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JPEG2000 cuts delays in digital video distribution

By John Wemekamp

Digital video distribution is a major growth area – and not just on traditional surveillance platforms such as naval combat systems, maritime patrol aircraft, or armored scout vehicles. Digital distribution removes the straitjacket of wired analog distribution, with discrete cables per video source, enabling video to be distributed over multiple carriers over long distances and at high quality and high resolutions. In addition, many armored vehicles are now being equipped with local situational awareness systems offering all-around vision with the hatches closed. These vehicles may also receive downlinked images of the battlefield from Unmanned Aerial Vehicle (UAV) sensors in real time.

Digital video applications

The most common applications are large, multisensor platforms with many crew stations, each one potentially able to view any-from-many video sources on one or several screens simultaneously. Distribution of analog video requires considerable cabling plus complex switching and scaling hardware at each crew station. The complexity of such systems is magnified by the recent introduction of higher-resolution, point-to-point digital video/audio interfaces with their restricted transmission distances and cable routing issues. These include the PC standards such as High-Definition Multimedia Interface (HDMI) found in modern flat-panel TVs and monitors. Some military applications achieve uncompressed digital video transmission using the ARINC 818 standard, which is based on Fibre Channel signaling (specifically FC-AV). Video compression and distribution as IP packets over an Ethernet network is a solution being adopted for large platforms. The same principles are being applied to many smaller platforms with multisensor payloads that may be required to share data and images externally across the digital battlefield.

However, compression can cause loss of clarity and detail and introduce delays into signal paths. Delay is usually unacceptable when used for fire direction or for driving a ground vehicle, making the choice of compression algorithm critical. The most familiar standards for video compression, MPEG-2 and MPEG-4, add delays of typically 300 mS by using multiple frames to discriminate changes. There may also be a loss of picture integrity plus some additional recovery time if one frame is lost or corrupted during transmission. The alternative is to use frame-by-frame compression of JPEG2000, where coding and decoding operate at frame rate and any delays are limited to transmission times through a network. JPEG2000 also offers selectable compression ratios for optimum use of bandwidth. For example, with a typical compression ratio of 30:1, TV rate video only requires a bandwidth of 1 Mbps through a network.

Managing costs and distribution

JPEG2000 is appropriate for all types of video distribution, offering better quality and response at similar overall cost compared to MPEG. One example where the solution is often strongly dictated by budget is local situational awareness in an armored vehicle. This uses a number of cameras at TV resolution and will require little image processing. A typical configuration is for each camera to incorporate JPEG2000 compression, hooking up directly to the vehicle's local network and using onboard embedded computing resources to decompress and display the images on one or two local displays. By using embedded computing resources, images and annotations added by the crew could also be distributed externally through radio or satellite links to command posts or to other vehicles on the ground. Larger platforms such as naval combat systems or surveillance aircraft will host more complex applications requiring additional image or display processing; these include target tracking, identification, and classification; sensor fusion; and windowing. The image processing will be more closely integrated with many embedded computing systems and will deal with video of much higher quality. This application will distribute not only compressed sensor video via the network, but it will also have many cooperative participants sharing processed/synthetic video from many sources (for example, from one combat system display console to many others).

JPEG2000 is now a well-accepted standard for high-quality video distribution, particularly in embedded systems modules such the Orion JPEG2000 PMC module from Curtiss-Wright Controls Embedded Computing (CWCEC) shown in Figure 1. Technology improvements are set to greatly improve packaging and

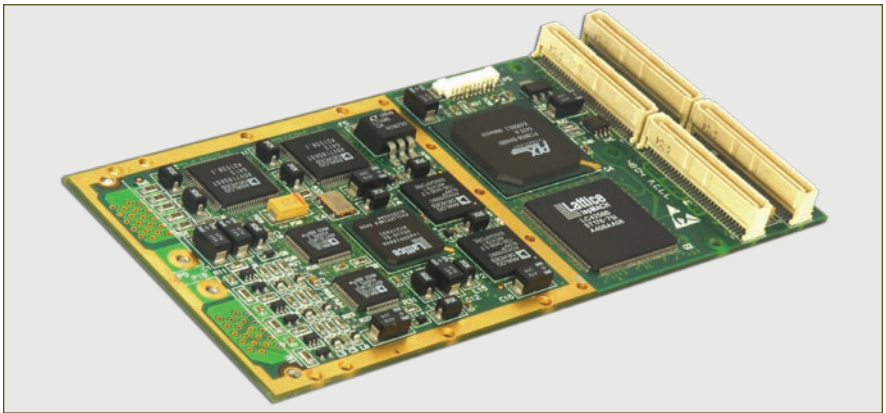

FIGURE 1: JPEG2000 is now a well-accepted standard for high-quality video distribution, particularly in embedded systems modules such Curtiss-Wright's Orion JPEG2000 PMC module.

performance of this class of product; PCI Express is replacing older PCI and PCI-X parallel interfaces. Secondly, an FPGA can now be used for real-time JPEG2000 compression and decompression on multiple channels at HD resolutions and beyond, up to 1,920 x 1,200. These improvements make it possible to implement capability onto just a single XMC/PMC module, compatible with off-the-shelf embedded computing standards, to support DVI as well as PAL/NTSC sensor and display video streams. In addition, such a module could operate as a JPEG2000 coprocessor for the interplatform, console-to-console, or platform-to-platform class of video distribution.

Moving compressed video as IP packets through a network saves space, weight, and cost by making more efficient use of what is often underutilized existing infrastructure. The new generation of JPEG2000 products provides the capability to incorporate HD levels of video resolution with the compression ratios and video quality to match current and future network, sensor, and display performance.

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