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A Study on the Stabilization of Bit Rate and LTE for the TV DMNG Broadcasting

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Abstract

Securing field screens through LTE broadcasting is a very valuable technology in news production because of its locality and concurrency. TV has the advantage of being able to deliver news faster than newspapers and make live coverage on the scene of events and events. To maximize this, not only middle-end broadcasters but also existing broadcasting stations are taking an active role in broadcasting using LTE. However LTE broadcasting has yet to secure any conflicting values of broadcasting stability and securing high-definition. The key to solving this difficulty is the transmission rate of Bit Rate. This paper compares the Bit Rate transmission method, which is variable and fixed, to provide more on-site screens through LTE, and presents the Bit Rate adjustment method as a method of screen stabilization through experiment. Consequently, the most stable broadcast screen can be obtained when transmitting and connecting it to broadcasting in a variable 5M method.

Keywords: Bit Rate, LTE broadcasting, Relaying Broadcasting, CBR, VBR, transmission rate, stability

1. INTRODUCTION

The biggest feature of recent TV news programs is that they actively use field-based screens that emphasize on-site and real-timeity to deliver information. A survey of 75 percent of U.S. television reporters shows that the screen is recognized as the most important component of information¹.

As a way to enhance viewer ratings by utilizing these field screens, a method of broadcasting that is competitively used by news channels and broadcasting stations is wireless LTE video transmission. LTE technology, evaluated as a representative result of digital convergence of broadcasting and communication, enables digital image transmission using wireless mobile communication means.

LTE stands for 'Long Term Evolution' and refers to 4G (generation) mobile communication technology. This indicates that it is a technology that has developed current system over a long period of time. The biggest characteristic that distinguishes LTE from third-generation mobile communication is its faster speed.¹ The wireless communication, which was created by the rapid technological convergence of broadcasting and communication, has also had a positive impact on the development of television broadcasting.

However, stability has yet to be assured, such as when a screen that is being relayed suddenly breaks or the quality of a picture drops because it is technically not yet complete. This may lead to broadcasting accidents during live broadcasts. Therefore, this paper seeks to derive the stability and quality improvement measures of radio relay by researching the optimal transmission methods for LTE radio broadcasting.

For this purpose, the main body studies the definition of Bit Rate, a key element of the transmission technology, and various methods of transmission using it. Effective Bit Rate optimization in broadcasting not only reduces the technical load on broadcast network systems but also provides more viewers with both quality and reliability.³

This paper will present an improvement in the quality of each situation and a stabilization plan through a comparative analysis of the transmission methods currently used in broadcasting sites. In particular, it is going to focus on the case of a general broadcasting company that has a strategy to enhance audience ratings while spearheading live news broadcasting using LTE.

2. Related Works

2.1 LTE relay status

The LTE broadcasting has the advantage of being able to be broadcast live by emergency equipment at outdoor events such as disasters. Because it can reduce relay time and cost and can move freely due to smaller equipment, limitations in relay regions have disappeared.



Figure 1. LTE Equipment and Real-time Broadcasting / LiveU

This convenience is often used on news sites. In South Korea, it was introduced to the site with the launch of General Channel Broadcasting companies in late 2011. Since then, various images have been introduced into real-time news. LTE broadcasting has been performing positive functions such as enhancing General Channel viewership. Recently, many broadcasting companies, including airwave, have introduced LTE broadcasting method and are using it in broadcasting fields. Table 1 shows the status of introduction of LTE relay in 2016 by Korean broadcasting companies.

Table 1. LTE Transmission System of Korea Broadcasting Company (2016)

	Public TV (KBS/MBC/SBS)	General Service TV (MBN/TVChosun/ Channel A/JTBC)	News Channel (YTN/YonhapTV)	total
TVU	6	19	25	50
LiveU	16	1		17
etc	7	12		19
total	29	32	25	86

However, LTE radio broadcasting with such low cost and high efficiency features has new challenges. This is due to low quality of broadcasting screen and concerns about broadcasting accident. In November 2013, an over-the-air company broadcasted it in an unusual manner at a press conference held by then Justice Minister Hwang Kyo-An. However, as a state-run broadcasting company, the break of the quality of the video was close to broadcasting accident.

Yoon Chang-joong's press conference in May 2013 is a prime example for the General Channel companies. Yoon Chang-joong, who was reporting a news conference on sexual harassment during his visit to the U.S., repeatedly lost his screen and, in turn, led to a live accident. On the same day, Y and A company stopped broadcasting and M stopped sending images and screen went to a standstill. This may be the cause of the failure to adjust the transmission Bit Rate depending on the site environment.

2.2 LTE Broadcasting Principle and Type

1) LTE Broadcasting Principle

For operation of LTE Broadcasting Principle equipment for live broadcasting, large transmission and reception plays large roles. Radio transmissions are manned by the field transit agents. On the General Service TV, video reporters are also responsible for the role of field staff. They install the camera and attach the package to the site. So-Called Backpack, Which is nickname of LTE Broadcasting gear, transmits video signals to the broadcasting server via wireless LTE connection network detected at the site. This enters the broadcasting company via receiving work of staff in a secondary control room, and the broadcaster puts on air lively through the screen.

Transmission personnel who are responsible for transmitting transmissions tend to be sensitive to transmission, 'ease of travel', 'ease of operation' and 'ease of operation'. On the other hand, members of the so-called "receiving trust" cited the "reception stability" and "ease of operation" as the main criteria. Double egress stability and reception stability are key items to prevent broadcast accidents.

Transmission personnel who are responsible for transmitting tend to focus 'transmission stability', 'ease of travel', and 'ease of operation'. On the other hand, reception personnel members of the secondary control room cited the "reception stability" and "ease of operation" as the main criteria. Among these, 'transmission stability' and 'reception stability' are the key items to prevent broadcast accidents.

2) Types of LTE Broadcasting

There are several types of equipment that can be labeled as a backpack, but the representative of the current

broadcasting company is 'TVU Network' and 'Live U'. They are capable of transmitting wireless networks up to 1080P and configured in various wireless networks such as LTE, 3G, WiBro and WI-FI etc. It is shown in the following Table 2.

Table 2. Type of LTE Broadcasting Comparison

Division	TVU	LIVE U
Manufacturer	TVU Networks	LiveU
Product Name	TVUPack TM8100HD	LU-60HD
Booting Time	About 5 Minutes	About 20 Minutes
OS	Linux	Windows
Configuration	Main Body, Battery, BNC	Main Body, Battery, BNC, Connecting Line
Advantage	Quick Booting, Simple Operation	High Definition Transmission, Touch Screen
Disadvantage	Low Definition Transmission, Instability	Long Booting Time, Complex manipulation
Specification	-Device: 4G/LTE, Wifi, Ethernet , Up to 10 -Weight: 5Kg -Battery: Gold-Mount Type Duplication -Maximum Transfer rate: H.264 10Mbps -OS: Linux	-Device: 4G/LTE, Wifi, Ethernet Up to 14 -Weight: 5Kg -Battery: Built-In Only Battery, Duplication -Maximum Transfer rate : H.264 10Mbps -OS: Windows
Remarks	-SBS, YTN, ChannelA, JTBC -Price: 30,000,000 Won	-KBS, TVChosun -Price: 30,000,000 Won

The biggest feature of the TVU is that it uses the operating system on Linux. Therefore, it is difficult to deal with Linux if there is lack of information. It has simple working principles and compact configure such as main body of Backpack, BNC(Bayonet Neill-Concelman), cables and batteries. It is easy to use and there are low system errors.

After replacing the battery with fast boot speed, it is possible to broadcast live broadcasts within approximately 5 minutes. If the transfer rate is greater than 5 megabytes per second, the quality of the transmission is acceptable, but under 5 megabytes the image is impaired.

In particular, the amount of flash that the camera flashes on, which results in a sudden increase in the amount of data received by the backpack, can cause a sudden cut off of signal and broadcasting accidents. The higher the number of backpackers operated by other broadcasting stations, the higher the risk of accidents.

LiveU uses a 4G LTE communication network to transmit real-time HD video in real time, using a 4G LTE communication network. Without a separate broadcasting system, a reporter can broadcast live broadcasts without delay. Recently, a groundbreaking device was developed that enabled reporters on the site to communicate with broadcasters. It is easy to handle because it is friendly with Windows based operating systems. Touch Screen is easy to operate and intuitive. However, it is a window-based version that often generates errors compared to the TVU based on Linux.

Better yet, it delivers high-definition video transmission under the condition of proper signal than TVU. However, it is not easy to respond to abrupt failures of field situation because the boot time takes approximately 20 minutes. Complex configurations can delay responding to live situations rather than simple TVU.⁴

2.3 Bit Rate

Bit Rate adjustment is the most important aspect of transmitting a TV relay screen wirelessly and in high definition. Bit Rate is the number of the bit that is processed at a specific time (usually seconds).⁵

That is the speed of processing information. The higher the Bit Rate, the better the picture quality, because the video has more information (bits). However, as Bit Rate becomes higher, bit number becomes much bigger. As Bit Rate is high, the amount of capacity will also increase, resulting in network load and transmission delay.

Appropriate adjustment of this Bit Rate is essential for the optimization of the LTE network, which is a transmission method that maximizes image quality satisfaction. If large volume of video traffic takes up more than a certain percentage of Bit Rates, the quality of the network will deteriorate rapidly. After all, Bit Rate optimization means taking these factors into account and setting the optimum bandwidth to maximize image quality satisfaction.⁶

Bit Rate is divided into two main types: CBR and VBR.

2.4 CBR/VBR

On TV radio relay, image transmission data compression uses fixed Bit Rate (CBR) and variable Bit Rate transmission (VBR). Fixed streaming video can maintain constant bit mass regardless of the characteristics of the input images, but the quality of the playback images is inconsistent and scenes switching frames are difficult to ensure uniform quality, such as poor quality. Therefore, it is advantageous to keep network stable such as broadcasting indoor situations where there is no movement of screen.

In contrast, variable streaming video ensures uniform quality regardless of scene switching and has a high compression ratio. But there is the wide variation in the amount of bits generated per frame, depending on the features of screen in the encoder. So it is difficult to maintain the image quality when transferring data to a network with limited bandwidth due to the wide variation in the amount of bits generated per frame.⁷

This means that the significant variation in the bit volume causes severe transmission delays in the buffer, or it is difficult to transmit all bit streams generated by transmission channels with bandwidth limited to excess capacity, resulting in a loss of connection. Therefore, the instantaneous data processing speed of the transceiver should be kept fairly high.⁸

Table 3. Characteristic of CBR and VBR Transmission

	CBR	VBR
Advantage	<ul style="list-style-type: none"> - advantage in transmission of standard still situation - network stability - constant Bit Rate 	<ul style="list-style-type: none"> - regular definition of video in every scene - control of occurrence Bit Rate
Disadvantage	<ul style="list-style-type: none"> - irregular definition quality of reply video -image degradation of cutaway 	<ul style="list-style-type: none"> - possibility pf severe transmission delay - steep variation of Bit Rate depended on characteristic of video - cut of transmission in heavy traffic

3. EXPERIMENT

Given the nature of this Bit Rate transmission, what is the proper transmission method for TV broadcasting? To study this, we are going to conduct an experiment where we compare quality by sending the same scene using fixed and variable respectively. The target is a screen that transmits on-site images of markets via LTE radio from the TV Chosun program "Information Center GwangHwa-Moon 640." The transmitter used the U.S.'LiveU's 'LU-60HD'. Compare the quality of each Bit Rate with the selected screen.

3.1 Experiment 1: Fixed vs. Variable Screen Quality

First of all, Experiment 1 showed the same scene in two ways: fixed and variable. Bit Rate was set to the same condition with 2M. The purpose of the project is not to check the quality of the same state under the same Bit Rate conditions, but to compare the quality of the two sides that would occur if there were a lot of transmission data such as screen changes and motion.



Figure 2. CBR 2Mbps



Figure 3. VBR 2Mbps

Table 4. Comparison of CBR and VBR Transmission

CBR	VBR
<ul style="list-style-type: none"> - more stable than VBR in background - quality deterioration occurs in face and Kimchi 	<ul style="list-style-type: none"> - overall stability of definition - minimized deterioration in face and Kimchi

The Figure 2. is a fixed Bit Rate transmission screen. If you look at the screen, the screen shows a more stable picture than the variable screen. However, the area where dynamic movements occurred showed degraded quality. Her face with a smile and her right hand holding kimchi were all in a bad mood. This is because motion pictures have more data loss. On the other hand, video with low motion has a less quality loss because there is less data lost despite low Bit Rate compression. Depreciation of motion-rich images under certain Bit Rate conditions is unavoidable.

The Figure 3. is a variable type relay screen. Overall, uniform quality can be seen. However, it can be expected that viewers will feel less likely to experience deterioration due to the minimal degradation of the quality of the picture than the fixed type, even though we can also see a decrease in the quality of the picture on the right and on the face.

The fundamental principle of image compression transmission is to eliminate the inherent redundancy of the images. This means that adjacent pixels in a frame usually eliminate spatial redundancy with similar colors. Time-continuous frame eliminates time redundancy which is usually composed of similar images.⁹

In the case of fixed-type, there was no problem with removing and transmitting spatial and time-consuming redundancy with only a certain Bit Rate, but in the case of screens with motion, variable type which can be varied in compression rates of a certain Bit Rate(or higher) are advantageous. Thus, for news broadcasts with a lot of movement in general, a floating formula may be a good way to prevent degradation of quality rather than a fixed one.

3.2 Experiment 2: Comparison of Quality by Variable Bit Rate

If so, what is the difference in quality with each Bit Rate for the variable? The Figure 3. broadcast the same scene in a variable way, but the Bit Rate was different. Adjust the Bit Rate to 1M, 3M, and 5M to compare the screen that was relayed to the picture quality.

Figure 4. is a screen that broadcasts a Bit Rate of 1M. Regardless of the background, characters' hand gestures and kimchi's movements, all of them show signs of degradation. Quality of picture is not guaranteed enough to be suitable for broadcasting. The Figure 5. is a 3M Bit Rate relay. The quality of the picture has improved considerably compared to 4 but still shows a lack of quality for broadcasting. Figure 6. is a screen that broadcasts the Bit Rate up to 5M. A stable high-definition screen can be found throughout the entire screen, including the face, even in the area of kimchi, where movement is intense.

Despite the application of the variable formula, the reason why the quality of the kimchi decreases is due to the characteristics of the variable transmission. That is, compression is performed flexibly. Variations between frames with severe motion changes cause traffic explosion during transmission, resulting in loss of image quality.



Figure 4. VBR 1Mbps



Figure 5. VBR 3Mbps



Figure 6. VBR 5Mbps

In fact, when there is a significant deviation between frames, it is difficult to satisfy both the effective Bit Rate and the continuity of image playback, and there is a problem where transmission is interrupted.¹⁰ In the actual experiment, there was a delay in transmission during the time when the motion of the screen was large.

However, As in Kim Hyung-seok's study¹¹ of the perceived subjective deterioration of the receptor depending on Bit Rate, if there is a variable transmission method that applies Bit Rate of more than a certain number of Bit Rate in certain areas, it is unlikely that picture deteriorates with Bit Rate above 5M.¹²

Table 5. Comparison of VBR Transmission using different Bit Rate

Figure 4. VBR 1Mbps	Figure 5. VBR 3Mbps	Figure 6. VBR 5Mbps
-Lowest quality definition -Unfit for broadcasting	-Better quality than that of 1Mbps -Possible for broadcasting -Quality deterioration in right hand motion part	-Overall quality stability including face -High quality for broadcasting -Instant massive transmission rate -Risk of transmission delay and disconnection

4. THE RESULT OF THE EXPERIMENT

The results obtained from the above experiment are as follows. First, the difference in quality between fixed and variable transmission methods studied in Experiment 1 was significant. If the Bit Rate is set to 2M, motion that indicates the character's action is not implemented properly in the picture. Because many of the dynamic changes require Bit Rates above the set value, fixed Bit Rates did not implement normal quality and hence the degradation of quality was inevitable.

Thus, the results of fixed-style motion can be found to be inadequate for outdoor filming with many dynamic changes such as motion. Rather, the fixed method is more suitable for broadcasting with LAN wires.

On the other hand, variable Bit Rate transmission can determine a satisfactory Bit Rate by reflecting the user's subjective quality assessment.¹³ Therefore, the quality of the smiley face and hand gestures was kept at a constant level compared to the fixed method.

As a result, flexible displays are efficient and stable in data transmission. Thus, considering the relationship with broadcasting conformity, it can be found that it is desirable to broadcast on a variable rather than a fixed basis. Considering this, it is efficient to use variable image transmission methods for most digital transmission and especially broadcasting LTE broadcasting.

The results of Experiment. 2 showed that under the same condition, the higher the transmission rate, the higher the image quality. However, the Bit Rate setting of 1M is considered inappropriate for broadcasting with the lowest quality. In case of 3M, the clarity is improved, and the motion part is still not good. While 5M was able to stabilize the entire screen and obtain high-quality screens, there was a risk that transmission could be lost.

To wrap up, quality that is below 2 Mb/s is not suitable for broadcasting because of low picture quality. The second, The higher the Bit Rate, the higher the overall quality, but there is a risk of the transmission delay and blocking the connection if motion-rich images are transmitted. It is recommended to select transmission rate around 3M as a method of adjustment in order to be able to maintain balance between quality communication and securing signal stability.

5. CONCLUSION

As we studied above, this paper investigated how to stabilize LTE radio relay in order to secure a field screen for news. In detail, we discussed the characteristics of image transmission methods and their suitability for broadcasting using Bit Rate, which is a core concept of broadcasting. Also we studied image transmission and broadcasting methods suitable for news by comparing quality and stability by Bit Rate. In the case of news broadcasting, it was concluded that the more flexible Bit Rate transmission method is suitable for broadcasting rather than fixed method. Even though the higher Bit Rate, the better the quality, to deal flexibly around 3M is optimal to secure broadcasting stability.

This study could have limitations in that it targeted LTE intermediaries of only one end broadcasting

company at a time when other prior research and technological advances on LTE utilization of broadcasters have not yet been made. As a task to be continued in the future, I think it is necessary to develop a prototype model and transmission protocol that can be applied to real-time LTE news broadcast video transmission systems.

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