CHAPTER 4

FEASIBILITY STUDY ON NEW ISC, TSC AND EARTH STATION PROJECT

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1. Background of the Feasibility Study

SLT is required to provide more international and national telecommunications facilities to meet the rapid increase of telephone demand in coming years. In 1997, telecommunications facilities capacity of SLT network will be around 597,000 lines in exchange capacity and around 937,000 lines in external plant, while JICA forecasts around 1,174,000 lines of telephone demand in 2005. SLT's capacity will become insufficient in 2000, even in the case that private networks other than SLT provide nearly a quarter of the demand after in 1997, in the local, trunk and international network. This feasibility study was planned to find a project to solve the gap to the demand on the trunk and international network expansion.

Before this feasibility study, SLT has driven forward its plans to meet the requirements pointed out in the new telecommunications policy, in line with the National Policy on Telecommunications which follows the Economic Policy Statement of the Government of Sri Lanka announced on 13th September 1994.

The Government of Sri Lanka intends to achieve the following targets:

a) Telephone to be made available on demand by 1998. All waiters' lists to be cleared by this time. Those who are far away from cable networks will be provided the service by wireless means.
b) To provide telephones, telegraph and facsimile access to all villages and villagers by 1998.

It was estimated, in keeping with the aspirations of the people and the demand arising from rapid economic growth, that the requirement for telephone (Direct Exchange Lines, DEL) will be in the following order of magnitude:

December 1995 - 460,000 lines;
December 1998 - 565,600 lines;
December 2000 - 636,000 lines.

In response to the requirements, SLT is expanding its network adding around 385,600 new lines to the existing approximately 180,000 lines by the year 1998. The on-going programmes by means of financing by World Bank, OECF, Finnish Export Credit, ADB, French Protocol, EDCF Korea, SLT fund and the supplier's credit for "150,000 Lines" were expected to meet the requirement. Those programmes are being carried out by introducing new digital exchanges, providing subscriber network by cables or radio systems, and expanding transmission network linking exchanges, whole the country except areas where there is security problem.

According to a recent study on telecommunications demand conducted by Japan International Co-operation Agency (JICA), however, it has been found that the telecommunications facilities to be provided by the year 1997 will be insufficient to meet the demand in the year 2000. This feasibility study aims to conduct a study on projects to be implemented by the year 2000.

This feasibility study puts focus on the facilities related to the international switching centre, other trunk network switching nodes of Colombo Metro Area to be introduced in Kotugoda, and a new earth station to be introduced in Kotugoda.

2. Objectives and Scope of the Project

2.1 Objectives

This project is aimed to provide by the year 2000 telecommunications facilities sufficient to meet international telecommunication traffic and national transit traffic to be increased in proportion to local exchange expansion.

JICA forecasts a total of 1,174,000 fixed telephone subscriber lines and another 196,000 mobile telephone lines in the year 2005 in its Master Plan Study. JICA advises Sri Lanka Telecom (SLT) to provide telecommunications facilities with which SLT can satisfy the demand in its network in due waiting time and with adequate grade of service. The forecast number of telephone subscriber lines is five times comparing to the existing. The traffic will increase corresponding to the telephone subscriber lines. For ensure a smooth traffic flow to foreign countries and within the country, international gateway switches' capacity and transit switches' capacity should be duly expanded. Such capacity should be available by the year

2000. A new earth station is also required to support the growing telecommunications network with different international links at the same time.

2.2 Project Location

This project will provide the telecommunications facilities stated in Section 2.3, in a new building to be provided by SLT in Kotugoda, Gampaha District. Figure 4-2-1 shows the objective telecommunications facilities in Kotugoda.

2.3 Scope of the Project

This project includes the purchase, installation, testing and training of:

a) One unit of switching system for ISC (International Switching Centre), one unit of switching system for NSC (National Switching Centre), and one unit of switching system for TSC (Tertiary Switching Centre), including such peripheral equipment as operator positions, power equipment, etc.;

b) One unit of earth station for satellite communication.

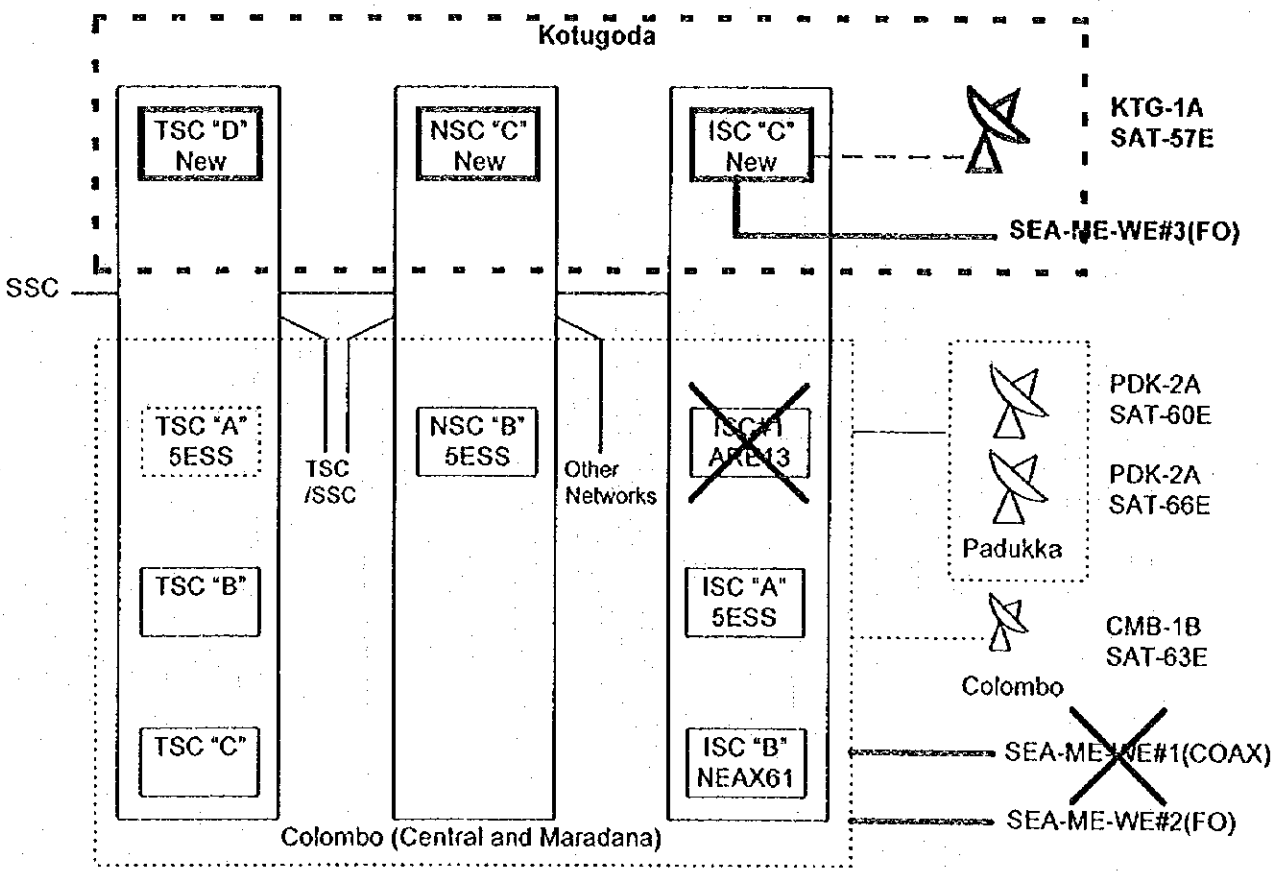


Figure 4-2-1 Objective Telecommunications Facilities

3. Socio-Economy

Most international calls are made by business users, or so-called "golden subscribers". Should the current telecom facilities or network systems, both of which are inadequate, fail to satisfy this market's potential demand, SLT's growth prospects would be placed in considerable jeopardy.

The government of Sri Lanka has been focusing on expanding the national economy, and the Board of Investment has been accordingly been active in inviting foreign capital investment into domestic industries. Under these circumstances, the construction of a second earth station is an effective project that would ensure network reliability and meet potential traffic demand in years to come.

Foreign investors are currently quite keen to make such direct investments in Sri Lanka. They are highly interested by the government:

1. Investment guarantees
2. Granting of tax holidays
3. Tax-free repatriation of dividends and royalties
4. Exemption from import duties

Given this situation, if government expectations are to be met, current efforts should focus on maintaining the reliability of facilities associated with international calls and promoting overseas direct investment.

4. Present Conditions of Telecommunications Services in Sri Lanka

4.1 Available Services in Sri Lanka

Sri Lanka has telecommunications network operating entities of various services in addition to the governmental organisation Sri Lanka Telecom (SLT). Most of private operating entities in Sri Lanka are located in Colombo City to exploit their asset for services.

As the leading network provider of Sri Lanka, SLT provides;

a) Plain ordinary telephone service (of domestic and international service);
b) Telex service (of domestic and international service);
c) Telegram service (of domestic and international service);
d) Leased circuits service;
e) Public payphone service;
f) Cellular mobile service;
g) Packet switched service under joint venture with Indian Saga;
h) Radio maritime services including INMARSAT services.

Private telecommunications network operating companies are providing various services supplementing the basic telecommunications services offered by SLT. There are four (4) providers of cellular mobile telephone service, five (5) providers of paging service, two (2) providers of stored and forward facsimile service, three (3) providers of data transmission service, one (1) provider of mobile radio trunking service and three (3) providers of payphone service.

4.2 Telephone Demand

Telephone demand has not been fulfiled and remained unsatisfactory for more than a decade. The number of waiters for basic telephone service exceeded the lines in use in number in 1994.

SLT offers basic telecommunications services to the public having around 280 exchanges scattered in the country. SLT's total capacity of telephone exchange was 237,000 with 180,000 subscriber lines in service as at the end of 1994. The fixed line telephone service, which is one of the most important service of the basic telecommunications services, has been

offered by only SLT up to now. In order to accelerate telephone demand fulfilment speed, two (2) wireless local loop (WLL) networks are to be introduced to provide fixed line telephone service in 1997.

SLT has increased the main lines or direct exchange lines (DEL) at an annual increase rate of 8.5 % for the past 10 years. The number of DELs at the end of the year 1994 recorded 180,724. However, the numbers of waiters recorded 45,924 in the year 1985 came up to 186,245 as of the end of 1994, i.e., it increased at an average increase rate of 16.8 % per year, which is almost double of DEL increase rate. Table 4-4-1 and Figure 4-4-1 shows the number of DELs and waiters and the increase trend, respectively. As read out of the Table and Figure, the expansion programs implemented by SLT for the past years have not been sufficient to meet the demand increase.

The Capital of Sri Lanka, Colombo, and surrounding areas, or the Colombo SSC Area, had 124,032 telephone lines in use as at the end of 1994. This was around 67 % of the national total.

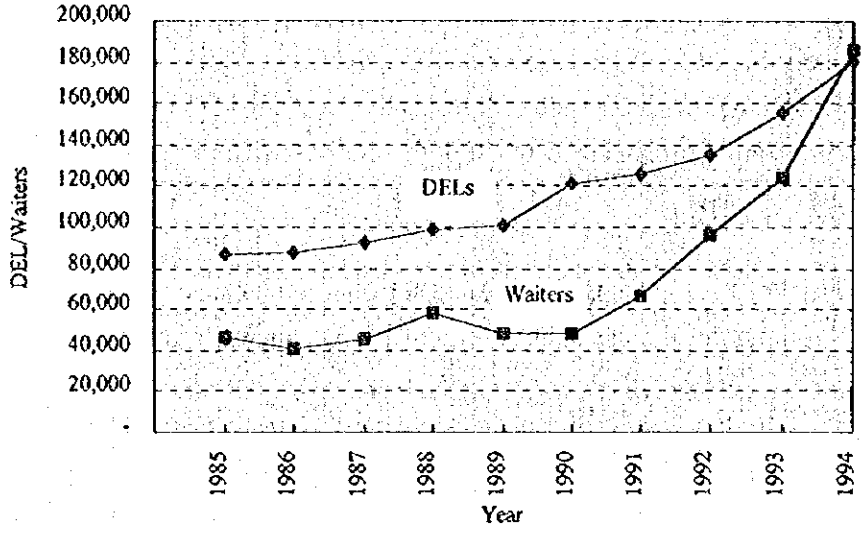
SLT plans to have a local exchange switching capacity of 587,000 subscriber lines and a total of external plant capacity of 937,000 primary loops in 1997 when the on-going projects end. It will be 316,000 subscriber lines for switching capacity and 506,000 primary loops for the external plant capacity in Colombo SSC Area in the year 1997. All the exchanges will be digital when the projects end in the year 1997.

The service grade for the lines in use was poor, i.e., the successful call rate remaind to mark around 30% in the national average in 1994. The number of faults per month per 100 DELs counted 25.99 as the national average, which was 16.78 in the objective area, in 1994.

Table 4-4-1 Number of DELs and Waiters for the Past 10 Years

Year	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994
DELs	86,599	87,974	92,779	98,920	101,162	121,388	125,834	135,504	155,475	180,724
Increase		1,375	4,805	6,141	2,242	20,226	4,446	9,670	19,971	25,249
Waiters	45,924	40,797	45,054	58,741	48,400	47,945	66,574	96,207	123,839	186,245

Source: SLT.



Source: SLT.

Figure 4-4-1 Increase Trend of the Number of DELs and Waiters

5. Project Basic Design

5.1 Forecast

5.1.1 Demand forecast

As discussed in Sec. 3 "Preconditions of the Feasibility Study", Chapter 1, Volume III, JICA forecast 813,752 fixed telephone lines, 1,174,243 fixed telephone lines and 1,995, 808 fixed telephone lines in the whole country in the year 2000, 2005 and 2015, respectively. The telephone demand includes a certain extent of hidden demand besides the demand apparently expressed.

The fixed telephone demand was forecast for the whole country based on a regression formula obtained through analysing correlation between Gross Domestic Per Capita (GDP) and the penetration rate of telephone lines of selected countries. ITU Data as at 1992 of selected 50 countries were collected for the analysis. The regression formula applied to forecast telephone demand is as follows. The national fixed telephone demand was divided to local areas in reference to their expressed demand, in principle.

$$\text{Ln}((ML + WE) / POP \times 100) = -5.149 + 0.9692 \times \text{Ln}(GDP/POP)$$

Where,
- Ln: National logarithmic operator;
- ML: Number of main lines as at 1992;
- WE: Number of registered waiters as at 1992;
- POP: Population as at 1992;
- GDP: GDP at 1992 price.

The mobile telephone demand was forecast for the whole country analysing trends in the world. JICA analysed the tendency in increase of subscriber numbers for past years of private cellular mobile service providers in Sri Lanka as well as the experience in some countries which have offered cellular mobile telephone service in the world. Following the analysis, JICA forecast 133,400 mobile cellular telephones in 2000, 195,800 in 2005 and 332,600 in 2015.

5.1.2 Traffic forecast

(1) Conditions

Traffic of the objective network was forecast on the condition that a) the total number of subscribers of fixed lines would be 872,546 and b) that of WLL network would be 301,696 lines, respectively, in the whole country in the year 2005. These values were obtained adding its 20 % to the expressed demand as stated in Sec. 3 "Preconditions of the Feasibility Study", Chapter 1, Volume III. Mobile cellular telephone was forecast at 195,800 in the year 2005.

The traffic was calculated assuming a calling rate (origination) of 0.08 erlangs per subscriber line per busiest one hour in Colombo Metro Area, 0.055 erlangs in areas other than Colombo Metro Area taking the mean value. Mobile cellular telephone was assumed to be as 0.04 erlangs. These values were decided learning after SLT's planning values. The calling rate (origination) of WLL was decided to be as 0.065 taking the mean value of SLT and mobile celullar subscriber design value.

Traffic distribution by call categories was assumed learning after SLT's planning values and taking account of the planned participation of WLL networks in 1997. Table 4-5-1 shows the assumed calling rate in erlangs and the share by call categories of SLT network subscribers. Table 4-5-2 shows the assumed calling rate and ISC call share applied to the calculation in this project.

Table 4-5-1 Traffic Distribution Ratio by Call Categories

Area	C.R. (Erl)	SLT Network			Other networks		Total
		Own	Within SSC	Others	WLL	Others	
Colombo SSC Area	0.080	8.9%	46.6%	16.5%	26.0%	2.0%	100.0%
Other areas	0.055	8.9%	14.8%	49.3%	26.0%	1.0%	100.0%

C.R.: Traffic per line per busiest one hour. *LE.XLS/(F-5)*

Source: Information derived from SLT and SLTA information.

Table 4-5-2 Calling Rate and ISC Traffic Distribution

Network		Subscribers	C/R (O/G)	ISC rate
SLT	Colombo Metro	479,623	0.080	0.0200
	Others	392,923	0.055	0.0100
WLL		301,696	0.065	0.0150
Mobile		195,800	0.040	0.0100
Total		**1,370,042**	-	-

ISC.XLS / Feasibility Study

Source: JICA Study team.

(2) Calculation outcome

The international call traffic was calculated with the conditions stated in previous paragraph to know the ISC capacity to be provided. Table 4-5-3 shows the traffic to be routed to/from ISC.

Table 4-5-3 ISC Traffic in 2005

Network		Subscribers	Traffic(erl)
SLT	Colombo Metro	479,623	767
	Others	392,923	216
WLL		301,696	292
Mobile		195,800	78
Total		**1,370,042**	**1,354**

ISC.XLS / Feasibility Study

Source: JICA Study team.

The national trunk traffic was calculated with the conditions stated in previous paragraph to know the NSC and TSC capacity to be provided. Table 4-5-5 shows the traffic originating from each SSC based on the forecast demand in 2005.

Table 4-5-4 Traffic of SSC in 2005

SSC	Demand for SLT in 2005	Traffic (Org., Erl)	%SLT Network			%Private Networks	
			Own	Local/SSC	Others	WLL	Others
		Traffic	8.9%	14.8%	49.3%	26.0%	1.0%
Ampara	3,671	201.9	17.9	29.9	99.6	52.5	2.0
Anuradhapura	11,806	649.3	57.7	96.1	320.2	168.8	6.5
Awissawella	10,826	595.4	52.9	88.1	293.7	154.8	6.0
Badulla	10,064	553.5	49.2	81.9	273.0	143.9	5.5
Bandarawela	6,805	374.3	33.2	55.4	184.6	97.3	3.7
Batticaloa	10,790	593.5	52.7	87.8	292.7	154.3	5.9
Chilaw	11,571	636.4	56.5	94.2	313.9	165.5	6.4
Colombo	479,623	38,369.8	3,407.0	17,888.0	6,331.0	9,976.2	767.4
Galle	22,640	1,245.2	110.6	184.3	614.1	323.8	12.5
Gampaha	34,624	1,904.3	169.1	281.8	939.2	495.1	19.0
Hambantota	12,640	695.2	61.7	102.9	342.9	180.8	7.0
Hatton	3,091	170.0	15.1	25.2	83.8	44.2	1.7
Jaffna	29,371	1,615.4	143.4	239.1	796.7	420.0	16.2
Kalmune	11,005	605.3	53.7	89.6	298.5	157.4	6.1
Kalutara	31,864	1,752.5	155.6	259.4	864.3	455.7	17.5
Kandy	47,844	2,631.4	233.7	389.5	1,297.8	684.2	26.3
Kegalle	12,842	706.3	62.7	104.5	348.4	183.6	7.1
Kurunegala	22,843	1,256.4	111.6	185.9	619.6	326.7	12.6
Mannar	1,849	101.7	9.0	15.1	50.2	26.4	1.0
Matale	9,396	516.8	45.9	76.5	254.9	134.4	5.2
Matara	20,094	1,105.2	98.1	163.6	545.1	287.3	11.1
Nawalapitiya	1,884	103.6	9.2	15.3	51.1	26.9	1.0
Negombo	26,378	1,450.8	128.8	214.7	715.5	377.2	14.5
Nuwara eliya	6,147	338.1	30.0	50.0	166.7	87.9	3.4
Polonnaruwa	5,737	315.5	28.0	46.7	155.6	82.0	3.2
Ratnapura	13,646	750.5	66.6	111.1	370.2	195.1	7.5
Trincomalee	8,284	455.6	40.5	67.4	224.7	118.5	4.6
Vavuniya	5,211	286.6	25.5	42.4	141.4	74.5	2.9
National total	872,546	59,980.6	5,326.1	21,086.5	16,989.9	15,595.2	983.5

ISC (TRF-by-SSC).XLS/(F-S)

Source: JICA Study team.

5.1.3 Circuit Requirements

The number of circuits to/from ISC to be provided in the year 2000 was calculated applying the traffic corresponding to the number of subscribers in the year 2005.

Table 4-5-5 shows the calculation outcome or the number of incoming circuits of domestic side of ISC.

Table 4-5-5 Domestic Side Incoming Circuits of ISC to be provided by 2000

Network		Sw. units to ISC	Traf./SWU (in Erl.)	Circuits per Sw. Unit (voice ch.)	(2MHz)	Total CCTs (voice ch.)
SLT	Colombo Metro	6	127.90	147	5	900
	Others	11	19.65	30	1	330
WLL		2	146.09	166	6	360
Mobile		3	26.11	37	2	180
Total		22	-	-	-	1,770

ISC.XLS / Feasibility Study

Source: JICA Study team.

The total number of domestic side incoming and outgoing circuits was obtained by multiplying the present in/out ratio of international call traffic. The total came up to 5,329 in number.

Table 4-5-6 (1/2) shows the number of international circuits of ISC. See Table 4-5-18, Chapter 4, for the detail showing by destination.

Table 4-5-6 Trunk Circuits to be provided by 2000 (1/2)
(for ISC)

Item	Incoming	Outgoing	Total
Total traffic (erl)	2,709	1,354	4,062
Number of destinations	38	38	38
Number of circuits	3,189	1,742	4,931

ISC.XLS / Feasibility Study

Source: JICA Study team.

The number of circuits to/from NSC and TSC to be provided in the year 2000 was also calculated applying the traffic corresponding to the number of subscribers in the year 2005. Table 4-5-6 (2/2) shows the number of circuits for NSC to be provided by the year 2000. As to the number of trunk circuits for TSC is shown in Table 2-5-9, Chapter 2, Volume III.

Table 4-5-6 Trunk Circuits to be provided by 2000 (1/2)
(for NSC)

No.	SSC	CCTs.	No.	SSC	CCTs.
1	Awissawella	0	18	Ratnapura	30
2	Colombo	2,340	19	Ampara	0
3	chilaw	0	20	Batticaloa	0
4	Gampaha	90	21	Badulla	0
5	Kegalle	30	22	Bandarawela	0
6	Kurunegala	30	23	Hatton	0
7	Kalutara	30	24	Kalmune	0
8	Negombo	30	25	Kandy	90
9	Anuradhapura	0	26	Matalae	0
10	Jaffna	60	27	Nawalapitiya	0
11	Mannar	0	28	Nuwara Eliya	0
12	Polonnaruwa	0	29	Colombo TSC	150
13	Trincomalee	0	30	Anuradhapura TSC	150
14	Vavunia	0	31	Galle TSC	120
15	Galle	30	32	Kandy TSC	150
16	Hambantota	0	33	ISC	90
17	Matarra	30		**Total**	**3,450**

Source: JICA Study team.

5.2 Project Site

5.2.1 Overview on Site

(1) Geographic Location

The SLT proposed the Kotugoda SLT yard as the site for new ISC/NSC/TSC together with the new earth station and new landing point for SEA-ME-WE3 international submarine cable system. To investigate the feasibility of proposed site, JICA study team surveyed the site in November 1995.

The site is one of SLT property yard at Kotugoda which located beside the Air Force Headquarters at 5 km north-east of Ja Ela town as shown in **Figure 4-5-1**. It is easy to access from Colombo with 45 minutes driving of car by using the A3, B33 and B13 main roads . The site has approx. 110 hectares (1.0 x 1.1 km) flat area with bush.

(2) Site Utilisation Plan

At present, the site is partly used for the stores and radio receiving station of maritime communication. The most of all area space is not yet utilised. There are some plans on the site to be used for new training centre and housing complex for SLT that is not deeply discussed yet. In addition to such plans, the site is suitable for various facilities such as the new telecom operation centre (like new ISC/NSC/TSC), new telecom maintenance centre and new telecom industries because of large flat yard and easy access from Colombo.

5.2.2 Justification for New Telecom Centre

(1) General View

The proposed site is generally suitable to construct SLT's telecom facilities in consideration with the following features:

1) The land is already obtained as SLT's property.
2) The space is too much sufficient for various facilities.
3) The cost for land preparation is not required because of flat and vacant.
4) High tension electricity is already prepared.
5) The transportation access is easy within 1 hour from Colombo.
6) The best security will be given by the neighbour (Air Force).

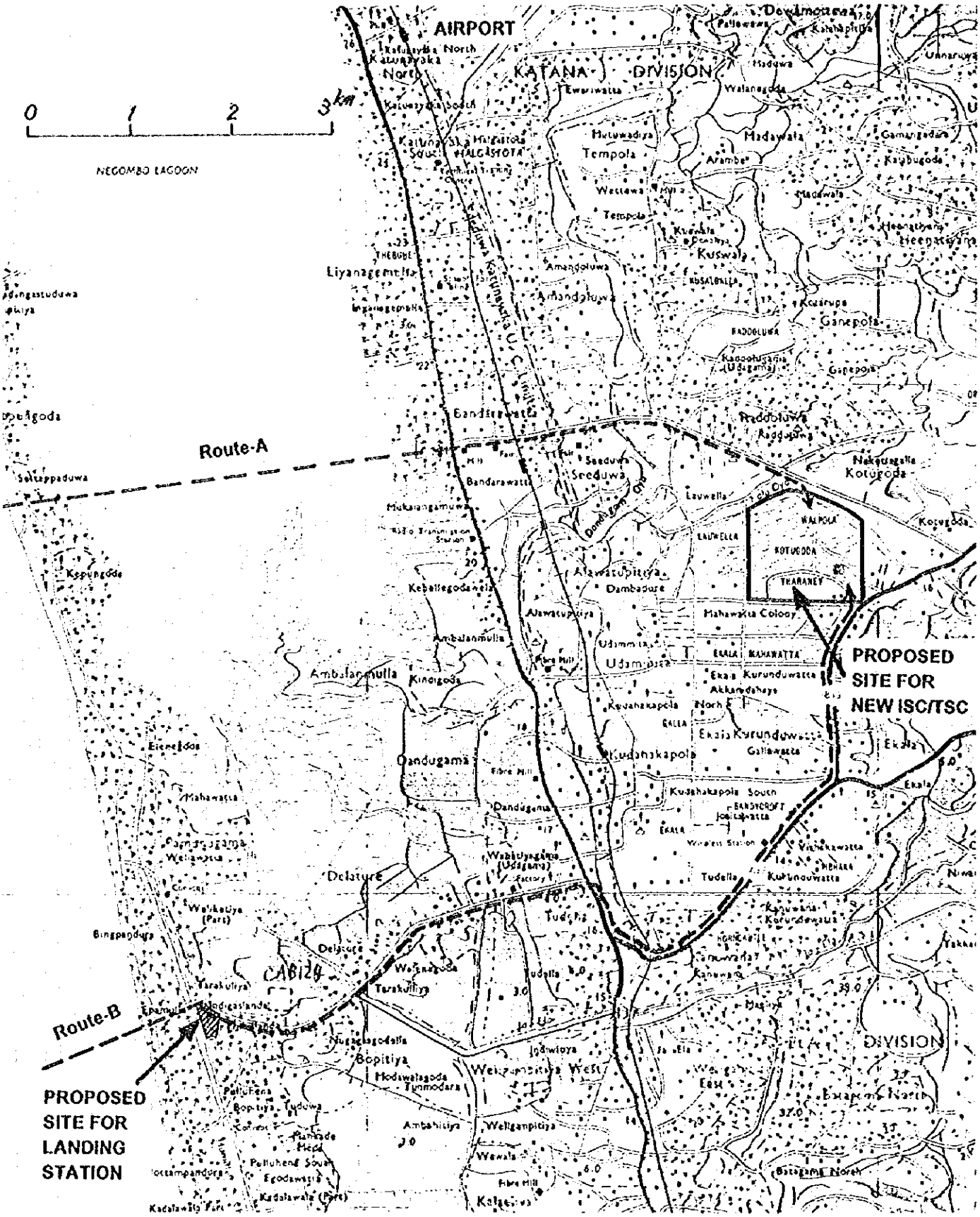


Figure 4-5-1 Location of Kotugoda New ISC/TSC Site

(2) New ISC/NSC/TSC

The site has very nice features for the new ISC/NSC/TSC (International Switching Centre, National Switching Centre and Tertiary Switching Centre) from the following considerations:

1) Within the Colombo Metro SSC area and close to Gampaha 2nd large SSC area.
2) Easy linking with major SSCs by the New Central Backbone Transmission Ring.
3) Reasonable separation from the existing Colombo ISC/TSC for backup function.
4) Common land for the New Earth Station.

The site is located in the centre of northern half of Colombo Metro SSC area and is close to Gampaha SSC area which has 2nd large telecom demand in the nation. It is easy to link with other major SSCs by the new Central Backbone Transmission Ring which covers about 80% of telephone subscribers of whole Sri Lanka as shown in **Figure 4-5-2**.

The geographical separation between the existing Colombo ISC/NSC/TSC is about 22 km which is reasonable to avoid simultaneous occurrence of unexpected damage. The internal connection is available to the new Earth Station which can be constructed in the same yard.

Therefore, the site is the best place for the new ISC/NSC/TSC which must function for the backup to Colombo ISC/NSC/TSC.

(3) New Earth Station

There are no any tall obstacles from the site to link with communication satellites on the equator. The most part of fixed satellite orbit is visible from the site.

Concerning radiowave interference, there are two noise sources, such as Ekala radio broadcast transmitting station and radar facilities at Katunayake international airport. The interference from the Ekala MF/HF broadcast transmitting station can be neglected because it is located 2 km far in south direction from the site. Based on our experiences, the separation of 1 km is sufficient to avoid the interference from such transmitting stations.

The interference from the airport surveillance radar (ASR) will also not affect the new earth station performance because the original radio frequency (2.7 - 2.9 GHz range) and 2nd harmonics are out of the used frequency range for INTELSAT communications.

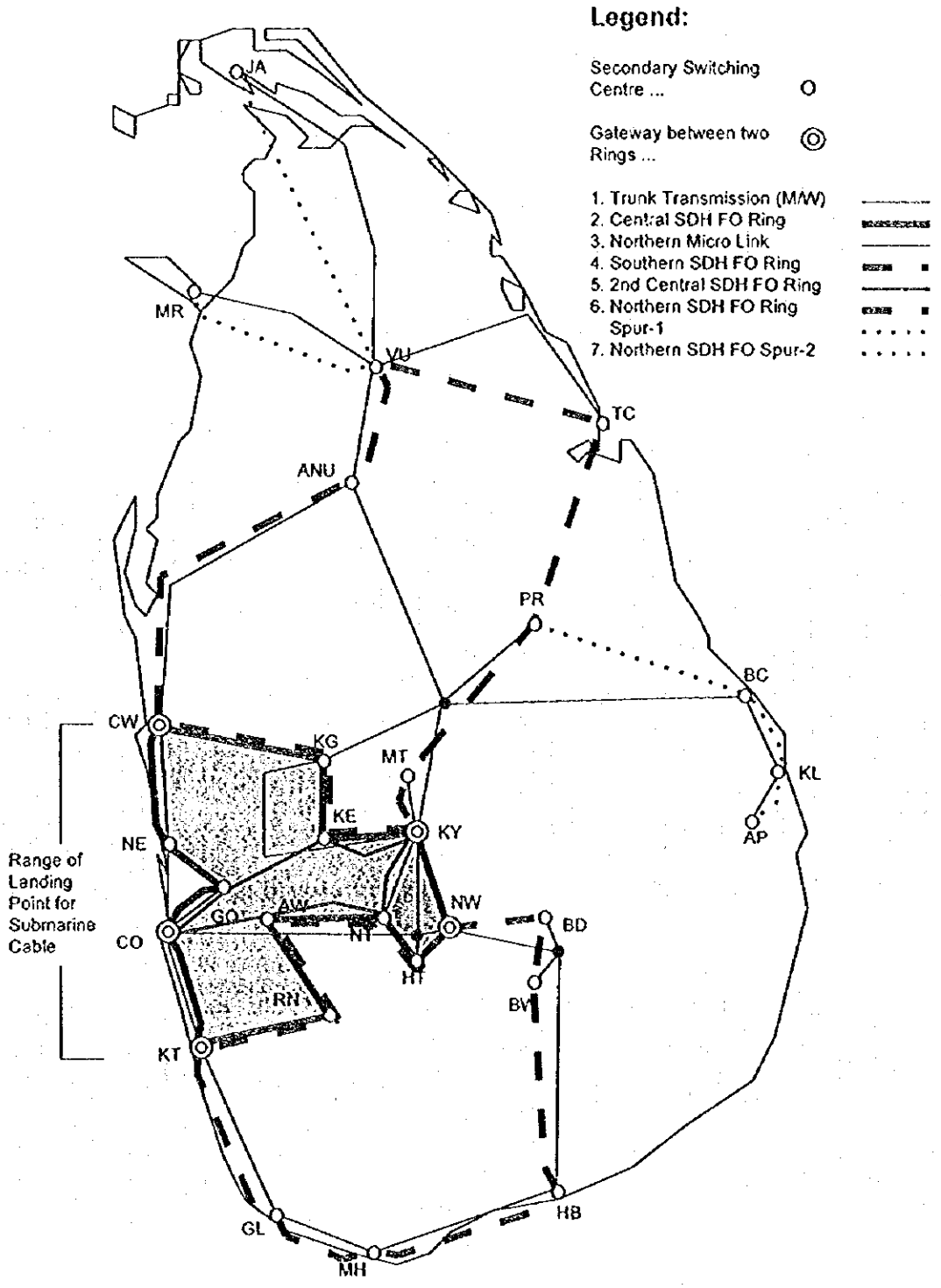


Figure 4-5-2 Backbone Transmission Ring and Submarine Cable Landing Point

However, the interference from the air route surveillance radar (ARSR) may affect the new earth station even though the ARSR is not installed yet at present. This problem is expected below.

The ARSR is operated with very high power (2,000 kW) in the frequency range of 1.30 - 1.35 GHz. If the ARSR is installed at the airport (6.5 km far from the site), the non-negligible 3rd harmonic noise will reach to the new earth station site as follow:

Pri = Pts + Gt' - Lp + Gr' = 3 + 16 - 121 - 10 = -122 dBW

where; Pri : ARSR 3rd harmonic noise (63dBW - 60dB = 3dBW)

Gt' : ARSR antenna gain for 0 elevation angle (36dBi - 20dB = 16dBi)

Lp : Propagation loss of 6.5km in 4GHz (121dB)

Gr' : Earth station antenna gain for airport direction (-10dBi)

On the other hand, based on the ITU-R recommendation SF.1006, the maximum permissible interference level is calculated as follows:

$Prp = 10 \log (kTrB) + 10\log (10^{Ms/10} - 1) + N_L - W$

$= -148.6 - 2.3 + 1 - 0 = -149.9$ dBW

The expected interference noise from ARSR is 38 dB higher than the permissible level. It is recommended that a new ARSR be located in the other place than Katunayake Airport. It is usually installed on the highland like Kandy. If it is located in the airport, the interference problem can be avoided by using the specific filter to eliminate the 3rd harmonic signal.ually installed on the highland like Kandy. If it is located in the airport, the interference problem can be avoided by using the specific filter to eliminate the 3rd harmonic signal.

Therefore, the Kotugoda site is suitable to construct the new earth station for international satellite communication links. It is advised that the wide space be kept at southern side of a new antenna to avoid further obstruction problems by neighbours.

(4) New Landing Station for Submarine Cables

The site is located 8 km far from seashore. If the submarine cable is directly led to the site, the cable must across the Negombo Lagoon in 3 km length and is buried beside the existing road in 4 km length as shown on **Route-A in Figure 4-5-1**. Damages will be given by the anchoring activities of fisherman's boats during long-term operation period. Further damages will be given by civil works to buried cable which crosses the A3 main road, railway and Dangugam Oya river. These damages will interrupts the international calls not only for Sri

Lanka but also other member countries of SEA-ME-WE Project because this landing station is used for repeating the all traffic among member countries. Therefore, the direct lead-in system is not recommended to this Kotugoda site.

The alternative landing plan **(Route-B)** is proposed as shown in **Figure 4-5-1**. On this Route-B plan, the landing station is located near the seashore west of Ja Ela town. The interconnection between the Landing Station and Kotugoda New ISC is done by the Tail Link of optic fibre cable system with 9 km length.

The another landing point be also studied by the committee of SLT. For the selection of landing point, the following conditions shall be considered:

1) The point between Chilaw and Kalutara is suitable to connect with the New Central Backbone Transmission Ring.
2) The point be selected in which damages by anchoring from ships or fisherman's activities are not expected.
3) The land space of 50m x 50m is required including underground storage space of 500m spare length for repairing damages along the seashore.

In case the another location is selected as the landing point, the new Central Backbone Transmission Ring or the new Colombo Metro Junction Ring will be utilised for the tail link between the Landing Station and Kotugoda New ISC.

5.3 Network Plan

5.3.1 Numbering Plan

(1) General

The existing numbering plan of Sri Lanka is to be changed radically before new network providers participate to the basic telecommunications service markets in 1997. The Government of Sri Lanka is going to introduce two networks by a wireless local loop (WLL) technology adding to the existing telecommunications networks provided by SLT and other private operators.

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

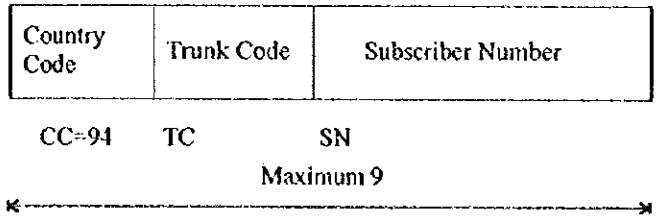
This Section intends to introduce the existing numbering plan and the direction of the numbering reform presented in SLTA's draft documents. SLT should change its existing numbering scheme in line with the new numbering plan.

(2) Number structure

Telephone number of Sri Lanka consists of Country code (CC), Trunk code (TC) and Subscriber number (SN). The CC is "94" in accordance with ITU-T Rec. E. 163. Figure 4-5-3 shows the existing number structure of Sri Lanka. The maximum number of digits of the telephone number (CC + TC + SN) of Sri Lanka is 9.

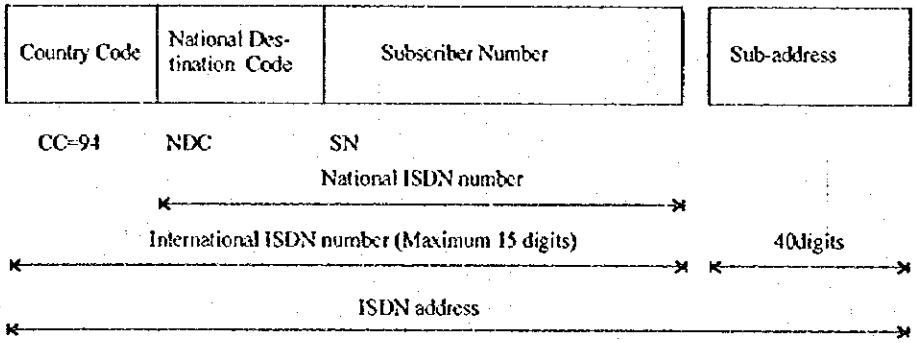
Sri Lanka plans to introduce an Integrated Services Digital Network (ISDN) in future. ITU-T Rec. E.164 recommends the number structure for ISDN era as shown in Figure 4-5-4.

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



Source: ITU-T.

Figure 4-5-3 Existing Number Structure of Sri Lanka



Source: ITU-T.

Figure 4-5-4 Number Structure for ISDN Era

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 4-5-7.

Table 4-5-7 Patterns of Existing National Significant Number

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

TC Trunk code

Exchange code

Subscriber number

Source: SLT.

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

SLT provides some 3-digit special numbers for the services to public. Table 4-5-8 shows the 3-digit numbers with corresponding services. In addition to the numbers shown in Table 4-5-8 SLT has fault reporting numbers such as "121", "122", "123", "124", "128", "128" and normal telephone numbers, the assignment of which is different by calling party's exchange code.

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

Table 4-5-8 3-digit Special Numbers for Public Services

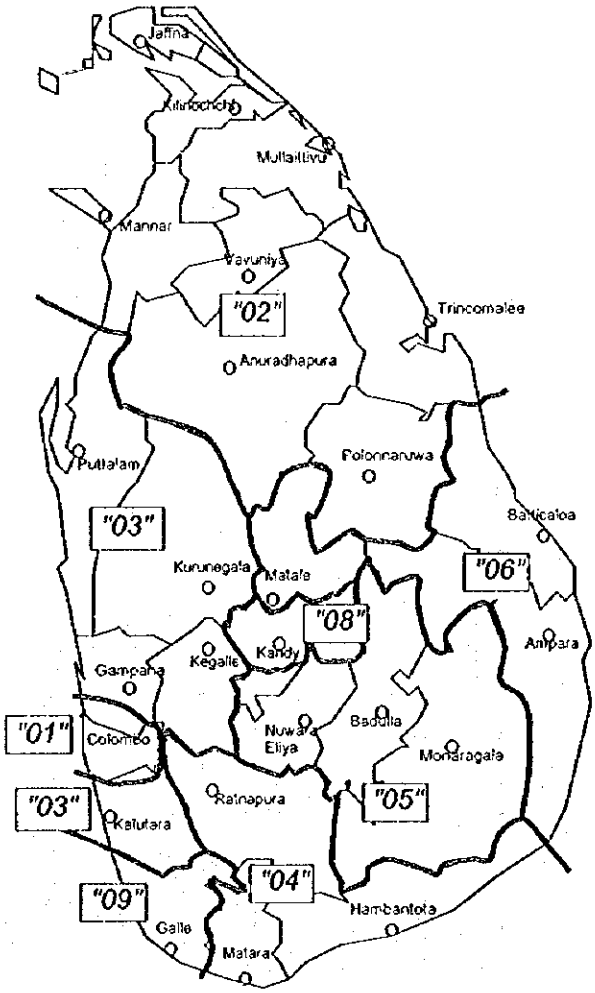
Service	Area A	Area B	Area C
Priority booking	120	-	-
Local & trunk bookings (Operator-assisted STD & Non STD)	101	101	101
Runk enquiries (Regarding charges, interruptions and delay of calls)	101	141	141
Operator-assisted alarm calls	101	101	-
Directory enquiries (Regarding telephone numbers not in the 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 4-5-5 shows the correspondence of the first digit of TC with prefix "0" and the geographical areas.



Source: SLT.

Figure 4-5-5 Existing Trunk Code First Digit

(4) Secondary Switching Centre Areas and Their Trunk Codes

SLT has four Tertiary Switching Centres (TSC) and 28 Secondary Switching Centres (SSCs) coming under TSCs. SLT distributes the SSCs in the whole Island giving one TC respectively. For a trunk call, the SSC trunk code is dialled before the exchange code and subscriber number. Colombo, Galle and Kandy have 1-digit TC and others have 2- to 3-digit TC. Table 4-5-9 shows the existing SSCs and their TCs.

Table 4-5-9 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.

(5) Present Number Capacity

(a) Destination Network Codes

Several private networks exist in Sri Lanka. Sri Lanka Telecommunications Authority (SLTA) intends to introduce, at a first estimate, 6 entities for Cellular service, 6 entities for paging service, and several entities for data communications network service. Some of them have inaugurated the services. Among them Mobitel, Celltel, Air Lanka, MTN and Call Link are identified by trunk codes "71", "72", "73", "77", and "78". The rest of trunk codes are recognised as the trunk codes of Sri Lanka Telecom (SLT) network. The trunk codes are used practically as the destination network (DN) codes. Table 4-5-10 shows the existing assignment of the first and second digits of NSN of Sri Lanka.

Table 4-5-10 Existing Assignment of the First and Second Digits of NSN of Sri Lanka

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

Source: SLT.

Trunk codes starting with "7" are assigned to the networks operated by entities other than SLT. However, free (not used) codes are few as found in Table 4-5-10. It is not sufficient to meet the planned numbers of new entrants. New services will require new trunk codes or destination network codes in future.

(b) Trunk codes of SLT network

SLT uses the NSN first digits "1" to "9" except "7", which is assigned as DN code for private companies' network, for providing the trunk codes (TC). The SLT trunk code consist of two digits except that of Galle, Colombo and Kandy. SLT keeps vacant 2-digit combinations more than 30 at present as found in Table 4-5-10, which are available for new SSCs to be introduced in future. Hence, the trunk code numbering capacity of SLT is sufficient if SLT remains with the existing numbering scheme.

(c) SLT Exchange codes and subscriber numbers

i) Colombo area

Colombo area is numbered by a six-digit numbering system. Table 4-5-11 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 4-5-11 Present Assignment of Exchange Codes and Subscriber Numbers in Colombo (as of Dec. 1994)

LOCAL AREA	Existing Demand (June 1994) Total	DEL	Waiters	Present No. Plan
ANGODA	2,154	326	1,828	578xxx
BORALESGAMUWA	2,564	1,473	1,091	509xxx/518xxx
CENTRAL	44,106	35,428	8,678	
HAVELOCK	22,535	17,885	4,650	
HOKANDARA	1,443	178	1,265	561xxx
HOMAGAMA	2,526	482	2,044	855xxx,857xxx
JA-ELA	5,672	1,323	4,349	536xxx-537xxx
KADAWATHA	3,786	656	3,130	525xxx
KADUWELA	1,442	193	1,249	5710xx-5714xx
KATUNAYAKE	4,599	1,687	2,912	452xxx-453xxx
KELANIYA	7,249	1,541	5,708	520xxx-521xxx
KOLLUPITIYA	6,770	4,047	2,723	573xxx-577xxx
KOTTE	16,556	7,158	9,398	862xxx-869xxx 87xxxx-89xxxx
MAHARAGAMA	9,013	1,543	7,470	850xxx-851xxx/84xxxx
MALWANA	1,399	419	980	5715xx-5719xx
MAKADANA	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	541xxx
CENTRAL CITY	15,972	15,972		421xxx-423xxx 43xxxx/44xxxx
CENTRAL SESS	18,802	18,802		32xxxx-33xxxx
HAVELOCK	18314	13664	4650	500xxx-503xxx ,58xxxx,508xxx
HAVELOCK TDM	4221	4221		59xxxx

Source: SLT.

This area has around 67% of the total equipped exchange capacity 237,586 of SLT. A six-digit numbering capacity is 500,000 to 600,000 subscriber lines practically. In this sense, the existing numbering capacity is sufficient to the equipped capacity in Colombo.

ii) Areas other than Colombo

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

(6) Expansion of Numbering Capacity

(a) General

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

(b) Length of NSN

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

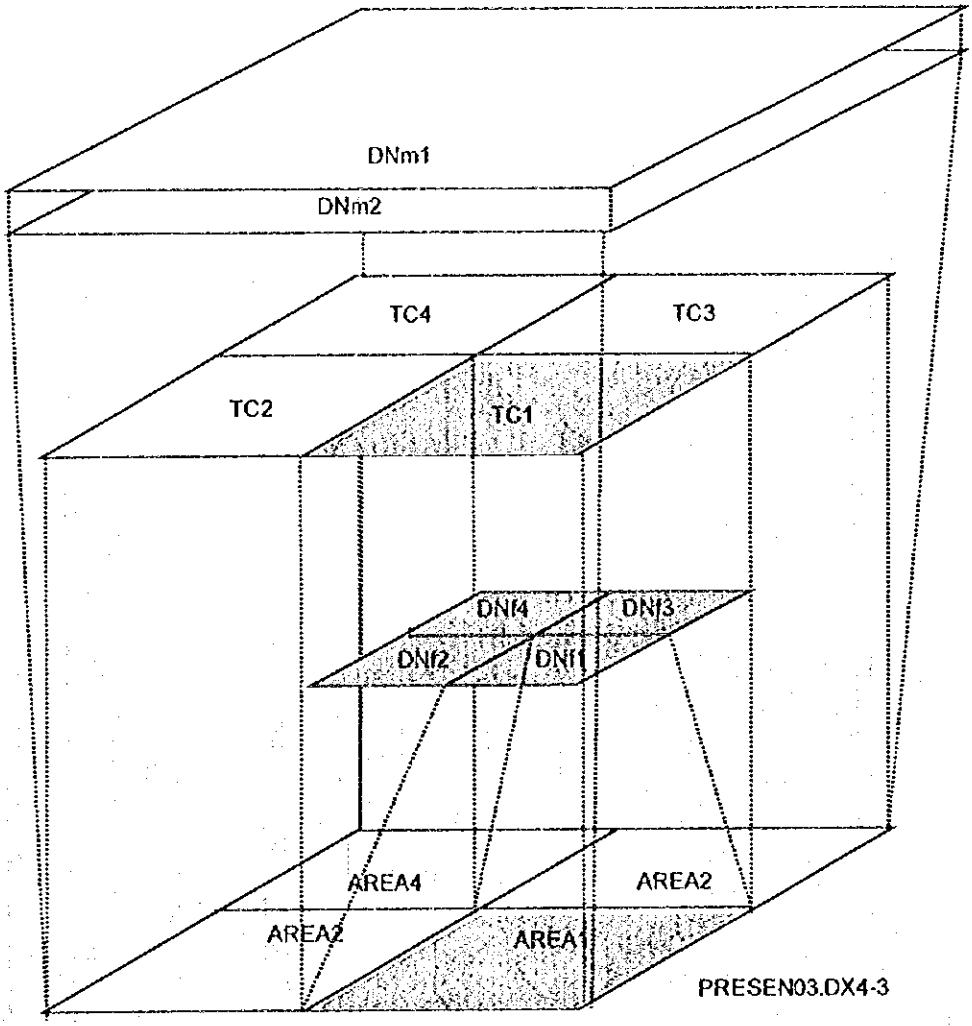
(c) Destination Network Code

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

Figure 4-5-6 shows the concept of numbering scheme of DNC to be applied to the Sri Lankan telecommunications networks after WLL network participation. In Figure 4-5-6, it is found that one TC (TC1) corresponds to one AREA (AREA1), but four DNs correspond to that area (AREA1).

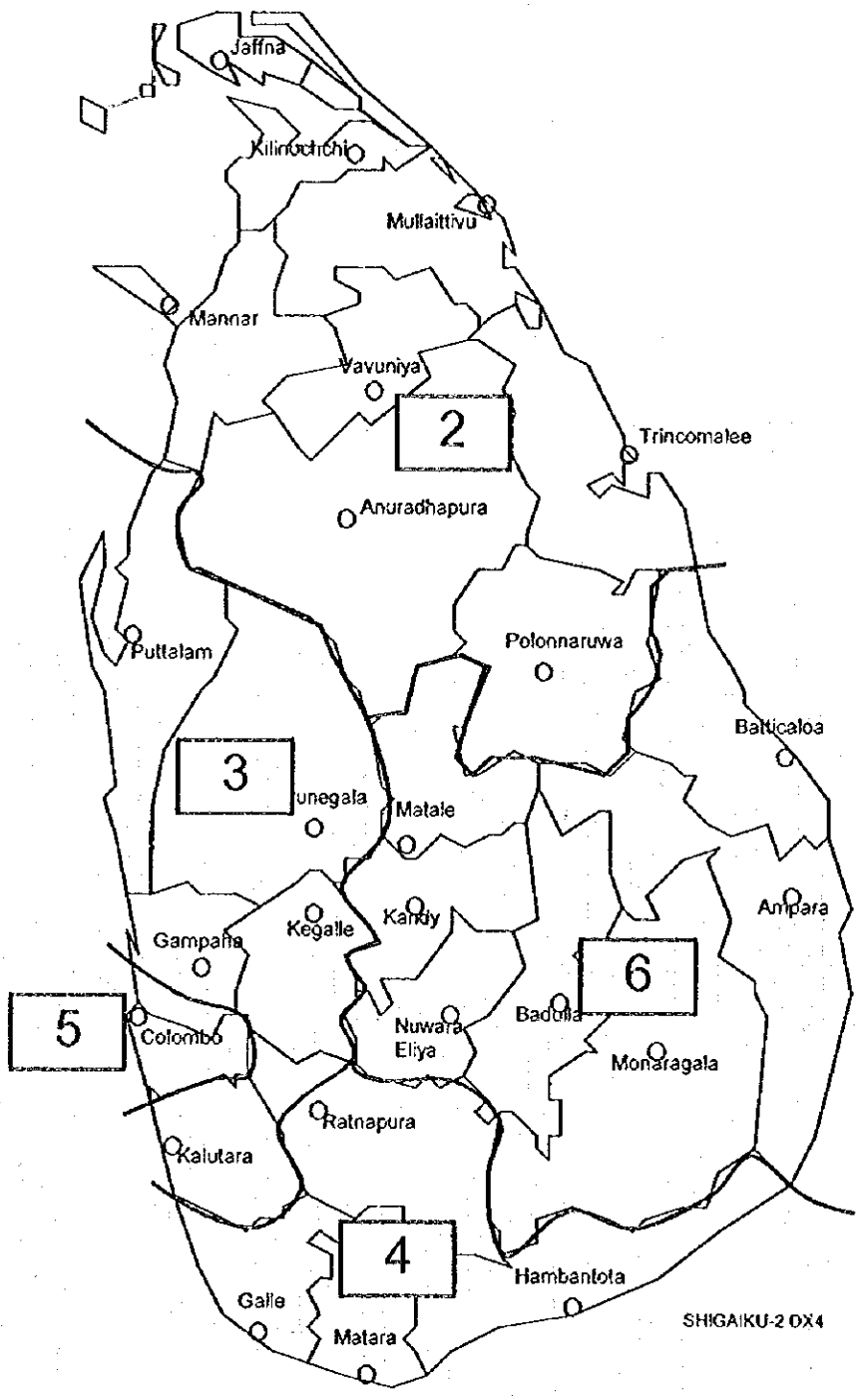
SLTA intends to reduce the number of trunk call areas. The trunk call areas or the SSC areas are 28 at present. It will be reduced to five areas.

Figure4-5-7 shows the first digit assignment of the fixed line networks in Sri Lanka after the introduction of a closed numbering scheme. Table 4-5-12 shows the planned DNC table.



Source: Information derived from SLT and SLTA information.

Figure 4-5-6 DNC Scheme after WLL Network Introduction (Draft)



Source: SLTA.

Figure 4-5-7 Closed Numbering First Digit Assignment in Future (Draft)

Table 4-5-12 Planned DNC in Future (Draft)

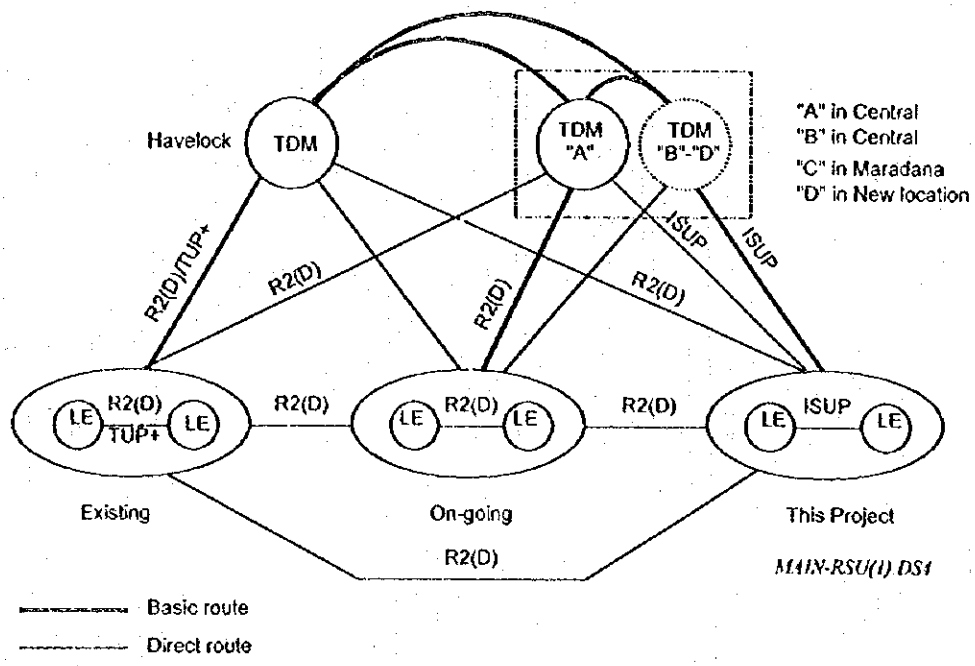
		1	2	3	4	5	6	7	8	9	0
1	Short Codes	Short Codes	Short Codes	Short Codes	Short Codes	Short Codes	Short Codes	Short Codes	Short Codes	Short Codes	Short Codes
2	North Region	Jaffna, Mannar, Vavuniya				Anuradhapura, Trincomalee, Polonnaruwa			New WLL Operators	Reserve	
3	Outer Colombo Region	Negombo, Chilaw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

Source: SLTA.

5.3.2 Signalling System

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

The new tandem switch to be introduced under on-going projects should be equipped with standard CCS No. 7 of ITU-T Blue Book. All the new exchanges to be introduced under new projects should also be equipped with standard CCS No. 7 of ITU-T Blue Book. Figure 4-5-8 shows a proposed signalling links between LEs and tandem exchanges. In Figure 4-5-8, Central TDM "B" to "D" present the virtual of TSC switching systems.



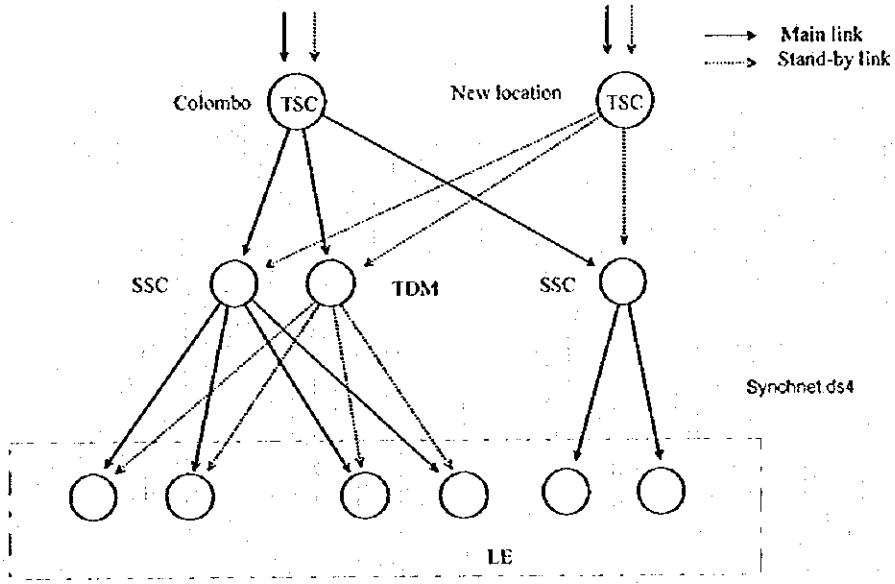
Source: JICA Study team.

Figure 4-5-8 Signalling Links between Local and Tandem Exchanges

5.3.3 Network Synchronisation

(1) Reference clock network structure

SLT reference clock network should be established in a tree form. National Switching Centre (NSC) and Tertiary Switching Centres (TSC) will come under ISCs, Secondary Switching Centres (SSC) will come under TSCs, Local Exchanges (LE) will come under SSCs, in principle. The reference clock links should be consisted of main and stand-by links. The reference clock pulses will be transferred from ISC to NSC and TSC, from TSC to SSC, and from SSC to LE. Figure 4-5-9 shows a proposed reference clock network in Colombo TSC area.



Source: JICA Study team.

Figure 4-5-9 Reference Clock Network in Colombo TSC Area

(2) Reference Clock Accuracy and Stability

ISC by NEAX 61-E (herein after referred to as ISC-A) and ISC by 5-ESS (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} in Colombo SSC Area.

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 ISC-A and ISC-C of the SLT network should be the gate switches to/from other networks.

(3) 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 to the rest through NSC and TSC.

5.3.4 Engineering Standards

(1) Traffic engineering

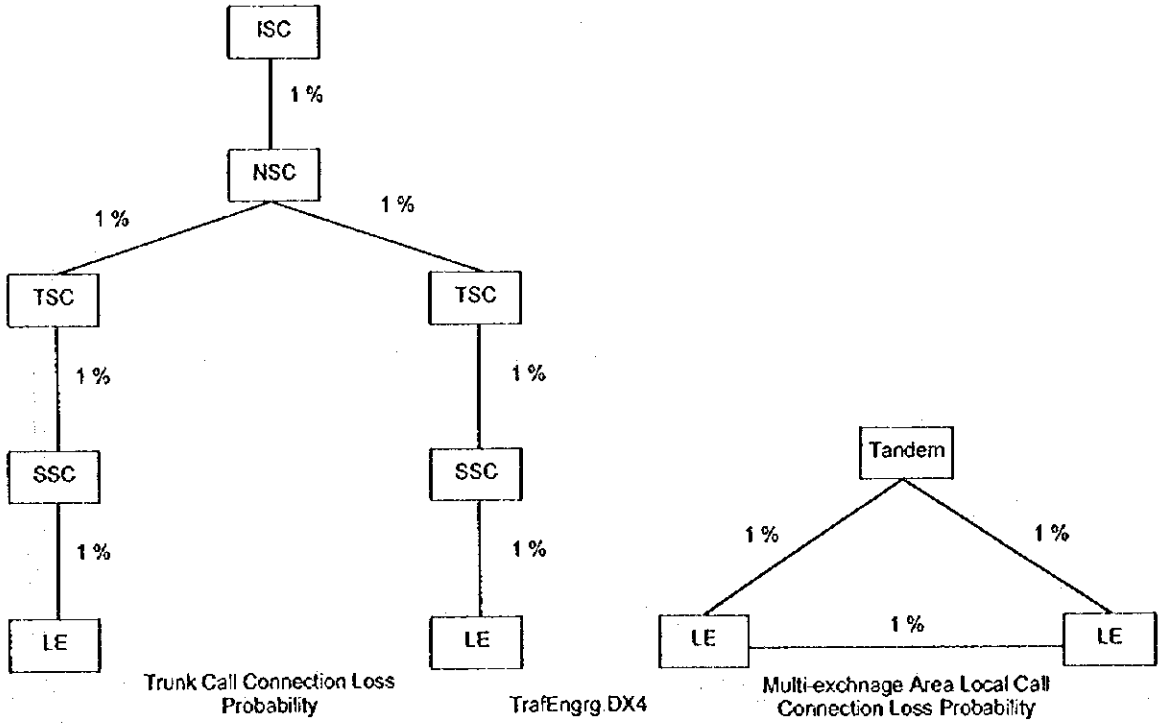
The following standard of loss probability to connections between two exchanges should be applied to the network under this project.

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

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

b) Connection loss probability distribution:

for basic route:	1 % per link (See Figure 4-5-10);
for short-cut route:	1 % per link.



Source: SLT.

Figure 4-5-10 Connection Loss Probability between Two Exchanges

Design objective of probability of inadequately handled call attempts occurring in a digital exchange should be as shown in Table 4-5-13.

Table 4-5-13 Probability of inadequately handled call attempts

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

Source: ITU-T REC. Q. 543.

(2) Transmission Performance

There are so many factors affecting transmission performance, and the standard for them is recommended by ITU-T. Loudness Rating (LR) and Bit Error Rate (BER) are regarded as main performance measures in general. Table 4-5-14 shows details of loudness ratings recommended by ITU-T.

Table 4-5-14 Values of Sending, Receiving, Circuit and Overall Loudness Rating

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

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

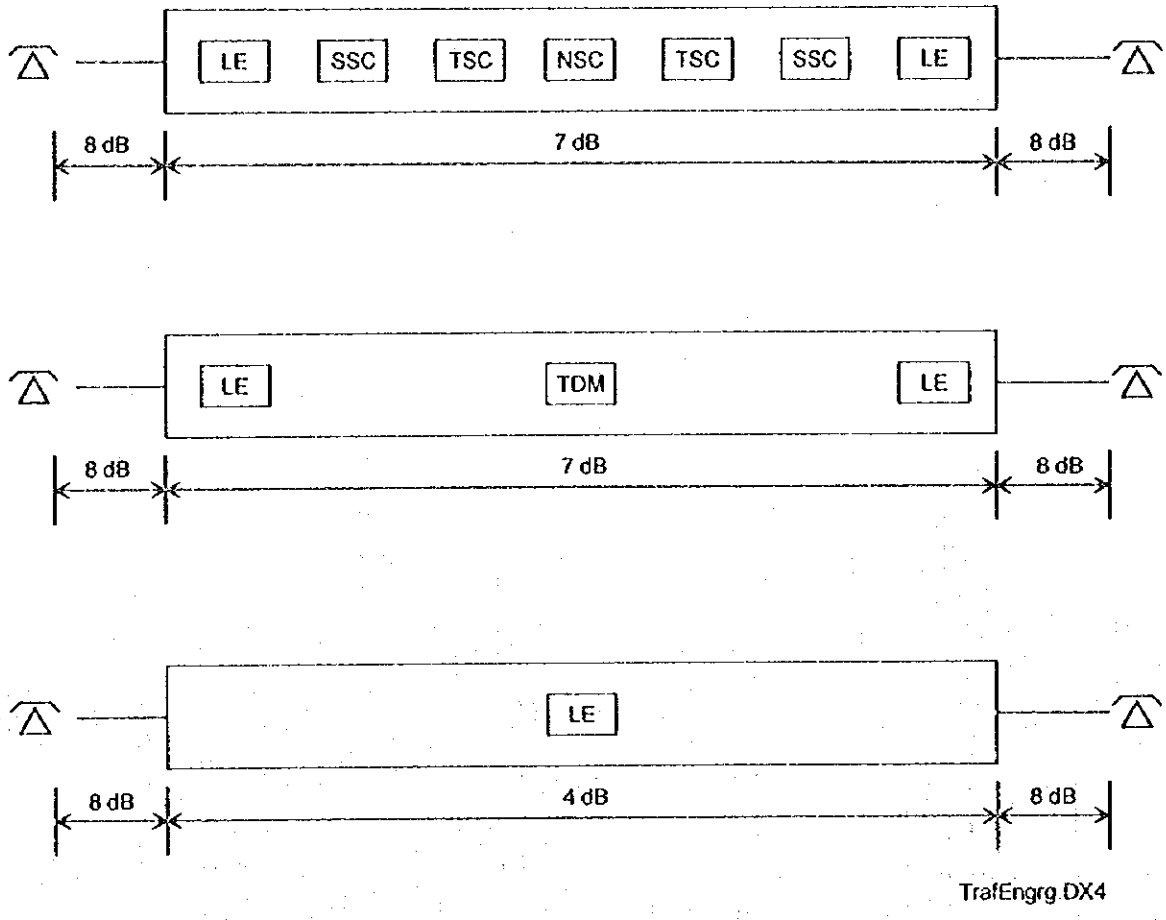
Note 2: n is the number of analogue international circuits.

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

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

Source: ITU-T Recommendation G.111

Figure 4-5-11 shows the example of LR allocation in the SLT network.



Source: JICA Study team.

Figure 4-5-11 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 4-5-15 below.

Table 4-5-15 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.

5.3.5 Charging System

(1) Call unit

The automatic telephone call of SLT network is charged in proportion to its duration. The duration is converted to equivalent number of call units based on the tariff. Table 4-5-16 shows the time allowed for one call unit.

Table 4-5-16 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 5-2-10 and converted to call units to record as charge data at automatic exchange. Digital exchanges have the function to record the call charge data stored in the call charge accumulator corresponding to each subscriber number on suitable data media. Analogue cross-bar exchanges without such

function have call meters corresponding to each subscriber number. Step-by-step exchanges have no function of trunk call charging and their subscribers are requested to ask operators for the trunk calls.

(2) Charging Node

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

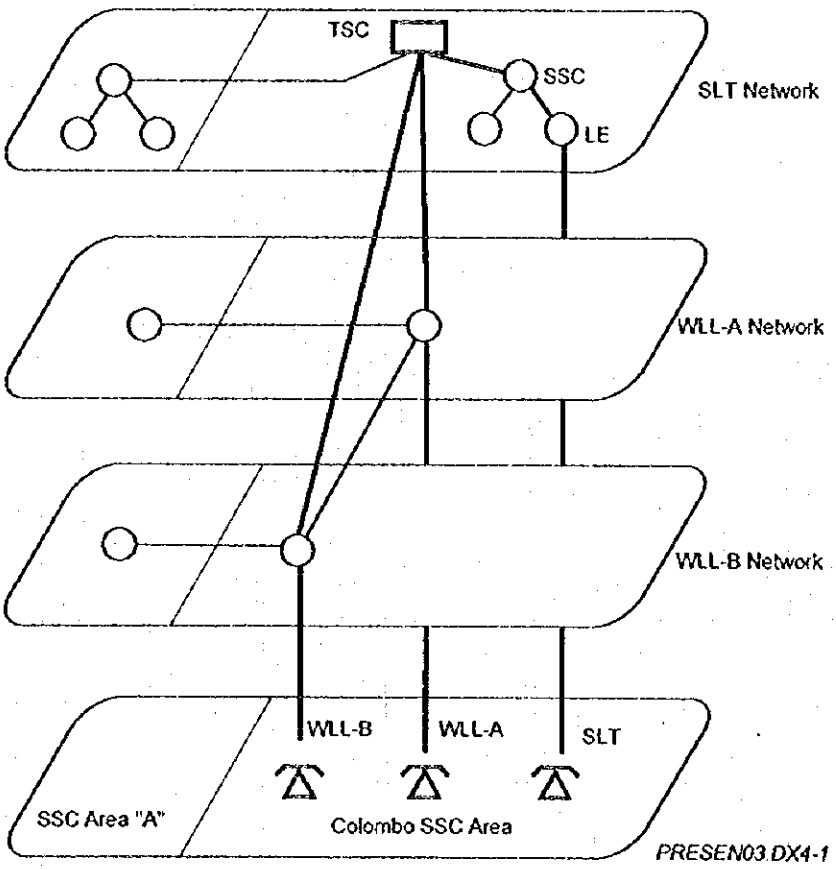
In the objective area, the local switching system to introduced under this project should be equipped with a function of detailed billing for trunk calls in addition to the local call charging function.

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

5.3.6 Interconnection with Other networks

(1) Interconnection with WLL networks

The *"Invitation for wireless local loop operators' licences" (30/Aug./1995)* stipulates that SLT's TSCs should be the interconnection points to other WLL networks. Figure 4-5-12 shows a general view of overlaid SLT and WLL new networks taking an example in Colombo SSC area.



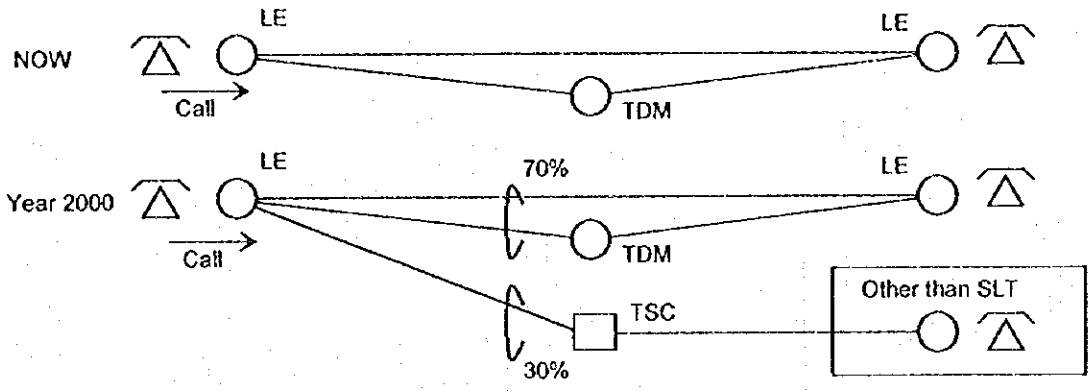
Source: Information derived from SLT and SLTA information.

Figure 4-5-12 Overlaid SLT and WLL Networks in 1997

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

recommends SLT to introduce new TSC units to meet the traffic in the year 2000 and requirements for the gateway switch in the multi-network era.

JICA forecast a total of 813,752 lines of demand for the fixed line network in the year 2000 including a hidden demand of 20% of expressed demand, among them 613,858 lines by SLT network. According to the JICA forecast, around one quarter of subscribers in the country will be catered by new WLL network providers in 1997. The tendency is supposed to go on for years as discussed in Cap. 1. In the case of Colombo Metro Area, as WLL networks are supposed to start their service there first, around 30 % of local call traffic will be routed to TSC. Figure 4-5-13 shows an example of traffic flow change in Colombo SSC area in the case new WLL networks are in operation as forecast in 2000.



Source: Information derived from SLT and SLTA information.

Figure 4-5-13 Traffic Flow after WLL Participation in Colombo in 2000

(2) Interconnection with mobile networks

The SLT gate-way switch to mobile networks is NSC. It is the second unit of NSC unit "B" which is a product of AT&T called "5-ESS" and was introduced in 1992. It has a capacity of 12,000 inter-exchange circuits. Among them 9,000 inter-exchange circuits are in use as at 1995. It is not equipped with CCS No. 7 signalling function. The new unit of switching system of NSC to be introduced in Kotugoda under "ISC, TSC and Earth station Project" will be used as another gate-way switch to mobile networks.

(3) Interconnection with IN layer

JICA recommends SLT to equip the new NSC unit with an IN layer gateway switch function under a project separate from this project. The IN layer gateway switch function is to be purchased together with IN layer facilities.

IN layer facilities will enable SLT to offer advanced services such as trunk free call service known as "800 call service" in many countries and premium charge call service. These services are available even before SLT introduces ISDN if the new NSC unit is equipped with IN gateway switch function. More information on IN services is given in Sec. 11 "Intelligent Network", Chapter 8, Volume II.

5.3.7 Switching Network

(1) Existing switching network

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

SLT telephone network hierarchy is consisted of ISC (International Switching Centre), NSC (National Switching Centre), TSC (Tertiary Switching Centre), SSC (Secondary Switching Centre) and LE (Local exchange). Some local exchanges are of main switching system and others are of remote unit of switching system. Figure 4-5-14 shows a general view of SLT national network.

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

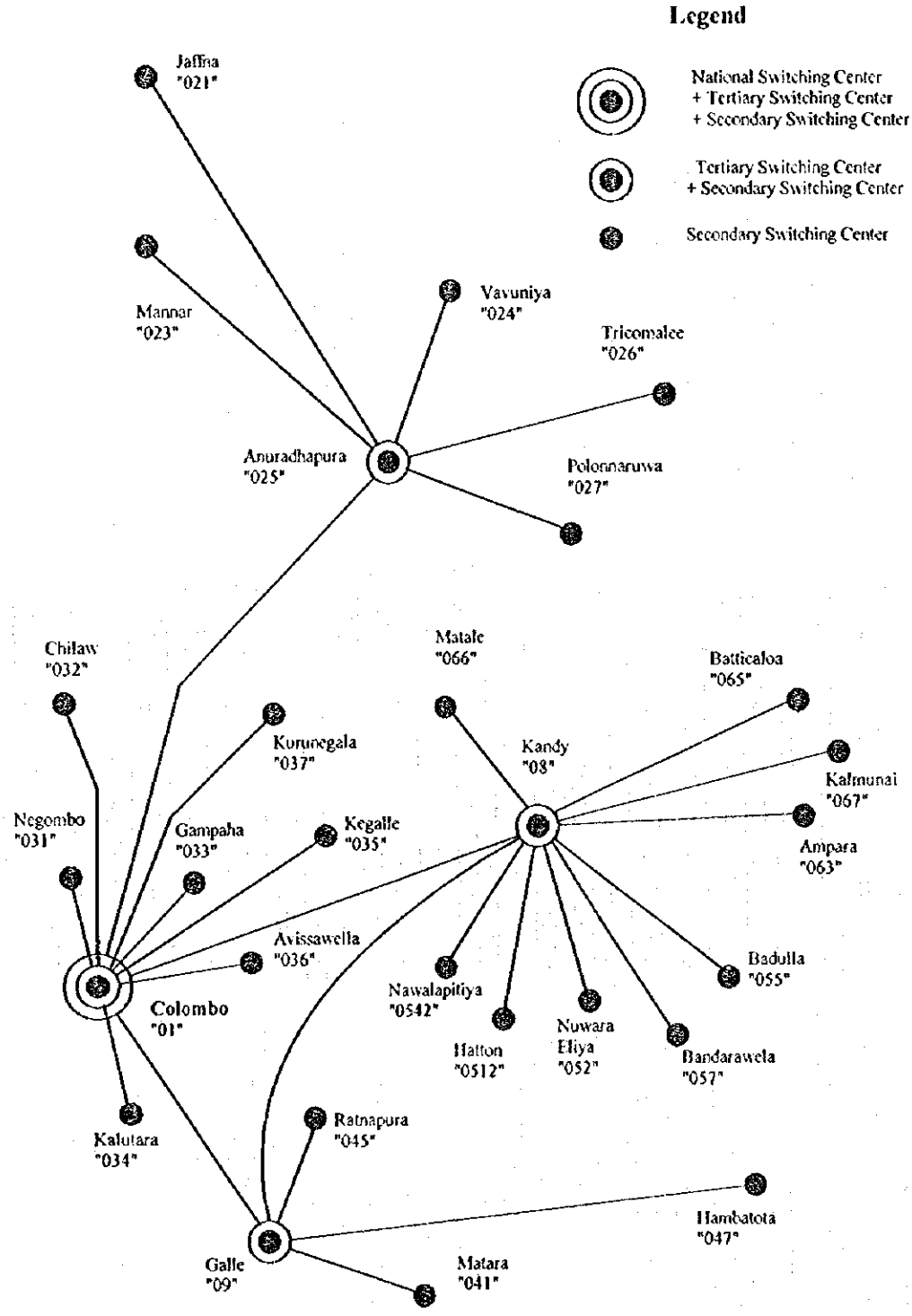
The second unit of NSC (hereinafter referred to as Unit "B") is a product of AT&T called "5-ESS" and was introduced in 1992. It has a capacity of 12,000 inter-exchange circuits. Among them 9,000 inter-exchange circuits are in use at present. It is not equipped with CCS No. 7.

In the Colombo Metro Area the NSC assumes the function of TSC (Tertiary Switching Centre) and SSC (Secondary Switching Centre) of Colombo Metro SSC Area. That is, there is no hardware proper to TSC or SSC in this area.

In the Colombo Metro Area, one unit of tandem switch (TDM) is situated at Havelock exchange. A new TDM will be introduced under the on-going project. The main exchanges are linked in the form of mesh network and the remote switch units are placed under respective main (host) exchange. Figure 4-5-15 and 4-5-16 shows the main exchanges and their remote switch units in Colombo Metro Area as of April 1995 and in 1997.

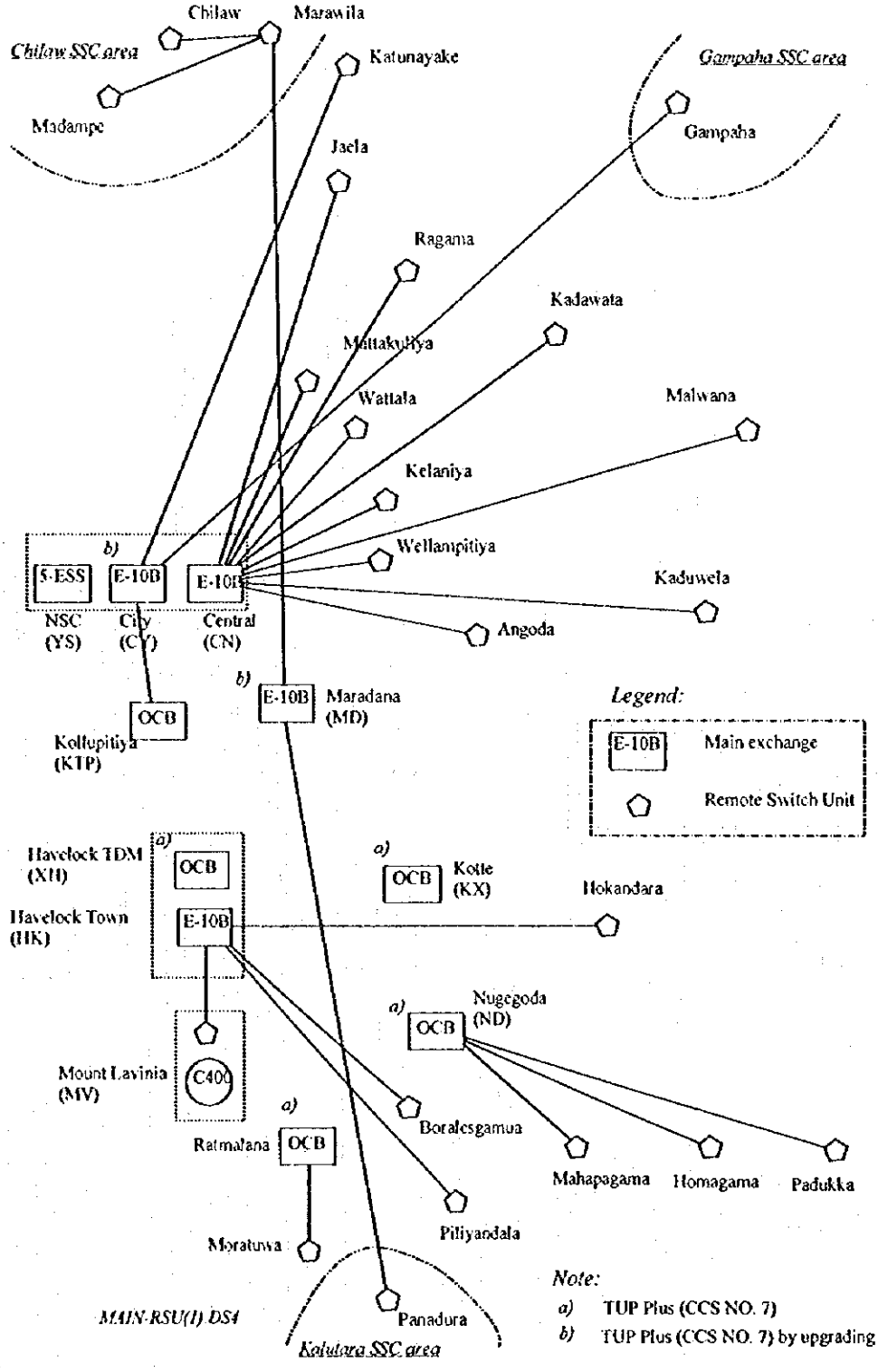
In the areas other than Colombo Metro Area, TSC is a multi-function switching unit serving simultaneously as SSC and LE mostly. SSC is also a multi-function switching unit of transit and local exchange in most cases. Most LEs are remote switch units of TSC or SSC.

SLT is now expanding its network in the whole country by on-going projects which are planned to be completed in 1997. Table 4-5-17 shows the planned capacity of exchanges in 1997.



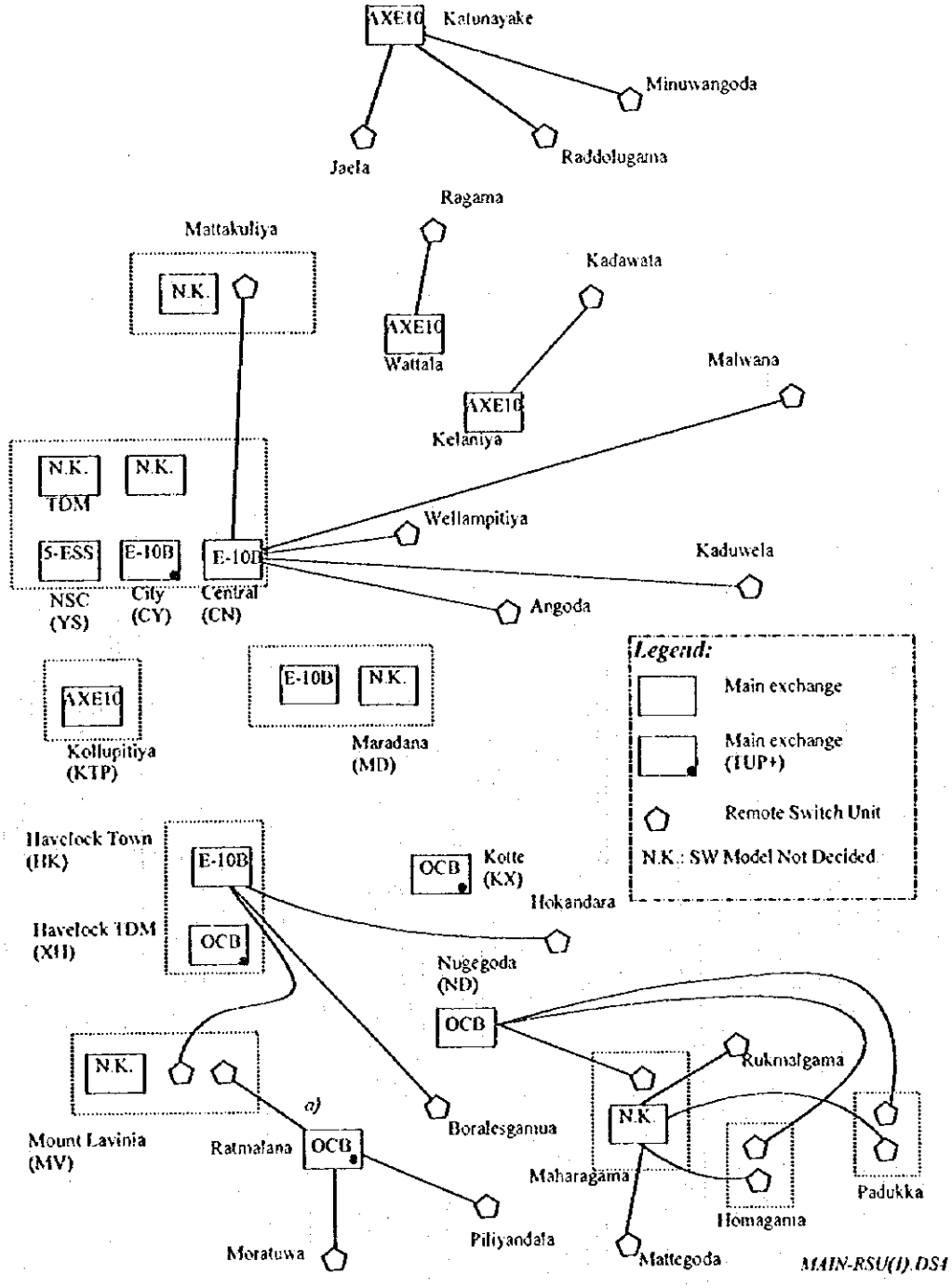
Source: Information derived from SLT information.

Figure 4-5-14 General View of SLT Network in 1995



Source: JICA Study team.

Figure 4-5-15 Exchanges and RSU Belonging Scheme in Colombo Metro Area as of April 1995



Source: JICA Study team.

Figure 4-5-16 Exchanges and RSU Belonging Scheme in Colombo Metro Area in 1997 Based on the Plan as of September 1995

Table 4-5-17 Planned Switch Capacity in 1997

SSC	Switching Capacity As at 30/06/95	Effective Capacity As at end of 1997
Ampara	500	3,644
Anuradhapura	3,858	6,858
Awissawella	2,640	5,000
Badulla	3,712	7,172
Bandarawela	2,420	3,940
Batticaloa	1,700	7,196
Chilaw	3,202	8,470
Colombo	168,543	316,027
Galle	5,126	19,555
Gampaha	4,982	11,484
Hambantota	4,326	8,402
Hatton	908	3,024
Jaffna	0	0
Kalmune	900	6,524
Kalutara	6,488	50,820
Kandy	11,819	47,254
Kegalle	3,364	6,672
Kurunegala	4,806	15,260
Mannar	600	1,400
Matale	2,887	10,628
Matara	12,547	15,000
Nawalapitiya	449	1,220
Negombo	4,252	13,600
Nuwara eliya	3,392	4,912
Polonnaruwa	1,050	5,450
Ratnapura	3,858	10,178
Trincomalee	954	4,650
Vavuniya	609	2,692
National total	259,890	597,032

Source: SLT.

(2) Proposed new network of SLT

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

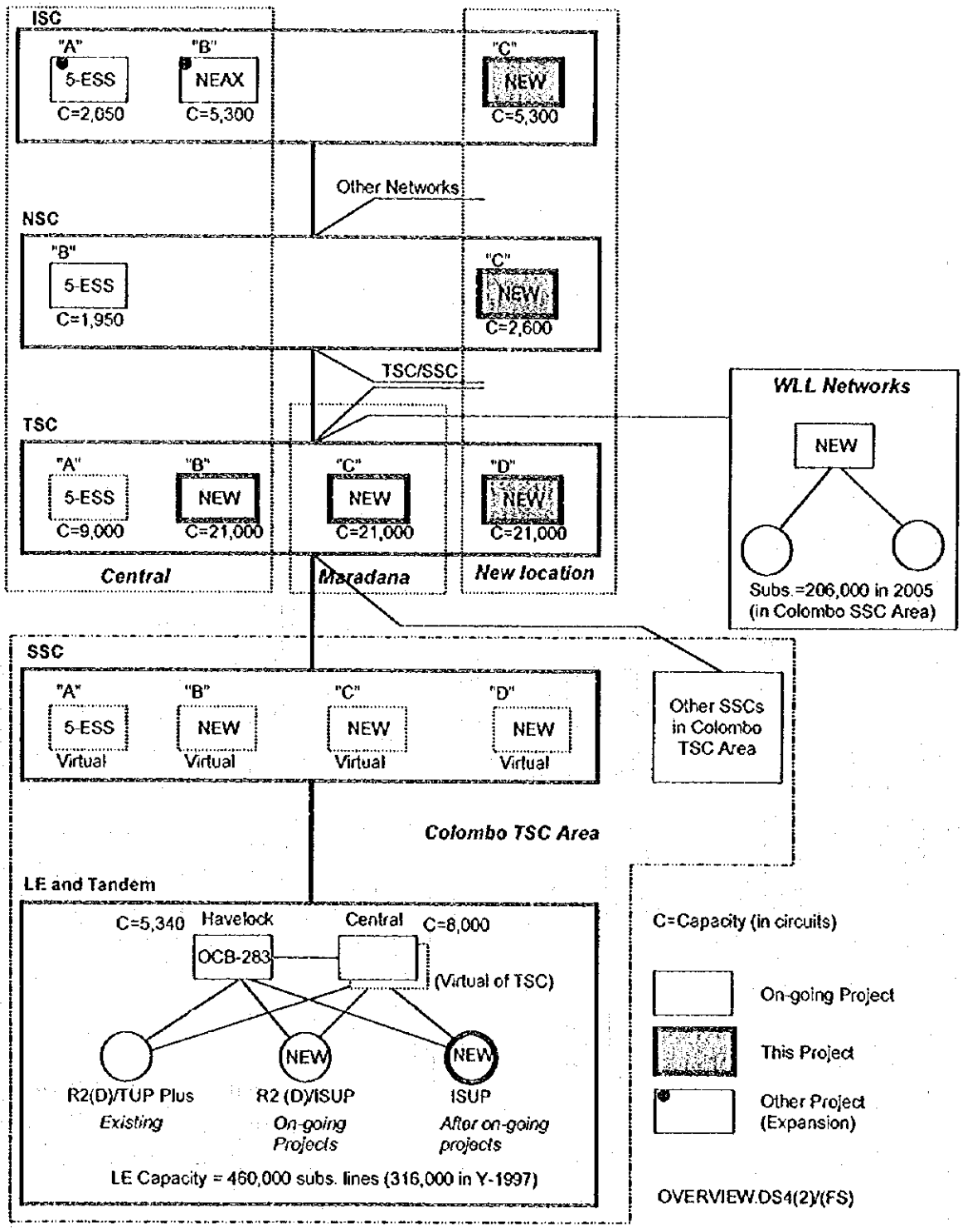
Some units of switching systems will be introduced under projects according to the demand forecast. It is necessary to introduce a new unit of international gateway switch, a new unit of NSC switch, and some units of transit switches, and capacity increase of local exchanges.

In this project, one (1) unit of ISC, one (1) unit of NSC and one (1) unit of TSC switching system will be introduced to meet the traffic increase by the year 2005. The new TSC unit is for Colombo TSC Area. Figure 4-5-17 shows the network in the year 2000 proposed under this project. Those transit switches' capacity expansion is required to meet the traffic increase to be brought about as the number of subscribers will be around five times in 2005 comparing to that at the end of 1994.

The proposed new ISC will contribute to provide more capacity of international switch to Sri Lankan network. The proposed new NSC should also be used as a gateway switch to IN (intelligent network) service layer in future. The gateway switch function should be given on the occasion of purchasing IN facilities separate from this project.

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

According to the preconditions of this feasibility study discussed in Chapter 1, Volume III, around 30% of fixed telephone lines will be catered by WLL networks in Colombo Metro area, and 26 % in whole the country, in 2005. This means nearly one-third of local and trunk traffic originated from the SLT subscribers will be routed to the interconnection point between SLT network and WLL network, or TSC. Based on this calculation, the SSC function and a part of TDM function was entrusted to TSC in the case of Colombo Metro Area.



Source: JICA Study team.

Figure 4-5-17 Proposed Network in Colombo Metro Area in 2000

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

Colombo TSC will be consisted of four (4) units of transit switch: Unit "A", "B", "C" and "D". See Figure 5-3-11. This was so decided based on the forecast traffic flow and taking account of reliability of transit level network. Under such structure, nearly 75% of circuits required to normal traffic load will be available in case where one of the four units goes out of service by failure.

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

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

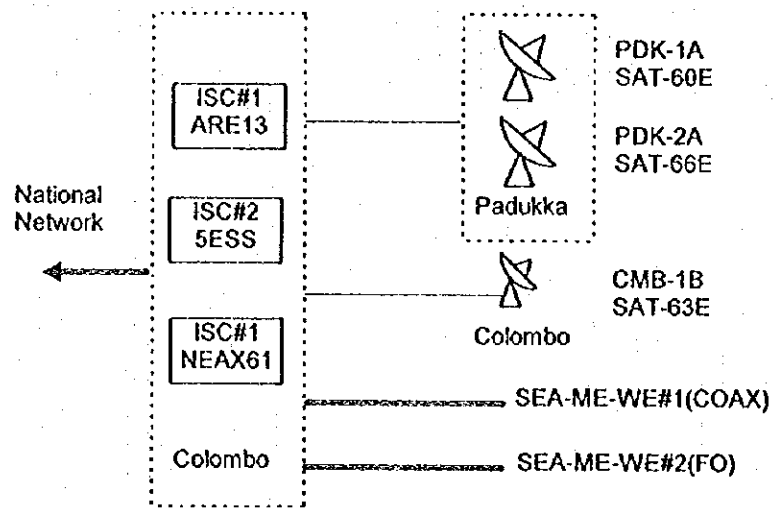
5.3.3 International Transmission Network

(1) Existing Network

The following five (5) international transmission systems are exist, and carries international traffic to/from 37 destination international carrier companies:

1) Padukka Standard-A Earth Station No.1 Antenna (PDK-1A)
2) Padukka Standard-A Earth Station No.2 Antenna (PDK-2A)
3) Colombo Standard-B Earth Station No.1 Antenna (COL-1B)
4) SEA-ME-WE Submarine Cable No.1 (SEA-ME-WE#1)
5) SEA-ME-WE Submarine Cable No.2 (SEA-ME-WE#2)

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, SCPC and IDR transmission. PDK-2A new earth station at Padukka for IDR, has just established in August 1995. COL-1B earth station (INTELSAT-B type) at SLT headquarters was commissioned in 1990, and is being operated for IDR transmission. 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 October 1994. Both submarine cables are landed at Colombo and terminated to the Colombo Central Exchange. **Figure 4-5-18** shows the overall network configuration of these systems.



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

Figure 4-5-18 Existing International Transmission Systems

(2) Proposed New Network

At present, all international transmission links are concentrated into Central Exchange located inside Colombo city. It is not so safe from the viewpoint of security. To solve this problem, JICA team proposes to establish 2nd ISC outside Colombo city. As mentioned before, the location for new international gateway centre is proposed at Kotugoda. The new earth station be constructed at same site of Kotugoda New ISC on the following reasons:

1) Two kinds (cable and radio) of links be connected to improve security.
2) Reliable international links can be realised by direct access without tail link.
3) Total capacity (762 cct.) of 3 existing earth stations is very small to required total international circuits (4931 cct.) in the year 2005.

On the other hand, SLT is going to rehabilitate the Padukka No.1 earth station facilities for IDR transmission with 141 circuits. And, instead of the existing SEA-ME-WE#1 system, the new submarine cable system will be landed at Mt. Lavinia under the SEA-ME-WE#3 project. SLT reserved the 780 circuits (30ch x 26 systems of 2Mbps) on this new submarine cable.

Considering the abovementioned matters, JICA team proposes the new configuration for international transmission network of Sri Lanka as shown in **Figure 4-5-19**.

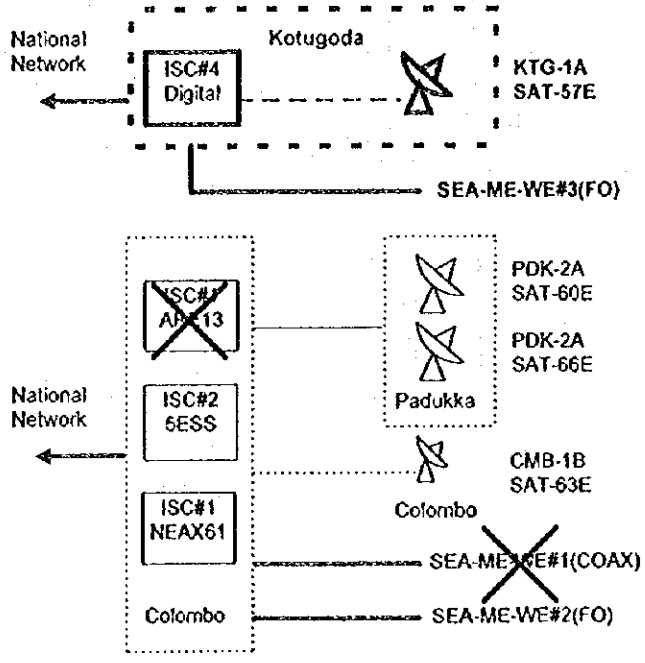


Figure 4-5-19 Proposed New International Transmission Systems

(3) Circuit Requirements

Table 4-5-18 shows the number of international circuits considering the increased traffic by the 20% supressed demand to the figures in Chapter 8, Volume II. The total circuit requirements becames 4,931 (Incoming 3,189 + Outgoing 1,742) in the year 2005.

Table 4-5-18 Number of International Circuits required in Year 2005

No.	Route	IC Traffic Share	OG Traffic Share	IC Circuit	OG Circuit
1	AUSTRALIA (TELST)	4.25%	5.63%	133	92
2	AUSTRALIA (OPTUS)	2.18%	0.19%	74	8
3	BANGLADESH	0.25%	0.35%	14	11
4	CANADA	12.02%	1.06%	350	23
5	FRANCE	1.30%	1.42%	48	29
6	GERMANY	2.99%	2.17%	97	41
7	HONGKONG	4.17%	6.14%	131	100
8	INDIA -ND	1.39%	2.10%	50	40
9	INDIA -B	4.25%	3.26%	133	57
10	INDIA -M	1.48%	6.89%	53	110
11	INDONESIA	0.32%	0.88%	16	20
12	ITALY	3.72%	2.26%	118	42
13	JAPAN (IDC)	1.17%	0.55%	44	15
14	JAPAN (ITJ)	1.35%	0.54%	49	14
15	JAPAN (KDD)	5.23%	3.54%	161	62
16	SINGAPORE	6.43%	16.41%	195	244
17	SWITZERLAND	6.07%	1.44%	185	29
18	TAIWAN TAIPEI	0.11%	1.04%	8	23
19	TAIWAN KAOSIUNG	0.11%	0.31%	8	10
20	UAE	4.61%	2.33%	144	43
21	UK (BT)	16.34%	19.79%	469	291
22	UK (MERCURY)	5.02%	3.56%	155	62
23	USA (ATT)	5.35%	3.65%	164	63
24	USA (MCI)	3.38%	1.44%	109	29
25	AUSTRIA	0.01%	0.48%	3	13
26	BAHRAIN	0.96%	0.08%	37	5
27	BRUNEI	0.09%	0.19%	7	8
28	DJIBOUTI	0.03%	0.01%	4	3
29	EGYPT	0.01%	0.38%	3	11
30	KOREA -S	0.49%	1.63%	22	32
31	MALAYSIA	0.86%	1.24%	34	26
32	MALDIVES	0.72%	1.66%	30	33
33	NETHERLANDS	0.55%	1.48%	24	30
34	NEPAL	0.07%	0.20%	6	8
35	PAKISTAN	0.56%	2.76%	24	50
36	S. ARABIA	1.51%	2.18%	54	41
37	SPAIN	0.23%	0.29%	13	10
38	THAILAND	0.43%	0.49%	20	14
	TOTAL	100.00%	100.00%	3189	1742
	Cumulative Traffic (Erl)			2708.6	1354.3

Source: Traffic Share: International Traffic Section of SLT (May 1995)
Cummulative Traffic: Estimated by JICA Team

(4) Circuit Accommodation Plan

The existing working international circuits are 1,292 in November 1995. As shown in **Table 4-5-19**, the satellite communication links are used for 59% of these circuits. The remaining 41% of circuits are accommodated in the submarine cable links.

The existing SEA-ME-WE#2 link can be used up to 532 circuits as the reserved capacity. This capacity may be expanded depending on the negotiation. The new SEA-ME-WE#3 link has larger capacity for future expansion. In general, the submarine cable link has advantages, such as low cost and small transmission delay. However, it has a disadvantage of long time repairing on cable cut accident. It means that the accommodation share be increased in submarine cable links. In Asia region, the average share of submarine cable links is forecasted about 60% in the year 2005.

Therefore, JICA team proposes the following basic concepts to accommodate number of international circuits in the year 2005:

1) Submarine cable shares 60% and satellite communication shares 40% of total.
2) Colombo ISC shares 60% and Kotugoda ISC shares 40% of total circuits.

Based on such concepts, **Table 4-5-19** shows the new circuit accommodation plan for the year 2005 in Sri Lanka.

Table 4-5-19 Expansion Plan for International Links

Link Name	Existing in 1995	Plan in 2005	Expansion
For Colombo ISC (Exist)			
1) Padukka ES#1	168 (13%)	373 (8%)	204
2) Padukka ES#2	232 (18%)	745 (15%)	513
3) Colombo ES	362 (28%)	362 (7%)	-
4) SEA-ME-WE#1 (Cox)	189 (15%)	-	-
5) SEA-ME-WE#2 (FO)	341 (26%)	1,479 (30%)	1,138
Sub-total	1,292 (100%)	2,959 (60%)	1,667
For Kotugoda ISC (New)			
1) Kotugoda ES	-	493 (10%)	493 (25%)
2) SEA-ME-WE#3 (FO)	-	1,479 (30%)	1,479 (75%)
Sub-total	-	1,972 (40%)	1,972 (100%)
Grand Total	1,292 (100%)	4,931 (100%)	

In Table 4-5-19, the following consideration is also taken:

1) The capacity of Padukka ES#1 and ES#2 be expanded.
2) The capacity of Colombo ES be remained because of Standard B type.
3) SEA-ME-WE#1 system be retiared until 2005 due to the life.
4) The capacity of SEA-ME-WE#2 and #3 be expanded with negotiation.

(5) Satellite Access Plan

For the INTELSAT fixed satellite communication links, 5 satellites can be used at Sri Lanka. **Table 4-5-20** shows the antenna orientation parameters at Kotugoda new earth station site.

Table 4-5-20 Antenna Orientation Parameters at Kotugoda

No.	Satellite Name	Sat. Location (longitude)	Elv Angle (degree)	Azimuth (degree)	Earth Station
1	INTELSAT-6 (IOR)	60 E	65.3	250.9	Padukka#1
2	INTELSAT-6 (IOR)	63 E	68.5	247.6	Colombo
3	INTELSAT-7 (IOR)	57 E	62.0	253.5	Kotugoda
4	INTELSAT-7 (IOR)	66 E	71.7	243.1	Padukka#2
5	INTELSAT-7 (APR)	91 E	74.5	122.6	Kotugoda

The proposed access satellites are IOR 57E and APR 91E at Kotugoda earth station even though other satellites can be access with co-ordination to Padukka earth station.

5.4 Facilities Plan

5.4.1 Switching facilities

(1) General

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

The capacity of switching system was dimensioned based on the number of circuits to be provided. The number of circuits was calculated from the traffic to and from the objective exchange. Traffic forecast and circuits calculation are discussed in previous sections.

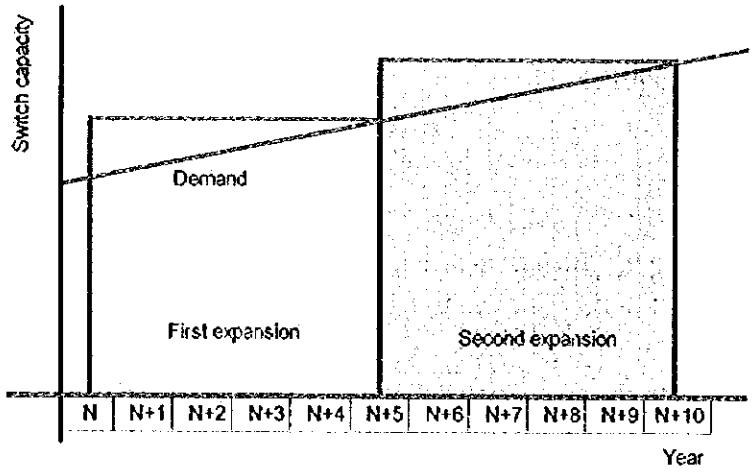
This project will provide one unit of ISC switching system, one unit of NSC switching system and one unit of TSC switching system to meet the possible traffic increase as the number of subscribers are expected to come up to 1,174, 243 in fixed telephone lines and 195,800 in mobile telephone lines, in the year 2005.

(2) Capacity dimensioning principles

The capacity of the switching system was designed so that the switching system capacity can meet the demand increase for five (5) years after installation. That is, every exchange will have a marginal period of capacity of five years when installation is completed. See Figure 4-5-20. This was so decided on the assumption that a project would take a period of five years from financing to commissioning. That is, the capacity was designed to meet the demand in 2005.

The capacity was designed also adding a certain extent of margin to the number of inter-exchange circuits required for normal load, for security reasons.

The transit switching centre was designed so that it would be consisted of two or more switching units and the capacity per one unit would not exceed 30,000 in number of circuits for security reasons. The switching units in a same exchange were called apart adding suffix, i.e., 1, 2, 3, ... or A, B, C, ... to the exchange name in the following tables and figures.



Source: JICA Study team.

Figure 4-5-20 Demand Increase and Switching System Capacity

(3) ISC capacity plan

Table 4-5-21 shows proposed capacity of ISC and sharing by unit. The number of circuits for normal load was obtained summing the number of circuits required for ISC. Unit "A" is the existing switching system having a capacity of 1,676 inter-exchange circuits. Unit "B" is the existing switching system having a capacity of 4.149 circuits. **Unit "C" is the new switching unit to be introduced under this project.**

Table4-5-21 ISC Capacity by Unit to be Provided by 2000

Year	Breakdown	Circuits for normal load	Planned Capacity			
			Unit "A" 5-ESS	Unit "B" NEAX-61	Unit "C" New	Total
Y-1997	International	-	851	2,020	-	2,871
	Domestic	-	825	2,129	-	2,954
	Total	-	1,676	4,149	-	5,825
Y-2000	International	4,931	990	2,550	2,550	6,090
	Domestic	5,329	1,060	2,750	2,750	6,560
	Total	10,260	2,050	5,300	5,300	12,650

Source: JICA Study team.

(4) NSC capacity plan

Table 4-5-22 shows proposed capacity of NSC and sharing by unit. The number of circuits for normal load was obtained summing the number of circuits required for NSC. Unit "A" is an existing switching system having a capacity of 12,000 inter-exchange circuits, or the part used as NSC Unit "B" 5-ESS. It is assumed that out of 12,000 circuits 1,960 inter-exchange circuits are available for NSC part in this study. **Unit "B" will be introduced under this project.**

Table 4-5-22 NSC Capacity by Unit to be Provided by 2000

Year	Circuits for normal load	Planned Capacity 1.32 Redundancy		
		Unit "A"	Unit "B"	Total
		5-ESS	New	
Y-1997	-	1,960	-	-
Y-2000	3,450	1,960	2,600	4,560

Source: JICA Study team.

(5) TSC capacity plan

Table 4-5-23 shows proposed capacity of TSC and sharing by unit. The number of circuits for normal load was obtained summing the number of circuits required for TSC and TDM. It was 58,380. TSC capacity was designed to have another 8,500 circuits for TDM. Havelock TDM, having a capacity of 5,340 in inter-exchange circuits at present, is required to have 12,630 circuits in 2000. Central TDM, which is expected to have a capacity of 8,000 in inter-exchange circuits in 1997, is required to have 22,550 circuits in 2000. The balance, or 8,500 circuits, was added to calculate the TSC capacity.

Unit "A" is an existing switching system having a capacity of 12,000 inter-exchange circuits, or the part used as TSC of NSC Unit "B" 5-ESS. It is assumed that out of 12,000 circuits 9,000 inter-exchange circuits are available for TSC/SSC part in this study. Unit "B" and "C" will be introduced under the "Local Network Expansion Project in Colombo Metro Area". **Unit "D" will be introduced under this project.**

Table 4-5-23 Colombo TSC Capacity by Unit

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

ISC.XLS / Feasibility Study

Source: JICA Study team.

(6) Peripheral equipment

An adequate quantity of peripheral equipment such as operator positions, charge input-output devices, system control terminals, distribution frames, etc. should be supplied together with the switching system. Details should be indicated in bidding specification after detailed design.

(7) Power equipment

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

An engine generator should be introduced under this project. Engine generator's capacity should be decided taking account of miscellaneous facilities such as office lighting, office air conditioning, lifts, etc., in addition to the power consumption of switching systems and related equipment and facilities.

Office facilities and telecommunications facilities including switching unit ISC "C", NSC "C" and TSC "D" may require a capacity of around 500 KVA. Exact capacity should be decided when a general idea becomes clear for building use.

5.4.2 Earth Station

(1) General Requirements

The general requirements for Kotugoda new earth station are proposed as follows:

1) Access satellites:	INTELSAT IOR or APR fixed satellite
2) Standard type:	INTELSAT standard A type
3) No. of antennas:	One at initial, two in future
4) Connected ISC:	Kotugoda new ISC in the same yard
5) Inauguration year:	Year 2000
6) Initial capacity:	463 circuits for the year 2005 demand
7) Facilities:	Telecom equipment and maintenance facilities

(2) System Configuration

The earth station be consists of the following components at least:

1) Antenna subsystem	18 m diameter antenna structure	1 set
	Antenna tracking system	1 set
2) LNA subsystem	32 K low noise amplifier	3 sets
	Switching assembly	1 set
3) HPA subsystem	1 kW TWT high power amplifier	2 sets
	Switching assembly	1 set
	Dummy load and waveguide	1 set
4) GCE subsystem	Up converter for IDR	4 sets
	Down converter for IDR	4 sets
	RF/IF switching assembly	1 set
	IDR modulator	4 sets
	IDR demodulator	4 sets
	Switching assembly	1 set
5) C&M subsystem	C&M system bay	1 set
	C&M console	1 set
	Engineering service console	1 set
6) MUX subsystem	Digital MUX terminal	1 set
	Echo cancellor bay	1 set
7) Power supply	500 kVA standby engine generator	2 sets
	AC UPS	2 sets
	DC power supply	2 sets

8) Test & Spares	Test equipment	1 lot
	Spare units	1 lot

5.4.3 Building

(1) General view of building

Under this project, two kinds of telecommunication facilities, such as the switching system for ISC/NSC/TSC and transmission system for earth station are installed. There are two ideas for building construction as follows:

1) Separate building for each facilities;
2) Common building for both facilities.

Usually, the building for earth station is constructed as the separate one line idea 1). However, in case that both systems are installed in same time under one package project, idea 2) is more economical and can save site space. The project package will be discussed later in SLT. Thereof, in this study, the building requirement is shown separately for each system.

(2) Building for switching systems

A new building is required for Kotugoda new ISC/NSC/TSC switching system. The space requirement is shown in Table 4-5-24 based on our experiences.

Table 4-5-24 Required Space for Switching System

Use	Space (m^2)	Remarks
ISC room	200	Including maintenance work space.
NSC and TSC room	200	Idem.
Operator positions room	200	Including support utilities.
Battery room	50	
Pwer room	50	
Engine generator room	50	
Toal	750	

ISC-4.XLS

Source: JICA Study team.

(3) Building for earth station

Some new building, such as one equipment buildign and several staff houses are required for Kotugoda Earth Station. The space requirement for equipment building is shown in Table 4-5-25 based on our experieces.

Table 4-5-25 Required Floor Space for Earth Station Equipment Building

Use	Space (m^2)	Remarks
GCE room	100	Including maintenance work space.
Control and monitor roo	30	Idem.
Power room	30	Including support utilities.
Battery room	30	
Engine generator room	60	
Storage	50	
Offices	50	
Total	350	

ISC-4.XLS

Source: JICA Study team.

6. Project Cost Estimate

6.1 Switching System Cost

The switching system project cost was estimated, for the switching system discussed in Sec. 5.4 Facilities Plan, on the assumption that the project would be executed under a turn-key basis.

The project cost was estimated referring to the cost of telecommunications facilities purchased recently by SLT and tendencies in some selected countries. Table 4-6-1 shows the estimated switching system project cost.

Table 4-6-1 Switching System Project Cost

Item	Cost (in US$ 1,000)		
	Total	Foreign currency portion	Local currency portion
1) Digital exchange	6,625	6,625	0
2) Other equipment	794	794	0
3) Building	2,000	0	2,000
4) Sub-total	9,419	7,419	2,000
5) Installation and others	757	757	0
6) Tax and duties	2,774	0	2,774
7) Engineering service	712	712	0
8) Contingency	1,018	1,018	0
9) Grand total	**14,680**	**9,906**	**4,774**

Source: JICA Study Team.

6.2 Earth Station Cost

The project cost for Kotugoda new earth station was estimated referring to the cost for Padukka No.2 antenna installation project. The estimated cost is summarised in **Table 6-1-4** below.

Table 4-6-2 Earth Station Project Cost

(Unit: US$ 1,000)

No.	Item	Foreign	Local	Total	Remarks
1	Equipment				
1.1	Antenna	530		530	
1.2	Telecom Eqpt	5,000		5,000	
1.3	Power Plant	560		560	
2	Installation				
2.1	Antenna	70	140	210	
2.2	Telecom Eqpt	370		370	
2.3	Power Plant	200		200	
3	Training etc.				
3.1	In Factory	400		400	
3.2	On Site	350		350	
3.3	Maint. Assist.	300		300	
4	Building				
4.1	Main Bld.	400	820	1,220	
4.2	Staff House		600	600	
5	Item 1-4 Total	8,180	1,560	9,740	
6	Tax and Duties				
6.1	Import Duties		1,659	1,659	(Item 1.1+1.2)x30%
6.2	Import Duties		196	196	(Item 1.3)x35%
6.3	Turn Over Tax		1,953	1,953	(Item1+4+6.1+6.2)x20%
7	Item 5-6 Total	8,180	5,368	13,548	
8	Consultancy	682		682	(Item 5)x7%
9	Contingencies	974		974	(Item 5)x10%
10	Grand-Total	9,836	5,368	15,204	

7. Project Implementation Plan

7.1 Implementation Schedule

7.1.1 General

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

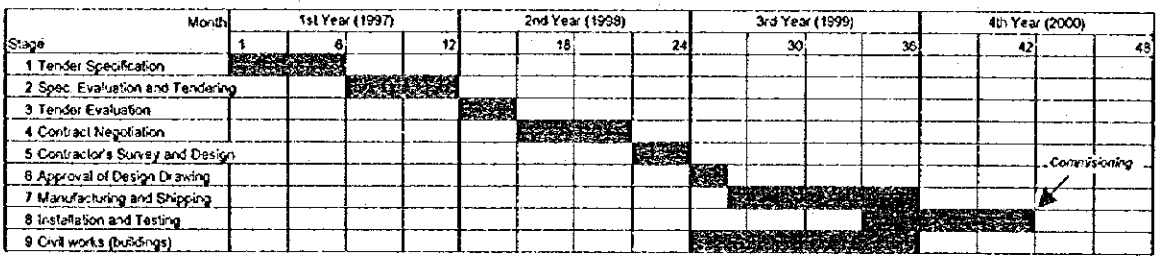
1) Preparing the tender specifications;
2) Specification evaluation and tendering;
3) Tender evaluation;
4) Supplier contract negotiation;
5) Contractor's survey and design;
6) Approval of design drawing;
7) Manufacturing and shipping;
8) Installation and testing.

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

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

7.1.2 Implementation Schedule of Switching System

Figure 4-7-1 shows the proposed implementation time schedule for the switching facilities portion of Local Network Expansion Project in Colombo Metro Area. The period for this portion was estimated to be 48 months.

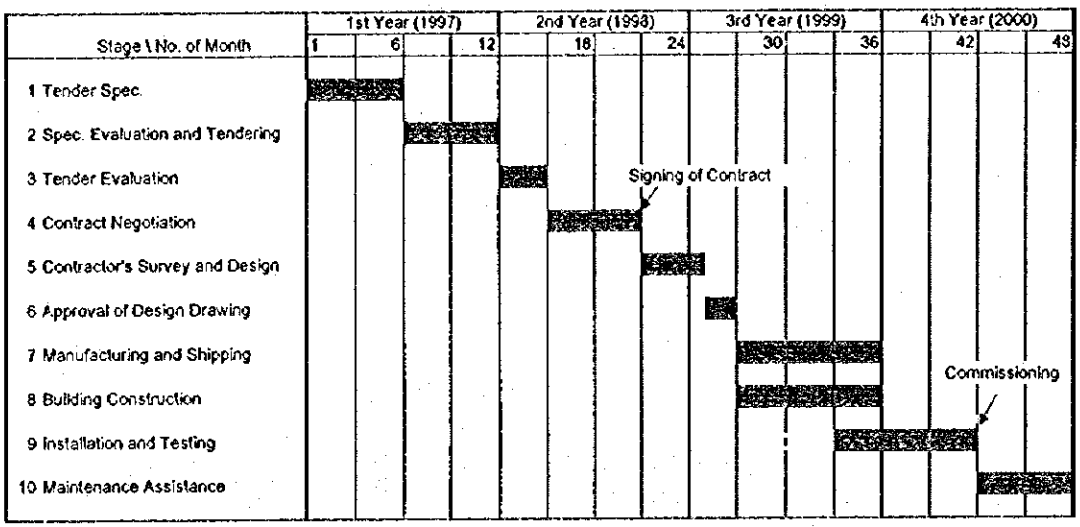


Source: JICA Study team.

Figure 4-7-1 Exchange Portion Implementation Time Schedule

7.1.2 Earth Station

The project implementation schedule for new earth station is shown in **Figure 4-7-2**. The total period to completion is estimated as 42 months.



Source: Team estimate

Figure 4-7-2 Implementation Schedule for Earth Station

7.2 Management on Project Implementation

7.2.1 For a Smooth Project Advance

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

Projects can be advanced smoothly by owner's effort. SLT is required to provide finance, personnel and facilities for a smooth advance of the project proposed based on this feasibility study.

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

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

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

7.2.2 Organisation

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

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

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

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

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

7.2.3 Attentions on Technical Matters

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

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

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

7.3 Operation and Maintenance

7.3.1 Exchange

SLT situates personnel for operation and maintenance of ISC switching system at its Headquarters in Colombo City. The existing organisational structure will not be necessary to change in principle. However, a certain extent of increase of personnel and training will be necessary.

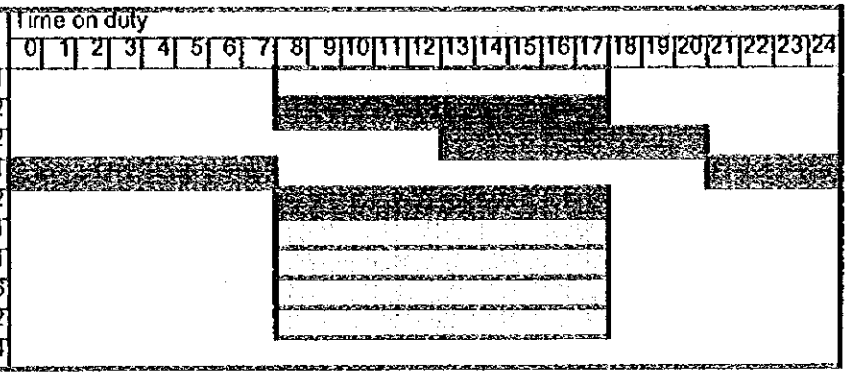
All the new units of switching systems to be introduced under this project should be put under operation, maintenance and management which is responsible at present, i.e., the ISC Unit "C" under "International Switching Centre" situated at OTS Building, and NSC "C" and TSC "D" under "Metropolitan Switching Division".

Recent digital switching system has very few troubles, though requires daily check in some extent. As the units of switching system increases, a certain extent of increase in work is inevitable.

Some new staff may be required for the operation and maintenance for the new switching systems. The number of personnel suggested below is based on the consultant experiences. The exact number of staff should be decided when the switching system technology is determined.

For the new ISC, NSC and TSC in the new location, it will be necessary to station two groups of maintenance personnel, i.e., one for ISC and the other for NSC/TSC. For the ISC, five persons should be assigned for moring and afternoon duties. As for the NSC/TSC, Figure 4-7-3 shows a model of work schedule which requires 14 persons.

Duty	Persons
After-night	1
Morning	2
Afternoon	2
Night	1
RSU cruising	2
Training	1
Administration	1
Off-duty	2.86
Vacation	0.82
Total	14



LE.XLS (ManPower)

Source: JICA Study team.

Figure 4-7-3 A Model of Work Schedule for New Switching Site

JICA recommends that spare parts be stored at a point in Colombo Metro, for instance, at the building of TSC in Colombo, if the new switching systems are of same technology as the existing. The spare parts should be delivered to the location when required in such case. If the new switching system is of another technology, the spare parts should be stored where the switching systems are installed.

7.3.2 Earth Station

The INTELSAT Standard A type earth station is usually operated with staff attended basis even in night like the existing Padukka earth station. The attended staff must monitor the system operating conditions in 24 hour basis. If there are some troubles on every links with connected other earth stations, the staff must repair as soon as possible with appropriate co-ordination with related organisations.

The proposed number of operation and maintenance staff for Kotugoda new earth station is shown in **Table 4-7-1**.

Table 4-7-1 Operation and Maintenance Staff for Kotugoda Earth Station

Duty	No. of Staff	Remarks
Station master	1	day time only
Technical co-ordination	3	day time only for radio, mux and power
O&M for transmission	8	2 x 4-shift
O&M for power plant	3	day time only
Administration	5	day time only
Total	20	

At the time of major problems in night time, the support of station manager and specific engineers is required. Therefore, it is proposed that the houses for key staffs be located inside the station yard.

The storage for spare units is to be included in the station building because the spares for new equipment will not be same design as the existing equipment for Padukka earth station.

7.4 Human Resource Development

7.4.1 Switching System

In order to maintain the new switching facilities in a good condition to offer satisfactory service to the users, human resource development by training is essential.

Training should be provided to one third of the personnel assigned for operation and maintenance of the new switching units, that is, 2 persons for ISC and 4 persons for NSC/TSC, when a new technology is introduced. They should be given a period of 3 months training in the supplier's country as the supplier has his appropriate training facilities in his country. The rest of the personnel assigned to the new switches should be given training by those 6 persons at the training centre and or at exchange site in Colombo. In the case of the switching systems of existing technology is introduced, the number of personnel for each trainig course should be reviewed. The exact number of trainees should be decideed when the technology is determined.

7.4.2 Earth Station

The basic technology for the new earth station is not so vary with the Padukka #2 antenna facilities. However, the details of equipment will not be same as the existing facilities. Therefore, the training for operation and maintenance staff must be carried out deeply under this project. The following training programs are proposed:

1) In-factory training: 4 engineers during 2 months
2) On-site training: 11 technicians during 2 months
3) Maintenance assistance: by 1 manufacturer engineer during 6 months

After completion of the project, the manufacturer engineer must stay in the new earth station during 6 months. He must assist operation and maintenance work of SLT with co-ordination with factories of the contractor.

8. Project Evaluation

8.1 Financial analysis

8.1.1 Basic Assumptions for Financial Analysis

The purpose of this analysis is to measure and assess the financial viability of the Kotugoda new ISC,TSC and Earth Station project under the following conditions and assumptions which have been discussed with SLT staff.

The financial evaluation has not dealt with nominal change of value such as inflation and currency exchange rate fluctuation to reveal essential viability of the Project.
In the sense, Net present value and Internal rate of return are typical means as the evaluation tool under the appraisal prerequisite, for the Project.

a) Fiscal Year

1 , January - 31 , December

b) Project Appraisal Period

FY 1997 - 2015 (19 years)

c) Fixed Price Base

Financial Projections have been done in 1995 constant price. In this mean, All costs shall be fixed at 1995 level. This price level, which was estimated to be the standard market price in 1995 will be adopted for all costs , such as construction costs and operating costs.

d) Exchange Rate

US$1.00 = SRs 50.0 (May 1995)
US$1.00 = Yen 85.0 (May 1995)

e) Long Term Loan

The long term loan will be lent to SLT on the following conditions;

Current Long - Term Loan Condition **(On lent loan)**

Interest rate	:	13.0%
Repayment	:	20 times over 10 years
		Fixed principal payment
Grace period	:	No grace period
Exchange loss	:	Government risk

Current Long - Term Loan Condition **(Direct loan)**

Interest rate	:	8.0%
Repayment	:	20 times over 10 years
		Fixed principal payment
Grace period	:	2 years
Exchange loss	:	SLT risk

f) Short - Term Loan Condition

In case of shortage of funds during the operation period, the short term finance is required to fulfil the cash deficits, if any.

Interest rate	:	20.0%
Repayment	:	repaid in next operating year after borrowing
		Fixed principal payment
Grace period	:	No grace period

g) Revenue Collecting ratio

The expected collecting ratio is set as following Table 3-8-1.

Table 4-8-1 Collecting Ratio

Year	Revenue Collecting Ratio
1995	80%
2000	81%
2005	85%
2010	88%
2015	90%

h) Turnover Tax (BTT)

BTT has been calculated at 20% of Domestic calls
No taxation will be provided in the account from 1997.

i) Corporate Income Tax, Import duty

Corporate Income Tax ;

40% of SLT's net taxable income.

Import duty applied in this evaluation is summarised in Table 4-8-2.

Table 4-8-2 Ratio of Import Duty

Items	Import duty	BTT	TTL Import duty
Exchange & Switching Equipment	10%	20%	32%
Radio & Transmission Equipment	10%	20%	32%
Cable & Subscriber Network	35%	20%	62%
Power plant	25%	20%	50%
Air-conditioning plant	35%	20%	62%
Motor Vehicles	50%	20%	80%

j) Insurance

The cost for insurance was assumed to be **approximately 0.1%** of the book value of Equipment & Facilities costs in each project year based on the current insurance system.

k) Depreciation

Full value of all asset items is depreciated without remaining salvage value, over the estimated useful lives of these assets. Depreciation method is provided as following table 4-8-3.

Table 4-8-3 Depreciation method

Items	Depreciation method
Buildings	50 years straight line
Plant	
Exchange & Switching Equipment	12.5 years straight line
Radio & Transmission Equipment	12.5 years straight line
Cable & Subscriber Network	25 years straight line
Power plant	20 years straight line
Air-conditioning plant	10 years straight line
Motor Vehicles	5 years straight line
Furniture & Equipment	5 years straight line

l) Working Capital

The amount of Working capital is assumed to be the following for each year of operation.

Account Receivable : Sales Revenue for 2 months
Account Payable : Operating costs for 2 month

m) GOSL Equity

The difference between the assets and liabilities transferred from SLTD to SLT on Sept.1991

n) Appropriation, Levy

No dividends to GOSL have been assumed.

A levy was paid to Director Treasury at their request and charged to Profit and Loss as pre Finance Act 38 of 1971.

8.1.2 Investment Plan

Estimate of the gross required capital funding for the New ISC/TSC and EARTH STATION PROJECT

The total investment cost can be summarised in Table 4-8-4.

(1) Digital Exchange

Table 4-8-4 (1/2) Total Investment Cost

Unit : US$'000

Items	Depre.	Total	Foreign	Local
Digital Exchange	12.5 yrs	6,625	6,625	0
Other Equipment	12.5 yrs	794	794	0
Building	50.0 yrs	2,000	0	2,000
Installation		397	397	0
Training		360	360	0
Tax	10%,35%	2,774	0	2,774
Engineering Service		712	712	0
Contingencies	10% of TTL	1,018	1,018	0
Total		14,680	9,906	4,774

(2) Earth Station

Table 4-8-4 (2/2) Total Investment Cost

Unit : US$'000

Items	Depre.	Total	Foreign	Local
Antenna	12.5 yrs	530	530	0
Other Equipment	12.5 yrs	5,560	5,560	0
Building	50.0 yrs	1,820	400	1,420
Installation		780	640	140
Training		1,050	1,050	0
Tax	10%,35%	3,808	0	3,808
Engineering Service		682	682	0
Contingencies	10% of TTL	974	974	0
Total		15,204	9,836	5,368
Grand Total		**29,884**	**19,742**	**10,142**

(2) Expenditure schedule

The total investment cost is disbursed in each project year of construction period as shown in Table 4-8-5.

Table 4-8-5 Expenditure Schedule

Unit : US$'000

Items	Project year					TOTAL
	1996	1997	1998	1999	2000	
Equipment & Facilities	0	0	5,698	11,396	11,396	28,490
Engineering service	142	415	279	0	558	1,394
Initial Working Capital	0	0	0	0	1,647	1,647
Interest during construction	0	0	358	1,193	2,147	3,698
Total	142	415	6,335	12,589	15,748	35,229

8.1.3 Sales revenue projection

Benefit from this project fall under one of the following four categories; (1) Installation charge,(2) Monthly rental charge,(3) Call charge,(4)others.
Table 4-8-6 indicates historical tariffs for telecommunications.

Table 4-8-6 A historical tariff level for telecommunications.

Unit : SRs

Year	1983	1985	1987	1989	1991		1993	
Local call charge / unit	0.90	1.10	1.10	1.35	1.00	1.50	1.20	1.80
Long distance call charge / unit (Ave. 50 sec)	1.80	2.20	2.20	2.70	2.00	3.00	1.20	1.80
Annual rental Business Non Business	 900 360	 1000 400	 1000 400	 1000 400	 960 960		 960 960	
Connection charge	7000	7000	7500	7500	7500		13000	

The benefits that can be expected from this project are as follows.

(1) Installation Charge
Total installation charges included in revenue are calculated by fixing the number of newly installed DELs for each fiscal year, based on the number of DELs installed as indicated in the supply plan, and multiplying this figure by an installation fee.

(2) Monthly Rental Charge
Monthly rental charges are calculated by multiplying the number of DELs newly installed in each fiscal year by monthly rental fee.

(3) Call Charge
For a telephone call to take place, both a call originator and a call receiver are necessary. In other words, establishment of the telephone facilities at only one end is not sufficient to produce a call charge. This project is only a portion of the Sri Lanka are telecommunications network, so call charges cannot be considered entirely as project benefits. Based on this understanding, a revenue distribution ratio was established, as shown in Table 4-8-6 below, in order to calculate expected project benefits.

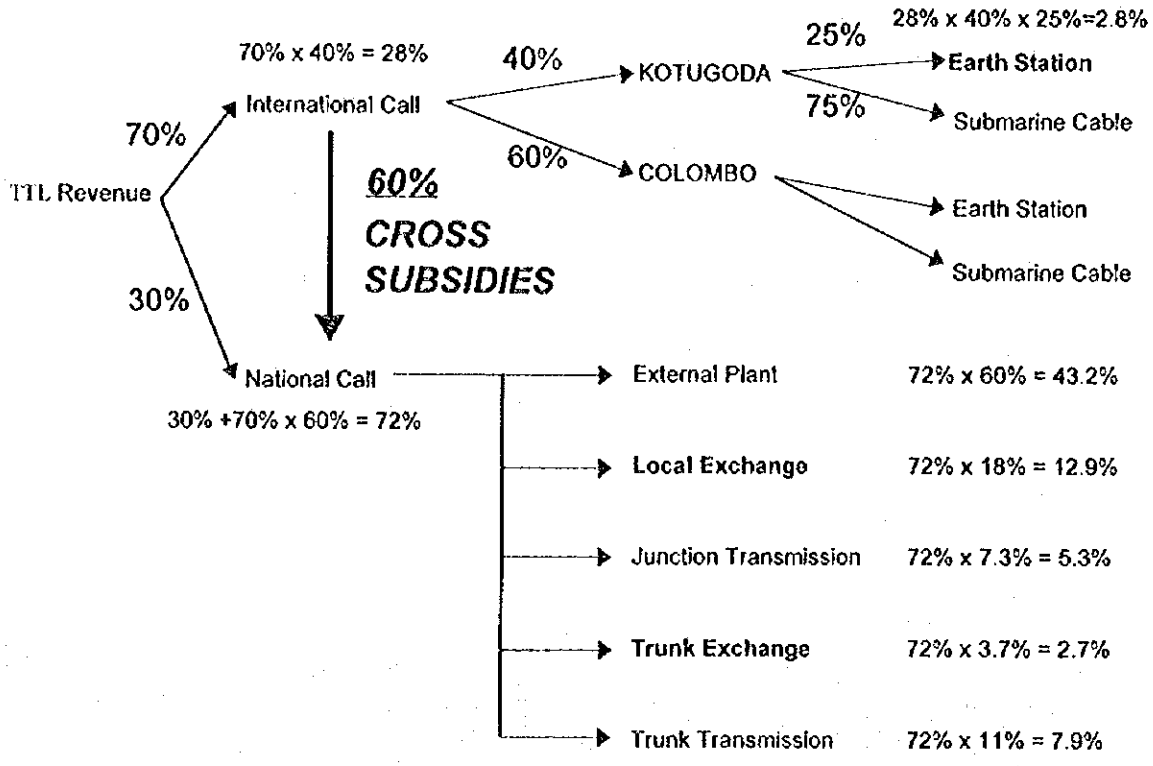


Figure 4-8-1 Concept figure of Revenue distribution

8.1.4 Revenue Distribution Ratio

After re-evaluating SLT's 1994 fixed asset ratio and the cost ratio used in JICA Master Plan (1985), Study team have determined the revenue distribution ratio related to the each network facility items. ***Given that cross subsidies are an actual factor, one which has supported SLT's operations during the company's development phase, a cross subsidy concept should also be applied in the evaluation of the project.***

The 1996 profit and loss statement reveals that total revenues come from international calls (70%) and domestic calls (30%). First, the gross revenue is broken down into international and domestic revenues based on the above relations. Then, the cross subsidies existing between the two systems are calculated as mentioned below. In this report, study team have assumed that 60% of the revenues for the international telecommunication system come from cross subsidies, to be returned to the national telecommunication system. This value of 60% is a tentative one for use only in this feasibility study, and is to be revised by the SLT staff whenever necessary. The concept flow is indicated in Figure 4-8-1.

The cross subsidies thus allocated now equal to 28% of the total revenue for the international telecommunication system, with the remaining 72% for the national telecommunication system. The international telecommunication system has two sub-systems : Kotugoda and Colombo. When the revenue is allocated with respect for these areas by number of subscription lines, the former accounts for 40% and the latter 60%. Thus the Kotugoda sub-system accounts for 11.2% of total revenues. Still downstream under the Kotugoda sub-system are Earth Station and Submarine cable facilities, accounting for 25% and 75% of revenue respectively, if allocated as in the same manner above. ***Accordingly, the Earth Station of the Kotugoda system accounts for 2.8% of total revenues.***

Next, ***the national system has been broken down into five categories*** with respect to facilities : (1) External Plant, (2) Junction Transmission, (3) Trunk Exchange, (4) Trunk Transmission, (5) Local exchange. After referring to SLT's asset structure and past financial data, Study team has determined the revenue distribution ratio of national telecommunication system in accordance with investment costs on these facilities. The revenue was then apportioned to each of the above categories by multiplying 72% (The revenue share of the national telecommunication system) respectively.

Note : The cross subsidy concept mentioned above must be similarly taken into consideration when fixing inter-operator access charges.

Profits subject to financial analysis were calculated by determining profits by call type (including international, STD, local and other calls) and multiplying these figures by the revenue distribution ratio which are shown in the Table 4-8-7.

Table 4-8-7 Revenue Distribution Ratio

Items	Revenue Distribution Ratio
Kotugoda,Earthstation	2.8%
Other International system	25.2%
National systems	
External Plant	43.2%
Local Exchange	12.9%
Junction Transmission	5.3%
Trunk Exchange	2.7%
Trunk Transmission	7.9%

Note : When cross subsidies are provided as part of the actual operations for the entity concerned, project evaluations should not assume that revenue is to be distributed only on the basis of the net fixed assets ratio. Otherwise, the evaluations will be biased, with the international telecommunications portion being underestimated. Revenue should be distributed subject to actual conditions in Sri Lanka.

Expected revenue calculated under the aforementioned conditions is shown in Table 4-8-8. The following revenues are those obtained through the operation of the telecommunication network established under the project. The revenues are deemed as the operating income of the project.

Table 4-8-8 Total Annual Revenue for the project

Year	Total Revenue : US$'000
2001	12,711
2003	15,432
2005	17,667
2010	17,667
2015	17,667

8.1.5 Operation expenses

The direct operation costs do not include interest payment and depreciation. The annual operation and maintenance (O&M) costs will be increased due to the increase of number of terminals. In accordance with SLT's past expenditure record, annual (O&M) cost has been calculated as following Table 4-8-9.

Table 4-8-9 Annual (O&M) Costs

Unit : US$'000

Year	Staff Costs	Other Costs	Total (O&M) cost
2001	162	2,666	2,828
2003	162	2,989	3,151
2005	162	3,255	3,417
2010	162	3,249	3,411
2015	162	3,246	3,408

It will be necessary to recruit 54 staff members over the entire project period. Study team has listed US$162,000 as an annual personnel expenditure on the assumption that US$3,000 would be necessary per person. As for general costs, study team has appropriated 12% of the expected annual revenue, using the data from SLT's 1995 profit and Loss Statement as reference. Staff costs are projected not to increase after 2001. Due to improved operational efficiency and the introduction of new technology, other costs per DEL are expected to decrease from 2001 to 2005. The rate of decrease is taken from figures used in proposed Master Plan.

8.1.6 Financial Analysis of the project

The purpose of the financial analysis is to measure and assess the financial viability of the priority projects under the above mentioned conditions and assumptions.

(1) Assessment of Project Feasibility

The financial soundness of the project will be assessed through the projection of the profit/loss, cash flows, etc. The result of this financial analysis is detailed in the output sheets that are attached to the annex.

a) Income Statement
b) Cash flow Statement

The summary of the result of financial analysis is shown in Table 4-8-10.

Table 4-8-10 Result of Financial Analysis

FIRROI has been calculated at 31.17 % (1997 - 2015)
FIRROE has been calculated at 26.90 % (1997 - 2015)

Unit : US$ '000

Year	Investment	EQUITY portion	Revenue	Total Expenses	Profit/Loss after Tax	Repayment	Cash Flow
1996	142	142	0	0	0	0	-142
1997	415	415	0	0	0	0	-415
1998	6,335	2,665	0	0	0	0	-2,665
1999	12,588	5,249	0	0	0	0	-5,249
2000	15,747	8,408	0	0	0	0	-8,408
2001	0	0	12,711	9,890	2,821	1,835	3,584
2002	0	0	14,063	10,384	3,679	1,835	4,439
2003	0	0	15,432	10,886	4,546	1,835	5,353
2004	0	0	16,485	11,236	5,246	1,835	6,033
2005	0	0	17,667	11,653	6,014	1,835	6,975
2010	0	0	17,667	10,766	6,901	1,835	7,583
2015	0	0	17,667	9,973	7,694	0	9,130

Note : O&M cost included Depreciation, Interest, staff cost and expense for Satellite utilisation, etc.

Table 4-8-11 Assumption of Financing Plan

Unit : US$ '000

Items	US$ '000	Share %
EQUITY	16,880	47.9%
L-T Loan	18,347	52.1%
TOTAL	35,228	100.0%

(2) Major Financial Indicators

The major financial indicators in each operation year will be calculated. Each indicator is obtained from the following formula:

- Net Profit on Equity on Sales Revenue
  Profit before tax / Equity(Paid in share capital)

- Debt Service Coverage Ratio
  (Net profit after tax + Depreciation + Interest) / (Repayment + Interest)

- Profit Break Even Point
  (OPC + D + I) / r x 100

- Cash Break Even Point
  ((OPC + D + I) + (R - D) / (1 - G) + WCI) / r x 100

where, OPC : Operating Costs
r : Sales revenue at each project year
R : Repayment of Long-term Loan
D : Depreciation
I : Interest on Long-term Loan
g : Tax rate
WCI : Working Capital Increase

Table 4-8-12 Major Financial Index

Items	2001	2003	2005	2010	2015
Net profit on Equity	16.7%	26.9%	35.6%	40.9%	45.6%
Dept Service Coverage Ratio	189%	247%	314%	465%	---
Profit Break Even Point	44.2%	38.5%	35.2%	33.6%	27.4%
Cash Break Even Point	14.3%	13.6%	12.6%	13.2%	15.8%

(3) Sensitivity Analysis

The effects on the profitability of the projects by the charges of conditions assumed in this financial analysis have been analysed. The changes of conditions(variable factors) and their variable ranges have been assumed as follows:

a) Total Investment Cost

+20% and -20% of the fluctuation of the Total Investment Cost at the construction stage excluding Interest during construction and Initial Working Capital .

b) Sales Revenue

+20% and -20% of the fluctuation of the sales revenue in each project year.

c) O&M cost

+20% and -20% of the fluctuation of the O&M cost in each project year.

d) Long - Term Loan condition

The result of the sensitivity analysis is summarised in Table 4-8-13.

Table 4-8-13 The result of the sensitivity analysis

Variable factor	Variation	IRROI (%)	IRROE (%)
Total Investment	+ 20%	26.90	22.19
	Base	**31.17**	**26.90**
	- 20%	36.96	33.17
Sales Revenue	+ 20%	36.33	32.09
	Base	**31.17**	**26.90**
	- 20%	25.43	21.04
O/M cost	+ 20%	29.89	25.61
	Base	**31.17**	**26.90**
	- 20%	32.41	28.15
L-T Loan condition 10 yrs repayment	Base Interest: 13% 0 yrs grace	**31.17**	**26.90**
	Interest: 8% 2 yrs grace	31.17	32.49
	Interest: 2.6% 0 yrs grace	31.17	37.24

8.1.7 Result of Financial Analysis

With Sri Lanka's improving economic relationship with India, South Asia and European countries, the qualitative and quantitative improvements in telecommunication services produced by the Project are expected to yield great effects. Recently, telecommunication projects have been anticipated to have great impact on both social and economic infrastructure. While such projects must provide widespread service for the general

public, they must offer sufficiently profitability to support the implementation of these services. The Project can be evaluated as adequately meeting both these requirements.

The expected profitability and financial condition will be discussed here. Following is an assessment of the forecast profitability and financial state of the project. The financial analysis of the project was conducted with the following conditions: ***Interest rate : 13.0% p.a. ; repayment period : 10 years.*** There will be a fund surplus throughout the life of the project. There is thus no need for a bridging finance, which is necessary during periods where there is a fund shortage. ***No cash flow problems will arise.***

The payout period for the capital of ***US$16,880,000*** required in the initial investment (Equity portion) is ***3.58 years.*** A cash flow of ***US$92,709,000*** is yielded throughout the operating period, with ***FIRROI at 31.17% and FIRROE at 26.90%.*** These IRR values suggest that the project will stand financially feasible coupled with the high returns assumed that the project can be operated without financial difficulty. This FIRROE is attained because the equity accounts for 47.9% of total Investment Costs and anticipated sales revenues are sufficient to maintain the stable operation.

Note should be made of the fact that FIRROE values are largely affected by changes in the percentage of equity in the total cost of investment.

The Cash Break Even Point for each fiscal year is lower than 16.0%. The Profit Even Point for each fiscal year of the project is lower than 45.0%. Debt Service Coverage Ratio for each fiscal year is more than 189.0% or higher. These levels point to a sound situation in terms of profits and funds.

These above mentioned findings indicate that the project has sufficient investment potential and that the conditions on the loans recently applied for are appropriate for the type of the project, strongly benefiting its investment potential.

This aspect of the Project represents part of its effects on social infrastructure, and will provide wide spread service for the general public. These findings indicate that the project has sufficient investment potential and that the conditions on the loans recently applied for are appropriate for the type of the project, strongly benefiting its investment potential. In this sense, the Cash surplus will surplus will support other low profitable projects in the corporate plan. The implementation of the project is an indispensable precondition to realise the Master Plan.

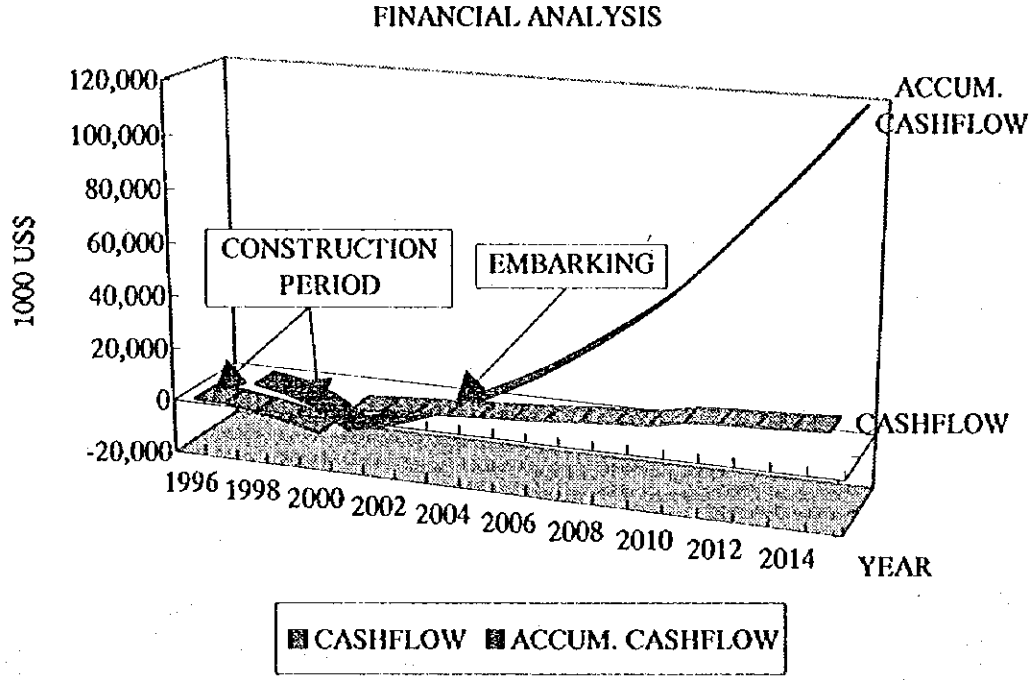


Figure 4-8-2 Result of Financial Analysis

8.2 Economic Evaluation

Telecommunication is almost universally recognised as an avenue for raising living standards and a key element of economic development. Thus telecommunication projects have an impact on individual and social welfare. As economic activity should be expanded on a national scale, telecommunications is acquiring strategic importance for growth and development. The telecommunication in Sri Lanka, however, is prevented to become mature mainly due to the national treasury problems for development on large scale.

It is clear that there will be adequate demand for the telecommunication service in Sri Lanka as the empirical evidence indicates that people place value on using telecommunications. In these circumstances, GOSL has come to reconsider ways and means for the improvement of the telecommunication systems. More wider scaled services are to be provided by Sri Lanka Telecommunication sector to satisfy the nation's needs. The necessity for planning new telecommunication networks is thus raised.

The economic appraisal is undertaken to ascertain the overall impact of the project on the Sri Lanka's economy. The Financial Analysis prepared was made from the view point of an investor, whereas the Economic Analysis is made from that of a government decision concerned with broader economic development objectives of the country.

8.2.1 Economic Costs

For the economic costs, the following items must be considered.

(1) Initial Investment Costs for Implementation of the Projects.

The Equipment and Facilities costs, Engineering services costs, Pre-operation costs and Initial working capital will be necessary as the initial cost for the economic value.

(2) Operating and Maintenance Costs

As the operating and maintenance costs, the staff costs, general expenses and insurance charges are required. These expenses must be analysed economically considering their economic values.

(3) Items of Transfer

The tax imposed on SLT is an actual expenditure for SLT. However, looking at the tax from a social perspective, it is only a transfer of cash from SLT to the government. Since it does not require an resources, it will not be considered a cost.

For the imposed on SLT is an actual expenditure for SLT. However, looking at the tax from a social perspective, it is only a transfer of cash from SLT to the government. Since it does not require any resources, it will not be considered a cost.

For the same reason, the insurance to be paid to domestic companies is a transfer item and therefore is excluded from the cost.

8.2.2 Economic Parameters

The financial value projected in the Financial Analysis will be converted to the economic value using the following factors.

(1) Foreign Exchange Premium

The Foreign exchange premium utilised in converting the market value into economic value is derived from the following Standard Conversion Factor(SCF) formula.

$$SCF = (M+X)/\{(M+Tm)+(X-Tx)\}$$

Where,

SCF: Standard Conversion Factor
M : CIF value of imports
X : FOB value of exports
Tm : All taxes on imports
Tx : All taxes on exports

Each value of the above parameters to obtain SCF and the result of calculation are summarised in Table 4-8-14.

Table 4-8-14 Foreign Exchange Premium

Year	Export(FOB) (US$ million)	Import(CIF) (US$ million)	Tax(Exp) (US$ million)	Tax(Imp) (US$ million)	SCF
1990	1,913	2,689	63.4	417.7	0.929
1991	2,040	3,037	26.7	437.0	0.925
1992	2,461	3,505	17.8	438.9	0.934
1993	2,859	4,008	1.1	419.0	0.943
1994	3,400	4,634	-	451.0	0.947
Average SCF					0.936
F.E.Premium					1.07

(2) National parameter

The financial values of costs items presented in 'Financial Evaluation' will be divided into local and foreign currencies. Although the value of national parameter is not announced the GOSL, the value is set up for the Master Plan with the assumption that socio-economic environment in the country will reach the average level of the South - Asia region. Then the economic values will be calculated using the value of national parameters (premium of economic value) as shown below:

- Construction** 0.73
- Unskilled Labor** 0.50
- Working Capital* 1.00
- Foreign Exchange Premium* 1.07

* : estimated by study team

** : These shadow price ratios were obtained from the IBRD

The factor for construction is applied to all locally source equipment and services and the factor for unskilled labour is applied to all local labour.

8.2.3 Economic Evaluation

(1) Determination of Economic Direct Benefit

The shadow price which is hidden in the tariff structure is adopted to estimate the Economic Direct Benefit and emphasis was placed on understanding the trends.

Table 4-8-15 Telephone call charges from 1983 to 1993

Unit : US$

Year	1987	1989	1991		1993	
Local call charge / unit	0.033	0.033	0.023	0.035	0.024	0.036
Long distance call charge / unit (Ave. 50 sec)	0.066	0.068	0.047	0.07	0.047	0.036
Annual rental						
Business	30.3	25.0	22.5		19.4	
Non Business	12.1	10.0	22.5		19.4	
Connection charge	227.0	187.0	176.0		260.0	

It is evident that charges quoted in Sri Lankan Rs are increasing each year. However, when they are converted into US dollars, as indicated in Table 4-8-15, it is clear that the charges are actually decreasing gradually. The highest charge with long distance call charge prices was recorded in 1991, at US$0.07 per call. Subscribers paid charges under this charge system. This means that subscribers understood that the value of a call was US$0.07. As of April 1993, the charge is priced at US$0.036 per call. This does not mean that the value of the call is declined, but is rather a cosmetic drop in value resulting from exchange rate fluctuations.

It can be interpreted that a premium is already incorporated in the current charges. The difference between the two, US$0.034 per call, is therefore seen as a shadow premium, and maximum values of the last eight years were applied for the estimate. The same way of thinking was applied to installation and rental fees.

The premium where the maximum value over the past eight years is used.

Local call charges	:	US$0.036 (1993)
Long distance call charges	:	US$0.07 (1991)
Annual rental	:	US$30.3 (1987)
Installation	:	US$260.0 (1993)

The total economic benefits are summarised as shown in Table 4-8-16.

Table 4-8-16 Benefit streams

Year	Total Benefit Streams (US$ 1,000)
2001	14,617
2002	16,173
2003	17,747
2004	18,958
2005	20,317
2010	20,317
2015	20,317

(2) Economic Cost Streams

The total investment and O&M costs in each project year summarised in Table 4-8-17 and 18 for Economic Analysis. The costs are converted into the economic cost using value of national parameter (Shadow premium)

Table 4-8-17 Total Economic Project Cost in each project year

Unit : US$ 000

Year	Total Investment
1996	152
1997	444
1998	5,705
1999	10,814
2000	11,411

Table 4-8-18 Total Economic O&M Cost

Unit : US$ '000

Year	Staff Costs	Other Costs	D.Insurance	Total O&M cost
2001	130	1,946	Trans.	2,076
2002	130	2,063	Trans.	2,193
2003	130	2,182	Trans.	2,312
2004	130	2,273	Trans.	2,403
2005	130	2,376	Trans.	2,506
2010	130	2,372	Trans.	2,502
2015	130	2,369	Trans.	2,499

D.Insurance : Damage Insurance

Trans. : Transfer items

(3) Assessment of Result of Economic Analysis

EIRR during the economic life span for the Base cases are calculated using the economic benefit and costs. EIRR, the measures to assess the economic viability, are summarised as shown in Table 4-8-19.

Table 4-8-19 Economic Cash Flow

Unit : US$'000

Year (FY)	Economic Benefit	Investment	Operating Expenses	Economic Cash Flow
1996	0	152	0	-152
1997	0	444	0	-444
1998	0	5,705	0	-5,705
1999	0	10,814	0	-10,814
2000	0	11,411	0	-11,411
2001	14,617	0	1,946	12,542
2002	16,173	0	2,063	13,980
2003	17,747	0	2,182	15,435
2004	18,958	0	2,273	16,555
2005	20,317	0	2,376	17,812
2006	20,317	0	2,375	17,813
2007	20,317	0	2,374	17,814
2008	20,317	0	2,373	17,814
2009	20,317	0	2,372	17,815
2010	20,317	0	2,372	17,816
2015	20,317	0	2,369	17,818
TOTAL	290,986	28,002	34,556	225,958

Net Present value (Discount rate 20%) for the Kotugoda new ISC,TSC and Earth station project

Cost (C)	:	US$ 34,249,000
Benefit (B)	:	US$ 17,948,000
B - C	:	US$ 16,301,000
B / C	:	1.91
EIRR	:	**38.36%**
FIRROI	:	**31.17%**

The EIRR for the project based on incremental cash flows as a result of the project has been calculated at ***38.36 percent.*** The project is expected to benefit the economy through higher economic activity, due to improved telecommunications facilities, which are difficult to quantify. In previous telecommunications projects world-wide, economic returns have been relatively high under conservative assumptions for consumer surplus and with no account taken of external benefits. Moreover , ***the Project benefits have been distributed widely, with significant shares being realised by rural and other low-income communities ; if GOSL are weighted for social objectives, EIRR would, therefore, exceed those calculated. This project is expected to realise a similar EIRR.***

9. Conclusion and Recommendation

9.1 Technical Aspect

In order to meet the telephone demand increasing rapidly in keeping with the aspirations of people and economic growth, and to satisfy the targets established following governmental policies, SLT is required to provide more capacity of telephone switching system, transmission network and external plant.

According to the study on telecommunications development of Sri Lanka, conducted by Japan International Co-operation Agency (JICA), the demand on telephone lines will be about 1,174,000 lines in the whole country in the year 2005. In Colombo Metro Area, the demand in the year to be provided by SLT, provided that 26% of the national demand is catered by private networks other than SLT network, is forecast to be around 480,000 lines.

SLT's capacity of telecommunications will be around 5,800 circuits of ISC and 12,000 circuits of NSC which assumes the function of TSC and SSC beside NSC being situated in Colombo City, when the on-going projects complete in 1997. JICA Study Team estimates that around 12,000 circuits for ISC, 4,600 circuits for NSC and 72,000 circuits for TSC will be necessary to meet the traffic to be derived from the subscribers in 2005. Besides the shortage of capacity in the number of circuits, it is desirable to take measures for higher reliability of telecommunications network, including decentralisation of the function concentrated to SLT Headquarters building.

Under such context, JICA Study Team analysed the present situation of existing telecommunications facilities to find an appropriate project for telecommunications facilities expansion. JICA Study Team made up this feasibility study with such line as;

a) In order to meet the demand in 2005, switching capacity expansion of ISC, NSC and Colombo TSC which should be situated in the new location;

b) Introduction of a new earth station for a diversified accesspoint to Sri Lanka telecommunications network to/from foreign countries.

Based on the study, JICA Study Team recommends SLT to expand its telecommunications capacity by the year 2000, in a new telecommunications centre to be inaugurated in Kotugoda, Gampaha, as follows:

a) Switching system;

- ISC: 5,300 international and national circuits;
- NSC: 2,600 trunk circuits;
- TSC: 21,000 trunk circuits.

b) Earth station;

- Earth station: 1 system;

JICA Study Team also recommends SLT, in carrying out the project proposed in this study, as follows.

a) To maintain the existing task force with General Manager of Projects, to make use of its know-how accumulated through projects for past years;

b) To establish a close contact with SLTA, for a smooth advance of the project in relation to WLL networks participation;

c) To complete the on-going projects as scheduled;

d) To review and justify the proposed telecommunications facilities capacity when the WLL networks start their services substantially;

e) To establish its network with CCS No. 7 of ITU-T specifications, for taking advantage at bidding procedures;

f) To give the new NSC the gateway switch function to Intelligent Network to be introduced apart from this project, the TSC to be introduced under this project the gateway switch function to WLL networks;

g) To raise a project for the expansion of ISC "A" and "B" up to their maximum equipped capactiy by SLT own hand, because that expansion is, being dependent very much to its manufacturer, not adequate for an open tender procedure.

9.2 Financial Aspect

There will be a fund surplus throughout the life of the project. There is thus no need for a bridging finance, which is necessary during periods where there is a fund shortage. ***No cash flow problems will arise.*** The payout period for the capital of ***US$16,880,000*** required in the initial investment (Equity portion) is ***3.58 years.*** A cash flow of ***US$92,709,000*** is yielded throughout the operating period, with ***FIRROI at 31.17% and FIRROE at 26.90%.*** These IRR values suggest that the project will stand financially feasible coupled with the high returns assumed that the project can be operated without financial difficulty. This FIRROE is attained because the equity accounts for 45.2% of total Investment Costs and anticipated sales revenues are sufficient to maintain the stable operation.

These above mentioned findings indicate that the project has sufficient investment potential and that the conditions on the loans recently applied for are appropriate for the type of the project, strongly benefiting its investment potential.

The EIRR for the project based on incremental cash flows as a result of the project has been calculated at ***38.36 percent.*** The project is expected to benefit the economy through higher economic activity, due to improved telecommunications facilities, which are difficult to quantify. In previous telecommunications projects world-wide, economic returns have been relatively high under conservative assumptions for consumer surplus and with no account taken of external benefits. Moreover , ***the Project benefits have been distributed widely, with significant shares being realised by rural and other low-income communities ; if GOSL are weighted for social objectives, EIRR would, therefore, exceed those calculated. This project is expected to realise a similar EIRR.***

The telecommunication sector is generally positioned within a nation's Economic Infrastructure. However, in Sri Lanka, investment circumstances and management bodies cause the sector take on the characteristics of Social Infrastructure as well. It is while it is impossible to say unconditionally that establishment of a telecommunications network will further economic and national development, introduction of an appropriate communications method at an appropriate time is nonetheless an important factor in encourage such development. The important word here is "appropriateness". SLT with adequate capacity and a suitable economic resources is necessary to ensure that maintenance, management and operation of a telecommunications network are sufficient.

There should be communications method befitting each county's levels of development. 200,000 DELs in 1995 too little for Sri Lanka at its stage of development. The economic circumstances surrounding Sri Lanka have taken a positive turn and foreign investors are beginning to look for investment opportunities. The environment for economic exchanges with surrounding countries is now beginning to shape up as well. the time is at hand for Sri Lanka to escape economic stagnation and start making great strides forward.

CHAPTER 5

OVERALL EVALUATION

CHAPTER 5

OVERALL EVALUATION

As mentioned earlier, SLT owes a great deal of its profitability to the presence of cross subsidies.

Generally speaking, cross subsidies are eventually to be abolished. Given the nation's challenging current socio-economic circumstances, however, GOSL has not yet been in a position to take such a drastic measure. The income level of general subscribers remains low. Given this situation, GOSL and Donor countries must deal with the thriving Colombo Metropolitan Area differently from other, unprofitable areas; specifically, by allocating private capital and Overseas Development Assistance (ODA) properly between the two.

At the SLT's present stage of development, where the cross subsidy system is a necessary evil, SLT must adhere to the following strategic goals:

(1)To enrol as many subscribers as possible in the Colombo Metro area
(2)To recruit international subscribers
(3)To satisfy the ever-increasing traffic volumes associated with success in the above two areas.

At present, SLT has three priority projects, as shown in following table.

Table 5-1 Result of Financial analysis
(1997 - 2015)

	Colombo Metro		Central Ring	Earth Station
	Case A	Case B		
FIRROI	18.37%	12.58%	16.41%	31.17%
FIRROE	10.12%	3.31%	8.49%	26.90%
EIRR	23.49%	17.50%	20.98%	38.36%
(Unit : US$'000)				
Capital Investment	199,228	122,100	33,916	29,884
Total Revenue	775,742	341,794	132,441	253,031
Accum. Cash Flow	163,310	30,412	25,311	92,709

The New ISC,TSC and Earth Station Project offers the highest Financial Internal Rate of Return (FIRR). Unless this project produces profits, SLT will be hard hit and could receive only soft loans. As a sensitivity analysis clearly shows, a shift from 8% to 13% interest rates creates more than a 5.59% drop in FIRROE. SLT must solidify itself by contracting for low-interest soft loans to help finance this project.

The Central Ring Fibre Optic Transmission Network Project also offers a fine FIRROI, at 16% or more. The proposed Master Plan foresees a rapid increase in the number of subscribers over the four-year period until the year 2000. If this forecast proves true, transmission networks must be strengthened to handle the resulting increase in telephone traffic. Any failure in this regard would permanently impair the project's profitability.

Lastly, the Local Network Expansion Project in Colombo Metro area is at the core of the three projects. Private WLL operators will begin operations in 1997, leading to a severe competition for lager market share in the industry. Private WLL operators are skilled at rapid installation of telephones, and unless SLT is able to install local networks in advance and satisfy subscriber's demand, SLT will not be a good match for them. If SLT succeeds in using ODA funds for this project, it can maintain, or rather, expand its market share in the Colombo Metro area in the years to come. Subscribers in this area currently account for more than 70% of the nation's international calls, which are the mainstay of SLT financial performance. It is thus all the more important that SLT increase its market share in the Colombo area.

According to the results of financial analyses, the Local network expansion project in Colombo Metro area itself offers very low profitability. The project, however, is an important touchstone in SLT's future management strategy. With the participation in 1997 of private WLL operators, the telecom sector in Sri Lanka will see fierce competition for market share in the Colombo Metro Area, where demand for telephones is enormous. Insofar as the private WLL operators offer superior speed of installation of telephone terminals, SLT has to establish a local network in advance and satisfy subscriber's needs, to effectively cope with the private WLL operators. ***SLT has accordingly drawn up its cable project as a countermeasure.***

To implement the project, priority must be laid on securing financing through low-interest soft loans, thereby allowing SLT to acquire a larger market share in the Colombo Metropolitan area, its core operation base. Otherwise, the SLT's financial performance could be hard hit, given that 70% of the international calls on which it relies originate in this area.

As shown in the results above, the profitability of External Plant project of the Local Network Expansion project package (Case B) is rather low: an IRROI (Internal Rate of Return on Investment) of 12.58%, and IRROE (Internal Rate of Return on Equity) of 3.31%. Bridge financing of US$ 1.6 million would thus be required for the initial 2-year operation period. In other words, with its low profitability, the Project cannot stand on its own without being supported by cross subsidies from the corporate SLT.

On the other hand, a sensitivity analysis reveals that a 20% decrease in total investment costs would improve the project's IRROI to 16.67% and IRROE to 8.02%. This trial calculation shows that the low profitability of the project is caused by the imbalance between its massive initial investment costs and its anticipated revenue.

Note : When internationally tendered, the investment costs per telephone line would be possibly fixed rather low, insofar as the estimated investment costs of US$ 609 per line (tax excluded) is not necessarily set particularly high from international standards.

When considered from SLT's standpoint, the low IRROE value derives from the strict investment condition requiring the equity ratio to exceed 50%. In addition, taxes and duties account for 50% or more of the equity portion. Import duties as high as 62% are levied on cable materials, resulting in inflated investment costs. Should the import duties be eliminated, IRROE would further improve to 5.96%.

At present IRROI, which is an index of project returns from the total investment, is 3.31%. This value is calculated only for the External Plant portion of Local Network Expansion project. What would the value be when this project is consolidated into a smallest network project ? To find out, Study team should perform an evaluation on the smallest network project, including switching and transmission facilities. It is clear from the evaluation results that the smallest network would be profitable enough if it generates project returns of IRROI of 18.37% and IRROE of 10.12%. Study team proposed here that the smallest network project including switching and transmission facilities be initiated, even though it would be a large project involving US$ 200 million or more. Multiple countries may provide funds, but this smallest network project should be conducted without being separated into switch, cable, and transmission facilities. Since a network project provides a direct path to tariff revenue, SLT will not be hindered in its operations.

Generally speaking, the IRROE value has been estimated slightly too low, since import duties are levied excessively on the equity portion. If it is possible to decrease the equity portion by 20%, the IRROE value would improve considerably. In countries where the financial discount rate is between 17% and 20%, private investors would have no interest in any project that generates a FIRROI of less than 20%.

Although study team have proposed three priority projects, study team expect that only the New ISC, TSC and Earth Station Project could be sufficiently profitable through private investment-based operations. As for the two remaining projects, though profitable to some extent, management through public investment by the government, such as ODA, seems more suitable than through private investment.

Under the circumstances, the cross subsidy system will have to be maintained for years to come. If the implementation of New ISC, TSC and Earth Station Project yields any profit, this profit should be returned to the telecom sector as much as possible. For this purpose, GOSL has to consider introducing ODA funds into the highly profitable New ISC, TSC and Earth Station Project.

If study team evaluate this priority project from the perspective that developing nations require infrastructure, which, whether private or public sector driven, represents a sort of common asset held both by the nation's citizens and its industries, to achieve sound growth, study team then must take the steps needed to support the creation of private enterprises, within the framework of Sri Lanka's existing development policies. Even if the telecommunication sector is shifted from a government-led to privatised format in the future, ODA as well as government policies must maintain a public orientation, in order that a tariff system accessible to low-income people can be maintained, and a framework prepared under which telecommunication sector can be founded in the future.

ANNEXES OF VOLUME-III