공동작업환경을 위한 그룹통신관리방식 설계

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요 약

그룹웨어기술은 분산된 환경에서도 서로 가까이 있는 것처럼 대화하고, 함께 협력하여 작업하며, 정보를 쉽게 교환할 수 있도록 해 주는 핵심적인 기술로 현재 많은 연구가 이루어 지고 있다. 본 논문은 공동작업환경을 위한 효율적인 그룹통신관리를 독립적인 모듈로 설계하여 그룹웨어 응용시스템의 개발을 지원하는 플랫폼으로 이용하고자 연구되었다. 논문에서는 우선 그룹통신관리를 위한 요구사항을 도출하기 위해 화상회의와 같은 응용 개발사례들을 분석하였으며, 공통적인 구조 및 기능적 특징들을 살펴보았다. 아울러 그룹통신관리와 직접적으로 관련이 있는 표준화와 연구활동 등을 통하여 기본개념의 설정이나 설계시 고려해야 할 사항들은 점검하였다. 이를 토대로 기본적인 그룹통신관리 모델을 정립하고, 그룹통신관리의 구조와 처리절차를 설계하였다. 또한 인터넷 환경에서의 그룹통신에 필요한 dynamic하고 global한 주소화 방식을 구현하기 위하여 IP 멀티캐스트 주소와 포트번호의 결정방법에 대한 구조 및 방식을 제시하였다. 특히 멀티캐스트 주소는 먼저 회의 준비단계에서 계층분산체계의 주소관리자들을 이용하여, 그룹이 포함된 도메인명칭을 이용하여 중앙의 주소관리자에게 지역 주소관리자의 주소확인을 의뢰하고, 그룹웨어 응용이 동작시 해당 지역의 주소관리자에게 Initiator의 IP 주소를 제시하여, 이 중 network 주소부분을 이용하므로써 주소가 실시간에 생성될 수 있도록 하였다. 아울러 신뢰성있는 데이타 전송서비스를 기술하고, 끝으로 설계검증의 한 방법으로 이미 개발된 응용서비스에 적용하기 위한 전체적인 시스템구조를 논의하였다.

The Design of Group Communications Management for Groupware Environment

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ABSTRACT

Advanced countries are very active in deploying the National Information Infrastructure which provides universal service to promise fruitful quality of future life. Even in the distributed environment, we can closely converse, work together, and share information in a very convenient way. This is actually enabled with the help of groupware technology, which are currently focused and researched in a larger popularity. The aim of this study is to design a portable pack for group communications management to support the development of groupware applications.₩In the paper we begin with technical survey, continue to build our own model for group communications management, and design its architecture and procedure. We also suggest group addressing mechanism under Internet environment such as how to create IP multicast address and IP port number dynamically and as a globally unique value for the communication session, with the help of the hierarchical and distributed address managers. We also indicate the reliable data transmission services to remedy the unreliable feature of the UDP multicast services, and finally the architecture applied to support the practical applications is briefly discussed for verification of the designed concept.

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1. Background

It is more strongly expected that the new emerging services provided on the Information superhighway will change our life. The Internet service must be its live example in that it helps people work at their home, navigate intoglobal information any time, and further create a new information-based society. This society will be thus organized based on the people's same speciality, same hobby or same task, rather than regional, organizational or national barriers. What we ought to notice recently from this point of view is the mature and the harmony of technologies in high speed telecommunications, high performance computing, as well as multimedia systems. With the help of these technologies, plenty of distributed and multimedia services could be introduced in our life. The desktop conference, the group editor, and the group distribution services are groupware applications much concerned recently and based on the group communications. Here, we can cite a well-known multimedia conferencing service on the Internet environment, so called MBONE, which works using the IP and UDP multicast service. Besides, we know that many studies providing group communications facilities have been actively carried out in terms of framework development, protocol design, and its standardization.

Our concern in this paper starts from this background, targeting to have a well-refined mechanism for the Group Communications Management by providing the session management for group communications, group address allocation and reliable multicast data transfer service in the Internet environment. In other word, we want to realize multimedia and group communications services with the typical TCP/IP multicast mechanism due to its highly practical utilization. Requirements in the design of the group communications management arose with new applications and some limitations of the TCP/IP multicast. These requirements are listed below :

- The group communications management should provide a mechanism to manage the group members. sessions, and addresses.
  - This must be done respectively for the group members and for the group communications session.
  - The establishment of multiple sessions in the same group should be permitted.
  - The uniqueness of the group address need to be guaranteed in the global network environment.
- Every member should be able to join and leave the group communications dynamically.
- It should support the following communication types :
  - point-to-point and point-to multipoint communications,
  - uni-directional and bi-directional communications.
- The receving data of different media and different senders must be able to be handled independently by the applications.
- Some applications necessitate the delivery of a single ACK for the multicast data sent.
- Reliable and semi-rereliable multicast services are required for text data or some compressed audio and video data. However UDP is unreliable, whereas TCP is only point-to-point.

This paper begins with some well-known technical survey to look at not only the application side but also the group communications management side. Next, we arrange and model it to be operable under TCP/IP environment. Then, we will depict the design of the architecture, the addressing, and the Group Communications Management. As a final step, we will apply the design to the N-Phone, so called(Multimedia Server X) based conference software and will give some conclusion.

2. Related Research and Development

Reference to already developed and well-known applications in use help us to understand requirements for Group Communications Management, the common architectural and functional view, as well as each of peculiar focus and environment.[2, 5, 14, 15] A lot of works have been done to settle the concrete concept to Group Communications Management. Such issues as management operations, addressing, and architecture are recently dealt in terms of international standardization and industrial implementation. ITU-T T.12x recommends well-designed framework for the conference and any other groupware environment. So, it gives us a good understanding of application examples which the Group Communications Management is supposed to support. ISO-ECTS and CIO are important to introduce a good model for the Group Communications Management, so that we could utilize their key concept for our modelling. Other references are related to the addressing architecture and scheme. From now, we will describe more about some of them quite related to our design.

2.1 ITU-T T. 12X

The[11, 12] papers defines communication of multimedia data and management of such system : the establishment of group conference and the participant identifications. The management of groups is processed by the Generic Conference Control(GCC) unit which provides many services : conference configuration, identifier assignation, conference management, control of membership, etc. In order to ensure the conference management reliability, a GCC agent must reside in every user system. Only one Top GCC, located in the Multipoint Communications Unit(MCU), centralizes all GCC Agent services information. The GCC Agent uses the services of the Multipoint Communications Services(MCS) to convey information to other participant GCC agents. The MCS module assumes the transport of data and routing, the connection establishments, the multicast channel setting up, and the addressing mechanism. There is one Controller Agent per user system that assures the local management services. On top of that, they request the MCU Controller which is the supreme Controller of the whole system in order to obtain general services.

2.2 ISO-ECTS

The[3, 6] and[12] documents establish recommendations for the session and transport layers, this concerning multipeer communications and group definition. The main characteristic of the ECTS draft is the group definitions : an Enrollment Group, a Registered Group, an Enrolled Group and an Active Group. Some primitives allow members to go forward states until the data transfer state : Registration, Activation, Bind, Join, etc. The Enrollment Group defined by a group address is the set of members able to be possibly registered into a conference. The Registered Group is the set of Enrollment Group entities that want to participate into conference. Registered Group members that have satisfied conditions to enter the conference go into the Enrolled Group. The Quality Of Service(QoS) and the Active Group Integrity(AGI) compose these conditions. The Enrolled Group may contains many Group Associations(GAs). These Group Associations distinguish member subsets and represent different type of conference. On top of AGI and QoS, GAs are defined by identifiers and group addresses. Many Group Conversations(GC) may be present into one GA. A GC defines a full duplex multipeer conversation, that uses a single media, among GA participants. These GCs are identified by GC-IDs and GC-addresses. Finally, the Active Group represents the Enrolled Group members that have entered the transfer phase.

2.3 CIO

The Group management model described by the CIO Race 2060[8, 9, 20] shows a typically distributed group management system architecture. A local component named Management User Agent(M-UA) is present in each member system and provides services to users. In addition, it forwards group information to their associated Group Management Directory Agents(GM-DA). The GM-DA manages global Information about user groups. A GM-DA is connected to one or more M-UA, and must share information with other GM-DAs in order to assure the compatibility of information. The functions of the M-UA and the GM-DA is to create, delete group, add, remove members, modify group properties and to supply status of group properties of any requesting participant. The group properties stored and managed by the GM-DA define member roles, group membership, access right, etc. This information deals with Quality Of Service(QoS) and ordering. In addition, it consists of the Active Group Integrity(AGI), the Association Topology Integrity(ATI), the Voting List(VL), the Notification List(NL) and the Access Control List (ACL). These parameters are defined during the progress of a conference participant towards the different member groups. These groups define the state of the participant and the advance of it in the data transfer phase. The Group Association properties include group-address, participant list, AGI, ATI, ACL, VL, NL and ordering. Multicast Conversations are defined with the group-address, the participant list, the AGI, the QoS and the reliability classes.

2.4 PGMP

The Process Group Management Protocol (PGMP) implemented by the department of computer science of the Keio University[16] provides reliable process group communications using IP multicast. In order to remedy the lack of IP multicasting management, it provides host group management and communications facilities. The main functions supported by the PGMP are group creation, dynamic membership changes, reliable message transfer mechanism. The group address allocation is provided by a Group Allocator located in every network. This allocator looks forward unused IP multicast addresses in order to assign them to new group names. These names are composed of two particles : the first one represents the domain(e.g. cs.keio.japan) and the second one specifies the type of service(e.g. conference). When a member wants to create a group it must request, via its PGMP module, a group address to the Address Allocator. When it is done, the member PGMP module creates a Group Information Table which contains group name, group address, other group status information and the Group-View which describes the group membership information. After these two phases, the requesting host requests other user PGMP modules for joining the new created group.

2.5 Multicast Group Address Management

The document[7] presents an architecture and associated protocols that manage multicast group addresses for the purpose of establishing and controlling multi-party sessions in the Internet environment. Four main entities compose this architecture : the Multicast Address Manager(MAM), the Connection Controller(CC), the Call Manager(CM) and the Data Transport module. The CM provides an interface to users who want to initiate and configure conferences. The CC keeps track of connection and assumes information maintenance. The MAM, located in each local network, remedies the lack of the IP environment in terms of management. Firstly, it builds an multicast address with the local network identifier of the initiator address that requests the creation of a group. Secondly, it dynamically allocates the new created host group address tol the group and executes a port number resolution mechanism for the use of communication channels, then it coordinates multiple sessions from the host view, and manages the role of users.

2.6 Host Group Management System

The Korea Advanced Institute of Science and Technology has also developed a Host Group Management System[13]. Three managers cooperate together : the Group Manager (GM), Group Address Manager(GAM) and the Group Agent(GA). The last one is responsible for communications and it is also charged to organize, to distribute events and to updates membership information when a member joins or leaves a group. The GAM must keep track of the availability of host group addresses to allocates them to newly created groups. The GM identifies groups, controls group membership, manages joining, leaving and coordinates the use of IP multicast addresses. These three managers use functions divided into five groups. Firstly, the GA uses special functions provided by the Group Communication to configure messages filtering. The Group Creation selects an IP multicast address for a group and assigns this address to the group. The Group Identification builds the IP multicast address with a particular mechanism : the network number of the group initiator composes one part of the IP multicast address. The Group Binding makes a dynamic link between a group name and a group address. The Membership Control informs members of changes about group membership (i.e. leave and join procedures).

2.7 Domain Name Server

People prefer to use names instead of numbering schemes to refer to computers. The Domain name server[15] supports it by translating a domain name to numbering address. A domain name system is implemented through the interaction of two components, the name resolver and the name server. The resolver is client software on a user's computer that queries domain name servers, normally translate domain name into IP addresses. The set of domains that a domain name server controls is referred to as a zone. A zone is a group of connected domain names within the hierarechy. There are four types of name server : primary, secondary, caching and slave. The primary server has the master database, and a secondary server has the same database as a backup for the primary server. On the other hand, a caching server knows the addresses of primary and secondary servers. The difference between a caching server and slave is the slave server can communicate with servers defined in the list.

2.8 Multicast Name Server

The document[17] introduces an architecture and protocol of a multicast address allocation server. It is basically employs a distributed nameserver architecture. So, any network administrator can place a single name server on one wide area network, or one on each LAN, or on each subnet, or else multiple name servers on each subnet. In other case it can be located on each node on the subnet. The Multicast name server protocol(MCNSP) specifies the manner in which nameservers interact with one another, and supports allocation of both MAC-level and UDP/IP-level multicast addresses. Since the nameservers make use of multicast address for their communication, they do not need to maintain tables of pointers to other name servers.

2.9 IETF - IGMP

One of the IETF drafts specifies recommendations about the implementation of host with a view to extend it for IP multicasting[4]. The Internet Group Management Protocol(IGMP) module is used by IP hosts to report their host membership to any immediately neighboring multicast router. Before to use the IGMP module, each host must join the all hosts at the initialization phase. This is made by addressing the datagram with the address 224.0.0.1. The IGMP messages are encapsulated in IP datagram with the IP protocol set up with the value 2. They are used to ask for and to report group address. In order to discover which groups have member on the network, multicast routers sends Query messages to all hosts by using datagram with the destination address set up with the value 224.0.0.1. Hosts respond by report messages that responding the group address they belong to. An other solution consists in responding with the IP address destination equal to the host group address. Thus, when a host receives this report message, it will overhear his own reports. Routers need not know which hosts belong to a group, but only that at least one host belongs to a group on a particular network. Multicast router sends query messages when it starts up or when it periodically refreshes his knowledge on a particular network. When a host joins a new group, it should transmit a report for that group rather than waiting for a query.

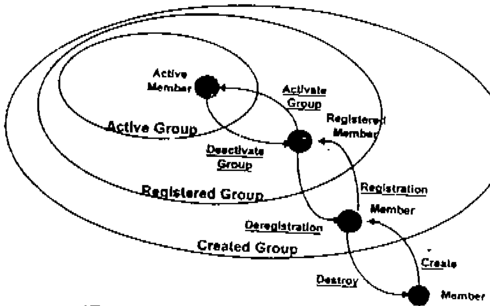
3. The Modelling for Group Communications Management

3.1 Notion of Group Communications Management

The Group Communications Management is designed to support efficient communications between group members. As it uses basic end-to-end Transport Services and provides services to Presentation Layer or applications directly, its proper place in the OSI reference model is the Session Layer. But in our model it is included into the Transport Layer in order to confirm reliability of multicast services. By grafting a Group Communications Management on the conference environment, we firstly are able to settle the communications session of the participating group members, secondly to resolve and assign the group address(i.e. IP multicast address) to a new session, and finally to configure the channels(e.g. video, audio, data, control, etc.) used in the conference.

3.2 Group Operations Model

The Group Operation Model, designed in Figure 3.2, describes the different groups that a member has to pass through from the non-



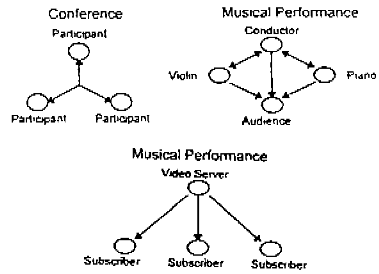
(Figure 3.2) Group Operations Model

created group state up to the active state where data messages can be exchanged among participants. A Created Group defines the background for member roles and conference properties. In addition, this group allows an administrator to configure the membership of the group to create. After this step, a member may belong to the Registered Group, that means this member has decided to participate into the conference(N.B. members have to accept some rules). The last group is the Active Group in which communication channels are defined and set up(e.g. QoS, Identifiers, other properties, etc.). The Group Communications Management we are dealing with is mainly concerned with the Active and the Registered Groups in this model.

3.3 Group Communications Model

3.3.1 In Applications

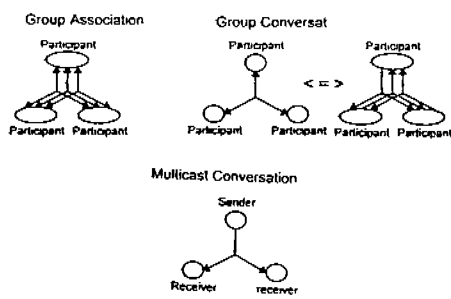
These three Group Communication Models described in the Figure 3.3.1 show what kind of conference model can be drawn. The first model represents a symetric conference(i.e. every member can send and receive messages), the second one shows an absolute asymetric conference that is a very pratical model but complex. Finally, the symetric but unidirectional model that compose the bidirectional symetric one is represented. This latter model can be used for distribution but not for exchange of data.



(Figure 3.3.1) Group Communications Models in Applications

3.3.2 For Multiple Media

We have seen that it is in the Active Group communication where channels are configurated;the Group Communication Model defines the way these channels interact together. The Group Communication Model is composed of three Groups : the Groups Association(GA), the Group Conversation(GC) and the Multicast Conversation(MC)(Figure 3.3.2). They define interactions among members and between channels.



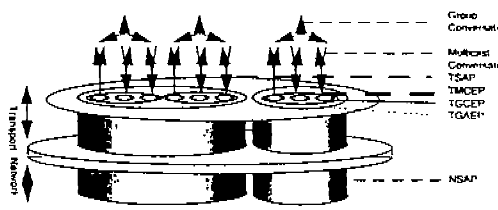
(Figure 3.3.2) Group Communication Model

The MCs consist of uni-directional multipoint communication channels with only one sender and many receivers. In order to build bi-directional communication channels we associate several uni-directional channels. So, this association will compose the GC that is a bi-directional channel between group members. The GC is characterized by the fact that these channels compose one single media channel. However, as conference systems use more than one media, The GCs of several single media GCs are combined together to form a GA.

But, since our addressing model is based on IP addressing, we need to understand the rules of IP multicast address and port number. For instance, the port number is a local value for point-to-point communication, but becomes a global value in case of multicast communication.

3.4 Group Addressing

In order to use and to distinguish the three groups that define the conference model(i.e. GA, GC, and MC) we have to introduce the notion of the group address and the End-Point concept. So, we will see how these End-Points are built in the Internet environment. The Transport Layer uses the Network Service Acces Point(NSAP)(i.e. IP multicast address in the Internet multicast environment) to handle services. The Transport Multicast Conversation End-Point(TMCEP) is defined by the NSAP, a transport protocol selector, and the GC Identifier more the MC identifier(i.e. GC id+MC id=port number). The Transport Group Conversation End-Point(TGCEP) comprises of a set of TMCEPs in order to provide full duplex channel of single media among gorup members. The Transport Group Association End-Point(TGAEP) can be accessed by the NSAP, and by the transport protocol selector. The Transport SAP represents the all the TGAEPs.



(Figure 3.4) Group End-Points definition

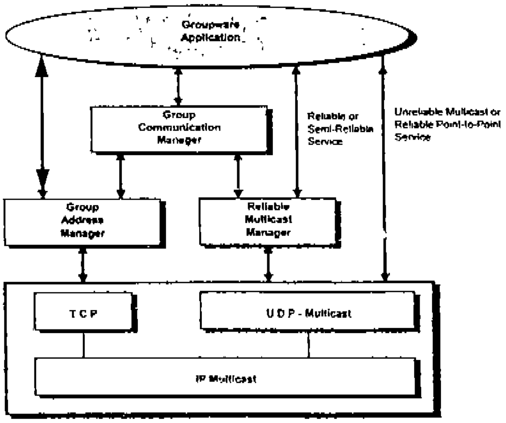
3.5 QoS Management

In multimedia and group communications environment, negotiation is needed to validate QoS values. Nowadays, since the various QoS requirements can be guaranteed by high speed networks, specific QoS depending on the media characteristics can be also satisfied. These kinds of parameters are delay, performance, jitters, and error rate. But in Internet environment, because of connectionless network protocol, we can not confirm the strict QoS values. So, we had better define the QoS in a quite loose way, like reliable or semi-reliable, partially ordered or fully ordered. Another issue with QoS is how every member will have an agreement under different environments, such as end-terminal and network situation. This can be completed by MC level, GC level, and GA level. If this is made for every MC channel, duplicated negotiations can be done for one GC because this latter one is used for single media shared by several members. Anyhow, of three level negotiations, we basically take the GA level negotiation, since we can expect simple negotiation procedure by exchanging all of QoS for multiple GCs simultaneously.

4. The Design of Group Communications Management

4.1 Architecture

In order to support group communications and management in a modular way, we have some components designed by their own roles. They are the Group Address Manager(GAM), the Group Communications Manager(GCM), and the Reliable Multicast Manager(RMM). The GAM builds IP multicast addresses as globally unique ones. An important point is that they ought to be made dynamically for



(Figure 4.1) Group Communication Management Architecture

each communications session. The GCM manages attendance of the group members, operates a management channel dedicated for a session, and monitors activities related to the session. This is used by groupware applications, but it may call GAM to get IP multicast addresses.

Since TCP and UDP do not provide multicast service reliably, two additional multicast services are considered to be satisfied with reliable and semi-reliable data service requirements. The RMM will be on top of UDP using UDP multicast, so its performance should be measured in group communications environment. This comes from the reason that applications can not work well with multiple TCP connections for multiple media and multiple users.

4.2 Address Mechanism

The addressing for group communication under Internet environment is regarded as providing IP multicast addresses and port numbers dynamically. Our idea for efficient addressing is to develope a new scheme by selecting and combining well-known addressing architectures and mechanisms. Although several schemes are referred to design our own addressing scheme, the result is somewhat different from each of them, also easy to implement, and very flexible. Since the number of groupware software and users will be gradually increased, and the location of group users participating in the active groupwork may be confined in a small area or spread over a large area, the flexibility in locating the address server is very crutial in the design. For instance, we refer to the Domain Name Server[15] and Multicast Name Server [17] to have the architecture of the hierarchitecture address managers, and the location of the address managers is based on the domain name similiar to the idea suggested in [16]. On the other hand, how to create a new IP address is very same to the schemes considered in[7] and[13]. We will show the framework and operations related to the creation of multicast transport addresses, and how their uniqueness is guaranteed.

4.2.1 Multicast Address Managers

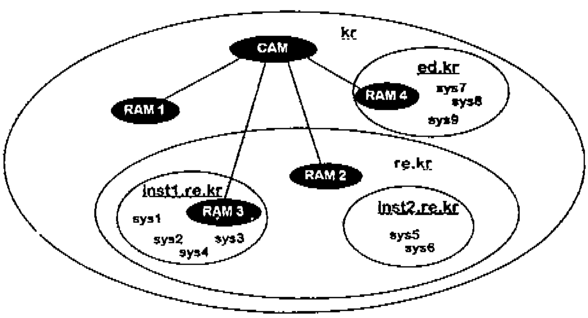
There can be many small sessions in a conference that may be held simultaneously. Also, the desktop conference system in a distributed environment allows us to join multiple sessions concurrently. During a session, we can create a new session by using a shared editor for better communication of the participants. Here, what we can see is that group activities become rather dynamic. Therefore, it seems like more persuasive to have each IP multicast address depending on the different session, so called Group Association, than the static meaning. Because multiple addresses could be made simultaneously, this environment requires a new IP address not conflicting with an old one. In relation to creation of new IP multicast address, we introduce cooperation between two types of Group Address Managers. They are Central Address Manager(CAM) and Regional Address Manager(RAM). Each RAM maintains the IP multicast addresses in a limited area, which is known as a domain name, on the other hand, the CAM has the addresses of the RAMs. The figure 4.2.1.a shows the relations between CAM and RAM. The RAM3 in the figure has the domain name inst1.re.kr and such end systems as sys1, sys2, sys3, and sys4. If, for instance, one group application in the sys1 wants to get a new IP multicast address, it should ask RAM3. Right here, the new multicast address is obtained with the host IP address of the sys1.

Here, to help better understanding, we show the key entries of two tables:

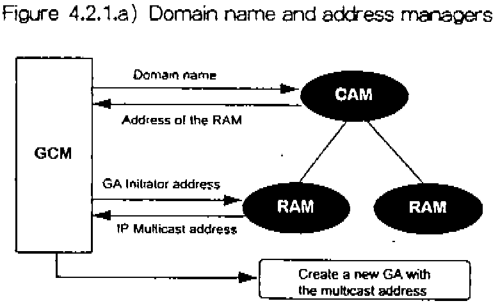
(CAM Table) Domain Name for a RAM; Host IP Address for the RAM

(RAM Table) Network Part of Host IP Address; IP Multicast Address; Time-To-Live

But we can think the case that we are not aware of the address of the RAMs. This time



(Figure 4.2.1.a) Domain name and address managers



(Figure 4.2.1.b) Procedure of creation of the new IP multicast address

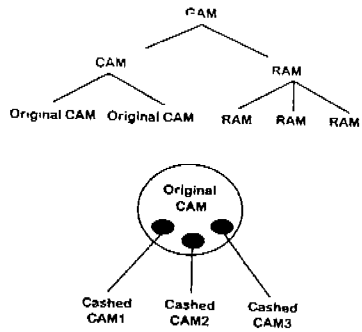
we should look at the CAM to examine the address of a suitable RAM with the domain name of the group which is translated from one's host IP address, as dipicted in the Figure 4.2.1.b. But the reference to the CAM is done by the network administrator in advance to the groupware software. This means this operation does not yield performance overhead. In this case the domain name inst2.re.kr may not have its own RAM, so the host sys5 and sys6 in the domain should RAM2 when they are in need of new IP multicast addresses. This assures a great deal of flexibility in locating RAMs, depending on the degree of groupware software utilization.

To guarantee the efficiency for the new address creation, we allow the multiple CAMs and hierarchical RAMs. For instance, the differenet parts of a CAM can be copied into some of the cached CAMs, as shown in the Figure 4.2.1.c.

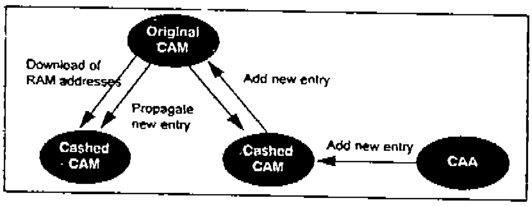
This can give us faster access to the address of a RAM, because we do not need to find the original CAM. In order to keep synchronization between the original CAM and the cached CAMs, the change of a cached CAM should be made as the same in the original one and all of relavant cached CAMs. If there appears a new cached CAM, its new data is downloaded from the original one.

4.2.2 Generation of IP Multicast Address

As IP multicast addresses are randomly chosen, the uniqueness of these addresses can not be assured. In order to avoid this problem we use a mechanism for the creation of IP multicast addresses, originally suggested in [7]. The multicast address is composed of two parts: the first one is the high byte of the address and represents the prefix of the IP multicast address(i.e. class D); the second part designates the network number of the



(Figure 4.2.1.c) Organization of Group Address Manager



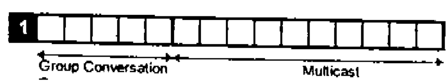
(Figure 4.2.1.d) Consistency Maintenence of Distributed CAMs

conference initiator IP address. However, because the number of possible simultaneous conference initiated from the same network depends of the IP class address this mechanism does not allow the creation of an infinity number of multicast address. By using this mechanism, the GAM can allocate 16∗65 536 multicast addresses per local network using class A addresses, 16∗256 multicast addresses per local network using class B addresses, and 16 multicast addresses if class C addresses.

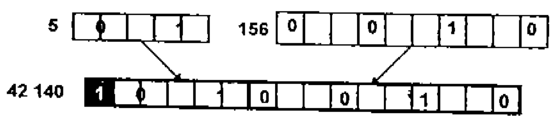
4.3.3 Port Allocation

In order to separately manage the GCs and MCs and to control acknowledgments for flow control from each user media channel we have to identify logically and physically all of different channels. For this, we will assign one port number to one MC. The port number assignment can be implemented in two ways; these solutions depend on the ability of the end-system environment, such as whether to share or not to share one port number by the more than one application. For instance some workstation O/S supports the port sharing, but PC O/S does not. Anyhow, our design assumes the port sharing environment because this will be realized even in the PC O/S in the near future. Another reason is that there might not be any conflict of port numbers for the time being since not much groupware applications are expected in use in the near coming days. In the Internet environment, the first 1,024 port numbers(i.e. port number 1 to port number 1,023) of the port mapper are reserved for the Unix system. On the other hand, the port numbers 1,024 to 5,000 may be automatically reserved by a programmer through the system. The port numbers from 5,000 to 65,536 are assigned by programmer too, but not randomly. When the port sharing is allowed in the end-system environment, we can build the port number with the GC and the MC identifiers. However, as the first 1,024 port numbers are reserved, we have to select the most significant bit to 1 (i.e. port number 32,768 to port number 65,536 can be chosen). Then, we are assured not to choose a reserved port number. So, we have chosen 5 bits for the GC identification and 10 bits for the MC identification.

Doing in this way, we can identifiy 32 GCs (i.e. 5 bits) and 1,024 MCs(i.e. 10 bits). Let see how to build a port number with an exam-



(Figure 4.2.3.a) Port number division

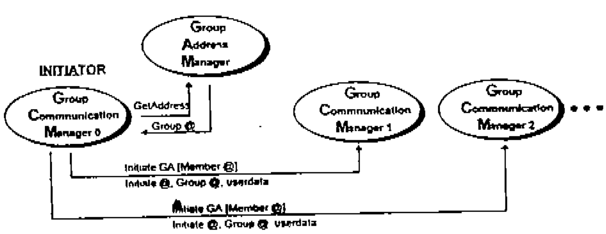


(Figure 4.2.3.b) Port number building

ple : if the GC identifier is 5 and the MC one is 156, then the port number will be 42,140.

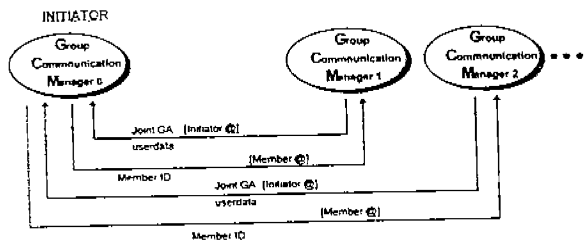
4.3 Procedure

We are going to explain an example scenario of group communications, by introducing a conference of a group so called ITU-T SG7. Here, in order to simplify the explannation, the group is assumed to use the same conference software. The group name, ITU-T SG7 is announced to the potential group members or unspecified group via e-mail or telephone or any other correspondence. The member who wants to be a member of the group requests a registration by giving its user name like the login name and the member address like the IP address as well as the port address. The IP address is used when any initiating member convenes some of members to a specific group communication session. In a conference, a single or multiple GAs are necessary depending on the type of group communications. The initiating member who wants to open up a new communication session nominate the members who he thinks to be in the session, and delivers InitiateGA signal to them. The InitiateGA transmits the group address which will be used for Multicast Conversation later, and also can distribute media type of GCs in a GA as the user data. The most important information for a GA is how many members are involved and what kind of GC channels are included.



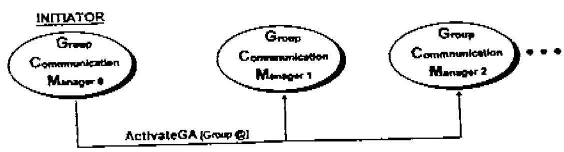
(Figure 4.3.a) Initiate GA procedure

The JoinGA is responced for the InitiateGA and made by whoever likes to join the GA. The user data for this primitive can be the QoS parameters and the multimedia I/O device identifiers of each member. The important thing in the JoinGA is to allocate each member with the member ID used as the multicast ID, this is to make up the port number for the Multicast Conversation. The user data means the negotiated QoS values distributed to the members.



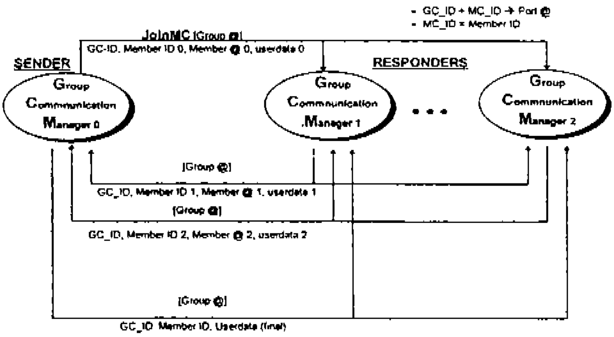
(Figure 4.3.b) Joint GA procedures

Before transmitting data, all members ought to be ready at the same time. This is enabled with the ActivateGA issued from the initiator who knows the situation of other participants.

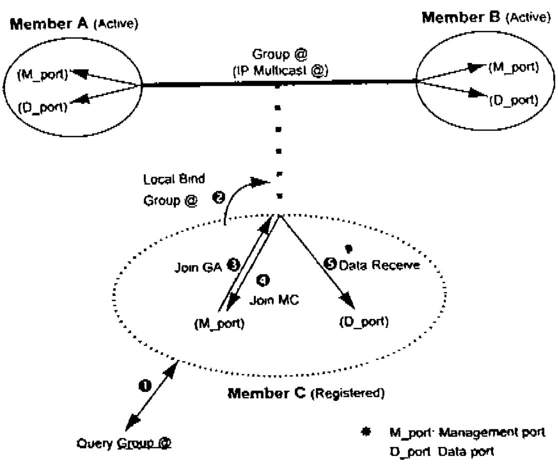


(Figure 4.3.c) Activate GA procedure

The JoinMC is initiated by every sender or a certain initiator. We will explain in more detail the case of multicast for simplicity in the followings. In the previous procedure, we have an initiating member for JoinGA and ActivateGA, but it needs not be the sender. In case of full matrix communication model every member can be a sender, on the other hand, in case of distribution service there should be a single sender. The sender first requests the JoinMC via the group management channel identified with the group address and the management port, but the actual data transmission will be carried out through the new port which is decided in the JoinMC procedure.



(Figure 4.3.d) Join MC procedure



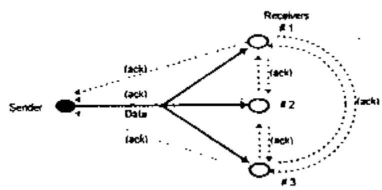
(Figure 4.3.e) Late join from a new member

This management channel is used for not only the connection request but the late join request. The Figure 4.3.e shows how the late join works in relation to the IP multicast address as well as the IP portxs. The member A and B in the figure are participating in a group communications. Here, the M-port with the IP multicast address is used as a management channel for the group behavior like join, leave, activate, deactivate. The actual data transmission is done on the D-port. A new member C wants to make delayed join for the session, firstly it should announce its intention onto the M-port channel, but the data exchange is also done with the D-port. The description here assumes that there is no port conflict.

4.4 Data Transfer Service

The data is transmitted by the IP multicast address, and the acknowledgement is returned to the same address for the reliable delivery. As we mentioned earlier we provide not only fully-reliable but also semi-reliable services. The fully-reliable is used for control and text data service, but semi-reliable is used for audio and video traffic.

Some applications may require all acks from all the members. On the other hand, a certain application requires a single ACK rather than all ACKs. In latter case, the data transfer service returns an ACK after knowing that all the receivers have correctly received data. Another beneficial service is to deliver the data to single or only some part of members in the group without reconfiguring the current group. This will be possible with the conveying the receiver member lists, and is useful for delivery of the control data information.



(Figure 4.4) Reliable Point-to-Multipoint Transmission

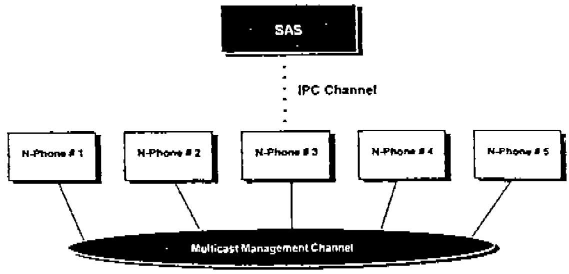
5. The Intregration of Group Communications Management with N-Phone and MUX

5.1 Integrated Architecture

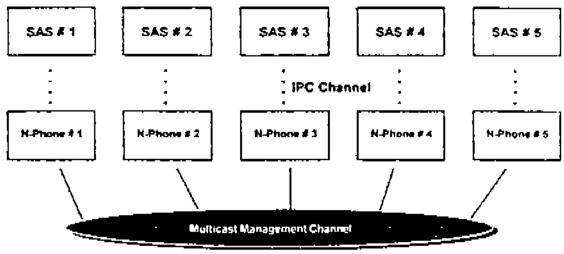
We will introduce how our Group Communications Management is applicable to a conference system : N-Phone. The Figure 5.1 shows the integrated architecture, which has the following components.

- N-Phone : Audio/Video conference software.
  More clearly speaking, it takes care of user interaction into the conference, but still represents the entire system.
- GED : Group Editor.
  Shared by group users for enhancing conversations.
- SAS : Shared Area Server.
  It is invoked for the same type of groupware applications. For example, there are one SAS for the N-Phone and one SAS for the GED. Its main role is to keep the shared information like the user IDs involved in the session, the distributed multimedia I/O device IDs for the N-Phone, and shared object informations for the GED.
- GUIDE : Group Users Interaction Daemon.
  The GUIDE is composed of residing processes located in every site, more a server process waiting for a new invocation call for the local or the remote system.
- C-Manager : Conference Manager
  It works as a bulletin board for all of group sessions being currently open.
- MUX : Multimedia Server.
  Its role is related to the synchronization, filtering, mixing and transmission of audio and video streams.

In this example, only one IP multicast address can be used. Although different ports are introduced for some of control, and data channels. In this case, we regard the GED as the child process of the N-Phone, so both applications always have the same participants. But we can have another case in which the GED can be used by a part of N-Phone participants. This case means that each application is allocated with a different IP multicast address, because information delivered to the different applications may yield unnecessary traffic through the same address.



(Figure 5.2.1.a) Management Channel(centralized SAS)



(Figure 5.2.1.b) Management Channel(Distributed SAS)

5.2 Group Communications Channels

5.2.1 Management channels

The centralized SAS in Figure 5.2.1.a coordinates and synchronizes management activities of all N-Phone processes. It keeps the track of shared information of the groupware session by communicating with N-Phone#3 which is assumed as a initiator of the conference in our explanation. For example, the N-Phone# 3 process informs the SAS of activities related to a session. This notification is kept as a global information shared by all the N-Phone processes. So, a N-Phone which tries to join in delay, should obtain this information first of all.

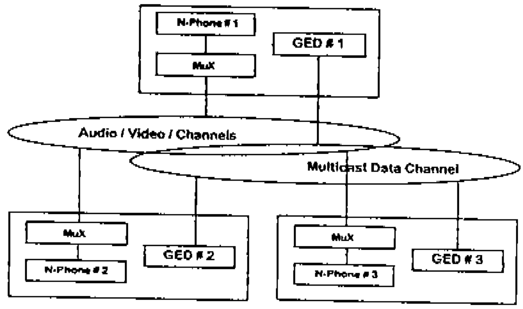
We can have another alternative which composes the distributed SASs dipicted in

Figure 5.2.1.b Its benefit comes from the case in which the original initiator should leave during a session. The distributed model allows another N-Phone process to take over the previous initiator's role.

Now, we introduce how the processes inter-work each other and use management channels. A IPC channel between the SAS and the N-Phones is a point-to-point channel used to save and to access the GA information. Another management channel is set up only between N-Phone processes and used for group communications operation like joinGA, activateGA, and so forth. But the result of this operation should be informed to the SAS, although detailed procedure between N-Phones is not reported every time. Once a N-Phone is initiated, it tells the SAS through the IPC channel about the beginning of a new session. Next, the SAS informs the session management information to the C-Manager. As it is mentioned before, if a new N-Phone is willing to join the current GA, then it first should ask the C-Manager about the on-going sessions, the management channel information and the Initiator's ID, to be used for the late join. Therefore it is possible to execute the late joinGA operation with this address. Through the JoinGA operation, The new member is able to access the shared information. The leave operation submitted by any member who wants to quit attendance of the session should also be notified to the SAS for maintaining consistency, by forbidding any other member to initiate the same operation during some critical time.

5.2.2 Integrated Architecture

In this architecture, audio and video transmission between members is made by the MUX process located in every site. Each MUX opens the MC channel for audio/video with the joinMC operation supported by RMM, and multicasts the data through the newly settled channel to other members. In case of GED, it additionally needs another data channel for transmitting text data like modified document contents. Besides, any application can set up the data channel for exchanging control commands.



(Figure 5.2.2) Data Channels

6. Conclusion

As mentioned earlier, we have recently developed a desktop conference system, so called N-Phone, in addition to the multimedia I/O server. So far, most of emphasis on the research was submitted to deal with multimedia stream processing like media synchronization and compression, as well as applications like the conference and multimedia group editor.

However, we meet new requirements to provide a generalized framework for group communications management first in order to easily accomodate various groupware applications, and secondly to support efficient group communications by using multicast communications rather than point-to-point communications.

We believe that the framework of the Group Communications Management can contribute to the development of groupware applications in a very flexible environment and in a more efficient way. This is enabled by the well-designed group management concept and commonly supported libraries.

This can be proved with our necessity for more complex groupware environment, because it becomes quite useful to have a multimedia presentation function while the conference and the whiteboard are being concurrently used. Another issue we are now absorbed in is to provide the reliable multicast service in a more efficient way. On the other hand, we are also developing a new multimedia transport protocol for high quality of service in the future. Since the TCP/IP has some weak points to enable versatile and powerful services in times to come, current studies to introduce new protocols will ultimately blossom. Even with new multimedia transprotocol to support multicast and real-time service, the Group Communications Management will do the considerable role of clarifying what and how the protocol works.

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