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PARTICIPANTS' REPORTS-7

# ICTP - URSI - ITU/BDT WORKSHOP ON THE USE OF RADIO FOR DIGITAL COMMUNICATIONS IN DEVELOPING COUNTRIES

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# "Wireless Solutions to Telecommunications and Information Infrastructure in Developing Countries: the Nigerian Experience"

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# Wireless Solutions to Telecommunications and Information Infrastructure in Developing Countries: The Nigerian Experience

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**ABSTRACT** : In this paper the wireless solution to telecommunication and information infrastructure in the developing countries is discussed. The use of wireless technology for rural telecommunication in order to halt the migration to urban centres is given adequate attention. The wireless solution in Nigeria is taken as a case study.

## 1 INTRODUCTION

The "Missing Link" report issued by the Maitland Commission (Independent Commission for World-wide Telecommunications Development) Report, in 1984 drew the attention of the world telecommunication community to the uncomfortably large gap in telecommunication facilities between the developed and developing countries and made some recommendations. The World Telecommunication Development Conference came up with the Buenos Aires Action Plans to redress the unsatisfactory telecommunication facilities existing in the developing countries of the world. Unfortunately the situation today has not changed in many of the developing countries especially those in Africa. In 1993 the ITU figures showed that 15% of the world population owned 71% of the world telephones. The developing countries are victims of poor telecommunication infrastructure. A major problem, which therefore confronts the society in such countries today is that it is not only isolated from the international community, but also from one another. For example, the average teledensity in Nigeria is less than 0.5 main line per 100 inhabitants; the African average is about 1.5, the world average for developing countries is about 2.8, while the world average stands at 19 and that of the developed countries over 45. Africa with 12% of the world population has only 2% of the world's main telephone lines.

The world is being driven by three major technological waves of which information technology is the most central and significant. The information technology requires as backbone an efficient telecommunication network for its operation and with the absence of such infrastructures in the developing countries the development of information network has suffered tremendously in such countries with the devastating effect on economic and industrial growth of such countries.

New technologies in areas such as switching and transmission have emerged, which could help the developing countries to leapfrog into the new age of telecommunications if obstacles such as the obnoxious monopoly oriented regulatory bottlenecks are removed. Some countries in South East Asia have taken advantage of the new technologies to develop their telecommunication infrastructure to a comfortable level. For example, South Korea increased her telephone facilities from 120,000 lines in 1961 to about 20 million in 1994. More than 2 billion people on the five continents live in rural areas where the telephone penetration is non-existent or close to zero. It is now being postulated that the development of advanced communications infrastructures is a pre-requisite to the maintenance and development of global economic, demographic, social, cultural and envrionmental equilibrium. In most of the developing countries, about 70% of the population resides in the rural areas and the teledensity in the rural areas could be as low as 0.006 to 100 inhabitants or non-existent, although the Buenos Aires Declaration recommends a figure of 1 for 1000 inhabitants by the year 2000 for rural areas. In effect the provision of telecommunication facilities in rural areas is of major importance in improving the telecommunication facilities in the developing countries.

In this paper the wireless solution to telecommunication and information infrastructure in the developing countries is discussed. The use of wireless technology for rural telecommunication in order to halt the migration to urban centres is given adequate attention in the paper.

## 2 CHARACTERISTICS OF SOME WIRELESS ACCESS NETWORKS

Some wireless access networks are considered, such as point-to-point, point to multipoint, cellular, cordless and satellite systems.

### 2.1 Single Channel point to point radio system

This provides the same access to the network as is given by a wire line. The subscriber terminal must be within radio range of a base station that is connected to the switching system. The mode of operation can be
(a) dedicated channel mode and (b) shared channel mode
Multichannel point to point radio system can be used to connect groups of subscribers to the switching system.. Such systems are microprocessor controlled and incorporate attractive features.

### 2.2 Multi-access radio system

This is a class of subscriber radio in which a single base station supports large numbers of remote subscribers by providing automatic access to channels on demand. Multi-access becomes advisable when the single channel radio cannot cope with the demand of a segment for integrated coverage. The systems are widely used for subscriber connections in rural and urban areas for telephony, data or video. The systems allow the common use of channels by many subscribers. The multi-access radio systems are either FDMA or TDMA.

#### 2.2.1 FDMA multi-access systems

These systems link subscribers onto a small number of radio channels. The central base station comprises a set of tranceivers (one for each channel), a traffic concentrator and a control unit. Fig. 1 shows an FDMA system for a single area. Some systems are integrated with telephone exchanges to save cost. They work in the 400 or the 900 Mhz band and provide between 180 to 2000 subscribers on a cellular radio usage basis. FDMA systems have a low initial cost. The main drawbacks of these FDMA systems are limitation of total capacity of the system, limited range because of restriction on the number of repeaters in one path and the central office gets complicated with increase in number of tranceivers.

#### 2.2.2 TDMA multi-access radio system

TDMA systems are fully digital, thus providing better quality. A TDMA system is illustrated in fig. 2. The TDMA protocol provides for 64kbps per bearer channel, thus making the technology ideally suited for those applications requiring basic rate ISDN service. However for voice applications, a number of users may share the same terminal. These systems link clusters of subscribers to a central base station connected to the public telephone network. A single pair of frequencies is used in each coverage area, access being provided by TDM and a large number of subscribers concentrating unto a smaller number ot time slots. Power consumption is low, hence outstations can be powered by solar power systems.
Some commercial multiple access radio systems employ:

i) Digital Radio Concentrator System (DRCS) capable of serving 256 subscribers in the 1.5 GHz frequency band.
ii) Digital Radio Multiple Access Subscrber System(DRMASS) which covers up to 1024 subscribers.

### 2.3 Fixed Cellular Based Systems

The normal full-blown cellular technology was originally designed to provide seamless and continuous mobile coverage in an area, including the provision of being handed over from one cell to another without interrupting the on-going connection. This requirement consequently results in complex real time control systems. However with the increasing demand for the application of fixed cellular solution to some telecommunication expansion , especially in rural areas in the developing countries, several manufacturers have either modified their infrastructure equipment or designed new systems to meet the requirements of that market. A fixed cellular terminal can be employed to provide telecommunication services such as telephone, fax, and data transmission to a number of subscribers, especially in the rural areas and also in urban areas. It is becoming popular in the developing countries

due to coverage, capacity and cost. The RURALCEL is a fixed cellular system used for rural telecommunication in Brazil. In Nigeria, the CELLUPHONE (CELLUlar conventional telePHONE) system is a fixed cellular which uses a conventional mobile set mounted in a special package to provide telecommunication facilities in rural and sub-urban areas.

The characteristics of some of the cellular systems available are summarised (Shapira,1995) in Table 1

i) Analogue Systems: AMPS, NMT, TACS

ii) Digital: GSM, DCS 1800, D-AMPS, IS 95, IS 54, etc.

DCS 1800: Digital Cellular System at 1800MHz based on GSM

D-AMPS: Digital Advanced Mobile Phone Service - uses the same radio channels as the analogue AMPS

iii) Third generation Systems: Digital (FPLMTS, UMTS).

| SYSTEM | ACCESS | CHANNEL | TIME SLOT | VOCODER | BAND |
|---|---|---|---|---|---|
| ANALOG | | | | | |
| AMPS | FDMA | 30 Khz | N/A | N/A | 800 MHz |
| NAMPS | FDMA | 10 Khz | N/A | N/A | 800 Mhz |
| TACS | FDMA | 25 Khz | N/A | N/A | 900 MHz |
| NTACS | FDMA | 12.5 Khz | N/A | N/A | 900 MHz |
| NMT | FDMA | 20 Khz | N/A | N/A | 450 Mhz |
| DIGITAL | | | | | |
| IS 95 | CDMA | 1230 | N/A | 8 K(VAR) | 800 MHz |
| GSM | TDMA | 200 | 8 | 13.2 K | 900 MHz |
| DCS-1800 | TDMA | 200 | 8 | 13.2 K | 1800 MHz |
| IS 54 | TDMA | 30 | 3 | 8 K | 800 MHz |
| JDC | TDMA | 25 | 3 | 8 K | 1500 MHz |
| ETDMA | TDMA | 30 | 6 | 4 K | 800 MHz |

Table 1: Summary of Cellular Systems Specifications (Shapira, 1995)

**FPLMTS - Future Public Land Mobile Telecommunication System (IMT 2000)**

A dominant feature of FPLMTS is a personal station to be usable anywhere worldwide providing a variety of radio coverages from very short range within buildings or urban areas, through medium range suburban to longer range rural coverage. FPLMTS will include use of vehicle mounted stations and links to aircraft, ships or satellites with international roaming facilities. FPLMTS (CCIR Report 1155) can provide telecommunication facilities particularly adapted to the needs of developing countries and remote areas by its capability for rapid provision of service in new areas, growth capacity and flexibility, potential for cost reductions resulting from technology advancement and mass production and capability for covering wide geographical areas.

**UMTS - Universal Mobile Telecommunications System**

The main UMTS targets ( Palestini (1995)) can be summarised as follows:

Integration of residential, office and cellular services into a single system based on one piece of user equipment, availability of a wide spectrum of services, simple, low-cost terminals for the residential segment and quality comparable to that of the fixed network. The others are: capacity and capability to serve more than 50% of the population, seamless global coverage, radio bearer services up to 144kb/s and further to 2 Mb/s, radio resource flexibility to allow for competition within a frequency band, high spectrum utilization efficiency, creation of direct satellite access, use of a new global frequency band, and low cost of services and terminals

## 3 RADIO IN THE LOCAL LOOP

The local loop consists of the network between the local exchange and the subscriber and is usually made up of the distribution network and the access network . The local loop is the last and one of the most expensive parts of the telecommunication network. The distribution network could be copper wire, coaxial cable, optical fibre, microwave point to point or satellite system as shown in fig. 3 (Cayla, 1995). Similarly the access network can be copper, optical fibre i.e FTTX solutions- fibre to the curb, office and home, coaxial, or radio network as shown in fig. 3.

Radio and fibre solutions to connect customers into network started to develop as alternatives to copper(fig. 4a) (Rosenne,1995) early in the 80's. Point to multi - point radio systems have been in service for a number of years and now dedicated radio access networks are introduced. Radio systems with careful frequency planning have become popular as an access system in rural areas in particular and in urban area applications. WLL (Wireless Local Loop), (fig. 4b) (Rosenne,1995) technology provides a viable and effective alternative to conventional hard wired solutions. In addition to enabling a high degree of mobility, implementation is considerably cheaper and faster and the new digital technologies provide high performance voice and data services.

### 3.1 Technical Requirements for fixed wireless subscriber access.

The technical requirements for wireless access to the fixed network are fundamentally the same as for any part of the fixed access segment of the network. These are: High voice quality 64Kbps PCM preferred per Rec.G.711/713 (32Kbps per G.726 acceptable), Group 3 fax transmission, V.34 data transmission or at least V.32 bis, an easy growth path to ISDN access and a high grade of service (low blocking probability) (Morris, 1995).
In addition, the wireless access should be capable of easy and compatible integration with the distribution equipment whether radio or cable, etc based, low power consumption, especially at the subscriber premises and reliability must be commensurate with the reliability of the network as a whole.

### 3.2 Key Issues of WLL

(i) Frequency Spectrum Availability: There is no specific allocation for WLL, hence use is made of mobile and fixed service bands. There is variety of frequency allocations worldwide and the present limited allocation availability restricts system selection.
(ii) Development of Standards: There is lack of specific WLL standards and there is divergent standardization framework. There is need for available guidance for WLL planning.
(iii) Performance Limitations: Some of these are demanding objectives, propagation impairments, codec distortion and performance trade-off. The performance objective is that "near wireline quality speech service should be provided consistent with the characteristics of the wireless environment"
The basic WLL disadvantage could be the transmission quality lower than in wired local networks due to non-LOS propagation, interference and speech coding. However, the basic WLL advantage is the modularity in terms of area coverage, system capacity and deployment.

## 4 SATELLITE SOLUTION

Satellite is used extensively in the developing countries in the provision of conventional international telecommunication using the INTELSAT satellite. However many countries have also leased transponders for domestic TV and telecommunication services. In Nigeria three transponders are leased for national TV broadcast and for some telecommunication services. Some developing countries, such as India and Brazil have their own satellites for telecommunication and other services. Satellite solution has been found very useful for the provision of rural telephony, radio and TV broadcasting. A typical use of satellite for rural telecommunication is shown in fig. 4. In the RASCOM ( Regional African Satellite Communication) project involving 50 African countries, about 2000 Earth stations were planned with the majority being small rural Earth stations to serve the over 70% rural population.

In addition, Very Small Aperture Satellite system (VSAT) has been used for data, telephony and other telecommunication services. STAR and MESH configurations are the two popular VSAT systems. VSAT has been a good candidate in the solution of the problem of international connectivity for electronic communications (especially INTERNET) in some developing countries especially in Africa, when the regulatory situation permits its usage. In Nigeria VSAT is utilised by private telecommunication providers and companies for telecommunication services within the country as a result of partial deregulation of the telecommunication industry a few years ago. Satellite communication can therefore be used in many forms by developing countries to leapfrog in the provision of telecommunication services both for the urban and rural areas.

## 5 NIGERIAN EXPERIENCE IN WIRELESS SOLUTION

Cellular telephony was introduced to Nigeria in 1992. The service covers three designated areas, viz: Area I (South West), Area II(South East and Area III (North), as shown in fig. 5. The Mobile Switching Centre (MSC) for Area I is located in Lagos with eleven Radio Base Stations (RBS) scattered over the coverage area. The MSC for Area II is at Enugu with ten RBS stations scattered over the coverage area. The MSC for Area III is located in Abuja with twelve associated RBS. The Areas I, II and III have capacities of 10,000, 5000 and 5,000 respectively, initially in 1992. In 1993/94, 25,000 extra cellular telephone lines were introduced. Areas I and II operate the Total Access Communication standard(TACS) with equipment supplied by Ericsson. Area III uses the Advanced Mobile Phone System (AMPS). There is the plan to increase the capacity of the services provided by the three areas as a result of the high demand for the services despite the fairly high traffic charges by the telephone company.

### 5.1 Wireless Rural Telecommunication

The economy of most African countries depends to a large extent on the agricultural sector (farming, livestock breeding and fish) except in a few oil producing states. In 1986 there were roughly 5.8 telephone sets per 100,000 inhabitants in fifty African countries studied under the RASCOM project, thus making Africa the most under-priviledged continent in terms of rural telecommunication. In addition, the comparative penetration index, which is the ratio between the DEL density in rural areas and that in urban areas in Africa was 0.03 in 1986. That is, urban density was 33 times higher than the rural density. In fact, there were some African countries with virtually no rural telecommunication. The situation has not changed much.

In recent times technological development has provided non-conventional techniques for provision of rural communication. For example, cellular mobile telephone system can be adapted to provide rural telecommunication. Celluphone system has been adapted for providing telecommunication facilities in rural areas. The celluphone system uses a fixed cellular terminal to provide the rural services such as telephone, fax, and data transmission. The celluphone system is a fixed terminal unit consisting of the cellular radio transceiver, microprocessor interface unit, antenna, solar power unit. The system operates in the 900 MHz frequency band with full duplex ETACS (Extended Total Access Communication System) transceiver, with channel spacing of 25kHz, duplex spacing (Tx and Rx) of 45kHz. The three basic configurations are the single channel, 4 channels and 24 channels. The celluphone extends the range of cellular coverage from the typical 20km up to 100km with features similar to urban telecommunication service. The use of PABX with the celluphone in order to permit the shared use of cellular telephone lines is shown in Fig. (6) (Nwaelom, 1994), thus expanding the usage.

The Nigerian Telecommunications PLC (NITEL) has installed the celluphone system in about 25 Local Government headquarters and some rural areas with economic viability. The efficient operation of the celluphone for rural application relies on channel availability, which automatically determines the system availability. Solar powered wireless payphones are now being installed in sub-urban and rural areas. In addition, single channel radio and multiple access radio systems have been employed to provide telecommunication services to some Local government Areas (LGA).

## 6 WIRELESS INFORMATION INFRASTRUCTURE

There have been several initiatives by international organisations in the provision of information network (especially Internet connectivity) in Africa with very little or insignificant impact in liberating Africa from isolation in the provision of information network. Although thousands and even millions of dollars might have been spent on various information network initiatives in Africa, there are major mitigating factors to the realisation of the objectives of the projects. Some of these are the lack of telephone backbone infrastructure for transmission within the countries, amongst African countries and with the outside world, regulatory matters, which still allows the monopoly of a government owned company or parastatal, which in most cases are inefficient on the international route, especially in the use of satellite for international telephone connection. For a country to enjoy full Internet connectivity, an international data transmission rate of 64kbps is desirable. The few African countries with 64kbps international link are : Morocco, Ghana, Uganda, Kenya, while only South Africa, Egypt and Senegal have

transmission capabilities greater than 64kbps (e.g. 128kbps). This is an unhealthy sittuation for the development of information network in Africa. Most of the countries in Africa have only 9.6kbps international transmission facilities. The use of VSAT and other satellite systems could solve this problem in Africa, if regulatory situation permits.

### 6.1 Wireless solution to information infrastrucure

There are several approaches to the wireless solution to information infrastructure. Wireless Local Area Network (LAN) is employed in many organisations. There is also the increasing use of radio in Wide Area Networks (WAN). Although the high frequency band allows only limited speed for data transmission, frequencies in the VHF/UHF bands as well as microwave frequency bands have been utilised in the provision of wireless solution to data transmission. VSAT is a good candidate for the provision of connectivity, especially international connectivity for information network in developing countries. At the Obafemi Awolowo University, Ile-Ife, Nigeria a Campus Wireless Computer Network has been established catering for over 500 users in less than 6 months of operation. The wireless system operates at 900 MHz using spread spectrum radio technique. The system is now been adopted by 26 Universities and Research Centres in Nigeria.

## 7 FUTURE WIRELESS SYSTEMS AND REGULATORY MATTERS

There are several wireless systems that will become fully operational in the future that can assist developing countries to leapfrog in the provision of telecommunication and information services to both the urban and rural areas in order to improve on the existing situation. Some of these are : Personal Communication System(PCS), use of Low Earth Orbit Satellites (LEO) and Medium Earth Orbit Satellites(MEO) to provide full coverage of major land masses. The Little LEOs and MEOs are a constellation of small low power satellites operating in the VHF and UHF bands, providing wireless voice and data communications to urban, remote areas as well as to mobile users. The satellites operate at altitudes of several hundred kilometres in a variety of orbits at frequencies below 2GHz and characterised by data rates of 9.6 to 19.2 Kbps. The pioneering companies in this technology are OrbComm, Starsys and VITA. The Big LEOs operate at frequencies above 2 GHz providing satellite services equivalent of cellular telephones and fax, with two way connection for voice, data, videoconferencing and high performance Internet services. The pioneering companies are Iridium, Teledesic and Globalstar. The IMT-2000 (FPLMTS) and the LEOs and MEOs are all designed to utilise hand held telecommunication terminals

These wireless systems will further offer tremendous advantage to developing countries to leapfrog in to the modern information age. However, the exploitation of the emerging wireless technologies will critically depend on the regulatory situation in the developing countries. If the telecommunication industyry is deregulated and private participation is encouraged coupled with the inflow of foreign investment, the present islation of the developing countries will be history.

## 8. REFERENCES


Ajayi, G. O. : Rural Communication in Africa, ICTP Second Workshop on Rural Communication in Developing Countries, March 1995, Trieste, Italy, H4.SMR/846-1

Cayla, G. : Wireless Local Loop: At last, the last mile, ITU Technology Summit, Telecom 95 , pp 331-335

Ivanek, F. : Wireless Communications, ICTP Workshop on Telematics, Oct. 1995, Trieste, Italy, SMR.875-12

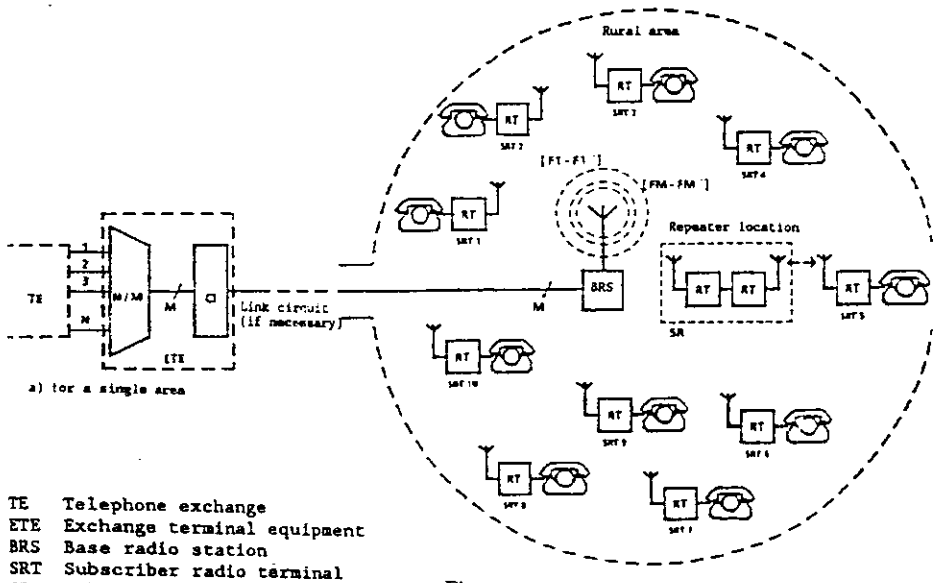
Morris M: Wireless access in the fixed network: The key to rural telecommunications development, ITU Technology Summit, pp 409-412

Nwaelom, R.E.: Telecommunication Services to Rural Areas: The 'Celluphone Angle ', NITEL Researh and Development Journal, 1(3), pp. 26 - 32, 1994.

Palestini, V. : Cellular Radio, Workshop on Telematics, ICTP, Trieste, Italy, Oct. 1995

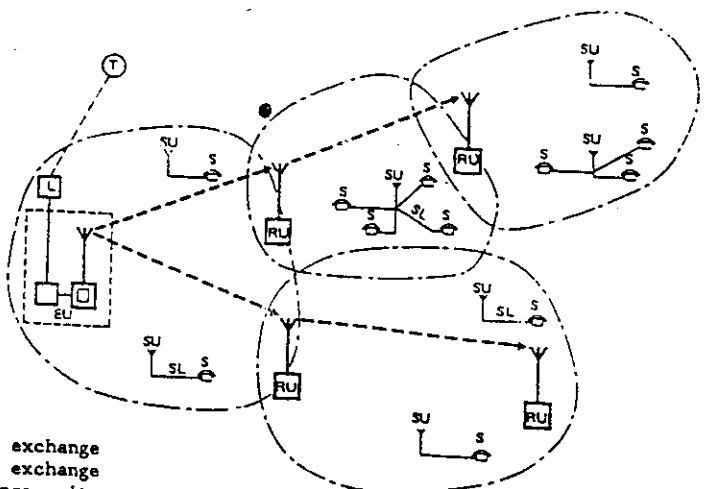
Rosenne, D. : Wireless Local Loop: The end of Local Loop Monopoly, ITU Technology Summit, Telecom 95, pp399-402

Shapira, J : Cellular Radio Network Design with Emphasis on CDMA IS 95, Fourth ICTP-URSI-ITU(BDT) College on Radiopropagation, Trieste, Italy, 1995




TE Telephone exchange
ETE Exchange terminal equipment
BRS Base radio station
SRT Subscriber radio terminal
SR Subscriber repeater

**Figure 1: FDMA System for a Single Area**




T Trunk exchange
L Local exchange
EU Exchange unit
RU Repeater unit
SU Subscriber unit
S Subscriber
SL Subscriber line

**Figure 2 : TDMA System**

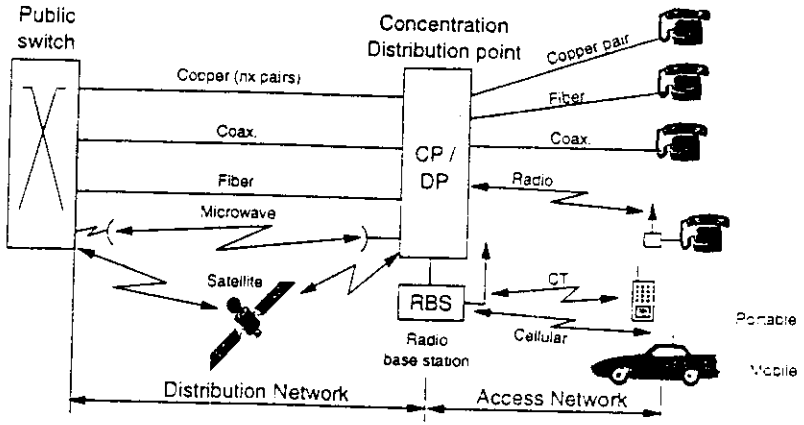



**Figure 3 : Definition of Local Loop**

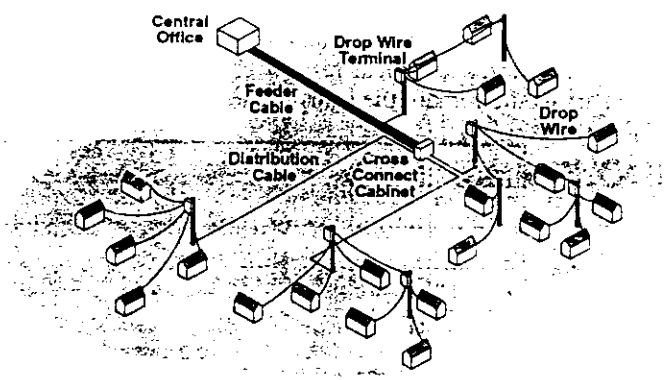



**Figure 4(a) : Copper Local Access Configuration**

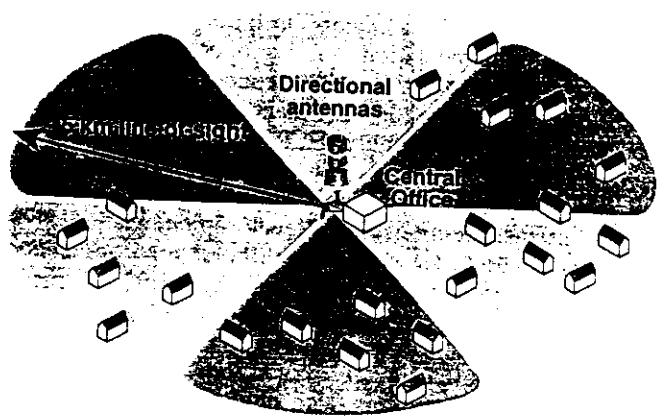



**Figure 4(b) : Sectorized/Centralized WLL System**

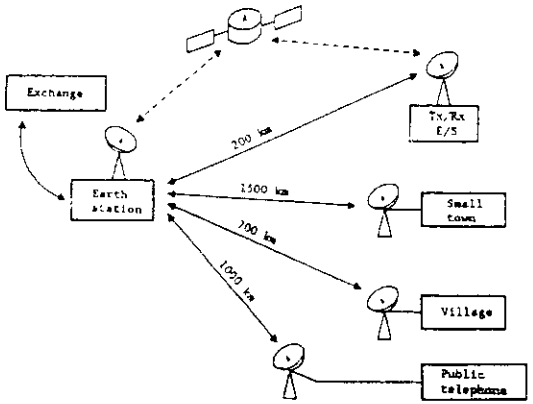



**Figure 5 : Use of Satellite for Rural Communication**

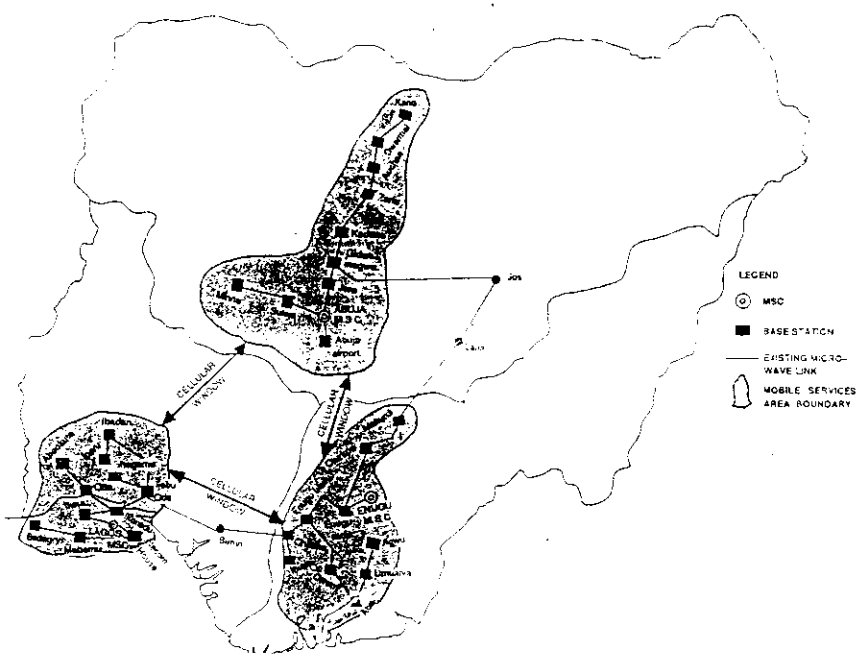



**Figure 6 : NITEL Cellular Mobile System Network Configuration in Nigeria**

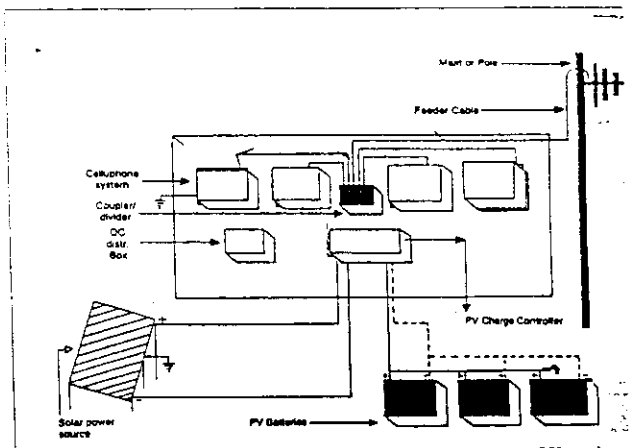



**Figure 7(a) : Layout of Installed Celluphone System in Nigeria**

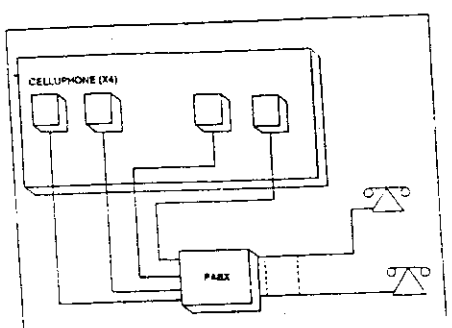



**Figure 7(b) : Typical Celluphone - PABX Link**

# Wireless Solutions to Telecommunications and Information Infrastructure in Developing Countries: The Nigerian Experience

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**The general situation in Africa today can be summarised as follows:**

*** A technological desert with poorly defined technology policies and strategies**

*** Virtually left out of the global information society**

*** Has 12% of world population, but 2% of world's main telephone lines**

*** Lowest annual growth in teledensity of any developing region.**

*** Has 35 of the world's 49 least telecommunication developed countries of the world**

*** Total number of telephone in Africa is less than those in Tokyo**

*** Ridden with failure of major technology - based projects**

*** Average level of income is the lowest, but cost of installing a telephone line (somewhat labour intensive ) is the highest**

*** Highest profit per telephone line and large waiting period (in some cases up to 9 years) for telephone service**

# Summary of Cellular Systems Specifications (Shapira, 1995)

| SYSTEM | ACCESS | CHANNEL | TIME SLOT | VOCODER | BAND |
|---|---|---|---|---|---|
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**Digital: GSM, DCS 1800, D-AMPS, IS 95, IS 54, etc.**

**DCS 1800: Digital Cellular System at 1800MHz based on GSM**

**D-AMPS: Digital Advanced Mobile Phone Service - uses the same radio channels as the analogue AMPS**

**Third generation Systems: Digital (FPLMTS, UMTS).**

# SOME WIRELESS ACCESS METHODS

**Single Channel point to point radio system**
**(a) dedicated channel mode and (b) shared channel mode**

**Multi-access radio system**

**(a) FDMA multi-access systems**

**(b) TDMA multi-access radio system**

**Fixed Cellular Based Systems**

**The RURALCEL is a fixed cellular system used for rural telecommunication in Brazil.**

**CELLUPHONE (CELLUlar conventional telePHONE) system is a fixed cellular for rural and sub-urban areas in Nigeria**

# RADIO IN THE LOCAL LOOP

## Technical Requirements for fixed wireless subscriber access.

**High voice quality 64Kbps PCM preferred per Rec.G.711/713 (32Kbps per G.726 acceptable)**

**Group 3 fax transmission, V.34 data transmission or at least V.32 bis**

**Easy growth path to ISDN access and a high grade of service (low blocking probability)**

**Capable of easy and compatible integration with the distribution equipment whether radio or cable Low power consumption, especially at the subscriber premises**

**Reliability commensurate with the reliability of the network as a whole.**

# Key Issues of WLL

**(i) Frequency Spectrum Availability: There is no specific allocation for WLL, hence use is made of mobile and fixed service bands. There is variety of frequency allocations worldwide and the present limited allocation availability restricts system selection.**

**(ii) Development of Standards: There is lack of specific WLL standards and there is divergent standardization framework. There is need for available guidance for WLL planning.**

**(iii) Performance Limitations: Some of these are demanding objectives, propagation impairments, codec distortion and performance trade-off. The performance objective is that "near wireline quality speech service should be provided consistent with the characteristics of the wireless environment"**

## SATELLITE SOLUTION

**RASCOM ( Regional African Satellite Communication) project involving 50 African countries, about 2000 Earth stations were planned with the majority being small rural Earth stations to serve the over 70% rural population.**

**Very Small Aperture Satellite System (VSAT)**
**INTERNET CONNECTIVITY IN AFRICA**

## WIRELESS INFORMATION INFRASTRUCTURE

**INTERNATIONAL DATA TRANSMISSION RATE IN AFRICAN COUNTRIES**

**Wireless solution to information infrastrucure**

**OAUNET RESULT OF COLLABORATION BETWEEN ICTP AND OBAFEMI AWOLOWO UNIVERITY (over 500 users in less than 6 months of operation)**
**Wireless system operates at 900 MHz using spread spectrum radio technique.**

## FUTURE WIRELESS SYSTEMS AND REGULATORY MATTERS

**Personal Communication System(PCS), use of Low Earth Orbit Satellites (LEO) and Medium Earth Orbit Satellites(MEO) to provide full coverage of major land masses**

**Critically dependent on the regulatory situation in the developing countries**

# FPLMTS - Future Public Land Mobile Telecommunication System (IMT 2000)

**Provision of needs of developing countries and remote areas:**

**Capability for rapid provision of service in new areas**

**Growth capacity and flexibility**

**Potential for cost reductions resulting from technology advancement**

**Mass production and capability for covering wide geographical areas.**

**UMTS - Universal Mobile Telecommunications System**

**FPLMTS - Future Public Land Mobile Telecommunication System (IMT 2000)**

**Provision of needs of developing countries and remote areas:**

**Capability for rapid provision of service in new areas**

**Growth capacity and flexibility**

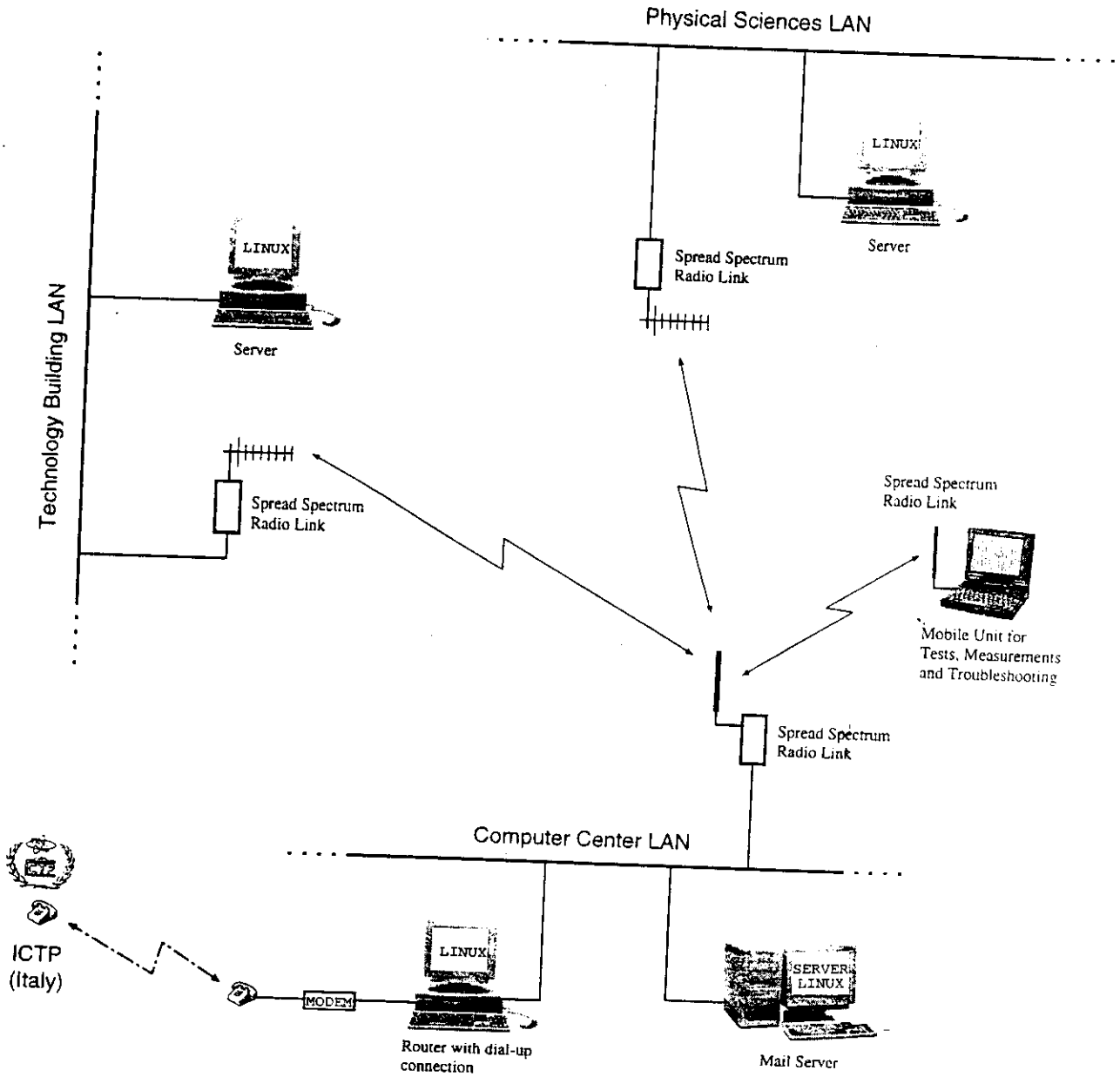
**Potential for cost reductions resulting from technology advancement**

**Mass production and capability for covering wide geographical areas.**

**UMTS - Universal Mobile Telecommunications System**

# INTERNATIONAL CENTRE FOR THEORETICAL PHYSICS(ICTP)/ OBAFEMI AWOLOWO UNIVERSITY (OAU) ACADEMIC COMPUTER NETWORK

# OAUNET

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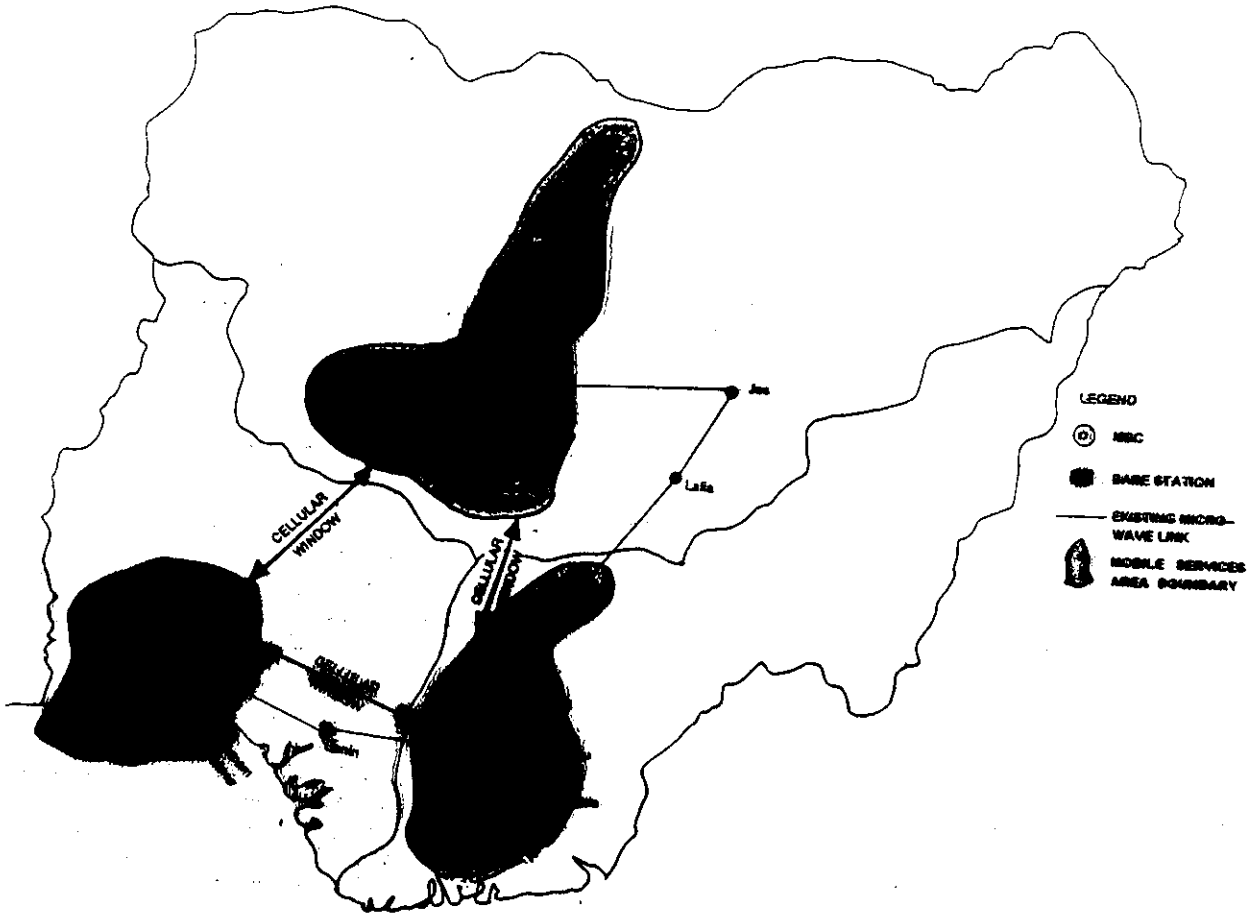
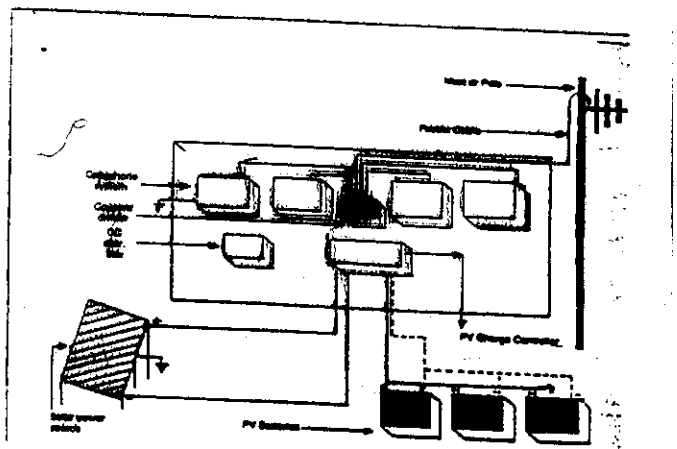
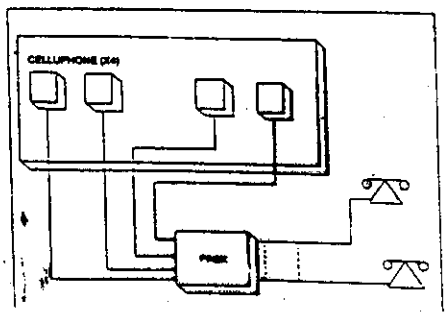
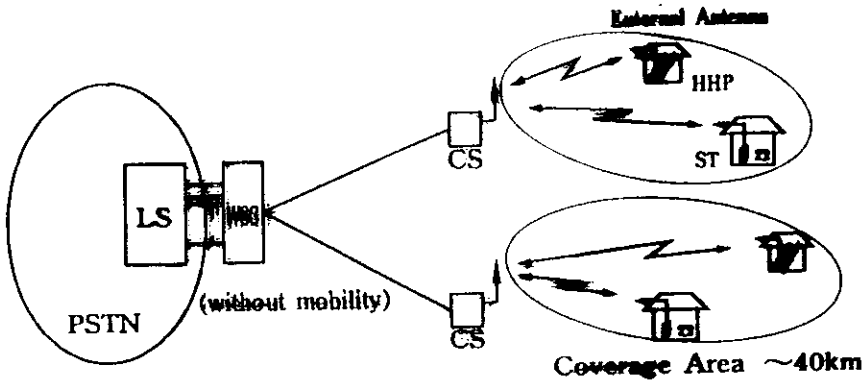


Layout of Installed Cellphone System in Nigeria

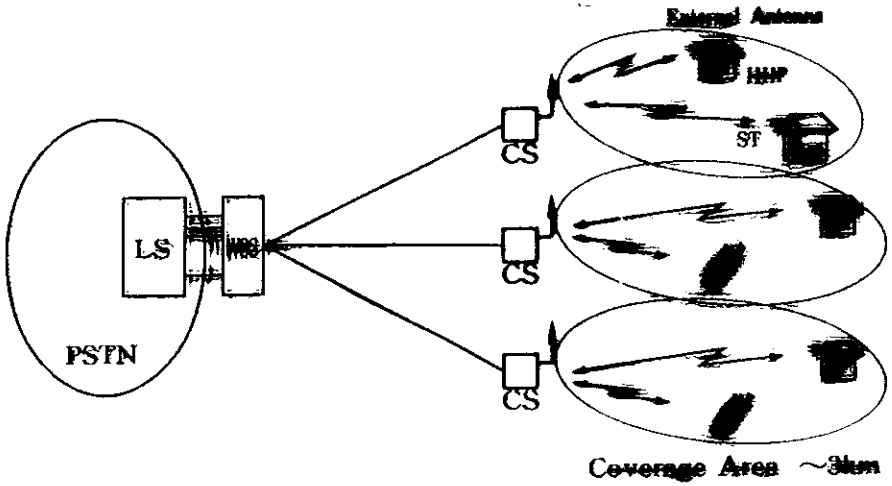



Typical Cellphone - PABX Link

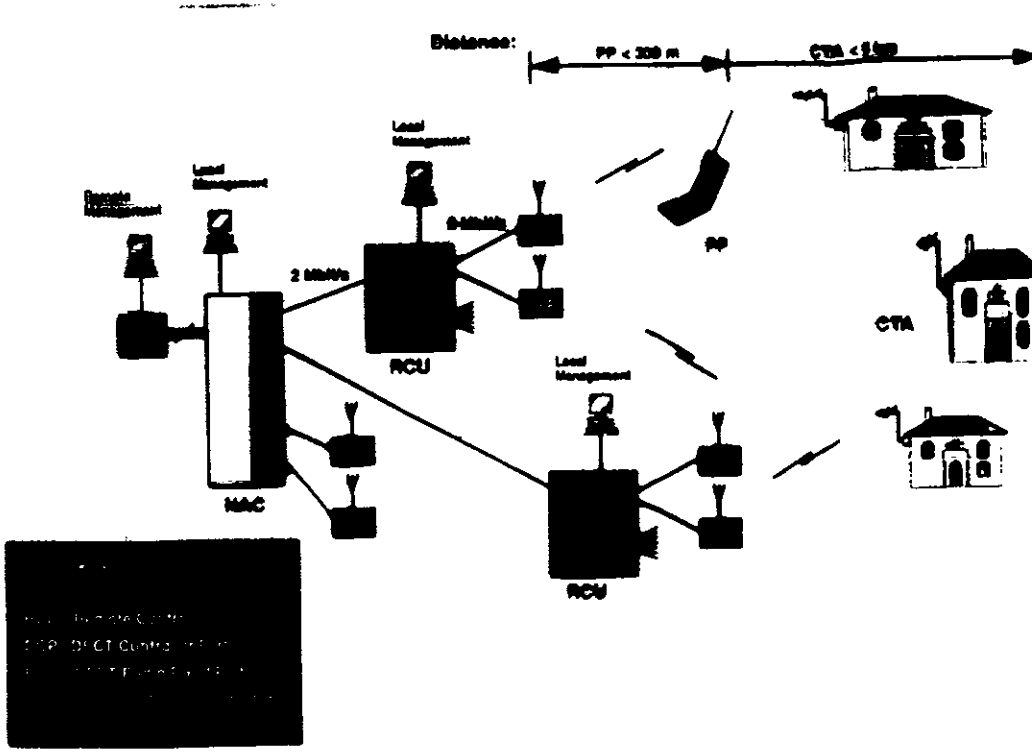



PSTN : Public Switched Telephone Network
LS : Local Switch
WSC : Wireless Service Controller (Concentrator)
CS : Cell Station
HHP : Hand-Held Portable Terminal
ST : Subscriber Terminal

*. Configuration of Fixed Cellular System*




*Configuration of Fixed Cordless System*




***Wireless Local Loop netw ork architectu***

## WLA SYSTEMS EVOLUTION

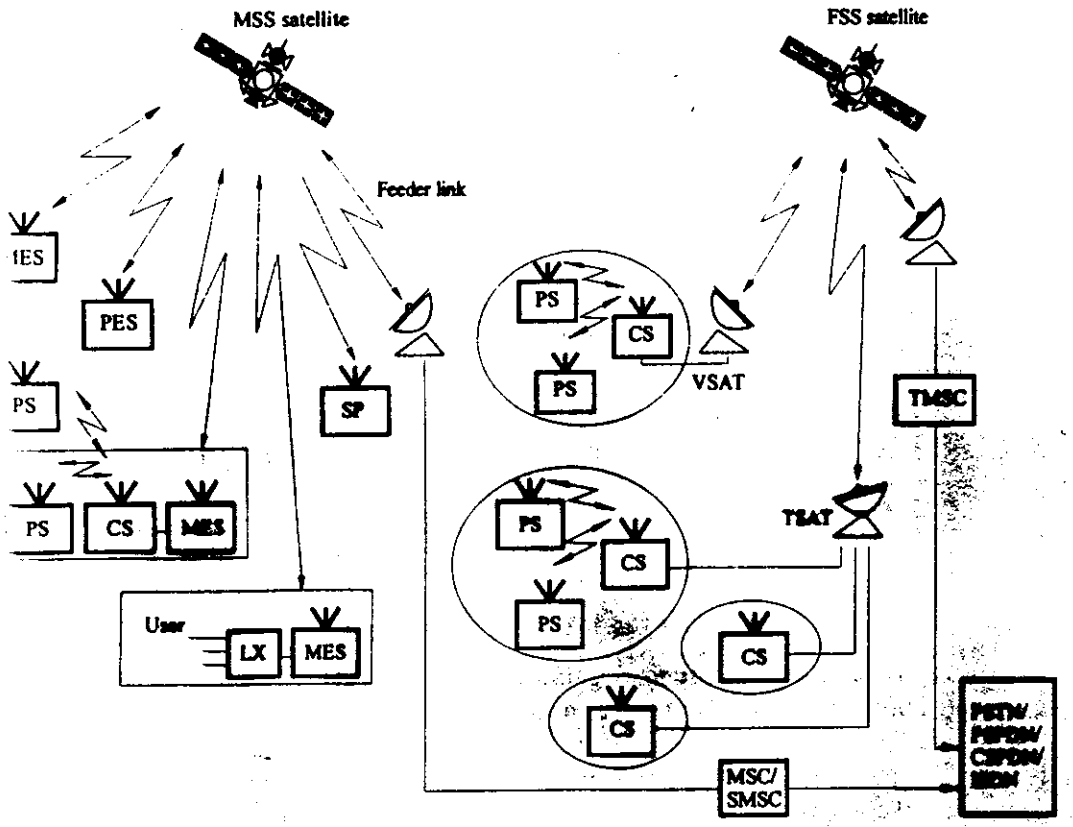
**analog** cellular based

digital cellular **based**

PCS & P-MP based

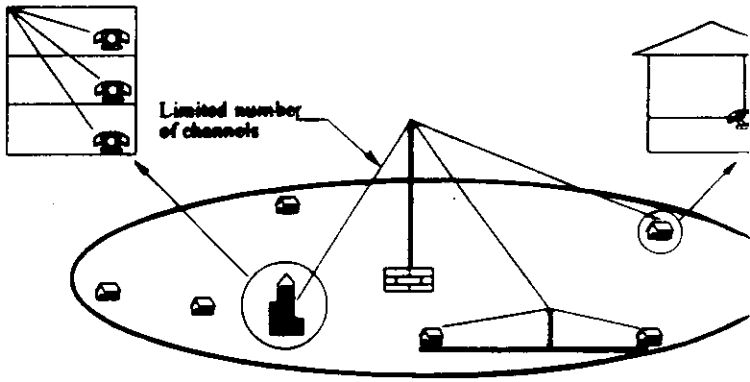
1994 1996 1998

**A FPLMTS network configuration involving MSS/FSS satellites**

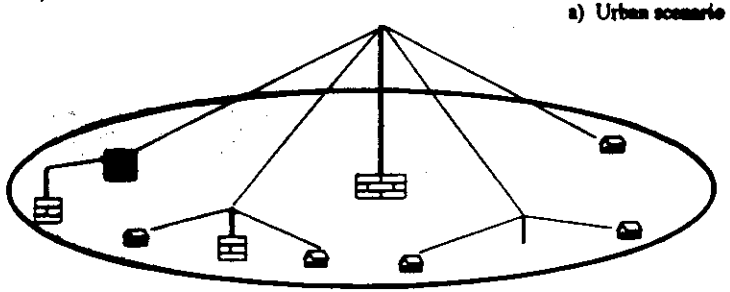



CS: call station
CSPDN: circuit switched public data network
ISDN: integrated services digital network
LX: local exchange
MES: mobile earth station
MSC: mobile switching centre
PES: personal earth station
PS: personal station
PSPDN: packet switched public data network
PSTN: public switched telephone network
SMSC: satellite mobile switching centre
SP: satellite pager
TMSC: terrestrial mobile switching centre
TSAT: T-1 VSAT
VSAT: very small aperture terminal
: terrestrial cellular network

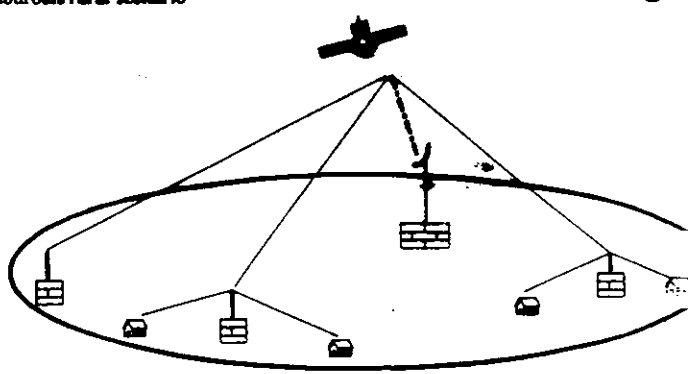
**Some possible uses of FPLMTS radio interfaces for network wireless access in the fixed service**



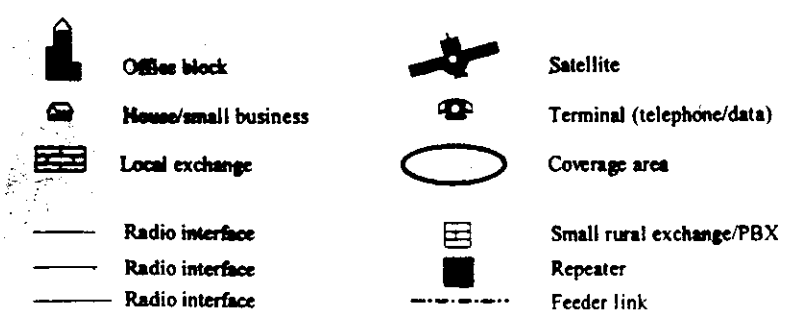

a) Urban scenario



b) Suburban/rural scenario



c) Remote areas scenario



INTERNATIONAL TELECOMMUNICATION UNION

**RADIOCOMMUNICATION STUDY GROUPS**

**Document 9A/36-E**
**Document 9B/45-E**
**Document 9D/79-E**
**19 November 1996**
**Original: English**

Source: Document 8A/TEMP/50

**Working Party 8A**

**LIAISON STATEMENT TO WORKING PARTIES 4A, 8B, 8C, 8D, 9A, 9B AND 9D AND TASK GROUP 8/1**

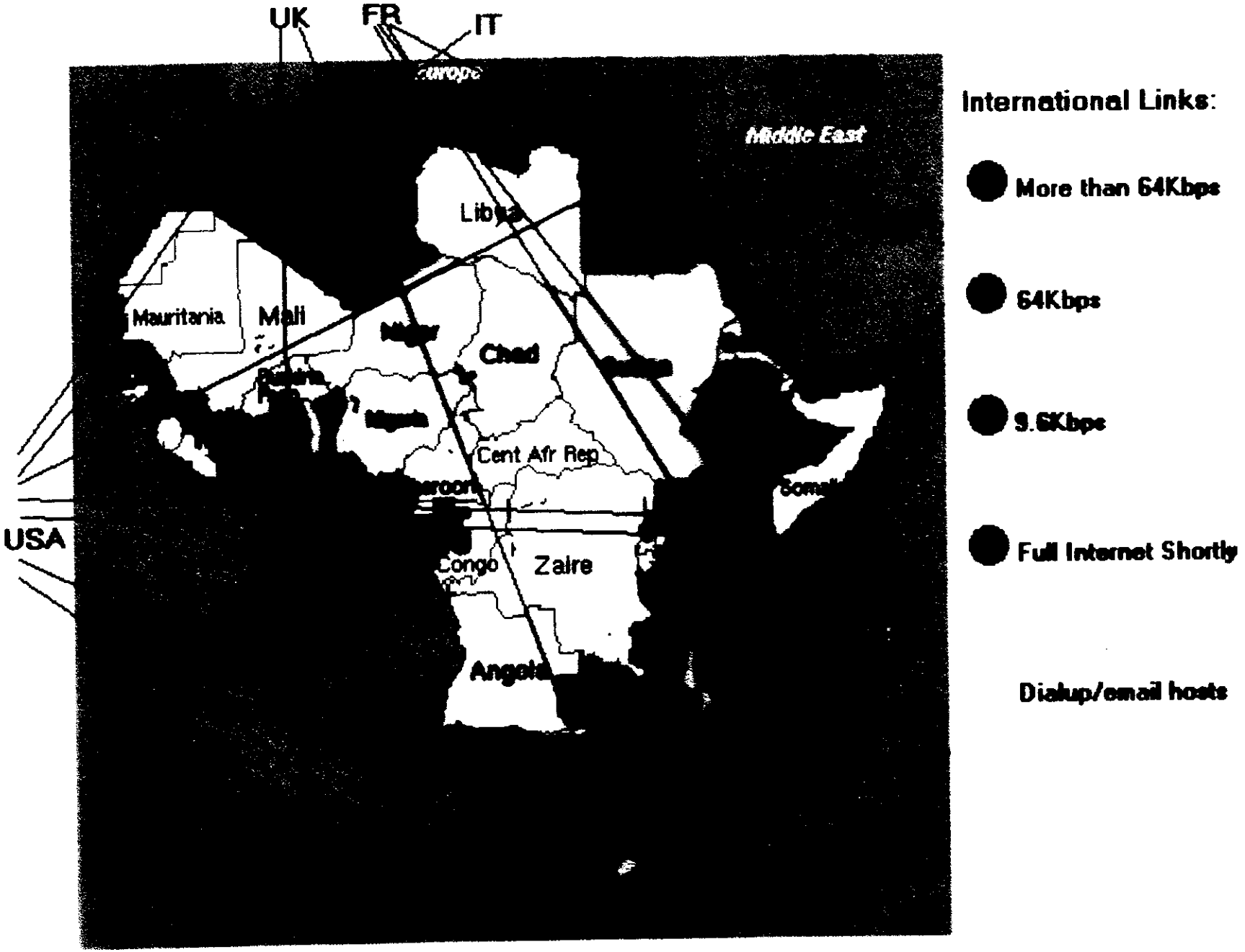
**FREQUENCY BANDS FOR CONSIDERATION FOR WIRELESS ACCESS LOCAL LOOP SYSTEMS**

**Working Party 8A has prepared a draft new Question** entitled "Frequency **bands, technical characteristics and operational requirements for wireless** access local **loop systems**", **which is attached for your information and comment.**

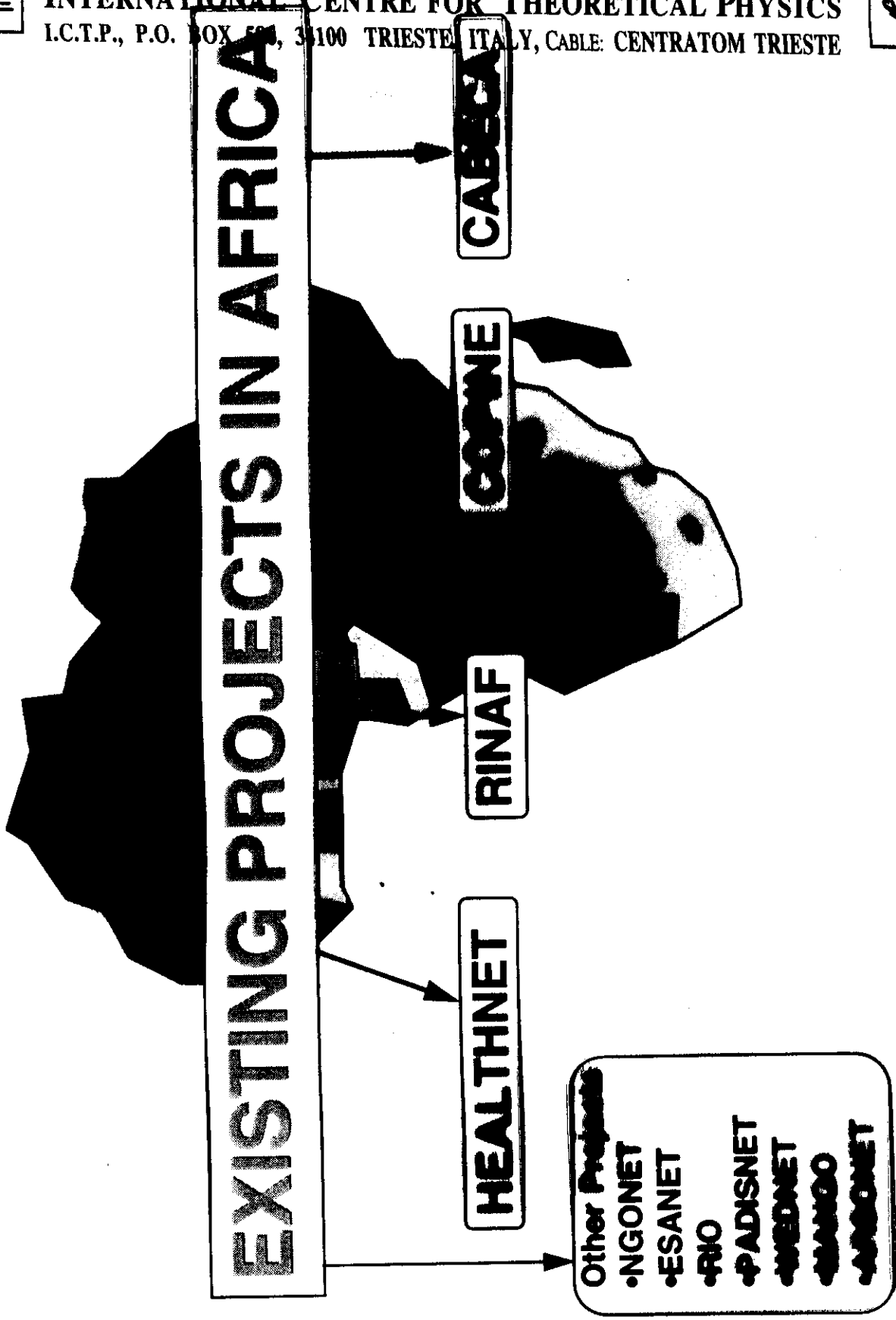
**Working Party 8A would like to receive information** on technical characteristics **and sharing criteria related to systems operating in bands being considered** for the implementation **of wireless access** local **loop** systems taking into consideration the frequency allocations by Article S5 **of the Radio Regulations**, including:

- 450 MHz band;
- 800 and 900 MHz bands, the cellular bands;
- 1.4 GHz point-to-multipoint (subscriber radio systems);
- 1 850 - 1 990 MHz, the PCS bands in Region 2;
- 1.8 and 1.9 GHz bands in Regions 1 and 3;
- 2 GHz IMT-2000/FPLMTS;
- 2.4, 2.6 GHz multipoint distribution systems (MDS) and point-to-multipoint systems;
- parts of 3.4 - 3.7 GHz;
- 10.5 GHz point-to-multipoint systems;
- 28/40 local multipoint communications/distribution systems (LMCS/LMDS).

**Attachment: Document 8A/TEMP/48**

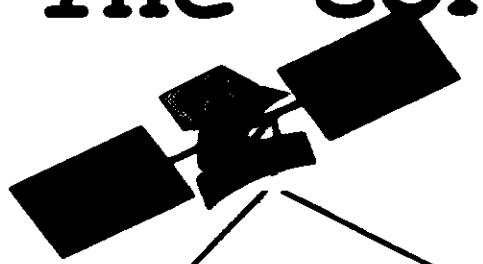

UK
FR
IT
Europe
Middle East
Libya
Mauritania
Mali
Chad
Cent Afr Rep
USA
Congo
Zaire
International Links:
More than 64Kbps
64Kbps
9.6Kbps
Full Internet Shortly
Dialup/email hosts

UNITED NATIONS EDUCATIONAL, SCIENTIFIC AND CULTURAL ORGANIZATION
INTERNATIONAL ATOMIC ENERGY AGENCY
INTERNATIONAL CENTRE FOR THEORETICAL PHYSICS
I.C.T.P., P.O. BOX 586, 34100 TRIESTE, ITALY, CABLE: CENTRATOM TRIESTE




MAIN BUILDING STRADA COSTIERA,11 TEL. 2240111 TELEFAX 224163 TELEX 460392 ADRIATICO GUEST HOUSE VIA GRIGNANO,9 TEL. 224241 TELEFAX 224531 TELEX 460449
MICROPROCESSOR LAB. VIA BEIRUT,31 TEL. 2249911 TELEFAX 224463 TELEX 460392 GALILEO GUEST HOUSE VIA BEIRUT ,7 TEL. 22401 TELEFAX 224559 TELEX 460392

# COPINE: The concept

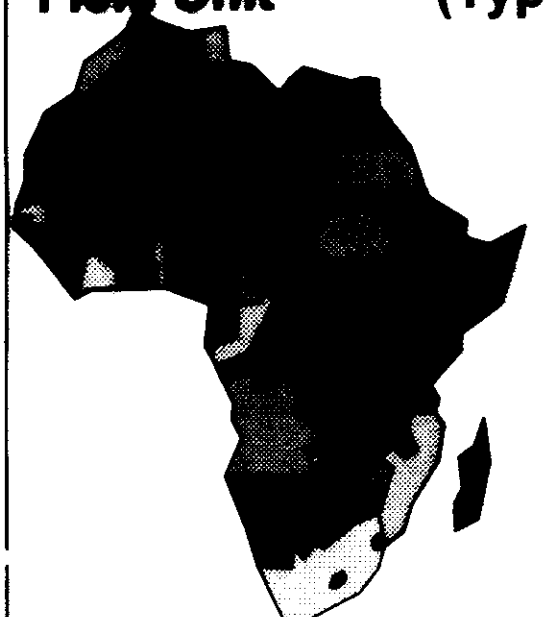


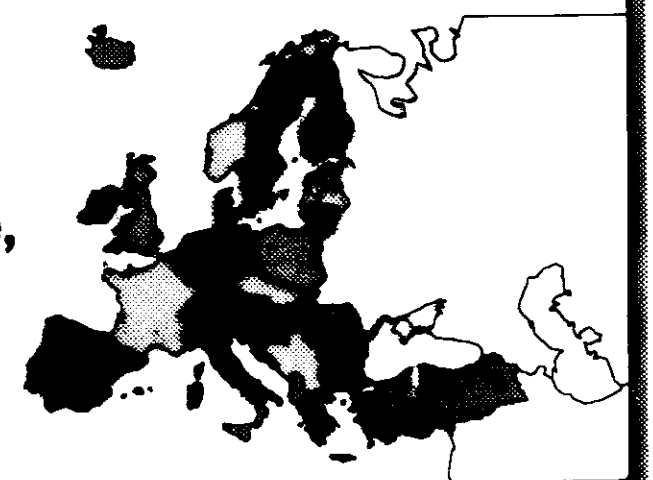
**5 European centres**

**International / National Centres - Type I station**

**12 African countries**

**National Centre (Type I station)**
**Field Unit (Type II station)**





**Data Transmissions**

- .Interactive audio, image, video and data
- .Large files ~ 100 Mb
- .Scanned documents
- .Voice

**OBJECTIVES**

- .capacity building for sustainable development
- .respond to immediate development needs
- .stimulate Euro-african industrial cooperation

**PRIORITIES**

- .Health care
- .Education
- .Natural resources and the environment
- .Science and technology

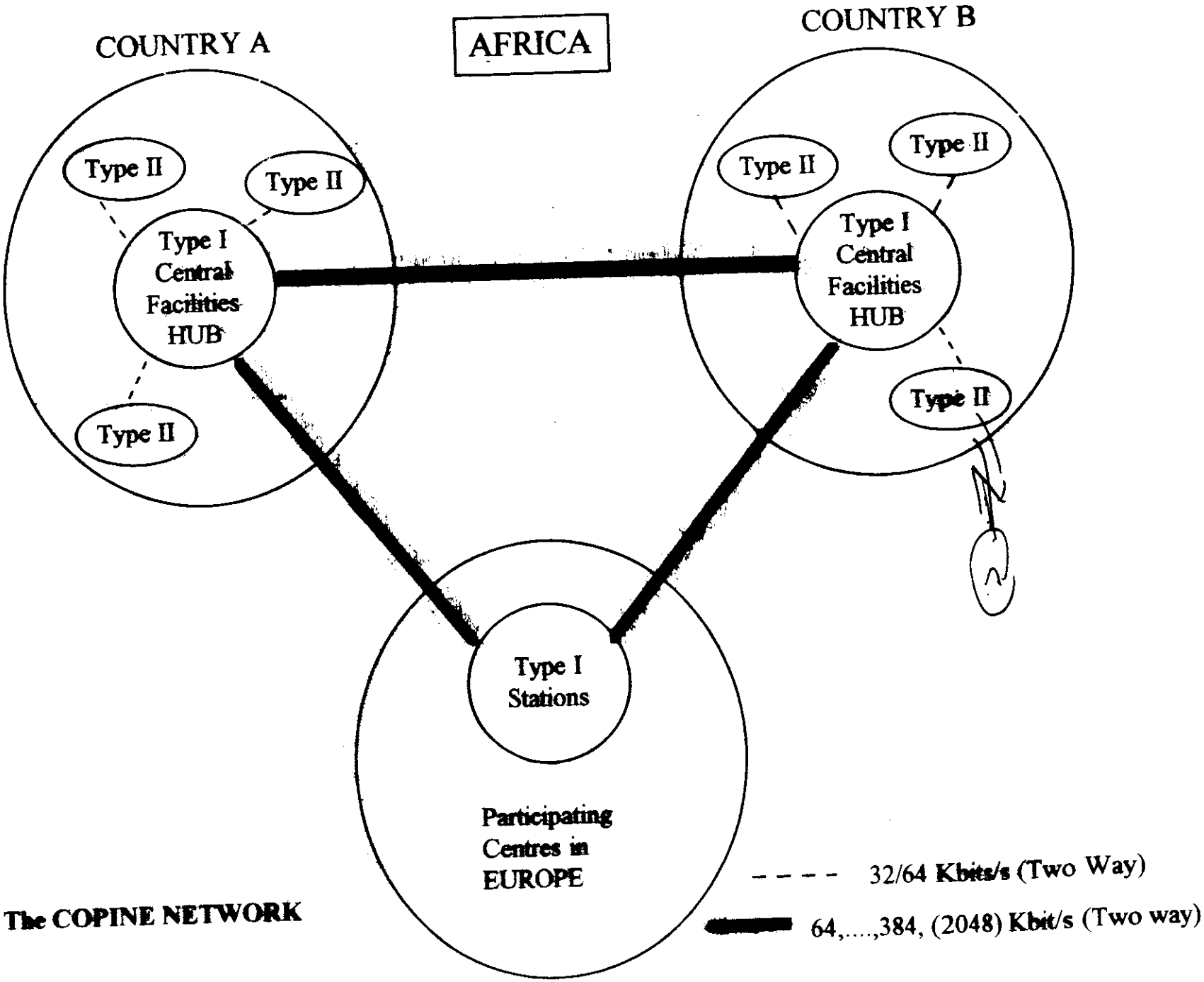
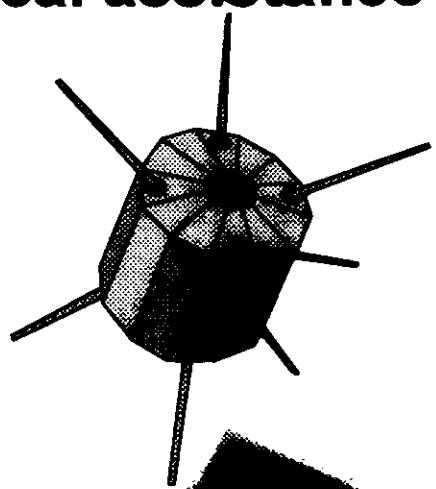



**Fig. 4 The COPINE NETWORK**

# APPLICATIONS

## Tele-education

* Distance education programmes
* Access to teaching materials
* "remote" technical assistance



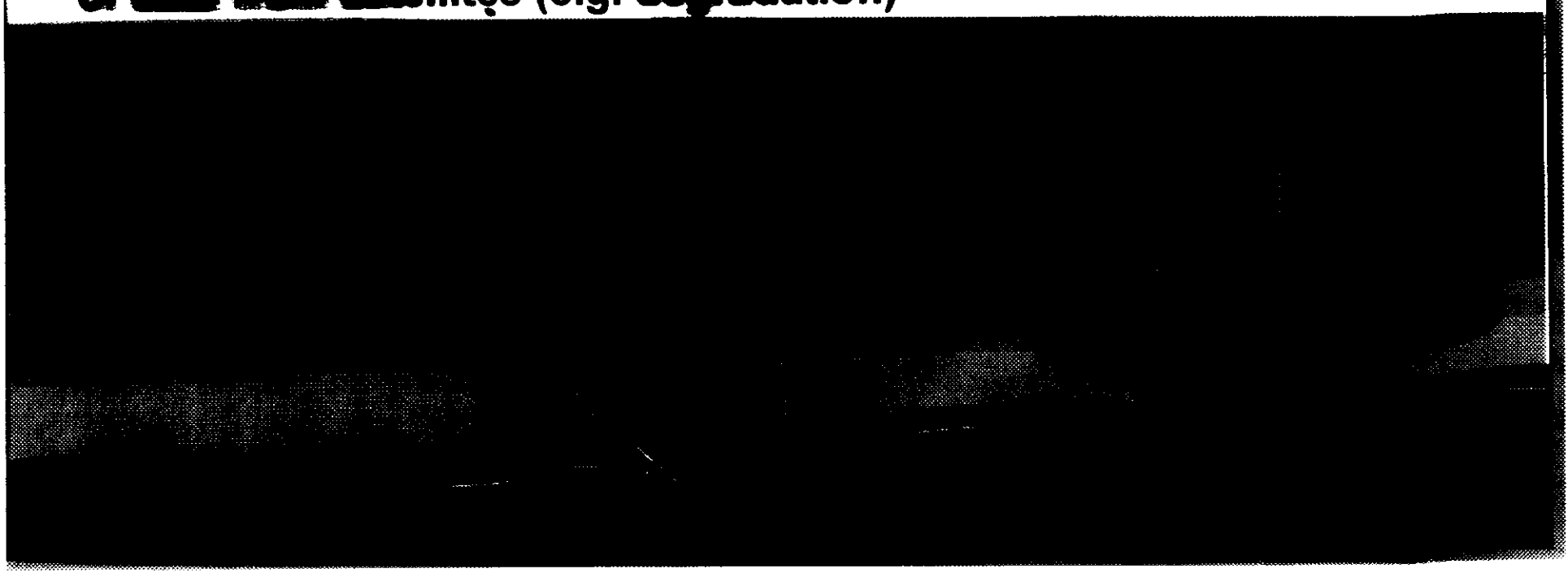
## Science and Technology

* Repatriation of data on African countries
* Access to research information
* Access to teaching materials
* Participation in collaborative research
* Stimulation of the development of a science and technology culture

# APPLICATIONS

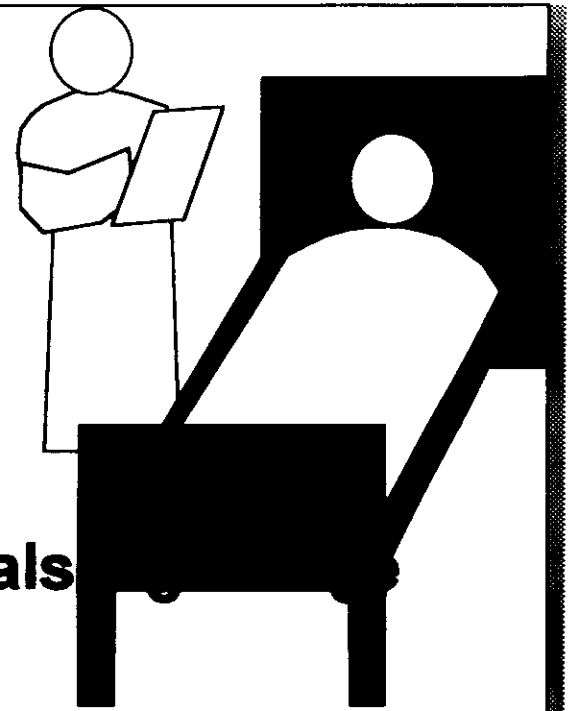
## Agriculture - Natural Resources and the Environment

* Food security (e.g. crop yield forecasts: agricultural production: pest control, famine early warning)
* Introduction of new technologies (e.g. biotechnology, genetic engineering)
* Environmental monitoring and assessment of natural resources (e.g. forests, soils, minerals, fisheries, wildlife..) with the aid of data from satellites (e.g. degradation)



# *APPLICATIONS*

## Tele-medicine



* Diagnosis and treatment
* Consultations among health professionals transmission: videoconferencing
* Access to global information sources on health issues
* Activities aimed at the prevention and control of disease
* Research (e.g. vaccines, drugs, diseases)
* Teaching

AJAYI '96