White Paper: Engineering Resilience in Defence Systems

Critical Considerations for Embedded Systems, Rugged Displays, and Secure Connectivity

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1. Executive Summary

Defence systems operate in environments where failure is not an inconvenience – it is a risk to mission success and human life. As modern defence platforms become increasingly digital, interconnected, and data-driven, the demand for robust, secure, and high-performance hardware has never been greater.

From vehicle-mounted systems and portable field equipment to command-and-control infrastructure, defence applications rely on a tightly integrated technology stack. This includes rugged displays, embedded computing platforms, and secure communication systems capable of operating in the harshest environments.

This paper explores the engineering principles required to deliver resilient defence systems, focusing on durability, security, and long-term reliability.

2. The Operational Environment: Defining Defence-Grade Reliability

Defence systems must perform reliably across a wide range of extreme and unpredictable environments:

- **Temperature Extremes:** Operation in environments ranging from arctic to desert conditions
- **Shock and Vibration:** Exposure to constant mechanical stress in land, sea, and air platforms

- **Ingress Protection:** Resistance to dust, water, salt spray, and chemical exposure
- **Electromagnetic Threats:** High levels of EMI and potential electronic warfare interference
- **Operational Continuity:** Systems must function reliably in mission-critical, high-pressure scenarios

Engineering for defence requires designing beyond commercial and even industrial-grade standards, ensuring performance under sustained stress.

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3. Ruggedised Displays & HMIs for Defence Applications

In defence environments, displays are critical for situational awareness, navigation, and operational control.

Visibility in Extreme Conditions

Displays must remain readable in all lighting environments:

- Sunlight-readable brightness levels (often exceeding 1,500 – 3,000 nits)
- Night-vision compatibility for low-light operations
- Wide viewing angles for multi-operator use

Durability and Protection

Rugged displays are engineered for resilience:

- Bonded displays to reduce reflections and improve structural integrity
- Hardened cover glass for impact resistance
- Sealed enclosures to meet high IP ratings

Reliable Interaction

User interfaces must function in challenging conditions:

- Glove-compatible touch interfaces
- Resistance to water, dust, and contaminants
- Physical controls or hybrid input where required for redundancy

Rugged By Design

TEMPERATURE EXTREMES
-40°C to +85°C operation

INGRESS PROTECTION
IP65 / IP67 sealed solutions

VIBRATION & SHOCK RESISTANT
MIL-STD compliant

24/7 OPERATION
Engineered for continuous uptime

4. The Intelligent Core: Embedded Defence Architecture

Embedded computing platforms in defence applications must balance performance with strict physical and operational constraints.

Feature	Technical Specification
Processing Power	High-performance ARM or x86 architectures for real-time processing
SWaP Optimisation	Size, Weight, and Power constraints for mobile and airborne systems
Ruggedisation	Shock-, vibration-, and temperature-resistant designs
Form Factors	Embedded SBCs, rugged industrial PCs, rack-mounted mission servers, and deployable edge computing platforms
Longevity	Extended lifecycle support aligned with defence programmes (10–20+ years)

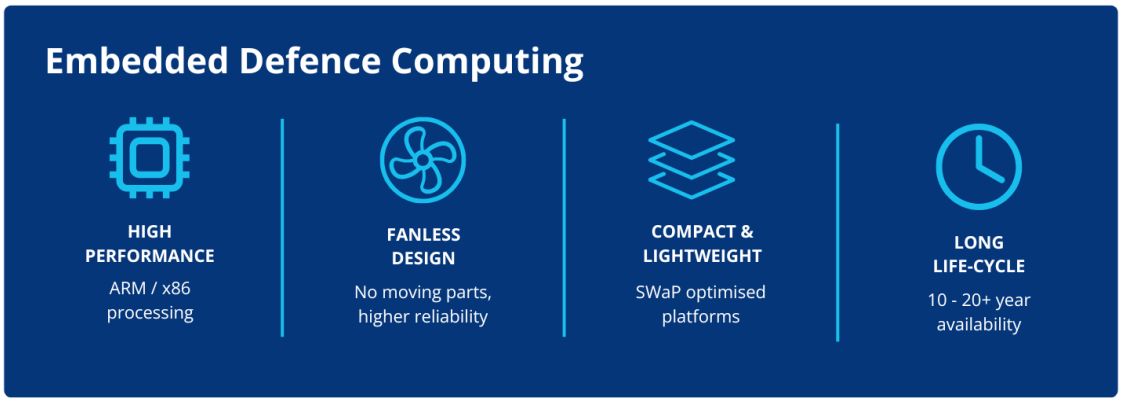
Key considerations:

- **Deterministic Performance:** Real-time processing for mission-critical applications
- **Fanless Designs:** Increased reliability and reduced failure points
- **Secure Boot & Hardware Security:** Protection against unauthorised access
- **Scalable Compute Architecture:** Supporting AI-enabled analytics, sensor processing, and mission coordination across distributed operational environments

Modern defence systems increasingly rely on rugged rack-mounted server hardware deployed within command vehicles, naval systems, airborne staging environments, mobile command centres, and fixed operational facilities. These high-performance compute platforms provide the processing capability required for command-and-control systems, AI-assisted analytics, radar processing, surveillance operations, and multi-sensor integration.

In deployed environments, edge computing platforms enable real-time data processing closer to the operational source, reducing latency and limiting reliance on remote network infrastructure. This capability is particularly important in contested or bandwidth-constrained environments where communications may be degraded or intermittent.

Defence edge servers and embedded AI platforms are also enabling advanced use cases including air defence coordination, autonomous rescue support systems, research vessel monitoring, and tectical staging room operations where rapid analysis and operational responsiveness are critical.



5. Secure Connectivity & Edge Intelligence

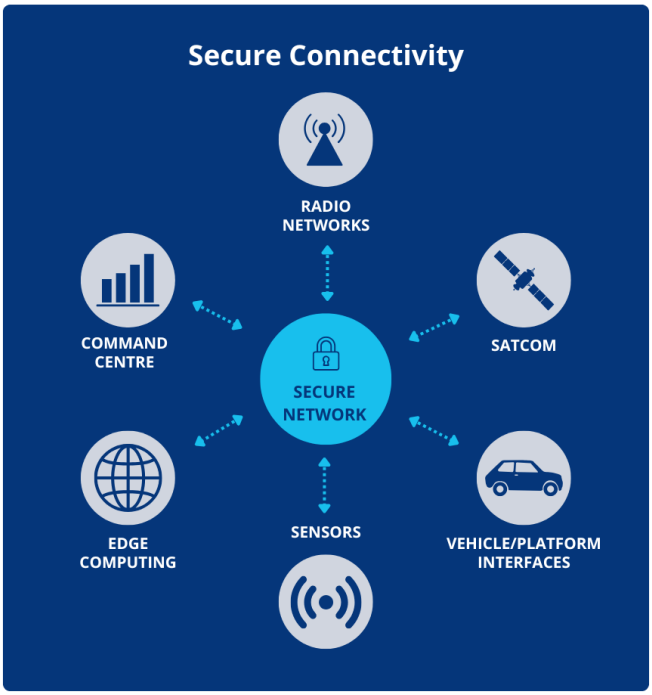
Modern defence systems rely on secure, real-time data exchange across distributed environments.

- **Secure Communications:** Encrypted data transmission and authentication protocols
- **Edge Processing:** Local data analysis to minimise latency and reduce reliance on external networks
- **Sensor Fusion:** Integration of multiple data sources for enhanced situational awareness
- **Resilient Networking:** Operation in degraded or contested communication environments

The adoption of rugged edge servers and distributed embedded computing is transforming how defence systems process and distribute operational intelligence. Rather than relying solely on centralised infrastructure, modern defence architectures increasingly support decentralised compute environments capable of processing mission-critical data directly at the tactical edge.

This enables faster operational decision making across applications such as air defence systems, unmanned platforms, rescue coordination, surveillance operations, and maritime research missions, while also improving resilience against network disruption or electronic warfare conditions.

Edge intelligence is critical for maintaining operational capability when connectivity is limited or compromised.



6. Signal Integrity and High-Reliability Interconnects

In defence systems, the integrity of signals and connections is fundamental to system performance.

- **EMI Shielding:** Protection against electromagnetic interference and electronic warfare conditions
- **High-Reliability Cabling:** Designed for extreme environments and continuous mechanical stress
- **Secure Connectors:** Locking mechanisms and rugged housings to prevent disconnection
- **Data Integrity Assurance:** Ensuring accurate transmission across all system components

Interconnect solutions must be engineered as mission-critical elements, not afterthoughts.

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7. Lifecycle Management: Design, Deployment, and Sustainment

Defence programmes require long-term planning and sustained support.

1. **Design & Prototyping:** Early validation under simulated operational conditions
2. **Qualified Testing:** Environmental, mechanical, and compliance testing
3. **Deployment:** Integration into platforms with strict operational requirements
4. **Sustainment:** Ongoing support, repair, and upgrades over extended lifecycles
5. **Obsolescence Management:** Ensuring continuity despite component end-of-life

Lifecycle management is essential to maintaining operational readiness over decades.

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8. Compliance, Certification, and Quality Assurance

Defence systems must adhere to stringent standards to ensure performance, safety, and reliability.

- **MIL-STD Compliance:** Environmental and operational standards for defence systems
- **ISO 9001:** Quality management systems
- **AS9100D:** Aerospace and defence quality management standard

As part of the Volex Group, Review Display Systems has access to advanced interconnect manufacturing capabilities through its sister company, GTK. This includes alignment with AS9100D-certified processes, enabling the development of high-reliability cabling, interconnect solutions suitable for aerospace and defence applications.

This access strengthens the overall supply chain, ensuring that critical components meet the highest level of quality assurance and traceability required in defence programmes.

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9. Conclusion: The Path Forward in Defence Engineering

The future of defence technology is defined by systems that are not only powerful, but resilient, secure, and adaptable. As operational environments become more complex and data-driven, the importance of robust hardware infrastructure continues to grow.

By integrating rugged displays, high-performance embedded systems, secure interconnect solutions, and rugged edge server architectures, defence platforms can achieve:

- Enhanced situational awareness
- Greater operational reliability
- Improved mission success rates
- Real-time operational intelligence at the tactical edge

Delivering these outcomes requires a shift toward fully integrated engineering approaches, where every component is designed with mission-critical performance in mind.

As AI adoption and sensor complexity continue to increase within defence applications, rack-mounted mission servers and distributed edge computing platforms will play a critical role in enabling next-generation command, surveillance, rescue, and autonomous operational capabilities.

Review Display Systems: A Volex Group Company

As part of the Volex Group, Review Display Systems provides defence customers with a vertically integrated approach to hardware design and manufacturing.

By combining expertise in rugged displays, embedded computing, and interconnect solutions, RDS delivers systems engineered for the most demanding environments. Through collaboration with group companies such as GTK, customers benefit from access to high-reliability, AS9100D-aligned manufacturing capabilities – supporting defence and aerospace applications where quality, traceability, and consistency are paramount.

This integrated model enables seamless progression from concept and prototyping through to production and long-term support, ensuring that defence systems remain reliable throughout their operational lifecycle.