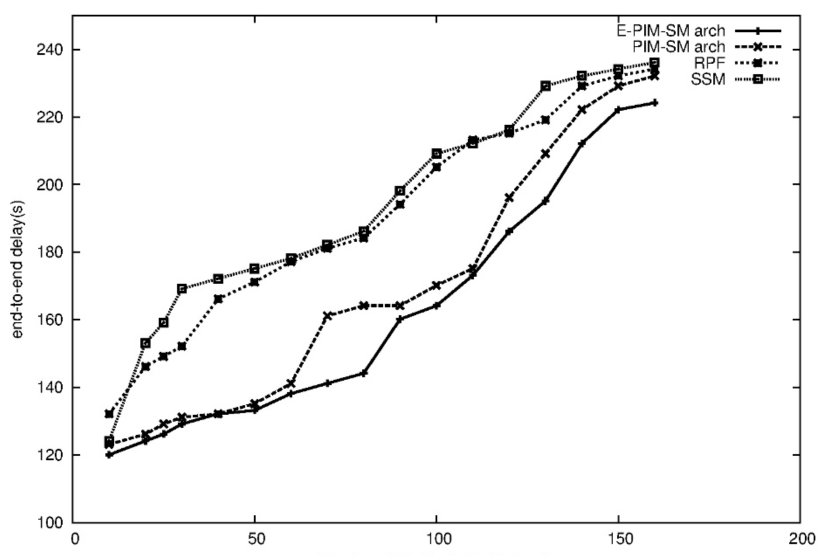

Figure 12: Comparison of End-to-End Delay

In Figure 12 the end-to-end Delay is plotted as a function of the number of nodes in the network topology, it shows that PIM-SM architecture decrease more the end-to-end delay to transmit multicast packet, this reduction is caused by using the same multicast tree in all multicast session whenever the multicast source move, followed by PIM-SM Arch V1 [23], RPF and SSM.

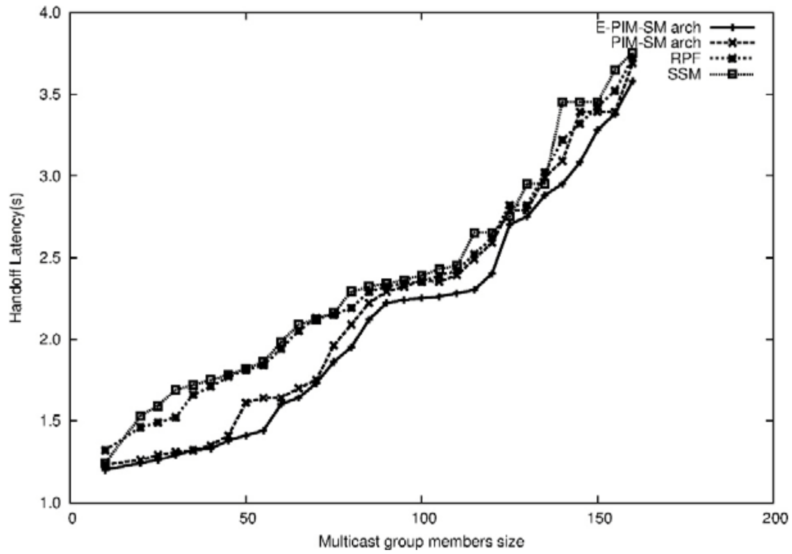

Figure 13: Comparison of Handoff Latency

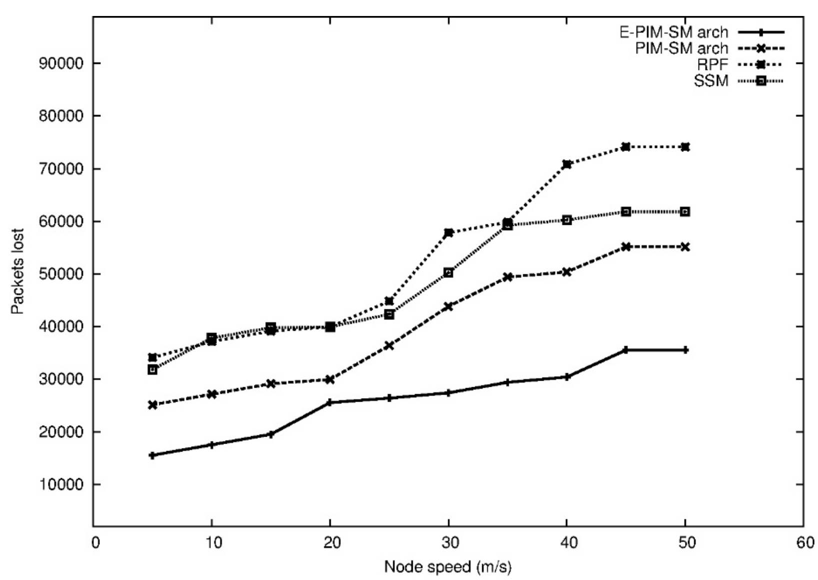

Figure 14: Comparison of Impact of mobility in Packets lost

Handoff latencies affect the service quality of mobile communication and multicast diffusion, especially, with real-time applications. Figure 13 shows the variation of Handoff Latency as a function of the nodes number in the network topology, it shows that PIM-SM based architecture reduce the Handoff latency time to transmit multicast packet to all multicast members, followed by PIM-SM Arch V1 [23], SSM and RPF.

Through handover from one IP subnet to another, the mobile source node needs to send multicast packets continuously while moving. However, the handover is unpredictable and there is no forwarding mechanism for multicast traffic addressed to mobile members, consequently a handover event generate a 100% of packets lost. Figure 14 shows Impact of mobility in Packets lost for the three schemes. it shows that PIM-SM based architecture reduce more the Packets lost generated in all members handover; it shows also that RPF and SSM schemes generate more Packets lost caused by time required to rebuild the multicast tree.

8 Conclusion and perspectives

In this article, the Enhanced version of PIM-SM protocol with GRASP-RP selection algorithm based architecture to transparent mobile sources was introduced and extensively evaluated. We first introduced and analysed the multicast routing protocols and mobile IPv6 protocol. We describe Multicast tree cost and fitness function used to evaluate optimal solution. Related work to address this issue has been discussed undertaken, we present solutions presented by individual researchers and the IETF. We second presented our proposal PIM-SM based architecture to make the handover of mobile sources transparent to both the primary multicast delivery tree and to the multicast receivers, a main importance is given to core selection function.

Supporting multicast with mobile sources is a serious enough issue to more merit attention. Integration of multicast routing protocols into mobile IPv6 environment with mobile multicast sources is dominated by the scheme used. Our scheme implements multicast in Mobile IPv6 efficiently, eliminates the “tree reconstruction” problem and optimizes the handover latency. Performance calculations and numerical results have proved these conclusions.

It is attractive and challenging to do research on multicast in Mobile IPv6 environment. There are still many unresolved issues, such as secure multicast in mobile IPv6, which are our future concerns, we will try also to expose our solution to reality and explore its practical feasibility

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