5.2 Network Plan

5.2.1 General

Sri Lanka plans to introduce two private fixed-line telecommunications networks in 1997 overlaying to the existing one provided by SLT. The new networks will be of wireless local loop (WLL) technology for providing fixed telephone lines. As a result, Sri Lanka will have three fixed-line networks and four mobile networks for telecommunications service. The WLL network introduction will bring about impacts also to the numbering scheme, signalling plan, network synchronisation, engineering standards, and facilities plan. The probable impacts to telecommunications network plan were discussed in Sec. 3, Chap. 18, Volume II. This feasibility study was conducted taking account of the impacts.

5.2.2 Numbering Plan

(1) Numbering plan change

SLTA (Sri Lanka Telecommunications Authority) is conducting a study of the numbering plan to be applied to the new national telecommunications network. The new numbering plan will offer an orderly numbering to fixed-line networks, mobile communications networks, and other new services.

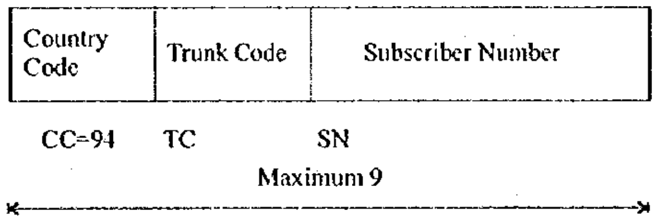
This Section intends to inform of the existing numbering plan and the direction of the numbering reform presented in SLTA's draft documents. SLT should change its existing numbering scheme in line with the new numbering plan.

(2) Number structure

Telephone number of Sri Lanka consists of Country code (CC), Trunk code (TC) and Subscriber number (SN). The CC is "94" in accordance with ITU-T Rec. E. 163. Figure 2-5-1 shows the existing number structure of Sri Lanka. The maximum number of digits of the telephone number (CC + TC + SN) of Sri Lanka is 9.

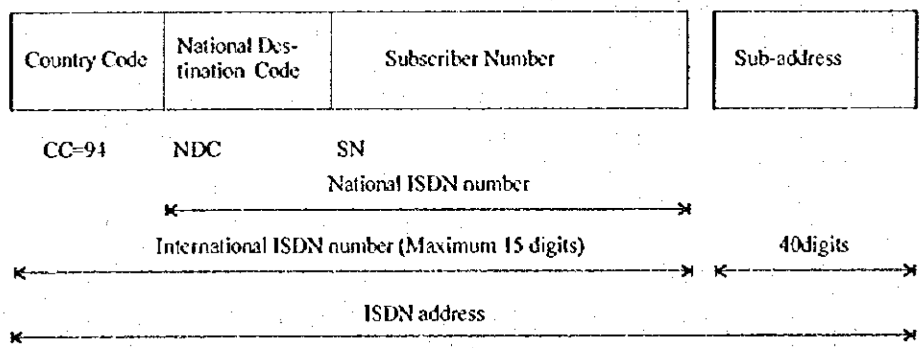
Sri Lanka plans to introduce an Integrated Services Digital Network (ISDN) in future. ITU-T Rec. E.164 recommends the number structure for ISDN era as shown in Figure 2-5-2.

The existing number structure should be modified to the structure of ISDN era when ISDN is introduced in addition to the existing SLT basic service network.



Source: ITU-T.

Figure 2-5-1 Existing Number Structure of Sri Lanka



Source: ITU-T.

Figure 2-5-2 Number Structure for ISDN Era

The national significant number, or the part consisting of TC and SN, in SLT network is 6 to 7 digits in length. TC varies 1 to 3 and SN varies 6 to 3 in digit. Colombo has 1-digit TC and 6-digit SN, Galle and Kandy have 1-digit TC and 5-digit SN. The SN consists of two parts; the first part corresponding to the switching unit (hereinafter referred to as exchange code) and the second corresponding to the subscriber line (hereinafter referred to as subscriber number). The combination of the number of digits of TC and SN (exchange code + subscriber number) can be classified into 8 patterns as shown in Table 2-5-10.

Table 2-5-10 Patterns of Existing National Significant Number

Code	A	B	C	D	E	F	G	H	Example
Pattern A	TC	1	2	3	4	5	6		Colombo
Pattern B	TC	1	2	3	4	5	6		Colombo
Pattern C	TC	1	2	3	4	5			Galle, Kandy
Pattern D	TC	TC	1	2	3	4	5		Kalutara, Kulunegara
Pattern E	TC	TC	1	2	3	4	5		Matugama, Neboda
Pattern F	TC	TC	1	2	3	4			Anuradhapura
Pattern G	TC	TC	1	2	3	4			Awiswella
Pattern H	TC	TC	TC	1	2	3			Deniyana, Nawalapitiya, Weligama

TC: Trunk code

(shaded): Exchange code

(blank box): Subscriber number

Source: SLT.

(3) Special Service Numbers and Prefix Code of Existing Plan

SLT provides some 3-digit special numbers for the services to public. Table 2-5-11 shows the 3-digit numbers with corresponding services. In addition to the numbers shown in Table 2-5-11 SLT has fault reporting numbers such as "121", "122", "123", "124", "128", "128" and normal telephone numbers, the assignment of which is different by calling party's exchange code.

Thus the many 3-digits numbers differs by exchange. SLT should uniform all the 3-digit numbers by service so that one service item shall have only one 3-digit number regardless where the caller is, under this project or taking an earlier opportunity, in accordance with the guidance by the numbering regulatory authority or SLTA.

Table 2-5-11 3-digit Special Numbers for Public Services

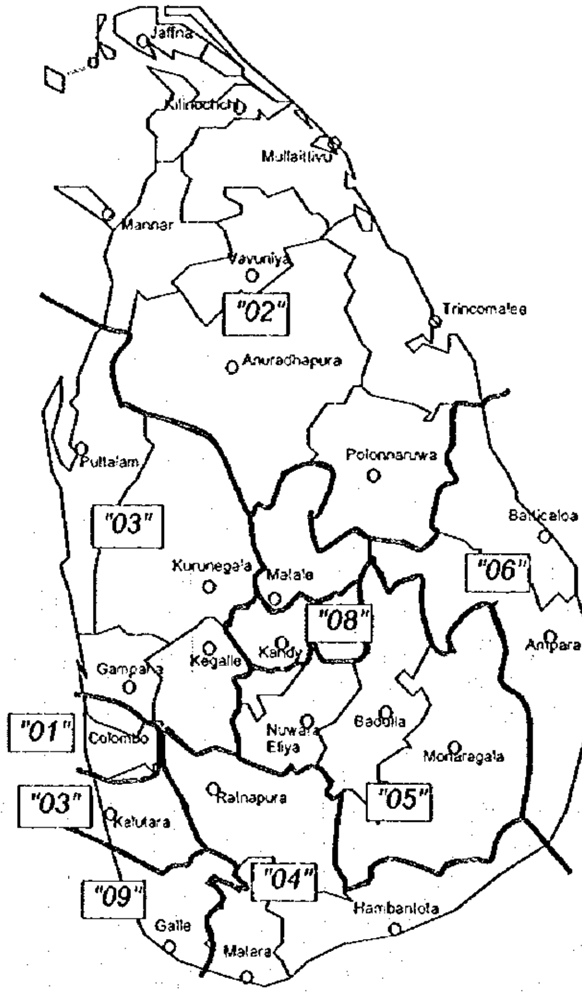
Service	Area A	Area B	Area C
Priority booking	120	-	-
Local & trunk bookings (Operator-assisted STD & Non STD)	101	101	101
Trunk enquiries (Regarding charges, interruptions and delay of calls)	101	141	141
Operator-assisted alarm calls	101	101	-
Directory enquiries (Regarding telephone numbers not in the directory	161	161	161
Time	104	101	101
Phonograms	133	133	133
International booking	100	101	144
International enquiries	134	101	101

Area A: Colombo Secondary Centre area.
Area B: Avissawella, Gampaha, Kalutara, Negombo and Panadura Secondary Centre areas.
Area C: Province.

Source: SLT.

In addition to the numbers shown in above table, several special numbers are used for the facilities such as a) Abbreviated dialling service, b) Absentee service, c) Call waiting service, d) Call forwarding service. These numbers start with "*" or "#" in some exchanges and with "14" in others.

The escape code or the trunk call prefix is "0". SLT divides the Island into 8 geographical areas giving TCs starting with "1","2", "3", "4", "5", "6", "8", and "9", respectively. The TC starting with "7" is assigned to the networks operated by entities other than SLT. "00" (including the escape code "0") is used for the international calls. Figure 2-5-3 shows the correspondence of the first digit of TC with prefix "0" and the geographical areas.



Source: SLT.

Figure 2-5-3 Existing Trunk Code First Digit

(4) Secondary Switching Centre Areas and Their Trunk Codes

SLT has four Tertiary Switching Centres (TSC) and 28 Secondary Switching Centres (SSCs) coming under TSCs. SLT distributes the SSCs in the whole Island giving one TC respectively. For a trunk call, the SSC trunk code is dialled before the exchange code and subscriber number. Colombo, Galle and Kandy have 1-digit TC and others have 2- to 3-digit TC. Table 2-5-12 shows the existing SSCs and their TCs.

Table 2-5-12 SSCs and Their Trunk Codes

TSC	SSC	Trunk code	TSC	SSC	Trunk code
Anuradhapura	Anuradhapura	25	Galle	Galle	9
	Jaffna	21		Hambantota	47
	Mannar	23		Matara	41
	Polonnaruwa	27		Ratunapura	45
	Trincomalee	26	Kandy	Ampara	63
	Vavuniya	24		Badulla	55
Colombo	Awissawella	36		Bandarawela	57
	Chilaw	32		Batticaloa	65
	Colombo	1		Hatton	512
	Gampaha	33		Kalmunai	67
	Kalutara	34		Kandy	8
	Kegalle	35		Matale	66
	Kurunegala	37		Nawalapitiya	542
	Negombo	31		Nuwara Eliya	52

Source: SLT.

(5) Present Number Capacity

(a) Destination Network Codes

Several private networks exist in Sri Lanka. Sri Lanka Telecommunications Authority (SLTA) intends to introduce, at a first estimate, 6 entities for Cellular service, 6 entities for paging service, and several entities for data communications network service. Some of them have inaugurated the services. Among them Mobitel, Celltel, Air Lanka, MTN and Call Link are identified by trunk codes "71", "72", "73", "77", and "78". The rest of trunk codes are recognised as the trunk codes of Sri Lanka Telecom (SLT) network. The trunk codes are used practically as the destination network (DN) codes. Table 2-5-13 shows the existing assignment of the first and second digits of NSN of Sri Lanka.

Table 2-5-13 Existing Assignment of the First and Second Digits of NSN of Sri Lanka

	B									
A	0	1	2	3	4	5	6	7	8	9
0		International	International	International	International	International	International	International	International	International
1			Colombo	Colombo	Colombo	Colombo	Colombo	Colombo	Colombo	Colombo
2		Jaffna		Mannar	Vavunia	Anuradhapura	Trincomalee	Polonnaruwa		
3		Negombo	Chilaw	Gampaha	Kalutara	Kegalle	Avissawella	Kurunegala		
4		Matara				Ratnapur		Hambantota		
5		Hatton	Nuwara Eliya		Nawalapitiya	Badulla		Bandarawela		
6				Ampara		Batticaloa	Matale	Kalmunai		
7		Mobitel	Celltel	Air Lanka				MTN	Call Link	
8			Kandy	Kandy	Kandy					
9			Galle	Galle	Galle	Galle	Galle			

Source: SLT.

Trunk codes starting with "7" are assigned to the networks operated by entities other than SLT. However, free (not used) codes are few as found in Table 2-5-13. It is not sufficient to meet the planned numbers of new entrants. New services will require new trunk codes or destination network codes in future.

(b) Trunk codes of SLT network

SLT uses the NSN first digits "1" to "9" except "7", which is assigned as DN code for private companies' network, for providing the trunk codes (TC). The SLT trunk code consist of two digits except that of Galle, Colombo and Kandy. SLT keeps vacant 2-digit combinations more than 30 at present as found in Table 2-5-13, which are available for new SSCs to be introduced in future. Hence, the trunk code numbering capacity of SLT is sufficient if SLT remains with the existing numbering scheme.

(c) SLT Exchange codes and subscriber numbers

i) Colombo area

Colombo area is numbered by a six-digit numbering system. Table 2-5-14 shows present assignment of exchange codes and subscriber numbers. The numerical letters indicate the exchange codes and the digits shown by "xxx" indicate the subscriber number.

Table 2-5-14 Present Assignment of Exchange Codes and Subscriber Numbers in Colombo (as of Dec. 1994)

LOCAL AREA	Existing Demand (June 1994) Total	DEL	Waiters	Present No. Plan
ANGODA	2,154	326	1,828	578xxx
BORALESGAMUWA	2,564	1,473	1,091	509xxx/518xxx
CENTRAL	44,106	35,428	8,678	
HAVELOCK	22,535	17,885	4,650	
HOKANDARA	1,443	178	1,265	561xxx
HOMAGAMA	2,526	482	2,044	855xxx,857xxx
JA-ELA	5,672	1,323	4,349	536xxx-537xxx
KADAWATHA	3,786	656	3,130	525xxx
KADUWELA	1,442	193	1,249	5710xx-5714xx
KATUNAYAKE	4,599	1,687	2,912	452xxx-453xxx
KELANIYA	7,249	1,541	5,708	520xxx-521xxx
KOLLUPITIYA	6,770	4,047	2,723	573xxx-577xxx
KOTTE	16,556	7,158	9,398	862xxx-869xxx 87xxxx-89xxxx
MAHARAGAMA	9,013	1,543	7,470	850xxx-851xxx/84xxxx
MALWANA	1,399	419	980	5715xx-5719xx
MARADANA	17,682	13,506	4,176	69xxxx,683xxx-688xxx
MATTAKKULIYA	3,799	2,335	1,464	522xxx-524xxx
MATTEGODA	250			
MORATUWA	4,721	1,467	3,254	64xxxx
MT.LAVINIA	13,140	8,744	4,396	71xxxx,72xxxx
MT.LAVINIA CSE	2,639	2,639		
NUGEGODA	18,175	12,965	5,210	852xxx-854xxx 856xxx 80xxxx-83xxxx
PADUKKA	865	158	707	858xxx-859xxx
PILIYANDALA	4,511	587	3,924	504xxx
RADDOLUGAMA	250			
RAGAMA	2,451	461	1,990	538xxx
RATMALANA	6,039	5,015	1,024	605xxx,607xxx 62xxxx-63xxxx
WATTALA	5,776	1,374	4,402	503xxx,531xxx
WELLAMPITIYA	1,996	442	1,554	572xxx
COLOMBO	214,108	124,032	89,576	
Details of Central and Havelock exchanges				
CENTRAL NORTH	9,332	654	8,678	544xxx
CENTRAL CITY	15,972	15,972		421xxx-423xxx 43xxxx/44xxxx
CENTRAL SESS	18,802	18,802		32xxxx-33xxxx
HAVELOCK	18314	13664	4650	500xxx-503xxx ,58xxxx,508xxx
HAVELOCK TDM	4221	4221		59xxxx

Source: SLT.

This area has around 67% of the total equipped exchange capacity 237,586 of SLT. A six-digit numbering capacity is 500,000 to 600,000 subscriber lines practically. In this sense, the existing numbering capacity is sufficient to the equipped capacity in Colombo. It will be insufficient, however, in some exchanges when switching system capacity expansion is planned.

ii) Areas other than Colombo

The number capacity is sufficient as a whole, but tight in some exchanges. In many exchanges, the subscriber number range is planned by a range of 10 to several hundreds.

(6) Expansion of Numbering Capacity

(a) General

The numbering plan of Sri Lanka is under study by the numbering plan regulatory authority or Sri Lanka Telecommunications Authority (SLTA). Accordingly, the numbering capacity of SLT network should be expanded in keeping with the study by SLTA. The following is a draft idea presented by SLTA as at November 1995.

(b) Length of NSN

A unified telephone number length system will be applied to all the fixed telephone networks in Sri Lanka. The length is planned to be 8 in digit of a closed numbering scheme.

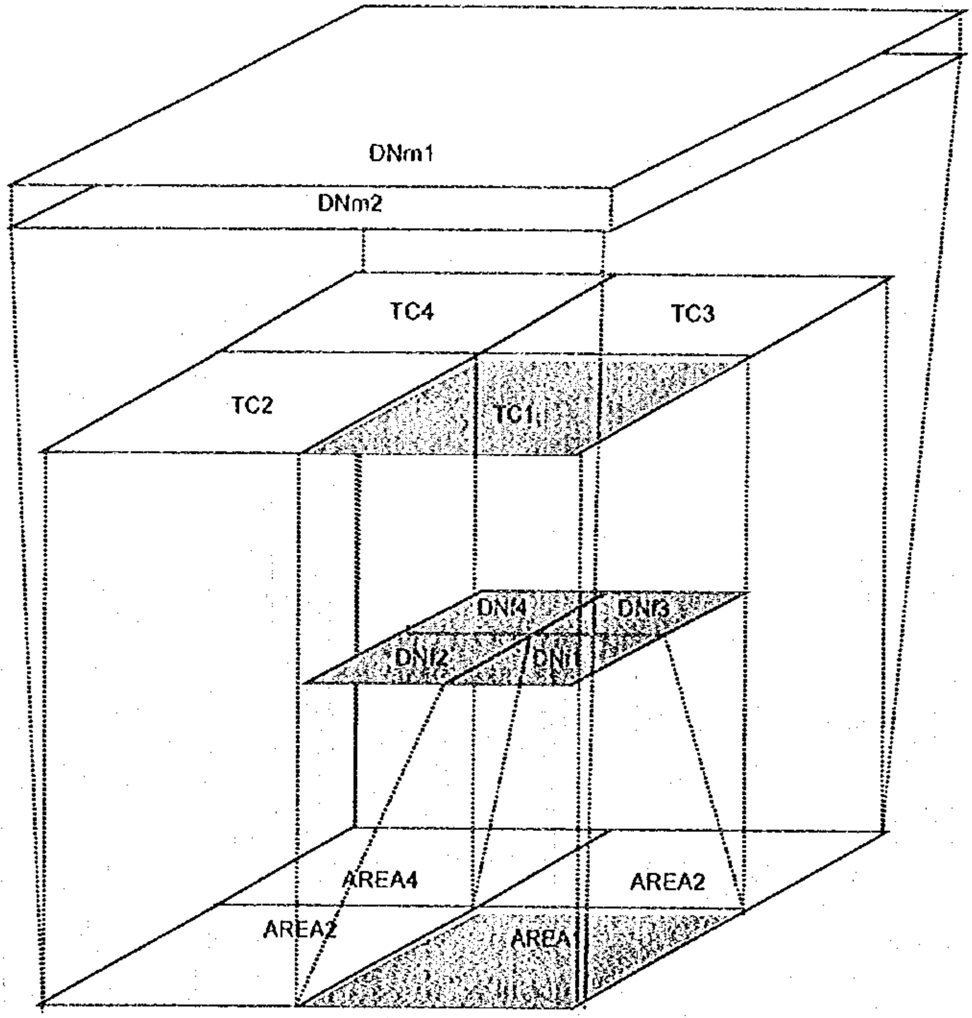
(c) Destination Network Code

In the case of fixed telephone line network, the destination network code (DNC) will be consisted in the order a) Area code, b) Network provider's code, and c) exchange code and subscriber number. While, the non-geographical network number structure will not be changed drastically.

Figure 2-5-4 shows the idea of numbering scheme of DNC to be applied to the Sri Lankan telecommunications networks after WLL network participation. In Figure 8-2-9, it is found that one TC (TC1) corresponds to one AREA (AREA1), but four DNs correspond to that area (AREA1).

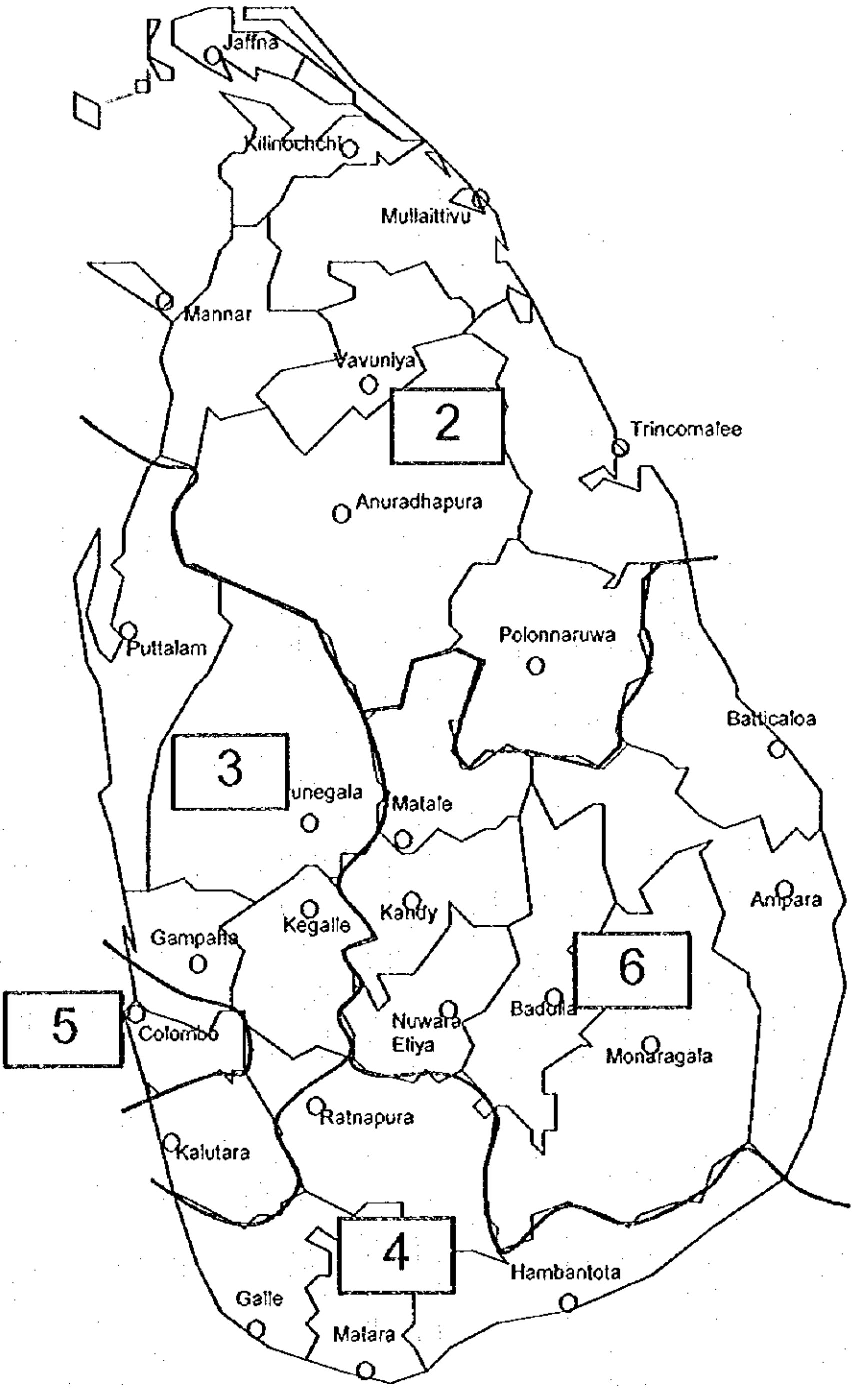
SLTA intends to reduce the number of trunk call areas. The trunk call areas or the SSC areas are 28 at present. It will be reduced to five areas.

Figure 2-5-5 shows the first digit assignment of the fixed-line networks in Sri Lanka after the introduction of a closed numbering scheme. Table 2-5-15 shows the planned DNC table.



Source: JICA Study Team (derived from SLT and SLTA information).

Figure 2-5-4 DNC Scheme after WLL Network Introduction (Draft)



Source: SLTA.

Figure 2-5-5 Closed Numbering First Digit Assignment in Future (Draft)

Table 2-5-15 Planned DNC in Future (Draft)

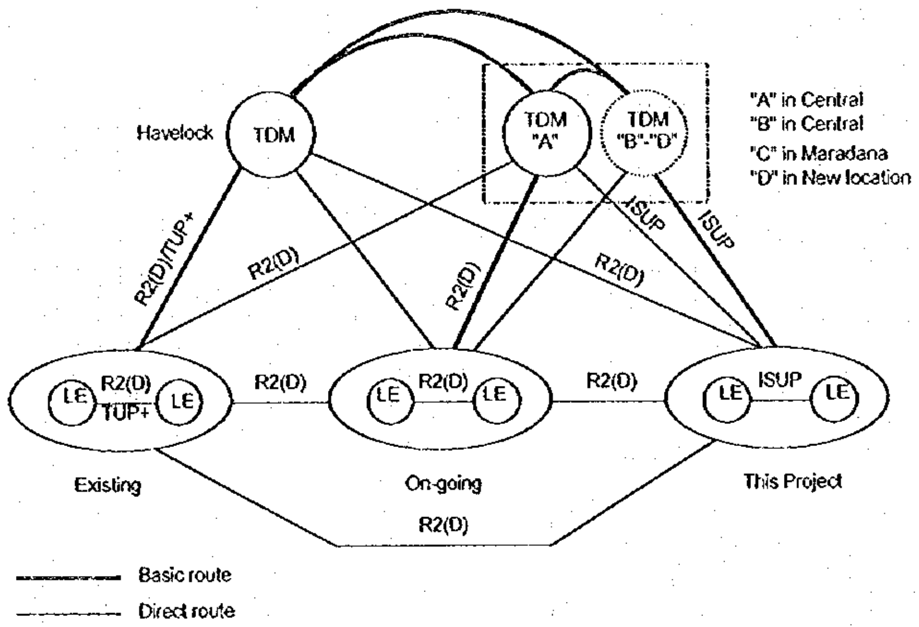
		1	2	3	4	5	6	7	8	9	0
1	Short Codes	Short Codes	Short Codes	Short Codes	Short Codes	Short Codes	Short Codes	Short Codes	Short Codes	Short Codes	Short Codes
2	North Region	Jaffna, Mannar, Vavuniya				Anuradhapura, Trincomalee, Polonnaruwa			New WLL Operators	Reserve	
3	Outer Colombo Region	Negombo, Chilaw		Gampaha	Kalutara	Kegalle	Awissawella	Kurunegala	New WLL Operators	Reserve	
4	South Region	Galle, Matara				Ratnapura		Hambantota	New WLL Operators	Reserve	
5	Colombo	Colombo (SLT start)						Colombo business networks	New WLL Operators	Reserve	
6	Centre East Region	Kandy		Nuwara Eliya, Nawalapitiya, Hatton		Batticaloa, Kalmunai, Ampara	Matale	Badulla, Bandarawela	New WLL Operators	Reserve	
7	Mobile	Mobitel	Celltel				Paging	MTN	Call Link	Reserve	
8	New Services	Local call rate							Nationally portable range	Reserve	Freephone
9	Reserve New Services	Value added services	Reserve	Reserve	Reserve	Reserve	Reserve	Reserve	Reserve	Reserve	Premium rate
0											International access

Source: SLTA.

5.2.2 Signalling system

The new network should be linked at all hierarchical levels by applying standard CCS No. 7 recommended by ITU-T. Blue Book specifications are preferable as applied in many countries. However, White Book specifications may be applied if they are substantially used world-wide when this project starts. Replacing conventional signalling systems by CCS No. 7 is a world trend to step into the ISDN era. Some links may remain with conventional signalling system, however, where the destination switch cannot meet this requirement.

The new tandem switch to be introduced under the on-going project should be equipped with standard CCS No. 7 of ITU-T Blue Book. All the new exchanges to be introduced under this project will be equipped with standard CCS No. 7 of ITU-T Blue Book. Figure 2-5-6 shows a proposed signalling links between LEs and tandem exchanges. In Figure 2-5-6 Central TDM "B" to "D" present the virtual of TSC switching systems.



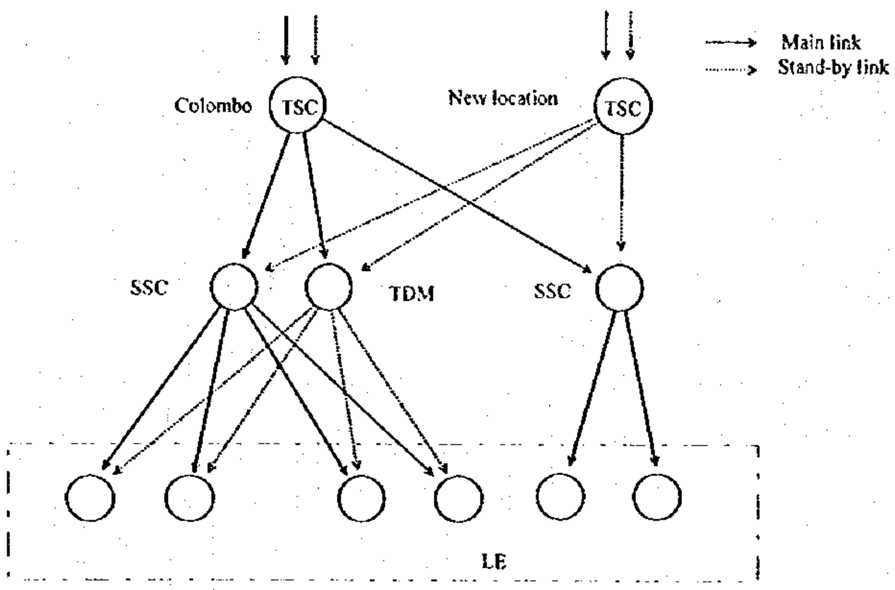
Source: JICA Study Team.

Figure 2-5-6 Signalling Links between Local and Tandem Exchanges

5.2.3 Network Synchronisation

(1) Reference clock network structure

SLT reference clock network should be established in a tree form. National Switching Centre (NSC) and Tertiary Switching Centres (TSC) will come under ISCs, Secondary Switching Centres (SSC) will come under TSCs, Local Exchanges (LE) will come under SSCs, in principle. The reference clock links should be consisted of main and stand-by links. The reference clock pulses will be transferred from ISC to NSC and TSC, from TSC to SSC, and from SSC to LE. Figure 2-5-7 shows a proposed reference clock network in Colombo TSC area.



Source: JICA Study Team.

Figure 2-5-7 Reference Clock Network in Colombo TSC Area

(2) Reference Clock Accuracy and Stability

ISC by 5-ESS (herein after referred to as ISC-A) and ISC by NEAX 61-E (herein after referred to as ISC-B) are equipped with a reference clock of accuracy of 10^{-11}, respectively, to satisfy the requirements of slip rate recommended by ITU-T. The existing switching systems other than that of ISC, that is, NSC switches and LE switches of E-10B, OCB-283, NEAX-61, and DX-220/210 are equipped with a clock module with stability of 10^{-10} per day.

The new ISC to be introduced in new location (hereinafter referred to as ISC-C) shall be equipped with a reference clock of accuracy of 10^{-11} in conformity with the slip rate defined by ITU-T Rec. G. 823/824. All digital exchanges to be introduced in future should be equipped with a clock module of stability of 10^{-10} in Colombo SSC Area.

(3) Reference Clock Supply to Other Networks

For the network synchronisation between SLT network and other networks provided by other entities, it is preferable that SLT supplies reference clock pulses to the others through its TSCs. National reference clock supply plan should be decided by SLTA and indicated to the network operating entities concerned.

5.2.4 Engineering Standards

(1) Traffic engineering

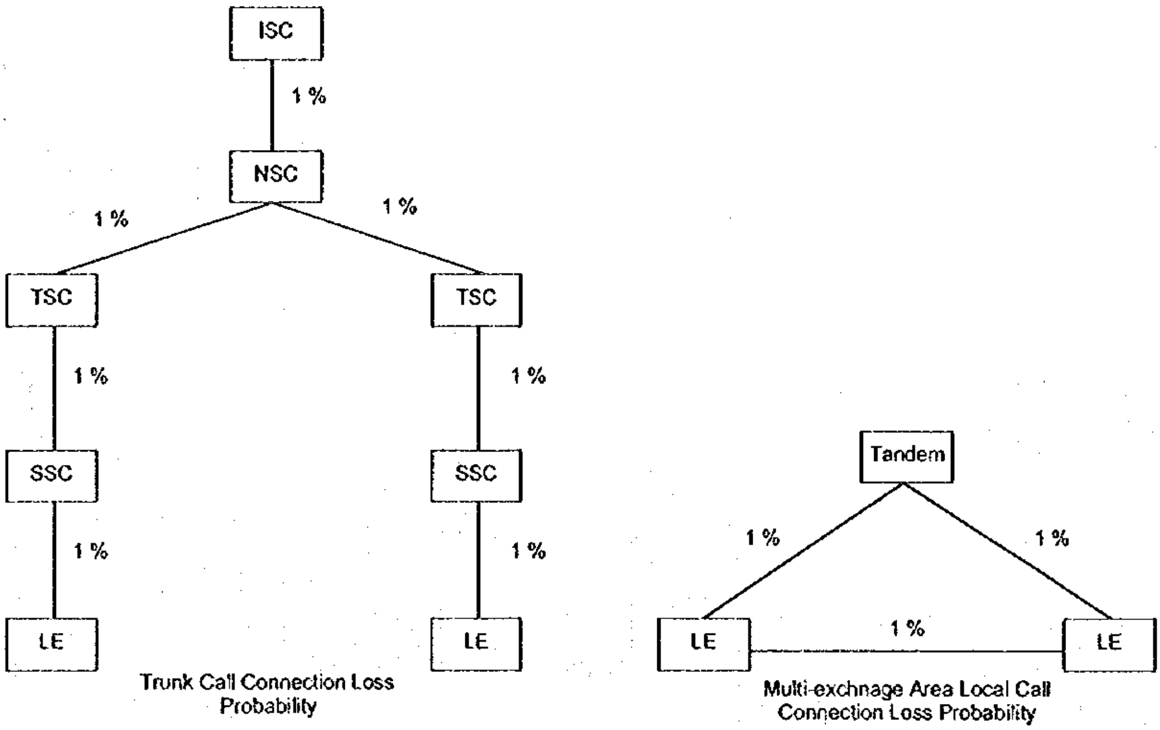
The following standard of loss probability to connections between two exchanges should be applied to the network under this project.

a) Overall loss probability of connection between two local exchanges at worst case:

for trunk traffic:	6 %.
for multi-exchange area traffic:	2 %;

b) Connection loss probability distribution:

for basic route:	1 % per link (See Figure 2-5-8.);
for short-cut route:	1 % per link.



Source: JICA Study Team.

Figure 2-5-8 Connection Loss Probability between Two Exchanges

Design objective of probability of inadequately handled call attempts occurring in a digital exchange should be as shown in Table 2-5-16.

Table 2-5-16 Probability of inadequately handled call attempts

Type of connection	Reference load A	Reference load B
Internal	10^{-2}	4×10^{-2}
Originating	5×10^{-3}	3×10^{-3}
Terminating	5×10^{-3}	3×10^{-3}
Transit	10^{-3}	10^{-2}

Source: ITU-T REC. Q. 543.

(2) Transmission Performance

There are so many factors affecting transmission performance, and the standard for them is recommended by ITU-T. Loudness Rating (LR) and Bit Error Rate (BER) are regarded as main performance measures in general. Table 2-5-17 shows details of loudness ratings recommended by ITU-T.

Table 2-5-17 Values of Sending, Receiving, Circuit and Overall Loudness Rating

		SLR (dB)	RLR (dB)	CLR (dB)	OLR (dB)
Optimum value					≈ 10
Traffic-weighted mean values	long-term objective	7 - 9	1 - 3	(Note 1)	8 - 12
	short-term objective	≤ 15	≤ 6	(Note 1)	≤ 21
an average-sized country		≤ 16.5	≤ 13	n x 0.5 (Note 2)	
Minimum for Sending		-1.5			

Note 1: CLR = 0 for a digital international circuit, 0.5 dB for an analogue one. The average number of international circuits is about 1.

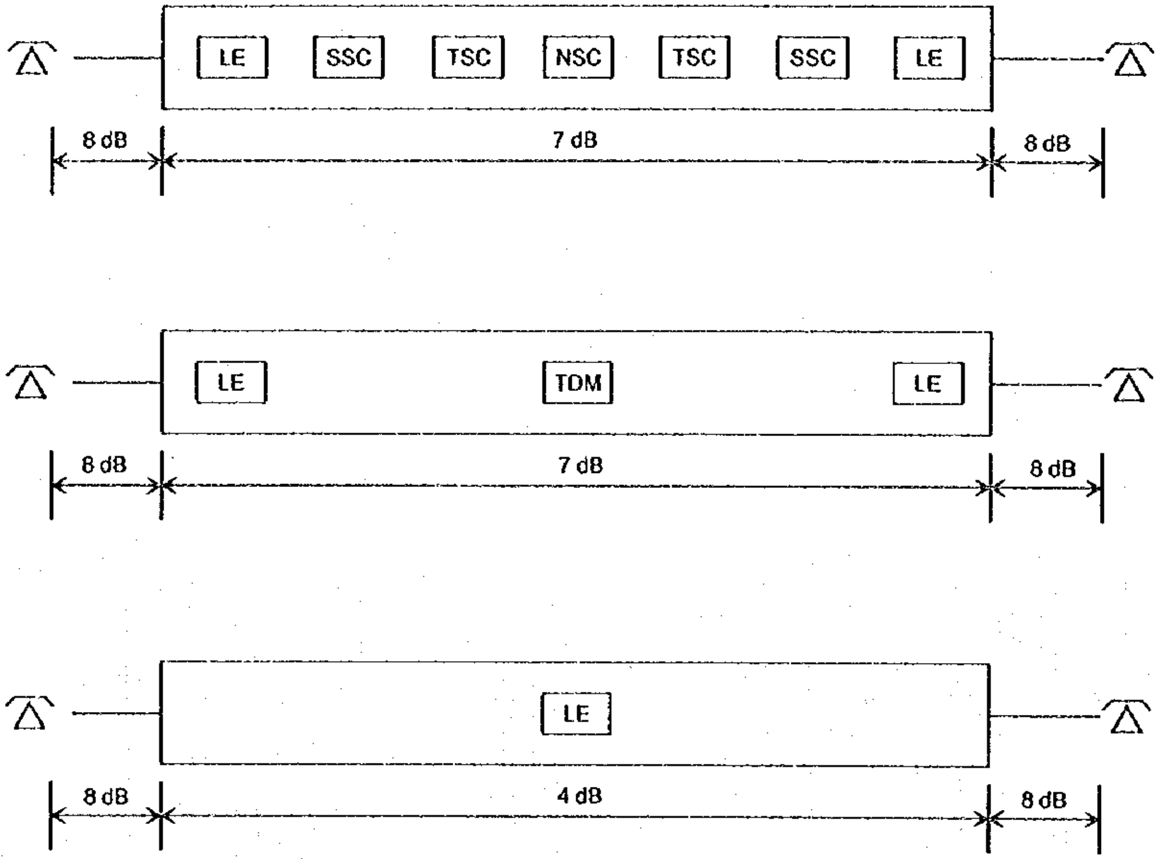
Note 2: n is the number of analogue international circuits.

Note 3: These values are for international connections, so CLR values are for international system inserted in two national systems.

Note 4: SLR and RLR values are at a 0 dBr point.

Source: ITU-T Recommendation G.111

Figure 2-5-9 shows the example of LR allocation in the SLT network.



Source: JICA Study Team.

Figure 2-5-9 Transmission Loss Allocation

Bit Error Rate (BER), which means the ratio of the errored bit to the whole bit number in long measuring period, have been employed as the bit error performance indicator of the digital transmission system. But, BER has the weak point that it cannot indicate the proper performance for the data signal, facsimile signal, video signal and etc. which affected by the bit error in the very short period such as burst bit error because the measurement is carried out on the long period base.

So, ITU-T provides the percentage of error performance degraded intervals for the 64 kbit/s circuit-switched connection used for voice traffic or as a "Bearer Channel" for data-type services. The error performance objectives for international ISDN connections are shown in the Table 2-5-18 below.

Table 2-5-18 Error Performance Objectives for International ISDN Connections

Performance Classification	Objective
Degraded Minutes (%DM)	Fewer than 10% of one-minute intervals to have a bit error ratio worse than 1 x 10^{-6}.
Severely Errored Seconds (%SES)	Fewer than 0.2% of one-second intervals to have a bit error ratio worse than 1 x 10^{-3}.
Errored Seconds (%ES)	Fewer than 8% of one-second intervals to have any errors. (equivalent to 92% of error-free seconds.)

Source: ITU-T Recommendation G.821

40% of the above objectives are allocated to the international section in the international hypothetical reference connection (HRX). These error performance indicators are regarded more suitable for the recent digital network.

5.2.5 Charging System

(1) Call unit

The automatic telephone call of SLT network is charged in proportion to its duration. The duration is converted to equivalent number of call units based on the tariff. Table 2-5-19 shows the time allowed for one call unit.

Table 2-5-19 Time Allowed for One Call Unit

Call class	Time allowed for one unit	
	Standard rate 08:00 to 18:00	Cheap rate 18:00 to 08:00
Between two subscribers of the same primary/secondary centre area	120 seconds	240 seconds
Between any two secodary centre areas	50 seconds	100 seconds

Source: SLT.

The duration of every call is calculated by the time shown in Table 2-5-19 and converted to call units to record as charge data at automatic exchange. Digital exchanges have the function to record the call charge data stored in the call charge accumulator corresponding to each subscriber number on suitable data media. Analogue cross-bar exchanges without such function have call meters corresponding to each subscriber number. Step-by-step exchanges have no function of trunk call charging and their subscribers are requested to ask operators for the trunk calls.

(2) Charging Node

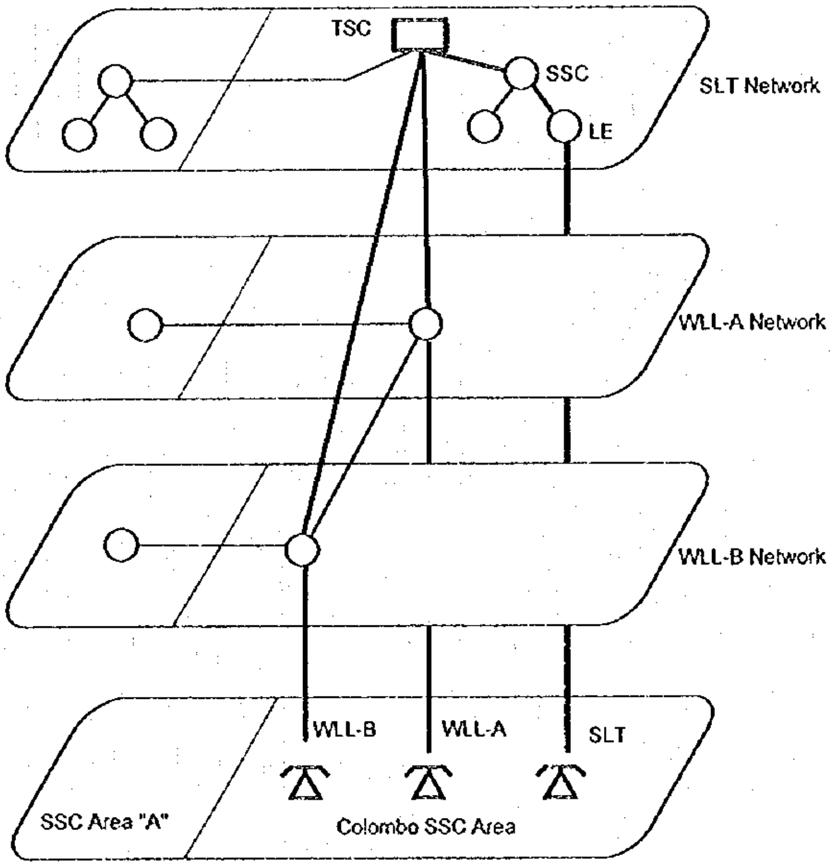
The charge nodes should be local exchanges of main exchange type, secondary switching centres, international switching centres and gate-way switches.

In the objective area, the local switching system to be introduced under this project should be equipped with a function of detailed billing for trunk calls in addition to the local call charging function.

International calls should be charged at international switching centre. As to the inter-network calls, the call charge data should be obtained at SLT gate way switches, i.e., NSC and TSC. Charges for advanced services allowed by IN system will be controlled by NSC.

5.2.6 Interconnection with WLL networks

The *"Invitation for wireless local loop operators' licences" (30/Aug./1995)* stipulates that SLT's TSCs should be the interconnection points to other WLL networks. Figure 2-5-10 shows a general view of overlaid SLT and WLL new networks taking an example in Colombo SSC area.

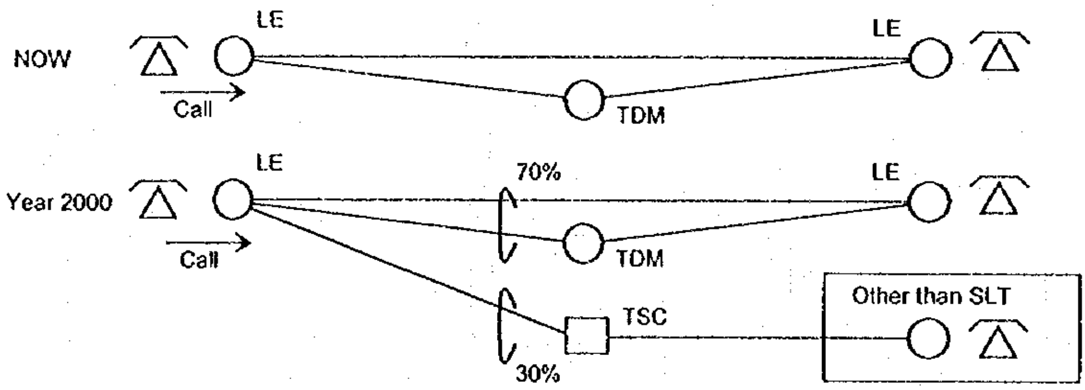


Source: JICA Study Team (derived from SLT and SLTA information).

Figure 2-5-10 Overlaid SLT and WLL Networks in 1997

SLT has a gateway switch to mobile cellular telephone networks. It is the second unit of NSC (hereinafter referred to as NSC Unit "B") which is a product of AT&T called "5-ESS" and was introduced in 1992. It has a capacity of 12,000 inter-exchange circuits. Among them 9,000 inter-exchange circuits are in use at present. It is not equipped with CCS No. 7. The capacity of this unit is not sufficient to deal with traffic demand in the year 2000. JICA Study Team recommends SLT to introduce new TSC switching units to meet the traffic in the year 2000 and requirements for the gateway switch in the multi-network era.

JICA Study Team forecast a total of 813,752 lines of demand for the fixed line network in the year 2000 including a hidden demand of 20% of expressed demand, among them 613,858 lines by SLT network. According to the JICA forecast, around one quarter of subscribers in the country will be catered by new WLL network providers in 1997. The tendency is supposed to go on for years as discussed in Cap. 1. In the case of Colombo Metro Area, as WLL networks are supposed to start their service there first, around 30 % of local call traffic will be routed to TSC. Figure 2-5-11 shows an example of traffic flow change in Colombo SSC area in the case new WLL networks are in operation as forecast in 2000.



Source: JICA Study Team (derived from SLT and SLTA information).

Figure 2-5-11 Traffic Flow after WLL Participation in Colombo in 2000

5.2.7 Switching Network

(1) Existing network

In Sri Lanka there are several private telecommunications networks besides SLT's public switched telephone network. They are private cellular telephone networks, Air Lanka network, data communications networks and others, as at 1995. The cellular telephone networks are interconnected with SLT telephone network through gateway switches. The gateway switch of SLT side is National Switching Centre (NSC).

SLT telephone network hierarchy is consisted of ISC (International Switching Centre), NSC (National Switching Centre), TSC (Tertiary Switching Centre), SSC (Secondary

Switching Centre) and LE (Local exchange). Some local exchanges are of main switching system and others are of remote unit of switching system. Figure 2-5-12 shows a general view of SLT national network.

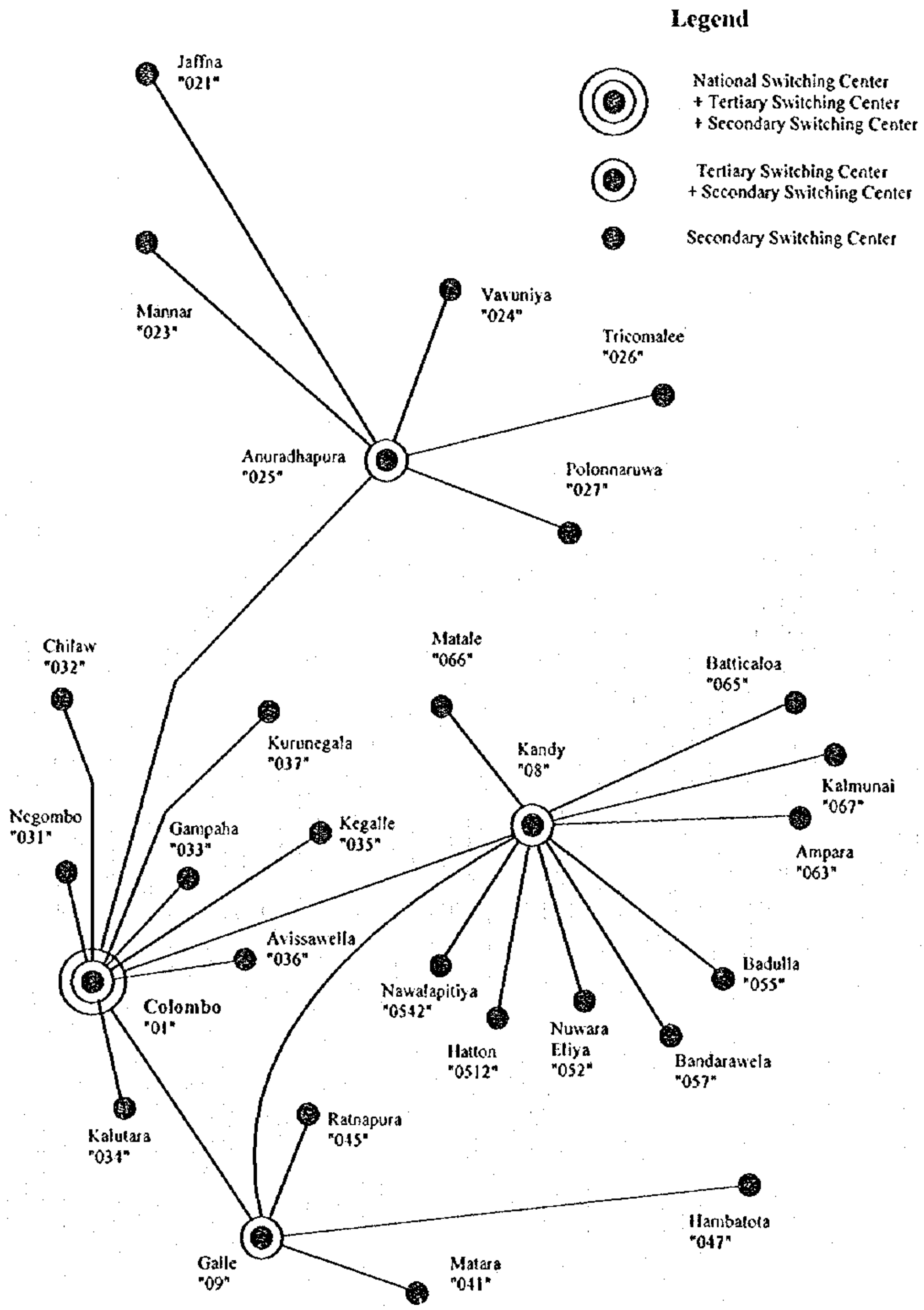
In the SLT network in Colombo Metro, there will be ISC, NSC, TSC, SSC and LE. The LE in Colombo Metro Area will comprise 19 units of main (host) switching system and 23 units of remote switching system when the on-going projects ends or in the year 1997. (Here the word "switching system" is used as defined in Rec. Q.9 of ITU-T and used as an element to form an exchange). See Table 2-5-20. Under the on-going projects, the local switching system capacity in Colombo Metro Area as many as 168,543 lines as at November 1995 will be increased up to 316,027, by introducing new units of switching system or by expanding the capacity of existing units. Some units of switching system will be replaced.

The exchanges, excluding those by remote switching system, in Colombo Metro Area are interconnected with other exchanges situated in the rest of the country through a transit switching centre situated at SLT Head Quarters. The transit switching centre is called NSC (National Switching Centre). The NSC consists of two units of switching system. The NSC assumes the function of TSC (Tertiary Switching Centre) and SSC (Secondary Switching Centre) of Colombo Metro SSC Area. That is, there is no hardware proper to TSC or SSC in this area.

The first unit of NSC (hereinafter referred to as Unit "A") is a product of NEC called "NEAX-61". It was introduced in 1981. It has approximately 700 working circuits at present being reduced its function gradually from its nominal capacity of 3,300 inter-exchange circuits. It is not equipped with CCS No. 7.

The second unit of NSC (hereinafter referred to as Unit "B") is a product of AT&T called "5-ESS" and was introduced in 1992. It has a capacity of 12,000 inter-exchange circuits. Among them 9,000 inter-exchange circuits are in use at present. It is not equipped with CCS No. 7.

The exchanges are linked in the form of mesh network. The remote switch units are placed under respective unit of main (host) switching system. Figure 2-5-13 shows the exchanges of main switching system and the remote switch unit belonging scheme in Colombo Metro Area as of April 1995.



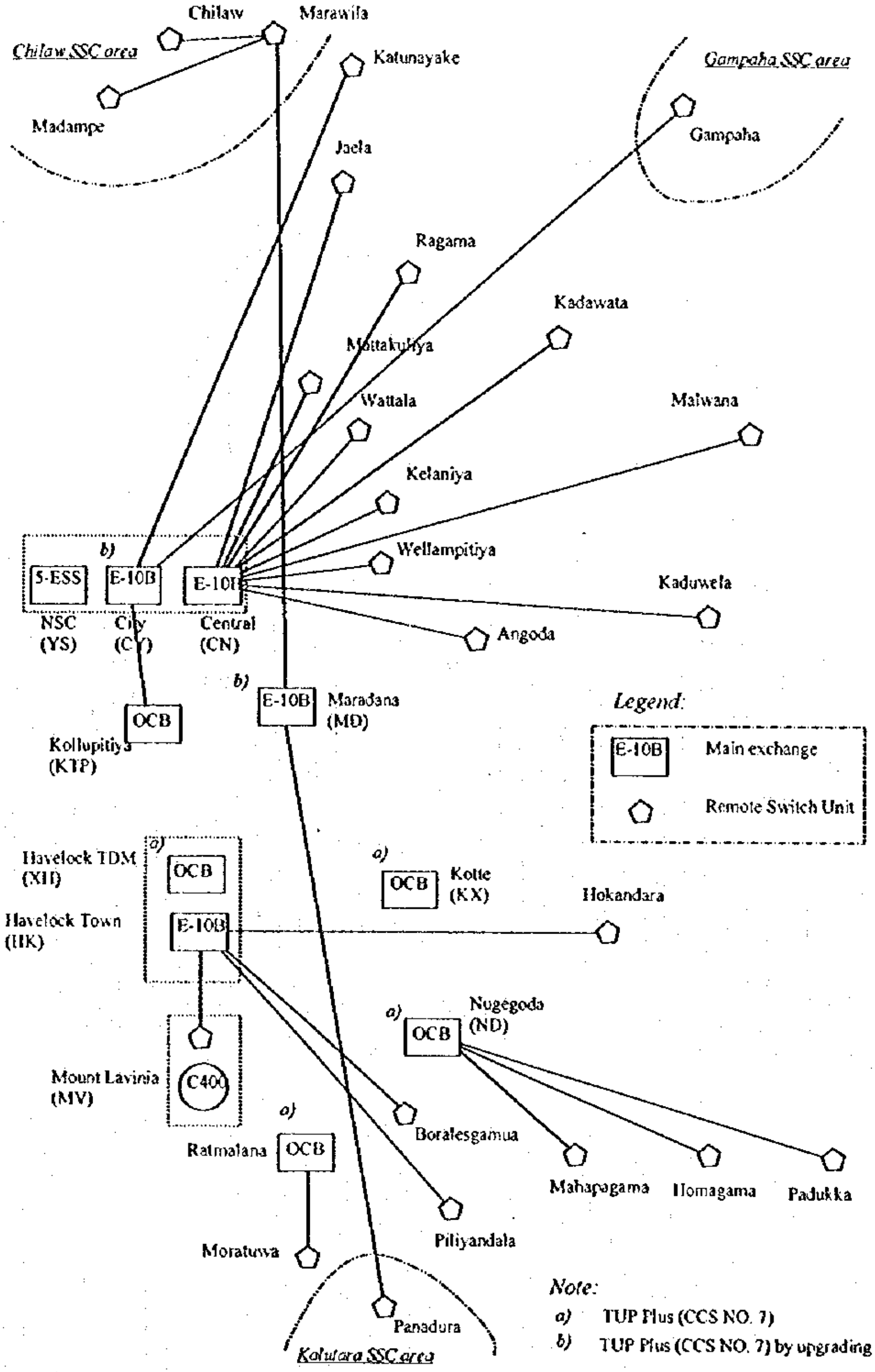
Source: SLT.

Figure 2-5-12 General View of SLT National Switching Network in 1995

SLT is now expanding its network also in Colombo Metro Area by on-going projects which are planned to be completed in 1997. Table 2-5-20 shows the planned capacity of exchanges and relation between main and remote switch units in 1997. Among them, Havelock TDM and Central TDM will be the multi-functioned switching systems of local and tandem (local transit) functions. Figure 2-5-14 shows the exchanges of main switching system and the remote switch unit belonging scheme in Colombo Metro Area in 1997 based on the plan as of September 1995.

In the Table 2-5-20, the exchanges categorised in Group "A" are those which were introduced before the on-going projects started. They are equipped with R2 (A), R2 (D), and modified Common Channel Signalling (CCS) No. 7. OCB-283 exchanges and E10-B of Central City, which are the products of CIT-Alcatel, are quipped with a modified CCS No. 7, called "TUP Plus". Their signalling function will not be modified under the on-going projects.

In the Table 2-5-20, the exchanges categorised in Group "B" are those which are under installation or to be introduced under the on-going projects. AXE-10 exchanges are equipped with R2 (A) and R2 (D), but not CCS No. 7. There is no plan in foreseeable future to equip them with CCS No. 7. Other exchanges marked with N.K. are under tender procedures. The tender specification claims the new exchanges be equipped with CCS No. 7.



Source: JICA Study Team.

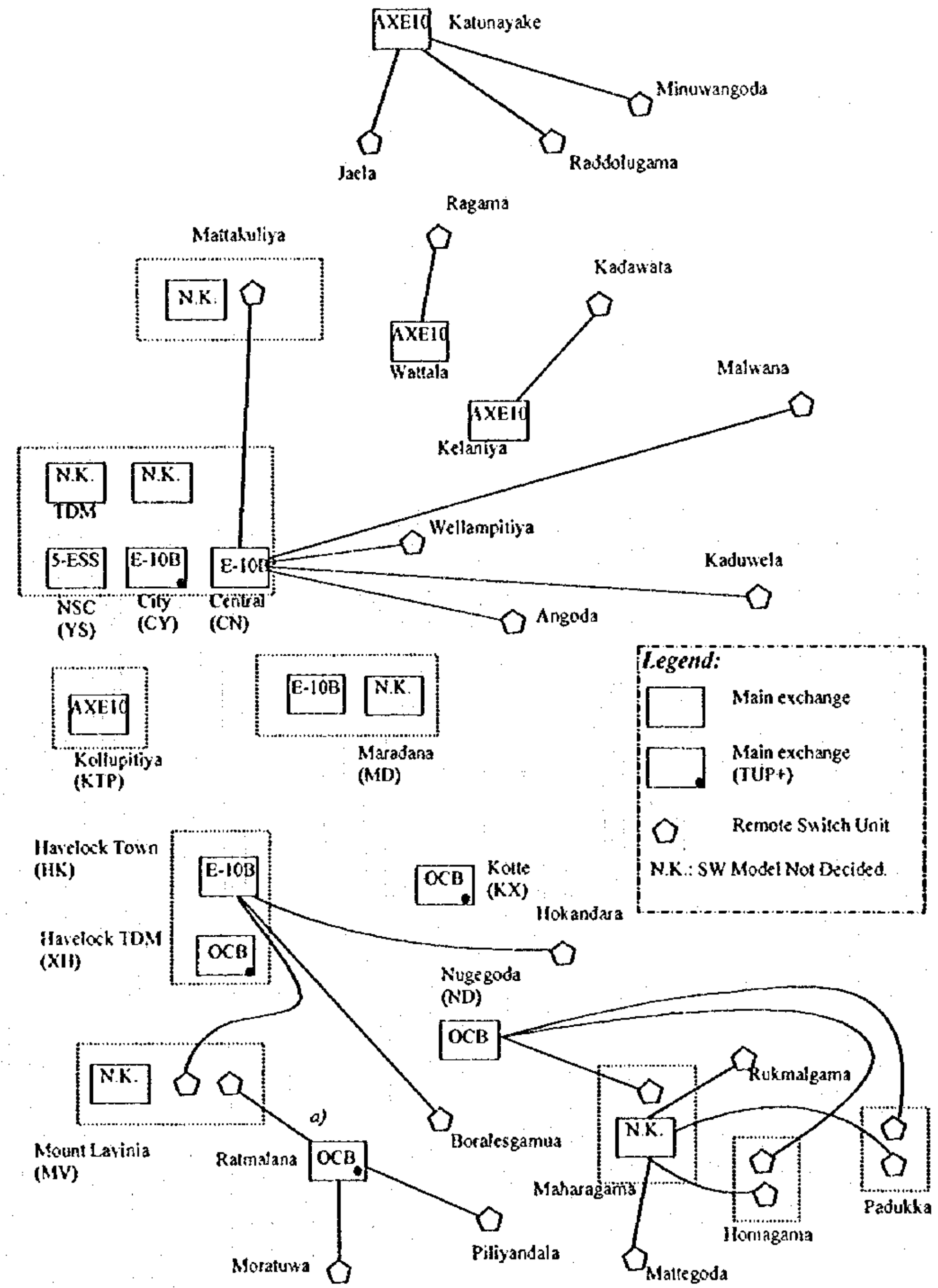
Figure 2-5-13 Exchanges and RSU Belonging Scheme in Colombo Metro Area as of April 1995

Table 2-5-20 Exchange Structure and Capacity in 1997 (Planned)

Group	Exchange			Capacity		On-going	Note-1	Note-2
	Main switching unit		RSU	in 1995	in 1997	project		
"A"	Central 5-ESS	5-ESS		24,000	24,000		NSC=12,000	S=92
	Central North	E-10B		3,620	3,620			S=83,94
			Angoda	1,024	1,024			S=83,95
			Kaduwela	1,024	1,024			S=83,95
			Malwana	1,024	1,024			S=83,95
			Mattakuliya	2,825	2,825			S=85,94
			Wellampitiya	1,024	1,024			S=83,95
	Central City	E-10B		20,000	20,000			S=89
	Havelock	E-10B		15,600	15,600			S=83,95
			Boralesgama	2,048	6,548	French		S=90,97
			Hokandara	1,024	2,524	French		S=83,97
			Mt. Lavinia	3,000	3,000			S=94
	Havelock	OCB-283		8,400	15,400	French	TDM=5,340	S=93,97
	Kotte	OCB-283		11,000	24,000	French		S=93,97
	Maradana	E-10B		16,536	16,536			S=89,94
	Nugegoda	OCB-283		15,128	22,128	French		S=93,97
			Homagama	500	500			S=83,93
			Maharagama	1,800	1,800			S=83,93
			Padukka	500	500			S=83,93
	Ratmalana	OCB-283		7,000	7,000			S=93
			Moratuwa	4,000	6,000	French		S=84,97
			Mt. Lavinia	1,000	1,000			S=94
			Piliyandara	700	5,000	French		R=97
	Sub-total			142,777	182,077			
"B"	Central New-1	N.K.		0	20,000	SCP		New
	Central TDM	N.K.		0	22,000	WB(IDA)	TDM=8,000	New
	Katunayake	AXE-10		2,000	5,000	WB-ICB		R=97
			Ja Ela	1,280	6,500	WB-ICB		R=97
			Minuwangoda	0	800	WB-ICB		New
			Raddolugama	0	1,000	WB-ICB		New
	Kelaniya	AXE-10		2,048	7,800	WB-ICB		R=97
			Kadawata	1,024	3,800	WB-ICB		R=97
	Kollupitiya	AXE-10		5,424	8,500	WB-ICB		R=97
	Maharagama	N.K.		0	10,000	SCP		New
			Homagama	0	2,500	SCP		New
			Mattegoda	0	3,000	SCP		New
			Padukka	0	1,500	SCP		New
			Rukmalgama	0	1,000	SCP		New
	Maradana	N.K.		0	10,000	SCP		New
	Mattakuliya	N.K.		0	6,000	SCP		New
	Mt. Lavinia	N.K.		12,000	13,750	SCP		New
	Wattala	AXE-10		1,510	8,000	WB-ICB		New
			Ragama	480	2,800	WB-ICB		New
	Sub-total			25,766	133,950			
Total				168,543	316,027			

Note: S=: Commisioning year and the latest expansion year.
R=: Replacement year.
WB: World bank project.
SCP: Supplier's credit (150K) project.
N.K.: Not known.

Source: SLT.



Source: JICA Study Team.

Figure 2-5-14 Exchanges and RSU Belonging Scheme in Colombo Metro Area in 1997 Based on the Plan as of September 1995

(3) Proposed new network of SLT

The hierarchical structure of SLT network will not be changed under this project. That is, the proposed new network will be consisted of ISC, NSC, TSC, SSC and LE levels as it is at present. RSU will be placed under LE.

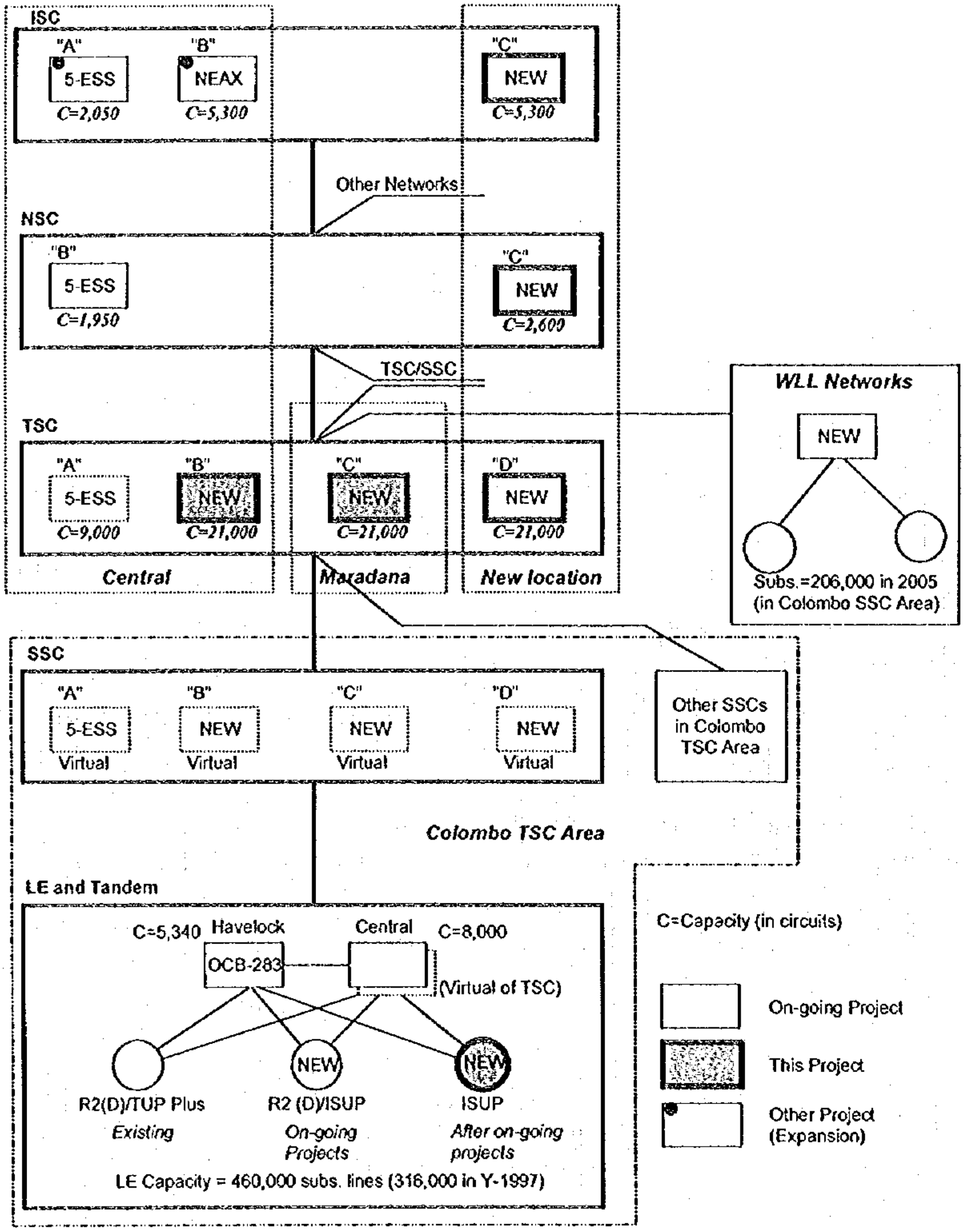
Some units of switching systems will be introduced under this project according to the demand forecast. It is necessary to introduce a new unit of international gateway switch, a new unit of NSC switch, and some units of transit switches, and capacity increase of local exchanges.

In this project, two (2) units of TSC switching system will be introduced to meet the traffic increase by the year 2005. Figure 2-5-15 shows the network in Colombo Metro Area in the year 2000 proposed under this project. TSC capacity expansion is inevitable as the number of subscribers will be 4.8 times in 2005 comparing to that at the end of 1994.

In the proposed new network, Colombo TSC will be a multi-function switching system also having the function of SSC and Local TDM (Tandem Switching Centre). This was so decided in consideration of the traffic flow after WLL network participation and network efficiency.

According to the demand forecast discussed in previous paragraph, around 30% of fixed telephone lines will be catered by WLL networks in Colombo Metro area, and 26 % in whole the country, in 2005. This means nearly one-third of local and trunk traffic originated from the SLT subscribers in Colombo Metro area will be routed to the interconnection point between SLT network and WLL network, or TSC. Based on this calculation, the SSC function and a part of TDM function was entrusted to TSC in the case of Colombo Metro Area.

Colombo Metro local exchange network will be made up of two levels in hierarchy, that is, LE and TDM. The local tandem switching centres will be Havelock TDM and Central TDM before this project completes. New hardware will be provided by means of new units of TSC under this project using part of TSC as TDM. The new units of TSC will be installed at Central, Maradana and a new location in Colombo Metro Area. Some LEs will be of main switching system and others of remote switch unit.



Source: JICA Study Team.

Figure 2-5-15 Proposed Network in Colombo Metro Area in 2000

Colombo TSC will be consisted of four (4) units of transit switch: Unit "A", "B", "C" and "D". See Figure 2-5-15. This was so decided based on the forecast traffic flow and taking account of reliability of transit level network. Under such structure, nearly 75% of circuits required to normal traffic load will be available in case where one of the four units goes out of service by failure.

TSC Unit "A" is the TSC part of the existing NSC "B" or 5-ESS introduced in 1992. Unit "B" to Unit "D" will be the new units to be introduced under new projects. Unit "B" and "C" will be introduced under this project and situated in Colombo Metro SSC Area. TSC Unit "D" should be introduced in a new location near Colombo City under ISC, TSC and Earth Station Project.

TSC Unit "B", "C" and "D" shall have partly the function of TDM for the Colombo Metro Area.

5.2.7 Transmission Network

Existing junction network consisting of fibre optic cable transmission links and some PCM cable transmission links can function up to around the year 2010. Even if additional capacities are added to these systems up to full transmission capacity, it will be not enough to cover the whole required traffic volume in near future. Besides this fact, network reliability and redundancy will be more important than ever. So, alternative transmission system should be constructed as the solution to these future problems.

This project is planned to be completed in the year 2000 so that the newly constructed transmission system can cover, working in parallel with existing transmission system, the traffic of exchanges in the area up to the year 2005. The proposed transmission sytem should be implemented before traffic increases by new exchanges and in one package, for it is a complete system designed to deal with that traffic. Accordingly, the proposed transmission system should be carried out in the first package, if the project is split in some packages.

Recently, Synchronous Digital Hierarchy (SDH) technology has been standardised at ITU and has been popular instead of conventional Plesiochronous Digital Hierarchy (PDH) technology. In SDH technology, the information is suitably conditioned for serial transmission on the selected media at a rate which is synchronised to the network. (ITU-T Recommendation G.708) SDH interface is the global united, fully synchronised interface based on 155.52 Mbit/s tributary unit called Synchronous Transfer Mode - 1 (STM-1) and it is expected to be dominant interface in future.

In SDH circumstances, any information, from low speed such as 2 Mbit/s to high speed such as 140 Mbit/s can be accommodated to the transmission frame directly, and even low speed information can be acquired from high speed pulse series directly. So that cross connect and line termination functions can be carried out at the high speed level. These features make system configuration simple and system modification easy, and realise integrated operation and maintenance system.

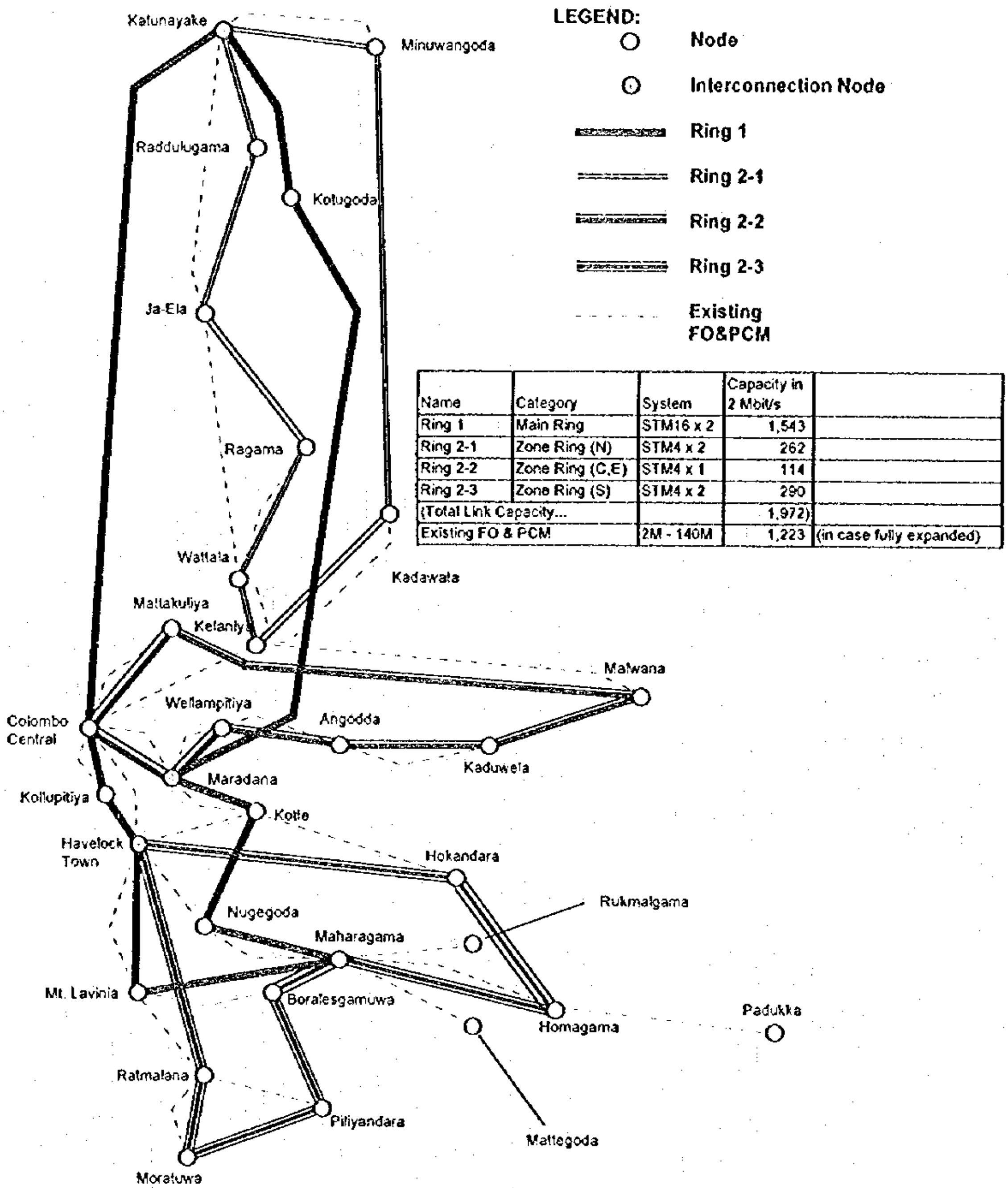
For application of SDH fibre optic cable system to the project, two physical cable structures, i.e. Ring structure and Point to point structure are expected to be employed. With SDH, high route security is best achieved when the route is configured as a ring.

There will be 31 nodes (including Kotugoda) in Colombo Metro area. For applying SDH fibre optic ring structure to the area, these 31 nodes should be separated into some groups.

This separation will be efficient for easy expansion in future. Considering economical factor and hierarchical structure, the network should be composed of high speed rings and low speed rings. Figure 2-5-16 and Table 2-5-21 show the newly proposed network system.

Construction of four (4) SDH ring fibre optic cable junction networks shown in the above table is proposed. These four (4) rings consisting of one (1) STM-16 (2,488.32 Mbit/s) high speed ring named Ring-1 and three (3) STM-4 (622.08 Mbit/s) rings named Ring-2-1, Ring-2-2 and Ring-2-3 will connect all exchanges in the area except Padukka, Rukmalgama and Mattegoda. Padukka exchange is located far from other exchanges. Rukmalgama and Mattegoda exchanges which will be established in 150K project have also difficulty in being included in ring structures because of their locations and their little required capacities (2 systems of 2 Mbit/s for Mattegoda, no additional systems for Padukka and Rukmalgama). So these node stations are decided to be not covered by this project.

Ring-1 will play the role as the backbone of the junction network and connect major 10 nodes in the area which include the proposed new ISC/TSC/SSC site, Kotugoda. Three (3) zone rings, Ring-2-1, Ring-2-2 and Ring-2-3 will handle traffic flow within their own zone. Traffic flow exceed each zone ring will be carried through Ring-1. So the transmission capacity of Ring-1 will be higher than those of other three (3) rings. These four ring configurations are supposed to be suitable for the future network expansion such as new exchange installation or capacity expansion. Minor change of capacity or new RSU installation will be made by the zone ring.



Name	Category	System	Capacity in 2 Mbit/s	
Ring 1	Main Ring	STM16 x 2	1,543	
Ring 2-1	Zone Ring (N)	STM4 x 2	262	
Ring 2-2	Zone Ring (C,E)	STM4 x 1	114	
Ring 2-3	Zone Ring (S)	STM4 x 2	290	
(Total Link Capacity...			1,972)	
Existing FO & PCM		2M - 140M	1,223	(in case fully expanded)

(Note1... Rukmalgama, Mattegoda and Padukka will not be covered by this project.)
(Note2... This figure does not show the actual cable routes.)

Source: JICA Study Team.

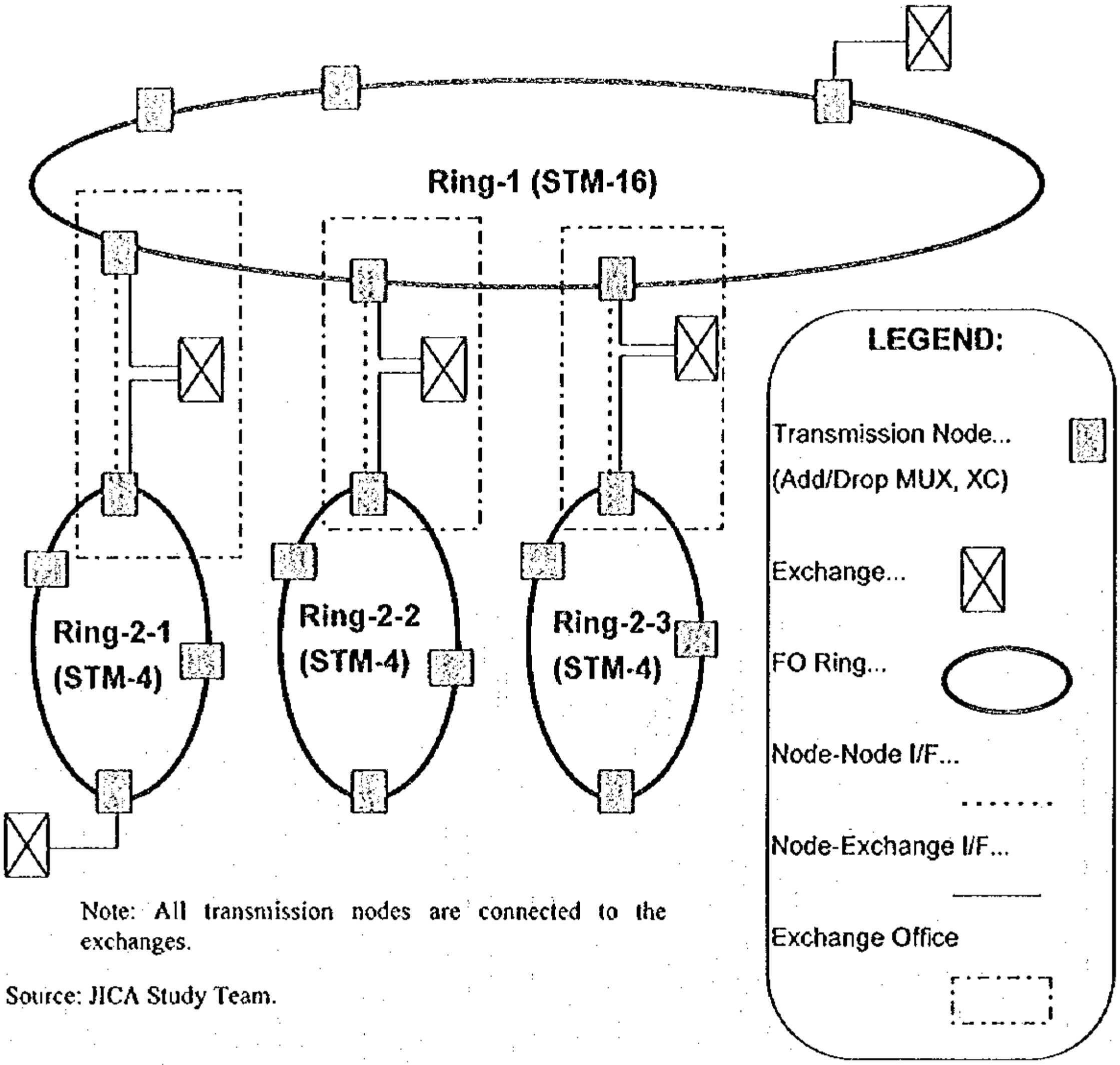
Figure 2-5-16 Proposed Fibre Optic Transmission System

Table 2-5-21 Proposed Ring Network Configuration

	Node	Ring-1	Ring-2-1	Ring-2-2	Ring-2-3	Remarks
1	CO	1		2		
2	MTK			3		
3	WT		5			
4	RG		6			
5	JL		7			
6	RAD		8			
7	KTY	2	1			Inter-Ring between Ring-1 and Ring-2-1
8	MWG		2			
9	KO	3				
10	KDW		3			
11	KI		4			
12	MAL			4		
13	KDL			5		
14	AN			6		
15	WI			7		
16	MD	4		1		Inter-Ring between Ring-1 and Ring-2-2
17	KX	5				
18	HC				2	
19	HO				3	
20	PK					Connect to HO, Not covered by this project
21	RUK					Connect to MHG, Not covered by this project
22	MAT					Connect to MHG, Not covered by this project
23	MHG	7			4	
24	ND	6				
25	BS				5	
26	PYL				6	
27	MF				7	
28	RM				8	
29	MV	8				
30	HK	9			1	Inter-Ring between Ring-1 and Ring-2-3
31	KPT	10				
Ring Capacity		2.5 Gbit/s	622 Mbit/s	622 Mbit/s	622 Mbit/s	
Route Length		167 km	88.9 km	62.1 km	68.8 km	386.8 km in total

Note: Number in shadowed column shows node connection order.

Source: JICA Study Team.



Note: All transmission nodes are connected to the exchanges.

Source: JICA Study Team.

Figure 2-5-17 Transmission Ring Concept Chart

5.2.8 External Plant

Subscriber Cable Access System shall be applied in principle to this project. The system is more advantageous than another system to in considering with a project cost in a high density demand area, and a stability of telephone service. And the system has been introduced in SLT already, it is easy to maintain the facilities.

Subscriber Access System is directly connected to Subscribers, and subscribers' opinions of telephone service are reflected to a Telecommunication Carrier directly. Therefore it is necessary to maintain service qualities that are Transmission Quality (Voice), Connection Loss Quality, Connection Delay Quality, Stability Quality (Fault Rate) and New Subscriber Connection Period etc. In these qualities, Transmission Quality, Stability Quality and Subscriber Connection Period are concerning with the External Plant.

At the same time, it is very important that to make a cable distributing system economical and flexible to connect subscribers. Generally an external plant cost is high, and a project period is long. Because it is necessary to distribute cables in wide area and to construct in social and natural environment.

Otherwise, there are many kind of Subscriber Access Systems except metallic Subscriber Cable System, such as Optical Fibre Access, Wireless Local Loop System etc. at present. A system to be applied shall be selected based on Economical Comparison, Maintenance Work methods and Geographical Conditions.

(1) Covering Area in this Study

This study covers seventeen (17) Exchange Centres in Colombo Metro Area as shown Figure 2-5-18 as a geographical location. The covering area has Satellite Commercial Area of Colombo Central, Location of Parliament, International Airport, Resort Area and Bed Town of Colombo Central. Therefore telephone demand in the area is rapidly increasing for both of Business and Residence Use.

(2) Outline of Subscriber Cable Access Network

The Outline of Subscriber Cable Access Network to be introduced is Shown in Figure 2-5-19. For the network, basically Subscriber Cable, Cross-Connection Cabinet and Conduit System shall be adopted.

Source: JICA Study team.

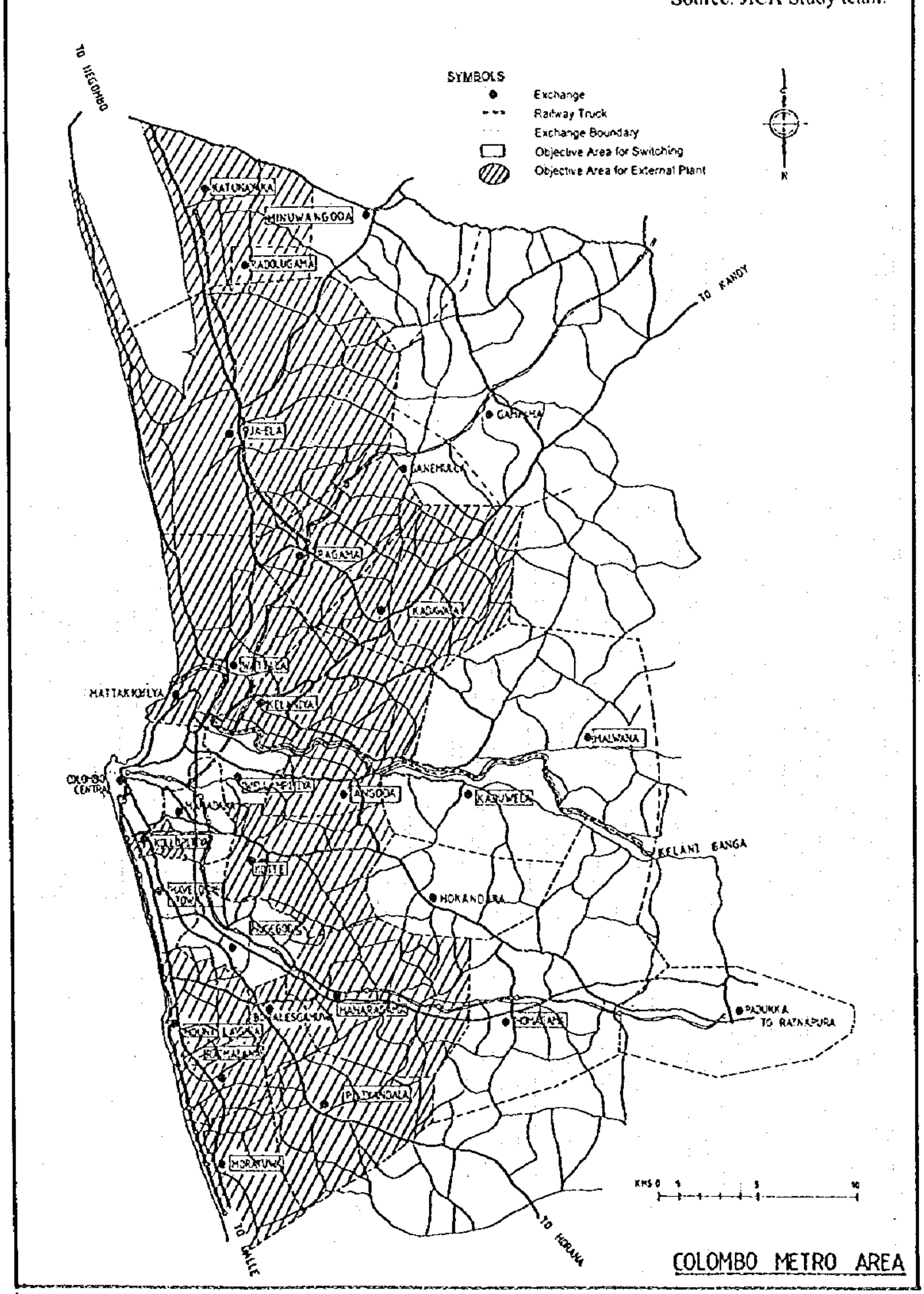
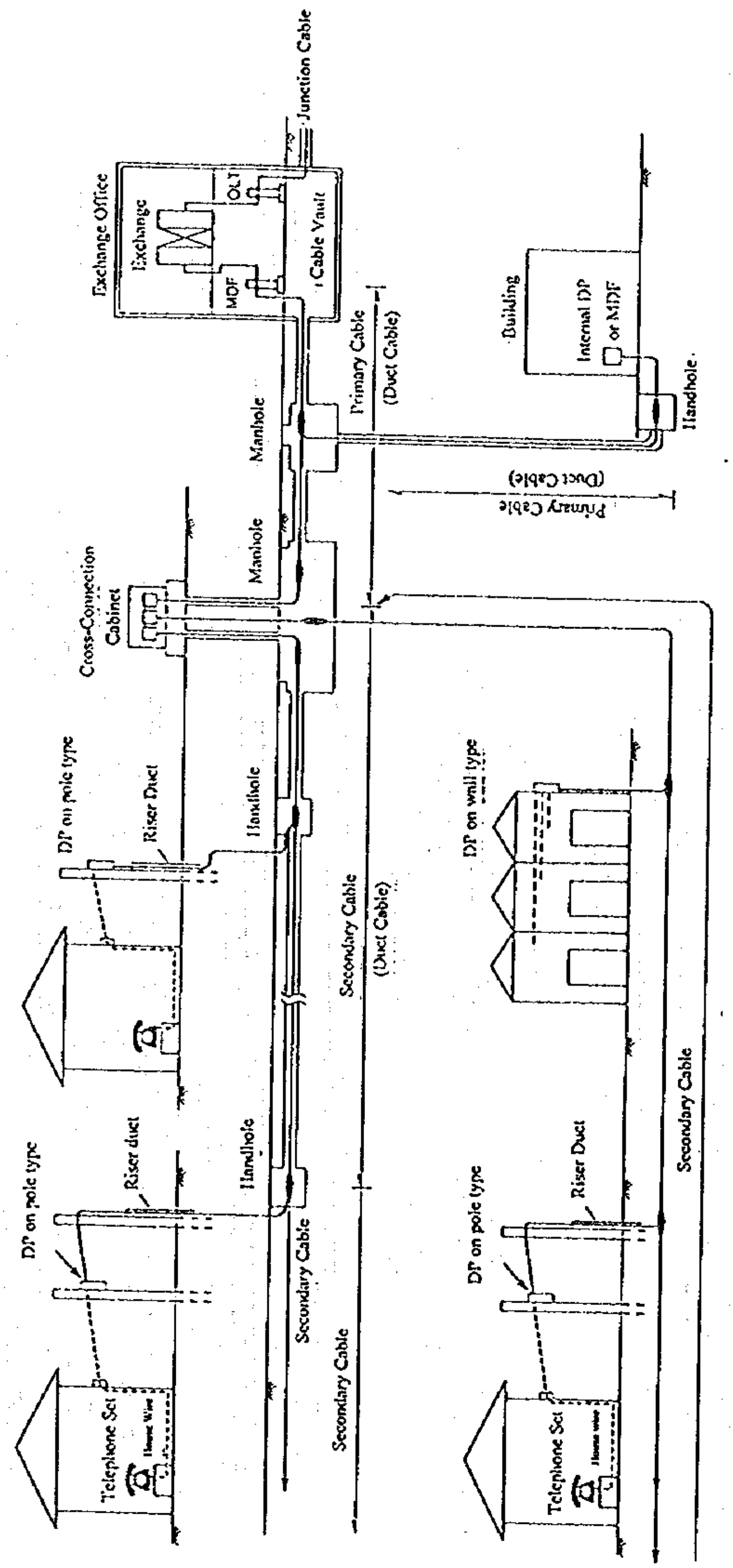


Figure 2-5-18 Exchanges and the Area for Feasibility Study



Source: JICA Study Team.

Figure 2-5-19 Outline of Subscriber Cable Access System

To make the system economic, the subscriber Cables are classified into Primary Cable and Secondary Cable. The primary cable has large capacity to gather primary cables of cross-connection cabinet areas and secondary cables, and the secondary cable which connects to distribution points (DPs) in a small area has small capacity. And Cross-Connection Cabinet is installed between primary cable and secondary cable to make the system flexible, the cabinet adjusts to connect primary cable and secondary cable efficiently.

This system has been introduced in SLT already, it is easy to maintain the facilities. The system is more advantageous than other systems in considering with a project cost in a high density demand area, and a stability of telephone service. For that reason, in principle the subscriber cable access system shall be applied for the project.

(3) Technical Requirements for External Plant

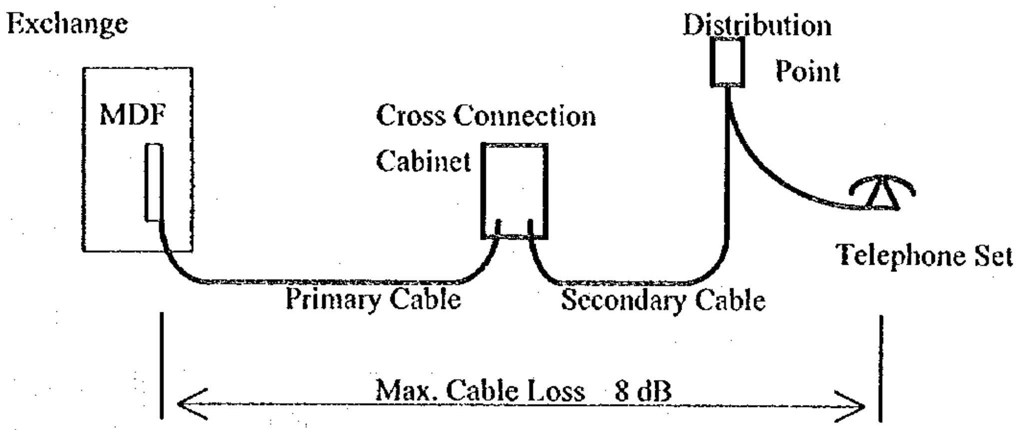
As mentioned on Telephone Service Quality according to ITU-T G111 and G121 Recommendation as shown in Table 2-5-22 which is describes in detail in the Master Plan, the technical requirement is to make the Loudness Rating (LR) of national connection chain smaller than the recommendation for a telephone service.

Table 2-5-22 LR values as cited in Recommendations G.111 and G.121

	SLR	CLR	RLR	OLR
Traffic-weighted mean values				
long term	7 - 9	0 - 0.5	1 - 3	8 - 12
short term	7 - 15	0 - 0.5	1 - 6	8 - 21
Maximum values for an average-sized country	16.5		13	
Minimum value	- 1.5			

Source: ITU.

A metallic cable has a Frequency Characteristics of transmission loss, therefore a standard of maximum cable loss shall be determined in each country in considering with a cable specification and a standard of telephone set. By the standard of Overall LR of National Chain, the value of Subscriber Cable Loss between MDF of an exchange centre and a subscriber is determined by SLT as maximum 8 dB at 1500 Hz, which agrees with the ITU Recommendations.



Source: SLT.

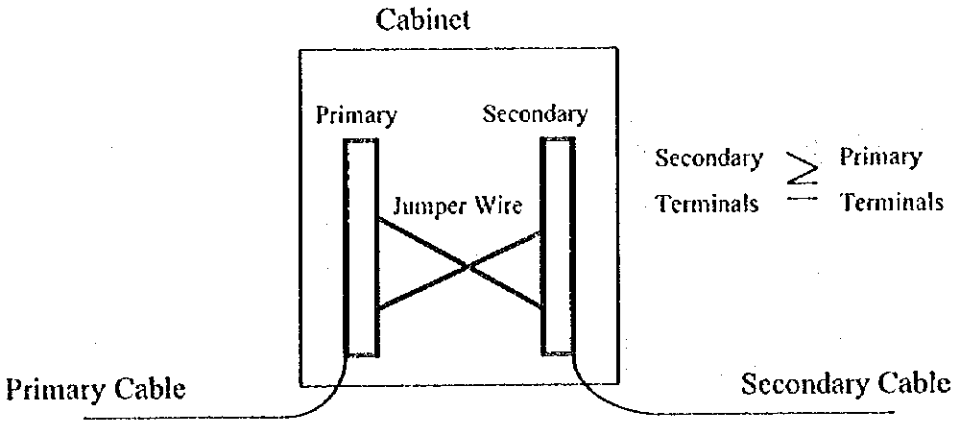
Figure 2-5-20 Cable Loss limitation between MDF and Telephone Set

(4) Flexible Distribution System of Cables

Generally, it is difficult to use 100 % of cable pairs, because a correct demand forecasting is not easy, subscribers are distributing in wide area, and a cable size (number of pairs) is at fixed intervals. Therefore the access network needs to have a flexible cable distribution method to connect subscribers efficiently.

a) Cross-Connection Cabinet System

Number of Secondary Terminals shall be larger than number of Primary Terminal. The standard of Cross-Connection Cabinet is shown in Subsection 5.3.3 Facility Plan of external plant.



Source: JICA Study Team.

Figure 2-5-21 Outline of Cross-Connection Cabinet

b) Number of Pipes for Conduit Route

For a primary cable route, the number of pipes shall be determined with a demand of 15 years ahead from a project completion year. And the route shall have spare pipe(s) which shall be used for new cable installation for Maintenance Use or for increasing demand rapidly. In the case of duct construction, usually an approval from Road Authority is necessary, and it is difficult to make a duct route immediately for new demand or for repairing damaged duct cable. Therefore, the duct route shall have sufficient number of pipes for including a demand in future.

For a secondary cable Route, the number of pipes shall be determined basically as same number as the necessary cable number in a project whose demand is 5 years ahead from a project completion year. However, the route such as that the number of cable pairs in the project is over about 300, the route shall have one spare pipe to be accommodated a new cable for Maintenance Use or for increasing demand rapidly. The standard of the number of Duct Route is described in Subsection 5-3-3 Facility Plan (External Plant).

c) Application of Cable Size and Establishment of STUMP

A cable size shall be selected upper rank capacity from a demand shall be applied. And STUMP (Spare Pairs) shall be applied at uncertain demand area to correspond to increasing demand.

(5) Maintenance Easy Work (Maintenance Management and Repair Work)

A network shall be simplified as much as possible to make a Maintenance Work easy and efficient. Therefore Multi Pair-Splicing shall not be applied for both primary cable and secondary cable.

A boundary of cabinet area shall be determined basically along a river, a wide road, a railway etc. in considering with geographical conditions to make subscriber cable and drop wire route easy and not to cross the them. And the number of expected subscribers in the cabinet area shall be determined in principle as maximum 600 for subscribers' management.

A conduit system shall be applied basically, the system is very stable in SLT, in considering with a situation of maintenance work that the staff of a telephone centre are busy for repairing fault facilities. The situation of fault statistics is shown in Table 2-5-23.

Table 2-5-23 Fault Statistics of Kurunegala RTE

from January to December, 19944

for 3,877 DELs

	Over Head Cable & Wire	Under Ground Cable	Others	Total
Number of Faults	6,750	1,136	471	8,357
Faults % by Location	81	14	5	100

Source: SLT.

(6) Dealing with New Service

New Services such as ISDN, Broad Band Leased Line Service etc. are not considered in this study, because these new services will not be expected at present in this study area. However, the subscriber cable access system is able to deal with a narrow band ISDN service (2B+D) using 4-wire of cable. Therefore the system adopted in this project can deal with a narrow band new service which will occur in near future. In case of occurring new broad band services, other subscriber access system, Fiber Optic Access system etc. shall be introduced.

(7) Application of Other Subscriber Access System

As mentioned above, there are many kind of Subscriber Access Systems, such as Optical Fibre Access, Wireless Local Loop System etc. at present.

In the case of corresponding in hurry to new subscribers for whom an external plant is not suitable for geographical conditions, construction problem or technical requirements, other access system shall be introduced. The system to be applied shall be selected based on Economical Comparison, Maintenance Work methods and Geographical Conditions. A example is described in Subsection 5-3-3 Facility Plan (External Plant).

5.3 Facilities Plan

5.3.1 Switching facilities

(1) General

The switching facilities were designed in the manner as stated in the following paragraphs. Here the word "switching system" is used as defined in ITU-T Rec. Q.9 and used as an element to form an exchange.

The capacity of switching systems was dimensioned based on the demand forecast and outcome of traffic forecast, referring to the planned capacity in 1997 shown in Table 2-5-20. The capacity should be reviewed and justified, however, referring to then demand on making a detail design as the demand likely fluctuates in years.

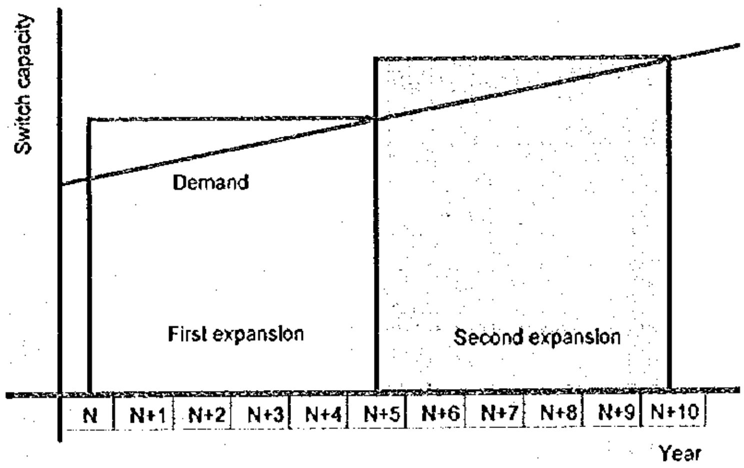
The exchanges the capacity of which would be smaller than the demand in 2000 were selected to this project to expand switching system capacity. This project will provide two units of TSC switching system of 42,000 inter-exchange circuits in total and a total capacity of 144,400 lines for 22 local exchanges.

(2) Capacity dimensioning principles

The capacity of the switching system was designed so that the switching system capacity can meet the demand increase for five (5) years after installation. That is, every exchange will have a marginal period of capacity of five years when installation is completed. See Figure 2-5-22. This was so decided on the assumption that a project would take a period of five years from financing to commissioning. The exchange capacity was designed practically referring to the traffic in the year 2005. Introduction year and last expansion year were referred to that indicated in Table 2-5-20.

The telephone switching systems the capacity of which was forecast more than 3,000 were planned as of stand alone switching system (main exchange) and the rest were planned as of remotely controlled unit of switching system (RSU) in consideration of recent tendencies in developing countries. The demarcation should be reviewed in consideration of the price and performance at the time of purchasing the switching systems, for this demarcation rule was applied just for finding the shape of a possible network structure for this feasibility study.

Additional new telephone switching unit was planned in the cases where a) telephone demand would be more than 30,000 in subscriber lines, in consideration of the effects of failure, and b) a total capacity more than 3,000 was required, for a purchase through open bidding procedures. The switching units, if two or more units of switching units were expected in a same exchange, were called apart adding suffix, i.e., 1, 2, 3, ... or A, B, C, ... to the exchange name in the following tables and figures.



Source: JICA Study team.

Figure 2-5-22 Demand Increase and Switching System Capacity

(3) TSC capacity plan

Table 2-5-24 shows proposed capacity of TSC and sharing by unit. The number of circuits for normal load was obtained summing the number of circuits required for TSC and TDM. Unit "A" is an existing switching system having a capacity of 12,000 inter-exchange circuits, or the part used as TSC of NSC Unit "B" 5-ESS. It is assumed that out of 12,000 circuits 9,000 inter-exchange circuits are available for TSC/SSC part in this study. Unit "B" and "C" will be introduced under this project. Unit "D" should be introduced under ISC, TSC and Earth Station Project.

Table 2-5-24 Colombo TSC Capacity by Unit

Year	Circuits for normal load	Planned Capacity 1.10 Redundancy				
		Unit "A"	Unit "B"	Unit "C"	Unit "D"	Total
		5-ESS	New	New	New	
Y-1997	-	9,000	-	-	-	9,000
Y-2000	65,590	9,000	21,000	21,000	21,000	72,000

Source: JICA Study team.

TSC composition by switching units and the number of circuits of TSC were designed so that the network can deal, in the case of failure of one of the TSC/SSC switching systems, with around 3/4 of the circuit quantity required for normal load.

(4) LE capacity plan

Table 2-5-25 shows proposed LE capacity expansion under this project. No removal nor replacement were planned as some exchanges had been introduced or expanded shortly before this study and others will be introduced during the period of the on-going projects as seen in Table 2-5-20.

Table 2-5-25 LE Capacity to be provided by 2000

Exchange	Demand %SLT= 70%		Switch capacity				
			Equipped	Increase			Total
	in 2000	in 2005	in 1997	New Sw.	SW. Exp.	Total	in 2000
Angoda	3,230	4,741	1,024	3,720		3,720	4,744
Boralesgamuwa	3,846	5,646	6,548			0	6,548
Central	66,134	97,108	89,620			0	89,620
Havelock	33,791	49,617	31,000	18,620		18,620	49,620
Hokandara	2,164	3,177	2,524			0	2,524
Homagama	3,787	5,560	3,000		2,560	2,560	5,560
Ja-Ela	8,230	12,291	6,500	5,800		5,800	12,300
Kadawata	5,494	8,204	3,800	4,410		4,410	8,210
Kaduwela	2,161	3,172	1,024		2,150	2,150	3,174
Katunayake	6,675	9,970	5,000	4,970		4,970	9,970
Kelaniya	10,520	15,712	7,800	7,920		7,920	15,720
Kollupitiya	10,152	14,905	8,500	6,410		6,410	14,910
Kotte	24,826	36,453	24,000	12,460		12,460	36,460
Maharagama	13,515	19,844	11,800	8,050		8,050	19,850
Malwana	2,030	3,031	1,024		2,010	2,010	3,034
Maradana	26,514	38,930	26,536			0	26,536
Mattakkuliya	5,696	8,362	8,825			0	8,825
Mattegoda	2,152	3,161	3,000			0	3,000
Minuwangoda	1,995	2,979	800		2,180	2,180	2,980
Moratuwa	7,080	10,395	6,000	4,400		4,400	10,400
Mount Lavinia	23,663	34,745	17,750	17,000		17,000	34,750
Nugegoda	27,254	40,017	22,128	17,890		17,890	40,018
Padukka	1,298	1,905	2,000			0	2,000
Piliyandala	6,763	9,930	5,000	4,930		4,930	9,930
Raddolugama	2,138	3,192	1,000		2,200	2,200	3,200
Ragama	3,561	5,317	2,800		2,520	2,520	5,320
Ratmalana	9,056	13,297	7,000	6,300		6,300	13,300
Rukmalgama	718	1,054	1,000			0	1,000
Wattala	8,380	12,516	8,000	4,520		4,520	12,520
Wellampitiya	2,994	4,395	1,024	3,380		3,380	4,404
Total	325,817	479,626	316,027	130,780	13,620	144,400	460,427

Source: JICA Study Team.

The total capacity in 2000 will be 460,336 by increasing 144,400 lines under this project. Out of 144,400, a total of 130,780 will be that implemented by new switching unit introduction and 13,620 will be by existing switch expansion. Table 2-5-26 shows the breakdown of capacity of each unit of switching system, conditions of switching room spaces and others.

Table 2-5-26 LE Capacity Breakdown and Switch Space Condition

Exchange	Component		Capacity		Space			
	Main(Model)	Remote under	in 1997	This project	Sw.	Power	MDF	Engine
Angoda	---	Central N.	1,024					
Angoda	New	---	---	3,720	E.S.A.	E.S.A.	E.S.A.	New
Boralesgamuwa	---	Havelock Town	6,548					
Central City	E-10B	---	20,000					
Central New	N.K.	---	20,000					
Central North	E-10B	---	3,620					
Central NSC "B"	5-ESS	---	24,000					
Central TDM	N.K.	---	22,000					
Havelock TDM	OCB-283	---	15,400					
Havelock Town	E-10B	---	15,600					
Havelock New	New	---	---	18,620	E.S.A.	E.S.A.	E.S.A.	
Hokandara	---	Havelock Town	2,524					
Homagama	---	Maharagama	2,500					
Homagama	---	Nugegoda	500					
Homagama	---	Maharagama	---	2,560	New	New	New	
Ja-Ela	New	---	---	6,200	E.S.A.	E.S.A.	E.S.A.	
Ja-Ela	---	Katunayake	6,500					
Kadawata	---	kelaniya	3,800					
Kadawata	New	---	---	4,410	E.S.A.	E.S.A.	E.S.A.	New
Kaduwela	---	Central N.	1,024					
Kaduwela	---	Central New	---	2,150	E.S.A.	E.S.A.	E.S.A.	
Katunayake	AXE-10	---	5,000					
Katunayake	New	---	---	4,970	E.S.A.	E.S.A.	E.S.A.	
Kelaniya	AXE-10	---	7,800					
Kelaniya	New	---	---	7,920	E.S.A.	E.S.A.	E.S.A.	
Kollupitiya	AXE-10	---	8,500					
Kollupitiya	New	---	---	6,410	E.S.A.	E.S.A.	E.S.A.	
Kotte	OCB-283	---	24,000					
Kotte	New	---	---	12,460	E.S.A.	E.S.A.	E.S.A.	
Maharagama	N.K.	---	10,000					
Maharagama	---	Nugegoda	1,800					
Maharagama	New	---	---	8,050	New	New	New	
Malwana	---	Central N.	1,024					
Malwana	---	Central New	---	2,010	E.S.A.	E.S.A.	E.S.A.	
Maradana	E-10B	---	16,536					
Maradana	N.K.	---	10,000					
Mattakuliya	N.K.	---	6,000					
Mattakuliya	---	Central N.	2,825					
Mattegoda	---	Maharagama	3,000					
Minuwangoda	---	Katunayake	500					
Minuwangoda	---	Katunayake	---	2,180	E.S.A.	E.S.A.	E.S.A.	
Moratuwa	---	Ratmalana	6,000					
Moratuwa	New	---	---	4,400	E.S.A.	E.S.A.	E.S.A.	New
Mt. Lavinia	N.K.	---	13,750					
Mt. Lavinia	---	Havelock Town	3,000					
Mt. Lavinia	---	Ratmalana	1,000					
Mt. Lavinia	New	---	---	17,000	E.S.A.	E.S.A.	E.S.A.	
Nugegoda	OCB-283		22,128					
Nugegoda	New	---	---	17,890	E.S.A.	E.S.A.	E.S.A.	
Padduka	---	Maharagama	1,500					
Padduka	---	Nugegoda	500					
Piliyandara	---	Ratmalana	5,000					
Piliyandara	New	---	---	4,930	New	New	New	New
Raddolugama	---	Katunayake	1,000					
Raddolugama	---	Katunayake	---	2,200	New	New	New	
Ragama	---	Wattala	2,800					
Ragama	---	Wattala	---	2,520	E.S.A.	E.S.A.	E.S.A.	
Ratmalana	OCB-283	---	7,000					
Ratmalana	New	---	---	6,300	E.S.A.	E.S.A.	E.S.A.	
Rukmalgama	---	Maharagama	1,000					
Wattala	AXE-10	---	8,000					
Wattala	New	---	---	4,520	E.S.A.	E.S.A.	E.S.A.	
Wellampitiya	---	Central N.	1,024					
Wellampitiya	New	---	---	3,380	E.S.A.	E.S.A.	E.S.A.	New
Welikeriya	---	Ja-Ela	---	600	New	New	New	
Total			316,027	144,400				

E.S.A.=Existing space is available. New=To be introduced under this project.

Source: JICA Study Team (arranged based on SLT information).

(5) Peripheral equipment

An adequate quantity of peripheral equipment such as charge input-output devices, system control terminals, distribution frames, etc. should be supplied together with the switching system. Details should be decided in preparing tender specifications.

5.3.2 Transmission Facilities

Required circuits were calculated based on the demand and traffic studies. The result is shown in Table 2-5-27. Considering existing and additional circuit availability, proposed circuit matrix shown in Table 2-5-28 was calculated. Following the transmission network plan, concrete circuit convergence to the four rings was done, and the result is shown in the Table 2-5-29.

Transmission capacity of each ring will be huge amount comparing the present capacity. For Ring-1, STM-16 (2.5 Gbit/s) capacity will be required. Other zone rings will be enough with STM-4 (600 Mbit/s) capacity. Capacity of STM-16 system is equivalent to 1,008 systems of 2 Mbit/s, or 30,240 voice channels, and STM-4 system is equivalent to 252 systems of 2 Mbit/s, or 7,560 voice channels.

Existing link capacity of fully expanded and newly installed link capacity by this project are expected as follows:

Existing link capacity of fully expanded:	1,223 systems of 2 Mbit/s tributaries (38 %)
Newly installed link capacity:	1,972 systems of 2 Mbit/s tributaries (62 %)

Ring network with SDH technology can offer self-healing function. Using 4 fibre for one system, 2 working paths for both directions will exist with 2 protection paths. This protected path idea in addition to the protected equipment will raise the reliability of the network further.

Table 2-5-27 Required Circuit Matrix in 2005

No. of Circuits in 2 Mbit/s			1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31		
	bothway		AN	BS	CO	HK	HC	HO	KO	JL	KDW	KDL	KTY	KI	KPT	KX	MHG	MAL	MD	MTK	MTG	MWG	MF	MV	ND	PK	PYL	RAD	RG	RM	RUK	WT	WI	Total	Except Own
1	Angoda	AN			31	1			4																									36	36
2	Boralesgamua	BS				36																												36	36
3	Colombo	CO	31		858	266			252	30	27	22	99	93	62	139	121	20	164	17			31	137	144		27			83		87	49	2759	1901
4	Havelock	HK	1	36	266	74	22		64	2	1		7	10	23	32	15		34	1			2	39	36		2			20		8	1	696	622
5	Hokandara	HC				22																												22	22
6	Homagama	HO															32								4									36	36
7	Kotugoda	KO	4		252	64				6	4		26	22	16	40	36		42	4			6	38	44		6			24		20	4	658	658
8	Ja-Ela	JL			30	2			6				44																					82	82
9	Kadawata	KDW			27	1			4					24																				56	56
10	Keduwnia	KDL			22																													22	22
11	Katunayake	KTY			99	7			26	44			26			2	2					20						22				2		250	224
12	Kelaniya	KI			93	10			22		24			8																		4		161	153
13	Kollupitiya	KPT			62	23			16						4				2															107	103
14	Kotte	KX			139	32			40				2			18	4		6					2	8					2				253	235
15	Maharagama	MHG			121	15		32	36				2			4	18		2		22			6	6	10	2			4	8			288	270
16	Malwana	MAL			20																													20	20
17	Maradana	MD			164	34			42						2	6	2		14						2									266	252
18	Mattakuliya	MTK			17	1			4																									22	22
19	Mattegoda	MTG															22																	22	22
20	Minuwangoda	MWG											20																					20	20
21	Moratuwa	MF			31	2			6																					40				79	79
22	Mt. Lavinia	MV			137	39			38							2	6							22	8					18				270	248
23	Nugegoda	ND			144	36		4	44							8	6		2					8	22	4				4				282	260
24	Padukka	PK															10								4									14	14
25	Piliyandara	PYL			27	2			6								2													32				69	69
26	Raddolugama	RAD											22																					22	22
27	Ragama	RG																														36		36	36
28	Ratumalana	RM			83	20			24							2	4						40	18	4		32			14				241	227
29	Rukumalgama	RUK															8																	8	8
30	Wattala	WT			87	8			20				2	4															36			8		165	157
31	Wellanpitiya	WI			49	1			4																									54	54
		Total	36	36	2759	696	22	36	658	82	56	22	250	161	107	253	288	20	266	22	22	20	79	270	282	14	69	22	36	241	8	165	54	3526	
	Except Own		36	36	1901	622	22	36	658	82	56	22	224	153	103	235	270	20	252	22	22	20	79	248	260	14	69	22	36	227	8	157	54		2983

Source: Team Estimate

Table 2-5-28 Proposed Circuit Matrix

	No. of Circuits in 2 Mbit/s		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31		
	bothway		AN	BS	CO	HK	HC	HO	KO	JL	KDW	KDL	KTY	KI	KPT	KX	MHG	MAL	MD	MTK	MTG	MWG	MF	MV	ND	PK	PYL	RAD	RG	RM	RUK	WT	WI	Total	Except Own
1	Angoda	AN			28	1			4																									33	33
2	Boralesgamua	BS				36																												36	36
3	Colombo	CO	28		[illegible]	123			252	10	27	18	56	45	4	115	121	10	26	3			31	109	93		27			74		48	43	2121	1263
4	Havelock	HK	1	36	123	74	19		64	2	1			5	17	6				1				25	6					8		2	1	391	317
5	Hokandara	HC				19																												19	19
6	Homagama	HO															3																	3	3
7	Kotugoda	KO	4		252	64				6	4		26	22	16	40	36		42	4			6	38	44		6			24		20	4	658	658
8	Ja-Ela	JL			10	2			6																									18	18
9	Kadawata	KDW			27	1			4					19																				51	51
10	Kaduwela	KDL			18																													18	18
11	Katunayake	KTY			56				26				26				2					20						22						152	126
12	Kelaniya	KI			45	5			22		19																					4		103	95
13	Kollupitiya	KPT			4	17			16																									41	37
14	Kotte	KX			115	6			40								4								4					2				189	171
15	Maharagama	MHG			121			3	36				2			4	18		2		2			6			2			4				200	182
16	Malwana	MAL			10																													10	10
17	Maradana	MD			26				42								2		24															84	70
18	Mattakuliya	MTK			3	1			4																									8	8
19	Mattegoda	MTG															2																	2	2
20	Minuwangoda	MWG											20																					20	20
21	Moratuwa	MF			31				6																					38				75	75
22	Mt. Lavinia	MV			109	25			38								6							22										200	178
23	Nugegoda	ND			93	6			44							4									22									169	147
24	Padukka	PK																																0	0
25	Piliyandara	PYL			27				6								2													20				55	55
26	Raddolugama	RAD											22																					22	22
27	Ragama	RG																														19		19	19
28	Ratmalana	RM			74	8			24							2	4						38				20			14				184	170
29	Rukumalgama	RUK																																0	0
30	Wattala	WT			48	2			20					4															19			8		101	93
31	Wellampitiya	WI			43	1			4																									48	48
		Total	33	36	2121	391	19	3	658	18	51	18	152	103	41	189	200	10	84	8	2	20	75	200	169	0	55	22	19	184	0	101	48	2515	
	Except Own		33	36	1263	317	19	3	658	18	51	18	126	95	37	171	182	10	70	8	2	20	75	178	147	0	55	22	19	170	0	93	48		1972

Source: Team Estimate

Table 2-5-29 Circuit Convergence (Distribution of 2 Mbit/s Tributaries)

(No. of 2 Mbit/s tributaries)

No.	Node		Ring 1a		Ring 1b		Total	Inter-Ring	Remarks
			within Ring	Other	within Ring	Other			
1	Colombo	CO	241	238	571		1050		1b for HK,KO,KX,MHG
2	Havelock	HK	48	13	174		235	160	1b for CO,KO,KX,MHG
3	Kotugoda	KO	166	100	392		658		1b for CO,HK,KX,MHG
4	Katunayake	KTY	77	0			77	178	
5	Kollupitiya	KPT	33	0			33		
6	Kotte	KX	4	2	154		160		1b for CO,HK,KO,MHG
7	Maradana	MD	58	0			58	15	
8	Maharagama	MHG	10	0	151		161		1b for CO,HK,KO,KX
9	Mt. Lavinia	MV	167	0			167		
10	Nugegoda	ND	134	0			134		
	(Sub-Total 1)		469	353	721		1543	353	
				822		721			

No.	Node		Ring 2-1a		Ring 2-1b		Total	Inter-Ring	Remarks
			within Ring	Other	within Ring	Other			
11	Ja-Ela	JL	0			16	16		2-1b for Other Rings
12	Kadawata	KDW	19			31	50		2-1b for Other Rings
13	Kelaniya	KI	23			66	89		2-1b for Other Rings
14	Minuwangoda	MWG	20			0	20		
15	Raddolugama	RAD	22			0	22		
16	Ragama	RG	19			0	19		
17	Wattala	WT	23			65	88		2-1b for Other Rings
	(Katunayake	KTY)	42			0	42	178	2-1b for Other Rings
	(Sub-Total 2)		84	0	0	178	262	178	
				84		178			

No.	Node		Ring 2-2a				Total	Inter-Ring	Remarks
			within Ring	Other					
18	Angoda	AN	27	5			32		
19	Kaduwela	KDL	18				18		
20	Malwana	MAL	10				10		
21	Mattakuliya	MTK	2	5			7		
22	Wellanpitiya	WI	42	5			47		
	(Colombo	CO)	99				99		
	(Maradana	MD)	0				0	15	
	(Sub-Total 3)		99	15			114	15	
				114					

No.	Node		Ring 2-3a		Ring 2-3b		Total	Inter-Ring	Remarks
			within Ring	Other	within Ring	Other			
23	Boralesgamua	BS	36			0	36		
24	Hokandara	HC	19			0	19		
25	Homagama	HO	3			0	3		
26	Moratuwa	MF	38			35	73		2-3b for Other Rings
27	Piliyandara	PYL	22			32	54		2-3b for Other Rings
28	Ratmalana	RM	70			93	163		2-3b for Other Rings
	(Havelock	HK)	63			0	63	160	2-3b for Other Rings
	(Maharagama	MHG)	9			0	9		
	(Sub-Total 3)		130	0	0	160	290	160	
				130		160			

Note: Within Ring... No. of 2M tributaries between nodes within the ring
Other...No. of 2M tributaries between nodes on other rings
Inter-Ring... No. of 2M tributaries for Inter-Ring connection

Source: JICA Study Team.

The following are the explanation of the related subsystems.

(1) MUX Subsystem

As a style of SDH fibre optic transmission system, 4-fibre bi-directional self-healing ring with line protection is assumed. In this system, each node station has STM-16 add/drop MUX equipment and/or STM-4 add/drop MUX equipment. Protection is realised at equipment level (1+1, N+1 for 2 Mbit/s interface) and line level (1+1). Major equipment at node station is as follows:

STM-16 Add Drop MUX (STM-16 / STM-4 I/F) consists of Optical T/R Unit, Cross Connect Unit, System Control Unit, Clock Generator Unit, STM-4 I/F Unit and etc.

STM-4 Add Drop MUX (STM-4 / 2 Mbit/s I/F) consists of Optical T/R Unit, Cross Connect Unit, System Control Unit, Clock Generator Unit, 2 Mbit/s I/F Unit and etc.

ETS Rack, Cable Termination Frame (CTF), Digital Distribution Frame (DDF) and **Local Craft Terminal**

Concrete MUX facilities plan for each station is shown in Table 2-5-30. Transmission capacity of Ring-1, high speed ring will be two (2) systems of STM-16 (1,543 systems of 2 Mbit/s tributaries). Ring-2-1, Ring-2-2 and Ring-2-3, low speed rings will have the capacity of two (2) systems of STM-4 (262 systems of 2 Mbit/s tributaries), one (1) system of STM-4 (114 systems of 2 Mbit/s tributaries) and two (2) systems of STM-4 (290 systems of 2 Mbit/s tributaries) respectively.

Each ring will have the spare capacity for the full. These spare capacities are recognised as the future expansion spaces. All rings except Ring 1b go through all participated node stations, so the capacity expansion will be easy. Ring 1b is designed for the high traffic exchange between some specific node stations. Ring capacities and spares are as follows:

(No. of 2 Mbit/s tributaries)

	Full Ring Capacity	Installed Capacity	Spare Capacity
Ring 1 (1a and 1b)	2,016 (STM-16 x 2)	1,543	473 (23.5 %)
Ring 2-1 (2-1a and 2-1b)	504 (STM-4 x 2)	262	242 (48.0 %)
Ring 2-2 (2-2a)	252 (STM-4 x 1)	114	138 (54.8 %)
Ring 2-3 (2-3a and 2-3b)	504 (STM-4 x 2)	290	214 (42.5 %)

Table 2-5-30 MUX Facilities Plan

No.	Node	Ring1a			Ring1b			Ring2-1a		Ring2-1b		Ring2-2a		Ring2-3a		Ring2-3b		Remarks
		No. of 2M I/F	STM16ADM	STM4ADM	No. of 2M I/F	STM16ADM	STM4ADM	No. of 2M I/F	STM4ADM	No. of 2M I/F	STM4ADM	No. of 2M I/F	STM4ADM	No. of 2M I/F	STM4ADM	No. of 2M I/F	STM4ADM	
1	Colombo	550	1	2	611	1	3					102	1					
2	Havelock Town	61+170	1	1	193	1	1							63	1	0+160	1	
3	Kotugoda	266	1	2	392	1	2											
4	Katunayake	84+192	1	2				42	1	0+192	1							
5	Kollupitiya	37	1	1														
6	Kotte	6	1	1	165	1	1											
7	Maradana	70+15	1	1								0+15	1					
8	Maharagama	10	1	1	161	1	1							9	1	0	1	
9	Mt. Lavinia	178	1	1														
10	Nugegoda	147	1	1														
11	Ja-Ela							0	1	18	1							
12	Kadawata							19	1	32	1							
13	Kelaniya							23	1	72	1							
14	Minuwangoda							20	1	0	1							
15	Raddolugama							22	1	0	1							
16	Ragama							19	1	0	1							
17	Wattala							23	1	70	1							
18	Angoda											33	1					
19	Kaduwela											18	1					
20	Malwana											10	1					
21	Mattakuliya											8	1					
22	Wellanpitiya											48	1					
23	Boralesgamua													36	1	0	1	
24	Hokandara													19	1	0	1	
25	Homagama													3	1	0	1	
26	Moratuwa													38	1	37	1	
27	Piliyandara													22	1	33	1	
28	Ratmalana													70	1	100	1	
	Total		10	13		5	8		8		8		7		8		8	

Note: '+ XXX' in the column "No. of 2M I/F" means the number of 2M I/F for connection with other rings.
Source: Team Study

(2) Fibre Optic Cable Subsystem

Transmission medium will be 1.5μm zero dispersion Single Mode Fibre cable and 4 cores of fibre optic cable for each 1+1 system are assumed for this system. For operation and maintenance purposes, other 6 cores will be used. For realising these transmission systems, existing duct system should be utilised as much as possible. Cable route plan is shown in Table 2-5-31.

Table 2-5-31 Cable Route Plan

No.	Section	Related Ring	No. of F.O. cable core	Route	Route Distance (km)	Overlap Route (km)	Existing Duct Length (km)	Civil Work for New Duct (km)	Cable Installation (km)	Remarks
1	CO - foot of Kelani Bridge	R1	2x4+6	Colombo-Negombo Rd.	4.7		4.7	0.0	4.8	
2	CO - MTK	R2-2	1x4+6	Alutmawatta Rd	5.5		5.5	0.0	5.7	
3	MTK - foot of Kelani Bridge	R2-2	1x4+6	Ferguson's Rd	2.5		0.0	2.5	2.6	
4	foot of Kelani Bridge - other side of Kelani Bridge	R1, R2-2	4x4+6	New Kelani Bridge	0.2		0.2	0.0	0.2	
5	other side of Kelani Bridge - WT	R1, R2-1	4x4+6	Colombo-Negombo Rd	3.9		3.9	0.0	4.0	
6	WT - Ragama Jct.	R1, R2-1	4x4+6	Colombo-Negombo Rd.	3.5		3.5	0.0	3.6	
7	Ragama Jct. - RG	R2-1	2x4+6	Ragama Rd.	2.6		2.6	0.0	2.7	
8	RG - Aniakande Jct.	R2-1	2x4+6	Ragama Rd.	2.8	0.6	0.0	2.2	2.9	
9	Ragama Jct. - Aniakande Jct.	R1	2x4+6	Colombo-Negombo Rd.	1.5		1.5	0.0	1.5	
10	Aniakande Jct. - JL	R1, R2-1	4x4+6	Colombo-Negombo Rd.	4.5		4.5	0.0	4.6	
11	JL - Bandarawata Jct.	R1, R2-1	4x4+6	Colombo-Negombo Rd.	5.9		5.9	0.0	6.1	
12	Bandarawata Jct. - RAD	R2-1	2x4+6	Radullugama Rd.	4.0		0.0	4.0	4.1	
13	RAD - Bandarawata Jct.	R2-1	2x4+6	Radullugama Rd.	4.0	4.0	0.0	0.0	4.1	
14	Bandarawata Jct. - KTY Jct.	R1, R2-1	4x4+6	Colombo-Negombo Rd.	2.8		2.8	0.0	2.9	
15	KTY Jct. - KTY	R1, R2-1	4x4+6	Airport Rd	3.1		3.1	0.0	3.2	
16	KTY - KTY Jct. on MWG Rd.	R1, R2-1	4x4+6	Airport Rd	1.7		1.7	0.0	1.8	
17	KTY Jct. on MWG Rd. - MWG	R1, R2-1	4x4+6	MWG Rd.	6.0		2.1	3.9	6.2	
18	MWG - KO Jct.	R1, R2-1	4x4+6	Colombo-Minuwangoda Rd.	7.1		0.0	7.1	7.3	
19	KO Jct. - KO	R1	2x4+6	KO approach	0.3		0.0	0.3	0.3	
20	KO - KO Jct.	R1	2x4+6	KO approach	0.3	0.3	0.0	0.0	0.3	
21	KO Jct. - KDW Jct.	R1, R2-1	4x4+6	CO MWG Rd., JL-GO Rd., Ganemulla Rd.	18.9		6.0	12.9	19.5	Duct exists around Ganemulla exchange.
22	KDW Jct. - KDW	R2-1	2x4+6	KDW approach	0.1		0.0	0.1	0.1	
23	KDW - KDW Jct.	R2-1	2x4+6	KDW approach	0.1	0.1	0.0	0.0	0.1	
24	KDW Jct. - Talanwaluhenpita Jct.		2x4+6	Colombo-Kandy Rd.	3.5		3.5	0.0	3.6	
25	Talanwaluhenpita Jct. - KI	R2-1, R2-2	3x4+6	Colombo-Kandy Rd.	3.1		3.1	0.0	3.2	
26	KI - other side of Kelani Bridge	R2-1, R2-2	3x4+6	Colombo-Kandy Rd.	2.1		2.1	0.0	2.2	
27	Talanwaluhenpita Jct. - MAL	R1, R2-2	3x4+6	Biyagama Rd.	14.5		14.5	0.0	14.9	
28	MAL - other side of Kaduwela Bridge	R1, R2-2	3x4+6	Malwana Rd.	5.4		5.4	0.0	5.6	
29	other side of Kaduwela Bridge - foot of Kaduwela Bridge	R1, R2-2	3x4+6	Kaduwela Bridge	0.7		0.4	0.3	0.7	Trench is used.
30	foot of Kaduwela Bridge - Angoda Jct.	R1	2x4+6	Avissawella Rd.	6.8		6.8	0.0	7.0	
31	Angoda Jct. - AN	R2-2	1x4+6	Angoda Rd.	0.6		0.6	0.0	0.6	
32	foot of Kaduwela Bridge - KDL	R2-2	1x4+6	Kaduwela-Talangama Rd.	0.2		0.2	0.0	0.2	
33	KDL - Talangama Jct.	R2-2	1x4+6	Kaduwela-Talangama Rd.	5.0		5.0	0.0	5.2	
34	Talangama Jct. - Koswatta Jct.	R2-2, R2-3	3x4+6	Koswatta Rd.	2.9		2.9	0.0	3.0	
35	Koswatta Jct. - AN	R2-2	1x4+6	Angoda Rd.	2.7		2.7	0.0	2.8	
36	Angoda Jct. - WI	R1, R2-2	3x4+6	Avissawella Rd.	3.7		3.7	0.0	3.8	
37	WI - MO	R1, R2-2	3x4+6	Kolonnawa Rd., D. De Silva MW., A. Rajakaruna MW.	3.9		3.9	0.0	4.0	
38	MO - CO	R2-2	1x4+6	Maradana Rd.	4.0		4.0	0.0	4.1	
39	MD - KX	R1	2x4+6	C. De Soysa, Horton Place, Sri Jayewardenepura Rd.	6.0		6.0	0.0	6.2	
40	Koswatta Jct. - KX	R2-3	2x4+6	Koswatta Rd.	2.9		2.9	0.0	3.0	
41	KX - Balapokuna Jct.	R1, R2-3	4x4+6	Kotte Rd.	4.5		0.0	4.5	4.6	
42	Balapokuna Jct. - HK	R2-3	2x4+6	High Level Rd.	3.7		3.7	0.0	3.8	
43	Balapokuna Jct. - ND	R1	2x4+6	High Level Rd.	0.1		0.1	0.0	0.1	
44	ND - MHG	R1	2x4+6	High Level Rd.	4.9		4.9	0.0	5.0	
45	Talangama Jct. - HC	R2-3	2x4+6	Hokandara Rd.	2.5		2.5	0.0	2.6	
46	HC - HO	R2-3	2x4+6	Hokandera Rd.	8.0		0.0	8.0	8.2	
47	MHG - HO	R2-3	2x4+6	High level Rd.	8.5		8.5	0.0	8.8	
48	MHG - BS	R1, R2-3	4x4+6	Maharagama Rd.	3.0		0.0	3.0	3.1	
49	BS - PYL	R1, R2-3	4x4+6	Horana Rd.	4.9		0.0	4.9	5.0	
50	PYL - Rawatawatta Jct.	R1, R2-3	4x4+6	Moratuwa-Piliyandala Rd.	4.4		4.4	0.0	4.5	
51	Rawatawatta Jct. - MF	R2-3	2x4+6	Behind Galle Rd.	1.4		0.0	1.4	1.4	
52	MF - Moratuwa Jct.	R2-3	2x4+6	Galle Rd	1.0		1.0	0.0	1.0	
53	Rawatawatta Jct. - Mawatuwa Jct.	R1	2x4+6	Moratuwa Piliyandala Rd.	0.3		0.3	0.0	0.3	
54	Moratuwa Jct. - RM	R1, R2-3	4x4+6	Galle Rd.	2.5		2.5	0.0	2.6	
55	RM - MV	R1, R2-3	4x4+6	Galle Rd.	3.7		3.7	0.0	3.8	
56	MV - HK	R1, R2-3	4x4+6	Galle Rd	5.5		5.5	0.0	5.7	
57	HK - KPT	R1	2x4+6	Galle Rd.	3.0		3.0	0.0	3.1	
58	KPT - CO	R1	2x4+6	Galle Rd	3.0		3.0	0.0	3.1	
	Total				218.9	5.0	158.8	55.1	225.5	

Source: JICA Study Team.

(3) Network Management System

SDH Network management systems will provide the following functions at least as described in ITU-T Recommendation G.784:

(1) Fault (maintenance) management such as Alarm surveillance, Alarm history management, testing and External events,
(2) Performance management such as Performance data collection, Performance monitoring history, Use of thresholds and Performance data reporting,
(3) Configuration management such as Provisioning, Status and control (protection switch) and Installation functions, and
(4) Security management.

The network management system will consist of a central management terminal and local craft terminals at each station.

(4) Cable Laying

It is assumed that duct and manhole system is applied for the all sections. Existing duct will cover 158.8 km length out of the whole 225.5 km length, or cover 70 % length of total.

5.3.3 External Plant

Subscribers are distributed in a wide area, and it is difficult to construct a external plant effectively, further more the external plant is exposed to natural and social environment that affect on it a damage or corrosion. Therefore, a design standard and material specifications are very important to prevent the inflections. In addition with that, a standard of external plant design and construction shall be made as to make the facility economically, easily and in short time.

5.3.3.1 Scope of the Project

(1) Covering Exchanges and Area in this Project

This Project covers following seventeen (17) Exchanges in Colombo Metro Area as shown in Table 2-5-32 with exchange situation including On-Going Project, and as shown in Figure 2-5-18 in subsection 5.2.4 as a geographical location.

Table 2-5-32 Exchange Situation and Demand for Feasibility Study

Exchange Name	Exchange Code	Primary Loops in Y 1995	Primary Loops in Y 1997	Demand in Y 2000	Demand in Y 2005
Angoda	AN	500	2,400	3,230	4,741
Boralesgamua	BS	2,300	2,300	3,846	5,646
Ja-Ela	JL	1,400	9,300	8,230	12,228
Kadawata	KDW	660	5,800	5,494	8,204
Katynayake	KTY	3,050	4,550	6,675	9,970
Kelaniya	KI	1,650	8,200	10,520	15,712
Kollupitiya	KPT	7,900	9,400	10,152	14,905
Kotte	KX	9,900	31,700	24,826	36,453
Maharagama	MHG	1,400	7,800	13,515	19,844
Mattakkuliya	MTK	5,900	5,900	5,696	8,362
Moratuwa	MF	1,500	6,900	7,080	10,395
Mount Lavinia	MV	15,600	15,600	23,663	34,745
Piliyandala	PYL	800	3,600	6,763	9,930
Raddolugama		0	0	2,138	3,192
Ragama	RG	1,500	3,000	3,561	5,317
Ratmalana	RM	9,000	9,000	9,056	13,297
Wattala	WT	1,700	8,700	8,380	12,516
Total		64,760	134,150	152,825	225,457

Source: JICA Study Team.

The covering area has satellite commercial area, the location of Parliament, international airport, resorts and dormitory town of Colombo Central. Therefore a telephone demand in the area is rapidly increasing for both of business and residence use.

(2) Demand to be used in this Project

This project is designed based on a demand in the year 2005, the demand is shown in the table 2-5-32. The demand is basically for telephone demand, therefore broad band services such as ISDN services are not considered in this project.

(3) Subscriber Access System to be used in this Project

The design of subscriber cable network is basically made using copper cables. However, in the case of implementation of this Project, the adoption of optical fibre cables for primary cable section shall be investigated from a view of cost effectiveness in the area where the rapid demand increase is expected.

(4) Expected new subscribers in this project

The expected number of new subscribers in this project shall be calculated with existing situation of exchanges including On-Going Project and the demand in the year 2005. Here, the expected number of DELs in the year 1997 is assumed that ninety (90) percent of the existing number of primary loops including on-going project. Thereupon the difference between the demand in the year 2005 and the expected number of DELs in the year 1997 is the number of new subscribers in this project.

Table 2-5-33 Expected New Subscribers in this Project

Exchange Name	Exchange Code	Primary Loops in 1997	Expected DELs in 1997 (90% of Loops)	Demand in 2005	Expected New DELs in the Project
Angoda	AN	2,400	2,160	4,741	2,581
Boralesgamua	BS	2,300	2,070	5,646	3,576
Ja-Ela	JL	9,300	8,370	12,228	3,858
Kadawata	KDW	5,800	5,220	8,204	2,984
Katynayake	KTY	4,550	4,095	9,970	5,875
Kelaniya	KI	8,200	7,380	15,712	8,332
Kollupitiya	KPT	9,400	8,460	14,905	6,445
Kotte	KX	31,700	28,530	36,453	7,923
Maharagama	MHG	7,800	7,020	19,844	12,824
Mattakkuliya	MTK	5,900	5,310	8,362	3,052
Moratuwa	MF	6,900	6,210	10,395	4,185
Mount Lavinia	MV	15,600	14,040	34,745	20,705
Piliyandala	PYL	3,600	3,240	9,930	6,690
Raddolugama		0	0	3,192	3,192
Ragama	RG	3,000	2,700	5,317	2,617
Ratmalana	RM	9,000	8,100	13,297	5,197
Wattala	WT	8,700	7,830	12,516	4,686
Total		134,150	120,735	225,457	104,722

Source: JICA Study Team.

The process of the calculation and the result of expected new subscribers in this project is shown in Table 2-5-33.

5.3.3.2 Basic Design Policy for External Plant

(1) Expansion Project Period (Provisioning Period)

A capacity of the external plant shall be designed to meet the demand forecast 5 years ahead of project completion year, because the expansion project is planned in every 5 years period in the Master Plan. Therefore a provisioning period of the primary cable and secondary cable shall be 5 years. But a provisioning period of the underground duct system for a primary cable shall be 15 years to make a repetition period of road digging long years, a public road has a regulation to use it for prevention of traffic jam etc. The other hand it makes cost reduction for a next expansion project to design the period long years. These provisioning periods of the external plant are described as follows.

a) Underground Duct System (for Primary Cable) : 15 years ahead (to meet demand as of 2015)

b) Underground Duct System (for Secondary Cable) : 5 years ahead (to meet demand as of 2005)

c) Primary Cable System : 5 years ahead (to meet demand as of 2005)

d) Secondary Cable System : 5 years ahead (to meet demand as of 2005)

(2) Determination of Cabinet Area's Boundary

A boundary of cabinet area shall be determined to take a demand and geographical conditions into consideration for an economical cost performance and maintenance work.

Therefore, it is suitable to make the boundary line along a river, a wide road or a railway etc.

The number of demand for a cabinet area shall be under 600, basically. The larger number of demand in cabinet area, the more economical it becomes for a primary cable. However, in the case of very wide area, a secondary cable cost is expensive, and a management of cable pairs is more difficult than small cabinet area for a maintenance and operation work. Therefore, it is suitable to make the number 400 in low density demand area , and 600 in high density demand area except very big building that has over 600 demand.

(3) Cabinet Area Modification

In the case of more than 600 demand in existing cabinet area, it is necessary to modify the boundary of cabinet area. The modification method is same as Determination of Cabinet Area's Boundary mentioned above. In addition with that, the area shall be modified to utilise existing cabinet and cables as much as possible.

(4) Distribution of Demand from Exchange to Cabinet Area

Demand forecasting data in each exchange is described in the Master Plan, a project shall be planned with the demand. It is necessary to distribute the demand of exchange to each cabinet area. For an external plant plan, the accurate demand in each cabinet area is very important to make a design easily and to make a project effectively and economically.

Each RTE has a waiting list with address of waiters, the detail design of external plant shall be used the waiting list to distribute the demand from the exchange area to each cabinet area. And then, it is possible to make a project economically and to eliminate the waiting list effectively.

(5) Location of Cross-Connection Cabinet

One cross-connection cabinet shall be established in one cabinet area. The location shall be selected at the centre of demand distribution of the cabinet area to make more economical primary cable and secondary cable, the centre is determined to make the length shortest between subscribers and exchange. In addition with that, the location shall be selected to avoid a damage from vehicular traffic for easier maintenance work.

(6) Route Selection of Conduit Route

a) 'for Primary Cable :

A conduit route shall be so selected that existing duct route which has vacant pipes is utilised.

In the case of new route, the conduit route shall be selected to make the distance along a road between an exchange and a cross-connection cabinet shortest.

Further more, the route shall be selected not to arise replacement work caused by other authorities such as Road, Water Supply, Electricity Authority etc. in near future. Accordingly, it is necessary to get information of Road Expansion or Reform, other constructions from Road Authority and City Development Planning Authority.

b) for Secondary Cable

A conduit route shall be selected to make the distance along a road between a cross-connection cabinet and a distribution point shortest. In addition with that, the route shall be chosen to gather distribution points as many as possible for economical cost performance.

(7) Location of Distribution Point

A location of distribution point shall be selected not to make the pole spans of drop wire over two (2) spans. For that reason, new subscribers locations shall be grasped.

Further more the location shall be chosen that a drop wire does not cross a wide road or a river for maintenance work.

(8) Countermeasures for High Cable Transmission Loss Subscribers

A standard of cable transmission loss limitation is 8 dB. In the case of over 8 dB cable transmission loss for a subscriber because of long distance from an exchange centre, the subscriber access system shall take measures to reduce the loss value or to introduce another subscriber access system.

a) Countermeasures Systems for High Cable Transmission Subscribers

There are many countermeasures systems for the high loss subscribers as shown in Table 2-5-34. The measures shall be selected using concrete case in due consideration of economical analysis, geographical conditions and maintenance work.

Loading Coil System and Telephone Set for high loss subscribers which does not have good transmission characteristics shall not be applied for the countermeasures in considering with new service in future.

Table 2-5-34 Systems for High Loss Subscriber

Countermeasures		Characteristics
Cable System	Telephone Set for High Loss Subscriber	- Existing cables are available - Narrow frequency band
	Subscriber Carrier System by Cable (Analogue)	- Reduction of cable pairs - Maintenance difficulty for faults - Existing in SLT
	Loading Coil System	- Very narrow frequency band - Stop the production
	Subscriber Access System by Optical Fibre	- Expensive - Available new services as ISDN etc.
New Exchange Establishment	Establishment of Remote Switch Centre	- Expensive - Profitable for large Number of subscribers
Radio System	Digital Radio Concentrator System	- Expensive - Profitable for low density Subscribers and long distance from Exchange low density
	Small Capacity Radio System	- Profitable for 1 or 2 subscribers in long distance are from Ex.

Source: JICA Study Team.

b) A Case of Western Area of Negombo Lagoon in Ja-Ela Exchange

The area around Kepungoda Village has about 200 waiters, but telephone services are not available in that area yet, because the road distance from Ja-Ela exchange is about 12 km. A demand in that area is expected 600 in the year 2005. However, a cable attenuation loss is over 8 dB, general subscriber cable system can not be applied because of telephone service quality.

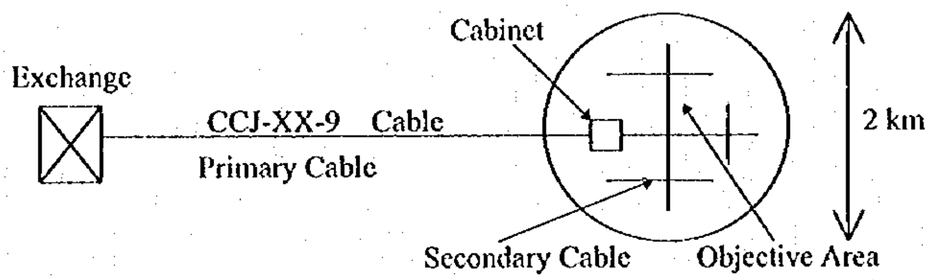
In this case, the study systems may be "Establishment of RSU", " Optical Fibre Access" and "Telephone Set for High Loss Subscribers".

The result of economical analysis is shown in Figure 2-5-24. In this case, the counter-measures of "Establishment of RSU" is most economical. Further more, it is easier to find a cable fault location etc. as maintenance work, because the cable length will be shorter than the telephone set for high loss subscribers. For that reasons, RSU shall be selected in this area at present.

c) An Example of System Selection by economical comparison

Following 3 example systems are calculated for economic comparison.

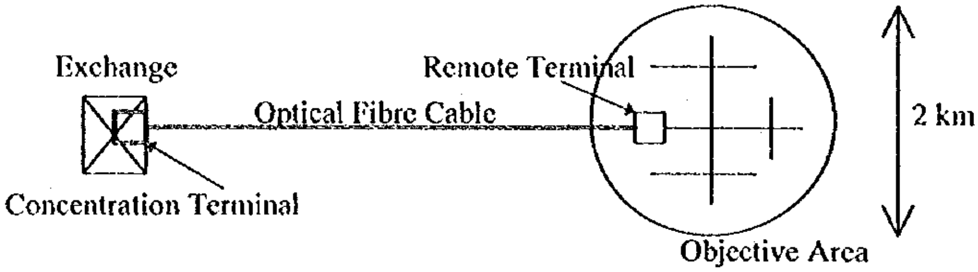
c-1) Countermeasure by 0.9 mm diameter cable and telephone set with amplifier



Source: JICA Study Team.

Figure 2-5-23 (1/3) Countermeasure by 0.9 mm Diameter Cable and Telephone Set with Amplifier

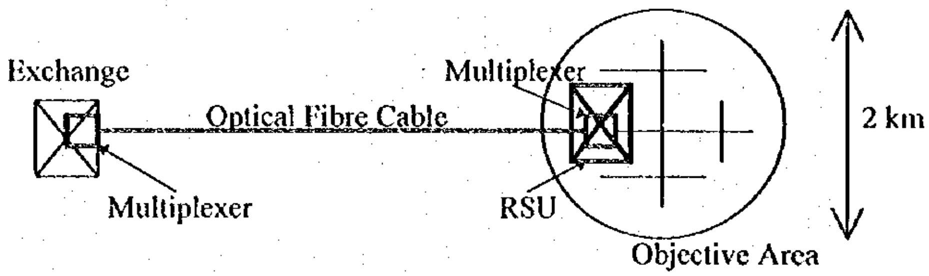
c-2) Countermeasure by Optical Fibre Access System



Source: JICA Study Team.

Figure 2-5-23 Countermeasure by Optical Fibre Access System (2/3)

c-3) Countermeasure by Establishment of RSU



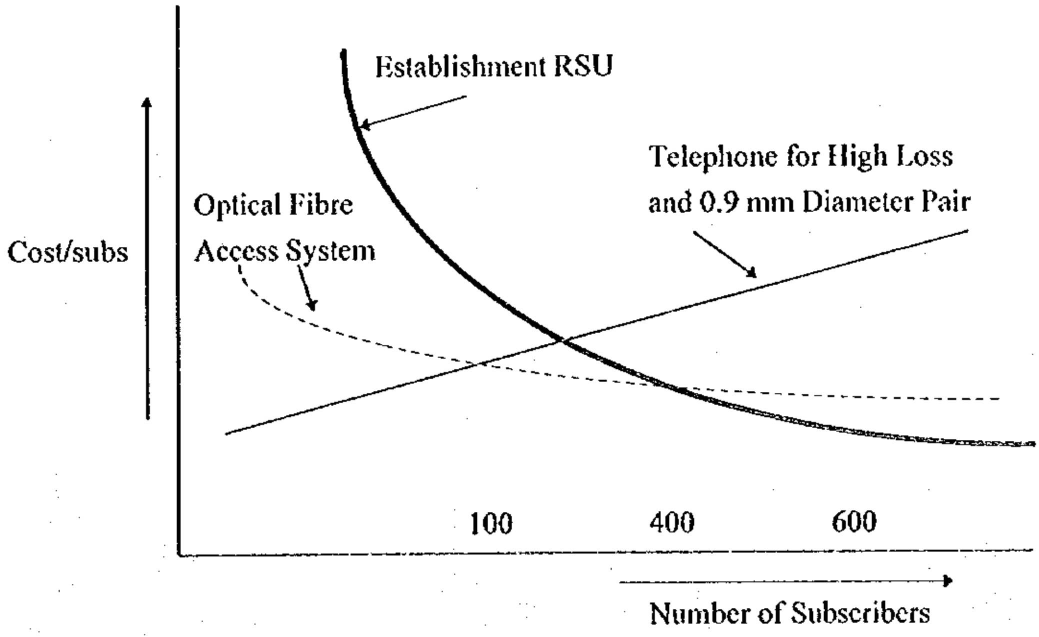
Source: JICA Study Team.

Figure 2-5-23 Countermeasure by Establishment of RSU (3/3)

The outline of calculation result is shown Figure 2-5-24, the three (3) examples are calculated about three (3) types demand density which are 100, 400 and 600.

In this examples, it is understood the countermeasures "by Establishment of RSU" is better in high density demand, the countermeasures of "0.9 mm diameter cable and telephone set with amplifier" is lower cost in very few demand.

And the Optical Fibre Access System is more expensive at present than other systems.



Source: JICA Study Team.

Figure 2-5-24 Example of Economical Cost Comparison

5.3.3.3 Technical Standards for Basic Design

Basic Design is executed according to following technical standards and specifications that are standards of SLT.

(1) Cable

Diameter of cable pair and its cable loss is shown table 2-5-35. The basic design of cable distribution shall be carried out with a combination of these cable diameters to make the project cost economical and less than 8 dB of Cable Loss..

Table 2-5-35 Standard of Cable Loss

Diameter of Conductor	Cable Loss (dB/km)	Loop Resistance (ohm/km)
0.4 mm	2.2	295
0.5 mm	1.75	187
0.65 mm	1.33	113
0.9 mm	0.93	58

Source: SLT.

a) Primary Cable Specification

All primary cables are conduit cables, and the type of cable is PE single sheath with moisture barrier and jelly filled cellular-solid PE insulated Pair/Quad type. Table 2-5-36 shows the cable size.

Table 2-5-36 Cable Size of Primary Cable

Conductor Diameter	Number of Pairs
0.4 mm	300, 400, 600, 800, 1000, 1200, 1500, 1800, 2400
0.5 mm	300, 400, 600, 800, 1000, 1200, 1800
0.65 mm	300, 400, 600, 800, 1000, 1200
0.9 mm	200, 300, 400, 600

Source: SLT.

b) Secondary Cable Specification

The secondary cable is conduit cable in Colombo Metro Area principle in principle, buried cable and aerial cable are applied exceptionally.

The structure of conduit cable is same as primary cable. The buried cable is PE sheath with moisture barrier and jelly filled cellular-solid PE insulated Pair/Quad type cable with steel tape armoured. The aerial cable is PE single sheath with moisture barrier and solid PE insulated Pair/Quad cable with messenger wire for self-supporting.

Cable size is shown in Table 2-5-37.

Table 2-5-37 Cable Size of Secondary Cable

Conduit Cable and Buried Cable	
Conductor Diameter	Number of Pairs
0.4 mm	10, 20, 30, 50, 100, 150, 200, 300, 400
0.5 mm	10, 20, 30, 50, 100, 150, 200, 300, 400
0.65 mm	10, 20, 30, 50, 100, 150, 200, 300, 400
0.9 mm	10, 20, 30, 50, 100, 150, 200, 300, (400)
	( ): for conduit only

Aerial Cable	
Conductor Diameter	Number of Pairs
0.4 mm	10, 20, 30, 50, 100, 150, 200, 300
0.5 mm	10, 20, 30, 50, 100, 150, 200
0.65 mm	10, 20, 30, 50, 100, 150, 200
0.9 mm	10, 20, 30, 50, 100, 150, 200

Source: SLT.

(2) Cable Splice Closure

Cable Splice Closure is applied as shown in Table 2-5-38.

Table 2-5-38 Closure Types

Type	Outside Diameter of Cables	Application
SC-C1	25 mm and less than 25 mm	Conduit Cable
SC-C2	More than 25 mm up to 50 mm	Conduit Cable
SC-C3	More than 50 mm	Conduit Cable
SC-B1	5 mm and less than 25 mm	Buried Cable
SC-B2	More than 25 mm up to 50 mm	Buried Cable
SC-B3	More than 50 mm	Buried Cable
SC-A1	5 mm and less than 25 mm	Aerial Cable
SC-A2	More than 25 mm up to 50 mm	Aerial Cable
SC-A3	More than 50 mm	Aerial Cable

Source: SLT.

(3) Cross-Connection Cabinet

Cross-connection cabinet is introduced in order to minimise the cost of primary and secondary cables, and to connect flexibly primary cable and secondary cable. The standard of cross-connection cabinet is an external type, and standard of the capacity is 1600 pair terminals.

The following Table 2-5-39 shows the cross-connection cabinet size, cable terminal block and riser cable size.

Table 2-5-39 Cross-Connection Cabinet Size

Capacity	Primary Pairs	Secondary Pairs
200	100	100
400	200	200
800	400	400
1200	600	600
1600	800	800
2000	1000	1000
2400	1200	1200
3200	1600	1600

Cable Terminal Block and Riser Cable Size	
Cable Terminal Block	Riser Cable Size
100 pairs	100 pairs, 0.5 mm of conductor diameter
200 pairs	100 pairs, 0.5 mm of conductor diameter

Source: SLT.

(4) Distribution Point

Three (3) types of Distribution Point are adopted in this project. Pole-mounted type is applied to connect subscriber in each house with drop wire. The internal Distribution Point is used for a building which accommodates over six lines with cable. The wall-mounted Distribution Point is employed in the case where the internal type is impractical. The following Table 2-5-40 shows type and capacity of Distribution Point.

Table 2-5-40 Capacity and Type of Distribution Point

Type	Capacity
Pole-Mounted Type	10
Wall-Mounted Type	10, 20, 30
Internal Type	10, 20, 30, 50, 100, 200

Source: SLT.

(5) Manhole and Handhole

Manholes and Handholes shall be established at cable branching points, others key places where rapid curve is, where a manhole cover can be opened easily.

The manholes type and size shall be determined in considering the number of pipe, accommodated cables and closures and working space. The types and sizes of standard manhole and handhole are shown in Table 2-5-41.

Table 2-5-41 Standard of Manhole and Handhole

Type	Length (cm)	Width (cm)	Height (cm)	Number of Pipe(s) to be accommodated
S - 1	200	120	150	2 - 4
S - 2	320	120	170	6 - 10
S - 3	320	160	170	12 - 20
S - 3(R)	320	160	220	12 - 20
S - 4	320	160	210	21 - 28
S - 4(R)	320	160	260	21 - 28
L - 1	245	120	150	2 - 4
L - 2	355	120	170	6 - 10
L - 3	405	160	170	12 - 20
T - 1	245	120	180	2 - 4
T - 2	355	120	200	6 - 10
T - 3	405	160	200	12 - 20
HH - 1	80	40	75	1
HH - 2	100	50	75	2
HH - 3	120	60	90	3 - 4
HH - 4	200	70	160	5 - 6

( ) is for Branch Manhole

Source: SLT.

(6) Pipe

a) Application of Pipe Specification

The pipe used in this project shall be PVC pipe or Steel pipe in principle. The PVC pipe shall be applied at a sidewalk, or at a place where a pressure of soil is not so high. The nominal inner diameter of pipe shall be 100 mm for a primary cable, and 50 mm for a secondary cable basically.

The steel pipe is applied at a road crossing not to be crushed because of a high pressure added by heavy dump truck, or at a bridge crossing to protect a cable accommodated in the pipe from fire. In the case of instructions to use another pipe by the road authority etc., this standard does not applied.

b) Standard Span Between Manholes and Handholes

The span between manholes shall be determined in consideration of cable branching and road condition along with the manholes locations. The maximum length between manholes shall be 200 meters for easy cable installation.

c) Duct Location

In the case where a carriageway and sidewalk are distinctly separated, the sidewalk shall be selected for the duct construction. Where there is no distinction between carriageway and sidewalk, the shoulder of road is used for duct construction.

d) Calculation of Required Number of Pipes

A number of pipes between manholes shall be determined according to a number of cables to be accommodated, in the number subscriber cables, junction cables and long distance transmission cables are included. The number of subscriber cables shall be calculated using demand of 15 years ahead, and the number of junction cables shall be taken junction cable plan of 15 years ahead also. When it is impossible to take a demand of 15 years after, may be calculated the demand as triple of 5 years ahead demand.

Spare pipe(s) for maintenance use shall be added for the number of pipes. The number of spare(s) is shown in Table 2-5-42. The number of spare pipe(s) depends on the number of cables to be accommodated.

For a secondary cable, the number of pipes shall be calculated as the same number of cables which each project plans, and main route such as over 300 pairs cable, one spare pipe shall be added to use for a demand increasing unpredictably.

Table 2-5-42 Standard Number of Spare Pipe(s)

	Number of Cables to be accommodated	Number of Spare Pipe(s)
for Primary Cable	1 - 15	1
	16 - 30	2
	31 and over	3
for Secondary Cable	Main Route : over 300 pairs Cable	1

Source: SLT.

5.3.3.4 Materials and Tools for Maintenance Use

It is necessary to station materials and tools for maintenance work. Necessary materials tools are listed in Table 2-5-43 to maintain External Plant in good condition after the commissioning plant.

Table 2-5-43 Materials and Tools for Maintenance Use

Item		Quantity	
Vehicle	VAN Type	14 Vehicles	2 Vehicles at each RTE in Colombo Metro
Cable	CC-10-5	3,500 m	500 m at each RTE in Colombo Metro
	CC-50-5	3,500 m	ditto
	CC-100-5	3,500 m	ditto
	CC-200-5	3,500 m	ditto
	CC-100-5	3,500 m	ditto
Closure	SC-C1	140 ea	20 ea at each RTE in Colombo Metro
	SC-C2	140 ea	ditto
	SC-C3	14 ea	2 ea at each RTE in Colombo Metro
Connector	1 Pairs	3,500 ea	500 ea at each RTE in Colombo Metro
	10 Pairs	350 ea	50 ea at each RTE in Colombo Metro
	25 Pairs	350 ea	ditto
Drop Wire		3,500 m	500 m at each RTE in Colombo Metro
Jumper Wire		3,500 m	500 m at each RTE in Colombo Metro
Distribution Point		350 ea	50 ea at each RTE in Colombo Metro
Telephone Set		700 ea	100 ea at each RTE in Colombo Metro
Fault Location Tester		70 ea	10 ea at each RTE in Colombo Metro
Portable Generator		14 ea	2 ea at each RTE in Colombo Metro
Ventilator		14 ea	2 ea at each RTE in Colombo Metro
Water Pump		14 ea	2 ea at each RTE in Colombo Metro
Air and Gas Checker		14 ea	2 ea at each RTE in Colombo Metro

Source: JICA Study Team.

5.3.3.5 Work of Local Portion

It is assumed according to the recommendation in Master Plan that SLT will contract out all new subscribers' connection which will relate this project. And the number of staffs will not increase after this project. Therefore operation and maintenance cost of SLT staff will not increase, however the contract out cost will be added by this project.

The expected number of new subscribers connected by this project is shown Table 2-5-33. The number is approximately 100,000, which will be contract out by SLT.

5.3.3.6 Amount of Main Work

Amount of main work for implementation of this project is shown in Table 2-5-44.

Table 2-5-44 Amount of Main Work in this Project

Exchange	Foregin Portion				Local Portion
	Number of New Cabinets (ea)	Primary Cable Capacity (pairs)	Number of Manholes (ea)	Conduit Length for Primary (km)	New Subscriber Connection
Angoda	4	3,600	18	3.2	2,581
Boralesgamua	6	5,000	25	4.5	3,576
Ja-Ela	7	5,500	26	5.1	3,858
Kadawata	5	4,200	21	4.0	2,984
Katunayake	8	6,600	19	3.2	5,875
Kelaniya	12	9,400	38	7.5	8,332
Kollupitiya	11	9,000	22	4.0	6,445
Kotte	14	9,000	26	4.4	7,923
Maharagama	25	17,200	151	23.3	12,824
Mattakkuliya	4	4,800	1	0.2	3,052
Moratuwa	8	6,000	28	5.5	4,185
Mount Lavinia	35	28,000	67	12.6	20,705
Piliyandala	11	7,600	122	21.1	6,690
Raddolugama	6	4,400	14	2.1	3,192
Ragama	4	3,400	16	3.0	2,617
Ratmalana	9	7,400	37	6.9	5,197
Wattala	8	6,700	3	0.4	4,686
Total	177	137,800	634	111.0	104,722

Source: JICA Study Team.

5.3.3.7 Administrative Classification of External Plant

The external plant cost should be calculated by facilities composing the external plant, because the depreciation and tax differ by the facilities. Table 2-5-45 shows the administrative classification of external plant of SLT and applied to the cost estimation in this project.

Table 2-5-45 Administrative Classification of External Plant

Administrative classification	Facilities included in the classification
Cable and conduit (depreciation: 25 years)	(1) Cables, closures and incidental accessories (2) Poles and incidental accessories (3) Monholes, handholes and incidental accessories (4) Cable ducts, riser ducts and incidental accessories (5) Cabinets and incidental accessories (6) DPs and incidental accessories
Other equipment (depreciation: 12.5 years)	(1) Subscriber premises equipment (Telephone set, protector, rosette, etc. (2) Fault location tester, etc. (3) Generator, pump, gas-checker, etc.

Source: SLT.

5.3.4 Power Equipment

(1) Power equipment for switching system

The power equipment includes power receiving panels, rectifiers, battery banks, engine generators. The power equipment capacity is subject to the exchanges to be proposed by supplier. Accordingly, the power equipment should be purchased as part of the switching system package. The power equipment for switching system should share the output to other telecommunications facilities including transmission system, if any at a same location.

Engine generators will be provided newly in the case a new main switching unit is introduced. The existing RSU does not have engine generators. In future, however, the engine generator should be introduced to all exchanges, including RSU, to guarantee higher reliability of facilities. Engine generators should be purchased for Angoda, Kadawata, Moratuwa, Piliyandara, and Wellanpitiya under this project. Engine generator's capacity should be decided taking account of miscellaneous facilities such as office lighting, office air conditioning, lifts, etc., in addition to the power consumption of switching systems and related equipment and facilities.

(2) Power equipment for transmission system

The power to the transmission system is now supplied from the power supply equipment of the exchange and its capacity is sufficient to supply power to new transmission equipment. The power consumption of the transmission system may be 200 to 500 Watt at each node station. Accordingly there is no need to introduce new power equipment for the new transmission system under this project.

5.3.5 Space for Equipment and Buildings

(1) Switching system

Most of the existing exchange buildings have sufficient space for new switching systems proposed under this project. However, the space is not sufficient in some exchanges. Additional space should be provided to five exchanges including Homagama and others. A new building was under construction for Homagama exchange as at November 1995. Table 2-5-26 shows the details of space availability for switching facilities of each exchange.

(2) Transmission system

Floor spaces and cable drawing spaces are available for new equipment to be introduced under this project at the all existing node stations except Kotugoda. The space for the transmission equipment will be provided when Kotugoda Exchange building is completed.

6. Project Cost Estimate

6.1 General

The project cost was estimated for the switching system, transmission system and the external plant discussed in Sec. 5.3 Facilities Plan on the assumption that the project would be executed under a turn-key basis.

The project cost was estimated referring to the cost of telecommunications facilities purchased recently by SLT and tendencies in some selected countries.

6.2 Switching Facilities Cost

Switching facilities cost was estimated for the capacity expansion of TSC "B" and "D" shown in Table 2-5-24 and local exchanges shown in Table 2-5-25. The estimated cost includes such peripheral facilities stated in Sec. 5.3.1 (5). Table 2-6-1 shows the estimated switching facilities cost.

Table 2-6-1 Switching Facilities Project Cost

Unit: US$1,000

Item		Total	Foreign	Local
1)	Digital exchange	29,164	29,164	0
2)	Other equipment	3,494	3,494	0
3)	Building	1,800	0	1,800
4)	Sub-total	34,458	32,658	1,800
5)	Installation and others	1,987	1,987	0
6)	Taxes and duties	10,810	0	10,810
7)	Engineering service	2,551	2,551	0
8)	Contingnecy	3,644	3,644	0
9)	Grand total	53,450	40,840	12,610

Source: JICA Study team.

6.3 Transmission Facilities Cost

Based on the previous network plan and facilities plan, the project cost for the transmission sub-system portion is estimated as Table 2-6-2. Cost for the arrangement of the equipment space is eliminated because the work will be carried out by SLT itself.

Table 2-6-2 Transmission Facilities Project Cost

Unit: US$1,000

Item		Total	Foreign	Local
1)	Transmission equipment	9,065	9,065	0
2)	Fibre optic cable	2,791	2,791	0
3)	External plant and others	1,547	1,045	502
4)	Sub-total	13,403	12,901	502
5)	Installation and others	2,157	2,021	136
6)	Taxes and duties	5,386	0	5,386
7)	Engineering service	1,089	1,089	0
8)	Contingnecy	1,556	1,556	0
9)	Grand total	23,591	17,567	6,024

Source: JICA study Team.

6.4 External Plant Cost

The external plant project cost was estimated regarding the external plant discussed in Section 5.3 Facilities Plan. The external plant cost comprises foreign currency portion and local currency portion. The foreign currency portion is mainly the cost related to such products as manholes, hand-holes, cable ducts, cabinets, primary cables and secondary cables, which are installed in the section from the main distributing frame (MDF) of exchange to the distribution points near subscriber premises. The local currency portion contains the cost for drop wires, inner wires, telephone sets and incidental accessories, which are used in the section after the distribution point. The local currency portion is the cost for new connections of subscriber lines to be carried out by SLT. Table 2-6-3 shows the estimated external plant project cost.

Table 2-6-3 External Plant Project Cost

Item		Total	Foreign	Local
1)	Cable and conduit	42,780	38,730	4,050
2)	Other equipment	11,650	640	11,010
3)	Vehicle	280	280	0
4)	Installation	30,150	18,007	12,143
5)	Taxes and duties	27,437	0	27,437
6)	Engineering service	4,037	4,037	0
7)	Contingnecy	5,766	5,766	0
8)	Grand total	122,100	67,460	54,640

Source: JICA Study Team.

6.5 Cost by Package

The project cost is estimated by three categories of telecommunications facilities, i.e., switching facilities, transmission facilities and external plant. Although it is simple to implement them under one package, the project can be split into some packages, by technical point of view, if the SLT's finance provision does not allow it then. Attention should be paid, in such case, so that each package is properly made up to provide a balanced network in relation to the traffic flow and facilities usage.

In splitting the project, the capacity of the switching facilities and external plant should be balanced at each exchange. Grouping of switching system units should be in harmony with the switching network structure. Splitting the proposed transmission facilities is not advantageous, because it is designed as a complete system. In such context, JICA Study Team advises SLT to split the project into two packages wherein a) the first package comprises switching facilities sub-package, external plant sub-package and transmission sub-package, and b) the second package comprises switching facilities sub-package, external plant sub-package, which are not included in the first package. Table 2-6-4 shows an example of splitting the switching facilities plan and external plant plan of the project into two packages. Each exchange cost is that allocated in proportion of planned lines to the total lines. The transmission facilities plan should always be in the first package. Regarding the exchanges, the first package picked up mainly those which are situated in central part of the Capital where the telephone demand is stronger than the rest in the objective area.

The packaging should be reviewed and justified before implementing the project, or during the detail design stage, as the conditions will likely change in years. SLT is re-arranging switch capacity plan under on-going projects, including a transfer of OCB-283 switch of Moratuwa and Piliyandara to Ratmalana. Such changes should be reflected to the new packaging. Attention should be paid to network structure on changing the package. The number of inter-exchange circuits should also be reviewed and justified referring to the new traffic flow and network structure.

Table 2-6-4 Project Splitting into Two Packages

Unit: US$1,000.

Pack-age	Exchange	F/S object	Switching facilities cost			External plant cost			Transmission facilites cost			Total project cost		
		Included/ Not included	Total	Foreign	Local	Total	Foreign	Local	Total	Foreign	Local	Total	Foreign	Local
I	TSC-B	Yes	4,601	3,665	936	-	-	-	-	-	-	4,601	3,665	936
I	TSC-C	Yes	4,601	3,665	936	-	-	-	-	-	-	4,601	3,665	936
-	*TSC Total*	-	*9,202*	*7,330*	*1,872*	-	-	-	-	-	-	*9,202*	*7,330*	*1,872*
I	Angoda	Yes	1,140	863	277	2,613	1,390	1,223	-	-	-	3,753	2,253	1,500
I	Boralesgamuwa	Yes	0	0	0	3,636	1,939	1,697	-	-	-	3,636	1,939	1,697
I	Kadawata	Yes	1,351	1,023	328	3,374	1,857	1,517	-	-	-	4,725	2,880	1,845
I	Kotte	Yes	3,818	2,892	926	9,860	5,625	4,235	-	-	-	13,678	8,517	5,161
I	Mattakkuliya	Yes	0	0	0	2,950	1,500	1,450	-	-	-	2,950	1,500	1,450
I	Moratuwa	Yes	1,348	1,021	327	4,705	2,581	2,124	-	-	-	6,053	3,602	2,451
I	Mount Lavinia	Yes	5,209	3,945	1,264	21,096	11,157	9,939	-	-	-	26,305	15,102	11,203
I	Piliyandala	Yes	1,511	1,144	367	9,843	5,879	3,964	-	-	-	11,354	7,023	4,331
I	Ratmalana	Yes	1,931	1,462	469	5,875	3,232	2,643	-	-	-	7,806	4,694	3,112
I	Havelock	No	5,706	4,321	1,385	0	0	0	-	-	-	5,706	4,321	1,385
I	Kaduwela	No	659	499	160	0	0	0	-	-	-	659	499	160
I	Malwana	No	616	466	150	0	0	0	-	-	-	616	466	150
I	Nugegoda	No	5,482	4,152	1,330	0	0	0	-	-	-	5,482	4,152	1,330
I	Wellampitiya	No	1,036	784	252	0	0	0	-	-	-	1,036	784	252
-	*LE Total*	-	*29,807*	*22,572*	*7,235*	*63,952*	*35,160*	*28,792*	-	-	-	*93,759*	*57,732*	*36,027*
-	Phase I total	-	39,009	29,902	9,107	63,952	35,160	28,792	23,591	17,567	6,024	126,552	82,629	43,923
II	Ja-Ela	Yes	1,777	1,346	431	4,354	2,392	1,962	-	-	-	6,131	3,738	2,393
II	Katunayake	Yes	1,523	1,153	370	5,975	3,102	2,873	-	-	-	7,498	4,255	3,243
II	Kelaniya	Yes	2,427	1,838	589	10,585	5,860	4,725	-	-	-	13,012	7,698	5,314
II	Kollupitiya	Yes	1,964	1,488	476	6,553	3,460	3,093	-	-	-	8,517	4,948	3,569
II	Maharagama	Yes	2,467	1,868	599	20,479	12,227	8,252	-	-	-	22,946	14,095	8,851
II	Raddolugama	Yes	674	511	163	2,864	1,443	1,421	-	-	-	3,538	1,954	1,584
II	Ragama	Yes	772	585	187	2,669	1,416	1,253	-	-	-	3,441	2,001	1,440
II	Wattala	Yes	1,385	1,049	336	4,669	2,400	2,269	-	-	-	6,054	3,449	2,605
II	Homagama	No	784	594	190	0	0	0	-	-	-	784	594	190
II	Minuwangoda	No	668	506	162	0	0	0	-	-	-	668	506	162
-	*LE Total*	-	*14,441*	*10,938*	*3,503*	*58,148*	*32,300*	*25,848*	-	-	-	*72,589*	*43,238*	*29,351*
-	Phase II total	-	14,441	10,938	3,503	58,148	32,300	25,848	0	0	0	72,589	43,238	29,351
N.P.	Central	No	0	0	0	0	0	0	-	-	-	0	0	0
N.P.	Hokandara	No	0	0	0	0	0	0	-	-	-	0	0	0
N.P.	Maradana	No	0	0	0	0	0	0	-	-	-	0	0	0
N.P.	Mattegoda	No	0	0	0	0	0	0	-	-	-	0	0	0
N.P.	Padukka	No	0	0	0	0	0	0	-	-	-	0	0	0
N.P.	Rukmalgama	No	0	0	0	0	0	0	-	-	-	0	0	0
-	*LE Toal*	-	*0*	*0*	*0*	*0*	*0*	*0*	-	-	-	*0*	*0*	*0*
-	No project total	-	0	0	0	0	0	0	-	-	-	0	0	0
-	*TSC Total*	-	*9,202*	*7,330*	*1,872*		-	-	-	-	-	*9,202*	*7,330*	*1,872*
-	*LE Total*	-	*41,248*	*33,510*	*10,738*	*122,100*	*67,460*	*54,640*	-	-	-	*166,348*	*100,970*	*65,378*
-	*Grand total*	-	*53,450*	*40,840*	*12,610*	*122,100*	*67,460*	*54,640*	*23,591*	*17,567*	*6,024*	*193,141*	*125,867*	*73,274*

Note: The cost by exchange is that allocated in proportion of planned lines (circuits) to the total lines (circuits), only for package re-arrangement.
N.P. Project is not planned.

Source: JICA Study Team.

7. Project Implementation Plan

7.1 Implementation Schedule

7.1.1 General

The proposed project implementation plan was made up on the assumption that the project is implemented under a turn-key basis and taking account of such work stages as;

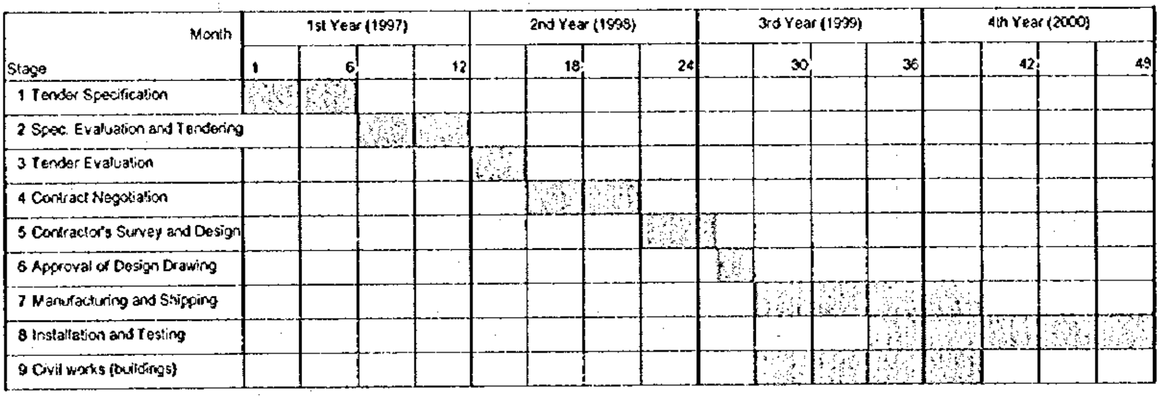
1) Preparing the tender specifications;
2) Specification evaluation and tendering;
3) Tender evaluation;
4) Supplier contract negotiation;
5) Contractor's survey and design;
6) Approval of design drawing;
7) Manufacturing and shipping;
8) Installation and testing.

It is very desirable that the projects proposed here be commenced as early as possible to make use of this feasibility study. Circumstances may be changed to review this feasibility study, if project commencement is delayed.

It is essential to pay careful attention to the advance of project once it has set out. Attention should be paid so that the project can advance quickly in keeping with the rules and procedures of Sri Lanakan Government and such of the foreign government providing the finance.

7.1.2 Implementation Schedule of Switching System Facilities

Figure 2-7-1 shows the implementation time schedule proposed for the switching facilities plan of Local Network Expansion Project in Colombo Metro Area. The period for this plan was estimated to be 48 months.

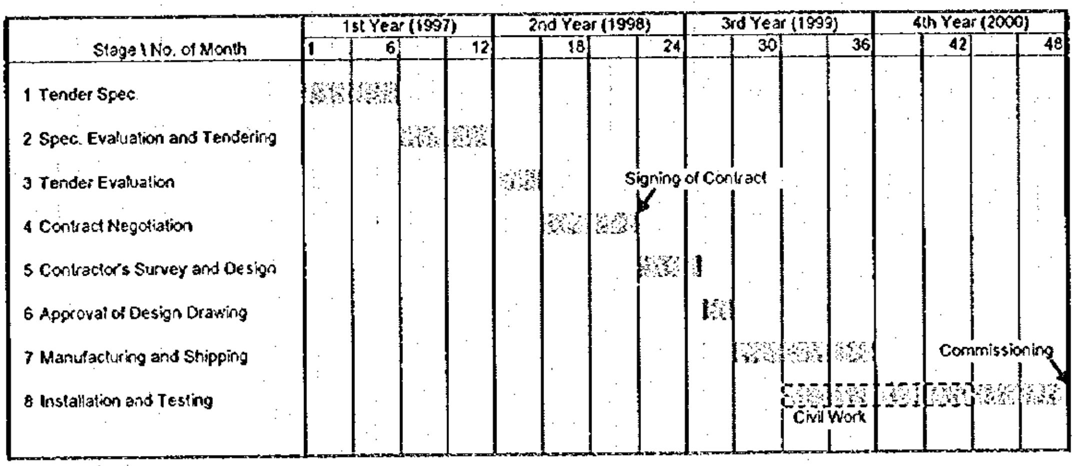


Source: JICA Study Team.

Figure 2-7-1 Switching System Facilities Implementation Time Schedule

7.1.3 Implementation Schedule of Transmission Facilities

Implementation schedule is shown in Figure 2-7-2. Total period to completion is estimated as 48 months. Synchronisation of the equipment installation work with external plant work should be kept.

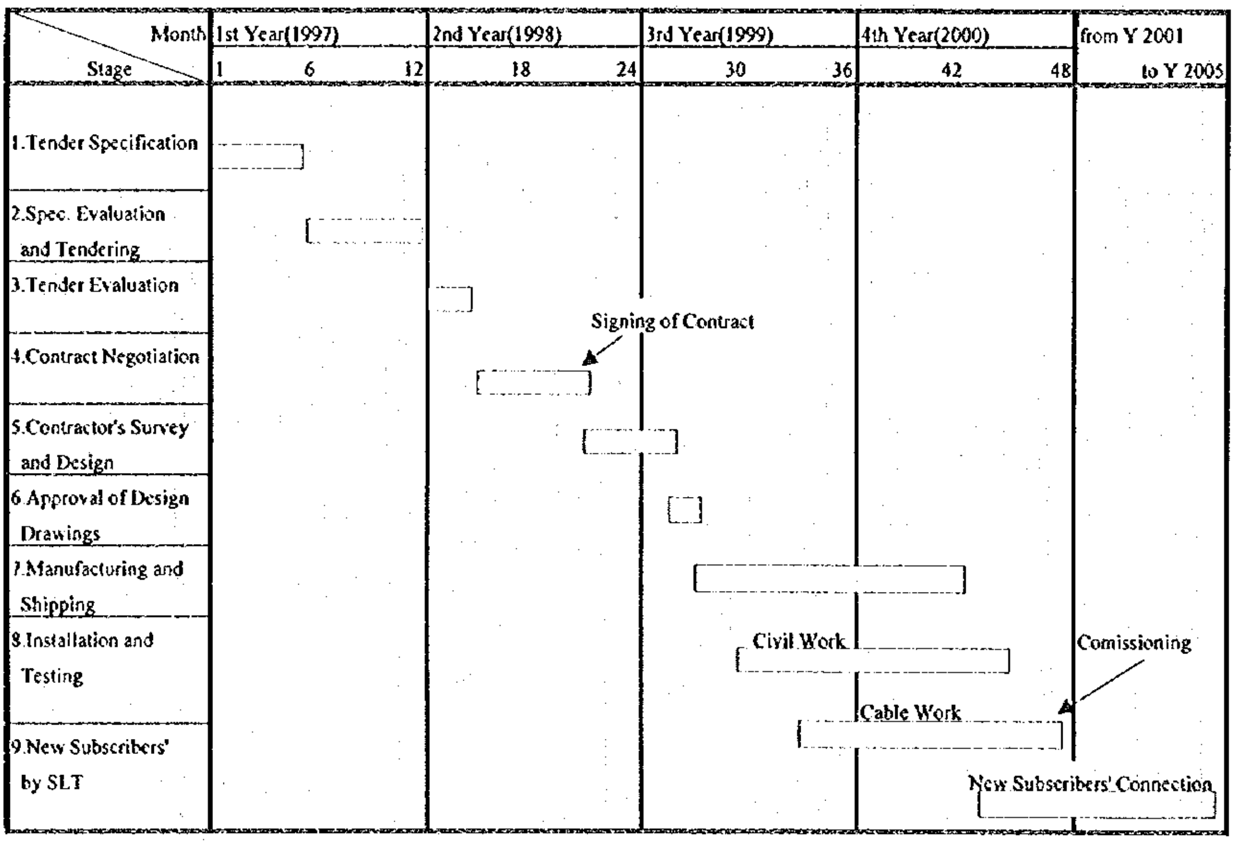


Source: JICA Study Team.

Figure 2-7-2 Transmission Facilities Implementation Time Schedule

7.1.4 Implementation Schedule of External Plant

Figure 2-7-3 shows the project implementation time schedule proposed for the external plant package. The portion to be provided by foreign currency should be completed by the end of the year 2000. It is the section from the main distributing frame (MDF) of exchange to the distribution points near subscriber premises, wherein the manholes, hand-holds, cable ducts, cabinets, primary cables and secondary cables are installed. The portion to be provided by local currency, which is the part related to the work of new line connections to be carried out by SLT, will last up to and including the year 2005.



Source: JICA Study team.

Figure 2-7-3 External Plant Implementation Time Schedule

7.2 Management on Project Implementation

7.2.1 Attentions for a Smooth Project Advance

This feasibility study was conducted based on the conditions as of 1995. It is desirable that SLT make effort to start the project in 1997, before the information in this feasibility study become out of date. In addition to that, it is very much desirable to start the project as soon as possible to meet the demand in coming years.

Owner's effort is essential for making the project advance smoothly. SLT is required to provide finance, personnel and facilities necessary for a smooth advance of the project proposed based on this feasibility study.

SLT is required to find a good finance. If the finance is provided by a foreign government, it is very important to pay attention to related rules and regulations having a close liaison with the authorities concerned. SLT should be aware of that project is delayed sometime because of procedures.

SLT is required to set up a over-all time table and forward the project referring to the time table. The over-all time table should be studied carefully and its breakdown should be given.

An effective use of consultants is essential. Experts for the project implementation will ease the management work not only in technical matters but also in administration matters.

7.2.2 Organisation

SLT has an organisation of task force for implementing telecommunications projects under General Manager of Projects. SLT has had good experiences through past projects and has accumulated sufficient know-how to carry out projects. SLT should keep that organisation also for the projects proposed under this Feasibility Study.

It is preferable to assign some personnel of technical field to manage the project implementation. For a smooth management of the projects, technical staff selection should cover the fields of network and traffic engineering, switching system, transmission system, external plant and civil works.

A close co-operation is essential for the officials in charge of project implementation, planning, maintenance, administration and others.

SLT should have an official or a group of persons who are in charge of the liaison service with government authorities including SLTA, authority for road traffic and construction, etc.

SLT will be required to keep a closer contact with SLTA than before as new WLL networks will be introduced in 1997. Restructuring in numbering scheme and telecommunications network structure will be the major impacts to SLT. SLTA is planning a numbering scheme change on the occasion of the WLL network introduction. SLTA also intends to provide the interconnection points between different networks. SLT has to implement its projects in harmony with other network providers.

7.2.3 Attentions on Technical Matters

The problems often found in the case of in-door equipment projects, such as switching system and transmission equipment, are mismatching of preparation timing of floor space for the equipment. The buildings should be prepared in a good timing so that the equipment to be installed can be carried in at a due time. Completion timing of switching system, transmission system and external plant should also be well organised.

The switching system is integrated to the existing network one by one usually. The integration of new unit of switching system involves the change of exchange data base, which should be done very carefully. SLT is required to station temporarily an adequate number of personnel at every site where software change and/or hardware connection/disconnection are needed. Such work should be prepared very much carefully, otherwise a confusion may come up in the telecommunications network.

Testing purchased facilities is essential. SLT is required to carry out various tests to verify the function of the telecommunications network when the equipment under this project is integrated in the existing network. Each equipment should be tested individually and as a component of the complicated network. Terminal to terminal connection test which involves other exchanges will be efficient to check the compatibility in the network. CCS signalling messages should also be monitored and analysed.

7.3 Operation and Maintenance

7.3.1 Operation and Maintenance of Switching System

SLT situates personnel for operation and maintenance of switching system at most part of main exchanges and key staff at some important exchanges. The existing organisational structure will not be changed by switching capacity expansion of this project in principle. However, a certain extent of increase of personnel and a training will be necessary.

All the new units of switching systems to be introduced under this project should be put under operation, maintenance and management which is responsible at present, since the new switching units are to be situated at existing exchanges.

Recent digital switching system has very few troubles, though requires daily check in some extent. As the units of switching system increases, a certain extent of increase in work is inevitable. SLT is expected to have 42 units of switching system in 1997 and this project will increase 22 units of switching system comparing to that in 1997. This will bring about an increase in daily work.

Some new staff may be required for the operation and maintenance for the new switching systems. Figure 2-7-4 shows a model of work schedule in the case a new technology is introduced. It is a model for a group of operation and maintenance personnel proposed for this project based on the consultant's experience. In this work schedule model, 14 persons will be required provided that the new exchanges are placed under daily work responsibility of one group situated at an maintenance operation centre for that technology. This model is prepared taking account of the work force now situated at some important exchanges. If the technology is the same as the existing one, the number of staff could be less than that and they should be assigned to some important points. The exact number of staff should be decided when the switching system technology is determined.

JICA Study Team recommends SLT to set up a maintenance and operation centre at an adequate exchange where the terminal equipment to control, supervise, monitor and collect traffic information is provided. The terminals should connected to all the exchanges to be purchased under this project. Most of daily check work can be done at the maintenance operation centre.

JICA Study Team recommends that spare parts be stored at a point in Colombo Metro, for instance, at the building of TSC in Colombo. The spare parts should be delivered to the location when required.

Duty	Persons	Time on duty																								
		0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
After-night	1									■	■	■	■	■	■	■	■	■	■							
Morning	2									■	■	■	■	■	■	■	■	■	■							
Afternoon	2														■	■	■	■	■	■	■	■				
Night	1	■	■	■	■	■	■	■	■														■	■	■	■
RSU cruising	2									■	■	■	■	■	■	■	■	■	■							
Training	1									■	■	■	■	■	■	■	■	■	■							
Administration	1									■	■	■	■	■	■	■	■	■	■							
Off-duty	2.86									■	■	■	■	■	■	■	■	■	■							
Vacation	0.82									■	■	■	■	■	■	■	■	■	■							
Total	14																									

Source: JICA Study Team.

Figure 2-7-4 A Model of Work Schedule for an Exchange of New Switch Technology

7.3.2 Operation and Maintenance of Transmission System

To insure satisfactory operation and maintenance of the Colombo Metro SDH Ring transmission system, the following should be taken into account:

(1) Arrangement of necessary manpower and its appropriate allocation to cover the all sections,
(2) Establishment of standard procedures of operation and maintenance,
(3) Adequate distribution of equipment, instruments, tools and vehicles for operation and maintenance, and
(4) Execution of training at manufacturer's factory and in Sri Lanka with respect to this project and also training at SLT's training centre on permanent basis.

Operation and maintenance (O&M) organisation was established for the fibre optic transmission system constructed under GCTNIP-I and II in the area. This organisation should be utilised for O&M work on this new transmission system. The engaged staff should be trained about this new transmission system. Even centralised network management system can ease the O&M work, corresponding to the increase of transmission capacity, the number of O&M staff may be increased.

Present O&M zones of Colombo Metro consists of Metro North and Metro South. Colombo Central and Havelock Town should be recognised as the O&M centres in the area respectively, and several RTEs are stationed in the following exchange offices.

Metro North: Colombo Central, Maradana and Wattala
Metro South: Havelock Town, Mt. Lavinia, Nugegoda and Kotte

Addition to the above two O&M centres, Katunayake should be also established as the O&M centre for covering the northern part in Metro North region. So, the organisation for O&M of this new transmission system will be as follows (Figure 2-7-5):

Colombo Central O&M centre... Head O&M centre, Metro North (1) coverage
Katunayake O&M centre... Metro North (2) coverage
Havelock Town O&M centre... Metro South coverage

Figure 2-7-5 O&M Organisation Chart for the System

Number of staff for O&M is estimated based on the staffing plan explained in the previous volume II. Concerned reference staffing standard is as Table 2-7-1 below.

Table 2-7-1 Reference Staffing Standard for Optical Fibre Transmission

Item	Capacity	DIT	IPT	Worker	Remarks
1920 ch (64 x 2 Mbit/s)	for each station	-	1	1	TR
more than 1,920 ch	for every 32 sys. of 2 Mbit/s ports work	-	+1	-	TR
	for every station	-	-	+2	OSP
	for every drop station	1	-	-	TR/OSP
	for every 200 km	-	2	1 splicer	OSP

Source: JICA Study Team.

As mentioned above, specific O&M personnel is assumed to be stationed only at three (3) O&M centres. At other node stations, staff having concurrent duty will control and maintenance the system, even some of them should be trained for the system. These idea came from the introduction of the centralised network management system. So, the number of specific staff is calculated as shown in Table 2-7-2.

Table 2-7-2 Required Number of Staff for O&M Centres

	Centre Name	DIT/TR	IPT/TR	IPT/OSP	Worker/ TR	Worker/ OSP	Total	Remarks
1	Colombo	1	2	2	2	4	11	two shifts
2	Katunayake	-	1	1	1	2	5	
3	Havelock Town	1	2	1	1	2	7	
	Total	2	5	4	4	8	23	

Source: JICA Study Team.

O&M centres except Colombo Central are staffed only during daytime and it will be said in general that employment of the network management system will reduce additional manpower, if appropriate measures as follows are taken:

(1) Simplification of maintenance work through adoption of complete panel or unit replacement method in case of failure is pursued to an extent possible. This will require to keep sufficient amount of spares on the route,

(2) Regular preventive maintenance work and the route patrol along the cable route is carried out,

(3) Training program for O&M staff in respect of SDH technique is established to maintain their O&M capability at a sufficient level, and

(4) All the O&M vehicles are maintained always on a good condition.

7.3.3 Operation and Maintenance of External Plant

The present situation in a RTE and a telephone centre is in hard condition, because there are many faults and many waiters, the staffs are very busy for dealing with customers who are waiters or have fault line. Facilities of external plant will increase more and more, at present SLT has on-going project that has about 70,000 new primary cable pairs, and proposed this project has over 100,000 primary cable pairs in Colombo Metro. If SLT can not change this maintenance work situation, maintenance work in the RTE and the telephone centre is busier than the situation at present. For this reason, all divisions in SLT shall consider the method to change the situation at present.

(1) Reflection Data of RTE to other Division

Each RTE has data of operation and maintenance work, but the data is not used efficiently yet. The data shall be utilised by planning division, specification division, project division and finance division. And other division shall respond to the RTE, for example planning division will be able to make a new project, and specification division will be able to reform a specification or a standard. It is necessary to connect all of divisions in SLT systematically. The problem is not for only operation and maintenance division.

(2) Location of Maintenance Centre

Each RTE has 4 or 5 exchange centres to manage and maintain the telecommunication system in his area. Generally, operation and maintenance in wide area is better than small area, to secure excellent staffs and to use tools efficiently. In the case of a few staffs in telephone centre, it is difficult that the staff obtain new knowledge of work. Because a scope of work in the small centre is not so wide that the staff is forced to work in narrow knowledge area.

Present locations of RTE are appropriate as a maintenance area at present, because there are many faults in external plant. However, in the case of fault rate reduction in future, maintenance centre shall be located in more wide area than RTE's location at present to make an operation and maintenance work more efficiently.

7.4 Human Resource Development

7.4.1 Switching System

In order to maintain the new switching facilities in a good condition to offer satisfactory service to the users human resource development by training is essential. Training should be provided to one third of the personnel assigned for operation and maintenance of the new switching units, or 4 persons, when a new technology is introduced. They should be given a period of 3 months training in the supplier's country as the supplier has his appropriate training facilities in his country. The rest of the personnel assigned to the new switches should be given training by those 4 persons at the training centre and or at exchange site in Colombo. In the case of the switching systems of existing technology is introduced, the number of personnel for each training course should be reviewed. The exact number of trainees should be decided when the technology is determined.

7.4.2 Transmission System

As mentioned above, it is necessary to train existing maintenance personnel engaging in the existing fibre optic transmission system in addition to newly transferred and recruited personnel.

The training should include not only factory training, on-the-job training (OJT) and classroom training, but also arrangement to establish training course on permanent basis at the training centre. For this purpose, provision of skilled instructors and a model set of SDH FO transmission equipment with a set of measuring equipment to the SLT training centre are necessary.

In the transmission field, SDH technology in microwave system or FO system will be prevailing instead of conventional PDH technology, so the training on the matter should be expanded to the whole concerned technical staff gradually.

Under Matara project and 150K project, many fibre optic cable transmission systems are being introduced now, and the related skills are required at many sites. From now on fibre optic cable will be popularly adopted to trunk transmission systems, so general knowledge on the matter at least should be transferred to all OSP engineers, technicians and workers.

7.4.3 External Plant

Quantity of external plant will be increasing with the increasing subscribers, and then management of operation and maintenance work will become important work more and more to reduce the maintenance expenditure. However maintenance staffs for external plant are busy for repairing work at present.

Design work and management work on construction for external plant will become also important, because a new subscriber connection work will contract out in near future. Of course, excellent maintenance staffs are important, they can find a fault location and repair immediately for a good service quality.

Operation and Maintenance Work in RTE or Telephone Centre are divided into three (3) work items mainly as shows follow. It is desirable that all staffs of RTE and Telephone Centre are well acquainted themselves with all of Operation and Maintenance work. But the desire is very difficult, accordingly a key person shall be trained.

Table 2-7-3 Classification of Operation and Maintenance Work for External Plant

Work Item	Breakdown Work
Management Work	(a) Analysis of Faults and Reflection to Planning Division (b) Grasp of Facility Condition and Reflection to Planning and Finance Division (including cable pair management, waiting list and plant record) (c) Analysis of Labour Cost and Reflection to Finance and Planning Division
Construction Work	(a) Design, Drawing to contract out (b) Supervision and Control of Project (c)Inspection an Test on Contract Work (d) Estimating Contract Cost (e) Work on Commissioning Facility
Repair Work	(a) Finding a Fault Location (b) Construction Work to repair a damaged Facility (c) Amendment a Plant Record

Source: JICA Study team.

For a staff of external plant section, experience of work is important. Therefore, at the first the key person in each RTE shall be trained by On the Job Training. The key person shall impart his knowledge to other staffs. Otherwise it is also useful to give lesson in a school to teach the outline of operation and maintenance work. In the case of training school lesson, the subjects shall be including breakdown work mentioned in the above table.

The key person shall be trained in a foreign organisation that has sufficient experience of training course on telecommunications or excellent Operation and Maintenance system on telecommunications system. The subjects of the training course shall have Planning, Drawing, Construction and Maintenance for External Plant including Optical Fibre Cable. A period of training course should be one(1) month. The number of trainees shows as in the following table.

Table 2-7-4 Trainees selected as a key person

Organisation	Number of Trainees
Colombo Central RTE	1
Havelock Town RTE	1
Kotte RTE	1
Maradana RTE	1
Mount Lavinia RTE	1
Nugegoda RTE	1
Wattala RTE	1
Planning Division, Headquarters	1
Maintenance Division, Headquarters	1
Total	9

JICA Study team.