

TRANSFORMING THE DEFENSE SUPPLY CHAIN

with Internet of Things (IoT) Commercial Innovations



**Harnessing the Power of the IoT
with Enterprise Sensor Integration (ESI)**



The Internet of Things: A Rapidly Evolving Opportunity

The estimated \$19 trillion Internet of Things (IoT) market is quickly evolving, creating both opportunities and challenges for commercial and defense industries. IoT vendors are flooding the market with Radio-Frequency Identification (RFID) and other IoT asset tracking technologies to tap this profitable market.

The IoT is about creating an efficient environment where massive amounts of data is captured from a network of “things” – sensors, software, electronics and actuators – and turned into actionable insights. It involves the collection and analysis of “Big Data” to aid in the decision-making process.

In the private sector, the Internet of Things connects smartphones, smart appliances, smart home thermostats, wearables and much more. The application of the IoT in the manufacturing industry – dubbed the Industrial Internet of Things (IIoT) or Industry 4.0 – leverages intelligent, connected devices to greatly improve operational efficiency, productivity, and profitability across manufacturing plants and supply chains.

There is also significant potential for IoT technology to revolutionize warfare and enhance situational awareness across the full spectrum of logistics management. Military IoT applications can deliver greater lethality and survivability to the warfighter while increasing efficiency and reducing costs. A connected battlespace can help commanders manage and interpret the sheer volume of data received from multiple sources – providing real-time, actionable intelligence.

Addressing Total Asset Visibility Goals

In the area of military transportation and distribution, an interoperable IoT environment can significantly enhance supply chain management, which is essential to warfighter readiness. IoT tracking sensors, including RFID tags, are helping the U.S. Department of Defense (DoD) achieve its Total Asset Visibility (TAV) goals and total end-to-end visibility across the DoD logistics system. A seamless and effective supply chain will ensure decision-makers have timely and accurate information on the location, quantity, condition, movement and status of assets. TAV provides a common operating picture, helping leaders manage unexpected disruptions.

To keep pace with IoT advances and meet cost-reduction goals, the military has capitalized on civilian IoT successes and lessons-learned. The DoD actively engages with industry leaders, including participating in conferences, such as *RFID Journal Live* and *RFID in Aerospace & Defense*, to keep abreast of the latest advances in Automatic Information Technology, or AIT.

Radio Frequency Identification (RFID) is a family of technologies enabling hands-off processing of materiel deploying through the Defense Transportation System. Materiel marked with RFID tags may be remotely identified, categorized, and located automatically within relatively short distances. Active RFID tags can hold relatively large amounts of data, are continuously powered, and are normally used when it is necessary that the tag be readable from a longer distance. Passive RFID tags temporarily store a small amount of energy received from the tag reader in order to generate a tag response. Passive RFID is used at the item, case, or pallet level.





Addressing Interoperability Challenges for IoT Success

In the commercial sector, the explosive growth of IoT technologies has also led to connectivity challenges. Many vendors' IoT solutions are not designed with interoperability in mind, which has led to a proliferation of proprietary devices that cannot share information with other sensors or networks. The DoD has also adopted a "stovepipe" approach to IoT technologies, which limits the ability to communicate across systems and services.

"Often, multiple services are involved in an operation, or multiple agencies are involved in a process, but information has to be passed between their stovepiped systems manually, which is inefficient and allows for human error. Fragmentation across DoD's IT architectures complicates the development and use of common security protocols and practices across the DoD network," according to Zheng & Carter report, [*Leveraging the Internet of Things for a More Efficient and Effective Military*](#).

The DoD has connected millions of sensors through extensive network infrastructures, including command-and-control systems, but these networks are developed independently with differing requirements and data formats. The ultimate challenge is connecting these technologies as part of a cohesive, intelligent network. Interoperability, therefore, is key to a true IoT infrastructure.

Tapestry Solutions, a Boeing Company, has addressed interoperability challenges for commercial manufacturing and supply chain operations with Enterprise Sensor Integration, (ESI), saving customers millions annually.

Serving as a gateway to the IoT, ESI is an innovative software platform that integrates disparate sensor technologies, including RFID, to connect people data and processes across factories and supply chains. ESI has been successfully deployed for Boeing and BAE Systems, and also holds great potential for similar asset tracking, sustainment and supply chain operations in the defense sector. (See ESI sidebars on pages 6 and 7.)

The IoT is not a new concept for the U.S. military. For years, the DoD has explored its use for network-centric warfare – the centerpiece of military transformation that relies on sensors, platforms and networks for battlefield situational awareness. The DoD is also looking at the IoT for drone surveillance and detection, boundary and harbor surveillance, and battlefield medical care. However, it remains cautious about deploying IoT at a broader scale due to cybersecurity threats, safety and privacy concerns.

In the area of logistics management, the DoD is actively using AIT devices such as RFID tags to track shipments and inventories. It also continues to drive IoT innovation with cloud computing, robotics and artificial intelligence.

"Connected devices can benefit today's militaries by increasing efficiency and effectiveness ... IoT devices and services can collect increasingly complex data and analyse it faster; make use of increased automation; reduce human error; deliver more precise and efficient military capabilities; and reduce personnel costs."

– Zheng & Carter, CSIS Report, 2015
[*Leveraging the Internet of Things for a More Efficient and Effective Military*](#)



Managing DoD Supply Chains: a Complex, Vital Task

While the unique demands of the warfighter require military-specific IoT applications, other functions closely mirror their civilian counterparts and can be more readily adopted by the military. These functions primarily involve the management of inventories, fleets and bases.

Although the military is making steady progress with IoT implementation for logistics management, “few systems make use of the full IoT potential, from networked sensors to digital analytics and automated responses,” notes Zheng & Carter. Additionally, common standards are protocols are needed to enable fast adoption and integration of the IoT, according to the 2017 NATO report, [The Internet of Things: Promises and Perils of a Disruptive Technology](#).

The DoD, which has one of the largest and most complex supply distribution networks in the world, is making asset visibility a priority. It manages millions of secondary inventory items, such as spares, worth about \$91 billion – and getting these supplies to right place at the right time is critical for mission success.

Because of long-standing weaknesses in the DoD supply chain – such as limited asset visibility and difficulties obtaining timely, accurate data – the U.S. Government Accountability Office (GAO) has identified materiel management and asset visibility as high-risk areas that need to be addressed. (Source: [GAO Defense Logistics Report, 2013](#))

Managing the military supply chain is an extremely complex, risky undertaking by its very

nature. It involves an unstable and unpredictable demand, moving end supply points, and ensuring equipment readiness for war. These challenges present complications such as difficult inventory and asset management, inefficient equipment maintenance and repair operations, overstocking of spare parts, and long ship times for spares that are not immediately available in the shop.

Getting a Grip on Asset Visibility

The U.S. military has been struggling with total asset visibility for decades. The DoD began implementing active RFID (aRFID) in 2001 for in-transit visibility in the United States, but the technology has been slow to gain ground.

By 2013, the GAO concluded that the DoD had made little progress with RFID implementation, mainly because it was unable to demonstrate the return on investment. The GAO 2013 Defense Logistics report outlined problems such as “lack of a common operating picture for distribution data that integrates DOD’s many transportation information systems; difficulties in collecting information on all incidents of pilferage of and damage to cargo; and ineffective tracking and managing of cargo containers.”

“One of the most complex and vital tasks facing the DoD is managing its supply chain to effectively and efficiently provide spare parts, food, fuel, and other critical supplies in support of U.S. Military forces. DOD’s goal and challenge are to deliver the right items in the right quantities to the right place at the right time – and at the right cost.”

– [GAO 2017 DEFENSE LOGISTICS report](#)

March 2017

Since then and other lessons learned through 15 years of war in Iraq and Afghanistan, the DoD has made great strides in fielding RFID and other enterprise-level asset visibility systems.

As of 2017, the DoD reports that it now has the “tools in place to support enterprise-level asset visibility,” including multiple methods of documenting deployment and distribution events. This has enabled the U.S. military to achieve near real-time visibility of equipment and tools at the wholesale and retail level.

“Asset visibility has arrived,” asserts the DoD in its 2017 report. The agency says it has successfully implemented enterprise-level asset visibility systems, refined business processes, enhanced component-level automated information system (AIS) capabilities, and incorporated automatic information technology. (Source: [STRATEGY for Improving DoD Asset Visibility](#), Aug. 2017)

Since the cost of RFID has decreased phenomenally, the technology has been deployed across military supplies and assets such as aircraft, tanks, weapons, ammunition, soldiers and equipment. Today, the U.S. military has the world’s largest active RFID network comprising 37 countries, 1,650 tag read/write sites with over 530 satellite-enabled tracking systems, according to the 2017 DoD STRATEGY.

While RFID has significant benefits for asset tracking and logistics management, its true potential can only be realized when integrated with other sensors and advanced analytics. The commercial industry is making progress with connectivity at manufacturing plants, particularly with RFID that automates tool tracking and workflow to prevent bottlenecks, but the military still lags behind in this area.



BCS3: Entering a New Age in Sustainment Information-Sharing

With sensor fusion as a core capability, Tapestry Solutions has been delivering asset management and supply chain solutions, including RFID, to military customers for decades. During the second U.S.-Iraq War, Tapestry Solutions developed the Army’s Battle Command Sustainment Support System (BCS3) in response to mounting pressure for better asset tracking.

First fielded in 2004, BCS3 was among the first battle command systems for logistics to filter critical logistics information for commanders and staff at all command levels in forward theatres of operations and other sites.

Still in limited use today during its divestiture, BCS3 provided commanders with a joint logistics common operating picture. It tied together information from numerous, disparate logistics systems, in-transit visibility and asset visibility systems, and other fragmented data sources.

Among the subsystems feeding into BCS3 were RFID tags and fixed-site interrogators. BCS3 processed RFID tag data and graphically depicted the data on a maps as well as reports.

The DoD faced challenges of achieving widespread RFID implementation at the time due to the high cost of implementation, but commercialization of RFID has dramatically reduced costs.



DLA: Staying on the Cutting Edge with IoT Solutions

The scope of logistics activity for defense forces – and the opportunity to selectively use IoT-enabled solutions – can be gleaned from the [U.S. Defense Logistics Agency Acquisition \(DLA\)](#) (J7) Directorate’s portfolio, which oversees procurement and management of approximately 6 million inventory items for the DoD.

DLA buys, stores and distributes food, fuel, uniform apparel, pharmaceutical, medical and surgical products and equipment, and weapons system repair parts for the military services and other customers worldwide. The agency is working to stay on the cutting edge by incorporating Internet of Things sensors as part of its Distribution Modernization Program, with the anticipation that the IoT will be the driving force that will improve the efficiency, according to the agency’s 2018 article, [DLA Using ‘Internet of Things’ to Support Warfighter](#).

“Logistics data used to be entered manually, which was not as efficient and sometimes hindered readiness. The use of IoT devices allows DLA to practice ‘just in time’ logistics, instead of ‘just in case’ logistics – enabling troops to order an item when they need it instead of keeping it in stock for days, weeks or longer,” according to the DLA article.

The DLA is incorporating both [RFID and Bluetooth tags](#), to provide better visibility of supplies that are in transit daily. The automated tracking will enable the agency to identify chokepoints and improve efficiency, in order to make better decisions about the distribution process.

The DLA works with over 12,000 commercial suppliers that utilize IoT technologies, and is looking to collaborate with industry leaders to increase readiness across the military.

IoT Benefits for Defense Logistics

- **INVENTORY MANAGEMENT** – Real-time supply chain visibility and predictive analytics enable the military to order parts and supplies on demand, and reduce stockpiling and loss.
- **REAL-TIME FLEET MANAGEMENT** – Adopting IoT devices for real-time fleet management, including sensors for cargo, geolocation, status, fuel efficiency and weight, can reduce fuel costs by as much as 25 percent while increasing fleet utilization.
- **CONDITION-BASED MAINTENANCE** – Retrofitting vehicle fleet with onboard sensors to monitor engine performance and parts facilitates on-demand ordering of parts, which reduces unanticipated failures.

– Zheng & Carter ([CSIS Report, 2015](#))

Enabling Predictive Maintenance

The IoT's proven commercial applications are being eyed to strengthen another part of the U.S. DoD's logistics portfolio – Maintenance, Repair and Overhaul (MRO) management, particularly in the area of predictive maintenance.

Traditionally, militaries have taken a more reactive approach to fleet maintenance, addressing problems as they occur. Unfortunately, this tactic leads to fleet downtime and affects readiness levels. With predictive analytics, fleet managers can stay on top of maintenance and mitigate failures *before* they occur. They can predict when maintenance and part replacement are required, resulting in less downtime for repairs. When integrated with DoD supply systems, logistics personnel can quickly locate, place orders and track replacement parts. This improves efficiency, reduces maintenance costs, increases equipment uptime, improves safety, and helps ensure mission success.

The [Pentagon's Defense Innovation Unit](#), aka "The Pentagon's Innovation Experiment" – founded in 2015 specifically to make faster use of emerging commercial technologies – is making progress in the area of predictive maintenance. Two recent contract awards highlight the DoD's interest in using the IoT to improve its weapons platforms' materiel readiness. One such effort envisions that the U.S. Army will use machine-learning software to predict when components on the Bradley Fighting Vehicle need maintenance. This strategy would better allow the service to predict component failures, decrease the frequency of unscheduled maintenance, and improve the productivity of repair operations for this tracked vehicle fleet.

Similarly, the innovation agency has tasked industry to build an artificial intelligence-based data management platform to aid military aircraft maintenance operations. Once mature, the U.S. Air Force plans to implement the platform along with the predictive maintenance system in a move to predict any equipment failure in its E-3 Sentry and the F-16 platforms.



CASE STUDIES: Boeing & BAE Systems

In the IIoT commercial market, ESI has significantly enhanced asset visibility, increased production rates and reduced costs for Boeing and BAE Systems.

At Boeing, ESI has interconnected nearly every aspect of the organization's asset management and supply chain – not just at a single factory, but across more than 50 Boeing sites around the U.S. This unity of information, powered by sensor integration, has saved Boeing more than \$100 million in the first year alone. The technology, proven to handle up to 6 billion RFID tag reads each week, continues to save customers millions each year.

Tapestry has also provided IoT solutions for aerospace and defense sector company, BAE Systems, successfully implementing the ESI-enabled RFID technology in 2018 at the company's Electronic Warfare Integrated Manufacturing Center (EW-IMC) in Nashua, NH. The primary task was to replace existing manual processes with RFID to effectively track and manage inventory, assets/tools and work-in-process (WIP). The RFID technology, driven by ESI, has automated the tracking of more than 200,000 assets, 30,000 parts and about 6,500 work orders at its plants.

BAE reports that the technology has significantly increased production capability at its factories and supply chain. Plans are underway to implement ESI at additional BAE Systems' plants around the country.

Empowering Forces with the Power of the IoT

With its commercial success deploying IoT solutions, backed by its extensive military domain experience, Tapestry is well positioned to take ESI to the next level for military logistics and supply chain operations. ESI addresses the military's demand for a common operating picture and actionable intelligence by connecting disparate sensors and networks through a smart integration platform.

ESI has the potential to solve communications gaps caused by massive data collection from disjointed systems, rapid changes in globally dispersed operations, and increasingly complex distribution and supply chain operations. Together with automation, powerful analytics and cloud capability, ESI can help decision-makers quickly process and interpret Big Data in real-time to make better decisions faster. ESI can help the DoD meet its Total Asset Visibility objectives to “deliver the right items in the right quantities to the right place at the right time – and at the right price.” ESI benefits include the following:

■ COST SAVINGS

Substantial cost savings are realized with improved inventory control, reduced asset misplacement and loss, and increased efficiency.

■ TOTAL ASSET VISIBILITY

ESI significantly improves operational visibility with mapping applications. The system visually displays where an asset is located, anywhere in the world, on maps and building layouts. ESI provides traceability and accountability for equipment and assets as they move through the supply chain. It also integrates with sensors that monitor temperature, humidity and pressure levels of assets.

■ DECISION-MAKING

Real-time data and analytics provide actionable information to decision-makers; problems can be addressed and mitigated in a timely manner.

■ AUTOMATION

Accurate, timely data improves production cycle time and equipment availability. Automated workflow processes mean fewer manual inputs and bottlenecks, and increased productivity and efficiency.

■ STANDARDIZATION

ESI ensures standardization across the enterprise, allowing asset management and tracking systems to talk to each other in the larger IoT ecosystem.



ESI: A Sensor-Agnostic IoT Platform

Tapestry Solutions, a Boeing Company, has transformed major manufacturing and supply chain operations with Enterprise Sensor Integration and related RFID technologies – resulting in substantial cost savings with increased productivity, asset visibility, standardization, safety and security.

Unlike other IoT sensor solutions, ESI features a unique “sensor-agnostic” platform that ensures interoperability with various hardware and software vendors’ IoT solutions, regardless of brand or data formats.

ESI connects sensors ranging from RFID position-information tags, passive and active GPS-enabled WiFi tags to embedded hardware and complex servers, both legacy and next generation systems. ESI also includes real-time alerts, and integration with sensors that monitor temperature sensors, pressure and humidity.

The software platform can be implemented across a global enterprise, either in the cloud or on dedicated servers, and also seamlessly integrates customers’ legacy and next generation systems.

With ESI, decision makers have total asset visibility of equipment, tools, cargo and processes – anywhere at any time for 360° supply chain clarity.



Tapestry Solutions, Inc. is a global provider of information management software and services for defense, government and commercial markets. We help solve logistics challenges for the world's largest and most complex supply chains. We also provide mission planning, training and simulation support to maximize readiness for our warfighters.

Supporting customers from more than 50 locations worldwide, Tapestry Solutions is part of Boeing Global Services. Operating as one of Boeing's three business units, Global Services is headquartered in the Dallas area.

**For more information about ESI,
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ES I

Enterprise Sensor Integration

Empower your Forces with the Power of the IoT

The Internet of Things is here, but are you ready? Get connected to the IoT with Enterprise Sensor Integration (ESI) technologies from Tapestry Solutions, a Boeing company. ESI is a revolutionary integration platform that seamlessly connects myriad of sensors, from RFID to WiFi. Field-proven and cost-effective, ESI turns Big Data into actionable insights and empowers your forces with situational awareness needed for mission success.

- Achieve Total Asset Visibility
- Automate Manual Processes
- Standardize the Enterprise
- Integrate the Supply Chain
- Leverage Big Data & Analytics
- Increase Readiness; Reduce Costs

