5. LONG-TERM NETWORK PLANNING

5. LONG-TERM NETWORK PLANNING

5.1 Strategies and Planning Process

(1) Network Development Strategies

Long-term plan for the telecommunications network in Jabotabek area during the period of 15 years from 1989 up to 2004 is prepared in accordance with the following development strategies.

a) Jakarta multi-exchange area is to expanded, in principle, up to 30-km radius zone from the center of DKI Jakarta, namely GB1 exchange, in due consideration of both the present circumstances of telecommunications services and regional development framework.

b) The penetration of telephone services in DKI Jakarta will be upgraded up to the level of around 15 main telephones per 100 inhabitants in 15 years.

c) The exchange area boundaries in Jabotabek area are to be redrawn based on the results of the study on optimum exchange size, demand forecast and socio-economic development in the said area.

d) Planning toward the establishment of target network shall comprise those for trunk networks terminating/originating in Jakarta, junction network in Jakarta multi-exchange area and network to incorporate its suburban area.

e) The transition of the network shall be clarified Repelita by Repelita.

f) The guideline for introducing/implementing ISDN shall be set forth.

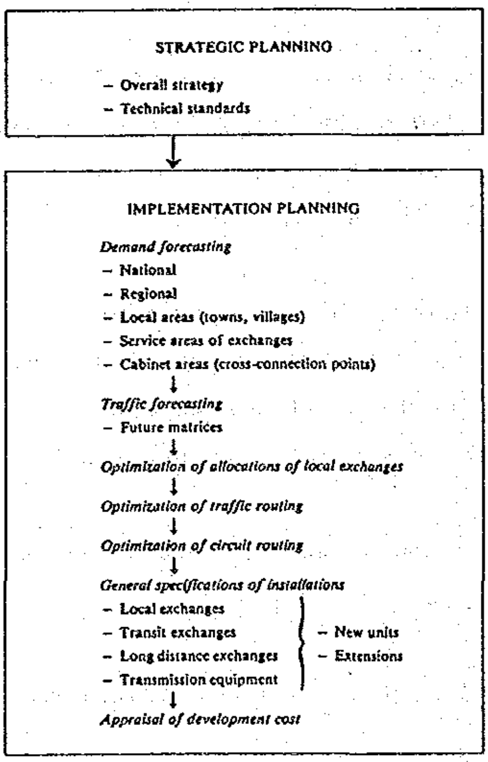
g) Strategic Development Plan (SDP '86 of POSTEL) shall be taken into consideration.

(2) Planning Process

Long-term network planning in Jabotabek area shall be carried out starting with the study on the existing conditions and environments around the telecommunications services, and including the following planning items:

- optimum exchange size;
- exchange area boundaries;
- network architecture;
- application criteria of switching system;
- routing plan;
- numbering plan; and
- signalling plan.

Figure below shows the general network planning process applicable to the Study to some extent.



Flow Chart of Planning Process

(Source: CCITT GAS 3 "General Network Planning")

5.2 Present Situation

5.2.1 Public Switched Telephone Network (PSTN)

(1) Switching System

The capacities of switching systems in Jabotabek area are as follows as of March, 1989:

- Jakarta multi-exchange area	434.6 k l.u.[1/]
- Jakarta suburban area	- k l.u.
- Bogor area	15.3 k l.u.
Total	449.9 k l.u.

The numbers of existing main telephone stations and waiting applicants are (as of May, 1988):

	No. of Expressed Demand	
	existing	waiting
- Jakarta multi-exchange area	305.9 k	208.2 k[1/]
- Jakarta suburban area	- k	- k
- Bogor area	9.0 k	6.9 k
Total	314.9 k	215.1 k

The expressed demand (existing subscribers + waiting applicants) amounts to approximately 530,000 in Jabotabek area with 60% of it met, while only about 70% of switching capacity is utilized. This is mainly due to mal-synchronization among the respective sub-system plannings, i.e., switching, subscriber cable network and transmission plannings.

The switching capacity as well as the expressed demand of each exchange appear in Table 8.4. Further detailed data are attached as ANNEX 5-1.

1/ Exchange areas of TAN, BEK, DEP and CIB were incorporated into the Jakarta multi-exchange area, in December 2, 1988.

(2) Subscriber Cable Network

The existing capacities of subscriber cable networks (those of primary cables in number of pairs, i.e., ssp, as of March, 1989) are as follows.

- Jakarta multi-exchange area	:	709.6 k ssp
- Jakarta suburban area	:	- k ssp
- Bogor area	:	18.5 k ssp
Total	:	728.1 k ssp

The capacity of primary cables terminated at each exchange is given in Table 8.4.

The detailed design work for expansion of subscriber cable network has been carried out by PMC Option Services (financed by the World Bank) for the core of DKI Jakarta and by local consultants for some other areas (by local budget).

(3) Junction Network

The digital junction network in Jabotabek area and the transmission network centering around DKI Jakarta are shown in Fig. 5.1.

(4) Exchange Building

VOLUME II of this report (PART II) presents in detail the floor/site layout of the existing exchange buildings in Jabotabek area, focusing on switching room, MDF room and transmission room. These information were collected through the period of second field survey of the Study.

On the other hand, Basic Design Reports submitted by PMC Option Services pointed out that many exchange buildings are to suffer from space shortage for future expansion/replacement of telecommunications facilities, especially switches and primary cables.

(5) Numbering Plan

At present, 6-digit and 7-digit subscriber numbering schemes are employed in DKI Jakarta. Maximum 700×10^3 subscribers for 6-digit and 7×10^6, for 7-digit are to be covered, securing the remaining numbering capacities for SLDD (Subscriber Long Distance Dialling), ISD (International Subscriber Dialling), suburban access code and special service numbers.

The present numbering plan in Jakarta multi-exchange area appears in Table 5.2 excluding BEK, TAN, DEP and CIB.

(6) Mobile Telephone System

There exist three kinds of mobile telephone systems in Indonesia, i.e.,:

- STKB INTI (non-cellular);
- STKB INTI (cellular TACS1/); and
- STKB-C (NMT2/ - 450).

1/ TACS: Total Access Communication System
2/ NMT : Nordic Mobile Telephone System

a) STKB INTI (Non-Cellular, Large Zone)
Started its service in 1974. There exist 5 base stations under operation over the frequency band of 350 MHz with an ultimate capacity of 2,152 (No. of mobile terminals = 1,824 as of Dec., '88).

b) STKB INTI (Cellular)
Started its service in Jakarta and Pulau Batam over the frequency band of 900 MHz with TACS-modified standards. It is planned that the system is introduced in Medan. Installed/to-be-installed capacities for these areas are as follows:

	Capacity	No. of Mobile Terminals
- Jakarta	1,000	766 (as of May '89)
- Medan	625	n.a.
- Pulau Batam	500	n.a.

c) STKB-C (NMT-450)

Started its service over the frequency band of 450 MHz in 1986. The number of subscribers in Jakarta was 5,557 as of July, 1988 with an ultimate capacity of 10,000 (extendable up to 15,000; No. of mobile terminals = 7,448, as of May '89).

This system had been planned to extend up to Bandung along the highway between Jakarta and Bandung as described already in 1.1.5 (4); Fig. 5.2 shows the schematic system configuration of STKB-C.

d) New Cellular Mobile Telephone System

In addition to STKB-C (450 MHz), the decision to introduce high-capacity cellular mobile telephone (CMT) system over the frequency band of 900 MHz was made by the government taking into account the worldwide trend, system compatibility and future demand growth for mobile telephone services. Given hereunder is a simple comparison between STKB-C and one of the prospective CMTs, NMT-900.

Table 5.1 STKB-C and New CMT 1/

	STKB-C (NMT-450)	New CMT (NMT-900)
Radio Freq. Band	450 MHz	900 MHz
No. of Radio Channels/ Base Station	130 - 220	1,000 - 1,999
No. of Subscribers/ Base Station (Capacity)	2,000 - 15,000	10,000 - 15,000

1/ CMT: Cellular Mobile Telephone

Table 5.2 Present Numbering Plan (as of Aug. '88)

S_1 \ S_2S_3	0 (0123456789)	1 (0123456789)	2 (0123456789)	3 (0123456789)	4 (0123456789)	5 (0123456789)	6 (0123456789)	7 (0123456789)	8 (0123456789)	9 (0123456789)	Remarks
0											STD ISD
1											Special Calls
2											Vacant
3		GB2 C	GB2 A	GB2 B	GB1 A	GB1 B	GB1 C	GB1 D	GB1 E	GB2 D	Gambir Transit Area
4		CPP A	CCP B	TPR B	CIL	KPG	PGG	RMG B	RMG A	TPR A	Cempaka Putih Transit Area
5		SM2 A	SM2 B	PLM C	PLM A, PLM B	JIA	SLP B	SM1 B, SM1 C	SM1 A	SLP A	Slipi Transit Area
6	KT2 E	CKG A	KT2 F, KT2 A	KT2 B	KT2 C	KT2 D	PLT A	KT1 A	ANC	KT1 B	Kota Transit Area
7		KB1 B	KB2 B, JAG	KB2 A	CPA A, CPA B	CPE B	CPE A	KB1A	PSM A, PSM B	KAL A	Kebayoran Transit Area
8	CW	JT2 A	TB A	TB B	PSR, JT2 C	JT2 B, JT1 B	KLD	GAN	JT1 A		Jatinegara Transit Area
9											Access to Suburban

Note: Telephone Directory No.: AB(C)-xxxx

EMD: 6 digits
PRX: 6 digits (less than 10,000 L.U.)
7 digits (more than 10,000 L.U.)

EWSD: 7 digits
NEC-XB: 7 digits

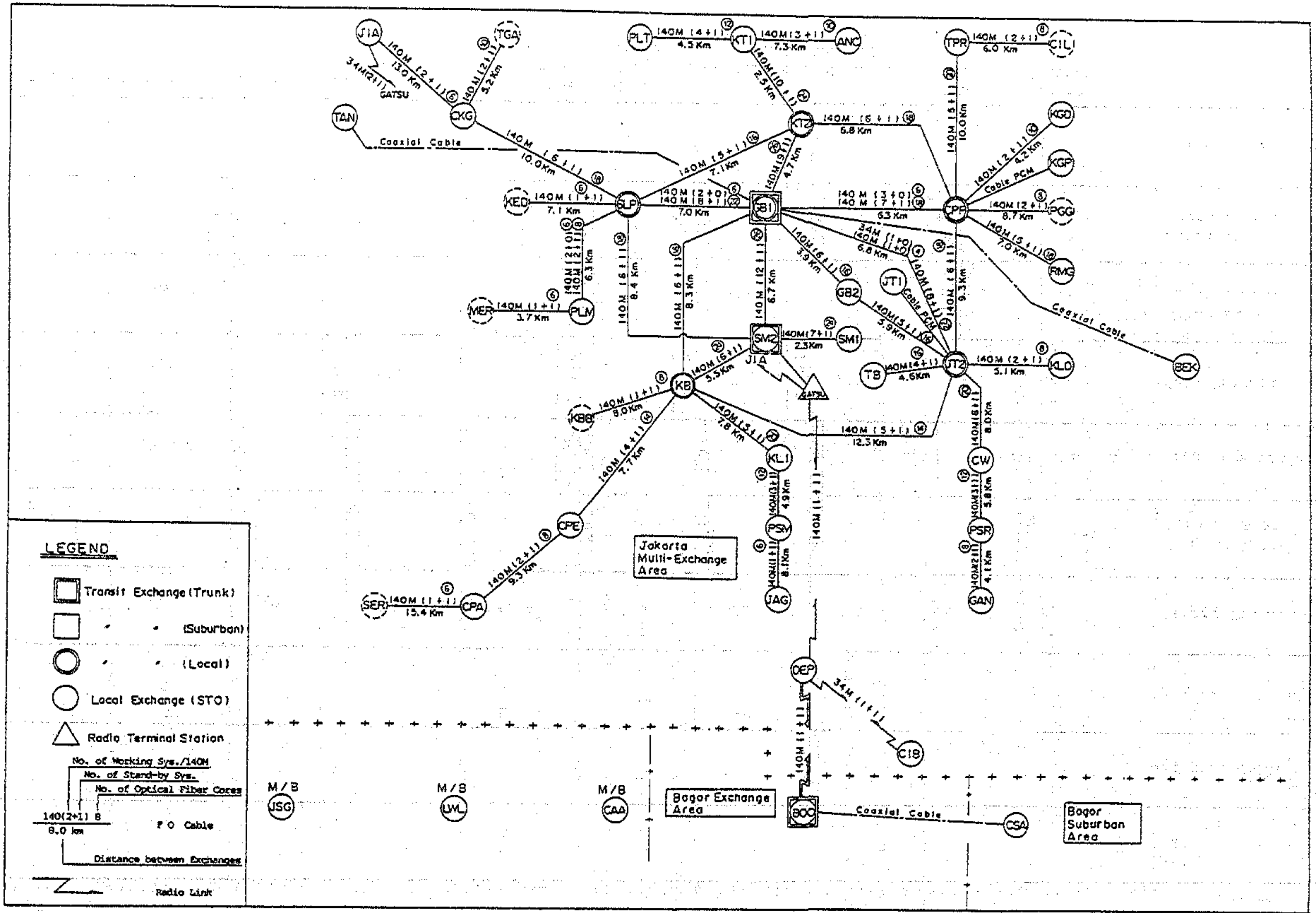


Fig. 5.1 Junction Network in Jabotabek Area (1/2)

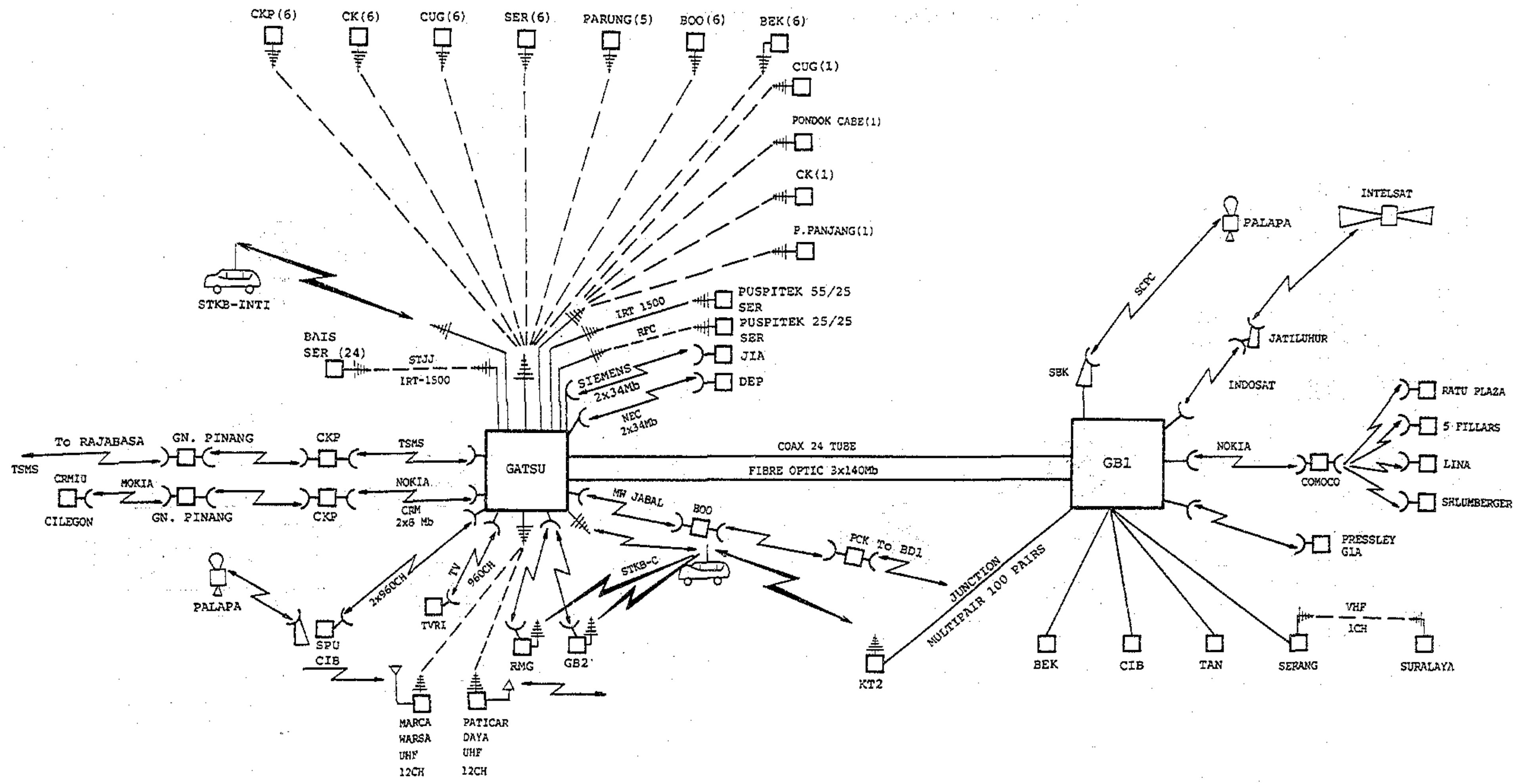
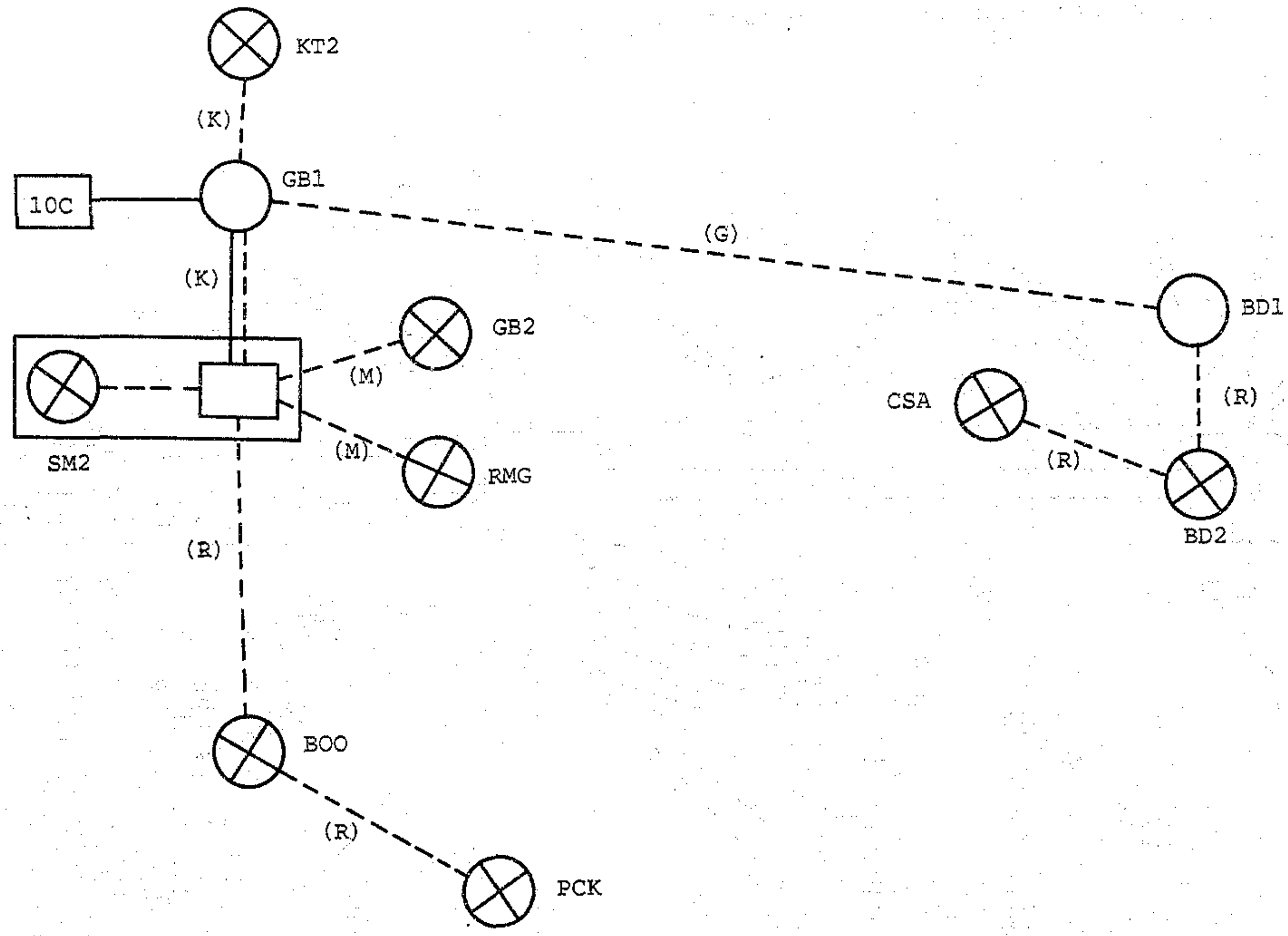


Fig. 5.1 Junction Network in Jabotabek Area (2/2)
(including Surrouding Areas)



Legenda :

Lokasi (alfabetis)

BD1 : Bandung 1
BD2 : Bandung 2
BOO : Bogor
CSA : Cisarua
GB1 : Gambir 1
GB2 : Gambir 2
KT2 : Kota 2
PCK : Puncak
RMG : Rawamangun
SM2 : Semanggi 2

Sistem Transmisi

(F) : Sistem Komunikas Serat Optik
(K) : Kabel Pasang - (Multipair cable)
(M) : Minilink 15
(R) : Radiolink 2 GHZ
(G) : Sistem Gelomban Jawa-Bali

- - - - Saluran Transmis
——— Saluran penghubu MTX - Sentral 10

Fig. 5.2 System Configuration of STKB-C (phase I)

5.2.2 Telex and Data Communications Network

The number of existing telex subscribers in Jabotabek area is about 7,000 and the total switching capacity is about 8,300 l.u. (6,000 for GB1 and 2,300 for GB2), referring to Fig. 5.3.

The replacement/expansion plan of telex switching system is planned as shown in Fig. 5.4 (1/2).

The telex switch to be newly introduced has the capability to handle data communications up to the bit rate of 9,600 bps, as well as teletex communications.

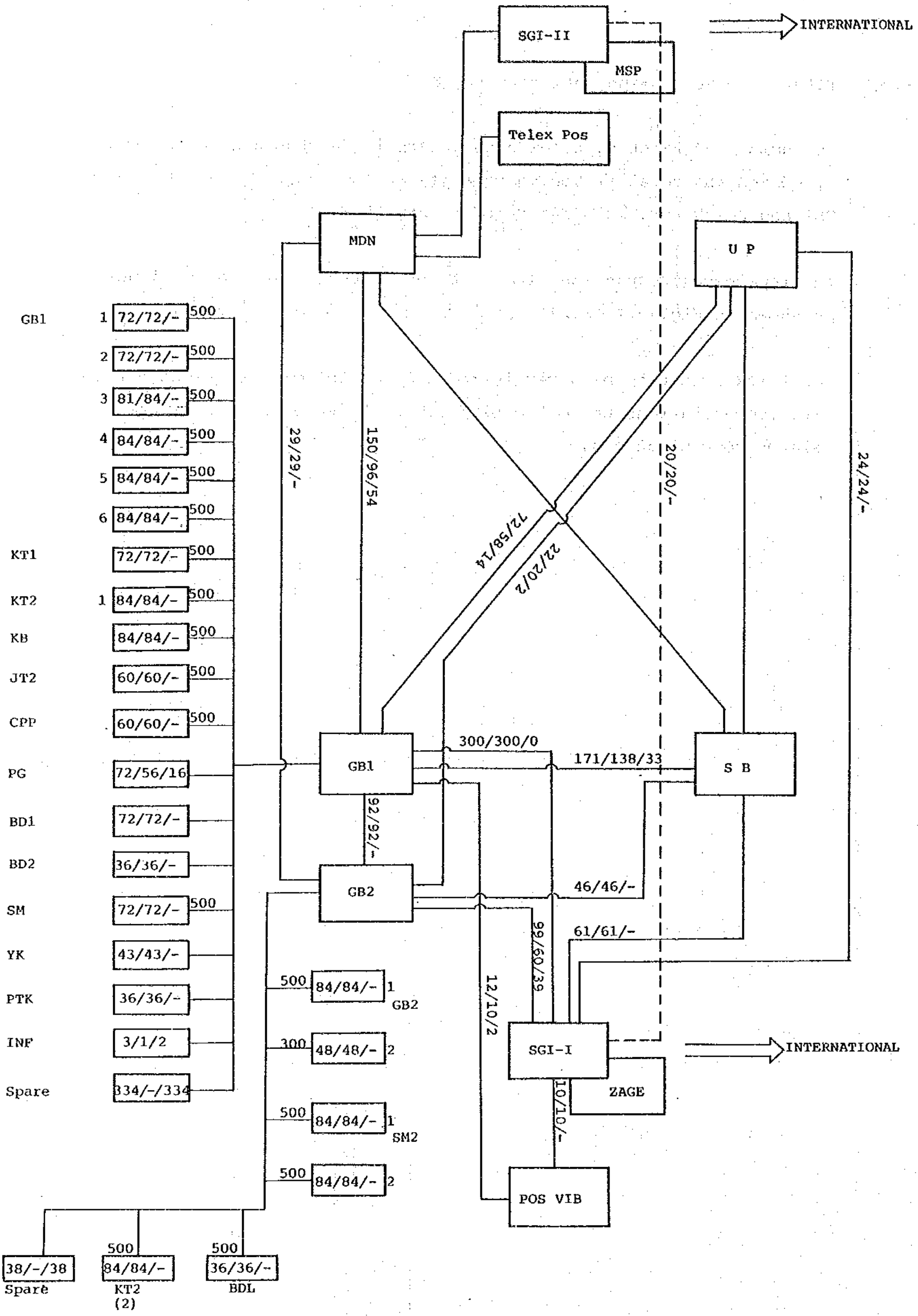


Fig. 5.3 Network Configuration of Telex Network (as of Aug. '88)

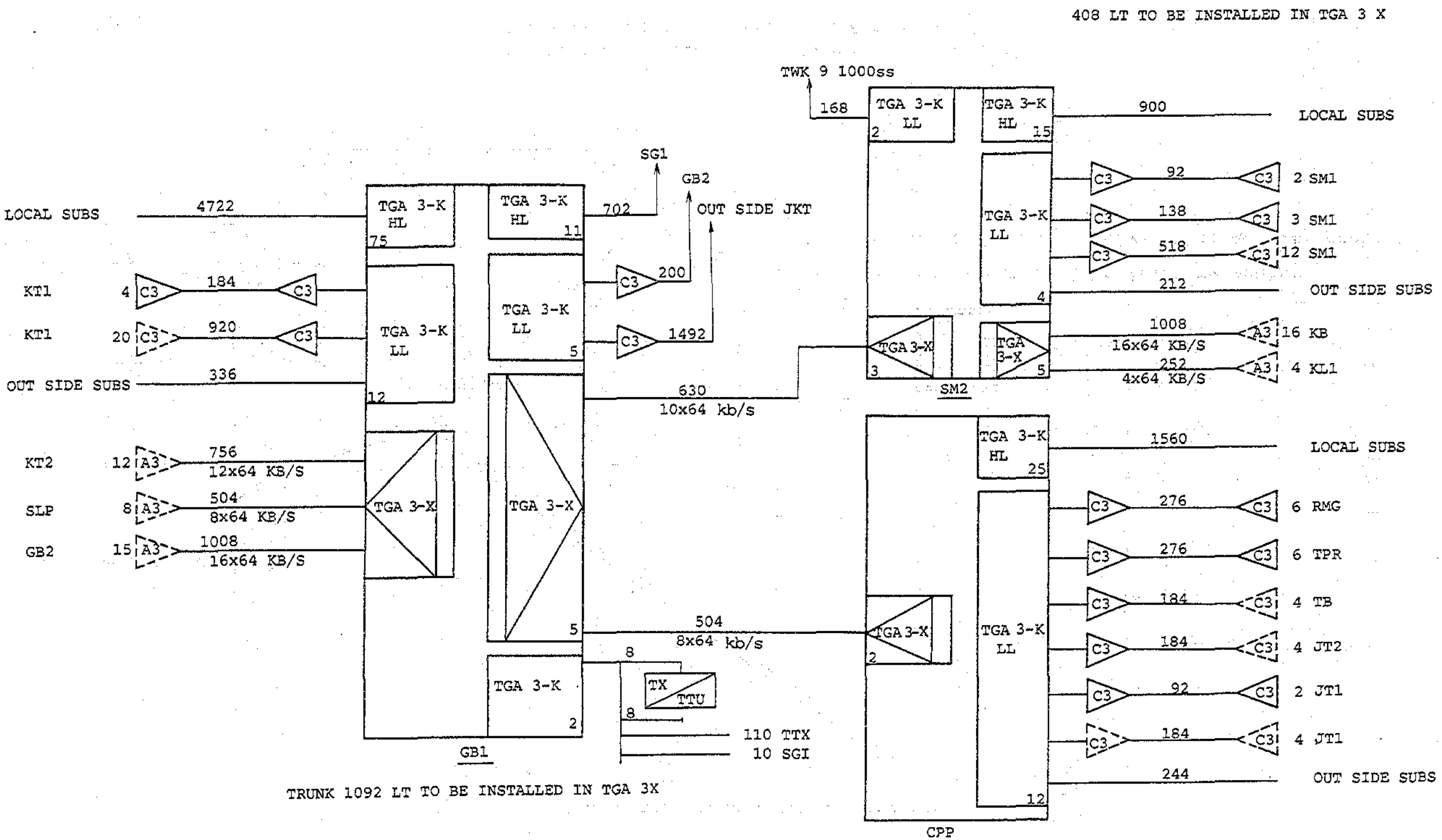


Fig. 5.4 Non-Voice Communications Network Planning (1/2)
(Telex EDX-C 14550 SS and Telex Package)

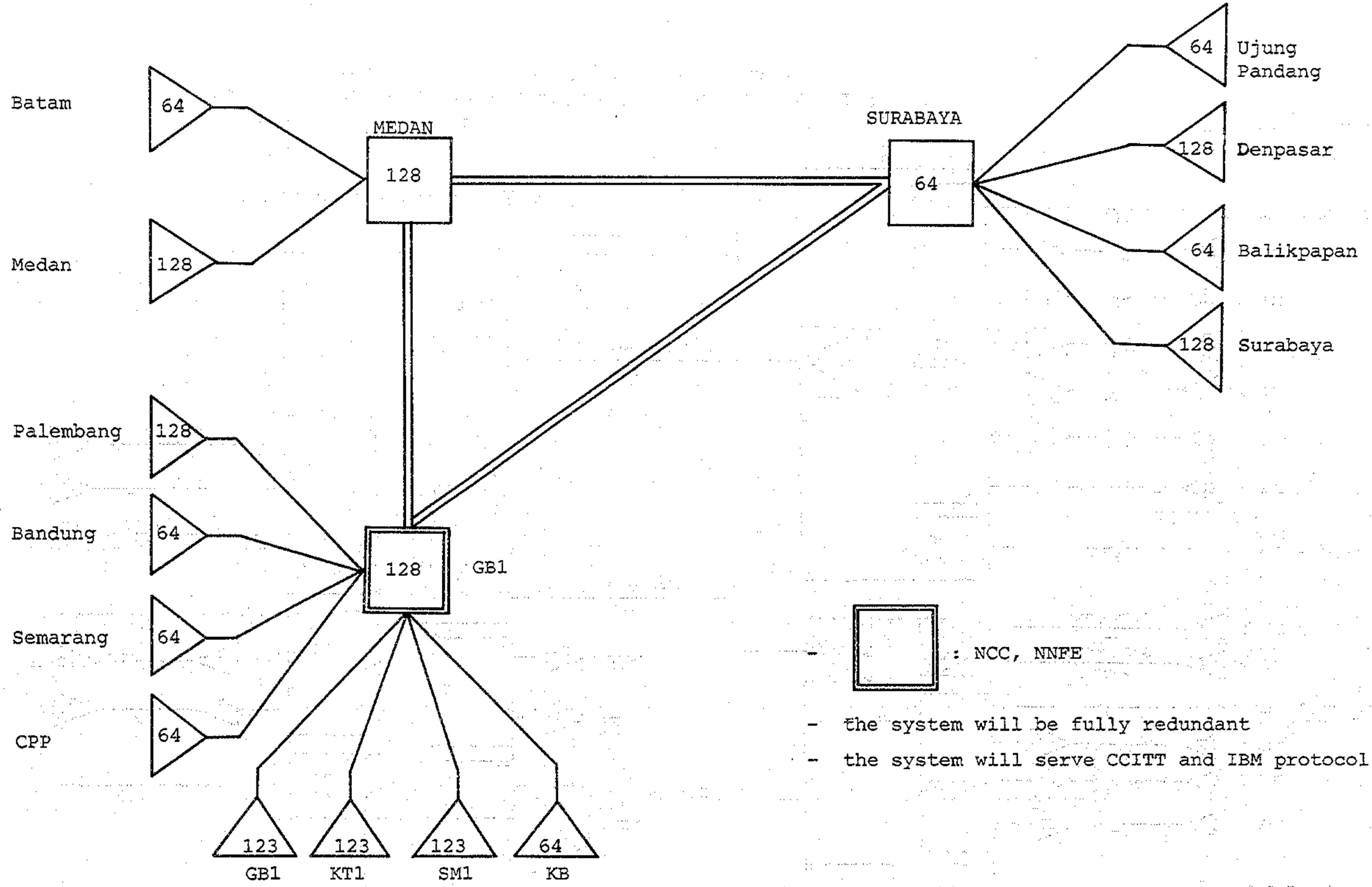


**Fig. 5.4 Non-Voice Communications Network Planning (2/2)
(Data Communication - Proposed Project)**

5.3 Development Planning for Telecommunications Network

5.3.1 Optimum Exchange Size

Optimum exchange size shall be dimensioned in due consideration of required all costs for connecting subscribers to switching facilities, e.g., switch, transmission system, power supply, supporting facilities, subscriber concentration cost. In dimensioning optimum exchange size, the following factors are taken into consideration:

- per-line switching cost;
- subscriber concentration cost; and
- subscriber density in an exchange area.

(1) Switching Cost

Recent technological development proves that the capacity in number of l.u. is no more dominant limiting factor to the cost of switching equipment itself, even though the more switching capacity, the less per-line switching cost. As shown in Fig. 5.5, per-line switching cost is different only by slight percent when switching capacity exceeds 10,000 l.u.

(2) Subscriber Concentration Cost and Subscriber Density

Per-line concentration cost (subscriber concentration cost) in one exchange area varies depending on both the size of exchange area and subscriber density in that area.

Average distance between exchange and subscribers decreases as the subscriber density increases as shown in Fig. 5.6. Fig. 5.7 shows the relationship between the subscriber density and the total cable length.

The average concentration cost per subscriber (per-line concentration cost) is shown for respective switching capacities in Fig. 5.8. The estimate of average cable length extendable from exchange is carried out assuming:

- uni-gauge system is employed for cable application.
- the figures set forth in "Fundamental Technical Plan/FTP '85" are adopted for the maximum cable length:

Maximum Cable Length

Diameter Conductor	Maximum Cable Length With PBX	Maximum Cable Length Without PBX
0.4 mm	2.7 km	3.0 km
0.6 mm	5.2 km	5.7 km
0.8 mm	7.6 km	8.4 km

(FTP '85)

- subscribers are distributed within a circle (service area) centering an exchange and the size of service area varies depending upon subscriber density.

It is clear from these figures that the concentration cost (subscriber cable cost together with the cost required for concentrating subscribers) increases as the switching capacity rises and that the average extendable cable length from exchange decreases in accordance with the increase of subscriber density.

On the other hand, the average distance between exchange and subscribers will vary depending on the distribution patterns of subscribers.

In the Study, the distribution pattern of subscribers is assumed to take uniform distribution model though there appear three more models in ANNEX 5-2. They are:

- uniform distribution model;
- exponential distribution model;

- exponential distribution model;
- semi-exponential distribution model; and
- unbalanced exponential distribution model.

ANNEX 5-2 presents general relationship between subscriber cable length and subscriber distribution pattern.

(3) Optimization of Exchange Size

To dimension the optimum size of exchange, two major cost items for initial investment cost are considered, i.e., switching cost and subscriber cable cost excluding the costs required for land procurement, supporting facilities, etc.

Per-line switching cost decreases and per-line concentration cost increases as the size of exchange becomes large depending on the subscriber density as shown in Fig. 5.9.

Based on the above assumptions, it is concluded as follows:

Subscriber Density vs. Optimum Exchange Size

Subscriber Density ($/km^2$)		Optimum Exchange Size	
up to	1,000	Approx.	20,000 l.u.
up to	5,000	Approx.	50,000 l.u.
more than	5,000	Approx.	70,000 l.u.

The optimum exchange size becomes large as the subscriber density increases as indicated by an arrow in Fig. 5.9. The arrow moves from the upper-left toward lower-right of the figure as the subscriber density increases.

(4) Optimum Exchange Size in Jakarta

Present demand density of the existing exchange areas in Jakarta multi-exchange area and estimated demand density in the year 2004 are shown in Fig. 5.10 and Fig. 5.11 respectively. For reference, ANNEX 5-3 gives detailed information concerning estimated demand density by each exchange at the end of each Repelita.

The typical characteristics of demand density in DKI Jakarta is summarized as follow:

a) Present condition

- highest	GB1	about 5,300/km^2
- lowest	GAN	about 5/km^2
- average		about 740/km^2

b) Future condition (2004)

- highest	SM2	about 12,000/km^2
- lowest	TGA	about 300/km^2
- average		about 2,600/km^2

The optimum exchange size in DKI Jakarta at the end of Repelita VII are assumed to be as follows:

- outskirts of DKI Jakarta	about 30,000
- periphery of DKI Jakarta	about 50,000
- center of DKI Jakarta	about 70,000

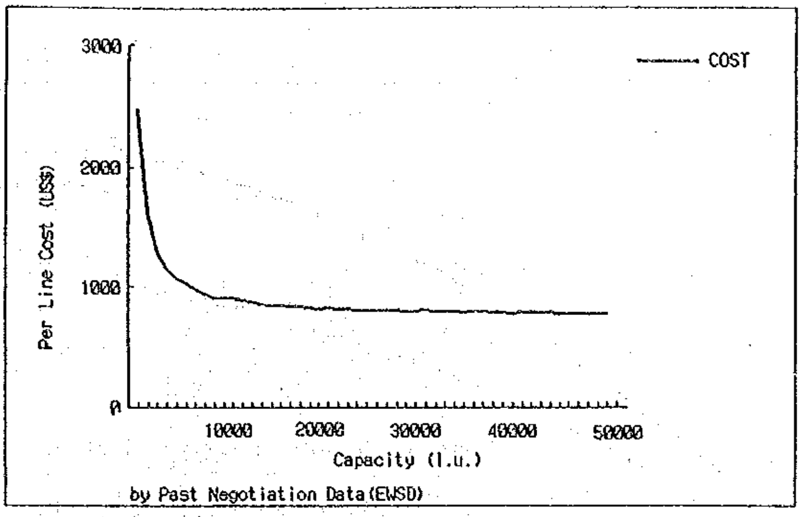


Fig. 5.5 Cost Estimation (STO)

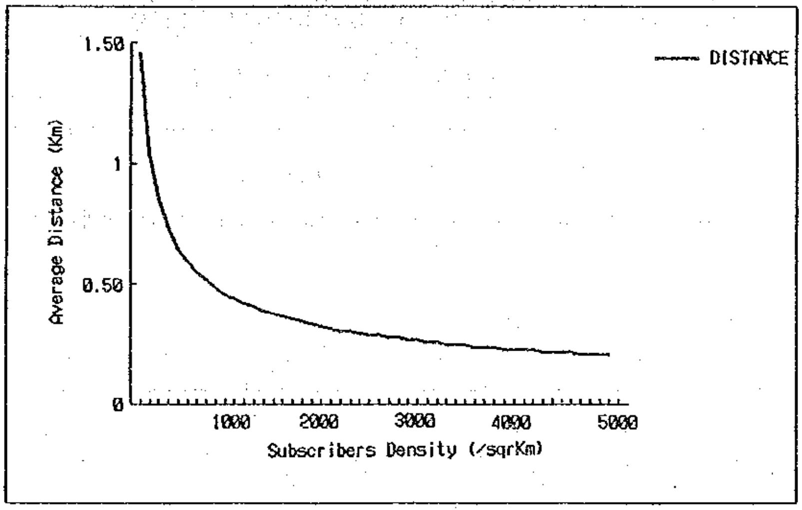


Fig. 5.6 Average Distance between Exchange and Subscriber

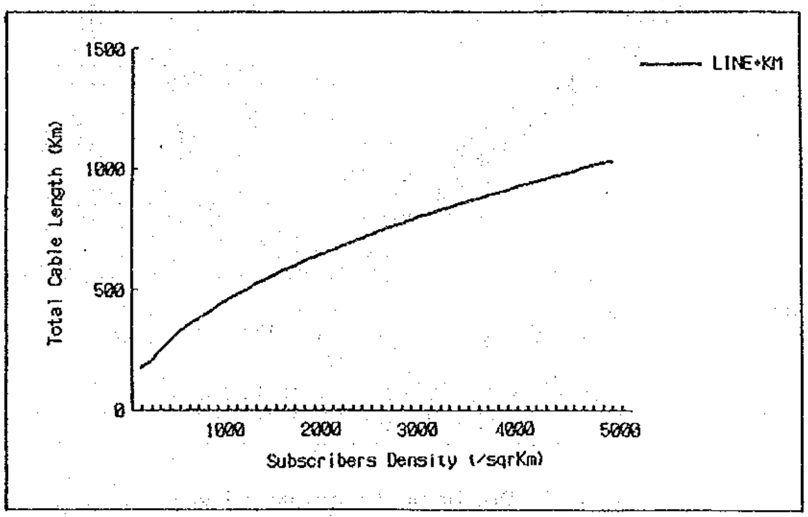


Fig. 5.7 Total Subscriber Cable Length

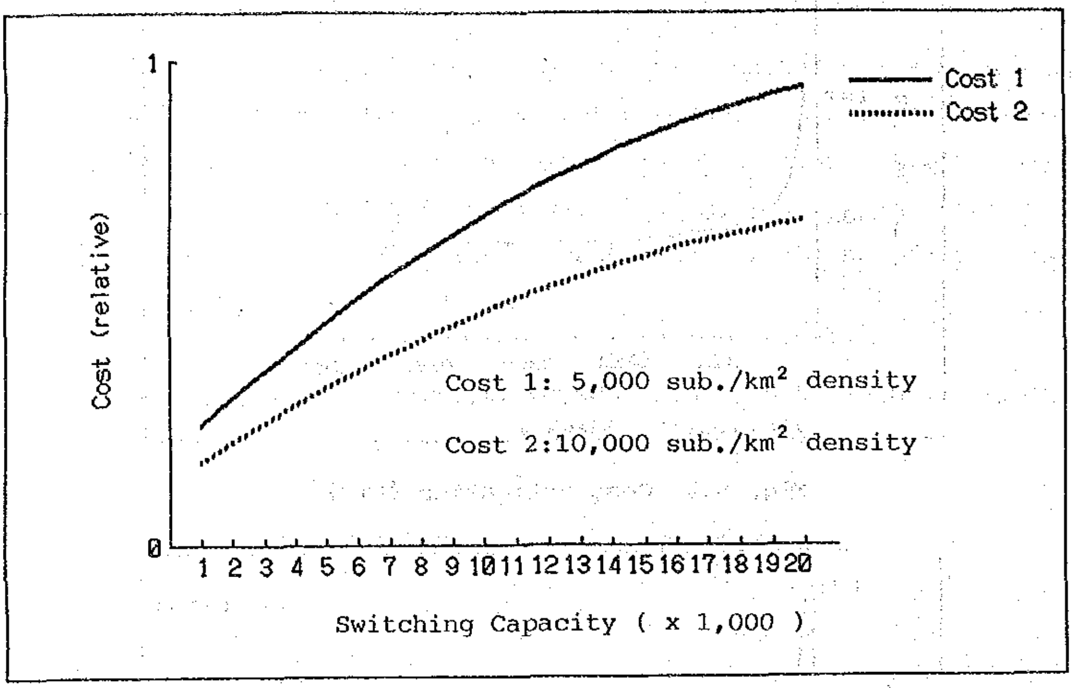


Fig. 5.8 Average Concentration Cost per Subscriber

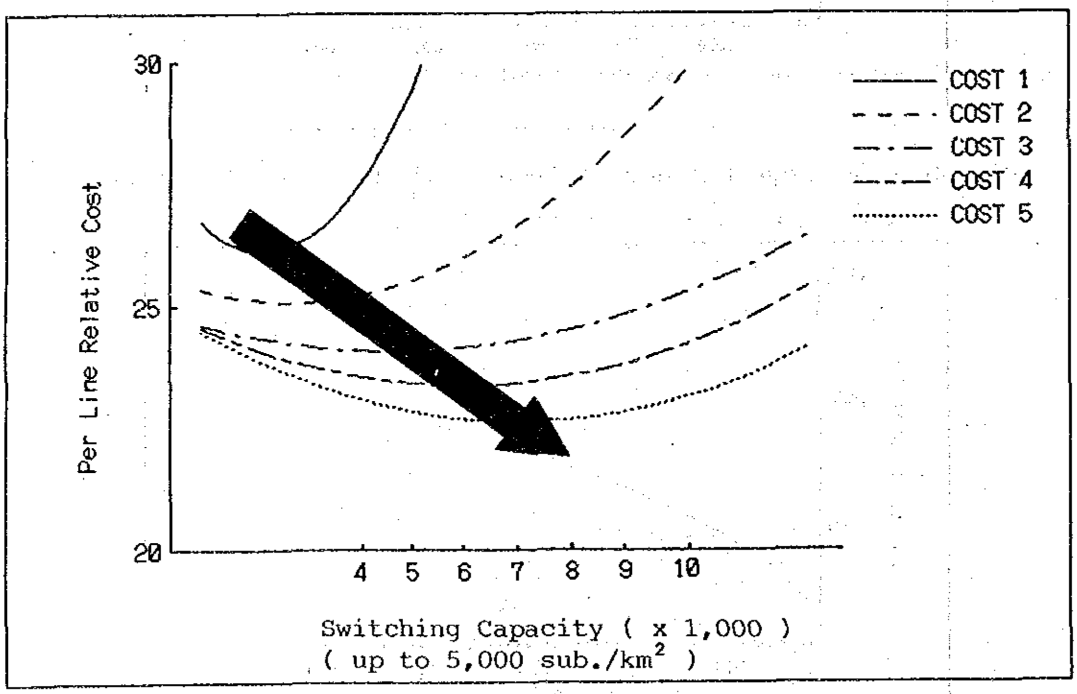


Fig. 5.9 Optimum Exchange Size

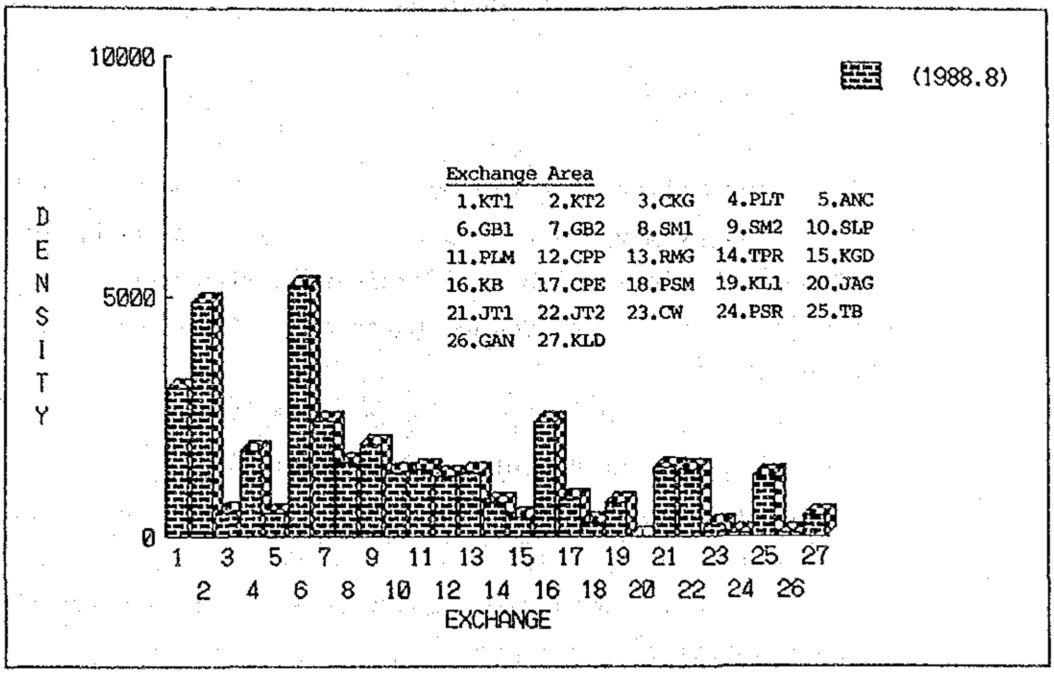


Fig. 5.10 Present Demand Density (/km^2)

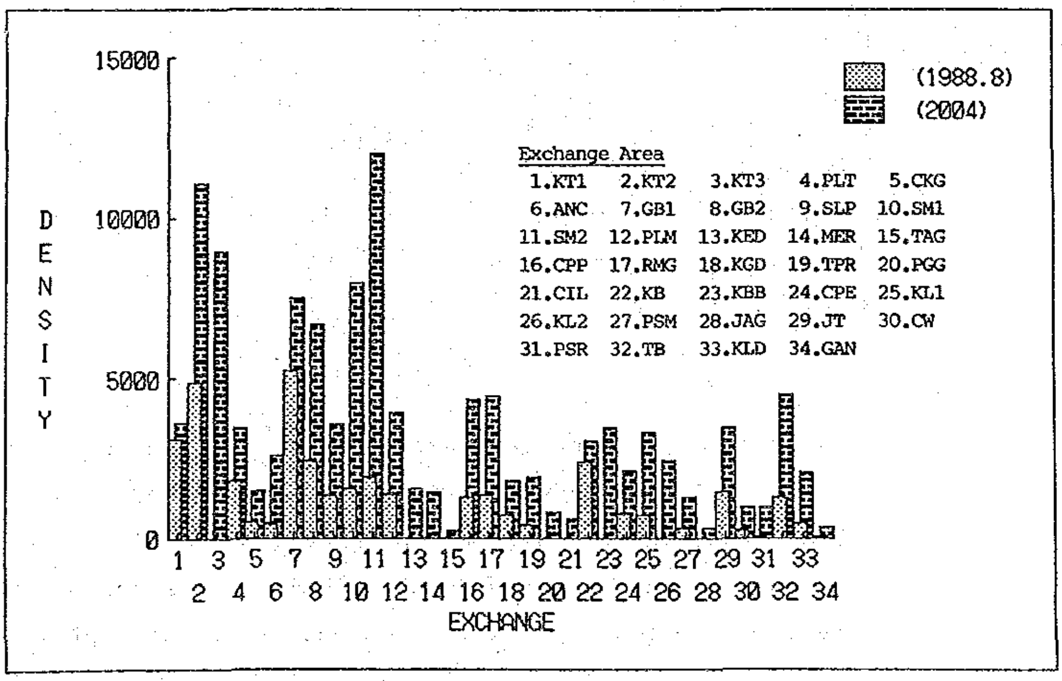


Fig. 5.11 Estimated Demand Density (/km^2)

5.3.2 Expansion of Jakarta Multi-Exchange Area

(1) Exchange Boundaries

Jabotabek area will preferably be divided into seventy two (72) exchange areas by the end of Repelita VII (year 2004) based on the following basic studies in coordination with the regional development framework and demand forecast in Chapters 3 and 4 respectively:

- to select the area center of each kecamatan;
- to study the telephone demand in 7-km radius zone from the center;
- to study the geographical conditions and transportability in respective areas; and
- to study the socio-economic surroundings around the area center.

The exchange area boundaries in Jabotabek area at the end of Repelita VII are depicted in Fig. 5.12 and the exchange areas are categorized as follows:

	No. of Exchange Areas	No. of Exchanges
Jakarta multi-exchange area	55	55
Jakarta suburban area	10	10
Bogor multi-exchange area	5	5
Bogor suburban area	2	2
(Total)	72	72

The forecasted demand for each exchange area in the outskirts of DKI Jakarta including Kabupaten Bogor and at the ends of Repelitas V through VII is shown in Table 5.3. Table 5.3 also includes exchange areas which exist in DKI Jakarta and are to be slightly expanded toward adjacent Botabek area, i.e., JAG, GAN and KLD/PDK exchange areas.

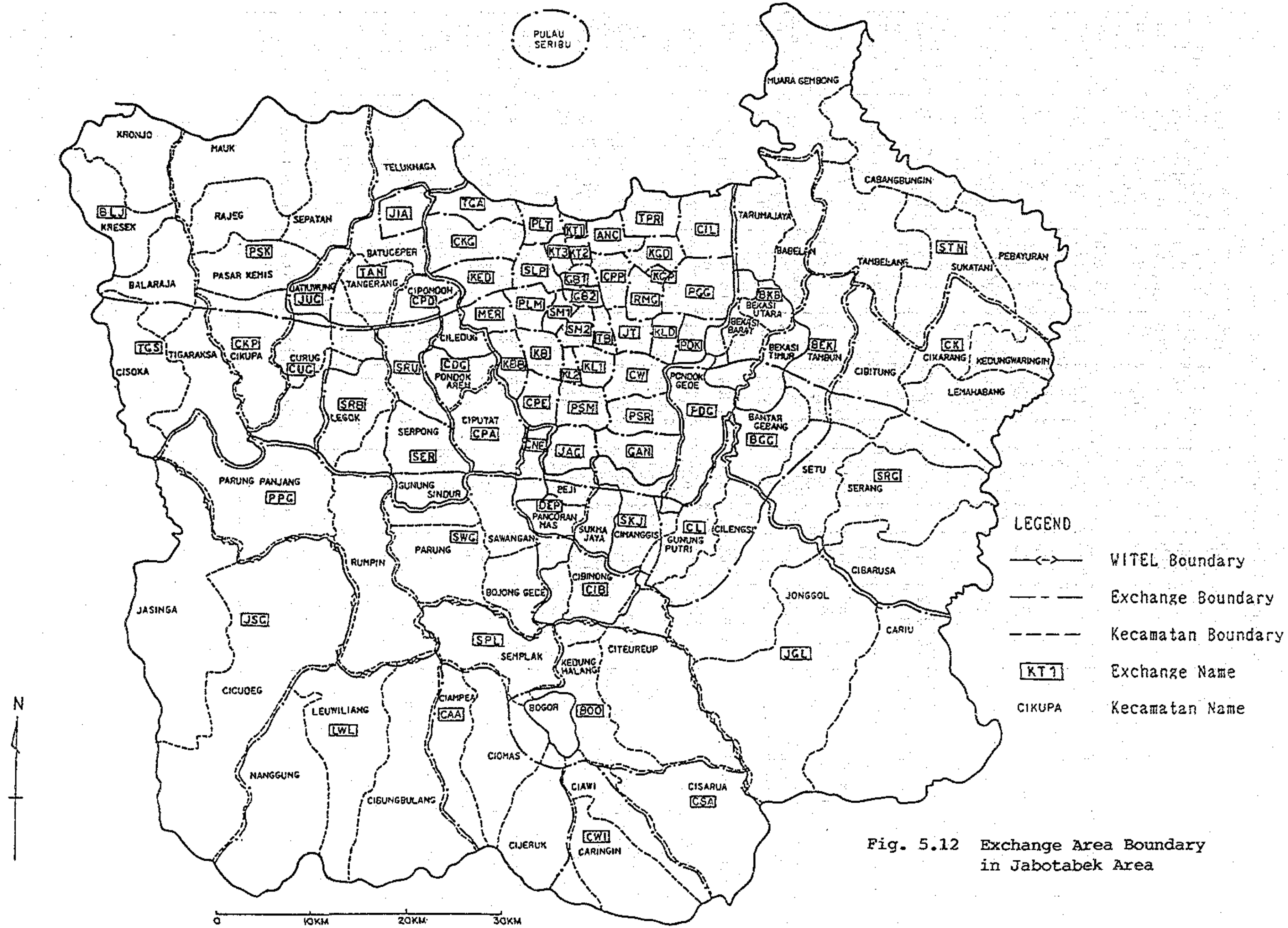


Fig. 5.12 Exchange Area Boundary
in Jabotabek Area

Table 5.3 Telephone Demand by Exchange in Botabek Area (1/5)

Ex. Area	Kecamatan Name	1994 Demand 1	1994 %	1994 Total	1999 Demand 2	1999 %	1999 Total	2004 Demand 3	2004 %	2004 Total
TAN	Teluknaga	494	100	494	924	100	924	1,485	100	1,485
	Tangerang	15,098	100	15,098	26,321	100	26,321	40,440	100	40,440
	Batu Ceper	4,549	100	4,549	7,836	100	7,836	11,940	100	11,940
	Jati Uwung	1,926	10	193	4,193	10	419	7,320	10	732
				(20,334)			(35,500)			(54,597)
JUG	Jati Uwung	1,926	90	1,733	4,193	90	3,774	7,320	90	6,588
				(1,733)			(3,774)			(6,588)
CPD	Cipondoh	2,918	75	2,189	5,084	75	3,813	7,810	75	5,858
	Ciledug	904	20	181	1,606	20	321	2,500	20	500
				(2,370)			(4,134)			(6,358)
SER	Serpong	10,352	50	5,176	22,400	50	11,200	39,000	50	19,500
	Gunung Sindur	431	50	216	885	50	443	1,500	50	750
				(5,392)			(11,643)			(20,250)
SRU	Serpong	10,352	33	3,451	22,400	33	7,467	39,000	33	13,000
	Cipondoh	2,918	25	730	5,084	25	1,271	7,810	25	1,953
				(4,181)			(8,738)			(14,953)
SRB	Serpong	10,352	17	1,725	22,400	17	3,733	39,000	17	6,500
	Legok	1,766	67	1,177	3,843	67	2,562	6,710	67	4,473
	Curug	1,437	30	431	3,143	30	943	5,500	30	1,650
				(3,333)			(7,238)			(12,623)
CDG	Ciledug	904	80	723	1,606	80	1,285	2,500	80	2,000
	Pondok Aren	2,096	100	2,096	4,382	100	4,382	7,500	100	7,500
				(2,819)			(5,667)			(9,500)
CPA	Ciputat	8,956	100	8,956	16,004	100	16,004	25,000	100	25,000
				(8,956)			(16,004)			(25,000)
CUG	Curug	1,437	70	1,006	3,143	70	2,200	5,500	70	3,850
	Legok	1,766	33	589	3,843	33	1,281	6,710	33	2,237
				(1,595)			(3,481)			(6,087)
CKP	Cikupa	1,585	90	1,427	3,440	90	3,096	6,000	90	5,400
				(1,427)			(3,096)			(5,400)
TGS	Tigaraksa	2,245	100	2,245	4,948	100	4,948	8,690	100	8,690
	Cisoka	207	100	207	456	100	456	800	100	800
	Balaraja	1,421	20	284	3,132	20	626	5,500	20	1,100
				(2,736)			(6,030)			(10,590)
BLJ	Balaraja	1,421	80	1,137	3,132	80	2,506	5,500	80	4,400
	Kresek	264	100	264	496	100	496	800	100	800
	Kronjo	264	100	264	496	100	496	800	100	800
				(1,665)			(3,498)			(6,000)
PSK	Cikupa	1,585	10	159	3,440	10	344	6,000	10	600
	Pasar Kemis	965	100	965	2,074	100	2,074	3,600	100	3,600
	Rajeg	264	100	264	496	100	496	800	100	800
	Mauk	449	100	449	840	100	840	1,350	100	1,350
	Sepatan	581	100	581	1,088	100	1,088	1,750	100	1,750
				(2,418)			(4,842)			(8,100)
Kabupaten Tangerang		Repelita V Total		58,959	Repelita VI Total		113,645	Repelita VII Total		186,046

Table 5.3 Telephone Demand by Exchange in Botabek Area (2/5)

Ex. Area	Kecamatan Name	1994 Demand 1	1994 %	1994 Total	1999 Demand 2	1999 %	1999 Total	2004 Demand 3	2004 %	2004 Total
STN	Sukatani	336	100	336	740	100	740	1,300	100	1,300
	Muara Gembong	78	100	78	171	100	171	300	100	300
	Cabang Bungin	168	100	168	370	100	370	650	100	650
	Pebayuran	271	100	271	598	100	598	1,050	100	1,050
	Tambelang	245	100	245	541	100	541	950	100	950
				(1,098)			(2,420)			(4,250)
BEK	Bekasi Timur	6,063	50	3,032	10,245	50	5,123	15,400	50	7,700
	Tambun	2,021	70	1,415	3,556	70	2,489	5,500	70	3,850
				(4,447)			(7,612)			(11,550)
BKB	Bekasi Barat	6,036	80	4,829	10,210	80	8,168	15,360	80	12,288
	Bekasi Utara	2,473	100	2,473	4,173	100	4,173	6,270	100	6,270
	Bekasi Selatan	8,220	60	4,932	13,889	60	8,333	20,880	60	12,528
	Tarumajaya	142	100	142	313	100	313	550	100	550
	Babelan	270	100	270	595	100	595	1,045	100	1,045
				(12,646)			(21,582)			(32,681)
BGG	Bekasi Timur	6,063	50	3,032	10,245	50	5,123	15,400	50	7,700
	Tambun	2,021	30	606	3,556	30	1,067	5,500	30	1,650
	Bantar Gebang	1,421	100	1,421	3,132	100	3,132	5,500	100	5,500
	Setu	116	20	23	256	20	51	450	20	90
				(5,082)			(9,373)			(14,940)
PDG	Pondok Gede	4,863	90	4,377	9,820	90	8,838	16,500	90	14,850
	Bekasi Selatan	8,220	30	2,466	13,889	30	4,167	20,880	30	6,264
	Jati Asih									
				(6,843)			(13,005)			(21,114)
CK	Cikarang	7,373	100	7,373	15,848	100	15,848	27,500	100	27,500
	Cibitung	889	80	711	1,628	80	1,302	2,585	80	2,068
	Lemah Abang	947	80	758	1,734	80	1,387	2,750	80	2,200
				(8,842)			(18,537)			(31,768)
SRG	Cibitung	889	20	178	1,628	20	326	2,585	20	517
	Lemah Abang	947	20	189	1,734	20	347	2,750	20	550
	Setu	116	80	93	256	80	205	450	80	360
	Serang	129	100	129	285	100	285	500	100	500
	Cibarusa	116	100	116	256	100	256	450	100	450
				(705)			(1,419)			(2,377)
Kabupaten Bekasi		Repelita V Total		39,663	Repelita VI Total		73,948	Repelita VII Total		118,680

Table 5.3 Telephone Demand by Exchange in Botabek Area (3/5)

Ex. Area	Kecamatan Name	1994 Demand 1	%	Total	1999 Demand 2	%	Total	2004 Demand 3	%	Total
PPG	Parung Panjang	1,113	100	1,113	2,383	100	2,383	4,125	100	4,125
	Rumpin	345	100	345	691	100	691	1,155	100	1,155
				(1,458)			(3,074)			(5,280)
SWG	Gunung Sindur	431	50	216	885	50	443	1,500	50	750
	Parung	1,548	100	1,548	3,221	100	3,221	5,500	100	5,500
	Sawangan	1,148	90	1,033	2,359	90	2,123	4,000	90	3,600
	Bojong Gede	1,405	60	843	2,174	60	1,304	3,050	60	1,830
				(3,640)			(7,091)			(11,680)
CNE	Cinere (Sawangan)	11,400	100	11,400	17,000	100	17,000	18,300	100	18,300
				(11,400)			(17,000)			(18,300)
DEP	Pancoran Mas	5,302	100	5,302	8,894	100	8,894	13,300	100	13,300
	Beji	2,946	90	2,651	4,935	90	4,442	7,370	90	6,633
	Sawangan	1,148	10	115	2,359	10	236	4,000	10	400
				(8,068)			(13,572)			(20,333)
SKJ	Sukma Jaya	8,778	100	8,778	14,718	100	14,718	22,000	100	22,000
	Cimanggis	2,108	80	1,686	3,299	80	2,639	4,675	80	3,740
				(10,464)			(17,357)			(25,740)
CIB	Cibinong	2,497	80	1,998	3,856	80	3,085	5,400	80	4,320
	Bojong Gede	1,405	40	562	2,174	40	870	3,050	40	1,220
	Citeureup	1,249	60	749	1,926	60	1,156	2,695	60	1,617
				(3,309)			(5,111)			(7,157)
CL	Cileungsi	3,332	90	2,999	6,610	90	5,949	11,000	90	9,900
	Gunung Putri	1,100	100	1,100	1,962	100	1,962	3,060	100	3,060
	Cimanggis	2,108	10	211	3,299	10	330	4,675	10	468
				(4,310)			(8,241)			(13,428)
JGL	Jonggol	1,127	100	1,127	2,247	100	2,247	3,750	100	3,750
	Cariu	538	100	538	1,057	100	1,057	1,750	100	1,750
	Cileungsi	3,332	10	333	6,610	10	661	11,000	10	1,100
				(1,998)			(3,965)			(6,600)
Kabupaten Bogor (Witel IV)		Repelita V Total		44,647	Repelita VI Total		75,411	Repelita VII Total		108,518
Total Witel IV		Repelita V Total		143,269	Repelita VI Total		263,004	Repelita VII Total		413,244

Table 5.3 Telephone Demand by Exchange in Botabek Area (4/5)

Ex. Area	Kecamatan Name	1994 Demand 1	1994 %	1994 Total	1999 Demand 2	1999 %	1999 Total	2004 Demand 3	2004 %	2004 Total
SPL	Semplak	3,531	70	2,472	5,592	70	3,914	8,000	70	5,600
				(2,472)			(3,914)			(5,600)
CSA	Cisarua	2,419	100	2,419	3,742	100	3,742	5,250	100	5,250
				(2,419)			(3,742)			(5,250)
CWI	Caringin	1,378	100	1,378	2,135	100	2,135	3,000	100	3,000
	Ciawi	2,094	50	1,047	3,241	50	1,621	4,550	50	2,275
	Cijeruk	2,542	30	763	3,926	30	1,178	5,500	30	1,650
				(3,188)			(4,934)			(6,925)
JSG	Jasinga	1,012	100	1,012	2,166	100	2,166	3,750	100	3,750
	Cigudeg	475	100	475	953	100	953	1,595	100	1,595
				(1,487)			(3,119)			(5,345)
LWL	Nanggung	456	100	456	748	100	748	1,100	100	1,100
	Leuwiliang	1,247	100	1,247	2,158	100	2,158	3,300	100	3,300
	Cibung Bulang	1,694	100	1,694	2,938	100	2,938	4,500	100	4,500
				(3,397)			(5,844)			(8,900)
CAA	Ciampea	993	100	993	1,631	100	1,631	2,400	100	2,400
	Ciomas	6,240	20	1,248	9,887	20	1,977	14,150	20	2,830
	Cijeruk	2,542	30	763	3,926	30	1,178	5,500	30	1,650
				(3,004)			(4,786)			(6,880)
BOO	Kodya Bogor	18,678	100	18,678	29,594	100	29,594	42,350	100	42,350
	Cibinong	2,497	20	499	3,856	20	771	5,400	20	1,080
	Semplak	3,531	30	1,059	5,592	30	1,678	8,000	30	2,400
	Ciomas	6,240	80	4,992	9,887	80	7,910	14,150	80	11,320
	Cijeruk	2,542	40	1,017	3,926	40	1,570	5,500	40	2,200
	Ciawi	2,094	50	1,047	3,241	50	1,621	4,550	50	2,275
	Kedung Halang	4,151	100	4,151	6,574	100	6,574	9,405	100	9,405
	Citeureup	1,249	40	500	1,926	40	770	2,695	40	1,078
				(31,943)			(50,488)			(72,108)
Kotamadya Bogor and Kabupaten Bogor (Witel V)		Repelita V Total 47,910			Repelita VI Total 76,827			Repelita VII Total 111,008		

Table 5.3 Telephone Demand by Exchange in Botabek Area (5/5)

Ex. Area	Area Name	1994			1999			2004		
		Demand 1	%	Total	Demand 2	%	Total	Demand 3	%	Total
JAG	(DKI Jakarta)	2,400	100	2,400	5,100	100	5,100	9,300	100	9,300
	Beji	2,946	10	295	4,935	10	494	7,370	10	737
				(2,695)			(5,594)			(10,037)
GAN	(DKI Jakarta)	6,000	100	6,000	11,200	100	11,200	18,400	100	18,400
	Cimanggis	2,108	10	211	3,299	10	330	4,675	10	468
				(6,211)			(11,530)			(18,868)
KLD	(DKI Jakarta)	16,000	70	11,200	32,000	70	22,400	52,200	70	36,540
	Pondok Gede	4,863	5	243	9,820	5	491	16,500	5	825
				(11,443)			(22,891)			(37,365)
PDK	(DKI Jakarta)	16,000	30	4,800	32,000	30	9,600	52,200	30	15,660
	Pondok Gede	4,863	5	243	9,820	5	491	16,500	5	825
	Bekasi Selatan	8,220	10	822	13,889	10	1,389	20,880	10	2,088
	Bekasi Barat	6,036	20	1,207	10,210	20	2,042	15,360	20	3,072
				(7,072)			(13,522)			(21,645)

(2) Expansion of Jakarta Multi-Exchange Area

Jakarta multi-exchange area comprises two distinct administrative areas, DKI Jakarta and its outskirts, i.e., Ciputat, Bekasi, Tangerang, Depok and Cibinong; Cibinong has the maximum crow-flight distance of over 30 km from the center of DKI Jakarta.

The areas surrounding DKI Jakarta within 1 - 2 hours mileage seem to have the closely correlated as in DKI Jakarta.

Currently available data show that 70 - 80% of incoming/outgoing telephone traffic of the outskirts of DKI Jakarta originates/terminates in DKI Jakarta; hence strong connection traffic-wise.

Shown in Fig. 1.3 through 1.5 are the expansion plans for the respective Repelitas, i.e., Repelita V, VI and VII up to 2004, prepared taking into account all the inputs above.

The following figures show the physical dimensions of "to-be-expanded" Jakarta multi-exchange area network.

a) Size of Jakarta Multi-Exchange Area

End of Pelita IV	Approx. 862 km^2
End of Repelita V	Approx. 1,535 km^2
End of Repelita VI	Approx. 2,025 km^2
End of Repelita VII	Approx. 2,025 km^2

b) No. of Exchanges in Jakarta Multi-Exchange Area

End of Pelita IV	DKI Jakarta	28
	Out of DKI Jakarta	6
	Total	34

End of Repelita V	DKI Jakarta	36
	Out of DKI Jakarta	14
	Total	50
End of Repelita VI	DKI Jakarta	36
	Out of DKI Jakarta	18
	Total	54
End of Repelita VII	DKI Jakarta	37
	Out of DKI Jakarta	18
	Total	55

5.3.3 Network Planning

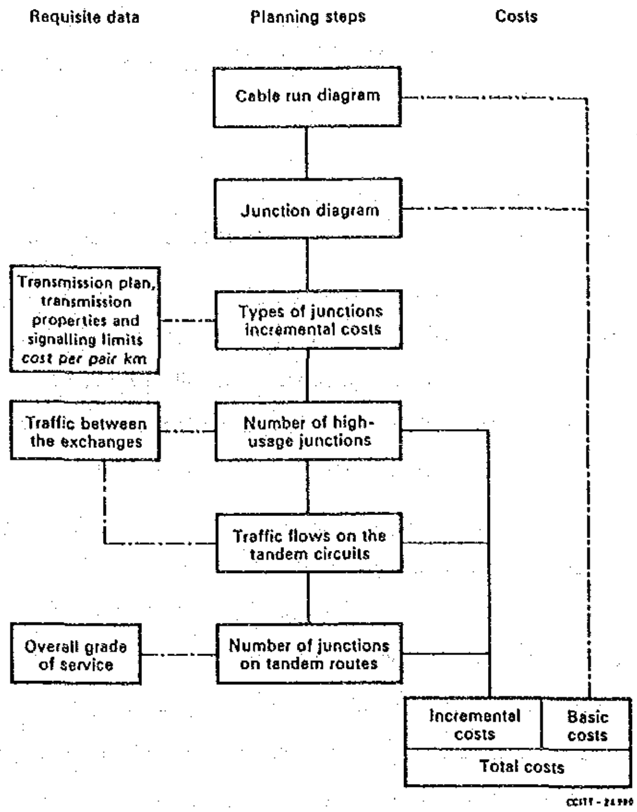
The telecommunications network in Jabotabek area shall be optimized in terms of the network in Jakarta multi-exchange area and the remaining networks to cover the areas other than Jakarta multi-exchange area taking into account its economy, security, flexibility and operation and maintenance.

(1) Junction Network in Multi-Exchange Area

For the purpose of network optimization, the Study takes in principle the same procedure as employed in CCITT Handbook "Local Network Planning"; FTP '85 ("Fundamental Technical Plan" of POSTEL) is referred to as for the routing rules of junction traffic.

a) General Flow Chart for Planning Junction Network

Shown below is the general planning flow for the junction network:



b) Junction Circuit Dimensioning

The Study applied alternate routing plan to junction circuit dimensioning for optimization purpose. General explanation of circuit dimensioning procedures is given in ANNEX 5-4.

Through circuit dimensioning process, following conditions are taken into consideration:

- Grade of service
  - for local junction : 0.005
  - for SLDD circuit : 0.01
  - for suburban circuit: 0.01

- Transmission media
  - analog SW to analog SW: analog
  - analog SW to digital SW: digital
  - digital SW to analog SW: - do. -
  - digital SW to digital SW: - do. -

- Minimum circuit requirement
  from analog SW : 6 cct

- Modularity
  from digital SW : 30 CH

- Local transit application
  for analog SW: terminating local transit
  for digital SW: originating and/or terminating local transit

c) Routing Plan for Junction Circuit

The digitalization of switching system in Jakarta multi-exchange area will reach the level of 97% at the end of Repelita VII provided the recommended expansion plan of the Study be implemented. (Refer to Chapter 8.)

The remaining capacity of analog switching systems would be about 70 x 10^3 at the end of Repelita VII (2004) if almost all analog switching systems be replaced due to expiration of their economic life (25 years). The analog local transit switching systems will also to be replaced at the end of Repelita VII.

Digitalization of the junction network is one of the prerequisites for introducing ISDN services; the total network cost will be reduced by digitalizing the junction circuits as the cost simulation study implies.

The outline of the above simulation study is as follows:

Preconditions

- Switching capacity : 400,000 l.u.
- Area size : DKI Jakarta
- Incremental junction cost: Same as employed for OECF JKT PCM Phase 2 Project

Sensitivity factor : Digitalization percentage of the junction circuit.

As a result of simulation study, it is concluded that the total network cost is reduced by about 15% when the junction circuits are fully digitalized. Then, 3-stage transition as for routing rules is recommendable as shown in Fig. 5.13.

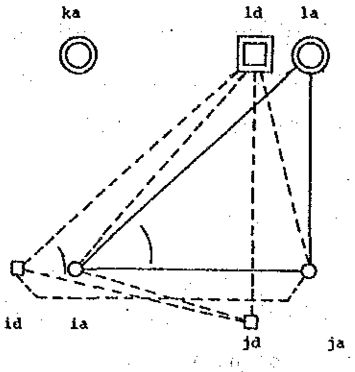
(2) Trunk Switching System

In Jakarta multi-exchange area, two trunk switching systems are currently located in GB1 and SM2 exchanges, though in the latter, digital switch is under installation at present.

It is a common practice that trunk switching facilities as well as trunk junction routes are duplicated or triplicated in capital cities like Tokyo; Tokyo has its duplicated trunk center in Takasaki City, about 100 km from the center of Tokyo.

Recommended here as an ultimate network configuration is that trunk switching facilities should be co-located in BEK, TAN and DEP exchanges from the viewpoint of maintaining the network security in Jakarta multi-exchange area as shown in Fig. 5.14.

Apart from the above ultimate network configuration, ANNEX 5-5 gives a guideline as well as foreseeable constraints for integrating the existing analog and digital trunk switches in Jakarta multi-exchange area.



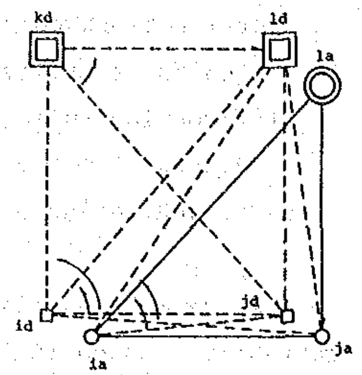
Existing Routing Condition

H.U. and Direct Route

ia - ja	analog
ia - jd, id - ja	digital with A/D Converter
id - jd	digital

Local Transit Route

ia - la, la - ja	analog
ia - ld, ld - ja	digital with A/D Converter
id - ld, ld - jd	digital



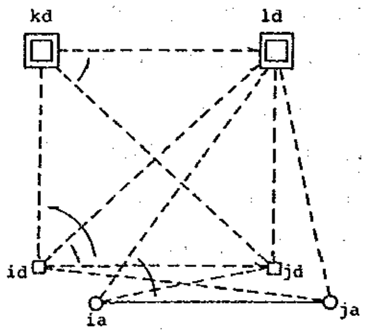
Transition Stage 1: Two Digital Local Transits

H.U. and Direct Route

ia - ja	analog
ia - jd, id - ja	digital with A/D Converter
id - jd	digital

Local Transit Route

ia - la, la - ja	analog
ia - ld, ld - ja	digital with A/D Converter
id - kd, kd - jd	digital
id - ld, ld - jd	〃
kd - ld	〃



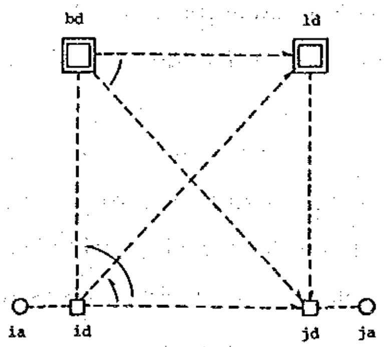
Transition Stage 2: Replacement of Analog Transit Facilities

H.U. and Direct Route

ia - ja	analog
ia - jd, id - ja	digital with A/D Converter
id - jd	digital

Local Transit Route

ia - ld, ld - ja	digital with A/D Converter
id - kd, kd - jd	digital
id - ld, ld - jd	〃
kd - ld	〃



Transition Stage 3: Replacement of Analog Transit Facilities and Analog Local Switching System becomes Satellite Office of Digital Local Switching System

H.U. and Direct Route

ia - id, jd - ja	digital with A/D Converter
Others	digital

Local Transit Route

All Routes	digital

Fig. 5.13 Routing Plan on Jakarta Junction Network

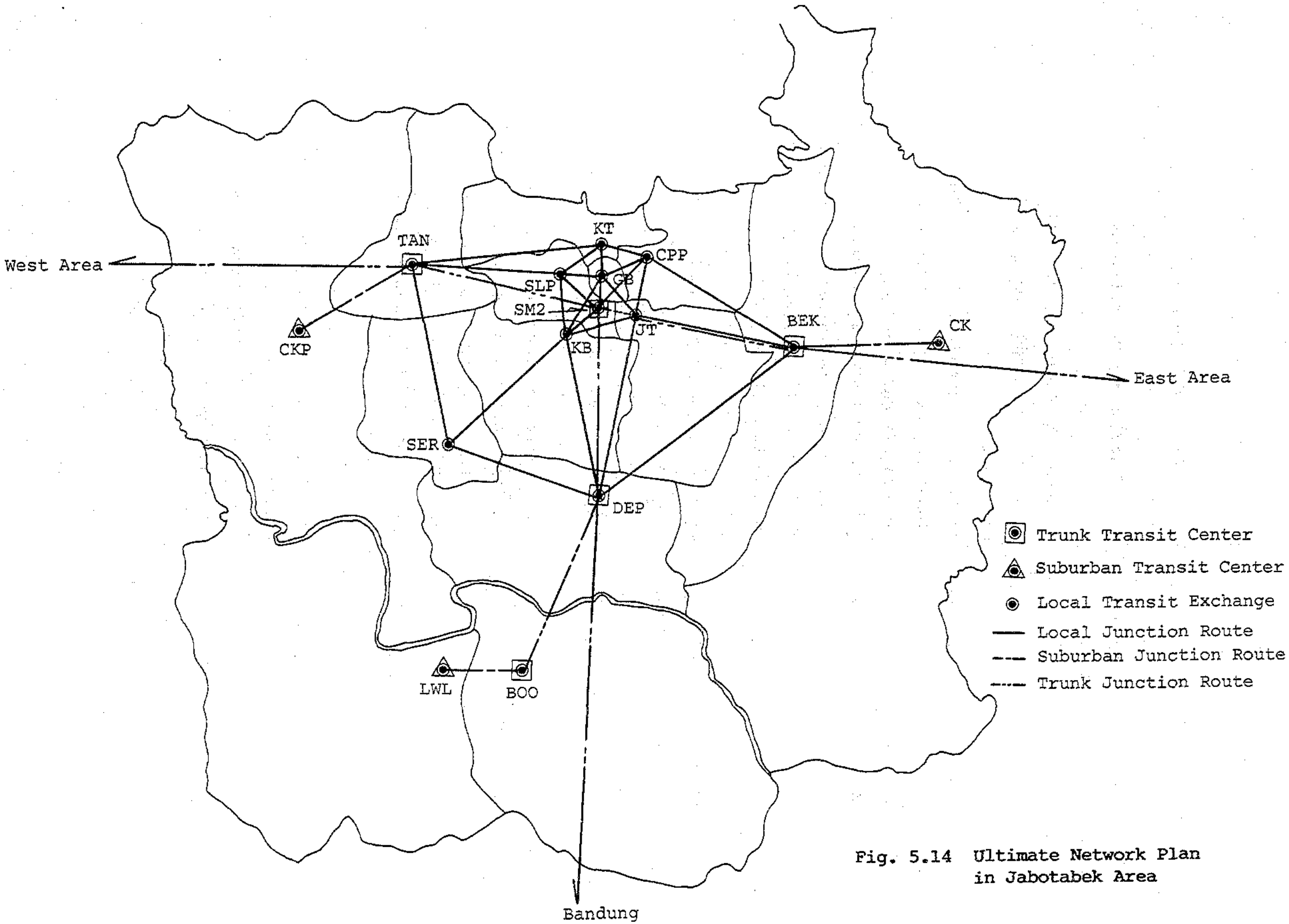


Fig. 5.14 Ultimate Network Plan in Jabotabek Area

5.3.4 Switching Application

(1) Types of Switching Systems

Currently used or planned in Indonesia are the following:

STDI(EWSD)	digital telephone switch, ISDN compatible with additional module provided.
EDX-P	packet switch used for SKDP, data signalling rate up to 48/64 kbps between DTE and DCE.
EDX-C	telex switch, usable for circuit switched data communications up to 9600 bps as well as for teletex service (2400 bps).

Furthermore, STDI has a family of systems to be applied in different surroundings as described below:

- STDI (EWSD)	main switching system.
- RLC (DLU)	remote line concentrator, traffic handling capacity up to 100 erl., not only applicable in remote premises but also able to be housed in STDI, parented to host STDI, no trunking capability.
- STDI-R	small stand-alone exchange unit for remote applications, less than 1,000 l.u., DLU + switching network + trunking capability.

(2) Cost Comparison for DLU Application

a) Cost Estimate of DLU

First of all, the cost estimate of DLU was carried out just for the application in remote premises; the results appear in Fig. 5.15 indicating that per-line cost of DLU is stabilized when the capacity of DLU exceeds 1,000 l.u.

b) Basic Cost Data Used for Comparative Study

Summarized below are the cost data used for comparative study:

- Cable
  - 1,200 pairs/0.4 mm .... Rp. 60 M/km
  - 800 pairs/0.6 mm .... Rp. 64 M/km
  - 400 pairs/0.8 mm .... Rp. 57 M/km

- Duct
  - for 0.4 mm/0.6 mm cable .. Rp. 17 M/km
  - for 0.8 mm cable .... Rp. 27 M/km

- Manhole
  - 2 m x 2 m x 5 m .... Rp. 16 M/km

- Land Procurement .... Rp. 200 k/m^2

- Building .... Cost of standard container

- PLN (commercial power source) Arrangement
  - up to 1,000 l.u. .... Rp. 2 M
  - up to 3,000 l.u. .... Rp. 3 M
  - up to 4,000 l.u. .... Rp. 4 M
  - up to 6,000 l.u. .... Rp. 5 M

c) Summary of Cost Comparison

The results of cost comparison for the application of DLU are summarized in Fig. 5.16.

The criteria for application of DLU to be derived from the comparative study here are:

- DLU is applicable where the distance between host exchange (STO) and DLU and required capacity of DLU meet the following conditions:

Application 1	more than 5.7 km
	more than 1,000 l.u.
Application 2	more than 4.2 km
	more than 2,000 l.u.

- DLU is not applicable in case where the distance between STO and DLU exceeds 3.0 km with more than 5,500 l.u. of capacity.

Exemplary applications of DLU are shown in Fig. 5.17.

(3) Further Considerations for DLU Application

Apart from the above comparison results, DLU will find its applications where:

- there exist constraints of spacial expandability in MDF (Main Distribution Frame), ducts, etc.;
- reduction of initial investment cost is imperative; and
- an urgent solution to relieve the constraints in the rapidly developing areas, e.g., real estate development areas, is required.

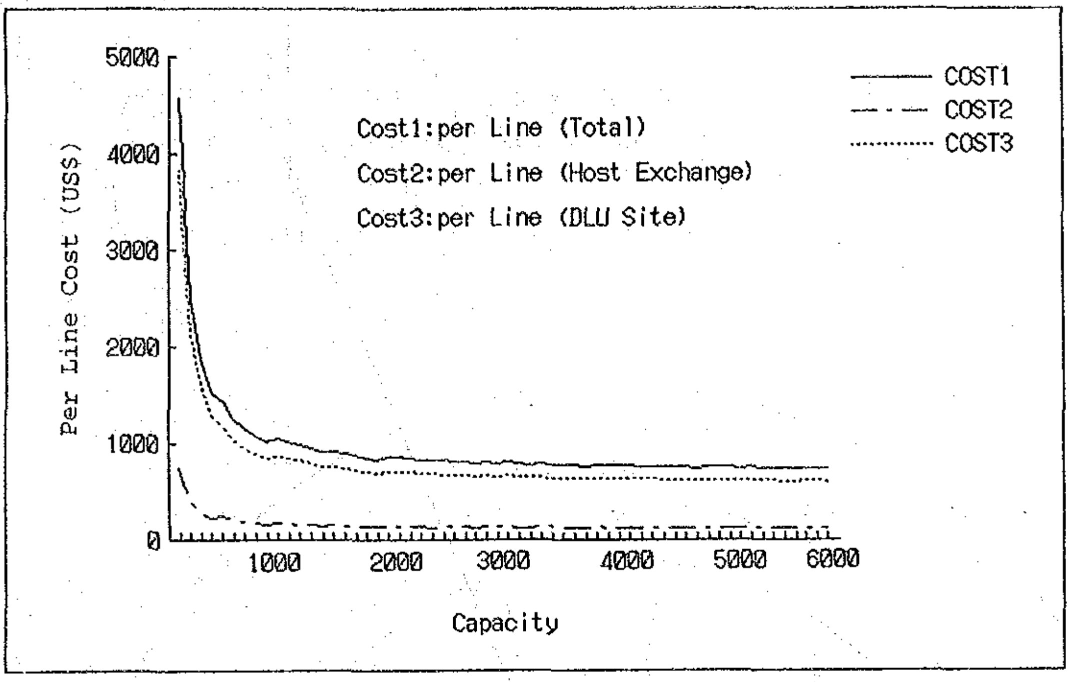


Fig. 5.15 Cost Estimation of RLC (DLU)

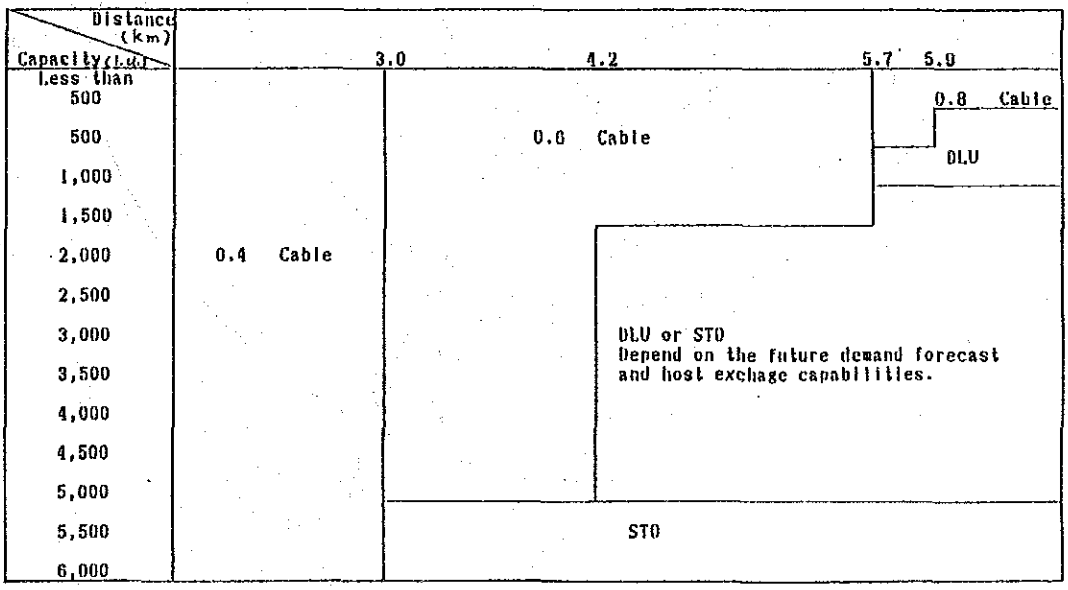


Fig. 5.16 Selection of Subscriber's Network Sub-System by Distance and Capacity

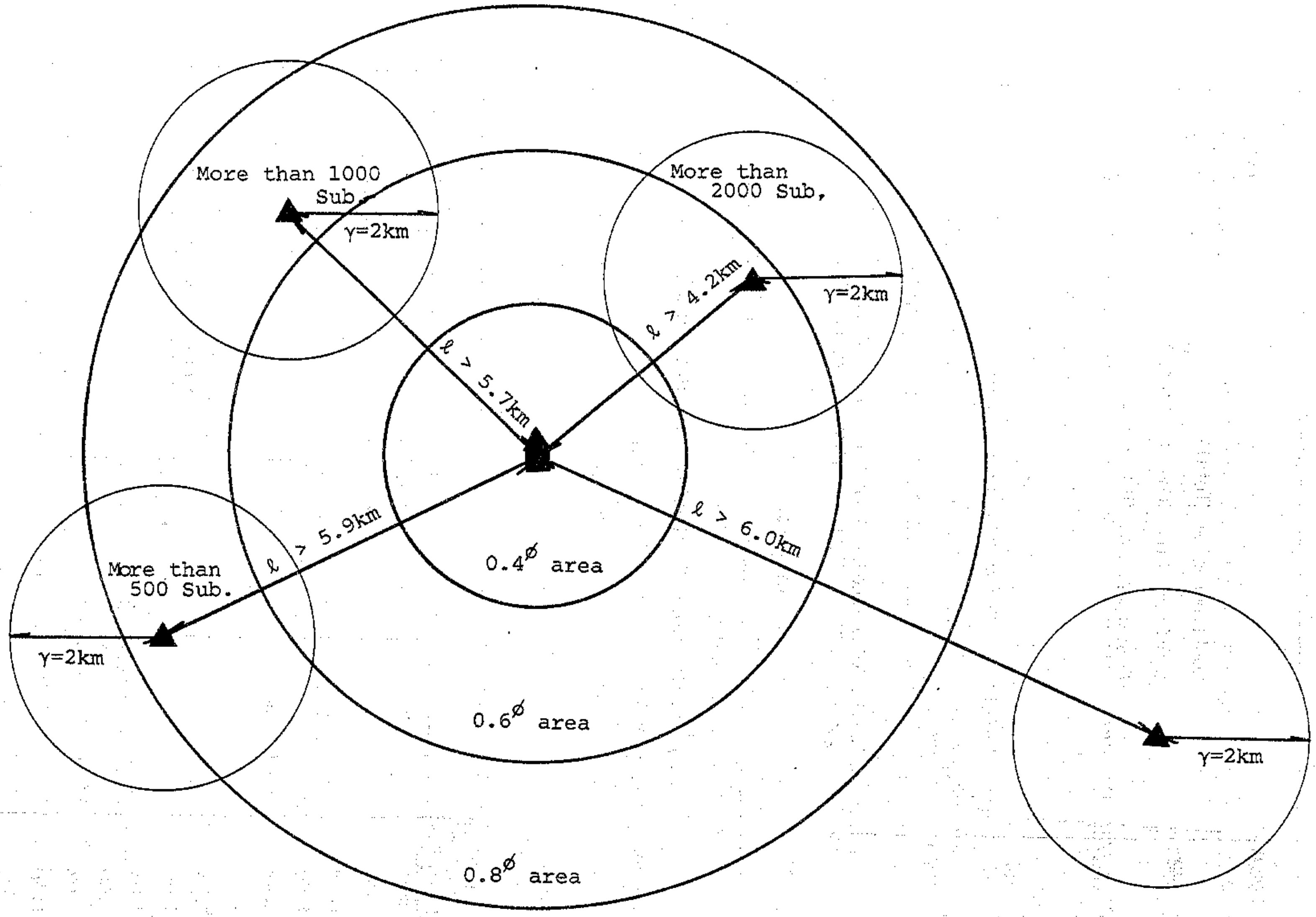


Fig. 5.17 Example of Application of DLU

5.3.5 Numbering Plan

The arrangement of numbering plan for telephone services as well as for ISDN services to be offered stage-by-stage is made in conjunction with the introduction of CCITT signalling system No. 7 (Common Channel Signalling/CCS) fit for digital networks/ISDN.

(1) Planning Period

The planning period of fifty (50) years is set forth for the arrangement of the numbering plan which is a common and preferable practice for many administrations in order to eliminate a lot of manpower required at the later stage of network development.

(2) Numbering Capacity

The required capacity for the numbering plan to be arranged is estimated by the use of linear growth of demand and adjusted in consideration of the estimated subscribers density for the respective areas (only for DKI Jakarta).

The forecasted telephone demand in the year 2044 appears in ANNEX 5-6 and is summarized as under on local-transit-area basis:

Local Transit Area	Demand/2044
Kota	983 k
Slipi	946 k
Jatinegara	878 k
Kebayoran	872 k
Cempaka Putih	747 k
Gambir	440 k
Bekasi	240 k
Tangerang	230 k
Depok	210 k
Serpong	120 k
(Total)	5,166 k

The required numbering capacity in Jakarta multi-exchange area will reach approximately 5.2×10^6 giving rise to the conclusion that **7-digit subscriber numbering scheme is to be employed in Jakarta multi-exchange area.**

(3) Numbering Plan

The numbering plan for Jakarta multi-exchange area is set forth as follows and that for Bogor area follows the current numbering scheme in that area:

a) Jakarta multi-exchange area comprises seven (7) sub-numbering areas with one (1) sub-numbering area assigned for Jakarta suburban area.

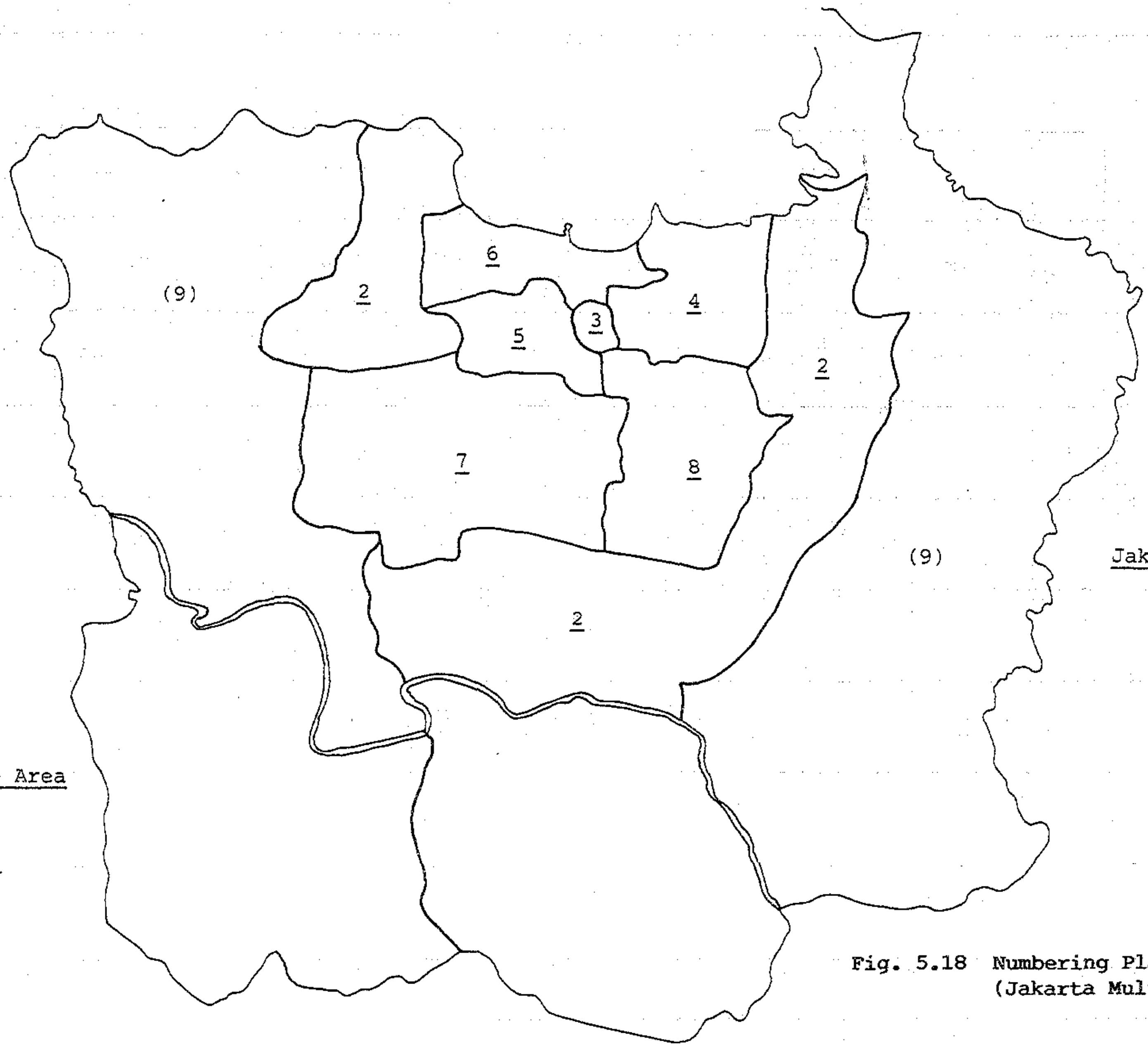
b) One unique number as S1-digit is designated to each sub-numbering area in Jakarta multi-exchange area.

c) For S1-digit, "0", "1" and "9" are not used to avoid the confusion with SLDD (ISD), special and suburban calls respectively.

d) In converting 6-digit subscriber numbers into 7-digit numbers, S3-digit is appended to the existing office codes as follows:

Old	New
S1 S2 XXXX	S1 S2 (S3) XXXX

The arranged numbering plan appears in Fig. 5.18 and Table 5.4.



Jakarta Message Area

Code A = 2
Code B = 1
Code S1 = x
(9): Prefix to Suburban

Bogor Message Area

Code A = 2
Code B = 5
Code C = 1

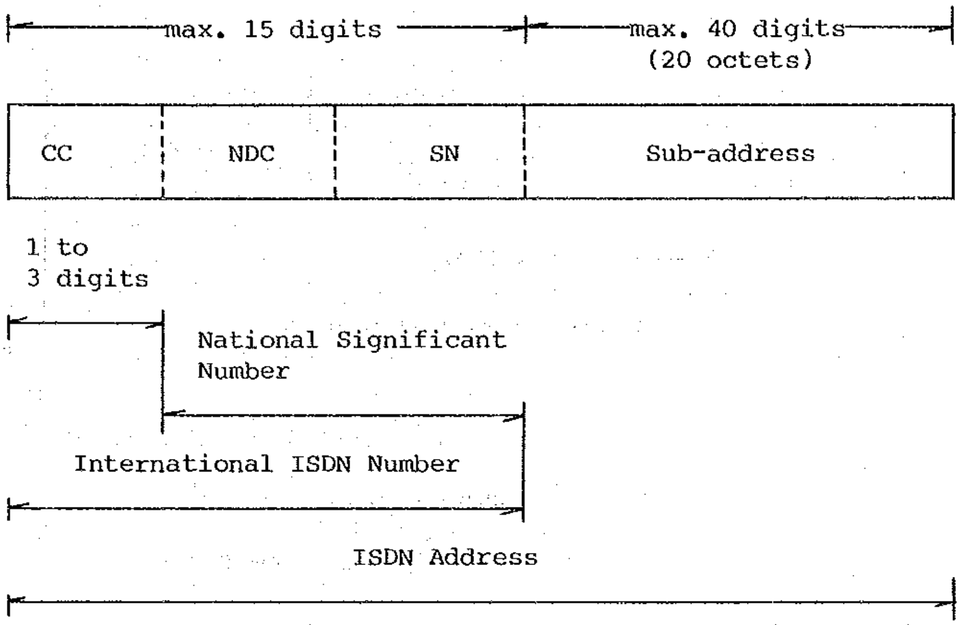
Fig. 5.18 Numbering Plan up to 2004
(Jakarta Multi-Exchange Area)

Table 5.4 Numbering Plan up to 2044 in Jakarta Multi-Exchange Area

S2 \ S1 (S3: 0 1 2 3 4 5 6 7 8 9)	0	1	2	3	4	5	6	7	8	9	Remarks
0											STD (ISD)
1											Special Calls
2		BEK, BGG	BKB	CL	CIB, SWG	DEP	SKJ	TAN	JUG, CPD		Bekasi, Tangerang Depok
3	GB1								GB 2		Gambir Transit Area
4		CPP		TPR	CIL	KGD	PGG	RMG			Cempaka Putih Transit Area
5	KED	SM 2		PLM		JIA	SLP	SM 1		MER	Slipi Transit Area
6	TGA	CKG		KT 3	KT 2		PLT		ANC	KT 1	Kota Transit Area
7	KL2	KB	JAG	KBB	CDG, CPA	CPE, CNE	CPE	SRB, SER, SRU	PSM, KBB	KL1	Kebayoran Transit Area
8	CW	JT		TB	PSR	JT	KLD	GAN			Jatinegara Transit Area
9											Suburban calls

(4) Numbering Plan for ISDN Services

CCITT recommends to employ the ISDN numbering scheme as depicted below:



CC : Country Code

NDC: National Destination Code

SN : Subscriber Number

The numbering scheme for ISDN services, however, is not mandatory to any administration as long as it employs an integrated numbering plan for its PSTN (public switched telephone network). (Refer to CCITT Rec. E.164.)

The long-term numbering plan for telephone services shall be adopted in the Study even for ISDN services as it has a numbering capacity of 10×10^6 (7-digit equivalent).

(5) Numbering Plan for No. 7 Signalling Network

a) Signal Format

<u>ISPC (International Signalling Point Code)</u>

N M L	K J I H G F E D	C B A
Zone identification	Area/network identification	Signalling point identification
Signalling area/network code (SANC)		
International signalling point code (ISPC)		
3	8	3

First bit transmitted →

CCITT-85260

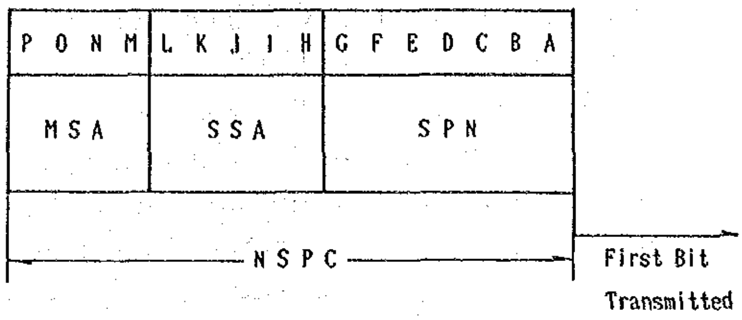
FIGURE 1/Q.708

Format for international signalling point code (ISPC)

<u>5-020</u> (5 for zone identification and 020 for area/network identification) was assigned for the SANC of Indonesia as shown in ANNEX-A of CCITT Rec. Q.708. However, assignment of signalling point identification in the sub-field (C.B.A) will be made by respective administrations.

Recommended here in the Study is to use the sub-field (C.B.A) for the purpose of designating network categories, e.g., PSTN, PSPDN (SKDP), ISDN.

NSPC (National Signalling Point Code)



MAS: Main Signalling Area Code (up to 16 areas)
SSA: Sub-Signalling Area Code (up to 32 areas)
SPN: Signalling Point Number (up to 128)

All the national signalling point codes (NSPC) shall consist of three identification sub-fields as indicated in the figure above.

- a sub-field of 4 bits (P to M) shall identify a main signalling area (MSA);
- a sub-field of 5 bits (L to H) shall identify a sub-signalling area (SSA); and
- a sub-field of 7 bits (G to A) shall identify a signalling point number.

b) Assignment of NSPC in Jabotabek Area

14 out of 32 sub-signalling area codes will be required to identify sub-signalling areas belonging to Jabotabek area (one main signalling area), e.g.,

Gambir area	:	00001
Cempaka Putih area	:	00010
Slipi area	:	00011

Kota area	:	00100
Kebayoran area	:	00101
Jatinegara area	:	00110
Bekasi area	:	00111
Depok area	:	01000
Serpong area	:	01001
Tangerang area	:	01010
Cikarang area	:	01011
Cikupa area	:	01100
Bogor area	:	01101
Leuwiliang area	:	01110

5.3.6 Signalling System

CCITT signalling system No. 7 (S.S. No. 7) shall be **introduced progressively aiming at establishing Integrated Services Digital Network (ISDN)** making use of the following features of S.S. No. 7:

- In S.S. No. 7 the signal messages could be transferred at any appropriate time and without restrictions on their transmission rate (at most 64 kbps) over the common channel.

- S.S. No. 7 is fit for the application to digital networks.

- S.S. No. 7 is tailored to be suitable for the use in the environment of common control/digital switch networks.

However, a special attention shall be paid to the "security" of signalling network in case where the common channel signalling (CCS) system is employed for the network since bulk of signal messages are conveyed over a single common channel.

(1) MFC and CCS

SMFC (Semi-compelled multi-frequency code) signalling system, a kind of MFCs, is dominant in Indonesia as an interexchange signalling system for common control/digital switches.

Described hereunder are the characteristics, merits or constraints and features of MFC and CCS.

a) MFC (Multi-Frequency Code) Signalling

[Characteristics]

- Utilization of speech paths for signal transfer.
- Uni-directional transfer of signal messages; identical with the direction of call set-up.
- Transmission of digital data in the form of analog signal over the speech paths.
- Channel-associated signalling.

[Constraints]

- Signal transfer is prohibited during conversation.
- Transfer of register signals is restricted only at the time of initial call set-up.
- Distribution/grouping of signal messages is required for the use of common control system.

[Features]

- **Limitation on transmission speed/time.**
- **Not appropriate for digitalization of networks**
- **Not suitable for common control system**

b) CCS (*Common Channel Signalling*)

[Characteristics]

- Separate data link other than speech paths.
- Utilization of data links.

[Merits and Constraints]

- Signal messages may be transferred in either direction notwithstanding the direction of call set-up.
- High transmission rate.
- Fit for digitalization of networks.
- Direct interaction is possible between control system and data link.

- "Network security" shall be paid attention.
- Signal messages are not conveyed over the speech paths.

[Features]

- Occasional transmission of signal messages at any appropriate time.
- Fit for digitalization of networks.
- Fit for common control system.
- Measures to be taken for "network security".
- Measures to be taken for the test of speech paths.

(2) S.S. No. 7 and OSI Model[1/]

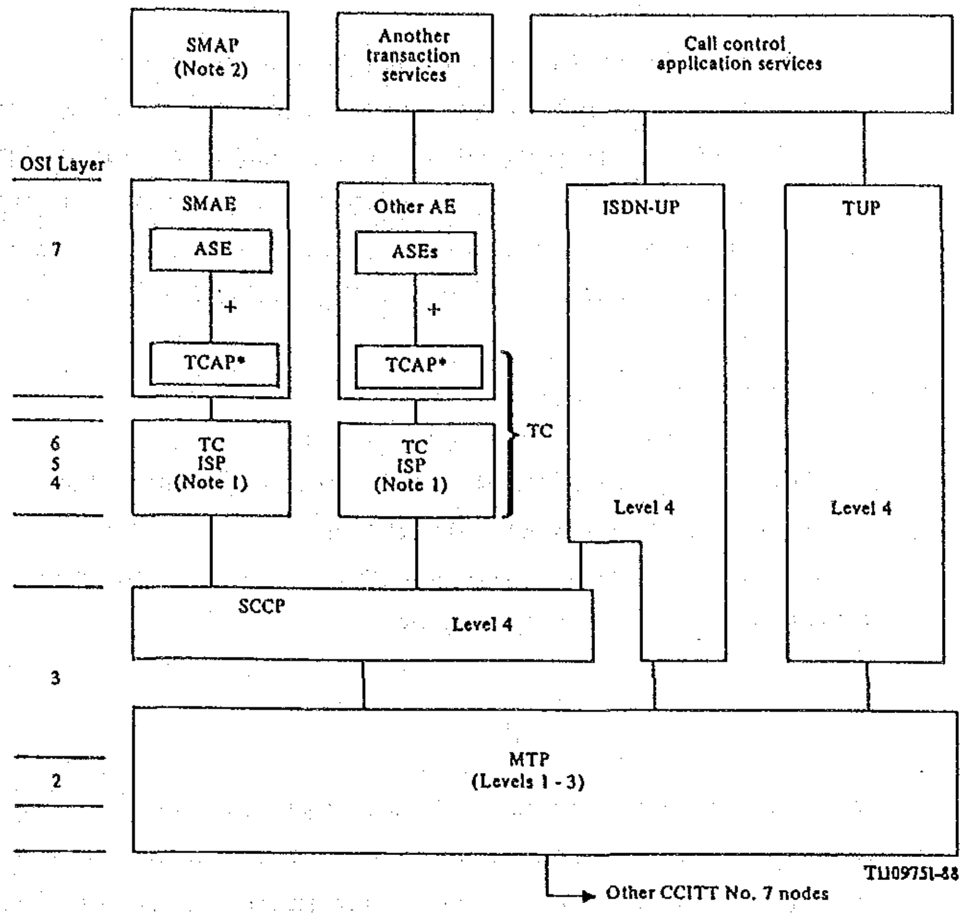
Evolution of CCITT Signalling System No. 7 (S.S. No. 7) architecture has been based on the Open Systems Interconnection (OSI) Reference Model.

The purpose of the Reference Model of Open Systems Interconnection for CCITT Application is to provide a well-defined structure for modelling the interconnection and exchange of information between users in a communications system. The approach allows standardized procedures to be defined not only to provide an open system interconnection between users over a single network, but also to permit interworking between networks to allow communication between users over several networks in tandem.

From the point of view of a particular layer, the lower layer provide a "transfer service" with specific features. The way in which the lower layers are realized is immaterial to the next higher layers. Correspondingly, the lower layers are not concerned with the meaning of the information coming from higher layers on the reasons for its transfer.

Depicted hereunder is the schematic diagram to show the relationship between S.S. No. 7 functional levels and OSI layering.

1/ CCITT Rec. Q.700 (Ap IX-106-E)



* TCAP is an ASE.
+ CCITT SS No. 7 primitive interface.

FIGURE 5/Q.700

Relationship between CCITT No. 7 functional levels and OSI layering

Fig. 5.19 Relationship between CCITT No. 7 Functional Levels and OSI Layering

Note 1: The TC ISP is for further study. As no signalling procedures are presently specified for this function, the TCAP messages are presented directly to the SCCP. Specific requirements for this ISP function will be defined when needed for future ASEs.

2: The set of functions that collectively encompass systems management are known as the Systems Management Application Process (SMAP).

3: The characteristics of each OSI layer are described below.

a) Physical Layer

The Physical Layer (**layer** 1) provides transparent transmission of a bit stream over a circuit built in some physical communications media. It furnishes the interface to the physical media and is responsible for relaying bits (i.e., interconnects data-circuits). A 64 kbps link is assumed for the CCITT S.S. No. 7 Physical Layer.

b) Data Link Layer

The Data Link Layer (**layer 2**) overcomes the limitations inherent in the physical circuits and allows errors in transmission to be detected and recovered, thereby masking deficiencies in transmission quality.

c) Network Layer

The Network Layer (**layer** 3) transfers data transparently by performing routing and relaying of data between end users. One or more of the sub-networks may interwork at the Network Layer to provide an end user to end user network service. A connectionless network provides for the transfer of data between end users, making no attempt to guarantee a relationship between two or more data messages from the same user.

d) Transport Layer

The Transport Layer (**layer 4**) provides end user to end user transfer optimizing the use of resources (i.e., network service) according to the type and character of the communication, and relieves the user of any concern for the details of transfer. The Transport Layer always operates end-to-end, enhancing the Network Layer when necessary to meet the quality of service objectives of the users.

e) Session Layer

The Session Layer (**layer** 5) coordinates the interaction with each association between communicating application processes. Full and half duplex dialogues are examples of possible Session Layer modes.

f) Presentation Layer

The Presentation Layer (**layer** 6) transforms the syntax of the data which is to be transferred into a form recognizable by the communicating application processes. For example, the Presentation Layer may convert a data stream from ASCII to EBCDIC.

g) Application Layer

The Application Layer (**layer** 7) specifies the nature of the communication required to satisfy the users' needs. This is the highest layer in the Model and so does not have a boundary with a higher layer. The Application Layer provides the sole means for the application processes to access the OSI environment.

(3) SCCP (Signalling Connection Control Part)

In the ISDN environment, non-associated[1/] message transfer function shall be upgraded in order to facilitate the users with the much more convenient services, e.g., telephone, data and facsimile services.

1/ Message Transfer Part (MTP, Layer 3)
Signalling System No. 7 is specified for use in the associated and quasi-associated modes. The Message Transfer Part does not include features to avoid out-of sequence arrival of messages or other problems that would typically arise in a fully non-associated mode of signalling with dynamic message routing. (CCITT Rec. Q.701)

a) Message Transfer among Signal End Points (SEPs)

SCCP is provided in order to offer sophisticated services to ISDN users. For example, an ISDN user may want to convert the communication mode from telephone to facsimile; SCCP facilitates the message transfer among SEPs in this case. However, the internationally standardized SCCP does not exist at this moment.

b) TCAP (Transaction Capabilities Application Part)

In the layer above SCCP, provided is the TCAP that defines transaction capabilities common to a variety of services in the ISDN environment, e.g., access service to the data base.

(4) Telephone User Part (TUP)/ISDN User Part (ISUP)

Standardization of TUP/ISUP is indispensable for realizing end-to-end ISDN services. However, the specifications of TUP/ISUP employed by Administrations differ from country to country.

It is a common understanding for the Administrations in the world that S.S. No. 7 is a "must" to upgrade the network toward the target. However, special **attention shall be paid for the introduction of S.S. No. 7 especially TUP/ISUP to be defined and will be standardized internationally in higher layers of OSI model.**

6. NETWORK MANAGEMENT

6. NETWORK MANAGEMENT

6.1 Institutional Framework

The number of employees per 1,000 subscribers, which is a good indicator of the institutional efficiency, was 53 and 25 for PERUMTEL as a whole and WITEL IV respectively in 1987.

Compared with the figures in other ASEAN countries, the figure 53 per 1,000 subscribers could be said very high (ASEAN: 10-35, Japan: 6). On the contrary, 25 per 1,000 subscribers indicates a comparatively fair productivity as far as WITEL IV is concerned, implicating the excessive concentration of subscribers in Jakarta area.

Expansion program in Repelita V

It is programed to install 530,000 l.u. in a coordinated manner with the expansion of subscriber cable network in Jakarta area during Repelita V.

In case that such a very ambitious target be achieved the total number of subscribers in Jakarta area would be more than double as compared with the existing; it is not recommendable to increase the number of employees in line with the increase of subscribers.

6.2 Organization of WITEL IV

Shown below is the organization chart of WITEL IV. The figures in brackets indicate the number of personnel assigned to the respective divisions and authorities.

KAWITEL (1) (Total = 6,501)

- INSPECTORATE (74)
- TECHNICAL DIVISION (845)
  - TEL SWITCHING
  - TRANSMISSION/TELEGRAPH
  - NETWORK
  - LOGISTICS
- ADMINISTRATION DIV. (855)
  - SECURITY
  - PERSONNEL
  - FINANCE
  - MARKETING
  - SECRETARIAT
- TECHNICAL AUTHORITY (1,659)
  - SWITCHING
  - TRANSMISSION/TELEGRAPH
  - JUNCTION
  - OPERATION
- SERVICE AUTHORITY (3,068)
  - JATINEGARA
  - KEBAYORAN BARU
  - JAKARTA KOTA
  - JAKARTA PUSAT
  - JAKARTA BARAT

(Source: SUBAG KEPEGAWAIAN)

As of Jan. 1989

Fig. 6.1 Organization of WITEL IV

Reorganization of WITEL IV

Reorganization of WITEL IV might be required in order to cope with the problems anticipated due to the excessive concentration of communication services in the core of Jakarta and expected explosive expansion of telephone services during Repelita V in such a way as described below:

a) Existing maintenance organizations (service authorities - DINYAN) shall be integrated with those OPMC (Outside Plant Maintenance Center) to be established in Jakarta area during Repelita V.

b) At least 5 OPMCs will be required even at an initial stage.

c) Reorganization of WITEL IV is necessary to speed up maintenance work in Jakarta.

d) WITEL IV will be reorganized to have:

- Vice - KAWITEL(s);
- Planning Division;
- Project Implementation Division with LAKPEMTEL (zone II) under the control of WITEL IV; and
- O & M Division

6.3 Operation and Maintenance (O & M)

6.3.1 Introduction

In accordance with the growth of the subscribers in Jakarta area, operation and maintenance shall be carried out more efficiently.

Centralization of O & M seems most promising for the efficient use of human resources and financial resources.

In Jakarta, such kind of centralization of O & M is taking place as for the switching network and the junction network.

- EWSD/STDI Switch:
  Centralized O & M system in SLP
- PRX Switch:
  Centralized O & M system in KT2
- Transmission/FO Junction Cable Network:
  Centralized O & M system in SM2

Notwithstanding the fact above, maintenance work for outside plant (OSP) has a different feature from that for switching/junction network since line-by-line work is required for maintaining OSP in order to offer satisfactory end-to-end services to the customers (subscribers).

6.3.2 Existing O & M System for OSP

There exist five service authorities (DINYANs) in Jakarta area; the organization chart is shown below.

KAWITEL (Total = 3,068)

- DINYAN "JATINEGARA" (696)
  - PMP (SERVICE QUALITY) (250)
  - MARKETING (149)
  - LINEMEN (297)
- DINYAN "KEBAYORAN BARU" (630)
  - PMP (178)
  - MARKETING (186)
  - LINEMEN (266)
- DINYAN "JAKARTA KOTA" (529)
  - PMP (112)
  - MARKETING (166)
  - LINEMEN (251)
- DINYAN "JAKARTA PUSAT" (618)
  - PMP (149)
  - MARKETING (177)
  - LINEMEN (292)
- DINYAN "JAKARTA BARAT" (595)
  - PMP (239)
  - MARKETING (239)
  - LINEMEN (228)
  - JIA (49)

(Source: SUBAG KEPEGAWAIAN)

As of Jan. 1989

Fig. 6.2 Service Authorities in Jakarta

Most of the DINYANs have an almost identical structure of the organization except for DINYAN "Jakarta Barat" which has a special maintenance unit in Jakarta International Airport.

The total number of personnel assigned for PMP (service quality = MDF, recording call meter and complaints settlement) is 928 (30%) out of 3,068.

The rest of personnel are assigned to:

- Marketing: 806 (26%)
- Linemen : 1,334 (43%)
  (Administration inclusive, JIA exclusive)

6.3.3 Fault Rate (="Q") Improvement

The fault rate (= faults/month per 100 lines) in Jakarta was approximately 8.0 according to the data Jan. through July, 1988[1/].

1/ IKHTISAR DATA GANGGUAN DALAM ANGKA GANGGUAN (Q) JAN. - JULY, 1988 KASUBUR PENGAWASAN KONDISI JARINGAN & EVALUASI GANGGUAN

6.3.4 Mobilization and Computer-Aided O & M

PERUMTEL/POSTEL has a plan to enhance the maintenance efficiency for OSP by establishing/introducing OPMCs (computer-aided OSP maintenance centers) scheme.

The experience of OPMC in Bandung triggered to plan for OPMCs in Jakarta area where "Q" is comparatively very high.

(1) OPMC

The target set forth in establishing OPMCs in Jakarta is based on the experience of Bandung OPMC.

- Fault Rate: 5.0 (faults/month per 100 lines)
- Working Efficiency: 3.0 (faults repaired/lineman per day)
- Days required for repairwork: within a single day to more than 70% of claims

A simple calculation reveals how important it is to raise the maintenance efficiency.

Assumptions

Area	: Jakarta
No. of lines	: 400,000
"Q"	: 8.0
Linemen per 1000 lines	= (1,400/400,000) x 1,000 = 3.5
Faults to be dealt with per lineman per day (Working Efficiency)	= 8/100 x 400,000/1,400/30 = 0.8 faults/lineman/day

By improving "Q" from 8.0 to 5.0, excessive number of lines could be maintained without increasing the number of linemen as follows:

400,000 x (8/100 - 5/100)/(0.8 x 30) = 500 lines
fixed

500 x 1,400 - 400,000 = 300,000 lines
(excessive no. of lines)

By upgrading the working efficiency from current 0.8 to 2.4 (= 3 times), the excessive number of linemen could be assigned for maintenance work for the increased number of lines as shown below;

1,400 - (400,000 x 8/100)/(2.4 x 30) = 960
(excessive no. of linemen)

(2) Computer-Aided OSP Maintenance

The day-to-day maintenance work is not so simple as described in the previous paragraph.

Efficient use of computer-aided OSP maintenance scheme shall be introduced to achieve the target being synchronized with OPMC.

PERUMTEL/POSTEL has a plan to introduce the computer-aided OSP maintenance software package which could be utilized for marketing and planning purposes as well.

6.4 S.S. No. 7 and O & M

TC[1/] in S.S. No. 7[2/] will facilitate the operation and maintenance work (O & M) in ISDN environments.

1/ TC: Transaction Capabilities (refer to 5.3.6)

2/ S.S. No. 7: CCITT Signalling System No. 7

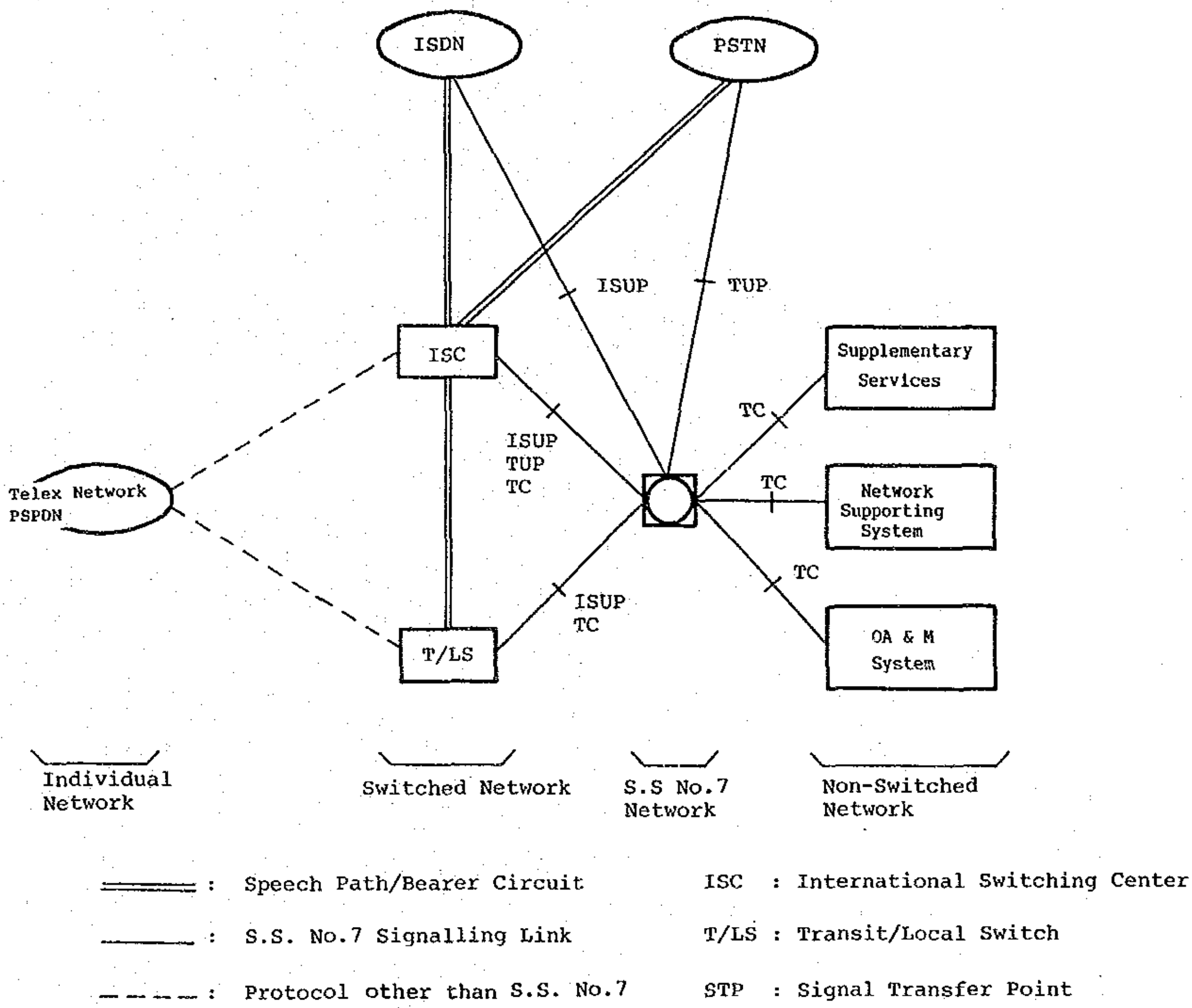
a) Application of TC

Application of TC could be taken into consideration in the following areas:

- data base for new/supplementary services;
- registration of roaming information in CMT (Cellular Mobile Telephone system); and
- interexchange of O & M data between exchanges and the network management center.

b) TC in ISDN

OMAP (Operation and Maintenance Application Part) over the layer of TC could contribute to upgrade the network performance; the following figure shows the typical network configuration with TC applied in consideration of the relationship with circuit control protocol, ISDN, etc.



(Source: "KDD Technical Journal" No. 130, Oct. '86)

Fig. 6.3 Typical Application of TC

7. NON-VOICE SERVICES AND ISDN

7. NON-VOICE SERVICES AND ISDN

7.1 Rationale behind ISDN

(1) Prerequisites for ISDN

The following description on ISDN is found in CCITT GAS 11 Handbook.

"An ISDN is a network in general evolving from a telephone IDN, that provides end-to-end digital connectivity to support a wide range of services, including voice and non-voice services, to which users have access by a limited set of standard multi-purpose user-network interfaces."

The following are prerequisites for ISDN:

a) The **rapidly growing demand for domestic and international digital communications services** will require equipment compatibility, and similarity of services and procedures across customers and networks to satisfy the end user needs,

b) Carriers should be able **to support a wide range of digital services** for voice and non-voice information over the same network, or suitably interconnected networks,

c) **Customers should realize reduced costs and complexity** in their subscription to, and use of, network services, and improved control over these services compared to the existing assortments of analog and digital network services,

d) **Carriers and customers should be able to decouple the evolution of customer premises equipment** from network systems in order to allow these technologies to evolve separately but in a compatible manner.

The standardization of technical requirements for ISDN has been studied progressively by CCITT. The CCITT recommendations for

ISDN, especially for user-network interface are based on the studies promoted by the study groups organized around SG XI and are known as **I-series Recommendations.** (Refer to Section 7.3.2 I-Series Recommendations.)

Telecommunication services supported by ISDN are defined in a broad sense as follows:

a) Bearer Services
Bearer services provide the capability for information transfer between user-network interfaces.

b) Teleservices
Teleservices support complete end-to-end capability of which services are extended to the functions of terminal equipment for communications between users.

7.1.1 Benefits from ISDN

ISDN brings about a lot of benefits to every member of society, e.g., for the network providers, for the users and for the manufacturers.

(1) For Network Providers

a) The basic access interface defined in I-series Recommendations is composed of two B-channels and one D-channel (2B+D). The bit rates of the B-channel and the D-channel in this interface structure are 64 kbps and 16 kbps respectively. A maximum number of eight (8) TEs (Terminal Equipment) can be accommodated in the bus-structured interface; two of the eight TEs can be used simultaneously over B-channels. Therefore, increase in traffic per subscriber, in other word, increase in revenue might be expected. Table 7.1 shows the typical transmission rates, holding time per busy-hour and erlangs per busy-hour for new services.

Table 7.1 Example of Assumed Attributes of New Services Transmission Rates (kbps)

Service	Large business		Medium business		Small business		Residence		Ave. holding time per BH	Erlangs
	1990	1995	1990	1995	1990	1995	1990	1995		
Non ISDN data	4.8	4.8	2.4	4.8	1.2		2.4	4 min	0.67	
ISDN data									12 CCS/BH	.33
Data base	32	32	4.8	4.8	1.2	2.4		2.4	10 min	.17
Fast fax	32	32							40 sec	.001
Slow fax			2.4	2.4					6 min	.10
Videotex							4.8	4.8	10 min	.17

(Source: CCITT GAS 10 Handbook)

b) ISDN could stimulate the demand for new services.

c) Reduction of operation and maintenance costs will be achieved since any kind of services is provided in a single network.

(2) For Users

a) ISDN enables a user to make an access to both plain old telephone services (POTS) and **new services** through a single pair of subscriber cable.

b) Worldwide use of ISDN TEs is possible because of their **portability.**

c) A user can use the digital transmission path of **high-speed** (64 kbps for basic access services) of **high-quality.**

d) Adoption of the standard interface will make TE markets more competitive resulting in **low prices of TEs.**

(3) For Manufacturers

a) By employing the **standard interface,** equipment manufacturers will be able to make long-term plans for research and development, manufacturing, and marketing of their products.

b) Proliferation of the use of standard interface will stimulate the **demand for new services** opening the market for manufacturers.

7.1.2 Evolution toward ISDN

(1) Approach toward Full-ISDN

ISDN trials have been carried out in many countries as depicted in Fig. 7.5. Administrations of other developed and developing countries are also considering ISDN field trials in an attempt to establish the best approach for implementing a full-scale ISDN.

ISDN, in general, evolves from its introduction toward full-ISDN as follows:

a) The telephone network will evolve from analog to digital network with the introduction of digital transmission and switching to provide **64 kbps connectivity.**

b) The 64 kbps ISDN will stem from the digital telephone network being enhanced by **access capabilities for other services** (ISDN user-network interfaces).

c) The 64 kbps ISDN will develop further from the 64 kbps network by incorporating additional capabilities for speeds other than 64 kbps.

ISDN actually may be implemented in a variety of configurations according to the specific national environment. The integration of PDN (public data network) and ISDN should be taken into consideration in the countries where PDNs exist. (Refer to 7.4 Interworking between ISDN and Data Communications Network.)

(2) ISDN Introduction in Indonesia

PERUMTEL/POSTEL in Indonesia has the following plan to introduce ISDN:

- Completion of study by 1990;
- Execution of field trial/pilot project by 1992; and
- Implementation of ISDN.

(3) Technical Requirements for ISDN

The following technical requirements should be met prior to the introduction of ISDN:

- **Digitalization** of switching equipment and transmission link between exchanges;
- **Synchronization** of network;
- Introduction of **CCITT No. 7** signalling system; and
- Digitalization of **subscriber transmission system** (Refer to Section 7.3.3 Subscriber Transmission System).

7.2 Non-Voice/Data Network Development Plan in Indonesia

7.2.1 Telex Network

(1) Number of Telex Terminals

At present, analog networks are dominant in Indonesia. One of the principal services provided over the analog networks is POTS (plain old telephone services); telex is a major non-voice service offered by the analog network. Table 7.2 shows the transition of the number of telex terminals in Indonesia from 1979 to 1987.

Table 7.2 Transition of Number of Telex Terminals

Year	No. of Telex Terminals DKI Jakarta	No. of Telex Terminals Nationwide	DKI Jakarta/ Nationwide
1979	2,464	4,009	62%
80	3,010	5,307	57
81	3,731	6,740	55
82	4,325	8,105	53
83	4,857	9,292	52
84	5,186	10,289	50
85	5,407	11,285	48
86	6,075	12,723	48
87	6,639	14,527	46

(Source: PMC Main Task)

Table 7.2 shows that the rate of increase in the number of telex terminals in DKI Jakarta has dwindled recently. In the whole of Indonesia, however, the increase rate shows an upward trend again in recent years.

The fact above suggests that demands for telex terminals tend to increase steadily until telephone services become readily available in an area. Once the telephone density in the area reaches a certain level, the increase rate in the number of telex terminals will slow down.

Another implication of Table 7.2 is that a large number of telex terminals have been spreading out in the areas other than DKI Jakarta during the last several years and that facsimile services are becoming dominant in DKI Jakarta instead of telex services.

(2) Telex Traffic Volume

The traffic volumes of international and domestic telex services are shown in Tables 7.3 and 7.4, respectively. As the figures show, the use of telex has entered a state of saturation in terms of traffic volume. This trend also suggests that the replacement of telex services with facsimile services is taking place.

Table 7.3 International Telex Traffic Volume

Year	Nationwide ($x10^6$ minutes)	DKI Jakarta ($x10^6$ minutes)	DKI Jakarta/ Nationwide
1982	10.1	8.0	79%
83	11.0	8.7	79
84	12.4	9.9	80
85	12.6	9.9	79
86	12.7	9.8	77

Table 7.4 Domestic Telex Traffic Volume

Year	Nationwide ($x10^6$ pulses)	DKI Jakarta ($x10^6$ pulses)	DKI Jakarta/ Nationwide
1982	271.9	115.5	42%
83	336.4	151.5	45
84	378.4	157.2	42
85	421.2	170.1	40
86	435.4	171.4	39

Let us take a look at the percentage of DKI Jakarta in 1986. In terms of the number of telex terminals, the percentage of DKI Jakarta is 48%, as indicated in Table 7.2. In terms of telex traffic volume, however, the percentage of DKI Jakarta in the same period is 39%, as shown in Table 7.4. This conversely implies that the telephone density in the areas other than DKI Jakarta is extremely low and that in these regions telex services had been used in place of telephone services.

(3) The Case in Malaysia

Table 7.5 shows data on telephone and telex services in Malaysia. Although Malaysia may have different social and environmental settings from Indonesia, some similarities in the development of telecommunications can be found from these data. Table 7.5 indicates that during the period while the telephone density is low, the number of telex terminals increases rapidly as a means of replacing telephones. Once telephone services become common to some extent, the increase of telex dwindles while telex is being replaced with facsimile. This trend is remarkable in the figures for international telex communications.

Table 7.5 Telephone and Telex Density in Malaysia

Year	Estimated Population (x 1,000)	Telex Sub.	Telex Density per 1,000	Telephone Sub.	Telephone Density per 100
1981	14,027	4,119	0.29	n.a.	n.a.
82	14,420	5,866	0.41	585,387	4.2
83	14,823	7,980	0.54	700,052	4.7
84	15,239	9,774	0.64	849,129	5.6
85	15,680	10,881	0.69	958,598	6.1
86	16,119	11,401	0.71	1,042,827	6.5

(Source: Annual Report/Jabatan Telecom Malaysia, 1986)

For reference outgoing international traffic volumes of telex, telephone and telegraph in Malaysia are shown in Table 7.6.

Table 7.6 Outgoing International Traffic Volume in Malaysia

Year	Telephone ($\times 10^6$ min.)	Telex ($\times 10^6$ min.)	Telegraph ($\times 10^6$ words)
1982	7.9	5.9	9.3
83	9.6	7.0	7.7
84	13.0	7.5	6.7
85	19.0	6.6	5.0
86	26.0	6.1	3.4

(Source: Annual Report/Jabatan Telekom Malaysia, 1986)

(4) Telex Network in Indonesia

Indonesia is currently in the course of replacing obsolete telex switching equipment and is working at expansion of its telex network.

In DKI Jakarta, the existing telex switching equipment at GB1 and SM2 are planned to be replaced with new ones along with capacity expansion. The following reasons explain the necessity of replacing those switching equipment.

a) The TWK-9 switching equipment have been used for years and are bound for degradation.

b) Digitalization of the junction network in Jakarta is in progress[1/], and it has become necessary to introduce new telex switching equipment with SPC capability.

(Refer to Fig. 5.3 and 5.4 (1/2) in Section 5.2.2 for ongoing and future projects on the telex network in Jakarta.) EDX-C, telex switch to be introduced in Indonesia, is capable of handling telex as well as teletex (circuit switching, X.21 call progress protocol, 2.4 kbps) and supports circuit switched data communications at a transmission rate of up to 9.6 kbps. However, ISDN is considered a preferable means of providing circuit switched data communications for the following reasons.

1/ OECF JKT PCM Phase 1 and Phase 2 Projects

a) Network synchronization has not been established in Indonesia.

b) Indonesia has a plan to implement ISDN in the near future.

c) CSPDN is economically suitable for long distance and large volume data transmission such as high speed file transfer. Yet great demands for such data transmission of large volume are not expected to arise for the time being.

(5) Current State of Teletex Services

West Germany, who was enthusiastic in the standardization of teletex services[1/], had started its first teletex services in March 1980 while some other European countries initiated their teletex services around 1984.

The type of the network to be used for teletex depends on the situations in respective countries; a CSPDN is most commonly adopted; some other countries use a PSPDN or a PSTN.

1/ Accepted for CCITT Recommendations in November 1980.

The standard ISDN teletex transmission rate is 2.4 kbps, which is roughly fifty (50) times as fast as telex of 50 bps. For telex services over a packet switched data network, a rate of 4.8 kbps, 9.6 kbps or 48 kbps is possible. Teletex services enable text communications while performing a local operation, such as word processing.

Teletex has emerged as a modern communication method to replace telex. There are a range of specifications regarding teletex, depending on the situation in each country. These specifications include the maximum number of terminals for duplex communications, prices of the terminals, charges, network to utilize, and conversion services between telex and teletex services.

On the other hand, the spread of teletex services has been slow. The main cause of this sluggish expansion would be because VANs, which allow facsimile and mailbox services at ease are more attractive to the users than teletex as a substitute for telex.

7.2.2 Data Communications over Leased Circuits and SKDP

There are a variety of networks over which data communications could be implemented:

- leased circuits;
- PSTN (Public Switched Telephone Network);
- CSPDN (Circuit Switched Public Data Network);
- PSPDN (Packet Switched Public Data Network); and
- ISDN (Integrated Services Digital Network).

Shown below are economical comparison of data networks types (GAS 11 Handbook); the network name in a domain indicates the most economical network type.

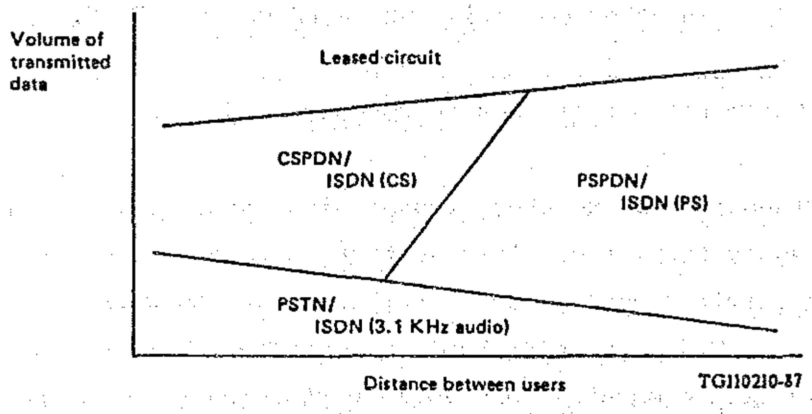


Fig. 7.1 Economical Comparison of Data Network Types (Volume-Distance)

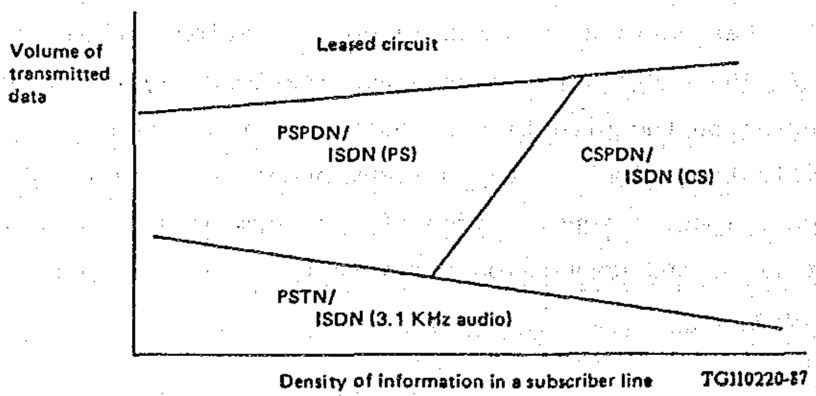


Fig. 7.2 Economical Comparison of Data Network Types (Volume-Density)

For the planning purpose, "typical user application" and "technical comparison" are attached in ANNEX 7-1. (GAS 11 Handbook)

Available for data communications in Indonesia are leased circuits, PSTN and PSPDN (=SKDP).

(1) Leased Circuits

Shown below is the growth of number of leased circuits used for data communications in Indonesia.

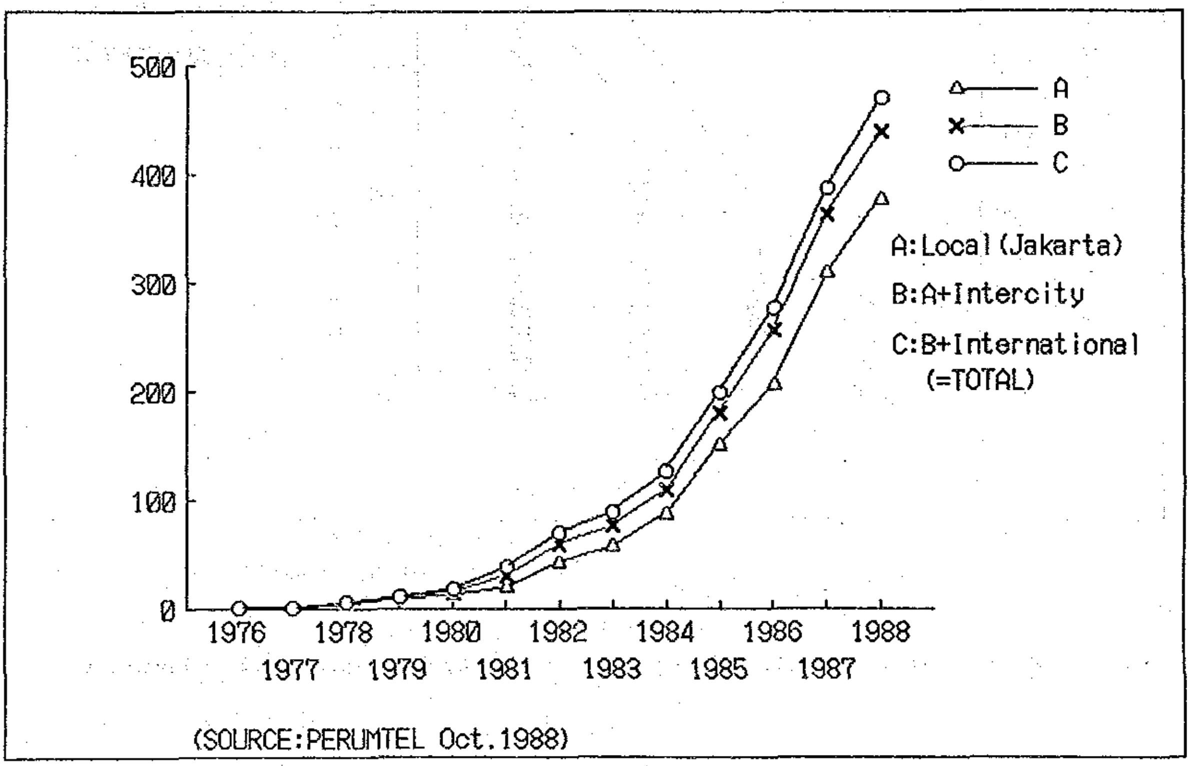
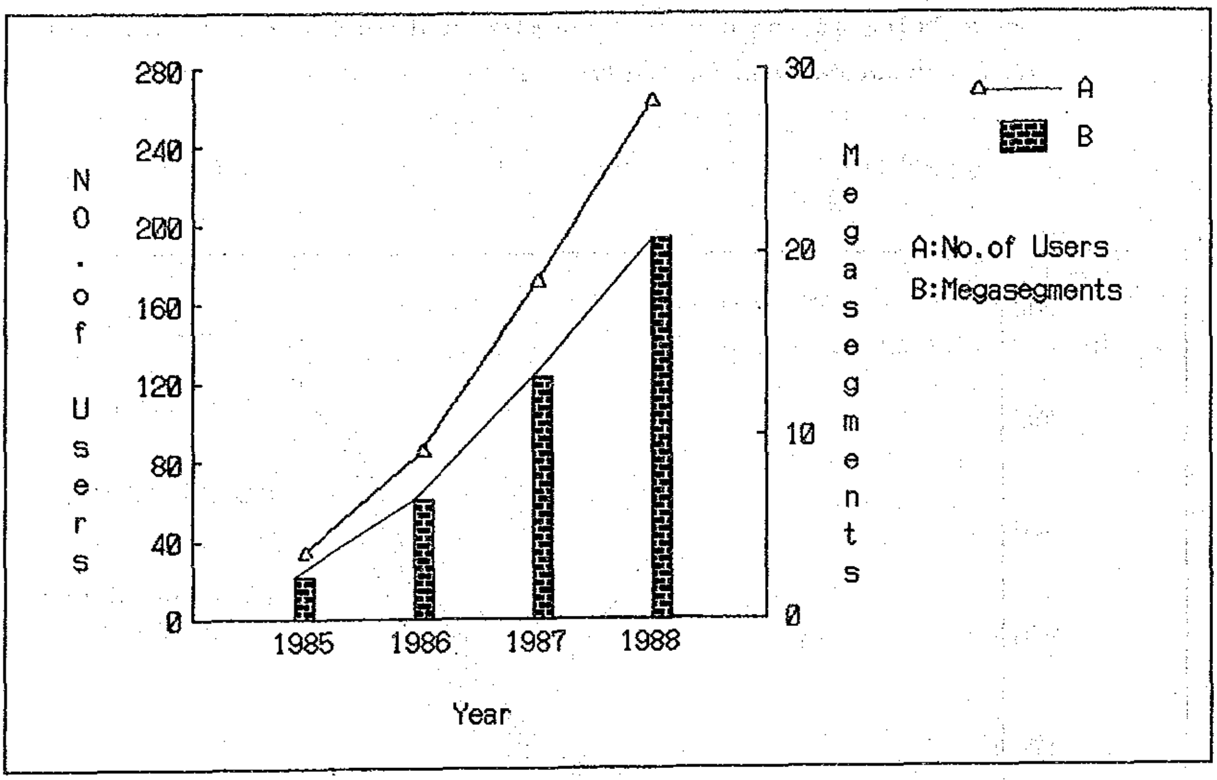


Fig. 7.3 Growth of Number of Leased Circuits Used for Data Communications

From the figure above, rapid growth of users over leased circuits has been observed (20 - 50% per annum); most of users (more than 80%, Sep. 1988) utilize leased circuits confined to data communications within Jakarta.

(2) SKDP (Packet Switched Public Data Network)

Shown below are the number of users of SKDP and volume of information transmitted over SKDP in megasegments, more than 90% of which is for international calls. Domestic calls are likely to be stimulated in accordance with the development of domestic data base.



(Source: PT. INDOSAT, Oct. 1988)

Fig. 7.4 Packet Switched Public Data Network/International + Domestic