



ULTRALIFE[®]

Ruggedizing Commercial Technology

for Military and Edge Environments

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Modern military and industrial operations demand computing solutions that perform reliably under extreme and unpredictable conditions. Ultralife Corporation specializes in transforming commercial off-the-shelf (COTS) technology into ruggedized systems engineered for tactical and edge deployments. This article details the technical approach, validation process, and operational impact of ruggedizing commercial computing platforms for mission-critical environments, with reference to real-world projects and the evolving requirements of defense and industrial sectors.



Commercial Hardware

Stable settings, server rooms, offices, or climate-controlled facilities



Tactical Deployment

Extreme temperatures, shock, vibration, dust, humidity, and electromagnetic interference

Technical Context: The Need for Ruggedization

Military and industrial users increasingly require advanced computing capabilities in environments far removed from controlled data centers. Commercial hardware is typically designed for stable settings—server rooms, offices, or climate-controlled facilities. In contrast, tactical deployments expose equipment to extreme temperatures, shock, vibration, dust, humidity, and electromagnetic interference. The pace of technological evolution

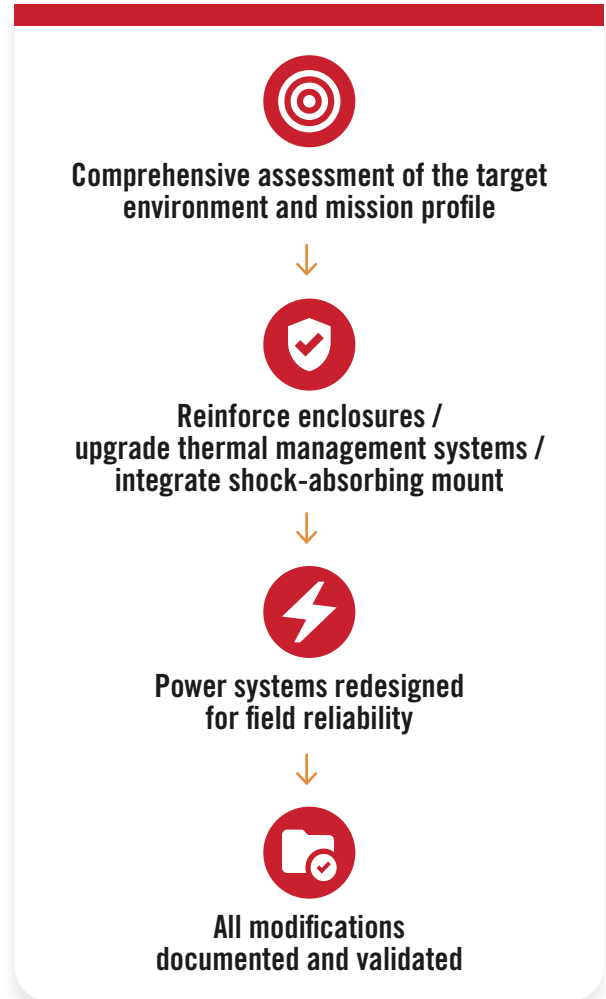
in the commercial sector outstrips traditional military R&D cycles, making rapid adaptation of COTS solutions essential for maintaining operational advantage. Ultralife's engineering team identifies commercial platforms with advanced capabilities and adapts them to meet stringent operational requirements, enabling rapid technology infusion while maintaining cost efficiency and leveraging the latest advancements in AI and edge computing.

Ruggedization Process: From Assessment to Deployment

The ruggedization workflow begins with a comprehensive assessment of the target environment and mission profile. Key factors include:

- Temperature extremes (e.g., -40°C to $+60^{\circ}\text{C}$)
- Mechanical shock and vibration (tracked vehicles, aircraft, field deployment)
- Ingress protection against dust and moisture
- Electromagnetic compatibility (EMC) and compliance with MIL-STD standards

Ultralife engineers reinforce enclosures, upgrade thermal management systems, and integrate shock-absorbing mounts. Power systems are redesigned for field reliability, supporting battery operation and spike & surge protection. All modifications are documented and validated to ensure traceability and repeatability. The process is iterative, involving close collaboration with end users and technology partners to ensure solutions are tailored to specific mission profiles.



Qualification and Certification: Objective Evidence for Mission Readiness

Unlike basic “designed-to” approaches, Ultralife conducts full environmental and EMC qualification on every ruggedized system. Testing protocols include:

- MIL-STD-810 series for shock, vibration, and temperature cycling
- IP ratings for dust and water ingress
- EMC/EMI compliance

Objective evidence from these tests is compiled and provided to customers, demonstrating that each solution meets or exceeds military and industrial standards. This rigorous process reduces risk and ensures operational readiness in the field. Documentation includes detailed test reports, compliance certifications, supporting procurement and deployment decisions for defense and industrial clients.

Case Study: HPE Server Ruggedization

The Challenge

A leading telecommunications provider commissioned Hewlett Packard Enterprise (HPE) to develop a high-capability server for 5G backbone infrastructure. The resulting commercial server offered advanced compute performance but was not designed for tactical military environments.

Our Approach

Ultralife partnered with HPE to adapt the server for military edge compute requirements. The project involved custom enclosure design for thermal and shock management, qualification to military standards, and integration of field-reliable power systems.

The engineering team addressed challenges including:

- Thermal management for high-density compute workloads
- Shock and vibration mitigation for vehicle and field deployments
- Compliance with MIL-STD and IP ingress protection standards

The Result

The ruggedized server was validated for use in tactical vehicles and forward operating bases, supporting AI workloads at the edge. Objective test data demonstrated reliable operation under extreme conditions, enabling rapid deployment in mission-critical scenarios.

Edge AI and the Crescent Server Initiative

Building on prior successes, Ultralife's Crescent Server program targets the next generation of edge AI computing. The focus is on delivering processing power directly to the individual warfighter or field operator, constrained by:

- Limited power availability (battery operation)
- Stringent thermal management (no active cooling)
- Minimal size and weight

Collaboration with our partner, Intel Corp., enables Ultralife to balance computing capability with operational constraints.

The Crescent AI platform is engineered for rapid deployment, supporting AI and machine learning applications in disconnected, austere environments. Key technical considerations include:

- Optimizing computing density within strict thermal and power budgets
- Modular design for rapid field replacement and upgrade
- Secure, tamper-resistant enclosures for operational security



Technical Methodology: Engineering for the Tactical Edge

Ultralife's engineering process emphasizes:

- **Environmental analysis:**
Defining operational extremes and failure modes
- **Component selection:**
Identifying COTS platforms with proven reliability and performance
- **Mechanical and electrical redesign:**
Reinforcing enclosures, upgrading connectors, and integrating field-reliable power systems

- **Validation and documentation:**
Conducting full qualification testing and providing objective evidence to support procurement and deployment

This methodology ensures that each ruggedized solution is not only technically robust but also fully traceable and repeatable for future deployments.

Agile, Customer-Focused Engineering

Ultralife's approach emphasizes close collaboration with end users and technology partners. Solutions are tailored to specific mission profiles, with rapid prototyping and iterative validation. This agility enables faster delivery of reliable, field-ready systems

that address evolving operational needs. The engineering team maintains open communication with clients throughout the project lifecycle, ensuring that technical requirements are met and that solutions remain aligned with mission objectives.



Operational Impact: Enabling Advanced Computing at the Edge



Rapid technology infusion from the commercial sector



Reduced total cost of ownership through COTS adaptation



Enhanced mission flexibility and operational resilience



Support for AI and machine learning applications at the tactical edge

Ruggedized commercial technology enables defense and industrial clients to deploy advanced computing capabilities in environments previously inaccessible to traditional IT infrastructure.

Benefits include:

- Rapid technology infusion from the commercial sector
- Reduced total cost of ownership through COTS adaptation

- Enhanced mission flexibility and operational resilience
- Support for AI and machine learning applications at the tactical edge

Ultralife's proven methodology delivers reliable, certified solutions that enable advanced computing at the tactical edge, supporting mission success in the most demanding environments.

Delivering Mission-Ready Computing Solutions

Ruggedizing commercial technology for military and edge environments requires deep technical expertise, rigorous validation, and a commitment to mission success. Ultralife's engineering-driven approach delivers reliable, certified solutions that enable advanced computing at the tactical edge.

Contact Ultralife to discuss custom ruggedization solutions for your operational requirements or to learn more about our technology platforms.

ULTRALIFE®

Ultralife is a global leader in mission-critical battery and RF power solutions, trusted by top OEMs and government agencies worldwide.

CONTACT US

to learn more about our ruggedization strategies.