

CHAPTER 15

RADIO FREQUENCY MANAGEMENT

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1. Present Status of Frequency Management

1.1 Management System

(1) Management Body

Based on the Sri Lanka Telecommunications Act, No. 25 of 1991, the Sri Lanka Telecommunications Authority (SLTA) is taking the radio frequency management. The Act specifies about this matter in the Section 5 item (v) and (w) as a part of the powers and duties of SLTA as follows:

- (v) to ensure the conservation and proper utilisation of the radio frequency spectrum by operators and other organisations and individuals who need to use radio frequencies;
- (w) to make and enforce compliance with rules to minimise electro-magnetic disturbance produced by electrical apparatus and all unauthorised radio frequency emissions.

The Act also specifies about licence for use of radio frequency in the Section 22 subsection (1) as follows:

- (1) No person shall use any radio frequency in Sri Lanka except under the authority of a licence issued by the Authority for that purpose under subsection (2). Every application for a licence under this section shall be made to the Authority in the prescribed.”

Usually, under the Act, the radio regulation is to be issued. However, in Sri Lanka, the radio regulation is not prepared yet. Details for radio frequency management are studied on demand in SLTA and decided by DGT time-by-time.

(2) Organisation

The radio frequency management is being executed by the Spectrum Management Division of SLTA. In November 1995, this division is composed of the following staff members:

a) Chief Engineer:	1
b) Engineer:	4
c) Technical Officer:	8

The engineers and technical officers are grouped in to 4 teams relating to the service categories shown in below. Each team are working for every kinds of management steps, such as technical check for licensing, charging for use of frequency, inspection of radio systems and monitoring of operation.

- a) SM-1 team: Overall allotment
- b) SM-2 team: Fixed service
- c) SM-3 team: Mobile service
- d) SM-4 and RI team: Maritime and aircraft radio services

There are some problems on the spectrum management. One problem is the shortage of staff. The technical check and data base maintenance are not smoothly executed. Another problem is the lack of geographic information system. The interference study is not completely carried out due to unavailability of computerised calculation system.

1.2 Licensing of Radio Station

(1) Procedure for Licensing

For licensing and assignment of radio frequency, the following procedure is to be adopted referring to Figure 15-1-1:

- Step-1 The application should address to the Director General of Telecommunications (DGT) of SLTA based on the application form including a brochure giving the technical parameters of proposed radio equipment. The application forms are available relating to service categories. These forms can be received from SLTA.

Step-2 After studying the technical parameters of equipment, DGT will inform the application to the Secretary, Ministry of Defence for clearance taking to account of the security aspect. For broadcasting service, the investigation by the Ministry of Media, Tourism and Aviation is also required.

Step-3 Once the clearance received from the Ministry of Defence, the charges should be paid according to the bandwidth and transmitting power.

Step-4 After payment, a frequency or frequencies are assigned according to the nature of service. The letters are also issued to the Import Controller and then to the Customs to clear the equipment.

Step-5 On the completion of installation, SLTA officers will check the equipment for its parameters. DGT will issue the licence if the equipment is in order.

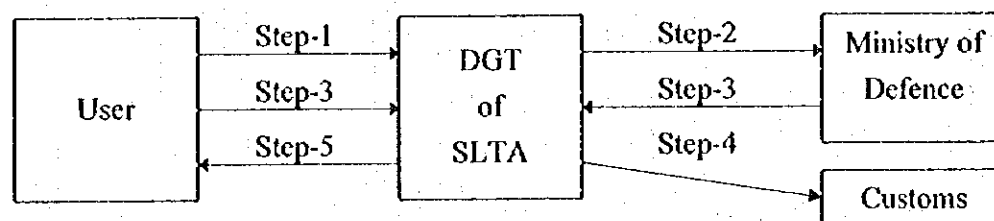


Figure 15-1-1 Procedure of Licensing and Assignment of Radio Frequency

(2) Charging for Radio Frequency

To use radio frequency, two kinds of charges are requested to licensed operators. There are the system licence charge on investment and annual frequency charge. All charges are utilised for management cost of SLTA.

(3) National Frequency Allocation Plan

The national frequency allocation plan is not yet finalised. At present, the general plan was tentatively concluded as shown in Table 15-1-1 through Table 15-1-4. The detailed plan is under study by SLTA.

Table 15-1-1 Radio Frequency Allocation Plan for Sri Lanka (Draft, 1/4)

Frequency Band (MHz)	Allocation Plan
30 - 35	FX, MB
35 - 35.500	Light Aviation Association
35.500 - 36.500	Paging Systems
36.500 - 37.000	ISM Eqpt. Low Power Equipment
37.000 - 37.200	Wireless Microphones
37.200 - 38	FX, MB
38 - 41	FX, MB-Duplex (PVT)
41 - 43	FX, MB-Simplex (PVT)
43 - 46	FX, MB-Duplex (PVT)
46 - 50	Cordless Telephones
50 - 54	Amateur
54 - 68	TV Broadcasting
68 - 73	FX, MB-Government
73 - 76	FX, MB-Simplex (PVT)
76 - 78	FX, MB-Duplex (PVT)
78 - 80	FX, MB-Simplex (PVT)
80 - 81	FX, MB-Duplex (PVT)
81 - 83	FX, MB-Duplex (PVT)
83 - 85	FX, MB-Simplex (PVT) (85.000 - 85.2 Microphones)
85 - 86	FX, MB-Duplex (PVT)
86 - 88	FX, MB-Simplex (PVT)
88 - 108	BC - FM/BC
108 - 117.975	Aeronautical Radio Navigation
117.975 - 137	Aeronautical Mobile (R)
137 - 138	Space Operation, Meteorological Satellite
138 - 139.500	FX, MB-Duplex (PVT)
139.500 - 140	MHz Paging Systems
140 - 142	FX, MB-Simplex (PVT)
142 - 144	FX, MB-Duplex (PVT)
144 - 146	Amateur, Amateur Satellite
146 - 148	FX, MB
148 - 149.9	Government
149.9 - 150.05	Radio Navigation Satellite
150.050 - 156.000	Government
156 - 157.425	Maritime Mobile
157.425 - 160.625	M.M.
160.625 - 162.025	Maritime Mobile
162.025 - 165	FX, MB-Duplex (PVT)
165 - 167	FX, MB (PVT) - Simplex
167 - 170	FX, MB (PVT) - Duplex
170 - 174	TV GUARD BAND
174 - 235	BC, TV
235 - 267	Government
267 - 272	Space to Earth - Space Operation
272 - 312	FX, MB
312 - 317	MHz Fixed, Mobile
317 - 328	Fixed, Mobile
328 - 335.4	Aero Radio Navigation

Note: FX: Fixed, MB: Mobile, BC: Broadcasting

Table 15-1-2 Radio Frequency Allocation Plan for Sri Lanka (Draft, 2/4)

Frequency Band (MHz)	Allocation Plan
335.400 - 337.450	FX, Dept. single channels
337.450 - 347.450	FX, Dept. Multiaccess System - Duplex
347.450 - 357.450	FX, Dept. Multiaccess System - Duplex
357.450 - 399.900	FX, MB - Not Allocated
399.9 - 400.050	Radio Navigation Satellite
400.050 - 400.15	Standard Freq. and Time Signal Satellite (400.100 MHz)
400.150 - 406	Meteorological Aids
406 - 406.100	Mobile Satellite
406 - 410	Radio Astronomy
410.100 - 414	FX, MB - Not Allocated
414 - 418.5	FX, MB - Duplex Operation
418.5 - 420	FX - Data Communication Dupop
420 - 428.5	FX, MB - Duplex Operation
428.5 - 430	FX - Data Communication Dupop
430 - 433.500	FX, MB - Defence
433.500 - 435	FX, MB - JOC Alert Communication Service
435 - 436	Amateur Amsat Oscar - 10
436 - 440	Radio Location
440 - 447	FX, MB - Duplex Operation
447 - 450	FX, MB - Simplex Operation
450 - 457	FX, MB - Duplex Operation
457 - 457.5	Paging Systems with more than 100 pagers
457.5 - 460	FX, MB - Not Allocated - Data Link
460 - 465	MCT Satellite - Space to Earth
465 - 470	FX, MB - ISM, GUARD BAND (465.025 - 466.00 - ISM)
470 - 710	TV Broadcasting - CH 21 - CH 50 (CH50 for Wireless Microphones)
710 - 806	TV Broadcast
806 - 960	Mobile Radio - Cellular Trunking)
960 - 1215	Aeronautical Radio Navigation
1215 - 1260	Radio Location, Radio Navigation Satellite
1260 - 1300	Radio Location, Radio Amateur
1300 - 1350	Aeronautical Radio Navigation
1350 - 1400	Radio Location
1400 - 1427	Earth Exploration Satellite Radio Astronomy Space Research
1427 - 1455	FX - SLTD DMAS
1455 - 1469	FX - CEB Radio Bearers
1469 - 1476	FX - CEB DMAS
1476 - 1504	FX - SLTD DMAS
1504 - 1518	FX - FX - CEB Radio Bearers
1518 - 1525	FX - CEB DMAS
1525 - 1535	FX - Space Operation - Not Allocated
1535 - 1542.500	Maritime Mobile Satellite Inmarsat Coast Earth Station
1542.2 - 1544	Maritime Mobile Satellite - Not Allocated
1544 - 1545	Mobile Satellite
1545 - 1559	Aeronautical Mobile Satellite (R)
1559 - 1610	Aeronautical Radio Navigation Radio Navigation - Satellite

Note: FX: Fixed, MB: Mobile, BC: Broadcasting

Table 15-1-3 Radio Frequency Allocation Plan for Sri Lanka (Draft) (3/4)

Frequency Band (MHz)	Allocation Plan
1610 - 1626.5	Aeronautical Radio Navigation
1626.5 - 1645.5	Maritime Mobile - Satellite
1645.5 - 1646.5	Mobile - Satellite
1646.5 - 1660	Aeronautical Mobile Satellite
1660 - 1660.5	Aeronautical Mobile Satellite (R)
	Radio Astronomy
1660.5 - 1668.4	Radio Astronomy
	Space Research
1668.4 - 1700	Meteorological Aids, FX
1700 - 1900	FX, Radio Relay Systems - Celltel, PVT.
1900 - 2100	FX, Radio Relay Systems - Not Allocated
2100 - 2300	FX, Radio Relay Systems - SLTD
2500 - 2700	FX, Radio Relay Systems - RESD for SLTD
2700 - 2900	Aeronautical Radio Navigation
2900 - 3100	Radio Navigation
3100 - 3300	Radio Location
3300 - 3400	Radio Location
3400 - 3500	FX, Fixed - Satellite
3500 - 3700	FX, MB, Fixed - Satellite
3700 - 3800	FX, MB, Fixed - Satellite - OTS RX
3800 - 3900	FX, Fixed Satellite
	OTS RX, Digital Relay Systems SLTD
3900 - 4192.5	FX, Digital Relay Systems SLTD
4192.5 - 4201	Maritime Mobile Satellite
4201 - 4400	Aeronautical Radio Navigation
4400 - 4500	FX, MB - Not Allocated
4500 - 4800	FX, MB, Fixed-Satellite
4800 - 5000	FX, MB
5000 - 5250	Aeronautical Radio Navigation
5250 - 5350	Radio Location
5350 - 5460	Aeronautical Radio Navigation
5460 - 5470	Radio Navigation
5470 - 5650	Maritime Radio Navigation
5650 - 5850	Radio Location
5850 - 5925	FX, MB, Fixed Satellite - Not Allocated
5925 - 7075	FX, Fixed Satellite, MB
	Radio Relay Systems
	Programme Links - Video
7075 - 7250	FX, Radio Relay Systems - SLTD
7250 - 7450	FX, Fixed-Satellite
	Radio Relay Systems - SLTD
7450 - 7550	FX, Fixed-Satellite, Meteorological-Satellite
	Radio Relay Systems - SLTD
7550 - 7750	FX, Fixed-Satellite
	Radio Relay Systems - SLTD
7750 - 7900	FX, Radio Relay Systems - SLTD
7900 - 8175	FX, Fixed-Satellite
	Radio Relay Systems - SLTD
8175 - 8215	FX, Fixed-Satellite, Meteorological-Satellite
	Not Allocated
8215 - 8400	FX, Fixed Satellite
8400 - 8500	FX, MB

Note: FX: Fixed, MB: Mobile, BC: Broadcasting

Table 15-1-4 Radio Frequency Allocation Plan for Sri Lanka (Draft, 4/4)

Frequency Band (MHz)	Allocation Plan
8500 - 8750	Radio Location
8750 - 8850	Radio Location, Aeronautical Radio Navigation
8850 - 9000	Radio Location, Maritime Radio Navigation
9000 - 9200	Aeronautical Radio Navigation
9200 - 9300	
9300 - 9500	Radio Navigation
9500 - 9800	Radio Location, Radio Navigation
9800 - 10000	Radio Location

Note: FX: Fixed, MB: Mobile, BC: Broadcasting

(4) Licensed Users

There are approx. 1,900 licensed users for radio frequencies in April 1995. These users are categorised in the following Table 15-1-2. The number of radio stations are not yet summarised by SLTA.

Table 15-1-2 Licensed Users

Category	No. of Users	Category	No. of Users
Broadcasting (FM radio)	7	Land Mobile	400
Broadcasting (TV)	6	Maritime (ship)	150
Fixed (HF)	140	Maritime (coast)	200
Fixed (VHF)	43	Aircraft	45
Fixed (UHF/SHF)	59	Radio amateur	250
CB	80	Others	520

(4) Computer System for Data Base

To file registration data of radio stations, a computer system is used in the Spectrum Management Division. This system consists of networked personal computers (5 sets) and a data base software (dBASE III+). Engineers of this division reported that the capacity and functions of the existing computer system are not so sufficient considering the large volume of licensed users and radio stations.

1.3 Monitoring System**(1) Monitoring Work**

The radio interference problems are reported about 50 times per month. To find the interference sources, SLTA is doing the monitoring work. There are two types of monitoring, such as continuous monitoring and on-demand monitoring. The continuous monitoring is carried out by using fixed station at Colombo and Kandy. The on-demand monitoring is carried out by using a mobile station.

(2) Facilities of Monitoring Stations

The existing monitoring facilities are located at the following stations:

- a) Colombo (Hub)
- b) Colombo (Slave for VHF/UHF)
- c) Kandy (Slave for VHF/UHF)
- d) Negombo (Slave for HF)
- e) Mobile (for VHF/UHF)

The HP85865B Signal Monitoring System is mainly used at present. It is very difficult to localise the interference sources because there is no directional finding receivers.

(3) Current Problems due to Interference

There are some problems due to interference. The problems are mainly exist in VHF band. The radio payphones and mobile transceivers using 400 MHz band cannot be effectively used due to interference. The new GSM cellular mobile system using 900 MHz band has some interference problems.

2. Frequency Management Improvement Plan

2.1 SLTA's Improvement Plan for Frequency Management

(1) Expansion of Monitoring Network

The SLTA is going to construct the new monitoring stations in near future at the following locations:

- a) Galle (for VHF/UHF)
- b) Anurdhapura (for HF/VHF/UHF)

(2) Improvement of RF Spectrum Management

The SLTA has planned to establish an automated RF spectrum management and administration system. This project has been requested in 1994 to the Japanese Government as a Grant Aid with the following cost estimate:

a) Hardware:	US\$ 1.0 Million
b) Software:	US\$ 2.5 Million
c) Technical Assistance:	US\$ 3.0 Million
Total:	US\$ 6.5 Million

2.2 Advise for Further Improvement

(1) Issue of Radio Regulations in Sri Lanka

To utilise the radio frequency effectively, the radio regulations must be issued in near future. For this work, the special task force team is to be established under the technical assistance of ITU-R or other administrations.

(2) Increase of Staff

In near future, the work volume of radio frequency management will increase in reflecting to the increase of radio stations. The present staff (only 13) will not sufficient for that increase. The number of staff must be increased.

(3) Introduction Computer System for Geographic Study

To carry out the interference analysis completely, the computerised geographic study system is required. The computer system is not so expensive, but to make geographic data base, it takes long time and large volume of manpower. This matter may be co-ordinated with the Map Survey Department and related authorities.

(4) Improvement of Radio Frequency Monitoring System

To speed up the radio frequency monitoring work in SLTA, the following facilities improvement is required:

- 1) Addition of fixed monitoring stations
- 2) Addition of mobile monitoring stations
- 3) Introduction of directional finding receivers

CHAPTER 16

PROJECT IMPLEMENTATION PLAN



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1. Project Formation

Project implementation plan consists of short-term plan by year 2000, medium-term plan by year 2005 and long-term plan by year 2015. Criteria of the project formation is as follows:

1.1 SSC Area Package

Improvement and expansion of 3 (three) sub-systems of switching, transmission and outside plant are considered to be implemented synchronously. So, telecommunications network within each SSC area is regarded as minimum unit of project package. Each SSC area package consists of all the necessary elements to form a network for particular area.

SSC area packages are combined under the following regional groups:

- a) Anuradhapura TSC area,
- b) Kandy TSC area,
- c) Galle TSC area,
- d) Outskirts area of Colombo,
- e) Middle-east area of Colombo,
- f) North area of Colombo, and
- g) South area of Colombo.

1.2 Single Project Package

Some projects such as earth station project, backbone transmission project and network management project are considered to be implemented individually.

2. Short-Term Plan and Selection of Priority Projects up to 2000

Priority projects to be implemented by year 2000 are shown in Table 16-2-1. These projects aim to meet the grown demand and to prepare no-waiter status from year 2001. Full digitisation of the national network and expansion of the network to whole of the island will be achieved in this term.

In Table 16-2-1, the priority for implementation is proposed on the following classification considering the importance from view points of national development and telecom sector activities:

- Class A:** High priority considering political and economic situations.
- Class B:** Medium priority for supporting social and economic activities.
- Class C:** Low priority to expand services for rural communities.

In order to conduct a feasibility study for the priority project(s), project formation has been made to formulate projects which will be implemented by the year 2000 and cover the whole Sri Lanka. As a first step, 21 projects including projects listed up as the third telecommunication project were formulated for achieving the telecommunications development targets. As a result of study, three projects of the above 21 projects were selected from a view of both national and telecommunications policy and socio-economic priority.

The expected profitability of priority project which will be implemented by FY 2000, evaluated here. Table 16-2-1 shows the results of a calculation of Financial Internal Rate of Return on Investment (FIRROI). *Projected FIRROI suggests that the priority projects other than the projects number 1-1, 1-10, 1-11 would be feasible to be implemented.* Projects number 1-1, 1-10, 1-11 target rural areas, with low return. The rural project is one which serves to meet basic human needs and which will provide principal infrastructure in the form of a public enterprises. The profitability of rural produce is quite low, which makes it difficult to carry out this kind of project using conventional fund raising methods. *Projected FIRROIs suggest that rural projects should be better to implement under the Grant financial scheme but not under the loan scheme.*

Table 16-2-1 Priority Projects to be implemented by the Year 2000 (1/3)

No.	Project Name	Description	Cost (Mil. US\$)	Status	Projected FIRROI	Priority	for F/S
1-1	Reconstruction of telecommunications network in north region	Jafna SSC Mannar SSC Vavunia SSC Microwave transmission network	114	F/S done	N.A	A	
1-2	SSC area network expansion project in Anuradhapura TSC area	Anuradhapura SSC Polonnaruwa SSC Trincomalee SSC	11		15.46%	A	
1-3	SSC area network expansion project in Kandy TSC area	Kandy SSC Matale SSC Nawarapitiya SSC Nuwara Eliya SSC Hatton SSC Badulla SSC Bandarawela SSC Ampara SSC Batticaloa SSC Kalumune SSC	33		23.97%	B	
1-4	SSC area network expansion project in Galle TSC area	Galle SSC Matara SSC Hambantota SSC Ratnapura SSC	35		13.87%	B	
1-5	SSC area network expansion project in outskirts of Colombo	Chilaw SSC Kurunegala SSC Kegalle SSC Negombo SSC Gampaha SSC Awissawella SSC Kalutara SSC	95		10.36%	A	

Table 16-2-1 Priority Projects to be implemented by the Year 2000 (2/3)

No.	Project Name	Description	Cost (Mil. US\$)	Status	Projected FIRROI	Priority	for F/S
1-6	Local network expansion project in middle-east area of Colombo	Angoda Exchange, etc.	61		15.73%	A	Proposed
1-7	Local network expansion project in north area of Colombo	Wattara Exchange, etc.	41		26.47%	B	
1-8	Local network expansion project in south area of Colombo	Nugegoda Exchange, etc.	132		6.60%	B	
1-9	Colombo Metro optical fibre ring transmission network project	Construction of SDH FO ring transmission network (4 rings)	23		37.14%	A	
1-10	Rural telecommunication network project (northern part)	Improvement of rural telecommunication network in northern 7 (seven) districts DMARS- 5,000 LU	50	F/S done	N.A	C	
1-11	Rural telecommunication network project (southern part)	Improvement of rural telecommunication network in southern 13 districts DMARS- 5,000 LU	50	F/S done	N.A	C	
1-12	Microwave backbone transmission network expansion project	Expansion of national backbone network (trunk transmission)	6	F/S done	32.45%	B	
1-13	Optical fibre backbone transmission network project (central ring)	SDH FO cable ring connection with 13 SSCs in the central area 850 km	20		23.85%	A	Proposed
1-14	Negombo international telecommunication project	New ISC, TSC and earth station in Negombo	25		16.46%	A	Proposed
1-15	SEA-ME-WE 3 international submarine cable project	Participation in international SEA-ME-WE 3 project	20		20.51%	B	
	Total		716				

Table 16-2-1 Priority Projects to be implemented by the Year 2000 (3/3)

No.	Project Name	Description	Cost (Mil. US\$)	Status	Priority	for F/S
2-1	GMDSS project (global maritime distress and safety system)	Construction of GMDSS facilities at Colombo, Galle and Trincomalee	3	Draft plan (JICA Expert)	A	
2-2	Radio frequency monitoring system project	Improvement of radio frequency monitoring and control system at SLTA	15	ODA request to Japan (SLTA)	A	
2-3	Improvement of telecommunications training centre in Colombo	Improvement of training facility and training programme			A	
2-4	Improvement of outside plant maintenance centre	Improvement of maintenance facility and staff			A	
2-5	ISDN/IN service development project	Development of ISDN/IN service network in Colombo			B	
2-6	Cellular mobile telephone network expansion project	Expansion of present cellular telephone network			B	
	Total					

3. Medium and Long-Term Plan

Based on the regional group category mentioned previously, project volume for medium-term by year 2005 and long-term by year 2015 has summarised as Table 16-3-1 below.

Table 16-3-1 Project Volume of Medium-Term and Long-Term Plan

No.	Project Name	Scope for Y-2005	Scope for Y- 2015
1	SSC area network expansion project in Anuradhapura TSC area	21,322 DEL	107,453 DEL
2	SSC area network expansion project in Kandy TSC area	26,260 DEL	174,873 DEL
3	SSC area network expansion project in Galle TSC area	28,111 DEL	103,220 DEL
4	SSC area network expansion project in outskirts area of Colombo	64,603 DEL	275,061 DEL
5	Local network expansion project in Colombo Metro Area	233,427 DEL	987,864 DEL
6	Backbone transmission system	Northern M/W link, Southern FO Ring	2nd Central FO Ring, Northern FO Ring, Eastern FO Spur Link, Northern FO Spur Link
7	International links	Expansion of 1,248 cct (Total 5,452 cct)	Expansion of 2,542 cct (Total 4,977 cct)
8	Expansion of ISDN/IN service	98 terminals Expansion, (Total 2,526 term.)	2,451 terminals Expansion, (Total 4,977 term.)
9	Expansion of cellular mobile telephone network	62,400 DEL Expansion, (Total 195,800)	136,800 DEL Expansion, (Total 332,600)

CHAPTER 17

EVALUATION OF MASTER PLAN



CHAPTER 17

EVALUATION OF MASTER PLAN

1. Introduction

Increasing economic activity in Sri Lanka, namely in information-intensive services sector, is generating a strong and growing demand for better and more varied telecommunications services. However, the dominant operator in the telecommunications sector, Sri Lanka Telecom. (SLT), has not been able to meet market expectations.

The performance of the telecommunications sector is weak and can be characterised as follows : (a) **Demand satisfaction is low.** In 1994, the total of 180,724 connected DEs account for only 49.2% of the existing demand (366,969) for basic telephone services. Demand satisfaction is expected to reach a 100% demand fulfilment in 2001, when new connections would be installed under the proposed Master Plan. (b) **Quality of service is not satisfactory.** Successful call completion rate is quite low at 28% because of bottlenecks resulting from the subscriber busy, no answer and incomplete dialling. Fault clear rate within 24 hours with an average of 55% and number of faults with an average of 26 faults per 100 lines per month, are major concerns.

1.1 Project Objectives

The objectives of the Master Plan(M/P) are to improve efficiency of telecommunication services in Sri Lanka by: (a) developing a market- oriented sector policy and a transparent regulatory framework; (b) encouraging new investment and services in the sector ; and (c) enhancing service quality, expanding network capacity and increasing geographical coverage.

1.2 Investment programme

The investment programme of the Master Plan should allow the number of connected subscribers to expand from present level of about 181,000 DEs to 1,670,000 DEs. In order to meet growth targets, expansion under the investment programme will significantly increase the number of subscribers it connects each year. Especially, first 4 years will be a heavy burden of SLT with an average of 90,000 new connections .

2. Cost and Revenue Estimation

2.1 Total Investment Cost

Total project cost is estimated at US\$2,294 million of which US\$ 897 million represent local cost and US\$ 1,397 million equivalent foreign exchange. The total project cost can be summarised as shown in Table 17-2-1 for the financial analysis. The total investment cost is distributed in each year of the Master Plan period as shown in Table 17-2-2.

Table 17-2-1 Total Project Cost by Facilities

Items	Total amount (US\$'000)	Share%
Cable	1,111,228	48.43
New Connection	326,970	14.25
Switch	623,574	27.18
Int. & Trans. (Area)	160,105	6.98
Trans.	72,240	3.16
Total	2,294,117	100.00

Table 17-2-2 Total Project Cost in each Project Year

Unit : US\$ 1,000

Year	Total Investment	Year	Total Investment
1997	0	2007	65,027
1998	207,427	2008	148,387
1999	276,091	2009	178,817
2000	159,785	2010	82,927
2001	33,162	2011	61,432
2002	41,316	2012	79,463
2003	124,857	2013	201,229
2004	161,083	2014	243,039
2005	85,934	2015	92,454
2006	51,687	Total	2,294,117

2.2 Total O&M Cost

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 of existing Telecom. network, annual O&M cost per DELs has been calculated as following Table 17-2-3.

Table 17-2-3 Total O&M Cost

Unit : US\$ '000

Year	Staff Costs	Other Costs	D.Insurance	Total O&M cost
1998	961	11,049	472	12,482
2000	2,884	28,688	602	32,174
2005	5,447	56,578	829	62,854
2010	7,049	87,191	996	95,236
2015	8,330	118,512	1,163	128,004

D.Insurance : Damage Insurance

2.3 Total Revenue

(i) Attributes of Telephone Subscribers

Telephone subscribers are classified on the basis of their attributes into two broad categories ; business users and residential users. According to statistical data compiled by SLT, business users accounted for 55 percent of all telephone subscribers in 1994. In general, the ratio of business users to total subscribers is high in countries where the penetration ratio remains low at 1.0 percent or so. Sri Lanka exhibits such a tendency. Trends in other countries were analysed in a time series based on penetration changes. The analysis shows us that the ratio of residential users increases as penetration improves. On the premise that Sri Lanka is following this general pattern, regression model of future trends in Sri Lanka were made by using data obtained from 34 countries around the world. The following table provides the results of this estimation, which show a reversal of business and residential subscriber ratios.

Table 17-2-4 Business and Residential Subscriber ratio

year	Business	Residence	Business	Residence
1994	99,398	81,326	55.00%	45.00%
1997	201,633	195,367	50.79%	49.21%
2000	305,303	361,697	45.77%	54.23%
2005	397,379	581,157	40.61%	59.39%
2010	465,592	845,203	35.52%	64.48%
2005	506,105	1,157,068	30.43%	69.57%

Source : JICA study team 1995

Such a reversal indicates that the profit structure will change. Therefore, the only question that remains is what kind of change will take place in the future.

First of all, it was expected that sales per subscriber would drop. Therefore, an attempt was made to verify whether such a phenomenon was already manifest. A time-series analysis showed that sales per telephone subscriber have been gradually falling since FY 1992.

Table 17-2-5 Sales per Subscriber

Items / year	1992	1993	1994
Sales per subscriber (US\$)	885	849	838

It seems that there are two causes for this gradual decline : (a) Revised tariffs that went into effect in March 1993, and (b) Changes in the subscribers' makeup.

An investigation of the total amount that subscribers had to pay in FY 1992, 1993 and 1994 revealed that telephone bills have been gradually increasing. Therefore, the negative effects of tariff revision have been slight. This phenomenon suggests that telephone use became more frequent as telephone charges dropped. Area-by-area analysis clearly supports this assumption.

Table 17-2-6 Billed Revenue (Jan - June, 1993)

Unit : Rs

Billing Centre	Jan.1993	February	March*	April	May	June
Ampara	924,544	945,501	1,332,374	549,285	1,1134,771	673,524
Anuradhapura	4,298,456	4,251,944	2,601,365	2,070,744	2,175,436	3,452,086
Badula	4,702,367	2,529,236	2,362,514	2,108,758	2,241,715	2,491,533
Batticaloa	1,607,108	1,397,864	759,410	602,863	633,455	750,106
Galle	5,877,498	5,433,545	4,243,796	3,667,389	3,595,534	3,776,360
Hambantota	2,718,804	2,334,400	1,773,978	1,404,639	1,456,862	2,326,196
Kalmunai	1,052,450	911,313	463,533	260,762	306,645	381,182
Kurunegala	5,095,101	4,724,815	6,246,718	3,986,723	3,386,518	3,961,409
Matara	6,374,502	5,758,418	4,376,075	3,306,514	2,567,570	2,769,574
Nuwara Eliya	2,629,515	2,068,083	2,063,137	1,747,166	1,703,959	1,709,726
Vavunia	1,061,836	996,647	444,515	412,361	526,550	473,933
Colombo central	95,051,353	85,798,875	94,492,162	92,525,456	95,016,396	98,252,227
National Total	271,005,862	248,214,231	259,991,368	251,087,024	263,008,264	281,191,021

Source : SLT CORPORATE PLANNING

Note : Detailed information are attached in Supporting

In light of this development , it is difficult to believe that tariff revision reduced sales per telephone subscriber. Therefore, it is reasonable to consider that implementation of 150K and other projects which are primarily targeted at residential subscribers are responsible for bringing about change in the ratios of business and residential subscribers.

The profit structure of SLT can be summed up in the following manner. SLT's profit structure during FY 1994 has the following two characteristics. Firstly, 70 percent of its gross earnings came from international telephone calls. Secondly, users who spent less than US\$ 100 on telephone charges accounted for more than 65 percent of all subscribers. These two characteristics have already been pointed out by SOFRECOM and the World Bank. If incoming international calls are included, 15 percent of subscribers, or "GOLDEN SUBSCRIBERS" account for more than 80 percent of sales. On average, Golden Subscribers paid US\$ 4,472 while the remaining 85 percent of subscribers paid US\$ 197 a year.

This suggests that Golden Subscribers comprise a crucial force whose behaviour will shape the future course of SLT. *Therefore, SLT must grasp tendencies among golden subscribers and reflect these tendencies in its investment and management plans.*

The scale of the telecommunications market in Sri Lanka is expected to expand rapidly in the future. What change will Golden subscribers exhibit? And how will SLT's profit structure change? It is unlikely that the ratio of Golden Subscribers to total subscribers will remain at 15 percent for the whole Master Plan period. It is only natural for this ratio to drop. Therefore, SLT's future profit structure was projected based on the following preconditions.

Note : Following the description of key customers in a SOFRECOM report, Study team have defined them in this report as subscribers (GOLDEN SUBSCRIBERS) account for more than 1,750 rupees per month.

(2) Golden Subscriber

The total number of Golden Subscribers in 2015 was arrived at by assuming average annual economic growth ratio of 6.2 percent. Annual subscriber increases during the period from FY 1997 to 2015 depend on the characteristics of proposed M/P. Because of this, subscriber increases in Sri Lanka's capital Colombo and surrounding metropolitan areas were adopted as standards, and numbers were assigned to new Golden Subscribers. During the period from 1994 to 1997, it was assumed that the number of Golden Subscribers would increase in an intensive manner as a result of preferential absorption of latent Golden Subscribers in Colombo and its vicinities.

Table 17-2-7 No. of Golden Subscriber

Unit: US\$ 000

Year	No. of Golden Subscriber	Share (%)	General sub.(%)
1994	27,108	15.00	85.00
1997	54,441	13.42	86.58
2000	63,728	9.55	90.45
2005	75,613	7.72	92.28
2015	101,820	6.10	93.90

(3) Total Revenue

Table 17-2-8 Total revenue of Golden Subscriber

Unit : US\$ 000

Year	TTL Revenue (Billed Amount)	Golden subscriber (Billed Amount)	Share(%)
1994	151,553	121,243	80.0%
1997	315,090	243,491	77.28%
2000	412,097	285,029	69.17%
2005	539,330	338,187	62.71%
2015	844,264	455,398	53.94%

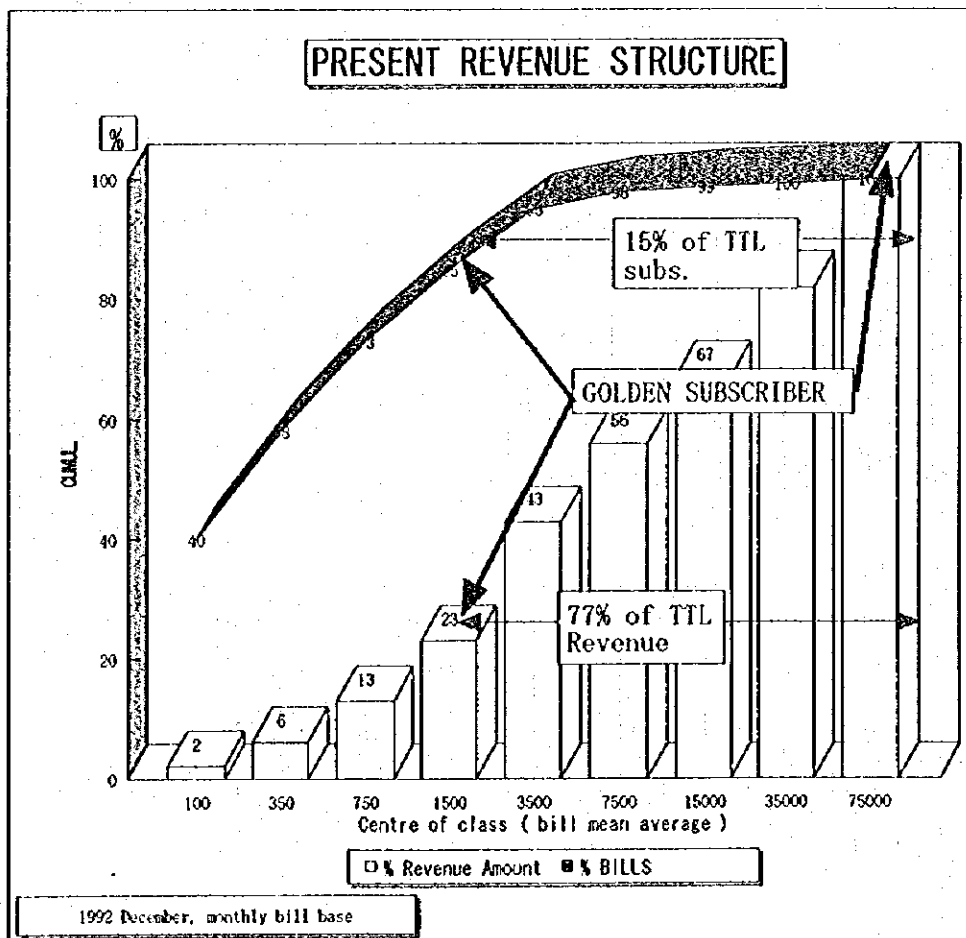


Figure 17-2-1 Present Revenue Structure

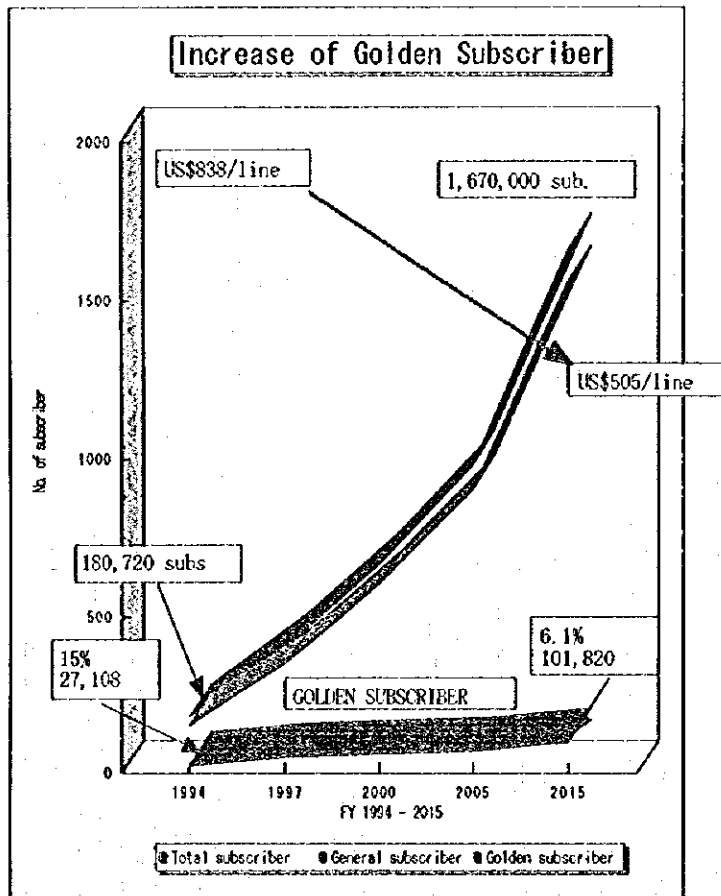


Figure 17-2-2 Increase of GOLDEN SUBSCRIBER

3. Financial Analysis on Master Plan

The Economic aspect of Master Plan will be examined so that the Democratic Socialist Republic of Sri Lanka can evaluate a Telecom. development plan which focuses on feasibility rather than financial aspect.

3.1 Concept for evaluating the Master Plan (M/P)

The telecommunications network, the target source of SLT's revenues, has only 180,720 subscribers. Sales revenues generated from this Telecom. network during the 1994 period will be about US\$ 132 million. Operating expenses for the telecommunication network will reach US\$ 55 million. After the deduction of interest and depreciation, SLT will have a sound financial status.

As indicated in 2.3, SLT operations have been supported by Golden Subscribers, who account for about 15% of all subscribers. SLT has thus far been capable of earning profits because the overall scale of the network is rather small, at 180,720 DEEs. However, the M/P have proposed targets mainly General subscribers who usually expend no more than US\$200 annually. As shown in Table 17-2-7, accounting for 90% or more of total subscribers by FY 2000.

A considerable difference in profitability is expected between the existing network and the M/P network is expected to be substantially different. To confirm this, the evaluation focused only on the M/P related portion. The relevant diagram are shown in Fig.17-3-1. The evaluation covered total investment costs, revenues, and expenditures, as shown in the shaded part (M/P) of the diagram.

With this evaluation, it becomes possible to review the type of financial sources required and the degree of profitability expected, whatever the M/P's characteristics.

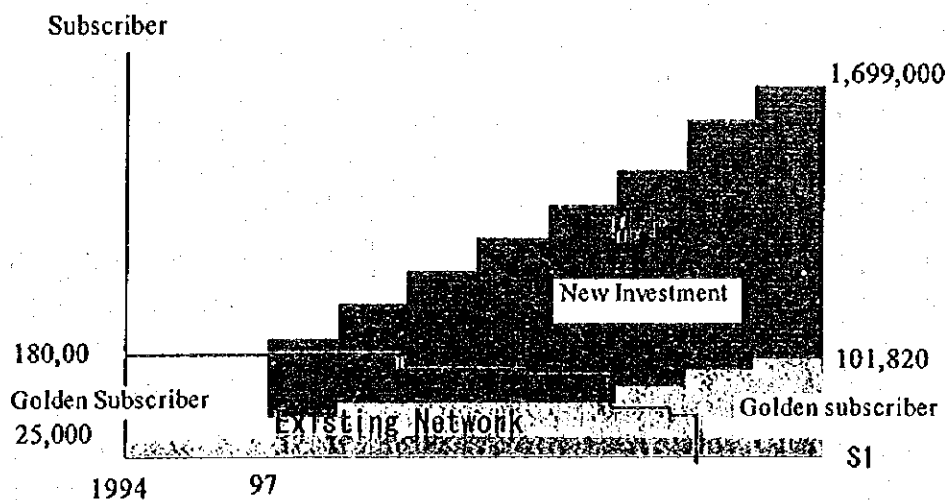


Figure 17-3-1 Concept Figure of Master Plan

3.2 Method of Financial Analysis

The method of financial analysis contrasts the total amount of the costs of construction, operation, etc. with the revenue obtained by the Call charge , Installation fees

and Rental fees to calculate the profit and make the various financial statement, etc. The section deals mainly with the calculation of Financial Internal Rates of Return (FIRR) which, by definition, is the discount rate which achieve a net present value of zero, when discounting sets of financial cash flows expected in the Master Plan.

While existing facilities are still in operation, it is difficult to evaluate the degree of contribution of the new investment. However, Study team tentatively figured revenues and expenditures assuming realistic conditions, extracted the parts related to the project and used these parts as the evaluation target.

3.3 Basic Assumptions for Financial Analysis

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

- 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) Revenue Collecting ratio

The expected collecting ratio is set as follows;

Table 17-3-1 The Expected Collecting Ratio

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

f) 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

g) 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

h) Foreign Grant Aid

Since Sri Lanka belongs to the LDC, bilateral aids are available to conduct through foreign grant aids. The foreign grant aids should be real grants, not to be subsidiary loans.

Duty : No duty, No charge
Belongings : SLT asset

i) Turnover Tax (BTT)

BTT has been calculated at 20% of Domestic calls

j) Corporate Income Tax, Import duty

40% of SLT's net taxable income.

No taxation is provided in the account, as there will not be any liability for taxes due to Capital Allowance.

Import duty : 20%

k) 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.

l) Depreciation

Full value of all asset items is depreciated without remaining salvage value, over the estimated useful lives of these assets. Depreciation is provided as follows;

Table 17-3-2 Depreciation method

Items	Depreciation method
Buildings	50 years straight line
<i>Plant</i>	
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

m) 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 months

n) GOSL Equity

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

o) 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 per Finance Act 38 of 1971.

3.4 Evaluation result for Base case

Table 17-3-3 Condition of Base scenario

Items	Condition
Business status	Parastatal
Levy	5.0% of GOSL capital investment
Corporation tax	No corporation tax paid due to capital allowance
Dividends	No dividends
Interest of L-T loan	13.0%
Repayment	10 yrs
Grace period	No grace period

The evaluation was performed under the assumption that SLT retains its current parastatal status. The evaluation ran through FY 2030, when investments to be made in FY 2014 will have been depreciated. Table 17-3-4 show the results. Under the M/P, the first annual profit comes in FY 2001 ; by 2004, the eighth year of the project, cumulative profitability is obtained, overcoming the losses incurred during the start-up period. Under the current assumptions, the major causes of cumulative losses over the eight-year period are high interest rates, time lags in investment effects, and Government Levy.

Table 17-3-4 Result of Financial Analysis

FIRROE has been calculated at 13.31% (1997 - 2030)

NPV(Discount rate at 10%) has been calculated at US\$255,156,000

Unit : US\$ '000

Year	Investment	Revenue	O&M Cost	Interest	Profit/Loss	Repayment	Cash Flow
1997	207,427	0	0	11,481	-11,481	5,186	-120,380
1998	276,091	27,622	27,041	32,231	-31,650	17,274	-175,172
1999	159,785	78,941	57,830	47,310	-26,199	28,171	-107,380
2000	33,162	123,039	80,374	49,658	-6,993	32,994	-20,672
2005	85,934	269,756	149,248	51,900	68,608	56,094	20,246
2010	82,927	422,284	221,564	23,066	177,654	23,099	177,221
2015	92,454	575,693	289,497	14,393	271,803	0	375,726
Total	2,294,117	5,667,357	3,006,123	643,050	2,018,184	560,936	855,681

Note : O&M cost included BTT, Depreciation, and staff cost etc.

Interest included GOSL LEVY

Table 17-3-5 Assumption of Financing Plan

Unit : US\$ '000

Items	US\$ '000	Share %
Internal generated funds	1,394,947	60.8%
L-T Loan	560,936	24.5%
GOSL Equity	338,234	14.7%
TOTAL	2,294,117	100.0

In cash flow terms, the fiscal year cash flow will turn positive in FY 2001, and onward thereafter, except for any year when investment exceeds US\$ 100 million. And the accumulated cash flow will remain positive after FY 2011. The payout period for the total required investment of US\$ 2,240 million is eight years. All of the additional funds needed for facility expansion can be paid out. A cash flow of US\$ 4,420 million is yielded throughout the evaluation period, with **FIRROE at 13.31%**. These FIRR values indicate a profitable ratio, showing a sound financial status for a public investment. There is a bottleneck, however, in that an overall shortfall in annual cash flow of US\$ 422 million will arise over the first four years of the project. In the current evaluation, a shortfall of US\$ 338 million over the first three years is to be covered by an investment from GOSL, which then has to increase its equity stake by this amount over the three years.

Should the investment for these initial four years be entirely covered by L-T Loans, the resultant high interest rates and repayment burdens would become excessive, and thus endanger SLT's operational standing. To avoid such a situation, another funding scenario was established using the following concepts, as shown in 17.3.5.

- (1) To minimise GOSL investment
- (2) To maximise internally generated funds such that SLT's operations are not hindered
- (3) To minimise the use of high-interest subsidiary loans

Although this evaluation assumes a GOSL capital investment of US\$ 338 million, the feasibility of this capital increase would be a key factor for the success of this M/P under the current parastatal status.

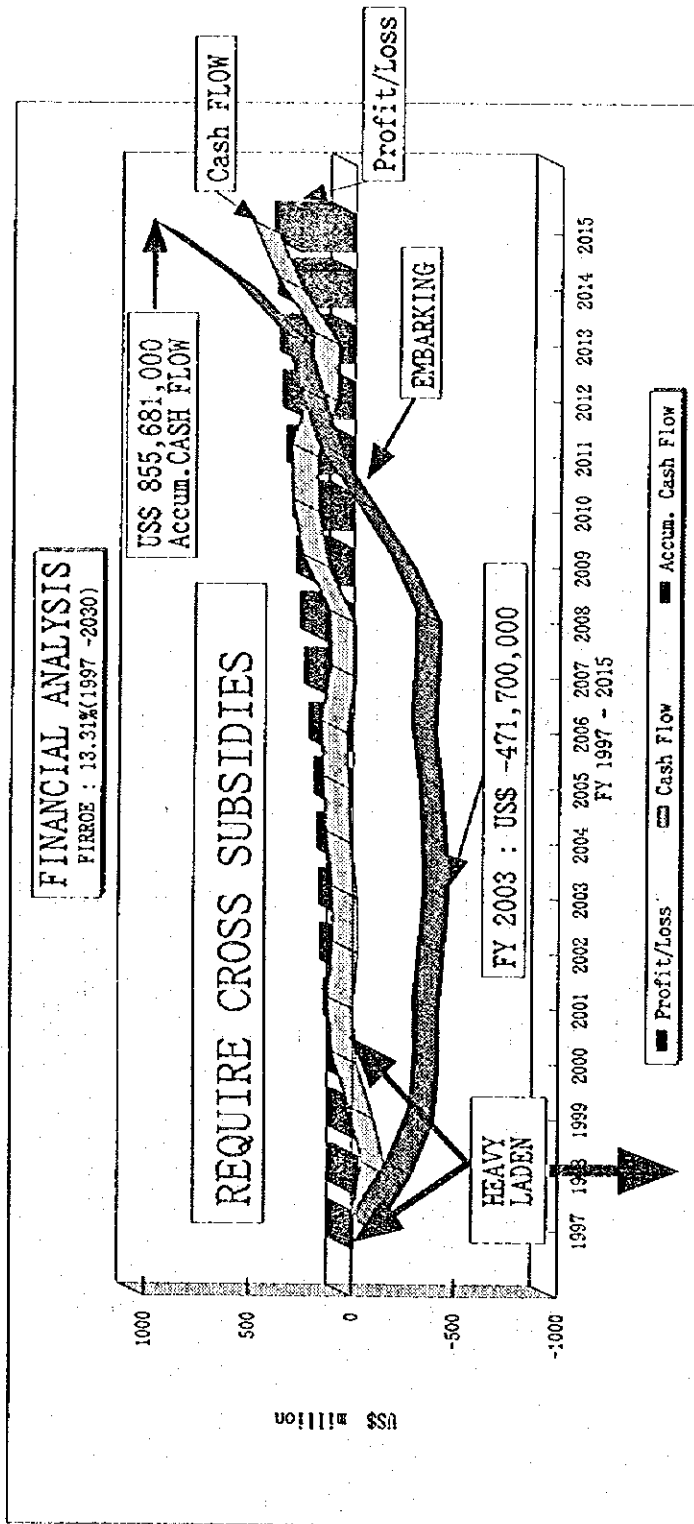


Figure 17-3-2 Result of Financial Analysis

3.5 Consideration

As we see in evaluation for base case of M/P, it can also be expected that a large profit will be realised once the deficit period is overcome. We would like to discuss how to overcome this deficit period.

Under the current assumptions, the major causes of cumulative losses over the eight-year period are high interest rates, short repayment period, time lags in investment effects, and large government Levy. Concerning the debt situation, the heavy burden at the start of the project is covered in Table 17-3-4. The long term loan condition without grace period is applied and become a negative cash flow factor once obligations begin to accumulate rapidly. Therefore, we examined alternative scenario A, in which the loan provisions must be changed in order to carry out the M/P.

(1) Alternative scenario A (ALT A)

Table 17-3-6 Condition of ALT A

Items	Condition
Business status	Parastatal
Levy	5.0% of GOSL capital investment
Corporation tax	No corporation tax paid due to capital allowance
Dividends	No dividends
Interest of L-T loan	8.0%
Repayment	30 yrs
Grace period	10 yrs

Since strict subsidiary loan conditions have been levied on SLT, a trial calculation was conducted using modified conditions. Under these, the modified loan conditions commonly adopted by international financial institutions is applied to the M/P, i.e., an 8% rate is used as interest, the same currently applied to SLT for suppliers credit (Direct loan).

FIRROE has been calculated at 22.62% (1997 - 2030)

NPV(Discount rate at 10%) has been calculated at US\$ 485,278,000

The first annual profit is then achieved in 2001, and cumulative profitability in 2003. On a cash flow basis, the fiscal year cash flow will turn positive as early as FY 2000; and the accumulated cash flow, by 2006 and then thereafter. The results improve greatly, as shown in Table 17-3-7. It is now clear that the current loan conditions are not suitable for the M/P,

which requires cross subsidies. It is hardly possible to pay high interest rates under the M/P, because the situation differs from that in existing entities, whose profit margins exceed 40%.

Table 17-3-7 Result of Financial Analysis (ALT A)

Unit : US\$ '000

Year	Investment	Revenue	O&M Cost	Interest	Profit/Loss	Repayment	Cash Flow
1997	207,427	0	0	8,193	-8,193	0	-49,679
1998	276,091	27,622	27,042	25,046	-24,466	0	-67,887
1999	159,785	78,941	57,831	38,994	-17,884	0	-22,959
2000	33,162	123,039	80,374	44,505	-1,840	0	10,843
2005	85,934	269,756	149,248	52,758	67,750	0	75,482
2010	82,927	422,284	221,564	46,914	153,806	25,981	150,492
2015	92,454	575,693	289,498	35,093	251,102	31,138	323,887
Total	2,294,117	5,667,359	3,006,126	817,790	1,843,443	213,016	1,090,692

Note : O&M cost included BTT, Depreciation, and staff cost etc.

Table 17-3-8 Assumption of Financing Plan

Unit : US\$ '000

Items	US\$ '000	Share %
Internal generated funds	1,612,626	70.3%
L-T Loan	622,768	27.1%
GOSL Equity	58,723	2.6%
TOTAL	2,294,117	100.0%

(2) Alternative scenario B (ALT B)

Table 17-3-9 Condition of ALT B

Items	Condition
Business status	100% state own company
Levy	no levy to GOSL
Corporation tax	40% of taxable income
Dividends	5% ~ 10%
Interest of L-T loan	8.0%
Repayment	10 yrs
Grace period	2 yrs

GOSL has been taking a positive attitude toward privatisation. It has tried hard to benefit society by providing an improved communication infrastructure ; rather than acting parastatally, it has sought to work through privatisation as much as possible. In 1995, however, the types of business targeted, degree of government regulation, timing, and other factors have not yet been clarified. Under alternative scenario B, the evaluation was performed on a 100% state-owned institution. There are certain differences from current operations :

- (1) Abolition of levies
- (2) Payment of corporate taxes
- (3) Payment of dividends
Dividends policy provisionally decided as shown in Table 17-3-11.
- (4) Abolition of subsidiary loans
- (5) Introduction of direct loans, etc.

Table 17-3-10 Loan Condition of ALT B

Items	Condition
Repayment period	10 yrs
Grace period	2 yrs
Interest	8.0 %
Guarantee	100% state own institution would not entail any guarantee from GOSL
Current Assets	Current assets are to be transferred without modification.

Table 17-3-11 Dividends Policy

Year	1997	2000	2005	2010	2015
Dividends %	1.0%	5.0%	5.0%	10.0%	20.0%

Table 17-3-12 shows the results of this evaluation.

In this scenario, as in the base scenario, GOSL is obliged to increase its equity stake by US\$ 287 million. While GOSL can earn at least US\$ 1,000 million of cash inflow in

dividends and taxes, the corporate tax burden would increase and FIRROE would decline to a low 8.68%. However, a meagre balance can be maintained and even dividends paid.

FIRROE has been calculated at 8.68% (1997 - 2030)

NPV(Discount rate at 10%) has been calculated at US\$ - 61,010,000

Note : FIRR values, being dependent on change in dividends, can be a criterion but have no significance on their own. They are merely provisional figures ; please make sure not to use them independently.

Table 17-3-12 Result of Financial Analysis (ALT B)

Unit : US\$ '000

Year	Investment	Revenue	Cost	Profit/Loss	Dividends	Repayment	Cash Flow
1997	207,427	0	4,1490	-4,149	948	0	-108,810
1998	276,091	27,622	40,238	-12,616	10,786	0	-149,650
1999	159,785	78,941	78,429	512	14,393	5,186	-72,077
2000	33,162	123,039	110,726	12,313	14,393	17,274	-39
2005	85,934	269,756	214,292	55,464	14,393	52,321	6,819
2010	82,927	422,284	310,092	112,192	28,786	52,878	65,481
2015	92,454	575,693	410,216	165,477	57,573	30,550	181,278
Total	2,294,117	5,667,359	4,281,590	1,385,769	414,740	754,766	-30,142

Note : Cost included BTT, Depreciation, Corporation Tax, Interest, and staff cost etc.

Table 17-3-13 Assumption of Financing Plan (ALT B)

Unit : US\$ '000

Items	US\$ '000	Share %
Internal generated funds	1,134,750	49.46%
L-T Loan	871,502	38.00%
GOSL Equity	287,865	12.54%
TOTAL	2,294,117	100.00%

With the payout period set as short as six years, SLT will be able to overcome its losses through efforts to reduce expenses, improve the tariff collection ratio, and other steps. On the other hand, the annual cash flows are negative throughout in every year where investment exceeds US\$ 100 million , and remain cumulatively negative until FY 2015. *It*

is thus clear that a substantial return cannot be expected from the equity investment ; rather the burden shall be shouldered by existing entities, though a meagre balance is maintained. Total values of the cash flow alone are around US\$ 886 million lower than in the base scenario until 2015.

This evaluation presupposes an investment of US\$ 287 million by GOSL. Should this be replaced by private capital, no change would result in the evaluation under the basic assumptions. Even if GOSL and private capital share a 51 : 49 equity stake, there would be hardly any change in the evaluation since dividends are allocated pro rata.

3.6 Comprehensive evaluation for Master Plan

In implementing the M/P, it is necessary to deal properly with cross subsidies. SLT's operations have thus far been supported by Golden subscribers. As the economy grows, demand for telephone installation has been increasing as new subscribers seek to enjoy the benefits of relatively low tariff rates. This demand, however, comes mostly from general subscribers ; revenue from these subscribers would hardly exceed US\$ 200 per capita annually. The M/P's projected profitability would be inferior to that of the existing network. To implement the M/P, the existing operational entities have to provide cross subsidies, particularly during its first four years. Without these, targeted demand can never be fulfilled completely.

This M/P is for an action programme positioned as the final stage of the basic minimum access structure, and functions as a low-return project thus far carried forward. Although continued investment is required at this stage, SLT-owned equity alone cannot accommodate it ; outside funds must be introduced. *In implementing an investment programme which require any cross subsidies, it is important to prevent the profit ratio from suffering and to focus on fulfilling demand. GOSL then has to be back up financially and to prepare a GOSL guarantee for foreign loans, as represented by GOSL additional investment.*

4. 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 M/P (Base scenario) on the Sri Lanka's economy. The Financial Analysis prepared in Section 17-3 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.

The result of financial analysis of the M/P (Base scenario) suggest that the new investment programme is classified a low profitable project, although considerable efforts are still necessary. It would be a mistake, when evaluating the M/P (Base scenario), to assess and discuss only one issue whether the large-scale investment will pay off or not. It will also be necessary to recognise and assess other issues; for example, the benefits of a countrywide communications network, solving the 100% demand fulfilment and providing services to northern and eastern regions.

4.1 Method of Economic Evaluation

In this Economic Analysis, the economic effect expected from the performance of these projects will be assessed dealing mainly with the calculation of Economic Internal Rate of Return (EIRR) when discounting sets of economic cost and benefit streams for the M/P. Through elimination of the value of transfer items and application of appropriate shadow

prices to the financial cost and benefit streams, the financial cash flows are transferred into economic cost and benefit streams to calculate the EIRR.

4.2 Economic Benefit

Economic Benefit of the Master Plan will be divided into direct and indirect benefits, which will be assessed separately.

(1) Direct Benefit

The direct benefit of these projects lays its importance in the economic value. Sales revenue in economic value to be generated by the Master Plan are estimated, based on investigation results concerning historical tariff level.

(2) Indirect Benefit

The improvement of Telecommunication networks will contribute a great deal to the improvement of the national well-being not simply in the form of economic benefit but also in term of social benefit.

Such indirect benefits conceivable are :

For Nations :

- Greater ease in emergency access to medical institutions
- Improved emergency communication, leading to upgrading and diversification of government and private services.
- Economic effects to enhance business activities.
- Increase in employment opportunities, improvement in security, etc.

For Sri Lanka Telecom. Sector :

- Nation-wide expansion of telecommunications service.
- Improvement of telecommunications service.
- Rapid innovation in telecommunications.
- Simplification of network management.
- Creating new services.

With the combination of above effects, national economic growth is promoted.

4.3 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 any 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.

4.4 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.

$$SCF = (M+X)/\{(M+T_m)+(X-T_x)\}$$

Where,

- SCF: Standard Conversion Factor
- M : CIF value of imports
- X : FOB value of exports
- T_m : All taxes on imports
- T_x : All taxes on exports

Each value of the above parameters to obtain SCF and the result of calculation are summarised in Table 17-4-1.

Table 17-4-1 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.

4.5 Economic Evaluation

Economic evaluation is more conceptual approach than the financial evaluation with the assumption that economic evaluation employs perspective of society while financial evaluation is based on business entity's perspective. Therefore, Economic benefit and cost are not directly related to actual monetary flow.

(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 17-4-2 Telephone call charges from 1983 to 1993

Year	Unit: US\$					
	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 17-4-2, 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 17-4-3.

Table 17-4-3 Benefit streams

<i>Year</i>	<i>Total Benefit Streams (US\$ 1,000)</i>
1997	0
2000	129,191
2005	283,244
2010	443,398
2015	604,477

(2) Economic Cost Streams

The total investment and O&M costs in each project year described in Section 17.2.2 resummarised in Table 17-4-4 for Economic Analysis. The costs are converted into the economic cost using value of national parameter (Shadow premium)

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

Unit : US\$ 1,000

Year	Total Investment	Year	Total Investment
1997	196,862	2007	139,695
1998	264,011	2008	168,814
1999	148,372	2009	76,533
2000	28,323	2010	55,860
2001	36,752	2011	73,243
2002	116,855	2012	191,455
2003	151,644	2013	231,651
2004	79,532	2014	85,112
2005	46,187	2015	0
2006	58,783	Total	2,149,686

Table 17-4-5 Total Economic O&M Cost

Unit : US\$ '000

Year	Staff Costs	Other Costs	D.Insurance	Total O&M cost
1998	721	8,469	-	9,190
2000	2,163	21,989	-	24,152
2005	4,085	43,367	-	47,452
2010	5,287	66,832	-	72,119
2015	6,248	90,839	-	97,087

D.Insurance : Damage Insurance

(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 17-4-6.

Table 17-4-6 Economic Cash Flow

Unit : US\$ 1000

Year (FY)	Economic Benefit	Investment	Operating Cost	Economic Cash Flow
1997	0	196,862	0	-196,862
1998	29,003	264,011	9,190	-244,197
1999	82,888	148,372	17,176	-82,660
2000	129,191	28,323	24,152	76,715
2001	166,900	36,752	29,293	100,856
2002	196,794	116,855	33,650	46,288
2003	224,943	151,644	38,281	35,018
2004	254,469	79,532	43,040	131,896
2005	283,244	46,187	47,452	189,604
2006	313,408	58,783	52,473	202,152
2007	346,940	139,695	57,725	149,521
2008	380,039	168,814	62,619	148,607
2009	412,509	76,533	67,689	268,289
2010	443,398	55,860	72,119	315,419
2011	472,919	73,243	76,739	322,937
2012	503,902	191,455	81,550	230,896
2013	536,089	231,651	86,522	217,915
2014	569,614	85,112	91,724	392,777
2015	604,477	0	97,087	507,390
TOTAL	5,950,725	2,149,686	988,478	2,812,561

Net Present value (Discount rate 10%) for M/P (Base scenario)

Cost (C)	:	US\$ 1,352,544,000
Benefit (B)	:	US\$ 1,873,466,000
B - C	:	US\$ 520,922,000
B / C	:	1.39
EIRROI	:	19.33%

The EIRR for the proposed M/P based on incremental cash flows as a result of the M/P has been calculated at **19.33 percent**. The M/P 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, *M/P 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 M/P is expected to realise a similar EIRR.*

The proposed M/P is expected to have economy-wide benefits. It will help promote investments in the sector ; improve SLT's efficiency, enhance service quality, expand network capacity, 100% demand fulfilment and increase geographical coverage. The number of subscribers and DELs will four times from 405,644 DELs, in 1997, to a minimum of 1,600,000 DELs in 2015. For business, improved telecommunications services will help enhance productivity, and *the presence of a sound regulatory framework will help build investor confidence.*

5. Financial Soundness as Total Business Entity

It is necessary to take the current business and operational situations into consideration in order to evaluate the feasibility of executing the Master Plan. In other words, it is necessary to predict the cash position in the event that the current network continues to operate, and to include the cash position in the Master Plan. SLT will construct, manage and operate the Master Plan as a part of SLT's business framework. Therefore, the appraisal of Master Plan call for the analysis of financial situation foreseen as a whole business entity, which means that consolidated cash position is to be analysed assuming the financial outputs obtained by the existing facilities. By such analysis, it is obviously proved how the financial position of SLT has been impacted as a whole.

(1) Forecast Cash position of Existing Facilities

The current financial situation of SLT has been set as follows:

- a) Accumulated debts as of Dec. 1994 were given as foreign debts. Repayment of these debts have been included in accordance with the repayment conditions of each loan.
- b) Existing facilities become increasingly obsolete every year, leading to at all unusable finally. Therefore, the supply capacity of existing facilities will decrease each year.
- c) By maintaining the exchange rate of June 1, 1995, (US\$ 1.00 = Rs 50.0), no exchange loss will occur from after 1995.

5.1 Financial Projection for Base scenario as Total Business Entity

Financial analysis of the M/P was conducted on the basis of the Income Statement, Balance Sheet, and other data supplied by the SLT. Result of the analysis are indicated in the Tables 17-5-1 ~ 17-5-5.

Table 17-5-1 Condition of Base scenario

Items	Condition
Business status	Parastatal
Levy	5.0% of GOSL capital investment
Corporation tax	No corporation tax paid due to capital allowance
Dividends	No dividends
Interest of L-T loan	13.0%
Repayment	10 yrs
Grace period	No grace period

(1) Stability

In order to analyse the financial stability, we have reviewed solvency ratio (equity to total assets), self-financing rate (annual depreciation plus surplus to annual investment), Debt/Equity ratio (Interest bearing loans to Equity) and Interest coverage ratio (Interest expense plus profit before tax to Interest expense).

The Solvency ratio, will regain from 50-percent level in fiscal year of 1997 to 99.4% in 2015. Since the target for this ratio is 40 percent, these figures indicate that SLT can afford to increase the proportion of outside capital, that is, L-T Loan and other borrowings, in its capital structure. In this sense, SLT will have a more potential to expand the Telecom. Network.

The interest coverage ratio is also anticipated to stay four times or greater. After 2005, this ratio will stand at over ten times. In view of these circumstances, it is possible to judge that the SLT will be able to comfortably shoulder investment worth about 800 million US dollars outlined under the M/P.

(2) Profitability

The Profitability ratio will generally remain high. While it is expected to decline somewhat in fiscal year of 1999 and 2000 because of pressures such as increased

depreciation, the situation is anticipated to improve in fiscal year of 2001, allowing the SLT to maintain profitability at a very high level.

(3) Growth Ratio

The Growth ratio will continue to stay at a high under the effect of above - explained high profitability. This implies that current financial conditions will facilitate additional new investment.

(4) Overall Evaluation

The Fixed asset turnover ratio, which reflects the efficiency of plant and equipment investment, will show rather low values from 0.20 in 1997 to 0.23 in 2000. This is a result of delayed returns from plant and equipment investment. However, the figure will improve to 0.40 in fiscal years of 2015. The growth potential also represents a progressively increase (1.00 times in 1999). A comprehensive look at these figures reveals that SLT continues to maintain a sound financial conditions, ready to be commercialisation. Table 17-5-3 shows the inflow as evaluated from GOSL's perspective.

Consequently, we can assume that the telecommunications business will remain soundly managed as long as plant and equipment investments are carried out according to the Master Plan.

Table 17-5-2 Significant Financial Indicators for the M/P Base Scenario

Items	1997	1998	1999	2000	2005	2015
STABILITY RATIO						
Interest Coverage Ratio(times) ((Profit before interest payable and tax)/Interest payable)	4.56	4.10	4.02	4.34	7.56	22.12
LIQUIDITY RATIO						
Current Ratio(%) (Current Assets / Current Liabilities)	140.8	147.3	159.3	190.0	409.9	1904.9
PROFITABILITY RATIO						
Profit margin(%) (Profit before tax / Sales)	18.4	16.1	10.5	9.7	29.5	50.8
GROWTH RATIO						
Sustainable Growth Ratio (Retained profit / Shareholder equity)	2.09	2.03	2.18	2.33	4.62	17.27
SOLVENCY RATIO(%)						
Equity / Total Assets	46.0	43.5	42.7	45.3	63.0	89.7
SELF FINANCING RATE(%)						
Annual Depreciation plus Surplus / Years Investments	54.9	52.1	107.1	1512.3	-----	-----
FIXED ASSETS TURN OVER RATIO						
Account receivable (days)	0.20	0.20	0.21	0.23	0.30	0.40
Net profit / Total asset(%)	145.2	129.4	123.5	119.1	104.5	87.2
	3.5	3.1	2.1	2.1	6.9	8.6

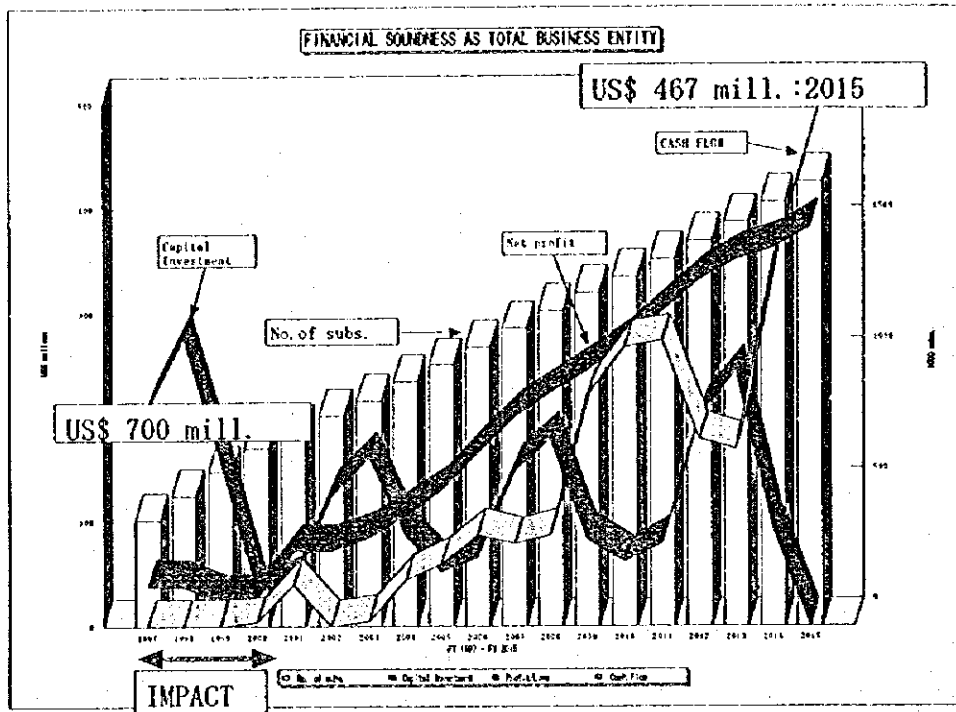


Figure 17-5-1 Financial soundness as Total Business Entity

Table 17-5-3 Summary of the Cash Inflow for M/P (Base scenario)

ITEMS	Total amount (US\$'000)
B.T.F	1,031,119
Corporation Tax	0
Levy	545,211
Dividends	0
Interest(13%-8%)	378,862
Cash flow	2,328,682
Total	4,283,874
Annual Average	225,467

5.2 Result of Evaluation for Alternative scenarios

As the evaluations presented by Table 17-5-4 indicate, both alternative scenarios suggest sound operational status of SLT.

Condition of ALT A

Items	Condition
Business status	Parastatal
Levy	5.0% of GOSL capital investment
Corporation tax	No corporation tax paid due to capital allowance
Dividends	No dividends
Interest of L-T loan	8.0%
Repayment	30 yrs
Grace period	10 yrs

Condition of ALT B

Items	Condition
Business status	100% state own company
Levy	no levy to GOSL
Corporation tax	40% of taxable income
Dividends	5 % ~ 10 %
Interest of L-T loan	8.0%
Repayment	10 yrs
Grace period	2 yrs

Table 17-5-4 Summary of Alternative scenarios

Unit : US\$'000

ITEMS	Base scenario	ALT A	ALT B
B.T.T	1,031,119	1,031,119	1,031,119
Corporation Tax	0	0	1,602,517
Levy	545,211	339,407	0
Dividends	0	0	631,613
Interest	378,862	996,197	0
Cash flow	2,328,682	2,334,551	841,921
Total	4,283,874	4,701,274	4,107,170
Annual Average	225,467	247,435	216,166

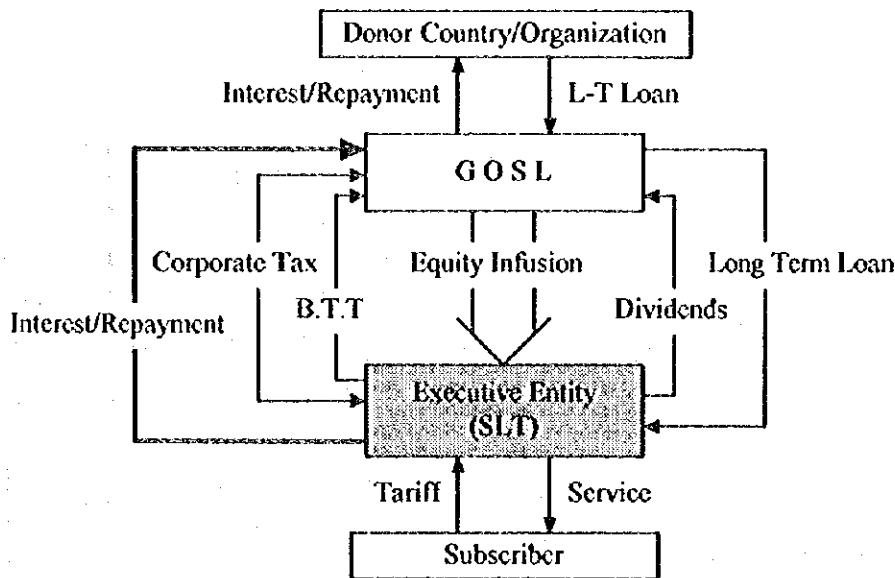


Figure 17-5-2 Concept Chert of Money Flow

Evaluation of Alternative scenario A includes changes in borrowing conditions and a requirement for GOSL to adopt a capital increase of about US\$ 59 million. The evaluation results clearly indicate that if this requirement is met, massive profits will be generated. Although the changes in borrowing conditions will act as a slight burden on GOSL, it is nonetheless expected to have holdings of US\$339 million as GOSL levy by the year 2015, when SLT will have retained earnings of US\$3,245 million. These expectations suggest that SLT will be able to exhibit sufficient performance as a parastatal and that great benefits will be brought to Sri Lanka.

In the case of Alternative B, the evaluation differs depending on whether the investment is made by GOSL or private investors. A project which takes more than 12 years to recover an initial investment of US\$287 million would seem less than appealing to private investors. The great challenge ahead is to assemble investors (including GOSL) who are interested in proceeding with this master plan. The evaluation itself indicates that if that particular hurdle is cleared, this master plan will greatly benefit Sri Lanka.

5.3 Scenario in Which GOSL is unable to Provide Increased Capital (ALT C)

Condition of ALT C	
Items	Condition
Business status	Company
Levy	no levy to GOSL
Corporation tax	40% of taxable income
Dividends	3 % ~ 20 %
Interest of L-T loan	8.0%
Repayment	10 yrs
Grace period	2 yrs

In the event that GOSL is, for some reasons, unable to provide increased capital, the required US\$67million for the initial three years of the M/P will have to be generated by private capital and long-term loans. Even in such case, if GOSL continues its policy of maintaining majority control of the overall capital structure (i.e., more than a 50% equity stake), the funding scenario indicated in Table 17-5-5 would apply.

Table 17-5-5 Funding Plan

Category	1997	1998	1999
LT-Loan	80%	80%	80%
Private	20%	20%	20%

In this regard, GOSL should at least issue certain loan guarantees (LGs) to ensure that the necessary funds can be raised, and thus to support the Telecom sector. It should be noted that raising all the funds required for M/P solely through the private sector would be extremely difficult, and imposes a tremendous risk burden on private investors.

Table 17-5-6 Summary of the cash inflow for M/P (ALT C)

ITEMS	Total amount (US\$'000)
B.T.T	1,031,119
Corporation Tax	1,577,182
Levy	0
Dividends	203,500
Interest	0
Cash flow	566,200
Total	3,378,001
Annual Average	177,789

Once the initial eight-year period is over, however, operational stability will return; massive borrowing will no longer be necessary. By 2010, all investments will be covered by internally generated funds. The financial projections in Table 17-5-6 suggests an accumulated cash flow of US\$832 million by 2015, with no reimbursement problems.

Based on a full consideration of these above conditions, GOSL should take a positive look at the LG option. In order to attract private investors under these circumstances, GOSL should also give serious consideration to the notion of allowing private investors to participate in tariff policy-making and to supply adequate tariff levels. *These measures represent the minimum requirements for avoiding risks of private investors.*

6. Conclusion

The foregoing evaluation confirmed the following points.

- (1) If SLT is operated in a reasonable and adequate manner, the proposed master plan will lead to production of substantial local-currency profits.
- (2) Under the unique condition in Sri Lanka, where demand exceeds supply, capital costs as well as other costs associated with providing and expanding telecommunications services will be easily recovered by tariff income, even if the tariff is set below the levels of other countries.

(3) Cross subsidies between international calls and domestic calls. If GOSL intends to continue the present tariff policy, the profits generated by international calls must be fully utilised to support the operational and investment activities associated with domestic calls.

The evaluations obtained from this study indicate that if the operator is a government-controlled entity involved in the social infrastructure (i.e., a 100%-state-owned parastatal), sufficient profitability can be expected. However, it remains unclear whether private investors will be interested in a project with a FIRR below 15.0% which is located in a county where the national discount rate is around 17.0% - 20.0%. The master plan presented here will support construction of a well-balanced network only if the entire plan is implemented. Of course, this plan includes some projects that require cross subsidies due to their inherent characteristics.

If these projects are abandoned because of their low profitability, the master plan's overall objectives will not be fulfilled. This point should be given particular consideration when private investment is introduced. Also, efficient measure should be adopted to help insure that the entire Master Plan is fulfilled.

CHAPTER 18

IMPACTS BY PARTICIPATION OF PRIVATE WLL OPERATORS

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IMPACTS BY PARTICIPATION OF PRIVATE WLL OPERATORS

Chapters 6 to 17 describe demand forecasts and telecommunications development plan based on the expressed demand (the existing telephone subscribers + waiters). On the other hand, this Chapter 18 covers impacts to be expected on condition that the suppressed demand which is estimated as 20% of the expressed demand will be expressed by participation of private WLL (Wireless Local Loop) operators. Details are described below.

1. Overview of Impacts to be Expected

A telecommunications policy in Sri Lanka has been established by the department of national planning keeping with the economic policy statement of Government of Sri Lanka which was announced on September 1994. The economic policy states that public investment would be needed to build the infrastructure which is required as a necessary complement to rapid private sector growth and socio-economic activities. Up to the present, private participation in value-added telecommunications services has been promoted in Sri Lanka in accordance with the telecommunications policy. However, basic telecommunications services have been monopolistically operated by Sri Lanka Telecom.

In the telecommunications policy, it is most important policy to eliminate waiting lists for telecommunications facilities. To cope with this situation, telephone service which is major service of basic telecommunication services is going to be opened to private WLL operators. The WLL operators was invited in August 1995 by SLTA and they will start their services in 1997. By participation of private WLL operators, the following various influences will be expected :

- a) Quicker network expansion by both SLT and private operators will bring higher telephone DEL supply speed.
- b) The higher supply speed will bring more expressed demand by activating suppressed demand.
- c) By sound competition among SLT and private operators including mobile telephone operators, various qualities of service will be much improved.
- d) Corporate efficiency of SLT will be much improved by the competition.
- e) A burden for the Government in the telecommunications sector will be reduced.

By participation of private WLL operators into POTS, the telephone demand will be increased. To fulfil such increased demand, the supply plan be modified. These matters will be expected on condition that :

- a) Suppressed demand will be remarkably expressed in consequence of completion of on-going projects by both SLT and private operators after the year 2000.
- b) The supply of DELs by private WLL operators is assumed as 200,000 in the year 2000 and 300,000 in the year 2005.
- c) The supply of DELs by SLT is estimated as 614,000 in 2000 and 873,000 in 2005. The figures of DEL are almost same as those of the original supply plan based on the expressed demand basis in the master plan.
- d) The provision of DELs by SLT will be mainly made by subscriber cables which is dimensioned covering the next 5 year demand.
- e) The accumulated number of DELs by the completion of on-going projects by the end of 1997 will reach to 571,200.
- f) In addition to the above number of DELs, the number of DELs to be newly supplied by SLT by the year 2000 will be 312,000.

From the above expected scenario, the modified telephone supply plan is proposed as shown in Figure 18-1-1 and Figure 18-1-2 and Table 18-1-1 to Table 18-1-3.

On such conditions, various impacts to be resulted by the participation of private WLL operators are analysed from the following point of view :

- Impacts on Socio-Economy
- Impacts on Telecommunications Network Plan
- Impacts on Financial and Investment Plan

Table 18-1-1 Telephone Supply Plan by SSC considering Suppressed Demand

No.	SSC	Capacity in 1997			SLT Exp. in 2000	Demand in 2000			Demand in 2005				
		Switch	Cable	Eff. Lines		Total	% of WLL	WLLs	SLT	Total	% of WLL	WLLs	SLT
8	Colombo	306,027	388,690	298,992	180,631	465,427	30%	139,628	325,799	685,176	30%	205,553	479,623
1	Ampara	3,644	4,650	3,577	0	2,891	10%	289	2,602	4,079	10%	408	3,671
2	Anuradhapura	7,050	12,130	7,050	4,756	10,639	10%	1,064	9,575	13,118	10%	1,312	11,806
3	Awissawella	5,000	8,770	5,000	5,826	8,273	10%	827	7,446	12,029	10%	1,203	10,826
4	Badulla	6,972	10,870	6,972	3,092	8,807	10%	881	7,926	11,182	10%	1,118	10,064
5	Bandarawela	3,940	5,900	3,940	2,865	6,042	10%	604	5,438	7,561	10%	756	6,805
6	Batticaloa	7,196	9,300	7,154	3,636	8,455	10%	846	7,609	11,989	10%	1,199	10,790
7	Chilaw	8,470	18,700	8,470	0	9,254	10%	925	8,329	12,857	10%	1,286	11,571
9	Galle	19,555	18,550	14,269	8,371	20,105	20%	4,021	16,084	28,300	20%	5,660	22,640
10	Gampaha	11,484	46,818	11,484	23,140	30,910	25%	7,728	23,182	46,165	25%	11,541	34,624
11	Hambantota	8,402	11,700	8,402	4,238	10,266	10%	1,027	9,239	14,045	10%	1,405	12,640
12	Hatton	2,850	3,385	2,604	0	2,777	10%	278	2,499	3,434	10%	343	3,091
13	Jaffna	0	0	0	29,371	27,398	20%	5,480	21,918	39,162	25%	9,791	29,371
14	Kalmune	6,524	6,400	4,923	6,082	8,672	10%	867	7,805	12,228	10%	1,223	11,005
15	Kalutara	50,820	67,825	50,820	0	29,209	20%	5,842	23,367	42,485	25%	10,621	31,864
16	Kandy	47,254	62,930	47,254	0	44,868	25%	11,217	33,651	63,792	25%	15,948	47,844
17	Kegalle	6,672	10,368	6,672	6,170	11,144	10%	1,114	10,030	16,052	20%	3,210	12,842
18	Kurunegala	15,260	20,800	15,260	7,583	22,074	20%	4,415	17,659	30,457	25%	7,614	22,843
19	Mannar	1,400	400	308	1,541	1,528	10%	153	1,375	2,054	10%	205	1,849
20	Matale	10,628	14,985	10,628	0	8,326	10%	833	7,493	10,440	10%	1,044	9,396
21	Matara	15,200	20,600	15,200	0	17,968	20%	3,594	14,374	25,117	20%	5,023	20,094
22	Nawalapitiya	1,394	3,380	1,394	0	1,471	10%	147	1,324	2,093	10%	209	1,884
23	Negombo	13,600	25,200	13,600	12,778	23,896	20%	4,779	19,117	35,171	25%	8,793	26,378
24	Nuwera Eliya	4,912	8,975	4,912	1,235	5,522	10%	552	4,970	6,830	10%	683	6,147
25	Polonnaruwa	5,450	9,400	5,450	0	4,951	10%	495	4,456	6,374	10%	637	5,737
26	Ratnapura	10,178	12,670	9,746	3,900	11,993	10%	1,199	10,794	17,058	20%	3,412	13,646
27	Trincomalee	4,650	7,470	4,650	3,634	6,516	10%	652	5,864	9,204	10%	920	8,284
28	Vavuniya	2,500	4,700	2,500	2,711	4,370	10%	437	3,933	5,790	10%	579	5,211
	Total	587,032	815,566	571,231	311,560	813,752	25%	199,894	613,858	1,174,242	26%	301,696	872,546
	Colombo	306,027	388,690	298,992	180,631	465,427	30%	139,628	325,799	685,176	30%	205,553	479,623
	Other SSCs	261,005	426,876	272,239	130,929	348,325	17%	60,266	288,059	489,066	20%	96,143	392,923

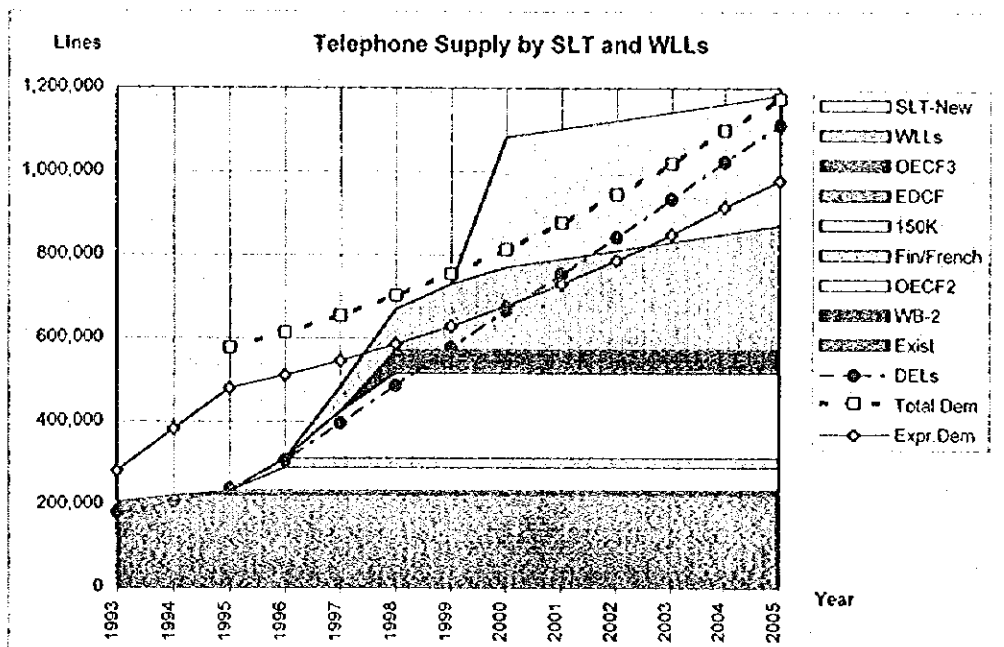


Figure 18-1-1 Telephone Supply by SLT and Private WLL Operators

Table 18-1-2 Telephone Supply by SLT and Private WLL Operators

Year	Exist	WB-2	OECF2	Fin/French	150K	EDCF	OECF3	WLLs
1993	207,227	0	0	0	0	0	0	0
1994	222,636	0	0	0	0	0	0	0
1995	222,636	11,064	0	0	0	0	0	0
1996	222,636	11,064	55,318	22,646	0	0	0	0
1997	222,636	11,064	55,318	22,646	113,389	0	0	60,000
1998	222,636	11,064	55,318	22,646	204,543	10,000	45,024	100,000
1999	222,636	11,064	55,318	22,646	204,543	10,000	45,024	160,000
2000	222,636	11,064	55,318	22,646	204,543	10,000	45,024	200,000
2001	222,636	11,064	55,318	22,646	204,543	10,000	45,024	220,000
2002	222,636	11,064	55,318	22,646	204,543	10,000	45,024	240,000
2003	222,636	11,064	55,318	22,646	204,543	10,000	45,024	260,000
2004	222,636	11,064	55,318	22,646	204,543	10,000	45,024	280,000
2005	222,636	11,064	55,318	22,646	204,543	10,000	45,024	300,000
Year	SLT-New	Total	Expr.Dem	Total Dem		Expr.DEL	Supp.DEL	DELTs
1993	0	207,227	281,836	0		180,720		180,720
1994	0	222,636	383,011	0		207,227		207,227
1995	0	233,700	480,679	576,815		237,000		237,000
1996	0	311,664	511,303	613,564		307,000		307,000
1997	0	485,053	545,869	655,043		397,000		397,000
1998	0	671,231	586,114	703,337		487,000		487,000
1999	0	731,231	629,600	755,520		577,000		577,000
2000	312,000	1,083,231	678,127	813,752		667,000		667,000
2001	312,000	1,103,231	731,811	878,173		731,811	21,954	753,765
2002	312,000	1,123,231	788,234	945,881		788,234	55,176	843,410
2003	312,000	1,143,231	850,024	1,020,029		850,024	85,002	935,026
2004	312,000	1,163,231	915,526	1,098,631		915,526	108,032	1,023,558
2005	312,000	1,183,231	978,536	1,174,243		978,536	133,081	1,111,617

Note: The volume shows approx. effective capacity for DELTs connection.

Table 18-1-3 Modified Telephone Supply Plan up to the Year 2015

A	B	C	D	E	F	G	H	I	J	K	L
Year	Expre Dem DEL+Waiter	20%Suppre Demand	Total Dem (B+C)	Fill Rate (F/B)%	Expre.DEL	Fill Rate (H/C)%	Supp DEL	Total DEL (F+H)	WLL's DE	WLL Shar (J/I)%	SLT's DEL (I-J)
1993	281,836			64%	180,720			180,720		0%	180,720
1994	383,011			54%	207,227			207,227		0%	207,227
1995	480,679	96,136	576,815	49%	237,000			237,000		0%	237,000
1996	511,303	102,261	613,564	60%	307,000			307,000		0%	307,000
1997	545,869	109,174	655,043	73%	397,000			397,000	60,000	15%	337,000
1998	586,114	117,223	703,337	83%	487,000			487,000	100,000	21%	387,000
1999	629,600	125,920	755,520	92%	577,000			577,000	160,000	28%	417,000
2000	678,127	135,625	813,752	98%	667,000			667,000	200,000	30%	467,000
2001	731,811	146,362	878,173	100%	731,811	15%	21,954	753,765	220,000	29%	533,765
2002	788,234	157,647	945,881	100%	788,234	35%	55,176	843,410	240,000	28%	603,410
2003	850,024	170,005	1,020,029	100%	850,024	50%	85,002	935,026	260,000	28%	675,026
2004	915,526	183,105	1,098,631	100%	915,526	59%	108,032	1,023,558	280,000	27%	743,558
2005	978,536	195,707	1,174,243	100%	978,536	68%	133,081	1,111,617	300,000	27%	811,617
2006	1,045,326	209,065	1,254,391	100%	1,045,326	75%	156,799	1,202,125	320,000	27%	882,125
2007	1,115,688	223,138	1,338,826	100%	1,115,688	79%	176,279	1,291,967	340,000	26%	951,967
2008	1,181,592	236,318	1,417,910	100%	1,181,592	84%	198,507	1,380,099	360,000	26%	1,020,099
2009	1,250,336	250,067	1,500,403	100%	1,250,336	87%	217,558	1,467,894	380,000	26%	1,087,894
2010	1,310,795	262,159	1,572,954	100%	1,310,795	93%	243,808	1,554,603	400,000	26%	1,154,603
2011	1,374,981	274,936	1,649,917	100%	1,374,981	97%	266,746	1,641,727	420,000	26%	1,221,727
2012	1,442,318	288,464	1,730,782	100%	1,442,318	100%	288,464	1,730,782	440,000	25%	1,290,782
2013	1,512,441	302,488	1,814,929	100%	1,512,441	100%	302,488	1,814,929	460,000	25%	1,354,929
2014	1,586,358	317,272	1,903,630	100%	1,586,358	100%	317,272	1,903,630	480,000	25%	1,423,630
2015	1,663,173	332,635	1,995,808	100%	1,663,173	100%	332,635	1,995,808	500,000	25%	1,495,808

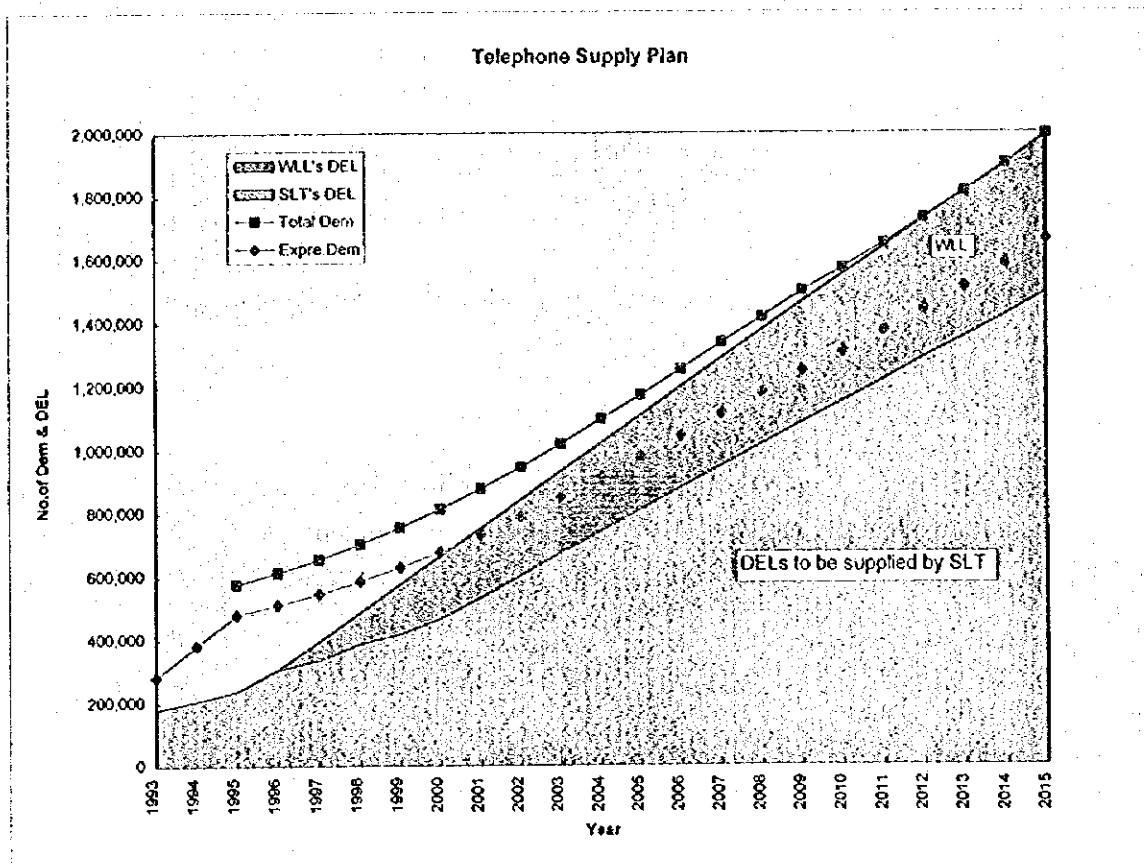


Figure 18-1-2 Modified Telephone Supply Plan up to the Year 2015

2. Impacts on Socio-Economy

The current challenge for Sri Lanka's telecommunication sector is how to meet the demand for over new 200,000 lines. The Government of Sri Lanka(GOSL) had been counting on Sri Lanka Telecom(SLT) to supply them, but SLT is a parastatal entity, and the project remains incomplete several years after being commissioned. Meanwhile demand has continued to grow, creating an even more unwieldy situation.

SLT has been doing as best it can under these circumstances, but pending demand topped about 340,000 lines in 1995. Seeking a drastic resolution to the problem, GOSL decided to allow private Wireless Local Loop(WLL) operators to enter the business as a step toward restructuring the country's communications sector. These private operators can enter only the local telecommunication services market. Two companies have chosen to do so, and now must install a total of 200,000 lines(100,000 each) by the year 2000.

How will this development affect Sri Lanka's communication sector? First, the WLL system currently offered by SLT is as following status:

Table 18-2-1 Current Tariff System for WLL and Mobile Telephone

ITEMS	Installation fee (Rs)	Note:
SLT WLL system	59,000	
SLT Basic telephone	13,000	
CELLTEL (mobile phone)	10,000	Incoming: 8Rs, outgoing: 10Rs
MOBITEL (mobile phone)	7,500	

Source: SLTA

As the table shows, there is a marked difference in installation fees between SLT's WLL service and the other alternatives. Also, there have been complaints by telephone users about the poor quality of SLT's WLL service, including problems such as:

- 1) persistent jamming,
- 2) frequent interference, and
- 3) high subscription fees.

Current SLT WLL prices result from the restricted nature of the market instead of yielding benefits through economies of scale, the current market structure actually reduces the

benefits available to SLT, thereby pushing up the subscription fee per line. The proposed project, which is targeted at 200,000 prospective subscribers, nearly as many as are currently registered, is expected to lower costs by taking advantage of economies of scale as well as improving existing service problems 1) and 2) mentioned above, which are caused by shortages of antennas and other equipment.

As of January 1996, however, there are no details available concerning the type of WLL system that will be introduced by private operators, or its price. The following argument is thus based on the assumption that mobile phones should be used as fixed telephones, with prices for these phones somewhere near those of basic fixed telephones.

Once WLL operations get underway, users will be surprised at the ease of installation of WLL phones. All they will have to do is pick up a WLL telephone unit at a store, receive a phone number, take the unit home, and plug it into an outlet by following the instructions in a simple manual. There will be no need to deal with the long waiting list maintained by SLT. This factor, among others, shows that this project will serve effectively meet current demand for additional lines.

3. Impacts on Telecommunications Network Plan

3.1 General

Sri Lanka plans to introduce two private fixed line networks in 1997 overlaying to the existing one provided by SLT. The new networks will be of wireless local loop (WLL) technology for providing fixed telephone lines. As a result, Sri Lanka will have three fixed line networks and four mobile networks for telecommunications service. The WLL network introduction will bring about impacts also to the numbering scheme, signalling plan, network synchronisation, engineering standards, and facilities plan. This Section deals with various impacts to be considered in planning SLT network after the WLL participation.

3.2 Numbering Plan

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

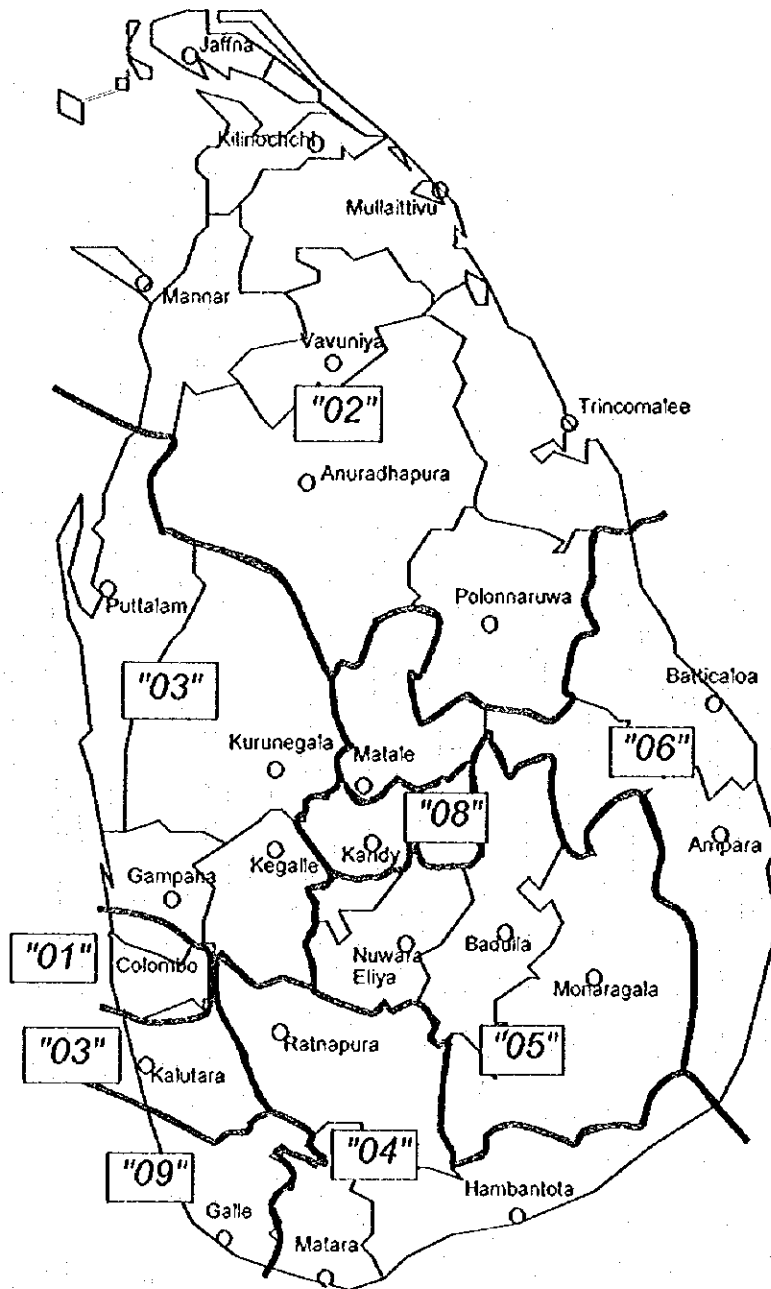
The existing numbering plan is that made up where one operating entity provides telecommunications services in the country. This is the way that many countries follow even nowadays. The existing numbering plan gives the private networks the trunk codes as if they are trunk call areas. For instance, the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

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

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

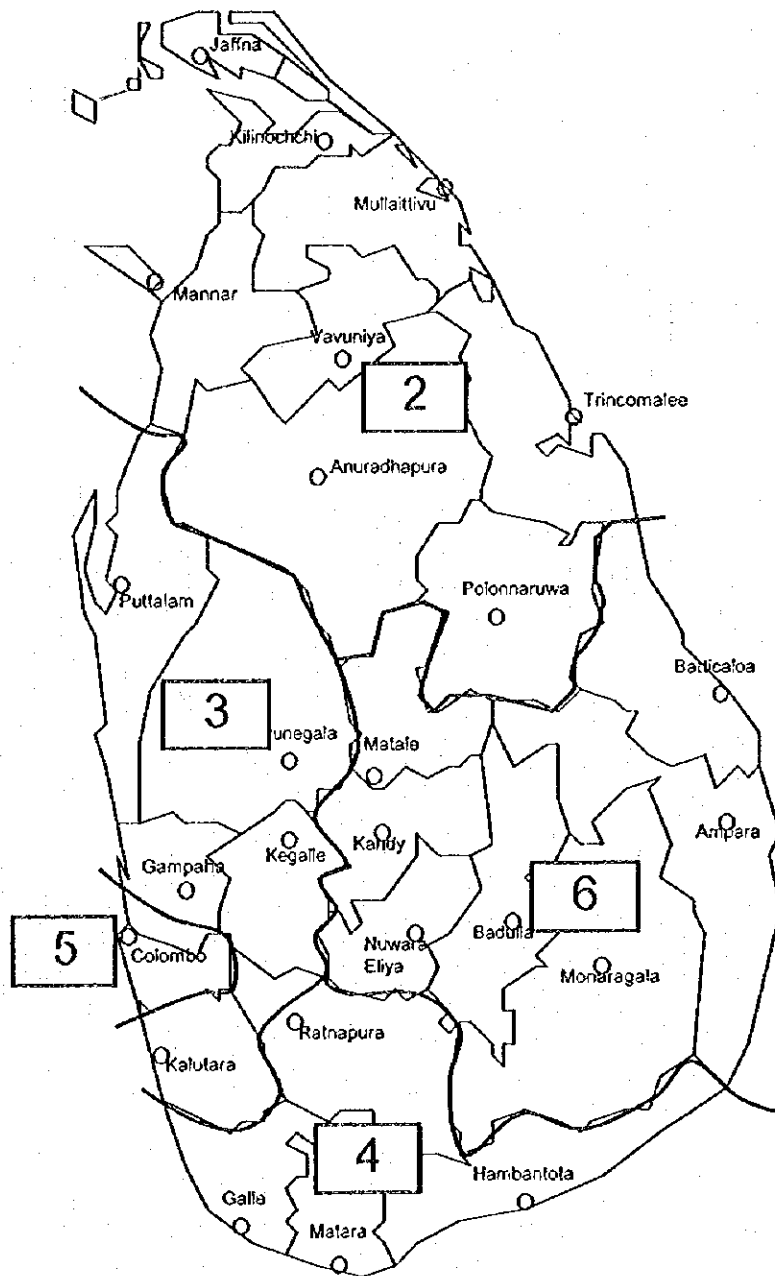
- b) Adoption of a closed number scheme. The new numbering plan is expected to have a closed numbering scheme, where no trunk prefix code is required. The existing SLT's network requires to dial "0" for trunk calls.
- c) Introduction of new DNC. The new numbering plan aims to give the first digit for distinguishing geographical areas or services and the second digit for distinguishing the network providers. That is, the new Destination Network Code (DNC) is two in digits. In the new numbering plan, the first digit "1" is for short codes, "2" to "6" for fixed line network, "7" for new services, "8" for new services, "9" for reserved for new services, and "0" for international call services. The second code "8" of the first digits "2" to "6" is assigned to WLL network providers other than SLT.
- d) Multi-networks in one local call area. The new numbering plan allows two (2) or more networks in one local area. The network provider will be distinguished by the second digit. That is, the new DNC will be consisted of Area Code followed by Network Provider's Code.

Figure 18-3-1 shows the first digits of existing numbering scheme and Figure 18-3-2 shows the first digit assignment of proposed closed numbering scheme (Draft). Table 18-3-2 shows the Planned DNC in Future (Draft).



Source: SLT.

Figure 18-3-1 Existing Trunk Code First Digit



Source: SLTA.

Figure 18-3-2 Closed Numbering First Digit Assignment in Future (Draft)

Table 18-3-1 Planned DNC in Future (Draft)

	1	2	3	4	5	6	7	8	9	0
Short Codes	Short Codes	Short Codes	Short Codes	Short Codes	Short Codes	Short Codes	Short Codes	Short Codes	Short Codes	Short Codes
1 North Region	Jaffna, Mannar, Vavuniya				Anuradhapura, Trincomalee, Polonnaruwa			New WLL Operators	Reserve	
2 Outer Colombo Region	Negombo, Chilaw		Gampaha	Kalutara	Kegalle	Kwessawella	Kurunegala	New WLL Operators	Reserve	
3 South Region	Galle, Matara				Katnapura		Hambantota	New WLL Operators	Reserve	
4 Colombo	Colombo (SCT start)						Colombo business networks	New WLL Operators	Reserve	
5 Centre East Region	Kandy		Nuwara Eliya, Nawalapitiya, Hattota		Baticaloa, Kahmutai, Angara	Matale	Badulla, Bandarawela	New WLL Operators	Reserve	
6 Mobile	Mobile	Cellul				Paging	MTN	Call Link	Reserve	
7 New Services	Local call rate							Nationally portable range	Reserve	Free phone
8 Reserve New Services	Value added services	Reserve	Reserve	Reserve	Reserve	Reserve	Reserve	Reserve	Reserve	Premium rate
9										International access
0										

Source: SLTA.

3.3 Signalling Plan

SLT should introduce the Common Channel Signalling System ITU-T (CCITT) No. 7 for the new TSC switches. Adopting CCS No. 7 is a world tendency as it is essential for providing new services.

Sri Lanka is coming into ISDN era same as many countries do all over the world. Sri Lanka is expected to start various new services in near future. Trunk Free (or Free Phone) service and Premium Rate service will be the first among the new services. Though some new services, including Trunk Fee and Premium Rate, are available by means of existing digital exchange network, the new services will require more communication which may be possible by CCS No. 7. In the future, the gateway switch will be required to deal with more data communication by signalling link than before for new services.

Attention should be paid to that the signalling links will be used very much more than conventional networks. Trunk Free and Premium Rate calls are given the speech path information after analysing the data transmitted to a data base by signalling link. Signalling link role will increase in the future network.

3.4 Network Synchronisation

All the networks in Sri Lanka should be synchronised with a certain slip rate to guarantee a permissible quality of service. SLT has a standard clock the accuracy of which is in compliance with ITU-T recommendations. SLT should maintain the clock accuracy to guarantee the quality of service to the calls to/from other networks.

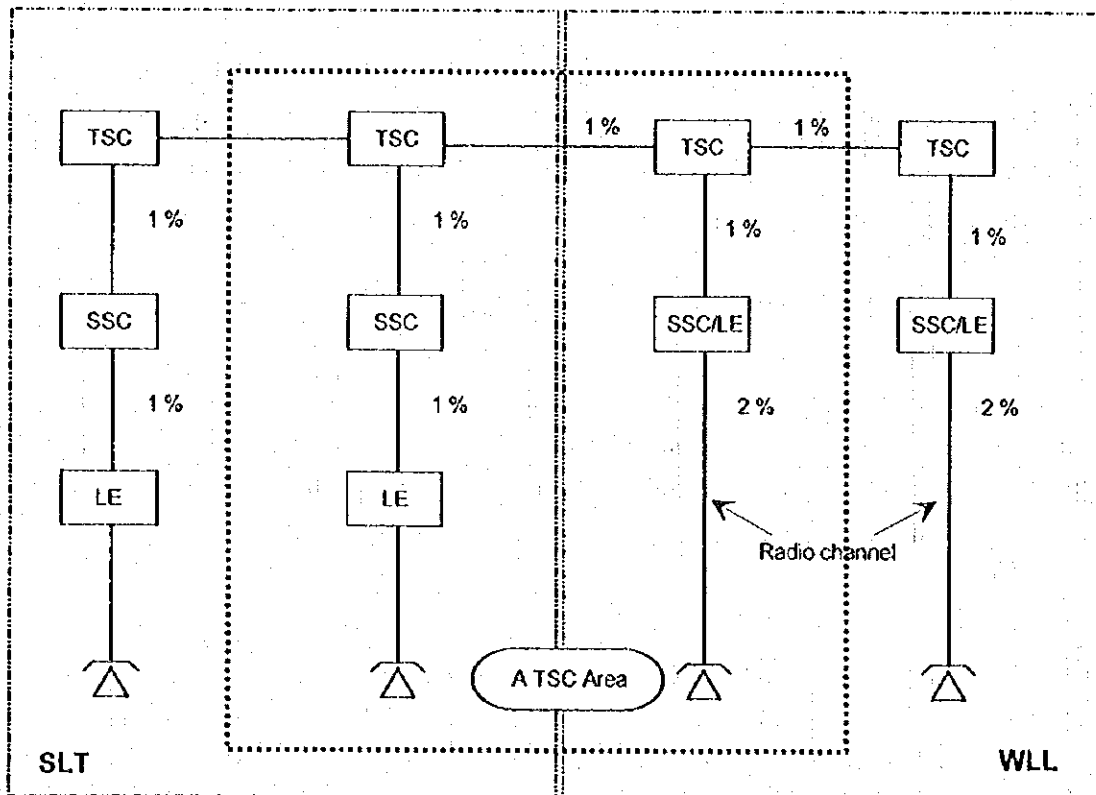
ISC by NEAX 61-E and ISC by 5-ESS are equipped with a reference clock of accuracy of 10^{-11} , respectively, to satisfy the requirements on slip rate recommended by CCITT Rec. G. 823/824. The existing E-10B, OCB-283, NEAX-61, and DX-220/210 exchanges are equipped with a clock module with stability of 10^{-10} per day.

JICA Study Team recommends SLTA to conduct a study for assessment on a network synchronisation system wherein SLT distributes the standard clock pulses to the other networks. SLT has the clock pulse generator which satisfies the international requirements and will be the biggest network even when the WLL networks are introduced in 1997.

3.5 Engineering Standards

3.5.1 Traffic engineering

WLL network link selection loss probability will be set up in compliance with the requirement stipulated in the "Invitation for wireless local loop operators' licences" (30/Aug./1995), that is, it will be determined as a factor to satisfy the call completion rate of 50% within WLL network. It is supposed that the new WLL networks will allocate 1% of loss probability per link between switching unit same as in many countries. They may refer to that the loss probability of mobile cellular terminal to switching system is set at 2 to 4% in many countries. Figure 18-3-3 shows the case where 1% is allocated to switch-to-switch link loss probability and 2% to WLL terminal-to-switch. Refer to Sec. 3.7.3 for WLL network structure.



Source: JICA Study Team.

Figure 18-3-3 A Model of Connection Loss Probability of WLL Network

3.5.2 Transmission Performance

Transmission performance should be same as applied to the existing SLT network even after the WLL networks are introduced into Sri Lanka telecommunications network.

3.6 Charging Plan

The new TSC switches of SLT should be equipped with the function to collect information necessary to calculate and record the charge to/from other networks. The information to be collected is the calling and called parties' number, the number of circuit used for the communication, time of communication start and end, traffic of circuits, traffic of signalling links, etc. Most information may be same as that required for ISC. The information to be collected actually should be decided through negotiations with other network providers.

3.7 Switching Network

3.7.1 National Network Configuration and Hierarchy

The network providers, including SLT, are free to decide the shape of their network configuration and hierarchy even after the participation of WLL network. The existing SLT's network is made up in an effective form to provide telecommunications network all over the country where most of subscriber lines are by cables. In this sense, SLT is not required to change the concept of the existing network configuration and hierarchy of exchanges. It should be noted, however, that the function of NSC will be changed as TSC is taking an important role in the trunk transit network increasing its capacity in near future. NSC will become a gateway switch to mobile cellular telephone network, intelligent network (IN), and to short code service operators as well as being a supporting transit node for TSC for overflowed traffic and network security.

The existing SLT network is consisted of such five (5) exchange ranks in hierarchy as ISC, NSC, TSC, SSC, and LE. The SLT's existing network, which has been developed along with the growth of the telephone demand, is a good form to provide telephone service all over the country. It is sure that the SLT network will develop in quantity of subscriber numbers and service areas even after the WLL participation.

SLT has around 280 local exchanges in total. Those exchanges are placed at adequate points to provide telecommunication service in the country. They are connected in an organic body covering effectively the country forming a star type network. Figure 18-3-4 shows the existing SLT network.

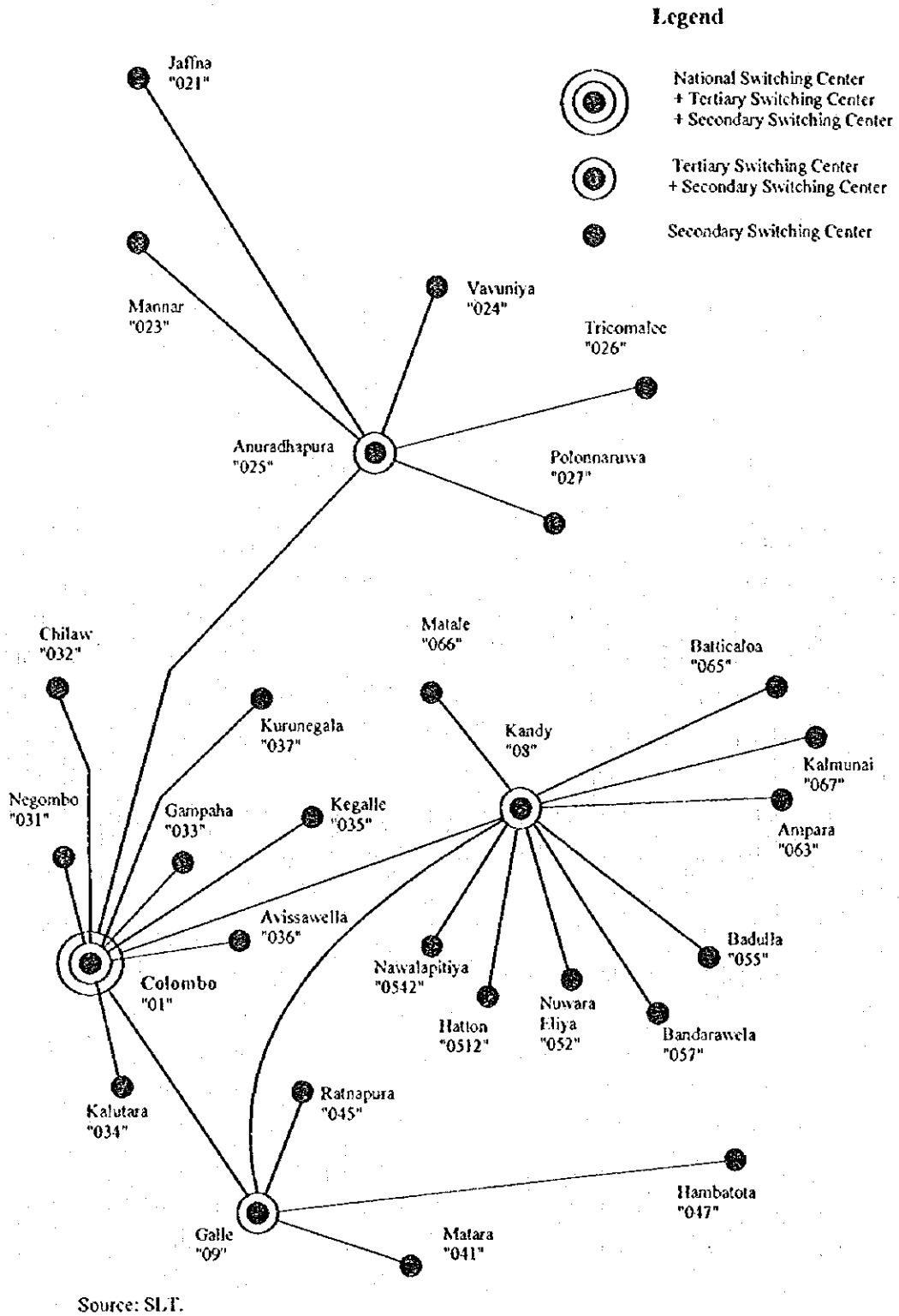
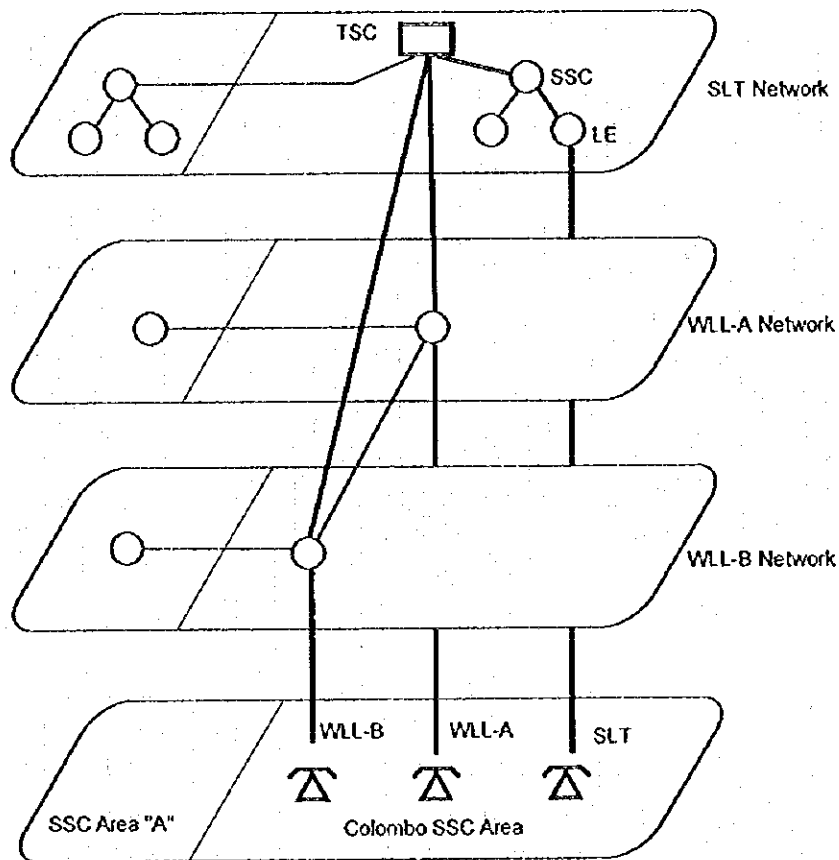


Figure 18-3-4 General View of SLT National Switching Network in 1995

3.7.2 Interconnection of Different Networks

All the networks should have their proper gateway switches to treat traffic to/from other networks. The existing SLT gateway switch to mobile cellular networks is NSC situated in Colombo City. In addition to this, SLT is required to provide new gateway switches for the traffic between SLT network and WLL networks in 1997.

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 18-3-5 shows a general view of overlaid SLT and WLL new networks taking an example in Colombo SSC area.



Source: JICA Study Team.

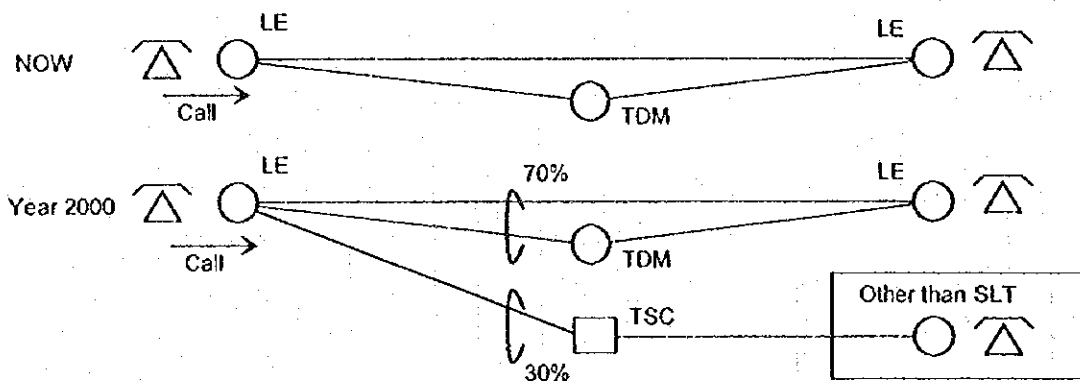
Figure 18-3-5 Overlaid SLT and WLL Networks in 1997

The decision of the Government of Sri Lanka providing four interconnection points for WLL networks is reasonable as it matches a foreseeable magnitude of national network. The

interconnection points may be increased in number in future when the inter-network traffic grows up. The increase in number of interconnection points should be decided in consideration of such probable factors a) that more complicated switching system, which will be more expensive than usual one, is required, b) that a careful attention will be required for business procedures and in maintenance together with different network operators, etc. That is, the interconnection point increase should be decided from a general analysis standing on a balance of cost and effect. It should be a treaty between operators.

SLT has a gateway switch to mobile cellular telephone networks. It is the second unit of NSC (hereinafter referred to as NSC Unit "B") which is a product of AT&T called "5-ESS" and was introduced in 1992. It has a capacity of 12,000 inter-exchange circuits. Among them 9,000 inter-exchange circuits are in use at present. It is not equipped with CCS No. 7. The capacity of this unit is not sufficient to deal with traffic demand in the year 2000. JICA Study Team recommends SLT to introduce new TSC 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 18-3-6 shows an example of traffic flow change in Colombo SSC area in the case new WLL networks are in operation as forecast in 2000.



Source: JICA Study Team.

Figure 18-3-6 Traffic Flow after WLL Participation in Colombo in 2000

3.7.3 WLL Network Structure

The new WLL networks will be made up of two stages making use of the advantage of radio system for subscriber network. The distance from a WLL subscriber to switching system can be remarkably longer than that by cable system and this will bring about a bigger service area of a switching system. That the recent digital switching system has big capacity in subscriber lines and the recent transmission system is in price decline tendency is likely to accelerate to set a bigger service area of exchange (hereinafter the "exchange" is defined as a switching centre consisting of one or more switching units). That is, the exchange capacity will be bigger than before. Besides, since the country is of an extension of 432 Km in length and 224 Km in width, it is very likely that new WLL networks will be of two stage for economical network structure. Figure 18-3-3 shows a probable WLL network structure.

3.8 Transmission Network

WLL operators will construct their own telecommunications network. According to the information, two newly introduced subscribers access networks will overlaid to existing SLT's subscriber access network. This section will make clear the expected features of transmission system in such circumstances.

3.8.1 Influence of the WLL Network

There will be two new telecommunications networks. The numbers of subscribers are expected to be 100,000 each in year 2000. Comparing to the number of present cellular mobile subscribers, which is about 40,000 in total, those network will affect very much to SLT network more than present cellular mobile network.

Switching network of SLT has been composed in hierarchical style. In this style of the network, local call is handled at the local exchange, and long distance call is handled by local

exchanges and appropriate transit exchanges called SSC, TSC or NSC. But, under the condition that some network has their own subscribers and exchanges respectively, and their subscribers are distributed in the whole country, call between other networks must flow through the interconnection point. Considering the number of WLL subscribers, these cases will occur very usually. Even if they live in close, their telephone line shall be connected at the interconnection point.

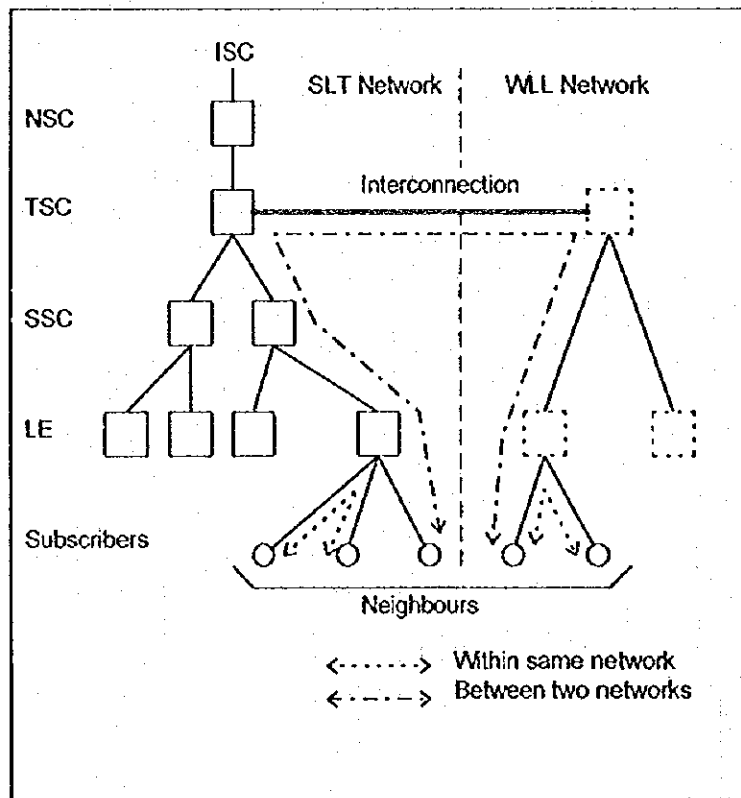


Figure 18-3-7 Traffic Flow between Two Networks

Tertiary switching centres at Colombo, Kandy, Anuradhapura and Galle will be regarded as the interconnection point between SLT network and WLL networks. So, telephone traffic between TSC and local exchanges of SLT will grow up in proportion to the growth of the number of subscribers in each network, and larger capacity will be required for the trunk transmission links. At the same time, WLL networks must have the enough capacity in their own networks also. At this moment, the structure or hierarchy of WLL network is not clear, so this study does not refer to their network. But SLT network should be prepared for working with WLL network well and preventing the traffic handling failure.

3.8.2 Trunk Transmission Network

According to the information on the WLL operators' licenses, licensee has an obligation to cater for self-supporting long distance network, using either own and/or leased facilities. Microwave radio links and optical fibre cables will be permitted for this purpose.

In case there are three trunk networks, advantages and disadvantages of the whole trunk network system are as follows:

(a) Advantages:

- Operators can manage and control their whole network easily without any special consideration.
- Three overlay networks are considered as secured mutual supplemented network. In case a network failed, other two network can work as alternative networks.

(b) Disadvantages:

- High construction cost is required comparing one network.
- It is difficult that operators have their own tower, antenna and fibre optic cable route each especially because of difficulty of land acquisition.
- Operators can not enjoy and utilise their integrated scale merit with separate transmission system. Separation affects the cost of transmission and the care of unused capacity is required.

For the relief of these disadvantages, Telecommunications Authority shall ensure that SLT and other licensed operators make available space in their premises, towers, power suppliers, etc. if such facilities are available, on the payment of reasonable rental charges.

3.8.3 Traffic and Circuit Study

The followings are the study for the traffic distribution presumption in the three cases of SLT and WLL networks' configurations.

The following conditions based on the master plan data are assumed for the calculations and the network hierarchy is shown in Figure 18-3-8:

Whole traffic volume	:	100
Route condition	:	Only final route exist. (Subs. - LE - SSC - TSC -)
Traffic distribution ratio	:	Intra-office call... 13 %
	:	Within SSC call... 51 %
	:	STD call for other SSCs... 36 %

(Other calls such as International call are not taken into account here.)

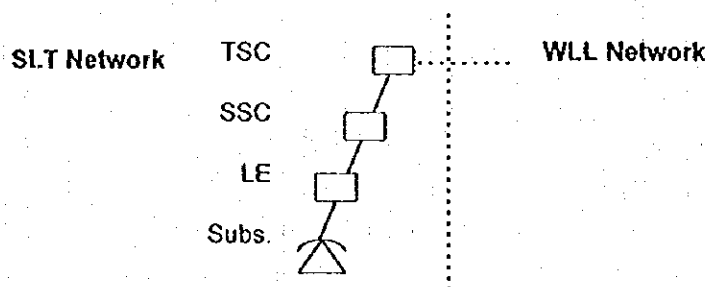


Figure 18-3-8 Network Configuration

(1) In the case SLT's network only exists

Traffic distribution along the transmission paths for one side (originating or terminating) are calculated as shown in the Table 18-3-2.

Table 18-3-2 Traffic Distribution in the Case (1)

Call	SLT Circuits			Remarks
	Subs. - LE	LE - SSC	SSC - TSC	
Intra-Office	13			
Within SSC	51	51		
Other SSC	36	36	36	
Total	100	87	36	

Source: JICA Study Team.

- (2) In the case SLT takes 70 % of the whole subscribers and WLL takes 30% of the whole subscribers

Whole traffic amount, 100 is distributed between SLT and WLL by the ratio of subscribers as following:

Between SLT - SLT call takes 49 ($100 \times 0.7 \times 0.7$)

Between SLT - WLL call takes 42 ($100 \times 0.7 \times 0.3 \times 2$)

Between WLL - WLL call takes 9 ($100 \times 0.3 \times 0.3$)

SLT - SLT call traffic is distributed in the ratio shown in the previous table. All call traffic between SLT - WLL go through along the paths LE - SSC - TSC in SLT network. WLL - WLL call will not affect to SLT network. These one side (originating or terminating) traffic distribution along the transmission paths of SLT are calculated as shown in the Table 18-3-3.

Table 18-3-3 Traffic Distribution in the Case (2)

Call	SLT Circuits			Remarks	
	Subs. - LE	LE - SSC	SSC - TSC		
SLT - SLT	Intra-Office	6			
	Within SSC	25	25		
	Other SSC	18	18	18	
	Sub-Total	49	43	18	
SLT - WLL	Intra-Office	3	3	3	Calls for WLL subs. in SLT's Intra Office area
	Within SSC	11	11	11	Calls for WLL subs. in SLT's SSC area
	Other SSC	7	7	7	Calls for WLL subs. in SLT's Other SSC area
	Sub-Total	21	21	21	
Total	70	64	39		

Source: JICA Study Team.

- (3) In the case SLT takes 70 % of the whole subscribers and WLL takes 30% of the whole subscribers, and WLL use SLT leased circuits for their trunk circuits.

Leased circuits of SLT will supposed to be used as shown in Figure 18-3-9. It is assumed that WLL employs two stage SW hierarchy and WLL LE is connected to SLT SSC, and WLL TSC is connected to SLT TSC as shown in the figure.

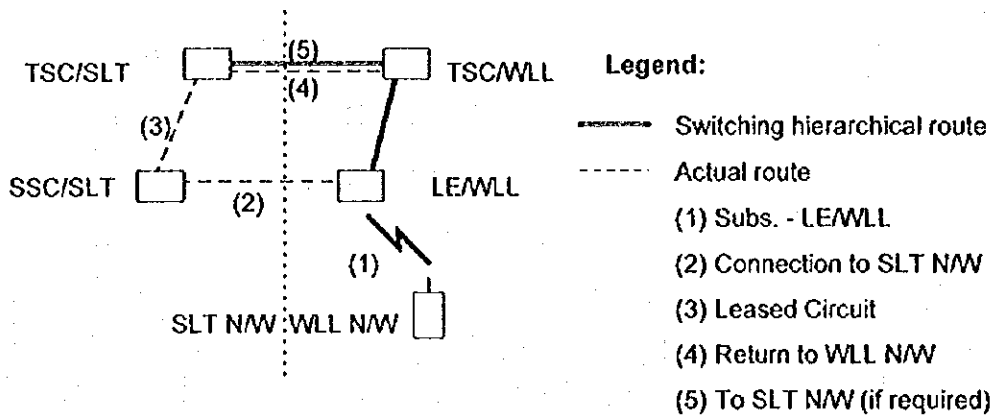


Figure 18-3-9 SLT Leased Circuit for WLL

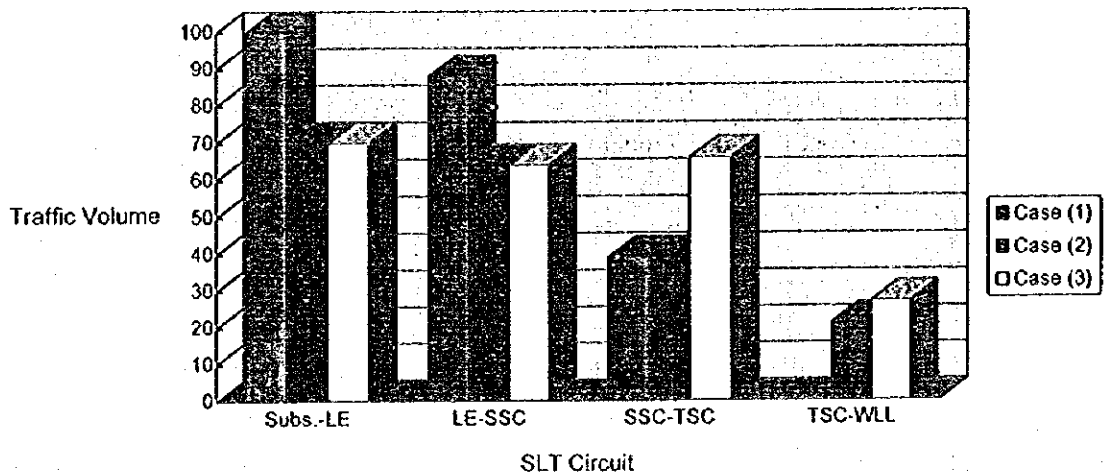
Considering above configuration, call traffic distribution is calculated as shown in Table 18-3-4.

Table 18-3-4 Traffic Distribution in the Case (3)

	Call	SLT Circuits			Remarks
		Subs. - LE	LE - SSC	SSC - TSC	
SLT - SLT	Intra-Office	6			
	Within SSC	25	25		
	Other SSC	18	18	18	
	Sub-Total	49	43	18	
SLT - WLL	Intra-Office	3	3	6	Calls for WLL subs. in SLT's Intra Office area
	Within SSC	11	11	22	Calls for WLL subs. in SLT's SSC area
	Other SSC	7	7	14	Calls for WLL subs. in SLT's Other SSC area
	Sub-Total	21	21	42	
WLL - WLL	Intra-Office				
	Other LE			6	LE-TSC traffic flow through SLT's SSC-TSC
	Sub-Total	0	0	6	
Total		70	64	66	

Source: JICA Study Team.

Considering both originating and terminating calls, above three cases are compared as shown in Figure 18-3-10. Total originating traffic volume for each case is same as 100.



Source: JICA Study Team.

Figure 18-3-10 Comparison of Traffic Volume on SLT Circuits

As shown in the above figure, call volume in SLT network will be reduced in the case (2), WLL participation. Indeed, call volume between subscribers of SLT and LE will be reduced in the proportion of the subscribers' decrease, but circuits between SSC and TSC will not change because of traffic flow between SLT and WLL.

In case (3), trunk circuits of SLT will carry more traffic than in case (1) and (2) because of traffic hand over for leasing circuits in WLL- WLL call.

Above study treats only traffic volume and is not include study on the number of circuits. But, it is said in general that the required number of circuits will be more than the estimate number in proportion of the traffic because the group size of subscribers will be smaller than ever and more circuit routes will appear, so circuit convergence efficiency will be lowered.

3.8.4. Treatment of the Master Plan

It is unclear that WLL operators have their own trunk network or they utilise leased circuit of SLT. From view point of whole telecommunications sector, calculated demand of

trunk transmission link and proposed trunk transmission network previously in this study will be required at least for whole transmission network.

Future backbone systems are considered in thick bunch basis so as to be treated in capacity units such as STM-1 (155.52 Mbit/s, 63 systems of 2 Mbit/s), STM-4 (622.08 Mbit/s, 252 systems of 2 Mbit/s) and STM-16 (2,488.32 Mbit/s, 1,008 systems of 2 Mbit/s). This idea came from the reduction of the cost, recent modularity trend and the importance to keep easy handling system. Meeting this idea, it will be important to prepare enough capacity for uncertain traffic behaviour between SLT network and WLL networks.

The network and facility plans of this master plan were drawn up based on the demand forecast result. So, even if the number of subscribers of SLT do not reach to the forecast figure because of advent of WLL network and the proposed transmission capacity is too much for subscribers of SLT in result, the traffic occurred between SLT network and WLL network will require some of extra transmission capacity.

So, proposed future trunk transmission network in this master plan previously is regarded as the reasonable network for SLT. Detail study will be required in the implementation stage of the future projects or the review of the master plan following the appearance of the network structure of WLL, but the network should have enough capacity.

3.9 Facilities Plan

3.9.1 Switching System

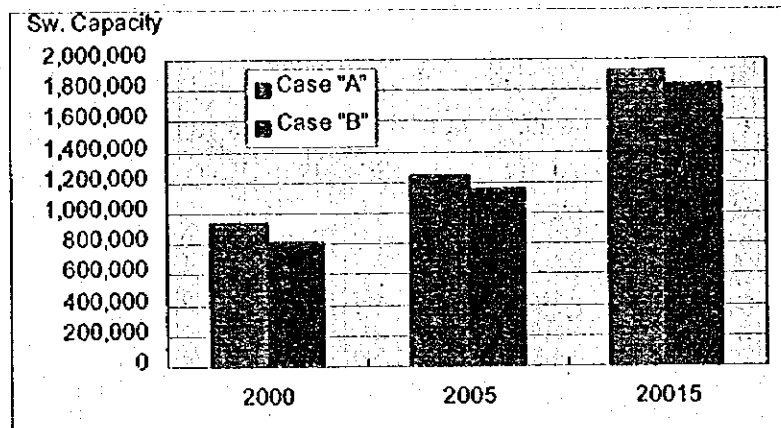
(a) SLT LE capacity

The SLT LE switching capacity will be smaller in number in the case the WLL networks are introduced, in comparison with that made up under the condition that all the demand of fixed line network is catered by SLT. Table 18-3-5 and Figure 18-3-11 show the SLT LE capacity to be provided in the year 2000, 2005 and 2015 comparing the two cases. In Table 18-3-5 and Figure 18-3-11, the Case A represents the LE capacity provided that all the demand of fixed lines are catered by SLT and the Case B represents the LE capacity to be provided by SLT after two WLL networks take part in 1997.

Table 18-3-5 Exchange Capacity

Year	2000	2005	20015
Case "A"	939,714	1,243,996	1,923,575
Case "B"	811,617	1,154,603	1,837,013

Source: JICA Study team.



Source: JICA Study team.

Figure 18-3-11 Exchange Capacity

(b) SLT Transit exchange capacity

SLT will be required to provide more switching system capacity in the case of TSC unlike the case of LE capacity. TSC capacity should be decided in consideration of the forecast saying that around a quarter of subscriber lines belong to WLL networks in 2000 and afterwards.

In the case of Colombo Metro Area, since around 30% of traffic originated from the SLT subscribers are supposed to go to private WLL subscribers, as mentioned in Sec. 3.7.2, SLT has to provide more TSC capacity comparing to the case discussed in Chap. 9.

The Colombo TSC capacity required in 2000, which aims to meet the demand in 2005, will be around 56,000 circuits for TSC being more than 10 times the case without private WLL networks. The Colombo SSC capacity should be smaller than previous calculation, because the SLT subscriber traffic to WLL networks will be routed from SLT local exchange directly to TSC. At the same time, the share of TDM in Colombo SSC Area will be reduced remarkably to have around 15,000 circuits in 2000 or a quarter of the case without private WLL networks.

In the case of Colombo SSC Area, which is the objective area for the Local Network Expansion Project in Colombo Metro Area, the SCC function and TDM function were entrusted to TSC in consideration of switching system capability of TSC and the number of circuits required to SSC and TDM.

SLT is required to pay more attention in deciding the switching capacity for expansion or SLT's capacity should be decided in consideration of directions of other network operators.

4. Impacts on Financial and Investment Plan

As stipulated in its original Master Plan, SLT is solely responsible for meeting the demand for new telephone installations. Accordingly, the capital investment during the initial three years represents a heavy burden, one affecting SLT's cash flow over ten years.

In 1995, GOSL declined to allow private capital into the market for basic telecommunication services, extending permission to two operators to offer such services provided that they install 200,000 telephone lines by the year 2000.

Table 18-4-1 The Expected Supply Plan for Private WLL and SLT Telephone

Year	Private WLL's DEL	SLT's DEL	TTL DELs	TTL Demand	Fill ratio
1997	60,000	337,000	397,000	655,043	60%
1998	100,000	387,000	487,000	703,337	69%
1999	160,000	417,000	577,000	755,520	76%
2000	200,000	467,000	667,000	813,752	80%
2005	300,000	811,617	1,111,617	1,174,243	95%
2015	500,000	1,495,808	1,995,808	1,995,808	100%

Such an expansion would satisfy as much as 80% of the total demand for basic telephones by the year 2000. GOSL's decision thus represented a revolutionary change for Sri Lanka's telephone sector, and will lead to an accelerated pace of new telephone installation. Although various issues remain, such as determining the relevant tariffs, the business and investment environment now seems stable enough that these private WLL operators will survive.

This section assesses the probable impact on SLT's Master Plan of the participation by these private WLL operators. It assumes that the government will make no additional investment into SLT, and that private capital and long-term loans will instead be used to fund the initial three year period.

Revised Master Plan with impacts by participation of private WLL operators will achieve annual profitability in 1999 and accumulated profitability in 2001, the project's fifth year. Annual cash flows of as much as US\$55 million must be obtained from outside

sources. This evaluation estimates that as much as US\$41 million of private capital must be invested over the initial three years of the project.

Accordingly, the number of direct exchange lines (DELs) operated by SLT will record a 30% decrease from 1997 to 2000 due to the presence of these WLL operators. The total required funds will concurrently decline 40%. Table 18-4-2 compares the original investment plan (Master Plan) with the revised investment plan. Since the original investment plan (Master Plan) calls for massive investment during the initial three years, long-term loans of US\$643 million and GOSL additional investment of US\$287 million were required. In the revised investment plan, however the presence of the WLL operators eliminates the need for any investments other than amounts of US\$230 million in long-term loan and US\$41 million in private capital during initial three years.

With this lower investment during the initial three years, additional needed funds could be procured, with the feasibility of the Master plan further improved. Funding shortages had been seen as an obstacle to SLT's meeting the telephone demand. Now that these shortages are to be resolved by the private operators' installation of 200,000 lines by the year 2000, however, the presence of the WLL operators will have a positive impact on Sri Lanka's telecom sector.

Table 18-4-2 Impact fo financial performance

Unit : US\$ 1000

Year	No. of subs. for MP		Investment		Profit/Loss		Cash Flow	
	Original	Revised	Original	Revised	Original	Revised	Original	Revised
1997	0	0	207,427	112,781	-11,481	-3,609	-120,380	-26,165
1998	95,292	53,333	276,091	89,836	-31,650	-7,848	-295,552	-45,566
1999	190,823	86,666	159,785	87,345	-26,199	1,115	-402,932	-55,108
2000	285,624	139,999	33,162	33,439	-6,993	5,256	-423,605	-52,906
2001	351,835	206,764	41,316	49,895	18,682	16,327	-422,692	-48,146
2002	409,505	276,409	124,857	153,757	35,506	27,367	-448,664	-55,275
2003	472,660	348,025	161,083	153,424	41,985	33,923	-471,700	-51,213
2004	539,613	416,557	85,934	90,808	50,046	41,828	-463,850	-26,925
2005	604,019	484,616	51,687	53,381	68,608	53,651	-443,604	-22,676
2010	943,629	827,602	61,432	62,862	177,654	120,192	-127,429	-11,851
2015	1,303,757	1,168,807	0	0	271,803	185,280	855,681	497,517
TOTAL	1,303,757	1,168,807	2,294,117	1,850,242	-----	-----	-----	-----

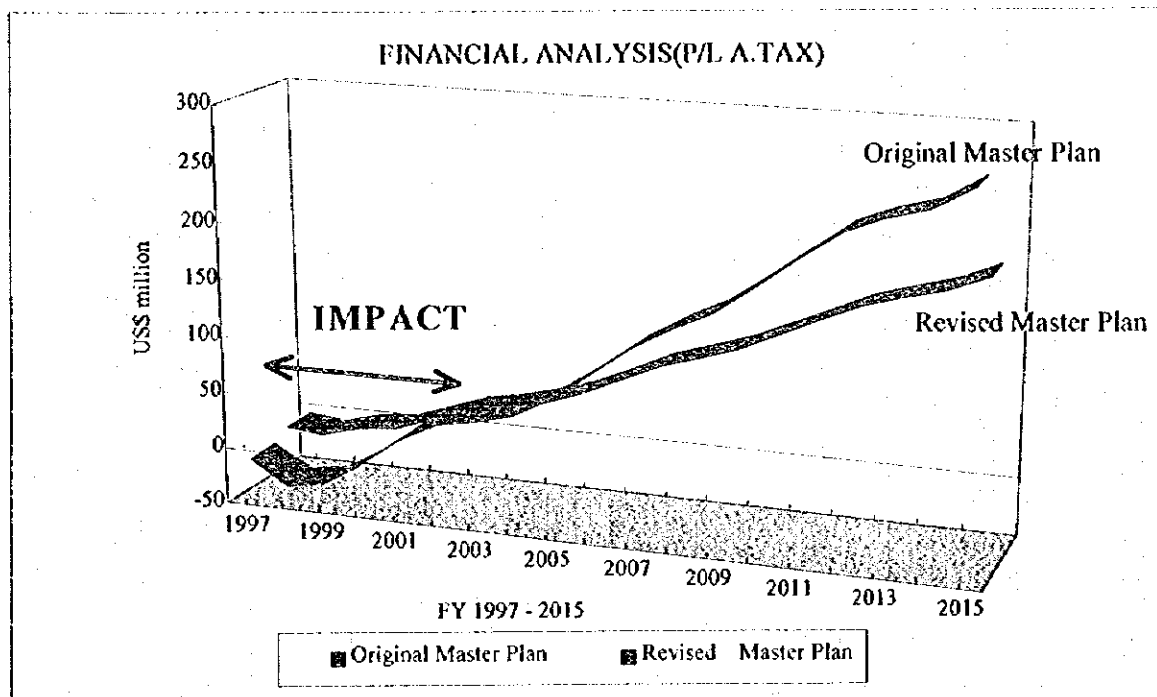


Figure 18-4-1 Financial Analysis on Private WLL Operator Participation (Profit Loss Statement)

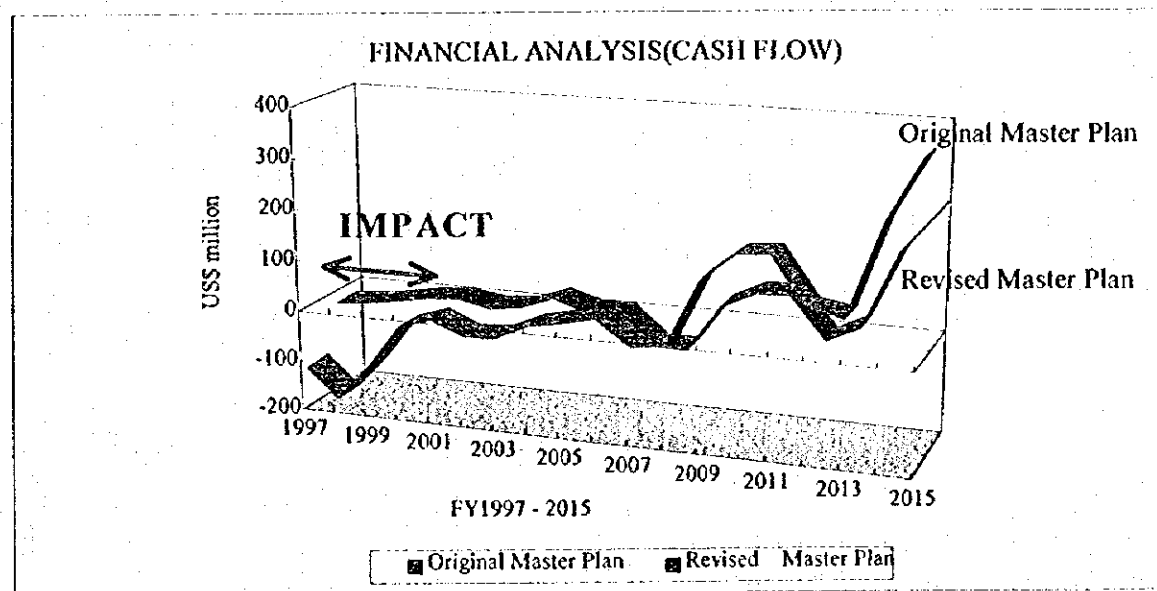


Figure 18-4-2 Financial Analysis on Private WLL Operator Participation (Cash Flow Statement)

CHAPTER 19

CONCLUSION AND RECOMMENDATIONS

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1. Overview of Master Plan

This master plan has been prepared based on the telecommunications policy 1994 which is outlined in keeping with the Economic Policy Statement of the Government of Sri Lanka. The Economic Policy states that public investment would be needed to build the infrastructure which is required as a necessary complement to rapid private sector growth and socio-economic activities. Major objectives of the telecommunications policy are as follows :

- To achieve universal service covering the whole country including all villages;
- To attain an acceptable quality of service for voice and data communications for both national and international communications;
- To eliminate waiting lists for telecommunications facilities;
- To provide prompt and effective attention to customer complaints and improve public relations.

Based on the above objectives, the master plan covers long-term development for the telecommunications networks up to 2015 in whole Sri Lanka. The planning period up to 2015 is divided into several milestones as target years i.e. a short-term plan on exchange basis up to 2000, a medium-term plan on exchange basis up to 2005 and a long-term plan on SSC area basis up to 2015. Key indexes of the master plan are shown in the following Table 19-1-1 :

Table 19-1-1 Overview of Master Plan (1/2)

Indexes	Sub-Indexes	Present Status as of 1994	Development Targets		
			Short-Term Targets By FY 2000	Medium-Term Targets by FY 2005	Long-Term Targets by FY 2015
Socio-Economy	Population	17,765,000	18,831,000	19,781,000	21,524,000
	GDP/Capita (US\$ Price in 1992)	534	761	1,056	1,673
	Expressed Demand	-	820,000	1,180,000	2,000,000
	+20% Hidden Demand (DEls)	-	-	-	-
Plain Ordinary Telephone Service (POTS)	Expressed Demand (DEls)	367,000	680,000	980,000	1,670,000
	Supply Volume (DEls)	181,000	667,000	980,000	1,670,000
	Switching Capacity (Line Units)	237,000	800,000	1,200,000	2,000,000
	DEls / 100 inhabitants	1.0	3.5	5.0	7.8
Telex Service	Network Coverage	to Major Villages	to All Villagers by 1998	-	-
	Telex Subscriber Demand	Decreasing	Decreasing	Decreasing	-
	Supply Volume (DEls)	1,560	No Expansion	No Expansion	to Other Services
	Gentex Service	88 Terminals for 44 Post Office	Same as the present	Same as the present	to Other Services
Leased Circuit	Voice Circuits, Data Circuits	Between Major Cities	Between Major Cities	Between All Districts	Nation-wide Service
	Ordinary Services by MF, HF, VHF / INMARSAT services	Ordinary Services / INMARSAT services	Ordinary Services / Enhancing INMARSAT services	Ordinary Services / Enhancing INMARSAT services	Ordinary Services / Enhancing INMARSAT services
	Cellular Mobile Telephone	Operated (32,500DEL)	Major Cities	All District Capitals	All Districts
	Public Payphones	Operated	All Villages	Increase the Number	Increase the Number
Maritime Communication Services	Electronic Mail	Operate in 1995	Major Cities	Major Districts	All District Capitals
	Data Communications	Operated	Major Cities	Major Districts	All District Capitals
	Voice Mail	Not Operated	Colombo	Major Cities	Major Districts
	Video Text	Not Operated	Colombo	Major Cities	Major Districts
Value Added Services	Audio Conference	Not Operated	Colombo	Major Cities	Major Districts
	Video Conference	Not Operated	Colombo	Major Cities	Major Districts
	Radio Paging	Operated	Major Cities	All District Capitals	Nation-wide Service
	Trunked Mobile Radio Services	Operated	Major Cities	Major Districts	All Districts
Value Added Services	Narrowband ISDN Services	Not Operated	Colombo	Major Cities	All District Capitals
	Broadband ISDN Services	Not Operated	-	-	Major Cities
	IN Services	Not Operated	Colombo	Major Cities	All Districts

Table 19-1-1 Overview of Master Plan (2/2)

Indexes	Sub-Indexes	Present Status as of 1994	Development Targets		
			Short-Term Targets By FY 2000	Medium-Term Targets by FY 2005	Long-Term Targets by FY 2015
Service Quality (for basic services)	Call Completion Rate	28%	45%	55%	70%
	No. of Faults (/ month / 100 DEL)	26	15	10	5
	Fault Clear Rate within 24 hours	55%	85%	90%	95%
Operational Efficiency (for basic services)	Number of Staff	7,500	9,200	10,000	10,900
	Staff / 1,000 DEL	42	14	10	7
Network Facilities	Switching System	Manual / Analog / Digital	100% Digital	100% Digital	100% Digital / Introduction of ATM
	Transmission System	Microwave & FOTS / Analogue & PDH	FOTS & Microwave / 100% Digital / Backbone by FOTS/ Introduction of SDH	FOTS & Microwave / 100% Digital / Expansion of Backbone by FOTS / Expansion of SDH	FOTS & Microwave / 100% Digital / Expansion of Backbone by FOTS / Expansion of SDH
Subscriber Network		Metallic Cable & Radio	Metallic Cable & Radio / Introduction of Optical Fibre Cable	Metallic, Optical Fibre and Radio system / Expansion of Optical Fibre	Metallic, Optical Fibre and Radio system / Expansion of Optical Fibre
	Maritime Communication	Conventional System	Introduction of GMDSS	-	-
Revenue	Revenue / DEL (US\$)	838	620	551	505
	Total Revenue (US\$1,000)	142,765	365,915	484,939	792,790
Expenditure	O&M Cost (US\$1,000)	55,402	101,117	131,547	196,298
	Other Cost (US\$1,000)	25,548	238,333	224,191	214,636
Profit	Profit before tax (US\$1,000)	61,814	26,465	129,201	381,856

dev-idx.318

Abbreviations:

DEL: Direct Exchange Line
 PDH: Plesiochronous Digital Hierarchy
 SDH: Synchronous Digital Hierarchy
 ATM: Asynchronous Transfer Mode
 FOTS: Fibre Optic Transmission System
 GMDSS: Global Maritime Distress and Safety System

2. Service Provision

2.1 Demand Fulfilment

As of the end of 1994, approximately 181,000 DEL (Direct Exchange Line) are provided as a result of development up to the present. However, approximately 186,000 people are registered and waiting for telephone lines. According to the telecommunications policy 1994, the Government of Sri Lanka intends to achieve 100% fulfilment to the telephone demand by 1998. However, it is not seemed that on-going project will catch up increasing expressed demand due to delay of the on-going projects. Considering the situation, this master plan has been prepared that 100% fulfilment is to be attained by 2001. In order to catch up the expressed demand, it is recommended that the following is to be well managed :

- a) an adequate supply plan catching up the demand up to five years ahead;
- b) proper management on project implementation;
- c) efficient new subscriber connection.

2.2 Programme Management

In order to achieve various development targets through smooth implementation of projects keeping the respective target completion time, total programme management on technical and financial aspects and co-ordination among projects is essentially recommended. For the execution of the programme management, it is recommended that a supervisory and control procedure is established with an adequate supervisory and control system as shown in the following Figure 19-2-1 :

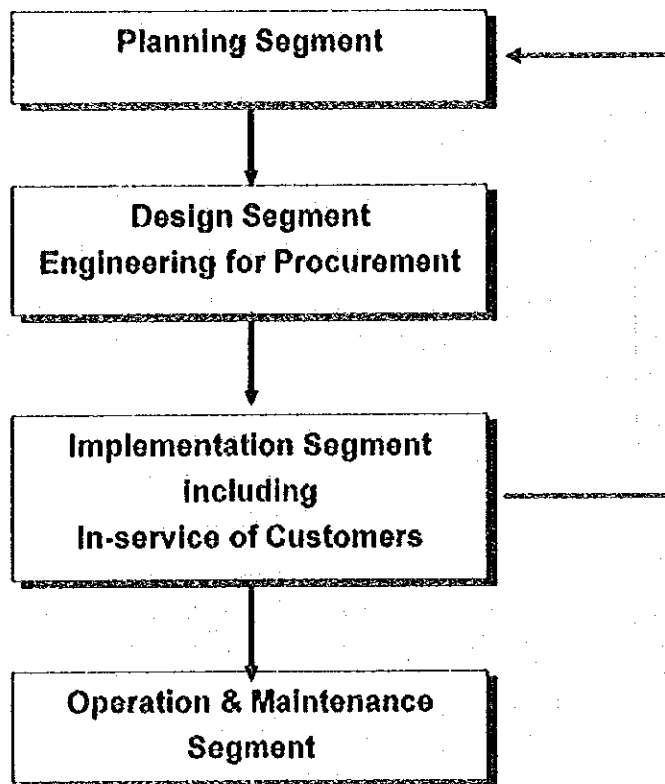


Figure 19-2-1 A Supervisory and Control Procedure on Programme Management

3. Telecommunications Service Quality

The service quality is still low level compared with those in developed countries. Low call completion rate will result loss of revenue from call charge and high faults rate will bring an increase of operation and maintenance cost. Low clear rate will affect to various customers' activities. By taking appropriate actions with an introduction of adequate quality control system, the present service quality is to be improved as shown in the following Table 19-3-1 :

Table 19-3-1 Improvement Targets of the Service Quality

Item	Target Year				Actions to be taken
	1994	2000	2005	2015	
Call Completion Rate	28%	45%	55%	70%	<ul style="list-style-type: none"> ■ Increase DEL for high traffic subscribers ■ Promote pilot number and call waiting service ■ Campaign to reduce incorrect dialling ■ Expand trunk lines
Fault Occurrence Rate	26	15	10	5	<ul style="list-style-type: none"> ■ Replace unreliable overhead lines ■ Improve lightning protectors ■ Up-grade skill of maintenance staff
Clearance Rate within 24 hours	55%	85%	90%	95%	<ul style="list-style-type: none"> ■ Modernise customer service management ■ Reinforce maintenance teams