System Assessment and Validation for Emergency Responders (SAVER)

Body Worn Camera Systems for Tactical Operations Technical Report

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Prepared by Space and Naval Warfare Systems Center Atlantic

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FOREWORD

The U.S. Department of Homeland Security (DHS) established the System Assessment and Validation for Emergency Responders (SAVER) Program to assist emergency responders making procurement decisions. Located within the Science and Technology Directorate (S&T) of DHS, the SAVER Program conducts objective assessments and validations on commercial equipment and systems, and provides those results along with other relevant equipment information to the emergency responder community in an operationally useful form. SAVER provides information on equipment that falls within the categories listed in the DHS Authorized Equipment List (AEL). The SAVER Program mission includes:

- Conducting impartial, practitioner-relevant, operationally oriented assessments and validations of emergency responder equipment; and
- Providing information, in the form of knowledge products, that enables decision-makers and responders to better select, procure, use, and maintain emergency responder equipment.

Information provided by the SAVER Program will be shared nationally with the responder community, providing a life- and cost-saving asset to DHS, as well as to Federal, state, and local responders.

The SAVER Program is supported by a network of Technical Agents who perform assessment and validation activities. Further SAVER focuses primarily on two main questions for the emergency responder community: "What equipment is available?" and "How does it perform?"

As a SAVER Program Technical Agent, the National Institute of Standards and Technology (NIST) provides expertise and analysis on key subject areas. NIST conducted an assessment of body worn camera systems for tactical operations. Body worn camera systems fall under the AEL reference number 13LE-00-SURV titled Equipment, Law Enforcement Surveillance. The results of this assessment are presented in this report.

Visit the SAVER section of the Responder Knowledge Base (RKB) website at https://www.rkb.us/saver for more information on the SAVER Program or to view additional reports on body worn camera systems or other technologies.

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1. OVERVIEW

In March 2013, an assessment of body worn camera systems was conducted during special weapons and tactics (SWAT) team training operations in Utah. The purpose of the assessment was to provide general information to law enforcement agencies that are considering employing and/or purchasing this technology.

2. BACKGROUND

Body worn camera systems are growing in popularity in the law enforcement community as well as in private commercial use. While they have been used for over a decade in the military and Federal law enforcement sector, many of the systems developed for these markets are beyond the cost margin of state or local law enforcement agencies. Body worn camera systems generally consist of a video and audio system with either a gyroscope to aide in stabilization of the image or secure mounting equipment to ensure a stabilized video feed. They are typically mounted on the helmet, belt, or chest; however, they can also be mounted to a piece of equipment, such as a bike or motorcycle. They contain a rechargeable battery that is either self-contained with the unit or as a separate pack mounted in proximity to the camera system.

Video and audio feeds from these units can be recorded to an internal removable secure digital (SD) or micro-SD card or to an internal drive. They are then either removed for download to a personal computer or connected via a universal serial bus (USB) cable for download. Camera systems developed specifically for law enforcement can also come with proprietary software to ensure proper download and chain-of-custody tracking of the video footage for courtroom evidence purposes.

Video feeds from these camera systems are used by law enforcement during internal reviews and as evidence in court. While many officers are still wary of being recorded, many now recognize that a body worn system can corroborate their actions during an internal review or court proceeding. Because of this, some officers are purchasing their own cameras for use during operations.

While there are numerous body worn camera systems in the marketplace today, it is important to recognize that most of them are not specifically designed for law enforcement use, and may not be well-suited to collect evidence or readily usable by officers in the field due to physical dimensions, accessibility, and usability.

3. ASSESSMENT METHODOLOGY

In order to perform a comparison of different camera technologies, formats, capabilities, mounting options, and download methods, several body worn camera systems were selected for assessment from both the commercial action sport market and the law enforcement market. The six units selected were representative of industry offerings, as well as the range of cost points, at the time of the assessment.

All camera systems were placed with approximately the same camera angle and field of view for comparison purposes. Video and audio footage from each camera system was captured for

3 to 10 minutes during training operations throughout the day, to assess the effects of lighting and sunlight on the functionality of each. They were also mounted at different locations on the evaluators to determine the stability of various mounts during operations as well as the field of view at the mount. Officers were trained in the usage of the camera systems—on/off switches, record notification, etc.—and provided feedback regarding ease of use during the assessment. To further assess the audio capabilities of the units, audio and video feeds were also captured during use at a shooting range. The audio capabilities and feedback issues were assessed after gunshots were fired from rifles and handguns.

Eight law enforcement officers served as evaluators for this assessment. All evaluators had at least 5 years of law enforcement experience. During the assessment, the evaluators rated the camera systems based on their knowledge of typical missions performed, awareness of the overall goals of the assessment, and familiarity with existing video systems in use. This assessment included the following key capabilities to be assessed:

- Is the body worn camera system such that it can be properly mounted to an officer's eye gear, chest, or helmet? How difficult is the mounting process?
- What is the best position for the camera: helmet mount, weapon mount, chest mount, eyeglass mount?
- What level of ruggedization is sufficient to withstand the majority of SWAT operations?
- Is the image quality such that the control station obtains more situational awareness or is the footage too shaky or distorted to be of use for this purpose?
- Are the body worn camera batteries durable enough to withstand a 4- to 12-hour mission?

These key questions were then expanded into a set of capability, deployability, and usability metrics. The evaluators performed the assessment during normal training operations. Prior to the assessment, the equipment was mounted on a typical helmet, protective eye equipment, and chest and body armor. The evaluators provided feedback as to the preferred mounting method based on ease of use and time to deploy. Training operations were conducted with equipment mounted in each location, so that evaluators could determine the best locations for obtaining video footage and for comfort.

The assessment was conducted in a training warehouse that simulated both a typical residential home and school facility, and provided a controlled lighting environment. Units were not exposed to weather conditions such as rain or extreme temperatures. If needed, these factors would need to be evaluated in a separate assessment.

4. RESULTS

Overall, commercial units typically used to record action and adventure sports did not have sufficient video quality in low light to accommodate SWAT needs. These camera systems typically contained a removable battery located on the unit, which was preferred. A major hindrance to proper use was the small size of the control buttons, which were not easily operated when wearing full tactical gear.

Of the assessed camera systems, the technical specifications listed in table 4-1 were rated the highest with an emphasis on low-light operations. These technical specifications may not apply to all law enforcement scenarios.

The helmet mount, secured with either specialized adhesive or drilled into the helmet, provided the best camera angle and stability. It was highly desirable for the camera systems to have removable and replaceable SD cards in order to maximize their operating time during tactical operations.

For the tactical scenarios employed in this assessment, the small personal units (approximately 4 inches in size) proved to have the shortest battery life. Also, most of the commercial action sport camera systems did not offer night or low-light video features and provided little or no useful video in dark environments.

Finally, remote viewing capability through Bluetooth and Wi-Fi connections was assessed. The results were disappointing due to the inability to broadcast to a distance greater than 100 feet. It would be preferred for the commanding officer to be able to remotely view the real-time video feed from the camera systems through a secure Internet connection; this potential future enhancement would be very useful to tactical operations. Some of the cameras advertise remote viewing in their literature and documentation, but they are designed for social media applications and do not serve their purpose from a command and control standpoint. Privacy issues would also be encountered if trying to use public Internet and social media applications to view a live operation.

Table 4-1. Highest Rated Technical Specifications for Low-Light Operations

Feature	Specification
Camera dimensions (L x W x H)	Approximately 3.00 x 0.75 x 0.75 inches
Camera weight	< 16 grams
Controller dimensions (L x W x H)	Approximately 0.25 x 0.75 x 3.50 inches
Controller weight	< 100 grams
Weather resistance	IPX2; MIL-STD 810F, method 506.4, procedure 1 (rain and blowing)
Minimum lux	≤ 0.1 lux
Audio	On/off
Frame rate	30 frames per second
Video resolution	640 x 480
Field of view	75°
Record time	4 hours
Pre-event buffer	Captures previous 30 seconds from start with no audio
Battery stand by time	12+ hours

Feature	Specification
Recharge time	6 hours for a fully depleted battery
Power activation	Slide switch on battery
Record activation	Push button – double-press to start recording, 3-second hold to end recording
Volume control	4 step momentary press
Video playback	Via phone application or Microsoft Deployment Toolkit (MDT) application
GPS coordinates	Via phone application
Operating temperature	-20°C to 50°C
Drop test	6 feet
Humidity	80% noncondensing

5. RECOMMENDATIONS

Key points to consider when evaluating and purchasing a body worn camera system:

- Lighting plays a key role in video systems. As most SWAT operations occur at night, camera systems that capture quality images in low light are important.

Darkness

Well-Lit

- Mounting considerations are important for the effective usage of the camera system. Insecure mounting leads to lost or damaged systems, as well as video angles that are unhelpful. For example, if a camera system is mounted improperly and the field of view is the ground or ceiling, there is significant decline in usefulness. The evaluators determined side-helmet mounts to be the most effective and stable during tactical operations.

Side-Helmet Mount

- Know the Federal, state, and local jurisdictions' processes for the collection of video and audio evidence. Jurisdictions may require removable SD or micro-SD cards to maintain the integrity of the evidence collected. Alternatively, jurisdictions may require evidence be uploaded in a specific manner, for instance with a proprietary

device. It is important to ensure that the camera system will support proper evidence collection methods.

- Battery life is a large consideration. Typical applications require standby power of 3 to 6 hours and recording battery life of 15 to 20 minutes for live, tactical operations. If a longer battery life is needed, removable battery packs may be interchanged.
- Removable SD cards proved to be the easiest download method for retrieving video and audio after an operation. Methods that require uploading evidence to a proprietary device or webpage needed a considerable amount of time and bandwidth.

- Officers involved in tactical operations are loaded down with equipment and body armor and are required to wear heavy gloves. When selecting a body worn camera system, buttons or controls that are large and easy to use with heavy gloves are important. Similarly, a single on/off switch and simple indication to the officer that the equipment is recording is also important. During the assessment, audio emissions from the camera systems, such as beeping for on/off switching, were often inaudible due to mounting locations, external noises, and protective gear.
- Light emitting diodes (LEDs) on the camera system may interfere with a stealth approach during a tactical operation. Any light indicators on the camera system should contain a shield so that they can be covered during the operation.
- Audio quality varies greatly from one camera system to another. Wind noise is a significant problem if the internal microphone is not properly placed within the unit.
- Gunshot noise is a key factor on audio during investigations and camera systems need to be able to record, with precision, the number of shots being fired from both the wearer and others nearby. Some systems may not be designed to record such loud noises at close range and some of the assessed systems experienced long delays in recording after a gunshot, causing missed audio of the event.
- The current market of body worn camera systems has a limited number of features for remote access and remote monitoring of the video feed. Some systems can connect to a smartphone or tablet to allow for "viewfinder" features, but actual viewing or re-broadcasting to another location is not yet a primary feature, and privacy issues must be addressed for any remote viewing/recording as well. Many of the remote viewing functions used social media applications and would not be a viable option for law enforcement.

6. CONCLUSIONS

Tactical operations provide a unique environment for body worn camera systems. The assessment results reflect usage in this unique environment and are not intended to be extrapolated into all law enforcement usage. Body worn camera systems used during normal day time operations (an officer on patrol) would have different requirements for use. For tactical operations, ruggedization, mounting options, low-light operation, and ease of use with tactical equipment are the most important factors to consider when purchasing a camera system.

Several mounting locations were considered including: side and front helmet mounting, eyeglass mounting, chest and belt mounting. The most stable, comfortable location and the mounting location that provided the best video was the side helmet mount. This location allowed ample width for the camera to avoid being hit or obstructed when going through doorways or windows and provided a useful field of view.

Low-light video capabilities were vital for obtaining useful video footage in low to medium light conditions. The units were assessed going from an exterior sunlight location to a low-light, indoor location and some camera systems automatically adjusted to low-light conditions.

Large buttons and shielded LEDs were features that were key usability components. A simple indication that the camera is recording is also an important feature. Removable SD cards and interchangeable battery packs are also important features to consider. Audio quality for the majority of systems was limited from a forensics point of view. Most of these systems are designed specifically for video image quality and audio quality is limited at best. Some of the systems allow for external microphones or external noise filtering, but none were extremely effective during firing operations. Further development efforts from the vendors are needed in order to improve audio quality for the camera systems assessed.

Finally, a future enhancement to the body worn camera technology that was important to tactical operations leaders was the ability to broadcast the real-time video feed via a secure Internet transmission to a commander located off-site. The Bluetooth and Wi-Fi options assessed were not of sufficient range to allow this capability to occur.

APPENDIX A. IMAGE SAMPLES

Sample images from raw video footage for comparison of resolution, lighting effects, and overall image quality:

Camera 1 high resolution (720p), widescreen, light and dark images:

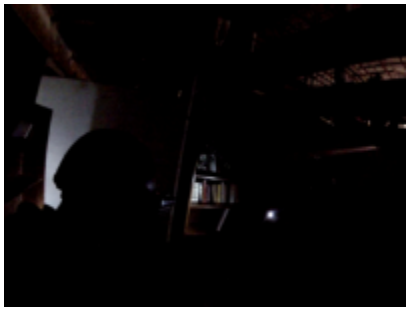


Camera 2 low resolution (video graphics array [VGA]), day/night capability, dark images:



Camera 2 low resolution (VGA), day/night capability, light images:


Camera 3 high resolution (720p), light and dark images:

Camera 4 high resolution (720p), day/night capability, light and dark images: