

Thematic-Based Group Communication

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INTRODUCTION

These days, communicating, working together, and collaborating without limitation of space and time is a preferable option for some people although they are physically far from each other. For such purposes, the one-to-many communication model is appropriate (Pardede, Szilvássy, Hosszú, & Kovács, 2002). Its well-elaborated but not-widely deployed realization is the IP-multicast, which is a scalable solution since theoretically it improves the efficiency of the use of bandwidth. Nevertheless, the deployment of IP-Multicast is too slow and expensive since it needs upgrading infrastructures (e.g., routers). For solving this problem, the application-level multicast (ALM), with the cost of efficiency, is offered as a solution. The ALM moves the multicast functionality from the network layer to the application layer.

This article reviews the most important fact of the ALM and introduces to the emerging area of the multicasting, namely the multicast over ad hoc networks, including geocast. After these a novel concept of modeling relative density of members called bunched mode and a proposed ALM multicast transport protocol called shortest tunnel first (STF) are described. The bunched mode is based on the thematic multicast concept (TMC), which means that it is a typical multicast scenario where there are many interested hosts in certain institutes and these institutes are relatively far from each other. This situation is called bunched mode, in which the members of a multicast group are locally in the dense mode, and globally their situation similar to the sparse mode because these spots are far from each other. This article also presents a simple chatting program called PardedeCAST as the tools of STF and TMC research.

The article ends with the description of the future trends in the multicast communication and the conclusions of the described technical facts and results.

BACKGROUND

Currently there is an increasing need for scalable and efficient group communication technology. The multicast is theoretically optimal for such purposes. It can be realized in the Datalink-level, IP-level, and Transport/Application-level (Hosszú, 2005). However, the IP-Multicast has a slow deployment; it has been implemented in the most operating systems (OS) and routers, but not widely enabled. Oppositely to the IP-multicast another approach called application-level multicast (ALM) is easy to deploy, but less efficient (Pardede, 2002).

The ALM protocols can be classified into two categories, namely the mesh-based and the tree-based solutions. The mesh-based protocol creates a mesh for the control plane at first with a redundant topology of the connections between members. After creating the mesh, the algorithm starts to construct a multicast tree. Such protocols are the Narada (Chu, Rao, Seshan, & Zhang, 2002), or the Gossamer (Chawathe, 2000).

The opposite of the mesh-based type is the tree-based protocol concept, where the multicast delivery tree is formed first and then each member discovers some others that are not neighbors and creates control links to these hosts. This solution is suitable for data transferring applications, which need high bandwidth, but not efficient for real-time purposes. Such protocols are the Yoid (Francis, 2000) and the host multicast tree protocol (HMTP) from Zhang, Jamin, and Zhang (2002).

Nowadays there is a fundamental change in the computer network technology due to the mobile networks. They are classified into two types, the infrastructure-based networks and the infrastructure-less, so-called ad hoc networks. The first one is based on the various wireless LAN (WLAN) technologies. They need base stations, called hot spots, but their advantage is the direct access to the Internet. Currently the latest computers are generally WLAN-enabled, and so the method to reach of the Internet is under fast change.

The second class of the mobile networks is the ad hoc topologies, which are dynamic structure of mobile devices that spontaneously form the network among them (Ni, Kremer, Stere, & Iftode, 2005). A network is ad hoc if it does not need any infrastructure. Such networks are the Bluetooth (Haartsen, 1998) and Mobile Ad Hoc Network (MANET), which comprise a set of wireless devices that can move around freely and communicate in relaying packets on behalf of one another (Mohapatra, Gui, & Li, 2004). The MANET is a self-organizing and self-configuring multihop wireless network, where the network topology changes dynamically due to participants' mobility. Ad hoc networks are getting a promising target platform, with the increasing deployment of smart equipments. Such devices are small wireless equipments with large computing power, and memory, as the PDAs or the smart phones. Furthermore computers can be embedded into cars, ships or fixed architectures as buildings. The topology of their network is dynamically changing as vehicles or persons move. Such networks can become part of larger ad-hoc networks spanning a whole town or even bigger geographical regions.

The ad hoc networks are very attractive for communication in the traffic environment, in convention centers, conferences and electronic classrooms (Hong, Xu, & Gerla, 2002). Nodes in this network model share the same random access wireless channel. They cooperate to engage in multihop forwarding. Each node functions not only as a host but also as a router that maintains routes to and forward data for other nodes in the network that may not be within direct wireless transmission range. Due to the special properties of the mobile host, specific multicast routing protocols have been developed for the multicast over ad hoc environment.

The simplest ad hoc multicast routing methods are flooding and tree-based routing. Flooding is very simple, which offers the lowest control overhead at the expense

of generating high data traffic. This situation is similar to the traditional IP-Multicast routing. However, in the wireless ad hoc environment, the *tree-based routing* fundamentally differs from the situation in the wired IP-Multicast, where the tree-based multicast routing algorithms are obviously the most efficient ones, such as in the multicast open shortest path first (MOSPF) routing protocol (Moy, 1994). Although the tree-based routing generates optimally small data traffic on the overlay in the wireless ad hoc network, but the tree maintenance and updates need a lot of control traffic. That is why the both simplest methods are not scalable for large groups.

A more sophisticated ad-hoc multicast routing protocol is the core-assisted mesh protocol (CAMP), which belongs to the mesh-based multicast routing protocols (Garcia-Luna-Aceves & Madruga, 1999). It uses a shared mesh to support multicast routing in a dynamic ad-hoc environment. This method uses cores to limit the control traffic needed to create multicast meshes. Unlike the core-based multicast routing protocol as the traditional Protocol Independent Multicast-Sparse Mode (PIM-SM) multicast routing protocol (Deering, Estrin, Farinacci, Jacobson, Liu, & Wei, 1996), CAMP does not require that all traffic flow through the core nodes. CAMP uses a receiver-initiated method for routers to join a multicast group. If a node wishing to join to the group, it uses a standard procedure to announce its membership. When none of its neighbors is mesh members, the node either sends a join request toward a core or attempt to reach a group member using an expanding-ring search process. Any mesh member can respond to the join request with a join Acknowledgement (ACK) that propagates back to the request originator.

Oppositely to the mesh-based routing protocols, which exploit variable topology, the so-called gossip-based multicast routing protocols exploit randomness in communication and mobility. Such multicast routing protocols apply gossip as a form of randomly controlled flooding to solve the problems of network news dissemination. This method involves member nodes to talk periodically to a random subset of other members. After each round of talk, the gossipers can recover their missed multicast packets from each other (Mohapatra et al., 2004). Oppositely to the deterministic approaches, this probabilistic method will better survive a highly dynamic ad hoc network because it operates independently of network topology and its random nature fit to the typical characteristics of the network.

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