위성 DMB에서 채널 용량 향상을 위한 계층변조 방식

송 정 익*, 이 경 탁*, 손 성 환*, 김 재 명*

Hierarchical Modulation Scheme for Capacity Enhancement in the Satellite DMB System

Jeong Ig Song*, Kyung Tak Lee*, Sung Hwan Sohn* *Associate Members,* Jae Moung Kim* *Lifelong Members*

요 약

이동통신을 비롯하여 많은 무선통신 시스템에서 사용자들의 멀티미디어 정보에 대한 수요가 증가함에 따라 채널의 용량을 늘리기 위한 여러 가지 방법들이 시도되고 있다. 그러나 현실적으로 여러 가지 제약에 의하여 사용할 수 있는 채널의 숫자와 용량이 제한되어 있다. 이러한 상황을 해결하여 좀 더 크고 많은 채널을 얻기 위한 여러 가지 방법들이 소개되었고 현재에도 연구되고 있다. 이 논문에서는 위성 DMB시스템을 기반으로 하여 제시된 여러 가지 방법 중 계층변조 방식을 이용하여 채널의 용량 및 그에 따른 성능을 분석하도록 한다. 특정 환경에서 사용자 수 증가에 의한 성능분석 및 계층변조 방식과 기존의 방법을 비교 분석하도록 한다.

Key Words : hierarchical modulation, satellite DMB, walsh code

ABSTRACT

Future communication systems are to be designed to support and serve multimedia and multipledata transmission. Nowadays, requirement of mobile subscribers for the various information such as movie, GPS (Global Positioning System) information, news - is increasing significantly. However, due to practical reasons, the capacity and number of capable channels are limited. To solve this problem, a large number of methods and schemes have been proposed and are under research. In this paper, we demonstrate how satellite DMB (Digital Multimedia Broadcasting) system works with hierarchical modulation scheme. By using hierarchical modulation, we can analyze the capacity. Meanwhile, system performance is evaluated and compared to conventional DMB system without using hierarchical modulation.

I. Introduction

Recently, communication system devices are well popularized. Now, Thousands of people own their cellular phones and more people are expected to use it. Communication service is changing a lot. In the past days mobile and telecommunication systems serve only one or two functions. Now, we can send messages, make a phone call and even watching TV and listening to music using wireless or mobile communication devices. Watching TV on one's cellular phone is not an unusual scene on the street anymore. DMB (Digital Media Broadcasting) system realized it. There are two types of DMB system.

* 인하대학교 무선전송연구실(night19@gmail.com, leekt61@empal.com, kittisn@naver.com, jaekim@inha.ac.kr)
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One is Terrestrial DMB and the other is Satellite DMB. In this paper we will focus on Satellite DMB system. It starts to service from year 2005 in Korea. This system provides eleven television channels and twenty six radio channels. Compare to the past mobile and wireless communication system which served only one or two functions - for example, cellular phone is just for the voice and text message - it's a great change. Moreover, subscribers requirement for multimedia information - like a motion picture, music, news and navigation, etc. - is enormously increased. Future system will be changed to meet these multi-functional requirements in one system. However, to transmit multimedia information, we have to consider the interference between channels and limitations of channel capacity. There is a limitation of using spectrum. One system can use only some specific band. Nevertheless the practical environment and situation is like this, the requirement of multimedia information is increasing. Therefore, we have to use spectrum channels effectively. Modulation techniques and encoding scheme can help to increase it. Satellite DMB system employs CDM (Code Division Multiplexing) techniques as a signal multiplexing method. Basically, CDM based DMB system using concatenate FEC (Forward Error Correction) of RS (Reed-Solomon) and convolution code. As well as, using QPSK modulation and spreading scheme of 64 Walsh code and 2048 PN code. We will show some modulation techniques to settle capacity problems.

This paper consists of four parts. The first part is introduction of this paper. Second part, we will mention a method to overcome channel limitation problems called hierarchical modulation and refer to non-uniform constellation scheme. Third part, we will show simulation results which compares proposed method to conventional method. Finally, we will make a conclusion.

Ⅱ. Hierarchical modulation

Some digital broadcast systems are designed with the flexibility of transmitting with different bit rates by allowing different modulating constellations (such as QPSK, 8PSK, 16QAM, 64QAM), and error correction codes of different coding rates.[1]For receiver, such a system to be adaptable and can be modified at all of the specific bit rates it desired. A virtue of this kind of system is it is easy to upgrade a system to increase the bit rate, simply changing to a modulator with a larger constellation or changing error correction code of higher rate.

Many existing systems can not maintain the flexibility, they use fixed modulation scheme, and error correction codes with fixed rates. However rising needs to upgrade the system to provide more service and higher quality than what they designed at first. Needs from commercial and technical development to force and allow higher bit rate to be transmitted through the same channel.

Commercially and technically, they push and pull each other. So, makes it possible to build a new concept receiver that can get a better performance.

Hierarchical modulation was initially proposed to provide different classes of data to users with different reception conditions [2], [3], [4]. This modulation scheme has been adapted in DVB (Digital Video Broadcasting) - S2 (Satellite 2nd. Generation) / DVB - T already. However, the purpose of using this scheme is slightly different. In DVB-S2 system, to guarantee backward compatibility it used 8PSK hierarchical modulation. While in DVB - T (Terrestrial) system, employshierarchical modulation to get a coverage extension or capacity enhancement. In this paper, as referred above, we focus on CDM based Satellite DMB system. Basic requirement of Satellite DMB by ARIB (Association of Radio Industries and Business) is at least VCD level video quality and analog FM audio quality. In 25MHz bandwidth we have to transmit audio, video, support data, etc. Therefore the importance of channel capacity is non-negotiable. Using hierarchical modulation, we can achieve more channel capacity.

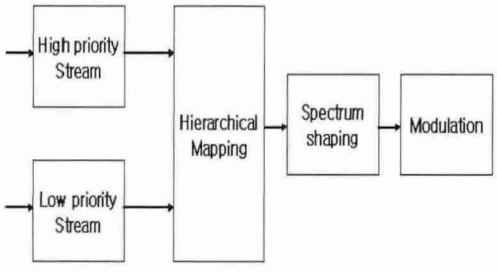

Figure 1. Hierarchical transmission system

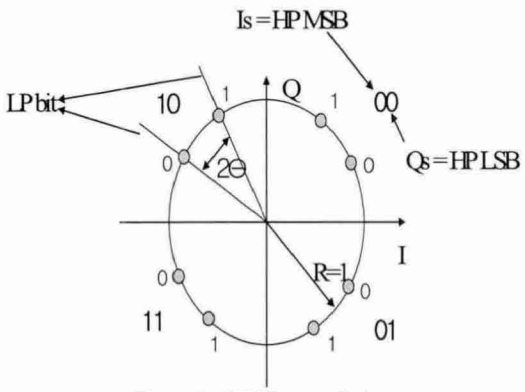

Figure 2. 8-PSK constellation

Figure 1. shows the hierarchical transmission system. This system consists of two signalswhich is called HP (High Priority) and LP. (Low Priority)
HP and LP stream inputted to hierarchical mapping module to make this two kinds of signals into one signal. As the Figure 2, hierarchical modulation mapping block locates three bits per symbol. One from LP encoded data and two bits from the HP encoder. Any point in first quadrant is treated as the 00. The variation in first quadrant causesno difference to make a decision. Therefore, after the secondary information is added, the originality is not changed. Receivers will continue to receive the HP bits and LP bits with the occurrence of only small difference. Finally we can get capacity enhancement sending two different signals. Angle Θ takesa important role in the system. Large angle Θmeans better LP performance to noise and interference, but it can effect badly to HP. Mathematically, the signal at the output of the hierarchical modulator can be calculated as [4]

$$v = \sum_{k} Ae^{j\phi} s(t - kT) \quad (1)$$

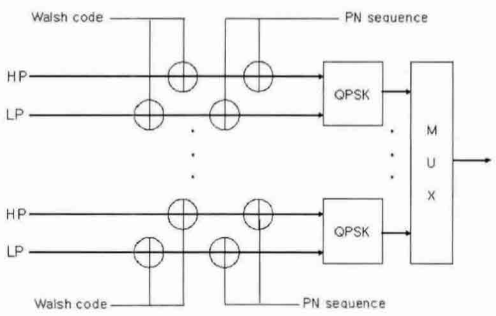

Figure 3. Hierarchical modulation adapted CDM

discrete phase ϕ has value in the range $\{\pi\pi/2*(i-1)+(\pi\pi/4) + (-1)i+k\phi\}$ (for i=1,2,3,4 and k=0,1).

If the angel Θ is decreasing, the constellation of 8-PSK is changed like a QPSK. Then the HP stream performance is better. In order to deal with a fundamental problem of digital transmission - the abrupt breakdown in reception below a critical field strength level[3]. Hierarchical modulation is carefully considerable.

Ⅲ. Simulation Result

Figure 3. is a sketch of hierarchical modulation adapted CDM transmitter part. We use channel model is ITU M.1225 satellite channel model A as below, 64-walsh code as spreading code.

After HP, LP stream is incoming and multiplied withwalsh code and PN sequence. Then use hierarchical modulation mapping two streams. In this paper we want to check capacity enhancement using hierarchical modulation. Adding more blocks to transmitter and receiver side, we can find out another effect. Figure 4. shows the block diagram of simulation for this paper. Hierarchical mapping block, combine two HP stream and one LP stream for 8-PSK modulation. 64-walsh code used as a spreading code. MUX adds as many as the number of channels, then added signals are undergoing through the channel. Specific channel model is shown in Table 1.

Table 1. is a well known ITU (International Telecommunication Union)-R (Radio communication) M.1225 satellite channel model A with 10% delay spread values. Satellite propagation normally includes a line of sight component and diffused multipath components, and hence tends to be rician distributed

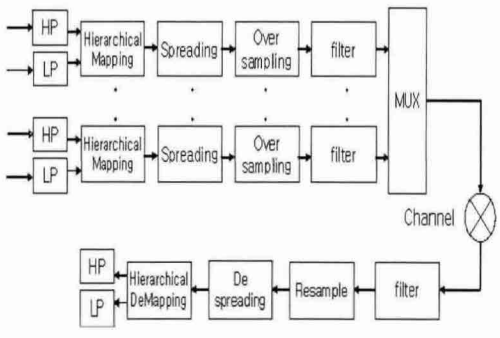

Figure 4. Simulation block diagram

with fading rates set by user and satellite motions.[6]

At the receiver side, the opposite side direction of transmitter is performed. Finally we despread, demap the received signal then discriminateHP and LP stream. Compare the original HP and LP stream with received stream, analyze the simulation result.

We will discuss and compare conventionalCDM (Code Division Multiple) and hierarchical modulation used CDM. As referred former section, Satellite DMB is CDM based system. Therefore we have to check and analyze conventional CDM first then, compare with hierarchical CDM.

Table 1. Channel model A

TAP #	Rel. Tap delay value (ns)	Tap Amplitude distribution	Parameter of amplitude distribution	Avg. amplitude with respect to free space propagation	Rice Factor	Doppler Spectrum
1	0	LOS:Rice NLOS : Rayleigh	10 log c 10 log Pm	0.0 -7.3	10 -	Rice Classic
2	100	Rayleigh	10 log Pm	-23.6	-	Classic
3	180	Rayleigh	10 log Pm	-28.1	-	Classic

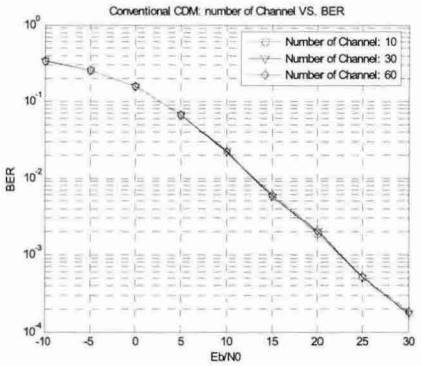

Figure 5. Performance analyze depend on Channel number(conventional CDM)

Figure 5. shows that under same conventional CDM system we vary number of channel. However,the number of channel changing, the performance is almost same. In Figure 6. we can find out the number of channel increased, channel performance is slightly degraded. Figure 7. shows the distance between two constellation in same quadrature is changed, the performance is changed also. As the Θ is increasing, the distance from / to HP stream is farther also.

This means the HP stream performance is going poor. In contrast to the HP, LP stream is going closer as the Θ is increased. Therefore the result graph shows that as the degree is increased, HP stream performance is going bad. LP stream represents good. Another property is when the HP stream is changed slightly, LP stream shows markable change. We can estimate that LP stream is more sensitive than HP stream.

The performance evaluation of satellite system with hierarchical modulation and without it is almost same as seen in Figure 8.

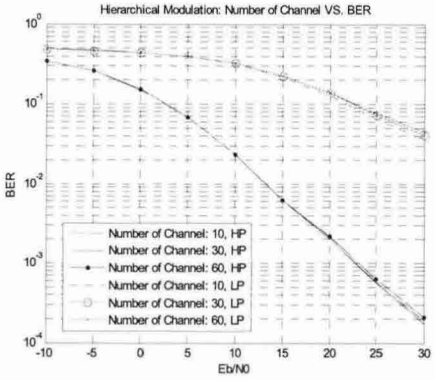

Figure 6. Performance analyze depend on number of channel (Hierarchical modulation)

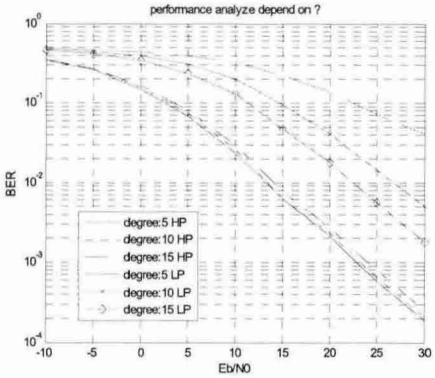

Figure 7. Performance depends on Θ

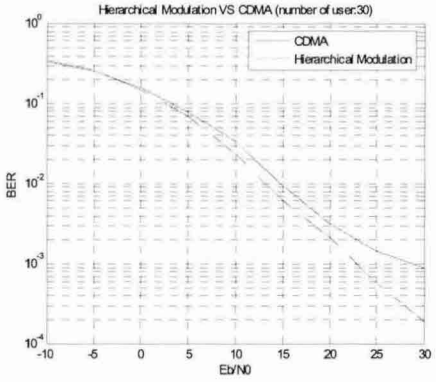

Figure 8. With or without hierarchical modulation

Ⅳ. Conclusions

Through the chapter one to four we discuss about what is DMB and under CDM based DMB system how can we have a larger capacity problem. Lots of method and schemes developed and proposed. A way out to this problem is hierarchical modulation. A view of performance, hierarchical modulation scheme is better than conventional CDM channel. Due to the use of uncoded signals, we have a slightly different performance within two schemes. However, we can adapt some schemes at the transmitter and receiver to get a both capacity enhancement and better performance. Still, if we use FEC and rake receiver we are expecting to better overall system performance. Also we can use HP stream decision feedback filter, it will help to increase LP stream reliability. By using these schemes we can get overall performance evaluation and capacity enhancement as well.

Acknowledgements

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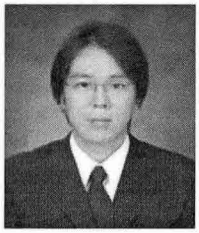
저 자

송 정 익(Jeong-ig Song) 학생회원

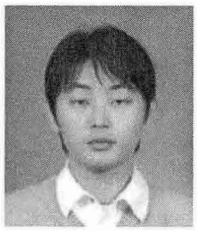
2006년 2월 : 인하대학교 전자공학과 졸업



2006년 3월~현재 : 인하대학교 정보통신대학원 석사과정

<관심분야> 무선인지기술, 통신공학,

이 경 탁(Kyoung-tak Lee) 학생회원

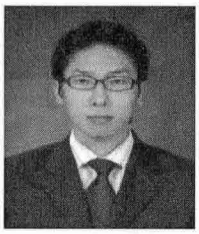


2005년 2월 : 인하대학교 전자공학과 졸업

2006년 3월~현재 : 인하대학교 정보통신대학원 석사과정

<관심분야> 광대역 무선전송, 이동통신, 통신공학

손 성 환(Sung-hwan Sohn) 학생회원



2004년 2월 : 인하대학교 전자공학과 졸업

2006년 2월 : 인하대학교 정보통신대학원 석사

2006년 3월~현재 : 인하대학교 정보통신대학원 박사과정

<관심분야> 이동통신, 무선인지기술

김 재 명(Jae-moung Kim) 종신회원

1974년 2월 : 한양대학교 전자공학과 졸업
1981년 8월 : 미국 남가주대학교(USC) 전기공학과 석사
1987년 8월 : 연세대학교 전자공학과 박사
1974년 3월~1979년 6월 : 한국과학기술연구소, 한국통신기술연구소 근무
1982년 9월~2003년 3월 : 한국전자통신연구원 위성통신연구단장 / 무선방송연구소 소장역임
2003년 4월~현재 : 인하대학교 정보통신대학원 교수, 한국방송공학회 부회장, 통신위성우주산업연구회 회장 외 정부 및 다수 기업에 기술자문으로 활동중

<관심분야> 광대역 무선전송, 이동통신 및 위성통신, 디지털 방송분야