Telephone exchanges, transmission links and subscriber networks will be expanded in proportion to the increase in DEL capacity. Other telecommunications facilities, including software for the telecommunications network, should also be expanded or newly provided in due time, to offer various services listed in Table 7-1-1.

2. Telephone switching system

2.1 Telephone switching system introduction policy

Telephone switching system will be introduced under the following policies in principle. In this paragraph, the word "switching system" is used as defined in CCITT Rec. Q.9 and used as an element to form an exchange.

The switching system demarcation by size applied hereto is in line with the guidelines of SLT and close to the actual situation found in SLT network. This switching system demarcation by size is for building up the telephone network plan, which should be reviewed and decided in consideration of price and performance on the occasion of purchase.

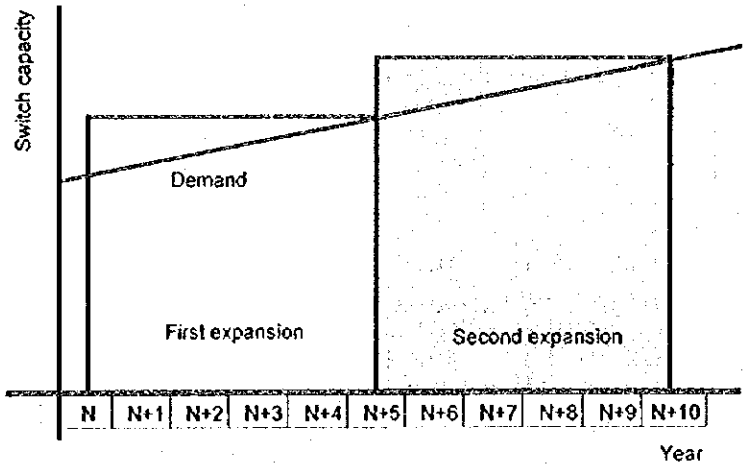
(Local exchange)

a) The telephone switching systems to be introduced under this Master Plan should be of digital type compatible with Integrated Services Digital Network (ISDN).

b) The telephone switching systems will be introduced or expanded to meet duly the demand forecast in Chapter 6. The capacity of the switching system will be designed to meet the demand increase for five (5) years after installation and its expansion project is planned every five (5) years. See Figure 9-2-1.

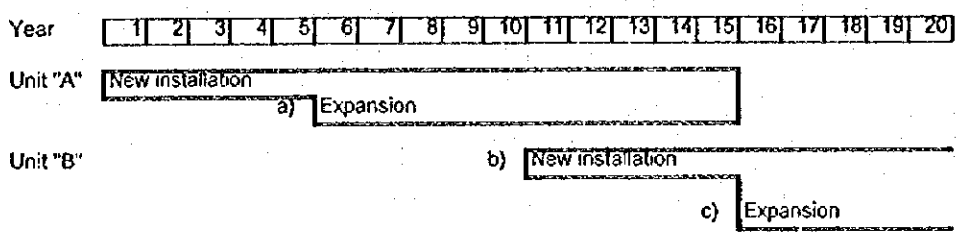
c) A new unit of switching system will be introduced where the existing switching system has a life less than 10 years. The switching system life is assumed to be 15 years after commission. See Figure 9-2-2. Commissioning year of each switching system is based on data indicated by SLT. However, in the case where the commissioning year of a switching system is not indicated, the replacement time of the switching system is planned referring to the introduction years of such model. NEAX-61E switching systems and 5-ESS switching systems were introduced in early 1990s, DX-210/220 switching systems in late 1980s,

NEAX-61K switching systems in early 1980s, cross-bar type switching systems in early 1970s, and SXS and manual switching systems before 1970. E-10B switching systems of early version were introduced in early 1980s and those of latest version in early 1990s.



Source: JICA Study team.

Figure 9-2-1 Demand Increase and Switching System Capacity



a) Project is planned every 5 years.
b) A new unit of switching system is planned where the existing one has a life less than 10 year
c) Unit "B" is expanded to meet demand increase and succeed Unit "A".
Unit "A" is discarded after 15 years of service.

Source: JICA Study team.

Figure 9-2-2 Switching System Life

d) The telephone switching system will be introduced where telephone demand is forecast 100 or more, according to the system selection guideline indicated in Figure 8-9-1. In the case where the telephone demand is less than 100 in subscriber lines, the telephone traffic is converged to SSC by an adequate way.

e) The telephone switching systems the capacity of which is forecast less than 3,000 are planned as of remotely controlled exchange type in principle and the rest are planned as of main exchange type.

f) Additional new telephone switching unit will be introduced where the telephone demand is forecast more than 30,000 subscriber lines for security reason.

(Tandem switch, SSC, TSC, NSC, ISC)

g) A tandem switch (TDM) will be introduced into Colombo area, in addition to the existing TDM situated at Havelock. While the existing Havelock TDM will converge the traffic to/from exchanges with R2(D) and TUP Plus signalling systems, the new TDM will converge the traffic to/from new exchanges to be provided with CCITT CCS No. 7 ISUP signalling system. The new TDM will be situated at Central Exchange.

h) Attention is paid to co-locate two (2) units of switching systems as many cases at transit exchanges as possible, in case of failure, taking opportunity of exchange expansion.

i) SSC is planned as transit-local combined exchange, except that in the Colombo area, in consideration of the fact that the total of demand in subscriber line number and the number of inter-exchange trunk circuits remains in the capacity of ordinary combined switching system, though Jaffna and Kandy must be catered by two units. See Table 9-2-1.

j) A new transit switching system will be introduced to establish a new TSC in Negombo in 1999 for providing a safer telephone network, in case of failure in Colombo TSC. Colombo TSC and Negombo TSC shall have sufficient inter-exchange trunk circuits, at the same time respectively, so that the network can maintain services though the grade of service goes down for some extent, even in the case one of them fails. They shall be equipped with approximately 75% of required inter-exchange trunk circuits, respectively (150% in total, of required capacity for normal case), in consideration of an increased traffic level beyond normal planned activity levels presented in CCITT Rec. Q.543.

Table 9-2-1 Required Exchange Capacity and Inter-exchange Trunk Circuits of SSCs

Year	2000	2005	2015	2000	2005	2015
SSC	Subscriber line capacity required			Inter-exchange circuits required		
Ampara	1,445	1,881	2,753	510	630	840
Anuradhapura	6,416	7,654	10,130	1,110	1,260	1,620
Awissawella	3,258	4,406	6,702	1,050	1,320	1,740
Badulla	4,062	4,909	6,603	1,050	1,230	1,500
Bandarawela	3,955	4,780	6,430	780	870	990
Batticaloa	5,065	6,738	10,084	1,080	1,230	1,710
Chilaw	3,347	4,292	6,182	1,110	1,410	1,800
Colombo SSC area	523,638	768,617	1,258,575	59,190	75,720	119,480
Galle	11,915	15,724	23,342	2,100	2,640	3,810
Gampaha	16,435	22,535	34,735	3,360	4,410	6,450
Hambantota	1,397	1,797	2,597	1,290	1,590	2,190
Hatton	2,012	2,406	3,194	450	510	630
Jaffna	22,287	29,685	44,481	2,610	3,450	5,100
Kalmune	5,745	7,557	11,181	1,020	1,200	1,770
Kalutara	6,377	8,621	13,109	2,880	3,750	5,490
Kandy	22,100	29,303	43,709	4,260	5,430	7,860
Kegalle	5,023	6,750	10,204	1,290	1,650	2,280
Kurunegala	11,258	14,668	21,488	2,310	2,820	4,170
Mannar	887	1,136	1,634	390	390	510
Matale	5,352	6,479	8,733	870	990	1,320
Matara	12,735	16,788	24,894	1,860	2,310	3,390
Nawalapitiya	1,458	1,933	2,883	390	450	510
Negombo	14,841	20,350	31,368	2,430	3,120	4,560
Nuwara eliya	3,873	4,633	6,153	690	810	930
Polonnaruwa	2,347	2,881	3,949	690	780	1,110
Ratnapura	7,180	9,575	14,365	1,350	1,650	2,490
Trincomalee	5,773	7,550	11,104	750	930	1,320
Vavuniya	3,242	4,137	5,927	630	750	870
National total	713,423	1,017,785	1,626,509	97,500	123,300	186,440

Source: JICA Study team.

k) A new switching system will be introduced into Negombo in 1999 to establish a new ISC to share the international telephone traffic with the existing ISC situated in Colombo. Sri Lanka will have two (2) units of international gate switches equipped with CCITT CCS ISUP signalling system and one unit of international gate switch not equipped with such signalling system. The allocation of a new ISC in Negombo will be effective for providing a safer international telecommunications network for Sri Lanka as it is completely concentrated in Colombo at present.

2.2 Exchange functions

The exchanges to be provided under this Master Plan should be digital exchanges which are in line with CCITT Rec. Q.500 series for making up an ISDN in Sri Lanka. Details should be stipulated on the occasion of purchase.

The switching systems to be provided under this Master Plan and applied to Tandem Switch, SSC, TSC, NSC, and ISC should be equipped with CCITT CCS No. 7 TUP and ISUP.

2.3 Telephone switching system capacity to be provided

2.3.1 Local Exchange Capacity

The existing local exchange capacity is supposed to increase up to approximately 619,000 in the year 1997, according to on-going projects as of April 1995. The local exchange capacity to be provided during this Master Plan period is calculated based on the telephone switching system introduction policy stated in Paragraph 2.1. It will be increased up to approximately 1,924,000 in the year 2015. Table 9-2-2 shows local exchange capacity of each SSC area by phases.

For the details on local exchange installation plan refer to Exchange Facilities Plan in DATA BOOK, VOL. V.

Table 9-2-2 Local Exchange Capacity Plan (by SSC area)

SSC	Capacity	New installation (in lines)			Removal (in lines)			Accumulated capacity (in lines)		
	1997	2000	2005	2015	2000	2005	2015	2000	2005	2015
Ampara	3,644	0	618	6,073	0	0	4,262	3,644	4,262	6,073
Anuradhapura	6,686	4,627	4,987	12,683	256	2,928	8,151	11,057	13,116	17,648
Awissawella	5,676	4,111	5,254	15,094	100	1,880	7,866	9,687	13,061	20,289
Badulla	7,088	2,359	5,013	10,705	228	3,078	6,359	9,219	11,154	15,500
Bandarawela	3,844	2,561	3,147	6,882	104	1,852	4,020	6,301	7,596	10,458
Batticaloa	7,190	2,465	3,078	17,604	0	0	11,060	9,661	12,739	19,277
Chilaw	8,470	2,358	3,700	17,924	0	1,448	10,843	10,828	13,086	20,167
Colombo	332,067	204,811	233,427	987,864	13,240	33,850	574,608	523,638	723,215	1,136,47
Galle	20,385	4,858	4,744	39,917	0	1,092	24,151	25,243	28,895	44,661
Gampaha	14,584	24,107	15,724	71,512	0	100	38,591	38,691	54,315	87,236
Hambantota	8,414	2,821	7,997	13,858	0	4,956	6,340	11,235	14,276	21,788
Hatton	3,770	317	63	4,344	104	0	3,832	3,983	4,046	4,558
Jaffna	0	32,459	11,006	66,806	0	0	43,257	32,459	43,465	67,014
Kalmune	6,524	2,745	3,259	15,577	0	0	8,551	9,269	12,528	19,554
Kalutara	45,990	582	5,700	66,894	256	1,520	48,970	46,316	50,496	68,414
Kandy	53,209	0	8,216	89,447	0	0	53,773	53,209	61,425	97,099
Kegalle	6,424	6,787	7,826	20,413	0	3,236	10,379	13,211	17,801	27,835
Kurunegala	15,286	9,473	12,186	37,287	0	4,456	20,683	24,759	32,489	49,093
Mannar	1,400	537	218	2,932	0	0	1,987	1,937	2,155	3,100
Matale	10,199	205	768	12,811	0	452	9,625	10,404	10,720	13,906
Matara	17,297	1,429	7,149	30,840	0	0	16,833	18,726	25,875	39,882
Nawalapitiya	1,874	0	594	2,997	0	0	1,918	1,874	2,468	3,547
Negombo	13,280	15,639	14,207	45,937	0	3,704	23,369	28,919	39,422	61,990
Nuwara eliya	3,348	4,237	1,504	8,433	2,033	400	5,884	5,552	6,656	9,205
Polonnaruwa	5,450	0	534	8,548	0	0	5,984	5,450	5,984	8,548
Ratnapura	10,134	2,808	8,221	18,605	0	3,402	8,393	12,942	17,761	27,973
Trincomalee	5,056	2,518	3,186	11,816	132	1,087	7,255	7,442	9,541	14,103
Vavuniya	2,692	1,366	1,391	4,668	0	0	1,930	4,058	5,449	8,187
National tota	619,987	336,180	373,723	1,648,471	16,453	69,448	968,892	939,714	1,243,996	1,923,57

Source: JICA Study team.

2.2.2 Tandem, SSC, TSC, NSC and ISC Capacity

The capacity of tandem switches, SSCs, TSCs, NSC and ISC is calculated based on the circuit calculation result discussed in Paragraph 5, Chapter 8. Table 9-2-3 shows the tandem switch capacity to be provided. Table 9-2-4 shows the inter-exchange circuit capacity of SSC, TSC and NSC to be provided. Table 9-2-5 shows ISC capacity to be provided.

Table 9-2-3 Tandem Switch Capacity

	1995	2000	2005	2015
Central	0	42,510	50,820	32,000
Havelock	7,740	7,740	7,740	0

Source: JICA Study team.

Table 9-2-6 shows NSC and TSC expansion plan to fulfil the required capacity shown in Table 9-2-4. Expansion of inter-exchange circuits of SSC will be don as part of transit-local combined exchange expansion listed in Exchange Facilities Plan in DATA BOOK, VOL V. Table 9-2-7 shows ISC expansion plan to fulfil the required capacity shown in Table 9-2-5.

Table 9-2-4 Trunk Circuit Capacity of SSC, TSC and NSC

Centres		Code	2000	2005	2015
SSC	Awissawella	AW	1,050	1,320	1,740
	Colombo	CO	59,190	75,720	119,480
	Chilaw	CW	1,110	1,410	1,800
	Gampaha	GQ	3,360	4,410	6,450
	Kegalle	KE	1,290	1,650	2,280
	Kurunegala	KG	2,310	2,820	4,170
	Kalutara	KT	2,880	3,750	5,490
	Negombo	NE	2,430	3,120	4,560
	Anuradhapura	ANU	1,110	1,260	1,620
	Jaffna	JA	2,610	3,450	5,100
	Mannar	MR	390	390	510
	Polonnaruwa	PR	690	780	1,110
	Trincomalee	TC	750	930	1,320
	Vavunia	VU	630	750	870
	Galle	GL	2,100	2,640	3,810
	Hambantota	HB	1,290	1,590	2,190
	Matara	MH	1,860	2,310	3,390
	Ratnapura	RN	1,350	1,650	2,490
	Ampara	AP	510	630	840
	Batticaloa	BC	1,080	1,230	1,710
	Badulla	BD	1,050	1,230	1,500
	Bandarawela	BW	780	870	990
	Hatton	HT	450	510	630
	Kalmune	KL	1,020	1,200	1,770
	Kandy	KY	4,260	5,430	7,860
	Matale	MT	870	990	1,320
	Nawalapitiya	NT	390	450	510
	Nuwara Eliya	NW	690	810	930
	SSC Total		***97,500***	***123,300***	***186,440***
TSC	Colombo TSC	XC	3,780	3,780	4,120
	New TSC	XN	3,780	3,780	4,120
	Anuradhapura TSC	XA	3,780	4,110	4,350
	Galle TSC	XG	2,640	2,880	2,970
	Kandy TSC	XK	5,880	6,360	6,540
	TSC Total		***19,860***	***20,910***	***22,100***
NSC	***NSC***	***YY***	***3,960***	***5,310***	***7,680***
National total			***121,320***	***149,520***	***216,220***

Source: JICA Study team.

Table 9-2-5 ISC Capacity

	1995	2000	2005	2015
Domestic	3,400	3,720	4,920	7,410
International	3,060	3,450	4,610	7,010
Total	6,800	7,170	9,530	14,420

Source: JICA Study team.

Table 9-2-6 NSC and TSC Expansion Plan

	Area	Unit	2000	2005	2015
NSC		A (5-ESS)	1,960	1,960	Replaced
		B (N-61)	Replaced	---	---
		C (New-1)	2,000	3,350	Replaced
		D (New-2)	---	---	3,800
		E (New-3)	---	---	3,880
	Increase		*2,000*	*1,350*	*7,680*
	Removal		*100*	*0*	*5,310*
TSC	Colombo	A (5-ESS)	3,780	3,780	Replaced
		B (N-61)	Replaced	---	---
		C (New-1)	---	---	4,120
	New	A (New)	3,780	3,780	Replaced
		B (New)	---	---	4,120
	Kandy	A (N-61K)	Replaced	---	---
		B (New)	5,880	6,360	Replaced
		C (SSC)	---	---	180
		D (New)	---	---	6,360
	Galle	A (SSC)	3,510	3,510	---
		B (New)	---	---	2,970
	Anuradhapura	A (N-61E)	720	720	Replaced
		B (New)	3,060	3,390	Replaced
		C (SSC)	---	---	240
		D (New)	---	---	4,110
	Increase		*12,720*	*810*	*22,100*
	Removal		*2,170*	*0*	*21,540*

Source: JICA Study team.

Table 9-2-7 ISC Expansion Plan

			2000	2005	2015
ISC	Domestic				
		Required	3,720	4,920	7,410
	Colombo	A (5-ESS)	600	600	Replaced
		B (N-61)	2,200	2,200	Replaced
		C (New)	---	---	4,000
	New	D (New)	920	2,120	Replaced
		E (New)	---	---	3,410
	Increase	---	*920*	*1,200*	*7,410*
	Removal	---	*0*	*0*	*4,920*
	International				
		Required	3,450	4,610	7,010
	Colombo	A (5-ESS)	540	540	
		B (N-61)	1,980	1,980	Replaced by C
		C (New)	---	---	3,600
	New	D (New)	930	2,090	Replaced by E
		E (New)	---	---	3,410
	Increase	---	*930*	*1,160*	*7,010*
	Removal	---	*0*	*0*	*4,610*

Source: JICA Study team.

Table 9-2-8 Transit Switches in Colombo/Negombo by Unit

	2000				2005				2015			
Switching Centre	NSC	TSC	SSC	TDM	NSC	TSC	SSC	TDM	NSC	TSC	SSC	TDM
Required	*3,960*	*5,040*	*59,190*	*50,250*	*5,310*	*4,980*	*75,720*	*58,560*	*7,680*	*5,490*	*119,480*	*32,000*
NSC-A (5-ESS)	1,960	3,780	3,260		1,960	3,780	3,260		Replaced	Replaced	Replaced	
NSC-B (N-61)	Replcd											
NSC-C (New-1)	2,000				3,350				Replaced			
NSC-D (New-2)									3,800			
NSC-E (New-3)									3,880			
TSC (New-A)		3,780				3,780				Replaced		
TSC (Colombo-A)										4,120	26,000	
TSC (New-B)										4,120		
SSC (Colombo-A)			29,930				29,930				Replaced	
SSC (Colombo-B)			26,000				26,000				Replaced	
SSC (Colombo-C)							16,530	8,310			16,530	8,310
SSC (Colombo-D)											26,000	
SSC (Colombo-E)											30,000	
SSC (Colombo-F)											20,950	
TDM (Central-A)				30,000				30,000				Replaced
TDM (Central-B)				12,510				12,510				Replaced
TDM (Central-C)												23,690
TDM (Havelock)				7,740				7,740				Replaced
Total	3,960	7,560	59,190	50,250	5,310	7,560	75,720	58,560	7,680	8,240	119,480	32,000

Note: This table is a breakdown of NSC and TSC in Colombo/Negombo of Table 9-2-6, which is presented together with details of SSC and TDM in Colombo.

Source: JICA Study team.

2.2.3 ISDN Switching Centre Capacity

ISDN Centres will be introduced into Colombo in 1999, in Kandy in 2004, and in Galle and Anuradhapura in 2014. Table 9-2-9 shows a proposed capacity plan. The relation ship between ISDN Centre and service areas are illustrated in Figure 8-4-9 to Figure 8-4-11.

Table 9-2-9 ISDN Centre Capacity

	2000	2005	2015
Colombo	2,500	4,500	8,000
Kandy	0	500	700
Galle	0	0	200
Anuradhapura	0	0	100
National total	2,500	5,000	9,000

Source: JICA Study team.

3. Transmission System

Transmission facility plan is categorised in 4 (four) portions such as National Backbone System, Local Transmission System, International Trunk Transmission System and Colombo Multi-Exchange Area Junction Network. Based on the results of traffic and circuit calculation, following facility plans were drawn up.

3.1 National Backbone System

To meet the traffic growth in association with increase of subscribers, national backbone transmission system should be expanded rapidly in capacity. Newly constructed trunk transmission network should be expanded continuously, and new SDH transmission network should be prepared in early stage.

Proposed future backbone transmission projects up to 2015 are as follows:

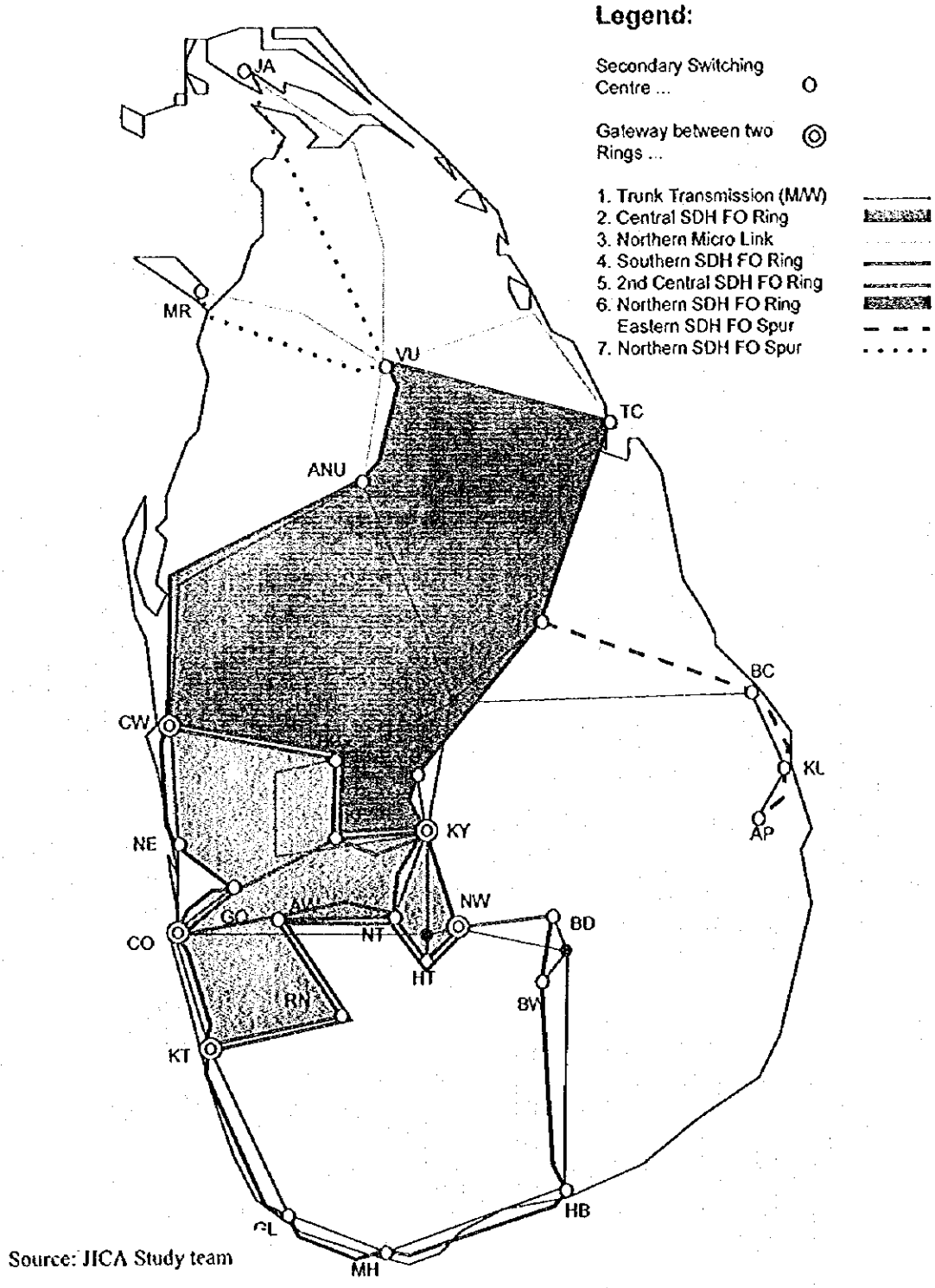
1. Expansion of Trunk Transmission Network;
2. Central SDH FO Ring;
3. Northern Micro Link;
4. Southern SDH FO Ring;
5. 2nd Central SDH FO Ring;
6. Northern SDH FO Ring and Eastern SDH FO Spur; and
7. Northern SDH FO Spur.

These networks are illustrated in Figure 9-3-1 and the proposed implementation schedule is shown in Table 9-3-1 below. Summary table is in Supporting.

Table 9-3-1 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: JICA Study Team.



Source: JICA Study team

Figure 9-3-1 Future National Transmission Network Plan

3.1.1 Expansion of Trunk Transmission Network

This project aims the expansion of newly constructed 140M trunk transmission network (ADB Transmission N/W). Large increase of the number of subscribers will require larger capacity of trunk transmission network. CO-ANU-KY link and CO-GL-HB-NW link should be expanded enough to cover the national network with Central SDH FO Ring.

Table 9-3-2 Trunk Transmission Expansion

No.	M/W Link	Existing System (1995)	Expanded System (1998)
1	CO-BenachiHill-HT	140M x 1	<-
2	C-BenachiHill-Hantana-KY	140M x 1	<-
3	Hantana-NT	140M x 1	<-
4	CO-KT-Pathirajakanda-GL-MH-HB-NW-BenachiHill-Hantana	140M x 1	140M x 3
5	CO-KT	140M x 1	Utilise for 4
6	Pathirajakanda-GL	140M x 1	Utilise for 4
7	CO-NE-Katunayake	140M x 1	<-
8	CO-NE-CW-ANU-Kirimathiyakanda-KG-Kandalama-Hantana-KY	140M x 1	140M x 2 (3)
9	Kirimethiyakanda-PO	140M x 1	<-
10	KY-Hantana-Kirimethiyakanda-BC-KL-AP	140M x 1	<-
11	KY-MT	None	140M x 1
12	Namunukura-BD	None	140M x 1
13	Namunukura-BW	None	140M x 1

Source: SLT.

3.1.2 Central SDH FO Ring

SDH FO Ring with STM-16 connects CO, GQ, NE, CW, KG, KE, KY, NW, HT, NT, AW, RN and KT in this order. This ring includes all SSCs in Colombo TSC area and Kandy, 2nd largest town. This ring meets the huge amount of the route traffic. This STM-16 ring has self-healing function and a transmission capacity of 1,008 systems of 2M bps stream. The routes of FO cable laying will be along the major roads and railways.

3.1.3 Northern Micro Link

This microwave network project aims quick rehabilitation of northern transmission network. Microwave radio system has an advantage in the construction period. Also road condition is not affected.

Transmission link and capacities included in this project are as follows;

ANU-Rep.-VU-Rep.-Rep.-JA:	140M x 2
VU-Rep.-TC:	140M x 1
VU-Rep.-MR:	34M x 2 (or 140M x 1)

3.1.4 Southern SDH FO Ring

To meet the growing traffic demand that will exceed the transmission capacity of the microwave link in the southern area, new FO ring will be established. This ring capacity will be STM-4 which has transmission capacity of 252 systems of 2M bps stream. Access points of the ring are KT, GL, MH, HB, BW, BD and NW. FO link between NW and KT are prepared in the previous Central SDH FO Ring Project.

3.1.5 2nd Central SDH FO Ring

This ring with STM-16 capacity (1,008 systems of 2M bps stream) connects CO, GQ, KE, KY, NT and AW in this order. This ring will take-over traffic among these 5 stations, and reduce the burden of the previous Central SDH FO Ring.

3.1.6 Northern SDH FO Ring and Eastern SDH FO Spur

The aim of this project is to replace aged microwave transmission link in North Central, North West and Eastern area with SDH FO Ring and FO spur. ANU, VU, TC, PR and MT will be connected with STM-4 ring. PR-BC-KL-AP FO spur link will be constructed at the same time.

3.1.7 Northern SDH FO Spur

JA, MR, VU and TC will be connected to already constructed national SDH ring network. Replacement of the former microwave system will be done after depreciation time of 12.5 years. This will complete the whole FO national transmission network.

3.2 Local Transmission System

Local transmission system within each SSC area except Colombo multi-exchange area is required to be expanded. Required transmission capacities of each SSC - LE link are summarised below. Detail information is shown in Supporting.

Table 9-3-3 Required 2M Systems in Each SSC except Colombo

No.	SSC	No. of SSC-LE Links	Required 2M Sys. in		
			Y 2000	Y 2005	Y 2015
1	Ampara	8	14	14	23
2	Anuradhapura	13	29	31	41
3	Awissawella	6	29	37	49
4	Badulla	11	30	35	45
5	Bandarawela	4	12	14	18
6	Batticaloa	4	21	28	36
7	Chilaw	14	39	48	59
8	Galle	11	53	67	87
9	Gampaha	13	98	121	175
10	Hambantota	15	53	64	87
11	Hatton	8	9	11	12
12	Jaffna	22	61	72	98
13	Kalmune	4	21	26	36
14	Kalutara	15	107	137	196
15	Kandy	20	122	152	210
16	Kegalle	7	37	48	62
17	Kurunegala	13	64	81	112
18	Mannar	11	14	15	16
19	Matale	13	23	25	35
20	Matara	17	49	57	76
21	Nawalapitiya	4	5	5	6
22	Negombo	9	90	117	169
23	Nuwara Eliya	8	13	14	19
24	Polonnaruwa	13	24	27	33
25	Ratnapura	8	33	39	60
26	Trincomalee	12	18	20	26
27	Vavunia	17	22	24	28
	Total	300	1090	1329	1814

Source: JICA Study Team.

3.3 International Trunk Transmission System

Required number of international circuits to/from each destination country is summarised as table bellow. Detail information is shown in previous Table 8-5-3.

Table 9-3-4 No. of International Circuits

	Y 2000	Y 2005	Y 2015
I.C. Circuit	2,284	3,056	4,656
O.G. Circuit	1,158	1,545	2,348
Total	3,442	4,601	7,004

Source: JICA Study team.

3.4 Colombo Multi-Exchange Area Junction Network

Table 9-3-5 shows Indicators of Colombo SSC area at present and future.

Table 9-3-5 Indicators of Colombo SSC Area

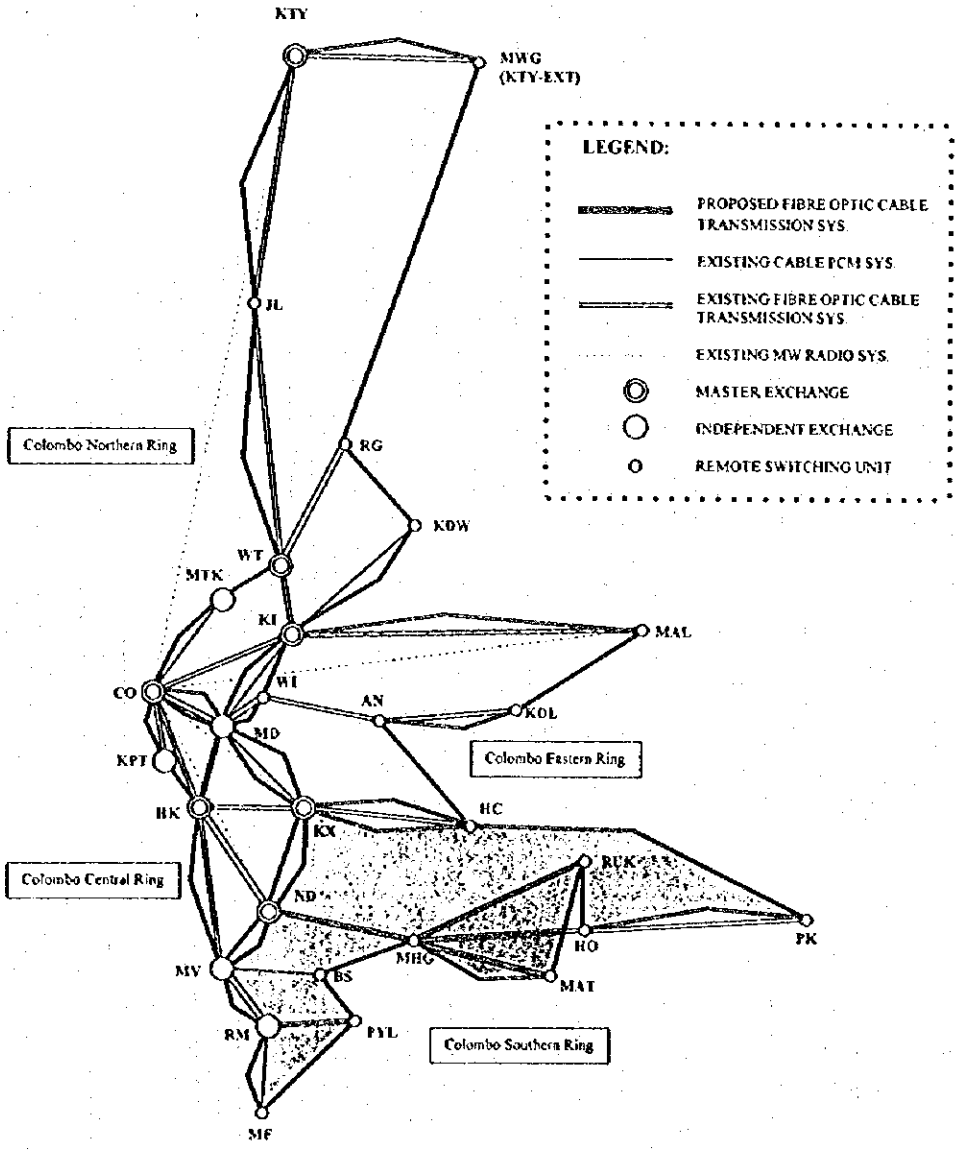
	Y-1994	Y-2000	Y-2005	Y-2010	Y-2015	Y-2020
No. of DELs	125,017	377,626	567,180	768,617	979,929	1,191,241
No. of Exchange units (MSU/RSU)	30		68	83		69
No. of 2M Sys. in Junction N/W	692		3,962	6,553		8,444

Source: JICA Study team.

Following rapid growth of number of subscribers in the area, traffic will be grown up significantly, so new transmission link of GCTNIP-II will be filled up and other fibre optic cable transmission systems will be required soon. Proposed new transmission networks are all of SDH FO ring as follows:

1. Greater Colombo Central SDH FO Ring (STM-16);
2. Greater Colombo Northern SDH FO Ring (STM-4);
3. Greater Colombo Eastern SDH FO Ring (STM-4); and
4. Greater Colombo Southern SDH FO Ring (STM-4).

Configurations of these transmission networks are shown in Figure 9-3-2. Colombo Central, Maradana, Kotte, Mt. Lavinia and Kelaniya will be the connecting points for the plural FO rings. Summary table is in Supporting.



Source: JICA Study team

Figure 9-3-2 Future Junction Network in Colombo Multi-Exchange Area

4. Subscriber Access Network Facilities

4.1 Quantitative Balance between Switching Capacity and Cable Loops

Expansion of subscriber access network tends to be delayed in comparison with that of switching equipment. For that reason, the quantitative imbalances between switching capacity and that of cable loop are found at many exchange areas. It is important not only to correct these existing imbalances but also not to make new imbalance in future. Further more, for maintaining telecommunication services in good condition, a project planning shall be considered always a total telecommunications system, (subscribers' facility, subscriber cable and civil work, local switching, junction, toll switch, trunk, building, power) in each project.

4.2 Replacement of Old Type or Damaged Facilities

It is planned to replace almost all lead sheathed or damaged cables by new cables in on-going projects. Therefore, after completion of on-going projects, it should be planned to replace the newly damaged cables and defective facilities between DP (distribution points) and subscribers, because of many faults in these facilities.

4.3 Expansion Plan of Subscriber Access Facilities

The installation plan of the subscriber network facility in this Master Plan is designed taking account of the following courses. As the result of the study, the increase of 1,761,380 cable pairs from 1999 to 2015 is required.

The expansion plan and the relation between demand and loops in each SSC area are shown in Table 9-4-1 and 9-4-2, respectively, and those in each exchange area are shown in Annex 6.

(1) The term for the installation in the whole Sri Lanka is from 1999 to 2015.

(2) The period of each installation work is less than two years in principle.

(3) The amount of the facility to be installed is equivalent to 1.3 times of the demand at five years later from the end of each installation work.

(4) For the balance of the quantity of the installation, the earliest completion of installation work in Colombo and Gampaha SSC areas is planned in 1999 and other areas in 2000.

(5) The installation works of the telephone switching system and subscriber access network facility is carried out at the same period as a rule.

(6) The specification edited by SLT for installation work is adopted in this installation work.

Table 9-4-1 Expansion Plan of External Plant (Cable Pair)

Year / SSC	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	Total
Ampara		760		510					840					840	870			3,820
Anuradhapura		3,690					2,160					2,720					2,720	11,290
Awissawella		4,610					3,600	730	140			3,790	770	150			3,790	17,580
Badulla		2,570		110			1,500		310	120		2,170		360	390		2,100	9,630
Bandarawela		2,570					1,540					1,800					1,850	7,760
Batticaloa		4,910		310			2,180		1,880			2,340		1,880			2,340	15,840
Chilaw		390				950	910			1,290		1,700			1,290		1,560	8,090
Colombo	330,940	6,580	2,860	270	23,650	206,440	18,440	7,740	7,730	23,580	203,890	19,250	7,740	7,730	23,580	203,890	19,240	1,113,550
Galle		15,760					5,130		4,890			4,890		4,890			4,890	40,450
Gampaha	36,630					18,450			2,000		18,850			2,000		18,820		96,750
Hambantota		3,970					3,130	1,120	330			3,400	1,130	250			3,400	16,730
Hatton		690					630					730					730	2,780
Jaffna		42,590					14,150					15,440					15,300	87,480
Kalmune		7,250		310			2,360	740	1,050			2,710	740	1,050			2,710	18,920
Kalutara		1,330		1,380		710		990	5,920	10,760			990	5,120	1,020	7,360		35,580
Kandy		4,940		2,640	10,120	3,600	500		8,540	9,520		820	2,720	9,130	9,520		820	62,870
Kegalle		6,170		310			5,660		280			6,150		280	120		6,150	25,120
Kurunegala		11,840	150		1,710		7,860	240	240	1,110		9,210	240	150	1,120		9,210	43,080
Mannar		2,130					290			260		520			260		310	3,770
Matale				30				100	80		1,550	190	120	190		1,530	150	3,940
Matara		6,320		440		5,240	1,290	940	520	300	5,460	1,450	1,190	520	420	5,460	1,420	30,970
Nawalapitiya		10										470			120		630	1,230
Negombo		13,130		140			13,120		640			13,930		740			13,940	55,640
Nuwara eliya							1,300		50			1,140		160	40		1,150	3,840
Polonnaruwa		320		440					820			130		1,140				2,850
Ratnapura		5,770		320		1,100	3,120	1,360	530	450	960	3,430	1,190	530	420	960	3,430	23,570
Trincomalee		2,570					2,970	80	60			3,190	100	60			3,150	12,180
Vavuniya		2,210					490	1,020	60			650	1,050	60			530	6,070
National Total	367,570	153,080	3,010	7,210	35,480	236,490	92,330	15,060	36,910	47,390	230,710	102,220	17,980	37,230	39,170	238,020	101,520	1,761,380

Table 9-4-2 Relation between Demand and Loops (Cable Pair)

(1/2)

SSC	Year	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
Ampara	Demand x 1.3	2,565	2,725	2,929	3,132	3,348	3,609	3,869	4,150	4,419	4,677	5,006	5,291	5,578	5,810	6,128	6,429	6,735	7,062	7,409
	Increase				760		510					840					840	870		
	Loops	4,650	4,650	4,650	5,410	5,410	5,920	5,920	5,920	5,920	5,920	6,760	6,760	6,760	6,760	6,760	7,600	8,470	8,470	8,470
Anuradhapura	Demand x 1.3	10,078	10,555	11,011	11,526	12,051	12,574	13,106	13,690	14,212	14,734	15,302	15,835	16,426	16,955	17,506	18,092	18,685	19,336	19,981
	Increase				3,690					2,160					2,720					2,720
	Loops	12,220	12,220	12,220	15,910	15,910	15,910	15,910	15,910	18,070	18,070	18,070	18,070	18,070	20,790	20,790	20,790	20,790	20,790	23,510
Awissawella	Demand x 1.3	7,185	7,722	8,304	8,962	9,588	10,451	11,288	12,173	13,031	13,941	14,899	15,794	16,732	17,557	18,429	19,352	20,310	21,328	22,374
	Increase				4,610					3,600	730	140			3,790	770	150			3,790
	Loops	8,770	8,770	8,770	13,380	13,380	13,380	13,380	13,380	16,980	17,710	17,850	17,850	17,850	21,640	22,410	22,560	22,560	22,560	26,350
Badulla	Demand x 1.3	8,268	8,681	9,105	9,541	10,050	10,542	11,068	11,609	12,113	12,636	13,178	13,711	14,261	14,763	15,323	15,854	16,437	17,057	17,663
	Increase				2,570		110			1,500		310	120		2,170		360	390		2,100
	Loops	10,660	10,660	10,660	13,230	13,230	13,340	13,340	13,340	14,840	14,840	15,150	15,270	15,270	17,440	17,440	17,800	18,190	18,190	20,290
Bandarawela	Demand x 1.3	5,704	5,975	6,248	6,546	6,869	7,180	7,526	7,866	8,191	8,520	8,862	9,203	9,547	9,875	10,222	10,577	10,942	11,346	11,735
	Increase				2,570					1,540					1,800					1,850
	Loops	5,900	5,900	5,900	8,470	8,470	8,470	8,470	8,470	10,010	10,010	10,010	10,010	10,010	11,810	11,810	11,810	11,810	11,810	13,660
Batticaloa	Demand x 1.3	7,444	7,979	8,537	9,160	9,837	10,586	11,371	12,211	12,988	13,862	14,750	15,577	16,461	17,278	18,106	18,994	19,898	20,870	21,860
	Increase				4,910		310			2,160		1,880			2,340		1,880			2,340
	Loops	9,300	9,300	9,300	14,210	14,210	14,520	14,520	14,520	16,700	16,700	16,580	16,580	16,580	20,920	20,920	22,800	22,800	22,800	25,140
Chilaw	Demand x 1.3	8,259	8,793	9,360	10,026	10,719	11,473	12,271	13,100	13,928	14,765	15,668	16,530	17,432	18,227	19,068	19,963	20,907	21,856	22,884
	Increase				390				950	910			1,290		1,700			1,290		1,550
	Loops	21,736	21,736	21,736	22,126	22,126	22,126	22,126	23,076	23,986	23,986	23,986	25,276	25,276	26,976	26,976	26,976	28,266	28,266	29,826
Colombo	Demand x 1.3	398,086	429,300	463,169	500,906	542,877	587,239	635,816	687,551	737,334	790,204	845,819	897,819	952,011	999,202	1,049,178	1,101,663	1,156,331	1,213,976	1,273,908
	Increase			330,940	6,580	2,860	270	23,650	206,440	18,440	7,740	7,730	23,580	203,890	19,250	7,740	7,730	23,580	203,890	19,240
	Loops	353,540	353,540	684,480	691,060	693,920	694,190	717,840	924,280	942,720	950,460	958,190	981,770	1,185,660	1,204,910	1,212,650	1,220,380	1,243,960	1,447,850	1,467,090
Galle	Demand x 1.3	17,802	19,053	20,345	21,780	23,410	25,054	26,915	28,803	30,658	32,638	34,701	36,626	38,661	40,459	42,380	44,379	46,471	48,692	50,994
	Increase				15,760					5,130		4,890			4,890		4,890			4,890
	Loops	18,550	18,550	18,550	34,310	34,310	34,310	34,310	34,310	39,440	39,440	44,330	44,330	44,330	49,220	49,220	54,110	54,110	54,110	59,000
Gampaha	Demand x 1.3	29,024	31,343	33,907	36,792	39,969	43,378	47,121	51,098	54,952	59,040	63,365	67,401	71,603	75,346	79,311	83,483	87,845	92,460	97,256
	Increase			36,630					18,450			2,000		18,850			2,000		18,820	
	Loops	15,816	15,816	52,446	52,446	52,446	52,446	52,446	70,896	70,896	70,896	72,896	72,896	91,746	91,746	91,746	93,746	93,746	112,566	112,566
Hambantota	Demand x 1.3	9,260	9,809	10,446	11,122	11,861	12,650	13,477	14,362	15,215	16,107	17,040	17,948	18,892	19,704	20,599	21,555	22,508	23,570	24,630
	Increase				3,970					3,130	1,120	330			3,400	1,130	250			3,400
	Loops	11,700	11,700	11,700	15,670	15,670	15,670	15,670	15,670	18,800	19,920	20,250	20,250	20,250	23,650	24,780	25,030	25,030	25,030	28,430
Hatton	Demand x 1.3	2,631	2,753	2,870	3,008	3,149	3,279	3,432	3,575	3,721	3,861	4,008	4,159	4,307	4,453	4,606	4,771	4,928	5,114	5,292
	Increase				690					630					730					730
	Loops	3,421	3,421	3,421	4,111	4,111	4,111	4,111	4,111	4,741	4,741	4,741	4,741	4,741	5,471	5,471	5,471	5,471	5,471	6,201
Jaffna	Demand x 1.3	24,014	25,756	27,615	29,682	32,003	34,308	36,941	39,716	42,426	45,158	48,196	51,030	53,866	56,540	59,344	62,269	65,364	68,507	71,847
	Increase				42,590					14,150					15,440					15,300
	Loops				42,590	42,590	42,590	42,590	42,590	56,740	56,740	56,740	56,740	56,740	72,180	72,180	72,180	72,180	72,180	87,480
Kalmune	Demand x 1.3	7,692	8,230	8,782	9,395	10,117	10,823	11,606	12,449	13,247	14,131	15,007	15,861	16,725	17,558	18,379	19,280	20,203	21,174	22,216
	Increase				7,250		310			2,360	740	1,050			2,710	740	1,050			2,710
	Loops	6,400	6,400	6,400	13,650	13,650	13,960	13,960	13,960	16,320	17,060	18,110	18,110	18,110	20,820	21,560	22,610	22,610	22,610	25,320
Kalutara	Demand x 1.3	25,349	27,260	29,305	31,643	34,203	36,902	39,872	43,013	46,025	49,252	52,627	55,817	59,124	62,020	65,116	68,366	71,772	75,334	79,057
	Increase				1,330		1,380		710		990	5,920	10,760			990	5,120	1,020	7,360	
	Loops	53,563	53,563	53,563	54,913	54,913	56,293	56,293	57,003	57,003	57,993	63,913	74,673	74,673	74,673	75,663	80,783	81,803	89,163	89,163

(2/2)

SSC	Year	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
Kandy	Demand x 1.3	39,455	42,255	45,280	48,607	52,281	56,165	60,375	64,809	69,108	73,642	78,400	82,857	87,549	91,633	95,965	100,524	105,238	110,202	115,328
	Increase				4,940		2,640	10,120	3,800	500		8,540	9,520		820	2,720	9,130	9,520		820
	Loops	52,130	52,130	52,130	57,070	57,070	59,710	69,830	83,430	83,930	83,930	92,470	101,990	101,990	102,810	105,530	114,660	124,180	124,180	125,000
Kegalle	Demand x 1.3	9,762	10,456	11,203	12,073	13,021	14,018	15,126	16,272	17,390	18,590	19,839	21,028	22,248	23,368	24,543	25,793	27,097	28,491	29,909
	Increase				6,170		310			5,660		280			6,150		280	120		6,150
	Loops	11,200	11,200	11,200	17,370	17,370	17,680	17,680	17,680	23,340	23,340	23,620	23,620	23,620	29,770	29,770	30,050	30,170	30,170	36,320
Kurunegala	Demand x 1.3	19,773	21,048	22,413	23,914	25,551	27,287	29,158	31,122	32,995	35,001	37,105	39,078	41,132	42,991	44,975	47,054	49,208	51,476	53,842
	Increase				11,840	150		1,710		7,860	240	240	1,110		9,210	240	150	1,120		9,210
	Loops	20,800	20,800	20,800	32,640	32,790	32,790	34,500	34,500	42,360	42,600	42,840	43,950	43,950	53,160	53,400	53,550	54,670	54,670	63,880
Manner	Demand x 1.3	1,381	1,476	1,569	1,655	1,776	1,863	1,968	2,140	2,226	2,378	2,495	2,612	2,764	2,847	2,969	3,078	3,246	3,364	3,506
	Increase				2,130					290			260		520			260		310
	Loops	400	400	400	2,530	2,530	2,530	2,530	2,530	2,820	2,820	2,820	3,080	3,080	3,600	3,600	3,600	3,860	3,860	4,170
Matale	Demand x 1.3	7,817	8,190	8,592	9,019	9,453	9,913	10,374	10,895	11,310	11,805	12,276	12,767	13,263	13,711	14,222	14,728	15,224	15,757	16,303
	Increase						30				100	60		1,550	190	120	190		1,530	150
	Loops	15,011	15,011	15,011	15,011	15,011	15,041	15,041	15,041	15,041	15,141	15,221	15,221	15,771	16,961	17,081	17,271	17,271	18,801	18,951
Matara	Demand x 1.3	15,995	17,038	18,187	19,465	20,853	22,318	23,934	25,601	27,210	28,932	30,748	32,443	34,232	35,870	37,573	39,394	41,249	43,225	45,274
	Increase				6,320		440		5,240	1,290	940	520	300	5,460	1,450	1,190	520	420	5,460	1,420
	Loops	20,610	20,610	20,610	26,930	26,930	27,370	27,370	32,610	33,900	34,840	35,360	35,660	41,120	42,570	43,760	44,280	44,700	50,160	51,580
Newalapitiya	Demand x 1.3	1,295	1,386	1,485	1,594	1,713	1,842	1,979	2,126	2,267	2,415	2,571	2,718	2,870	3,006	3,147	3,296	3,450	3,614	3,782
	Increase				10										470			120		630
	Loops	3,455	3,455	3,455	3,465	3,465	3,465	3,465	3,465	3,465	3,465	3,465	3,465	3,465	3,935	3,935	3,935	4,055	4,055	4,585
Negombo	Demand x 1.3	20,609	22,190	23,924	25,887	28,042	30,336	32,851	35,511	38,102	40,833	43,732	46,432	49,261	51,773	54,436	57,242	60,177	63,258	66,481
	Increase				13,130		140			13,120		640			13,930		740			13,940
	Loops	25,100	25,100	25,100	38,230	38,230	38,370	38,370	38,370	51,490	51,490	52,130	52,130	52,130	66,060	66,060	66,800	66,800	66,800	80,740
Nuwara eliya	Demand x 1.3	5,229	5,477	5,714	5,963	6,262	6,521	6,824	7,115	7,400	7,678	7,970	8,268	8,567	8,852	9,162	9,491	9,806	10,174	10,527
	Increase									1,300		50			1,140		160	40		1,150
	Loops	8,965	8,965	8,965	8,965	8,965	8,965	8,965	8,965	10,265	10,265	10,315	10,315	10,315	11,455	11,455	11,615	11,655	11,655	12,805
Polonnaruwa	Demand x 1.3	4,628	4,850	5,108	5,364	5,647	5,956	6,250	6,596	6,906	7,222	7,562	7,872	8,216	8,499	8,853	9,200	9,569	9,935	10,316
	Increase				320		440					820			130		1,140			
	Loops	8,895	8,895	8,895	9,215	9,215	9,655	9,655	9,655	9,655	9,655	10,475	10,475	10,475	10,605	10,605	11,745	11,745	11,745	11,745
Ratnapura	Demand x 1.3	10,581	11,294	12,089	12,992	13,982	15,005	16,138	17,326	18,480	19,699	21,002	22,207	23,498	24,647	25,859	27,164	28,516	29,942	31,425
	Increase				5,770		320		1,100	3,120	1,360	530	450	960	3,430	1,190	530	420	960	3,430
	Loops	12,670	12,670	12,670	18,440	18,440	18,760	18,760	19,860	22,980	24,340	24,870	25,320	26,280	29,710	30,900	31,430	31,850	32,810	36,240
Trincomalee	Demand x 1.3	5,758	6,158	6,573	7,059	7,588	8,139	8,743	9,365	9,971	10,622	11,305	11,941	12,600	13,174	13,801	14,456	15,137	15,856	16,600
	Increase				2,570					2,970	80	60			3,190	100	60			3,150
	Loops	7,930	7,930	7,930	10,500	10,500	10,500	10,500	10,500	13,470	13,550	13,610	13,610	13,610	16,800	16,900	16,960	16,960	16,960	20,110
Vavuniya	Demand x 1.3	3,968	4,206	4,412	4,735	4,995	5,266	5,612	5,950	6,273	6,581	6,939	7,248	7,595	7,920	8,265	8,568	8,939	9,267	9,707
	Increase				2,210					490	1,020	50			650	1,050	60			530
	Loops	5,550	5,550	5,550	7,760	7,760	7,760	7,760	7,760	8,250	9,270	9,330	9,330	9,330	9,980	11,030	11,090	11,090	11,090	11,620
National Total	Demand x 1.3	709,630	761,948	818,480	881,565	951,354	1,024,704	1,105,031	1,190,184	1,272,097	1,356,924	1,450,394	1,536,070	1,625,437	1,704,034	1,787,475	1,875,013	1,966,174	2,062,266	2,162,125
	Increase			367,570	153,060	3,010	7,210	35,460	236,490	92,330	15,060	36,910	47,390	230,710	102,220	17,980	37,230	39,170	238,020	101,520
	Loops	738,962	738,962	1,106,532	1,259,612	1,262,622	1,269,832	1,305,312	1,541,802	1,634,132	1,649,192	1,686,102	1,733,492	1,964,202	2,066,422	2,084,402	2,121,632	2,160,802	2,398,822	2,500,342

Note : The number of the loops in 1997 is based on the data of the on-going projects as of April 1995.

CHAPTER 10

OTHER TELECOMMUNICATIONS NETWORK PLAN

CHAPTER 10

OTHER TELECOMMUNICATIONS NETWORK PLAN

1. Telex Network

1.1 Existing Telex Network

The Telex exchange is situated in Sri Lanka Telecom Headquarters in Colombo. The Telex exchange serves whole the country. The telex exchange is of type NEDIX 510A manufactured by Nippon Electric Co. (NEC) and put into service in the year 1980. The equipped capacity of the telex exchange is 2,520 ports. There are 213 international circuits routed via the Earth Station at Padukka. Table 10-1-1 shows the foreign destinations and traffic.

The number of working lines is 1,560 as of March 1995. Among them 123 telex terminals are used as Gentex terminals being situated at 50 stations scattered to whole the country. Table 10-1-2 shows Gentex stations with terminals.

The majority of telex subscribers are in the Colombo area. Those that are outside Colombo are connected through analogue voice frequency telegraph (VFT) equipment installed at CTO building on one hand and that at the outstations on the other. Figure 10-1-1 shows the network configuration.

Some of these Gentex terminals are situated in the offices of SLT and some are situated in main post offices or sub-post offices. Where main post offices or sub-post offices are not equipped with Gentex terminals the telegrams are routed via telephone to the nearest phonogram operator position which is situated in an exchange of SLT. The operator at the phonogram position copies the telegram onto a form and passes it along with others to the Gentex terminal in the same SLT exchange. Delivery of such telegrams utilises the reverse procedure. The phonogram operator transmits telegrams by telephone to those post offices and sub-post offices without Gentex facilities.

SLT has 13 point-to-point international duplex teleprinter circuits for cables operated by OTS. The international destinations are China (Beijing), Dubai, Hong Kong, India (Bombay), Japan, Karachi, London, Rome, Singapore, Sydney, USA ITT, USA RCA, and USA WUI.

Table 10-1-1 Telex International Circuits and Traffic

(in erlang)

ROUTE	EXISTING CCTS	BUSY HOUR TRAFFIC (B/W)	ROUTE	EXISTING CCTS	BUSY HOUR TRAFFIC (B/W)
PARIS	7	0	USA		
ROME	7	1	RCA	10	0
BERNE (SWLAND)	10	1	ITT	19	2
LONDON	28	3	WUI	11	1
SYDNEY	8	1	TRT	10	0
TOKYO	14	2	PAKISTAN	6	1
HONGKONG	18	1	HAMBURG	10	1
BOMBAY	14	2	AUSTRIA	2	1
KUALALAMPUR	3	1	THAILAND	4	1
PEKING	2	1	MADRAS	6	2
SINGAPORE (KD)	6	0	DUBAI	5	1
SINGAPORE (ED)	5	2	SEAQUL	5	2
			BANGLADESH	3	1
National total				213	28

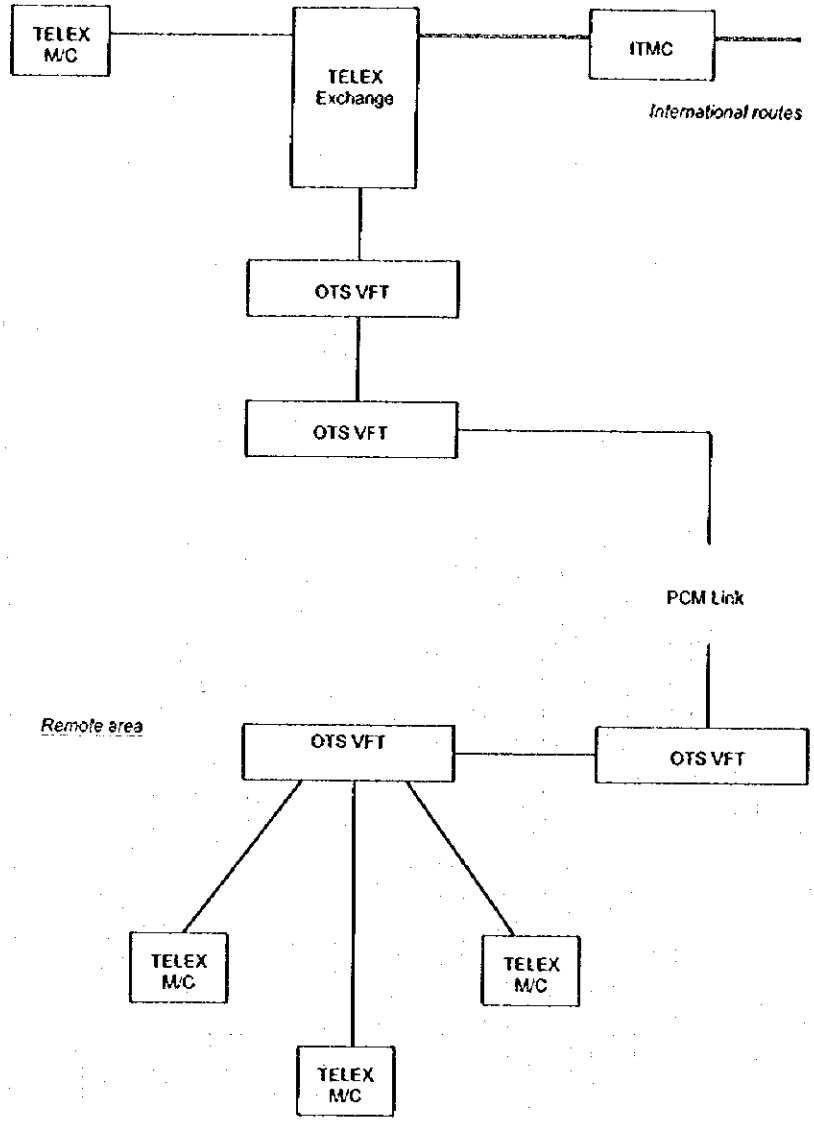
Source: SLT, as of December 1994. Teleprnt.XLS

Table 10-1-2 Gentex Stations

No.	Station	Qty of Gentex Teleprinters	Qty of Duplex Teleprinters Working to Colombo CTO
1	Ambalangoda	2	
2	Anuradhapura	2	1
3	Avissawella	2	
4	Ampara	2	
5	Baddula	2	1
6	Bandarawela	2	
7	Batticaloa	2	
8	Colombo	16	8
9	Chilaw	2	
10	Colombo Radio (Ship to Shore)	1	
11	Colombo OTS	2	
12	Chunnakkam	1	
13	Dehiwala	1	
14	Gampaha	2	
15	Campola	2	
16	Galle	3	
17	Hatton	2	
18	Hambantota	2	
19	Kalutara JA	2	
20	Kalmunai	1	
21	Kandy	5	
22	Kelaniya	1	
23	Kegalle	2	
24	Kotahena	3	
25	Kotte (Parliament)	1	
26	Kurunegala	2	1
27	Mannar	2	
28	Matara	2	1
29	Mirigama	2	
30	Mount Lavinia	1	
31	Moratuwa	1	
32	Matale	3	
33	Nawalapitiya	2	
34	Nugegoda	1	
35	Nuwara Eliya	2	
36	Negombo	2	1
37	Pilimatalawa	2	
38	Polgahawela	2	
39	Polonnaruwa	2	
40	Puttalam	2	
41	Panadura	2	
42	Peradeniya	2	
43	Point Pedro	1	
44	Ratnapura	3	
45	Slave Island	3	
46	Tangalle	2	
47	Trincomolee	2	
48	Veyangoda	2	
49	Vavuniya	1	
50	Weligama	1	
	Total	110	13

Teleprnt XLS

Source: SLT.



VFT: Voice Frequency Transmission
ITMC: International Telecommunication Maintenance Centre

Source: SLT.

Figure 10-1-1 Telex Network Configuration

1.2 Future Telex Network

1.2.1 Transition to new system

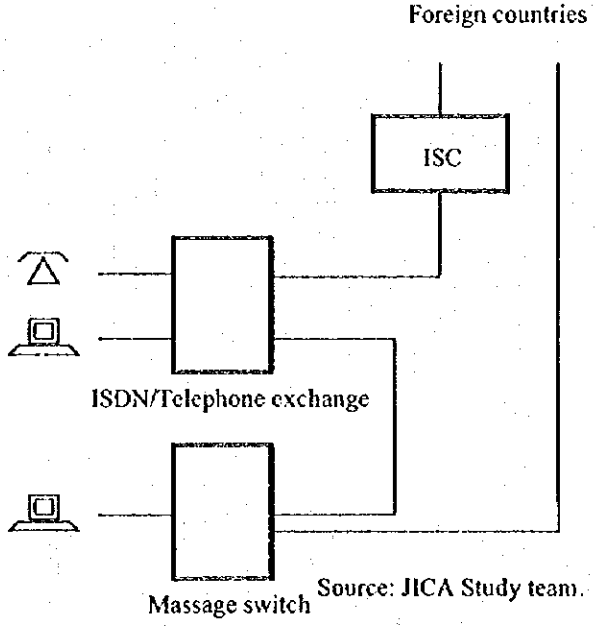
In consideration of the fact that the telex traffic is decreasing all over the world, JICA recommends SLT to transfer gradually the telex service and telegram service to the facsimile

service or data communication service. The facsimile and data communication services are available by basic telephone network. The substitution of telex and telegram service by facsimile service will become possible as most parts of the Island will be integrated into the automatic digital telephone network under this Master Plan. Almost of the existing telegram stations without telephone line at present may be able to be equipped with facsimile terminals or data terminals in 2015 when the Master Plan projects complete. The international telex service will be, however, maintained by means of a new message switch planned by SLT as it is not a discretion of SLT but a bilateral matter.

1.2.2 New telex network for the time being

SLT is going to introduce a new message switch to continue telex service. SLT set up a committee to discuss the telex network in future. In November 1994, the committee discussed the future of international telex service, taking into account the present situation of the telex service, conditions of the telex exchange and the discontinuation of the production of spare parts. The committee decided to recommend the procurement of a message switch to handle international telex and national/international telegraph service. It was also decided to operate both systems in parallel until the telex exchange is discontinued.

The existing telex network shall remain without replacement, running in parallel with the new massage switch. It is preferable that the new message switch is put into service before the year 2000 as the existing telex exchange will be aged as old as 20 years in that year. New applications for telex facilities should be guided to facsimile service or data communication service through telephone network.



Source: JICA Study team.

Figure 10-1-2 Text Communication Network

The new message switch should take interface with ISDN to be introduced by the year 2000. SLT should encourage the telex users to transfer their facilities to facsimile or data communication facilities after 1998 as the telephone network becomes full digital. By the year 2015, text messages will be proceeded through ISDN, telephone network or the message switch as shown in Figure 10-1-2.

2. Data Communication Network

2.1 Existing Data Communication Network

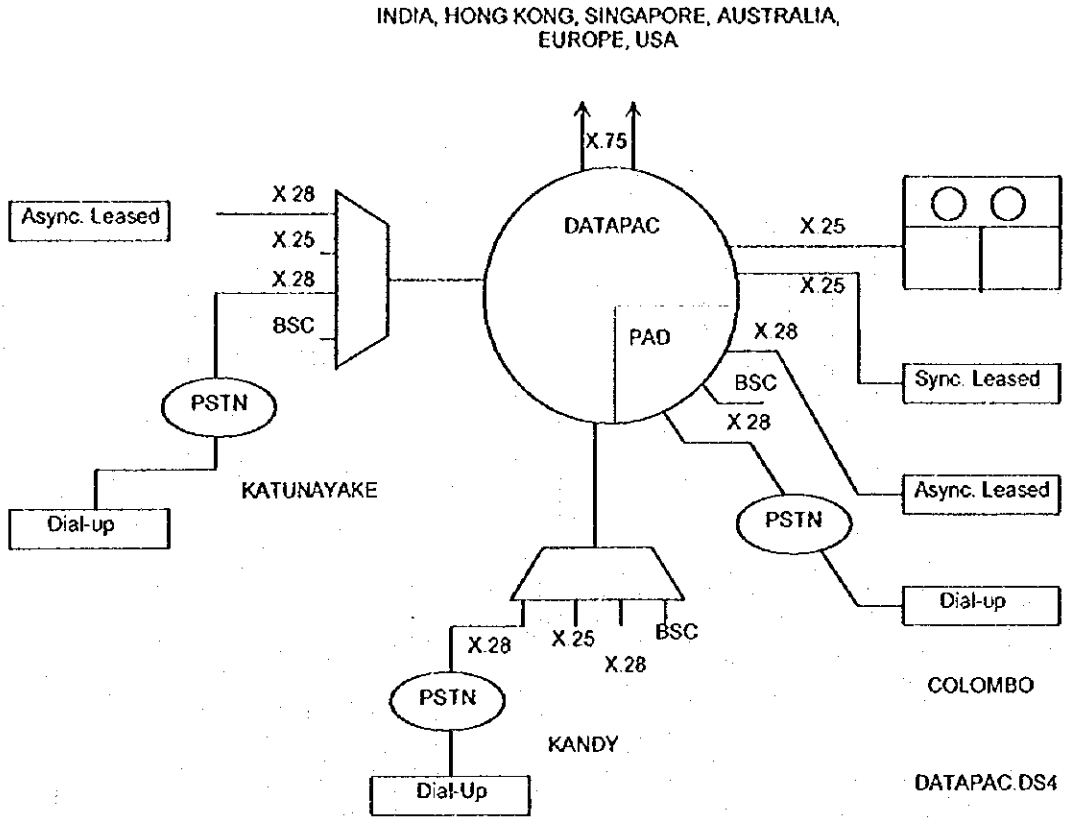
Data communication service is provided by three operators; i.e., Sri Lanka Telecom (SLT), Lanka Communication Services and Electrotek. DataPAC switching system, operated by SLT, is situated in the SLT Headquarters building in Colombo. Its data network identification code (DNIC) is "4131". It was put into service on May 12, 1993. The DataNET operated by Lanka Communication Services is situated in Colombo. It has the data network identification code (DNIC) "4132" and was commissioned in 1993. The data communications network operated by Electotek has "4133" as its DNIC.

The DataPAC has 3 subscribers by means of dedicated lines and another 22 subscribers via public switched telephone network (PSTN). Those 22 subscribers are called dial-up line subscribers and three of them have dedicated telephone number to get access to the packet switch network. Majority of the subscribers are in Colombo, some in Katunayake and in Kandy.

The SLT public switched packet data network (PSPDN) makes use of ISO standard X.25 Packet Switching technology. It supports internationally standardised communication protocols and allows computers and other data devices to communicate each other. Figure 10-2-1 shows DataPAC network configuration.

The DataPAC asynchronous packet assembler/disassembler (PAD) and the packet switch are Motorola Codex products. The PAD consist of 6 ports which support X.28 terminals either connected directly or through switched lines. The packet switch also support 6 ports which are configured as X. 25. But switch ports can be configured as X.28 if needed. The maximum capacity of this equipment is 24 ports by inserting two more cards of X.25 or PAD type.

DataPAC PSPDN is connected to Gateway Packet Switch Services (GPSS) of Bombay, India, for providing international connectivity. Around 30 countries and 100 different public data networks are accessible via GPSS, India. DataPAC DNIC (4131) is loaded and validated to many international data networks to meet the present customer requirements. Table 10-2-1 shows international PSPDN available for DataPAC subscribers.



Source: SLT.

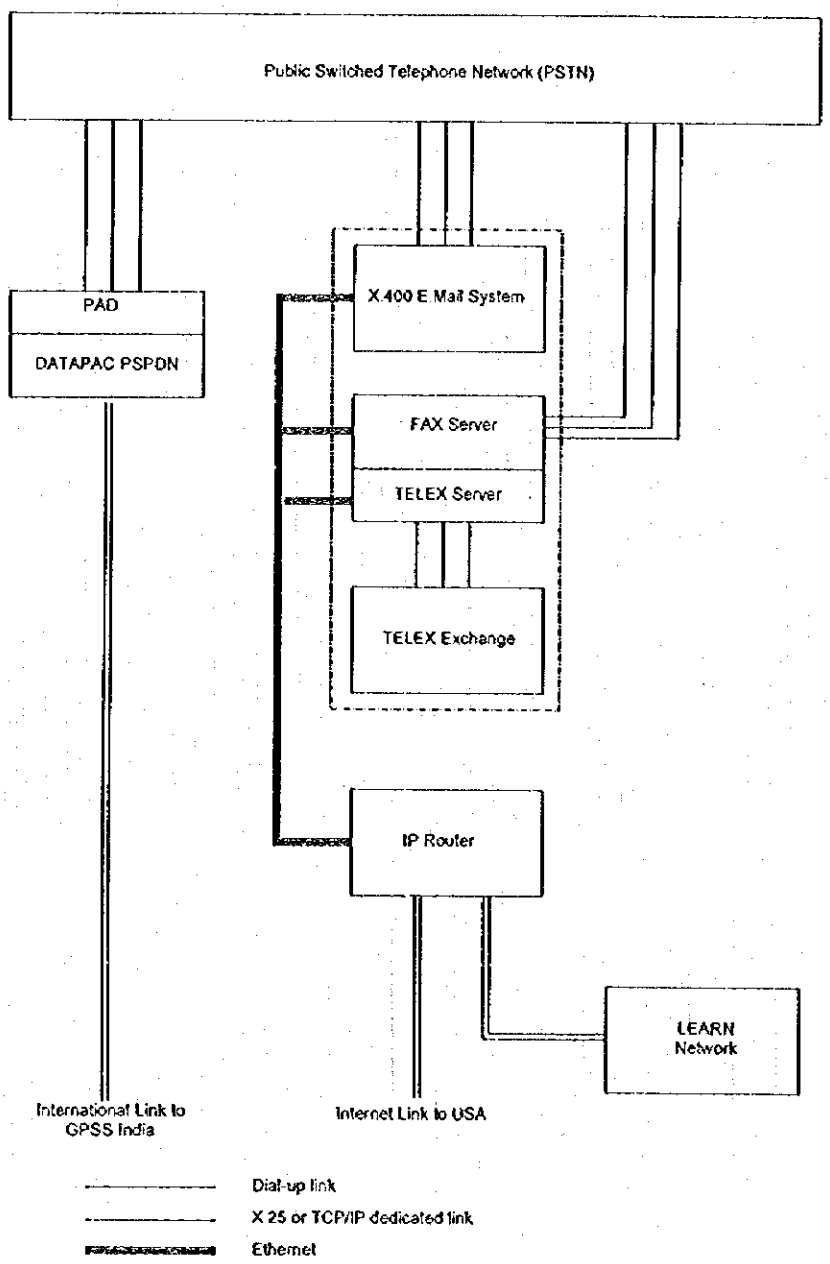
Figure 10-2-1 DataPAC Network Configuration.

Table 10-2-1 International PSPDN Available for DataPAC Subscribers

No.	Country	Network	DNIC	No.	Country	Network	DNIC
1	Argentina	Arpac	7222	19		PSS	2342
2	Australia	AUSTPA	5052	20		HULL	2352
3		Midas	5053	21		Mercury	2350
4	Belgium	DCS	2062	22	U.S.A.	PTN 1	3101
5	Brasil	Interdata	7240	23		MCIIWUI	3104
6		Renpac	7241	24		Tymnet	3106
7	France	NTI	2081	25		Sprintnet	3110
8	Germany	Datex-P	2624	26		Graphnet	3116, 3118
9	Hongkong	IDAS	4542	27		Autonet	3126
10		DATAPAK	4545	28		Compuserve	3132
11		HANS	4546	29		AT&T	3134
12	India	GPSS	4042	30		Geisco	3136
13	Japan	Venus-P	4408	31		Infonet	3137
14	Korea	HiNET-P	4500	32		Netexpress	3139
15	Netherland	Datanet 1	2040, 2041,2049	33		Bell Atlantic	3141
16	Philippines	Philcom	5152	34		S-W Bell	3146
17	Singapore	Telepac	5252	35		Digipac	3147
18	U.K.	IPSS	2341				

Source: SLT.

There are many value-added services that can be provided using DataPAC and some of those services are being added to the existing system and expected to be commissioned in 1995. They are, a) X.400 Electronic Mail System and b) Facsimile-telex server. The local computer network "LEARN", which is used by three universities in Sri Lanka, will be connected from PSTN subscribers through an IP Router to be added to the SLT data communication network shortly. Figure 10-2-2 shows the connection diagram of the value-added network.



Source: SLT.

Figure 10-2-2 Connection Diagram of SLT Value-added Network

2.2 Future Data Communication Network

JICA recommends SLT to transfer gradually the data communications service and value-added services now provided by or planned for the SLT computer system network (hereinafter referred to as SLT Value-Added Computer Network, temporarily) to the ISDN that JICA recommends SLT to introduce by the year 2000. SLT is going to offer such value-added services by the SLT Value-Added Computer Network comprising X.400 E-Mail system, Facsimile server, Telex server and IP router. It will be practical before the ISDN is expanded sufficiently to the public.

SLT has commissioned the DataPAC for packet switching service in 1993. The packet switching system is planned to be expanded soon to meet the increase in demand.

The computer system for value-added service is expected to accommodate 1,500 subscribers or more. The number of subscribers will be reviewed sometime after the subscriber behaviour is studied by SLT after commissioning.

New data communication demand will be catered by several optional ways, such as, leased circuits, existing packet switching networks, SLT basic telephone network, or SLT's ISDN. The SLT telephone network will be full digital after the on-going projects complete in 1997. The ISDN is recommended to be introduced by the year 2000.

JICA recommends SLT to equip the ISDN with packet handling function. The ISDN may dominate the data communication service if its tariff is set competitive to the existing packet switching networks. The ISDN can be designed to offer all the supplementary services which are provided by the existing packet switch networks. Accordingly, it is preferable that SLT caters for new data communication demand by the ISDN or leased circuits.

JICA recommends SLT to introduce an Intelligent Network (IN) by the year 2000. Various kinds of services will be available after the IN is introduced. The available services under IN are presented in the Volume of Supporting Documents. Electronic mail service, facsimile service, text message service, which are planned for the SLT Value-added Computer Network, may be provided by independent network under new destination network code (DNC. Refer to Numbering Plan of Chapter 8.).

3. Leased Circuit Network

3.1 Present Status of Leased Circuit Network

Leased circuit service is provided by SLT. Number of the provided circuits is about 1,500, and 80 % of the total volume is supposed to be provided in Colombo. Clients of the service are bank, embassies, airline, insurance, security companies and so on. Classified number of circuits are shown in Table 10-3-1 below.

Table 10-3-1 Classified Number of Leased Circuits

Usage Category	No. of CCT	Remarks
DATA	985	
TELEX	401	
X.25 PACKET	4	For Connection to Packet Network in India
(UNKNOWN)	75	
Total	1,465	

Source: SLT.

2M bps stream leased circuits are provided to Mobitel for their trunk link as table 10-3-2 below. There are no any other client for 2M bps stream leased circuits service now, because of insufficiency of trunk circuit capacity.

Table 10-3-2 2M bps Leased Circuits for Mobitel

Link Section	Number of 2M bps Leased Circuits
Colombo - Kandy	1
Colombo - Anuradhapura	1
Colombo - Galle	1
Colombo - Kalutara	1
Colombo - Negombo	1
Colombo - Nugegoda	2
Colombo - Ratnapura	2

Source: SLT.

3.2 Future Plan for Leased Circuit Network

According to the result of demand forecast, the number of leased circuits will rise to 17,891 in 2015 as described in Chapter 6. Leased circuits will be provided as a part of trunk transmission network physically, but it will be an over-lay network to PSTN from the viewpoint of network structure. Considering business activity, circuit distribution ratio is assumed as:

Within Colombo	:	81%
Between Colombo and other SSC	:	18%
Between SSC except Colombo	:	1%

Based on the demand figure in Table 6-7-13 in Chapter 6, provided circuits by 2M bps unit is decided for 2000, 2005 and 2015 as shown in Table 10-3-3. .

Table 10-3-3 Leased Circuits Provision Plan

(unit: 2M Sys.)	Y-2000	Y-2005	Y-2015
Within Colombo	7,077	8,786	21,906
Between Colombo and other SSC	1573	1952	4868
Between SSC except Colombo	87	108	270
Total	8,737	10,846	27,044

Note: Shown number of System will cover the following 5 years demand.

Source: SLT.

These 2M bps stream will be distributed to appropriate sections according to the ratio of PSTN voice circuits. Detail provision plan is at Annexes.

4. Maritime Communication Network

4.1 Present Status of Maritime Communication

(1) Existing Services

The maritime public communication services are operated by the SLT. The coastal radio stations are listed below.

Table 10-4-1 List of Coastal Stations in Sri Lanka

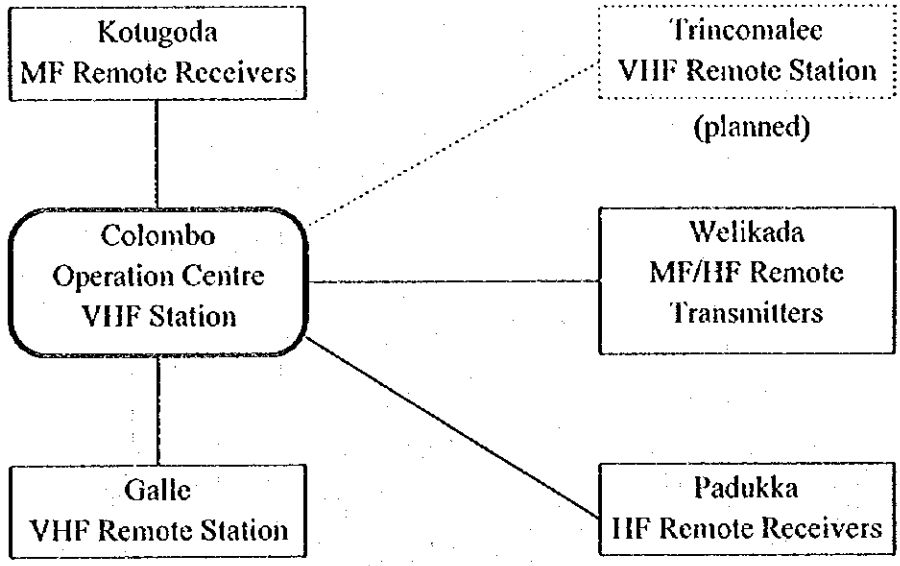
Coastal Station	Call Sign	Frequency Band	Services
Colombo Radio	4PB	MF, HF, VHF	Telephone, Telegraph
Galle Radio	4PG	VHF	Telephone, Telegraph
Trincomalee Radio	4Px	(planned)	

Source: SLTA.

The VHF telephone calls are mainly used. The traffic volume is 100 calls/day at Colombo and 20 calls/day at Galle in 1994. The traffic of HF telephone is only 3 to 4 calls/day at Colombo.

(2) Existing Coastal Stations

The existing maritime communication network of SLT is illustrated below. The system is old type with manual operation.



Source: SLTA.

Figure 10-4-1 The Existing Maritime Communication Network

(3) Number of Ships

At present, there are only 42 large ships of Sri Lanka nationals. In addition to them, about 4,000 small boats are used by fisher men. Most of all boats do not have any radio communication facilities except for 128 boats.

On the other hand, many large foreign ships visit or pass through Sri Lanka sea area. In the year 1994, the number of large ships reached to 3,251 they visited to Colombo port. Based on the information from staff of SLT, the ship traffic is summarised as follows:

Table 10-4-2 Ship Traffic per Month at Major Ports and Areas in Sri Lanka

Port or Sea Area	Number of Large Ships
Colombo Port	270 / month
Trincomalee	30 / month
Galle Port	3-4 / month
South Sea Area of Galle	9,000 / month
Total of Sri Lanka Area	9,304 / month

Source: SLT.

Most of all large ships will require the maritime communication services with Sri Lanka coastal stations.

(4) Search and Rescue

There are some accidents in Sri Lanka sea area. The number of accidents is about 5 per year. At present, the Rescue Co-ordination Centre (RCC) is not established yet by the government. The search and rescue services are provided only by the Navy of Sri Lanka.

4.2 Improvement Plan for Maritime Communication

(1) GMDSS

To improve emergency maritime communication, the Global Maritime Distress and Safety System (GMDSS) is introduced internationally. This new reliable communication system was standardised under the International Maritime Organisation (IMO). Under the international convention on maritime search and rescue 1979, every countries must be provide the GMDSS services before February 1999. Referring to the Study Report (April 1995) by JICA expert, the new GMDSS facilities are required in Sri Lanka as shown in below.

(2) New Facilities in Colombo Coast Station

1) One VHF DSC sub-system consisting of one transceiver (CH70), one DSC distress terminal and one associated VHF antenna.

2) One MF/HF DSC sub-system consisting one DSC distress terminal, four MF/HF receivers (2187.5kHz, 8414.5kHz, 4207.5kHz and 12577kHz) with one MF/HF antenna, one antenna multiple coupler and one MF/HF transmitter with antenna.

3) One NAVTEX broadcasting sub-system consisting one MF transmitter and one NAVTEX(FEC) terminal.

4) One NBDP(ARQ)/SSB sub-system consisting one ARQ modem, VDU/Keyboard, one MF/HF(F1B/SSB) receiver and one MF/HF transmitter with antenna.

5) One land use facsimile equipment and one telex terminal which is exclusively used for the maritime safety communication.

(3) New Facilities for Galle and Trincomalee Coast Stations

1) One VHF DSC sub-system consisting one transceiver (CH70), one DSC distress terminal and one associated VHF antenna.

2) One MF DSC sub-system consisting one DSC distress terminal, one MF receiver (2187.5kHz) with antenna and one MF/HF transmitter with antenna.

3) One NAVTEX broadcasting sub-system consisting one MF transmitter and one NAVTEX(FEC) terminal.

4) One NBDP(ARQ)/SSB sub-system consisting one ARQ modem, VDU/Keyboard, one MF(F1B/SSB) receiver and one MF/HF transmitter with antenna.

5) One land use facsimile equipment and one telex terminal which is exclusively used for maritime safety communication.

5. Mobile Telephone Network

5.1 Present Status of Cellular Mobile Telephone Service

(1) Cellular Service Operators

In Sri Lanka, the cellular mobile telephone service is provided by private companies under licence of SLTA. The curent operators are listed below.

Table 10-5-1 Cellular Mobile Telephone Service Operators

Network Name	Celltel	Call Link	Mobitel	MTN Networks
Foreign Partner	MIC (USA)	Singapore Telecom	Telstra (Australia)	Telecom Malaysia
System	TACS	TACS	AMPS	GSM
Frequency Band	800-900MHz	800-900MHz	800-900MHz	1.8-1.9GHz
Access No.	072	078	071	
Established	1989	Jan.1993	April 1993	March 1995
No. of Subscribers (in June 1995)	18,000	7,800	12,462	1,500
Tariff Connection Charge Monthly Charge Call Charge / min.	 Rs 10,000 Rs 1,265 Rs 4-5 / out		 Rs 7,500 Rs 1,450 Rs 5 / out Rs 4 / in	 Rs 35,000
No. of Staff	250		70	
Roaming	none		in Asia	

Source: SLTA.

(2) Growth Trend

The number of cellular mobile subscribers was rapidly increased in Sri Lanka during paset few years. The grwoth trend is shown in the following table:

Table 10-5-2 The Growth Trend in the Number of Cellular Mobile Subscribers

Year	1989	1990	1991	1992	1993	1994	June 1995
Celltel	500	1,010	1,973	4,000	6,000	16,000	18,000
Others	-	-	-	-	7,000	16,500	21,800
Total	500	1,010	1,973	4,000	13,000	32,500	39,800
Annual Growth	-	102%	95%	103%	225%	150%	-

Source: SLTA.

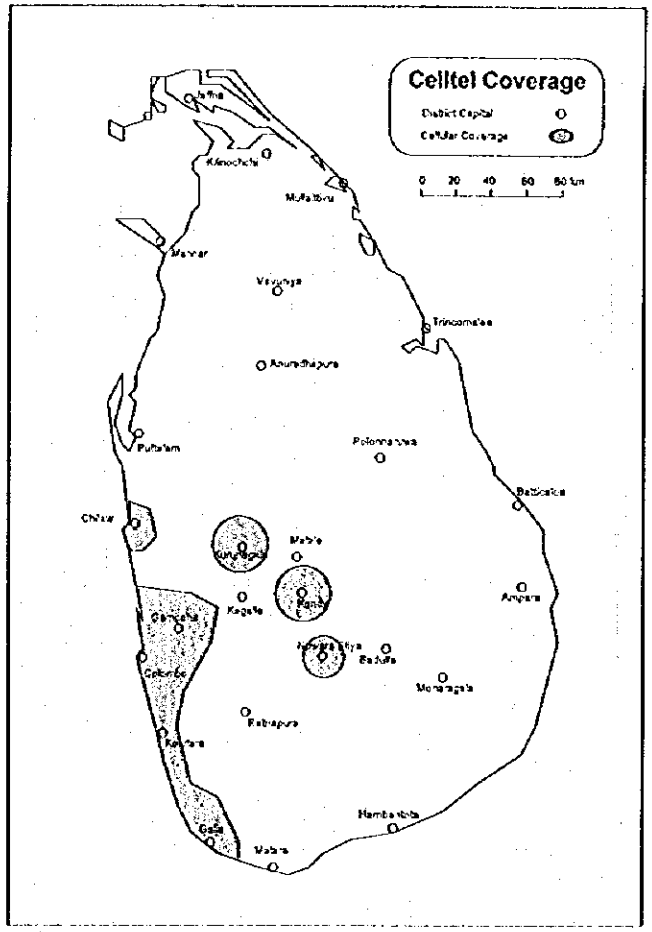
(3) Celltel Network

The Celltel network is operated by the Celltel Lnaka Limited mainly invested by the Miliam International Cellular (MIC) campany of USA. Coverage areas are shown in Figure 10-5-1. The network consists of four digital switches in Colombo, Kandy and Galle, and 22 base stations. They have own trunk links to connect between base stations and switches. This network is inter-connected with SLT telephone network at Colombo.

The registered adress of subscribers is as follows:

Colombo: 80%
Kandy: 15%
Others: 5%

90% of subscribers are using mobile telephones for business.



Source: Celltel.

Figure 10-5-1 Celltel Network

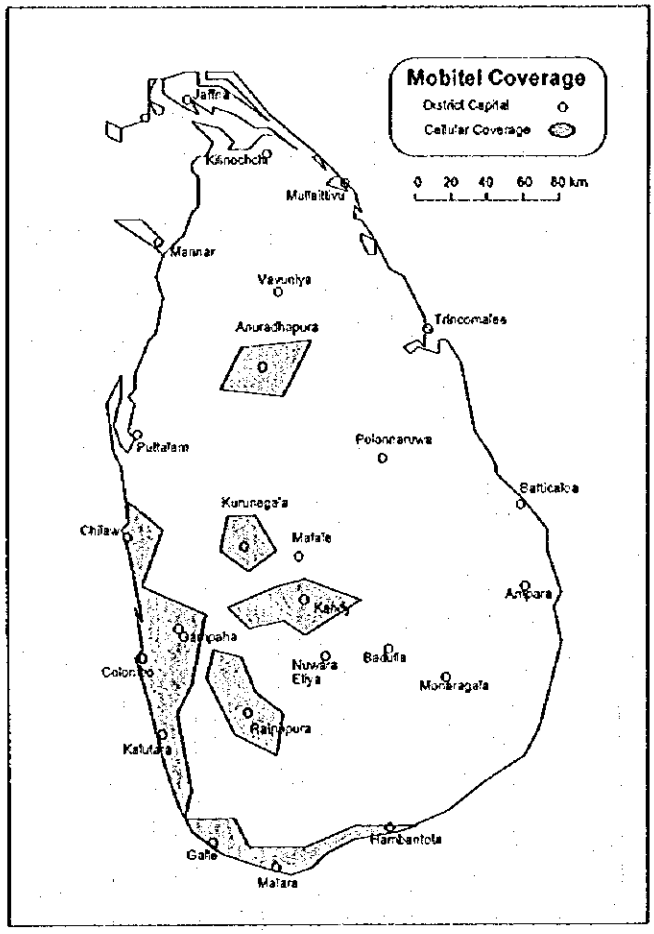
Subscribers in Celltel network can use not only ordinaly telephone but also facimile and voice mail services.

Mobile terminals are supplied by Motrola, Nokia, Kokusai, Antel and Sony. Celltel is going to introduce the new digital phones, such as GSM system. The coverage area will also be expanded to Puttalam, Dambulla, Ratnapura, Badulla and Bandarawela towns.

(4) Mobitel Network

The Mobitel network is operated by the OTC Australia (Pvt) Ltd which is the subsidiary of the Telstra Corporation of Australia. This operation has started at April 1993 as the BOT project to be transfered to SLT after 7 years. However, to expand the network and to introduce new technorogies, this agreement was changed to the joint venture partnership operation from May 1995.

Present coverage areas are shown in Figure 10-5-2. The network consists of one digital switch in Colombo and 20 base stations. They are leasing SLT trunk links to connect between base stations and switches except for the one own link between Galle and Matara. The Mobitel network is inter-connected with SLT telephone network at Colombo.



Source: Mobitel

Figure 10-5-2 Mobitel Network

The Mobitel provides subscribers with international roaming to other AMPS networks. At present, the roaming operation is available in five Asia countries, such as Australia, New Zealand, Hong Kong, Singapore, Thailand and Malasiya.

5.2 Expansion Plan of Cellular Mobile Telephone Network

(1) Network Expansion

Referring to the demand forecast results and the development targets stated before, the following network expansion is proposed up to the year 2015:

Table 10-5-3 Cellular Mobile Telephone Network Expansion up to 2015

Item	Y-1995	Y-2000	Y-2005	Y-2015
Coverage	Several Cities	Major Cities	District Capitals	Major DS Capitals
Districts Introduced	11 districts	17 districts with Nuwara Elia Badulla Matale Trincomalee Puttalam Jaffna	All (25) districts	All (25) districts
Supply Volume	39,800	133,400	195,800	332,600

Source: JICA Study team.

Until the year 2000, the following 6 cities are proposed for the new introduction of mobile telephone service:

1) For tourism activities: Nuwara Elia, Badulla and Matale
2) For industry activities: Trincomalee, Puttlam and Jaffna

The same value as demand is proposed for the supply in each target year to realise the 100% fulfilment in general.

(2) System Improvement

The most of all existing networks are operated in the analogue system mainly for telephone service. In future, these networks must be replaced with the digital system which can accept the flexibility for various kinds service applications and high speed data communication.

CHAPTER 11

OPERATION AND MAINTENANCE PLAN

CHAPTER 11

OPERATION AND MAINTENANCE PLAN

1. General

1.1 Definition

The purpose of maintenance is to retain and perform a required function of the telecommunications network.

Operation is all operational daily activities, to run the telecommunications facilities effectively and efficiently, for provision of the customer services which include the new connections and small scale projects.

- Effectiveness means doing the right thing, i.e., producing the desired results.
- Efficiency is a measurement of the use of resources to achieve results.

1.2 Consideration to General Maintenance

Following general maintenance items are recommended to be employed:

a) To prepare procedures in order to take combined maintenance activities of all technical and administrative ones, including supervision actions.

b) To set-up target Quality of Services (QoS) for the customer services considering with cost-effective operation, e.g., fault rates, call completion rates, manpower rate.

c) To develop further the network management system.
Following network maintenance methods should be applied.

- Preventive maintenance:
The maintenance carried out at predetermined intervals or according to prescribed criteria and intended to reduce the probability of failure or the degradation of the functioning of an item.
The preventive maintenance should be applied mainly to External Plant maintenance.

- Corrective maintenance:
  The maintenance carried out after fault recognition and intended to restore an item to a state in which it can perform a required function.

- Controlled maintenance:
  A method to sustain a desired quality of service by the systematic application of analysis techniques using centralised supervisory facilities and/or sampling to minimise preventive maintenance and to reduce corrective maintenance. The controlled maintenance should be applied to Switching and Transmission systems maintenance.

d) To provide maintenance tools and equipment becoming available to introduction of new services, evolution of new network technologies.

2. Present Status and Problems on Operation and Maintenance

2.1 Operation and Maintenance Situation in 1992-1993

(1) Korea Telecom's Report

Korea Telecom made survey and analysis for O&M status in the Greater Colombo Area (End/91-Mid/92). Recommended improvements items are as follows:

a) Establishment of O&M improvement plan.
   - Definition of functions and their allocations for each Department
   - Set-up O&M job flow/procedures
   - Introduction of preventive maintenance

b) Setting-up of the system which controls the O&M data flow in order to solve major problems of high traffic, poor successful call rate, high fault rate, lack of technical manpower, etc.
   - Fault record management
   - Traffic data management
   - Reporting system

c) Study on O&M policies and functions for new service requirements.

d) Centralisation of O&M maintenance system after improvement of present manual working system.

(2) SOFRECOM's Report

SOFRECOM made a study in the years 1992 to 1994 regarding O&M status and improvement plan in Sri Lanka and reported the problem situations and recommendations under the title "Analysis of the Present Situation Operation and Maintenance" in December 1992, May 1993 and "Network Management and Operational Plan", in February 1994.

Findings at the time of study, assessment of the situations and short term actions to be initiated were reported. Main items of their reports are shown below.

Findings:

a) O&M organisation is supported by HQ and RTEs which regional organisations are more involved in Outside Plant. Region Heads are not yet settled.

b) Switching and Transmission Divisions at HQ are concentrated on the Metro area.

c) Regional level O&M activities are supported by RTE. 40% of difficulties encountered are linked to materials management and logistic aspects.

d) Planning, Projects and Operation Divisions are insulated each other. As a result, needs of materials or funding by RTE sometimes fails compilation of pre-programme due to no links with network planning.

e) Main problem of fault clearance is existed at outside plant, i.e., shortage of tools, vehicles and spare parts.

f) Application procedure for new connections consists of commercial phase and construction phase, construction phase may take 4-6 months due to process and material arrangement.

g) Digital exchanges provide enormous amount of data for monitoring the quality of services. However, compilation and analysis of the management data are not

carried out systematically. Management Data means in this case, traffic flow, QoS of local loop, fault clearance performance.

h) Following problems are also observed.
- Shortage of external plant materials, forwarding and delivery on site,
- Repairing of telephone instruments,
- Tools and measuring equipment
- One vehicle per 3-4 teams

i) Staffing productivity is 56/1000 DELs in SLT in 1992. On the other hand, in some other countries, the figures are 5 - 30.

j) DGMM Metro and Regions are more involved in the Outside Plant and customers' complaints. The Region Heads are not yet settled in their organisation. Many operational tasks are carried out by HQ organisation.

k) DGM Switching and DGM Transmission are concentrated on the Metro area which represent about 75% of the equipment. Sub-regional switching and transmission engineers cover only the first level of maintenance.

l) 40% of difficulties encountered by RTE are linked to materials management and logistic aspects. RTE activity is mainly consumed by commercial operation tasks, and not for network operation and maintenance oriented. Financial allocation and authorisation to withdraw the materials take from 1 to 6 months (average of 3 months).

Guide-lines to the above are as mentioned below;

a) SLT should organise Operation and Maintenance activity into four levels of functionality, supported by Methods and Procedures.

1- Operation and Maintenance Headquarters at the national level (HQ level), with functional activities and monitoring logic and technical support services. National network management system (NMS) may be set up at headquarters level of the size of the country.

2- Regional O&M (Provinces and Metro level, TSC area), in charge of operation and maintenance for the province where it is located and the regional network management.

3- Local Operation and Maintenance (RTE level, SSC area), in charge of operation and maintenance for one or several exchange areas (being understood that customer activities are re-organised under a Commercial Directorate).

4- Fault Handling Unit (District Inspector Telecoms, DIT level), taking care of the local loop and outside plant from MDF up to instrument set.

b) SLT should clearly define the tasks, the functions for each level and the associated resources.

c) SLT should define the activity objectives, telephone service with a certain level of QoS which have an appropriate balance with costs, and definition of a correlated financial system

d) SLT should set up O&M programmes to react to loss of QoS and network performance, which should be involved in the planning process

e) SLT should set up Procedures giving guarantee that:

- Projects and Operations are closely co-ordinating and aiming at the SLT's objectives.
- Small projects are a part of the Operations.
- O&M Programmes should be included in the planning process.
- The management of the technical resources of the network is fully set up.
- To be in position to negotiate the necessary resources.

f) SLT should organise the repair activity in a National Repair Centre, under O&M responsibility.

- Gathering all repairing activities in a repair centre under O&M monitoring.
- Developing the principle of "Replacement of card".
- Paying a special attention to the phone instruments flow.

g) SLT should review and re-define the RTE functions and associated procedures.

- Re-engineer the RTE tasks.
- Set up an information system for production, waiting list, QoS, budget.
- Develop autonomy for OSP operation (small projects).
- Set up a waiting list management.
- Set up a fault analysis and follow up for subscriber lines and cables as well as for switching and transmission.
- Develop an annual maintenance programme in OSP.
- Develop a preventive maintenance for subscriber lines.
- Set up technical data base and record files.
- Set up a Local and Head office organisations for customers' service.

h) SLT should ease day to day new connection procedure.

i) SLT should apply Preventive and Controlled maintenance:

- To choose one test area and to build up maintenance programme, small scale projects for outside plant.
- To check and analyse the network congestion for switching system.
- To develop controlled maintenance activity for transmission system.

j) SLT should organise a Centralised O&M Centre for a network management system.

k) SLT should re-organise materials management and re-define transportation, training and staffing policies

l) SLT should set up an O&M indicators system and executive report system which is to cope with MIS.

m)To replace fault telephone instruments and not to repair at site.

2.2 Operation and Maintenance Situation at present (April, 1995)

JICA Mission made surveys, interviews and discussions with SLT staff at 13 RTEs and over 30 telephone exchanges, including RSUs, in April, 1995 as well as the same surveys at HQ, and collected various data, information and documents regarding the present situation of O&M activities in SLT.

Visited RTE offices are as follows:

(1) Kandy,	(2) Anuradhapura,	(3) Chilaw,	(4) Kurunegala,
(5) Polonnaruwa,	(6) Galle,	(7) Hambantota,	(8) Matara,
(9) Badulla,	(10) Bandarawela,	(11) Hatton,	(12) Nuwara Eliya,
(13) Kalutara.			

In general, it was observed that a considerable improvements have been applied and implemented by HQ and RTE levels in response to the above recommendations. According to our observation, SLT is taking their successive efforts to improve O&M activities and work procedures.

(1) Improved Items

Followings are those improved items we found:

a) Network Management System

SLT has already applied for foreign financing for establishment of Network Management Centre for switching and transmission network. Operation of the new system will be required when 150K Suppliers Credit Project will be completed in 1997/98.

b) Quality of Services

Application of Quality of Service Indicators has been made since the mid/end of 1993. QoS monitoring data are being collected systematically and reported to management levels on monthly basis.

- Call completion rates are being collected, analysed and reported by Corporate Planning group.
- Faults statistics are being reported by Corporate Planning group also.

c) Traffic Measurement

Traffic measurement, analysis and routine discussion meetings are being held on monthly basis sponsored by DGM Traffic in HQ and being participated by all RTEs. We observed that the traffic meetings are being proceeded in accordance with the Quality Control Concept.

d) New Connection Procedure

Improvement/simplification of new telephone connection procedure have been applied since at the beginning of 1995.

- Commercial procedure was promptly simplified.
- Accordingly, required more than one month period from receipt of application up to call for payment (inform Request for Payment to the applicant) decreased to 1
- 2 weeks period.
- Supply of installation materials has also been improved, even though quantity wise still some problems remained, some RTE is sending his truck to Central Warehouse in Colombo city once a week for obtaining delivery of required materials.
- If there is no technical problem and the required materials are available, now all new connection works from receipt of application up to telephone connection can be completed within one month period according to RTE.

e) Short-term O&M Plan

3 Year O&M Functional Plan was prepared over the time frame of 1995 up to 1997.

f) Repair Centre Activity

Repair Centres of digital switching system are functioning except DX200 switching system.

Damaged cards of OCB 283/E10B and NEAX-61 digital switching systems are being repaired at Repair Centres located at Colombo Central. Repairs can be made 1 to 3 months period.

Damaged cards of 5 ESS digital switching system are sent to Repair Centre in Singapore. Repaired cards are returned to Sri Lanka within 3 months after ordering.

140 damaged cards of DX 200/210/220 digital switching system were sent for repair to manufacturer, since at the end of May 1994 up to April 1995. However, none of the 140 cards have been returned yet (May 1995).
Local Repair Centre of DX 200 switching system will be established at the end of 1995. Therefore, it is expected that the new Repair Centre will accelerate the repair speed of damaged cards.

g) Productivity: No. of staff/1000 DELs are sharply decreasing as shown in the Table below:

Table 11-2-1 Improvement of Productivity

Year	1986	1988	1990	1992	1994
No.of staff/1000DEL	94	87	77	56	42

(2) Items to be Improved

Items still to be improved pointed out by consultants since 1992/3 and some items found by JICA Mission are as follows:

a) One Year O&M Plan
Preparation of Annual O&M Improvement Plan is recommended in order to define routine activities for improvement of facilities/rehabilitations under the programme and with budget.

b) Method and Procedure
O&M methods and procedures of activities at 4 levels should established.

c) Network Management System
Centralised network management system should be organised for controlled maintenance of the switching and transmission systems. However, it is recommended to apply rather simplified management system. One or several monitoring terminals, to be connected to each type of switching system independently, will be installed for each E10B, NEAX, DX 200, AXE at O & M Centres.

A plan to provide sole O&M Centre compatible with several different types of switching system will still require comprehensive studies for essentially required scope of works of the proposed Network Management System, availability of softwares and their cost and benefit comparison.

d) Shortage of External Plant Materials

Though supply of installation materials are being improved, RTE offices are still facing the problem of shortage or none availability of installation materials.

Limitation of budget and complicated tendering procedures are the main causes of the delay of supply or unavailability of materials.

Materials Management system should be further improved with reference to the ITU Recommendation (Refer to Chapter 13).

e) Shortage of Tools, Test Equipment and Required Effective Use of Vehicles

Shortage of these items especially in the field of external plant is generating serious problems in connection with customers' services, lower productivity and cause of potential faults because the fault locations are being executed by Cut-and-try method instead of Measurement by fault locators.

GMM, DGMM and Managers are required to improve the use of construction vehicles for external plant repair/installation, switching and transmission staff for replacement of cards and surveillance, more effectively.

f) Lateral Communications among Planning, Projects and Operation Divisions

Communications are being improved since 1994. However, more closer communications between Planning and Operation Divisions are requested for promotion of urgent projects, to be acknowledged the latest status of proposed projects by Operation Division.

g) Strengthening of New Connection Organisation

SLT holds a lot of waiters which have already cumulated to 186,245 waiters at the end of 1994, in which about 86,000 new registrations were made in 1994 with response to the advertisement on news papers regarding highlighted possibility of new connections, progress of on-going pipe line projects and started projects.

Therefore, SLT decided the target number of new connections in 1995 as 56,000 which is sized as the double work volume compared with that achieved in 1994.

h) Expansion of Customer Services Division

56,000 new connections in 1995 and raised new connection rate up to 90,000 per year in 1997 - 2000, will require a drastic improvement of office work efficiency in each RTE area.

Preparation of the expanded organisation, system and procedures will be the urgent requests.

i) Improvement of Productivity

Following countermeasures are required:

- Improvement of fault clearance speeds by providing tools, test equipment, vehicles, installation materials, and development of the Office Automation (personal computers) at RTE office level.

- Reinforcement of staff converted from analogue technology to the digital technology area by providing training. In the year 2000, it is planned that 100% of switching systems will be digitised.

j) Field Test of Outside Plant Maintenance Programme

Application of the Preventive maintenance to external plant is required so as to reduce occurrence possibility of outside plant faults. Preventive maintenance criteria and practices should be provided by HQ through field tests.

k) Study Adoption of Quick Response Arrestor against Lightning and Cost Review

Subscriber cards of digital switching equipment tend to get damages due to lightning surge which rise up quite sharply in a range of several nano-seconds (ns) to several-ten ns. However, quick response arrestor, e.g., 5-pole arrestor, is usually expensive. Therefore, it is necessary to have cost comparison between the replacement costs of damaged cards and provision costs of high performance arrestor and to have statistical fault data treatment to focus high lightning damage areas.

l) Set up of Target Figures of QoS at each Region

Each Region or each RTE area should have their own target figures of QoS in order to improve their service qualities based on the step by step approach methods, i.e., to set-up more realistic and achievable figures in near future than consolidated nation-wide standard target figure.

The national target figure was set as 10/month/100 DEL. However, the actual fault rate in the area showed 110/month/100 DEL in some RTE area. Therefore, it may be quite difficult for relevant RTE staff to find effective countermeasures to achieve the target figure immediately.

Faults statistics and their causes should be analysed at first then realistic countermeasures would be found and the action programme would give possible target figure with required period to achieve the target figure. Introduction of QC circle for the subject at RTE level is recommended.

m) Quality of Telephone Instrument

Fault rate of the telephone instrument showed 1.2/month/100 DEL according to the nation-wide fault statistics in March 1995. This figure is considered quite high. Therefore, it is necessary to confirm cause of the faults. There may be some causes of occurrence of telephone instrument faults, however, it should be noted that the quality of the telephone instrument should be assured by the manufacturers and guaranteed which should be made before issuance of the Type Approval and purchase.

Assurance should be made by at least 2 items, the one is a guarantee of the products with one year period since delivered. The other is submission of factory inspection certificate. The factories which have Certificate of Registration of a firm of assessed capability of ISO 9000 Series should submit Final inspection/test procedures and data for delivery. Other factories which have no Registration should submit Factory inspection/test specification and procedures. And for delivery of instruments, Inspection and test data carried out based on Factory Inspection and Test Specification provided by SLT should be submitted.

n) Improvement of Plant Recording System

Subscribers lines administration system has to be improved, it should not be relied to personal memories but to datasheets. SLT is intending to apply Subscriber Line Management System (SLMS) to administration, operation and maintenance of the subscribers line system.

The plant records drawings should be updated whenever the change of the plant has been made. The contractor who has carried out some expansion work of the existing network usually submits As-built drawings. SLT have to integrate the

expanded facilities and update the relevant plant records without fail. Maintenance as well as further expansion planning of the facilities will be made based on the updated plant records.

2.3 Quality of Service and Network Performance

According to CCITT Recommendations, two categories of performance measurement, i.e., Quality of Service (QoS) and Network performance (NP) are defined.

The QoS is measured on customer-to-customer basis, while the NP, between the network termination point A and the other network termination point B, eliminating the influence by customer's premises equipment and customer's human factor.

Thus, parameters such as loudness, percentage of calls with excessive distortion or percentage of calls failed due to network congestion are categorised as NP, while the quality of conversation, the successful connection ratio, etc. are categorised as QoS.
To indicate the reliability performance of the network, "Failure Rate" or "MTBF (Mean Time Between Failures)" statistically estimated from data on reported failures are used.

In reporting failures, it is necessary to describe the phenomena of failure and measures taken for fault correction precisely. The fault claimed from a customer sometimes is of "Fault not found" or "Right when tested", and such a fact should be clearly mentioned in the report.

Following items are also important parameters to judge the quality of service of the Service Provider SLT:

- Waiting time to get connection after application
- Errors in Billing and delivery timing of the Bills
- Waiting time to get dial tone and call completion time after dialling

Chapter G. Performance Indicators of the "Master Plan for the Telecommunications Authority of Sri Lanka" mentions that the first item mentioned in the Act (section 4 (a)) as a task for the Authority is "provision of reliable and efficient ... service".

The Master Plan for SLTA mentioned that this should be monitored, and a good way is to monitor performance, using suitable indicators. The following list of performance indicators is recommended as a first set of indicators for monitoring Sri Lanka

telecommunications operators (indicators marked @ are proposed to be monitored per secondary area or RTE area):

Quality of Service indicators

* call completion rate
* maintenance @
* waiting time @
* payphone density
* operator response time
* customer satisfaction @

Efficiency indicators

* usage efficiency
* overall efficiency
* staff productivity
* cost of services
* financial performance

Publishing performance figures (together with international comparison) will establish pressure on operators to improve performance. Reliable statistic is one of the most important tools to monitor performance and is essential for obtaining external financing, as financiers have to know the status of the borrower before granting financing.

(1) Quality of Service & Network Performance

The Master Plan for TASL shows a sample call completion breakdown for clarification purpose, near a good situation as:

answer	60%
no answer	10%
busy	15%
abandoned attempt	10%
congestion	3%
technical faults	2%
total attempt	100%

The measurements of traffic, carried out on monthly basis, were followed up by regular meetings. The summary of the analysed results for 4th quarter of 1994 is given below.

Table 11-2-2 Quality of Services and Network Performance in 1994

Indicators	Abbr.	Oct.	Nov.	Dec.
1.Global Effectiveness Rate	GER	30.95	29.54	28.41
2.Outgoing Ineffectiveness Rate	OIR	72.09	74.34	72.49
3.Incoming Ineffectiveness Rate	IIR	57.38	67.12	63.82
4.Unsuccessful Calls due to Busy No.	UC 1	53.53	46.31	49.57
5.Unsuccessful Calls due to No Answer	UC 2	0.89	3.74	1.03
6.Unsuccessful Calls due to Customer Error	UC 3	31.30	29.64	26.00
7.Unsuccessful Calls due to Exchange	UC 4	4.26	6.12	9.51
8.Unsuccessful Calls due to Forward System	UC 5	19.90	23.63	26.08
9.Unavailability of Service due to Switching Failure	US 1	5.26	8.07	13.40
10.Unavailability of Service due to Transmission Failure	US 2	241.65	119.76	210.97
11.Unavailability of Service due to Power & Air-conditioning Failure	US 3	2.03	45.85	0.33
12.Global Unavailability of Service	GUS	249.69	171.82	161.17

Note:

GER = [Total number of completed calls (outgoing, incoming, local)] / [Total number of calls handled (outgoing, incoming, local)] x 100

Standard GER : 70%

OIR = {1 - [Number of outgoing completed calls (outgoing and local)] / [Number of outgoing calls handled (outgoing and local)]} x 100

Standard OIR : 35%

IIR = {1 - [Number of incoming completed calls] / [Number of incoming calls handled]} x 100

Standard IIR : 35%

UC 1 = [Number of incoming and local non completed calls due to busy subscribers] / [Number of incoming and local calls handled] x 100

Standard UC 1 : 15%

UC 2 = [Number of incoming and local non completed calls due to no answer] / [Number of incoming and local calls handled] x 100

Standard UC 2 : 15%

UC 3 = [Number of outgoing and local non completed calls due to customer error] / [Number of outgoing and local calls offered] x 100

Standard UC 3 : 10%

UC 4 = [Number of outgoing and local non completed calls due to an exchange failure] / [Number of outgoing, incoming and local calls handled] x 100

Standard UC 4 : 0.01%

UC 5 = [Number of outgoing non completed calls due to forward system] / [Number of outgoing calls \handled] x 100

Standard UC5 : 15%

US 1 = [(Number of subscribers equipment involved due to a switching centre fault) x (Total time out of service)] / [(Number of subscribers equipment installed and linked to the SCUs) x (Total duration of operation period (1 month))] x 10 exp 5

US 2 = [(Number of subscribers equipment involved due to a transmission failure) x (Total time out of service)] / [(Number of subscribers equipment installed and linked to the SCUs) x (Total duration of operation period (1 month))] x 10 exp 5

US 3 = [(Number of subscribers equipment involved due to a Power-A/C failure)x (Total time out of service)] / [(Number of subscribers equipment installed and linked to the SCUs) x (Total duration of operation period (1 month))] x 10 exp 5

GUS = [Unavailability of service due to switching failure] + [Unavailability of service due to transmission failure] + [Unavability of service due to Power-A/C failure]

High rate of the party "busy" and low rate of "no answer" mean a lot of high traffic subscribers exist. Therefore, it is important to advise subscribers with high traffic to apply for more DELs to be provided and to lower the traffic per telephone set.

Table 11-2-3 Call Completion Rates in Asian Countries in 1991

Country	Main Telephone Lines (x1000)	MTL/100 Inhabitants (%)	Call Completion Rate (%)
Bhutan	2.4	0.15	56.1
Laos	6.5	0.15	50
Indonesia	1,276.6	0.68	39.4
Sri Lanka	125.8	0.73	30
Philippines	647.9	1.03	30
Thailand	1,553.2	2.73	54.5
Maldives	7.6	3.42	52
Malaysia	1,816.9	9.91	50
Singapore	1101.1	39.85	70
Japan	56,252.9	45.39	83.5

Note :

Data extracted from "World Telecom Visual Data" issued by New Japan ITU Association, June 1993, "Asia-Pacific Telecommunication Indicators" issued by ITU, May 1993 and "Yearbook of common Carrier Telecommunication Statistics" issued by ITU, 1993.

(2) Target Call Completion Rates

Present status of Call Completion Rate of SLT nation-wide is 28% in 1994. Considering the other countries status and the present conditions in Sri Lanka, following target figures are recommended:

Table 11-2-4 Target Call Completion Rates

Item/Year	1994	2000	2005	2010	2015
Call completion rate	28%	45%	55%	63%	70%

Following items are the recommended ACTIONS in order to achieve the above targets:

a) To increase the number of DELs for high traffic subscribers,
b) To promote application of Pilot Numbers (Hunting system) and application of Call Waiting Service,

c) To campaign to reduce Incorrect dialling by subscribers,

d) To expand trunk lines

(3) Faults Status

Number of faults/month/100 DELs in the year 1994 are shown in the Table below. According to the Table below, the number of faults in the Regions are twice higher than that of in the Metro area. Obsolete outside plant facilities are still being used in the regions, e.g., paper insulated lead sheathed cables, open wires.

Table 11-2-5 Monthly Faults per 100 DEL for the Year 1994

month	Metro	Regions	Total
Jan	14.35	31.96	23.15
Feb	14.87	32.82	23.85
Mar	16.52	34.15	25.33
Apr	14.17	36.74	25.46
May	17.39	38.61	28.00
Jun	17.84	40.92	29.38
Jul	18.31	39.49	28.90
Aug	16.14	33.50	24.82
Sep	18.45	37.59	28.02
Oct	18.75	32.58	25.66
Nov	18.35	32.79	25.57
Dec	16.26	31.33	23.80
Average	16.78	35.21	25.99

Average monthly faults per 100 DEL is 26. It means that one subscriber will suffer a trouble once every four months.

Number of faults/month/100 DELs in each RTE area in March 1995 are shown in the Table below.

Table 11-2-6 No. of Faults/month/100 DELs in March 1995

RTE/ SSC	No.of DEL	No.of Faults	Faults/ 100DEL	RTE/ SSC	No.of DEL	No.of Faults	Faults/ 100DEL
Metro				Region			
Central	46,632	4527	9.7	Kandy	8,932	2,562	28.7
Maradana	16,644	2235	13.4	Battikaloa	1,667	387	23.2
Havelock	17,885	1370	7.7	Trincomale	873	313	35.8
Mt.Lavinia	20,725	3048	14.7	Vavuniya	716	204	28.4
Nugegoda	15,419	1969	12.8	Anuradhapura	2,824	645	22.8
Kotte	8,706	2010	23.0	Chilaw	1,946	492	25.3
				Kurunegala	3,877	710	18.3
				Avissawela	1,920	487	25.3
				Kegalle	2,033	724	35.6
				Ratnapura	2,710	812	30.0
				Galle	3,569	774	21.7
				Hambantota	2,840	471	16.6
				Matara	1,834	1,896	103.4
				Badulla	2,743	775	28.3
				Bandarawe	2,400	506	21.0
				Hatton	1,093	221	20.2
				Nuwara Eliya	1,589	455	28.6
				Gampaha	2,146	1,084	50.5
				Kalutara	4,771	1,409	29.5
				Negombo	5,258	1,693	32.2
Average			12.0	Average			29.8

Following Table shows percentage of faults occurred by place according to the statistics of March 1995 for the above 26 RTE areas.

Table 11-2-7 Faults Occurrence Ratio by Places

Item	Exch-ange	MDF	Under-ground	Over-head	Internal Wiring	Instru-ment	Total
Ratio by Place	7%	1%	9%	70%	5%	8%	100%

As shown in the above Table, majority (70%) of the faults are being occurred at the Overhead portion (Drop wires) and about 10% of the faults occurred at underground cable portion. Rate of telephone instrument faults of 8% is high rate. About 90% of the faults are being occurred at outside plant and subscriber premises portion.

Table 11-2-8 Monthly Faults Cleared within 24 Hours in Year 1994

Month	Metro	Regions	Total
Jan.	38.85	54.02	46.44
Feb.	50.38	62.48	56.43
Mar.	50.51	64.35	57.43
Apr.	59.60	62.80	61.20
May.	47.35	65.61	56.48
Jun.	48.82	62.35	55.59
Jul.	54.13	61.00	57.57
Aug.	46.81	67.58	57.20
Sep.	50.00	66.04	58.02
Oct.	43.92	62.81	53.35
Nov.	42.43	55.05	48.74
Dec.	50.08	58.32	54.20
Average	48.57	61.87	55.22

About half of the faults are being repaired in the next day. However, remaining half faults can not be repaired in the next day. Considering the nature of the faults, i.e., about 70% of the faults are occurred at drop wire portion, and 10% are at subscribers' premises, this clearance rate is rather low.

Table 11-2-9 Faults/month/100 DELs & Fault Clearance Rates in Asian Countries in 1991

Country	Faults/month/100DEL	Faults Cleared Next Day (%)
Bhutan	16.2	80
Laos	10.1	30
Indonesia	4.2	73
India	17.4	84
Pakistan	10	80
Philippines	6	78
Thailand	4.3	89
Maldives	4.7	81
Malaysia	6.5	93
Singapore	1.1	N.A.
Newzealand	3.8	95
Japan	0.5	N.A.

Note :

Data extracted from "World Telecom Visual Data" issued by New Japan ITU Association, June 1993, "Asia-Pacific Telecommunication Indicators" issued by ITU, May 1993 and "Yearbook of common Carrier Telecommunication Statistics" issued by ITU, 1993.

(4) Target Fault Rates and Clearance Rates

Based on the above situations, the following target figures for the Faults/month/100 DELs and Faults Clearance Rates are recommended:

Table 11-2-10 Target Faults Rate & Clearance Rate

Item/Year	1994	2000	2005	2010	2015
Faults/month/100DELs	26	15	10	7.5	5
Faults clearance rate next day (24 hours)	55%	85%	90%	93%	95%

Following items are the recommended actions in order to achieve the above targets:

a) To replace unreliable overhead lines,
b) To improve lightning protectors,
c) To up-grade skill of maintenance staff,
d) To modernise customer service management,
e) To reinforce maintenance teams.

2.4 New Connections

Master Plan for TASL mentions that according to available information SLT administers a very strict waiting list order of connection of subscribers. Even if there is switching capacity as well as loop capacity, waiting customers will not normally be connected if not at the top of the waiting list. This seems to contribute to low utilisation rate of the network. It is necessary to increase the new telephone connection capability of SLT.

Table 11-2-11 Achieved New Connections in 1993 and 1994

Month	New connections in 1993			New connections in 1994		
	Metro	Regions	Total	Metro	Regions	Total
Jan.	623	223	846	1,581	542	2,123
Feb.	1,962	400	2,362	1,440	430	1,870
Mar.	1,586	431	2,017	1,615	478	2,093
Apr.	828	336	1,164	1,219	395	1,614
May.	809	344	1,153	1,704	428	2,132
Jun.	1,422	532	1,954	1,752	560	2,312
Jul.	1,160	638	1,798	1,917	618	2,535
Aug.	1,008	534	1,542	1,987	509	2,496
Sep.	1,200	596	1,796	1,661	498	2,159
Oct.	1,279	705	1,984	1,400	530	1,930
Nov.	1,705	698	2,403	1,595	509	2,104
Dec.	2,592	659	3,251	1,419	535	1,954
Total	**16,174**	**6,096**	**22,270**	**19,290**	**6,032**	**25,322**
Average	1,348	508	1,856	1,607	503	2,110
Improved Rate	-	-	-	+20%	-1%	+14%

At present, more than 50% of the new connections are being given to private contractors, and achieved new connections in the year 1994 were about 25,000.

However, sharp growing of telephone demand is recently observed and the actual telephone expansion projects are in progress. In addition to the above, the 150K Suppliers Credit Project is expected to be completed in the year 1997 also.

Therefore, it is a quite urgent request to reinforce new connections capability of SLT for both hardware and software fields. Following is the new connection schedule in accordance with the long term demand forecast:

Table 11-2-12 Demand, No.of DELs, New Connections & Waiters in Planning Period

Unit: x1000

Year	1995	1996	1997	1998	1999	2000	2001	2005	2010	2015
Demand	481	511	546	586	630	678	732	979	1,311	1,663
No.of DELs	237	307	397	487	577	667	732	979	1,311	1,663
New Con-nections	56	70	90	90	90	90	65	247 *1	332 *2	352 *3
Cumulated Waiters	244	204	149	99	53	11	0	0	0	0

Note : *1 : 2002~2005, *2 : 2006~2010, *3 : 2011~2015

2.5 Quality Control Activities

Quality control activities have been started in 1994. However, the activities are still in an initial stage. Traffic measurements and analysis meetings being held on monthly basis are a part of SLT quality control activities.

3. Urgent Operation and Maintenance Improvement Plan

3.1 Items to be Improved

According to the foregoing paragraph (2) Items to be Improved of sub-section 2.2 Operation and Maintenance at Present, some urgent actions are required for the following items:

a) Strengthening of new connections organisation and development of Customer Service system,
b) Improvement of productivity, call completion rate, faults clearance speed, training, staff work efficiency, and set-up QoS at each Region,
c) Preventive maintenance programme for outside plant and to decrease occurrence of external plant' faults,
d) Study adoption of quick response lightning arrestor,
e) Confirmation of quality of telephone instrument,
f) Annual O&M Improvement Plant,
g) Methods and procedures for O&M activities,
h) Financing and installation of Network Management Centre for switching and transmission,
i) Supply of outside plant installation and repair materials, tools, test equipment and vehicles,
Improvement of Materials Management system,
j) Improvement of lateral communications through expansion of MIS project, estimated project cost is Rp.100 million, to be fiancee by self fund,
k) Improvement of Plant Record system.

3.2 Strengthening of New Connections Capability

(1) Necessity to Strengthen New Connections Capability

SLT holds a lot of waiters which have already been cumulated to 186,245 waiters at the end of 1994, in which about 86,000 new registrations were made in 1994 with response to the advertisement on news papers regarding highlighted possibility of new connections, progress of on-going pipe line projects and started projects.

On the other hand, achieved number of new connections in 1994 were 25,322 DELs, it means that achieved average new connections per month was 2,110 DELs. If the new connections in 1995 were proceeded with the same pace done in 1994, elimination of the cumulated 186,000 waiters will take about 88 months or 7.3 years according to the simple calculation (186,245/2,110=88).

It is expected that about 176,000 lines of switching capacities will become available at the end of 1995 according to the schedule of on going projects. Besides, at the end of 1997, the total switching capacities will be reached up to 620,000 lines including 150K Suppliers Credit Project. Subscribers' lines networks are also expanded to cope with the expansion scale of switching equipment.

At present the average waiting period is about 5 years long (longest waiting period is 10 years). Therefore, average waiting periods should be decreased as soon as possible. It should be to realise 3 years waiting period up to the year 1997/98, 2 years waiting period at the year 1998/99 and finally it should be reached to the target figure of waiting period within one year at the year of 2000/01.

Accordingly, 90,000 new connections per year pace of new connections will be required through the years 1997 - 2000. This target figure of new connections can be realised by obtaining the assistance of private sector (contractors).

According to the demand forecast, annual increase of the demand is estimated 30,000~80,000 from 1995 up to 2015. After conquering the busiest periods of 1995~2000, therefore, SLT will have an enough capabilities to make new connections within a waiting period of one year if other switching and external plant capacities have been installed on schedule.

As for immediate request, therefore, SLT decided the first target number of new connections in 1995 as 56,000 which is sized as the double work volume compared with that achieved in 1994.

(2) Expansion of Customer Services Division

56,000 new connections in 1995 and raised new connection rate up to 90,000 per year in 1997 - 2000, as mentioned above, will require a drastic improvement of office work efficiency in each RTE area.

Because all procedures for registration of applicants up to completion of the connections have to be done by SLT itself. The procedural workloads to be given to RTEE and arrangement of efficiency improvement procedures to be done by HQ are quite large. These works have to be absorbed by expanding the workforces of Customer Services Divisions with the aid of computers (Office Automation).

Preparation of the expanded organisation, system and procedures will be the urgent requests. As a conclusion, SLT should entrust a lot of new connection works to the contractors, expand Customer Service Division and develop Office Automation.

3.3 Improvement of Training Facilities

As described in Chapter 12. Human Resources Development Plan, the strengthening of the capabilities of Telecom Training Centres by means of the purchase of training facilities, dispatch of foreign experts and consultants, training of TTC instructors, follow up of instructors and management staff of TTC, and provision of text books and references are required. SLT proposed for financing for the project with estimated cost of Rp.500 million (US$ 10 million).

3.4 Network Management System

(1) Network Management Centre

In order to realise the most effective and maximum utilisation of the existing telecommunications network, it is requested to apply Network Management Centre for Switching and Transmission in the 3rd Telecommunications Development Programme. For the operation of the new network management system, O&M organisation, operating system and procedures, and training of human resources are required.

a) Standardisation of formats of data which are required for the judgement of network performance ability, i.e., call completion rate, faults status, etc.

b) Standardisation of Data collection, reporting and analysing procedures.

c) Existence of the organisation which continuously analyse the reported data and to assemble the conclusions which are obtained from the analysis results.

d) Existence of powerful organisation which formulate actual improvement implementation plan , budgeting and execution.

e) Availability of well trained staff who are to execute above mentioned various activities.

Since SLT has applied the above new technologies and assignment into its own organisations in the mid of 1993, SLT have obtained many statistical data and the derived conclusions and implementation plans which are effectively being applied at present.

In case of digital switching and transmission systems, probability of fault occurrence became negligible small. Therefore, the necessity of corrective maintenance becomes quite small compared with the necessity of controlled/preventive maintenance.

The meaning of controlled maintenance is understood as an improvement of network performance through data collection, using centralised supervisory facilities, analysis thereof and taking appropriate countermeasures. As mentioned in the above paragraph 2.2 (1), however, the centralised network management system to be applied at this time should be as simple as possible.

SLT Operation Division will prepare O&M Action Plans periodically (annually, semi-annually, quarterly) with provision of budgets and give work order to related RTEs, furthermore, prepare requests to the SLT Planning Division about Telecom Facilities Improvement Projects.

For firm implementation of the good quality installation work and corrective maintenance work in case of the External plant system, Standardisation of Practices, Engineering criteria, SIP (Standard Installation Practice), SOP (Standard Operation and Maintenance Practice), are quite important request. However, in case of digital switching equipment and transmission equipment, the preventive procedures have been incorporated in the software and the importance is stressed to improve the call completion by analysing the causes of low call completion rate and taking appropriate countermeasures.

(2) Subscriber Line Management and Operation System

In connection with the subscriber lines management, SLT proposed to apply "Subscriber Line Management and Operation System" which is:

a) To improve efficiency and effectiveness of subscriber line maintenance functions using limited human resources,
b) To implement a controlled maintenance policy for subscriber line maintenance as compared to the corrective maintenance being carried out presently,
c) To enhance the quality of service to subscribers by carrying out maintenance on outside plant even before they are aware that a fault has occurred.

This project involves the provision of the following components:

a) A study to find the optimum number and location of the subscriber line management systems,
b) The provision of the necessary hardware, software, and communication facilities required for the subscriber line management and operation system,
c) consultant services,
d) Training for SLT staff.

3.5 Safety Measures

Following is prepared as an example of safety measures in order for SLT to set up a Standard Practice for safety measures.

3.5.1 Safety Policy

It is an objective of the Company management to prevent all injuries to employees, third parties and any loss or damage to plant or property whilst at the same time achieving installation, maintenance works. To ensure that the desired results are achieved, the following safety and loss prevention policy and working arrangement are laid down:

(1) Company Responsibility

Ultimate responsibility for overall safety and control of losses rests with the management of the Company. To allow operation in a practical frame work, management delegates the responsibilities for implementation of all required safety procedures, methods, designs and technical safeguards. Authority is delegated to Department Managers and to all supervisory personnel in all line functions in the same manner and to the same degree as their responsibility for installation and maintenance is delegated.

(2) Individual Responsibility

Each individual has a responsibility in his own right to act a safe manner. Having been taught how to act in a safe manner by the Company it is everyone's responsibility to continue to act in a safe manner using all relevant procedures and equipment.

(3) Incident Reporting System

An incident reporting system is set up to report any undesired event that either results in or could result in, injury or loss and downgrades the efficiency of SLT operation.

Reporting should include but is not limited to such things as :

a) Personal injury,
b) Damage to plant and equipment,
c) Damage to third party's property,
d) Fire,
e) Theft.

(4) Safety Committee and Responsible Person

Safety Committee is established in Headquarters, Regions and RTEs. GMM Projects, Metro, Regions will be the chair persons of the Committee in Headquarters and Regions levels and RTEE will be the chair persons of the Committee at RTE areas. GMM Metro and Regions will assign a responsible person in each telephone exchange office, RSU, repeater station, etc.

The works involved in laying or withdrawing of cables are mainly performed on roads. These works are indispensable prerequisite to ensure sufficient protection and safety measures for not only SLT employees performing the works but also general passers-by and vehicles. RTEE will assign a responsible person in each installation team for safety works and accident prevention.

3.5.2 Safety Provisions

(1) Work on Road

Utmost care shall be taken for the installation and maintenance works on road, especially the road with high traffic or vehicles are running with high speeds, by providing signals, warning signs, lightings, traffic control persons, etc.

Prior to starting installation or maintenance works on roads, approval of occupying the roads for the works shall be obtained from the relevant authority, owner, administrator or police station. Date, period of the works, features of the works, safety measures to be applied, traffic control methods ,etc., should be informed to the authority together with the said application for approval of road occupancy.

a) Signals, Communication Equipment

A uniform standard signal system shall be used on all operations.

Hand signals may be used during laying of underground cables into ducts, erection of poles, laying of wires, messenger wires and overhead cables.

Traffic Control Signals may be used where restriction of vehicles running is required during cable laying works by means of either Lighting, Signs and/or Flags with traffic control men.

Radio equipment, transceivers, telephones shall be used when a distance between traffic control men at the both ends is long.

Traffic control men shall be dependable and qualified by experiences with the operation.

b) Signs, MH Screens, Barricades, Warning Markers, Ropes, Lightings

Signs indicating "Under Construction" and barricades shall be placed to provide adequate warning of hazards to the public.

In addition, manhole screen shall be placed at manhole location in case of underground cable works.

Warning red flags and instruction markers shall be placed at least one set and more flags and markers where the circumstances required.

A distance of restricted traffic is longer, then the range of restricted area should be shown by stretching the rope or tape along side the work area border.

In case the work should be done at night, it is necessary to install night markers and lightings, i.e., illumination electric lights for signs, light reflectors, flashing warning lights for the pedestrians and vehicle drivers.

(2) Clothing and Protective Equipment

a) External plant personnel shall be provided with, and must wear, uniform, safety hats (helmets), hand protections (gloves), and safety boots issued by the Company. Cloths shall be inspected regularly and maintained in serviceable and sanitary conditions. Persons who work on poles shall be provided with linemen's safety belts.

b) Persons who work on microwave antenna towers shall have the same provisions with external plant persons.

(3) Poisonous Gases inside Manholes and Cable Vaults

a) Instrument shall be provided to test atmospheres for poisonous gases standing inside Manholes and Cable vaults. Poisonous gas detector shall be used prior to entering the manholes and cable vaults.

b) Air ventilation equipment shall be employed before entering the manholes and cable vaults.

c) In case if the flame by torch lamp or other means must be used inside manhole, special attention is required for confirmation of no remaining of any flammable gases inside MH so as not to cause any explosion of the gas and accordingly damages to cables inside MH.

3.6 Preventive Maintenance Procedure

(1) Scheduled Maintenance to Decrease Faults

As described at the beginning part of this Chapter 11, Preventive Maintenance is the maintenance carried out at predetermined intervals or according to prescribed criteria and intended to reduce the probability of failure or the degradation of the functioning of the facilities. The preventive maintenance should be applied to external plant maintenance.

(2) Replacement of Overhead Facilities to Improve Customer Service

According to the Faults statistic data shown in the Table 11-2-7 Faults Occurrence Ratio by Places, 70% of the faults are being occurred at Overhead part (Drop wires or Open wires). Therefore, intentional efforts to decrease the No. of faults effectively will be to focus the efforts to improve the overhead facilities.

In regional areas, overhead facilities are made of either steel reinforced drop wires or 2 separate copper wires with insulations which are installed on insulators like open wire installation. Main cause of the faults of overhead facilities are expected to be loose contacts due to many joint portions of copper wires existed between DP (Distribution point) and subscriber premises and also obsolete facilities. If this section will be replaced by a new drop wire without intermediate jointings, the number of faults will be drastically decreased.

SLT's revenue loss due to overhead facilities faults is estimated to Rp.148 million in 1994. It means that each subscriber could not use his telephone set during no service period of 5.7 days per year and the revenue in amount of Rs.820 per year was lost by SLT due to overhead facilities troubles.

If the replacement of drop wire cost is assumed to Rs.6,000/subscriber, the invested replacement cost will be recovered in 7.3 years. Accordingly, from the 8th year since replacement has been made SLT will get additional revenue of the amount of Rs.820/year/subscriber.

However, the subject of the improvement of customer service is quite important and it is not merely the subject of cost and revenue. Therefore, it is considered the urgent request to replace faulty overhead parts and accordingly to improve the customer service.

Basis of the above calculations are as follows:

a) Revenue, international & domestic calls : Rs.9,495 million in the year 1994
b) No. of subscribers in 1994 : 181 thousand subs.
c) Revenue/day/subscriber in 1994 : Rs. 144/day/subs.
(Rs.9,495,000,000/181,000/365)
d) Total No. of faults occurred in 1994 : 565,000 faults/year
(0.26/month/DEL x 181,000 subs x 12 months)

e) No. of faults occurred at overhead part : 395,000 faults/year
(565,000 x 0.7)

f) Frequencies one subscriber suffer faults at overhead part in a year : 2.2 times/year
(395,000/faults/year / 181,000 subs.)

g) No. of required repair days per fault : 2.6 days/fault
(50% of faults repaired 24 hours (1 day) + 35% of faults repaired 3 days + 15% of faults repaired 7 days)

h) No. of No connection days/year/subs.
due to overhead part fault : 5.7 days/year/subs.
(2.2 times/year x 2.6 days/fault)

i) Revenue loss/year/subs : Rs.820/year/subs.
(5.7 days/year/sub x Rs.144/day/subs.)

j) Revenue loss total due to overhead faults : Rs.148 million
(Rs.820/year/subs x 181,000 subs.)

k) Replacement cost on overhead part : Rs.6,000/subs.
(Service costs : Rs.3,000/subs.)
(Costs of materials, tools, equipment, vehicles, etc.: Rs.3,000/subs.)

(3) Field Test of Outside Plant Maintenance Programme

As described at item j) Field test of Outside Plant Maintenance Programme, of paragraph (2) Items to be Improved of sub-section 2.2 Operation and Maintenance Situation at Present, a Rehabilitation (Replacement) project of Overhead facilities (Drop wires) should be applied to some selected exchange areas.

Steps to be taken for the subject will be as follows:

a) To choose some RTE areas with high fault rates,
b) To analyse fault statistics in detail,
c) To thoroughly survey at sites and clarify technically the causes of the overhead facilities faults,
d) To establish the appropriate countermeasures and measure the effectiveness,
e) To prepare implementation schedule, budgeting, manpower and materials allocations,
f) To execute countermeasures,
g) From the above field trial, the Standard Installation Practices can be formulated,
h) SIP will be applied to other RTE areas.

4. Future Operation and Maintenance Improvement Plan

4.1 Organisation and Job

(1) Adaptation of Intermediate Level Management Organisation

a) Decentralisation of Management

At present, a size of the network in SLT is approximately 240,000 lines. However, in the 10 years time to come, the size of SLT network will be expanded to the order of one million lines.

In order to control and manage an expanded huge network, the managerial organisation should be coherent with the network organisation.

Therefore, decentralisation of the SLT organisation within 5-10 years to come should be an inevitable request.

Before decentralisation of Headquatrers organisation, it is necessary to strengthen the Headquarters present status of functions and completely establish all job procedures so that Regional offices will not have any confusion for their new works when the decentralisation is made.

On the other hand, the Headquarters tasks should be relieved of the operational details and to be concentrated to the functional management tasks.

Transfer of Headquarters functions to lower level organisation should be started from O&M concerned functions.

b) Intermediate Level Management Organisation

4~5 Regional organisations are recommended to be established as receiving organisation of the decentralisation. Each TSC location should be the location of the Regional office. Present 9 DGM Regions and Metros should be integrated to the new Regional offices.

c) TSC Area as Managerial Area

A limited number of qualified Engineers have to be spread over to whole Regions. The Network Management system (TMN/NMS) are introduced and the remote control system of the network becomes available. Therefore, now the managerial area boundary should be enlarged based on the enlarged maintenance surveillance area of NMS.

It is considered appropriate that one managerial area will be each TSC area (Tertiary Switching Centre area) which was advised also in the SOFRECOM study

report. Therefore, it is recommended to merge present sub-division of 7 regions in the Regional Area into 3 TSC areas in order to greatly improve the business productivity (TSC : Galle, Kandy and Anuradhapura).

d) Greater Colombo Area
Two alternatives are considered;

- **Option 1 :** One managerial area, as the network in greater Colombo area is one self unity eventhough the network configuration is hierarchically consisting of NSC, TSC, SSC and LE but TSC and SSC in Colombo area are virtual,
- Greater Colombo area is one Local Area, and integrated management under one hand is advisable.

- **Option 2 :** Two M.A.,i.e., Colombo Metro & Colombo Outskirts Region, as new TSC Negombo will be established, the Colombo managerial area may be broken into two M.A.

(2) Job

a) Headquarters level functions (HQ level) should be concentrated to Administrative jobs such as:
- Preparation of Operation and Maintenance Policies,
- Issuance of Instructions,
- Standardisation of Methods and Procedures,
- Negotiation, liaison with other HQ divisions, other domestic, foreign parties,
- Preparation, approval of Budget,
- Administration of budget consumption, work progress, QoS, NP improvement, network management.

b) Maintenance area office level functions (RTE/SSC level) should be such as:
- Day to day operation and maintenance works,
- Customer relations,
- Material management,
- Small projects, and new connections,
- Periodic measurements of traffic, QoS and performance indicators and reporting.

c) Intermediate managerial level functions (Region level) should be such as:
- Improvement of the networks,
- Higher level trouble shooting for operation and maintenance,
- Monitoring, analysis and instruction for improvement of traffic, QoS and performance indicators,
- Contracting of new connections, repair works,
- Preparation of regional budget,
- Administration of budget, work progress, human resources.

(3) Management by Objective

In order to improve the effectiveness and efficiency of the SLT business activities, the company have to take efforts to improve the productivity. Therefore, it is necessary to cultivate the capability of individual SLT staff and delegate the authorities to each level of SLT staff. The each staff should understand the business objective and work actively and challenge toward realisation of the targets assigned to him.

Management by Objective cycle is as shown below:

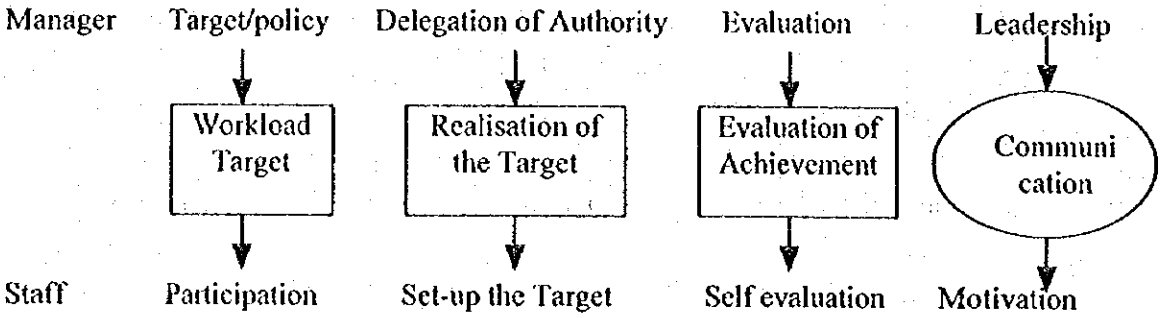


Figure 11-4-1 Management by Objective

4.2 Target Quality of Services

The subject has been discussed in the Sub-section 2.3 Quality of Service and Network Performance. The following table shows the target QoS:

Table 11-4-1 Target Quality of Service

Item/Year	1994	2000	2005	2010	2015
Call completion rate	28%	45%	55%	63%	70%
Faults/month/100DELs	26	15	10	7.5	5
Faults clearance rate next day (24 hours)	55%	85%	90%	93%	95%

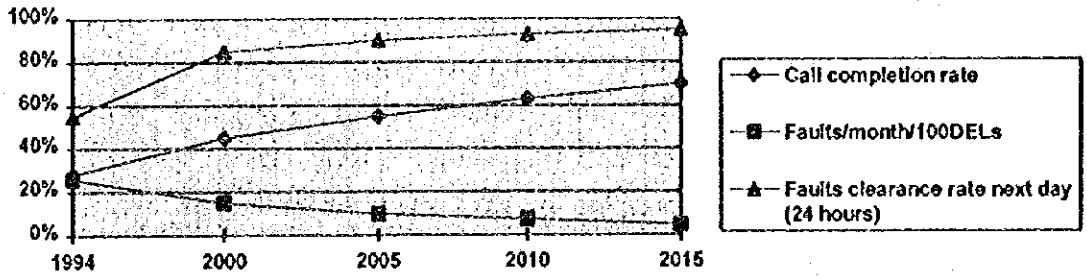


Figure 11-4-2 Target Quality of Service

4.3 Total Quality Control System

SLT has already started the Quality Control activities such as traffic measurement and analysis meeting. However, it is recommended to further expand these activities in other fields, for instance, improvement of external plant, decrease of faults occurrence and speed up of fault clearances.

The following is a brief explanation of TQC. The explanation is mainly extracted from "Kaizen, the key to Japan's competitive success", author Mr. M. Amai, issued by McGraw-Hill Publishing Company.

4.3.1 Quality Control System

(1) Definition to Quality Control

The terms of Quality control, Total quality control and Quality are defined as follows:

Quality Control is a system of means to economically produce goods or services that satisfy customer requirements. When QC was firstly introduced in 1950, the main emphasis was on improving product quality by applying statistical tools in the production processes. Now, QC is used as a tool to build a system of continuing interaction among all elements responsible for the conduct of a company's business so as to achieve the improved quality that satisfies the customer's demand.

Total Quality Control is the organised QC activities involving everyone in a company - managers and workers - in a totally integrated effort toward improving performance at every level. This improved performance is directed toward satisfying such crossfunctional goals as quality, cost, scheduling, manpower development, and new product development. It is assumed that these activities ultimately lead to increased customer satisfaction. (also referred to as CWQC - Company-Wide Quality Control).

Quality is anything that can be improved. In TQC, the first and foremost concern is with the quality of people. A company able to build quality into its people is already halfway toward producing quality products. The three building blocks of business are Hardware, Software and Humanware. Only after the Humanware is squarely in place should the hardware and software aspects of business be considered. According to the JIS (Japan Industrial Standards), the term of TQC is also explained as follows:

Implementing quality control effectively necessitates the co-operation of all people in the company, including top management, managers, supervisors, and workers in all areas of corporate activities such as market research and development, product planning, design, preparation for production, purchasing, vendor management, manufacturing, inspection, sales and after-services, as well as financial control, personnel administration, and training and education. Quality control carried out in this manner is called company-wide quality control or total quality control.

In order to satisfy customer requirements, essential 3 conditions to QC system are QCS (Quality, Cost, Scheduling). Quality products or quality service within a certain reasonable costs have to be delivered to customers within a certain limited period.

(2) PDCA Cycle

The PDCA (Plan, Do, Check, Action) Cycle is an adaptation of the Deming wheel. Where the Deming wheel stresses the need for constant interaction among research, design, production, and sales, the PDCA Cycle asserts that every managerial action can be improved by careful application of the sequence: plan, do, check, action.

As for refinement of the PDCA Cycle, it will be useful to apply SDCA (Standardise, Do, Check, Action) Cycle, i.e., management decides first to establish the standard before performing the regular PDCA function.

Steps of Plan, Do, Check and Action are explained as follows:

a) Plan: It begins with a study of the current situation, during which data are gathered to be used in formulating a plan for improvement.
The study is made by using statistical tools such as the seven tools of QC as shown in later part.

b) Do: Once this plan has been finalised, it is implemented by applying the above plan.

c) After that, the implementation is checked to see whether it has brought about the anticipated improvement.

d) When the experiment has been successful, a final action such as methodological standardisation, institutionalisation of the improvement is taken to ensure that the new methods introduced will be practised continuously for sustained improvement.

The series of PDCA activities are cyclic and the improvements/upgrading should be continued. PDCA Cycle and Problem solving cycle are illustrated in the Figures 11-4-3 and 4.

(3) Standardisation of Results

Any kind of implementation, i.e., planning, designing, manufacturing, installation, operation, maintenance, consist of 4M elements (Man, Machine, Material, Method). There must be a precise standard of measurement for every manager, every worker, every machine, every material, and every process. Without standards nobody knows the starting point of work improvement exactly. Management have to understand where the company stands and what the work standards are. Managements' job is to establish standards and then to introduce discipline so that the standards are maintained.

So as to proceed the improvement in an effective way, to take the following 3S actions becomes very important works to be elaborated by managers:

- Standardisation of the elements,
- Simplification of a series of jobs,
- Specialisation of work fields.

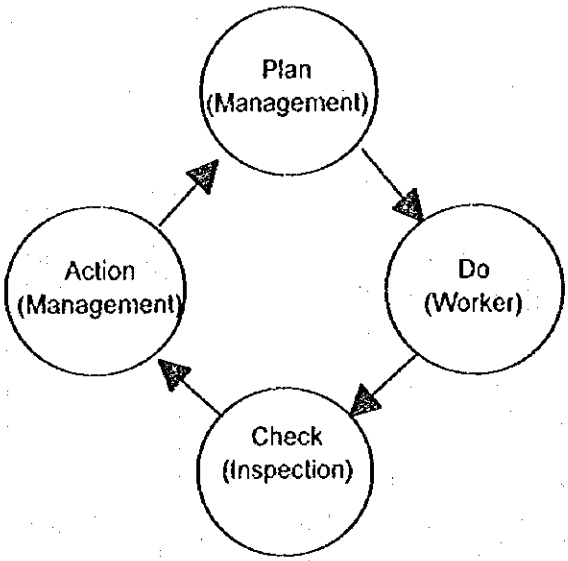


Figure 11-4-3 PDCA Cycle

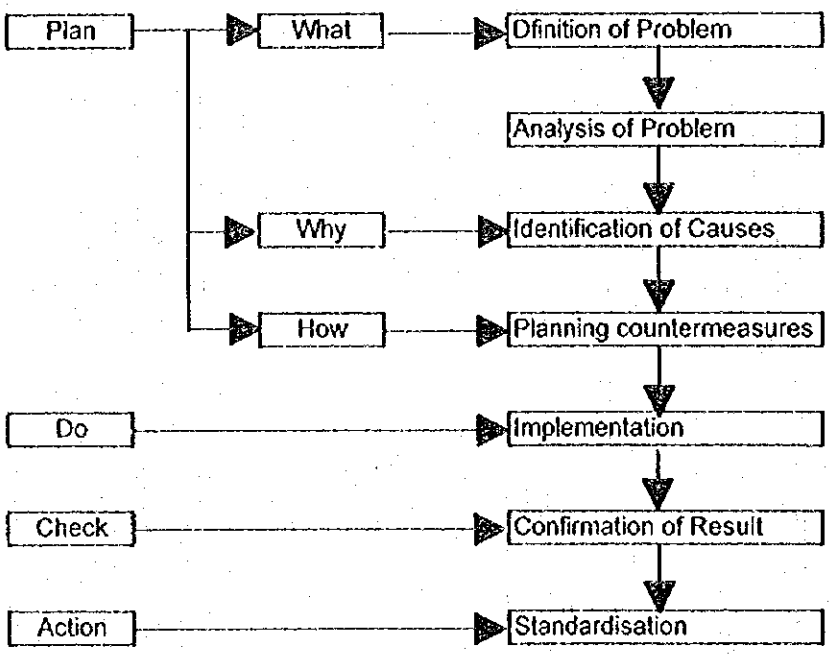


Figure 11-4-4 Problem Solving Cycle

(4) The Seven Statistical Tools (Problem Solving Tools)

This approach is applied when data are available and the job is to analyse the data to solve a particular problem.

a) Pareto Diagrams

These diagrams classify problems according to cause and phenomenon. The problems are diagrammed according to priority, using a bar-graph format, with 100 percent indicating the total amount of value lost.

b) Cause-and-effect Diagrams

These diagrams are used to analyse the characteristics of a process or situation and the factors that contribute to them. Cause-and-effect diagrams are also called "Fishbone Graphs" or "Godzilla-bone Graphs".

c) Histograms

The frequency data obtained from measurements display a peak around a certain value. The variation of quality characteristics is called "Distribution", and the figure that illustrates frequency in the form of a pole is referred to as a Histogram. This is used mainly to determine problems by checking the dispersion shape, centre value, and nature of dispersion.

d) Control Charts

There are two types of variations: the inevitable variations that occur under normal conditions and those that can be traced to a cause. The latter are referred to as "abnormal". Control charts serve to detect abnormal trends with the help of graphs. These graphs differ from standard line graphs in that they have control limit lines at the centre, top, and bottom levels. Sample data are plotted in dots on the graph to evaluate process situations and trends.

e) Scatter Diagrams

Two pieces of corresponding data are plotted in a scatter diagram. The relation between these plotted dots illustrates the relationship between the corresponding data.

f) Graphs

There are many kinds of graphs employed, depending on the shape desired and the purpose of analysis. Bar graphs compare value via parallel bars, while line graphs are used to illustrate variations over a period of time. Circle graphs indicate the categorical breakdown of values, and radar charts assist in the analysis of previously evaluated items.

g) Checksheets

These are designed to tabulate the results through routine checking of the situation.

(5) The New Seven QC Tools

In many management situation, the necessary data are not always available and what data available are in the minds of people concerned and not in the status of quantitative but rather subjective. Therefore, it is necessary to go beyond the analytical approach and to use a design approach to problem solving. The New Seven QC Tools are useful tools to find solutions for these cases.

a) Relations Diagram

This diagram clarifies the interrelations in a complex situation involving many interrelated factors and serves to clarify the cause-and-effect relationships among factors.

b) Affinity Diagram

This is essentially a brain storming method. It is based on group work in which every participant writes down his ideas and the ideas are then grouped and realigned by subject matter.

c) Tree Diagram

This is an extension of the value engineering concept of functional analysis. It is applied to show the interrelations among goals and measures.

d) Matrix Diagram

This format is used to clarify the relations between two different factors. The matrix diagram is often used in deploying quality requirements into counterpart (engineering) characteristics and then into production requirements.

e) Matrix Data-analysis Diagram

This diagram is used when the matrix chart does not provide sufficiently detailed information. This is the only method within the New Seven that is based on data analysis and gives numerical results.

f) PDPC (Process Decision Program Chart)

This is an application of the process decision program chart used in operations research. Because implementation programs to achieve specific goals do not always go according to plan, and because unexpected developments are likely to have serious consequences. PDPC has been developed not only to arrive at the optimum conclusion but also to avoid surprises.

g) Arrow Diagram

This is often used in PERT (Program Evaluation and Review Technique) and CPM (Critical Path Method). It uses a network representation to show the steps necessary to implement a plan.

4.3.2 QC Application at Faults Clearance

Faults occurrence ratio by places of whole Sri Lanka in the year 1994 are shown in the Table 11-2-7 in which majority of the faults are being occurred at the Overhead portion (70% of total number of faults). Faults clearance rate within 24 hours of whole Sri Lanka in 1994 are shown in the Table 11-2-8 in which the average rate was 55%. Faults rates in each RTE area have largely varied each other, e.g., Havelock RTE area in Colombo had 7.7 faults/month/100DELs in March 1995. On the other hand, Matara area had 103.4 faults/month/100DELs in the same period.

As an example, "Monthly Summary of Faults & Maintenance Performance in the year 1994 " for Kurunegala RTE area is shown in the Table 11-4-2. Average No. of Faults/month/100DELs in 1994 was 14.9. On the other hand, the target faults rate in the year 2000 is set at 15%. Therefore, RTE Kurunegala is requested to set up a new its own target, say, 10% at the end of 1995 and RTE will take all efforts to realise this new target.

Table 11-4-3 No. of Faults by Place in Kurunegala RTE in 1994 shows that the majority of faults have been occurred at Overhead portion (80%). Therefore, it is suggested to introduce Preventive Maintenance Procedure as described in the Sub-section 3.6 and to replace obsolete overhead facilities with new ones.

Table 11-4-4 Faults Clearance Period in Kurunegala RTE in 1994 shows that the clearance ratio in 24 hours was 28% which is too low compared with whole country's average of 55%. Maintenance area size of Kurunegala is one of the largest area in Sri Lanka, farthest exchange location may have 50 km distance from Kurunegala exchange. However, it is requested to improve this low figure of 28% by means of analysing the causes and finding some countermeasures. Figure 11-4-7 Cause of Fault Clearance Delay shows some causes of low faults clearance rate as an example.

Thus, it is recommended that each RTE will organise QC group in his organisation and try to apply OC activities in order to solve the facing problems.

Table 11-4-2 Monthly Summary of Faults & Maintenance Performance

RTE: KURUNEGALA DGM: NWP & NCP MONTH: JAN - DEC. YEAR: 1994

LOCAL EXCHANGE	EQUIPPED CAPACITY	PRIMARY LOOPS at MDF	NEW DEL ADDED	TOTAL No of DEL	TOTAL No of WAITERS	No of FAULTS Regd	FAULTS CLEARED									
							RWT	EXCH	MDF	UG	OH	Internal Wiring	Instrument	WITHIN 0 - 24 Hr	WITHIN 24 - 72 Hr	OVER 72 Hr
January	3664	9700	14	3568	4958	729		24		131	549		25	232	268	229
February	3664	9700	15	3583	5559	706		21		74	567			310	101	258
March	2664	9700	15	3598	5817	698		10		55	604		3	263	71	343
April	3664	9700	12	3608	5925	750		29		68	610	1	14	245	98	347
May	3664	9700	5	3608	6066	615		8		7	464		5	152	181	130
June	3664	9700	15	3624	6234	731		29		83	493	1	20	101	221	191
July	4760	9700	21	3615	6355	666		55		59	561		6	123	311	206
August	4760	9700	28	3673	6457	673		20	2	71	565			108	201	222
September	4760	9700	34	3707	6657	281		19	9	116	601	4	7	136	289	305
October	4740	9700	36	3743	6760	897		31	13	165	586			127	252	363
November	4740	9700	30	3771	6872	771		51		153	589			150	201	277
December	4742	9700	22	3793	7043	988		32	16	154	561	2	14	220	218	323
TOTAL	4742	9700	247	3793	7043	8505	0	329	40	1136	6750	8	94	2167	2412	3194

Table 11-4-3 No. of Faults by Place

RTE: Kurunegara Year: 1994

Place	OH	UG	Exch	Instr	MDF	Internal	Total
% by place	80.77	13.59	3.94	1.12	0.48	0.10	100.00
Cumlated %	80.77	94.36	98.30	99.43	99.90	100.00	
Faults/place	6750	1136	329	94	40	8	8357

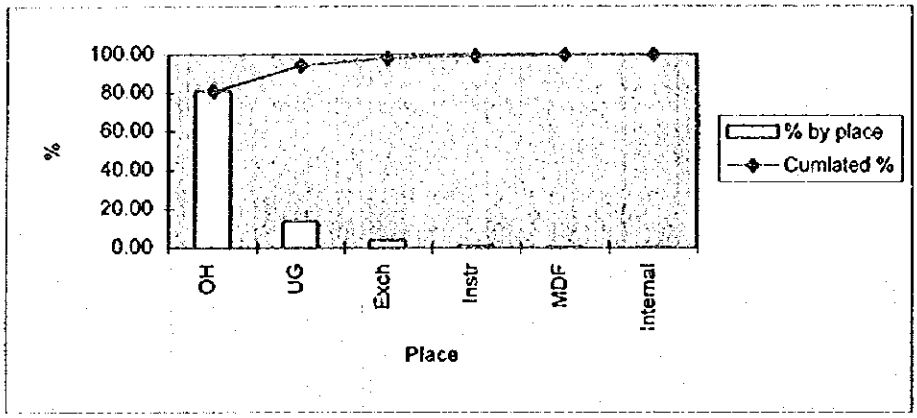


Figure 11-4-5 No. of Faults by Place

Table 11-4-4 Faults Clearance Period

RTE: Kurunegara Year: 1994

Priod	0-24 hrs	24-72 hrs	ver 72 hr	Total
% by period	27.88	31.03	41.09	100.00
Cumulated %tage	27.88	58.91	100.00	
Faults/period	2167	2412	3194	7773

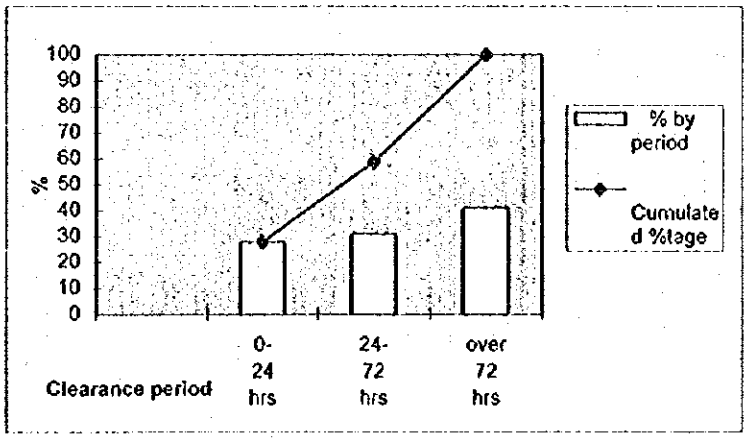


Figure 11-4-6 Faults Clearance Period

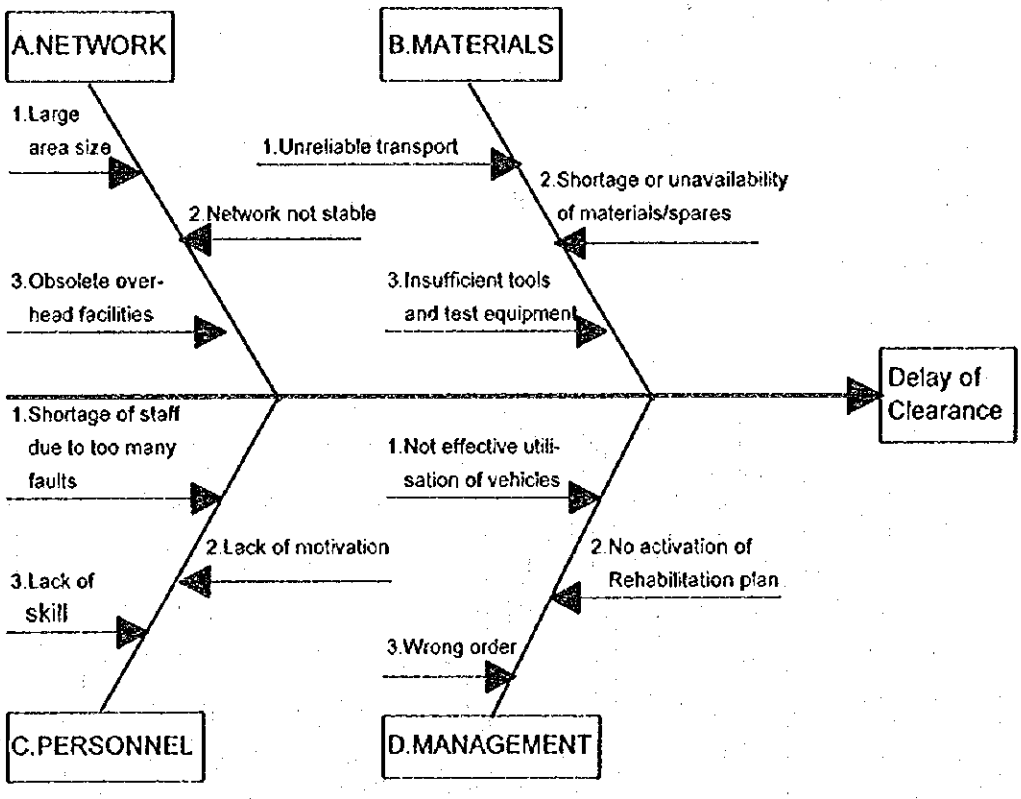


Figure 11-4-7 Cause of Fault Clearance Delay

4.3.3 TQC Application as Management by Policy

(1) Definition of Management by Policy

Management by Policy is an integrated management system with a group of actions, PDCA, in order to achieve the company's Annual Policy which is prepared by the Managing Director based on the company's objectives, Corporate Plan and Long/Medium term Plans. Subjects are selected according to the priority of urgency, importance.

a) **Plan:** The Action Plan is prepared based on the Corporate Plan (basic concept and business strategies), Long and Medium Term Plans and Annual Policy instructed by Managing Director of the company and deployed to every organisational level.

   Review results of former PDCA cycle and the change of environment should be incorporated in the Action Plan.

   The Action Plan utilises all company's business resources, i.e., Personnel, Materials, Funds and Information and plans, they have to be the most appropriate combination of quality, quantity and cost. The Plan schemes for level up and strengthening of the potential of the company, participation by all personnel and to expect continuous improvements.

b) **Do:** Implementation of the Action Plan is followed and checked. PDCA cycles should be repeated during the implementation period.

c) **Check:** Implementation results are evaluated by Divisions/Regions and commented by the Managing Director (diagnosis), and the problems encountered are analysed.

d) **Action:** Review and improvement to the above results are made and reflected to the following Action planning period. Review includes countermeasures to the problems, improvement of procedures and standards, check points and management levels.

(2) Procedures to Solve Problems under Management by Policy

Procedure to solve the problem will be started from the selection of the subject and be proceeded in accordance with QC Story described below.

QC Story:

Plan:

a) Selection of subject
b) Reason of the selection of subject
c) Grasp of present situation, status
d) Set up of target
e) Analysis of the present status

Do:

f) Planning of countermeasures and implementation with PDCA cycle

Check:

g) Confirmation of the effects

Action:

h) Standardisation of the countermeasures, procedures
i) Remaining problem and improvement planning hereafter

(3) Features of Management by Policy and its Effects

a) Improvement of communications (Top down and Bottom up)
   During planning stage, explanation of annual policy and discussions will be executed between top management and middle, lower Managements.
b) Education, level up of personnel
   Discussions are made regarding management levels, check points, pick up problems, evaluation, standardisation
c) Weighting to Process
   Assessment of the Process is given more weighting. If some problem is found, the weighting is given to pursuit of causes rather than pursuit of responsibility.
d) Participation of Top Management
   Top management diagnose the implementation results. Intention of the top management can be comprehensively communicated up to lowest level of the organisation.

e) Administration by data

All processes are made based on QC system. Therefore, the administration is proceeded in accordance with data processing system.

f) Human resources development

Cultivation of capability to human resources and level up of organisational activities are expected through the PDCA cycles.

Figure 11-4-8 shows a Flow of Management by Policy.

(4) Management Items

Improvements of performance indicators, Call completion rates, Number of faults per month per 100DELs, Faults clearance within 24 hours, New connections, Human resources and training, International telephone services, Revenues, Telecommunications projects, are being proceeded by SLT.

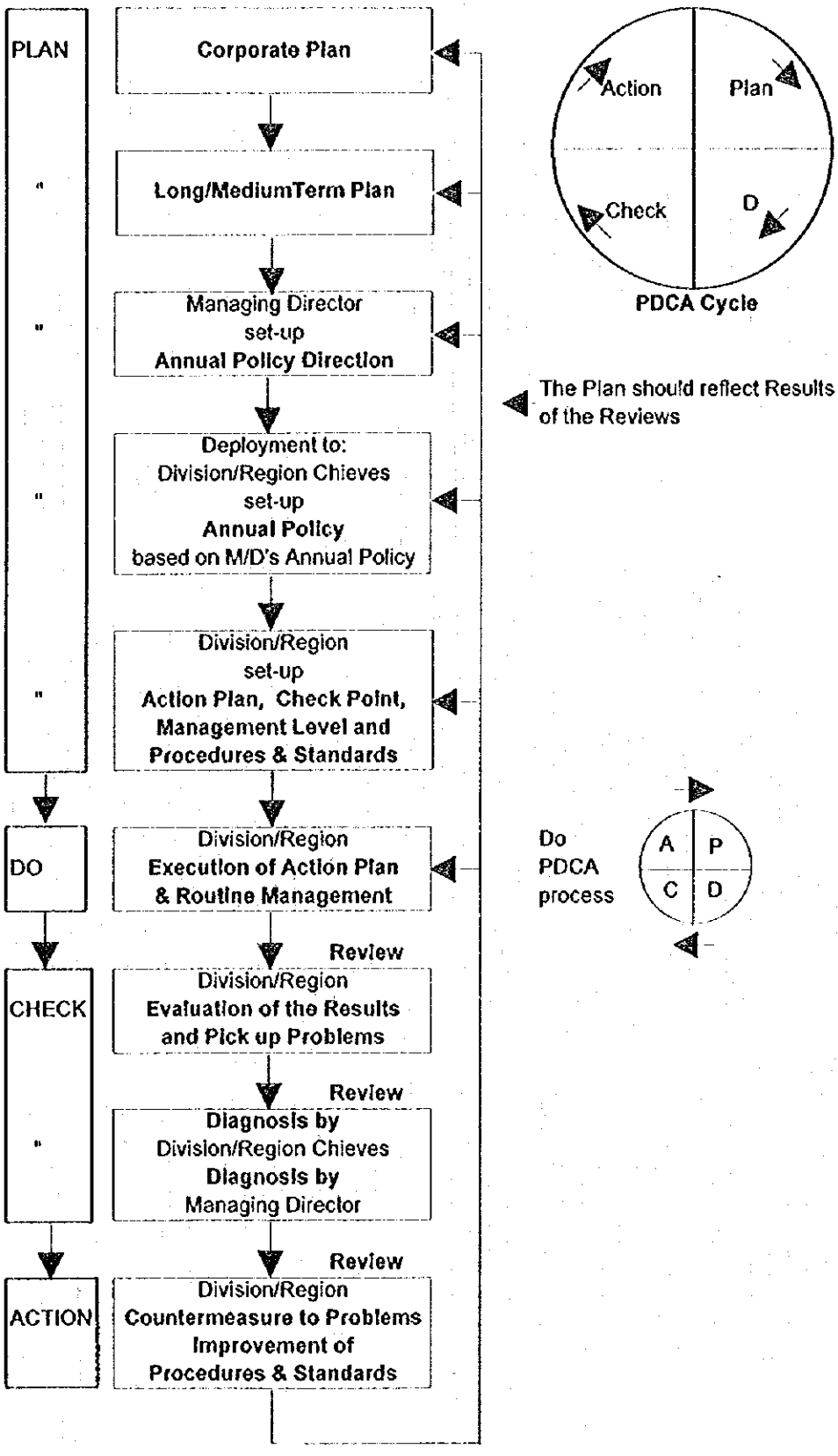


Figure 11-4-8 Flow of Management by Policy

CHAPTER 12

HUMAN RESOURCE DEVELOPMENT PLAN

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HUMAN RESOURCE DEVELOPMENT PLAN

1. General

So as to run the business efficiently and effectively, it will be necessary to review status of the business operating elements which are Organisation, Management & Procedures and Human Resources.

It is considered that the most important factor among them is the Human Resources. In extreme case, in small scale companies, existence of a small group of superior managers may be able to support the company in sound business conditions even though the organisation and procedures are not satisfactorily provided.

Quality of staff, willingness of each staff to bring their works with successful results and improved productivity of staff and Company are essential factors for smooth operation of the Company.

SLT, as specialised business operator to the public telecommunications service, is particularly requested to upgrade their technical capabilities of the SLT staff so as to completely follow up the rapid development and renovation of the technologies.

Provision of Recruitment policy and appropriate training courses are also important inputs to the Company for prosperous growth of SLT in the future and upgrading of SLT staff quality. Willingness to the achievement of good works will be supported by their proud to the work with SLT and provision of supporting conditions by the Company, i.e., salary system, allowances, welfare, etc. Staff provided with equipped well by modern tools and facilities in doing the installation and maintenance works will improve their productivity considerably.

Productivity is measured by the rate of manpower per thousand subscribers, fault clearance efficiency, a number of new connections per team or staff per period.

Following Table shows the number of main telephone lines, number of Telecom employees and number of staff/1000 main telephone lines in some countries in western Europe.

Figures are extracted from the "Yearbook of Common Carrier Telecommunication Statistics" issued by ITU 1993:

Table 12-1-1 Improvement of Productivity in Some Western European Countries

No. of DEL & No. of Staff : x1000

Country	Item	1983	1985	1987	1989	1991
Denmark	No. of DEL	2,403	2,543	2,711	2,848	2,972
	No. of Staff	N.A.	N.A.	19	18	N.A.
	Staff/1000DEL	N.A.	N.A.	7	6	N.A.
Spain	No. of DEL	8,457	9,340	10,240	11,800	13,264
	No. of Staff	72	72	63	71	76
	Staff/1000DEL	8	8	6	6	6
Norway	No. of DEL	1,554	1,758	1,949	2,070	2,198
	No. of Staff	18	17	18	16	15
	Staff/1000DEL	12	10	9	8	7
U.K.	No. of DEL	20,190	21,650	22,770	24,910	25,595
	No. of Staff	242	227	237	246	211
	Staff/1000DEL	12	10	10	10	8
Sweden	No. of DEL	5,017	5,242	5,481	5,716	5,948
	No. of Staff	40	42	43	42	39
	Staff/1000DEL	8	8	8	7	7
Switzerland	No. of DEL	3,095	3,277	3,500	3,785	4,082
	No. of Staff	18	18	19	21	22
	Staff/1000DEL	6	6	5	5	5

N.A. : Data are not available.

From the above Productivity figures, the states of their Productivity and the trend of improvement of Productivity are seen.

And also the following figures are the number of staff/1000 DELs in Asian countries, figures are also extracted from "Yearbook of Common Carrier Telecommunication Statistics" issued by ITU 1993:

Table 12-1-2 Improvement of Productivity in Asian Countries

No. of DEL & No. of Staff : x1000

Country	No. of DELs		No. of Staff		No. of Staff/1000DEL	
	1982	1991	1982	1991	1982	1991
Bhutan	1.3	2.4	N.A.	0.4	N.A.	167
Laos	5.4	6.5	0.8	0.9	148	138
Bangladesh	110	249.8	20	19.3	182	77
China	2,342.5	8,450.6	504.1	531.3	215	63
Sri Lanka	70.4	125.8	9.5	7.4	135	59
India	2,465.3	5,809.9	322.2	345.4	131	59
Pakistan	337.7	1,116.1	36.3	54.1	107	48
Indonesia	472.3	1,276.6	28.5	41.1	60	32
Philippines	480.7	647.9	29.4	17.5	61	27
Thailand	434.3	1,553.2	15.3	24.8	35	16
Malaysia	585.4	1,816.9	29.8	28.8	51	16
Australia	5,479.6	8,046.0	88.1	81.1	16	10
Singapore	643.0	1,101.1	12.4	9.8	19	9
Newzealand	1,197.7	1,493.0	24.3	13.6	20	9
Hongkong	1,477.0	2,642.4	15.5	15.4	10	6
Japan	42,429.0	56,252.9	330.0	266.1	8	5
Korea	4,079.6	14,572.6	37.0	57.9	9	4
:	:	:	:	:	:	:
Asia Pacific	67,881.0	116,015.0	1,586.0	1,581.0	23	14

N.A. : Data are not available.

Asia Pacific : Figures of No. of DELs and No. of Staff are totals in Asia Pacific region.

Figures of No. of Staff/1000 DEL are average in Asia Pacific region.

The countries where the Productivity are 10 or less than 10, the Penetrations are more than 30% (Australia : 46.4%, Hongkong : 45.9%, Japan : 45.4%, Newzealand : 44.2%, Singapore : 39.9%, Korea : 33.7%).

Number of staff per 1000 DELs has a wide variety of figures by the countries in the world. Some developed countries have level of the productivity of 4 to 10/1000 DELs.