CHAPTER 9 TELECOMMUNICATIONS NETWORK PLAN

9.1 Basic Concept of Proposed Network Plan

The study of the Proposed Network Plan should necessarily include a broad range of factors, from the expected national socio-economic develpment, government policy to resource availability. Of particular importance are demands of the various services, including those services not available at present, and the extent of financial resources. Other important consideratios include the existing network, transition strategies, interworking with other networks, operation and maintenance, administrative structure, numbering, signalling and other fundamental plans.

9.1.1 Fundamental Network Plan

The Network Master Plan is proposed considering:

1) The network is designed considering economical deployment and ease of operation and maintenance.
2) The proposed network will be deployed utilizing the latest technologies at present.
3) The network will be able to accommodate expected demand of existing and new application of basic telephone and non-telephone services that interface to the conventional networks.
4) The network should facilitate the development of ICT (Information and Communication Technology) covering the major areas of Ethiopia.

9.1.2 Evolution of Existing Network to IP

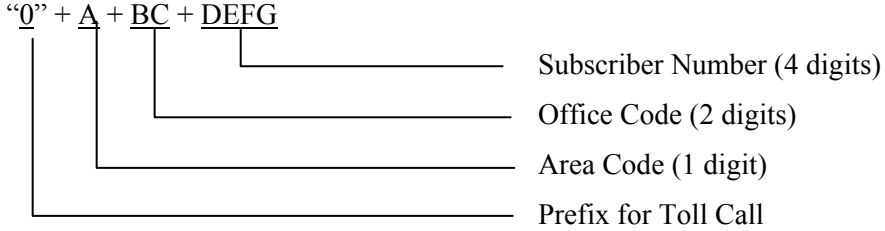
Some countries have introduced IP telephony to converge the telephone network and data communication network. In order to utilze the accumulated assets economically and efficiently, the existing switching systems (PSTN) should be used to the utmost of its equipment life. Considering this factor the new IP network is to be overlaid with the existing network and the conventional networks will coexist with the IP network during the transitional period.

9.2 Fundamental Technical Plan

9.2.1 Numbering Plan

(1) Existing Number Structure

The telephone number structure of Ethiopia consists of Country code (CC), Area code (AC), Office Code (OC) and Subscriber number (SN) as follows:



The country code "251" is given in accordance with ITU-T Rec. E. 163.

(a) Area Code Arranged to the Regions is As Follows:

"01" : Addis Ababa, "02" : South Eastern, "03" : North Eastern, "04" : Northern

"05" : Eastern, "06" : Southern "07" : Western "08":North Western

Office codes (OC) in each telecom region are as follows and OC list of exchanges is as shown in the following Table 9.2-1.

Table 9.2-1 Office Code assignment

AC	Office Code (OC)
01	11, 12, 14～16, 18～20, 22, 23, 26, 27, 29, 30～38, 40～43, 45～49, 50～54,
01	55～59, 60～68, 70～73, 75～79, 80～82, 84, 87
02	11, 12, 14, 16, 20, 21, 24, 26, 31, 32, 70
03	11, 16, 31, 33, 34, 36, 37, 51, 54～56, 61, 64, 66
04	40, 42～46, 71, 74, 75, 77
05	11, 12, 51, 66, 74, 75, 76
06	10, 15, 16, 20, 22, 24, 25, 26, 31, 34, 35, 41, 44, 45, 51, 54～56, 61, 64～66, 68, 74, 75, 77, 81
07	11, 21, 24, 31, 35, 41, 45, 51, 54, 55, 56, 61, 64～66, 68, 71, 74～76
08	11, 14, 20, 21, 24, 25, 37, 41, 44, 45, 61, 65, 71, 74～76

(b) Special Service Number

ETC employs some 2 and 3 digits numbers start with "9" for special services to the public. The following Table shows the 2 and 3 digits numbers with corresponding services.

Table 9.2-2 Special Service Number

Number	Purpose
91	Police
92	Ambulance
93	Fire Fighting
97	Telephone Directory
98	International Operator
99	National Operator
901	Time Signal (Amharic)
902	- ditto - (English)
903	Office for Advising HIV/AIDS Patients
961--5	Fault Maintenance at each Zone in Addis Ababa

In addition to the numbers shown in the above Table, several special number are used for the facilities such as Call Waiting service, 3-party call service and Call Forwarding service.

(c) Escape Code

The escape code or toll call prefix is "0". ETC divides the country into 8 telecom regions giving ACs starting with "1"---"8".

"00"(including the escape code "0") is used for international calls.

"09" is used for mobile-phone calls.

(d) Mobile Code (MC)

The structure of mobile telephone number consists of 1-digit prefix and 6-digit subscriber number and "9" is assigned to prefix.

(2) Proposed Future Numbering Scheme

The proposed numbering plan is expected to deal with the expected demand of services and the changing environment from the monopoly telecom operator to plural operators era as well as changing from the conventional networks to IP networks. The new operators are expected to mainly enter to Mobile-phone services and IP/Data services.

Therefore, the existing numbering plan should be systematically reformed for a competitive business environment and various new services to be introduced in the future.

In case of a local call on the existing network, the subscribers start to dial the 1st digit of Office Code (OC) "9" is assigned to the special service number which consists 2-digit or 3-digit.

In case of a toll call, "0" + area code "1"---"8" are dialed. "09" is assigned to the mobile telephone network.

Considering the above conditions and in order to avoid the confusion of the subscribers, the following are recommended for immediate purpose:

(a) Office Code (OC) & Subscriber Number (SN)

The current 2-digit office code and 4-digit subscriber number continue to be used for immediate demand and the existing 6-digit numbering capacity can cover 500,000 to 600,000 subscribers practically.

The fixed-switched networks are scheduled up to 650,000 subscribers for some time and VoIP network will take the demand share of the fixed-phone after the year 2005.

(b) Area Code (AC) and Mobile Code (MC)

A change of area code is not required unless the division of telecom region is reformed.

Mobile code should be changed from 1-digit to 2-digit considering the new network to be operated by entities other than ETC who may enter to this mobile sector.

(c) Special Service Number

Current special numbers start with "9" are assigned to some services as described in (1)-(b) of this Section, however, the number of current items in services are not so many compared with other countries. More items of special services are expected to be provided by ETC in the future.

Considering the above points the digits of special numbers should be unified into 3-digit. However, service to start with "9" should be kept in accordance with the numbering plan.

(d) Access Code for International Services & Others

At present in order to access to international gateway, subscribers dial "00" and country code of destination on the current numbering structure. However "00" will be assigned as the pre-fix for VoIP networks and services, and the access number to international gateway shall be changed to "001".

(e) IP Telephone

According to the Master Plan, IP telephony will be quite common in the future and VoIP is expected to be introduced after 2005. In case of IP telephony, the numbering scheme of the PSTN network can not be used because of their completely different addressing system.

Terminal equipment including IP telephone on the IP network is given individual IP Address to recognize particular terminal and IP system functions, which is completely different from the addressing scheme of the conventional telephone network.

In case a conventional telephone number would be given to IP telephone for the subscriber's convenience, the given telephone number is translated to IP address in the IP network. In order to have easy access to IP network, the prefix "00" will be preferably given to the telephone number of IP telephone.

(3) Recommendation for the Proposed Numbering Plan

(a) Assumed Conditions for Numbering Plan

The following conditions are assumed for the proposed numbering plan.

- Forecasted volume of various services to be provided are as shown below

- **Table 9.2-3 Volume of Various Services**

Services		2005	2010	2020	Ultimate
Fix-SW	AA	400K	400K	400K	0
	Nation	650K	650K	650K	0
Fix-SW (IP)	AA	-	300K	600K	
	Nation	50K	650K	1,500K	30,000K
Mobile	AA	130K	200K	300K	
	Nation	210K	310K	650K	40,000K
Internet	Nation	80K	200K	400K	10,000K

- Telecommunications services market will be opened after the year 2010 and new carriers/providers are expected in the field of mobile-phone/Internet services.
- Number "9" will continue to be used as the prefix for special services.

(b) Evaluation of the Current Numbering Scheme

("0" for toll, "00" for international, first digit as area code, $2^{nd}/3^{rd}$ digits for exchange codes, last 4 digits for subscriber identifications)

- 00, X, XX, XXXX

1) The capacity of existing numbering scheme for the fixed switching network is expected to withstand for the life time of conventional network.

2) The capacity of current numbering scheme of the Mobile-phone (09-XX-XXXX) can withstand until the new carrier will commence the service (after year 2008).

3）Internet service will use the IP address other than the numbering plan.

4）New numbering scheme for VoIP shall be introduced using pre-fix digit “00”, when required.

5）In relation with the above scheme, the international call pre-fix “00” shall be changed to “001”

(c) Recommendation of the Renumbering Scheme for the Ultimate Period.

1) The numbering scheme will consist of:

- Subscriber code 4 digit
- Office code 2-4 digit depending on the volume of each area
- Area code 1 digit
- Service code 1 digit (VoIP/Mobile/International/etc.)
- Carrier (Provider) code 1 digit
- 0, 00 Open code

2) Numbering scheme for the fixed-switched network shall be kept as it is (for the life time up to 2020).

3) Current numbering for Mobile-phone shall be kept up to the introduction of the new carrier. Change of numbering will be around year 2010.

092 XX XXXX
↑ Carrier code (ETC when required)

For other carrier

↓

093 XX XXXX

4 XX XXXX

5 XX XXXX

Office code may be increased to 4-digit depending on the network growth.

4) VoIP (in future, when required)

00 2 2 1 XX XXXX

- XXXX: Subscriber code (4 digit)
- XX: Office code (2-4 digit depending on growth)
- 1: Area code (1 for Addis Ababa)
- 2: Carrier code (2 for ETC)
- 2: Service code (2 for VoIP, 1 will be used for international.)
- 00: Open code

5) Other carrier (provider) and services

Give the number 3~8 of the carrier code for the new carrier (provider) and the number 2~8 of the service code for the kind of services.

6） International call

In case the service code will be given to VoIP, the pre-fix for the international call will be changed to"001" instead of "00"

(d) Alternative

In case the specific service code will not be given to VoIP as is the same fixed-phone category, one digit shall be added to the office code of Addis Ababa.

Addis Ababa telephone number.

01 **X**XX XXXX

Additional office code digit to Addis Ababa area only

Area code

In case ETC will select this alternative the telephone number change (additional digit) shall be advertised (as well as the notice to the customers) at least 3 months prior to the number change.

9.2.2 Signaling Plan

(1) Existing Signaling Plan

ITU-T R2 signaling system is used between the analogue switching system and the digital switching system and also in some cases between digital switching systems. Small type of digital switching system, RAX does not have CCS No.7 function and ITU-T R2 is still used.

ISUP of CCS No.7 signaling system is used between the digital switching systems. ETC has been introducing CCS No.7 links between the switching systems while replacing the old analogue switching systems with digital switching systems.

ETC is introducing CCS No.7 links between the switching systems, while replacing the legacy analogue switching systems with the digital switching systems.

The existing switching systems, which have CCS No.7, are:

AXE-10, DMS-10, DMS-100

The existing switching systems, which have ITU-T R2 are:

RAX, C-400, ARF-101, ARF-102

The following Table 9.2-4 shows signaling system applied to the links between the types of switching system.

Table 9.2-4 Current Signalling Between Swithces

	AXE-10	DMS-10	DMS-100	RAX	ARF-101	ARF-102	C-400
AXE-10	CCS No.7	CCS No.7	CCS No.7	R2	R2	R2	R2
DMS-10	CCS No.7	CCS No.7	CCS No.7	R2	R2	R2	R2
DMS-100	CCS No.7	CCS No.7	CCS No.7	R2	R2	R2	R2
RAX	R2	R2	R2	R2	R2	R2	R2
ARF-101	R2	R2	R2	R2	R2	R2	R2
ARF-102	R2	R2	R2	R2	R2	R2	R2
C-400	R2	R2	R2	R2	R2	R2	R2

ITU-T No.5 signaling system operates international links between ISC (AXE-10) and foreign countries.

(2) Transition to CCS No.7 Signaling Link

ETC is implementing the Eighth development program which contains not only the expansion of the network but also replacement of analogue switching systems with digital switching systems as well as RAX with another type digital switching system. As a result CCS No.7 signalling links will be established between all the exchanges, and no more ITU-T R2 will exist in the country by the year 2007.

(3) CCS No.7 Link Network

The exchanges at all the levels will be connected with CCS No.7 when all exchanges are equipped with such signalling system.

The network configuration of signalling link in Addis Ababa Multi Exchange Area (MEA) will be mesh type, i.e. , the mesh type network will be configured with the Secondary center and 6 tandem exchanges. The configuration in other areas will be a star type.

(4) Interfacing with Different Networks

After the year 2005, VoIP will be introduced in Ethiopia and the telephone numbers are given to IP telephones, although, VoIP is a sort of data transport. Besides, some entities will enter to the operation business of telecommunication network. Mobile network with the roaming function is rapidly growing.

As long as PSTN will remain as a conventional type of network for considerable amount of time, CCS No.7 will not disappear in the near future. Therefore, it is essential that all the networks in Ethiopia are linked by CCS No.7 specified in ITU-T recommendations.

9.2.3 Synchronization Plan

(1) Network Synchronization Hierarchy

TR-III as the Secondary Center is the point to originate the master clock pulses for the ETC network. The master clock pulses are sent to other exchanges through master clock pulse links established basically according to the telephone network hierarchy. All the exchanges in ETC network have to be synchronized by the master-slave method under the Secondary Center.

(2) Master Clock Accuracy and Stability

TR-III is equipped with the master clock of accuracy of 10^{-11} in conformity with the slip rate defined by ITU-T Rec. G. 823/824. All digital exchange to be introduced in the existing networks will have to be equipped with a clock module of stability of 10^{-10}.

(3) Master Clock Network Structure

TR-III serves Master Clock pulses for the entire Tandem, Primary Centre exchanges and their corresponding local exchanges. However, the exchanges in area code "08" are not served with Master Clock pulses generated by TR-III exchange and the area uses its own PCM clock instead of the Master Clock.

Figure 9.2-1 shows Synchronisation Plan in Addis Ababa.

Only one (1) Master Clock is equipped at TR-III exchange serving master clock pulses for most of exchanges as mentioned above.

Although VoIP will be introduce after year 2005 and no new digital exchanges will be installed any more, the existing networks will be expanded and the number of subscribers will be tremendously increased by the completion of ETC's Eighth development program. In order to deal with such an expanded large network, synchronisation system and plan should be revised as follows:

(a) New Master Clock

A new Master Clock should be introduced in new location and its accuracy should be 10^{-11} in accordance with ITU-T Rec. G. 823/824. The existing and new master clock will be linked each other.

(b) Duplication of Links

In order to avoid any unexpected occurrence such as interruption of a master clock link, stand-by links should be introduced. Figure 9.2.-1 shows concept of the duplicated master clock network, which will be installed in the new international switching center.

(4) Master Clock Supply to Other Networks

For the network synchronisation between ETC's networks and other networks operated by other entities, ETC should supply master clock pulses if required. In this case, the master clock pluses should be sent through the ETC gateway switches to other networks.

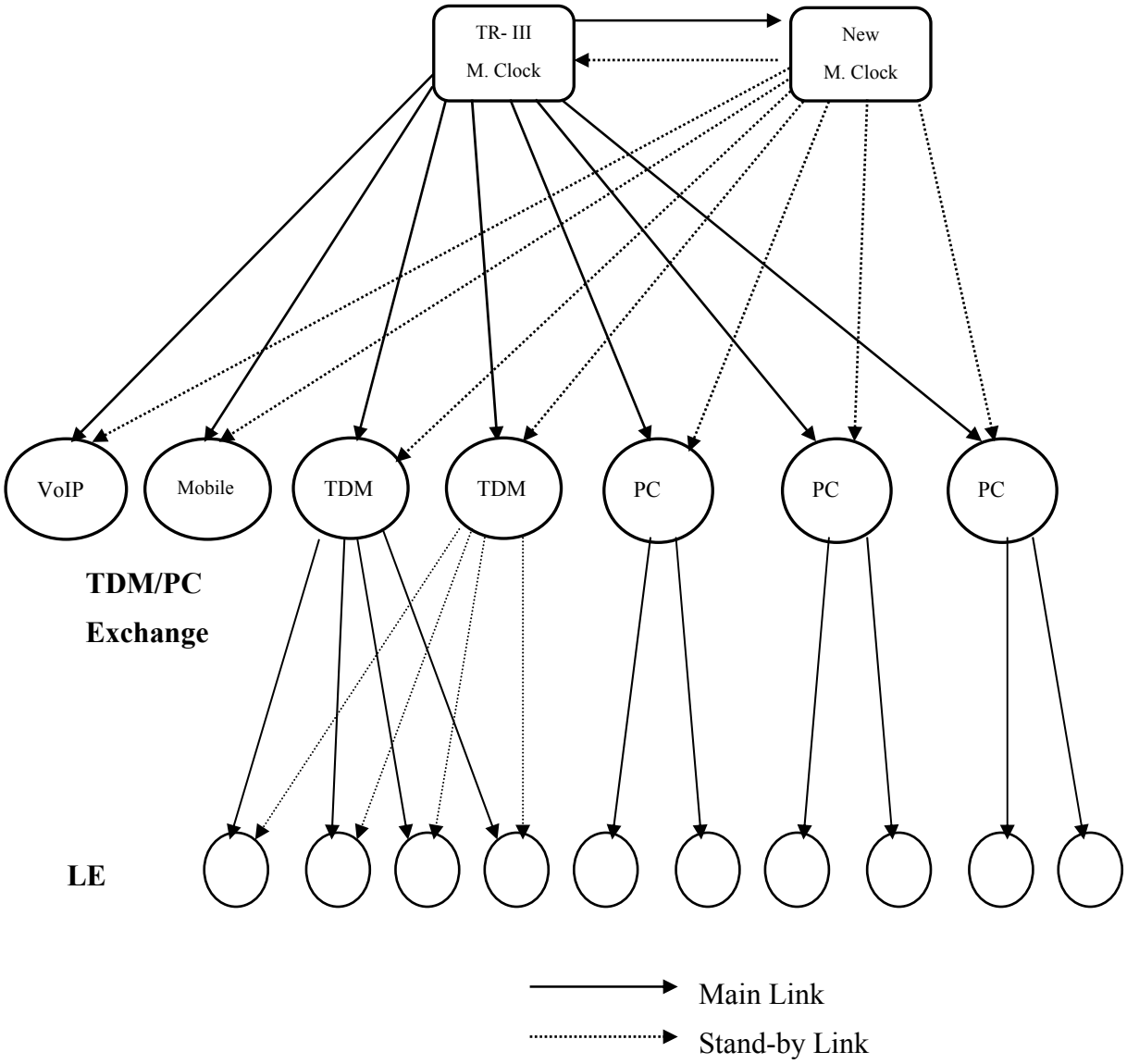


Figure 9.2-1 Duplicated Master Clock Network

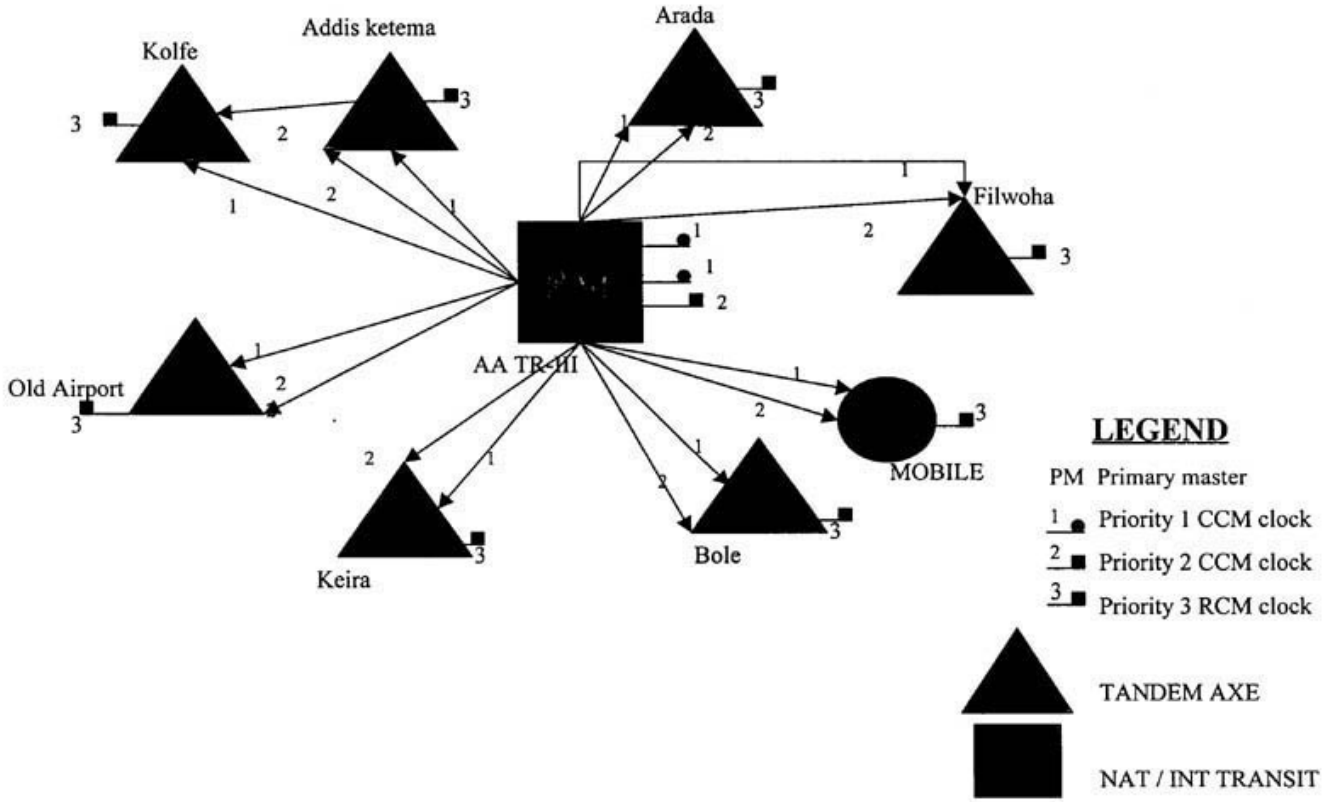


Figure 9.2-2 SYNCHRONIZATION PLAN FOR ADDIS ABABA AREA

9.2.4 Routing Plan

The numbers of subscribers of both the existing fixed and mobile networks are rapidly increasing. In particular, the number of mobile subscriber is expected to increase to 200,000 by the year 2005.

Also, it is planned that VoIP is going to be introduced from 2005 instead of expanding the conventional existing network. Considering this situation the existing routing plan should be reviewed and re-planned.

In the case of existing networks, inter-network calls (fixed and mobile-phone) are carried on the routs as shown in Figure 9.4-8.

(1) Fixed Network

The traffic is routed through backbone route, i.e., from LE to PC or tandem, and to NSC/ISC. The network in Addis Ababa zone area is configured by 6 tandems, on which the call from LEs are addressed. To these 6 tandems and NSC/ISC have the full mesh network. The existing routing plans for each region (Area Code 01～08) are as shown in Figure 9.4-9

(a) Region "01"

Region "01" consists of 2 areas as Addis Ababa zones and the rest of provincial areas.

As shown in Figure 9.4-8, the network in Addis Ababa Multi Exchange Area (MEA) consists of 6 tandem exchanges and 1 Secondary Center, AA TR-III. Each tandem exchange covers its own zone where some local exchanges exists.

All tandem exchanges are connected with each others i.e. mesh type of network is employed in Addis Ababa MEA. The local exchanges located in provincial areas of Addis Ababa with no direct connection to any of the tandem exchanges, are directly connected to the Secondary Centre.

The Secondary Centre is handling all calls not only between Addis Ababa and other regions but also between the regions, mobile and regions, etc.

Routings of the originated calls are as follows:

- Local Call within Addis Ababa zone: LE→TDM→LE
  LE→TDM→TDM→LE
- Toll call from Addis Ababa zone to province in "01": LE→TDM→SC→LE
- Toll call from province in "01" to Addis Ababa zone: LE→SC→TDM→LE
- Toll call from Addis Ababa zone to other region: LE→TDM→SC→PC→LE
- Toll call from other region to Addis Ababa zone: LE→PC→SC→TDM→LE
- Call from Addis Ababa zone to Mobile network: LE→TDM→MSC

◆ Call from Mobile network to Addis Ababa zone: MSC→TDM→LE
MSC→TDM→TDM→LE

Note: Interface points of Fixed network for Mobile are: Filwoha, Keira, A. Ketema & SC

(b) Regions "02" to "08"

The network configurations other than that of Region "01" are simple Star types. The network in each region is basically configured with 1 Primary Center and some local exchanges.

The existing Primary Centres are linked with the Secondary Center but not with any other Primary Center except Mekele & Dessie and Jimma & Nekempte.

Routings of the originated calls are as follows:

◆ Local call within the same region : LE→LE
LE→PC→LE

◆ Toll call within the same region : LE→PC→LE

◆ Toll call between different region: LE→PC→SC→PC→LE

◆ Toll call between "03" & "04", Jimma & Nekempte in "07" LE→PC→PC→LE

◆ Call to Mobile network: LE→PC→SC→MSC

◆ Call from Mobile network: MSC→SC→PC→LE

(c) Master Plan

The Master Plan proposes the followings routing plan in order to keep up with the increasing load on the Secondary Centre and other major gate switching systems and avoid unexpected occurrences such as traffic congestion and an interruption of transmission system.

1) Region "01"

- Unification of provincial area and Addis Ababa zone

Some local exchanges in the provincial areas are linked with the Secondary Center without any connection to a particular tandem exchanges. In order to simplify the administration and network management, these local exchanges will be linked with the corresponding tandem instead of the Secondary Centre.

The followings are new subordinate exchanges and their host tandem. The route change may be done upon the completion of the O/F junction rings.

Tandem	Subordinate
Addis Ketema	Ambo, Holeta
Arada	Fitch, Kuyu
Bole	Debre Berhan
Keira	Duken
Old Airport	Ghion, Wolkite

◆ To increase routes in zones

Some local exchanges belong to the tandem exchanges do not have the direct routes. Besides, such local exchanges accommodate the large number of subscribers, which means high traffic is loaded is expected on their tandem exchanges.

Therefore, the mesh type network in Addis Ababa zone will have to be expanded to include the following local exchanges:

Nefas silk, Akaki, Yeka, Kolfe, Sidist Kilo, Gerji, Bole Michael, D.Zeit, Ayur Tena

In future, the direct routes are to be increased considering the over-load traffic on tandems.

2) Region "02"～"08"

It is unnecessary to change the basic routing plan in the regions, however, new MSCs which will be installed in the same areas of PC "04", "05", "06" and "08". And the new routes will be provided between the PC and MSC in the same region. The MSC will be installed in all Primary Center sites having the interface at each PC in the near future.

(2) Mobile Network

There is one (1) MSC in the mobile network at present time and four (4) interface points are provided for the fixed network.

However, four (4) MSC will be newly installed in the regions of PC "04" "05", "06" and "08".

New routings of the originated calls are as follows:

◆ Call from all mobile-phones to Addis Ababa zone:

Addis Ababa MSC → TDM → LE
↓
LE

◆ Call from MSCs in the regions "04", "05", "06" and "08"

MSC "0X"→PC "0X"→LE

to LE in the same region:

◆ Call from MSCs in the regions "04", "05", "06" and "08"

MSC "0X"→AA MSC→SC

to LE in other region: →PC "0Y"→LE

◆ Call from all mobile-phones in the regions other than "04",

Addis Ababa MSC→SC

"05", "06" and "08" to PC "02", "03" and "07": →PC→LE

(3) International Routing

International exchange is a combined exchange with Secondary Centre. The exchange is named

A.A TR-III and is combined for the function of handling the toll transit and international calls. All the international routes are concentrated to A.A. TR-III, i.e. only one international exchange exists in the country.

There are 19 routes between Ethiopia and other countries including some African countries. However considering the occurrence of unexpected failure on the exchange, other international exchange will be required. The new International Switching Center is recommendable to be installed at Nazareth where the new O/F trunk cable from AA TR-III is to be terminated.

(4) IP Network

VoIP will be introduced after 2005 and the existing legacy system will be gradually decreasing. VoIP is a sort of data communication like an Internet and the both data and voice traffic will be carried on the same IP network.

In case of IP network no fixed routing is required. The IP networks consist of mainly routers and links to connect them. A router has links to other routers and the router select a route to carry a packet in accordance with Overhead Signaling of the packet. Therefore, the packets of the same call may be separately carried on different routes.

9.2.5 Technical Standard for "Point of Interface"

ITU and ISO Recommendations are for the global technical standardization for the network and facility. In Ethiopia the present Telecommunication sector has decided to divide its organization into 3 Departments; namely the fixed telephone, mobile telephone, data transmission and Internet. These will be liberalized in future and might open the network to several new operators (New Common Carrier: NCC) who participate in this field. Hence, one of these required key points is the interface conditions between the different network and systems. A new operator is possible to commence his services after connecting his network with ETC networks and facilities.

It should be understood that NCC's entry agreements is made under establishment of fair and equitable rules, for example, no discrimination of entry, suitable tariffs, payment for ETC, etc.

1) Point of Interface (POI)

There will be several cases of interface point at ETC telecommunications facility.

a. Interface at Trunk Switch level (eg. Long distance and mobile carriers)
b. Interface at Local Switch level
c. Interface at Subscriber Connecting Level

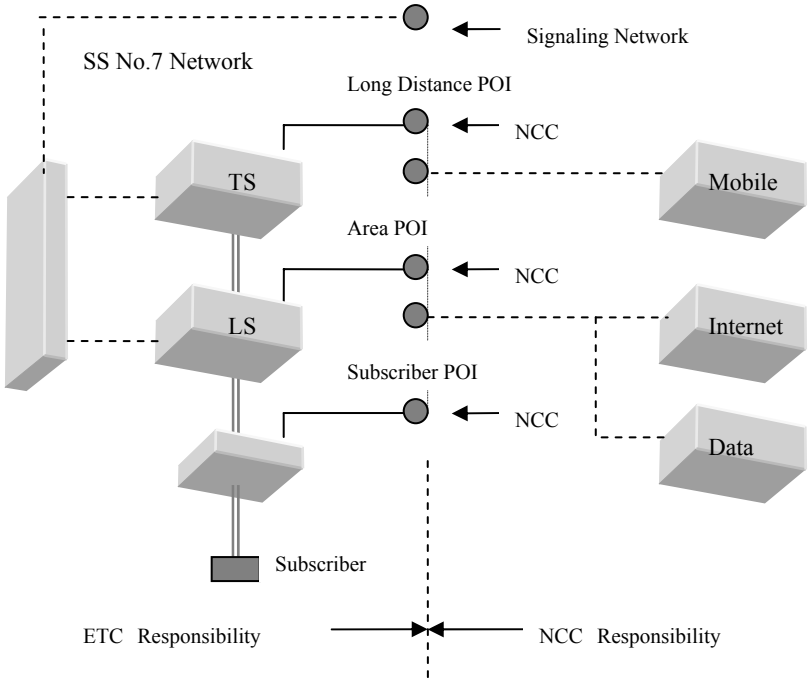


Figure 9.2.3 Point of Interface

Bit stream for the interface in most cases will be on a 2Mbps basis. And analog interface is not accepted. The NCC shall prepare the gateway switches and interface point facility (such as Digital Distribution Frame)

As shown in Figure 9.2-4, at the point of interface of NCC network is connected through the both ends of ETC and NCC Gate Switches. The gate switches have registers and examine the calls based on signaling data whether the call is registered or not.

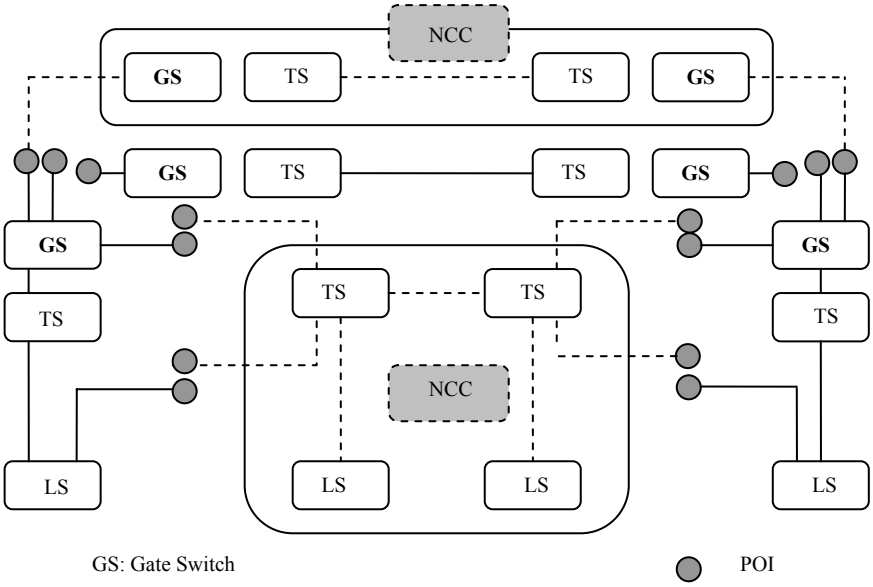


Figure 9.2-4 Typical Interface of NCC

2) International Standard for Network and Facility

In any cases of network connection NCC shall subordinate existing status and service quality. In case a new NCC network is connected with the existing PSTN, it should follow the existing ETC networks interface conditions, which are fully complied with ITU-T and ITU-R Recommendations concerned.

For the IP network interconnection, NCC also should follow the ITU Recommendations. There are many international standard under discussion in ITU-T Study Groups such as IP telephony, multimedia aspects etc. These new Recommendations shall be observed before the interconnection.

The following ITU-T Recommendations are to be referred.

E- Series: Numbering Plan

G- Series: Transmission

I- Series: ISDN

Q- Series: Switch and Signaling System

V & X: Data Communication

Table 9.2-5 ITU Study Group (Reference)

ITU-T STUDY GROUP	
SG 2	Network, Service, Operation
SG 3	Tariff, Billing
SG 4	Telecommunication Management Network (TMN), Network
SG 5	Protection of Electromagnetic
SG 6	Outside Plant
SG 7	Data Network, Open System Communications
SG 8	Telematic System
SG 9	Television, Audio Transmission
SG 10	Language of Telecommunication System, General Software Elements
SG 11	Signaling, Protocol
SG 12	End to End Transmission Quality for Network and Terminal
SG 13	General Aspects for Network, IP Network
SG 15	Transmission Network, System and Facility
SG 16	Multimedia Service and System, System, Terminals

9.2.6 Trend of New Technology and Services

Recent rapidly-progressing technological development in the telecommunications services allows us the worldwide socio-economic activities using voice, data processing and Internet for various customers. In consequence, international economic relationship has increasingly grown to be complicated but tightly connected. In these circumstances, volume of information transactions in

economic entities, not only enhancement of conventional telecommunications capability, but also introduction of new type telecommunications versatility is required.

Accordingly, telecommunications network has become more important infrastructure and indispensable for the nation's activities. Introduction of the latest technology brings us a reform toward the 'ICT human society'. Several new services with notable technology are becoming conspicuous and will come into use.

(1) Internet Protocol Network

Using TCP/IP Protocol, different types of computers, networks and Operation System (OS) can be interconnected. IP network mainly consists of Gateway, Routers and Servers that replace telephone exchange equipment, and realizes the following;

- Integration of wired, mobile and broadcasting networks
- Friendly to Internet
- Easy to introducing multimedia service
- Flexible facility expansion
- Low business investment and operation costs

(2) International Mobile Telecommunications 2000 (IMT-2000)

This 3rd generation mobile communication system is capable of commonly use in all over the world, recommended by ITU as the international standard. It applies 2GHz frequency band, spectrum dispersal transmission, 2Mbit/s, packet transmission for high speed wideband services (W-CDMA: Wideband Code Division Multiple Access). In addition 4th generation is under development, transmission speed is 10 times that of IMT-2000 (20 Mbits/s).

In Europe GPRS is to be introduced as a mobile packet transmission which enables to fully utilize the present GSM system

(3) Wireless Data Service

ETC will introduce in the near future the Internet access to e-mail, fax/data transmission and small message service (SMS) by mobile telephone set.

(4) High Speed Subscriber Access (xDSL: x Digital Subscriber Line)

Using existing subscriber lines (metallic cable pairs), digital broadband Internet access is possible. There is cable distance limitation. However this service can be applied to Internet users by ETC any time if so required.

ASDL: Down ward 500K-8Mbit/s, Up 200K-1Mbit/s (3km-6km)

HDSL: Down/Up 2Mbit/s (3.6km)

SDSL: Down/Up 160k-2Mbit/s (3km-7km)

RDSL: Down 1.5Mkbit/s-8Mb/s, Up 16kb/s-1Mb/s (2.7-5.5km)

VDSL: Down ward 13-52Mbit/s, Up 1.6 Mbit-2.3Mbit/s (300m-1.5km)

ADSL: Asymmetric DSL HDSL: High bit rate DSL SDSL: Symmetric DSL

RDSL: Rate adaptive DSL VDSL: Very high bit rate DSL

(5) Rural Area Communications

There are still a lot of villages where the telecommunication services are not available. For the subscriber access, several networks are planned such as WLL (Wireless Local Loop), VSATs, GSM 400, CDMA (Code Division Multiple Access) etc.

Followings are partly extracted from **ITU document;** New Technologies for Rural Applications, Final report of ITU-D Focus Group 7 (ITU 2001). For further details refer to the said Doc.

GSM 400

The European Telecommunications Standards Institute (ETSI) has established a regional standard for implementation of the Global System for Mobile (GSM) in the 400 MHz band. The use of frequencies in the 400 MHz enables a wider area to be covered by each base station. Wide area coverage is better suited to low density rural populations spread over a wide area.

PMP/DRCS (Point to multipoint/Wide band Digital Radio Concentrator System)

The systems provide completely wireless implementation between the local exchange and subscriber telephone over very long distance. DRCS with wide band IP network solution for PCO in rural area will be the most economical solution for multi-media era due to the lower installation and maintenance cost an no attendance of maintenance person required.

CDMA 450

A trial is currently (4Q 2000) underway to demonstrate the use of CDMA technology in and around the 450 MHz band, providing wider coverage from each base station rather than 850 MHz or 1900 MHz.

VSATs（Integrated VSAT/WLL systems）

Intelsat provided the Focus Group with a set of general guidelines for selecting the most economically feasible VSAT solution based on the population distribution, subscriber density and other characteristics of rural area being served. According to Intelsat's findings, a VSAT connected directly to subscribers is most likely to be a viable solution when serving geographically scattered population requiring fewer than 20 lines per site.

VSATs with wireless local loop systems are generally feasible for clusters of population requiring between 20 and 300 lines per site. Finally, Intelsat's studies showed that VSAT plus macro-cellular wireless local loop (up to 30 km radius) could be a feasible solution to serve medium density populations requiring more than 300 lines per site.

9.3 Public Switched Telephone Network

The entire telecommunication networks in Ethiopia belong to ETC monopoly and there are 3 switching networks, which are the fixed telephone network, mobile telephone network and the IP network.

The telephone switching networks is configured with the analogue switches such as ARF-102, C-400 and the digital switches as AXE-10, DMS-10, DMS-100 and RAX.

ETC is carrying out to replace the entire analogue switches with digital switches on ETC's Eighth Development Program. The facilities to be replaced, expanded and newly installed are still conventional digital switching system in accordance with the Eighth development program.

ETC' Eighth development program is the final to install the conventional facilities.

This Master Plan covers from the year 2003 to 2020, however, the short term of 2003 and 2004 is to overlapped to ETC' Eighth development program, therefore, the plan for this period in Master Plan is prepared in consideration of the said ETC's plan to be executed in the same period.

9.3.1 New Routing Plan for PSTN

In Addis Ababa Metropolitan area, the some existing routing plan applies that the local switches in the areas are connected through Central Transit Switches (TR-III). This routing plan will be modified to avoid heavy traffic load at Central Transit Switch.

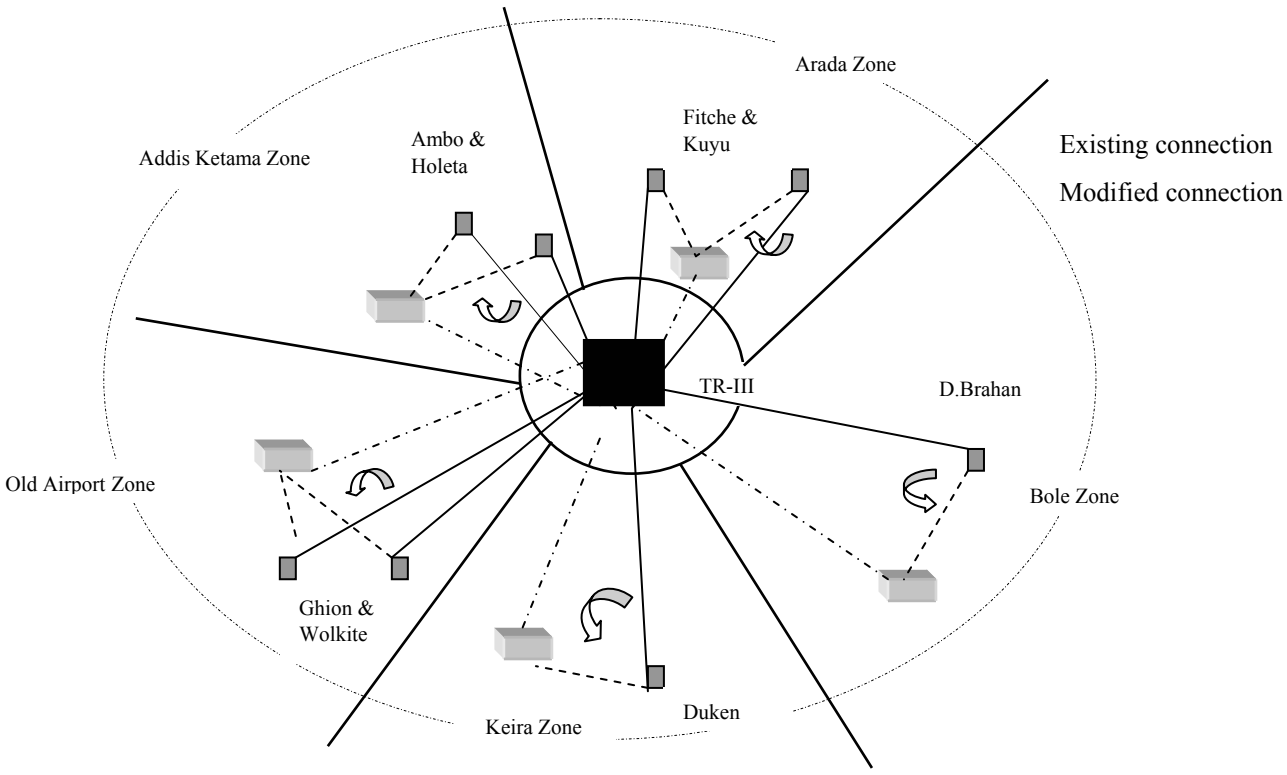


Figure 9.3-1 Change of Routing

9.3.2 Network Arrangement

To cope with the traffic volume increase from both fixed and mobile stations the new IP network is planned between the primary centers and the secondary center, but at the secondary center additional switches will not be installed. To ease the traffic load at Addis Ababa exchanges the direct routes are planned between the local exchanges.

Considering the above mentioned points, the following 4 stations will have the mobile exchanges, which interface with PSTN.

Mekele, Dire Dawa, Shashemene and Bahir Dar

9.4 IP-Based Network

9.4.1 Network Selection

Drawing up the long term Master Plan, it is requisite to take into account of the world trend of new technology that will be applied and accelerated in the future. Remarkable new technology to meet the field of telecommunications are Internet Protocol network, high speed subscriber access, international mobile telecommunications (IMT-2000), mobile data service etc. Especially, Internet Protocol Network is one of the main topics at this time. It is predicted that most countries will introduce IP network sooner or later. The network will exactly empower the Information and Technology oriented human society.

The network planning contains the study on the switching network, transmission network and subscriber access network; the transmission network includes mobile and rural networks.

This section deals with the new technology of IP network.

9.4.2 Internet Protocol Network (IP Network)

IP Network is one of the most attractive networks. This network is economical in cost and versatile network capability that meet Information and Technology (IT) requirements. The Master Plan will propose to apply this network in future stage. The broadband (high speed) network will contribute all future requirements of National Information Infrastructure. (NII).

(a) Present Network

The present networks play important roll with digital exchange and digital transmission systems. Analog systems are still in operation in some portions. Several projects are going on under the present ETC's Eighth 5-year Telecommunications Development Plan (2000-2004). In the Development Plan, new provision and further expansion have adopted the conventional Public Switched Telephone Network (PSTN). Hereafter, IP network might be widely spread out all over the world in the early 21st Century and conventional network might gradually cease to exist. In the Master Plan, such trend and status quo shall be taken into account. This is the turning point to make a strategic decision how the next generation network should be introduced and how the present conventional networks will be replaced with it.

The Master Plan design applies the conventional network for the short term and early middle terms. New network plan with new technology will be applied in the middle term to long term. The present networks and systems are still in good working conditions, so that they can be fully operated during their life time and not to be replaced with the new network.

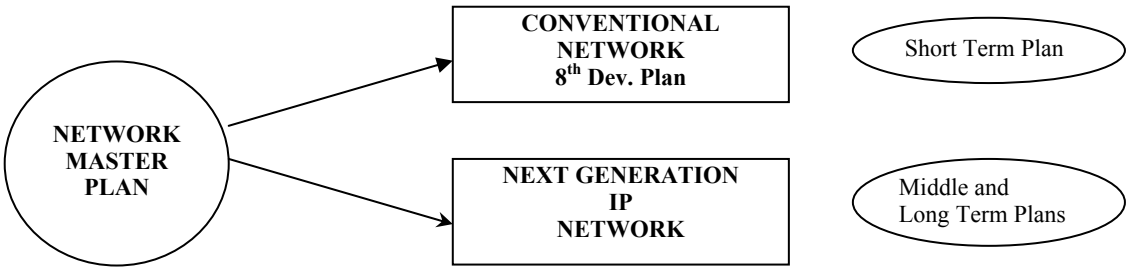


Figure 9.4-1 Short and Long Terms Plans in Master Plan

(b) World Trend on Telecommunications Needs

In the latter 20th Century, a new network with a concept applying Internet Protocol (IP) technology has come up. Hence, the future network will be drastically changed. This is the most advanced and evolved wideband transmission network which have been realized in the some countries, because of its economical network construction cost, its versatile abilities and IT oriented capability.

The network construction cost (switching equipment) will be reduced by one-third compared with the conventional one, further more the network can cope with various telecommunications requirements integrating voice, data as well as mobile telephone (Mobile IP & ROHC; Robust Header Compression technology under study), digital TV signals (8Mbps), and other multimedia data like movies. Figures 9.4-1 and 9.4-2 illustrate a surrounding status of IP Network in the final form. It is estimated that the most countries will get to this kind of the network early in this Century. However, there are still problems outstanding such as mobile and access network limitation.

Networks to be newly constructed have got to follow the world trend. In the IP Network the switching equipment is not used but replaced it with the several kinds of Routers and Gateway Switches which are very inexpensive.

According to current information, some major manufactures in the world are considering that they reduce or put an end on their production of the switching equipment including the spare modules and parts. Within 10 years from now, conventional digital switch equipment might be difficult to purchase, and then expansion of conventional equipment will become hard. This is a serious point to be considered by the telecommunications operators.

So far and even nowadays, Telecommunication Authorities in many countries have made their efforts making huge investment to construct and expand the telecommunications networks of

the conventional type. It is practically difficult and impossible to fully replace the present networks with the IP Network in a short time. Therefore, study on smooth transition to IP network is essential.

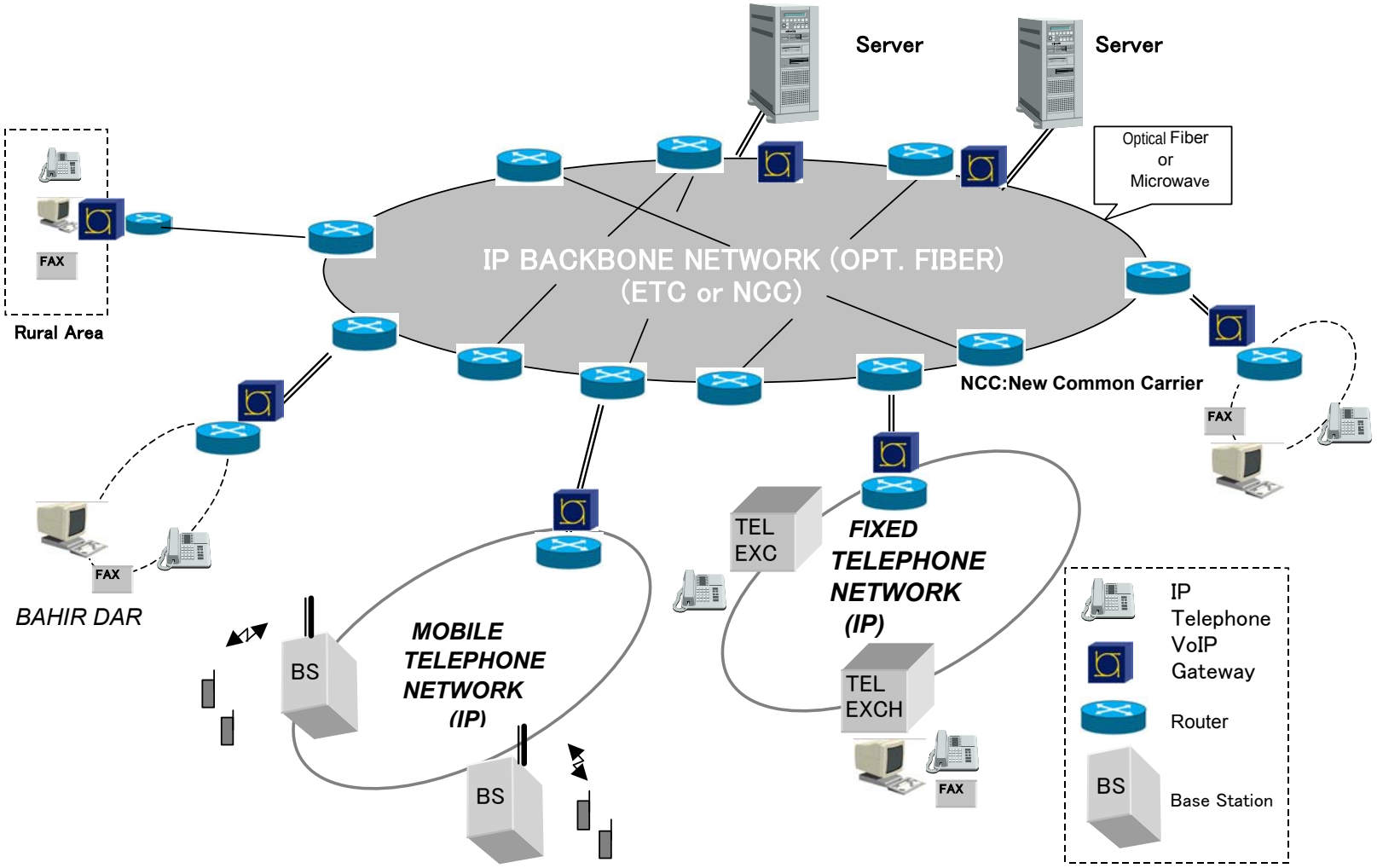


Figure 9.4-2 Expectation to IP Network

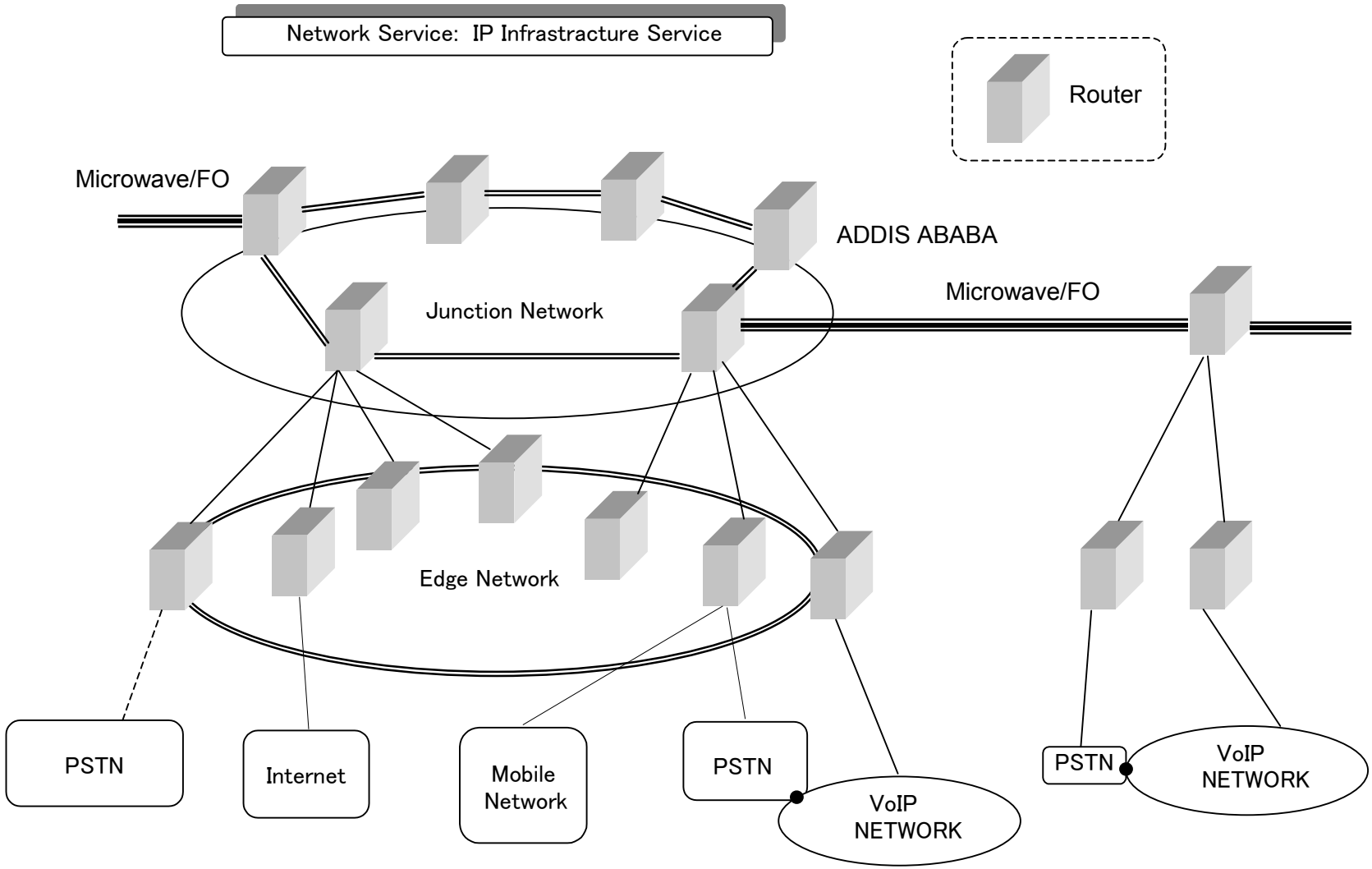


Figure 9.4-3 Typical IP Network Layout

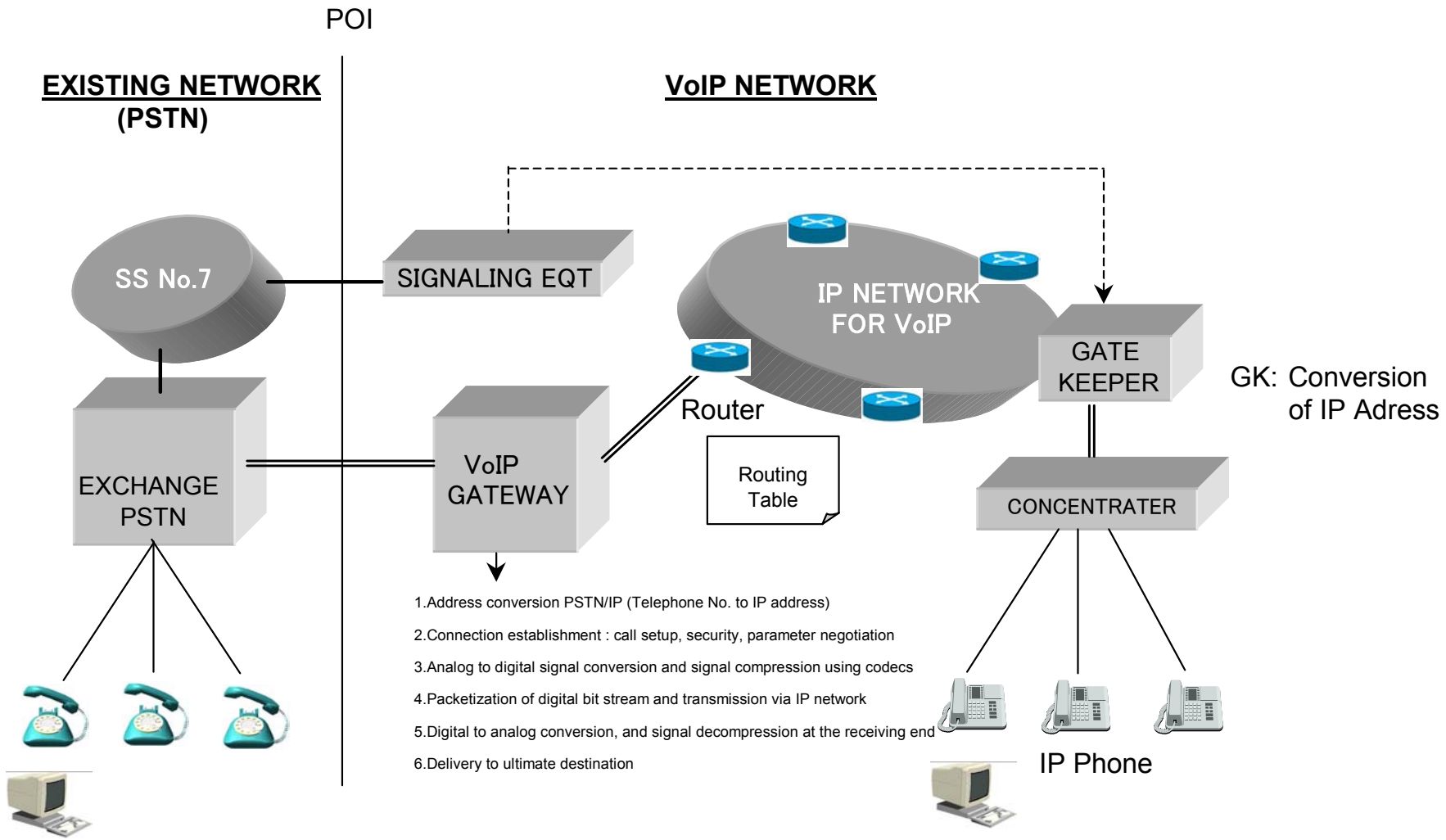


Figure 9.4-4 Interface between PSTN and VoIP Network

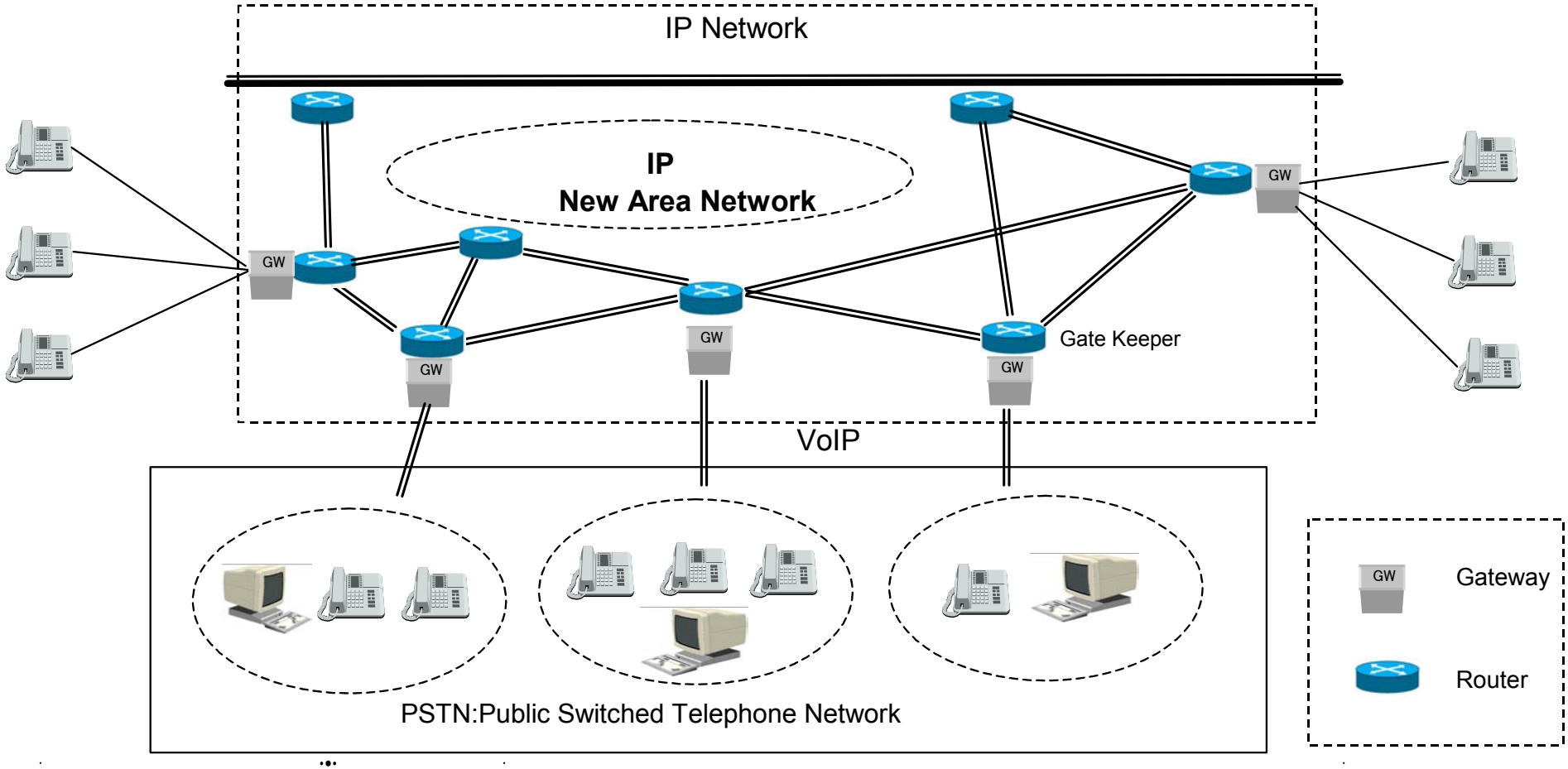


Figure 9.4-5 Temporary IP Network Model

(c) Comparison of Networks

Comparison between PSTN network and IP network appears below. Remarkable points are transmission channel occupancy, compatibility and construction cost.

Table 9.4-1 Comparison of PSTN and IP Network

Item	Conventional Network	IP Network
(1) Exchange Equipment	Digital/Analog Switch	No SWs, using Router and gateway SW.
(2) Transmission channel	Occupied during speech	Shared with packetization reducing Nos. of CHs
(3) Data transmission	Digital (no packetization) Separate bearer like data network	Digital packetization (Voice/data) Same bearer, network
(4) Speech quality	Very good Guaranteed type	Same level as mobile telephone (VoIP) * Best effort type
(5) Mobile telephone interface	Digital switch	Router (Under study)
(6) Cost	1/1 (excl. transmission system)	1/3 (excl. transmission system)

* Delay time, packet loss: To be improved within 1-2 years with QoS development

(d) Network Strategy and Process

There are several cases for implementing IP Network make up. Selection of priority depends on situation (traffic volume) and decision with careful study. In the Master Plan, the following strategy and process are proposed for provision of next generation network. The existing and under construction systems are to be operated during equipment life span. The existing systems are considered to be operational for about 15 years or more. The short and middle term plans for system expansion (Eighth Development Plan) are carried out based on conservative network. However, the next expansion (Middle-Term Telecommunications Development Plan) shall be planned in consideration of IP network. The present network (PSTN) is able to interface with new IP network as shown in Figures 9.4-9 and 9.4-10.

9.4.3 Switching Networks Design Strategy

In the Middle and Long Term Plans, the networks will be designed to meet IP network applying the radio system, gateways, routers and servers etc., However, as aforementioned, the presently working equipment and system still have the capability to operate continuously for more than 15 years. A new network will be new established adopting VoIP and IP oriented plan.

PSTN is to be interfaced with new VoIP network.

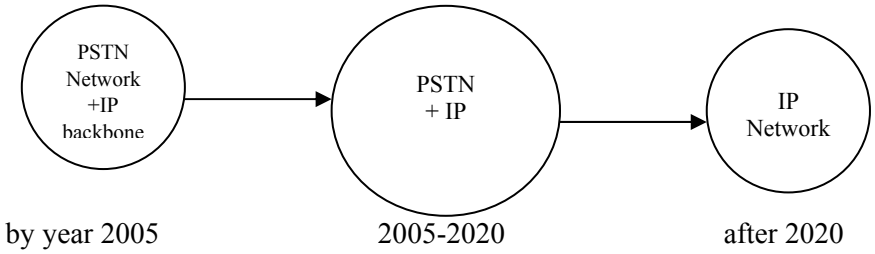


Figure 9.4-6 Transition to IP Network

9.4.4 IP Network Routing Plan

As the present PSTN still continues its' operation for considerable time from now on, the new IP network is to be constructed in overlay fashion.

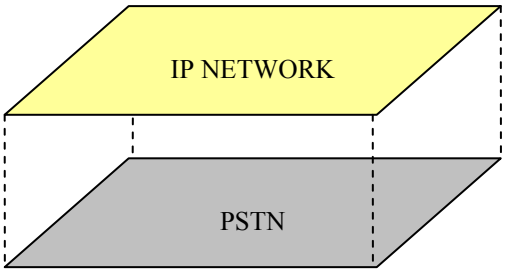


Figure 9.4-7 Network Overly

The present network diagram and routing plan appear in Figures 3.2-1 and 3.2-2. For more detailed network design refer to Chapter 9.8 Transmission Network.

IP network interconnections to PSTN and rural network interface are illustrated in Figure 9.4-10. Figure 9.4-11 illustrates the rural network connection to IP network.

Routing for IP network in the years 2005, 2010 to 2020 are planned as shown in Figures 9.4-12 and 9.4-13 (a), (b) respectively.