INTERNATIONAL TELECOMMUNICATION UNION

# Special concerns of developing countries in relation to the work of the Radiocommunication and Telecommunication Standardization Sectors

BDT
TELECOMMUNICATION
DEVELOPMENT
BUREAU

## ITU-D Study Groups

First Study Period (1995-1998)
Report on Question 1/2

# PUBLICATIONS OF ITU-D STUDY GROUPS

## Study Period 1995-1998

### Study Group 1

| | |
|---|---|
| **Report on Question 1/1** | Role of telecommunications in economic, social and cultural development |
| **Report on Question 2/1** | Telecommunication policies and their repercussions at the level of institutional, regulatory and operational aspects of services |
| **Report on Question 3/1** | Impact of the introduction and utilization of new technologies on the commercial and regulatory environment of telecommunications |
| **Report on Question 4/1** | Policies and ways for financing telecommunication infrastructures in developing countries |
| **Report on Question 5/1** | Industrialization and transfer of technology |

### Study Group 2

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|---|---|
| **Report on Question 1/2** | Special concerns of developing countries in relation to the work of the Radiocommunication and Telecommunication Standardization Sectors |
| **Report on Question 2/2** | Preparation of handbooks for developing countries |
| Handbook on | *New developments in rural telecommunications* |
| Handbook on | *New technologies and new services* |
| Handbook on | *National Radio Frequency Spectrum Management and Monitoring System – Economic, Organizational and Regulatory Aspects* |
| **Report on Question 3/2** | Planning, management, operation and maintenance of telecommunication networks |
| **Report on Question 4/2** | Communications for rural and remote areas |
| **Report on Question 5/2** | Human resources development and management |
| **Report on Question 6/2** | Impact of telecommunications in health-care and other social services |
| **Report on Question 7/2** | Telecommunication support for the protection of the environment |
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# Special concerns of developing countries in relation to the work of the Radiocommunication and Telecommunication Standardization Sectors

## Contents

REPORT ON QUESTION 1/2

# Special concerns of developing countries in relation to the work of the Radiocommunication and Telecommunication Standardization Sectors

## 1 Introduction

**1.1** As decided by the Working Party A/2 (WPA/2) meeting in September 1996, the Rapporteurs' Group for Question 1/2 *Special concern of developing countries in relation to the work of the Radiocommunication and Telecommunication Standardization Sectors* met in Geneva on 29 and 30 April 1997 in order to finalize its report on this Question for the next meeting of Working Party A/2 (Geneva, 29 September-2 October 1997). The Rapporteurs' Group studied the proposed draft prepared by the Rapporteur and Associate Rapporteurs and entrusted them to prepare its final report taking into consideration all agreed modifications and amendments.

**1.2** Working Party A/2 of Study Group 2 adopted this report in its meetings on 30 September and 1 October 1997, with minor modifications and additions, and presented it to the full Study Group for its adoption.

**1.3** The output of this Question as adopted by Study Group 2 is shown below.

## 2 Outputs

### 2.1 Question 1/2 – Part a)

**"Identify Radiocommunication Sector and Telecommunication Standardization Sector Study Group Questions of particular concern to developing countries and systematically inform them of the progress of work and facilitate the presentation of their views to the relevant Study Groups in ITU-T and ITU-R"**

**2.1.1** Study Group 2 agreed on the attached list of those Questions of special concern with the relevant progress report on each of them. Annex 1, attached herewith in two parts, and Appendix 1 (ITU-T List of Supplements) represent those Questions and the progress achieved.

#### 2.1.2 Future of Question 1/2 – Part a)

It was agreed to keep this part of the Question as an independent question, its results being of an informative nature on progress achieved by the two other Sectors and being of great importance to the whole developing sector. The proposed draft text of this revised Question 1/2 – Part a) is attached here as Annex 2 – Part 1.

### 2.2 Question 1/2 – Part b)

**"Within the parameters of the work ongoing within the other two Sectors, identify issues that, due to the unique characteristics of developing countries, require specialized study which cannot be undertaken within the other two Sectors; establish the priority assigned to these issues, and implement a work programme to study them"**

**2.2.1** Although this part of Question 1/2 was assigned to the Rapporteurs' Group of Question 1/2, it is applicable to all work of the two Study Groups of the Development Sector. The Rapporteurs' Group considered the list of Questions assigned to Study Groups 1 and 2 as an answer to this part of the Question. All new and/or modified Questions proposed by any Study Group and/or Working Party should be considered as a response to this part of this Question. It was so agreed.

#### 2.2.2 Future of Question 1/2 – Part b)

All possible Questions which result from the identified main technical arrays plus other Questions emanating from other Rapporteurs and Associate Rapporteurs, and endorsed by the Study Groups, will be forwarded to the WTDC-98 for its appreciation and adoption, if so wished. Such a list is the answer to this part of this Question.

## 2.3 Question 1/2 – Part c)

**"After consideration of the work being done under ITU-R Resolution 11 and in coordination with ITU-R Study Group 1, ITU-D Study Group 2 would, if necessary, adapt spectrum management models to the needs of developing countries, taking account of their human resources, technological and financial requirements, with particular emphasis on the use of automated systems"**

The work progress of this part of the Question was carried through the relevant BAAP Programme No. 6 (Frequency Management). Study Group 2, Working Party A/2 and the Rapporteurs' Group were unable to provide any serious support to this part, except for the modest follow-up on its progress. Taking into consideration the excellent relations between those responsible for this Question in the BDT Secretariat and the experts on the matter, available only in Study Group 1 of the Radiocommunication Sector, which led to the successful development of the Basic Automated Spectrum Management System (BASMS), this part of the Question is totally answered by the development of BASMS and the relevant training courses.

### 2.3.1 Future of Question 1/2 – Part c)

Taking into consideration the excellent results achieved by BAAP Programme No. 6, the Study Group agreed to the proposal to discontinue any activity by the Study Group as regards this part of the Question in the next cycle after the World Telecommunication Development Conference 1998.

## 2.4 Question 1/2 – Part d)

**"Determine a work programme to assist developing countries to evaluate the appropriateness of a broad array of technologies (including satellite and terrestrial radiocommunications) to satisfy their equipment and service requirements and to encourage modernization and normalization; to ensure interoperability of networks; develop a methodology to analyse the benefits and costs associated with investment in relevant technologies and implementation of related systems; and identify associated requirements for human resource development"**

As recognized by Working Party A/2, Question 1/2 – Part d) was merged with Part b) of the same Question. In treating these two parts, the following technical arrays were reconfirmed by the Study Group:

**Array a – Broadband transmission on copper wire loops**

The Study Group adopted Document 2/263 corr. 1 which is a corrigendum to Annex 4 to Document 2/263 (see Annex 3), and agreed to nominate Mr. B. Peuch as new Associate Rapporteur for this technical array. It also adopted draft Question 1/2 Part d) as contained in Document 2/285, which is attached hereto as Annex 2, Part 2.

**Array b – Wireless loop access**

The Study Group meeting took note of Annex 5 to Document 2/263 (see Annex 4), and agreed that there would be no Study Question on wireless loop access, taking into consideration that the Handbook on Land Mobile, Vol. 1 on wireless loops – prepared by SG8 of the Radiocommunication Sector – is a direct answer to this part of the question.

**Array c – The geostationary, non-geostationary FSS and MSS systems capabilities**

The Study Group adopted Annex 6 to Document 2/263 (see Annex 5), and agreed to insert some editorial amendments as well as to modify the document to reflect the output of the work of the Group of Experts appointed by the Director of the BDT pursuant to Opinion No. 5 of the WTPF-96. The Study Group agreed to leave the responsibility of proposing a new Study Question to this Group of Experts on this issue as a result of their work to be annexed to their report on this opinion which will be addressed to the Director.

**Array d – Digital, audio and video broadcasting with related interactivity**

The Study Group adopted Annex 7 to Document 2/263 (see Annex 6), and approved the proposed liaison statement to the Chairman of ITU-R JWP 10-11 S. It also adopted draft Question 1/2 Part (d) as contained in Annex 2, Part 3, and modified it to include access networks where needed (between studios and transmitting stations) as well as to treat the question of interactivity in the domain of broadcasting.

### Array e – Frequency Agile

The Study Group adopted Annex 7 and welcomed the liaison statement in Document 2/266 and agreed that this statement meets the objectives of this array in Annex 7 for the time being.

### Array f – Stratospheric Telecommunication Service: An opportunity to close the information gap

The Study Group adopted Document 2/281 which had also been covered in the two Handbooks dealing with rural telecommunications and new technologies, considering this technology as an additional technical array for consideration in the future work of the Study Group (see Annex 8).

ANNEX 1

PART 1

# ITU-R Questions of particular concern to developing countries

## STUDY GROUP 1

## Spectrum management

## 1 Questions

Q.205/1 – Long-term strategies for spectrum utilization

Q.206/1 – Strategies for economic approaches to national spectrum management and their financing

Q.207/1 – Assessment, for spectrum planning and strategy development purposes, of the benefits arising from the use of the radio spectrum

Q.208/1 – Alternative methods of spectrum management

Q.215/1 – Monitoring of the radio coverage of land mobile networks to verify compliance with a given licence

## 2 Handbooks and/or the equivalent

### 2.1 Issued

**2.1.1** "National spectrum management 1995"

**2.1.2** "Spectrum monitoring" (English 1995; French and Spanish 1996)

### 2.2 Under preparation

**2.2.1** "Computer-aided techniques for spectrum management" (expected to be issued early 1998)

## 3 Recommendations (SM-series)

**3.1** Question Q55-3/1: A new version of the corresponding Recommendation SM.329 was approved as version 7 by the Radio Assembly in October 1997.

**3.2** No Recommendation yet for Question 205.

**3.3** As regards the other three Questions (206/1, 207/1 and 208/1), no Recommendations have been adopted yet. However, a new Report entitled "Economic Aspects of Spectrum Management" was approved by Study Group 1 in its last meeting in July 1997. This Report will assist in the future for developing any Recommendation relevant to those three Questions. A copy of this Report was distributed to each Administration.

## 4 Remarks

**4.1** The Chairman of Study Group 1 requested that the following three Recommendations should also be brought to the attention of the Development Sector:

- Recommendation SM.1131: "Factors to consider in allocating spectrum on a world-wide basis".
- Recommendation SM.1132: "General principles and methods for sharing between radio services".
- Recommendation SM.1133: "Spectrum utilization of broadly defined services".

These are available in ITU-R Recommendations, 1995, SM series.

**4.2** A special collaboration exists between the Development Sector and Study Group 1 as regards the development of BASMS, where the Chairman and experts of this Study Group helped in developing and updating the system and in providing the necessary training on it.

# STUDY GROUP 3

## Radiowave propagation

## 1 Questions

Q.203-1/3 – Propagation data and prediction methods for terrestrial broadcasting and terrestrial mobile services at frequencies above 30 MHz

Q.222/3 – Measurements and databanks

Q.223/3 – Prediction of sky-wave propagation conditions, signal intensity and circuit performance at frequencies between about 1.6 and 30 MHz

## 2 Handbooks and/or the equivalent

### 2.1 Issued

**2.1.1** "Curves for radiowave propagation over the surface of the earth" (1991)

**2.1.2** "Radiowave propagation information for predictions for earth-to-space path communications" (1997)

**2.1.3** "Radiometeorology" (1996)

**2.1.4** "The ionosphere and its effects on radiowave propagation" (1998)

### 2.2 Under preparation

**2.2.1** "Radiowave propagation information for predictions for signal levels likely to cause interference and for evaluation of coordination distances" (expected to be published in 1999)

**2.2.2** "Radiowave propagation information for predictions for terrestrial path communications" (expected to be published in 1999)

**2.2.3** "Operational forecasting and near real-time assessment of ionospheric variability associated with radiocommunications (expected to be published in 1999)

## 3 Recommendations (P-series)

**3.1** Among the Recommendations developed by Study Group 3, the following two Recommendations are essential to all ITU members, including the ITU-D members. Although these two Recommendations are not relevant to the Questions identified by Working Party A/2, they are:

– Recommendation P.341: "The concept of transmission loss for radio links"

– Recommendation P.1144: "Guide to the application of propagation methods of Study Group 3".

This second Recommendation could be considered as a mother Recommendation and a quick and easy way to identify the required Recommendation for each application.

### 3.2 Question 203-1/3

– Recommendation P.1145: "Propagation data for the terrestrial land mobile service in the VHF and UHF bands"

– Recommendation P.529: "Prediction methods for the terrestrial land mobile services in the VHF and UHF bands"

– Recommendation P.370: "VHF and UHF propagation curves for the frequency range from 30 MHz to 1 000 MHz"

### 3.3 Question 222/3

– Recommendation P.846: "Measurements of ionospheric and related characteristics" (revision)

– Recommendation P.845: "HF field strength measurement" (revision)

– Recommendation P.1148: "Standardized procedure for comparing predictions and observed HF sky-wave signal intensities and the presentation of such comparisons" (new)

### 3.4 Question 223/3

– Recommendation P.1239: "ITU-R reference ionospheric characteristics" (revision)

– Recommendation P.1040: "ITU-R methods of basic MUF, operational MUF and Ray-path prediction" (revision)

– Recommendation P.533: "HF propagation prediction method" (revision)

# STUDY GROUP 4

# Fixed-satellite service

## 1 Questions

The only Question which was selected was Question 43/4 "Use of small earth stations in the fixed-satellite service in the event of natural disasters, epidemics, famines and similar emergencies for warning and relief operations", and it has been completed by issuing the necessary Recommendation ITU-R S.1001, thus answering this Question. It was deleted by Study Group 4 in 1995.

## 2 Handbooks and/or the equivalent

### 2.1 Issued

**2.1.1** "CCIR Handbook on Satellite Communications (fixed-satellite service)" (2nd edition 1988).

To this Handbook, we should add the three Supplements:

– Supplement 1: "Effect of WARC Orb-88 Decisions" (1991)

– Supplement 2: "Computer programme for satellite communications" (1993)

– Supplement 3: "VSAT systems and earth stations" (1995)

**2.1.2** "Satellite News Gathering (SNG) user guide" (1996)

### 2.2 Under preparation

**2.2.1** A revision 3 to the "Handbook on Satellite Communications" (1988 issue), taking into consideration all technical and operational development since the last edition. This edition is expected to be ready in 1998.

## 3 Recommendations (S-series)

– Recommendation S.1001: "Use of systems in the fixed-satellite services in the event of natural disasters and similar emergencies for warning and relief operations" (issued 1994)

# STUDY GROUP 7

# Science services

## 1 Questions

Q.204-1/7 – Sharing of the band 1 675-1 710 MHz between the mobile-satellite service and the meteorological aids services

## 2 Handbooks and/or the equivalent

### 2.1 Issued

**2.1.1** "Radio Astronomy" (1995). This handbook is intended to be used by the spectrum managers to understand the frequency sharing issues and their implications.

**2.1.2** "Selection and Use of Precise Frequency and Time Systems". Issued recently. This handbook explains the relation between precision frequencies and standard timing for spectrum managers.

### 2.2 Under preparation

**2.2.1** "Data relay satellite". This handbook will explain how different radio sensors at different low altitudes could work with their parent receiving fixed satellites at the GSO orbit. It is expected to be ready end 1997 or soon after.

**2.2.2** "Space research". This handbook will address mainly the sharing issues between frequencies needed for research in outer space and those used by other services. It is expected to be ready end 1997 or after.

## 3 Recommendations (SA-series)

### 3.1 Question SA.204-1/7

– Recommendation SA.1158: "Sharing of the 1 675-1 710 MHz band between the meteorological satellite service (space-to-earth) and the mobile-satellite service (earth-to-space)" (new).

# STUDY GROUP 8

# Mobile, radiodetermination, amateur and related satellite services

## 1 Questions

Q.209/8 – Contributions of the mobile and amateur services and associated satellite services to the improvement of disaster communications

Q.48-3/8 – Techniques and frequency usage in the amateur service and amateur satellite service

Q.77-3/8 – Adaptation of mobile radiocommunication technology to the needs of developing countries. A revised version No. 3 of this Question was proposed by the relevant Working Party and adopted by the Study Group 8 meeting in June 1997.

Q.218/8 – Essential technical requirements of mobile earth stations for global and regional geostationary mobile-satellite service systems in the band 1-3 GHz.

# 2 Handbooks and/or the equivalent

## 2.1 Issued

**2.1.1** "Land Mobile" (including Wireless Access). A very important handbook for the Development Sector. Volume I (Wireless Access Local Loop) of this handbook was issued in 1997. Volume II (Principles and Approaches on Evolution to IMT-2000/FPLMTS) of this handbook will also be issued in 1997 or early 1998.

## 2.2 Under preparation

**2.2.1** "Mobile-satellite communications". Also a very important handbook for the Development Sector, taking into consideration its relevance also for rural communications. This handbook is expected to be published in 1998.

# 3 Recommendations (M-series)

## 3.1 Question 209/8

– Recommendation M.830 issued 1994: "Operational procedures in the bands 1 530-1 544 MHz and 1 626.5-1 645.5 MHz which are used for distress and safety purposes as specified for GMDSS"

– Recommendation 1042 issued 1994: "Disaster communications in the amateur and amateur satellite services"

## 3.2 Question 48/8

The 1994 M-series – "Amateur service and amateur satellite service":

– Recommendation M.1041: "Future Amateur Radio System (FARS)"

– Recommendation M.1042: See also Question 209

– Recommendation M.1043: "Use of the amateur and amateur satellite services in the developing countries"

– Recommendation M.1044: "Frequency sharing criteria in the amateur and amateur satellite services"

## 3.3 Question 77/8

– Recommendation M.819-1: "Future Public Land Mobile Telecommunication Systems (FPLMTS) for developing countries".

Revision 2 of Recommendation M.819-2 was adopted by Study Group 8 taking into consideration the editorial amendments proposed by the ITU-D Working Party A/2 meeting in October 1996.

### 3.4 Question 218/8

– Recommendation M.

N. B. – The follow-up of revised Recommendations and/or new Recommendations adopted by the last meeting of Study Group 8 in June 1997 is worth mentioning; they are related to relevant Resolutions and Recommendations adopted at WRCs (e.g. Resolution 716 and Recommendation 717, both adopted at WRC-95):

a) Recommendation ITU-R IS 1141 (revision) – "Sharing in the 1-3 GHz Frequency Range between N-GSO space stations operating in the MSS and stations in the FS".

b) Recommendation ITU-R IS 1142 (revision) – "Sharing in the 1-3 GHz Frequency Range between GSO space stations operating in the MSS and stations in the FS".

c) Recommendation ITU-R IS 1143 (revision) – "System specific methodology for coordination of N-GSO space stations (space-to-earth) operating in the MSS with the FS".

d) Recommendation ITU-R [Doc. 8/77] (new) – "The basis of a methodology to assess the impact of interference from a TDMA/FDMA N-GSO MSS satellite system operating in the 2 GHz range on the performance of line-of-sight FS receivers".

# STUDY GROUP 9

## Fixed services

## 1 Questions

Q.146/9 – Improvements in the performance and efficiency of HF radiotelephone circuits

Q.125-3/9 – Point-to-multipoint radio systems

Q.208/9 – Necessary planning tools to assist those administrations considering a replanning of their terrestrial fixed network with 2 GHz range

The Rapporteurs' Group proposed the addition of a new Question:

Q.205/9 – Technical and operational implications of using discrete blocks of spectrum by adaptive HF systems

## 2 Handbooks and/or the equivalent

### 2.1 Issued

**2.1.1** "Digital Radio-Relay Systems". A very important handbook, addressing also the needs of developing countries, issued in 1997.

### 2.2 Under preparation

**2.2.1** "HF adaptive systems", requested by the Development Sector. It is expected to be published early 1999.

## 3 Recommendations (F-series)

### 3.1 Question 125/9

– Recommendation F.701-2: "Radio frequency channel arrangements for analogue and digital point-to-multipoint radio systems operating in frequency bands in the range 1 350-2 690 GHz (1.5, 1.8, 2.0, 2.2, 2.4 and 2.6 GHz)" (revision)

– Recommendation F.1098-1: "Radio frequency channel arrangements for radio-relay systems in the range 1 900-2 300 MHz"
– Recommendation F.1242: "Radio frequency channel arrangements for radio-relay systems in the range 1 350-1 530 MHz"
– Recommendation F.1243: "Radio frequency channel arrangements for radio-relay systems in the range 2 290-2 670 MHz"
– Recommendation F.755-1: "Point-to-multipoint systems used in the fixed service" (revision)
– Recommendation F.756: "TDMA point-to-multipoint systems used as radio concentrators" (new)
– Recommendation F.1104: "Requirements for point-to-multipoint radio systems used in the local grade portion of an ISDN connection"

### 3.2 Question 146/9

– Recommendation F.335-2: "Use of the radio links in the international telephone circuits"
– Recommendation F.455-2: "Improved transmission systems for HF radio-telephone circuits"
– Recommendation F.480: "Semi-automatic operation on HF radio-telephone circuits. Devices for remote connection to an automatic exchange by radio-telephone circuits" (new)
– Recommendation F.1111-1: "Improved Lincompex systems for HF radio-telephone circuits" (revision)

### 3.3 Question 208/9

– Recommendation ITU-R F.1335: "Technical and operational considerations in the phased transitional approach for bands shared between the mobile satellite service and the fixed service of 2 GHz"

# STUDY GROUP 10

# Broadcasting service – Sound

## 1 Questions

Q.64/10 – System design for HF broadcasting

Q.65-1/10 – Short-distance broadcasting in band 7 (HF) in the tropical zone

Q.73-1/10 – Sound broadcasting in band 8 (VHF) in the tropical zone

NOTE – Digital broadcasting systems: work is currently in progress on the following three issues:

1) digital sound broadcasting system standards at frequencies below 30 MHz;
2) planning for digital sound broadcasting at various frequency bands;
3) spectrum management for digital sound broadcasting.

Any questions in the above three areas will be picked up and any other issues regarding digital broadcasting systems are to be addressed in Part d) of Question 1/2.

## 2 Handbooks and/or the equivalent

### 2.1 Issued

**2.1.1** ITU-R special publication on "Digital Sound Broadcasting (DSB)" (1995).

**2.1.2** "High-frequency broadcasting schedule". This is a publication on diskette prepared in accordance with Article 17 of the Radio Regulations (a periodical for a 12 month duration).

### 2.2 Under preparation

**2.2.1** "HF broadcasting systems". A very useful handbook for the Development Sector. It is expected to be published by the end of 1997 or beginning 1998.

**2.2.2** "LF and MF sound broadcasting systems". A very useful handbook for the ITU-D. Its publication is foreseen to be in 1998 by the Radiocommunication Sector.

## 3 Recommendations (BS-series)

There are no Recommendations relevant to the three Questions since the three of them called for handbooks.

### 3.1 Question 64/10

The handbook mentioned under item 2.2.1 is the answer to this Question.

### 3.2 Question 65-1/10

This Question calls for a handbook also. The handbook mentioned under item 2.2.1 will cover also Question 65-1/10 as regards sound broadcasting in the tropical zones.

### 3.3 Question 73-1/10

This Question calls for a handbook also. However, in Study Group 10 there is no Group yet responsible for such a handbook. It is proposed that Working Party A/2 will discuss this matter in order to take appropriate action.

## 4 Conclusion

Proper coordination with the Rapporteurs' Group for Question 8/2 (public broadcasting) of ITU-D Working Party A/2 is maintained.

# STUDY GROUP 11

# Broadcasting service – Television

## 1 Questions

No Question was identified. However, all relevant Questions of Working Party 11C on planning of terrestrial digital broadcasting (both sound and television) as well as those Questions of Working Party 10-11S on satellite broadcasting (both sound and television) will be considered under Part d) of BDT Question 1/2: "Digital, audio and video broadcasting with related interactivity". Also all relevant Recommendations in response to the relevant Questions of WP 11C and Joint WP 10-11S will be taken into consideration.

## 2 Handbooks and/or the equivalent

### 2.1 Issued

**2.1.1** "Television systems used around the world". Still a useful reference.

**2.1.2** "Digital television signals: coding and interfacing within studios" (1995).

**2.1.3** "Subjective assessment methodology in television" (1995).

### 2.2 Under preparation

**2.2.1** "Teletext systems". This handbook is intended for developing countries wishing to introduce such a form of data broadcasting. Publication is expected early 1998.

Study Group 11 also responded positively to the request for the possible development of a handbook on terrestrial television planning taking into consideration digitization of the television signal.

## 3 Recommendations

None.

## 4 Conclusion

Proper coordination with the Rapporteurs' Group for Question 8/2 (public broadcasting) of ITU-D Working Party A/2 is maintained.

ANNEX 1

PART 2

# ITU-T Questions of particular concern to developing countries

## Introduction

As agreed by the last meeting of ITU-D Working Party A/2, Part 2 is an update of all Questions with their new reference numbers adopted by the World Telecommunication Standardization Conference (WTSC), which took place in October 1996. The Rapporteur has also maintained the old numbering for easy reference and follow-up. However, the final document will in future only carry the new numbers adopted by the WTSC-96.

# STUDY GROUP 2

## Network and service definitions

## 1 Questions

Question 1/2 – Applications of numbering and addressing plans for fixed and mobile services (former Question 5/2)

Question 10/2 – Management and development of PSTN-based telecommunication services (former Question 4/1)

Question 16/2 – Human factors issues in telecommunications affecting multiple services or not related to specific services (former Questions 17/1 and 19/1)

Question 17/2 – Human factors aspects of voice and non-voice services using public terminals (former Question 18/1)

*Remarks*

a) As a result of the adoption by the WTSC-96 of Resolution 29 relevant to the alternative calling procedures, new Question 3/2 (former Question 8/2, modified to meet the relevant objectives of Resolution 29 as regards the service quality of networks) is proposed to be included in the list.

b) A joint Rapporteurs' Group representing Study Groups 2, 3 and 11 (all involved in the application of Resolution 29), was created and met for the first time at the end of May 1997 to tackle the important issue of "call back". This joint Rapporteurs' Group was chaired by the Chairman of Study Group 11, Dr. S. Kano.

## 2 Handbooks and/or the equivalent

### 2.1 Issued

**2.1.1** In the past, many useful ITU-D documents were prepared for publication in collaboration with former Study Group 1, mainly to facilitate the operational activities of the telecommunication services, e.g. Bureaufax tables, gentex tables, codes and abbreviations for the use of the international telecommunication services, etc. In addition, Appendix 1, attached to this report, contains a list of valid Supplements to those Recommendations pertinent to former Study Group 1 (i.e. E- and F-series), as well as those for Study Group 2.

**2.1.2** Instructions for the international telephone service (1993).

### 2.2 Under preparation

None.

## 3 Recommendations

### 3.1 for Question 10/2 (former Question 4)

– F.16: “Global virtual network services” (new)
– E.117: “Terminal devices used in connection with the public telephone service (other than telephone)” (revision)
– E.152: “International free phone service” (revision)
– E.153: “Home country direct” (new)

### 3.2 Proposed new Questions (former 16/2 and 17/2)

– F.902: “Interactive services design guidelines” (new)
– E.135: “Human factors aspects of public terminals for people with disabilities” (new)
– F.910: “Procedures for designing, evaluating and selecting symbols, pictograms and icons” (new)
– E.121: “Pictograms, symbols and icons to assist users of the telephone service” (revision)

### 3.3 Question 1/2 (former Question 5/2)

– E.162: “Capability of seven digit analysis for international E.164 numbers at time T” (new)
– E.169: “Application of E.164 numbering plan for universal international freephone numbers for international freephone service” (new)
– E.165-1: “Use of escape code “o” within the E.164 numbering plan during the transition period to implementation of number plan interworking (NPI) mechanism” (new under approval by balloting)
– E.191: “B-ISDN numbering and addressing” (new under approval by balloting)
– E. 166/X.122: “Numbering plan interworking for the E.164 and X.121 numbering plans” (revision under approval by balloting)

# STUDY GROUP 3

# Tariff and accounting principles including related telecommunications economic and policy issues

## 1 Questions

Question 1/3 – Study of economic issues and of the impact of national policies as they relate to the development of telecommunication services and networks (a new Question supported by all delegates of developing countries to WTSC-96, it inherits part of the responsibilities of former Study Group 1. This Question reflected also the relevant parts of Resolution 29 of the WTSC-96).

Question 2/3 – Reform and development of charging, accounting and settlement principles for the international telephone services (former Question 5, plus relevant parts of former Questions 8, 9, 10 and 23).

Question 8/3 – Regional costing studies for the development of cost models together with related economic and policy issues (former Questions 13 and 14 and the basis for the work of the regional tariff groups TAF, TAL, TAS and TEUREM).

Question 9/3 – Terms and definitions of Recommendations dealing with charging and accounting principles.

## 2 Handbooks and/or the equivalent

**2.1** Three Supplements to Study Group 3 Recommendations are worth mentioning again here. Also, two of them are issued:

Supplement 1: "Cost and tariff study method" (1988).

Supplement 2: "Methods for carrying out a cost price study by regional tariff groups" (1988).

### 2.2 Under publication

Supplement 3: "Handbook on the methodology for determining costs and establishing national tariffs".

## 3 Recommendations

### 3.1 Question 2/3 (former Question 5)

– D.120: "Charging and accounting principles for the automated telephone credit card service" (revision)

– D.140: "Accounting rate principles for international telephone services" (addition of an annex)

– D.155: "Guiding principles governing the apportionment of accounting rates in the intercontinental telephone relations" (revision)

– D.170: "Monthly telephone and telex accounts" (revision)

– D.190: "Exchange of international traffic accounting data between Administrations using electronic data interchange (EDD) techniques" (revision).

### 3.2 Questions 8/3 (all emanated from the Regional Tariff Groups, former Questions 13 and 14)

– D.300 R: "Determination of accounting rate shares in telephone relations between countries in Europe and the Mediterranean Basin"

– D.301 R: as D.300 R but for telex

– D.302 R: as D.300 R but for telegrams

– D.303 R: as D.300 R but for circuits of sound and television programme transmission

– D.307 R: "Renumeration of digital systems and channels used in telecommunication relations between the countries of Europe and the Mediterranean Basin"

– D.500 R: "Accounting rates applicable to telephone relations between countries in Asia and Oceania" (also a Supplement was issued to this Recommendation on methods of carrying out the cost price study in Asia and Oceania)

– D.501 R: The same as D.500 R but for telex

– D.600 R: "Determination of accounting rate shares and collection charges in telephone relations between countries in Africa" (revision)

– D.601 R: The same as D.600 R but for telex relations

## 4 Conclusion

**4.1** It is worth mentioning that a sufficient number of delegations from developing countries participate actively in the work of this Study Group, which is not the case for the rest of the Study Groups, where the participation of delegations from developing countries is minimal, or non-existent in some cases.

**4.2** Study Group 3 is the lead Study Group for implementing both Resolutions 21 and 22 of the Kyoto Plenipotentiary Conference as regards the Standardization Sector:

– Resolution 21 on "Special measures concerning alternative calling procedures on international telecommunication networks".

– Resolution 22 on "Apportionment of revenues coming from international telecommunications services".

**4.3** Study Group 3 is the lead Study Group for implementing Resolution 29 of WTSC-96 on alternative calling methods as well as on all studies of economic issues.

**4.4** The new proposed Question 1/3 is among the important Questions of special concern to the developing countries.

**4.5** It is worth mentioning that the activities of the Regional Tariff Group for Europe and the Mediterranean Basin was frozen as of mid-1995, given the new regulatory framework in Europe, it became as an *ad hoc* group which would meet as and when the need arose, based on the proposed new Question 8/2.

# STUDY GROUP 4

# TMN and network maintenance

## 1 Questions

Question 1/4 – Terms and definition (former Question 1 with updated text)

Question 3/4 – Maintenance of switched international networks (former Question 18 with updated text)

Question 10/4 – Test and measurement techniques and equipment for use in transmission equipment (former Questions 24 with updated text)

Question 13/4 – TMN principles, architecture and methodology

## 2 Handbooks and/or the equivalent

### 2.1 Issued

"Quality of service and network performance" (1993)

### 2.2 Under publication

None.

## 3 Recommendations

### 3.1 Question 1/4 (former Question 1/4)

– M.60: "Maintenance terminology and definitions"

### 3.2 Question 3/4 (former Question 18/4)

None.

### 3.3 Question 10/4 (former Question 24/4)

– O.1: "Scope and application of measurement equipment specifications covered in the O-series Recommendations" (revision)
– O.33: "Automatic equipment for rapidly measuring stereophonic pairs and monophonic sound programme circuits, links and connections" (revision)
– O.41: "Psophometer for use on telephone-type circuits" (revision)
– O.133: "Equipment for measuring the performance of PCM encoders and decoders"
– O.150: "General requirements for performance measurements on digital transmission equipment" (revision)
– O.181: "Equipment to assess performance on STM-N interfaces".

### 3.4 Question 13/4

– M.3010: "Principles for a Telecommunications Management Network"

NOTE – This last Recommendation is being revised, enlarged, split into two separate Recommendations to include additionally: management domains, security control access, TMN/IN and Q-adaptor.

In addition to the above-mentioned Recommendations, the Recommendations mentioned below are important to be noted by the Development Sector:

– O.151 (10/92): "Error performance measuring equipment operating at the primary rate and above"
– O.152 (10/92): "Error performance measuring equipment for bit rates of 64 kbit/s and N × 64 kbit/s"
– O.153 (10/92): "Basic parameters for the measurement of error performance at bit rates below the primary rate"
– O.162 (10/92): "Equipment to perform in-service monitoring on 2 048, 8 448, 34 368 and 139 264 kbit/s signals"
– O.171 (04/97): "Timing jitter measuring equipment for digital systems"
– O.191 (04/97): "Equipment to assess ATM layer cell transfer performance"

# STUDY GROUP 5

## Protection against electromagnetic environment effects

## 1 Questions

Question 12/5 – Interference produced by power lines and electrified railway lines into telecommunication lines (one of the outcomes of this Question is the "Updating of Directives", former Question 13)

## 2 Handbooks and/or the equivalent

### 2.1 Issued

**2.1.1** "CCITT Directives concerning the protection of telecommunication lines against harmful effects from electrical power and electrified railway lines":

Volume I – "Design construction and operational principles of telecommunications, power and electrified railway facilities" (revision 1990)
Volume II – "Calculating induced voltages and currents in practical cases" (revision)
Volume III – "Capacitive inductive and conductive coupling: physical theory and calculation method" (revision 1990)
Volume IV – "Inducing currents and voltages in electrified railway systems" (revision 1990)
Volume V – "Inducing currents and voltages in power transmission and distribution systems" (revision 1990)

Volume VI – "Danger and disturbance" (revision 1990)

Volume VII – "Protective measures and safety precautions" (revision 1990)

Volume VIII – "Protective devices" (revision 1990)

Volume IX – "Testing methods and measuring apparatus" (revision 1990).

**2.1.2** "The protection of telecommunication lines and equipment against lightning discharges". Originally published in 1974, composed of five chapters, then chapters 6, 7 and 8 appeared in 1978, and recently chapters 9 and 10 were issued in 1995.

### 2.2 Under preparation

**2.2.1** An update. New Volumes II and V of the Directives will be issued in 1997.

**2.2.2** An update of Volume VI of the Directives as a result of the adoption of the new annex to Recommendation 26 "Protection of telecommunication lines against harmful effects from electric power and electrified railway lines" is under consideration for an appropriate form of publication. The same applies also to the updated materials of Volumes VII and VIII.

**2.2.3** A new Handbook on "Earthing of telecommunication installations" is under preparation, publishing date is not known yet (to replace an old Handbook issued in 1976).

**2.2.4** A new Handbook contains descriptions of measuring and testing methods related to electromagnetic compatibility. Work started in the existing cycle, expected to be finished in the next cycle 1996-2000. Publishing date is not known yet.

**2.2.5** Possible additional chapters to the Handbook "Protection of telecommunication lines and equipment against lightning discharges". Publishing date is not known yet.

## 3 Recommendations

Not applicable.

## 4 Remarks

Taking into consideration the importance of the activities of this Study Group for the majority of developing Administrations, Study Group 2/D requested, in a liaison statement, the assistance of Study Group 5 to prepare a recommendation or a guideline on how to use the output of this Study Group citing Recommendations, directives, handbook and in which circumstances. Study Group 5 responded positively in its last meeting in February 1997 and created an Ad hoc Group composed of the Vice-chairman, Chairmen of the three Working Parties and some other experts to respond to this request.

The Ad hoc Group met for the first time in Budapest (Hungary) in May 1997, and continued working on the guide until it was approved by the Study Group 5 meeting in September 1997. It is now available. It will be updated whenever new or revised SG5 publications are approved.

# STUDY GROUP 6

# Outside plant

## 1 Questions

Question 3/6 – Amendments and additions to manuals (former Question 5 with updating)

Question 5/6 – Optical fibre cable installations (former Question 6 with updating)

Question 6/6 – Optical fibre cable network maintenance (former Question 8 with updating)

## 2 Handbooks and/or the equivalent

### 2.1 Issued

**2.1.1** "Preservation of wooden poles carrying overhead telecommunication lines" (1974)

**2.1.2** "Jointing of plastic-sheathed cable" (1978)

**2.1.3** "Jointing of telecommunication cable conductors" (published 1982)

**2.1.4** "Outside plant technologies for public networks" (published 1991)

**2.1.5** "Application of computers and micro-processors to the construction, installation and protection of telecommunication cables" (in response to Question 3 published in 1994)

**2.1.6** "Construction, installation, jointing and protection of optical fibre cables" (published in 1994)

### 2.2 Under preparation

None.

## 3 Recommendations

### 3.1 Question 3/6

None.

### 3.2 Question 5/6

None.

### 3.3 Question 6/6

None.

All these Questions are answered mainly by Handbooks; Recommendations are under preparation.

## 4 Remarks

A new Question 12/6 "Trenchless techniques for the construction of underground infrastructures for telecommunication cables installation" was adopted by the WTSC-96 as proposed by Study Group 6. As a result of its adoption, it will be proposed to the final meeting of ITU-D Study Group 2 to be adopted among those Questions of particular concern.

# STUDY GROUP 7

## Data networks and open system communications

## 1 Questions

Question 1/7 – Technical characteristics, classes of services, facilities and categories of access for network providing data communication (continuation of former Question 1)

Question 3/7 – Numbering plan for public data networks (continuation of former Question 3)

Question 15/7 – Directory systems (former Question 15 with parts of former Question 18)

## 2 Handbooks and/or the equivalent

### 2.1 Issued

None.

### 2.2 Under preparation

A Handbook on security, expected to be published in 1998.

## 3 Recommendations

### 3.1 Question 1

- X.1: "International user classes of service in, and categories of access to, public data networks and ISDNs" (revision)
- X.2: "International data transmission services and optional user facilities in public data networks and ISDNs (revision)
- X.7: "Technical characteristics of data transmission services" (revision)

### 3.2 Question 3

- X.121: "International number plan for public data networks" (revision)
- X.122/E.166: "Numbering plan interworking for the E.164 and X.121 numbering plans" (revision joint responsibility with Study Group 2 (new)
- X.123: "Mapping between escape codes and TOA/NPI for E.164/X.121 numbering plan interworking during transition period" (new)

### 3.3 Question 15

- X.500: "Information technology (I.T.), O.S.I., The directory: overview of concept models and services" (new)
- X.501: "I.T., OSI, The directory: models" (new)
- X.509: "I.T., OSI, The directory: authentication-framework" (new)
- X.511: "I.T., OSI, The directory: abstract service definition" (new)
- X.518: "I.T., OSI, The directory: procedures for distribution operation" (new)
- X.519: "I.T., OSI, The directory: protocol specifications" (new)
- X.520: "I.T., OSI, The directory: selected attribute types" (new)
- X.521: "I.T., OSI, The directory: selected object classes" (new)
- X.525: "I.T., OSI, The directory: replication"

All these Recommendations are common texts with their equivalent at ISO/IEC.

# STUDY GROUP 8

# Characteristics of telematic systems

## 1 Questions

Question 1/8 – Facsimile terminals (former Questions 5 and 9)

# 2 Handbooks and/or the equivalent

## 2.1 Issued

"Individual standardized test charts Nos. 2, 3 and 4 for document facsimile transmission (high quality)", to be used in conjunction with the relevant Recommendations of the corresponding facsimile terminal (a manual to use these test charts is also available).

## 2.2 Under preparation

None.

# 3 Recommendations

## 3.1 Question 1 (relevant to former Question 9)

– Amendment 1 to 503: "A document application profile for the interchange of Group 4 facsimile documents". Amendment 2 – Annex B: "Extension for continuous tone colour and grey-scale image document" (new)

– Amendment 2 to 503: "A document application profile for the interchange of Group 4 facsimile" (new)

– Amendment 1 to 521: "Communication application profile BT0 for document bulk transfer based on the session service" (new)

– T.563: "Terminal characteristics for Group 4 facsimile apparatus" (new)

– Amendment 1 to T.563 modifying it.

# STUDY GROUP 9

## Television and sound transmission

# 1 Questions

Question 4/9 – Digital networks carrying sound programme signals for contribution and primary distribution (former Question 38 with updating)

Question 12/9 – Digital networks carrying television signals for contribution and primary distribution (former Question 39 with updating)

# 2 Handbooks and/or the equivalent

## 2.1 Issued

None.

## 2.2 Under preparation

None.

## 3 Recommendations

### 3.1 Question 12/9 (relevant to former Question 39)

– J.82: “Transport of MPEG-2 constant bit rate television”.

### 3.2 Question 4/9 (relevant to former Question 38)

– J.52: “Digital transmission of high-quality sound programme signals using one, two or three 64 Kbit/s channels per mono signal (and up to six per stereo signal)”.

# STUDY GROUP 10

# Languages for telecommunication applications

## 1 Questions

No Question was retained.

## 2 Handbooks and/or the equivalent

Despite the above, handbooks relevant to the CHILL language were retained:

**2.1** CHILL formal definition – Volume I

**2.2** CHILL formal definition – Volume II

**2.3** Introduction to the CHILL (1993)

# STUDY GROUP 11

# Signalling requirements and protocols

## 1 Questions

Question 12/11 – Network signalling for the support of narrow-band ISDN services (merger of former Questions 21 and 23)

Question 19/11 – Signalling methods used by alternative calling procedures (new Question generated by WTSC-96, as a result of adopting Resolution 29)

## 2 Handbooks and/or the equivalent

### 2.1 Issued

**2.1.1** “Guidelines for preparing and conducting field trials of digital switching equipments” (1987)

**2.1.2** “ISDN field trial guidelines” (1991)

**2.1.3** “Guidelines for implementing a signalling system No. 7 network” (1991)

### 2.2 Under preparation

None.

## 3 Recommendations

### 3.1 Question 12/11 (relevant to former Question 23)

– Q.696: "Interworking of signalling systems – logic procedures for interworking of Signalling System No. 7 to R3".

### 3.2 Question 19/11

A preliminary report was prepared, identifying the issues.

# STUDY GROUP 12

# End-to-end transmission performance of networks and terminals

## 1 Questions

Question 2/12 – Definitions in the fields of telephonometry, speech signal processing, video signal processing, multimedia terminal equipment and of characteristics of international connections and circuits (former Question 3)

Question 4/12 – Updating the handbook on telephonometry (continuation of former Question 4)

## 2 Handbooks and/or the equivalent

### 2.1 Issued

**2.1.1** "Telephonometry" (published 1993)

### 2.2 Under preparation

**2.2.1** Updating the Handbook referred to in 2.1.1 (see Question 4/12)

## 3 Recommendations

### 3.1 Question 2/12 (relevant to former Question 17)

– G.115: "Mean active speech level for announcement and speech synthesis system" (new).

### 3.2 Question 4/12 (relevant to former Question 25)

Updating the Handbook will be the answer.

# STUDY GROUP 13

# General network aspects

## 1 Questions

Question 24/13 – Global information infrastructure – GII (new Question)

Question 25/13 – GII principles and framework (new Question)

Question 28/13 – Vocabulary for general network aspects (continuation of former Question 24)

## 2 Handbooks and/or the equivalent

### 2.1 Issued

None.

### 2.2 Under preparation

None.

## 3 Recommendations

### 3.1 Question 24/13

Under preparation.

### 3.2 Question 25/13

Under preparation.

### 3.3 Question 28/13

– I.113: "Vocabulary of terms for broadband aspects of ISDN" (revision).

# STUDY GROUP 15

# Transport networks, systems and equipment

## 1 Questions

Question 1/15 – Access network transport (new Question)

Question 2/15 – Characteristics of optical systems in local access networks for transport and distribution (continuation of former Question 24)

Question 15/15 – Characteristics and text methods of optical fibres and cables (continuation of Question 23)

## 2 Handbooks and/or the equivalent

### 2.1 Issued

**2.1.1** "Optical fibres for telecommunications" (published 1984)

**2.1.2** "Optical fibre system planning guide" (published 1989)

**2.1.3** "Transmission planning" (published 1993)

### 2.2 Under preparation

None.

## 3 Recommendations

### 3.1 Question 1/15

None.

### 3.2 Question 2/15

– G.981: "PDH optical fibre systems for the local network" (new)

### 3.3 Question 15/15

– G.655: "Characteristics of non-zero dispersion single made optical fibre cable" (new)
– G. 982: "Optical access networks to support services up to ISDN primary rate or equivalent bit rates" (new).

# STUDY GROUP 16

# Multimedia services and systems

## 1 Questions

Question 4/16-3 – Modems for switched telephone network and telephone-type leased circuits (continuation of Question 1 of former Study Group 14)

*Remark*

Taking into consideration the creation of this new Study Group, its Question 1/16 "Audiovisual/multimedia services" is proposed for inclusion among those Questions of particular concern.

## 2 Handbooks and/or the equivalent

### 2.1 Issued

None.

### 2.2 Under preparation

None.

# 3 Recommendations

## 3.1 Question 1/16

None.

## 3.2 Question 4/16

– V.34 (v.fast): "A modem operating at data signalling rates of up to 28.800 bit/s for use on the general switched telephone network and on leased point-to-point 2-wire telephone-type circuit" (new)

– V.8: "Procedure for starting sessions of data transmission over the general switched telephone network" (new)

– V.8 *bis*: "Procedures for the identification and selection of common modems of operation between DCES and between DTES over the general switched telephone network and on leased point-to-point telephone-type circuits"(new)

– V.61: "A simultaneous voice plus data modem, etc." (new)

– V.70: "Procedures for simultaneous transmission on data and digital voice signals" (new)

– V.75: "DSVD terminal control procedures" (new)

– V.76: "Generic multiplexer using X.42 LAMP based procedure" (new)

– V.34: "A modem operating at data signalling rates of up to 33.600 bit/s (revision)

ANNEX 2

PART 1

**Draft Question 1/2 – Part a)**

## Identify Study Group Questions in the ITU-T and ITU-R Sectors which are of particular interest to developing countries and systematically, by way of annual progress reports, inform them of the progress of work on the questions to facilitate their contributions to the work on those questions as well as, ultimately, to benefit from their outputs in a timely manner

### 1 Statement of problem or situation

ITU-T and ITU-R do undertake very many study questions of diverse purposes, outputs and focus. Some of these questions are, or could be, of particular concern to developing countries. The developing countries are not so well endowed with resources to follow the work of even a limited number of Study Groups nor are they kept informed of which questions have been agreed for study, their purposes and the status of their implementation. There is no doubt that some developing countries are now in a position to take part in the work of some of the Study Group questions and nearly all are likely to benefit from the output of these questions.

### 2 Question or issue proposed for study

Identification on a continuing basis of those Study Group Questions in the ITU-T and ITU-R Sectors which are of particular interest to developing countries based on an agreed set of guidelines.

### 3 Specification of the expected output

Annual Progress Reports indicating status of the selected questions and, where completed, an indication of how the outputs can be obtained.

### 4 Required timing of the expected output

Annually, *ad infinitum*.

### 5 "Proposers/Sponsors" – Those who requested study of the Question or issue

The question was originally adopted by the WTDC-94.

### 6 Input required, in carrying out the study

1) Examination of all the ITU-T and ITU-R Study Group Questions with a view to selecting those of interest to developing countries.

2) Request for updating information from the ITU-T and ITU-R Sectors on the selected Questions.

3) Discussion in the relevant ITU-D Study Group.

## 7 Target audience for the output

| | Developed countries | Developing countries | LDCs |
|---|---|---|---|
| **Telecom policy makers** | * | X | X |
| **Telecom regulators** | * | X | X |
| **Telecom operators** | * | X | X |

** The Question outputs are specifically targeted to developing countries and LDCs although it is in the interest of telecommunication policy makers in the developed countries to be aware of the interests of developing and least developed countries.*

### 7.1 Target audience – Who specifically will use the output?

Depending on the nature of the output, upper- to middle-level managers among operators and regulators in developing and least developed countries are the predominant users of the output.

## 8 Proposed method of handling this Question/issue

It is proposed that this Question be handled within a Study Group.

## 9 Coordination requirements of the study

The ITU-D Study Group dealing with this question will need to coordinate with:

– relevant Focal Points in BDT;

– Coordinators of relevant project activities in BDT;

– Regional and Scientific Organizations with mandates over the subject matter of the question.

## 10 Other relevant information

As may become apparent within the very long life of this question.

N.B. – This is a unique question with a double-barrelled output: first, its own output of an annual progress report, and secondly, the final outputs of the selected Study Group Questions of the ITU-T and the ITU-R Sectors. In discussing output, the two should therefore be borne in mind.

ANNEX 2

PART 2

**Draft Question 1/2 – Part d)**

# Examine broadband communications over traditional copper wires on aspects of technologies, systems and applications

This study will include a cost/benefit analysis as well as an examination of the level of complexity of deploying such solutions, in particular in conjunction with existing or future backbone infrastructure.

## 1 Statement of problem or situation

There are more than 600 million copper loops installed world-wide. A vast majority of them can support broadband communications using Digital Subscriber Line (DSL) technologies without any particular reengineering.

These new techniques permit deployment of applications (telemedicine, distance learning, tele-work, Internet access, intranet access) which require multi-megabit per second transmission capabilities on the same access networks which so far were only supporting multi-kilobit per second transmission.

The main merit of broadband communication over traditional copper lines using DSL technologies is the ability to leverage existing investments already made by telecommunication administrations. Also, developed countries have successfully conducted trials, and the technology and products have reached a level of maturity which permits us to consider large-scale deployments. Therefore, developing countries can begin to benefit from such experience immediately.

ITU-D can play a role in assisting Sector members evaluate the appropriateness of this technical array and analyse the economic issues involved in deploying broadband communication applications over traditional copper loops, including the integration of these access network solutions with existing or future backbone networks infrastructure.

## 2 Question or issue proposed for study

Identify the technical and economic impacts and development aspects of the deployment of broadband communication technologies and applications on traditional copper loops using DSL technologies with particular attention to cost of customer premises equipment, easiness of deployment, and integration with existing and future backbone infrastructure.

## 3 Specification of the expected output

- Description and evaluation of the DSL technologies (report, Year 1998).
- Economic cost-benefit analysis of deployment of broadband communication technologies, products, and applications over traditional copper loops, including an assessment of the demands in developing countries and the interoperability of these solutions with existing and future backbone infrastructure (report, Year 1998).
- Guidelines for access network deployment using DSL technologies (Year 1999).
- Recommendation (Year 2000).

## 4 Required timing of the expected output

The course of the next ITU-D Study Period.

## 5 "Proposers/Sponsors" – Those who expected study of the Question or issue

This technological array was originally adopted for study by Working Party A/2 during its meeting in May 1995.

## 6 Input required, in carrying out the study

1) Collection of related contributions and data from ITU-D Member States and Sector members, and those organizations and groups listed below in Part 9 of this document.
2) Examination of ITU-T Study Group Questions related to this technological array.
3) Discussion of the relevant ITU-D Study Groups.

## 7 Target audience for the output

| | Developed countries | Developing countries | LDCs |
|---|---|---|---|
| **Telecom policy makers** | X | X | X |
| **Telecom regulators** | X | X | X |
| **Service providers** | X | X | X |
| **Manufacturers** | X | X | X |

### 7.1 Target audience – Who specifically will use the output?

Users of the output to be middle and upper-level managers among operators and service providers world-wide. Manufacturers will also gain information for designing their solutions with developing countries and LDCs in mind.

## 8 Proposed method of handling this Question/issue

It is proposed that this Question be handled within a Study Group.

## 9 Coordination requirements of the study

The ITU-D Rapporteur's Group dealing with this question should coordinate closely with:

- the relevant Study Groups in ITU-T;
- other International and Regional Organizations, as appropriate.

ANNEX 2

PART 3

**Draft Question 1/2 – Part d)**

## Examine digital broadcasting technologies and systems, including cost/benefit analyses, assessment of demands on human resources, interoperability of digital systems with existing analog networks, and methods of migration from analog to digital techniques

## 1 Statement of problem or situation

While it seems clear that the migration to digital broadcasting technologies will be universal over time, it will not progress evenly in all countries or regions. Ironically, some satellite digital broadcasting technologies will be introduced in the developing countries before they become available in the developed countries.

ITU-D can play a role in assisting Member States evaluate the economic issues involved in migrating from analog to digital broadcasting methods, such as the introduction of digital technology into radio program production (see Note), and the provision of high bandwidth terrestrial links between studios and satellite feeder link stations. ITU-D could also provide updates on related Studies being conducted in the ITU-R and ITU-T Sectors.

NOTE – The latter is a goal set forth in the Beirut Declaration, which emanated from the 1996 Regional Telecommunication Development Conference for the Arab States (AR-RTDC96).

## 2 Question or issue proposed for study

Identify the economic impact and development aspects of proposed and existing digital sound, television and cable broadcasting systems, with particular attention on receiver costs; identify migration techniques from analog to digital broadcasting, taking into consideration the experiences of ITU-D Member States and Sector members.

## 3 Specification of the expected output

Economic cost-benefit analyses of various digital broadcast systems, including an assessment of the demands of these systems on human resources in developing countries and the systems' interoperability with existing networks. The collection, analysis and periodic dissemination of relevant data received from those organizations and groups listed below in paragraph 9 of this document. Periodic updates on Studies taking place in the other ITU Sectors, including analysis of any economic issues that these Studies might raise. Analysis of various migration techniques/strategies. Examination of distance education applications for satellite digital sound broadcast services, including interactivity.

## 4 Required timing of the expected output

The course of the next ITU-D Study Period.

## 5 "Proposers/Sponsors" – Those who requested study of the Question or issue

This technological array was originally adopted for study by Working Party A/2 during its meeting in May 1995.

# 6 Input required, in carrying out the study

1) Collection of related contributions and data from ITU-D Member States and Sector members, and those organizations and groups listed below in paragraph 9 of this document.

2) Examination of ITU-T and ITU-R Study Group Questions related to this technological array.

3) Discussion in the relevant ITU-D Study Group.

# 7 Target audience for the output

| | Developed countries | Developing countries | LDCs |
|---|---|---|---|
| **Telecom policy makers** | * | * | * |
| **Telecom regulators** | * | * | * |
| **Broadcasting operators** | * | * | * |
| * *The Question outputs are generally targeted to broadcasters, policy makers and regulators world-wide, and more specifically to those in developing and least developed countries.* | | | |

## 7.1 Target audience – Who specifically will use the output?

Users of the output are expected to be middle and upper level Managers among Operators and Regulators world-wide.

# 8 Proposed method of handling this Question/issue

It is proposed that this Question be handled within a Study Group.

# 9 Coordination requirements of the study

The ITU-D Rapporteur's Group dealing with this Question should coordinate closely with:

– Other ITU-D Rapporteur's Groups dealing with similar issues, in particular the successor Groups to Questions 3/1, 2/2 and 8/2.

– The relevant Focal Points in the BDT.

– The ITU-D's SPACECOM Project.

– The Regional Broadcasting Unions and Associations.

– Other International and Regional Organizations, as appropriate.

ANNEX 3

# Broadband transmission over existing copper wire loops

## Abstract

Broadband transmission over traditional copper loops is made possible by the use of Digital Subscriber Line (DSL) technologies. This paper attempts to explain why, from both the technical and market perspectives, xDSL technologies are today considered as the most promising of the broadband access technology options for both residential and business users. An overview of the family of xDSL technologies is provided. The evolution of xDSL regarding aspects of price, standardization, and interoperability is explored – demonstrating a strong technology push. Key factors of the xDSL business case are discussed – demonstrating a strong market pull. An overview of xDSL trials, applications and network models is provided. The conditions are right for xDSL to advance rapidly to mass market adoption.

## 1 Broadband Access Technologies

In the domain of wide area network access, there are numerous technology options that are presently competing for market share and acceptance. These technology options originate from both the WAN and LAN environments and include: ISDN, ATM, ATM25, switched Ethernet, Frame Relay, several technologies for data transmission over coaxial (CATV) cable, and the family of Digital Subscriber Line technologies.

In the past year, xDSL technologies have attracted a great deal of attention as the access solution of the future – in both the home and business application environments. Originally, xDSL technologies, operating over the existing infrastructure of copper wiring, were proposed as an intermediate access solution for the residential area before the extensive installation of a hybrid fibre-coax (HFC) infrastructure or fibre-to-the-home (FTTH). It has become apparent that the installation of an HFC or FTTH infrastructure will require a far larger investment and a much longer deployment schedule (measured in decades) than previously envisioned. Therefore, the "intermediate" period of xDSL deployment may well be with us far into the 21$^{st}$ century.

Although xDSL technologies have seemingly "emerged" from data communications labs only recently, they have actually existed for a number of years – although without the notoriety they enjoy today. Why then has xDSL suddenly achieved its present status as potentially the most promising of the broadband access technology options for both residential and business users? This article attempts to shed light on this question from both the technical and market perspectives.

## 2 The Essence of xDSL

For decades, conventional wisdom has held that analogue modems would reach a 56 kbit/s ceiling in terms of maximum possible bandwidth without compression. In actuality, the 56 kbit/s threshold refers only to the amount of bandwidth that is theoretically possible over the audible spectra of frequencies. The audible spectra consists of only the bottom 4 kHz of total spectra available on a typical pair of telephone wires.

However, the entire spectra of frequency transmittable over copper wire is typically in the area of 500 kHz. The way xDSL technologies achieve their exponential increase over analogue modems that are common today is by exploiting frequencies above 4 kHz. These frequencies have previously not been used due to the difficulties they cause for normal transmission of voice traffic. Frequencies above 4 kHz transmitted over a pair of copper wires in a binder tend to disrupt Plain Old Telephone Service (POTS) by introducing unacceptable levels of near end crosstalk to other wire pairs in the same binder.

xDSL technologies employ highly sophisticated techniques that limit near end crosstalk and, therefore, greatly expand the bandwidth potential over a single pair of copper wires. As an added benefit, these techniques not only permit POTS service to be continue unaffected over wire pairs in the same binder, they also permit POTS service to continue simultaneously on the same wire pair upon which xDSL transmission takes place.

These techniques have been made possible by the continuing advancement of lower cost and more powerful Digital Signalling Processing (DSP) chips, that require less and less electric power. While the concept of utilizing the higher frequencies available on a telephone line for providing broadband access has existed for over a decade, it has only become feasible in the last five years due to the developments in DSP technology.

In the early 1990s, xDSL technologies (specifically ADSL) were tested by some of the RBOCs in the US, as well as several European PTTs. Many of the tests gave birth to full-scale trials. However, at that time, the driving applications behind deploying xDSL were Video on Demand (VOD) and Interactive TV (ITV). Those applications were seen as potentially explosive sources of revenue growth for the residential market, and ADSL was the phone companies' delivery weapon against the CATV networks that were gearing up to deliver these services over their coaxial cable infrastructure.

Much to the disappointment of cable companies and telcos alike, both VOD and ITV failed miserably as "killer applications" that would justify a full-scale roll out of these services. At that point, ADSL was, to a large degree, forgotten.

In 1995, interest shifted toward the online world and, more specifically, the World Wide Web (WWW). As has been clear from the beginning of the Web in 1993, far more bandwidth is required in order to make the Web a universally accessible "information superhighway", as well as to support the more demanding Web-based applications. The increasing demand for bandwidth with which to access the Web is one of the primary applications at which xDSL technologies are now targeted. However, xDSL technologies are also being looked at in conjunction with several other applications and these applications may produce a far greater revenue stream in the near term (i.e. 1997-1998) compared to broadband Web access for the residential market. Among these applications are:

- *IntrAnet access* for organizations that are standardizing on a Web-based, client server model. An organization that has implemented an IntrAnet will require the higher bandwidth afforded by xDSL in order to link their Remote Office/Branch Office (ROBO) environments and telecommuters to the more demanding, business-oriented applications running on their private Web servers.

- *Low-cost, high throughput, LAN-to-LAN connectivity*. xDSL technologies have the potential to prove far more effective in this role than ISDN or traditional leased lines.

- *Frame Relay Access*. Since xDSL operates at the physical layers, it could emerge as the most cost-effective method of carrying Frame Relay traffic from the service subscriber to the Frame Relay network. Frame Relay over xDSL serves the first two applications we have mentioned, as well as greatly reduces the cost of using Frame Relay in other applications such as carrying legacy mainframe traffic or even voice traffic.

- *ATM network access*. As with Frame Relay, xDSL technologies can also be used to carry ATM cells to an ATM access device where they are statistically multiplexed over an ATM backbone.

- *Leased Line Provisioning.* xDSL can be used to greatly reduce the cost of provisioning T-1/E-1 lines from the central office (CO) to the customer's site.

## 2.1 ADSL – Asymmetric Digital Subscriber Line

While there are many flavours of xDSL technology, ADSL perhaps holds the greatest potential for mass deployment. Therefore, we will cover ADSL here in a separate section. In the past, ADSL has perhaps gained the most attention as the flavour of xDSL that holds the greatest near-term potential for providing broadband access to residential and SOHO (small office, home office) markets. However, recently, ADSL has been recognized as a potentially ideal solution for the corporate inter-networking market, as well as the general consumer market.

As its name indicates, ADSL apportions bandwidth asymmetrically. That is, more bandwidth is allocated for "downstream" transmission (i.e. for traffic from the service provider to the subscriber) than upstream traffic (i.e. for traffic from the subscriber to the service provider).

ADSL achieves its asymmetrical bandwidth structure by dividing the local loop into four classes of channels: higher bandwidth, simplex (uni-directional) channels, lower bandwidth duplex (bi-directional) channels, a duplex control channel, and a POTS channel, which occupies the lowest 4 kHz of frequency on the line. Transmission occurring on either the simplex or duplex channels does not affect the POTS channel. This ability to simultaneously provide POTS service alongside broadband data and/or video services across the same copper wire pair is one of ADSL's primary advantages relative to other access technologies, such as ISDN.

The logic behind this asymmetrical structure is based on the applications that are most likely to be provisioned to the residential and SOHO markets, namely Video on Demand (VOD) and Internet Access. These applications require only text-based queries to be initiated from the subscriber to the service provider.

In other words, the majority of traffic to residential or SOHO subscribers, be it video, file downloads, or applet downloads, flows in one direction. Therefore, bandwidth for these applications is allocated asymmetrically in order to enable overlapping use of the higher frequencies available. However, this asymmetrical apportioning of bandwidth also corresponds to data flows in most client/server applications and particularly IntrAnet applications. Hence, ADSL also proves to be quite well suited as an access technology for business applications in small, medium, and even enterprise scale networks.

**Speeds and Feeds for ADSL**

ADSL, as presently standardized by ANSI (American National Standards Institute), is defined as having eight transport classes: four classes based on multiples of T-1 (1.5 Mbit/s) downstream bandwidth and three classes based on multiples of E-1 (2.0 Mbit/s) downstream bandwidth. Each class specifies a *maximum* possible bandwidth, both downstream and upstream, under a given set of variables such as loop length, wire gauge, and line condition. Classes 1 and 2M1 support the maximum downstream/upstream bandwidth under the best conditions, while Classes 4 and 2M3 represent the maximum downstream/upstream bandwidth under the worst conditions. The following charts show the maximum bandwidth possible for each transport class.

TABLE 1

**Transport Classes For T-1 Based Downstream Multiples**

| **Transport Class** | **1** | **2** | **3** | **4** |
|---|---|---|---|---|
| Maximum Capacity For Downstream Simplex Channels | 6.144 Mbit/s | 4.608 Mbit/s | 3.072 Mbit/s | 1.536 Mbit/s |
| Maximum Capacity For Upstream Duplex Channels | 640 kbit/s (576 kbit/s of usable bandwidth) | 608 kbit/s (544 kbit/s of usable bandwidth) | 608 kbit/s (544 kbit/s of usable bandwidth) | 176 kbit/s (160 kbit/s of usable bandwidth) |
| Control Channel (included in the above maximum for the upstream duplex channels) | 64 kbit/s | 64 kbit/s | 64 kbit/s | 16 kbit/s |
| POTS Channel | 64 kbit/s | 64 kbit/s | 64 kbit/s | 64 kbit/s |

TABLE 2

**Transport Classes For E-1 Based Downstream Multiples**

| **Transport Class** | **2M1** | **2M2** | **2M3** |
|---|---|---|---|
| Downstream Simplex Channels | 6.144 Mbit/s | 4.096 Mbit/s | 2.048 Mbit/s |
| Upstream Duplex Channels | 640 kbit/s | 608 kbit/s | 176 kbit/s |
| Control Channel | 64 kbit/s | 64 kbit/s | 16 kbit/s |
| POTS Channel | 64 kbit/s | 64 kbit/s | 64 kbit/s |

In addition to these standardized bandwidth specifications, progress in DSP chip-sets have enabled ADSL modems to achieve even faster speeds both upstream and downstream. The fastest speeds announced to date are 12 Mbit/s and 2 Mbit/s for downstream and upstream speeds respectively. Needless to say, ADSL features a very large number of speed options within a single technology. Nevertheless, ADSL seems to the highest potential in the xDSL family to be able to offer cheap, broadband access to both the home and the office in the near term.

## 2.2 Other xDSL Flavours

### 2.2.1 RADSL – Rate Adaptive Digital Subscriber Line

RADSL technology is a sub-set of ADSL that automatically adjusts line speed based on a series of initial tests that determine the maximum speed possible on a particular line. As one can see from Table 1 and Table 2, ADSL speeds can vary greatly based on a number of conditions. In areas where there is a large variance in the length of the local loop (distance from the subscriber to the CO), the gauge of the wire, and the condition of the line, it becomes difficult to determine what speeds should be provisioned over each line. Fluctuating conditions such as weather further act to change the maximum possible throughput on a given line. Since RADSL accommodates the maximum speed available across a particular line, much of the effort can be taken out of provisioning ADSL. This factor is leading the market to favour RADSL over fixed rate ADSL. Everything presented in the following paragraphs concerning ADSL fully applies to RADSL. For easiness, we will keep referring to ADSL.

### 2.2.2 SDSL – Symmetric Digital Subscriber Line

As expected, SDSL provides the same amount bandwidth upstream as downstream. The price paid for maintaining bandwidth symmetry is lower aggregate bandwidth. At this point, systems operating at 384 kbit/s, 768 kbit/s, 1.5 Mbit/s (T-1), and 2 Mbit/s (E-1) are available. For this reason, SDSL is not considered a contender in the effort to provide low cost, broadband applications to the residential and SOHO markets. However, most technologies in use today for transmission over the wide area are symmetric (e.g. TDM, Frame Relay, etc.), and remember that xDSL operates at the physical layer of the OSI networking model. Therefore, SDSL can be used as the underlying transmission scheme for traditional network technologies and services.

The advantage of transporting, say, Frame Relay traffic over an SDSL line is cost. Frame Relay service or a leased line could be provisioned over a single pair of telephone wires rather than multiple wires or even fibre optic cable. This has the potential of greatly reducing the cost of provisioning existing services for the applications demand today. In the case of Frame Relay, the demand is expected to continue to increase for years to come.

SDSL's symmetric transmission scheme is also optimized for some emerging applications as well. Isochronous applications, such as video conferencing, have the same bandwidth requirements upstream as they do downstream. SDSL is also well suited to a peer-to-peer Internet model where Web sites are very highly distributed (i.e. a Web site in every home). However, the current trends indicate that, while everyone may have their own Web site, they are co-located on centralized servers, thus preserving the asymmetric traffic model. As for video conferencing, while it has a very strong business case, it remains to be seen whether this application will become a dominant form of personal communication in the near term.

### 2.2.3 VDSL – Very-high Digital Subscriber Line

VDSL is essentially the same as ADSL. Like ADSL, VDSL is an asymmetrical transmission scheme. However, compared to ADSL, VDSL is designed for much higher transmission rates (up to 30 to 51 Mbit/s) than ADSL over extremely short distances (500 to 1 000 ft). For this reason VDSL is seen by some people as a much more futuristic technology relative to other xDSL technologies, becoming appropriate only when applications begin to demand that kind of bandwidth and in conjunction with Fibre to the Curb (FTTC) deployment. In addition, the VDSL's severe distance limitation precludes it from being implemented in all but the densest environments.

Despite these shortcomings, there are situations in which VDSL deployment could be justified. Where dense access environments exist, such as large office buildings or business parks that typically have a CO located on or very near the premises, VDSL could be used to provide lower-cost integrated access or LAN-to-LAN connectivity across a broadband network such as ATM, SONET, or SDH.

### 2.2.4 HDSL – High-bit-rate Digital Subscriber Line

HDSL is the most widely deployed of the xDSL technologies and has been commercially available for a number of years. Unlike the other xDSL technologies, HDSL uses two pairs of copper cable rather than one. Most HDSL implementations provide either 1.5 Mbit/s or 2 Mbit/s of symmetrical bandwidth at up to 12 000 ft from the CO. These speeds conform to T-1 and E-1 standards respectively and, therefore, HDSL's primary application to date has been the provisioning of T-1/E-1 leased lines in areas that have a high density of business customers (e.g. office parks) and a collocated CO.

HDSL has been attractive in the T-1/E-1 space because it greatly reduces the cost of traditional T-1/E-1 provisioning by eliminating the need for repeaters, loop conditioning, or pair selection. HDSL enjoys a relatively large installed base for this application and, to a certain extent, has been responsible for the substantial decrease in leased line costs that we have seen over the last few years. Nevertheless, in order to compete successfully with SDSL technology in the provisioning of traditional data services, HDSL needs to develop and expand its distance and bandwidth capacities. Otherwise, SDSL, requiring only a single copper pair for transmission, will emerge as the superior solution.

# 3 The Evolution of xDSL

Still early in its technology life cycle, xDSL continues to advance rapidly. Gains are being made in faster bit rates, further reach, lower power requirements, alternative configurations and lower costs. Meanwhile, the standards work progresses at a furious pace.

## 3.1 xDSL Price/Performance

A price/performance analysis of xDSL-based solutions vis-à-vis other broadband access solutions would not be complete unless it included the infrastructural and organizational investments that are necessary in order to implement each technology. Clearly, one of the critical and exciting aspects of xDSL is the prospect of service providers provisioning broadband networking solutions over the existing infrastructure of copper telephone lines.

For the end user customer, one of the most compelling applications for broadband access technologies is Internet access. The following chart shows the cost per unit bandwidth for the end user customer. Various access technologies are compared.

TABLE 3

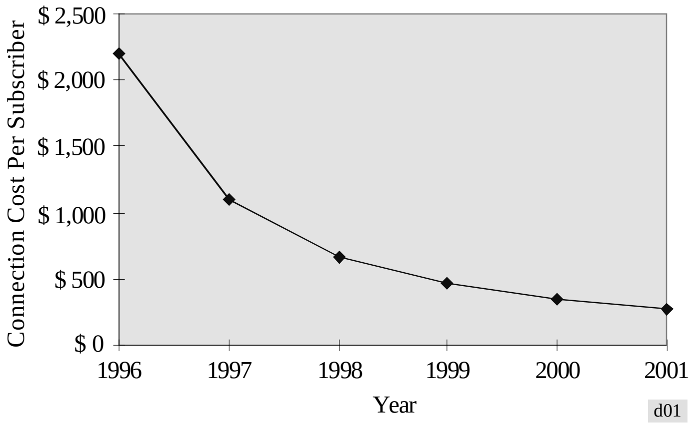
**Internet Access Technologies Measured By Cost-of-Service/Unit Bandwidth**

| Access Technology | Number of Nodes Connected to One CO/Head-end | Bandwidth Per Node – Downstream/Upstream | Monthly Cost of Internet Access | Cost of Bandwidth Provided ($/kbit/s) |
|---|---|---|---|---|
| ADSL Modem | 225 | 6 Mbit/s/0.74 Mbit/s | $ 90 | $ 0.015/$ 1.22 |
| 28.8 kbit/s Modem | 225 | 0.0288 Mbit/s | $ 11 | $ 3.82 |
| ISDN BRI | 225 | 0.128 Mbit/s | $ 60 | $ 4.69 |
| T-1 Leased Line | 225 | 1.5 Mbit/s | $ 1,200 | $ 7.74 |
| Cable Modem | 1 | 10 Mbit/s/1 Mbit/s | $ 50 | $ 0.05/$ 0.5 |
| Cable Modem | 5 | 2 Mbit/s/0.2 Mbit/s | $ 50 | $ 0.25/$ 2.50 |
| Cable Modem | 25 | 400 kbit/s/40 kbit/s | $ 50 | $ 1.25/$ 12.50 |
| Cable Modem | 225 | 44 kbit/s/4 kbit/s | $ 50 | $ 11.36/$ 113.64 |

The above comparisons reflect the pricing of ADSL modems and other technologies as they stand at this very moment. Of course, the prices of ADSL modems will certainly decrease substantially over the next year and may even fall by a whole order of magnitude by the year 2002. The falling prices of ADSL modems will result in a corresponding decrease in the price of ADSL services. Furthermore, not only are prices likely to fall substantially, but performance is also expected to rise. For example, recently an ADSL chip-set supporting 12 Mbit/s has been successfully tested and, for short distances, VDSL modems will support speeds between 30 Mbit/s and 50 Mbit/s.

FIGURE 1

**Per Subscriber ADSL Deployment Cost Forecast**




## 3.2 xDSL Standards

As is the case for many physical layer technologies, ANSI, ETSI, and now ITU-T are actively involved in creating standards for xDSL. Additionally, since ADSL and VDSL, in particular, provide the foundation of a platform for new residential broadband services, additional organizations are involved in the specification work for ADSL and VDSL. These organizations include: the ATM Forum, the ADSL Forum, the TIA, and DAVIC. These organizations are creating interoperability specifications that span the end-to-end residential broadband systems. While the ATM Forum covers only ATM over ADSL and VDSL, the other organizations also produce specifications for IP/packet mode and bit synchronous mode over ADSL and VDSL end systems.

### 3.2.1 ANSI, ETSI, and ITU-T

The focus of xDSL standardization work to date has been in ANSI T1E1.4. T1E1.4 is currently working on all the xDSL technologies; HDSL (SDSL), ADSL (RADSL), and VDSL. Work on HDSL started in late 1989. ADSL work started in 1992. Work is progressing on the following: a standard for HDSL2 (a second generation for single-pair HDSL), Issue 2 of two-pair HDSL, Issue 2 of ADSL, CAP-based ADSL, and VDSL.

ETSI TM6 has also been a major contributor to the xDSL standardization work. ETSI xDSL work began in 1992 and currently covers all the xDSL technologies. TM6 decisions are being made with consideration of T1E1.4 work.

Recently, ITU-T assigned a new question to Study Group (SG) 15, “Access Network Transport”. The question calls for international standardization for DCEs providing high-speed digital access services including modulation techniques and procedures for HDSL, ADSL, and VDSL. While the core xDSL work is beginning in SG15 in 1997, there will be some related items in Study Group 13 as well.

### 3.2.2 The ADSL Forum, DAVIC, and the ATM Forum

Unlike the standards bodies discussed above, these forums and consortiums have established a record pace for publishing specifications. Focusing on the end-to-end systems issues for packet, ATM, or bit synchronous services over ADSL/RADSL and VDSL transport, these organizations are actively liaising with each other as well as T1E1.4 and TM6.

Formed in late 1994, the ADSL Forum is currently close to publishing Issue 1 documents on Packet and ATM Modes over ADSL. There appears to be consensus in this Forum to take on VDSL systems issues going forward as they interpret the “A” in ADSL Forum to mean “Any” xDSL.

Formed in late 1991, the ATM Forum has two working groups relevant to ADSL specifications. The Physical Layer (PHY) Working Group covers all physical medium dependent (PMD) sub-layers and transmission convergence (TC) sub-layers for ATM. Although the ATM Forum has yet to work on an ADSL or VDSL PMD, contributions have been heard on TC layer issues for both ADSL and VDSL. The end-to-end system aspects for ATM over ADSL and VDSL are discussed in the Residential Broadband (RBB) Working Group. This group meets jointly with PHY on ADSL and VDSL physical layer issues and is exchanging liaisons with nearly all the other organizations mentioned in this section. Recently the RBB group has asked the ADSL Forum for a joint work session to further work on the ADSL Forum’s specification for ATM over ADSL and subsequently ATM over VDSL.

DAVIC (the Digital Audio Visual Council) is also nearing publication of an ADSL ATM Mapping specification as part of DAVIC 1.2. This specification includes definition of an ATM TC layer for ADSL. The DAVIC specification will reference the ADSL Forum document if it is done in time.

Other organizations working on related items include IEEE P.1007, the TIA TR41.5 (specification for a network gateway), and IEEE 802.14 (for VDSL).

### 3.3 xDSL Interoperability

xDSL is not ISDN nor ATM. xDSL interoperability is not end-to-end compatibility – i.e. end-user to end-user nor end-user to switching system. End-to-end interoperability is within the context of a short span line driver. For today’s deployment purposes, interoperability is only needed over the short span from premises to central office.

Given the almost frenzied pace of the standards work and the rapid pace of technology innovation in the xDSL space, we are witnessing an extremely strong technology push.

## 4. The Business Case for xDSL

Several factors are key in developing the business case for deploying xDSL. In particular, for the residential broadband market, the business case for ADSL is based on consideration of:

- *new revenue* generation from value-added services such as Internet access and VOD. Given the eroding POTS market, where price competition is high and the threat of alternative services such as voice over the Internet is increasing, ADSL gives service providers the option to skim the cream by offering higher priced and higher margin residential broadband services.

- *infrastructure deployment/upgrade costs*. Utilizing the existing copper twisted pair and not requiring any terminal adapters nor special client or host software, provisioning simply requires the addition of two ADSL modems per subscriber line.

- *incremental deployment options*. ADSL deployment does not require groups of subscribers to be enabled at a time nor an entire switch to be upgraded. Each and every subscriber line can be made ADSL-ready independently.

- *easy migration path*. If higher speed services are needed at a particular subscriber location, the ADSL equipment can be replaced by VDSL equipment (and perhaps a longer fibre run). The ADSL equipment can then be reused at another subscriber location.

- *service provisioning time* improvements. ADSL installations are essentially “plug and play” compared to other infrastructures in support of residential broadband services.

- *network “hold times”* improvements. Internet calls are tying up network resources for hours. The POTS network, originally designed for voice calls averaging only minutes in duration, is becoming increasingly taxed. ADSL allows the telcos to free these resources by redirecting the ADSL calls at the central office to an auxiliary high speed data network.

- *network switch port and loop utilization* improvements. SOHO workers, like myself, can replace their two to four line offices (one for office voice calls, office fax calls, Internet/IntrAnet calls, and one for personal calls) with one line ADSL service.

- *minimizing lost revenues* due to the competitive threat. In addition to the threat from the CATV companies, the deregulated telco environment allows for competition in the local loop. Who will be the first to deploy ADSL and capture the new revenue stream?

With these many factors contributing to building a positive business case, we will witness strong market pull from both the end users and the service providers for ADSL.

# 5 xDSL Broadband Services

## 5.1 Applications

xDSL applications can be roughly divided into residential user and corporate user categories. Over time, in many cases, as work at home and on-line commerce become more prevalent, the distinction between residential and corporate user will blur.

### 5.1.1 Residential User Applications

#### 5.1.1.1 Internet Access

As everyone knows, the advent of the World Wide Web has resulted in the phenomenal growth of the Internet over the past two years. However, the infrastructure of the Internet has yet to be optimized for transferring the rich graphics common on today’s Web sites. The majority of users accessing the WWW do so via the Public Switched Telephone Network (PSTN) and 14.4 kbit/s or 28.8 kbit/s modems. In addition to the bandwidth limitations of analogue access, the switches that make up the PSTN are optimized for short connections that characterize telephone calls rather than calls of several hours that typify Internet access sessions. This problem puts a great deal of strain on the PSTN and potentially threatens the low, fixed pricing model of Internet access.

In addition to expanding bandwidth for Internet access by a factor of over one-hundred, service providers are looking to xDSL as a way of keeping Internet traffic off the PSTN. Although there are various network models, the idea is to shunt traffic from xDSL connections off the local loop directly on to the Internet. POTS splitters at both ends of the local would keep normal telephony service intact.

Another aspect of the Web that makes xDSL a compelling access solution is the asymmetric nature of Web-based data communications. In most cases, the only upstream traffic users send to the service provider are Universal Resource Locators (URLs), which are very short text messages that allow the user to move from Web page to page. The majority of Web traffic flows downstream in the form of graphic intensive Web pages, moderate to large text files, audio files, and even video clips downloaded by the user from Web servers. Clearly, ADSL’s asymmetric apportioning of bandwidth is optimized for Web access.

#### 5.1.1.2 TV/Video – On-Demand (VOD)

ADSL was originally targeted as a way for telephone companies (telcos) to compete with cablecos by delivering TV programming and VOD services to residential customers over the ordinary telephone wires. While VOD did not prove to be the killer application everyone had hoped for, bundled with Internet access, the ROI (return on investment) analysis looks much more compelling. Furthermore, most countries outside of North America do have very small CATV network infrastructures. By delivering TV programming and VOD services bundled with other services, including Internet access and POTS service, ADSL can enable the PTTs of many countries to become a one-stop-shop for communications and content.

### 5.1.2 Corporate User Applications

#### 5.1.2.1 Leased Line Provisioning

Perhaps the most popular xDSL application to date is to greatly reduce the cost of provisioning T-1 or E-1 leased lines from the CO to the customer's site. HDSL has been used in this way for the last few years and has achieved a great deal success. In the following year, it is expected that SDSL will replace HDSL in this application since the same performance and reach characteristics can be achieved with only one pair of wires (SDSL) as opposed to two (HDSL).

xDSL technologies, SDSL in particular, will also give non-telco service providers [e.g. VANs (Value Added Networks), ISPs (Internet Service Providers), and CAPs (Competitive Access Providers)] the ability to provision T-1 and E-1 leased lines themselves, given they have access to the local loop. If these service providers are able to lease "dark copper" from a particular telco's CO to the customer, as well as lease space for their switching equipment at the CO, then these service providers would be able to provision T-1 and E-1 leased lines to the customer at very low cost using xDSL. It should be noted that, in the US, the recently passed telecommunications reform legislation has been written to allow non-telco service providers access to the local loop and the CO.

#### 5.1.2.2 LAN-to-LAN Interconnect

In the legacy host-terminal network environment, wide area bandwidth requirements are modest, requiring only the transmission of keystrokes and textual screen updates. However, as client/server applications continue to take on mission critical tasks of the enterprise, and as they become increasingly bandwidth intensive, cost-effective broadband technologies become extremely attractive for linking LANs throughout the enterprise network.

It is the strength of the demand for LAN-to-LAN connectivity solutions that has pushed the Frame Relay services market to above 100% average annual growth over the past three years. xDSL is expected to enjoy similar growth over the next several years pushed by the demand to connect LANs at broadband speeds for a fraction of the cost of leased lines. While ADSL is certainly a viable and, in some instances a very attractive technology for LAN-to-LAN connectivity, symmetric technologies such as HDSL and SDSL will be most popular in this application initially.

#### 5.1.2.3 Frame Relay Provisioning

In many of the situations where xDSL is used to connect LANs, Frame Relay can be used as the transport mechanism in order to keep the present network architecture intact, maintain the current network management applications, and ease migration overall. However, provisioning Frame Relay services over xDSL has applicability in and of itself for uses outside LAN-to-LAN connectivity, such as integrating legacy data transport and voice transport within the enterprise. This later application is attracting interest in international markets because customers can take advantage of the relatively distance-insensitive pricing that characterizes Frame Relay offerings. Essentially, all of the applications that are available using Frame Relay are available when Frame Relay is run over xDSL.

The advantages of using xDSL as the underlying transport mechanism are:

- *Cost* – since it can be deployed over an existing telephone line, xDSL represents very close to an order of magnitude of cost savings when compared to provisioning a T-1 or an E1 for Frame Relay access.

- *Increased Bandwidth* – at this point, the vast majority of Frame Relay services are limited to T-1 or E1 speeds. Using ADSL as a transport technology, Frame Relay could achieve speeds of 6 Mbit/s downstream today.

These costs and bandwidth advantages may enable Frame Relay over xDSL to be used in ROBO and possibly even SOHO residential environments.

#### 5.1.2.4 IntrAnet Access

While Internet access will be a critical market for xDSL going forward, IntrAnet access may be more important in the near term. IntrAnets are private networks that utilise Web-based architectural components (Web servers, browser, horizontal linkage, etc.) and Web protocols/languages (TCP/IP, HTML, Java, etc.) to deliver enterprise-wide applications. Many organizations are moving to an IntrAnet architecture as a way to amalgamate multiple applications, systems, and platforms under the umbrella of a single network architecture. However, IntrAnet access is at least as, if not more, bandwidth intensive than Internet access. Therefore, ADSL is ideal for enabling organizations to connect telecommuters to the company's IntrAnet at speeds similar to what they are used to on the corporate LAN. In addition, ADSL can be used to give cheap, high speed IntrAnet access to remote/branch offices, thus avoiding the expense of installing and maintaining proxy web servers on site at these peripheral offices. Additionally, ADSL can give high speed IntrAnet access to corporate employees while working from their residence.

## 5.2 Trials

The following is an overview of a few of the many xDSL trials that are presently being conducted.

### 5.2.1 GTE ADSL Trial in Redmond, Washington

GTE has recently launched a six month trial for ADSL service in Redmond, Washington. While Microsoft will be the primary subscriber, the University of Washington and several local businesses will also participate. Several applications using the ADSL service will be deployed, including Internet access, remote access for people working at home, Web server egress, as well as possible video conferencing services over SDSL. Initially, the ADSL services will provide 1.5 Mbit/s of bandwidth downstream and 64 kbit/s upstream. Later, the service will also offer speeds of 6 Mbit/s downstream and 640 kbit/s upstream.

### 5.2.2 US West ADSL Trials in Boulder and Minneapolis/St. Paul

This trail began in April of 1996 and is available solely for its own employees. Both ADSL (1.5 Mbit/s/64 kbit/s) and HDSL (740 kbit/s) services are being tested for Internet access and remote access of corporate LANs by users based at home. The subsequent phase of this trial will be to open up the service to selected non-US West employees who will also use the service for Internet access and for accessing their own corporate LANs. US West foresees commercial ADSL services beginning to be rolled out in certain areas by the end of 1997.

### 5.2.3 UUNet ADSL Trial in Toronto

Internet Service Provider (ISP), UUNet Canada, is presently testing a 1.5 Mbit/s/64 kbit/s ADSL service for a single corporate customer that has multiple remote sites. The Internet and IntrAnet access are the primary applications being evaluated. This trial began in June of 1996 and is significant in that it is one of the first trails conducted by an ISP.

### 5.2.4 Swiss Telecom ADSL Trial

Swiss Telecom has been conducting a trial for multiple services delivered over ADSL to approximately two-hundred households. These services included video-on-demand, "edutainment" programming, and online shopping. The ADSL service in this trial provides 2 Mbit/s of bandwidth downstream and 9.6 kbit/s upstream.

# 6 xDSL Network deployment models

Since xDSL is a point-to-point transmission technology functioning primarily at the physical layer, it can support a variety of networking protocols. Most service providers are looking to xDSL and ADSL in particular to serve as the access technology component in a broadband network architecture that will support multiple services and applications. Depending upon the technological or strategic inclination of the specific service provider, the application and/or services delivered, and the market (corporate or residential) for those applications and services, the nature of this new broadband architecture can vary greatly.

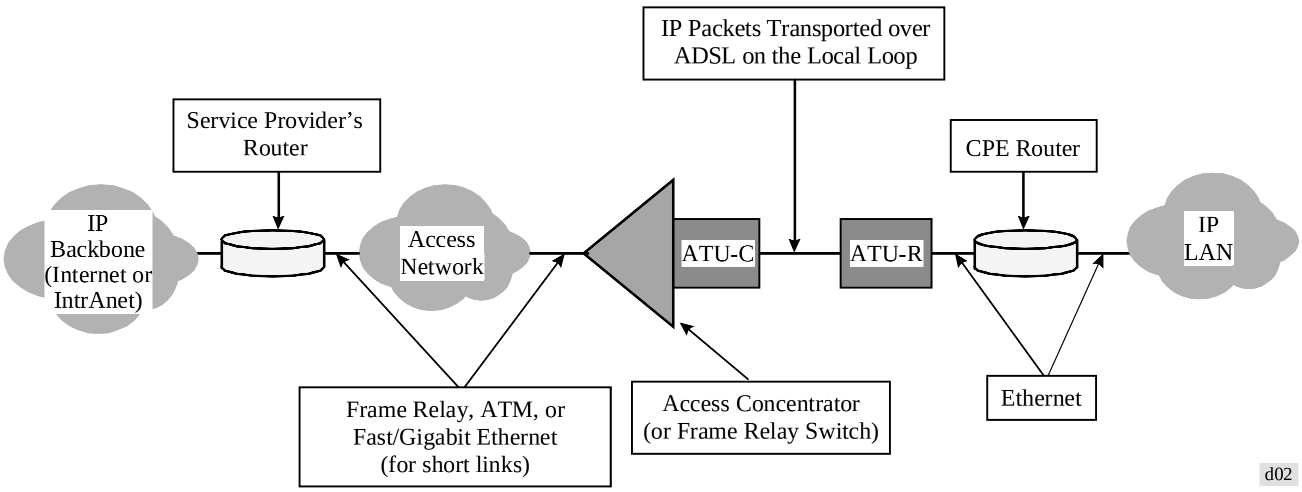
Because the subject of broadband network architecture delves into issues that are beyond the scope of this article, we will only describe three basic architectural alternatives for xDSL deployment.

*It is important to understand that, at this stage, there is little consensus regarding which network architecture or model is most appropriate to support xDSL as an access technology and that there are several permutations of the basic models outlined here. The ATU-C is an ADSL terminal unit for the central office. The ATU-R is an ADSL terminal unit for the remote site.*

## 6.1 IP Model

FIGURE 2

**IP Model**



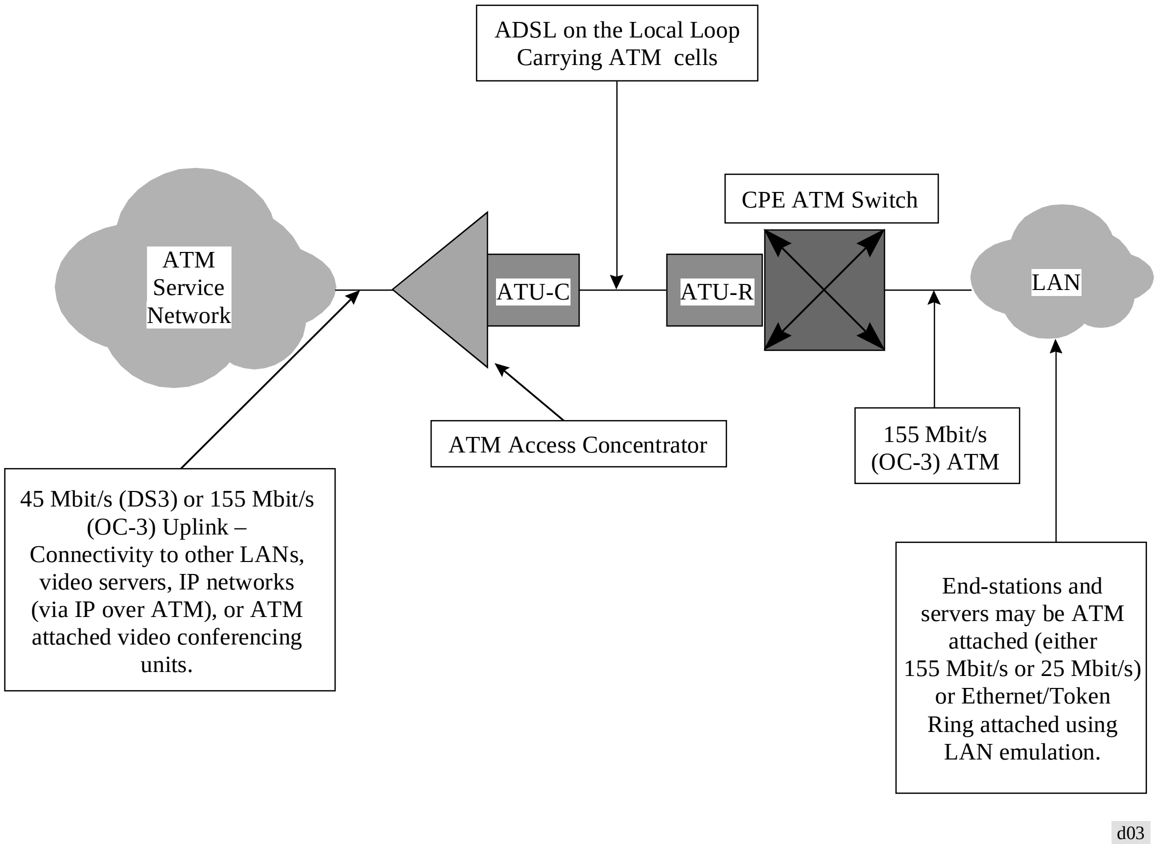

Using ADSL as a transport mechanism for IP traffic is the obvious choice for Internet access applications but the model depicted is only one of many possible versions of this model. In addition, the IP model can also serve other applications as well such as IntrAnet access, LAN-to-LAN connectivity, and others. While several intermediary protocols, such as Frame Relay or ATM could be used between IP and ADSL, the ADSL Forum has also specified transporting IP packets directly over ADSL without the use of an intervening protocol. This scenario can be seen as similar to running IP directly over a physical layer transport mechanism such as SONET. In this case, a router or a device with integrated routing would be necessary at the CO, rather than an access concentrator or switch operating only at layer two.

Depicted above is a corporate user application. IP can also be used, of course, for residential applications. In this case, a personal computer or, perhaps, an Internet TV is located on the ATU-R side of the ADSL line (the ATU-R may reside in the PC's bus or be connected to the PC via Ethernet) and access to the IP network is established via a PPP (Point-to-Point Protocol) over ADSL connection.

## 6.2 ATM End-to-end Model

FIGURE 3

**End-to-End ATM Model**



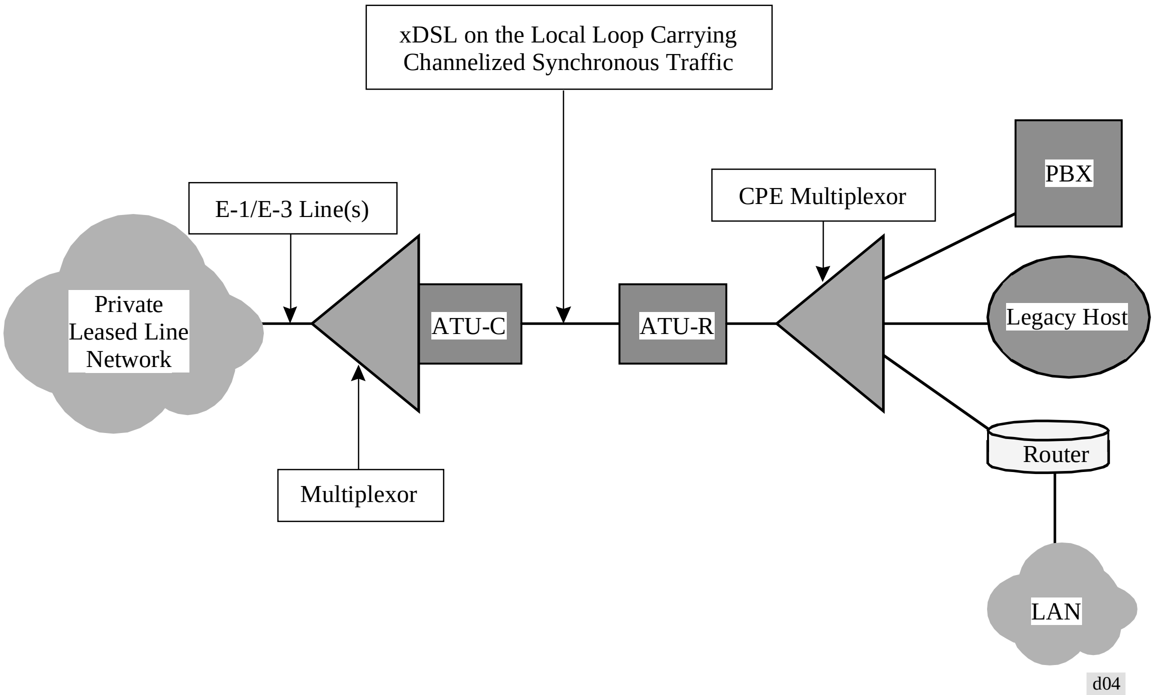

Due to the fact that ADSL provides a dedicated connection of relatively high bandwidth, it may also be used to extend the ATM network and, therefore, the Quality of Service (QOS) properties of ATM all the way to the desktop. The ADSL Forum has specified how ATM cells are transported over ADSL, essentially the ATM User Network Interface (UNI) tunnelled through the ADSL line. By having desktop applications talk directly to the ATM network, bandwidth can be reserved (and guaranteed) end-to-end across the network. This facilitates the deployment of isochronous, delay-sensitive applications such as voice, video conferencing, etc. The next release of Windows 95 will include an API, Winsock 2, which will allow applications to request QOS from the ATM network.

However, ATM, particularly ATM operating at speeds below 25 Mbit/s, exacts a fairly high overhead and, therefore, may not be justified by many applications that do not have stringent QOS requirements or are able to function with the non-guaranteed QOS services offered by protocols such as RSVP (ReSerVation Protocol). In addition, many large organizations that would require ATM service may be better off subscribing to a 45 Mbit/s (DS-3) or 155 Mbit/s (OC-3) ATM service operating over fibre rather than transporting ATM cells over multiple ADSL lines. Finally, to the degree that organizations are interested in ATM service for peer-to-peer applications such as video conferencing, the asymmetric apportioning of bandwidth under ADSL would not be optimal.

### 6.3 Circuit-Switched model

FIGURE 4

**Circuit Switched Model**




As we mentioned earlier, xDSL technologies can be used simply to drastically reduce the cost of leased line provisioning. In this way, xDSL technologies can be smoothly integrated into existing network architectures that are based on private, leased lines using Time Division Multiplexing (TDM) technology.

## 7 Conclusion

The answer to the question posed in the beginning of this document, “why has xDSL emerged as the access technology of choice?”, is based on infrastructure. The xDSL family of technologies provides a wide variety of line-driving schemes to accomplish and satisfy different market needs over today’s infrastructure. Although xDSL has application in both the corporate and the residential environments, within the residential broadband space alone, we have a plethora of possibilities. The market needs are still evolving. There is no single tool to build a house. In the context of xDSL, whether two pair, single pair, asymmetric, symmetric, rate-adaptive, or multi-channel, digital subscriber loop technologies are all tools to be utilized in building a service. xDSL has the flexibility to meet the market challenges.

ANNEX 4

## ITU-D Recommendation/Guideline on Implementation of Wireless Loop Access

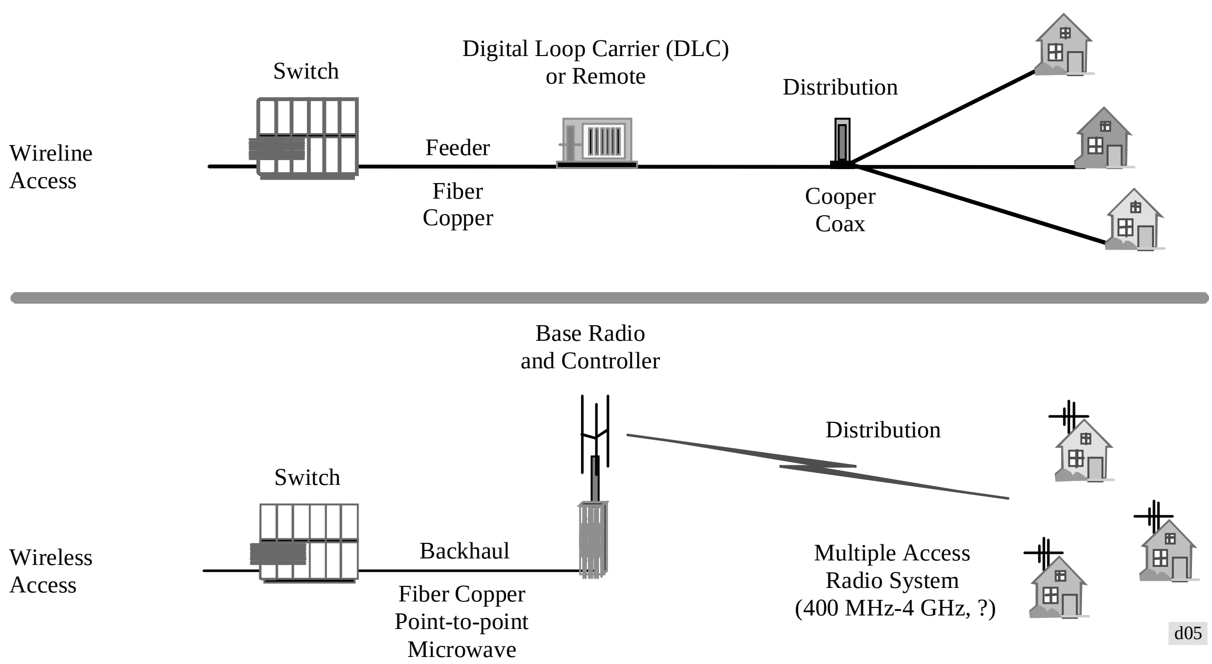
## 1 Introduction

Advances in technology and competitive access are driving the revolution towards wireless access infrastructure for the provision of basic telephone service. Whether a developing or a developed economy, traditionally the most difficult component of the network to build and the least cost-effective to maintain has proven to be the local access network. The sheer scope of investment and engineering efforts required to build and maintain copper-based networks has created lofty barriers to entry and has made high penetration rates for basic telephone service available only to industrialized nations of the world. Even the relatively low target subscriber density (teledensity) rate of 20 lines per 100 population set by the ITU, has been far beyond the capability of many nations until recently.

Wireless Access Local Loop Systems, also know as Fixed Wireless Access (FWA), Radio Local Loop (RLL) or Wireless Local Loop (WLL), is an application of radio technology and personal communication systems experiencing tremendous growth, especially in developing economies. Figure 1 introduces wireless access by comparing it to wireline access. The key characteristic of wireless access is the use of a multiple access radio system instead of wires (e.g., copper or coax) in the distribution/access network, whether or not radio (point-to-point microwave) is used in the backhaul network.

FIGURE 5

**Wireline Access and Wireless Access Comparison**




In general, any radio system could be used for fixed radio access and the suitability is a function of a number of factors. The most suitable system for a particular application will tend in general to depend on the requirements of the end user (POTS only or many service features), the cost of deployment (which will depend on the density of the subscriber population and the type of system being considered) and the availability of the appropriate radiofrequency spectrum for that system. The requirement for mobility, or evolution for mobility, would tend to drive the deployment of systems derived from cellular or PCS systems. Alternatively, the requirement for wireline quality and services (such as G3 FAX and voiceband data or even ISDN) would tend to be drivers towards special-purpose designed systems. Another important consideration is how to approach integration of the fixed wireless access system with the overall network philosophy of the operator. For example, any particular problem (end user and operator requirements) may be best solved with a mixed solution of wired and wireless technology. Understanding the drivers for the deployment of each technology is a key factor in minimizing the cost and maximizing the effectiveness of the solution.

The contents of this document are based on the ITU-R Land Mobile (including Wireless Access) Handbook, to which the reader is referred for further information. Parts of it are also based on a study by the European Bank for Reconstruction and Development (see Section 5).

## 2 Access Requirements

There is significant variation in the characteristics of the local loop, particularly in developing countries, from the perspective of teledensity and loop length. Urban and suburban applications require high capacity – hundreds and sometimes thousands of subscribers per square kilometer. Villages and towns, on the other hand, often isolated from major population centers, may require only a few hundred subscribers. Rural areas have unique requirements, small clusters of a few lines each in very isolated pockets.

In addition to topography and teledensity, other factors differentiate network applications, for example, service set, performance and quality objectives. On a network basis, solutions must satisfy cost and build-out timing objectives. A country's specific situation, such as infrastructure which may already be in place, mandated air interface standards, a variety of interface requirements, and even terrain and climate can influence what the optimal wireless solution is. The variation in access characteristics necessitates a family of wireless access products to meet specific needs.

## 3 Advantages of Wireless Access

The advantages in employing wireless access are lower life-cycle cost, flexibility in network design and faster deployment. These advantages are illustrated in Figures 6 (a)-6 (d). Traditional copper networks consist of distribution cables, pedestals or splice boxes, and feeder plant. Most of the cost of constructing loops can be associated with the vast, branching network of copper cable that connects with the individual homes. In fact, the last few hundred meters of distribution copper may account for up to 50% of the total cost of the local loop. Most capital cost associated with the construction of a wireless network can be characterized as being "electronics". By contrast, in a copper network, significant cost is incurred for cable material and construction, whose costs over time are not decreasing nearly as fast as "electronics" costs, see Figure 6 (a).

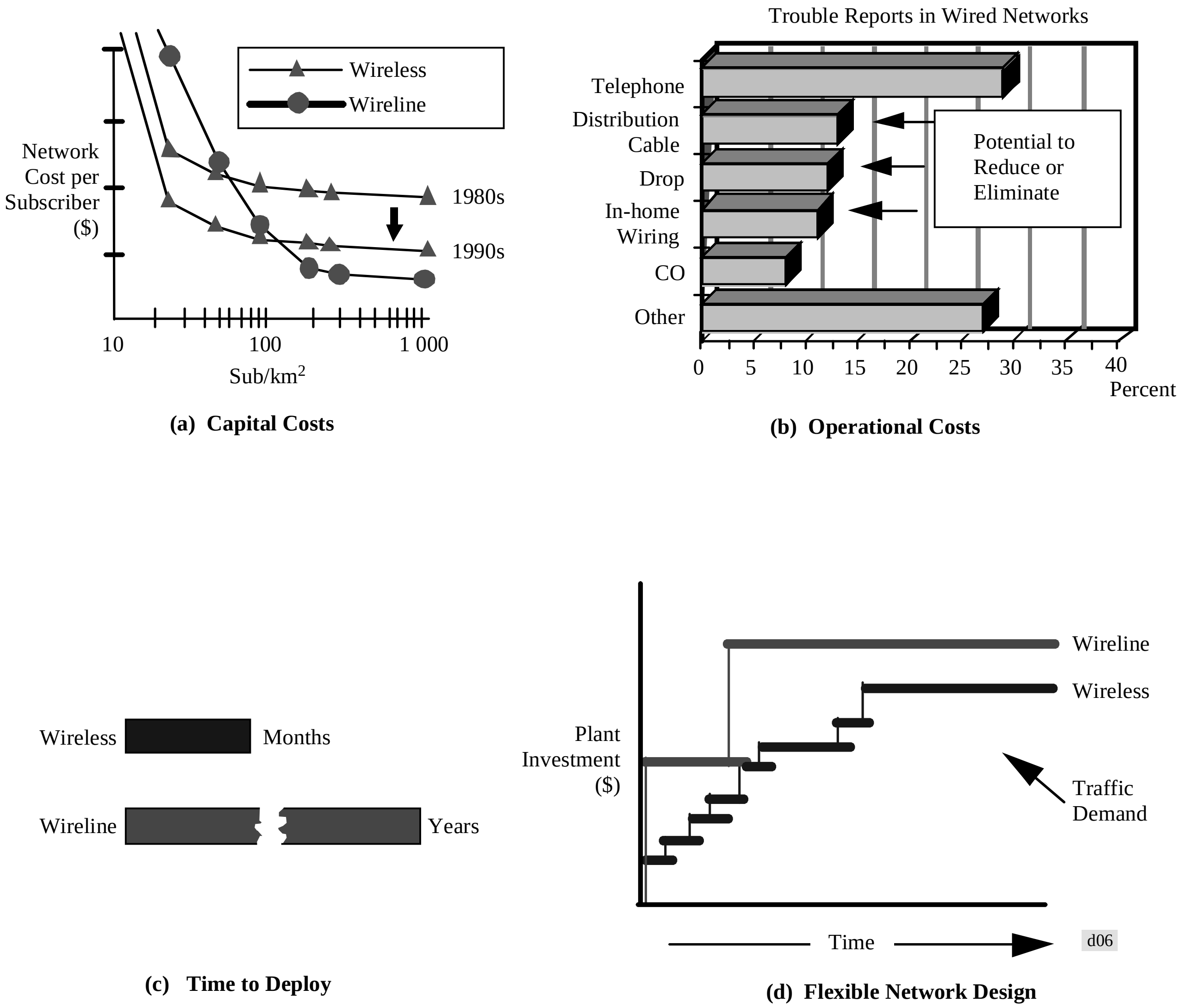
Operational cost savings provide another advantage to employing wireless loops, see Figure 6 (b). The elimination of copper distribution and copper drops reduces operations costs due to fewer trouble reports, dispatch and repair activities. Studies have shown that wireless loops can reduce operating expense by as much as 25% per subscriber per year. A reduction in installation and operating costs, coupled with capital cost savings, results in lower life-cycle costs for wireless access systems. Also, a wireless infrastructure involves less outside plant; hence it is less vulnerable to theft and vandalism.

Customers waiting for telephone service represent an opportunity cost, therefore rapid deployment of any access system is critical to the business case. As evidenced in the cellular industry, wireless systems can literally be installed in a matter of months, or even weeks, as opposed to years with copper-based access, accelerating returns which can be reinvested in building network capabilities further, see Figure 6 (c).

Another positive attribute for wireless access is that wireless distribution is more "forgiving" to uncertainty in subscriber demand forecasts, see Figure 6 (d). Wireline infrastructure requires a larger, up front investment which is exposed to uncertainty in demand. Traditionally, telephone companies over-provision (just-in-case) since construction in already-established neighborhoods is even more expensive. In wireless, incremental investment which can more closely track subscriber demand results in faster playback and reduces financial exposure to over-provisioning.

FIGURE 6

**Comparison of Wireless and Wireline System in Terms of: (a) Capital Costs, (b) Operational Costs, (c) Time to Deploy, and (d) Flexible Network Design**



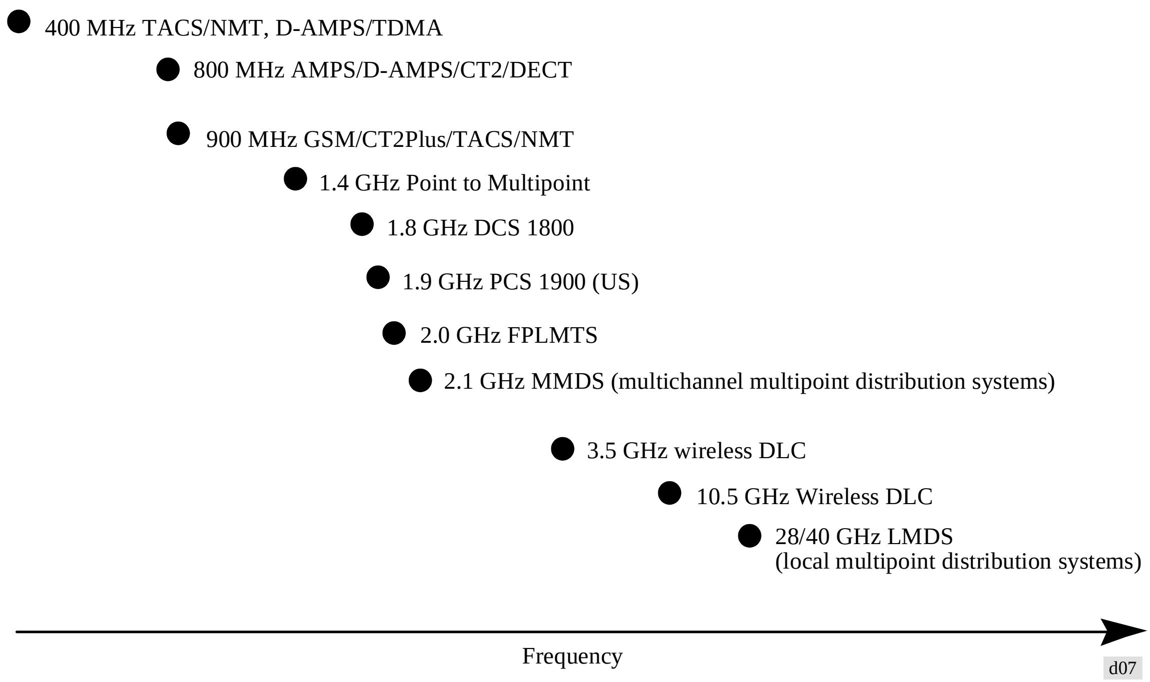

In addition, in some cases wireless access may offer potential for evolution and synergy with mobile services. An infrastructure supporting a fixed wireless system using an air interface developed for mobile services (e.g. ITU-R Recommendations M.622, M.687-1, M.819-1, M.1033, and M.1073) might be readily extended to support mobile users. Alternatively, special-purpose systems can be designed to meet the quality requirements in an optimal manner.

## 4 Radio Spectrum Considerations

Radio spectrum requirements and availability need to be examined. Figure 7 shows typical bands of the radio spectrum where fixed wireless access systems operate. The precise availability of radio spectrum for these applications is subject to local regulations. For example, the 3.5 GHz band has been endorsed by CEPT/ETSI, as is the 10.5 GHz band for use in Europe. Also, in Region 2 the 3.4-3.7 GHz band is being considered for wireless access applications in the Americas. The applications shown in Figure 7 for different frequency bands may be known by different names which are related to the traditional use of these bands. However, the common underlying aspect is wireless access, which may take many flavors depending on the signal transfer capabilities offered (e.g. voice, data, image, video), mix of service (e.g. purely fixed, mixed fixed/mobile, nomadic), range (e.g. use of repeaters), etc.

FIGURE 7

**Typical Bands of Radio Spectrum for Wireless Access**




## 5 Examples of Case Studies

The contents of this section (Section 5) are based on a study commissioned by the European Bank for Reconstruction and Development on key technological and policy options for the telecommunication sector in Central and Eastern European countries (see Note). The purpose of the study was to provide relevant information and guidance to both network operators and policy makers in decision making regarding technological options to be used in introduction, replacement, modernization and extension of telecommunication networks in their countries. In reviewing the report of this study, it became clear that the findings and conclusions of this study would be very useful to the developing countries in their efforts to improve and enhance their telecommunication facilities.

NOTE – Gareth Davies, Steve Carter, Stuart Macintosh, et al., “Key Technological and Policy Options for the Telecommunications Sector in Central and Eastern Europe and Former Soviet Union”, London, England: Coopers and Lybrand and the Telecommunications Team, European Bank for Reconstruction and Development, March 1995.

The existing telecommunication networks in the developing countries are either obsolete or inadequate to provide the platforms on which modern industrial economies are built, and failure to remedy this critical shortcoming will limit the ability of many developing countries to improve living standards for majority of their people.

The lifetime costs per subscriber were analysed for a number of wireless access technologies that have been proposed or are in use for the local loop: In particular: NMT 450; TACS, AMPS; GSM; DCS 1800, PCS 1900 (US), Fixed WLL (TDMA based). For details on the models and assumptions used for the calculations, the reader should refer to the study. The annual lifetime cost contains the capital cost, the operating cost and the replacement cost. The analysis shows that the costs of wireless access delivered local loops have fallen considerably in the last few years and that wireless access solutions are now capable of providing a cost-effective alternative to a wireline local loop system. In particular, wireless access systems are attractive at lower subscriber densities as the costs of a wireless access system do not increase with the distance to the subscriber (up to the propagation limit of the cell). See Figures 8 and 9.

FIGURE 8

**Comparison of Lifetime Costs – Wireless Access vs. Wireline Systems for Very Low Density Subscriber Densities**

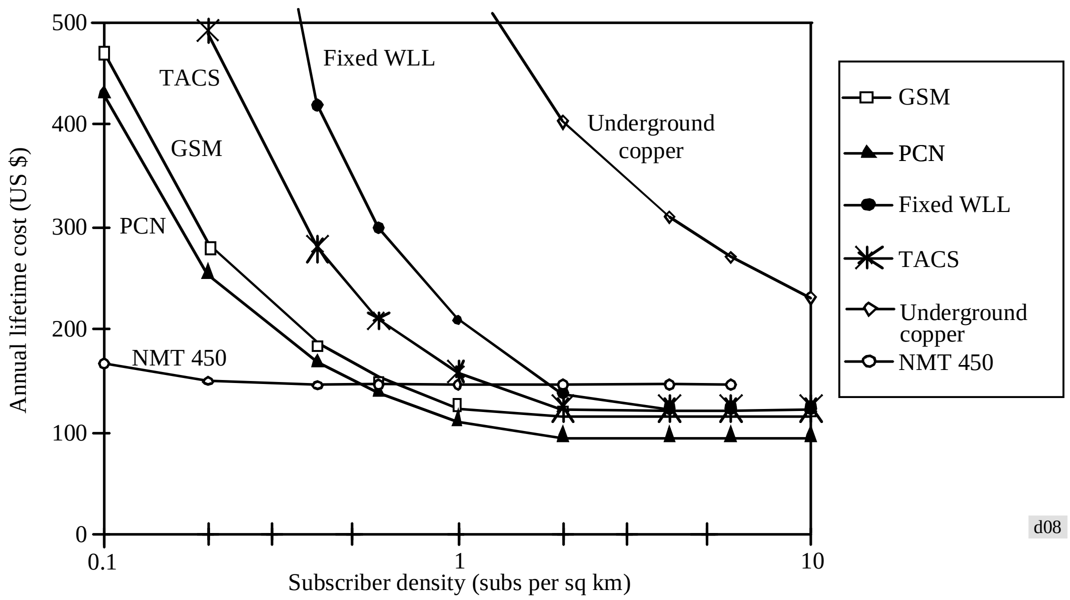
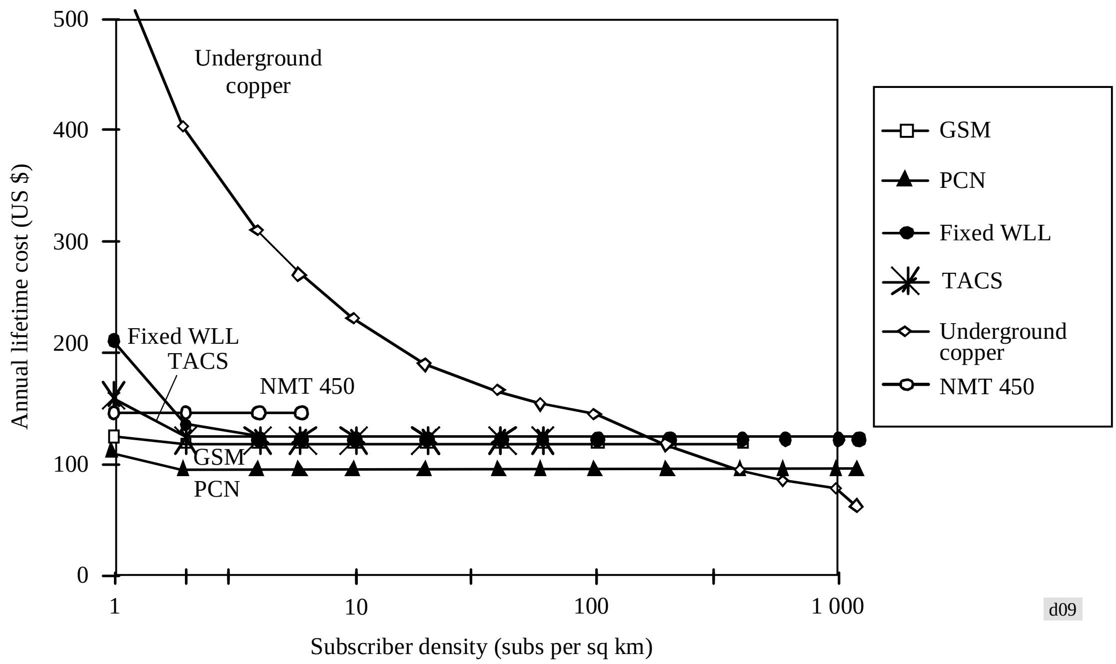



FIGURE 9

**Comparison of Lifetime Costs – Wireless Access vs. Wireline Systems for Low to High Subscriber Densities**




Wireless access systems offer lower lifetime costs per subscriber than a wireline-based network at lower subscriber densities – below approximately 200-400 subscribers per square kilometer (assuming average residential calling rates). This assumes, however, that spectrum is available.

The exact position of the crossover point depends inevitably upon the assumptions made, and will vary depending on traffic levels and the actual distribution of subscribers.

Nevertheless, the analysis suggests that a significant percentage of residential subscribers could be cost effectively provided with a wireless access local loop. This does not mean that current operators will rapidly replace their existing copper networks with wireless access systems, but it does indicate that new market entrants, or operators in new areas, are likely to make increased use wireless access.

**Wireless access based systems are cost effective for the provision of telephony services to typical residential subscribers, particularly in rural and suburban areas, or for new entrants in competitive urban markets.**

The analysis clearly suggested that wireless access is a very attractive local loop technology for new market entrants. The figures presented are in terms of subscriber density, not population density. In practice, it could take a new operator several years to achieve subscriber densities approaching 400 subscribers per square kilometer even in urban areas, and in suburban and rural areas this figure may never be achieved where there is more than one competing operator. At very low densities below about one subscriber per square kilometer, the majority of the wireless systems exhibit a rapid increase in the cost per subscriber as the cells reach their maximum size and additional cells have to be added to accommodate increased subscriber spacing. By the time the subscriber density has fallen to 0.1 subscribers per square kilometer, the lifetime cost has increased to between 500 and 1,500 US $ per line except for low frequency systems (such as NMT 450). However, wireless access would still provide a cost-effective way of providing the services relative to wireline – see Figure 8.

The main conclusions of the European Bank for Reconstruction and Development study were:

- wireless access based systems are likely to be cost effective compared to traditional copper networks at customer densities below 200-400 subscribers per square kilometer. Many residential consumers will therefore be most cost effectively served via wireless access systems; the attractiveness of wireless access based systems will also be influenced by customer acceptance;
- wireless access based systems can be developed cost effectively and their rollout can be tied closely to the take up of service by customers. Such costs can also be minimized and wireless access based systems are likely to be preferred by new operators who wish to provide large-scale telephony services.

## 6 Conclusions and Recommendations

The potential for Fixed Wireless Access (FWA) to enhance availability of basic and enhanced telecommunications services in many countries globally is substantial. In recognition of this opportunity and to facilitate the realization, countries need to be aware of the need for and identification of frequency spectrum bands that can be used for FWA in their regions and countries.

Wireless technologies represent an opportunity for a major improvement in mobile, portable and fixed communication services for individuals or business which would be integrated into a variety of competing access networks. To facilitate the development of Fixed Wireless Access systems it is desirable that sufficient radio spectrum bands be identified for this application.

It is recommended that:

1) countries identify frequency bands that may be used for fixed wireless access in their countries;
2) the ITU-R Land Mobile (including Wireless Access) Handbook be used as a starting point in planning the implementation of wireless access.

ANNEX 5

# The geostationary, non-geostationary FSS and MSS systems capabilities

## 1 Defining the Needs

With regard to considering the capabilities of satellite-based communications in the context of Question1/2, we must concentrate on the priority telecommunication needs of the developing world. With this in mind, this paper focuses on those technologies that have the potential to directly provide the basic telecommunications services necessary for economic and social advancement. The priority needs consist of extending services to the many communities that have never been served, and deepening and diversifying the service portfolio that is available to developing urban and commercial centers.

## 2 Satellite-based Telecommunication

With respect to satisfying these needs, satellite technology has basic advantages over other communication technologies. Any type of telecommunications service can be provided via satellite virtually anywhere in the world at a cost that is not a factor of geographical distance or of topography. Depending on the type of service, the terrestrial infrastructure requirements necessary to receive services are minimal when compared to the immense cost, in time and monetary terms, of providing the same services via extension of existing terrestrial networks.

Geostationary and non-geostationary FSS and MSS systems provide the expeditious and most cost-effective and flexible means for many developing countries to introduce universal basic telephony services and significantly expand access by the business community and the general public to the global telecommunications network. For many, satellites are and can be used to provide emergency services and assist in the disaster relief efforts for which reliable, full-time telecommunications services are essential.

Satellite services can provide an unparalleled capability for implementing telemedicine and distance learning programs to populations that otherwise would not have access to or benefit from basic healthcare and education programs. In the same manner, expanded access to the global information highway will be possible for many only through satellite systems.

Extending reliable, high quality telecommunication services to rural areas in most instances also brings economic development and benefits to developing countries through the creation or expansion of businesses (e.g. tourism, agricultural trading, exploitation of natural resources, etc.), diversification of exports and increased revenues from telephony services themselves.

### 2.1 Urban and Commercial Areas

In urban areas, there is generally sufficient infrastructure to support basic communications for commercial purposes and reasonable interconnection to the PSTN. However, the existing network is often outdated and inflexible. It cannot be easily augmented because of resource constraints to provide the services that have become the staple of modern business practice in the industrialized countries. Its limited reliance on terrestrial equipment allows satellite technology to provide the additional capacity needed to offer a greater variety of services and new technologies, at anytime, and anywhere.

### 2.2 Remote and Rural Areas

Many communities in remote and rural areas still are without basic telephone service because of difficult environmental and local conditions as well as lack of infrastructure for transportation, electric power and, generally, the relative immaturity of economic and social conditions. However, there is also widespread governmental recognition of the importance of a balance between rural and urban areas in the provision of telecommunication services and its positive effects on local economies. These effects include:

- access to larger markets by entrepreneurs and small businesses;
- encouragement of larger businesses to move outside the urban areas, thus facilitating job creation;
- growth and expansion of existing and new businesses in smaller communities;

- decrease or, in extreme cases, even reverse rural to urban migration;
- political stability, a feeling of national identity and social development such as health and education.

Connection via satellite is the logical alternative to achieve the objective of expansion of telecommunication services including broadcasting to such areas on a cost-effective basis using such global satellite services.

## 3 Mobile Communication Services

Over the past ten years, the mobile communications market has grown at a rate which has far exceeded even the most optimistic forecasts of network operators and equipment providers alike and has proved to be one of the most profitable parts of the telecommunications sector. This, in turn, has led to market entry by a large number of new operators, suppliers and rapid advances in technologies, and, consequently, a dramatic reduction in costs to the user.

Over the same period, access to widespread mobile services has expanded from the more affluent developed countries to virtually every country in the world to some degree. These mobile services are often being used to supplement existing terrestrial wired systems in urban areas where expansion of the wired system is not economically feasible or too time consuming in response to the level of service demand, both for business and personal telecommunications requirements. The advent of the Global Mobile Personal Communications by Satellites (GMPCS) technologies now promises to fully exploit the advantages of wireless mobile communications systems on a worldwide basis.

In this case, the mobile satellite services will be defined as those that require only minimal or no pre-existing infrastructure to function. In other words, those that are fully self-sufficient without depending on external power sources or regular maintenance, although the services they provide may be designated as fixed or semi-fixed. For the purpose of this review, these services include voice/data, global positioning and space imaging.

### 3.1 Mobile Satellite Systems (Voice/Data)

Mobile satellite systems providing primarily voice/data capabilities, particularly those known as Global Mobile Personal Communications by Satellite (GMPCS), include those in geostationary orbit as well as those in medium and low earth orbit. It is widely recognized that the mobile satellite services can help to extend basic telecommunication services to remote and rural areas. Mobile satellite communication technologies are among the most cost-effective means to introduce universal basic telecommunication services in developing countries and they are available today.

### 3.2 Geostationary Systems

There is one global mobile satellite system in operation today, the INMARSAT system, plus several regional geostationary mobile satellite systems are planned. The Inmarsat system offers a variety of services including: telephone, fax, data (low, medium and high speed data), telex, distress alerting, slow scan TV, group calls (point-to-multipoint), polling, SCADA (Supervisory Control and Data Adquisition). Distress alerts have the highest priority in the Inmarsat network.

Certain radiodetermination and position reporting services are also available. Inmarsat's third generation satellites carry a navigation payload for providing services in conjunction with the US GPS system and the Russian Glonass system. Inmarsat provides space segment capacity to the land earth station operators who, in turn, offer their Inmarsat services to the end user, either directly or via other telecom operators or service providers who have routing agreements with them. The land earth station operators offer a variety of value-added services.

The range of people that use mobile satellite services is very wide and it includes:

- On land: journalists, travelling executives, disaster relief agencies, government officials, trucks, trains, mineral exploitation companies, construction workers at remote sites (hydropower, roads), telecentres, farmers, ranchers, etc.
- At sea: fishing boats, yachts, cargo ships, container vessels, drilling rigs, oil tankers, liquid natural gas carriers, passenger cruise ships, etc.
- In the air: airlines, corporate aircraft, general aviation, helicopters, etc.

### 3.3 Non-Geostationary Orbit Systems (Low Earth Orbit Systems-LEOs)

LEO satellites are relatively small, and are located in orbits much closer to the earth's surface than geostationary satellites providing fixed services. They are able to receive signals from devices as small as a pocket-sized mobile pager or phone.

In general, two types of LEO systems have been or are expected to be deployed by the late 1990's: Little LEO systems providing mobile low-speed data and messaging services and used for data gathering, electronic facsimile, two-way paging and electronic mail (several systems providing these types of services are also planned for deployment in the geostationary orbit); and Big LEO systems (including middle earth orbit-MEO systems) which will provide some or all of the above services in addition to real-time voice, and be used to provide global mobile telephone services via small personal handsets. In both systems, services will be available on a global basis, subject to the satisfaction of national licensing requirements. (Some systems providing these types of services are also planned for deployment in the geostationary orbit.)

While today's mobile phone user can already use existing land-based cellular technology to "roam", i.e. make calls outside the local cellular network coverage, internationally, the number of different mobile cellular systems and standards worldwide means that global roaming is not practical. The advantage of using one of the GMPCS systems is the fact that a single standard will be implemented within the system no matter where the user happens to be, providing the basis for a truly global roaming capability.

Existing and planned GMPCS systems can provide telecommunications access in remote areas, as well as to communities which, for economic reasons, do not have access to fixed line telephony, i.e. where the density of customers and traffic per square kilometer is so low that the fixed costs of terrestrial infrastructure are excessive relative to achievable revenues. Cellular telephony has already proved an enormous boom to many developing nations because of its ability to provide a reliable communications infrastructure without the substantial investment needed to install and maintain a large wireline network. The new GMPCS systems could extend this benefit to even more communities.

Following is a list of global mobile satellite systems that were either in service or planned as of October 1996 (Source: ITU World Telecommunications Policy Forum Documents, October 1996).

| Name of System | Type of System | Number of Satellites | Type of Service | Operational |
|---|---|---|---|---|
| Orbcomm | Little LEO | 28 | Data | 2 satellites operational; full system mid-1997 |
| E-Sat | Little LEO | 6 | Data | 1997 |
| FAISAT (Final Analysis) | Little LEO | 26 | Data, voicemail, voice paging | 1997 |
| VITAsat (VITA) | Little LEO | 2 | Data | 1997 |
| Koskon (Polyot) | Big LEO | 32 | Voice, data, fax paging | 1997 |
| Globalstar | Big LEO | 48 | Voice, data, fax, paging, GPS | 1998 |
| Iridium | Big LEO | 66 | Voice, data, fax, paging | 1998 |
| GE Starsys | Little LEO | 24 | Data, messaging | 1998 |
| GEMnet (CTA Commercial Systems) | Little LEO | 38 | Data | 1999 |
| LEO One USA | Little LEO | 48 | Data | 1999 |

| Name of System | Type of System | Number of Satellites | Type of Service | Operational |
|---|---|---|---|---|
| ECCO (Constellation/ TELEBRAS) | Big LEO | 46 | Voice, data, fax, paging | 2000 |
| ICO | MEO | 10 | Voice, data, fax, paging | 2000 |
| Ellipso (MCHI) | LEO/MEO | 17 | Voice, data, paging, e-mail | 2000 |
| Odyssey | Big LEO | 12 | Data, voice, fax, short message | 2000 |
| Celsat (Hughes/Nortel) | GEO | 3 | Voice, data, fax, paging | 2000 |
| Inmarsat 3* | GEO | 5 | Voice, data, fax | In service |
| Spaceway (Hughes Network Systems) | GEO | 12 | Voice, data, video, broadband services | 2000 |

Another category of the new LEO Mobile Satellite Systems is the Broadband LEO, planned to provide global access to a broad range of voice, data and broadband video communications services at fiber-like quality. These systems plan to offer high-capacity, "bandwidth-on-demand" capabilities which will allow the use of small, low-power terminals and antennas, thus potentially opening up service areas in all parts of the world that would not otherwise be economical to service through terrestrial means. Another objective in the design of these broadband systems is to achieve compatibility with the existing fiber-based infrastructure standards in terms of bit error rates and transmission delay. Two such systems, Teledesic and M-Star, are currently planned and under development. These systems plan to deploy 288 and 72 satellites, respectively. Teledesic's start date is currently projected for 2002, while M-Star expects to be operational in the 1999/2000 timeframe.

### 3.3.1 Big LEO Satellite System Capabilities/Services

Big LEO satellite systems have the capability to provide narrow and broadband mobile fixed services to anywhere in the world. The terminals currently vary from fixed to semi-fixed units in the form of mobile exchanges, telephone booth installations and briefcase size portable telephone sets. Handheld, cellular phone-sized terminals will become commonplace with the advent of the GMPCS by the close of the century.

a) *Mobile Exchange Unit*

The Mobile exchange units allow terrestrial-based networks to be plugged directly into the satellite constellation. This capability advances the possibility of pockets of individual cellular networks serving remote communities, connected to each other and the rest of the world through the satellite constellation.

b) *Phone Booths*

Although there has been some limited employment of the satellite phone booths, the new GMPCS systems plan to include the concept as an integral part of their product portfolios. The booth would be established in remote villages and towns and used as a normal pay phone.

Both the mobile exchange and the phone booth can be solar powered, requiring no pre-existing power supply to operate. Furthermore, both remain entirely mobile, and can be easily moved from one local to another, as demand requires.

c) *GMPCS Handsets*

Handsets used with the GMPCS will be comparable in size and weight with early generations of cellular telephones. The mobility of GMPCS hand-held units will allow them to be employed in the same innovative way as cellular telephones are sometimes used in extending telephone services in developing countries. It is expected in many regions of Africa that the teleboutique will bring telephone service to unserved communities. In the same manner as a cellular phone, GMPCS units can be transported through a circuit of communities, stopping for a period of time to provide rented service. The roaming ability of the GMPCS allow them to extend the teleboutique to rural areas that are not covered by ground-based cellular networks.

More importantly, many of the Big LEO systems plan to offer dual-mode and multi-mode phones that will interface with both the satellite networks as well as the terrestrial wireless networks. This will enable users to take advantage of cellular or terrestrial wireless networks when available, plus have the added convenience of the coverage of a global satellite network when out of the terrrestrial wireless network's range. This feature will greatly enhance the roaming capabilities of the networks.

### 3.3.2 Little LEO System Capabilities/Services

Little LEO satellites provide a multiplicity of services, including:

- Tracking – truck trailers, containers, railcars, cargo and hazardous materials.
- Monitoring – soil, water and climate conditions, geological surveys, etc.
- Data Acquisition – water and power utility meter readings, oil and gas pipeline monitoring.
- E-mail – remote access.
- Paging – one- and two-way alphanumeric global messaging.
- Emergency – national disaster and other emergency warnings.
- Supervisory Control & Data Acquisition – one- and two-way data collection and control from fixed and mobile assets.

### 3.3.3 Global Positioning Satellites

Global positioning satellites, originally designed in the 1970's for military use to guide troops and missiles, has in the 1990's evolved to include many commercial and personal uses. This has been made possible by policy changes by the United States government, allowing commercial access to the 24-satellite Global Positioning System (GPS), and by Russia, allowing commercial access to the Glonass system, coupled with the development and availability of a variety of relatively low-cost small, portable receivers.

Both systems consist of 24-satellite constellations in medium earth orbit offering continuous global, all-weather wireless operation providing precise information concerning location and velocity to anyone or any object equipped with a receiver. To date, most commercial applications are focussing on the U.S. GPS system because most of the low-cost receiver and software developments have been directed towards the use of that system. The GPS system is already widely used in the commercial trucking industry in the U.S., and in such simple applications as providing hikers with information concerning their location in wilderness areas.

Global satellite positioning technology is expected to dramatically improve today's commercial airline navigation systems both domestically and internationally (over the oceans), allowing planes to fly shorter, more direct routes and increasing the numbers of flights possible in a given air space. Use of the GPS navigation system will also allow instrument-only approaches at literally thousands of airports around the world that could not be equipped and staffed economically to handle such approaches with conventional navigational gear. This will improve the air transportation systems and economic development in many parts of the world. Similarly, GPS technology will make it feasible to establish new air strips in remote areas for purposes, for example, of commercial exploitation of natural resources, provision of health and medical services and education programs.

Other uses of GPS technologies of potential interest for application in rural areas include the ability to establish property/boundary lines easily and accurately without the need for surveying, road building, search and rescue efforts and tracking the deployment of government units and assets (both military and civilian). In many cases, GPS technologies will be coupled with satellite imaging technologies to provide a highly detailed visual image with highly accurate geopositioning data.

### 3.3.4 Space Imaging Satellite Systems

Space imaging satellite technology was developed for military and intelligence gathering and weather research purposes starting in the 1970's. In the past decade, what was once highly classified technology has become almost commonplace, with civilian-based imaging satellites already having been deployed by France, Russia, Brazil and India. In the U.S., policy changes have allowed growing access to government systems for an increasing number of commercial applications during the same period and several private companies plan to launch and operate fully commercial imaging and positioning satellite systems during 1997. These systems are expected to have a ground resolution of between 1 and 3 meters and the ability to download images of the same geographical point on earth every 2 or 3 days. As in the case of GPS technology, the explosion in commercial use of space imaging satellites has led to significantly reduced consumer costs and this trend is expected to continue for the foreseeable future.

Space imaging satellites have many applications of potential interest to developing countries and use in rural areas. For example, space imaging has enormous potential to assist developing economies in managing agricultural production by providing early warning of disease or insect infestations, areas needing increased irrigation or other actions required to protect the harvest. Space imaging can play a significant role in monitoring the environment and assessing the short- and long-term effect of natural disasters such as droughts, floods, fires, etc. The technology will be an important tool in planning the routing and building of roads and utility lines in areas which heretofore have been difficult to survey and map. It can be used to establish boundaries and property lines and resolve potential disputes, clearing property titles, etc., all important elements in economic development.

## 4 Fixed satellite services

Fixed Satellite Services (FSS) are defined for the purpose of this review as services provided in the frequency bands allocated to the FSS primarily for the provision of voice, data and video services from satellites in geostationary orbit. These services rely on a fixed terrestrial infrastructure to transmit, receive and distribute services.

From the inception of the INTELSAT and INTERSPUTNIK systems in the mid-1960’s, a very large number of global, regional and national FSS systems have now been deployed providing a wide range of services in and among nearly all nations, territories and dependencies in the world. These systems have played an important role in the interconnection of developing countries to the international switched public network for voice and data, and in accessing both international and national video programming.

In the past decade, advances in satellite technology have made possible much higher satellite transmit power which, coupled with innovative earth station antenna design and the introduction of digital transmission techniques, has resulted in the ability to significantly reduce the size and cost of antennas and the bandwidth needed for the transmission and reception of services from the geostationary orbit. This lower cost has, in turn, made possible the expansion of existing services and the introduction of new services in developing countries, serving the needs of remote and rural areas. Using such advanced techniques as Time Division Multiple Access (TDMA) and Demand Assignment Multiple Access (DAMA) makes it possible to utilize optimally a high-cost resource (the satellite) and to implement a rural telecommunication system more economically than one established by traditional means, provided that the service is desired as soon as possible, and simultaneously, in all communities throughout the rural area of the country.

The FSS systems can be used to provide trunk links between small towns originating enough traffic to justify a permanent assignment of capacity. They can also be used to provide an access link between an isolated user, such as a remote, isolated community, or a doctor or educator, and the national network (and by extension, to the PSTN). When telecommunication infrastructure is lacking, the fastest and most economical means of telephony service expansion is via wireless. The combination of VSAT and Wireless Local Loop (WLL), technologies opens opportunities for the rural telecommunication market.

Another important advantage of FSS systems for system planners is the ease with which they can meet unforecasted traffic loads. In places where traffic loads are difficult to estimate, operation can be initiated with a few circuits and the capacity adjusted simply by adding more channel equipment at the affected location until a satisfactory grade of service is achieved. FSS systems with DAMA provide an efficient way to service a multiplicity of low-traffic stations and, in addition, provide a centralized tool for traffic and traffic growth analysis because all calls are controlled by a master central station. Finally, the use of FSS systems for the provision of rural and remote areas reduces the cost of maintenance and the need for skilled engineering staff compared to terrestrial systems.

## 4.1 Voice/Data Services

High quality and highly reliable voice/data services with global or regional connectivity are provided through several different analog and digital transmission techniques, although most analog services are being converted to digital in the interests of space segment use efficiency and lower cost to users. Services are typically provided through digital carriers, TDMA, SCPC and, more recently, DAMA systems. These techniques provide users with a very wide range of options in terms of carrier size and connectivity compared to the analog era. The flexibility in carrier sizing has been particularly beneficial to developing countries and users with small traffic load requirements, enabling them to establish many new small links directly and thus reducing reliance on via routing through larger countries to achieve the desired connectivity.

Following is a summary description of the various digital transmission techniques used in FSS systems for the provision of voice/data services. The summary is based on the services provided by the INTELSAT global system but is representative of the types of transmission techniques that can be employed on any FSS network (global, regional, national) with today's high powered satellites.

### 4.1.1 Intermediate Data Rate (IDR) Digital Carriers

The use of IDR digital carriers provides a fully integrated digital service through the public switched network (PSTN). It provides ISDN quality international and domestic switched services on a point-to-point or low connectivity basis and can be used for the full range of international and domestic PSTN applications, including:

- Voice transmissions
- Data transmission
- Digital television
- Video conferencing
- Audio or Printed Material distribution
- ISDN applications
- Dedicated private digital networks

IDR carriers may be configured for different capacity rates, from 64 kbit/s up to 155 Mbit/s and are thus suitable for very small to very large traffic requirements.

### 4.1.2 TDMA

TDMA is designed for medium route traffic with high connectivity requirements (international, regional), providing a digital network solution for a community of users. TDMA combines the efficient use of satellite resources with flexible handling options and lower equipment costs. Today's TDMA terminals are now only one-fifth of the first generation terminal's size and cost, making TDMA available to a larger community of users and requiring less upfront capital investment. TDMA can be used to provide the same full range of international and domestic PSTN applications as IDR.

### 4.1.3 DAMA

DAMA is a usage-based, state-of-the-art service for thin-route PSTN services with either high or low connectivity requirements, and provides small users an easy solution to digitizing their networks. Instant, dial-up connectivity between a large community of users, with one channel providing direct connectivity and dynamic switching to all users in the network makes DAMA a cost-effective solution for thin-route operators. DAMA can be used for voice and voice band data as well as facsimile. A wide range of antenna sizes can be utilized from large gateway earth stations to Very Small Aperture Terminals ( VSATs). In the INTELSAT DAMA system, which is approved for operation globally, the space segment charge is US$ 0.05 per minute of completed call time throughout the system including use of VSATs as small as one meter in diameter for data calls. This demonstrates the efficiency with which DAMA systems operate. Future applications of DAMA technologies anticipate providing on-demand $n \times 64$ kbit/s connections, offering higher bandwidth applications, such as occasional-use digital video.

Work is also ongoing by INTELSAT on the development of equipment interfaces that will allow integration of conventional cellular telephony systems with VSAT-based DAMA systems. This brings the prospect of fully wireless and fully mobile telephony with local national and international reach to all areas of the world at very low rates. In actual field use, the Wireless Local Loop (WLL) has a range of approximately 30 km without the use of repeaters.

Mobile cellular systems, in combination with a VSAT-based DAMA terminal, are particularly well suited to remote areas, with no telecommunication infrastructure or backhaul to a regional switching center. The WLL system supports the standard analogue (AMPS) and digital mobile cellular phones and public kiosk installations would also be possible for a village or township community. Field trials are expected during 1997 to demonstrate the feasibility and benefits of the DAMA-WLL service.

#### 4.1.4 Analog

Most FSS systems also have the capability to continue to provide analog FDM/FM services until existing terrestrial transmission equipment has been amortized.

### 4.2 Private Network Services

In today's competitive marketplace and global economy, which are characterized by a rapidly growing number of communications links between businesses in developed countries with subsidiaries in developing countries, advanced telecommunications services are essential. Private network services using digital techniques and VSAT technologies are ideally provided through the global and regional FSS systems and are particularly well suited for meeting point-to-multipoint networking requirements.

The various VSAT configurations allow private networks, capable of data and voice communications, to be constructed which can be connected to the PSTN. These self-contained networks can serve as the backbone for a variety of communications applications including not only telephony but distance learning, telemedicine and research as well. While cost and pre-existing infrastructure requirements are still issues with regards to the application of VSAT networks to the development of remote and rural telephony applications, the use of the systems for commercial purposes is quickly expanding through the cities of developing regions. This expansion has positive implications for the rural/remote application in that economies of scale will bring the expense of VSAT networks to a more affordable level.

### 4.3 Domestic/Regional Satellites and Leases

The lease of bulk transponder capacity for the establishment of domestic and/or regional networks was one of the earliest applications of FSS systems to either enhance individual elements of existing telecommunications networks, or to provide the main telecommunications infrastructure of whole areas. In some cases, leasing bulk transponder capacity makes available services and facilities not viable by terrestrial techniques. Today's generation of higher powered satellites and associated smaller antennas make such systems even more feasible for developing countries to implement. Typically, domestic leases are used to provide national TV programming and domestic PSN services.

### 4.4 Video Services

FSS satellites in geostationary orbit have a unique capability for the provision of video services and have played a major role in the development and expansion of the television broadcast industry. The broadband capabilities and wide coverage areas of satellites make them the ideal vehicle for TV transmissions and satellite newsgathering activities, allowing broadcasters literally to transmit programming from any point on the earth's surface to any other point (or multiple points). Video programming can be provided through both analog and digital transmissions.

International satellite-based communications deliver television and radio services both in analog and digital form. A full-time program distribution is secured to the world's major broadcasters as well as to broadcasters of all size and nationalities. International satellite capacities are now available for commercial carriers around the world in:

1) Multi-Channel per Carrier (MCPC) services. This approach is highly cost effective for the programmer, maximizes usage of the satellite resource and transmission power and allows for signal reception using small dishes.

2) Single Channel Per Carrier (SCPC) services, in which broadcasters have the freedom to transmit to the satellite from virtually any location within the satellite's coverage area. Among the most exciting developments in the television industry has been the advent of direct-to-home (DTH) television, in which programming is delivered directly to the consumer via satellite.

Typical video service applications include:

- Video contribution to content integrators
- Video distribution to TVRO stations
- Video teleconferencing networks
- Direct-to-Home (DTH) TV broadcasting

### 4.5 Digital Audio Broadcasting

Satellite-based Digital Audio Broadcasting (DAB) service involves the transmission of digital sound signals from a satellite directly to portable, stationary and mobile (car) radio receivers. This type of service represents a large leap in satellite broadcasting technology, since, unlike direct-to-home (DTH) services, no satellite dish is required to receive the digital radio programs. In addition, satellite DAB technology will enable radio broadcasters to exceed the geographic coverage area offered by shortwave transmitters, with a sound quality ranging from the equivalent of AM mono to compact disc stereo, at a low cost.

As described in the preceding section, satellite broadcasting services can be either Multi-Channel per Carrier (MCPC) or Single Channel per Carrier (SCPC). ITU-R has recommended two separate satellite DAB systems as world-wide standards:

1) Digital System A, which uses and MCPC and COFDM (Coherent Orthogonal Frequency Division Multiplex) approach; and
2) Digital System B, which uses an SCPC and TDM (Time Division Multiplex) approach.

Certain satellite DAB systems that have been notified through ITU employ On-board Baseband Processing (OBP) technology. This approach allows radio broadcasters to transmit their programs to the satellite(s) directly from their ground-based studios. The digitized radio signals are then regenerated on board the satellite(s) and retransmitted back to the ground, to be received by small, credit card sized antennas incorporated into specially designed radios.

Satellite DAB service will offer educators and health specialists the ability to reach remote, rural and developing areas with specialized programming. Radio-based distance education and health programs will even be able to offer digital images, to accompany the audio portion of the programs, provided the radio receivers are equipped with Liquid Crystal Display (LCD) screens.

### 4.6 GSO Broadband Multimedia Satellites

Telecommunications which allow a high degree of communication between people, broadcasting which distributes to people, and computing which allows interactivity by people are converging and ushering in an era of multimedia systems. A new generation of GSO FSS satellites, also known as multimedia satellites, are under development to operate in the 20/30 GHz band with advanced infrastructure – “switchboards in the sky” and intersatellite links to provide low-cost broadband interactive communications services anywhere on the face of the earth.

## 5 Conclusion

Satellite technologies have the potential to directly provide the basic telecommunications services necessary for economic and social advancement. Any type of telecommunications service can be provided via satellite virtually anywhere in the world at a cost that is not a factor of geographical distance or of topography. Expanding reliable, high quality telecommunication services to rural areas in most instances also brings economic development and benefits to developing countries through the creation or expansion of businesses and increased revenues from telephony services themselves.

ANNEX 6

# Digital, audio and video broadcasting with related interactivity

## 1 Introduction

Television (TV) and radio broadcasting have, since their invention, been governed by analog transmission methods. However, in the coming years, more and more TV and radio broadcasters globally are likely to switch to digital transmission techniques for a variety of reasons. This Executive Summary will briefly highlight those reasons, particularly the economic issues that the transition to digital will raise.

### 1.1 Digital Versus Analog Transmission

Digitization involves the conversion of analog signals into a series of discrete coded signals. These coded signals consist of a stream of binary pulses representing ones and zeroes. In the case of radio (sound) signals, the binary pulses represent the sound pressure levels at successive points in time. By contrast, the traditional analog method is a direct representation of the sequence of sound pressures, hence requiring more bandwidth.

There are two main processes involved in converting an analog sound program into a digital representation:

i) chopping the continuous sound wave into a series of samples; and

ii) converting the samples into binary pulses (i.e. ones and zeros). In order to transmit, or to store and then retrieve, a binary pulse, it is only necessary to recognize whether the final result is a one or a zero. This can be accomplished even if the signal is severely distorted. On the other hand, the slightest distortion in an analog transmission affects the sound itself.

When a digitally transmitted signal reaches a receiver, it must first be converted back into analog form. In the case of radio, the converted analog signal is then amplified and fed to the loudspeakers, with a resulting sound quality that is a more faithful replica of the original sound transmitted from the studio. Depending upon the sampling rate used on the original analog program, the sound emitted from the radio can range in quality from the equivalent of AM (medium wave) monaural to CD (compact disk) stereo.

### 1.2 Digital Compression

Direct, over-the-air broadcasting of digitized television and/or sound signals would result in the most faithful representation of the original analog signal. However, this method of digital transmission would require enormous bandwidth and would not be an efficient use of either economic or natural resources. What has made digital transmission economically practical is the advent of digital compression technology such as the ISO MPEG (International Organization for Standardization Motion Pictures Experts Group) family of standards.

MPEG and similar encoding technologies allow a broadcaster to take a full-bandwidth analog signal, digitize and compress it, then decompress it and return it to a full-bandwidth analog format at the receiver end, with little noticeable degradation to the video and/or audio quality. Digital compression works by reducing the number of bits (ones and zeros) in a digital signal by using mathematical algorithms to eliminate redundant information, thereby reducing the space the signal occupies when being transmitted or recorded. Stated differently, when a signal is compressed, artifacts that the human eye or ear are unable to discern are simply omitted. Transmitting only “useful” information, i.e. only information that human senses can perceive, saves bandwidth, and therefore economic resources.

Since a digitized signal cannot discriminate between sound, video and data, radio listeners and TV viewers can receive value-added data services such as weather advisories or stock market information, while simultaneously enjoying crisp visual images and/or up to CD quality sound. Digital television also allows for a wide-screen television format, similar to that found in cinemas, and even interactivity between the broadcaster and the viewer. For example, some television decoders have a built-in capacity to connect to the Internet and CD-ROM, and to send and receive faxes, provided that there is a cable or modem connection between the sender and receiver. Interactivity is also possible with digital radio, by use of a return channel such as a fixed or mobile telephone.

### 1.3 Digital Delivery Methods

Digital signals can be transmitted over air terrestrially, via satellite, or through wired cable networks. The costs and benefits of each delivery system may vary greatly. Terrestrial digital TV broadcasting offers some advantages over satellite or cable video delivery, such as the ability to provide local content or portable reception. In addition, at least in areas where the signal is strong, an external satellite dish may not be required for terrestrial TV reception.

Generally, digital satellite broadcasting provides greater channel capacity than digital terrestrial methods. Satellite broadcasters are also able to achieve a much wider coverage area than their terrestrial counterparts. This is of particular importance to large or sparsely populated countries, or to a government or commercial broadcaster that desires to reach audiences beyond its borders. The minimal terrestrial infrastructure required for satellite broadcasting, and the associated decrease in maintenance costs, can greatly reduce the costs of transmission.

A common challenge to digital broadcasters is the need to convince consumers to purchase special receivers or decoders in order to receive the new services. In addition to providing a high quality signal, therefore, broadcasters should strive to provide high quality programming in order to encourage viewers and listeners to migrate towards digital.

## 2 Digital TV Broadcasting

The popularity of satellite delivered digital TV is increasing rapidly, not only in the developed world, but also in many developing regions. For example, in the Asia-Pacific region in 1996, 195 transponders were used to broadcast 210 analog channels, and little growth is expected in this market. By contrast, 60 transponders were used in 1996 to broadcast 225 digital channels, and these numbers are forecast to increase dramatically in the coming years.

The main advantage cited in this trend toward satellite digital TV is cost savings: digital transmissions tend to be much more frequency efficient than analog transmissions, which in turn can translate into large savings for broadcasters.

### 2.1 European Experience

The European Digital Video Broadcasting (DVB) Project was established in 1993 to organize a common European approach on the future of digital TV via satellite, cable and terrestrial transmission. The DVB Project brought together technical proposals for a compression, modulation and multiplexing format for the various delivery methods.

At the onset, the Project focused on satellite and cable standards because of the perceived market demand for these services. The Project first established a set of user requirements for satellite and cable services. Then, based on those requirements, it adopted a satellite system that can adapt to current and future satellite transponder designs, and a matching cable system that takes advantage of cable network characteristics. The technical specifications for the satellite and cable services were produced and standardized in 1994.

Technical specifications for a terrestrial DVB standard were produced and submitted for testing and standardization in late 1995. However, the DVB Project perceives a lower market demand in Europe for terrestrial DVB, compared to satellite and cable digital services. In addition, terrestrial DVB faces serious challenges in Europe because of frequency congestion in the existing VHF/UHF bands. Moreover, the allocation of additional frequency bands in Europe, or on a global basis, currently is not foreseen.

### 2.2 United States Experience

In 1987, the U.S. Federal Communications Commission (FCC) established the Advisory Committee on Advanced Television Service to study, evaluate and to recommend an Advanced Television, or ATV, System for the U.S. to replace the current NTSC system. Twenty-two different proposals had been made by various companies early in the process, but by the end of 1992 only four systems remained for consideration, all of them digital. The four system proponents combined the best features of their separate systems into a single digital High Definition TV (HDTV) system that has come to be known as the “Grand Alliance” system.

At the end of 1995, the Advisory Committee recommended the Grand Alliance system to the FCC as the U.S. ATV/HDTV terrestrial transmission standard, and the system received the FCC's endorsement at the end of 1996.

TV manufacturers are expected to begin marketing ATV sets in volume by late 1998. Computer companies have also stated their intention to build personal computers with capability of receiving ATV signals beginning in 1998. Since the Grand Alliance system will be compatible and interoperable with computer technology, it can accommodate the merging of digital TV and computer services.

The FCC plan is to transition the Nation to ATV and digital HDTV by assigning each of the 1 650 existing high power TV stations a second 6 MHz TV channel to transmit the ATV/HDTV service during a transition period of ten to fifteen years, during which both NTSC and ATV/HDTV would be simulcast. After the transition period, the NTSC service will be abandoned and one of the two 6 MHz channels returned to the government for reuse.

# 3 Digital Sound Broadcasting

Digital radio programs have been available for some time now as an ancillary service to satellite digital TV or cable networks. The main drawback of this service is that a satellite dish or cable connection is required to receive the digital radio signal, thus not allowing for portable or mobile (car) radio reception. However, with the advent of new technology and a favorable global regulatory regime, digital radio services to portable, fixed and mobile receivers will soon be widely available.

## 3.1 World-Wide Frequency Allocations

Satellite Digital Sound Broadcasting (S-DSB) applications have been studied internationally for at least 25 years. At the behest of a number of developing countries, ITU Member States first considered allocating frequencies for S-DSB at the 1979 World Administrative Radio Conference (WARC-79).

NOTE – In ITU circles, the terms "Satellite Digital Sound Broadcasting", and "Broadcasting Satellite Service (Sound)", or "BSS(S)", have been used interchangeably. In the United States, the term "Satellite Digital Audio Radio Service", or "Satellite DARS," is used to describe this service. The preferred terminology in Canada is "Satellite Digital Radio Broadcasting", or "S-DRB," while in Europe the term "Satellite Digital Audio Broadcasting", or "S-DAB" is employed.

ITU deferred consideration of frequency allocations until WARC-92, at which time it allocated three frequency bands for S-DSB and "complementary terrestrial broadcasting." Each ITU Member State accepted one or more of the bands, sometimes with conditions limiting their use until 2007.

## 3.2 Terrestrial DSB Technologies

Terrestrial DSB systems are currently being studied and implemented in different parts of the world. Systems that would use frequencies other than the traditional AM/FM (i.e. medium wave/long wave, respectively) bands are often referred to as "out-of-band" systems. Conversely, systems that would use the same frequencies now used by existing AM/FM stations are referred to as "in-band" systems. Both systems offer up to CD-quality audio and require less transmission power than traditional analog systems.

In Europe, a consortium of governmental and industrial actors known as Eureka-147 has developed an out-of-band system that typically uses the L-band or VHF Band III. This system, referred to in ITU documents as Digital System A, has achieved ITU Recommendations for both satellite and terrestrial digital transmission (see Note). The launch of T-DSB in Europe is currently planned for mid to late 1998, and plans are also underway to introduce T-DSB service in Canada.

NOTE – The technical parameters of the system are described in ITU-R BS. 1114-1, Annex 1 (for terrestrial transmission) and ITU-R BO. 1130-1, Annex 1 (for satellite transmission).

In the United States, several industrial actors are developing various in-band systems. U.S. broadcasters favor use of in-band systems because they would not have to seek allocation of additional spectrum, since radio stations could transmit both digital and analog signals on their originally licensed frequency or channel. In addition, broadcasters could continue to use existing transmission infrastructure, with some modification, thus avoiding the potentially large investments that would be required to replace existing transmitters.

One in-band system, known as "in-band on-channel", or "IBOC", proposes sending the digital audio signal over the same channel as the existing AM/FM analog signal, but at a reduced power level in order to avoid interference with the simultaneously transmitted analog signal.

A different technique, known as "in-band adjacent-channel", or "IBAC", would broadcast the digital signal in "guard band" – the frequencies on either side of existing FM channels that are left unused in order to guard against interference from stations on adjacent channels. The IBAC system also proposes a digital signal that is much weaker than the analog signals in order to avoid adjacent channel interference.

There has also been a proposal for an "in band on-carrier" system, which would employ the sub-carrier portion of the FM signal to transmit high speed digital audio, multimedia and data services. In addition, preliminary studies have taken place to examine the viability of international digital radio transmission using the short-wave bands.

## 3.3 Satellite DSB Technologies

Satellite DSB involves the transmission of audio and auxiliary data transmissions directly from a satellite to fixed, portable and mobile receivers with omnidirectional antennas. In some cases, a broadcaster can uplink to a satellite directly from the studio of a terrestrial radio station. Direct re-broadcasting of the digital sound signal from the satellite increases exponentially the coverage area of the radio station. S-DSB allows radio broadcasters to reach remote, rural and developing regions, or to provide regional or continental coverage. In addition to a wide coverage area, satellite DSB also offers audio quality ranging from AM monaural (suitable for talk radio) to CD stereo, at a low cost.

Most S-DSB systems that have been Advance Published through ITU will be deployed in the geostationary orbit. This orbital arc offers a high elevation angle to most developing countries situated close to the equator, which in turn minimizes signal blockage due to buildings or other infrastructure, allowing for a more reliable service. The highly elliptical orbit has also been proposed as a suitable alternative to the geostationary orbit, for providing service in countries in more extreme latitudes, such as northern Europe or Canada.

There are currently two systems that have achieved ITU-R Recommendations for S-DSB service: the first, Digital System A, uses an engineering technique known as Coherent Orthogonal Frequency Division Multiplex (COFDM); the second, Digital System B, uses a technique known as Time Division Multiplex (TDM). A technical comparison of COFDM and TDM multiplex transmissions has previously been published as part of the Chairman's Report for the Joint Working Party 10-11S, ITU-R, and is produced in this document as Appendix 1.

NOTE – The technical parameters of System B are described in ITU-R BO. 1130-1, Annex 2.

## 3.4 Digital Radio Receivers

Both satellite and terrestrial DSB services will require new, digital radios. In addition to DSB broadcasts, these new radios should be able to receive traditional AM and FM programs. And most importantly, particularly in the developing world context, the new radios must be made affordable.

NOTE – See Recommendation ITU-R BO. 789, recommends 12, which states that DSB systems should "allow manufacturing low-cost receivers and antennas through mass production."

Currently, there are over 2 billion radios in use, with more than half of them in the developing countries. In those same countries, approximately 130 million radios are sold each year. Thus, while digital radios will cost more than analog radios initially, manufacturers are hoping ultimately to be able to achieve the economies of scale needed to reduce the cost of digital radios to the level of analog radios. Since the technology required to manufacture digital radios is very advanced, it is possible for developing countries to become involved in the manufacture and assembly of these items, potentially leading to lower radio manufacturing costs.

As noted above, WARC '92 allocated multiple frequency bands for DSB globally. Therefore, radio manufacturers, like their TV and VCR counter-parts, may be required to build different types of receivers for sale in different parts of the world (see Note). For the average consumer, multiple standards for DSB are likely to have little impact. For the international traveler, sufficient market demand may exist to prompt manufacturers to make available dual or multi-system radio receivers.

NOTE – For example, Digital System A can operate in the L-Band or VHF Bands, but for technical reasons cannot operate in the S-Band. Since the United States has allocated only the S-Band (2.3 GHz) for S-DSB service, Digital System A satellite receivers will not be used in the U.S.

# 4 Conclusions

1) The economic and human resource issues involved in making the transition from analog to digital broadcasting should be studied in further detail, taking into account studies that may have already been undertaken so as to minimize duplication of efforts.

2) Since satellite DSB services will be widespread before the end of the decade, developing countries may require the guidance provided by ITU-R technical Recommendations in order to evaluate competing S-DSB systems that cover their territories. This Annex 6 contains a liaison statement from the Chairman of ITU-D Working Party A/2, to the Chairman of ITU-R Working Party 10-11S, encouraging that Working Party to take as a matter of high priority the task of issuing technical Recommendations of satellite systems that will provide partial or complete coverage of the developing world.

3) Annex 6 also provides a cost/benefit analysis of analog versus digital broadcasting technologies, focusing on radio broadcasting. Appendix 1 to this Annex contains a technical comparison between two approaches to satellite digital radio broadcasting.

**Acknowledgements**

The following sources were consulted in the preparation of this Executive Summary:

1) Proceedings of the BroadcastAsia ’96 Conference (Singapore).

2) Proceedings of the Third Montreux International Radio Symposium (Montreux, Switzerland, 1996).

3) Proceedings of the 33rd General Assembly of the Asia-Pacific Broadcasting Union (ABU) (1996, Hong Kong).

## 4.1 Example of a cost/benefit analysis for international radio broadcasting

### 4.1.1 Introduction

Paragraph 4.1.2 of this Annex presents a cost analysis both for medium-wave and short-wave radio transmission services. The prices quoted are non-proprietary, derived mainly from the experiences of existing international broadcasters. In addition to price information, Section 3 of the following Table of the analysis presents a comparison of the geographic coverage areas achieved by medium-wave, short-wave and satellite digital sound broadcasting (S-DSB) services, respectively. The analysis does not include the cost to transmit digital radio programs for retransmission on analog terrestrial networks, nor the cost of transmitting digital radio programs as an ancillary service to existing satellite television services.

Paragraph 4.1.3 of this Annex includes a brief description of digital receiver costs, and Appendix 1 contains a comparison of two different S-DSB systems.

### 4.1.2 Cost analysis

| **1. *MEDIUM WAVE – SINGLE TRANSMITTER*** | Base Line Figures (U.S. $) | Salary @ U.S. $ 40K | Salary @ U.S. $ 100K | Power @ U.S. $ 0.04 | Power @ U.S. $ 0.24 |
|---|---|---|---|---|---|
| | | | | | |
| Transmitter Installation (500 kW) | $ 3,235,000 | | | | |
| Depreciation (years) | 20 | | | | |
| Maintenance & Repair Costs (3% of Installation) | $ 97,050 | | | | |
| *Hourly Depreciation Costs (16 hrs/day)* | *$ 44* | | | | |
| **Total Annual Depreciation** | **$ 258,800** | | | | |
| | | | | | |
| Power Consumption (kilowatt-hour) | 660 | | | 660 | 660 |
| Cost per kWh | $ 0.117 | | | $ 0.040 | $ 0.240 |
| *Total Power Cost per hour* | *$ 77* | | | *$ 26* | *$ 158* |
| **Total Annual Power Costs (16 hrs./day)** | **$ 450,965** | | | **$ 154,176** | **$ 925,056** |
| | | | | | |
| Maintenance Staff | 4 | 4 | 4 | | |
| Annual Salary & Benefits of Staff | $ 58,800 | $ 40,000 | $ 100,000 | | |
| *Hourly Staff Costs (16 hrs/day)* | *$ 40* | *$ 27* | *$ 68* | | |
| **Total Annual Staff Costs** | **$ 235,200** | **$ 160,000** | **$ 400,000** | | |
| | | | | | |
| **Total Hourly Costs** | **$ 162** | **$ 166** | **$ 189** | **$ 111** | **$ 243** |
| **Total Annual Costs** | **$ 944,965** | **$ 869,765** | **$ 1,109,765** | **$ 648,176** | **$ 1,419,056** |

NOTE 1 – *Currency:* All prices are stated in terms of United States dollars.

NOTE 2 – *Terrestrial infrastructure:* The costs for all transmitter installations assumes land, building, antennae farm and power gear.

NOTE 3 – *Power costs:* Since the cost of electrical power varies greatly, the analysis examines three different price levels: $ 0.117 per kilowatt-hour (kWh); $ 0.040 per kWh; and $ 0.24 per kWh, respectively.

NOTE 4 – *Salary costs:* The analysis assumes several levels of total annual salary costs, to cover a maintenance staff of four people working a total of 16 hours per day. The different salary levels examined are: $ 58,800 (the base line salary), $ 40,000 and $ 100,000, respectively.

NOTE 5 – *Hours of operation:* The terrestrial infrastructure is assumed to operate 16 hours per day, or 5 840 hours per year.

| 2. ***SHORTWAVE – SINGLE TRANSMITTER SITE*** | Base Line Figures (U.S. $) | Salary @ U.S. $ 40K | Salary @ U.S. $ 100K | Power @ U.S. $ 0.04 | Power @ U.S. $ 0.24 |
|---|---|---|---|---|---|
| | | | | | |
| Transmitter Installation (500 kW) | $ 3,200,000 | | | | |
| Depreciation (years) | 20 | | | | |
| Maintenance & Repair Costs (6% of Installation) | $ 192,000 | | | | |
| *Hourly Depreciation Costs (16 hrs/day)* | *$ 60* | | | | |
| **Total Annual Depreciation** | **$ 352,000** | | | | |
| | | | | | |
| Power Consumption (kilowatt-hour) | 650 | | | 650 | 650 |
| Cost per kWh | $ 0.117 | | | $ 0.040 | $ 0.240 |
| *Total Power Cost per hour* | *$ 76* | | | *$ 26* | *$ 156* |
| **Total Annual Power Costs (16 hrs./day)** | **$ 444,132** | | | **$ 151,840** | **$ 911,040** |
| | | | | | |
| Maintenance Staff | 4 | 4 | 4 | | |
| Annual Salary & Benefits of Staff | $ 58,800 | $ 40,000 | $ 100,000 | | |
| *Hourly Staff Costs (16 hrs/day)* | *$ 40* | *$ 27* | *$ 68* | | |
| **Total Annual Staff Costs** | **$ 235,200** | **$ 160,000** | **$ 400,000** | | |
| | | | | | |
| **Total Hourly Costs** | **$ 177** | **$ 164** | **$ 204** | **$ 126** | **$ 256** |
| **Total Annual Costs** | **$ 1,031,332** | **$ 956,132** | **$ 1,196,132** | **$ 739,040** | **$ 1,498,240** |

NOTE 1 – *Currency:* All prices are stated in terms of United States dollars.

NOTE 2 – *Terrestrial infrastructure:* The costs for all transmitter installations assumes land, building, antennae farm and power gear. Although the prices are for a single transmitter, large international broadcasters typically employ several short-wave transmitters in order to broadcast on three or four frequencies, thereby ensuring signal reception.

NOTE 3 – *Power costs:* Since the cost of electrical power varies greatly, the analysis examines three different price levels: $ 0.117 per kilowatt-hour (kWh); $ 0.040 per kWh; and $ 0.24 per kWh, respectively.

NOTE 4 – *Salary costs:* The analysis assumes several levels of total annual salary costs, to cover a maintenance staff of four people working a total of 16 hours per day. The different salary levels examined are: $ 58,800 (the base line salary), $ 40,000 and $ 100,000, respectively.

NOTE 5 – *Hours of operation:* The terrestrial infrastructure is assumed to operate 16 hours per day, or 5 840 hours per year.

| **3. *COVERAGE AREAS*** | | | |
|---|---|---|---|
| | **Coverage Area ($km^2$)** | **Coverage Area of a Satellite Beam ($km^2$)** | **Difference in coverage areas ($km^2$)** |
| Medium Wave (500 kW) | 250 000 | 14 000 000 | 13 750 000 |
| Short Wave (500 kW) | 8 000 000 | 14 000 000 | 6 000 000 |

NOTE 1 – *Satellite beams:* The satellite is assumed to be in geostationary orbit, with three equally sized spot beams covering different geographic areas within a region. The above figure represents the coverage area of a single beam.

NOTE 2 – *Satellite transmission costs:* Specific price information for a satellite DSB service is not available, due to the proprietary nature of the information. However, the analysis assumes a lower cost for satellite transmission due to the following factors:

a) satellite services require minimal terrestrial infrastructure and therefore incur less maintenance, repair and depreciation costs;

b) power costs are also much lower since satellites employ solar energy; and

c) in terms of value of services, satellites offer much wider geographic coverage areas.

NOTE 3 – *Hours of operation:* The terrestrial infrastructure is assumed to operate 16 hours per day, or 5 840 hours per year. The satellite operates on a 24-hour basis.

NOTE 4 – *Satellite earth stations:* The analysis does not cover the cost to “uplink” to a satellite via an individual or shared feeder link station (satellite dish), including hardware and personnel costs.

### 4.1.3 Receiver Costs

Terrestrial digital television is due to be introduced in the United States in 1998. At the start of service, the sets are predicted to be priced at U.S. $ 1,000 – $ 1,500 more than comparable analog sets, although manufacturers hope the price differential will fall quickly by one half or one third.

At the time of this writing, the European launch of terrestrial digital sound services is scheduled to coincide with the Internationale Funkausstellung (World Consumer Electronics Fair, or "IFA"), Europe's largest consumer electronics trade show, to be held from 30 August to 7 September in Berlin, Germany. Several radio manufacturers are reportedly preparing to display their Digital System A-compatible receivers at IFA '97.

Prior to this official launch of Digital System A, many European countries have conducted and continue to operate pilot projects of the transmission system. Current retail costs for receivers in Germany, without state subsidization, range from DM 3,200 to DM 4,500 (approximately U.S. $ 1,700 to $ 2,400). With state subsidization, prices begin at just under DM 1,000 (approximately U.S. $ 535).

It is important to note, however, that the above prices are based on the production of only a few hundred receiver sets. After the introduction of competing receiver brands at IFA '97, prices are expected to drop sharply. The cost of a digital receiver with FM capability is predicted to fall to approximately DM 1,000, without any state subsidization.

Satellite digital radios will be available at the retail level in late 1998. At the AsiaTelecom '97 held in Singapore in June, four Japanese manufacturers announced their intention to mass produce and distribute receivers compatible with the WorldSpace S-DSB system (a description of this system is contained in Attachment 1 to this Annex). The receivers are expected initially to cost approximately U.S. $ 150 more than comparable analog radios. Since the radios will be distributed globally, the manufacturers (Hitachi, Sanyo, Panasonic and JVC) predict that economies of scale will drive these prices down quickly.

# Liaison Statement

FROM: CHAIRMAN, ITU-D WP A/2

TO: CHAIRMAN, ITU-R JWP 10-11S

SUBJECT: RECOMMENDATION OF SATELLITE DIGITAL SOUND BROADCASTING SYTEMS BEING INTRODUCED IN THE DEVELOPING WORLD

ITU-D Question 1/2 is entitled “Special concerns of developing countries in relation to the work of the Radiocommunication and Telecommunication Standardization Sectors”. The Rapporteurs’ Group for this Question has been instructed by Study Group 2 to examine a “broad array of technologies”, including satellite digital sound broadcasting (S-DSB) systems. The economic and development aspects of S-DSB systems have been and continue to be studied within the framework of ITU-D Rapporteurs’ Groups and Working Parties.

ITU has Advance Published several S-DSB satellite networks that propose providing service to all or parts of the developing world (see Note). In evaluating the appropriateness of competing S-DSB systems, ITU-R technical Recommendations can be very useful tools for developing country broadcasters. ITU-D WP A/2 therefore requests that ITU-R JWP 10-11S makes it a high priority to include in ITU-R Recommendation BO. 1130-1 those S-DSB satellite networks intended to operate in the developing world.

NOTE – One such satellite system has been accepted for inclusion in the JWP 10-11S Chairman’s Report on Broadcasting Service (Sound).

APPENDIX 1

DOCUMENT: EXTRACT FROM ITU-R DOCUMENT 10-11S/1-E (CHAIRMAN'S REPORT – REF. N:\BRSGA\TEXT95\SG11\10-11S\001E4.DOC)

SOURCE: UNITED STATES OF AMERICA

**3.A.3bis1 New Annex Description of AFRIBSS system**

# 1 Introduction

ITU-R Documents 10-11S/67 and 2-2/93 dated November 10, 1994 contained a general description of a proposed BSS (sound) system identified in the ITU-R Weekly Circular as AFRIBSS. The satellite system was designed to provide a range of digital sound broadcasting (DSB) quality and ancillary digital data from a geostationary satellite for reception by vehicular, portable and fixed L-Band receivers within the provisions of Recommendation ITU-R BO.789. Subsequent and ongoing systems development resulted in the digital audio multiplexing scheme modification from FDM to TDM. This provides a system design alternative to that described in Annex 1 of ITU-R Recommendation BO.1130. This document presents a summary description of and the rationale behind the transmission scheme selected.

## 1.1 Background

The transmission method selected is one that is well suited for the high effeciency of use of the satellite (AFRIBSS) in-orbit resource. On the uplinks it uses a multiplicity of 16 kbit/s FDMA carriers that are channel coded by use of concatenated Reed Solomon block coders (rate 255/223) and a Rate 1/2, constraint length of 7, Viterbi convolution coders for forward error correction (FEC). Each coded channel transmission rate is then 36.82 kbit/s. Upon reception, this yields an error rate of no greater than $10^{-4}$ at an Eb/No of 2.5 dB. The system supports up to 288 of these 16 kbit/s uplink carriers. Broadcasters can use the lowest 16 kbit/s rate for AM monaural radio quality voice/music programming and the channels can be combined to provide rates of 32, 64, 96 and 128 kbit/s to support FM mono, stereo and CD quality by use of MPEG II-Layer 3 program source coding. Broadcasters access the satellite in a global beam using about 12 watts of power with a 1.5 m diameter parabolic dish antenna.

An on-board baseband processor is used to receive the uplink FDMA carriers, demodulate to digital baseband and route to one or more downlink time division multiplexors. Downlinks are provided in three 5.7° beams strategically pointed to cover major regions of the earth at elevation angles of 40° and greater. Each beam carries 96 16 kbit/s channels on a single Time Division Multiples (TDM) carrier. This carrier is contained in a bandwidth of approximately 8.8 dB relative to a received BER of $10^{-4}$ using a receiver with a Figure of Merit (G/T) –13.4 dB/K. Each TDM digital stream is QPSK modulated on an L-Band carrier, optimally filtered to confine its power to a 2.5 MHz bandwidth.

## 1.2 Discussion

A link budget of the TDM/MCPC operation is given in Table 4. The use of TDM/MCPC (Multiple Channel per Carrier) permits the 300 W TWTA power amplifier to operate within 0.3 dB of saturated power output. This is significantly better than can be achieved with frequency division multiplexing methods using linearizers with the TWTA's. Other factors listed in Table 4 that favour TDM/MCPC are required Eb/No and the non-linearity losses. Furthermore, because the on-board baseband processor regenerates the uplink signals, noise on the uplink does not add to downlink noise, rather the error rates add. This can result in an enhancement of up to 2.5 dB compared to non-regenerative operation. Thus the combined use of single channel per transponder operation and on-board regeneration can result in an overall 3.0 to 5.0 enhancement in the link margin for TDM/MCPC compared to multiple carrier techniques.

TDM/MCPC carries a single bit stream having a useful bit rate of 1.536 Mbit/s. This bit rate will support 24 (64 kbit/s) or 96 (16 kbit/s) channels. Calculation of the overall link budget for this operation, assuming the on-board baseband processor, results in an 8.8 dB margin per channel.

In addition to the above, the audio compression algorithms used in the TDM/MCPC is MPEG II Layer 3 rather than Layer 2.

Since multipath is a problem that is encountered principally for horizontal terrestrial transmission and for low elevation angles to the satellite, the impact of this feature diminishes as elevation angles increase. The proposed TDM system has earth coverages within the service contours (4dB) at elevation angles of 40° or greater. The TDM/MCPC 8.8 dB link margin is of more benefit since the multipath factor is diminished and the margin can be used to mitigate signal blockage, in-building penetration and reception under foliage situations. Therefore, in this particular application, TDM/MCPC has the requisite benefits for the coverage desired.

## 1.3 Summary

| Parameter | TDM/MCPC |
|---|---|
| Space segment power efficiency | High |
| Independent FDMA uplinks | Yes |
| Uplink signal regeneration | Yes |
| TWTA Output B.O. | 0.3 dB |
| Required Eb/No @ $10^{-4}$ | 2.5 dB |
| Non-linearity degradation | 0.5 dB |
| Receiver operating margin * | 8.8 dB |
| 64 kbit/s Channels per ensemble | 24 |
| Equivalent noise b/w | 1 756 kHz |
| Separation between ensembles | 2.5 MHz |
| Useful bit rate | 1.536 Mbit/s |
| Audio compression (MPEG) | Layer 3 |
| Channel Coding | Rate 1/2 Viterbi + RS (255/223) |

* Assumes a space segment equipped with a 300 watt TWTA, saturated output with antenna gain of 25.5 dBi at edge of coverage (– 4 dB) into a receiver with a G/T –13.4 dB/K.

## 1.4 Conclusion

Figure 10 shows the general TDM/MCPC system configuration. The system design has been optimized taking into consideration:

i) the advantages provided by rapidly developing digital technoligies available to service providers; and

ii) meeting the service demands of broadcasters and consumers in the intended service region; and

iii) achieving the maximum efficiency of power and bandwidth while keeping the radio receiver complexity to a reasonable level.

The specific technical market requirements taken into account in this satellite DSB system have led to a design different from those presently submitted to ITU-R Study Groups. Therefore, for this particular specialized DSB transmission method, it is expected that, when the system specifications are more fully defined and are available and technical feasibility is confirmed, the system be considered for inclusion in ITU-R Recommendation BO.1130.

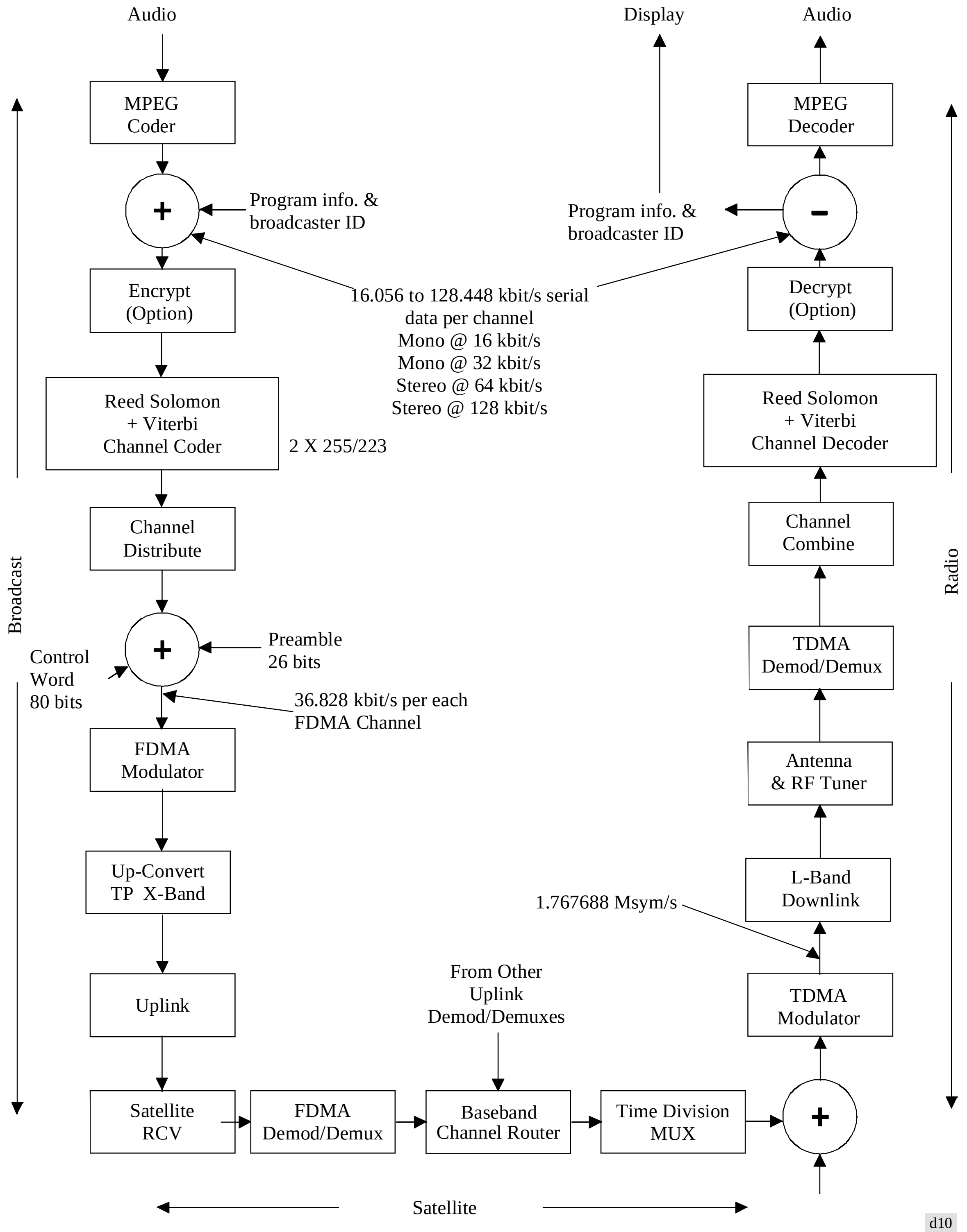
TABLE 4

**TDM (MCPC) Link Budget**

| **Typical Link Budget** | **TDM/MCPC** |
|---|---|
| | |
| Frequency (GHz) | 1.5 |
| | |
| Satellite | |
| Repeater output power (W) | 300 |
| Output losses (dB) | 0.5 |
| OBO (dB) | 0.3 |
| Antenna gain (dB) | 25.5 |
| **e.i.r.p. (dBW)** | 49.5 |
| | |
| Propagation | |
| Elevation (degrees) | 45 |
| Range (km) | 37 413.1 |
| Pointing losses (dB) | 0 |
| Free space losses (dB) | 187.4 |
| Atmospheric losses (dB) | 0.1 |
| | |
| Radio Receiver | |
| Power flux density (dB(W/$m^2$)) | –113.1 |
| G/T (dB/K) | –13.4 |
| Received C/No (dB(Hz)) | 77.1 |
| | |
| Required Eb/No (dB) @ $10^{-4}$ | 2.5 |
| Non-linearity losses (dB) | 0.5 |
| Sys. Implem. losses (dB) | 1 |
| Hardware losses (dB) | 0.5 |
| Interference allowance (dB) | 2 |
| | |
| Bit rate (kHz) | 1 536 |
| | |
| Required C/No (dB(Hz)) | 68.4 |
| | |
| **MARGIN** | 8.8 |

FIGURE 10

**General TDM/MCPC System Configuration**



ANNEX 7

# Frequency Agile Systems

## 1 Introduction

### 1.1 Regulatory provisions up to 1995

International agreements for the frequency regulations and assignment for the HF fixed services have been based on long standing procedure. Proposals for new assignments are submitted to the ITU Radiocommunication Bureau (BR). BR examines the proposal and submits it to a technical examination for compatibility with existing assignments. If the result of the technical examination shows that the proposed use will not cause harmful interference to existing assignment, the assignment is included in the Master International Frequency Register. The administration may then proceed to authorise the assignment.

This process is of dubious technical value at HF. The use of HF is governed by the variable nature of the ionospheric propagation and real-time frequency management may be undertaken by the circuit operators who have to amend frequency schedules according to the season, etc., and who also may make decisions to depart from scheduled usage when short-term changes in ionospheric conditions, or the presence of interference, dictate. Thus frequencies actually in use may not be those expected for that time. The propagation models used by BR in the technical examination are statistical in nature and cannot include short-term considerations. Thus the frequency listing in the Master Register is an inadequate guide to actual occupancy. Moreover, it is well known that some assignments included in the Register have ceased to be used by operational systems and in some cases relate to circuits which have never been put into operation.

### 1.2 The World Radiocommunication Conference 1995

WRC-95 had amongst its tasks a consideration of the simplification of the Radio Regulations, to aid use by the administrations, etc. and also to aid the efficiency of the work of BR. A simplified set of Regulations was agreed which should come into force in due course. However, by means of Resolution 23 (WRC-95), it was decided that the BR, with immediate effect, would no longer make any technical examination of proposed frequency assignments in the unplanned frequency bands below 28 MHz.

Thus any proposals by administrations for the registration of assignments in the Master International Frequency Register would take place without any check for incompatibilities, and countries which relied on this process to ensure satisfactory, interference-free communication will not now have that perceived safeguard.

The remaining Regulations still require notification to BR and listing in the MIFR. However, without any checks, and thus without anything to be gained from registering the date of an assignment, it may be expected that the listing in the MIFR will progressively degenerate and that new assignments will not be notified.

ITU also has the purpose of offering technical assistance to developing countries and of promoting the development of technical facilities and their most efficient operation. It might be considered that the withdrawal of a technical examination by BR would reduce the technical assistance available, despite the imperfections of the previous arrangements. Countries without the resources for their own monitoring and planning are alarmed that there will no longer be any such assistance in enabling them to maintain the quality of their existing services

### 1.3 Recommendation 720 (CMR-95)

Recommendation 720, entitled “*The flexible and efficient use of the radio spectrum by fixed and some mobile services in the MF and HF bands using block allocations for adaptive systems*”, recognises “that further studies are essential to permit the introduction of frequency agile equipment coupled with the power of digital signal processing for frequency control and error correction techniques” and goes on to instruct the Director, BR, “to ensure, in consultation with the Study Group Chairmen, that the studies now in hand are completed as a matter of urgency and in time for WRC-97”.

It may be noted that the scope of the Recommendation includes mobile services and there may be applications in off-route aeronautical bands and for some of the non-planned mobile bands which are used by the maritime mobile services. It is however likely to be most useful to commence studies for fixed service applications, since this use often involves extended periods of operation and thus extended incidence of potential interference.

Thus there is now an opportunity for a major updating of the frequency management techniques at HF. But this imposes a very severe time constraint on the studies since they must be largely completed by October 1996 and finalized by January 1997.

## 2 General considerations

### 2.1 The use of modern technology

Fortunately, modern technology now permits another solution to the HF problem. Whilst the use of frequency agile systems may not necessarily use the minimum number of frequencies, the assurance of reliable communication given by such systems should result in more efficient operation, the avoidance of situations where interference might be caused, and a reduction in the techniques used to preserve access to a channel when there is no current traffic – overall an increase in efficiency of spectrum *utilization*.

A small recent UK monitoring programme showed that about half of the transmissions monitored were coded and could not be examined, but of the other half, 41% were sending call signs or idling signals – just to keep the channel in use. This spectrum wastage will be avoided by agile systems, thus reducing the overall congestion and interference.

### 2.2 Development to date

The first generation of adaptive MF and HF systems were developed in the late 1970s/early 1980s. At that time, control equipment was becoming available at reasonable costs and processing power, and the latest generation radio equipment was computer controllable (mainly intended for enabling remote control capability). This generation of equipment could only establish a radio link by selecting one traffic frequency among a small number of pre-set frequencies. The link was then handed over to the operator.

More functionality was added during the 1980s, enabling fully automatic link establishment, link maintenance during message transfer and link disconnection. Such systems could react adaptively to changes in link conditions, e.g. by changing the traffic frequency, the transmitter power and/or the modulation format. Since manufacturers developed their own specific systems, the capability to interoperate with systems from other manufacturers was at best limited.

In the United States, this resulted in a joint effort between customers and manufacturers to develop a standard, thereby fulfilling the prime objective within the US governmental authorities, i.e. interoperability between systems from different manufacturers. This US standard, defined in its military version as MIL-STD-188-141A and in its civilian version as FED-STD-1045A, commonly referred to as the *ALE standard* (Automatic Link Establishment), has more or less become the *de facto* standard around the world. A recent survey revealed that at least 15 000 ALE systems have been established so far. Of these, 2/3 were sold outside the United States to countries in Europe, Africa and South America. The HF Industry Association (HFIA), an open-to-all organization focusing on promoting and developing the ALE standard, is predicting a growth from 15 000 systems in 1996 to more than one million systems early next century.

Today, several different types of adaptive systems are in operation or under procurement. NATO has started work to develop a NATO standard (STANAG). The strategy selected for another automatic adaptive system KV 90, used by the Swedish Armed Forces, will probably be adopted for several of the more advanced defence systems under development or procurement. KV 90 is able to operate in two modes; one being the US ALE mode, as defined in MIL-STD-188-141A, and one the KV 90 internal synchronous mode. The ALE mode will be used when communicating with other adaptive MF and HF networks and the synchronous mode will enable high performance communication within the defence radio nets, giving faster link establishment times and higher user data rates.

The term adaptive HF systems has become synonymous with the current generation of automatic HF systems. In order for the regulatory framework not to set unintentional restraints on the future development of these type of HF systems, a new term (not identifiable with a particular generation or system) has been suggested: frequency agile HF systems, which only defines the frequency usage of the HF frequency spectrum by these HF systems.

### 2.3 Benefits for developing countries

Adaptive systems will offer special benefit to developing countries as well, for both commercial and government users. This will include lower-cost access to global or regional communications. Some countries have limited wire structure, and they can save money by using HF instead of satellite communications in many cases. Adaptive systems makes HF radios as easy to use as many telephones or SATCOM.

With the modern equipment already available or under development, the need for skilled radio operators can be completely dispensed with, because any frequency agile system will automatically select the optimal working frequency at any given instance, and perform the requested communication in an interference-free environment and with the highest possible degree of accuracy. By this system, the whole radio frequency spectrum will always be available to any operator who needs to use it in a timely manner.

*It should be emphasized that allocation of radio frequency spectra to this new mode of operation, at the national level, is always under the full authority of each government*.

## 3 The Radiocommunication Assembly1995

The 1995 Radiocommunication Assembly adopted two new Questions which are relevant for the HF fixed services. These are: Question ITU-R [XC/1A] "Block allocations for adaptive Systems in the HF Band"; and Question ITU-R [Doc. 9/40] "Technical and Operational Implications of using Discrete Blocks of Spectrum by Adaptive HF Systems". Both these Questions have the same purpose – to provide justification for a new regulatory environment at HF. The Study Groups had envisaged a steady series of studies extending over, say, the next four years so as to reach firm conclusions on the merit of such systems.

### 3.1 Works carried out by ITU-R Study Groups 9 and 1

For some years, ITU-R study Group 9 has been considering the advantages which might occur from the use of frequency adaptive HF fixed services. A Recommendation has now been adopted on the traffic capacity of such systems (RA-95 Doc. 9/1022). Although this is a first version which would still merit further improvements, this Recommendation does give methods for quantifying traffic capacity and would be equally valid for similar applications in the mobile services.

Document 1A/TEMP/24 (21 August 1995), "Preliminary draft new Recommendation, Block allocations for adaptive systems in the HF band", is also relevant.

### 3.2 Progress of WP 9C

Matters relating to Adaptive Systems will be studied by the ITU-R Study Groups as follows.

CPM-96 designated WP 1A as lead group for WRC-97 agenda item 1.5 (Adaptive Systems, Rec. 720) and WP 9C as one of the supporting groups.

Professor Les Barclay accepted to work as WP 9C Rapporteur on this subject. He would work in order to incorporate the views and contributions of WP 9C participants into a document which will be submitted to the October 1996 meeting of WP 1A.

The output of the studies should address:

– improvements in spectrum occupancy;

– improvement in service quality or error performance;

– techniques for interference avoidance;

– estimation of the impact on spectrum *utilization* by the use of channel soundings;

– improvement in quality and availability, for those applications which do not utilize adaptive techniques.

## 4 Frequency Bands suitable for Block Allocations to Frequency Agile System

The ultimate (and futuristic) goal would be to de-regulate the whole spectrum below about 30 MHz, all bands and services concerned, with the exception, however, of certain bands or channels allocated to safety services, including radiodetermination and radio astronomy bands. With the modern equipment already available or under development, the need for skilled radio operators or *a priori* planning of services and bands can be completely dispensed with, because any frequency agile system will automatically select the optimal working frequency at any given instance, and perform the requested communication in an interference-free environment and with the highest possible degree of accuracy. By this system, the whole radio frequency spectrum will always be available to any operator who needs to use it in a timely manner. It is recognized, however, that the present allocation of the frequency bands to the various services should be maintained for the time being.

The initial step for the consideration of suitable frequency bands to be used by Frequency Agile Systems should be based on the following guiding principles:

– The band should be primarily allocated to the Fixed and (Land) Mobile services.

– The band should not explicitly mention Maritime and/or Aeronautical mobile services.

– Bands allocated or shared with the Broadcasting service, Radiodetermination service, the Amateur service or radio astronomy should not be considered.

– Bands for the Fixed and Mobile services of a given Region but which, in an adjacent Region, are allocated to one or more of the other services should not be considered.

– Bands involving safety services should not be considered (RR S5.155, S5.155A and S5.155B).

– Frequency bands above 25 MHz should not be considered because of their extensive use for "CB" transmissions and low-power devices.

– The footnotes affecting some of the proposed bands should be considered for compatibility.

## 5 Regulatory amendments

In the preparation of texts for the Draft ITU-R Recommendations relating to Question ITU-R 147/9 ("Adaptive HF Systems"), etc., it would be appropriate to consider suitable definitions of certain terms and expressions also with a view to making proposals for amending the Radio Regulations;

Under Article **S1** (*Terms and Definitions*), there will be a need to define terms such as *Block Allocation, Frequency Agile System*, or *Adaptive System*, etc.

Various provisions need to be amended or added; for example, in Article **S4** (*Assignment and Use of Frequencies*), recognition should be given to the new technology and mode of operation of Frequency Agile Systems. Also, in Article **S5** (*Table Frequency Allocations*), those bands in which Frequency Agile Systems are allowed to operate should be indicated by a footnote.

Other Articles, such as **S15** (*Interference*) and **S19** (*Identification of stations*), may also need the inclusion of some provisions relating to this new mode of operation.

Under the present regulatory regime, each frequency usage should, in principle, be notified and recorded as an assignment in the Master Frequency Register. It is obvious that, in the case of a fully automatic system, which can operate on a very high number of either predetermined channels, or randomly selected channels (within the authorized frequency band for the service concerned), it would be impracticable to notify and record all of those "assignments". Therefore, amendments to i.a. Appendix **S4** (*Characteristics to be used in the application of the Procedures of Chapter **SIII***) need to be introduced.

# 6 Technical description of some operational systems

## 6.1 Main characteristics

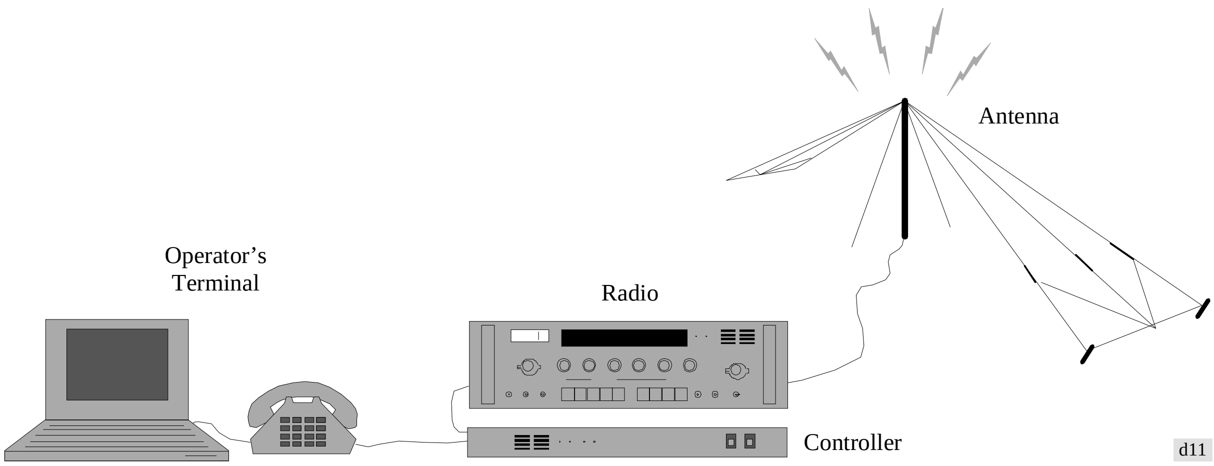
The salient features of the adaptive MF and HF systems are:

- Easy to use – the adaptive systems will establish, maintain and disconnect the MF and HF link without the need for an operator to interact technically. This alleviates the requirement for using trained radio personnel.
- Increased reliability – the percentage of time in which the adaptive systems will provide a high quality service is much higher than traditional fixed frequency systems. This is ensured by the use of adaptive frequency selection, automatic repetition on request and more robust modulation waveforms.
- Flexibility – an adaptive system will continuously analyse and update link quality assessment information making it possible to select the most suitable traffic frequency for each particular time instant. This adaptive behaviour minimizes the time periods in which a mobile station cannot communicate with another mobile station or a fixed station. It also increases the possibility that a low-power mobile station will be able to make contact with another station.

## 6.2 General description

The following describes a common set of functions that are embedded in most of the various types of systems that have been developed. “Common” in this respect does not necessarily mean that they have been implemented in the same way thus enabling inter-communication. It only means that the same type of functionality has been implemented. A more thorough description can be found in ITU-R Rec. F.1110, “Adaptive Radio Systems for Frequencies below about 30 MHz”.

An adaptive station, here defined as being able to provide the operator with a radio link, consists of the following elements:




The main functions of the controller unit in an adaptive system are frequency management and link quality assessment, link preparation and establishment, link maintenance and disconnection.

## 6.3 Frequency management and link quality assessment

All frequencies that can be used at any given instant are stored in a frequency pool. Some adaptive systems may differentiate between transmitter and receiver frequency, others may use the same frequency for both transmission and reception. In general, five to ten frequencies are stored in a frequency pool, but some adaptive systems have the capability to store and use up to several hundred frequencies.

When there is no traffic, a station will scan the frequencies of the pool, dwelling on each frequency for a specific time period sufficiently long as to ensure that an incoming call can be detected. Some systems will simultaneously perform a passive channel analysis by measuring the interference level on each frequency.

Link quality assessment information is collected after a link has been disconnected. The information is used to select appropriate traffic frequencies between the stations in a net. If little traffic is passed within the net, an automatic sounding function may be activated to provide link quality assessment. A station will then at regular intervals perform a special sounding call consecutively on each frequency from the frequency pool. All other stations in the net detecting this sounding call will update their individual link quality assessment table.

### 6.4 Link preparation and establishment

The operator will order a link to be initiated either by using the ordinary telephone or via the operator terminal. When a station is ordered to establish a link, it will select the assumed most suitable frequency in the frequency pool. The receiver is set to that frequency, and the controller unit will measure the interference level on that frequency. If the interference level is above a certain threshold, the frequency is rejected and the controller will test the second best frequency. If a usable frequency cannot be found, a "failure" status report will be issued to the operator. Otherwise a call will be initiated.

When a called station detects a call, it automatically responds and reports the call to its operator. The calling station confirms the reception of the response, and messages can than be transferred or alternatively the link can be handed over to the operators for voice operation.

### 6.5 Link maintenance and disconnection

If a link is under control of a controller unit, e.g. when passing text or data messages, it may react adaptively to changes in link conditions. If, for example, the link degrades, a change to a new frequency may be initiated automatically.

Either operator is able to disconnect the link. The controller unit will then issue the appropriate commands to ensure that both stations disconnect the link in an orderly manner. The stations will thereafter resume scanning the frequencies in the frequency pool.

### 6.6 Broadcast transmissions

The same procedure can be used when performing broadcast transmissions with the exception that the link is considered established after the call has been performed on the first found accessible frequency. A data or text message will be passed directly following the link establishment phase while the link disconnect message ends the transmission. The called stations will stay on the traffic frequency until they have detected the link disconnect message.

## 7 Conclusion

The Regulatory changes which may be proposed in WRC are intended to take advantage of the improvement in performance which modern technology allows; to obviate the need for trained personnel so that the equipment will be easier to operate; to reduce interference by automatic monitoring of the frequencies being used; and to reduce initial and maintenance cost by the use of modern technology.

ANNEX 8

# Stratospheric telecommunication service: an opportunity to close the information gap

## 1 Introduction

Stratospheric Telecommunications Service (STS) is a new technology that can revolutionize the wireless industry. Platforms can now be kept stationary in the upper atmosphere and serve as high-speed Internet gateways and relays for portable multimedia devices. Such stratospheric platforms have several economic and technology advantages as compared with either space or ground-based networks.

## 2 Stratospheric infrastructure

Stratospheric platforms will be deployed from lightly used airfields commencing in 1999. The platforms will consist of an extremely strong, lightweight, multi-layer skin containing buoyant helium-filled cells, a station-keeping system consisting of GPS and an advanced propulsion system, a telecommunications payload, integrated amorphous silicon solar panels for daytime power, and fuel cells for night-time power. Baseline platform characteristics of an example system are provided in Table 1.

Although stratospheric platforms are an old idea, they have only recently become practical through the development of station-keeping technologies. The enabling technologies are its propulsion system for station-keeping, GPS for accurate position-keeping, and ultra-thin fabric hulls for long duration buoyancy.

TABLE 5

**Stratospheric Platform Parameters (Example System)**

| | |
|---|---|
| Operating Altitude | 21-23 km |
| Lift at Altitude | 0.062 kg/m$^3$ |
| Hull Volume | 170 000 m$^3$ |
| Gross Lift at Altitude | 12.5 metric tons |
| Hull Area | 25 000 m$^2$ |
| Envelope Weight | 5 628 kg |
| Payload | 4 912 kg |
| Dimensions | 150 m by 50 m |
| Speed | 200 km/hour |
| Operating Frequencies | 47.2-47.5 GHz and 47.9-48.2 GHz |

A global network of domestically-operated stratospheric platforms is deployed in a population-based heterogeneous manner instead of the orbital dynamics-based homogeneous spacing of low-earth orbital satellites. Gateway earth stations connect each stratospheric platform to the public switched telephone network. Portable and fixed communication devices are used to send and receive digital information via the stratospheric platforms and gateway earth station. Channel speeds range up to 512 kbit/s for a portable 5 dBi antenna, and up to OC-3 (155 Mbit/s) for a fixed high gain antenna.

From the stratosphere, communication links of high-angles can be established across large land areas. For example, at 23 km altitude, links with 30° angles of elevation extend out to a radial distance of 50 km from the center of coverage. Throughout any urban area centered around a stratospheric platform, the angles of elevation exceed 50°. The footprint of each stratospheric platform is approximately 1 000 km in diameter to the coverage horizon.

Considerable effort has gone into ensuring the safety of stratospheric platforms. They are deployed from cleared airspace like the hundreds of high altitude balloons that are launched worldwide each day and they reach their stratospheric altitude within only a few hours. They then move under their own power through the stratosphere to fixed locations above metropolitan areas at altitudes high above all commercial and most military aircraft. Redundant safety systems prevent deflation and system failures and provide advance warning so that the platforms can be maneuvered to service centers or unpopulated areas for recovery and repair. Each platform will be subject to inspection, approval and regulation by aviation authorities such as the Federal Aviation Administration, ICAO, and national regulators in each administration.

## 3 Stratospheric telecommunications applications

Stratospheric platforms are designed with telecommunications technology capable of providing full duplex digital channels of from 64 kbit/s to 155 Mbit/s. At these speeds, full motion video conferencing and web TV applications can be supported at the low-end, and high-speed OC-3 LAN, MAN & WAN channels can be implemented at the high end. Generally, stratospheric platforms will enable a complete blending of digital telephony, computer and video information to be delivered to hand-held multimedia terminals, wireless local loop terminals and fixed wireless network rods. A list of stratospheric services is provided in Table 6.

TABLE 6

**Stratospheric Services**

| | |
|---|---|
| Digital Telephony, Fax and E-mail | 64 kbit/s |
| Full Motion Videophone Service | 256 kbit/s |
| High Speed Web Surfing, Web TV and File Transfers | 512 kbit/s-1.5 Mbit/s |
| E1, T3, OC-3 LANs, MANs, & WANs | 2.054 Mbit/s-155 Mbit/s |

Stratospheric transmissions can connect mobile or pocket telephones to desktop phones via millimeter wave transmission or conventional microwave bands. Similarly, laptop or notebook computers can transmit or receive information directly via a stratospheric platform, or connect through to a gateway ground station and the public switched telephone network (PSTN) to either cellular or desktop phones or databases such as the World Wide Web anywhere in the world. The stratospheric pocketphones and laptop PCs will need only 100 milliwatts of transmit power. In this way, the STS can become a developing nation's lowest-cost high-speed digital backbone.

One of the most common multimedia applications of STS technology will be for video telephony between two service subscribers in the same coverage areas. Here the STS overcomes the bandwidth limitations of traditional infrastructure that have impeded videophone to date.

Alternatively, two STS users can communicate with each other in different coverage areas via gateway groundstations and the PSTN. High-speed digital services will still be supported so long as the interconnection over the PSTN has adequate bandwidth, or so long as double or triple hopping via STS OC-3 gateways directly linking adjacent stratospheric stations are used.

It is also possible for communications to be maintained between an STS user and an STS non-user. Here the gateway ground station and PSTN serve to provide throughput compatibility. If the PSTN lacks adequate bandwidth or ATM switching capability, gateway ground stations can be used with different antennas inter-connecting multiple stratospheric platforms. This will enable stratospheric communicators in one coverage area to enjoy direct communications with stratospheric communicators in adjacent coverage areas, although a “last-leg” of PSTN must be used to connect the non-STS subscriber. By extension, entire continents can be interconnected by stratospheric platforms alone for long distance links, including transoceanic platforms interconnected by satellite or inter-platform laser transmission.

## 4 Stratospheric requirements

By general agreement, there are approximately 50 million Internet users in the world today. By 2005 it is expected that there will be 300 million people using Internet as a ubiquitous secure multimedia communications medium connecting businesses and homes for business, entertainment and educational applications. A large majority of these users can be expected to prefer high-speed wireless connections over low-speed wired connections.

It is widely recognized that more than half the people in the world have never placed a phone call. This stunning demonstration of the information gap between developed and developing countries requires a cost-effective solution that brings the developing countries high-speed channels (to close the gap) at affordable prices. Simply providing phone circuits to developing countries, while developed countries go broadband, will not close the gap. And the information gap cannot be closed at dollar per minute tariffs or with thousand dollar terminals. What is needed are flexible broadband channels, accessible via a $100 user terminal, and delivered to developing country markets for just a few cents a minute. These needs can be fully addressed with the unique stratospheric architectural advantages of large coverage area, close proximity to earth and low-cost technology.

## 5 The stratosphere's natural advantages

Stratospheric platforms have intrinsic advantages that enable STS to provide communications capacity to metropolitan areas at a low infrastructure cost per subscriber. A single platform can provide a metropolitan area with full duplex broadband service to more than one million subscribers. If the frequencies are divided into narrowband channels, a platform can provide basic telephone service to a substantially larger number of subscribers.

For example, an STS platform at 21 kilometers altitude using 300 MHz of bandwidth in each direction in the 47.2-47.5 and 47.9-48.2 GHz, and a 27.1 dBW EIRP, can generate 691 spot beams over an 80 km diameter coverage area with the great majority of users enjoying elevation angles ranging from 45 degrees to 90 degrees and all using elevation angles greater than 15 degrees. Assuming a frequency re-use factor of 9, the total metropolitan capacity of the system is 7.68 Gbit/s which can be directed to provide high-speed services to high density populations at a low cost, ideal for the developed and the developing world.

The STS should be located in the high millimeter wave band (47-48 GHz) because those frequencies are unoccupied worldwide, allocated to the Fixed Service, allow for condensed data packaging and small portable antennas, and are still below the atmospheric absorption peaks which stand from 49 GHz.

The STS at 47 GHz has the capability to satisfy the one billion household challenge for universal portable broadband service. The key to the high capacity of STS at 47 GHz is a super efficient frequency re-use communications architecture. Each stratospheric platform can generate up to 2 100 hexagonal cells which enables every seventh cell to reuse a frequency. Hence each stratospheric platform can reuse its frequency assignment 300 times.

The 300 times frequency re-use factor of STS at 47 GHz gives rise to a capacity to serve 1.5 billion simultaneous users with 64 kbit/s channels, assuming an average of 2.4 hours per day use, a 300 MHz link in each direction, one bit per hertz modulation, 250 worldwide platforms and use of 50 percent of the bandwidth for gateway links. Correspondingly larger or smaller numbers of users can be served with alternative network architectures.

## 6 Stratospheric implementation schedule

STS will begin deployment starting in 1999. At a deployment rate of one platform per week, 90 percent of the world's population could be covered by 2005. Most major cities would be covered by 2001. It is hard to imagine a more efficient means of achieving universal broadband service and thus closing the information gap. Estimates of platform and payload costs from international manufacturers are less than half of satellite system costs, due to the avoidance of rocket launch costs, resulting in a capital cost per subscriber of not more than $ 40 assuming 64 kbit/s channels.

Global roll-out of STS multimedia services can proceed quickly by focusing on new urban markets. Since the stratospheric platform footprint is as large as 1 000 km diameter, each urban market covered also brings multimedia service to a vast rural region as well. For developing countries, the STS at 47 GHz offers an unprecedented opportunity to leapfrog into broadband multimedia parity with the most economically developed states.

As early as 2003, every country in the world can expect to have at least partial coverage with stratospheric multimedia service. Countries can then roll-out stratospheric platforms to smaller markets within their borders as they deem most advisable. With the stratospheric telecommunications service, access to full multimedia information will be a birthright of peoples everywhere, from Africa to the Americas and from Asia to Europe.

## 7 Stratospheric regulatory issues

From a regulatory perspective, ITU and the domestic telecommunications authorities that have considered the matter have concluded that stratospheric services in the 47 GHz bands are best defined as a high density fixed service using stations located in the stratosphere. The service is high density because of the extraordinarily high number of communication circuits it can provide in a rather small, urban area. The technology creates a fixed service because most user terminals will be accessed through a fixed antenna. Another reason the STS has been considered a fixed service is because the platforms do not meet the definition of a space service and therefore must be a terrestrial service.

Each stratospheric system will operate within national airspace, not transnational outer space and, therefore, will be regulated as a domestic service by the country it serves. This will enable domestic authorities to regulate the frequency use and the system technology. However, in order for STS to be economically feasible in global application, stratospheric systems also require an international designation to enable worldwide compatibility of components and systems as well as investor confidence necessary to rapidly build-out the service.

An opportunity for global regulatory approval for STS will arise at the ITU's World Radio Conference beginning in October 1997. Certain proposals submitted to ITU by national authorities seeking a worldwide allocation in the 47 GHz bands for stratospheric services will be considered at WRC-97 under agenda item 1.9.6 which instructs the conference to "identify suitable frequency bands above 30 GHz for use by the fixed service for high density application." The CEPT, CITEL and APT regional telecommunications organizations have adopted common positions in favor of such an allocation. And, during 1996 and the first half of 1997, the United States, Italy, Australia, and Colombia submitted STS notifications to ITU. In July, 1997, the United States Federal Communications Commission released a Report and Order stating that it expects that the "predominant use" of the 47.2-48.2 GHz bands may be by STS systems.

Frequency management experts have selected and supported use of the 47 GHz band for stratospheric services because the bands are not being utilized, they comprise adequate bandwidth for every country to implement a national STS system, and stratospheric platforms provide high elevation angles to users which enable use of the bands despite high levels of atmospheric absorption. The high elevation angles of an STS distinguish it sharply from existing or proposed systems that employ low angles of elevation and long path lengths.

ITU has already reserved bands in the vicinity of 47 GHz band for broadcasting satellite service (BSS) feeder links. Those transmissions are compatible with STS because they are generally limited to a few remote earth stations with which coordination can be effected (there is now no existing BSS use of these bands).

## 8 Conclusion

A global stratospheric telecommunications system employing fixed platforms in the stratosphere could meet the world's demand for affordable high speed wireless communications.

APPENDIX 1

## List of Supplements to the ITU-T Recommendations

International Telecommunication Union – Telecommunications Standardization Bureau

## 1. Extracts from the List of the ITU-T Recommendations – April 1998

SERIES D

### General tariff principles

#### Supplements to the Series D Recommendations

**Suppl. 1 (11/88)** Cost and tariff study method

Blue Book Fascicle II.1

**Suppl. 2 (11/88)** Method for carrying out a cost price study by regional tariff groups

Blue Book Fascicle II.1

**Suppl. 3 (03/93)** Handbook on the methodology for determining costs and establishing national tariffs

44pp **E** 7508 **F** 7509 **S** 7510 22 CHF

**Suppl. 5 (10/84)** Modelling of an experimental test design for the determination of inexperienced user difficulties in setting up international calls using nationally available instructions, or to compare different sets of instructions

Red Book Fascicle II.2

**Suppl. 6 (11/88)** Preparation of information to customers travelling abroad

Blue Book Fascicle II.2

**Suppl. 7 (11/88)** Description of INMARSAT existing and planned systems

Blue Book Fascicle II.2

SERIES E

### Overall network operation, telephone service, service operation and human factors

#### Supplements to the Series E Recommendations relating to the operations of the international service

**Suppl. 1 (11/88)** List of possible supplementary telephone services which may be offered to subscribers

Blue Book Fascicle II.2

**Suppl. 2 (01/94)** Various tones used in national networks

30pp **E** 5529 **F** 5528 **S** 5530 15 CHF

**Suppl. 3 (11/88)** North American precise audible tone plan

This Supplement is also included in Q.100 series as Supplement 5

Blue Book Fascicle II.2

**Suppl. 4 (11/88)** Treatment of calls considered as “terminating abnormally”

This Supplement is also included in Q.100 series as Supplement 6

Blue Book Fascicle II.2

#### Supplements to the Series E Recommendations relating to telephone network management and traffic engineering

**Suppl. 1 (11/88)** Table of the Erlang formula

Blue Book Fascicle II.3

**Suppl. 2 (11/88)** Curves showing the relation between the traffic offered and the number of circuits required

Blue Book Fascicle II.3

**Suppl. 3 (10/76)** Information on traffic routing in the international network

See Supplement 7, Orange Book Fascicle II.2

**Suppl. 4 (10/76)** Use of computers for network planning and circuit group dimensioning

See Supplement 8, Orange Book Fascicle II.2

**Suppl. 5 (11/88)** Teletraffic implications for international switching and operational procedures resulting from a failure of a transmission facility

Blue Book Fascicle II.3

**Suppl. 7 (11/88)** Guide for evaluating and implementing alternate routing networks

Blue Book Fascicle II.3

SERIES F
## Non-telephone telecommunication services

### Supplements to the Series F Recommendations

**Suppl. 1 (11/88)** Definitions relating to telegraph, telematic and data transmission services

Blue Book Fascicle II.4

**Suppl. 2 (11/88)** Terms and definitions for telex

Blue Book Fascicle II.4

**Suppl. 3 (11/88)** Outline description of the INMARSAT standard-c system and the services it may support

Blue Book Fascicle II.4

SERIES G
## Transmission systems and media, digital systems and networks

### Supplements to Section 1 of the Series G Recommendations

**Suppl. 29 (03/93)** Planning of mixed analogue-digital circuits (chains, connections)

24pp **E** 4868 **F** 4867 **S** 4869 15 CHF

**Suppl. 31 (03/93)** Principles of determining an impedance strategy for the local network

7pp **E** 4662 **F** 4661 **S** 4663 11 CHF

**Suppl. 32 (03/93)** Transmission aspects of digital mobile radio systems

7pp **E** 4811 **F** 4810 **S** 4812 11 CHF

### Supplements to Sections 2 to 5 of the Series G Recommendations

**Suppl. 4 (12/72)** Certain methods of avoiding the transmission of excessive noise between interconnected systems

Green Book Volume III.2, page 572

**Suppl. 5 (10/84)** Measurement of the load of telephone circuits under field conditions

Red Book Fascicle III.2, page 295

**Suppl. 6 (12/72)** Example showing how the total value of line noise specified for the hypothetical reference circuit on open-wire lines might be broken down into its various components

Green Book Volume III.2, page 589

**Suppl. 7 (12/72)** Loss-frequency response of channel-translating equipment used in some countries for international circuits

Green Book Volume III.2, page 590

**Suppl. 8 (12/72)** Method proposed by the Belgian telephone administration for interconnection between coaxial and symmetric pair systems

Green Book Volume III.2, page 591

**Suppl. 9 (12/72)** Roll effect in coaxial pair systems

Green Book Volume III.2, page 592

**Suppl. 13 (10/76)** Noise at the terminals of the battery supply

Orange Book Fascicle III.3, page 664

**Suppl. 17 (10/84)** Group-delay distortion performance of terminal equipment

Red Book Fascicle III.2, page 311

**Suppl. 22 (10/84)** Mathematical models of multiplex signals

Red Book Fascicle III.2, page 326

**Suppl. 26 (10/84)** Estimating the signal load margin of FDM wideband amplifier equipment and transmission systems

Red Book Fascicle III.2, page 344

**Suppl. 27 (10/84)** Interference from external sources

This Supplement is also published as G.900 series supplement in Red Book fascicle III.3

Red Book Fascicle III.2, page 346

### Supplements to Section 6 of the Series G Recommendations

**Suppl. 11 (11/88)** Data on cable ships and submersible equipments of various countries

Blue Book Fascicle III.3

**Suppl. 18 (10/84)** Information on submarine cables used in deep water

Red Book Fascicle III.2, page 313

**Suppl. 19 (10/84)** Digital crosstalk measurement (method used by the Administrations of France, the Netherlands and Spain)

Red Book Fascicle III.2, page 326

**Suppl. 33 (11/88)** Examples of fibre design guidelines (diagrams used in Japan and in the United Kingdom)

Blue Book Fascicle III.3

### Supplements to Section 7 of the Series G Recommendations

**Suppl. 28 (10/84)** Application of transmultiplexers, FDM codecs, data-in-voice (DIV) systems and data-over-voice (DOV) systems during the transition from an analogue to a digital network

Red Book Fascicle III.3, page 397

**Suppl. 31 (11/88)** Status of work of presently considered digital circuit multiplication equipment (DCME) documents

Blue Book Fascicle III.4

**Suppl. 32 (11/88)** Transfer of alarm information on 60-channel transmultiplexing equipment

Blue Book Fascicle III.4

### Supplements to Sections 8 and 9 of the Series G Recommendations

**Suppl. 15 (10/76)** Almost-differential quasi-ternary code (ADQ code)

Orange Book Fascicle III.3, page 673

**Suppl. 27 (10/84)** Interference from external sources

This Supplement is also published as G.500 series supplement in Red Book fascicle III.2

**Suppl. 34 (11/88)** Temperature in underground containers for the installation of repeaters

Blue Book Fascicle III.5

**Suppl. 35 (11/88)** Guidelines concerning the measurement of wander

Blue Book Fascicle III.5

**Suppl. 36 (11/88)** Jitter and wander accumulation in digital networks

Blue Book Fascicle III.5

SERIES H

## Audiovisual and multimedia systems

### Supplements to the Series H Recommendations

**Suppl. 5 (10/84)** Measurement of the load of telephone circuits under field conditions

Red Book Fascicle III.2, page 295

**Suppl. 16 (10/84)** Out-of-band characteristics of signals applied to leased telephone-type circuits

Red Book Fascicle III.4, page 191

SERIES M

## Maintenance: international transmission systems, telephone circuits, telegraphy, facsimile and leased circuits

### Supplements to the Series M Recommendations

*Technical information*

**Suppl. 1.1 (12/72)** Prefixes used in the decimal system

Green Book Fascicle IV.2, page 409

**Suppl. 1.2 (12/72)** Transmission measurement conversion tables

Green Book Fascicle IV.2, page 409

**Suppl. 1.3 (12/72)** The normal (or Laplace-Gauss) distribution

Green Book Fascicle IV.2, page 416

**Suppl. 1.4 (12/72)** Methods of quality control

Green Book Fascicle IV.2, page 422

**Suppl. 1.5 (12/72)** Mathematical processing of the measurement results of the variations of the overall loss of telephone circuits

Green Book Fascicle IV.2, page 451

**Suppl. 1.6 (12/72)** Statistical theory requirements

Green Book Fascicle IV.2, page 459

*Measuring techniques*

**Suppl. 2.1 (12/72)** Some general observations concerning measuring instruments and measuring techniques

Green Book Fascicle IV.2, page 463

**Suppl. 2.2 (12/72)** Measurements of loss

Green Book Fascicle IV.2, page 471

**Suppl. 2.3 (12/72)** Level measurements

Green Book Fascicle IV.2, page 475

**Suppl. 2.4 (12/72)** Measurement of crosstalk

Green Book Fascicle IV.2, page 480

**Suppl. 2.5 (12/72)** Measuring errors and differences due to impedance inaccuracies of instruments and apparatus. Use of decoupled measuring points

Green Book Fascicle IV.2, page 482

**Suppl. 2.6 (12/72)** Errors in the indications given by level-measuring instruments due to interfering signals

Green Book Fascicle IV.2, page 489

**Suppl. 2.7 (12/72)** Measurement of group delay and group-delay distortion

Green Book Fascicle IV.2, page 492

**Suppl. 2.8 (12/72)** Measurement of sudden phase changes on circuits

Green Book Fascicle IV.2, page 508

**Suppl. 2.9 (12/72)** Vibration testing

Green Book Fascicle IV.2, page 511

**Suppl. 2.10 (12/72)** Method for measuring the frequency shift introduced by a carrier channel

Green Book Fascicle IV.2, page 522

**Suppl. 2.11 (11/88)** Rapid verification test for echo control devices

Blue Book Fascicle IV.3

**Suppl. 2.12 (12/72)** An automatic data acquisition and effective processing procedure for group and supergroup pilot levels

Green Book Fascicle IV.2, page 524

**Suppl. 2.13 (10/76)** Loop method for the maintenance of 4-wire telephone-type leased circuits

Orange Book Volume IV.1, page 267

**Suppl. 2.14 (10/76)** Automatic measuring device for carrier systems with a large number of channels

Orange Book Volume IV.1, page 268

**Suppl. 2.15 (10/76)** Detection of circuit faults

Orange Book Volume IV.1, page 275

**Suppl. 2.16 (11/88)** Receiving relative levels at renters' premises for international leased circuits used for data transmission

Blue Book Fascicle IV.3

**Suppl. 2.17 (11/88)** Results of an investigation of the service availability performance of international leased circuits made in 1982

Blue Book Fascicle IV.3

*Transmission performance of the international network*

**Suppl. 4.1 (11/80)** Stability of overall loss and psophometric noise: results of routine maintenance measurements made on the international network during the first half of 1978

Yellow Book Fascicle IV.3, page 68

**Suppl. 4.2 (11/80)** Results and analysis of the 10th series of tests of short breaks in transmission

Yellow Book Fascicle IV.3, page 80

**Suppl. 4.3 (12/72)** Characteristics of leased international telephone-type circuits

Green Book Fascicle IV.2, page 564

**Suppl. 4.5 (12/72)** Instructions for making future measurements of the transmisison quality of complete connections for recording the results of the measurements

Green Book Fascicle IV.2, page 569

**Suppl. 4.6 (12/72)** Instructions for making future measurements of the transmission quality of national extensions (excluding subscriber's local lines) and for recording the results of the measurements

Green Book Fascicle IV.2, page 580

**Suppl. 4.7 (12/72)** Instructions for making future measurements of the transmission quality of international circuits and international centres and for recording the results of the measurements

Green Book Fascicle IV.2, page 582

**Suppl. 4.8 (12/72)** Results and analysis of tests of impulsive noise

Green Book Fascicle IV.2, page 593

**Suppl. 4.9 (10/76)** Weighting of measurements relating to the stability of circuits in the international network according to the size of circuit groups

Orange Book Volume IV.1, page 283

**Suppl. 4.10 (11/80)** Transient analogue circuit impairments and their effect on data transmission

Yellow Book Fascicle IV.3, page 86

*Miscellaneous*

**Suppl. 6.1 (12/72)** Effect on maintenance of the introduction of new components and of modern equipment design

Green Book Fascicle IV.2 page 620

**Suppl. 6.2 (11/88)** New operation and maintenance organization in the Milan Italcable intercontinental telecommunications centre

Blue Book Fascicle IV.3

SERIES N

## Maintenance: international sound programme and television transmission circuits

### Supplements to the Series N Recommendations

**Suppl. 5.2 (11/88)** Setting-up and testing of international videoconference studios

Blue Book Fascicle IV.3

SERIES O
## Specifications of measuring equipment

### Supplements to the Series O Recommendations

**Suppl. 3.1 (11/88)** Measuring instrument requirements – Sinusoidal signal generators and level-measuring instruments
Blue Book Fascicle IV.4

**Suppl. 3.2 (12/72)** Noise measuring instruments for telecommunication circuits
Green Book Fascicle IV.2, page 534

**Suppl. 3.3 (12/72)** Principal characteristics of volume indicators
Green Book Fascicle IV.2, page 548

**Suppl. 3.4 (10/76)** Consideration of interworking between different designs of apparatus for measuring quantizing distortion
Orange Book Volume IV.2, page 85

**Suppl. 3.6 (11/88)** Crosstalk test device for carrier-transmission on coaxial systems
Blue Book Fascicle IV.4

**Suppl. 3.7 (11/88)** A measuring signal (multitone test signal) for fast measurement of amplitude and phase for telephone type circuits
Blue Book Fascicle IV.4

**Suppl. 3.8 (11/88)** Guidelines concerning the measurement of jitter
Blue Book Fascicle IV.4

SERIES P
## Telephone transmission quality, telephone installations, local line networks

### Supplements to the Series P Recommendations

**Suppl. 3 (03/93)** Models for predicting transmission quality from objective measurements
105pp **E** 5153 **F** 5217 **S** 5253 38 CHF

**Suppl. 11 (12/94)** Some effects of sidetone
5pp **E** 6178 **F** 6177 **S** 6179 8 CHF

**Suppl. 20 (03/93)** Examples of measurements of handset receive-frequency responses: dependence on earcap leakage losses
5pp **E** 4844 **F** 4843 **S** 4845 8 CHF

**Suppl. 23 (02/98)** ITU-T coded-speech database
This Supplement includes 3 CD-ROMs
To be published...

SERIES Q
## Switching and signalling

### Supplements to the Series Q.100 Recommendations

**Suppl. 1 (12/72)** Report on the energy transmitted by control signals and tones
Green Book Fascicle VI.4

**Suppl. 2 (11/88)** Characteristics of speech interpolation systems affecting signalling
Blue Book Fascicle VI.1

**Suppl. 3 (11/88)** Information received on national voice-frequency signalling systems
Blue Book Fascicle VI.1

**Suppl. 4 (11/88)** Various tones used in national networks
This Supplement is published in E.100 series as Supplement 2

**Suppl. 5 (11/88)** North American precise audible tone plan
This Supplement is published in E series as Supplement 3

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