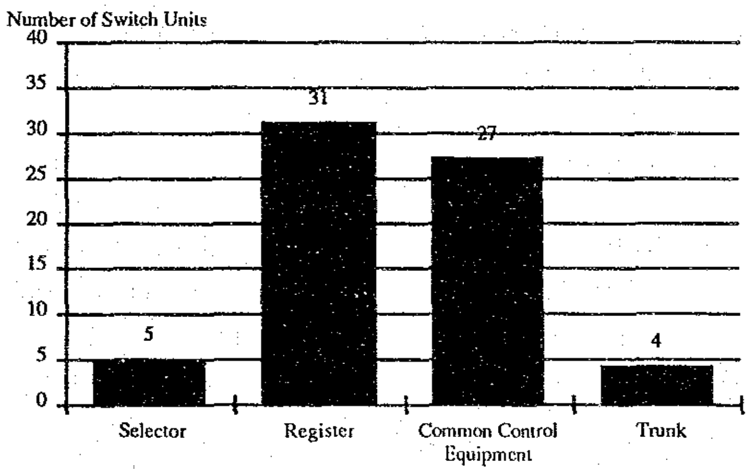
Table 2.3.1-1 The Plant Control Target Value of each equipment category

	Plant control target value (per 1,000 subscriber lines)
Selector	0.3
Register	0.1
Common Control Equipment	0.1
Trunk	0.05

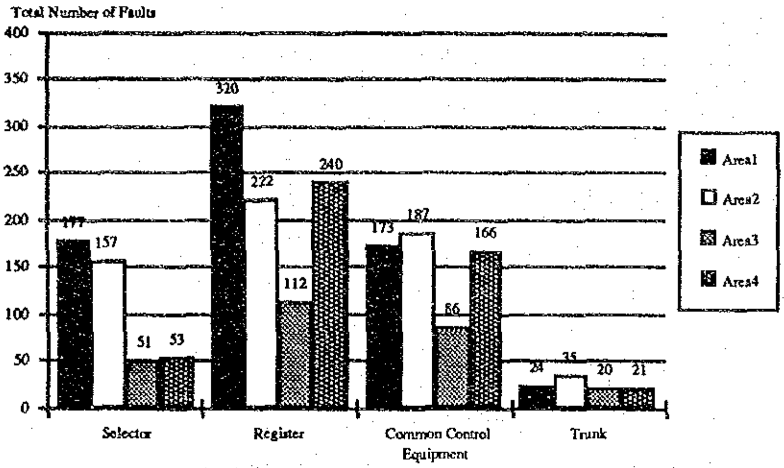
There are 40 switch units equipped with the XB switches (C400) in the BMA. Figure 2.3.1-4 shows the total number of the XB switch units of which the number of repairs exceeded the plant control target Figure There is one more switch unit equipped with the XB switch (ARF-102); however, it was excluded from the study because its repair reporting system was different.



(Source: Monthly Report from the Center of Metropolitan Switching Office)

Figure 2.3.1-4 Total Number of XB Switching Units of which the number of repairs Exceeded Plant Control Target Value in each Equipment Category

Repairs for the register, the common control equipment, and the selector were more frequently needed in the Area 1 and 2 than the other areas. Since these two areas are business and commercial areas, it is considered that many in-coming and out-going business calls caused physical deterioration of the facilities which demanded the repairs. The total number of the XB switch faults in each area is shown in Figure 2.3.1–5.



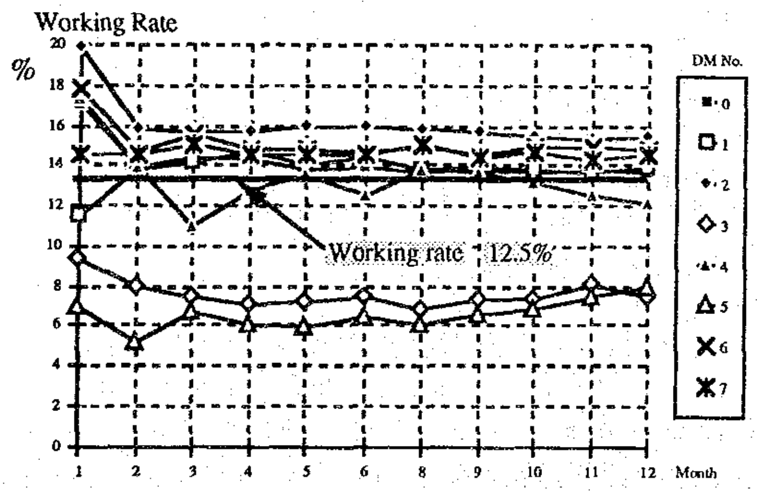
(Source: Monthly Report from the Center of Metropolitan Switching Office)

Figure 2.3.1-5 Total Number of XB Switch Faults in Each Area

How DM (Dial Tone Marker) and CM (Completing Marker) have been utilized is explained by using the PNC-1 unit as an example.

a) DM (Dial Tone Marker)

There are 8 DMs in the PNC 1 unit. Figure 2.3.1-6 shows their working rates expressed in 1991 which were compiled from the Monthly Fault Report. Table 2.3.1-2 shows the average annual working rates and standardized working rates, taking 12.5% as the over all standard working rate for each DM.



(Source: Monthly Report from the Center of Metropolitan Switching Office)

Figure 2.3.1 -6 DM Working Rate of PNC-1 Switch Unit in 1991

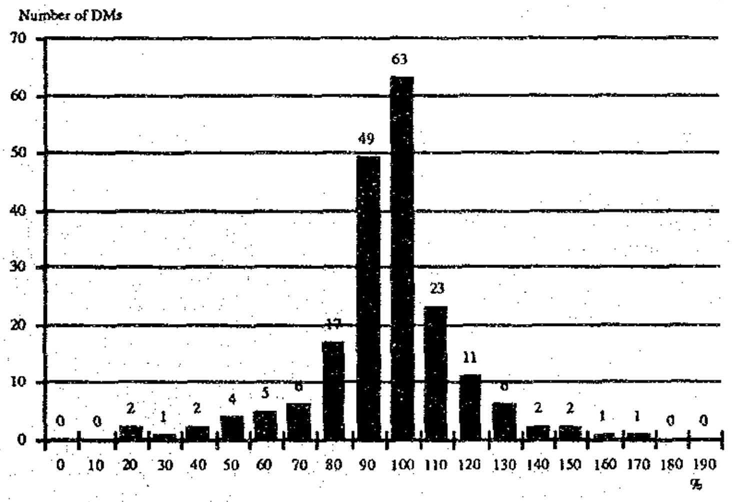
Table 2.3.1-2 DM Working Rate and Standardized Working Rate of PNC-1 Switch unit in 1991.

DM number	0	1	2	3	4	5	6	7
Working Rate (%)	14.19	13.79	16.07	7.60	13.31	6.57	15.16	13.30
SWR(%)	114	110	129	61	106	53	121	106

Note SWR: Standardized Working Rate

Figure 2.3.1-6 tells that the working rates of the DM No. 3 and No. 5 are well below the over-all average working rate (12.5%). When a facility as a total system is in a time-worn, deteriorated, poorly maintained condition (even though some parts were replaced by new ones), it cannot properly work for high traffic situations and will eventually seize to function; however, it resumes its work for normal traffic situations.

At the same time, other facilities are affected by the low working rate facilities and are utilized in higher working than the average working rate (12.5%). This seems what happened in this case. If this situation continues to prevail, it will promote the deterioration of all facilities. Figure 2.3.1-7 shows the distribution of the standardized working rates of 195 DMs of the XB switches (C400) in the BMA.



(Source: Monthly Report from the Center of Metropolitan Switching Office)

Figure 2.3.1-7 Distribution of Standardized Working Rates of 195 DMs in 1991

Of the 195 DMs, 20 DMs (10.30%) have below 80% working rate and 23 DMs (11.79%) have above 120% working rate. These DMs are the major cause of the dial tone delay in busy hours. Figure 2.3.1-8 shows the percentage distribution of the standardized working rates of the DMs in 1991.

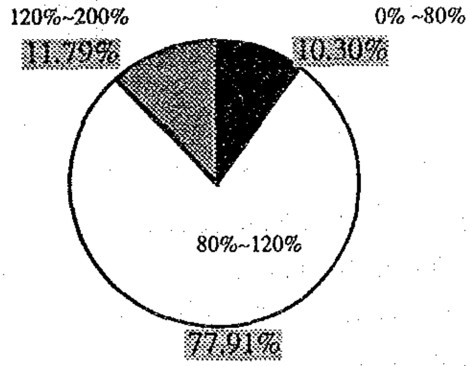
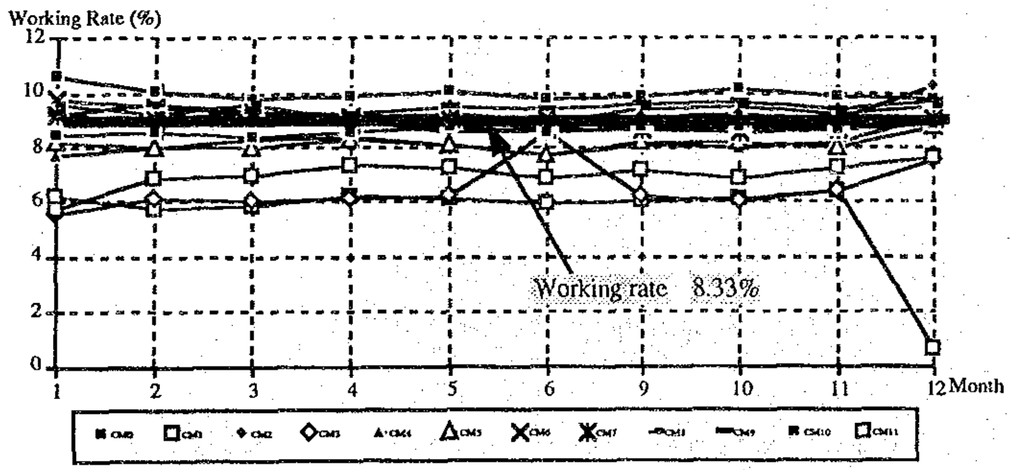


Figure 2.3.1-8 Percentage Distribution of Standardized DM Working Rates

b) CM (Completing Marker)

There are 12 CMs of the PNC-1 unit. Figure 2.3.1-9 shows monthly CM working rates of the PNC-1 switch unit in 1991. Table 2.3.1-3 shows average annual working rates, and standardized working rates, using the over-all average working rate as the standard for each CM.



(Source: Monthly Report from the Center of Metropolitan Switching Office)

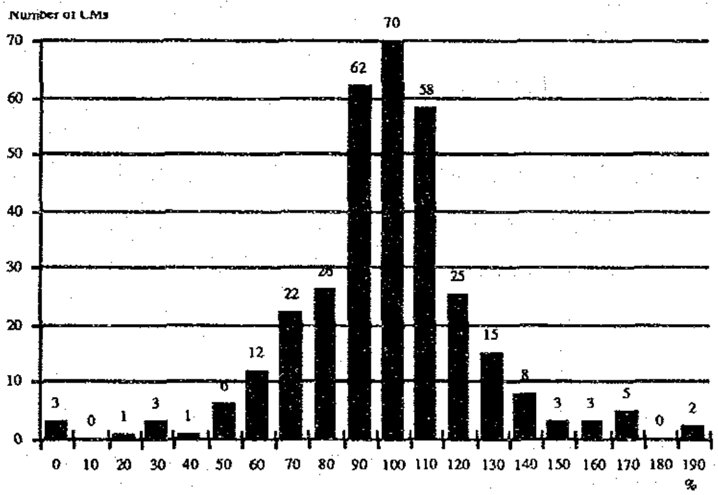
Figure 2.3.1-9 CM Working Rate of PNC-1 Switch Unit in 1991

Table 2.3.1-3 CM Working Rate and Standardized Working Rate of PNC-1 Switch Unit in 1991

CM Number / Working Rate	0	1	2	3	4	5	6	7	8	9	10	11
Working Rate (%)	10.01	5.53	9.18	6.5	8.17	8.15	9.12	8.91	9.3	9.46	8.65	7.01
SWR (%)	120	66	110	78	98	98	109	107	112	113	104	84

Note: SWR: Standardized

Figure 2.3.1-9 tells that the working rates of the CM No. 1, CM No. 3 and No. 11 are well below the over-all average working rate (8.33%). The reason can be the same as that stated in the DM case. Figure 2.3.1-10 shows the distribution of the standardized working rates of 325 CMs of the XB switches (C400) in the BMA.



(Source: Monthly Report from the Center of Metropolitan Switching Office)

Figure 2.3.1-10 Distribution of standardized Working Rates of 325 CMs in 1991

Of the 325 CMs, 48 CMs (14.77%) are below 80% working rate, 61 CMs (18.77%) are above 120% working rate. These CMs are the major cause of the dial tone delay in busy hours. Figure 2.3.1-11 shows the percentage distribution of the standardized rates of the CMs.

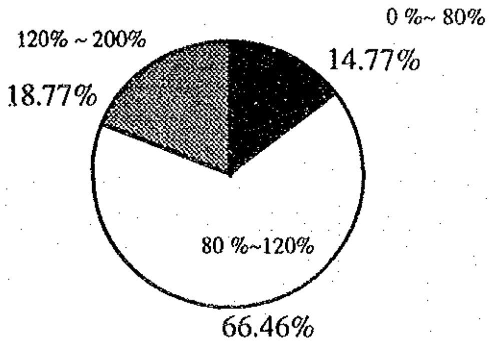


Figure 2.3.1-11 Percentage Distribution of Standardized CM Working Rates in 1991

2) SPC Switch Fault

Faults of the SPC switches are classified into LIB (Line Interface Board) fault, OTH (Other Board) fault and phase trouble categories. The LIB faults mean faults occurred in subscriber line packages. The OTH faults mean faults occurred in the common control equipment of the SPC switches. The LIB and OTH faults are hardware related to faults, while phase trouble is not.

The total numbers of repaired SPC switch faults are 2838 in 1989, 2640 in 1990, and 2529 in 1991 according to the Monthly Fault Report. Figure 2.3.1-12 shows the total numbers per 1,000 subscriber lines and total numbers of repaired LIB and OTH faults in 1989, 1990 and 1991.

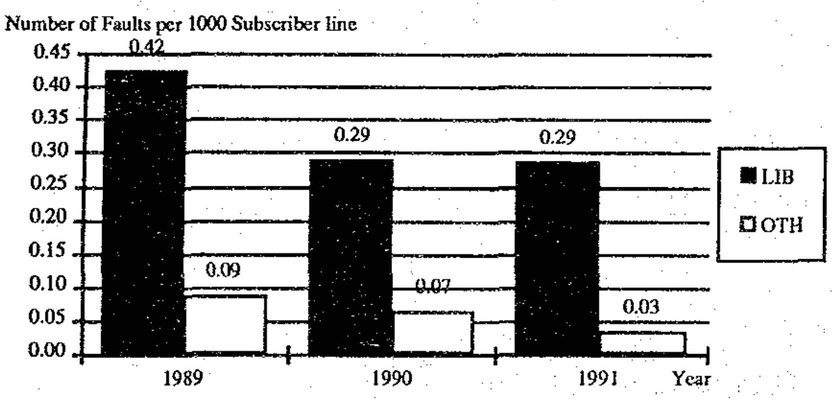
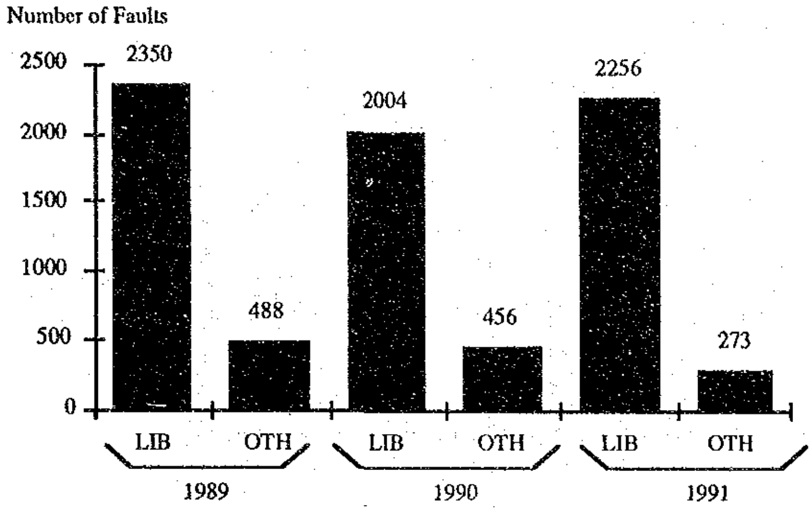


Figure 2.3.1-12 Fault Ratio of LIB and OTH (1/2)



Source: Monthly Report from the Center of Metropolitan Switching Office

Figure 2.3.1-12 Total Number of LIB and OTH Faults (2/2)

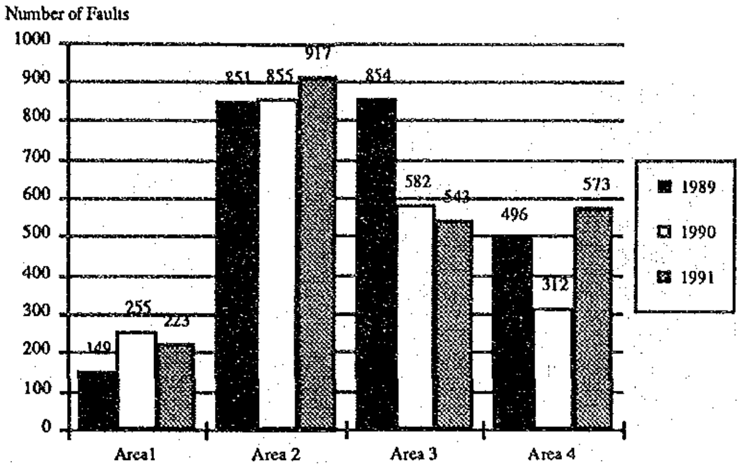
Table 2.3.1-4 also shows the total numbers of repaired LIB and OTH faults in 1989, 1990, and 1991 and the percentage distribution.

Table 2.3.1-4 Number of Repaired LIB Fault and OTH Faults

Year	1989	1990	1991	Total	Ratio(%)
LIB	2350	2004	2256	6610	84.45
OTH	488	456	273	1217	15.55
Total	2,838	2,460	2,529	7,827	100

a) LIB (Line Interface Board)

More repairs on LIB were needed in the Area 2 and 3 than those other Areas. The faults have been caused by faults of subscriber line packages due to high electricity current and voltage inflow by electro magnetic induction and line crossing with power lines. Figure 2.3.1-13 shows the total number of repaired LIB faults in each area.

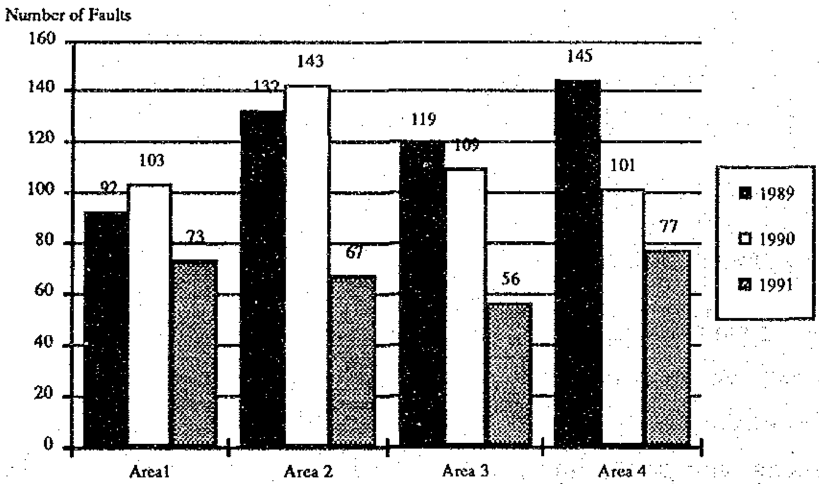


(Source: Monthly Report from the Center of Metropolitan Switching Office)

Figure 2.3.1-13 Total Number of LIB Faults in each area

b) OTH (Other Board)

The number of repairs has been decreasing each year in all areas. Figure 2.3.1-14 shows the total number of repaired OTH faults in each area over the last three years.



(Source: Monthly Report from the Center of Metropolitan Switching Office)

Figure 2.3.1-14 Total Number of OTH Faults

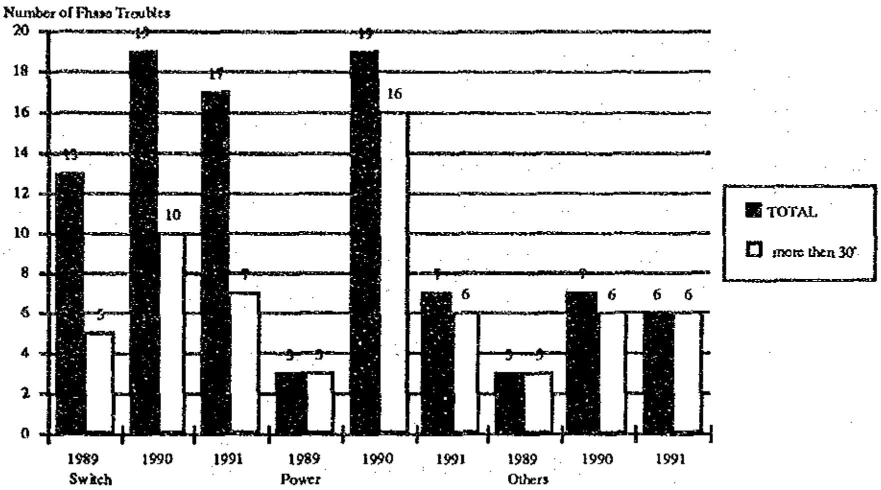
c) Phase Trouble

Phase trouble means that calls cannot be connected because of troubles in switches . For the SPC switch, phase trouble is classified in 6 phase (Ph-0.5, Ph-1, Ph-1.5, Ph-2, Ph-2.5, Ph-3). An SPC switch has its own autonomous restart function to go back the normal condition by disconnecting all in-coming and out-going calls, especially when the trouble beyond Ph-2 (Ph-2, Ph - 2.5, Ph-3) occurs. Table 2.3.1-5 shows restart procedures of Ph-2, Ph-2.5 and Ph-3.

Table 2.3.1-5 Restart Procedure of SPC Switch

RESTART PHASE	INITIATION	CALL EFFECTIVENESS	CHARGING	FILE RELOAD
Phase 2	Failure of Phase 1.5 restart or manual operation	No telephony during initialization	Subscribers who have been cut off are not charged	No
Phase 2.5	Failure of Phase 2 restart or manual operation	No telephony during initialization	Subscribers who have been cut off are not charged	Yes
Phase 3	Manual operation	No telephony	Subscribers who have been cut off are not charged	Yes

Phase trouble are also caused by power outage and line cuts between main switching offices and local switching offices. Figure 2.3.1-15 shows the total number of phase troubles and the number of troubles which lasted for more than 30 minutes because of switch, power, other troubles for the last three years.



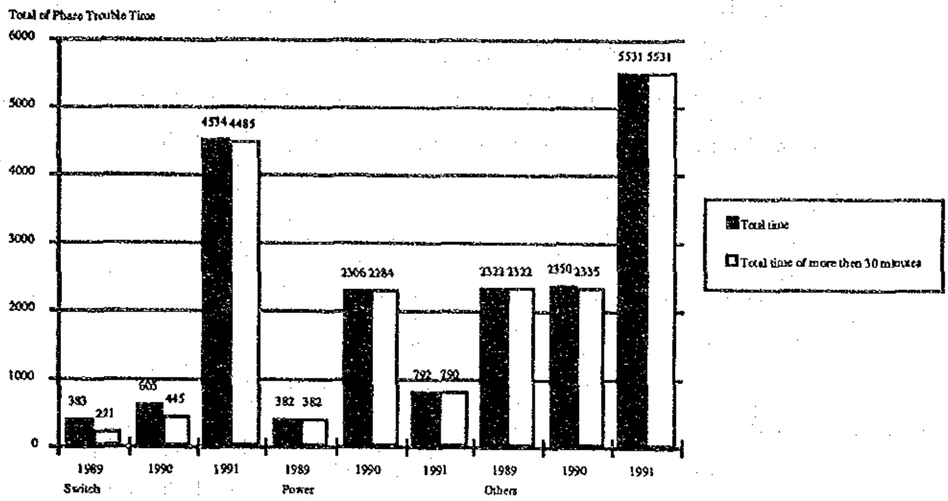
(Source: Monthly Report from the Center of Metropolitan Switching Office)

Figure 2.3.1-15 Total Number of Phase Trouble

The down time caused by switch and other trouble in 1991 sharply increased from the that in 1990. The reason behind the sharp increase of the switch phase trouble is the lack of careful checking and coordination of software's and hardwares of Switches. The sharp increase of the other phase troubles is mainly due to either bit errors of PCM or optic fiber line cuts.

The average lengths of phase trouble time are 44.5 minutes for switch troubles, 142.8 minutes in power troubles and 389.2 minutes in other troubles in 1990 and 640.2 minutes for switch troubles, 131.7 minutes for power troubles and 930.2 minutes for other troubles in 1991.

Figure 2.3.1-16 shows the total amount of trouble time switch, power and other troubles for the last three years.

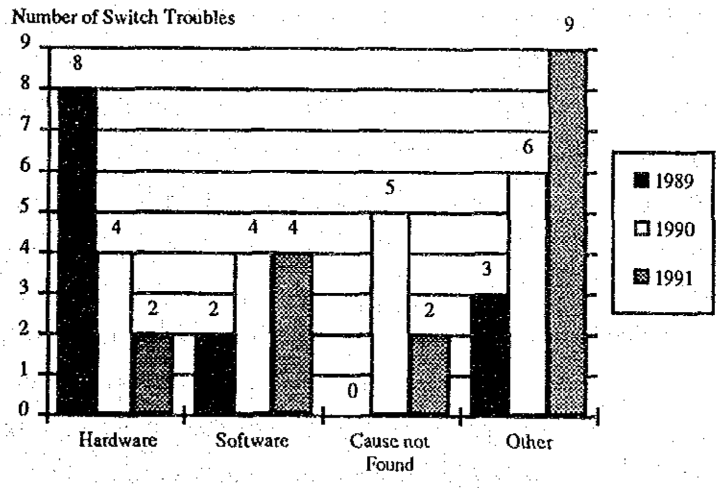


Source: Monthly Report from the Center of Metropolitan Switching Office

Figure 2.3.1-16 Total Amount of Phase Trouble Time

i) Switch Troubles

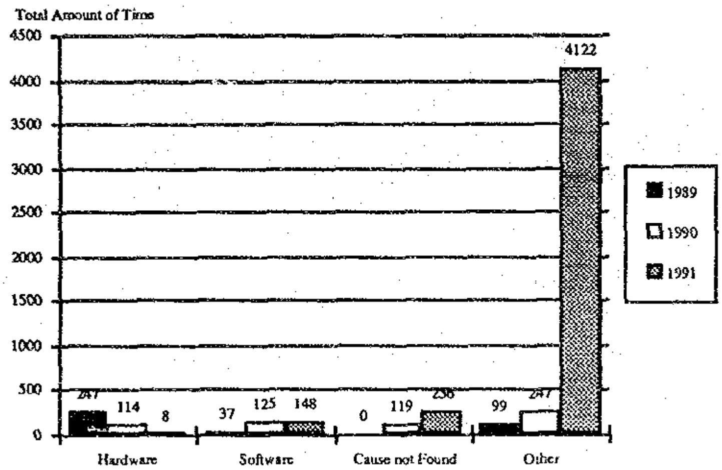
Switch troubles are classified into 4 categories (hardware, software, cause not found, and other). Figure 2.3.1-17 shows the number of switch troubles of each category for the last three years. Figure 2.3.1-18 shows the total length of switch trouble time of each category for the last three years.



(Source: Monthly Report from the Center of Metropolitan Switching Office)

Figure 2.3.1-17 Total Number of Switch Troubles

According to Figure 2.3.1-17 and 18, the number of switch troubles classified in the other category (troubles caused by operational and construction mistakes) have been gradually increasing and the total length of trouble time of the other category has sharply increased.

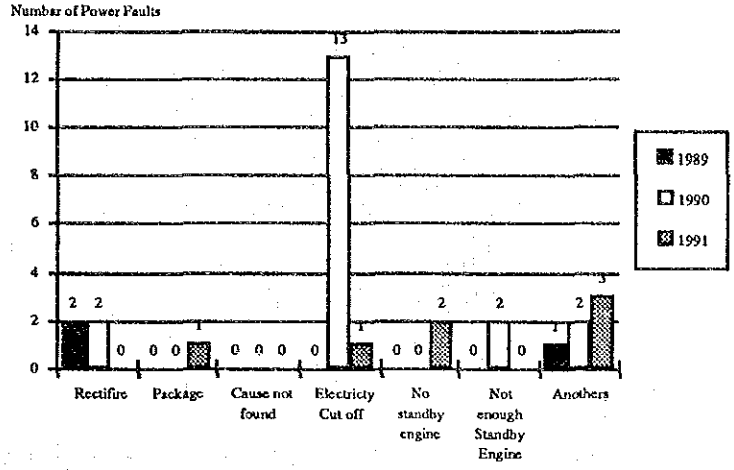


Source: Monthly Report from the Center of Metropolitan Switching Office)

Figure 2.3.1-18 Total Amount of Switch Troubles

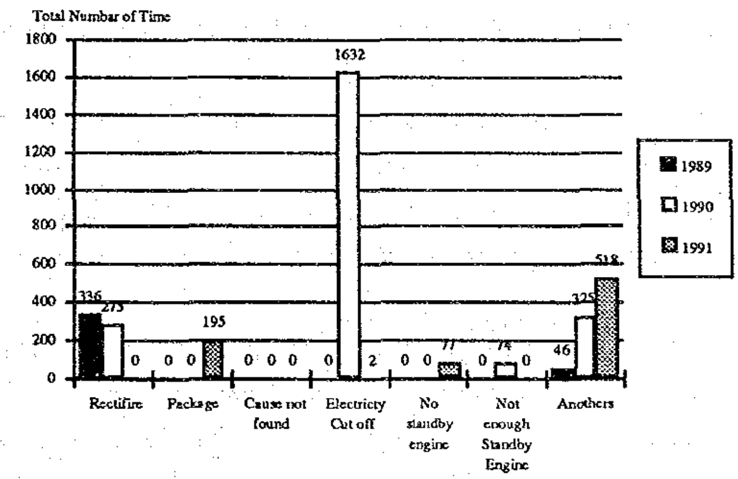
ii) Power Facility Faults

By the study on causes of the power troubles in the BMA for the last three years (1989 - 1991), the causes are classified into 7 categories (rectifier, package, cause not found, temperature increase of switch room, no stand-by generator, not enough stand-by generator capacity and others). Of the above 7 categories, troubles related due to temperature increase of switch room, no stand-by generator, and not enough stand-by generator capacity are primarily caused by power outage. Figure 2.3.1-19 shows the total number of troubles of each category for the last three years. Figure 2.3.1-20 shows the total length of troubles time of each category for the last three years. There were 13 troubles related to temperature increase of switch room to power outage in 1990; however, their causes are not clear. Figure 2.3.1-21 shows the percentage distribution of the trouble categories. The number of troubles cause by power outage is 29 (62% of all troubles).



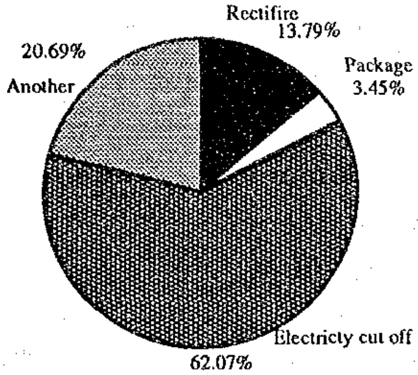
(Source: Monthly Report from the Center of Metropolitan Switching Office)

Figure 2.3.1-19 Total Number of Power Troubles in the BMA



(Source: Monthly Report from the Center of Metropolitan Switching Office)

Figure 2.3.1-20 Total Amount of Power Trouble Time



(Source: Monthly Report from the Center of Metropolitan Switching Office)

Figure 2.3.1-21 Percentage Distribution of Trouble Categories

The following 3 cases can be expected when a switch stops to work.

- Air-conditioning stops as soon as power outage occurs. This leads to gradual temperature increase and eventual switching system down (over 45°C).
- Due to the lack of stand-by generators, batteries run out for supplying power (3 hours in the BMA) when power outage prolongs.
- Due to the lack of sufficient stand-by generating capacity, stand-by generators will be over-loaded and stop working eventually.

TOT has already Figure d out how much additional capacity would be needed for stand-by generators. They have been promoting an action plan to purchase emergency portable stand-by generators. Since, air-conditioning for the SPC switches is provided by the ordinary commercial power source, it will stop when power outage occurs. Hence, supplying power to air-conditioning systems from stand-by generators must be considered as an alternative method. ANNEX shows the present office in the BMA and necessary capacity of stand-by generators in each switching.

iii) Recommendation

At present, when the trouble of Ph-2 (Ph-2, Ph-2.5, Ph-3) beyond occurs, the trouble information system is not yet set up on TOT.

But, the number of Phase trouble more than 30 minutes reported 19 faults (Total 30 faults in 1991) according to the Monthly Faults Report.

If, Maintenance Center or Center of Metropolitan switch office do not get information from Local exchange when the trouble beyond Ph-2.

Then this is the reason of traffic congestion in the BMA telecommunication network.

Therefor to prevent the traffic congestion. TOT should set up the trouble information system when the trouble beyond Ph-2 between LE and MC or center of metropolitan switch office if on-going the trouble, another LE or MC etc. can restrict the originating call to trouble exchange unit.

Note: Trouble Information System
In the case of on-going trouble beyond Ph-2 the Local Exchange Staff is responsible for information supply to Maintenance Center or center of metropolitan switch office.

Definition of Extraordinary Maintenance Control Value' is recommended to upgrade the telecommunications quality as shows in Table 2.3.1-6. The following conditions are required under implementation of this project.

- Some maintenance control target value should be set up by TOT according to the table. Setting up the trial period will be required. Result of extraordinary fault repair time and necessary data are always examined and compared with the target value during the trial period.

- If necessary, the target value should be revised and the revised one will be set up as the new target value in next period. Thus, the trial will enter next stage.

- If necessary, a new maintenance target value such as a maintenance target value for leased line may be added.

Table 2.3.1-6 Improvement Measures for Switching & Network

Titles	Remarks
1. Definition of Maintenance Control Value	Definition of the fault to be informed to the TOT executives concerned Extraordinary Fault Control -The BMA- *One switching unit of LE is isolated from the others in exceeding xx*1 minutes. (by fault of switching facility, the trunk junction circuits, etc. i) *One tandem switching unit falls into confusion for a period exceeded xx*1 minutes. (by fault of switching facility the trunk junction circuits, etc.) -Whole Kingdom *A PC, SC or TC is isolated from the other PCs (SCs, TCs) in exceeding xx*1 minutes. (by fault switching, trunk circuits, etc.) *Software fault in a switching unit that exceeds xx*1 minutes with fault level more than Phase 2 Note: *1 Figure should be decided by TOT *1

Maintenance Activity

a) Maintenance Management

Maintenance management activities are as follows:

i) Collection of daily fault data

Daily fault data for each switch unit are recorded by each switching office.

- XB switch

The number of repairs and equipment adjustment is recorded.

- SPC switch

The number of repairs and phase troubles is recorded.

- Power

The number of repairs is recorded.

ii) Monthly Maintenance Report (the metropolitan)

The Center of Metropolitan Switching Offices compiles a monthly report from the daily fault reports sent from each switching office.

iii) Monthly Maintenance Report (the whole country)

The Sector of Switching Office compiles a monthly report from the daily fault reports sent from the provincial areas and the center of metropolitan switching offices.

b) Plant Control Management System

i) Plant Control

- Data Collection System

The monthly reports are used for plant control in TOT.

- Maintenance Test for Plant Control

TOT executes the existing routine maintenance tests of the switching facilities. However the results are not recorded. It is necessary to record the maintenance test results.

ii) Plant Control Target Value

The plant control target values of the XB switches are shown in Table 2.3.1-7.

Table 2.3.1-7 Plant Control Target Values of XB Switch (per 1,000 subscribers a month)

	Plant control target value (per 1,000 subscriber lines)
Selector	0.3
Register	0.1
Common Control Equipment	0.1
Trunk	0.05

The plant control target value of SPC switch unit and Power plant are not yet set up.

2.3.2 Improvement Measures

The Study Team proposes 1) to replace the XB switches by the SPC switches and 2) to introduce improved line protectors to improve the switching facility fault ratio.

1) Replacement of XB Switch with SPC Switch

The Study Team proposes to start replacing the XB switches by the SPC switches in 1993 and finish the replacement by 2000. The number of planned line units to be replaced are 234,824 in the BMA and 10,426 in the Surrounding Area between 1993 and 1997.
However, replacing XB switch with SPC switch is carried out from various viewpoint; not only out-of service condition (fault ratio) but also telephone demand, demand for new service, efficiency of O & M, smooth and even replacement and purchase of spare parts as discussed in the Chapter 13 of Main Report of the Long-term Plan Study.

Besides, the number of circuits to be replace related to replacement of XB switch. The total number of replacement of circuits is 3,154. ANNEX shows the traffic data.

By the end of 1997, 68.2% and 100% of the XB switches will be replaced in the BMA and the Surrounding Area, respectively according to the plan. Figure 2.3.2-1, Figure 2.3.2-2 and Table 2. 3.2-1, Table 2.3.2-2 show the number of replaced line units and the cumulative percentage replacement in each year.

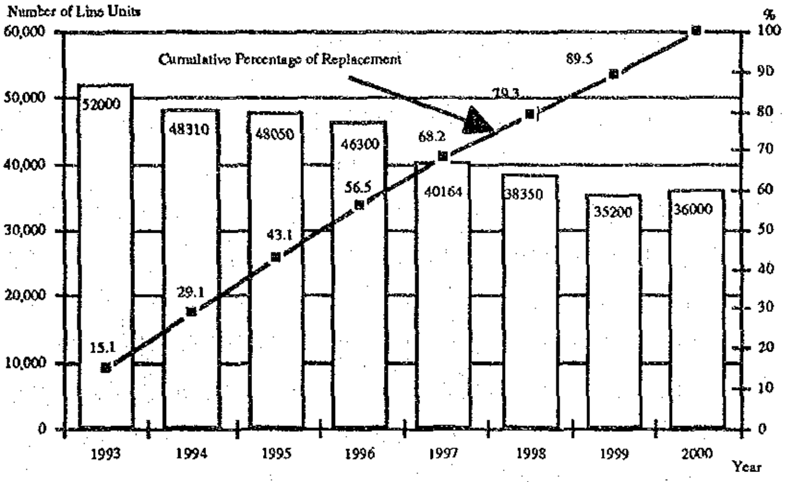


Figure 2.3.2-1 Replacement Plan of XB Switches in the BMA

Table 2.3.2-1 Replacement Plan of XB Switches in the BMA

Year	1993	1994	1995	1996	1997	Total
Line Units	52,000	48,310	48,050	46,300	40,164	234,824

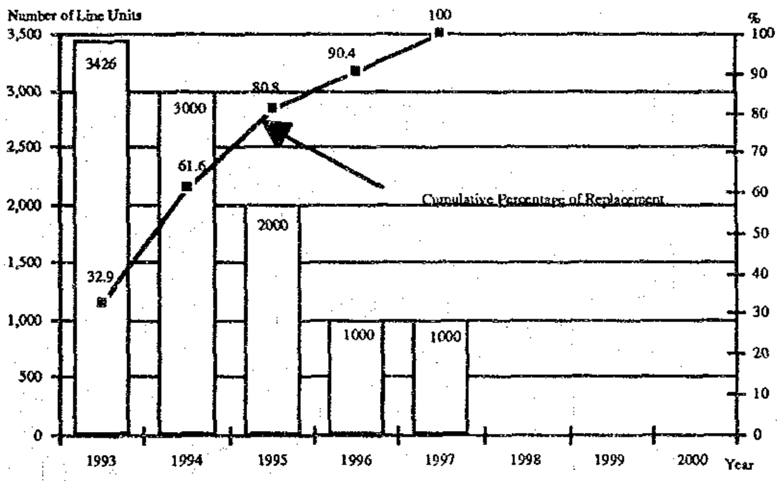


Figure 2.3.2-2 Replacement Plan of XB Switches in the Surrounding Area

Table 2.3.2-2 Replacement Plan of XB Switches in the Surrounding Area

Year	1993	1994	1995	1996	1997	Total
Line Units	3,426	3,000	2,000	1,000	1,000	10,426

2) Introduction of improved versions of line protectors

Of all faults of the SPC switches (LIB, OTH), the LIB faults take up 84.5% (average of the past three years). They can be mainly caused by high electricity current and voltage inflow by line crossings with power lines. To protect switches from high electricity current and voltage inflow, line protectors are usually equipped. In many occasions it is found that they do not function properly. TOT has been developing new improved line protectors and installed them in one PTT switch office (Pathum Thani) and one other switch office as test cases. So far they have obtained good results. The line protectors installed in existing SPC switches at the end of FY 1991 (855,066) are to be replaced with improved ones in turn in Phase-1. The total number of hardware faults of SPC switches for last three years and the yearly replacement plan of line protectors with priority due to the average fault ratio of each switch unit in Phase-1 is shown in APPENDIX. It is expected to reduce about 70% of the LIB faults by installing the improved line protectors in five years starting from 1993 as a measure to reduce the SPC switch faults.

Figure 2.3.2-3 and Table 2.3.2-3 show the number of planned improved line protectors and the cumulative percentage figure of each year.

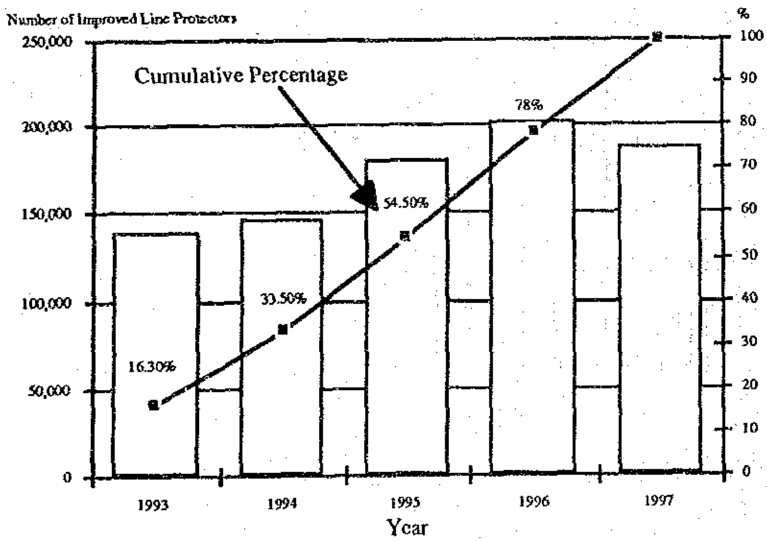


Figure 2.3.2-3 Installation Plan of Improved Line Protectors in the BMA

Table 2.3.2-3 Installation Plan of Improved Line Protectors in the BMA

Year	1993	1994	1995	1996	1997	Total
The Number of Line Protectors	139,484	146,954	179,591	201,749	187,288	855,066

3) Results

It is expected to reduce the number of faults in a year from 22,056 in 1991 to 10,756 by the end of 1997 by the fault preventive measures. Figure 2.3.2-4 show the expected number of the XB and SPC switch faults in each year.

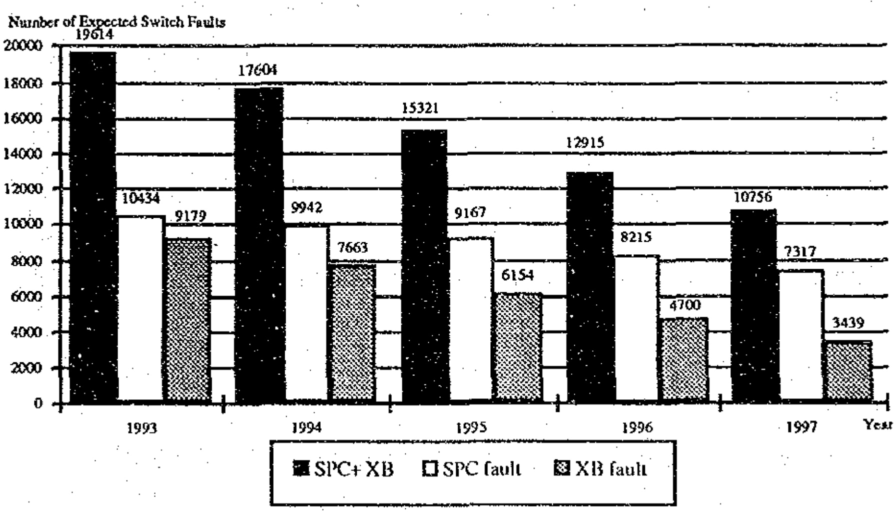


Figure 2.3.2-4 Total Number of Expected Switch Faults in Each Year in the BMA

The total number of expected switch faults are estimated from switching faults Figure (1838 faults a month) in 1991 and the number of XB subscriber lines are already attached the improved line protector when the replacement from XB switch to SPC switch. then The number of estimated faults computation method as follow:

{(Total number of expected SPC faults) - (Expected number of SPC switch faults by installation of improved line protector) }+ (Total number of XB faults) = Total number of expected switch faults

The computation method is shown as follows.

(1) Number of faults a month = 1838 faults

(average number of switching facility faults found by customers claims in the BMA in FY 1991)

(2) Fault rates of SPC and XB switches

SPC 51.0%, XB 49.0%

(fault data in KKM exchange from Nov. 1991 to Mar. 1992)

Total number of SPC Switch faults is 937 a month, and total number of XB Switch faults is 901 a month.

(Ex) 1,838 faults x 0.51 = 937 faults (Number of SPC faults)

(3) Fault rates of LIB and OTH of SPC Switch

LIB 84.4%, OTH 15.6%

(average number of switch faults over past 3 years 1989,1990,1991)

(4) Number of XB Switch faults per subscriber line a month : 0.00261(average of fiscal 1991)

901 faults / 344,374 (Number of XB line capacity in 1992) = 0.0026 faults per subscriber line

(5) Number of SPC Switch faults per subscriber line a month : 0.00107(average of fiscal 1991)

937 faults / 872,658 (Number of SPC line capacity in 1992) = 0.00107 faults per subscriber line

(6) Replacement rate of XB switch : (Example 15.1% in 1993)

(7) Introduction rate of the improved line protector : (Example 16.3% in 1993)

(8) Effect rate of replacement of the improved line protectors : 70 %

* <u>Example</u>

a) Total number of expected XB switch faults in 1993

(Total Number of line units after Replacement of XB Switches) x (4) x 12 months

= Total Number of XB Switch Faults

(344,374 - 52,000) x 0.00261 x 12 months

= 9157 faults (Expected number of faults in 1993 year)

b) Total number of expected SPC switch faults in 1993

Present number of SPC switch faults + {(Total number of expansion of SPC Line Units x (5) x Rate of OTH Fault} + {((Total number of expansion of SPC Line units) x (5) x Rate of LIB Fault) x(1-(8))} x 12 months = Expected number of SPC switch faults

{937 + 52,000 x 0.00107 x 0.156 + 52,000 x 0.00107 x 0.844 x 0.3} x 12 months
= (937 + 8.7 + 14.088) x 12
= 11552 faults

c) Expected number to be reduced of SPC faults by installation of improved line protectors in 1993

((Present number of Faults x (7)) x Rate of OTH Fault x (8)) x12 = Expected number of SPC switch faults

((937 x 0.163) x 0.844 x 0.7) x 12 = (149.92 x 0.8445 x 0.7) x 12 months= 1083 faults

Total

Total number of SPC Switch faults
(b) - (c) = 11552 - 1083 = 10469 faults

Total number of XB Switch faults
(a) = 9157

Total number of faults (SPC + XB)
((b) - (c)) + (a) = 10469 + 9157 = 19626 faults (Number of expected faults in 1993)

2.4 Transmission Facility

2.4.1 Facility Fault

1) Present State of Working Channel

Number of working channels in TOT transmission network in Thailand are 275,301 as shown in Table 2.4.1 which are consisted of metallic PCM cable, microwave system and optical fiber system and coaxial cable system. Seventy percent of channels are metallic PCM cable system that are almost applied in BMA. They will be replaced by optical fiber system by the end of 2007 as shown in Figure 2.4.1-1.

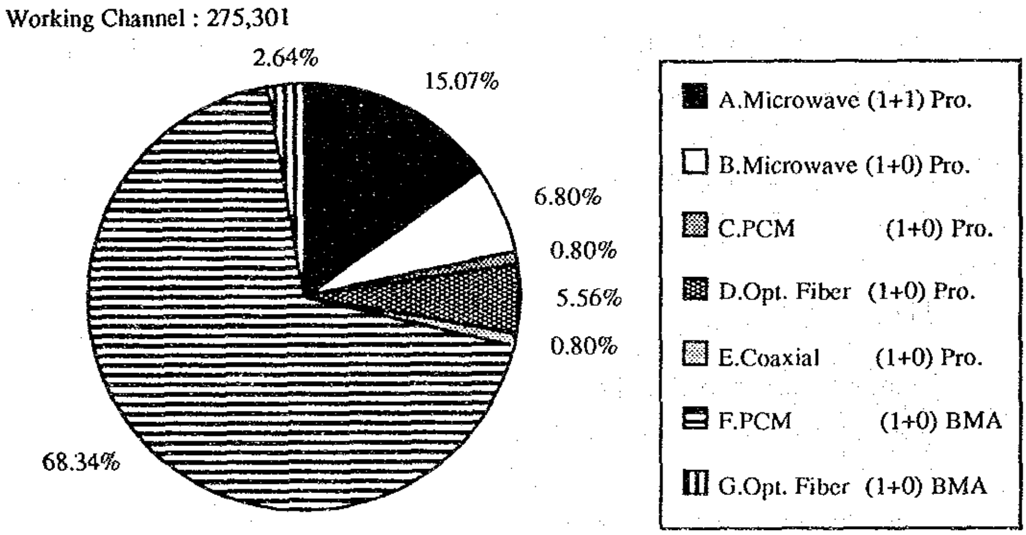


Figure 2.4.1-1 Structure of Transmission System (Working cct. February 1992)

2) Present State of Facility Fault

TOT has arranged the faults every month in "the monthly report" for long time. After studying statistic fault data of past twelve months , the Study Team decided to focus the monthly report on February 1992. Because the report seems to show the average fault condition in the TOT transmission network. Table 2.4.1 shows present state of faults in TOT transmission network on February 1992.

Table 2.4.1 Fault Statistic Data (February, 1992)

Transmission system	*2 working cct.	*2 Fault cct.	*2 Fault cct. (m./cct.)	*2 Fault cct. (m. x cct.)	Availability of Service
1. Microwave with Protection	41,476	3,240	24.7590	80,219	99.9407
2. Microwave without Protection	18,722	604	5.0353	609	99.9879
3. Prov.*4 PCM Cable	2,208	7	32.6539	229	99.9218
Fault of Equipment					100.0000
Fault of Cable		7	35.6539	250	99.9218
4. Prov. Optical Fiber Cable	15,301	1,972	527.0249	1,039,293	98.7379
Fault of Equipment		78	6.1937	483	99.9851
Fault of Cable		1,894	520.8312	986,454	98.7527
5. Prov. Coaxial Cable	2,204	345	36.1311	12,465	99.9134
Fault of Equipment					100.0000
Fault of Cable		345	36.1311	12,465	99.9134
6. BMA PCM Cable	188,130	11,040	80.00	883,200	99.8084
Fault of Equipment		7,710	52.17	402,231	99.8750
Fault of Cable		3,330	27.83	92,674	99.9333
7. BMA Optical Fiber Cable	7,260	*1 ***	*1 ***	*1 ***	*1 ***
Fault of Equipment					
Fault of Cable					
8. BMA Coaxial Cable	*1 ***	*1 ***	*1 ***	*1 ***	*1 ***
Fault of Equipment					
Fault of Cable					
Total	275,301	17,208			
9. Leased line (Whole Kingdom)	*3 7,971	*1 ***	*1 ***	*1 ***	*1 ***
Fault of Trans. Equipment					
Fault of Subs. Equipment					
The others					

Note: *1 No report.
*2 Cct stands for circuit, m stands for minute.
*3 Leased lines are included in the above figure 275,301.
*4 Prov. : Provincial.

a) Fault Condition

Number of the fault circuits classified nine items is shown in Figure 2.4.1-2. The feature of the fault in each system is as follows;

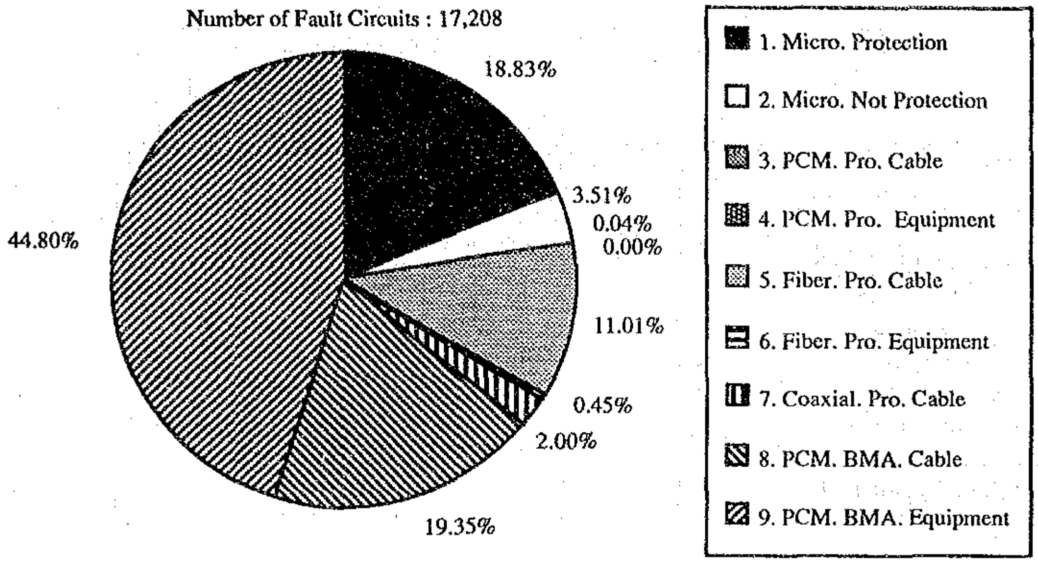


Figure 2.4.1-2 Fault Condition of Each System

i) Forty-five percent of fault circuits is in PCM system in the BMA that reached to 11,040 circuits. The lengths of fault hours of them are divided into the following items.

Number of circuits repaired			Number of Circuits	Percentage
within	1	day	8,190	74.18 (%)
within	1-3	days	2,070	18.75 (%)
within	3-7	days	630	5.71 (%)
over	7	days	150	1.36 (%)
Total			11,040	100.00 (%)

Seventy-four (74) of the fault circuits are repaired within one day and ninety-nine (99) percent of them are repaired within seven days, however, a few circuits exceed seven days for repairing.

ii) Nineteen percent (3,240 circuits) of fault circuits are in microwave with protection system. Condition of them is as in the following.

Number of circuits repaired			Number of Circuits	Percentage
within	150	minutes	1,894	58.46 (%)
within	1	day	877	27.07 (%)
over	1	day	469	14.48 (%)
Total			3,240	100.00 (%)

Fifty-eight percent (1,894 circuits) of the fault circuits are repaired within 150 minutes. Eighty-six percent (2,771 circuits) of them are cleared within one day. Thus, the length of fault hours in microwave system is shorter than PCM system.

iii) Ten percent (1,972 circuits) of the fault circuits are in optical fiber system in province. Twenty-one percent (420 circuits) of them are repaired within one day, however, the other fault circuits are repaired over one day.

b) Feature of Each Facility

Forty-seven (47) faults that caused 17,208 fault circuits occur in February, 1992. They are classified seven kinds of facility such as microwave, multiplexer, optical fiber equipment, optical fiber cable, PCM cable, coaxial cable and power. Figure 2.4.1-3 shows the faults by types of facility. Feature of the fault by types of facility in each item is as in the following.

i) Microwave equipment includes both of analog and digital microwave facilities. Details of them are transmitter, receiver and antenna except multiplexer. Number of fault occurrence in microwave equipment is the biggest in transmission system, which number reaches to 47 faults.

ii) Multiplexer include both of digital and analog of all transmission systems. All of these faults are happened by power unit panels in multiplexers.

iii) Causes of the faults for optical fiber, PCM and coaxial cable are cable cut by construction vehicles such as trucks and bulldozers.

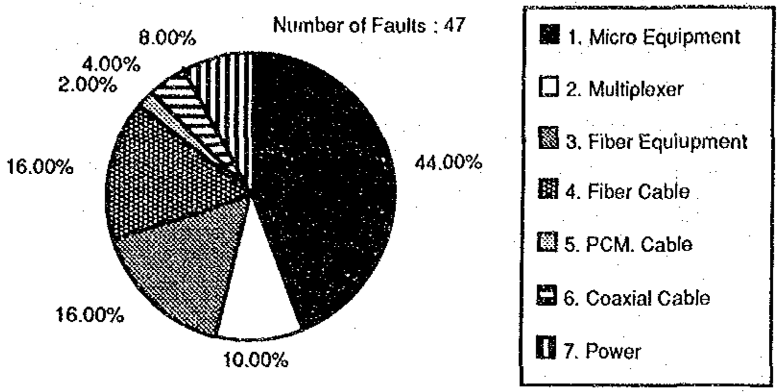


Figure 2.4.1-3 Faults by Types of Facility

More detailed analysis of the fault is described in APPENDIX.

3) Present State of Extraordinary Fault

a) Extraordinary Fault Record

TOT experienced great damages in its telecommunications facilities from a big typhoon in 1989. One microwave tower felt down. In southern part of Thailand, Hat AI, Surtax Than, communications were cut out from other regions. In that time, TOT made its best effort to recover its own microwave transmission system as soon as possible. As a result, TOT could quickly restore its telecommunications network system between Bangkok and the southern areas.

b) Other Fault Record

Any other big extraordinary faults except the above damage by typhoon in TOT telecommunications network system has not been recorded.

4) Present State of Leased Line Fault

The Study Team got information that TOT has to pay back to leased line customers when fault hour of a leased line exceeds seven days. However, the Study Team could not get any lease line fault data from TOT.

2.4.2 Improvement Measure

In order to upgrade the telecommunications services qualities, the following improvement measures are proposed in accordance with the proposed maintenance control system described in section 2.5.

1) Maintenance Control Value

a) Analysis of Maintenance Control System in TOT

i) Plant Control Target Value

TOT has set up the plant control target values as shown in Table 2.4.2. Availability of transmission facility has been adopted as the plant control target value.

Table 2.4.2 Plant Control Target Value

(TOT Monthly Report)

Facility Name	Fault circuits minute/circuit/month	Availability (%)
1. Microwave system with protection	<150.00	>99.6600
2. (1) Microwave system without protection	<866.00	>98.000
(2) Optical fiber system	<866.00	>98.000
(3) PCM-30 system	<866.00	>98.000

Note: Availability = (1 - facility not working time /facility working time) x 100 (%)
= (1 - fault channels x fault hours / working channels x working hours) x 100 (%)

ii) Present State of Facility Availability

Present state of the plant control target values for the availability in main facility (the past five months) is shown in Figure 2.4.2-1. TOT has adopted average facility control system. Almost of facility condition seem to keep good condition in this control system as shown in Figure 2.4.2-1.

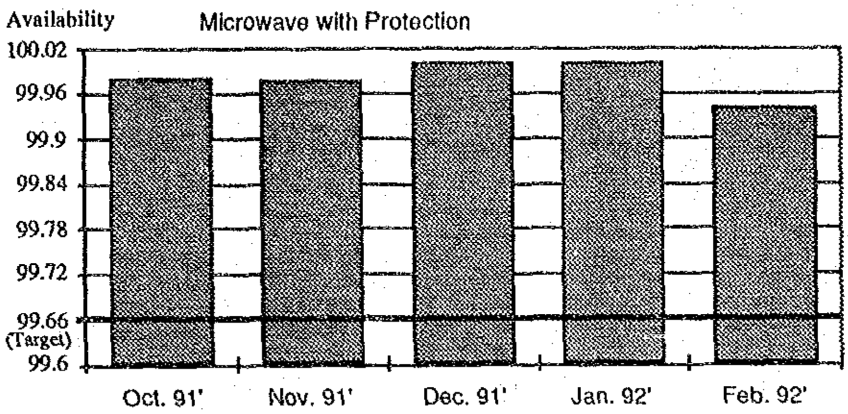


Figure 2.4.2-1 (a) Facility Availability

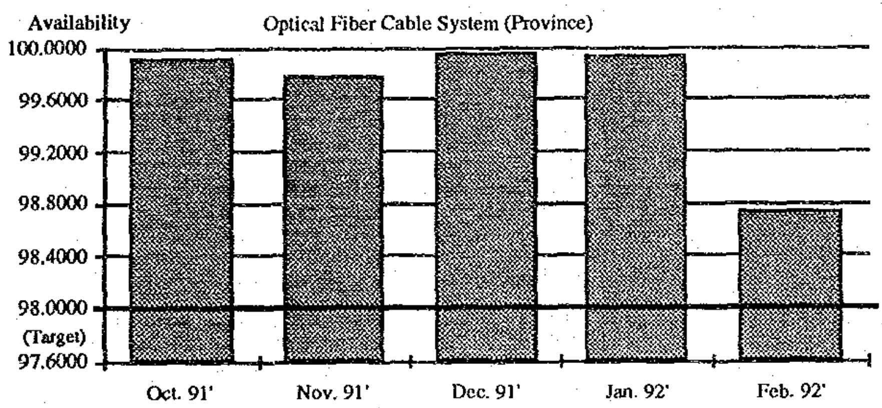


Figure 2.4.2-1 (b) Facility Availability

b) Analysis of the Control System

An average fault control system is a one way to grasp the average telecommunication services quality in transmission section, however, some faults that take a long repair time (more than 1 week) are found in the monthly report. (detailed fault occurrence is described in APPENDIX). The Study Team can not analyze anymore what TOT has done any actions for the result of these faults. The Study Team proposes to set up an additional control value for managing repair time of faults as in the following.

c) Setting up Additional Fault Control Target Value

Setting a target value of fault control is useful to upgrade the service quality in this section. This value that applies both recovering with change over of the fault rout and fixing the fault is adopted all transmission network. A recommended value is as follows;

		First step (by 1995)	Second step (by 1997)
1.	PCM & Fiber System Target Value (minutes) (limit of repair time)	10,000 (7 days)	3,000 (2 days)
2.	Microwave (includes Multiplexer & Power) Target Value (minutes) (limit of repair time)	5,000 (3.5 days)	3,000 (2 days)

Note :

Reason of the Recommendation

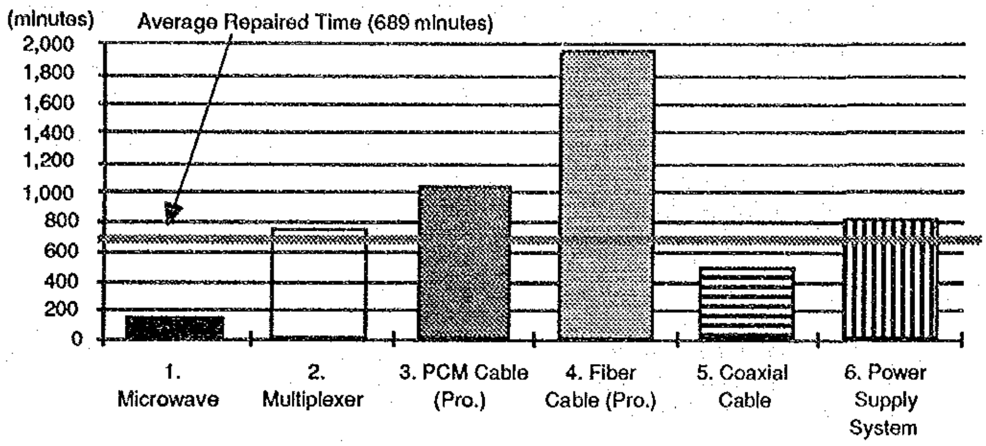
- Average fault time per one fault is shown in Figure 2.4.2-2. Average fault time in all items (microwave, multiplexer, PCM cable, Fiber cable, coaxial cable and power supply system) is 689 minutes.

- Faults that exceeded 10,000 minutes are almost occur in the PCM system in the BMA in recent five months. Meanwhile, when a leased line fault exceeds one week (10,080 minutes), TOT has to pay back the money to the customer by the regulation. The Study Team, therefore, would like to propose this value as first step.

- Fixing optical fiber cables that were cut off by road construction had been fixed within 3 days in average. TOT has a plan to replace the PCM system in the BMA in the seventh TOT ESDP. Figure 3,000 minutes (around 2 days) in the second step seems to be not so uncomfortable.

- It seems that fixing time for the faults of microwave system, multiplexer and power supply system are depend on time to reach the fault place and to keep spare panels for repairing them. Therefore, TOT will be able to satisfy the target value by improvement of the fault repair system.

- However, this figure should be reviewed in accordance with requirement of the customer of leased line and affection of interruption in the society.



Source TOT monthly report

Figure 2.4.2-2 Average Fault hours in Each Item (November 1991 and February 1992)

2) Extraordinary Fault Control

a) Analysis of the Control System

- As described in section 2.5, TOT has already established the information system for extraordinary faults, however, it has not set up a definition of fault to be informed to the TOT executives. Setting up a definition of the fault is proposed by the Study Team.

b) Setting up Fault Control Value

Definition of extraordinary faults that must be reported to the TOT's executives concerned should be decided. The following definition should be considered as a tentative fault that should be informed to the executive concerned.

BMA

- One switching unit of LE office is isolated for ** minutes by both fault of the switching facility and the junction trunk circuits from other office.
- One switching unit of tandem office falls into confusion for ** minutes by both fault of the switching and the junction trunk circuits.

Whole kingdom

- A PC (includes SC and TC) is isolated by both fault of the switching facility and the toll trunk circuits from other PCs (SCs and TCs).

Note; ** Value should be defined by TOT.

The above recommendation is a just tentative definition. Therefore, this recommendation should be reconsidered by the sectors concerned in TOT when the implementation plan is decided. Some examples of the control value in Japan is introduced in APPENDIX.

c) Improvement of Extraordinary Fault Control System

In addition to the extra ordinary fault information system, a general control system for extraordinary fault is required. The Study Team has proposed establishment of a national center for the network management in the long-term plan (refer to Section 12.4 in Part-1). The national network control center should have the function of extraordinary fault control.

3) Improvement of Maintenance Control Activity

Many methods are considered for fault control as described in section 2.5. One way is to prevent occurrence of faults and the other way is to secure the telecommunications network and recover the fault as soon as possible for keeping the telecommunications services in good condition. In this subsection, the Study Team focus its mind on the improvement plan of the last part mentioned above.

The following procedures are useful to secure the trunk circuits when transmission routes are cut off by accidents such as disasters and road constructions.

a) Completion of Doubled or Looped Transmission Network in the Spur Routes

TOT has already planed to install doubled or looped transmission routes in Bangkok metropolitan junction and long distance transmission network, however, spur transmission network has not realized doubled or looped routs yet. Therefore, microwave system in provincial areas should be adopted stand by system. Further more, almost spur route transmission systems should be planed to form link type network as shown in Figure 2.4.2-3.

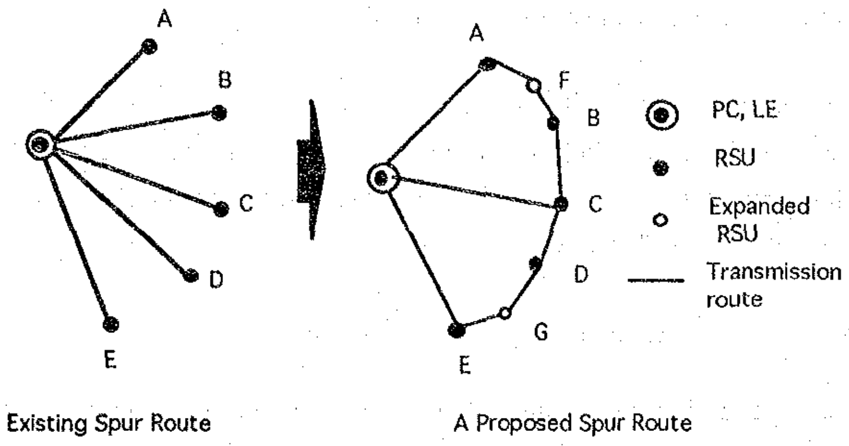


Figure 2.4.2-3 A Link Type Transmission Network in Spur Route

b) Introduction of a Tool for Channel Assignment in Doubled or Looped Transmission Routes

Channel assignment of trunk circuits between switching offices should be divided into doubled transmission routes. Computer system will be required to carry out the channel assignment for complicated network such as the Bangkok metropolitan network. The Study Team recommends to introduce a computerized channel assignment system in Phase-1.

4) Improvement of Deteriorated facility Control

a) Facility Control System

Regarding to deteriorated facility control system, a control system is proposed as described in section 2.5.

b) Replacement of PCM Cable System

Replacement of PCM cable system has already been proposed in the Long-term Plan. Therefore, detailed comments for the replacement will be described later in Chapter 4.

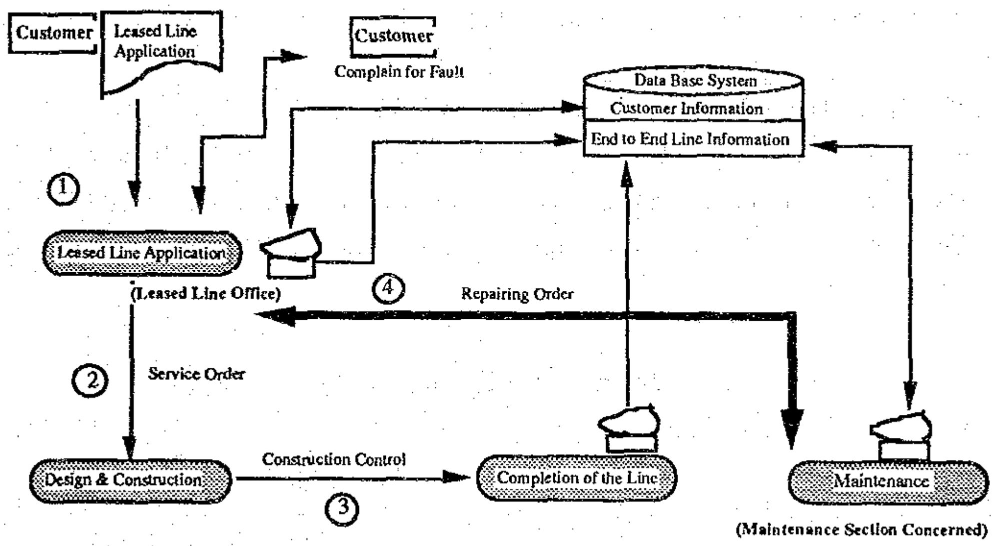
5) Improvement of Leased Line Control

a) Fault Control Value

To establish a fault control value for leased line is necessary for offering better services to the customers, however, the Study Team does not recommend a control target value for leased line because of having no statistic fault data of leased line.

b) Introduction of a Computerized Maintenance Control System

TOT has already established a leased line office to improve the service quality of leased lines as mentioned before, however, the function of this system does not work sufficiently. To accelerate the activity of this function, introduction of a computerized leased line control system is required. An idea of the control system is shown in Figure 2.4.2-4. Further study should be achieved when TOT decides to implement a leased line control system.



Note: Concept of the System
1. Data base is used for both the construction work and maintenance work of leaded line.
2. The leased line office registers the customer information and the end to end information of the line to the data base by using a work station.
3. The office order to design and construction of the line to the sections concerned.
4. The office also controls the progress of the construction.
5. The construction sections register the necessary information to the database when the line is completed.
6. The office orders to repair the line to the sections concerned when the customer applies the trouble of the leased line.
7. The sections concerned can use the data base to repair the line.

Figure 2.4.2-4 Proposed Leased Line Control; System

c) Introduction of Leased Line Repair System
(Introduction of Leased Line Testing System LLTS)

Main flow of the leased line maintenance activity is summarized in the following as shown in Figure 2.4.2-5.

- Leased line office orders to the maintenance sections concerned to repair the fault when it receives a complain from a customer.

- The maintenance sections check, find out and repair the fault.

- They have to contact each other to repair the fault as soon as possible.

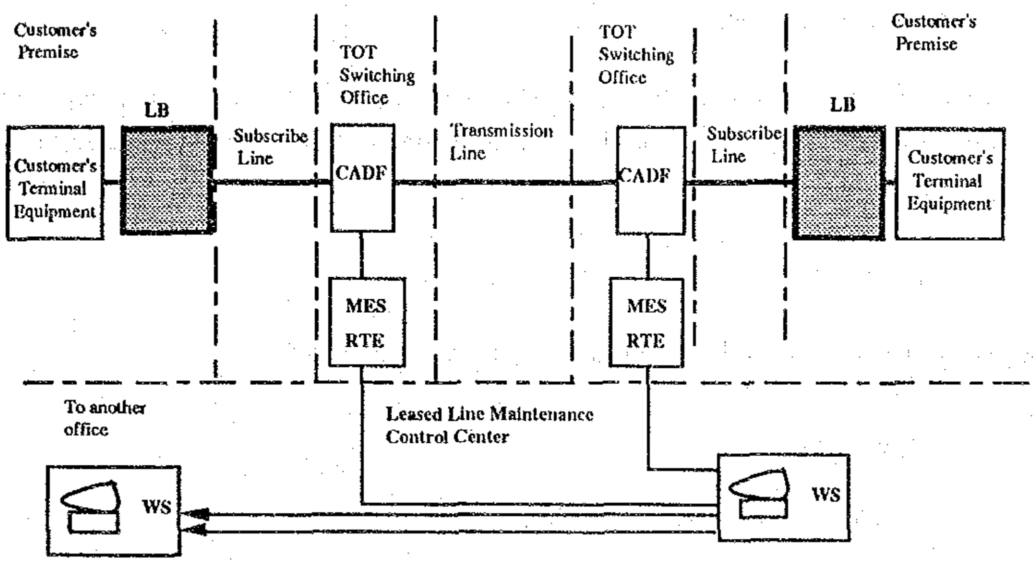
- The leased line office controls the repair work of the sections concerned.

Mentioned above, in spite of being urged by the customer to repair as soon as possible it takes long time to contact each section concerned. Therefore, an efficient tool to test the fault circuit and find out the fault portion is required.

The Study Team recommends introduction of Leased Line Testing System (LLTS) which can test a fault line circuit and find out the fault span. Furthermore, LLTS is added the function to change over the fault trunk line to the standby channel. Concept of LLTS is shown in Figure 2.4.2-5. Additional explain is described in APPENDIX.

The Study Team recommends the following five switching offices that will be introduced LLTS initially.

PNC, KKM SRW, SRR, ASD, PTW



WS : Work Station
MES : Measurement Equipment for Transmission
RTE : Remote Testing Control Equipment
CADF : Circuit Access Distributing Frame
LB : Loop-back Device

Figure 2.4.2-5 Concept of a Proposed LLTS

Function of LLTS is as follows:

1 WS is installed in the leased line maintenance center.

2 operator in the leased line maintenance center examines the fault leased line by accessing the work station.

3 WS is connected to the RTE in each switching office with data link.

4 RTE controls MES and CADF by receiving an order from WS so that the operator can see loop resistance of the subscriber line and characteristics of the transmission circuit change over the fault transmission channel to standby channel.

5 MES measures the above test via CADF by a controlling order from RTE .

6 CADF connects the fault leased line to MES and changes over the fault transmission circuits to standby channel by the order from RTE.

7 LB makes loop-back of the fault subscriber line for a line test by a controlling order from RTE.

2.5 Operation and Maintenance

Enhancement of the customer services quality has become more important not only in improving the facility fault ratio but also in establishing a suitable maintenance system for reducing the fault ratio.

2.5.1 Present State

A detailed explanation about the present state is given in APPENDIX.

1) Outside Plant Section

a) Situation of Official Monthly Maintenance Report

i) Shortage of Analyzing Fault Performance

The report is little analyzed the maintenance performance. It reports no more than a fault history. Besides, the outside plant maintenance section does not systematically plan for rehabilitation and preventive maintenance activities. It means that they make several maintenance plans by using individual work experiences of the staff.

ii) Shortage of Reliability

The Study Team found that some data in the report were different among the areas. There were also many errors. The report is not only a TOT official report but also a precious data source for improving the fault ratio.

b) Shortage of Office Automation System (17 Complaint Center)

The management of customer records in the 17 complaint centers still depends on manual work. When a staff despatches a repair team and keeps fault histories to customer records, the leading part is paper works. The system cannot quickly deal with fault repairs. It cannot correctly report to the official "Monthly Report" of TOT after fault repairs. Because the official "Monthly Report" is dealt by a computer and is based on fault information from the 17 complaint centers. Actually, an error rate reported to the computer is very high (about 30%). It can be caused by the manual works.

c) Environment of Maintenance Activity

A suitable staff allocation for fault repair activities such as shortening the repair time and saving the operation cost is an important matter. Because the fault repair activities mostly depend on manpower. The establishment of a proper staffing system is indispensable for realizing successful maintenance operations.

i) Labor Productivity

Figure 2.5.1-1 shows the number of faults per employee in the ordinary telephone as an example.

- Ordinary Telephone

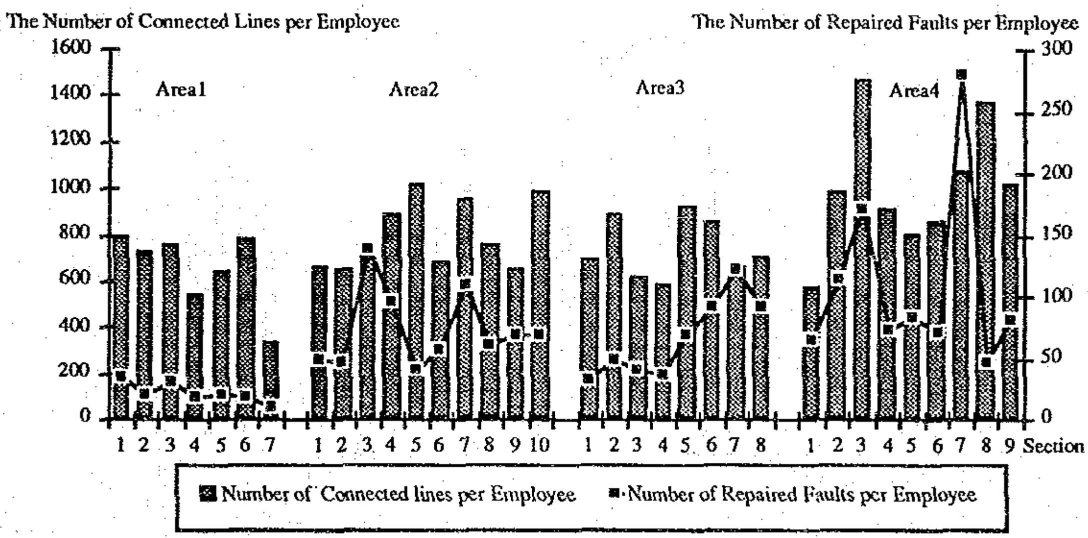


Figure 2.5.1-1 Number of Connected Lines per Employee and Number of Faults per Employee in each Section

The maintenance area 1 is the lowest number of faults per employee. Especially, it is significantly different from the maintenance areas 1 and 4.

- PABX

The maintenance area 3 is lower than other areas in the number of faults per employee. Especially, it is quite different from the maintenance areas 3 and 4 (see APPENDIX).

- Public Telephone

The maintenance area 1 is higher than other areas in the number of faults per employee (see APPENDIX).

ii) Customer Service Situation

- Ordinary Telephone

A very important thing for TOT is to shorten the repair time in order to increase the customer service quality. Figure 2.5.1-2 shows the repair completion ratio within one day. The maintenance areas 1 and 4 are lower than other areas in repair completion ratio within one day.

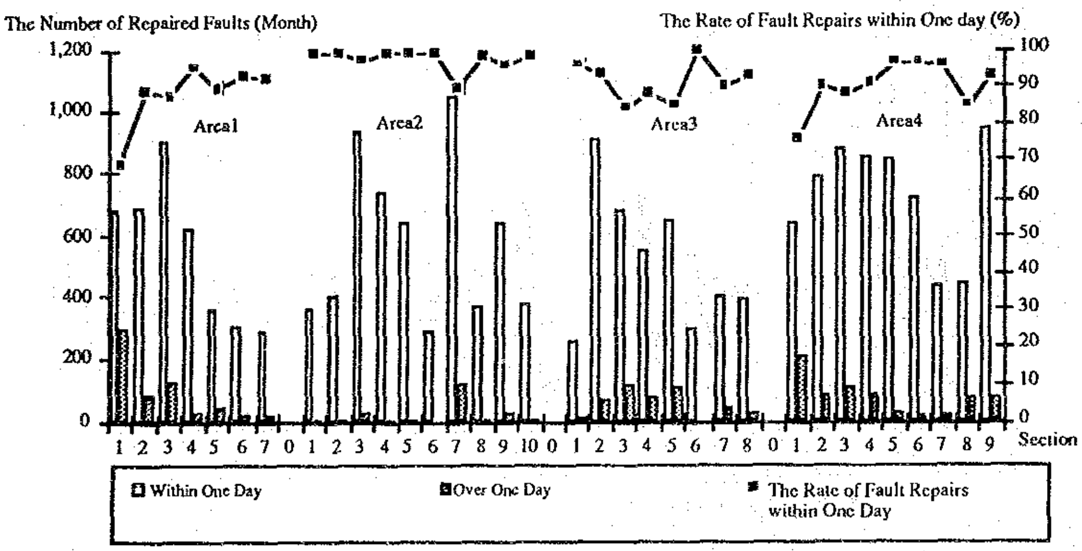


Figure 2.5.1-2 Required Days for Recovering Faults in Each Maintenance Sections (Ordinary Telephone)

- PABX Field

The maintenance area 4 is the lowest repair completion ratio within one day (refer to APPENDIX).

- Public Telephone Field

The maintenance area 4 is the lowest repair completion ratio one day (refer to APPENDIX).

d) Situation of Despatch System

At present, TOT does not repair customer premises facilities such as protectors, and inside wires except government premises. If a fault in customer premises occurs, a drop wire team is despatched the fault place. Because TOT cannot separate fault points between TOT side to customer sides. This is inefficient from the viewpoint of operation cost and total required hours for fault recovery.

e) Shortage of Materials Management

i) Public Telephone

There are many broken public telephone sets in the storehouse of TOT public telephone maintenance office. Even though the repair centers run short of spare parts for repairing broken public telephones, maintenance office cannot send them to the repair centers.

At present, TOT is replacing public telephone sets from Italian-made ones to Japanese-made ones in the BMA. However, TOT does not have Japanese-made spare parts. Because the terms of a contract between TOT and the Japanese-supplier does not include an item about buying spare parts. From this situation, if a part of public telephone is broken, TOT cannot help replacing with a new telephone set. It will take not only more time for replacing broken telephones but also be expensive to buy new telephones.

ii) Shortage of Delivery System

In the outside plant maintenance field, when the stock of spare parts runs short, repair teams must go to the stock center of TOT to obtain spare parts. This material management system in TOT is non economical and inefficient in the sense of wasting repair time.

f) Shortage of Human Resource Management

During the field survey, the Study Team was told that there were not enough maintenance staffs in each outside plant section. It was also told that 25% to 50% of the maintenance staff work overtime work on Saturdays and Sundays. On the other hand, they little work overtime (after 4:00 P.M.) on weekdays.

TOT has a plan to recruit more people than ever before. The two million line expansion project in the BMA is carried out by a private firm using the BTO method from 1992 to 1996. It can be foreseen that the present work volume of each department in TOT will not increase except the commercial departments (it is not clear whether TOT will take care of the maintenance work of drop wires expand in the seventh project or the private sectors will do it). When the fault ratio will go down after this, the required number of staff for maintenance will also go down.

2) Switching Section

a) Non-Existence of Centralized Maintenance System for SPC Switches

At present, TOT is establishing a decentralized work scheme for improving customers service quality. The decentralization policy is hopeful to be adopted to the sections which directly contact with customers such as commercial and outside plant sections.
In a facility maintenance field, a centralized maintenance system is very useful for an efficient work. However, the Study Team did not hear that the switching section has a concrete centralization plan for the SPC switches.

b) Shortage of Fault Record Management

i) Shortage of Fault Record Management

The section issues two kinds of fault performance reports. One is the "Switching Monthly Report" based on the faults detected by alarm and routine tests. The other is the official "Monthly Maintenance Report" of TOT based on fault information of the complaint centers. A substantial part of the fault repair performance in this section are reported in the "Switching Monthly Report" and the official "Monthly Maintenance Report".

On the other hand, when the section makes a maintenance plan for facility expansion and replacement, they use only the "Switching Monthly Report". However, no reporting form for the Switching Monthly Report is unavailable in this section.

ii) Shortage of Follow-up System for Human Development

If staff of an exchange office cannot recover a fault by themselves, they ask for help to staff of the upper supporting section by phone. However, after recovery, the staff of upper supporting section gives little explanation to the end office staff about the repair work (the contents of problem, the cause and recovery method etc.). If the same fault occurs in the exchange office, the staff will not be able to recover the fault again.

c) Shortage of Spare Parts for SPC Switches

Most exchange offices are in serious shortage condition for spare parts for the SPC switches. Spare parts (package) are expensive and many in kinds. It is difficult for every exchange office to stock all spare parts. The primary place for keeping them are Unit of Switching Office in each maintenance area.

Once a package fault occurs in an exchange office, the maintenance staff inquires to Unit of Switching Office and other exchange offices by phone. Even Unit of Switching Office does not often stock the required packages.

At present, TOT is making free contracts with its suppliers about procurement of spare parts, TOT said that it takes about 6 months for waiting period from request to receipt. In a sense, it may be unavoidable situation. Because a supplier does not hope to have many stocks. Therefore, it can be assumed that they start its product after receiving the order.

There are different management methods about keeping spare part records in exchange offices. Some exchange offices have still taken a manual spare parts record because TOT does not have a standard form for keeping spare part records.

3) Transmission Section

a) Maintenance Activity

TOT has already reorganized the telecommunications operation in 1991 for providing better telecommunications services to customers.
Employees of the transmission section in the provincial area belong to the provincial telecommunication center. However, the transmission sector in the Sector of Telecommunication Network supports them from the viewpoint of engineering designs and transmission maintenance techniques.

b) Leased Line Maintenance Activity

TOT has established a leased line office in Operation Bureau to improve the service quality of leased line about one year ago. This office has taken care of both installation and maintenance of the leased lines.

TOT is now changing trunk circuits of leased lines of deteriorated routes such as analog and PCM routes to new transmission routes such as optical fiber and digital microwave routes; however, it has not completed yet.

2.5.2 Improvement Measures

1) Outside Plant Section

a) Improvement of Monthly Maintenance Report

i) Promotion of Analyzing Fault Performance

The section does not analyze the maintenance performance in the "Monthly Maintenance Report". It reports no more than a fault history. This section does not plan for rehabilitation and preventive activities. They make several maintenance plans by using staff's individual work experience in each area.

In order to actually analyze the maintenance performance, TOT should increase the data in the Monthly Maintenance Report. It means that fault cause and locations should be reported in detail in the Report. The COBOL capacity of the computer can increase the data.

ii) Establishment of Reliable Monthly Maintenance Report

Without having correct maintenance performance reports, TOT cannot improve the fault ratio. Because the reports are precious data source for improving the situation. Besides, an error ratio of data reported to the computer is very high (about 30%).

iii) Introduction of Office Automation System

The cause of the unreliable monthly maintenance report depends on managing the customer record by manual in the complaint center. Therefore, in order to create the reliable report, realize a quick despatch system in complaint center, TOT should introduce the computerized customer record system. In the near future, TOT needs to reconsider the total automation system including outside plant records, using common data base for both system.

b) Improvement of Despatch System

If a fault in customer premises occurs, a drop wire team of the outside plant maintenance section is sure to be despatched to the fault place. Because TOT cannot distinguish a point of the fault between TOT side to customer side. This is inefficient situation from the viewpoint of increasing operation cost and fault repair time. In order to solve this issue, TOT needs to improve the present test system for being able to distinguish a fault point.

c) Improvement of Materials Management System

i) Security of Spare Parts

The public telephone section should secure the proper spare parts for establishing rapidly repairing system and saving cost. Besides, after this, when TOT contracts its suppliers, the item of buying spare parts needs to be included in a contract.

ii) Establishment of Delivery System

In the outside plant maintenance section, when the stock of spare parts runs short, a repair team themselves must go out for taking spare parts to stock center of TOT. From now on, TOT should consider a systematic delivery system by using a private company.

2) Switching Section

a) Establishment of Centralized Maintenance System for SPC Switches

In order to manage the telecommunications networks effectively and economically, a centralized telecommunications network management system is necessary for the section. Because it has mainly two merits. One is to be able to centrally monitor and control the network within the managing area. The other is to be able to efficiently allocate experts to exchange offices.

In the Long-term Plan, it is recommended that establishment of a centralized maintenance system needs after replacing all XB switches with SPC switches.

However, if TOT immediately introduces a centralized operation system for the SPC switches, from the viewpoint of saving operation cost and reliability, it must adopt the system early.

b) Establishment of Stock Management System

The spare parts (package) for the SPC switches are expensive. It is difficult and inefficient to stock enough spare parts in each exchange office. TOT needs to manage suitable stock within the limit of budget. Therefore, TOT should try to forecast necessary spare parts of half or one year, in addition to establishing an efficient stock system, TOT needs to introduce spare parts management system (same form and on-line) by using computer.

c) Improvement of Fault Report System

At present, a fault reporting form for reporting fault from each exchange office does not exist the switching section. The section should formalize a fault reporting form.

d) Technical Skill Advancement

When a fault occurs in some exchange office, it is important to a make document which describes each system name, the contents of the problem, the cause and the recovery method after recovery. And these documents should be explained to maintenance staff at meetings. The explanation will be useful for the maintenance staff to advance the skills. The fault recovery time will be reduced when the same fault occurs.

3) Transmission Section

a) Improvement of Extraordinary Fault Control System

In addition to the extra ordinary fault information system, a general control system for extraordinary faults is required. The Study Team has proposed to establish a national center for the network management in the long term plan (refer Chapter 12.4 in Volume -I). The national network control center should have the function of extraordinary fault control.

4) Improvement of Human Resource Management

a) Manpower Planning

Figure 2.5.2-1 shows the required number of staff for maintenance work in each section from FY1993 to FY1997. Table 2.5.2 and Figure 2.5.2-2 show the number of saved staff (saved manpower costs) in the same period. The estimation method is described in APPENDIX.

The two million line expansion project in the BMA is carried out by a private firm using the BTO method from FY1992 to FY1996. It can be foreseen that the present work volume of each department in TOT will not increase except the public telephone section and the commercial section (it is not clear whether TOT will take care of the maintenance work of drop wires expand in the seventh project or the private sectors will do it).

Therefore, when the fault ratio will go down after this, the required number of staff will also go down because work load for maintenance diminishes. When TOT will carry out to replace the XB switches with the SPC switches, the required number of staff will also decreases because work volume for maintaining SPC switch is less than that of XB switch. TOT can save the manpower cost by carrying out the projects proposed.

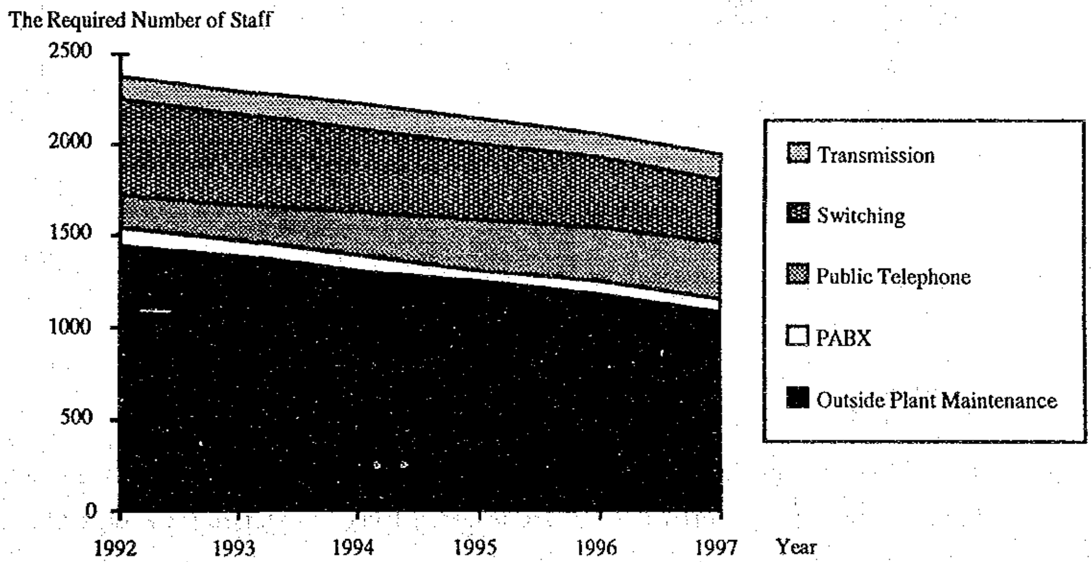


Figure 2.5.2-1 Required Number of Staffs for Maintenance

Table 2.5.2 Number of Saved Staffs and Saved Cost for Maintenance

	1993	1994	1995	1996	1997	Total
The Number of Saved Staff in the Outside Plant Section	46	39 (85)	50 (135)	48 (183)	81 (268)	264
The Number of Saved Staff in the Switching Section	36	36 (72)	31 (103)	34 (137)	31 (168)	168
Total	82	75 (157)	81 (238)	82 (320)	112 (432)	432
The Saved Manpower Costs in the Outside Plant Section	3.19	9.68	18.11	27.85	43.33	102.16
The Saved Manpower Costs in the Switching Section	2.49	8.20	13.81	20.85	27.56	72.91
Total	5.68	17.88	31.92	48.70	70.89	175.07

Note : ( ) shows the total number of saved staff from FY1993 to the year concerned.
The saved manpower costs unit is Million Baht.

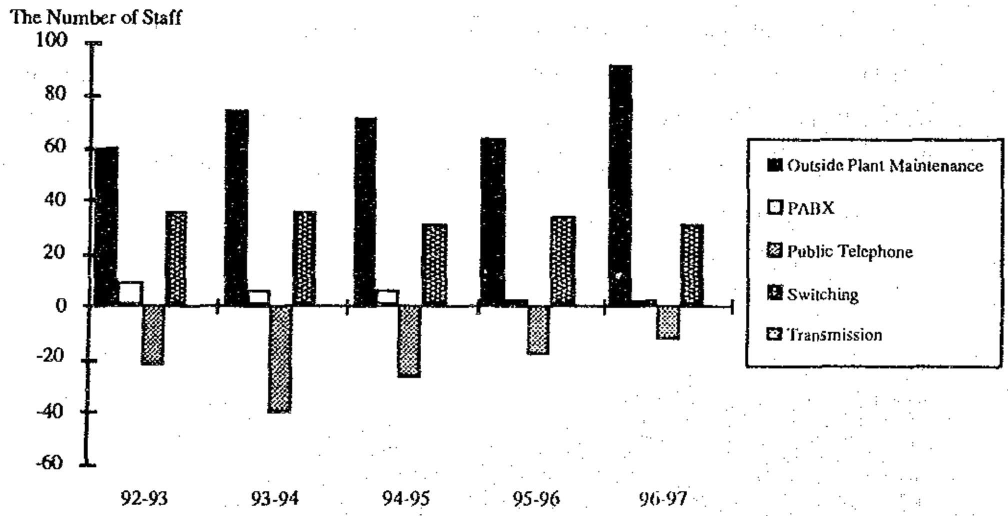


Figure 2.5.2-2 Number of Saved Maintenance and Repairing Staffs

b) Staffing

If TOT has a plan for moving staff among maintenance sections, and reviewing maintenance work performance, some attentions for staffing are described as follows.

i) Outside Plant Maintenance Section

From Section 2.5.1 1), the maintenance area 4 is in a serious situation for repair activities compared with other areas. If the cause depends on shortage of manpower, TOT needs to fill up the necessary manpower to the maintenance area 4. However, the method is not to recruit all-out new people but making efficient use of the TOT staff by relocating and re-assigning people from other areas.

On the other hand, the maintenance area 1 needs to review the work activities for maintenance such as the despatch system, the work method and the staff morale. Because the customer service level (the days required for fault recovery) and the labor productivity (the number of faults per employee) in this area is not good, in spite of very important for politics and economic activities. Because big users and government are concentrated on this area, and traffic jam sometimes happens. Besides, fault repair activities can be difficult compared with other area. However, this area needs to improve the situations by enhancing the service status. This area is required to solve the problem, and, if necessary, this area may need to adopt a work system (such as setting up special repair team and using a more small-sized motor vehicle etc.) different from other areas one.

ii) PABX Section

From Section 2.5.1 1), the maintenance area 4 is also in a serious condition for fault repair activities compared with other areas. As mentioned above, this area needs to take countermeasures after solving the problem.

iii) Public Telephone Section

The maintenance area 4 needs to review the work activities for maintenance such as the despatch system, the work method and the staff morale. Because the service level and the labor productivity in this area is not good. The ways for improving the situation are a mentioned above.

c) Recommendation for Adopting Effective Staffing Policy

i) Recruitment Plan

The Fifth, Sixth and Seventh National Economic and Social Development plans have pointed out the necessity of improvement in state enterprise management efficiency.

There is a possibility that the Thai government will deregulate the telecommunications business and let the private sectors participate in the business not only as the present concession bases but also as carriers. In the near future, TOT can no longer keep its monopolistic position as it used to be, and TOT will face competition market.

In order to survive the competition, TOT will have to save its expenditures, minimize the operating cost, reduce its rate and increase the share and net profits. The staff remuneration is not the exception and needs to be reduced. However, it is not easy to reduce the number of staff nor the salary level.

ii) Promoting Rationalization System

Introduction of new systems such as SPC switches, the network management systems, and computerized systems for operation and maintenance (COLONETR etc.) can also save the staff. It is necessary for TOT to establish and implement the relocation and utilization plans of the saved staff.

iii) Improving for Imbalance of Services Level

The goal of the public utility enterprises is to provide the better quality and sufficient quantity of the services for the nation constantly. If TOT cannot provide same level of services anywhere in the study area, because of inappropriate allocation of the staff, the customers may leave TOT and select other telecommunications business enterprises.

2.5.3 Establishment of Maintenance Control System

1) Necessity of Maintenance Control System

The study team sets up a guideline for formulating an implementation plan to improve the telecommunications service quality, particularly improvement of the fault ratio. The main purpose of the telecommunications enterprise is to provide the better and more widespread telecommunications services. Therefore, maintaining the telecommunications facilities including the outside plant, switching equipment, transmission equipment and power plant in good condition by means of an organized system is very important.

Addition to this, maintenance cost should be considered for operating a telecommunications facility in good condition from the view point of economical situations. Because the telecommunications sector needs to get benefit from telecommunications operation. If high maintenance cost is to improve the service quality, the facilities should be replaced.

2) Maintenance Control System

Implementation of the projects is expected to reduce both the fault occurrences and the repair hours. As the trend of telecommunications maintenance activity, started from corrective maintenance in the early stage, with "repair when broken", then through the middle age of preventive maintenance, of "prevent breakage", and finally controlled maintenance has become applied in many countries recently, on the bases of Maintenance Control System. These systems consist of mainly three control items such as service control, plant control and extraordinary failure control as shown in Figure 2.5.3.

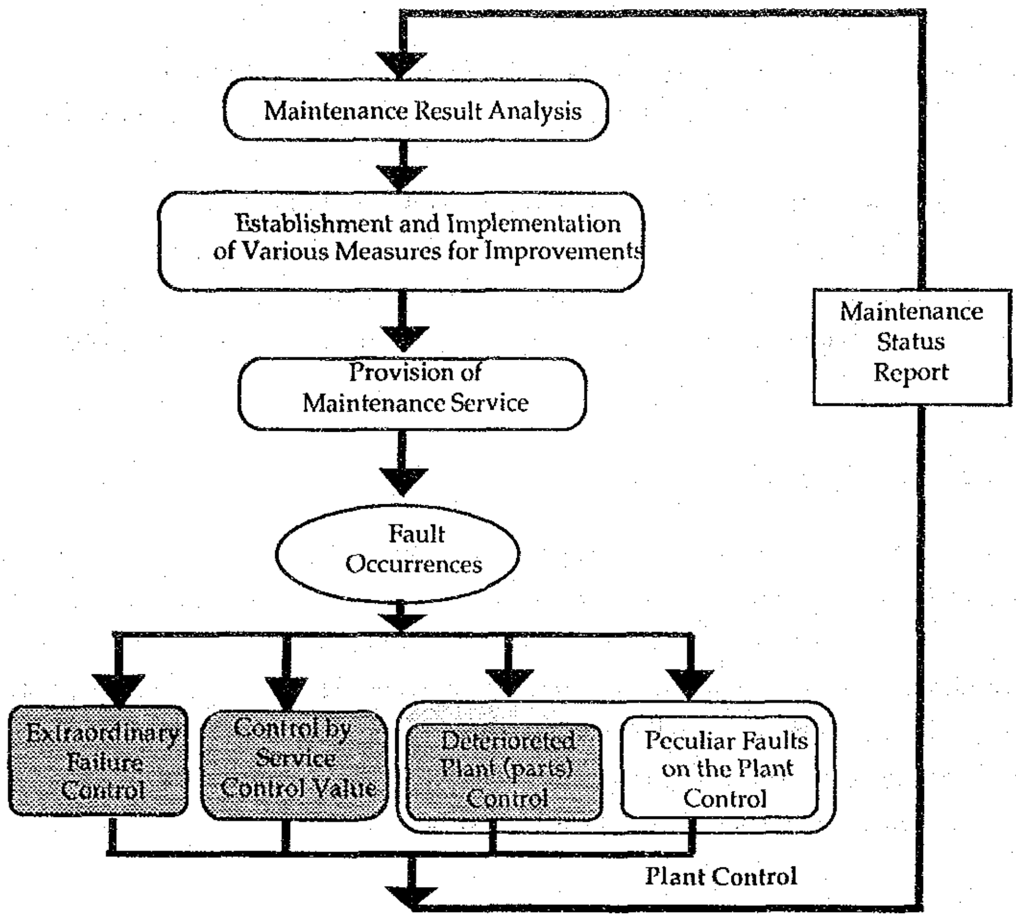


Figure 2.5.3 Cycle of Maintenance Control System

These three main items are as follows.

a) Service Control

This is to measure maintenance service level for customers who are unsatisfied with the service and to provide telecommunications service in good condition while improving these complaints. Therefore, the service control value is the lowest limit of service level and its limit has to be observed for every office and every circuit.

b) Extraordinarily Failure Control

The big scale faults that deteriorate the level of telecommunications services to a considerable extent, and the extraordinary congestion of telecommunications traffic are counted as extraordinary failures. They are individually controlled whenever failure occur. While the counter measure are examined to the failures taking the occasion for the failure into consideration.

c) Plant Control

For offering the high quality service to the customers and achieving maintenance activity safely and efficiently, each section concerned is required to manage quality of the facilities. The section concerned always analyzes the state of facilities and takes necessary actions to keep the equipment in good conditions. Actual plant control is divided into three sub items as follows.

i) Peculiar Faults on the plant Control

There are several special causes in facility faults that may require improvement of the design, improvement of construction method, etc. They are treated and maintained separately from ordinary facilities. The following causes in faults are classified into peculiar faults.

- Maintenance centers can not take actions to prevent the fault occurrence in normal way.
- Faults which do not have clear causes and happen many times.
- The reason of the fault is considered to be the design or construction method of the facility.
- The reason of the fault is considered to be defect parts or materials of equipment.
- Other special cause of the faults.

These faults will be found out by arranging the fault data with maintenance control system; and controlled by the maintenance cycle shown in the figure.

ii) Deteriorated Facility Control

The purpose of this system is to reflect the deteriorated facilities, which were picked up, to daily maintenance work and facility improvement plans in order to maintain the service quality in good condition. Consequently, the control system is to find out deteriorated plants based on limit value of deteriorated facilities, which is setup by a part of plants.

- Procedure of Deteriorated Plant Control System

Establishment of standard for judgment of deteriorated plants,
Finding of deteriorated plants (with daily maintenance activity),
Implementation of improvement measures on daily maintenance work,
Preparation of improvement plan,
Execution of rehabilitation plans,
Evaluation of the plan,
Feed back to a) or d).

- Judgment Standard for Deteriorated Plants

To control the deteriorated plant, judgment standard for deteriorated plants must be defined in each section concerned. In outside plant section, the judgment standard should be decided in consideration of typical environmental condition in Thailand.

3) Improvement of Maintenance Control System

The Study Team considers that TOT has had its maintenance system and continued maintenance activity in each section. It seems, however, it is necessary to entirely improve from effectively and economically view point. The establishment of maintenance control system is required not only for keeping the telecommunications service quality in good condition but also getting trust in the customers.

4) Transition of Improving Fault Ratio in Japan

The transition of improving the fault ratio in Japan is shown in APPENDIX.

CHAPTER 3

IMPROVEMENT OF CALL COMPLETION RATIO

CHAPTER 3 STUDY FOR IMPROVEMENT OF CALL COMPLETION RATIO

3.1 Overview

3.1.1 . Introduction

TOT is eager to improve its customer service and has set the target of the call completion ratio at 50% which should be achieved by 1996.

The duty of the Study Team is to find out bottlenecks of the network that aggravate the network service performance and to make an implementation plan to achieve the target. Cost and revenue estimation and other matter such as organization, its authority and responsibility for caring out the activity are also studied in this work.

In undertaking the study, the Study Team focused on NEAX-61 SPC switches in the BMA because of the following reasons.

1) At present, all of the SPC local switches in the BMA are NEAX-61.
2) The XB switches have been planned to be replaced by the SPC switches in the near future.

3.1.2 Overview

1) Present State of Network Performance

The telephone call completion ratio measured at the NEAX-61 switches in the BMA in March 1992 is 23.5% and the categories of incompleted calls are P.S.Abandon (26.3%), B-sub busy (24.4%), P.D.Abandon (7.7%), ringing abandon (5.8%), congestion (5.5%), technical fault (5.1% and others (1.2%).

As for the service performance from the viewpoint of destination category basis, the completion ratio of local calls is 38%, STD calls 31% and that of ISD calls is 42%. (In the calculation, P.S.Abandon calls are eliminated from total calls.) Calls to cellular mobile telephones are categorized as STD calls and the completion ratio of calls to cellular mobile telephones is 24%. The ratio is rather low compared with other STD calls. The completion ratio of calls to paging phones is 77% (measured at switches to which paging switches are accommodated), but it was found that some paging service providers do not have enough circuits between local switches and paging equipment.

Traffic pattern observations in a day were undertaken at 9 switches in the BMA. The busy hour was at 10:00 to 11:00 in the morning at almost every measured exchanges.

There are two traffic peaks. One is in the morning and the other is in the afternoon. But another peak is seen in the evening at exchanges in the residential area.

2) Outline of Improvement Measures

The Study Team carried out a study on causes of incompleted calls and on measures to improve the problems.

P.S.Abandon calls are the biggest problem that severely affects the completion ratio of the TOT network. After a field trial at Phra Khanong-T6, it was found that some P.S.Abandon calls originate in proportion to traffic volume and other P.S.Abandon calls originate independently from traffic volume. The fact that the former P.S.Abandon calls originate from faulty subscriber lines including faulty public telephones was also found out. To reduce P.S.Abandon calls, firstly to clear all the faulty subscriber lines and secondary to rehabilitate deteriorated subscriber lines are effective measures.

B-sub busy calls are the second factor for aggravating the completion ratio. But the Study Team considers that reducing B-sub busy calls is the most important work in this project because B-sub busy situation occurs at the final stage in a call process after occupying most of the network facility. Improvement of B-sub busy situation will directly influence the revenue of TOT. Introducing hunting systems to the subscribers who have more than one telephone line is considered as the most effective method to improve the terminating call completion ratio. But according to the data from the CDAS, about 80% of the subscribers who use PABX have not introduced the hunting system, yet. The Study Team recommends that TOT firstly promotes hunting system introduction. Secondary, installing additional main telephone lines is necessary because there are many subscribers who do not have enough lines even though they have already started using the hunting system. The third measure is to promote installing the call waiting service to the subscribers who have single telephone line.

Other measures to improve the completion ratio such as installing the Automatic Information System for changed number subscribers, installing Automatic Howling Tone Sender for users who leave their telephones off-hook are recommended by the Study Team.

3.2 Definition and Classification of Call Status

3.2.1 Definition of Call Completion Ratio

According to the CCITT Recommendations E.600, the terms of Call Attempt, Successful Call Attempt, Completed Call Attempt and Completion Ratio are defined as follows:

Call Attempt	=	An attempt to achieve a connection to one or more devices attached to a telecommunications network.
Successful Call Attempt	=	A call attempt that receives intelligible information about the state of the called user.
Completed Call Attempt	=	A successful call attempt that receives an answer signal.
Completion Ratio	=	The ratio of the number of completed call attempt to the total number of call attempts at a given point of a network.

In this report the Study Team uses these terms in accordance with the Recommendations. (We have to be careful in using the term of Successful Call Attempt because a call attempt that has encountered called subscriber busy or called subscriber no answer is counted as a Successful Call Attempt.)

3.2.2 Classification of Call Status

Figure 3.2.2 shows categories of call status in a call process, which are used in this report.

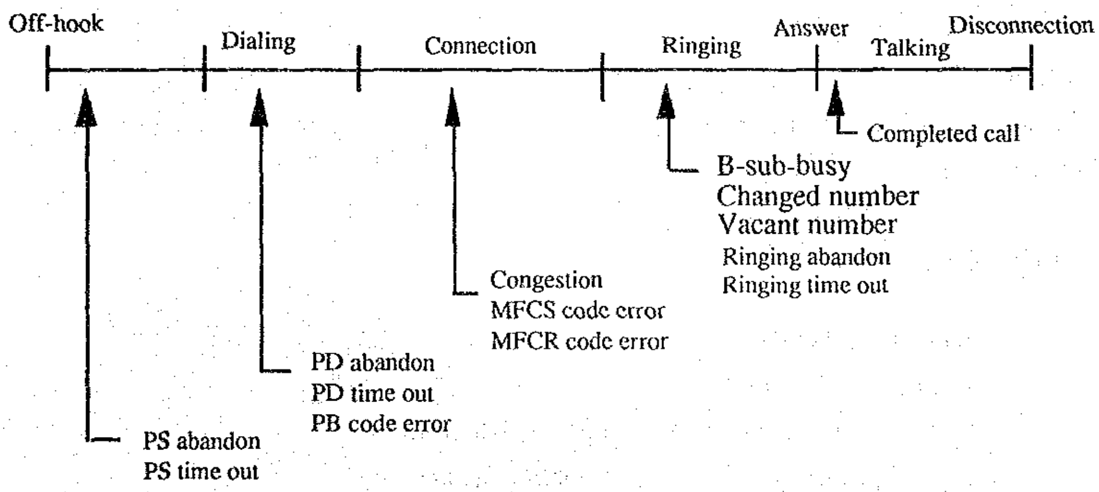


Figure 3.2.2 Categories of Call Status in the stage of a Call Process

The meanings of terms peculiar to traffic engineering and being used in this report are described below.

A-sub

Calling party

B-sub

Called party

Busy Hour

The uninterrupted period of 60 minutes for which the average intensity of traffic or the number of call attempts is at the maximum.

Dial-tone Delay

Time interval between off hook and reception of dial tone.

P.S.Abandon (Permanent Signal Abandon)

A call which sends the switch equipment a signal that the subscriber has gone off-hook but goes back on-hook before sending no dial pulses.

P.S.Time-out (Permanent Signal Time-out)

A call which sends the switch equipment a signal that the subscriber has gone off-hook but dose not send any dial pulses within a specified period of time.

P.D.Abandon (Partial Dial Abandon)

A call which abandons after the switch equipment has been received first digit but before receives enough digits to route a call.

P.D.Time-out (Partial Dial Time-out)

A call from which the switch equipment has been received one or more digits but has not been received the next digit within a specified period of time.

Ringing Abandon

A call which abandons while waiting called subscriber's answer after the call has reached called subscriber.

Ringing Time-out

A call which does not receive the answer within a specified period of time after the call has reached called subscriber.

3.2.3 Abbreviation

CCR	Call Completion Ratio
ISD	International Subscriber Dialing
MFCR	Multi Frequency signaling, Compelled Register
MFCS	Multi Frequency signaling, Compelled Sender
PB	Push Button
STD	Subscriber Trunk Dialing

3.3 Present State of Network Service Performance and Traffic Characteristics

The purpose of this section is to describe the results of the study on the present state of service performance in the BMA and its traffic characteristics such as traffic fluctuations in 24 hours.

3.3.1 Network Service Performance

1) Outlook of Network Service Performance

Figure 3.3.1-1 shows an outlook of network performance which was measured during the busy hour at the NEAX-61 switches in the BMA in March 1992 by the NCOM Center. The completion ratio is 23.5%. Category items of incompleted calls and their percentage shares are P.S.Abandon 26.8%, B-sub-busy 24.4%, P.D.Abandon 7.7%, Ringing abandon 5.8%, Congestion 5.5%, Faults 5.1% and Others 1.2%.

Table 3.3.1-1 shows categories of call status which are also shown in Figure 3.2.2.

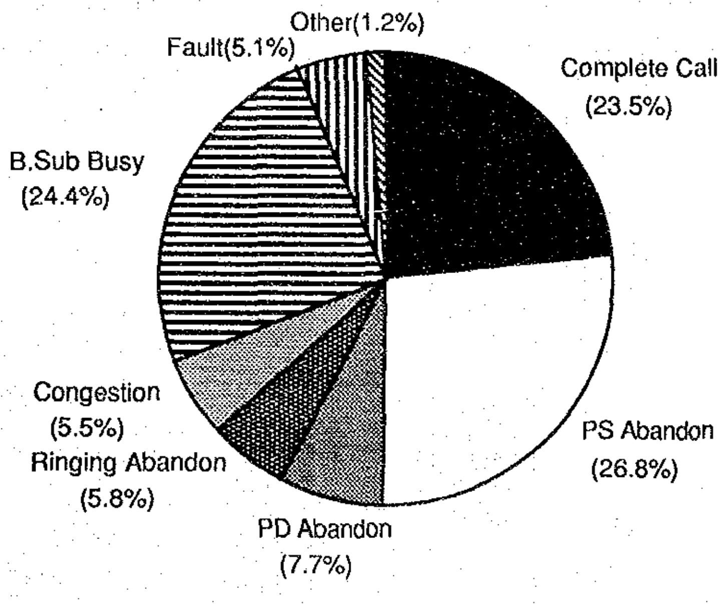


Figure 3.3.1-1 Service Performance in the BMA (March, 1992) (Observed during Busy Hour)

Table 3.3.1-1 Comparison of Categories between Figure 3.3.1-1 and Figure 3.2.2

Figure 3.3.1-1	Figure 3.2.2
Completed call	Completed call
P.S.Abandon	P.S.Abandon
B-sub-busy	B-sub-busy
P.D.Abandon	P.D.Abandon
Ringing abandon	Ringing abandon, Ringing time-out, B-sub No Answer
Congestion	Congestion
Fault	P.S.Time-out, P.D.Time-out, MFCS code error, MFCR code error
Others	Vacant number

Figure 3.3.1-2 shows a comparison of the service performance between the TOT network and the NTT network. The source of the TOT data is the same as that of Figure 3.3.1-1. The NTT data was compiled in 1984. In the TOT network, P.S.Abandon and B-sub busy are conspicuously higher than those in the NTT network. The two phenomena are the main causes for aggravating the call completion ratio of the TOT network.

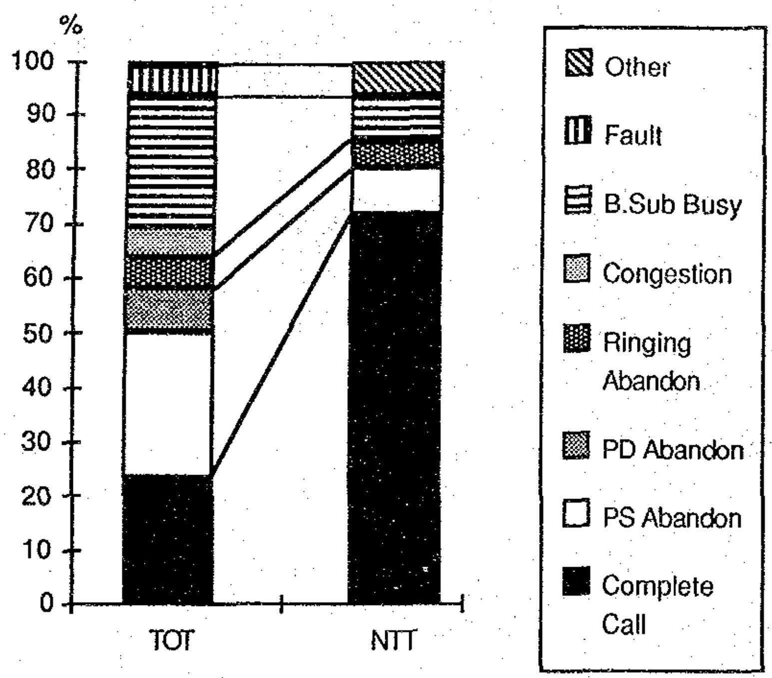


Figure 3.3.1-2 Comparison of Service Performance between TOT and NTT

Table 3.3.1-2 shows the international call completion ratios of seven Asian countries, which were measured on originating calls from the U.S.A. It is supposed that the measurement was undertaken at an international gate-way switch in the USA and the figure of the performance includes factor of status of international links. So, from this figure we can not directly evaluate the level of service performance of the domestic network of each country, but we can roughly grasp the conditions of these countries.

Table 3.3.1-2 International Call Completion Ratio

Country	Completion Ratio
Thailand	46.1 (%)
Japan	73.1
Singapore	72.3
Hong Kong	70.4
Korea	58.0
Malaysia	50.0
Indonesia	32.8

(Measured by AT&T, 1991)

2) Completion Ratio on Terminating Category Basis

To understand the situation of service performance in more detail, the Study Team chose 9 NEAX-61 switches and made service observations during the busy hour on the days of 20,21,23 and 24 in April 1992. The 9 switches are Ploem Chit - T3, Pathum Wam -2, Surawong - 4 in business area, Bang Kae, Charang Samitwong - 2, Pak Kret in residential area and Samran Rat - 4, Hua Mak - 2, Lat Phrao - 1 in business and residential mixed areas. Hereinafter these switches are referred as the sampled switches in this report.

a) Local Call, STD Call and ISD Call

Figure 3.3.1-3 shows the completion ratio and the call volume of local calls, STD calls, ISD calls measured at the sampled switches. (The Data of Figures 3.3.1-3 ~ -6 are compiled in ANNEX.) The completion ratio of local calls is 38%, STD calls 31%, ISD calls is 42%. The average of the three categories is 38%. It is severely influenced by local calls because the volume of local calls occupies more than 90% of the total calls as shown in Figure 3.3.1-4. We should be careful that in this data

P.S.Abandon is eliminated because the P.S.abandon can not be counted in the terminating call categories because of no dial pulse reception.

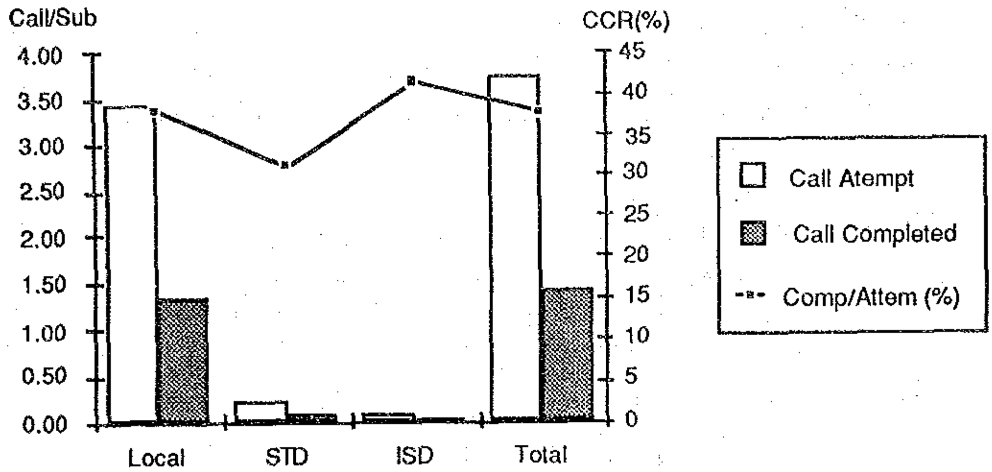


Figure 3.3.1-3 Completion Ratio and Call Volume of Local, STD and ISD Calls

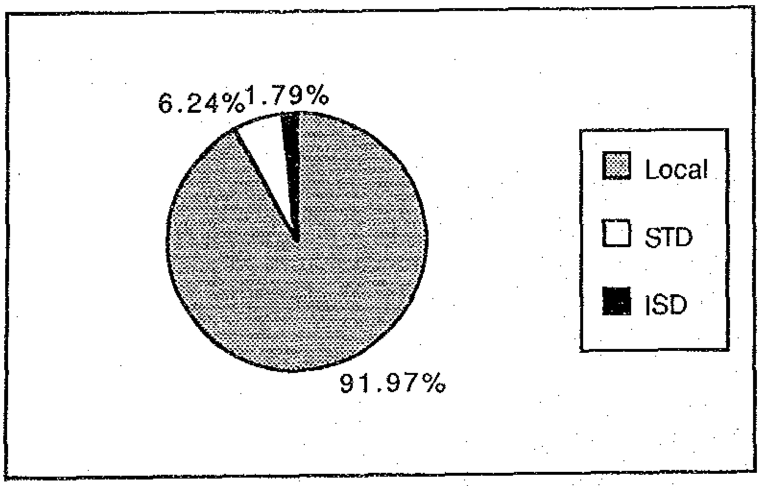


Figure 3.3.1-4 Proportion of Call Volume of Local, STD and ISD Calls

b) STD Call Classified by Destination

Figure 3.3.1-5 shows the completion ratio of STD calls to each destination code measured at the sampled switches. "01" is to cellular mobile telephone and "09" is to Malaysia. The completion ratio of "01" is the lowest among other destinations.

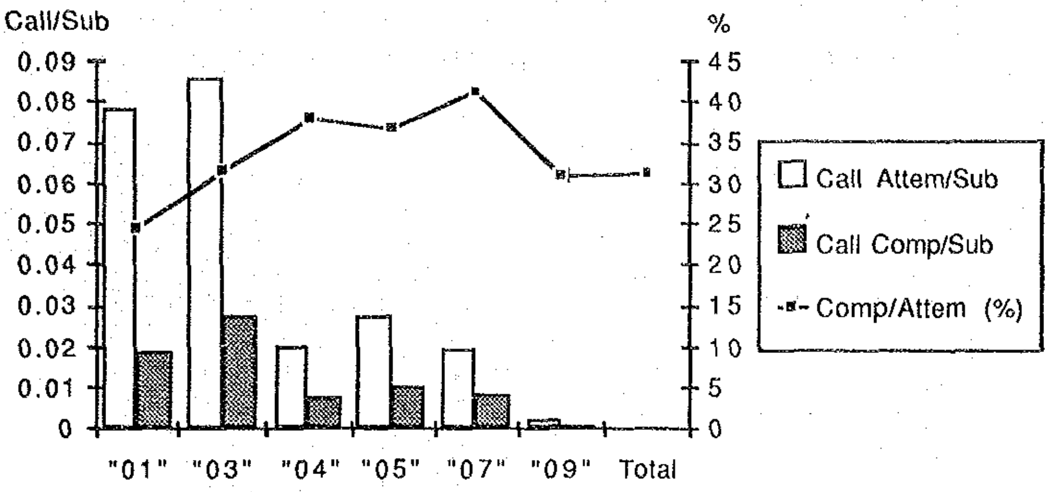


Figure 3.3.1-5 Completion Ratio of STD Call to Each Level Code

c) Calls to Cellular Mobile Telephone

Figure 3.3.1-6 shows the completion ratio of terminating calls to each cellular mobile telephone service carriers measured at the sampled switches. Newly started services (900 MHz and World Phone) show higher completion ratios.

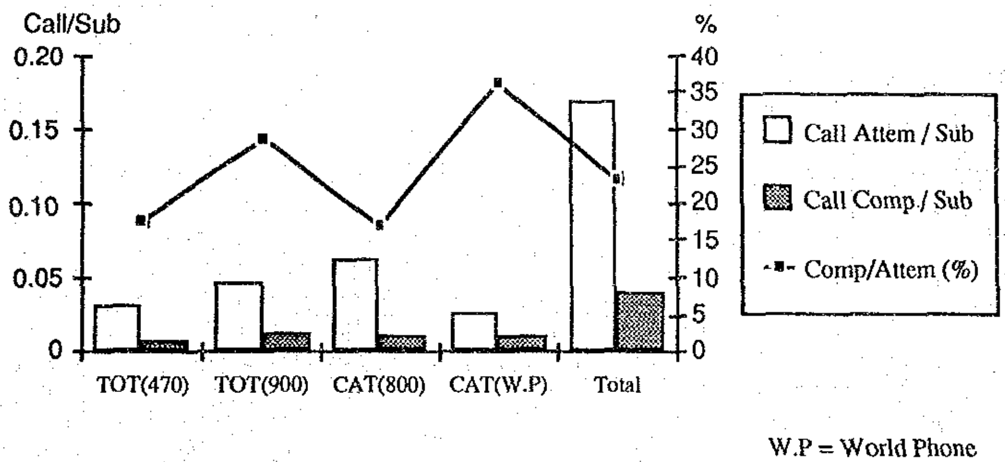


Figure 3.3.1-6 Completion Ratios of Calls to Cellular Mobile Telephones

d) Calls to Paging Phones

Table 3.3.1-3 and Figure 3.3.1-7 show service performance of the paging service measured at terminating local switches (local switches to which paging service equipment are accommodated). Service level of some providers is affected by trunk busy of trunks between terminating local switches and paging service equipment.

Table 3.3.1-3 Service Performance of Paging Service

Average Terminating Call (Busy Hour)
Measured 3/23 ~ 3/27,1992

Terminating Category	Term. Call	Comp. Call	Comp/Term	Busy
151(KK)	5,724	5,416	0.95	1
151(PKG)	758	737	0.97	0
152	7,809	6,816	0.87	96
153	113	99	0.87	0
161	1,131	1,105	0.98	0
162	2,210	2,125	0.96	21
253-2233	1,205	891	0.74	302
253-7766	3,356	2,517	0.75	780
253-7788	7,911	3,862	0.49	3,953
254-7788	398	246	0.62	147
255-7788	1,944	1,380	0.71	531

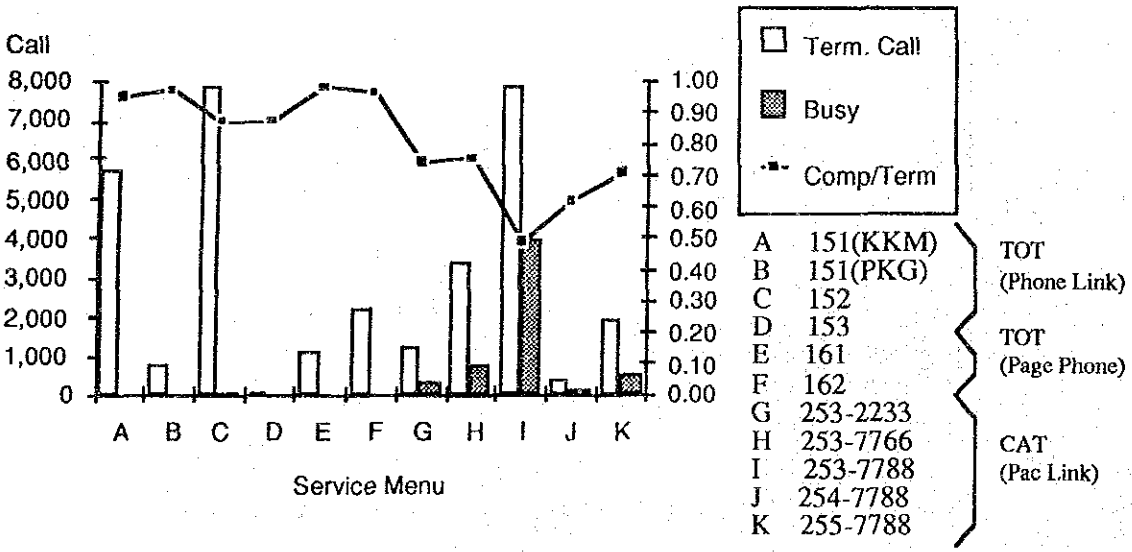


Figure 3.3.1-7 Service Performance of Paging Service
(Measured at busy hour on 3/23 ~ 3/27, 1992)

3.3.2 Traffic Characteristics

1) Traffic Fluctuations in 24 Hours

In order to examine when the busy hour exists in a day, the measurement of the traffic pattern was undertaken in the busy hour of the network. The measurement was undertaken at the sampled switches on the days of 20,21,23 and 24 in April 1992. In the measurement, P.S.Abandon calls are eliminated for the reason that the number of P.S.Abandons greatly varies according to the weather condition as being described in the following Chapter.

Figure 3.3.2-1 shows a traffic load curve of 24 hours of Ploen Chit - T3 as a sample of the business area, Figure 3.3.3-2 shows that of Charan Sanitwong - 2 as a sample of the residential area. (The figures of other switches are shown in APPENDIX.) In both switches the busy hour is 10:00 ~ 11:00 am. At Ploen Chit - T3, the concentration ratio of the busy hour (ratio of the number of calls in the busy hour to all day) is higher than that at Charan Sanitwong - 2. Another conspicuous difference is that at Charan Sanitwong - 2 there are three traffic peaks in a day while there are two peaks at Ploen Chit - T3.

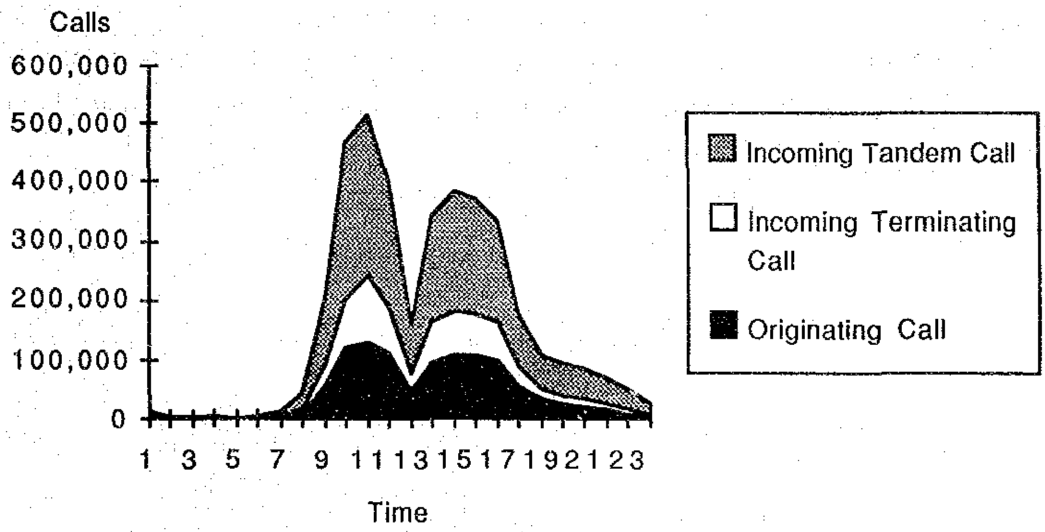


Figure 3.3.2-1 Daily Traffic Pattern Load Curve: Business Area (Ploen Chit-T3) (Average value of the measured days)

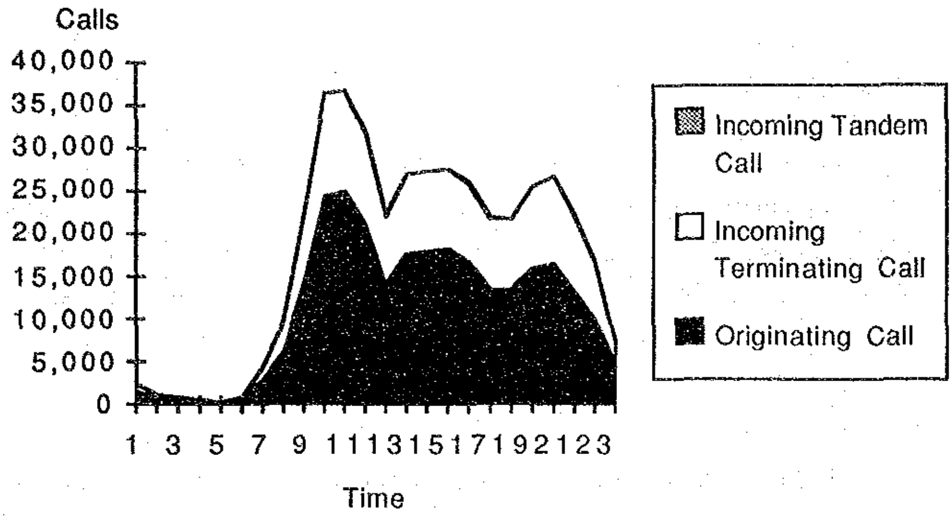


Figure 3.3.2-2 Daily Traffic Load Curve: Residential Area (Charun Sanitwong) (the average of the measured days)

2) Transition of Service Performance in a Day

Figure 3.3.2-3 and Figure 3.3.2-4 show the hourly change of service performance of originating calls from Ploen Chit-T3, with respect to the number of calls and percentage share, respectively. Those of in Charun Sanitwong are shown in Figure 3.3.2-5 and Figure 3.3.2-6. (Those of other sampled switches are compiled in APPENDIX.) From these figures, even though traffic is low, the completion ratio during the night time is not so good because of high B-sub-busy.

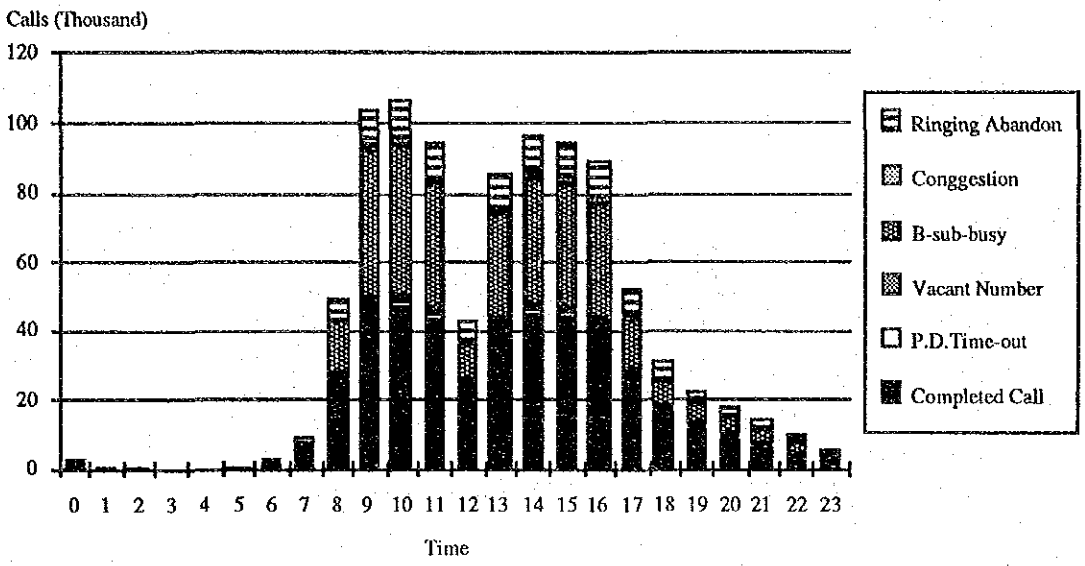


Figure 3.3.2-3 Hourly Change of Service Performance in the Number of Calls (Ploen Chit-T3)
(the average of the measured days)

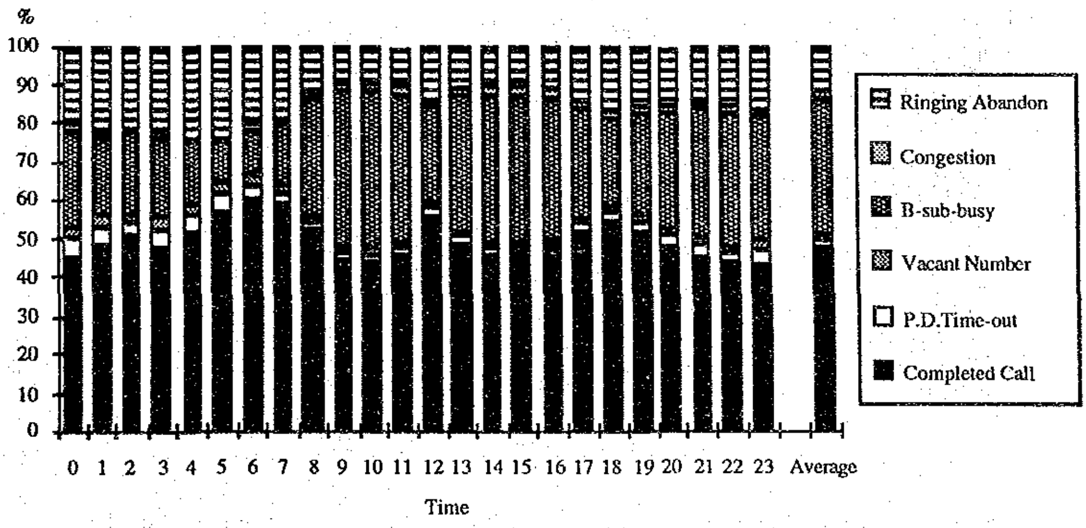


Figure 3.3.2-4 Hourly Change of Service Performance in the Percentage Share (Ploen Chit-T3)
(the average of the measured days)

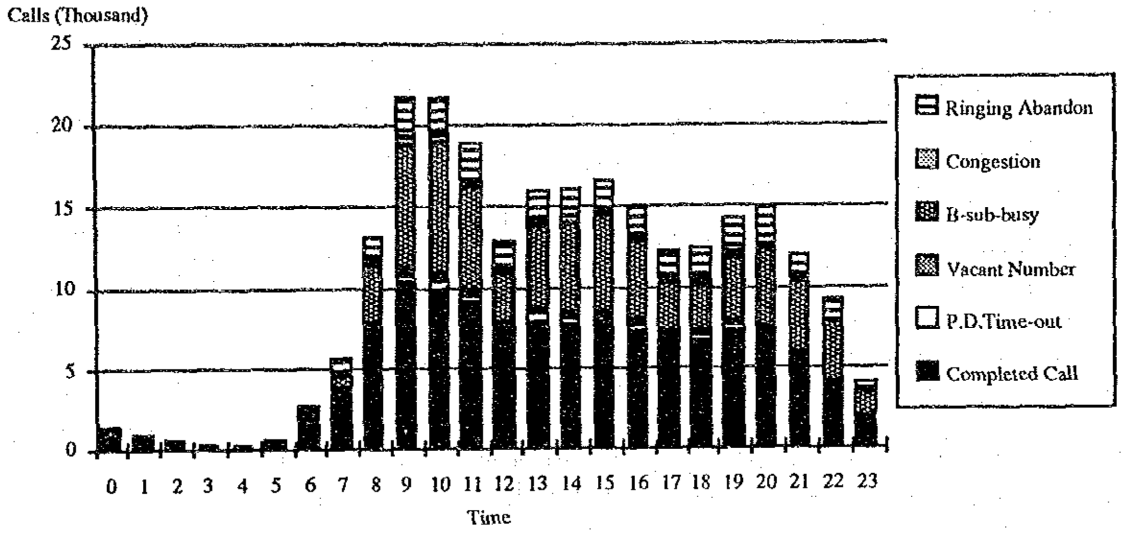


Figure 3.3.2-5 Hourly Change of Service Performance in the Number of Calls (Charun Sanitwong)
(the average of the measured days)

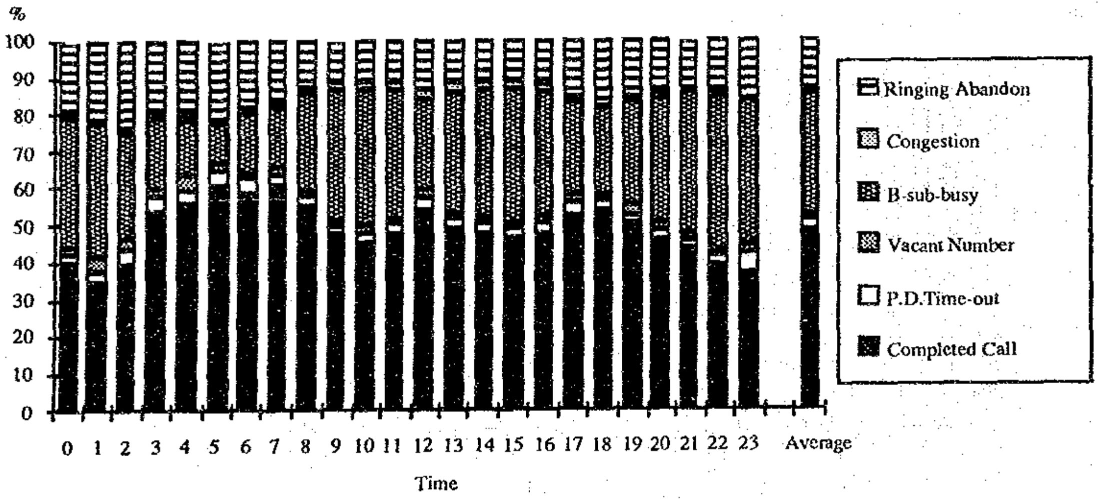


Figure 3.3.2-6 Hourly Change of Service Performance in the Percentage Share (Charun Sanitwong)
(the average of the measured days)

3) Concentration Ratio

Table 3.3.2-1 shows the number of calls in the busy hour, in all day and its concentration ratio (ratio of the number of calls in the busy hour to all day) at the sampled switches. The average concentration ratio of the sampled switches is 11.7%.

Table 3.3.2-1 Concentration Ratio at the Sampled Switches

(the average of the measured days)

Switch Name	All Day Calls	Busy Hour Calls	Concentration Ratio
PLOENCHIT	1,079,753	131,709	12.2 (%)
PATHUMWAN	481,445	52,272	10.9
SURAWONG	1,001,062	126,650	12.7
BANGKAE	157,742	16,844	10.7
CHARANGSANITWONG	270,766	24,856	9.2
PAKKRET	216,630	22,459	10.4
SAMRANRAT	766,914	91,119	11.9
HUAMAK	520,720	53,619	10.3
LADPRAO-1	406,229	52,995	13.0
Total	4,901,258	572,522	11.7

4) Call Completion Ratio in the Busy Hour and All Day

Table 3.3.2-2 shows the relationship between call completion ratio of the busy hour and that of all day at the sampled switches. On the average, the completion ratio in all day is 15% higher than that in the busy hour. This will be used as a factor of revenue estimation in the following Chapter.

Table 3.3.2-2 Call Completion Ratio in the Busy Hour and in All Day

(the average of the measured days)

Switch Name	All Day	Busy Hour	(All Day)/(Busy Hour)
PLOENCHIT	41.1	35.3	1.16
PATHUMWAN	41.8	37.9	1.10
SURAWONG	43.1	36.5	1.18
BANGKAE	41.3	35.6	1.16
CHARANGSANITWONG	43.5	39.8	1.09
PAKKRET	38.5	34.4	1.12
SAMRANRAT	44.1	39.3	1.12
HUAMAK	37.7	34.7	1.09
LADPRAO-1	37.8	28.5	1.33
Average	41.4	35.9	1.15

3.4 P.S.Abandon Calls

The Study Team carried out a field trial to find out a method to reduce the P.S. Abandon Calls. This section describes the situation of P.S.Abandon calls in the studied switch, the process of the field trial, the results of the trial and conclusion of the study.

The team chose Phra Kanong-T6 as a case study switch that is one of the telephone offices experiencing the highest P.S.Abandon calls.

3.4.1 Status of P.S.Abandon Calls

Figure 3.4.1-1 shows the status of P.S.Abandon calls in the studied switch measured on every busy hour in March, 1992. The number of the P.S.Abandon calls varies in a range from 10,000 to 35,000. The average is about 20,000 and occupies 44% of the total originating calls. This means that almost a half of the originating calls is P.S.Abandon calls.

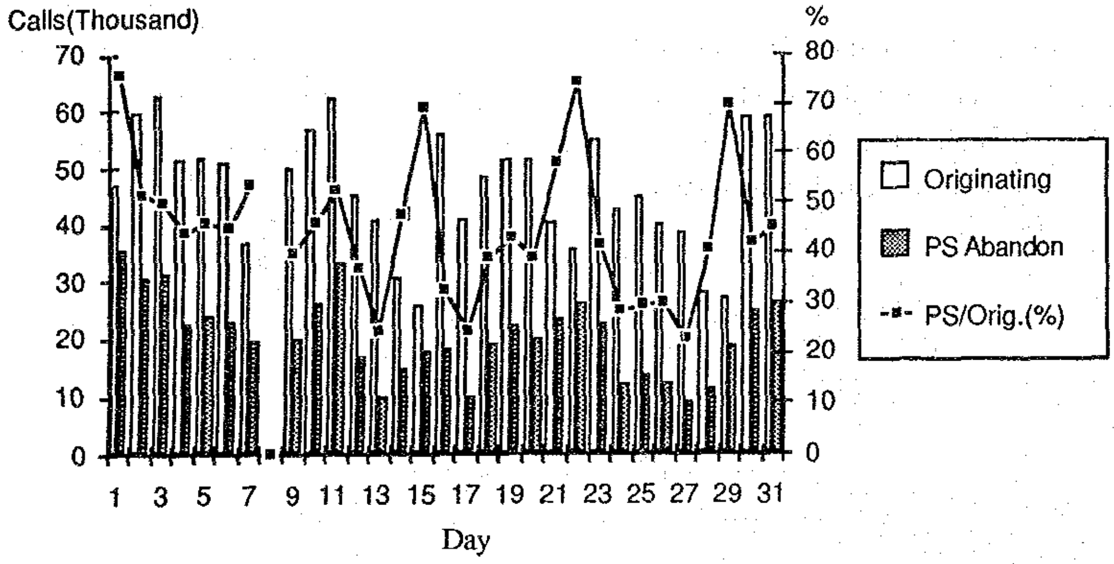


Figure 3.4.1-1 P.S.Abandon Calls in March 1992 at PKG-T6

Figure 3.4.1-2 shows the hourly change of P.S. Abandon calls in a day. The proportion of the number of P.S. Abandon calls to originating calls is higher during lower traffic time. This means that some of the P.S. Abandon calls occur in proportion to traffic volume and the others occur independently from traffic volume.

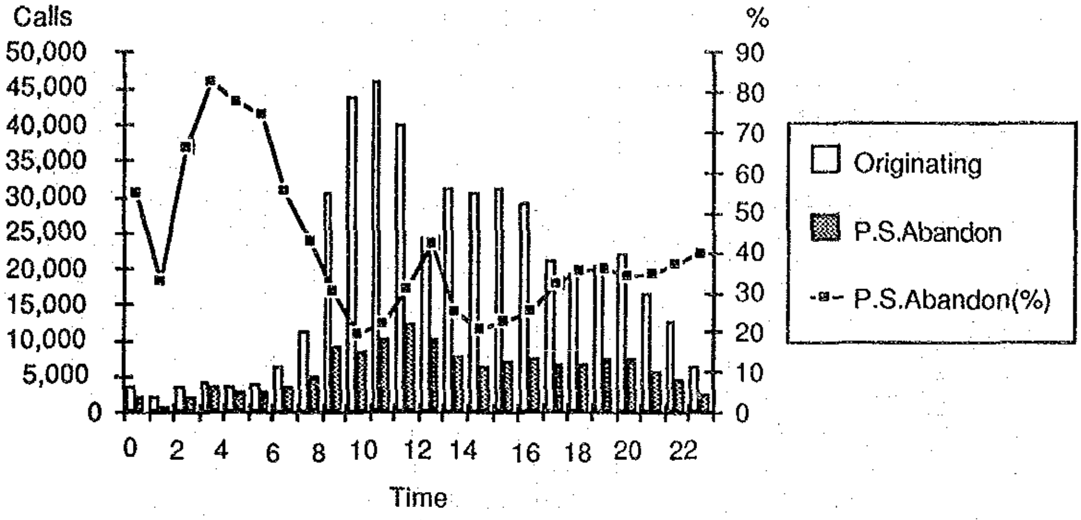


Figure 3.4.1-2 P.S.Abandon Calls in 24 Hours at PKG-T6 on April 20, 1992

3.4.2 Causes of P.S. Abandon Calls

From service observations for the purpose of finding the causes of the P.S. Abandon calls, the Study Team undertook "Service Observation" at Phra Kanong-T6 by using a function of the SPC switch. By the function we can know the telephone number of a originating call. We found a group of subscriber lines which originate high P.S. Abandons calls.

The samples of P.S.Abandon originating calls from the subscriber lines are shown in Table 3.4.2-1 and Table 3.4.2-2. From the data in Table 3.4.2-1 which were measured at the night time, we can find that a small number of subscribers (including No Subscriber Number) originate a large number of the P.S.Abandons calls. On the other hand, according to the data in Table 3.4.2-2 which were measured in the day time, more subscribers originate relatively many P.S.Abandon calls and the number of P.S.Abandon calls from those subscribers are not conspicuously concentrated. Another difference is that in the day time some public telephones originate the P.S.Abandon calls.

Table 3.4.2-1 P.S.Abandon Calls and Subscriber Line Faults (PKG-T6)

Measured on April 20 (2:00 ~ 2:26), 1992

Tel. NO	Occurrence	%	Sub. Category	Test Results	Cause of Fault
No Sub. NO	98	27.37			
3325744	171	47.77	Normal	Line short	In house wire
3319379	26	7.26	Normal	Line short	In house wire
3322814	12	3.35	Normal	Line short	In house wire
3324183	11	3.07	Normal	Line short	In house wire
3325078	6	1.68	Normal	Line short	In house wire
3316840	3	0.84	Normal		
3322089	3	0.84	Normal		
3322387	3	0.84	Normal		
3331278	3	0.84	Normal		
3310015	2	0.56	Normal		
3313200	2	0.56	Normal		
3317113	2	0.56	Normal		
3317317	2	0.56	Normal		
1 x 14 Sub.	14	3.91			
Total *	358	100.00			

Note: * The summation of the all percentages is not equal to the total because of the rounding off the figures.

Table 3.4.2-2 P.S.Abandon Calls and Subscriber Line Faults (PKG-T6)

Measured on April 20(10:00 ~ 10:38), 1992

Tel. NO	Occurrence	%	Normal/Public	Test Results	Cause of Fault
No Sub. NO	51	5.18	-	-	-
3322814	42	4.26	Normal	Line short	In house wire
3320568	13	1.32	Public	Good	-
3310414	12	1.22	Public	Good	-
3330569	11	1.12	Public	Low ins.	Coin stay
3320478	9	0.91	Public	Low ins.	Coin stay
3310446	9	0.91	Public	Low ins.	Coin stay
8 x 6 Sub	48	4.87			
7 x 6 Sub	42	4.26			
6 x 3 Sub	18	1.83			
5 x 13 Sub	65	6.60			
4 x 14 Sub.	56	5.69			
3 x 28 Sub.	84	8.53			
2 x 73 Sub.	146	14.82			
1 x 379 Sub.	379	38.48			
Total	985	100			

Later, it was found that these subscriber lines originating high P.S.Abandon calls had faults in their subscriber lines. This is also shown in Table 3.4.2-1 and 3.4.2-2. In the case of ordinary subscribers, most of the faults were found in their in house wires. In the case of public telephones, most of the faults were found in the terminal sets (coins stay in the coin slots).

In the mean time, we found that there were some P.S.Abandon calls that have no originating subscribers numbers. After a pursuit work of the causes, we found that the P.S.Abandon calls also came from faulty subscriber lines that had been canceled for subscription but the jumpers in the MDF had not been removed yet. After disconnection of the faulty subscriber lines at the MDF which had no subscriber number, P.S.Abandon calls did not originate. Figure 3.4.2 shows the process to find locations of no-subscriber-number P.S.Abandon calls in the subscriber line frame.

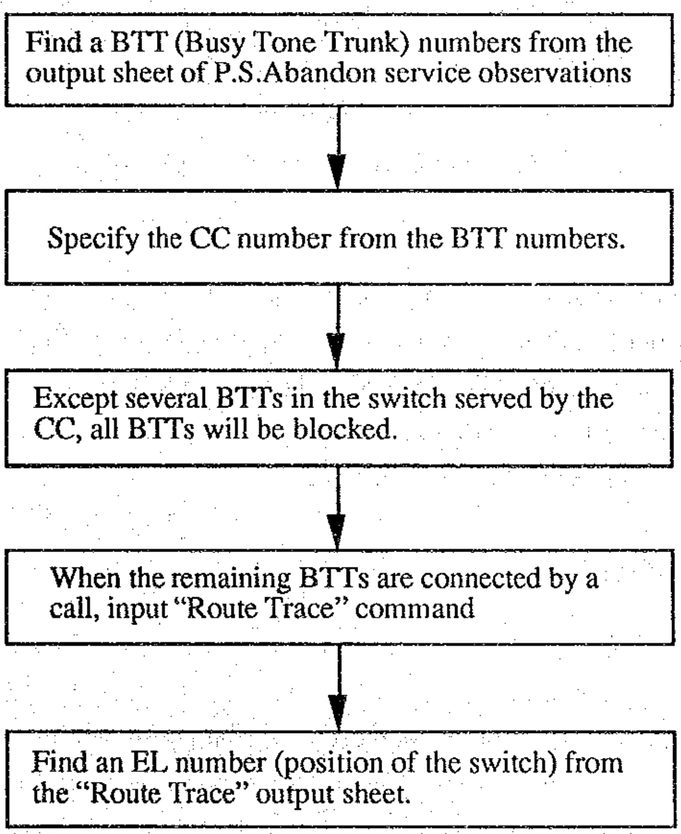


Figure 3.4.2 Process of Finding the Locations of No-sub-number P.S.Abandon calls

3.4.3 Field Trial

After finding the results mentioned above, the Study Team carried out a field trial by the process shown in Figure 3.4.3 intending to reduce P.S.Abandon calls in the switch.

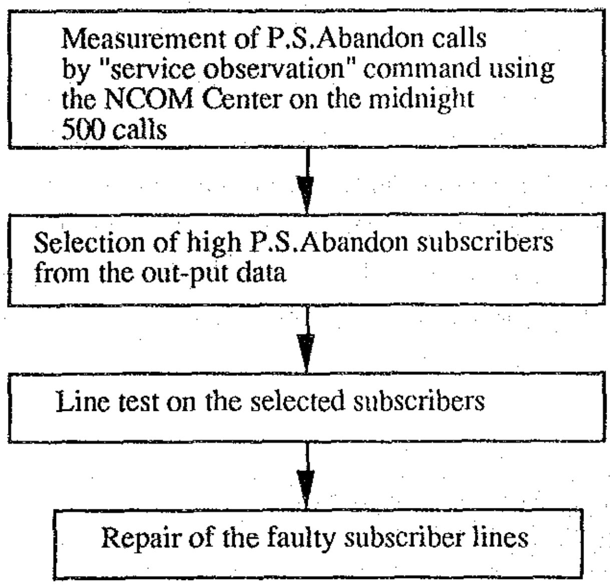


Figure 3.4.3 The Process of Field Trial on Reducing P.S.Abandon Calls

This field trial was undertaken on 20th and 22nd in April, 4th, 6th, 8th, 12th and 15th in May. The status of P.S.Abandon calls measured on these days, the results of the subscriber line test and the places of the faults are compiled in APPENDIX. Line status of some of the subscribers who originated P.S.Abandon calls during the observation period, had been already changed to good conditions when they were tested.

3.4.4 Results of the Field Trial

During this field trial, 40 faulty subscriber lines were repaired. But, because of the limited time for the Work in Thailand, not all faulty subscribers in the switch were found and repaired. The daily change of P.S.Abandon calls before and after the trial are shown in Figure 3.4.4. This result shows that the trial was effective to reduce P.S.Abandon calls. Before the field trial, the average number P.S. Abandon call was 44% of the total calls but after the field trial, that was reduced to 20% of the total calls.

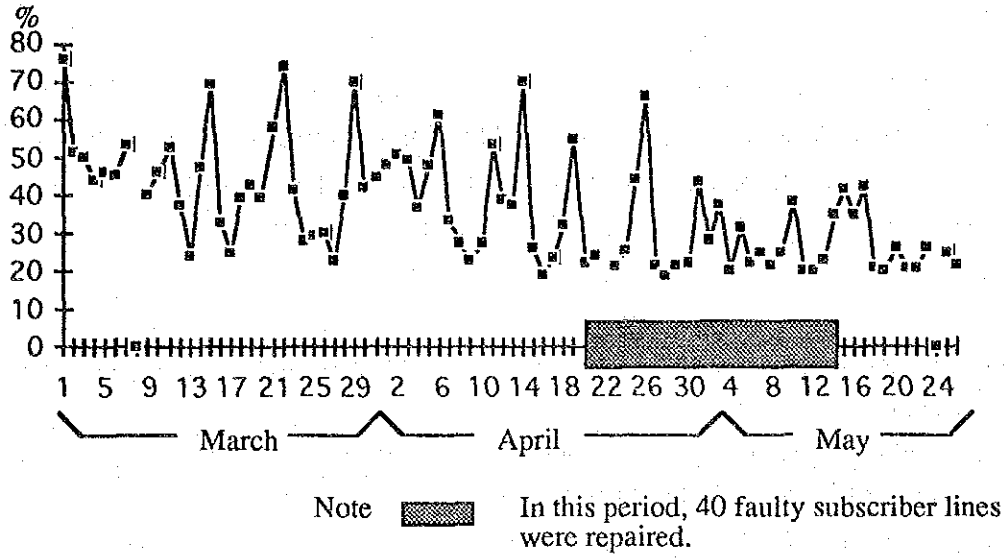


Figure 3.4.4 Transition of P.S.Abandon Ratio to Total Originating Calls

3.4.5 Conclusion

From the field trial we can concluded as follows:

1. Some of the P.S. Abandon calls occur in proportion to traffic volume but some occur independently from traffic volume.

2. P.S. Abandon calls which occur independently from traffic volume are probably caused by faulty subscriber lines

3. Most of the faults which cause P.S. Abandon calls exist in in-house-wires and drop wires in case of ordinary subscribers and in terminal sets in case of public telephones.

4. By replacement of the faulty subscriber lines from the network, P.S. Abandon calls can be remarkably reduced.

5. Since some of the P.S. Abandon calls originate in proportion to traffic volume (caused by user's), it is difficult to eliminate P.S. Abandon calls completely.

3.5 B-sub Busy

The unsuccessful call ratio because of B-sub busy was 24.4% in March 1992 for Bangkok Metropolitan Area. The largest cause is P.S. Abandon (26.8%). B-sub busy is the second large cause of the low call completion ratio (CCR) in Bangkok at present. If TOT can reduce B-sub busy, the CCR will become much improved and it will contribute revenue increase directly.

In order to reduce B-sub busy and increase the CCR to the traffic congested subscribers, the following measures are effective:

1) Introduction of Hunting System for Multi-line Subscribers,
2) Installation of Additional Main Telephone Lines, and
3) Introduction of Call Waiting Service.

Hunting system is effective for a high B-sub busy subscriber who installs and uses more than one telephone line (multi-line user). Hunting system is available for those subscribers who use main telephone lines accommodated in the same switching unit.

This section intends to clarify the present situation and issues on those measures to improve high B-sub busy in Bangkok; and try to propose possible solutions.

3.5.1 Improvement Method of B-sub Busy

There are some subscribers to whom it is difficult to make a telephone call because their telephone lines are always busy (B-sub Busy). Travel agencies, taxi reservations, country clubs (to reserve golf playing), and ticket reservation agencies are typical high B-sub busy subscribers in Japan. In order to improve incoming call completion for those high B-sub busy subscribers, the following measures are directly effective:

1) Introducing <u>hunting system</u> for those subscribers who use two or more than two telephone lines in a same place without using the system yet,

2) Installing <u>additional main telephone lines</u> into their hunting system if they already use hunting group but they have still frequent B-sub busy,

3) introducing <u>additional main telephone lines</u> and introducing <u>hunting system</u> if they are using only one telephone line, and

4) installing Call Waiting (C/W) service when they have only one main telephone line and they can not afford to install additional telephone lines.

3.5.2 Hunting System

1) Effectiveness of Hunting System

Incoming traffic efficiency can be improved remarkably by introducing hunting system when a subscriber has two or more than two telephone lines (multi-line subscribers). Hunting system (or pilot number system) is effective also because any additional cost is not necessary for subscribers to apply for and use it.

Under the condition of the 10% loss probability for example, the maximum traffic capability can be estimated by the Erlang theory. Table 3.5.21 and Figure 3.5.2-1 show that traffic capability can become 5.19, 6.77, and 7.50 times larger when a subscriber has 5, 10, and 15 main telephone lines with hunting system, respectively.

Table 3.5.2-1 Traffic Capability Comparison between Hunting System and Independent Lines

Number of Line	Traffic Capability (erl)		Efficiency (Hunting/Independent)
	Hunting System	Independent Line	
1	0.111	0.111	1.00
2	0.595	0.222	2.68
3	1.271	0.333	3.82
4	2.045	0.444	4.61
5	2.881	0.555	5.19
10	7.511	1.111	6.77
15	12.484	1.665	7.50
20	17.613	2.220	7.93
30	28.113	3.330	8.44
40	38.787	4.440	8.74

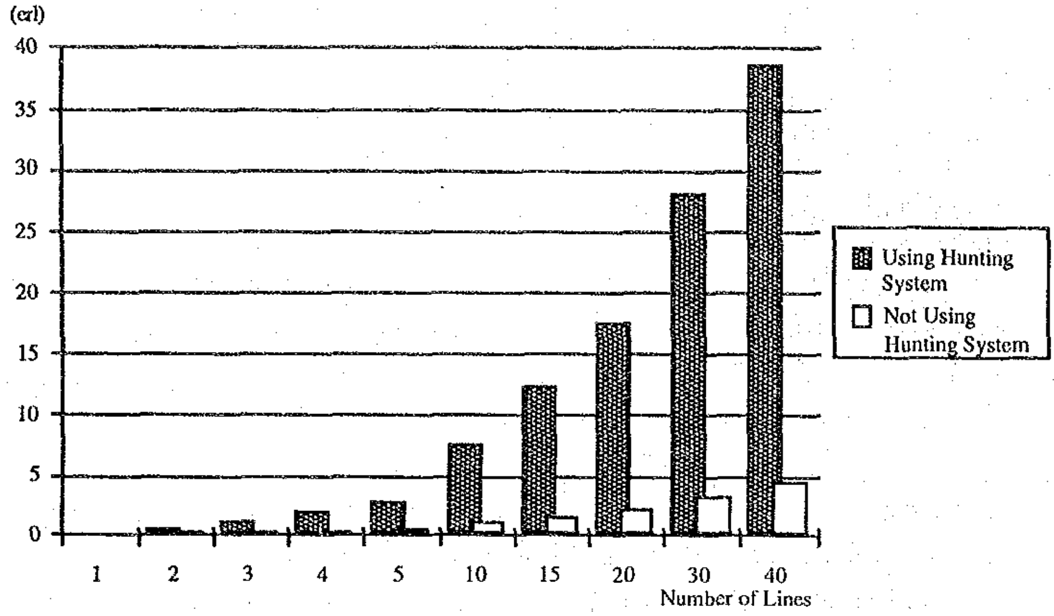


Figure 3.5.2-1 Traffic Capability Comparison between Hunting System and Independent Lines

TOT has adopted two types as for hunting system: one is single hunting system (or "Non Slip Function") used mainly in the XB switching systems; and the other is group hunting system (or "Slip Function") mainly used in the SPC switching systems.

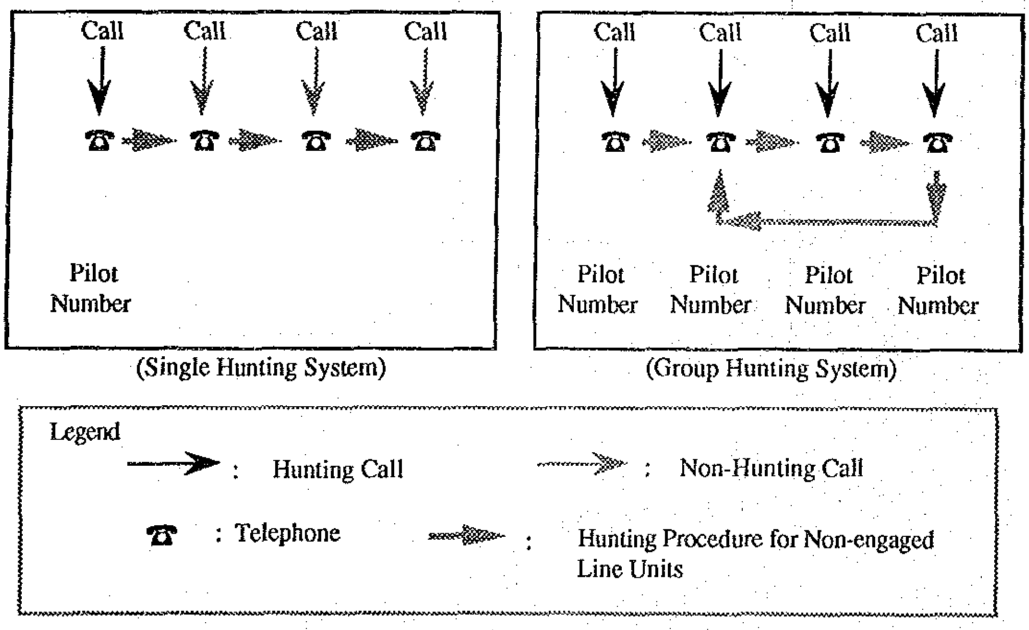


Figure 3.5.2-2 Single Hunting System and Group Hunting System Configuration

2) The Present Situation of Hunting System Usage in Bangkok

a) Hunting System Usage for PABX Users

The hunting system is quite effective to increase traffic capability and reduce B-sub busy; however, introduction of the hunting system is not so common among the multi-line subscribers in the BMA at present. Table 3.5.2-2 and Figure 3.5.2-3 show the frequency distribution of the number and percentage of PABX subscribers in both using and not using the hunting system groups.

Table 3.5.2-2 The Number of Hunting System Users in PABX Subscribers in the BMA

Range of Main Tel. Line per Subscriber	Frequency: Number of Subscribers				Total
	Using Hunting System		Not Using Hunting System		
2	18	1.74%	1,019	98.26%	1,037
3-5	365	7.88%	4,269	92.12%	4,634
6-10	670	18.69%	2,915	81.31%	3,585
11-50	1,242	45.20%	1,506	54.80%	2,748
51-100	106	79.10%	28	20.90%	134
101-	43	86.00%	7	14.00%	50
Total	2,444	20.05%	9,744	79.95%	12,188

Source: Computer Directory Assistance System (CDAS) Center, TOT (May 1992)

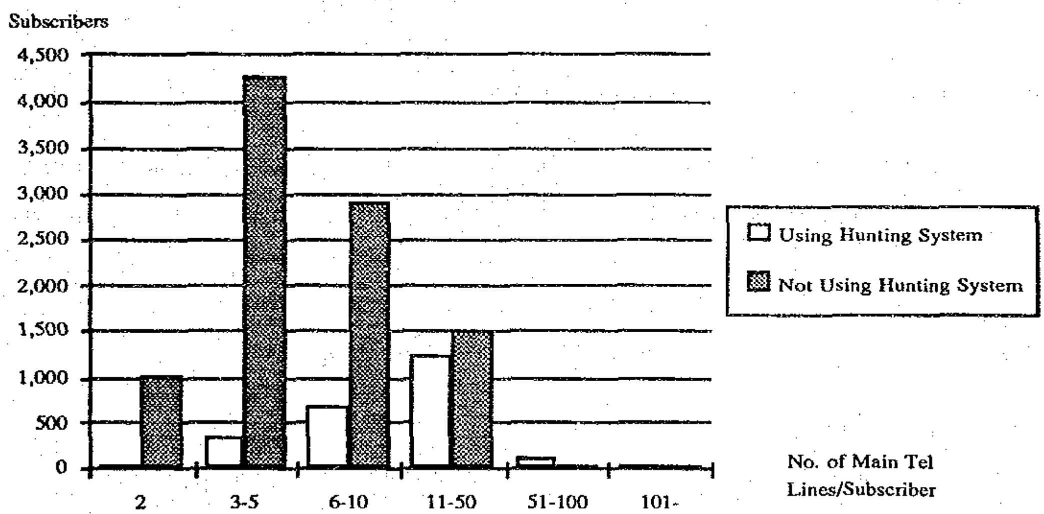


Figure 3.5.2-3 The Introduction of Hunting System for PABX Subscriber classified by the Number of Main Telephone Lines

Table 3.5.2-2 and Figure 3.5.2-3 show that there are 12,188 PABX subscribers in the BMA; however, 79.95% of them are not using the hunting system. 58% of the subscribers who have more than 10 but less than and equal to 50 main telephone lines are not using the hunting system. More than 80% of those who have more than 5 but less than 11 telephone lines are also not using the system.

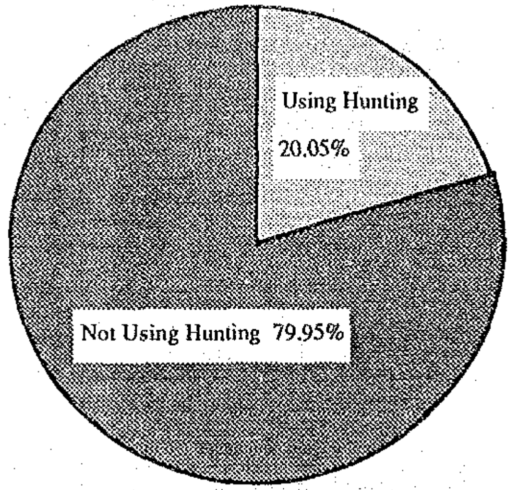


Figure 3.5.2-4 Share of Hunting System Users for PABX in BMA

In total, only 20% of the PABX subscribers are using the hunting system and 80% of them are not using the system as Figure 3.5.2-4 illustrates.

It is quite inefficient for a PABX to use multiple main telephone lines without a hunting system. This causes high B-sub busy.

When this low usage rate of the hunting system for PABX subscribers is taken into consideration, introduction and usage of the hunting system for ordinary multi-line subscribers (those who are not using PABXs) may also stay in a low level.

The following section describes the frequency distribution of the number of multi-line users in the BMA including both business and residential subscribers.

b) Frequency Distribution of Multi-line Subscribers

Table 3.5.2-3 and Figure 3.5.2-5 show the frequency distribution of the number of multi-line business subscribers in the BMA.

Table 3.5.2-3 Frequency Table of Multi-line Business Subscribers in the BMA (as of May 28, 1991)

Main Tel. line per Subscriber	Number of Subscriber		Number of Telephone Lines	
	Frequency	Share	Total Tel. Line	Share
1: Single-line	60,473	60.64%	60,473	19.55%
Sub Total: Multi-line	39,246	39.36%	248,889	80.45%
2-3	19,723	19.78%	53,652	17.34%
4-5	9,467	9.49%	41,290	13.35%
6-10	6,309	6.33%	45,726	14.78%
11-50	3,407	3.42%	63,258	20.45%
51-100	227	0.23%	15,543	5.02%
101-200	60	0.06%	8,078	2.61%
201-500	37	0.04%	12,080	3.90%
500-	16	0.02%	9,262	2.99%
Total	99,719	100.00%	309,362	100.00%

Source: AT&T Directories (Thailand) Ltd.

Note: The number of subscriber in the table includes only those who list their names in the Telephone Directory.

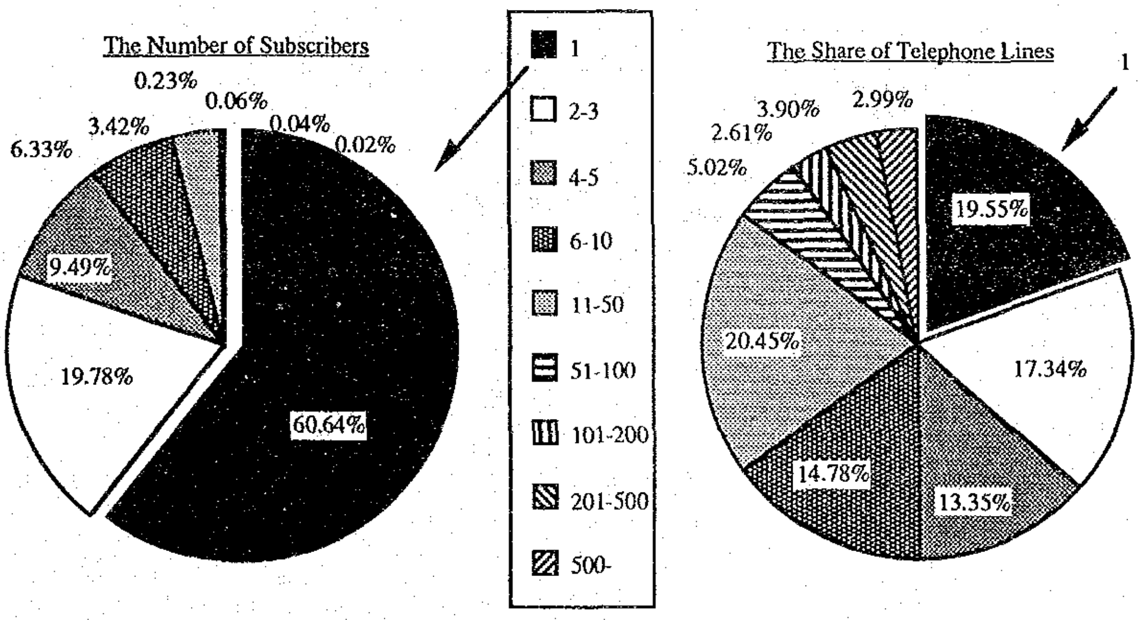


Figure 3.5.2-5 Frequency Distribution of Multi-line Business Subscribers in the BMA

Table 3.5.2-3 and Figure 3.5.2-4 indicate the followings:

i) While 60.64% of the business subscribers are the single-line subscribers, they take up only 19.55% of the total telephone lines,

ii) While the multi-line subscribers have 39.36% share in the number of total business subscribers, they occupy 80.45% in the all business telephone lines in the BMA.

The following table and figure show the frequency distribution of the multi-line subscribers of residential users in the BMA.

Table 3.5.2-4 Frequency Distribution of the number of Main Telephone Lines for Residential Subscriber in the BMA (as of May 28, 1991)

Main Tel. line per Subscriber	Number of Subscriber		Number of Telephone Lines	
	Frequency	Share	Total Tel. Line	Share
1: Single-line	391,537	78.62%	391,537	52.77%
Sub Total: Multi-Line	106,478	21.38%	350,363	47.23%
2-3	81,254	16.32%	219,612	29.60%
4-5	19,460	3.91%	82,997	11.19%
6-10	4,922	0.99%	34,407	4.64%
11-50	833	0.17%	12,730	1.72%
51-100	8	0.00%	455	0.06%
101-200	1	0.00%	162	0.02%
201-500	0	0.00%	0	0.00%
500-	0	0.00%	0	0.00%
Total	498,015	100.00%	741,900	100.00%

Source: AT&T Directories (Thailand) Ltd.

Note: The number of subscriber in the table includes only those who list their name in the Telephone Directory.

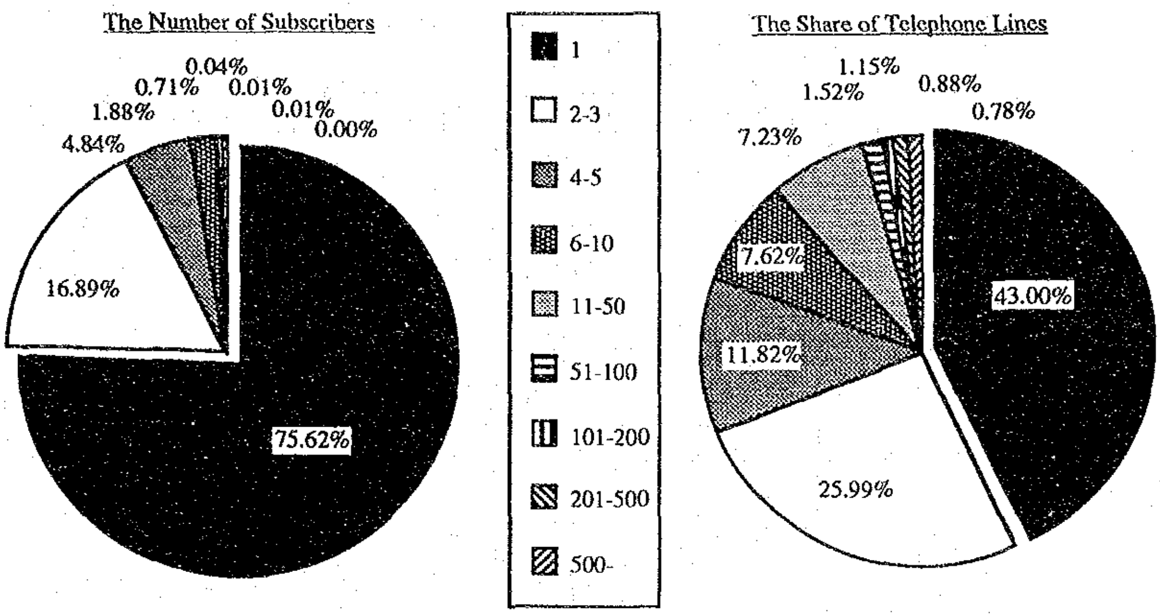


Figure 3.5.2-6 Frequency Distribution of Multi-line Residential Subscribers

Table 3.5.2-4 and Figure 3.5.2-6 indicate the followings:

i) 78.62% of the residential subscribers are single-line users; however, their share is 52.77% in the total number of the telephone lines,

ii) While the multi-line subscribers have 21.38% share in the number of total residential subscribers, they occupy 47.23% in all residential telephone lines in the BMA.

Table 3.5.2-5 and Figure 3.5.2-7 show the frequency distribution of both business and residential subscribers in the BMA.

There are 145,724 multi-line subscribers. They have 599,252 main telephone lines in the whole Kingdom. Because approximately 80% of the PABX users are not using the hunting system at present, at least 80% of the multi-line subscribers are not using the system. Therefore, approximately 117,000 multi-line subscribers are probably non-hunting system users.

Table 3.5.2-5 Frequency Distribution of the Number of Multi-line Business & Residential Subscribers in the BMA (as of May 28, 1991)

Main Tel. line per Subscriber	Number of Subscriber		Number of Telephone Lines	
	Frequency	Share	Total Tel. Line	Share
1: Single-line	452,010	75.62%	452,010	43.00%
Sub Total: Multi-line	145,724	24.38%	599,252	57.00%
2-3	100,977	16.89%	273,264	25.99%
4-5	28,927	4.84%	124,287	11.82%
6-10	11,231	1.88%	80,133	7.62%
11-50	4,240	0.71%	75,988	7.23%
51-100	235	0.04%	15,998	1.52%
101-200	61	0.01%	8,240	0.78%
201-500	37	0.01%	12,080	1.15%
500-	16	0.00%	9,262	0.88%
Total	597,734	100.00%	1,051,262	100.00%

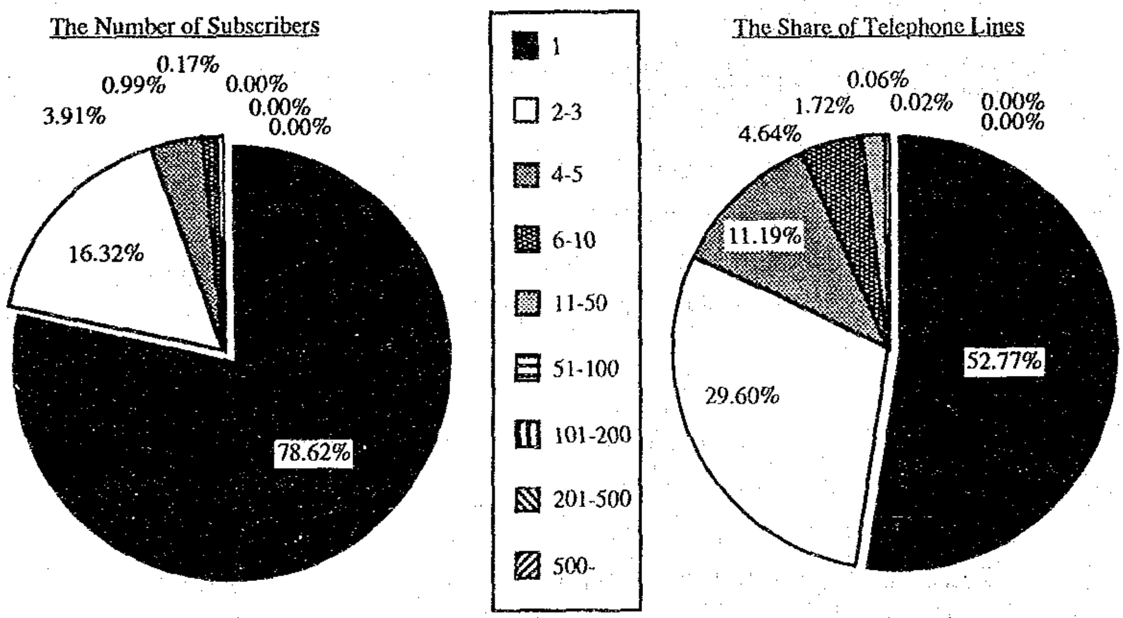


Figure 3.5.2-7 Frequency Distribution of Multi-line Business & Residential Subscribers

3) Difficulties and Obstacles to Apply for the Hunting System

Usage of the hunting system for the multi-line subscribers will stay at a low level in the BMA. There may be some difficulties or obstacles for the multi-line subscribers to apply for and use the hunting system. In order to find out about the difficulties and bottlenecks for introducing and using the hunting system, the present application regulation (or procedures) and subscribers class assignment in the switching systems for the hunting system are examined.

In conclusion, there exists no particular difficulty nor obstacle in the present application procedures and regulation to apply for the hunting system. There is also no limitation in the switching systems capacity to use the hunting system. However, the Study Team has found that there is a misunderstanding widely spread among the TOT staff. This might be one of the reasons of the low usage rate of the hunting system among the multi-line subscribers.

a) Application Procedure and Conditions of Introducing "Hunting System"

i) In order to apply for the hunting system to TOT, a subscriber must submit an application letter to TOT. The application and usage of the hunting system are free of charge. However, there exist some cases in which subscribers have to pay some additional deposits.

The amount of deposit which a subscriber must pay to install a telephone line has been increased several times. The latest increase was from 2,500 Baht to 3,000 Baht in the year of 1982. Those subscribers who have paid less than 3,000 Baht before the deposit increase have to pay the balance when applying TOT anything to change the subscription status and conditions such as applying for relocation, changing the telephone number, and introducing the hunting system.

ii) Before applying for hunting group system, all the main telephone lines should belong to the same switching unit because of physical and technical nature of the switching systems. It is, therefore, necessary for those subscribers, who have different exchange (office) code telephone numbers, to change their telephone numbers and make them within the same exchange code in order to introduce the hunting system.

iii) Changing the telephone number costs 500 Baht per number; however, changing from a rotary-dial type telephone number to a tone-dial type telephone number is free of charge.

iv) It is possible for a subscriber to include the different owners' telephone numbers (lines) in his hunting system by written permissions from the different subscribers. In this case, it is not necessary to transfer the telephone ownership to apply for the hunting system to include the different owners' telephone lines.

v) Procedures to Transfer the Subscriber Telephone Ownership
The application form for the ownership transfers of subscriber telephones can be obtained in its subscriber service offices. The charge for the transfer of telephone ownership is 1,000 Baht per line. It is also necessary to clear unpaid telephone bills before transfers.

vi) Restriction Period for Reallocation of Ceased Telephone Number
The restriction period for reallocation of a ceased telephone number is 45 days by the TOT internal regulation; however, the TOT commercial section tends to keep a ceased number for more than 90 days in practice. The Telephone Directory states that the reallocation period is at leased 6 months.

b) No Capacity Limitation for Using Hunting System in the Switching Systems

i) The XB switching system can accommodate the hunting system within the capacity of relay groups which are loaded on the XB switching unit. There is no other condition and limitation for the XB switching unit to accommodate the hunting systems. The XB switching system has two (2) subscriber classes. One is a special class (PABX, coin public telephone, private meter, test lines) and the other is an ordinary subscriber class. All the telephone numbers in a XB switch unit are fixed for each class initially but both classes can provide the hunting system within the relay group capacity limitation.

According to the special survey conducted by a JICA expert three years ago, there was no XB switching unit which used up the relay group capacity and could not provide the hunting system in the BMA.

ii) The SPC switching unit has no limitation to provide the hunting system. The SPC switching system has two different subscriber classes. One is 4LC for a special class and the other is 8LC for an ordinary class. Both subscriber class categories can provide the hunting system without any limitation of capacity.

There exist two misunderstandings among the TOT staff. Only the PABX subscribers could use the hunting system. The hunting system is available within the capacity for up to 5% of the main telephone lines in the switching unit. However, not only PABX but also ordinary subscribers can use the