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Efficient Codec Design, Internet Anomaly Correction and Embedded Cellular Technology Make Single Modem ENG Practical

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Abstract

*Electronic News Gathering (**ENG**) has been in existence since the beginning of TV and Radio broadcasting. The first such methods involved recordings created on the spot and played back later at the studio location. The first person to get the story back to the station and on-the-air was the one who got the scoop. Portable transmitters allowed the news crews to go live on the scene. However, video transmitters and video encoders can be complicated equipment to set up and along with the large microwave antenna sizes and logistics requirements of setting up the shot, a technical crew as well as a reporter was necessary - even when time was short - capturing breaking news. The Internet has become attractive as a conduit for ENG - it is readily available almost anywhere, and the costs are reasonable. A big problem with the Internet and broadcasting has always been data rate and maintaining acceptable video quality during periods of heavy data use and throughput bottlenecks, when there are not enough bits to go around.*

First, MPEG-2 and then H.264 video encoding, have allowed substantial data throughput reductions. Then as semiconductors got smaller and more efficient, so did the video encoding hardware. Wired internet gave way to cell modem technology and these cell modems have actually helped create a new type of spontaneity - where instant communication from almost anywhere to almost anywhere - is normal, and often-times, expected. It did not take long for the immediacy of cell phones to be added to the ENG toolbox of TV stations in the form of the laptop USB data modem. The laptops used software encoders which, in concert with the data modems, sent the recorded files back to the studio - a better method - still not live. A way was needed to combine video and audio encoding and a cell data modem into an appliance that would be easy to use, fast to deploy, and practical for the broadcaster. Using a more efficient encoder and adjusting streaming video parameters for the best picture permits a further data rate reduction, allowing the use of a single modem and reducing the amount of spectrum required, while maintaining a quality video image. This technique also needs less infrastructure, boasts a reduced part count and is overall less expensive for the end user. Single modem ENG is a reality and is a perfect fit for the organization who wishes to use today's technology as a springboard to increased Electronic News Gathering capabilities.

INTRODUCTION

It has been said that necessity is the mother of invention. If so, broadcast engineers have given birth or given inspiration to practically every type of audio & video delivery system out there. In particular, the area of remote broadcasting and specifically, ENG, has seen a lot of seat-of-the-pants, get it on the air quick developments. Certainly, cellular USB modems have been plugged into laptops running multimedia software with cables tossed across a room and out a window to get the story. These tricks are not out of the ordinary during a remote broadcast event – however, putting it all together in one magic box as a complete system is a new twist. The implementation is shown in the block diagram at Figure 1. This complete approach was not solely focused on the desired result of getting a program on the air – substantial design efforts were spent on the equipment footprint, interoperability with other remote devices, available power sources in the field, operation with more than one type of wireless internet device and providing an uncluttered, friendly user interface. The following description shows that by using this whole-package design concept, the name of the game was to eliminate the ENG point of pain.

STREAMING OVER THE INTERNET

How can video and audio travel over the internet? Real-time video and audio uses the Real-Time Protocol (RTP) carried over UDP protocol [1]. Data is shipped between source and destination addresses in packets and is bursty in nature. A real-time streaming system needs to at a minimum have a buffer system at the decoder to clock out packets at the proper rate. Too much buffering can create unacceptable input to output delay or even lip sync issues. There are other tricks that can be used to reduce lost data such as forward error correction, which further increases the bit rate, and error concealment, which requires an increased amount of processing overhead. Considering the non-deterministic nature of the Internet data path, it is an additional benefit that RTP traffic does not require 100 percent reliability to be useful as a streaming protocol [2]. This fact allows full-motion, usable video to be decoded when encoded with the proper parameters.

SINGLE MODEM TECHNOLOGY

Specialized Encoding & Decoding

With an efficient codec system, a single cellular modem can be used for ENG through the Internet.

The encoding and decoding processes have been optimized for moving video and audio over the path created by this type of cellular data modem connection. H.264 video encoding and AAC (Advanced Audio Coding) are the standard of choice for compressing video and audio signals for distribution on this type of channel. H.264 can provide very good video quality at lower bit rates compared to using MPEG-2, for instance [3]. H.264 codec complexity is at a minimum, which helped reduce the R&D time. Using H.264 encoding (adjusted to certain parameters) a bit stream can be created to pass full motion video over a single cellular modem data channel. Innovative use of AAC audio streaming also allows implementation of a dual channel audio path from encoder to decoder and a second dual channel path in the reverse direction, from decoder to encoder. This set up provides program audio to accompany the video and additionally, separate IFB (interruptible-foldback) audio to and from the ENG site. Built-in IFB is icing on the cake for a remote crew – this increased functionality allows private communication with the master control location – without installing extra equipment. The codec was implemented using embedded hardware with Digital Signal Processing (DSP) devices in this product for several reasons. DSP is inherently low-latency - they are fast – these devices are performing a single function and are not required to perform additional, simultaneous housekeeping tasks which can add delay to the encoding and decoding. Furthermore, unlike a software-based codec system, they are practically immune to viruses. Additionally, these DSPs require much smaller power supplies, use less energy and generate less heat. This translates into better efficiency and less maintenance for the end user.

Robustivity to the Rescue

Sometimes the cell site gets swamped with connection requests from new modems that move into the coverage area or the existing connected modems compete for more and more of the data bit pie. This type of activity creates a bottleneck that causes the amount of available data bandwidth to be reduced. As the available bandwidth decreases the chance of seeing noticeable artifacts in the video increases. If the video parameters can be adjusted "on the fly" to accommodate changing bandwidth conditions, then artifacts can be kept to a minimum and a very presentable picture is obtained. Using this method, the so called best-effort internet delivery system works well. However, there are a host of parameters that can be adjusted on an H.264 codec system – the bit-rate, frame-rate, GOP (Group of Pictures) setting and a few housekeeping settings. It would be a near-impossibility for the user to adjust these parameters discretely, whether using a menu selection system or a series of knobs and switches scattered across the equipment's front panel. Additionally, there are combinations of settings that would not work properly at all and such a method of H.264 parameter adjustments would also not be repeatable, for example, for a routinely used ENG location – it would take too much time to set up the shot. A way was needed to make the codec set up simple, fast and repeatable: Robustivity. The Robustivity number is the result of laboratory simulations along with months of accompanying field tests to verify and tweek the lab results. The bit-rate, frame-rate, GOP and housekeeping are all automatically set up by choosing a single Robustivity number. Figure 2 shows the approximate relationship between bitrate and Robustivity number for a 3G cellular connection. So for any particular remote broadcast location, a Robustivity number is chosen that will produce the best video. During the broadcast, if the cellular conditions change, the Robustivity can be changed – while still streaming – without interrupting the newsgathering operations. Robustivity allows the user to make the most of the present cellular data path conditions and produce the best quality picture.

CHOICE OF HARDWARE

Embedded Modems Necessary

It is important to properly choose a modem for a unit that is intended to be used in the field. An important item to consider is the modem's physical mounting requirements. Using the electrical connection, such as the USB connector, as the sole means of anchoring the modem can cause problems if the modem falls out or if the USB mating connectors pull apart because of vibration or other abuse. Using an embedded modem with, for example, a mini PCI-express form factor will provide both a solid electrical connection and a stable, latching hold-down mechanism. Figure 3 shows the positive capture provided by mini PCI-express. These types of embedded modems are industrial grade, mount flat against the circuit board to conserve space and have industry standard RF connectors built in for both a main and diversity antenna. The functional operating temperature range is also beyond that of consumer-type USB modems – an important parameter since an ENG system could be used during any season, inside or outside.

Permanent Fixed Gain Antenna

When modems are entirely enclosed by the equipment case the antenna must be external. An AT&T technical brief indicates that it is difficult to get even 75% efficiency from an embedded antenna - which equates to a power loss of -1.2 dB [4]. An antenna physically mounted to the equipment metalwork and RF cable securely attached to the modem creates a stable and repeatable operating environment by keeping the antenna feedpoint, RF cabling and connections out of the user's reach, as shown in Figure 4. This method also helps maintain compliance with any FCC Part 15 measurement requirements. A broadband external, low-profile antenna for this application has a gain of approximately 3 dBi. This gain will permit the cell modem to operate with a lower power level and reduce the current requirements from the on-board battery, further increasing the efficiency, and benefiting the end user by increasing the time between battery changes.

Using Wi-Fi Access Points

In locations where there are restrictions on cell service, installing a dedicated access point is the best way to go. In urban areas, a Wi-Fi access point with gain antennas works very reliably, since these are locations where there are heavy demands on the existing cellular service during newsworthy events such as high-profile jury trials, political conventions and mass transit occurrences. If there are regular broadcasts from a townsquare or court house, for instance, weatherproof Wi-Fi access points can be installed on street light poles and connected to an Internet connection or piggybacked onto a city-wide WAN. Industrial access points are not large, use little power and are easily mounted. This type of Wi-Fi set up can be used to route either over the Internet (to the decoder) or, if the WAN is large, it can be configured as an intranet depending on the situation. Access points can be programmed with passwords and encryption to keep network access private. A 5 Megabit per second video data rate can be expected over this kind of link.

A Single Package for Ease of Use

Being able to choose between both cellular and Wi-Fi connections provides for flexibility for a newsgathering operation. It was realized that for maximum benefit, a single-modem cellular ENG system should be able to accommodate 2 embedded modems so that a switch can be made to the second modem if needed. For example, the end user may choose to install a Verizon-provisioned modem in slot 1 and an AT&T-provisioned modem in slot 2 so that the cellular network can be changed if traveling to a different geographical location to cover a news event. A one-size-fits-all configuration with a cellular modem in slot 1 and a Wi-Fi modem in slot 2 has been found to be reasonable combination for most ENG situations.

SUMMARY

A system has been presented that transforms Electronic News Gathering into Easy News Gathering by creatively combining hardware and firmware technologies into a practical application-specific device - benefiting broadcasters by solving the age old problem of getting the news story from here to there. It's a brave new world, constantly filling with new technology and new techniques. It is imperative to play to the strengths of each platform to gain maximum productivity.

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FUTURE DEVELOPMENTS

List of Figures

(Figure 1). Signal flow block diagram of the NewsShark system.

(Figure 2). Robustivity abbreviated chart showing numbers vs. bitrate for 3G operation.

(Figure 3). Picture of mini PCI-express latching hold-down system.

(Figure 4). Picture of how permanent fixed-gain antenna is mounted.

References

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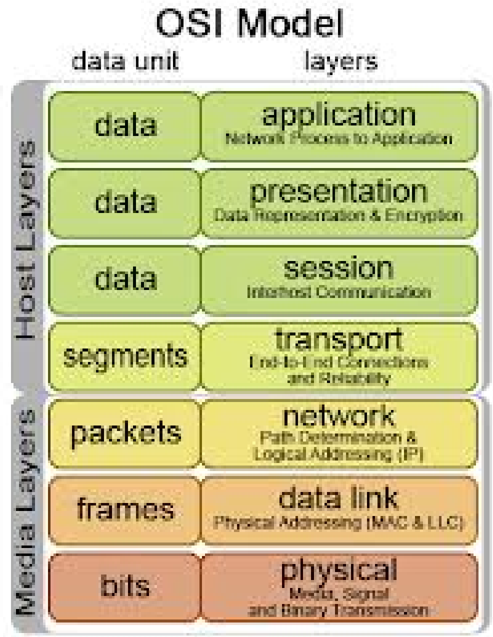

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