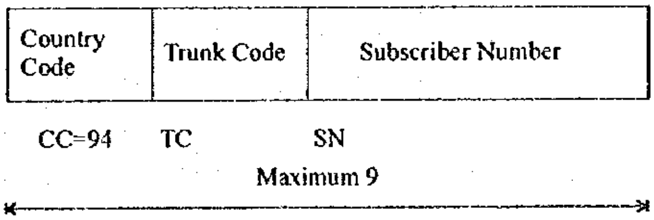
2. Fundamental Technical Plan

2.1 Numbering Plan

2.1.1 Number structure

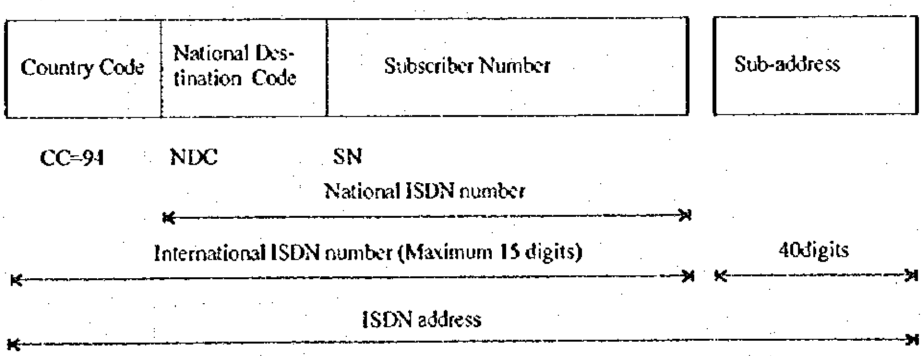
Telephone number of Sri Lanka consists of Country code (CC), Trunk code (TC) and Subscriber number (SN). The CC is "94" in accordance with ITU-T Rec. E. 163. Figure 8-2-1 shows the existing number structure of Sri Lanka. The maximum number of digits of the telephone number (CC + TC + SN) of Sri Lanka is 9.



Source: ITU.

Figure 8-2-1 Existing Number structure of Sri Lanka

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 8-2-2.



Source: ITU.

Figure 8-2-2 Number structure for ISDN era

2.1.2 Patterns of Existing National Significant Number in SLT

The national significant number, or the part consisting of TC and SN, in SLT network is 6 to 7 digit 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 8-2-1.

Table 8-2-1 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	1	3	4			Awiswella
Pattern H	TC	TC	TC	1	2	3			Deniyana, Nawalapitiya, Weligama

TC: Trunk code
(dark shading): Exchange code
(blank box): Subscriber number

Source: SLT.

2.1.3 Special Service Numbers and Prefix Code of Existing Plan

SLT provides some 3-digit special numbers for the services to public. Table 8-2-2 shows the 3-digit numbers with corresponding services. In addition to the numbers shown in Table 8-2-2 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. Study Team recommends SLT to uniform all the 3-digit numbers by service, that is, one service item should have only one 3-digit number regardless where the caller is.

Table 8-2-2 3-digit Special Numbers for Public Services

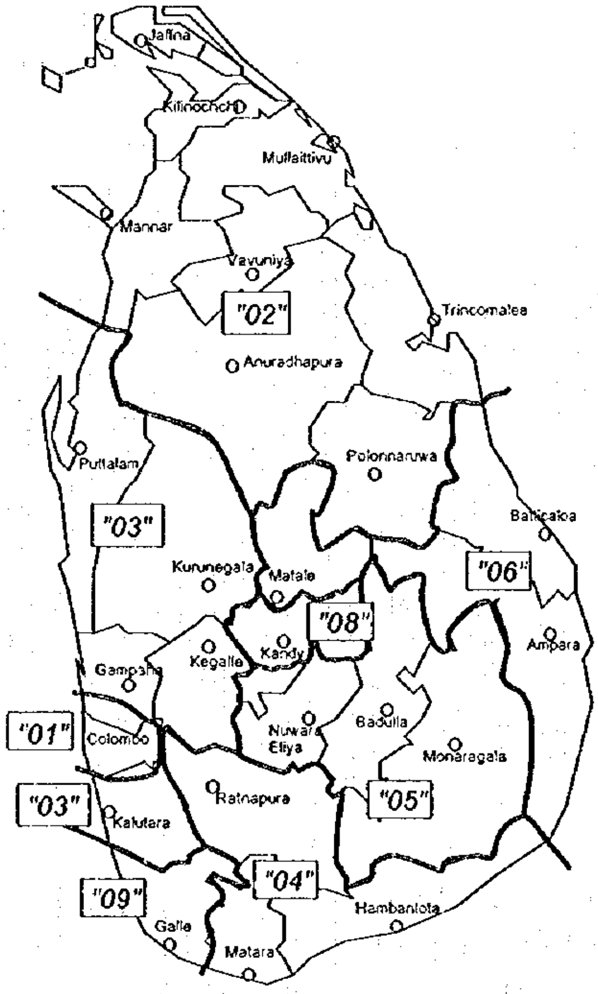
Service	Area A	Area B	Area C
Priority booking	120	-	-
Local & trunk bookings (Operator-assisted STD & Non STD)	101	101	101
Trunk enquiries (Regarding charges, interruptions and delay of calls)	101	141	141
Operator-assisted alarm calls	101	101	-
Directory enquiries (Regarding telephone numbers not in 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 8-2-3 shows the correspondence of the first digit of TC with prefix "0" and the geographical areas.



Source: SLT.

Figure 8-2-3 Existing Trunk Code First Digit Assignment

2.1.4 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 8-2-3 shows the existing SSCs and their TCs.

Table 8-2-3 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		Ratnapura	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.

2.1.5 Present Number Capacity

(1) 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 8-2-4 shows the existing assignment of the first and second digits of NSN of Sri Lanka.

Table 8-2-4 First and Second Digits of NSN of Sri Lanka as of 1995

A \ B	0	1	2	3	4	5	6	7	8	9
0		International								
1			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							
9			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 8-2-4. 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.

(2) 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 Colombo and Kandy. SLT keeps vacant 2-digit combinations more than 30 at present as found in Table 8-2-4, which are available for new SSCs to be introduced in future. Hence, the trunk code numbering capacity of SLT is sufficient.

(3) SLT Exchange codes and subscriber numbers

a) Colombo area

Colombo area is numbered by a six-digit numbering system. Table 8-2-5 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 8-2-5 Exchange Codes and Subscriber Numbers in Colombo (Dec. 1994)

LOCAL AREA	Existing Demand (June 1994)			Present No: Plan
	Total	DEL	Waiters	
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 3ESS	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.

However, the number capacity of the exchange is tight sometimes due to a 3-digit number range. The subscriber number capacity of one exchange is 1,000 in that numbering. That numbering results in a problem of telephone number (exchange code + subscriber number) change when the demand exceeds 1,000 or the number capacity. The exchanges encountered by problems in providing telephone numbers to the demand in 1994 are, as of December 1994, Angoda (1,824 (demand) to 1,000 (capacity)), Hokandara (1,265 to 1,000), Ja-Ela (4,349 to 2,000), Kadawatha (3,130 to 1,000), Kaduwela (1,249 to 500), Katunayake (2,912 to 2,000), Kelaniya (5,708 to 2,000), Malwana (980 to 500), Piliyandala (3,924 to 1,000), Ragama (1,990 to 1,000), Wattala (4,402 to 2,000), Wellanpittiya (1,554 to 1,000).

According to the demand forecast, the telephone demand in Colombo will exceed 500,000 lines in early 21st century. It is recommended to expand the numbering capacity for getting a redundancy in numbering. The redundancy will also result in that SLT can avoid telephone number change for a long time and easier administration of telephone number. Telephone number expansion models are presented in Section 2.1.6.

b) 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. It is recommended to apply a plain numbering system, or the same number of digits in the whole SLT network, in the wake of the recommended telephone number in Colombo.

2.1.6 Future Numbering Scheme

Sri Lanka Telecommunications Authority (SLTA), which is the regulatory authority of numbering plan of the country, is studying for reforming the existing numbering plan in the country. The new numbering plan is expected to deal with the change to ISDN era as well as the change to be required for introduction of WLL networks in 1997. SLT has to change the existing numbering plan in compliance with the guideline to be prepared by SLTA.

The existing numbering plan is that made up where one operating entity provides telecommunications services in the country. This is the way that many countries follow even nowadays. The existing numbering plan gives the private networks the trunk codes as if they are trunk call areas. For instance, the cellular mobile network Mobitel, Celltel, Air Lanka, MTN and Call Link are identified by trunk codes "71", "72", "73", "77", and "78". SLTA is reforming this numbering plan systematically as various kind of services are expected in a competitive circumstance.

SLTA is conducting a study of new numbering plan, including changing the following points.

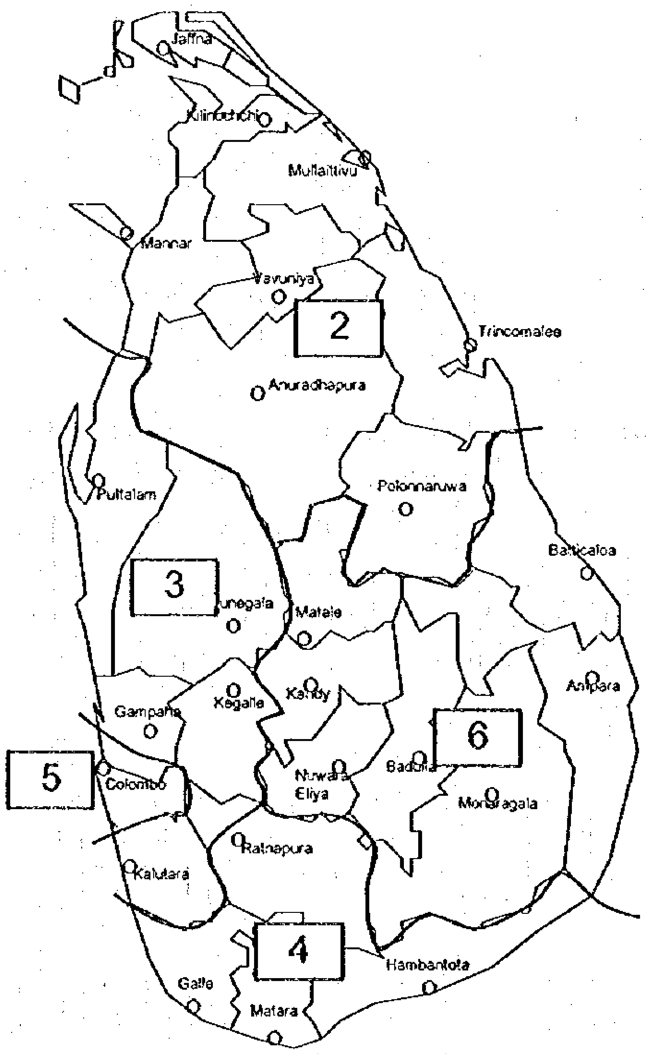
a) Reduction of trunk call areas in number. The new numbering plan is expected to have five (5) trunk call areas, reducing from 28 at present. This trunk call area reform will bring about a trunk code change to SLT exchanges.

b) Adoption of a closed number scheme. The new numbering plan is expected to have a closed numbering scheme, where no trunk prefix code is required. The existing SLT's network requires to dial "0" for trunk calls.

c) Introduction of new DNC. The new numbering plan aims to give the first digit for distinguishing geographical areas or services and the second digit for distinguishing the network providers. That is, the new Destination Network Code (DNC) is two in digits. In the new numbering plan, the first digit "1" is for short codes, "2" to "6" for fixed line network, "7" for new services, "8" for new services, "9" for reserved for new services, and "0" for international call services. The second code "8" of the first digits "2" to "6" is assigned to network providers other than SLT.

d) Multi-networks in one local call area. The new numbering plan allows two (2) or more networks in one local area. The network provider will be distinguished by the second digit. That is, the new DNC will be consisted of Area Code followed by Network Provider's Code.

Figure 8-2-3 shows the first digits of existing numbering scheme and Figure 8-2-4 shows the first digit assignment of proposed closed numbering scheme (Draft). Table 8-2-6 shows the Planned DNC in Future (Draft) and Figure 8-2-5 shows the concept of the correspondence of DN, TC and geographical areas.



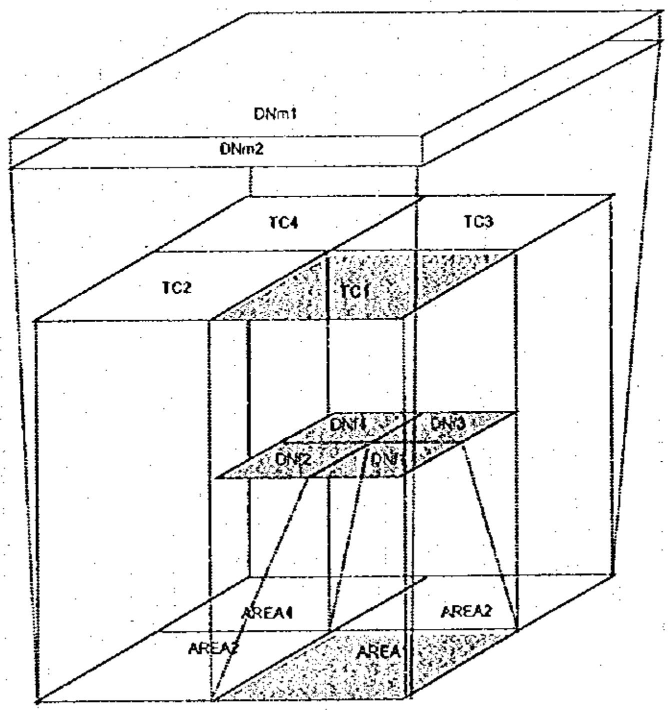
Source: SLTA.

Figure 8-2-4 Closed Numbering First Digit Assignment in Future (Draft)

Table 8-2-6 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.



Source: Study Team.

Figure 8-2-5 Correspondence of DN, TC and Area (Drfat)

2.2 Signalling Plan

2.2.1 Existing Signalling System

SLT now uses mainly R2(A), R2(D), ITU-T No. 5 and partly CCS No. 7. Old signalling system is used in some sections related to SXS exchanges.

R2(A) and R2(D) are the signalling systems applied to the majority of the SLT network links. They are used to connect most part of the automatic exchanges. R2(A) is used also to the links between ARE-13 International Switching Centre (ISC) and exchanges of the national network.

The CCS No. 7 is applied to the links between 7 digital exchanges fabricated by CIT Alcatel, i.e., the latest version OCB-283 and E-10B (P-11 version). SLT plans to apply the CCS No. 7, in addition to them, to the links from the new ISC fabricated by NEC, expected to start service during the period of this study, to the above-mentioned OCB-283, E-10B (P-11), and some foreign country international switches.

A few old signalling systems are applied to the links connecting SXS exchanges, common battery manual switch boards and magneto manual switch boards. SLT plans to replace those old-fashioned exchanges with digital ones in a few years. Accordingly, such old signalling systems will be deleted shortly. Table 8-2-7 shows the detail of signalling systems applied to SLT network.

Table 8-2-7 Signalling Systems Now in Use in SLT Network

	5-ESS	DX210/220	E-10B	OCB-283	NEAX	Cross-bar	SXS
5-ESS	D	D	D	D	D	A	O
DX210/220	D	D	D	D	D	A	O
E-10B	D	D	D	D	D	A	O
OCB-283	D	D	D	N7	D	A	O
NEAX	D	D	D	D	D	A	O
Cross-bar	A	A	A	A	A	A	O
SXS	O	O	O	O	O	O	O

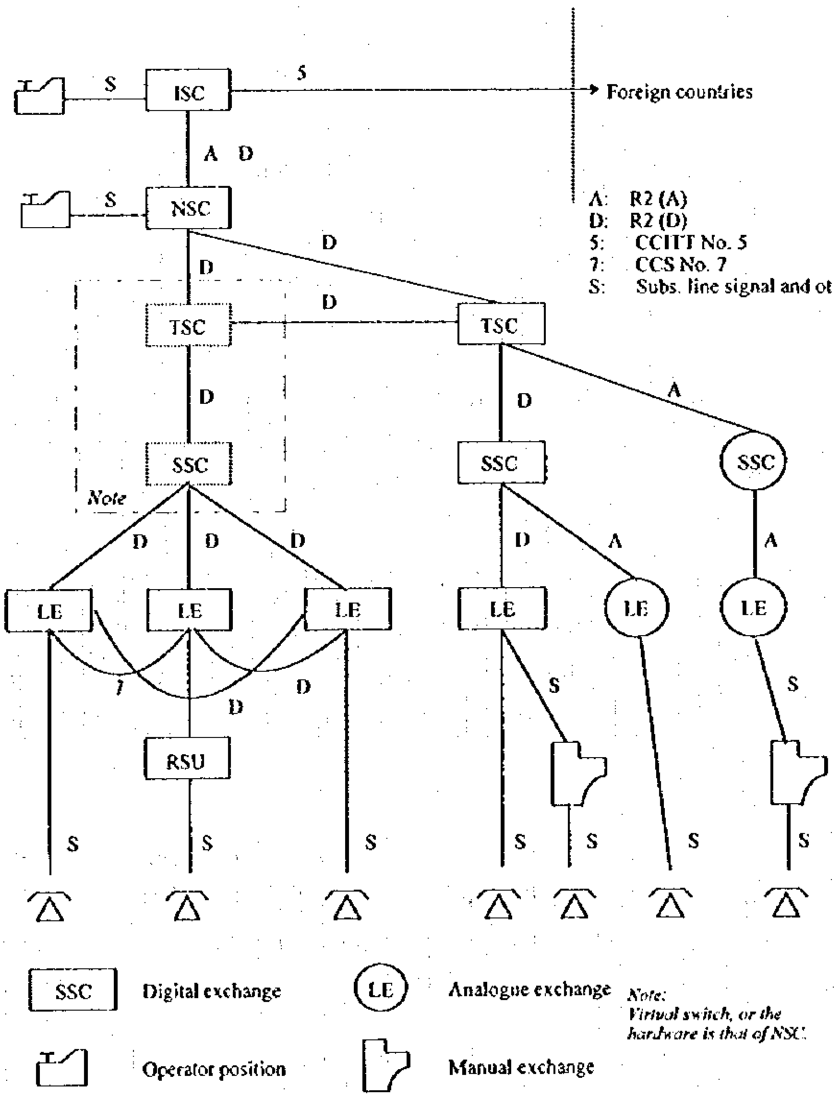
Note: N7: Signalling system No. 7.
D: R2 (D).
A: R2 (A).
O: Others.

Source: SLT.

2.2.2 Inter-exchange Signalling Links

(1) Present inter-exchange signalling link

During the transition phase from the existing manual/automatic and analogue/digital network to the completely digitised network, various types of interfaces and signalling systems will be required in the network. Figure 8-2-6 illustrates the types of connections to be supported by different signalling systems before CCS No. 7 is fully introduced.



Source: SLT.

Figure 8-2-6 Signalling Systems before Full CCS No. 7 Network

Existing 7 exchanges of OCB-283 and E-10B (P-11), all situated in Colombo, are equipped with Telephone User Part (TUP) function of CCS No. 7. The OCB-283 TUP is a modified one and called "TUP plus". It is designed to deal with some extra services in addition to the normal TUP defined by ITU-T. In addition to them, the 5-ESS fabricated by AT&T, which is a multi-function switch of NSC, TSC, SSC and LE, is capable (but not equipped) of TUP defined by ITU-T.

International links from ISC (ARE-13) and ISC (5-ESS) to foreign country switches are operated by ITU-T No. 5 signalling system. Domestic links from/to ISC (ARE-13) are operated by R2 (A) and those from ISC (5-ESS) are by R2(D). The new ISC (NEAX-61E), which is expected to be put into service during the period of this Study, is equipped with TUP and ISUP function and will be connect by R2 (D) and CCS No. 7 with domestic exchanges and by ITU-T No. 5 and CCS No. 7 with foreign exchanges. Signalling system No. 7 TUP and ISUP defined by ITU-T should be used whenever possible in future.

(2) Transition to new inter-exchange signalling link

Study Team recommends SLT to transfer the existing inter-exchange signalling link network to that made up in conformity with the ITU-T CCS specifications widely used over the world.

Existing SLT telephone network will be overlaid by an integrated services digital network (ISDN) before whole the country is transferred to a complete ISDN. During the transfer phase, some exchanges will be equipped with TUP and others with ISDN User Part (ISUP). Links originating and terminating within ISDN should be operated by ISUP and others by TUP.

All the new exchanges to be purchased in future shall apply the CCS No. 7, if the counter exchange is equipped with that function and the link is digital. If not, the new exchange should be linked with such counter exchange by means of the signalling function given to the counter exchange.

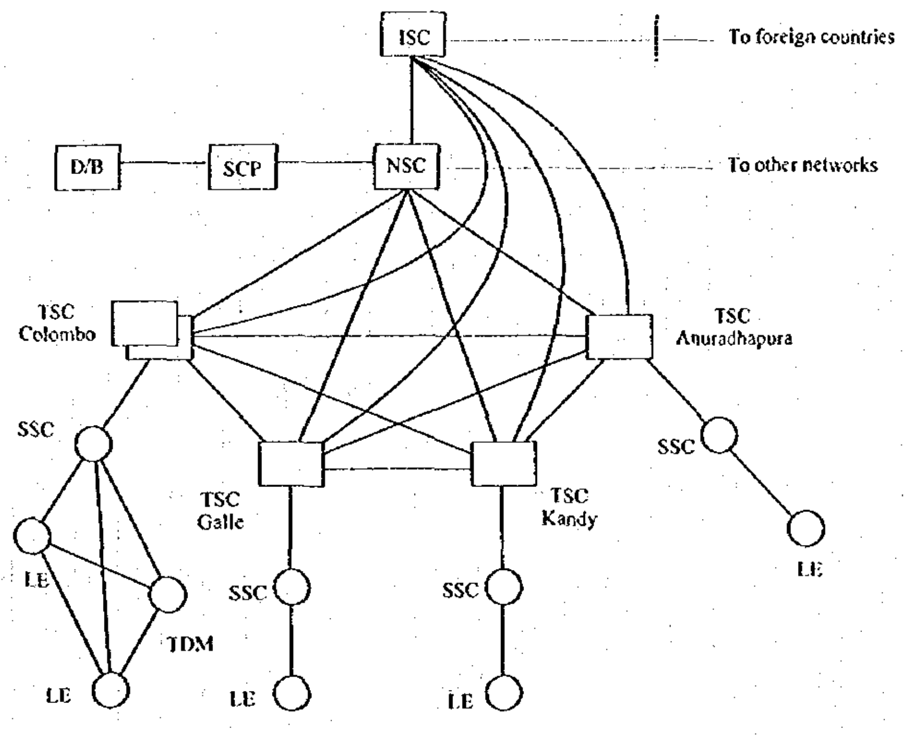
2.2.3 Common Channel Signalling System No. 7 Link Network

(1) Network structure

The exchanges at all levels will be connected by CCS No. 7 when all the exchanges are equipped with that signalling system. The signalling links upper than Tertiary switching centre will be made up in mesh and that lower than Tertiary switching centre will be made up in star type.

Dedicated signalling links will be established when Signal Control Point (SCP) or data base points are introduced for Intelligent Network (IN). Figure 8-2-7 shows a model of CCS No. 7 network for SLT.

As to the signalling time slot, SLT has provided CCS signalling links using the time slot No. 16 of a 2-Mbps communication channel between exchanges. Using the time slot No. 16 should remain unchanged as it is an international standard specified by ITU-T.



Note:
For simplicity, only the basic signalling links are

Source: JICA Study Team.

Figure 8-2-7 A model of SLT CCS No. 7 Signalling Link Network

(2) Signalling point code

a) International Signalling Point Code

Signal point code in the international network is defined in ITU-T Rec. Q.708. Figure 8-2-8 shows the format for the international signalling point code (ISPC). The international gate switch in Sri Lanka is given "04" as Zone code and "026" as Network, followed by a 3-bit value as Switch.

<table>
<tr><td>N</td><td>M</td><td>L</td><td>K</td><td>J</td><td>I</td><td>H</td><td>G</td><td>F</td><td>E</td><td>D</td><td>C</td><td>B</td><td>A</td></tr>
<tr><td colspan="3">Zone Identification</td><td colspan="8">Area/Network Identification</td><td colspan="3">Signalling Point Identification</td></tr>
<tr><td colspan="11">Signalling Are/Network Code (SANC)</td><td colspan="3"></td></tr>
<tr><td colspan="14">International Signalling Point Code (ISPC)</td></tr>
</table>

Source: ITU.

Figure 8-2-8 Format for the International Signalling Point Code (ISPC)

b) Domestic Signalling Point Code

For the domestic network, SLT discussed two signalling point code format types modelling after ISPC and selected that shown in Figure 8-2-9. This format consist of three fields, i.e., District, Network and Switch. Another format consists of four fields, i.e., Tertiary centre, Secondary centre, Local area and Switch as shown in Figure 8-2-10.

The signalling point code is not significant actually in the existing telecommunications network at present, because the traffic is of basic telephone call which is routed by analysing the called party telephone number. The signalling point code is significant when the signalling link network is independent from voice link network and signals are routed freely in the signalling network in future. Such network will be introduced in Sri Lanka when an intelligent layer is applied to ISDN. It is preferable to review the domestic signalling point code when it becomes significant in future.

SLT's present network signal point codes are assigned in accordance with the format shown in Figure 8-2-9. This format permits 32 districts, 16 networks and 32 exchanges. Sri Lanka has 25 Districts. As to the network (digit I to F), SLT counts 7 networks as ISC, NSC, TSC, SSC, Local, Mobile and Data. In this format, the local network of a district is allowed to have 32 signal points or switch units.

N	M	L	K	J	I	H	G	F	E	D	C	B	A
District					Network				Switch				

Source: SLT.

Figure 8-2-9 Existing SLT Signalling Point Code Format

According to the demand forecast, the National Capital, or Colombo SSC area (the area with trunk code "01"), is expected to find a demand of around 840,000 telephone lines in the year 2015. This demand will require more than 70 units of switching system provided that one unit has 10,000 lines in the average.

According to the above calculation, it is necessary to give two district codes to Colombo District dividing it into two areas. Other Districts will have very few possibility to require two District Codes.

Figure 8-2-10 shows an alternative for signalling point code format, which was discussed before in SLT. This format well coincides with the SLT network hierarchy in effect. This format allows 8 Tertiary centres in the country, 16 Secondary centres under one TSC, 16 Local areas under one SSC and 8 Switches in one local area. The Local area and Switch can be dealt with as one coding field, if necessary. In this case, 128 exchanges are allowed under one SSC. This capacity is, if all codes are assigned to only local switches and one exchange is assumed to have 10,000 subscriber lines in the average, as much as 1,280,000 subscriber lines.

Accordingly, this format capacity is sufficient to cover the signalling point code demand in Colombo SSC area in the year 2015 and forward. It is desirable to adopt the signalling code format shown in Figure 8-2-10 when it becomes significant in future, because it coincides completely with the SLT telephone network hierarchy at present, as long as SLT maintains it.

N	M	L	K	J	I	H	G	F	E	D	C	B	A
Tertiary area			Secondary area				Local area				Switch		

Source: SLT.

Figure 8-2-10 Proposed SLT Signalling Point Code Format

2.2.4 Interfacing of Different Networks

It is preferable that all the networks in Sri Lanka are linked by CCS No. 7 specified in ITU-T recommendations. The gate switch of SLT network should be NSC in Colombo for the time being and this gate switch should be linked to the gate switches of other networks operated by entities other than SLT.

The signalling point codes for the international gate switch of the networks other than SLT, if it is introduced in future, should be in conformity with ITU-T recommendations. That of domestic part of other networks than SLT is discretion of each entity. Domestic network signalling point codes must be decided making match to its network.

2.3 Synchronisation Plan

2.3.1 Network Synchronisation Hierarchy

The international switching centre (ISC) should be the point to originate the reference clock pulses for the SLT network. The reference clock pulses should be transferred to other exchanges through reference clock pulse links established basically according to the telephone network hierarchy. All the exchanges in SLT network should be synchronised by the master-slave method under the ISC.

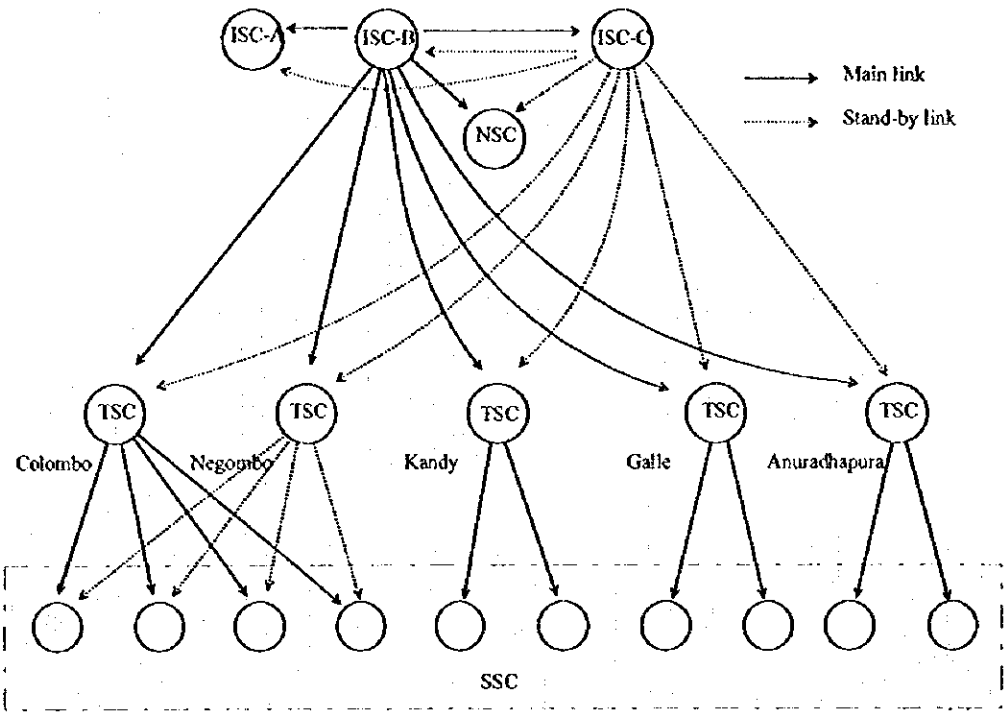
2.3.2 Reference Clock Accuracy and Stability

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 on slip rate recommended by ITU-T. The existing E-10B, OCB-283, NEAX-61, and DX-220/210 exchanges 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} or 10^{-6} per day.

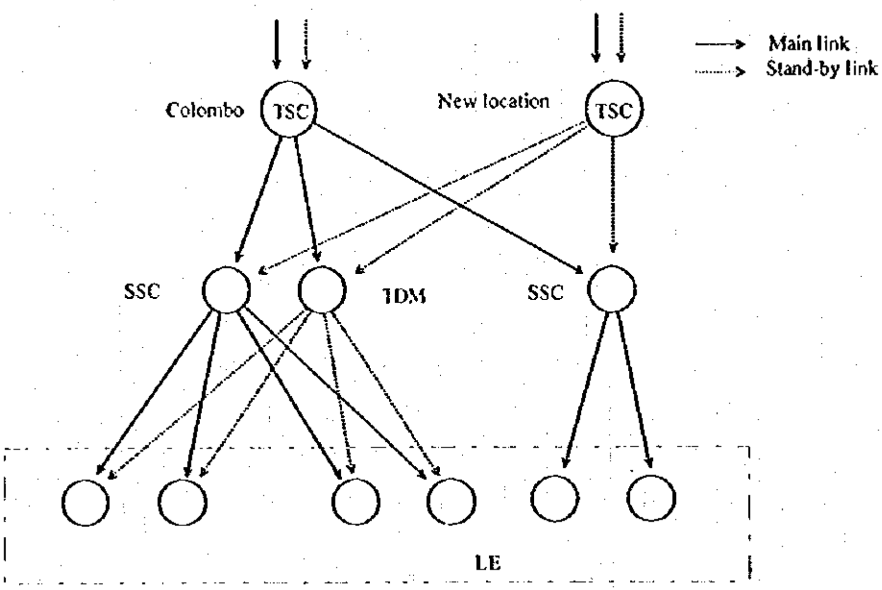
2.3.3 Reference clock network structure

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 8-2-11 shows a proposed reference clock national network of SLT. Figure 8-2-12 shows a proposed reference clock network in Colombo TSC area.



Source: JICA Study Team.

Figure 8-2-11 National Reference Clock Network of SLT



Source: JICA Study Team.

Figure 8-2-12 Reference Clock Network in Colombo TSC Area

The stability of clocks of TSCs and SSCs should be at 10^{-10} and that of LEs should be at 10^{-10} or 10^{-6}. The local exchange in a area where the exchange is connected by direct circuits in addition to the link to its superintendent exchange in exchange hierarchy should be equipped with a clock module of stability of 10^{-10} and others at 10^{-6} /day.

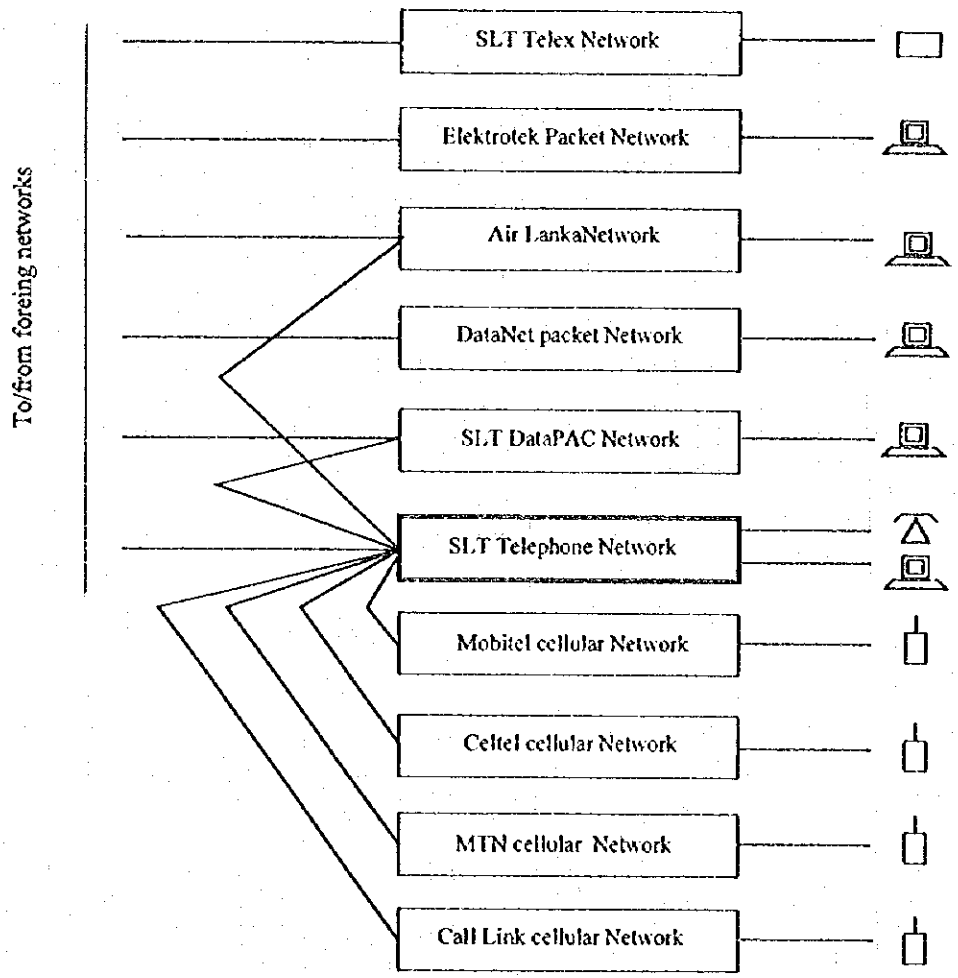
2.3.4 Reference Clock Supply to Other Networks

For the network synchronisation between SLT network and other networks provided by other entities, SLT should supply reference clock pulses if required by other network providers. In this case, the reference clock pulses should be transfered through SLT gateway switches to other networks. Dedicated data links may be provided between gateway switches, if other network providers need it.

2.4 Inter-network Connection

2.4.1 Inter-network Connection of Existing Networks in Sri Lanka

In Sri Lanka there are several telecommunications networks besides SLT telephone network; i.e., cellular telephone networks, data communication networks, telex network, facsimile networks, dedicated circuits networks and paging networks. Some of them are inter-connected with SLT telephone network through trunk circuits and others are connected by normal subscriber lines. Data communications network except DataPAC are not inter-connected with SLT telephone network. Figure 8-2-13 shows the existing major networks and inter-connection between them.



Source: JICA Study Team.

Figure 8-2-13 Existing Major Networks and Inter-connection between Them

SLT data communication network is inter-connected with SLT telephone network through normal telephone lines and with foreign networks.

The cellular telephone networks, Air Lanka network and Payphone network are interconnected with SLT telephone network through trunk circuits to 5-ESS NSC. Among them, Mobitel, Call Link and Celltel networks are inter-connected with E-10B (P-11) City Exchange through trunk circuits. Paging service networks, pay telephone networks except that by Payphone, facsimile networks are now inter-connected with SLT telephone network by means of normal telephone subscriber numbers.

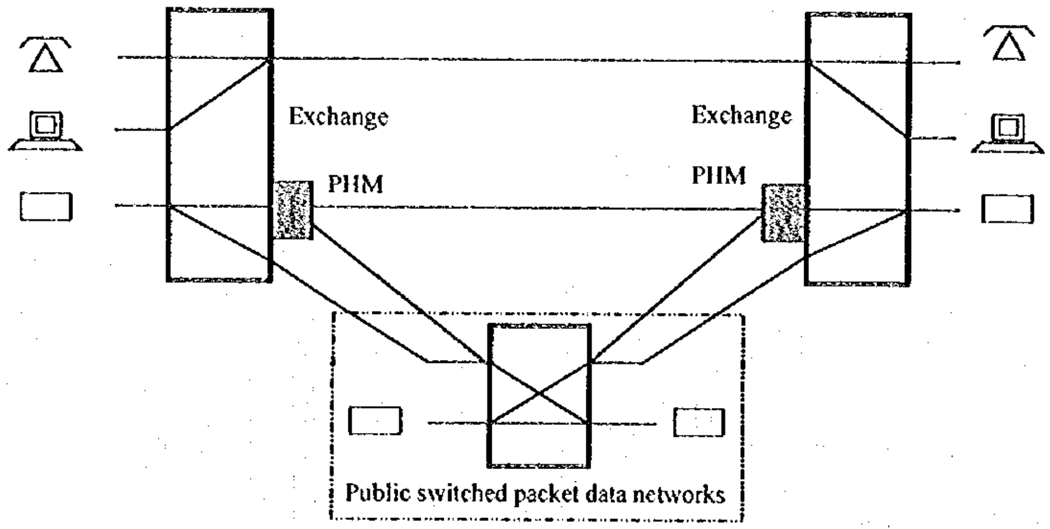
2.4.2 Inter-network Connection in Future

SLTA is re-arranging the existing numbering plan with the intention to invite some more private telecommunications network providers in future. It will give a proper Destination Network Code (DNC) to each of them. Then following the new numbering system which includes the DNCs, all the networks, including existing SLT and cellular networks, will have the option to establish the direct inter-network connection each other.

SLT network will be inter-connected with the existing and new networks through a gateway switch. The SLT gateway switch should be, primarily, the NSC in Colombo. The number of gateway switches or the connection points will be increased in proportion to the growth of inter-network traffic, involving Kandy, Galle and Anuradhapura in future. The signalling system between the gateway switches should be CCS No. 7.

For the public switched packet data network (PSPDN), another gateway switch is planned in SLT network. The gateway switch shall be the ISDN Centre to be situated in Colombo. The inter-network connection will be realised by X.75 protocol.

It is proposed in this Master Plan to introduce an ISDN by the year 2000. The ISDN will have a packet handling function and be inter-connected with the existing SLT packet switching system "DataPAC". Figure 8-2-14 shows a probable inter-network connection between SLT ISDN and public switched packet data networks. The SLT ISDN will be inter-connected with other data communication networks by X.75 protocol, if required.



Source: JICA Study Team.

Figure 8-2-14 Probable Inter-Network Connection between SLT ISDN and PSPDN

2.5 Charging System Plan

2.5.1 Existing Charging System

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 8-2-8 shows the time allowed for one call unit.

Table 8-2-8 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 8-2-8 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.

2.5.2 Exchange Functions for Charging

Since the tariff system is revised by various reasons, the switching system shall be flexible to meet such changes. SLT stipulates that the digital exchanges to be used as local or secondary switching centre switch should be so designed that the time of one call unit, hours during which the rate is applied and the days during which the rate is applied can be changed by man-machine interface at site when necessary.

The switching node related to charge should be able to record the call charge data stored in the call charge accumulator on suitable data media, such as reel/cassette type magnetic tape, hard disk, laser disk or floppy disk, etc. Every digital exchange related to charge is so designed to allow getting out put of charge data by man-machine inter-face at site when necessary. SLT gate-way switches should be able to record detailed data concerning the used circuits.

SLT is going to provide a full digital telephone network by on-going projects. Since cross-bar exchanges and step-by-step exchanges are cleared out by the on-going projects, every local exchange and secondary switching centre switch will be equipped with the above-stated functions. Then SLT will be able to issue detailed message bills for all subscribers.

2.5.3 Charging Node

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

Local calls should be charged at local exchange. Trunk calls should be charged at Secondary switching centre where the trunk calls are originated

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. Charges for advanced services allowed by IN system will be controlled by NSC.

2.5.4 Charge Data Format

Charge data format should be in conformity with the specifications defined by SLT. The specicifications are presented in DATA BOOK, Volume V.

2.6 Engineering Standards

2.6.1 Traffic engineering

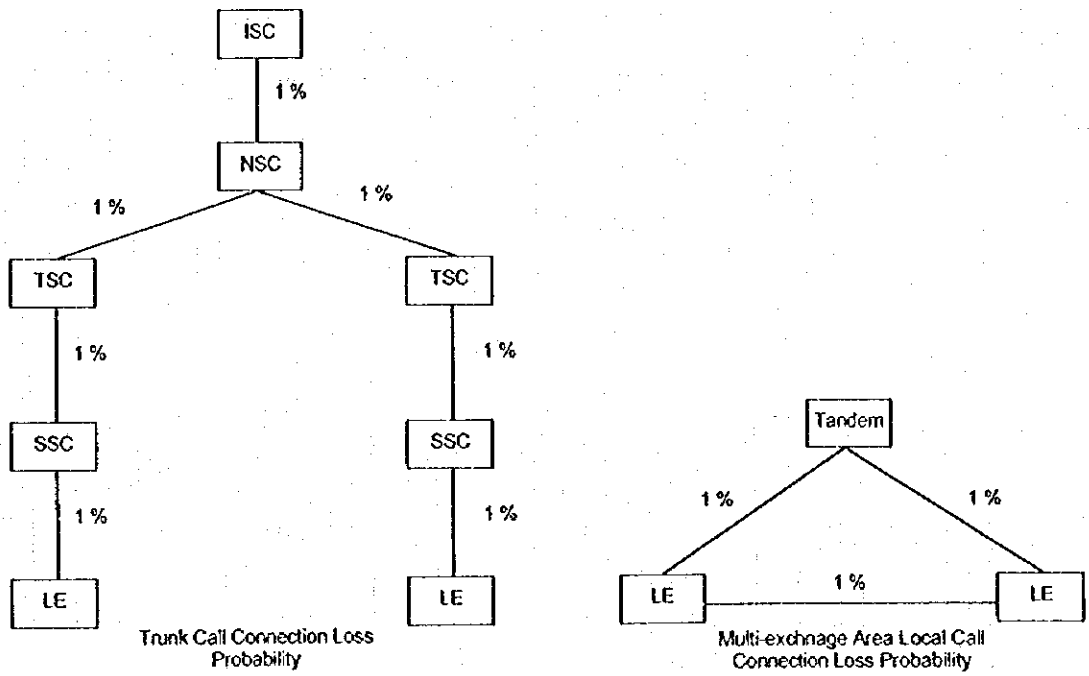
SLT applies the following standard of loss probability to connections between two exchanges.

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 8-2-15.);
for short-cut route:	1 % per link.



Source: SLT.

Figure 8-2-15 Connection Loss Probability between Two Exchanges

SLT's design objective of probability of inadequately handled call attempts occurring in a digital exchange is as shown in Table 8-2-9.

Table 8-2-9 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.

2.6.2 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. The effects of these two measures are as follows.

Loudness Rating (LR) is an objective measure of the loudness loss, i.e. a weighted, electro-acoustic loss between certain interfaces in the telephone network according to ITU-T recommendation G. 111. It is used instead of the previous Reference Equivalent (RE). Loudness rating consists of Overall Loudness Rating (OLR), Send Loudness Rating (SLR), Receive Loudness Rating (RLR) and Circuit Loudness Rating (CLR). These are defined as follows and recommended values are shown in the Table 8-2-10.

OLR... The loudness loss between the speaking subscriber's mouth and the listening subscriber's ear via a connection. OLR = SLR + RLR + CLR

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

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

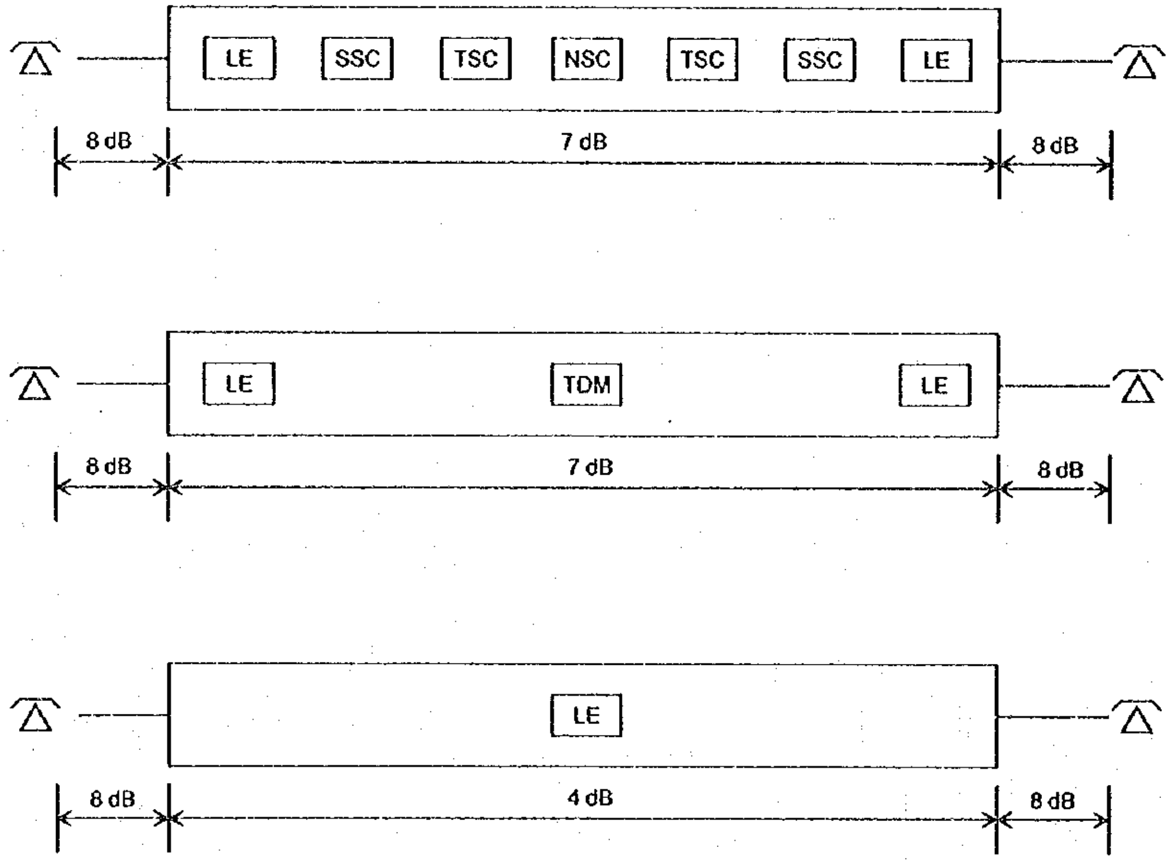
CLR... The loudness loss between two electrical interface in the network (via circuit), each interface terminated by its nominal impedance which may be complex. [The loudness loss is here approximately equivalent to the weighted (dB) average of the composite electric loss.]

Table 8-2-10 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

Conforming to this recommendation, SLT should provide their LR allocation in the national network. Figure 8-2-16 shows the example of LR allocation.



Source: JICA Study Team.

Figure 8-2-16 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 8-2-11 below.

Table 8-2-11 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 1×10^{6}.
Severely Errored Seconds (%SES)	Fewer than 0.2% of one-second intervals to have a bit error ratio worse than 1×10^{-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.

Other factors to be specified conforming to ITU-T Recommendations are as follows:

- slip;
- jitters, wander;
- propagation time;
- quantizing distortion;
- quantizing noise; and
- echo.

3. Signalling System No. 7 Fundamental Technical Plan

3.1 Signalling System No. 7 Specifications

3.1.1 General

ITU-T Recommendations indicate the Signalling System No. 7 protocols which provide the signalling functions required to support services in a telephone network, data communication network, as well as basic bearer services and supplementary services for voice and non-voice applications in an integrated services digital network (ISDN). Leading telephone switching system manufacturers fabricate their products in compliance with the specifications defined by such Recommendations and supply them to users for international and national applications.

ITU-T Recommendations deal with fundamentally the international networks. However, most signalling procedures, information elements and message types specified for international use are also required in typical national applications. Coding space has been reserved in order to allow national administrations and recognised private operating agencies to introduce network specific signalling messages and elements of information within the internationally standardised protocol structure.

The signalling messages specified by ITU-T cover most services essential to a general telephone network. Accordingly, SLT can establish its signalling link network making use of the messages already specified by ITU-T.

SLT has prepared specifications of CCS No. 7 protocol in order to apply to exchnages to be introduced under the on-going projects. The specifications cover a certain extent of normal connection protocol being in conformaity with related ITU-T recommendations. Volume V "Data Book" shows the specification. It is recommended to conduct a further study aiming to develop for establishing guidelines or specifications regarding the detailed parts of Signalling System No. 7 for SLT network use and getting harmony with exchange control software specifications. SLT should introduce only the signalling systems defined by ITU-T in order to avoid inter-working problems or cost increase afterwards.

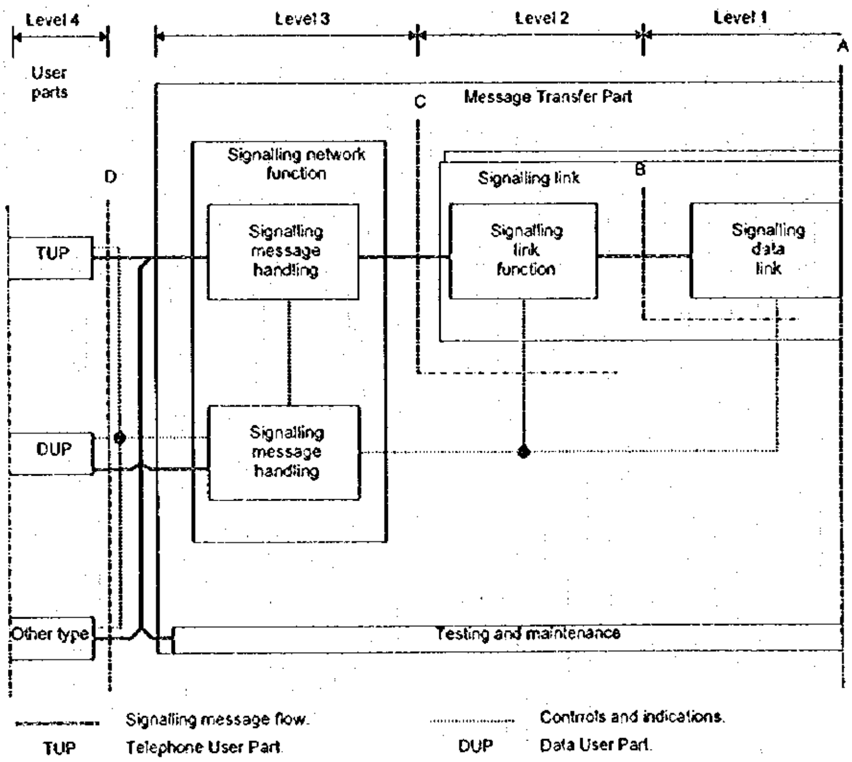
3.1.2 Structure of Signalling System No. 7

The functional principle of the Signalling System No. 7 structure is the division of function into a common Message Transfer Part (MTP) on one hand and separate User parts for different users on the other.

As a further separation, the necessary elements of the signalling system are specified in accordance with a level concept in which:

- the functions of the Message Transfer Part are separated into three functional levels, and
- the User Parts constitute parallel elements at the fourth function level.

Figure 8-3-1 shows the level structure. The system structure shown in Figure 8-3-1 is not a specification of an implementation of the system. The functional boundaries B, C and D may or may not exist as interfaces in an implementation. The interactions by means of controls and indications may be direct or via other functions. However, the structure shown in Figure 8-3-1 may be regarded as a possible model of an implementation.



Source: ITU-T.

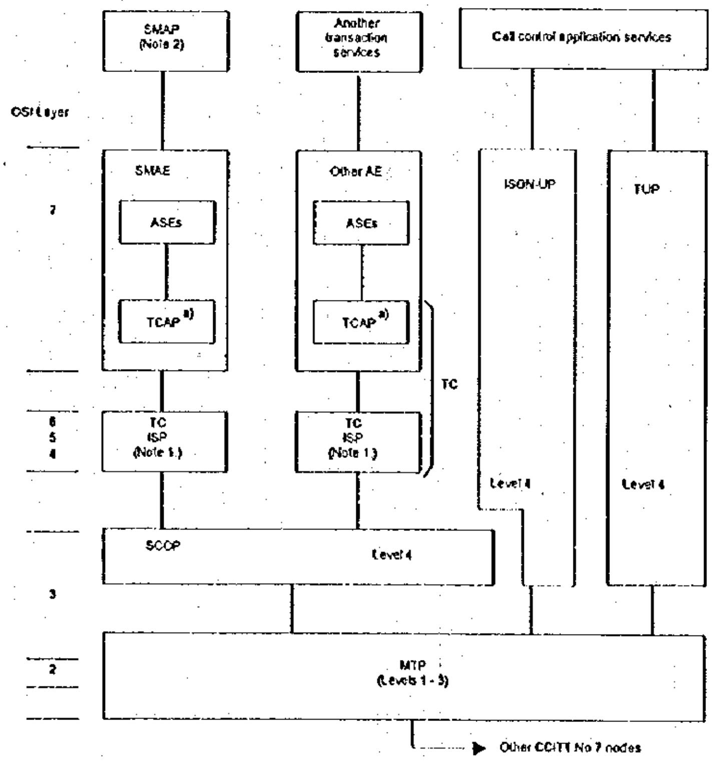
Figure 8-3-1 General Structure of Signalling System Functions

3.1.3 Signal Unit Formats and Signalling Protocol

ITU-T Rec. Q.703 defines signal unit formats applied to transmit signals between the Signalling System No. 7 implementations. They are Fill-in signal unit (FISU), Link status signal unit (LSSU) and Message signal unit (MSU).

ITU-T Rec. Q.723 specifies telephone signal message formats and codes. ITU-T Rec. Q. 763 specifies ISDN User Part message formats and codes. ITU-T Q. 724 and Q. 764 specify signalling procedures for the set-up and clear down of telephone connection and ISDN conneciions respectively.

The Signalling System No. 7 provides protocols for the signalling functions required to support services in a telephone network, a data communications network and an integrated services digital network. The protocols are Telephone User Part (TUP), Data User Part (DUP), ISDN User Part (ISUP), etc. In addition to such user parts, the Signalling System No. 7 includes Signalling Connection Control Part (SCCP) and Transaction Control Application Protocol (TCAP) as its elements, which will be used for an intelligent network. Figure 8-3-2 shows the relationship of functional levels of TUP, ISUP, SCCP and TCAP.



Source: ITU-T

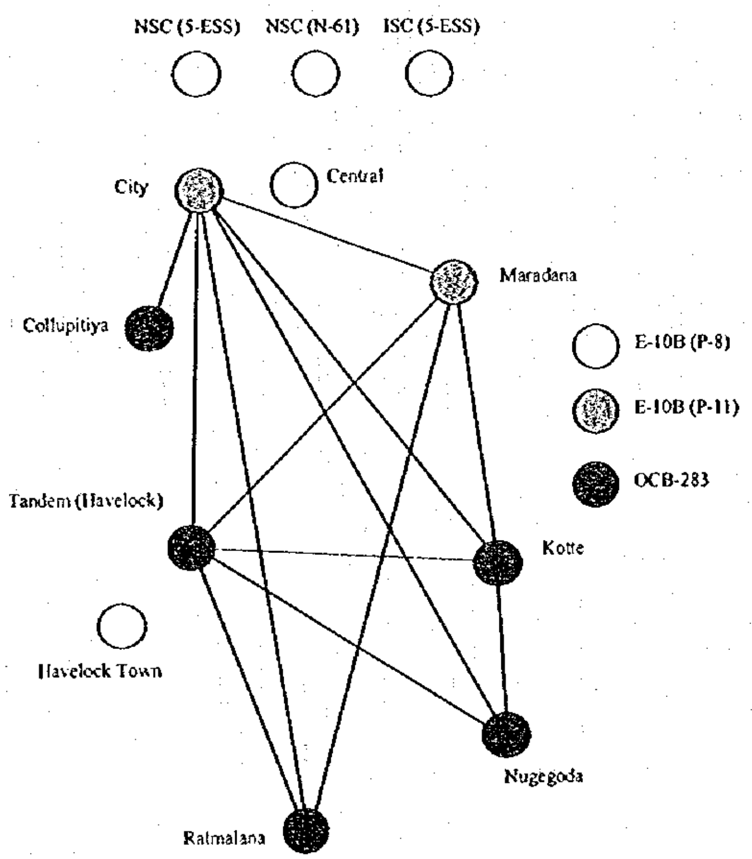
Figure 8-3-2 Relationship of Functional Levels

3.2 Signalling System No. 7 Implementation in SLT network

3.2.1 Existing Network of Signalling System No. 7

Different technologies of digital exchanges are in use in SLT network. They are from CIT Alcatel of France, NEC of Japan, Nokia of Norway, Ericsson of Sweden. Moreover, Korean products are going to be introduced under on-going projects.

Among the above-mentioned digital exchanges, some exchanges fabricated by CIT-Alcatel and situated in Colombo were connected by the Signalling System No. 7 links for the first time in Sri Lanka. Other exchanges in Colombo are not integrated into the Signalling System No. 7 network. They are ISC (5-ESS), NSC (N-61), NSC (5-ESS), Central (E-10B) and Havelock Town (E-10B). Exchanges situated out of Colombo are not connected by the Signalling System No. 7. Figure 8-3-3 shows the existing CCS No. 7 network which has been introduced in Colombo.



Source: SLT.

Figure 8-3-3 Existing Digital Exchanges and CCS No. 7 Network in Colombo

As found in Figure 8-3-3, the Signalling System No. 7 network in Colombo is formed almost in mesh. The signalling links are provided by the time slot No. 16 of 2-Mbps circuits between exchanges.

The telephone user part now applied to the exchanges by CIT-Alcatel in Colombo is called TUP Plus. The TUP Plus is slightly modified compared to the standard telephone user part specified by ITU-T. Table 8-3-1 shows heading codes of TUP Plus comparing to that of ITU-T blue book. Heading code TAC, CHC, CHA, CHP and OPR are not defined in blue book as defined in TUP Plus version.

Table 8-3-1 Heading Codes of TUP Plus Comparing to ITU-T Blue Book

H0/H1	0000	0001	0010	0011	0100	0101	0110	0111	1000	1001	1010	1011	1100	1101	1110	1111
	<						Spare, reserved for national use									>
0000				*TAC*	*CHC*				*CHA*							
0001		IAM	IAI	SAM	SAO											
0010		GSM		COT	CCF											
0011		GRQ														
0100		ACM	CHG													
0101		SEC	CGC	NNC	ADI	CFL	SSB	UNN	LOS	SST	ACB	DPN	MPR			EUM
0110	ANU	ANC	ANN	CBK	CLF	RAN	FOT	CCL								
0111		RLG	BLO	BLA	UBL	UBA	CCR	RSC								
1000		MGB	MBA	MGU	MUA	HGB	HBA	HGU	HUA	GRS	GRA	SGB	SBA	SGU	SUA	
1001					RESERVED											
1010		ACC			Spare reserved for international and basic national use											
1011																
1100		*CHP*			Spare reserved for national use											
1101		*OPR*														
1110																
1111																

CHP Charging pulse signal
OPR Operation signal
CHC Change units collection message
CHC Charging acknowledgment signal
TAC Tariff change message

[IAM] Defined in Blue Book.
[SBA] Defined in Blue Book, national option
[*OPR*] Not defined in Blue Book.

Source: ITU and SLT.

The new ISC by NEC, the installation of which has recently been completed, will be incorporated into the Colombo CCS No. 7 network. The telephone user part of the new ISC is modified compatible with the TUP Plus.

3.2.2 Expansion of CCS No. 7 Network

All the transmission systems linking ISCs, NSCs, TSCs and SSCs in SLT network are digital, i.e., the transmission systems are ready to provide a nation-wide CCS No. 7 network.

SLT is expanding its network by introducing digital exchanges and by replacing analogue exchanges with digital ones through the on-going projects which will complete in the year 1997 adding approximately 385,600 new lines to the existing approximately 180,000 lines. SLT is going to provide those new exchanges with ISUP to connect them.

SLT has introduced various types of digital exchanges and so will do in future too. It may be probable that different types of digital exchange coexist in a city being connected each other by the Signalling System No. 7. JICA Study Team recommends, taking such probable condition into consideration, that new exchanges to be procured in future be equipped only with the standard TUP or ISUP for a smooth compatibility of different technology exchanges. It is also recommended to use time slot No. 16 for the signalling link in conformity with the ITU-T specification.

3.3 Technical aspects on MTP, TUP and ISUP

3.3.1 General

The Signalling System No. 7 is so established that national administrations and recognised private operating agencies are requested to fit the detailed parts of the message signal codes to their network requirement. SLT is requested to decide the details in harmony with exchange control software or service plans. Message transfer part, telephone user part and ISDN user part will be involved in deciding the details.

3.3.2 Message Transfer Part (MTP)

ITU-T Recommendation Q. 704 describes signal message formats and codes for the message transfer part. Table 8-3-2 shows the heading code allocation of the telephone user part. Message transfer part to be used by SLT should be in compliance with the specifications by ITU-T Recommendations.

Table 8-3-2 Heading Code Allocation of MTP

Message Group	H1 / H0	0000	0001	0010	0011	0100	0101	0110	0111	1000	1001	1010	1011	1100	1101	1110	1111
	0000																
CHM	0001		COO	COA			CBD	CBA									
ECM	0010		ECO	ECA													
FCM	0011		RCT	TFC													
TFM	0100		TFP	*	TFR		TFA	*									
RSM	0101		RST	RSR													
MIM	0110		LIN	LUN	LIA	LUA	LID	LFU	LLT	LRT							
TRM	0111		TRA														
DLM	1000		DLC	CSS	CNS	CNP											
	1001																
UFC	1010		UPU														
	1011																
	1100																
	1101																
	1110																
	1111																

Note Note - Values marked * should not be used
(codes used in the Yellow Book for TFP and TFA acknowledgement).

Source: ITU.

3.3.3 Telephone User part (TUP)

ITU-T Recommendation Q. 723 describes telephone signal message formats and codes for the telephone user parts. Table 8-3-3 shows the heading code allocation of the telephone user part.

Some messages consist of only Label and Heading codes and other consist of Label, Heading codes and some more information elements. A local call connection which ends normally involves such messages as a) Initial address message, b) Address complete message, c) Answer signal, charge, d) Clear-forward signal, and d) Release-guard signal. A coding example of the initial address message is shown in Supporting Document.

Each of the messages indicated in Table 8-3-3 should be analysed to apply to a specific network and proper values should be given taking harmony with network and exchange specifications.

Table 8-3-3 Heading Code Allocation of Telephone User Part

H0/H1	0000	0001	0010	0011	0100	0101	0110	0111	1000	1001	1010	1011	1100	1101	1110	1111
0000	< Spare, reserved for national use >															
0001		IAM	IAI	SAM	SAO											
0010		GSM		COT	CCF											
0011		GRQ														
0100		ACM	CHG													
0101		SEC	CGC	NNC	ADI	CFL	SSB	UNN	LOS	SST	ACB	DPN	MPR			EUM
0110	ANU	ANC	ANN	CBK	CLF	RAN	FOT	CCL								
0111		RLG	BLO	BLA	UBL	UBA	CCR	RSC								
1000		MGB	MBA	MGU	MUA	HGB	HBA	HGU	HUA	GRS	GRA	SGB	SBA	SGU	SUA	
1001					RESERVED											
1010		ACC			Spare reserved for international and basic national use											
1011																
1100					Spare reserved for national use											
1101																
1110																
1111																

Source: ITU.

3.3.4 Integrated Services Digital Network User Part (ISUP)

The integrated services digital network (ISDN) user part is the Signalling System No. 7 protocol which provides the signalling functions required to support basic bearer services and supplementary services for voice and non-voice applications in an integrated services digital network.

The ISDN User Part makes use of the services provided y the Message Transfer Part (MTP) and in some cases by the Signalling Connection Control Part (SCCP) for the transfer of information between ISDN User Parts.

The ISDN User Part protocol which supports the basic bearer service is described in Recommendations Q. 761 to Q. 764 and Q. 766. Recommendation Q. 766 deals with ISDN User Part performance objectives. Table 8-3-4 shows massage types and corresponding codes. Table 8-3-5 shows parameter names and corresponding codes. Details of each parameter is indicated in Recommendation Q. 763. The parameters should be given correct values in accordance with service provision plan of SLT.

Table 8-3-4 Message Types and Corresponding Codes

Message Type	Reference (Table)	Code
Address complete	5/Q.763	00000110
Answer	6/Q.763	00001001
Blocking	23/Q.763	00010011
Blocking acknowledgement	23/Q.763	00010101
Call modification completed	24/Q.763	00011101
Call modification request	24/Q.763	00011100
Call modification reject	24/Q.763	00011110
Call progress	7/Q.763	00101100
Circuit group blocking	25/Q.763	00011000
Circuit group blocking acknowledgement	25/Q.763	00011010
circuit group query	26/Q.763	00101010
Circuit group query response	8/Q.763	00101011
Circuit group reset	26/Q.763	00010111
Circuit group reset acknowledgement	9/Q.763	00101001
Circuit group unblocking	25/Q.763	00011001
Circuit group unblocking acknowledgement	25/Q.763	00011011
Charge information a)	(see Note)	00110001
Confusion	10/Q.763	00101111
Connect	11/Q.763	00000111
Continuity	12/Q.763	00000101
Continuity check request	23/Q.763	00010001
Delayed release a)	21/Q.763	00100111
Facility accepted	27/Q.763	00100000
Facility reject	13/Q.763	00100001
Facility request	27/Q.763	00011111
Forwarded transfer	21/Q.763	00001000
Information	14/Q.763	00000100
Information request	15/Q.763	00000011
Initial address	16/Q.763	00000001
Loop back acknowledgement a)	23/Q.763	00100100
Overload a)	23/Q.763	00110000
Pass-along	28/Q.763	00101000
Release	17/Q.763	00001100
Release Complete	18/Q.763	00010000
Reset circuit	23/Q.763	00010010
Resume	22/Q.763	00001110
Subsequent address	19/Q.763	00000010
Suspend	22/Q.763	00001101
Unblocking	23/Q.763	00010100
Unblocking acknowledgement	23/Q.763	00010110
Uneuipped CIC a)	23/Q.763	00101110
User-to-user information	20/Q.763	00101101
Reserved (used in 1984 version)		00001010
		00001011
		00001111
		00100010
		00100011
		00100101
		00100110

Source: ITU.

Table 8-3-5 Parameter Names and Corresponding Codes

Parameter name	Reference	Code
Access transport	3.2	00000011
Automatic congestion level	3.3	00100111
Backward call indicators	3.4	00010001
Call modification indicators	3.5	00010111
Call reference	3.6	00000001
Called party number	3.7	00000100
Calling party number	3.8	00001010
Calling party's category	3.9	00001001
Cause indicators	3.1	00010010
Circuit group supervision message type indicator	3.11	00010101
Circuit state indicator	3.12	00100110
Closed user group interlock code	3.13	00011010
Connected number	3.14	00100001
Connection request	3.15	00001101
Continuity indicators	3.16	00010000
End of optional parameters	3.17	00000000
Event information	3.18	00100100
Facility indicator	3.19	00011000
Forward call indicators	3.2	00000111
Information indicators	3.21	00001111
Information request indicators	3.22	00001110
Nature of connection indicators	3.23	00000110
Optional backward call indicators	3.24	00101001
Optional forward call indicators	3.25	00001000
Original called number	3.26	0011000
Range and status	3.27	00010110
Redirecting number	3.28	00001011
Redirection information	3.29	00010011
Redirection number	3.3	00001100
Signalling point code a)	3.31	00011110
Subsequent number	3.32	00000101
Suspend/Resume indicators	3.33	00100010
Transit network selection a)	3.34	00100011
Transmission medium requirement	3.35	00000010
User service information	3.36	00011101
User-to-user indicators	3.37	00101010
User-to-user information	3.38	00100000
Reserved (used in 1984 version, Red Book)		00010100
		00011001
		00011011
		00011100
		00011111
		00100101

Source: ITU.

3.3.5 Signalling System No. 7 Test Specifications

Test specifications should be established to test protocol performance in a given implementation. The test specifications are presented in ITU-T Recommendations Q. 780 to Q. 783. However, it is recognised that certain tests require capabilities of the system that are not explicitly defined in the relevant Recommendations, and these capabilities may not be present in all implementations. As a consequence, certain test in the Recommendations may not be possible in all implementations.

Test items should be selected duly to test protocol performance of the given implementation in consideration of its signalling network configuration, the number of linksets and links of each linkset, and the numbering plan.

The level 2 test descriptions should indicate protocols of every signal unit, wherein the exchange of the signal units is indicated in correct order and adequate timings. The test description should be formed to test reactions followed by various link status including link initialisation, activation, deactivation, etc.

The level 3 and 4 test descriptions should indicate protocols of signal units , wherein the exchange of the signal units is indicated in correct order and adequate timings. The test description should be formed to test reactions to every signal unit defined by SLT.

4. Switching Network Plan

4.1 Existing Switching Network

4.1.1. Telephone Network Hierarchy

Major telephone networks in Sri Lanka are the telephone network operated by Sri Lanka Telecom (SLT) and four cellular telephone networks operated by private entities. In addition to them, there are some minor networks such as pay telephone networks and paging service networks having access to local exchanges. The Lanka Air private network is also inter-connected to SLT telephone network. The SLT telephone network covers whole the Island though paralysed totally in northern areas. The private cellular telephone networks cover the National Capital and some major cities.

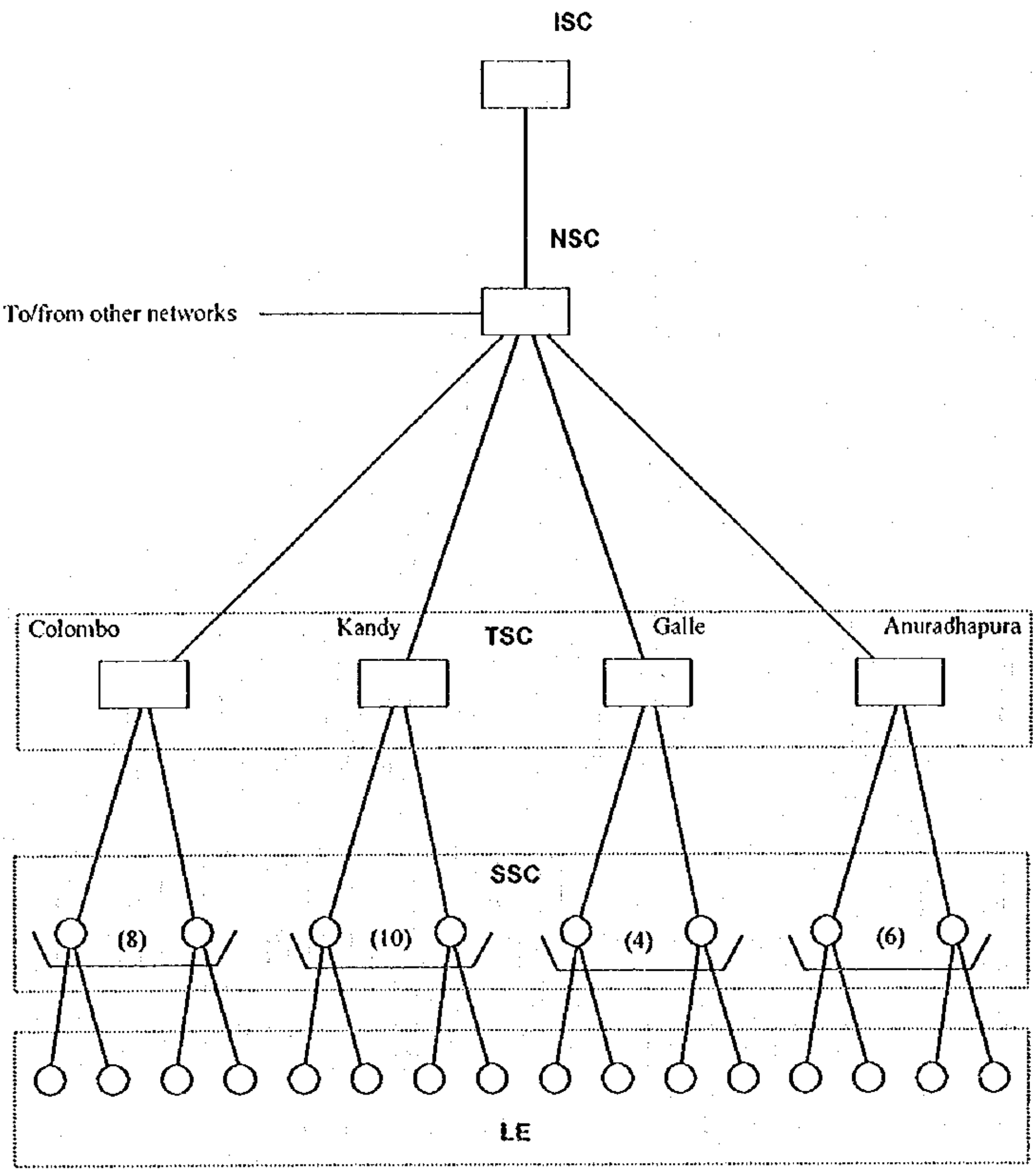
The SLT telephone network consists of such stages as International Switching Centre (ISC), National Switching Centre (NSC), Tertiary Switching Centre (TSC), Secondary Switching Centre (SSC) and Local exchanges (LE). Figure 8-4-1 shows the hierarchical structure of existing telephone network of SLT.

The International Switching Centre is one in number, consisting of two units of switching systems, and situated in Colombo.

The National Switching Centre is one in number, consisting of two units of switching systems, and situated in Colombo.

The Tertiary Switching Centre is four in number and situated in Colombo, Kandy, Galle and Anuradhapura, that is, the country is divided into four Tertiary Switching Centre Areas. These Tertiary Switching Centres come under the National Switching Centre in the SLT telephone network hierarchy.

The Secondary Switching Centre is 28 in umber whole the Island and situated in major cities, that is, the country is divided into 28 Secondary Switching Centre Areas. These Secondary Switching Centres come under Tertiary Switching Centre in corresponding Tertiary Switching Centre Area. Colombo Tertiary Switching Centre has eight Secondary Switching Centres, Kandy has 10 Secondary Switching Centres, Galle has four Secondary Switching Centres and Anuradhapura has six Secondary Switching Centres respectively. Local exchanges are placed under Secondary Switching Centre.



Note:
Telephone switching unit 5-ESS situated at Central Exchange has the function of NSC, TSC, SSC and LE. Besides, there are some telephone switching units with combined function of TSC, SSC and/or LE.

ISC International switching centre
NSC National switching centre
TSC Tertiary switching centre
SSC Secondary switching centre
LE Local exchange

Source: SLT.

Figure 8-4-1 Hierarchical Structure of Existing Telephone Network of SLT

4.1.2 Existing Exchanges and Capacity

(1) International Switching Centre

The International Switching Centre (ISC) is situated in Sri Lanka Telecom (SLT) Headquarters in Colombo. There are two units of switching system in the ISC; they are ARE-13 of Ericcson and 5-ESS of AT&T. The unit "ARE-13" was put into service in 1979 and expanded in 1985, and the unit "5-ESS" in 1991.

The unit "ARE-13" has a capacity of approximately 1,000 inter-exchange circuits including 500 international circuits. This switching unit had a total of 265 working inter-exchange circuits to domestic side exchanges and 189 circuits to foreign exchanges at the end of March 1995. This switching unit is under replacement with a new international gate-way switch. The new international gate-way switch is of type NEAX-61E with a circuit capacity of approximately 2,200 for the domestic side and approximately 2,000 for the international side. The NEAX-61E international switch has 1 supervisor position and 18 operator positions installed. The NEAX-61E international switch will have a total of 2,129 circuits to domestic exchanges and 2,020 circuits to foreign exchanges when fully commissioned.

The unit "5-ESS" has a capacity of approximately 2,400 inter-exchange circuits including approximately 1,200 international circuits. This switching unit has a total of 855 working circuits for domestic side and 902 working circuits for foreign side.

(2) National Switching Centre

The National Switching Centre is situated in the SLT Headquarters in Colombo. The NSC consist of two units of digital switching system. The unit of type NEAX-61K (hereinafter referred to as unit "A") of NEC, Japan, was put into service in 1981, and the unit of type 5-ESS (hereinafter referred to as unit "B") of AT&T, U.S.A., was put into service in 1992.

The unit "A" has a capacity of 3,300 inter-exchange circuits. The unit "A" has a total of 688 working circuits. The unit "B" has a capacity of 9,000 inter-exchange circuits. The unit 'B" has 8,984 working circuits.

(3) Tertiary Switching Centre

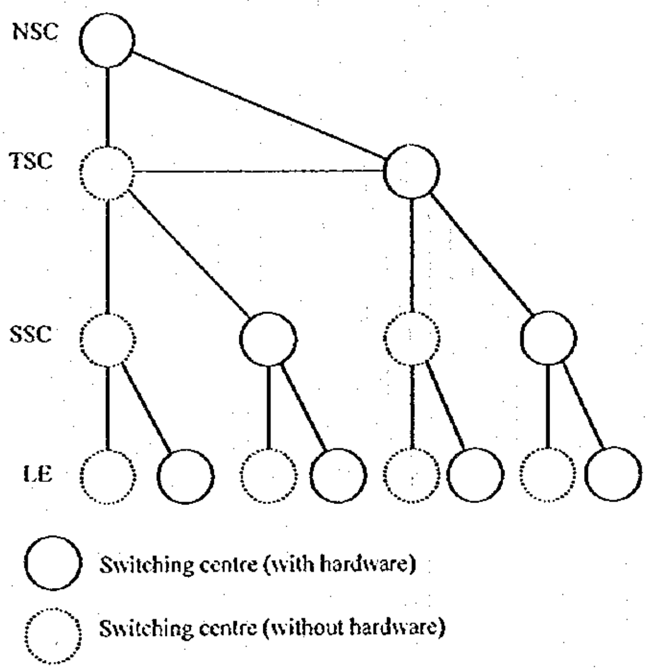
There are four (4) Tertiary Switching Centres (TSC) in SLT network. However, TSC and SSC in Colombo are virtual, that is, The NSC is working as Tertiary Switching Centre (TSC) and Secondary Switching Centre (SSC) of Colombo at the same time. There isn't separate hardware for TSC and SSC in Colombo. The virtual exchange concept is found in many exchanges. Figure 8-4-2 shows the concept.

TSC Galle is of type NEAX-61 with a capacity of approximately 1,200 inter-exchange circuits and 1,030 working circuits. TSC Kandy is of type NEAX-61 with a capacity of approximately 2,000 inter-exchange circuits and 1,776 working circuits. TSC Anuradhapura is of type NEAX-61 with a capacity of 1,200 inter-exchange circuits and 713 working circuits.

(4) Secondary Switching Centre and Local Exchange

There are 28 Secondary Switching Centres (SSC) in SLT network. However, the secondary switching centre function of Kandy, Galle and Anuradhapura is assumed by tertiary switching centre. The secondary switching centre in those cities are virtual. There is no separate hardware for them. The secondary switching centres assume the role of local exchange at the same time except a few centres. Such local exchanges are virtual too. See Figure 8-4-2.

The secondary switching centre consists of one or two units of switching system.



Source: JICA Study team

Figure 8-4-2
Switching Hardware and Hierarchical Function

SLT has a total of 284 telephone exchanges or nodes with subscriber line access in the country including three radio multi-access systems. The exchange capacity is 237,466 lines and 180,724 lines are in use as of December 1994. Among them 160 exchanges are digital which supply approximately 156,000 subscriber lines. Table 8-4-1 shows the exchange capacity and working lines by SSC area and Table 8-4-2 shows the exchange facilities and working lines by exchange type.

Table 8-4-1 Exchange Capacity and Working Lines by SSC

SSC	Equipped Switch capacity	Number of DELs
Ampara	500	475
Anuradhapura	3,858	2,751
Awissawella	2,640	1,821
Badulla	3,586	3,208
Bandarawela	2,340	1,815
Batticaloa	1,700	1,629
Chilaw	2,865	1,771
Colombo	159,141	124,032
Galle	5,095	3,393
Gampaha	2,774	2,114
Hambantota	4,326	2,793
Hatton	962	803
Jaffna	0	0
Kalmune	900	900
Kalutara	6,124	4,562
Kandy	11,771	8,421
Kegalle	3,084	1,947
Kurunegala	4,742	3,793
Mannar	600	124
Matale	2,731	2,104
Matara	2,115	1,830
Nawalapitiya	420	329
Negombo	5,896	3,461
Nuwera Eliya	2,848	1,860
Polonnaruwa	1,070	747
Ratnapura	3,856	2,634
Trincomalee	922	824
Vavuniya	600	583
Total	237,466	180,724

Source: SLT.

Table 8-4-2 Exchange Facilities and Working Lines by Exchange Type

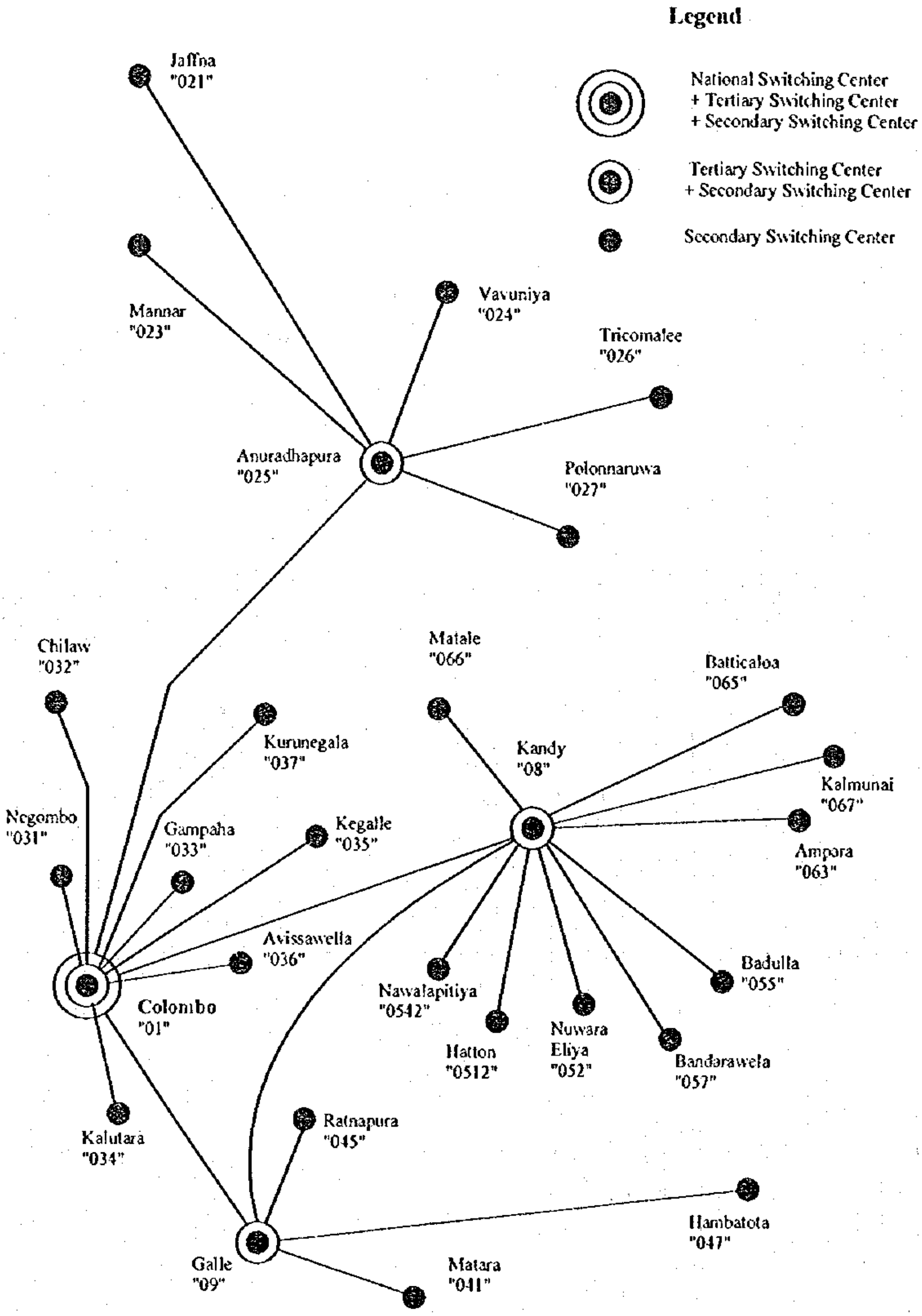
Exchange Type		Model	Exchange Capactiy	No. of DEL	No. of Exchanges	Remarks
Automatic	Digital	5-ESS	24,500	19,285	2	
		AXE-10	5,000	4,973	1	
		DX-200	2,372	1,866	5	
		DX-210	640	605	1	
		E10-B	92,838	73,155	8	
		HDX-10	300	261	1	
		NEAX-61	8,876	6,068	6	
		NEAX-61E	3,471	766	4	
		NEAX-61K	10,037	7,322	8	
		NEAX-61VSE	1,726	1,476	3	
		RSU	54,443	40,373	119	RSU of digital exchnage.
	Analogue	C23	10,776	8,004	18	
		ERS	800	406	4	
		NC400	12,000	8,744	1	
		NC460	6,900	5,597	7	
		PABX	96	61	1	
		SXS	2,062	1,239	33	
Manual		20S	20	19	1	
		CBS	134	103	23	
		MAG	125	88	23	
		MILT64	120	59	2	
Subscriber line extension system			230	254	12	Radio and cables.
Total			237,466	180,724	283	

Note: DEL: Direct Exchange Lines; RSU: Remote Switch Unit.

Source: SLT.

4.1.3 Inter-exchange Network Configuration

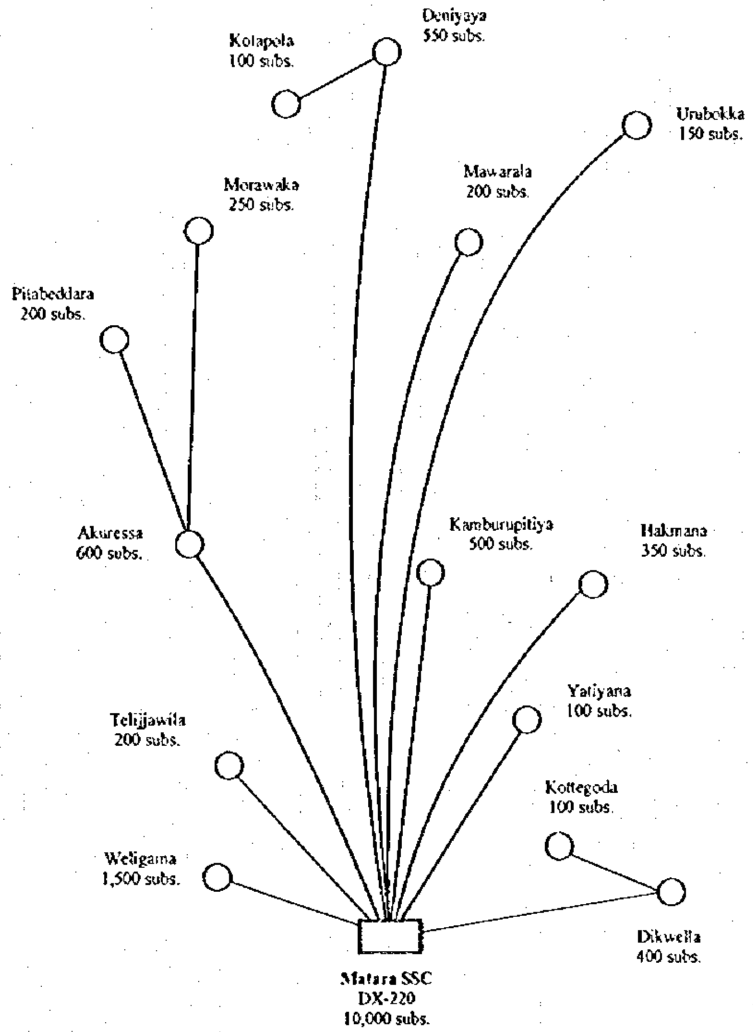
SLT trunk network is a multiple-stage star type network basically. Tertiary Switching Centres are linked to National Switching Centre on one hand, having direct links between them except Anuradhapura Tertiary Switching Centre on the other. Secondary Switching Centre traffic is connected through Tertiary Switching Centres. Figure 8-4-3 shows the existing trunk network configuration or inter-exchange link structure.



Source: SLT.

Figure 8-4-3 Existing Telephone Network Structure

Links between a Secondary Switching Centre and local exchanges under the former is made up in a star type. The host-remote system is a typical technology to make junctions under digital SSC in SLT network. SLT is replacing all analogue exchanges with digital ones under on-going projects, which will complete in 1997, and the most of the junction networks under SSC will be set up applying the host-remote technology. Figure 8-4-4 shows a typical inter-exchange network configuration introduced in Matara SSC.

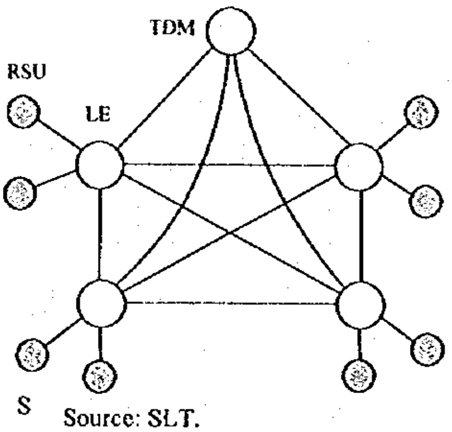


Source: SLT.

Figure 8-4-4 Network Configuration in Matara SSC

Many cities have only one exchange and a few cities have two or three exchanges. In the cities where two or three units of switching system are introduced, the switching systems are collocated at a same premises. Accordingly, local inter-exchange network is composed of only the link connecting them each other.

The national capital, Colombo, is the city with many local exchanges (LE). There are 10 main exchanges and 19 remote switch units (RSU) in Colombo SSC area. Among the main exchanges, only one exchange, Mount Lavinia, is analogue. The rest are digital. The network type of the national capital is of mesh type at the LE main exchange level and star type at remote switch unit level. See Figure 8-4-5.

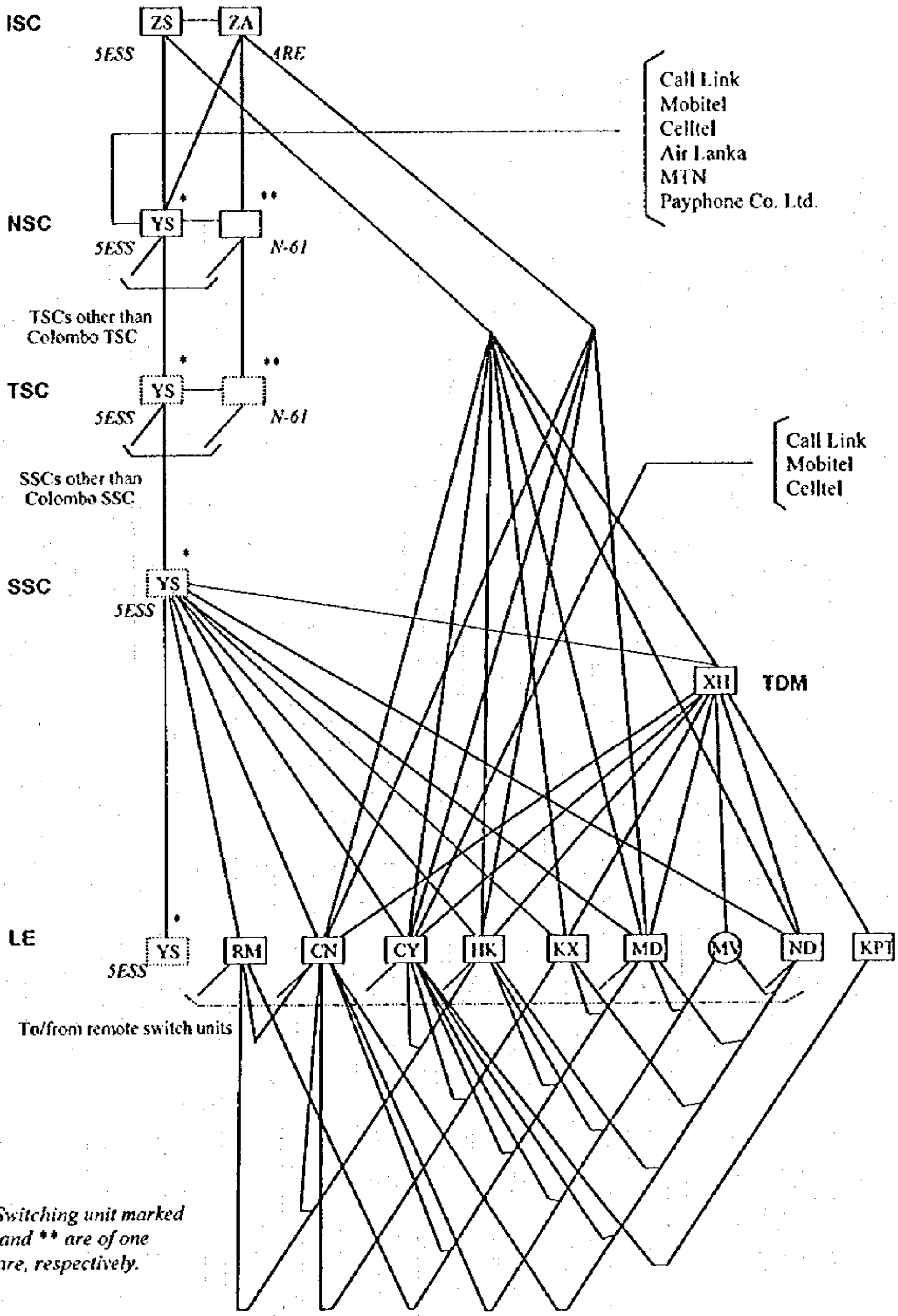


Source: SLT.

Figure 8-4-5
Network Type of Colombo

Figure 8-4-6 shows the existing inter-exchange dire exchanges in Colombo SSC area and Figure 8-4-7 shows the relation between the LE main (host) exchanges and remote switch units. Among the 19 RSUs, Chilaw, Marawilla and Madampe in Chilaw SSC area, Gampaha in Gampaha SSC area, and Panadura in Kalutara SSC area are of temporary connection.

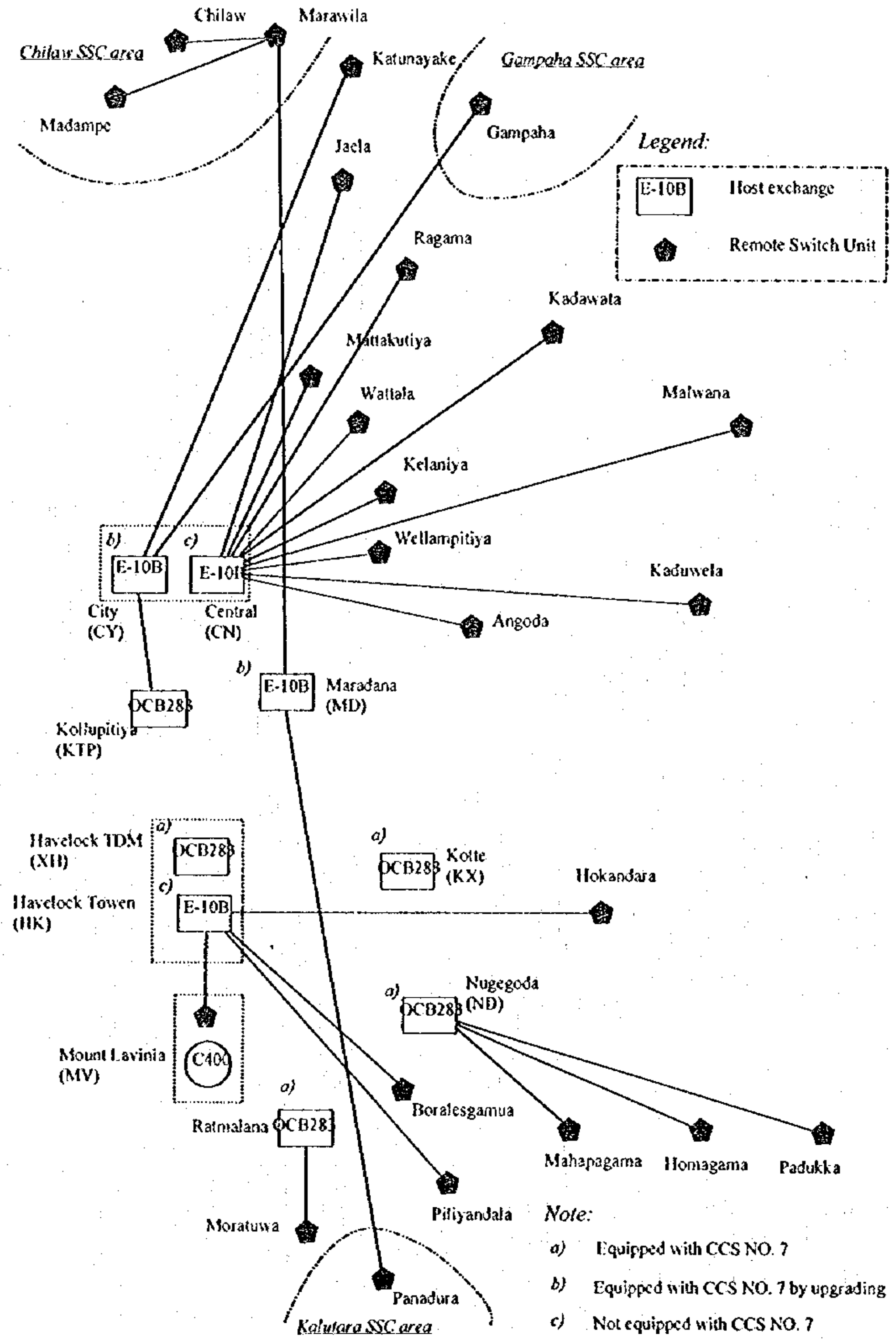
Cellular networks and Payphone Co. Ltd. private network are inter-connected with SLT network through National Switching Centre (5-ESS) and City (E-10B). Air Lanka private network makes use of the SLT network for providing their closed network.



*Note: Switching unit marked with * and ** are of one hardware, respectively.*

Source: SLT.

Figure 8-4-6 Existing Inter-exchange Direct and Basic Route Links of Main Exchanges in Colombo SSC



Source: SLT.

Figure 8-4-7 Relation between Main (host) Exchanges and Remote Switch Units

4.2 New Switching Network

4.2.1 Telephone Network Hierarchy

The existing hierarchical configuration of telephone network of SLT comprises such five levels as ISC, NSC, TSC SSC and local exchanges. See Figure 8-4-1. JICA recommends SLT to make a certain modification to the existing telephone network in relation to the function of NSC and the concept for providing links between exchanges so that the SLT network can meet new requirements in coming years.

The first modification is related to the function of NSC. The existing NSC is the trunk traffic transit point among TSCs and international traffic to ISC, as well as being the gate switch to other networks. The NSC is planned to have another role to provide advanced services in ISDN era as the gate switch to Intelligent Network (IN) system from conventional exchanges without ISUP function for the time being. The NSC's share of inter-connection traffic between TSCs will be reduced as TSCs will be enforced as stated below.

The second modification is related to network configuration. Recent digital technology has lowered the cost of links between exchanges and, thanks to it, the exchanges can be linked directly or in a mesh network. Direct connection of exchanges will result in an economical network as it reduces switching stages.

TSCs will be linked in a complete mesh network as traffic density is estimated sufficient to establish direct links between them. Anurahapura TSC, which has no links with other exchanges than Colombo TSC in present network, will have links with all other TSCs.

SSCs will have direct links each other where the traffic is estimated as big as the traffic capacity of one 2MHz-channel or more between them. The SSCs are planned to have more direct links than they have at present.

The thrid modification is related to the transfer of signalling system from R2 (D) or TUP Plus of CIT Alcatel to ISUP of ITU-T. In Colombo area, local exchanges (LEs) have direct links running with R2 (D) or TUP Plus between them in many cases and Havelock Tandem (TDM) supports them by means of links connected to all the local exchanges. Such existing network configuration is planned to remain unchanged. However, since they are running with R2 (D) or TUP Plus, they have to be inter-connected to new exchanges equipped with only CCS ISUP through a tandem switch. That is, introduction of a new TDM which can be compatible with TUP Plus, R2 (D) and ISUP is essential.

All the new exchanges to be purchased under this Master Plan are planned to be equipped with CCS ISUP of ITU-T specifications. SSCs in Colombo area are planned to be equipped with both CCS TUP and ISUP so that they can establish direct links with the existing and new exchanges.

Network configuration in areas other than Colombo will remain unchanged basically. Other local exchanges in areas other than Colombo are remote switch units placed under a host exchange which, in many cases, performs SSC function. In some SSC areas, however, there are main (or stand alone) exchanges which perfoms only LE funciton.

4.2.2 Introduction of New Exchanges

(1) ISC and TSC

JICA recommends SLT to introduce new exchanges for decentralising ISC and Colombo TSC function. ISC, NSC and TSC Colombo are all situated in the SLT Headquarters, performing the most important role in SLT network. Therefore, as a part of steps providing highly secured telecommunications network, a new ISC and a new TSC should be introduced in an adequate city other than Colombo.

Negombo has been discussed in SLT as one of the candidates where to land submarine cables in future because of geographical advantages. JICA agrees with the idea to have an alternative landing point of submarine cables in Negombo and recommends to make it a supplementary international access point with a new ISC and a new TSC in case the international access point in Colombo fails. In this case, the new TSC in Negombo shall be a supplementary centre of TSC Colombo working in parallel.

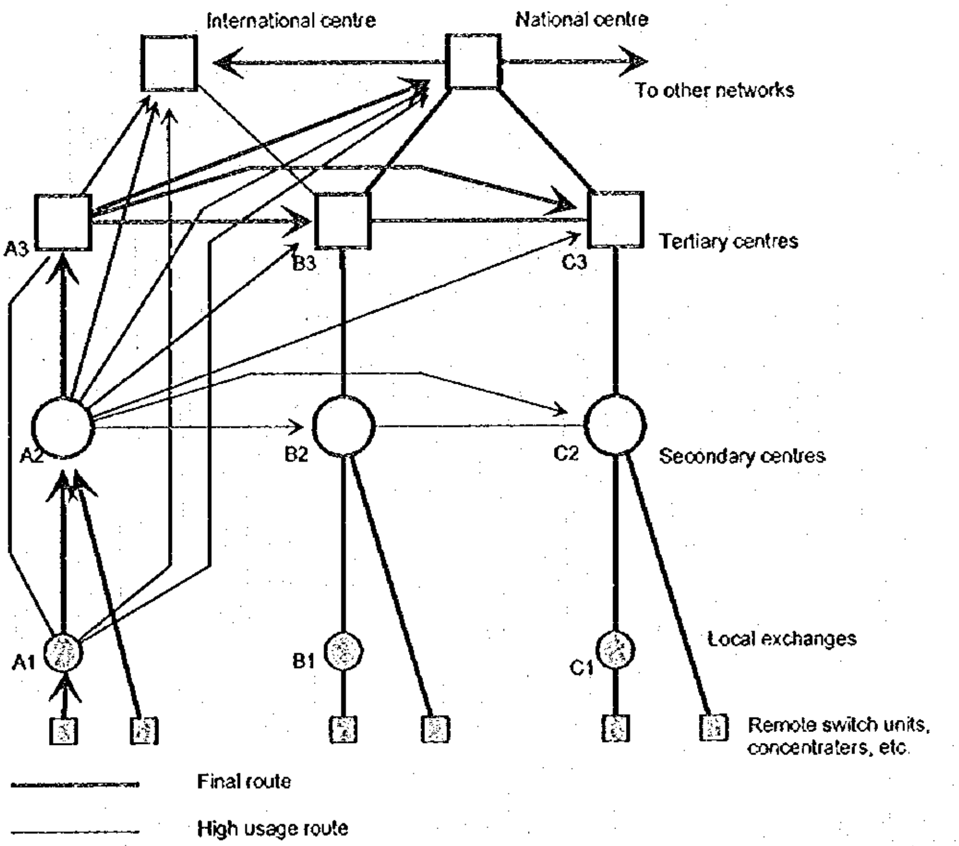
(2) Traffic concentration points of no-telephone villages

JICA recommends SLT to introduce some new telephone traffic concentration points in addition to those SLT has planned up to March 1995. This recommend aims to minimise the number of towns where divisional secretariat centre (a governmental organisation) is situated without telephone service. 72 towns will be integrated into telephone service network. They will be provided with RSU or connected to the nearest SSC by wireless loops where their traffic is estimated low.

4.2.3 Routing Plan

(1) General

JICA recommends SLT to go on with the present routing scheme of far-to-near rotation, wherein a short-cut link is selected primarily, if available, before catching final rout link. Figure 8-4-8 shows the routing scheme. It should be noted that all the short-cut links are not provided for all exchanges.



Note 1: For simplicity, only traffic from A abranch destined for B, C branches, other networks and international switching centre is presented.

Note 2: Tertiary centres are mesh connected.

Note 3: Levels are shown separately but two or more may be combined in one exchange hardware/building.

Source: ITU.

Figure 8-4-8 Routing Principle

(2) International call traffic

An international call originated at a local exchange will be proceeded to ISC through SSC, TSC and NSC if all preceding short-cut links are not available.

(3) Trunk call traffic

A trunk call originated at a local exchange will be proceeded to its destined local exchange establishing a link of SSC-TSC-NSC-TSC-SSC, if all preceding short-cut links are not available.

(4) Local call traffic

A local call originated at a local exchange where two or more exchanges are situated, in areas other than Colombo, will be proceeded through direct link between local exchanges.

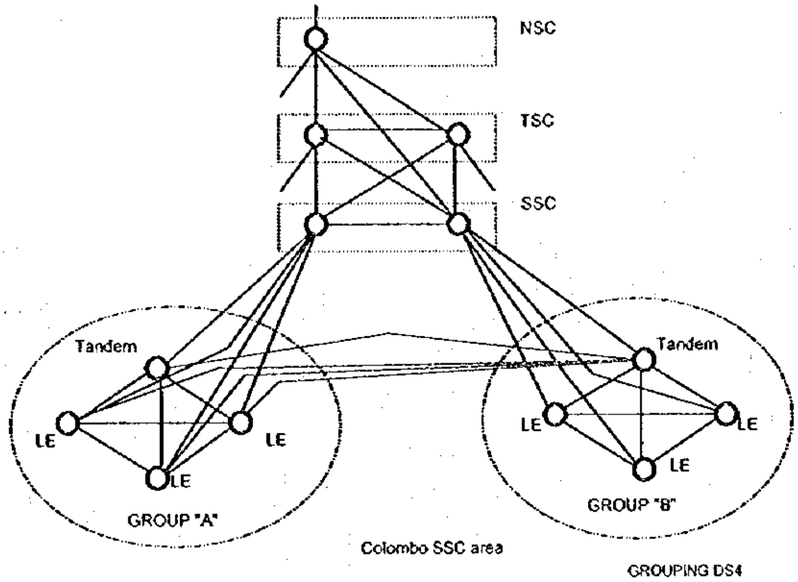
A local call originated at a local exchange in Colombo area will be proceeded through a direct link between local exchanges in principle. However, a local call originated at a local exchange with signalling system TUP plus by CIT-Alcatel or R2(D) of ITU-T and destined to a exchange which runs under signalling system ITU-T ISUP will be proceeded through tandem exchange. Figure 8-4-9 shows an example to group exchanges into two categories.

(5) International operator call traffic

All calls to ISC operator position will be concentrated to ISC. ISC operator positions will be situated in Colombo ISC and Negombo ISC. Those two ISCs should work in parallel to share the international operator assistance call traffic.

(6) National operator call traffic

Calls to national operator including trunk bookings, telephone directory inquiries and phonograms should be concentrated to operator positions of Galle TSC, Kandy TSC, Anuradhapura TSC and NSC. For the night, all the national operator calls should be concentrated to NSC.



Note:
a) GROUP "A": Exchnages with signalling R2(D) and TUP Plus.
b) GROUP "B": Exchnages with signalling CCITT ISUP.
c) High usage links of Local Exchnage (LE) are not indicated.
Virtual exchange.

Source: JICA Study team.

Figure 8-4-9 Exchange Grouping in Colombo Area

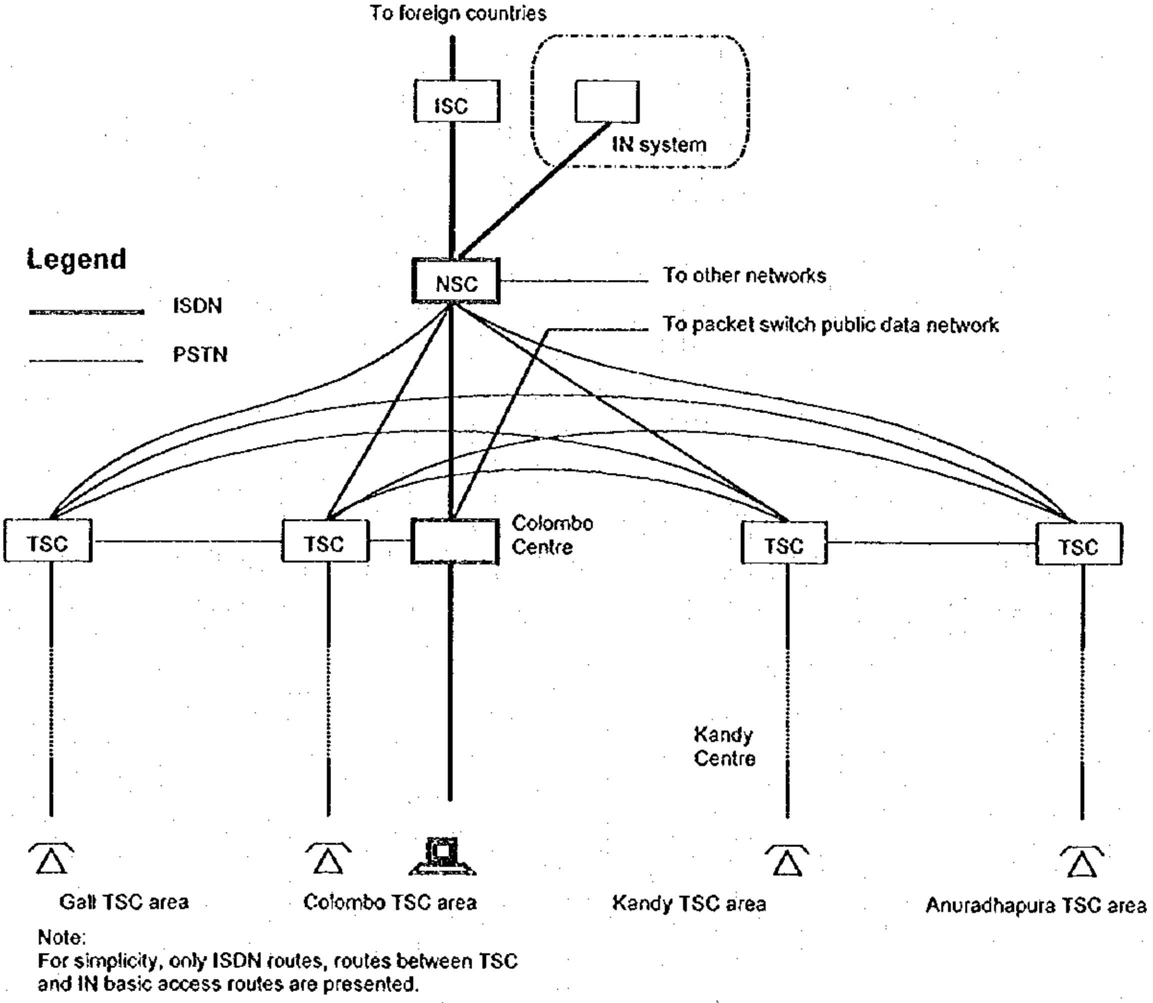
(7) Inter-network call traffic

Inter-network calls will be proceeded through NSC, i.e., SLT network will be inter-connected with mobile networks, paging networks, etc. through NSC in Colombo.

4.2.4 ISDN and IN Expansion

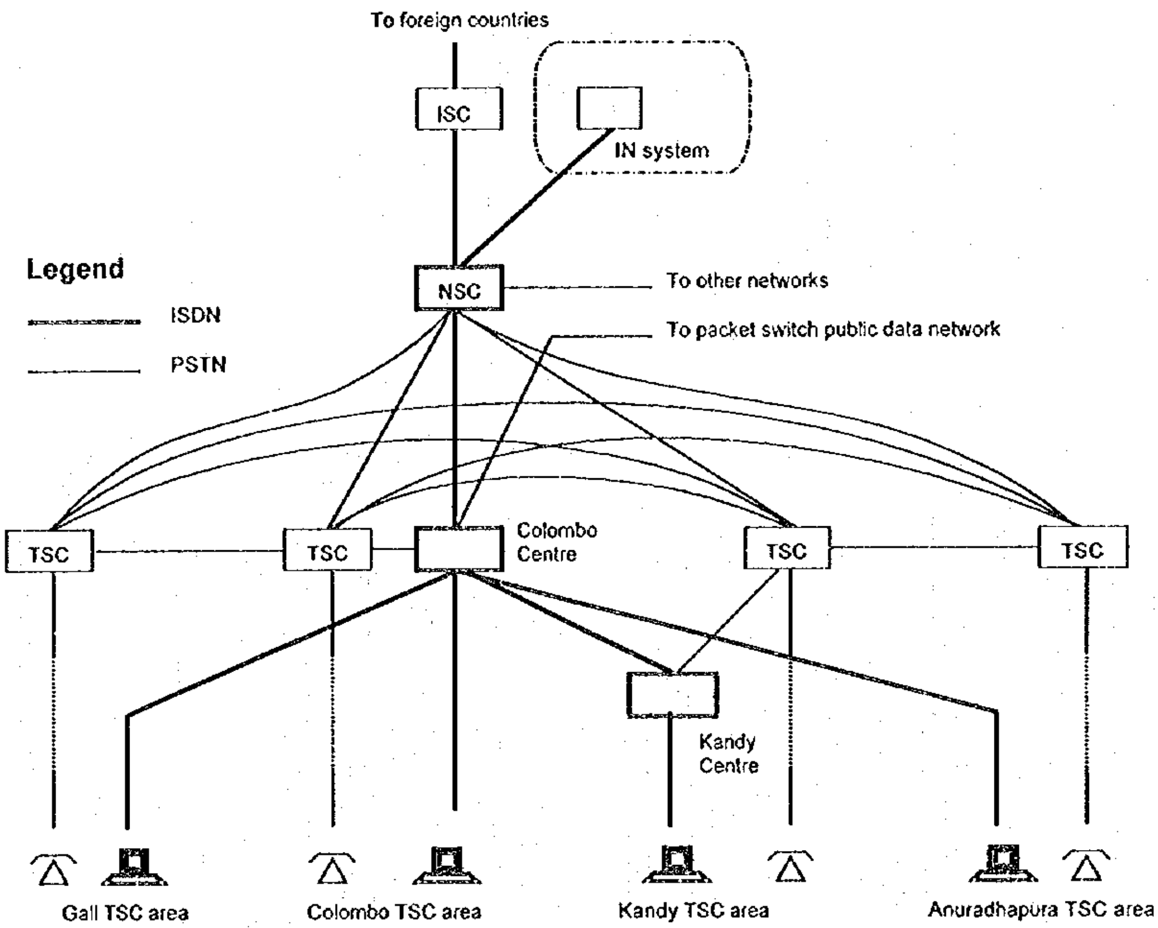
ISDN traffic will be processed by Colombo ISDN Centre which will be introduced by the year 2000. Another ISDN Centres will be introduced in Kandy by the year 2005 and in Galle and Anuradhapura by 2015, if enough demand is found.

IN traffic will be originated from exchanges in normal telephone network as well as ISDN Centres. The IN traffic of normal exchange will be routed through SSC, TSC and NSC, which will become a gate switch to IN layer, from Local Exchanges. ISDN Centre will have a direct access to NSC. Figure 8-4-9 to Figure 8-4-11 show proposed growth of ISDN in Sri Lanka.



Source: JICA Study Team.

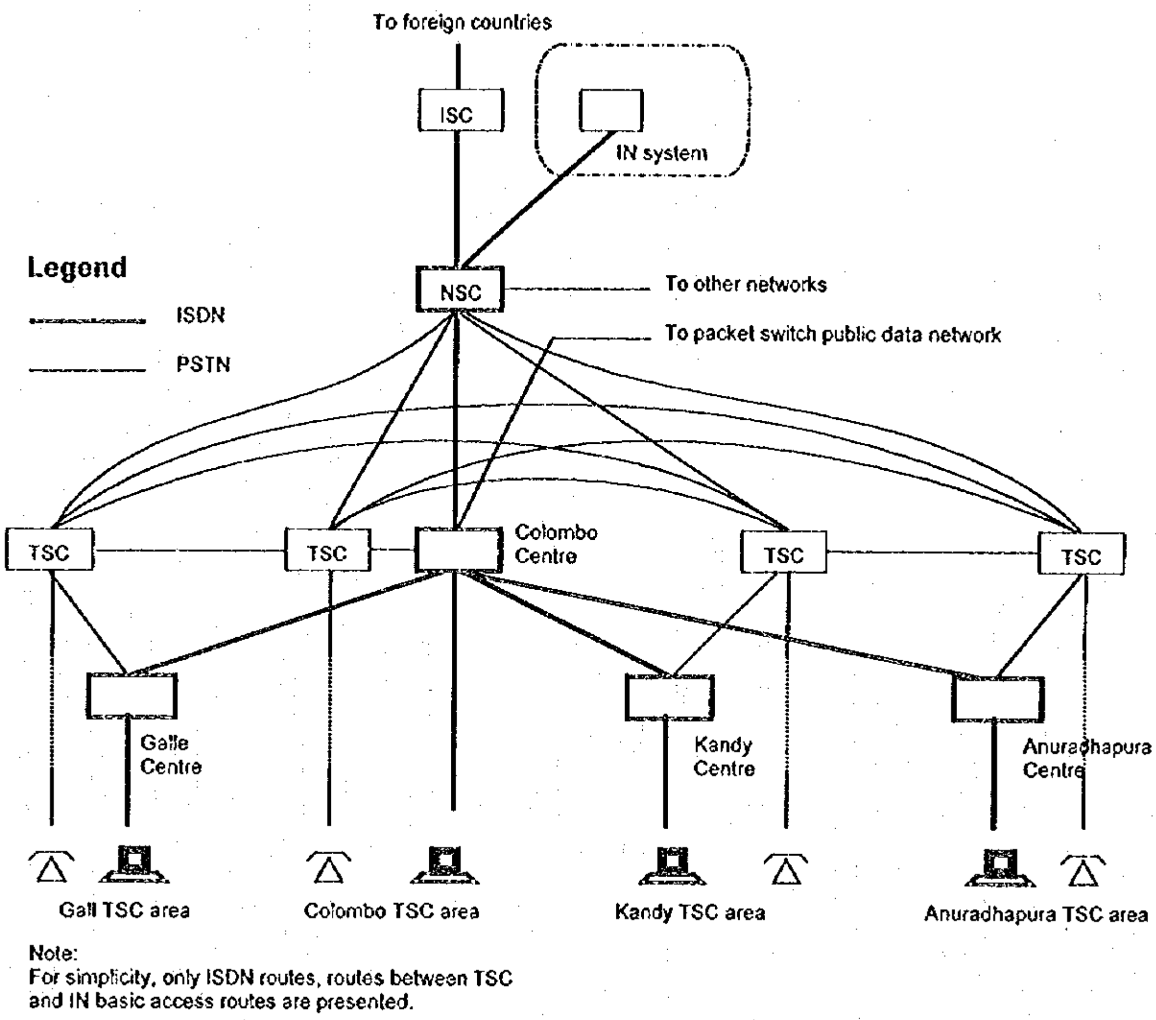
Figure 8-4-10 ISDN and IN by the year 2000



Note:
For simplicity, only ISDN routes, routes between TSC and IN basic access routes are presented.

Source: JICA Study team.

Figure 8-4-11 ISDN and IN by the year 2005



Source: JICA Study team.

Figure 8-4-12 ISDN and IN by the year 2015

5. Telephone Traffic Forecast and Circuit Calculation for Trunk Network

Traffic forecast is made for dimensioning of the future target network consisting of both switching network and transmission network. Traffic is measured between each two exchanges and decided objectively, so the volume is treated as the measure of the call volume between two exchanges and it will decide the suitable transmission capacity of the section. Originating and terminating traffic volume between exchanges areas depends on the number of subscribers in the areas and strength of socio-economical relation between the areas.

Traffic and circuit calculation have done for estimate of required facilities. Facilities provision will be done for covering the following 5 years traffic at least. So, for estimate facilities up to 2000, 2005 and 2015, the target years of traffic and circuit calculation are 2005, 2010 and 2020 for sections between SSC areas, and 2005 and 2010 for sections within SSC areas, International sections and Colombo multi-exchange area. Calculated results of traffic and circuit are shown in Supporting.

5.1 Traffic per Subscriber for Planning

For the purpose of planning, the following originating traffic per subscriber and traffic distribution ratio are applied by area category:

a) Originating Traffic

1. Colombo Multi-Exchange Area		0.08 Erlang/subs.
2. Other areas	1 - 2,000 subs.	0.065 Erlang/subs.
3. Other areas	2,001 - 5,000 subs.	0.055 Erlang/subs.
4. Other areas	5,001 subs. -	0.045 Erlang/subs.

b) Traffic Distribution Ratio

Outgoing traffic distribution ratio is assumed to be as Table 8-5-1 below. Incoming traffic is assumed to be same to Outgoing traffic except Other N/W and International traffic. Double of Outgoing traffic is assumed to be Incoming traffic for Other N/W and International traffic referring to present traffic status.

Table 8-5-1 Traffic Distribution Ratio

	Intra-Office	Local/SSC	STD	Other N/W	International	Special No.	Total
Colombo Multi-Exchange Area	12%	63%	20%	2%	2%	1%	100%
Other Areas	12%	20%	65%	1%	1%	1%	100%

Note: Values in Local/SSC columns means local traffic for Colombo multi-exchange area and traffic within SSC for Other areas.

Source: SLT

c) Path for the traffic flow is assumed that trunk link between each SSC is by mesh configuration network, and SSC-LE link is by star configuration network (final route only).

5.2 Calculation Condition for Sections between SSC Areas

Traffic for the exchange sections between SSCs are calculated by applying Gravity model or the methodology presented in General Network Planning, GAS-3, ITU-T.

(1) Traffic Distribution

The following calculation conditions are considered:

a) Outgoing traffic by exchange
b) Crow flight distance between exchanges
c) Community factor

(2) The number of Circuits between Exchanges

The number of circuits between SSCs is calculated based on the following factors:

a) Distributed traffic matrix
b) Cost ratio

c) Traffic routing condition

(3) Planning Conditions

The followings are applied planning conditions;

1. Digital Modularity	:	30 ch
2. Grade of Service Criterion	:	0.01
3. Additional Trunk Capacity	:	0.83 erl.
4. Lower Routing Method Threshold	:	20.00 erl.
5. Higher Routing Method Threshold	:	100.00 erl.

After obtaining the circuit matrices for voice, leased circuits and N-ISDN circuits were distributed based on the proportion of voice circuits. Number of required circuits in 2000 is shown in Table 8-5-2. These numbers of circuits will cover the traffic exchange for the sections between SSC areas up to 2005. Other data is in Supporting.

5.3 Calculation Condition for Sections within SSC Areas

Traffic and circuit calculation for the exchange sections within each SSC area are made based on traffic distribution ratios from a subscriber.

5.4 Calculation Conditions for International Sections

Traffic for international sections are calculated in above '5.3 Calculation Condition for Sections within SSC Areas.' Traffic distribution to countries is made based on the present traffic distribution ratio. Number of circuits by destination country is shown in Table 8-5-3.

Table 8-5-2 Number of Required Circuits between SSCs in Year 2000

DISTRIBUTION OF WHOLE CIRCUITS (VOICE, LEASED AND N-ISDN)
(Y-2000)

Base Demand Data is of Year 2005

(64KBPS UNIT) BETWEEN		1 AW	2 CO	3 CW	4 GQ	5 KE	6 KG	7 KT	8 NE	9 ANU	10 JA	11 MR	12 PR	13 TC	14 VU	15 GL	16 HB	17 MH	18 RN	19 AP	20 BC	21 BD	22 BW	23 HT	24 KL	25 KY	26 MT	27 NT	28 NW	29 XC	30 XA	31 XG	32 XK	33 YY	34 ZZ	TOTAL
1 Awissawella	AW		690																											420			30			1140
2 Colombo	CO	690		690	2400	750	1350	2010	1710	600	1530	120	360	360	300	1260	690	1050	780	210	570	570	390	180	510	2490	420	120	360	780				2820	2820	28890
3 Chilaw	CW		690																											360	60	30	60			1200
4 Gampaha	GQ		2400				90	60	90		90					90										150				540	60	30	60	90	60	3810
5 Kegalle	KE		750				60																			90				330	60	60	60	30		1440
6 Kurunegala	KG		1350		90	60		90	90		90					60		60								180				360	60	30	150	30	30	2730
7 Kalutara	KT		2010		60		90		90		90					90	60	90								120				360	60	60	120	30	30	3360
8 Negombo	NE		1710		90		90	90			90															90				420	30	60	30	30	60	2790
9 Anuradhapura	ANU		600								90															90					450		30			1260
10 Jaffna	JA		1530		90		90	90	90	90						90		90								150					570		60	60	30	3030
11 Mannar	MR		120																												330					450
12 Polonnaruwa	PR		360																											30	300		60			750
13 Trincomalee	TC		360																												390		60			810
14 Vavuniya	VU		300																												360		30			690
15 Galle	GL		1260		90		60	90			90							90								120					30	510	30	30	30	2430
16 Hambantota	HB		690					60										60								90				30	60	420	60			1470
17 Matara	MH		1050				60	90			90					90	60		60							90				60	60	420	30	30	30	2220
18 Ratnapura	RN		780															60								90				120	60	270	60	30	30	1500
19 Ampara	AP		210																											30			330			570
20 Batticaloa	BC		570																						60	90					60		450			1230
21 Badulla	BD		570																							90				30		60	420			1170
22 Bandarawela	BW		390																											30		30	390			840
23 Hatton	HT		180																											60			270			510
24 Kalmunai	KL		510																		60					90				30	60	60	360			1170
25 Kandy	KY		2490		150	90	180	120	90	90	150					120	90	90	90		90	90			90		90			30			660	90	90	4980
26 Matale	MT		420																							90							450			960
27 Nawalapitiya	NT		120																											30			300			450
28 Nuwara Eliya	NW		360																														390			750
29 Colombo TSC	XC	420	780	360	540	330	360	360	420				30				30	60	120	30		30	30	60	30	30		30			240	150	270	150	180	5040
30 Anuradhapura TSC	XA			60	60	60	60	60	30	450	570	330	300	390	360	30	60	60	60		60				60					240		90	180	150	60	3780
31 Galle TSC	XG			30	30	60	30	60	60							510	420	420	270			60	30		60					150	90		180	120	60	2640
32 Kandy TSC	XK	30		60	60	60	150	120	30	30	60		60	60	30	30	60	30	60	330	450	420	390	270	360	660	450	300	390	270	180	180		180	120	5880
33 NSC	YY		2820		90	30	30	30	30		60					30		30	30							90				150	150	120	180		90	3960
34 IBC	ZZ		2820		60		30	30	60		30					30		30	30							90				180	60	60	120	90		3720
																																				48810

Source: SLT

Table 8-5-3 Required International Circuits

No.	ROUTE	Incoming Traffic (%)	Outgoing Traffic (%)	Y-2000 Incoming (Ccts.)	Y-2000 Outgoing (Ccts.)	Y-2005 Incoming (Ccts.)	Y-2005 Outgoing (Ccts.)	Y-2015 Incoming (Ccts.)	Y-2015 Outgoing (Ccts.)
1	AUSTRALIA (TELST)	4.25%	5.63%	113	79	148	102	219	150
2	AUSTRALIA (OPTUS)	2.18%	0.19%	63	7	81	8	119	10
3	BANGLADESH	0.25%	0.35%	12	10	15	12	20	16
4	CANADA	12.02%	1.06%	295	20	390	25	586	35
5	FRANCE	1.30%	1.42%	41	25	52	32	75	45
6	GERMANY	2.99%	2.17%	83	35	107	45	158	64
7	HONGKONG	4.17%	6.14%	111	85	145	110	215	162
8	INDIA -ND	1.39%	2.10%	43	34	55	44	80	63
9	INDIA -B	4.25%	3.26%	113	49	148	63	219	92
10	INDIA -M	1.48%	6.89%	45	94	58	122	84	180
11	INDONESIA	0.32%	0.88%	14	18	18	22	24	31
12	ITALY	3.72%	2.26%	100	36	131	46	193	66
13	JAPAN (IDC)	1.17%	0.55%	38	13	48	16	69	21
14	JAPAN (ITJ)	1.35%	0.54%	42	13	54	16	77	21
15	JAPAN (KDD)	5.23%	3.54%	136	53	179	68	266	98
16	SINGAPORE	6.43%	16.41%	165	206	216	272	322	406
17	SWITZERLAND	6.07%	1.44%	156	26	205	32	305	45
18	TAIWAN TAIPEI	0.11%	1.04%	7	20	9	25	11	35
19	TAIWAN KAOSIUNG	0.11%	0.31%	8	9	9	11	12	14
20	UAE	4.61%	2.33%	122	37	159	48	236	68
21	UK (BT)	16.34%	19.79%	394	245	522	324	787	486
22	UK (MERCURY)	5.02%	3.56%	131	53	172	68	256	99
23	USA (ATT)	5.35%	3.65%	139	54	182	70	271	101
24	USA (MCI)	3.38%	1.44%	92	26	120	32	177	45
25	AUSTRIA	0.01%	0.48%	3	12	3	14	4	19
26	BAHRAIN	0.96%	0.08%	32	5	41	5	58	6
27	BRUNEI	0.09%	0.19%	7	7	8	8	10	11
28	DJIBOUTI	0.03%	0.01%	4	2	5	3	6	3
29	EGYPT	0.01%	0.38%	3	10	3	12	4	16
30	KOREA -S	0.49%	1.63%	19	28	24	36	33	50
31	MALAYSIA	0.86%	1.24%	29	23	37	29	53	40
32	MALDIVES	0.72%	1.66%	26	29	32	36	46	51
33	NETHERLANDS	0.55%	1.48%	21	26	26	33	36	47
34	NEPAL	0.07%	0.20%	6	7	7	8	8	11
35	PAKISTAN	0.56%	2.76%	21	43	26	55	37	79
36	S. ARABIA	1.51%	2.18%	46	35	59	45	85	64
37	SPAIN	0.23%	0.29%	11	9	14	10	19	14
38	THAILAND	0.43%	0.49%	18	12	22	15	30	20
	TOTAL	100.00%	100.00%	2709	1495	3530	1922	5210	2784
	Cumulative International Traffic (E)			2257.2	1128.6	3032.4	1516.2	4643.2	2321.6

Source: SLT

6. Telephone Traffic Forecast and Circuit Calculation for Colombo Metropolitan Area

Colombo Metropolitan Area is treated as a multi-exchange area, and it consists of one (1) TSC exchange, one (1) tandem exchange and 28 local exchanges. There will be added two (2) exchanges more by the 150k project.

Traffic forest for this junction network will be done in a style of making traffic matrix of the exchange unit area based on the assumption of mesh configuration network. So, the methods of traffic forecast, distribution and circuit calculation are same to the method for the trunk network.

Planning conditions are as follows;

1. Digital Modularity : 30 ch
2. Grade of Service Criterion : 0.01
3. Additional Trunk Capacity : 0.75 erl.
4. Lower Routing Method Threshold : 20.00 erl.
5. Higher Routing Method Threshold: 100.00 erl.
6. Basic Routing Rule
   - Directly : allowed
   - Via Terminating Tandem : allowed
   - Via Originating Tandem : allowed
   - Via Both Tandems : allowed
7. Overflow Method Specification : multi stage

Existing local exchanges and newly constructed local exchanges up to year 1997 was assumed to belong to existing Havelock Tandem exchange and other new exchanges constructed after that was assumed to belong to new Colombo Tandem exchange. This division is based on the fitness to CCS No.7 signalling system. Existing and planned exchanges are considered to be not suit for the signalling system completely.

Traffic distribution matrices have been made for sections between each exchange unit. Traffic from/to RSU is combined to the traffic of the host exchange after that. Final route for local traffic within the area is via tandem exchanges. Calculated matrix of number of circuits in year 2005 is shown in Table 8-6-1, and other data is in Supporting.

Table 8-6-1 Number of Required Circuits in Colombo Metro Area in 2000

7. Transmission Network Plan

Microwave radio system and fibre optic cable system constitute the national backbone transmission network. For spur and junction links, UHF radio, cable PCM, and open wire transmission systems are used besides microwave radio and fibre optic cable systems. Digital transmission system has been introduced since early 1980s, and the digitalisation ratio (ratio of digitalised channel) of the trunk transmission network has reached to 87% in year 1994. On-going projects such as 2nd Telecommunications Project (Trunk Transmission Network) and Matara Telecommunication Development Project will achieve the almost fully digitalised nation-wide trunk transmission network.

7.1 Criteria for Transmission System Selection

There are some factors to be examined for the selection of the transmission system. Major examination points are as follows;

- Transmission capacity
- Construction period
- Construction cost
- Easiness of operation & maintenance (integration of O&M system, correspondence to TMN)
- Service quality (reliability)
- Expandability
- Staffing
- Limitations for the application such as natural resource (radio frequency), interference, terrestrial condition of the section and the permission for the road occupancy

Out of the above, the most considerable factor is the transmission capacity. Considering the demand for the capacity in future when the "wide bandwidth required" services such as video transmission and ISDN will be realised, the requirement for the larger transmission capacity will be risen.

Conventional transmission systems has been developed based on the Plesiochronous Digital Hierarchy (PDH) technology. 140 Mbit/s capacity was the maximum in PDH circumstance, but Synchronous Digital Hierarchy (SDH) technology has expanded the maximum transmission capacity to 2.5 Gbit/s and more.

Type of transmission system is categorised in cable PCM transmission system, microwave radio transmission system and fibre optic cable transmission system in general. Available transmission capacity for each system is summarised as shown in the following table.

Table 8-7-1 Available Transmission Capacity

	Transmission Capacity	Cable PCM	Microwave Radio	Fibre Optic Cable
PDH	2 Mbit/s	Available	Available	Available
	8 Mbit/s		Available	Available
	34 Mbit/s		Available	Available
	140 Mbit/s		Available	Available
SDH	STM1 (156 Mbit/s)		Available	Available
	STM4 (622 Mbit/s)			Available
	STM16 (2.5 Gbit/s)			Available

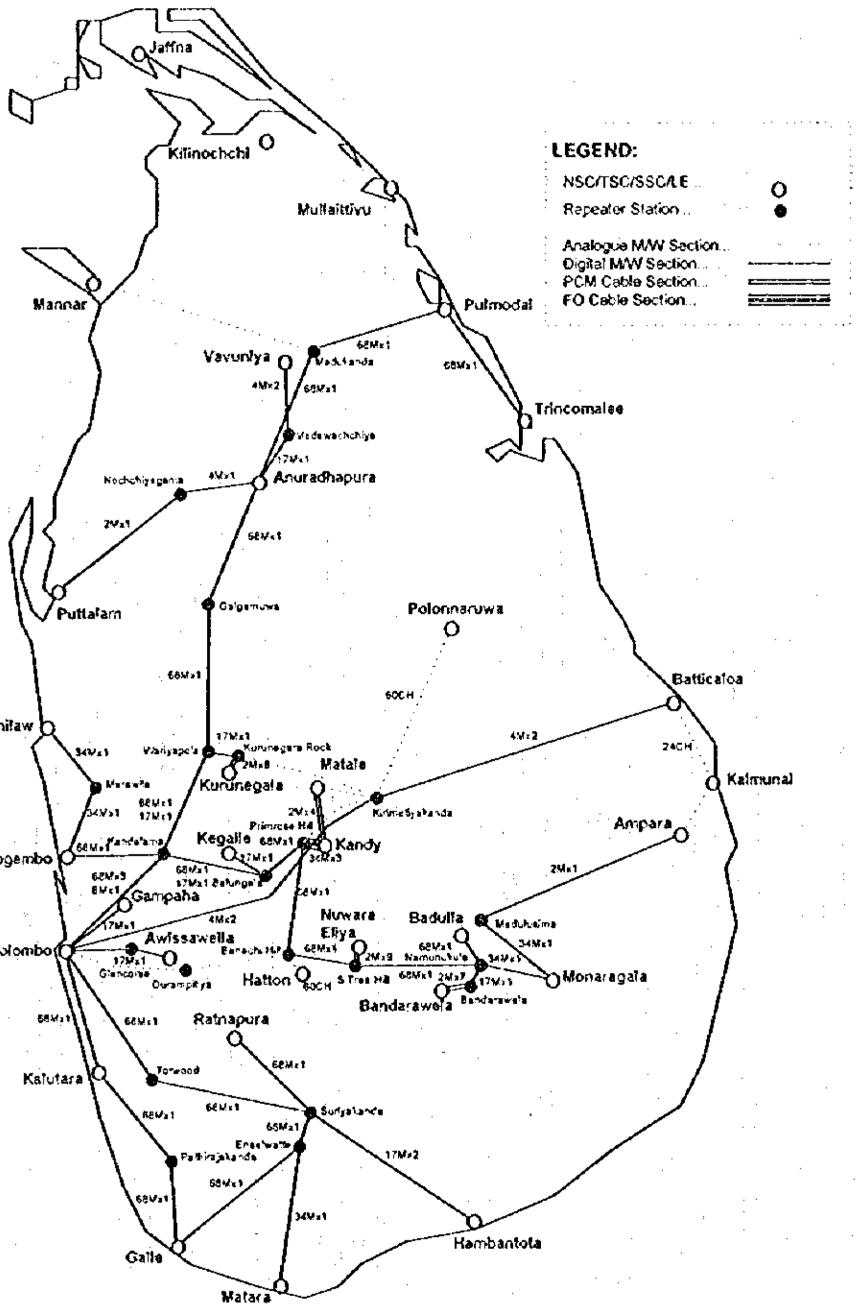
Source: JICA Study team

Large transmission capacities such as STM4 and STM16 are only available in fibre optic cable transmission system in general, even 10 Gbit/s capacity transmission is available in the system now. These developments have lowered the transmission cost per channel. So, future backbone transmission is expected to be dominant by fibre optic cable transmission system and supported by microwave radio system partly.

7.2 National Backbone System

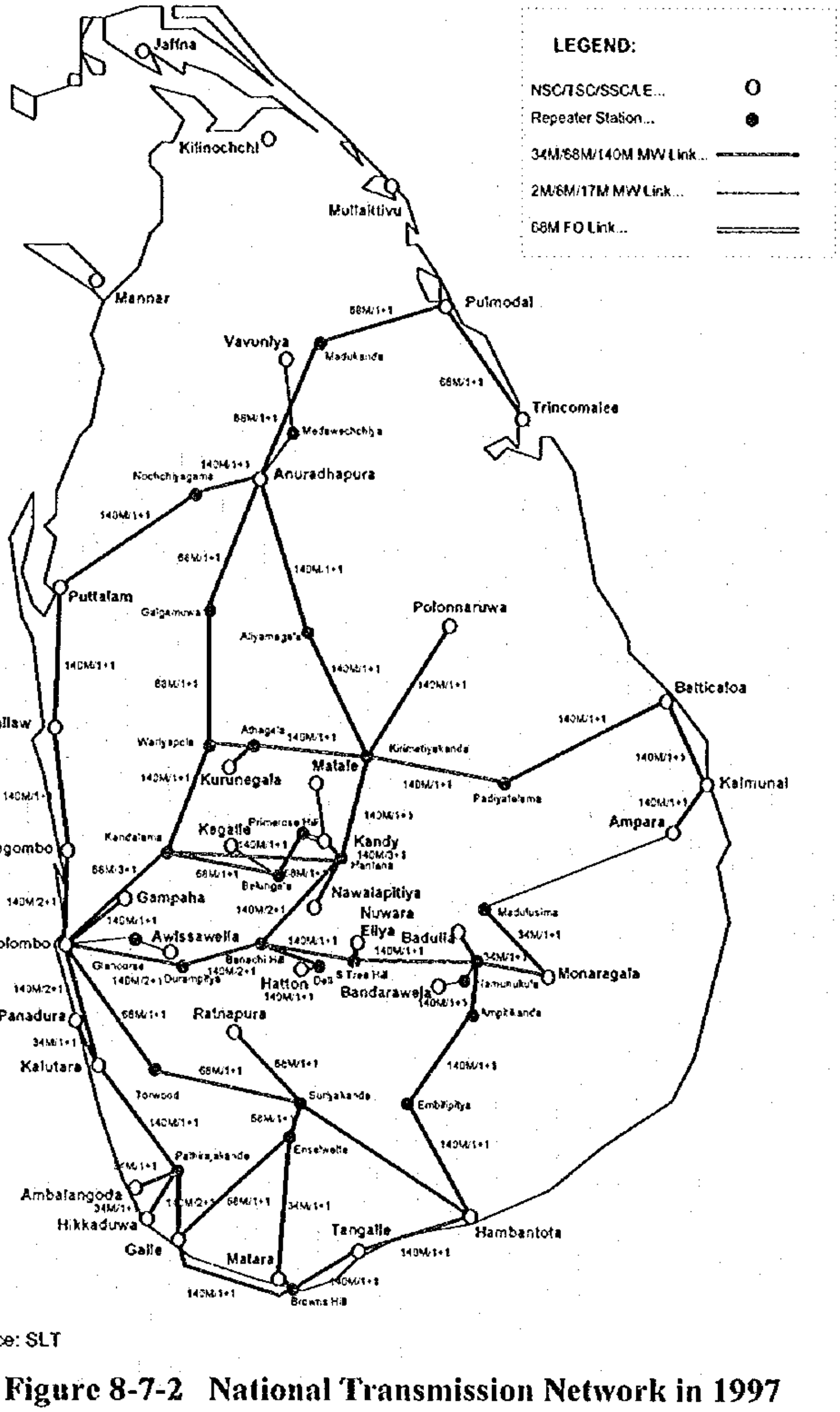
Colombo - Kandy link, Colombo - Anuradhapura link and Colombo - Galle link form the national backbone transmission system. New trunk backbone system with 140 Mbit/s capacity of microwave radio system (2nd Telecommunications Project) is under construction. Completion of this project will expand the transmission capacity and realise loop configuration of the national backbone transmission network. Further expansion of this new trunk backbone system is under planning. Existing national transmission network is shown in Figure 8-7-1, and network in year 1997 is shown in Figure 8-7-2. Summary tables of existing and on-going transmission link is attached in Data-book.

Up to present, microwave radio system has played main role in transmission network. Considering huge increase of the traffic volume in future because of subscribers increase and service enhancement, expansion of fibre optic cable system will be required. And conventional PDH (Presiochronous Digital Hierarchy) based system will be replaced with SDH (Synchronous Digital Hierarchy) based system gradually. So, the next target for the national transmission network will be the construction of SDH based fibre optic cable network. SDH ring network has self-healing function, and it will improve the network reliability. Microwave radio system will be alternative system to fibre optic cable system at that time.



Source: SLT

Figure 8-7-1 National Transmission Network as of May, 1995



Source: SLT

Figure 8-7-2 National Transmission Network in 1997

7.3 Local Transmission Network

Local Transmission Network means the within SSC area network consisting of each SSC - LE links. Which are by open wire carrier, radio, fibre optic cable and cable PCM transmission system. Recent cost deterioration of fibre optic cable system will strengthen the utilisation of the system for even small capacity local transmission network.

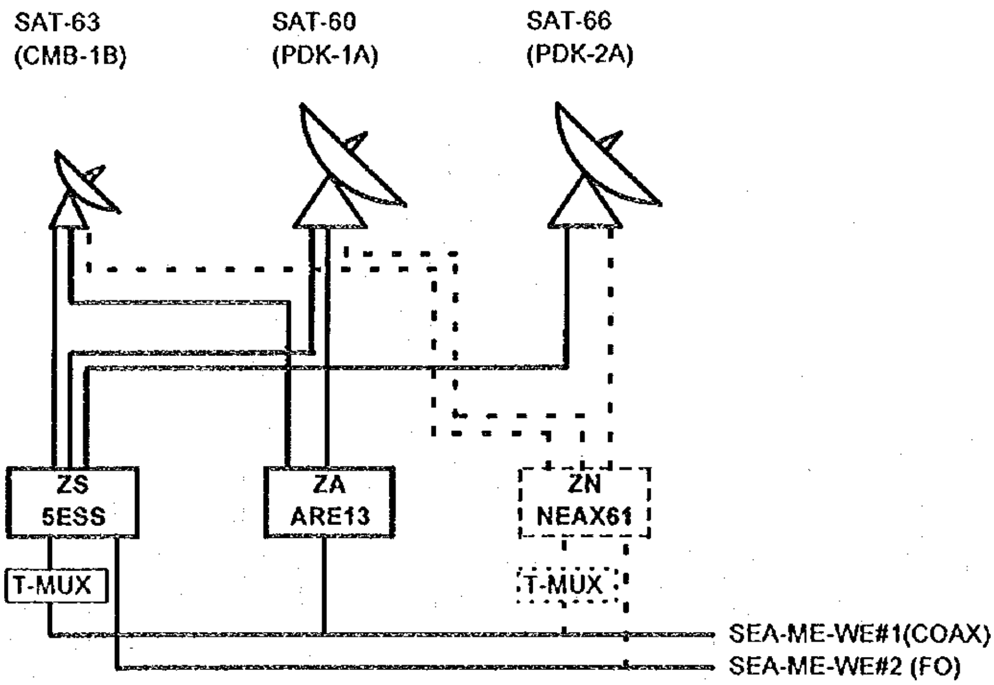
Local transmission network in Matara SSC area was digitalised in 1995. Several link will be also digitalised under WB/Spur project and GCTNIP-II project in this year (1996). And 150k project, nation-wide telecommunications network expansion project expected to be completed in 1997, will improve local transmission network in quality, reliability and capacity. Summary table of on-going local transmission project is attached in Data-book.

7.4 International Trunk Transmission Network

There are five (5) international transmission systems at present, and carries international traffic to/from 37 destination international carrier companies. PDK-1A earth station (INTELSAT-A type) was commissioned in 1975 at Padukka, the outskirts of Colombo, and have been reformed several times up to now. PDK-1A handles FDM/FM and SCPC transmission. COL-1B earth station (INTELSAT-B type) at SLT headquarters was commissioned in 1990, and is equipped IDR transmission facilities. PDK-2A, latest earth station at Padukka, has just established recently. SEA-ME-WE#1 is a coaxial submarine cable system commissioned in 1985, and SEA-ME-WE#2 is a fibre optic submarine cable system commissioned in 1994. Both submarine cables are landed at Colombo. These system configuration is shown in Figure 8-7-3. Present number of circuits and traffic volume for each destination are shown in Table 8-7-2.

Formerly, a terrestrial microwave link between Sri Lanka and India through Mannar existed. But the link was out of order and abandoned.

SLT is planning construction of new international gateway station at the outskirts of Colombo. New standard-A earth station will be placed closely, and also submarine cable will be landed at the site in future. This project will give the greater site and route diversities for network security.



Note: ARE-13, analogue ISC, will be replaced with NEAX-61 within one year.

Source: SLT.

Figure 8-7-3 Configuration of International Telecommunications Network

Table 8-7-2 Number of International Circuits and Traffic as of April, 1995

	ISC1 (ARE13)			ISC2 (5ESS)			TOTAL		
ROUTE	Existing Ccts.	IC Traffic (Erlang)	OG Traffic (Erlang)	Existing Ccts.	IC Traffic (Erlang)	OG Traffic (Erlang)	Existing Ccts.	IC Traffic (Erlang)	OG Traffic (Erlang)
AUSTRALIA (TELST)	7	3.50	0.46	49	17.38	8.55	56	20.88	9.01
AUSTRALIA (OPTUS)	-	-	-	15	10.72	0.30	15	10.72	0.30
BANGLADESH	1	0.36	0.01	2	0.86	0.55	3	1.22	0.56
CANADA	-	-	-	74	59.11	1.69	74	59.11	1.69
FRANCE	3	0.00	0.05	10	6.41	2.22	13	6.41	2.27
GERMANY	-	-	-	20	14.69	3.47	20	14.69	3.47
HONGKONG	10	5.41	0.38	28	15.08	9.44	38	20.49	9.82
INDIA -ND	-	-	-	30	6.83	3.36	30	6.83	3.36
INDIA -B	3	1.07	0.00	45	19.83	5.22	48	20.90	5.22
INDIA -M	2	1.14	0.00	23	6.13	11.02	25	7.27	11.02
INDONESIA	4	0.61	1.41	2	0.97	-	6	1.58	1.41
ITALY	3	1.00	0.00	38	17.27	3.61	41	18.27	3.61
JAPAN (IDC)	-	-	-	8	5.77	0.88	8	5.77	0.88
JAPAN (ITJ)	-	-	-	30	6.61	0.86	30	6.61	0.86
JAPAN (KDD)									
I/C	-	-	-	2	1.94	-	2	1.94	-
B/W	4	0.68	0.00	43	23.11	5.66	47	23.79	5.66
SINGAPORE	6	0.04	1.81	87	31.58	24.44	93	31.62	26.25
SWITZERLAND	7	3.77	0.00	46	26.05	2.30	53	29.82	2.30
TAIWAN									
TAIPEI	2	0.00	0.29	20	0.52	1.38	22	0.52	1.67
KAOSIUNG	-	-	-	10	0.55	0.50	10	0.55	0.50
UAE	5	4.27	0.00	25	18.41	3.72	30	22.68	3.72
UK (BT)	29	9.63	9.02	120	70.69	22.63	149	80.32	31.65
UK (MERCURY)	-	-	-	60	24.69	5.69	60	24.69	5.69
USA (ATT)	4	1.03	0.00	68	25.27	5.83	72	26.30	5.83
USA (MCI)	-	-	-	24	16.63	2.30	24	16.63	2.30
AUSTRIA	3	0.07	0.76	-	-	-	3	0.07	0.76
BAHRAIN	7	4.72	0.13	-	-	-	7	4.72	0.13
BRUNEI	3	0.43	0.31	-	-	-	3	0.43	0.31
DJIBOUTI	2	0.15	0.02	-	-	-	2	0.15	0.02
EGYPT	1	0.07	0.60	-	-	-	1	0.07	0.60
KOREA -S	6	2.40	2.60	-	-	-	6	2.40	2.60
MALAYSIA	11	4.21	1.99	-	-	-	11	4.21	1.99
MALDIVES	11	3.56	2.65	-	-	-	11	3.56	2.65
NETHERLANDS	11	2.70	2.37	-	-	-	11	2.70	2.37
NEPAL	1	0.32	0.32	-	-	-	1	0.32	0.32
PAKISTAN	9	2.73	4.41	-	-	-	9	2.73	4.41
S. ARABIA	20	7.41	3.48	-	-	-	20	7.41	3.48
SPAIN	4	1.11	0.46	-	-	-	4	1.11	0.46
THAILAND	4	2.11	0.78	-	-	-	4	2.11	0.78
TOTAL	183	64.50	34.31	879	427.10	125.62	1,062	491.60	159.93

Source: SLT

7.5 Northern and Eastern Provinces Development Target

Most of transmission facilities at northern and eastern provinces are supposed to be damaged and abandoned. When the unstable social condition is solved, immediate reconstruction program will be required for Anuradhapura - Jaffna link, Anuradhapura - Mannar link and SSC-LE link within Northern and Eastern Provinces. For immediate reconstruction of the transmission link in the area, microwave radio system has advantages over cable transmission system.

8. Transmission Network Plan for Colombo Metropolitan Area

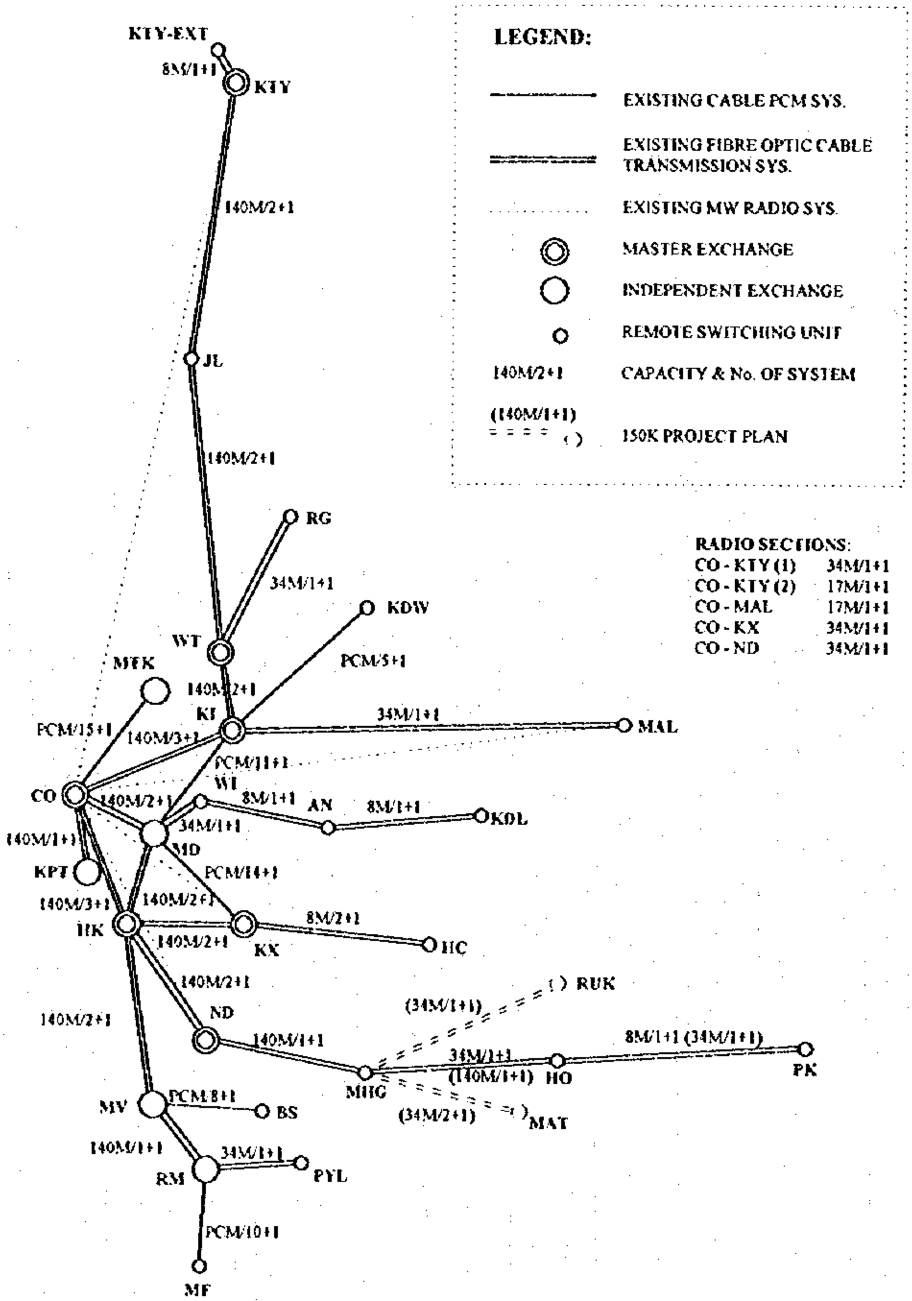
8.1 Present Colombo Metro Area Junction Network

All of 27 exchanges within the area are connected by fibre optic cable or PCM cable with digital transmission technology. Completion of Greater Colombo Telecommunication Network Improvement Project (GCTNIP) will make the fibre optic cable transmission network coverage expand to 23 sections. Present Colombo Metro area Junction Network is shown in Figure 8-8-1.

150k project will set new exchanges at Mattegoda and Rukmalgama, and link these exchanges to Maharagama by fibre optic cable transmission system in 1996/1997. At the same time, transmission capacities of some fibre optic cable link will be expanded.

8.2 Future Colombo Metro Area Junction Network

Colombo Metropolitan Area is most important and most contemporary area in the nation. So, network reliability and security will be most important factors for future transmission network planning. So, next target of network improvement will be the replacement of PCM cable with fibre optic cable and completion of Colombo surrounding ring network. Future junction network will be constructed adopting SDH fibre optic cable transmission system with ring configuration. Present "star" based network configuration will be modified to "ring" based configuration, and "star" based links will be supplement links to the SDH cable transmission links.



NOTE: This chart shows junction transmission network which will be realized after GCTNIP - Phase-II completion in 1995.

Source: SLT

Figure 8-8-1 Junction Transmission Network in Colombo Metro Area

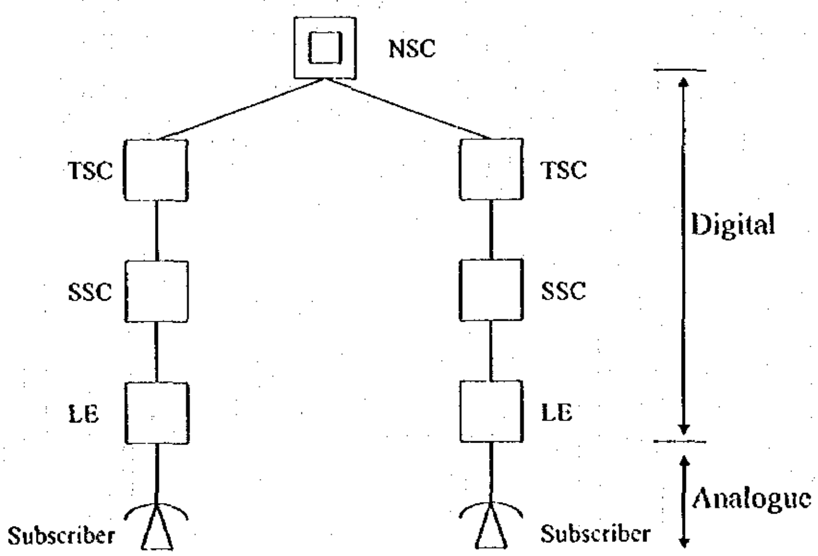
9. Subscriber Access Network

This subsection will study the Subscriber Access Network System, in consideration of the status quo of the SLT's national transmission network for telephone services. In addition, in view of the current frequent breakdown of the network and a large number of waiting applicants, an example of a system to feed the data collected by the Operation and Maintenance Department to the Planning Department will represented. This system will serve for enhancing the reliability of the Subscriber Access Network and solving the waiting applicant problem.

9.1 Technical Requirements for Subscriber Access Network

9.1.1 Transmission Hierarchy of National Network

The transmission hierarchy adopted by SLT is as shown in Figure 8-9-1. Because both switching and transmission systems will be fully digitalised. Here, as of October 1995, about 87% of the transmission channels connecting LEs and other higher ranking exchanges have been digitalised.



Source: JICA Study team.

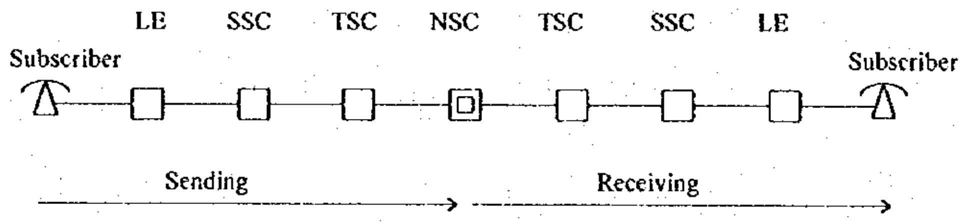
Figure 8-9-1 Transmission Hierarchy

The metallic cable system has been adopted for most of the existing subscriber access systems, and WLL (wireless local loop) system has been introduced only for limited areas. For most of LEs, RSUs have been installed.

9.1.2 Definition of National Loudness Ratings (LRs)

ITU-T G.121 recommends the loudness ratings (LRs) to be adopted by individual countries to ensure satisfactory speech power. Hence the Subscriber Access Network is required to satisfy such recommendation.

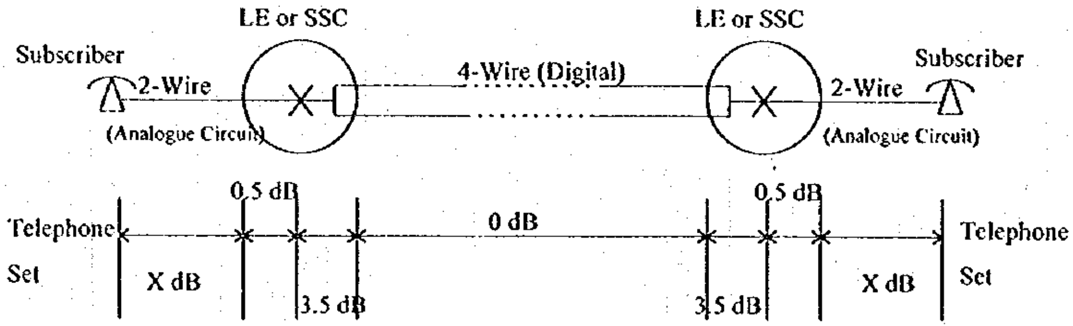
A long haul national telephone connection of SLT is assumed to be as shown in Figure 8-9-2.



Source: ITU.

Figure 8-9-2 National Telephone Connection

Electrical transmission characteristics of the above connection can be illustrated as shown in Figure 8-9-3, where X represents transmission loss of SLT's subscriber cables.



Source: JICA Study team.

Figure 8-9-3 Electrical Transmission Characteristics

LR values recommended by ITU-I G.111 and G.121 are given in Table 8-9-1. The technical requirements for the national telephone connection depend on the maximum values of the recommended LR. On the other hand, in order to determine LR values, electrical characteristics of telephone sets and transmission characteristics of subscriber cables have to be standardised, and to standardise these characteristics, telephone sets to be connected to the access network must also be standardised in each country. In Sri Lanka, however, standardisation is yet to be made, and the study will be made, based on the standardisation adopted in Japan.

Table 8-9-1 LR Values Recommended in G.111 and G.121

(Unit: dB)

	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.

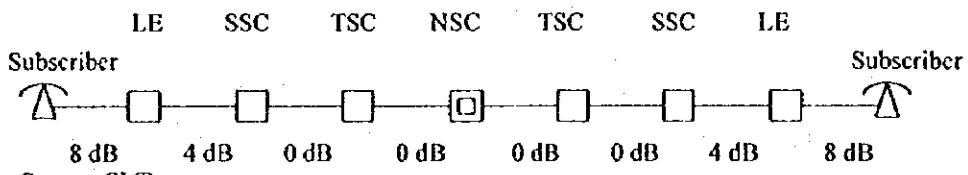
Table 8-9-2 LRs of Telephone Set Connected to Subscriber Cables
(Electrical Transmission Cable Loss: X, in the case of X>4dB)

	LR Values
SLR	-2.5 + 1.4X (dB)
RLR	-8.2 + 0.6X (dB)

Source: JICA Study team.

Now, taking into account the loss variation of 3 dB, i.e., 1 dB for telephone set, 1 dB for hybrid conversion and 1 dB for intra-exchange, and the maximum values of SLR given in the above Tables 8-9-1 and 8-9-2, X=8.6 dB can be obtained. When the maximum values of RLR are taken into account, X=14 dB can be obtained.

From the above, it can be said that the subscriber cable loss of 8dB as Figure 8-9-4 for the access network adopted by SLT is appropriate to the short term target.



Source: SLT.

Figure 8-9-4 Electrical Transmission Loss by National Connection

9.2 New Subscriber Access Systems

In recent years, various systems for application of optical fibre system and radio system to subscriber access network have been researched, developed and introduced in many countries. SLT also already has adopted DRMASS (Digital Radio Multiple Access Subscriber System) for subscribers which are located very far from the switching centre.

These new systems should be employed for the reasons of economic aspects and technical issues against the new services like ISDN etc. The guide to select the system is shown in Figure 8-9-5, but it is important to select the fittest system for the content of the demand.

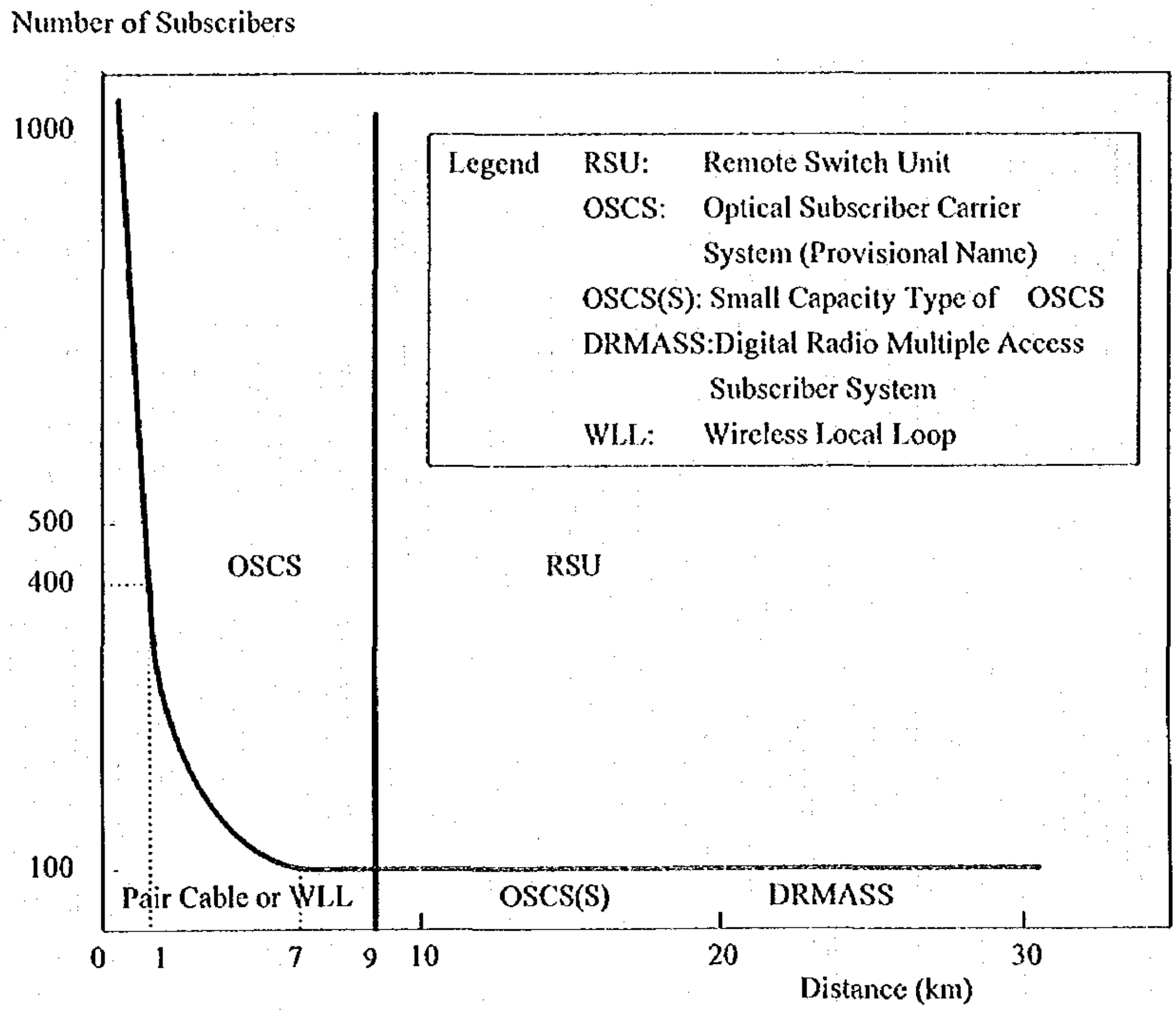


Figure 8-9-5 System Selection Chart

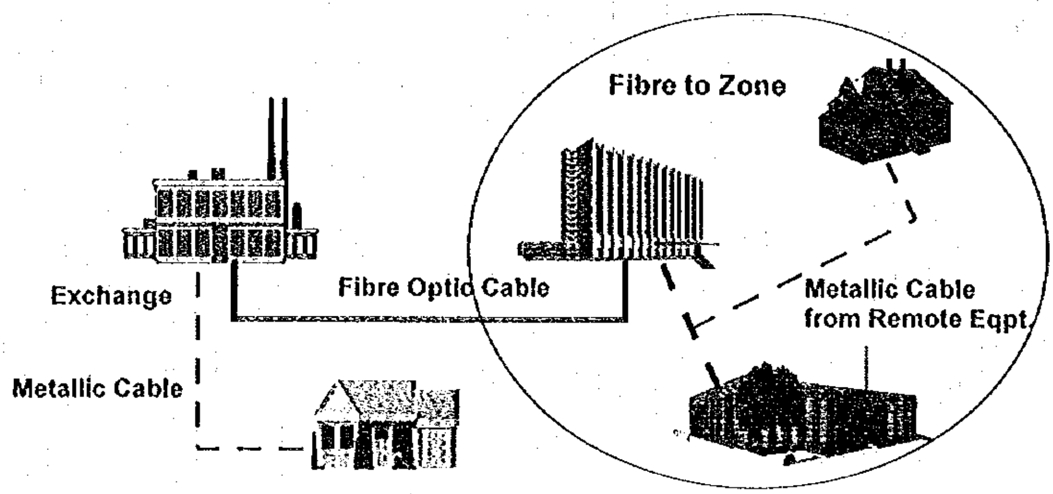
9.2.1 Application of Fibre Optic Subscriber Access

In past few years, the fibre optic subscriber access system is applied in many large cities in the world. This application realises effective and flexible network in urban areas. It will be useful for subscriber access network of major cities in Sri Lanka also. **Table 8-9-3** and **Figure 8-9-6** show the guidelines of cable system applications.

Table 8-9-3 Cable System Applications for Subscriber Access

System	Metallic to House	Fibre to Zone	Fibre to House
Media	Metallic Cable	Optic Fibre Cable + Metallic Cable	Optic Fibre Cable
Use for	Medium density zone	High density zone	Specific customers
Coverage	5-7 km radius	up to approx. 20 km	up to approx. 20 km
Message Signal	Voice - 192 kbps	Broadband to zone	Broadband to house
Electric in Subs	-	AC in zone	AC in house
Major Appli.	General	Business zone Housing complex	High-rise building Business complex
Terminal Eqpt.	-	Remote Terminal Remote Switch	Remote Terminal Digital PBX
Inv. Cost / sub	$600 - $900	depend on conditions	depend on conditions

Source: JICA Study Team.



Source: JICA Study Team.

Figure 8-9-6 Cable System Applications for Subscriber Access

9.2.2 Application of Wireless Local Loops (WLL)

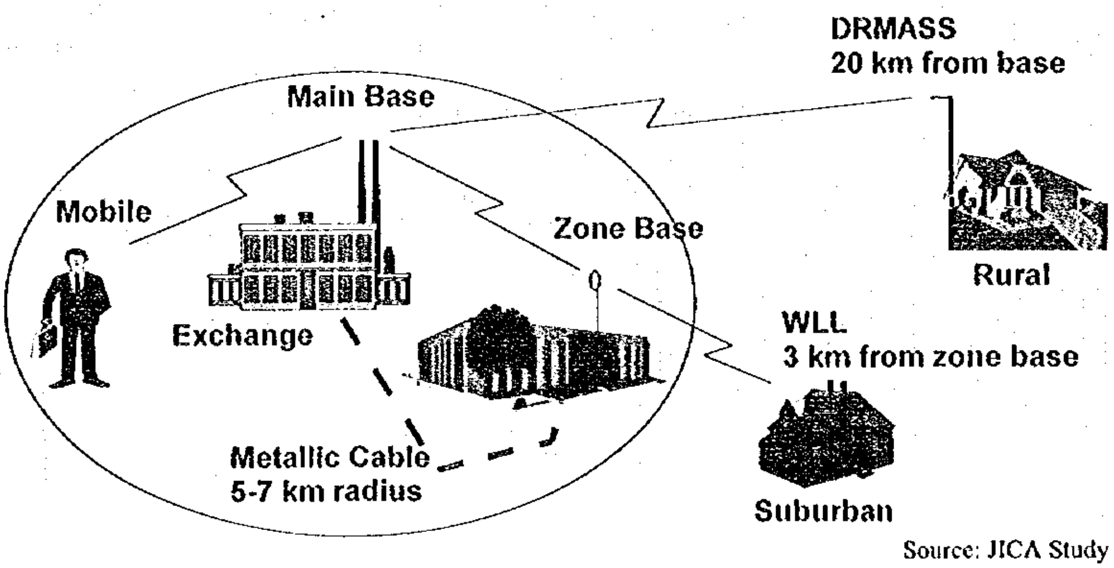
During last few years, the Wireless Local Loop (WLL) system has been developed for the telephone subscriber access with competitive investment cost to usual metallic pairs cable system. This system requires only a small antenna (indoor or wall mount type) for subscriber terminal. The transmission quality varies depending on the physical conditions of subscriber premises. **Table 8-9-4** and **Figure 8-9-7** explaine the comparison of WLL and other radio subscriber access systems.

Table 8-9-4 Radio System Applications for Subscriber Access

System	Wire Loops	Wireless Loops	DRMASS	Cellular Mobile
Media	Metallic Cable	Radio 400MHz-3GHz	Radio 800MHz-2GHz	Radio 800MHz-2GHz
Use for	Fixed	Fixed	Fixed	Mobile
Coverage	5-7 km radius	1-3 km radius 100km with rep.	20 km radius 300km with rep.	5 - 20 km radius
Message Signal	Voice - 192kbps	Voice - 32 kbps	Voice - 64 kbps	Voice - 32 kbps
Antenna in Subs	-	Small	Large	Built-in
Electric in Subs	-	AC	AC	Battery
Major Appli.	Urban/Suburban	Suburban	Rural	Urban/Suburban
Inv. Cost / sub	$600-900	$700-$1,000	$5,000-$10,000	$1,000-$2,000

Note: The cost of local switch is not included.

Source: JICA Study Team.



Source: JICA Study Team.

Figure 8-9-7 Radio System Applications for Subscriber Access

9.3 Efficient Procedure of External Plant Network

9.3.1 Improvement of Subscriber Service Level and Reduction of Maintenance Work

The fault rate of Telephone Service is very high as much as 20 cases per month per hundred subscribers as shown in the Table 8-9-5. The heavy fault repair work affects gravely the work force in each maintenance centre.

Table 8-9-5 Fault Rate of Telephone Service in SLT

in March 1995

	Number of DEL	Number of Faults	Faults/100DEL /Month
Metro	124,011	15,159	12.2
Region	55,741	16,620	29.8
Total	17,779	31,779	17.7

Source: SLT.

Most of the faults is in External Plant, the Table 8-9-6 shows the fault statistics of Kurunegala RTE. Every RTE also analyses the number of fault occurrences and fault locations for statistical use. The faults rate and the fault locations are as same as the table in each RTE.

Table 8-9-6 Fault Statistics of Kurunegala RTE

from January to December, 1994, for 3,877 DELs

	Over Head Cable & Wire	Under Ground Cable	Exchange	Instrument	MDF	Internal Wire	Total
Number of Faults	6,750	1,136	329	94	40	8	8,357
Faults % by Location	80.8	13.6	3.9	1.1	0.5	0.1	100

Source: SLT

We made an hearing investigation on the fault analysis results done in Wattala RTE and Nugegoda RTE in December 1995, which gave us the same result as obtained in Kurunegala RTE, that is, the major part of faults occurred in overhead 2-wires. We did not analyse the specific fault causes. We discussed over the possible fault causes with its staff, and understood that overhead 2-wires are structurally weak in tension and in insulating coating, so, in case of tree collapse or contacts the wires were often cut off and there happened many false line crossings. In the rural areas and suburbs of the Metropolitan Area the overhead 2-wires are used for a long distance as subscriber leading-in lines. In this case we observed an example that ten or more faults occurred a year in one subscriber line because of bad weather.

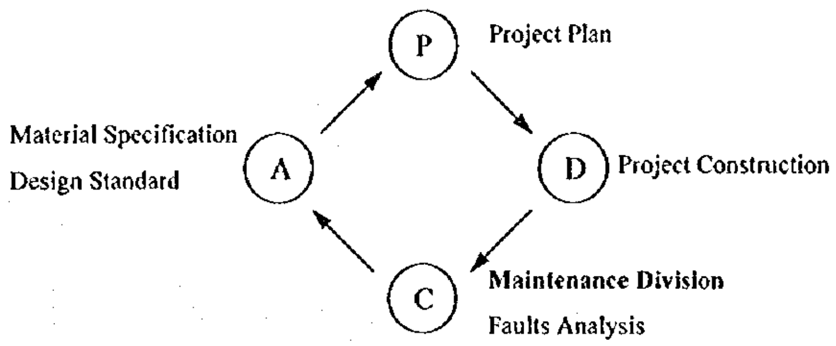
In order to reduce faults in overhead 2-wires which occupy 80% of all faults in outside plants it will be necessary to replace successively the overhead 2 wires of two or more pole span with aerial cables as indicated in the design standards of SLT. Moreover, if, even after completion of replacement of the overhead 2 wires of long distance with aerial cables, many faults still occur in the remaining overhead 2-wires, the subscriber leading-in lines should be considered to be replaced with drop wires with supporting messenger.

9.3.2 Usage of Outside Plant O&M Data in Planning and Technical Specification Establishing Departments

(1) Reflection of Maintenance Data in Planning and Technical Specification Establishing Use

As mentioned in the subsection 9.3.1, every RTE gathers detailed statistical data on the number of fault occurrences and fault locations, but they have not yet understood well objective fault causes. Therefore, these statistical data only are not enough for the technical department to revise technical specifications and also not enough for the planning department to revise its faculty replacement standards and improve design standards in relation to faculty positioning, etc.

For PDCA viewed from the line maintenance side it is important to analyse faults causes as well as to collect data on the number of fault occurrences and their locations in order to reflect the statistical fault data for revision of technical specifications of line faculties and for improvement of design standards as shown in Figure 8-9-8.



Source: JICA Study team.

Figure 8-9-8 PDCA View for Line Maintenance

It is also important to consider the way of establishment of a maintenance system which will be able to work effectively in the whole SLT organisation in order to maintain well more and more growing subscriber line faculties, realise subscriber's satisfaction and reduce maintenance work. Therefore, the fault statistical data must be collected by using the sheet shown in Table 8-9-7, in order that the maintenance data of the maintenance department be utilised well in the technical specification establishing department as well as in the planning department. Moreover, it is needed to establish a section which collect maintenance data from RTEs and analyse them as a whole for SLT.

Table 8-9-7 Example of Fault Statistical Data Sheet

Causes / Fault Locations	Causes by Natural Phenomena										Causes by Human Behavior or Artificial Structure									Total
	Strong Wind	Heavy Rain	Corrosion (Salt)	Corrosion (Others)	Flood	Earthquake	Lightning	Animal	Insect	Others	Fire	Accident by Vehicle	SLT's Construction	Others Construction	Corrosion by Exhaust	Induction (Power)	Induction (Railway)	Intentional Damage	Others	
1 Telephone Set																				
(1) Handset																				
(2) Circuit																				
(3) Cord																				
(4) Others																				
2 Rosette																				
3 Internal wire																				
4 Internal Cable																				
5 Protective Device																				
6 Drop Wire																				
7 Off 2 Wires																				
8 Distribution Point																				
DP(on Pole)																				
DP(on Wall)																				
DP(Indoor)																				
9 Secondary Cable																				
Aerial Cable																				
(1) Cable																				
(2) Closure																				
(3) Others																				
10 Duct Cable																				
(1) Cable																				
(2) Closure																				
(3) Others																				
11 Buried Cable																				
(1) Cable																				
(2) Closure																				
(3) Others																				
12 Cross Connection CAB																				
Termination Block																				
Jumper Wire																				
Others																				
13 Primary Cable																				
a Aerial Cable																				
(1) Cable																				
(2) Closure																				
(3) Others																				
b Duct Cable																				
(1) Cable																				
(2) Closure																				
(3) Others																				
c Buried Cable																				
(1) Cable																				
(2) Closure																				
(3) Others																				
14 Exchange Center																				
(1) Closure																				
(2) Termination Block																				
(3) Jumper Wire																				
(4) Others																				
Total																				

(2) Usage of Waiting List in Planning Department

Every RTE collects information about waiting applicants categorised by regions or villages. However, we observe that this information is not well utilised in the planning department. In an outside plant development planning, collection of information of waiting applicants in each cabinet area is very important to decide primary cable capacity, and also collection of it in each small area is very important to decide secondary cable capacity, moreover collection of it in each region or village is needed to know the telephone demand.

For effective use of information of waiting applicants it is necessary to establish a system in which RTEs' information of waiting applicants categorised by region or village can be informed to the planning department in company with the maintenance data mentioned in Subsection 9.3.2 (1). Furthermore, in order to analyse effectively a great amount of data, consideration is needed to construct a communication system by computer.

(3) How to Perform Effectively Subscriber New Connection Work

a) Performing of Small Scale Work in RTE

According the present way of work in SLT, upon completion of a big telecommunication project in a telephone exchange office a great number of new subscribers is offered with telephone service all together, so the whole line capacity of newly installed exchange is covered up very soon. As a result, subscriber new connection can no longer be performed for 5 to 8 years until next project. This situation leads to a big accumulative waiting list.

In order to improve this situation it is necessary for a very big project to construct switch and cable facilities in order to satisfy the telephone demand of five years later after completion of the project, and it is also needed to establish a construction system in which small scale cable construction works of 400 pairs or less can be performed by RTE itself under its responsibility and authority in order to flexibly cope with demand increase or demand fluctuation in a RTE controlling telephone office. For this motive RTE itself has to employ outside plant design technicians/engineers and construction work technicians/engineers. And, a storage system for the cables, drop wires, customer equipment, etc. is also necessary for construction works required to absorb demand fluctuations. From the RTE staff some people shall be assigned as these technicians or engineers after receiving necessary intensive training in view of activation and effective employment of RTE personnel. Personnel upbringing requires effective use of SLT training centre and OJT curriculum for design and construction practices. Furthermore, if it is difficult to gather necessary construction work force from a point of view of outside plant department personnel plan, upbringing of construction companies for small scale construction works should be considered so that they may make a contract for these works.

b) Introduction of Plug & Jack Type Customer Equipment

There is a so called "subscriber cable conductor and customer equipment retention system by use of plug and jack" similar to the plug socket system for electric power facilities for the purpose of effective connection and transfer of telephone subscribers. In this respect we consider that it is still premature to introduce this retention system in SLT, because SLT has a so big waiting list and its switch and cable capacity is so small that vacant terminals and cables should be utilised for new subscriber connection. However, in the near future when the number of subscribers and telecommunication facility capacity will increase very much, subscriber transfer orders will also increase drastically, and when considering the possibility of telephone apparatus market deregulation, it is necessary to study the introduction way of "plug & jack system" for customer wiring for the purpose of service order work reduction and subscriber service improvement in future.

10. Integrated Services Digital Network (ISDN)

10.1 Introduction of ISDN

Many industry advanced countries have introduced ISDN. Such countries have introduced the ISDN for providing services on voice communication, facsimile communication, elementary video communication, data transmission, etc. That ISDN is capable to transmit signals of a speed up to 2 Mb/s and is called N-ISDN.

It is expected that the demand on video conference, video telephone, data communication between LANs, high speed broad band data communication will come out in future, which require a transmission speed up to several hundred Mega-bits per second. The terminals may have multi-functions. That ISDN is called B-ISDN.

Sri Lanka is in the development stage of individual network era, where the ordinary telephone network, cellular telephone networks, data communication networks and telex network coexist by means of individual network. The existing networks should grow up to an ISDN gradually. JICA recommends SLT to introduce an N-ISDN by the year 2000 to offer ISDN services in major cities in order to achieve the target on ISDN shown in Table 7-1-1. The N-ISDN will be expanded gradually to provide such services to all district capitals in 2015. A B-ISDN may be introduced by the year 2015. Figure 8-10-1 shows a network integration steps to B-ISDN.

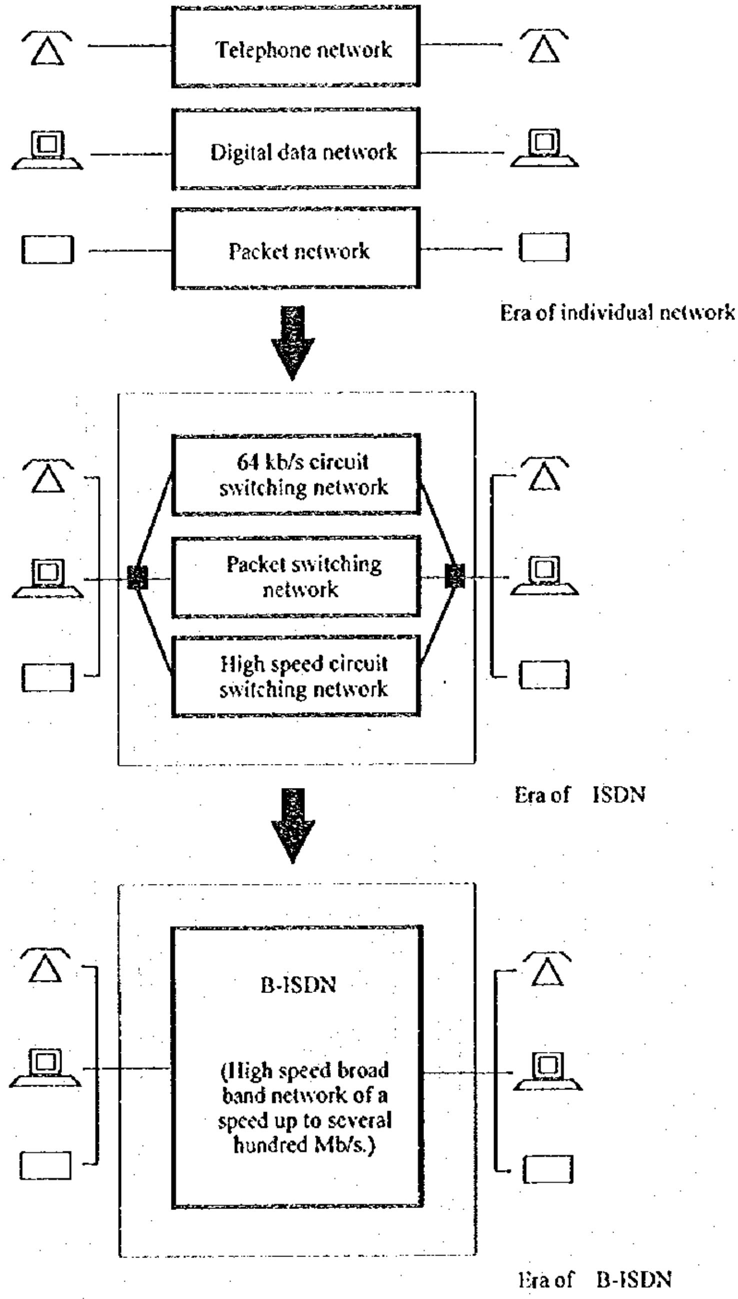


Figure 8-10-1 Network Integration Steps to B-ISDN

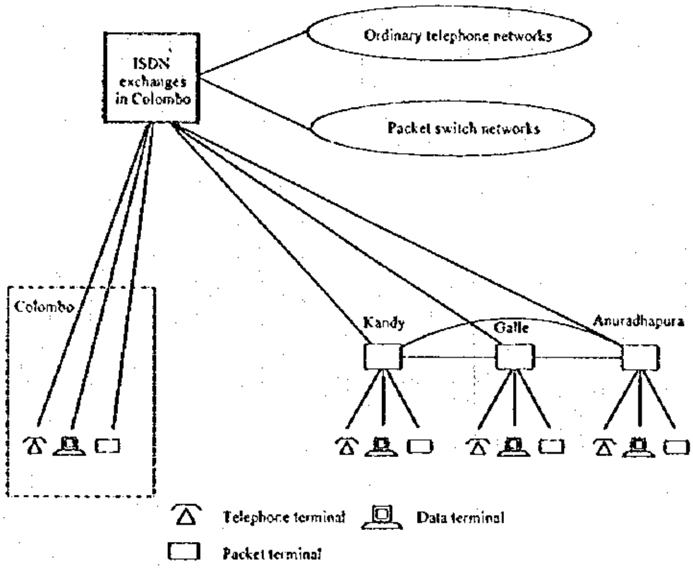
10.2 Essential Technologies for ISDN

The essential technologies to establish an integrated services digital network are digital exchanges, Signalling System No. 7 and digital transmission paths.

SLT is going to purchase digital exchanges equipped with integrated services digital network user part (ISUP) of Signalling System No. 7 through the on-going projects in Colombo. The ISUP being introduced is intended to offer telephonic services by the standard specifications defined by ITU-T Blue books. JICA recommends SLT to adopt the standard specifications by ITU-T though variations are provided by manufacturers.

10.3 ISDN Expansion

This Master Plan suggests to introduce a digital exchange with ISDN function in Colombo by the year 2000. Introduction of another small size ISDN exchange is planned to Kandy by the year 2005. ISDN Centre in Colombo shall offer services in Colombo, Anuradhapura and Galle. Kandy ISDN Centre shall offer the services in Kandy. Another two (2) ISDN centres may be situated at Galle and Anuradhapura if the demand goes up enough. Figure 8-10-2 shows a proposed ISDN network for Sri Lanka in 2015. Since the ISDN service is the first time in Sri Lankan telecommunications service history, the ISDN Centre size and its traffic routing should be reviewed on the occasion of purchase and even after introduction.



Source: JICA Study team.

Figure 8-10-2 Proposed ISDN network for SLT in 2015

All ISDN Centres shall have interface with ordinary telephone network at TSC level. Colombo ISDN Centre shall have, in addition to this, inter-face with Packet Switch Public Network (PSPN) including DataPack of SLT, DataNet of Lanka Communication Service, and another PSPN of Electrotek.

10.4 ISDN Interfaces and Service Features

The ISDN to be introduced should have, as ISDN user network interface, the Basic Access Interface of 2B+D and Primary Rate Access Interface of 30B+D, which are in conformity with ITU-T Recommendations. The ISDN should have also ISDN Network Node Interface including X.75 for Packet Switched Data Network and Signalling System No. 7 ISDN User Part (ISUP) for Common Channel Signalling Network. Figure 8-10-3, Figure 8-10-4 and Figure 8-10-5 show examples of circuit switched call connection, B-Channel Packet Call connection, and D-Channel Packet Call connection, respectively, which may be realised by the ISDN suggested in this Master Plan.

ITU-T Recommendations define three (3) types of ISDN services, that is, Bearer services, Teleservices and Supplementary services. The Bearer services provide the means to convey information between users. Teleservices combine the transportation and the information processing functions, employing bearer service. The supplementary service may be used with one or more of the bearer or teleservices to enhance services.

Bearer services include;

- Circuit mode 64 Kbps voice bearer service;
  A service suitable for speech information;
- Circuit mode 64 Kbps unrestricted bearer service;
  A service suitable for telephone, facsimile of Group 4, and video telephone;
- Circuit mode 64 Kbps 3.1 KHz Audio bearer service;
  A service providing the transfer of speech and 3.1 KHz bandwidth information such as voice-band data via modems and facsimile G2/G3.
- Packet mode (Virtual circuit);
  A service providing the unrestricted transfer of user information in the packet mode over virtual circuit.

Teleservices include;

- Telephone call
- Telex
- Facsimile
- Videotex

Supplementary services include;

- Direct Inward Dialling (PBX-DID);
  A service which enables direct calling from a user to another user on a PBX without the assistance of attendant;
- Multiple \subscriber Number;
  A service which assigns multiple ISDN Numbers to a single subscriber line;
- Calling Line Identification Presentation;
  A service which provides the called party with the calling party's ISDN number, possibly along with the subaddress;
- Calling Line Identification Restriction;
  A service which restricts presentation of the calling party's ISDN Number and subaddress;
- Malicious Call Trace;
  A service which traces a malicious call to the source;
- Subaddressing;
  A service which addresses a particular terminal on an ISDN Number by using 20-digit identification number (subaddress) in addition to the ISDN Number;
- Call Forwarding Busy Line;
  A service which forwards calls for an ISDN Number to the pre-registered directory number when the called Number is busy.
- Call Forwarding Don't Answer (Call Forwarding No Reply);
  A service which forwards calls for an ISDN Number to the pre-registered directory number when the call meets no replay at the ISDN Number;
- Call Forwarding Unconditional;
  A service which forwards all calls for an ISDN Number to the pre-registered directory number regardless of the condition of the called terminal;

- Call Waiting;
  A service which audibly notifies a user that another call is incoming while the user is already active on a call. Then the user can answer the incoming call by "hook flash", placing the ongoing call on hold;
- three-way Calling (Three Party service);
  A service which enables a three-way conversation without assistance of attendant. That is, the user who is already active on a call holds that call, makes an additional call to a third party, and then joins the two calls together into a three-way call;
- Closed User Group (CUG);
  A service which enables users to form groups, to and from which access may be restricted. Three types of CUG services are available;
  Closed User Group (CUG), which permits intra-group communications. Outgoing/incoming calls from/to the group are restricted.
  CUG with Outgoing Access, which permits outgoing access from the group and restricts incoming access to the group. User terminals can individually be registered for this service.
  CUG with Incoming Access, which permits incoming access to the group and restricts outgoing access. User terminals can individually be registered for this service.

- User-to-User Signalling;
  A service which allows a user to send/receive information to/from another ISDN user over the signalling channel.

NT: Network Termination
TA: Terminal Adapter
TDNW: Time Division Network

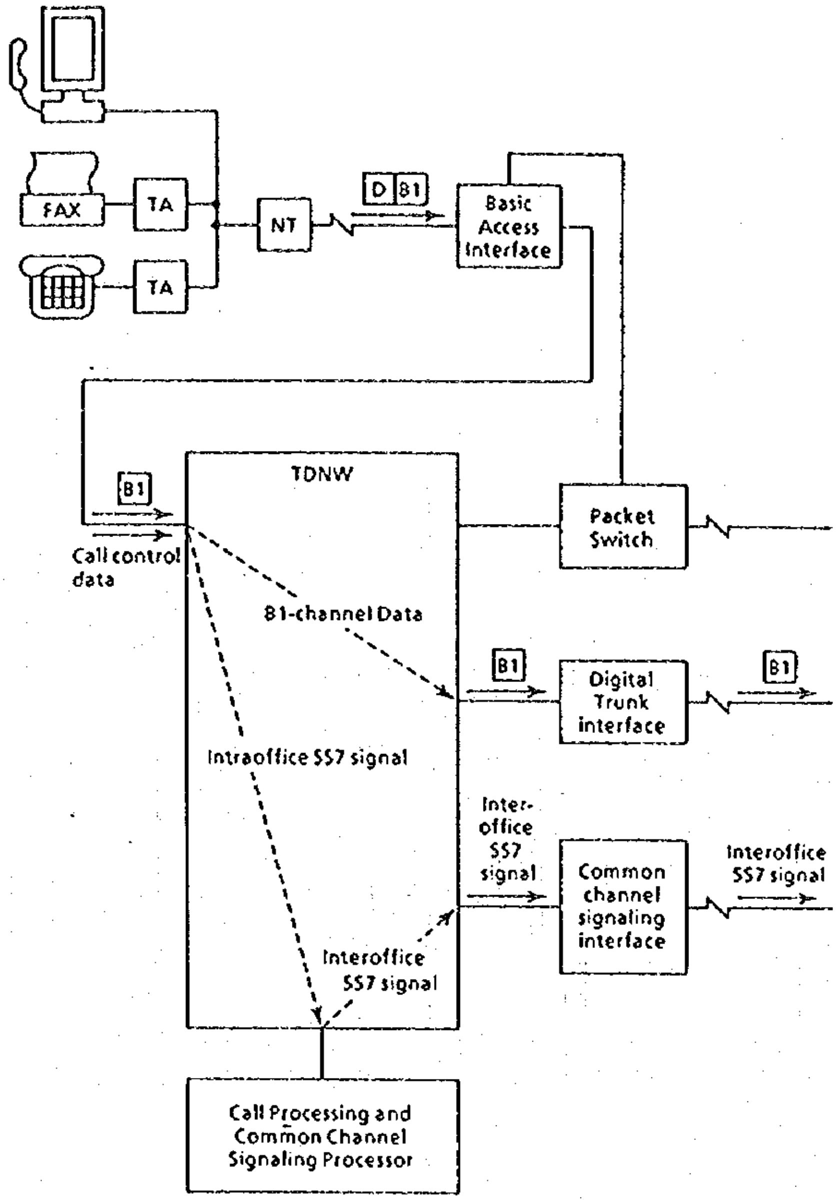


Figure 8-10-3 Connection Model of Circuit Switched Call

NT: Network Termination
TA: Terminal Adapter
TDNW: Time Division Network

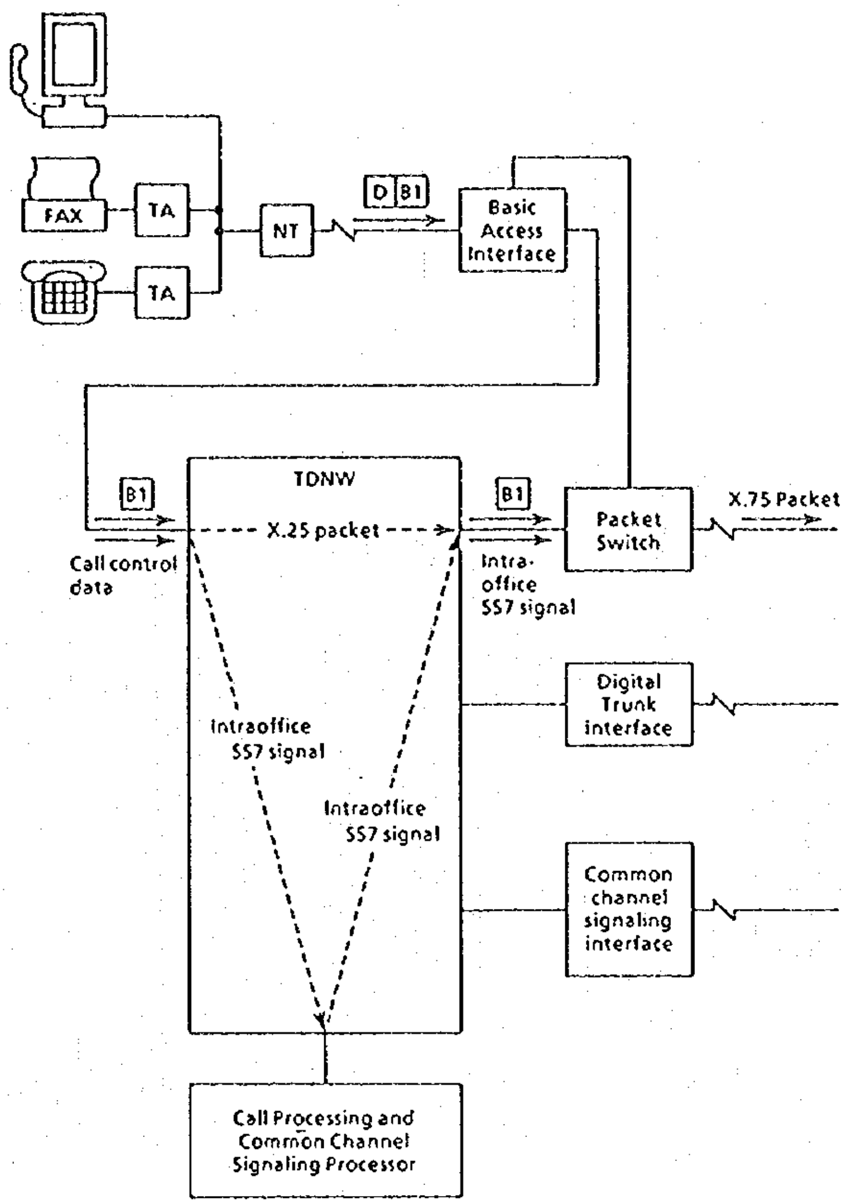


Figure 8-10-4 Connection Model of B-Channel Packet Call

NT: Network Termination
TA: Terminal Adapter
TDNW: Time Division Network

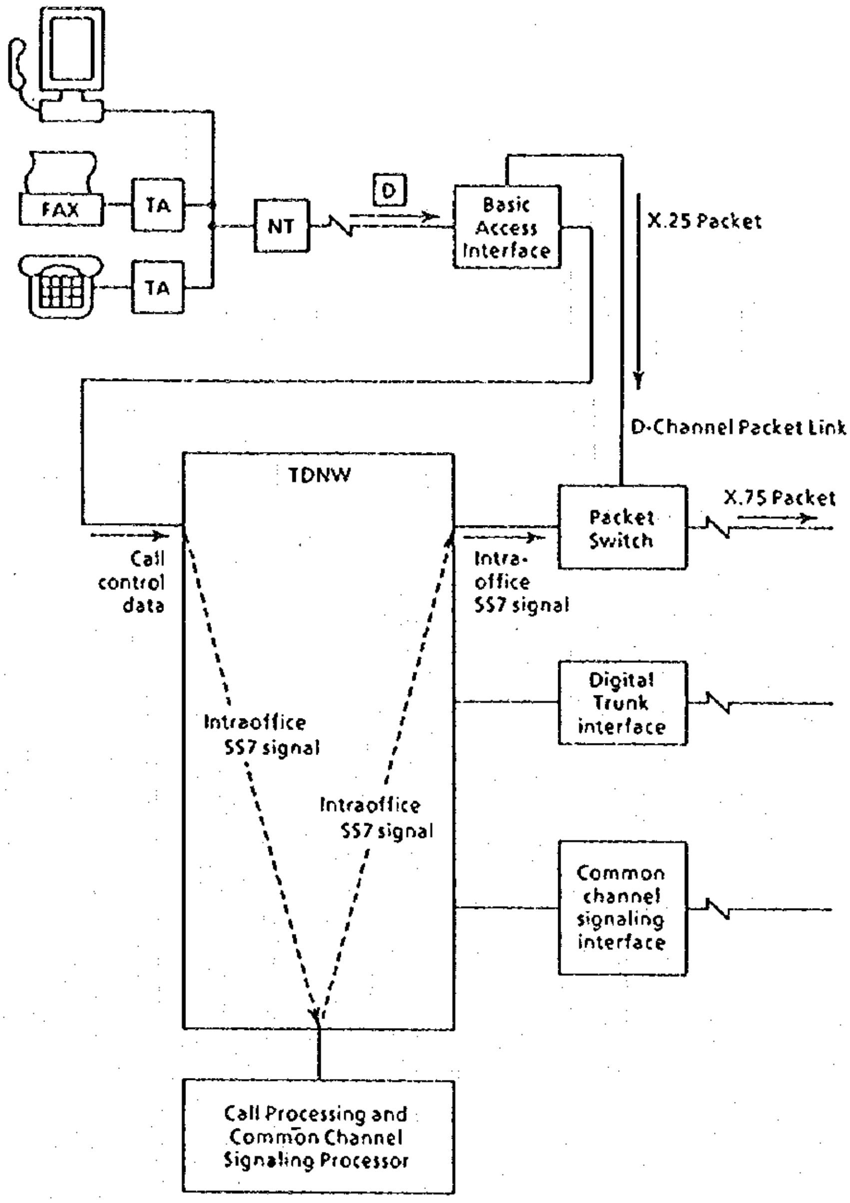


Figure 8-10-5 Connection Model of D-Channel Packet Call

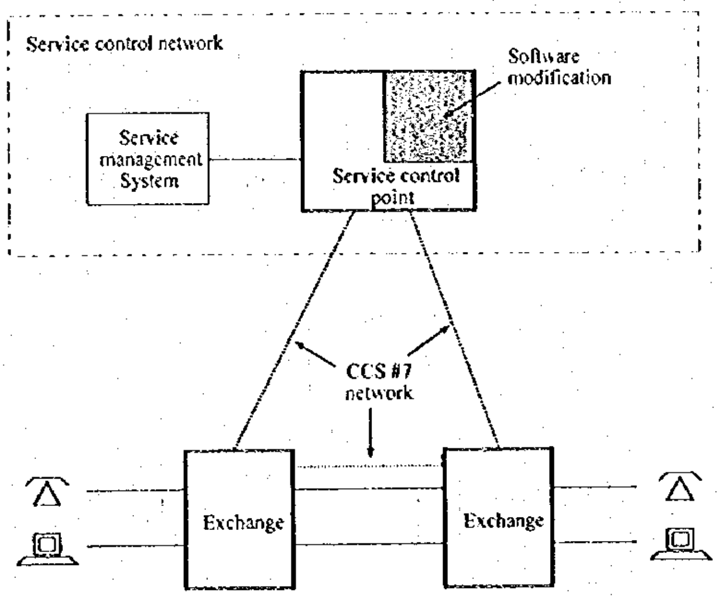
11. Intelligent Network

11.1 Conception of Intelligent Network

The Intelligent Network (IN) is an idea wherein the telecommunication service providers could offer new services independent of telephone exchange vendors proposed by an American company in 1984. The idea has been developed as a new network architecture idea by Multi Vendor Interaction Forum (MVI) in the United States of America and by ITU-T internationally.

The functions necessary for establishing communication have been provided by switching systems so far. Accordingly, it was essential to modify all related software of the switching systems when a new service was introduced. It was an expensive work.

The integrated network will have a service control network besides speech path network. The service control network, or the Intelligent layer, will be consisted of service control function, traffic procession function, information procession function and data bases, etc. The speech path network, or the transport layer, will be provided by ISDN and existing PSTN. Once the integrated network is introduced, new services will be introduced by software modification of service control point. Figure 8-11-1 shows the concept.



Souce: JICA Study team.

Figure 8-11-1 Concept of Integrated Network in Future

11.2 New Services in Intelligent Network Era

An intelligent network will offer various services making use of its flexibility in such functions as the number conversion, charge processing, connection control, etc. The typical services offered by an Intelligent Network architecture are as shown below.

Toll free or Free phone;

The called party (service subscriber) is charged for the call instead of the calling party.

Premium rate;

The operating company collects the fees for the information offered to service users by the service subscriber. The operating company is paid for collecting the information fees as well as the charges for the service subscription and telephone calls made.

Virtual private network;

The Virtual Private Network uses the public network and allows the application of the same services provided by the private network at low rates without special systems, including private branch switching system.

Calling card service (CCS);

The service user can make phone calls using a calling card authorised by the service subscriber, who is charged for the calls made (the service user may be the same person as the service subscriber). This service is a combination of the account card calling and the credit card calling defined in the CS-1 recommendations (Q.12XX series, ITU-T or CCITT).

Televoting;

This service allows voting by telephone. A call made by a service user to a telephone number registered by the service subscriber is counted as a vote.

Split charging;

The called party (service subscriber) pays part of the charge for the call terminating to the called party number.

Universal personal telecommunications (UPT);

A network-independent personal number is assigned to the service subscriber. The service subscriber can make and receive calls anytime anywhere by registering that number for desired telephone terminal. Calls originating from the telephone terminal for which the personal number is registered are charged to that number.

11.3 Introduction of an Intelligent Network to SLT Network

The fundamentals to introduce an integrated network are digital exchanges and CCS No. 7 signalling system technology, data base management technology, etc. Introduction of an Intelligent Network is planned by the year 2000 in this Master Plan. Introduction of a new NSC switching unit is planned in this Master Plan to offer IN services in 2000. The new NSC switching unit will be equipped with a gate switch function to the intelligent layer.

For the first stage of IN introduction, the majority of IN service users will be the subscribers connected to the normal telephone network. SLT can offer, for instance, Free phone service and Premium rate call service, by means of the network that SLT maintains at present. The present network cannot support fully the IN service because of its inter-exchange signalling function.

If an ISDN is introduced by the year 2000, SLT may offer more integrated network services making use of the ISDN. The number of subscribers which can receive such IN services will increase as the ISDN is planned to expanded to major cities gradually. The available popular services include;

- Toll Free Call (Freephone) service;
- Premium rate call service;
- Virtual private network service;
- Calling card service;
- Televoting;
- Split charging;
- Universal personal telecommunications.

Figure 8-11-2 shows a concept of the toll free call service.

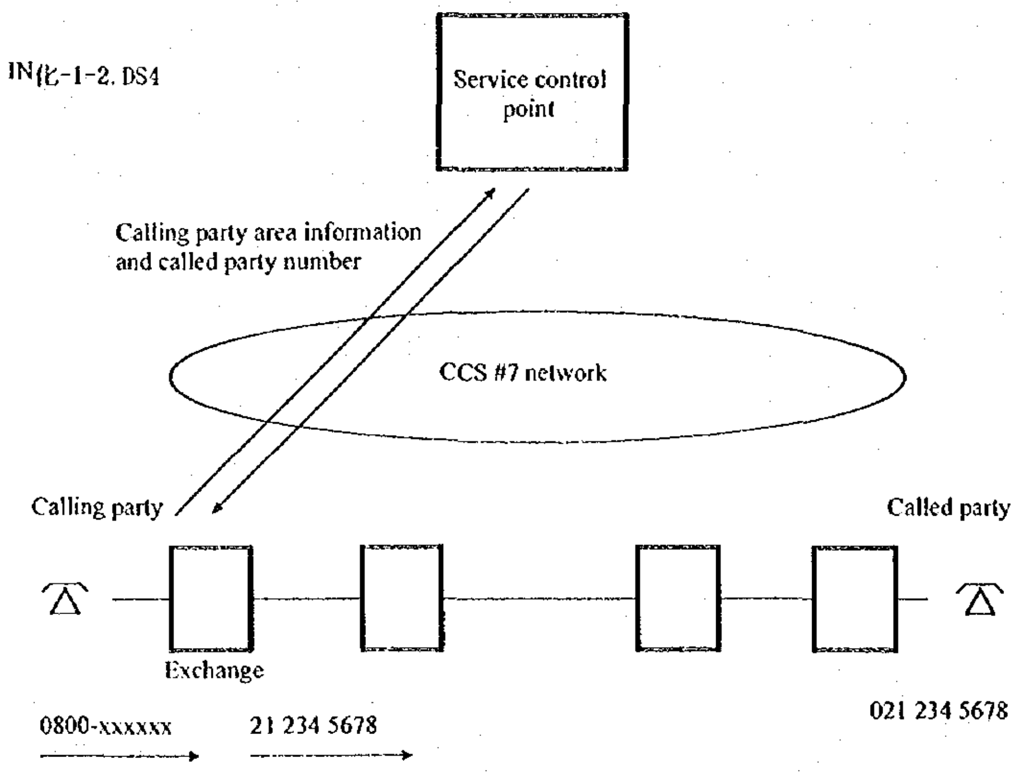


Figure 8-11-2 Concept of Toll Free Call Service

CHAPTER 9

TELECOMMUNICATIONS NETWORK FACILITIES PLAN

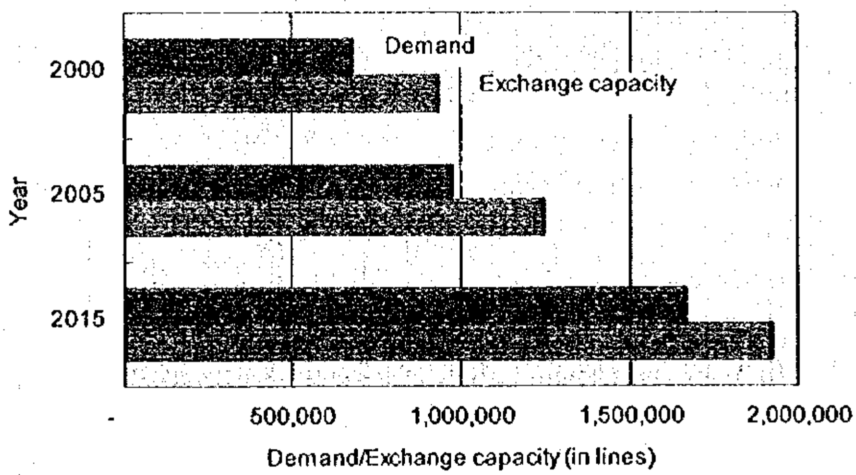
CHAPTER 9

TELECOMMUNICATIONS NETWORK FACILITIES PLAN

1. General

The telecommunications network facilities plan is set up in order to provide conditions necessary to complete the key development targets indicated in Table 7-1-1.

JICA forecasts a) 678,000 direct exchange lines (DELs) of telephone demand in the year 2000, b) 979,000 DELs in the year 2005 and c) 1,663,000 DELs in the year 2015 in thole the coountry. The demand could come up approximately to 2,000,000 in DELs if 20% of hidden demand is taken into account as shown in Table 7-1-1. It is stipulated in Chapter 7, as a most important target, to fulfil every new application of basic telephone service within one year after its registration in the year 2001 and afterwards. In order to satisfy this target, it is necessary to increase telephone exchange capacity of a total of 320,000 direct exchange lines (DELs) for the period from 1998 to 2000, a total of 304,000 DELs for the period from 2001 to 2005, and a total of 680,000 DELs for the period from 2006 to 2015, as the exchange capacity is supposed to be 619,000 in 1997 when ongoing projects end. With that exchange capacity, every exchange will be able to cater for the telephone demand for five (5) years after its expansion. By this capacity increase Sri Lanka will come to have a total capacity of approximately 1,924,000 DELs in the year 2015. See Figure 9-1-1.



Source: JICA Study team.

Figure 9-1-1 Telephone Demand and Exchange Capacity