《特別寄稿》

미래의 환경에 맞는 새로운 개인 휴대 통신 서비스를 위한 광대역 멀티미디어 통신망의 설계

On the Design of a New Broadband Personalized Multimedia Network for Future Requirements

최 진 식, 은 종 관
(한국과학기술원 전기 및 전자공학과 통신연구실)

□차 례□

Abstract

In this paper, we propose a new network architecture for the future broadband personalized multimedia network. We first consider the service and technical requirements for supporting future advanced services such as personalized and intelligent communication services. In addition, we consider the design and implementation of the future network. Considering these requirements, we propose a new network architecture and its control scheme that can efficiently support the future personalized and intelligent services as well as broadband multimedia services. The network provides only a relatively simple core set of functions such as basic end-to-end connectivity, integrated access, and primitive network intelligence of user location. More intelligent features (e.g., personalized calling, virtual private networking and so on) can be offered through the additional network facilities or computing devices through an intelligent network.

요 약

최근 우리는 광대역종합정보통신망과 멀티미디어 통신망외에 개인휴대통신망의 시대를 맞이하고 있다. 미래에 통신 서비스는 다양한 정보의 송수신 뿐만 아니라 언제 어디서든지 어느 누구와도 통신이 가능하게 하는 시대를 맞이 할 것이다. 이러한 요구는 망에서 제공되는 통신 시스템 자체의 발전과 그 통신망을 기반으로하는 정보의 종

류와 기능의 다양화에 기반을 두고 구현될 것이다.

본 논문에서는 이러한 요구를 모두 충족시킬 수 있는 새로운 망의 구조와 제어방법을 제안한다. 우선 첫째로 미래의 서비스 변화나 요구사항, 망 설계시 요구되는 사항과, 또 그러한 망을 실제로 구현 설치할 때 필요한 사항등을 제시한다. 그리고 이러한 요구사항들을 충족 시킬 수 있는 새로운 망으로서 Broadband personalized multimedia network(BPMN)을 제안하고 그 제어방법 및 운용방법등을 제안한다. 제안된 망은 지능적 서비스나 기능은 모두 부가적인 장비나 서비스 제공자에 의해 제공되는 모듈화된 구조로 기존의 망으로부터의 발전에 적합하며 새로운 망의 기술이나 서비스의 추가 또한 쉽게 이루어질 수 있는 구조이다. 망의 제어도 지역적 분산형태로 다양한 서비스를 각각의 기능에 알맞도록 선택하여 제공할 수 있는 완전 분산제어 방법을 새로이 제안하였다.

I. INTRODUCTION

Recently, we are moving into an age of personalized information networking, with users anticipating increasing freedom to communicate with people and to retrieve information any time, anywhere. This trend is mainly caused by the emerging new communication technologys and by the provision of network intelligence. Communication industries are undergoing major changes in equipment technologies, network architectures, and service offerings. Particularly, telecommunication networks are changing at a much faster rate than has ever previously been experienced. Because new and improved underlying electronic and photonic technologies that enable the cost reduction of switching and transmission systems are emerging continuously, it is possible to have new network technologies that can provide a wide range of new applications, such as broadband multimedia systems, personal communication systems and powerful databases to implement advanced intelligent networks [1] (see Fig. 1).

These changes have provided opportunities and challenges for the network and for the user who utilizes a combination of new, existing, and ad hoc planning processes and systems to achieve their objectives. Moreover, there is an explosion of new ideas for applications involving broadband multimedia communication, personalized communication and intelligent information services [5]-[8]. To support these changes, network providers must respond quickly, specifying and analyzing alternative solutions to determine the "best" strategy for network modernization, new service deployment, or future customers' demands (e.g., BISDN, intelligent signaling technologies, global communication services and so on).

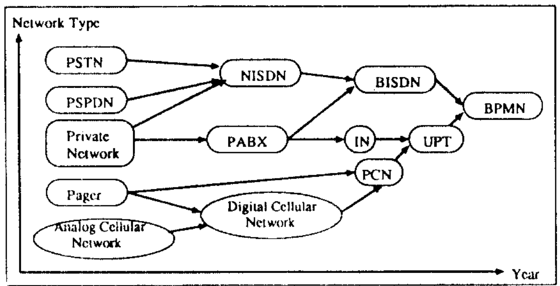


Fig. 1. Network evolution step

Particularly, the communication network is confronted with a pressing need to accommodate not only the dramatic evolution of network technologies, but also newly emerging and evolving applications. Moreover, combination of these developments accelerates the rate of introduction of new architectures and services. Consequently, we have to design a new network that has the form of advanced integrated wired and wireless global network architecture [10]. In addition, there should be the network control capability to allow creation of more intelligent services as well as broadband multimedia services.

In this paper, we introduce a new advanced network architecture called the broadband personalized multimedia network (BPMN) and its control scheme. It has the integrated form of the current BISDN network architecture and intelligent mobile network. Our focus here is not on the administrative issues of managing the future personal services. We only propose the future network requirements, architecture and control scheme.

The remainder of this paper is organized as follows. We first introduce the overall requirements and functions of the future network in Section II. We then present issues related to the specific design and implementation considerations. In Section III, we propose a new network architecture and its protocol structure. In Section IV, we present the major aspects in network control: addressing, routing, location registration algorithm and connection control. Finally, we will make a conclusion in Section V.

Ⅱ. DESIGN AND IMPLEMENTATION CONSIDERATION OF THE FUTURE NETWORK

Many existing services are currently being met by a number of separate networks. These networks have evolved separately to meet specific service needs [4]. One can usually classify them in three kinds of network performance requirements: user grade of service (GOS) requirements, network management requirements, and system designer requirements [3]. However, there exists basic dilemma while optimal performance parameters are being made to satisfy these requirements. Hence, in this paper, we consider only the significant factors of design and implementation aspects for the future network.

A. Design consideration

1) Network Efficiency

To be competitive in future network environments, it is important that the cost to build the network must be as low as possible. In addition, the future network should offer services to each person, and the number of subscribers must be virtually unlimited. Eventually, the future network must provide services to everyone, at a reasonable price that can be controlled as the user's needs or budgets change.

2) Network Transparency

Another major consideration of the future network is the network transparency. One aspect of transparency is that the information units should be transferred across the network with little manipulation or alteration. Consequently, the information units should be transferred within the network as closely to those offered to the network as possible. Another aspect is related with the capability of service provisions, such as the efficiency and kinds of service that can be offered. This comes from the increasing demand for well controlled communications service over a wide range of networks, and this is needed for the following reasons: a) to provide enough flexibility within the network so that different user requirements can be met as efficiently as possible, and b) to ensure that cell or packet processing requirements do not grow beyond the capabilities of cheap workstation adaptors.

For future high-speed networks to be successful, the transparency should not be viewed only as a backbone network issue that provides its own network transport facilities, but viewed as an end-to-end issue which reflects how the inside networking system (software, host interface, local attachment, backbone network, etc.) satisfies the needs of end-user applications. Thus, we should consider the network as the one that extends all the way to the end user rather than terminating at some well defined user-network interface.

3) Network Intelligence

Another key design consideration of the future network is the network intelligence. Since the characteristic of services to be carried in the future is likely to become increasingly diverse (For example, universal personal telecommunications (UPT), card calling, intelligent networking and so on). Therefore, the future network should supply greater degrees of intelligence and freedom. This network intelligence will be provided by the structures of network elements such as utilizing databases and control software. The service-dependent network intelligence such as specific database services can be provided by an intelligent network, and service-independent intelligence such as user location or naming call and so on can be provided by some form of intelligent signaling service. Although these intelligence are motivated in the interests of telecommunications service providers to satisfy their existing and potential market needs rapidly, cost effectively and easily, they can be provided customers with flexibility and controllability of network and user information. Moreover, these intelligence will be dynamically linked together by a signaling or data network employing high-speed common channel signaling so as to supply the freedom of signaling.

B. Implementation Consideration

Now, we suggest a systematic approach to implement a future BPMN so that the design parameters would be tuned within an acceptable set. This approach is based on the following features.

1) Modularity

Modularity is advantageous for minimizing the restriction of network size and maximizing flexibility of network installation, so it has been considered as one of the guiding principles in implementation. Also, the modular structure makes it easier to cooperate the existing diverse networks and to accommodate new alternatives as the technology matures.

2) Open system

The emphasis on open systems, which can be applied to both the network and network elements, is given due to the competition of vendors among different nations. There will be increased attention on standardizing network interfaces and access mechanisms for various end-user terminals and services.

3) Migration with existing networks

Since the evolution of a network can not be accomplished in a short period, the future network has to reduce the implementing gap and minimize the service difference. Moreover, it is clear that a significant proportion of customers will continuously require most of existing services, although these services may be enhanced in bandwidth and flexibility. Therefore, it is considered that present networks such as circuit-or packet-switched network, mobile network, satellite network and local area networks will be served continuously until all the networks will be replaced with the future access network. Consequently, existing networks will be replaced smoothly by the proposed network, and also the existing and networks will coexist.

Ⅲ. PROPOSED BPMN NETWORK ARCHITECTURE

The proposed network is motivated, under these circumstances, to move toward a paradigm of ultimate broadband personalized multimedia communication. Although a future network mentioned above is not yet in the implementation stage, it is necessary to define the principal features of such a network in order to provide a feasible direction for the evolution strategy.

The basic system philosophies of our BPMN architecture are as follows. The proposed network consists of an access network and a transport network. Fig. 2 shows the overall architecture of the proposed network. The access network is the interface between the customers and the proposed network system. Each node with small circle in Fig. 2 represents an access network as a smallest independent paging area. At the customer premise equipment, new terminal equipment as a form of portable handy terminal will be developed in the future to provide all the necessary services, culminating ultimate personalized multimedia services. However, these changes will not be made in a short time, but will be accomplished gradually.

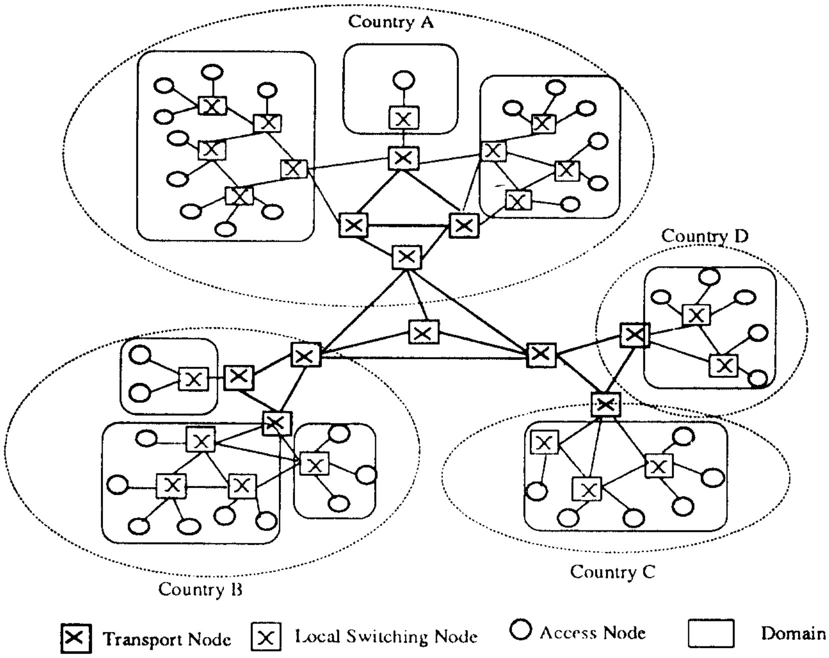


Fig. 2. BPMN network structure

Therefore, existing access networks, such as packet switched public data network (PSPDN), private automatic branch exchange (PABX), local area network, and so on, can serve the customer in the same way as they do today, although most of the transport networks will be replaced with a future network. In addition, it is thought that mobile networks will be more widely used to provide services from any location. In order to accommodate these requirements, our proposed network includes all existing wired and mobile radio network as an access network. Moreover, our network makes it possible that existing access networks or future access networks can evolve independently to provide their own services to all customers. This can reduce operation and maintenance costs and allows customers to use service access pattern according to their service demands. Consequently, the proposed network can be evolved in a smooth and cost-effective manner from existing networks.

Since a single access network cannot cover the whole world, several access networks will be used and they are interconnected each other via a high-speed transport network. The transport network has a layered structure: a lower domain routing network and an upper transport network. The domain routing network consists of a high-speed switching system and a transmission system based on the ATM technology. The major advantage of the ATM technology is that all information is carried in a small fixed cells, so that different type of information can be switched and multiplexed in a unified manner. Here, the switching system interconnects several access nodes through the virtual end-to-end transport channels between access nodes.

Each domain routing network is used to maintain home location registers as a database. These databases are similar to the combination of the home location register (HLR) and visitor location register (VLR) specified in the CCITT recommendation [18]. One of the fundamental aspects of our network is the separation of intelligent service control and service data from basic call control. The separated service control, for example, makes it possible to plan and implement new IN services in a modular fashion, thus minimizing the implementation cost and time. Moreover, this service data can be applicable to the signaling system to provide intelligent signaling services. This can be seen as an extension of the already existing signaling system.

The upper transport network consists of a low level switching system and a transmission system. With the deployment of many intercontinental cables, including undersea optical cable and satellite links, this upper transport network will easily cover the whole world. Moreover, this transmission system easily supplies enough bandwidth up to 100 Gb/s with the development of optical switch and wavelength division multiplexing (WDM) techniques. This network itself has a layered structure according to the switching hierarchy. Therefore, the transport network can be handled just as a single digital circuit pack, and advanced network functions such as the synchronous optical network (SONET) can be realized simply.

The most important advantage of our network is the potential capability of implementing a virtual network, in which it is relatively easy to add new communication capabilities such as database, value added system and so on. Since the proposed network will define a relatively simple core set of network architecture that provides basic connectivity and personal communication capabilities, it can have the capability of overlaying various supplementary private networking systems and service capabilities in the form of embedded networks. For example, virtual enterprise networks can be installed in the proposed network using some of shared switches and trunks. And, IN networks can be dynamically constructed in the proposed network according to each service type. Consequently, it would be useful and efficient to implement public and private networks on top of the basic network facilities while combining with the emerging technologies, such as intelligent database and high-performance computing system, in a distributed form.

Such an embedded virtual network also gives many advantages as follows. First, it has the capability to configure dynamically the virtual network that can support specific functions. Second, it has the capability to add easily new communication capabilities such as personalized call, mobile call, and multimedia call through a global network, while maintaining the whole network system consistently. Third, it is advantageous in that the service provider pays attention in service type and quality only, but not physical network planning, maintenance and management. The most important advantage is that the embedded virtual network reduces the network construction cost. The user only pays for the specific service used rather than paying for facilities which have been leased or used.

Ⅳ. FRAMEWORK FOR NETWORK CONTROL

An overall network control plane is comprised of a distributed network and connection controls. The distributed network control is exercised by the network nodes to control traffic flows. These network controls include flow controls, capacity controls and routing controls. Since the flow and capacity controls are sensitive to traffic demand changes, these are not consistent with our goal of future network design. Therefore, we only consider the routing control technique and apply it to the proposed network. At the high end of operating time scales, there are connection controls that operate on virtual circuits. High-performance connection set-up controls and location registration algorithm are also provided in order to adapt changes in traffic patterns (e.g., congestion, failures, user mobility, etc.). All of these control plane will be based on efficient addressing mentioned below.

A. Addressing

Addressing is an important aspect of the future network design. Conventionally, address is a special kind of name that is oriented to machine processing [12]. It has capabilities to identify communication entities and generate a route simultaneously [14]. In the future, however, the network will have a worldwide unique structure. Moreover, mobile communications services will allow a user to move within a network. Therefore, the global address space that allows all end users to designate each other will be required and the capability of dynamic binding between address and route will also be required.

In this paper, we propose two kinds of addresses used in the network: home address and physical location address. The home address is a registered address of each user. The physical location address is the address where the user can be reached in the network. Each home address can be linked with several physical location address, if he moves to some place. This physical address is always obtained from the database at home address, where each physical address indicates routing. All of these addresses consist of the following three parts. The first part is the address of a domain network, which is assigned by the global network authority for the object location block. The second part is the primitive address to indicate the access node of communication entity. This primitive address is assigned and managed by the domain authority autonomously. This is a hierarchical address that specifies the route that indicates how to get there. The third is the flat address that represents the communication entity itself and shows what is sought. Our addressing scheme provides the ability of dynamic combination of the domain address, hierarchical address and flat address for representing home and physical addresses of each user. And it can also identify the communication entity in the overall communication network by combining the home domain address and the flat address.

B. Location Updating Algorithm

One of the crucial problems of a connection control system is locating a specific user among many moving portable users in an efficient manner. The existing techniques for locating moving customers in the network are paging and registration.

Considering a large number of customers in a global system, the paging technique, if applied without the knowledge of location of the customers, is impractical. The registration technique [8], which records all movements of customers in a central database, is also questionable because keeping track of such a large number of customers in real time with a single computer is not a simple task using current technology. A distributed version of the registration technique is presented in [19]. Although this algorithm is applicable in UPT, it needs overhead of databases for containing all customers information in its subdirectory.

The proposed algorithm should be able to update the location information of all customers in the system with a small overhead in a distributed fashion [20] as follows. In the wired network, it is the responsibility of the user to inform the network of his location. Whenever a customer moves into a different location area, a location updating message is transmitted to the home database to indicate the current physical location address and available terminal type. This can be performed manually by dialing an identification code at a terminal or automatically by a smart card. In the wireless network, registration can automatically be performed by the use of a personal handy terminal.

Each base station in an access network continuously transmits its identification information. By monitoring this information from the surrounding bases, all portable terminals are able to determine the strongest base station and lock it. Whenever a customer moves into a different paging area, a location updating message is transmitted to the home database to indicate the current paging area address and available terminal type. Large paging area will be required to achieve low updating message while small paging area is necessary to get the spectrum efficiency and high capacity required. In order to overcome the speed difference among moving vehicle types, each user must change its current location address depending on the type of access network dynamically. For example, if a customer moves using a car, then a customer must change its current location as the location address of a car phone access network. In this way, we can overcome the speed difference of different access networks.

C. Basic Routing Structures

Routing is a fundamental problem for supporting the communication infrastructure [15]. In fact, the term routing is used with two different meanings:routing as a mapping function, and as an action of forwarding a packet. Here we consider only the first one.

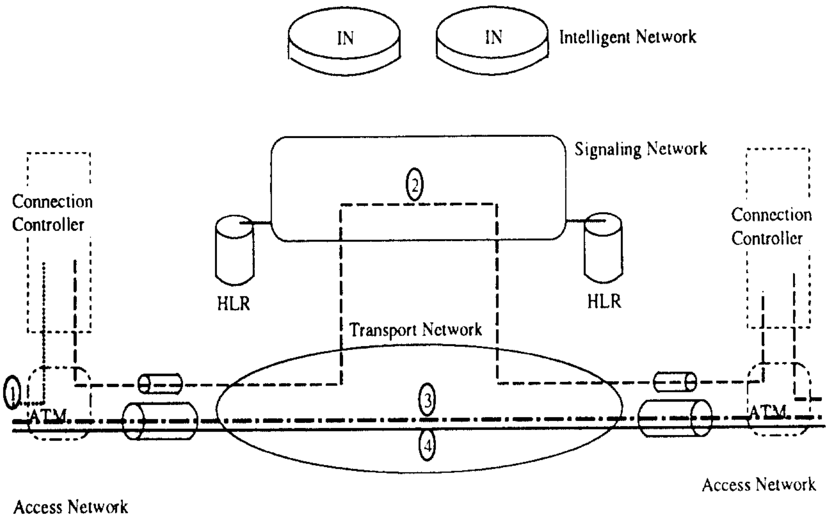
We have used a hybrid approach to obtain the benefits of both hierarchical and non-hierarchical routing. Only within the domain, the dynamic non-hierarchical routing (DNHR) strategy is used to reduce the routing table size, the computation complexity of route generation, and to increase the speed of updating of routing information that is caused by the change of network configuration. On the other hand, the conventional hierarchical routing strategy is used in the transport network. The hierarchical routing will be implemented over the logical path that forms a structured topology (e.g., mesh, cube, etc.). These two routing schemes work independently, and are developed according to their own strategies. Such a combined routing strategy has advantages of time-variable routing and simple implementation of adaptive routing using the above addressing scheme.

D. Connection Control Algorithm

Once addressing and routing strategies have been chosen, there is still the problem of connection control about how to make end-to-end virtual path between communication entities. Fig. 3 and 4 show the steps involved in preliminary connection setup and advanced intelligent service such as card calling and 800 service, etc. Fig. 3 shows a non-intelligent connection control procedure. When the calling party knows the physical address of called party and does not need any intelligent service, the calling party places a connection request to the called party in step (1). At that time, the physical address information will be transferred to the signaling network in step (2). After the signaling network receives the message, it will find an available route to setup a virtual connection between two access nodes in step (3). Receiving the connection request message from the access node, the destination node will make a connection using the flat address in the given access network. After that, the end-to-end user communication channel will be constructed over this virtual circuit using the user identifier in step (4).

To offer more intelligent signaling service, our connection control procedure will be complemented with network intelligence such as home database or other intelligent database, which shown in Fig. 4. The home database will maintain the location information of their domain user, terminal type and so on. It is automatically registered by the mobile user to indicate his current location and active interface type. On the other hand, other intelligence will be provided by an additional intelligent database system in the form of intelligent network. For example, if customers want to use a specific intelligent service, then they choose service features at first, and access the specific IN to take the necessary information (1)-(2). After that, they make a connection with the service provider as a single virtual entity using the information received from IN (3)-(5).

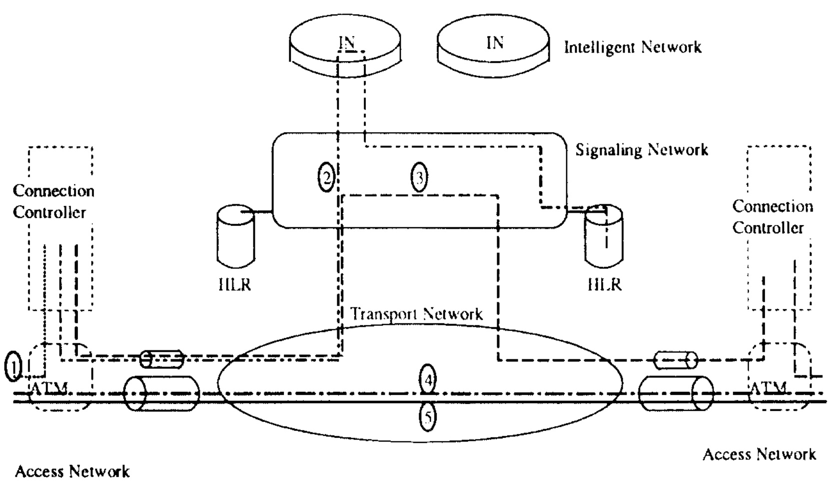
The outstanding points of the connection control scheme are as follows. It has the dynamic



① Access Request　　② Connection Request

③ Connection Setup　　④ End-to-end Connection Setup

Fig. 3. Flow diagram of preliminary connection control procedures



① Access Request　　② Network Intelligence Access

③ Connection Request　　④ Connection Setup

⑤ End-to-end Connection Setup

Fig. 4. Flow diagram of intelligent connection control procedures

binding of the domain network address, location address and user identifier. Therefore it can provide a global uniqueness, network-independent addressing and hierarchical routing technique. Another is the separation of preliminary connection control and intelligent signaling features so as to support diversity of signaling services. Moreover, as the personal user information would be managed by the network itself, not by the intelligent server, it is easy to implement various intelligent networks related with the personal information.

V. CONCLUSION

In this paper, we presented an overview of the future broadband personalized multimedia network. First, we considered the technology and service trends for the future network, and also considered the future network requirements in three aspects: user GOS, network management, and system designer aspects. In addition, we considered the design and implementation of the future network.

With these considerations, we first presented a new network architecture that has only basic functionalities. A variety of supplementary intelligent systems and services can be overlaid upon the proposed network. Moreover, the preliminary network intelligence such as the user information and its management are preserved in each domain access network in a distributed form. Therefore, more intelligent network can easily be constructed over the network using a simple core set of communication capabilities such as the basic end-to-end connectivity, and integrated wired and radio access.

Many advantages can be obtained by moving preliminary network intelligence into the transport network. First, it compensates the development gap between the transport network and the inteligent service network. Second, various intelligent service networks can be constructed over the same global network without any interference. Third, our location updating procedure is useful in location registration and in tracing the user in a distributed fashion. Lastly, it can provide advanced services without changing the transport network, but simply adding a new service feature as an embedded network type.

The success of these strategies will depend upon the ability to implement reliable and secure distributed communication networks, and management environments over the proposed network. However, primitive connection facilities will also be important in having a flexible intelligent network configuration by placing database and service-oriented functional blocks in the network. Although this technology is only related with the field of network control, it is a fundamental function to implement a faster and more reliable communication platform which has capable of supporting advanced intelligence in networks.

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최 진 식

- 1981년 3월~1985년 2월 : 서강대학교 전자과
- 1985년 3월~1987년 2월 : 한국과학기술원 석사
- 1987년 1월~1991년 1월 : 금성정보통신
- 1990년 9월~1995년 8월 : 한국과학기술원 박사
- 1995년 9월~현재 : 공주대학교 전임강사

은 종 관

- 1964년 6월 : Univ. of Delaware 공학사
- 1966년 6월 : 동대학원, 공학석사
- 1969년 6월 : 동대학원, 공학박사
- 1964년~1969년 : Univ. of Delaware, Research Fellow
- 1969년~1973년 : Univ. of Maine, 전자공학 조교수
- 1973년~1977년 : Stanford연구소, 책임연구원
- 1982년 1월~1983년 6월 : 한국과학기술원 공학장
- 1983년 7월~1989년 6월 : 한국과학기술원 통신공학 연구실장
- 1977년 7월~현재 : 한국과학기술원 전기 및 전자공학과 교수
  IEEE Fellow, 뉴욕 학술원 정회원
  한국과학기술 한림원 종신회원