The Small Tactical Universal Battery Series – Helping To Solve Modern Tactical Power Challenges

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Abstract

Today's Soldiers use a multitude of tactical electronic devices for operations – including some COTS devices adapted for military use. Many of these tactical electronics devices rely on different or unique types of batteries for power. This has created an undue 'battery burden' on the Soldier, and logistical complexity for the military. The Small Tactical Universal Battery (STUB) addresses all of these issues and brings the latest power technology to the field as well. Delivering unequaled levels of power interoperability, commonality, flexibility, and standardization, the STUB is the next-generation of mission-ready tactical power.

Keywords

STUB; Military Batteries; Tactical Power; C5ISR; USB; USB-C; USB PD; USB PPS; USB-IF; Army Modernization

Introduction

The modern Warfighter relies upon numerous electronic devices to operate as an integrated platform in a wider network that delivers unmatched operational performance. However, this technologically-enabled capability presents some very real operational energy challenges.

For the dismounted Warfighter this typically means having to carry numerous spare batteries of multiple types in order to have enough power for a 72-hour operational period – as different devices have to use different types of batteries matched to the power requirements of that device, and some devices with the same power profile nonetheless use batteries with a different mechanical or electrical interface than others.

The Tactical Power Challenge

This lack of power source interoperability has placed a heavy burden on our Soldiers, often amounting to 20-40 lbs. or more of spare batteries being carried. This often also contributes to a total individual operational load of well over 100 lbs. Needless to say, this erodes both physical and cognitive performance, with also degrades readiness, operational performance, and lethality.

The illustration that follows shows how the ever-growing need for tactical power has put an increasing burden on the Warfighter (and the operational issues this can lead to). This "battery burden" however, has also led to increased program cost, logistical complexity, and supply chain vulnerability.

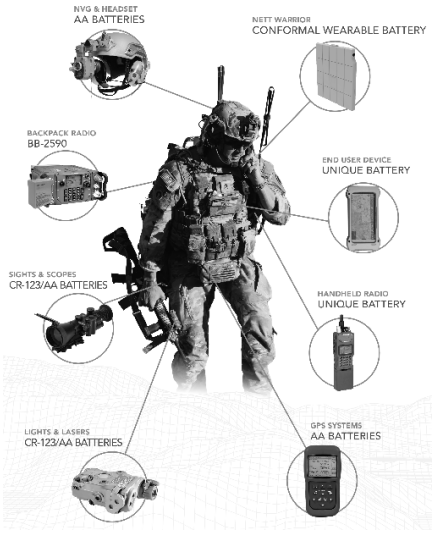

Figure 1. Illustration of the various types of batteries needed to power typical dismounted tactical electronic devices.

As the US Army began numerous modernization initiatives in recent years, it became clear that the power demands of new tactical electronics systems would require even more spare batteries to be carried by the Soldier. Using data from the US Army's Command, Control, Communications, Computers, Cyber, Intelligence, Surveillance and Reconnaissance Center (C5ISR) power team, the graph below shows that we are already past the point of needing more than double the amount of operational energy required by the Nett Warrior system- and will need even more as time goes on.

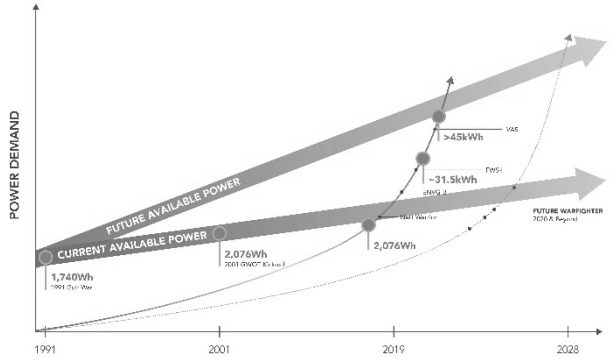

Figure 2. Illustration showing the total Wh / kWh of energy required by a typical infantry squad for a 72-hour operation.

Scoping the Challenge(s)

Although not shown on the previous graph, the Army's solicitation for Next-Generation Squad Weapon (NGSW) specifications included the requirement for future incorporation of a powered rail system with a common power source mounted on or attached to the weapon. This requirement was due to the next-generation aiming and targeting systems intended for the NGSW weapons and highlighted the importance (and urgency) of devoting efforts towards creating standardized families of batteries for tactical electronics.

Now, there are valid reasons why different military devices have traditionally needed different batteries:

1. Output Voltage
    a. Different devices operate at different voltages – ranging from 3.3-21V – and cell chemistry, cell configuration, and power requirements dictate what a battery's output needs to be
2. Form Factor
    a. A device's required energy drives the number and type of cells used in a battery, which it turn shapes a battery's size, weight, and form – as to human factors such as ergonomics
3. Connection Interface
    a. Several commonly used military batteries are similar in size, weight, and energy capacity but are not interchangeable as they have different electrical and mechanical connections
4. COTS Compatibility
    a. Military electronics equipment traditionally isn't interoperable with commercial devices – as there hasn't been a need to COTS-compatibility, military equipment also needs to meet more rigorous standards of robustness

In studies from 2018-2019, the C5ISR team also identified what they saw as three fundamental human factors design criteria for a family of portable / handheld device batteries:

1. Must have a common interface
2. Keep a constant 2D cross section
3. Expand in 3rd dimension to increase capacity

However, the team also established that the lack of a common battery/cell voltage would limit interoperability even more than a common form or mechanical interface.

USB Provides a Path Forward

USB protocols are defined by USB Implementers Forum (USB-IF) - the group of companies that has developed, certified, and shepherded the USB standard over the years, and now counts more than 700 companies in its membership.

USB protocols have come a long way since the initial standard was launched in 1996 to standardize the connection of peripherals to personal computers. It is fact no exaggeration to say that mobile USB devices have now totally transformed the way that consumers and businesses utilize communications and information technology.

Mobile technologies are also transforming operations in the tactical environment. Operators are relying more and more on the power of mobile solutions to make informed decisions that impact mission success. One example of this is the Nett Warrior (NW) system which uses a secured, COTS mobile device running the Android Team Awareness Kit (ATAK) app to enhance operational capabilities.

While mobile platforms have proven to be a force multiplier for our Warfighter, the power and equipment needed to support these devices has resulted not only in an increase to the Soldier's combat load but also adds a new layer of complexity.

In response to that challenge, the Army developed the Conformal Wearable Battery (CWB). This ergonomic power source was originally developed in 2008 and was a significant step forward in supporting the need for a wearable power solution. Referring back to Figure 2, we can see however that only 10 years after its introduction, the CWB was already becoming over-stretched in delivering the amount of power needed by the modern Warfighter.

Built on a culture of innovation, Xentris Wireless has been working with leaders in the commercial mobile device industry to solve the same challenges faced by the military – how to provide power, more efficiently, with less weight and bulk, for new mobile products with more advanced features.

Features like Wi-Fi, GPS, Bluetooth, sensors, video, social media apps, etc. are all commonly found in modern-day mobile phones – and have enabled the mobile data-enable lifestyle that we take for granted. However, these applications also heavily use the processor, as do hardware features such as color LCD screens, and they all draws significant amount of power - especially if they are used at the same time.

With the evolution of the 5G network and advances in data speeds, today's mobile devices consume more and more power. But because 5G deployment is also limited in its coverage, the constant switching between the 5G and 4G networks also has a significant impact on battery life.

Referring again to Figure 2, the Army is also experiencing the fact that increasing device features and capabilities dramatically increases power consumption. Another inescapable fact is that although the Army has fielded devices with USB technology incorporated, they are based on protocols and standards that are now obsolete and don't deliver the full capabilities and benefits that the Army needs.

USB power capabilities have dramatically improved over the past 13 years. USB Power Delivery (PD) 3.0 introduced

in 2019 has the capability to charge devices at 100 watts. But it's not just about raw power, power also needs to be managed and delivered at the right rate for more efficiency and faster charging times - both the charger and the device need to be able to communicate the maximum they are capable of or else they will default to a lower charging rate. This continual source / sink communication is what happens with USB PD and Programmable Power Supply (PPS).

PPS allows for stepwise changes in current and voltage – decreasing the conversion loss during charging, and thereby ensuring that charging is more efficient. Due to more efficient charging, less heat is produced - which increases a battery's lifespan, and decreases thermal radiation (i.e., heat signature). USB PD together with Programmable Power Supply (PPS) also enables devices to fast-charge over a USB connection.

USB PD brings other benefits, too. The direction of power is not fixed, so you charge a device and at the same time charge the battery pack itself. Knowing the importance of such adaptive fast-charging solutions, Xentris Wireless was the first mobile device company to develop and receive certification for a USB PD device.

As we noted earlier, Soldiers are equipped with a variety of devices that have different voltage requirements (see Figure 1). This is one of the main reasons why Soldiers are therefore burdened with different types of batteries for different devices. In the commercial world however, as the multi-voltage capabilities of USB PD have expanded, Xentris Wireless has developed high capacity, fast-charging solutions that handle everything from 5-volt smartphones and tablets to 20-volt laptops. Radios that require 14-volts can also be supported USB PD and PPS.

The final piece of the USB puzzle was the development of the USB Type-C / USB-C connector. USB-C is designed to replace all previous types with a single reversible connector that can be used to transmit power, data, video, and audio signals with quantum leaps forward in capability.

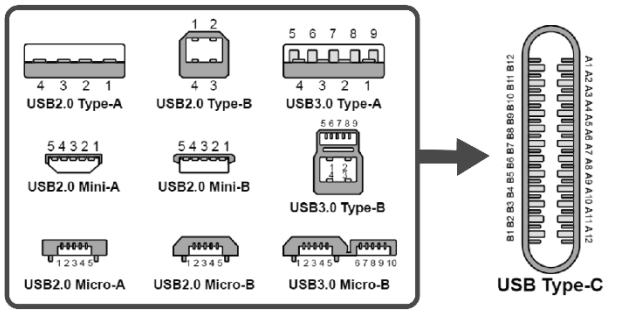

Figure 3. USB connector evolution, Type A to USB-C. Source: USB-Implementers Forum

Reversibility is also one of the key highlights of the USB-C connector that makes it especially user-friendly – this makes the connecting of cables much easier and simpler and brings particular benefits to military applications.

With a view to all the capabilities and benefits that modern USB technologies can deliver, Army DEVCOM's C5ISR center approached Xentris Wireless with a project to explore the feasibility of incorporating the USB Power Delivery (USB PD) standard for military batteries into the existing Battery Management System (BMS) circuitry. The project would demonstrate how this function could allow battery packs of different configurations to be interoperable across multiple devices by managing the delivery of different voltages as required.

The USB PD BMS concept was successfully demonstrated, and this became the nexus for the development of what became known as the Small Tactical Universal Battery (STUB) series. At its core, the STUB was intended become a standard, USB-enabled, centralized power source that supports different voltages to eliminate the need for multiple types of spare batteries.

The advantages aren't just technical though. Even more importantly, a standard family of improved, adaptive, dismounted power sources would have the benefits of reducing the Soldier's battery burden – while improving operational capabilities and Soldier lethality – and also simplify the Army's logistics tail. Leveraging commercial technologies and components would additionally provide overall program cost savings through standardization and economies of scale.

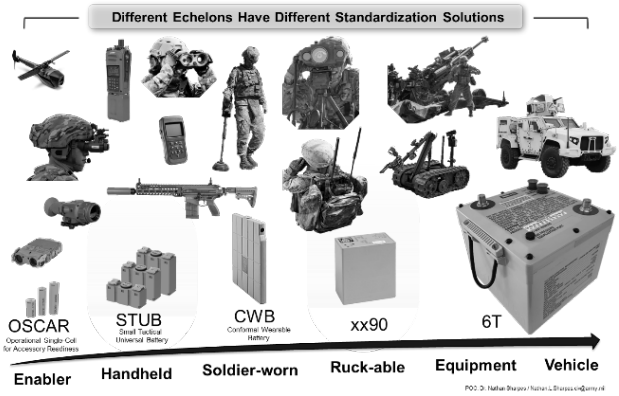

Figure 4. The US Army's Battery Standardization vision / road map, as defined in 2020 by the C5ISR team. Source: Dr. Nathan Sharpes, C5ISR Team, DEVCOM Power Division

The STUB Is Born

In July 2020 the Small Tactical Universal Battery (STUB) program was kicked off, and the EXO Charge division of Xentris Wireless began working on the STUB series with a C5ISR team led by Dr. Nathan L. Sharpes.

The STUB series supports adaptive power requirements across multiple device platforms and features a standard interface that allows Soldiers to swap STUBs between devices - eliminating the need for device-specific batteries.

Applications for the STUB series include HF/UHF radios, GPS systems, night vision devices, satellite communication

systems, surveillance systems and sensors, ranging and targeting systems, mine detectors and more.

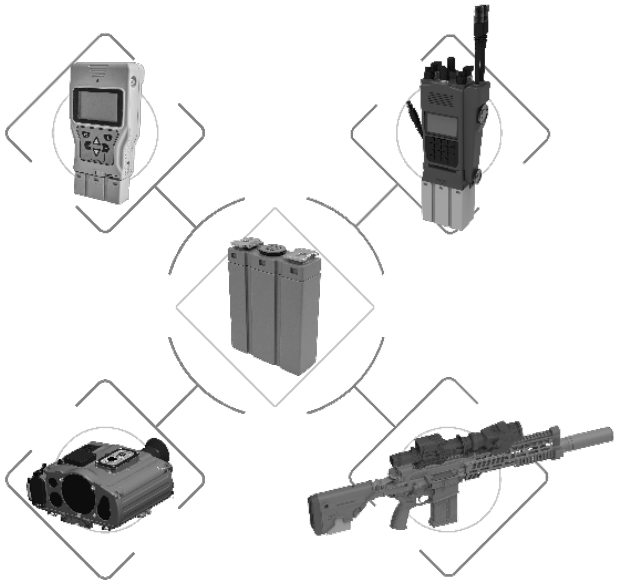

Figure 5. The Small Tactical Universal Battery (STUB) series is intended to become the interoperable power source for all handheld equipment in the DoD.

With eight different size/capacity options, as well as multiple different attachment methods, all with the same standard connection interface, the STUB delivers unprecedented levels of interoperability for maximum operational flexibility and capability.

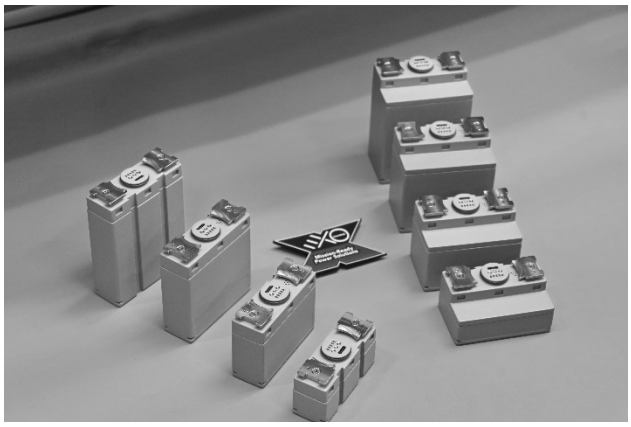

Figure 6. The eight different sizes of the Small Tactical Universal Battery (STUB) series – in both single cell-stack and double cell-stack configurations.

The STUB series features rechargeable Lithium-Ion battery packs in 1-cell (1S1P) through 8-cell (4S2P) configuration, with a capacity of 3.5 Ah (xS1P) or 7Ah (xS2P). The STUB series features USB PD (Power Delivery) interface and PPS (Programmable Power Supply) output interface, with VBus and GND output terminals as well as a CC (Communication Channel) terminal – as well as reversible, bi-directional, multi-voltage, power delivery through its USB-C connector.

The available output voltage through PD interface is 5V, 9V, 12V, 15V and 20V. The available output voltage through 1S1P PPS interface is 3.3V and 11V. Maximum discharge current depends on output voltage and battery pack configuration and can be as low as 750 mA or as high as 5A.

STUBs are charged using the USB PD interface. A charging voltage is applied to the PD connection interface using a USB Type-C cable in order to charge, and any USB PD compliant charger can be used to execute fast charging. STUB packs can also be charged using contact terminals (VBus and GND), and adapters for the standard Army chargers (ABC & UBC) are currently in development.

For added practicality and user-friendliness, each STUB model incorporates a unique 'double-tap' feature that enables users to check the battery's State-of-Charge via LED indicators on the top of the battery. This double-tap feature also activates the built-in Power Transfer feature that enables a STUB to transfer its energy to another STUB through a USB-C cable.

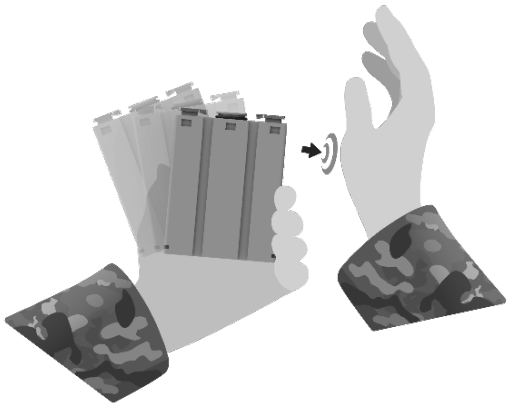

Figure 7. An illustration showcasing the 'double-tap' feature for checking the state-of-charge, as well as activating the STUB-to-STUB power transfer feature.

The STUB series is now USB-IF certified, is successfully going through MIL-PRF qualification, and has already been certified to MIL-STD-810H and -461G, UN 38.3 and IP68 standards. Delivering unequaled levels of interoperability, commonality, flexibility, and standardization, the STUB family is ready to become the ideal mission-ready power source for next generation tactical electronics.

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