C-HPAV Technologies and Its Application in the Integration of Three Networks in China

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Abstract. AS a cable access technology, China's Home Plug AV (C-HPAV) has become one of the major technologies of Ethernet over Coaxial (EOC) in Chia, and it has been widely used in the integration construct of three networks. It has also been popularized to many regions with the development of the next generation networks of radio and television. This paper mainly discusses the technical details of C-HPAV and detailed introduces its structure of the physical layer and MAC layer, and then gives a comprehensive comparison with Home Plug AV (HPAV) which is designed to run Ethernet over the existing electrical system. At last, we analyze its current application and deployment situations in the integration of three networks in China.

1. Introduction

The integration of three networks was proposed definitely for the first time in March 15, 2001 in China, which would promote the integration of telecommunications network, radio & television network and Internet to minimize the cost for operating these three networks.

In the evolution process of broadband communication network, digital television network and the next generation of Internet, the technical functions of the three networks tend to coincide through the technological transformation, and the scope of their business tends to be the same, so the telecommunications network, radio & television network and Internet can be integrated into one network, interconnecting, interworking and resource sharing. As long as the experimental points increase gradually, the Ethernet over Coaxial (EOC) technology based on IEEE1901 standard and HPAV solve the last 100 meter access problem after making a full use of existing home coaxial cable resources which used by cable television [8, 11]. C-HPAV standard has been drafted by part of the network operators, chip manufacturers, research institutes, and equipment manufacturers. Utilizing HPAV as its technical prototype, C-HPAV adopts the technical features of IEEEl901 standard and using coaxial cable instead of the power line in HPAV as the transmission media of Ethernet [12]. In technology the C-HPAV standard uses HPAV as a reference and improved it in physical layer, MAC layer, convergence layer and network layer. In this paper, we first introduce the technology features of C-HPAV and then compare it with HPAV. At last, we describe the development status of the integration of three networks in China.

2. C-HPAV

2.1 C-HPAV Architecture.

C-HPAV combined the advantages of HPAV and improved making it meet the demands of China. HPAV technology solves family internet access issue to improve home network coverage problem by transmitting Ethernet though power line. C-HPAV serves people various internet services by the technology using on coaxial cables. This technology, which is one of the coaxial cable Ethernet access technologies, optimizes the physical layer protocol and media access layer protocol based on Chinese radio spectrum standard establishing a point-to-multipoint communication framework and enhancing central office and terminal management protocol.

Cable TV network operator only needs to make a full use of coaxial cable network resources and providing various service accesses because those resources already exists in Hybrid Fiber-Coaxial (HFC) . The system is divided into three parts, namely: head-end equipment CLT (Coax Line Terminal, coaxial cable line terminal, here specifically refers to the C-HPAV network head), multiple user terminals CNU (Coax Network Unit, coaxial cable Network unit, here refers specifically to the C-HPAV network terminal), and the CLT and CNU coaxial cable distribution network, which is connected with many other coaxial cable access technology similar to the network structure is very suitable for domestic cable television access network [6].

Head-end equipment CLT mainly to complete the Ethernet data signal modulation and demodulation, through the mixing device and cable television signal mixed access to the cable television coaxial distribution network. The user receives the mixed signal through the CNU and separates the data signal and the television signal into the CNU demodulation module and the television receiving device respectively. The CNU device provides an Ethernet interface on the user side to connect to the user's TV set-top box, PC terminal, IP telephone terminal, or other network switching device.
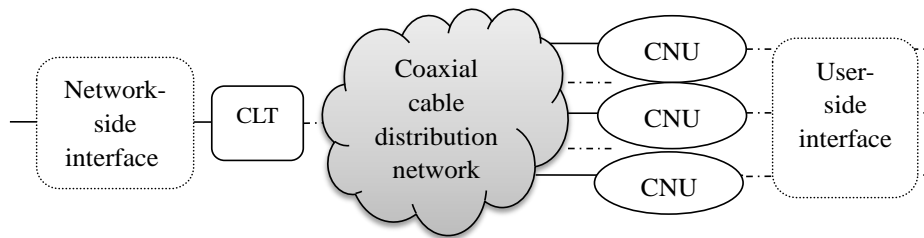
The C-HPAV system framework diagram display in Fig 1.

Fig. 1: C-HPAV system framework diagram

2.2 C-HPAV Technical Features.

C-HPAV standard uses OFDM technology in physical layer to modulate transmission signal over the spectrum range at least below 65MHz [7]. The subcarriers are divided into 2880 units with 24.414 kHz as the unit. Each subcarrier is individually modulated using BPSK to 4096QAM mode, and in practical applications it is possible to support a subtle subcarrier alone to cope with poor channel environments such as strong noise interference on the network [4].

The C-HPAV system has two modes of operation: basic mode and extended mode. Using different physical spectral range is the main difference between those two work modes.

The basic mode spectrum range is 7.6-30MHz, which could coexist in the same HFC network with early DOCSIS or Euro-DOCSIS technology with the purpose of achieving a smooth transition of network and business to avoid operational risks in the implementation process [9]. And at the same time, the frequency band of basic mode spectrum range equal to HPAV, making the HPAV technology to C-HPAV technology transition has become much simple which is the basic model existence meaning.

Table 1 Basic mode subcarrier mask:

Frequency (MHZ)	subcarrier switch
F<=7.6	subcarrier 0-311 off
7.6<F<30.0	subcarrier 312-1228 open
F>=30.0	subcarrier 1229-2662 off

Table 2 Extended subcarrier mask in extended mode:

Frequency (MHZ)	subcarrier switch
F<=7.6	subcarrier 0-311 off
7.6<F<65.0	subcarrier 312-2661 open
F>=65.0	subcarrier 2662-3072 off

The MAC layer of C-HPAV supports both are CSMA / CA and TDMA channel access modes, which can co-exist in the same network and allocated by the CLT through the beacon period to match

the channel resources and meet the needs of the network operator even save resources on channel at the same time [3]. The beacon period is in the range of 5 to 40ms. The actual value is based on the characteristics of the network and the service. Too low beacon period can increase latency and jitter performance, but will reduce the available bandwidth of the network. When multiple users use the Internet service, the CNU can be configured for CSMA 3 working mode and do not occupy TDMA resources [12]. For CNUs with video on demand, video and audio communication, the configuration is changed to TDMA 3 work mode to ensure the quality of business transmission [10].

The Fig 2 is a complete beacon cycle.

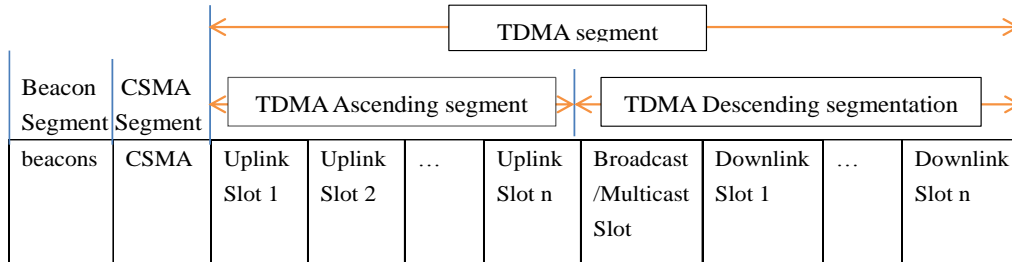| Beacon Segment	CSMA Segment	TDMA segment							
		TDMA Ascending segment				TDMA Descending segmentation			
beacons	CSMA	Uplink Slot 1	Uplink Slot 2	…	Uplink Slot n	Broadcast /Multicast Slot	Downlink Slot 1	…	Downlink Slot n

Fig 2: Beacon structure

The C-HPAV system has great noise immunity. When the system is built, the initial channel assessment can be performed by detecting the interaction of the packets and the dynamic channel assessment is performed by the interactive probe packet when the channel quality changes as the situation changes. When we use it, we detect the quality of the channel through the network management system or special instruments and other tools to collect the specific connection of each sub-carrier state.

2.3 Application in the Integration of Three Networks.

C-HPAV, as an Ethernet-based coaxial cable access technology, provides enough bi-directional data bandwidth for the NGB network access section after considering the transformation of original low-bandwidth two-way network to meet the needs of users higher transmission bandwidth[2]. It also supports various businesses for integration of three networks. NGB is the main technical route for integration radio and TV network.

They launched NGB project clearly and definitely with the support of 3TNet Technology for CATV Network. Shanghai is the first experimental unit for integration of three networks, and already determines 2 years experiment, the first attempt to complete the transformation of the cable network and commercial promotion with the goal of 500 thousand users. And they planned to increase at least 5 million cable TV users NGB network transformation of the city and universal HD interactive TV in 3 to 5 years [2]. China issued a notice on the integration of three networks promotion program in 2015, clearly pointed out speed up the national comprehensive promotion of integration of three networks, promote information network infrastructure interoperability and resource sharing, promote integration of three networks key information technology Product development and manufacturing on the basis of summing up the pilot experience.

3.   Comparison of C-HPAV and HPAV

On the one hand, HPAV system solves the home Internet coverage problem through the transmission of Ethernet, on the other hand, the C-HPAV solves the transmission of cable TV signals and video signals problem through coaxial cable network [5, 6], and it is the one of the most important difference functions between C-HPAV and HPAV system.

China simplifies the complex structure of the original mesh network HPAV technology according to the national C-HPAV coaxial cable access network architecture. This technology definite point-to-multipoint bidirectional access network topology suitable for coaxial cable distribution network and corresponding system control and management mechanism, optimize access to the site to accept and exit the relevant workflow. This technology also definite adaptive selection mechanism to

achieve optimal modulation mode, optimize the signal modulation mode in coaxial cable broadband network transmission data [3]. The C-HPAV system carries a variety of services, such as IP data service, cable TV service, video-on-demand services, which transmit television signals and data services through coaxial cables [2]. C-HPAV has many useful functions like exchange based on the MAC address, the two layer isolation, VLAN, and supports unicast, multicast and broadcast storm suppression, support multi service bearer, multi service QOS protection, and priority handling mechanism, current limiting and ACL [13].

The advantages of these two systems are the use of OFDM technology, the advantage of this technology is that OFDM has a good frequency adaptive channel adaptive ability, and strong anti-narrow noise and anti-pulse noise capability, while OFDM Of the time domain pulse shaping, in the case of no additional filtering, but also has excellent spectral selection.

4. Summary

C-HPAV technology access to provide sufficient two-way data bandwidth for the city in the NGB network has laid a solid foundation to achieve more rapid and efficient city to expand the integration of three networks business. At the same time, the application of this technology is improving gradually, part of the electronic industry transformation and improve people's livelihood to make greater contributions in order to promote the upgrading of consumption.

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