# INTERNATIONAL ATOMIC ENERGY AGENCY UNITED NATIONS EDUCATIONAL, SCIENTIFIC AND CULTURAL ORGANIZATION INTERNATIONAL CENTRE FOR THEORETICAL PHYSICS



I.C.T.P., P.O. BOX 586, 34100 TRIESTE, ITALY, CABLE: CENTRATOM TRIESTE

H4.SMR/841-15

FOURTH ICTP-URSI-ITU(BDT) COLLEGE ON RADIOPROPAGATION: Propagation, Informatics and Radiocommunication System Planning

30 January - 3 March 1995

Miramare - Trieste, Italy

Spectrum Management

R.G. Struzak International Telecommunications Union (ITU) Geneva, Switzerland

MAIN RITTERING STRAIG COMMING 11 TH 2740111T=.... 224142 T=... 460402 A.... G H V G O T 224241 T=.... 224521 T=... 46044



R. G. Struzak

SPCTMING2.PPT\*94

R.G. Struzek, Grand Raw, CH-1262 Eyeles, Switzerland

# An introduction to Spectrum Management

R. G. Struzak

### Topic

- ◆ Spectrum management an emerging discipline
  - vital for the future of radio
  - of growing importance for the society
- ◆ Synonyms:
  - Frequency allocation
  - Frequency management
  - Spectrum-orbit management

### Scope

- ◆ What is the spectrum
- ◆ How is it used
- ◆ How is it allocated and managed
- ♦ What International Organizations are involved
- ◆ What are the Radio Regulations
- What are current spectrum management problems

RESIDENCE FOR THE SECOND CONTRACT SECOND

# What is the Spectrum?

- Origin: A mathematical correspt
- Then: A measurable quantity
- Now: A resource
  - includes the Geostationary Satellite Orbit Market value: >> \$400G (1991)

### The spectrum: a mathematical concept

$$S(\omega) = \int_{-\infty}^{\infty} f(t)e^{-j\omega t}dt.$$

J.-B. Fourier (1768-1830)

The spectrum: a measurable quantity Spectrum analyzer First experiment: H. Hertz (1880)

### The spectrum a resource

- ◆ The spectrum is "...technology, industry, money, culture and power..." [J.D. Bedin]
- "... radio frequencies and Geostationary satellits orbit are limited natural resources. They must be used efficiently and economically ... so that countries ... may have equitable access to both..." [Int. Telecom. Conv. 1982]

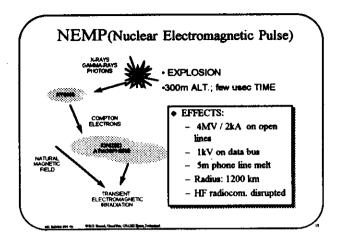
First applications: G. Marconi, A. Popov (1895)

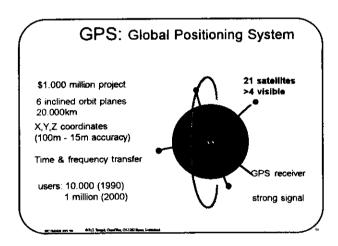
### Spectrum use

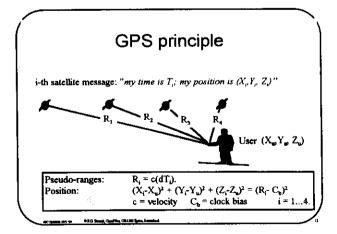
- ◆ Defense
- ◆ Public safety
- ◆ Disaster relief
- ◆ Location
- Navigation
- ◆ Communication
- ◆ Measurements
- ◆ Management
- Weather prediction
- Matter processing (ISM)
- ◆ Medicine, veterinary
- ◆ Earth & Universe exploration
- ◆ Education, culture
  - ◆ Mass media, entertainment

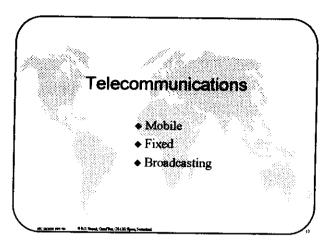
#### Defense

- ◆ C³ (Command, Control, Communication)
- ◆ Radar, Radio guidance
- ♦ Interception, Reconnaissance
- ◆ Desinformation
- Jamming
- Electronic weapons









### **Emergency communication**

- Catastrophes
- ◆ Disasters
  - Earthquakes, Volcanoes, Typhoons, Floods
- ◆ Medical & Veterinary aid
- Fire services
- ◆ Police
- ◆ Remote & rural areas

Mobile radio
Reasons for use

EPPICIENCY IMPROVEMENT

COST SAVING

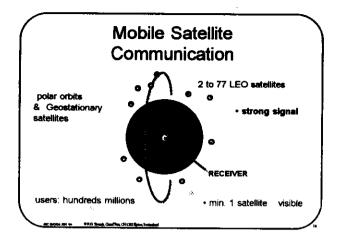
IMPROVED SECURITY

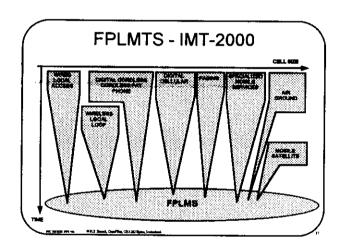
BETTER MANAGEMENT

PRESTIGE

0 20 40 50 80 100

>6x107 cordless & cellular phones





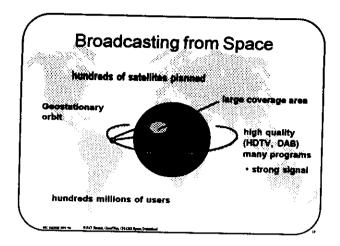
### **BROADCASTING: SOUND & TV**

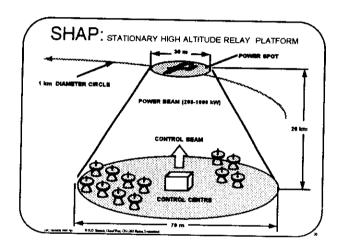
- Alarms, alerts
- Culture
- News
- Entertainment
- ◆ Information
- Publicity
- ◆ Education
- Propaganda

Vital for people in remote regions and for illiterate population (>2 billion people)

6x109 TV sets; much more AM/FM radios

C DESCRIPTION OF THE STREET, CHILDRING SPRING SPRINGS





# Industrial applications (1)

- ◆ Metallurgy
  - hardening, soldering, welding, melting, refining, ultrasonic cleaning, electro-crossion treatment
- ◆ Semiconductors: soldering melting, refining
- ◆ Wood & furniture: drying, gluing
- ◆ Building operations: concrete drying & crushing
- ◆ Power converters

# Industrial applications (2)

- ◆ Chemical processes: plasma heating
- ◆ Ceramic & glass production: drying, heating
- ◆ Mining operations: heating & crushing rock
- Food processing: drying, heating, sealing, insect deinfestation
- ◆ Paper, Rubber, Textile industries: drying
- ◆ Road maintenance: asphalt melting

# Scientific applications

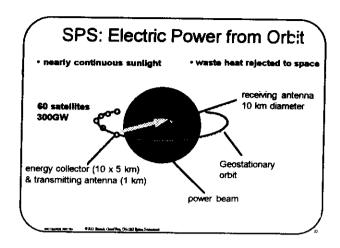
- ◆ Particle accelerators & separators
- ◆ Energy transfer experiments
- ◆ Thermonuclear fusion experiments

1. VERY LARGE ARRAY, D - 36KM
RES. + ARCSECOND (AT 6CM)

2. VLBI - continental distances
D + 10 000KM
RES. + MILLIARCSECOND (AT 6CM)

3. SPACE VLBI - ORBITAL STATIONS
D + 10 000 KM
RES. + MILLIARCSECOND

1 milliarcsecond: 7mm button at million km



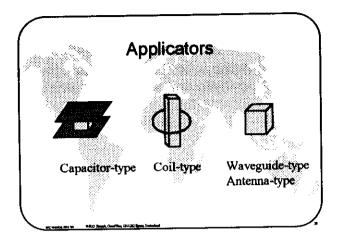
### Medical applications

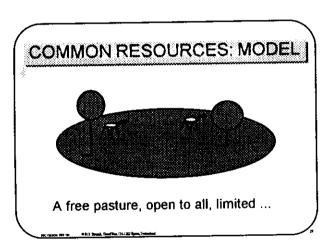
- ◆ Bone fracture treatment
- Cancer treatment: RF-induced hyperthermia
- Diathermy
- ◆ RF surgical apparata
- ◆ Nuclear resonance imaging

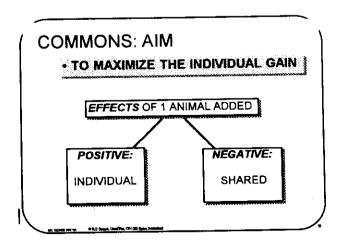
official control of the State Country (St. 120 Specifical State Country)

### Domestic applications

- ♦ Microwave ovens
- Intruder alarms
- ◆ Induction ovens
- RF-guided toys
- RF lightening
- Garage openers







**COMMONS: PROCESS** 

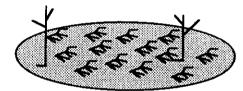


Each Herdsman adds 1 animal more...

...and more...

SCHOOLSE IN SEC. Sent Courts (USD Sent Court

COMMONS: RESULTS



"...Ruin is the destination toward all men rush, each pursuing his own best interest, in a society that believes in the freedom of the commons..."

18: Harris and the St. O Standy Const. Co. (1945 Species States

\_\_\_\_

COMMONS: HISTORY

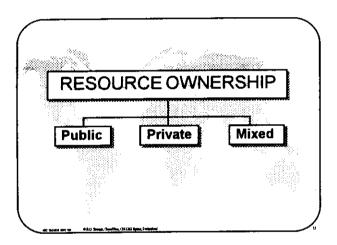
- Farmland & Pasture Areas
  - ownership concept
- Hunting & Fishing Areas

ORG. Speed, Control, CH12C Speed, Subpare

- · Land, Water, Air
  - pollution concept
- Environment
  - protection concept, national parks etc.

### **Similarities**

	Pasture	Spectrum
Open to All	Yes	Yes
Free of Charge	Yes	Yes
Limited	Yes	Yes
Max. Indiv. Gain	Yes	Yes



# ALLOCATION MODELS

- BY LOTTERY
- ACCORDING TO CRITERIA
- BY NEGOTIATIONS
- MIXED

### **ALLOCATION CRITERIA**

- . 'FIRST-COME, FIRST-SERVED'
- NEEDS, 'PUBLIC INTEREST'
- · MERITS
- · WEALTH (MARKET MECHANISM)
  - SUPPLY- DEMAND- PRICE
- · OTHER?

### Values & Goals

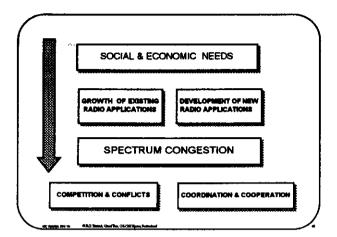
- Hierarchy of Values
  - The hierarchies of values and preferences of each individual are inconsistent...
- ◆ Preference of Goals
  - Different groups have different preferences which are partially in conflict with those of other groups...
- ◆ Tradition
- ◆ Dominance

Brooks

#### **TRENDS**

- ◆ Dominant model of "quality of life"
- ◆ Social pressure for better "quality of life"
- ◆ Multinational businesses, open market
- Liberalization, privatization, deregulation
- Global competition
- ◆ Continuation of technological development
- ◆ Concentration of capital, technology, power

THE SECOND PROPERTY OF SECOND CONTRACT CONTRACT SECOND SECOND



### Growth of radio

000000 x 0000x x0000000000	- 1 N			
of Athleses of	NUMBER	OROWTH*	DOUBLING PERIOD	
C. MOB. RADIO	5.5M	80%	1 YEAR	
SATELLITES	3600	24%	3 YEARS	
ISM APPLICAT.	120M	7%	10 YEARS	
			") PER ANNUM	

TELECOM MARKET: \$400G (1990)

### Resource scarcity

- ◆ Conflicts between
  - + those who have access to the resource and those who do not
  - + those who want to use the resource in incompatible way s
  - + those who manage the resource and those who request to use it
- ◆ Resource Management to solve the conflicts
- ◆ Resource Allocation a compromise balance between conflicting interests of competing groups

# DISPROPORTION

- ◆ Increasing gap between the "rich" and the "poor"
- 90% OF TV RECEIVERS
- -15% OF COUNTRIES
- 85% R&D EXPENDITURE 4% OF COUNTRIES
- 70% OF SCIENTISTS\*
- -4% OF COUNTRIES

\*and engineers

# PRIVATIZATION & LIBERALIZATION GLOBALIZATION OF ECONOMIC ACTIVITIES TECHNOLOGICAL PRIOVATIONS INCREASED USER REQUIREMENTS

# PROBLEMS - DEVELOPED COUNTRIES

- UNEMPLOYMENT
- OVERPRODUCTION
- ◆ SHORTAGE OF ENERGY & RESOURCES
- **◆ ENVIRONMENTAL POLLUTION**
- ◆ SOCIAL UNREST

### PROBLEMS - DEVELOPING COUNTRIES

- ◆ OVERPOPULATION
- ◆ SHORTAGE OF FOOD & WATER
- 'BRAIN-DRAIN'
- ◆ SHCRTAGE OF 'KNOW-HOW' & 'KNOW-WHY'
- ◆ SHORTAGE OF CAPITAL RESOURCES
- **◆ SOCIAL UNREST**

### Science

...By its very nature, science is well equipped for internationally coordinated efforts directed to the solution of common problems...

...Science is universal, independent of nationality, ideological convictions or political orientation, which makes joint efforts much easier than in any other field...

### International collaboration

- ◆ FIRST RADIO CONFERENCES
  - -BERLIN 1906
  - -LONDON 1912
  - -WASHINGTON 1927

# International coordination of spectrum use

- to avoid interference across borders
- ♦ to enable international operations
  - maritime, aeronautical, satellite
- ◆ to create large equipment markets

att notes on as PRO Seed Conflor (9420 See Seed)

# UN Agencies involved in spectrum/orbit issues

- -- ITU
- ICAO
- IMO
- WMO
- UNESCO

er noon ye 9 M.O Sent. Carthy, CH (AC Barr, Setting)

### International Organizations 1

involved in spectrum/orbit issues

- ♦ ABU
- ◆ APT
- **◆ ARABSAT**
- ◆ ASBU
- ASETA
- ◆ ATU

- ♦ BIH
- ◆ CEPT
- ◆ CIGRE
- ◆ CIRM · CISPR
- CITEL

International Organizations 2 involved in spectrum ortik lesues • GCC • COSPAR **◆ EBU**  GULFVISION • IAB • EC + ESA • IALA ◆ ETSI ◆ IARU ◆ EUTELSAT ◆ IATA

Notes

### International Organizations 3 involved in spectrum orbit issues

- IAU
- ♦ IBI
- . ICSU
- ◆ ŒC
- INMARSAT
- ◆ INTELSAT
- IUCAF

- NANBA
- ◆ OTI
- ◆ PATU
- ◆ SITA S
- ◆ UAPT
- ◆ URSI
- ◆ URTNA

ITU

- oldest specialized agency of UN (1865)
- over 180 member countries
- → ~\$100M budget
- ◆ ~800 staff in the headquarters
- ◆ languages: <u>EFS</u>CRA

### ITU: PURPOSES

- . ALLOCATION OF RF SPECTRUM ON A GLOBAL SCALE
- COORDINATION OF THE USE MADE OF THE SPECTRUM
- REGISTRATION OF FREQUENCY & ORBITAL POSITION ASSIGNMENTS
- COOPERATION & TECHNICAL ASSISTANCE TO DEVELOPING COUNTRIES, STANDARDIZATION, etc.

ACT THE STATE OF T

Plenipotentiary Conferences

World Conferences Council Telecommunications

General Secretariat

Radiocommunication Standadrization Sector

Development Sector

TTU Radiocommunication
Sector

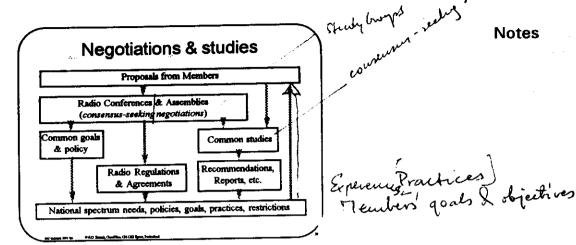
World/Regional
Radiocommunication
Conferences

Radio Regulations Board

Director

Advisory Group

Radiocommunication Bureau

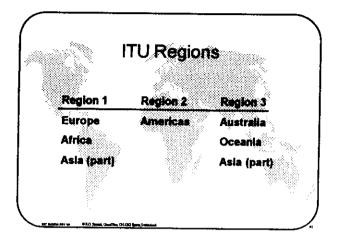


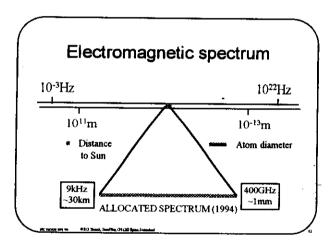
# International Radio Regulations

- international treaty
- specifies provisions (~2000) determining the use of radio frequencies and radio equipment
- ◆ contains international Table of Frequency Allocations (9 kHz - 400 GHz)

### Other provisions of RR

- rules for operation of radio stations
- procedures (>40) for frequency coordination
- ◆ provisions (>2000) for radio services (>40)
- frequency plans for assignments or allotments
- ♦ 3 Volumes, semand



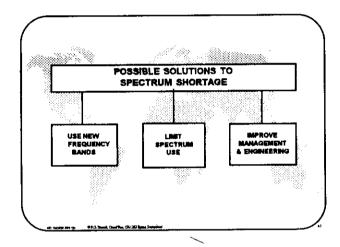


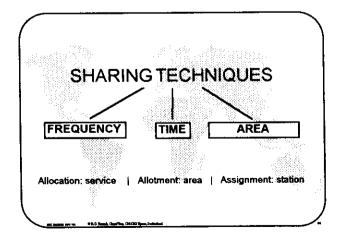
# **Spectrum Resource**

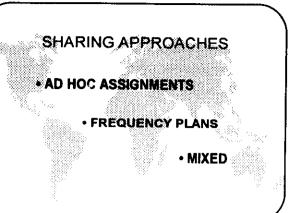
- Public, Free of Charge
- International Allocation, Regulation & Control
- Equitable Access

# Spectrum use principles

- Coordination
- Consultation
- Negotiation
- Compromise
- Consensus







### "Ad hoc" assignments

Advantages	Disadvantages
efficient resource use	"latecomers" problem
dynamic	πot "optimal"
responsive to	constraints on later
technological progress	uses

### "Latecomers" problem

... Developing countries complain that the developed countries are sizing most of the available positions in the Geostationary orbit ...

... Countries that may want to set up their first national satellite systems in 10 or 20 years' time fear that there will be no room for them ...

Withers

### Frequency planning

Advantages	Disadvantages
equal status for all	exclusive allocation
can be "optimal"	"warehousing"
simple notification	"freezes" technology
	. <u></u>

### "Warehousing" problem

Each country has an incentive to overestimate its requirements, and there are a few accepted or objective criteria for evaluating each country stated need ...

... the individual country itself may have only the dimmest perception of its needs over the time period for which the plan is to be constructed ...

### National Spectrum Management

Policy, planning, allocation International cooperation Licensing, Assignment Equipment authorization Liaison, Consultation Standards, Specifications, Fees Enforcement, Control, Monitoring Education, Training

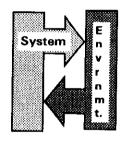
Support: legal, engineering, computer, administrative...

....

# SPECTRUM ENGINEERING

- Methods, models, data
  - Assessment of the resource
  - Evaluation of spectrum use
  - -- EMC analyses & predictions
  - Sharing
  - Monitoring

# EMC - Electromagnetic Compatibility



 ability (of a system or device) to function satisfactorily in its EM environment without causing intolerable disturbance to that environment.

IEC

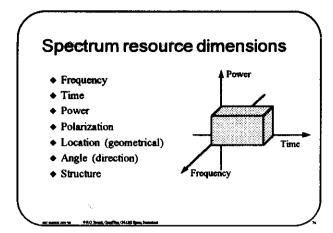
# Spectrum Used = Spectrum denied

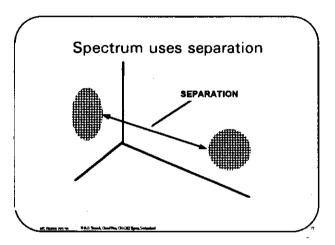
**Transmitters** deny the spectrum to receivers. **Receivers** deny the spectrum to transmitters.

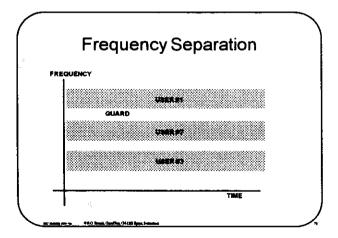
#### **DENIAL**

- **•ADMINISTRATIVE**
- •PHYSICAL

© 1994 R.G. Struzak, Grand'Rue, CH-1262 Eysins, Switzerland. All rights reserved





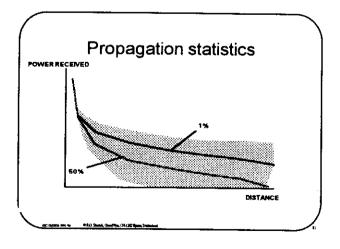


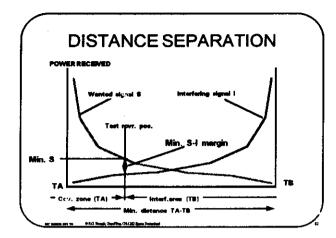
$$TL_0 = 20\log\left(\frac{4\pi d}{\lambda}\right) \frac{1}{2\pi}$$
 distance wavelength

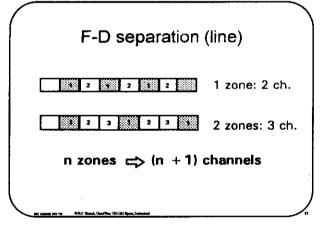
CONTRACT PRODUCTION CHIEFLY SALES

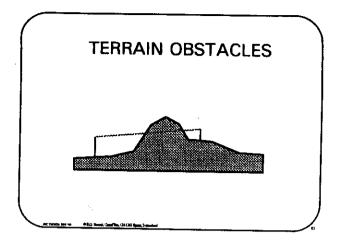
### Excess transmission loss

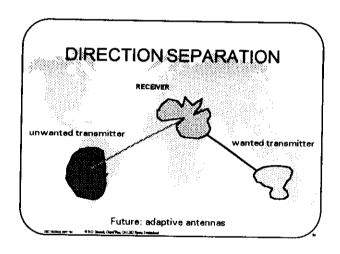
PIC TRANSPERSON - OR O Should, Complete, CR4 (\$50 \$500), Submission

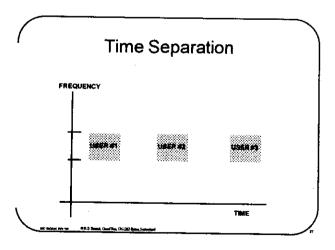


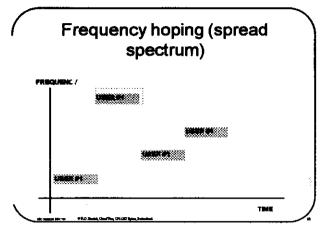


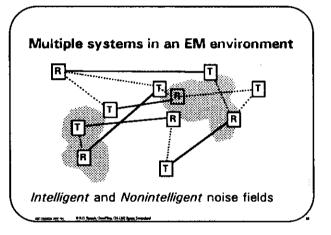








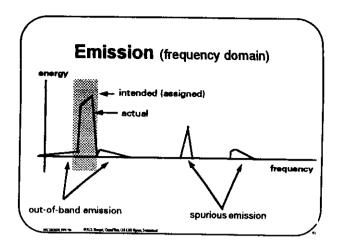


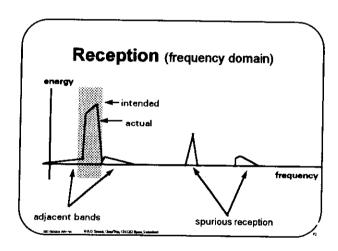


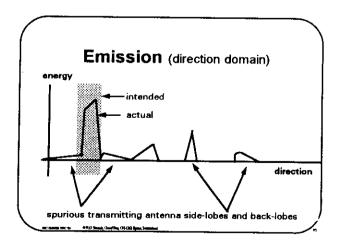
### EM pollution (RFI, EMI)

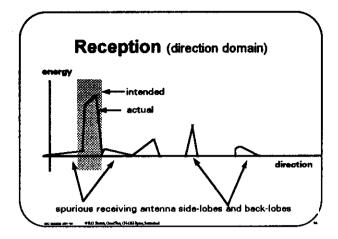
- ◆ Natural radiation
  - + Terrestrial (atmospheric, precipitation, static)
  - + Extra-terrestrial (solar, stellar, cosmic)
- ◆ Man-made radiation
  - + Communication (transmitters, receivers)
  - ₄ ISM
  - + Power (generation, conversion, transmission, distribution)
  - + Varia (vehicles, traction, tools, toys, computers, ...)

HIC DESIGN HAVE BEEN SHOOK, CHARTING CHICAD Spins, Solombia









### Engineering problems

- · LARGE NUMBER OF STATIONS
- COMPLEX INTERACTIONS
- REAL-LIFE PROBLEMS INTRACTABLE?

ME BARRO SHI NE 980 Sheet Out Reg (H124 Speed Secondary

### The future

- Progressive spectrum congestion
- More problems
  - + political, organizational, legal, technical, scientific
- ◆ Increased role of cooperation
  - objectives: individual ar common?
  - sovereignty?
- ◆ Increased role of Spectrum Management

### Summary

- ◆ The spectrum is a strategic and scarce resource vital for the society.
- The demand for the spectrum is increasing and cannot be fully satisfied with the present technology and management system.
- ◆ The use of spectrum requires improvements in cooperation, coordination, and management on a local, regional, and international scales.

Notes

### Where to get more information

- ♦ Books
  - Spectrum Management & Engineering (Matos), IEEE Press
  - EMC in Radio Engineering (Rotkiewicz), Elsevier
- ◆ Publications of the ITU, ICAO, IMO, EBU, ...
- ◆ Journals: IEEE Transactions (EMC, Comm, VT, ...)
- ◆ Regular Seminars (ICTP, ITU, USA...)
- ◆ Regular Symposia URSI & IEEE
  - EMC Symposia: IEEE, Wroclaw, Zurich...

	UN Agencies	
ITU	International Telecommunication Union	Place des Nations, CH-1211, Geneve 20
ICAO	International Civil Aviation Organization	Place de l'Aviation Internationale, 1000 rue Sherbrooke Ouest, Montreal, Quebec, H3A 2R2, Canada
IMO	International Maritime Organization	4, Albert Embankment, GB- London, SE1 7SR
WMO	World Meteorological Organization	41, avenue Giuseppe-Motta, CH-1211 Geneve 20
	Other International	
	Organizations	
ABU	Asia-Pacific Broadcasting Union	POB 1164, Kuala Lumpur 22-07, Malaysia
APT	Asia-Pacific Telecommunity	Soi 5, Chaengwattana Road, Thungsonghong, Bangkhen, Bangkok 10210, Thailand
ARABSAT	Arab Satellite Communications Organization	POB 1038, Riyadh, Saudi Arabia
ASBU	Arab States Broadcasting Union	17, rue El-Mansoura, BP 65 El Menzach, El Menzach IV, Tunis 1914, Tunisia
ASETA	Associat, of State Telecom. Undertakings of the Andean Sub-Regional Agreement	Ave. Coruna, 2669, y Gonzàlez Suàrez, Casilla Postale 6042, Quito, Ecuador
ATU	Arab Telecommunication Union	POB 28015, Baghdad, Iraq
BIH	International Time Bureau	61, avenue de l'Obsevatoire, F-75014 Paris
CEPT	Conference of the European Administrations of Posts and Telecommunications	
CIGRE	International Conference on Large High Voltage Electric Systems	122, boulevard Haussmann, F-75008 Paris
CIRM	International Maritime Radio Association	Southbank House, Black Prince Road, GB- London SE1 7SJ
CISPR	International Special Committee on Radio Interference	3, rue de Varembé, CH-1211 Geneva 20
CITEL	Inter-American Telecommunications Conference	1889 F Street, N.W. OAS, Washington, DC 20006, USA
COSPAR	Committee on Space Research	51, boulevard de Montmorency, F-75016, Paris
EBU	European Broadcasting Union	Ancienne Route 17A, BP 67, CH-1218 Grand Saconnex, Geneva
ESA	European Space Agency	8-10 rue Mario Nikis, F-75738 Paris
ETSI	European Telecommunications Standards Institute	Route des Lucioles, F-06921, Sophia Antipolis
EU CEC	European Union - Commission of the European Communities	Brussels
EUTELSAT	European Telecommunications Satellite Organization	Tour Maine-Montparnasse, 33, avenue du Maine, F-75755 Paris Cedex 15
GCC	Gulf Cooperation Council for Arab Countries	POB 26831, Manama, Bahrain
GULFVISION		POB 6802, Riyadh, Saudi Arabia
IAB	International Association of Broadcasting	Calle Yi No. 1264, Montevideo, Uruguay
IALA	International Association of Lighthouse Authorities	13, rue Yvon-Villarceau, F-75116 Paris
IARU	International Amateur Radio Union	225 Main Street, POB AAA, Newington,

## List of International organizations involved in spectrum use issues

		C
TATEA		Connecticut 06111, USA
IATA	International Air Transport	IATA Building, 2000 Peel Street, Montreal,
	Association	Quebec H3A 2R4 Canada
IAU	International Astronomical Union	61, avenue de l'Observatoire, F-75014, Paris
IBI	Intergovernmental Bureau for Informatics	POB 10253, 23, viale Civiltà del Lavoro, I- 00144 Roma
ICSU	International Council of Scientific Unions	51, boulevard Mario Nikis, F-75015 Paris
IEC	International Electrotechnical Commission	3, rue de Varembé, CH-1211 Geneva 20
INMARSAT	International Maritime Satellite Organization	40, Melton Street, GB-London NW1 2EQ
INTELSAT	International Telecommunications	3400, International Drive, N.W.,
	Satellite Organization	Washington, DC 20008-3098, USA
IUCAF	Inter-Union Commission on	c/o Dr. A.R. Thompson, National Radio
	Frequency Allocations for Radio	Astronomy Observatory, Edgement Road,
	Astronomy and Space Science	Charlottesville, Virginia 22903, USA
NANBA	North American National	1500, Bronson Ave., Ottawa, Ontario KIG
	Broadcasters Association	3J5, Canada
OTI	Ibero-American Television Organization	Varsovia 44, 4 piso, Mexico 6, D.F., Mexico
PATU	Panafrican Telecommunication Union	BP 8634, Kinshasa, Zaire
SITA	International Society for	112, avenue Charles-de-Gaulle, F-92522
	Aeronautical Telecommunications	Nauilly-sur-Seine
UAPT	African Postal and	Avenue Patrice Lumumba, BP 44.
	Telecommunications union	Brazzaville, Congo
URSI	International Union of Radio	c/o Universiteit Gent (LEA), St
	Science	Pietersnieuwstraat 41, B-9000 Gent Belgique
URTNA	Union of National Radio and	Centre technique, BP 39, Bamako, Mali
	Television Organizations of Africa	, samuro, mai



# Simulation model for evaluating interference threat to radiocommunication systems\*



by R. G. STRUZAK

#### ABSTRACT

This article describes an interactive microcomputer simulation model which is intended to serve as an engineering tool for the analysis of man-made interference threat to a radiocommunication system. Simulation technique is used to imitate experiments with the system, environment and their interaction. Various modifications can be simulated and their effects on the system performance analysed. Input data are supplied by the user, and the computer produces pictures, maps and statistics, describing the interference threat. The model allows for experiments with directive antennas, multiple man-made interference sources randomly located in three-dimensional space and with various propagation mechanisms. The areas occupied by the interference sources and victim receivers can be separate or coincide, totally or partially. Assumptions, limitations, algorithms, performance criteria and application examples are presented.

## 1. Introduction

HIS article describes an interactive microcomputer simulation model developed to analyse electromagnetic compatibility (EMC) problems. EMC is the ability of a system to function satisfactorily in its electromagnetic environment without introducing intolerable disturbance to that environment. In this article, we discuss the interference threat to radiocommunication systems due to man-made interference environment. Limiting of man-made interference is vital to many applications and services, and has been included in the programmes of several national, regional and world-wide organizations. These organizations include, among others, the International Telecommunication Union [ITU, 1989], the International Electrotechnical Commission (IEC), the International Radio Consultative Committee [CCIR, 1986], the International Special Committee on Radio Interference [CISPR, 1987] and the European Economic Community [EEC, 1989]. Interference-free operation of communication systems is becoming more and more difficult to ensure, due to

<sup>\*</sup> The opinions expressed in this article are the author's personal views, and do not necessarily reflect those of the CCIR or the ITU. The model described above is still evolving, as the experience drawn from its use increases. The current version works with personal computers type IBM PCAT or compatible. Copies of the simulation software are available through the ITU Telecom Information Exchange Service (TIES) under the directory "RS3".

the growing number of users of the radio-frequency spectrum and growing competition between them [Rotkiewicz, 1982]. The problem of undesired RF radiation from industrial, scientific and medical (ISM) equipment is an example [Struzak, 1985]. In spite of the intentions of 160 or so Member countries of the ITU [ITU, WARC-79], and in spite of many years of efforts [CISPR, 1987], widely acceptable recommendations on ISM radiation limits have not been reached [CCIR, 1986].

Recommendations relating to EMC are usually a compromise between two parties representing opposite interests. Evaluating the interference threat is one of the key problems in finding a compromise. When one party claims to overestimate, and another one to underestimate the interference threat, the only reasonable way is to refer to experimental evidence. As the experimental data available is incomplete, special measuring campaigns would be needed for that purpose. Such campaigns would be too expensive and would require too much time. In seeking a more practical solution, a simulation approach was proposed [Struzak, 1984]. Numerical simulation has become a powerful tool in various applications supplementing traditional mathematical analyses and "real-world" experiments (see, for example [Shannon, 1975]). A simulated experiment is less expensive and avoids all risks of the "real world". It is easier to prepare, to perform, to control and to repeat. It can modify the time scale, if the "real" experiment runs too quickly or too slowly. Processes which normally require months or years to develop can be accelerated to run in minutes. Another important characteristic of numerical simulation is its ability to examine systems which are intractable to experimental manipulation and too complex for exact mathematical treatment. Examining new systems which exist only in conceptual forms, testing hypotheses, or examining postulated modifications to existing systems, are examples of such applications. The first simulations were limited to large computers. Now, microcomputers have as much computing capability as mainframes of only a few years ago, and the technique is becoming more popular. In spite of this trend, the literature on simulation of EMC problems is scarce. The bibliography by Dudewicz [Dudewicz and Karian, 1985] contains about 500 papers on simulation and lists more than 80 application areas, but disregards the EMC issues. Simulation of certain EMC problems is addressed by Lee [Lee and Smith, 1983], Koester [Koester et al., 1986] and Cook [Cook, 1987]. All of them use large computers. Microcomputer models are proposed by Struzak [Struzak, 1984] and Weinberg [Weinberg and Wilson, 1986] to study ISM interference. These models, however, are limited to two-dimensional space, omnidirectional antennas and simplistic propagation mechanisms. The objective of this work was to examine the feasibility of microcomputer simulation of EMC problems involving threedimensional space, directive antennas, more elaborate propagation mechanisms and random influences.

The rest of the article is organized as follows. The input data and general algorithm are presented in section 2. Major assumptions, limitations and device models are discussed in section 3. Section 4 deals with the output of the simulation. Computational aspects are treated in section 5, and application examples in section 6. Comments on future work are given in section 7, and concluding remarks in section 8.

## 2. General algorithm

The aim of the simulation is to imitate modifications to various parameters of the radiocommunication system, its environment, or both, and to predict the effects of these modifications on system performance. The simulation process involves input data, simulation software, simulation hardware and output data. The input data is transformed into the output data in accordance with the algorithms included in the software. The general algorithm of simulation consists of three major steps illustrated by figure 1. The first step is to determine that which is to be simulated. The input data is applied to define the fixed parameters of the model and the boundaries for its pseudo-random variables, and to determine the EMC criteria and simulation scope. The input data is listed in figure 2 [CISPR, 1987]. They are read from default files or supplied by the user, and have to be selected from populations that might occur in an actual situation. The second step is the simulation of system-environment interaction, and evaluating the performance of individual transmitter-receiver links of the system. Figure 3 illustrates the algorithm applied. Here, concepts of simulation scenes and test points are used. A simulation scene represents a specific configuration of the transmitter, receivers and interference sources (figure 4 shows an example). The test points are the points at which the receivers might be installed. Simulation scenes are generated and the performance of transmitter-receiver links analysed. For that purpose, the relevant input data is applied to the computer programs which contain models of the devices and processes involved. The models are discussed in section 3. Each transmitter-receiver link is examined separately, and the expected values of the signal level and noise margin are computed. These raw simulation results are compared with the EMC criteria. The third and last simulation step is the determination of the system performance and evaluation of the interference threat. On the basis of the examination of the individual communication links, various global measures of the system performance are computed, as discussed in section 4. All phases of the simulation process are displayed on a control panel on the screen. The panel contains several windows, each of them representing a set of data (figure 5).

## Deterministic or probabilistic simulation

The model can be used for deterministic and probabilistic simulation. In the deterministic simulation, the values of all variables can be predicted with precision and in the probabilistic simulation, some of the variables are random and only the boundaries within which they are confined can be determined. Flipping a coin is a good example. Although laws of physics to predict its position (given the initial velocity, spin, etc.) are well known, it is practically impossible to determine in advance whether the coin lands on heads or tails. The probabilistic simulation (known also as the Monte Carlo simulation) amounts to a repetition of simulated trials and a collection of statistics representing global results. In the deterministic simulation, a simulation scene is generated and analysed once for all. There is no reason to repeat deterministic experiments because each of them gives, in principle, the same results. When random input components are present, however, the system performance is subject to statistical dispersion, and each trial may give a different result. In order to obtain results which are statistically significant, the simulation experiment has to be repeated. Simulation scenes are sequentially generated, each time with a new set of random components, and the system performance is determined and treated as a "sample" of statistical data. Section 5 gives more details on repeated trials.

#### 3. Assumptions, limitations, device models

In computer modelling, all assumptions, variables, and relationships must be described by numbers, with an accuracy commensurate with the accuracy required of the results. Even external influences, left out in real-world experiments, have to be defined precisely. The assumptions, on which our model is based, are discussed below, together with the model limitations.

## Radio communication system

Simulated in the computer, it consists of one transmitting and one or more receiving stations. If two or more wanted transmitters are involved, as for example in hyperbolic navigational systems, each of them has to be treated separately. If there is more than one receiving station, all are of the same type. A narrow-frequency band is taken into account. It means that a separate model has to be created to simulate each spurious or non-linear response of the receivers. The distribution of the wanted signal is defined by the transmitting antenna and propagation model. Reflected signals are disregarded.

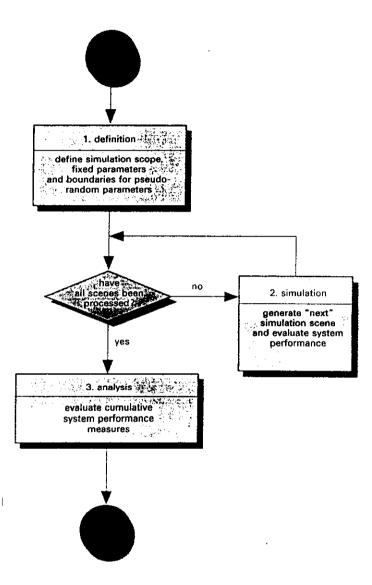


Figure 1-General algorithm of simulation experiments (simplified)

#### Antennas

The transmitting and receiving antennas can be isotropic or directional; adaptive antennas are not included. Receiving antennas are situated at test points and, if they are directional, they are pointed towards the transmitter. An antenna model represents the directive radiation pattern of the original antenna in consistency with the objectives of the simulation.

#### input data

parameters defining communication system

reference level of wanted signal transmitting antenna pattern' receiving antenna pattern\* receiver noise level\*

> parameters defining interference environment

number of RFI sources deployment of RFI sources in 3D space\* RFI source radiation level\* RFI source screening/attenuation\* external background noise level\*

> parameters defining propagation process

propagation loss of wanted signal\* propagation loss of unwanted signals\*

parameters defining EMC criteria

minimum acceptable level of wanted signal minimum acceptable signal-noise margin

parameters defining test domain

position of test area in 3D space dimensions of test area number of test points

parameters marked by \* involve pseudo-random components imitating natural variability, random spread and measuring uncertainty

Figure 2-Input parameters of the simulation model

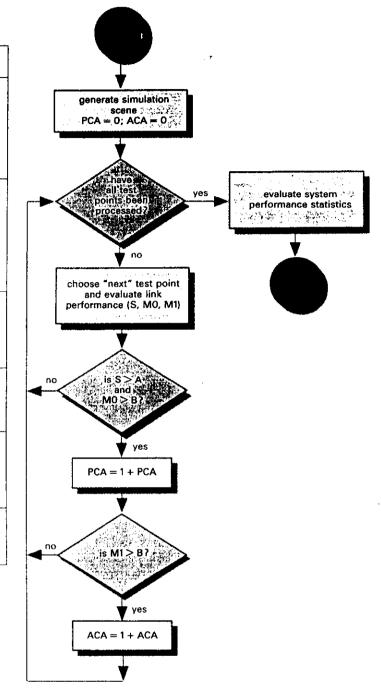
In our case, two models are provided: one for the transmitting antenna and another for the receiving antenna. The models are in the form:

antenna gain = (antenna gain in the azimuth plane

+ antenna gain in the elevation plane

+ random component) [dB]

The gains are relative to the maximum gain. The gain in the azimuth plane and in the elevation plane are mutually independent. Examples are shown in figure 5.



= minimum acceptable signal level

ACA = actual coverage area size

= minimum acceptable noise margin

M0 = background-noise margin

= resultant-noise margin PCA = potential coverage area size

= signal level

Figure 3-System performance evaluation algorithm (simplified)

## Interference environment

This environment, simulated in the computer, consists of two components. The first is the background environmental noise and it is assumed to be independent of direction and distance. The second component is the noise from unwanted manmade radio-frequency interference (RFI) sources and it depends on the distance from, and direction to, the sources. Only radiation phenomena are taken into account. The sources are randomly distributed in space and have random radiation patterns. The area occupied by them is in the form of a three-dimensional rectangular box (figure 4). It can be separate or coinciding, totally or partially, with the area occupied by the communication system. The RFI sources are of the point-type; distributed sources (e.g. power lines) are not included in the model. Radiation limits are usually defined as the level of unwanted signal at a reference distance from the source, and the simulation model accepts this definition. Local attenuation of radiation by buildings, or by additional screening structures, is taken into account. The distribution of interfering signals is determined by the propagation model. The interference sources are co-frequency with the transmitter. Off-channel interference can be simulated by introducing equivalent co-channel interference source(s). Frequencyhopping and intermittent sources are excluded. A narrow frequency band is taken into account. It means that a separate model has to be created to simulate each harmonic or spurious radiation.

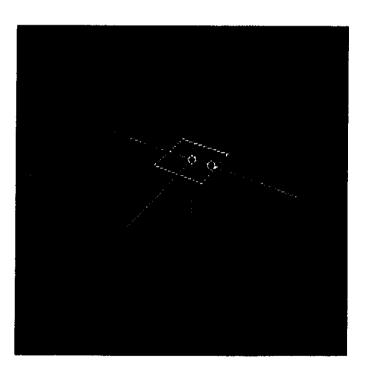
#### Propagation

A propagation model determines the level of wanted (or unwanted) signal which is exceeded (or not exceeded, respectively) at the receiving antenna during a given proportion of time. For instance, the level of the wanted signal may be required to be not less than A dB during 99.9% of time, and the level of undesired signal-not greater than B dB during 0.1% of time. Zero-gain antennas are assumed at both the transmitting and receiving stations. The software offers a class of models simulating different propagation mechanisms, from which the user selects a model which is the most appropriate for his application (see, for example [CCIR, 1986]). Propagation loss is assumed to be dependent on distance, but independent of the bearing to the radiation source. It means that actual terrain shadowing, reflections, and multipath propagation are disregarded. Two separate propagation models are provided, one for the wanted signal and another for the interfering signals. The models are in the form:

All variables are relative to a given reference level. An example is shown in figure 5.

## EMC criteria and link performance

It is assumed that the degradation of communication links is attributable to two elements: the first is the internal (receiver) noise and the second is the external noise and unwanted signals. The signal level and the noise level serve as the measure of performance of each individual transmitter-receiver link. They are computed using formulas listed in figure 6. The computations involve models of antennas and propagation processes, and require determination of distances and direction angles between the receivers and radiation sources (figure 7). "Signal" is the wanted signal, and the resultant noise includes



red point = transmitter position
blue point = reference point
green lines = co-ordinate axes
yellow lines = test area borders
red lines = interference source area borders

Figure 4-Simulation scene as shown on the computer display. Red point: transmitter position; blue point: reference point. The system performance is determined at a number of test points distributed over the test area. The size and position of the test area is defined by the user



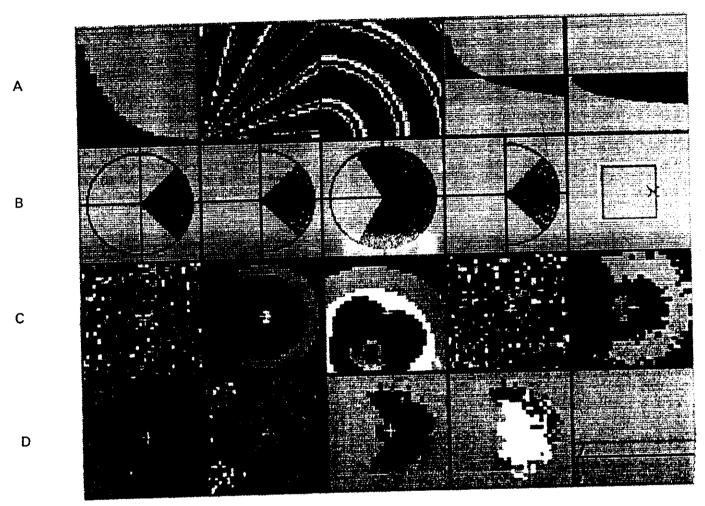


Figure 5-Control panel displaying various phases of simulation experiment on the computer screen. The windows represent th following data (letters indicate the rows and numbers indicate columns):

Al: signal correction factor; A2: direction angles; A3: distances; A4: wanted signal propagation; A5: unwanted signa propagation

B1: receiving antenna pattern (azimuth); B2: receiving antenna pattern (elevation); B3: transmitting antenna pattern (azimuth B4: transmitting antenna pattern (elevation); B5: test area and view of interfering source area

C1: noise map; C2: wanted signal map; C3: interfering signal map (current); C4: interfering signal map (cumulative); C5: no. margin map (background)

D1: noise margin map (resultant); D2: wanted-unwanted signal margin map; D3: coverage map (potential); D4: coverage m (actual); D5: coverage loss index (current, cumulative, maximum and minimum values)

the internal and external noise (background noise) and all undesired signals. The effect of multiple interference signals and noise is calculated by means of the power sum method. This seems to be a reasonable approach to continuous disturbances; discontinuous ones may require another approximation. The noise causes a degradation of the link performance and, in some cases, can lead to a disruption of the normal operation of the link. "Normal", in this context, refers to "satisfying given technical and operational requirements". The criterion of the "normal" operation built in the model requires that both the wanted signal level and the noise margin are greater than their respective minimum acceptable values. The noise margin is the difference between the levels of the wanted signal level and resultant noise. It is also called "protection margin", "signal/noise ratio", etc. (in some systems, the noise temperature concept is used; such systems can be simulated, if the temperature is "translated" into an equivalent noise margin). Numerical values of the minimum signal and minimum noise margin are set up by the user, depending on the application, signal processing method, error correction, etc. [CCIR, 1986].

## Noise and random components

Random components, like the receiver noise and environmental noise, are modelled using a standard random number generator. It produces pseudo-random numbers, uniformly distributed.

## Test domain

The performance of the radiocommunication system depends on the performance of its transmitter-receiver links. With mobile systems, as for instance in aeronautical communications, all expected locations of transmitting and receiving stations must be taken into account. In the simulation model, these locations coincide with the test points. Such an approach may require a great number of computations. A quick order of magnitude analysis illustrates this point. The test domain should be large enough to embrace a significant part of the system and its behaviour in time. On the other hand, the resolution of the model has to be fine enough to capture the smallest scales that are relevant. The number of test points, with a regular time-space grid, yields

$$N_{4D} = \left(\frac{D_{\text{máx}}}{D_{\text{min}}}\right)^4 \tag{3}$$

where  $N_{4D}$  is the number of nodes of the grid.  $D_{\rm max}$  and  $D_{\rm min}$  denote the length scales associated with the largest and smallest distances in space or in time, respectively. If  $D_{\rm max}$  is 100 times greater than  $D_{\rm min}$ , then there are  $10^8$  test points. At each of them, all relevant signals have to be evaluated. With

output data: link performance measures data on signal received data on noise margin  $MO = 20 \log \left[ \frac{S}{\sqrt{NR^2 + NB^2}} \right]$  $M1 = 20 \log \left[ \frac{S}{\sqrt{NR^2 + NB^2 + \sum_{i} I_i^2}} \right]$ = 1, 2, 3, ..., NIS = unwanted signal from i-th RFI source [V] = signal I, at the reference distance [V] LA = local screening/attenuation factor M0 = background-noise margin [dB] M1 = resultant-noise margin [dB] NB = background-noise [V] NR = receiver noise [V] NIS = number of RFI sources PA = propagation attenuation factor RA = receiver antenna discrimination factor = wanted signal [V] = signal S at the reference point [V] = transmitter antenna discrimination factor

Figure 6-Output simulation data (raw): definition of performance measures of individual radiocommunication link

 $10^2$  RFI sources, there are  $10^8 \times 10^2 = 10^{10}$  signals to evaluate. Even with 0.1 ms per signal, this would require  $10^6$  s, or about 300 h, of computing time. To keep the simulation time within practical limits, we exclude the time variable and restrict the test domain to a plane. The plane can, however, be fixed at different positions, which is equivalent to a series of cuts through the volume of interest. Thus, a possibility exists to explore the system performance in three dimensions (figure 4). The number of test points,  $N_{2D}$ , amounts now to:

$$N_{2D} = \left(\frac{D_{\text{max}}}{D_{\text{min}}}\right)^2 \tag{4}$$

The data of the previous example would give 104 test points and 100 s of computing time. With the time variable not involved explicitly, the simulation model is valid for a short instant of time. During that time, neither the system, nor the environment, nor their interaction, can change significantly. The test points are now distributed over a test plane, which may be inadequate for those systems for which the curvature of the Earth is relevant (e.g. satellite systems).

## 4. System performance measures

During the simulation process, the system performance is examined at each test point. With a large number of test points, this produces huge collections of numerical data. The analysis of such collections surpasses the possibility of human perception and, as an aid, we use maps. Colour maps of the test area provide a visual display of the variable values and status of communication links at all test points. There are several kinds of maps produced: signal maps, noise maps, noise-margin maps, and coverage maps, which give information about the operation conditions of communication links. Examples are shown in figure 5 (see also figures 11 to 13). Such a pictorial representation of abstract concepts helps to identify interference structures which may be too complex to conceptualize otherwise. Moreover, some statistical indices are provided which characterize the overall situation by a few numbers only (figure 8). Basic statistics and interference statistics are provided to quantify the degree of interference threat; we will discuss them below. In addition to the maps and statistics, histograms of distributions of variables are provided (figure 9).

## Coverage area and coverage loss

At any given time, each communication link may be in one of two possible states: "normal operation" or "unacceptable operation". The coverage area is defined as the set of test points under "normal operation". In reality, we refer to the actual coverage area which is defined with the actual interference environment. However, we also introduce here the concept of the ideal, or potential coverage area which is determined with an ideal environment. The ideal environment consist of the background noise only: all RFI sources are inactive or removed. Note that it is unrealistic to expect that all existing RFI sources can be really switched-off or removed, but the concept is useful for reference purposes. The actual coverage area is usually less than the potential coverage area, and the difference, or coverage loss, indicates the degree of interference threat. In order to quantify this threat, the potential and actual coverage areas are compared one with another

distance and direction from point 
$$P_2$$
 to point  $P_1$ 

distance =  $\sqrt{(x_1 - x_2)^2 + (y_1 - y_2)^2 + (z_1 - z_2)^2}$ 

azimuth angle =  $\arctan\left[\frac{y_1 - y_2}{x_1 - x_2}\right]$ 

elevation angle =  $\arctan\left[\frac{z_1 - z_2}{\sqrt{(x_1 - x_2)^2 + (y_1 - y_2)^2}}\right]$ 
 $x_1, y_1, z_1, x_2, y_2, z_2$  are co-ordinates of the points

Figure 7-Distance and direction (vector) from point P2 to point P1

point-by-point, and each test point is marked "0" or "1". The "0" means "no harmful interference", the "1" means "unacceptable interference". The characteristics "1" and "0" are qualitative in nature and follow the binomial distribution. The requirement of exact representation of the coverage areas calls for a large sample, i.e. a large number of test points. With too small a sample, the results are statistically insignificant. With too large a sample, the simulation time is too long. Some aspects of the sample size are discussed in section 5.

#### Coverage loss index

It represents the expected likelihood that a receiver, operating normally without RFI sources, will suffer unacceptable interference after the RFI sources are activated. Its definition is given in figure 8. It involves the relative difference between the actual and potential coverage areas of the system [Anderson, 1976]. This index has a straightforward interpretation. In addition to the loss in the geographical coverage area, it represents the relative loss in the population served, if the population is distributed uniformly over the area of interest. In economic terms, it may be interpreted as the loss of capital due to radio interference. A simple reasoning leads to that conclusion. The total cost of the radiocommunication system is distributed among these radio links which work normally in the absence of RFI sources. When the RFI sources are active, the coverage loss index gives the proportion of the links which cannot continue to work normally. It is exactly the proportion of the total cost which cannot be used as intended. In the literature, rather than the coverage loss index, the interference complaint index and the probability of interference have been applied. They are discussed below.

### Interference complaint index

The CISPR uses a concept which we will call "interference complaint index" [CISPR, 1975]. It is the likelihood of unacceptable interference suffered by a receiver. It is defined as the number of interference complaints divided by the total number of receiver licences (figure 8). Under some conditions, it can be derived from the coverage loss index. If the number of receiver locations is the same as the number of licences, NRP = NRL, and if the number of receivers suffering interference coincides with the number of complaints, NRI = NIC, then both indices are equal (the equality is valid as well if these numbers remain in the same proportion). The coverage loss index involves uniform criteria and characteristics of the system, whereas the interference complaint index relates to a population of different receivers and subjective, case-by-case, EMC criteria. As a result, the two indices can only be approximatively equal.

## Probability of interference

The probability of interference is used by Weinberg [Weinberg and Wilson, 1986]. He takes into account all receivers, all RFI

sources, and all possible interactions between them. Under certain conditions, this probability can be derived from the coverage loss index. As is seen from figure 8, the probability of interference involves the number of receivers and the number of RFI sources, whereas the coverage loss index involves only receivers. Thus, if the same interference criteria are applied, the coverage loss index is NIS times greater than the probability of interference, where NIS is the number of interference sources.

## 5. Computational aspects

#### Test sample

The sample size, i.e. the number of test points, determines the uncertainty with which statistical performance measures of the system are estimated. Let the "population mean" of a variable relate to an unlimited set of all possible test points, and let the "sample mean" relate to a limited set of test points involved in the experiment (sample). Because of a limited

output data: system performance measures		
basic statistics	interference statistics	
$mean = \frac{\sum_{i=1}^{n} (x_i)}{n}$	coverage loss index = $\frac{NRI}{NRP}$	
$variance = \frac{\sum_{i=1}^{n} (mean - x_i)^2}{n}$	interference complaint index = $\frac{\text{NIC}}{\text{NRL}}$	
standard deviation = $\sqrt{\text{variance}}$	probability of interference = $\frac{NRI}{NRP \times NIS}$	
i=1, 2, 3,, n n= sample size $x_i=$ signal level, noise level, or noise margin at i-th test point	NIC = number of interference complaints NRI = number of receiver locations excluded from the potential coverage area due to RFI NRL = number of receiving stations licences NRP = size of the potential coverage area NIS = total number of RFI sources	

Figure 8-Output simulation data: definition of system performance statistics

sample, the population mean and the sample mean of the same variable may differ. The probability that they differ by no more than a quantity ERR (error) is subject to the following Tchebysheff's inequality [Burington and May, 1953]:

$$P\{(\text{mean} - \text{mean*}) < \text{ERR}\} > 1 - \frac{\left(\frac{\text{variance}}{\text{ERR}}\right)^2}{n}$$
 (5)

 $P\{x\}$  is the probability of event x, mean is the population mean, mean\* is the sample mean, variance is the population variance, and n is the sample size. By selecting a sufficiently large sample (n), the probability that the sample mean will fall within a small interval about the population mean can be made as near to unity as desired. If, for example, the maximum acceptable error equals 10% of the variance with a probability of 0.95 or greater, then the sample size should not be less than 2000 test points.

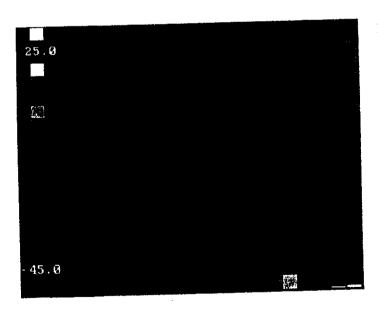


Figure 9—Histogram of noise margin over the test area as shown on the computer display. The colour scale on the left indicates the 5-dB value intervals, between -45 and 25 dB. The vertical bars indicate the percentage of test points at which the noise margin falls into the specific interval. The cumulative curve represents the percentage of test points having a noise margin less or equal to a specific value

#### Coverage area

The coverage area size imposes a limit on the coverage loss index. Let the total number of test points diminish, other conditions being constant. Then, the number of test points without interference, and the number of test points suffering interference, will change. As long as there are many test points, their ratio remains constant. With too small coverage area size, the model resolution imposes a limit. A example illustrates this point. Let the potential consist of 100 test points, and let one of the unacceptable interference. The coverage the number of test points is diminished by two cases possible: either the test point suffice a member of the new potential coverage as the first case, the coverage loss index is 1/99 as it equals zero. The limit imposed on the cover.

coverage loss index 
$$\geq \frac{1}{n}$$

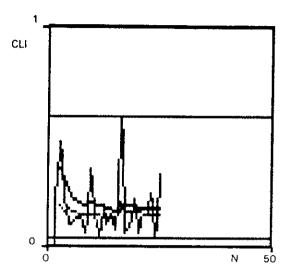
For example, if a low coverage loss index is of intsay  $10^{-3}$ , then the potential coverage area should con 1000 test points or more.

## Repeating tests

In the Monte Carlo simulations, the required number of runs can be determined at the beginning of the simulation experiment. However, the simulation model also accepts another approach: instead of taking a decision before the simulation experiment begins, a sequential analysis of cumulated data indicates when sufficient number of observations have been made. For that purpose, the cumulative mean and standard deviation of the coverage loss index is calculated after each run. After a sufficient number of runs, the mean differs from its asymptotic or "true" value by no more than a given quantity (formula (5)). This shows that further repetitions are superfluous. The cumulative mean is the final result of the repeated simulation experiment. The variance shows how the individual scenes are spread out from the mean. Figure 10 shows an example.

## Acceleration of computation

To keep simulation time short, two provisions are made: firstly, simulation variables are represented as integers, as much as possible and secondly, the number of repeated computations is kept to a minimum. The antenna and propagation models are stored in the computer memory and to use them, vectors joining the test points and radiation sources have to be determined (figure 7). With 100 sources and 1000 test points,



red horizontal line = maximum value observed (about 60%) blue horizontal line = mimimum value observed (about 3%) green line = values observed for individual simulation black line = cumulative mean value light-blue line = cumulative standard deviation

Figure 10-Coverage loss index versus the number of repetitions in a repeated experiment as shown on the computer display. Probablistic simulation, a single interference source, 1600 test points, 25 repetitions

there are 10<sup>5</sup> vectors. Instead of computing each vector from original formulas, we use precomputed tables. In order to determine the resultant level of the unwanted signal at the test points, we process the signals in pairs. The greater signal of the pair is selected and the difference between the signal levels is calculated. If the difference is greater than 30 dB, then the lower signal is disregarded, otherwise a correction factor is applied to the greater signal. The correction factor is computed only once.

## 6. Applications

The simulation model is "user friendly". It is "menu driven" and does not require any knowledge of programming languages. Its input data can easily be adapted to the user's needs and it is not restricted to any specific EMC problem, communication system, or radio interference source, except for limitations indicated in section 3. A typical application example is shown in figure 11. This figure presents results of experiments

which imitate actual measurements of signal level at the output of the receiving antennas. It takes only a few minutes to collect the results from thousands of test points distributed over a large area and to analyse them statistically. Based on such data, one can evaluate the interference threat without the necessity of a costly "real-world" measuring campaign (such a campaign, however, may be required to validate the model, or to verify the conclusions). An important feature of the simulation model is its flexibility in creating a variety of interference scenarios. This facilitates sensitivity analyses and helps to examine the effects of variation of the technical design decisions. It also allows for the generation of "if-then" data for such decisions. The results, even complex ones, are presented in graphical form, easy to understand. This makes the model a useful tool for didactic application and also for examining relative effectiveness of the various measures undertaken to reach EMC. The simulation model does not contain any optimization algorithm to generate explicitly a "best" solution with respect to predetermined criteria. Instead, such a solution can be approached experimentally, utilizing a step-by-

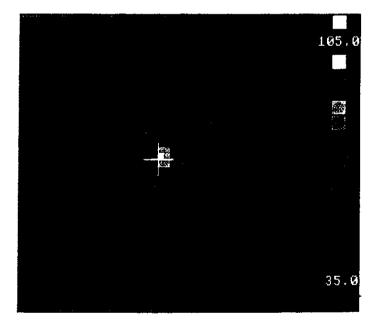
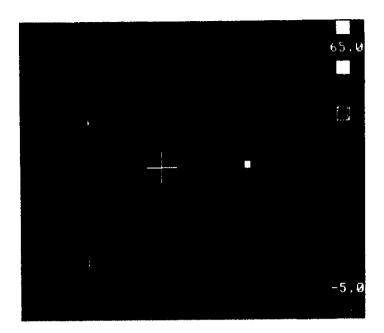


Figure 11-Map of the wanted signal level over the test area as shown on the computer display. The colour scale at the right side indicates the signal level in 5-dB steps. Areas where the signal level is below 35 dB are in black; areas with the level above 105 dB are in white. The transmitter position coincides with the white cross. Probabilistic simulation, a single interference source, 1600 test points, simulation time about 1 min



cations. Two examples illustrate this point: in figure 12 an interference-free area is visible in the form of the figure "8". What conditions must be met to generate such interferencefree areas? How to maximize them? Figure 13 shows interference regions on a coverage map. With a single source, a single interference region might be expected; the map, however, shows a few such regions, some of them far away from the source. In which circumstances do such "far" RFI regions appear? How to minimize them? A general answer is that these are the effects of the spatial distribution of the equipment, propagation processes, antenna radiation patterns, etc. A detailed analysis is beyond the scope of this article; however, such an analysis might offer new elements in discussions of EMC issues.

Figure 12-Map of the interfering signal level over the test area as shown on the computer screen. The colour scale at the right side indicates the signal level in 5-dB steps. Areas where the signal level is below -5 dB are in black; areas with the level above 65 dB are in white. The transmitter position is marked by "+"; the interference source position coincides with the white square. Note the interference-free region in the form of "8" between the transmitter and interference source. Probabilistic simulation, a single interference source, 1600 test points

step simulation and evaluation process. Iterative application of simulation and evaluation leads to a learning process regarding the impact of alternative solutions. When a compromise solution is sought to satisfy conflicting interests, the alternatives may be proposed by the various interest groups involved. This may be helpful in overcoming those difficulties in deriving the EMC recommendations which result from the lack of experimental data. Another characteristic of the model is that it introduces a number of variables permitting the examination of complex interference situations in more detail than previously possible. It is to be remembered, however, that the model cannot correct errors in the input data as some errors may even cumulate. In practical applications, simulation results have to be critically reviewed, with allowance for an uncertainty margin.

# = actual coverage area = area lost due to unacceptable interference

vellow red red + yellow = potential coverage area

## 7. Future work

Future work is planned to remove certain limitations of the model and to answer some new questions related to its appli-

Figure 13-Map of the coverage area as shown on the computer screen. The interference source position is indicated by the arrows. Probabilistic simulation, a single interference source, 1136 test points. The coverage loss index is about 20%

## 8. Concluding remarks

A new microcomputer model, imitating interactions between radiocommunication systems and the environment, has been described. The histograms, maps, and statistical indices produced by the model may help to evaluate interference effects on the system performance. The coverage loss index has been introduced to quantify the interference threat. The model is a new simulation tool, creating new opportunities. The essential characteristic of simulation is the use of models for experimentation. Having a simulation model of a real system or process, it is quite easy to after the various parameters of the model and observe how it operates with these changes. If the model and input data are correct, conclusions drawn from these observations are applicable to the original system or process. This characteristic makes simulation techniques promising as regards engineering and management applications. Both, good engineering and effective management, require an understanding of the system of concern and a means of studying the impact of the various alternatives possible. The simulation model fulfills these requirements.

### Acknoledgements

The first prototype of the simulation model described in this article was created when the author was with the Institute of Telecommunications, Wroclaw [Struzak, 1984]. At that time, he also served as the Chairman of CCIR Interim Working Party 1/4 on ISM radiation limits, and various versions of the simulation software were submitted for tests by the Members of the Working Party. Their co-operation is gratefully acknowledged, as is the encouragement of CCIR Director Mr R. C. Kirby. Comments of Messrs T. Dvorak, R. Showers and K. A. Hughes are greatly appreciated.

(Original language: English)

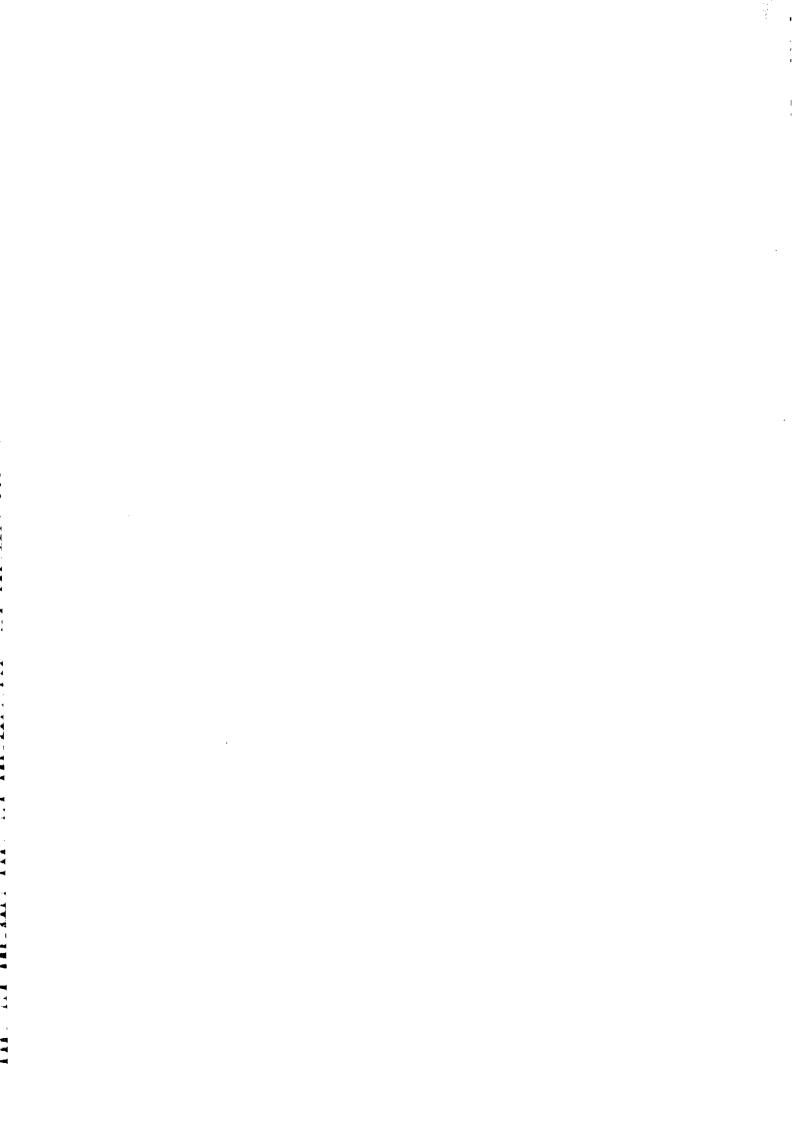
#### Bibliography

- Anderson D. P.: Service area lost due to interfering transmissions, *IEEE International Symposium on EMC* (Washington, DC, 13-15 July 1976), pages 53-58
- Burington R. S. and May D. C., Jr.: Handbook of probability and statistics with tables, Handbook Publishers (Sandusky, Ohio), 1953, page 152
- CCIR: XVIth Plenary Assembly (Dubrovnik, 1986), Vols. I (Spectrum utilization and monitoring), V (Propagation in non-ionized media) and VI (Propagation in ionized media)
- CISPR: Statistics of complaints and sources of interference, Publication 7B (1975)

- Ibid.: Determination of limits for industrial, scientific and medical equipment, Publication 23 (1987)
- Cook C. E.: Modelling interference effects for land-mobile and airmobile communications, *IEEE Transactions on Communications*, February 1987, Vol. COM-35, No. 2, pages 151-165
- EEC: Council Directive No. 336 of 3 May 1989 on the Approximation of the Laws of the Member States Relating to EMC, Official Journal of the European Communities (23 May 1989)
- Dudewicz E. J. and Karian Z. A.: Modern design and analysis of discrete-event computer simulations, IEEE Computer Society Press (1985)
- ITU: Constitution of the International Telecommunication Union (Nice, 1989), Article 30, Item 156
- Koester D. P., Smith L. E, Stevens R. R., Jr. and Cook C. E.: A computer model to evaluate airborne receiver performance in interference environments, *IEEE Transactions on Communications*, May 1986, Vol. COM-34, No. 5, pages 462-474
- Lee W. C. Y. and Smith H. L.: A computer simulation model for the evaluation of mobile radio systems in the military tactical environment, *IEEE Transactions on Vehicular Technology*, May 1983, Vol. VT-32, No. 2, pages 177-190
- Shannon R. E.: Systems simulation, Prentice Hall, Inc. (1975)
- Rotkiewicz W.: Electromagnetic compatibility in radio engineering, Elsevier Scientific Publishing Company (1982)
- Struzak R. G.: Computer simulation model proposed for use in studies of ISM radiation limits, CCIR Document IWP 1/4-71 (1984)
- Ibid.: Vestigial radiation from industrial, scientific, and medical radio-frequency equipment; in Nonlinear and environmental electromagnetics, edited by H. Kikuchi, Elsevier Science Publishers (1985)
- ITU, WARC-79: Resolution No. 63 relating to the protection of radiocommunication services against interference caused by radiation from industrial, scientific and medical (ISM) equipment
- Weinberg D. I. and Wilson T. L.: A model for predicting changes in the probability of television interference by industrial, scientific, and medical (ISM) equipment, *IEEE International Sym*posium on EMC (San Diego, CA, 16-18 September 1986), pages 313-321

### Author

Ryszard G. Struzak is the Head of the CCIR Department which deals with the spectrum management techniques, radio wave propagation, and space research Study Groups. He is also a Senior Counsellor to the CCIR Director. Earlier, he served as a Professor at the Technical University, Wroclaw, and as the Head of the Institute of Telecommunications, Wroclaw Branch. He was nominated Chairman of CCIR IWP 1/4 (1980-1985), elected Vice-Chairman of CCIR Study Group 1 (1974-1985) and elected Vice-Chairman of the International Union of Radio Science (URSI) Commission E (1984-1987). Mr Struzak is a Fellow of the Institute of Electrical and Electronics Engineers (IEEE).



# Microcomputer modelling, analysis and planning in terrestrial television broadcasting

Digital terrain maps, spectrum-related data banks and computer simulation help to examine the operation of existing television broadcasting networks and find a place for new stations

by R. G. STRUZAK\*

#### ABSTRACT

This article describes a simulation model of a national network of television broadcasting stations. The performance of a station depends on its siting and its antenna, on its radiated power and frequency, and on surrounding terrain and electromagnetic environment. All these factors can be analysed using the simulation model. Simulation can help in the maintenance of the existing television stations and in the planning of new stations by making "what-if" considerations fast, simple and effective. The simulation model has been developed as an engineering aid in planning the low-power rebroadcasting stations.

#### 1. Introduction

## 1.1 Background

Our society places increased demands on television. There are more television receivers in use throughout the world than there are telephones.[1] Broadcasting networks involve thousands of television transmitters. Without careful co-ordination. they would all dissolve in a chaos of mutual interference. High-power transmitting stations are coordinated at international conferences,[2] but many low-power television stations only require national co-ordination. Such stations, of less than 1 W and up to 1000 W, can operate unattended and are more and more popular. For only a fraction of the cost of high-power stations, they provide services complementary to the main broadcasting network, for

example, local information, local market advertisement, services for special interest groups, clubs, minority communities, ethnic groups and church communities. In the United States, a local broadcast station is seen as a basic cultural force in the community it serves.[3] Another application of lowpower stations is the delivery of television programmes to small communities in remote areas. Still another application is the filling of coverage gaps. Such gaps in the coverage by terrestrial and satellite transmitters are due to shadowing and

<sup>\*</sup> The opinions expressed in this article are the author's personal views, and do not necessarily reflect those of the International Radio Consultative Committee (CCIR) or the International Telecommunication Union (ITU).

reflections by terrain obstacles and man-made structures: although the signal can be delivered by cable, low-power rebroadcasting is often more practical. In spite of a spectacular growth of cable and satellite technology, terrestrial broadcasting remains the principal means for delivery of television to the home, and heavy investment in the equipment indicates that it will continue for a number of years to come. The number of low-power stations is growing fast both in large cities and in small localities in remote areas. According to the statistics of the European Broadcasting Union (EBU), about 95% of all television transmitting stations in Europe are low-power.[4] In Australia, about 80% of all television transmitting stations are translators.[5]

With the privatization of the broadcasting sector, a great demand for additional transmitters is to be expected. For example, some 6000 applications for such stations were registered in the United States during a period of one year.[6] However, to find space for a new station is not an easy task in regions with well-developed television broadcasting networks. Each application requires a detailed evaluation to ensure that the proposed station will neither suffer nor create interference. Often an existing station also requires an evaluation. A new transmitter, even distant, can modify signal environment, and man-made structures can modify the signal propagation conditions. Ultimately, any evaluation of a station, existing or planned, is based on field measurements. From these measurements, one determines the station coverage and identifies any coverage deficiency. The volume of such measurements increases with the number of transmitters and with the coverage area. In the measurements, test transmitters must often be used to generate a test signal.[7, 8] As such experiments are expensive, weather-dependent and time-consuming, one avoids them as much as possible, especially in inaccessible areas.

## 1.2 Development of automated tools

Automated tools have been developed to reduce the labour and cost of the field experiments.[9] Signal levels can be predicted instead of being measured, and computers can do the job, if supplied with propagation models and data. In order to have accurate predictions, propagation models involving detailed topographic data must be used.[10-12] Manual extraction of the data from

source maps for each propagation path is a time-consuming task that can be automated by converting these maps into computer-readable form.[13,14] The data of transmitting and receiving stations, however, must still be prepared and introduced manually. The ultimate step is, therefore, to integrate all relevant models and data into one system that can simulate the operation of the complete transmitter network.[15] This article discusses the implementation of such a simulation system.

Computer simulation can radically reduce the number of the required "real life" experiments and offer substantial gains in cost and in time. What is, however, even more important is that such an approach can help in an economic use of the radio-frequency spectrum, as more decision variants can be examined within the imposed time and cost limits. The essential characteristic of simulation is the use of models for experimentation. A simulated experiment is less expensive and avoids all risks and difficulties of the "real world". It is easier to prepare, to perform, to control, to modify and to repeat. Another important characteristic of the simulation is its ability to examine systems that exist only in conceptual form, or are intractable to experimental manipulation and exact mathematical treatment. Having a simulation model of a system, it is quite easy to alter the parameters of the model and observe how it operates with these changes. The conclusions drawn from these observations are applicable to the original system if the model and input data are correct.[16] The simulation can only give an estimate of the actual performance of the station, and an experimental verification in the field is usually required, but the volume of field measurements is minimized.

Underlying the software advances is the steady rise in hardware performance. The first automatic systems required large computers and highly qualified professional staff. The high hardware cost and complex user's interface limited their application to a few moneyed centres. The progress in computer technology has opened new perspectives. As recently as 1970, nearly 100% of the world's computer power was concentrated in large computers. By 1990, such machines held less than 1% of the world's computer power. Personal microcomputers, available at everyone's desk, became as powerful as an early 1970s mainframe, for a fraction of its price. As a consequence, the interest in microcomputer-aided spectrum engineering has

been fast growing.[17] The demand for microcomputer software is great, but only a few minicomputer spectrum engineering systems have been described in the literature [18, 19], possibly because firstly, frequency-spectrum engineering tasks are computing-intensive and involve huge collections of data (until recently, they exceeded the capabilities of microcomputers), and secondly. the spectrum-engineering software market is limited.[20] These factors do not encourage software developers.

## 1.3 Organization of the article

The rest of the text is organized as follows: section 2 describes the databases, among which, in particular, are digital terrain maps. The following section describes how the model can be used to analyse the performance of an existing television network, for example to identify the coverage gaps. Section 4 discusses the planning process of a new television station and its harmonization with the existing television network and topographic envi-

ronment. Section 5 discusses the overall performance and limitations of the model and gives results of its verification. Section 6 contains concluding remarks. The presented system was demonstrated at serninars of the International Frequency Registration Board (IFRB).[21] It is a new, simplified version of the software developed earlier for a large computer and described in reference [14].

### 2. The databases

The main aim of the simulation model is to imitate a network of television broadcasting stations. Another objective is to facilitate the storage. retrieval, and analysis of the information that is needed to evaluate the operation of the stations. The model integrates several elements, discussed below and shown in figure 1. It incorporates data banks, radio-wave propagation algorithms and electromagnetic compatibility (EMC) criteria. These are based, as much as possible, on the CCIR texts.

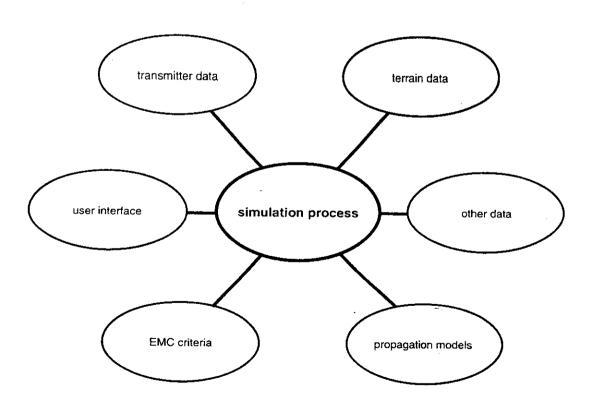
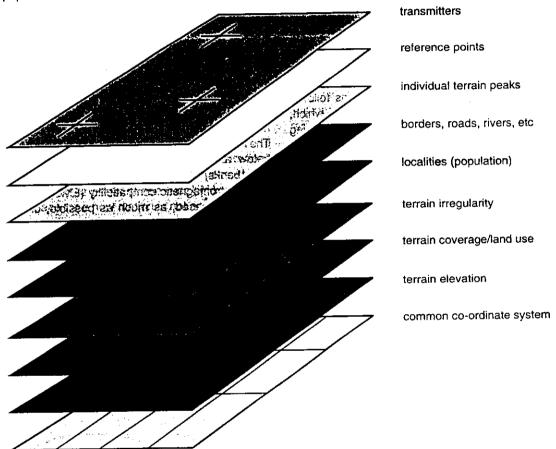


Figure 1-Simulation model (simplified diagram)

## 2.1 Geographical database

Numerous geography-related data are necessary to evaluate the effects of VHF/UHF signal propagation. In addition to the terrain relief, information is required about administrative boundaries, population distribution, roads, power line networks,

etc. Usually, that information is extracted from various sources. Since no common standards exist, rarely the same scale, projection and co-ordinate systems are used. The data must be made mutually consistent and converted to a digital form before they can be used in a computer system. All geography-related data are thus referred to the Earth



	cell size / resolution
dividual terrain points	50 m
es (roads, borders, etc.)	100 m
rrain elevation	250 × 250 m
rrain coverage/land use	250 × 250 m
rrain irregularity	25 × 25 km

Figure 2-Geography-related data use common co-ordinate system. Data from maps in various scales can be automatically adjusted and superimposed

Table 1 Approximate resolution of various maps

map scale	surface resolution* (m)	height resolution** (m)
1:1 000 000	1 000	20
1:500 000	500	10
1:250 000	250	4
1:100 000	100 .	2
1:50 000	50	1
1:25 000	25	0.5
1:10 000	10	0.25

<sup>\*</sup> The surface resolution is defined here as the distance (in terrain) between two points spaced by 1 mm on a given map.

ellipsoid, independently of the projection system adopted in the source maps, and the points on the Earth surface are identified by their geographic coordinates (figure 2).

## 2.1.1 Data representation

The way the geographic data are stored in a computer depends on the required accuracy and available computer memory. Table 1 compares the approximate resolution of various maps. A 1:50 000 map offers about 50 m of the surface resolution and about 1 m of the height resolution. Usually, such a precision is quite sufficient for planning UHF/VHF television broadcasting.

There are two methods of computer representation of geographic data. The first one uses regularly spaced discrete data, and the other irregularly spaced data, with interpolation betweeen the discrete data points. In our simulation model we use both methods. Such a combination results in the increased accuracy of terrain representation and economic use of the computer memory.

## · Regularly spaced data

The basic topographic data are the terrain elevations at regularly spaced points with implicit co-ordinates. Each point represents a terrain cell, in

the form of a square. The location of an individual point is not specified but is calculated using its row number, column number and cell size. The data are stored in the matrix form. The regular structure assures a quick access to the data by its address derived from the geographical co-ordinates. The cell size must be small enough to reflect the terrain details with required accuracy. According to our experience, in hilly and undulated regions, the maximum cell size is about 250 m. In flat areas. larger cells of about 500 m give practically the same elevation accuracy. On the other hand, the smaller the cell size, the greater is the number of cells for a given territory. Table 2 shows the approximate relationship between the cell size and cell number. For example, a territory of 1000 x 1000 km needs 4 million 500-m cells, or 400 million 50-m cells. In our simulation model, various scales of map and cell sizes can be used. The capability of automatically combining different map scales is one of the most important features of the system.

Table 3 compares cell sizes of digital terrain maps used in various countries. Many of these maps have been created for the purposes of the mobile radiocommunication service in the VHF/ UHF frequency bands.[22, 23] Digital maps with cell size of the order of 20 m are now in preparation in several countries.

Table 2 Cell size and cell number for an area of 1000 × 1000 km

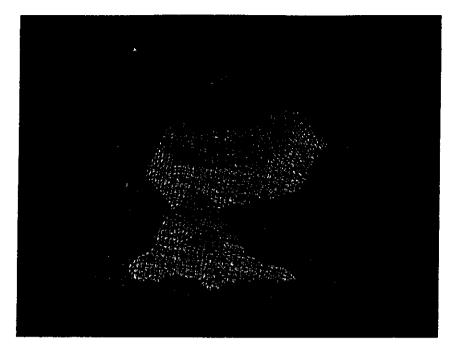
cell size (linear) (m)	cell size (angular)*	number of cells
1 000	32.3"	1 million
500	16.2″	4 million
250	8.08″	16 million
100	3.23″	100 million
50	1.62″	400 million
25	0.81″	1.6 billion
10	0.32″	10 billion
1	0.03"	1000 billion

<sup>\*</sup> On the Equator (arc seconds).

<sup>\*\*</sup> The height resolution is defined here as one-tenth of the basic height-contour interval on a given map.

Table 3 Cell size of various digital maps

country	cell size (m)	notes ,	
Canada	-500	Whitteker J. H.: Propagation prediction from a topographic data base, IEEE International Communications Conference-ICC '83 (Boston, Massachusetts, 19-23 June 1983), Vol. 1, pages 44-48	
Czech and Siovak Federal Republic	-100	Bak P.: private communication (1991)	
Finland	~200	Karjalainen J.: private communication (1991)	
France	-100	Meyer S. and Pihan J.: Coverage prediction for rural telephony systems, IEEE International Communications Conference-ICC '83 (Boston, Massachusetts, 19-23 June 1983), Vol. 1, pages 72-76	
Germany	-100	Loew K. and Lorenz R. W.: Determination of service areas for mobile communication with a topographical data base, <i>IEEE Internationa Communications Conference-ICC '83 (Boston, Massachusetts, 19-23 June 1983)</i> , Vol. 1, pages 54-58	
Ireland	1000	See reference [4]	
Italy	-2301	<sup>1</sup> See reference [ <sup>19</sup> ]	
	~400 <sup>2</sup>	<sup>2</sup> Freni A., Giuli D. and Fossi M.: Simulation models for meteorologica radar siting, <i>Alta Frequenza</i> , 1989, Vol. LVIII, No. 4, pages 419-426	
Japan	~5001	<sup>1</sup> See reference [ <sup>9</sup> ]	
	~250²	<sup>2</sup> Niimi H., Hirabayasi T. and Kajiyama M.: Computer aided analysis o propagation characteristics using topographical mesh-data basis, IEEI International Communications Conference—ICC '83 (Boston, Massa chusetts, 19-23 June 1983), Vol. 1, pages 49-53	
Netherlands	~100	Mawira A. and Stortelder B.: The development of propagation models and CAD tools for the planning of mobile communication networks, Alta Frequenza, February/March 1988, Vol. LVII, No. 2, pages 83-88	
Poland	~10001	<sup>1</sup> Since the 1950s. See Struzak R. G.: Radio frequency spectrum management, <i>Telecommunication Journal</i> , July 1981, Vol. 48, No. VI pages 410-413	
	~250²	<sup>2</sup> Since 1975	
South Africa	400¹ 200²	In rural flat areas, Koffernan A.: private communication     In urban areas and mountainous terrain	
Sweden	-50	Wieweg L: private communication (1992)	
Switzerland	250	Kartachoff P.: private communication (1991)	
United Kingdom	500	Ibrahim M. F. A., Parsons J. D. and Dadson C. E.: Signal strength prediction in urban areas using a topographical and environmental data base, IEEE International Communications Conference—ICC '83 (Boston Massachusetts, 19-23 June 1983), Vol. 1, pages 64-67	
United States	100	Spies K. P. and Paulson S. J.: TOPOG: a computerized worldwide terrain elevation data base generation and retrieval system, NTIA-Report 81-61 (1981)	
Yugoslavia	-100	Starcevic D.: Production of digital model of topographic map for radio communication planning, <i>Proceedings of the Fifth International Wroclaw Symposium on Electromagnetic Compatibility–EMC 80 (17-19 September 1980)</i> , Part 2, pages 477-485	



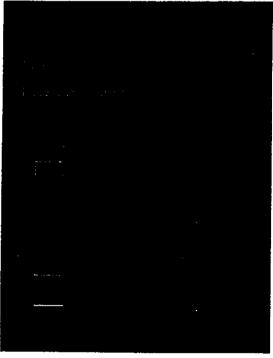
#### Irregulariy spaced data

In addition to the data just described, our digital terrain model also contains irregularly spaced data with explicit co-ordinates. These are terrain elevations at specific points that are important for the radio wave propagation, like mountain peaks or passes. In hilly regions, the number of such points reaches up to a few percent of the regular lattice

Figures 3A and 3B show fragments of the topographic data bank.



Figure 3A-Terrain elevation data bank: pseudo-threedimensional visualization. A fragment of the terrain surface displayed on the screen. Terrain elevations at line intersections are stored in the computer memory. False colours and visual perspective are added to create a realistic appearance of the terrain. The scale of the picture and position of the observation point can be modified. Such a representation can be used for error detection in the database, as errors tend to give rise to unnatural-looking features



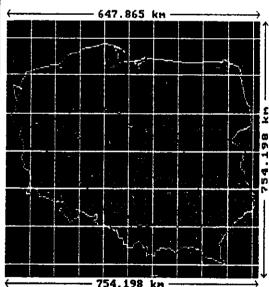


Figure 3B-Terrain elevation data bank: two-dimensional visualization

Right window: physical map of the country derived from the topographic data bank, as displayed on the screen. A colour scale is used to differentiate terrain elevation classes, the scale can be modified. The horizontal and vertical lines on the map are the meridians and parallels. The country borders, main rivers and major cities are visible

Left window: each pixel on the map represents an area of 5 x 5 km, derived from a digital working map with a resolution of 1 km. The source digital map has the resolution of 50/50 m

## Terrain irregularity data

For fast propagation predictions in accordance with the relevant CCIR Recommendation, [24] there is a map of terrain irregularity factor  $\Delta h$  provided in digital form. The country is divided into geographic rectangles of approximately  $25 \times 28$  km, and 12 numbers are stored for each rectangle. These are the  $\Delta h$  values at 12 azimuths taken every 30°.

#### Other data

Associated with each cell is the information about the terrain coverage within the cell. The coverage is ranked in eight categories that include forests, built-up areas of various intensity, open area, sea, etc. Other information stored deals with the administrative borders, roads, contours of cities and localities, power lines, etc. These were coded by digitizing the co-ordinates of selected points along each line.

#### 2.1.2 Data organization

The total area of the country has been divided into 60 "pages" or geographic rectangles of 1° latitude  $\times$  1° longitude. Each page of the digitized map is kept in a separate file, identified by the geographic co-ordinates of the south-west corner. Within the file, data are organized as a matrix [c, r] where column index c = 0...287 and row index r = 0...443 for the smallest cells. Digital maps with larger cells are also possible. These are represented by smaller matrices:

Each element of the matrix is 16-bit long. Twelve bits represent terrain elevation, covering the elevation span from the sea level up to more than 4000 m. Three bits describe the terrain coverage, allowing for a differentiation among eight coverage classes. One bit contains information on whether or not there exists an associated file with the specific terrain points. Such files are also identified by geographic co-ordinates. The data are record-structured, and each record contains three co-ordinates (x, y, z) of a point. The linearly-related geographical data are also record-structured. Each record contains (x, y) co-ordinates (6-bit real numbers),

interpreted as the geographic longitude and latitude in radians. The terrain information occupies about 20 megabytes disk space.

## 2.1.3 Data capture

The data were extracted manually from the 1:50 000 source map, as automated tools were unavailable at the time of the data bank creation. Special temperature-insensitive transparencies were used for that purpose. A precise grid of geographic lines was drawn on each transparency, defining cell borders every 12.5 seconds in the north-south direction and roughly 8 seconds in the east-west direction. It is about 5 mm on the map, or 250 m in terrain, the same in both directions. The grid was then superimposed on the map, and the terrain height was coded at the intersections of the grid lines. The elevation values were estimated by visual interpolation from adjacent isarithms. Over flat regions it was sufficient to read the elevation every second line.

Conversion of data from the source map to the computer introduces inaccuracies, and special precautions were undertaken to minimize errors (figure 4). The elevations were read by well-trained professionals, recorded on magnetic (audio) cassette and then typed independently on two sets of perforated cards. Typing errors were identified by the computer and checked against the master map. To identify read-out errors, the elevation gradient between adjacent cells was examined. In case of inconsistency, the data were checked again. The inevitable random errors in elevation are estimated to be in the order of one-tenth of the terrain irregularity [25]  $\Delta h$ , or one-tenth of the contour interval over flat areas.[26] The uncertainty in reading the x, y position on the map is in the order of 1 mm (50 m in terrain).

#### 2.2 Transmitter database

The transmitter database incorporates all information needed about television transmitting stations. The technical information includes the geographic co-ordinates, frequency channel, offset, polarization, effective antenna height and power radiated at various azimuths. The data format is compatible with the CCIR Recommendations and ITU/IFRB standards. The administrative data include the country, name and status of the station. There are three status categories foreseen. All legally operating stations belong to the first

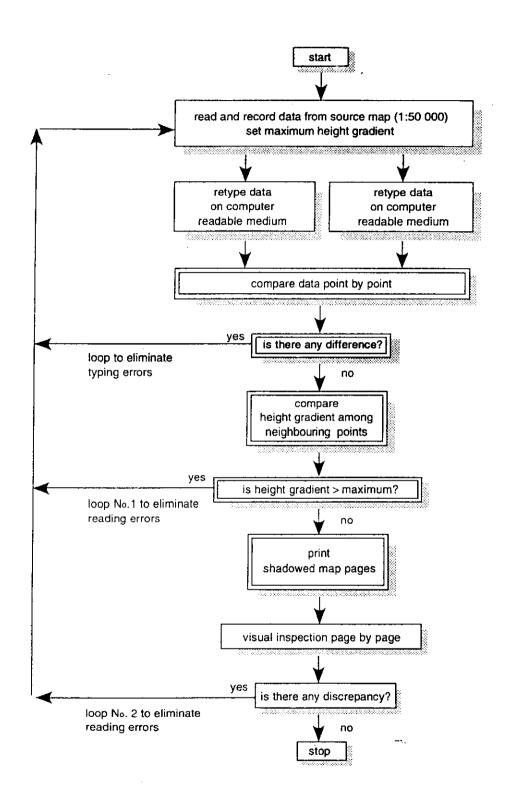


Figure 4-Extracting data from the source map (simplified diagram). The double-framed tasks were performed automatically

category. Their data must remain intact. The second category includes the stations that do not physically exist but are notified, or co-ordinated. Their data should not be changed, except for minor modifications allowed. The third category embraces all planned or tested stations whose data can be modified at will when alternative solutions are to be examined.

## 3. Analysing station operation

## 3.1 Tasks performed

With the simulation model, the manager can analyse the operation of an existing television broadcasting network and assess its performance. He can quickly identify all wanted and unwanted signals at any given location, and answer questions such

- what is the coverage area of the station?
- is there any coverage gap?
- what is the interference threat?
- what television programmes can be received at a given location?

Table 4 contains a non-exhaustive list of tasks that are facilitated by the simulation model. These are discussed in the following sections.

## Table 4

## Examples of tasks performed automatically with the simulation model

- · determination of equipment characteristics
- · determination of signal environment at a given
- · determination of the coverage area of transmitting station
- · EMC examination
- · extraction and analysis of terrain elevation profile
- · extraction of terrain coverage data
- · field-strength prediction of wanted and unwanted signals
- · great circle computations of distance and bearing
- · maintenance of signal environment documentation
- · maintenance of technical documentation of stations
- production of documents for frequency co-ordination/notification
- · production of various extracts, reports and maps
- · simulation of field-strength measurements
- simulation of various experiments in the field
- spectrum analysis

#### Table 5

## Main characteristics of television rebroadcasting stations

- power radiated
- transmission frequency
- transmitting antenna:
  - height
- radiation pattern
- polarization
- · transmitting station site
- · minimum signal level
- · receiving antenna:
  - height
  - radiation pattern
  - polarization
- · receiving station site
- · reception frequency

#### 3.2 How it works

The simulation model is interactive with a userfriendly graphical interface. Such a visualization provides the most efficient way of man-machine communication, keeping in mind the large band of the human visual system and the computer speed. Relevant information is presented in the form of colour maps and diagrams on the screen in various scales, depending on the user's selection. All operations previously carried out on paper maps are performed on the cathode ray tube display with the computer aid. Special windows and cursors help to communicate with the computer. The results of simulation can also be presented in numeric form and/or written into computer files for further reviewing, processing, or printing. The model involves all major parameters of television rebroadcasting stations, shown in table 5.

## 3.3 Coverage analysis

In order to estimate the extent of the station coverage area at VHF and higher frequencies, visibility tests are usually performed. The classic approach involves the performance of such tests in the field in "real life" conditions, on a suitable topographic map, or on a scaled "physical" relief terrain model.[27] The terrain relief is analysed and the line-of-sight (LOS) coverage maps are produced. Such maps identify "shadow" areas (with excess attenuation due to terrain shielding) and "visible" areas. In our approach, the tests are

accomplished in the computer memory, using the digital terrain data bank. [28] To produce a LOS map, the region considered is divided into small cells. The size of these cells is independent of the dimension of the cells of the digital terrain map. Each cell is represented by a point. The position of the transmitting antenna, borders of the region to be analysed and receiving antenna height are determined by the user. Two heights of receiving antenna are provided, maximal and minimal. The software simulates the displacement of the receiving antenna from one point to another, over the entire region. For every point, the terrain elevation profile between the transmitting and receiving antennas is produced. and the LOS is constructed. An alternative is to construct and examine the first Fresnel zone ellipse. (The elevation profile is discussed in the following section.) Then the relative position of the line against the terrain elevation profile is analysed (figures 5A, 5B and 5C).

## 3.4 Terrain elevation profile analysis

Terrain elevation profiles are automatically generated by the software, given the transmitter and receiver locations. For that purpose, a geographic map with two cursors is provided on the screen. One cursor symbolizes the transmitter and the other represents the receiver. Each can be moved freely by the user. Their current geographic co-ordinates are displayed in separate windows on the screen, together with the local terrain elevation, antenna height and terrain coverage symbol. The software extracts the terrain profile from the database along the great circle path connecting the transmitting and receiving antennas. The effective Earth's radius is introduced to allow for the tropospheric refraction of electromagnetic waves. To accelerate computations, the great circle path is approximated by a number of loxodromes. (The great circle is the shortest path between two points on a sphere.

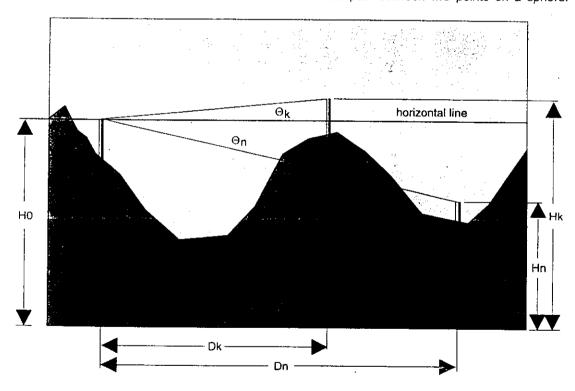


Figure 5A-LOS maps: visibility test (principle). Indexes "0" and "n" indicate the endpoints of the path, Ho, H1, H2,...Hn are the elevations, and D1, D2,... distances of successive points from point "0" along the path. Let

$$\theta_k = \text{arctan}\bigg\{\frac{H_k - H_0}{D_k}\bigg\} \text{, } k = 1, \, 2, ... \, n.$$

if  $\theta_i < \theta_n$ , i=1,2,... (n-1), then the n-th point of the path is visible

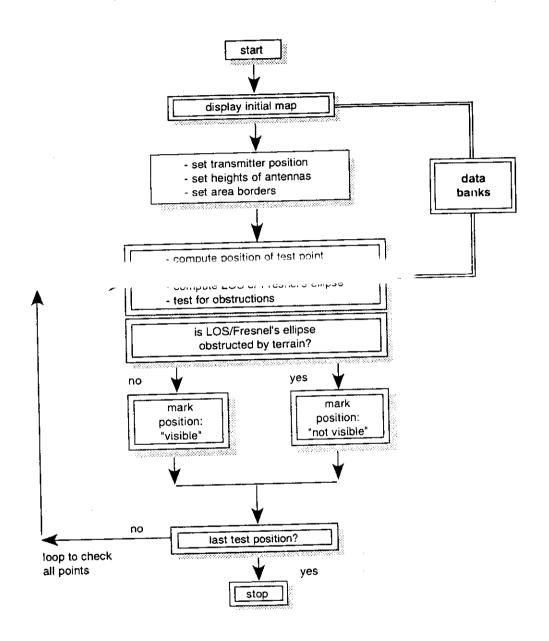


Figure 5B–LOS maps: production process (simplified diagram). The double-framed tasks are performed automatically. Instead of the LOS, the first Fresnel zone may be produced and examined for terrain obstructions

and the second of the second o

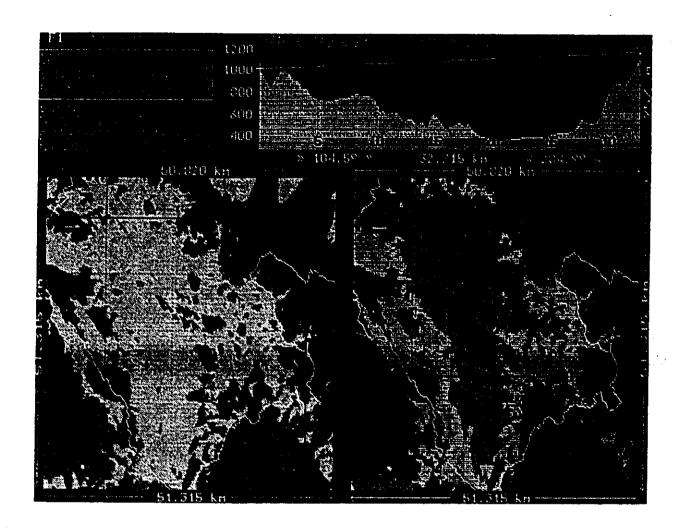


Figure 5C-LOS maps: example

Lower-left window: map showing visible (grey) and invisible areas (blue and dark blue) of the region. The blue colour means that the LOS between the transmitting and receiving antennas is obstructed. The blue and dark-blue colours correspond, respectively, to the minimum and maximum receiving antenna height above the ground. These heights are selected by the user. Visible are: the position of the transmitting antenna (yellow point), geographic co-ordinates (vertical and horizontal black dashed lines), border of the country (yellow line) and distances (white lines outside the window)

Lower-right window: the same as the lower-left window but with more details. The visible additional elements are: one position of the receiving antenna (the left end of the LOS), the transmitting antenna position and LOS (grey line from the transmitting antenna), and terrain elevation (various colours)

Upper-right window: terrain profile between the two antennas. Visible are: distance and elevation markers, LOS connecting the antenna centres, direction angles and distance between the antennas (the bottom line), and propagation information specific to the path (the top line). The Earth curvature is corrected for diffraction effects

Upper-left and middle-left windows: terrain elevation, antenna height and geographic co-ordinates of the transmitting (x) and receiving (+) antennas

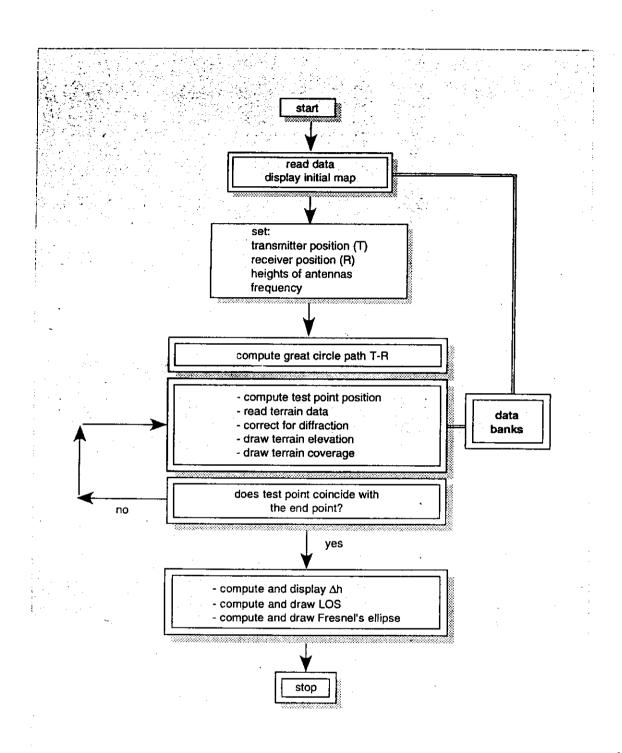


Figure 6A-Terrain elevation profile: production process (simplified diagram). The double-framed tasks are performed automatically

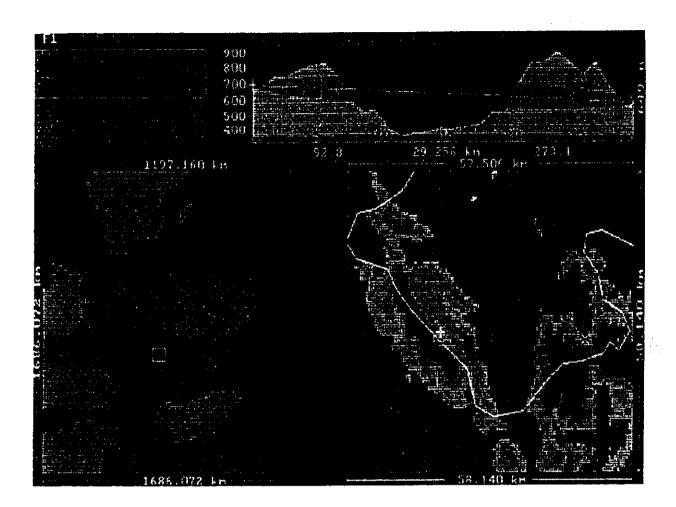


Figure 6B-Terrain elevation profile: visualization

Lower-left window: administrative map of Central Europe (status of 1989). Visible are various countries and seas. The small (white) square near the centre marks the region displayed in the adjacent window. The distances are indicated outside the window

Lower-right window: a more detailed physical map of the region displayed in the adjacent window. The markers (+, x) indicate the positions of the transmitting and receiving antennas, respectively. Their co-ordinates are shown in separate windows in the left upper-side of the screen. The terrain elevation profile between the antennas is displayed in a separate window in the upper part of the screen. The user can move the antenna positions freely. Visible are the border of the country (yellow line), terrain elevation (represented by coloured pixels), and distances (white lines outside the window)

Upper-right window: terrain elevation profile between the transmitting and receiving antennas (+, x) automatically extracted from the data bank. Visible are: the distance and elevation markers and scales, LOS connecting the antenna centres and first Fresnel zone. The Earth curvature is corrected for diffraction effects. The direction angles and distance between the antennas (the boftom line) and propagation information (the top line) are also shown

Upper-left and middle-left windows: transmitting and receiving antennas data. Shown are: the terrain elevation, antenna height and geographic co-ordinates

Note: The interrelated information displayed in various windows is automatically updated.

The loxodrome, or rhumbline, is the path of constant heading between two points on the Earth's surface; it intersects all lines of longitude at the same angle. On the Mercator projection, it is represented by the straight line between the two points.) The software generates co-ordinates of 400 uniformly spaced points along the path, and determines the terrain elevation at each point. For points not included in the terrain database, linear interpolation between the nearest four database points is applied. If there is a specific terrain point (peak) in the vicinity, the result is corrected by taking the elevation of that point into account. In addition to the terrain elevation profile, the computer determines the terrain coverage, bearings and distance between the antennas, the first Fresnel zone, and parameter Δh. Figures 6A and 6B illustrate the process.

## 3.5 Field-strength prediction

The software automatically performs the propagation predictions necessary for the analysis of station operation. There are two approaches to field-strength prediction. The first is based on the analysis of many thousands of measurement results. It uses a set of curves indicating how the fieldstrength changes with distance, without involving details of the path between the transmitter and receiver. The second approach employs calculations based on optical theories. It takes account of the unique terrain characteristics of the propagation path involved. The second method is generally more accurate than the first, but requires a large amount of detailed data. The software incorporates both. The first one is automatically selected if the propagation path is not covered by the digital map. In such a case, CCIR propagation curves are used (see reference [23]). The second approach is automatically applied if detailed terrain elevation and coverage along propagation path data are available in the computer memory. The field strength is determined for 1%, 10% and 50% of the time. Corrections for attenuation by forests and built-up areas are included, as appropriate. These models are described in reference [29]. Figure 7 shows the results.

### 3.6 Signal environment analysis

The model simulates two kinds of signal measurements, one using a field-strength meter, and another using spectrum analyser. In both cases it assumes an ideal equipment, i.e. a directive

antenna without side- and back-lobes and spectrum analyser without spurious responses. For that purpose, the model uses a transmitter working data file, terrain data bank and propagation models described in previous sections. The working file may contain all transmitters, or only transmitters preselected in accordance with specific criteria, in order to accelerate the process. The user fixes the position of the test point, and the software identifies all signals that would be observed there. The frequency, magnitude, polarization and direction of arrival are determined for each signal together with the distance to its transmitter. The software identifies, channel by channel and transmitter by transmitter, all signals that exceed a given threshold value (in our case 20 dB above 1 μV/m) and



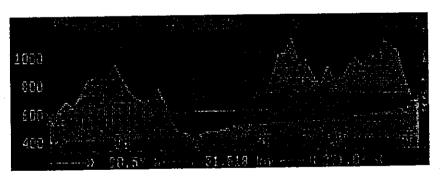


Figure 7-Point-to-point propagation prediction: visualization of the results. The top line indicates the terrain irregularity factor  $\Delta h$  of the propagation path and field strength in  $dB(\mu V/m)$  for 1 kW e.r.p. exceeded for different percentages of time. Visible is the terrain elevation profile along the propagation path. The bottom line shows the bearing angles and distance between the transmitting and receiving antennas. The right scale indicates the elevation in meters above the sea level. The bottom scale shows the distance in kilometres, and the right scale the elevation span in meters

Upper window: case of the first Fresnel zone free; note the signal level about 60 dB

Lower window: case of the first Fresnel zone obstructed; note the signal level about 10 dB

disregards signals below that level. The maximum signal is also identified for each frequency channel and offset category. Figure 8B shows the results.

## 3.7 EMC analysis

#### 3.7.1 EMC models

EMC is the ability of a device or system to function satisfactorily in its electromagnetic environment without introducing intolerable disturbance to that environment. There are several possible mechanisms of incompatibility in television broadcasting. These fall in two categories: the co-channel interference and interference due to equipment imperfections. Limited receiver selectivity, limited linearity and local oscillator radiation are examples of imperfections. They are discussed below.

#### Co-channel interference

If the wanted and unwanted signals fall in the same frequency channel and the two signals are commensurate, horizontal bars appear on the television screen, moving slowly up and down. The effect does not depend on the receiver design. It can be reduced by increasing the wanted-unwanted signal margin at the receiver input and/or by offsetting the carrier frequencies of the wanted and unwanted stations. For instance, with a frequency difference of about 10 kHz, the required protection margin can be reduced by about 18 dB (table 4).

## Interference due to limited selectivity

Due to the limited selectivity of the receiver, the energy from the two channels adjacent to that to which the receiver is tuned can cause interference. Similarly, the signal that is separated from the received channel by twice the intermediate frequency of the receiver can cause the image-channel interference. To reduce the interference threat, adjacent and image signal levels have to be limited. Table 6 lists the limits incorporated in the model.

## · Interference due to local oscillator

Radiation from the local oscillators of nearby receivers can interfere with the wanted signal. The radiation at the oscillator fundamental frequency and at each harmonic frequency can affect one channel. It means that reception in frequency bands 3, 4 and 5 may suffer interference from the harmonics of the local oscillator of receivers tuned to lower bands.

## · Interference due to limited receiver linearity

If two stations deliver strong signals into the receiver and use channels separated by the intermediate frequency, they can mix due to the nonlinearities in receiver circuitry. The product can ride through into the IF amplifier and produce interference beat. The worst case is when these two strong unwanted signals are located around a relatively weak wanted television signal. Intermodulation interference may also appear with strong input signals. Usually, it is the two-signal, third-order intermodulation, involving twice the frequency of one station minus the frequency of the other. A non-linearity in the front of the receiver may produce two spurious signals, one above the higher and a second below the lower of the two channels involved.

#### 3.7.2 Analysis

All signals are analysed above the specified threshold and potential conflicts are signalized. The recognized conflicts are co-channel, adjacent channel and image channel. The signal level required to overcome the interference is suggested, taking into account the required protection margins. The software signalizes also local oscillator conflicts. At UHF it is the fundamental oscillator frequency, and at VHF it is the second or third harmonic. Figure 8A illustrates the process. The results of the EMC evaluation and signal environment analysis are displayed together (figure 8B).

## 3.8 Reference points

The results of simulations can be stored in the computer memory. There are two reasons to save the results. Firstly, they may be used as a reference to identify any change or anomaly in the operation of stations. Secondly, if the parameters of a station do not change, the results of simulations of that station can be reused as many times as needed, offering a significant economy. For that purpose, a set of some 3600 reference points has been selected and signal environment at these points has been determined. There is at least one point for each transmitting station and for each locality. These are distributed over the whole territory, one reference point per 10×10 km area on average. The frequency, level, polarization, azimuth of arrival and source of every signal that can be received at each reference point have been stored in the computer

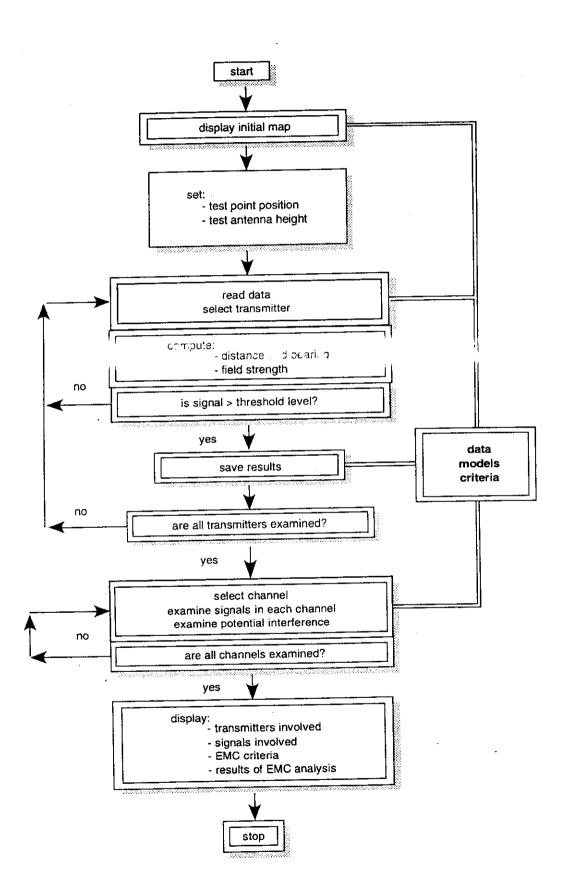


Figure 8A-Signal environment: flow diagram (simplified). The double-framed tasks are performed automatically

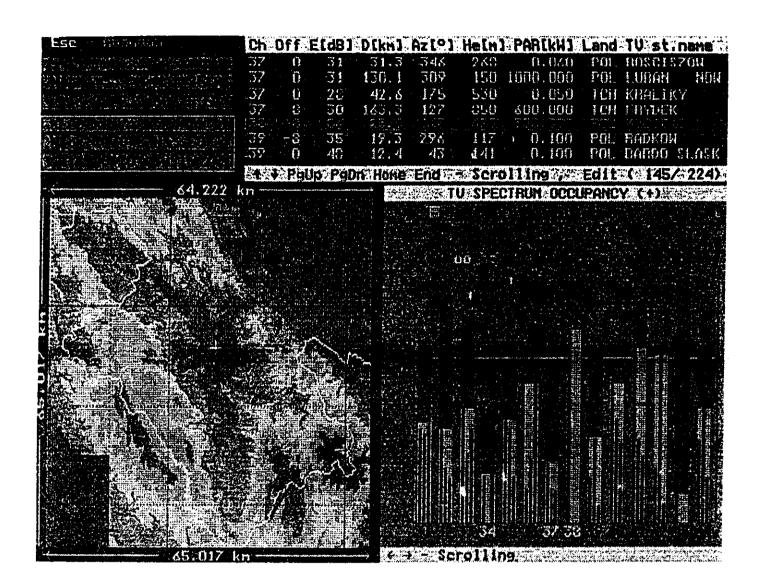


Figure 8B-Signal environment: visualization

Lower-left window: a physical map of a region showing the position of the receiving test station (+). Visible are: the positions of the transmitting stations (yellow points), geographic co-ordinates ivertical and horizontal black dashed lines), border of the country (yellow line) and distances (wnite lines outside the window)

Upper-right window: list of television transmitting stations which produce, at the location of the receiving test station, signals equal to, or greater than, the fixed minimum level. Indicated are: the radio-frequency channel number and offset (Ch. Off), level (E) in dB(1 µV/m), distance from. and bearing to, the transmitting station (D, Az), effective antenna height and e.r.p. of the transmitting station (He, PAR), and name of the country and of the transmitting station (Land, TV st.name)

Lower-right window: an imitation of the screen of a "smart" spectrum analyser. The horizontal and vertical axes represent the radio frequency channels and the signal level observed at the station, respectively. The norizontal white line is the required minimum usable signal level. The orange bars are the maximum signal levels within the channels. The red lines are the maximum signal levels with specific offsets. The dark-blue pars indicate the signal level required to overcome potential adjacent- and image-channel interference. They involve signals in the adjacent and image channels and minimum acceptable interference margins. Channel numbers marked in red or orange are warnings about potential oscillator interference

Upper-left window: terrain elevation, antenna height and geographic co-ordinates of the receiving test station (+)

Middle-reft window: The name, terrain elevation, antenna height and geographic co-ordinates of the selected transmitting station (x)

memory. Only signals above a threshold level are taken into account, and the information occupies about 60 megabytes of disk space. The results of simulation kept in memory can be complemented by the results of the field measurements. With this in mind, the control points are located in such places that are not only significant but also easily accessible and easily identifiable in the terrain.

#### 3.9 Transmitter data visualization

The access to the information on transmitting stations is possible by the name of station, frequency channel, or location. The inter-related data from different files can be displayed simultaneously. as shown in figures 9A and 9B. The transmitter database includes all television transmitters existing and planned ov ?

television transmitting stations that have been notified internationally and are situated within about 600 km distance from the country border.

## 4. Planning new stations

This section deals with planning applications, with emphasis on the rebroadcasting.

#### 4.1 Planning tasks

The computer simulation model can be used as a tool to examine effects of various planning deaisions and/or project alternatives. With this tool, the planner can quickly answer such questions as:

- what is the distance to the nearest transport road?
  - what signal will be the best for reception?
- what frequency channel will be the best for transmission?
- will the proposed radio link be obstructed by terrain obstacles?

X 3

television network?

 will it suffer interference from the existing stations?

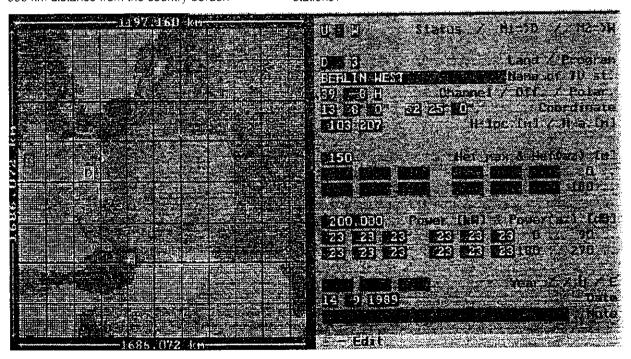


Figure 9A-Transmitter data visualization with large-scale map (example)

Left window; administrative map of Central Europe (status of 1989) showing the position of the relevision transmitting stations. The horizontal and vertical lines represent the meridians and paralleic. Distances are indicated outside the window. Different colours are used to distinguish between countries. Letters indicate positions of the transmitting stations. Note station D

Right window: standard form listing the main technical characteristics of station E

Note: The interrelated information displayed in various windows is automatically updated.

 what will be the coverage area of the proposed station?

To plan a new broadcasting station is a major undertaking. With an overcrowded radio-frequency spectrum, any new installation must be harmonized

with all existing and planned stations. Each signal must be examined in detail to ensure that the investment is successful and the new station will neither suffer, nor produce, harmful interference. At VHF and higher frequencies, "terrain shielding" or

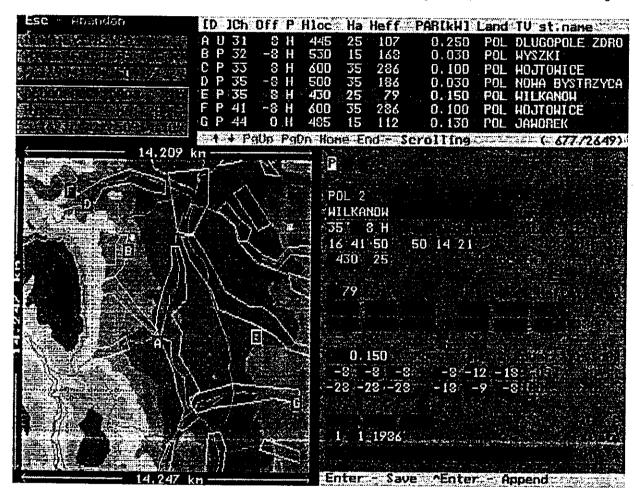


Figure 9B-Transmitter data visualization with detailed map (example)

Left window: physical map of selected region about 14 x 14 km. Visible are: geographic co-ordinates (vertical and horizontal black dashed lines), roads (red lines), contours of built-up areas (orange lines), rivers (blue lines), terrain elevation above the sea level (areas in various colours), positions of selected television transmitting stations (framed letters), distances (white lines outside the window). Note the highlighted station E

Upper window: (partial) list of television transmitting stations displayed in the left-window. Indicated are: the position on the map and formal status (D), number of frequency channel, offset and polarization (Ch, Off, P), terrain elevation and actual and effective antenna heights (Hoc, Ha, Heff), effective isotropically radiated power (PAR), name of the country and station (Land, TV st.name). Note the highlighted station E. The lowest row lists commands available, and, on the right side, the identification number of the highlighted station divided by the total number of the stations in the transmitter working database

Right window: the form listing the characteristics of the station E highlighted in the other windows (the form is not completely filled in). It serves to view, add, modify, or delete the station characteristics

Note: The interrelated information displayed in various windows is automatically updated.

"site shielding", that is the diffraction losses caused by the intervening terrain, can often be deliberately used to reduce the intensity of unwanted signals.[30] Thus, the likelihood of interference to, or from, another system can significantly be reduced. The station design depends on the geography of the country, the population distribution and the availability of broadcast frequencies, and a careful design and positioning of the antenna and selection of frequency channels are required. In addition to the signal coverage and EMC considerations, the selection must also accommodate such factors as physical access to the site, cost, legal aspects, and other limitations. To select a feasible variant from the variety of possible deployment scenarios, many analyses and comparisons have to be made. The station siting, working frequency, power radiated, and antenna radiation pattern are among the parameters that can be varied to achieve the best cost performance ratio. In order to reach a practicable solution, it might be necessary to examine many combinations of these parameters. To select a station siting, Hufford [25], for example, examined some 80 potential locations and some million calculations might be required.[31] To reduce the related labour to manageable proportions, computer-aided tools are indispensable.

Two characteristics of rebroadcasting stations are of major importance: the coverage area and EMC. The LOS coverage, approximating the potential coverage, is one of the decisive parameters for the selection of the station site. In this context, the coverage area (of a terrestrial transmitting radio station) means the area associated with the station within which, under specified technical conditions, the intended communication is feasible. The EMC decides about the frequency selections. Coverage area predictions and EMC evaluations require data about the local terrain and signal environment. The more precise the data, the better the selections. Each rebroadcasting station needs two frequency channels, one for reception and one for transmission. These should be compatible between themselves and with the signal environment. Ideally, the transmission channel should be free from any other signal, and its use should not interfere with the actual and planned use of frequency channels. The reception channel should contain only the wanted signal, strong enough and interference-free. The simulation tool helps to make such a selection. In a preliminary planning stage, if the number of appropriate frequency channels is insufficient, only the transmitting channel is determined. The signal for retransmission must then be delivered by cable or microwave link. In more critical situations, special selection techniques may be required.[32] These, however, are beyond the scope of this article.

### 4.2 Planning through simulation

One of the main aims of our simulation tool is to help to select technical characteristics of television rebroadcasting stations listed in table 5. It covers only technical elements and figure 10 illustrates the approach. The user has to input the instructions. The software automatically extracts and processes all additional data needed and performs the analyses described in previous sections. The results of simulated experiments and examinations are displayed on the screen for the interpretation, analysis and evaluation of the user, who is to decide whether the current characteristics are satisfactory, or another variant should be examined. In the latter case he introduces new instructions, and simulation is repeated with new data. This cycle can be repeated as many times as needed, until an acceptable version is selected, or the iteration process is discontinued. Ideally, this process would be automated to optimize the system for the wanted behaviour. The station planning is, however, too complex, and human reasoning is necessary. The final selection is based on a comparative analysis of several alternatives possible. The larger the number of alternatives analysed, the better the final solution. Extensive interaction between the planner and simulation model is necessary to tune parameters before embarking on experimental verification in the field.

To restrict interference effects, co-sited transmissions and overlapping coverage areas should avoid conflicting frequency channel combinations, and levels of the unwanted signals should be kept within the tolerable limits. Table 6 lists the minimum requirements built in the model. There are three measures to follow these requirements. Firstly, the attenuation of the unwanted signal over the LOS propagation path may be used. It means that minimum separation distances between the stations must be observed.[33] Secondly, additional attenuation due to terrain obstacles may be exploited. Finally, the required amount of attenuation may be obtained by the directional antenna design.

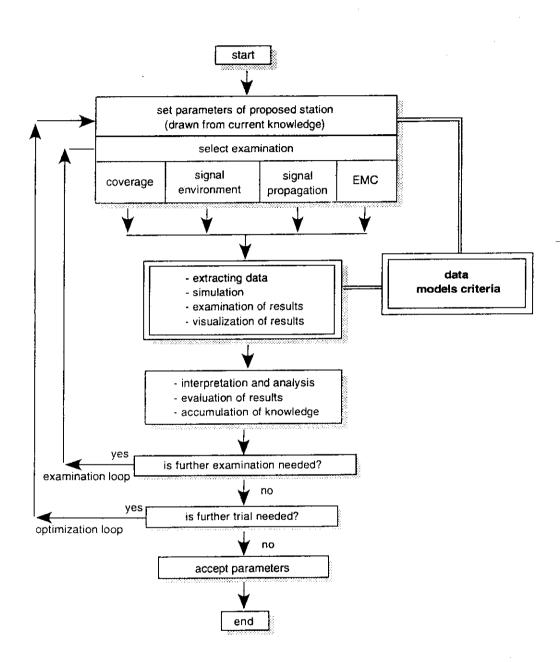


Figure 10-Planning through simulation: the process (simplified diagram). The double-framed tasks are performed automatically

### 5. Verification, performances and **limitations**

This section discusses the overall performances and limitations of the model. It also gives results of the verification of the data banks and propagation models.

### 5.1 Verification

### 5.1.1 Terrain data verification

The terrain elevation profiles derived automatically from the digital map were verified against those extracted manually from the source (paper) map.[34] About 100 randomly selected paths in various regions were used for that purpose. A sample of about 6000 points at intersections of the paths with confour lines was tested, and table 7 hummarizes the lesuits. The mean different 1 m, the correlation coefficient was above 0.99, and the standard deviation of the difference did not exceed 15 m in mountainous terrain. It seems fair to conclude that our topographic data bank contains nearly all the elevation information one could reasonably expect to extract from the source map.

### 5.1.2 Transmitter data verification

Transmitter data were checked against the master copies of notifications submitted to the national authority and to the IFRB. A part of the data was verified against the actual installations. Some discrepancies were discovered on that occasion.

Table 6 Minimum tolerable wanted-unwanted signal margins

unwanted signal type	channel No.*	margin (dB)	remarks	
co-channel	С	45	no offset	
	1	27	offset (non-precision)	
	İ	22	precision offset	
adjacent channel	c+1	-12	upper adjacent channel	
	c – 1	-6	lower adjacent channel	
mage channel	c.+9	13		

<sup>\*</sup> Channel No. c is the channel to which the receiver is tuned in.

5.1.0 0 Jin

As the field-strength prediction models have aiready been verified by other authors, the software was checked only against errors. For that purpose, a comparison was made between the signal levels measured in the field and predicted by the simulation model. The test sample was limited to 36 transmitter-receiver links in a hilly region (400 to 1000 m above sea level). The mean difference between the measured values and predicted ones was 3 dB, the mean-square difference 5 dB and the correlation coefficient 0.87. These results correspond to the accuracy of the field-strength

Table 7 Results of verification

	item	sample size	mean difference	standard deviation	correlation coefficient	maximum difference	minimum difference
terrain elevation*	all terrain types (135-1300 m)	6 117	0 m	12 m	0.998	143 m	-75 m
	flat terrain (135-255 m)	1 242	0 m	4 m	0.996	19 m	-30 m
	undulated terrain (200-840 m)	1 524	–1 m	10 m	0.994	40 m	47 m
	mountainous terrain (260-1300 m)	3 351	0 m	15 m	0.996	67 m	-75 m
field streng	yth**	36	3 dB	5 dB	0.875	12 dB	-8 dB

Difference between the terrain elevation above sea level at the same points derived automatically from the digital terrain data base and extracted manually from the source map by skilled persons.

<sup>\*\*</sup> Difference between the measured and predicted field strength levels.

Table 8 Simulation model performances

No.	task	time* (seconds)	remarks
1	transmitter-file search and data extraction	<1	500 transmitters
2	signal environment and spectrum occupancy estimation	< 10**	500 transmitters
3	EMC analysis and interference threat evaluation	< 10**	500 transmitters
4	transmitter-receiver distance and bearing computing	< 1***	50 km distance
5	terrain-profile extracting	< 1***	50 km distance
6	terrain irregularity ( $\Delta h$ ) evaluation	< 1***	50 km, 400 points
7	first Fresnel zone determination	< 1***	50 km, 400 points
8	point-to-point propagation predicting	< 1***	50 km, 50%, 10%, 1% of time
9	LOS coverage area predicting	< 20	50 × 50 km, 90 000 points

- The time required to perform the task; the task volume is characterized in the column "remarks".
- \*\* The total time of performing tasks 2 and 3 together.

measurements [35] and are similar to those published in the literature.[36-38]

### 5.2 Performances

Table 8 illustrates the overall performance in terms of time required to perform the specific task. Rows 1 to 3 of the table list the tasks relevant to the analysis of the station operation. Rows 4 to 9 list the tasks relevant to the planning of a new station. These performances were observed with the personal computer Compag 386/20e with a mathematical co-processor, EGA/VGA graphic card, 4 megabytes RAM, 80 megabytes hard disk and DOS.5 operating system. Better performances may be expected with faster microprocessors and larger memory.

### 5.3 Limitations

The computer hardware limits the speed of simulation computations and the maximum number of transmitters processed within a reasonable time. The simulation model described in this article has been running successfully on a personal microcomputer type IBM-AT or compatible. The system allows to simulate a network of about 10 000 transmitters over a territory of about 1500 x 1500 km. At present, the simulation model is limited to

Secam D/K television systems. The propagation prediction models refer to VHF/UHF frequency bands, land paths, standard atmosphere and temperate climate (the main-frame version includes four different propagation models). As they are based on measurements within some 500 km distance, the predictions for greater distances are less reliable. The model restricts the signal propagation path to the vertical plane connecting the transmitting and receiving antennas. Multipath propagation, effects of reflection from terrain obstacles, buildings, etc., as well as ducting phenomena, are disregarded.

### 6. Conclusion

### 6.1 Summary

The growing demand for frequencies can be satisfied by improving the control over interference among stations and by reducing the spectrum wasted due to interference. The interference reduction involves analyses of huge amounts of spectrum- and geography-related data. Without automation, the job would be hopeless. This article shows how the task can be facilitated by a computer system that integrates the analysis, design and documentation. The strength of the described system lies in its precision, efficiency, simplicity of use

<sup>\*\*\*</sup>The total time of performing tasks 4 through 8 together.

and low cost. Together with its earlier version, it has been used to analyse the operation of thousands of television transmitters and to plan several hundreds of new low-power rebroadcasting stations. It offered substantial economies:

- in the time spent for technical examinations and analyses;
- in the frequency spectrum used through tighter "packing" of stations;
  - in energy and in cost.

The experience indicated its possible further development, and appropriate work has already been initiated. This section contains some remarks in this connection.

### 6.2 Future development

Two independent displays are sidered: to make the simulation tool more universal and to make it more accurate.

### 6.2.1 Other services

Our simulation model is restricted to a specific country and a specific radiocommunication service. Could it be applied to other services and other countries? The answer is: yes, but data banks, propagation models and criteria have to be modified as appropriate. Cellular mobile radio, rural radiotelephony, microwave links and sound broadcasting applications at VHF and higher frequencies could use the digital terrain elevation data banks and other elements of the model.

### 6.2.2 More accuracy

A better imitation of the real world requires more accurate propagation models and data. Three comments can be made in this connection. Firstly, more accurate digital maps are not a technical problem today. Digital maps of some regions are available on compact disks (CD-ROM). Microcomputer tools exist to convert conventional maps into digital format. In addition, satellite technology offers digital maps from the sky.[39] The ITU publishes various maps,[40, 41] but digital terrain elevation maps are not available within that organization. On an international scale, the Food and Agriculture Organization of the United Nations (FAO) is developing a worldwide geographic information system (see FAO: Geographic information systems in FAO (Rome, 1988). Unfortunately, FAO's terrain data cannot be used in VHF/UHF radiocommunication applications. The resolution of generally available digital maps from satellites reaches about 10 m. A 1-m resolution or less is possible with today's technology. However, to collect and maintain these data with the corresponding degree of reliability might be difficult. Many man-made structures of such dimensions would have to be included in the data banks. As the structures can be created, destroyed, modified, or displaced, the data would need frequent updating. Otherwise, the data bank would be inaccurate. Secondly, in order to improve propagation predictions, multiple propagation modes should be included and a three-dimensional propagation model would be required for that purpose. Various ray-tracing techniques are possible here. Unfortunately, all of them are computing-intensive and require huge amounts of data. The existing paragnal computers are unable to cope with such

rinally, it seems unreasonable to require norm simulation results more precise than field-strength measurements. It is the measuring uncertainty that defines the accuracy required from the computer simulation.

### 6.2.3 Wider application

The EMC examinations require data about the transmitting stations and terrain within the range of approximately 1500 km. With small countries, such distances spread outside the country's territory, so that the same data are used in two or more countries. An exchange could eliminate the need to duplicate data collection and maintenance. A common co-ordinate system, and common data structure would make such an exchange easier. The ITU maintains data banks on radiocommunication stations that seek international recognition, and it could also maintain digital terrain data banks and simulation models, similar to that presented in this article. Many time-consuming technical examinations could be then automated and made more accurate. The system would be accessible for consultations and trial examinations by all those interested. Its operation would resemble an air-ticket reservation network, where a client can consult flight schedules, select connections, reserve seats and buy tickets in his local travel office. In our case, it would be the assignment of the frequency and position of a station, rather than the airplane seat, and the local spectrum management office rather than the travel office, but the concept is the same. The results of the examinations could be available at the user's desk almost instantaneously. In the case of a positive finding, formal notification could be done automatically. Otherwise, potential conflicts would be identified and necessary negotiations among the involved parties could begin without delay. Facsimile and videoconferencing, complementing the computer communications, could facilitate the negotiations and consultations. A group of highly qualified experts would maintain the system at headquarters and be available for consultations. Such a group might also help in solving those spectrum management problems which result from the lack of sufficiently experienced professional staff, especially in developing countries. The border between national and international spectrum management would be blurred. The spectrum management would be more efficient not only in terms of the involved cost and time, but also in terms of spectrum conservation, which is even more important.

### 6.3 Acknowledgement

The software presented in this article, including the databases, has been developed and tested at the Institute of Telecommunications, Wroclaw Branch (Poland). Collaboration with the Institute of Telecommunications and Acoustics (Politechnika Wroclawska) and the Institute of Geography (Uniwersytet Wroclawski) is acknowledged. Several people collaborated with the author, and it is not possible to list all of them here.

The first working version of the software was developed by Messrs W. Sega and W. Waszkis in the 1970s, as a part of their doctoral dissertation. The topographic data were extracted under P. Adamczyk. For this work, the author's team was honoured by the Award of the Minister of Telecommunications of Poland (1984) and by other awards. Later, A. Marszalek converted the software to a personal microcomputer, and prepared an original graphic interface.[42] It brought him the "Micro-Laur" award in a computer software contest in 1989. Messrs Z. Janek, J. Sobolewski and T. Stromich also collaborated. The Polish Administration has offered the software to CCIR, under CCIR Resolution 88\*.

The author also wishes to express his gratitude to Messrs P. Balz, K. Bjornsjo, P. Kartachoff, J. Karjalainen and L. Wieweg, for their comments during the preparation of the manuscript, and to Mr R. C. Kirby, CCIR Director, for his encouragement to publish the article.

(Original language: English)

### References

- [1] Waters G. T.: The evolution of broadcasting in Europe, Proceedings of the 1991 International Symposium on Broadcasting Technology-ISBT '91, Zhuhai (China), 29-31 August 1991, pages 33-42
- [2] Eden H.: Frequency planning methods for sound and television broadcasting, Telecommunication Journal, January 1986, Vol. 53, No. I, pages 30-47
- [3] Flaherty J. A.: HDTV systems and applications: the U.S. position, Proceedings of the 1991 International Symposium on Broadcasting Technology-ISBT '91, Zhuhai (China), 29-31 August 1991, pages 232-233
- EBU: Planning parameters and methods for terrestrial television broadcasting in the VHF/UHF bands (Tech. 3254, 1988)
- [5] Blair R. H.: The rebuilding of Australia's regional television stations, Telecommunication Journal of Australia, 1991, Vol. 41, No. 2, pages 67-72
- [6] Jacobs G.: Low-power television, IEEE Spectrum, June 1982, pages 54-59
- [7] Massucci M.: Choix de l'emplacement d'un réémetteur de télévision en O dm avec essai d'émission en vraie grandeur, Radiodiffusion télévision, 1980, No. 61, 1/5, pages 6-14
- Vujasinovic M., Mirkovic M., Pavic B. and Tadic V.: Mobile TV system as a powerful tool for designing and locating a stationary TV transmitter, Proceedings of the 1991 International Symposium on Broadcasting Technology-ISBT '91, Zhuhai (China), 29-31 August 1991, pages 492-495
- CCIR: Handbook on spectrum management and computer-aided techniques, ITU (Geneva, 1987)
- [10] Causebrook J. H.: Computer prediction of UHF broadcast service areas, BBC Research Department Report 1974/4
- [11] Dadson C. E., Durkin J. and Martin R. E.: Computer prediction of field strength in the planning of radio systems, IEEE Transactions on Vehicular Technology, February 1975, Vol. VT-24, No. 1, pages 1-8
- [12] Longley A. G. and Rice P. L.: Prediction of tropospheric radio transmission loss over irregular terrain. A computer method, ESSA Technical Report, ERL-79-ITS67 (Boulder, Colorado, 1968)
- [13] Scheihing C., Jablinske R. and Scott J.: Topographic considerations in environmental predictions, IEEE EMC Symposium Record, Washington, DC, 18-20 July 1967, pages 106-125
- [14] Isola C, and Riccardi M.: Computer-aided VHF/UHF fieldstrength predictions, EBU Review-Technical, April 1988, No. 228, pages 68-77
- [15] Sega W., Struzak R. G. and Waszkis W.: Interactive computer simulation system for analysis of television broadcast networks (in Polish), Przegl. Telekom., 1982, No. 2/3, pages 35-40 -...
- [16] Struzak R. G.: Simulation model for evaluating interference threat to radiocommunication systems, Telecommunication Journal, December 1990, Vol. 57, No. XII, pages 827-839

<sup>\*</sup> Copies of the software are available on an "as is" basis directly from the Polish Administrations, Institute of Telecommunications, Wroclaw Branch, or from the CCIR Director, with a handling charge.

- [17] Ibid.: Computer-aided spectrum engineering, Proceedings of the 9th International Zurich Symposium on Electromagnetic Compatibility-EMC 91, (12-14 March 1991), pages 193-198
- [18] Beck R. and Kruger M.: GRAND-A program system for radio network planning, Philips Telecommunication Review, September 1991, Vol. 49, No. 3, pages 18-22
- [19] Del Duce V., Isola C. and Virgadamo G.: Interactive graphic procedure for broadcasting frequency management making use of terrain data bank on high-definition CAD workstations, Telecommunication Journal, September 1990, Vol. 57, No. IX, pages 620-629
- [20] Cesky T.: Applicability of engineering models in frequency planning, Proceedings of the Tenth International Wroclaw Symposium on Electromagnetic Compatibility-EMC 90 (26-29 June 1990), Part 2, pages 1011-1013
- [21] Struzak R. G.: Low-power TV stations planning on PC using terrain data bank, IFRB Seminar on Frequency Management and the Use of the Radio Frequency Spectrum and the Geostationary-Satellite Orbit, (Geneva, 8-12 October 1990), pages 123-127. Use of topographic data bank, Regional Seminar on Frequency Management and the Use of the Radio Frequency Spectrum and Geostationary-Satellite Orbit (Athens, 9-13 September 1991), organized by the Telecommunications Development Bureau (BDT) and the IFRB (Document No. 23). Utilisation de la banque de données topographiques, Cycle d'études régional sur la gestion des fréquences et l'utilisation des fréquences radioélectriques et de l'orbite des satellites géostationnaires (Praia, Cap-Vert, 28 octobre-1er novembre 1991), organized by the IFRB and the BDT (Document No. 6, Addendum No. 1)
- [22] Bonfatti F., Bonora S., Falciasecca G. and Frullone M.: Structure and use of a geographic data base for mobile radio propagation prediction, IEEE International Communications Conference-ICC '83 (Boston, Massachusetts, 19-23 June 1983), pages 77-81
- [23] Damosso E. and Lingua B.: A computer prediction technique for land mobile propagation in VHF and UHF bands, IEEE International Communications Conference-ICC '83 (Boston, Massachusetts, 19-23 June 1983), pages 59-63
- [24] CCIR: XVIIth Plenary Assembly (Düsseldorf, 1990), Recommendation 370-5 (VHF and UHF propagation curves for the frequency range from 30 MHz to 1000 MHz)
- [25] Hufford G. A.: Techniques for the evaluation of proposed VHF TV drop-ins, OT Report 77-112, US Office of Telecommunications (July 1977)
- [26] MacDougall E. B.: Computer programming for spatial problems, Edward Arnold Publ. Ltd. (1976)
- [27] Kaltbeitzer K. H.: Site selection for VHF and UHF transmitting stations (Tech. 3104, 1965)
- [28] Sega W., Struzak R. G. and Waszkis W.: Computer prediction of VHF/UHF transmitting station coverage area, Proceedings of the Fifth International Wroclaw Symposium on Electromagnetic Compatibility-EMC 80 (17-19 September 1980), Part 2, pages 497-505
- [29] Sega W. and Waszkis W.: Zastosowanie symulacji komputerowej do analizy i prognozowania dzialania ultrakrokofalowych systemow radiodyfuzyjnych (in Polish), Politechnika Wrocławska, Raport 128/PRE-019/79 (1979)

- [30] Dougherty H. T. and Dutton E. J.: Quantifying the effects of terrain for VHF and higher frequency application, NTIA-Report 86-200 (1986)
- [31] Commission of the European Communities: COST Project 210-Influence of the atmosphere on interference between radiocommunication systems at frequencies above 1 GHz; EUR 13407 EN;ECSC-EEC-EAEC (Brussels, Luxembourg, 1990)
- [32] Struzak R. G.: Optimum frequency planning: a new concept, Telecommunication Journal, January 1982, Vol. 49, No. I. pages 29-36
- [33] Dixon J.: UHF-TV taboos: the FCC electromagnetic compatibility plan for UHF television, IEEE Transactions on Electromagnetic Compatibility, January 1964, Vol. EMC-6. No. 1, pages 29-32
- [34] Sega W.: Digital terrain map for television and land mobile radio, Proceedings of the Seventh International Wroclaw Symposium on Electromagnetic Compatibility-EMC 84, Part 2, pages 949-955
- [35] CCIR: XVIth Plenary Assembly (Dubrovnik, 1986), Vol. V (Propagation in non-ionized media), Report 227-3 (General methods of measuring the field-strength and related parameters)
- [36] Krank W. and Stöcker F.: The use of a topographical data bank for field-strength forecasting in the Südwestfunk service area, (in German) Rundfunktechnische Mitteilungen, July/August 1982, No. 4, pages 162-179
- [37] Grosskopf R.: Comparison of field-strength prediction methods in the UHF range, EBU Review-Technical, June 1988, No. 229, pages 102-110
- [38] Sandell R. S.: VHF/UHF field-strength prediction, EBU Review-Technical, August 1991, No. 248, pages 184-192
- [39] Westwell-Roper A. and Beckow S.: Mapping from space, Space, March-April 1987, Vol. 3, No. 1, pages 24-28
- [40] CCIR: Report 340-5 (CCIR Atlas of ionospheric characteristics), ITU (Geneva, 1988)
- [41] Ibid. Report 717-2 (World atlas of ground conductivities), ITU (Geneva, 1988)
- [42] Marszalek A.: Mapki TV (in Polish), Report of the Institute of Telecommunications (Wroclaw, 1989)

### Banking transportation and the second

### Author

Ryszard G. Struzak is the Head of Technical Department B and a Senior Counsellor in the CCIR Secretariat. He is responsible, among others, for the CCIR Study Groups on spectrum management, propagation, science services, interservice sharing and compatibility. Before joining the CCIR, Mr Struzak was the Head of the Institute of Telecommunications, Wrociaw Branch, and a professor at the Technical University, Wrocław. He authored numerous technical publications and was invited to deliver lectures in many countries. Mr Struzak served as the Chairman of CCIR IWP 1/4, Vice-Chairman of CCIR Study Groups 1 and Vice-Chairman of Commission E of the International Union of Radio Science (URSI). He cofounded the International Wroclaw Symposium on Electromagnetic Compatibility (EMC) and he is a fellow of the Institute of Electrical and Electronics Engineers (IEEE).

wo Th

# 12th International Wroclaw Symposium on Electromagnetic Compatibility 28 June - 1 July 1994, Wroclaw, Poland

At the Secretariat we received 2 reports on this Symposium and both are printed below. the first was received from Prof. Dr. F.L.H.M. Stumpers, the official URSI representative and Program Chair at the Symposium, the second report was written by the Symposium Organizers.

## Report by Prof. Dr. F.L.H.M. Stumpers URSI Representative

This symposium was attended by 250 persons from many countries. A survey was given by myself in Electromagnetic Compatibility 1994 (late papers) and for Lightning by Prof. Ianoz (321-325). There is not enough place to repeat all this here.

Dr. C. Baum started the symposium on Monday, June 27 with a tutorial on EMP. The clarity of his lectures is wellknown, this was no exception. Tuesday, June 28, at 9 o'clock the opening session of the symposium, had introductory papers by professor Majewski, chairman Symposium Council, Professor Bem, symposium chairman and myself as chairman scientific program committee. At 11 o'clock a special ceremony took place in the Aula, led by the Rector, prof. Wiszniewski, (with ermine mantle) in which the Senate conferred the degree of doctor honoris causa on me. Three vice rectors, nine deans, two scepters were present, as well as my promoter professor Bem. The university choir sang the national anthem, the polonaise "Farewell to the fatherland", Mozart's "Laudate Dominum" and the academic anthem "Gaude Mater Polonia" during pauses in the ceremony. After the ceremony a reception was held, during which many symposium attendees came to congratulate me, as well as ministers and other polish personalities. For myself and my wife it was an unforgettable day. In the afternoon I chaired a special session, in which professor Sir Francis Graham Smith spoke on "The radio Universe". The following session, chaired by dr. Spoelstra treated "Interference effects in radio astronomy". In the evening there was a cocktail party in the medieval townhall. The European Community required in its E.C. Directive on EMC, that all equipment, placed on the European market should comply with a set of harmonized standards, covering both interference and immunity. The aim of this Directive is clear: to avoid, that an apparatus disturbs the working of other electrical apparatus in its neighbourhood, and that its own working is disturbed by interference, occurring in its normal environment. In EMC the role of a generic requirement is limited, as any specific product standard overrules the generic standard. The generic standard measures EMC fields between 30 MHz and 1 GHz, whereas the household appliances standard measures between 30 and 300 MHz, and with regard to immunity the draft household appliances. Standard does not require any test for household appliances, containing no electronic control. This directive created a shortage of relevant engineering

skills in the UK., where Marvin set up an M.Sc. course at York and Hull universities, and a consortium of these universities with those in Paderborn (Germany), Patras (Greece) and Rome (Italy) plans to agree on a pan-European M.Sc.See Marvin, Anaheim EMC Symp. 158-163, 1992. Professor Habiger criticized in this Symposium an ESD requirement (IEC 801-2), that an apparatus should withstand 10 pulses at each level 2, 4, 6, 8 kV, and thinks this number should be increased to 100, 500 or 1000. Obviously this would require automatization. Bochkov did tests for noise immunity, in order to improve on the tests of IEC 801-4. using methods of experimental design theory. His new multi-factorial tests are an improvement on the test, discussed here in his 1992 paper. Vrolijk also starts from IEC 801-2 and 4. He discusses a draft immunity standard for household appliances. For mass-produced appliances the CISPR 80/ 80 method could be used (80% of the appliances comply with the requirements with at least 80% confidence). Another paper on immunity of a different type was given by Pietranik and Zarko. They propose to use the third order intermodulation factor as the parameter, that characterizes the receiver's immunity against intermodulation. Immunity will be on our agendas for several more years.

In the biological effects section, rats and mice are the favourite animals. One wonders, whether there will be enough correlation between the effects on humans, and the effects on these small animals. Yoshino drew attention to the danger of sitting to near to the cathode ray screen, as computer people usually do. He suggested the use of a conductive transparent coating film, that also found application in USA. Sweden was one of the first countries, to draw attention to this danger. So far CENELEC has not found it necessary, to follow in this direction. Yoshino sees also a danger in car transmitters and walkie-talkies in cars, if the head of the operator is too near to the antenna. Antennas should be installed with care, and preferably above the head of the operator. Studies were done at wavelengths of 2 m, 70 cm and 24 cm. Further study is necessary.

Seismogenic emissions preceding earthquakes have been a subject of interest in the (former) USSR and Japan (Gokhberg, Yoshino). A group of Greek scientists around Kopanas and Varotsos came up with a formidable result: They predicted on March 1,994, that an earthquake of magnitude 6.0 would occur between April 11 and 18 in the sea area between the western Peloponesus and Zakynthos island. It really happened on April 16 and the magnitude was 5.8. The Greek authorities have confirmed this. We really hope to see a follow-up!

To protect radioastronomy reception by a 25 meter high screen around the antenna was tried at Arecibo, and Nancay is studying the effect of a 30 to 40 meter high screen around its telescope. The general knowledge of radio-astronomers is exemplified by Ponsonby, who showed the Russians,

how they might decrease the sidebands of their GLONASS transmitters and in that way help the radio astronomers, without any disadvantage to themselves.

We had a number of papers on printed circuit boards by John and his colleagues at Siemens-Nixdorf. Analogous research is done at Philips Research and it will be possible to compare results at the Zurich Symposium.

Professor Kikuchi drew attention to the effect of chaos and chaotic fluctuations in gas discharges. From an EMC point of view it is interesting to find out whether it is easier to suppress the chaotic fluctuations or to suppress their effects. Mayher, Parlow, Boe and Goddard have drawn attention to the relation between EMC and Frequency Management in this and earlier Wroclaw EMC Symposia.

Other subjects we can only mention: Antennas and Propagation. EMC in Power engineering. Lightning and LEMP. EMI Reduction Techniques. Whistlers.

As you may see on the example of this symposium, EMC is really a multidimensional field of research and in our highly technological civilization, an indispensable one. Without attention to Compatibility this civilization based on intensive use of electromagnetic energy cannot develop further.

Prof. Dr. F.L.H.M. Stumpers Honorary President URSI

### Report by the Symposium Organizers:

The Symposium was organized by the Association of Polish Electrical Engineers, the Institute of Telecommunications, and the Wroclaw Technical University. It was co-sponsored by URSI and supported by ITU-R, ITU-T, and other international organizations as well as by national associations of electrical and electronic engineers from 17 countries.

The Symposium Council was chaired by Prof. W. Majewski (Poland) with vice chairman Prof. R. Struzak (Poland), and the Scientific Program Committee by Prof. F.L.H.M. Stumpers with vice chairmen Mr. Th. Irmer (ITU-TSB), and Mr. R.C. Kirby (ITU-BR). The co-chairmen of the Symposium were Prof. D.J. Bem and Mr. J. Rutkowski, and the Organizing Committee was chaired by Mr. W. Moron. There were 250 participants from 26 countries. The most numerous groups were from Poland (117), Russian Federation (21), Germany (15), Hungary (10), UK (10), France (8), Japan (8), USA (8). Some people came from Canada, China, Thailand, Greece and the Republic of South Africa.

Because of the financial problems some authors (especially from China and the former Soviet Union) had to resign from the participation, but they declared their willingness to come to the next Wroclaw Symposium.

Proceedings containing 134 papers accepted for presentation, delivered by 281 authors and co-authors from 26 countries were available to all the participants during the Symposium.

On the day before the Symposium opening, a Tutorial Lecture was given by Dr. C.E. Baum (USA). He presented the topic "EMP and Related Matters".

The Symposium was opened by its chairman, Prof. D.J. Bem. On behalf of Symposium Patron the Minister of Posts and Telecommunications of the Republic of Poland, the audience was greeted by the PTT vice-minister, Mr. M. Rusin

After the Symposium opening a rather unusual event took place. It was a sublime ceremony of conferment of a honorary doctor's degree on Professor F.L.H.M. Stumpers granted as an appreciation of fruitful cooperation in the field of EMC by the Technical university of Wroclaw, the symposium host and one of its co-organizer. All Symposium participants were invited to attend that ceremony. Prof. Stumpers has been the Scientific Program Chairman of the Symposium since 1975.

Plenary sessions were held on the first and third day. The following two papers were presented:

- "The Radio Universe" by Prof. Sir F. Graham-Smith (UK).
- "The International Framework for Spectrum Management" by Mr. M. Goddard (UK).

The third plenary paper "Biological Effects of Electromagnetic Fields" by Prof. L. Miro (France) was not presented because the author could not come, nevertheless the paper was inserted into the Proceedings.

Twenty three regular and six poster sessions covered various fields of EMC. Only 94 papers out of 134 contained in the Proceedings were presented because of some authors absence. All the sessions were held in English.

The core of the Symposium was formed of the following invited sessions:

- High Power Electromagnetics, organizer Dr. C.E. Baum (USA)
- EMC in Amateur Radio Service, organizer Mr. H. Cichón (Poland); IARU Region sponsored sessions,
- Coupling to Cables and Structures, organizer Prof. P.
   Degauque (France); URSI Commission E sponsored session
- Regulations and Standards in EMC, organizer Mr. G. Goldberg (Switzerland)
- Terrestrial EM Noise, organizer Prof. M. Hayakawa (Japan); URSI Commission E sponsored session
- Lightning and LEMP, organizer Prof. M. Ianoz (Switzerland);
- Noise, Fluctuations and Chaos, organizer Prof. H. Kikuchi (Japan); URSI Commission E sponsored session
- EMC in Science Services Activities of the ITU Radiocommunication Study Group 7, organizer Mr. H.G. Kimball (USA); ITU-RR sponsored session
- EMC in Science Services Interference Effects in Radio astronomy, organizer Dr. T.A. Th. Spoelstra (The Netherlands); ESF - CRAF sponsored session
- EMC in Wire Communications, organizer Prof. G. Varju (Hungary); ITU-T SG5 sponsored session
- Alternatives to Open Area Test Sites, organizer Mr.

- P.F. Wilson (Switzerland):
- Biological Effects of Electromagnetic Waves, organizer Prof. T. Yoshino (Japan); URSI Commission K sponsored session
- Seismogenic EM Emissions for Earthquake and Volcanic - Eruptions Prediction, organizer Prof. Yoshino (Japan); URSI Commission E sponsored session.

The titles of the other sessions were

- Antennas and Propagation EMC Aspects
- EMC in Power Engineering
- EMC in Printed Circuit Boards
- EMC Measurements and Instrumentation
- EMC Prediction Analysis and Modelling
- EMI Sources and Coupling Paths to Victim
- EMI Reduction Techniques, Regulation and Standards in EMC
- Spectrum Management, Sharing and Monitoring.

The "Open Forum on Standardization in EMC" evoked a great interest. It was organized by Mr. M.C. Vrolijk (The Netherlands) and key speakers were: Mr. G. Goldberg (chairman of IEC ACEC), Mr. R. Denoble (president of CENELEC) and Mr. Ch. J. Corbett (ETSI).

The same interest evoked a round table discussion on "Spectrum Management: Resolving Future Spectrum Requirements". It was co-organized and co-chaired by Mr. Th. Boe (Norway) and R.J. Mayher (USA); the key speakers were: Mr. M. Goddard (UK), Mr. R.D. Parlow (USA), Mr. W. Sega (Poland), and Mr. R.G. Struzak (Poland).

Two workshops accompanied the Symposium:

- Overview of Pulse Disturbances, organized by Rohde & Schwarz (Austria).
- The emissions and Immunity Testing in EMCO GTEM Cell, organized by EMCO EUROPE (Germany).

Young Scientists Program was organized with the financial support of URS1. Support was offered to three young scientists, and two key speakers were partially supported. The organizers contacted also the International Science Foundation (Washington, USA) which offered financial

support to scientists from the former Soviet Union. Three scientists attented the symposium with this help.

A technical exhibition was held during the Symposium with the participation of 10 companies.

There was also a literature exhibition including publications of international organizations (URSI, ITU-R, ITU-T, ETSI, EBU, CENELEC and IEC (CISPR, and TC77)), and some books from Prentice-Hall (UK).

Both exhibitions were well received and well-attended. A computer room was available to all participants to enable software presentation and in depth discussions, as well as E-mail through Internet Network

A Joint Meeting of the Symposium Council, the Scientific Program Committee, and the Organizing Committee, together with Session Chairmen was held on the last day. It was co-chaired by Prof. R. Struzak vice chairman of the Symposium Council, and Prof. F.L. Stumpers, chairman of the Scientific Program Committee. The present Symposium and future improvements were discussed.

Generally, the current event was positively evaluated and it was stressed that the broad range of the Symposium topics resulting from the accepted EMC definition should be continued. It was agreed that due to such strategy fruitful new ideas are often born, and duplication of efforts can be avoided thanks to contacts and discussions among specialists involved in various fields of EMC.

It was also emphasized that a mixing of theoretical and engineering topics is very fruitful and should be retained. The positive influence of the interaction between those involved in theory and those involved in the engineering practice cannot be overestimated.

Copies of the Symposium Proceedings are available from: EMC Symposium

Box 2141

51-645 Wrocław 12, Poland

fax : +4871 483248 tlx : 712118 ilw pl,

The 13th Wroclaw Symposium on EMC is planned for June 25-28, 1996.

The Organizing Committee

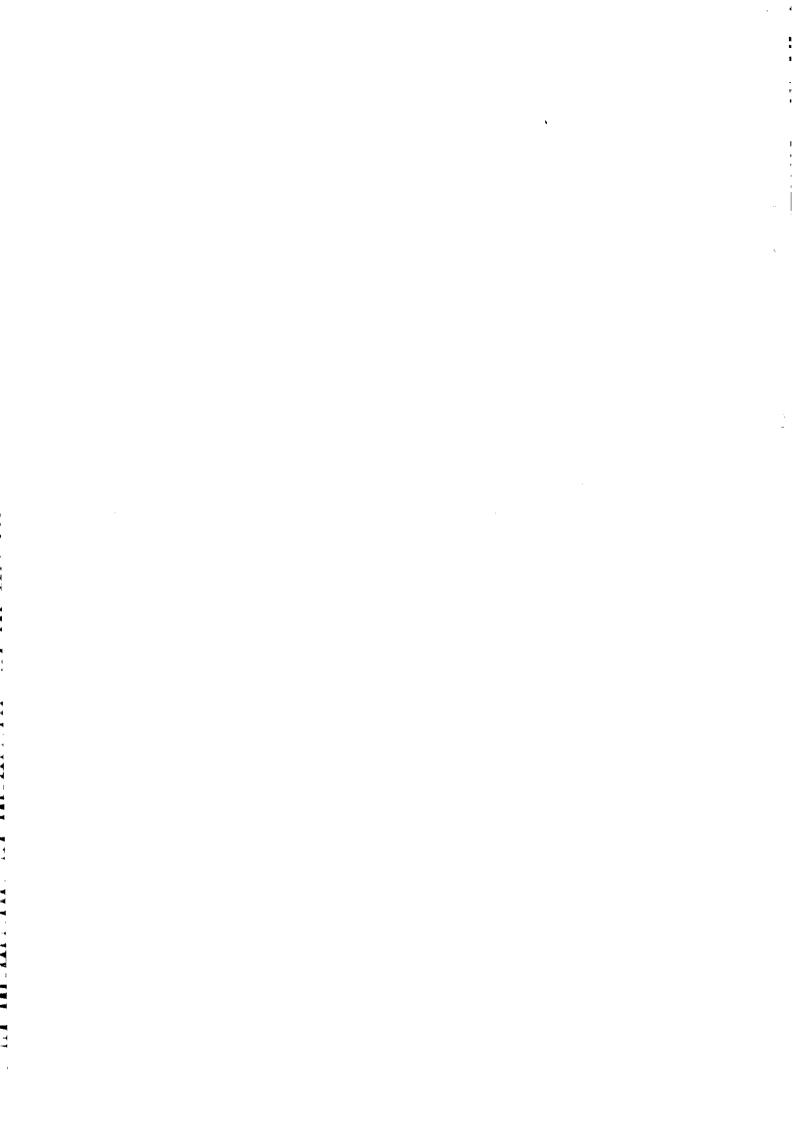
# MATHEMATICAL METHODS IN ELECTROMAGNETIC THEORY MMET'94

7-10 September 1994, Kharkov, Ukraine

The two preceding International Conferences on Mathematical Methods in Electromagnetic Theory (MMET'90 and MMET'91) caused a great interest of the participants, both from inside and outside the Former Soviet Union. This lead us to the conclusion of the necessity of holding the MMET conference on a regular basis.

MMET'94 is the fifth conference in this series, the first two being for domestic attendance only with Russian as working language. This time the Conference is organized by the

National URSI Committee of the Ukraine, in cooperation with the URSI Commission B. It was held on September 7-10, 1994, in the Kharkov State University. I am grateful to Prof. L.N. Litvinenko, Vice-President of the Ukrainian NC URSI, Prof. O.A. Tretyakov, Chairman of the Commission B of NC URSI, Prof. V.A. Svich, Rector of the Kharkov State University, and Prof. A.D. Olver, Chairman of the URSI Commission B, and the staff of the ERO USARDSG-UK for their great support and encouragement.

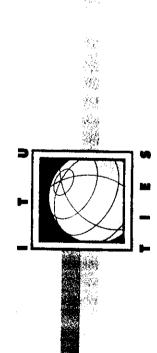


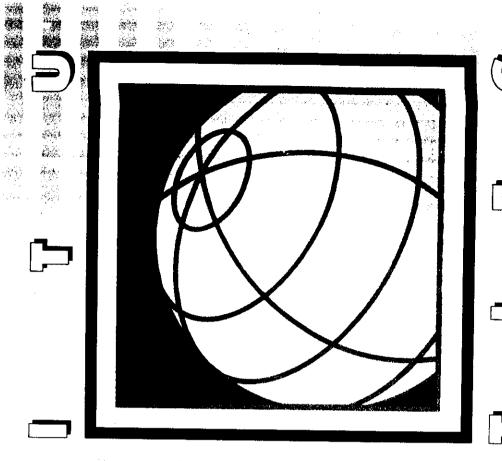


# ITU TIES HELPDESK

For additional information, support and registration please contact:

ITU TIES HELPDESK International Telecommunication Union Information Services Department Place des Nations 1211 Geneva 20 Switzerland TEL: +41 22 730 5054 FAX: +41 22 730 5337 Internet email: helpdesk@itu.ch X.400 email: S=helpdesk; P=itu; A=arcom; C=ch Telex: 421 000 uit ch







£14.78.



# ITU TELECOM INFORMATION EXCHANGE SERVICES



a set of networked information resources and services offered The ITU Telecom Information Exchange Services (ITU TIES) is



charge or registration, includes: TIES Public Services, open to the general public without

- General information about the ITU
- Access to ITU public documents
- Access to ITU public databases
- Access to information services of other UN organizations
- Access to the global Gopher server network
- Auto-answering robot mailboxes (e.g., ITUDOC)



services provided include: organizations, UN and specialized agencies, etc. The States, telecom operators, IT industries, standardization activities: Administrations and Missions representing Member telecom-related information by the participants in ITU support the requirements tor electronic exchange of The goal of the TIES Services for Registered Users is to

- All TIES Public Services mentioned above
- Access to non-public ITU documents
- Internet and X.400 electronic mail accounts
- Internet Telnet and FTP services
- Access to restricted or subscription-based ITU databases (e.g., tariffs database)

 Access to other external information services (e.g., ETSI, UN ICC)

emulation program (examples include Procomm, Crosstalk, Kermit, MS-Windows Terminal). Required software on your computer is a VT100 terminal

- Public TELNET access: gopher.itu.ch
- Registered TELNET access: ties.itu.ch
- X.25 access: #2284681111112
- Dial-up access: +41-22-733-7575

services for registered users or enter "gopher" to access the At logon enter your username and password to access the



The pointer to the TIES Gopher is:

Host=into.itu.ch Name=International Telecommunication Union (ITU)

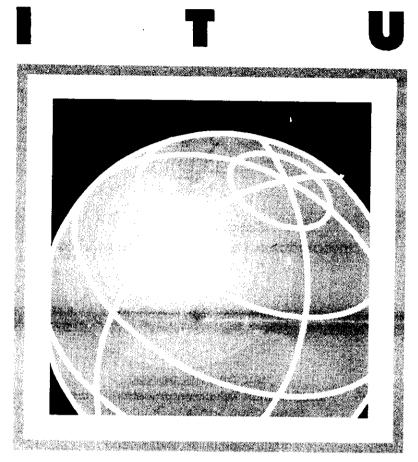
Port=70



Restricted to registered users: ftp.itu.ch



body of the message to get a help file describing the use of Send an Internet email to itudoc@itu.ch with HELP in the the ITUDOC autoanswering robot



TIES

Public Services Guide

October 1994



# Copyright © 1994 International Telecommunication Union



ITU TIES HELPDESK
International Telecommunication Union
Information Services Department
Place des Nations
1211 Geneva 20, Switzerland

TEL: +41 22 730 5054 or 5555
FAX: +41 22 730 5337
Internet: helpdesk@itu.ch
X.400: S=helpdesk; A=arcom; P=itu; C=ch

Telex: 421 000 uit ch

### TABLE OF CONTENTS

INTRODUCTION	
WHAT IS THE ITU?	
ITU TELECOMMUNICATION STANDARDIZATION SECTOR ITU RADIOCOMMUNICATION SECTOR ITU TELECOMMUNICATION DEVELOPMENT SECTOR TELECOMMUNICATION DEVELOPMENT SECTOR	
TIES SERVICES	
TIES PUBLIC SERVICES	10
TIES SERVICES FOR REGISTERED USERS	11
SIGNING UP FOR TIES SERVICES FOR REGISTERED USERS	12
CONNECTING TO TIES	13
THE INTERFACE: GOPHER	14
TIES INTERACTIVE INTERFACE.	
TELNET	
X.25	
DIAL-UP	
TIES CLIENT/SERVER INTERFACE	15
TIES ELECTRONIC MAIL INTERFACES	16
USING THE TIES INTERACTIVE INTERFACE	17
GOPHER BASICS	18
DISPLAYING DOCUMENTS/FILES	21
ACCESSING ITU INFOBASES	22
THE ITU DOCUMENT STORE (ITUDOC)	24
SEARCHING USING KEYWORDS IN TITLES	28

DOWNLOADING DOCUMENTS/FILES	32
NAVIGATING THROUGH NON-ITU GOPHERSPACE	33
INFORMATION SEARCH IN NON-ITU GOPHERSPACE	34
THE "FLIP SIDE" OF GOPHER	37
TIES SERVICES FOR REGISTERED USERS	38
USING TIES ELECTRONIC MAIL INTERFACES	
ITUDOC ELECTRONIC MAIL INTERFACE	38
TAM EMAIL ADDRESS FOR ITUDOC	39
ITUDOC AUTO-ANSWERING MAILBOX COMMANDS	40
ITUDOC ROAD MAP AND INDEX FILES	44
TIPS USING THE ITUDOC EMAIL INTERFACE	45
HOW TO GET HELP	
GENERAL TIES HELP	45
HELP ON ITU-T ELECTRONIC INFORMATION RESOURCES	46
HELP ON ITU-R ELECTRONIC INFORMATION RESOURCES	46
HELP ON ITU-D ELECTRONIC INFORMATION RESOURCES	47
ANNEX A - QUICK START FOR EXPERTS	
ANNEX B - USING AN INTERNET ACCESS PROVIDER	
PDIAL - PUBLIC DIALUP INTERNET ACCESS LIST	50
TIPS ON CHOOSING AN INTERNET ACCESS PROVIDER	50
PUBLIC DATA NETWORK ACCESS INFORMATION	51
SAMPLE INTERNET ACCESS PROVIDERS	52
NORTH AMERICA	52
MAINLAND EUROPE	54
NORTH AFRICA	55
ANNEX C - DOCUMENT RETRIEVAL FORMATS	56
ANNEX D - TIES/ITUDOC CONDITIONS OF USE AND COPY	RIGHT
NOTICE	,

TIES

ANNEX E - ACCESS TO ITUDOC FROM MAJOR EMAIL SERVICE , PROVIDERS	
ANNEX F - TIES REGISTRATION FORM63	

Page 5

October 1994

### Introduction

Welcome to Telecom Information Exchange Services (TIES). TIES is a set of networked electronic information resources and services offered by the International Telecommunication Union (ITU). The goal of TIES is to support the requirements for electronic exchange of telecom-related information by the general public and the ITU's member countries.<sup>1</sup>

### What is the ITU?

The ITU is a United Nations specialized agency dealing with telecommunications headquartered in Geneva, Switzerland. ITU activities include the regulation, standardization, coordination and development of international telecommunications. The International Telecommunication Union is basically organized into three sectors that reflect its main activities (standardization, radiocommunication and development).

- ITU Telecommunication Standardization Sector (ITU-T)
- ITU Radiocommunication Sector (I7 U-R)
- ITU Telecommunication Development Sector (ITU-D)

TIES electronic information resources and services principally relate to the activities of these sectors. A summary of the three ITU sectors is given below.

### **ITU Telecommunication Standardization Sector**

The Telecommunication Standardization Sector (ITU-T) fulfills the purposes of the ITU relating to telecommunication standardization by studying technical, operating and tariff questions and adopting recommendations on them with a view to standardizing telecommunications on a worldwide basis.

The ITU-T (formerly CCITT) facilitates the development of global standards (Recommendations) for telecommunications, including:

general network planning, network operation and network architecture

<sup>&</sup>lt;sup>1</sup>183 as of March 1994.

- terminals (e.g. data modems, multiplexer), systems (e.g. switching/signaling/transmission), networks (e.g. telephone, data. ISDN, B-ISDN)
- services and applications (e.g. multimedia)
- operations and maintenance (e.g. telecommunication management network)
- tariff principles and accounting rates.

In order to achieve its objectives, ITU-T works through world telecommunication standardization conferences, telecommunication standardization study groups, the Telecommunication Standardization Advisory Group and the Telecommunication Standardization Bureau (TSB). The Bureau, headed by an elected Director, provides technical, administrative and logistic support for the conferences and meetings of the groups mentioned above.

The ITU-T work programme for the 1993-1996 period comprises 289 questions on a diversity of subjects such as ISDN services, directory services for telematic services, tariffs principles for global virtual network services or for intelligent networks, customer network management service, colour faxes, Programming Communication Interfaces, telematics on ISDN, long term intelligent network architecture and intelligent network capability sets, signaling requirements for FPLMTS (Future Public Land Mobile Telecommunication Systems), telecommunications for the physically impaired, integrated video services, broadband connectionless data service on broadband ISDN, optical systems, SDH and ATM equipment, to name but a few.

ITU-T standards especially relevant to computing are the V series of recommendations on modems (e.g., V.32, V.34, V.42), the X series on data networks and OSI (e.g., X.25, X.200 Series, X.400 Series, X.500 Series, X.700 Series), the I and Q series that define ISDN, the Z series that define specification and programming languages (SDL, CHILL), the T series on text communication (teletex, fax, videotex, ODA) and the H series on digital sound and video encoding.

### **ITU Radiocommunication Sector**

The ITU Radiocommunication Sector is responsible for international radio regulation and for recommendations on technical and operational matters in radiocommunication. It continues the work of World Administrative Radio

Conferences, the International Frequency Registration Board (IFRB) and the International Radio Consultative Committee (CCIR).

World Radiocommunication Conferences (WRC) are held normally every two years to approve international radio regulations which facilitate compatible and equitable use of the radio frequency spectrum and satellite orbits. The first WRC was held in November 1993.

The Radiocommunication Assembly (RA) and ITU-R Study Groups (formerly CCIR) support the work of conferences and issue Recommendations on technical and operational questions for radiocommunication systems and services. The RA meets normally every two years, in association with the WRC, to organize and approve work of Study Groups. Study Groups represent the work of some 1500 technical and regulatory experts from administrations and telecommunication organizations, in some sixty Task Groups and Working Parties. Approximately 630 ITU-R Recommendations are currently in force.

For example, ITU-R Study Groups set up for the 1994-1995 Study Period include work on spectrum management, science services, inter-service frequency sharing and compatibility, radiowave propagation, fixed services, fixed-satellite services, broadcast services (sound and television) and mobile, radiodetermination and amateur services.

A part-time Radio Regulations Board (RRB) approves procedures which may be required for application of the Radio Regulations, and is consulted by the Bureau on issues of application of the radio regulations, or interference cases, which the Bureau itself cannot satisfactorily resolve.

The specialized secretariat of the Radiocommunication Sector is the Radiocommunication Bureau (BR): the acronym is derived from the French..

### ITU Telecommunication Development Sector

The ITU was one of the first organizations to grasp the connection between the development of telecommunications and general socio-economic development in the developing world. The ITU Development Sector's aim is to contribute to the growth and development of telecommunications throughout the world, with particular emphasis on the requirements of developing countries.

Activities of the Development Sector include providing advice, information and assistance in all aspects of telecommunications including structural, policy and

regulatory issues. This assistance may include: advising and assisting in network planning, evaluating existing systems and advising on the operation and maintenance of such systems and on the installation of new ones, preparing specifications for equipment in collaboration with the requesting administrations, participating in the evaluation of tenders, mobilizing resources, modernizing and expanding networks, advising and assisting in all aspects of training, engineering and management, establishing research and development centres, formulating development programmes/projects, as well as executing projects financed by the United Nations Development Programme (UNDP) and others.

The specialized secretariat of the Development Sector is the Telecommunication Development Bureau (BDT): the acronym is derived from the French.

### **TELECOM**

Part of the General Secretariat of the ITU, TELECOM is responsible for the organization, every four years, of a world telecommunication exhibition and forum. TELECOM also organizes regional telecommunication exhibitions and fora at four-year intervals for Asia, Africa, Americas and Europe at the invitation of telecommunication administrations of ITU Member countries.

The exhibitions offer a very comprehensive display of telecommunication equipment and services on an international scale. All the aspects of modern telecommunications, from digital transmission and switching technologies to integrated services digital networks, are presented. TELECOM is a unique showcase second to none.

The fora, considered a privileged meeting ground for leaders from every professional background, are organized in conjunction with the exhibition and deal with modern technology as well as with emerging trends in the political, legal, economic and technical areas of telecommunications. Administration, management, financing, research, equipment supply and every other issue relating to the transport and processing of information is discussed.

### **TIES Services**

TIES provides access to electronic information resources and services of the ITU and other networked sites. TIES services can be basically divided into TIES Public Services and TIES Services for Registered Users. Both are described below.

### **TIES Public Services**

TIES Public Services are open to the general public without charge or registration. Here are a few examples:

- General information about the ITU: organization, functions and contacts;
- Access to public ITU documents such as telecom/computing standards<sup>2</sup> and other standards-related information;
- Directories for ITU Staff and access to the Global Telecom Directory (contains global telecom contact names/offices);
- ITU Infobases (databases) containing information such as calendar of ITU
  events, list of ITU publications dealing with standardization,
  radiocommunication and development, project status of ITU-T
  Recommendations, ITU-D development activities, Data Network
  Identification Codes (DNIC);
- United Nations Infobases (Register of UN Development Activities, Directory of UN Databases and Information Services (DUNDIS), books in print of the United Nations System);
- Access to information services of other UN organizations (e.g., UNDP, WHO);
- Access to the international Internet Gopher server network;

<sup>&</sup>lt;sup>2</sup> Access to electronic standards will require a subscription fee starting sometime in 1995.

- Access to Gopher information search tools (e.g., Veronica);
- World-wide library catalogs;
- Auto-answering robot mailboxes (ITUDOC, WHOIS);
- And more...

### **TIES Services for Registered Users**

TIES Services for Registered Users are only available to participants in ITU activities. Examples of Services for Registered Users include:

- All TIES Public Services:
- Access to restricted documents on the TIES Gopher. For example, this gives
  access to documents restricted to participants in ITU activities.
- Internet and X.400 electronic mail accounts;
- Internet Telnet and FTP services;
- Access to restricted or subscription-based ITU databases such as:
  - Telecom Services and Tariffs (joint project with Lynx Technologies);
  - MARS Maritime mobile Access & Retrieval System;
- Access to other non-ITU information services such as:
  - Bulletin boards of other organizations (e.g., European Telecommunications Standards Institute, T1 BBS-2: Committee T1 Bulletin Board System);
  - Gateway to UN International Computing Centre (ICC);
  - European Telecommunications Standards Institute (ETSI);
  - European Conference of Post and Telecom Administration (CEPT);
  - COSINE Network's Central Information Service:

- Telecommunication Technology Committee Bulletin Board (TTC);
- And more...

### Signing Up for TIES Services for Registered Users

TIES Services for Registered Users are only available if you are a participant in ITU activities and associated with:

- ITU Member States' ministries, embassies, missions
- Telecommunications Operating Agencies
- Industrial Organizations
- National Frequency Administration Services
- Telecommunications Research Organizations
- International and Regional Telecommunications Organizations
- Standardization Organizations
- International organizations

Services for Registered Users are also available on special application for:

- Telecommunications Consulting Needs
- Libraries, Training Institutes, Universities

A TIES Registration Form is attached to the end of this document. Additional registration forms are available from:

ITU TIES HELPDESK
International Telecommunication Union
Information Services Department
Place des Nations
1211 Geneva 20
Switzerland

TEL: +41 22 730 5554 FAX: +41 22 730 5337

Internet email: helpdesk@itu.ch

X.400 email: S=helpdesk;A=arcom;P=itu;C=ch

Telex: 421 000 uit ch

An electronic version of the TIES Registration Form is available by return electronic mail by sending the following message:

To: itudoc@itu.ch FROM: (NAME) SUBJECT: (IGNORED)

START GET ITU-2659 END

### **Connecting to TIES**

No registration is required for access to TIES Public Services. If you meet the requirements for access to TIES Services for Registered Users, please complete and return the TIES Registration Form attached to the end of this document. Electronic versions of the TIES Registration Form can be submitted by electronic mail to the address on the inside cover of this guide. Processing of your application should take 2-4 weeks. You will receive documentation and a logon name/password by return mail.

TIES supports three access methods: interactive, client/server and via email. The best method for you to access TIES depends on the computing and connectivity options that you have available. If you're an expert in computers

and communications, you can go immediately to Annex A - Quick Start for Experts on page 48.

### The Interface: Gopher

The TIES interface is mainly based on computer software originally developed at the University of Minnesota called **Gopher**. The basic function of Gopher is to facilitate access to networked electronic information resources. Thousands of Gopher servers around the world now account for a considerable fraction of the traffic on the Internet, a world-wide network of computers.

Gopher uses a menu-based system that permits navigating through hierarchies of electronic information resources or services. You can think of Gopher as sort of an electronic "tree". Navigating along different "branches" takes you to the electronic "leaves" which can be documents, graphic images, software, access to databases or gateways to other computers.

A detailed description of the method to access TIES is given below. Some of the connectivity information provided is fairly technical and possibly inappropriate for your computing environment, telecommunications infrastructure or geographical location. You may wish to consult with local experts for the best solution in your environment. As a general rule, remember that obtaining a high speed and reliable connection will greatly facilitate access.

### **TIES Interactive Interface**

The interactive interface is currently (October 1994) the <u>only</u> method to access TIES Services for Registered Users. Required software on your computer is a VT100 full-screen terminal emulation program (examples include Procomm, Crosstalk, Reflection, Kermit, MS-Windows Terminal). Connectivity to the TIES interactive interface is possible via Telnet, X.25 or direct modem dial-up.

An appealing connectivity option (in terms of speed and cost) is to connect via an Internet access provider offering public dial-up access to a **Telnet** service. See Annex B for some tips on using an Internet access provider.

When asked for a username, login as 'gopher' for access to TIES Public Services or with your TIES username and password for access to TIES Services for Registered Users. Connection details are given below:

### TELNET

If you have a TIES username and password:

ties.itu.ch

If you don't have a TIES username and password (logon as 'gopher'): gopher.itu.ch

### X.25

Call the X.25 DTE address, on TELEPAC, the Swiss PSPDN:

#228468111112

where # is local prefix for international routing

### **DIAL-UP**

+41 22 733 7575 (Swiss telephone number)

Direct dial-up is <u>only</u> recommended for Western Europe. Supported dial-up modern protocols include ITU-T (CCITT) V.21, V.22, V.22bis, V.32, V.32bis, V.42, V.42bis, Bell212A and MNP 2, 3, 4, 5. Basic settings should be no parity, 8 data bits (necessary for on-line reading of multilingual material), speed 300 to 14,400 bps.

### TIES Client/Server Interface

Gopher uses what is called the client/server model. This means that the computing labor is divided between the program the user invokes (the "client") and a program running on a main computer (the "server"). When you use the TIES interactive interface described above, you are actually accessing a shared Gopher client running on an ITU computer. However, it is possible to run client software directly on your computer. Advantages include support for a graphical user interface and direct file "saving" to your local computer (instead of "downloading"). Examples of graphical clients include NCSA Mosaic (a World Wide Web browser), Macintosh TurboGopher and MS-Windows WinGopher. A disadvantage of using the Gopher client/server interface is that access is currently only possible to TIES Public Services.

To run a Gopher client on your computer, you require a direct Internet connection or dial-up Internet "IP" services (e.g., supporting SLIP or PPP) from an Internet access provider. Note that configuration of dial-up IP services can require considerable system configuration expertise.

The 'Gopher' pointer to the ITU Gopher Server is:

# Name=International Telecommunication Union (ITU) Host=info.ltu.ch Port=70

The Uniform Resource Locator (URL) for usage with a World Wide Web browser (e.g., Mosaic, Cello) is:

### gopher://info.itu.ch/

An appealing connectivity option (in terms of speed and cost) is to connect via an Internet access provider offering public dial-up access to a Gopher service. You can locate the TIES Gopher server from other Gopher servers by following a "path" similar to:

Gophers in the World / International Organizations / International Telecommunication Union (ITU)

Gophers in the World / Switzerland / International Telecommunication Union (ITU)

See Annex B for some tips on using an Internet access provider.

### **TIES Electronic Mail Interfaces**

The TIES electronic mail interfaces do not require access to Gopher. Services available include ITUDOC which gives access to the ITU Document Store (containing thousands of public telecom documents) and the WHOIS UN email directory query service. To access the TIES electronic mail interfaces, you can use any email system that supports Internet email style addressing.<sup>3</sup> This includes major service providers that have Internet email gateways (e.g., MCI and Compuserve - see page 38).

<sup>3</sup>RFC 822 Addressing

The ITU Document Store is described in detail on pages 24-27 and the ITUDOC electronic mail interface is described on page 38. You can also get a help file describing use of ITUDOC by sending the following email message:

To: Itudoc@itu.ch FROM: (NAME) SUBJECT: (IGNORED)

### HELP

Help on the WHOIS UN email directory query service are available by sending the following email message:

To: whois@itu.ch FROM: (NAME) SUBJECT: (IGNORED)

HELP

### Using the TIES Interactive Interface

When you use the TIES Interactive Interface, you are actually using a Gopher client located on an ITU computer. Examples of using this Gopher interface are shown below. Most Gopher interfaces share the same basic principles of use. However, if you are running a Gopher client on your computer or accessing a client provided by an Internet access provider, you may need to refer to the specific documentation for that client.

If you are connecting via Telnet, X.25 or dial-up, make sure that your terminal emulation software is set up to emulate at least VT100. After connecting, you will receive the following prompt.

I.T.U. Telecom Information Exchange Services (TIES)
Username:

Login as 'gopher' for access to TIES Public Services or with your TIES username and password for access to TIES Services for Registered Users.

Page 17

October 1994

### **Gopher Basics**

After logging on, the TIES main Gopher menu appears. 4

```
International Telecommunication Union (ITU)

--> 1. About ITU, TIES, ITUDOC, Copyright, Gopher.../
2. Search menu titles in ITU Gopher <?>
3. ITU Standards, Publications, Databases, Meetings, Press.../
4. ITU Telecommunication Standardization Sector/
5. ITU Radiocommunication Sector/
6. ITU Telecommunication Development Sector/
7. ITU General Secretariat & TELECOM/
8. ITU Office of the Secretary-General/
9. ITU Kyoto Plenipotentiary Conference 94/
10. Telecommunications-related topics/
11. United Nations & international organizations/
12. Other information services/
13. Email, private directory, Telnet, FTP, ALL-IN-1, .../

Press ? Help, q Quit, D Download Page: 1/1
```

As shown above, the main Gopher interface is a menu of numbered items with titles. To get on-line help, press '?'. To the left of the menu is a pointer  $\rightarrow$  that can be moved up and down the item list with the cursor keys.<sup>5</sup> Titles ending in the slash " $\Gamma$ " character indicate there are sub-menus.

Menu items can be selected by pointing to them or typing in their number then pressing <Enter>. To move up a menu, press 'u' for up. Pressing 'm' takes you back to the main menu. The "Page: x/x" field at the bottom right of the screen indicates the current page and total number of pages. If there are multiple pages of items then moving the pointer → below the last item will jump to the first

October 1994

<sup>&</sup>lt;sup>4</sup> Screens in this document may differ slightly from what you see due to TIES enhancements.

<sup>&</sup>lt;sup>5</sup>If you cannot use the cursor keys to move the pointer up and down TIES has a problem recognizing your terminal emulation - try setting it to VT100. If you are using Microsoft Windows Terminal, make sure the "Settings / Terminal Preferences / Use Function, Arrows, and Ctrl Keys for Windows" check box is unclicked.

item on the next page. Likewise, moving the pointer  $\rightarrow$  above the first item will jump to the last item on the last page.

TIES TIP: Don't be afraid to explore. You can always retrace your steps by pressing 'u' or go to the main menu by pressing 'm'.

A quick help reference to the TIES Gopher interface is given below.

Quick TIES Gopher Help  Moving Around				
Down	Move to next line			
Right, Enter	"Enter" or display current item			
Left, u	"Exit" current item or go up a level			
→, +, Page Down	View next page			
←, -, Page Up	View previous page			
0-9	Go to a specific line			
m	Go back to the main menu			
Other Comman	nds			
D	Download a file			
S	Save file (TIES Registered Users or if you are			
	running Gopher client (e.g. Mosaic))			
<u>q</u> O	Quit with prompt			
	Quit unconditionally			
	Display technical information about current item			
<u>/</u>	Search for an item in the menu			
n	Find next search item			
O Ctrl D	Open a Gopher server			
Ctrl-R	Refresh the screen			

If you select "About ITU, TIES, ITUDOC, Copyright, Gopher...?" from the main TIES menu, the corresponding sub-menu is displayed.

```
About ITU, TIES, ITUDOC, Copyright, Gopher...

--> 1. TIES/ITUDOC Conditions of Use and Copyright Notice
2. About ITU/
3. About ITU TIES/
4. About ITUDOC/
5. About Gopher/
6. About Internet/

Press ? Help, q Quit, u up a menu, D Download Page: 1/1
```

Note that some menu items also end in the slash "/" character indicating that there are additional sub-menus. If you select "About ITU/" from this menu, the corresponding sub-menu is displayed.

```
About ITU

--> 1. ITU's History/
2. ITU Member Countries/
3. ITU's Constitution, Convention/
4. Members of Radiocommunication Sector (ITU-R)/
5. Members of Telecommunication Development Sector (ITU-D)/
6. Members of Telecommunication Standardization Sector (ITU-T)/
7. What is ITU?/
8. The New ITU/
9. ITU's Goal and Mission/
10. ITU's Organization/
11. ITU's Top Management/
12. ITU Acronyms/
13. ITU Headquarters Address/
14. ITU Logo in Windows Bitmap Format (640 x 480 (VGA) size) - can be .../

Press ? Help, q Quit, u up a menu, D Download Page: 1/1
```

### Displaying Documents/Files

If you select "What is ITU/" from the menu above, the available formats for this item is shown along with the size of the file and date it was last updated. This item is a text (ASCII) file and therefore can be displayed on-screen: pressing <Enter> displays the corresponding text.

What is ITU

International Telecommunication Union (ITU)

The ITU is a world-wide organization within which governments and private sector coordinate the establishment and operation of telecommunication networks and services; it is responsible for the regulation, standardization, coordination and development of international telecommunications as well as the harmonization of national policies.

The ITU is an agency of the United Nations.

Press <RETURN> to continue,

<m> to mail, <D> to download, <s> to save, or to print:

The text is left displayed on the screen until you type <Return> or <Enter>. If the text is longer than a single screen, pressing <space> displays the next screen. If the text is longer than a single screen, pressing 'q' then <Enter> quits viewing and returns you to the previous menu.

TIES TIP: You can email a document to yourself after viewing it. After you quit viewing, press 'm' to mail it to an Internet email address. Internet email addresses have the form name@domain (for example, "jlsmith@xyz.com"). If you have a TIES account, your TIES Internet email address is "firstname.lastname@itu.ch". You can also use your TIES logon name as a mail address.

As demonstrated, most Gopher commands are executed by typing single letter keystrokes. Pay attention to the case of letters: Gopher <u>differentiates</u> between upper and lower case letters. For example, pressing 'q' to quit Gopher asks you for confirmation while pressing 'Q' causes you to quit immediately.

ı

### **Accessing ITU Infobases**

TIES provides infobases (a kind of database) which you can query. If you select "ITU Standards, Publications, Databases, Meetings, Press...!" from the main TIES menu, the following screen is displayed.

```
ITU Telecom Information Exchange Services (TIES)

ITU Standards, Publications, Databases, Meetings, Press...

--> 1. ITU Telecommunication Standards (ITU-T Recommendations)/
2. ITU Radiocommunication Standards (ITU-R Recommendations)/
3. ITU Publications (July 1994 Catalogue)
4. ITU Press Releases/
5. ITU Schedule of Meetings/
6. ITU-Lynx Tarriffs and MARS Databases
7. ITU Global Telecom Directory/
8. Catalogue of ITU-T Recommendations/
9. Catalogue of ITU-R Recommendations/
10. Catalogue of ITU-R Questions/
11. Database of ITU Software for Frequency Management/
12. ITU/BDT Databases/
13. ITU Constitution, Convention, .../
14. ITU Telephone Directory/
15. ITU Telecommunication Terminology Database (TERMITE)

Press ? Help, q Quit, u up a menu, D Download Page: 1/1
```

Let's imagine we are looking for telecom contact points in Switzerland. The "ITU Global Telecom Directory/" is an infobase of telecom contacts around the world so we'll select that.

```
ITU Telecom Information Exchange Services (TIES)

ITU Global Telecom Directory

--> 1. How to Search the ITU Global Telecom Directory

2. Search the ITU Global Telecom Directory <?>
3. How to Get a Printed Copy

4. Please HELP to Keep the Directory Up-to-Date

Press ? Help, q Quit, u up a menu, D Download

Page: 1/1
```

Note the menu item "Search the ITU Global Telecom Directory <?>". Gopher menu items ending with the symbol "<?>" indicate that this is a database search. If you select this item, you are prompted for the words to search for:

```
ITU Telecom Information Exchange Services (TIES)

ITU Global Telecom Directory

1. How to Search the ITU Global Telecom Directory

-> 2. Search the ITU Global Telecom Directory <?>
3. How to Get a Printed Copy
4. Please HELP to Keep the Directory Up-to-Date

----Search the ITU Global Telecom Directory

Words to search for

switzerland

[Help: ^-] [Cancel: ^G]

Press ? Help, q Quit, u up a menu, D Download

Page: 1/1
```

We can now type in "switzerland" and press <Enter> which will result in a list of telecom contacts in Switzerland.

Page 23

October 1994

Search the ITU Global Telecom Directory: switzerland

--> 1. Swiss Telecom PTT, (Switzerland)
2. Swiss Telecom PTT, (Switzerland)
3. Cerberus Ltd., (Switzerland)
4. Zellweger Telecommunications, (Switzerland)
5. Joint Inspection Unit, (Switzerland)
6. Landis & Gyr Communications (Suisse)S.A., (Switzerland)
7. Siemens-Albis S.A., (Switzerland)
8. Alcatel STR AG, (Switzerland)
9. Commission économique pour l'Europe, (Switzerland)
10. Organisation météorologique mondiale, (Switzerland)
11. Union postale universelle, (Switzerland)
12. Swiss Telecom PTT, (Switzerland)
13. Ascom Tech AG, (Switzerland)
14. Union Internationale des télécommunications, (Switzerland)
15. Organisation Internationale du travail, (Switzerland)
16. Comité consultatif pour les questions administratives, (Switzerland)
17. Union internationale de l'industrie du gaz, (Switzerland)
18. Office des Nations Unies à Genève, (Switzerland)
Press ? Help, q Quit, u up a menu, D Download
Page: 1/3

# The ITU Document Store (ITUDOC)

The ITU Document Store (ITUDOC) is ITU's electronic document database. ITUDOC contains thousands of electronic documents on a wide variety of telecom-related subjects. ITUDOC is organized into a tree structure of hierarchical groups. Access to ITUDOC is possible through several user interfaces including TIES Gopher, FTP,6 and electronic mail. At the root level, the ITU Document Store is divided into main groups that represent the organizational structure of ITU and key topic areas. Therefore, all TIES interfaces basically mirror the structure of the ITU Document Store.

<sup>&</sup>lt;sup>6</sup> FTP (file transfer protocol) is a program for file transfer between Internet connected computers. An advantage of FTP is that it provides very fast file transfer. A disadvantage of FTP is that it has a non-user-friendly interface. Currently, the TIES FTP interface is only available to TIES Registered Users. See the TIES Registered Users Guide for more information.

Every ITU Document Store group has a title and a short name. Each group also has a path which is the list of short names used to reach the group from the root (separated with the '/' character). If you access ITUDOC with a Gopher interface, the titles are used to "navigate" to a specific group. If you access ITUDOC with FTP<sup>7</sup> or the electronic mail interface<sup>8</sup>, you use a group's path to refer to it.

For example, one of the main groups of the TIES Gopher has the title:

# ITU Telecommunication Standardization Sector9

with the corresponding path:

## itu-t

Suppose you're interested in finding Recommendations (standards) published by the ITU Telecommunication Standardization Sector. These are found in:

# ITU Telecommunication Standardization Sector / Recommendations

with the corresponding path:

#### itu-t/rec

Let's suppose you are specifically interested in an X Series Recommendation (e.g., X.400). X Series Recommendations are found in:

# ITU Telecommunication Standardization Sector / Recommendations / X Series Recommendations

with the corresponding path:

## itu-t/rec/x

This group contains the actual documents related to X Series Recommendations.

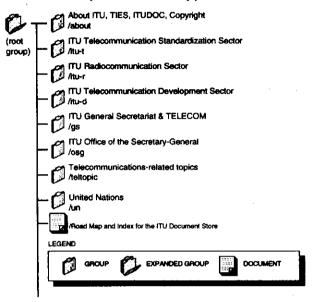
<sup>&</sup>lt;sup>7</sup>Described in the TIES Registered Users Guide.

<sup>&</sup>lt;sup>8</sup>Described on page 38.

<sup>&</sup>lt;sup>9</sup>includes former CCITT groups and documents

Here is a graphical representation of the root group of the ITU Document Store (October 1994). Group titles with paths are shown on the right.

# ITU Document Store (ITU Root Group)



The ITU Telecommunication Standardization Sector Group, shown above in the root group, is partially graphically expanded on the next page (as of October 1994).

# A Series Recommendations Circular Letters 8 Series Recommendations Study Group 1 Study Group 2 /com2 Study Group 4 Study Group 5 List of (TU-T Recommendations Study Group 6 Study Group 7 Study Group 8 /com8 Circular Letter Study Group 9 /com9 Circular Letter Study Group 10 /com10 Study Group 11 Collective Letters Study Group 12 /corn12 Contributions /contr Study Group 13 /corn13 Reports /reports Study Group 14 /com14 Study Group 15 Tariff Group for Africa Tariff Group for Latin America Tariff Group for Asia and Oceania Taniff Group for Europe and the Mediterranean Basin Telecommunication Standardization Advisory Group LEGEND GROUP EXPANDED GROUP DOCUMENT

ITU Document Store (ITU Telecommunication Standardization Sector)

TIES TIP: Please note that because TIES/TUDOC contains electronic publications, usage implies that you accept the conditions of use and copyright notice as described in the document "TIES/TUDOC Conditions of Use and Copyright Notice" (see Annex D).

For example, you can find ITU Telecommunication Standardization Sector Recommendations by selecting from the TIES Gopher main menu, "ITU Telecommunication Standardization Sector/" then "Recommendations/" then the series of Recommendations in which you are interested (e.g., "Series I Recommendations/"). This method takes you progressively down through a hierarchy of items until you find the file or document you need to access.

```
ITU Telecom Information Exchange Services (TIES)
                    ITU Telecommunication Standardization Sector
          TSB Databases (ITU-T Catalogue, ...)/
           Operational Bulletin/
           Lists annexed to Operational Bulletin/
           Recommendations/
           World Telecommunication Standardization Conference/
           Circulars/
           Study Group 1/
           Study Group 2/
      9. Study Group 3/
10. Study Group 4/
       11. Study Group 5/
      12. Study Group 6/
13. Study Group 7/
       14. Study Group 8/
      15. Study Group 9 (formerly CMTT)/
16. Study Group 10/
17. Study Group 11/
       18. Study Group 12/
                                                                                Page: 1/2
Press ? Help, q Quit, u up a menu, D Download
```

# **Searching Using Keywords in Titles**

You can also search across the TIES Gopher hierarchy by selecting from the main menu "Search menu titles in ITU Gopher <?>" Let's imagine you're searching for references to "isdn":

If you enter "isdn" and press <Enter>, the following list of documents is returned. Note that the "Page 1/6" indicates there are six pages of items related to your search request for the text "isdn". You can move to the next page by pressing "Page Down" or moving the pointer below the last item on the screen.

```
Search menu titles in ITU Gopher: isdn

--> 1. [004] Exemple Cover Page - ISDN field trial guidelines / Handbook/
2. [ITU-R 78-1] Use of satellite communication systems in the B-ISDN/
3. [ITU-R 89-2] Compatibility for interworking between the mobile-sat../
4. [com13-r9] Report of the first meeting of the JCG on B-ISDN, Genev../
5. [D.220] Recommendation D.220 - Charging and accounting principles ../
6. [D.232] Recommendation D.232 (rev. 1) - Specific tariff and accoun../
7. [D.240] Recommendation D.250 - General charging and accounting principles ../
8. [D.250] Recommendation D.250 - General charging and accounting principles ../
9. [D.260] Recommendation D.260 - Charging and accounting capabilitie../
10. [E.721] Recommendation E.721 - Network grade of service parameters../
11. [E.164] Recommendation E.164...331 - Numbering plan for the ISDN era/
12. [E.172] Recommendation E.172 - ISDN routing plan/
13. [E.710] Recommendation E.710 - ISDN traffic modelling overview/
14. [E.730] Recommendation E.710 - ISDN dimensioning methods overview/
15. [E.215] Recommendation E.215 - Telephone..llite services of INMARSAT/
16. [E.331] Recommendation E.331 - Minimum user-terminal interface for../
17. [E.846] Recommendation E.846 - Accessibility for 64 kbits circuit ../
18. [F.721] Recommendation F.721 - Videotelephony teleservice for ISDN/
Press ? Help, q Quit, u up a menu, D Download Page: 1/6
```

TIES TIP: Note that some titles are long and disappear off the right side of the screen. A trick to read the entire title on screen is to press "=". This is the Gopher command for displaying technical information about an item but it also shows the entire title.

Sometimes several formats or languages are available for a specific item. For example, if you select from the list above, ITU-T Recommendation D.220 "Charging and accounting principles to be applied to international circuit-mode demand bearer services provided over the integrated services digital network (ISDN)", you may see a menu like this.

```
ITU Telecom Information Exchange Services (TIES)

[D.220] Recommendation D.220 - Charging and accounting principles to be appli...

--> 1. [POSTSCRIPT Lang: E Bytes: 135938 Updated: 94-07-08 ITU-3176]
2. [POSTSCRIPT Lang: F Bytes: 105547 Updated: 94-07-08 ITU-2280]
3. [POSTSCRIPT Lang: S Bytes: 105124 Updated: 94-07-08 ITU-3364]
4. [WINWORD2.0 Lang: E Bytes: 55873 Updated: 94-05-25 ITU-1066. <Bin>
5. [WINWORD2.0 Lang: F Bytes: 60993 Updated: 94-05-25 ITU-1066. <Bin>
6. [WINWORD2.0 Lang: S Bytes: 61047 Updated: 94-05-25 ITU-1067. <Bin>
Press ? Help, q Quit, u up a menu, D Download Page: 1/1
```

This means that this document is available in 6 formats and/or languages. In this case, the document is available in English, French and Spanish in Postscript and Microsoft Word for Windows 2.0 format. Each document listed also has a last updated date (yy-mm-dd) and a file size (useful to estimate downloading times).

The entry of the form ITU-xxxx is the ITU's Unique Permanent Identifier (UPI) code for the document. The UPI is used to uniquely identify documents/files stored on ITUDOC. If you already know the UPI of a document, you can search for it directly.

Note that although Postscript files have an ASCII representation (indicated by no symbol at the end of the item), they are not meant to be read on-screen. They should be downloaded and copied to a Postscript printer or viewed with a

Postscript file viewer. 10 Items ending with '<Bin>' or '<PC Bin>' are binary documents/files and cannot be displayed on screen: they can only be downloaded 'D' or saved 's'.

- TIES TIP: Saving 's' is only permitted if you are running a Gopher client or World Wide Web browser (e.g., Mosaic) on your computer or if you logged on as a registered TIES user. In the latter case, files are saved to your TIES private directory (only available to TIES Registered Users). If you need the file on your computer, it is probably easier to directly download it from Gopher.
- TIES TIP: You should, of course, make sure you have the capability to read a specific format before retrieving it. For example, almost all computing environments can read simple ASCII text files. However, if you wish to retrieve a document posted in Microsoft's Word for Windows format, you will require access to a corresponding version of this program or an appropriate filter into your word processing program. See Annex C for a description of some common formats posted.
- TIES TIP: Some documents/files stored on ITUDOC and accessed either through the TIES Gopher, FTP or electronic mail interface have been archived or compressed with the PKZIP program. This is indicated by the name "ZIP" or the prefix "ZIP" before the document/file format. For example, compressed Postscript files are referred to as "ZIPPOSTSCRIPT". To uncompress this file, you need a program called PKUNZIP or equivalent. Self-extracting MSDOS and Macintosh versions of these utilities are available under:
  - ⇒ About ITU, ITU TIES, ITUDOC, Copyright Notice, Gopher.../
     ⇒ About ITU TIES/
     ⇒ Other TIES Information/
     ⇒ Utilities/

 $<sup>^{10}</sup>$ A popular public domain Postscript file viewer is "Ghostscript". This is available from many computer sites around the world.

<sup>11</sup> Described in the TIES Registered Users Guide.

# **Downloading Documents/Files**

TIES supports several methods for downloading documents/files (e.g., Kermit, XModem, Reflection WRQ, FTP, email). Let's imagine you want to download the English version of Recommendation V.120 in Postscript format: press 'D' and the following screen appears.

```
ITU Telecom Information Exchange Services (TIES)
[D.220] Recommendation D.220 - Charging and accounting principles to be appli...
-->+---[POSTSCRIPT Lang: E Bytes: 135938 Updated: 94-07-08 ITU-3176]---+
            1. Zmodem
            2. Ymodem
                                                                           Bin>
            3. Xmodem-1K
                                                                           Bin>
             4. Xmodem-CRC
             5. Kermit
             6. Text
             7. Mail File
             8. Print File
             9. WRQ
       Choose a download method (1-9):
       [Help: ?] [Cancel: ^G]
Press ? Help, q Quit, u up a menu, D Download
                                                                    Page: 1/1
```

By typing a number then <Enter>, you can choose the desired file transfer protocol. For example, selecting the menu item "Kermit" will start Kermit file transfer on the TIES Gopher Server. You can then invoke the corresponding file transfer protocol on your computer, supply a local filename, and download the file.

TIES TIP: If you are using the Reflection® terminal emulation program, here's a tip on setting up file transfer for uploading or downloading files:

Select File / Transfer Setup...
Select Transfer Protocol: WRQ
Select Predefined Settings...
Select WRQ Protocol to Unix
OK
Select Tranfer Link: 7-bit

OK

- TIES TIP: The TIES Gopher download menu also supports emailing binary documents/files. Because most email systems can only handle ASCII formatted mail, binary formats are first converted to the UUENCODE format (an ASCII representation) before mailing. To decode the UUENCODED file back into its original binary format, you will require a utility program called UUDECODE. An MS-DOS version of this program is available in the ITU Document Store in the group:
  - ⇒ About ITU, ITU TIES, ITUDOC, Copyright Notice, Gopher.../
     ⇒ About ITU TIES/
     ⇒ Other TIES Information/
     ⇒ Utilities/
- TIES TIP: You should only use the Print and Text file transfer options with text (ASCII) files.

# **Navigating Through Non-ITU Gopherspace**

The TIES Gopher lets you navigate in both ITU provided electronic resources and among other Gopher servers around the world (known to Gopher regulars as "Gopherspace"). For example, if the TIES Gopher main menu item "Other information services/" is selected from the main TIES menu, the following menu is displayed and permits browsing Gopher servers around the world.

```
ITU Telecom Information Exchange Services (TIES)
                                    Other information services
             Press Releases, News, Weather, .../
Phone, E-mail, X.400, X.500 Directories/
             Worldwide Library Services/
             Reference Info, Dictionaries, Bookstores, .../
Selected European Information Services/
             Selected US Information Services/
             Gophers in the World/
        8. Gophers in the World sorted by country/
9. Gopher servers sorted by subject (SUNIC)/
10. French Speaking Gophers/
        11. German Gopher Servers/
12. Education and Training/
13. Selected Public Domain Software Archives/
        14. Computer hardware and software companies/
        15. Gopher Jewels.../
        16. Gopher servers added lately to the net/
        17. Access to External Telecom Information Services
        18. Worldwide Information Search/
                                                                                            Page: 1/1
Press ? Help, q Quit, u up a menu, D Download
```

# Information Search in Non-ITU Gopherspace

The TIES Gopher permits searching for information on any topic in Gopherspace. For example, if you select "Worldwide Information Search/" from the menu above, the following screen is displayed.

```
Search the headings of all gophers (Veronica, jughead)

--> 1. FAQ: Frequently-Asked Questions About Veronica
2. How to Compose Veronica Queries
3. Veronica Home Directory (University of Nevada at Reno) /
4. Search Gopherspace (via SUNET, Sweden) <?>
5. Search Gopherspace (via UNINETT, U. of Bergen) <?>
6. Search Gopherspace (via UNINETT, U. of Bergen) <?>
7. Search Gopherspace for GOPHER DIRECTORIES (Via UNINETT, U. of B. <?>
8. Search Gopherspace (via University of Koeln) <?>
9. Search Gopherspace (via University of Koeln) <?>
10. Search Gopherspace (via University of Koeln) <?>
11. Search Gopherspace (via Univ. of Manchester) <?>
11. Search Gopherspace (via Univ. of Pisa, Italy) <?>
12. Search Gopherspace (via Univ. of Pisa, Italy) <?>
13. Search Gopherspace (via Univ. of Pisa, Italy) <?>
14. Search Gopherspace (via America Online) <?>
15. Search Gopherspace (via Univ. of Nevada at Reno) <?>
16. Search Gopherspace (via Univ. of Nevada at Reno) <?>
17. Search Gopherspace for GOPHER DIRECTORIES (via America Online) <?>
18. Search Gopherspace (via Univ. of Nevada at Reno) <?>
18. Search Gopherspace (via NYSERNet, New York) <?>
Press ? Help, q Quit, u up a menu, D Download Page: 1/2
```

Selecting one of the menu item to "Search Gopherspace..." gives access to a Gopher indexing service that runs at selected computing sites around the world. These Veronica "index servers" provide keyword searches of titles on all public Gopher servers. These indices are updated roughly on a weekly basis.

- TIES TIP: Sometimes it takes a very long time for a remote computer to reply due to network congestion or computer overload. To abort, type Ctrl-C. Gopher will prompt you "Really quit (y/n)?". Type 'n' to return to the current menu.
- TIES TIP: If a Gopher index server fails to respond or indicates that it currently has too many users, try another one. Veronica servers typically have access to the same information.

Let's imagine we are searching for information about Africa. If you select "Search Gopherspace (via America Online) <?>" and enter "africa", a list of menu items from Gopher servers around the world having the word "africa" in their menus is returned.

<sup>&</sup>lt;sup>12</sup>For those interested in the naming of Internet tools, Veronica is an acronym for Very Easy Rodent-Oriented Net-wide Index to Computerized Archives. Veronica is also a character in the popular "Archie" comic book series. Archie is also the name of an Internet tool for indexing "FTP" sites. Therefore, one can say that Veronica is to Gopher as Archie is to FTP.

```
Search Gopherspace (via America Online): africa

--> 1. africa-n.log9308
2. africa-n.log9319
3. africa-n.log9310
4. africa-n.log9311
5. africa-n.log9312
6. AFRICA-N - AFRICA-N Africa News & Information Service/
7. Afro 5143 Geography of West Africa
8. Geog 5143 Geography of West Africa
9. Hist 3432 History of Africa: 1800 to Present
10. Africa/
11. A directory: NGOs in the forestry sector. 2nd Africa edition.
12. The conservation atlas of tropical forests: Africa.
13. (Man, forests and the past in Africa.)
14. Politics and forestry in South Africa: Racism, social engineering
15. West Africa: Resource management policies and the tropical forest
16. Arid-zone forestry policy in North Africa region.
17. Harmonization of selected forestry policies in Africa.
18. An introduction to forest management planning in South Africa.
```

TIES TIP: The Gopher command "=" for displaying technical information about an item gives an indication of the Gopher site offering the information. For example, if we point at item 3 above and press "=", the following screen appears:

```
Type=0
Name=africa-n.log9310
Path=0/listserv/africa-n/africa-n.log9310
Host=vm.utcc.utoronto.ca
Port=70
URL: gopher://vm.utcc.utoronto.ca:70/00/listserv/africa-n/africa-n.log9310

Press <RETURN> to continue,

<m> to mail, <D> to download, <s> to save, or  to print:
```

Computer hosting this information is located at the University of Toronto in Canada.

# The "Flip Side" of Gopher

The good news about navigating through all the Gopher servers in the world ("Gopherspace") is the wealth of information available. But that's also the bad news: there is no guarantee that the information you get back (e.g., using Veronica) is correct, up-to-date and/or well-organized. There are lots of reasons for this. One is that it takes a lot of work to maintain electronic information resources and most



Internet information providers are offering "free" services for local users so there is little motivation to provide services or categorization that caters to remote "Gophernauts". When you pay for something your expectations should be high. Likewise, when you don't pay for something, your expectations shouldn't be too high.

Another problem is that Gopher servers tended to be set up, organized and maintained by computer scientists instead of librarians; the latter having far more experience in categorizing and ordering information so that the rest of us can find it.

"The future belongs to neither the conduit or content players, but those who control the filtering, searching and sense-making tools we will rely on to navigate through the expanses of cyberspace."

Paul Saffo, Wired: March 1994

We make a lot of effort to keep ITU's electronic information resources well organized, correct and up-to-date: if you think you find something that is not (entirely possible since we have thousands of information resources), please tell us and we will correct it.

October 1994

# **TIES Services for Registered Users**

Pressing 'm' takes you back to the TIES main menu. If you logged on with a TIES username and password, additional menu items are available on the main screen such as "Email, private directory, Telnet, FTP, ALL-IN-1, ... /". Selecting this menu item displays a menu only available for TIES Registered Users.

A TIES Registered Users Guide is available upon request from the ITU TIES Help Desk (address on the inside cover of this guide).

# **Using TIES Electronic Mail Interfaces**

The TIES electronic mail interfaces only require access to an Internet compatible email system. Services available include access to the ITU Document Store (ITUDOC) and the WHOIS UN email directory query service.

#### **ITUDOC Electronic Mail Interface**

The ITUDOC electronic mail interface is via a TIES Auto-Answering Mailbox (TAM). The TAM is a "robot" electronic mailbox with access to the ITU Document Store. You can send electronic mail to the TAM as you would send electronic mail to a person outside your organization or company. However, your message should only contain simple commands (see ITUDOC Auto-Answering Mailbox Commands on page 40). When the TAM receives a message, it scans it for commands which it interprets and processes. It then constructs and mails a reply back to you.

To help you find your way around with the ITUDOC electronic mail interface, "Road Map and Index" files are available. These files are updated approximately the 1st and 15th of each month and describe each group's structure and list the available documents (see ITUDOC Road Map and Index Files on page 44).

October 1994 Page 38

# TAM eMail Address for ITUDOC

The TAM can be addressed using Internet email conventions<sup>13</sup>. This address is:

# itudoc@itu.ch

If you do not have direct access to Internet compliant mail, most major email service providers (e.g., MCI, Compuserve) provide gateway facilities and can access the TAM (see page 38).

Here is an example of an email message to ITUDOC:

LIST LIST ITU-T LIST ITU-T/REC GET ITU-1100 GET ITU-1800

**END** 

The above message asks the TAM to:

- send a help file listing and explaining TAM commands;
- 2. send a list of groups and/or documents in the root of the ITU Document Store;
- 3. send a list of groups and/or documents in the "ITU Telecommunication Standardization Sector" group.

<sup>13</sup>A caveat about access through UUCP sites: Although UUCP sites typically have access to Internet compliant mail, there is a considerable difference between email access through the Internet and UUCP: UUCP sites typically do not have the store and forward capacities for file transfer. It is considered a breach of UUCP etiquette to transfer large files or documents without first arranging it with the administrators of affected sites along the route.

- 4. send a list of groups and/or documents in the "ITU Telecommunication Standardization Sector / Recommendations" group;
- 5. send two documents that have, respectively, UPIs (Unique Permanent Identifiers) of ITU-1100 and ITU-1800. The UPI is the ITU code used to uniquely identify a document stored on ITUDOC. These two documents correspond to Road Map and Index files for the "ITU Telecommunication Standardization Sector" group and the "About ITUDOC" group (see ITUDOC Road Map and Index Files on page 44).

## **ITUDOC Auto-Answering Mailbox Commands**

The commands that you can send to the TAM consist of a command word followed, in some cases, by an argument. Commands and arguments can be specified in upper, lower or mixed case.

Every line of your mail message to the TAM should contain a valid command. Only commands contained in the mail message are interpreted. All other lines and the mail subject field are ignored (you can use the subject field to document queries for your own use). Up to 50 lines per message are processed by the TAM. Every GET, LIST, HELP, and TEST commands generate separate replies.

#### START

This command tells the TAM to begin processing commands after this line. If this command is present, any text in the mail message before this command is ignored.

#### **TEST**

This command is used to test that the TAM can receive mail from your electronic mail system and can also respond back to your mail system. The TAM will acknowledge your message and send a help document. Typically, if you have not received a reply within 48 hours, there is a connectivity problem between your electronic mail system and the TAM.

#### HELP

This command sends the latest help file listing and explaining the commands understood by the TAM (which may differ from this manual due to enhancements).

## LIST <PATH>

This command returns a list of groups and/or documents in the specified group. The path to a group is defined by its location relative from the root of the ITU Document Store. For example:

LIST LIST ABOUT LIST ITU-T LIST ITU-T/REC LIST ITU-T/REC/X LIST ITU-R LIST ITU-D

The first example of the LIST command above returns a list of groups and/or documents at the root group of the ITU Document Store.

#### GET <UPI>

When the TAM sends a list of documents and/or groups, it provides a Unique Permanent Identifier (UPI) code for every document in each available format and language. The UPI is the code used to retrieve the document that you want. For example:

GET ITU-1100 GET ITU-1800

You should only retrieve documents in formats that can be handled by your electronic mail system (see ENCODE below).

## **ENCODE <MIME>**

Most mail systems can handle ASCII documents attached to mail messages but may have difficulties with non-ASCII (i.e., 'binary') formats such as word processing and graphics files. With the ENCODE command, you can request the TAM to encode non-ASCII files into the UUENCODE format or to use the Internet MIME (Multipurpose Internet Mail Extensions) encoding standard. To decode a UUENCODED file back into its original binary format, you will need a utility program called UUDECODE. This program is widely available in different computing environments. MIME-compliant email systems should automatically convert back to the original format. Enter the ENCODE command in your mail message before any GET commands retrieving binary formats if your mail system can only support ASCII formats. To retrieve files in the MIME standard, use the ENCODE MIME command before GET commands. For example:

ENCODE GET ITU-2314 GET ITU-2315 ENCODE MIME GET ITU-2314 GET ITU-2315

If the TAM is replying to Internet mail, the ENCODE command is automatically applied.

# HUMAN

Since the TAM is a 'robot', it may not understand exactly what you are trying to say to it. If you type the command HUMAN followed by any message, the TAM will STOP processing commands and automatically forward your mail message to an ITU help desk. For example:

#### **HUMAN**

I am having a problem locating a document concerning XXXX. Could you please tell me where it is available?

Thank you, Bill Pagoda pagoda@xyz.com 11181 ISP Street, Suite FOD26 Sacramento, California Tel: 916-555-8613 Fax: 916-555-8859

If your problem is related to a connectivity issue (e.g., you are not receiving responses from the TAM), please include other contact information such as your postal address, email address and telephone and fax number.

#### **END**

This optional command tells the TAM to ignore the rest of the mail message. This command is required if your mail message contains text after your commands that you want the TAM to ignore (e.g., your signature).

# **ITUDOC Road Map and Index Files**

Here are the UPIs (Unique Permanent Identifiers) for key Road Map and Index files. These files are updated approximately the 1st and 15th of each month and describe each group's structure and list the available documents. You can retrieve these files with the GET command.

UPI	Title
ITU-1100	Road Map and Index for ITU Telecommunication Standardization Sector Group
ITU-1200	Road Map and Index for ITU Radiocommunication Sector Group
ITU-1300	Road Map and Index for ITU Development Sector Group
ITU-1400	Title: Road Map and Index for the About ITU, TIES, ITUDOC, Copyright Group
ITU-1600	Road Map and Index for the complete ITU Document Store (NB: large)
ITU-1700	Road Map and Index for the ITU General Secretariat & TELECOM Group
ITU-1900	Road Map and Index for the United Nations UN/EDIFACT Standards Database (EDICORE) Group
ITU-2000	Road Map and Index for the ITU Office of the Secretary General Group

For example, the email message below retrieves the Road Map and Index file for the ITU Telecommunication Standardization Sector Group:

To: itudoc@itu.ch FROM: (NAME)

SUBJECT: (IGNORED)

START

GET ITU-1100

**END** 

# Tips Using the ITUDOC Email Interface

When using the email interface to ITUDOC, please recognize that there are sometimes problems with international email connections. The electronic mail circuits between the TAM and your mail system can fail or be temporarily out of order. In this case, email can be delayed or not delivered. So, the first advice if you have a problem is to try again.

The ITUDOC TAM will only reply to valid commands. If the argument to a LIST command or GET command cannot be interpreted then you will receive an error message explaining why. If the TAM cannot process any commands in your mail message, it will send back a help file.

If you have problems retrieving large documents, your mail system or gateways to your system may not support large file attachments.

The volume of email messages sent to the TAM does not permit monitoring the processing of each message. If you have problems that you can't resolve, use the HUMAN command and enter a written description of the problem in the mail message; include your complete contact information (e.g., telephone, FAX number - especially if your query is related to an email problem). The TAM forwards messages containing the HUMAN command to the ITU TIES Help Desk.

# How to Get Help

# **General TIES Help**

If you have general questions relating to the TIES interface, connectivity or related technical issues, please contact:

ITU TIES HELPDESK
International Telecommunication Union
Information Services Department
Place des Nations
1211 Geneva 20
Switzerland

TEL: +41 22 730 5554 FAX: +41 22 730 5337

Internet email: helpdesk@itu.ch

X.400 email: S=helpdesk;A=arcom;P=itu;C=ch

Telex: 421 000 uit ch

## Help on ITU-T Electronic Information Resources

If you have questions relating to the ITU Telecommunication Standardization Sector (ITU-T) documents or other ITU-T electronic information resources, please contact:

Telecommunication Standardization Bureau Electronic Document Handling International Telecommunication Union Place des Nations
1211 Geneva 20, Switzerland

TEL: +41 22 730 5857/5859

FAX: +41 22 730 5853

X.400 email: S=tsbedh; A=arcom; P=itu; C=ch

Internet email: tsbedh@itu.ch

# Help on ITU-R Electronic Information Resources

If you have questions relating to the ITU Radiocommunication Sector (ITU-R) documents or other ITU-R electronic information resources, please contact:

Radiocommunication Bureau
Electronic Document Handling (BR-EDH)
International Telecommunication Union
Place des Nations
1211 Geneva 20, Switzerland

X.400 email: S=bredh; A=arcom; P=itu; C=ch

Internet email: bredh@itu.ch Tel.: +41 22 730 5810/5800 Fax: +41 22 730 5785

# Help on ITU-D Electronic Information Resources

If you have questions relating to the ITU Telecommunication Development Sector (ITU-D) documents or related electronic information resources, please contact:

Telecommunications Development Bureau International Telecommunication Union Place des Nations 1211 Geneva 20, Switzerland FAX: +41 22 730 5484

X.400 email: S=bdtmail; A=arcom; P=itu; C=ch

Internet email: bdtmail@itu.ch

# **ANNEX A - Quick Start for Experts**

If you're already an expert in computers and communications, here's the quick start connect info for TIES.

#### **GOPHER CLIENT**

Pointer to the ITU Gopher Server is:

Name=International Telecommunication Union (ITU) Host=info.itu.ch Port=70

The URL for a WWW Browser is:

#### gopher://info.itu.ch/

Note that native Gopher clients or WWW browser will only give access to TIES Public Services.

#### TELNET

TIES Public Services (login as 'gopher')

gopher.itu.ch

TIES Services for Registered Users

ties.itu.ch (login with TIES username and password)

# X.25

Call the X.25 DTE address, on TELEPAC, the Swiss PSPDN

#228468111112

where # is local prefix for international routing.

### **DIAL-UP**

+41 22 733 7575 (Swiss telephone number)

Recommended for Western Europe only. Supported modem protocols include ITU-T (CCITT) V.21, V.22, V.22bis, V.32, V.32bis, V.42, V.42bis

October 1994

Recommendations, Bell212A and MNP 2, 3, 4, 5. Basic settings should be no parity, 8 data bits (necessary for on-line reading of multilingual material), speed 300 to 14,400 bps.

# **EMAIL ACCESS TO ITUDOC**

For help on the ITUDOC electronic mail interface, send a message with the line HELP in it to:

itudoc@itu.ch

The robot mail server will return to you a help document. To recrieve files, send the command:

GET <UPI>

where <UPI> is the UPI (Unique Permanent Identifier) for the document. For example, to retrieve the index of the ITU-T (ITU Telecommunication Standardization Sector) Group, send the command:

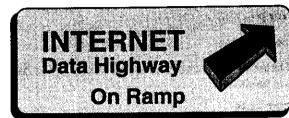
**GET ITU-1100** 

See page 44 for the UPIs of other ITUDOC index files. You can place multiple commands in a single message (maximum 50).

# **ANNEX B - Using An Internet Access Provider**

The Internet is a world-wide network of computers offering access to millions of people and terabytes of data. Increasingly, commercial Internet Access

Providers (IAPs) are providing inexpensive public access to the Internet using your regular modem and computer. IAPs provide Internet services for monthly fees and/or actual connect-time charges. You can think of IAPs as Internet "on-ramp"



points to the world data superhighway.

# **PDIAL - Public Dialup Internet Access List**

The best compilation of dial-up Internet Access Providers is called PDIAL (Public Dialup Internet Access List). PDIAL provides a comprehensive list of Internet service providers offering dialup services (e.g., Telnet, Gopher). It is prepared by Peter Kaminski of "The Information Deli".

To receive the current edition of the PDIAL, send email containing the phrase "Send PDIAL" to "info-deli-server@netcom.com". If you have Internet FTP access, you can obtain the latest PDIAL from:

ftp.netcom.com:/pub/info-deli/public-access/pdial [192.100.81.100]

The information listed in the PDIAL changes rapidly. If your edition of PDIAL is more than 2 months old, you should obtain a new one. PDIAL can also be found in the TIES Gopher server by following the "path":

About ITU, TIES, ITUDOC, Copyright, Gopher.../ About Internet / Public Dialup Internet Access List (PDIAL)

## Tips on Choosing an Internet Access Provider

A primary consideration is telephone charges which can be a major part of your Internet access cost. Therefore, you should try to locate an IAP with a dial-up

number in your local area, preferably with no per-minute charges. If there aren't any, then you should check for access to:

- A Public Data Network (PDN). For example, some IAPs are accessable through the Compuserve data network which has local dial-up in many locations. International access is sometimes possible through a PDN. Contact the relevant IAP for information on their PDN access.
- An 800 number. International users who do not have an IAP in their region can investigate using a telecom operator (e.g., AT&T, MCI, Sprint) in their country who can offer dial-tone services that can reach 800 numbers.
- Direct-dial long distance number.

As a general rule, remember that obtaining a high speed and reliable connection will greatly facilitate your use of TIES. Typically the highest dial-up capabilities currently offered by IAPs is at ITU-T V.42bis speeds (as of October 1994) although some are starting to supply V.34 access. V.42bis supports 14,400 bps and with additional compression offers higher throughput. V.34 is a recently approved standard and supports even higher speeds.

If you need access to TIES Services for Registered Users then we recommend:

- Obtain a V.34 or V.42bis modern and a terminal emulation program supporting a well known file transfer protectol (e.g., Kermit).
- Contact an Internet Access Provider and tell them you need dial-up access at V.42bis or V.34 (preferable) speeds to **Telnet** services. If you only need access to TIES Public Services, you can ask them for access only to a **Gopher** service (see page 16 for how to get to ITU TIES Gopher from other Gopher servers).

# **Public Data Network Access Information**

Here's how to get local access numbers and/or information for some public data networks.

## BT Tymnet

For information and local access numbers, call 800-937-2862 (voice) or 215-666-1770 (voice).

Page 51

October 1994

Compuserve Packet Network

Note: You do not have to be a Compuserve user to use the Compuserve Packet Network to access an IAP. For information and local access numbers, call 800-848-8199 (voice).

#### **PSINet**

For information, call 800-82PSI82 (voice) or 703-620-6651 (voice) or send email to "all-info@psi.com".

# Sample Internet Access Providers

Given below are a few commercial Internet Access Providers extracted from the PDIAL list and other sources.

#### NORTH AMERICA

## **DELPHI**

Dialup: 800-365-4636 'JOINDELPHI password:INTERNETSIG'

Area Codes: 617, PDN

Local Access: MA: Boston; KS: Kansas City

Long Distance: Sprintnet or Tymnet: \$9/hour weekday business hours, no charge

nights and weekends

Services: ftp, telnet, feeds, user groups, wire services, member conferencing Fees: \$10/month for 4 hours or \$20/month for 20 hours + \$3/month for Internet

services

Email Address: walthowe@delphi.com Voice Telephone Number: 800-544-4005

### NETCOM

Name: Netcom Online Communication Services

Dialup: 206-547-5992, 214-753-0045, 303-758-0101, 310-842-8835, 312-380-0340, 404-303-9765, 408-241-9760, 408-459-9851, 415-328-9940, 415-985-5650, 503-626-6833, 510-274-2900, 510-426-6610, 510-865-9004, 617-237-8600, 619-234-0524, 703-255-5951, 714-708-3800, 818-585-3400, 916-965-

1371

Area Codes: 206, 213, 214, 303, 310, 312, 404, 408, 415, 503, 510, 617, 619,

703, 714, 718, 818, 916

Local Access: CA: Alameda, Irvine, Los Angeles, Palo Alto, Pasadena, Sacramento, San Diego, San Francisco, San Jose, Santa Cruz, Walnut Creek;

CO: Denver; DC: Washington; GA: Atlanta; IL: Chicago; MA: Boston; OR:

Portland; TX: Dallas; WA: Seattle Long Distance: provided by user

Services: shell, ftp, telnet, irc, WAIS, gopher, SLIP/PPP, ftp space, feeds, dns

Fees: \$19.50/month + \$20.00 signup Email Address: info@netcom.com

Voice Telephone Number: 408-554-8649, 800-501-8649

FAX: 408-241-9145

# PSI-WORLD-DIAL

Name: PSI's World-Dial Service

Dialup: send email to numbers-info@psi.com

Area Codes: PDN

Long Distance: [per hour, off-peak/peak] V.22bis: \$1.25/\$2.75; V.32:

\$3.00/\$4.50; 14.4K; \$4.00/\$6.50

Services: telnet, rlogin, tn3270, XRemote Fees: \$9/month minimum + \$19 startup

Email Address: all-info@psi.com, world-dial-info@psi.com

Voice Telephone Number: 703-620-6651

FAX: 703-620-4586

#### **ALTERNET**

Name: AlterNet from UUNET Technologies, Inc.

Dialup: contact for numbers

Area Codes: 212, 408, 415, 510, 617, 703, 800, PDN

Local Access: Washington, D.C.; CA: Berkeley, Palo Alto, San Jose; MA:

Boston; NY: New York City Long Distance: provided by user

Services: terminal access to telnet, UUCP (e-mail/news), check with provider

Fees: check with provider

Email Address: alternet-info@uunet.uu.net, info@uunet.uu.net

Voice Telephone Number: 703 204 8000, 800 4UUNET4 (1 800 488 6384)

FAX: 703-876-5059

#### **UUNET-Canada**

Name: UUNET Canada, Inc. Dialup: contact for numbers

Area Codes: 416, 905, 519, 613, 514, 604, 403

Local Access: ON: Toronto, Ottawa, Kitchener/Waterloo, London, Hamilton,

QC: Montreal, AB: Calgary, BC: Vancouver

Long Distance: provided by user

Services: terminal access to telnet only, UUCP (e-mail/news),

SLIP/PPP, shared or dedicated basis, from v.32bis to 56k+

Fees: (All Cdn\$ + GST) TAC: \$6/hr, UUCP: \$20/mo + \$6/hr, IP/UUCP:

\$50/mo + \$6/hr, ask for prices on other services

Email Address: info@uunet.ca

Voice Telephone Number: 416-368-6621

FAX: 416-368-1350

## **WORLD**

Name: World

Dialup: 739-9753 'new' Area Codes: 800, PDN Local Access: Boston, MA

Long Distance: Compuserve Packet Network: \$5.60/hour

Services: shell, ftp, telnet, irc

Fees: \$5.00/month + \$2.00/hr or \$20/month for 20 hours

Email Address: office@world.std.com Voice Telephone Number: 617-739-0202

#### MAINLAND EUROPE

#### **EUNet**

Name: EUnet

Dialup: contact for number, PDN (e.g., Transpac in France)

Area Codes: contact for numbers (27 countries)

Local Access: Major Cities Services: e-mail, telnet, IP Fees: contact for information Email Address: info@EU.net

Voice Telephone Number: +31 20 592 5109 (Amsterdam)

FAX: +31 20 592 5163

# DIRCON

Name: The Direct Connection Dialup: +44 (0)81 317 2222 Area Codes: +44 (0)81

October 1994

Local Access: London, England Long Distance: provided by user

Services: shell or menu, UUCP feeds, SLIP/PPP, ftp, telnet, gopher, WAIS,

Archie, personal ftp/file space, email-to-fax

Fees: Subscriptions from GBPounds 10 per month, no on-line charges.

GBPounds 7.50 signup fee.

Email Address: helpdesk@dircon.co.uk Voice Telephone Number: +44 (0)81 317 0100

Fax Number: +44 (0)81 317 0100

#### **IBMPCUG**

Name: UK PC User Group Dialup: +44 (0)81 863 6646 Area Codes: +44 (0)81

Local Access: London, England Long Distance: provided by user Services: ftp, telnet, bbs, irc, feeds

Fees: GBPounds 15.50/month or 160/year + 10 startup (no time charges)

Email Address: info@ibmpcug.co.uk

Voice Telephone Number: +44 (0)81 863 6646

## NORTH AFRICA

#### **EUNet**

Name: EUnet

Dialup: contact for number, PDN (e.g., Transpac in France)

Area Codes: contact for numbers (27 countries)

Local Access: Major Cities Services: e-mail, telnet, IP Fees: contact for information Email Address: info@EU.net

Voice Telephone Number: +31 20 592 5109 (Amsterdam)

FAX: +31 20 592 5163 (Amsterdam)

## **ANNEX C - Document Retrieval Formats**

Below is given an explanation of several document formats that TIES/ITUDOC offers for retrieval:

#### **ASCII**

Often the only format that different word processors have in common is a line-oriented format using ASCII characters. If the master or original format of a document in the ITU Document Store is different from ASCII then conversion to ASCII may have resulted in loss of information content and/or formatting. ASCII files have the file extension .txt

#### Microsoft RTF

Microsoft Rich Text Format (RTF) is a standard form of encoding for text and graphics interchange that can be used with different microcomputers and operating systems.

RTF can represent all objects contained in ITU documents (e.g. multilingual text, footnotes, headers, footers, symbol sets, tables, mathematical formulas, geometric and raster graphics, font information, layout, structure elements). A standard RTF file consists of only 7-bit ASCII characters so it can be transported more easily between various mail systems. If your word processing tool can read RTF then this is a useful format. RTF files have the file extension .rtf

## Word for Windows

Word for Windows is the ITU standard document processing tool and is therefore the ITU native document format. The version being used as of October 1994 is Word for Windows Version 2.0. Word for Windows files have the extension .doc

#### Postscript

Postscript is a final form document - in other words, it typically cannot be edited or revised. It can only be printed or viewed on-screen. However, the Postscript form of a document is typically identical to the

October 1994 Page 56

ITU printed page form. Postscript files are 7-bit ASCII and so can be transported between various electronic mail systems (however, they are typically very large files). After you receive a Postscript file, you can copy it to your Postscript laser printer for a printed version of the document. Note that ITU documents are paginated for A4 paper size and so all text may not fit on North American Letter size paper. If this causes difficulty you may wish to obtain a public-domain Postscript file viewer called Ghostscript. Ghostscript is available at many computer sites around the world. Postscript files have the file extension.ps

## ODA/ODIF

The Open Document Architecture (ODA) and Open Document Interchange Format (ODIF) are ITU-T (CCITT) Recommendations (T.410 series) also adopted by International Organization for Standardization (ISO 8613). ODA is a modern, object-oriented document architecture for the description of both the logical and layout structures of a document. Examples of logical objects are abstracts, titles, sections, paragraphs, figures, tables, etc. Examples of layout objects are pages, columns, frames, etc. ODA provides for the representation of documents in processable form, which allows revision by a recipient, and formatted form, which allows the precise specification of the document layout. ODA also supports the transfer of documents in formatted processable form. ODIF defines the data stream of the actual interchange format. ODIF files currently accessed via the ITUDOC Service can correspond to the European Workshop on Open Systems (EWOS) Q112 or the ISP 11181 (FOD26) document application profile (DAP). They have been converted to ODIF from Rich Text Format (RTF) by the Bull ODA Product Set (BOPS). ODIF files have the file extension .odf. If you are interested in more information on ODA, please contact the Open Document Architecture Consortium (ODAC):

Page 57

October 1994

ODAC Avenue Marcel Thiry 204 1200 Brussels Belgium Tel. +32 2 774 9623 Fax. +32 2 774 9690

## ZIP Format

Some documents/files stored on TIES/ITUDOC have been archived or compressed with the PKZIP program. This is indicated by the name "ZIP" or the prefix "ZIP" before the document/file format. For example, compressed Postscript files are referred to in TIES/ITUDOC as "ZIPPOSTSCRIPT". To uncompress this file, you need a program called PKUNZIP or equivalent. Self-extracting MSDOS and Macintosh versions of these utilities are available in the "About ITU, TIES, ITUDOC, Copyright, Gopher.../ About ITU TIES/ Other TIES Information/ Utilities/".

#### Other Formats

Other document formats may be available on the ITU Document Store. Retrieving these formats via the TAM depends upon the capability of the electronic mail system you use (e.g. support for binary message attachments). The latest list of formats used on the ITU Document Store is available in the group "About ITU, TIES, ITUDOC, Copyright, Gopher... / About ITUDOC".

October 1994 Page 58

# ANNEX D - TIES/ITUDOC Conditions of Use and Copyright Notice

"Access to databases of the International Telecommunication Union (ITU) for consultation of documents and/or information retrieval is permitted by the ITU subject to the user's acceptance of ITU's provisions and conditions of copyright contained within each document which obliges the user not to duplicate the document or parts thereof for distribution or sale external to the user's organization. Such information may be utilised in the receiving organization, as required, to further the work of the ITU or any standards body developing related standards, to provide guidance for product or service development and implementation and to serve as support documentation associated with a product or service."

For special arrangement or further clarification regarding this policy, please contact:

Mr. Michel Giroux
Chairman of the ITU Publication Policy Committee
International Telecommunication Union
Place des Nations
1211 Geneva 20
Switzerland
FAX: +41 22 730 5785

Internet email: giroux@itu.ch

X.400 email: S=giroux; P=itu; A=arcom; C=ch

# Annex E - Access to ITUDOC from Major eMail Service Providers

The ITUDOC email interface is accessible from several major email service providers.

# **ACCESS FROM MCI**

MCI users can access the TAM through MCI's facilities for access to other mail systems (EMS). The TAM can be accessed through MCI's Internet gateway. You can then download documents from your MCI mailbox using a file transfer program in your communications package (e.g. Kermit or Zmodem). If you have problems with one gateway, please try the other.

# ACCESS FROM MCI MAIL VIA INTERNET:

- 1. At COMMAND, type CREATE
- 2. At TO, type ITUDOC followed by EMS in parentheses. For example,

TO: ITUDOC (EMS)

3. At the prompt EMS: type INTERNET. For example,

**EMS: INTERNET** 

4. At MBX: type itudoc@itu.ch. For example,

MBX: itudoc@itu.ch

- 5. At the next MBX: type return to end addressing
- 6. Complete as usual

# HOW TO DOWNLOAD DOCUMENTS FROM MCI MAIL:

File transfer protocols supported by MCI include

- Zmodem
- Kermit
- Text (MCI account default for downloading ASCII data only)

If the document you retrieve from your MCI mailbox is a binary format, you must use either Zmodem or Kermit transfer protocols.

- 1. Note the number of the message you want to download.
- 2. At COMMAND, type DOWNLOAD followed by the number of the message you want to DOWNLOAD and the name of the protocol you want to use. For example,

# **COMMAND: DOWNLOAD 3 KERMIT**

- 3. MCI will provide a message that explains how many files are contained in the transfer. You will receive an itemized list of the text and binary message segments contained in each download request. When prompted, enter a filename for each file you wish to download or press return if you wish to skip that segment. Specify a file extension that corresponds to the document type. The TAM always returns two message segments in reply to a GET command. The first message segment part is always in ASCII format and contains information (attributes) of the document (e.g., title, file size and type). The second message segment part is the actual document. You may choose only to download the second message segment which is the actual document.
- 4. When you have completed assignment of filenames for the messages you wish to download, press return to begin. You may then need to give the command for your communications software to begin the download process.

For more complete information, use MCI's HELP DOWNLOAD command.

#### **ACCESS FROM COMPUSERVE**

Compuserve mail users can access the TAM through Compuserve's Internet mail gateway facility.

# ACCESS FROM COMPUSERVE MAIL VIA INTERNET:

- 1. Choose COMPOSE a new message, edit the message with TAM commands, then choose SEND
- At SEND TO (NAME OR USER ID), type >internet:itudoc@itu.ch For example,

Send to (Name or User ID): >internet:itudoc@itu.ch

- 3. At SUBJECT, type any text (TAM ignores subject fields)
- 4. Complete as usual

# HOW TO DOWNLOAD DOCUMENTS FROM COMPUSERVE:

For complete information, use Compuserve's HELP DOWNLOAD command.

# **Annex F - TIES Registration Form**

No registration is required for access to TIES Public Services. If you meet the requirements for access to TIES Services for Registered Users (see page 12), please complete and return the TIES Registration Form attached to the end of this document.

ITU TIES HELPDESK International Telecommunication Union Information Services Department Place des Nations 1211 Geneva 20 Switzerland

TEL: +41 22 730 5554 FAX: +41 22 730 5337

internet email: helpdesk@itu.ch

X.400 email: S=helpdesk;A=arcom;P=itu;C=ch

Telex: 421 000 uit ch

Processing of your application should take 2-4 weeks. You will receive documentation and a logon name/password by return mail.

An electronic version of the TIES Registration Form is available by return electronic mail by sending the following message:

To: Itudoc@itu.ch FROM: (NAME) SUBJECT: (IGNORED)

START GET ITU-2659 END

Electronic versions of the TIES Registration Form can be submitted by electronic mail to the email address above.

TIES User Registration Form										
Dr.	Mr.	Mrs.	Miss	M.	s					
Last Name										
First Name(s	)									
Job Title					<u> </u>		·			
Organization/Company										
Department/s	Service			.h				,		
Address				<u> </u>						
				· .						
							,			
		Country	/	<u></u> ,,						
Telephone				Fax		·				
Email Address					Tele	ex				
ITU Activities Participation (Member Administration, Sector members, Study Groups, etc.)  This information is required.										
Communic	ations s	oftware				<u> </u>				
Signature					Date					

ITU TIES HELPDESK
International Telecommunication Union
Information Services Department
Place des Nations
1211 Geneva 20, Switzerland

TEL: +41 22 730 5054 or 5555
FAX: +41 22 730 5337
Internet: helpdesk@itu.ch
X.400: S=helpdesk; A=arcom; P=itu; C=ch
Telex: 421 000 uit ch