Why Cutting-Edge Video Solutions Are Essential for Enhanced Situational Awareness

Read About

Introduction

As warfare moves from asymmetric counterinsurgency focused operations, militaries must consider necessary requirements for success in an ever-developing battlefield, often characterized by increased technology. In an age, where technological dominance reigns, the on-board sensor suites, optics, mission systems and vehicle architectures become the eyes and ears of the crew members, as well as the soldiers on board, making militaries around the world rely on video imagery for situational awareness. It is vital that armored units have an intimate understanding of their surrounding terrain as well as the systems capabilities to deal swiftly with incoming threats, whatever the conditions.

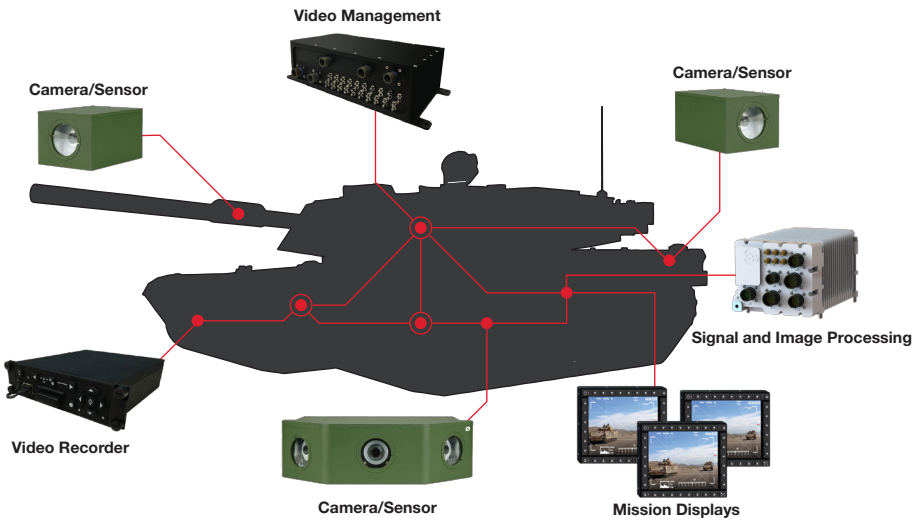


Figure 1: Example of a modern situational awareness system on a ground vehicle

As cameras and sensors are added to ground vehicles for increased operator situational awareness, advancements in video management and display technology are enhancing the capabilities with smaller, lighter systems that decrease SWaP while increasing functionality.

The backbone of modern defence capabilities, intelligence, surveillance, and reconnaissance (ISR) relies on a robust and diverse network of integrated sensors, aircraft, and manpower. The value of this network ultimately relies on human capability to clearly see sensor imagery, discern important details, and take decisive action. In the field, we have little or no control over the lighting and environmental conditions under which images are acquired from a sensor.

Situational Awareness Tools and Technologies Are Always Evolving

The tools and technologies that provide situational awareness are continuously evolving. In the earliest days of battle, a map would be considered an important situational awareness tool. Today, still cameras, video cameras, Global Positioning Systems (GPSs), and other innovations were developed aiming to enhance the situational awareness of operators.

As technologies continue to advance, increasingly sophisticated onboard sensors and mission systems have become the eyes and ears for everyone on ground and air platforms. Cutting-edge video and image processing solutions, from sensor to screen, have become the best way to get all of this information to warfighters in a fast and effective way (Figure 3).

The Future Is Getting Closer

While enhanced situational awareness (ESA) solutions on the level often seen in movies such as Iron Man or Minority Report aren't yet available for defense and aerospace applications today, technologies are rapidly evolving, and this is where they are headed.

Most ESA solutions share a key feature: the ability to seamlessly blend large amounts of data from multiple sources, then visually present it to people in a highly intuitive way, in as close to real time as possible.

Cutting-edge video solutions for defense and aerospace today have the capability to overlay images and information from multiple sensors and systems and visually present them to warfighters, providing a coherent, near-real-time view. These solutions are the first step on the road to the augmented reality (AR) solutions that are hitting the military market in the next few years. Further in the future, sensor fusion and neural networks will be used by deep learning applications to not only provide the warfighter with information but also assist them in decision making. For more information on AI and machine, learning read the white paper "Machine Learning and Artificial Intelligence in Defense and Aerospace Applications".

Situational Awareness Informs Decision-Making

There are several definitions for situational awareness and situational understanding. However, they all share the ideas expressed in these Reconnaissance, Surveillance, and Target Acquisition (RSTA) squadron definitions provided by Major Brad C. Dostal, a military analyst at the U.S. Center for Army Lessons Learned (CALL).

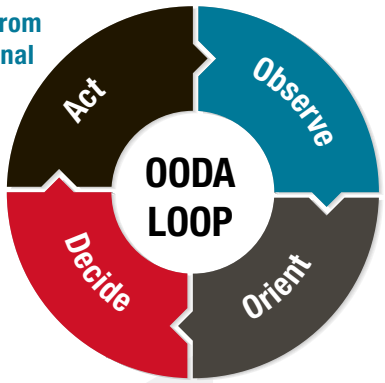
Situational awareness is "the ability to maintain a constant, clear mental picture of relevant information and the tactical situation including friendly and threat situations as well as terrain."[1]

Situational understanding is "the product of applying analysis and judgment to the unit's situational awareness to determine the relationships of the factors present and form logical conclusions concerning threats to the force or mission accomplishment, opportunities for mission accomplishment, and gaps in information."[2]

According to Dostal, situational understanding allows leaders to avoid surprises, make rapid decisions, and choose when and where to conduct engagements, and achieve decisive outcomes.[3]

Situational awareness is also a key component in the Observe, Orient, Decide, Act (OODA) loop developed in the mid-twentieth century by military strategist and U.S. Air Force Colonel John Boyd. The OODA loop is a four-step approach to decision-making that focuses on filtering available information, putting it in context, and quickly making the most appropriate decision while also understanding that changes can be made as more data becomes available.[4]

Figure 2: The path from raw data to situational awareness and understanding



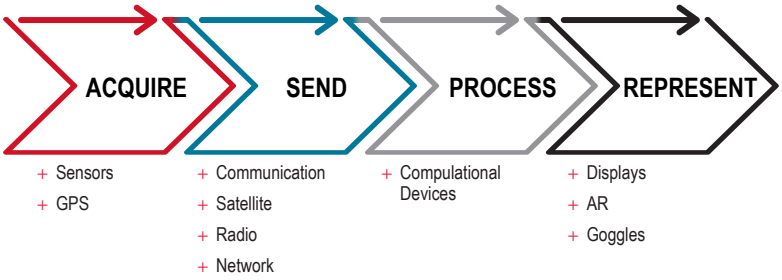


Figure 3: The Path from Data Acquisition to Representation

The Path from Data Acquisition to Representation

Acquire Data with Real-Time Sensors

Today, sensors can be used just about anywhere to monitor almost anything, from temperature, pressure, and humidity levels to camera-based vision systems monitoring people and machine movements in real time. These sensors range from high-definition, thermal and infrared cameras to GPS, radar, speed indicators, and other application-specific sensors. Advancements in sensor technology have placed smart sensors in homes, industry, and even in the military. Sensor networks enable platforms to obtain huge amounts of information that can increase precision, for example, while providing information back to the network, where ultimately machines can make data based decisions.

Send Data to Processor through On-Board Network

Sending large data sets to other onboard systems to improve situational awareness requires a significant amount of bandwidth, which often leads to an overload of the communication infrastructure. The latest advancements in Ethernet technology enable tomorrow AI applications with 200 GbE. However, defense and aerospace platforms often lag behind industry technology advancements due to the ruggedizaton and security required. Today, many platforms have 10 GbE, and manufacturers offer ruggedized 10 GbE switches and routers with Cisco® technology. These networks can already handle the bandwidth required for AI and machine learning applications.

Process Data to Present Useful Information to the Warfighter

Processing the myriad of sensor data before presenting it to the warfighter as useful information is the heart of an AI system. Machine learning techniques can be used to take the real world sensor data and identify it by comparing the features to those learned in a training data set. They use the result of the comparisons to make decisions and take actions. With faster access to more accurate intelligence, warfighters are in a much better position to make informed decisions that help protect people and equipment in the field.

This processing happens in dedicated hardware developed by industry leaders such as Intel® and NVIDIA®. Both companies offer software frameworks based on common industry standards so developers can implement machine learning and AI algorithms on a variety of hardware platforms. For defense and aerospace applications, the hardware not only needs to fully support the advanced software these companies develop, but also requires ruggedization, SWaP optimization, and flexibility.

To operate with the levels of speed and performance that warfighters need in the field, some machine learning and AI applications must run on very high-performance hardware. However, when selecting the appropriate underlying hardware, trade-offs must be made to balance application performance with heat dissipation and power requirements. Field conditions are nothing like data center conditions,

and applications must be able to safely and reliably perform at an adequately high level in a wide variety of environments.

Added to a modern video system that can manipulate video feeds and enable video blending and video stitching, AI applications get one-step closer to the science fiction portrayal of being provided data in your field of vision that you can manipulate with the swipe of a finger. Today, video system components can layer regular camera feeds with infrared and thermal imaging feeds, and can display mapping, telemetry, image metadata, and other relevant data inputs along with video streams. Coupling AI applications running on high-performance processors with such a video system provides situational awareness that is beyond what is available to today's warfighter.

In the early days of sensor integration into platforms, it seemed logical to add computer processing capabilities to the back of the mission display. Since then, technology has continued to evolve, and all-in-one video display and computing solutions no longer have an obvious advantage over simple, standalone displays or the bandwidth to host the large number of data points and inputs required under ESA operations (for more information, read "Why Smart Displays May Not be the Cleverest Choice"). In many cases, a simple video display connected to a separate computing component is the better choice, offering the following benefits:

+ Reduced cost of computer processing compared to smart displays
+ Simplified upgrades to computer processing capabilities
+ Increased deployment flexibility and improved thermal management in SWaP-constrained spaces

A simple system would have a few sensors that are fed into a computer where data processing takes place, and then the information is sent to a display. Advanced systems today have a large number of sensor and camera signals that are managed from a central management and distribution system. Video gateways, switches, and multiplexers manipulate the image and data streams before outputting the results to the computer or mission display.

To increase situational awareness, many video distribution solutions provide a range of image configuration options. The most sophisticated solutions can simultaneously deliver multiple unique video streams to a number of displays and computers. They also allow warfighters to quickly and easily manipulate views with the touch of a button, and provide the following features:

+ Real-time views with zoom capabilities
+ Simultaneous camera views using picture-in-picture technology and window overlays
+ Video streaming and blending capabilities

In addition, video management and distribution systems provide high performance video processing and extensive I/O that supports multiple sensors and displays. Enabling all video streams between the distribution technology and the display over minimal wiring and provide a SWaP optimized solution.

Modern video management and distribution systems are able to synchronize the video streams from all video cameras and other sensors, add diagnostic data, text, and graphics (from an image and processing computer running an AI application, for example) that put the visuals in context for warfighters, then deliver it to mission displays with extremely low latency.

Represent the Information to the Warfighter

There have been numerous advances in display technologies over the last decade, and each one plays an important role in helping warfighters quickly and easily assimilate mission-critical information:

+ High-brightness LED backlights make displays easy to read in low light conditions.
+ Fully bonded displays are highly reliable, reduce reflections, and provide superior clarity and contrast compared to legacy non-bonded displays.
+ Projected capacitive (PCAP) touch screens support intuitive, multi-touch gestures, don't require a stylus, and can be used while wearing

gloves. They are also lighter weight and more durable than resistive touch screens. For more information, read our white paper "PCAP Touch Screens in Defense and Aerospace."

+ LCD technology provides more viewing angles, allowing warfighters to easily see the information on the screen from the side as well as the front.
+ Anti-reflection and anti-glare coatings provide better visibility in bright light conditions.

For more information on the advancements in display technology, read our white paper "How Modern Mission Displays Give Operators Critical New Visibility."

A look at the different levels of video systems available for ground vehicles illustrates the effect that increasingly advanced technologies have on situational awareness.

The most basic video systems allow warfighters who are in the vehicle or operating it remotely to view the images from one vehicle-mounted camera at a time, providing a rudimentary level of visibility.

Multi-display and picture-in-picture solutions allow warfighters to simultaneously view images from multiple vehicle-mounted cameras so they can consider their surroundings on all sides of the vehicle at all times. With potentially more than a dozen camera views to choose from, warfighters can easily access the optimal combination of views for the task or maneuver they're executing.

360 degree video systems give warfighters an even higher level of situational awareness. These systems blend accurate, fully stitched images from all vehicle-mounted cameras into a seamless, panoramic image that most closely resembles what the human eye sees, while minimizing latency and therefore preventing motion sickness.

The next step is to move this crucial insight and visibility right into warfighters' helmets or visors. In the next five years or so, we can expect to see AR solutions that put the video feeds, maps, GPS coordinates, speed indicators, and other information warfighters need right in their field of view, with minimal latency, that they will be able to use intuitive gestures to control the information they see at each phase of task execution.

Flexibility, Interoperability, and Latency

The goal of every ESA solution is to get the right information to the right person at the right time in a form that can be rapidly assimilated and used. The only way to achieve this goal is to deploy end-to-end video solutions where all system components are seamlessly integrated.

Any other approach introduces significant risks, including interoperability issues, increased latency, increased complexity, and more challenging maintenance and upgrades. These shortcomings will make it far too difficult to acquire, distribute, and intuitively present the extremely high volumes of data that will be available in the battlespace of the future.

The end-to-end architecture for ESA varies depending on the specific application and platform. However, most solutions require the video management components shown in Figure 1.

As technologies evolve, so will system architectures. As a result, each system component must be:

+ Flexible
+ Adaptable
+ Expandable
+ Interoperable
+ Easy to deploy, use, and upgrade
+ Low SWaP

Extremely low video system latency is also essential for warfighters to have complete confidence that what they are seeing is the reality at the time while minimizing motion sickness caused by delays between what is seen and what is felt. If information is delayed and warfighters are uncertain about their situation, they are far more likely to hesitate when responding to threats, collide with obstructions or humans, or unknowingly enter dangerous territory.

To reduce latency end to end, each video system component must function in as close to real time as possible:

A United Kingdom (UK) Ministry of Defence study found that military vehicle drivers could safely drive a vehicle through a visual display when the overall video system latency is 40 ms or lower.

A study looking into the effects of video latency on general situational awareness found that warfighters remain adequately aware of their surroundings when overall video system latency is 160 ms or lower.

For more information, read our white paper "Reducing Latency in Ground Vehicle Video Systems."

Curtiss-Wright End-To-End Video Solutions

Curtiss-Wright's end-to-end video and computing solutions enhance warfighter situational awareness today, and are paving the way to the ultimate situational awareness solutions of tomorrow. As advancements in AI application development, processing power, sensors, and network technologies increase, reality will get closer to the science fiction depiction of AI.

We offer a broad range of rugged modules, systems, and solutions that are optimized for machine learning and AI applications:

+ General-purpose graphics processing units (GPGPUs) with massive parallel processing capabilities that are considered to be AI engines, featuring NVIDIA Quadro® Turing™ technology, which was designed to support machine learning as well as more traditional graphics-intensive applications
+ Intel processing solutions with high-performance Xeon® processors
+ Rugged, powerful, and flexible ultra-small form factor (USFF) mission computers that feature NVIDIA Jetson TX2i SOM
+ Software support that includes integration of deep learning frameworks

System integrators can choose from a selection of OpenVPX™ cards in 3U, 6U, and mezzanine form factors, or work with our experienced system architects to design pre-integrated modifiable COTS systems. This flexibility enablesthe optimal combination of functionality, interfaces, performance, and SWaP for their application requirements.

To support the shift toward emerging open standards and protect our customers' investments for years to come, many of our modules are developed in alignment to The Open Group Sensor Open Systems Architecture™ (SOSA) Technical Standard and C5ISR/EW Modular Open Suite of Standards (CMOSS).

As well, we take a building block approach to video system design, providing ruggedized mission displays, video distribution systems and video recorders, as well as complete video management systems that maximize flexibility and ease the integration of future technology advancements. Some of our video system solutions that are enhancing warfighters situational awareness in the field today include:

+ The RVG-MS1 Multi-Sensor Rugged Video Gateway, which provides 25 inputs and 20 outputs in a unit that weighs only 3.25 kg (7.17 lbs) and requires only 80 W of power maximum. This SWaP-optimized video gateway supports single, dual, triple, and quad views in a variety of layouts.
+ Ground Vehicle Display Units (GVDUs) that feature ruggedized PCAP touch screen displays designed for the unique requirements of ground vehicles, where there is less light, more sand and water in the air, and greater need to operate the display while wearing gloves
+ The VRDV7000, a lightweight, small form factor dual-channel HD video recorder that allows warfighters to easily review recently captured video footage to verify situations

All of our video and processing solutions are designed and built to withstand extreme temperatures, shock, vibration, sand, water, and other challenging environmental conditions to ensure long-term, reliable operation on any terrain and in any weather conditions.

They meet key industry standards, including:

+ MIL-STD-461F for radiated emissions and electromagnetic compatibility
+ MIL-STE-1275E for power and electrostatic discharge
+ MIL-STD-810G for environmental engineering design and testing
+ DO-160G

Our solutions also address the key technical challenges associated with reducing latency in individual solution components and across the end-to-end solution.

Beyond Video Solutions

At Curtiss-Wright, we recognize that continuous innovation is critical for enhanced situational awareness. As a result, we are constantly striving to simplify the relationship between warfighter and machine, and to incorporate video into increasingly advanced, innovative, and intuitive solutions. By collaborating with technology leaders to ensure the hardware we develop supports the advanced software development needed for ESA, as well as leveraging decades of video system design and development for aerospace and defense applications, Curtiss-Wright provides the tools and systems required to enhance warfighters mission success, today.

Contact us for more information about how new technologies are influencing the evolution of Curtiss-Wright's enhanced situational awareness solutions.

Author

Val Chrysostomou
Video System Product Manager
Curtiss-Wright Defense Solutions

Learn More

Curtiss-Wright Products

- Computing Systems
- Displays
- GPGPU, Graphics & Video Modules
- Processor Modules
- Recorders
- Software Tools
- Video Distribution and Management

Curtiss-Wright White Papers

- Ground Vehicle Video Management System Integration
- Machine Learning and Artificial Intelligence in Defense and Aerospace Applications - What You Need to Know
- Projected Capacitive (PCAP) Touch Screens in Defense and Aerospace
- Reducing Integration Headaches with Ground Vehicle Optimized Displays
- Why Smart video displays May not be the Cleverest Choice

References

1. https://www.globalsecurity.org/military/library/report/call/call_01-18_ch6.htm
2. https://www.globalsecurity.org/military/library/report/call/call_01-18_ch6.htm
3. https://www.globalsecurity.org/military/library/report/call/call_01-18_ch6.htm
4. https://searchcio.techtarget.com/definition/OODA-loop