SOLDIER SYSTEM POWER INTEGRATION AND FIELD EVALUATIONS

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1. ABSTRACT

The Natick Soldier RD&E Center has been working on maturing and demonstrating advanced concepts and technologies that provide a substantial increase in combat effectiveness for the Small Combat Unit operating in the Future Force Unit of Action. The paper describes the power solutions tested to-date as part of these integrated Soldier systems and also discusses some new power sources planned for demonstration in the next few years.

2. INTRODUCTION

The Natick Soldier RD&E Center (NSRDEC) has been working on maturing, integrating, and demonstrating advanced power solutions for modular, open-architecture, Soldier/Small Combat Unit (SCU) system of systems that will significantly enhance the combat effectiveness of the SCU operating in the Future Force Unit of Action. The demonstrations are done through participation in major Army-sponsored experimentations, including (a) U.S. Army Communications-Electronics Research, Development and Engineering Center's (CERDEC) Command, Control, Communications, Computers, Intelligence, Surveillance, and Reconnaissance (C4ISR) On the Move (OTM) at Fort Dix, N.J., and (b) U.S. Army Training and Doctrine Command's (TRADOC) Air Assault Expeditionary Force (AAEF) Spirals at Fort Benning, Ga. OTM is focused on the technical and engineering aspects of establishing the future force network and making it work in a field environment. AAEF is about exploring how the network enhances operational effectiveness and it also provides the opportunity to experiment with Soldiers in the field to get feedback on Soldier acceptability of the equipment and to gain insights on the tactical utility of the capabilities.

The systems being matured and demonstrated by NSRDEC employ government controlled Modular Open System Architecture (MOSA), focused on current and future emerging battle command systems, to bring net-centric operations down to the SCU. This relevant situational awareness information at the Soldier level has historically been cumbersome and complicated to obtain. Furthermore, systems developed in the past were customized solutions with proprietary restrictions. Using the open system design allows new technologies and products to be integrated with reduced non-recurring engineering costs. The MOSA approach increases the ability of the contractors, vendors, and government teams to incorporate new technology easily and effectively for the dismounted Soldier and SCU. The SCU uses Soldier-borne system components, supplemental SCU equipment, sensors, robotics, a distributed information database, and networked communications to execute collective warfighter functions. These systems undergo yearly refinement to ensure the warfighter obtains the right technology by duty position. Optimal distribution of operational capabilities across teams and squads are investigated to maximize small unit mission performance.

3. SYSTEM CONFIGURATIONS TESTED TO-DATE

An example of the leader system configurations tested to-date is shown in Figure 1. It includes a wearable Soldier radio terminal (e.g. WSRT) for communication and networking, body worn antenna (BWA) and headgear, global positioning system (GPS), a processor, goggle mounted display, precision position system or navigation sub system (PPS/NSS), wireless body receiver (WBR), a rechargeable lithium-ion battery (e.g. BB-2590) with smart bus (SMBus) capability, a zinc-air battery or fuel-cell as mission extender power sources, a Power Manager, a multi-function laser (MFL), a weapon wireless input device (WPN WID) and a hub for data/power distribution. The leader system also includes mapping and situational awareness software (e.g. FalconView) and targeting software (e.g. BareBones) viewed in a goggle-mounted display.

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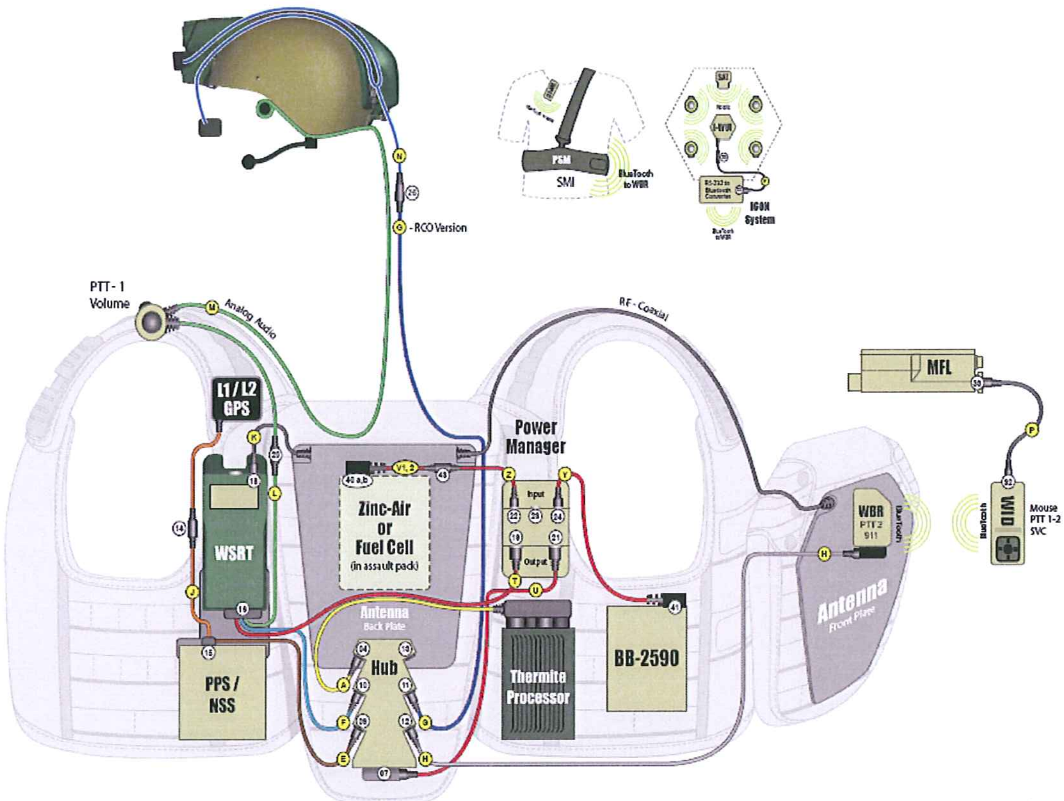


Figure 1. Example of Leader System Configuration

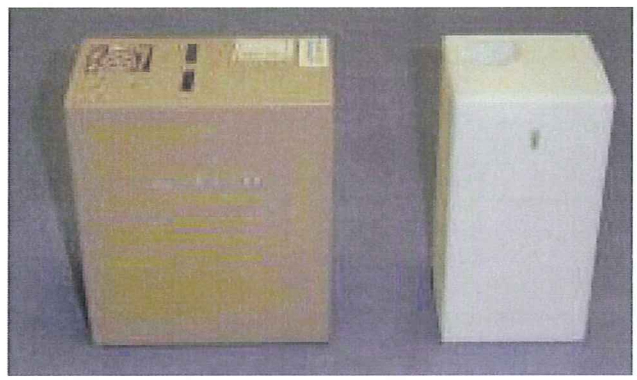
The specific objectives for which the power components were tested are: (1) Compatibility with Soldier equipment – no electromagnetic interference issues, correct interfaces and voltages, and compliance with Smart Management Bus (SM Bus) specifications, (2) Human factors compliance and usability – fits in space available, switches/connectors/LCD screens are accessible, and safety issues resolved, and (3) Reliable operation under various field conditions – vibration/shock/dirt/moisture resistant, operate under environmental extremes, and meet performance goals. Some observations from the tests done so far are mentioned here. These include: connector issues with the BB-2590 battery due to complex state-of-charge measurement; the Zinc-air battery showed potential to increase the mission runtime if used in parallel with Li-ion rechargeable battery, however some of the batteries leaked electrolyte; the direct methanol fuel cell provided the specified power output and showed increase in runtime, however reliability was poor due to electromagnetic interference, pump failure, and orientation; and the power manager allowed use of any power source as input power with high conversion efficiency. In addition, all power components including batteries, fuel cell, and power manager were assessed by Soldiers to be too large and heavy.

Another key Soldier system performance metric measured during field experiments related to power and energy was sustainability of power sources which, as specified by the Ground Soldier System (GSS) Capability Development Document (CDD), says that the power source must support autonomous operations for at least 24 hours (ideally 72 hours) without resupply. This metric or requirement, however, is a function of not only the energy content of the power sources but also the energy demand of the power consuming devices, mission activities of the exercise, and the power management techniques employed. Measurement of this sustainment metric was done by collecting data on detailed energy usage and power profiles for multiple Soldier systems tested at OTM and AAEF. As expected, energy usage was affected by duty position, equipment in use, and mission activities of the exercise performed. The leader positions for which energy usage was measured included squad leader, team leader, platoon leader, and platoon sergeant. The peak power consumption for these leader positions was in the range of 50-80 watts. The average power consumption for these leader positions varied from 20-30 watts. The average power consumption for the rifleman position was in the range of 8-10 watts.

4. PATH FORWARD

The new Soldier system power solutions planned for maturation and demonstration during the next four years include: a wearable, conformal, rechargeable battery that mates with body armor both in front and back, as illustrated in Figure 2, and thus frees up real estate on the load bearing chassis; a primary battery with lithium carbon monofluoride chemistry that has twice the energy density of the current BA 5590 battery and thus can provide the same energy in half the size (Figure 3); hybrid power sources based on methanol fuel cells (both direct and reformed methanol types) with 2X reduction in weight or increase in mission time for multi-day missions compared to current rechargeable batteries (Figure 4); and man-portable JP-8 fueled power source for charging batteries closer to the front lines enabling effective tactical use of rechargeable batteries with lightweight and efficient systems (Figure 5). Also planned for demonstration is an "intelligent" energy-management automated controller integrated into the Soldier system that simultaneously manages power sources and sinks to maximize mission duration and combat effectiveness.

Figure 2. Wearable Conformal Rechargeable battery



Current New

Figure 3. Lithium Carbon Monofluoride half-size BA5590 battery

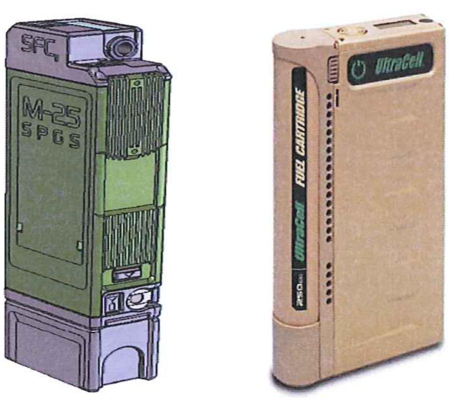


Figure 4. Direct and Reformed Methanol fuel cell

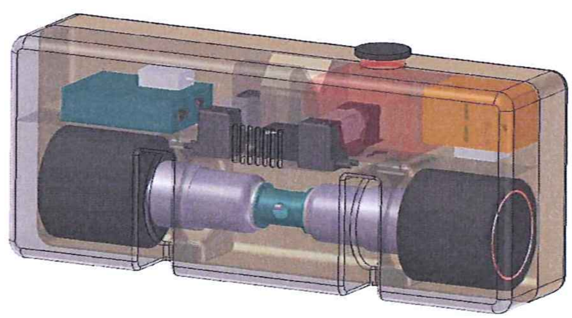


Figure 5. JP-8 Fueled portable power source

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