8. Project Evaluation

8.1 Financial analysis

Sri Lanka telecommunication sector needs to take a steady approach to the maturation of the telecommunication networks in Colombo Metro area. Among the various project packages conceived, the projects to be selected with the priority are financially analysed in this section.

Case A : *External Plant + Switching system + Transmission system*
Case B : *External Plant only*

8.1.1 Basic Assumptions for Financial Analysis

The purpose of this analysis is to measure and assess the financial viability of the Local Network Expansion project in Colombo Metro area project under the following conditions and assumptions which have been discussed with SLT staff.

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

a) Fiscal Year

1 , January - 31 , December

b) Project Appraisal Period

FY 1997 - 2015 (19 years)

c) Fixed Price Base

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

d) Exchange Rate

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

e) Long Term Loan

The long term loan will be lent to SLT on the following conditions;
Current Long - Term Loan Condition **(On lent loan)**

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

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

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

f) Short - Term Loan Condition
In case of shortage of funds during the operation period, the short term finance is required to fulfil the cash deficits, if any.

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

g) Turnover Tax (BTT)

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

h) Revenue Collecting ratio

Under the assumption that subscribers in the studied area have characteristics commonly observed in average subscribers in Sri Lanka, an average nation-wide revenue- collecting ratio was applied to our feasibility study, as was done in the Master Plan.

Delinquent subscribers have thus far had their telephone lines disconnected by SLT. Due, however, to deficient collection capabilities among the sections in charge and to insufficient billing systems, disconnections have been based on data that was several months old. Thus, more strict countermeasures have yet to be established. As shown in Table 2-8-1, expected revenue-collecting ratio has shown a pattern of annual increases over the years. The collection ratio is expected to be 90% for fiscal 2015, which will require comprehensive company-wide efforts on the part of SLT to achieve.

Table 2-8-1 Revenue collecting ratio

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

i) Corporate Income Tax, Import duty

Corporate Income Tax ;

40% of SLT's net taxable income.

Import duty summarised in Table 2-8-2

Table 2-8-2 Ratio of Import Duty

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

j) Insurance

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

k) Depreciation

Full value of all asset items is depreciated without remaining salvage value, over the estimated useful lives of these assets. Depreciation is provided as following Table 2-8-3;

Table 2-8-3 Depreciation method

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

l) Working Capital

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

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

m) GOSL Equity

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

n) Appropriation, Levy

No dividends to GOSL have been assumed.

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

8.1.2 Investment Plan

Estimate of the gross required capital funding for the Local Network expansion project in Colombo Metro Area.

(1) Total investment cost

The total investment cost can be summarised in Table 2-8-4.

Table 2-8-4 (1/3) Total Investment Cost for External plants

Unit : US$'000

Items	Deprc.	Total	Foreign	Local
External Plant	25.0 yrs	42,780	38,731	4,049
Other Equipment	12.5 yrs	11,651	640	11,011
Vehicle	5.0 yrs	280	280	0
Installation		29,971	17,827	12,144
Training		180	180	0
Tax	10%,35%	27,436	0	27,436
Engineering Service		4,036	4,036	0
Contingencies	10% of TTL	5,766	5,766	0
Total		122,100	67,460	54,640

Table 2-8-4 (2/3) Total Investment Cost for Switching facilities

Unit : US$'000

Items	Depre.	Total	Foreign	Local
Digital Exchange	12.5 yrs	29,164	29,164	0
Other Equipment	12.5 yrs	3,494	3,494	0
Building	50.0 yrs	1,800	0	1,800
Installation		1,747	1,747	0
Training		240	240	0
Tax	10%,35%	10,810	0	10,810
Engineering Service		2,551	2,551	0
Contingencies	10% of TTL	3,644	3,644	0
Total		53,450	40,840	12,610

Table 2-8-4 (3/3) Total Investment Cost for transmission facilities

Unit : US$'000

Items	Depre.	Total	Foreign	Local
Transmission	12.5 yrs	9,065	9,065	0
External Plant	12.5 yrs	4,298	3,795	502
Vehicle	5.0 yrs	40	40	0
Installation		1,857	1,721	136
Training		300	300	0
Tax	10%,35%	5,386	0	5,386
Engineering Service		1,089	1,089	0
Contingencies	10% of TTL	1,556	1,556	0
Total		23,591	17,567	6,024

Grand Total		199,141	125,867	73,274

(2) Expenditure schedule

The total investment cost is disbursed in each project year of construction period as shown in Table 2-8-5.

Table 2-8-5(1/2) Expenditure Schedule (Case A)

Unit : US$'000

Items	Project year					TOTAL
	1996	1997	1998	1999	2000	
Equipment & Facilities	0	0	31,607	63,214	96,644	191,465
Engineering service	510	2,560	1,535	0	3,011	7,676
Initial Working Capital	0	0	0	3,235	1,950	5,185
Interest during construction	0	0	2,305	7,682	13,828	23,815
Total	510	2,560	35,447	74,131	115,493	228,141

Table 2-8-5(2/2) Expenditure Schedule (Case B)

Unit : US$'000

Items	Project year					TOTAL
	1996	1997	1998	1999	2000	
Equipment & Facilities	0	0	16,927	33,854	67,284	118,064
Engineering service	0	1,614	807	0	1,614	4,036
Initial Working Capital	0	0	0	1,020	1,523	2,543
Interest during construction	0	0	1,237	4,123	7,421	12,780
Total	0	1,614	18,971	38,996	77,842	137,423

8.1.3 Sales revenue projection

Benefit from this project fall under one of the following four categories; (1) Installation charge,(2) Monthly rental charge,(3) Call charge,(4)others.

Table 2-8-6 indicates historical tariffs for telecommunications.

Table 2-8-6 A historical tariff level for telecommunications.

Unit : SRs

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

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

(1) Installation Charge

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

(2) Monthly Rental Charge

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

(3) Call Charge

For a telephone call to take place, both a call originator and a call receiver are necessary. In other words, establishment of the telephone facilities at only one end is not sufficient to produce a call charge. This project is only a portion of the Sri Lanka are telecommunications network, so call charges cannot be considered entirely as project benefits. Based on this understanding, a revenue distribution ratio was established, as shown in Table 2-8-7 below, in order to calculate expected project benefits.

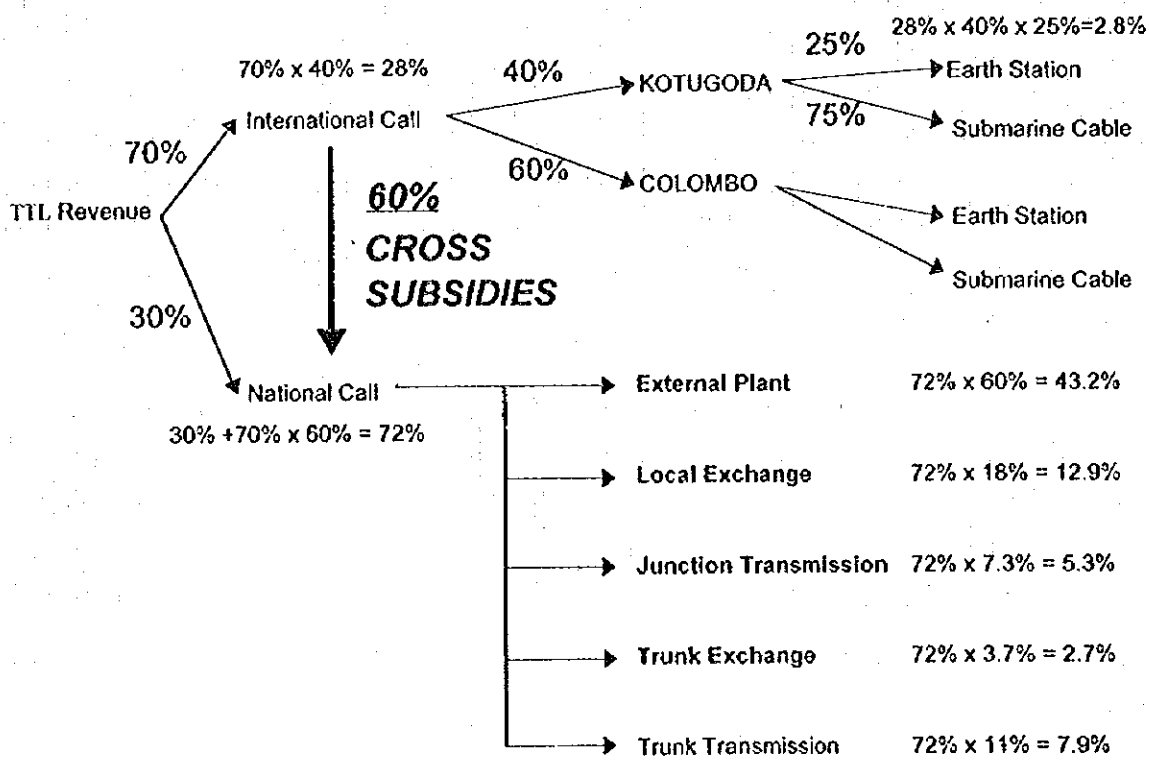


Figure 2-8-1 Concept figure of Revenue distribution

8.1.4 Revenue Distribution Ratio

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

The 1996 profit and loss statement reveals that total revenues come from international calls (70%) and domestic calls (30%). First, the gross revenue is broken down into international and domestic revenues based on the above relations. Then, the cross subsidies existing between the two systems are calculated as mentioned below. In this report, study team have assumed that 60% of the revenues for the international telecommunication system come from cross subsidies, to be returned to the national telecommunication system. This value of 60% is a tentative one for use only in this feasibility study, and is to be revised by the SLT staff whenever necessary. The concept flow is indicated in Figure 2-8-1.

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

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

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

Profits subject to financial analysis were calculated by determining profits by call type (including international, STD, local and other calls) and multiplying these figures by the revenue distribution ratio which are shown in the Table 2-8-7.

Table 2-8-7 Revenue Distribution Ratio

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

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

8.1.5 Expected Annual Revenue

The Local Network Expansion project in Colombo Metro area is composed of three subsystems: External Plant, Transmission, and Digital Switching. While the subscriber base for the External Plant project is assumed to increase as a result of the proposed project, figures for the Transmission and Switch systems include both subscribers to existing facilities as well as newly added subscribers.

The proposed project is composed of a 4-year cable and civil works project and a 6-year cable connection project. In FY2015, the external plant project will have been almost completed, and the cable connection project will follow. As noted earlier, the Colombo metro area enjoys great demand, but the current target area is a high-demand urban centre as well. Once telephone construction work begins in target area, potential demand will turn up, with subscriber applications flooding in during the start-up period. As shown in the Master

Plan, SLT's aim is to install a telephone within one year after a subscriber application is received. Table 2-8-8 shows a connection schedule for subscribers. Since the construction work starts near the Exchange, more construction work has been scheduled in the first 3-year period than in the last 3-year period. As many as 30,000 telephone lines will have been installed during the peak in fiscal 2001.

Table 2-8-8 Subscriber connection schedule for External Plant Project

YEAR	Increase	TTL No. of subscriber
2000	15,000	15,000
2001	30,000	45,000
2002	20,000	65,000
2003	15,000	80,000
2004	15,000	95,000
2005	9,722	104,722
2010	0	104,722
2015	0	104,722

Expected revenue calculated under the aforementioned conditions is shown in Table 2-8-9. The following revenues are those obtained through the operation of the telecommunication network established under the project. The revenues are deemed as the operating income of the project.

Table 2-8-9 Total Annual Revenue for the project

Unit : US$'000

Year	Case A	Case B (External Plant)
2000	22,363	7,154
2001	35,649	17,535
2003	45,042	21,113
2005	55,108	25,234
2010	52,580	22,706
2015	52,580	22,706

The revenue projection method of this financial analysis is detailed in the output sheets that are attached to the annex.

8.1.5 Operation expenses

The direct operation costs do not include interest payment and depreciation. The annual operation and maintenance (O&M) costs will be increased due to the increase of number of terminals. In accordance with SLT's past expenditure record, annual (O&M) cost has been calculated as following Table 2-8-10 and 2-8-11.

(1) Case A (External Plant, Switch, Transmission)

Table 2-8-10 Annual (O&M) Costs for Case A

Unit : US$'000

Year	Staff Costs	Other Costs	Total (O&M) cost
2000	162	2,789	2,951
2001	162	4,376	4,538
2003	162	5,487	5,649
2005	162	6,680	6,842
2010	162	6,345	6,507
2015	162	6,327	6,489

It will be necessary to recruit 54 staff members over the entire project period. Study team has listed US$162,000 as an annual personnel expenditure on the assumption that US$3,000 would be necessary per person. As for general costs, study team has appropriated 12% of the expected annual revenue, using the data from SLT's 1995 profit and Loss Statement as reference.

Staff costs are projected not to increase after 2001. Due to improved operational efficiency and the introduction of new technology, other costs per DEL are expected to decrease from 2001 to 2005. The rate of decrease is taken from figures used in proposed Master Plan.

(2) Case B (External plant project only)

Table 2-8-11 Annual (O&M) Costs for Case B

Unit : US$'000

Year	Staff Costs	Other Costs	Total (O&M) cost
2000	120	916	1,036
2001	120	2,158	2,278
2003	120	2,580	2,700
2005	120	3,068	3,188
2010	120	2,752	2,872
2015	120	2,741	2,861

It will be necessary to recruit 40 staff members over the entire project period. Study team has listed US$120,000 as an annual personnel expenditure on the assumption that US$3,000 would be necessary per person. As for general costs, study team has appropriated 12% of the expected annual revenue, using the data from SLT's 1995 profit and Loss Statement as reference.

Staff costs are projected not to increase after 2001. Due to improved operational efficiency and the introduction of new technology, other costs per DEL are expected to decrease from 2001 to 2005. The rate of decrease is taken from figures used in proposed Master Plan.

8.1.6 Financial Analysis of Case A

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

Case A : External Plant + Digital Exchange + Transmission

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

a) Income Statement

b) Cash flow Statement

The summary of the result of financial analysis is shown in Table 2-8-12.

Table 2-8-12 Result of Financial Analysis for Case A

FIRROI has been calculated at 18.37 % (1997 - 2015)

FIRROE has been calculated at 10.12 % (1997 - 2015)

Unit : US$ '000

Year	Investment	EQUITY portion	Revenue	Total Expenses	Profit/Loss after Tax	Repayment	Cash Flow
1996	510	510	0	0	0	0	-510
1997	2,560	2,560	0	0	0	0	-2,560
1998	35,447	11,809	0	0	0	0	-11,809
1999	74,132	26,856	0	0	0	0	-26,856
2000	115,493	54,817	22,363	13,345	9,018	0	-54,817
2001	0	0	35,649	30,972	4,677	11,819	113
2002	0	0	40,384	32,280	8,104	11,819	3,551
2003	0	0	45,042	33,551	11,491	11,819	6,689
2004	0	0	51,391	35,621	15,770	11,819	11,354
2005	0	0	55,108	35,682	19,426	11,819	14,647
2010	0	0	52,580	29,669	22,911	11,819	17,442
2015	0	0	52,580	25,979	26,601	0	28,358

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

Table 2-8-13 Assumption of Financing Plan (Case A)

Unit : US$ '000

Items	US$ '000	Share %
EQUITY	96,552	42.3%
L-T Loan	118,190	51.8%
Internal Generated Funds	13,399	5.9%
TOTAL	228,141	100.0%

8.1.7 Financial Analysis of Case B

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

Case B : External Plant portion only

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

a) Income Statement
b) Cash flow Statement

The summary of the result of financial analysis is shown in Table 2-8-14.

Table 2-8-14 Result of Financial Analysis for Case B (External Plant)

FIRROI has been calculated at 12.58 % (1997 - 2015)
FIRROE has been calculated at 3.31 % (1997 - 2015)

Unit : US$ '000

Year	*Investment*	*EQUITY portion*	*Revenue*	*Total Expenses*	*Profit/Loss after Tax*	*Repayment*	*Cash Flow*
1997	1,614	1,614	0	0	0	0	-1,614
1998	18,971	6,286	0	0	0	0	-6,286
1999	38,996	13,626	0	0	0	0	-13,626
2000	77,842	48,133	7,154	4,486	2,668	0	-48,133
2001	0	0	17,535	15,432	2,103	6,342	0
2002	0	0	19,299	15,887	3,412	7,335	0
2003	0	0	21,113	16,209	4,904	7,025	904
2004	0	0	24,395	17,179	7,216	6,342	4,257
2005	0	0	25,234	16,664	8,570	6,342	5,414
2010	0	0	22,706	12,886	9,820	6,342	6,121
2015	0	0	22,706	11,825	10,881	0	12,592

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

Table 2-8-15 Assumption of Financing Plan for Case B

Unit : US$ '000

Items	US$ '000	Share %
EQUITY	69,659	50.7%
L-T Loan	63,424	46.2%
Internal Generated Funds	4,340	3.1%
TOTAL	137,423	100.0%

8.1.8 Major Financial Indicators

The major financial indicators in each operation year summarised in Table 2-8-16 and 2-8-17. Each indicator is obtained from the following formula:

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

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

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

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

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

Table 2-8-16 Major Financial Index for Case A

Items	2001	2003	2005	2010	2015
Net profit on Equity	4.3%	10.5%	17.7%	20.8%	24.2%
Dept Service Coverage Ratio	103%	132%	168%	231%	---
Profit Break Even Point	35.0%	30.2%	24.5%	24.5%	15.7%
Cash Break Even Point	5.1%	7.1%	6.6%	7.2%	10.9%

Table 2-8-17 Major Financial Index for Case B (External Plant only)

Items	2001	2003	2005	2010	2015
Net profit on Equity	2.8%	6.6%	11.6%	13.3%	14.7%
Dept Service Coverage Ratio	95%	110%	145%	185%	---
Profit Break Even Point	33.0%	30.0%	23.8%	24.3%	20.1%
Cash Break Even Point	5.9%	8.6%	6.4%	7.7%	9.4%

8.1.9 Sensitivity Analysis

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

a) Total Investment Cost

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

b) Sales Revenue

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

c) O&M cost

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

d) Long - Term Loan condition

The result of the sensitivity analysis is summarised in Table 2-8-18 and 2-8-19.

Table 2-8-18 The result of the sensitivity analysis for Project A

Variable factor	Variation	FIRROI (%)	FIRROE (%)
Total Investment	+ 20%	14.90	5.85
	Base	**18.37**	**10.12**
	- 20%	23.16	15.89
Sales Revenue	+ 20%	22.26	14.33
	Base	**18.37**	**10.12**
	- 20%	14.14	5.43
O/M cost	+ 20%	17.79	9.49
	Base	**18.37**	**10.12**
	- 20%	18.94	10.74
L-T Loan condition 10 yrs repayment	Base Interest: 13% 0 yrs grace	**18.37**	**10.12**
	Interest: 8% 2 yrs grace	**18.37**	14.33
	Interest: 2.6% 0 yrs grace	**18.37**	20.77

Table 2-8-19 The result of the sensitivity analysis for Project B
External Plant project

Variable factor	Variation	FIRROI (%)	FIRROE (%)
Total Investment	+ 20%	9.58	n.a
	Base	**12.58**	**3.31**
	- 20%	16.67	8.02
Sales Revenue	+ 20%	13.08	3.69
	Base	**12.58**	**3.31**
	- 20%	12.09	2.92
O/M cost	+ 20%	12.10	2.78
	Base	**12.58**	**3.31**
	- 20%	13.06	3.83
L-T Loan condition 10 yrs repayment	Base Interest: 13% 0 yrs grace	**12.58**	**3.31**
	Interest: 8% 2 yrs grace	**12.58**	5.46
	Interest: 2.6% 0 yrs grace	**12.58**	10.93

n.a : not applicable

8.1.10 Result of Financial Analysis

With Sri Lanka's improving economic relationship with India, South Asia and European countries, the qualitative and quantitative improvements in telecommunication services produced by the Project are expected to yield great effects. Recently, telecommunication projects have been anticipated to have great impact on both social and economic infrastructure. While such projects must provide widespread service for the general public, they must offer sufficiently profitability to support the implementation of these services. The Project can be evaluated as adequately meeting both these requirements.

(1) Case A (External Plant + Digital Exchange + Transmission)

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

The payout period for the capital of ***US$96,552,000*** required in the initial investment (Equity portion) is ***8.98 years.*** A cash flow of ***US$163,310,000*** is yielded throughout the operating period, with ***FIRROI at 18.37% and FIRROE at 10.12%.*** These IRR values suggest that the project will stand financially feasible coupled with the high returns assumed that the project can be operated without financial difficulty. This FIRROE is attained because the equity accounts for 35.1% of total Investment Costs and anticipated sales revenues are sufficient to maintain the stable operation.

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

The Cash Break Even Point for each fiscal year is lower than 11.0%. The Profit Break Even Point for each fiscal year of the project is lower than 35.0%. Debt Service Coverage Ratio for each fiscal year is more than 100.0% or higher. These levels point to a sound situation in terms of profits and funds.

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

(2) Case B (External Plant portion only)

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

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

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

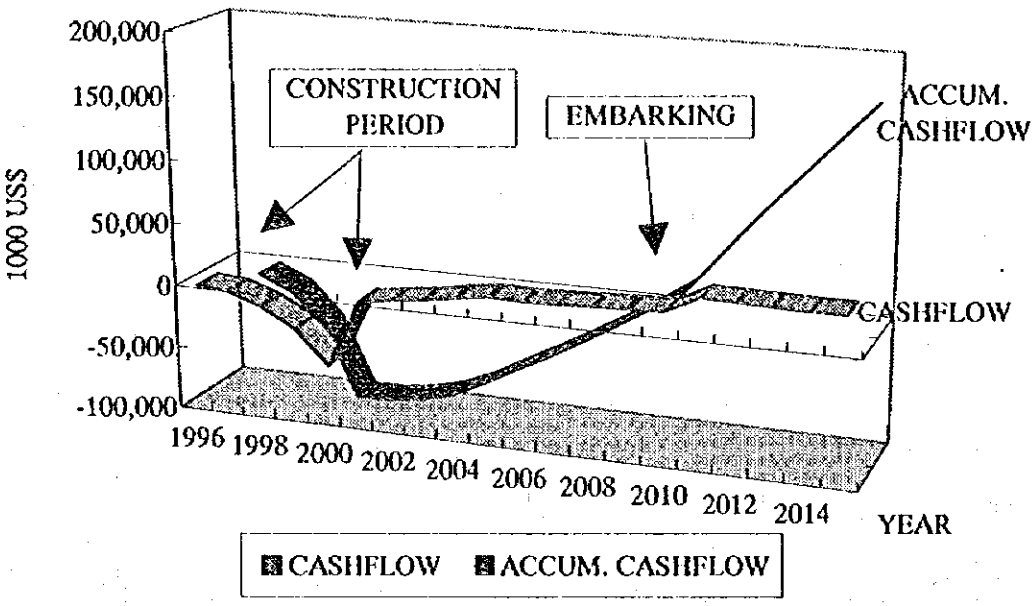


Figure 2-8-2 Result of Financial Analysis for Case A

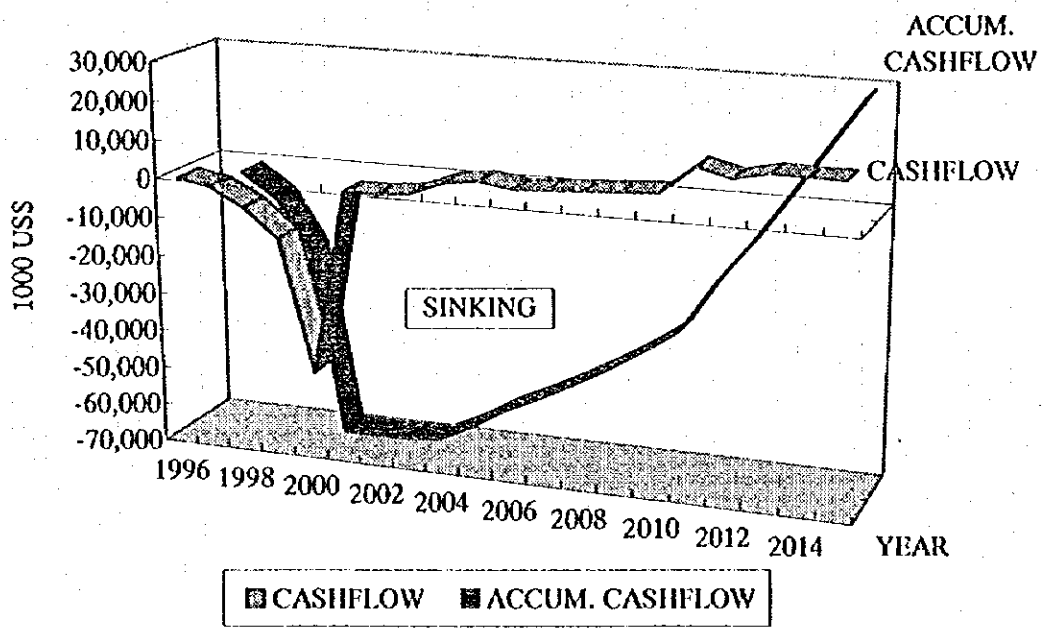


Figure 2-8-3 Result of Financial Analysis for Case B

8.2 Economic Evaluation

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

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

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

8.2.1 Economic Costs

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

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

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

(2) Operating and Maintenance Costs

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

(3) Items of Transfer

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

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

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

8.2.2 Economic Parameters

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

(1) Foreign Exchange Premium

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

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

Where,

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

Each value of the above parameters to obtain SCF and the result of calculation are summarised in Table 2-8-20.

Table 2-8-20 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 parameters

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

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

* : estimated by study team

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

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

8.2.3 Economic Evaluation

(1) Determination of Economic Direct Benefit

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

Table 2-8-21 Telephone call charges from 1987 to 1993

Unit : US$

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

It is evident that charges quoted in Sri Lankan Rs are increasing each year. However, when they are converted into US dollars, as indicated in Table 2-8-21, 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 2-8-22.

Table 2-8-22 Total Benefit streams

Unit : US$'000

Years	Benefit stream of Case A	Benefit stream of Case B
2000	25,718	8,227
2001	40,996	20,165
2002	46,441	22,193
2003	51,799	24,280
2004	59,100	28,055
2005	63,374	29,019
2010	60,468	26,112
2015	60,468	26,112

(2) Economic Cost Streams

The total investment and O&M costs in each project year summarised in Table 2-8-22 ~ 25 for Economic Analysis. The costs are converted into the economic cost using value of national parameter (Shadow premium)

Table 2-8-23 Total Economic Project Cost in each project year

Unit : US$'000

Year	Case A	Case B
1996	546	0
1997	2,740	1,727
1998	32,753	17,533
1999	62,220	33,339
2000	90,421	59,982

Table 2-8-24 Total Economic O&M Cost (Case A)

Unit : US$ '000

Year	Staff Costs	Other Costs	D.Insurance	Total O&M cost
2000	130	2,036	Trans.	2,166
2001	130	3,194	Trans.	3,324
2002	130	3,603	Trans.	3,733
2003	130	4,006	Trans.	4,136
2004	130	4,556	Trans.	4,686
2005	130	4,877	Trans.	5,007
2010	130	4,632	Trans.	4,762
2015	130	4,619	Trans.	4,749

D.Insurance : Damage Insurance,

Trans. : Transfer items

Table 2-8-25 Total Economic O&M Cost (Case B)

Unit : US$ '000

Year	Staff Costs	Other Costs	D.Insurance	Total O&M cost
2000	96	668	Trans.	764
2001	96	1,575	Trans.	1,671
2002	96	1,727	Trans.	1,823
2003	96	1,883	Trans.	1,979
2004	96	2,168	Trans.	2,264
2005	96	2,240	Trans.	2,336
2010	96	2,009	Trans.	2,105
2015	96	2,001	Trans.	2,097

D.Insurance : Damage Insurance,

Trans. : Transfer items

8.2.4 Assessment of Result of Economic Analysis

(1) Case A (External Plant + Digital Exchange + Transmission)

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 2-8-26.

Table 2-8-26 Economic Cash Flow for Case A

EIRR : 23.49%

Unit : US$ '000

Year (FY)	Economic Benefit	Investment	Operating Expenses	Economic Cash Flow
1996	0	546	0	-546
1997	0	2,740	0	-2,740
1998	0	32,753	0	-32,753
1999	0	62,220	0	-62,220
2000	25,718	90,421	2,166	-66,869
2001	40,996	0	3,324	37,672
2002	46,441	0	3,733	42,708
2003	51,799	0	4,136	47,664
2004	59,100	0	4,686	54,414
2005	63,374	0	5,007	58,368
2006	60,468	0	4,781	55,687
2010	60,468	0	4,762	55,706
2015	60,468	0	4,749	55,719
TOTAL	892,103	188,680	70,664	632,759

Net Present value (Discount rate 20%) for Local Network Expansion project in Colombo Metro area project

Cost (C)	:	US$ 118,362,000
Benefit (B)	:	US$ 172,381,000
B - C	:	US$ 54,019,000
B / C	:	1.46
EIRR	:	**23.49%**
FIRROI	:	**18.37%**

The EIRR for the project based on incremental cash flows as a result of the project has been calculated at ***23.49 percent.*** The project is expected to benefit the economy through higher economic activity, due to improved telecommunications facilities, which are difficult to quantify. In previous telecommunications projects world-wide, economic returns have been relatively high under conservative assumptions for consumer surplus and with no account taken of external benefits. Moreover , ***the Project benefits have been distributed widely, with significant shares being realised by rural and other low-income communities ; if GOSL are weighted for social objectives, EIRR would, therefore, exceed those calculated. This project is expected to realise a similar EIRR.***

(2) Case B (External Plant portion only)

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 2-8-27.

Table 2-8-27 Economic Cash Flow for Case B
EIRR : 17.50%

Unit : US$ '000

Year (FY)	Economic Benefit	Investment	Operating Expenses	Economic Cash Flow
1997	0	1,727	0	-1,727
1998	0	17,533	0	-17,533
1999	0	33,339	0	-33,339
2000	8,227	59,982	764	-52,519
2001	20,165	0	1,671	18,494
2002	22,193	0	1,823	20,370
2003	24,280	0	1,979	22,300
2004	28,055	0	2,264	25,790
2005	29,019	0	2,336	26,683
2006	26,112	0	2,113	24,000
2010	26,112	0	2,105	24,008
2015	26,112	0	2,097	24,016
TOTAL	393,064	125,403	31,880	248,602

Net Present value (Discount rate 20%) for Local Network Expansion project in Colombo Metro area project.

Cost (C)	:	US$	55,608,000
Benefit (B)	:	US$	49,705,000
B - C	:	US$	-5,903,000
B / C	:	0.89	
EIRR	**:**	**17.50%**	
FIRROI	**:**	**12.58%**	

The EIRR for the project based on incremental cash flows as a result of the project has been calculated at ***17.50 percent.*** The project is expected to benefit the economy through higher economic activity, due to improved telecommunications facilities, which are difficult to quantify. In previous telecommunications projects world-wide, economic returns have been relatively high under conservative assumptions for consumer surplus and with no account taken of external benefits. Moreover , ***the Project benefits have been distributed widely, with significant shares being realised by rural and other low-income communities ; if GOSL are weighted for social objectives, EIRR would, therefore, exceed those calculated. This project is expected to realise a similar EIRR.***

8.3 Consideration for the project scale of Local Network expansion Project in Colombo Metro area

Study team have proposed in this report that the Local Network Expansion Project in Colombo Metro area should be implemented as a network project in which Switch, Transmission, and Cable facilities are simultaneously consolidated. This is because the network project ensures tariff revenues upon completion. Under the assumption that the Local Network Expansion project in Colombo Metro area could possibly be implemented in multiple stages, Packages I and II have been prepared so that the Project could function at least as a Telecommunication Network. These two proposed projects are evaluated here.

Study team report here the results of a financial evaluation on Package I and II, using the same conditions used for the overall evaluation.

❑ **Project name** :	**Package-I**	**Package-II**
❑ FIRROI :	20.79%	13.79%
❑ FIRROE :	12.87%	4.95%
❑ Capital Investment :	US$ 126,550,000	US$ 72,590,000
❑ Total Revenue :	US$ 553,597,000	US$ 222,145,000
❑ Accum. Cash Flow :	US$ 134,705,000	US$ 27,668,000

As is clear from the results, Package I remedies the lower profitability of Package II. This is because the Transmission project is included in Package I. In other words, Package I is different from Package II in terms of the characteristics and scale of the project concerned.

Since the priority is on construction of a well-balanced Telecom Network, Package I is drawn up to include the Cable Project, which serves a core, high-demand urban centre. Accordingly, a tightly organised Transmission Network must be fully implemented as part of the first-stage communications infrastructure, if the telecommunications traffic derived from an ever-increasing subscriber base is to be handled smoothly. If the Network is implemented in a flawed manner, communications will be inadequate and profitability non-existent. For the Cable Project to achieve profitability, the Transmission facilities and Switching facilities must be combined into a single package. With the resulting increase in Services, such as call completion rate, etc., SLT's overall corporate revenues will rise as well.

In terms of the cash flow of Package I, financing should remain positive throughout the project. Consequently, no funding problems are expected. Although initial investment of $58,056,000 is required, the recovery period is set to be 7.52 years. In addition, the available cash flow will be US$134,705,000 throughout the operation period, yielding an 20.79% FIRROI against the total investment, and a 12.87% FIRROE against internal funds. Either ratio is indicative of a sound financial position.

On the other hand, Package II offers poorer profitability: IRROI is 13.79% and IRROE, 4.95%. Bridge financing of US$ 2.34 million will be required during the initial 3 year period. In other words, with its low profitability, Package II requires cross subsidies from SLT, indicating that the Project cannot be pursued on a stand-alone basis. Since Package II is a project involving the Colombo Metropolis, one of the few profitable zones in the country, a plan should be drawn up outlining a single, self-supporting project requiring no cross subsidies from SLT.

Considering from overall evaluation results, independent operation of Package II would require the following measures:

(1) Introduction of foreign grants
(2) Introduction of government subsidies
(3) Combined execution of Packages I and II.

Given that the privatisation of SLT has been seriously reviewed, (1) and (2) above can hardly be considered feasible, with (3) becoming an option of last resort. This leads to a conclusion that, except for unavoidable cases, Packages I and II should be carried out simultaneously as much as possible, rather than separately.

9. Conclusion and Recommendation

9.1 Technical Aspect

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

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

SLT's capacity of telecommunications will be around 597,000 lines in switching system and 937,000 lines in external plant in the whole country when the on-going projects complete in 1997. In Colombo Metro Area, in the year 1997, the switching system capacity will be around 316,000 lines and the external plant capacity will be around 400,000 lines.

SLT is required to have the capacity of telecommunications sufficient to provide telecommunications service within one year for every application after its registration. To satisfy that requirement, the exchanges should be given a switching capacity sufficient to cater the demand for five years after its completion. The external plant and the transmission system should also be expanded to correspond to the demand and traffic.

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

a) In order to meet the demand in 2005, switching capacity expansion of the exchanges the capacity of which will not be sufficient in the year 2000;

b) Transmission capacity expansion to meet the traffic to be originated by the demand in 2005; and

d) In order to meet the demand in 2005 at least, external plant capacity expansion of the exchange the external plant capacity of which will not be sufficient in the year 2000.

Based on the study, JICA Study Team recommends SLT to expand its telecommunications capacity by the year 2000, in Colombo Metro Area, as follows:

a) Switching system;

- Local exchange: 144,000 subscriber lines;
- TSC: 42,000 inter-exchange lines (2 units).

b) Transmission system;

- STM-16 system: 2 system;
- STM-4 system: 5 systems.

c) External plant;

- Primary cables: 70,000pair-Km.;
- Secondary cables: 75,000pair-Km.

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

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

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

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

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

e) To pay careful attention to re-arrange the project packages, if any, in relation to the network structure.

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

9.2 Financial Aspect

9.2.1 Case A (External plant + Digital Exchange + Transmission)

There will be a fund surplus throughout the life of the project. There is thus no need for a bridging finance, which is necessary during periods where there is a fund shortage. ***No cash flow problems will arise.***

The payout period for the capital of ***US$96,552,000*** required in the initial investment (Equity portion) is ***8.98 years***. A cash flow of ***US$163,310,000*** is yielded throughout the operating period, with ***FIRROI at 18.37% and FIRROE at 10.12%***. These IRR values suggest that the project will stand financially feasible coupled with the high returns assumed that the project can be operated without financial difficulty. This FIRROE is attained because the equity accounts for 35.1% of total Investment Costs and anticipated sales revenues are sufficient to maintain the stable operation.

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

The EIRR for the project based on incremental cash flows as a result of the project has been calculated at ***23.49 percent***. The project is expected to benefit the economy through higher economic activity, due to improved telecommunications facilities, which are difficult to quantify. In previous telecommunications projects world-wide, economic returns have been relatively high under conservative assumptions for consumer surplus and with no account taken of external benefits. Moreover , ***the Project benefits have been distributed widely, with significant shares being realised by rural and other low-income communities ; if GOSL are weighted for social objectives, EIRR would, therefore, exceed those calculated. This project is expected to realise a similar EIRR.***

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

To seize this opportunity, Sri Lanka needs to establish a telecommunications network; lack of one poses significant development risks. Sri Lanka must development a sufficient telecommunications network in Colombo metro area, and make this network serve as a lubricating oil that enhances the synergy between various economic sectors. For this to happen, the Priority Project that SLT is now preparing plans an indispensable role.

9.2.2 Case B (External plant portion only)

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

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

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

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

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

9.2.3 Overall evaluation for the Local Network Expansion project in Colombo Metro area

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

At present IRROI, which is an index of project returns from the total investment, is 12.58%. This value is calculated only for the External plant portion of the priority project. What would the value be when this project is consolidated into a smallest network project ? To find out, Study team should perform an evaluation on the smallest network project, including switch and transmission facilities. It is clear from the evaluation results that the smallest network would be profitable enough if it generates project returns of IRROI of 18.37% and IRROE of 10.12%. ***Study team proposed here that the smallest network project (Case A) including switch and transmission facilities be initiated, even though it would be a large project involving US$ 200 million or more. Multiple countries may provide funds, but this smallest network project should be conducted without being separated into switch,***

cable, and transmission facilities. Since a network project provides a direct path to tariff revenue, SLT will not be hindered in its operations.

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

CHAPTER 3

FEASIBILITY STUDY ON CENTRAL RING FIBRE OPTIC TRANSMISSION NETWORK PROJECT

CHAPTER 3

FEASIBILITY STUDY ON CENTRAL RING FIBRE OPTIC TRANSMISSION NETWORK PROJECT

1. Background of the Feasibility Study

SLT is proceeding the telecommunications network expansion. Recent development programmes are compiled in Second Telecommunication Development Programme (1990 - 1997) and Third Telecommunication Development Programme (1996 - 2000). Under these programmes, some projects have been implemented. In the transmission field, the Trunk Transmission Project and 150K Project are going on.

The Central region (around Colombo and Kandy area) is the most populous area and regarded as the backbone of the national economy. Recognising the importance of the region, SLT has developed this region with highest priority. Recently national backbone system has been renewed under the Trunk Transmission Project and this system is expected to improve the call completion ratio by adding more transmission capacity into the region. (Added capacity will be 214 systems of 2 Mbit/s in the whole country.) But, according to the Master Plan Study, rapid increase of subscribers (667,000 in 2000, 1,111,617 in 2005 comparing 180,724 in 1994) will result trunk transmission capacity inadequate soon.

This project was planned for establishment of the new backbone trunk transmission network and covering the rapid expansion of the trunk traffic in the area.

2. Objectives and Scope of the Project

2.1 Objectives of the Project

This project aims at establishment of the new fibre optic backbone transmission system in the Central region for covering the increase of subscriber number, improvement of the call completion ratio and preparation for future wide band services such as ISDN. These efficiencies will be to meet the telecommunications policy objective, to attain acceptable quality of service for voice and data communications for both national and international communications.

2.2 Scope of the Project

(1) This project facilitates the new backbone transmission system in Central region for covering the huge traffic demand in the region in the year 2005. As the expected transmission capacity is large (1,493 systems of 2 Mbit/s) and the new system should be alternative to the existing microwave transmission system, so fibre optic cable transmission system will be adopted and it will connect most of all SSCs in the area. This transmission system will be a part of national fibre optic transmission network.

(2) The newly constructed backbone transmission system should be expandable easily in future and meet the world trend, so SDH (Synchronous Digital Hierarchy) ring transmission technology should be adopted.

(3) Target nodes to be connected are following 14 sites and the route plan is shown in Figure 3-2-1.

Target Nodes:

Colombo (CO), Gampaha (GQ), Kotugoda (KO, new ISC/NSC/TSC/SSC site), Negombo (NE), Chilaw (CW), Kurunegala (KG), Kegalle (KE), Kandy (KY), Nuwara Eliya (NW), Hatton (HT), Nawalapitiya (NT), Avissawella (AW), Ratnapura (RN) and Kalutara (KT).

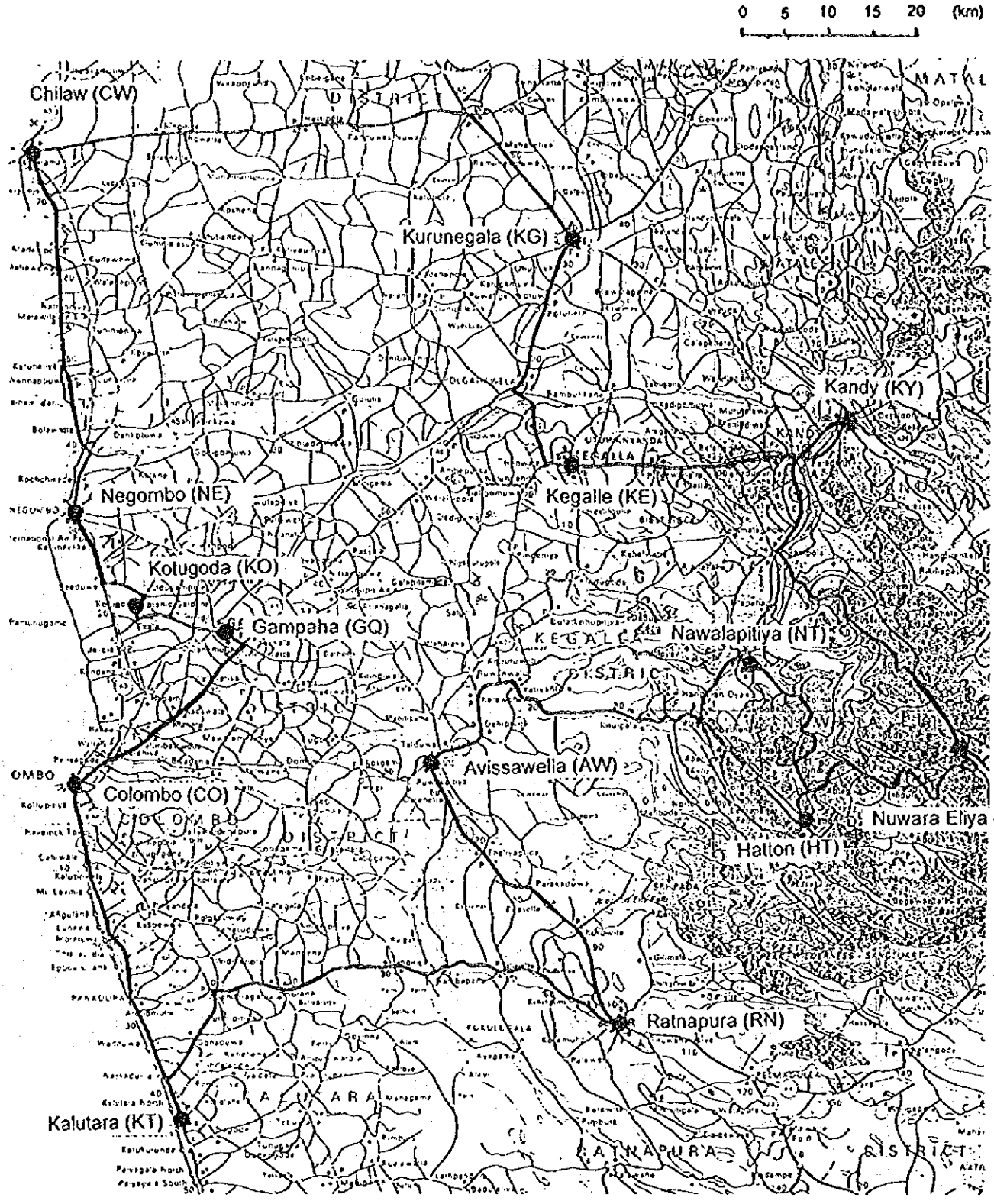


Figure 3-2-1 Central Ring Transmission System Route Plan

2.3 Future National Transmission Plan

In the Master Plan, JICA study team drew the future national transmission network plan. Proposed future backbone transmission projects up to 2015 are scheduled as shown in Table 3-2-1.

Table 3-2-1 Proposed Implementation Schedule

		1996 - 2000	2000 - 2005	2005 - 2010	2010-2015
1.	Expansion of Trunk Transmission Network				
2.	Central SDH Ring				
3.	Northern Micro Link				
4.	Southern SDH FO Ring				
5.	2nd Central SDH FO Ring				
6.	Northern SDH FO Ring, Eastern SDH FO Spur				
7.	Northern SDH FO Spur				

Source: Team Estimate

Central Ring Fibre Optic transmission system will constitute the future backbone transmission network with Southern Fibre Optic transmission system and Northern Micro Link before 2005. Figure 3-2-2 shows the future national transmission plan taken from the Master Plan.

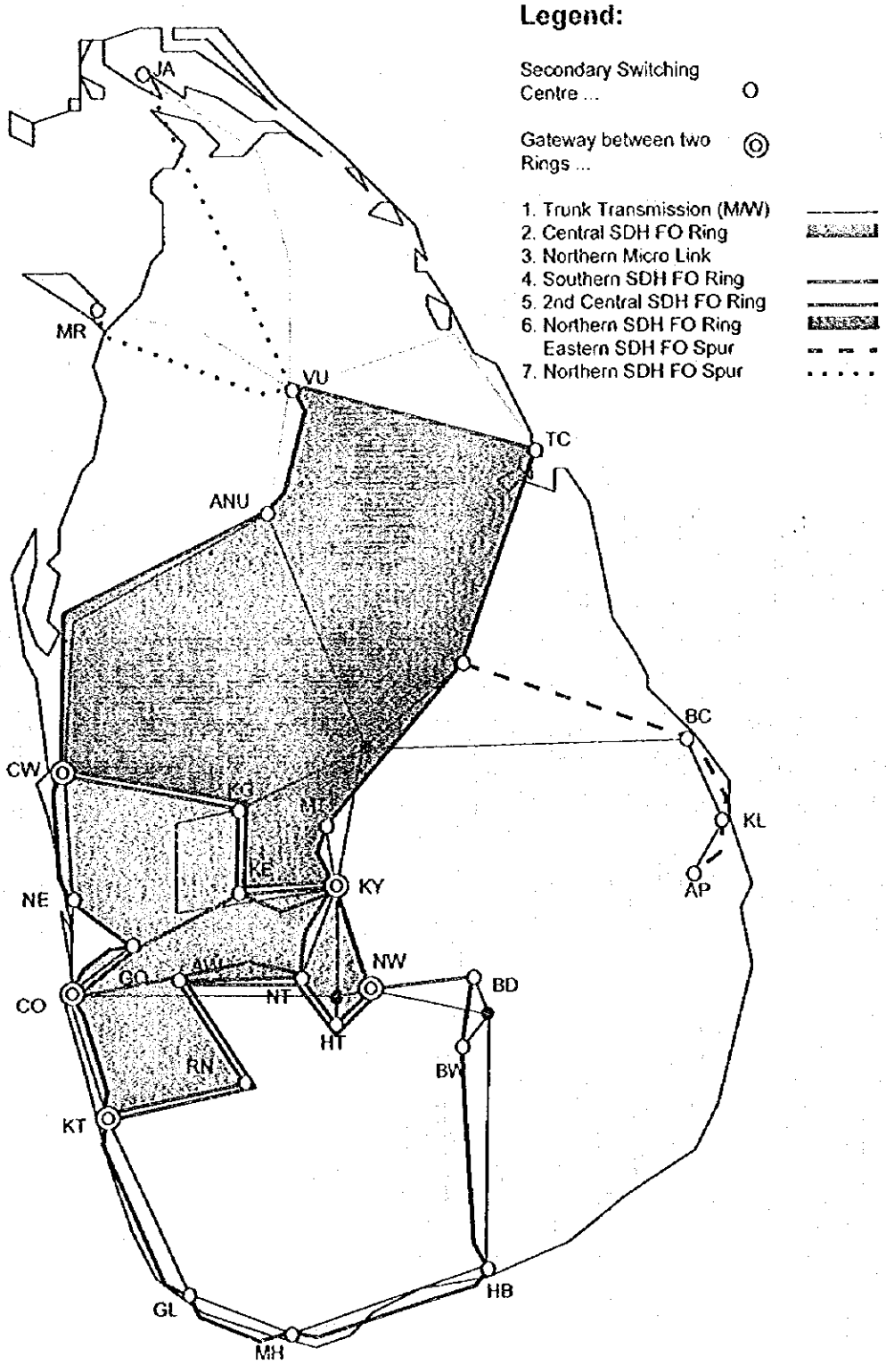


Figure 3-2-2 Future National Transmission Network Plan

3. Socio-Economy in the Objective Area

The proposed central ring fibre optic transmission system would link the most economically vital cities in the nation.

This system covers most of major economic active area accounting about 50% of nation's population and over 60% of its GDP. Sri Lanka's future growth will undoubtedly depend on these cities. As their population increases, so will the number of telecom subscribers. If no measures are taken to address this phenomenon, however the resulting rapid increase in telephone traffic from the targeted area will inevitably lead to a shortage of trunk transmission capacity. Once such a situation develops, no telecommunications program claiming time saving as its raison d'être could be effective. Certain preventive measures (the project) must thus be taken in advance.

Moreover, in order to satisfy the growing needs for ISDN services, there must be a shift from radio transmission to fibre optic transmission, thereby providing support for high-volume information traffic.

The current network system cannot be reliable, because its structural limitations do not allow radio transmission to be used as a backup in the event of a partial system failure (e.g. impairment of trunk link, etc.). The proposed system clearly seems to eliminate this shortcoming.

Table 3-3-1 GRDP and Population in the Related Districts

Related District Name	GRDP (USD mill.)	Population (1994)	GRDP/Capita (USD)
Western			
Colombo	1,726	2,007,703	860
Gampaha	1,387	1,695,728	818
Kalutara	734	937,183	783
Sabaragamuwa			
Ratnapura	313	918,684	341
Central			
Kandy	484	1,218,865	397
Nuwara Eliya	210	670,128	313
Northwest			
Kurunegala	578	1,375,591	420
Total	5,432 (65%)	8,823,882 (50%)	616
National Total	8,414 (100%)	17,765,348 (100%)	474

Note: 1992 Factor Cost

4. Present Conditions of Telecommunications Services in the Objective Area

Present network of SLT is composed adopting hierarchical structure. Hierarchical order of exchanges are as ISC (International Switching Centre), NSC (National Switching Centre), TSC (Tertiary Switching Centre), SSC (Secondary Switching Centre) and LE (Local Exchange). The number of exchanges and subscribers in each SSC area at present is shown in Table 3-4-1.

Existing national backbone transmission system consists of some digital microwave transmission systems. Transmission capacities of these microwave systems are mainly 68 Mbit/s and the installed year is around 1985. Installation of the new microwave backbone transmission system is progressed now under the Trunk Transmission Project. Existing backbone microwave systems will be replaced with this new system. After the completion, 140M transmission systems will connect all major SSCs and TSCs, and 214 systems of 2 Mbit/s will be added to existing trunk capacity. Transmission capacity between each node after Trunk Transmission Project is shown in Table 3-4-2.

150K Project being carried out by SSC area with supplier's credit, aims to expand the network within each SSC area. The number of target SSC areas are 24. The project consists of new installation of exchanges, expansion of subscriber's cable network and modernisation of trunk link between SSC and LE. It is expected to be completed in year 1997.

Considering life expectancy of these new trunk transmission system, these system will work up to around the year 2010. Figure 3-4-1 shows national transmission network in year 1997.

Table 3-4-1 Present Number of Exchanges and Subscribers

No.	TSC	SSC	Abbr.	No. of LEs	No. of Subscribers	Target Nodes
1	Colombo	Avissawella	AW	7	1,821	v
2		Chilaw	CW	15	1,771	v
3		Colombo	CO	30	124,032	v
4		Gampaha	GQ	13	2,114	v
5		Kalutara	KT	10	4,562	v
6		Kegalle	KE	7	1,947	v
7		Kurunegala	KG	13	3,793	v
8		Negombo	NE	8	3,461	v
9	Anuradhapura	Anuradhapura	ANU	13	2,751	
10		Jaffna	JA	0	0	
11		Mannar	MR	1	124	
12		Polonnaruwa	PR	2	730	
13		Trincomalee	TC	2	824	
14		Vavunia	VU	1	583	
15	Galle	Galle	GL	13	3,393	
16		Hambantota	HB	15	2,793	
17		Matara	MR	16	1,830	
18		Ratnapura	RN	8	2,634	v
19	Kandy	Ampara	AP	1	475	
20		Badulla	BD	15	3,208	
21		Bandarawella	BW	5	1,815	
22		Batticaloa	BC	3	1,629	
23		Hatton	HT	8	803	v
24		Kalmune	KL	2	900	
25		Kandy	KY	17	8,421	v
26		Matale	MT	11	2,121	
27		Nawalapitiya	NT	4	329	v
28		Nuwara Eliya	NW	9	1,860	v
	Total			249	180,724	

Note: As of Dec. 1994

Source: SLT

Table 3-4-2 Existing 2 Mbit/s Streams between Each Node

EXISTING 2M BPS STREAMS BETWEEN EACH NODE

Base Data...1995

These numbers are as at the period of completion of Trunk Transmission Project Expansion.

(2M bps Unit)		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	
BETWEEN		AW	CO	CW	GO	KE	KG	KT	NE	ANU	JA	MR	PR	TC	VU	GL	HB	MH	RN	AP	BC	BD	BW	HT	KL	KY	MT	NT	NW	KO	TOTAL
1 Avissawella	AW		4																												4
2 Colombo	CO	4		6	22	4	15	79	20	29			4			23	7	12	3	3	10	8	8	19	5	59	1	3	4		348
3 Chilaw	CW		6				1		3																						10
4 Gampaha	GQ		22																												22
5 Kegalle	KE		4																												4
6 Kurunegala	KG		15	1				1		1						2										17					35
7 Kalutara	KT		79				1																			1					80
8 Negombo	NE		20	3						1																2					26
9 Anuradhapura	ANU		29				1		1				18	2	1	2	1	1			1				1	9					67
10 Jaffna	JA																														0
11 Mannar	MR																														0
12 Polonnaruwa	PR		4							18																1					23
13 Trincomalee	TC									2																					2
14 Vavuniya	VU									1																					1
15 Galle	GL		23					2		2							17	14	3		1					7					69
16 Hambantota	HB		7							1						17		10								2					37
17 Matara	MH		12							1						14	10									2					39
18 Ratnapura	RN		3													3															6
19 Ampara	AP		3																		1				1	8					13
20 Batticaloa	BC		10							1						1				1					2	9					24
21 Beruwala	BD		8																				5			13			4		30
22 Bandaraweia	BW		8																			5				12			4		29
23 Hatton	HT		19																							16					35
24 Kelmune	KL		5							1										1	2					9					18
25 Kandy	KY		59				17	1	2	9			1			7	2	7		8	9	13	12	16	9		2	5	6		182
26 Matale	MT		1																							2					3
27 Nuwaraeliya	NT		3																							5					8
28 Nuwara Eliya	NW		4																			4	4			8					20
29 Kotugoda	KO																														0
Total		4	348	10	22	4	33	83	26	67	0	0	23	2	1	69	37	39	6	13	24	30	29	35	18	182	3	8	20	0	569
																															569

Note:
Existing capacities are based on the data as of October, 1994.
Additions are as follows:
i) 18 systems on CO - GQ by GCTNIP-II
ii) Systems added by Trunk Transmission Project
iii) Expected maximum 2M bps capacities are considered for Trunk Transmission Project.
iv) BD and BW link (proposed in the expension) are included

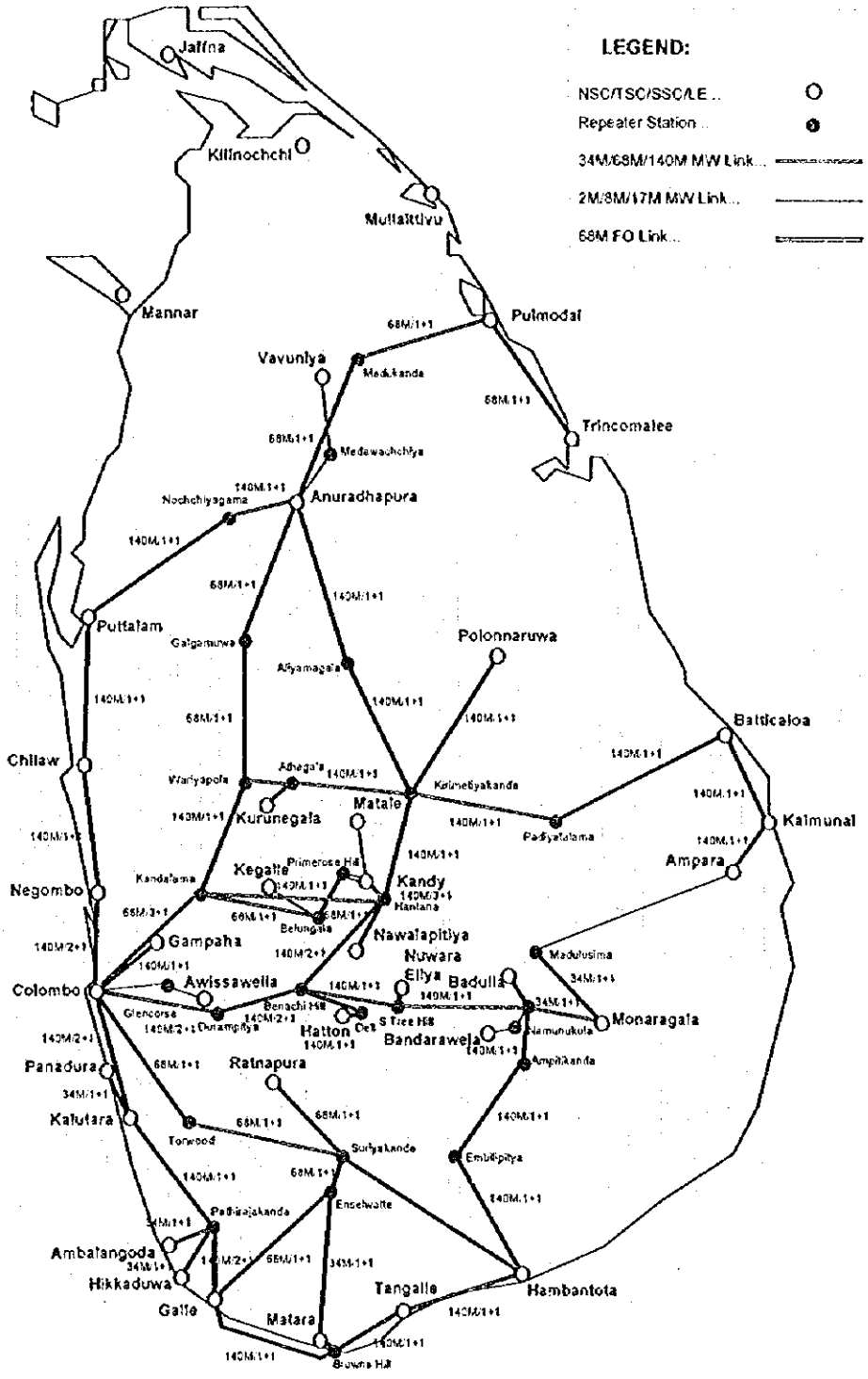


Figure 3-4-1 National Transmission Network in 1997

5. Project Basic Design

5.1 Forecast

5.1.1 Demand Forecast

Demand forecast by the macroscopic method was done in the Master Plan Study. The forecast was based on GDP (Gross Domestic Product) /Capita data for 50 countries at 1992, obtained from ITU data book. From the analysis of these data, the regression model was drawn and some adjustment was added later. The regression formula for forecasting future demand is as follows:

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

where, Ln : natural logarithmic operator
ML : the number of main lines
WE : the number of registered waiters
POP : population
GDP : GDP

Forecasted demand was distributed to local exchanges using GRDP (Gross Regional Domestic Product) and demand data for each district in the Master Plan study.

WLL participation will accelerate the speed that hidden demand changes to expressed demand. As an precondition described in the Chapter 1, telephone supply plan was modified and Table 3-5-1 below shows the forecasted figures by TSC areas.

Table 3-5-1 Forecasted Direct Exchange Lines (DEL) by TSC

TSC \ Year	Present DELs (1994)	1997 DELs (Original)	2000 DELs (Original)	2000 DELs (include WLL)	2005 DELs (Original)	2005 DELs (include WLL)
Colombo	143,501	296,856	493,246	492,246	733,660	833,713
Anuradhapura	5,012	13,766	43,773	45,356	63,086	71,144
Galle	10,650	32,714	49,582	49,358	70,433	80,036
Kandy	21,561	53,664	80,399	80,040	111,357	126,724
Total DELs	180,724	397,000	667,000	667,000	978,536	1,111,617

Source: Team estimate.

Comparing modified number of DELs with original figure, 1,111,617 subscribers (or DELs) in total (for SLT and WLL) are expected in 2005 instead of 978,536 of the original figure in the master plan, and which is 13.6% increased. This total figure (for SLT and WLL) is separated as follows:

Modified number of subscribers in total...	1,111,617
SLT subscribers (2005)...	811,617
WLL subscribers (2005, two companies)...	300,000

5.1.2 Circuit Estimate

It is unclear that WLL operators have their own trunk network or they utilise leased circuits of SLT. Future backbone systems are considered in thick bunch basis so as to be treated in capacity unit of 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 system cost, recent modularity trend and the importance to keep easy handling system. Meeting this idea, it will be important to prepare enough capacity. So, this feasibility study assumes WLL operators utilise leased circuits of SLT as their trunk network and required transmission capacity between each SSC-SSC link will be in proportion to the number of subscribers.

Required transmission capacity between each SSC-SSC link is obtained by 1.29 times (1.136 x 1.136) expansion of the calculated capacity in the master plan.

5.1.3 Consideration on NSC

NSC has the functions of gateway switch between SLT network and other networks such as cellular mobile networks, final path between each TSCs and final path along SSC - TSC - NSC - ISC link. And most of WLL subscribers' traffic will not go through NSC. So, the number of circuits concerned to NSC is calculated as follows based on the proportion of the modified number to the original number of SLT's subscribers at 2005:

$$\text{Modified number of circuits to/from NSC} = \frac{\text{Modified number of SLT's subscribers (2005)}}{\text{Original number of SLT's subscribers (2005)}} \times \text{Original number of circuits to/from NSC}$$

$$= \frac{811{,}617}{978{,}536} \times \text{Original number of circuits to/from NSC}$$

$$= 0.829 \times \text{Original number of circuits to/from NSC}$$

5.1.4 New Kotugoda ISC/NSC/TSC

Another factor to be considered is the establishment of new ISC/NSC/TSC at Kotugoda, outskirts of Colombo. This new ISC/NSC/TSC establishment is also under proposition and feasibility study. Exchange capacity proposed in the feasibility study for Colombo and Kotugoda is as shown in Table 3-5-2.

Table 3-5-2 Proposed Exchange Capacity of ISC, NSC and TSC

	ISC	NSC	TSC	Total
Colombo- A	2,050	1,950	9,000	13,000
Colombo- B	5,300		21,000	26,300
Colombo (Maradana)			21,000	21,000
Colombo Total	7,350	1,950	51,000	60,300
	(58.1%)	(42.9%)	(70.8%)	(67.6%)
Kotugoda	5,300	2,600	21,000	28,900
	(41.9%)	(57.1%)	(29.2%)	(32.4%)
Total	12,650	4,550	72,000	89,200

New TSC installed at Kotugoda is expected also to have the function of SSC, so, the circuit matrices are arranged as Colombo ISC/NSC/TSC/SSC takes 70% of the related number of circuit and Kotugoda ISC/NSC/TSC/SSC takes 30%. More 10% margin to both site are added and 5% volume of the circuit related to ISC/NSC/TSC/SSC are provided to Colombo ISC-Kotugoda ISC, Colombo NSC - Kotugoda NSC, Colombo TSC - Kotugoda TSC, Colombo SSC - Kotugoda SSC respectively.

Total number of 2 Mbit/s between each node considering above factors is shown in Table 3-5-3, and required number of 2 Mbit/s is shown in Table 3-5-4.

Table 3-5-3 Total No. of 2 Mbit/s Streams between Each Node in 2005

TOTAL NO. OF 2M BPS BETWEEN EACH NODE

(Y-2000)

Base Data 2005

Total Number does not include the number of 2M bps streams within same node

(2M bps Unit)		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	
BETWEEN		AW	CO	CW	GQ	KE	KG	KT	NE	ANU	JA	MR	PR	TC	VU	GL	HB	MH	RN	AP	BC	BD	BW	HT	KL	KY	MT	NT	NW	KO	TOTAL
1 Avissawella	AW		40																							2				20	62
2 Colombo	CO	40	164	37	107	39	62	84	78	36	56	4	14	12	11	59	26	42	35	10	20	22	16	10	20	112	15	6	12	191	1176
3 Chilaw	CW		37							3						2										3				19	64
4 Gampaha	GQ		107				4	3	4	3	4					6										10				55	196
5 Kegalle	KE		39				3			3						3										7				20	75
6 Kurunegala	KG		62		4	3		4	4	3	4					5		3								15				32	139
7 Kalutara	KT		84		3		4		4	3	4					7	3	4								11				43	170
8 Negombo	NE		78		4		4	4		2	4					3										6				40	145
9 Anuradhapura	ANU		36	3	3	3	3	3	2	20	29	15	13	17	16	22	3	3	3		3				3	14				19	213
10 Jaffna	JA		56		4		4	4	4	29						4		4								10				28	147
11 Mannar	MR		4							15																				2	21
12 Polonnaruwa	PR		14							13																3				7	37
13 Trincomalee	TC		12							17																3				6	38
14 Vavuniya	VU		11							16																2				6	35
15 Galle	GL		59	2	6	3	5	7	3	22	4					22	19	23	12			3	2		3	15			4	31	219
16 Hambantota	HB		26					3		3						19		3								7				13	74
17 Matara	MH		42				3	4		3	4					23	3		3							6				22	113
18 Ratnapura	RN		35							3						12		3								7				19	79
19 Ampara	AP		10																							15				5	30
20 Batticaloa	BC		20							3															3	24				10	60
21 Badulla	BD		22													3										23				11	59
22 Bandarawela	BW		16													2										17				8	43
23 Hatton	HT		10																							12				6	28
24 Kamuna	KL		20							3						3					3					20				10	59
25 Kandy	KY	2	112	3	10	7	15	11	6	14	10		3	3	2	15	7	6	7	15	24	23	17	12	20	29	24	13	17	57	456
26 Matale	MT		15																							24				8	47
27 Nuwaraeliya	NT		6																							13				3	22
28 Nuwara Eliya	NW		12																							17				6	35
29 Kotugoda	KO	20	191	19	55	20	32	43	40	19	28	2	7	6	6	31	13	22	19	5	10	11	8	6	10	57	8	3	6	43	697
Total		62	1,176	64	196	75	139	170	145	213	147	21	37	38	35	219	74	113	79	30	60	59	43	28	59	455	47	22	35	697	2269
																															2269

Table 3-5-4 Required No. of 2 Mbit/s Streams between Each Node in 2005

REQUIRED 2M BPS STREAMS BETWEEN EACH NODE

(Y-2000)

Base Data : 2005

Required No. = Total No. - Existing No.

(2M bps Unit)		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	
BETWEEN		AW	CO	CW	GO	KE	KG	KT	NE	ANU	JA	MR	PR	TC	VU	GL	HB	MH	RN	AP	BC	BD	BW	HT	KL	KY	MT	NT	NW	KO	TOTAL
1 Avissawella	AW		36																							2				20	58
2 Colombo	CO	36		31	85	35	47	5	58	7	56	4	10	12	11	36	19	30	32	7	10	14	8		15	53	14	3	8	191	837
3 Chilaw	CW		31							3						2										3				19	58
4 Gampaha	GO		85				4	3	4	3	4					6										10				55	174
5 Kegalle	KE		35				3			3						3										7				20	71
6 Kurunegala	KG		47		4	3		3	4	2	4					5		3												32	107
7 Kalutara	KT		5		3		3		4	3	4					5	3	4								10				43	87
8 Negombo	NE		58		4		4	4		1	4					3										4				40	122
9 Anuradhapura	ANU		7	3	3	3	2	3	1		29	15		15	15	20	2	2	3		2				2	5				19	151
10 Jaffna	JA		56		4		4	4	4	29						4		4								10				28	147
11 Mannar	MR		4							15																				2	21
12 Polonnaruwa	PR		10																							2				7	19
13 Trincomalee	TC		12							15																3				6	36
14 Vavuniya	VU		11							15																2				6	34
15 Galle	GL		36	2	6	3	5	5	3	20	4						2	9	9			3	2		3	8				31	151
16 Hambantota	HB		19					3		2						2										5				13	44
17 Matara	MH		30				3	4		2	4					9			3							4				22	81
18 Ratnapura	RN		32							3						9		3								7				19	73
19 Ampara	AP		7																							7				5	19
20 Batticaloa	BC		10							2															1	15				10	38
21 Badulla	BD		14													3										10				11	38
22 Bandarawela	BW		8													2										5				8	23
23 Hatton	HT																													6	6
24 Kalmunai	KL		15							2						3					1					11				10	42
25 Kandy	KY	2	53	3	10	7		10	4	5	10		2	3	2	8	5	4	7	7	15	10	5		11		22	8	9	57	270
26 Matara	MT		14																							22				8	44
27 Nuwaraeliya	NT		3																							8				3	14
28 Nuwara Eliya	NW		8																							9				6	23
29 Kotugoda	KO	20	191	19	55	20	32	43	40	19	28	2	7	6	6	31	13	22	19	5	10	11	8	6	10	57	8	3	6	697	697
Total		58	837	58	174	71	107	87	122	151	147	21	19	36	34	151	44	81	73	19	38	38	23	6	42	279	44	14	23	697	1747
																															1747

5.2 Network Plan

5.2.1 Transmission System

Besides increase of subscribers and improvement of the call completion ratio, high speed and wide transmission bandwidth will be required for the transmission system following the trend for future "wide bandwidth required" services such as video transmission and ISDN from now on.

There are two main transmission system physically for backbone link in general, microwave radio system and fibre optic cable system. Microwave radio system has advantages in installation period and terrestrial freedom of the section and the maximum capacity of the system is 140 Mbit/s or 155 Mbit/s (STM-1) in general. But fibre optic cable system is free from electromagnetic interference and has advantage in transmission capacity hugely, the maximum capacity of the system is 2.5 Gbit/s in general, even 10 Gbit/s capacity transmission is available now. These developments have lowered the transmission cost per channel. So, future backbone transmission is expected to be dominated by fibre optic system and partly supported by microwave system.

Following above ideas, fibre optic cable system is regarded to be suit for this new transmission system and it also can work as alternative to the existing microwave system.

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

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

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

Conditions described above are applied to the network structure. Outline of the network is described as following:

Construction of one (1) SDH ring fibre optic cable backbone transmission network is proposed. This ring will work as an alternative transmission system to the new microwave transmission system and be a part of national fibre optic cable transmission network. Expected network configuration is shown in Figure 3-5-1.

Transmission capacity is decided based on the distribution of 2 Mbit/s tributaries, so combination of STM-16 ring and STM-4 ring is considered.

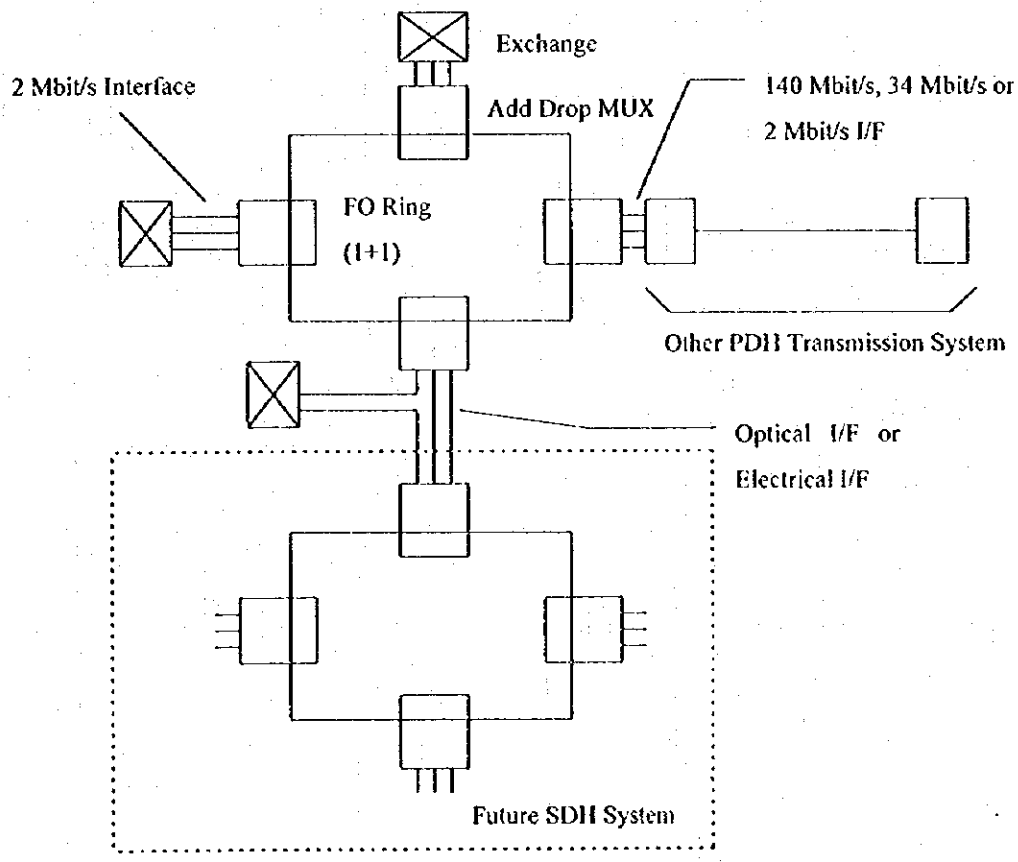
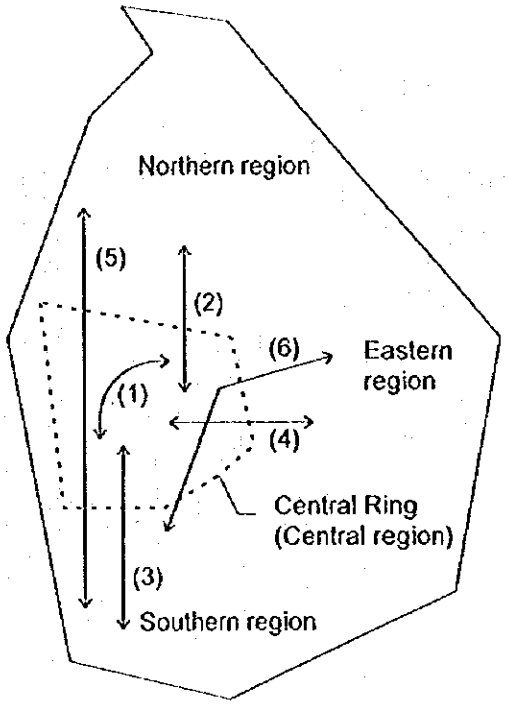


Figure 3-5-1 Expected Network Configuration

5.2.2 Network Structure

Proposed system is expected to carry the traffic not only that between the nodes along the Central Ring but also that between these nodes and the nodes in other regions such as northern region and southern region. Considering present status of the backbone transmission network and geographical condition, the traffic which will be carried by this system is categorised as shown in Figure 3-5-2 below. Traffic between the node in northern region and the node in eastern region will be flow through Kandy, and will not be related to this central ring.



(1)... Traffic between the nodes in central region
(2)... Traffic between the node in central region and the node in northern region
(3)... Traffic between the node in central region and the node in southern region
(4)... Traffic between the node in central region and the node in eastern region
(5)... Traffic between the node in northern region and the node in southern region
(6)... Traffic between the node in eastern region and the node in southern region

Figure 3-5-2 Traffic Category related to Central Ring Transmission System

STM-4 and STM-16 are considered as the capacity unit of this transmission system. Structure consisted of one (1) STM-16 ring and two (2) STM-4 rings will be the best from economical view. STM-4 ring will be able to deal future increased traffic by grading up of the system to STM-16.

Out of the whole required transmission capacity shown in the previous Table 3-5-4, the capacity allocation plan of some links were adjusted so as to be suited to these structures. After this adjustment, traffic category for each ring was arranged as shown in the following Table 3-5-5. Figure 3-5-3, Table 3-5-6 and Table 3-5-7 show the detail of the adjustment and actual capacity allocation plan.

Table 3-5-5 Traffic Category for Each Ring

Ring Name	Traffic Category	Ring Capacity	Installed Capacity
STM-16:	(1) Traffic between the nodes in central region	1,008	989
STM-4-1:	(2) Traffic between the node in central region and the node in northern region (4) Traffic between the node in central region and the node in eastern region	252	252
STM-4-2:	(3) Traffic between the node in central region and the node in southern region (5) Traffic between the node in northern region and the node in southern region (6) Traffic between the node in eastern region and the node in southern region	252	252

Source: Team

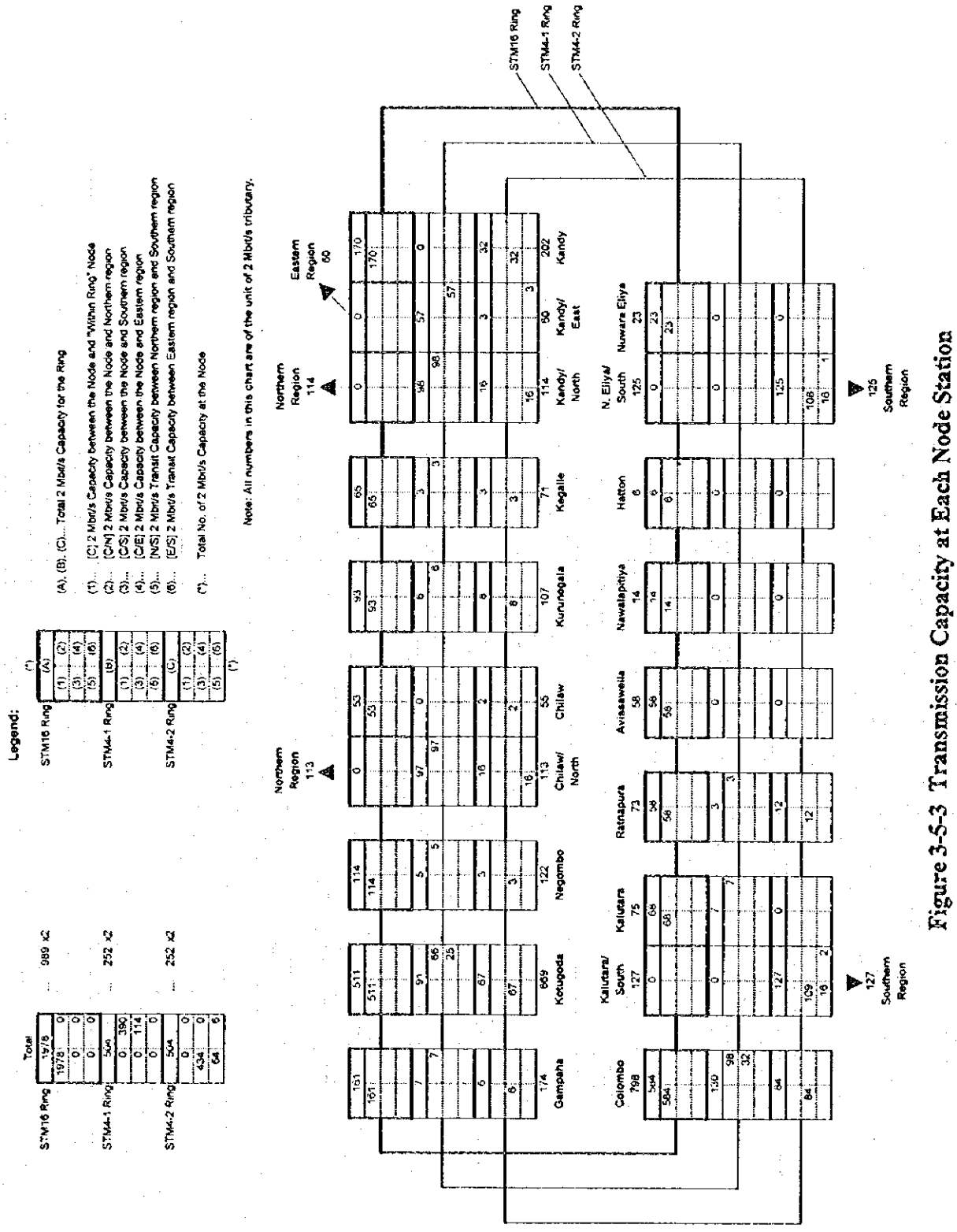


Figure 3-5-3 Transmission Capacity at Each Node Station

Table 3-5-6 2 Mbit/s Stream Matrix between Each SSC for Central Ring System

1. Original Figure

		(2M bps Unit)		1	2	3	4	5	6	7	8	9	10	11	12	13	14					
		BETWEEN		CO	GQ	KO	NE	CW	KG	KE	KY	NW	HT	NT	AW	RN	KT	C-Total	N-Total	S-Total	E-Total	TOTAL
1	C	Colombo	CO		85	191	58	31	47	35	53	8		3	36	32	5	584	114	107	32	837
2	C	Gampaha	GQ	85		55	4		4		10						3	161	7	6		174
3	C	Kotugoda	KO	191	55		40	19	32	20	57	6	6	3	20	19	43	511	76	85	25	697
4	C	Negombo	NE	58	4	40			4		4						4	114	5	3		122
5	C/N	Chilaw	CW	31		19					3							53	3	2		58
6	C	Kurunegala	KG	47	4	32	4			3							3	93	6	8		107
7	C	Kegalle	KE	35		20			3		7							65	3	3		71
8	C/N	Kandy	KY	53	10	57	4	3		7		9		8	2	7	10	170	44	32	33	279
9	C/S	Nuwara Eliya	NW	8		6					9							23				23
10	C	Hatton	HT			6												6				6
11	C	Nawalapitiya	NT	3		3					8							14				14
12	C	Avissawella	AW	36		20					2							58				58
13	C	Ratnapura	RN	32		19					7							58	3	12		73
14	C/S	Kalutara	KT	5	3	43	4		3		10							68	7	12		87
		C-Total		584	161	511	114	53	93	65	170	23	6	14	58	58	68	989	268	270	90	1617
		N-Total		114	7	76	5	3	8	3	44					3	7	268	74	32	4	378
		S-Total		107	6	85	3	2	8	3	32					12	12	270	32	16	3	321
		E-Total		32		25					33							90	4	3	1	98
		Total		837	174	697	122	58	107	71	279	23	6	14	58	73	87	1,617	378	321	98	1747
		Within C-Ring		584	161	511	114	53	93	65	170	23	6	14	58	58	68					
		With Outer Nodes		253	13	186	8	5	14	6	109					15	19					

2. Adjusted Figure .... These Adjusted Figures were adopted to Facility Planning.

		(2M bps Unit)		1	2	3	4	5	6	7	8	9	10	11	12	13	14					
		BETWEEN		CO	GQ	KO	NE	CW	KG	KE	KY	NW	HT	NT	AW	RN	KT	C-Total	N-Total	S-Total	E-Total	TOTAL
1	C	Colombo	CO		85	191	58	31	47	35	53	8		3	36	32	5	584	[illegible]	[illegible]	32	798
2	C	Gampaha	GQ	85		55	4		4		10						3	161	7	6		174
3	C	Kotugoda	KO	191	55		40	19	32	20	57	6	6	3	20	19	43	511	[illegible]	[illegible]	25	669
4	C	Negombo	NE	58	4	40			4		4						4	114	5	3		122
5	C/N	Chilaw	CW	31		19					3							53	[illegible]	2		55
6	C	Kurunegala	KG	47	4	32	4			3							3	93	6	8		107
7	C	Kegalle	KE	35		20			3		7							65	3	3		71
8	C/N	Kandy	KY	53	10	57	4	3		7		9		8	2	7	10	170	[illegible]	32	[illegible]	202
9	C/S	Nuwara Eliya	NW	8		6					9							23				23
10	C	Hatton	HT			6												6				6
11	C	Nawalapitiya	NT	3		3					8							14				14
12	C	Avissawella	AW	36		20					2							58				58
13	C	Ratnapura	RN	32		19					7							58	3	12		73
14	C/S	Kalutara	KT	5	3	43	4		3		10							68	7	[illegible]		75
		C-Total		584	161	511	114	53	93	65	170	23	6	14	58	58	68	989	195	217	57	1458
		N-Total		[illegible]	7	[illegible]	5	[illegible]	8	3	[illegible]					3	7	195	[illegible]	32	[illegible]	227
		S-Total		[illegible]	6	[illegible]	3	2	8	3	32					12	[illegible]	217	32	[illegible]	3	252
		E-Total		32		25					[illegible]							57	[illegible]	3	[illegible]	60
		Total		798	174	669	122	55	107	71	202	23	6	14	58	73	75	1,458	227	252	60	1493
		Within C-Ring		584	161	511	114	53	93	65	170	23	6	14	58	58	68					
		With Outer Nodes		214	13	158	8	2	14	6	32					15	7					

[illegible] ... Adjusted Figure

Table 3-5-7 Distribution of 2 Mbit/s Tributaries

No.	\Destination Node Area Node\	Central Ring	Northern region	Eastern region	Southern region	Northern - Southern	Eastern - Southern	Total	Remarks
1	Colombo	584	98	32	84			798	
2	Gampaha	161	7		6			174	
3	Kotugoda	511	66	25	67			669	
4	Negombo	114	5		3			122	
5	Chilaw	53			2			55	
	Chilaw/Northern		97			16		113	Interconnection with Northern region
6	Kurunegala	93	6		8			107	
7	Kegalle	65	3		3			71	
8	Kandy	170			32			202	
	Kandy/Northern		98			16		114	Interconnection with Northern region
	Kandy/Eastern			57			3	60	Interconnection with Eastern region
9	Nuwara Eliya	23						23	
	N. Eliya/Southern				108	16	1	125	Interconnection with Southern region
10	Hatton	6						6	
11	Nawalapitiya	14						14	
12	Avissawella	58						58	
13	Ratnapura	58	3		12			73	
14	Kalutara	68	7					75	Interconnection with Southern region
	Kalutara/Southern				109	16	2	127	
	C-Ring Capacity	989	195	57	217	32	3		
			252				252	1493	
	Ring Name	STM16	STM4-1		STM4-2				

	Included nodes	Interconnection points
Northern region...	ANU, VU, TC, PR, MT, MR, JA	Chilaw, Kandy
Eastern region...	BC, KL, AP	Kandy
Southern region...	BD, BW, HB, MH, GL	Kalutara, Nuwara Eliya

Note: Northern region and Eastern region connect at Kandy, so C-Ring will not be related.
No. of 2 Mbit/s tributaries between Colombo and Northern, Southern regions
and between Kotugoda and Northern, Southern regions are adjusted.

Source: Network Plan, fsnacap4.xls

5.2.3 Cable Route Selection

There are some considerations on cable route selections as follows:

(1) The shortest road between SSCs will be used.

(2) Existing duct route should be selected as much as possible.

(3) In Colombo Metro area, duct should be applied because of reliability. If there are no duct routes along the selected route, new ducts should be constructed.

(4) Out of Colombo metro area, basically Direct Buried Cable should be applied for lowering cost.

(5) At main highway as A3 Road (Chilaw to Kalutara), duct should be applied for reliability.

(6) Railway trucks and electric towers will not be suitable for the cable route because of limited available spaces which will cause maintenance work difficult and dangerous.

(7) Incoming and outgoing cables to/from each SSC should be separated for ring structure. And these cable routes are also selected to be separated for avoiding an isolation of the SSC. (Refer to Figure 3-5-4.)

(8) Steel duct should be applied for road crossing points and over-bridge sections.

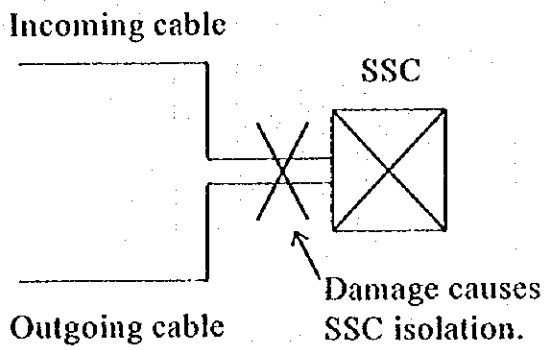


Figure 3-5-4 SSC Isolation

5.3 Facilities Plan

5.3.1 MUX Subsystem

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

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

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

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

Concrete MUX facilities plan for each station is shown in Table 3-5-8. Transmission capacity of this ring will be one (1) system of STM-16 (989 systems of 2 Mbit/s installed) and two (2) systems of STM-4 (504 systems of 2 Mbit/s installed). STM-16 ring will handle traffic exchange between the internal node stations of the ring, and STM-4 rings will handle traffic exchange between the internal node stations and node stations in the northern, eastern and southern regions. These three (3) rings (STM-16, STM-4-1 and STM-4-2) may be connected one another in 2 Mbit/s tributary unit at each node station.

These large capacity, equivalent to 44,790 voice channels will take 75 % of the whole SSC-SSC transmission capacity in 2005. The proportion of installed capacity for the microwave system and this Central ring system will be as follows:

Microwave system (national)...	499 systems of 2 Mbit/s	25 %
Central Ring system...	1,493 systems of 2 Mbit/s	75 %

There will be some capacity reserved in STM-16 ring for the future traffic increase. Moreover, system grading up from STM-4 to STM-16 will increase the capacity of handling traffic.

Table 3-5-8 MUX Facilities Plan

No.	Node	STM16 System		STM4 System-1	STM4 System-2
		STM16 Add/Drop MUX	STM4 Add/Drop MUX	STM4 Add/Drop MUX	STM4 Add/Drop MUX
1	Colombo	1	3	1	1
2	Gampaha	1	1	1	1
3	Kotugoda	1	3	1	1
4	Negombo	1	1	1	1
5	Chilaw	1	1	1	1
6	Kurunegala	1	1	1	1
7	Kegalle	1	1	1	1
8	Kandy	1	1	1	1
9	Nuwara Eliya	1	1	1	1
10	Hatton	1	1	1	1
11	Nawalapitiya	1	1	1	1
12	Avissawella	1	1	1	1
13	Ratnapura	1	1	1	1
14	Kalutara	1	1	1	1
	Ring Capacity (No. of 2 Mbit/s tributaries)		989	252	252

Note: STM16 handles traffic exchange between internal node stations in the ring.
STM4-1 handles traffic exchange between internal node station and node stations in northern/eastern regions
STM-4-2 handles traffic exchange between internal node station and node stations in southern region and traffic exchange between northern/eastern region and southern region.

Source: Team Calculate

5.3.2 Fibre Optic Cable Subsystem

Transmission medium will be 1.5μm zero dispersion Single Mode Fibre cable and 4 cores of fibre optic cable for each 1+1 system are assumed for this system. For operation and maintenance purposes, other 6 cores will be used. In this occasion, some fibre media should be prepared for the future northern part fibre optic transmission link and southern part fibre optic transmission link especially in the direct cable buried sections. It is assumed that two (2) STM-4 systems are enough for these regional transmission systems both. So, the total number of required cores is calculated as shown in Table 3-5-9.

Table 3-5-9 Required Number of Fibre Optic Cable Cores

	Section	Requirement for this system	Reservation for future system	Total	Lying style	Remarks
1	Kalutara - Colombo - Chilaw	4 c x 3 sys + 6 c		18 c	Duct	
2	Chilaw - Kandy	4 c x 3 sys + 6 c	4 c x 2 sys + 6 c	32 c	Direct Buried	future northern link
3	Kandy - Nuwara Eliya	4 c x 3 sys + 6 c		18 c	Direct Buried	
4	Nuwara Eliya - Kalutara	4 c x 3 sys + 6 c	4 c x 2 sys + 6 c	32 c	Direct Buried	future southern link

Source: Team Study

5.3.3 Network Management System

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

(1) Fault (maintenance) management such as Alarm surveillance, Alarm history management, testing and External events,

(2) Performance management such as Performance data collection, Performance monitoring history, Use of thresholds and Performance data reporting,

(3) Configuration management such as Provisioning, Status and control (protection switch) and Installation functions, and

(4) Security management.

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

5.3.4 Cable Laying

It is assumed that duct and manhole system is applied for the section between Chilaw and Kalutara and the inside city area. Especially steel duct should be applied for road crossing points and over-bridge sections. For the rest, direct buried system is assumed.

Distance between the node stations varies from 50 km to 80 km. These distances are able to be covered by direct cable connection without repeater stations. The fibre optic cable route is shown in the previous Figure 3-2-1, following Table 3-5-10 and Table 3-5-11.

5.3.5 Power Equipment

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

5.3.6 Space for Equipment and Buildings

Floor spaces and cable drawing spaces are available for new equipment to be introduced under this project at the all existing node stations except Kotugoda. The space for the transmission equipment will be provided when Kotugoda Exchange building is completed. At some stations, it is difficult to find enough spaces for the equipment in the transmission rooms, but the spaces will be available by removal of unused old systems or utilising the other rooms on the period of installation.

Table 3-5-10 Cable Route Selection

No.	Section	Route
1	CO - GQ	Colombo-Kandy Rd. (A1)
2	GQ - KO	Gampaha-Jaela Rd. (A33)
3	KO - NE	Colombo-Negombo Rd. (A3)
4	NE - CW	Negombo-Chilaw Rd. (A3)
5	CW - KG	Chilaw-Wariyapola Rd. (B), Puttaram-Kurunegala Rd. (A10)
6	KG - KE	Kurunegala-Ambepussa Rd. (A6), Polgahawela-Kegalle Rd. (A19)
7	KE -KY	Colombo-Kandy Rd. (A1)
8	KY - NW	Kandy-Badulla Rd. (A5)
9	NW - HT	NuwaraEliya-Avissawella Rd. (A7)
10	HT - NT	Via Kotagala, Kotagala-Nawalapitiya Rd. (m)
11	NT - AW	Nawalapitiya-Gingathena Rd. (B), NuwaraEliya-Avissawella Rd. (A7)
12	AW - RN	Colombo-Ratnapura Rd. (A4)
13	RN - KT	Ratnapura-Panadura Rd. (A8), Bandaragama-Waskaduwa Rd. (B)
14	KT - CO	Galle-Colombo Rd. (A2)

Note: Description in parenthesis shows the A-grade main road number (A*) or the B-grade main roads (B) or the minor roads (m).

Source: Team Study

Table 3-5-11 Fibre Optic Cable Laying

No.	Section	Route Distance (km)	Overlap Route (km)	Existing Duct Length (km)	Civil Work (km)		Cable Installation (km)	
					New Duct	Trench for Buried Cable	Duct Cable	Buried Cable
1	CO - GQ	36.2	0	23.3	12.9	0	37.3	0
2	GQ - KO	12.2	0	5.3	6.9	0	12.6	0
3	KO - NE	18.1	0	2.8	15.3	0	18.6	0
4	NE - CW	47.1	1.5	0	45.6	0	48.5	0
5	CW - KG	74.0	0	0	5.5	68.5	5.7	69.9
6	KG - KE	34.5	1.0	0	2.0	31.5	3.1	32.1
7	KE -KY	38.9	0.5	0	4.4	34.0	5.0	34.7
8	KY - NW	75.1	7.0	0	0	68.1	7.2	69.5
9	NW - HT	40.9	0.8	0	4.5	35.6	5.5	36.3
10	HT - NT	33.1	6.6	0	2.0	24.5	8.9	25.0
11	NT - AW	66.5	0.0	0	2.0	64.5	2.1	65.8
12	AW - RN	45.5	0.0	0	1.8	43.7	1.9	44.6
13	RN - KT	80.1	3.7	0	3.7	72.7	7.6	74.2
14	KT - CO	45.2	7.5	20.2	17.5	0	46.6	0
	Total	647.4	28.6	51.6	124.1	443.1	210.6	452.1

Note: Abbreviation of the node name is as follows:

CO...	Colombo	GQ...	Gampaha	KO...	Kotugoda	NE...	Negombo
CW...	Chilaw	KG...	Kurunegala	KE...	Kegalle	KY...	Kandy
NW...	Nuwara Eliya	HT...	Hatton	NT...	Nawalapitiya	AW...	Avissawella
RN...	Ratnapura	KT...	Kalutara				

Source: Team study

6. Project Cost Estimate

Based on the previous network plan and facilities plan, the project cost is estimated as Table 3-6-1. Cost for the arrangement of the equipment space is eliminated because the work will be carried out by SLT itself.

Table 3-6-1 Project Cost

	Item	Cost (x 1,000 US$)		
		Total	Foreign Currency Portion	Local Currency Portion
1	Transmission Eqpt.	6,726	6,726	-
2	Fibre Optic Cable	7,952	7,952	-
3	External Plant & Others	3,453	2,322	1,131
4	Sub-Total (1-3)	18,131	17,000	1,131
5	Installation & Others	3,371	1,486	1,885
6	Import Duty/ Tax	8,759	-	8,759
7	Engineering Service	1,505	1,505	-
8	Contingency	2,150	2,150	-
9	Grand Total (4-8)	33,916	22,141	11,775

Source: Team estimate

7. Project Implementation Plan

7.1 Implementation Schedule

7.1.1 General

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

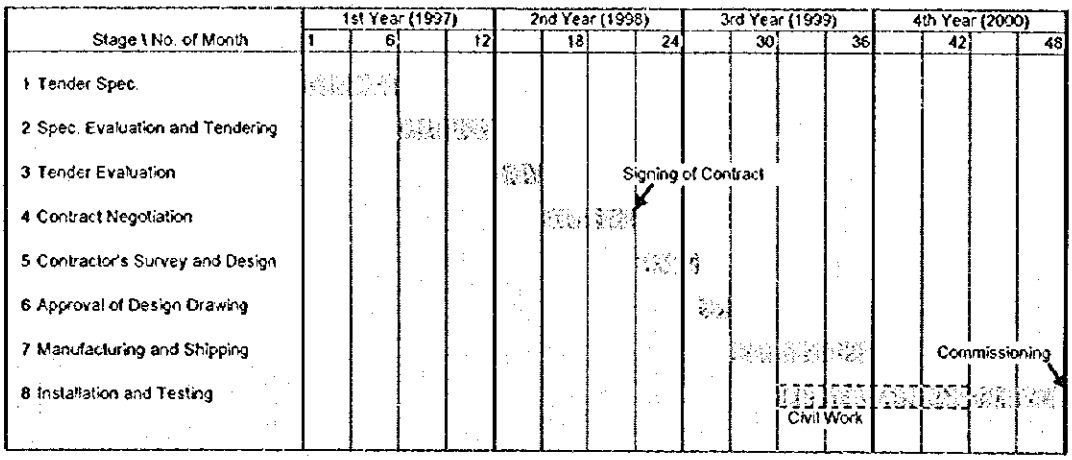
1) Preparing the tender specifications;
2) Specification evaluation and tendering;
3) Tender evaluation;
4) Supplier contract negotiation;
5) Contractor's survey and design;
6) Approval of design drawing;
7) Manufacturing and shipping;
8) Installation and testing.

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

It is essential to pay careful attention to the advance of project once it has set out. Attention should be paid so that the project can advance quickly in keeping with the rules and procedures in the government, and that between the authorities of government concerned when the finance is provided by foreign government.

7.1.2 Implementation Schedule

Implementation schedule is shown in Figure 3-7-1. Total period to completion is estimated as 48 months. Synchronisation of the equipment installation work with external plant work should be kept.



Source: Team estimate

Figure 3-7-1 Implementation Schedule

7.2 Management on Project Implementation

7.2.1 For a Smooth Project Advance

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

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

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

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

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

7.2.2 Organisation

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

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

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

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

SLT will be required to keep a closer contact with SLTA than before as new WLL networks will be introduced in 1997. Restructuring of telecommunications network will be the major impact to SLT. Traffic demand on the trunk transmission network should be studied carefully in association with WLL networks. SLT has to implement its projects in harmony with other network providers.

7.2.3 Attention on Technical Matters

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

7.3 Operation and Maintenance

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

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

Operation and maintenance (O&M) organisation was established for the microwave transmission system in the region. Following the movement of microwave to fibre optic cable, these staff should be trained to catch up this movement.

O&M zones should be based on TSC boundaries. So, from Kegalle to Avissawella via Colombo will be in Colombo O&M zone and the rest will be in Kandy O&M zone. Considering allocation of stations and TSC boundaries, Ratnapura should be functioned as sub-O&M centre in Colombo O&M zone. Figure 3-7-2 shows the proposed O&M zones for this project.

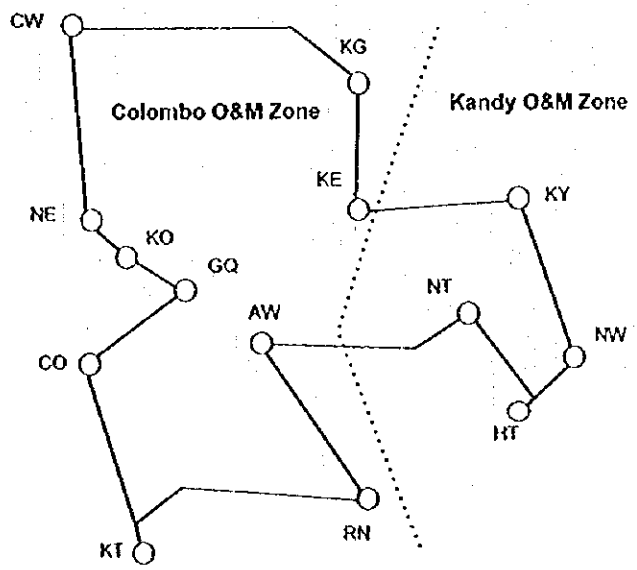


Figure 3-7-2 O&M Zones for Central Ring Transmission System

Number of staff for O&M is estimated based on the staffing plan explained in the previous Volume II. Concerned reference staffing standard is as Table 3-7-1 below.

Table 3-7-1 Reference Staffing Standard for Optical Fibre Transmission

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

Source: Team

Applying this standard to each node station, the number of staff is calculated as shown in Table 3-7-2 with some assumptions.

Table 3-7-2 Required Number of Staff for Each Station

	Station Name	DIT/TR	IPT/TR	IPT/OSP	Worker/ TR	Worker/ OSP	Total	Remarks
1	Colombo	1	2 + 2*	2	2*	4*	5 + 8*	two shifts
2	Gampaha	1*	1 + 1*	-	1*	2*	1 + 5*	
3	Kotugoda	1*	1 + 1*	-	1*	2*	1 + 5*	
4	Negombo	1*	1 + 1*	-	1*	2*	1 + 5*	
5	Chilaw	1*	1 + 1*	-	1*	2*	1 + 5*	
6	Kurunegala	1*	1 + 1*	-	1*	1*	1 + 4*	
7	Kegalle	1*	1 + 1*	-	1*	1*	1 + 4*	
8	Kandy	1	2*	2	1*	2*	3 + 5*	
9	Nuwara Eliya	1*	1 + 1*	-	1*	1*	1 + 4*	
10	Hatton	1*	1	-	1*	1*	1 + 3*	
11	Nawalapitiya	1*	1	-	1*	1*	1 + 3*	
12	Avissawella	1*	1	-	1*	1*	1 + 3*	
13	Ratnapura	1	2*	2	1*	2*	3 + 5*	
14	Kalutara	1*	1 + 1*	-	1*	2*	1 + 5*	
	Total	3 + 11*	13 +14*	6	15*	24*	22+64*	

Note: DIT... District Inspector Telecoms, IPT... Inspector Telecoms

Asterisk (*) means they will be supporting staff concurrently maintaining the other system.

Assumptions are as follows:

2 IPT/TRs are maximum for each station except Colombo.

2 Workers/OSP are maximum for each station except Colombo.

Source: Team estimate

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

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

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

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

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

7.4 Human Resource Development

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

The training should include not only factory training, OJT and classroom training, but also arrangement to establish training course on permanent basis in the training centre. For this purpose, provision of a model set of SDH FO transmission equipment with a set of measuring equipment to the SLT training centre is necessary.

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

8. Project Evaluation

8.1 Financial analysis

8.1.1 Basic Assumptions for Financial Analysis

The purpose of this analysis is to measure and assess the financial viability of the Central Ring Fibre optic transmission network project under the following conditions and assumptions which have been discussed with SLT staff.

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

a) Fiscal Year

1 , January - 31 , December

b) Project Appraisal Period

FY 1997 - 2015 (19 years)

c) Fixed Price Base

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

d) Exchange Rate

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

e) Long Term Loan

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

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

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

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

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

f) Short - Term Loan Condition

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

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

g) Revenue Collecting ratio

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

Table 3-8-1 Collecting ratio

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

h) Turnover Tax (BTT)

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

i) Corporate Income Tax, Import duty

Corporate Income Tax ;

40% of SLT's net taxable income.

Import duty applied in this evaluation is shown in Table 3-8-2.

Table 3-8-2 Ratio of Import Duty

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

j) Insurance

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

k) Depreciation

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

Table 3-8-3 Depreciation method

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

l) Working Capital

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

Account Receivable : Sales Revenue for 3 months
Account Payable : Operating costs for 1 month

m) GOSL Equity

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

n) Appropriation, Levy

No dividends to GOSL have been assumed.

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

8.1.2 Investment Plan

Estimate of the gross required capital funding for the the Central Ring Fibre optic transmission network project

(1) Total required capital cost

The total investment cost can be summarized in Table 3-8-4.

Table 3-8-4 Total required capital cost

Unit : US$1000

Items	Depre.	Total	Foreign	Local
Transmission	12.5 yrs	6,726	6,726	0
Fibre Optic cable	25.0 yrs	11,345	10,214	1,131
Vehicles	5.0 yrs	60	60	0
Installation		3,151	1,266	1,885
Training		220	220	0
Tax	10%,35%	8,759	0	8,759
Engineering service	7% of TTL	1,505	1,505	0
Contingencies	10% of TTL	2,150	2,150	0
Total		33,916	22,141	11,775

(2) Expenditure schedule

The total investment cost is disbursed in each project year of construction period as shown in Table 3-8-5.

Table 3-8-5 Expenditure Schedule

Unit : US$1000

Items	Project year					TOTAL
	1996	1997	1998	1999	2000	
Euipment & Facilities	0	0	6,482	12,965	12,965	32,412
Engineering service	301	301	301	0	602	1,505
Initial Working Capital	0	0	0	0	930	930
Interest during construction			403	1,341	2,414	4,158
Total	301	301	7,186	14,306	16,911	39,005

8.1.3 Sales revenue projection

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

Table 3-8-6 Histrical tariff level for telecommunications

Unit : SRs

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

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

(1) Installation Charge

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

(2) Monthly Rental Charge

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

(3) Call Charge

For a telephone call to take place, both a call originator and a call receiver are necessary. In other words, establishment of the telephone facilities at only one end is not sufficient to produce a call charge. This project is only a portion of the Sri Lanka are telecommunications network, so call charges cannot be considered entirely as project benefits. Based on this understanding, a revenue distribution ratio was established, as shown in Table 3-8-7 below, in order to calculate expected project benefits.

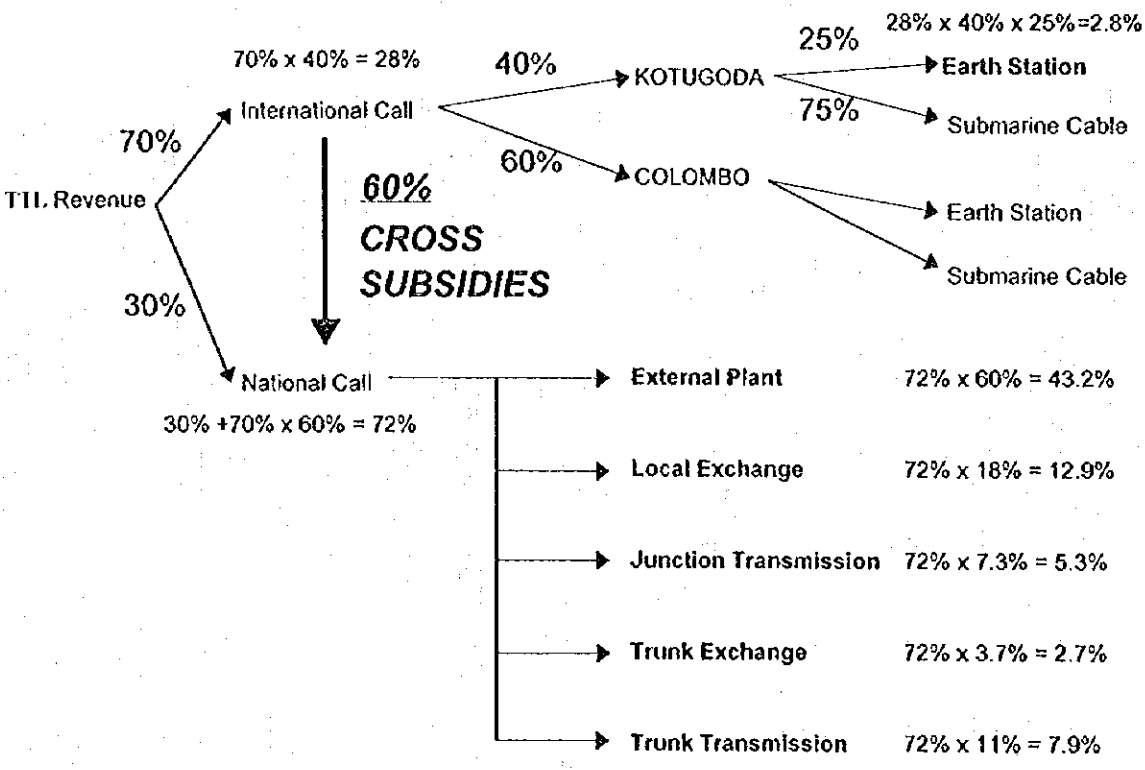


Figure 3-8-1 Concept figure of Revenue distribution

8.1.4 Revenue Distribution Ratio

After re-evaluating SLT's 1994 fixed asset ratio and the cost ratio used in JICA Master Plan (1985), Study team have determined the revenue distribution ratio related to the each network facility items. ***Given that cross subsidies are an actual factor, one which has***

supported SLT's operations during the company's development phase, a cross subsidy concept should also be applied in the evaluation of the project.

The 1996 profit and loss statement reveals that total revenues come from international calls (70%) and domestic calls (30%). First, the gross revenue is broken down into internatinal and domestic revenues based on the above relations. Then, the cross subsidies existing between the two systems are calculated as mentioned below. In this report, study team have assumed that 60% of the revenues for the international telecommunication system come from cross subsidies, to be returned to the national telecommunication system. This value of 60% is a tentative one for use only in this feasibility study, and is to be revised by the SLT staff whenever necessary. The concept flow is indicated in Figure 3-8-1.

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

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

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

Profits subject to financial analysis were calculated by determining profits by call type (including international, STD, local and other calls) and multiplying these figures by the revenue distribution ratio which are shown in the Table 3-8-7.

Table 3-8-7 Revenue Distribution Ratio

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

Expected revenue calculated under the aforementioned conditions is shown in Table 3-8-8. The following revenues are those obtained through the operation of the telecommunication network established under the project. The revenues are deemed as the operating income of the project.

Table 3-8-8 Total Annual Revenue for the project

Year	Total Revenue : USD'000
2001	6,658
2003	7,987
2005	9,254
2010	9,254
2015	9,254

8.1.5 Operation expenses

The direct operation costs do not include interest payment and depreciation. The annual operation and maintenance (O&M) costs will be increased due to the increase of number of terminals. In accordance with SLT's past expenditure record, annual (O&M) cost has been calculated as following Table 3-8-9.

Table 3-8-9 Annual (O&M) Costs

Unit : 1000USD

Year	Staff Costs	Other Costs	Total (O&M) cost
2001	258	817	1,075
2003	258	974	1,232
2005	258	1,124	1,382
2010	258	1,119	1,377
2015	258	1,115	1,373

It will be necessary to recruit 86 staff members over the entire project period. Study team has listed US$258,000 as an annual personnel expenditure on the assumption that US$3,000 would be necessary per person. As for general costs, study team has appropriated 12% of the expected annual revenue, using the data from SLT's 1995 profit and Loss Statement as reference.

Staff costs are projected not to increase after 2001. Due to improved opeartional efficiency and the introduction of new technology, other costs per DEL are expected to decrease from 2001 to 2005. The rate of decrease is taken from figures used in proposed Master Plan.

8.1.6 Financial Analysis of the project

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

(1) Assessment of Project Feasibility

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

a) Income Statement
b) Cash flow Statement

The summary of the result of financial analysis is shown in Table 3-8-10.
Note : the evaluation don't take corporate tax into account.

Table 3-8-10 Result of Financial Analysis

FIRROI has been calculated at 16.41 % (1997 - 2015)
FIRROE has been calculated at 8.49 % (1997 - 2015)

Unit : US$ 1000

Year	*Investment*	*EQUITY portion*	*Revenue*	*Total Expenses*	*Profit/Loss after Tax*	*Repayment*	*Cash Flow*
1996	301	301	0	0	0	0	-301
1997	301	301	0	0	0	0	-301
1998	7,186	3,059	0	0	0	0	-3,059
1999	14,306	6,052	0	0	0	0	-6,052
2000	16,911	8,657	0	0	0	0	-8,657
2001	0	0	6,658	5,701	957	2,064	94
2002	0	0	7,366	5,873	1,493	2,064	643
2003	0	0	7,987	6,005	1,982	2,064	1,128
2004	0	0	8,635	6,149	2,486	2,064	1,636
2005	0	0	9,254	6,279	2,975	2,064	2,216
2010	0	0	9,254	5,284	3,970	2,064	2,899
2015	0	0	9,254	4,798	4,456	0	4,910

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

Table 3-8-11 Assumption of Financing Plan

Unit : US$ '000

Items	*US$ '000*	*Share %*
EQUITY	18,369	47.1%
L-T Loan	20,636	52.9%
TOTAL	39,005	100.0%

(2) Major Financial Indicators

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

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

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

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

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

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

Table 3-8-12 Major Financial Index

Items	2001	2003	2005	2010	2015
Net profit on Equity	5.21%	10.79%	16.19%	21.61%	24.3%
Dept Service Coverage Ratio	104%	129%	160%	224%	---
Profit Break Even Point	35.7%	31.7%	29.0%	25.6%	19.7%
Cash Break Even Point	9.31%	9.6%	8.9%	10.3%	12.7%

(3) Sensitivity Analysis

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

a) Total Investment Cost

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

b) Sales Revenue

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

c) O&M cost

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

d) Long - Term Loan condition

The result of the sensitivity analysis is summarized in Table 3-8-13.

8.1.7 Result of Financial Analysis

With Sri Lanka's improving economic relationship with surrounding countries, the qualitative and quantitative improvements in telecommunication services produced by the Project are expected to yield great effects. Recently, telecommunication projects have been anticipated to have great impact on both social and economic infrastructure. While such projects must provide widespread service for the general public, they must offer sufficiently profitability to support the implementation of these services. The Project can be evaluated as adequately meeting both these requirements.

The expected profitability and financial condition will be discussed here. Following is an assessment of the forecast profitability and financial state of the project. The financial analysis of the project was conducted with the following conditions: ***Interest rate : 13.0% p.a. ; repayment period : 10 years.***

There will be a fund surplus throughout the life of the project. There is thus no need for a bridging finance, which is necessary during periods where there is a fund shortage. ***No cash flow problems will arise.***

The payout period for the capital of ***US$18,369,160*** required in the initial investment (Equity portion) is ***9.92 years***. A cash flow of ***US$25,311,000*** is yielded throughout the operating period, with ***FIRROI at 16.41% and FIRROE at 8.49%***. These IRR values suggest that the project will stand financially feasible coupled with the high returns assumed that the project can be operated without financial difficulty. This FIRROE is attained because the equity accounts for 47.1% of total Investment Costs and anticipated sales revenues are sufficient to maintain the stable operation.

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

The Cash Break Even Point for each fiscal year is lower than 13.0%. The Profit Even Point for each fiscal year of the project is lower than 40.0%. Debt Service Coverage Ratio for each fiscal year is more than 100.0% or higher. These levels point to a sound situation in terms of profits and funds.

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

8.1.8 The result of sensitivity analysis

Table 3-8-13 The result of the sensitivity analysis

Variable factor	Variation	IRROI (%)	IRROE (%)
Total Investment	+ 20%	13.38	4.70
	Base	**16.41**	**8.49**
	- 20%	20.48	13.44
Sales Revenue	+ 20%	19.82	12.26
	Base	**16.41**	**8.49**
	- 20%	12.58	4.15
O/M cost	+ 20%	15.78	7.80
	Base	**16.41**	**8.49**
	- 20%	17.02	9.17
L-T Loan condition 10 yrs repayment	Base Interest: 13% 0 yrs grace	**16.41**	**8.49**
	Interest: 8% 2 yrs grace	16.41	11.94
	Interest: 2.6% 0 yrs grace	16.41	17.65

If the Total Investment costs varies by plus or minus 20% from the base value, the FIRR value also fluctuates by about 7%. Although the total costs of investment do affect the project's profitability to some extent, they do not have a life or death influence over the project. Fluctuation of sales revenue affect the project's profitability to a relatively some extent. If sales revenue vary from the estimates by plus or munus 20%, FIRR values fluctuate by about 7%. But even where sales revenues drop 20%, the FIRROI of 16.41% remains above 12.58%. It therefore seems that the profitability of the project, as one which serves to meet a social welfare needs, is secure.

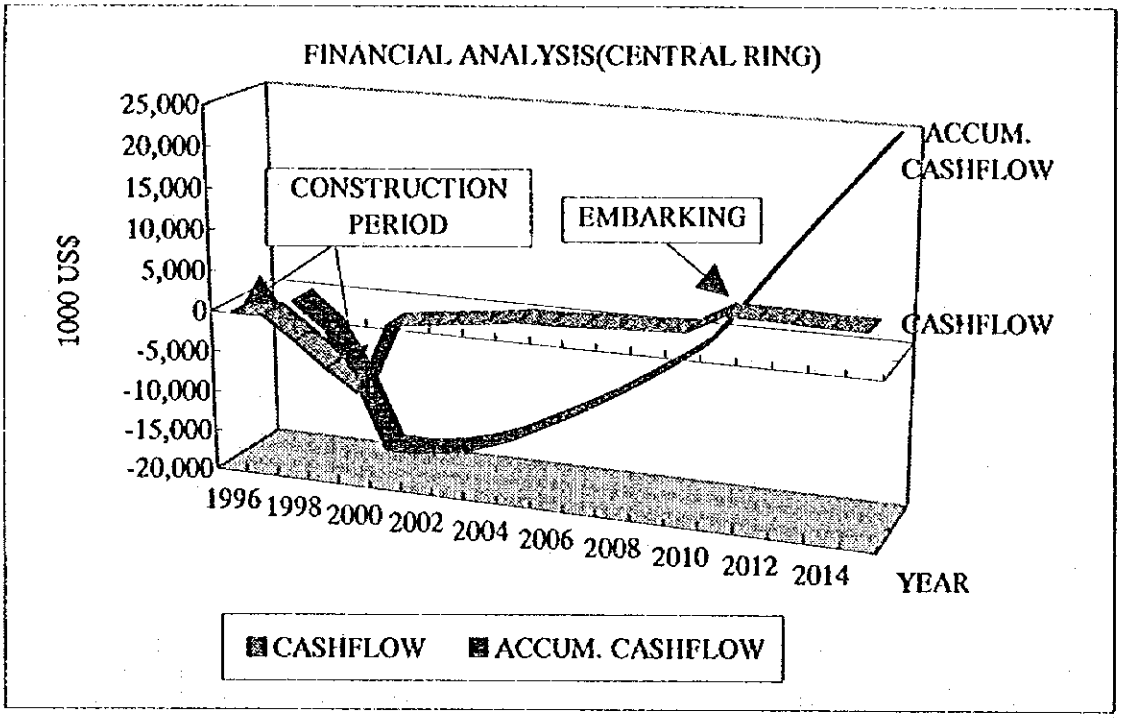


Figure 3-8-2 Result of Financial Analysis

8.2 Economic Evaluation

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

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

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

8.2.1 Economic Costs

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

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

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

(2) Operating and Maintenance Costs

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

(3) Items of Transfer

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

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

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

8.2.2 Economic Parameters

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

(1) Foreign Exchange Premium

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

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

Where,

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

Each value of the above parameters to obtain SCF and the result of calculation are summarised in Table 3-8-14.

Table 3-8-14 Foreign Exchange Premium

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

(2) National parameters

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

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

* : estimated by study team

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

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

8.2.3 Economic Evaluation

(1) Determination of Economic Direct Benefit

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

Table 3-8-15 Telephone call charges from 1983 to 1993

Unit : US$

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

It is evident that charges quoted in Sri Lankan Rs are increasing each year. However, when they are converted into US dollars, as indicated in Table 3-8-15, it is clear that the charges are actually decreasing gradually. The highest charge with long distance call charge prices was recorded in 1991, at US$0.07 per call. Subscribers paid charges under this charge system. This means that subscribers understood that the value of a call was US$0.07. As of April 1993, the charge is priced at US$0.036 per call. This does not mean that the value of the call is declined, but is rather a cosmetic drop in value resulting from exchange rate fluctuations.

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

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

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

The total economic benefits are summarised as shown in Table 3-8-16.

Table 3-8-16 Benefit streams

Year	*Total Benefit Streams (US$ 1,000)*
2001	7,656
2002	8,471
2003	9,185
2004	9,930
2005	10,642
2010	10,642
2015	10,642

(2) Economic Cost Streams

The total investment and O&M costs in each project year summarized in Table 3-8-15 for Economic Analysis. The costs are converted into the economic cost using value of national parameter (Shadow premium)

Table 3-8-17 Total Economic Project Cost in each project year

Unit : US$ 000

Year	Total Investment
1996	322
1997	322
1998	6,457
1999	12,271
2000	12,915

Table 3-8-18 Total Economic O&M Cost

Unit : US$ '000

Year	Staff Costs	Other Costs	D.Insurance	Total O&M cost
2001	206	597	Trans.	803
2002	206	658	Trans.	864
2003	206	711	Trans.	918
2004	206	767	Trans.	973
2005	206	820	Trans.	1,026
2010	206	817	Trans.	1,023
2015	206	814	Trans.	1,020

D.Insurance : Damage Insurance

Trans. : Transfer items

(3) Assessment of Result of Economic Analysis

EIRR during the economic life span for the Base cases are calculated using the economic benefit and costs. EIRR, the measures to assess the economic viability, are summarised as shown in Table 3-8-19.

Table 3-8-19 Economic Cash Flow

Unit : US$ 1000

Year (FY)	Economic Benefit	Investment	Operating Expenses	Economic Cash Flow
1996	0	322	0	-322
1997	0	322	0	-322
1998	0	6,457	0	-6,457
1999	0	12,271	0	-12,271
2000	0	12,915	0	-12,915
2001	7,656	0	803	6,853
2002	8,471	0	864	7,607
2003	9,185	0	918	8,268
2004	9,930	0	973	8,957
2005	10,642	0	1,026	9,616
2006	10,642	0	1,026	9,616
2007	10,642	0	1,025	9,617
2008	10,642	0	1,024	9,618
2009	10,642	0	1,023	9,619
2010	10,642	0	1,023	9,619
2015	10,642	0	1,020	9,622
TOTAL	152,308	32,287	14,813	105,208

Net Present value (Discount rate 20%) for Central Ring Fibre Optic Transmission Project

Cost (C)	:	US$ 17,914,000
Benefit (B)	:	US$ 17,108,000
B - C	:	US$ 806,000
B / C	:	1.05
EIRR	***:***	***20.98%***
FIRROI	***:***	***16.41%***

The EIRR for the project based on incremental cash flows as a result of the project has been calculated at ***20.98 percent***. The project is expected to benefit the economy through higher economic activity, due to improved telecommunications facilities, which are difficult to quantify. In previous telecommunications projects world-wide, economic returns have been relatively high under conservative assumptions for consumer surplus and with no account taken of external benefits. Moreover , ***the Project benefits have been distributed widely, with significant shares being realised by rural and other low-income communities ; if GOSL are weighted for social objectives, EIRR would, therefore, exceed those calculated. This project is expected to realise a similar EIRR.***

9. Conclusion and Recommendations

9.1 Technical Aspect

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

According to the study on telecommunications development of Sri Lanka about 1,112,000 DELs including WLL DELs are expected in the whole country in the year 2005. Majority of these DELs will fall under the Central region. With the rapid increase of DELs, present trunk circuit capacity will be short soon. Besides the shortage of capacity in the number of circuits, it is desirable to take measures for higher reliability of telecommunications network, including circuit redundancy.

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

a) Transmission capacity expansion to meet the traffic to be originated by the subscribers in 2005.

Based on the feasibility, Study Team recommends SLT to expand its telecommunications capacity by the year 2000, in Central region as follows:

a) Trunk Transmission system;

- Fibre optic cable transmission system: 620 km length;
- STM-16 system: 1 system;
- STM-4 system: 2 systems

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

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

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

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

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

e) To pay special attention to the direct cable buried section, which impairment cause the permanent obstruct of the system, even though self-healing function will establish the link in alternative routes and so network can work properly.

9.2 Financial Aspect

As a population increases in targeted area, so will the number of telecom subscribers. If no measures are taken to adress this phenomenon, however the resulting rapid increase in telephone traffic from the targeted area will inevitably lead to a shortage of trunk transmission capacity. Once such a situation develops, no telecommunication s program claiming time saving as its raison d'être could be effective. Certain preventive measures must thus be taken in advance.

There will be a fund surplus throughout the life of the project. There is thus no need for a bridging finance, which is necessary during periods where there is a fund shortage. ***No cash flow problems will arise.*** The payout period for the capital of ***US$18,369,160*** required in the initial investment (Equity portion) is ***9.92 years***. A cash flow of ***US$25,311,000*** is yielded throughout the operating period, with ***FIRROI at 16.41% and FIRROE at 8.49%.*** These IRR values suggest that the project will stand financially feasible coupled with the high returns assumed that the project can be operated without financial difficulty. This FIRROE is attained because the equity accounts for 47.1% of total Investment Costs and anticipated sales revenues are sufficient to maintain the stable operation.

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

The EIRR for the project based on incremental cash flows as a result of the project has been calculated at *20.98 percent*. The project is expected to benefit the economy through higher economic activity, due to improved telecommunications facilities, which are difficult to quantify. In previous telecommunications projects world-wide, economic returns have been relatively high under conservative assumptions for consumer surplus and with no account taken of external benefits. Moreover , *the Project benefits have been distributed widely, with significant shares being realised by rural and other low-income communities ; if GOSL are weighted for social objectives, EIRR would, therefore, exceed those calculated. This project is expected to realise a similar EIRR.*

Launching of this project is considered promising, especially if the project is undertaken with the help of a ODA funds. Implementation is likely to contribute to enhancement of economic development and improvement of social welfare of Sri Lankan people.