Update on NATO Standardisation Efforts For Dismounted Soldier Power

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Abstract: *This paper will provide an update on the latest NATO efforts and standards for power interfaces on the dismounted soldier.*

To improve partner interoperability NATO has the aim to increase standardisation between nations. The NATO Land Capability Group Dismounted Soldier Systems (LCG DSS) is tasked with improving standardisation and interoperability for the dismounted soldier.

The Power Team of Experts (ToE) sub group has written a number of NATO Standardisation Agreements (STANAGs) documents pertaining to dismounted soldier power including defining the battery interface (STANAG 4695), defining a data and power interface (STANAG 4851) and defining requirements for interoperable battery chargers (STANREC 4819).

NATO is now considering whether new future standards are required to allow higher data rates and higher powers for the dismounted soldier.

It is important to socialise such standards to industry and NATO militaries and to discuss opportunities for future standardisation. In particular this paper will describe work on a NATO standard power connector as defined in STANAG 4695 and the associated Allied Engineering Publication, AEP-95, a NATO standard data connector as defined in STANAG 4851 and AEP 4851 and a proposal for a NATO standard battery charging interface as will be defined in STANREC 4819, along with some efforts planned for the future.

The Power Team of Experts is keen to socialize these standards and other efforts around the battery, connector and soldier system community to receive comments on their suitability and to drive wider adoption.

Keywords: standardisation; interoperability; NATO; generic soldier architecture; STANAG 4695, STANAG 4851 STANREC 4819.

Introduction

Many modern conflicts are often undertaken by a coalition of forces consisting of elements from a number of partner nations. NATO war gaming has highlighted the need for greater interoperability between users of dismounted soldier equipment.

In addition, dismounted soldiers are now carrying ever-increasing amounts of electronic capabilities which must be seamlessly integrated within the soldier system, other platforms (vehicle, aviation) and with coalition partners. These trends lead to an increased importance for standardisation (where mechanical and electrical characteristics are specifically defined) and interoperability (allowing different systems to interact). Without standardisation, all solutions become single source which eliminates the ability for a "plug and play" capability. Interoperability is important to assure that the transfer of data between various systems/nations is seamless, as well as the sharing of energy resources. In reality there is no interoperability without some form of standardisation.

Within NATO, the Land Capability Group on Dismounted Soldier Systems (LCG DSS) is responsible for the standardisation and interoperability of everything worn and utilized by the dismounted soldier, from weapons to clothing to tactics. This is accomplished by the creation and acceptance of Standardisation Agreements (STANAGs) and Standardisation Recommendations (STANRECs).

Due to the importance of energy to the success of the dismounted soldier's mission, LCG DSS established the Power Team of Experts as a Sub-Group (SG) The Power Team of Experts is a multinational group of subject matter experts (SMEs) tasked to author STANAGs and STANRECs, and provide technical support for all matters related to power generation and distribution for the dismounted soldier.

Power Interoperability & Connectivity (NATO STANAG 4695)

NATO LCG DSS envisions that in coalition operations soldiers may find their batteries running low and will need to obtain energy from sources other than the system's native battery. These sources may include another nation's battery, some form of portable generator or even a mobile platform such as a vehicle. It assumes that the end item has the ability to use, or condition the energy provided in a safe manner.

To accomplish this will require a standardised connector and definition of expected power source parameters. Ideally coalition partners would standardise on a common set of soldier batteries. However, realistically this is seen as unlikely in the near to medium term. To enable the sharing of energy, the Power Sub-Group authored STANAG 4695; "ELECTRICAL INTERFACE SPECIFICATIONS FOR DISMOUNTED SOLDIER SYSTEMS (DSS) LEVEL 2 POWER CONNECTOR INTEROPERABILITY"[1].

STANAGs tend to be overarching documents and much of the technical detail is provided in the associated Allied Engineering Publication (AEP) AEP 4695[2]. The STANAG 4695 received sufficient votes from NATO members and was approved by the NAAG (NATO Army Armaments Group) for promulgation in 2018. It has subsequently been reviewed and a second edition STANAG 4695 Edition 2 has been written and promulgated in 2022.

The adaptation of this STANAG requires that all power generation equipment designed in the future that might be available to the dismounted soldier have at least one output port that meets the requirements of the STANAG. However, it is expected that legacy equipment will remain for a considerable period of time. This requirement can also be met by the use of adapters.

Definition and implementation of a standard NATO soldier power connector means that even if such a connector is not on every relevant soldier power source, each partner nation will only need to carry a single adapter from their national interface to the common NATO interface, rather than the need to carry adapters to every conceivable partner nation power source.

The NATO STANAG 4695 connector has been based around the US Nett Warrior power connector. It has also been written into the UK Generic Soldier Architecture (GSA) as defined in Defence Standard 23-12. It should however be noted that NATO does not specify a given manufacturer. It does refer to qualified part numbers as tested by the US Army but allows any equivalent connector. The details on how to prove equivalence are not defined and it will be the responsibility of a host nation to provide sponsorship and evidence to the NATO LCG DSS Power Team of Experts to have additional connectors included. The connector cited in the STANAG is already in use on a wide range of military power sources and equipment of a number of nations. This is one of the main reasons it was selected.

The key metrics for the connector are given below.

Table 1. Electrical characteristics of a STANAG 4695 compliant power source

	Level 2 Complaint Power Source
Voltage	8-32 V
Current	0-5 A

Table 2. Pin assignments for a STANAG 4695 compliant connector

Contact location	Description	Terminal markings
1	V+ Battery Voltage	Batt +
2	V- Battery Voltage	Batt -
3	Charge +	Charge +
4	SMBus data	Data
5	SMBus clock	Clock
6	SMBus ID (10K Thermistor to Ground)	SB ID

The only significant revision of the Edition 2 from Edition 1 of STANAG 4695 is the removal of the optional 7th central pin that was allowed to be a second V+ line. Further analysis showed that allowing an optional 7th pin might lead to situations where mating could not be achieved e.g. where one nation had a receptacle with sockets containing only 6 sockets and a filled center pin and another nation had a plug with pins with 7 pins.

It was found that there was a mix of products in the marketplace with both filled and unfilled center sockets. Removal of the optimal 7th pin in Edition 2 removes this risk of non-mating.

Copies of the document can be obtained from your national representative or by contacting one of the authors of this paper.

It is expected that in the first instance this STANAG will allow sharing of batteries but it is also intended to allow alternative power sources such as fuel cells and thermoelectric devices to be shared and ultimately energy harvesting devices such as solar panels and kinetic generators, although some form of power management will be needed to facilitate this.

Data Interoperability & Connectivity (NATO STANAG 4851)

Soldiers also require the ability to share data between body mounted electronic devices such as sensors, an End User Device (EUD), usually a smartphone, and a data enabled radio. NATO also followed the US Army Nett Warrior approach for this connector, using the same physical connector as STANAG 4695 but with different (but coherent) pin assignments. The reasoning for this decision was again the wide use of the connector and the ability to use the same cables for both data and power provision, simplifying logistics and reducing system costs.

The soldier data connector is defined in STANAG 4851, “COMBINED POWER AND DATA ACCESSORY CONNECTOR FOR DISMOUNTED SOLDIER SYSTEMS (DSS)” and the associated AEP 4851. This was

promulgated in June 2022. The connector also needs to distribute power to devices since using separate cables for power and data leads to an unacceptable solution for a dismounted soldier. To avoid this problem, the USB 2 data protocol was selected, and the connector also provides a 5 V (up to 2 A) line for low power electronic devices and a 10-20 V 5 A line for higher power devices. It is noted that the input voltage for STANAG 4695 and the distribution voltage of STANG 4851 is different. This was to allow nations to use a wider range of battery inputs from national batteries. Ultimately, the systems could be simplified if all soldier batteries were to be in the 10-20 V range. Table 3 shows the pin assignments. The main difference is the SMBus and charge pins of STANG 4695 have been repurposed as USB voltage and data pins in STANAG 4851. Comparison of the two tables shows that there is a potential risk that if a battery charge pin (pin 3) of STANAG 4695 were to be connected to the V+ pin (Pin 1) and a power source be directly connected to a device expecting the data connector 4851 that a higher voltage could be applied than the 5 V the data device would be expecting, potentially causing harm. For this reason STANAG 4695 recommends a diode, or other protective device, be fitted to the charge pin.

Table 3. Pin assignments for the STANAG 4851 data interface

CONTACT LOCATION	PAN FUNCTION
1	Power (10-20 VDC, 5 A max)
2	Ground – extended pin
3	Power (5 VDC, 250 mA min 2 A max)
4	USB + (data)
5	USB – (data)
6	No connect (or reserved for National Implementation)

Battery Charging Interoperability (NATO STANREC 4819)

For dismounted soldiers fighting side by side, it was identified that there would be operational benefit in being able to charge one another's batteries. NATO War Gaming identified where soldiers from one nation on a joint exercise would end up at the forward operating base of another nation and be unable to recharge their equipment's batteries for the following day's mission.

Originally each new military battery was issued with its own dedicated charger that had the correct charging algorithm preprogrammed. This leads to a proliferation of different, single application chargers which greatly complicates the logistics associated with charging batteries.

Recently such chargers have become more flexible by use of adapter trays. This allows one modular charger to be reconfigured for multiple different types of batteries by using different battery trays. This gives a nation flexibility in that it can buy battery chargers and then upgrade them to charge new batteries when required by buying new battery trays and reprogramming the charger. The charger knows which battery charge profile to use by recognizing the battery tray. This provides a nation some degree of charger standardisation but does little to implement charging interoperability between nations.

The implementation of STANAG 4695 allows for one nation to obtain electrical energy/harvest from another energy source but does not provide sufficient requirements to allow for interoperable battery charging. To enable this a charger must know and apply the correct charging profile for the battery.

STANREC 4819 addresses the need for interoperable charging by defining additional requirements for both military unique batteries and chargers based on commercial standards already established.

Different batteries have different charging requirements. This is because they use different chemistries or have different numbers of cells within them. For safety reasons and to maximize battery lifetimes they must be charged according to their required charging profile. The concept of interoperable charging is further complicated by the actual location of the charging contacts for a specific battery configuration. This makes interoperable charging very difficult.

However, industry has defined a smart battery charging specification which helps with this problem. The Smart Battery Charger (SBC) Specification allows chargers to charge multiple different types of batteries by allowing battery-dependent charge profiles that are dictated by the smart batteries themselves. In effect the battery tells the charger how to charge it.

Therefore, by using the industry standard SBC specification coupled to the STANAG 4695 connector both a standard connector and communication protocol is defined. This should allow one NATO partner nation to recharge their compliant batteries on another nation's compliant charger without any forward planning.

This concept has shown to be successful in limited laboratory testing but has yet to be used operationally. STANREC 4819 was recently (March 2023) submitted to the NATO Standards Organization (NSO) to distribute to NATO member nations for voting.

The NATO LCG DSS Power ToE would welcome comments from battery or battery charger manufacturers as to the viability of this approach and any additional information industry would wish to see in a future STANREC 4819 revision.

Future Effort – Power and Data Connectivity

It is believed that the current connectors defined in STANAGS 4695 and 4851 are sufficient for current needs and this approach has been derisked by their adoption by the US Army and other nations. However, it is recognized that there is likely to be a growth in the demand for more power and more/higher data throughput for dismounted soldier systems in the future.

NATO has also produced STANREC 4845, the NATO Soldier System Reference Architecture (NSSRA). It has been informed by other soldier architecture work including the UK Generic Soldier Architecture and the European Defence Agency's Generic Open Soldier System Reference Architecture (GOSSRA). This is a very large document in seven volumes covering all levels of the NATO Architecture Framework. The most relevant to power sources is volume 5 – Technical view. This recommends a future power standard of USB power delivery (PD) and a future data standard of USB 3. At the time of writing, the STANREC could not recommend a connector since there was not a suitable rugged, open or multiple source connector suitable for soldier systems.

Future Work – Other Endeavors

Other efforts that are planned LCG DSS include:

- Identification of potential connectors for use to connect helmet and weapon mounted peripherals
- Wireless (defined as the lack of cables) power and data transmission
- Including fuel cells into existing and future STANAGs and STANRECs
- Standardisation of a common connector to provide the USB 3 and USB PD functionality recommended by STANREC 4845
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Conclusions

Future soldier systems are likely to be more integrated than they are today and if they are to remain flexible and upgradable an open architecture is required.

NATO LCG DSS is developing a range of STANAGS which will improve the interoperability of power sources and powered equipment between NATO nations. The first of these, STANAG 4695, defines a power and power related interface to allow batteries to be shared, either directly or via an adaptor and the second STANAG 4851 allows data interoperability. STANREC 4819 adds additional requirements to allow interoperable battery charging.

The ToE welcomes and encourages academia and industry to participate in the development of the various documents. This should be via you national representative to LCG DSS or by contacting the authors of this paper.

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