CHAPTER 12 SPECTRUM MANAGEMENT

12.1 General

With the progress of the development of the information infrastructure in Ethiopia, radio communications have quite a big role for navigation, aviation, police, fire, satellite, broadcasting, TV, wireless subscriber access networks which is expected to expand increasingly in the future, and mobile telecommunications networks as well. Consequently, utilization of radio waves will be greatly increased in future. However, in Ethiopia, the regulatory framework for spectrum management and monitoring system to cope with such vast increase of utilization of radio wave is not developed yet. The absence of institutionalized radio frequency utilization rules and procedures will cause disorder giving rise to interference of radio waves by unlicensed radio station operators. Unless there is an established check and control mechanism, effective utilization of the frequency spectrum which is a limited resource will become difficult. If the situation is not timely resolved it will have a serious impact on the development of radio communication which now a days plays an important role in the socio-economic activities of the country. Frequency Monitoring, therefore, will contribute to the effective and efficient utilization of radio frequencies as an international natural resource for radio communication and broadcasting.

Spectrum management, dealing with frequency allocation and monitoring the proper use of the resource is an important tool for healthy development of both the telecommunication and broadcasting sectors. In Ethiopia, the newly established frequency monitoring section of the ETA is expected to organize its facility and manpower in order to discharge its responsibility as spectrum management function.

The purpose of spectrum monitoring is to support the spectrum management processes in general. The purpose of frequency assignment and the planning functions is to:

a) Assist in the resolution of electromagnetic spectrum interference, whether on a local, regional or global scale, so that radio services and stations may exist compatibly, reducing and minimizing resources associated with installing and operating these telecommunication services and provide economic benefit to a country's infrastructure having access to interference free, accessible telecommunication services;

b) Assist in ensuring an acceptable interference level of radio and television reception by the general public;

c) Provide valuable monitoring data to an administration's electromagnetic spectrum management process such as the actual use of frequencies and bands (i.e., occupancy), verification of proper technical and operational characteristics of transmitted signals, detection and identification of illegal transmitters and the generation and verification of frequency records;

d) Provide valuable monitoring data for programs organized by the Radio-communication Bureau, for example in preparing reports to Radio-communication Conferences in seeking special assistance of administrations in finding frequencies.

(Source: ITU HANDBOOK ON SPECTRUM MONITORING in 1995, the latest edition)

12.2 Approach to Reform of Spectrum Management System

The increase in the expansion of wireless subscriber access networks and mobile communication system in the country, will make frequency monitoring an important undertaking than ever before.

(1) Definition of Spectrum Management

Spectrum management is the combination of administrative, scientific and technical procedures necessary to ensure the efficient operation of radio communication equipment and services without causing harmful interference. Simply stated, spectrum management is the overall process of regulating and administering use of the radio frequency spectrum. The goal of spectrum management is to maximize spectrum efficiency and minimize interference. Rules and regulations, based on relevant legislation, form a regulatory and legal basis for the spectrum management process. Databases of information, including details of all authorized users of spectrum, provide the administrative and technical basis for the process. Analysis of the information in these databases facilitates the spectrum management process resulting in decisions for spectrum allocations, frequency assignments and licensing. Spectrum monitoring provides the inspection, verification and enforcement necessary to maintain the integrity of the spectrum management process.

(2) Elements of Spectrum Management

The functions and tools of spectrum management are shown below.

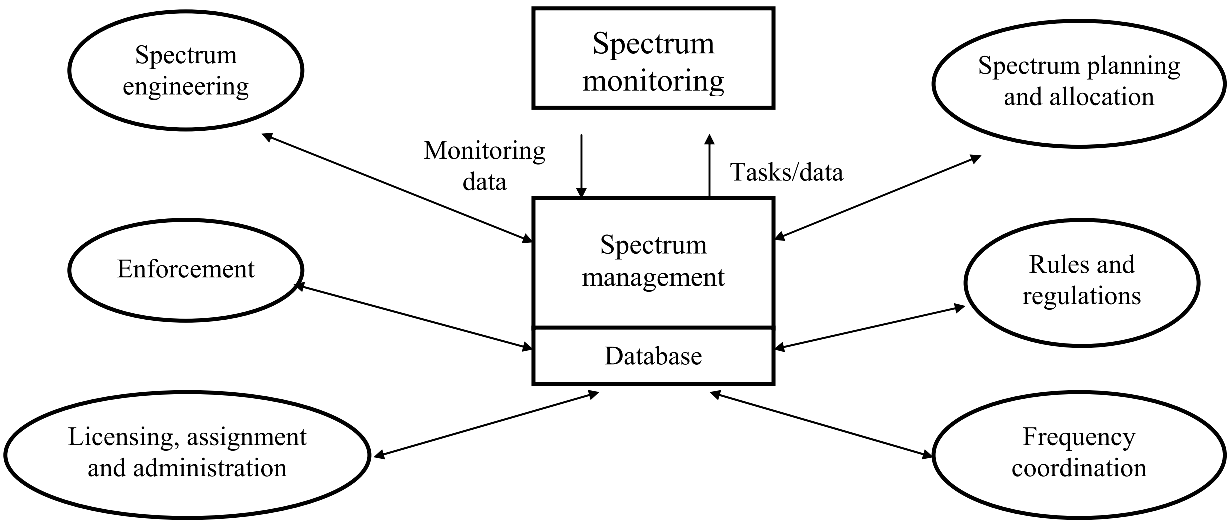


Fig.12.2-1 Functions and Tools of Spectrum Management

(Source) ITU HANDBOOK ON SPECTRUM MONITORING in 1995, the latest Edition

Elements of spectrum management includes,

a) Spectrum allocation,

b) Rules and regulations,

c) Data-base management,

d) Frequency coordination,

e) Licensing, assignment and administration

f) Spectrum monitoring.

Each element will be described and be included a proposal if any;

(a) Spectrum Allocation

Spectrum allocation is the process of distribution of radio frequency spectrum between different radio services on either an exclusive or shared basis. At the international level the allocation is governed by the World Radio communication Conferences (WRC) and reflected in the ITU Radio Regulations. Based on the international frequency allocation table administration allocate frequency band to national radio services and specific systems.

Ethiopian Telecommunication Agency (ETA) has proclaimed the licensing and frequency management as its core objectives in PROC. No. 49/1996 and Council of Ministers Regulation on Telecommunication Services (Reg. No. 47/1999) and has already prepared a national frequency allocation plan (data base) as described in Section 3.13 of Chapter 3.

(b) Rules and Regulations

ITU has established general rules and regulations regarding international spectrum allocation and spectrum management. These are contained in the Radio Regulations by ITU. Taking into account these international regulations, each member nation creates its own legislation, relevant rules, registrations to accommodate its national radio communication infrastructure and goals. The intent of these rules is to provide a necessary structure for administration and enforcement of the spectrum management process.

(c) Data-base Management

An integral component of spectrum management is the ability to store, maintain and access information about each individual communications system. This information forms the spectrum management system database, which is a description of all of the relevant parameters of individual radio communication facilities necessary to perform spectrum management. The database enables the governing agency to conduct various engineering and managerial analyses to ensure spectrum efficiency, operational compliance with the technical rules and regulations, and non-interference between the systems. The Frequency Distribution and Recording Section of Frequency Management Division in ETA is controlling and managing the work of recording previously assigned frequencies and those frequencies applied for into the data-base.

(d) Frequency Coordination

The radio spectrum is a scarce national resource and the demand from both private and government users continue to increase. It is, therefore, necessary to create a mechanism by which frequency can be assigned to particular services and systems whereby the greatest number of users can be accommodated. This is called the frequency coordination process. The frequency coordination starts with the process of selecting frequencies for a system that will not cause harmful interference to other existing systems. The purpose of this process is to maximize frequency re-use while minimizing operational interference between communications systems. There are several key elements to consider in the frequency coordination process. First, the Administration must define the Rules and Regulations which will become the basis for it. Next, there must be an exchange of information between the applicant for a new service and the coordination agency. The information must contain sufficient technical data so that the coordinating agency can perform detailed interference analyses to assure that the new service will not cause harmful interference into existing radio facilities. The effectiveness of frequency coordination is directly related to the accuracy of the records contained in the database and the ability to accurately predict the operation of a proposed system.

International frequency coordination is a procedure that can be implemented before giving a frequency assignment to a station. This frequency coordination procedure is usually a special agreement concluded between two or more countries.

(e) Licensing, Assignment and Administration

ETA has a Licensing Division which is consisted of Radio Licensing Section and Other Equipment Licensing Section. The division functions licensing, assignment and administration in granting authority for use of radio spectrum to individual users. The licensing process is a source of revenue for the Agency in the form of fees when the initial license is granted, fees for renewal of existing licenses, and fines or penalties for operating without the proper license, operating outside of the licensed parameters or operating in defiance of the established rules and regulations. Thus, spectrum monitoring becomes very important factor to be managed for Spectrum Management.

(f) Spectrum Monitoring

The action to be taken by ETA among the elements of spectrum management is Spectrum monitoring. Data collected through the monitoring process is needed by spectrum management, spectrum monitoring and spectrum enforcement officials in order to carry out their respective missions. At the highest level, the data required are: parameters; data regarding the location and transmission parameters of legal and illegal emitters; data regarding interference between or among transmitters; and recommendations to resolve interference. Operators also need these data as well as parametric data regarding signal center frequency, bandwidth, power, modulation type and rate, azimuth direction of signal source (or location), the time signals are present, emitter identification and signal content. These data may be grouped as follows:

1) Identity and location of illegal/unknown/unauthorized emissions.
2) Locations, frequency and mode of SOS and emergency location beacon (ELB) emitters, if tasked to monitor these bands.

3) Bands/frequencies experiencing congestion, interference and/or coordination problems. Observations and recommendations to alleviate problems are also part of this data grouping.

4) Quantity and frequency range of under-utilized spectrum and channel capacity.

5) Measurement of authorized emitter parameters to include power, frequency, bandwidth, modulation type and rates.

These data should be annotated with the time of signal intercept (year, month, day, hour and minute), with information about the signal intercepted to include the station name, location and operator. This data is needed in both real-time and as historical data by spectrum monitoring and spectrum enhancement officials and as historical data by spectrum management officials. Spectrum monitoring operators should be able to provide the data in report form as required.

(3) Recommendation of Frequency Monitoring Facilities in Ethiopia

The frequency bands which are recommended to be monitored are HF and VHF/UHF bands. Necessary new facilities to be implemented for monitoring frequencies are as follows,

(a) Fixed Direction Measuring System

The system measures coming direction of radio waves and the propagated point from the cross point of direction angles by using more than two sets of measuring equipment.

(b) Monitoring Quality of Radio Wave

The system monitors frequency deviation, occupied frequency band and spurious radiation.

(c) Spectrum Auto Recording System

The system records the radiated frequency and time distribution status to check the interference.

12.3 Spectrum Management Plan

The Study Team will recommend a Spectrum Management Plan taking the present status of spectrum management in ETA into consideration.

12.3.1 Construction Plan of New Monitoring Station

(1) HF Monitoring Station

a) Fixed direction measuring equipment for HF band shall be located at least three locations apart from 300 km to 500 km (preferably around 1,000 km) each other. Additionally, the following features are desirable if long-range direction finder is to be installed:

   * It is desirable that no mountains, hills, large man-made structures or other obstructions project to a vertical angle of more than 3° above the horizontal as viewed from the proposed site. There should be no valleys or other major depressions within 1,000 m from the site of direction finder, and even greater spacing to such natural terrain features is desirable.

   * Maximum terrain deviation from the reference ground elevation at the center of the direction finder should not exceed about 1 m within a 200 m distance.

* There should be no lakes or other large bodies of water within 1 km of the location.
* Large buried conduits or metal pipes may, unless deeply buried, cause direction-finding errors. Minimum separation of 200 m is recommended.
* A minimum separation distance of 200 m is recommended between the closest direction-finding antenna element and any metallic fence. If the fence is more than about 2.5 m high, greater spacing is desirable. Rail or tram lines and large metal-reinforced structures, including water towers, should be at least 1 km distant. The following is the summarized table.

Table 12.3-1 Minimum Distances Between Obstacles and Direction Finder

Obstacle	Minimum distance (m)
Non-metallic one-storied building: -a single building -a group of buildings	 100 200
Two-or three-storied non-metallic buildings	250
Non-metallic buildings of over the three storied	300 and over depending on height
Small buildings with metal roofs	250
Metal structures (small sheds. Etc.)	800
Reservoirs, large metal structures, metal bridges	Over 1,500
Open-wire telephone lines, low-tensions lines	250 – 300
High-tension lines with pylons 20 m high	1,000
High-tension lines with pylons 30 m and over	2,000
Rail way lines	400
Isolated trees	100
Small groups of trees	200
Forests	800
Metal fences	200
Small antennas	200
Large antennas	400
Lakes	1,000

b) Antenna system for direction measuring equipment requires sufficient and flat land area without obstructions to disturb radio waves nearby. Depending upon the frequency ranges to be covered, the presence of nearby radio transmitters may severely limit the monitoring capabilities. In evaluating the possible adverse effects of such transmitters, not only the field strength of the fundamental signal but also of harmonics should be taken into account. Additionally, the presence of two or more transmitters, even though on frequencies remote from the proposed frequency coverage of the monitoring station, may be troublesome because of inter-modulation products from such stations occurring at frequencies of interest to the monitoring station cannot be precisely given so as to cover all eventualities, the following limits are recommended in Table 12.3-2. If the limits are exceeded, they should be carefully evaluated in terms of the probability of interference.

Table 12.3-2 Protection from Strong Transmitter Fields

Fundamental frequency, f	Field-strengths standard (mV/m)	Root-sum-square value of the field strengths of the fundamental signals (mV/m)	Minimum distance spacing (km)
9 kHz $\leqslant f <$ 174 MHz	10	30	<1 kW : 1 1 to 10 kW : 5 > 10 kW : 10
174 MHz $\leqslant f <$ 960 MHz	50	150	< 1 kW : 1 1 to 10 kW : 2 > 10 kW : 5

Note 1 - The root-sum-square field strength value applies to multiple signals, but only when all are within the RF pass-band of the monitoring receiver.

Note 2 - In multi-transmitter installations, where a number of high-power transmitters may be operating simultaneously, the minimum distance limits are important. Likewise, close proximity to FM and TV broadcast stations utilizing tall towers should be avoided, even though they are outside the normal frequency coverage of the monitoring station, because the towers may be sources of error with respect to the long-range direction finders.

Note 3 – Inter-modulation products from such stations may also fall within the frequency ranges of interest to the monitoring station. If it is planned to use active antenna multi-couplers at the monitoring station, inter-modulation within the multi-couplers may become a serious problem in strong signal areas.

Old Sululta HF receiver and monitoring stations shall be a candidate to be reused for one of new monitoring stations since the HF band requires wide space for antennas. For detail guidelines on site designing a reference shall be made to ITU HANDBOOK ON SPECTRUM MONITORING possessed by ETA and ITU HANDBOOK FOR MONITORING STATIONS.

(2) VHF/UHF Monitoring Station

The VHF/UHF Monitoring Station shall be recommended to construct in the center of city area where the radio waves are crowded, since VHF/UHF bands have mainly a line of sight propagation characteristic.

Plural monitoring stations are to be considered to construct to cover the whole city and the provision of mobile monitoring station combined will be better solution.

The propagation conditions encountered in the VHF/UHF bands generally restrict reception to near line of site distances. In order to increase the reception area coverage, the VHF/UHF antennas are usually mounted at the top of a tower positioned near the monitoring building. In this manner, coaxial line losses, which can become high at these frequencies, are kept to a minimum. To overcome the increasing transmission path losses at the higher frequencies, high gain antennas with directional patterns are sometimes more desirable than lower gain, omni-directional types.

Dimensions of the VHF/UHF directional antennas are usually small enough to permit rotation, so as to provide reception from various azimuths, as well as to indicate the general direction of reception.

There are three primary considerations which must be examined when a site for monitoring station antennas is being chosen: the interference noise level, the effects of terrain on the performance of the antennas, and the interference of one antenna with others nearby. These factors, such as economic and political considerations will influence the location and layout of the monitoring station itself.

Interference to reception from man-made sources may take many forms. One of the most important sources to avoid when choosing an antenna site, is a nearby broadcasting station. Even though the operating frequency of the station may be very different from the proposed monitoring frequencies, there can be significant interference caused by radiation of spurious emissions and harmonics of principal frequency, intermediate-frequency and audio frequency circuits. Receiver desensitization may also occur, even if spurious response is not noted. Other man-made noise sources such as X-ray and diathermy machines, high voltage power generation and distribution facilities, welding and heavy industrial fabrication processes, street lighting, heavy concentrations of vehicular traffic, and even large areas of residential buildings may create significant levels which may override wanted radio-frequency signals. In addition to direct radiation, noise from these sources may be conducted over power distribution lines to cause interference to areas at considerably greater distances than those affected by direct radiation.

The influence of the terrain on reception is important factor since the monitoring antennas are usually co-sited with a direction finding antenna. It is also important that the terrain is flat, free of discontinuities, and has an uninterrupted view in all directions in order to avoid errors in the azimuth of arrival of the radio waves.

(3) Typical Layout for Monitoring Station and Building

D.Figure 12.3-1 shows an example of monitoring station layout. The configuration provides for a long range direction finder and HF communication facilities. D.Figure 12.3-2 shows details of a typical building dimensions and shape, availability of roads and utility services.

D.Figure 12.3-3 shows an example of typical monitoring building for a staff of twenty or less combined supervisory, monitoring and office personnel.

The extensive RF, IF, audio, power and control cabling required for interconnecting various components within the monitoring building and for cable circuits from antennas and other external facilities, makes it common practice to incorporate cable ducts into the floor of the building. These ducts should be provided with frequent access openings to simplify installation and replacement of the various cable. It is suggested that incoming signal and control cables from antennas, direction finders, and the transmitter building be routed to a terminal board at the point where the cables enter the building, with all incoming cables terminated at this board using appropriate connectors. This arrangement permits more rapid isolation of cable faults than is possible when the various cables are run directly to the equipment racks within the building. Also it is not good engineering practice to run RF or audio cables in the same ductwork as power cables.

(4) Building for Emergency Power Plant

The building should be of adequate size to house the power generating equipment and any related machinery or equipment. For larger plants, an underground fuel tank is desirable; it should be installed several meters away from the building to minimize fire hazards. Transfer of fuel from the main tank to a small storage tank within the building may be accomplished with an appropriate pump. The building itself should be constructed of fire-proof or fire-resistant materials (e.g., sheet or masonry). The power plant building should be separated from the main monitoring building by 15 m or more as a fire protection expedient.

(5) Other Facilities

(a)Water and Sewage Services

Since monitoring stations are normally somewhat isolated from residential or commercially developed areas, public water and sewage facilities are often not available. If a well is proposed as a water supply, the system should be designed to provide a fully adequate water supply both with respect to quantity and pressure, not only for domestic use but also for fire protection. Similarly, the sewage disposal plant should be designed with a margin of safety to provide for expected future needs, and should be sufficiently distant from the well to avoid communication of the water supply.

(b)Roadways

In addition to an access road from the public highway to the building area, service roads should normally be provided to the direction finder, the transmitter building, the field-strength recorder booth and other outlying facilities so that motor vehicles may be used to convey equipment to and from these sites. These should be all-weather roads suitable for the terrain and soil conditions so as to ensure operation throughout the year.

(c)Fencing

Fences may be desirable to protect the plant from livestock or wild animals and, in some cases, from human intruders. Depending upon the local circumstances, the entire property may be fenced, or it may be determined that only the building area requires fences. If a decision is reached to install metallic fences, they should be sufficiently remote from critical installations, such as long-range direction finders and field-strength measurement installations (usually 200 m or more to avoid possible interference to the proper operation of such devices. Metallic fences should be well grounded to ensure that there are no floating conductors that can resonate and reradiate stray electromagnetic energy, or even cause RF burns where the y pass close to the monitoring station's communications antennas.

12.3.2 General Description of Typical System

(1) Consideration for HF Monitoring Station

Illegal radio stations shall be controlled and radio interference obstructions shall be regulated for maintaining order in Ethiopia without delay. Necessary monitoring of radiated radio wave and clearance checking for determination of new radio channels shall be considered as follows,

a) Monitoring stations shall be installed at least 3 locations considering geographical conditions. The main station shall be installed in Addis Ababa city or the suburbs and collect the measured data by the remote control.

b) In addition to the above mentioned items direction finding shall be carried out for measuring direction of illegally radiated radio waves. Typical Block Diagram of HF Radio Monitoring and Direction Finding System is shown in D.Figure 12.3-4 and the composition is shown in D.Table 12.3-1 for the references.

c) General functions of monitoring system

  * Direction measurement of radiated radio wave
  * Frequency measurement
  * Receiving input level measurement
  * Occupied frequency band measurement
  * Field strength measurement
  * Spectrum display for receiving radio wave
  * Demodulation of receiving radio wave
  * Auto. Rec. and recording of radiated wave by schedule setting
  * Spectrum auto. Recording of radiated radio wave
  * Search for data base of radio stations etc.

(2) Consideration for VHF/UHF Monitoring System

The system shall monitor radiated radio waves and location finding of radiated source in metropolitan Addis Ababa area and followings shall be considered,

1) VHF/UHF fixed direction measuring equipment shall be installed triangularly in location apart 15 to 20 km from each other, and master station will be installed in suitable location of Addis Ababa and the others, to be unattended sub stations which are remotely controlled by the master to collect measured data from them.

2) The measurement other than Addis Ababa shall be carried out by mobile system. The typical system composition is shown in D.Figure 12.3-5, Block Diagram of VHF/UHF Radio Monitoring and Direction Finding System and the composition is shown in D.Table 12.3-2 for the references.

Unattended sub stations are to be installed to catch the illegally radiated waves at least at two stations (depending upon the areas to be monitored).These stations are controlled by the master station.

The master station shall control sub stations and check the collected data on database. The station is composed of direction finder, monitoring, control console, computerized remote control system, transmission system for data to mobile monitoring, database, etc. In addition, mobile direction finding vehicles and mobile monitoring vehicles are provided for the measurement of outskirts of Addis Ababa.

3) General functions of direction finding and monitoring system

- * Direction measurement is carried out by appointing substation to be set receiver on frequency etc.
- * Monitoring station receives the transmitted data and display on CRT map as a radiated source, and also has a facility to record the data automatically according to the schedule set in advance.
- * Transmitted signal from substation will be receiver audio signal, direction finding and alarm signals at abnormal status.
- * Mobile direction finding vehicle has almost same function as fixed monitoring station and controls each substation and display the transmitted data on CRT from substation.
- * Monitoring station monitors radiated radio waves (quality, rec. level and demodulation) and records automatically the spectrum of radiated waves. The station remotely controls substation to record the spectrum of radiated waves.

12.3.3 Installation of New Monitoring Facilities

(1) HF Monitoring Facilities

The performance of a monitoring station is directly related to the quality of the antennas, receivers and radio direction finders.

1) Antennas

There are many kinds of antennas existed for the HF band, however, omni-directional antenna is basically needed. For example,

a) Inverted Cone Antenna
b) Conical Monopoly Antenna, etc.,

and the typical. Antennas required directional characteristics will be as follows,

c) Rhombic Antenna
d) Log-periodic Antenna,

but, these are required wide areas for installation.

2) HF Receiver

Typical recommended specification for HF receiver is given below for a reference.

Table.12.3-3 Typical Recommended Specification for HF Receiver

Function	Minimal	More Sophisticated
Frequency Range	10 kHz to 30 MHz	10 kHz to 30 MHz
Tuning Resolution	10 Hz	1Hz
Tuning Error Input for external Reference	1 ppm	0.1 ppm 1/5/10 MHz
Input (Antenna input) VSWR VSWR for field strength	50 ohms, nominal < 3 < 2	50 ohms, nominal < 2 < 2
Pre-selection	For various bands	e.g. sub-octave
3rd order Intercept	20 dBm	40 dBm
2nd order Intercept	40 dBm	70 dBm
Noise Figure	14 dB above 50 kHz	14 dB
LO-Phase Noise	100 dBc/Hz	120 dBc/Hz
IF Rejection	80 dB	100 dB
Image Rejection	80 dB	100 dB
IF Bandwidths (-6 dB)	1; 3; 9 kHz	0.2; 0.15; etc. up to 16 kHz
Selectivity 60 to 6 dB	Between 2:1 and 8:1	2:1
Detection modes	AM,CW,LSB,USB (A3B, A1A etc.)	FM, FSK
AGC range	80 dB	140 dB
Outputs – IF Audio IF monitor	455 kHz, 525 kHz, 4 MHz 0 dBm 600 ohms with depending on RF bandwidth	Digital IF Output 0 dBm 600 ohms 1 Hz for a 250 Hz band displayed
Remote Control	IEEE 488 RS232C	RS485
Electromagnetic- Susceptibility - perturbations		CEI 801-2; -3; -4 CISPR 11 group 1
Operating Temperature Range	0 to 45℃	- 25℃ to 55℃ (-25℃ to - 10℃ degrading performance)
Relative Humidity	80 %	95 % non-condensing
Vibration	CEI 68-2-6	CEI 68-2-6

(Source) ITU HANDBOOK ON SPECTRUM MONITORING in 1995, the latest Edition

(2) VHF/UHF Monitoring Facilities

a) Antennas

The propagation conditions encountered in the VHF and UHF bands generally restrict reception to near line-of-sight distances. In order to increase the reception area coverage, the VHF and UHF antennas are usually mounted at the top of a tower positioned near the mounting building.

i) Omuni-directional Type

ii) The antenna that is well suited for use in the VHF/UHF range is a discone or wide-band vertical monopole.

iii) Directional Type

iv) There are several types of antennas such as Yagi, Corner reflector, Log-periodic etc.

b) VHF/UHF Receiver

Typical recommended specification for VHF/UHF receiver is given below for a reference.

Table12.3-4 Typical Recommended Specification for VHF/UHF Receiver

Function	Minimal	More Sophisticated
Frequency Range		30 to 500 (1000, 2000, 2700 MHz)
Tuning Resolution	1 kHz	10Hz
Tuning Error Input for external Reference	1 ppm	0.1 ppm 1/5/10 MHz
Synthesizer tuning speed	20 ms	0.3 ms
Input (Antenna input) VSWR VSWR for field strength	50 ohms, nominal < 3 < 2	50 ohms, nominal < 2.5 < 2
Pre-selection	Tracking	
3rd order Intercept	10 dBm	17 dBm
2nd order Intercept	30 dBm	40 dBm
Noise Figure	12 dB	8 dB
LO-Phase Noise	100 dBc/Hz	120 dBc/Hz
IF Rejection	80 dB	90 dB
Image Rejection	80 dB	90 dB
IF Bandwidths (-6 dB)	4; 8; 15; 30; 100; 120; 250; 300 kHz	900 kHz
Selectivity 60 to 6 dB	Between 2:1 and 8:1	2:1
Detection modes	AM, FM, CW	LSB, USB
AGC range	120 dB	120 dB
Outputs – IF Audio IF monitor	Frequency to be indicated 0 dBm 600 ohms with depending on RF bandwidth	e.g.10.7 or 21.4 MHz 0 dBm 600 ohms Computer Display
Remote Control	IEEE 488 RS232C	IEEE 488 RS232C
Electromagnetic- Susceptibility - perturbations		CEI 801-2; -3; -4 CISPR 11 group 1
Operating Temperature Range	0 to 45ºC	- 25ºC to 55ºC (-25ºC to - 10ºC degrading performance)
Relative Humidity	80 %	95 % non-condensing
Vibration	CEI 68-2-6	CEI 68-2-6

(Source) ITU HANDBOOK ON SPECTRUM MONITORING in 1995, the latest Edition

c) Direction Finders

The purpose of radio direction finder is to determine the position of any source of electromagnetic radiation by means of the propagation properties of radio waves.

Radio direction finding can be used to determine the position of a radio transmitter or a source of radio noise, if these are situated on the surface of the Earth. It can be seen the radio direction finding becomes indispensable for the following purposes:

i) location of a transmitter in a distress situation;

ii) location of an unauthorized transmitter;

iii) location of an interfering transmitter which cannot be identified by other means;

iv) determination of the site of a source of harmful interference of reception, such as electrical equipment, a defective insulators on a power line, etc.;

v) identification of transmitters, both known and unknown.

12.3.4 Training

Training will be needed for operating new facilities when they are introduced to ETA. To operate efficiently the system, abilities of operators and maintenance personnel would become important factors.

Application to be dispatched for training of spectrum management to foreign countries would be one of the solutions to enhance operation.

CHAPTER 13 PROJECT IMPLEMENTATION PLAN

13.1 Reinforcement of Project Implementation Body

In this Master Plan, the nature of projects to be implemented is diversified. The projects include huge expansions in mobile communication infrastructure in addition to the expansion of conventional fixed-phone network, the Internet network, and introduction of VoIP as well as rural telecommunications. Projects to improve efficiency of Customer Services, Operations and Maintenance as well as Project Management in ETC are also in the scope.

In order for several projects to be implemented on due schedule for long terms and nationwide, ETC must be equipped with proper functions and organizations. These functions and organizations are to be in charge of project management in all of the following areas, and also are responsible for trouble-shootings for each of the project on a permanent basis.

- Project planning, designing, and bidding
- Constructions
- Systems acceptance
- Hand-over of systems to operation and maintenance department
- Subscriber connection

Coordination with projects management and corresponding departments within ETC, as well as examinations and engineering of technical problems is the key function of HQ. As project implementation involves unexpected issues, actions and additional fund must be taken in timely manner so that the influence on ETC's overall project implementation schedule can be minimized.

Implementation (after contract) of the regional project is to be managed by the project management team established in the region.

Project monitoring reports from regional offices should be submitted periodically to the HQ management for proper analyses on construction progress, problems and corrective actions, subscriber connection status, and so on. This should support smooth progress of project implementation, with consultation on problems to related management personnel, if necessary.

13.1.1 Procurement Method and Packaging

It is recommendable that a single turnkey project covers OSP, transmission, and switching facilities, and is to be implemented in parallel.

Basic design for OSP should be completed before the determination of switching capacities for taking consistency with line unit count. OSP construction should precede so that subscriber connections are to be ready immediately upon the completion of switching facilities installation, as construction works for OSP requires more time than those for transmission and switching facilities.

Each construction order should be given for one region in order to avoid high costs for small-scale works diverted to plural regions and difficulty in construction quality management.

13.1.2 Out-sourcing

Although the indicators regarding economic development and demand growth are ambiguous related to ICT, facility expansion with priority on mobile and rural communications network as well as the Internet must be accomplished for the telecommunications sector development.

In this Master Plan, the facility volume of year 2001 is to be increased more than double by the fiscal year of 2005/06.

Under these circumstances, in order to minimize sector risks and compress the increase of the fixed cost, the policy of out-sourcing to external entities (companies) is strongly recommended. Such out-sourcing shall be applied in the following fields:

- OSP construction works including civil works, such as construction of duct system, manhole, etc.
- Building construction and other related works
- New subscriber connection works
- Part of the fault recovery works of OSP
- Operation of PCO services in rural areas

There are some local construction companies who have carried out OSP construction work for ETC under the supervision of foreign construction companies, to whom licenses would be granted by ETA shortly to be engaged in installation of telecommunications facilities.

However, the works undertaken by the local companies will be limited to some simple installation works, such as installation of direct buried cable, aerial cable, etc.

Considering the current shortage of capital, technical skill, tools and equipment, etc., ETC shall keep the stable and continuous orders to encourage local construction companies aiming at increasing their capability of technical and construction management. In the initial stage, the local companies will be involved as the sub-contractors to the turnkey project contractor.

(1) Outside Plant Construction

The expansion of 1,000,000 fixed-phone lines by 2020/21 is planned in the Master Plan, which corresponds to construction of more than 50,000 lines per year.

However, since ETC has a limited capacity of installing approximately 10,000 fixed telephone lines per year by itself, out-sourcing to foreign construction companies is recommended for the OSP project with large scale installation, and the rest, to local construction companies.

Under these circumstances, it will be more effective for ETC not to increase the number of employees but to re-educate the current OSP staff for designing, inspection, and supervision as well as for operation and maintenance.

Such out-sourcing may be realized by organizing 3 or 4 local companies, each with the task forces to install the new connections of 10,000 to 20,000 lines per year, as well as to execute the small size network expansion. This is expected to encourage the local economic development.

Selected companies should possess the wide range of know-how including construction administration, construction standard quality management, safety policy, and own testing function.

In addition, ETC should maintain a stable annual order volume for the growth of local companies. Recovery works upon large-scale disasters, as well as ad-hoc route changes, are recommendable to be ordered to local companies.

(2) Local Manufacturers for OSP Construction Material

Manufacturers of current telecommunications OSP materials offer cabinet box, terminal boxes, protection pipes for riser cables, and other minor products.

It is necessary to review the specifications and to upgrade the quality of such manufacturers, since such quality directly affects the maintainability of the networks to be under the rapid expansion of OSP facilities.

Materials of local products will include PVC ducts for primary underground cables and sub-ducts for optical fiber cables (HDPE).

It is recommendable to replace poles currently made of eucalyptus by those made of concrete and/or steel pole for resistance and natural conservation.

(3) Local Suppliers for Civil Work Materials

Most of the existing ducts are made of concrete, measuring 1-meter in length and having 2 or 4 holes. ETC has introduced PVC duct since 1997, as duct made of concrete are not suitable for installation of cables due to high friction and unstable joints.

Recently, ETC decided to specify the utilization of local made PVC duct in the tender specifications, instead of supplying imported PVC ducts to contractor by ETC.

It is recommendable that manholes shall be manufactured at local factories, i.e., pre-cast type manhole and transported to construction sites, since installation at site results in longer time, difficult construction and poor quality, and causing prolonged traffic interruption.

13.2 Project Implementation Plan for Short Term (by 2005/2006)

13.2.1 Project List for Short Term

For further improvement of telecommunication services, telecommunication network expansion projects are to be actively implemented placing priority to the 46 priority projects selected out of various projects planned under Eighth Telecommunications Development Plan, and also mobile-phone service expansion as well as rural telecommunications improvement in line with government policy.

A Feasibility Study was carried out by JICA Study Team for 3 telecommunication development projects selected out of 31 high priority projects including 8 projects nominated by JICA Study Team, i.e., 2 projects in Mekele and Bahir Dar regions, which include both urban and rural telecommunication network expansion, and one backbone transmission project for Addis Ababa and Nazareth route. The criteria/procedures applied for selection of projects and results are given in the Supporting Document.

(1) Fixed-phone Network Expansion

Construction of local access network shall be implemented with high priority to maximize the utilization of idle exchange lines as early as well as providing new subscriber connections. The idle lines in 2002 are as follows:

Situation of Jan. 2002	Switch capacity (l.u.)	Connected subs.	**Idle line**
Addis Ababa area	335,665	207,495	**128,170**
Other area	218,509	112,008	**106,501**
Total	554,174	319,503	**234,666**

Local network including new/expansion of digital switch for **priority projects** shall be expanded paying attention to the capacities of local access network and switching unit so as not to cause further idle lines of exchange units by conducting micro demand survey in advance.

The application of WLL is preferably minimized due to the higher cost compared with the copper loop, even though the system requires shorter deploying period and is able to provide subscriber connections quickly in a wide area regardless of the subscriber locations.

In the major regional cities, where mobile-phone service are expanded to, some of the demands for fixed-phone may turn out to be mobile-phone subscribers. Taking into account the above trend, build facilities for fixed-phone network is limited to cover 75% of the total fixed-phone demands.

Replacement of RAX exchanges, which were installed recently but have problems with billing and signaling function, is to be implemented for 32 exchanges with 28,250 lines.

Under the Eighth 5-Year Telecommunications Development Plan, introduction of 163 new digital switches are planned, however, the plan is not supported by the basic plan of local access network. The plan is to be further studied and is to be supported by the basic plan of local access network. Upon completion of preparation, this plan is to be implemented by employing VoIP technology in the first phase of Middle Term.

Welencomi (500 LU, WAAZ) and Senidafe (500 LU, EAAZ) are to be implemented within the framework of the priority projects subject that local access network would become available in time.

In addition, the priority projects include the replacement of analog switches in Addis Ababa area (50,000 LU) and 2,000 LU expansion in Nazareth, which are to be implemented within Short Term. While, an expansion of 1,000 LU in Azzero (08 area, DMS-10) may be implemented in the 1st phase of the Middle Term.

About 60,000 pairs of paper insulated cables are still being utilized in Addis Ababa area, which are causing frequent troubles due to low insulation resistance, especially in rainy season. For improving the service quality, rehabilitation of those cables is to be implemented in this Short Term.

(2) Mobile-phone Network Expansion

Mobile-phone services shall be expanded to the 12 regional towns listed below, which is more profitable and required shorter construction period.

- Dire Dawa, Harar, Dessie, Mekele, Gondar, Bahir Dar, Nekempte, Jimma, Awassa, Shashemene, Assela, Ziway

Expansion of the mobile-phone system capacity is to be decided taking into account the shifting demand from fixed-phone, temporal users which might be increased by the introduction of prepaid card system, and also increasing trend of subscribers in the past years not only in Ethiopia but also in neighboring countries.

Taking into account the above, the system capacity is to be expanded to **260,000** LU (60,000+**200,000**) by 2003/04 and **400,000** LU (260,000+**140,000**) by 2004/05, respectively.

(3) Construction of Optical Fiber Junction Ring in Addis Ababa

Optical fiber junction link with double ring configuration is to be established, connecting NSC, MSC, 6 tandem exchanges and 6(*) local exchanges located on the junction cable route, to alleviate heavy load of NSC/ISC transit switch owing to traffic increase in both fixed and mobile-phone services, as well as to establish the high reliability of the network.

(*): Sidis Killo, Yeka, Gergi, Bole Michael, Nefas Silk and Kolfe

The junction network configuration is shown in Figure 13.1-1.

A junction ring with STM-16 is to be established in full redundancy configuration. An add/drop function is to be facilitated to each node including local exchanges on the ring. For Filwoha and Keira where both East and West rings are interconnected each other, cross connection function is to be provided.

(4) Establishment of IP Network and Modification of Routing Plan

The network capacity is expanded for both fixed-phone and mobile-phone to cope with the increasing circuit requirements. The subscriber numbers in 2005 is estimated as follows:

	2001/02	2005/06
Fixed-phone	300,000	600,000
Mobile-phone	40,000	300,000.

In this regard, transmission as well as key switching nodes will carry the heavy load or be over-loaded. The half of the trunk circuits among primary centers and Addis Ababa tandem exchanges are to be implemented using IP based network without giving the overload on the NSC/ISC transit exchange.

Considering the above situation, IP network is to be established connecting 8 PCs in the regions, MSC and 6 tandem exchanges to alleviate heavy load on the NSC/ISC transit switch and to provide base for VoIP to be introduced from the 1st phase of the Middle Term. The facilities installed in respective PCs and Tandem exchanges in Addis Ababa are capable of handling traffic volume in 2005/06, and are the key nodes for coming VoIP, so that the investment cost would be rather high.

The system configuration of IP network is given in Figure 13.1-2.

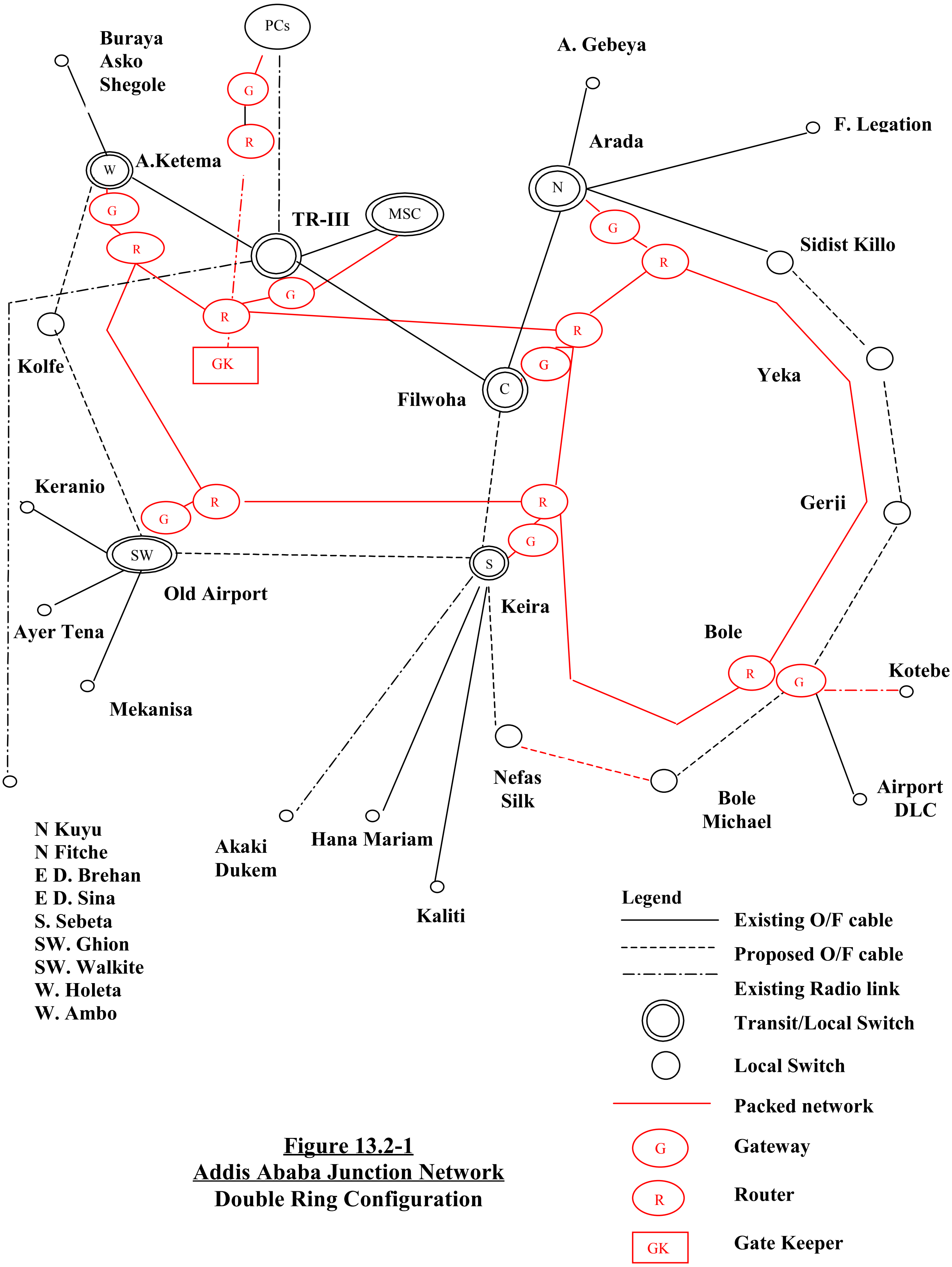


Figure 13.2-1
Addis Ababa Junction Network
Double Ring Configuration

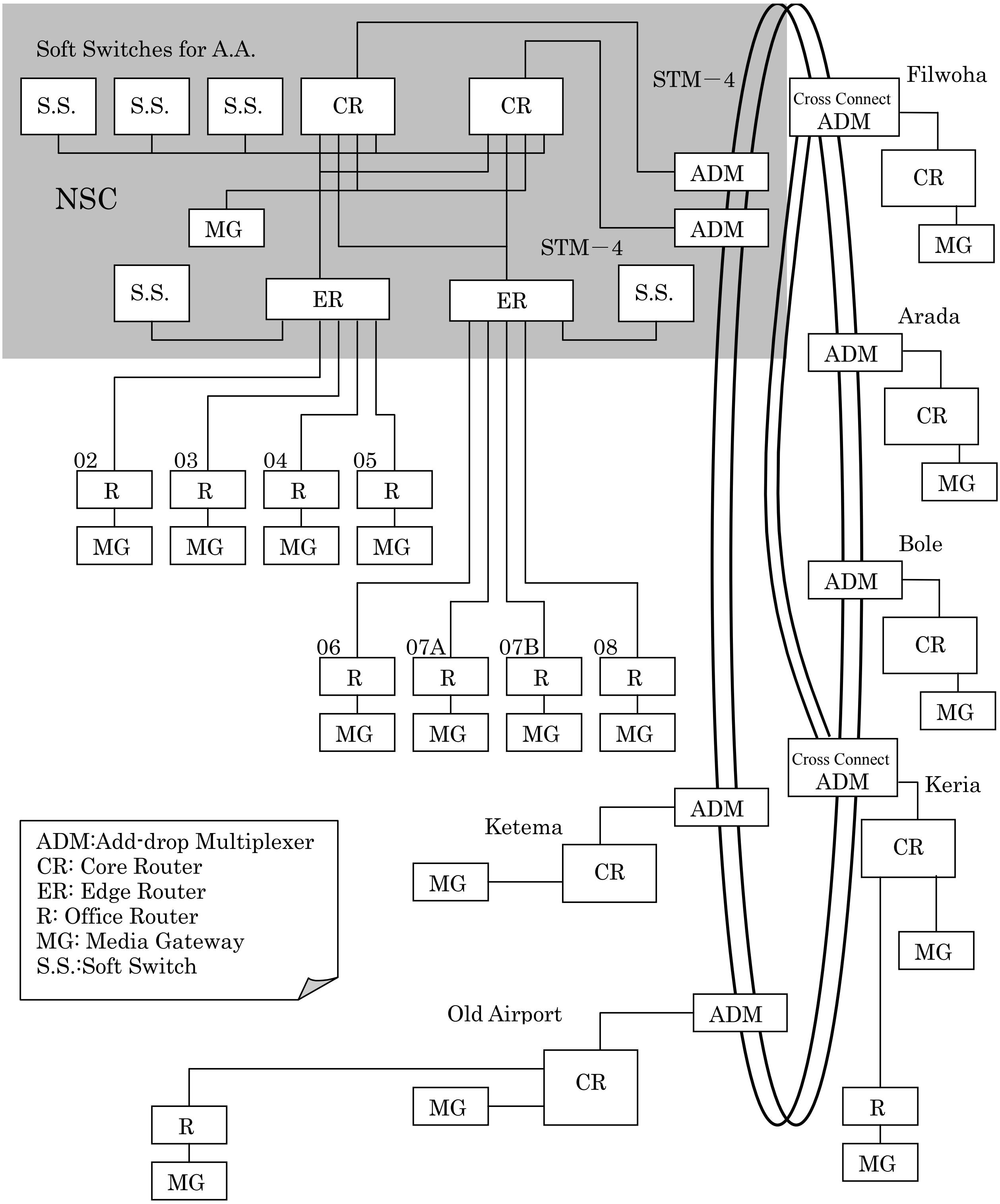


Figure 13.2-2 National IP Network Configuration

(5) Examination of the Key Nodes for Coming VoIP (PCs, Tandem)

Direct routing is to be applied for some local exchanges in Addis Ababa area to reduce load on tandem exchanges, i.e., Sidis Kilo, Yeka, Bole Michael, Nefas silk, Debre Zait, Akaki, Ayur tena and Kolfe.

With the same reasoning, direct routing is to be applied for the following exchanges in regions.

04 Area: Mekele (27,156), Adwa (4,032), Axum (3,092), Shile (4,436), Selekleka (4,020) and Adigrat (3,527)

06 Area: Shashemene (7,085) Awassa (14,349), Dilla (3,888) and Zway (3,071)

08 Area: Bahir Dar (22,894), D. Tabur (3,338), D. Marcos (6,606) and Gondar (15,718)

Table 13.2-1 Traffic Volume at NSC and Tandem Exchange

Exchange Name	Switch type	Exist. Line unit	After 8th l.u.	D2005	Tandem load 2005	Traffic in Erl.	Traffic in Erl.	Action
						I/C	O/G	
TR-III	AXE10					(1,569)	(1,716)	
Filwoha (C)	AXE10	41,856	61,856	51,045	51,045	2,168	2,381	OK
Arada (N)	AXE10	18,432	48,432	52,053	63,053	2,682	2,891	2 units
Bole (E)	AXE10	24,576	34,576	38,239	38,239	1,656	1,816	OK
Keira (S)	AXE10	17,152	27,152	51,284	62,886	2,504	2,155	2 units
Old Airport (SW)	AXE10	29,184	29,184	45,151	55,941	2,358	2,591	OK
A. Ketama	AXE10	18,432	48,432	73,671	90,860	3,621	3,999	2 units
Mobile MSC						(2,963)	(2541)	

Table 13.2-2 Exchange Capacity and Demand

Primary Center	Switch Type	Exist Cap.	After 8th Dev.	Demand 2005	PC area D2005	Primary Center node capacity
2 Nazareth	AXE 10	16,256	18,256	28,663	46,700	OK
3 Dessie	DMS	4,911	6,911	8,910	30,900	OK
4 Mekele	DMS	6,000	21,000	27,156	64,900	Apply Direct
5 Dire Dawa	AXE 10	14,336	18,336	12,921	41,900	OK
6 Shashemene	DMS	5,000	7,000	7,085	64,900	Apply Direct
7 Jimma	AXE 10	8,192	8,192	10,881	24,628	OK
7 Nekempte	AXE 10	4,096	4,096	4,091	23,272	OK
8 Bahir Dar	AXE 10	7,168	13,168	22,894	73,700	Apply Direct

(6) Expansion of PDN and Internet Services

For expanding the public data network as well as Internet services nationwide, 5 PoPs are additionally established in the regional towns, i.e., Yeka, Gerji, Kotebe, Akaki and Debre Braham.

(7) Rural Telecommunications Network Construction

In accordance with the Government policy of promoting rural area development, a total of 700 PCOs is to be constructed in rural areas for providing public phone services and also for providing subscriber connections to Farmers' Association and other agencies in the neighboring areas.

Table 13.2-3 Number of New PCOs (Short Term)

Region	Total	Region	Total	Region	Total
Tigray	55	Somari	20	Harari	2
Affar	10	Benishagul-Gumuz	33	Dire Dawa	2
Amhara	179	SNNP	112		
Oromiya	269	Gambela	18	Total	700

For establishing rural telecommunications network, both terrestrial radio transmission system and VSAT system (Faraway system) are applied. VSAT system is mainly applied for the remote areas as well as the sites located in the mountainous area, in principle. However, the application of VSAT system is to be minimized as only limited transmission bandwidth is available, which is not suitable for future IT services, such as Internet service, remote education service, etc. In principle each system is to be equipped with 8 channels in terms of telephone channels; 3 channels out of 8 channels are allocated for PCO use, and rest is for individual subscribers including Farmer's Association. However, the actual circuit assignment may vary depending on the situation of the sites.

(VSAT System):

VSAT system is planned to establish at 15 new sites (8 in Somali and 7 in Benishagle-Gumuz) during the Short Term, and the rest are planned by terrestrial radio system.

In addition to the above, 10 VSAT systems are to be newly constructed for replacing the existing HF, Long Line, etc. at Humera (04 area), Misrak Gashamo, Segeg, Shilabo, Kelafo, Mushil, Adele (06 area), Bare, Dollo Oddo (02 area) and Abderai (08 area), and 2 existing VSAT systems would be expanded in capacity at Gode and Warder (06 area).

The, existing 44 VSAT systems are to be replaced with terrestrial microwave system to cope with increasing traffic requirements.

(PCO Operation):

For simplifying the operation of PCO services, introduction of pre-paid card system is preferable other than the operator assisted call operation. For operator assisted call, computer with printer is to be introduced for establishing telephone connections by operator and for issuing invoices of call charge. It is required to keep enough prepaid cards in each PCO for selling purpose to customers.

Operation of PCO business, such as, selling pre-paid cards to customers, collecting call charges, etc. are to be outsourced to private sector with contract to minimize the running cost of ETC, except maintenance work of the telecommunications facilities which is to be carried out by ETC.

(8) Transmission Network Construction

In addition to the construction of backbone transmission link planned under the Eighth Telecommunications Development Plan of ETC, construction of 17 new links is to be implemented and system expansion of 15 links is also to be implemented.

Besides the above, a fiber optic transmission link with STM-16 SDH digital hierarchy is to be constructed for (NSC/TR III–Deble Zeit–Adama West M/W Rep.–Nazareth: Approx. 100 km) section to cope with increasing traffic, especially to relieve the increasing circuits requirements on the existing Addis Ababa–Mt.Furi microwave link.

With establishment of the above transmission link, network security would be extremely improved for the existing transmission networks extending towards East (Dire Dawa), Southeastern regions (Goba) and Southern (Shahemene) as the existing transmission system is used as a backup and/or load sharing by both new and existing routes becomes available.

For installing the cable, it is recommended to lay the cable in the duct for the city area of Addis Ababa and Nazareth, and the rest section is by aerial cable installation method from security as well as economical viewpoints. The transmission route plan appears in Figure 13.2-3.

Add/drop function is to be provided at Debre Zeit.

While, as shown in Table 13.2-4, a quit number of new spur links and expansion of existing links become necessary for improvement of the services by the end of Short Term. However, it would be difficult and not realistic to establish within the Short Term from viewpoints of the remaining period of Short Term and budget required. Therefore it is recommended to implement those projects in both Short Term and Middle Term. Construction of links required for establishing the 163 new exchanges under the Eighth Telecommunications Development Plan is to be implemented in the Middle Term together with the construction of VoIP facilities.

Table 13.2-4 Spur Link Expansion

Construction/Expansion	Number of links
PDH Construction	327*
PDH Expansion	74

* : Repeater stations in spur link are not included.

(9) Improvement of Operation and Management

a) Operation status of switch and transmission systems are being supervised in each region/zone concerned. However, such information and data are to be sent to head office to take necessary actions by the corresponding divisions in head office, i.e., for providing assistance/suggestion to maintenance staff for trouble shooting and also for planning purposes, such as network expansion, replacement plan of existing facilities, etc., by analyzing those information/data. For this purpose, the subsystem developed for monitoring purpose is to be integrated to CIMIS, which is being implemented by ETC to modernize the management of huge resources, intensive project planning, control and monitoring and extensive capacity building

The explanation of CIMIS is given in the Supporting Document.

b) Improvement of Project Management

Information regarding planning, design, bidding, construction, system acceptance, subscriber connection and other aspects should be shared among different but corresponding/related departments and divisions within ETC for higher efficiency in performance and seamless project management.

For this purpose, computer aided system is to be established in the ETC head office, connecting corresponding/related department/divisions and is to be incorporated into CIMIS.

c) Customer Service Improvement

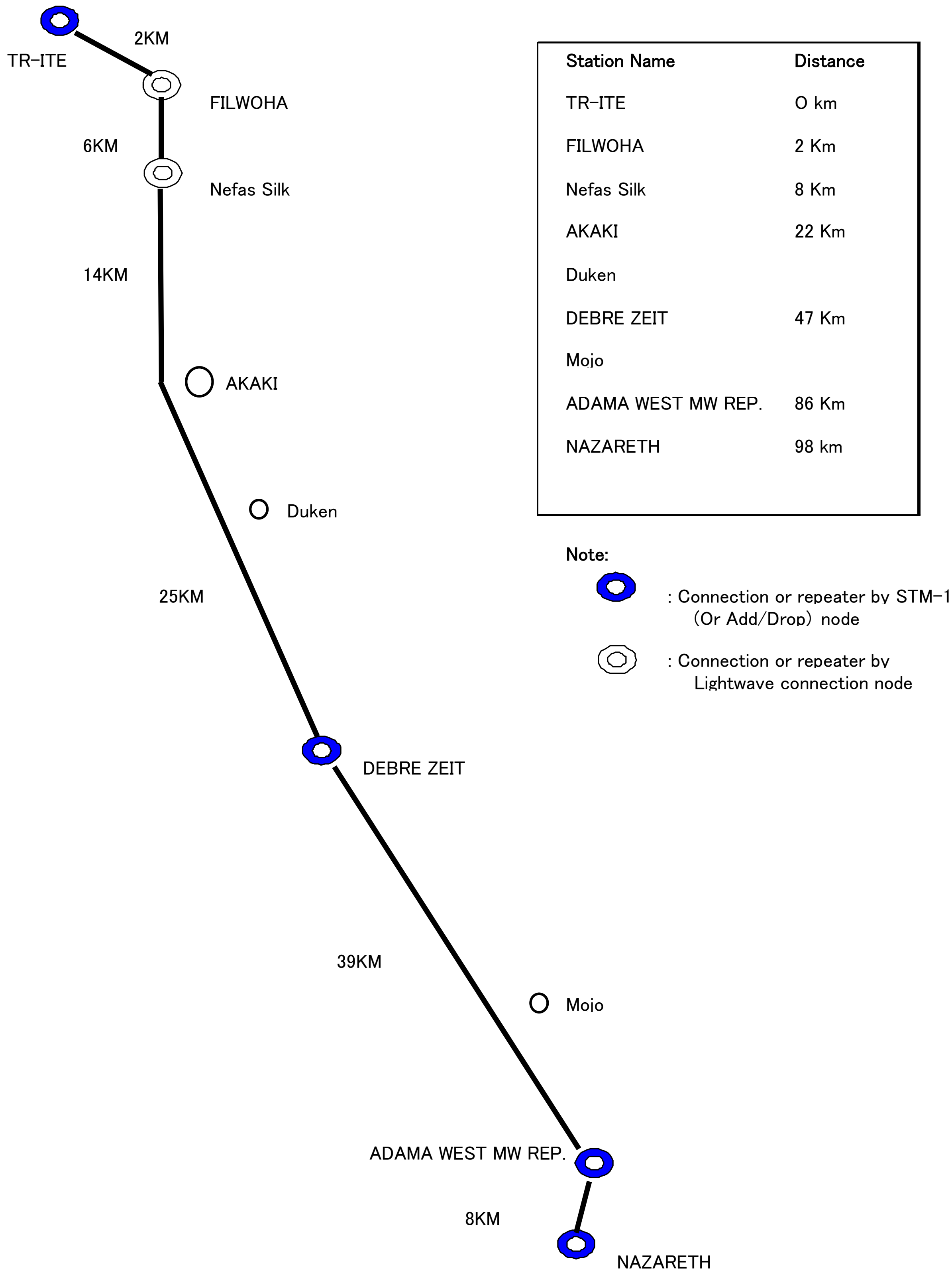
Currently, introduction of computer aided system is being implemented by ETC for efficient subscriber management, processing and management of subscriber connection order for applicants. The sub-system is to be integrated to CIMIS.

d)Establishment OPMC (Outside Plant Maintenance Center)

- Two (2) OPMCs are to be established in Addis Ababa zones to perform the new subscriber connections, fault restore and preventive maintenance of the local access network in all Addis Ababa zone in a effective way with reasonable number of staff, and to increase customer satisfaction by shortening waiting time for subscriber connection as well as service interruption period due to faults. In addition to the above tasks, On-the-Job training is performed for the new maintenance staff as well as for the staff of the companies who are going to undertake maintenance work including installation of OSP.

All necessary installation materials, tools, measuring equipment and vehicles are to be kept in respective centers.

List Project for Short Term in Given in Table 13.2-1. The details of the project scope and implementation schedule of the priority projects are shown in D.Table 4.4-1～3 of Data File.



Station Name	Distance
TR-ITE	0 km
FILWOHA	2 Km
Nefas Silk	8 Km
AKAKI	22 Km
Duken	
DEBRE ZEIT	47 Km
Mojo	
ADAMA WEST MW REP.	86 Km
NAZARETH	98 km

Figure 13.2-3 AA-Nazareth Backbone Transmission Route Plan

Table 13.2-5 Project List for Short Term

No.	Project Name	Description
1	Urban and Regional Town Telecom Expansion Project	A.A Zone and 8 Regions
	Access Network (OSP, WLL, FTZ) including OSP Rehabilitation (60,000 Pairs) in A.A - OSP - WLL - FTZ	296,900 Pairs - 226,400 Pairs - 27,000 lines - 108,500 LU
	Digital Switch - New and Expansion - Replacement of Analog - Replacement of RAX exchange VoIP	124,500 LU - 103,000 LU - 78,500 LU - 28,250 LU 27,000 LU
	Payphone	65 Units
2	Mobile Network Expansion Project	13 Regional towns including A.A (400,000 LU in Capacity) - 200,000 LU in 2003/04 - 200,000 LU in 2005/06
3	Rural Telecommunications Network Project	700 Rural Communities
4	IP based Network	IP based Network Connecting 8 PCs, MSC and 6 Tandem Exchs. in A.A
5	Transmission Network Expansion - Backbone Transmission System - Optical Fiber - M/W - Super radio system - Junction Link - VSAT	 - Addis Ababa – Nazareth (100 km) - 17 new links and 1 expansion link - Approx. 120 new links - Optical fiber ring in A.A (60 km) - 27 sites including 15 new PCO
6	Introduction of CIMIS - Customer Services - Operation and Maintenance - Project management	 - 8 Regions and 6 Zones - Integration of sub-system to CIMIS - ETC head office/project site
7	OPMC Project	Establishment of 2 OPMCs in A.A
8	Cyber Café / POP Expansion Project	Cyber Café: 16, POP: 5

13.3 Project Implementation for Middle Term and Long Term

Project scope for Middle Term by 2010/11 and Long Term by 2020/21 is given in Table 13.3-1.

Table 13.3-1 Project List for Middle/Long Term

No.	Project Name	Scope up to 2010/11	Scope up to 2020/21
1	Fixed-phone Network Expansion - VoIP - Subscriber Access Network (OSP, WLL, FTZ) - Payphone	 226,000 LU 271,000 Pair 600	 667,000 LU 768,000 Pair 1400
2	Mobile-phone Network Capacity Expansion	150,000 LU	410,000 LU
3	Rural Telecom Network Expansion	1,527 PCOs (including 65 VSAT)	2,891 PCOs (including 96 VSAT)
4	Transmission Network Expansion - Microwave - Satellite	 - Backbone: 17 links - Spur Route: 200 links - 12 sites	 -backbone: 18 links - Spur Route
5	POP & Cyber-café Expansion	15 POP/48 C. Cafe	5 POP/ -
6	Rehabilitation of OSP (with OSP and FTZ)	60,500 Pairs	--
7	Construction of 2nd International Gateway	1	
8	Establishment of OPMC	9	-

(1) Middle Term

Middle Term Procurement is to be carried out in two periods, which concentrates primarily on incomplete projects under the Eighth 5-Year Development Program.

(a) First Period

a) Fixed Telephone Network Expansion Project

VoIP should be introduced for network construction from the beginning of the Middle Term, basically without any more construction of digital switching:

- VoIP construction at 163 sites: 90,250 LU
- Replacement of Analog Exchange 2 Sites 1,500 LU
- Access network by OSP, WLL, FTZ: 286,500 pairs (OSP:118,400, FTZ: 121,500, WLL: 46,600)
- Paper-insulated lead-sheathed cables replacement in the regional town with high frequency of problems: 60,500 pairs
- Construction of Second gateway NSC/ISC exchange in Nazareth

The second NSC/ISC is to be established in Nazareth with digital switching system, in principle. Master clock at NSC/ISC might be replaced with new one because of its lifetime in the Middle Term. In addition, sub-master clock (Cesium) is to be provided in the second NSC/ISC for security of the network operation. Expansion of IP based network is to be implemented, namely, edge routers and Soft-switches installed in Addis Ababa are to be added to cope with the increasing traffic.

- Establishment of OPMC 9 OPMCs (8 Primary Centers including Nekempte, and Harar)

b) Transmission Construction

Trunk and spur link expansion shall be implemented employing microwave and optical fiber methods, as well as new VSAT construction for remote PCOs. Links necessary for new switching equipment under the Eighth Telecommunications Development Plan are to be constructed, which are postponed from Short Term.

It is planned to upgrade 179 VSATs employing FaraWay during Middle/Long Term to cope with increasing demand.

c) Internet and Cyber Café Expansion

Expansion of 15 POPs and 48 Cyber Cafés in regional medium and small-scale towns.

(b) Second Period

- Expansion of mobile-phone network for additional 150,000 LU capacity
- Construction of VoIP 131,000 LU

The highest priority is placed on Addis Ababa, where 70,000 LU are to be installed, while other target areas are not determined and are depend on the priority of ETC.

- Subscriber Access Network Construction 210,500 Pairs
- Transmission Network Construction

  Links necessary for new VoIP sites (131,000 LU) are to be executed.
- POP Expansion:

  -1 each in Harar, Goba Wolaita, Dilla, Arbaminch, Mettu, Debre Markos and Gondar

  - 4 cyber cafés per city

(2) Long Term

d) Fixed Telephone Network Expansion Project

- VoIP network construction is to be expanded.

  - VoIP construction: 667,000 LU

  - Access network by OSP, WLL, FTZ: 768,300 pairs (OSP: 557,500, FTZ: 154,000, WLL: 56,800)

e) Mobile Telephone Network Expansion

Mobile telephone services should be expanded to 8 medium- and small-scale cities and major junction roads. 460,000 LU in capacity

f) Rural Telecommunications Network Construction

- A total of 2,891 PCOs should be constructed in rural areas.

g) Transmission Construction

- Trunk and spur expansion lines should be implemented applying micro and optical fiber methods, as well as new VSAT construction for remote PCOs.

h) Internet and Cyber Café Expansion

- Expansion of 5 PoP in regional medium- and small-scale cities.
- Ring configuration may be applied for North microwave routes connecting Axum and Gonder, and Mille and Dire Dawa.
- The terrestrial international routes (to Djibouti, Kenya and Sudan) may be configured with the route diversity applying the O/F overhead route along EEPCO power transmission routes, when economically applicable (co-operation with EEPCO).

13.4 Project Cost

Project Cost for Short Term and Middle/Long-Term are given in Table 13.4-1.

Table 13-4-1(1/2) Project Cost for Short-Term

No	Project Name	Description	Foreign ('000 US$)	Local ('000. US$)	Total Cost ('000 US$)
1	Urban and Regional Town Telecom Expansion Project	A.A Zone and 8 Regions - Local Access, Switch, payphone	121,198	42,151	163,279
2	Mobile Network Expansion Project	13 Regional Towns	134,146	1,450	135,596
3	Rural Telecommunications Network Project	700 Rural Communities	44,164	10,551	54,715
4	IP based Network Project	Connecting PCs, MSC & 6 Tandem Exchanges in A.A	11,040	1,227	12,267
5	Backbone Transmission	A.A - Nazareth	4,453	1,754	6,207
6	Junction Link	Addis Ababa	5,319	7,991	13,310
7	Transmission Network Expansion Project	Microwave, Fiber, DRCS, Satellite	96,031	18,356	114,386
8	CIMIC Project	Customer Services, O&M, Project Monitoring	14,019	3,505	17,524
9	OPMC Project	Establishment of OPMC in A.A	2,000	340	2,340
10	Cyber Café / POP Expansion Project	Cyber Café: 16, POP: 5	1,166	13	1,179
11	Technical Support by Civil Engineer	Standardization of station building, duct system	376	0	376
	Total		433,840	87,338	521,177

A total of US$ 521,177,000 is required to implement projects planned for the short term period of the Master Plan.

Table 13.4-1(2/2) Project Cost for Middle Term and Long Term

Target Year	2010/11			2020/21		
Unit	Foreign (Mil. $)	Local (Mil. $)	Total (Mil. $)	Foreign (Mil. $)	Local (Mil. $)	Total (Mil. $)
Fixed Telephone	114.8	34.8	149.6	266.2	93.7	359.9
Mobile-phone	59.9	0.6	60.6	163.1	1.8	164.9
Rural Telecom	89.1	22.8	111.9	175.7	44.0	219.7
Transmission Expansion	72.6	26.6	99.2	31.8	8.3	40.1
IP Network	0.0	0.0	0.0	1.7	0.2	1.9
POP & C. Café Expansion	4.3	0.0	4.4	0	0	0
OPMC Expansion	9.0	1.5	10.5			
Building Construction	0.0	1.0	1.0			
CIMIS	5.0	3.5	8.5	10.0	7.0	17.0
Spectrum Management	9.7	2.0	11.7			
Total Cost	**364.4**	**92.8**	**457.3**	**648.6**	**155.8**	**804.4**

A total of US$ 1,261,800,000 is required to implement projects planned for the middle and long term period of the Master Plan.