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Nett Warrior
Interconnect Architecture
White Paper

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REVISION HISTORY

CHANGE RECORD

This sheet is a record of each issue of this document. When the revised document is issued, the previous issue is automatically superseded.

Specification Configuration Management Change Record Table

Version	Date	Configuration Management	Pages Changed	Reason for Change
Original, 1	4 June 2012	David Troxel	N/A	First approved release
Version 2	11 January 2013	David Troxel	Cover, 1, 5, Header	Added cover page and change record. Added part numbers for other approved connectors. Added header with document number and version to all pages
Version 3	31 January 2014	David Troxel	Cover, 1, 5,	Updated date, change record and latest part numbers for Glenair crimp connectors.
Version 4	20 October 2014	David Troxel	Cover, Header, 1, 5	Updated date, change record, and added bulkhead alternatives Receptacle with Pins. Updated table to correct reflect voltage range available on Pin 1.
Version 5	30 January 2017	David Troxel	All,	Updated Change Record Added section titles for clarity Added new part numbers per NW-ECP-019 Added details regarding NW software interface
Version 6	20 October 2017	David Troxel	Table IV	Updated to add bulkhead connector alternatives from TE Connectivity.
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White Paper
On
Nett Warrior Interconnect Architecture

This paper describes the history and technical details of the Nett Warrior (NW) Personal Area Network (PAN) and the trade-offs considered during the analysis and design activities.

1.0 System Description

Nett Warrior is a Soldier-worn situational awareness and battle command system, integrated into the body armor ensemble and carried by Soldiers in leadership positions during combat and tactical training operations. NW provides an electronic display to the Soldier, primarily used as a moving map with near-real time updates indicating positions of other NW Soldiers and relevant tactical data, exchanged among the systems. NW can employ a variety of digital tactical radios for communications. The NW PAN distributes electrical power and digital data between the NW Commercial-based End User Device (EUD) and the attached tactical radio. The PAN also permits connection to an external battery for longer mission duration, and additional capabilities when connected to a USB hub with ancillary devices, such as external military-grade GPS, sensors, additional radios, and other data input/output components.

2.0 Pertinent Historical Information

The NW system is an evolutionary product, derived from earlier efforts with the Land Warrior (LW) Program, and the NW Technology Development (TD) Phase. LW was used in combat operations in Iraq and Afghanistan and brings user operational feedback into the system definition and design process. During LW development, interconnect solutions presented a challenge in meeting the ruggedness requirements, environmental compatibility and human factors preferences for a Soldier-worn system. LW implemented multiple unsuccessful alternatives before concluding on a defined PAN solution for physical interconnects, power and the data interchange protocol.

The program selected and tested multiple types of connectors during the Land Warrior evolution beginning in 1999. Connectors and cables were a continuing challenge, especially in meeting the human factors requirements for size, flexibility, robustness and ability to integrate within the body armor. In addition, the battlefield conditions – sand, dirt, mud, water, and vibration proved problematic with certain connectors. Following a trade study in August 2003, the Land Warrior prime contractor recommended use of the Glenair Series 80 connectors as the path forward. This was implemented as the common connector for LW, and continued later into the NW TD phase. The program has over 13 years of experience with this type of connector, including multiple combat deployments, extensive field testing, and system qualification testing in laboratory environments.

In parallel, US Army Communications-Electronics Research, Development and Engineering Center (CERDEC) and U.S. Army Communications-Electronics Command (CECOM) addressed the challenge of providing centralized power to the LW system that considered the stringent size, weight and power (SWAP) requirements for dismounted operations. The power efforts coordinated with LW development and produced multiple battery variants and other external power devices. The standard power interface is a Glenair 807 series push-pull breakaway connector with 12 to 15 pound nominal detach force, extended ground pin for mate first, break

last, and “Y” clocking. Pinouts for the battery interface are shown below in Table I and illustrated in Figure 1.

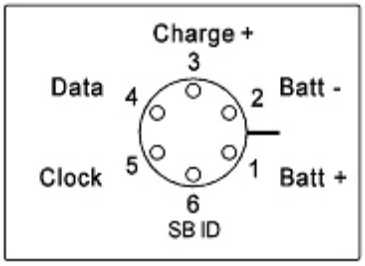

FIGURE 1: Battery Interface Pinouts

TABLE I: Battery Interface Pin Assignments

Pin #	Function
1	Power (10-16 VDC variable)
2	Ground – extended pin
3	Not Connected
4	SM Bus Data
5	SM Bus Clock
6	SM Bus ID

LW systems have now been retired; however thousands of batteries are still in the inventory and new batteries are employing the standard power interface.

Concurrent with the physical connector evolution, the program implemented several data bus designs. The ultimate solution for LW and NW data protocols is currently the USB standard – version 1.1 for low power consumption where usable, and version 2.0 when high data throughput is required.

3.0 Analysis and Design

The USB protocol and need to distribute power determine the absolute minimum number of conductors. In this case, five conductors meet the requirements.

3.1 Land Warrior (Not Current)

Land Warrior’s original design employed 12 cable configurations with specific applications:

- Unique battery/power cables
- Multiple length PAN cables
- Breakaway connections for safety concerns (helmet, weapon)
- Anti-vibration threaded connections for reliability in the soldier environment for highly integrated, inaccessible modules.

3.2 Nett Warrior Technology Development (TD) (Not Current)

The NW TD Phase design evolved to 6 or less types of cables (depending on contractor) with specific applications:

- Unique battery/power cable
- Multiple length PAN cables
- Specialized cables for video and audio

Where LW and NW TD Phase PAN cables employed quick-disconnect connectors, these used the “Normal” clocking configuration to prevent inadvertent and unsafe connection to quick-disconnect power sources with the “Y” clocking keyway feature. Other connectors were Glenair 807 series, in most applications threaded versions with anti-vibration feature. Note that the LW

and NW TD Phase PAN transfers power at battery voltage, not the usual USB 5 VDC level. The LW and NW PAN architectures implemented the pinouts shown below in Table II.

TABLE II: NW and LW PAN Interface Pin Assignments

Pin #	Function
1	Battery Power (10-16 VDC variable)
2	Ground – extended pin
3	USB Detect
4	USB +
5	USB -
6	Not Connected

4.0 Nett Warrior Technical Architecture – Production Phase (Current)

The NW technical architecture defines interconnects for power distribution, data transfer protocols, and physical connectors. Its design and definition considered the proven performance in the LW program, NW TD phase activities, the short timeline to production, and the desire to minimize risk. Trade-offs included the type of connector (quick disconnect, threaded anti-vibration), the number of conductors needed and associated connector pin count, EMI/EMC design, human factors integration, compatibility with existing power source solutions, battlefield supportability/redundancy and manufacturing economics associated with large scale production.

The NW production phase technical architecture objectives are as follows:

- Minimize cable complexity
- Reduce parts counts through commonality
- Provide redundancy through commonality
- Consider future expandability
- Implement electrical safety provisions
- Satisfy human factors and soldier integration requirements
- Compatibility with existing and emerging power sources

Engineering analysis concluded that sufficient pinouts and conductors are available with the proven connector series to define a universal connector set throughout the NW system. This has specific advantages:

- A single cable configuration throughout the system for PAN and power
- Compatibility with existing power sources
- Consistent interface for future expandability
- Only two types of connectors (plug with compatible receptacle) throughout the system for economy of scale in manufacturing
- Reduced cable line items for sustainment phase cost avoidance
- Potential redundancy or possible degraded mode operations if a single cable fails during missions
- Distributed 5V power for USB compatibility
- Distributed battery source voltage for high power peripherals
- Electrical safety provisions incorporated
- Flexibility for human factors and soldier integration
- Ability to daisy-chain for extended length

Feedback on the breakaway type of connector from the NW TD phase indicated no issues with user acceptance, robustness or environmental compliance. For the NW production system, the much simpler interconnect requirements and Soldier accessibility to cables also permits use of the breakaway connector instead of the threaded type.

The resulting solution is a dual-purpose cable with six conductors. This overall configuration is driven by backward compatibility with existing power sources which have already defined the pinouts for conductors 1,2,4,5 and 6. The distributed 5VDC power moves from the earlier NW TD phase pinout to Pin #3, resulting in a dual voltage power bus. The cable can be used to supply only power (when connected to an external battery) and can also be used as a NW PAN cable to distribute power and data. The interconnect design permits two modes of operation as shown below.

TABLE III: NW Production Phase Interface Pin Assignments

Pin #	Power Function	PAN Function
1	Power (10-20 VDC)	Power (10-20 VDC)
2	Ground – extended pin	Ground – extended pin
3	Not Connected	Power (5 VDC @ 2A Max)
4	SM Bus Data	USB +
5	SM Bus Clock	USB -
6	SM Bus ID	USB Detect

4.1 Approved Connectors

The connectors listed below in Table IV are approved for use with Nett Warrior systems and components.

TABLE IV: List of Approved Connectors by Vendor and Part Number

Vendor	Push-Pull Plug with Pins	Push-Pull Receptacle with Sockets
Glenair	8070-1676-06ZNU6-6PY	8070-1675-01ZNU6-6SY
	807-309-06ZNU6-6PY	807-348-01ZNU6-6SY
	807-871-06ZNU6-6PY	807-216-07ZNU6-6DY
	8070-1153-##ZNU6-6**	807-874-++ZNU6-6SY
TE Connectivity	2226910-1	2226920-1
		2828420-1
		2828420-2
		2828340-1

- select either Front (00) or Rear (07) chassis mounting
** - select either PC Tail (PC) or Solder Cups (EC) for internal connection
++ - select either Front (00), In-line [cable] (01), or Rear (07) mounting options

Where the interconnect cable is used for power only, Pin #3 is not connected at the corresponding installed connector on the secondary device. Where USB compliant input voltage is needed (such as on the NW Commercial-based End User Device for battery charging) the 5 VDC from a regulator module distributes lower voltage power, and Pin #1 is not connected on the device. Where high power peripherals may be connected, the battery source voltage on Pin #1 provides sufficient energy to be managed within the device.

4.2 Radio Interface Drivers

The NW software baseline contains preconfigured drivers to allow the NW End User Device to interface with tactical Radios. These drivers include:

- CDC_Eth
- RNDIS
- ASIX

5.0 Conclusions

The NW technical architecture permits integrating future modules and devices using a consistent interconnect configuration. During production and based on current fielding projections, the NW program plans to acquire in excess of 50,000 cables. The economics of a single type of cable/connector set, dual use for power and/or data, interchangeability, and daisy chaining capability for extended length will result in significant cost avoidance.

Future power source development activities should recognize the fact that the interface in place for current batteries has become the de-facto standard for use throughout the US Army with the NW program for data and power distribution. Any battery interface changes that require different connector configurations could affect the adoption decision for use in the NW system, and will result in schedule impacts, as well as additional costs, risk, and potential reliability issues.

Approved for release

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