

Study on Power Mobile Multimedia System

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Abstract—The mobility and flexible configuration features of mobile multimedia systems make it an important mean for power system communication. Especially, the mobile video conference can acquire the important on-the-spot information rapidly, and can bring great convenience for power production. This paper analyzed the next-generation broadband wireless communications technology such as 3G, 4G, and video compression technology, proposes the mobile video conference network mode used in power system. On this basis, the experimental system of power mobile multimedia application is proposed, and the experiment is executed with China's 3G network and 4G test network. In experiment with 3G network, considering H.264 and H.263++ video codec, as well as different bit rates and resolution of images, the mobile video conference data transmission rate and delay data under different conditions is obtained. In experiment with 4G network, the mobile HD video transmission and video conference is tested. According to the experimental results, the power mobile multimedia application recommendations in the 3G and 4G environments is proposed. This paper provides reference for the mobile multimedia technology in power system.

Keywords—Mobile Multimedia System, Mobile Video Conference, Experimental System, 3G, 4G

I. INTRODUCTION

In recent years, multimedia communication has been rapid development with rich user experience, but it primarily based on fixed network; With development of user requirement, the multimedia technology should meet the demands of anytime, anywhere communications. With 3G, 4G mobile communication network more mature and gradually deployed, the high transmission rate can support mobile multimedia communication. Meanwhile, with emergence of some multimedia codec technologies[1-4], such as G.723.1, AMR and video MPEG-4, H.263, which is suitable for mobile environments, the multimedia data can be transmitted efficiently in low-bandwidth mobile communication environments. In addition, the mobile multimedia can provide more flexible business applications such as mobile video telephony, video and audio on-demand and mobile video monitor and etc.. which can widely used in enterprises.

In power enterprises, with the increasing capacity of information, the new work pattern, such as video meetings, mobile office, remote monitoring and emergency communications, is gradually formed. The technical features of mobile multimedia can meet this demand appropriately. Especially, the mobile video conference system plays an

important role in production management. The geographically dispersed participants can use portable mobile devices to join the meeting immediately. When production accidents occur and the commander can't reach the field immediately, the mobile video conference system can be used to capture real-time voice, video, and data on the accident spot and sent commands, to make operation of power facilities restored as soon as possible.

In this paper, the next-generation broadband wireless communications technology such as 3G, 4G, and video compression technology is analysed. The power mobile video conference network mode is proposed. On this basis, carry out mobile video conference experiment based on China's 3G network and 4G experimental network. According to the experimental results, the power mobile multimedia application recommendations in the 3G and 4G environment is proposed.

II. ANALYSIS OF VIDEO COMPRESSION AND BROADBAND WIRELESS COMMUNICATION

Video data has the features of large amount data, error sensitive, complex compression algorithms; The features of wireless channel is limited bandwidth, the high error rate due to interference, and multi-path effects and etc.; The wireless video terminal is portable, power limited, and can not use the complex compression algorithm[5]. All of the above reasons bring a challenge to wireless video communication.

TABLE 1. DATA RATE WITH DIFFERENT VIDEO COMPRESSION STANDARD

Compression standard	Typical data rate
H.261	$p \times 64\text{Kb/s}$
MPEG-1	$<1.5\text{Mb/s}$
MPEG-2	$1.5\text{-}35\text{Mb/s}$
MPEG-4	$8\text{Kb/s}\sim 35\text{Mb/s}$
H.263(H.263+,H.263++)	$8\text{Kb/s}\sim 1.5\text{Mb/s}$
H.264	$4\text{Kb/s}\sim 30\text{Mb/s}$

TABLE 2. DATA TRANSMISSION RATE OF 2G, 3G AND 4G

Communication standard		Data transmission rate
2G	GPRS	Theoretical upper limit 172.2Kb/s

	CDMA1X	Theoretical upper limit 153.6Kb/s
3G	WCDMA	384Kb/s~2Mb/s
	CDMA2000	384Kb/s~2Mb/s
	TD-SCDMA	384Kb/s~2Mb/s
4G	IMT-Advanced	Uplink 500Mb/s, downlink 1Gb/s

Compared table 1 with table 2, data rate transmission of 2G can not meet the clear, consistent requirements of video streaming. Compared with 2G, the rate of 3G has been greatly improved. Video telephone, online TV and other multimedia services have been successfully applied to the 3G mobile communication network[6]. But the requests of more clear and smooth video data transmission, higher-quality video, maintaining a high data rate communications with high-speed mobile environment, make higher demand on mobile communications network.

LTE (Long Term Evolution) [7] project is the evolution of 3G, started in 2004 Toronto 3GPP meeting. LTE is a transition between 3G and 4G technology, which is the global standard for 3.9G, with uplink peak data rate 50Mb / s and downlink 100 Mb / s; LTE-Advanced is generally considered as industry standard for 4G, with the uplink peak rate up to 500Mb / s and downlink 1Gb / s. With such a high transmission rate, 4G can deliver better quality streaming video images and provide richer multimedia services. At the same time, to ensure data reliability and reduce error rates, 4G systems are not only using channel coding, interleaving and other technologies, but also hybrid automatic retransmission (HARQ) error control for the link[8,9]. All of the above advantages of 4G create good conditions for mobile multimedia applications.

III. POWER MOBILE VIDEO CONFERENCE NETWORK MODE

As shown in Figure 1, the communication network architecture consists of the electric power private network, mobile communication network and the internet. The backbone network is composed of fiber, the access network includes fiber, Ethernet, power line carrier, microwave, satellite circuits, broadband wireless[10] and etc..

The terminal can use broadband wireless technology such as 3G、4G to access local/metro core network, and then exchange information with video conference system. In emergency communication, PDA, laptop computer, video capture and other terminals can use 3G, 4G wireless network to connect the emergency communication vehicle, and the vehicle access the command center through satellite [11], fiber or 3G/4G network.

To ensure the safety, the confidentiality and specificity of power communication, video conference data processing and controlling is executed in the conference center. When different network connected, the video gateway achieves protocol conversion, data processing and the corresponding control. The mobile video conference can be connected to

power video conference systems in each provincial power company, and form a unified video conference system.

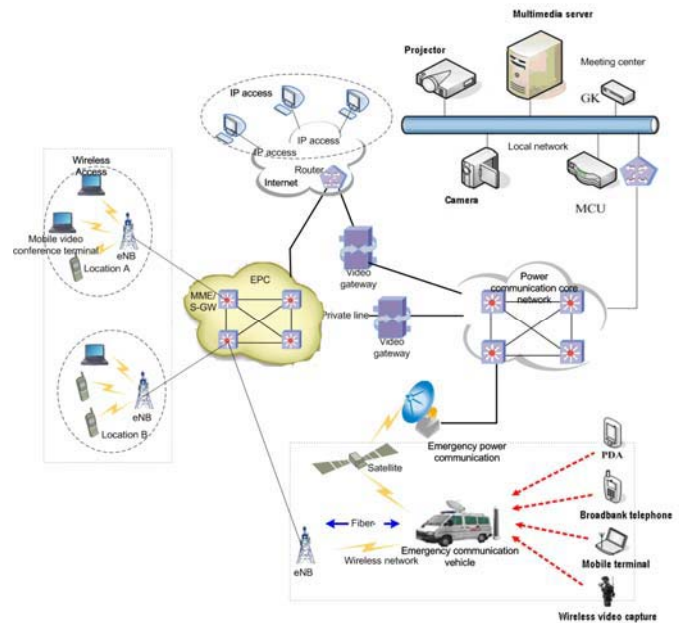
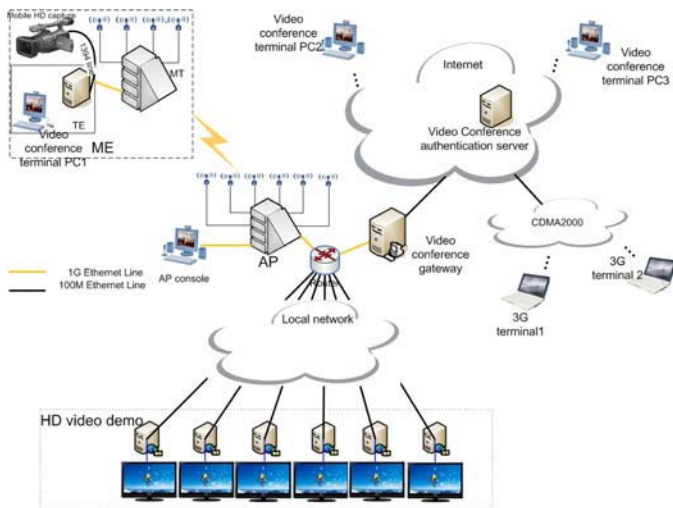


Figure 1. Power mobile video conference network mode

IV. POWER MOBILE MULTIMEDIA EXPERIMENTAL SYSTEM

For testing mobile multimedia system with different network environment, the power mobile multimedia experimental system is proposed in the paper. As shown in Figure 2, the mobile video experimental system fits the requirements of IMT-Advanced 4G Gbps TDD system, the air interface rate of the system can reach up to 1 Gbps. The mobile terminal (MT) executes wireless transmission and other related function, the terminal equipment (TE) executes end to end application; The mobile terminal (MT) includes four receive antennas, terminal equipment (TE) is mainly responsible for video streams sending and receiving with the MT; AP (access point) is a connection point between wireless network and wired network, which includes six antennas, three multi-antenna panels. AP console give intuitive graphical interface to monitor the status of the wireless link, including the empty rate, channel correlation, constellation diagram, business rate and bit error rate. This experimental system also includes a 3G network environment (CDMA2000), so the experimental system can test video system with wire network, 3G, 4G networks or mixed environment, and the experimental scenario can includes mobile video conference, remote mobile monitoring, high-definition mobile video transmission experiments, both the current and future broadband wireless communications technology can be tested in this system.



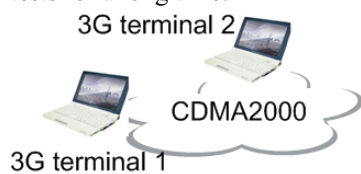
V. POWER MOBILE MULTIMEDIA EXPERIMENT WITH 3G

The 3G experiment considered H.264 [12-13] and H.263 + video codec, as well as different bit rates and resolution of images, and that mobile video conference data transmission rate and delay data under different conditions is obtained. The cdma2000 EVDO provide by china telecom is selected for 3G network, and AVCon(name of a video conference software) is used to provide mobile conference service.

A. Experiment 1

1) Experiment 1 scenario

As shown in Figure 3, the two mobile terminals connect 3G network with a CDMA2000 card. With H.264 and H.263++ video codec, different bit rate and resolution of the image, we take statistical tests for a long time.



2) Experiment 1 result

As shown in Figure 4, with H.263 ++ codec, when the image rate and resolution changing, data transmission rate take notable changes. With $176 * 144$ resolution and 64kbps image rate, the minimum data transmission rate is 80kbps with H.263 ++ codec; In the same conditions, the minimum data transmission rate is 15kbps with H.264 codec. With resolution of $640 * 480$ and image rate of 768kbps, the maximum data transmission rate is 400kbps with H.263 ++ codec; In the same conditions, with H.264 codec, the maximum data rate is only 60kbps. In the same resolution and image rate with H.263 ++ codec, the transmission rate is 6 to 20 times greater than transmission rate with H.264 codec. With H.264 codec, the required video transmission rate is small. When the image rate and resolution changing, the data transmission rate takes s obvious changes. Therefore, the compression rate with

H.264 codec is more outstanding, and more suitable for transmission rate constrained mobile environments.

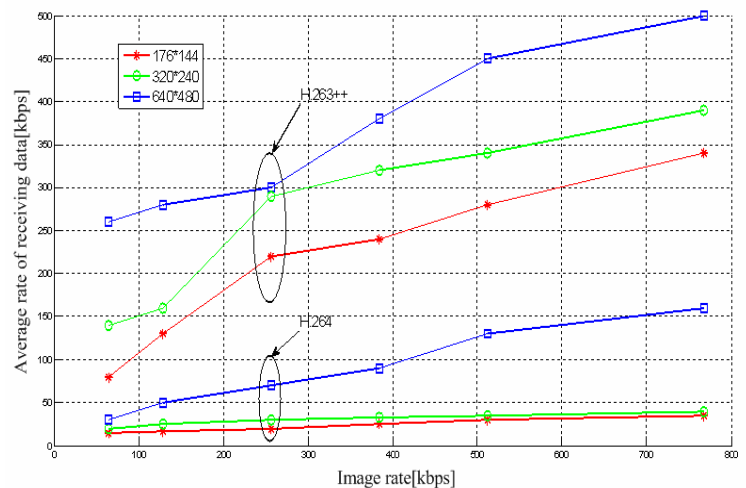


Figure 4. Rate experiment

As shown in Figure 5, the maximum value of delay is 5.52s, and the minimum is 3.77s, average is 5.12s. The delay is notable. The primary reason is the following:

- (1) The delay caused by encoding of the camera, which is about 100ms;
- (2) AVCON video conference server delay, the delay is about 1 to 3 seconds;
- (3) 3G network and IP network convergence delay brought about a few hundred milliseconds;
- (4) The delay caused by video decoding terminal, which depends on the terminal performance.

Therefore, the delay is mainly caused by AVCon video conference server.

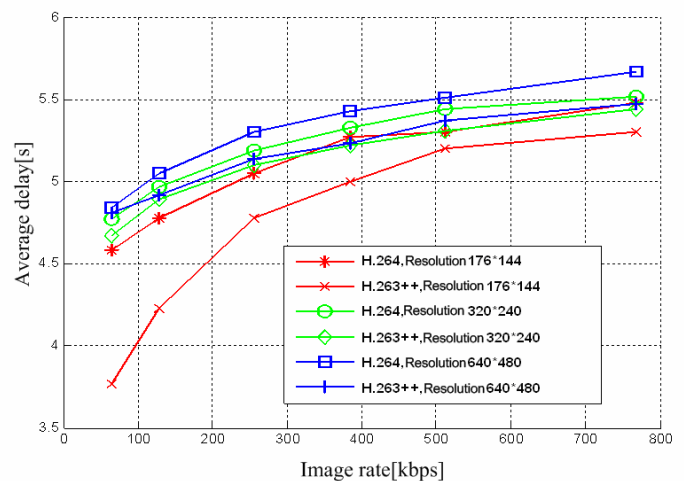


Figure 5. Average delay experiment

B. Experiment 2

1) Experiment 2 scenario

Diagram illustrating a video conference system architecture:

- A central cloud labeled **Internet** contains a **Video conference server** icon.
- Four **Fixed line terminal** icons (desktop computers) are connected to the Internet cloud.
- A **3G terminal1** (laptop) is connected to the Internet cloud via a cloud labeled **CDMA2000**.

2) Experiment 2 result

Through this experiment, the proposed video conference network based on the 3G part is verified. Depends on experimental data, the recommendations is proposed under 3G video conference environment.

1) Experiment 1 scenario

The experimental process is the following:

- (1) When the system link is stable, the ME terminal start MSN AV Conference, and requests connection to the Internet, and then, fixed-line video conference user start MSN AV Conference request.
- (2) The mobile video conference terminal PC1 sends a request packet to the MT, MT sends the request packet to AP through the wireless link; AP send it to the video conference gateway. After the video gateway communicate with the authentication server, the feedback packet send to PC1, and then, the terminal achieved video conference access.
- (3) PC2 and PC3 access video conference with the same way above.

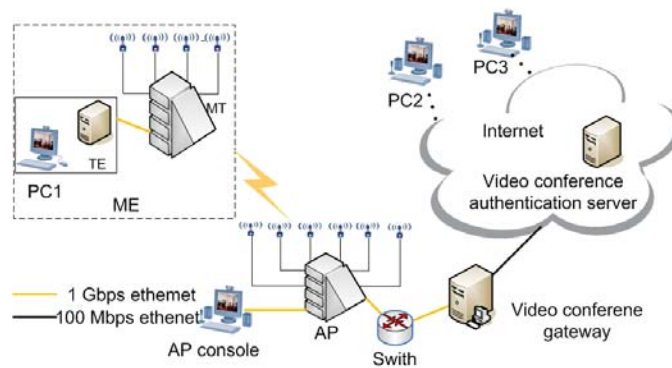


Figure 7. Mobile video conference scenario

2) Experiment 1 result

The experiment result is shown in the following table:

TABLE 3. RESULT 1 OF VIDEO CONFERENCE EXPERIMENT

Multimedia	Symmetry	Data Rate	Key Indicator		
			End to End Delay	One-Time Call Shake	Frame Error Rate
Sound	Two-way	4~64k bit/s	<100ms	<1ms	<0.5%
Video	Two-way	33~38 4kbit/s	<100ms Lip-sync: <100ms	<2ms	<0.5%

TABLE 4. RESULT 2 OF VIDEO CONFERENCE EXPERIMENT

Multimedia	Symmetry	Key indicator		
		MOS	Access Success Rate	Air Interface Bit Error Rate
Sound	Two-way	5	99.5%	$<10^{-6}$
Video	Two-way	4	99%	$<10^{-6}$

As shown in TABLE3 and TABLE4, the end to end one way delay is less than 100ms, one-time call shake is less than 2ms, Frame Error Rate is less than 0.5%, Access Success Rate is more than 99%, and Air Interface BER(Bit Error Rate) is less than 10^{-6} . The results show that the 4G mobile video conference has a very good performance. MOS (Mean Opinion Score)[14] is more than 4, which means the user experience is good. Therefore, 4G video conference system is fully able to meet the requirements of mobile video conference.

2) Experiment 2 scenario

Live high-definition video acquisition and transmission experimental scenario is shown in Figure 8, which simulates the acquisition of the emergency live video.

- (1) Service request: When system Link is stable, AP-side terminal request a media video transmission; a terminal can test multiple high-definition video;
- (2) Business Transmission: MT Business Server respond for AP's request and start services;

(3) Demonstrates: Play multi-channel high-definition demo video terminal to verify system link transmission capacity.

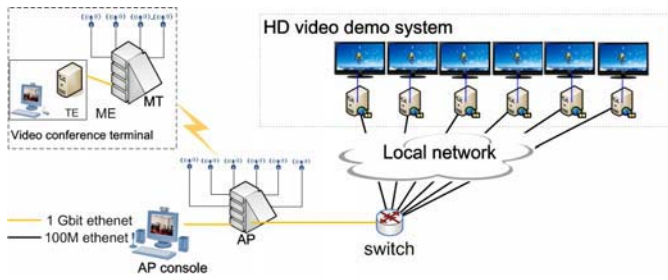


Figure 8. HD experiment scenario

2) Experiment 2 result

The result is shown in the following table after 1000 times test.

TABLE 5. RESULT OF HD TRANSMISSION EXPERIMENT

HD Standard	Transmission Rate(Mbps)	Maximum Number of HD Video	Delay (ms)	Frame Error Rate	Video MOS
MPEG-4HD1	18	55	<100	<0.5%	5
MPEG-4HD2	20	50	<100	<0.5%	5
MPEG-4 HD 3	25	40	<100	<0.5%	5
H.264 HD 1	20	50	<100	<0.5%	5
H.264 HD2	25	40	<100	<0.5%	5
H.264 HD3	28	35	<100	<0.5%	5

As shown in TABLE 5, the delay is less than 100ms, FER is less than 0.5%, Maximum Number of HD can reach up to 55 with MPEG-4 coding. The video MOS is 5, the highest value, means the user experience is very good. Depends on experimental data, 4G multimedia network can meet the required of HD video transmission in emergency circumstance.

Through this experiment, with 2 scenarios and a number of indicators, the proposed video conference network based on the 4G part is verified. 4G multimedia network can meet the requirement of mobile power multimedia system.

VII. CONCLUSIONS

According to the experimental results, the power mobile multimedia application recommendations with the broadband wireless communication is proposed in the following.

The power mobile multimedia system relies on advanced wireless networks that support high transmission rate, high bandwidth and high-capacity data services for mobile networks. For normal quality video transmission, even if the more mature GPRS network or CDMA 1X network, the rate is also difficult to meet the requirements of video transmission.

With maximum speed of 3G network up to 2Mbps, to some extent, this problem can be solved. China's cdma2000 network can support for point to point video conference, but the transmission delay, about 5s, has some unsatisfactory, which give user poor experience. After analysis, the delay comes from the video conference server mostly, which can be optimized.

H.264 has many advantages: high compression efficiency, strong error resilience against packet loss, and H.264 adaptable stream structure of the network, high network adaptability. As the environment is complex on the power spot, sometimes very poor, H. 264 is suitable for low-bandwidth power mobile multimedia communication. The disadvantage of H.264 is that algorithm is complex, which requires high performance of terminal.

In the experiment, whatever high-definition video transmission or video conference system, the 4G network can meet the demands of video services. 4G standard defines that the peak data transmission rate is up to 1Gbps, while 3G network only support 2Mbps peak, about 500-times increase. Therefore, 4G is the ideal wireless transmission network for the future of power mobile multimedia applications.

Through the power multimedia experiment with 3G and 4G, the proposed power video conference network is verified. The experiment provides reference for the mobile multimedia technology used in power system.

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