



**OMNETICS**  
CONNECTOR CORPORATION

# Soldiers of the Future

## PART ONE

**W**arfare has consistently been one of humanity's longest-standing industries, with access to the latest technology almost always being the singular factor for victory. Early human conflicts were shaped by materials, with stone implements being defeated by bronze, which in turn gave way to iron.

Gunpowder, however, was arguably one of the most significant, as it became the great leveler, making it possible for the smallest person to vanquish the largest. As gunpowder became adopted, artillery evolved alongside bringing devastating capabilities. But it was the introduction of rifled shells that made artillery truly viable, allowing armies to strike with precision over previously unimaginable distances.

Fast forward to modern times, and warfare is no longer defined solely by raw firepower. Dominance is now increasingly tied to information access, control of the airspace, and the skill of

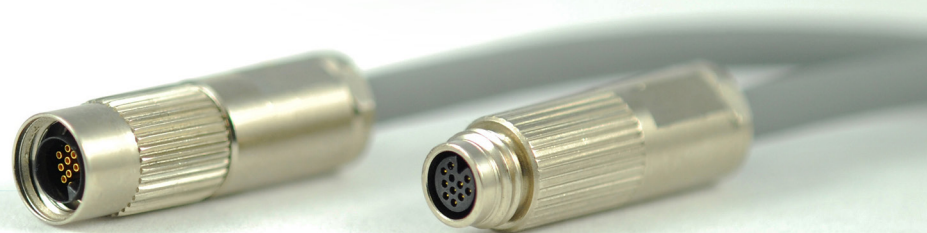
personnel. However, this technological trend does not stop at strategic assets.

Improvements in miniaturization, connectivity, and sensor technology are now empowering individual soldiers. Now, a single combatant can operate with the capability of an entire unit thanks to enhanced situational awareness, real-time data feeds, and smart systems.

The battlefield is no longer just about who has more troops or heavier weapons, but who integrates technology most effectively.

### Challenges Soldiers Face

The modern soldier faces many challenges, whether they are from the environment, the equipment being used, or the enemy itself.



One of the biggest challenges is personal protective equipment. While armor and helmets provide essential protection, their weight and bulk can impact mobility and endurance significantly. These challenges also extend to other worn equipment, such as advanced optics, night vision devices, and heads-up displays. Simply put, every extra ounce that a soldier carries compounds fatigue and reduces reaction speed.

Wearable sensors, devices capable of tracking key health vitals, can further multiply these issues. As they must interface with multiple points on the body while remaining secure, they need to be comfortable, and easily removable, both for combat maneuvers and for treating casualties. Wearables and connectors that are complex or difficult to remove can have lethal consequences.

Electronic devices, while critical for modern soldiers, must also remain undetectable. Emissions of electromagnetic radiation, however minor, can betray a soldier's location with devastating consequences, especially in the era of autonomous drones capable of homing in on electronic signatures.

And then there are the environments experienced by soldiers: mud, dust, water, and extreme temperatures can render even the most rugged electronics inoperable. Even for scenarios at the far edge of plausibility (such as nuclear, EMP, or high-interference environments), shielded electronics becomes an absolute necessity. Designing systems that survive such extremes without compromising usability is a problem that military engineers have yet to fully solve.

## What This Means for Connectors

Given the challenges faced by soldiers, the connectors that link their equipment are far from ordinary as they must balance seemingly contradictory requirements: ease of use, reliability, and environmental resilience.

Connectors used on soldiers need to have the ability to be rapidly connected and disconnected without tools or complex mechanisms. For example, a simple push-and-twist action can be the difference between maintaining functionality under fire and causing a distraction that gets a soldier or their team killed. At the same time, such connectors need to remain sealed against dirt, moisture, and other environmental hazards.

Reliability is a requirement that cannot be negotiated, as any loss of signal, power, or data could be fatal. Everything from HUDs to health monitors are all critical for mission success and survivability, and connectors that fail to keep these devices operational place a soldier at immediate risk. Such devices often require connectors capable of sustaining Ethernet or USB-level speeds, all while being carefully shielded to prevent interference or detection.

Weight and profile are also critical factors in connector selection. Connectors and cables must be compact and lightweight to avoid adding fatigue or increasing visibility, which is why surface treatments (painting, coating, or anodizing), are commonly used to help ensure non-reflective finishes

## Conclusion

The future of warfare will depend on fully integrated electronics at the individual level, where mission success and survival hinge as much on the reliability of interconnects as on strategy or training. Connectors, often overlooked, must be rugged yet easy to operate, lightweight without sacrificing performance, and capable of carrying high-bandwidth data and power. Just as critical is environmental resilience, ensuring functionality in dust, moisture, electromagnetic interference, and extreme conditions. In the end, these small components may well decide the effectiveness of advanced soldier systems, where every second counts and every failure carries risk.



## PART TWO

# Linking Soldiers, Systems and Sensors

In part one, we focused on the evolving challenges faced by modern soldiers and how technology continues to reshape the battlefield. Connectors, often overlooked compared to sensors or processors, play a critical role in keeping battlefield systems operational. Whether linking power supplies, transmitting data, or interfacing with control systems, they must endure the combined stresses of combat: shock, vibration, moisture, and contamination. A single failure can mean the loss of communications or situational awareness at a crucial moment.

However, the requirements extend far beyond the soldier's immediate gear. Modern defense networks integrate soldiers with vehicles, drones, command infrastructure, and battlefield sensors, creating a tightly woven system of information and control. The connectors used across this ecosystem (on weapons, body-worn systems, and support platforms), must maintain compatibility, security, and reliability under the same extreme conditions.

Understanding how these systems interact and how they tie back to individual soldiers reveals just how critical robust interconnect solutions have become in modern defense design.

## How Modern Soldiers Work

The modern soldier bears little resemblance to their counterpart from just a few decades ago. Instead of being equipped with some basic body armor and a rifle, today's soldiers function as part of a complex system, integrated into a network of sensors, communication platforms, and computing devices.

Next-generation combat systems are also merging augmented reality, artificial intelligence, and advanced sensing to create head-mounted displays capable of overlaying digital information onto the real world, allowing soldiers to identify targets, view terrain data, or even visualize enemy outlines through walls using sensor fusion from radar and/or thermal imaging systems.

In all these systems, connectivity forms the fundamental backbone, where individual soldiers operate as part of a

mesh network where data (ranging from enemy positions to environmental readings), is constantly shared and updated. This interconnected structure means that every movement, signal, and observation can be instantly relayed to command centers, vehicles, or other troops, creating a live, dynamic view of the combat zone.

Biometric and performance data are also becoming part of the network. Wearable systems can track heart rate, fatigue, hydration, and overall health, giving medics and commanders critical situational insight. Some platforms go even further, tracking mission performance and analytics to help evaluate combat effectiveness.

Behind all of this technological sophistication lies a vast array of connectors and interfaces that keep power, data, and communications flowing. Each link must handle vibration, moisture, and dirt without degradation, as the failure of a single connector could sever an entire data chain. Modern warfare now depends as much on reliable interconnects as it does on tactics or firepower.

## What challenges does this face?

Modern battlefield-ready connectors find themselves in the unusual position of operating in extreme environmental stress while having massive data demands. But the front-line idiom "*if you emit, you die*" really captures the most central problem: anything that broadcasts can be tracked, jammed, or targeted.

This is why militaries such as those in Ukraine have adopted fiber-linked or non-jammable drone systems. As soon as a continuous radio signal appears, opposing forces can triangulate its source and respond with artillery, electronic countermeasures, or worse. In this kind of environment, every signal, connector, and cable becomes part of a survival strategy, not just a design decision.

Compounding this challenge is data volume. Real-time imaging, thermal vision, and acoustic sensing demand significant

bandwidth. A single 4K camera running at 60 frames per second generating up to 50 megabytes per second of data before compression. Multiply that across multiple sensors and soldiers, and the system load quickly becomes staggering.

Environmental resilience is the next major concern. Soldiers operate in urban ruins, deserts, jungles, snow, and seawater, often within hours of each other. Dust, moisture, and chemical contaminants are ever-present, and connectors must maintain performance through repeated exposure and cleaning. While the term “cleanability” may not be an engineering term, it is however crucial, especially for optical or high-frequency connections where even minor contamination can cripple performance.

Weight, size, and handling are also serious factors that affect soldiers. Soldiers carry heavy loads, and connectors must fit into compact, ergonomically constrained systems. Operations often require gloved hands or quick adjustments in difficult positions, creating practical challenges in using and maintaining interconnects in the field.

Finally, the stealth considerations and requirements further influence connector characteristics, as coloration, surface finish, and reflectivity all affect concealment, particularly in daylight or under night vision.

## The Role of Connectors in These Advanced Links

To say that connectors are the unseen backbone of modern soldier systems is not an exaggeration. On the individual soldier, connectors link sensors, wearables, and communication devices

to on-body computational systems, ensuring that real-time data (ranging from positional tracking to biometrics), reaches processing units without interruption. This represents the first link in the chain before information is transmitted across the battlespace.

Once data leaves the soldier, it must be received, decoded, and acted upon. Receivers might be fellow soldiers, vehicles, or remote command posts, each forming part of an interconnected network. Connectors within these systems are just as critical, as they handle the aggregation of high-volume data from multiple sources. While the data may travel wirelessly over the final link, the connectors within these receivers manage the raw streams, often under continuous load and in complex operational environments.

Regardless of where a connector is, each and every one feels the effect of environmental pressures across the entire network. Those carried by soldiers are exposed to vibration, impact, moisture, dust, and wide temperature ranges and be readily available via quick-disconnect capabilities. In contrast, connectors in stationary systems, such as command posts or vehicle consoles, face different demands. They often carry higher data loads, aggregating multiple soldier inputs simultaneously, and are expected to maintain stable connections over long durations without frequent handling.

In both cases, the performance of the connector directly impacts the reliability of the system. Any degradation in signal integrity or mechanical failure can disrupt critical communications and sensor feedback. Connectors, therefore, are not mere hardware components, they are essential to the complex data ecosystem that defines modern, networked soldier operations.

## Conclusion

The modern battlefield isn't defined by individual skill alone; is shaped by the integration of sensors, computing, and communication systems. Connectors, components that are too often overlooked, are central to this integration, quietly ensuring that data flows reliably from the soldier to the squad and onward to command centers.

As soldiers are equipped with increasingly advanced capabilities, the need for connectors that can sustain high performance under extreme environmental and operational stresses becomes ever more critical. These components must maintain signal integrity and withstand mechanical strain while operating across a variety of conditions without failure.

For engineers designing the next generation of military hardware, understanding the unique demands placed on connectors is essential. These insights guide the creation of systems that support soldiers effectively, enabling advanced technology to enhance operational capability without introducing new points of failure.



## PART THREE

# AUTONOMOUS ALLIES – Robotics, Drones and the Next Frontline

In Soldiers of the future part 2, we examined how soldiers are evolving, integrating advanced systems and rugged interconnections to operate effectively in complex environments. The battlefield itself, however, is undergoing a seismic shift. Autonomous and semi-autonomous machines are taking on roles that were once the sole domain of human troops.

From drones conducting reconnaissance and precision strikes to ground vehicles and robotic mules carrying equipment, these systems extend the operational reach of soldiers, reduce risk, and provide critical real-time data. Their integration into human-led units fundamentally changed how missions are planned, executed, and sustained.

But these robotic systems rely on highly reliable interconnect technologies to function in real time. Connectors and cabling link sensors, actuators, power systems, and communication modules, form the physical backbone of machines that must endure harsh environments while delivering high-speed data and precise control. Understanding how these interconnects perform under operational stress is key to appreciating the growing impact of robotics on modern warfare and the evolution of the soldier-machine team.

## The Rise of Robots

Over the last decade, military robotics has advanced at an unprecedented pace, moving beyond experimental prototypes to operational systems capable of reconnaissance, logistics support, and even front-line engagement. Modern drones now span a vast spectrum, ranging from palm-sized surveillance units that can slip unnoticed into enemy territory to large, weaponized aircraft operating hundreds or thousands of miles away.

Ground robots are also increasingly integral to operations, albeit still in their infancy. Such systems are able to carry heavy equipment, detect mines, and enter hazardous areas ahead of soldiers, acting as a protective barrier between personnel and danger.

In these systems autonomy is quickly becoming a defining characteristic, whereby GPS, onboard cameras, pre-loaded maps, and sensors are fused together to determine location and orientation. These systems make real-time decisions about pathfinding, obstacle avoidance, and even target prioritization without constant human input. Artificial intelligence combined with sophisticated sensors transforms these platforms from passive tools into active participants, capable of interacting with their environment and adapting to unpredictable conditions.

The ultimate objective for such platforms however is a coordinated human-machine team. Soldiers and autonomous systems operate in tandem, each complementing the other's strengths. Robots provide enhanced situational awareness, extended reach, and the ability to undertake high-risk tasks, while humans retain strategic judgment and adaptability. At the center of this capability remains one fundamental component, the connector.

## The Challenges Robots Face

Robotic systems on the battlefield encounter many of the same environmental stresses as soldiers, but they also face additional, machine-specific challenges.

Extreme temperatures, vibration, impacts, moisture, dust, and uneven or obstructed terrain can all interfere with mechanical reliability and the integrity of data connections. Unlike soldiers, robots rely entirely on their internal systems to maintain functionality, so any disruption in power or signal flow can quickly incapacitate the platform.

Power systems pose another critical vulnerability. Mobile robots rely on high-density energy sources, typically batteries or hybrid systems, which must deliver consistent power output while withstanding severe vibration, impacts, and environmental extremes.

Bandwidth demands are equally extreme. Navigation data, multi-sensor telemetry, high-definition video feeds, and command links must move continuously through the system, putting heavy strain on both interconnects and onboard processing. Signal integrity and low latency are mission-critical where lag, interference, or data degradation can disrupt synchronized maneuvers, compromise intelligence, or slow response times in life-threatening situations

But as robots gain autonomy, cybersecurity and data protection also become incredibly important. Communications must be resistant to interception, jamming, spoofing, and cyberattack. This means that protocols and communication methods must balance reliability, stealth, and speed, minimizing emissions that could reveal the robot's position while maintaining sufficient connectivity to command structures and allied units.

Finally, wireless communications introduce further complexity. Maintaining low detectability while transmitting essential information is a constant tension. While exact protocols may vary (ranging from short-range low-energy radio to line-of-sight optical links or encrypted bursts), the underlying challenge remains the same: how to transmit necessary data without compromising the system's mission or intent. Every element of the robot's interconnect infrastructure, from onboard connectors to wireless interfaces, is critical in meeting these demands.

## How Connectors Play a Key Role

Connectors form the essential backbone of power and data needs found in modern autonomous systems, providing the

physical and electrical pathways that link sensors, processors, and communication modules. Without reliable interconnects, data from vision, radar, LIDAR, or telemetry cannot reach onboard computers in real time, compromising both autonomous decision-making and coordinated operations.

Bridging the gap between human and robotic units, they allow soldiers to interface with control modules, charge systems, or transfer mission-critical data securely. The reliability and versatility of these interconnects directly influence operational flexibility, mission duration, and responsiveness in complex environments.

For aerial drones, the challenge of balancing weight constraints and bandwidth requirements against the constant vibration from powered flight. Connectors must be lightweight to avoid overburdening the platform while simultaneously remaining robust enough to maintain signal integrity under high-frequency movement, rapid acceleration, and environmental extremes such as temperature fluctuations or moisture. Even small failures in these connections can degrade sensor input or disrupt control links, potentially bringing an end to the drone.

Ground robots face different but equally punishing conditions. While weight is less of a concern, these systems require sealed, shock-resistant connectors that can deliver both power and high-speed data across rugged terrain. Vibration, impacts, dust, and water exposure are continuous threats, and connectors must maintain mechanical and electrical integrity under these conditions. Modular designs are also particularly important, as they allow for quick field maintenance, rapid sensor interchangeability, and system upgrades.

The ongoing miniaturization and exponential increase in bandwidth, rugged connectors are critical for the next generation of autonomous defense technology. Performance continues to shape what robotic systems can achieve on the modern battlefield, making these often-overlooked components indispensable to both manned and unmanned operations.

## Conclusion

The battlefield of the future will be defined by integration of humans and machines, working together through fast, reliable data networks and interconnect systems. Robotics and drones amplify operational reach, provide intelligence at scale, and reduce the exposure of soldiers to direct risk, fundamentally reshaping how missions are conducted.

The performance of these systems, however, depends on the reliability of the connectors that link every sensor, actuator, and processor. These interconnects are critical to ensuring that data flows without interruption, commands are executed precisely, and autonomous systems remain responsive under extreme conditions.

As technology continues to advance, the development of ruggedized, high-bandwidth connectors will remain a decisive factor in the battlefield success of autonomous allies. Their design directly influences how well robotic systems can support soldiers, making interconnect engineering a cornerstone of next-generation military capability.