Use of the Apple iPod Touch for Live Training

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ABSTRACT

The Multiple Integrated Laser Engagement System (MILES) has been an effective Live Training technology for decades in the U.S. Army. During its existence, MILES has continued to improve in all areas including performance and usability with the newest family of technology referred to as Instrumented-MILES or I-MILES. The newest program and capability from this family of technologies is the Tactical Vehicle System (TVS). TVS is a laser-based training device that supports the force-on-force and force-on-target training needs of soldiers occupying various heavy weight, medium weight, and light weight, tracked or multi-wheeled tactical vehicles that do not have an embedded fire control system. TVS primarily supports crew-served weapon systems associated with a vehicle, but can also be used on low and medium protected structures and fixed equipment, such as bridges, bunkers, ammunition caches, refuel depots, and buildings.

In addition to providing the latest I-MILES capabilities, the TVS program is leading the way in the use of commercial products in the Live Training domain. TVS incorporates an Apple iPod Touch for system configuration as well as for enhancing training manuals and products. This paper will explore the capabilities, limitations, and dangers of using one of the most well known commercial products to meet the needs of the warfighter. The paper will begin with a brief overview of the use of commercial products with a focus on handheld mobile devices. The concept of operations of the TVS will then be explained. The use of the iPod Touch within TVS will be discussed, including the concept of operations, the benefits, and unique challenges. This discussion includes Information Assurance (IA) and software upgrade considerations. The paper will describe re-use of 3D models from the virtual domain of the SE Core Database Virtual Environment Development (DVED) program. It will conclude with lessons learned from a lifecycle management perspective and discuss future use of commercial products of this nature along with possible drawbacks and benefits to the warfighter.

ABOUT THE AUTHORS

Jesse Campos is the government Lead Engineer of the TVS program at the Program Executive Office for Simulation, Training, and Instrumentation (PEO STRI). Mr. Campos has been involved in the DoD training domain for over 15 years, primarily focused on the software engineering discipline. Prior to joining PEO STRI, Mr. Campos worked within the M&S community as a contractor on various government programs including the Synthetic Environment Data Representation and Interchange Specification (SEDRIS), One Semi Automated Forces (OneSAF), One Tactical Engagement Simulation System (OneTESS), and the Future Combat System (FCS). Mr. Campos is a graduate of the University of Central Florida with a BS in Electrical Engineering, a BA in Political Science, and a Masters in Business Administration.

Chris Jackson is the PM Live Training Systems Information Assurance Security Engineer. He is a Certified Information Systems Security Professional through ISC2 and holds the Information Systems Security Engineering Professional concentration from the same organization. Prior to joining the PM LTS organization, Chris spent eleven years working systems security on a number of government programs as a contractor. Mr. Jackson has participated in the development and fielding of a number of systems to the Department of Defense in all three classification domains, Unclassified, Secret and Top Secret/SCI. In his current position Mr. Jackson is working systems security and accreditation for Live Training Systems. Mr. Jackson is a graduate of Alfred University with a BS in Business Administration and served in the US Army for eleven years prior to beginning work as a systems security engineer.

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INTRODUCTION

Live Training products and solutions strive to replicate actual operational conditions using the same weapons and environments to prepare the warfighter for warfare. The Multiple Integrated Laser Engagement System (MILES) has been an effective Live Training technology for decades in the U.S. Army. This family of products instruments the actual weapons and vehicles used by soldiers to train as they fight. As the MILES has evolved, it continues to progress towards a commodity solution, if not a Commercial off-the-shelf (COTS) solution. Specifically, there is a small subset of vendors who provide proven technologies and provide the possibility of integrating truly COTS components such as the iPod Touch. TVS is an example of a training system which includes a COTS product for Live Training.

DOD COMMERCIAL PRODUCT USAGE

DOD commercial product usage has continued to increase throughout the years due to many factors including cost, availability, and product obsolescence. Specifically, the acquisition process cannot follow a stovepipe mentality with requirements defined and a product coming to fruition a decade later. Instead, programs develop supply chains and define iterative capabilities with defined technology insertion points. This environment is conducive to the use of commercial products which continue to improve in capabilities and performance every few years or couple of years.

Usage in Training Environment

The training environment has seen increased use of commercial devices, due to the availability of extensive computing power. As a result, visual systems and other training solutions that were custom solutions have become integration tasks that incorporate COTS hardware such as high end desktops or graphics boards.

While the training environment has used these COTS products, the use of hand-held devices has lagged as training functions have not been clearly identified for these capabilities. Handheld devices provide good solutions for a variety of unique tasks such as gaming, inventory tracking, maps, etc. These do not lend themselves to providing training environments or training solutions as of yet. For example, an iPod Touch is a platform that can perform many different simple tasks well with limited capabilities.

Usage in Operational Environment

The operational environment for the Army has actually embraced the handheld device faster than the training community, due in large part to need in the field. The current battlefield requires interconnected, networked soldiers and systems. The iPod Touch has been used for translating applications, annotating maps, linking text and voice recordings to photos, and other intelligence gathering devices. Military applications to display aerial video from drones and teleconference have been developed. Another example, which was cited within the TVS program, is a ballistics calculator name BulletFlight. This application (shown in Figure 1 mounted on the M110) runs on an iPod Touch and iPhone and is developed for snipers. Yet another example is the Vcommunicator which provides translations with full media support such as audio, video, and animations.

Figure 1. iPod Touch running BulletFlight on an M110

TVS CONCEPT OF OPERATIONS

In order to evaluate and appreciate the use of commercial products for the Tactical Vehicle System (TVS), one must understand its intended operation and usage. The TVS is the latest product in the Instrumented-Multiple Integrated Laser Engagement System (I-MILES) product line. TVS is a laser-based tactical engagement training system used for both force-on-force (FOF) exercises at the Maneuver Combat Training Centers (MCTCs) and home stations as well as force-on-target (FOT) training. In addition, TVS provides information for After Action Reviews (AAR) to assess Techniques, Tactics, and Procedures (TTPs). The TVS integrates into instrumentation systems fielded by Program Manager Training Devices (PM TRADE), providing near real time tracking ability and high-level training fidelity.

I-MILES systems are composed of a transmitter which uses a 0.904 micron laser to encode messages which are decoded by a detector, or set of detectors. The detectors can be placed in many different configurations on personnel, vehicles, and structures. Figure 2 shows three examples of I-MILES detection components: a detector belt for vehicles, a torso vest and helmet detectors from the Individual Weapon System (IWS), and a wireless detector for vehicles or structures.

Figure 2 Sample of I-MILES detectors

The laser transmitter can take many shapes and forms as shown in Figure 3. While detectors do not vary considerably in performance, laser detectors have significant performance differences. For example, a small arms transmitter (SAT) for an M2 machine gun is calibrated to reach targets at approximately 900 meters away. This produces a smaller beam profile than a 120 mm main gun transmitter optimized at much larger distances. Even though the laser characteristics are different for each transmitter, the actual encoding is consistent and defined by the MILES Classification Coding (MCC) standard maintained by PEO STRI. As the latest I-MILES solution, TVS provides the above capabilities with specific functionality for tactical vehicles.

Figure 3 Small arms laser trasmitter (SAT) and laser transmitter in gun tube

TVS System Overview

TVS is a laser-based training device that supports the force-on-force and force-on-target training needs of soldiers occupying various heavy weight, medium weight, and light weight, tracked or multi-wheeled tactical vehicles that do not have an embedded fire control system. TVS supports crew-served weapon systems that are appended to, installed on, or associated with the vehicle. TVS is versatile in that it can also be used on low and medium protected structures and fixed equipment, such as bridges, bunkers, ammunition caches, refuel depots, and buildings. TVS supports having no SATs, one SAT, or two SATs. The information contained in the MILES laser transmission includes codes to identify the player, weapon, and ammunition. The TVS processes the information to produce real-time casualty assessment (RTCA). The RTCA can produce one of several outcomes: catastrophic kill, firepower kill, mobility kill, communication kill, hit, or near miss.

In order to provide the above functionality, the TVS uses a Personal Area Network (PAN) using 802.15.4 wireless RF communications to communicate between system components. The 802.15.4 physical layer operates in the 2.4GHz Industrial, Scientific, and Medical (ISM) band which is unlicensed world-wide. Each TVS system has a PAN ID and channel used by the components of the system. In addition, TVS uses 802.11 wireless RF communications to communicate with an iPod Touch. During setup, the iPod Touch establishes a link with the TVS system and uses that link for showing status and sending configuration commands to the system (e.g. setting vehicle type). After a training mission is complete, a Training Data Transfer Device, such as a laptop, would be connected

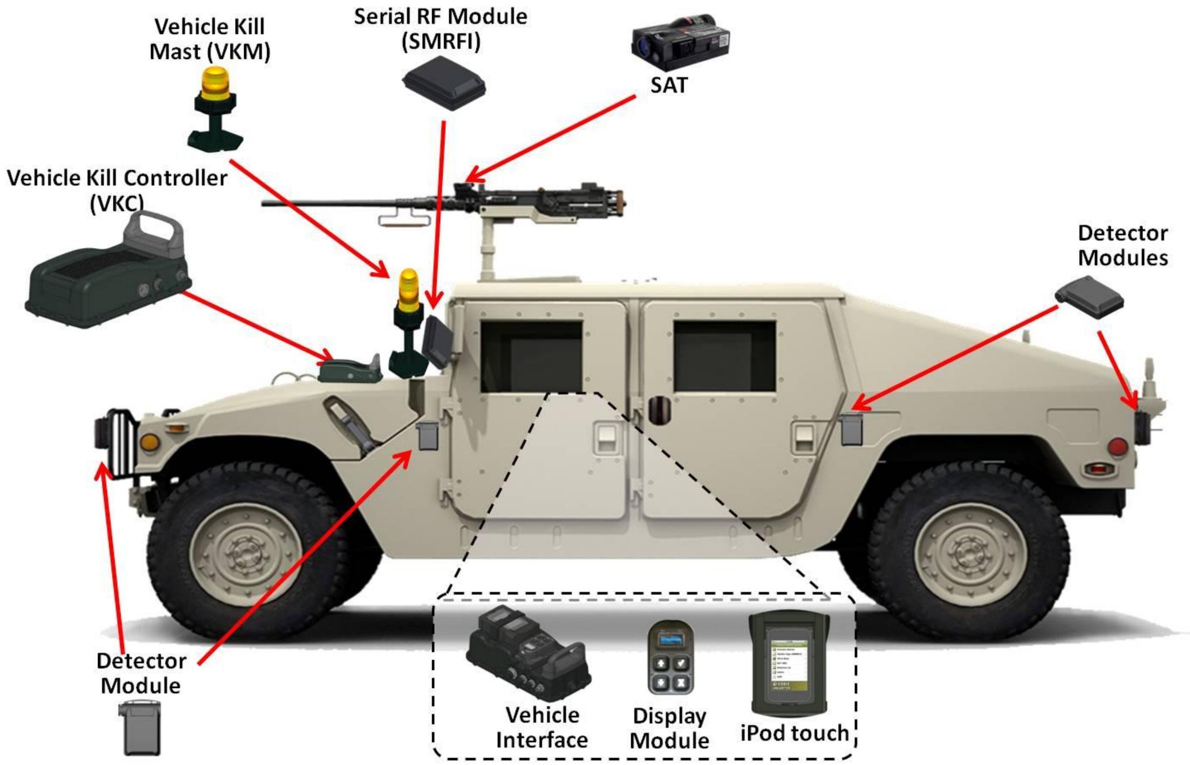

Figure 4 TVS Components

to the TVS system, and would download all of the events that were recorded during the training mission. This data is referred to as After Action Review (AAR) data.

TVS System Components

The TVS components are shown in Figure 4 as they would be used on a vehicle in the operational environment.

The vehicle kill controller (VKC) is the main system coordinator. It receives messages from the Detector Module(s) when the vehicle is fired upon, performs the MILES fire routine, performs the casualty assessment, then commands audio/visual cues to components in the system equipped to provide those cues.

The vehicle kill mast (VKM) flashes upon command from the VKC to indicate engagement results. The VKM is designed to be visible from the highest point of the vehicle and be seen at a distance of at least 1800 meters.

The vehicle detector modules (VDMs) are battery powered, low power devices that decode incoming laser pulses. The VDM decodes an incoming laser signal according to the MILES PMT90 standard then transmits the information over the PAN network to the VKC. The VDM has the capability of detecting mud or other obstruction of its face which would render it “invisible” to laser energy, thus reducing the training effectiveness of the system. The number of VDMs required is based on the type of vehicle to be instrumented.

The TVS system can have up to two SATs associated via the PAN network. The SAT is used to simulate a weapon that is appended to the vehicle. The SAT detects blank fire and shoots MILES laser codes with the ammo type of the weapon it is simulating, as well as the PID that was assigned to it. When the VKC, determines that a catastrophic or weapons kill has occurred, it will disable the SAT.

The serial module radio frequency interface (SMRFI) is a small device that is connected to and powered by the VKC. The SMRFI serves as a router on the PAN and provides additional range for the VKC and allows the VKC to more easily communicate to the VIU. .

The vehicle interface unit (VIU) is placed on the inside of the vehicle to interface with the crew of a vehicle. It provides a docking mechanism for the Display Module which provides power. The VIU interfaces to an intercom system and inject audio cues to indicate vehicle status, engagement results, etc

The Display Module is the crew's main interface to the system during operation in a training exercise. It has a display that can show the outcome of engagement events, BIT, etc and a built-in speaker that can play audio cues.

The final TVS component is the iPod Touch to be discussed in the following sections.

iPod Touch CONCEPT OF OPERATIONS

The iPod Touch in the TVS is designed to be a very easy to use and interactive tool to aid the crew in the proper installation and configuration of the system. The rich user interface, step-by-step guides, and wireless interaction with the system enable the crew to install the system correctly and in the shortest amount of time possible. Proper installation and configuration of the system is critical to its performance and reliability in the field, so that the system can provide the maximum training value for which it was designed, keep the crew's interest high in using the system, and reduce the burden on training and maintenance personnel. In order to maximize life of the iPod Touch, the TVS configuration provides the device a protective case as shown in Figure 5.

When used on the TVS, the crew will unpack the iPod Touch, power it up, and run the TVS app that has been installed on it. The initial screen is shown on the rightmost graphic of Figure 5. All usage of the iPod Touch will move forward from this application. All other applications on the iPod touch, while still resident, are disabled using the iPhone/iPod Touch Configuration Utility provided by the manufacturer. This ensures that the iPod Touch will not be used for any ancillary reasons such as web browsing or attempted to be modified with additional data such as music or videos.

When setup is complete, the TVS application is exited, and the iPod Touch is either put to sleep or powered off. The iPod Touch is docked onto the flat docking surface of the VIU using the built-in strap and connected with the USB cable so that the iPod Touch's battery is charged when connected to the VIU. After the system has been reset and the iPod Touch connected to the VIU, the system can monitor the presence of the iPod Touch and issue a cheat kill if the iPod Touch is disconnected. This feature is referred to as "iPod Touch Interlock," and its purpose is to ensure the iPod Touch is kept with the rest of the TVS system and to discourage the use of the iPod Touch during operation of and training with TVS.

Figure 5 TVS iPod Touch in case (front and back) and TVS app

Usage

The TVS app provides the following at the top level:

- Quick Start Guide; which provides the installation instructions,
- Configure Menu; which provides another means of installing based on components,
- Connect capability to initiates a wireless connection to the TVS system,
- System Status Menu; to check the TVS status, and,
- Admin Menu; to perform administrative functions.

The Quick Start Guide includes an "installation wizard" that guides the crew step-by-step through the physical installation of the components, including where to put them, how to connect the cables, how to power them, etc. The menus used to initiate these instructions are shown in Figure 6 starting with the top level menu and moving clockwise through the different capabilities. The usage and functionality is described in Table 1.

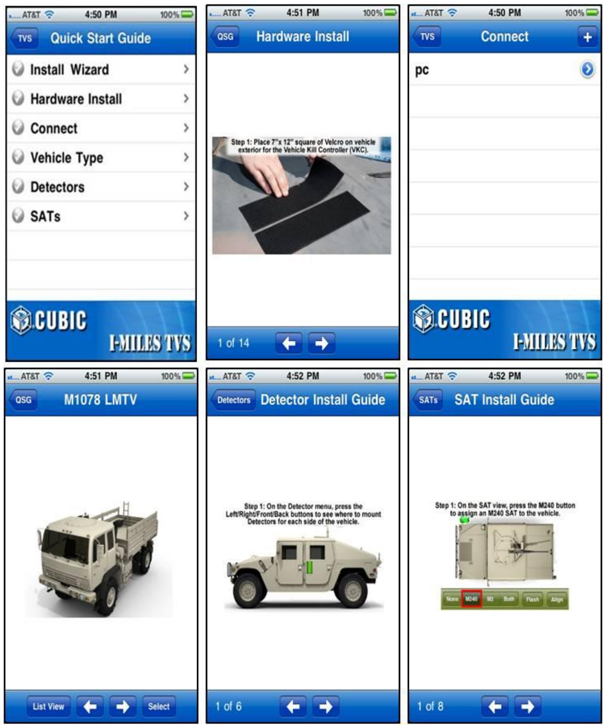

Figure 6 Quick Start Guide menu and subsequent functionality

Table 1: Quick Start Guide Features

Feature	Description
Installation Wizard	Provides step-by-step guide to installing and configuring the TVS system.
Connect	Initiates a wireless connection to the TVS system.
Vehicle Type	Crew selects which vehicle the system is being installed on. The application uses this data to show instructions and graphics appropriate for that platform installation, including the number of detectors to install and where to install them. The vehicle type selection sends the selection data to the system so that it knows the configuration (e.g. number of detectors and vulnerability).
Detectors	The crew selects the side of the vehicle on which they are installing detectors, and the app responds by showing the number and location of detectors for that side. The app sends an "identify" command to the system, so that all detectors assigned to that side flash their LED to identify themselves to the crew.
SATs	The crew selects whether to associate no SATs, one M2 SAT, one M240 SAT, or both M2 and M240 SAT to the TVS target system.

Additionally, the iPod TVS application has a "trusted user" mode that is entered with an appropriate username and password. In this mode, the trusted user (e.g. training observer/controller) can use the WiFi link to administer the system as described in Table 2.

Table 2: Admin Level Features

Feature	Description
Dry Fire	Sends a dry fire command to an associated SAT.
Fire Laser	Enable red laser of an associated SAT for alignment
Reset	Sets TVS to a "ready" state
Resurrect	Clears a kill
Catastrophic Kill	Sets to TVS a dead state
Mobility Kill	Sets TVS to a non mobile state
Firepower Kill	Disables the SAT from firing if present
Communication Kill	Sets state to communication kill
Hit	Registers a hit on the TVS
Near Miss	Registers a near miss on the TVS
Set PID	Select between BLUFOR or OPFOR PID.

The TVS Operator and Maintenance Manuals are loaded on the iPod Touch for the soldier. While it is not standard operating procedure to provide the manuals with all issued equipment, the iPod Touch provides this option because of its significant storage capability. Additionally, the rich user interface allows flexibility in developing the manuals with an enhanced user interface.

iPod Touch BENEFITS

The biggest benefit of the iPod Touch is the powerful user interface which allows for a rich multi-media experience using the touch screen. This is demonstrated in the installation wizards as well as the manuals. This capability allows a user to use a menu-driven application instead of working through hard copy manuals. For example, the placement of components can be customized to the individual vehicles upon which the TVS will be installed as shown in Figure 7. Each of these figures is an individual step that demonstrates the placement along with instructions allowing a user to zoom in on the placement as necessary.

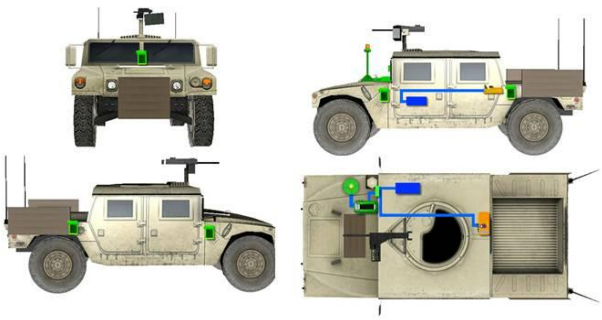

Figure 7 TVS Component placement using iPod Touch Graphics capabilities

This capability provides not only a cleaner, more efficient method to work through installation and the manuals, but it also provides flexibility in developing capabilities such as searching and indexing the manual. Finally, it also provides capabilities to add audio and video as well as animated illustrations to improve the system.

Because the iPod Touch is ubiquitous, the majority of users and warfighters will be familiar with it and its capabilities. This provides a reduce learning curve or barrier to using the training system. In addition to familiarity by the user, the wide user base of a commercial product like the iPod Touch, provides a large development base with increasing capabilities and functionality. This more readily introduces capabilities to the platform, but also provides a larger workforce with expertise in this area.

Finally, by using the iPod Touch platform, the Army can leverage a proven commercial solution along with its built in capabilities, functionality, and processes. For example, under TVS, an “app” was created using the standard development platform and libraries and installed on the iPod Touch. In order to update the TVS app, the iPod Touch need only be connected and a new version of the application downloaded as an update to the application. This reuses the built in functionality of the iPod Touch platform and commercial applications of this platform. Furthermore, this is consistent with the trends in software of providing automatic updates not only to desktops but to hand-held devices. In the case of the iPod Touch, it uses the same software as commercial systems, and updates are performed with iTunes.

iPod Touch CHALLENGES AND LIMITATIONS

While the iPod Touch promises usability enhancements for efficient setup and intuitive interface that is familiar to warfighter, it is not without significant challenges that must be handled through a combination of design, training, and policy. The three challenges faced when training the warfighter are: 1) keeping the iPod Touch charged, 2) maintaining the proper interaction with the crew, and 3) maintaining iPod Touch functionality within all environmental conditions.

iPod Touch Charging

The TVS requirement for battery life when a component is not connected to vehicle power is 100 hours of operation. This is a requirement that is not met by the iPod Touch. As a result, the iPod Touch needs to be connected to the VIU. The VIU provides power to the connected iPod Touch when the VI is powered on, regardless of whether the VIU is on the vehicle or internal battery power. The VIU provides power to the iPod Touch if it is powered off, as long as external power is being provided to the VIU. In addition, the iPod Touch can be charged using the traditional methods: connecting it to a USB host or to a standard AC outlet.

iPod Touch Interlock

There are several concerns with using a commercial product, such as the iPod Touch. One is the temptation of the crew while in training to use the device for standard commercial functionality, and the second, is the possibility of loss or theft. As a result, the interlock feature was designed to keep the iPod Touch with the TVS system and to discourage the use of the device during training. After the system is reset and the iPod Touch is connected, the system will monitor for the presence of the iPod Touch and issue a cheat kill if it is not detected. The interlock feature and the issuance of cheat kills may not be desirable for all deployments of TVS. While the cheat kill functionality might be required in the long term, the initial fielding will not have a cheat kill issued, but will instead log an event that the iPod was not present and require that the training coordinators manage the situation through administrative means. In addition, a training site might prefer that the iPod Touch stay with an admin/controller or on the crew commander’s person instead of the crew.

When deploying on a bridge or other structure, it would not be desirable to leave the iPod Touch unattended or exposed to the outside environment, so the system will need to operate without the iPod Touch. Finally, if the crew needs to undock the iPod Touch to access Operator Manuals that are hosted on it during field use or the course of an exercise, the interlock feature would be a detriment.

Environmental Qualifications

The iPod Touch is a commercial off the shelf (COTS) device that is not intended to meet the military environmental requirements. For TVS, the iPod Touch is provided in a protective case which improves the iPod Touch's susceptibility in certain factors. The protective case offers limited protection against water and shock, but the iPod should not be expected to survive the harsh environmental conditions the rest of the system was designed to survive. This is a limitation that was acceptable as the iPod should only be used during installation, setup, and tear-down.

In order to determine how best to deal with the limitations of the device, characterization testing was performed. Initial testing was performed to baseline the expected behavior with TVS fielding. The specifications for the iPod Touch specify an operating temperature from 0° C to 35° C, a storage temperature of - 20° C to 45° C, and a relative humidity of 5% to 95% non-condensing. The TVS required an operating temperature from -18°C to 49° C and a storage temperature from -33° C to 71° C. The TVS humidity requirement was up to 100% humidity. In addition, the iPod Touch needed to be evaluated against the shock and vibration requirements defined for TVS.

Initial testing was performed on a third generation iPod for vibration and thermal boundaries as these were the greatest concerns. The TVS was fielded with the 4th generation iPod Touch devices, but at the time of this writing, formal tests had not been completed. For the testing performed, functionality was tested for the areas of audio, touch screen, and WiFi. First, audible music or key clicks coming from the auxiliary speakers were verified. Second, verification that the touch screen reacted to touch and was clear was performed. Finally, the iPod Touch ability to connect to a network and load an internet page were tested.

For vibration testing, the iPod Touch was clamped down to the vibration table and run through a 1/4g sine sweep from 5Hz to 1GHz and showed a peak response ratio of 6.7 at 500Hz. The unit was then installed on a mounting feature and subjected to the M113 top vibration profile in the vertical, lateral and longitudinal axis. The iPod Touch remained fully functional after the test in all three areas, thus passing the vibration requirements.

For high temperature testing, the iPod Touch was placed in an environmental chamber set to +70°C. An audio cable was routed outside the chamber and connected to powered computer speakers. After approximately 1 hour, it was noted that the audio no longer worked from the unit. The unit was otherwise fully functional. The audio resumed when the unit was allowed to cool. As a result, the iPod Touch did not meet the high temperature requirements for operation, although the operation of the iPod for TVS does not require audio capability. Since the iPod Touch resumed full functionality once it reached a lower temperature, the storage requirements were met.

For low temperature assessment, the iPod Touch was placed in a chamber set at -10°C for one hour, and the unit remained fully functional. The chamber was then set to -15°C, and the battery level showed ~25% battery remaining, but otherwise the unit was fully functional. After one hour at -20°C, the unit powered itself down and would not power on. The unit was allowed to warm to room temperature and resumed normal functionality with the battery level indicator displaying a full battery. As a result, the low temperature requirements are not met, although the device was fully operational at -15°C, right above the TVS performance requirement of -18°C. For storage requirements, the iPod Touch was placed in a chamber set at -35°C and allowed to soak for 4.5 hrs. The unit was then allowed to warm at room temperature from which no failures were noted. As a result, the storage requirement was met.

Based on the initial assessments, as expected, the iPod Touch does not meet the full environmental conditions. In order to fully quantify what impact this may have on the full life cycle of the project, the final iPod Touch model will be run through formal test procedures and results captured.

INFORMATION ASSURANCE CONSIDERATIONS

In information assurance, the greatest challenge is balancing the usability of the system with the security that must be applied to the system. This is especially challenging in the case of TVS with the inclusion of the iPod Touch. The TVS iPod Touch is an end-user item that will change hands with almost every use. The TVS system as a whole will most certainly be drawn from a training support center or other government point of issue prior to an exercise, either as an individual item, or as part of a training unit's suite of MILES equipment. It must be assumed that the end user will have little to no previous training on the TVS iPod Touch and as such the use must be intuitive to the user. As the iPod Touch will not be in proximity to any personnel with administrative rights, the device must be configured in a manner that is not just secure, but also does not negatively impact the user's ability to conduct or take part in training. This is a delicate balance that must tip in favor of the user. If the device prevents the user from taking part in training then there is no reason for the device.

The iPod Touch provides the user the ability to quickly access graphical step-by-step installation procedures for the particular vehicle as well as the weapon SAT. There is no end-user data resident on the device nor is there ability for the end-user to enter data onto the device. It is a setup, configuration and reference tool for the user. Part of the security concern for the device was to ensure that end-users cannot add, modify and delete any data that is already loaded on the device. It is hoped that mitigating the user's ability to do so, will also discourage the loss of the iPod Touch during operations. Any application that was not deemed required for TVS operations was removed from the iPod Touch using the iPhone Configuration Utility. This includes the iTunes, Safari and YouTube applications among others. The user is also prevented from accessing system level applications such as searching or joining other networks or viewing the systems configuration information. The iPod Touch was intentionally configured to provide very limited functionality other than the TVS application itself. It should also be mentioned that system updates, software upgrades and configuration changes will be performed through the cable connection using the configuration utility instead of the typical commercial method of configuration using a WiFi connection.

The wireless capability of the system allows the iPod Touch to be used without the traditional cabling that would have proven cumbersome as the user walks around the vehicle during the TVS setup process. During this process the user ensures that the various components of the TVS system are functioning and to pair the weapon's SAT with the VKC. There is no sensitive or user data being passed wirelessly between the various TVS components as all of the data is specific to the TVS system.

The wireless access point hosted by the VKC is only available for a limited amount of time after initial boot up. It is during that time that the iPod Touch must be wirelessly linked to its specific VKC. If the iPod Touch does not link to the VKC within the allotted time period, the VKC will shut down the wireless access point. Additionally, the TVS wireless access point will only connect to the iPod Touch that has been configured with its Service Set Identifier (SSID) with preconfigured IP addresses. In the event that an unauthorized device does manage to determine the correct SSID and IP address configuration, only the TVS application on the iPod Touch actually communicates with the VKC.

The iPod Touch device is accredited as a component of the TVS system as a whole. There are significant difficulties with accrediting such training devices. The most obvious one is the wireless encryption. The cost and logistics of encrypting the wireless link as well as the difficulties in maintaining it became problematic. Each VKC and iPod Touch would have to be paired individually and the tracking of the key would be difficult considering the 3000+ systems to be fielded.
Through discussions with the accrediting authorities, it was determined that the wireless access point would not be encrypted. This determination was made based on the type of information being passed, the fact that the IP address must be known to join the TVS network, and because specialized software had to be used to join the network. Not encrypting the system simplifies troubleshooting and maintenance of the system, especially regarding replacement items. The emphasis is ensuring that the user receives effective training while the system remains secure.

SE CORE DATABASE VIRTUAL ENVIRONMENT DATABASE DEVELOPMENT

The TVS system was designed to support a minimum of 128 vehicle types (i.e. types of vehicles that can be instrumented with a TVS kit). Each type requires its own installation instructions and documentation, as well as its own vulnerability data. At the time of this writing, TVS had identified 88 unique types, which included vehicles, structures, and trailers.

Based on initial prototyping with the iPod Touch, 3D models of vehicles is the preferred method to highlight component placement (see Figure 7). Unfortunately, these models are not easy to come by, and normally must be purchased or developed. As both a cost and time savings, the Synthetic Environment Core Database Virtual Environment Development (SE Core DVED) was contacted regarding their Common Moving Models (CM2) capabilities (see reference for further information). While SE Core DVED builds databases used for training, the program has a set of high fidelity models that were effective for use on TVS on the iPod Touch. Using these models, TVS was able to use representative models for 65 out of the 88 vehicle types. An example is provided in Figure 8. The top picture is a MaxxPro, and the bottom is a DVED model of an RG-33L. The model is representative of MRAP category 2 vehicles including the MaxxPro category 2, Cougar, RG-31, and the MRAP ambulance. The cost savings realized from leveraging these 3-D vehicle representations are significant, not only in reduced development time, but also from not having to conduct vehicle surveys. These surveys are time intensive, and it's hard to access to vehicles on military installations.

Figure 8 DVED Usage on iPod Touch

LESSONS LEARNED

Lifecycle management lessons learned

In acquisition programs, maintenance costs are a majority of the total life cycle cost of a system and can consume over two thirds of the cost. On the TVS program, the supportability and maintainability of the TVS system is heavily impacted by the iPod Touch. The actual procurement cost of the iPod Touch hardware, versus the rest of the TVS components, is in the order of 3% to 4%, but the maintenance considerations were disproportionately higher.

The reliability requirement for a TVS system is a minimum acceptable mean time between essential functional failure of 1,660 hours and an operating availability of 90%. The maintainability requirement for a TVS system is a mean time to repair of no more than 60 minutes. No authoritative data was found regarding the reliability of the iPod touch outside of commercial usage with typical life spans of years to be replaced by a newer model. The maintainability requirement poses a significant concern as the iPod Touch is not meant for normal repair outside of possible screen replacement. Repairs are normally done by Apple authorized businesses, which will require government facilities or government support contractors either developing new capabilities, or treating the component as a disposable item.

The iPod Touch requires a higher spares rate than the comparable display module component. One of the reasons behind the higher spares rate is the possible high frequency of the iPod Touch being lost or taken from the kit. While the component has been configured for TVS, it does not require significant expertise to use the freely available configuration utility to reconfigure it to a default state.

The replacement of an iPod Touch introduces another risk that needs to be managed through the lifecycle of the program: planned obsolescence. Specifically, Apple has released a new generation of iPod Touch every September since 2007, with the previous generation of equipment discounted. This is further compounded by software updates to the operating system (iOS) which are rolled out typically annually, as problems are addressed, or additional functionality is provided. Table 3 provides the iPod Touch release and iOS versions during the period when production started up until the final version supported. For example, at the time of writing, the current iOS is 4.3.3, which is portable on both 3rd and 4th generation models. For TVS, development began with the 3rd generation model, but fielding was planned with a 4th generation.

Table 3: iPod Touch Historical Data

Model	Release	iOS Start	iOS End
1st Gen	9-13-07	1.1	3.1.3
2nd Gen	9-9-08	2.1.1	4.2.1

Model	Release	iOS Start	iOS End
3rd Gen	9-9-09	3.1.1	4.3.3
4th Gen	9-8-10	4.1	4.3.3

In addition to software updates related to the iOS, the iPod Touch will also require updates to the TVS app. These updates are based on any functional changes that might be required by iOS updates and also content changes. Since the current plan is to have a finished iPod Touch that will freeze the iOS and the model of the iPod Touch, functional changes should be minimal. The content on the other hand is expected to continue for the next couple of years as vehicle configuration data is finalized. The iOS can be updated through normal Apple mechanism, iTunes, but the TVS app will be updated using the configuration utility. The level of updates remains to be seen at this time.

Lessons Learned for Future Applications

In many ways the use of iPod Touch on the TVS program has been a pilot program with challenges and considerations not previously seen. Until it is fielded and warfighters use it within the training environment, very few conclusions can be made about the relative value that it brings to the TVS system. Data is currently not there to evaluate time savings and increased training effectiveness. Nevertheless, the TVS iPod Touch will provide a clear indicator of value as it is used in the next few years.

One lesson that has been clearly observed is to better consider the lifecycle issues related to use of such a commercial product, including both hardware and software modifications. As with most programs, TVS documentation fell behind system development, which significantly affected the iPod Touch. As the iPod Touch is both a system component and a documentation component, it suffers in both regards from delayed implementation and out-of-date documentation.

Multi-media handheld devices, like the iPod Touch, represent a true revolution in delivery possibilities for technical manuals and documentation. TVS was constrained by the mandate that all documentation must be provided in paper copy. While the iPod Touch was conceived as the primary means for user interaction, paper documents provide significant bottlenecks. Bottlenecks exist because the iPod Touch is a software product that has to go under configuration management separate than a document. As a result, more care has to be invested when deconflicting the content in manuals from the content in the iPod Touch and the system functionality.

Commercial wireless devices are moving toward a central repository where content resides and which are accessed through mobile devices. The release of the Apple iCloud is the next indication of this trend. This design is evident in the iPod Touch, and it provides capabilities to simplify documentation creation and software updates that are currently rendered unusable by the realities of acquisition programs. Ideally, a team would continue to develop training materials for a central repository that are disseminated through multiple delivery modes, while only needing to update one TVS server. The mobile devices, such as the VKC and the iPod Touch, would then query the server for updates and get the latest capabilities pushed. The warfighter would easily be able to get the latest information from the TVS server at any time. At present, this could not be accomplished for TVS, but would be appropriate for other capabilities such as a comprehensive training suite employing a learning management system. At some point in the near future, the ideal situation will be when the realities of the acquisition community more closely align to, and support, the cutting-edge technologies available to provide full-system training for the warfighter.

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