Chapter 6
Ultra-High-Definition Video Transmission for Mission-Critical Communication Systems Applications:
Challenges and Solutions

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ABSTRACT

With the standardization of ultra-high-definition formats and their increasing adoption within the multimedia industry, it has become vital to investigate how such a resolution could impact the quality of experience with respect to mission-critical communication systems. While this standardization enables improved perceptual quality of video content, how it can be used in mission-critical communications remains a challenge, with the main challenge being processing. This chapter discusses the challenges and potential solutions for the deployment of ultra-high-definition video transmission for mission-critical applications. In addition, it examines the state-of-the-art solutions for video processing and explores potential solutions. Finally, the authors predict future research directions in this area.

INTRODUCTION

Video content consumption over Internet Protocol (IP) has become ubiquitous, especially since it can be accessed anywhere, anytime, and on an expanding variety of user devices, such as laptops, tablets, smartphones, and PCs. With current advancements in both processing and networking capabilities, a

DOI: 10.4018/978-1-5225-2113-6.ch006

demand in higher quality video has also emerged. Consequently, recent years have seen the rise of video applications, such as streaming and video conferencing. Another area that would benefit immensely from the advancement of video is Public Safety Communication (PSC).

Traditional public safety communication currently uses Plesiochronous Digital Hierarchy (PDH) and/or Synchronous Digital Hierarchy (SDH)-/Synchronous Optical Network (SONET)-based Time-Division Multiplexing (TDM) technologies. IP-based video systems have evolved and now provide superior performance over traditional approaches to mission-critical systems. Indeed, many PSC networks are evolving to broadband solutions that use IP Wide Area Networks (WAN) for video surveillance and better integration with growing Information Technology (IT)-based applications (Alcatel-Lucent, 2013).

Video surveillance systems utilize video content to enable personnel to monitor an area, or even a collection of areas, from a central location, 24 hours, 7 days a week, and therefore reduces the need to delegate a large number of people to patrol the area. Surveillance systems are not new; however, there have been changes in the deployment of such systems in recent years. For Instance, a basic system might simply save the content on a storage device for further or future analysis, while more advanced systems can enable real-time analysis and can perform tasks such as recognizing changes in critical areas or the identification of certain objects. The video surveillance market is expected to grow by 14.8% by 2018 (Hsu & Chen, 2015).

Despite remarkable advances in the technical specifications of video surveillance, especially in the commercial domain, there has been an increasing need for higher quality content. In addition, most operators of video surveillance systems struggle both with the needed storage and computational complexity imposed by video applications of increasing quality and complexity. This is because most devices used for video surveillance have intrinsic constraints in storage and processing. The issue of processing can be partially solved with parallel computing (Wen-Mei, 2011), thereby providing new opportunities for future resolutions, while that of storage can be solved with the use of cloud computing resources (Zhu, Luo, Wang, & Li, 2011). Currently, resolutions up to full high definition (1080p) are available and can be deployed sparsely for Mission-Critical Communications (MCC). While 1080p resolution provides improved video quality, the use of this resolution is limited, especially with capture distance (approximately 120m), thus limiting the number of objects.

In recent years in the video domain, there have been significant improvements in video resolutions, with a major shift towards Ultra-High-Definition (UHD) TV (Nakasu, 2012), aimed at increasing the overall viewing experience. Currently, UHDTV standards allows two resolutions, namely 3840 x 2160 (4kUHD) and 7680 x 4320 (8kUHD), with 4kUHD now gaining ground in sectors such as broadcasting, cinemas, and video gaming. UHDTV is thus gaining increasing momentum. According to Cisco (Webster, 2015), IP video traffic is expected to account for 80% of all traffic by the year 2019, especially with the increasing consumption of IP-based UHD content. Mission-critical communication systems can therefore benefit enormously from the adoption of resolutions above 1080p, which will give better video quality, image analysis, and a wider area of coverage. UHD technology increases situational awareness and significantly enhances the ability of the operator, since finely detailed imagery is received. For example, covering a large environment will be much easier with the increased resolution. In addition, it will also allow the operator to zoom into the picture without sacrificing image quality, since more pixels are available, thereby making it optimal for mission-critical communication.

In this book chapter, the authors focus on UHD video transmission for mission-critical communications. The building blocks of UHD video transmission systems are illustrated in Figure 1. The first process involves the capture of UHD content using either a camera or a file-based source. In the second layer,

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