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QOS PARAMETER ANALYSIS ON CENTRALIZED MODE & DENSE MODE MULTICASTING PROTOCOLS IN A NETWORK

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Abstract

There are three fundamental types of IPv4 addresses: unicast, broadcast, and multicast. A unicast address is designed to transmit a packet to a single destination. A broadcast address is used to send a datagram to an entire sub network. A multicast address is designed to enable the delivery of datagram to a set of hosts that have been configured as members of a multicast group in various scattered sub networks.

Multicasting is not connection oriented. A multicast datagram is delivered to destination group members with the same “best-effort” reliability as a standard unicast IP datagram. This means that a multicast datagram is not guaranteed to reach all members of the group, or arrive in the same order relative to the transmission of other packets.

The only difference between a multicast IP packet and a unicast IP packet is the presence of a “group address” in the Destination Address field of the IP header. Instead of a Class A, B, or C IP address, multicasting employs a Class D destination address format (224.0.0.0-239.255.255.255). Multicast routing differs from unicast routing in several ways. The most important differences are in the ways that multicast routers use source and destination addresses. A multicast packet is addressed to a special IP address representing a group of devices that can be scattered anywhere throughout a network. Since the destinations can be anywhere, the only reliable way to eliminate loops in multicast routing is to look at the reverse path back to the source. So, while unicast routing cares where the packet is going, multicast routing also needs to know where it came from. For

this reason, multicast routing protocols such as Protocol Independent Multicast (PIM) always work with the source address and destination group simultaneously. The usual notation for a multicast route is *(Source, Group)*, as opposed to the unicast case in which routes are defined by the destination address alone.

A multicast routing strategy is the mechanism by which the multicast distribution tree is computed in the simulation. Ns supports three multiast route computation strategies: **centralised, dense mode(DM) or shared tree mode(ST).**

Centralized Multicast The centralized multicast is a sparse mode implementation of multicast similar to PIM-SM. A Rendezvous Point (RP) rooted shared tree is built for a multicast group. The actual sending of prune, join messages etc. to set up state at the nodes is not simulated. A centralized computation agent is used to compute the forwarding trees and set up multicast forwarding state, S, G at the relevant nodes as new receivers join a group. Data packets from the senders to a group are unicast to the RP.

Dense Mode The Dense Mode protocol (DM.tcl) is an implementation of a dense–mode–like protocol. Depending on the value of DM class variable CacheMissMode it can run in one of two modes. If Cache Miss Mode is set to pimdm (default), PIM-DM-like forwarding rules will be used.

Introduction

1.1.1. First-Generation Mobile Systems

The first generation of analog cellular systems included the Advanced Mobile Telephone System (AMPS) [1] which was made available in 1983. A total of 40MHz of spectrum was allocated from the 800MHz band by the Federal Communications Commission (FCC) for AMPS. It was first deployed in Chicago, with a service area of 2100 square miles [2]. AMPS offered 832 channels, with a data rate of 10 kbps. Although omnidirectional antennas were used in the earlier AMPS implementation, it was realized that using directional antennas would yield better cell reuse. In fact, the smallest reuse factor that would fulfill the 18db signal-to-interference ratio (SIR) using 120-degree directional antennas was found to be 7. Hence, a 7-cell reuse pattern was adopted for AMPS. Transmissions from the base stations to mobiles occur over the forward channel using frequencies between 869-894 MHz. The reverse channel is used for transmissions from mobiles to base station, using frequencies between 824-849 MHz. In Europe, TACS (Total Access Communications System) was introduced with 1000 channels and a data rate of 8 kbps. AMPS and TACS use the frequency modulation (FM) technique for radio transmission. Traffic is multiplexed onto an FDMA (frequency division multiple access) system. In Scandinavian countries, the Nordic Mobile Telephone is used.

1.1.2. Second-Generation Mobile Systems

Compared to first-generation systems, second-generation (2G) systems use digital multiple access technology, such as TDMA (time division multiple access) and CDMA (code division multiple access). Global System for Mobile Communications, or GSM [3], uses TDMA technology to support multiple users.Examples of second-generation systems are GSM, Cordless Telephone (CT2), Personal Access Communications Systems (PACS), and Digital European Cordless Telephone (DECT [4]). A new design was introduced into the mobile switching center of second-generation systems. In particular, the use of base station controllers (BSCs) lightens the load placed on the MSC (mobile switching center) found in first-generation systems. This design allows the interface between the MSC and BSC to be standardized. Hence, considerable attention was devoted to interoperability and standardization in second-generation systems so that carriers could employ different manufacturers for the MSC and BSCs.In addition to enhancements in MSC design, the mobile-assisted handoff mechanism was introduced. By sensing signals received from adjacent base stations, a mobile unit can trigger a handoff by performing explicit signalling with the network.Second generation protocols use digital encoding and include GSM, D-AMPS (TDMA) and CDMA (IS-95). 2G networks are in current use around the world. The protocols behind 2G networks support voice and some limited data communications, such as Fax and short messaging service (SMS), and most 2G protocols offer different levels of encryption, and security. While first-generation systems support primarily voice traffic, second-generation systems support voice, paging, data, and fax services.

1.1.3. 2.5G Mobile Systems

The move into the 2.5G world will begin with General Packet Radio Service (GPRS). GPRS is a radio technology for GSM networks that adds packet-switching protocols, shorter setup time for ISP connections, and the possibility to charge by the amount of data sent, rather than connection time. Packet switching is a technique whereby the information (voice or data) to be sent is broken up into packets, of at most a few Kbytes each, which are then routed by the network between different destinations based on addressing data within each packet. Use of network resources is optimized as the resources are needed only during the handling of each packet.The next generation of data heading towards third generation and personal multimedia environments builds on GPRS and is known as Enhanced Data rate for GSM Evolution (EDGE). EDGE will also be a significant contributor in 2.5G. It will allow GSM operators to use existing GSM radio bands to offer wireless multimedia IP-based services and applications at theoretical maximum speeds of 384 kbps with a bit-rate of 48 kbps per timeslot and up to 69.2 kbps per timeslot in good radio conditions. EDGE will let operators function without a 3G license and compete with 3G networks offering similar data services. Implementing EDGE will be relatively painless and will require relatively small changes to network hardware and software as it uses the same TDMA (Time Division Multiple Access) frame structure, logic channel and 200 kHz carrier bandwidth as today's GSM networks. As EDGE progresses to coexistence with 3G WCDMA, data rates of up to ATMlike speeds of 2 Mbps could be available.GPRS will support flexible data transmission rates as well as continuous connection to the network. GPRS is the most significant step towards 3G.

1.1.4. Third-Generation Mobile Systems

Third-generation mobile systems are faced with several challenging technical issues, such as the provision of seamless services across both wired and wireless networks and universal mobility. In Europe, there are three evolving networks under investigation: (a) UMTS (Universal Mobile Telecommunications Systems), (b) MBS (Mobile Broadband Systems), and (c) WLAN (Wireless Local Area Networks).The use of hierarchical cell structures is proposed for IMT2000. The overlaying of cell structures allows different rates of mobility to be serviced and handled by different cells. Advanced multiple access techniques are also being investigated, and two promising proposals have evolved, one based on wideband CDMA and another that uses a hybrid TDMA/CDMA/FDMA approach.

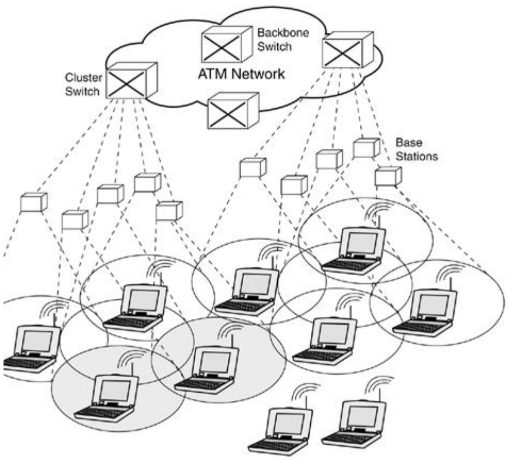

Figure 1.1. The architecture of a cellular wireless network based on ATM

1.2. Global System for Mobile Communications (GSM)

GSM is commonly referred to as the second-generation mobile cellular system. GSM has its own set of communication protocols, interfaces, and functional entities. It is capable of supporting roaming, and carrying speech and data traffic. The GSM network architecture (see Figure 1.2) comprises several base transceiver stations (BTS), which are clustered and connected to a base station controller (BSC). Several BSCs are then connected to an MSC. The MSC has access to several databases, including the visiting location register (VLR), home location register (HLR), and equipment identity register (EIR).

It is responsible for establishing, managing, and clearing connections, as well as routing calls to the proper radio cell. It supports call rerouting at times of mobility. A gateway MSC provides an interface to the public telephone network.

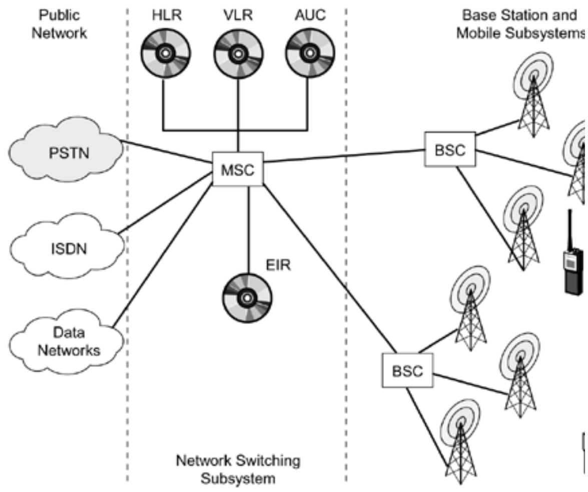

Figure 1.2. The network architecture of GSM.

The HLR provides identity information about a GSM user, its home subscription base, and service profiles. It also keeps track of mobile users registered within its home area that may have roamed to other areas. The VLR stores information about subscribers visiting a particular area within the control of a specific MSC.

Table 1.1. The IMSI in GSM

Mobile Country Code
Mobile Network Code
Mobile Subscriber Identification Code

The authentication center (AC) is used to protect subscribers from unauthorized access. It checks and authenticates when a user powers up and registers with the network. The EIR is used for equipment registration so that the hardware in use can be identified. Hence if a device is stolen, service access can be denied by the network. Also, if a device has not been previously approved by the network vendor (perhaps subject to the payment of fees by the user), EIR checks can prevent the device from accessing the network. In GSM, each mobile device is uniquely identified by an IMSI (international mobile subscriber identity). It identifies the country in which the mobile system resides, the mobile network, and the mobile subscriber. The IMSI is stored on a subscriber identity module (SIM), which can exist in the form of a plug-in module or an insertable card. With a SIM, a user can practically use any mobile phone to access network services

1.3. General Packet Radio Service (GPRS)

The GSM general packet radio service (GPRS) is a data overlay over the voice-based GSM cellular network. It consists of a packet wireless access network and an IP-based backbone. GPRS is designed to transmit small amounts of frequently sent data or large amounts of infrequently sent data. GPRS has been seen as an evolution toward UMTS (Universal Mobile Telecommunications

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Systems). Users can access IP services via GPRS/GSM networks.

GPRS services include both point-to-point and point-to-multipoint communications. The network architecture of GPRS is shown in Figure 1.3. Gateway GSN (GGSN) nodes provide interworking functions with external packet-switched networks. A serving GPRS support node (SGSN), on the other hand, keeps track of an individual mobile station's location and provides security and access control. As shown in Figure 1.3, base stations (BSSs) are connected to SGSNs, which are subsequently connected to the backbone network. SGSNs interact with MSCs and various databases to support mobility management functions. The BSSs provide wireless access through a TDMA MAC protocol. Both the mobile station (MS) and SGSNs execute the SNDCP (Subnetwork-Dependent Convergence Protocol), which is responsible for compression/decompression and segmentation and reassembly of traffic. The SGSNs and GGSNs execute the GTP (GPRS Tunnelling Protocol), which allows the forwarding of packets between an external public data networks (PDN) and mobile unit (MU). It also allows multiprotocol packets to be tunneled through the GPRS backbone.

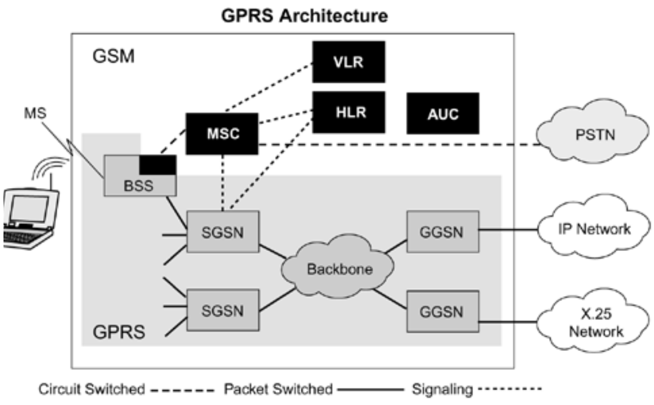

Figure 1.3. Architecture of GSM general packet radio service.

1.4. Personal Communications Services (PCSs)

The FCC defines PCS [5] as "Radio communications that encompass mobile and ancillary fixed communication that provides services to individuals and business and can be integrated with a variety of competing networks." However, the Telecommunications Industry Association (TIA) has a different definition for PCS:

A mobile radio voice and data service for the provision of unit-to-unit communicatoins, which can have the capability of public switched telephone network access, and which is based on microcellular or other technologies that enhance spectrum capacity to the point where it will offer the potential of essentially ubiquitous and unlimited, untethered communications.

PCS can also be defined in a broader sense [6] as a set of capabilities that allows some combination of personal mobility and service management. In short, PCS [7] is a commonly used term that defines the next generation of advanced wireless networks providing personalized communication services. In Europe, the term "personal communication networks (PCNs)" is used instead of PCS.

The basic requirements for a PCS are:

- Users must be able to make calls wherever they are
- Offered services must be reliable and of good quality
- Provision of multiple services such as voice, fax, video, paging, etc., must be available.

Unlike AMPS, PCS is aimed at the personal consumer industry for mass consumption. The FCC's view of PCS is one where the public switched telephone network (PSTN) is connected to a variety of other networks, such as CATV (cable television), AMPS cellular systems, etc.

1.5. Wireless LANs (WLANS)

Wireless LAN technology has evolved to extend to existing wired networks. Local area networks (LANs) are mostly based on Ethernet media access technology that consists of an interconnection of hosts and routers. LANs are restricted by distance. They are commonly found in offices and inside buildings. Interconnection using wires can be expensive when it comes to relocating servers, printers, and hosts.

Now, more wireless LANs (WLANs) are being deployed in offices. Most WLANs are compatible with Ethernet, and hence, there is no need for protocol conversion. The IEEE has standardized 802.11 protocols to support WLANs media access. A radio base station can be installed in a network to serve multiple wireless hosts over 100-200 m. A host (for example, a laptop) can be wirelessly enabled by installing a wireless adapter and the appropriate communication driver. A user can perform all network-related functions as long as he or she is within the coverage area of the radio base station. This gives the user the capability to perform work beyond his or her office space.

As shown in Figure 1.4, several overlapping radio cells can be used to provide wireless connectivity over a desired region. If a wireless host migrates from one radio cell to another within the same subnet, then there is no handoff. It is basically bridging, since the host's packet will eventually be broadcast onto the same Ethernet backbone. WLANs support existing TCP /IP-based applications. There has been considerable debate in the past as to the low throughput WLANs provide compared to high-speed wired networks. It was not long ago that switched Ethernet technology [8] evolved, bringing the communication throughput of Ethernet into the gigabit range. The desire to support higher throughput and ad hoc mobile communications has prompted the ETSI (European Communications Standard Institute) to produce a standard for high-performance Radio LAN (HIPERLAN), at 20Mbps throughput with a self-organizing and distributed control network architecture. HIPERLAN II is a wireless ATM system operating at the 17GHz band.

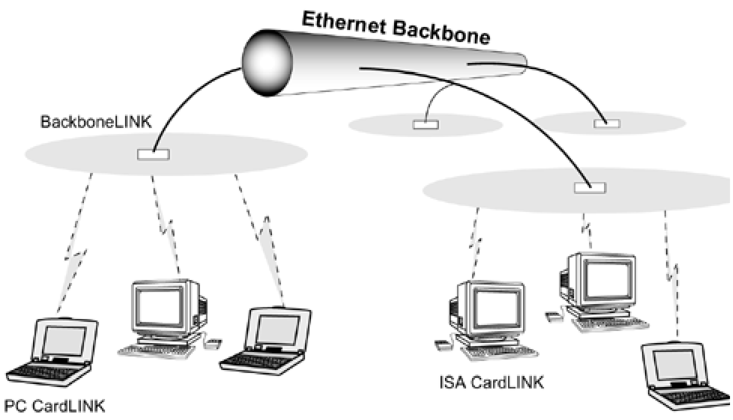

Figure 1.4. A WLAN with an Ethernet wired backbone

1.6. Universal Mobile Telecommunications System (UMTS)

The Universal Mobile Telecommunications System (UMTS) is commonly referred to as a third-generation system. It is targeted to be deployed in 2002. UMTS employs an ATM-based switching network architecture and aims to provide services for both mobile and fixed subscribers by common call-processing procedures. The UMTS architecture is split into core (switching) networks, control (service) networks, and access networks. The core network is responsible for performing switching and transmission functions. The control network supports roaming through the presence of mobility management functions. Finally, the radio access network provides channel access to mobile users and performs radio resource management and signalling. UMTS will include both terrestrial and global satellite components. The UMTS network comprises: (a) the mobile terminal, (b) the base transceiver station (BTS), (c) the cell site switch (CSS), (d) mobile service control points (MSCP), and (e) the UMTS mobility service (UMS). UMTS employs a hierarchical cell structure, with macrocells overlaying microcells and picocells. Highly mobile traffic is operated on the macrocells to reduce the number of handoffs required. UMTS aims to support roaming across different networks. The UMTS Radio Access System (UTRA) will provide at least 144 kbps for full-mobility applications, 384 kbps for limited-mobility applications, and 2.048 Mbps for low-mobility applications. UMTS terminals will be multiband and multimode so that they can work with different standards. UMTS is also designed to offer data rate on-demand. The network will react to a user's needs, based on his/her profile and current resource availability in the network. UMTS supports the virtual home environment (VHE) concept, where a personal mobile user will continue to experience a consistent set of services even if he/she roams from his/her home network to other UMTS operators. VHE supports a consistent working environment regardless of a user's location or mode of access. UMTS will also support adaptation of requirements due to different data rate availability under different environments, so that users can continue to use their communication services.To support universal roaming and global coverage, UMTS will include both terrestrial and satellite systems. It will enable roaming with other networks, such as GSM. UMTS will provide a flexible broadband access technology that supports both IP and non-IP traffic in a variety of modes, such as packet, circuit-switched, and virtual circuit

Previous Work

2.1 Multicast Routing on the Internet

This section is devoted to some existing multicast routing protocols on the Internet. They belong to the categories of source-based routing and RP based shared tree routing. They all use Internet Group Membership Protocol (IGMP) as the basis for group management. The requirement in network areas with a shared medium (e.g., Ethernet segment) is that a designated router is informed of group membership [WZ01].

2.1.1 PIM-Sparse Mode

PIM-Sparse mode [DEF76, DEF78] is more efficient for geographically distributed group members in the network with low density. Two basic premises exist for this mode [WZ01]: Group membership is based on explicit join operations; and RPs are provided. The explicit group join is designed to reduce the production of multicast data units by a sender at the beginning. Data is sent from the source to the RP. If members exist in a domain, this domain needs to register through explicit join to the group in order to get routed data from the RP. In real applications, more than one RP.s are distributed across the network, although each group utilizes only one RP. When a receiver intends to join a group, it uses IGMP to signal in the subnet so that the designated router is aware of its group membership. After obtaining the RP information for this group, the router periodically sends an explicit join data unit (PIM join) to the RP.

The senders use tunneling to establish unicast paths to the RP, which is the root for the multicast tree (Figure 3.1). This tree is not necessarily optimal for the individual combinations of senders in a group [WZ01]. When a sender starts transmitting data to a group, its designated router forwards the data encapsulated in a unicast register data unit to the RP. There the data is decapsulated and routed as multicast data along the multicast tree rooted at the RP. The option of switching to a source-specific tree is provided, which relieves the overhead for encapsulation and decapsulation for high data rate streams, e.g., a significant number of data packets have been received in a certain period from a particular source. Only the RP or routers with local group members can initiate the transition from the shared tree to the source specific tree. As in Figure 3.2, PIM router 2 can initiate the transition from shared tree to specific tree for sender S1, while keep the shared tree for sender S2. It sends a pruning message to the RP, which generates an entry in the form (S, G) and sets appropriate bits indicating that the RP is part of the shared tree but not of the specific tree. The new route from sender S1 to the receiver includes PIM router 2 without any involvement of the RP. PIM router 2 periodically sends PIM join to the sender S1. After receiving data from the sender S1, PIM router 2 locally sets a bit to indicate specific tree transmission for this sender.

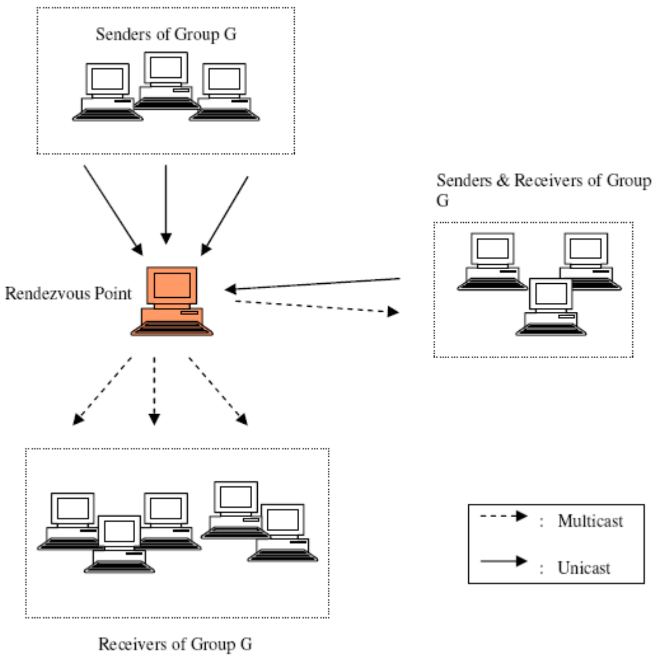

Figure 2.1: Shared Tree Multicast with a Rendezvous Point

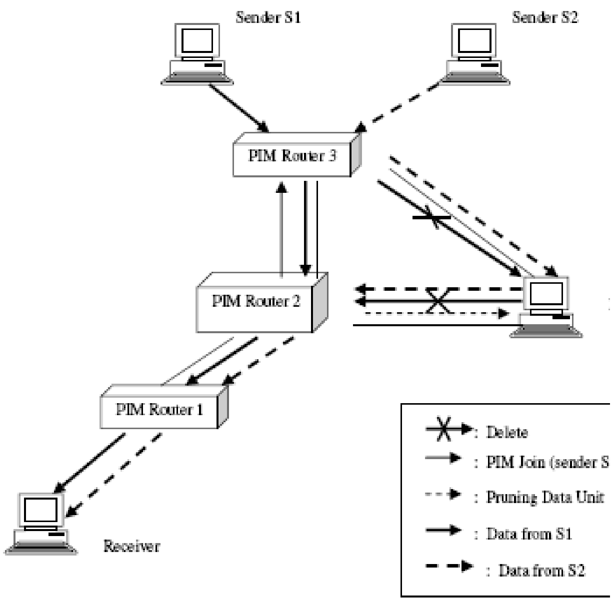

Figure 2.2: Source Specific Tree for Sender S1 and Shared Tree for Sender S2 in PIM-SM

Three situations exist for a router to keep a multicast routing entry when a receiver wants to join a group: No entry exists for group G; Entry for group G exists with unspecified source; and entry for group G exists with specified source S [WZ01]. If no multicast entry for group G exists yet in the router and a join data unit is received, a wildcard route entry (*, G) is created for the group. The wildcard stands for any source. After the router invokes a hash function to determine a RP, it sends a join data unit to this RP. If the group exists in the router in the form (*, G), then the data is delivered along the shared tree. And there is no need for the router to send another join to the RP for group G. If a special tree exists for sender S, this fact is noted in the router on the specific tree as (S, G), and no join data unit is sent to the RP. Data are forwarded on the source specific tree. A multicast routing entry in the router is not deleted as long as there is a group member and the router is required to forward data units to receivers in other subnet, i.e., dependent routers exist

2.1.2 PIM-Dense Mode

PIM-dense mode [DEF99] is designed for multicast communication in small networks and high group density. No RP is used. The protocol builds a source specific multicast tree for each sender as soon as it starts sending data. Multicast routing entries in the form (S, G) are kept in related routers under the mechanism of timeout. At startup, it assumes that all subnets wish to receive data. Therefore, flooding and pruning are used. Graft data units are sent to support immediate integration of new group members into the multicast tree. PIM-DM routers periodically send Hello data units in order to become acquainted with their neighbours in the network. Due to flooding, data can end up being sent unnecessarily to network areas in which no group members are located. However, this is considered acceptable because it is assumed that the density of a group will be very high, the distance between members are short, and consequently the additional overhead will be low [WZ01

Problem Identification

Multicasting allows us to send a data packet to multiple sites at the same time. The key here is the ability to send one message to one or more nodes in a single operation. This provides a tremendous amount of savings in band-width when compared to traditional unicast transmission which sends messages to multiple nodes through replication of the message to each node. Besides the performance improvement over unicast transmission, multicast allows the construction of truly distributed applications. There are several new and exiting applications such as real-time audio and video conferencing which make good use of multicast services. Because of the real-time constraints on these services, there is a constant data flow requirement and a very low tolerance to transmission delay jitters, hence multicast routing protocols should satisfy these constraints. Multicasting is also often used for synchronization, duplication, and coherency of data in Distributed and Database Systems. For the implementation of coherency one needs to use atomic operations among different machines. This atomicity can be achieved by using multicasting. The same can be said for synchronization in Distributed Systems

Conclusion

In this work we will implement the Centralized mode and Dense mode Multicast routing protocols, in Tool command language and integrated the module in the ns-2 Simulator. The performance of the protocols were measured with respect to metrics like Packet delivery ratio, end – end delay etc. I have made the performance comparison of the protocols. Simulations were carried out with identical topologies and running different protocols on the mobile node.

The results of the simulation will indicate that performance of the Dense mode protocol is superior to standard Centralized mode protocol. It is also observed that the performance is better especially when the pause time is low. For higher pause time although Dense mode is better for most cases but their delivery ratio remains close to each other. It is also true that any of the single protocol does not supersede the other one. There performance depends upon the different scenarios

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