



Power Distribution Interconnects for Electrifying the Battlefield

Summary

This whitepaper provides military procurement officials, program managers, and industry developers with a comprehensive view of the technical, operational, and acquisition drivers behind next-generation interconnect solutions. It outlines current capability gaps, identifies emerging technologies, and highlights procurement-relevant considerations for integrating rugged, scalable, and future-ready power distribution systems into modernization programs.

Introduction

DoD modernization initiatives increasingly depend on electrified systems capable of delivering high power density, silent mobility, enhanced sensing, and autonomous operation. These advancements require energy distribution infrastructure that meets stringent military performance, survivability, and logistics requirements.

Interconnect technologies occupy a critical role in this modernization trajectory. They provide the physical and electrical interface through which platforms and subsystems receive power, exchange data, and maintain operational readiness. As system voltage levels rise and mission profiles grow more complex, legacy connection architectures are no longer adequate. Procurement programs must prioritize interconnect solutions that align with platform-level electrification strategies, lifecycle cost considerations, and evolving battlefield requirements.

This paper provides defense and industry stakeholders with a structured understanding of the capabilities required for next-generation power distribution interfaces, supporting informed acquisition decisions and industry investment strategies.

Problem Statement

Military systems are experiencing a surge in electrical demand driven by electrified propulsion, advanced computing, multifunction sensor arrays, and energy-intensive weapons. This creates stress on traditional network solutions that were never designed for megawatt-scale power or compact electronic architecture.

Furthermore, procurement programs face additional challenges:

- Space, weight, and power (SWaP) pressures restrict the footprint available for cables, connectors, and routing pathways.



- Harsh operating environments demand ruggedization beyond commercial standards, including compliance with MIL-STDs for shock, vibration, EMI/EMC, and environmental exposure.
- Maintenance and sustainment burdens increase when junctions lack modularity or require specialized tools in the field.
- Growing interoperability requirements complicate integration across joint, coalition, and vendor-diverse systems.

These factors underscore the need for acquisition strategies that prioritize next-generation interconnect solutions designed for resilience, modularity, and long-term lifecycle affordability.

Operational Drivers

The procurement landscape is shaped by several mission and capability drivers directly influencing connection requirements.

Electrification of Platforms

Hybrid-electric and full-electric combat vehicles require high-current linkages for propulsion, energy storage, and auxiliary power systems. Unmanned systems, UAS, UGV, and UUV – depend on lightweight, rugged connectors capable of supporting both propulsion and payload electronics. Directed-energy weapon systems introduce extremely high burst-power requirements, creating new challenges for thermal management and high-current delivery.

Power-Heavy Mission Profiles

Silent watch, silent mobility, edge computing, and contested electromagnetic environments all require clean, stable, low-signature electrical power. Expeditionary units increasingly rely on mobile microgrids capable of integrating renewable sources and rapidly reconfiguring based on mission requirements.

Interconnect technologies must support these evolving mission profiles through advanced shielding, arc-resistant interfaces, and modularity that accelerates deployment.

Technical Requirements for Battlefield Interconnects

Procurement officials and industry developers must ensure that interconnect systems meet several key performance categories.

Electrical Performance



Interfaces must support higher voltages and currents while maintaining power quality and thermal stability. Arc-safe mating and unmating are essential for operator safety and compliance with military field-handling procedures.

Environmental Robustness

Compliance with MIL-STD-810 and related standards ensures survivability under shock, vibration, humidity, temperature extremes, and chemical exposure. Long-term corrosion resistance is essential for lowering sustainment costs.

Electromagnetic Compatibility

Modern platforms feature dense electronic architectures, requiring integrations with robust EMI shielding, grounding strategies, and filtering to prevent signal degradation or equipment malfunction.

Maintainability and Field Serviceability

Programs must consider lifecycle costs and field logistics. Connections should support rapid installation and replacement, ideally without specialized tools. Keying and ergonomic design features reduce training requirements and human error.

Interconnect Architectures and Technologies

Industry innovation is producing a new generation of interconnect solutions aligned with DoD requirements.

High-Power Connectors and Cabling

Advances in high-current connectors, including enhanced-contact geometries and rugged housings, support rapid connection underload. Flexible armored cables provide mechanical resilience while enabling tight routing within SWaP-constrained platforms.

Modular Bus and Rail Systems

Modular AC, DC, and hybrid power buses enable scalable power distribution in vehicles, command posts, and microgrids. These systems support plug-and-play architectures that simplify field upgrades and future system integration.

Solid-State Power Distribution

Solid-state switching and protection systems provide automated fault detection, load management, and real-time diagnostics - enhancing reliability and reducing maintenance intervals. These systems are



particularly relevant for procurement programs seeking higher technology readiness and reduced sustainment burden.

Advanced Materials

Emerging conductor materials reduces mass while increasing current handling capacity, supporting both vehicle electrification and dismounted soldier systems. High-temperature insulators and rugged polymer formulations improve reliability in extreme environments.

System Integration Considerations

Integration of interconnect solutions must be evaluated at both platform and enterprise levels.

Platform-Level Integration

Vehicles and unmanned systems require coordinated design across propulsion, energy storage, sensors, and communication subsystems. Integration points must minimize EMI, thermal hotspots, and mechanical stress while supporting modular upgrades.

Network-Level Integration

Forward operating bases, mobile energy hubs, and distributed command facilities rely on interoperable microgrid architectures. Interconnect solutions must support rapid deployment, scalable power generation, and integration with next-generation energy storage.

Safety and Compliance

Procurement requirements should emphasize thermal monitoring, arc fault protection, and compliance with MIL and IEC standards. Intelligent monitoring and prognostics further reduce risk and enhance mission readiness.

Example Applications

Electrified tactical vehicles leverage high-power interfaces to support propulsion, onboard power distribution, and auxiliary mission systems. These connectors must balance current capacity with ruggedization and rapid serviceability.

Unmanned systems require lightweight yet resilient interconnects capable of supporting propulsion motors, avionics, and high-bandwidth payloads without compromising endurance.



Expeditionary microgrids depend on modular junction architectures that allow rapid configuration of generators, renewable energy sources, and storage assets. These systems reduce logistics burdens and increase operational flexibility, both key considerations for acquisition and deployment planning.

Roadmap and Future Outlook

The future battlefield will feature increasingly digitized and intelligent power distribution ecosystems. Smart interconnects equipped with diagnostic sensors and solid-state protection will provide real-time health monitoring and support predictive maintenance models.

High-voltage DC architectures will expand, offering efficiencies aligned with modern energy storage and electrified propulsion. Artificial intelligence and automated energy management will optimize power allocation across platforms and installations.

These trends will require continued collaboration between DoD, industry, and standards bodies to ensure interoperability, cybersecurity, and sustained lifecycle affordability.

Conclusion

As electrification becomes foundational to modern military capability, power distribution interfaces emerge as critical components of operational readiness and platform reliability. Procurement decisions must prioritize rugged, modular, and scalable linkage architectures capable of meeting evolving power demands while minimizing sustainment burden.

Industry plays a pivotal role in advancing these technologies. By investing in advanced materials, smart switching, and modular bus architectures, suppliers can directly support DoD's modernization goals and improve energy resilience across the force.

Effective interconnect solutions are no longer peripheral - they are central to ensuring mission success in the electrified battlespace.