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DVB-H 시스템을 위한 단일 주파수 네트워크의 성능

Performance of Single Frequency Network for DVB-H System

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Abstract In this paper, several computer simulations are investigated to confirm the DVB-H system performance and to find proper single frequency network cell coverage. From the result, we confirm that 2K mode transmission is more robust to Doppler frequency than 8K mode. The result of this paper can be partially applied to the design the single frequency network.

요 약 본 논문에서는 DVB-H 시스템의 성능측정과 적절한 단일주파수망의 셀 커버리지를 연구하기 위하여 컴퓨터를 이용한 모의실험을 수행하였다. 수행된 결과로부터 2K 전송모드가 8K 전송모드에 비하여 도플러 주파수에 강인함을 확인 할 수 있다. 본 논문의결과는 단일주파수망 설계에 있어 부분적으로 응용될 수 있다.

Key words : Digital Video Broadcasting (DVB), DVB-Terrestrial (DVB-T), DVB-Handheld (DVB-H), OFDM, Single frequeny network (SFN)

Ⅰ. Introduction

During the recent years, existing analog broad casting system are considerably changed by drastic evolution of digital based techniques. Standardizations such as the Digital Video Broadcasting (DVB) project to transmit digital contents for subscribers are provided and published by ETSI (European Telecommunications Standards Institute).

In Europe, several nations, Germany, Netherlands, France and Finland, already provide or test the mobile broadcasting services based on DVB-T and DVB-H.

The DVB community was requested to develop technical specification missing in the original DVB-T to allow transmit of large multimedia contents to handheld terminals. Therefore, DVB project proposed DVB-H for a system handheld devices[1-6].

DVB-H (Digital Video Broadcasting - Handheld) standard is derived from DVB-T (Digital Video Broadcasting - Terrestrial)[7-9] for fixed and in-car reception of digital TV by commercial requirement in 2004[10]. It has lighter, smaller and effective power consumption characteristics than DVB-T system thereby proper to handheld mobile terminal. Moreover DVB-H can be working together with the existing wireless mobile communication network and IP backbone network. Therefore, we can image that this DVB-H system will be bridge-building role in join the broadcasting system and whole world cellular radio network.

DVB-H has a several constructive elements such as time slicing[11], MPE-FEC[12] (Multi-Protocol

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Encapsulation Forward Error Correction) and in-depth interleaving for 2K and 4K mode. These characteristic elements are introduced in the following section.

In the traditional analog television broadcasting system, transmitters had a several frequency network in according to different location. This multi-frequency network (MFN) has a number of shortcomings both service quality and in radio spectrum utilization. To overcome this limitation of analog system, more efficient transmission mechanism required and developed with help of abundant digital techniques. As a result, single frequency network (SFN) scheme was beginning to rise by using FFT (Fast Fourier Transform) processing.

There are several important advantages of SFN compare to the conventional MFN:

A. High spectrum efficiency
B. Operate at lower power
C. Easy setup of gap-filling transmitters

It is expected that SFN make drastically improve the spectrum efficiency because SFN transmitter network broadcasts identical information at the same frequency band.

To implementation the DVB-H system, the issue of design SFN is main problem among any others. Fortunately, DVB-H supports an additive 4K mode (include existing 2K and 8K mode) to provide flexibility of network planning.

To determine optimal SFN coverage research and measurements are carried out in several countries. Parameters related to SFN design include transmitted power, transmission mode, carrier to noise radio. Doppler frequency, echo effect, antenna height and so on.

In this paper, we consider SFN planning issues based on the DVB-H system. Three mode transmission schemes are all considered in both AWGN and Rayleigh fading channel. In the case of Rayleigh fading channel, Doppler frequencies are included in according to mobility. Simulations are achieved using by MATLAB Simulink and C language.

The remainder of this paper includes : In section Ⅱ, the DVB-H system overview will be introduced briefly. In section Ⅲ, consideration of SFN are described. In section Ⅳ, simulation results are presented and conclusion contains in the section Ⅴ.

Ⅱ. DVB-H System Model

Although DVB-H transmission system could be operated on for both fixed and mobile terminal, several specifications must be considered for handheld terminal that is portability and low power consumption. Several requirements to achieve the DVB-H are described as follows:

A. To reduce average power consumption, repetition of power cut off is needed during the receive mode.
B. To maintenance of service, Handoff function is needed.
C. Sufficient flexibility of mobility must be guaranteed.
D. Severe interference effects such as from manmade or other electric appliance must be mitigated.
E. Because DVB-H system aim to whole global service, different standard according to each country have to accommodated.

1. Link layer

DVB-H link layer have two consecutive components that is time-slicing and MPE-FEC techniques. To reduce average power consumption and support handover, time-slicing is mandatory item in the DVB-H system. Transmission data will be made by burst type, thereby instantaneous higher rate data than conventional streaming mechanism could be transmitted. Present received data has information of next burst's time scheduling called delta-t. Time-slicing make receiver to active mode only during the receive state. Therefore, receiver can use power only when needed. Unlike receiver, however, transmitter is always active mode. Also, time-slicing supports monitor adjacent cell when non-active mode. It make possible to support quasi-optimum handover doing switch receiving from the transmitted stream to another stream when non-active mode as well as conventional handover.

MPE-FEC is used to improve and compensate Doppler effect, carrier to noise interference and impulse interference during the channel transmission. Unlike time-slicing, MPE-FEC is not a mandatory. However, MPE-FEC technique make possible to low error rate and high data rate at the receiver by adding forward error correct function.

2. Physical layer

DVB-H physical layer include several additive function such as DVB-H signaling 4K transmission mode and in-depth symbol interleaver.

Like as time-slicing, DVB-H signaling also mandatory item in the DVB-H signaling is to provide a robust and easy access to the receiver. Specially, transmission parameter signaling (TPS) is a very robust to channel environment in the case of very low C/N values.

With 2K and 8K mode, additive 4K transmission mode is provided for support flexibility of single frequency network (SFN) cell coverage in DVB-H system. From several researched, it is known that there is a trade-off relation between mobility of mobile terminal and SFN size.

Trade-off relations include following matters:

A. **DVB-H 8K mode** can be used in the case of using single transmitter and three kinds of cell coverage (large, middle and small size). It also can allow Doppler tolerance when mobile terminal moved with high speed.

B. **DVB-H 4K mode** can be used both for single transmitter and two kinds of cell coverage (small and middle size). Its Doppler tolerance allows very high speed reception.

C. **DVB-H 2K mode** also suitable for single transmitter and for small SFN size. It provides the most Doppler tolerance with extremely high speed reception.

Both 2K and 4K modes are can be operated with in-depth interleaver to support the flexibility of the system. It would be improve the memory efficiency and channel fading effect.

Ⅲ. Consideration of Single Frequency Network Planning

The coverage of DVB-H SFN is characterized by a perfect reception of informational signal in spite of very rapid mobility. Also, due to the single frequency operation in single cell, finding proper cell size becomes critical issues in view of implementation.

Fortunately, DVB-H standard provides a variable network design parameters such ax three kinds of transmission mode with in-depth schemes and several modulation schemes.

Therefore, service provider requires research on the network plan according to service specific or terrestrial environment before open up a market.

DVB-H standard recommends three level approach for define the coverage as follow:

A. **Reception location** : In the coverage of $0.5m \times 0.5m$ area, C/I or C/N values are achieved for 90% of the time with moving the handheld terminal.

B. **Small area coverage**: Small area is defined as typically $100m \times 100m$. In this small area, coverage is distinguished as "Good: at least 95% reception" and :Acceptable: at least 70%

reception".

C. **Coverage area** : The coverage area is made up of the sum of the individual small area.

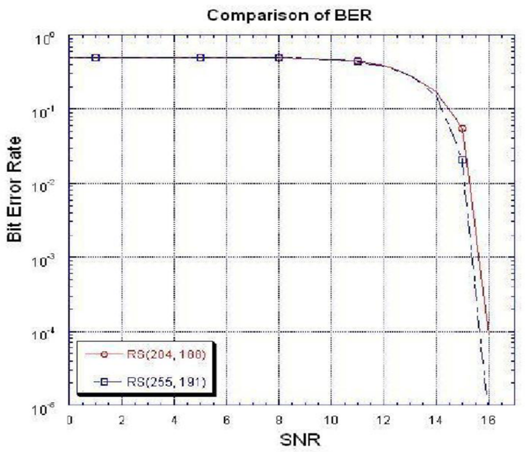

Fig. 1. Comparison of BER between DVB-T and DVB-H.
그림. 1. DVB-T와 DVB-H의 BER 비교

For mobile reception the percentages defined above were 99% and 90%, respectively. And these percentages are achieved at the edge of the coverage area.

Another planning criterion is minimum signal levels to overcome interferences that are given as the minimum receiver input power and the equivalent receiver input voltage.

Ⅳ. Simulation

In this section, we investigated several computer simulations with MATLAB Simulink and C language to confirm the performance of DVB-H system and its characteristics. First of all, to compare DVB-H system with DVB-T, BER performance comparison is shown in the fig. 1. In this example, we assume that the main difference is RS code such as RS(204, 188) for DVB-T and RS(255, 191) for DVB-H system, respectively. From result, in the case of AWGN channel and 2K mode, they have closely similar to BER performance. Because RS(255, 191) has more robust to error tolerance, DVB-H BER performance is better than DVB-T with same channel environment.

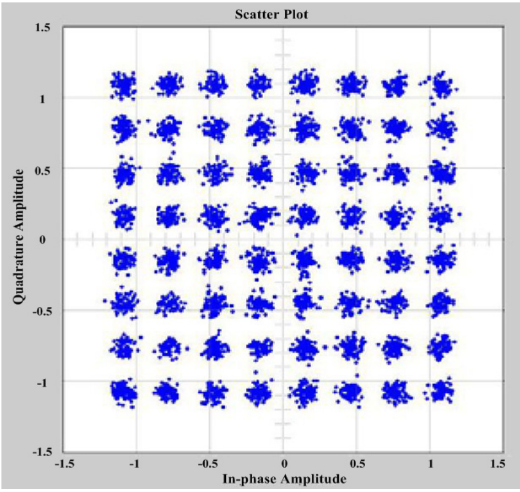

Fig. 2. Signal constellation at SNR=21dB.
그림. 2. SNR=21dB에서의 신호의 성상도.

The signal constellation of 64-QAM at SNR=21dB is shown in fig. 2. DVB-H standard provide three kinds of modulation techniques such as QPSK, 16-QAM and 64-QAM. Due to Euclidean distance, these modulation schemes have different performance.

The spectrum mask of 2K mode 8MHz band at SNR=21dB is shown in fig. 3.

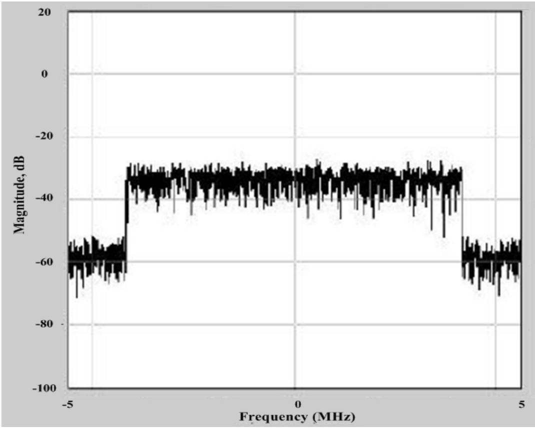

Fig. 3. Spectrum mask of 8MHz band at SNR=21dB.
그림. 3. SNR=21dB에서의 8MHz밴드의 스펙트럼 마스크.

The Doppler frequency vs. carrier to noise ration measured in LAB test according to alpha=2 and 4 is respectively shown in fig. 4 and 5. From results, we confirm that 2K mode is more robust to Doppler frequency effect than 8K mode. Therefore, we expect that 2K mode is more proper to rapidly moving vehicle terminal rather than go on foot. It is also conformable with above mention in section Ⅱ.

Additionally, we can conjecture the larger cell coverage the harder damage from Doppler frequency. To confirm this phenomenon, practical measurement required. However, in this paper, that is not yet executed. The remainder objective of this paper is to investigate practical examination so that precisely compare these LAB test results to practical measurement.

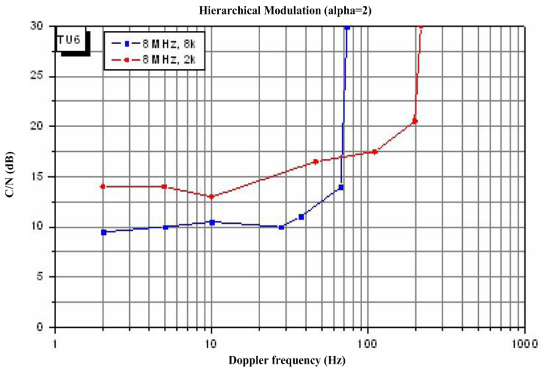

Fig. 4. Doppler frequency vs. C/N of 8MHz band (alpha=2).
그림. 4. 8MHz밴드에서 도플러 주파수 대 C/N.

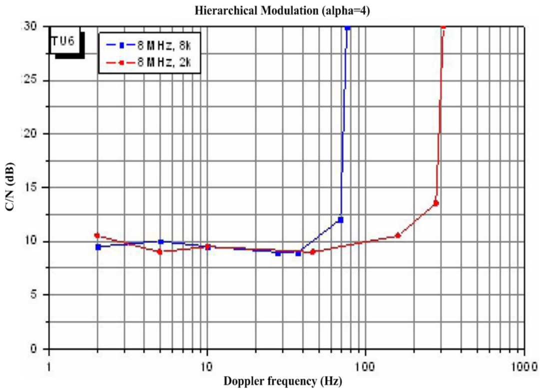

Fig. 5. Doppler frequency vs. C/N of 8MHz band (alpha=4).
그림. 5. 8MHz밴드에서 도플러 주파수 대 C/N.

Ⅴ. Conclusions

In this paper, several computer simulations and LAB tests are investigated to confirm DVB-H system performance and to find proper single frequency network cell coverage. From simulation results and LAB test results, we confirm that 2K mode transmission is more robust to channel environment such as Doppler frequency than 8K mode.

To more precise research, applying different transmission schemes (4K mode and in-depth interleaver) to DVB-H SFN planning is required. And also, compare practical field measurement to simulation results is needed.

The results of this paper can be partially applied to the design the single frequency network.

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