CHAPTER 4

History of Mongolian Telecommunications Sector

CHAPTER 4

HISTORY OF MONGOLIAN TELECOMMUNICATIONS SECTOR

1. Past Recommendations for transition Toword Market Economy

1.1 Urgent Needs for Mongolian Telecommunications

Different from the cases in ordinary developing countries to which donor countries have provided economical assistance so far, development of telecommunications services in Mongolia carries two aspects of impending serious problems simultaneously.

(1) As the recently produced MTC business plan (1996-2000) describes, the telecommunications network in this country mostly consists of obsolete and fault-prone equipment. It is badly in need to take urgent measures to sustain its network in order to continue to provide basic communications services for the people's lives. Furthermore, the significant influence of efficiency in telecommunication services to the development of national economy as a whole in the modern society urges the country to innovate the communication means to the level of the international standard rapidly.

(2) Mongolia changed the course of national development in 1990 and now all out effort is being made to convert the total national economy from command economy under socialism to market economy under free competition. Same type of experiment is under way in many former socialist countries. If transition takes time and gets mired, the weak side of two social systems are ready to be overlapped and may amplify transitional confusion. Transition must be carried out on a discreet planning and quickly once started.

The institution, organization and management plan with regard to telecommunications of Mongolia must be proposed in this context.

1.2 Assistance To Find Strategies

For the purpose of assisting challenge to this unprecedented transition of economic system and necessary sector reform, Telecom Corporation of New Zealand (TCNZ) conducted survey on telecommunications situation in Mongolia and produced the report and recommendable transition timetable as early as 1991. Later, under the contract with the Asian Development Bank, BT Teleconsult Ltd. in association with Touche Ross Management Consultant conducted reviewing survey on implementation progress of TCNZ recommendations and produced a draft Telecommunication Development Plan for Mongolia in 1993. On those basis the ADB Master Plan for Telecommunication Development in Mongolia was produced. Implementation of the plan was accelerated in 1995.

Institutional organizational and managerial reformation in the telecommunications sector showed an initial movement when Mongolian Telecommunications Authority (MTA) was established and took over the sector management functions together with service provision activities so far undertaken by Mongolian Ministry of Communications (MOC). After reformation went through several steps since then, the achievement in 1995 was noteworthy because it is understood to be the eventual answer to the proposals and recommendations so far provided to the future development of Mongolian telecommunications sector. The reformation has been made through policy dialogue between ADB consultants and Mongolian concerns.

In this regard, the recommendations and proposals to improve telecommunications services in Mongolia should be gone through before we evaluate the recent achievement of institutional organizational and managerial reform in the Mongolian telecommunications sector.

1.3 Summary of Recommendations so far Provided by ADB and the relative consultant

Summary of Recommendations concerning Institutional Organizational and Managerial Reformation in the Telecommunications Sector in Mongolia is enumerated here under.

1.3.1 Enactment of Telecommunications Law

The enactment of the Telecommunications Law should be proceeded urgently so that a legal framework for policy, investment and regulation can be established. A legislative and regulatory framework is necessary for investment decisions and to attract foreign interests as well as to clearly define and limit the role of the government.

1.3.2 Structure for Sector development and Corporate Governance

An understanding of sector development should be deepened and corporate governance should be established. Realization of the fact that telecommunications sector is a vital part of the infrastructure of the country for social cohesion in the modern world and achieving the government's objective of attractive attracting foreign investment into the country should be strengthened. In this regard, an organizational restructuring so as to separate telecommunications activities from other functions of government and clarify an accountability for the sector performances should be promoted.

1.3.3 Separation of the Operating Functions from the Sector Management

The operating functions should be split from the sector management functions. The reporting line of telecommunications organization in the local area should be transferred to the operating entity and the formal role of the government in the operational decisions at the local level should be eliminated so that the national strategies on centrally determined priorities could be developed within sectoral arrangement associated with modern commercial practices instead of command economy.

1.3.4 Establishment of the Regulatory Body

The confusion between sector management and operator regulation will persist without the formulation of regulatory procedures for the operators. Establishment of regulatory body in Mongolia was recommended as an objective of urgent action.

Given the scarce resources, the system in which sector management and regulation of the sector is in the hands of the same officials is the most practical. However, the separation of functions into deferent organizations is recommendable as the clearest way of driving home the message about the difference between sectory policy making and regulation in a market economy.

1.3.5 Stakeholders Board

Stakeholders board was also proposed in consideration that the board would provide Director General of the operating company with sounding board for his strategies and decisions. At the same time the board was expected to act as a buffer between the General Directors and government agencies with responsibility for the sector.

1.3.6 Replacement of the Charters by the Licenses

While the primary legislation governing the telecommunications sector is absent, the charters for the main entities in the sector set out the framework of rights and obligations and in some cases performance targets. Those charters should be supplanted by licenses when necessary legislation is in place. Licensing system should be the basis for regulation.

1.3.7 Enabling Measures instead of Directive Measures

The recommendation was made that presentation on the use of enabling measures instead of directive measures in achieving policy should be made to all officials and ministers involved in telecommunications policy.

1.3.8 Necessity of Private Foreign Investors

The survey has shown that there are significant resource gaps in the telecommunications sector in Mongolia. Private foreign investors will almost certainly be necessary if these gaps are to be closed quickly. After a satisfactory local telecommunications law is passed, foreign participation in the equity of the operators should be allowed. The wider economic benefits of accessing foreign technology, skills and capital are likely to outweigh the transfer of profits from Mongolia. There is a risk that if Mongolian operators do not provide service they will be bypassed or lose potential investor to another country.

1.3.9 Privatization of MTC

MTC should be privatized in the short term. This would confirm the separation of the government roles as owner and regulator.

1.3.10 Planning Functions at the Ministerial Level

It was recommended that the Communications Department in the Ministry responsible for the telecommunications sector be restructured to take account of its re-focusing as the sponsor of Mongolia's national telecommunications development and creator of an appropriate environment for success in development.

The planning section of the Department will be charged with reviewing Mongolia's national telecommunications needs in the light of national economic and other developments. This is a separate activity from the planning undertaken by the operators.

1.3.11 Other Functions to be fulfilled by the Ministry

The administration section with responsibility for legislation and associated matters, would also have initial responsibilities for licensing of operators, appointment of stakeholder board and general directors.

The frequency management section would be responsible for administration of the national radio and television spectrum, liaison with and licensing of telecommunications and broadcasting operators.

The international affairs section would manage representation of Mongolia on international telecommunications bodies such as ITU and its regional and sub-regional organizations as well as CCIR, WARC and other related organizations.

The development aid section would be the interface with development and aid agencies. Its principal role would be facilitation and co-ordination of aid financing rather than as controller of actual aid funds. The proposed structure separates responsibility for legislation matters and relationships with aid donors.

1.3.12 Detailed Design of the Regulatory Body

As to proposed establishment of the Regulatory body, preference among a number of option is the separated regulator for the telecommunications sector, if only because it will permit the sector to develop more quickly. In the proposed structure, the Director of the regulatory body will be independent of the ministry in the way in which he conducts his operations but he will have a reporting link into the ministry at ministerial level. This link will be by way of an annual report on the activities of the regulatory body.

Funding of the regulatory body will be the responsibility of the ministry who may utilize license fees for this purpose. The regulatory body should also be permitted to retain for its use the fees obtained from undertaking type approval work.

The scope of the regulatory body's activities includes one particular function to address customer complaints. Customer complaints to be dealt by the regulatory body in this case are limited to the complaints relating to the general conduct of the operators and not those relating to service such as delays in installation or maintenance.

The regulatory body should have a small but experienced staff and the Director of the regulatory body would have sufficient status to engender respect from operators and government alike. Ideally, the Director will have a sound administrative background, with a good understanding of, and sympathy for, the free market economic system. He should be supported by senior specialists in economic planning, legislation and in telecommunications system management.

For type-approval work, the regulatory body will need a senior telecommunications engineer, with a good understanding of international standards - supported by technician-level staff able to carry out tests and who have sufficient technical understanding to keep abreast of development in telecommunications networks and equipment.

It is suggested that a total complement of 20 staff should be adequate in the initial stage of the regulatory body's operations. This staff complement includes regulatory specialists, technical and support staff.

1.3.13 Of the Stakeholders Board of MTC

The organizational structure of MTC as an operating company need to be re-focused from an engineering organization to one with strong customer orientation.

Establishment of Stakeholders Board was proposed as the strategic decision-making body of MTC. As the name indicates, Stakeholders Board should comprise those with an interest in MTC.

The chairman of Stakeholders Board should be from a commercial rather than government administrative background and be appointed by the minister after consultation with the general director with approval of the prime minister.

According to proposed image of the Stakeholders Board, the majority of the Board members is to be from commercial and business sector and expectedly an appropriate mix of members will provide considerable guidance and support for MTC's executive management team.

1.3.14 Creation of Project Implementation Unit

Creation of Project Implementation Unit was proposed. The role of the PIU would be to design, specify, issue and evaluate tenders, and supervise project control of all telecommunications projects within MTC during the period of main donor-aid and investment activity. The PIU would be created under a component of the aid-financing.

Initially, it is envisaged that the PIU would be staffed by experienced expatriate project management staff who would be required to train Mongolian counterparts in all aspects of project design, specification, tendering and supervision. Subsequently the expatriate staff would handover full PIU activities to their Mongolian counterparts. At that time, the PIU could be incorporated into the main Technical Planning Unit.

2. History of The Sector Reformation

2.1 Short History of the Sector Reformation

Until Oct. 1990, the services in the telecommunications sector of Mongolia were solely provided as governmental services under Mongolian Ministry of Communications (MOC).

In order to improve accountability for telecommunication activities among other governmental services, Mongolian Telecommunications Authority (MTA) was established in Oct. 1990 and took over the functions so far fulfilled by the Ministry of Communication. MTA formally was given more autonomy from government structure but the BT Teleconsult's report pointed out impression of informal mechanisms of influence and remained control of the government. Following series of structural reformation of Mongolian telecommunications sector looks continuously guided by recommendations from outside consultants to eliminate this informal influences of the government.

In order to split the operational function from the sector management function including the policy making function, MTA was split into two organizations. Mongolian Telecommunications Company (MTC) was established February 1992 and the operational functions were undertaken by MTC as the operator of the telecommunications system. MTA with remained sector management functions were converted to the Mongolian Government Department of Communications (MGDC).

In the meanwhile, Mongolian Datacommunication Company (MDC) was moved from the sector of National Development Board (NDB) and included in the telecommunications sector.

September 1992, Ministry of Roads Transport and Communications (MRTC) was organized and MGDC was transformed to Department of Communication and Information Technology inside MRTC.

April 1994, in addition to the above, the construction function was integrated and the Ministry of Infrastructure Development (MOID) was established. In MOID the Department of Communications was organized as supervisory organization to MTC and MDC.

So far the organizational reformation concerning the telecommunications sector in Mongolia had mostly been confined within governmental part of the structure. Reformation process penetrated down to the operational level in 1995.

2.2 Establishment of MCAC and (New) MTC

September 1st., 1995, Mongolian Telecommunication Company was split into two parts.

1. Mongolian Communications Asset Company (MCAC)
2. Mongolian Telecommunications Company (MTC)

Mongolian Communications Asset Company (MCAC) is 100% owned by the Mongolian government. MCAC owns communication equipment as government assets and is supposed to take responsibility for rehabilitation and expansion of the network. Liabilities incurred for purchase of fixed assets were transferred to MCAC.

Mongolian Telecommunications Company (MTC) was reformed to be a shareholding company with foreign investment. Shareholding ratio of the MTC was set out as Mongolian government 60%, Korea Telecom 40% and in the course of time a limited part of shares held by Mongolian government is scheduled to be transferred to the employees of telecommunications sector. Capital participation of Korea Telecom in MTC was approved August 31, 1995.

MTC from now on is responsible for service operation under the lease agreement for telecommunication equipment with MCAC.

Those reformation of the sector as of September 1, 1995 looks distinctive in three points.

(1) A 100% government owned asset company was established and the operation company is expected to provide basic telecommunications services under lease contract of equipment with the asset company. Separation between asset holding and operation is unique if not absolutely unprecedented.

(2) Foreign capital was admitted in the operating company at this timing (A basic legislation Telecommunication Law was not passed yet through parliamentary deliberation) as substantial as 40% shareholding ratio and the foreign participant, Korea Telecom, was expected not only to undertake overall assistance to improve telecommunications services but also to be relied upon as a core player in the business management. It is so stipulated that one of the directors nominated by Korea Telecom shall be appointed the initial chairperson of directors for a term of 3 years. While one of the directors nominated by the Mongolian Government shall be appointed the initial managing director for the term of 3 years.

(3) Reformation was not only external but in quality the both newly established companies were more clearly endowed commercial character of profit orientation. Particularly the MTC is encouraged and obliged to aim at payment of dividends to shareholders. The company is even requested to explore and implement, as soon as is reasonably practicable, the listing of the Company on the Mongolian Stock Exchange.

2.3 Recent Development of the Sector Reform

2.3.1 Commencement of Activities by the Regulatory Commission

The non-staff Telecommunications Regulatory Commission started its activities towards the end of 1995. The Telecommunications Regulatory commission was established by a Ministerial Order issued by the Ministry of Infrastructure Development (MOID) on August 4, 1995. The Regulator, who is the full-time Chairman of the commission, was appointed in September 1995.

2.3.2 Telecommunications Act Mongoria

Telecommunications Act Mongoria passed parliamentary deliberation on November 17, 1995 and came into effect as the first basic legislation of telecommunications in Mongolia.

The regulation of communication service and production by the states are defined.

Regulatory Council with its authorities is described
Licensing procedures are clarified.
The term Communication Networks is defined.
Rights and obligations of the operators and customers are stipulated.

2.3.3 The First Version of MTC Business Plan

The Mongolian Telecommunications Company (MTC) drafted out the first version of MTC Business Plan (1996 to 2000) on December 6, 1995. It was the first of the long waited corporate plan of MTC. The Business Plan originally was scheduled to be produced as a part of the technical assistance project known as A Corporate Plan and Human Resource Development Master Plan. The project was financially supported by Nordic Group and Korea Telecom is expected to play a central role in its practice. The Agreement between the Government and Korea Telecom relating to Mongolian Telecommunication Company stipulates the expected role of Korea Telecom.

Due to delay in the technical assistance program and in consideration of obligation on the part of MTC to submit the corporate plan to the donors of ODA (ADB, KfW and Nordic Group) by no later than 31 December 1995, the first version of the business plan was reportedly produced by Mongolian staffs of MTC only assisted by the consultants who were responsible for Project Design & Management.

The Business Plan could be circulated to ADB, KfW and the Nordic Group as well as to MOID and MCAC in expectation that the Plan serves as a vehicle to inform them of the status of MTC's compliance with the loan covenants as well as of the high priority proposals that require timely consideration of those organizations and the Government.

Korea Telecom's preliminary directions and plans are said to be excluded from the Business Plan. KT's business proposals are to be incorporated to the Business Plan in early 1996.

The project defined by Japanese International Cooperation Agency (JICA), whose survey on the network development in Ulaanbaatar is under way, is also to be incorporated in the Plan as soon as the conclusion comes out.

2.3.4 Project Implementation Unit (PIU)

The principle was established that the Project Implementation Unit (PIU) of MTC be transferred to the Mongolian Communications Asset Company (MCAC). In connection with asset ownership of telecommunications, MCAC is expected to undertake the sub-borrower's position in the official financing such as from ADB, KfW, the Nordic Group and in future other donors. Necessity of shifting PIU organization to MCAC is explained by the expected functions of MCAC that are purchasing owning and managing of the assets required for and resulted from expansion and rehabilitation of telecommunications network.

According to the Draft Business Plan (1996 to 2000) of MTC, the functions of PIU will progressively be transferred from MTC to MCAC in order to minimize disruption of ongoing activities and proposedly be completed by June 30, 1996.

3. Overview on The Current Structure of The Sector

3.1 Resulted Structure of Mongolian Telecommunications Sector

After all the reformations and changes enumerated in the chapter 2 above, the current configuration of the Mongolian telecommunications sector could be described as follows.

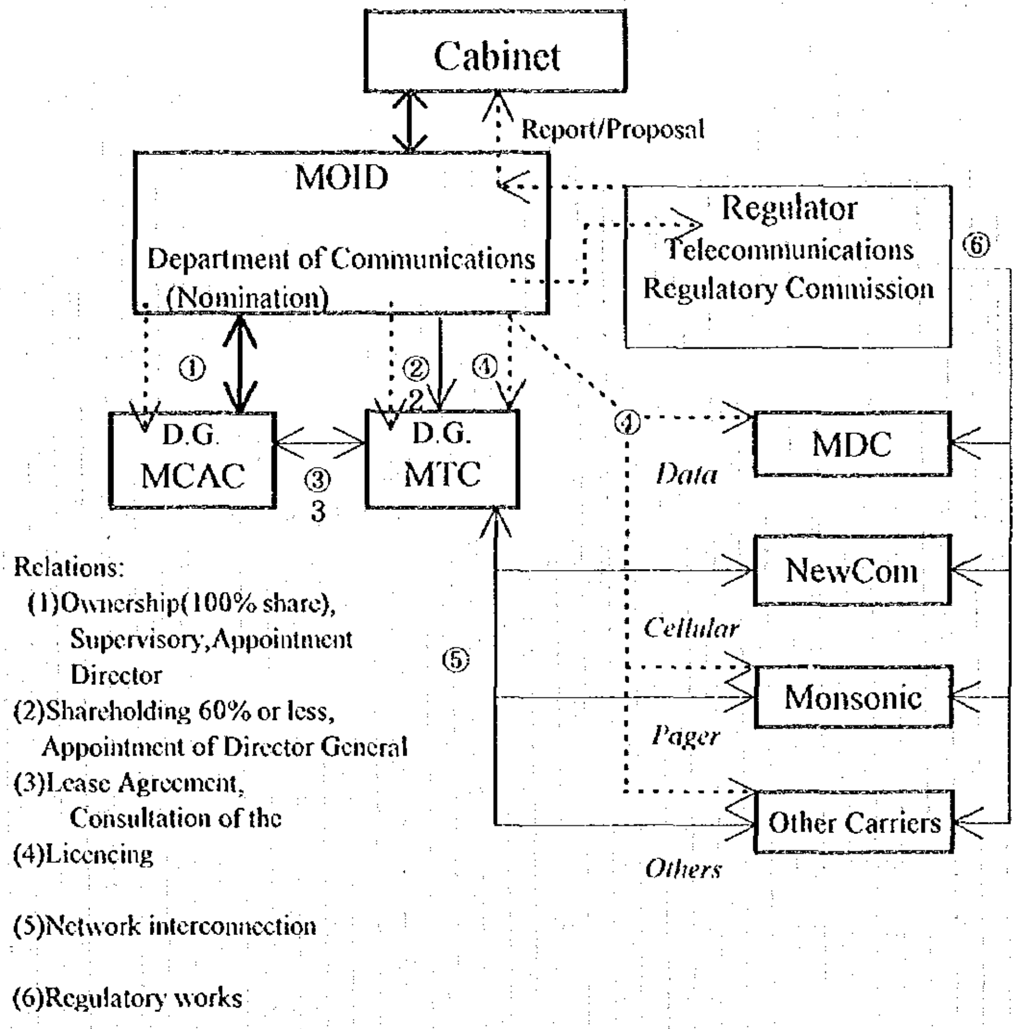


Figure 4-3-1 Organizational Structure of Telecommunication Sector

At the time of beginning 1996, the functional characters of the core entities in the above figure are understood to be as follows:

3.2 Ministry of Infrastructure Development (MOID) Department of Communications

The administration of the telecommunications sector belongs to the Department of Communication of MOID. MOID covers Civil aviation, Railway, Road, Other Transportation, Constructing & Building Material and Communications.

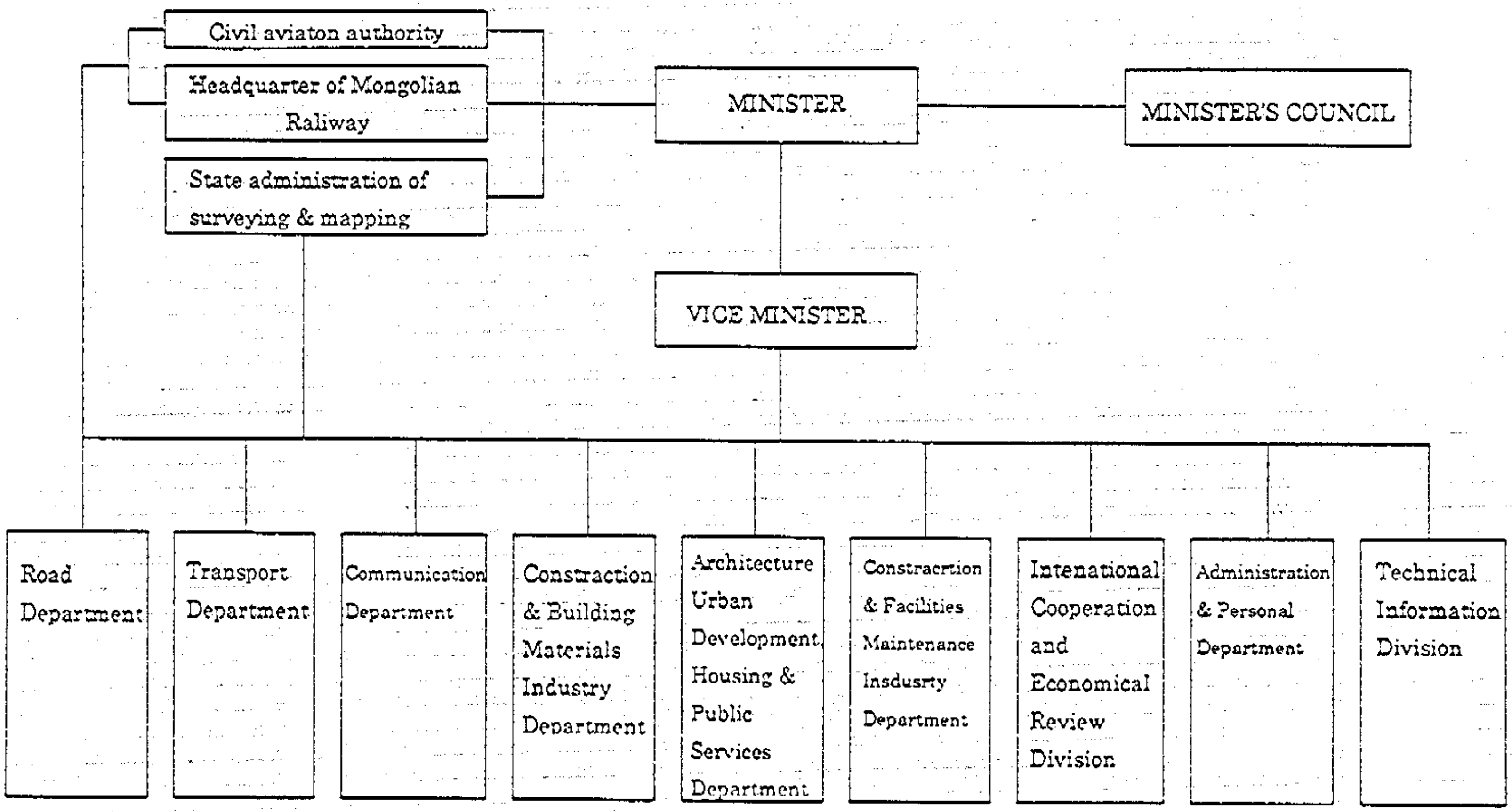


Figure 4-3-2 Organization Chart of the Ministry of Infrastructure Department (MOID)

Administrative functions:	• Administering laws related to telecommunications
	• Granting licenses to the carriers
	• Management of radio frequency and its allocation
Planning functions :	• Policy and planning relating to social targets for network expansion and access to basic service
	• Policy advice to the Minister
	• Advising the Government on further competition in basic services and on policy statements for issue to the Regulator
Diplomatic functions :	• Facilitating aid funding
	• Administering Mongolia's international obligations
Monitoring functions :	• Monitoring performance of sector development

3.3 Telecommunications Regulatory Commissions

Mongolia has chosen the Regulatory Commissions system as the regulatory system for the telecommunications sector. The movement is in accordance with the recommendation made by ADB related consultants in the time of MRTC. The recommendation imaged the regulatory body as follows:

A separated regulator for telecommunications sector was preferred so as to permit the sector quicker development. The Director of the regulatory body would be independent from the Ministry in his conducts. The Director would have reporting link into the Ministry by way of the annual report on the activities of the regulatory body.

The Ministry would be responsible for funding of the regulatory body and license fee would be utilized for that purpose. The regulatory body should also be permitted to retain the type approvals fee for its use.

The recommendation envisaged that the regulatory body should have a small but experienced staff and that the Director of the authority would have sufficient status to engender respect from operators and government alike. A good understanding of, and sympathy for, the free market economic system was expected to the Director.

A particular activity expected to the regulatory body is to address customer complaints relating to the general conduct of the operators. The recommendation recognized a needs of engineering forces to support the activities of the regulatory body. For type-approval work, a senior engineer with a good understanding of international standards and a staff of technician level to be able to carry out tests for constantly developing equipment. The recommendation prospected that with regulatory specialists, technical and support staff being inclusive, a total complement of 20 staff should be adequate.

A lately available information about an actual establishment of the telecommunications Regulatory Commission outlines the body as follows:

The Chairman (Director) will be supported by three part-time commissioners and a full-time expert. The part-time commissioners represent customers, the private sector and MTC.

A difference between the regulation from the governmental authority and the one from the regulatory Commission is suggested here. The Regulatory Commission is independent from the governmental authority though the Director is nominated by the Minister and it reports to the Cabinet through the Ministry of Infrastructure Development (MOID). The Regulatory Commission, though its duty is to regulate the sector, is supported by the carriers and other private concerns. A more democratized character could be seen. In the earlier recommendations, we can find out the phrase that the regulator should deal with operators at arms length, being enabling rather than being directive.

Out of the informed list of responsibility of the Commission enumerated hereunder, we can understand that the practical jobs to implement the rules and principles of telecommunications and the technical jobs which require specialty and expertise are separated from the Authority and handed over to the Regulatory Commission. The Commission could be said to have a character of interface between the authority and the private sector.

Responsibility of the Regulatory Commission stipulated in its Charter

Monitoring&EnforcingFunctions:

- Monitoring and enforcing license condition
- Setting and monitoring service quality standard

Approval Functions :

- Approving the pricing of monopoly service
- Setting type approval conditions

Arbitration & Protectionfun:

- Handling customer and competitor complaints
- Arbitrating in disputes between carriers
- Protecting privacy of communications and individuals

In the light of those responsibilities, the part-time commissioner from MTC to support the Director is believed to be representing carriers in operation neutrally as a whole instead of representing a particular stake of a single private company MTC.

3.4 Mongolian Communications Asset Company (MCAC)

MCAC is defined as the asset holder of the basic telecommunications network solely held by the Government, the Ministry of Infrastructure Development.

Its mandate is stipulated to carry on business in all aspects of purchasing owning managing and leasing telecommunications assets in relation to basic telecommunications services in Mongolia.

MCAC is not allowed to provide any form of telecommunications services. Income of MCAC is solely produced from lease rental contracted with MTC.

The lease contract has been closed between MCAC and MTC covering 20 years until midnight July 31, 2015 and extension of further 20 years is possible.

MCAC is to make available to MTC the fund for approved projects. The liabilities resulted from purchase of the telecommunications equipment is transferred to MCAC. Replacing the previous MTC, MCAC is to take a position of the sub-borrower for the loan provided by ADB KfW the Nordic Group through Mongolian Bank. In future, MCAC is to take same position for the Official Development Aid from any other countries. MCAC would be responsible for debt service.

In this connection, the Project Implementation Unit (PIU) is to be transferred from MTC to MCAC.

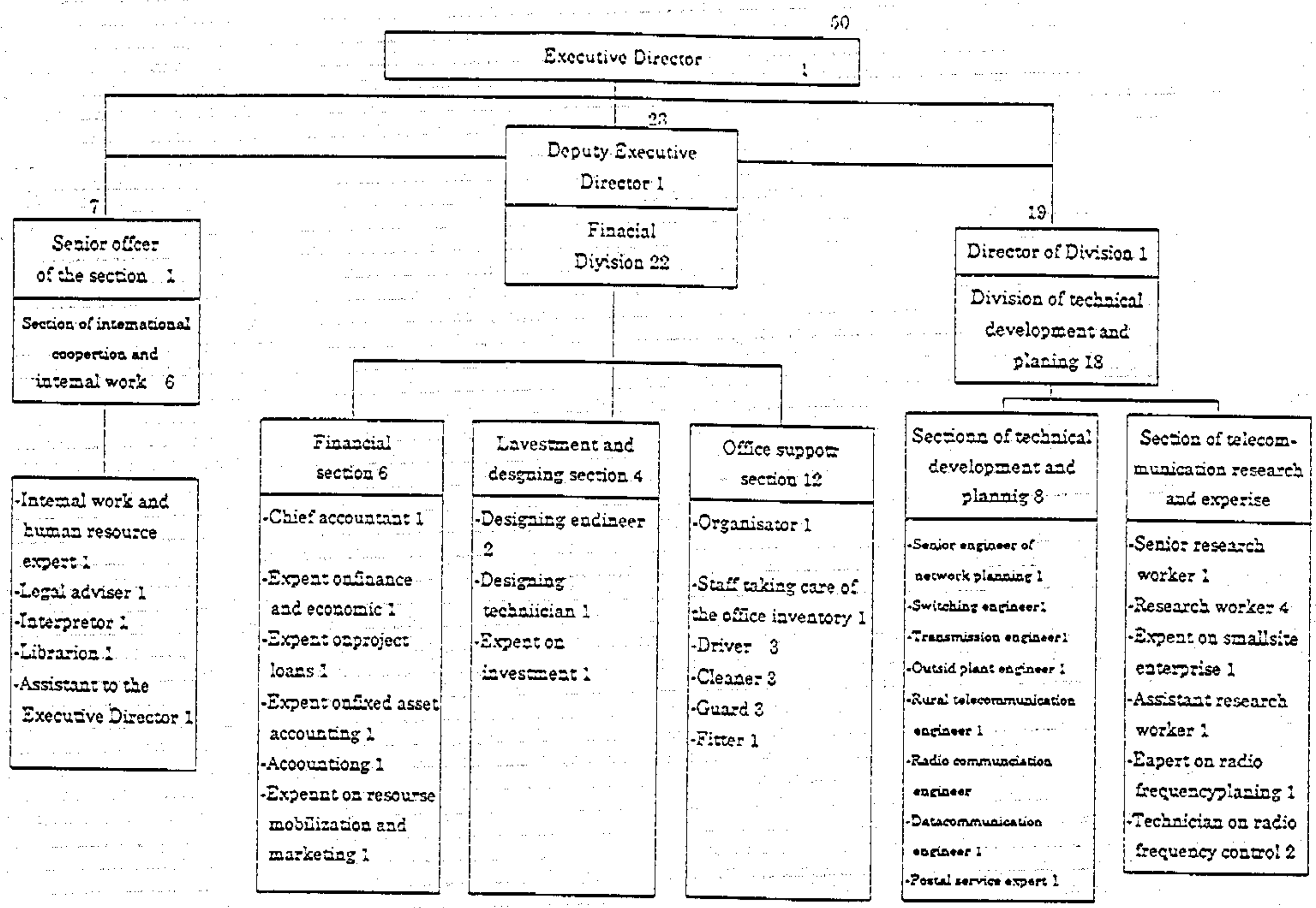


Figure 4-3-3 Organizational Chart of MCAC

3.5 Mongolian Telecommunications Company (MTC)

MTC has been established as an operating company for the basic telecommunications services. Basic telecommunication services are defined as local, national and international telephony, leased circuit, telegraph and telex services provided to the public. Basic services excludes cellular telephony, paging system and other public mobile services which are called value-added services in Mongolia.

MTC was granted exclusive right to provide basic telecommunications services throughout and to and from Mongolia until December 31, 1998. Exceptional cases are the limited range services by Mongolian Railway Company, limited local services not well served by MTC and determined by the Governmental Body and limited services by PABX owners.

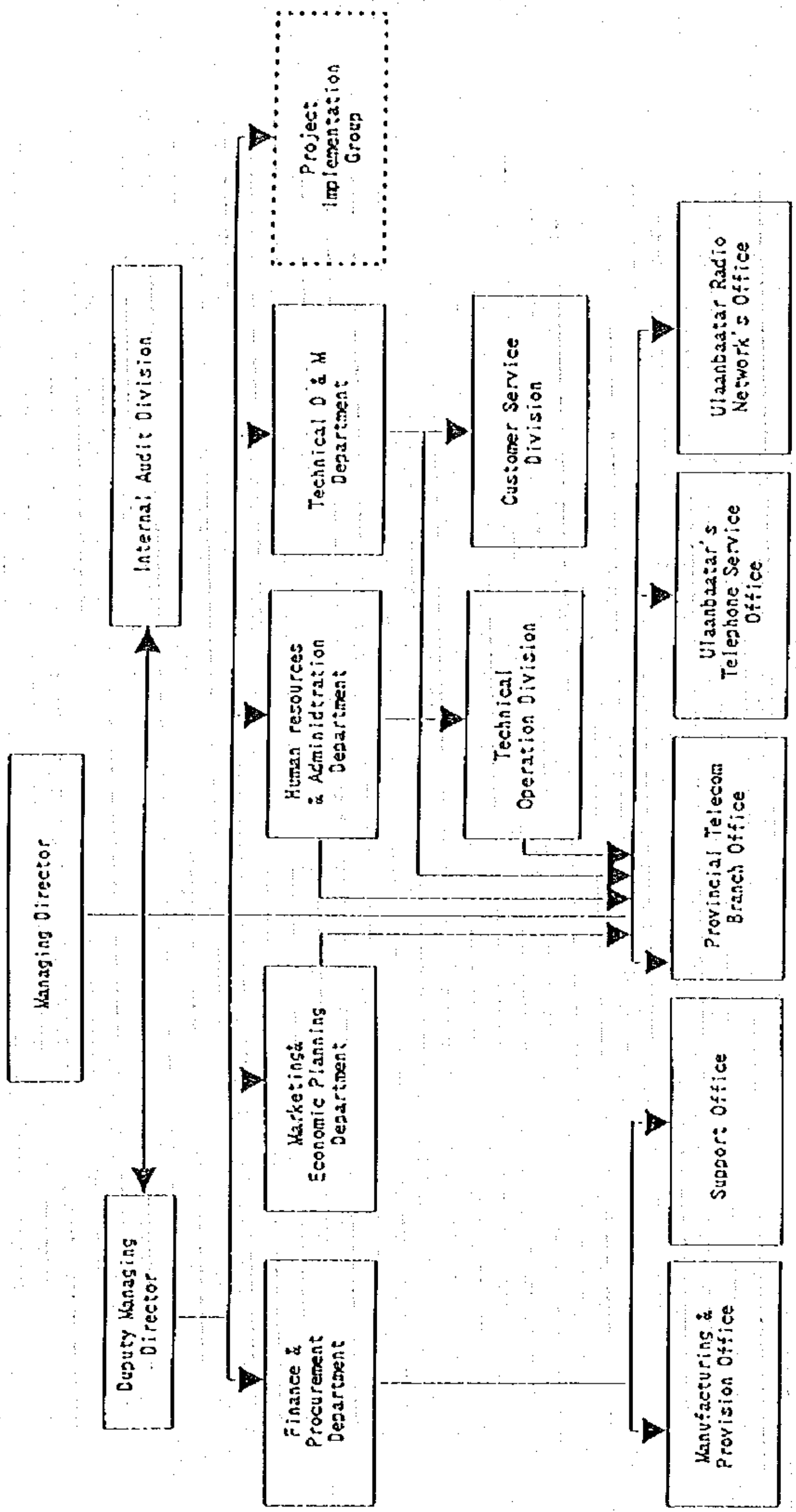


Figure 4-3-4 Organizational Chart of MTC

CHAPTER 5

Technical Standard for Quality of Service

CHAPTER 5

TECHNICAL STANDARD FOR QUALITY OF SERVICE

1. Performance Concepts of Quality of Service (related to Rec. E . 800)

The diagram in Figure 1-1 is intended to provide an overview of the factors which contribute collectively to the overall quality of service as perceived by the user of a telecommunication service. The terms in the diagram can be thought of as generally applying either to the quality of service levels actually achieved in practice , to objectives which represent quality of service goals to be achieved, or to requirements which reflect design specifications.

The diagram in Figure 1-1 is also structured to show that one quality of service factor can depend on a number of others. It is important to note - although it is not explicitly stated in each of the definitions to follow - that the value of a characteristic measure of a particular factor may depend directly on corresponding values of other factors which contribute to it. This necessitates, whenever the value of a measure is given, that all of the conditions having an impact on that value be clearly stated.

An essential aspect of the global evaluation of a service is the opinion of the users of the service. The result of this evaluation expresses the users' degrees of satisfaction.

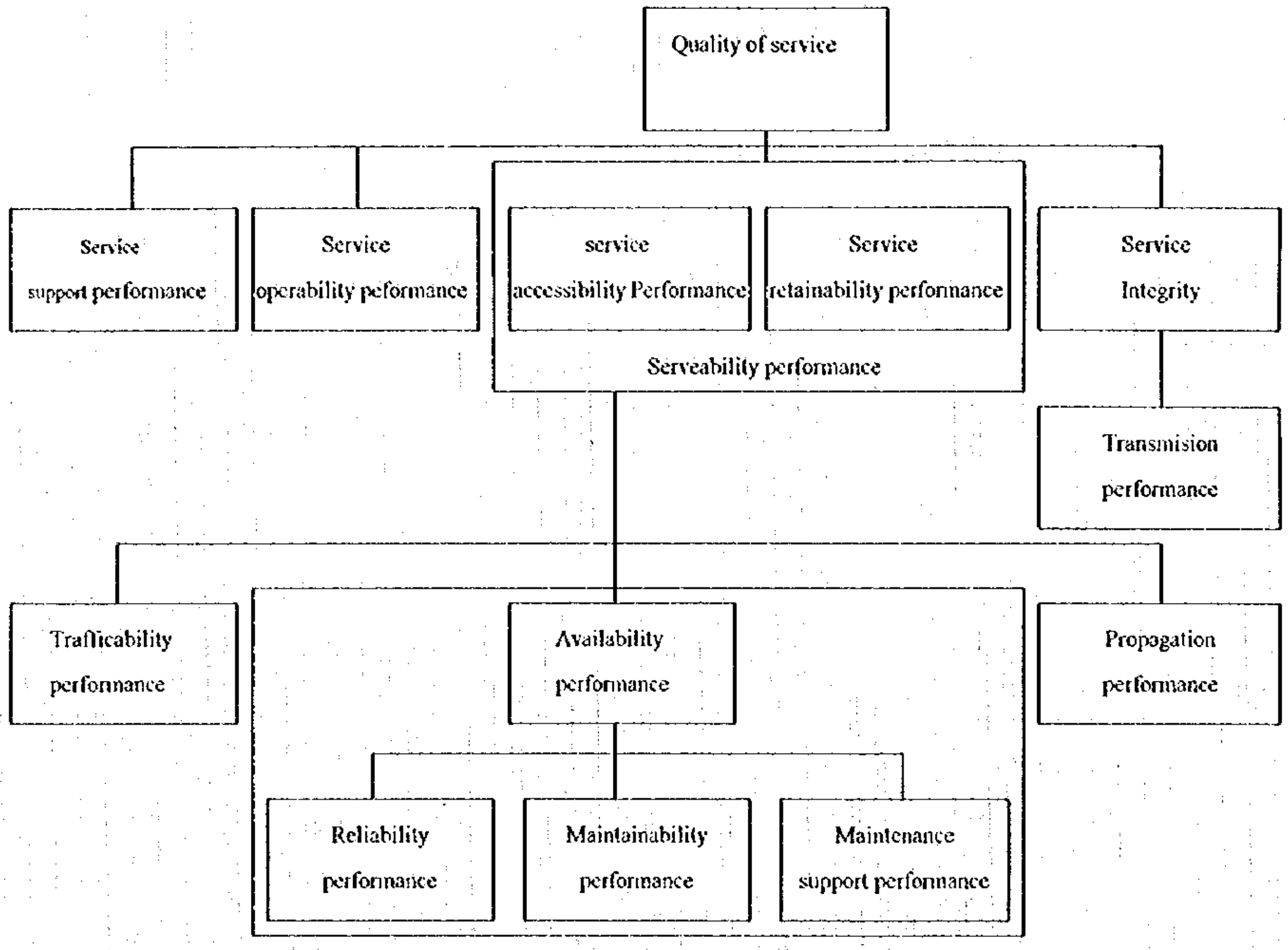


Figure 1-1 Performance Concepts

2. Standard Connection

2.1 National Telephone Connection

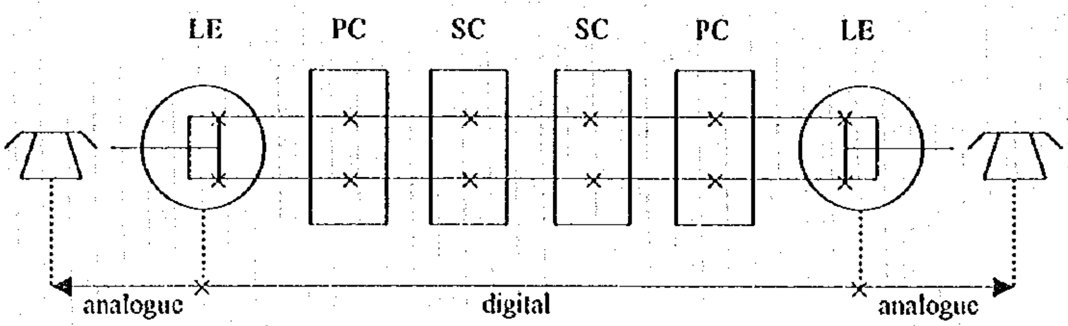
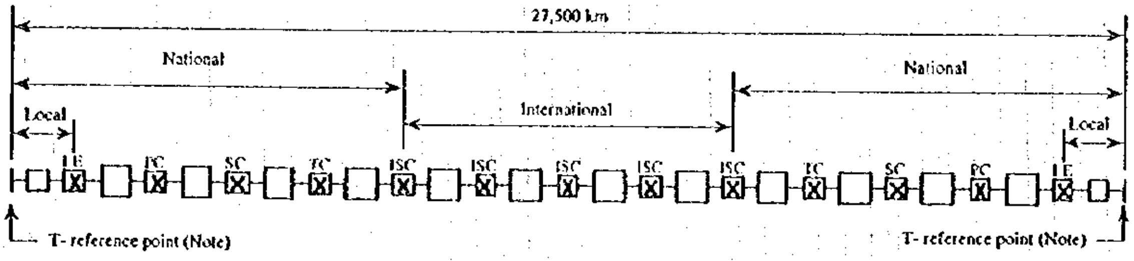


Figure 2-1 National Telephone Connection in Mongolia (in 2010)

2.2 Standard Digital Hypothetical Reference Connection (HRX)

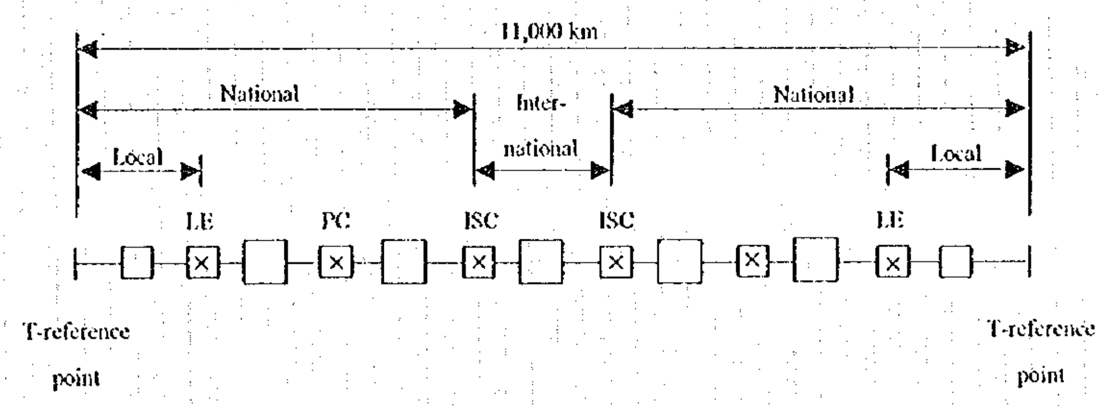
A digital HRX is a model in which studies to overall performance may be conducted, thereby facilitating the formulation of standards and objectives.



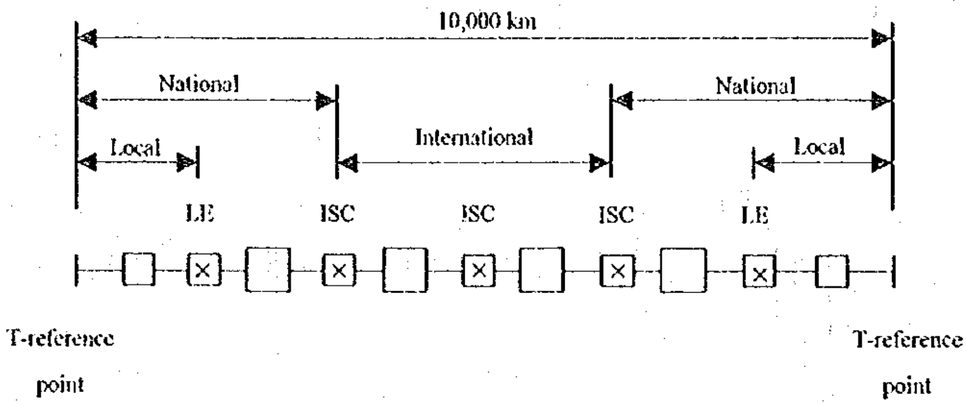
LE Local exchange
PC primary centre
SC Secondary centre
TC Tertiary centre
ISC International switching center

☐ Digital link
☒ Digital exchange

(a) Standard Digital Hypothetical Reference Connection (longest length)



(b) Standard digital hypothetical reference connection
(moderate length)



(c) Standard digital hypothetical reference connection

Figure 2-2 Standard Digital Hypothetical Reference Connection

3. Target Values for Quality of Services

In order to make a qualified network, the design work should be done so as to satisfy each target value of the connection accessibility performance, the transmission performance and the availability performance for the network. Table 3-1 shows the target values for each quality of service between subscribers through connections of Figure 2-1 and Figure 2-2.

Table 3-1 The Target Values for Quality of Services

Performance	Grade of Service	Target Values		Related CCITT Recommendations
Connection Accessibility performance	Initial address message delay (for signalling system No. 7 networks)	Total delay International National	4 sec. 1.5 sec. 2.5 sec.	Rec. E723
	Answer message delay (for signalling system No. 7 networks)	Total delay International National	2.5 sec. 1.0 sec. 1.5 sec.	Rec. E723

	Probability of end-end blocking	Local connection 2% Toll connection 3% International connection 5%	Rec. E721
Transmission Performance	Transmission Loss For Digital Links	Total loss 0 dB	
	Bit Error Ratio for Severely Errored Seconds of Digital Network	Fewer than 0.2% of one second intervals to have a bit error ratio worse than $1 \cdot 10^{-3}$	Rec. G821
Availability Performance	A 2,500 km hypothetical reference circuit in one direction (Analog cable transmission systems and associated equipment)	> 99.6% for one year duration	Rec. G602

4. National Network Transmission Loss Allocation

Figure 4-1 shows a typical national transmission network between subscribers, and its loss allocation.

The transmission loss allocated to the two wire subscriber lines is 9.5 dB, and its direct current loop resistance is 1500 ohm. The loss for digital section and hybrid portion of transmitting end at local exchange are 0 dB and 4 dB for intra-traffic or 8 dB for outgoing traffic. This loss allocation is shown in Figure 4-1.

Tese losses of 8 dB or 4 dB come from Figure 4-2. Because of the average transmission delay time in Mongolian national network is in 11 ms to 17.5 ms , the national digital network sections loss for the best MOS is 8 dB for outgoing traffic and 4 dB for intra traffic.

Therefore, transmitting side exchange has to have two attenuator insertion functions, or intra traffic connection (4 dB attenuation) and outgoing traffic connection (8 dB attenuation).

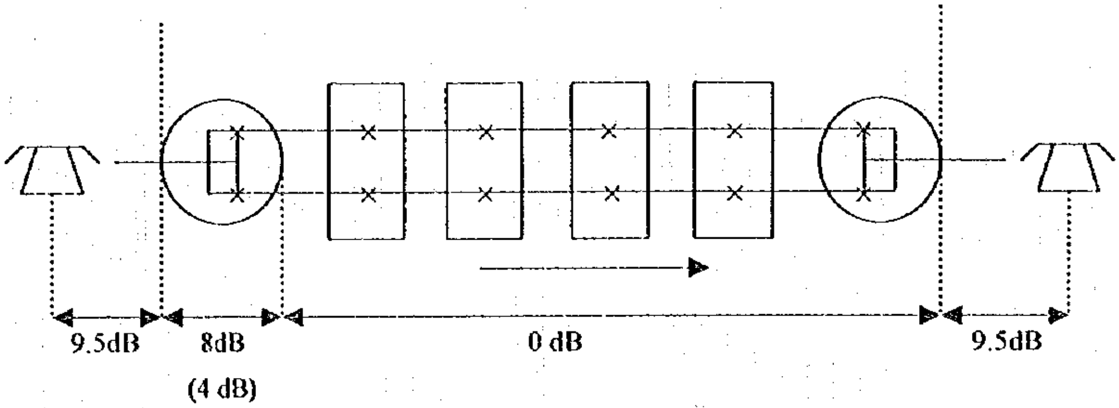


Figure 4-1 National Network Transmission Loss Allocation

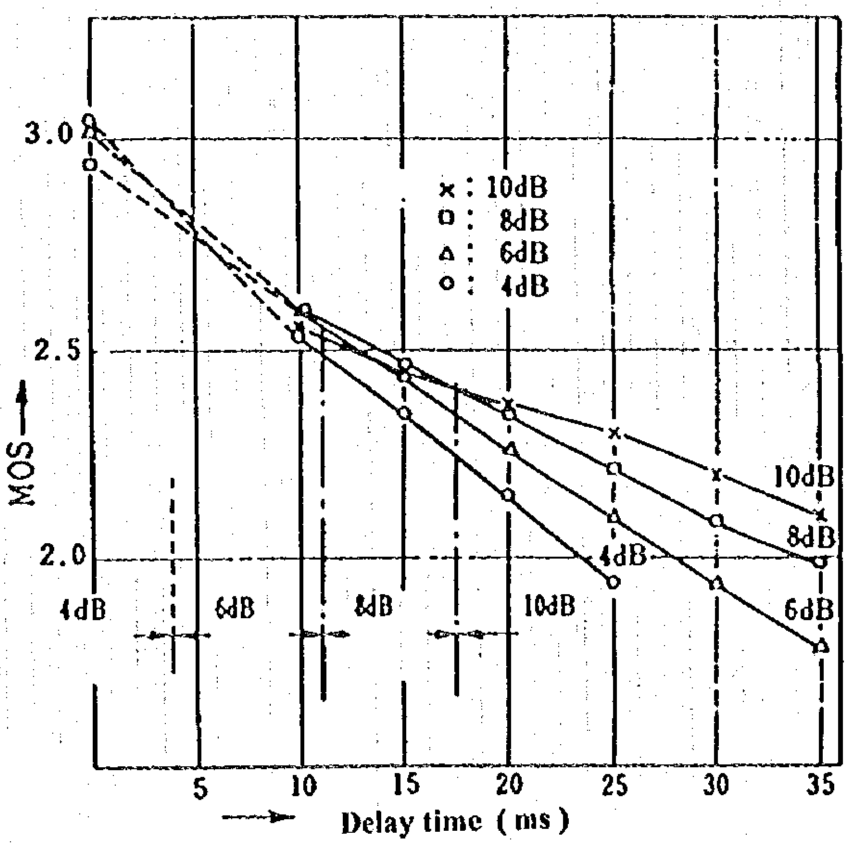


Figure 4-2 Delay time and Mean Opinion Score (MOS)

5. Transmission Performance

There are so many factors affecting, and the standard for them is recommended by ITU-T. Loudness Rating (LR) and Bit Error Rate (BER) are regarded as main performance measures in general.

5.1 Loudness Rating (related to Rec. P)

An essential purpose of a telephone connection is to provide a transmission path for speech between a talker's mouth and the ear of a listener. The loudness of the received speech signal depends on acoustic pressure provided by the talker and the loudness loss of the acoustic-to-acoustic path from the input to a telephone microphone at one end of the connection to the output of a telephone receiver at the other end of the connection. The effectiveness of speech communication over telephone connections and customer satisfaction depend, to a large extent, on the loudness loss which is provided. Loudness rating is an objective measure of the loudness loss, i.e. a weighted, electro-acoustic loss between certain interfaces in the telephone network. If the circuit between the interfaces is subdivided into sections the sum of the individual section LRs is equal to the total LR. In loudness rating contexts, the subscribers are represented from a measuring point of view by an artificial mouth and an artificial ear respectively, both being accurately specified.

5.1.1 Definition of Loudness Rating

(1) Overall loudness rating (OLR)

The loudness loss between the speaking subscriber's mouth and the listening subscriber's ear via a connection.

(2) Sending loudness rating (SLR)

The loudness loss between the speaking subscriber's mouth and an electric interface in the network. [The loudness loss is here defined as the weighted (dB) average of driving sound pressure to measured voltage.]

(3) Receive loudness rating (RLR)

The loudness loss between an electric interface in the network and the listening subscriber's ear. [The loudness loss is here defined as the weighted (dB) average of driving e. m. f. to measured sound pressure.]

(4) Circuit loudness rating (CLR)

The loudness loss between two electrical interfaces in the network (via a circuit) , each interface terminated by its nominal impedance which may be complex. [The loudness loss is here approximately equivalent to the weighted (dB) average of the composite electric loss.] Junction loudness rating (JLR) is a special case of CLR, the terminations being 600 ohms resistive.

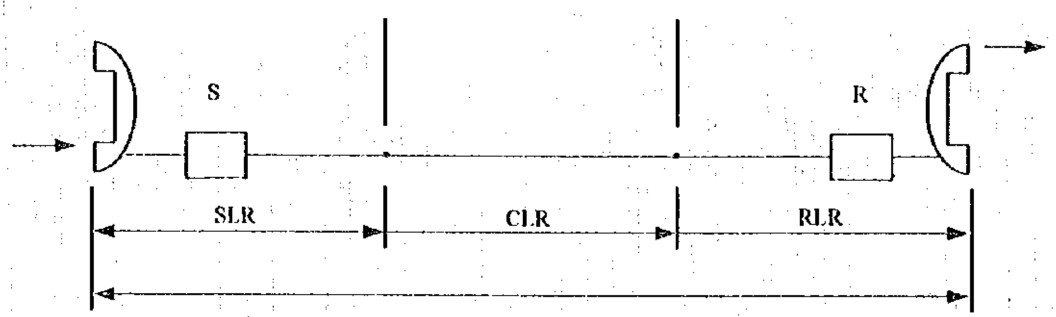


Figure 5-1 Designation of LRs

5.1.2 Calculation of OLR

The relations between subscriber cable loss and SLR, RLR are shown by the following equations for more than 7 dB of its cable loss ;

$$SLR = 4.4 + 0.8\ L\ (dB)$$
$$RLR = -8.9 + 0.7\ L\ (dB)$$

OLR is the summation of SLR, CLR and RLR.

In the case of all digital transmission line, attenuation distortion of CLR due to frequencies can be neglected

5.1.3 Customer Opinion

Customer opinion, as a function of loudness loss, can vary with the test group and the particular test design. The opinion results presented in Table 5-2 are representative of laboratory conversation test results for telephone connections in which other characteristics such as circuit noise are contributing little impairment. These results indicate the importance of loudness loss control.

As the overall loudness rating is 15.5 dB in Ulaanbaatar city, "good plus excellent " percentage of the representative opinion results is approximately 90 %.

Table 5-2 Relation between OLR and Opinion Results

Overall loudness rating (db)	Representative opinion results	
	Percent "good plus excellent"	Percent "good plus excellent"
5 to 15	> 90	< 1
20	80	4
25	65	10
30	45	20

5.2 Bit Error Rate (BER)

5.2.1 Error Performance Objectives

The performance objectives are stated for each direction of a 64 Kbit/s circuit-switched connection used for voice traffic or as a " Bearer Channel " for data-type services. The following BERs and intervals are used in the statement of objectives:

(1) a BER of less than $1 \cdot 10^{-6}$ for $T_0 = 1$ minute;

(2) a BER of less than $1 \cdot 10^{-3}$ for $T_0 = 1$ second;

(3) zero error for $T_0 = 1$ second (equivalent to the concept of error free seconds EFS)

These categories equate to those of Table 5-3.

Table 5-3 Error Performance Objectives for International ISDN Connections

Performance Classification	Objective
Degraded minutes (DM)	Fewer than 10% of one-minute intervals to have a bit error ratio worse than $1 \cdot 10^{-6}$
Severely errored seconds (SES)	Fewer than 0.2% of one-second intervals to have a bit error ratio worse than $1 \cdot 10^{-3}$
Errored seconds (ES)	Fewer than 8% of one-second intervals to have any errors (equipment to 92% error-free seconds)

5.2.2 Allocation of Overall Objectives

Apportionment is based on the assumed use of transmission systems having qualities falling into one of a limited number of different classifications.

Three distinct quality classifications have been identified representative of practical digital transmission circuits and are independent of the transmission systems used. these classifications are termed local grade, medium grade and high grade and their usage generally tends to be dependent on their location within a network.

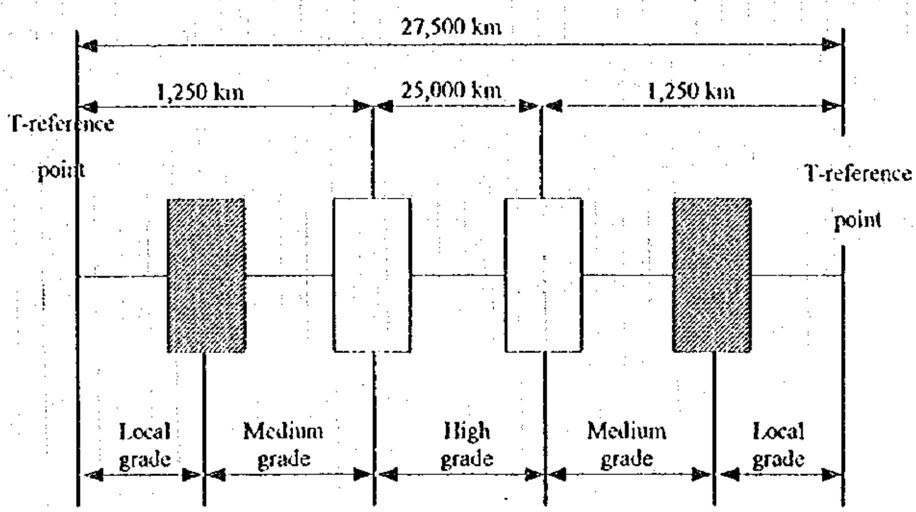


Figure 5-2 Circuit Quality Demarcation of Longest HRX

(a) Apportionment for the degraded minutes and errored seconds requirements.

The apportment of the permitted degradation, i.e. 10% degrade minutes and 8% errored seconds, is given in Table 5-4. The derived network performance objectives are given Table 5-5.

Table 5-4 Allocation of the Degraded Minutes and Errored Seconds Objectives for the Three Circuit Classification

Circuit Classification	Allocation of the degraded minutes and errored seconds objectives given in Table 5-3.
Local grade (2 ends)	15% block allowance to each end
Medium grade (2 ends)	15% block allowance to each end
High grade	40% (equivalent to conceptual quality of 0.0016% per km for 25,000 km)

Table 5-5 Allocation of Percent Degraded Minute Interval and Errored Seconds Objectives

Circuit Classification	Network Performance Objectives at 64 kbit/s	
	% degraded minutes	% errored seconds
Local grade	1.5	1.2
Medium grade	1.5	1.2
High grade	4.0	3.2

(b) Approximately for severely errored seconds

The total allocation of 0.2% severely errored seconds is subdivided into each circuit classification (i.e. local, medium, high grades) in the following manner:

i) 0.1% is divided between the three circuit classifications in the same proportion as adopted for the other objectives. This results in the allocation as shown in Table 5-6.

ii) The remaining 0.1% is a block allowance to the medium and high grade classification to accommodate the occurrence of adverse network conditions occasionally experienced (intended to mean the worst month of the year) on transmission systems. Because of the statistical nature of the occurrence of worst month effects in a world- wide connection, it is considered that following allowances are consistent with the total 0.1% future:

- 0.05% to a 2,500 km HRDP for radio relay system which can be used in the high grade and the medium grade portion of the connection;
- 0.01% to a satellite HRDP (the CCIR are continuing studies on severely errored seconds performance for satellites system and this value eventually need to be increased).

Table 5-6 Allocation of Severely Errored Seconds

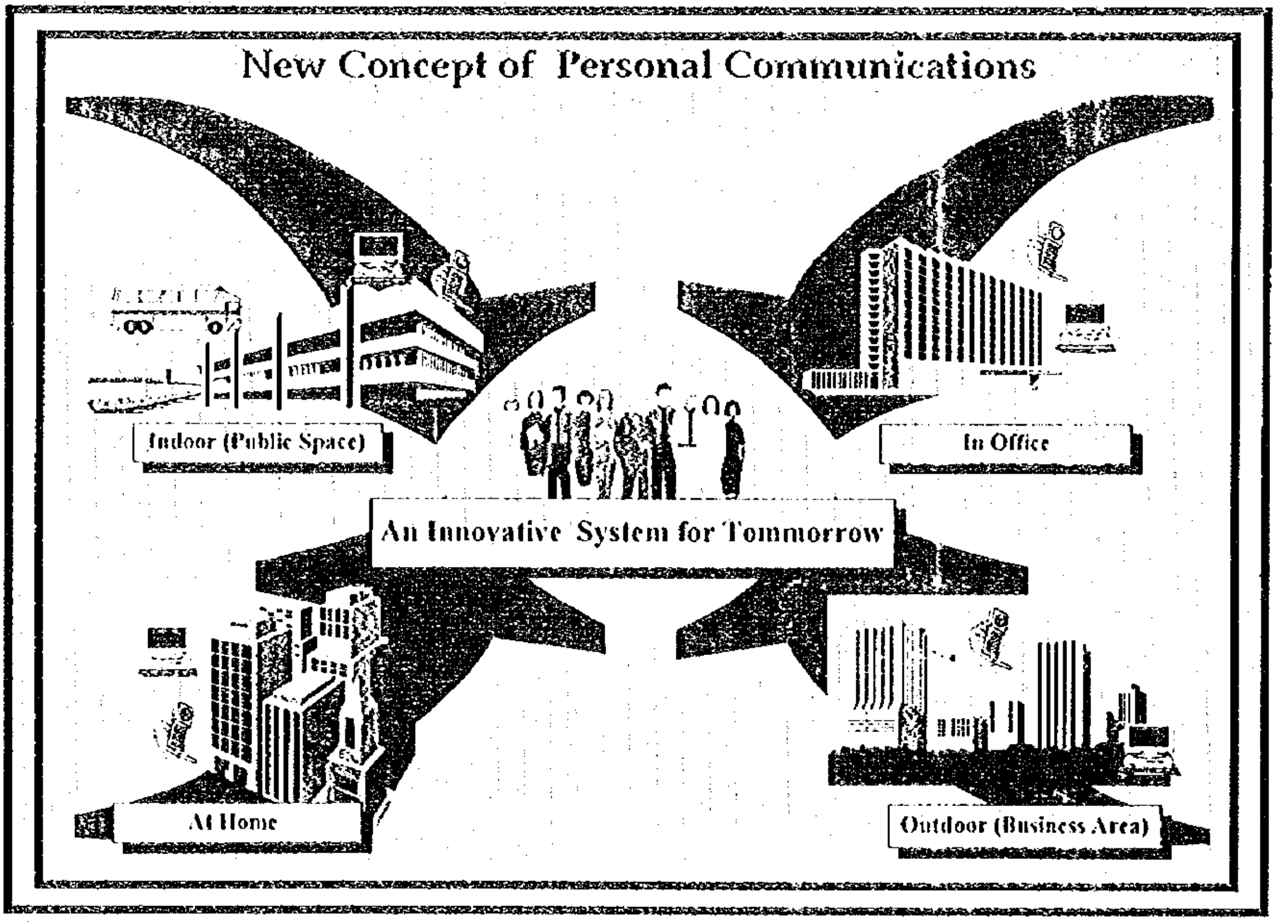
Circuit Classification	Allocation of severely errored seconds objectives
Local grade	0.015% block allowance to each end
Medium grade	0.015% block allowance each end
High grade	0.04%

CHAPTER 6

Personal Handy-Phone System

Personal Handy-Phone System (PHS)

Guidebook



Ministry of Posts & Telecommunications, Japan

Preface

The Contents of this **Guidebook** present a comprehensive introduction to the **Personal Handy-Phone System (PHS)** technology so that readers may learn outline of the technology and its application.

Because of the much greater and diversified interest in **PHS** since the **PHS** service was begun in July 1995, the key technology of **PHS** has likewise been progressed. At the same time, the technology has been paid much attention since it could be applied in various way not only for Mobile Telecommunications but also for Wireless Local Loop and Indoor Telecommunications.

This **Guidebook** therefore has been designed for those who are engaged in engineering or operation of telecommunications systems. The readers are expected to have the fundamental knowledge on technologies of the conventional telecommunication systems.

The authors are experts from the **Ministry of Posts and Telecommunications, Consulting Company, PHS Services Providers, Manufactures,** and so forth. They shared the drafting work in close co-operation with one another.

Many thanks to the authors who made every endeavor to write this **Guidebook.** Especially, much appreciation should be given to Mr. T. Takeshita and Mr. N. Nakajima of Nippon Telecommunications Consulting Co., Ltd. (NTC) for their works in editing this **Guidebook.**

Mitsuo Igarashi
Director-General
Telecommunications Bureau,
Ministry of Posts & Telecommunications, Japan

Table of Contents

Executive Summary

The **Ministry of Posts and Telecommunications of Japan (MPT)** has been proceeding the study to develop the **Personal Handy-Phone System (PHS)** to fulfill the demand of *"anytime and anywhere"* personal communication since 1989.

MPT is considering that the development of **PHS** is essential to meet various needs for personal communications services in such a manner that **PHS** users can enjoy the voice communication, fax transmission as well as data communication even if users are at home, in office and outside at reasonable cost.

Chapter 1 PHS Service Concept

The concept of **PHS** service is to provide:

- *Wireless multimedia communications,*
- *Terminal mobility,*
- *Complete two way communications, and*
- *Alternative access method to network.*

In other words, **PHS** must make it possible to use the small and lightweight handsets at home, in office and outside not only for voice communication but also fax as well as data communications with high quality at reasonable cost, without being tapped easily.

PHS development was proceeded with the following key technologies to realize the potential needs:

- *Adoption of micro-cell structure,*
- *Use of existing network,*
- *Adoption of digital radio link,*
- *Adoption of dynamic channel assignment,*
- *Adoption of 32kbps ADPCM voice coding.*

Chapter 2 Applications

PHS is a new kind of communication service that enables one to enjoy the cost and convenience advantages of digital cordless phones in various situations. Followings are the basic applications of **PHS**.

(1) Mobile Telecommunications

Users in outdoor can establish communication by accessing the cell stations installed around town. As explained later, by accessing the household base unit, **PHS** can be used at home as ordinary cordless telephone at the **Public Switched Telephone Network (PSTN)** tariff.

A key PHS advantage over cellular phones is its superior economy. Though **PHS** adopts micro-cell architecture, the total per subscriber cost of **PHS** services will be relatively low compared with cellular system. Generally, the current cellular system is constructed independently from the existing PSTN. While this architecture might also be proposed, an architecture that a **PHS** network would be constructed by means of attaching new function to existing PSTN/ISDN would be more efficient. This method allows carriers to drastically reduce the initial cost of facilities. This, in turn, allows the carriers to offer services at a reasonable cost to customers.

(2) Wireless Local Loop (WLL)

WLL is designed to serve the local loop or customer access network between the customer and the local exchange by radio. The connection of customers to their local exchanges is no longer restricted to physical media like copper wire, coaxial cable and optical fiber.

WLL provides the means to access the PSTN for the areas where the conventional local loop systems are not available. By introducing WLL, the waiting applicants can be satisfied with the faster telephone installation, and the service providers with the inexpensive investments, compared with the wired solution.

(3) Indoor Application

PHS is also applied for digital wireless PBX which is used for digital wireless telephone system for office use. The system consists of personal stations (**PHS** handsets), cell stations, and the wireless PBX. The wireless interface between the personal stations and cell stations is also standardized by **Association of Radio Industries and Businesses (ARIB)** in Japan. The wireless PBX has been realized by adding wireless functions to existing digital PBXs.

Chapter 3 Market of the Mobile Telecommunications

PHS can provide mobile telecommunication service with low charges. Thus, it is expected **PHS** will be used by the general public and spread much more beyond existing cellular mobile telecommunication service.

Following markets are expected to be the target of **PHS** in Japan:

- The market of the personal users,
- The market of mobile telecommunication in urban areas, and
- The market of data exchange using mobile telephone.

According to the demand forecast by **MPT**, 30 percent of the Japanese population will use **PHS**, totaling 38 million of **PHS** handsets in circulation in the Japanese **PHS** market in the year 2010. This is a figure based on the result of market research by questionnaire. However, *if one family purchases one PHS handset, it will be 43 million.* If one person purchases one PHS handset, as many as 100 million PHS handsets will circulate in Japan.

It can be deduced from the result of the above mentioned questionnaire that *the intention to use PHS turned out to be 100%, if the monthly basic charge does not exceed 3,000 yen.* It can be said that this is a credible figure because the charge of 2,700 yen is offered when the service starts. The mass production system introduced to cope with the future increasing demand may contribute to the further reduction of charge.

It is understood from the figure of survey result that *the public seeks economical charges besides such convenient feature as mobility.* Therefore, PHS of which main feature is the low cost will create larger demand among the general public.

PHS has an outstanding data communication capability. PHS data transaction terminal will allow an access to data communication network such as **Internet** anytime from anywhere for mobile computing. Therefore, PHS market will expand through potential demands other than telephone.

Chapter 4 Comparison among Systems

PHS is compared with DECT, PACS and CT-2 from the viewpoint of major technical elements as shown in Figure 1 and Table 1.

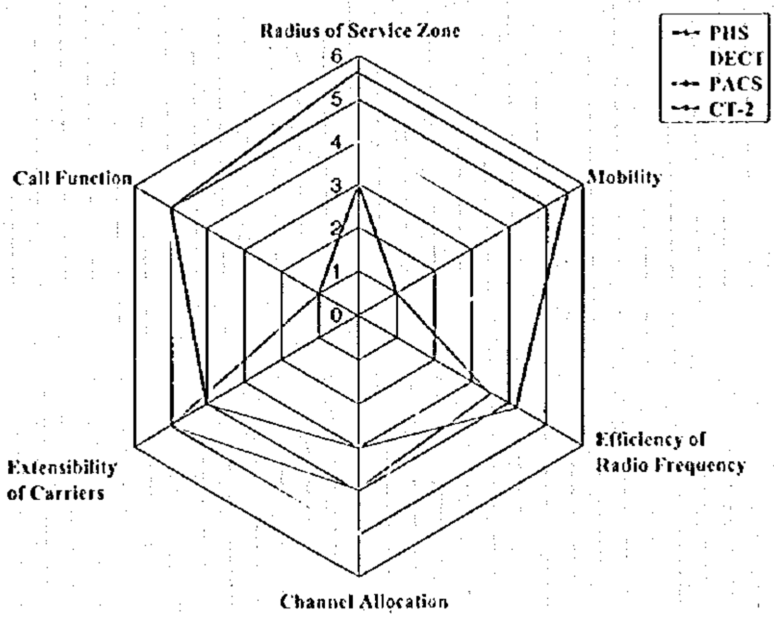


Figure 1 Comparison among Systems

Table 1. Comparison among Systems (as mobile communications)

	PHS	DECT	PACS	CT-2
Radius of service zone	100-500m	100-150m	300-800m	50-150m
Mobility	Motorcar speed in the downtown	Walking speed	Motorcar speed	Stay
Call function	Both way	Both way	Both way	No incoming
Channel allocation	Dynamic	Dynamic	Fixed or QSAFA	Dynamic
Efficiency of radio frequency	300kHz, 4ch (75kHz/ch)	1,728kHz, 12ch (144kHz/ch)	300kHz×2,8ch (75kHz/ch)	100kHz, 1ch (100kHz/ch)
Extensibility of carriers	Flexible (TDD)	Flexible (TDD)	Restricted (FDD)	Flexible (TDD)

Chapter 1 Introduction

- On the way to personal communications -

Development of "*Mobile Telecommunication System*" is generally aiming at the following three objectives:

- *Effective use of radio frequency,*
- *Provision of highly advanced services, and*
- *Realization of economical system.*

"***Effective use of radio frequency***" stems from the fact that the radio frequency is limited as resource and the same frequency can not be used at the same time and same place. This objective can be achieved by R&D of radio frequency technology for using commonly time, space and frequency among users as much as possible.

"***Provision of highly advanced services***" is the objective for responding to the requirements toward the personal communications.

"***Realization of economical system***" is the objective for deployment of "*Mobile Telecommunication*". For the highly advanced services, the system will become complex and its cost will be increased. Therefore, it is essential to reduce the system cost with standardization, usage of LSI, functioning by software instead of hardware logic, and so forth.

MPT, keeping in mind the above key objectives, has been proceeding with the study to develop **PHS** to fulfill the demand of "*anytime and anywhere*" personal communication since 1989.

PHS is a new concept of communication system that provides an economical wireless access service toward the above concept of "*anytime and anywhere*" for personal communications.

MPT is considering that the development of **PHS** is essential to meet various needs for personal communications services in such a manner that *PHS users can enjoy the voice communication, fax transmission as well as data communication even if users are at home, in office and outside at reasonable cost.*

PHS technology is similar to residential cordless telephone, comprising of **PHS** handsets called ***Personal Stations (PS) and Cell Stations (CS)***, but performs advanced digital communications features. Its function is similar to that of cellular system, allowing handoff from one cell to another, but *in motorcar speed in downtown.*

From October 1993 to March 1995, field trial was conducted in the areas of **Sapporo, Tokyo, Osaka and Takamatsu.** The monitors engaged in this field trial were satisfied with **PHS** service, and the completeness of **PHS** was verified from the technical viewpoints. *During the field trial, many delegations from related organizations not only in Japan but also from other countries came to observe the trials, and the gratifying responses were obtained.*

MPT has formally announced the final licensing guidelines for the **PHS,** based on the final report of the **PHS** field trial assessment study committee. *With these guidelines, up to three licensees are going to be authorized for each regional block, whose requirements are to achieve 50% of total residential population coverage within 5 years.* Considering these guidelines, NTT Personal Communication Network Group, DDI Pocket Telephone Group and Astel Group have established **PHS** operation companies.

NTT Personal Communication Network Group and DDI Pocket Telephone Group have started their commercial services in July 1995, and Astel Group is planning to begin its commercial service in October 1995.

There is a growing demand for more convenient and advanced services to dial directly to *anywhere, anytime.* **PHS** is an attractive approach to meet this growing demand, and is regarded as being *the first step toward the realization of the personal communications.*

This **Guidebook** provides:

- *PHS Concept and Service Objectives,*
- *PHS Applications and their System Configurations,*
- *PHS Market Considerations, and*
- *PHS Superiority over other Systems.*

In addition to the above, the following supplements are provided in this **Guidebook:**

- *PHS Base Technology, aiming at offering the detailed technical data and demand forecast methodology for PHS planning, and*
- *PHS Standard Publication List.*

Chapter 2 PHS Service Concept & Objectives

The concept of PHS service is to provide;

- *Wireless multimedia communications,*
- *Terminal mobility,*
- *Complete two way communications, and*
- *Alternative access method to network.*

In other words, PHS must make possible to use the small and lightweight terminal at home, in office and outside not only for voice communication but also fax as well as data communications with high quality at reasonable cost without monitoring easily.

PHS service concept is illustrated in Figure 2.1.

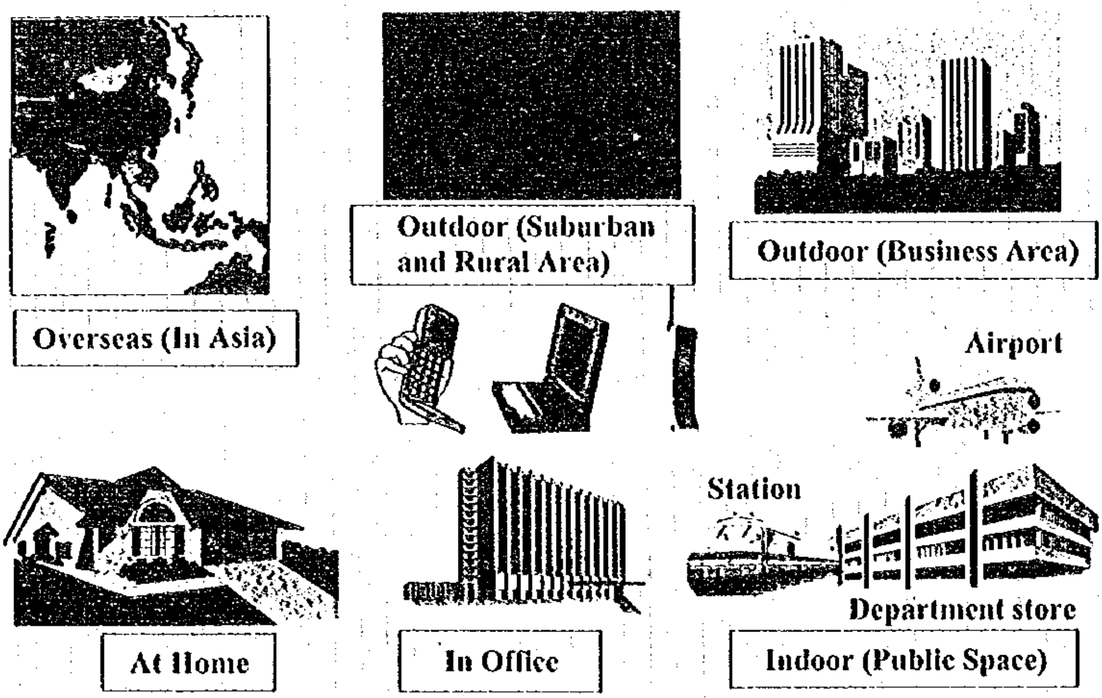


Figure 2.1 PHS Service Concept

Fundamentals of those requirements are based upon the following issues in cellular system, cordless telephone system, and so forth:

Disadvantages of cellular system;

- Portable telephone by cellular system is convenient, but its subscription and call charges are still high,
- Portable telephone by analog cellular system is very noisy sometime,
- Battery for portable telephone for cellular system must be recharged frequently,
- Capability of cellular system is not enough to transmit and receive fax message and other form of data, and
- Voice communication by analog cellular system can be easily tapped by third party.

Disadvantages of cordless telephone system;

- Home-use cordless telephone covers only approximately 100m from home base station equipment, and
- Voice communication by home use cordless telephone can be easily monitored by third party.

Disadvantages of paging system;

- Pager is convenient and its subscription and call charges are low, but two way voice communication is not possible.

PHS is developed to solve the above problems to satisfy the potential demand for personal communications. PHS development was proceeded with the following key technologies to realize the potential needs:

Adoption of micro-cell structure;

- For reducing the cell station construction cost,
- For reducing the terminal size and weight as well as power consumption, and
- For handling the high volume of communication traffic.

Use of existing network;

- For reducing the PHS network construction cost.

Adoption of digital radio link;

- For ensuring the high communication quality,
- For enhancing the multimedia communication capability,
- For reducing the size and weight of handsets, and
- For avoiding the "being tapped".

Adoption of dynamic channel assignment;

- For simplifying the cell station engineering, and
- For using the frequencies effectively.

Adoption of 32Kbps ADPCM voice coding;

- For ensuring the high voice communication quality, and
- For securing the G3 fax communication.

Along with the above basic guideline, **PHS** development activities started at the **Association of Radio and Industries and Businesses (ARIB) and Telecommunication Technology Committee (TTC)** of Japan for standardization of the system, highlighted on "Common Air Interface", *"Network-Public Cell Interface" and "Network-Network Interface".*

Basic personal communication service concept is illustrated In Figure 2.2.

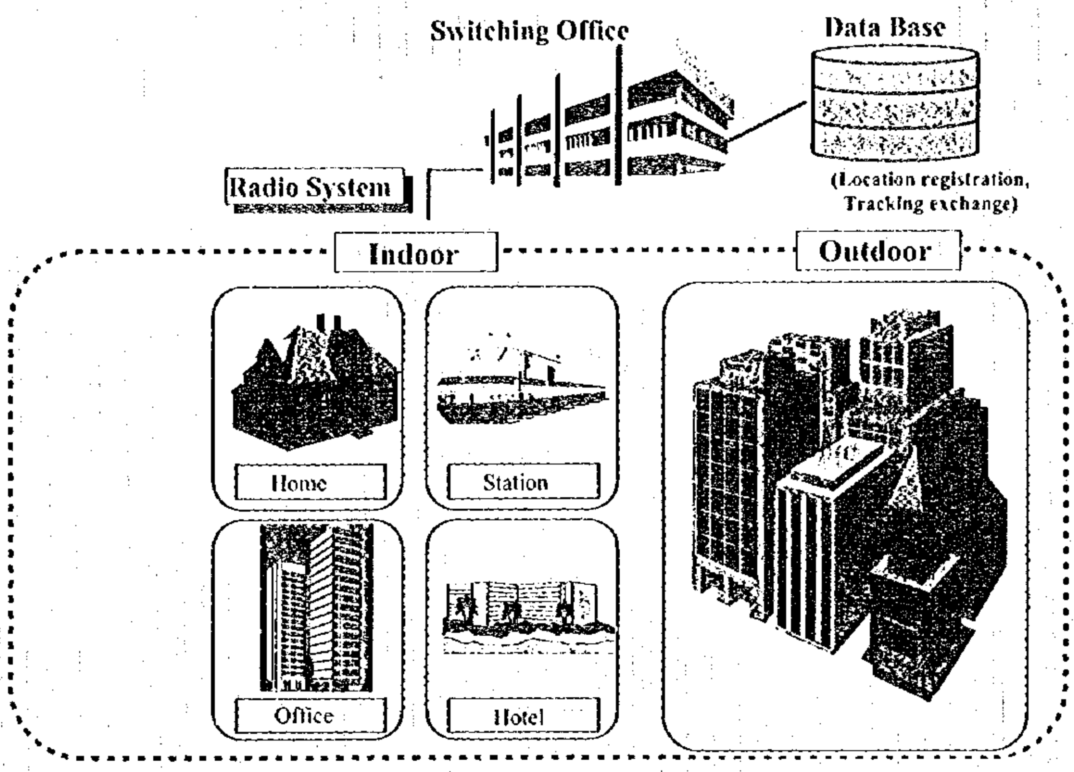


Figure 2.2 Basic Personal Cmmunication Service Concept

With tremendous efforts, PHS was put into commercial service in the selected areas starting July 1995, with the following notable features:

By small and lightweight terminal;

- Size 111~150mm(L) × 43~58mm(W) × 21~31.5mm(D)
- Weight 95~220g
- Capacity 98~189cc

For anytime and anywhere communication;

- At home as cordless telephone
- In office as portable extension
- Outdoor as mobile telephone

With multimedia communication capability;

With high quality communication;

Without "being tapped" easily;

With continuous terminal operation without battery recharging;

- 4 ~ 15 hours continuous communication mode,
- 4 days ~ 2 weeks continuous stand-by mode.

With transceiver function;

- 3 minutes communication between pre-arranged terminals.

PHS service ideas are illustrated in Figure 2.3.

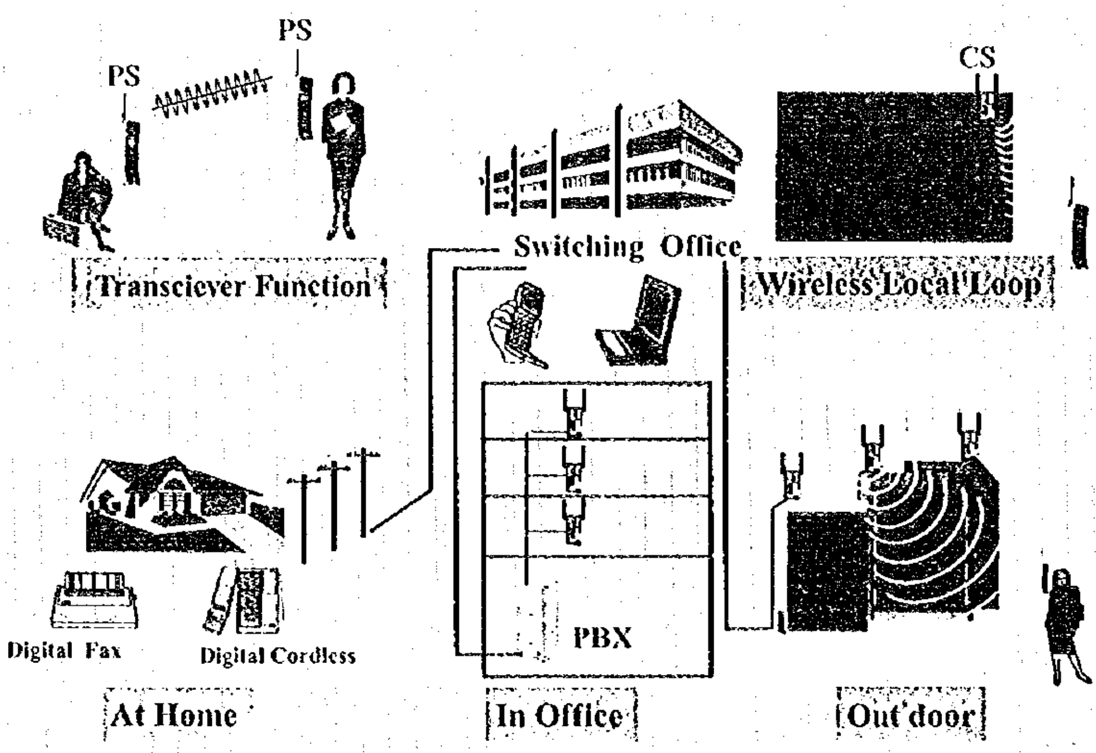


Figure 2.3 PHS Service Ideas

Chapter 3 Applications & System Configurations

3.1 General

PHS will be categorized to the mobility features. In general, there are the following 4 kinds of services.

(1) Fixed use

This is a service using a fixed terminal for accessing the network by **PHS**, instead of using physical media like copper wire, as illustrated in Figure 3.1.

(2) Mobility within a cell

This is a service of PHS home use like cordless telephone, as illustrated in Figure 3.2.

(3) Mobility over multiple cells

This is a service to expand the service area and to allow users moving around in office building as illustrated in Figure 3.3.

(4) Full mobility

This is a service similar to cellular system, as illustrated in Figure 3.4.

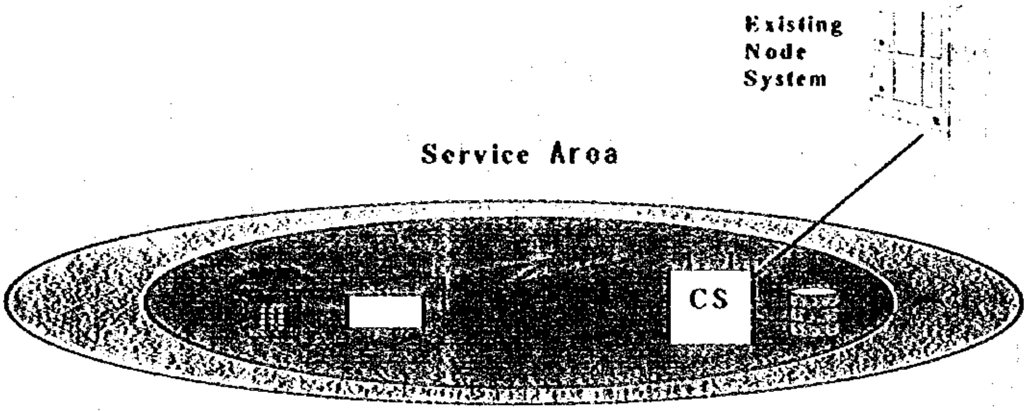


Figure 3.1 Fixed use

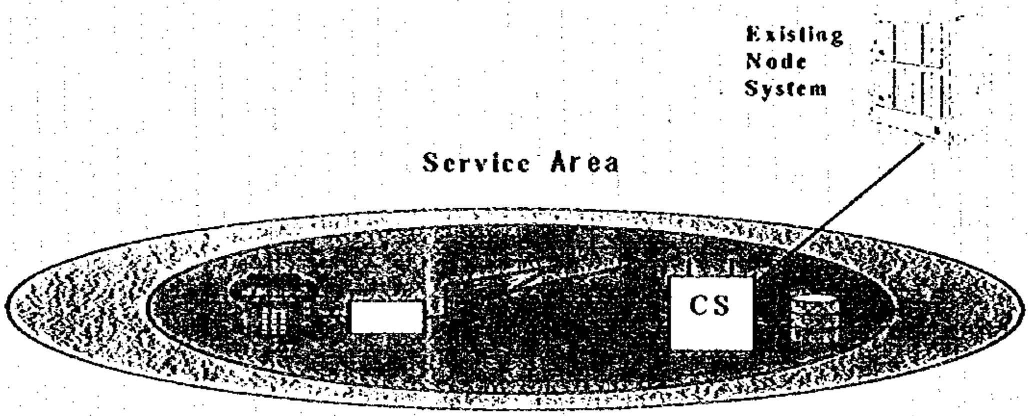


Figure 3.2 Mobility within a cell

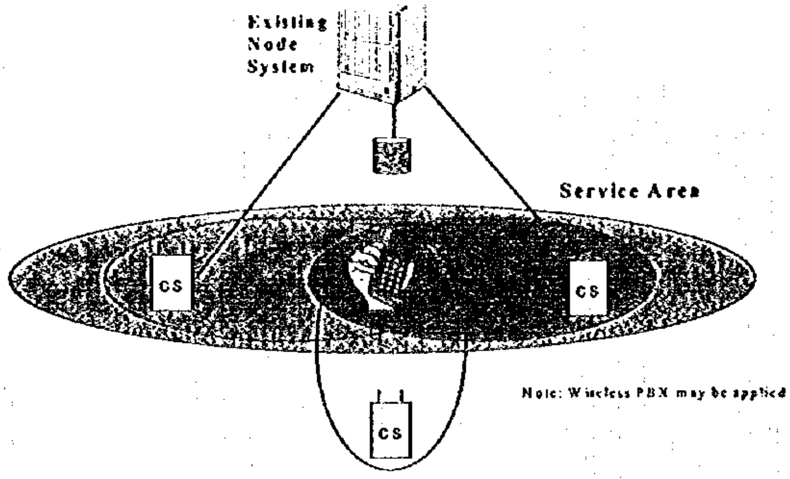


Figure 3.3 Mobility over multiple cells

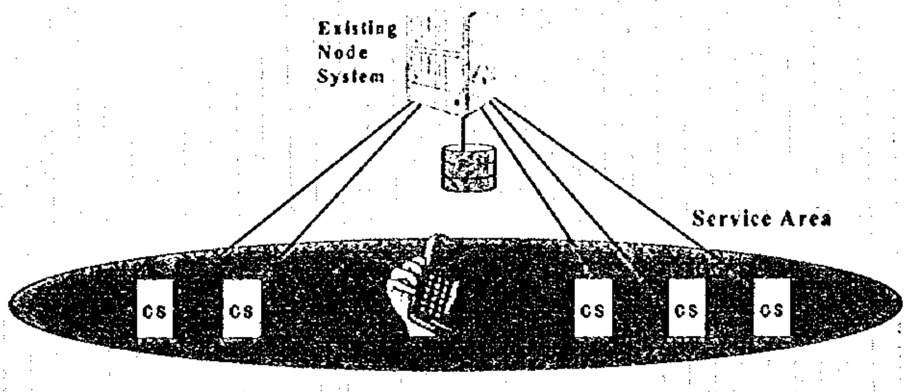


Figure 3.4 Full Mobility

3.2 Applications

PHS is a new kind of communication services that enables one to enjoy the *cost, performance and convenience advantages* of digital cordless phones in various situations.

Followings are basic applications of PHS.

3.2.1 Mobile Telecommunications

Users outdoors can establish communication by accessing a cell station installed around town. As explained later, by accessing the household base station, **PHS** can be used at home as ordinary cordless telephone at the PSTN tariff.

A key PHS advantage over cellular phones is its superior economy. Though PHS adopts *micro-cell architecture,* the total cost of cell stations will be relatively low compared with cellular system. Generally, the current cellular system is constructed independently from the existing PSTN. While this architecture might also be proposed, an architecture that a PHS network would be constructed by means of attaching new function to existing PSTN/ISDN would be more efficient. This method allows carriers to drastically reduce the initial cost of facilities. This, in turn, allows the carriers to offer services at a reasonable cost to customers.

Idea of *"Mobile Telecommunication by PHS"* is illustrated in Figure 3.5 .

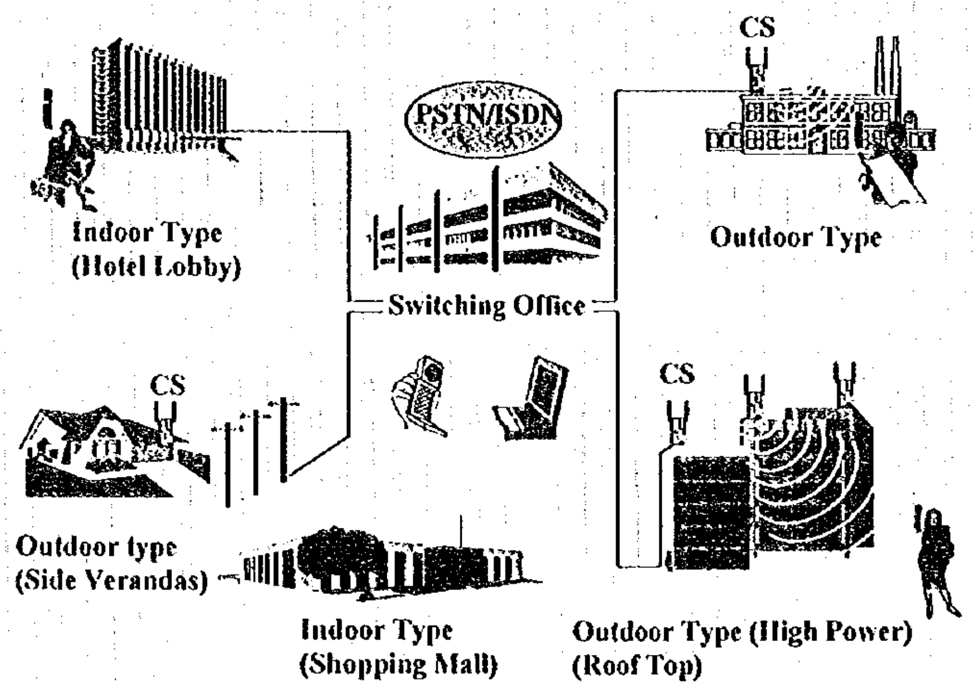


Figure 3.5 Idea of Mobile Telecommunication by PHS

3.2.2 Wireless Local Loop (WLL)

WLL is designed to serve the local loop or customer access network between the customer and the local exchange by radio. The connection of customers to their local exchanges is no longer restricted to physical media like copper wire, coaxial cable and optical fiber.

WLL offers the means to access the PSTN for the areas where the conventional local loop systems are not feasible. By introducing **WLL**, *the waiting applicants can be serviced with faster telephone installation, and the service providers can put into service with less investments, compared with the wired solution.*

PHS can be adopted for use as an economic and quick method of providing a "fixed" telephone service. Standardization of **WLL** adopting **PHS** had already been completed by **ARIB**.

Idea of *"Wireless Local Loop by PHS"* is illustrated in Figure 3.6 on next page.

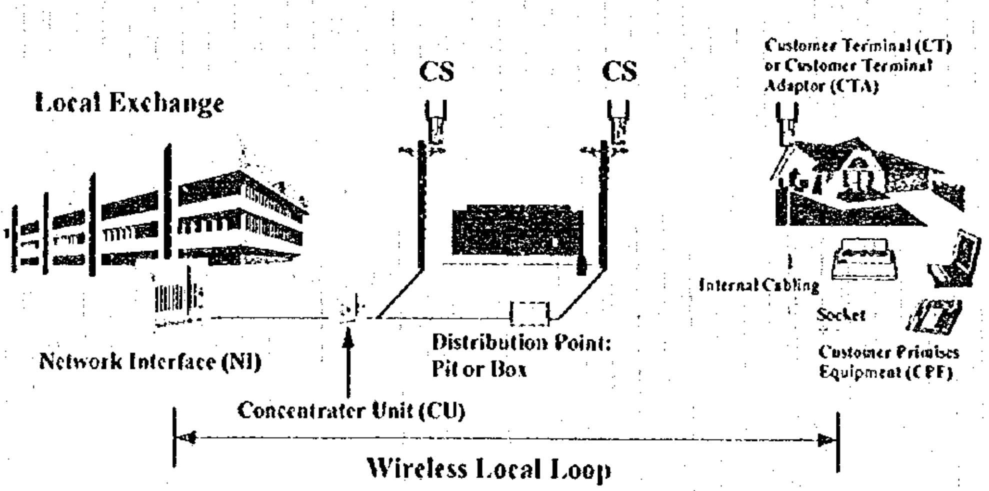


Figure 3.6 Idea of Wireless Local Loop by PHS

3.2.3 Indoor Application

PHS is also applied to digital wireless PBX which is used for digital wireless telephone system for office use. The system consists of personal stations, cell stations, and the wireless PBX. The wireless interface between the personal stations and cell stations is also standardized by ARIB. The wireless PBX has been realized by adding wireless functions to existing digital PBXs.

Followings are the features of PHS indoor system:

- -Wiring cost is saved by adopting PHS for indoor system in the office,
- -Seamless area network for communication is offered anywhere in the office,
- -Office cordless phone having many functions is useful while on the move in the office,
- -The system strongly supports network services and value-added services in the office, and
- -Non-voice communication is applied to facsimile and data terminals in the office.

Idea of *"Indoor Application by PHS"* is illustrated in Figure 3.7.

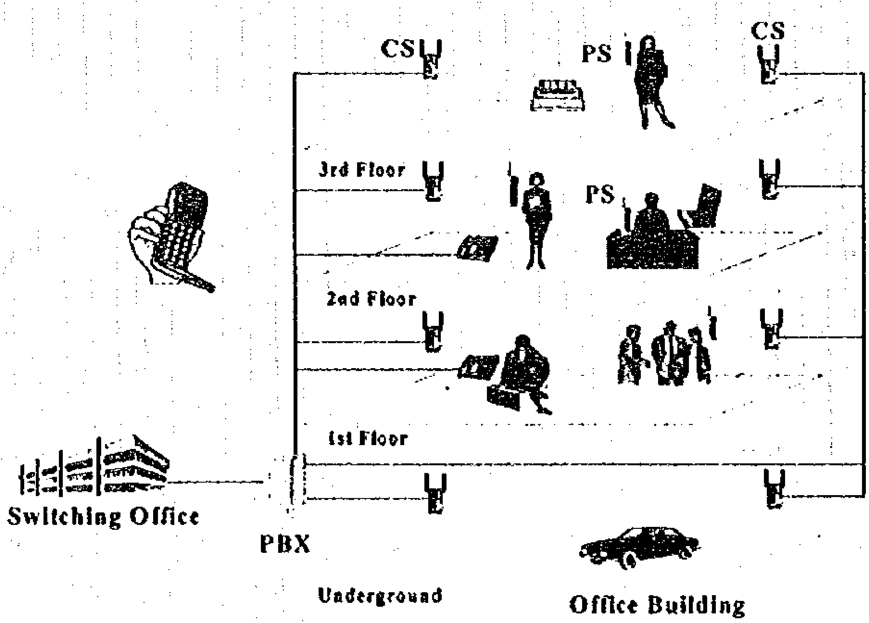


Figure 3.7 Idea of Indoor Application by PHS

3.3 System Configurations

3.3.1 Mobile Telecommunications

(1) General Network Architecture

To minimize the cost of the network, *it is desirable to utilize the conventional network and equipment as much as possible.* In particular, subscriber lines and exchange offices should be shared with other system in order to shorten the period for building the **PHS** network. General ideas of **PHS** network architectures are shown in Figures 3.8 and 3.9.

Figure 3.8 is an example of a totally new **PHS** network.

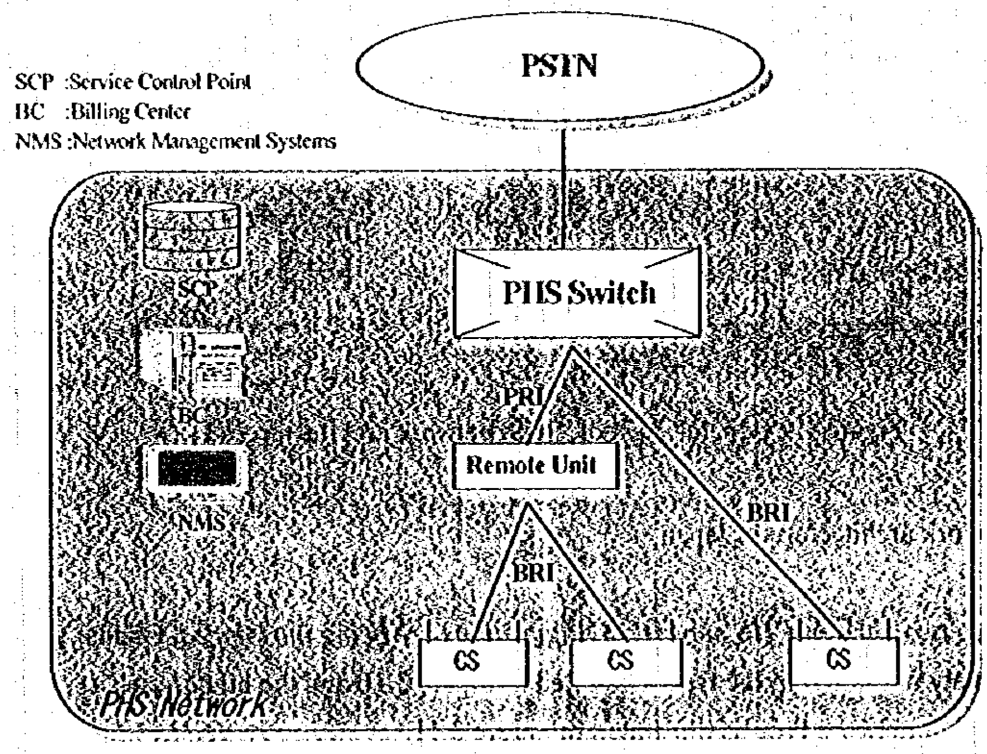


Figure 3.8 General idea of PHS network architectures (1)

Figure 3.9 shows the application of existing equipment. Other than implementing **Service Control Point (SCP), Billing Center (BC) and Network Management System (NMS)** specifically for **PHS**, existing equipment can be used. Depending on the situation, PHS adapter can also be a part of ISDN Switch, thus enabling PHS service to be offered.

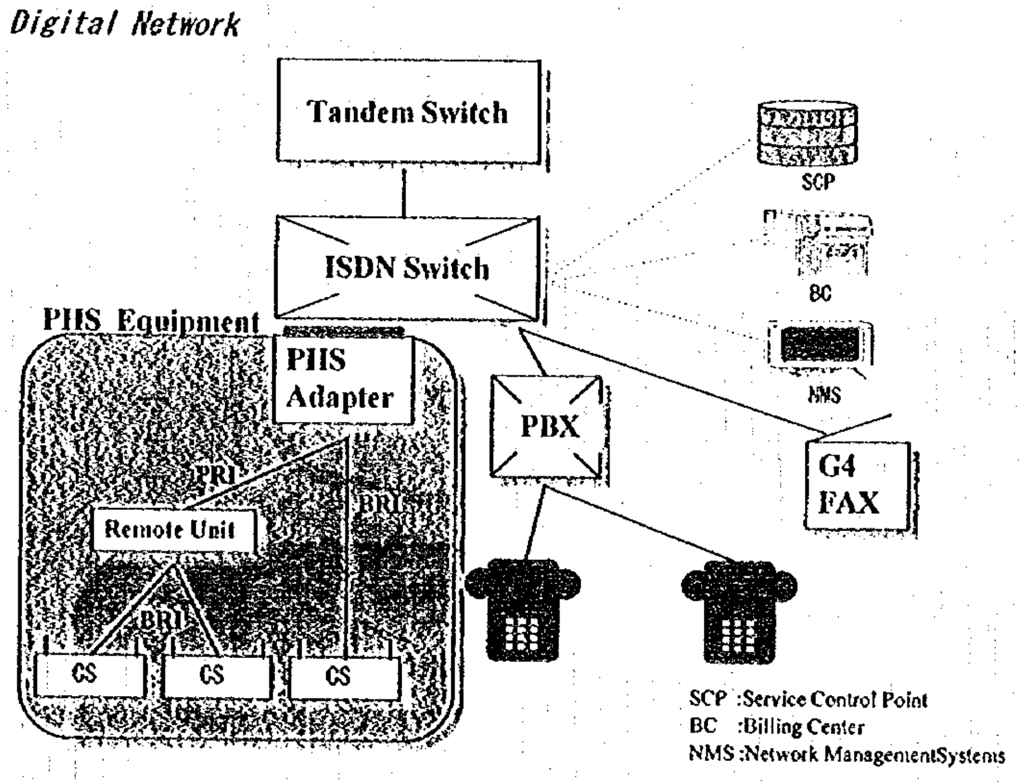
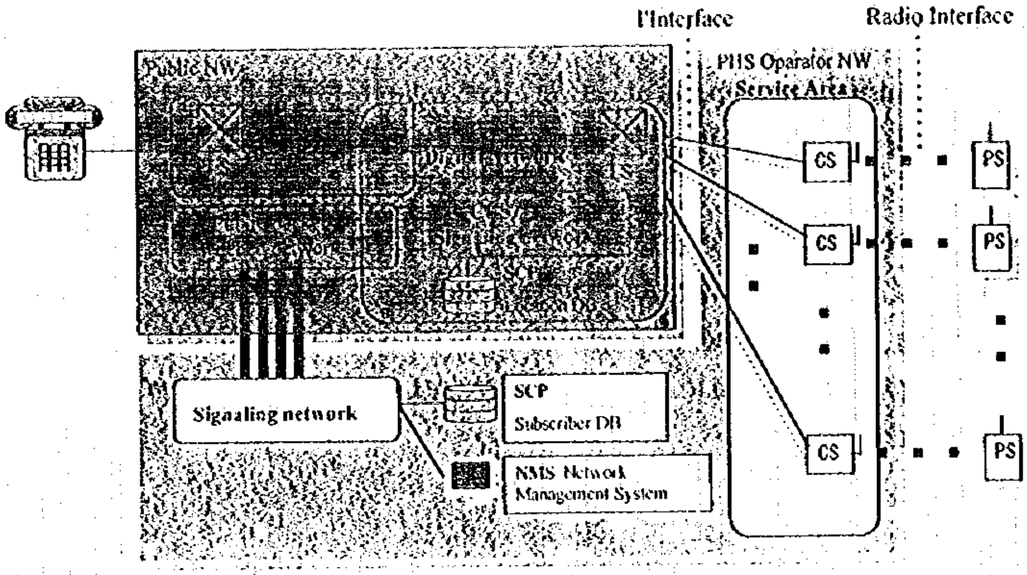


Figure 3.9 General idea of PHS network architectures (2)

(2) Network architecture in Japan

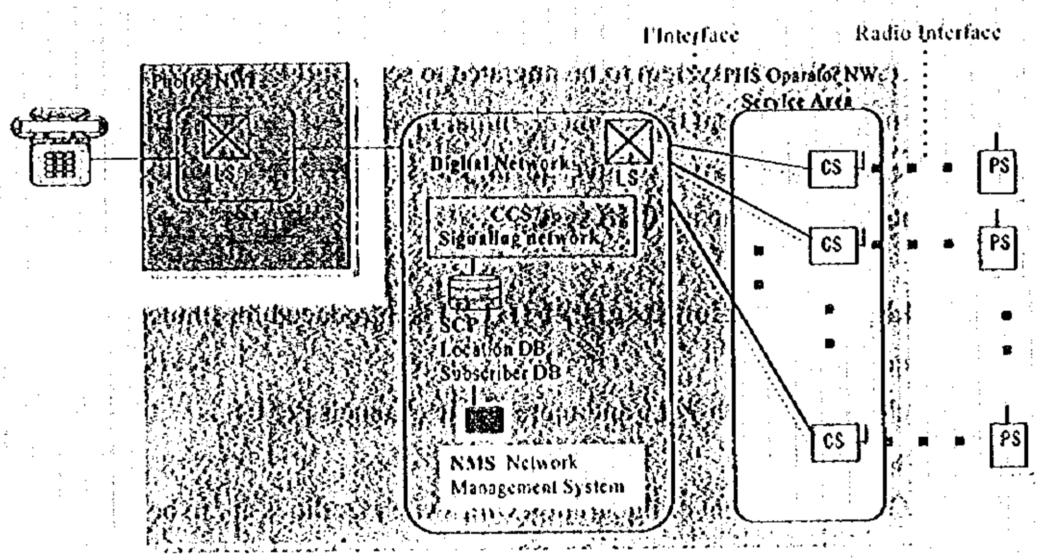
In Japan, two types of PHS network configurations are being introduced. One is public network utilizing the type illustrated in Figure 3.10 and the other is an independent network type as illustrated in Figure 3.11.

Total PHS network consists of cell stations and digital network. The digital network allows PHS cell stations to interconnect with fixed telephone networks (PSTN). Digital network consists of switching system, signaling network, packet network, SCP for service control function such as location registration and authentication, and NMS that manages entire network.



CS:Cell Station PS:Personal Station
LS:Local Switch CCS7:Common Channel Signaling System No.7

Figure 3.10 PHS Network Configurations (Public Network Utilizing Type)



CS :Cell Station PS:Personal Station
LS :Local Switch CCS7:Common Channel Signaling System No.7

Figure 3.11 PHS Network Configurations (Independent Network Type)

PHS operators that adopt the public network utilizing type maintains its own subscriber database and NMS in addition to cell stations and depend on fixed telephone network operator for the remaining functions.

PHS operators using the independent network type will provide their own fixed digital network, switching system, cell stations and databases.

One of the merits of *the public network utilizing type is that it requires less facilities owned by PHS operators and, consequently, needs smaller initial investment than independent network operators.* On the other hand, *the independent network operators will be able to develop new services without coordination with digital network operators.*

3.3.2 Wireless Local Loop

A typical PHS based WLL systems is explained.

(1) Basic System Configuration

It is the basic concept for the system to be migrated to serve full PHS features in future without major equipment replacement. Initial investment for the WLL solution will be protected in terms of investment. The system differs with the following points from an ordinary PHS system.

- **Small Home Location Register (HLR)** is introduced for limited mobility management,
- Multi-channel CS with 7 ,11 and more traffic channels per CS is introduced, and
- Small O&M equipment or integration with switch facilities are to be developed, such as small NMS for CS management, integrated BC and SDM.

Where, NMS : Network Management System
BC : Billing Center Facilities
SDM : Subscriber Data Management System

The NMS for CS, BC and SDM are specially required for PHS services in addition to end user serviceability. The system configuration of the PHS based WLL system is illustrated in Figure 3.12.

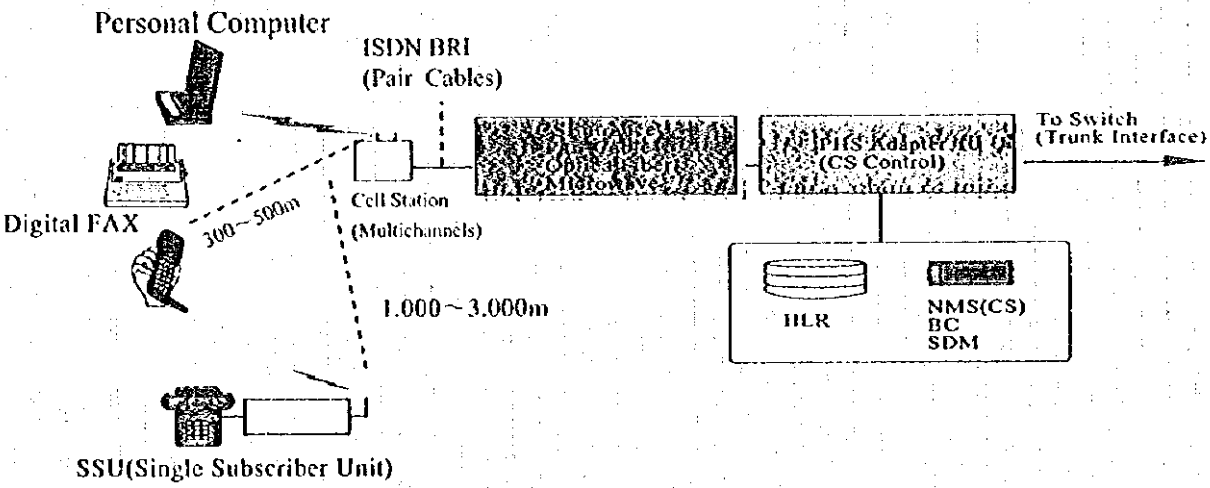


Figure 3.12 Basic Configuration of PHS based WLL System

In the figure, the PHS adapter terminates the PHS processing and interfaces to switching system by using an ordinary trunk interface. Since the PHS adapter has similar functions to a switching system such as charging, subscriber data management and office data management, it is not required to interface to the switching system by subscriber interface like analog pair cables.

The PHS adapter controls the PHS cell stations by using modified *ISDN Basic Rate Interface (I' interface)* as defined by TTC. There are various connection methods between CS and the PHS adapter, such as ordinary pair cables, optical fiber and microwave.

As for the CS for WLL solution, multi-channel CS will be utilized. It has more than 7 traffic channels in order to handle WLL subscriber traffic which is expected to be higher than that of an ordinary PHS subscriber moving outside. By using high power CS with more than 100mW (average) per channel and the external antenna equipped with the Single Subscriber Unit (SSU), it is expected that the location of WLL subscribers are 1,000 to 3,000 meters away from CS.

(2) Application of PHS based WLL

Usually, *the **PHS based WLL** system is suitable for urban and suburban application due to its small coverage area of PHS radio zone.* However, it can be applied also to rural areas if the suitable radio transmission equipment is used between a switching system and CSs. One of such possible transmission equipment is a point to multi-point TDMA system. A typical example of system configuration using the point to multi-point TDMA is illustrated in Figure 3.13.

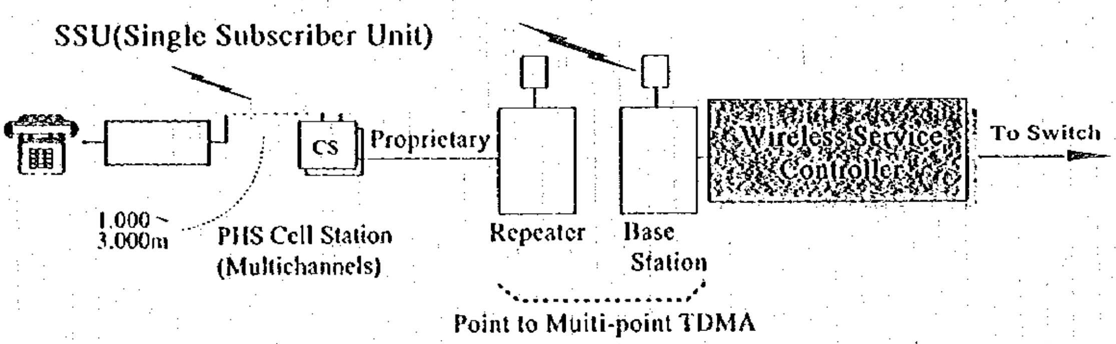


Figure 3.13 Applications of PHS based WLL System

The **wireless service controller (WSC)** interfaces to a switching system by using standard subscriber interface such as an ordinary pair cables for digital interface. It enables the system to interwork with any switches. The WSC has a function to concentrate the lines and terminates any air interfaces from access networks.

The point to multi-point TDMA system is used for connection between PHS cell station and WSC to realize complete WLL from switch to subscribers. An example of radio frequency for the TDMA radio system is 1.5GHz or 2.4GHz band. *Distance between a cell station and switching system will be maximum of 1,000 kilometers.* Number of traffic channels per system is 60 to 120 on the TDMA radio system to cover rural area to suburban area. *Distance between SSU and CS, 1,000 ~ 3,000 meters will be ensured with PHS air interface* as explained before.

3.3.3 Indoor Application

Figure 3.14 shows the system configuration for one of PHS indoor applications. In the basic configuration, only the PBX is responsible for system control.

The cell station provides an *extension line interface (called a B interface) and air interface (called an A interface)* of RCR STD-28 compliant interface.

All control functions are implemented on a distributed autonomous control basis. The PBX accommodates those functions that are essential for fixed telephone system operation, while the radio-link control functions, characteristic of mobile telecommunications, are distributed to the PHS handsets and the cell station.

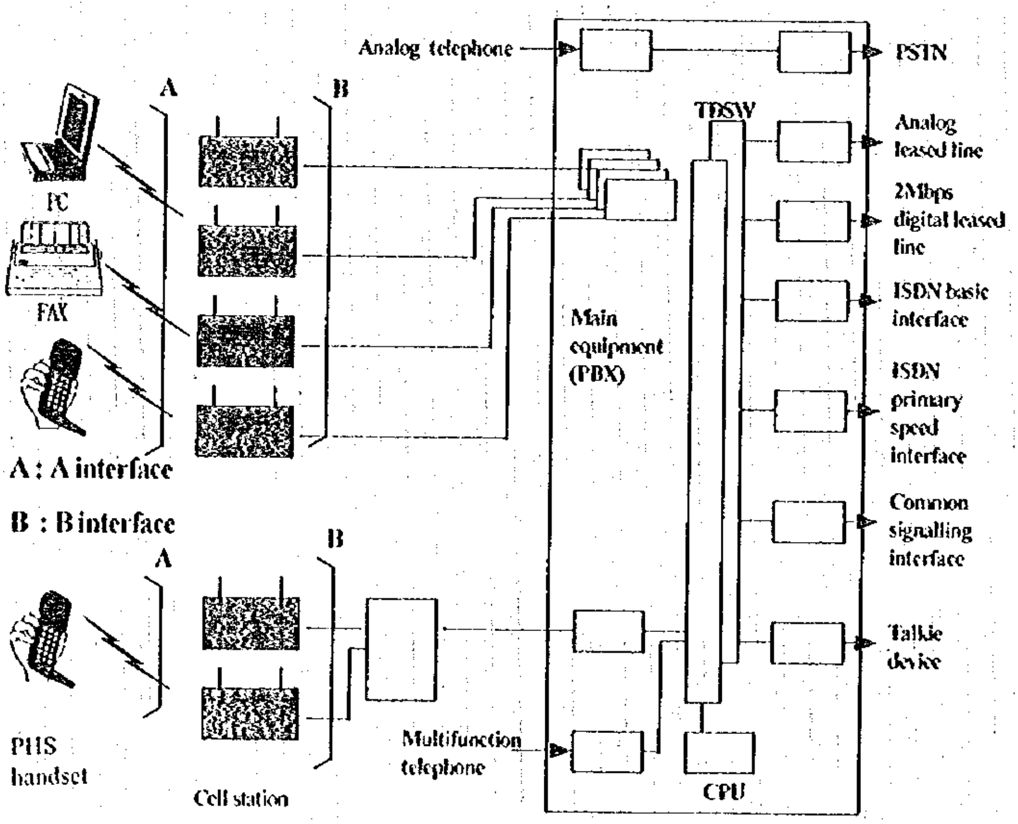


Figure 3.14 System Configuration

Chapter 4 Market Analysis

4.1 Market of the Mobile Telecommunications

PHS can provide mobile telecommunication service with low charges. Therefore, it is expected *PHS will be used by the general public and spread much more than existing cellular mobile telecommunication service.*

Following markets are expected to be the target of **PHS** in Japan:

- The market of the personal users,
- The market of mobile telecommunication in urban areas, and
- The market of data exchange using mobile telephone.

4.1.1 Market Size

According to the demand forecast by **MPT**, *30 percent of the Japanese population will use PHS, totaling 38 million of PHS handsets in circulation in the Japanese PHS market in the year 2010.* This is a figure based on the result of market research by questionnaire. However, *if one family purchases one PHS handset, it will be 43 million.*

If one person purchases one **PHS** handset, as many as **100 million PHS** handset will circulate in Japan.

It can be deduced from the result of the above mentioned questionnaire that the intention to use PHS turned out to be 100%, if the monthly basic charge does not exceed 3,000 yen. It can be said that this is a credible figure because the charge of 2,700 yen is offered when the service starts. The mass production system introduced to cope with the future increasing demand may contribute to the further reduction of charge.

4.1.2 Market Trend

4.1.2.1 Mobile telecommunication is becoming personalized

Recently, cordless telephone is increasing rapidly in Japan. It has gained a great popularity since 1987 when each manufacturer joined to enter the market and its demand is increasing steadily. *In late 1992, the total sales of cordless telephone exceeded 14 million units.* Now, it is said that there is nobody who has never used cordless telephone, because cordless telephone is used by so many families. Cordless telephone enables mobility inside house and even outside house although the area for use is limited. Pager market, too, has become vigorous with sharply increasing demand since the entry of new competitors in 1986 (Refer to Figure 4.1). *Especially, pager demand is sharply increasing among the young generation such as high school students. Approximately, 40 percent of the new subscribers in 1993 are female, 60 percent among which are in their teens and twenties.* The fact that cordless telephone and pager were favorably received by the general public indicates that there will be a demand for mobile telecommunication services among general public.

Under these circumstances, **PHS** is expected to call a larger demand and to penetrate deeply into the public since its advent just as was the cordless telephone.

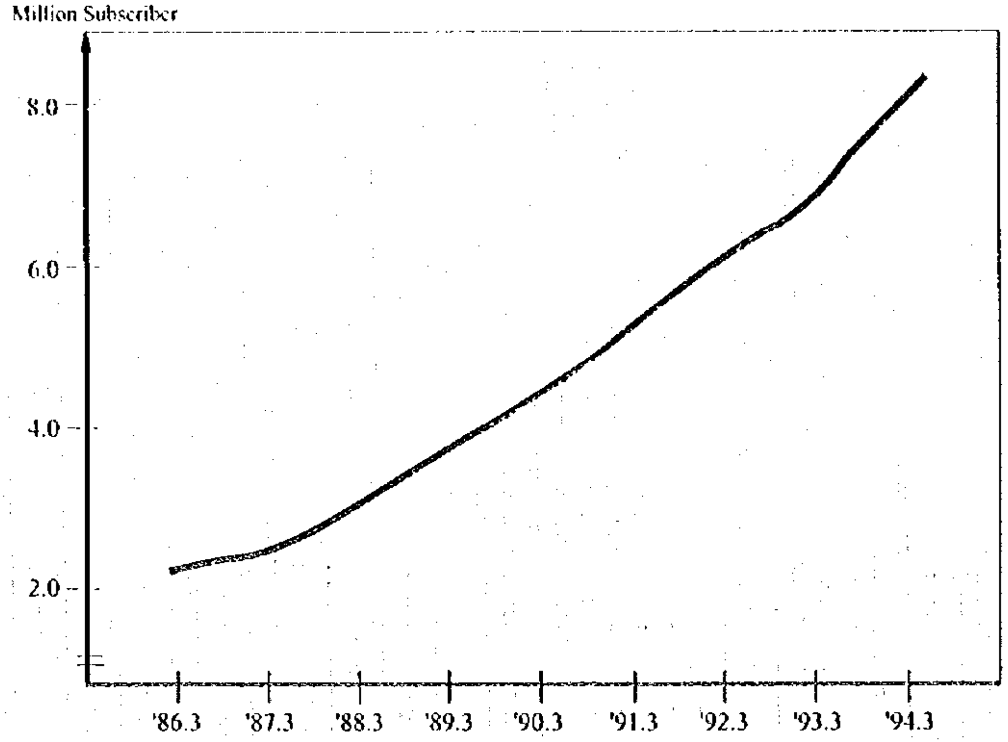


Figure 4.1 Subscriber of Pager in Japan

4.1.2.2 With low charges, PHS will be widely accepted by the general public

It is understood from the figure of survey result (Refer to Figure 4.2) that the public seeks economical charges besides such convenient feature as mobility.

Therefore, low cost feature of PHS will create a larger demand among the general public.

This is proved by the facts that subscribers of the cellular system are increasing rapidly after the charges became lower with the introduction of "Low-Call system" in 1994 (Refer to Figure 4.3). Number of subscribers became 4.32 million in 1994.

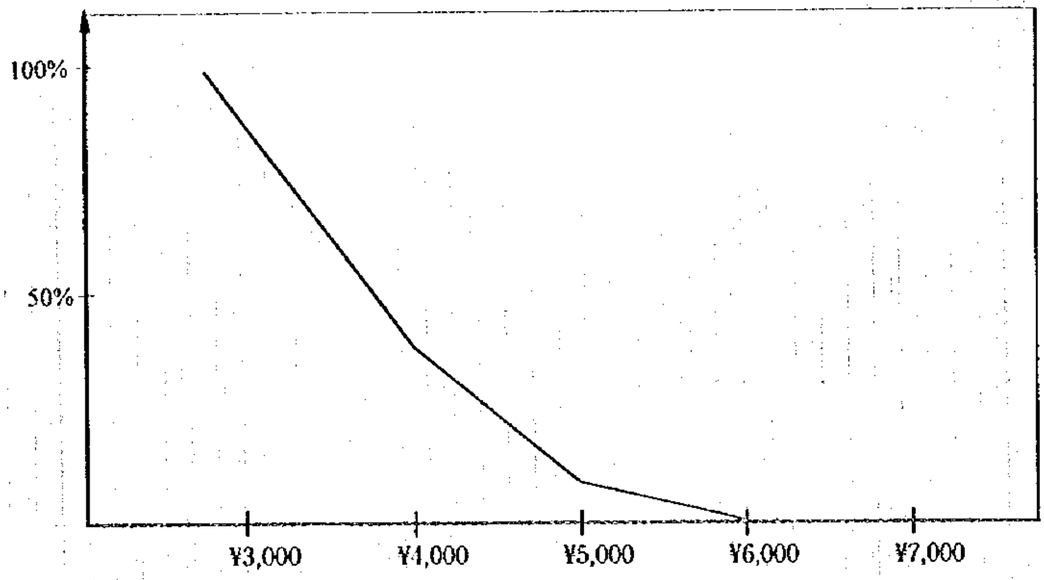


Figure 4.2 Result of Market Research

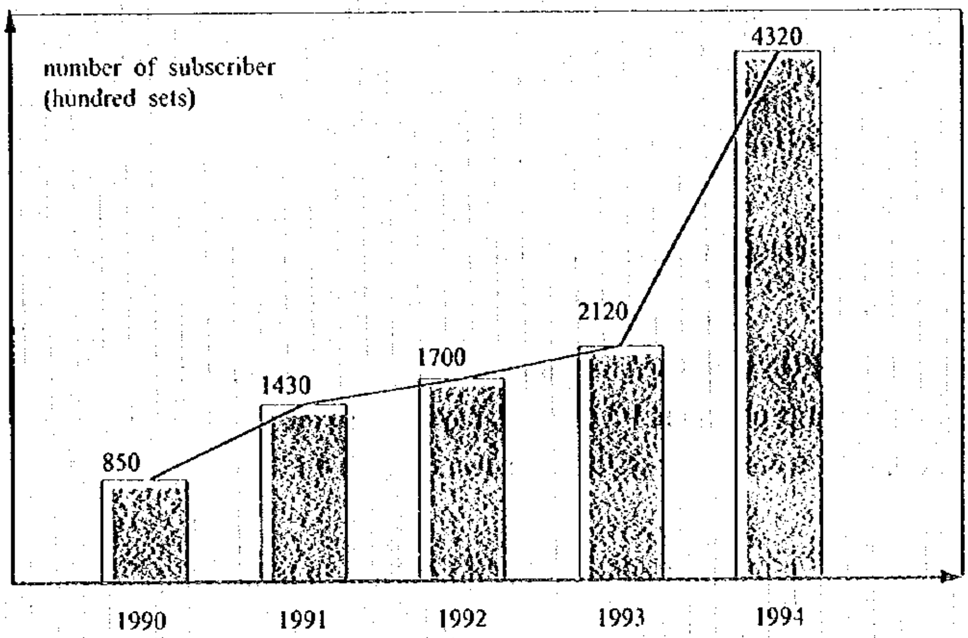


Figure 4.3 The change of subscriber of cellular system in Japan

PHS allows outgoing call, incoming call and low speed moving anywhere outside, similar to that of the cellular system. And the charges are low almost equal to existing fixed telephone. ***Not requiring high speed mobility like cellular system enables PHS***

network configuration very simple as shown in Figure 4.4. Moreover, *less infrastructure cost per one subscriber than cellular system is allowed by microcell structure with large traffic handling capability.*

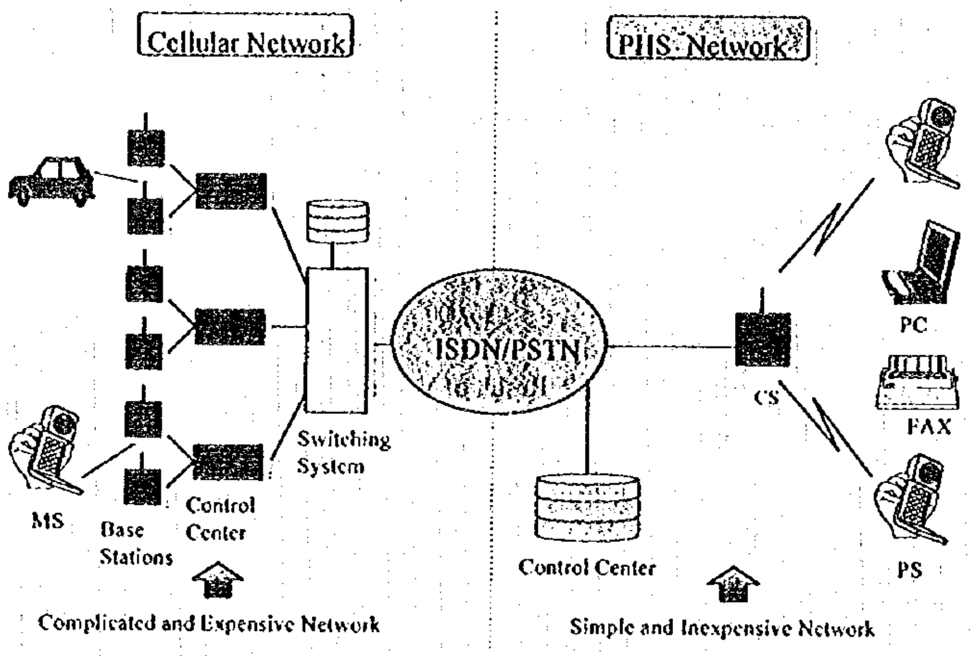


Figure 4.4 Comparison of System configurations

For these reason, **PHS** can be serviced with lower charges than cellular system. The monthly basic charge of PHS is 1/3 of cellular system and the charge for a local telephone call is 1/6 of cellular system as shown in Table 4.1.

Table 4.1 Comparison of the Charges in Japan

Item		PHS	Cellular ※
Monthly Basic Charge		¥2,700	¥8,400
Charge for 3 min. day time.	local	¥40	¥230
	160Km～	¥200	¥300

※NTT DoCoMo, Analog, Plan A (in 1995.6)

4.1.2.3 Mobile telecommunication market in urban area

One of the remarkable features of PHS is that the coverage area of one CS is quite small with the radius up to 500 meters and it has a large traffic handling capacity. This means that *PHS is suitable for service in the populous area with large traffic* as illustrated in Figure 4.5.

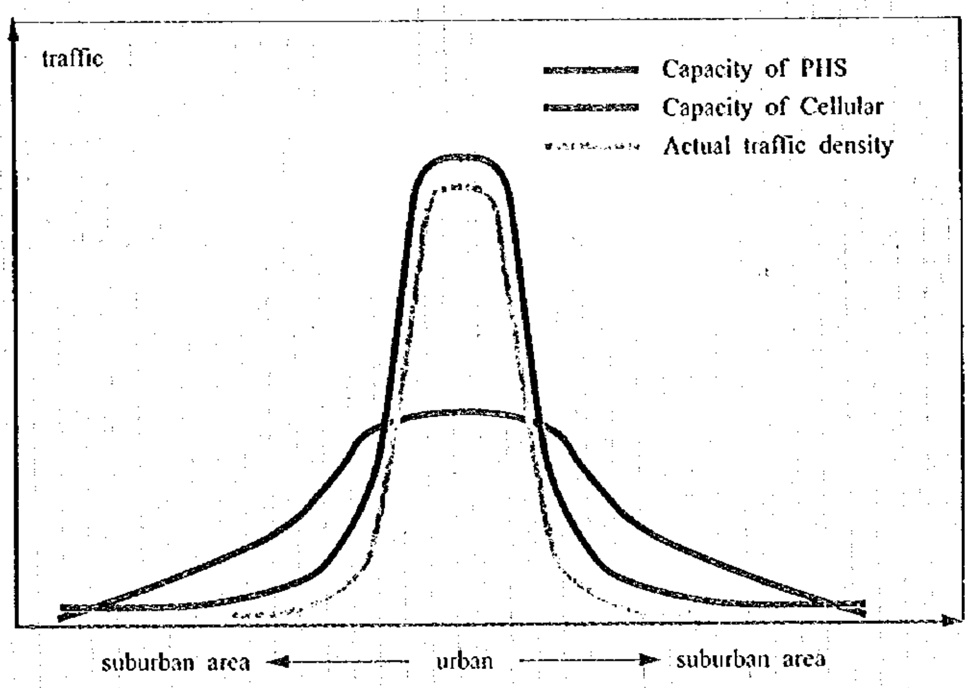


Figure 4.5 Traffic capacity distribution

In the urban area, there is a sporadic sudden increase in traffic demand at certain areas due to the construction of skyscrapers, and so forth. In this case, it is possible with PHS to install multiple CS to allow coverage area redundancy, because it adopts technology such as **dynamic channel assign (DCA)** that prevents interference, even if cells are not installed orderly. Therefore, it can handle increase in traffic demand easily. This is also one of the reasons why PHS is suitable for the service in the urban areas.

4.1.2.4 Potential demand for Mobile telecommunication by PHS

PHS has an outstanding data communication capability. One of the features of ADPCM voice encoding system is the capability to allow analog modem communication, which

enables fax transmission and simple data communication. Data transmission speed is 32 kbps. It is the speed to allow the transmission of 4,000 characters-worth information per second. **PHS** data transaction terminal will allow the access to data communication network such as Internet anytime, anywhere for mobile computing.
Therefore, **PHS** market will expand through a potential demand other than telephone.

4.1.2.5 Market structure after the introduction of PHS

The introduction of **PHS** will stimulate the mobile telecommunication market. Although in many occasions PHS is compared with cellular system, each target market is different as shown in Figure 4.6. Figure 4.7 shows the expected mobile telecommunication market after the introduction of **PHS**. *Cellular system target is for executives who seek high convenience regardless of the costs, while PHS target is for the general public who forms the periphery of the entire mobile telecommunication market.*

In proportion to increase of **PHS** demand, cellular market will also expand.
As a result, the entire mobile telecommunication market grows further.

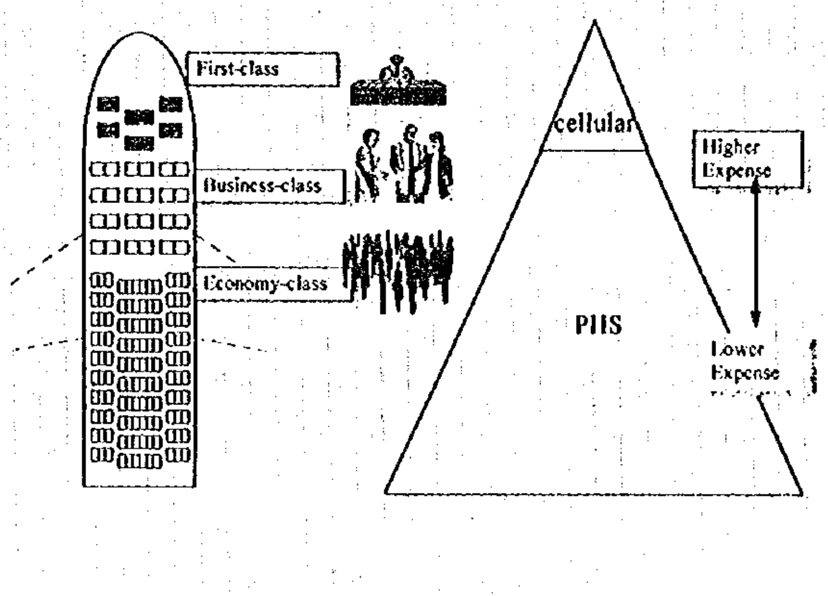


Figure 4.6 Market structure of mobile telecommunication

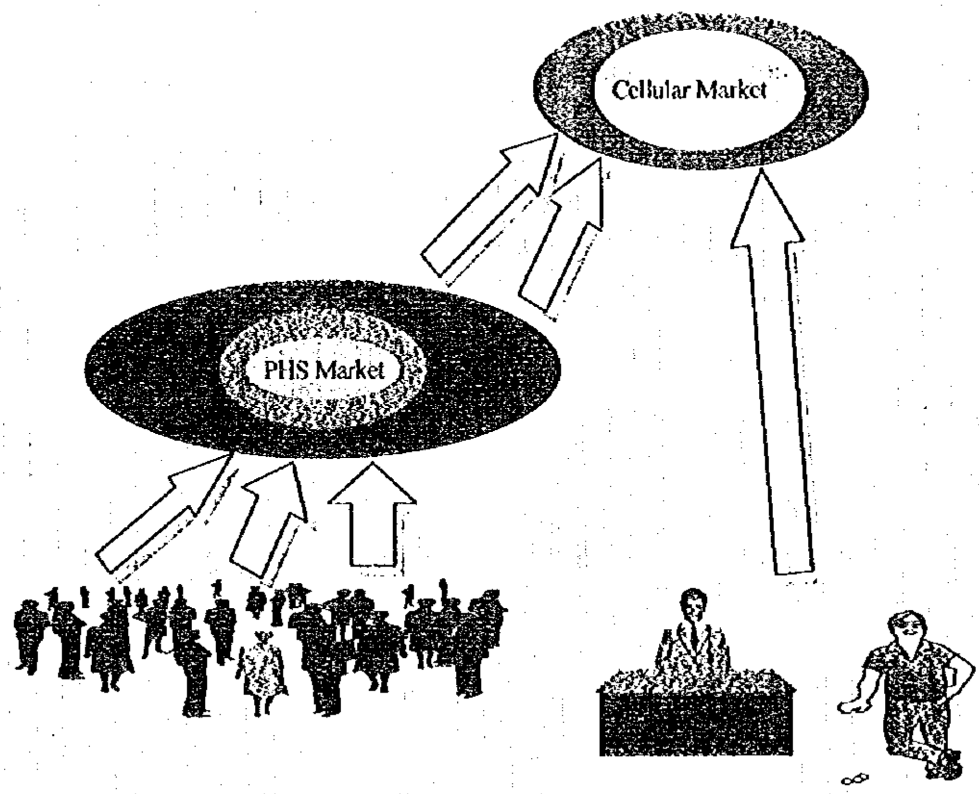


Figure 4.7 From PHS to Cellular System

4.2 *Market of Wireless Local Loop*

4.2.1 Market Size

Average telephone density of **OECD** member countries (Canada, France, Germany, Italy, Japan, UK, USA) is 51.7 telephone lines per 100 population in 1993. It will take a decade to increase 10 telephone lines per 100 population with use of the conventional wired local loop solution.

The countries, where the telephone lines per 100 population is less than 10, will take about 20 year time frame to accomplish 30 to 40 lines per 100 population with wired solution.

Considering the advantages of WLL against wired telephone, such as ease of construction work, short construction period, future expandability, low investment, robustness against disaster, and so forth, it can be said that the future telephone demand can be fulfilled effectively by combining the WLL solution and the conventional wired local loop solution.

Thus, potential market demand for WLL of each country can be calculated as follows:

wP = (rP - cP) × R

where ;

wP : Potential market demand for WLL

rP : Required phone number

cP : Current phone number

R : Expected Ratio to use WLL - 0.5★

★ This ratio shall be adjusted by planning authority of each country.

4.2.2 Market Trend

The telephone density in developing countries is rather low, even in large cities compared with cities in developed countries. However, the waiting applicants in the cities of developing countries are considerably high because of insufficient local loop facilities.

In such case, WLL has an advantage to quickly increase the number of telephone subscribers economically without new and additional constructions of conventional local loop facilities.

While the huge demand for the conventional wired local loop network exists, **PHS based WLL** is also suitable for the following markets ;

(1) *New operator to deploy quick and economic telephone service without constructing local cable network.*

(2) *Rural telephone service to meet economic and quick deployment of the telephone service eliminating the cabling investment.*

(3) *Quick and economical voice and data service to the high density and/or business area.*

(4) *Temporary telephone service such as restoration of failed wired network and urgent establishment of temporary circuits at disaster area or at exhibition/event sites.*

4.3 Market for Indoor Application

PHS Indoor Application is intended *for use in business offices, industrial complexes, shopping malls and large residential buildings such as apartments.*

Business-use cordless telephones are intended to transform business-use fixed telephone systems to a cordless platform. Thus, in addition to offering services characteristic of mobile communications, the system must also incorporate the total range of services traditionally offered through **Private Branch Exchanges (PBX)**. Through application of interface specifications that allow proprietary optional features, **PHS based indoor application systems** satisfy this requirement. Moreover, its expandability is one of their most valuable features.

With the characteristics of **PHS indoor application**, the market of wireless PBX is expected to grow in the future.

Chapter 5 Comparison among Systems

5.1 Comparison between PHS and Cellular System

5.1.1 General Comparison

PHS and cellular system are compared from the viewpoint of major technical items as shown in Table 5.1.

Table 5.1 General Comparison between Cellular System and PHS

Item	Cellular System	PHS
Radius of Each CS Coverage Area	1 to 15 km approx.	less than 500 m approx.
Available Areas	Wide areas covering cities, railways and main roads	Continuous coverage in Urban Area, Spot Area in the Suburbs
Service Network	Independent Network	Connect to ISDN / PSTN (Application of ISDN / PSTN)
Usage	Outdoor / Vehicular	Outdoor and Indoor (Home and Office)
Possible speed of handover	High Speed / Vehicle	Motorcar speed in downtown
Frequency Band	800MHz, 1.5GHz	1.9GHz
CS Tx Power (average)	500mW to 50W	less than 500mW
CS Size	1,800 Liters approx.	1-10 Liters approx

5.1.2 Comparison of Network

The network architecture for Cellular System and PHS is shown in Figure 5.1.
PHS network architecture is simple and inexpensive. Therefore its construction cost is low compared with Cellular System.

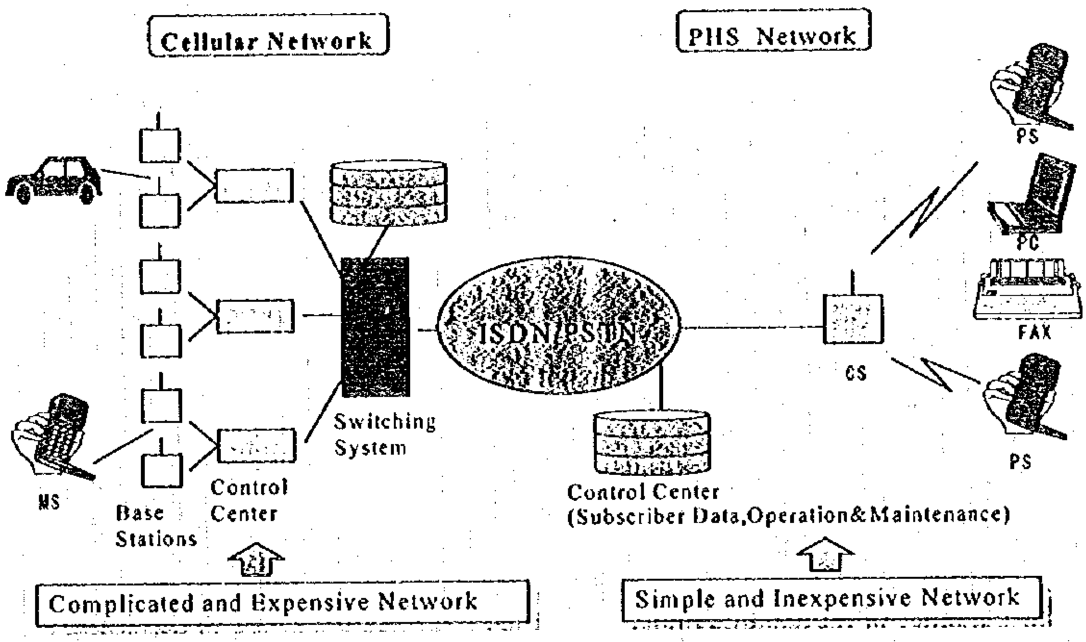


Figure 5.1 Networks for Cellular Systems and PHS

5.1.3 Comparison of Cell Station Construction Cost

The Comparison of CS construction cost between Cellular System and PHS is shown in Table 5.2. In the case of Tokyo, the cost of PHS CS construction per one subscriber is only one sixth of that of Cellular System.

Table 5.2 Comparison of CS Construction Cost

Item	Cellular	:	PHS
Number of CS in Tokyo Metropolitan area	60 approx.	:	40,000 approx.
Cost ratio for single CS	200	:	1
Total CS Cost (ratio)	1	:	3
Subscriber Capacity (ratio)	1	:	20
Ratio of CS construction cost per each subscriber	6	:	1

In this case, cost ratio for single CS is empirical and subscriber capacity ratio is estimated in consideration of the number of CS per coverage area (number of CS/km^2). It can be concluded that PHS is the inexpensive system supported by low cost CS, compared with Cellular System.

5.1.4 Other PHS Features

Followings are PHS features which do not exist in cellular system.

(1) Smaller size and longer operation time of handsets because of the smaller transmission power.
(2) Smaller CS can be installed anywhere, even underground shopping areas, inside buildings or rooftop of buildings.
(3) PHS hand over is feasible only at limited speed.
(4) Subscriber capacity increased by reusing the same frequency.

5.2 PHS in Comparison with DECT, PACS and CT-2

5.2.1 General Comparison

Comparison with DECT, PACS and CT-2 from the viewpoint of major technical elements is shown in Tables 5.3 and 5.4 as well as in Figure 5.2.

Table 5.3 General Comparison of PHS, DECT, PACS and CT-2 (1/2)

Parameters	PHS	DECT	PACS	CT-2
Frequency (MHz)	1,895-1,918.1	1,880-1,900	Up Link: 1,850-1,910 Down Link: 1,930-1,990	864.05-868.05
Duplex Method	TDMA / TDD	TDMA / TDD	TDMA / FDD	FDMA / TDD
CS Tx Power Average (Peak)	500mW(4W) 20mW(160mW) 10mW(80mW)	10mW(250mW)	800mW	5mW(10mW)
PS Tx Power Average (Peak)	10mW(80mW)	10mW(250mW)	25mW(200mW)	5mW(10mW)
Voice CODEC	32kbps / ADPCM	32kbps / ADPCM	32kbps / ADPCM	32kbps / ADPCM

Table 5.4 General Comparison of PHS, DECT, PACS and CT-2 (2/2)

Item	PHS	DECT	PACS	CT-2
Radius of service zone	100-500m	100-150m	300-800m	50-150m
Mobility	Motorcar speed in the downtown	Walking speed	Motorcar speed	Stay
Call function	Both way	Both way	Both way	No incoming
Channel allocation	Dynamic	Dynamic	Fixed or QSAFA	Dynamic
Efficiency of radio frequency	300kHz, 4ch (75kHz/ch)	1,728kHz, 12ch (144kHz/ch)	300kHz×2,8ch (75kHz/ch)	100kHz, 1ch (100kHz/ch)
Extensibility of carriers	Flexible (TDD)	Flexible (TDD)	Restricted (FDD)	Flexible (TDD)

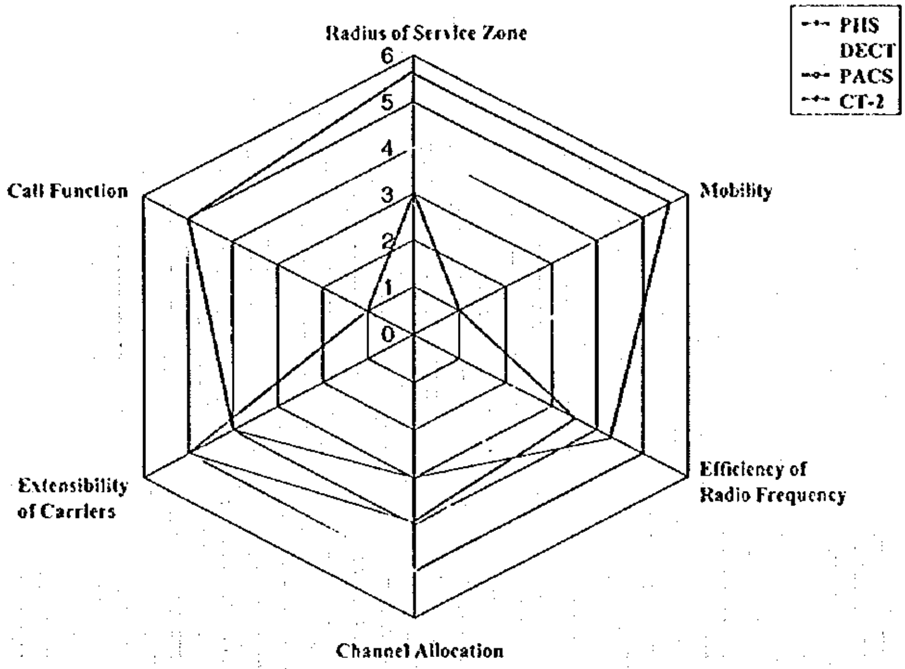


Figure 5.2 Comparison amonig PCS Systems

5.2.2 Comparison between PHS and DECT

PHS covers wider areas including outdoor public use and cordless home use, while DECT is suitable for high traffic wireless PBX environment as shown in Figure 5.3 and Table 5.5.

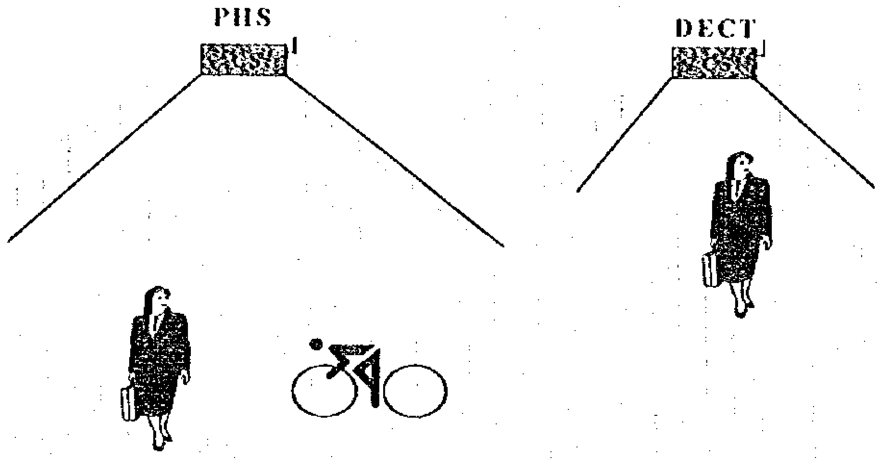


Figure 5.3 Comparison between PHS and DECT

Table 5.5 Comparison between PHS and DECT

Item	Efficiency of radio frequency	Radius of Service Zone	Mobility
PHS	300kHz, 4ch (75kHz/ch)	300-500m (384kbps)	Motorcar speed in the downtown
DECT	1,728kHz, 12ch (144kHz/ch)	100-150m (1,152kbps)	Walking speed

5.2.3 Comparison between PHS and PACS

PHS uses radio spectrum more flexibly and sharing the channel in both frequency and time domain, and no frequency assignment engineering is necessary for the installation of all stations as shown in Figure 5.4 and Table 5.6.

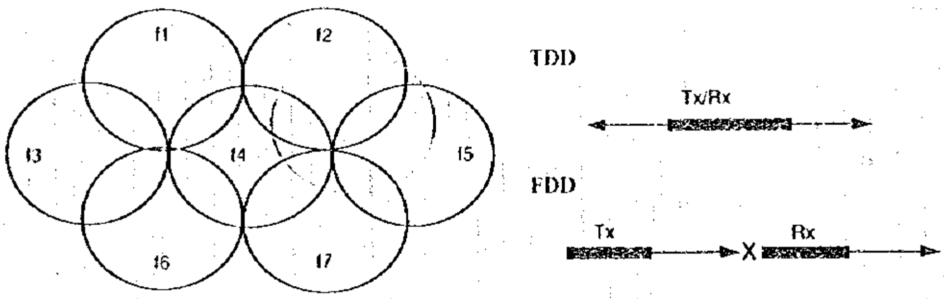


Figure 5.4 Comparison between PHS and PACS

Table 5.6 Comparison between PHS and PACS

Item	Channel allocation Method	Extensibility of carrier
PHS	dynamic allocation	flexible (TDD)
PACS	fixed for each base station	restricted (FDD)

5.2.4 Comparison between PHS and CT-2

PHS subscriber can enjoy the functions to originate and receive calls during moving, while CT-2 is limited to originate call on standing. In addition, one CS of PHS can handle 3 traffic channels at the same time, while one CT-2 base station is limited to handle 1 traffic channel.

Technical Comparison between **PHS** and CT-2 is shown in Table 5.7.

Table 5.7 Comparison between PHS and PACS

Item	Channels / carrier	Mobility	Call Originating / Terminating Function
PHS	4	Motorcar speed in the downtown	Originating and Terminating
CT-2	1	Stay	Outgoing Only

5.3 Comparison between WLL and Conventional Local Loop

The comparison of WLL and conventional local loop systems is summarized in Table 5.8.

Table 5.8 Comparison between WLL and Conventional Local Loop

Item		WLL	Conventional Local Loop
Infrastructure consolidation	Ease of construction work	Easy (Cell stations only)	Large scale
	Construction period	Short	Long
	Expandability	Easy expansion by increasing channels only on cell station	Large-scale work required if no spare cables available
	Adoption of new services	Easy in the case of digital system	Introduction of digital system required
Maintenance and operation	Economy	Maintenance for only cell stations	Maintenance over spread required
	Personnel	Small number of staff	Large number of staff because over spread
	Ease of operation	Cell stations only involved	Responded to over spread
Robustness to disaster	Content of Disaster	Cell station and subscriber premises	Possibly widespread (over spread)
	Measures for propagation path	Can be ignored	Extensive measures required
	Time to Recover	Short period (spot maintenance)	Long Period (over spread maintenance)

WLL provides several advantages over conventional local loop systems. These include in general:

- *Telecommunications facilities can be constructed in short time,*
- *Initial investment for facility installation is relatively small,*
- *Facility maintenance and operation are very easy, and*
- *Ease for providing adequate traffic handling capacity.*

(1) Short time service-in

Once switches and cell stations are installed, it will take only a few days to install PHS phone at subscriber's premises. Meanwhile, it will take much more time to install cables (sometimes requiring civil work) to each telephone set in the conventional local loop network.

(2) Between US$320 and US$360 instead of US$1,000

Installation cost of the cables to each telephone set in the conventional local loop system is said to be US$1,000 per line including switches and cables, but excluding telephone sets.

Meanwhile WLL requires only switches, cell stations and PHS handsets, and installation cost for WLL is said to be between US$320 and US$360 per line, excluding PHS handset although the cost depends on geographical situation and other circumstances.

(3) Ease of maintenance

Maintenance work is required for CS and media between CS and switching equipment for WLL, while the maintenance work is required for the entire local loop facilities for the conventional wired local loop system. Maintenance work volume is considerably small in WLL.

(4) Ease to increase traffic handling capacity

In case the traffic increase is expected at certain areas, what the service provider should do only is to install additional CS.

Supplement

PHS Base Technology

Table Of Contents

Section 1 PHS System Overview

1.1 System Configuration and Air Interface Specification

PHS service concept is to offer convenient service like the conventional portable phone service around town at inexpensive rates. For achieving this concept economically, it is concluded that it is essential to utilize the existing network rather than building a separate network anew as in the case of cellular/portable phone service. This approach will make it possible for users to enjoy the wide range of services with a digital network in order to achieve the required functions such as location registration, authentication and handover.

PHS uses dynamic channel assignment and autonomous decentralized radio channel control technologies, which enable **PHS** operators to realize efficient and flexible use of frequencies and release PHS operators from troublesome frequency re-use planning.

The Telecommunication Technology Council has examined a technical basis for the mandatory standard for the air interface between **Personal Station (PS) and Cell Station (CS)**. In April 1993, the Council submitted its final report on the interface standard to MPT. The air interface has been standardized as **RCR STD-28** by the **Association of Radio Industries and Businesses (ARIB)** which is a Japanese standardization organization for Radio and Broadcasting issues. The main features of **RCR STD-28** air interface specification is shown in Table 1.1.

The network interface between cell station and digital network has been standardized as JT-Q921-b, JT-Q931-b and JT-Q932-a by the **Telecommunication Technology Committee (TTC)** which is a Japanese standardization organization for network issues. The standardized network interface is based on an ISDN interface, which is modified to support **PHS** specific functions such as location registration, authentication and handover. **PHS** service control procedure and inter-network interface have been also standardized. For physical connection between cell station and digital network will make it possible to inaugurate commercial **PHS** service at rates that are only approximately one-third to one-half of those for cellular/portable phones. Figure 1.1 shows **PHS** system configuration.

Table 1.1 Air interface specification

Frequency Band	1.9 GHz
Access Method	TDMA / TDD
Traffic Channel / RF Carrier	4
Modulation Method	π /4 QPSK
Voice CODEC	32 kbp ADPCM
Transmission Rate	384 kbps
Output Power	CS : 500mW or less PS : 10mW or less
Carrier Spacing	300 kHz

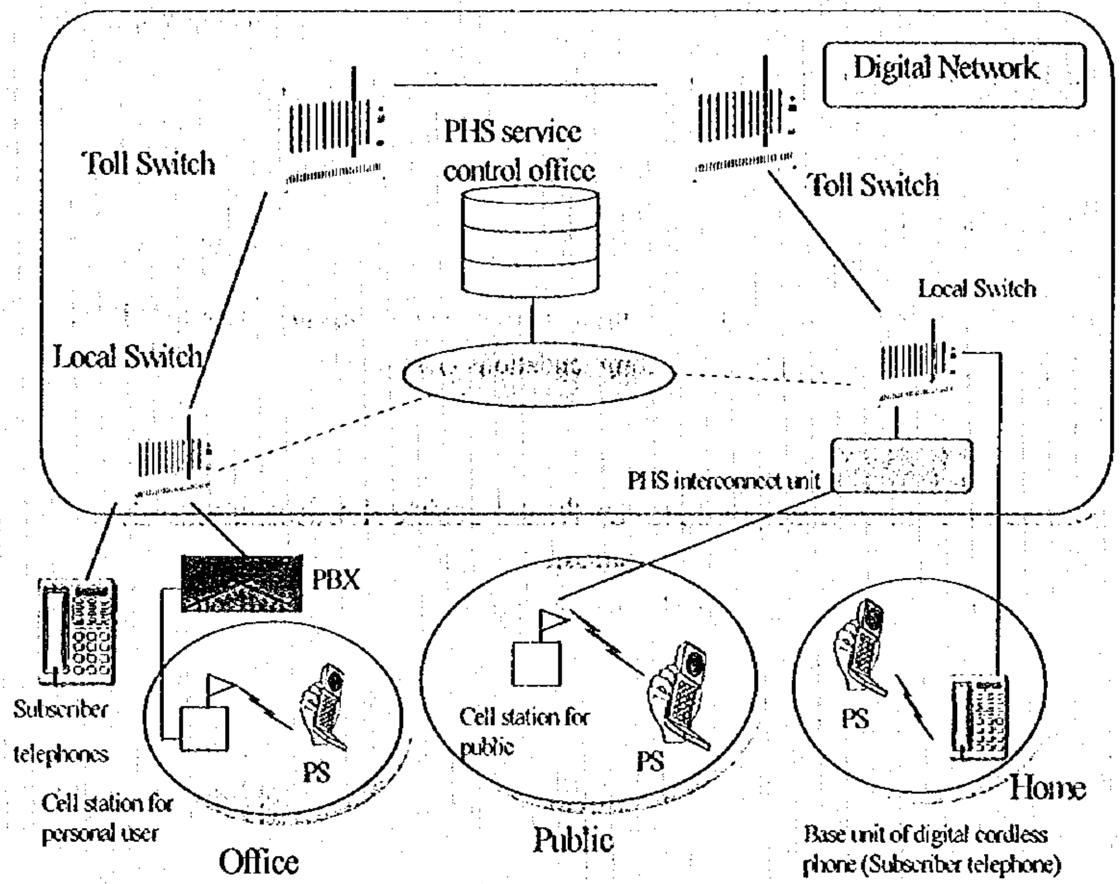


Figure 1.1 PHS System Configuration

1.2 Main Characteristics of PHS

1.2.1 Structure of TDMA/TDD time slot for PHS

Structure of TDMA/TDD time slot for PHS is as follows:

- 4-Channel multiplex for 1-radio carrier (TDMA),
- Duplex uplink and downlink on same radio carrier (TDD),
- Efficient use of radio carrier can be achieved, and
- TDD enables RF module to be a simple structure.

RF circuit is provided with the same structure for both uplink and downlink connection, and it can be used for direct communication between PHS handsets easily.

1.2.2 Audio Codec

The 64kbps full rate voice coding is employed first, then its signal is transcoded into 32kbps ADPCM based on ITU-T recommendations G.711 and G.726 respectively as shown in Figure 1.2.

The ADPCM compresses speech data, without degrading speech quality. Performance with voiceband data transmission using modems is not subject to significant degradation and applicable to non-speech service. Comparison of voice coding methods is given in Table 1.2.

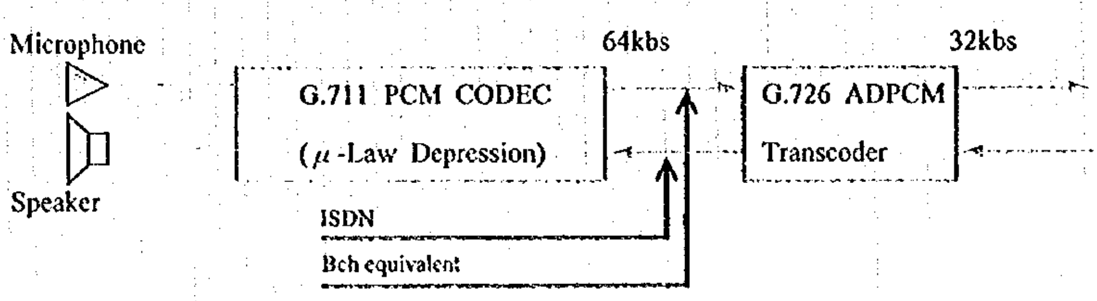


Figure 1.2 Voice Coding

Table 1.2 Comparison of Voice Coding

Item	PCM	ADPCM	V-CELP
System	ISDN	PHS,DECT,PACS, CT2+	Japan Digital Cellular American digital Cellular
Bit rate (Compression)	64kbps	32kbps	11.2kbps(Japan) 13kbps(US) -Full Rate-
Audio quality	○	○	△
Data transmission	◎	○	△

1.2.3 Encryption function for PHS

PHS has a standardized encryption function as shown in Figure 1.3.
Encryption is performed with EX-OR based on the pseudo random data from PN16 generator circuit.

Encryption key is the 4-character hexadecimal number which is stored as the initial value for the scramble circuit. This encryption key is transmitted to CS in the service channel establishment phase.

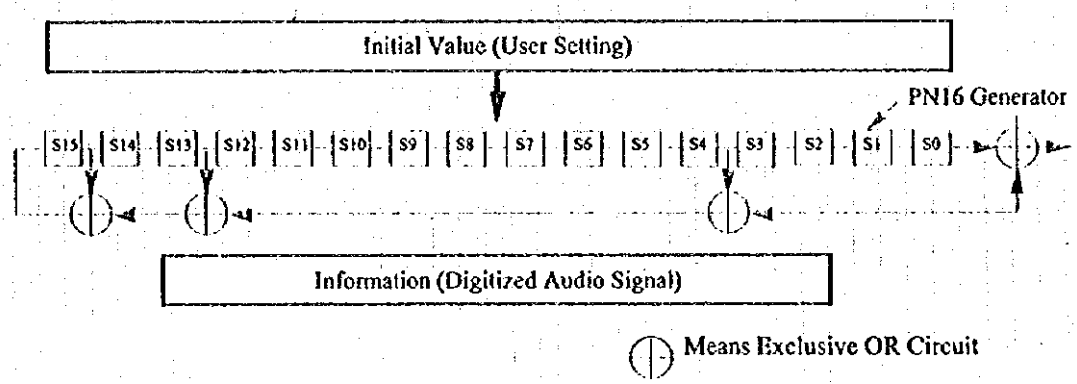


Figure 1.3 Encryption Function for PHS

1.3 Essential Elements of PHS

1.3.1 Outline

Figure 1.4 shows the configuration of PHS. The shaded sections are the main parts of equipment newly added for PHS service.

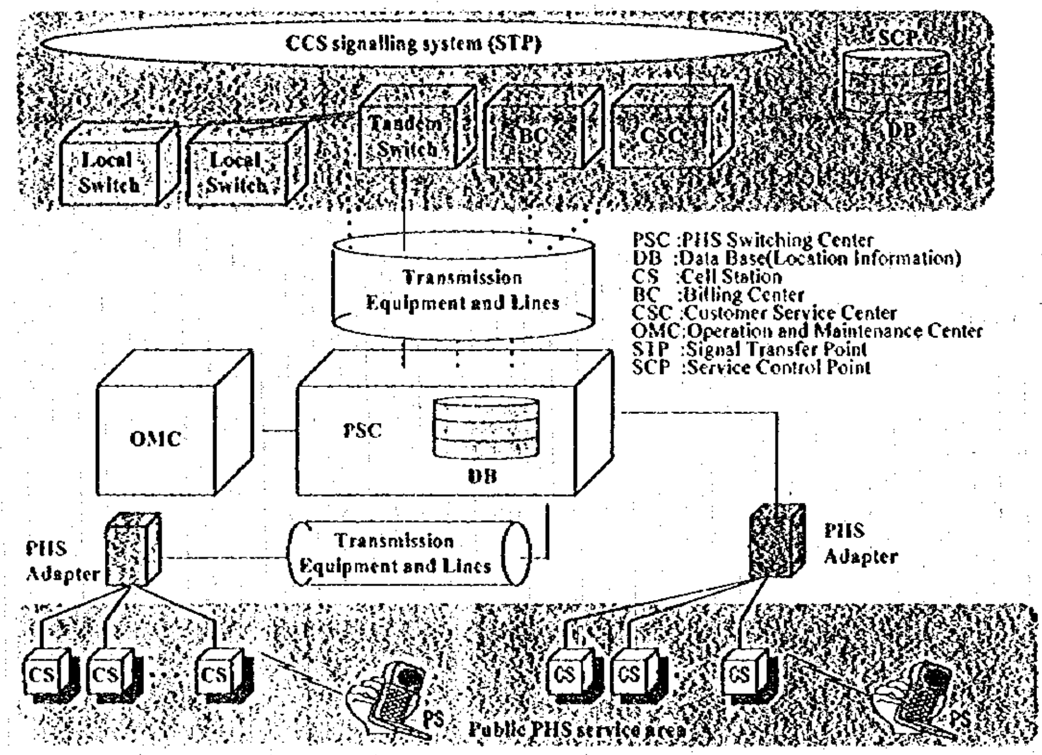


Figure 1.4 PHS System Configuration

1.3.2 PHS Switching Center (PSC)

There are following two typical network configurations for developing PHS.

(1) Use of existing PSTN /ISDN in establishing PHS network, and

(2) Establishment of independent PHS network from existing PSTN but use of PSTN for inter-connecting PHS networks, like cellular system.

The configuration of PSC depends on which way the operation company would choose. Figure 1.5 shows 3 different PSC implementation plans. For an operator who can use PSTN/ISDN, plan 1 or 2 gives an advantage of reducing the initial investment for introducing PHS.

Table 1.3 shows specifications of PHS Adapter as an example.

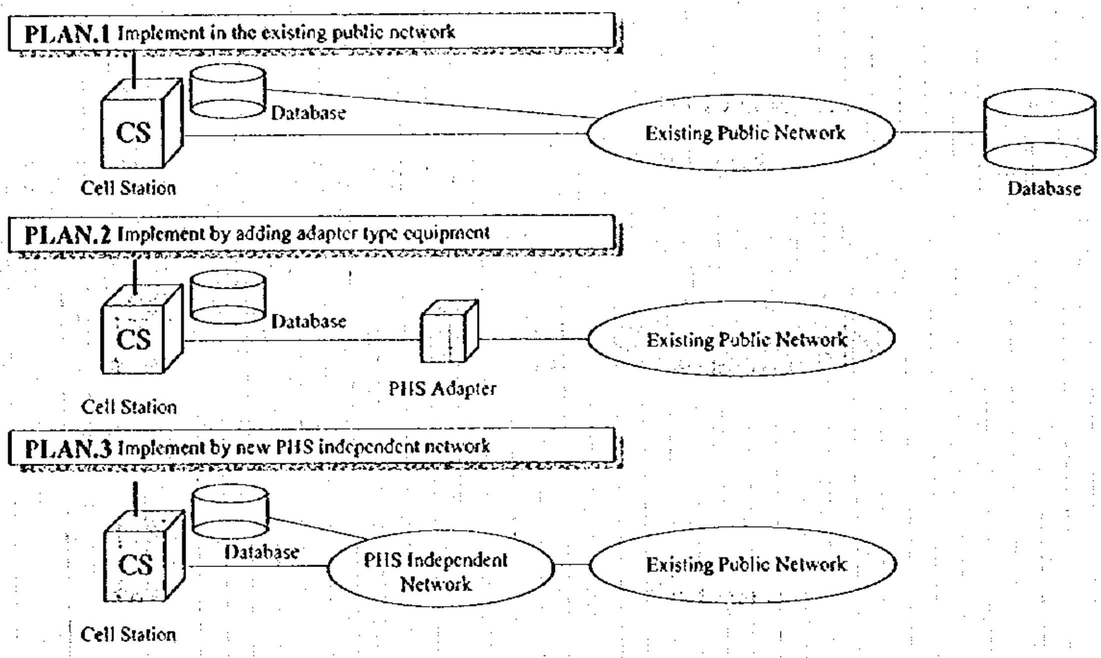


Figure 1.5 Three PSC Implementation Plans

Table 1.3 Typical PHS Adapter Specification

Item	Contents
Traffic limit	10,000 BHCA
Maximum number of CS units	780 units
Maximum number of lines per CS	8 lines(15 B ch)
CS interface	1 interface (BRI: Basic Rate Interface)
Maximum number of lines per PHS-EX	24 lines (540 B ch)
PHS-EX interface	1 interface (PRI: Primary Rate Interface)
Primary Rate	1.5 Mbps

1.3.3 Cell Station

Microcell structure is adopted in PHS, and many indoor/outdoor CSs are required. In implementing PHS service, the following types of CS are used in general.

(1) Indoor type .... Low output type (ex: 10 mW)
(2) Outdoor type ..... Standard output type (ex: 20 mW)
High output type (ex: 100 to 500 mW)

Figure 1.6 shows an example of CS installation.

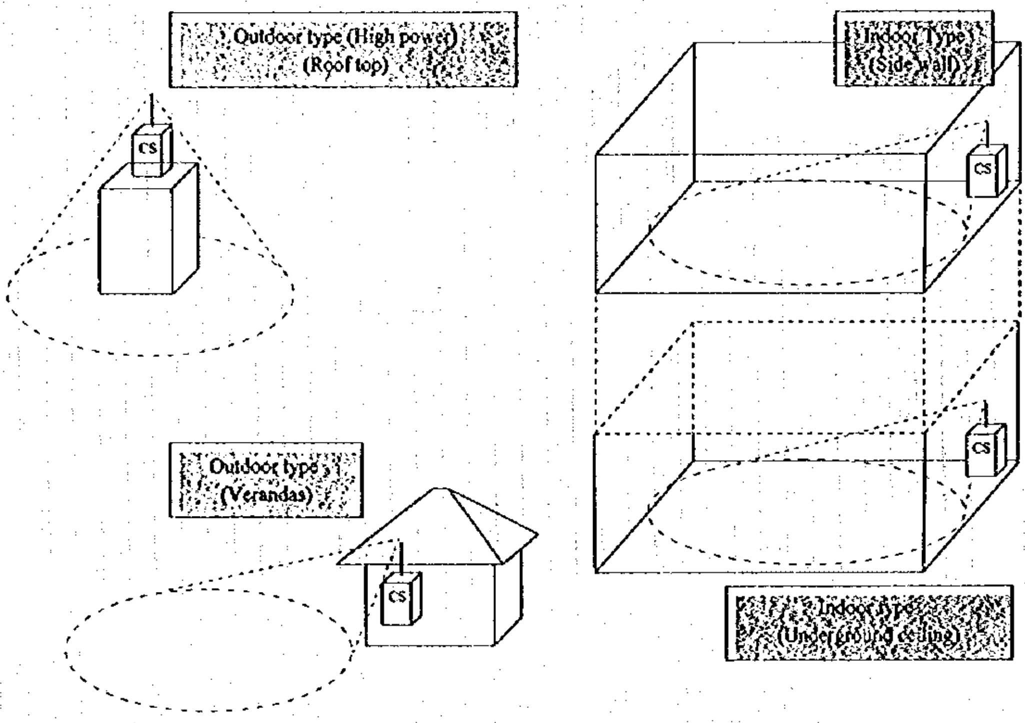


Figure 1.6 Example of CS Installtion

CS has the function called "Group Control " to increase communication channels (T-ch) in an area with heavy traffic for controlling multiple CSs via the same control channel.

Table 1.4 shows the typical CS specifications of the standard type.

Table 1.4 Typical CS Specifications of the Standard Type

Item	Present Specification
RF Output Power	20mW (Average)
Network Interface	ITU-T Rec. G.961 (TCM／TCH) Basic Interface (2B+D)×2
Size	A4 document Size (approx. 5 litter)
Weight	Approx. 4kg
Power Consumption	Approx. 15W
Power Source	Local Power Feeding (AC 100V) (AC 220V version will be also available)
Counter Plan for Power Failure	Battery Back-up (Optional)

1.3.4 Personal Station (PS)

PS for PHS service can be used at home, office, and outdoors. Furthermore, its transceiver function allows to the user direct communication with other PS. Table 1.5 shows the typical specifications of PS.

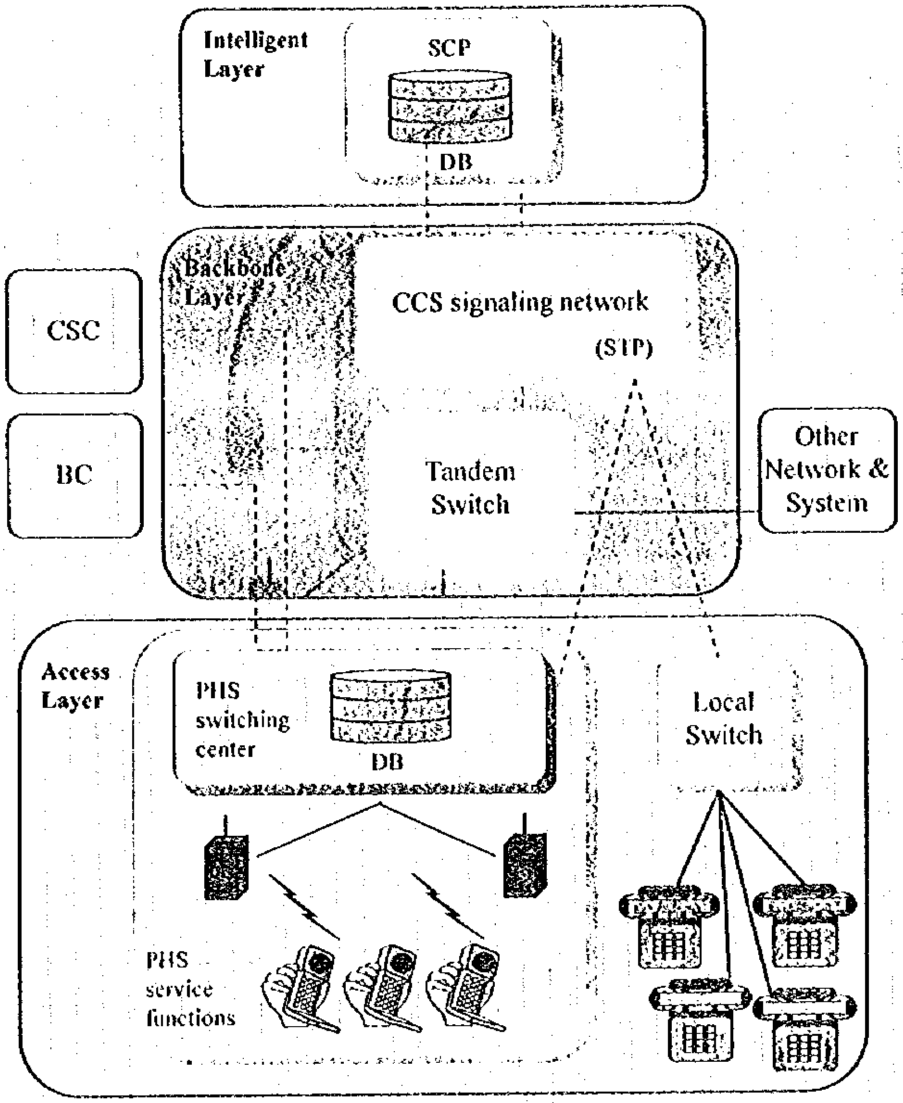
Table 1.5 Typical Specification of PS

Item	Present Specification (Example)
Size (W×H×D) (mm)	43×111×21 ~58×150×31.5
Volume	98~189ml
Weight	95~220g
Talk time	more than 4 hours
Stand-by time	more than 100 hours
Main features	· Enable calls to be made from anywhere - the home, the office, and the public. · Direct communications between PS · Back light for LCD and keys · Telephone number directory · Ring tone select · Loudness control · One touch re-dial

1.3.5 Intelligent Network (IN)

PHS network in IN application is shown in Figure 1.7. Since PHS network is used as the access layer in this application, making use of existing networks as a part of IN (for example, introduction of AIN recommended by ITU-T Q.1205) allows integration of control of various services of PSTN. It also has the integrated databases for mobile communication service with PHS networks. If database of location information is managed in SCP as shown in Figure 1.8, various control functions such as handover will be easily realized.

Implementation of IN will also lead to future mobile communication for UPT and other services.



STP:Signal Transport Point
SCP:Service Control Point
BC :Billing Center
CSC:Customer Service Center
DB :Location Information Data Base

Figure 1.7 Network Configuration

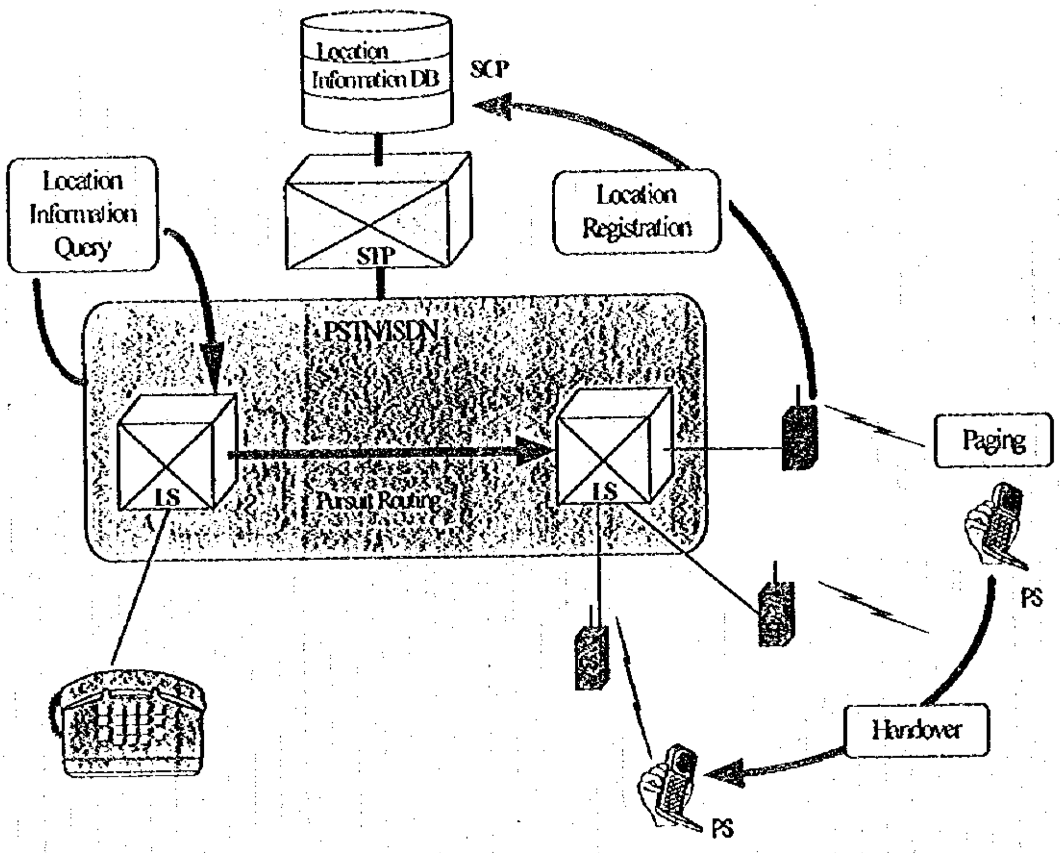


Figure 1.8 IN Application for PHS System

1.4 Frequency Allocation for PHS

Frequency allocation for **PHS** had been studied at the **MPT** using the report from the **Telecommunications Technology Council**, a consultative council for the **MPT**. The proposal for the 23 MHz allocation in the 1.9 GHz band was authorized in September, 1993 by a report from the Radio Regulatory Council. The report from the **Radio Regulatory Council** recommends the allocation of ***1895-1906.1 MHz for private use*** including direct communications between handsets, and ***1895-1918.1 MHz for public use.*** This allocation is made with reference to the traffic density and necessary spectrum consideration in the report from the ***Telecommunications Technology Council.***

Table 1.6 in the next page is the current frequency plan for **PHS.** *The total number of frequency carriers are 77.* Control carriers for private use are assigned to 1898.450MHz and 1900.250 MHz for Japan, and 1903.850 MHz and 1905.650 MHz for the countries other than Japan. 4 control carriers for public use are reserved, of which 3 carriers are assigned for each **PHS** operator respectively and one for spare in Japan.

Spectrum for public use is 12 MHz currently. Spectrum for private use is 11 MHz, which can be shared with public use. TDMA/TDD is adopted in **PHS**, therefore, use of pair channels is not required for two-way communication and both lower and upper side of spectrum can be easily expanded.

The cell station can automatically pick up carriers at random and select an available carrier which has no interference problem, and assign an available traffic channel. If available carrier does not exist, PS will automatically request a call set up again. Thus the system can automatically assign an available channel.

Any cell station can be added or moved without any consideration for frequency reuse plan. This is one of the characteristics in **PHS.** As the channel allocation scheme described above, channel is automatically assigned dynamically. Consequently, an operator does not have to carry out the frequency reuse engineering.

Table 1.6 Frequency Plan for Presonal Handy-phone System

Carrier	Frequency carrier(MHz)	Type of Use	Carrier	Frequency carrier(MHz)	Type of Use	Carrier	Frequency carrier(MHz)	Type of Use	Carrier	Frequency carrier(MHz)	Type of Use
1	1895.150		21	1901.150		41	1907.150		61	1913.150	
2	450		22	450		42	450		62	450	
3	750		23	750		43	750		63	750	
4	1896.050	Direct	24	1902.050		44	1908.050		64	1914.050	
5	350	communication	25	350		45	350		65	350	
6	650	between	26	650	Private	46	650		66	650	
7	950	PSs/Private	27	950	Use*1	47	950		67	950	Public Use
8	1897.250	Use	28	1903.250		48	1909.250		68	1915.250	
9	550	Private	29	550		49	550	Public Use	69	550	
10	850	Use*1	30	850	Control Ch(Ex.Japan) (Private Use) *3	50	850		70	850	Guard-ch
11	1898.150		31	1904.150		51	1910.150		71	1916.150	Spare C-ch
12	450	Control Ch(Japan) (Private Use)*2	32	450		52	450		72	450	Guard-ch
13	750		33	750		53	750		73	750	Control-ch1
14	1899.050		34	1905.050		54	1911.050		74	1917.050	Guard-ch
15	350		35	350		55	350		75	350	Control-ch2
16	650		36	650	Control Ch(Ex.Japan) (Private Use) *3	56	650		76	650	Guard-ch
17	950		37	950		57	950		77	950	Control-ch3
18	1900.250	Control Ch(Japan) (Private Use)*2	38	1906.250		58	1912.250				
19	550		39	550	Public Use	59	550				
20	850		40	850		60	850				

*1 This frequency bandwidth can be used for public use.

*2 For outside of Japan, it is used for communication carrier for private use.

*3 For Japan, it is used for communication carrier for private use.