REPORT ITU-R BT.2025

# PROGRESS ON DEVELOPMENT AND IMPLEMENTATION OF INTERACTIVITY IN BROADCASTING SYSTEMS AND SERVICES

(Question ITU-R 256/11)

(2000)

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**Foreword**

This Report is a compilation of contributions of members of Radiocommunication Task Group 11/5 from the inauguration of that Task Group in 1997 to its merger with JTG 10-11 in February 2000 to form Joint Working Party 10-11M. It charts the progress of the development and implementation of Interactive Broadcast systems and services throughout the last three years of the 20th century. Whilst some of the contributions are three years old at the time of compiling this Report, it does in fact provide a brief history of the start-up of Interactive Services.

The Report is in five main parts: General Introduction, Europe, North America, Asia-Pacific region and Spectrum Considerations. Since this Report provides an overview of interactive television services in various regions of the world, some repetition may result in order to present a thorough description of the situation in each country of interest.

# 1 Interactivity in broadcasting services

## 1.1 Introduction

Multimedia featuring various presentational possibilities and interactive viewing is rapidly growing in the fields of telecommunications and computing. In telecommunications, interactivity is effected by two-way transmission facilities. Computers and package media achieve interactivity using data stored in the memories of their terminal. Broadcasting services have so far been marked by real-time, one-way transmission and passive viewing only.

Communications networks will be used for new broadcasting services that need an up-link from the viewer to the broadcasting station. TV programmes will increase in number and be separated into those received passively and those that the consumer can receive interactively. A receiver will be provided with a HDTV display and a server so that the viewer can easily operate it through personal filters and software agents.

This Report discusses interactivity in the broadcasting system, mainly based on one-way transmissions, as well as its effectiveness in broadcasting services. First, usage, implementation and required functions for introducing interactivity to broadcasting services are discussed. The practicality of interactive services in one-way broadcasting transmission is clarified.

## 1.2 What is interactive viewing?

Interaction and two-way information transmission, as offered by a telephone conversation, almost offer “face-to-face” services across remote places beyond spatial limits. In information offering services, a viewer enters their response while watching the information presented. Subsequent information is displayed according to the response entered. Such repeated presentations and responses enable viewers to obtain information as if they were conversing with the sender of the information. This process, generally called interactivity, is one of the important functions for achieving information services that are user friendly to the viewer and easy to operate with no particular training.

Interactive viewing is defined as viewing broadcasting or information services in which information presented is interactively altered in response to viewer’s choices. Table 1.1 gives a comparison of interactivity among different media. Interactivity in this context includes a case with some time-lag and some inequality in the presentation method and content of information between senders and viewers, which is not the case with telephony interactivity. That is, a viewer’s response is given as a choice among some of the items presented; the method and the presentation of the information content depend on the given transmission capacity and the coding used in the broadcasting system. Interactivity which is similar to that in telecommunication media can be ensured with a system consisting of two-way Cable Television (CATV) and/or telephone transmission lines or other alternative media (satellite, terrestrial, microwaves, etc). On the other hand the one-way transmission system specific to the broadcasting field, when used alone, will adopt a different system configuration from those media mentioned above to achieve interactivity.

## 1.3 Functions required for interactive broadcasting services

The following functions are desirable for interactive broadcasting services:

a) the display in use should have a resolution capable of displaying information with a sufficient visibility to obtain better responses from the viewer;

b) access and use of information is easy to understand for the viewer to give a response;

c) subsequent information that is responsive to the viewer’s choice is specified with link data. Programme producers have control over a broad range of link destinations of linked data;

d) information from the viewer can be sent through public switched telephone network (PSTN)/integrated services digital network (ISDN), CATV or other media (terrestrial, satellite, etc), depending on system requirement.

TABLE 1.1

**Interactivity in each media**

| Media | Class of interaction | Features |
|---|---|---|
| Telecommunication | Strong interaction<br>(Two-way transmission) | One-to-one communication<br>Real-time response<br>Call loss with traffic limitation |
| Broadcasting | Strong interaction<br>(Asymmetrical two-way transmission: return request by viewer) | One-to-many communication<br>Real-time response |
| | Medium Interaction<br>(Asymmetrical two-way transmission: return request by broadcaster) | One-to-many communication<br>Non-real-time response |
| | Weak interaction<br>(One-way transmission + off-line return channel) | One-to-many communication |
| | Interaction w/o return channel<br>(One-way transmission + Home server) | One-to-many communication<br>Real-time response |
| Package | Interaction w/o return channel<br>(Large read only memory) | Stand-alone system at user side<br>Real-time response with receiver |

In item a), resolution requirements depend on the service used. It would be practical to use a display device which has been or may be widely used as a home terminal unit such as a high definition television (HDTV) set to keep the terminal cost as low as possible. In terms of human interfaces in b), it is necessary to allow viewers to select appropriate ones when their preferences are diverse. Item c) is important to minimize restrictions when producing programmes of interactive multimedia information to achieve a greater variety of programmes.

## 1.4 Modes of interactivity in broadcasting

In various broadcasting services including existing media such as television and those which will be available in the future, there are many modes of interactive viewing. They can be divided into three major categories in terms of interactivity: channel selection, stepped viewing and participation:

– Channel selection

The viewer switches between existing multiple broadcast channels using the TV receiver’s channel selector. Programmes are viewed which have been produced with no intention for interactivity. “Zapping” is an example of this mode of use.

– Stepped viewing (stepped development of information)

A series of programmes designed to be presented step-by-step are received by viewers so that they can give a response at each step. This is the case with TV-related information services and multimedia information services such as TV newspapers.

– Participation

The programme information sent from a broadcasting station is changed in real-time by responding to the inputs from viewers. That is, the viewer participates in programme production. This viewing mode includes the case of a request programme accepting postcard and telephone requests when assuming a very long time-lag. If, however, a certain real-time factor is considered as a prerequisite for this viewing mode, it is essential to use an uplink from the viewer to the broadcast station.

Each of the major categories is divided into more than one mode of viewing with their proper facilities. One of the facilities is a viewer-controlled programme reproduction timing, which allows the viewer to change viewing timings freely, such as pause, review and fast-forward when viewing of the programme. Another one is a service including a telecommunications facility, through which the receiver gives a purchase order command for a product chosen from items presented by the programme as in tele-shopping. Table 1.2 summarizes the modes for the interactive viewing in broadcasting.

TABLE 1.2

**Modes of interactivity in broadcasting**

| Major categories for modes of interactive viewing | Programme type | Programme changed by users responses | Programme reproduction timing | Command transmission via a network | Examples of broadcasting services |
|---|---|---|---|---|---|
| Channel Selection | Not interactive | Not changed | Not controllable | Not available | TV channel selection |
| | Not interactive | Not changed | Controllable | Not available | Any time video<br>Video on demand (VOD) |
| Stepped Viewing | Interactive | Not changed | Controllable | Not available | TV newspaper<br>News on demand (NOD) |
| | Interactive | Not changed | Controllable | Available | Shopping with TV Information (tele-shopping) |
| Participation viewing | Interactive | Changed | Not controllable | Available | Debate programme including real-time questionnaires survey |
| | Interactive | Changed | Controllable | Available | Auction of used car |

## 1.5 Actual interactivity in broadcasting services

Development of interactive broadcasting has been carried out mainly with CATV [Namba, 1979] although there are fruitful experiences in satellite and terrestrial environments. The services such as VOD, NOD and tele-shopping are subjects of experiments using the two-way CATV networks. Conversely, conventional broadcasting using terrestrial and satellite signals basically adheres to one-way transmission. This results in features unique to the broadcasting system which allow a large number of unspecified viewers to enjoy high-quality programmes at a lower cost without call loss. Other features of traditional broadcasting lie in that it allows real-time transmission and carefree viewing while doing something else. To implement interactivity while taking advantage of those features of broadcasting there are three different broadcasting system configurations, one being selective or stored reception via a one-way broadcasting and the other being two-way transmission. The basic configurations of such broadcasting systems [Namba, 1979; Isobe *et al.*, 1995], are shown in Fig. 1.1.

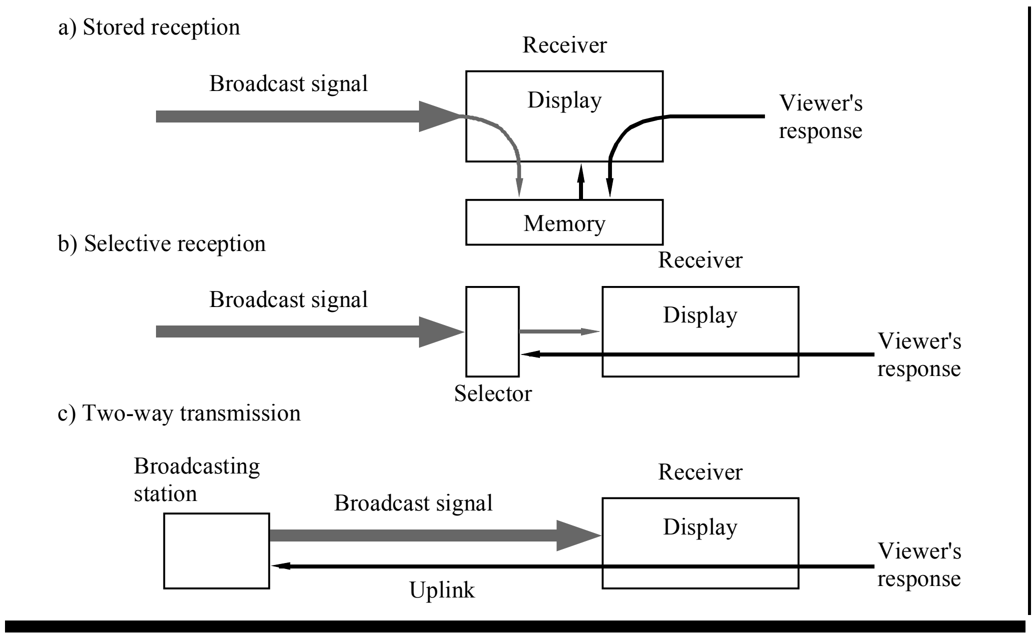
Figure 1.1a) shows the basic configuration for stored reception which is categorized as “Interaction without return channel”. All broadcasted data of a specific programme are temporarily stored in the receiver’s memory. Viewers can view the programme interactively using these stored data. The quality of interactivity depends on the storage capacity of the receiver.

Figure 1.1b) shows the way selective reception, which is categorized as “Weak interaction”, is performed. A number of content units are repeatedly broadcast so that the viewer can receive the programme selectively. This configuration is suitable for real-time services. The quality of interactivity depends on transmission capacity.

Figure 1.1c) is a configuration using two-way transmission which is categorized as “Strong interaction”. Requests and responses of a viewer are transmitted to the broadcasting station through an uplink so that they can receive the programme interactively. It is difficult with the existing broadcasting scheme to implement two-way transmission which takes advantage of the feature of broadcasting whereby a programme and its cost can be shared among many people. If the return channel is requested by broadcaster, the configuration is categorized as “Medium interaction”. In this class, the return channel is used for collecting service-related data such as view-log data.

FIGURE 1.1

**Configuration of an interactive reception**

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The relationship between these system configurations and the viewing modes above is summarized in Table 1.3.

TABLE 1.3

**Viewing modes and system configurations**

| Viewing modes of interactivity | Stored reception (interaction w/o return channel) | Selective reception (weak interaction) | Two-way: return request by broadcaster (medium interaction) | Two-way: return request by viewer (strong interaction) |
|---|---|---|---|---|
| Channel selection | O | O | O | |
| Stepped viewing | O | O | O | O |
| Participation viewing | | | | O |

### 1.6 Conclusion

Interactivity in broadcasting services is studied in terms of required functions, modes and methods. The practicality of interactive services in one-way broadcasting transmission is clarified. When introducing interactivity into broadcasting, it seems essential to ensure stepped viewing of one-way transmitted information by means of real-time selective reception or stored reception.

## 2 Europe

### 2.1 Progress of interactive digital television services in Europe (1997)

Recently several solutions have been studied to implement an Interactive TV service; most of them were based on analogue TV to which interactivity features were added mainly using PSTN telephone lines to collect users' data. The recent advent of digital TV in Europe has significantly modified possible scenarios for application of interactivity to TV services.

The need to respond to the demand for a common solution for the provision of Digital TV interactive services led to several European collaborative advanced communications technologies and services (ACTS) projects supported by the European Commission, INTERACT, DIGISAT and S3M. The objectives of the INTERACT studies include the characterization of the return channel for both digital cable and terrestrial networks, and the design and construction of a prototype for terrestrial return channel signaling. On the other hand, the DIGISAT and S3M projects were oriented to characterize and implement a prototype of satellite return channel system for the provision of interactive services associated to digital video broadcasting (DVB) technology for individual and collective users (satellite master antenna television, SMATV).

The more recent advances from the Interact, DIGISAT and S3M projects are reported below.

During October 1997, INTERACT carried out preliminary over-air tests using the prototype Synchronous FDMA (SFDMA) equipment. The UHF return channel transmitter was located inside a building at the Centre Commun d'Etudes de Télédiffusion et Télécommunications (CCETT) in Rennes, France, and the return channel signals were received at a distance of 30 km at the St Pern high-power UHF broadcast site. Successful reception was achieved when transmitting the return channel signals from a domestic rooftop Yagi aerial, and furthermore reception was also shown to be possible when transmitting from a portable indoor antenna.

The demonstrator was prepared for field testing in early 1998 at DVB-T host sites in France. A detailed description of this Field Trial Facility has been prepared (INTERACT ACTS Deliverable DE009 – Establishment of Field Trial Facility). Theoretical studies were also commenced in order to determine how many users could be supported by the overall system.

The ACTS Interactive Terrestrial Television Integration Project, "iTTi", carried out detailed system integration studies over an 18 month period starting in spring 1998. This new project also included new partners with expertise in silicon development, and was expected to provide accurate estimations of the complexity and costs of the interactive set-top box and network equipment.

Thus standardization of the SFDMA system was postponed whilst awaiting completion of the existing and proposed new studies. The results of these studies were to be submitted for consideration by the DVB project and any standardization activity that might in due course follow would take place only if the DVB project decided to adopt the system.

### 2.2 Overview of interactive digital television services in Europe (1998)

This Report deals with a general overview of the activity undertaken in Europe concerning experiments and trials aimed at the introduction of interactive TV in the digital domain.

A short reference to activity that was undertaken by the former Digital Audio Visual Council (DAVIC) organization is also reported.

#### 2.2.1 Differences in national environments

The introduction of digital broadcasting services in Europe has exposed clear differences between countries. The pressure to introduce digital services has come mainly from pioneering operators who have started services to fill gaps that have been identified in the broadcasting market in particular countries. There has been no simple pattern of introduction, and although a number of digital satellite services were expected to commence in 1995, they were all subsequently delayed, for a number of reasons.

Once formally launched, the market for digital satellite services has been particularly successful and competitive in France, where historically there was little analogue satellite penetration. Three services are offered from Canal+ (Canal Satellite), TPS (Television par Satellite) and AB Sat. This compares with a much lower number of installations of digital satellite receivers in Germany over a similar period of time. Two factors which clearly differentiate between Germany and France are the very different levels of investment in cable and the existing offer of analogue programming by satellite. In Germany, Deutsche Telekom has installed cable facilities massively over the last ten years to reach more than 80% of the population and all terrestrial national and regional programmes are offered in simultaneous broadcast by satellite.

In the United Kingdom, analogue satellite services have been earning significant revenues for the major operator BSkyB, and it could be argued that early announcements of impending digital satellite service launches would have had an adverse destabilizing effect on analogue set-top box and subscription sales. In the event, BSkyB plans to launch digital services on Astra 2A were delayed until autumn 1998. This new launch date may be linked more closely with the competition expected from digital terrestrial television services in late 1998, rather than to simple consumer demand. The launch plans for digital satellite in the United Kingdom included a significant element of interactivity, and are notable by the creation of a strategic alliance known as BIB (British Interactive Broadcasting) formed from BSkyB with the telecom operator BT, a bank, and a consumer manufacturer.

## 2.3 Planned services by country

### 2.3.1 The Digital TV Market in Germany

At the beginning of 1996 there were two consortia intending to compete in the German digital TV market. These were the “Multimedia Betriebsgesellschaft” (MMBG) lead by Bertelsmann AG on the one hand and the Kirch Group on the other. The latter plays a major role in television production, its distribution and licensing in Germany and other European countries.

Both of the two competitors had started to develop a set-top box (MMBG: “media box”, Kirch: “d-Box”) under their own license. Very soon it was clear that these set-top boxes would be incompatible with each other. This incompatibility arose from different types of conditional access verification methods that were used in the boxes. The conditional access systems used were the SECA system for the media box and the Irdeto system for the d-Box. Although two set-top boxes in the market being incompatible with each other would obviously hinder the introduction of digital TV services in Germany an agreement between the competitors could not be reached. Rather than intensifying their efforts to find a compromise each of the two competitors tried to find national and international partners to consolidate their position in the market.

#### 2.3.1.1 DF1 – Das Digitale Fernsehen

On 28 July, 1996 the Kirch Group launched its services under the name of “DF1 – Das Digitale Fernsehen” with the transmission of the Formula 1 “Grand Prix” at Hockenheim/Germany. At that time there were very few set-top boxes available giving a very limited circle of consumers the ability to receive that motor race digitally. Nevertheless it seemed that the fact of being the first in the market had brought the Kirch Group into the leading market position.

In the first two months of service of the Kirch Group’s digital programmes about 5 000 decoders had been sold. Approximately the same number of users had subscribed to one of the offered service packages. At the end of 1996 about 20 000 people had subscribed to the DF1 pay-TV services, much less than previously expected. The predicted number (estimation made before the launch of services) of subscribers amounted to 200 000 until the end of 1996, to 1 700 000 by the end of 1997 and to 2 000 000 by the year 2000. According to DF1 officials this over-estimation was mainly due to two wrong assumptions: on the one hand DF1 had expected to get their services onto cable networks very soon, and on the other hand the successful analogue pay-TV programme “Premiere” was to be “digitized” and integrated in the DF1 services, but this did not happen. Although the estimated figures were not achieved the Kirch Group tried to strengthen its market position in the following months by contracting new partners. These were, amongst others, Warner Bros., Disney/ABC International TV, Columbia TriStar International Television and MCA. Moreover talks between Deutsche Telekom AG and the Kirch Group concerning the distribution of Kirch’s programmes via cable networks of Deutsche Telekom AG had started. However, until mid 1997 very little progress had been made concerning any kind of agreement between those two companies. This may have been due to several reasons, but one main point of argument was the billing system which both of them would have been keen to control. Finally in the beginning of July 1997 an agreement with Deutsche Telekom AG was reached.

#### 2.3.1.2 Other Competitors

##### 2.3.1.2.1 MMBG

In contrast to the growth of the Kirch Group and its partnerships, several partners left the MMBG. One of these was Deutsche Telekom AG who said that they would prefer to offer their networks independently to every competitor. The MMBG's original intention to launch their digital TV services in autumn 1996 could not be achieved. Considering the agreement between Deutsche Telekom AG, CLT-UFA and the Kirch Group, the MMBG was effectively overtaken by events.

##### 2.3.1.2.2 Premiere

"Premiere" was the first programme service operator to offer analogue pay-TV services in Germany. Their subscribers reached about 1 million in number during recent years. During the last months Premiere offered their subscribers an exchange of their analogue Set-Top Box (STB) for the digital media box. This offer was limited to 30 000 pieces (20 000 satellite and 10 000 cable STBs) although there were requests from more than 55 000 subscribers. The available STBs that had been produced by Philips were given away on a "first come - first served" basis. Subscribers had to pay a monthly hire charge of DM 10 (≈ 5.3 ECU) for their STB, whereas the monthly rate for the services remained unchanged (DM 40 ≈ 21.2 ECU) in comparison to the analogue programmes that were already being distributed. From the beginning of September 1997 the monthly hire charge for the digital STBs was to be doubled.

The new STB allowed subscribers to access the channel "Premiere zwei" and four additional pay-per-view channels where sports, cinema and music programmes were offered. The new services were to start on 15 February 1997.

At the beginning of 1997 Premiere sued DF1 for the marketing of their services all over Germany. In their view DF1 had permission for broadcasting only to Bavaria but not for the whole country. This complaint was granted at first instance but was later dismissed by a higher court. This action seems to be rather surprising since DF1 held 37.5% of the Premiere shares, but may be explained by taking into account that Bertelsmann AG held the majority of the shares.

##### 2.3.1.2.3 Free-to-air offers

Other providers in Germany that offer their digital programmes without additional payment: for example the German public broadcasting companies such as ARD and ZDF broadcast their programmes digitally via satellite. To support these services there was a demand from these operators for a very cheap (200-300 DM) STB without any conditional access and billing features. Such set-top boxes were being developed from early 1997 by several consumer electronics manufacturers in Germany with the help of the Institute for Communications Technology (IRT).

Deutsche Telekom AG (DTAG) had been preparing its networks for the broadcasting of digital TV services: in four German metropolitan areas digital fibre feed systems for trial purposes were due to be built by Robert Bosch GmbH on behalf of DTAG. These feeding systems would provide some million households with DVB programmes. Every connected household would be able to receive up to 150 digital programmes on condition that the household possessed a STB.

#### 2.3.1.3 Market assessment (early 1997)

According to research carried out in early 1997 by the TV Strategy Group, 57% of German respondents polled would not spend more money on new media services, and a very high proportion (89%) would definitely not buy a digital decoder for DM 1 000 (530 ECU) on top of a monthly subscription charge to receive digital services. Another research institute (Prognos) also assessed the chances of success for digital TV in Germany more pessimistically than two years previously.

According to them only about 1.1 to 1.9 million households (i.e. 3-5%) would be able to receive digital TV services by the end of the year 2000. The reason for this pessimistic view was that full availability of digital TV would not be reached before autumn 1997 and that the spending power of the German consumer had grown less than expected. A higher market penetration could only be reached if Premiere succeeded in equipping as many of their subscribers as possible with digital STBs. It was also noted that DF1 had missed by a wide margin their marketing goals.

#### 2.3.1.4 Change of strategy

In spring 1997 there was a request by DF1 to raise a rather high loan from a Bavarian fund. This request had already been granted but after it was made public there was a lot of criticism by the German public which finally led to the renunciation of the loan by DF1.

Although DF1 did not use the loan, but only made a request for it, this request and the number of "missing" subscribers made it more and more obvious that the current marketing strategy of DF1 was unlikely to succeed in the German pay-TV market.

As a consequence talks between the Kirch Group, Bertelsmann AG and Deutsche Telekom AG had been intensified resulting in an initial agreement between the Kirch Group and CLT-UFA (the biggest broadcasting company in Europe, owned by Bertelsmann AG by 49%) at the end of June 1997. On condition that national and international anti-trust and media laws would not forbid the planned cooperation, CLT-UFA and the Kirch Group would work together concerning the following items:

– In agreement with CanalPlus, the third shareholder of pay-TV programme Premiere, CLT-UFA and the Kirch Group would raise their number of Premiere shares to 50% each. This would be related to the expansion of digital services by Premiere. The Kirch Group would provide Premiere with the required movie material.

– In favour of a fast market introduction, the “d-Box” (developed by Beta Research, a subsidiary of the Kirch Group) was chosen as the platform via which digital programmes of the co-operating partners could be received. The partners considered the operation of up to 50 digital programmes and additional Pay-per-View services to be viable not only in technical but also in economical terms.

– Both of the partners declared that they were willing to deliver the required conditional access related data via the cable network of Deutsche Telekom AG with which talks had already started. These talks led to a second agreement between Deutsche Telekom AG, CLT-UFA and the Kirch Group which comprised the following items:

  – Deutsche Telekom AG would operate the technical platform for the distribution of digital TV programmes in their cable networks which explicitly included the conditional access system. This would ensure that their cable networks would be offered to all content providers (including public broadcasters like ARD and ZDF) without discrimination or other arbitrary limitations and that “every” household would be able to access their content via a digital set-top box.

  – Deutsche Telekom AG would provide an electronic programme guide (EPG) independent of any content provider.

  – The chosen standard for the conditional access system would be that of the “d-Box” developed by Beta Research. Because of the dominant market position of these three partners this of course means that any other competitor in the German set-top box market would have to be compliant to that specification which would become a de-facto standard!

  – In order to have a common standard (at least as far as the conditional access system is concerned) for the cable and satellite market, the three partners agreed to a new division of the shares of Beta Research (so far owned 100% by the Kirch Group): every partner would then hold a third of all shares.

  – Deutsche Telekom on the one hand, and the Kirch Group and CLT-UFA on the other hand, reached an agreement concerning the fee that the latter had to pay to DTAG for the distribution of their signals in DTAG’s cable network. This payment consisted of an annual fee (about DM 9 million per channel in the beginning increasing to about DM 19 million per channel later on) plus a percentage of the content providers’ turnover.

  – CLT-UFA and the Kirch Group would probably need (and get) seven digital channels in the hyperband. (For ARD and ZDF four channels were foreseen altogether whereas RTL, Sat 1 and Pro 7 would have to share two channels.)

When publishing this agreement DTAG also announced that they would provide two additional analogue channels in the hyperband for a transition period until end of 1998. Furthermore DTAG would raise the price for the cable connection by 15% (to almost DM 26 per month per household) in the autumn. DTAG justified this not only by the expansion of the services but also by the introduction of VAT payment duty to the former state company, Deutsche Telekom.

The agreement between the three partners was not welcomed by everybody in Germany. Representatives from the anti-trust commission had already indicated that this agreement might have difficulties in passing through their authorities. Moreover ANGA (German union of private cable operators) also criticised the planned cooperation and the underlying agreement, citing the following reasons:

Deutsche Telekom AG could only reach one third of all cabled households in Germany via their access networks. Hence the agreement being made did not consider two thirds of all cabled households which were mainly served by ANGA. Although the majority of end users therefore depend on ANGA access networks, ANGA’s position had not been considered during negotiations between DTAG, CLT-UFA and the Kirch Group. According to ANGA it was quite obvious that a neutral (in terms of programmes and services) platform for digital TV could only be established when the conditional access system was run by all network operators and not solely by DTAG. ANGA therefore sought the inclusion of private network operators in the marketing of digital TV. Moreover ANGA proposed having the DTAG-CLT-UFA-Kirch agreement checked by a cartel office since CLT-UFA and Kirch would be allowed to use DTAG’s cable networks at a rather low price that did not correspond to real network operation costs.

#### 2.3.1.5 Technical Equipment

As mentioned above the first German provider for digital pay-TV was the Kirch Group. Their programmes were broadcast via satellite for reception by means of conventional satellite antenna dish and traditional TV set which, however, must be connected with each other by the Kirch Group's d-Box.

Based on the agreement with Deutsche Telekom AG the Kirch Group was supposed to get its DF1 services onto the cable in an early timeframe. These services would be accessible via a modified set-top box adapted to cable-specific requirements. The STB was due to be developed by Beta Research and possibly to be produced under license by other consumer electronic manufacturers.

The first generation of d-Boxes for satellite reception had been produced by Nokia. One of its main advantages was its plug-and-play capability, a major criterion for users not familiar with the operation of consumer electronic devices. The software for the operating system could easily be updated by downloading the latest version "over-the-air". At the time the d-Box could not be run in an interactive mode. This meant requests for movies in the framework of the video-on-demand service having to be carried out individually via telephone. Although being announced at the beginning of 1997, the in-built modem for accessing the public telephone network was not yet activated by a software update.

The d-Box was first sold at a price of DM 890 (i.e. about 470 ECUs) which had remained stable until spring 1997. Since this price was subsidized – the true price was estimated to be around twice the subsidized one – there was a remarkable demand for these d-Boxes in other European countries where unsubsidized STBs were sold at a much higher price. As it was not in the interest of the Kirch group to subsidize the launch of digital TV services other than their own, the d-Boxes were updated with software that made it impossible to receive pay-TV services other than those provided by the Kirch Group. This action was agreed in advance between Kirch and the other European pay-TV providers. It makes clear the idea that STBs in different countries of the EC have to be considered as *national products*!

Since the end of May 1997 the d-Boxes have been sold at a higher price of almost DM 1 200. In contrast d-Boxes have since then been available for rent at a price of DM 19. In order to make this new offer palatable to the potential customers a special service package was offered that included the hire charge for the d-Box and all DF1 programmes. This package was available for DM 50 for three months, but could not be extended to more than three months for that price.

#### 2.3.1.6 Services

When launching its digital pay-TV services DF1, the Kirch Group offered their programmes in two packages. The basic package comprised 14 TV programmes, 30 radio programmes (DMX), 1 information channel and a subscriber's magazine. It was available for DM 20 (10.5 ECU) per month. The enlarged package cost DM 10 more and included – apart from the services of package 1 – the access to the Near-Video-on-Demand channel "Cinedom" and a sports channel. Movies in the framework of Cinedom were available for DM 6 (3.15 ECU) per movie. After two months of service about 5 000 customers had subscribed to DF1, about two thirds of whom had chosen to subscribe to the enlarged package.

In the meantime the Kirch Group had changed its structure of offers. Its services were then offered in four main packages and three supplementary packages. The main packages were called Super (DM 40 monthly rate), Movie (DM 35), Sports (DM 30) and Basic (DM 20).

All of these four packages covered several selected video channels provided by DF1 (e.g. Cinedom, Classic Movies, Series, Kids & Teens, Documentation, International Channels, Music, Radio) as well as some international radio programmes. The only difference between these four packages was the selection of the Movies and the Sports channel. Whereas the Super package included both of the channels, the Basic package comprised none of them.

The three supplementary service packages offered by DF1 were the classical music channel Classica which could be accessed either exclusively (charge: DM 20 per month) or in addition to the main packages (additional fee: DM 10 per month) and the exclusive access to the Near-Video-on-Demand channel Cinedom (single clearing: DM 25, DM 6 per movie).

### 2.3.2 The situation in the Netherlands

The market place for Interactive services in the Netherlands was less certain. A first project attempt at the introduction of interactive television by De Tros, one of the public broadcasters, failed because of the system and the low volume of interactive programmes. In a second experiment, the sports network Sport 7 was introduced, which could be watched through a decoder. Sport 7 had to shutdown after only one year, during which viewers could see the programme for free on cable without the need of a decoder. In a third example, the major Dutch commercial television stations on satellite switched from analogue to digital transmission, requiring consumers to change their decoder without being compensated for the costs of doing this. These developments shocked the Dutch consumer and made the risk of introducing STB (with or without interactivity) only higher.

#### 2.3.2.1 Return channel for interactive services

Because most households already had an analogue television set and a telephone, most of the interactive television services available nowadays used the PSTN as the return channel. The PSTN was also expected to play a major role in the introduction of future digital services.

In the Netherlands several non-programme related interactive services exist based on Teletext in combination with PSTN. Examples of operational services were information on renting or buying houses, obtaining house purchase mortgages, and taking out insurance policies.

#### 2.3.2.2 Eurobox

A common standard for digital set-top boxes for cable had been developed at the initiative of the European Cable Communication Association (ECCA). The ECCA represents 21 cable operators from 14 European counties. Four major cable operators specified and agreed on this set-top box for cable called the Eurobox, although one, Deutsche Telekom AG since withdrawn from the agreement. The remaining cable operators (Casema, Mediakabel, and Telia InfoMedia Television) together owned a high proportion of the cable connections to European households (with DTAG this would have been around 50%). They hoped to deliver more than one million set-top boxes over the next two years. By ordering large numbers of decoders the price was hoped to be below USD 250.

The Eurobox was to be placed between the CATV-wall-outlet and an ordinary TV set. It would be able to receive and decode scrambled and unscrambled DVB signals. The interface would be fully in accordance with DVB/ETSI standards. The Eurobox was specified to provide a minimum of functionality and requirements. Features such as a PAL/SECAM coder, RF modulator, CATV modem and PSTN modem were included. At first the Eurobox would have a PSTN modem for the interactive return channel. The conditional access system module would be specified in accordance with the individual cable operator’s CA-System. The conditional access for the above-mentioned operators was based on the Viaccess system and the Open-TV API was to be used.

The Eurobox was to be introduced at the Internationale Funkausstellung 1997 in Berlin. The roll-out in Germany was originally planned to take place in October 1997 and in November for the Netherlands. Around April 1998 a new tender for the second generation Eurobox was to be issued.

#### 2.3.2.3 Introduction of DVB and interactive services by Casema

With 25 years of experience and more than a million subscribers, Casema has achieved a prominent place in the cable television industry. Casema has been rapidly growing from a network management service to a Full Service Operator.

Casema had already begun to take part in the development of new cable services. Pay-per-view, video-on-demand, home-shopping, alarm systems, data communication and cable telephoning were either being offered already by Casema or would be available in the foreseeable future. Casema operates cable networks in 115 Dutch communities, giving a market share of 23%.

Casema was upgrading its coaxial network to a Hybrid Fibre Coax (HFC) network. The backbone of the network would consist of fibre optic SDH-rings with a high availability. The new topology would offer data services, analogue and digital radio and television and telephony. The channel allocation of the C60 concept is shown in Table 2.1.

TABLE 2.1

**C60 Concept Channel Allocation**

| MHz | Service | Technique | Remarks |
|---|---|---|---|
| 5-30 | Telephony/Datacom | Cable DECT | Bidirectional |
| 45-73 | Multimedia | 64-256-QAM | Unidirectional |
| 87.5-108 | Radio | FM | 32 programmes |
| 109-160 | Digital Radio | 16-QAM | > 250 programmes |
| 175-238 | PAL-TV | AM | 9 programmes |
| 238-448 | DVB-TV | 64-256-QAM | 25 bouquets |
| 470-862 | PAL-TV | AM | 25 programmes + 3 at home |

Cable Operators had used PSTN for the interactive return channel in the past. The future return channel on the cable networks of Casema, however, was to be based on Cable DECT.

The introduction of the C60 concept took place where the cable network had been upgraded and it would be another two years before the Casema cable infrastructure was expected to be completed.

### 2.3.3 The situation in Spain

#### 2.3.3.1 Terrestrial

Due to the high density and the geographical relief of the country, terrestrial is the main broadcast means, 99% of surface coverage having been reached. Two main scenarios were identifiable:

– *Metropolitan and urban area*: most of the people live in apartment buildings, with reception based on MATV antennas.

– *Rural area*: people live in houses, with reception achieved via individual antennas.

Five nation-wide broadcasters are available: TVE1, TVE2, Antena3, Tele5 and Canal+. TVE is a public broadcaster, and the others are private companies.

There are also six regional TV organizations, owned by the Regional Governments, broadcasting one or two different programmes in their respective coverage areas.

In addition, many local TV stations have appeared, but at the time there was no regulation. Coverage was usually limited to a city area.

#### 2.3.3.2 Satellite

Satellite broadcasting was a significant application, and has been the first medium to migrate to the digital TV era. The satellite digital TV services started in Spain in 1995. Nowadays, there are two groups offering digital satellite TV in Spain to individual or collective users (SMATV):

– *Canal Satélite Digital (CSD):* the group is lead by Grupo Prisa (Canal+)

– *Vía Digital:* the group lead by Telefonica

– *CSD* started to commercialize its channels on the 31 January 1997, having achieved more than 200 000 subscriptions. At present, 55 TV channels, 41 audio channels and 6 interactive services are being offered:

*PREMIUM+* (Basico and Canal + Digital) includes:

20 TV thematic channels (Canal+, Sports, documentaries etc)
20 audio channels
TV services Guide, Mosaic, pay-per-view (PPV)
The package price is 4 995 Ptas

*BASICO* includes:
10 TV thematic channels (Sports, documentaries, etc)
More than 30 audio channels
TV services Guide, Mosaic, PPV
The price is 1 995 Ptas

*CINE* includes:
4 channels related to the cinema environment and movies
Price 1 495 Ptas

*CANAL+ DIGITAL* includes:
3 digital channels
TV services Guide, Mosaic
Price is 3 660 Ptas

*NATURE:* Nature, fishing and hunting. 14h/day offering programmes exclusively dedicated to these activities
750 Ptas

*MUSIC:* includes:
Muzzic: jazz, opera, dancing
Multiclasica: Classic music
750 Ptas

*C: DIRECTO:* Allows direct download of the computer latest versions of computer utilities and games
750 Ptas

All the above-mentioned options need also a subscription of 32 600 Ptas.

For the implementation of PPV services PSTN modems are used.

Simulcrypt is being used for conditional access.

CSD broadcasts its services via ASTRA.

– *Vía Digital* started to commercialize its services on 15 September 1997 having achieved up to now some 450 000 subscribers. Services are offered under a subscription of 5 000 Ptas and the various prices of the services chosen. The 77 channels currently available are distributed in the following way:

*BÁSICO* (35 channels) includes:

| | |
|---|---|
| Cinema | Education |
| Sports | Women Channel |
| Audio | New Age |
| Children | Travel |
| News | Regional Channels |
| Music | Economy |
| TV Classics | |

*TEMÁTICO:* 7 cinema channels specialized in different styles (CINE TEMATICO) and 2 cinema channels with the more recent American films (PREMIÈRE).

*PALCO:* 11 PPV channels on trial until December 1997
Videoclub: Cinema
Events.

*CANALES A LA CARTA:* Channels specially dedicated to some sectors of the population. At present, three channels are available: CANAL BARCA, FUTBOL TOTAL and PLAYBOYTV.

Vía Digital broadcasts its services via HISPASAT, having a total capacity of 11 transponders, each of them being able to deliver up to 8 digital channels. The DVB Common Interface is to be provided in receiving equipment to be used for conditional access. VIA DIGITAL is already providing interactive services, implementing a PSTN return channel associated to its DVB-S signals, in particular interactive publicity and games.

#### 2.3.3.3 CATV

CATV networks have shown significant development during recent years. Basically, newer CATV networks have been established in some cities. Just three regions are supporting services: Castilla-León, Valencia, and Cataluña. Early expansion of these networks to other regions, such as Andalucia or Madrid, was foreseen and then to the remainder of the country in a medium term.

In Castilla-Leon, one district was planned, and the network being developed. The transmission was to be analogue and mainly via a fibre network. There were 30 000 users, but the coverage reached 95% in some places.

In the case of Cataluña, there are three districts and it has been laying out an HFC network, which, initially would support 20 000 users. In a second phase this would be extended up to 40 000 users.

In Valencia, a cable installation had reached 11 000 users up to now. The number of user outlets was expected to be increased up to 300 000 by the end of the century.

The service offered was a Basic Package of 15 to 20 TV Channels. Prices vary between 1 500 to 2 500 Ptas as a monthly charge and a subscription fee in the range of 5 000 to 10 000 Ptas. No other telecommunication service was provided apart from the delivery of radio services normally delivered by FM signals.

#### 2.3.3.4 Interactive Services

Interactive services are starting to be developed, examples of commercial interactive services are those of VIA DIGITAL in connection with its digital TV platform and using a PSTN connection and other less sophisticated than those where a telephone call is made as return channel. There have been several experiences on interactive services using other transmission media, for example those experienced by DIGISAT and S3M projects (leadered by HISPASAT) where a two-way satellite channel is established between the user and the service provider. Also, there have been some experiments on tele-education at the UPM (Universidad Politecnica de Madrid), implementing broadcast and return channel via satellite. Almost all broadcasters are present on the Internet, offering information.

#### 2.3.3.5 The future

The trend for the future implies the transition from analogue to digital television in terrestrial television and the implementation of new interactive services (data broadcasting, multimedia communications) using the current operative satellite digital TV platforms. In cable context, a transition from analogue to digital will be carried out.

#### 2.3.3.5.1 Terrestrial

RETEVISION and the Spanish Administration had planned the introduction of digital terrestrial TV in Spain at the earliest possible date, within the window of opportunity 1997-1998. The Spanish Administration was also working on the preparation of an appropriate regulatory framework for the introduction of these services in Spain.

RETEVISION, in collaboration with the Spanish Administration and several Broadcasters, had started to set-up, since early 1996, an experimental digital terrestrial TV network in the Madrid area, compliant with the DVB-T specification.

This experiment, called the VIDITER project, was contributing to the launching of digital terrestrial broadcasting services in Spain, tests demonstrating the possibilities of digital terrestrial TV and encouraging mainly the Spanish broadcasters and manufacturers to the use and development of this new technology.

The experimental network was a complete digital terrestrial TV chain. It comprised four main parts:

– The production TV studio and the master control room

– Source coding based on MPEG-2

– A primary distribution network

– A secondary distribution network.

A very simplified digital terrestrial television (DTT) network began running in May 1997 in Madrid for trials.

Once the VIDITER project had achieved its purpose, DTT would be introduced in Spain in a commercial way, broadcasting regular services, such as free-to-air services, PPV ones and pay-TV programmes.

It would comprise two phases: initially it would reach about 67% of the population by July 1998; the second stage would spread the coverage up to 77.5% by July 1999.

Until the whole changeover from analogue to digital television is completed, a simulcasting period is desirable, in order to make the transition easier. It is recommended that this simulcasting period should last for 10 or 15 years, with an end date to be decided by the Government. After this simulcasting period, analogue television services will be closed down, and the previously occupied frequencies will be available for use by others services, such as data broadcasting, mobile radio services, etc.

The transition from analogue to digital transmission potentially allows the terrestrial broadcasters to offer a greater choice of programming to the viewer, due to the multiplex facility of digital transmissions.

The conditional access mode is a key issue. There were two proposed models:

– SIMULCRYPT: The owner of the entire conditional access system including the STB is the Broadcaster. This may offer the advantage that the cost of the STB may be subsidized by the Broadcaster. On the other hand, this can mean that STBs will tend to differ among the different Broadcasters.

– MULTICRYPT: The STB proposed is standard, and the access to different services would be provided via different smart cards and CA modules plugged into the DVB Common Interface.

#### 2.3.3.5.2 Satellite

The future for satellite digital TV will be the implementation of full satellite return channels system (as those proposed by DIGISAT and S3M) or those analysed by the DVB Project and to include new services and technologies to be provided through the Set-Top Box (multicasting, multimedia services, etc).

#### 2.3.3.5.3 CATV

As mentioned previously, CATV networks are now expanding. Their main objective has been focused on acquiring a greater degree of coverage, at least in big cities. Due to this, CATV networks are expected to need a longer period for the transition to digital.

Future situation:

– Provision of SFNs in terrestrial.

– Increase of Digital Satellite broadcasting.

– Increase of coverage in CATV. Transition from analogue to digital.

#### 2.3.3.5.4 Interactive Services

- There are some experiences on interactive services to be offered by satellite digital TV platform including multimedia services. VIA DIGITAL has already started to offer this kind of services.
- PPV and other Interactive Services via PSTN modems are already offered, related to satellite broadcasting.
- PPV and other Interactive Services via PSTN modems in the medium term, related to terrestrial broadcasting.
- New possibilities of interaction channels via terrestrial and satellite, in the long term.

#### 2.3.3.5.5 TV-Anywhere

With the rapid developments in high volume digital storage in consumer platforms, the TV-Anywhere forum was established in Europe. It has started work to develop open specifications designed to allow consumer electronics manufacturers, content creators, telcos, broadcasters and service providers to exploit such storage. This group has effectively taken over where DAVIC left off, with respect to developing "TV-Anywhere" systems specifications. Activities have also started in Japan on this topic as part of the definition of the Integrated Service Television (ISTV) receiver (see § 4.3.1.3.1).

### 2.3.4 DAVIC

The former DAVIC project completed its work in late 1999 (but see § 2.3.3.5.5), had adopted a generalized model of interactive delivery systems, that was intended to cover all classes of systems, but initially limited to a model for the delivery of Services on Demand. The model is thorough and appropriate for this context.

DAVIC had turned its attention to the development of specifications for hybrid delivery systems that combine the use of the digital broadcast channel with the World Wide Web. It had developed an Enhanced Digital Broadcasting Contour with two variants. The first variant supplies WWW format signals in a one-way digital broadcast channel alongside other linear programming. The second couples the digital forward channel to an Internet channel, which provides interactive capacity for Web delivered pages. This can in turn be made to provide feedback for the linear channel if needed.

This Enhanced Digital Broadcast Contour seems particularly relevant for interactive television, and needs to be considered carefully in introduction strategies.

## 2.4 Equipment Developments and Technical Trials

### 2.4.1 The UHF Return Channel: Field Trials carried out by the ACTS INTERACT Project (August 1998)

This provides some of the findings of the ACTS INTERACT Project. It summarizes the first laboratory tests of the SFDMA return channel system tolerances, describes the subsequent first field trials in Rennes and Metz (France), and reports on and analyses the results obtained. The results are shown to confirm the general feasibility of the SFDMA system for providing return link access within the existing UHF television broadcasting band.

#### 2.4.1.1 Introduction

A first hardware demonstrator of a UHF Synchronous FDMA (SFDMA)-based return channel for DVB-T systems was constructed by INTERACT, a three-and-a-half year European collaborative ACTS project which began studies in September 1995, and which has recently concluded its work. Information on the INTERACT project, including technical details of the SFDMA UHF return channel scheme were contributed to the first meeting of Radiocommunications TG 11-5 (Doc. 11-5/3 – The Terrestrial return Channel) and are also presented [Allan *et al.*, 1998].

Three system-layers were developed for this purpose; from bottom to top: the SFDMA Physical, the MAC (medium access control) layers, and also a simple interactive application. An initial version of the demonstrator was completed during summer 1997 (Return Channel Demonstrator Complete, INTERACT Deliverable Report DE010), and was shown at Montreux '97 in June 1997 in a closed-circuit configuration without an RF over-air path.

The return channel physical access part consisted of one SFDMA user transmitter, one emulator of SFDMA multiple access, and one receiving equipment for the base station. In the MAC layer, the most common functionalities of the "Interim Specification for DVB Interaction Channel for Terrestrial Systems-based on SFDMA" (Interim specification for DVB interaction channel for terrestrial systems based on SFDMA (v3.3), DVB Technical Module TM1894) were implemented. The draft specification was later updated within the INTERACT project (Specification for an interaction channel for terrestrial systems based on SFDMA (v.3.4), INTERACT Deliverable DE007).

Various laboratory tests and field trial measurements have been carried out within INTERACT. A preliminary over-air test took place in October 1997 at the CCETT in Rennes, France. This was followed by further testing, and more extensive over-air trials took place in Metz, France, during July 1998.

Paragraph 2.4.1.2 reports on the laboratory tests made at CCETT on the SFDMA system tolerances, regarding power regulation, frequency and time synchronization of the SFDMA return channel modulator.

Paragraph 2.4.1.3 presents a brief summary of the earlier preliminary on-air trials of the prototype in Rennes.

Paragraph 2.4.1.4 reports in more detail on more exhaustive on-air trials in Metz and its surrounding region: the required powers for the SFDMA transmission were measured in 26 different locations and analysed and compared with the corresponding Analogue and Digital TV received signal levels.

Paragraph 2.4.1.5 summarizes the conclusions arising from the various experiments and tests, which confirm the general feasibility of the SFDMA system for providing return link access within the UHF television broadcasting band. It also addresses the anticipated future progress of the then on-going technical investigation surrounding the SFDMA UHF return channel for DVB-T.

#### 2.4.1.2 Laboratory tests on system tolerances

Extensive laboratory measurements were carried out with the prototype, also including the multi-user emulator, with the aim of measuring the system tolerance values for power regulation, time and frequency synchronization.

##### 2.4.1.2.1 Test overview

The INTERACT demonstrator was used for the measurements described in this report.

Four transmission modes were implemented; Transmission Mode 1 (see references in the first paragraph of § 2.4.1.1 for a description of the various modes of operation) was used for the laboratory tests with the following parameters:

**Transmission parameters**

- Mode 1
- Global return channel bandwidth: 1 MHz
- Carrier spacing: 1 kHz
- Number of carriers: 1 000
- Modulation scheme: Differential QPSK
- Coding rates: 1/2, 2/3, 3/4, no coding.

Only one carrier is modulated in the digital modulator of the demonstrator; the carrier index (frequency) is 503.

A Pseudo Random Binary Sequence (PRBS) test pattern generates $2^{20} – 1$ bit. Polynomial for PRBS generator is $x^{20} + x^{17} + 1$.

Various tests were made:

*Without coding*

- robustness of the modulation against interference
- tolerances on the degradation of the carrier itself
- tolerance on the degradation of the carrier as a function of:
  - all other imperfect carriers
  - the two adjacent imperfect ones
- tolerance on the degradation of the carrier itself and the two imperfect adjacent ones.

*With 1/2, 2/3 and 3/4 coding rates*

- tolerances on the degradation of the carrier itself
- tolerance on the degradation of the two adjacent ones
- tolerance on the degradation of the carrier itself and the two adjacent ones.

### 2.4.1.2.2 Summary of tests on the system tolerances

The results confirmed perfectly the software simulation previously carried out within INTERACT.

Table 2.2 summarizes, for the different encoding rates, the experimental (and theoretical) tolerances on the user's return channel transmitter characteristics: time ($\Delta t$) and frequency ($\Delta f/C_s$) synchronization precision, tolerated spreading of the received powers ($\Delta A$, acceptance on power ranging). The values given assume a 6 dB increase on the power requirement for individual carriers.

TABLE 2.2

**Summary of return channel transmitter tolerances at the cost of an extra 6 dB power for individual carriers**

| Coding rate | No coding | 3/4 | 2/3 | 1/2 |
|---|---|---|---|---|
| $\Delta t$ | $\pm T_s/10$ | $\pm T_s/6$ | $\pm T_s/6$ | $\pm T_s/5$ |
| $\Delta f/C_s$ | ± 0.03 | ± 0.04 | ± 0.05 | ± 0.075 |
| $\Delta A$ | 20 dB | 17 dB | 17 dB | 20 dB |

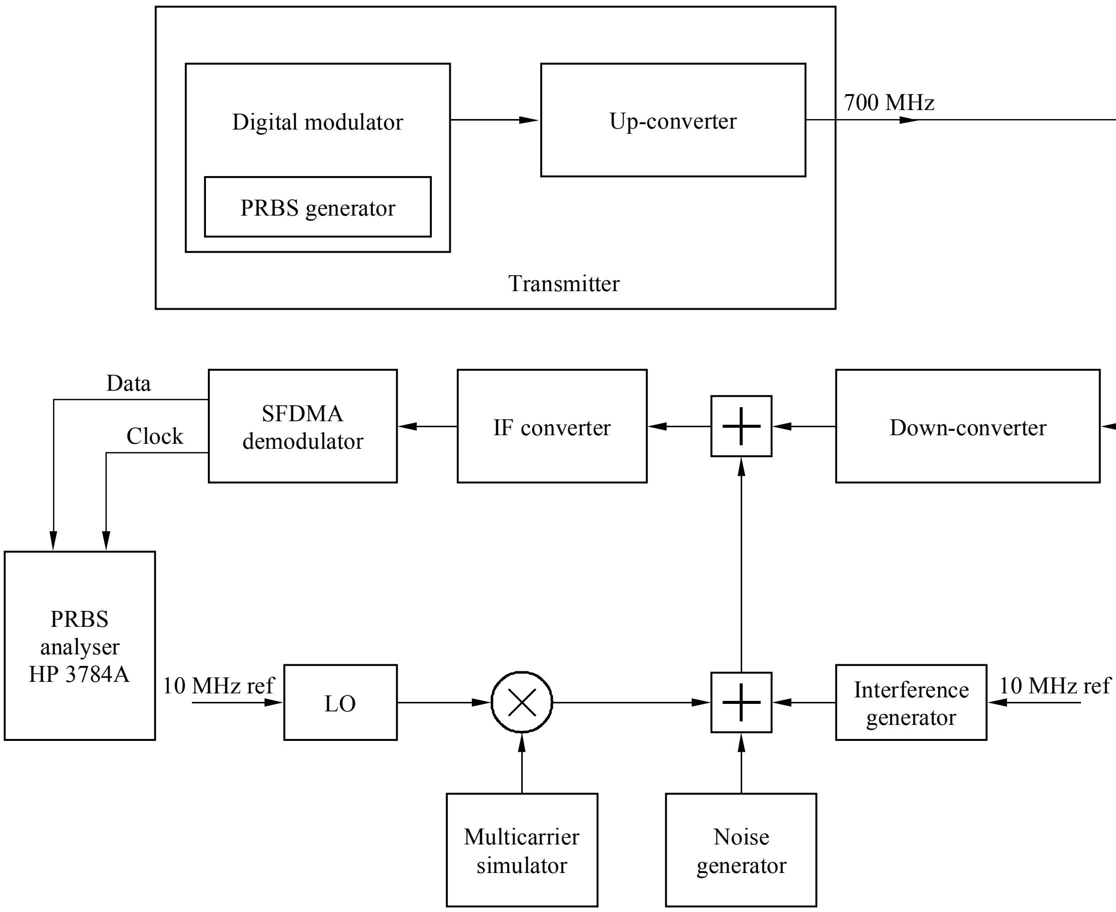
where:

$T_s$ : SFDMA Symbol duration

$C_s$ : carrier spacing

FIGURE 2.1

**Test measurement block diagram**

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For SFDMA transmission mode 1 (broadcasting/collecting network cell of 37.5 km radius) $T_S$ and $C_S$ are respectively 1.25 ms and 1 kHz. Hence, the derived absolute tolerance values are given in Table 2.3.

TABLE 2.3

**Absolute tolerances on the return channel transmitter in mode 1, at the cost of an extra 6 dB power for individual carriers**

| Coding rate | No coding | 3/4 | 2/3 | 1/2 |
|---|---|---|---|---|
| $\Delta t$ | ± 0.125 ms | ± 0.210 ms | ± 0.210 ms | ± 0.250 ms |
| $\Delta f$ | ± 30 Hz | ± 40 Hz | ± 50 Hz | ± 75 Hz |
| $\Delta A$ | 20 dB | 17 dB | 17 dB | 20 dB |

Experimental measurements show the great robustness of the system against narrowband interference in the return channel band. An interfering unmodulated carrier at a level up to 25 dB greater than the typical received power of one individual carrier will disturb only 2 carriers, whereas even with a level between 25 and 40 dB higher than the typical level, only 3 carriers are unusable.

The most critical requirement of SFDMA is confirmed: the tolerance on the stability of the UHF frequency of the SFDMA carrier produced by a user terminal.

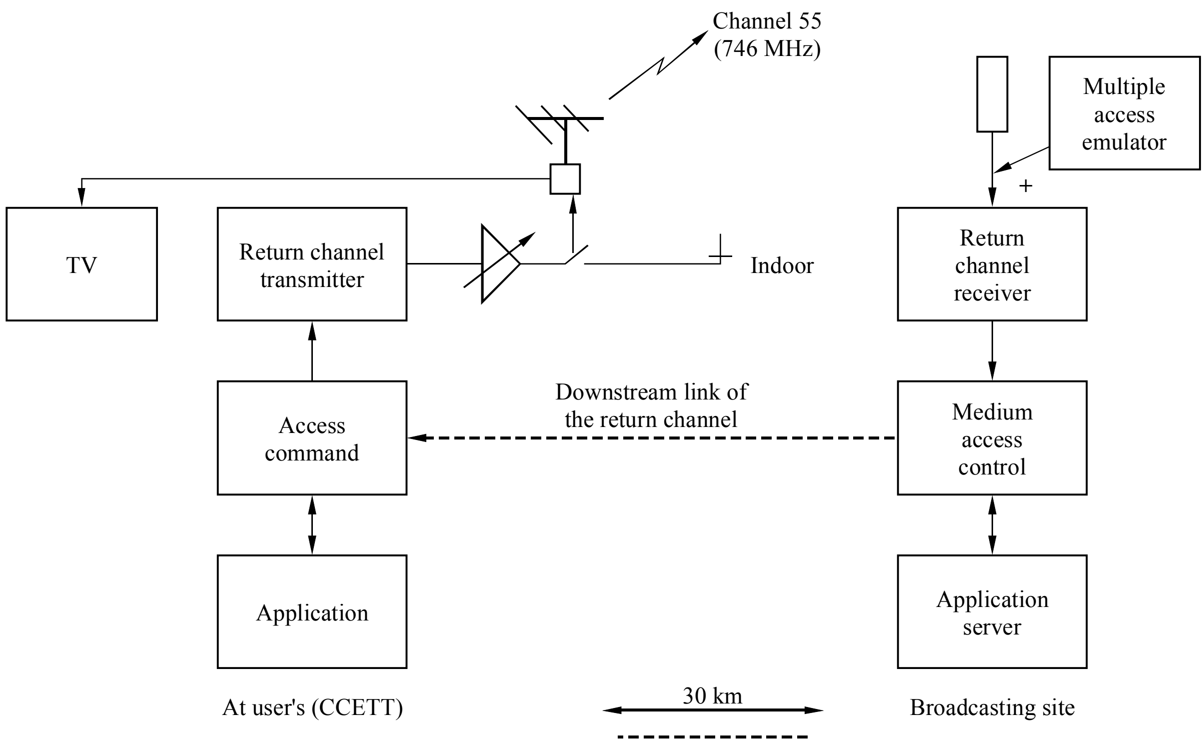
### 2.4.1.3 Over-air trials in Rennes (France)

#### 2.4.1.3.1 Static field tests at CCETT

Figure 2.2 illustrates the field tests in Rennes. The user was sited in Rennes (in CCETT’s premises) and the return channel signal was transmitted, either by the rooftop antenna or from an indoor antenna, directly to the TDF St-Pern high-power broadcast television transmitting site located 30 km from CCETT. Two specific SFDMA transmission modes (modes 0 and 1) are compliant with this distance. Mode 1 is the one referred to hereafter for the measurements.

FIGURE 2.2

**Block diagram of the over-air return channel experiment in Rennes**

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St-Pern (see Fig. 2.3) is a principal transmitting site for TDF. The total transmitter power for television in the UHF/VHF bands exceeds 100 kW, with a total ERP in excess of 2 mW. The broadcasting antenna platforms are at heights of 200 m, 260 m and 270 m above ground level. On this same transmitting mast, reception of the return channel signal is achieved with a 13 dB gain antenna located at a height of 132 m.

FIGURE 2.3

**The St-Pern transmitting site**

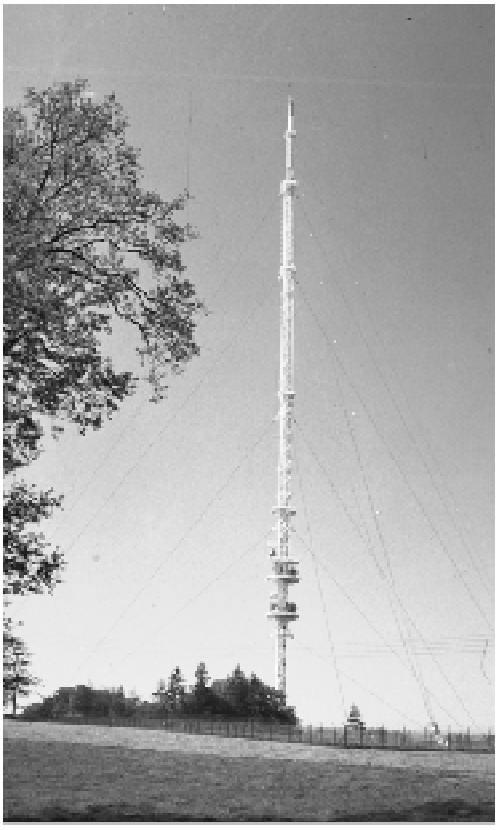

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Table 2.4 gives the selected reference return channel signal parameters, and outlines the required transmitted powers that have to be delivered from the user's transmitter, located at the CCETT, to feed the rooftop antenna on the one hand (the rejection filter that isolates the TV reception from the return channel transmission being taken into consideration in this case) and the indoor antenna on the other hand). It is important to point out that the CCETT is located on a small hill (69 m above sea level), in a rural environment, and therefore propagation is very close to free space.

#### 2.4.1.4 Over-air trials in Metz (France)

##### 2.4.1.4.1 Experimental set-up

###### 2.4.1.4.1.1 Experimentation purpose

The goal of the experimentation, which took place over a two-week period in July 1998 in the Metz region, was to place the INTERACT SFDMA demonstrator hardware into a real transmission and reception environment and to test its RF performance under different location and propagation conditions.

Theoretical analyses were performed throughout the project on the RF parameters needed by the return link in order to achieve coverage similar to that of TV transmissions. But figures derived from this study could be validated only by means of real experimentation.

TABLE 2.4

**Required power for the test trial in Rennes (from CCETT) for defined parameters**

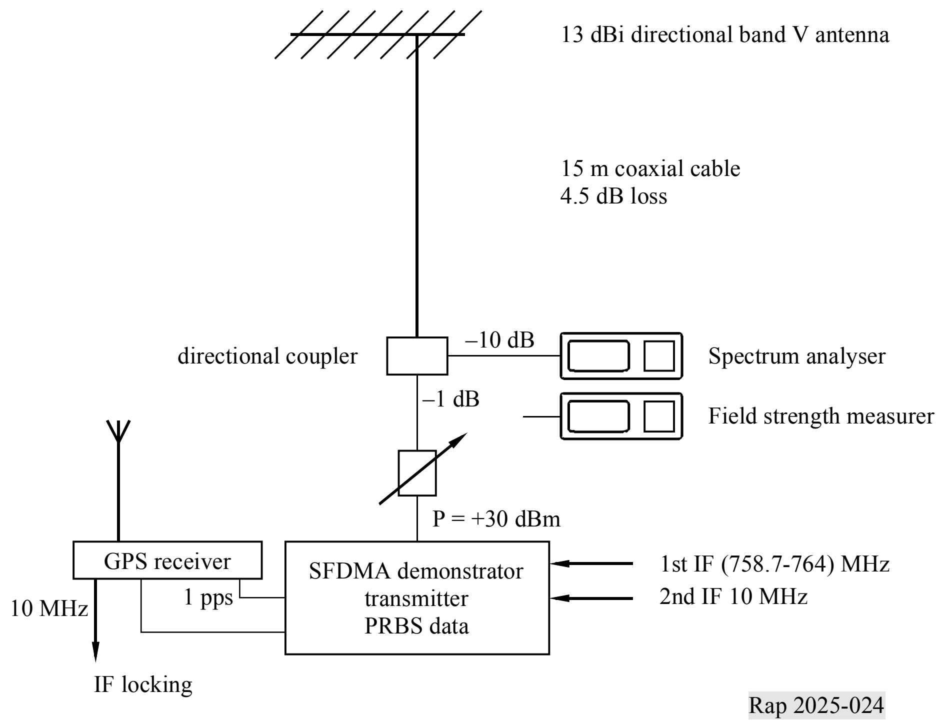
| | | | |
|---|---|---|---|
| Transmission mode | 1 | | |
| Signal bandwidth (kHz) | 1 | | |
| Modulation | D-QPSK | | |
| Perfect conditions of time and frequency synchronization and power ranging | | | |
| Distance (km) | 30 | | |
| Coding rate | 1/2 | 2/3 | 3/4 |
| Data rate (kbit/s) | 0.76 | 1.012 | 1.14 |
| Required power with rooftop antenna (mW) (BER < $1 \times 10^{-4}$) | 0.4 | 0.6 | 0.7 |
| Required power with indoor antenna (mW) (BER < $1 \times 10^{-4}$) | 8 | 11 | 15 |

#### 2.4.1.4.1.2 Return link transmitter

Figure 2.4 depicts the transmitter hardware which was installed in a survey vehicle. It was composed mainly of the demonstrator arrangement (PRBS generator + SFDMA modulator + up-converter + amplifier) and the GPS locked 10 MHz generator. A complete set of TV analogue and digital measuring equipment, i.e., spectrum analyser and field strength measurer, were also fitted into the vehicle. The telescopic antenna was raised to 10 m height at each testing point and pointed toward TDF's LUTTANGE television transmitter (aligned using maximum RF received TV signal), then it was connected to the demonstrator hardware.

FIGURE 2.4

**Return channel transmitter set-up**



Transmission parameters were as follows:

– single modulated carrier in mode 1 (1 kHz BW)

– set of 3 tested frequencies : 752.25-757.0-757.5 MHz

– RF power : max 32 dBm (1.5 W) + 10 dB and 1 dB step attenuator

– no channel coding

– horizontal polarization.

#### 2.4.1.4.1.3 Receiver

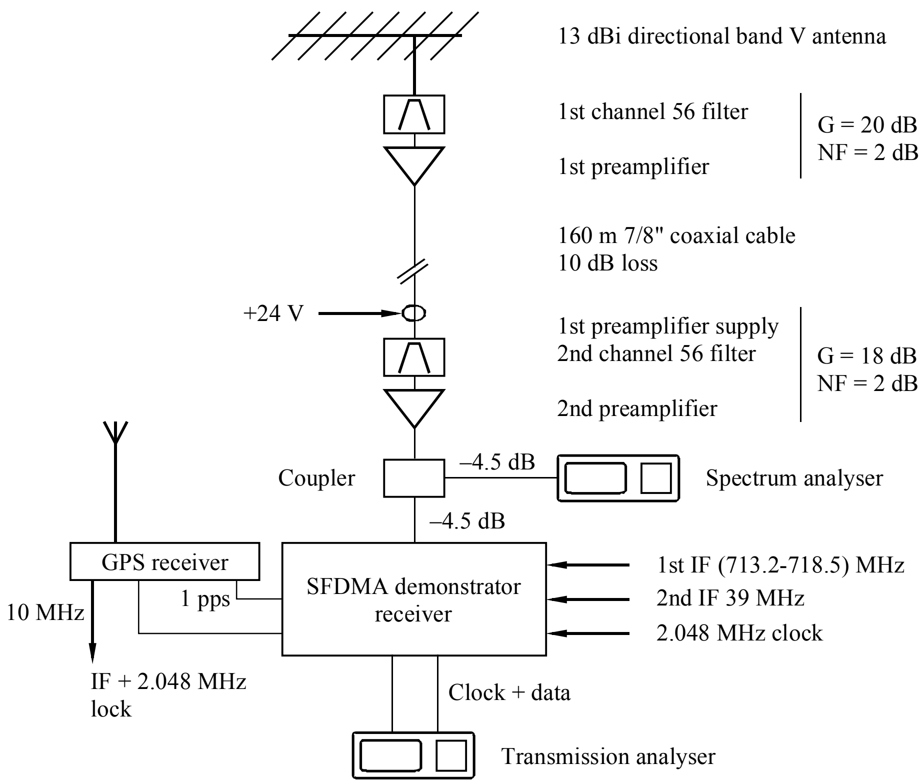
Figure 2.5 depicts the receiving arrangement which was installed at the LUTTANGE TV broadcasting site located 22 km from Metz. The receiving antenna was installed at 150 m height, adjacent to the following antennae:

– 10 m below a 200 kW ERP analogue TV transmission (CH 39) multiplexed with a 4 kW ERP digital TV (CH 40)

– 80 m below a 1 000 kW ERP analogue TV transmissions (CH 31, 34, 37).

FIGURE 2.5

**Return channel receiver set-up**

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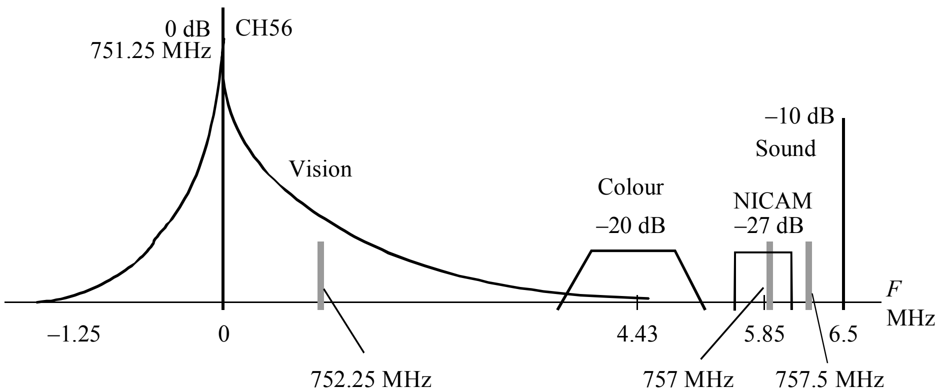
A first 20 dB selective pre-amplification device with an appropriately low noise figure tuned to channel 56 gave rejection of the high-level TV signals broadcast on the site and feeds the 180 m length of coaxial cable. A second 18 dB selective pre-amplification stage provided a further amplification before feeding the demonstrator receiver. A coupler allowed measurement of the received RF level on a spectrum analyser. Finally, gross BER (no Viterbi decoder was set-up in this experiment for the sake of simplicity, however its demodulation gain is known: 5 dB for a 3/4 CR) and frame synchronization presence were measured after data demodulation.

#### 2.4.1.4.1.4 Frequency allocation

The proposal was to test 3 frequency allocations in the received spectrum segment located in the upper part of band V in TV channel 56. Within the crowded UHF spectrum received on the broadcasting mast at 150 m height, channel 56 appeared to be one of the cleanest; i.e., having a relatively low level of interference at its vision carrier frequency. Figure 2.6 gives a view of the allocation regarding the incoming TV interfering signals. The figures from the Metz trial (§ 2.4.1.4.4.2), show an actual spectrum plot composed of the addition of L-SECAM (France) and B-G PAL channels (Germany) due to the boundary location of the receiving point.

FIGURE 2.6

**SFDMA carrier location in analogue UHF channel 56**




*Allocation 1*: 757.5 MHz in the "cleanest" zone in an L-SECAM TV channel, between L-NICAM and L audio sub-carrier

*Allocation 2*: 757 MHz within the NICAM signal

*Allocation 3*: 752.25 MHz within the vision signal

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#### 2.4.1.4.2 Trial results

##### 2.4.1.4.2.1 Received levels and BER performances

TABLE 2.5

**Measurement results**

| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
|---|---|---|---|---|---|---|---|---|
| Pt | Distance (km) | TV Rx levels on CH 39 and 40 | | Tx - Rx levels all $f$ allocations | | | Tx & margin for BER ≈ $1 \times 10^{-4}$ $f_1$ allocation | |
| | | Analogue (dBm) | Digital (dBm) | Tx (dBm) | Rx (dBm) | BER | Tx level (dBm) | Margin (dB) |
| 1 | 20 | –47 | –67 | 30 | –60 | 0 | 5 | 25 |
| 2 | 25 | –63* | –79* | 30 | –79 | 0 | 22 | 8 |
| 3 | 25 | –61* | –73 | 30 | –80 | 0 | 26 | 4 |
| 4 | 23 | –54 | –67 | 30 | –62 | 0 | 11 | 19 |
| 5 | 36 | –48 | –65 | 30 | –60 | 0 | 9 | 21 |
| 6 | 34 | –27 | –45 | 8 | –60 | 0 | –17 | 47 |
| 7 | 39 | –40 | –53 | 11 | –63 | 0 | –13 | 43 |
| 8 | 7 | –15 | –32 | –18 | –72 | $7 \times 10^{-6}$ | –23 | 53 |
| 9 | 8 | –16 | –33 | 0 | –58 | 0 | –23 | 53 |
| 10 | 18 | –59* | –71 | 30 | –68 | 0 | 12 | 18 |
| 11 | 19 | –48 | –69 | 30 | –63 | 0 | 4 | 26 |
| 12 | 20 | –59* | –71 | 30 | –66 | 0 | 14 | 16 |
| 13 | 21 | –57* | –74 | 30 | –60 | 0 | 3 | 27 |
| 14 | 22 | –39 | –52 | 30 | –56 | 0 | –8 | 38 |
| 15 | 23 | –48 | –61 | 30 | –54 | 0 | –2 | 32 |
| 16 | 20 | –37 | –47 | 10 | –60 | 0 | –22 | 52 |
| 17 | 19 | –54 | –67 | 30 | –57 | 0 | –2 | 32 |
| 18 | 21 | –41 | –56 | 15 | –60 | 0 | –2 | 32 |
| 19 | 19 | –33 | –46 | 6 | –60 | 0 | –16 | 46 |
| 20 | 22 | –59* | –72 | 30 | –66 | 0 | 16 | 14 |
| 21 | 27 | –45 | –57 | 30 | –48 | 0 | –7 | 37 |
| 22 | 44 | –52 | –65 | 30 | –60 | 0 | 4 | 26 |
| 23 | 44 | –78* | –78* | 30 | –83 | 0 | 26 | 4 |
| 24 | 44 | –66* | –76* | 30 | –75 | 0 | 17 | 13 |
| 25 | 32 | –50 | –64 | 30 | –57 | 0 | –2 | 32 |
| 26 | 20 | No signal* | No signal* | 32 | –73 | 0 | 23 | 7 |

*Column information*:

1 Measurement point: 1 to 25 outdoor, 26 indoor.

2 Distance van/receiving point.

3 Received analogue CH 39TV level 300 kHz Resolution Bandwidth, (* = reception below threshold).

4 Received digital TV level CH 40 8 MHz Resolution Bandwidth, (* = reception below threshold).

5 Transmitter RF power (before antenna) 30 and 32 dBm excepted when receiver saturation occurred.

6 Received RF level on spectrum analyser.

7 BER (after 10 minutes error counting).

8 Transmitted RF power for BER close to $10^{-4}$ on allocation $f_1$.

9 Margin (power back-off) compared to a 30 dBm transmission on allocation $f_1$.

#### 2.4.1.4.2.2 Analysis

From the limited set of collected measurements, first conclusions on the feasibility of the system may be derived, and information on the use of certain frequency bands, and maximum required RF power can also be derived. However, for the long term, further trials need to be performed in similar environments for the sake of greater prediction accuracy.

##### 2.4.1.4.2.2.1 Frequency allocation

Concerning the frequency allocations $f_2$ and $f_3$, measurements and calculations not given here for a BER limit of $1 \times 10^{-4}$ indicate that a margin loss of 7 dB appears between allocation 1 and 2, and 4 dB between allocation 1 and 3, proving the interfering effect of the tested sub-carriers and the required RF power increase to overcome this effect. However, additional tests need to be performed with the upgraded demonstrator, as the Viterbi decoder will certainly alleviate part of the interfering effect of the analogue sub-carriers.

##### 2.4.1.4.2.2.2 Data correlation

A data correlation analysis performed on the received television signal strength levels in the survey vehicle and the received return link signal at the broadcasting site indicated a strong correlation (> 0.92) between the signals at both ends. This confirmed that the received TV signals could be used as an indicator of the return link feasibility.

##### 2.4.1.4.2.2.3 Max RF Power (outdoor conditions)

The RF power needed to take into account various distances and propagation conditions can be derived from Table 2.5 by selecting the Tx level needed for a $1 \times 10^{-4}$ BER. The large variations in Tx level observed (up to 36 dB for the same distance) are due to various propagation conditions; § 2.4.1.4.4.2 gives further explanations of the geographical situation of each point which may be clear (= line of sight), or obstructed. By analysing the data in Table 2.5, it is possible to derive as a first conclusion that a 30 dBm transmission power offers enough margin to enable a return link service to work even at the points where TV service is absent; however, further analysis is needed.

The TV reception signal level thresholds commonly used are :

– analogue TV reception : 55 dBμV, i.e. –54 dBm 75 Ω

– digital DVB-T reception in 8K 64-QAM 1/32 guard interval in Gaussian channel ($C/N \approx 22$ dB): 35 dBμV, i.e. –74 dBm 75 Ω.

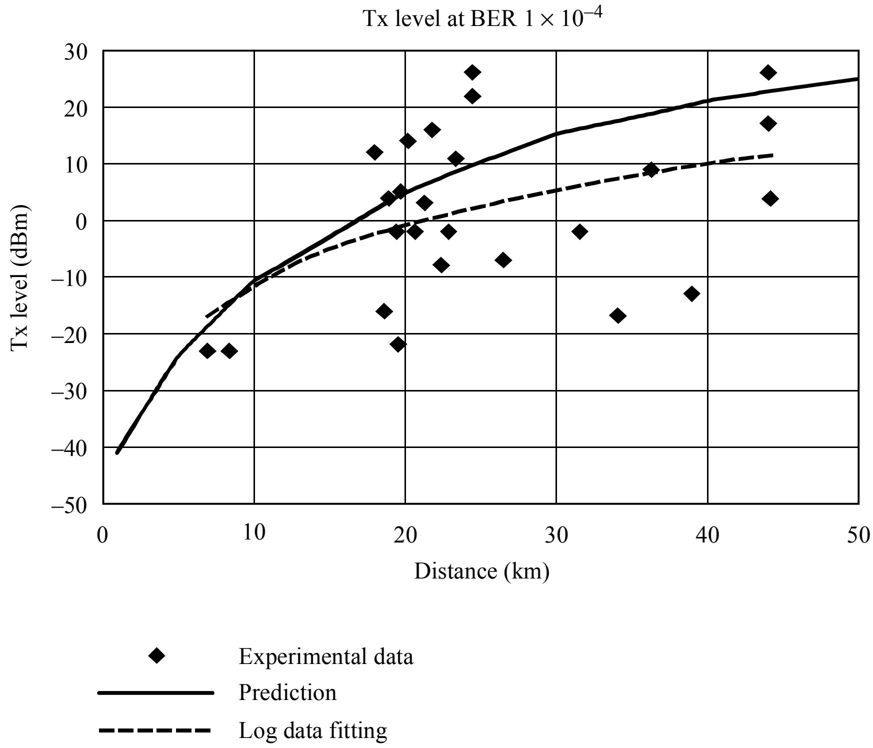
By taking into consideration outdoor points where both analogue and digital reception levels are both above their thresholds (points 16/25), $P_{max}$ = 11 dBm (point 4); taking only digital reception (which is more realistic; points 22/25), leads to $P_{max}$ = 26 dBm at point 5 located approximately at mid-range of the TV service area radius (50 km).

Figure 2.7 compares a prediction based on the actual transmission parameters (installed antenna, preamplifiers, receiver sensitivity at BER = $1 \times 10^{-4}$, etc.) and propagation model Recommendation ITU-R P.370 (50,50) with the experimental Tx levels. As already mentioned, this limited set of data does not permit definitive conclusions to be derived; nevertheless, it should be mentioned that prediction is quite pessimistic, as 70% of the points are under the Recommendation ITU-R P.370 based curve. A fitting function was also applied on the experimental data in order to derive its logarithmic tendency, and it shows a good 10 dB difference with the ITU-R based curve at the edge of the TV analogue or digital service area (≈ 40 km).

To be mentioned also is the need for the determination of the Tx power margin needed to cope with the field strength variability due to various location configurations (test points 22, 23, 24, almost co-located, clearly show the variability effect). A standard deviation figure is generally derived from a large set of experimental data (in order to determine TV planning parameters) and applied as an additional margin on a 50% location prediction model in order to give a certain degree of service availability (for example, 90% in fixed DVB-T reception). This standard deviation was provisionally assessed to be the same as that used in an analogue channel as narrow bandwidth channels were being considered ($\sigma \approx 10$ dB in analogue UHF and 1.3 $\sigma$ for 90% location coverage probability); this figure also needs to be validated with further tests.

FIGURE 2.7

**Theoretical and experimental transmission power levels**

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A provisional assessment of the maximum RF power needed to cover a 50 km distance using the actual experimental set-up can be made. The following calculation based on Fig. 2.7, gives the maximum required Tx power:

– Tx power for 50 km (log fitting curve for 50% of location) : ≈ +15 dBm

– Margin for increasing 50% → 90% locations = +13 dB

– Coding gain for CR = 3/4 : –5 dB

⇒ Max Tx power : 15 + 13 – 5 = **23 dBm**.

This figure is compatible with the theoretical one given in § 2.4.1.4.4.5 (+20 dBm for 50 km range in mode 1) although the reception configurations are slightly different (improved installation, reception in a non-interfered channel).

### 2.4.1.4.2.2.4 Max RF Power (indoor conditions)

Only location point 26 gives an indication of the RF power needed in indoor situations ($P$ = 23 dBm at 20 km) but the experimentation conditions were not appropriate as no TV signals could be received. Further trials would be performed when Metz was covered by a DVB-T gap-filler transmitter (to be addressed by the MOTIVATE project trials at the end of 1998).

### 2.4.1.4.3 Conclusions from the trials in Metz

The experiments based on the Metz test platform have shown results confirming the general feasibility of the SFDMA system for providing return link access in UHF channels. The results are consistent with the theoretical calculations made on the RF parameters, especially on the transmission power needed to enable a service range compatible with television reception.

However, further trials need to be performed on a second generation demonstration equipment that will offer easier and optimized set-up capabilities, in order to consolidate the different RF parameters and to test new configurations such as the indoor mode.

#### 2.4.1.4.4 Annexes to the Metz trial

##### 2.4.1.4.4.1 Receiver performance

Before mounting the different equipment on the experimentation site, laboratory measurements gave the following performance for the receiver for signal level/BER at 757 MHz:

TABLE 2 .6

**Return channel receiver performance**

| Rx level (dBm) | BER after 5 min |
|---|---|
| > –40 | Sync loss (receiver saturation) |
| –42 | $2 \times 10^{-2}$ |
| –47 | $2 \times 10^{-4}$ |
| –53 | 0 |
| –63 | 0 |
| –73 | 0 |
| –77 | $2 \times 10^{-5}$ |
| –83 | $2 \times 10^{-4}$ (sensibility threshold) |
| –87 | $1.5 \times 10^{-3}$ |
| –93 | $1.6 \times 10^{-2}$ |
| < –93 | Sync loss |

It can be seen that a 36 dB dynamic range [–47 to –83 dBm] is available for BER measurements down to $1 \times 10^{-4}$.

##### 2.4.1.4.4.2 Spectrum plots

FIGURE 2.8

**Channel 56 spectrum allocation in a free zone between L-NICAM and L-sound sub-carriers**

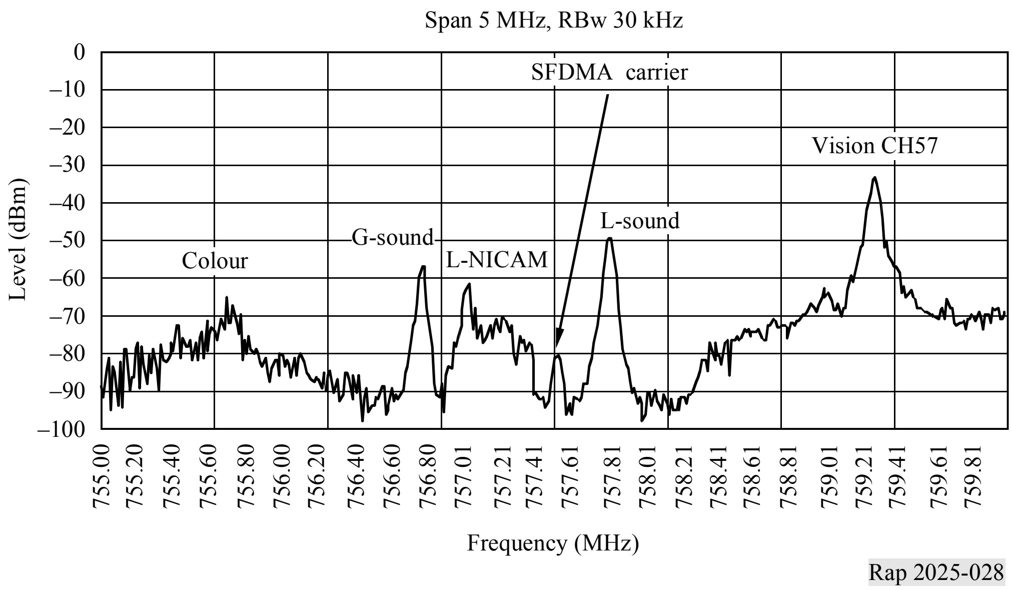

FIGURE 2.9

**Zoom on the same zone**

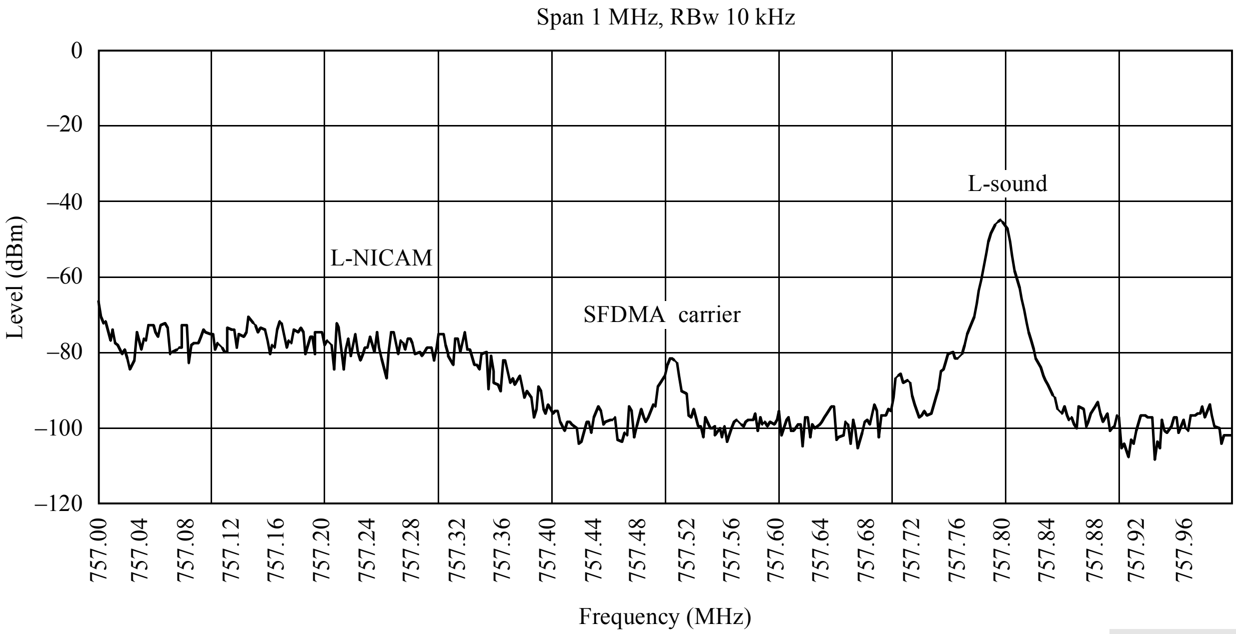


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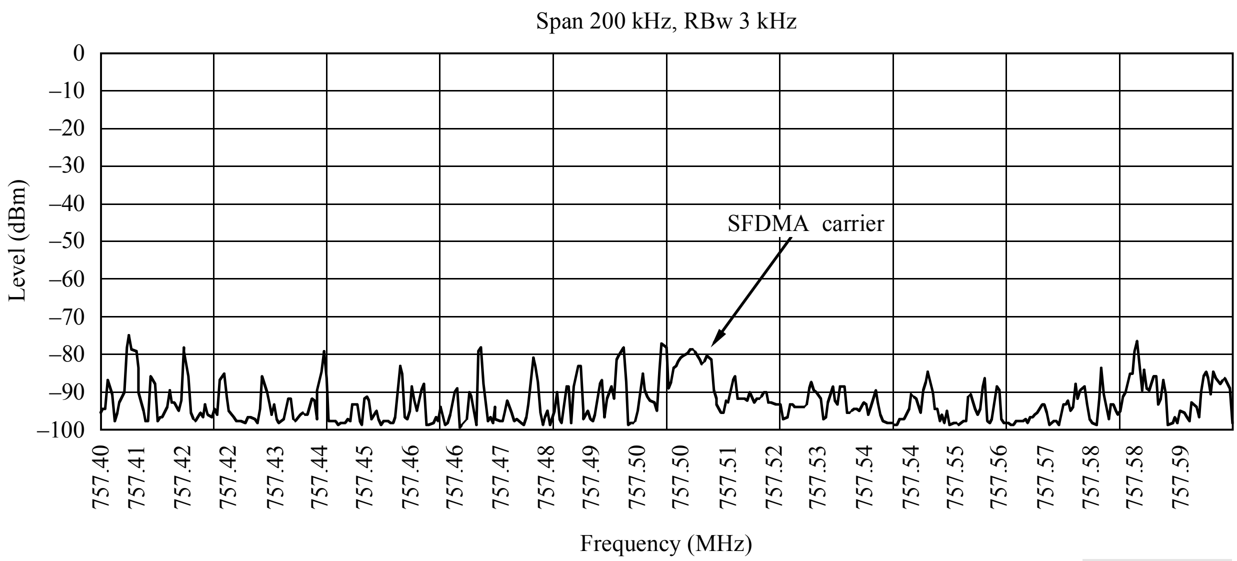
FIGURE 2.10

**Further zooming + max hold showing the presence of multiple interference due to intermodulation products and mast lighting discharges**

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#### 2.4.1.4.4.3 Test points location

TABLE 2.7

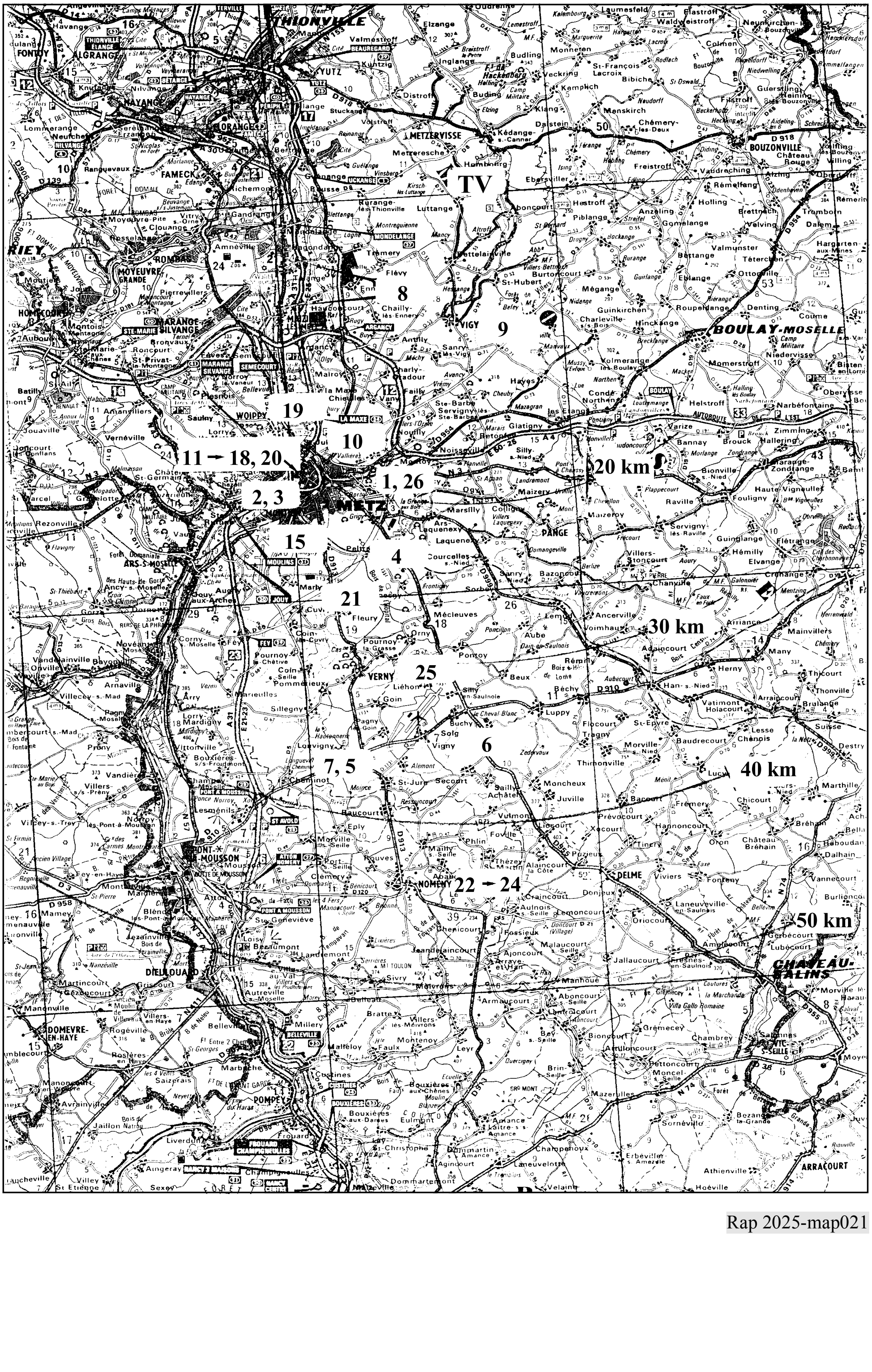
**Locations of the 26 test points in and around Metz**

| Point | Location | Coordinates | Distance (km) | Azimuth (degrees) | Propagation profile |
|---|---|---|---|---|---|
| 1 | TDF-C2R Parking | N 49°06'35" E 6°13'45" 198 m | 19.7 | 19 | Obstructed |
| 2 | Moulins cimetière | N 49°06'14" E 6°06'30" | 24.5 | 38 | Obstructed |
| 3 | Scy-Chazelle Champion | N 49°06'31" E 6°06'60" | 24.5 | 40 | Obstructed |
| 4 | Peltre stade | N 49°4'37" E 6°13'11" | 23.36 | 18 | Obstructed |
| 5 | Louvigny église | N 48°57'50" E 6°10'52" 330 m | 36.3 | 16 | Half clear |
| 6 | Vigny | N 48°58'20" E 6°14'49" 200 m | 34 | 16 | Clear |
| 7 | Cheminot mairie | N 48°56'57" E 6°08'17" | 39 | 20 | Clear |
| 8 | Flévy, arrêt de bus monument aux morts | N 49°14'19" E 6°14'29" 72 m | 7 | 52 | Clear |
| 9 | Vigy gare | N 49°12'14" E 6°17'26" 435 m | 8.4 | 13 | Clear |
| 10 | Saint-Julien rue des Pins | N 49°7'59" E 6°12'40" 198 m | 18 | 26 | Obstructed |
| 11 | Metz Borny caserne Brioux | N 49°07'11" E 6°12'41" | 19 | 24 | Half clear |
| 12 | Metz Plantières ancienne rue de Didier Frossard | N 49°06'45" E 6°12'01" | 20.2 | 25 | Obstructed |
| 13 | Metz gare parking Sernam | N 49°06'29" E 6°10'43" | 21.3 | 28 | Obstructed |
| 14 | Metz Sablon rue Mangin | N 49°06'08" E 6°09'53" 111 m | 22.4 | 30 | Clear |
| 15 | Montigny Commissariat | N 49°06'10" E 6°09'05" 141 m | 22.8 | 32 | Half clear |
| 16 | Metz Pontifroy UEM | N 49°07'45" E 6°10'22" 129 m | 19.5 | 32 | Clear |
| 17 | Metz Pontifroy rue Lardemelle | N 49°07'42" E 6°10'45" 84 m | 19.4 | 31 | Obstructed |
| 18 | Metz Devant les Ponts place du 14 juillet | N 49°07'49" E 6°08'45" 219 m | 20.6 | 37 | Clear |
| 19 | Woippy place de la mairie | N 49°09'06" E 6°08'53" 87 m | 18.6 | 41 | Clear |
| 20 | Queuleu, en face de chez Pierre Kasser | N 49°06'5" E 6°11'16" 177 m | 21.7 | 26 | Obstructed |
| 21 | Marly parking Leclerc | N 49°04'05" E 6°08'31" 330 m | 26.5 | 29 | Half clear |
| 22 | Nomeny centre émetteur | N 48°53'03" E 6°13'29" 321 m | 44.2 | 8 | Obstructed |
| 23 | Nomeny quai Emile Benoit | N 48°53'23" E 6°13'29" 228 m | 43.7 | 9 | Obstructed |
| 24 | Nomeny rue sous les vignes | N 48°53'24" E 6°13'14" 243 m | 43.7 | 9 | Obstructed |
| 25 | Verny, collège entrée du village | N 49°00'19" E 6°11'56" 201 m | 31.5 | 16 | Obstructed |
| 26 | TDF-C2R, salle de conférence, antenne – demi onde accordée | N 49°06'35" E 6°13'45" 198 m | 19.7 | 19 | Obstructed indoor |

All the points are located in an area where the directional return link receiving antenna has its maximal gain.

#### 2.4.1.4.4.4 Map showing locations of test points

**Locations of the return channel test transmission points in the Metz area**

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#### 2.4.1.4.4.5 Service Range

The service range given in Fig. 2.11, for the four SFDMA transmission modes, can be calculated using Table 2.8 that includes RF figures derived from current DVB-T user-side assumptions (as antenna locations, gains, etc., in the fixed and portable modes) and propagation model assessments for rural and urban areas.

FIGURE 2.11

**Theoretical service range (km) for the different transmission modes from 0 dBm (1 mW) to +30 dBm (1 W)**

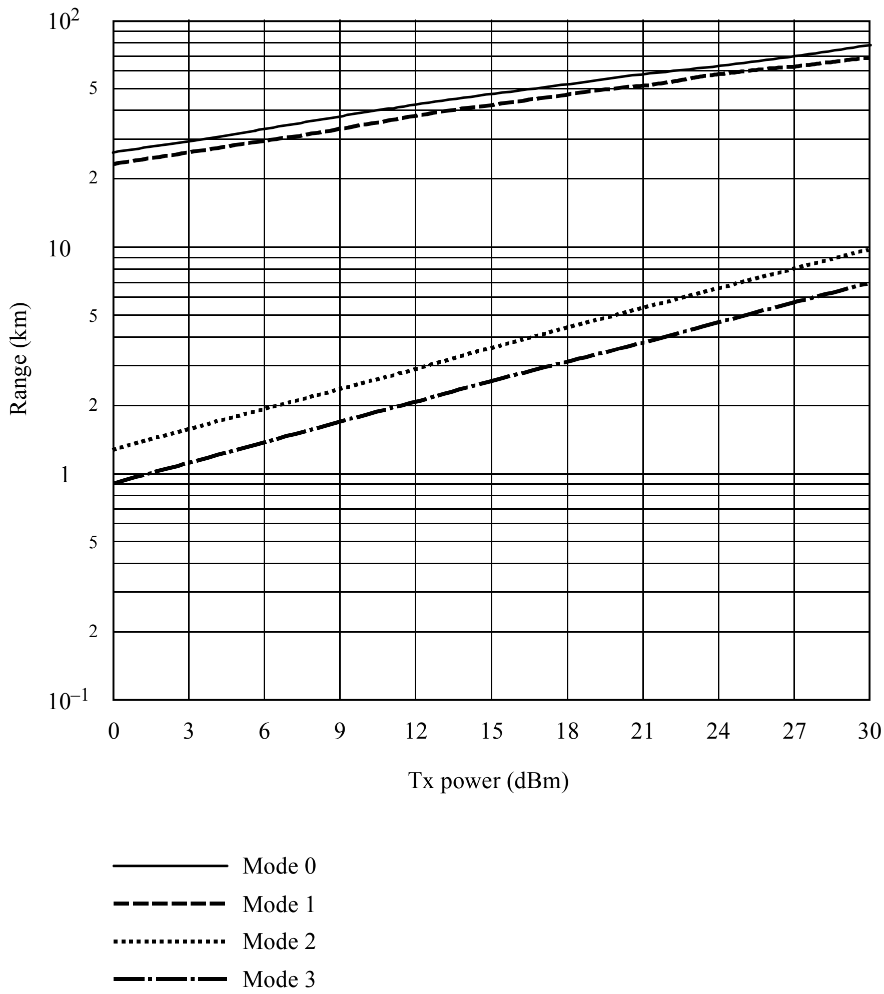


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TABLE 2.8

**RF figures for the service area determination in the four transmission modes**

| Transmission modes | Mode 0 | Mode 1 | Mode 2 | Mode 3 |
|---|---|---|---|---|
| Antenna location | Outdoor/fixed DVB-T mode | | Indoor/portable DVB-T mode | |
| Frequency (MHz) | 800 | 800 | 800 | 800 |
| Bandwidth | 500 Hz | 1 kHz | 4 kHz | 16 kHz |
| Modulation scheme | π/4D_QPSK | | π/8D_8PSK | |
| *C*/*N*, *CR* = 3/4 for BER = $1 \times 10^{-4}$ (dB) | 10 | | 15 | |
| Height of the receiving antenna (m) | 150 | | 50 | |
| Gain of the receiving antenna (dBi) | 13 | | | |
| Receiver and antenna noise figure (dB) | 2 | | | |
| Min received level (dBm) | –135 | –132 | –121 | –115 |
| Transmitting antenna height (user side) (m) | Outdoor 10 | | Indoor 10 | |
| Transmitting antenna gain (user side) (dBi) | 13 | | 5 | |
| Cable loss (dB) | 4 | | 0 | |
| Diplexer loss (dB) | 4 | | | |
| Indoor penet. loss | – | | 15 | |
| Propagation models | Rec. ITU-R P.370 | | OKUMURA-HATA suburban | |
| Margin 50% location > 70 and 90% | 13 dB (90%) | | 5 dB (70%) | |
| Service range for 30 dBm transmission power (km) | 77.5 | 70 | 10 | 7 |

#### 2.4.1.5 General conclusions

– Two field trials of the SFDMA UHF return channel were set up in Rennes and in Metz (France), at real and operational high-power broadcast transmitting stations; their configurations are described above.

– The experimentation using both the Metz and Rennes test platforms has shown results confirming the general feasibility of the SFDMA system as a return link access in UHF channels;

  furthermore:

  – the feasibility of the reception of infinitesimal signals (–120, –130 dBm for a 1 kHz bandwidth) at a principal UHF broadcasting site (with ERP transmitted powers in excess of a Megawatt) has been proven,

  – the results are consistent with the theoretical calculations made on the RF parameters and the proposed transmission power required to enable a service range compatible with the TV reception: in a rural environment and in the most secure transmission mode (QPSK with 1/2 coding rate): 1 Watt for a range up to 70 km.

– The theoretical SFDMA system tolerances have been proven to be valid by an exhaustive comparison with the laboratory tests.

– But important developments and trials are still ahead!

In the future, further trials need to be performed in order to:

– consolidate the different RF parameters, with an optimized metrology

– test new transmitting configurations such as the indoor-mode

– improve the system performances in the urban environment (by implementing relay stations...).

Last, but not least, the integration of the SFDMA return channel into the DVB-T system (while fulfilling the system requirements) will have to be proved feasible: this is one of the aims of the 18-month iTTi (Interactive Terrestrial Tv Integration) ACTS project which began work in March 1998.

The DVB group is being kept informed of progress, and it should be noted that any future move towards standardization of the system will in due course be at the discretion of the DVB group.

### 2.4.2 Digisat demonstration

During the TELECOM INTERACTIVE' 97 international event, held in Geneva from 8 to 14 September 1997, the DIGISAT project carried out the first worldwide live demonstration of the return channel via satellite for SMATV systems. The demonstrations performed allowed visitors to Palexpo (Geneva) to access, via a DVB-RC based satellite return channel, a WWW local server located in Arganda (Madrid-Spain). This server was integrated with the required application for managing a multi-access performance and with a number of WWW local pages. These demonstrations were performed in accordance with the TR 101 201 DVB-RC document.

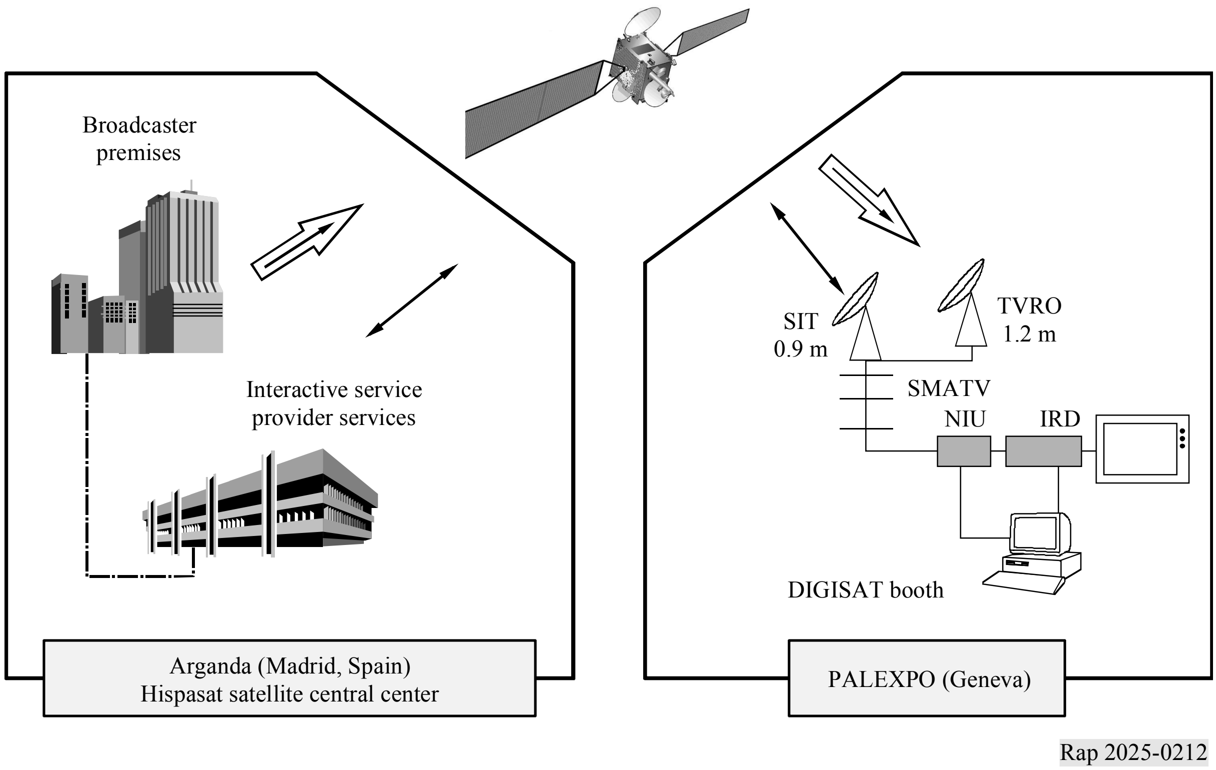
At HISPASAT SCC in Arganda (Madrid), the interactive server was connected to the Master Station (HUB). When a request from a user was received by the server, the server identified which user was requesting and forwarded the addressed information to the DVB-S chain (the user received the Forward Interaction Path which was embedded into the DVB-TS), which was received in Palexpo (Geneva) through the data output of the DVB-IRD connected to the client PC.

The Forward Interaction Path was embedded into the DVB-S Transport Stream following the DVB specification for data broadcasting (see Fig. 2.12).

FIGURE 2.12

**DIGISAT system implementation**

(DIGISAT demonstration)




The satellite section of the interactive system was based on a CDMA satellite network for the specific implementation performed in DIGISAT, with SITs working in the Ku band (14/11-12 GHz). The following key points define the satellite section used for the interactive system demonstration:

– CDMA satellite multiple access technology.

– Satellite channel access control mode based on Slotted-Aloha protocol.

– Antenna sizes: 1.20 m for the HUB located at Arganda and 0.90 m for the SIT located at Geneva (see Note 1).

– SIT power amplifier level: 2 W.

NOTE 1 – This specific configuration was used for the Demo. In Operational conditions the SIT antenna size can be reduced to 55 cm and the amplifier power level to 0.5 W following the analysis performed in DIGISAT.

Regarding the Interactive System Coaxial Section, the demonstrated prototype equipment was based on a subset of the options provided by the DVB-RC-CATV specification (ETS 300 800). The Coaxial Section Grouping Terminal and two IIMs based on PC platforms were available for transporting the visitor interactive requests to the satellite section.

The interface between the satellite and coaxial section is based on RS-232 and SLIP (Serial Line IP) communication protocol between both sides as recommended in prTR 101 201.

After DIGISAT Project, S3M gave an step further in the development and introduction of interactive services via satellite: S3M project (March 1998-December 1999) has developed and tested a return channel system via satellite for SMATV particularized for small SMATV installations. The project has tested and demonstrated in several public events during 1999 the technical and economical viability of a return channel via satellite where the advantage is the share of the infrastructure cost among all the users in a building. The S3M project has also cooperated in the ITU-T SG 9 in the production of the draft Recommendation J.118 (J.smatv/matv).

# 3 North America

## 3.1 Development of Interactive Television Systems in Canada

Canadians are early adopters of advanced technologies and spend a high percentage of their disposable income on new technology and services. Therefore, it is expected that Interactive Television Systems will be introduced in Canada in the near future. These systems are being developed, in parallel, with the introduction of digital television services.

### 3.1.1 Digital television in Canada

Canada is on the way to digitize its television distribution systems. Digital television services are already available from one DBS and one direct-to-home (DTH) satellite programme providers. Digital Television Terrestrial Broadcasting (DTTB) in the UHF-VHF band is expected to begin before the year 2000 using the Advanced Television System Committee (ATSC), A-53 standard. Digital television will also be available on cable television networks. Licences have been issued to Multipoint Distribution Systems (MDS) operating in the band between 2.596 and 2.686 GHz and to Local Multipoint Communication Systems (LMCS) in the band between 27.35 and 28.35 GHz. Both will provide digital television broadcasting and are planning to offer interactive services.

### 3.1.2 Interactive Television in Canada

Some Interactive Television services are already available in Canada. The oldest one is the teletext service (ITU-R Teletext System C) which provides local interactive services (no return channel) using data transmitted in the Vertical Blanking Interval of the NTSC television signal. Two overscan (i.e., data at the edge of the picture) and two sub-video (i.e., data spread within the video signal) methods of ancillary digital data insertion within the analogue television signal were approved in 1997. Two-way data services are also available from some cable television operators. They provide high data rate to the home for services such as Internet access.

In Canada it is expected that interactive services will be available soon after the introduction of digital television distribution through DTTB, cable television networks, MDS and LMCS. High-speed data transmission via satellite is already available to provide video news-on-demand services to personal computers. Interactive services will be provided soon by satellite television direct broadcast services (DBS).

The Communication Research Centre is collaborating with the European Space Agency (ESA) to conduct a study for the creation of a testbed to be known as BESTLAB (Broadband ESA Satellite Testbed Laboratory). It will be a multi-node distributed broadband satellite communications laboratory for multimedia satellite applications and technologies.

A serious concern for the new interactive services is the need for interoperability between these various medium. For example a DTTB transmission may be picked-up by a national satellite programme provider that may distribute the programme including the interactive data to cable networks, as well as to MDS and LMCS networks. At the other end, the user may wish to receive the interactive data from any of these medium and reply to it using the return channel of his choice. Compatibility, or at least harmonization, is very desirable. The importance of interoperability was also stressed in the recommendations of the Task Force on the Implementation of Digital Television in Canada.

Canada is therefore monitoring and, as much as possible, is participating in the work of various groups around the world dealing with interactive television. Of special interest to Canada are the following groups:

– ATSC Specialist Group T3-S13 on Data Broadcasting which issued a first draft specification on Data Broadcasting for Terrestrial Broadcasting and Cable distribution in November 1997.

– ATSC Specialist Group T3-S16 on Interactive Services.

– European Digital Video Broadcasting (DVB) Project on Data Broadcasting, the recommendation of which was approved on 2 May, 1997.

– European DVB project Working Group on System for Interactive Services which proposed Interaction Channels for Cable Television (CATV), Public Switched Telephone Network (PSTN) and ISDN.

– Radiocommunication Study Group 11 Task Group 5 on Interactive Television.

– Telecommunication Standardization Study Group 9 Working Party 1 on Interactive Cable Television Services.

– Radiocommunication Joint Working Party 10-11S.

There has also been significant interest in the experiment being carried out by the European INTERACT project using spectrum within the television UHF broadcast band for the return channel of interactive services. Considering, however, the desire in North America to re-allocate some of the UHF television spectrum to other services, any requirement for spectrum in the UHF band that could be allocated for a return channel for interactive television services would need to be identified as soon as possible.

There is a high probability that most messages coming from the end-user will be sent over the public switched or cellular telephone networks which are both widely available in North America. Some transmissions could also take place over LMCS networks as the spectrum allocated to these services is not restricted to one-way transmission only. Dealing effectively with data coming from the end-users' interactions will require that wireless systems service area be relatively small to limit the number of users sharing the same facilities and to avoid the need for powerful transmitters in consumer equipment.

For similar reasons direct interaction via satellite is not expected to be widespread except in some remote areas of Canada where distant education and remote diagnostic have been successfully tested.

### 3.1.3 MDS, MCS and LMCS in Canada

For many years multichannel broadcasting of video, audio and data, has been done using coaxial cable. Only recently, terrestrial microwave transmitters operating at frequencies ranging from 2 to 45 GHz, have become available for multichannel broadcasting.

Multipoint Distribution Systems (MDS), Multipoint Communication Systems (MCS) and Local Multipoint Communication Systems (LMCS) are systems using terrestrial microwave transmitters operating between 2 and 45 GHz. These broadband wireless systems are also known outside Canada as Multichannel Multipoint Distribution System (MMDS), Local Multipoint Distribution System (LMDS) and Multipoint Video Distribution System (MVDS).

These wireless systems typically operate over a bandwidth from a few dozen megahertz for MDS to more than one GHz for LMCS. A target reception area is typically covered by many transmitters, often in a cellular configuration for LMCS. This cellular configuration reduces transmission power requirements and makes it easier to provide two-way communication. The size of the cells will depend on the frequency of operation. The receiving installation is fixed and typically uses a roof-top directional antenna and an existing satellite or cable receiver with a suitable down converter.

These broadband wireless systems can either be complementary or competitive to established wired services such as telephone and cable television. In North America for example, they will compete with widely available existing services. In countries where telephone or cable television services are not as widespread, wireless broadband systems can be used to quickly make them available to a large population.

#### 3.1.3.1 Broadband wireless services

So far, the main service provided by broadband wireless systems has been television programmes. Transition from analogue transmission to digital is making it possible to increase the number of programmes available. Digital transmission also provides an easier way to offer services such as pay-per-view or even video-on-demand due to the relative ease with which encryption and conditional access can be provided with digital technologies.

Given its cellular and local nature, broadband wireless systems can be designed to enable two-way communications. Services such as Internet access or telephony are possible. Typically the data rates will be different for the transmission from the hub to the subscriber than for the reverse. For example, rates in the order of 10 megabits/sec for the downlink and 10-20 kilobits/sec for the uplink could support a large number of different applications. These systems could provide a wireless extension to Local Area Networks which can carry voice, data and video using a new control layer protocol. They could also be used as the backbone transmission system for Personal Communication Systems (PCS). These systems may also be used to support video services for specialized applications such as telemedicine or video teleconferencing. A return video channel can also be used to provide security or traffic monitoring.

#### 3.1.3.2 Some technical considerations

Implementation of broadband wireless systems will need to take into consideration a number of restrictions due to the propagation of signals at these frequencies.

Most of the time microwave signals can be received only if the transmitter antenna is in line-of-sight of the receiving antenna. Reflections from the ground or buildings may suffer too much attenuation to provide a satisfactory reception.

Signal attenuation due to path loss increases with the frequency of operation. At the higher frequencies, vegetation absorption has to be taken into account. Moisture, rain or snow will also cause significant attenuation at operation above 10 GHz. Rain rate and drop size distribution can be used to predict the attenuation. These are particularly annoying effects as they vary with weather conditions. Areas with heavy rain or snow precipitation may require a more robust implementation than in an area with a drier climate.

#### 3.1.3.3 MDS

At the moment, the most widely used broadband wireless systems are MDS. Most MDS operate in the 2.5 GHz band. Earlier implementations have used analogue transmission methods, such as Amplitude Modulated Vestigial Sideband (AM-VSB), to transmit video programmes. Transition to digital transmission is now taking place mostly using a version of QAM. There has been extensive licensing of MDS in Canada, primarily for wireless cable services. Licences have been granted in the provinces of Manitoba and Saskatchewan, southern parts of the province of Ontario, the National Capital Region and major centres of the province of Quebec. All these systems are in operation at the present time.

Frequency of operation of MDS in Canada is between 2.596 to 2.686 GHz which will support up to fifteen 6 MHz channels. At these frequencies the cell size can be quite large, from 15-60 km radius. The maximum e.i.r.p. allowed is 1.585 W/channel (32 dBW). Typical waveguide loss is 3 dB and the transmit antenna gain is 12-15 dB. Receiving antenna diameters range from 0.3 m and 0.8 m with gains from 15 to 24 dB. The down-converter has a 4 to 8 dB noise figure and converts the signal to TV frequencies (cable or UHF).

#### 3.1.3.4 MCS

The frequency band 2.500-2.596 MHz has been available for MCS applications for many years, under the provisions found in the Microwave Spectrum Utilization Policies in the Range of 1-20 GHz. Until recently, the Department had received relatively few comprehensive applications for the development of MCS in this band. However, the prospect of increased competition in the provision of local telecommunication and broadcasting distribution services, the demand for Internet service, and advances in digital MCS technology have provided new business opportunities in the use of this band for the distribution of both telecommunication and broadcast services.

#### 3.1.3.5 LMCS

Local Multipoint Communications Systems are also called Local Microwave Communications Systems or Last Mile Connection Systems. In October 1996, Canada issued LMCS licenses to three different organizations selected among 13 proponents. WIC Connexus and Digital Vision will each serve 33 urban markets. The third organization, Regional Vision, will cover 127 small communities. Each organization has been allocated the band between 27.35 and 28.35 GHz. The band 25.35 to 27.35 GHz of spectrum will be licensed in the future. LMCS in Canada will be in competition with cable television, telephone networks and satellite systems.

QPSK modulation has been tested in Calgary and Toronto on LMCS networks operating at 28 GHz. A digital signal from a satellite was up-converted in frequency for transmission. At the reception site, the signal was down-converted and fed to a satellite video decoder. The service was found to be fully satisfactory. QPSK modulation is more robust to phase noise and interference than higher order modulation such as 16-QAM and above, but requires more spectrum to transmit the same amount of data.

Tests were also carried out at the Communications Research Centre (CRC) in Canada, to evaluate the performance of another digital modulation technique, Coded Orthogonal Frequency Division Multiplexing (COFDM), for LMCS. These laboratory and field tests were conducted using a prototype 6 MHz COFDM-6 modem and a LMCS transmitter-receiver. The results of laboratory and field tests have shown that COFDM can be used for LMCS applications. The laboratory results also show that the main advantage of using COFDM is the ability to deal with strong ghosts.

### 3.1.4 Interactive Mobile Datacasting using Digital System A (Digital Audio Broadcasting)

In September 1997, the Communications Research Centre (CRC) in Ottawa, Canada, launched a multi-year project to investigate the capability of the Digital Audio Broadcasting System A (DAB) technology to provide reliable interactive multimedia services to portable and mobile wireless receivers. A secondary objective of this project was to demonstrate that DAB had the potential to become a major component of the Canadian Information Highway when integrated with the existing and future wireless telecom infrastructure. Since DAB is an all digital technology, it can be considered as a robust pipeline carrying data at rates in the vicinity of 1.2 Mbit/s to the radio receiver. Its relatively wide bandwidth and its robustness in the mobile environment make it the best option to economically transmit large data files to a multitude of receivers. When combining this downstream point-to-multipoint data channel to a narrow point-to-point upstream channel such as PCS (Personal Communications System, which is used here as a generic term for highly portable two-way telecommunications devices), the service becomes bidirectional and true interactivity can be offered.

This DAB datacasting project will generate scientific data on the transmission channel characteristics and the required level of bit error correction for suitable performance of the multimedia services in a mobile environment. It will also yield information on the feasibility and difficulty of integrating four technologies: DAB, PCS, GPS (Global Positioning System) and computer technologies. Credit must be given to the MEMO project in Europe, which instigated this system concept in 1994. The MEMO project and other similar projects (HumiDAB, ERTICO, MOTIVATE, MoMuSys) are an important source of information for those involved in the Canadian project. However, there are significant differences between Canada and Europe in areas such as the telecommunications infrastructure and the broadcasting regulatory environment, which must be considered in the development of new multimedia mobile services. It was also considered important to incorporate hardware and software technology which has already been developed by Canadian companies. Lastly, having to develop such a system is probably the best way to fully appreciate the technical challenges hidden in this promising system concept.

This section describes the demonstration system in its current state and gives a preview of the future activities of this project. It is hoped that the information presented herein will be useful in the context of a new ITU-R Question on this topic.

#### 3.1.4.1 Potential data services carried by DAB

A wide variety of applications and services can potentially be offered and carried by a mobile datacasting service. Some services are simply data services in the sense that they are downloaded to the receiver either in a data stream or in packets. Their content may be simple paging messages but they could also be multimedia information characterized by images or even video accompanying text and sound. Interactivity is an extra level of sophistication that will enhance greatly some of the services. This, however, automatically raises the issue of addressability and security in the communications. Conditional access and billing will be an inherent part of the interactive multimedia system. Applets, which are small software applications that execute themselves on the receiver computer (or application decoder), will also be common in a not so distant future. Examples of datacasting services include Intelligent Transportation Systems (ITS) applications such as traffic information, tourist information and route guidance for travellers, paging/e-mail two-way services, emergency warnings, assistance to delivery vehicles, instant access to news and weather information from the World Wide Web and access to pre-selected web sites.

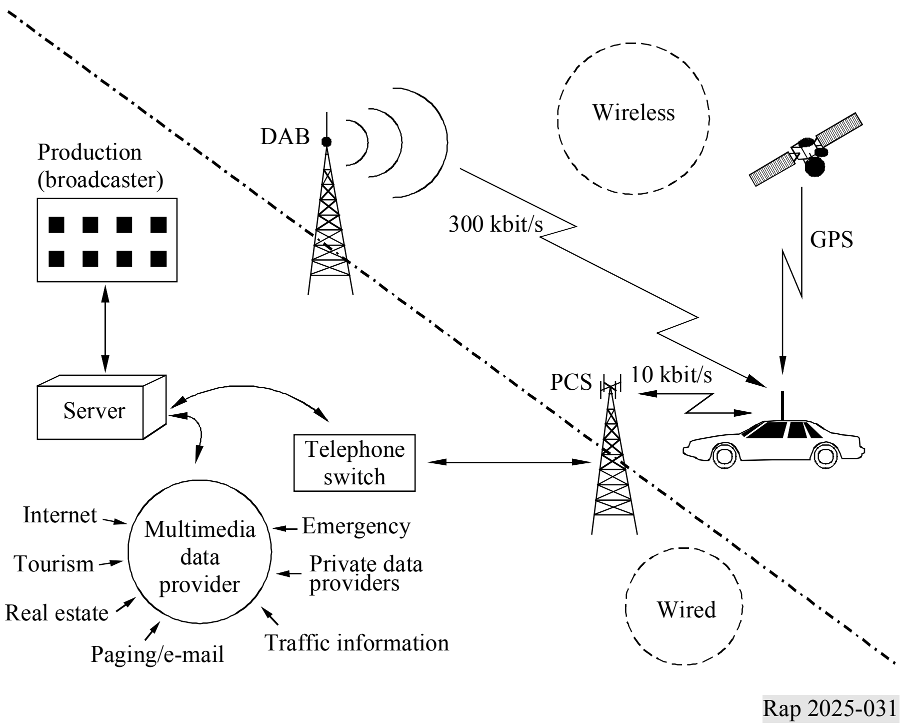
The most appropriate applications for datacasting via DAB are those which share two main attributes: they provide information that is desired by many mobile users, and they are characterized by asymmetry of the data flow. It is interesting to note the parallels between wireless datacasting and the evolution of the wired network. In the latter, more and more emphasis is being seen on broadcasting types of applications using server push technology and multicast routing. A true digital broadcasting system is an inherently more efficient means of carrying such applications, and it brings with it the advantage of mobile and portable access. Another strong trend is the introduction of multimedia services in PCS-type wireless systems. DAB can complement these systems by providing a higher-bandwidth data pipe and a highly effective medium for delivering time-critical data to many users simultaneously. Some datacasting applications, particularly in the ITS area, are viable without a return link; however, the option of having a lower-bandwidth return link increases the scope of the applications considerably.

### 3.1.4.2 The system concept

The basic concept (Fig. 3.1) is to make the Wired world accessible to the Wireless world through the combined use of DAB and mobile/wireless packet data systems. The connection between the two worlds is made by introducing a Datacasting Server which provides the interface between the information (or content) providers (mostly Internet but also other types of multimedia data services) and the two communication infrastructures, the radio broadcasting system and the telecommunication system. The Multimedia Data Provider gathers data services from the various sources whose content is appealing to users in motion. This data is channelled to the Datacasting Server which prepares this data for transmission either over DAB or via the narrow-band telecom link (telephone switch and then wireless packet data network, here labelled PCS) to the mobile unit. A return link is provided at the mobile unit by the wireless data network service. The mobile terminal is able to integrate DAB data and audio, GPS (Global Positioning System) and two-way PCS services through a rather complex but user-friendly MMI (man-machine interface), common to all services.

FIGURE 3.1

**The system concept: integrating two wireless technologies to expand the Internet from the wired to the wireless world**




Rap 2025-031

#### 3.1.4.3 The experimental system

A first prototype of this interactive/multimedia mobile datacasting system has been developed. In May 1998, access to Internet services was demonstrated while driving the demonstration vehicle around. A number of industry partners have accepted to participate in this project by contributing their hardware and software products. Although most of the system components and a good portion of the software are items commercially available, not all the components could be found and some software had to be created to complete the integration of the system. This development is ongoing but at the time of writing, the experimental system has the following characteristics:

– Downlink: Up to 320 kbit/s of stream data using Eureka-147 DAB standard;

– Uplink: Up to 4.8 kbit/s using a packet data wireless communication system;

– Audio: Up to 5 CD-quality stereophonic programmes per DAB channel (trade off with data capacity);

– User interface: Easy to use software in a menu-driven web browser environment that integrates a touch screen, voice synthesis, keyboard and mouse.

– A number of additional functions will be added later in the course of the project, including:

  – Voice recognition for hands-free control;

  – Addressability and conditional access;

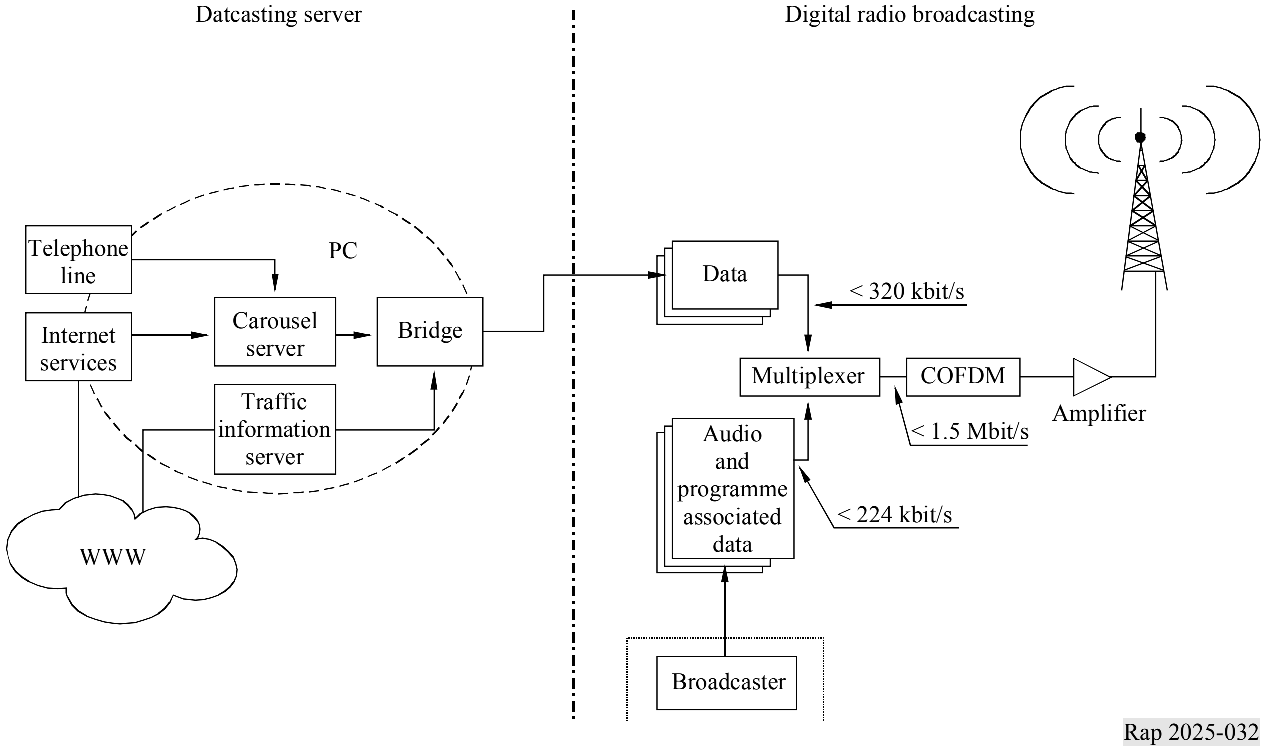
  – A GPS receiver to provide route guidance and geo-coding capabilities.

#### 3.1.4.4 The transmission system

Figure 3.2 shows a simplified block diagram of the complete transmission system. The Datacasting Server and the DAB transmission facilities used for this experiment are part of the Experimental DRB System in Ottawa (see the corresponding web site: http://www.drb.crc.ca/ottawa) and the CRC DRB Testbed.

FIGURE 3.2

**Block diagram of the transmission system**



### 3.1.4.5 The mobile terminal

The Mobile Terminal is still under development. Its current configuration includes two DAB receivers, a computer and a packet data radio modem. The man-machine interface (MMI) consists of a 15" touch screen display complemented by a small keyboard and a trackball pointing device. Figure 3.3 illustrates the concept that is represented by the current experimental implementation, except for the GPS component which will be added later during the research programme. Figure 3.4 shows the MMI mounted on the Mobile Terminal.

FIGURE 3.3

**Simplified block diagram of the mobile terminal**

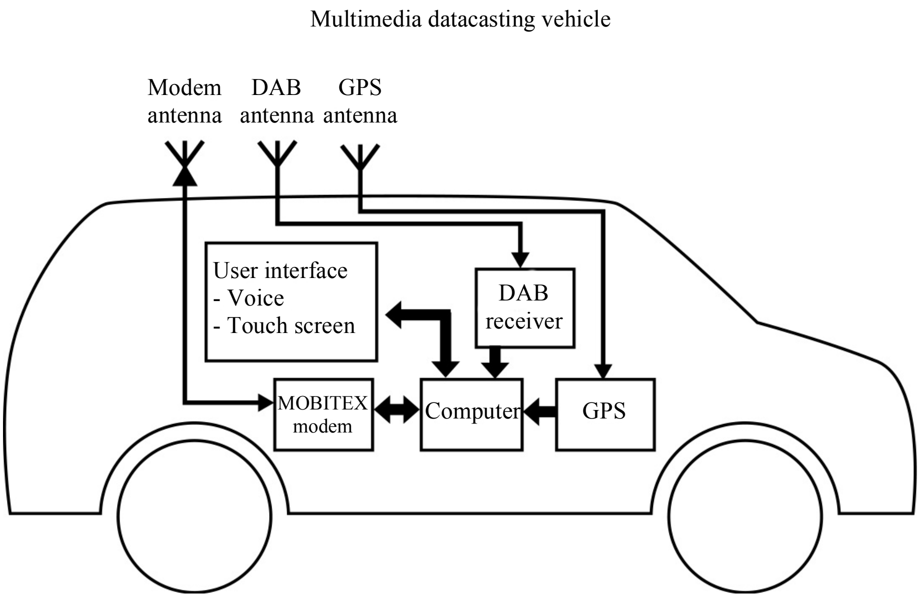



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FIGURE 3.4

**Mobile terminal**

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#### 3.1.4.6 The return link

The return link uses a wireless data network available across Canada. In order to minimize set up and connection time, it was decided to use a packet switched network instead of a dial up service. In the future, a more voice-oriented PCS network could also be used. This would allow reuse of devices that are more accessible to the general public. Also being explored is the possibility of making a more efficient use of the narrow-band downlink to transmit data that does not need to be on the DAB downlink. As an example, the wireless data network infrastructure in Ottawa allows transmission of up to 4.8 kbit/s. When inside the network's coverage area, a request through the radio modem uplink reaches the Datacasting Server within 5 to 15 s. More investigation will be done on uplink latency. Additional latency in the carousel (part of the Datacasting Server) makes the loop time depend on: the service priority, the position in the transmission sequence and the volume of data to be transmitted within one carousel cycle.

#### 3.1.4.7 Demonstrations

The experimental system was demonstrated publicly for the first time at CRC in Ottawa, on 6 February, 1998. A video programme was successfully transmitted and received via the independent data channel. By 27 March, all system components, except GPS, had been integrated and the proof of concept was achieved. Since then, the software and services have evolved but the concept has not changed. The current installation of the terminal is such that it occupies the place of the right seat at the front of the demonstration vehicle. During the course of the year, this vehicle was demonstrated to the wireless community (May 1998) and to the broadcasting community (Nov. 1998). One interesting outcome of these demonstration activities is that certain sectors of the potential market for mobile datacasting services have already reacted positively to the prospect of equipping their vehicles with such receivers.

#### 3.1.4.8 The scientific program

On the scientific side, the research effort is focusing on the need to characterize bit error statistics for datacasting services. The error protection and coding methods suitable for audio services may not be appropriate for data services. Content and Service Providers will need guidelines to adapt their data to this new medium by choosing the appropriate error protection method for a specific data service. The field and laboratory measurements will help to determine and quantify the distribution of isolated and burst errors. Protection methods will be evaluated according to criteria such as increased robustness, additional overhead required, etc. Coverage measurements will also be carried out to compare the coverage achieved by the audio services with that of the datacasting services.

#### 3.1.4.9 Future activities

The demonstration system has been useful to show a concept, but the most important issues remain unresolved. Technical issues needing investigation include:

– Data capacity truly available on the DAB system in various situations.

– Data traffic/volume considerations versus requirements by users and service providers: data rates, size of data files, access time, redundancy, need for confirmation, sensitivity to errors, congestion handling, latency, priority/urgency, etc.

– A decision process to determine when to use DAB or wireless communication to download a file to the mobile user.

– Techniques for addressability, conditional access, billing and security for unique users and closed user groups.

– Methods to interface datacasting services with DAB and to control the data multiplex.

– DAB receiver readiness for multimedia datacasting (i.e., receiver features needed to support interactive multimedia datacasting).

#### 3.1.4.10 Conclusion

It is believed that once the Canadian DAB infrastructure has been deployed, the datacasting services will be introduced gradually, possibly for commercial entities first, and later for the general public. This will bring a potential for growth in the software and hardware manufacturing industry and in the IT industry sectors who will opt to pioneer the provision of multimedia services to mobile receivers. DAB is indeed an obvious choice to reliably provide information to moving vehicles. Consequently, DAB will be a fundamental element of the implementation of ITS (Intelligent Transportation Systems) services in Canada. The Mobile Datacasting demonstration system is the result of a fruitful collaboration between CRC and various Canadian partners. It was successfully demonstrated to the two industry sectors involved, wireless telecom and radio broadcasting. Many companies already have products that can be integrated into this new medium. (See also: Voyer, R. and McLarnon, B., An interactive mobile datacasting system. Fourth International DAB Symposium, Singapore, January 1999: and the CRC's web site on datacasting: http://www.drb.crc.ca/datacasting/.)

### 3.1.5 Canadian perspective on the European INTERACT project UHF Return Channel

INTERACT (see Document 11-5/3) is a European series of projects for the development of interactive services with the goal to develop a system to look for possible standardization of interaction channels and to complete field trials of this system.

This text discussed the potential of using of a UHF return channel and the two field trials in Rennes and Metz. (See § 2.4 to 2.1.4.5)

#### 3.1.5.1 Canadian Interest

Canada is monitoring the progress of these projects, especially the use of a UHF channel as a two-way channel for interactive television services. With DTV planned to go on-air soon in Canada, broadcasters will naturally want to offer new services to maximize the return on their investment. Being able to offer interactive services without the need of another transmission medium could make it easier to start new interactive services.

At the time of writing, regulatory concerns have not been taken into consideration. Currently, the Canadian interest is purely technical. The proper regulatory organizations, will need to study and decide if spectrum should and could be assigned to this two-way data service and how.

#### 3.1.5.2 Brief Description of the INTERACT UHF Return Channel

This system offers three types of interactive services: a broadcast service, a connection-oriented service and a connectionless service. The proposed standard consists of a series of protocols following roughly the OSI Layers.

The signal being transmitted on the return channel consists of bursts of data, using SFDMA (Synchronous Frequency Division Multiple Access) and Time Division Multiplexing. The symbols are encoded with D-QPSK or D-8PSK modulation.

There are 4 modes of operation for different levels of robustness and depending on the end user receiving conditions, indoor or outdoor. The mode of operation is chosen according to the application requirements. Essentially, it becomes a matter of trade-off between robustness and data capacity.

The INTERACT prototype manages the data from all the receivers and the stations transmitting interactive programmes. The data can be distributed on any of the UHF channels that have been designated for interactive services.

Once analogue television stations are no longer in operation, some of these UHF channels could be designated for two-way communications with a number of 1 MHz signals sharing a television channel bandwidth. In Europe, there could be up to 8 interactive channels of 1 MHz in a 8 MHz television channel.

#### 3.1.5.3 Adaptation for Canada

In Canada, there will be a transition period when television stations will simulcast the NTSC signal and the DTV signal. After the transition period, all television stations are to cease transmitting NTSC.

During the transition period when both NTSC and DTV stations co-exist, the spectrum in Canada will be very congested to allow in-band interactive applications. The spectrum may remain congested after the transition period due to possible re-allocation of the upper part of the spectrum to non-broadcasting services.

#### 3.1.5.4 Conclusion

The European system INTERACT offers a lot of potential for interactive applications. Canada monitors with interest the work developments of INTERACT in Europe, although thus far, that interest is purely technical. Spectrum regulatory authorities in Canada have yet to consider if spectrum should or should not be assigned for interactive applications.

## 3.2 ATSC Activities

### 3.2.1 Progress in standards for interactive services protocols in the United States of America

Development of a standard for interactive services protocols for digital television is ongoing in the United States of America with work also being undertaken by various other administrations in Region 2 as well as in the ATSC T3/S16 group. Functional requirements and design guidelines for the standard have been well developed. Review of some existing tool sets including DVB, DAVIC, ISO-IEC MPEG-2 have taken place. Two elements of the standards design resulting from these investigations are worth noting.

The first concerns the cost of a system design, which requires a receiver to access an object carousel to obtain the interactive server's NSAP address. This, in effect, requires a receiver to utilize object carousels before it can make use of the return channel. In addition to substantially costlier hardware, implementation of Object Carousel will require the receiver manufacturer to obtain a license for CORBA and/or use the MHEG API. This added cost is not justified for the typical application to be deployed on low cost receivers.

ATSC T3/S16 feels it is important to define a framework where lower cost receivers can inter-operate in a network with more sophisticated receivers. ATSC is working on a mechanism to be placed at various points in the protocol stack that allows a low cost receiver to obtain the necessary information to establish a connection to an interactive server without the use of object carousels.

Within ATSC T3/S16, it has been determined that the best approach will be to have an extensible protocol stack with well defined interfaces at each level of the stack. The application would have the ability to enter the protocol stack at any point. This would allow more expensive, higher functionality, receivers to inter-operate in the same network as lower cost, lower functionality, receivers.

The cost of a receiver, which can implement object carousel, will decrease over time. However, in order to have a receiver that is cost effective today, the ability to allow applications to receive their required data by use of lower levels in the protocol stack is needed.

The second, a fundamental design guideline for ATSC T3/S16, is to separate as cleanly as possible the interactive service protocols from the lower layer network and physical protocols. This, too, is seen as an advantage in providing a lower cost solution for the client receiver.

### 3.2.2 ATSC interactive services protocols definition and system design guidelines

#### 3.2.2.1 Scope

This section defines the Protocols necessary to provide digital broadcast interactive services, including:

– Definition of session protocols for interactive services

– Specification of a system concept which includes required behaviour and minimum performance of transport facilities and lower layers for interactive services.

The Standard employs system profiles with varying degrees of latency and data return rates. These protocols shall be scalable and media independent and wherever possible use industry standards which drive interoperable services as appropriate for protocols suitable for ATSC.

#### 3.2.2.2 Functional Requirements

Interactivity means the circumstance whereby the actions of one partner to a conversation affect the actions of another, either directly or indirectly. This does not imply a decision-making ability by both partners, nor does it imply physical co-location of the partners. This protocol presumes that one partner is physically separate from the other, but implementations could use the protocol for interactions between a stored sequence of information and a volitional partner.

The protocol describes a means for a service provider to converse with many distinct, physically remote and physically dispersed entities nearly simultaneously.

#### 3.2.2.3 Requirements Context

The Interactive Services Protocol (ISP) is designed for broadcast support for information delivery in the context of interactivity. It provides services at the conceptual level of the OSI Session layer. This means that the ISP session protocol provides facilities to manage dialogue (the orderly exchange of context- or state-sensitive information), to recover from errors in the transport layers beneath (if any), and to provide simple sequencing for the independent actions of the conversants.

A session, in this context, is a sequence of message exchanges between two parties that depend upon the mutual evolving context of the conversation for semantic interpretation. It could be as simple as a request/reply pair of messages, or be a conversation that extends over hundreds of messages spanning many days. Session management will provide a means to sequence the conversation, but the determination of who communicates next is the responsibility of higher layers.

This protocol might be used in systems that use DSM-CC to manage the information flow from service provider to user. In this instance, DSM-CC may manage the conversation (if any) and the network resources necessary to *transport* information. DSM-CC also defines a session, logically contained within, or subordinate, to the ISP protocol session, that is, "an association between two Users providing the capability to group together the resources needed for an instance of a service."

Thus the concept of ISP session refers to a sequence of messages between communicating entities for which sequencing, synchronization, and/or context are important. Sessions are uniquely identifiable, but the criteria to determine when to terminate a session and begin a new one is not specified by the protocol. Such is an application level responsibility. Whether or not auxiliary resource management is required within a session is likewise not specified by the protocol.

The key attributes of the protocol are:

– There is a broadcast or high-order multicast electronic transport path.

– There is a simplex or duplex unicast path logically distinct from the broadcast path.

– Each path may contain diverse physical mechanisms both between a single instance of conversants, and among the whole class of conversants.

The service provider is an organization that logically communicates with many users simultaneously. The provider may be an alliance of many business entities or only one, but its key property is that each ISP session is coherent from inception to termination by only one logical service provider. Thus a service provider is not a business or equipment entity, but a collection of resources that is willing and able to maintain dialogic coherence over the lifetime of a single session.

The end user device could be a set-top box that logically communicates with those humans within sight and hearing of a single attached display device. These requirements use the term *receiving equipment* with the understanding that the functionality of the terminating equipment is implied, not its name or packaging.

An ISP session has an unusual definition of beginning time. A service provider will broadcast information that provides sufficient information so a session (i.e., a two way conversation) *may* be established. The start of the session is the logical (not physical) time that the invitation was broadcast. When receiving equipment responds to this offer to communicate, an actual session is established whose logical start time is the logical time of the invitation. Thus one could consider that at the time of initial broadcast, many nascent sessions are created, but only a few are made actual by the initial response to the broadcast invitation. It is possible that one receiving equipment may respond multiple times to the invitation, creating multiple sessions between the same two conversants from the same initial invitation.

#### 3.2.2.4 Requirements

##### 3.2.2.4.1 Two communication paths

The interaction facility has one electronic path that uses a broadcast or high-order multicast, simplex method. This path is accessible to all receiving equipment with appropriate authority and access. The interaction facility also includes a path for logically private communication between the receiving equipment and service provider. That path may be simplex or duplex. The two paths are presumed physically disjoint, even though some realizations may share a common physical layer for both paths. The two disjoint path requirement implies that the Interactive Service protocol cannot presume that the transport layer properties for the two paths are related.

For purposes of this specification, the *Downstream Channel* means the simplex broadcast path from service provider to receiving equipment. The *Interaction Channel* is the simplex or duplex path from the receiving equipment to service provider.

#### 3.2.2.4.2 Nature of Interaction Channel

The Interaction Channel has no requirement on its latency, speed, or reliability of transmission. In particular, there is no assumption that the Interaction Channel is electronic nor always available.

The Interaction Channel may require specific actions to connect to the service provider, including identifying the end point, identifying the potential communication mechanisms (e.g., analogue telephone), establishing a connection, etc. This protocol does not specify how to accomplish such activity, but it presumes that it will be accomplished given sufficient information, possibly transported by this protocol.

The Interaction Channel may be duplex so logically private messages can be sent from the service provider to the receiving equipment. However, use of the Interaction Channel for this communication is not required by the protocol.

#### 3.2.2.4.3 Channel Efficiency

Because service providers may communicate with many receiving equipments simultaneously, the protocol must be efficient regarding the protocol-required overhead. One implication of this requirement is that dialogues may have extended scope in time to permit a grouping of communication over the Interaction Channel in cases where the set-up overhead of the Interaction Channel is larger than desirable for the anticipated service.

#### 3.2.2.4.4 Protocol Nature

The Interactive Services protocol provides services appropriate to the Session Layer as characterized by the OSI model. Actions at this level include dialogue management, operation sequence management, and dialogue synchronization.

The protocol may make no assumptions about the transport, network, data link, and physical layers below. The protocol should effectively use protocols at lower layers. In particular, it should not hinder the use of typical lower layer protocols specified by T3/S13, DSM-CC, and the Internet TCP/IP suite.

The protocol assumes that each partner, within the context of a single session, emits a sequence of messages whose intra-sequence ordering is unambiguously reconstructable by the receiving partner. There is no requirement that each message from a partner traverse the same logical or physical path. In particular, the service provider may send some messages over the Downstream Channel and some over the Interaction Channel (if it is duplex), so long as sequenceability is preserved.

#### 3.2.2.4.5 Session Management

The protocol must provide the means to begin, continue, and terminate a logical session between the service provider and the receiving equipment. This means that the protocol must provide one or more means to uniquely identify the communicating partners in the session (because each partner may participate in more than one session at a time), and to sequence communications within the session.

A session is a sequence of messages between two communicating partners. A session is established when receiving equipment transports a valid reply to an invitation to communicate from a service provider. Within a session, messages must be uniquely ordered for each partner's sequence of messages. This specifically does not require sequencability between the message sequences from each partner.

Sessions are uniquely distinguishable from each other within an explicitly defined time interval. Sessions have a defined beginning and a defined ending. Sessions begin at the logical time of the initial invitation to communicate by the service provider, and sessions end when one or both communicating partners send an implicit or explicit session termination message.

Session identification and sequencing methods must ensure session and message sequence uniqueness between two communicating partners over time spans of at least the explicitly defined time interval. Should an implementation choose to permit multiple simultaneous sessions between two communicating partners, the protocol implementation must provide means to distinguish messages that belong to the distinct sessions. There is specifically no requirement to provide any inter-session coordination in such a case.

The protocol must provide one or more mechanisms to temporally sequence actions of the service provider and of the receiving equipment. In this context, an action is not a message, but what an entity does in the context of the sequence of messages already received and sent. Thus this requirement intends that absolute temporal ordering is achievable between successfully communicating partners. The protocol need not guarantee this property, but only provide the mechanism to achieve it if there are no confounding errors.

A single session will use only one transport-level path abstraction for Downstream Channel communication and only one transport-level path abstraction for Interaction Channel communication. The intent of this requirement is not to constrain the implementation of the transport and lower layers, but to require that any path-specific information required of the session layer by the transport layer (e.g., an address, transport behavioural properties) not change during a single session.

The protocol must provide one or more mechanisms whereby specific receiving equipment generated messages may be uniquely related to specific service provider messages. *Specific* in this requirement applies only to the context of a session. However, because one service provider may participate in many simultaneous sessions, but use substantially identical messages in the Downstream Channel for all sessions, implementations may choose to make message uniqueness span many sessions over an extended time.

#### 3.2.2.4.6 Session Control

The protocol may presume that all communication sessions are logically initiated by the service provider. This explicitly permits the service provider to control the session identification and sequencing mechanisms.

The protocol must provide one or more methods for the service provider to unilaterally terminate sessions.

The protocol must provide one or more methods for the receiving equipment to terminate a session.

The protocol must provide one or more methods for loss of communication paths to terminate a session. This requirement does not require a session to be terminated solely if a (e.g.) telephone connection is lost and must be reconnected. However, it does require that a session be terminated before a Downstream or an Interaction Channel can change transport mechanisms in such a way that the change is visible to the ISP (session) layer.

The protocol must provide means for the service provider to advise the receiving equipment of the available Interaction Channel facilities and protocols.

#### 3.2.2.4.7 Presentation Interface

Implementations will define all failure semantics to the invoking software or hardware.

Implementations will define all success semantics to the invoking software or hardware.

Implementations of the protocol will translate all failure semantics from invoked mechanisms to failure semantics defined for this protocol.

#### 3.2.2.4.8 User Control

To support privacy and security concerns, the receiving equipment must ensure that no transmission to the service provider occurs without the explicit permission of the user. This requirement does not imply explicit human approval of every message. In particular, it may be sufficient that the installation of a software or hardware component that requires periodic receiving equipment to service provider communications is sufficient permission.

## 3.3 System services offer common characteristics of interactive television broadcasting to both commercial and emergency response markets

This section addresses *decides* 2 from both ITU-R Question 256/11 – Interactive Television Broadcasting Systems, and Question 241/11 – Interactive Satellite Broadcasting Systems (Television, Sound, and Data): What interactive services (or near-interactive services) are likely to be needed and what are the requirements for the return data channel. However, near-interactive services are not part of this Section. It highlights common characteristics of interactive services that could be provided to both the commercial and emergency response communities. It is written from a disaster response user perspective and lists the anticipated needs for satellite interactive broadcast systems.

It suggests unique constraints that would control a broadcast and return channel for such users, but that could be attractive features of commercial return links. While the set of disaster response users may be small and have focused needs, the interactive broadcast needs themselves could be similar to those anticipated from strictly commercial users. The interactive services as presented here do not depend on any specific return path, other than that an independence from terrestrial networks is desired and therefore a satellite path is preferred.

A broad interpretation of television is used: the broadcast signal is assumed to be a digital signal and any digital broadcast could be transmitted, data, video, or television.

### 3.3.1 Background

Disaster response personnel usually have unique telecommunications constraints placed on them when deployed. They must have the flexibility to communicate outside of an existing telecommunications infrastructure, which may be physically impaired, congested, or non-existent. While short-range communications can often be conducted using some form of land mobile system, communications with a distant central headquarters is often impossible, given these constraints. These people have a need to communicate via portable access through some other independent system, such as a satellite system. While portable point-to-point voice service via satellite is now available, digital data service with an associated broadcast offers attractive additional capabilities.

As communications and information processing equipment becomes more portable and users become more accustomed to working in electronic groups, disaster response personnel and their headquarters will come to expect greater communications capabilities. These capabilities may include increased standardized transfer and sharing of imagery and other data information and increased interactions between each other. One way these work habits can be optimized is by using broadcasting to the group and a return channel for responses.

### 3.3.2 Desired Services

*Query-Response:* Disaster response communications can often be facilitated by a reporting system with headquarters making requests of all field personnel simultaneously. These requests could be ad hoc (requiring field users to update data immediately), or standardized (requiring timed updates). Often the answers could involve significant amounts of information, such as delivery of reports or imagery. Consequently, while a low bit rate return channel would support some applications, it would be preferable to have a return link that could accept a 56-64 kbit/s stream from the user (later referred to herein as an equivalent 56 kbit channel).

*Conferencing:* Voice and data conferencing (e.g. white boarding) could be especially useful between field personnel and a headquarters and not overly demanding on the capabilities of return links likely to be possible. Most whiteboard services can be accommodated on 56 kbit channels. Videoconferencing would be desirable, but is understood to require a different type of return channel.

*Broadcast inputs*: Where field personnel need to make inputs to broadcasts themselves, such as emergency announcements to other people in an emergency area, these inputs would require a voice grade circuit for voice announcements or for imagery to be broadcast.

*Other Data Services:* Other office-type data services that could be duplicated in the field include e-mail with enclosures, Internet Access, and various forms of multicasting.

### 3.3.3 Constraints on the Return Channel

The portability requirements of the equipment carried by emergency response personnel will affect the selection of a return channel, as well as the bandwidth requirements. Size and power requirements of a portable return channel terminal may force selection of a low power link. When terrestrial links are available, the user should have the option of selecting the terrestrial facility if the signal quality requirements justify it. In fact, a third party may provide the interactive service rather than the broadcast provider.

### 3.3.4 Proposal

It is proposed that the ITU-R SG 11 interactive channel model include reference to a low power return channel capable of accepting an equivalent 56 kbit data stream as a desirable end point for development of interactive service systems.

a) In the ITU-R JWP 10-11S Interactive Services Report being developed by the Special Rapporteur for Interactive Services, include a specific reference to a low power, equivalent 56 kbit service return channel.

b) In the ITU-R TG 11/5 Report, refer to the need for a standardized user-system interface that can be used with a range of hardware between commercial set-top terminals and Personal Computer-based applications.

c) Develop a standard set of protocols that will support a wide range of digital data transfer applications over links of various speeds.

# 4 Asia-Pacific Region

## 4.1 Overview of interactive broadcasting services in ABU

### 4.1.1 Introduction

In the ABU, a question for interactive television and sound broadcasting services is assigned to its Working Party A (WP-A) chaired by Mr. H. Miyazawa of NHK (Japan). WP-A is a part of the Technical Committee that is chaired by Mr. H. Ohtsuka of NHK (Japan) and directed by Mr. O. Khushu of ABU.

WP-A had met in November 1998 and the following is a summary of the outputs of this meeting relevant to ITU-R TG 11/5 activities.

### 4.1.2 ABU WP-A topics relevant to Task Group 11/5

WP-A has several sub-working groups in its body to study various kinds of technical topics of its interest. SPG A-2 is one of these sub-working groups and is assigned to the question concerning interactive television and sound broadcasting services while it is also responsible for other topics including parental control and data broadcasting. The following are the items that were discussed during the last meeting of WP-A of the ABU.

*Item 1:* To study HTML TV data on VBI and an enhanced teletext system.

*Item 2:* To study the Data Broadcasting Systems developed, or under development, worldwide.

*Item 3:* To recommend specifications for ancillary signals for 625- and 525-line television signals, including embedded (and enhanced) teletext.

*Item 4:* To monitor developments in Parental Control System Technologies.

In this section, Items 1), 2), and 3) are discussed.

*SPG A-2: Broadcasting ancillary information services*

*Organization of body*

| | |
|---|---|
| Coordinator: | Mr. Toshiro Yoshimura (NHK) |
| Rapporteur of PCS: | Mr. Brian Roberts (TVNZ) |
| Members: | NNA, NHK, TRT, AIR, MBC, PBC, KBS, DDI. |

Mr. Toshiro Yoshimura was appointed as a coordinator of SPG A-2 instead of Mr. Akira Ohya (NHK), who has been a specialist of studies of new technologies, in particular multimedia services in broadcasting, who reports on the current status to SPG A-2.

Mr. Brian Roberts, WP 11A Special Rapporteur on PCS, was appointed as the special rapporteur reporting to the Working Party A. ITU-R Working Party 11A is trying to establish the level of interest in PCS (Personal Communication Systems) throughout the world. SPG A-2 also reports on the current status of HTML data services and enhanced teletext system in Japan. It also reported on DAVIC's activity from the viewpoint of multimedia services in digital broadcasting.

a) Task A.2.1: To study HTML TV data on VBI and enhanced teletext systems.

b) Achievement A.2.1.1: Study of HTML Data Services.

Two HTML (Hyper Text Mark-up Language) data broadcasting services with TV VBIs and a service based on enhanced teletext system have already begun in Japan. Such an ancillary data service gives broadcasting a chance to add interactive functions using a return channel. In this Section, these interactive systems are shown in Table 4.1.

Table 4.1, whose data are a part of the result of surveys conducted by the Association of Radio Industries and Businesses (ARIB) in October 1997, provides system parameters of these interactive television services. These three systems make use of VBI data for a forward data channel and PSTN for a control channel that can provide interactive function. Outlines of these systems are also shown in § 4.3.1.2.2.

TABLE 4.1

**Interactive systems available in Japan***

| | TV Asahi | Tokyo Broadcasting System<br>NEC Corp. | TV Tokyo<br>Toshiba Corp. |
|---|---|---|---|
| 1. Name of the system | DataWave ADAMSTV-Asahi Data and TV Multimedia Service | BitCast | INTERTEXT<br>(IT vision) |
| 2. Features of the system | Service contents are news, weather information, sports, shopping, etc.<br>These services can be accessed anytime | – Data are transmitted with TV broadcast and decoded in a particular receiving board for PCs.<br>– Viewer can access Internet-based data (programme related/independent web page) while watching TV.<br>– Link information is included in the data so those viewers can jump to object Internet pages to obtain detailed information | Responses from viewers are gathered up in a short time (about 10 s) and these data are sent to broadcast station immediately in real-time mode, or later time in off-line mode after some batch processing. TV programme related/ independent services and/or on-line services are also available |
| 3. Downstream channel | | | |
| Physical medium | Terrestrial TV | Terrestrial TV | Terrestrial TV |
| Signal format | Multiplexed in VBI (vertical blanking interval) of the NTSC signal | Multiplexed in VBI (vertical blanking interval) of the NTSC signal | Multiplexed in VBI (vertical blanking interval) of the NTSC signal |
| 4. Upstream channel | | | |
| Physical medium | | Internet (Most of the users are considered to be connected through PSTN to the provider) | PSTN |
| Multiplexing | Telephone call from subscriber | Users access to upstream line with link information included in the broadcast data | Telephone call from subscriber |
| Protocol | | PPP<br>TCP/IP | PPP<br>Original session |
| API (application programme interface) | | BitCast based on Internet explore as a component | Text base. ICAP (Interactive Communicating Applications Protocol) |
| 5. Development update | | | |
| State of the art | – Services available for PCs<br>– Services for TVs now being tested | Service available | Service available |
| Services available from | June 1997 | October 1997 | October 1996 |

* After producing this Table, Fuji Television launched its BitCast service in June 1998.

a) Task A.2.2: To evaluate data broadcasting systems already developed or under development worldwide.

b) Achievement A.2.2.1: Study of activity of DAVIC.

DAVIC standardized technical specifications for interactive audio-visual systems based on ATM and MPEG technologies.

At the time of writing DAVIC 1.3 (published in September 1997) was the latest specification which featured content and meta-data packaging, Java APIs for DVB service information and a new concept of “Contours” – the first instance for Enhanced Digital Broadcasting and Interactive Digital Broadcasting.

At the DAVIC Monterey meeting (December 1997) a decision was made to adopt the following new work items and to develop its specification further:

– digital audio-visual broadcast over IP-based networks;

– delivery of interactive multimedia over IP;

– interactive multimedia services based on in-home storage;

– integration of DAVIC and Internet Content;

– speech and audio services over IP;

– content distribution from the home;

– content contribution network systems.

The area of DAVIC's activity is enlarged including the IP-based system and the in-home storage system. DAVIC aimed to create the IP-based system specification which has interoperability with the existing Internet and provide the ability to control quality of services within DAVIC intranet. The in-home storage system is also promising as it will enlarge the interactive function of broadcasting and telecommunication applications. Meta-data set is one of the most important components to be specified for the in-home storage system. These specifications were finalized and published as DAVIC 1.5.

*New Task*

*SPG A-8: Broadcast delivery by Internet*

To study of web-casting or inter-casting.

*Conclusion part of SPG A-2 report*

This Section provides the summary of the return paths that appeared in the Radiocommunication TG 11/5 and Telecommunication Standardization WP 1/9 documents. These might be helpful to produce the spectrum planning of interactive return paths.

#### 4.1.3 Conclusion: ABU Area

As far as looking at the Chairman's Report of ABU WP-A, the activities related to interactive television and sound broadcasting services are limited in Japan only. There are many other intensive discussions on digital broadcasting and other related issues in this ABU technical committee. Many administrations have schedules for introducing digital satellite and/or terrestrial digital broadcasting in the very near future. It is expected that there will soon be some active study efforts on how to introduce interactive television and sound broadcasting in the ABU countries of Region 3.

### 4.2 Activities outside the ABU Area

In Asia and Oceania there have been many developments, field testing and deployment of interactive television services during recent years.

In Australia, Telstra Research Laboratories (TRL) are involved in R&D in the area of video retrieval services. Optus Vision in Australia has also demonstrated Internet links over its broadband cable network. That is shown in § 4.3.2.

Hong Kong Telecom has been running its interactive television services Interactive Multimedia Services (IMS) since 1996. That is shown in § 4.3.3.

### 4.3 Planned services by country

#### 4.3.1 Japan

#### 4.3.1.1 Introduction

Significant progress has been made towards the introduction of interactive television services using various delivery media (terrestrial over-the-air, satellite and cable). Some of the services, in particular those currently being introduced, using the analogue television system, while the later services will use digital television systems. This section charts the progress made, both in terms of interactive service deployment as well as planning for them during 1997 and 1998.

#### 4.3.1.2 Market and Service Information

##### 4.3.1.2.1 Progress of Interactive Television Services in Japan (1997)

In Japan, there have been significant activities in interactive television services during the last year. These services are commercial interactive TV broadcasting services. However they use conventional analogue television signals for their forward channels and public switched telephone networks (PSTN) for their return channels.

This section provides a brief report of the status of interactive television services, including current analogue terrestrial interactive broadcasting services, future digital satellite interactive broadcasting services and the current capabilities for the return path of the existing cable-television networks in Japan.

The section is divided into two parts. The first shows the result of the technical survey for terrestrial interactive television services whilst the second exhibits the result of the technical survey for the usage of return channels in the existing cable-television systems in Japan.

##### 4.3.1.2.2 Terrestrial and Satellite Broadcasting

###### 4.3.1.2.2.1 Terrestrial Broadcasting

The ARIB conducted a technical survey in October 1997 of the current status of interactive television services. Recent Japanese interactive services make use of PSTN for the two-way control channel and VBI data for the forward data channel in the analogue NTSC broadcasting environment.

In the survey, broadcasters and manufacturers, all of whom were the members of ARIB, responded to the questionnaire. Table 4.2 shows the result of this survey and shows system parameters of commercial and experimental interactive television services in Japan.

There are three television broadcasters who have started interactive television services. The first commercial interactive television broadcasting was launched in October 1996 in the Tokyo metropolitan area and using the “IT-Vision” system.

All three commercial interactive television systems make use of VBI data for a forward data channel and PSTN for a control channel. In fact, PSTN is the only possible option unless there are two-way cable television systems.

Outlines of these three systems are shown in the following:

| *Broadcaster, System Name* | *Display Device* | *Display Processing* | *Return Signal Processing* | *Launch Date* |
|---|---|---|---|---|
| TV-Tokyo Inter Text / IT Vision | NTSC television | Wink Engine | PPP Server + ICAP, TCP/IP | October 1996 |
| TV-Asahi ADAMS* | NTSC television | Browser | PPP Server TCP/IP | April 1998 |
| | On Personal computer | Browser | PPP Server TCP/IP | June 1997 |
| TBS (Japan) BitCast | On Personal computer | Browser | PPP Server TCP/IP | October 1997 |

* ADAMS: TV Asahi Data and Multimedia Service.

###### 4.3.1.2.2.2 Digital Satellite Broadcasting

Three experimental systems are shown in Table 4.2. Next generation systems will make use of data over MPEG transport stream architecture, but still make use of PSTN for a control channel. J-SAT SSS (Star Stream Service) will be launched in April 1998, according to plan. DVX (Digital Video Extension) using DirecTV Japan will be in service some time in 1998. ISDB (Integrated Services Digital Broadcasting) using the next generation broadcasting satellite instead of current BS-4a will be in service in 2000. ARIB is now proceeding a standardization process of ISDN as the data broadcasting system for digital broadcasting environment.

TABLE 4.2

**Interactive TV systems available or emerging in Japan**

| | Tokyo Broadcasting System | TV Tokyo Toshiba Corp. | Mitsubishi Electric Corp. | TV Asahi | NEC Corp. | Yomiurishimbun | Matsushita | Microsoft | NHK ARIB |
|---|---|---|---|---|---|---|---|---|---|
| 1. Name of the system | Bitcast | INTERTEXT<br>(IT vision) | Internet TV | DataWave<br>ADAMS | J-SAT SSS | Summit<br>(Text News) | DVX | WebTV<br>– Next generation | ISDB |
| 2. Features of the system | – Data are transmitted with TV broadcast and decoded in a particular receiving board for PCs.<br>– Viewer can access Internet-based data (programme related/independent web page) while watching TV.<br>– Link information is included in the data so those viewers can jump to object Internet pages to obtain detailed information | Responses from viewers are gathered up in a short time (about 10 s) and these data are sent to broadcast station immediately in real-time mode, or later time in off-line mode after some batch processing. TV programme related/independent services and/or on-line services are also available | Internet and teletext can be accessed through a multi-function TV that has double windows | Service contents are News, weather information, sports, shopping, etc.<br>These services can be accessed anytime | Video/audio/data distribution through big pipe (30 Mbit/s) of broadcast satellite.<br>IRDs receive video/audio and PCs receive data | – Text news is now provided for CATV. They are planned to be expanded as multimedia type.<br>– Electric newspaper can be downloaded as a package and is now under experiment.<br>– Searching services through upstream lines are considered in the future | – Interactive contents are expressed in a high quality video using MPEG decoder.<br>– Interactive services are also available through public telephone line | – Connection to NTSC display available.<br>– Extremely low cost | – Broadcasting system independent of broadcasting medium/- service.<br>– Various multimedia services are provided based on high quality video of HDTV.<br>– Media fusion of broadcasting with communication and package media is in sight |

TABLE 4.2 *(continued)*

| | Tokyo Broadcasting System | TV Tokyo Toshiba Corp. | Mitsubishi Electric Corp. | TV Asahi | NEC Corp. | Yomiurishimbun | Matsushita | Microsoft | NHK ARIB |
|---|---|---|---|---|---|---|---|---|---|
| 3. Down-stream channel | | | | | | | | | |
| Physical medium | Terrestrial TV | Terrestrial TV | Terrestrial TV and Internet (PSTN) | Terrestrial TV | Broadcast satellite MCPC (Multi Channel per Carrier) | – Text news: data through VBI and/or broadcast satellite.<br>– Electronic newspaper: data through communication satellite and/or common carrier | Digital broadcast compatible with DVB | PSTN, CATV, terrestrial TV | Satellite, Terrestrial TV, Cable, etc. |
| Signal format | Multiplexed in VBI (vertical blanking interval) of the NTSC signal | Multiplexed in VBI (vertical blanking interval) of the NTSC signal | Multiplexed in the VBI (vertical blanking interval) of the NTSC signal | Multiplexed in VBI (vertical blanking interval) of the NTSC signal | MPEG-2 TS (transport stream) packet | | MPEG-2 TS (transport stream) packet<br>– Video stream consists of intra-picture carousel.<br>– Data stream consists of carousel such as link information, script etc. | VBI, MPEG data packet | Digital broad-casting based on MPEG-2 systems |

TABLE 4.2 *(continued)*

| | Tokyo Broadcasting System | TV Tokyo Toshiba Corp. | Mitsubishi Electric Corp. | TV Asahi | NEC Corp. | Yomiurishimbun | Matsushita | Microsoft | NHK ARIB |
|---|---|---|---|---|---|---|---|---|---|
| 4. Upstream channel | | | | | | | | | |
| Physical medium | Internet (Most of the users are considered to be connected through PSTN to the provider) | PSTN | PSTN | | – PSTN<br>– Private line | – PSTN or selectively INS line for general home use.<br>– Mobile services are also planned to be considered | – Public telephone line.<br>– Other medium also available | PSTN, Cable modem | – PSTN, INS line, etc.<br>– Possible con-nection line for general home use.<br>– Mobile telephone, PHS for mobile reception of terrestrial TV |
| Multiplexing | Users access to upstream line with link information included in the broadcast data | Telephone calling from subscriber | Telephone call from subscriber | Telephone call from subscriber | | | Not specified | Not specified | Telephone call from subscriber |
| Protocol | PPP<br>TCP/IP | PPP<br>Original session | | PPP<br>TCP/IP | Original | | Not specified. DSM-CC U-U protocol is available | Original | PPP<br>TCP/IP |
| API (application programme interface) | Bitcast based on Internet explore as a component | Text base. ICAP (Interactive Communicating Applications protocol) | | | Original | Standardization of format is desired for expression of Electronic newspaper | DVX byte code | | MHEG |

TABLE 4.2 *(end)*

| | Tokyo Broadcasting System | TV Tokyo Toshiba Corp. | Mitsubishi Electric Corp. | TV Asahi | NEC Corp. | Yomiurishimbun | Matsushita | Microsoft | NHK ARIB |
|---|---|---|---|---|---|---|---|---|---|
| 5. Development update | | | | | | | | | |
| State of the art | Service available | Service available | | – Services available for PCs.<br>– Services for TVs now being tested | – Test completed.<br>– Now being manufactured | – Now testing for CATV use.<br>– Interactive services are under development | Services available soon | Under development | Under development |
| Services available from | October 1997 | October 1996 | October 1996 | June 1997 | April 1998 | Spring 1998 for CATV | Within 1998 | Planned to be available in 1998 | Technical specification in 1998 and planned to be available in 2000 |

#### 4.3.1.2.3 Cable Television

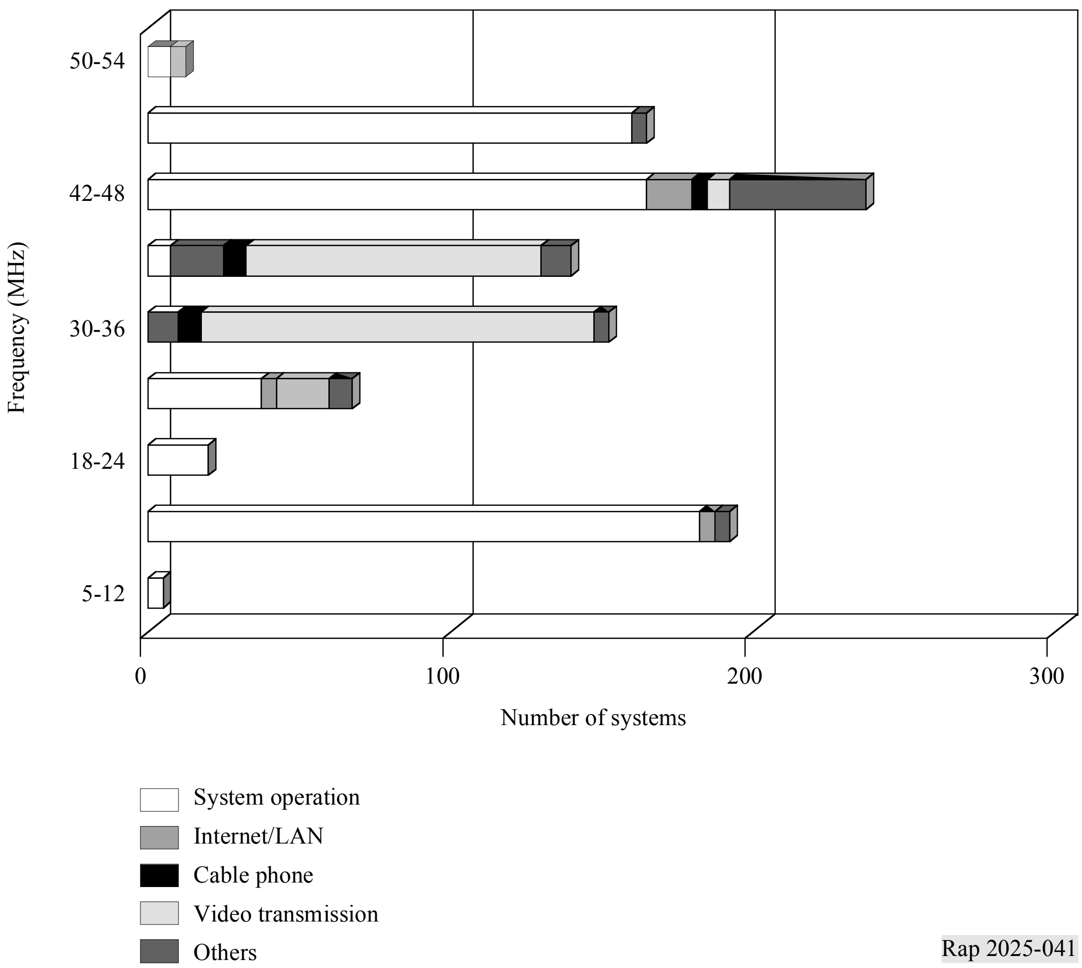
The Japanese Cable Television Engineering Association (JCTEA) also conducted a technical survey recently concerning the channel allocation for both downstream and upstream signals. For the upstream channel, almost of all Japanese cable television system operators make use of spectrum between 10 to 50 MHz band, or 10 to 55 MHz band. Using this upstream channel, the high-speed data service using cable modems, has become more popular recently.

In Japan, almost of all cable television system operators have upstream capabilities. In fact, 219 cable systems have upstream channels.

For interactive television services, upstream channels are the most significant issues among many physical factors. With this point of view, two-way cable television systems would be an appropriate infrastructure even for terrestrial and satellite digital broadcasting services. In these cases, upstream data are terminated at cable-television head-end and these data are forwarded to the specific destinations.

FIGURE 4.1

**Current usage of upstream channel in Japan**



#### 4.3.1.2.4 Activity on Interactive Television in Japan (1998)

There has been significant progress in digital satellite and terrestrial broadcasting in Japan after the previous SG 10 and SG 11 block meetings last March and April.

The next BS (Broadcasting Satellite) will be launched in summer of 2000 and digital broadcasting services will be in the commercial phase from December of the same year. Preparing for these services, ARIB (Association of Radio Industries and Businesses) has finished standardization of the physical and network layers of the BS digital broadcasting system, and has organized a working group to establish a new standard of EPG, SI, and multimedia data encoding. In March 1999, the Telecommunication Technical Council will approve the final draft standard for EPG and SI produced by this working group.

Two experimental efforts are reported recently related to interactive services and future BS digital broadcasting. The first is "TV Anytime", which is a typical example of an interactive service *without* return channel. The other is the video programme named "Health care for the future", which is a simulation of future programme production using interactive services. This programme also has the distinctive feature of being able to use facsimile transmission for the return channel. The experimental "TV Anytime" system employs MHEG for API and DSM-CC for the mass storage control.

In conventional television broadcasting services, there are also several efforts to investigate future programme productions of interactive television services. Special analogue TV receivers are assumed to have data manipulation capabilities from VBI (Vertical Blanking Insertion) transmission. These can handle EPG (Electronic Programme Guide) for their special feature. Another one is the experimental effort to produce video clips for ad-insertion that is intended to make use of interactive capabilities. Interactive data provides additional information related to the inserted ad-video clips. These interactive TV services use HTML for API and Internet connection for interaction channel.

#### 4.3.1.2.5 Interactive Broadcasting Experiments for BS Digital Broadcasting

##### 4.3.1.2.5.1 TV Anytime: Interactive Services based on Home Storage

NHK has been developing an integrated services television (ISTV) which is a home-based comprehensive information terminal. The ISTV is capable of receiving, besides the digital broadcasting services, various information services offered to the home through existing broadcasting media and telecommunications media.

The important component of ISTV is a built-in home server for automatic recording and reproduction. For example, broadcasters can transmit stock-type programmes for each day all at once, perhaps at a fixed time in the morning, and then broadcast at fixed intervals the automatically updated news and weather information. Viewers can watch them at any time they like through a simple home interactive system. This is called TV Anytime.

##### 4.3.1.2.5.2 Examples of TV Anytime

Using home storage devices, it is possible to integrate viewer's services. TV provides the following services:

– EPG (Electric Programme Guide)

– Anytime services

  Anytime news, Anytime weather forecasts
  On demand viewing of favourite programmes
  Programme zapping (virtual multi-channel programmes)

– Non real-time services

  Data broadcast (such as TV newspaper)
  Information related to broadcast programmes
  Downloadable programmes
  Super HDTV, 3DTV etc. (virtual broadband services)

– One way interactive services

  Digest viewing or non-linear viewing within stored programmes

– Improvement of the rate of service time

  Recovery from the receiving errors by a rainfall attenuation etc.

#### 4.3.1.2.6 Interactive Broadcasting Experiments Using Current Analogue Broadcasting System

There are other experimental efforts to prepare for future interactive services using the current analogue TV system. The first case uses a Bitcast receiver and the second a recently developed ADAMS TV-Asahi Data and Multimedia Service receiver.

#### 4.3.1.2.6.1 Ad-insertion Video Clip Using Interactive System

Tokyo Broadcasting System has started experimental ad-insertions using its current TV channel from this summer.

The Bitcast system is used as an interactive capability in this case. User interface is HTML and Internet connection is assumed as an interaction channel. In a main TV channel, an ad-insertion video clip is transmitted while related data are offered through VBI data transmission. Viewers can read the related information to the ad-insertion video clip.

#### 4.3.1.2.6.2 Analogue TV Receiver with EPG

TV Asahi started EPG using current analogue TV channel. Viewers use special ADAMS TV receivers to enjoy this service.

This autumn, specially designed TV receivers, which can manipulate VBI data, will appear in the retail market. This receiver can use EPG data which is transmitted through VBI.

### 4.3.1.3 Technical Details

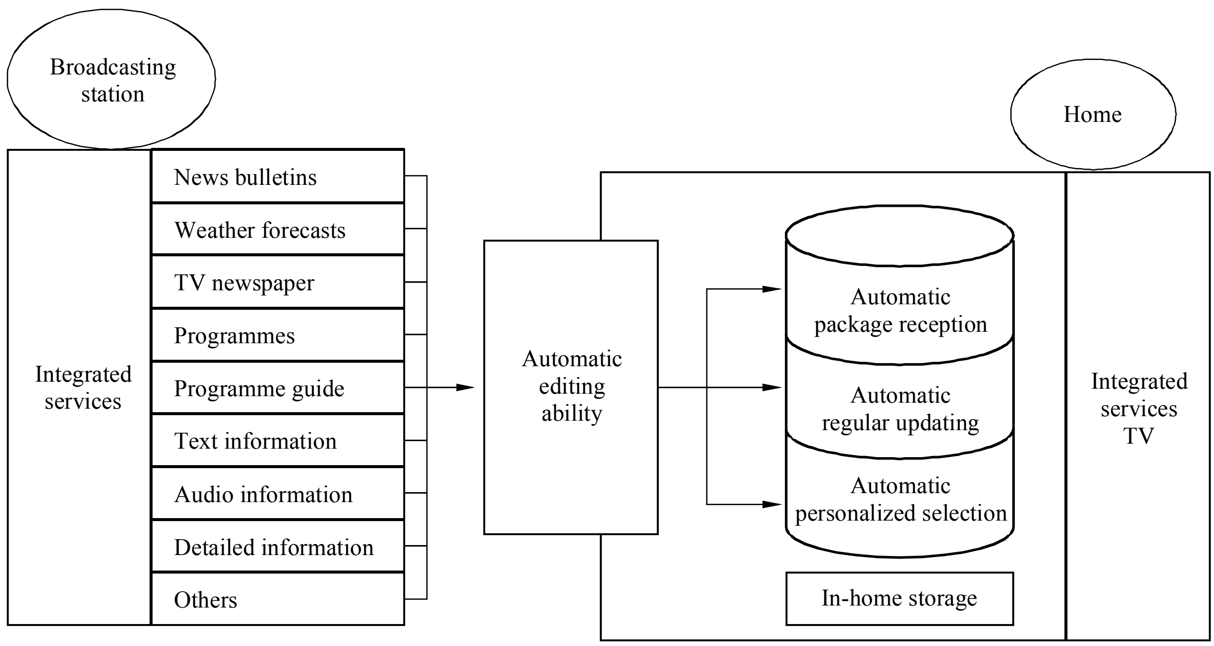
#### 4.3.1.3.1 Functions of home storage devices for TV Anytime

Home storage is designed as a three-layer system that allows viewers to select any services they want from the given information categories. The broadcasting station transmits information and programmes to the television receivers during a fixed time (for example early morning hours when people are still asleep). The ISTV receiver selects and classifies this updating information (using its self-editing function) and stores it in its home storage. Then any information or programme which viewers like can be called up with a one-touch icon, anytime they like. This home interactive service can be used around the clock.

Storage and home-delivery of information is depicted in Fig. 4.2.

FIGURE 4.2

**Storage and home-delivery of information**




Rap 2025-042

The following describes how the three-layer system of home storage acts:

– Automatic Package Reception

  Like the home delivery of newspapers, the TV newspaper and programmes can reach viewers' homes while they are still asleep.

– Automatic Regular Updating

  News items and weather forecasts are to be automatically updated at fixed intervals, using the anytime functions.

– Automatic Personalized Selection

  Information, visual material, data on performers and other items which viewers are interested in can be automatically called up, selected and videotaped.

#### 4.3.1.3.2 Experimental Programme Production Using Facsimile As a Return Channel

NHK demonstrated an experimental system for interactive service at an open house exhibition of its laboratories in May 1998. A sample programme titled "Health care in the future" was assumed to have three scenarios and change its story depending on the viewer's answers. In this system, three types of user interface were assumed: a TV with on-screen display for additional information and remote controller, a facsimile machine for hand-written answers and a PC with keyboard connected to TV receiver. Answer forms are distributed via data broadcasts in advance and viewers can either input answers on a TV screen with remote controller, or fill in the form by hand, or type answers directly on a PC.

Before the answers are sent to the broadcasting station, they are automatically processed inside the receiver to reduce redundant data. Facsimile data are analysed with graphic recognition tool. The information of checked items are extracted and values are encoded before transmission. The hand-written parts are also extracted and transmitted as graphical data, which are collected and stored in the multimedia database of the broadcasting station. Thus, the station can quickly sum up opinions from viewers.

#### 4.3.1.3.3 Future Digital TV Receivers

In this section, future digital TV receivers are discussed briefly.

Considering the recent situation of digital broadcasting and interactive services, it is beneficial to use the physical layer of the return channel in order to classify interactive services. This is the same position as adopted in TG 11/5.

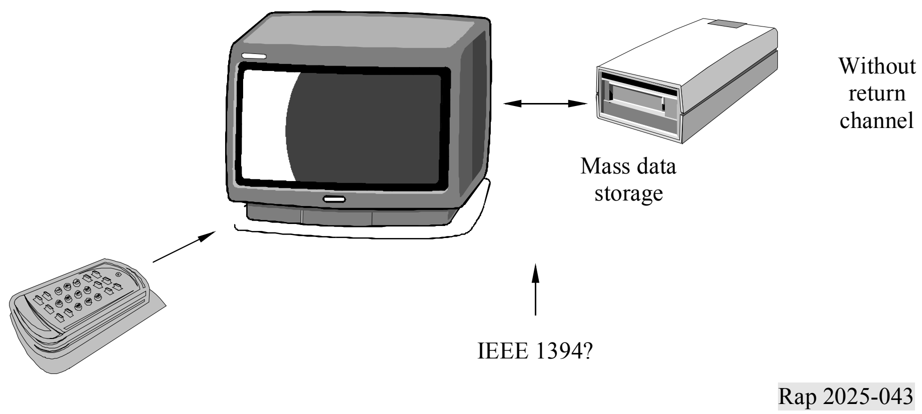
The number of subscribers is a very important parameter for interactive broadcasting services. Broadcasters will need to prepare receiving equipment capable of manipulating properly a large number of viewer's responses.

However, interactive television services are still in the very early stage. There is little information about the relationship between the number of subscribers and suitable interactive channel architecture.

In Japan the TV Anytime style of system is the most likely system architecture for countrywide interactive broadcasting. A typical receiver is shown in Fig. 4.3. This is one example of the interactive service without return channel.

FIGURE 4.3

**Experimental digital TV receiver for TV Anytime service**

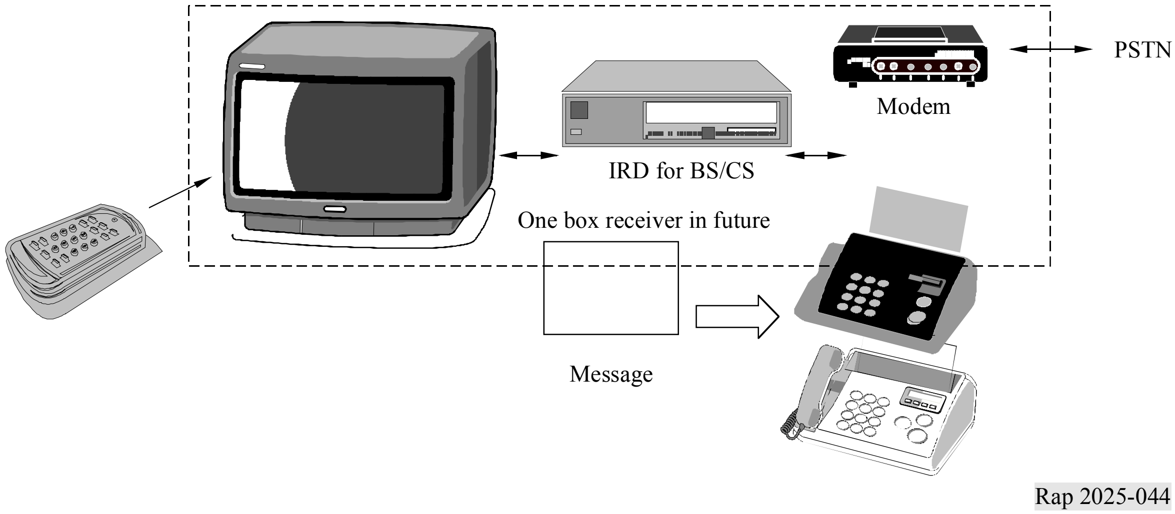


The second case is the receiver with store-and-forward type protocol and near-real time protocol.

In this case, two types of return channel protocol can be assumed. The first one is store-and-forward type, however the second one has (near) real-time response capabilities. A typical example of the latter case is the sample programme titled Health care in the future described in the previous section. A typical receiver is shown in Fig. 4.4.

FIGURE 4.4

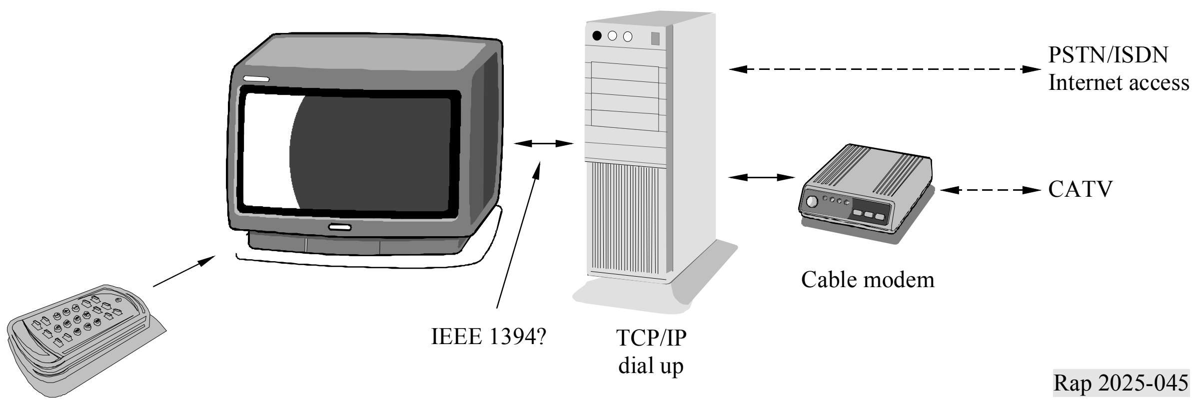
**TV set with BS/CS IRD and modem with near real-time or store-and-forward return channel**




The most advanced interactive receiver will be a combination of TV receiver, Personal Computer, and communication interfaces. A personal computer is suitable to manipulate the interaction channel and TCP/IP protocol. Connection between future digital TV receiver and PC will be IEEE 1394 most likely. Digital TV receivers will have relatively longer lifetime than PCs. This is the reason PC is written separately in Fig. 4.5. Cable modem will be a possible interaction channel while the PSTN will be most widely used in Japan. In this case, accessed media will be Internet most likely.

FIGURE 4.5

**Experimental model for interactive TV receiver with real-time response channel**



#### 4.3.1.3.4 Requirements for Interactive Services in CATV and SMATV Systems

##### 4.3.1.3.4.1 Introduction

This section describes a necessary condition of constructing interactive service systems among satellite, SMATV and CATV networks. The satellite system should be used for downstream only and SMATV/CATV should contain upstream channels to form realistic interactive service systems.

##### 4.3.1.3.4.2 Interactive System Overview

The contents of interactive services are transmitted through satellite channels. The head-end equipment of SMATV receives satellite downlink signals and distributes them to internal coaxial transmission lines after conversion into the format compliant with ITU-T Rec. J.83, Annex C. The actual SMATV head-end has two major facilities; one is the distribution of satellite downlink signals, the other is interaction with CATV or PSTN/ISDN networks which deal with upstream channel for SMATV and its own interactive service signals as well. Figure 4.6 depicts a fundamental model for interactive systems.

FIGURE 4.6

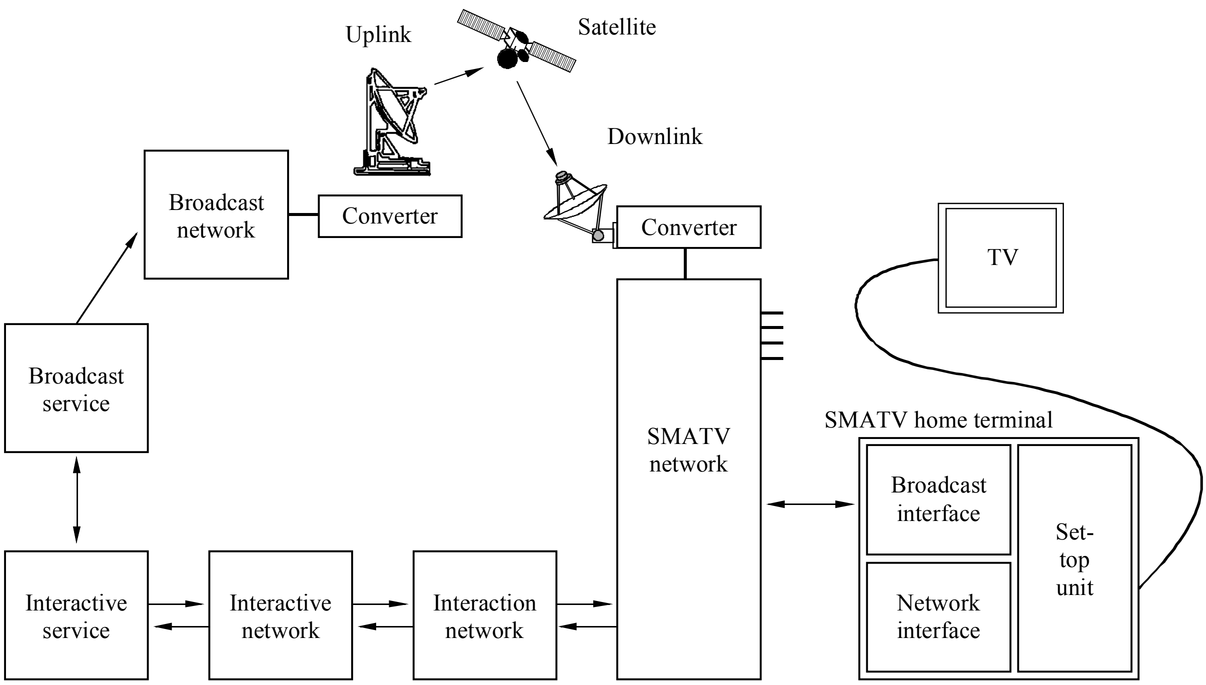



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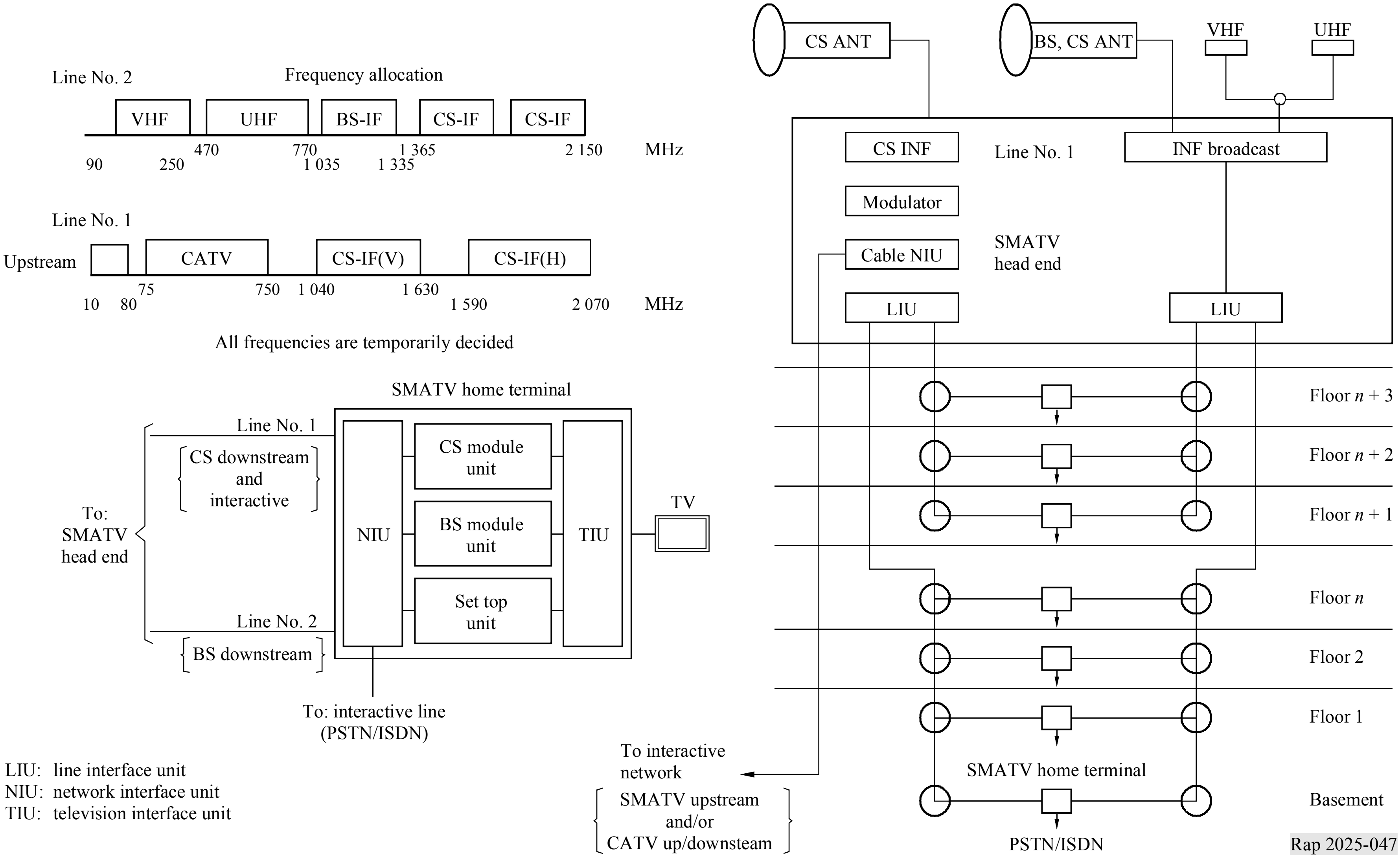
Figure 4.7 shows a simplified block diagram of the SMATV system. The system has a complete two-way construction, i.e. Line No. 1 and Line No. 2 systems. Half of Line No. 1 is for ordinary one-way broadcast services via satellite or CATV networks. The other half of Line No. 1 is for interactive broadcast services that consist of satellite (downstream) channel and interaction (upstream) channel. Line No. 2 is for one-way terrestrial and analogue-mode satellite programmes at this time, however interactive channels might be required when terrestrial systems are digitized. The upper limit of frequency bandwidth of SMATV system is approximately 2 GHz.

FIGURE 4.7

**SMATV distribution network**




LIU: line interface unit
NIU: network interface unit
TIU: television interface unit

The demand information from the subscriber's Set-Top Unit located at the SMATV Home Terminal is sent to the interactive service provider through the cable NIU (Network Interface Unit) of the SMATV head-end and interaction network. The cable NIU is a key component for interactive and ordinary broadcast services at the head-end. The physical upstream channel consists of the half of Lines No. 1 and No. 2 that includes cable NIU, LIU (Line Interface Unit) at head-end and interaction network as a return channel. In case of interactive SMATV system, the interaction network is used for upstream only. Interaction network may consist of CATV or PSTN/ISDN networks.

#### 4.3.1.3.4.3 Interactive Channel

From the characteristic of On-Demand interactive services it is desirable to use asymmetrical channel construction because the bandwidth is less required for upstream channels compared with downstream channels. It is not appropriate to deal with upstream signals over satellite from the view point of economic usage of satellite frequency bandwidth. In Fig. 4.6, the interactive network deals with SMATV upstream signals and the network entities are CATV or PSTN/ISDN networks.

The downstream signal from satellite should be distributed to each home terminal (Set-Top Unit) from the SMATV head end after frequency conversion. This part should be compliant with ITU-T Rec. J.84 System C III ( Transmodulation from QPSK to QAM ). The upstream signal should be sent to interaction network after encoding of error correction and QPSK modulation in a burst mode.

The block diagram of the NIU of SMATV home terminal and the cable NIU of the head end equipment are shown in Figs. 4.8 and 4.9 respectively.

FIGURE 4.8

**Conceptual block diagram for the NIU transceiver**

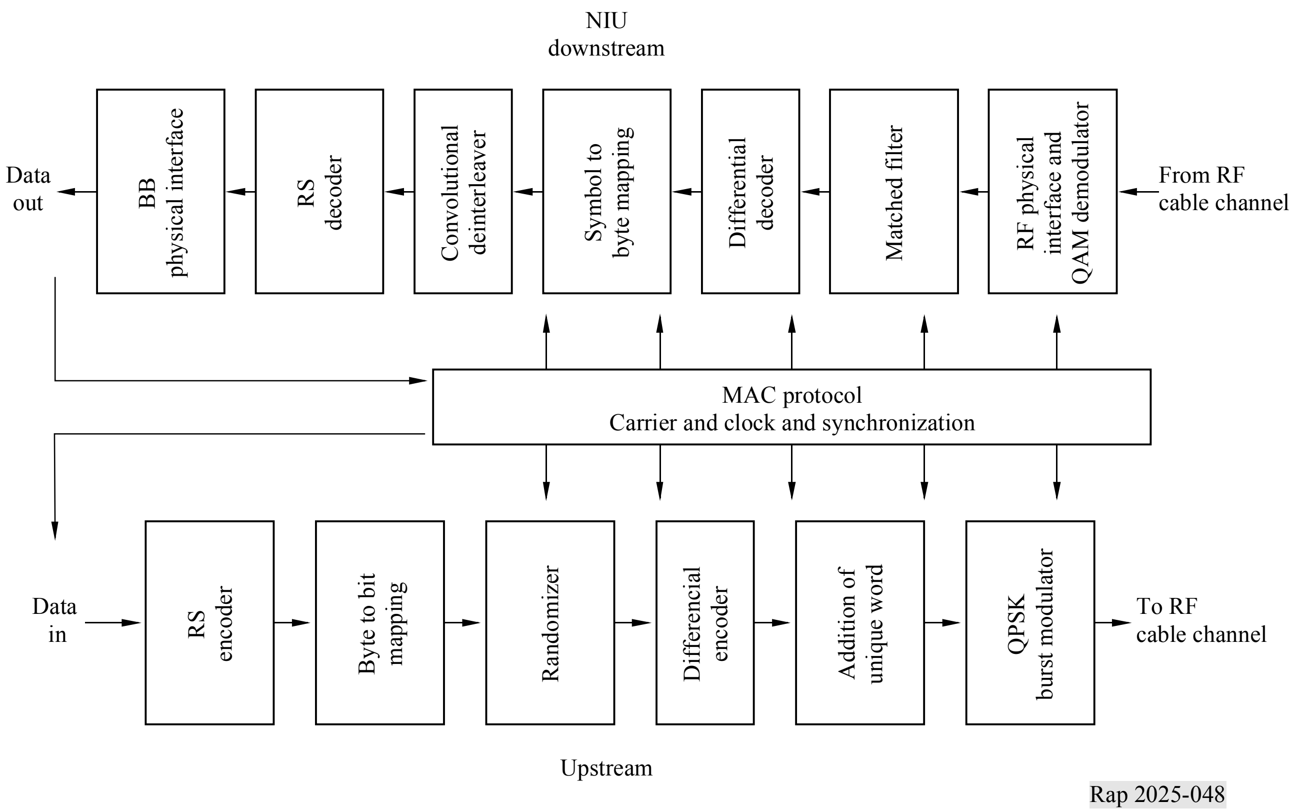
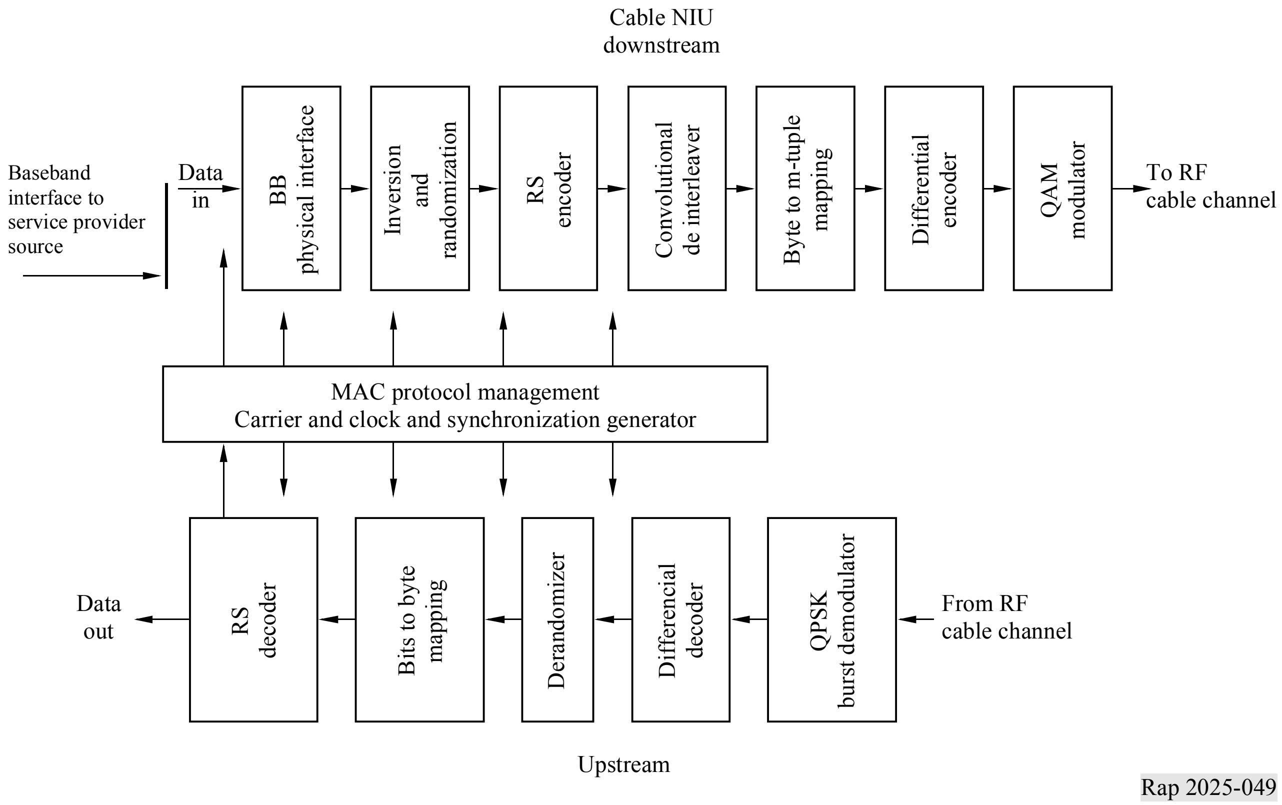


FIGURE 4.9

**Conceptual block diagram for the cable NIU transceiver**

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#### 4.3.1.3.4.4 Physical Channel

Table 4.3 shows a summary of the physical layer specification for the NIU and Cable NIU. The details of the physical layer specification should satisfy Annex C of ITU-T Rec. J.112.

TABLE 4.3

**Physical Layer Specification**

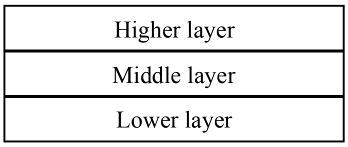
| | Upstream | Downstream |
|---|---|---|
| Maximum Symbol Rate | 2 304 ksym/s | 5.274 Msym/s |
| Bandwidth | 3 000 KHz | 6 MHz, ITU-T Rec. J.83 Annex C |
| Modulation Type | QPSK Differential | 64-QAM |
| Frequency Range | 10 to 60 MHz | 75-2 150 MHz |
| Error Correction | RS | RS |
| Transmission Level | +70 to +110 dB(μV) | +100 to +110 dB(μV) |
| Bit Error Rate | $1 \times 10^{-}6$ at CNR = 20 dB | $1 \times 10^{-8}$ at CNR = 27 dB |

#### 4.3.1.3.4.5 Protocol Stack

The major content of broadcast interactive services is likely to be high-quality video and audio programmes that require real-time, reliable (QoS guaranteed) low-latency connection. The protocol stack for interactive services should satisfy these requirements. Figure 4.10 shows a fundamental protocol stack.

FIGURE 4.10

**Fundamental protocol stack**

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#### 4.3.1.3.4.5.1 Higher Layer

The higher layer should contain application protocol, security control and administrative control protocols for total management of the SMATV network. However standardization of these higher layer protocols are not within the scope of this report.

#### 4.3.1.3.4.5.2 Middle Layer

Network independent protocol should be basically compliant with ITU-T Rec. J.111, Network Independent Protocols for Interactive Services. However from the view point of cost reduction, as suggested by ITU-T Rec. J.111 should allow the implementation of a specific protocol for weak interaction (non-real-time or off-line) systems. Those middle layer protocols are under study by JCTEA.

#### 4.3.1.3.4.5.3 Lower Layer

The lower layer should contain Physical layer and Physical Media Dependent (PMD) specifications. These specifications should be compliant with Annex C of ITU-T Rec. J.112. Media Access Control (MAC) is a main protocol of this layer in order to operate upstream and downstream in a synchronous mode. Contention resolution of the upstream signal should be treated in this protocol. The MAC protocol is now being studied by JCTEA.

#### 4.3.1.3.5 Interactive Services over CATV and SMATV Systems

Upstream bandwidth for interactive CATV and SMATV systems should be decided by the service contents over upstream channels. As a feasible content through CATV/SMATV systems, the Internet connection is the most likely required service of subscribers. Some experimental trials are being started.

Compared with similar services over telephone line by network operators, a CATV/SMATV network has an advantage in its transmission capacity. It is expected that an Internet and/or Intranet system using TCP/IP will grow rapidly and services for high-density, high-speed data transmission are required trough CATV/SMATV systems.

Table 4.4 shows the necessary transmission speed for interactive services over CATV in Japan, but not for upstream channels. Assuming a symmetrical network for high-speed data transmission, the required data speed for upstream is specified as follows. Furthermore the difference of throughput of each device should be considered in the actual system design.

#### 4.3.1.3.5.1 General Open local area network (LAN) Services

a) Low speed services for subscriber

b) The data speed should be less than 1.5 Mbit/s for each 6 MHz upstream channel for 500-2 000 subscribers (max. 2 000 terminals) per one node.

c) High-speed services for subscriber

d) The data speed should be at least 1.5 Mbit/s for each 6 MHz upstream channel for 200 subscribers (max. 2 000 terminals) per one node.

e) A 6 MHz reserve channel should be provided for degradation of throughput or future increase of subscriber.

#### 4.3.1.3.5.2 High-Speed LAN Services

A high-speed data channel should be provided for proprietary use for each 6 MHz bandwidth.

As shown above, at least four channels (24 MHz) are required for basic IP connections over LAN services. Taking into account other service request transactions, the preferable minimum bandwidth would be twice this, i.e. 48 MHz.

TABLE 4.4

**Network Transmission Speed**

| Network | Transmission Speed |
|---|---|
| Public telephone line-Analogue | Max. 28.8 kbit/s |
| Public telephone line-ISDN | Max. 128 kbit/s |
| Open Computer Network | 128 kbit/s |
| CATV | 10 Mbit/s |

Table 4.5 shows the required transmission speed for symmetrical interactive services over CATV network.

TABLE 4.5

**Required Transmission Speed for Interactive Services over CATV**

| Speed | Services | Coding | Transmission Speed | Modulation | Bandwidth |
|---|---|---|---|---|---|
| High | Telemedicine (Home Care) | MPEG-2 | 5-30 Mbit/s | 64-QAM | 6 MHz |
| High | | | 5-30 Mbit/s | | |
| High | Distance Learning | MPEG-1/2 | 1.5-5 Mbit/s | QPSK | 3 MHz |
| Low | | MPEG-1 | 1.5 Mbit/s | QPSK | 85 kHz |
| High | Games | MPEG-2 | 1.5-10 Mbit/s | 64-QAM | 2 MHz |
| High | | | 1.5-10 Mbit/s | | |
| Low | Telephone | Analogue | 3.4 kHz | QPSK | 26 kHz |
| Low | | | | | |
| High | Telephone | μ-law PCM | 64 kbit/s | QPSK | 48 kHz |
| Low | | | | | |
| Low | PC Communication Internet | TCP-IP | 64 kbit/s-1.5 Mbit/s | QPSK | 1.2 MHz |
| Low | | | | | |
| Low | Electronic Mail (Text, Audio, Video) | | Up to 1.5 Mbit/s | QPSK | 1 MHz |
| Low | | | | | |
| Low | Security Monitor | | 64 kbit/s | QPSK | 48 kHz |
| Low | | | 64 kbit/s | | |
| High | Virtual Amusement Park | MPEG-2 | 6 Mbit/s | 64-QAM | 1.2 MHz |
| High | | | 6 Mbit/s | 64-QAM | 1.2 MHz |
| Low | High-way Traffic Information Service | JPEG | 1.5 Mbit/s | QPSK | 1.2 MHz |
| Low | | | 64 kbit/s | | 48 kHz |
| Low | Ticket Reservation Service | | 19.2 kbit/s | QPSK | 15 kHz |
| Low | | | 19.2 kbit/s | | |
| High | Electronic Library Museum, Art Gallery | MPEG-2 | 1.5-10 Mbit/s | 64-QAM | 6 MHz |
| Low | | | 9.6-128 kbit/s | QPSK | 96 kHz |
| Low | Electronic News Publishing | | Up to 1.5 Mbit/s | QPSK | 1.2 MHz |
| Low | | | 9.6 kbit/s | | 7.2 kHz |
| High | TV Shopping | MPEG-1 | 5-10 Mbit/s | 64-QAM | 6 MHz |
| Low | | | 19.2 kbit/s | QPSK | 15 kHz |
| High | Game Software Distribution | | 2 Mbit/s | QPSK | 1.5 MHz |
| Low | | | 9.6 kbit/s | | 7.2 kHz |
| High | Video on Demand | MPEG-2 | 5-30 Mbit/s | 64-QAM | 6 MHz |
| Low | | | 9.6-64 kbit/s | QPSK | 48 kHz |
| High | Karaoke on Demand | MPEG-2 | 5-30 Mbit/s | 64-QAM | 6 MHz |
| Low | | | 9.6-64 kbit/s | QPSK | 48 kHz |

NOTE 1 – Upper column: Downstream, Lower: Upstream.

NOTE 2 – Roll-off of 64-QAM is 13%, QPSK 15%.

**References**

| | |
|---|---|
| Rec. ITU-T J.83-C | Annex C to ITU-T Recommendation J.83 (10/95) – Digital multi-programme systems for television sound and data services for cable distribution. |
| Rec. ITU-T J.84 | ITU-T Recommendation J.84. |
| Rec. ITU-T J.110 | ITU-T Recommendation J.110 – Basic principles for a worldwide common family of systems for the provision of interactive television services. |
| Rec. ITU-T J.112-C | Annex C to ITU-T Recommendation J.112 – Transmission systems for interactive cable television systems. |
| Rec. ITU-T J.111 | ITU-T Recommendation J.ini – Network independent protocols for interactive services. |
| Rec. ITU-T J.113 | ITU-T Recommendation J.113 – Digital video broadcasting interactive channel through the PSTN/ISDN. |
| ISO/IEC 13818-6 | Information technology: coding of moving pictures and associated audio – Part 6 – Digital storage media command and control (DSM-CC). |
| ETS 300802 | Digital video broadcasting; Network independent protocols for DVB interactive services. |
| DVB-RC-205 Rev.1 | DVB interaction channel for satellite master antenna television (SMATV) systems; Guidelines for versions based on satellite and coaxial sections. |

### 4.3.1.4 Japan proposal for two new classes of digital interactive television broadcasting services

#### 4.3.1.4.1 Introduction and summary

The first proposal is to introduce a service class, so called medium interaction. The current Japanese Digital Integrated Receiver and Decoder (DIRD) for digital satellite broadcasting services has a return channel using PSTN. Broadcasters are making use of these return channels, right now, to collect view-log-data of their pay-per-view services. This application could not be categorized into real-time interaction services but is a typical example of a strong interactive service as defined in TG 11/5. It is appropriate to report briefly the Japanese situation concerning medium interaction and to give an outline of the definition for medium interaction in order to draw attention of TG 11/5 to this new class. The second proposal is also to introduce a new class, defined as interactive service without return channel. Viewers can enjoy real interactive television services by using interaction processing between digital receiver and home server. This system does not use a return channel in this application. Broadcasters ouput large and varied amounts of data into home server. The home server should have sufficient data storage capacity and should have the necessary software agent to select a user's required data from of the broadcast data.

#### 4.3.1.4.2 Medium Interaction

Medium interaction using non real-time protocols is simple but, sometimes, specific while strong interaction using real-time interaction protocols is well functioned but complicated. The Strong Interaction class is defined in the Figure of Addendum 1 of Document 11-5/16 (Chairman's Report). The Medium Interaction class has the following characteristics and requirements.

– DIRD has a specific memory to store interactive service related data (e.g. view-log).
– DIRD should have secure memory to store service charge related data.
– Broadcasting station makes a call periodically (e.g. once a month) and a responding DIRD forwards the stored data to the broadcasting station. (Broadcasting station can avoid heavy congestion of PSTN traffic using this method.)
– DIRD does not make any telephone call spontaneously.
– In many cases, the return path is PSTN or ISDN.
– Cost of DIRD should be minimized.
– Busy-line time period of PSTN/ISDN should be minimized.
– To use a simplified interaction protocol rather than fully specified protocols like ITU-T Rec. J.111.
– If an interaction protocol has a proprietary portion, DIRD should have Down-Line-Loading capability to update the specific interaction protocol to another one.

The following parts of this section show the outline of hardware and software requirements for current DIRD specifications.

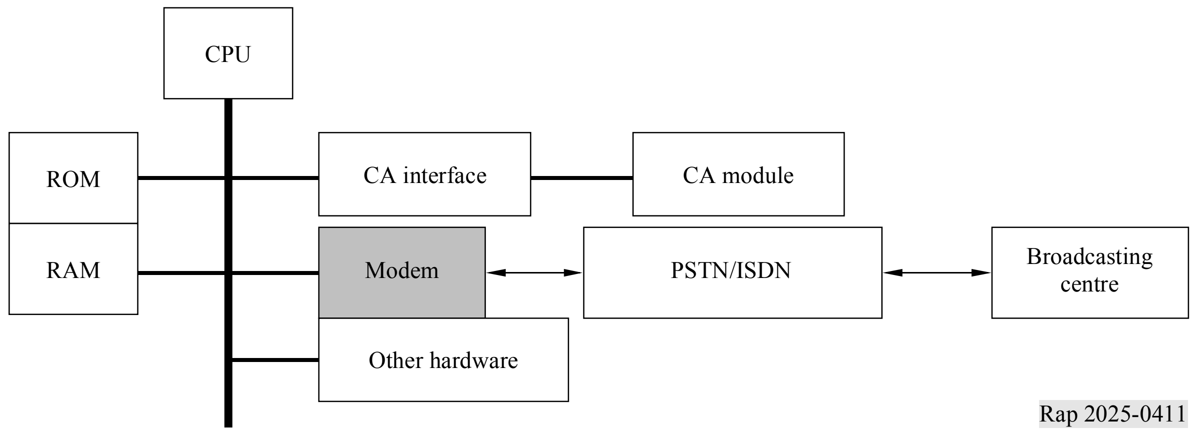
#### 4.3.1.4.2.1 Hardware Requirement for the current DIRD

There are two, and will be one additional, digital satellite television broadcasters in Japan. These three broadcasting service providers, in total, will adopt a common DIRD hardware and two types of interaction protocols including conditional access systems. The ARIB is encouraged to develop common hardware architecture and a part of the interaction software of DIRD.

Figure 4.11 shows hardware architecture of control block adopted in current DIRD.

FIGURE 4.11

**Typical DIRD hardware architecture for Japanese satellite broadcasting services**




According to the ARIB document of DIRD, hardware requirements for return channel modem are as follows:

– Telephone modular receptor should be used.

– V.22*bis* (2400 BPS) or more is required.

– Error management scheme is MNP 4 or more.

– Can be used with 0-prefix for PBX connection.

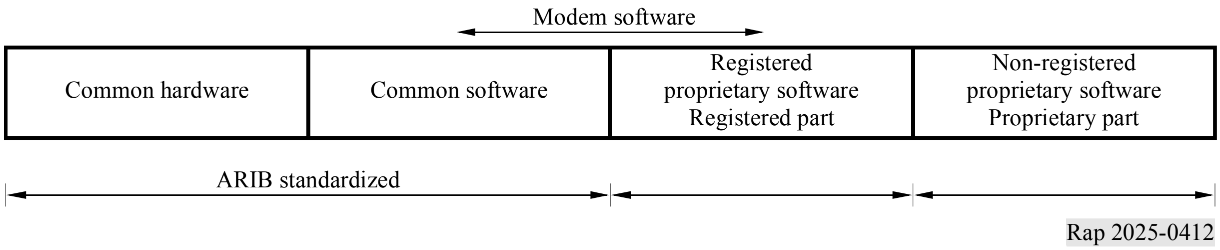
#### 4.3.1.4.2.2 Software requirement of Japanese DIRD

The software module of the return channel modem is divided into a common part and a registered proprietary part. In this case, the registered modem software includes low-speed interface of the proprietary conditional access system. However the high-speed interface of the conditional access system is standardized in the hardware specification. In these situations the standardized procedure is necessary to download the software package for proprietary modem functionality that should work on the common modem hardware.

If a viewer decides to change service provider from A to B, the modem software package and conditional access system should be updated for provider B using standardized down-line-loading protocol. 2M-byte memory (typically using flash ROM) is prepared for this purpose. These down-line-loading data are on the air periodically through broadcast channel. Figure 4.12 gives a brief explanation of modem software architecture for Japanese DIRD.

FIGURE 4.12

**Modem software for current Japanese DIRD**




#### 4.3.1.4.3 Interactive services without return channel

Home Server system is a typical application of interactive service without return channel. Cost per bit of digital mass storage media is getting lower very rapidly while the communication charge remains still in higher level in Japan. Considering these situations, real-time interaction using full-time PSTN connection could not have reasonable cost per performance ratio.

There are two proposals in this class in Japan.

NHK (Nihon Hosou Kyokai) Science & Technical Laboratories propose one example of this class, which is called Home Server right now. This application is one of Integrated Service Digital Broadcasting (ISDB) services. ISDB has wide service range of broadcasting applications including digital television, digital audio, data broadcasting, and Home Server. ARIB has started the standardizing effort on this issue. Another companion contribution from Japan has detail about ISDB.

DirecTV Japan, that is the second service provider of digital satellite broadcasting, proposes the other interaction service of this class and its service name is InteracTV. As shown in the previous contribution, Document 11-5/4(Rev.1)-E, this service was called DVX previously. Intra frames are selected from MPEG-2 bit-stream and are stored in the memory bank in DIRD box. Viewers can select their desired still pictures from memory bank.

### 4.3.1.5 Report of service server system for existing interactive television system using VBI forward channel and PSTN interaction channel

In Japan, the first interactive television service was launched in October 1996. This system is called IT-Vision, which uses VBI forward data channel and PSTN interaction channel. Regularly scheduled programmes, which are directly linked to IT-Vision interactive system, are broadcasted weekly for more than 30 hours by TV-Tokyo over the Tokyo Metropolitan area.

This Report provides some technical information concerning specific feature of IT-Vision receiver and the design concept of central server complex, and also explains some techniques how to avoid traffic congestion of the telephony system for large amounts of viewer’s instantaneous responses.

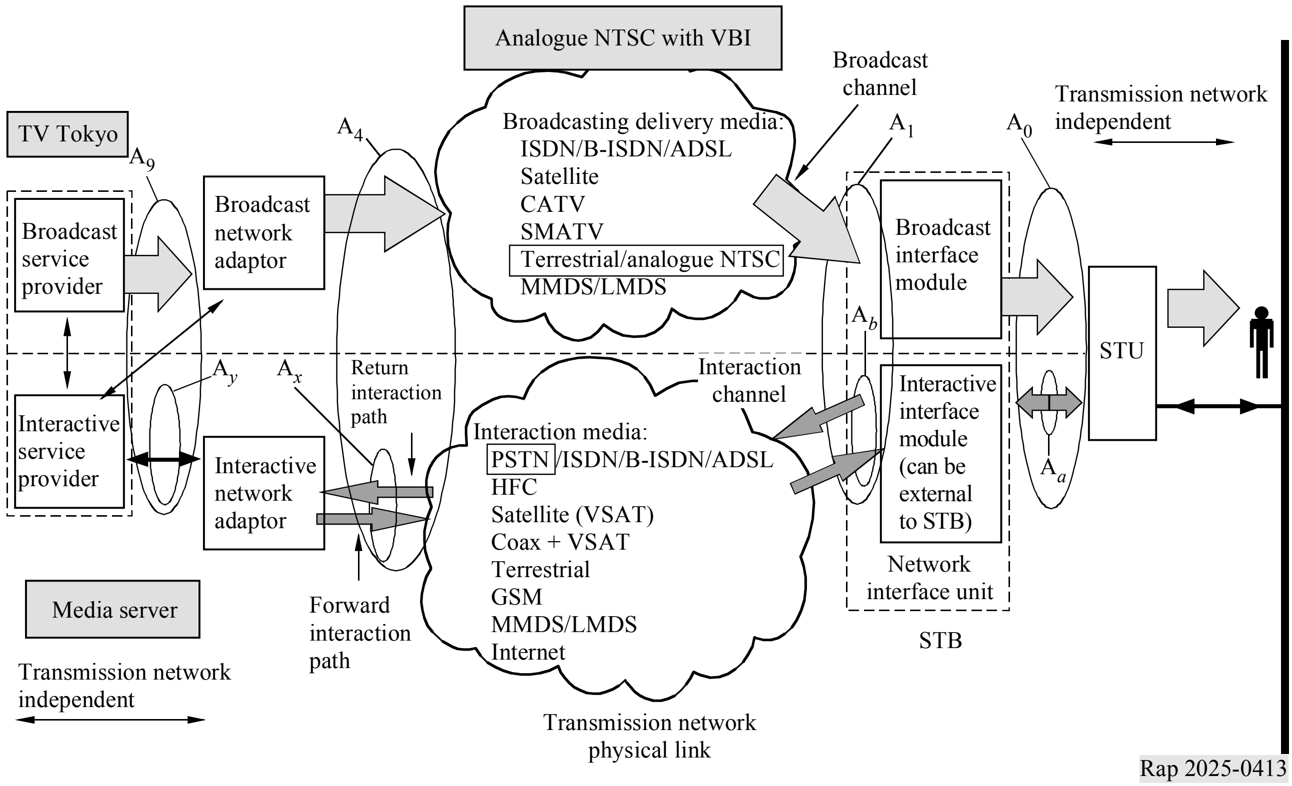
These considerations will be helpful to establish the standard for an interactive television and sound broadcasting system, which is the final target of Radiocommunication TG 11/5, in the digital broadcasting environment, while the current IT-Vision system uses a conventional analogue-based VBI data transmission system.

#### 4.3.1.5.1 System Overview of IT-Vision

Basically, IT-Vision system has the same system architecture as the reference model while the only difference is the forward broadcasting channel. This system is based on an analogue NTSC system with a VBI forward data channel. The Interactive Service Provider defined in Fig. 4.13 is called the Media-Serve, that is, the specific commercial organization providing interactive service information to the broadcaster by receiving and processing significant amounts of, and various kinds of, responses from viewers. This corporation also provides the function for Interactive Network Adapter which is also defined in Fig. 4.13.

FIGURE 4.13

**Functional refence model for interactive television services (ITU-T Recommendation J.110)**




In the simple responding mode which is shown Table 4.6, this system keeps the telephony connection between local switch and home terminal for minimum time period. In this case, the modem of the IT-Vision home terminal uses the fixed-rate mode of 2 400 bit/s in order to avoid long negotiation time. Tele-Gong mode needs to hold the telephony connection less than 30 s per call typically while negotiation time needs more than 30 s to fix the higher transmission speed.

TABLE 4.6

**Types of Traffic and Features**

| Responding mode | Type of broadcasting contents | Network | Result of data processing to be reported to broadcast service provider | Manageable Traffic | Danger of Congestion |
|---|---|---|---|---|---|
| Simple Response | Voting | Tele-Gong(1) | The number of call | Large | |
| | Quiz with gift | Tele-Gong with Cut-Through(2) | The number of calls and sample data | Large (Small number of cut-through processing) | |
| Complex Response | Ticket reservation | Normal call | All calls should be processed | Medium | |
| | Tele-shopping/ Info-marcial(3) | Toll free call | All calls should be processed | Small | Large |

(1) Tele-Gong is the special function implemented in the local telephony switch. There is no further connection to higher telephony network. Only the number of viewer's choices/answers is counted and reported to Interactive Service Provider.

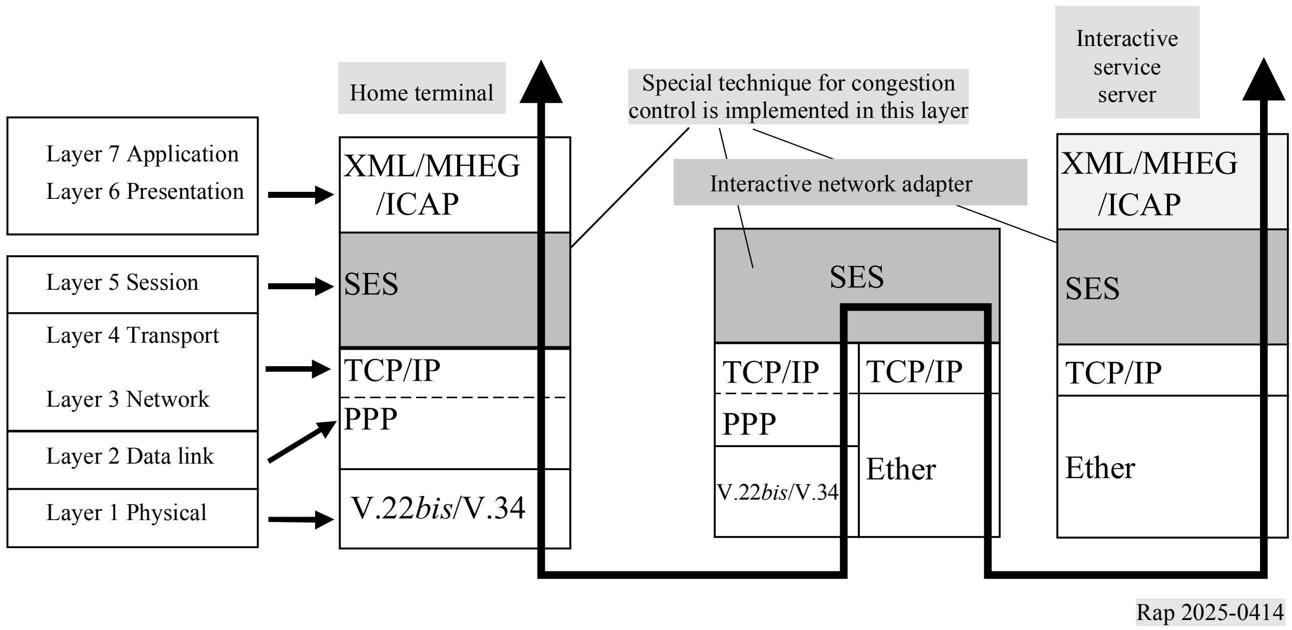
(2) In Cut-Through mode, limited numbers of responses from viewers, for example the inputted message from quiz winner, are processed and forwarded to the Interactive Service Provider.

(3) Info-marcial is abbreviation of Information and Commercial.

Figure 4.14 shows the protocol stack of the IT-Vision system. The main features of this system are implemented in the session layer. These are the special techniques to avoid traffic congestion. The next section provides a brief explanation of these techniques.

FIGURE 4.14

**Protocol stack for IT-vision system**




#### 4.3.1.5.2 Some Techniques on How To Avoid Telephony Traffic Congestion

In this interactive broadcasting system, PSTN is the first choice for an interaction channel. Of course, there are alternative choices for the interaction channel. For example, Cable Modem (Rec. ITU-T J.112) is considered as the second choice for this purpose in Japan. However, Cable Television has relatively low penetration rate in Japan right now, hence the most promising medium for an interaction channel is the PSTN system.

Generally, minimizing the connection time between a home terminal and a local telephony switch is very important to avoid traffic congestion. These techniques are effective to reduce the number of telephone lines satisfying the required quality of interactive broadcasting services. Long-term average of traffic is not so heavy but the instantaneous peak is estimated to be very high in these applications.

In the simple responding mode, Tele-Gong system is adopted to satisfy these requirements. This function is implemented in the local telephony switch of the local access provider or telephone network provider. This technique is effective when necessary statistics for the broadcaster are the numbers of "Yes" and "No" types of viewer's response.

The second technique is assumed to be used in the complex responding mode. As shown in Table 4.7, the complex responding mode needs the full connection between home terminal and the Interactive Service Server of the interactive service provider. Furthermore, there is a risk of congestion because the complex responding mode could hold the line for a significantly longer period than that of the simple responding mode. There are two techniques implemented to avoid traffic congestion in the IT-Vision system as shown in the following. These functions are implemented in the session layer of Fig. 4.14.

– Responding Delay Control

  When a viewer pushes the Send button on the remote controller, the home terminal controls the actual transmission timing using random numbers, etc. According to experimental testing, peak traffic is reduced from 10 to 4 (60% reduction) when 0 to 180 s delay interval is adopted in the case of 25 total calls. Another case shows that the peak load falls from 12 to 11 (8% reduction) when 0 to 30 s delay interval is adopted in the case of 51 total calls.

– Access Restriction Using Terminal Identification Number

Server access is granted if a part of the terminal identification number is equal to the given numbers given from the broadcaster when the viewer hits the send button. The interactive service provider can control the restriction grade though the forward data channel. This is just the same idea of conventional access restriction using the last digit of the telephone number.

#### 4.3.1.5.3 Current Server System and Result of Experimental Broadcasting

Table 4.7 shows the parameter sets for several grades of Interactive Service Server and telephone line concentrator that are the main functions of Interactive Service Provider. The relation with the number of telephone lines to be installed and the number of IT-Vision terminals is also provided in Table 4.7. Currently, Media Serve has 120 telephone lines that have adequate capacity to receive data from more than 17 000 existing home terminals. Table 4.8 shows the result of viewer's response for the promotional broadcasting using IT-Vision system. In this case, simple responding mode was used to count the voting result from viewers not only using the IT-Vision terminal but also normal telephone with push button. A total of 90 000 responses were recorded for 3-time voting during a 30-min long broadcasting programme.

TABLE 4.7

**Interactive Service Server Capabilities**

| Server System | Maximum capacity of telephone lines to be installed | Previous IT-Vision Terminal with complex response(1) using 2 400 bit/s | Current IT-Vision Terminal with complex response(1) using 33.6 kbit/s |
|---|---|---|---|
| Windows NT Base | 12-24 | 200-600 | 1 200-3 200 |
| Solaris Base(2) (Medium) | 48-144 | 1 500-5 200 | 7 500-26 000 |
| Solaris Base (Large) | 288-576 | 11 000-23 000 | 55 000-115 000 |

(1) Complex responding mode requires full connection between home terminal and interactive service server.

(2) Current actual implementations in Media Server Inc is in this category.

In case of simple responding mode, the acceptable number of IT-Vision terminal by interactive service server is much larger than that of complex responding mode.

TABLE 4.8

**Result of Viewer's Response in Actual Interactive Broadcasting Service**

| Programme Length | The Number of Voting | The Number of Response per Voting | The Total Number of Voting per TV Programme |
|---|---|---|---|
| 30 min | 3 | 30 000 | 90 000 |

#### 4.3.1.5.4 Conclusion

Because interactive broadcasting services are still in the early stages, the data shown in Table 4.8 is helpful for consideration of the requirements necessary to establish standards for interactive television and sound broadcasting services.

### 4.3.2 Australia

Telstra Research Laboratories (TRL) in Australia are involved in R&D in the area of video retrieval services. TRL researchers have been working to develop a content management system for delivering video services over the Internet. The system could work over BigPond Cable, Telstra's cable modem service or ADSL (asymmetric digital subscriber loop) platforms.

The project involves the development of a video-programme indexing and management and retrieval system that enables streaming of video over IP (Internet Protocol) networks. The system would have VCR-type controls (pause, rewind, etc.) and interface with standard Internet browsers. The system could be used for accessing archived video programmes.

In 1996 Telstra conducted trials of both broadcast video delivery and Video-On-Demand services on ADSL which were accessible from several homes and across several exchange areas.

Telstra has a commercial broadband cable service which was launched in early 1997, which can support video and audio retrieval services as well as other Internet services on HFC cable network.

Optus Vision in Australia has also demonstrated Internet links over its broadband cable network. The demonstration formed part of an education trial Optus Vision was conducting with eight secondary schools in Sydney and Melbourne in 1996.

Optus Vision's cable modems being used as part of the trial demonstrated two-way data transmission speeds of up to 10 Mbit/s. The demonstration also showed for the first time simultaneous delivery of television and data transmission via Opus Vision's network.

### 4.3.3 Hong Kong

Hong Kong Telecom's activities are somewhat out of TG 11/5's scope. However, it is still important to report its efforts. This system makes use of telecommunication network for the forward data channel and for the control channel. According to its roll out plane, interactive television services will be launched in 1997.

#### 4.3.3.1 Technical Situation

Each customer's home is equipped with a set-top box, which comes complete with a handheld remote controller. Programmes are centrally stored in digital, compressed form on a video server. They are transmitted along telephone lines to set-top boxes connected to phone sockets and a television, activated only when there is specific call-up from the customer.

The major components which go together to provide Interactive Multimedia Services (IMS) are as follows:

**Video Compression**

Although it has long been possible to convert video information into digital form, the quantity of bits generated for analogue/digital conversion is formidable. It is the advent of compression technology that has greatly reduced this enormous amount of data into a more manageable size.

**Video Server**

The video server is actually a number of computers linked together, forming a high-speed processing platform needed to store and deliver the vast quantities of data represented by compressed, digitized video.

##### 4.3.3.1.1 The Set-Top Box

The compressed, digital video content is delivered via the telecommunications network to the set-top box, whose job is to decompress, decode and reconstruct the television signal into a form acceptable to an ordinary domestic television set.

#### 4.3.3.2 The Network

Hong Kong Telecom's digital network is responsible for making the connection between the video server and the customer's set-top box when customer requests access to the service. The network also carries commands input by the customer, e.g. programme selection, fast forward, pause etc. back to the video server.

# 5 Spectrum considerations

## 5.1 Spectrum planning for interaction paths

### 5.1.1 Introduction

As noted in the Chairman's Report of Radiocommunications TG 11/5, the implication of interactive TV services on spectrum planning needs to be studied.

Searching for recent ITU contributions mainly to Radiocommunications TG 11/5 and Telecommunication Standardization WP 1/9, there are several documents dealing with return channel issues. The following are a summary of documents found in related ITU contributions. It is still early to produce spectrum planning for interaction paths, however, it is important to summarize the recent situation concerning interaction return paths, in order to prepare for future spectrum planning.

### 5.1.2 UHF Return Channel Spectrum Requirements

In Canada during the transition period when both NTSC and DTV systems will co-exist, the television broadcasting spectrum will be very congested. Finding suitable spectrum to implement a return channel in the UHF spectrum as suggested by the European INTERACT project may not be possible because of the additional interference that such a return channel may cause for the implementation of digital television.

At this point in time, the technical considerations above have not taken into account any regulatory concerns that Canadian authorities may have with respect to reuse of the spectrum that may be freed up when NTSC television transmissions cease.

### 5.1.3 Summary of recent proposal for return paths

Table 4.9 is a summary of physical layer of return paths, which appeared in the recent Radiocommunications TG 11/5 and Telecommunication Standardization SG 9 contributions.

## 5.2 Conclusions

MDS may be more appropriate for broadcast (one-way) applications while LMCS with its larger available spectrum and smaller cell sizes is likely to be more appropriate for interactive services. These two systems could therefore be considered complementary to each other.

These systems are currently introduced competitively, using different standards. It is expected that they may be deployed cooperatively in the future and, therefore, use compatible standard among DBS, cable, MDS and LMCS.

More tests are required in order to characterize the transmission channels for different frequency bands and to determine for each of the wideband wireless transmission systems the most suitable digital modulation scheme. There is also a need to develop appropriate coverage prediction software and databases which include not only topographical data but also vegetation and buildings information to identify the most appropriate design for network configuration. In particular there is a lack of information on the effectiveness of passive (reflectors) and active on-frequency repeaters. Finally demonstrations and market studies are necessary to assure consumers' acceptance.

TABLE 4.9

**Physical layer of return paths**

| Return Interaction Path | Frequency Band | Forward Interaction Path | System | Reference |
|---|---|---|---|---|
| PSTN | (2 400 bits/s) | PSTN/Broadcast Channel | Satellite Broadcasting | 11-5/20 |
| Modified DECT<br>(Between STB and DECT Base Station) | 15-35 MHz | DECT/Cable (Coaxial Section) | MATV/SMATV | Telecommunication Standardization<br>SG 9-D27 |
| UHF broadcast channel | 500-750 MHz | Terrestrial Broadcast Channel | Terrestrial TV | 11-5/15 |
| DECT | 1.88-1.9 GHz | DECT/Other Downstream Media | Not Specified | ITU-T COM 9-21 |
| MCS | 2.500-2.596 GHz | MCS/Other Downstream Media | Not Specified | 11-5/21, 22 |
| VSAT in the FSS band<br>(Between SIT and Service Provider) | Ku (11/12/14 GHz) | Satellite Channel | SMATV | 11-5/17, 19 |
| VSAT in the FSS band<br>(Between SIT and Service Provider) | Ka (19-30 GHz) | Satellite Channel | SMATV | 11-5/17, 19 |
| Cable (Bidirectional)<br>(Between Group Terminal and SIT) | Not mentioned<br>(Cable) | Cable | SMATV | 11-5/19 |
| Cable (Bidirectional)<br>(Between Home and Head end) | 10-60 MHz (Cable)<br>3 MHz bandwidth | Cable | SMATV | Telecommunication Standardization<br>SG 9-D52 |
| LMCS | 27.35-28.35 GHz<br>25.35-27.35 GHz in the future in Canada | LMCS/MDS (MMDS) | MDS (MMDS) | 11-5/21, 22 |

DECT: Digital enhanced cordless telecommunications

MMDS: Multichannel multipoint distribution system

SIT: Satellite interactive terminal

VSAT: Very small aperture terminal.

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