DNS–Based Allocation of Multicast Addresses

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INTRODUCTION

Despite the efficiency of the IP-multicast it has not been deployed in the whole Internet. The main reason is that the wide-area multicasting among the different autonomous systems (AS) has not been solved perfectly. The global address allocation is especially a problematic part of Internet-wide multicasting. This article addresses such problems in order to review the existing methods and the emerging research results (Hosszú, 2005).

IP-multicasting uses a shared IPv4 address range. In Internet-wide applications the dynamic allocation and reuse of addresses is essential. Recent Internet-wide IP-multicasting protocols (MBGP/MSDP/PIM-SM) have scalability or complexity problems (McBride, et al., 2004). This article introduces the existing solution for the wide-area multicasting and also proposes a novel method, which overcomes the limitations of the previous approaches.

Current wide-area multicasting is based on the PIM-SM multicast routing protocol, which was developed and maintained by the Internet Engineering Task Force (IETF) Protocol Independent Multicast (PIM) Working Group. This working group is chartered to standardize and promote the Protocol Independent Multicast—Sparse Mode (PIM-SM) (Fenner et al., 2006), and the experimental Bi-directional Protocol Independent Multicast (BIDIR-PIM) (Handley et al., 2005) ensure that building and ending the multicast distribution trees has already been solved inside a routing domain, where all the routers are under the same administration (or a strict hierarchy of the administrators), where there is a homogenous infrastructure for registering the sources and the receivers. The sophisticated multicast routing protocols work efficiently inside a multicast routing domain, however, the Internet is composed of several ASs and wide-area multicasting needs the inter-AS (inter-domain) routing as well (Savola, 2006).

BACKGROUND

The advantages of the multicast are especially the effective bandwidth usage and the dynamic nature of the multicast delivery tree. The alternative of the IP-multicast is the application-level multicast (ALM), where the multiplication point of the multicast distribution tree is the hosts and not the routers, as in case of the IP-multicast (Banerjee et al., 2002). The ALM methods are inherently less efficient than the IP-multicast, since the hosts in the case of the ALM generate duplicated traffic around the hosts; furthermore, the distribution tree of the ALM methods is less optimal than the multicast tree constructed by the IP-multicast, since the ALM protocols generally do not take into account the real topology of the network, but use a virtual network, called an overlay. The third disadvantage of the ALM is the inherent unreliability of its multiplication points, since these are hosts, which are run by users without any responsibility for the whole communication.

The well-elaborated IP-multicast routing protocols, the most widely-used Protocol Independent Multicast—Sparse Mode (PIM-SM) (Fenner et al., 2006), and the experimental Bi-directional Protocol Independent Multicast (BIDIR-PIM) (Handley et al., 2005) ensure that building and ending the multicast distribution trees has already been solved inside a routing domain, where all the routers are under the same administration (or a strict hierarchy of the administrators), where there is a homogenous infrastructure for registering the sources and the receivers. The sophisticated multicast routing protocols work efficiently inside a multicast routing domain, however, the Internet is composed of several ASs and wide-area multicasting needs the inter-AS (inter-domain) routing as well (Savola, 2006).
Unluckily, the cooperation of the ASs in transmitting the multicast traffic has not been completely solved yet. One of its problems is the address allocation (to reliably choose a unique multicast IP address from the existing address range). There are existing solutions for address allocation (Johnson & Johnson, 1999), but they are not scalable and not reliable enough.

Another barrier of wide-area IP-multicasting is the source discovery. It arises at the network level, when in a certain routing domain a multicast address has been allocated, and a new host in another domain should want to join to this multicast group address. The intra-domain multicast routing protocols do not announce the allocated multicast addresses to other domains, so this host has no chance to join the existing multicast session from a remote domain. Since the address allocations and the source discovery are strongly related problems, the solution proposed in this article will be discussed together.

In the case of the intra-domain multicast, the problems above are solved. The multicast addresses are allocated dynamically and they are registered at router level, e.g., in the case of the popular PIM-SM multicast routing protocol, the Rendezvous Point (RP) router is responsible to register all the used multicast addresses (Kim et al., 2003). The dynamic allocation of the multicast IP-addresses is easy to manage, as Figure 1 shows.

In the case of inter-domain multicasting, the Multi-protocol BGP (MBGP) multicast inter-domain routing protocol is used in order to make routes among the ASs (Bates, et al., 1998), where every router exchanges routing information with its neighboring peers (Rajvaidya & Almeroth, 2003) regularly.

In order to solve the source discovery problem, the Multicast Source Discovery Protocol (MSDP) was developed and standardized, which makes it possible to use independent multicast routing methods inside the domains while the multicast sessions originating from or to another domains reach all the participants. Every separate PIM-SM domain uses its own Rendezvous Point (RP) independently from other PIM-SM domains. The information about active sessions (sources) is replicated between the domains by the MSDP protocol, which means a flooding among them. Every MSDP host informs its peers about the multicast sources known by it. The new information is downloaded to the database of its local RP. The native multicast routing between the domains (inter-domain routing) is done by the MBGP protocol. The advantage of the MSDP is that it solves the problem of the Internet-wide resource discovery, however, due to the periodical flooding, its scalability is limited. That is why the MSDP-based inter-domain multicast is named short-term solution, since some researchers state that a more scalable system (see below) should have been used.

In order to obtain a solution for the address allocation problem, an address allocation method called GLOP is developed (Meyer & Lothberg, 2000), which statically assigns multicast IP-address ranges to the ASs. The protocol encodes the AS-number into the multicast addresses, namely the second and third segments of the IP-address are the coded AS-number. GLOP uses the 233/8 address range from the whole 224/4 (224.0.0.0... 239.255.255.255) range, which is dedicated for the IP-multicast. The main problem of this method is that every AS uses only a small amount of an address (the fourth segment of the IP-address), which means there are only 256 different addresses.

Another solution for the address allocation, which solves the source discovery as well, is the Multicast Address Allocation Architecture (MAAA). The MAAA is a three-level architecture, including the Inter-domain level, the Intra-domain level, and the Host-to-network level. The implementation of the top level of the archi-