1.5 Handover

Hand-over is the essential service for ensuring uninterrupted communication when **PHS** handset moves from one cell to another.

PHS has two hand-over types; one is "recalling-type" and another is "**traffic channel (TCH)** switching-type". In the recalling type hand over, change of communication channel is done in such a manner that handset establishes a connection by the same way as a call originating in a new communication cell. In the TCH switching-type hand over, change of communication channel is done in such a manner that handset establishes a connection by synchronizing burst signals.

There is a short time intermission when hand over occurs in the recalling type. As for hand-over process duration, the TCH switching-type is faster than the recalling-type. However, the TCH switching-type must assign a new channel from a new cell before hand-over with the self-control architecture in handset, and it is difficult to be realized at this time.

In **PHS**, hand-over is performed for across cell boundary in motorcar speed in the downtown. If new CS is not available when hand-over is required, communication channel is switched back to previous CS. Therefore, the communication channel is restored when returning quickly to previous cell.

Figure 1.9 explains hand-over from one cell to the other.

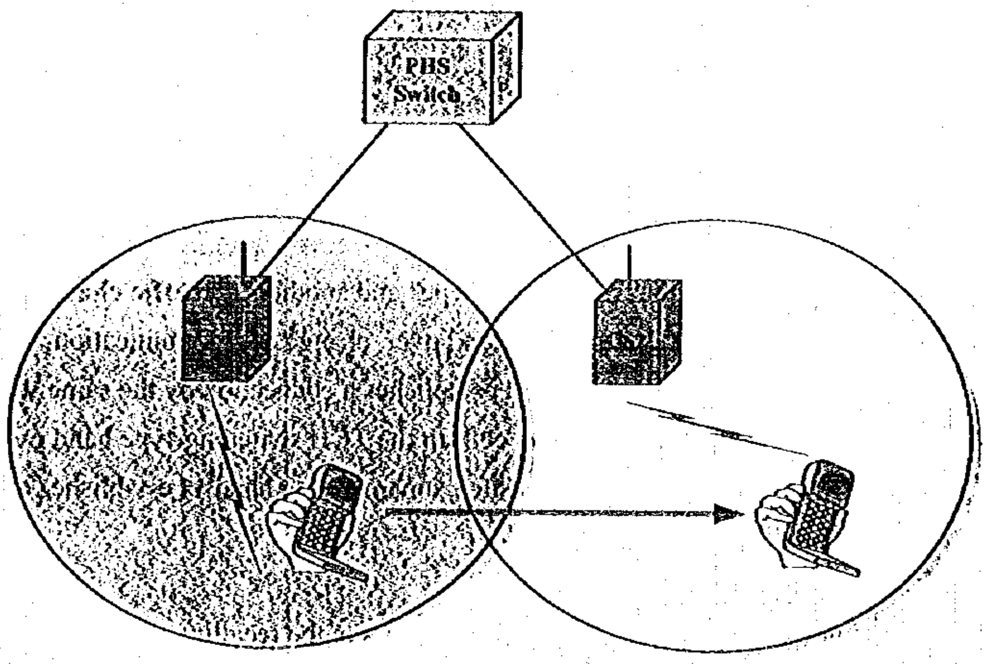


Figure 1.9 Handover from one cell to the other

1.6 Inter-Connection with Other Network and Roaming Capability

1.6.1 Inter-connection with Other Networks

Figure 1.10 shows the configuration of inter-connection between **PHS** and other networks. Inter-connection between cellular networks and **PHS** of multiple operators is made via fixed telephone network, i.e., PSTN by using **CCS No. 7 ISUP** signaling system, which is based on ITU-T recommendations and employed in existing networks.

1.6.2 Roaming Capability

Roaming capability is essential for providing the same service among multiple operators' by using the same PS.

Figure 1.10 shows how this roaming function is achieved in **PHS**. For accessing procedure to other **PHS** operator's database, use of **INAP** signaling system is recommended. As to the procedure of roaming control, **TTC** is now working on its standardization of JT-Q1218 framework.

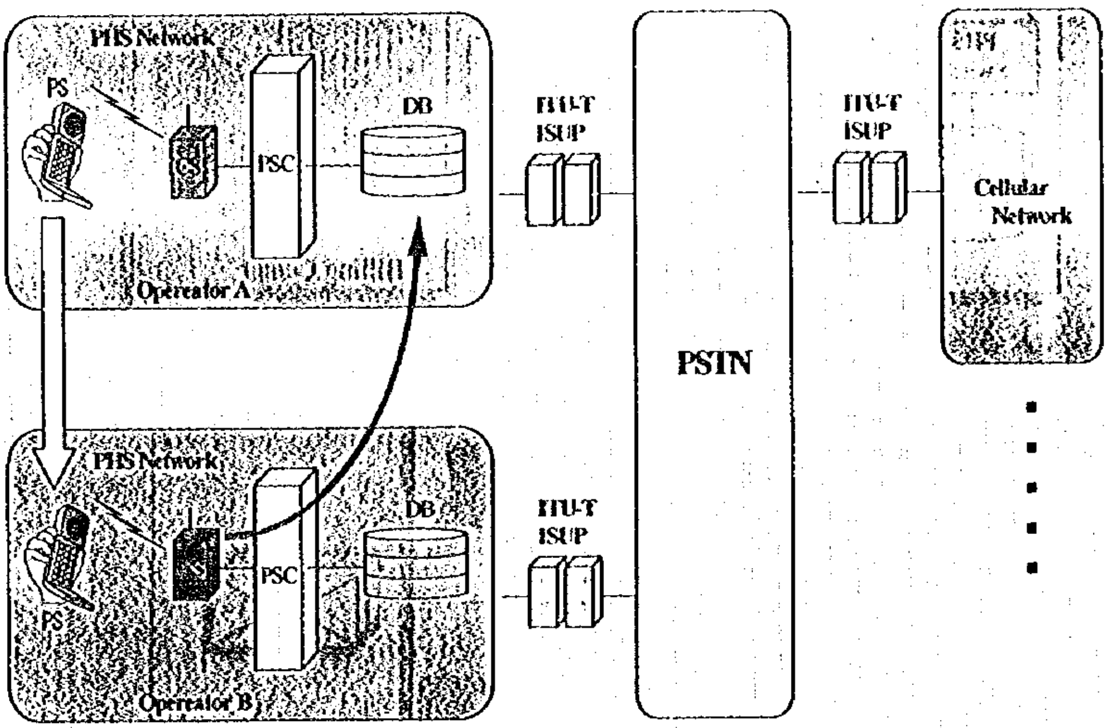


Figure 1.10 Network Interconnection

1.7 Billing System

Since a billing with detailed call information is required to keep good relationships with subscribers, the bills prepared by the billing system will provide detailed information on call by call basis. This will include the starting and ending times of the calls, the destination number and the call charge.

If subscriber is late in his payment, **PHS** services will be interrupted after the warning is issued. Services can be restored immediately upon payment. It is recommended to establish one billing center for processing call information efficiently, depending upon volume of **PHS** subscribers. This center will be connected directly to the **PHS** switching center.

Main functions of the billing system are shown in Figure 1.11.

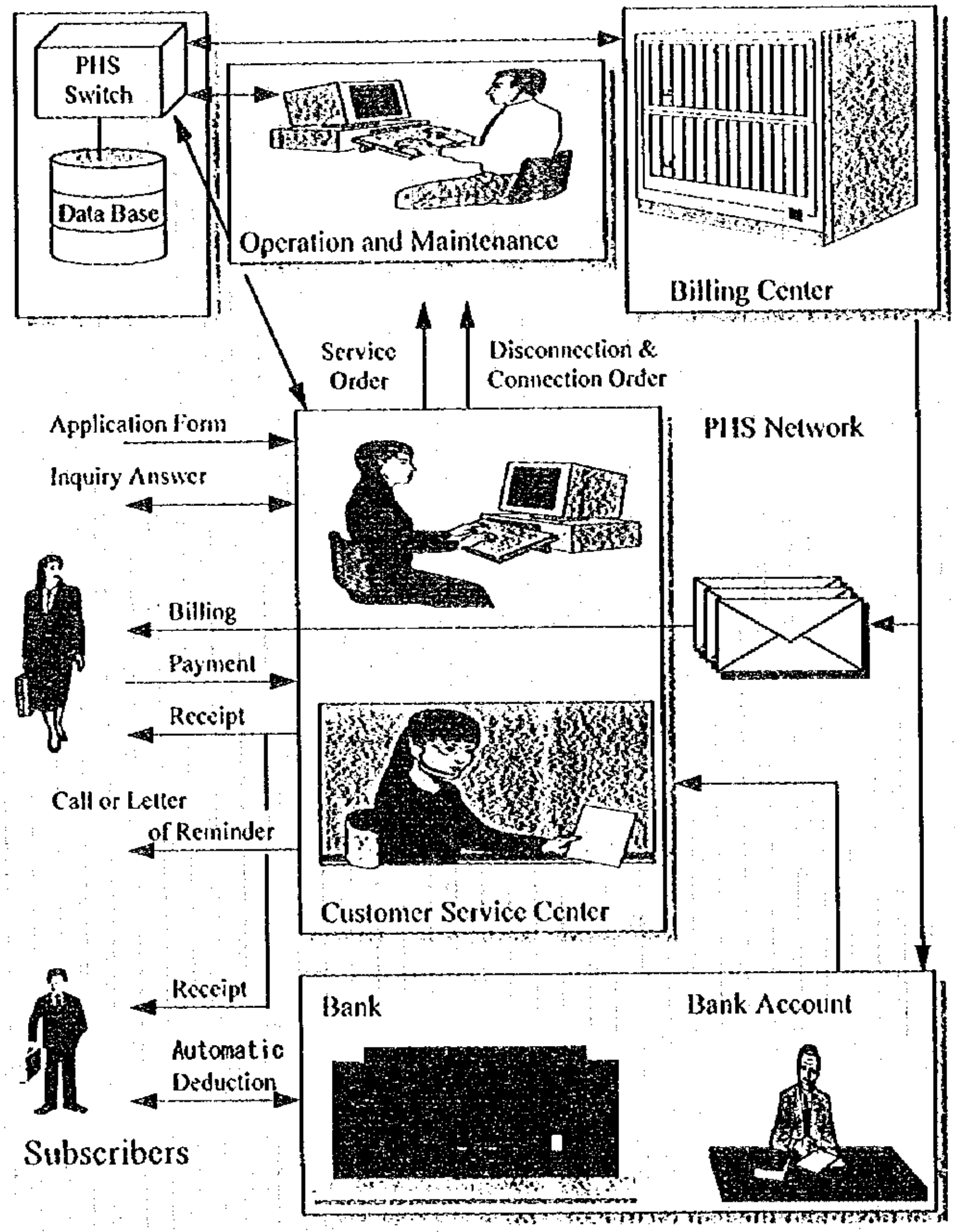


Figure 1.11 Main Function of Billing System

1.8 Network Capability

1.8.1 Traffic Handling Capability

In a cell, multiple CSs can be installed, depending upon traffic volume to be handled. Table 1.7 shows the maximum number of subscribers corresponding to number of CSs, which is calculated on the conditions shown in Table 1.8.

Table 1.7 Cell Capacity

No. of Units in a CS	No. of traffic channels	Maximum offered traffic	Maximum number of subscribers
1 (basic)	3	0.72 Erlangs	35
2	7	3.2 Erlangs	162
3	11	6.3 Erlangs	316
4	15	9.6 Erlangs	482
...	...	...	...

(Note : No. of CSs is not limited to 4.)

Table 1.8 Traffic Condition

Call Generation	Poisson Distribution
Originating and receiving call	0.02 Erlangs/subscriber
Allowable blocking rate	3%

(Reference : Estimated average holding time would be 100 - 120 seconds.)

1.8.2 PHS Switching Center Specification

Table 1.9 shows typical specification of PHS switching center.

Table 1.9 Typical Specification of PHS Switching Center

Item			Specification	
			Single System	Multi System
Common Item	System Capacity	Network Capacity	1,000 Erlang.	22,500 Erlang.
	Network	Digital Transmission Interface	1.544Mbps(24ch/24TS) 2.048Mbps(30ch/32TS)	
	Processor	Max. No. of Processors	1	32
		Word Length	32 bit/Word	
ISDN	U-Interface		2B1Q Echo Canceler	
	Remote access system		RDLU (16CS/RDLU,62CS/Frame)	
	Range of concentration		1:1～4:1	
Others	Common Channel Signaling		ITU-T No.7	
	Ambient Conditions	Temperature	5℃～40℃	
		Humidity	20%～40%	
	Construction	Cabling	Raised floor cabling / Overhead cabling	
	Mounting	frame Dimensions	2,100H x1,072W x 540Dmm	
	Power Supply	Direct Current	-48V±5V	

To cover an area far from a PHS switching center, remote transmission technology is used to connect the PHS switching center with the CS.

Table 1.10 shows functions of PHS switching center.

Table 1.10 PHS Switching Center Functions

Paging	· Call termination request to multiple interface · Interface group list management
Authentication	· Generating authentication random pattern · Sending authentication random pattern to CS · Receiving the result from CS · Checking the result from CS
Handover	· Receiving and analyzing request from CS · Channel exchange from CS to CS, within a PHS Switching Center
PB Tone Transmission	· Generating PB-tone · Sending PB-tone in B-channel
Traffic Observation	· Traffic measurements provided by PHS Switching Center are categorized as follows: CALL ATTEMPTS (Originating Call, incoming call and other) CALL COMPLETION (Originating outgoing calls signaling complete, incoming terminating calls answered, and other) TRAFFIC DISTRIBUTION

1.9 Network Management and Security

1.9.1 Network Management

Since many CSs are used in a **PHS** network, **PHS** network management functions such as monitoring and controls are become necessary. For **PHS** network management, the **Operating and Maintenance Center (OMC)** should be installed as shown in Figure 1.12. Use of **public packet network (PSPDN)** with **X.25** interface for the connection between **PHS** networks and OMC is recommended. If the use of PSPDN is not feasible, circuit switching of DSSI interface via PSC is an alternative solution.

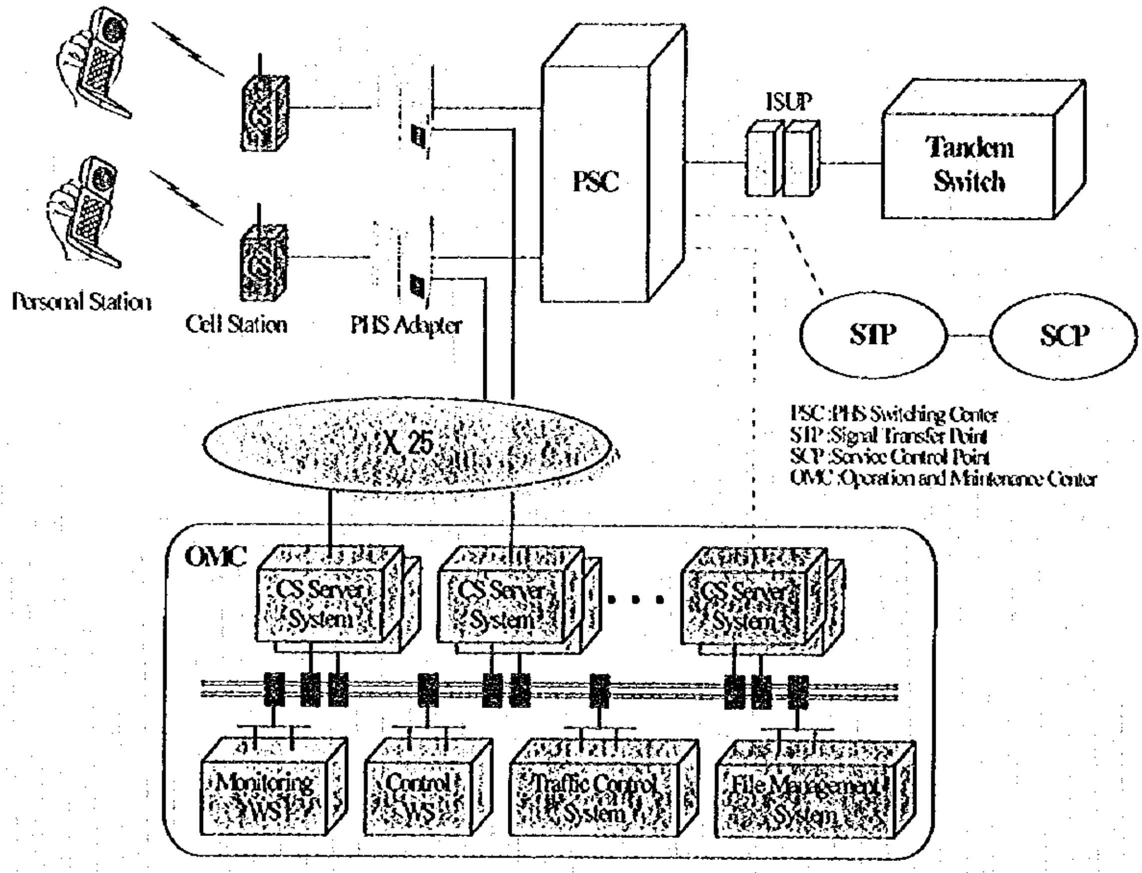


Figure 1.12 OMC Configuration (Example)

1.9.2 Security

In PHS, the radio section is completely digital, together with an encryption function. Therefore, an excellent communication quality can be ensured and tapping and interference can be reduced. To prevent unauthorized utilization of PS, all the originating and terminating calls are processed with authentication sequence using the authentication key which corresponds to the pre-registered PS number in PHS network. Figure 1.13 shows the authentication sequence for an originating call.

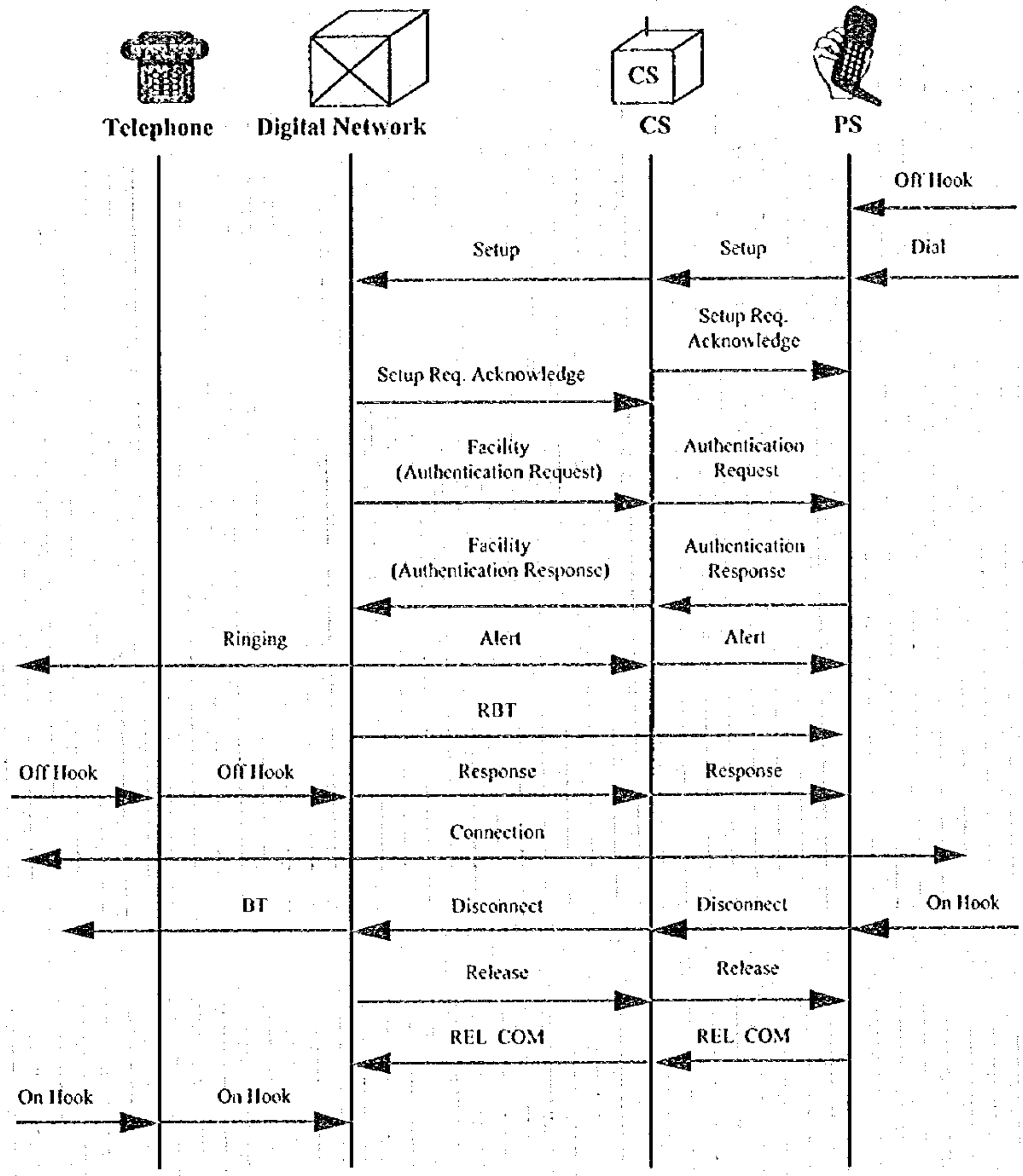


Figure 1.13 Call Processing Sequence(Origination Example)

Section 2 WLL System Overview

2.1 Requirements for WLL Solution

To introduce a proper **PHS based WLL system**, an operator should consider the following points in view of the differences compared with the standard **PHS** services.

(1)High traffic rate

Although the usual **PHS** services require typically 0.03 erlangs per subscriber, the WLL solution requires high traffic rate of 0.1 erlangs per subscriber or more since telephone service is introduced in the area where the conventional telephone service is supposed to be provided and communication demand is expected to be higher. Thus, larger channel capacity is required per cell.

(2)High voice quality

At present, there is an outstanding difference on voice quality between cellular system and fixed telephone networks. The former has the limitations not only on the ordinary voice quality but also on the data communication capability using modem as well as facsimile transmission capability.

PHS can provide the features of accessibility to various advanced services by using "Multi-Frequency (MF)" tones through 32kbps digital radio channel, as available in fixed telephone network.

(3)Mobility

Considering the capability of mobility, proper WLL configuration will be selected.

(4)Fixed terminal

In the case that the mobility is not required, there are two types of fixed terminals. One a **single subscriber unit (SSU)** with an ordinary telephone apparatus connected to desktop transceiver unit, and another is **multiple subscriber unit(MSU)** which is installed in buildings to accommodate multiple subscriber lines like remote switching system or a **digital loop carrier (DLC)** system.

(5)Coverage area

By using an external antenna, the coverage area can be increased up to 1,000 to 3,000 meters if necessary. However, it should be considered that it may put influence on radio propagation to/from other **PHS** cell stations owned by not only the WLL operator but also **PHS** operators. In this case frequency assignment should be coordinated in advance between them.

(6)Pay phone

If the pay phone is introduced by WLL, optional signaling on its air interface is required. The standard PHS air interface for controlling the pay phone is now under work in **ARIB.**

(7)Connection to cell station

The **PHS** standard interface between cell stations and switches is an ISDN **Basic Rate Interface(BRI)** using pair cables. In the case that an operator does not have such cable network facilities, there are various solutions such as optical fibers, radio links, and combinations of these.

(8)Security

Due to radio access, unauthorized use of terminal should be eliminated by using the standard **PHS** authentication procedures.

2.2 System Configuration

(1)Basic system configuration

The basic concept emphasized future expandability toward providing full **PHS** features without major equipment replacement and by minimizing initial investment for the WLL solution.

The system differs on the following points from an ordinary PHS system:

- Small HLR(Home Location Register) is introduced for limited mobility management,
- Multi-channel Cell Station(CS) with 7 ,11 and more traffic channels per CS is introduced,
- Small scale 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 required for PHS services for ensuring user satisfaction.

The system configuration of the **PHS** based **WLL** system is illustrated in Figure 2.1.

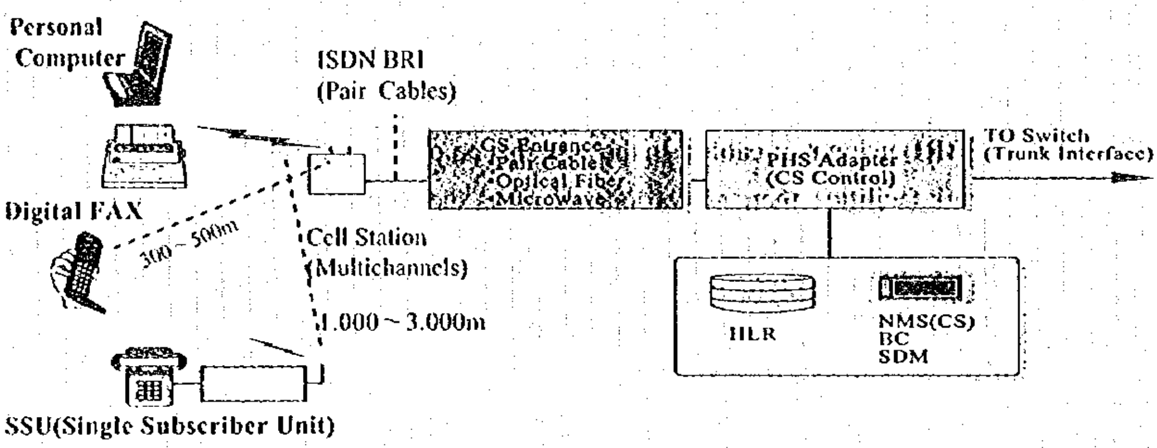


Figure 2.1 Basic Configuration of PHS based WLL System

In this figure, for **PHS** call processing, **PHS** adapter is placed between CS and switching system. The **PHS** adapter has similar functions to a switching system for charging, subscriber data management and office data management, and it is not required to adopt subscriber interface like as analog pair cables for interworking with the switching system, but with trunk interface. The **PHS** adapter controls the **PHS** CSs by using I' interface as defined by TTC.

There are various connection means 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 traffic channels more than 7 in order to handle higher traffic for a WLL subscribers, than an ordinary PHS subscriber moving around. A high power CS with more than 100mW(average) per channel may be used depending on a WLL subscriber, and the external antenna equipped with the SSU is used, if 1,000 to 3,000 meters coverage from CS is required.

(2) Application of PHS based WLL

The PHS based WLL system will be usually suitable for an urban and suburban application due to its small coverage area of each cell. However, it can be applied also to rural areas if the suitable radio transmission systems are used between a switching system and the CSs instead of pair cables. One of them will be a point to multi-point TDMA system. A typical example of system configuration using the point to multi-point TDMA is illustrated in Figure 2.2.

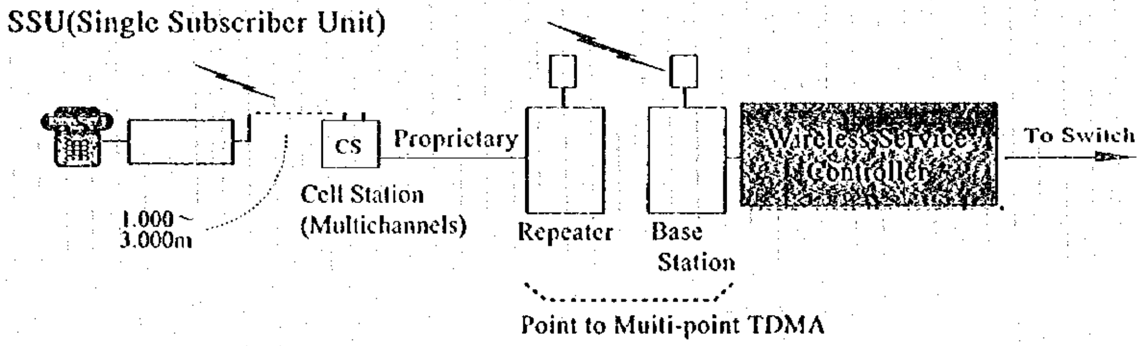


Figure 2.2 Applications of PHS based WLL System

The wireless service controller (WSC) is connected with a switching system by using standard subscriber interfaces such as an ordinary pair cables on a digital basis. This enables WSC to interwork with any manufacture's switches. The WSC has a function to concentrate the lines and terminates any air interfaces from access networks. The connection between PHS cell station and WSC will be by the point to multi-point TDMA system for realizing complete wireless local loop from switch to subscribers.

Radio frequency available for the TDMA radio system will be in 1.5GHz or 2.4GHz band. Distance from switching system to a cell station will be less than 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. 1,000 to 3,000 meters from CS to subscribers is serviced by the PHS standard air interface.

2.3 Service Features

The **PHS based WLL** system can provide various service features common to those of an ordinary **PHS**. In addition, there are the following special features for a WLL system which are available or being planned.

(1)Basic Features

- Multi-Frequency (MF) tone sending for accessing various services,
- Suppress ringing current for line testing,
- Line testing of impedance, capacitance and resistance measurement,
  (This may be applied when the distance between SSU and a telephone apparatus is comparatively long.)
- Hooking signal sending, and
- Reverse polarity.

(2) Supplementary Features

- Metering pulses for pay phone control and change information services using an out band frequency such as 16KHz,
- Coin control signals,
- Calling number sending, and
- Priority subscriber.

(3)Data services

- Modem, Fax as teleservices, and
- 32kbps x N unrestricted digital information services such as bearer services.

Section 3 Wireless PBX System Overview

3.1 Development Objectives

PHS Indoor Application System (PHS-IAS) was developed to replace wireless business-use telephone systems. The principle prerequisites for introducing the system were:

- To provide the convenience that is characteristic of wireless systems while maintaining the advanced functionality of conventional fixed telephone systems, and
- To furnish an upgrade path to future adaptations of data communications.

The specific objectives of the technical development are as follows:

- Provide advanced functions supporting supplementary PBX services,
- Create a highly flexible system structure allowing unlimited capacity,
- Realize the ability to suit localized high-density traffic environments,
- Ensure the ability to provide stable service considering radiowave propagation characteristics in the building, and
- Provide high compatibility with PBXs, and ensure excellent installation and maintenance.

3.2 System Configuration

Figure 3.1 shows the system configuration. In the basic configuration, only the PBX is responsible for system control. The cell stations for the PHS handsets just appear as PBX extension lines. The PHS handset is equipped with functions almost equivalent to those found in advanced portable telephones. In addition, the function to select one of three modes, i.e., business mode, public mode, and direct handset calling mode, is provided in the handset. The cell station provides termination between the PHS handset and the PBX with an extension line interface (called a B interface),and it provides an **RCR STD-28**-compliant interface (called an A interface) on the radio side.

All control functions are implemented on a distributed autonomous control basis. The

PBX unit accommodates those functions that are essential for fixed telephone system operation, while the radio-link control functions are distributed to the PHS handsets and the cell station.

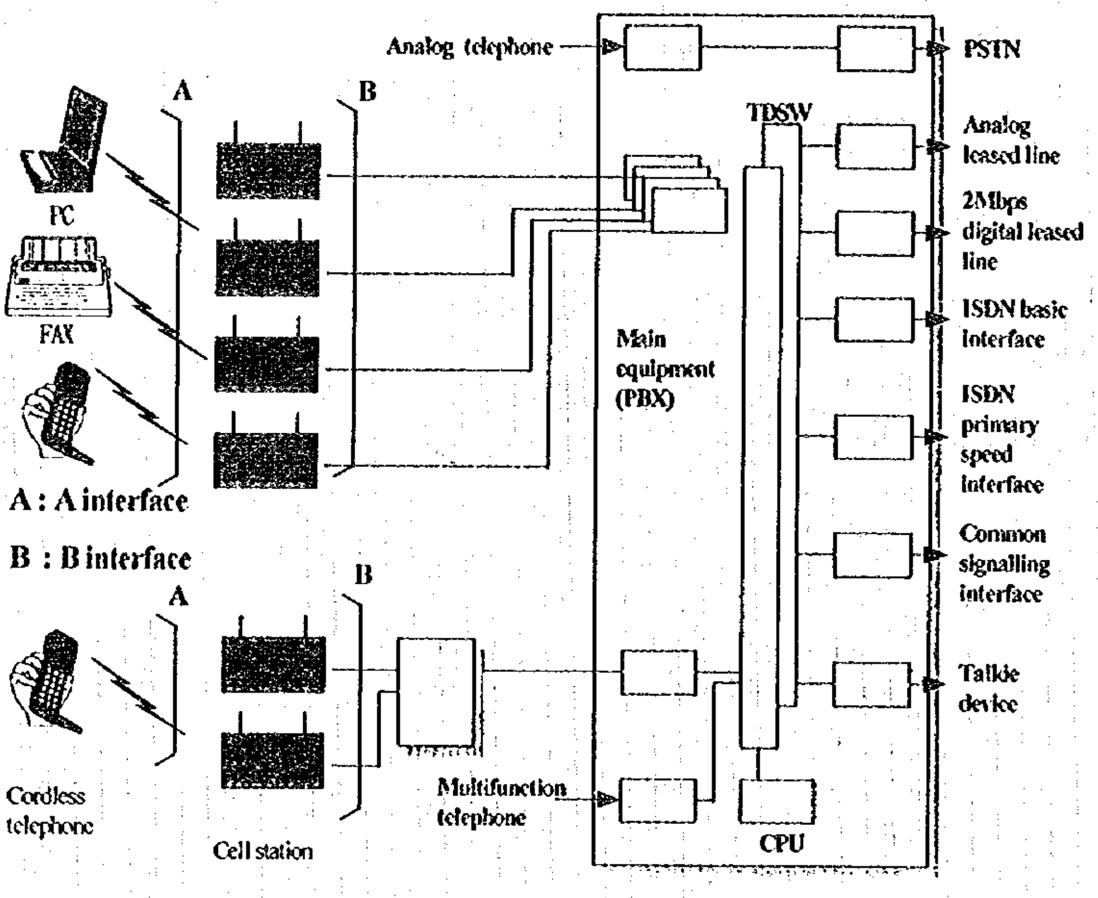


Figure 3.1 System Configuration

3.3 Wireless System

Table 3.1 shows the main specifications of the RCR STD-28-compliant 2.3 Radio system.

Table 3.1 Radio Features

Item	Contents
Radio frequency	for private use 1,895MHz～1,906.1MHz for public use 1,895MHz～1,918.1MHz
Carrier spacing	300KHz
Output power	10mW
Radio access	TDMA-TDD
Number of TDMA slots	4 (for full rate CODEC)
Modulation	π /4 shift QPSK (roll-off factor = 0.5)
Transmission bit rate	384kbps
Speech coding	32kbps ADPCM

The radio interface has four-channel time division multiple access capability with time division duplexing (4-channel TDMA-TDD), which provides one control channel and three traffic channels for each cell station. Figure 3.2 shows a typical radio channel structure when three cordless handsets are active on a single cell station. RCR STD-28 does not specify the location of the slot for the control channel, thus the system allows any one of the four slots to be defined as the control slot.

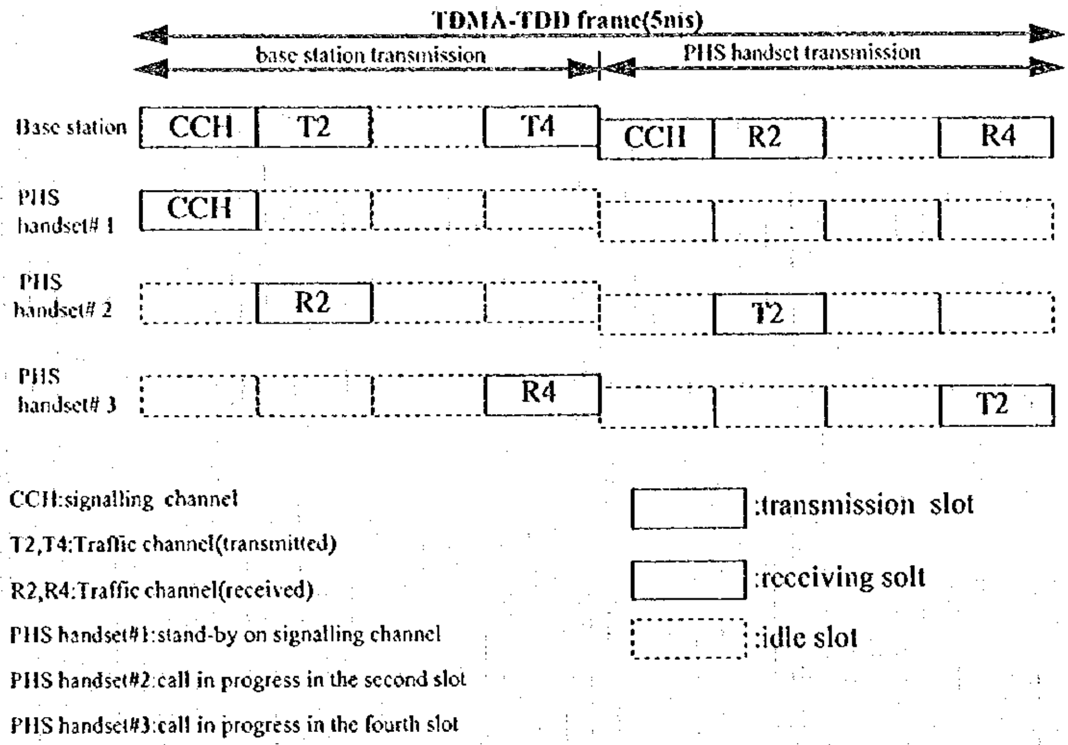


Figure 3.2 Typical Radio Channel Structure

In the radio frequency allocation shown in Table 1.6, 37 carrier frequencies are available for private use, of which two are dedicated to control. The remaining 35 are used for traffic channels, 10 of which are also used for direct communication between handsets.

Since the control channel and traffic channel are separated as mentioned above, traffic channel can be assigned in a distributed and autonomous manner by employing the switching TDMA mechanism. To derive the maximum benefits of carrier switching TDMA, the cell station uses a synchronizing system that synchronizes radio frame by superimposing synchronization data on the B interface. This radio frame synchronization with carrier switching TDMA produces improvement in frequency utilization when compared with asynchronous systems.

Likewise, by using TDMA-TDD and providing the cell station with both reception and transmission diversity, data communication quality on a traffic channel can be improved without installing multiple antenna- or receiver-branch diversity mechanisms into the cordless handsets.

Figure 3.3 shows **bit error rate (BER)** performance of the received signal of the cordless handset. The figure shows a diversity gain of 3dB with a bit error rate of 4× 10-3 .

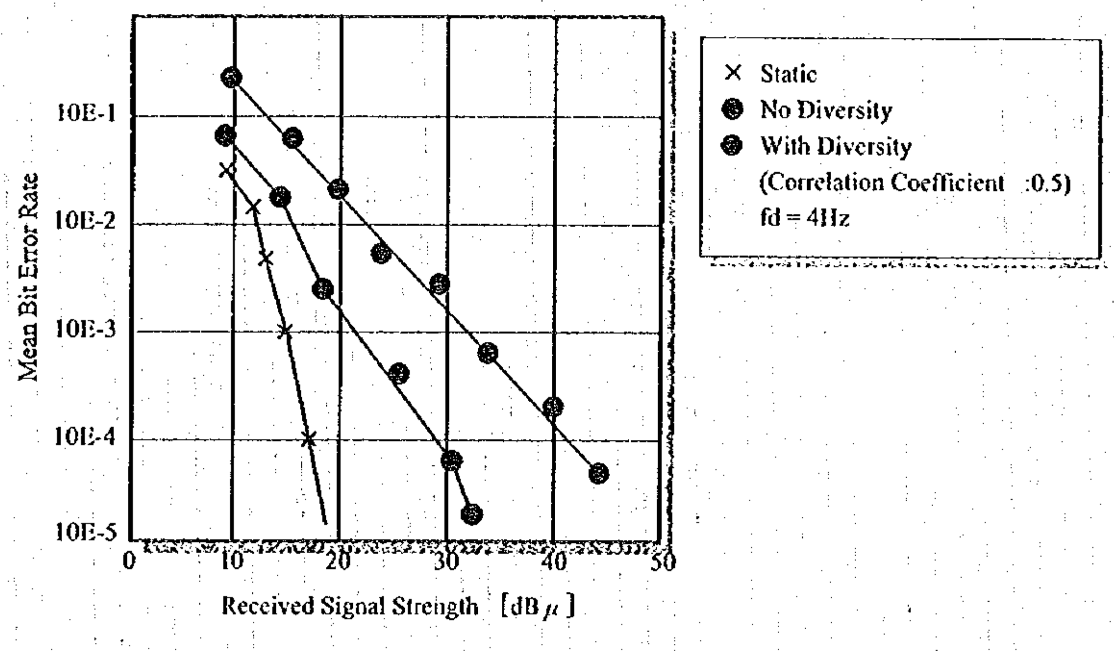


Figure 3.3 BER Performance

In addition, to handle high telecommunication traffic demand in office buildings, PHS-JAS is designed to remove excess transmission power.

Transmission power control for the base station is used mainly to control the size of the radio cell, then transmission power of the PHS handset is controlled independently depending on the signal receiving level from the base station to prevent excessive receiving signal level at the cell station.

3.4. System Control Features

(1) Functional Assignment and Interface Requirements

Table 3.2 shows the functional assignment to each physical network in consideration of the optimal the total software size, distributed and autonomous control mechanisms.

Table 3.2 Functional Assignment

Function	note	PBX	Base station	PHS handset
Network	authentication	YES	NO	YES
	location registration	YES	NO	YES
Radio link control	handover	NO	YES	YES
	down link radio frame synchronization	YES	YES	NO
	signaling channel processing	NO	YES	NO
	traffic channel allocation	NO	YES	NO
	interference control	NO	YES	YES
Speech transmission	speech coding/decoding	YES	NO	YES
	voice muting	NO	YES	YES
	echo handling	NO	NO	YES
	encryption	NO	YES	YES
Supplementary services	DTMF tone transmission	YES	NO	YES
	call transfer	YES	NO	YES
	group calling in	YES	NO	YES
	direct communication between cordless telephones	NO	NO	YES

One of the essential functions in the radio link control block is the traffic channel assignment. This is achieved by a distributed-autonomous dynamic channel assignment scheme, with which the idle channel is selected for new communication demand from the available channel resources mapped in two-dimensional frequency-time matrix renewed by the result of checking signal strength when call is established. Another feature of the cell station is complete handling of the signaling process over the radio segment.

PHS handsets also have some autonomous functions; they perform reconnect type handoff by selecting the new cell station prior to handoff. The process used here precludes the need for radio link monitoring on the network side. Re-connect type handoff offers stable communication quality even if radio link quality sharply deteriorates during a call due to nonuniformities at radio cell boundaries.
For supplementary services, the cell station acts simply as a layer 1 converter. Thus, the layer 3 signaling data are exchanged between the PBX and the PHS handsets without any processing at the cell station.

Table 3.3 shows the A and B interface requirements. **PHS** related standards only define those features necessary to support basic services. Features required to support supplementary services can be implemented by using optional and operator-defined areas in signaling messages.

Table 3.3 Interface Requirements

<table>
<tr><th rowspan="3">Layer</th><th colspan="2">A interface
(base station to PHS handset)</th><th colspan="2">B interface
(PBX to base station)</th></tr>
<tr></tr>
<tr><th>Requirements</th><th>Hints of approach</th><th>Requirements</th><th>Hints of approach</th></tr>
<tr><td>Layer 3</td><td>· conformity to **RCR STD-28**
· implementation of supplementary services
· data communication/ fax communication</td><td rowspan="3">· use of option field</td><td>· conformity to ISDN
· implementation of supplementary service
· data communication/ fax communication
· implementation of a set of maintenance functions</td><td>· conformity to Q931
· provision of network inherent function
· provision of proprietary function</td></tr>
<tr><td>Layer 2</td><td>conformity to
· **RCR STD-28**</td><td>· implementation of HDLC-level logic</td><td rowspan="2">· ISDN S-point or digital multi-function telephone interface</td></tr>
<tr><td>Layer 1</td><td>· conformity to RCR STD-28</td><td>· support of metallic line
· baseband transmission
· minimum transmission delay
· power supply</td></tr>
</table>

(2) Signaling Protocols

RCR STD-28 defines a three-layer protocol for call connection. The phase for communication link set up is called the link channel setup phase.
Upon incoming calls, the PHS handset to which the incoming call is terminated is firstly identified in this phase, then it is paged and the link is set up through the nearest cell station.

The next phase is the traffic channel setup phase, in which the layer 3 signaling messages are exchanged through a communication channel. By exchanging signaling messages in the traffic channel, the reduction of the total amount of signaling messages on the control channel can be realized.

Figure 3.4 shows the protocol model in the system, Figure 3.5 shows the call control procedure on incoming call and Table 3.5 shows the typical supplementary services.

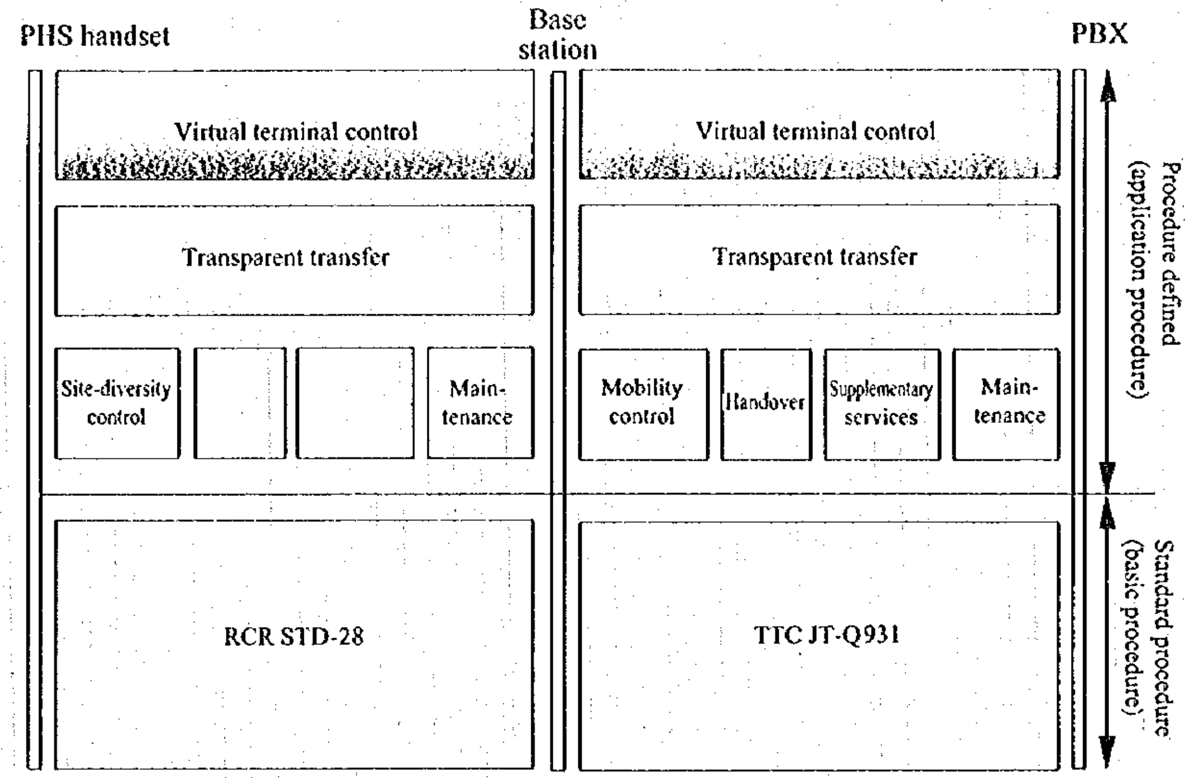


Figure 3.5 Protocol Model

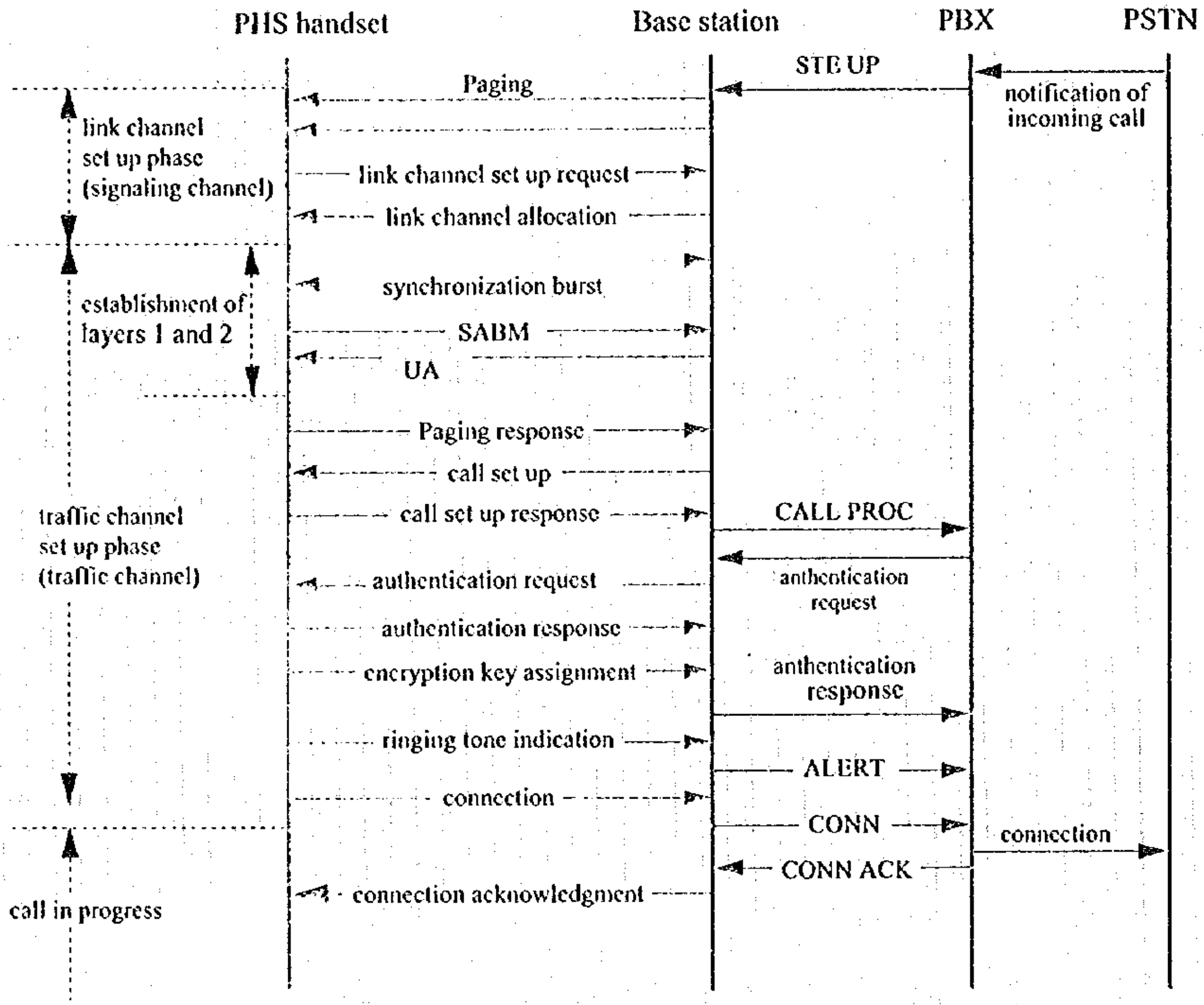


Figure 3.4 Call Control Procedure on Incoming Call

Table 3.5 Typical Supplementary Services

Service	Features	Service	Features
Step call	In extension calling, this feature calls idle telephone being called.	Call waiting	This feature provides communication with a third party on a call basis during conversation.
Camp on	When the line is busy, this feature reserves the line and waits until it becomes free.	Conference calling	This feature provides calling of and simultaneous conversation with other parties at any time during conversation.
Charge notification	This feature notifies charging information from NTT or internal charging information within PBX after conversation.	Alarm on long-time conversation	This feature provides and audio alarm everytime a fixed period of conversation.
No answer alarm for incomingcall	This feature switches the ringing tone in case these is no answer during a certain period.	Optimal route selection	This feature provides automatic selection of the lowest charging route (or service provider) when calling.
Call pick up	This feature provides a function to pick up the incoming call with a telephone other than the telephone being called.	Call managemen	this feature provides management of extension number/calling number/conversation period of time etc. when using outside or private lines.
Non complete incoming call notification	This feature provides the calling party notification when there has been no response from the cordless telephone paged.	Dial in	This feature provides arbitrary selection of DI, DID, DIL for incoming calls. DI : dial in DID : direct in dial DIL : direct in line
Call forwarding	This feature transfers incoming call to a designated telephone.		
Call Forwarding no reply	This feature transfers an incoming call to a designated telephone when the called party gives no response to the incoming call over a fixed period.	Data downloading to base station	This feature downloads data to PHS handsets through PBX.
Calling line identification presentation	This feature displays of the calling party's telephone number on the telephone.	Data download to cordless phone	This feature downloads data to PHS handsets through PBX.
DTMF tone transmission during communication	This feature provides DTMF tone transmission to the other party during conversation.	Base station supervision and control	This feature provides supervision and state control of base station.
Information transfer in communication	This feature transfers messages to the other party's PHS handsets during conversation.	Traffic measurement	This feature measures traffic such as counting the number of signaling messages transmitted and received.
Call transfer	This feature allows the user to transfer an active call to a third party.	Failure history handling	This feature manages failure information of base station.

Note : Service feature names and contents may vary according to PBX types.

3.5 Hardware Configuration

(1) Base Station

Table 3.6 shows the typical base station specification, and Figure 3.6 shows the typical base station configuration.

Table 3.6 Typical Base Station Specification

Item	Contents
PBX interface	metallic 4 wires
Power supply scheme	PBX power supply -48V local power supply 100V
Maximum distance from PBX	PBX power supply 500m local power supply 800m
Volume	800 (cm^3)
Weight	630g

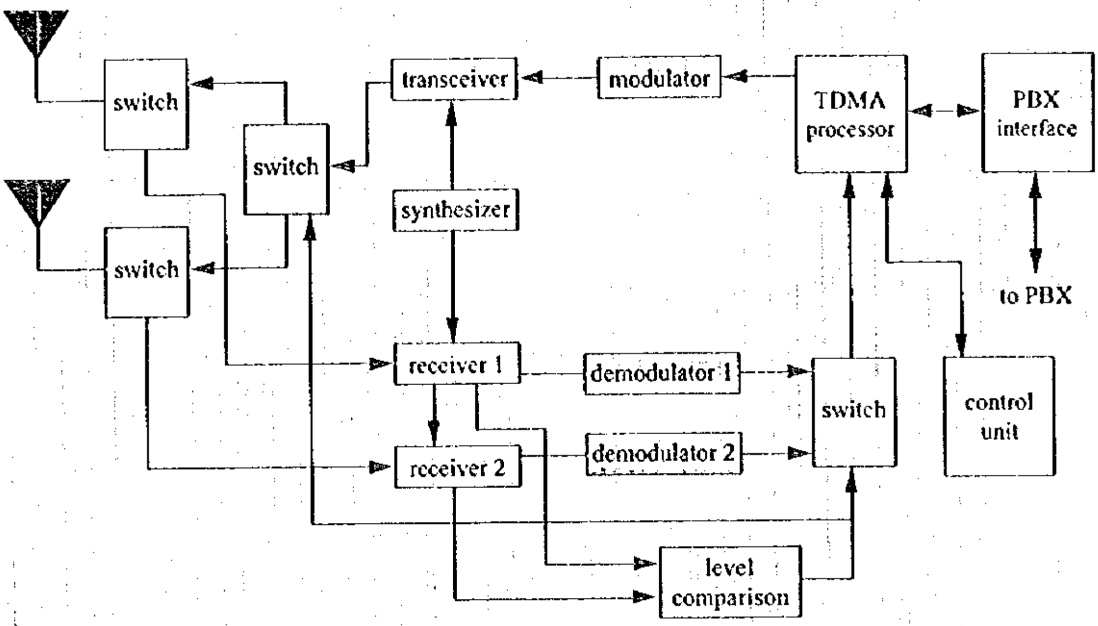


Figure 3.6 Typical Base Station Configuration

TDMA-TDD enables the antennas to share both transmitting and receiving with the RF switches. To implement receiving diversity, the receiving unit has two receiving branches, while the transmitting unit has switches for switching antennas to provide transmission diversity.

These switches use GaAs FETs and the spacing between the two antennas is 10 cm, which gives an antenna correlation of roughly 0.5. The synthesizer requires high-speed switching to change carriers within the slot guard time (41 μ s).

In this system, this change over is implemented by switching two synthesizers. The TDMA-signal processing unit includes some basic functions such as transmission burst composition and received burst decomposition. It also has some additional functions such as encryption and speech muting.

(2) PHS Handset

Table 3.7 shows the typical PHS handset specifications, and Figure 3.7 shows the configuration of the PHS handset.

Table 3.7 Typical PHS Handset Specifications

Size (without antenna)	111～150mm(L)×43～58mm(W)×21～31.5mm(D)
Volume	98～189cc
Weight	95～220g
Battery	Nickel metal hydride battery
Battery life	Talk time : over 4 hours, stand-by time : over 100 hours.

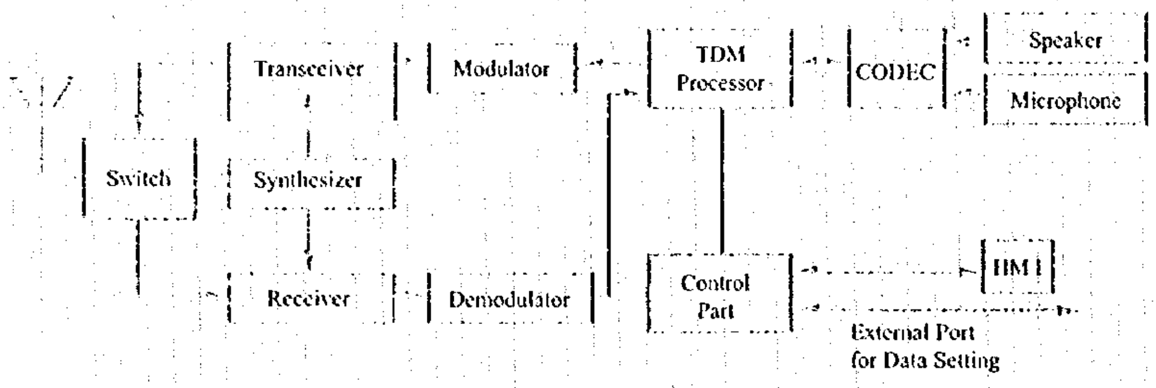


Figure 3.7 Typical Handset Configuration

To obtain better quality of speech signal, a speech muting and echo suppression device is installed in the handset. Speech muting is implemented by replacing voice data in which errors have been detected, and inserting an attenuator for the signal conversion process to the original voice signal. Echo suppression is implemented by detecting outgoing voice signal and inserting an attenuator for the incoming voice signal. The control unit is connected by an external interface, through which new service features can be implemented. In addition, as with advanced portable telephones, an electronic notepad function can be added to the control panel. A man-machine interface for utilizing PBX services has also been incorporated. The size and weight of the handset have been made roughly the same as those of advanced portable telephones, which gives complete portability.

(3) Optional Fax/Modem Adapter

Optional Fax/Modem adapter is offered for facsimile and data communication, supported by 32kbps ADPCM transmission capability.

The adapter is designed to permit a facsimile or modem to be connected directly to the cordless handset.

Section 4 Arrangement of Cell Station

4.1 Coverage of Cell Station

(1) Radio wave propagation characteristic

Since 1.9GHz radio frequency band is used in PHS, the effect of direct wave from a transmitter and reflective wave is much stronger than that of diffracted wave.

In the urban area, as shown in Figure 4.1, radio waves propagate directly or reflect in areas where the buildings are densely constructed.

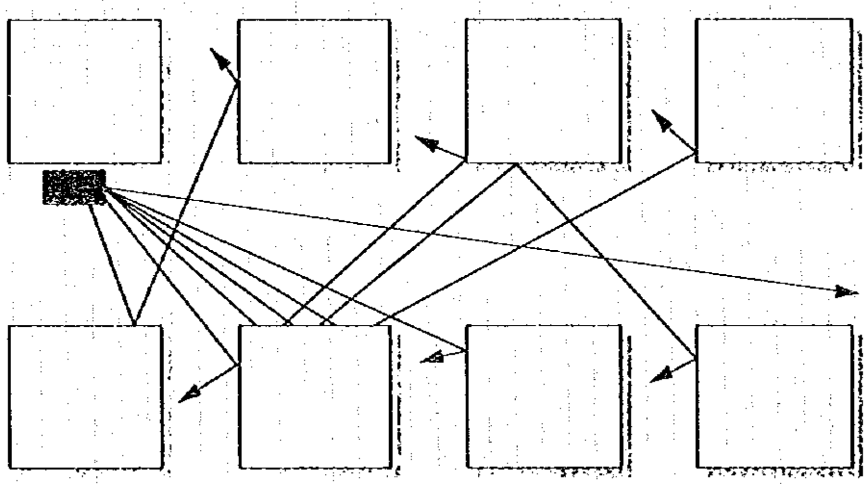
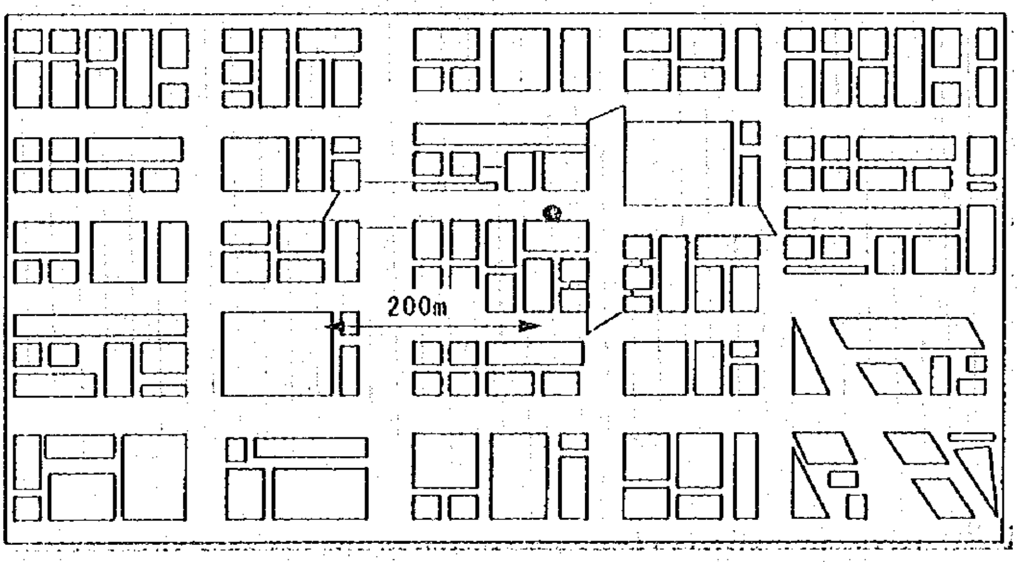


Figure 4.1 Propagation Model in the Urban Area

(2) CS coverage in the urban area

CS coverage in the urban area depends mainly on the height of the CS location from the ground.

Two cases of cell coverage consideration are shown in Figure 4.2 and Figure 4.3. Figure 4.2 is the case where the CS is installed lower than the surrounding buildings height, i.e., on top of a public telephone box. Figure 4.3 shows the case where the CS is installed higher than the surrounding buildings height, i.e., on the roof of a building. When the CS is installed at a low position as shown in Figure 4.2, the CS coverage is limited to the area below the buildings. On the other hand, if it is installed at a higher position, the coverage becomes wider, as shown in Figure 4.3.



Figyr 4.2 CS Coverage in Urban Area(CS is installrd low)

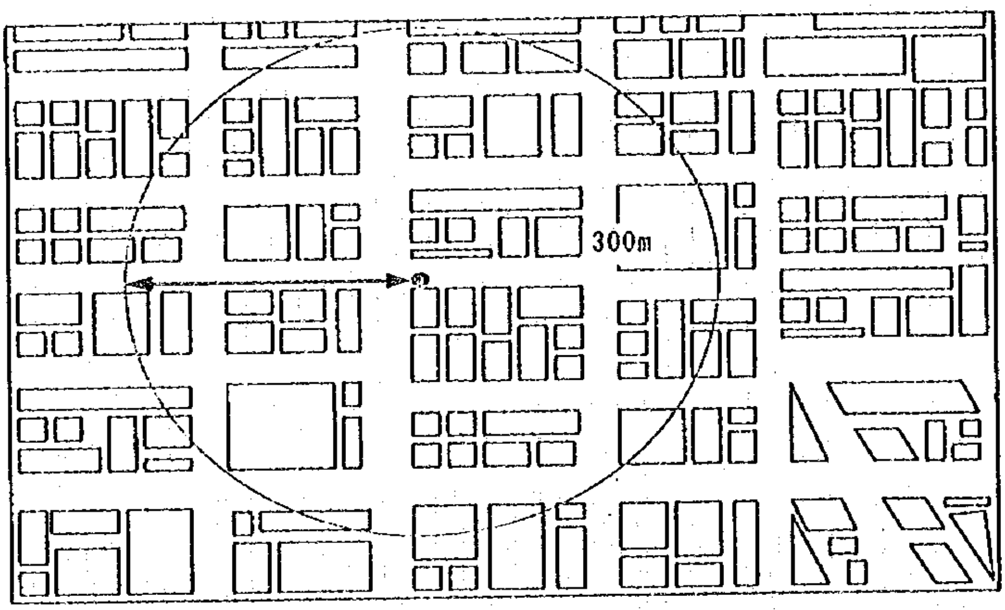


Figure 4.2 CS Coverage in Urban Area (CS is installrd high)

(3) Radio zone in suburban area

Since there are not so many buildings which obstruct the radio wave propagation in suburban area, one cell station can cover an area of 300～500m radius.

(4) CS coverage in the buildings

Inside the building, the CS coverage depends mainly on the layout of rooms, floor arrangement and the material of walls, and will be an area of 100m radius.

4.2 Cell Station Installation

Since CS is small and lightweight (capacity: 1～10 liter, weight: 1～10kg), it can be installed at any place, i.e., on top of a telephone box, a lamp pole, the roof and indoor of building, ceiling of underground shopping center.

4.3 Cell Planning of PHS

As **PHS** applies **Dynamic Channel Assignment (DCA)**, available channel is assigned automatically. Therefore, it is not necessary to assign frequencies to each cell. Advantages of DCA are:

- Location for cell station installation is easily selected, and
- Overlapping of cell boundary is possible.

These advantages ease the installation of CS when traffic becomes high.

Section 5 Method of Demand Forecast

5.1 Demand Forecast in Japan

According to the demand forecast by the MPT, 30 percent of the Japanese population will use PHS, totaling *38 million PHS units in circulation in the Japanese PHS market in the year 2010.* This is a figure based on the result of market research implemented in the form of a questionnaire. However, if one family purchases one PHS unit, 43 million units will circulate. If one person purchases one unit, as many as 100 million units 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 3000 yen. It can be said that this is a credible ratio because the charge, 2700 yen will be offered when the service starts and because the mass production system introduced to cope with the future increasing demand may contribute to the further reduction of charge.

The followings are reference for demand forecasting the PHS subscriber:

Ref.1.1 Determination of penetration ratio

In order to forecast the future demand, market research based on questionnaire will be the most effective method.

After performing the opinion survey on PHS service content, monthly basic charge and communication charge, the degree of their willingness to use shall be demonstrated, regarding the final penetration ratio.

Ref.1.2 Determination of demand

Number of units can be figured out from the future population multiplied by the penetration ratio obtained.

Ref.1.3 Calculation of yearly demand

If the penetration ratio obtained is regarded as the upper limit of **PHS** penetration ratio, the yearly growth of the penetration ratio will be along the growth curve. Among the growth curves, so-called logistic curve is especially used very frequently and will be able to forecast the **PHS** demand.

Obtain the number of yearly penetration units from the yearly population multiplied by the yearly penetration ratio obtained from this curve.

In Figure 5.1, the expected **PHS** demand growth curve is illustrated.

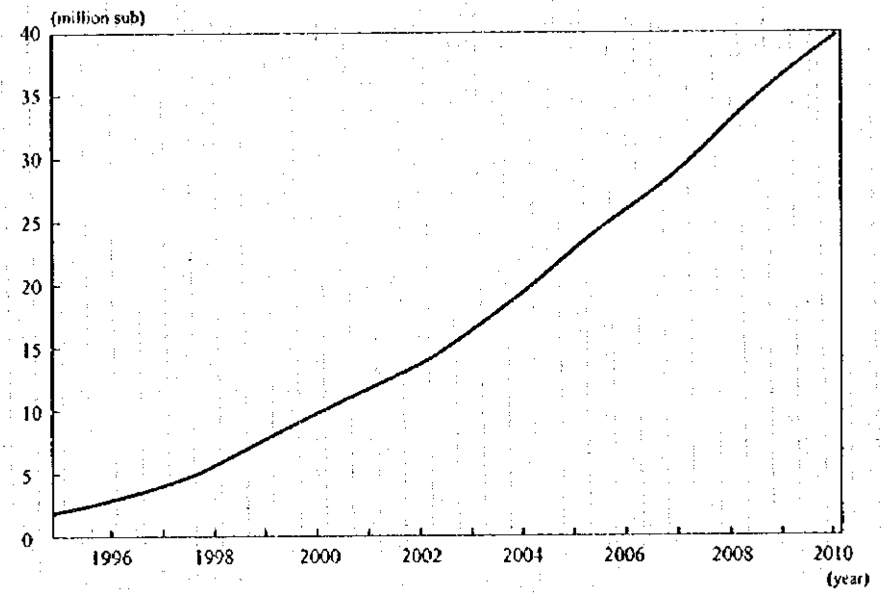


Figure 5.1 PHS Demand Growth in Japan

Ref.2.1 Growth curve

Growth curve in general consists of several stages and each stage reflects different growth rate.

It shall be considered that there are introduction phase, deployment phase and saturation phase in growth curve as illustrated in Figure 5.2

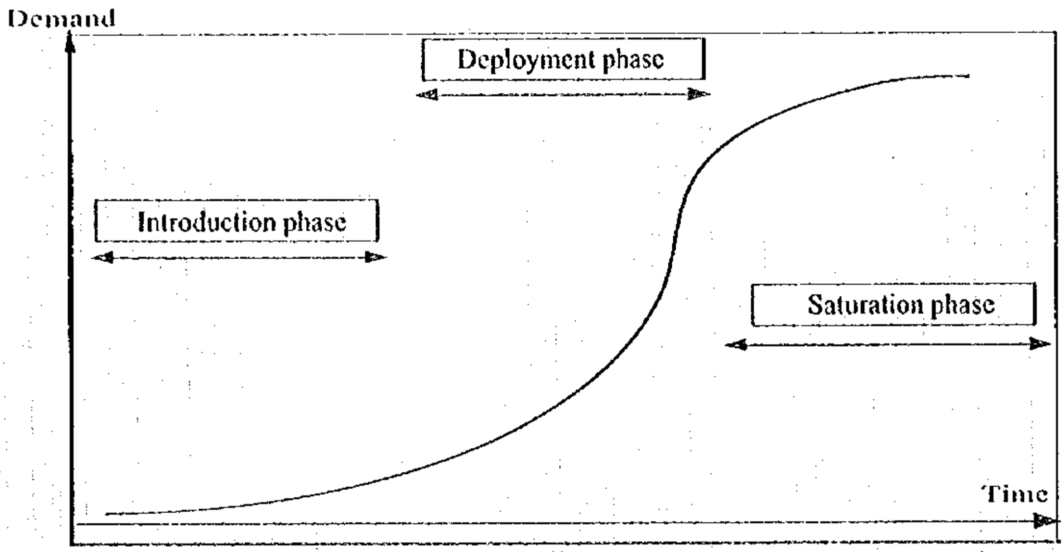


Figure 5.2 Typical Growth Gurve by 3Phases

Ref.2.2 Introduction phase

Shortly after the introduction of service, major users will be "vanguards". Those who immediately subscribe "unfamiliar" service are wealthy people reacting quickly to new services. Therefore, demand will not extensively and rapidly increase during this introduction phase.

Ref.2.3 Deployment phase

Service has been widely known, and its convenience becomes the "talk of town". Those who subscribed to the service in the introduction phase are the good publicity to the people who have not yet subscribed. Users and demand will sharply increase as a result of such chain reaction.

Ref.2.4 Saturation phase

Service has spread through the general public. It will be possible to provide more economical services as a result of scale merit. Those who have been a careful trend watcher and refrained from using the service are expected to subscribe the service during this phase. However, newly created demand is not so large and the total demand will be saturated.

Supplement

Standard Publication List

Ⅰ. Air Interface Standard for PHS

RCR STD-28 Personal Handy-phone System (RCR standard version 1)

Ⅱ.User-Network Interface standards for PHS

JT-Q921-b Second Generation Cordless Telephone System Public Cell Station - Digital Network Interface Layer 2 - Specification

JT-Q931-b Second Generation Cordless Telephone System Public Cell Station - Digital Network Interface Layer 3 - Specification

JT-Q932-a Second Generation Cordless Telephone System Public Cell Station - Digital Network Interface - PHS Service Control Procedure

Ⅲ. Inter-Network Interface standards for PHS

JT-Q1218 Inter-Network Interface for Intelligent Network

JT-Q1218-a Inter-Network Interface for PHS Roaming

CHAPTER 7

FINANCIAL, ECONOMIC AND SOCIAL ANALYSES

1 Results of Socio-Economic Survey

1.1 Objective of the Socio-Economic Survey

A Socio-Economic Survey was conducted during the second survey in Mongolia. The objective of the survey was to collect information on economic and social aspects of telecommunications development. The results are inputted into economic and social analyses for the basic plan up to the year 2010 and the priority projects. The following is an outline of the Socio-Economic Survey conducted.

- Period of the survey : March 6 to 17, 1996
- Sample and targets :

Type	Category	Ger	Apartment	Total
A	Households recently installing a phone	2	13	15
B	Households having no phone	11	10	21
C	Person using privately-run pay phone	-	-	14
D	Company recently installing a phone	-	-	6
Total		-	-	56

- Area : Duregs of Chingeltei, Bayangol, Suhbaatar, Bayanzurkh, Han-Uul and Songinohairhan
- Method : Generally person-to-person interview survey, partly interview survey by telephone

1.2 Profile of Interviewees

A profile of the interviewees are presented in Table 7-1-1 by category.

1.3 Findings

(1) Purpose of Making Telephone Calls

Table 7-1-2 shows a percentage distribution of the purpose of telephone calls of 15 interviewees who have recently installed a phone. It is shown that most telephone calls, 70 to 100% are made to contact friends and relatives. Four out of 15 interviewees responded that they sometimes make calls for business purpose. Emergency cases are cited by eight respondents, most of which is for calling an ambulance. Other emergency cases included calling police and locksmith.

(2) Willingness-to-pay- for Timed Local Calls

Table 7-1-3 shows willingness-to-pay of 14 residential subscribers and 6 business subscribers for timed local call tariff. The objective of this question was to collect data for estimating consumer surplus for calls. Section 7.2 following this section presents a detail of how these data are processed. In general, business subscribers show higher willingness-to pay than residential subscribers, indicating the stronger need for telephone calls for business purpose.

(3) Willingness-to-pay for Installation Charge

Table 7-1-4 shows data on the willingness-to-pay of households having no phone and companies for installation charge. A question was asked in such a manner as to up to how much they would be ready to pay if a telephone is installed immediately. For interviewees who answer they cannot afford the existing installation charge at 12,000 Tugrig, they were asked how much the maximum charge they could afford was. Out of 18 household interviewees, 16 gave values higher than the existing charge level.

For business subscribers who were asked the same question for an assumed situation in which they have no phone, 5 out of 6 interviewees gave values higher than the existing installation charge at 24,000 Tugrig.

These data are processed to derive consumer surplus for installation charge as shown in section 7.2

(4) Travel as the Alternative Means of Communication

Table 7-1-5 shows the percentage of making travel as a means of communication in the absence of telephone, travel means, distance of travel and time spent for travel. The level of dependence on traveling varies from 10% to 100%. Mostly travels are made by bus. Travel distance varies from the shortest 1 km to 20 km. Travel time ranges between 15 minutes and 2 hours.

(5) Improvements in Life after Installing a Phone

A question was asked as to what improvements interviewees feel after installing a phone. For them to be able to compare the situations before and after installing a phone, subscribers who installed a phone early 1996, January to March, are selected and interviewed.

Responses included the following. A detail is shown in Table 7-1-6.

- Easier to communicate with people
- Saves a lot of time and travel expenses
- Easy to call an ambulance and a doctor
- Speedier and more successful work
- The life became interesting and comfortable.
- Easier communication, especially for old people

(6) Experience of Troubles Because of Having No Phone

A question was asked to households who have no phone as to problems they had because of having no phone. Table 7-1-7 shows the answers. They are summarized as follows.

- difficulty in calling an ambulance
- difficulty in contacting a friend for an important message
- difficulty in calling police

Difficulty in calling an ambulance was mentioned by 8 respondents out of 12 respondents who gave specific examples of trouble.

(7) Present and Desired Distance to Nearest Phone

A question was asked to households having no phone and people who have come to privately-run payphones as to the distance that people travel to get to the phone and desired distance to the nearest phone. The nearest phone include both privately-run payphones and someone else's residential phone. Table 7-1-8 and 7-1-9 shows the result. The present distance of travel people make to get to a phone varies from the longest 3 kilometers to the shortest 2 meters who lives in an apartment and usually uses his neighbor's phone. Desired distance ranges between the longest 500 meters to 20 meters. These data are referred to in formulating a basic concept of the Digital Radio Concentration System (DRCS) project.

(8) Use of Privately-Run Payphones

Table 7-1-10 shows how privately-run payphones are used by people, including charge level, length of calls, frequency and purpose of calls. Charge is either 20 Tugrig or 30 Tugrig. A range of length of a call is one minute to 6 minutes per call. Frequency of coming to pay phone varies from 1 to

2 times a day to 1 to 2 times a month. Most calls are made to talk with family, relatives or friends. These data are processed to derive the willingness-to-pay for public phones planned by the DRCS project.

Table 7-1-1 (1/4)

Profile of Interviewees : Type A (Households which have recently installed a phone)

No.	Date of inter-view	Interviewee			Area			Total monthly income	Number of house-hold members	Date of installing a phone
1)	2)	sex 3)	age	status	Dureg	Horoo	Type	4)		
8	7	m	16	child	Chingeltei	8	ger	40,000	3	?-1977
11	8	m	21	head	Bayangol	14	apt.	50,000	2	3-1996
15	11	m	52	head	Suhbaatar	13	ger	18,000	5	2-1996
35	14	m	16	child	Bayangol	14	apt.	30,000	6	2-1996
36	14	f	27	wife	Bayanzurkh	18	apt.	30,000	3	1-1996
37	14	f	35	wife	Han-Uul	2	apt.	30,000	4	1-1996
38	14	f	37	child	Han-Uul	2	apt.	25,000	4	1-1996
39	15	m	60	head	Han-Uul	2	apt.	8,000	3	1-1996
44	15	f	38	wife	Songinohairhan	7	apt.	22,000	3	1-1996
45	15	f	37	wife	Songinohairhan	16	apt.	60,000	4	1-1996
46	15	f	33	child	Songinohairhan	16	apt.	5,000	5	1-1996
47	15	m	31	child	Bayangol	17	apt.	14,000	5	1-1996
48	16	m	25	child	Songinohairhan	17	apt.	34,000	3	2-1996
49	16	m	65	head	Bayangol	14	apt.	7,600	7	2-1996
57	15	m	30	head	Bayangol	14	apt.	33,000	4	1-1996

Notes :

1) Serial numbers given in the interview survey

2) Day of March 1996

3) m : male, f : female

4) sum of regular and average irregular income

Table 7-1-1 (2/4)
Profile of Interviewees : Type B (Households having no phone)

No.	Date of interview	Interviewee			Area			Total monthly income (tg)	Number of household member	Remarks
		sex	age	status	Duureg	Horoo	Type			
1)	2)	3)						4)		
1	6	m	68	head	Bayangol	14	apt.	10,000	2	
2	6	m	36	head	Han-Uul	1	apt.	28,000	3	
3	6	f	55	wife	Bayangol	6	apt.	60,000	5	
7	7	f	n.a.	wife	Chingeltei	8	ger	22,000	4	
9	7	m	57	head	Chingeltei	11	ger	40,000	3	
10	7	m	46	head	Chingeltei	18	ger	25,000	4	
14	11	f	15	child	Bayangol	15	apt.	30,000	9	
16	11	m	38	head	Suhbaatar	13	ger	60,000	5	
33	14	m	26	head	Chingeltei	6	ger	20,000	4	
34	14	f	33	wife	Suhbaatar	15	ger	40,000	4	
40	15	f	47	wife	Han-Uul	2	apt.	60,000	8	
41	15	m	28	head	Han-uul	2	apt.	80,000	3	
42	15	m	20	child	Bayanzurkh	1	apt.	45,000	6	
43	15	f	50	wife	Bayanzurkh	1	apt.	15,000	3	
50	16	m	46	head	Han-Uul	5	ger	32,000	5	
51	16	m	14	child	Han-Uul	5	ger	40,000	5	
52	16	f	51	wife	Suhbaatar	8	apt.	65,000	4	
53	16	m	29	child	Suhbaatar	1	apt.	38,000	4	
54	17	f	34	wife	Bayanzurkh	10	ger	8,000	3	
55	17	m	71	*	Bayanzurkh	10	ger	25,000	6	* head's father
56	17	m	39	child	Bayanzurkh	1	ger	20,000	3	

Notes :
1) Serial numbers given in the interview survey
2) Day of March 1996
3) m : male, f : female
4) sum of regular and average irregular income

Table 7-1-1 (3/4)

Profile of Interviewees : Type C (Person who came to a privately run pay phone)

No. 1)	Date of interview 2)	Interviewee sex 3)	Interviewee age	Payhone Dureg	Payhone Place/Operator
4	7	f	n.a.	Bayangol	Post Office No.24
5	7	f	n.a.	Bayangol	Post Office No.24
12	11	f	21	Suhbaatar	National University of Mongolia building No.2
13	11	f	42	Suhbaatar	National University of Mongolia building No.2
17	12	f	n.a.	Chingeltei	State Department Store
18	12	m	27		State Department Store
19	12	f	30	Suhbaatar	Central Post office
20	12	f	27	Suhbaatar	Central Post office
21	12	m	41	Suhbaatar	Transportation Center
22	12	f	39	Suhbaatar	Transportation Center
23	12	m	19	Bayangol	Railway station
24	12	f	68	Bayangol	Railway station
31	14	m	56	Chingeltei	Shop No.1
32	14	f	35	Chingeltei	Shop No.1

Notes :

1) Serial numbers given in the interview survey

2) Day of March 1996

3) m : male, f : female

Table 7-1-1 (4/4)

Profile of Interviewees : Type D (Company which has recently installed a phone)

No. 1)	Date of inter-view 2)	Location of company		Type of business	Month/year of establish-ment	Number of employ-ees	Month/year of installing a phone	Period of waiting before install-attion
		Dureg	Horoo					
25	13	Han-Uul	2	for manufacturing	March, 1991	10	Feb, 1996	1 year
26	13	Bayanzurkh	1	vegetables	July, 1995	7	Feb, 1996	4 years
27	13	Han-Uul	n.a.	textile manufacturing	Nov. 1991	28	Feb, 1996	1.5 years
28	13	Han-Uul	3	private hospital	Aug. 1989	25	Feb, 1996	2 years
29	13	Songinohairhan	5	construction	Dec. 1995	2	Jan. 1996	4 years
30	14	Bayanzurkh	10	Stoarage facility	1993	40	Dec. 1995	2 yeaes

Notes :

1) Serial numbers given in the interview survey

2) Day of March 1996

Table 7-1-2

Purpose of Telephone Calls : Households which have recently had a phone installed

(Unit : %)

No. 1)	Area	Purpose					Remarks for emergency cases
		Calling friends	Calling relatives	Business	Emer-gency	Social services	
8	ger	80	10	8	2	0	
11	ger	70	20	10	0	0	
15	apt.	25	60	0	15	0	to call an ambulance
35	apt.	50	50	0	0	0	
36	apt.	50	48	0	2	0	to call an ambulance
37	apt.	20	80	0	0	0	
38	apt.	90	8	0	2	0	illness
39	apt.	20	80	0	0	0	
44	apt.	30	50	0	0	20	
45	apt.	30	60	0	10	0	to call an ambulance
46	apt.	50	50	0	0	0	
47	apt.	20	50	20	10	0	to call a locksmith
48	apt.	40	30	30	0	0	
49	apt.	20	70	0	10	0	to call an ambulance/police
57	apt.	50	40	0	10	0	illness

1) serial numbers given in the interview survey

Table 7-1-3
Willingness-to-pay for Call Charge of Residential and Business Subscribers Who Recently Obtained a Phone

(Unit : tugrig/minute)

No. 1)	Area	Maximum allowable local call charge	Remarks
(Residential Subscribers)			
11	apt.	3.5	
15	ger	3.0	
35	apt.	3.0	
36	apt.	5.0	
37	apt.	3.0	
38	apt.	3.0	
39	apt.	no	against timed local call
44	apt.	3.0	
45	apt.	3.0	
46	apt.	no	against timed local call
47	apt.	3.0	
48	apt.	3.0	
49	apt.	no	against timed local call
57	apt.	no	against timed local call
(Business Subscribers)			
25	-	3.0	for manufacturing
26	-	10.0	vegetables
27	-	5.0	textile manufacturing
28	-	3.5	private hospital
29	-	5.0	construction
30	-	4.0	storage facility

Notes :
1) Serial numbers given in the interview survey

Table 7-1-4
Willingness-to-pay for Telephone Installation of Households Having No Phone and Companies with Phones

(Unit : tugrig)

No. 1)	Area	Maximum allowable installation charge	Remarks
(Residential Subscriber)			
1	apt.	15,000	
2	apt.	20,000	
3	apt.	25,000	
9	ger	15,000	
10	ger	20,000	
14	apt.	25,000	
16	ger	-	Phone is not needed.
33	ger	20,000	
34	ger	25,000	
40	apt.	20,000	
41	apt.	35,000	
42	apt.	15,000	
43	apt.	10,000	
50	ger	8,000	
51	ger	20,000	
52	apt.	30,000	
53	apt.	15,000	
54	ger	-	cannot afford call charge
55	ger	20,000	
56	ger	10,000	
(Business Subscriber)		2)	
25	-	40,000	
26	-	50,000	
27	-	24,000	
28	-	30,000	
29	-	50,000	
30	-	30,000	

Notes :
1) Serial numbers given in the interview survey
2) Figures were given to the question assuming an imaginary situation in which they have no phone and a phone be installed immdeately.

Table 7-1-5
Distance of Travels People Make In the Absence of Telephone

No. 1)	Area	% of travelling for communication	Means of travel	Distance of travel	Length of travel
1	apt.	10%	bus	9.8 km	n.a.
2	apt.	100%	bus	9.8 km	60 min.
3	apt.	100%	bus	1 to 20 km	n.a.
			childrens' car		na.
7	ger	80%	bus	15 to 20 km	1.5-2.0 hrs
9	ger	20%	bus	5 - 10 km	30-40 min.
10	ger	60%	bus	6 km	20 min.
14	apt.	10%	bus	5-10 km	20-30 min.
16	ger	40%	bus	7-15 km	40-60 min.
33	ger	20%	bus	10 km	30-40 min.
34	ger	10%	bus	5-7 km	30-50 min.
40	apt.	15%	bus	2-8 km	20-60 min.
41	apt.	10%	bus	4-5 km	40 min.
42	apt.	15%	bus	4-5 km	15-20min.
43	apt.	0%	-	-	-
50	ger	30%	bus	2-4 km	15-30 min.
51	ger	10%	bus	10 km	1 hrs.
52	apt.	5%	bus	2-15 km	20-90min.
53	apt.	20%	bus	7-8 km	30-40 min.
54	ger	80%	bus	10-12 km	1 hrs. more
55	ger	25%	bus	5-10 km	1-1.5 hrs.
56	ger	70%	bus	5-8 km	40-90 min.

Notes :
1) Serial numbers given in the interview survey

Table 7-1-6 Improvements in life after having a phone at home

No. 8 (Ger area)
No information.

No. 11 (Apartment area)
Easier communication. Saves a lot of time and travel expenditure.

No. 15 (Apartment area)
Saves time and travel expenditure. Easy to call an ambulance.

No. 35 (Apartment area)
No answer

No. 36 (Apartment area)
Any work goes on faster.

No. 37 (Apartment area)
Convenient to call doctor for my new-born baby.

No. 38 (Apartment area)
It became possible to communicate with friends and relatives with whom we have not seen for a long time.

No. 39 (Apartment area)
Feel more comfortable. Life has become more interesting. Saves a lot of time and travel expenditure.

No. 45 (Apartment area)
Easier to communicate. Easy to call an ambulance for children who often gets sick.

No. 46 (Apartment area)
No definite idea. But we like it very much.

No. 47 (Apartment area)
Easy for my parents, who are pensioners, old and cannot go out easily, to communicate with many people.

No. 48 (Apartment area)

Everything goes on faster. Works became more successful.

No. 49 (Apartment area)

A phone is useful for an old man like himself, who cannot go everywhere on his own.

No. 50 (Apartment area)

Like to chat with friends and relatives over the phone.

Table 7-1-7 Experience of a trouble because of having no phone

No. 1 (apartment area)

Recently I had a heart attack. It was impossible to find a phone to call an ambulance because neighbors did not open the door at night.

No. 2 (apartment area)

I could not call an ambulance when my daughter was born. I delivered the baby without receiving medical care.

No. 3 (apartment area)

No experience.

No. 7 (apartment area)

When the younger child got sick, we could not find a phone to call an ambulance. So we sent someone to the hospital.

No. 9 (apartment area)

When my wife got sick, I could not find a phone to call an ambulance. So I myself went to the hospital.

No. 10 (apartment area)

My younger sister was going to deliver a baby on January 30, 1996. We caught a taxi to Altanshagai company office to call an ambulance from there. All together it took over 40 minutes.

No. 14 (apartment area)

No experience.

No. 16 (apartment area)

Once I broke my leg and could not reach the pay phone we usually used.
So I had to wait until children came from school.

No. 33 (apartment area)

When my first baby was born, we could not call an ambulance, so we caught a taxi to get to the hospital.

No. 34 (apartment area)

No experience yet.

No. 40 (apartment area)

When my husband's mother had a heart attack, they could not call an ambulance for half an hour.

No. 41 (apartment area)

When we were away from our home visiting the countryside, our friends from Dornod aimag could not check by phone whether we were at home or not. So they spent a lot of money hiring a taxi to our empty apartment.

No. 42 (apartment area)

No experience.

No. 43 (apartment area)

Because our neighbors are very kind, they always let us use their phone.

No. 50 (ger)

Once, two young drunken men tried to enter into our fence. We could not call the police, so there was a fight.

No. 51 (ger)

He cannot remember.

No. 51 (apartment area)

No experience.

No. 53 (apartment area)

When my mother got seriously ill, I spent more than an hour to find a pay phone to call an ambulance. The nearest pay phone was not working then.

No. 54 (Ger)

When our house was burglarized, we could not find a phone to call the police. So we went to the police office by bus.

No. 55 (Ger)

We have had a lot of troubles.

No. 56 (Ger)

Yesterday, I spent almost 3 hours and 200 tugrig to tell my relatives that my parents would not be able to attend the birthday party.

Table 7-1-8

Current Telephone Use and Desired Distance to the Nearest Telephone of Households Having No Telephone

No. 1)	Area	Telephone currently used			Desired distance from your home (meter)
		Whose phone ?	Proportion (%) 2)	Distance from your home (meter)	
1	apt.	someone else's	90%	n.a.	n.a.
2	apt.	none	-	-	-
3	apt.	none	-	-	-
7	ger	someone else's	20%	1,500	500
9	ger	payphone	90%	500	200
10	ger	payphone	40%	800	200
14	apt.	neighbor	40%	2	50
		payphone	40%	700	-
16	ger	payphone	60%	150	n.a.
33	ger	payphone	80%	3,000	n.a.
34	ger	neighbor	60%	30	50
		payphone	30%	1,000	-
40	apt.	payphone	85%	150	50
41	apt.	neighbor	40%	10	20
		payphone	50%	250	-
42	apt.	neighbor	40%	5	50
		payphone	45%	200	-
43	apt.	neighbor	100%	10	30
50	ger	payphone	70%	500	n.a.
51	ger	neighbor	50%	50	20
		payphone	40%	1,000	-
52	apt.	neighbor	80%	5	n.a.
53	apt.	payphone	80%	300	n.a.
54	ger	travel	n.a.	n.a.	n.a.
55	ger	payphone	70%	2,000	n.a.
56	ger	someone else's	30%	1,000	100

Notes :

1) Serial numbers given in the interview survey

2) Proportions to all the means of communication including using someone else's phone, travel, using payphone, mail, telegram, and asking someone to deliver a message.

Table 7-1-9
Present and Desired Distance to the Nearest Pay Phone (opinions of those interviewed at existing pay phones)

No.	Distance to the nearest pay phone (meters)	Desired distance to the pay phone (meters)
4	n.a	100
5	50	50
13	30	30
17	80	50
20	700	100
22	20	20
23	300	300
24	n.a.	50
31	50	50

Table 7-1-10 A Profile of Telephone Calls from Privately-managed Payphones

No.	Come from	Charge and length of talk				Frequency	Purpose	Remarks
		This time		Ususally				
	1)	Charge (tugrigs)	length (minutes)	Charge (tugrigs)	length (minutes)	(times)		
4	H	20	?	20	2 to 3	1-2/month	to talk with husband	
5	H	-	-	20	3	1-2/month	to talk with husband	
12	H	20	1	20	no limit	2 to 3/ week	to talk with a friend	have a phone at home
13	H	20	3	20	1 to 3	2 to 3/ week	to talk with a relative	
17	H	20	2	20	1 to 5	0 to 1 /week	to talk with my grandmother	
18	H	30	3	n.a.	n.a.	no	business	have a phone at home
19	O	20	2	20	3	2 to 3 /month	-	additional 5tg for additional 1 minute
20	H	20	3	20	3	1 to 2/ day	to talk with a friend	
21	H	30	1 to 2	n.a.	n.a.	no	to talk with his wife	have a phone at home
22	H	30	6	30	3 to 4	2 to 3/ day	to talk with a friend	
23	H	30	2	30	1 to 5	0 to 2 / week	to check if her sister is at home	
24	*	30	1	30	1 to 5	2 to 3/ year	to talk with her son	* from her relative's apartment
31	H	30	4	30	1 to 10	3 to 5 /week	to talk with former counterpart	
32	O	30	2	30	1 to 3	1 to 2 / month	-	

Notes :

1) H : home, O : office

2. Estimation of Consumer Surplus

2.1 General

During the second survey in Mongolia, February to March 1996, an interview survey was conducted with the objective of collecting data on social and economic impacts of the telecommunication development (hereafter called "the Socio-Economic Survey"). One of the outputs of the survey is data on the willingness- to-pay of people on local calls and installation charge. These data are processed and applied to the economic analysis of the priority projects and the basic plan. The data on willingness-to-pay are processed in such a way as to generate demand curves for local calls and installation of a phone. These data are useful in capturing the order of magnitude of economic impacts of the proposed projects. Under a larger scale survey, more refined models could be derived. The following are the numbers of samples collected.

Local calls
residential subscriber : 14
business subscriber : 6
Installation charge
residential subscriber : 18
business subscriber : 6

2.2 Outline of Data Collected

Questions are asked to interviewees in such a way as to up to what level of timed local call charge or installation charge they are ready to pay. For local call charge, the data are collected from households and companies which recently installed a phone . An assumption is that they will receive better telecommunication service by the proposed telecommunication development. This point is explicitly explained to the interviewees. For installation charge, questions are asked to households having no phone at present and companies which recently installed a phone assuming a situation in which they have no phone. They are asked up to what charge level they are ready to pay for immediate installation of a phone. In both cases, an interviewee was asked to choose yes or no to charge levels given by the interviewer in an ascending order. When the interviewee answered no, the inquiry stops and the highest charge level at which the interviewee answered yes is regard as his/her willingness-to-pay level for local call or installation charge.

Table 7-1-3 and Table 7-1-4 in the previous section show the result of the inquiries concerning the willingness-to-pay of interviewees.

2.3 Derivation of Consumer Surplus

The collected data can be plotted on graphs in a conceptual manner as shown in Figure 7-2-1. The shaded areas correspond to revenue portion, calculated by multiplying existing or planned tariff level and demand. The portion above the shaded areas and below the demand curves are regarded as consumer surplus. Areas of these consumer surplus portions are calculated as the sum of trapezoids and triangles. Once these two kinds of areas, revenue portion and consumer surplus portion, are measured, their proportions can be derived. Assuming the same proportions can be applied to Ulaanbaatar as a whole, economic benefit of the proposed projects can be measured by applying these proportions to the forecast revenue. The following are the proportions of consumer surplus portion to revenue portion derived from the collected data.

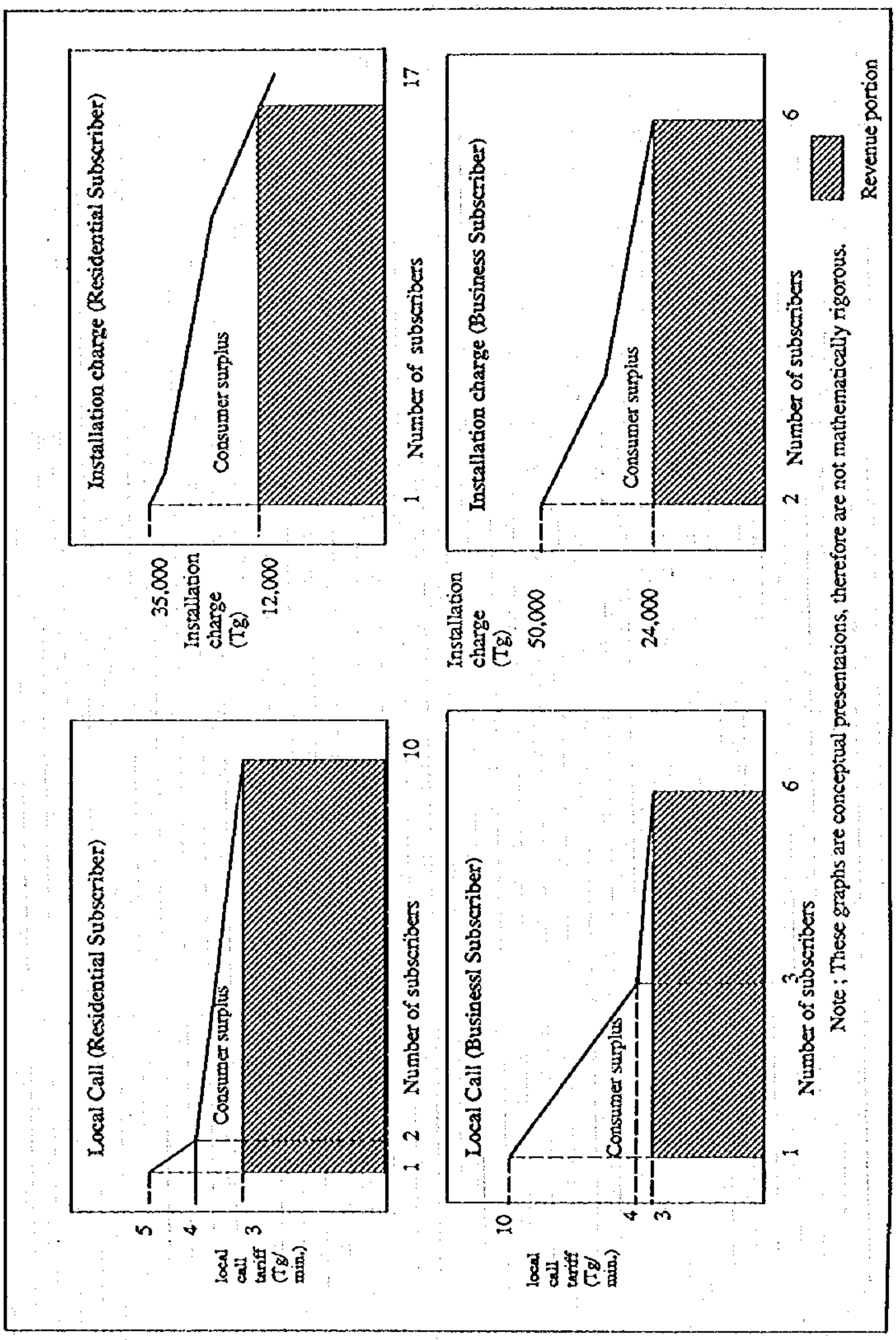
Local call

- residential subscriber : 12%
- business subscriber : 77%

Installation charge

- residential subscriber : 75%
- business subscriber : 48%

Figure 7-2-1 Graphic Presentation of Consumer Surplus of Local Call and Installation Charges



Note ; These graphs are conceptual presentations, therefore are not mathematically rigorous.

3. HOUSEHOLD EXPENDITURE ON TELECOMMUNICATIONS

An analysis is made on the affordability of lowest income stratum household demanding telephone. In the financial analysis, the planned new tariff is applied to local calls. The minimum monthly households demanding telephone is set at Tg. 43,100 per month under the present tariff system which charges only a monthly rent of Tg. 420 for local calls. In the new tariff, local calls will be charged at Tg. 3 per minute for calls beyond 150 minutes per month. The point of the analysis is to confirm if Tg. 43,100 per month would still be the minimum income stratum under the new tariff.

The attached three tables show the proportions of expenditure on telecommunications by income group in Japan, Korea and Singapore. Though data in lower income countries would ideally be more relevant to Mongolia, the problem with the data in those countries is that lower income households surveyed usually include many households without telephone, thus lowering the average proportions of expenditure on telecommunications. Household survey data targeting only those households with telephones are generally unavailable. The data in Japan, Korea and Singapore are more trustworthy since most of the households surveyed, even those in lowest income stratum, have telephones.

The tables show that the following proportions are spent on telecommunications by the lowest income households.

- Japan : 3.2%
- Korea : 3.7%
- Singapore : 2.9%

Assuming 3% is the average expenditure on telecommunications by the lowest income group with a monthly income of Tg. 43,100, the following call minute is derived.

- Tg. 43,100 times 3% = Tg. 1,293 per month		
- Tg. 1,293 divided into :	rent portion :	Tg. 420 = 150 minutes per month
	charged call :	Tg. 873 = 291 minutes per month*
- Total		= 441 minutes
- 441 minutes per month = 15 minutes per day		

These calculations indicate that the lowest income households will be able to make local calls for 15 minutes per day on average if they are ready to spend 3% of their income on telephone charge. These conditions are highly possible to take place. This finding supports the assumption in the demand forecast that the households with an income of Tg. 43,100 per month is regarded as the minimum income level of telephone demand, even under the new local call tariff level.

Table 7-3-1 Proportion of Household Expenditure on Telecommunications by Income Group

(Japan 1993)

Annual income group (million yen)	Monthly expenditure on telecommunication (Yen/month)	Annual Income (thousand yen/year)	Proportion of telecoomunication (%)
Average	6,599	7,370	1.1
-1.999	4,172	1,570	3.2
2.0 - 2.499	4,609	2,240	2.5
2.5 - 2.999	5,094	2,740	2.2
3.0 - 3.499	5,226	3,230	1.9
3.5 - 3.999	5,548	3,720	1.8
4.0 - 4.499	5,424	4,220	1.5
5.0 - 5.499	5,652	4,730	1.4
5.5 - 5.999	5,968	5,220	1.4
6.0 - 6.499	5,996	5,730	1.3
6.5 - 6.999	6,206	6,210	1.2
7.0 - 7.499	6,265	6,740	1.1
7.5 - 7.999	6,172	7,200	1.0
8.0 - 8.499	7,093	7,720	1.1
8.5 - 8.999	7,319	8,450	1.0
9.0 - 9.999	7,865	9,450	1.0
10.0 - 12.499	8,017	11,040	0.9
12.5-14.999	8,735	13,540	0.8
15.0 -	10,124	21,290	0.6

(Korea 1994)

(Unit : thousand won)

Monthly income group	Monthly expenditure on telecommunication	Monthly Income	Proportion of telecoomunication (%)
Average	20	1,279	1.6
-300	10	270	3.7
300 - 399	13	414	3.1
400 - 499	14	542	2.7
500 - 599	16	629	2.6
600 - 699	17	737	2.3
700 - 799	18	855	2.1
800 - 899	19	967	2.0
900 - 999	21	1,078	1.9
1,000 - 1,099	20	1,191	1.7
1,100- 1,199	21	1,298	1.6
1,200-1,299	22	1,405	1.6
1,300-1,499	23	1,571	1.4
1,500-1,699	24	1,798	1.3
1,700-1,899	26	2,003	1.3
1,900 -	29	3,464	0.8

Source : 1994 Annual report on the Family income and Expenditure Survey (National Statistical office, Korea)

(Taiwan 1982)

(Unit : %)

Monthly income group	Proportion of telecoomunication (%)
Average	1.4
1 (lowest)	2.9
2	2.5
3	2.1
4	1.7
5	1.3
6	1.1
7	0.9
8	0.9
9	0.7
10 (highest)	0.5

Source : Report on the Household Expenditure Survey 1982/1983 (Department of Statistics, Singapore. March 1985)