CHAPTER 4 REVIEW OF THE TELECOMMUNICATIONS DEVELOPMENT PLAN

4.1 Over-View of the Network Situation in January 2002

Imbalanced investment has been made weighted on switching system, and the transmission system has also been constructed in parallel with the switching system.

As the result, many idle switching lines are waiting for the new connections as given below:

Situation of Jan. 2002	switch capacity (l.u)	connected subscribers	**idle line**
Addis Ababa area	335,665	207,495	**128,170**
Other area	218,509	112,008	**106,501**
Total	554,174	319,503	**234,671**

In addition to the above, the last part of the carry-over of 7th Project has been completed currently as follows :

Sidist Kilo	21,000 l.u.
Asko	4,000 l.u.
Mekanisa	2,000 l.u.

Local access network on the above switch capacity is just under the tender evaluation.

Total idle capacity of the switching lines (260,000) is much beyond the number of the waiting applicant (160,000).

The reason of this heavy idle capacity is to be clearly addressed on the delay (or negligence) of the construction of the local access network, or on the over estimation of each node capacity.

4.2 Progress of the Expansion of the Local Access Network

1) Implementation

ETC has taken action to expand the local access network .

Through	ICB	Sidist Kiro/ Asko/ Mekanisa under evaluation
Through	LCB	Dilla (5,100pr), Adigrat (3,800), Dessie (6,400), Gondar (5,600)
Installation by ETC		other small sites

And currently “Turnkey projects for Nefas Silk, Arada, Yeka, and Garji” have been completed.

2) Expansion capacity of the local access network in Regions/ Adis Ababa

ETC has completed the design of the copper loops, the part of which has been put into implementation.

ER (Dire Dawa)	3,400
SER (Nazareth)	12,850
SR (Shashemine)	23,350
SWR (Jimma)	3,450
NER (Dessie)	14,700
NR (Mekele)	27,150
NWR (Bahir Dar)	25,300
WR (Nekempte	5,250
Total	**115,450**

In addition to the above, **total 34,700pr expansion is planned for Adis Ababa network,** but the actual implementation status are unknown.

Arada 4,900, Keira 2,000, Akaki 3,000, Old airport 4,000, Ayur Tuna 4,700, Sebeta 2,800, Waliso 2,800, Wolkite 2,500, A. Ketama 4,000, Kolfe 3,800, Shegole 200.

3) Implementation of the above 1) & 2) will take further 2 years .

Addis	70,000 MDF pairs
Regions	115,000 MDF pairs

However, the full implementation of the above will not cover up the current idle capacity of the switching lines, i.e. 262,000 l.u.

4) Current Plan of ETC (Nov.2002)

ETC has currently summerized the on-going and planned OSP projects for the period as from July 2002 up to June 2004.

Addis Ababa Zones

Copper access (by ETC)	85,000 pairs
Copper access (Out-sourcing)	55,000 pairs
Optical access	20,000 pairs
Sub Total	160,000 pairs

Regions

Copper access (by ETC)	65,000 pairs
Copper access (Out-sourcing)	30,000 pairs
Digital pair gain system	14,000 lines
Sub Total	109,000 lines
Total	269,000 lines

4.3 The Policy of the Next (Eighth) Development Plan as the Recommendation

1) Fixed phone network

Considering the current problem of the imbalanced investment as well as the huge idle capacity, the next step investment plan shall be firstly addressed on the solution to the imbalance, and secondary on the highest priority area considering the well-balanced facilities and the demands situation (the list of waiting applicant).

1st priority Local access network for full utilization of idle switching capacity

2nd priority Expansion of (Switch + Local access network) for the long list of waiting applicant

3rd priority New area well supported by the basic design of the local access network and the surveyed demands (micro demand survey)

2) Mobile-phone and PDN

The mobile-phone and PDN services have been rapidly growing all over the world.

Considering the world-wide trend of the growth, the advanced investment will encourage and promote the demand growth, especially of the mobile-phone.

4.4 Review of Priority Project (46 Projects)

Taking the investment policy given in item 4.3 above into consideration, the priority projects were evaluated as shown in D.Table 4.4.1 of the Data File, and the summary is as follows:

1) Work Contents of original 45 projects in the Regions (Refer to D.Table 4.4-1)

Switch expansion/analog replacement	70,000 l.u.
WLL	8,000 lines
Copper loops (After review)	142,800 MDF pr

After evaluation

On-going copper loop project	61,600 MDF pr (Design completed)
P. Project Switch	53,000 l.u.
Copper loop	41,000 MDF pr

2) Work contents of 46th Addis Ababa project

Details are given in D.Table 4.4-2 of the Data File.

Original work contents	Switch (replacement of Analog)	50,000 l.u.
	WLL	30,000 lines
	Copper loop(After review)	200,000 MDF pr

Evaluated work contents

Switch (replacement of Analog)	50,000 l.u.
WLL (maximum)	19,000 lines
Copper loop (addition)	127,100 MDF pr
(Rehabilitation)	60,000 MDF pr

Concerning the application of WLL, it will be preferable to apply the minimum quantity due to the higher cost in comparison with the copper loop.

4.5 Eighth Development Plan of Fixed-phone Network

4.5.1 Expansion Plan of Switching Capacity

(1) Switching Line Expansion Plan

The plan (draft) is composed of 2 phases as given below:

Table 4.5-1 Switching Expansion Plan (Phase I)

Phase 1	Expansion		Replace		New	
Area No.	No. of L.E.	Capacity l.u.	No. of L.E.	Capacity l.u.	No. of L.E.	Capacity l.u.
01	5	28,000			5	3,000
02	0	0			5	2,750
03	3	8,000			15	7,750
04	5	23,000			3	1,750
05	3	16,000			16	10,250
06	2	8,000			6	3,000
07	-	-			10	5,000
08	3	11,000			16	10,250
Total	21	94000			76	43,750

Table 4.5-2 Switching Expansion Plan (Phase II)

Phase II	Expansion		Replace		New	
Area No.	No. of L.E.	Capacity l.u.	No. of L.E.	Capacity l.u.	No. of L.E.	Capacity l.u.
01	9	22,000	1	1,000	7	4,000
02			1	1,000	11	6,500
03			3	1,750	3	1,500
04			1	500	11	5,750
05			2	1,500	15	8,500
06			9	8,250	18	9,000
07			6	5,250	9	4,750
08			6	5000	13	6,500
Total	9	22,000	29	24,250	87	46,500

The plan will not be supported by the expansion plan of the local access network, however.

In order to confirm the maturity of the plan, this plan was compared with the priority projects, which were supported by the local access networks.

As the result, the switch expansion portion of Addis Ababa (28,000+22,000) line units except 10,000 lines of Filwoha are justified for the implementation under the priority projects. Expansion portion of regional areas have been already included in the Priority Projects.

Replacements given above are of RAX type digital switches which were recently installed, but are reported not operating well. The replacement will be required, due to the lack of CCS7 and unstable charging function. The replacement of the around 30,000 l.u. will be required within the framework of the priority projects, however.

Concerning (76+87) new sites for new digital switches, the plan is not supported by the demands and local access network. The plan is to be further studied and is to be supported by the basic plan of local access network. Upon the completion of the preparation, this plan may be implemented in the first phase of middle-term plan. Welencomi (500 l.u., WAAZ) and Sendafa (500 l.u., EAAZ) are to be implemented within the framework of the priority projects, however.

In addition to the above, the priority projects includes the replacement of analog switches of Addis Ababa area (50,000 l.u.) and 2,000 l.u. expansion of Nazareth (02 area).

1000 lu expansion of Azezo (08 area, DMS-10) may be implementated in the first phase of the middle-term plan.

(2) Review of the Table of 5 Years Target

1) Target of switching capacity (additional 469,514 l.u.)

The packaged capacity of Ph I+II is 206,250 l.u, out of which 90,250 l.u. are to be distributed to new 163 sites, where situation of outside plant are not clear, i.e., no OSP design will be prepared. The planning for the procurement of the remaining 263,264 l.u. will not be commenced yet. However, around 260,000 l.u. idle capacity is waiting for the new connection.

While, the design for OSP is so far completed only for 185,000 MDF pairs (equivalent to 142,000 new subscriber connections), which will take further at least 18 months for the readiness of new connection.

In order to avoid the further increase of the idle capacity of switching system, the priority of the investment shall be given on OSP. The enhancement of the OSP design shall be firstly addressed in the eighth 5-year plan.

2) Target of new subscriber connection

The given target of new connections in the table is:

	2000	2001	2002	2003	2004	2005
New con.	50,000	91,000	100,000	110,000	120,000	130,000
Total DEL	249,000	340,000	440,000	550,000	670,000	800,000

While the DEL in Jan. 2002 is 319,500, which does not reach to the target of one year before. As the reference, the past achievement of DEL were, 50,000 (2000), 30,000 (1999), 8,000 (1998), 7,000 (1997), 7,000 (1996), 5,000 (1995).

The given target figures could not be appreciated (too big) due to the heavy delay of OSP construction, limited waiting list (155,000 only) as well as the current world-wide trend of the decreasing (low growth rate) of the fixed-phone demands.

(3) Suggestion for the Modification of the Target

- **Investment on switching system shall be well synchronized with the expansion plan of the local access network, which will take more time for the installation than switch/transmission.**
- **Investment on the fixed-phone network shall be carefully done considering the trend of the waiting applicant, especially in the city core areas of the capital city. It will take rather long time for the city reconstruction and development, which will be done by the private sector.**
- **Considering the world-wide trend of the decreasing demands of the fixed-phone, the investment on the new services, especially on the mobile-phone shall be enhanced, then encourage the demand growth of the new services.**
- **Implementation (or designing) of the local access network shall be hastened in order to use the current idle capacity of the switching line.**
- **Considering the transit period of the circuit switch to the packet switch, the expantion by the circuit switching system may be minimized to the reasonable acceptable extent. The switch expansion plan (new small nodes) not supported by the basic plan of the local access network shall not be allowed.**

4.5.2 Expansion of VSAT and DRCS

Eighth Plan intends to expand to 123 new sites of DRCS services and 24 new sites of VSAT services. This plan is to be implemented as scheduled.

4.5.3 Expansion Plan of Transmission Network

SDH transmission network is planned in the Eighth Development Program for major routes such as, Addis Ababa to Morer via Dessie and Mekele for north route, Dessie to Musali for north-east route, Addis Ababa to Jijiga via Dire Dawa and Harar for east route, Shashemene to Marza for south route, Nekempte to Asossa and Dembidollo for West route, Jimma to Gambela for South-West route, and Addis Ababa to Dollar Hill via Bahir Dar and Gonder for North-West route.

These links are constructed or to be constructed using FD (frequency diversity) and SD (space diversity) technique because some links have longer path beyond the normal transmission distance, since the location of existing stations are selected based on 2GHz-band transmission profile. Spur

links covering the neighboring areas along the routes are also being expanded by the Eighth Development Program using PDH transmission system.

The planned projects in the ETC Eighth Development Program for 1993-1997 EC (July 2000 - June 2005 GC) are shown in the following Table. More than half of them have been completed or are under construction as of June 2002 GC.

Table 4.5-3 Transmission Expansion Plan Under Eighth Development Program

No	Description	Remarks
1	VHF, UHF & Microwave Survey	
2	Digital M/W system	
2.1	Harer-Jijiga	Please see the On-going Project list.*
2.2	Nekemte-Assosa-D/Dollo	Please see the On-going Project list.*
2.3	Jimma-Gambella	Please see the On-going Project list.*
2.4	AA-Gonder	Please see the On-going Project list.*
2.5	Dessie-Mekele-Shire	Please see the On-going Project list.*
2.6	AA-D/Dawa	Please see the On-going Project list.*
2.7	Dessie-Bure	Please see the On-going Project list.*
2.8	Tibebilo-Fincha	Spur link to Fincha from Tibebilo.
2.9	Nazareth-Modjo	(included in item 2.6)
2.10	Agaro-Limu Genet	Spur link to Limu Genet from Agaro
2.11	Shashemene-Moyale	Please see the On-going Project list.*
2.12	Shashemene-A/Minch	Shashemene, Shone, Alaba Kulito, Boditi, W Sodo, Areka, A/Minch, Chencha, Lante, Konso
2.13	Nazareth-Goba	Nazareth, Abomssa, Sire, Diskis, Robe, Dera, Huruta, Iteya, Assela, Kerssa, Bekoji, Sagure, Asassa, Adaba, Gobesa, Goba, Agarfa, Goro
2.14	Gonder-Shire	Sheraro, Adi Dairo, Shire, Amba Giorgis, Gonder, Indabaguna, Debark, Dabat, Tekil Dengay
2.15	Gonder-Metema	Please see the On-going Project list.*
2.16	Axum-Adigrat-Zalanbesa	Axum, Rama, Inticho, Adet, Wukro Maray, Zalambessa, Adigrat
2.17	AA-D/Berhan-Fiche	D/Birhan, Mehal Meda, Inewari, Fitche, Alem Ketema, Welenkomi, Ginchi, Addis Alem, Burayu, Alem Gena, Tulu Bolo, Sendafa, AA
2.18	Nekempte-Ambo Link	Nekempte, Sire, Ijaji, Gedo, Guder, Ambo, Inchini, Shino, Jeldu, Gendeberet
2.19	Dessie-Woldia Link	Dessie, Haike, Harbu, Chefa Robit, Kemise, Majete, Wuchale, Wurgessa, Merssa, Sirinka, Woldia, Kobo Robit, Kobo, Korem, Sekota
2.20	Links from Mekele	Maynebri, Adigudom, Mekele, Quiha, Temben, Wukro, Negash, Senkata, Idaga Hamus
2.21	Aman-Mizan Teferi	Optical Fiber Cable between Aman and Mizan Teferi.
2.22	Adamitulu-Zeway	Spur link to Adamitulu from Zeway West.
2.23	SDH(Remaining work)	
3	Optical Fiber Transmission	
3.1	Intern Exchange network	A part of AA Junction Network
3.2	Inter exchange turn key	A part of AA Junction Network
9	Satellite Communication	
9.1	VSAT	75 remote stations
9.2	International	Rehabilitation of Sululta-1
9.3	DC-DC Converter	For DOMSAT antenna to apply for FaraWay

Digital Microwave shown in the above table (item No 2) is checked comparing to the transmission capacity of 2005 and 2010 GC described in Chapter 9 of this report. Respective projects of the Digital Microwave are confirmed to be all basic, fundamental and top urgent. And their capacity, in most cases, is appropriate under the demand, though some of them are not determined yet in the plan. The capacity for those projects that have not been decided is recommended in the report. The necessary capacity of each links of the transmission network in 2010 GC is given in supporting document "Transmission capacity based on the forecast demand".

Optical Fiber Transmission in the above table (item No.3) is the project installing 67.33km of cable in Addis Ababa and 4.2km in Sheno, Hossaina and Ataye. Major part of the project had been completed by TCIL, India in February 2002, and the remaining is under construction by ETC itself. The earliest completion is requested for all the projects in the Optical Fiber Transmission.

Every project of Satellite Communication in the above table (item No.9) is also the inevitable one with high priority for improvement of telecommunications services.

4.5.4 Review of the Expansion Plan of Mobile Telephone

Implementation targets of the Eighth 5-Year Development Plan of ETC of the mobile telephone customers are to be 61,727 in 2005 including additional major 12 cities. This target, after a drastic revision of the plan by ETC in April 2002, is raised 6.5-fold to 400,000 customers by 2005. The current system has the capacity of 60,000 lines. The new GPRS system will have 200,000 line capacity, which will be introduced by year 2004.

The plan is on the line of the international trend of the rapid growth of this business, and is also on the line of the development direction of Ethiopian telecommunications sector. In order to realize the rapid growth, the introduction of the pre-paid system has also decided. Based on the SIM (Subscriber Identification Module) card introduction plan, its procurement procedure is running for 60,000 cards.

4.6 Review of the Expansion Plan of Internet Services

The Seventh Telecommunication Development Plan aimed at the increase of the number of Internet subscribers up to 4,163. However, it actually reached and diffused 2,461 (59.1%) in the year 2000. In January 2001 additional POPs were established in major 8 cities with total capacity of 4,436, and the subscribers increased by 4,073 in total as of January 2000 according to ETC 8th Development Report (in May 2002, 6,000 subscribers). ETC customer service says that 50 new subscribers can be accepted per week.

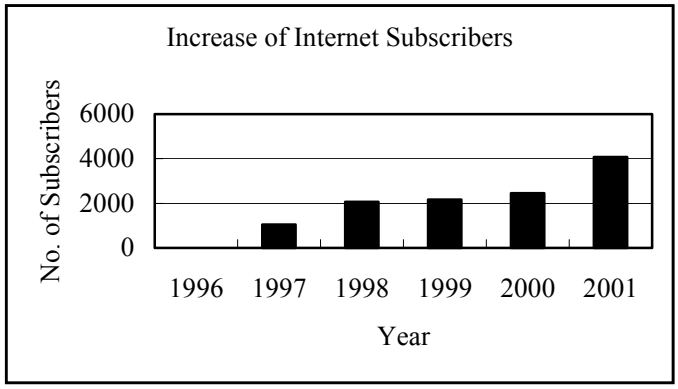


Figure 4.6-1 Increase of Internet Subscribers

Eighth 5-Year Telecommunication Development Plan (2000/01-2004/05) intended to increase the number of the Internet subscribers up to 31,961 by the year 2004/05.

The forecasted subscribers in the Eighth Development Plan were as follows:

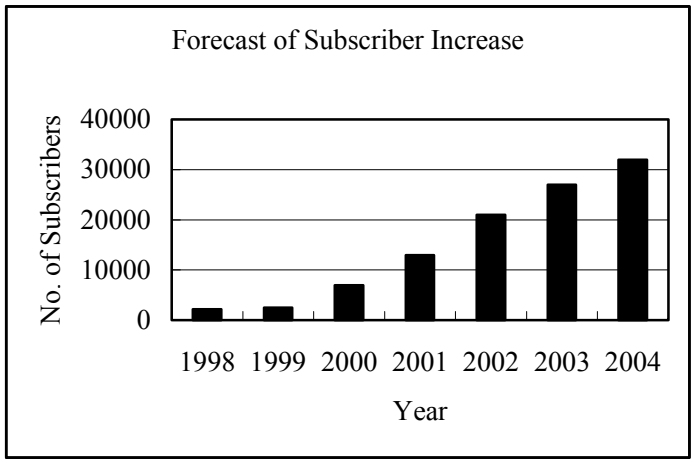


Figure 4.6-2 Forecast of Subscriber Increase

(Source: Eighth 5-Year Telecommunication Development Plan)

Comparing the figures between the present status of subscribers 6,000 and forecasted number (20,961 in 2002), there is still big deviation. However, in the near future demand of Internet subscriber will be increased by Internet access from the mobile telephones. Growth of private subscribers will be greatly depended on the diffusion of the computer users, Internet mobile-phones and tariffs. It is also necessary for ETC to promote the encouragement of the demands. For example, ETC makes free of connection fee for initial 2 months, or extension of allowed hour per month for new subscribers.

4.7 Project Formation for the Fixed-phone Network

In order to avoid the imbalanced network as well as the investment on the idle facilities, the required procedures for the project formation shall be exactly followed.

1) Demand forecast & supply target
2) Site requirement with confirmed waiting list

3) Confirmation of the required system capacity based on the micro demand survey (basic design of the local access network) paying attention on the forecasted demands, waiting list, city planning and so on.

4) Packaging the projects taking the project cycle and implementation time duration into consideration

Sw/Tr portion installation time	10-12 months
OSP portion	16-24 months

5) Drafting the implementation time schedule considering the procurement method (Tender preparation period, Tender floating, Tender evaluation, Approval period, contract negotiation, etc.)

ICB Turn-key base
ICB Construction with S/V base
LCB
Material procurement
Installation by ETC
Etc.

6) Finalization of over-all implementation schedule, budget disbursement schedule and new subscribers connection target as well as facility transfer target to O/M.

4.8 Project Management of the Implementation Contract

The frequent delay of the project implementation would be experienced, especially of the outside plant projects mainly due to the following reasons of ETC side:

1) Delay of the Authorities' approval on the work sites
2) Delay of the work under ETC's responsibility
3) Modification/change of the contracted scope of works.
4) Ambiguity in the technical as well as the contractual conditions

While, the contractor will cause delay due to:

1) Shortage of the running capital
2) Shortage of resources (skilled man-power, delay of local material, delay of shipping)
3) Delay of detailed engineering/designing
4) Repeated work due to the low quality works/materials
5) Shortage of internal/external coordination, especially with local authorities
6) Damages to telecom facilities and/or other utilities
7) Etc.

In order to avoid the delay and to hand-over the completed facilities in time to O/M division for achieving the target of the new subscriber connection, the strong project management shall be established. For the acceptance test of the completed facilities, the witness of the O/M division will be of essential.

CHAPTER 5 DEMAND FORECAST

The MP study presents the forecasted need for telecommunications service in Ethiopia for a period of 20 years on a macro level. This will be further elaborated over the planning horizon and regional level. The forecast in this chapter includes the demand for fixed-phone, mobile-phone, and the Internet services.

Demand forecasting of telecommunication services involves the consideration of many socio-economic variables and future economic development of the country. Due to constraints of data availability in ETC and in Ethiopia, the demand forecasting has been undertaken using the most probable population growth rate and the very optimistic GDP, growth, which was projected by IME World Bank and Central National Bank.

Telephone penetration rate (the number of telephones per 100 inhabitants) has been used to indicate the level of the development of telecommunication infrastructure in a country.

ITU is now promoting **public policies on universal access** to create appropriate telecommunication infrastructure and institutional capabilities for developing countries. **Universal Access** generally refers to a situation where every person has access to a publicly available telephone service within a reasonable walking distance.

Considering the situation in Ethiopia, where 80% of the population live in rural areas, and government's policy goal to enhance significantly public access to basic and more advanced telecommunication services, the MP tries to promote universal access policy.

5.1 Population Growth Rate

Ethiopia entered the 20th century with about 11 million people and left it with about 65.344 million people. At the beginning of the 21st century, the estimated annual growth rate reached 2.87%. Looking at past population growth rates, Ethiopia indicated growth of 3.01% in its population between 1994 - 2001. By 2002, the total population had reached about 67.22 million. The population projection announced by National Population Agency is indicated in Table 5.1-1.

Table 5.1-1 Future Population

Unit: 1000

Year	Population	Year	Population
2002	67,221	**2008**	79,220
2003	69,126	**2009**	81,343
2004	71,065	**2010**	83,483
2005	73,044	**2015**	94,526
2006	75,068	**2020**	106,003
2007	77,128	Ave. G.rate : 2.56%	

The demographic equation of birth minus deaths plus or minus international migration determines whether population grow or decline, and how much change occurs each year. International migration has not been playing a significant part in shaping the population direction of Ethiopia.

In Ethiopia, births exceeded deaths by a substantial margin, so that a sharp increase in levels of fertility, along with a slight decline in mortality, has historically played an important role in determining population growth. However, recently, mortality has taken on new importance as a factor of population change affected by the HIV/AIDS pandemic.

Projected Population of Ethiopia by Region is indicated in Table 5.1-2.

Table 5.1-2 Projected Population of Ethiopia by Region: 1995 – 2020

						Unit: 1000
	1995	2000	2005	2010	2015	2020
Ethiopia	**54,650**	**63,495**	**73,044**	**83,483**	**94,526**	**106,003**
Tiger	**3,203**	**3,694**	**4,223**	**4,802**	**5,423**	**6,073**
Affar	**1,079**	**1,216**	**1,359**	**1,510**	**1,663**	**1,819**
Amhara	**14,128**	**16,295**	**18,626**	**21,182**	**23,917**	**26,803**
Oromiya	**19,158**	**22,354**	**25,817**	**29,621**	**33,649**	**37,840**
Somali	**3,249**	**3,698**	**4,218**	**4,798**	**5,412**	**6,037**
Benishangul	**470**	**537**	**610**	**689**	**773**	**862**
SNNPR	**10,627**	**12,515**	**14,490**	**16,602**	**18,798**	**21,066**
Gambella	**185**	**211**	**240**	**271**	**305**	**340**
Harari	**135**	**160**	**190**	**222**	**257**	**295**
Addis Ababa	**2,157**	**2,495**	**2,887**	**3,328**	**3,792**	**4,246**
Dire Dawa	**259**	**318**	**384**	**458**	**537**	**622**

Source: Central Statistical Authority

Table 5.1-3 Demographic Indicators by Major Region of Africa (1995 – 2000)

Indicator	Ethiopia	Sub-Sahara Africa	Eastern Africa
Population growth rate	2.92	2.46	2.57
Crude birth rate	44.17	40.5	42.4
Crude death rate	14.96	15.7	17.5
Total Fertility rate	6.52	5.48	5.79
Infant mortality rate	110	93	101
Mortality under age 5	161	n.a.	161
Life expectancy at birth			
* Males	50.9	47.2	44.4
* Females	53.0	50.0	46.4
* Both sexes	52.0	48.6	45.4

Source: United Nations

5.2 Economic Growth Rate

FY1991 – FY1999 showed average economic growth of 3.98% p.a. Economic growth rate of FY2002 - FY2020 shown in Table 5.2-1 has been projected by IMF, World Bank and Central National Bank.

The GDP/cap. figure used for demand forecasting is to be given in US dollars. While, the sharp decline of the exchange rate of Birr to US$ will lead to the under-evaluation of the current market status, and thus lead to suppression of the telephone demands. In this concern, the exchange rate over the previous three years (1997/98 – 1999/2000) was averaged and applied for the conversion to US dollars (US$1.00 = Birr 7.51).

The figure for GDP/cap. after conversion is shown in Table 5.2-2. The economic forecasts are subjected to the assumption of no major droughts and no wars during the objective period. The demand and economic forecasts use the fixed prices of FY2000, so figures are shown in US dollars for convenience.

Future economic growth rate up to 2020 has never been published by the Ethiopia Government. Economic projection is made by the study team through discussion with staff of IMF and World Bank. Table 5.2-2 and shows GDP/cap. up to 2020.

Table 5.2-1 Future Economic Growth for GDP

Unit: US$ million

Year	Growth Rate	GDP	Year	Growth Rate	GDP
2000/01	7.90%	8,568	2005/06	6.50%	11,784
2001/02	7.00%	9,167	2010/11	6.50%	16,135
2002/03	6.50%	9,760	2015/16	6.00%	21,972
2003/04	6.50%	10,394	2020/21	6.00%	29,382
2004/05	6.50%	11,067	Average G.rate : 6.36%		

Source: IMF, National Bank of Ethiopia

Table 5.2-2 Future Economic Growth for GDP/cap. (2000/01 Price)

Unit: US$

Year	GDP/cap.	Year	GDP/cap.
2000/01	135	2005/06	161
2001/02	140	2010/11	193
2002/03	145	2015/16	232
2003/04	150	2020/21	277
2004/05	156		

Source: IMF, National Bank of Ethiopia (Economic Growth Ratio)
Central Statistical Authority (Population Forecast) Study Team

According to the economic forecast, Ethiopia's GDP per capita is to be doubled from the current US$135 to US$270 in year 2020, if real GDP growth rate would be of 6.36%.

It is very important to note that this forecast is achieved through the optimistic scenario. It assumes that :

1) There will be no natural disasters (such as severe drought or climate change), no war or no adverse international trade condition such as significant fall in commodity prices until 2020.
2) Continuous foreign investment and steady privatization over industries.

3) Gross domestic investment is expected to rise to approx.20% of GDP from the current figure 17.2% (2000/01)

4) Gross domestic savings is also forecasted to increase from 0.9% (2000/01) to 12.6% (2010/11) of GDP.

5.3 Demand Forecast

Communications services in Ethiopia mainly consist of fixed- and mobile- telephone services and Internet services. Although telegraph and telex services being provided, these traditional services are to be replaced shortly by the other services in accordance with the technology development.

Accordingly, in this chapter demands for fixed-phone, mobile-phone, and for the Internet services are to be forecasted;

1) Fixed-phone demands

It has been an established fact that there is a strongly correlated linear relationship between telephone penetration and GDP of a country. ITU studies have proved that this is realistic to set a long term objective for the telephone network.

Macro-demand study using the current ITU data for the number of subscribers vs. GDP/capita, and is to be adjusted through the micro study paying attention on the current status of number of subscribers, waiting lists and the expandability of service areas in Ethiopia.

2) Mobile-phone demands

First pass macro-demand study using current ITU data for the number of mobile-phone density vs. GDP/capita is applied to forecast mobile-phone demand. This is not a sufficiently accurate model due to declining cost of mobile-phone, substitution effects for fixed phone and the rapid progress of the service expansion receiving the private investment. The model has to be adjusted applying the current world trend of the rapid progress as well as the experienced quick increase of the subscribers in the initial stage of the service commencement due to the short construction period required.

3) Internet & data services

No applicable model is available for the demand forecasting, but the services are rapidly increasing all over the world as the key tools for making the information world changing the life-style of 21st century.

For the demand forecast, the study team assumed the rapid increase of the PC holders as well as the service provision through mobile-phone and the social requirements for remote educational, medical services and governmental administration services.

5.3.1 Fixed -phone Demand Forecast

Macro Demand Forecast (fixed-phone)

The close correlation between the GDP/capita and the telephone penetration is well known. On the other hand, the number of the waiting applicant are huge in such countries of low GDP/capita due to the low investment capability / efficiency. When the GDP/capita having been reached to the some level (US$10,000), the waiting list has been cleared to almost "0".

Upon examining the correletion between GDP/capita and the fixed-phone penetration using the ITU data for 46 countries, ITU model could be applicable for the macro demand forecast due to the high correlation factor (R^2 =0.8308)

While, the regression analysis using the past experiences of ETC, (which shows somewhat 10,000 increase of DEL/annum.) will not adequate considering the current intension of the development program. The approach using the logistic curves such as Gonvelz curve will also be difficult due to the less data available to determine the key parameters (satuletion point, status of the current progress, etc.)

The approximate equation of the ITU model for the telephone penetration was determined as follows with 46 countries' data similar to Ethiopia in terms of the economy (>100US$), the population (>10,000,000) and the land area(>300,000sqKm) :

$$y=0.004x^{0.9889}$$

While, the current telephone penetration and the waiting list in year 2000 are reported as follows :

Population	63,495,000	GDP/capita	US$ 135
Main lines	283,683	Telephone penetration	0.45%
Waiters	155,208	Resistered demand density	0.691%

In relation with the above current status, the formula will be adjusted to :

$Y=0.18+0.004x^{.9889}$ (demand density)

Where, X is GDP/capita

When the above formula will be applied to the expected socio-economical conditions of year 2020, which will be :

Population 106,000,000 GDP/capita US$ 277,

then the demand density (Y) will be 1.222% and the demands will be 1,295,320 by the year 2020.

Note: The above figure does not include the potential demands, which is not registered as the waiting applicants.

A sensitivity analysis is done by shifting to the current economic growth rate of 4% (pessimistic scenario)and a very optimistic economic growth rate scenario of 10%. The results are given in the following table and graph (Fig. 5.3-1).

Table 5.3-1 Economic Growth Rate and Macro Demand

	Existing growth	Normal	High growth
Year	4%	6.30%	10%
2001	439,000	439,000	439,000
2020	903,400	1,295,300	2,122,100

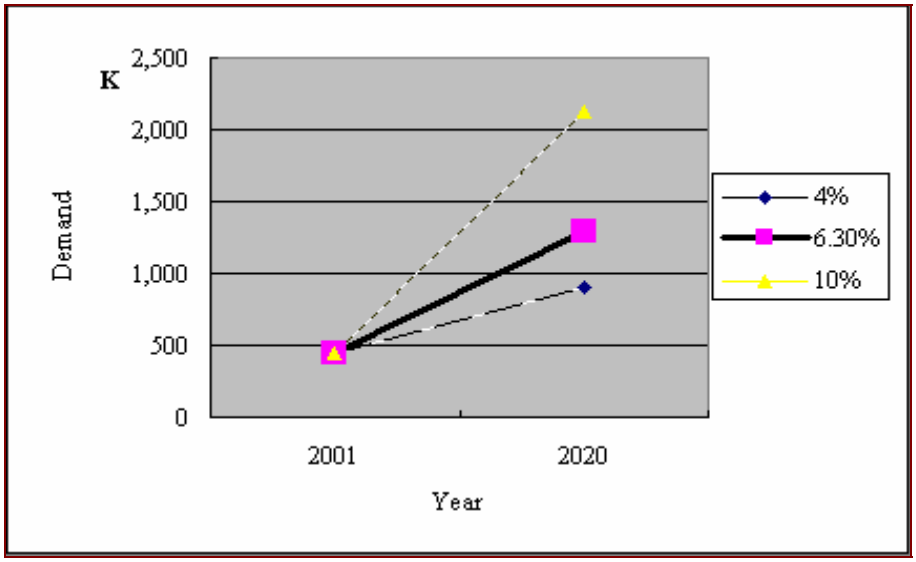


Fig. 5.3-1 Economic Growth and Macro Demand Forecast

Finaly JICA study team selected 6.3% growth rate in macro demand.

Each region's macro demand is given in the Data File.

Micro Demand Forecast (fixed-phone)

1) Model of Macro demand density taking from ITU statistics is to be applied.

   Model $y = 0.18 + 0.004x^{0.9889}$

   Where, y is the demand density and x is the GDP/capita.

2) Assessment to the **micro demands.**

Step 1

The micro-demand is to be forecasted for each exchange area bases depending on the actual site conditions.

The initial demand of the year 2001 is to be given by the existing subscribers, waiting applicants and the suppressed demand, which are assumed to be the same figure as the waiting applicants. In addition, the specific area expansion factor will be given to such exchange area , where service area expansion is envisaged.

The area expansion factor is applied only to the sourounding area of Addis Tandem area.

Central zone	1.0	No area expansion expected
West	1.1	
North, East, South, South-West	1.2	

Step-2

The demand for each year is to be determined applying the demand density increment ratio and the population increment ratio over the demands of the previous year.

Demand density increment ratio will depend on the increase of GDP/capita, which is assumed to be 6.3%/annum.

Initial demand density (national level) is to be adjusted to
(DEL290,887+Waiter155,208)/6,3495,000 x100= 0.703%

Initial demand density of Addis Ababa is also to be adjusted to

(DEL208,000+Waitor75,000)/pop2,574,000x100=11.577%

Population increment is assumed to be 2.56%/annum.

1) Rural demand (Demand on ITU Model)

2000	2005	2010	2015	2020
18,799	27,073	38,259	53,318	72,510

2) Table 5.3-2 shows micro demand of each telephone code number**.**

Table 5.3-2 Micro Demand of Each Telephone Code Number

Region	**Micro D**	Micro D	**Micro D**	Micro D	Micro D	Micro D	Micro D
	2001	2003	**2005**	2007	2010	2015	2020
1	455,900	508,200	546,600	603,200	659,700	794,000	945,400
2	32,100	39,900	46,700	57,800	68,800	100,700	145,300
3	20,800	26,500	30,900	38,200	45,500	66,100	95,000
4	46,200	56,300	64,900	78,800	92,700	132,300	186,700
5	32,200	37,600	41,900	55,700	69,500	94,800	128,400
6	47,100	53,900	64,900	76,200	87,500	117,600	155,300
7	34,700	42,200	47,900	56,600	65,400	88,700	118,300
8	50,800	63,200	73,700	91,200	108,800	158,800	228,900
No2-No8	263,900	319,600	370,900	454,500	538,200	759,000	1,057,900
Total	719,800	827,800	917,500	1,057,700	1,197,900	1,553,000	2,003,300
Rural	18,800	23,000	27,100	32,700	38,300	53,400	72,600
G.Total	738,600	850,800	944,600	1,090,400	1,214,800	1,606,400	2,075,900

5) The micro demand forecast of each telephone exchange is given in the Data File.

However, this micro-demand is forecasted based on the limited informations such as existing subscribers, waiting applicants list and the service area expandability only, and no attention has been paid on the city planning, area specialities and so on.

Accordingly, the micro-demand shall be further studied, and adjusted prior to the actual site implementation.

5.3.2 Mobile-phone Demand Forecast

(1) Current Trend of Mobile-phone Expansion

Many private operators are involved in the mobile-phone market all over the world including the under-development countries, and the subscribers have increased in some countries beyond those of fixed phone.

This phenomenon may be assumed due to:

1) Delay or shortage of fixed phone investment
2) Maturity of the fixed-phone market, i.e., most of fixed-phone demands has been satisfied, and mobile-phone requirement is increasing.

In addition, the installation period of mobile-phone facilities is very short, composed with wired of local access network, and the initial deployment priority is given to the high demand density area, so that the operator will enjoy the rapid increase of the subscribers especially in the initial operation stage.

Due to the selection of the profitable area for the initial stage, the investment cost per line looks like rather cheaper than that for the fixed line.

(2) Case Study of the Mobile-phone Operation in Some Similar Countries

	1995	2000	2002	Density (2000)
a) Bolivia (population: 8.3 M)				
Fixed Phone (1,000 lines)	246	502		6%
Mobile-phone (1,000 lines)	7.2	710		8.6%
GDP per Capita (US$)	906	996		
b) Bangladesh (population: 137.4 M)				
Fixed Phone (1,000 lines)	287	497	700	0.5%
Mobile-phone (1,000 lines)	2.5	205	750	0.55%
GDP per Capita (US$)	246	265		
c) Uganda (population: 22.2 M)				
Fixed Phone (1,000 lines)	39	62		0.3%
Mobile-phone (1,000 lines)	1.7	89		0.9%
GDP per Capita (US$)	294	250		
d) Malawi (population: 10.0 M)				
Fixed Phone (1,000 lines)	34	45		0.45%
Mobile-phone (1,000 lines)	0.4	49		0.5%
GDP per Capita (US$)	153	152		

e) Sri Lanka (population: 18.9 M)

Fixed Phone (1,000 lines)	206	767	4.1%
Mobile-phone (1,000 lines)	51	430	2.3%
GDP per Capita (US$)	719	861	

Short Evaluation of the Above Cases

All of above cases, private mobile-phone operators have been involved.

Cases of Bangladesh, Uganda, and Malawi show the almost same condition of the poor fixed-phone penetration, i.e., less than 1 % , where the mobile-phone will partially take the demands for the fixed phone paying attention on the rapid service connection of the mobile-phone. In these counties, the fixed-phone operator will have the long list of the waiting applicants.

In the case of Bolivia, urban area demands for the fixed-phone will be already saturated, so that the personal demands for the mobile-phone will be highlighted.

In the case of Sri Lanka, the investment on the fixed-phone facility would be still running with the high level, while the mobile-phone expansion is running more rapidly. Upon saturation of the fixed-phone demands of the capital and main cities, the expansion of the fixed-phone network will be shortly ceased, while the mobile-phone network will be further expanded.

(3) Size of the Mobile-phone Market

The demand for the fixed phone is to be originated based on the places, such as offices, houses and so on. While, the demand for mobile-phone is to be originated from each personnel.

In this regard, the long-term demand for the mobile-phone will reach to 1.2-2 times of the fixed-phone demand, in urban areas.

However, the extension of the mobile-phone network to the remote/rural areas will be delayed (or, will not be made) due to the high cost per line for the time being.

(4) Mobile-phone Demand Forecast in Ethiopia

1） ITU Model

Taking from the statistic data of ITU (from the data book year 2001), the demand density to GDP per capita may be assessed using the following formula:

$Y = aX + b$, where Y: demand density, X: GDP per capita

$Y = 0.0017X - 0.3026$ （Both side logarithm scale）

However, the correlation between mobile-phone penetration and GDP/capita is not so close in comparison with that of the fixed-phone as shown in the cases of the other countries given in item (2) above.

This formula is to be applied only on urban area.

2） Adjustment to the Current Demand

The above formula is to be adjusted to meet with the current situation of mobile-phone market in the urban area of Ethiopia:

Urban population: 9,742,000 (2001)
GDP per capita (X): US$300 as estimated for urban area
Mobile-phone subscriber: 36,000
Waiting applicant: 33,000
Current total demand: 102,000 (36,000+33,000+33,000)
Current demand density: 1.047%

The adjusted formula based on the current situation is:

$Y = 0.0017X + 0.537$ (Both side logarithm scale)

3) Adjustment of the Initial Market Development

In many countries, a rapid increase of mobile-phone has been experienced during the initial several years of the service commencement.

Considering this fact, the above conditions shall be further adjusted giving the initial enhancement rate of the mobile-phone market in the following manner:

Year 2001: 1.4 times

Year 2020: 1.15 times

4) Accordingly Micro demand is forecasted.

Table 5.3-3 Mobile-phone Demand

Year	GDP/cap.	Urban Pop.	Demand Density	Enhance	**Demand**	Addis Concentration	Addis
2001	$300	9,742	1.047	1.4000	142,798		
2005	$500	11,509	1.387	1.3375	213,505	59.50%	127,035
2007		12,562	1.523	1.3125	252,653	57.34%	143,602
2010	$700	14,141	1.727	1.2750	311,374	54.10%	168,453
2015	$900	17,213	2.067	1.2125	431,399	49.40%	213,111
2020	$1,200	20,743	2.577	1.1500	614,729	47.10%	289,537

Demand distribution to major cities is estimated to be proportional to those of fixed phone distribution. The following table gives the distribution to each primary center area bases.

Table 5.3-4 Mobile-phone Demand Forecast in Major Cities

			2005	2005	2010	2015	2020
			Demand	ETC's Plan	Demand	Demand	Demand
Tigray	4	Mekele	15,200	18,000	24,600	38,000	57,400
Tigray	4	Adi Grat					
Amhara	3	Dessie	7,200	5,000	12,100	19,000	29,200
Amhara	8	Bahir Dar	17,200	16,000	28,900	45,700	70,400
Amhara	8	Gondar					
Oromiya	2	Nazareth	10,900		18,300	29,000	44,700
Oromiya	2	Assela		4,000			
Oromiya	6	Shashemene	15,100	5,000	23,200	33,800	47,700
Oromiya	6	Zway		4,000			
SNNP	6	Awassa		10,000			
SNNP	6	Arba Minch					
SNNP	6	Sodo(Welaita)					
Oromiya	7	Nkempte	3,800	4,000	5,900	8,500	12,200
Oromiya	7	Jimma	7,400	6,000	11,500	17,000	24,200
Somali	5	Jijiga					
Harari	5	Harar					
Harari	5	(Meyumuluke)	Include Harar		0	0	0
Dire Dawa	5	Dire Dawa	9,800	16,000	18,500	27,300	39,500
		Total	86,600	100,000	143,000	218,300	325,300
Addis	1	Addis	127,035	100,000	168,453	213,111	289,537
Addis (E)	1	(Debre Berhan)	Include Addis				
Addis (N)	1	(Debre Libanos)	Include Addis				
Addis (S)	1	(Debre Zeit)	Include Addis				
Total Demand			**213,635**	**200,000**	**311,453**	**431,411**	**614,837**

5) Trend of Mobile-phone Service Contents

Mobile-phone will become the key facility to provide the information technology services of the next generation, i.e., broadband information send/receive at anywhere, anytime, and with anybody.

IT service contents, which are so far enjoyable through computers, will be provided by mobile-phone in a very near future.

In this regard, the network for mobile-phone will preferably formed by IP technology (Internet Protocol).

6) Investment Policy for Mobile-phone Network

In order to enhance the market development, the capacity of the mobile-phone network will be provided much enough to cover the forecast demand, especially in the initial

stage of the service introduction.

However, considering that ITU's statistic data would not be sufficient to define the real demands and the current world-wide trend of rapid development of mobile-phone network, **the demand of mobile-phone shall be reviewed by the year 2005** in order to avoid the idle capacity.

5.3.3 Internet/Data Service Demand Forecast

(1) Current Situation of Internet/Data Services

Data services will be applicable through ISDN network, but service contents will be very limited or not be available. The data network now is privately operated for each enterprise purposes such as banking system, flight management system, insurance management system and so on leasing ETC's transmission system.

Concerning the internet services、the experienced annual increase of the subscribers are shown in table 5.3-5.

Table 5.3-5 Current Situation

Year	1997	1998	1999	2000	2001	2002, Jan.
Subscriber	1,042	2,068	2,163	2,461	4,073	6,151

(2)Internet Demand Forecast

1） From 2001 to 2005, internet demand will be increased by double per year same as the experienced rate.

Table 5.3-6 Initial Demand Forecast for Internet/Data/IT

Year	2000	2001	2002	2003	2004
Demand	2,461	4,073	8,200	16,400	32,800

2） After year 2005, the internet demand(computer) will be increased by 10% per year, and new kinds of demands (from mobile-phone, education, medical, government administration) will be originated as given Table 5.3-7 below.

Table 5.3-7 After Year 2005 Internet Demand Forecast

From	2005/6	2010	2015	2020
Mobile	64,000	93,400	129,500	184,500
Computer	36,000	58,100	93,600	150,700
Education	2,000	10,000	20,000	30,000
Medical	2,000	10,000	15,000	20,000
Gov't Admin.	5,000	10,000	15,000	20,000
Total Demand	109,000	181,500	273,100	405,200

5.4 Shift of Fixed-phone Demand to Mobile-phone

Due to the quick connection of the new applicant, parts of the fixed-phone demand will be shifted to the mobile-phone, and as the world-wide trends, the fixed-phone demands are decreasing after the introduction of the mobile-phone services.

In order to avoide the over-investment on the fixed-phone network, the target network capacity for the fixed-phone will be reduced by around 25%.

	2005	2010	2015	2020
Fixed Demand	917,500	1,197,900	1,553,000	2,003,300
Target capacity	688,100	898,400	1,164,800	1,502,500

Considering the above reduced target of the fixed-phone network capacity, the majority of the balance demands are to be considered to be shifted to the mobile-phone. In addition, due to the application of the pre-paid system, many temporary users will be expected. Accordingly, the network capacity of the mobile-phone will be prepared for:

	2005	2010	2015	2020
Original Demand	213,500	311,400	431,400	614,800
Shift from fixed (60%)	82,000	179,700	233,000	300,500
Temporaly user	10%	7%	6%	5%
Expected Temp. User	21,400	21,800	25,900	30,800
Total Target Capacity	**316,800**	**509,800**	**688,100**	**946,000**

Note: Temporary users will be more than the above, but is limited to the minimum considering the 2-step adjustment given for the original mobile-phone demands.

5.5 Other Telecommunications Demands

5.5.1 TV Channel

34 Mbps stream is already addresed in the trunk transmission routs to the far-end stations, where the TV trasmission station is located (So far 19 setes)

This 34 Mbps stream will be used by TV 3 channels and broadcasting channels in the future and no expiation will be considered in this concern.

5.5.2 Leased Circuit

A military circuit has been independently established by the army, and the telecommunications sector has no obligarion to provide the military channels.

The current leased channels are only 159, and ar not increasing.

The dedicated circuits will be reauired for the specific high security information exchanges such as e-government, insuarance, bank network, stock market, nation-wise long distance transportation services nation-wise big scale trade, but the majority of the IT services / contents (e-education, e-medical, e-commerce etc.) will be processed economically through web-sites; i.e., public IP network.

The leased circuits' requirement will be originated mainly in Addis Ababa area, where the network capacity is to be sufficient subject to the O/F junction ring.

In this regard, no specific demands of the leased circuit will be added.

CHAPTER 6 TRAFFIC FORECAST AND CIRCUIT CALCULATION

6.1 Traffic Forecast

This chapter present the forecast of the demand for the traffic expected to be generated both from fixed and mobile networks envisaged over the planning period. Due to the structure and design of telecommunication systems, the circuit provision cannot be made to match all short time variations of traffic. The various parts of the system must, therefore, be extended in steps large enough to last for a certain period, usually for a period of 5 years. The extension step must be so large that disturbing congestion can be avoided during the whole period.

For such an extension period, a traffic forecast is made which should describe how the traffic would vary and grow. The provision depends on following facts.

1) The revenue from telephone traffic will depend on the traffic carried, usually on the number of conversations established.
2) The expenditure depends on the grade of service it is desired to give to the subscribers under peak traffic conditions.
3) Most of the carried traffic volume is handled at times when there is practically no congestion at all.

In this MP traffic forecast has been carried out to determine circuit requirement for the years of 2003, 2005, 2010, 2015 and 2020 based on the demand forecast data and various traffic modeling assumptions.
Besides the demand forecast, different assumptions regarding expected level of calling rate, change of call mix among different customer segments, shift of traffic to other media, etc. have been used to determine the level of traffic in the planning period.

Calculated circuit requirements for years 2003 and 2005 shown in this report is basically for the conventional circuit switching network, due to the ongoing conventional switching expansion plan under ETC's Eighth 5-Year Development Program to be carried on until 2004/05.

Considering the planned introduction of VoIP (Voice over Internet Protocol) networks in this MP, which is expected after year 2005 upon the completion of the major parts of Eighth 5-Year Development Program of the corporation, calculated circuit requirements for years 2010, 2015 and 2020 is based on VoIP systems. Transmission capacity requirement will be drastically reduced upon the introduction of VoIP.

6.1.1 Assumptions for Traffic Forecast (Fixed-phone)

The applied traffic forecast method for the conventional type of network is basically the same as commonly used method for the general telecommunication networks in the world.

The originating traffic volumes for each node and for each objective year are calculated based on the assumed originating traffic/lines of each subscriber category and the call mixture.

The objective area of the traffic forecast is generally of the urban area, where the population is to be more than 1,000.

Note: ETC had applied total traffic/line of 100 mErl for urban subscribers and of 50mErl for rural subscribers for engineering purpose.

The traffic calculation has been carried out based on the following elements and conditions.

1) Change of Call Mixture

ETC categorize the area as Business, Government, Residence and others, and those mix of the subscriber categories data as on July 2001 are:

	Addis Ababa	Other Towns
Business	17.2 %	22.2 %
Government	9.4 %	15.9 %
Residence	71.5 %	59.1 %
Others	1.9 %	2.8 %

The above proportion will change with the increase of the residential subscriber.

Generally, calling rate of the subscribers in the residential areas much lower than that of other categories. In this regard, the calling rate is to be declined for the long term, as the proportion of residential subscribers will be increased, and be reached to more than 80 % of the total number of subscribers.

2) Traffic shift to other media

Currently, due to rapid growth of the new type communication services such as the Mobile-phone and Internet services, the significant part on the fixed-phone traffic is shifting to such new media.

Accordingly, depending on the spreading of new type communication media, the traffic of the fixed-phone should be evaluated.

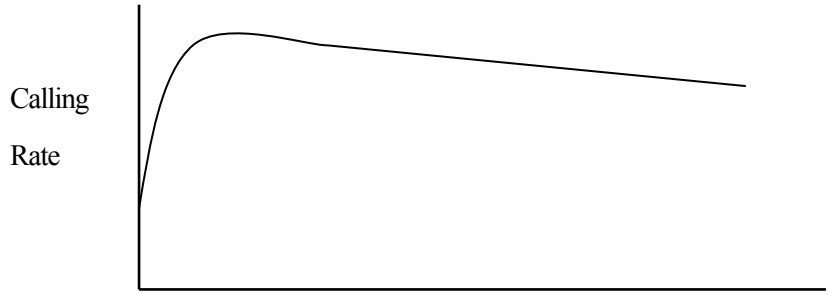
The expected degree of influences due to the mentioned above are estimated as follows

	Shift to IP	Shift to Mobile
International call	A	C
Toll call	C	B
Local call	B	C
When well developed (Increase of mobile / Internet)	A	A

* Where A represents the heaviest shift, and C means light shift.

3) Assumed trend of Calling Rate on the Fixed-phone

The following shows the expected trend of Calling Rate:



4) Assumed calling rate applied in this report

Over the above trend, the influence of call mix and traffic shift to other type communication media should be take into consideration. Accordingly, the evaluated Calling rate is assumed to be:

		2001	2005	2010	2015	2020
Call mixture						
Business (85 m Erl)	%	33.4	30.0	28.0	26.0	25.0
Residence (25 m Erl)	%	66.6	70.0	72.0	74.0	75.0
Calling Rate (m Erl)		45.04	43.0	41.8	40.6	40.0
Shift to other media						
Mobile %		3	5	10	15	20
Internet %		0.5	2	5	8	10
Evaluated Fixed-phone traffic (m Erl)		43.5	40.0	35.5	31.3	28.0
Calling Rate for Eng. purpose (m Erl)		**57**	**50**	**48**	**44**	**40**
(+30% to the evaluated)						

Hence, 0.05 Erl calling rate per subscriber is applied to the traffic calculation for year 2005 in this report for engineering purpose.

6.1.2 Traffic Distribution or Traffic Flow

The national network is composed of the Addis Ababa multi-exchange area (by 6 tandems) and 8 primary center areas currently, two - third of the subscriber are in AA area.

In order to define the traffic flow, the study team applied the following assumptions due to the shortage of the traffic data.

1) Community interest coefficient

AA area:

- 80% of the originating calls AA area is to be terminated within the same AA area without any specific mutual interest
- 20% is to be terminated to the other area

Primary center area:

- 70% of the originated calls of each PC area is to be terminated within the same PC area

without any specific mutual interest except the calls terminated within the same local exchange area.

- 30% is to be terminated to the other area than the own PC area.
- 50% of the originated calls of each local exchange area is to be terminated within the same local exchange area; i.e. 20% is to be terminated within the same PC area.

Note: In case the specific community interests are observed, the above assumed traffic flow is to be modified.

2) Traffic flow matrix

The traffic flow matrix has made based on the above community relations applying the gravity of subscribers of each area, but considering the traffic routing plan as well as the traffic flow of mobile-phone. IP traffic under the dial-up connection will not affect this traffic flow calculation except the transmission capacity.

The matrix is given in the Data File for years of 2005 implementation base, 2005 demand base and year 2010, 2015, and 2020 demand base.

6.1.3 International Traffic

All the international traffic is carried through the SC and set up rate is 5 % of the traffic on SC.

The past growth of international traffic from 1987 to 2001 is shown in the following table.

Table 6.1-1 The Past Growth of International Traffic From 1987 to 2001

G.C.	OG calls (million)	Y.G.R.	OG mins (million)	Y.G.R.	IC calls (million)	Y.G.R.	IC mins	Y.G.R./ sub.year
1987/88	0.48		2.9		1.07		9.41	
1988/89	0.67	39.6%	4.7	62.1%	1.62	51.4%	12.25	30.2%
1989/90	1.2	79.1%	7.3	55.3%	2.15	32.7%	15.09	23.2%
1990/91	1.7	41.7%	8.9	21.9%	2.7	25.6%	17.92	18.8%
1991/92	2.1	23.5%	10.1	13.5%	3.24	20.0%	20.76	15.8%
1992/93	2.8	33.3%	10.9	7.9%	4.09	26.2%	22.88	10.2%
1993/94	3.1	10.7%	11.5	5.5%	4.49	9.8%	23.17	1.3%
1994/95	3.1	0.0%	10.5	-8.7%	5.45	21.4%	26.15	12.9%
1995/96	3.41	10.0%	10.35	-1.4%	6.47	18.7%	32.5	24.3%
1996/97	3.56	4.4%	10.69	3.3%	7.19	11.1%	37.05	14.0%
1997/98	3.94	10.7%	11.84	10.8%	8.44	17.4%	41.83	12.9%
1998/99	4.08	3.6%	12.45	5.2%	9.43	11.7%	46.5	11.2%
1999/00	4.36	6.9%	13.42	**7.8%**	9.1	-3.5%	44.88	**-3.5%**
2000/01	4.62	6.0%	13.42	**0.0%**	8.78	-3.5%	43.26	**-3.6%**
Total average		20.7%		14.1%		18.4%		12.9%
Past-5Ys average		6.3%		5.4%		6.6%		6.2%
Past-3Ys average		5.5%		4.3%		1.6%		1.4%

ETC has enjoyed the constant growth of the international traffic until the year 1998/1999, but was found to be decreasing as of the year 1999/00.

Due to the effect of globalization of the business environment, the international traffic is increasing from time to time, but such traffic is drastically shifting to the Internet services.

Accordingly, the traffic on the international switch will not be increased, but will be drastically reduced depending on the penetration of the IP subscribers.

Taking the traffic-reducing trend into consideration, no growth of international voice traffic is assumed in this Master Plan. Rapid increase of IP based international traffic is assumed instead.

The assumed traffic increases (10% per annum) as well as the international circuit requirement are given in D.Table 6.1-1.

International traffic via satellite is supposed to be compressed by DCME (digital circuit multiplication equipment) or LRE (low rate encoder) in order to economize the satellite transponder fee. LRE will be applied for the traffic over 30 channels and under 60 channels and DCME is provisionally for over 60 and under 240 channels here.

6.1.4 VoIP Traffic

Calculation method in this report is the same as that of existing network for a convenience.

6.1.5 Mobile Traffic

The numbers of mobile telephone subscribers is rapidly increasing and ETC plans to expand the capacity of the network up to 400,000 by the year 2005.

At present, all the calls within the existing mobile network are handled by only one switching system, which is located in Addis Ababa.

Interface between Mobile network and Fixed network at present is made at four (4) exchanges such as Secondary Center, Addis Ketema, Filwoha and Keira.

(1) Calling Rate

The call mix (ratio of the business subscribers) also affects the mobile-phone traffic.

However, traffic does not go high during the busy hours as experienced on the fixed-phone network. In addition peak traffic level is less than that of the fixed network. However, high traffic time duration is much longer than that of the fixed network.

In this report, due to the lack of the basic data, calling rate at the busy hour is assumed to be 80 % of that of the fixed-phone and the assumptions are as follows:

	2001	2005	2010	2015	2020
Mobile-phone basic	63.2	36.0	34.4	33.4	32.0
Call mix (ratio of business) %	90.0	33.4	30.0	28.0	26.0
Shifted from fixed-phone %	0.9	1.7	2.9	4.06	6.0
Assumed calling Rate (m Erl)	64.1	37.7	37.3	37.46	38.0
Calling Rate for Eng. Purpose (m Erl)		**40**	**40**	**40**	**40**

Hence, 0.04 Erl calling rate per subscriber is applied to the traffic calculation in this report for the engineering purpose.

(2) Traffic Distribution

There are some interfaces links between the mobile network and the existing fixed networks, and the traffic distribution from the mobile network to some destinations are as follows:

1) Addis Ababa area

There is a one MSC in Addis Ababa and it has links from/to SC and 3 TDMs, while in order to keep up with the increasing traffic, to install other exchanges in the region "04", "05" "06" and "08" is strongly recommended in this report. Therefore, the following traffic destinations are set up on Addis Ababa MSC:

40 %: to within Addis Ababa Mobile

20 %: to SC

40 %: to Addis Ababa MEA

2) Other PC Areas

4 MSCs should be newly installed in the regions mentioned above to avoid concentrating heavy traffic to the existing MSC. Then traffic distributions at those new exchanges are as follows:

40 %: to fixed-phone in the same PC area

30 %: to other areas through the PC and SC

30 %: to within the mobile network

6.1.6 IP Network Traffic (Data Network)

Internet services are provided by dial-up connection to POP. Internet traffic is to be extended up to the POPs located at each PC or Tandem, and is fully local traffic.

The duration of POP connection will be rather long, i.e., more than 5 minutes/connection, and majority of the business user will apply the connection during busy hour.

Residential user is very rare to have the access to POP during the busy hour.

	2001	**2005**	**2010**	**2015**	**2020**
Call Mix (business %)	100	65	50	40	30
Calling rate (m Erl)	100	68.5	55	46	37

6.2 Circuit Calculation

Circuit calculation is carried out based on the result of forecasted traffic data and is carried out for two types of different networks such as the networks configured with the conventional circuit switching systems, and with the IP network routers. Calculation methods are absolutely different as described below:

6.2.1 Circuit Calculation for PSTN

PSTN as "Conventional type network" in this report is defined as the circuit switching structure used, to exchange information between 2 subscribers, exclusively occupying a circuit with 64kbps or 32kbps, where the 64kbps circuit is commonly used.

Therefore, the purpose of circuit calculation in case of the conventional systems is to get the number of required 64kbps circuits.

"Grade of Service (GOS)" is an important element for this calculation. This is because, traffic congestion rate changes according to change in GOS figures. For example, if GOS is 0.01, probability of encountering a busy circuit is 1%. ETC has set up its standard indexes in terms of GOS as follows:

Inter-Region Backbone Circuit: 0.005

Other than above: 0.01

However, a GOS of 0.005 is applied to the entire circuits in this report, because, 0.005 and 0.01 do not make big difference to the result of calculations, and such level of difference does not affect equipment price very much.

The calculation results are shown in D.Table 6.3-1～7.

6.2.2 Circuit Calculation for IP Network

The method of circuit calculation for IP network is absolutely different from the conventional type of network. IP network carries packetized data as well as VoIP. In case of the conventional type network, a circuit is held until the time a subscriber is on hook, and it is called as "Connection Type". However, in the case of VoIP (Voice on Internet Protocol), 64kbps of digital voice is compressed and packetized to the many data packet.

The packets do not occupy a particular channel and the same stream can carry many packets of different calls. It is called as "Connectionless Type"

The concept of GOS is not applied for the circuit calculation.

Each packet is given an overhead signal that contains data of destination address, etc. And no data packet is made at the empty time of conversations.

(1) Packeting Way of the Voice is As Follows;

			Paketing cycle	Pay load	Header	Required Band/ch
a)	G711	64 kbps	20 ms	160 B	40 B	80 kbps
b)	G726	16 kbps	20 ms	40 B	40 B	32 kbps
c)	G729	8 kbps	20 ms	20 B	40 B	24 kbps
d)	G729	8 kbps	40 ms	40 B	40 B	16 kbps

B: Byte (1 Byte is equivalent to be 8 bps)

The delay of the packet is classified as follows.

High class (equivalent to Fixed-phone)	< 100 ms
Medium class (equivalent to mobile-phone)	<150 ms
Acceptable class	<400 ms

In Ethiopia, 50-60ms delay due to the long transmission links is feared. Accordingly the delay of the packet is to be kept not more than 40ms in order to maintain the high class.

(2) Application of the Packeting Standard under the Master Plan

In this master plan, G729 is applied with 40 ms packeting cycle as the majority, and G711 is applied for the specific service such as the facsimile service, which is not accepted by G729. Accordingly, the circuit (64 kbps) requirement of the VoIP is to be 1/4 of the normal voice band digital stream.

6.3 Traffic Matrix

Reference is made to D.Tables 6.3-1～7.

6.3.1 Direct Mesh Network for Addis Ababa Big Nodes.

Current traffic routing is fully depended on the backbone network (LE-Tandem-Tandem-LE).

This routing rule will be too much heavy on Tandems. In order to decrease the heavy loads on tandems, direct routes shall be introduced in the next expansion stage to the following big nodes.

C:	Filwoha
N:	Arvada, Sidist Killo
E:	Bole, Yeka, Gerji, Bole Michael
W:	A.Ketama, Kolfe
S:	Kirkos, Nefas Silk, Akaki, D.Zeit
SW:	Old Airport, Ayur Tuna
NSC/ISC	
MSC	

Direct route may be increased to other big nodes in addition to the above.

6.3.2 Traffic Routing Rule of Mobile-phone

1) The Mobile-phone has the independent network, and has the interfaces with the fixed-phone network at
   - NSC/ISC
   - 3 AA tandems (Filwoha, A Ketama, Keira)
   - 4 PCs (Mekele, D/Dawa, Shashemene, Bahir Dar)
2) Calls among mobile-phones are to be settled within mobile network.

3) Mobile-phone to fixed-phone

- AA area through 3 tandems
- 4, 5, 6 & 8 areas through each PC
- 2, 3 & 7 areas through each PC via NSC

4) Fixed-phone to mobile-phone

AA area through tandems

4, 5, 6 & 8 areas through each PC

2, 3 & 7 areas through NSC via each PC

Note: At the next expansion phase of the mobile network, interface points shall be given to the remaining PCs (2, 3 & 7) and to the remaining tandems. Interface points to the remaining 3 tandems (and big LEs) may be introduced immediately considering the heavy loads given to the tandems.

6.3.3 Traffic Distribution to the Packet Network

Considering the huge expansion of the fixed-phone network (320K→650K subscribers) and of the mobile-phone network (36K→210K .subscribers), and the limited traffic handling capacity of NSC/ISC, the part of the increased traffic over the backbone network (PCs/Tandems-NSC) shall be carried through the newly introduced packet network..

The packet network among 8 PCs and 6 tandems shall be established within the short-term plan. Traffic given to NSC/ISC will be limited to 10k Erlang. The over-flow portions are to be carried via packet network.