THE MODULAR TACTICAL SYSTEM & UNMANNED AERIAL SYSTEMS

MODULAR TACTICAL SYSTEM USE FOR C2 WITH MULTIPLE UAS PLATFORMS AND DISTRIBUTED COMMUNICATIONS IN UAS APPLICATIONS
The Modular Tactical System (MTS) supports a variety of mission sets which require a tactical digital communications system. It serves as a combat enabler, bridging a wearable computer running application specific software (UAS C2 software) with peripherals such as hand controllers, ISR receivers, etc. to radios. This allows critical information to be shared digitally across the battlespace. The system is modular in nature enabling full foot-mobile operations and is fully integrated into the operator's vest, pack, or vehicle.

What separates the MTS from a CF-19 or other computers is the ability to serve as a communications manager and support power distribution (1 x battery powering the carried radios and receivers). Support for a variety of I/O was designed into the MTS to allow the communications ports to connect with hand-held radios, receivers and many other peripherals. The MTS is IP67 and can be used with gloves in extreme operating conditions. MTS is unique in that it is Operator-designed to allow the Operator to do his job on the move.

The MTS currently has been tested as an Operational Control Unit (OCU) for Command and Control (C2) of Small and Medium Unmanned Aerial System (UAS) platforms to include Scan Eagle, Puma, Raven and Maverick while providing the SOF UAS Operator with an "on-the-move" day and night capability. After action reports within the U.S. Special Operations community have highly praised the MTS in this role.

The MTS is a Program of Record product within the USAF and USMC.

The Modular Tactical System (MTS) has its origins in the Fires community. As a tactical computer with built in communications support, it caught the attention of the SOF UAS Operator to solve a tactical problem. The initial challenge was for those missions, where carrying a CF-19 made sense, to have FalconView and the flight control software on the mission. The CF-19 was carried in a Rucksack along with the AeroVironment Hub, batteries (and spares) along with cabling. The problem, was the overall solution was heavy and didn’t lend well to dismounted operations. The Toughbook was heavy, required extra batteries and cabling, had poor night vision/light discipline and sunlight viewable capabilities, and required the Operator to stop walking to set up and use. These were challenges that were addressed with the MTS.

For work with Puma and Raven, the MTS replaced the CF-19. This was accomplished by connecting the AV Hub to our Tactical Mission Controller by way of an Ethernet cable and changing the IP settings originally set up for the CF-19. The Operator was able to successfully load and utilize all UAS specific software they had operating on their CF-19, but now the system was integrated on the Plate Carrier (or Assault Pack) for wear, which increased mobility by allowing for use while patrolling during dismounted operations. The configuration was tested several times at the range and the Operators...
were pleased with the results. Operators dropped approximately 10lbs of weight off the Rucksack configuration.

Taking this one step further, BDAT started working with SPAWAR in Point Loma, CA with the team that developed the Multi-robotic Operational Control Unit (MOCU). The MOCU software was installed on the MTS and a DDL radio was used along with an X-Box controller. The MOCU software is still a work in progress for flight approval. However the software ran exceptionally well on the MTS and met the User's intent. By using a software "hub", MOCU eliminated the AeroVironment hand controller, Hub spare battery and cabling. This offered another substantial weight savings for the UAS Operator on the order of 15lbs over the initial Rucksack version. The real estate for SUAS C2 on the Operator plate carrier was significantly reduced.

The MTS is also the hardware solution for the Backpack Forward Ground Control Station (BPFGS) for Scan Eagle. BDAT developed a C2 radio for use with Scan Eagle that is about the size of a deck of cards. Cabling for the entire solution is minimal and BDAT was able to leverage our patent pending cable management system for wear on the plate carrier to significantly minimize exposed cables as points of failure. Several proof-of-concept tests were conducted using Scan Eagle as an expeditionary element through Backpack Forward Ground Control Station in support of a 3rd Fleet exercise and NSW operations. Using the MTS Kit allowed quick transport of an operating UAS system to and from different ships and within the fleet. It was determined that the best location to fly from was on the bridge – this allowed the FMV feed to be displayed to the Officer in Tactical Command (OTC) in order to provide additional situational awareness towards the decision making process. The Operator was able to setup the kit, external antenna mount and viewing monitor on the bridge of multiple naval warships in less than 30 minutes.

The MTS was also referred to Prioria by SDF UAS Operators due to some interest in Maverick. Prioria loaded their software and flew the plane. No issues. This, like other integration efforts have required very little engineering resources by either party to make the application successful.

Controlling multiple UAS/RPA platforms from one common ground control station is the next logical step in dismounted operations. To date, BDAT has conducted successful efforts with Scan Eagle, Puma, Raven, and Maverick. Not only has the C2 element been informally tested, but we are also sharing the information captured by the UAS Operator via the wave relay radio. NSW is currently testing the MTS with the Persistent System MPU-4 Wave Relay radio. It allows the UAS Operator to share video so others have the same SA as the UAS Operator. It also allows the Operator to capture window or screen shots and distribute or save them on the MTS for later review. This empowers the UAS Operator to provide distributed communications across the battlespace.

Other applications include control of airborne ISR payloads via Shield Aviation’s Universal Device Management System (UDMS) which interfaces with the MTS. During our most recent demo with Naval Special Warfare members, the MTS was used to control and manipulate the FLIR Star SAFIRE 380HLD on board the ARES UAS via their standard issue wave relay radio. SEAL JTACs viewed this as a major breakthrough and game-changing capability - the ability to control a Generation VI / 15” Gimbal, providing 1080p FMV to the dismounted Operator on an MTS, opens a wide range of tactical possibilities.

**SYSTEM DESIGN**

The core components of the MTS are the Tactical Mission Controller, the Universal Tactical Display, a GPS, the Tactical Hub, and BDAT system software.

BDAT knows from experience that the key to superior performance and execution is a completely integrated system that is simple, intuitive, and reliable. Black Diamond took the challenge to solve this problem by integrating a purpose built, highly optimized, environmentally compliant system. The MTS is a wearable communications and computing system; not just a commercial computer system with smart cables and a separate box for power management. BDAT built the MTS system with the sole purpose of serving the dismounted or disadvantaged operator. Every detail, from the development of Night Vision Goggle (NVG) Mode for night operations to the best location to fly from was on the bridge – this allowed the FMV feed to be displayed to the OTC in order to provide additional situational awareness towards the decision making process. The MTS, using power, data, cable management and peripheral control reduces the overall weight of the system by minimizing the number and type of batteries needed. It also showcases it’s versatility by reducing the number of other systems needed to perform multiple tasks on the battlefield. For example, the MTS used by the UAS Operator could also be used as part of the SSE kit without carrying additional equipment.

**SYSTEM ARCHITECTURE**

Processing performance, power dissipated in the form of heat, and battery life all compete directly with each other. The higher the processing performance, the higher the power consumption and the hotter the device gets. This equates to more batteries being required to perform the same functions which increases cost and weight while increasing the logistical burden. The MTS is designed to balance these features in order to maximize the usefulness of the system. The MTS is designed with the power management hardware combined with the processing hardware. The drawbacks to the separate power manager architecture are significant; the MTS was designed with these drawbacks in mind and eliminated them by combining the power manager functions into the TMC.
The Universal Tactical Display (UTD) doesn't extend outside of the front plate area, get in the way of a radio antenna, or worse, the shouldering of a weapon. It's small enough to avoid those pitfalls; however, it must also be large enough for the Operator to see everything he needs in order to do his job. The 6.5” display on the UTD is the perfect balance of requirements. The programmable buttons on the front of the UTD allows the Operator to get to system functions and/or important software applications with a single click. There are also built-in button combinations, such as NVG mode, that allow the Operator to toggle in and out of a night vision setting so the Operator can maintain stealth in the dark. This quick access feature-set is extremely important when the Operator has to deal with many other factors around him.

Since the display is the focus of the Operator's activity, it is crucial that the input mechanism is robust, precise, and easy to use. However, it can be difficult to make a one-size-fits-all input device due to the varying opinions and preferences of each operator, so multiple options were incorporated into the UTD. The primary interface is the touch screen, which can be operated with a finger, gloved finger or the tethered, easy to reach stylus. The secondary interface is the optical joystick, placed in the natural position of the Operator's thumb. These separate input mechanisms also act as backups for each other in the case one of them is damaged and stops working.

Furthermore, the UTD's LCD is an industrial model with a wider temperature range. The system has been utilized in combat operations through all four seasons in Afghanistan. BDAT also developed large buttons allowing manipulation by a gloved finger.

**NIGHT VISION MODE**

Night operations are also critical in the UTD Design. Being able to operate at night while not blooming the Operator with the glow of the display as well as being able to see the display with NVGs were key factors in the UTD design. Another Key aspect of the UTD NVG mode is during a power cycle the UTD will boot to NVG mode, therefore reducing the chance of an inadvertent compromise. One of the challenges for the UAS Operator in vehicles is using the CF-19 while maintaining light discipline. Most solutions that offer light discipline provide a poor viewing experience for the Operator. The MTS, in NVG mode, provides a tactical advantage whether in a vehicle or on foot-patrol. With zero illumination, any bloom is unnoticeable outside of 5-10m (dependent on conditions).
The types and use of HMDs are varied. In all cases, the device can be used simultaneously with the UTD, and has the optional resolutions of 640x480, 800x600 or 1024x768, all user selectable. The display mode options are clone and extended desktop. The HMD and UTD have both been utilized simultaneously, specifically supporting UAS Operations. Once the Operator has the plane loitering, they can close up the display (and double tap the power button to turn off the display to save battery) then view the video in an HMD. It allows greater heads up time with two hands free. UAS Operators took full advantage of this capability and praised its tactical usefulness.

The number one failure point for a wearable system is the cables. Any possible precaution should be taken to avoid these failures, and the MTS design makes that happen. MTS cable management, using BDAT's patent pending architecture, has a crucial advantage over other systems by minimizing exposed or uncomfortable cable routings. UAS Operators utilizing BDAT equipment have been evenly split over utilizing the system on a Plate Carrier or in our Assault Pack. For the Scan Eagle set up, the trend is near 100% for utilizing the Plate Carrier in overt military operations.

The I/O Hub is an important part of the MTS due to its ad-hoc nature. It offers 2 x USB and 1 x Serial connection along with a circular rugged USB connection and an audio port. The audio port became valuable for the Scan Eagle operator as their software provides them with audio commands. The Operator used a dual comm. Push-to-Talk (PTT) and was able to listen to software audio as well as the inter-team radio communications simultaneously. The feedback was extremely valuable and an overlooked problem in the past. This re-enforces that the design aspects of the MTS were in-line with what the Operator requires.

Power is important to the dismounted Operator and power equals battery weight. The MTS supports virtually all major power sources currently used on the battlefield. The MTS can be powered with military batteries (5590/2590 and rechargeable batteries) The TMC contains a backup battery for hot-swapping. Additionally, the MTS provides two power ports for primary and priority- auxiliary power inputs. The auxiliary power input is meant to serve as an ad-hoc power source input for quickly connecting to a supplemental power source (i.e. vehicle power). MTS provides a firmware definable power manager function, which makes system power consumption, and therefore battery life, variable depending upon which battery(s) are used, which peripheral(s) are being powered and what power manager profile is in effect. MTS can operate and remotely power up to three handheld radio/receiver products from one single 5590 battery. The MTS Power Manager allows for unregulated 9 – 35 VDC input and demonstrated compliance with MIL-STD-1275 Rev D for surges and spikes. This means, that unlike many commercial systems which require an external power input filter, the MTS Power Manager built into the TMC accepts "dirty power* without the need for an external filter. This feature reduces total cost of ownership by not only eliminating redundant/extra equipment, but makes the MTS "power agnostic*. BDAT also offers the WEDGE which connects to the Harris PRC-152 and the Thales PRC-148 radios and allows these radios to be powered from the MTS system-level battery such as the BA-5590. This aides the Operator in decreasing overall weight and simplifying resupply logistics by carrying fewer batteries and battery types. It offers two modes of operation: battery-eliminator mode and radio battery trickle-charge mode.
The MTS is currently a Program of Record product within the USAF and USMC for Digital Fires and is a Technical Readiness Level (TRL) 9 solution that has been deployed in combat since 2010. Over the last year, NSW has utilized the MTS for UAS Operators and AARs have touted its excellence in providing a dismounted solution with day/night capabilities that works in maritime and hostile environments. It has also proven to significantly lighten the load on the UAS Operator. Examples have been provided in how the Modular Tactical System has proven itself in a variety of evolutions in supporting UAS applications and been successful in every effort. The MTS is ready to move forward as a mobile ground control station for UAS platforms. Black Diamond Advanced Technology is seeking USSOCOM approvals to move forward with formal testing and integration efforts with the program office to further capitalize on the successes to date and support for the UAS Operator.