Market research note

Enhancing productivity- How Bluetooth® technology is powering intelligent industrial operations

Bluetooth®

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Executive summary

The IoT is increasingly at the forefront of digital transformation within industrial and logistics enterprises, as they look to address a range of challenges today and over the next decade.

Bluetooth® technology is playing an increasingly vital role in this process, delivering enhanced end-to-end manufacturing and supply chain visibility, reducing downtime, amplifying operational efficiencies, and creating safer and more automated working environments. This is being achieved through a number of transformative technologies, including real-time locating systems, smart labels, machine and environmental sensors, and data loggers, as well as robotics, human-machine interfaces (HMIs), and inventory management solutions. The continued innovation of Bluetooth® technology, growth of tailored industrial solutions, and the increased convergence with Edge AI capabilities will ensure Bluetooth® technology remains at the forefront of industrial transformation over the next decade and beyond.

The growing productivity challenge

Manufacturing and logistics organizations continue to be squeezed by a mix of economic, geopolitical, supply-chain, regulatory, labor, and technology pressures.

Manufacturing and logistics organizations continue to be squeezed by a mix of economic, geopolitical, supply-chain, regulatory, labor, and technology pressures. Recent years have brought trade disputes, tariffs, regional conflicts, volatile demand, and inventory issues. Meanwhile, rising inflation and higher energy and transportation costs have further eroded margins, while global supply-chain disruptions have limited access to critical components and slowed delivery of finished goods. At the same time, stricter safety, compliance, and sustainability requirements are raising operational expectations, while labor shortages make it harder to attract and retain skilled workers, further increasing the need for more efficient processes and safer, more satisfying working environments.

These pressures are leading industrial enterprises to invest more in digitalization, highlighted in figure 2 below. These incentives are giving enterprises greater visibility into their entire operations and driving new efficiencies, while firms further along the digital transformation process can more readily deal with challenges of today and the future.

According to ABI Research's most recent forecasts, the industrial and manufacturing sector will spend US$224.7 billion on digital transformation in 2026. This represents a year-over-year (YoY) growth rate of 13.8 percent. Fundamental to this digital transformation is the wide range of wireless Internet of Things (IoT) devices capable of providing real-time insights into industrial operations, in which Bluetooth® technology is already being extensively leveraged. Meanwhile, new Bluetooth® based solutions that can solve specific industry pain points are emerging on a regular basis, compounded by accelerated interest in the deployment of Edge AI that can help scale the benefits of machine learning to a wider range of devices.

This paper seeks to demonstrate how Bluetooth® connectivity is enabling measurable productivity gains in manufacturing and logistics environments; highlight example use cases, products, and benefits; and showcase the growing opportunities for Bluetooth® technology as a scalable, reliable, low-power, interoperable enabler of digital transformation across multiple industries and the wider supply chain.

Figure 2: Digitalization drivers for manufacturing and logistics enterprises Source: ABI Research

Enhanced visibility

The monitoring of industrial assets across the factory floor, warehouse, or logistics operations is becoming increasingly vital to improving the efficiency, reliability, safety, and productivity of a facility.

In addition, end-to-end supply-chain tracking is becoming critical to the development of more sustainable, safer, and resilient operations. Bluetooth® technology plays a fundamental role in delivering real-time visibility into the inventory, movement, and status of assets. This is enabling more intelligent decision making and creating efficiencies that ripple through the supply chain, driving enhanced productivity.

Asset and inventory visibility

One of the major ways in which Bluetooth® connectivity is enabling enhanced asset and inventory visibility is through real-time locating systems (RTLS). A large and growing ecosystem of Bluetooth® location service providers are deploying the technology to deliver increased productivity, improved staff and visitor safety and security, greater automation, reduced asset losses, and enhanced compliance and traceability.

Quuppa, in partnership with BlueUp and Bit Tonic, deployed their angle-of-arrival based RTLS solution inside an automotive manufacturer's facility. The deployment equipped semi-finished products, which are often indistinguishable and can be difficult to track, with a tracking tag, eliminating the manual tracking errors that led to lengthy searches and delays in production. For outdoors, a drone system was developed, also using Bluetooth® AoA technology, to enable enhanced indoor and outdoor visibility that led to a significant increase in production efficiency.

BlueIoT deployed an AoA-based Bluetooth® solution for the forklift warehouse of HANGCHA Group, one of the leading material handling equipment manufacturers in China and around the globe. The organization produces and stores more than 170,000 vehicles each year, with some forklifts off the production line being placed randomly throughout the large warehouse. Identify the model or position of a specific vehicle became an extremely time-consuming, manual process that led to a typical 10–15-minute search time for staff, who often came back without success. To solve this, the warehouse was re-organized into specific zones for their unique purpose, and each forklift was equipped with a tag to monitor its location,down to 0.5 meters, via localization anchor points. This reduced the average search time down to 1 minute, achieving a 90 percent efficiency increase on average.

Innovation in this space continues with the arrival of ultra-low power, energy harvesting, and small form-factor tags, allowing more assets to be tracked cost effectively and maintenance free. Some products on the market can already harvest ambient indoor light to enable sustainable deployments of warehouses, factories, and logistics environments.

Manufacturing and logistics enterprises can see tremendous cost savings through enhanced operational efficiencies, increased worker safety, and loss prevention, among other valuable use cases. The volume of assets that need tracking will open up enormous opportunities for Bluetooth® solution providers in the years to come.

Shipment and logistics tracking

Other enterprise use cases for Bluetooth® connectivity can help identify new operational efficiencies and better traceability across the supply chain, such as Bluetooth® data loggers for cold chain monitoring across the transportation network. These devices can help improve visibility of temperature, humidity, and movement throughout the entire product journey, providing notifications when goods have exceeded their pre-defined limits, identifying any issues or bottlenecks in the transportation of goods, addressing problems in real-time to reduce wastage, and meeting new regulatory compliance requirements. Sensor tags can relay information via a Bluetooth® signal to cellular-connected wireless gateways in the vehicle or via smartphone and tablet devices for instant cloud monitoring.

A new category of Bluetooth® devices, known as smart labels, have the potential to drastically expand the tracking capabilities to a whole new class of items and products. There have been many recent high-volume deployments of both passive and active smart label solutions, and new entrants continue to innovate with their own unique solutions and tracking architectures, bringing strong competition to this space. ABI Research believes that this market, though still immature, has the potential to rapidly accelerate in the coming years and will be one of the largest volume opportunities for Bluetooth® technology over the next decade.

In the UK, the Royal Mail partnered with Wiliot to deploy its battery-free Bluetooth® sensors on over 900,000 rolling cages and Bluetooth® readers in 8,000 vehicles, enabling automated real-time tracking and enhanced visibility across its whole delivery network. The deployment enabled greater visibility of inventory across 5,000 locations, discovered over 180,000 unaccounted for rolling cages worth over £20 million, and optimized labor and vehicle utilization.

Reelables has developed a paper-thin, active beaconing Bluetooth® smart label that can provide real-time inventory and shipment visibility. With a range of up to 100 meters, these printed solutions can be tracked outside of specific choke points, while an eco-friendly Zn-Mn alternative battery coating incorporated in the label allows for easy disposal alongside a lifespan of up to one year. These solutions can help to identify bottlenecks in the supply chain, avoid lengthy search times, automate data collection, and reduce loss and spoilage thanks to an in-built temperature sensor.

Reduced downtime

Bluetooth® technology is increasingly being leveraged within a wide array of industrial sensors to monitor the condition and performance of industrial equipment.

This can span motors, pumps, fans, storage tanks, gearboxes, and conveyors, as well as an expanding selection of smaller industrial machinery. The growing availability of Bluetooth® sensors can now enable a new range of previously unconnected and unmonitored devices to share information and use predictive and preventative maintenance to ensure smoother and safer operations, increase performance, ensure regulation compliance, and reduce the risk of costly downtime. Bluetooth® enabled condition monitoring solutions are expected to achieve a CAGR of 30 percent between 2025 and 2030, making it one of the fastest growing opportunities for Bluetooth® technology in the industrial sector.

Equipment condition monitoring and predictive maintenance

ABB provides a Bluetooth® enabled sensor that can be added to various industrial assets, such as motors, powertrains, fans, and other equipment, to provide extensive insight into machine health and performance. The sensor can detect even minor changes in equipment condition, enabling advanced warning of damage to bearings and other components. This, combined with advanced machine-learning algorithms, can enable proactive and predictive maintenance, enabling operators to take action to reduce the threat of downtime and increase the effectiveness and lifespan of their equipment. By leveraging Bluetooth® connectivity, the solution can support up to 15-year battery life with hourly readings, while enabling equipment that is installed in challenging, hazardous, or difficult to reach locations to be monitored for the first time.

There are a whole host of other solution providers with Bluetooth® industrial condition monitoring solutions tailored to the diverse range of high-performance machinery. For example, TE Connectivity provide Bluetooth® sensors that can enable remote vibration and temperature monitoring of a range of industrial equipment, from high-end machinery, conveyors, pumps, oil and gas equipment, and compressors to AGVs, robots, and other machinery. These solutions can support a battery life of up to ten years. Bluetooth® solution providers such as Ezurio have also developed a comprehensive range of sensor devices as part of their Industrial IoT offering portfolios, combining the low-power benefits of Bluetooth® technology with extended range capabilities, as well as RTLS functionality.

Environmental condition monitoring

Alongside the equipment itself, Bluetooth® sensors are also being deployed to monitor the environmental conditions within a range of manufacturing and logistics environments. These can help ensure that valuable assets or equipment are stored in the correct conditions, that production processes are carried out according to specific regulations, and that wastage and production errors are reduced while automating compliance procedures. In addition, these sensors can better ensure the safety and comfort of personnel. Companies such as Zebra offer Bluetooth® sensors and data loggers that monitor temperature to help better monitor sensitive raw materials and components, reduce potential waste, and improving staff efficiency through the automatic gathering of environmental data for compliance purposes.

Other Bluetooth® wearables and portable devices can be leveraged for safety applications. For example, portable Bluetooth® gas detectors and worker safety devices can be paired to smartphones to provide threat readings, alarms, man-down status, compliance status, worker location, and other information remotely via a dedicated app. This is particularly vital in remote work areas where there may not be any RTLS or other connectivity infrastructure, allowing organizations to respond quickly and effectively to any safety-related incidents. For example, Honeywell offers a single-gas detector with Bluetooth® connectivity that provides real-time visibility into the status and safety of hazardous-area workers, alongside automating records management for compliance purposes. Other solutions enable users to monitor their noise-exposure levels in real time through Bluetooth® connectivity to a mobile device.

ABI Research expects that with the arrival of more advanced Edge AI capabilities, alongside further reductions in power consumption and range optimization enabled by continued Bluetooth® LE enhancements, wireless sensors of all types will experience a strong period of growth. The ability for Edge AI to enable more autonomous decision making at the device or local network level, without the need to send potentially business-sensitive data to the cloud, can also help to reduce the latency of decision making, which may be critical in reducing further downtime and can help scale predictive maintenance to a wider range of assets.

Increased automation

In addition to providing enhanced visibility and reduced downtime, Bluetooth® technology is also leveraged within manufacturing and logistics environments to help enhance productivity through greater automation, optimizing workflow, enhancing compliance and traceability, and enabling safer remote operation and control of industrial equipment.

Remote operation and automated compliance

There are several industrial and manufacturing devices that leverage Bluetooth® technology to enhance worker productivity and safety while automating records management and compliance. Some notable examples include human-machine interfaces (HMIs), inventory management solutions, and connected tools.

HMIs enable operators to interact with machines, enabling communication with programmable logic controllers (PLCs) and industrial PCs (IPCs) to acquire and display information, support the management of supervisory control and data acquisition (SCADA) and manufacturing execution system (MES) solutions, alongside activating critical machine actions, such as switching machines on and off or increasing production speed. Industrial HMI devices have typically relied on physical connections such as serial ports. However, Bluetooth® technology now allows operators to control industrial devices wirelessly, enabling smartphones, tablets, and PCs to display more intuitive user interfaces (UIs) that simplify the operation of industrial equipment. This also helps reduce the cost of expensive physical interface components, saves time and cost in educating end users on specific HMI systems, simplifies maintenance and installation time and costs, increases deployment flexibility, and improves worker safety in potentially hazardous environments. Ezurio has developed a Bluetooth® HMI platform, enabling OEMs to develop advanced HMI solutions with embedded connectivity that is specifically optimized to perform in harsh environments.

Industrial handheld barcode scanners or radio frequency identification (RFID) readers and wearable devices are commonly used in manufacturing and logistics settings. Most of these devices are equipped with Bluetooth® technology to connect to peripheral devices, such as PCs and smartphones, portable or industrial printers, headsets, and other devices, via a Bluetooth® connection. Workers are also leveraging wearable scanners in smart manufacturing and warehouse environments to speed up and automate package scanning and component or assembly processes. As hundreds of packages are scanned per day, using a handheld scanner that must be picked up and put down during each scan is not always efficient. Wearable scanners can significantly increase worker productivity and comfort, while Bluetooth® connectivity is used to communicate with a mobile computer or smartphone for automated data logging.

Intelligent tools equipped with Bluetooth® technology have the potential to connect directly to a smartphone app or via a controller to an MES, enabling a number of valuable use cases. This includes monitoring the condition of tools for predictive and preventative maintenance, enhanced traceability, better quality assurance via automated logging of measurement and other operational events, remote authentication and provisioning, usage monitoring, and tool tracking, among others. Combined, these efforts can support greater operational efficiencies, reduce wastage and loss, identify potential errors in the production process, and increase worker satisfaction. Some solution providers, such as Hydrajaws, have developed a Bluetooth® torque wrench adaptor that attaches to existing tools and automatically captures torque data via a dedicated reporting app. This enables enhanced compliance and traceability for various production environments.

Work cell and people flow optimization

In addition to improving the visibility of assets and materials, RTLS can also enhance the safety of staff and visitors. Staff can be equipped with RTLS-enabled tags, badges, clothing, or other devices that can be tracked in real time to identify their location in remote environments. In emergency response situations, these devices can also identify if personnel have fallen or stopped moving, have entered a restricted or hazardous area, and are in close proximity to a moving vehicle, as well as enable more automated and accelerated employee mustering.

RTLS can help minimize production errors and ensure compliance. For example, by tagging tools, assets, and workers, RTLS can ensure the right tool is being used by the right person, on the right component, at the right time, and that it has also been calibrated or maintained in the correct manner. Alongside reducing costly errors, this can also help to automate compliance and have a digital record of all activities on the factory floor.

RTLS can also lead to a number of wider operational efficiencies, including route optimization, indoor navigation, and task guidance for personnel, identifying potential bottlenecks in production, and enabling more efficient inventory management. This can apply to intralogistics applications as well, helping to optimize yard management and vehicle utilization, maximizing resource allocation, and reducing storage costs. Enhanced visibility of these challenges can enable more optimal resource allocation, reduce worker stress and fatigue, and enhance production output using existing labor resources.

One way in which RTLS helped improve productivity was through the deployment of BlueIoT's RTLS solution at the Shanghai Research Institute of Building Sciences Co., Ltd (SRIBS). The deployment equipped personnel with wearable tags to give them the optimal route to nearby assets, enable the nearest member to complete a task, provide safety geofencing, and automate other tasks such as attendance checking. Thanks to sub-meter level accuracy and a latency of within one second, the deployment was able to save 50 percent on time spent in object finding and route optimization, increase production capacity by 65 percent, and improve productivity by 40 percent while delivering a 30 percent decrease in production cycle time and a 50 percent reduction of floor space.

How Bluetooth® technology enhances productivity

Thanks to several inherent benefits, Bluetooth® technology continues to enable measurable productivity gains in manufacturing and logistics environments, alongside the wider supply chain.

These include:

- Strong resilience to interference and a robustness that enables Bluetooth® technology to be deployed in harsh industrial environments.
- Ultra-low power consumption that can support years of battery life for industrial sensors, reducing maintenance costs while enabling new categories of battery-free or energy-harvesting asset tracking tags and smart labels. These can drastically enhance the visibility of operations and illuminate supply-chain challenges from component sourcing to delivery.
- Enabling high volumes and scalability while maximizing ROI. as Bluetooth® technology's low-cost application supports smaller form factors.
- Seamless offloading of data to various record management systems and the cloud. With many industrial deployments relying on connectivity to wireless access points, gateways, industrial PCs, as well as smartphones, tablets, and wearables, the ubiquitous presence of Bluetooth technology in these areas is a key advantage. The huge installed base of devices can also help enable decentralized smart-label tracking networks across the supply chain.
- Seamless device connection and improved remote control of operations allows Bluetooth® technology to support an extended range of capabilities, delivering up to 100s of meters of connectivity that could be vital in larger-scale facilities.
- Increased integration of Edge AI capabilities within Bluetooth® solutions that will help deliver more localized decision making, decreasing the time and cost it takes to transmit data to the cloud, further reducing power consumption, and improving data privacy and enterprise security.

The availability of tailored solutions from leading Bluetooth® chipset and module providers is driving the creation of differentiated, application-specific platforms that can help guarantee high levels of performance in difficult environments while maximizing efficiency and ROI.

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