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Interactive Cable Networks and Existing Trends in Germany

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1. Introduction

Cable television networks (CaTV) all over the world are in the process of being upgraded towards two-way broadband communication. A return path is installed where not yet available and the frequency range in downstream direction is expanded. These new CATV networks will not only broadcast analogue TV and audio, they will be used to transmit digital signals for high-speed interactive services after all. Some of such services still address the television set at the end user's home, but others allow connection of computers and even telephone sets as well. New services will be available when new devices, so-called set-top boxes, cable modems and headends are on the market place. To succeed in this market, open standards are required to ensure interoperability between products manufactured by different vendors. Open standards, e.g. DVB and DOCSIS, are solutions for a global system.

2. International Activities

Groups and organizations involved in the development of standards for interactive digital transmission in CATV networks are shown in Fig. 1. At the beginning, three groups were working on that subject: CableLabs, DVB/DAVIC and IEEE 802.14 (DVB: Digital Video Broadcasting, DAVIC: Digital Audio Visual Council, DOCSIS: Data Over Cable Service Interface Specification). In the last two years, the original race between these three systems narrowed down to a competition between the DOCSIS and the DVB system.

2.1 Activities in the US: CableLabs

2.1.1 Cable Modem

The "DOCSIS CableModem" started in Jan. 1996 and finally produced the specification DOCSIS 1.0. Later, versions 1.1 and 1.2 were added which provide guaranteed bandwidth, i.e. Quality of Service and advanced physical layer. The goal of the DOCSIS specifications is to provide interoperability among products of different manufacturers.

2.1.2 Technical description of DOCSIS

Downstream transmission

The physical layer is conform with ITU-T Rec. J.83 Annex B with minor modifications. The frequency range is 88 - 860 MHz with 6 MHz bandwidth channels. This indicates the strong orientation to the North American market. Two modulation schemes: 64-QAM and 256-QAM. Square-root raised cosine filter with roll-off factors 0.18 and 0.12 for 64-QAM and for 256-QAM, resp. Forward error correction consists of a concatenated RS (128,122) coder and a „trellis coded modulation" as inner code. An interleaver with variable depth is specified to support low-latency applications.

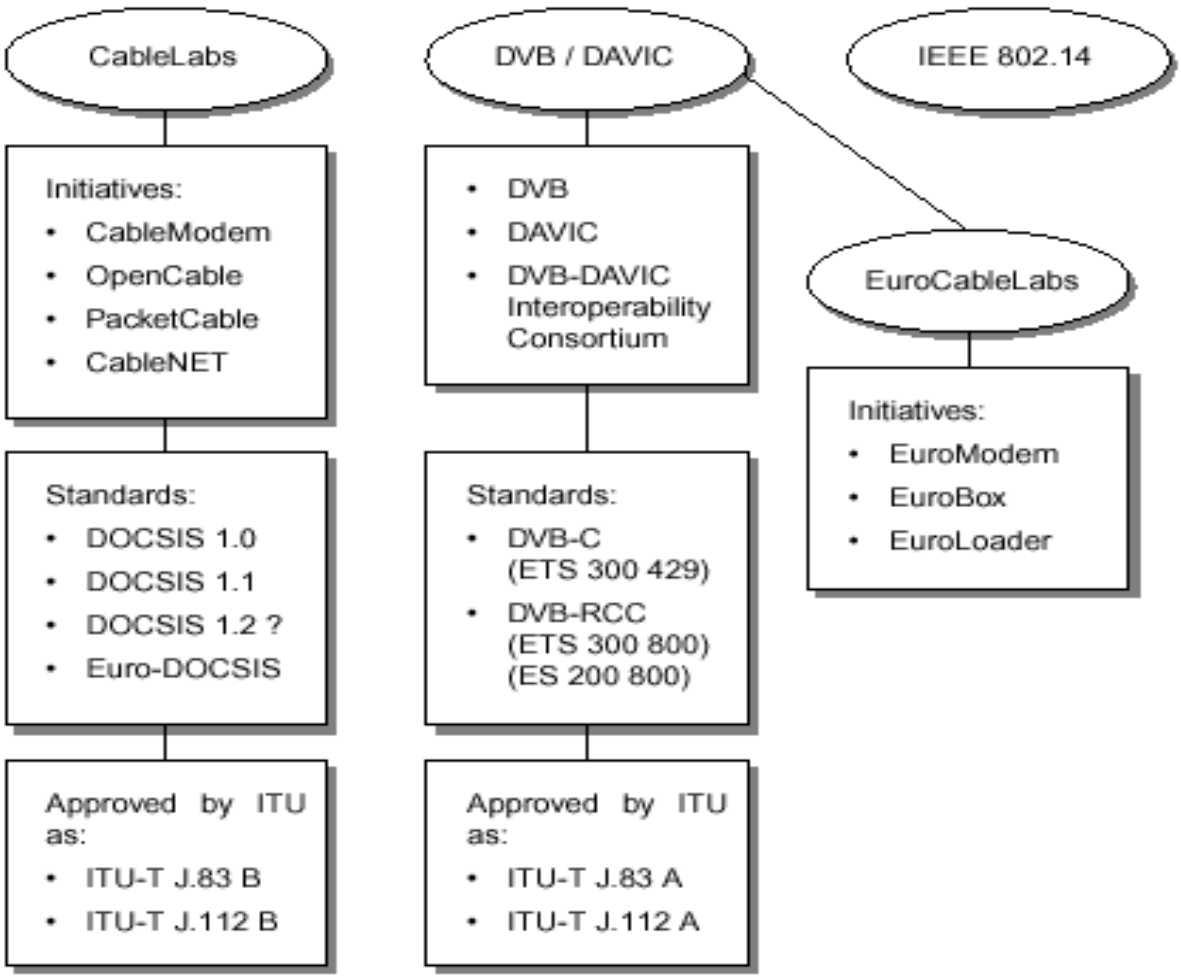

Fig. 1: Consortia and standardization activities for interactive cable systems

Upstream transmission

Upstream physical layer is specified in the DOCSIS Radio Frequency Interface Specification (SP-RFI) which was adopted as ITU-T Rec. J.112 Annex B. This includes physical and MAC layers. The physical layer uses a FDMA/TDMA burst modulation format. Each burst supports flexible modulation, symbol rate, preamble, randomization and programmable FEC encoding. All upstream parameters of a cable modem can be configured by the headend. The signal processing includes the following elements:

- Blocking of Data: Data packets are separated into information blocks (= data bytes in one codeword).
- FEC encode: The Reed-Solomon forward error correction is very flexible and allows code words with a length between 18 and 255 bytes as input and supports programmable strength of error protection. Values from t = 0 (no error protection) up to t = 10 (strongest error protection) are possible.
- Scrambling: Data is randomized by using a pseudo random binary sequence generator.
- Preamble prepend: A preamble with variable length is inserted after scrambling of the data.
- Symbol Map: This element maps the data stream into modulator symbols.
- Filter: Square-root raised cosine filter with roll-off factor 0.25.
- Modulator: DOCSIS specifies QPSK and 16-QAM, alternatively
- Possible channel bandwidths are given in Tab. 1.

2.1.3 Euro-DOCSIS

Changes are only made on the physical layer while the MAC and higher layers are not modified. Important changes in downstream direction are:

8 MHz channels, 100 - 860 MHz frequency range, ITU-T J.83 A forward error correction.

In upstream direction: 5 - 65 MHz frequency range.

Bandwidth	**Bit rate for QPSK**	**Bit rate for 16-QAM**
200 kHz	320 kbit/s	640 kbit/s
400 kHz	640 kbit/s	1.28 Mbit/s
800 kHz	1.28 Mbit/s	2.56 Mbit/s
1.6 MHz	2.56 Mbit/s	5.12 Mbit/s
3.2 MHz	5.12 Mbit/s	10.24 Mbit/s

Tab. 1: Bandwidths and bitrates for upstream transmission DOCSIS

2.1.4 OpenCable

Set up in 1997, OpenCable is a project managed through CableLabs and is aimed at developing a new generation of interoperable digital set-top boxes and other advanced digital devices for the television market. These devices would be capable of delivering digital video, data and interactive services to a television set. The features also may be built into consumer electronics devices, such as new digital cable ready television receivers. 6 interim specifications were released in April 2000.

2.1.5 PacketCable

PacketCable is another initiative of CableLabs which builds on top of the DOCSIS cable modem infrastructure. PacketCable networks are two-way cable-based packet networks which use the internet protocol (IP) to deliver a wide range of multimedia services, such as IP telephony, videoconferencing, and other multimedia applications. By implementing IP telephony, several difficulties including signaling and how to connect the PSTN, existing networks, internet, and cable networks have to be solved. In December 1999, CableLabs has completed the PacketCable 1.0 specification.

2.1.6 CableNet

A convention, as part of the annual Western Show in Los Angeles, where companies can present their latest products.

2.2 European activities: DVB and EuroCableLabs

2.2.1 DVB

The Digital Video Broadcasting (DVB) project was created in 1993 with the aim of developing a global family of standards for digital television. The strongest support for DVB is in Europe, but several countries in other parts of the world are implementing or testing DVB systems as well. Fig. 2 shows the principle of the system.

Features of the DVB standard include in downstream direction (broadcast channel):
- MPEG-2 transport layer
- 70 - 862 MHz frequency range
- 7 MHz or 8 MHz channels
- 16-QAM, 32-QAM, 64-QAM, 128-QAM, 256-QAM modulation (up to ~52 Mbit/s)

In the out-of-band forward interaction channel:
- ATM framing
- 70 - 130 MHz and 300 - 862 MHz frequency range (preferred)

• 1 MHz or 2 MHz channels
• QPSK modulation scheme (up to 3.088 Mbit/s)

and in upstream direction:
• ATM framing
• 5 - 65 MHz frequency range
• 200 kHz, 1 MHz, 2 MHz or 4 MHz channels
• QPSK modulation scheme (up to 6.176 Mbit/s)

Some further developments and additions to the original ETS 300 800 standard were resulting in a second and third version of this standard which were recently adopted by ETSI in the new DVB-RCC standard ES 200 800 which replaces the „old“ ETS 300 800.

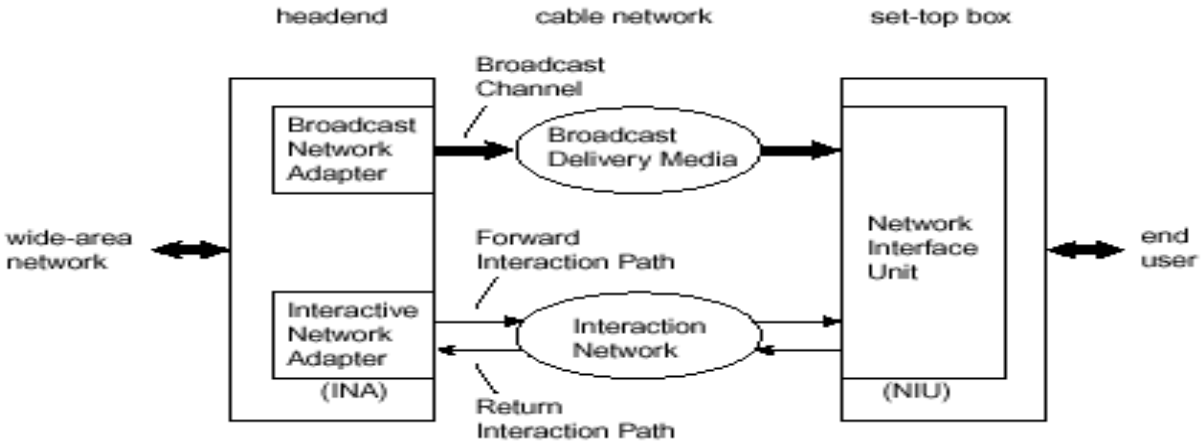

Fig. 2: Interactive DVB cable system

2.2.2 DVB-DAVIC Interoperability Consortium

In the recently defined plan of certification of inter-operable products like EuroModems or EuroBoxes, the DVB-DAVIC Interoperability Consortium is responsible for execution of interoperability tests. More than 10 manufacturers are members of this group.

2.2.3 EuroCableLabs

EuroCableLabs, an organization of European cable operators, was founded as a counterpart to the U.S. CableLabs to foster European cable modem and set-top box activities. The following projects were launched: EuroModem, EuroBox and EuroLoader.

2.2.4 EuroModem

Two types of EuroModems were defined in the EuroModem 1.0 specification that was published in May 1999: The class A EuroModem with basic functionality, mainly used for high-speed internet access with up to 50.8 Mbit/s in downstream direction and up to 6 Mbit/s in upstream direction. The class B EuroModem is enhanced to guarantee several levels of QoS and support of time-sensitive applications, like voice over IP or video conferencing. It allows direct connection of a telephone set. The functionality of a class B EuroModem is similar to a DOCSIS 1.1 based modem.

2.2.5 EuroBox

The EuroBox project that was set up in March 1997 to specify a standardized platform for inter-operable advanced digital set-top boxes to be used in a CaTV network. The box supports pay-TV, pay per view, audio, Electronic Program Guide and other interactive applications.

2.2.6 EuroLoader

This is the latest EuroCableLabs initiative presented in September 1999. EuroLoader is the first approach for a standardized software loader. It specifies the resident software in set-top boxes or cable modems and the software download mechanism.

3. Status and Trends in Germany

In Germany about 21 million cable television households are connected at present. About 18 million belong to the largest network provider Deutsche Telekom, the remaining number of about 3 million is scattered among several smaller providers.

According to a regulation of the European Community in Brussels, Deutsche Telekom is in the process of dividing the network into about 9 regional parts which will be operated by private companies where Deutsche Telekom will have a minor share [9]. 55% of the North-Rhine Westphalian and mayor parts of the Baden-Wuerttemberg network were sold recently to Callahan Assoc. USA. 65% of the network in the state Hesse was also divested recently. According to Deutsche Telekom announcements [9], futher divestments will follow.

As a consequence, strong competition between CaTV network and service providers can be expected. The target of the new companies is not only to provide conventional TV distribution to the consumers, but also to offer interactive services, first of all telephony and fast internet access. Thus, an additional field of competition is opened up for the benefit of the consumers. To do so, the cable television networks have to be upgraded for interactive services, and emerging techniquese and standards as outlined in the previous sections will come into operation. At present, it can be expected that not only the European DVB system will come into play in Germany.

4. References

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[4] SP-RFI, version 05: DOCSIS Radio Frequency Interface Specification, November 1999.
[5] SP-RFIv1.1, version 04: DOCSIS 1.1 Radio Frequency Interface Specification, April 2000.
[6] ITU-T Recommendation J.83: „Digital multi-programme systems for television, sound and data services for cable distribution“, July 1997.
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