WHITE PAPER

Connected tools: redefining construction and assembly worksites

A step ahead in efficiency, monitoring, and maintenance

Abstract

Over the past three decades, connected tools have proven valuable on construction and assembly sites, reducing the time to complete tasks, improving workflow, and increasing worker safety. While Bluetooth was the first technology to enable connected tools, a practical aspect limited their full potential. More recently, other technologies have overcome this issue, stepping forward toward more efficient methods that establish seamless location and connectivity without relying on any external factors.

White paper: Connected tools: redefining construction and assembly worksites

Author: Ludger Boeggering, Senior Principal Application Marketing EMEA,
Energy and Industry 4.0, u-blox AG

Contents

Executive summary

Since their arrival more than thirty years ago, connected tools have proliferated in many industries, including construction and assembly. They have directly impacted workers and businesses alike and will play a key role in digitizing these industries.

The main driving forces influencing the development of connected tools have been digitization and electrification, both necessary to access valuable data. With this data, companies have improved their overall workflow, worker safety, quality, and the completion time of their tasks. This data has also influenced the readiness of tools and accelerated response times when deviations occur. Such data has been key to what is known as predictive maintenance.

Today, the market offers a wide range of connected tools, from the simplest to the most advanced. Within this spectrum, we can identify five main categories: do-it-yourself, professional, test and measurement, assembly solutions, and robotics. Special attention has been paid to professional, test and measurement, and assembly solutions directly impacting construction and assembly sites.

Bluetooth was the original technology that linked connected devices to the cloud. Over the past two decades, many advances have been made with this technology. Yet, Bluetooth has never been able to solve one practical issue that is highly relevant for proper data collection.

To solve this practical aspect, the focus needs to be of an alternative nature. Mobile and cloud connectivity requires a different handling solution that involves releasing workers from the duty of establishing connectivity with the cloud.

Three technologies stand out as potential solutions to this conundrum: cellular, Wi-Fi, and high-precision GNSS. Each can provide specific solutions to achieve seamless location and connectivity within work sites depending on the environment. The amount of data these technologies can handle, compatibility in an assembly environment, and direct connectivity are further reasons why Wi-Fi and cellular are gaining traction.

When migrating to alternative technologies, it is imperative to consider their security. No company or workplace wants to be exposed to a security breach. These three technologies, however, address security at different levels.

Introduction

The construction and assembly industries are undergoing a transformation driven by the integration of advanced technologies. In this new era, connected tools powered by the Internet of Things (IoT) and next-generation sensors improve efficiency, safety, and project management, redefining traditional and defining new construction workflows.

This technological evolution affects workers. Driven by tools equipped with smart capabilities, they are gradually moving away from traditional mechanical functions. In addition, battery-powered tools that more easily connect to the IoT are replacing combustion-powered tools. From wearables that monitor worker safety to augmented reality (AR) glasses that provide on-site visualization, construction and assembly professionals now have access to real-time insights and seamless communication. This alters construction and assembly sites, transforming them into smart and connected ecosystems.

Construction companies also have access to greater visibility into site progress by using Building Information Modeling (BIM) software (as a kind of digital twin), tool localization, and digital project management tools. Supported by these technologies, organizations can strengthen stakeholder collaboration, leading to a more sustainable and informed approach to construction. This shift increases productivity, contributes to a safer work environment, minimizes errors, optimizes resources, and promotes an informed decision-making culture that becomes part of the construction project lifecycle.

Connected power tools in construction will play a central role in the development of the industry in the coming years, but not before solving some inconveniences. The World Economic Forum (WEF) has recognized the main challenges and actions to solve them in its **Shaping the Future of Construction** series of publications.

The situation with assembly plants mirrors that of construction sites when it comes to connected tools. Currently, connected assembly tools are at the heart of networked systems that achieve distribution based on logic and intelligence. And when these assembly tools are aligned with other connected systems to create a complete assembly line, the true advantages can be seen. In these arrangements, the Manufacturing Execution System (MES) serves as the brain, processing all the data linked by connected tools.

To become part of this production chain, a connected assembly tool must integrate real-time controllers, multiple sensors capable of measuring processes, and wired or wireless connectivity. High-precision, low-torque, high-speed assembly, and gluing and riveting tools are examples of connected tools designed for assembly environments.

The WEF has recognized two main obstacles for the construction industry: 1) The Infrastructure and Urban development (IU) industry has lagged behind the digital technology transformation. 2) A talent gap hinders the IU industry's digitalization (**An Action Plan to Solve the Industry's Talent Gap**), where corporate educators are not enough to train workers in new skills, including connected tools.

The WEF, however, has also recognized that the sector can find support in BIM and connected tools to accelerate digitalization. BIM systems oversee the creation, collection, storage, and sharing of information derived from construction data. In **Inspiring Innovators Redefine the Industry** (Feb 2017), the WEF has shown that BIM systems can optimize building construction, handover, operation, and maintenance. The New Karolinska Solna Hospital in Stockholm exemplifies it. The building blocks of these systems are connected sensors, tools, and construction equipment (**An Action Plan to Accelerate Building Information Modeling (BIM) Adoption** (February 2018)).

As digital technologies drive the transformation of business models, the WEF has visualized **Future Scenarios and Implications for the Industry**, in which connected tools undoubtedly carry a heavy weight.

Digitalization, the driving force

Digitalization has been the primary driving force behind the evolution of connected tools. It has revolutionized these tools by providing access to relevant information that was previously unavailable.

The main reason for the interest in digitization is that it enables industries, construction sites, hospitals, etc., to collect valuable data from devices. Some examples include useful information about workers' daily activities, such as localization and distance information, time of use, and recording of individual tightening operations to track production quality.

But this data goes beyond the worker itself. From the perspective of a construction company, it can improve the entire workflow. Imagine a construction site where workers are performing activities, moving all over the place, with tools lying around, left here and there. Every trip saved in finding materials or replacing a tool in this dynamic environment can affect worker safety and completion time.

Workers potentially spend 1/3 of their time on other tasks, such as searching for suitable materials and tools.

Digitalization can then increase the focus on the actual task, improve worker safety by monitoring tool status, and ensure the right tool is used for the right task.

Digitization is also convenient for toolmakers. It allows them to ensure 1) the readiness of tools for use and 2) a quick service response in the event of anomalies. This is where predictive maintenance comes into play. The data collected can be used to track tool status and respond proactively. And if these manufacturers have accessories and materials in their portfolio, they can be easily integrated into these processes.

In other words, access to a wealth of data that can be extracted from devices for subsequent analysis is significant in improving aspects such as organization, efficiency, maintenance, future planning, and OEM-user interaction.

Types of connected tools

So far, we have given a superficial description of what construction and assembly connected tools are and a glimpse of their role in the future development of industries. Still, connected tools is a generic term that covers a wide range of applications and use cases. The following figure shows the types of connected tools found in the market.

While the do-it-yourself and robotic types have their place in the market, construction and assembly sites rely primarily on the in-between categories.

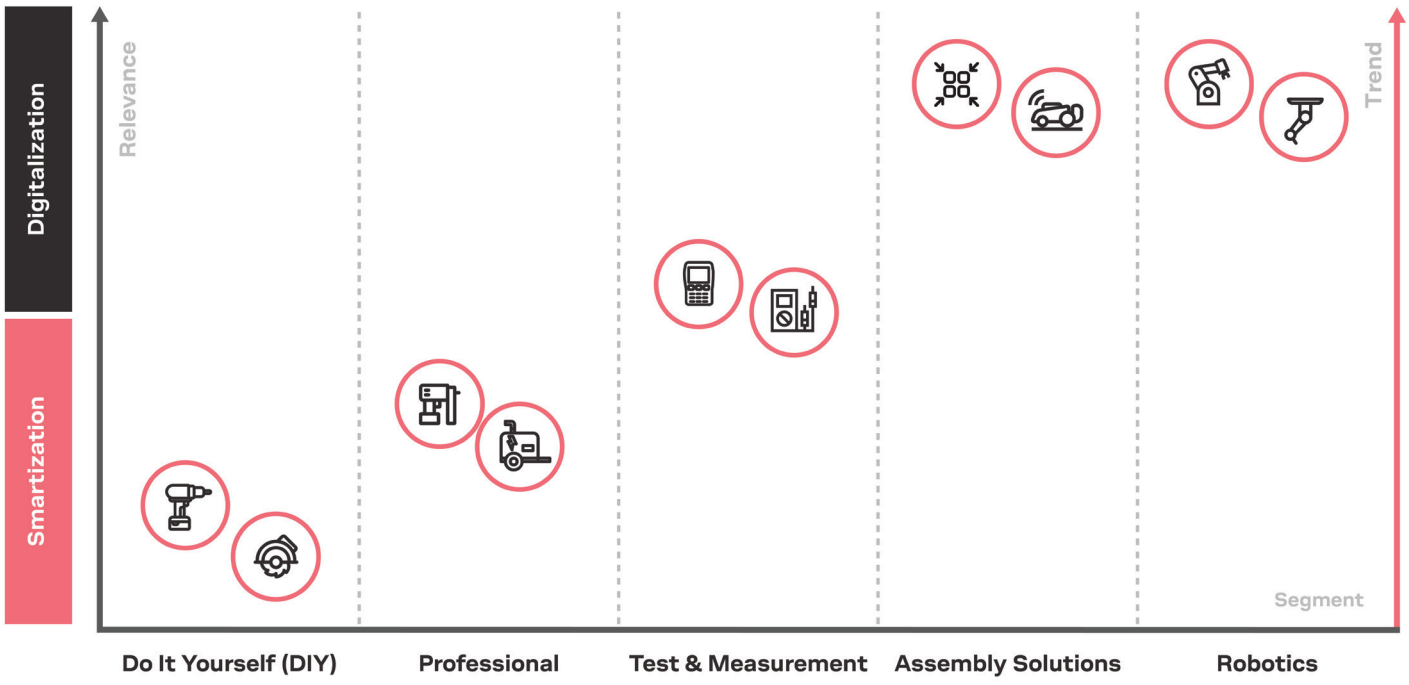

Figure 1. Types of connected tools

Professional

Professional connected tools for construction and assembly are devices with connectivity capabilities that communicate and share data with other devices or systems. Professional construction environments commonly use these tools to improve efficiency, productivity, and data management. The term covers a wide range of equipment. Here are just a few examples.

- **Smart helmets** with Augmented Reality (AR) have display and communication capabilities that enhance worker safety. They also provide real-time information, instructions, and visualizations without the use of hands, contributing to the reduction of errors and the increase in efficiency.
- **Connected power tools** can monitor usage, track location, and receive maintenance alerts.
- **Wearable sensors**, including smart vests, belts, and suits, can monitor worker movement, posture, and potential exposure to hazardous conditions. Their primary goal is to keep the worker safe.

- **Professional connected tools** bring connectivity and smart capabilities to various industries to improve efficiency, automation, and decision-making processes.

Test and measurement

Connected test and measurement tools are used to test, analyze, and measure various parameters. These tools, equipped with connectivity features, transmit data, receive instructions, and can be monitored and controlled remotely. Integrating connectivity into these devices increases efficiency, facilitates data analysis, and allows remote operation (in some cases). Common examples of these connected tools include:

- **Digital Multimeters** (DMM) are versatile tools for measuring the voltage, current, and resistance of electronic circuits. Connected DMMs transmit real-time measurement data to a computer or a mobile device for data logging and analysis.
- **Thermal imaging cameras** detect temperature variations. This helps workers identify problems such as insulation gaps, electrical faults, or Heating, Ventilation, and Air Conditioning (HVAC) irregularities.

- **Connected laser distance measurers** can provide accurate distance measurements for layout and surveying. Relying on connectivity features, these tools can transfer data to smartphones or centralized computers.
- **Connected concrete testers** are designed to test concrete properties, including strength and consistency. They can obtain real-time information on concrete quality by connecting to data management systems.
- **Connected geotechnical instruments** are essential for measuring soil properties, slope stability, and foundation conditions. These instruments generate reliable, real-time information to monitor and analyze soil characteristics.

Assembly solutions

Manufacturing and assembly processes that require connectivity capabilities use tools and equipment designed to improve efficiency, provide real-time data, and often enable integration with broader manufacturing systems. These tools contribute to smart manufacturing and Industry 4.0 initiatives. Such assembly processes integrate automation, data exchange, and advanced technologies into the manufacturing environment. Examples of connected tools for assembly solutions include:

- **Smart screwdrivers,** equipped with sensors and data transmission capabilities, measure torque, angle, and other parameters while tightening screws. They then transmit the data to a central system for analysis and quality control.

- **Connected torque wrenches and nutrunners** are used in assembly processes that feature connectivity for data logging and remote monitoring. They help manufacturers ensure that components are correctly tightened to specified torque values by providing real-time data on the torque applied. This helps maintain consistency and quality in assembly processes.
- **Smart assembly stations** with connected tools and sensors monitor and guide workers through assembly processes. Such stations provide instructions, detect errors, and ensure quality control.
- **Radio Frequency Identification (RFID) tags and readers** can track tools, equipment, and materials throughout the assembly process. Networked RFID systems are essential for inventory management, traceability, and process optimization.

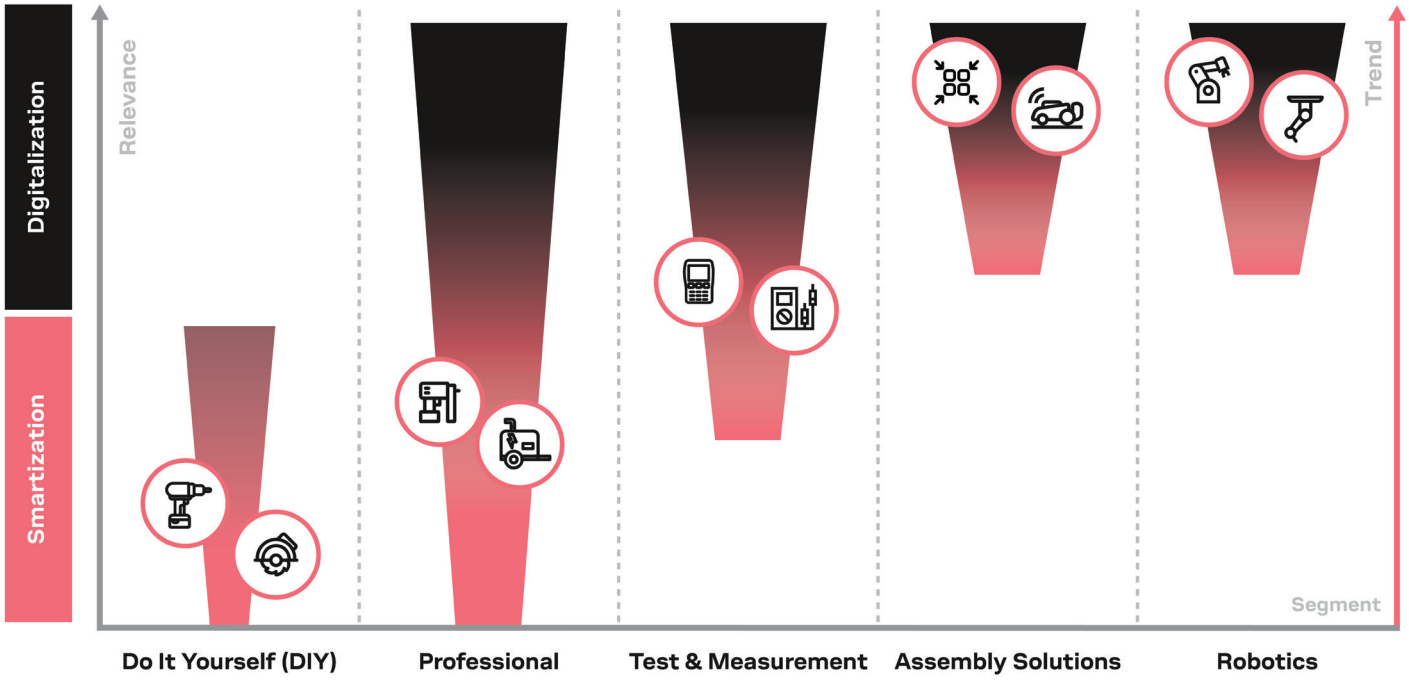

Figure 2. Smartization vs Digitalization connected tools

As the figure above shows, tools are becoming more digitized and less smartified as they make more sense for processes and use cases.

Bluetooth: from devices to the cloud

Since the arrival of connected tools in the early 2000s, Bluetooth has been the technology of choice for accessing data. The advent of the first connected tools using Bluetooth created opportunities such as wireless connectivity, local control, data synchronization, and integration with smart devices. The main expectations for these capabilities were better user experience, more efficient collaboration, and real-time monitoring.

From a theoretical and technical standpoint, Bluetooth has been a significant step forward in data collection over the past few decades.

Unfortunately, one critical and practical aspect hasn't been adequately addressed during this time: This technology always requires establishing a connection with a gateway (such as the user's smartphone) to then send the data to the cloud. This is always accompanied by establishing the connection in advance or on an ad hoc basis in the field, not to mention that it often must be manually arranged by the worker.

Despite its automatic connectivity limitations, Bluetooth remains a significant and relevant technology for local service, communication, and configuration.

The connected power tools dilemma

As it stands right now, using Bluetooth for data transfer would require workers to use the technology and connect the tools to their smartphones. However, lack of time, knowledge, willingness, and even awareness are some of the reasons why the connection doesn't happen.

As a result, workers inadvertently create breaks in the communication chain that range from not uploading daily data to weeks or months without communication. Once the connection is lost, no one can access the tool's status until the user reconnects.

This has shown that mobile and cloud connectivity management should be handled at a different level. The current focus is on relieving workers of setting up equipment. Companies can ensure worker safety and communication with other tools by doing so. In addition, by transmitting all the available data generated during use, companies can avoid significant delays and take full advantage of the potential access to data that a work site can generate.

Proper data upload from connected tools is critical to unlocking their full potential to enhance efficiency, decision-making, collaboration, and compliance across all levels of an organization. Ensuring this availability is essential for companies to make appropriate decisions that impact employees and the business. It also enables the use of analytics to improve current and next-generation tools.

Advantages of direct connected tools connectivity

Connected tools offer many benefits when they automatically connect to the network and the cloud without relying on the workers in the field. The tables below highlight just a few.

For power tools:

Productivity increment	Costs control	Asset management simplification	Transparency over the tool crib
Reduce downtime	Provide proactive services	Tool management features	Guide to related products
Consistent process documentability	Manage repair orders and tool exchange	Identify and analyze usage trends	Transparency on tool location and usage
-	-	Onboard battery diagnostics	Access to videos and instructions via the APP

Figure 3. Key advantages of power tools

For assembly tools:

Productivity increment	Asset management simplification
Reduce downtime	Tool management features
Full traceability for every process	-
Consistent process documentability	Onboard battery diagnostics

Figure 4. Key advantages of assembly tools

More specific benefits vary by industry. For instance, tool OEMs gain direct insight into tool function analysis that can improve next-generation designs. The OEMs can then provide their customers, such as construction companies, with valuable analysis and insights to solve their key challenges. This data can help contractors and workers optimize daily processes and operations. It also provides information that can be used in new ways, enabling the next level of asset utilization and labor efficiency.

Localization via cellular communication, Wi-Fi sniffing, high precision GNSS, and the right technology according to each scenario

Migrating from Bluetooth to another technology enabling direct connectivity would benefit case scenarios where connected tools impact workspaces and complete solutions within those locations. Such a different perspective represents a significant change for the present but also for the near future.

Location via these technologies enables precise tracking and monitoring in various applications. For instance, connected tools can be precisely localized by networks and provide real-time data.

These location technologies benefit on-site workers and supervisors. Real-time location tracking ensures workers' quick location in the event of an emergency, improving their overall safety. Moreover, tools with location capabilities contribute to better task management by allowing supervisors to monitor the progress of fieldwork and allocate resources more effectively.

Monitoring the exact location of tools and equipment in the construction and assembly industries also has a direct impact on operational efficiency: By integrating tracking technology, businesses can optimize routes, improve security, and streamline resource management.

In terms of case scenarios, the technology used will depend on the type of facility that requires connectivity. The most prominent are construction sites and assembly plants. Both could use location via cellular networks, Wi-Fi sniffing, and, in some cases, high-precision GNSS for specific purposes.

On a construction site, for instance, it is essential to have access to indoor and outdoor positioning

information that is accurate to the 2-digit meter level. And ideally, the positioning information should extend to the floor level.

In some cases, high precision positioning is also needed. In the field of plastic welding, for example, high precision positioning is required to document the welding process properly.

Beyond localization

Accurate measurement and analysis can improve quality control and maintenance in industries such as manufacturing and construction. The connectivity capabilities of connected tools based on cellular communication provide the flexibility and efficiency needed for test and measurement processes. Here is how the technologies benefit these specific environments:

Construction sites. Managing professional connected tools on the job site provides visibility into usage. Analyzing this usage and supporting jobsite solutions can lead to a more efficient workforce and better, more structured resource planning.

Connected test and measurement tools on a construction site enable a faster, more accurate measurement process that can be performed in the field. Subsequent design processes and documentation can be significantly simplified. These tools can also be configured and controlled locally.

Assembly plants. Connected tools for assembly solutions are designed to correctly parameterize the workstation according to the assembly task at the job site location and recording of critical screwing processes. This can be applied to any section of the assembly line.

Critical to these tools is the ability to collect and analyze process data throughout the lifecycle of an industrial assembly program and during safety-critical tightening connections according to VDI/VDE 2862. This analysis allows companies to evaluate quality control and traceability.

By integrating direct connectivity into assembly solutions, companies can achieve production efficiencies, reduce errors, improve quality control, and gain valuable insight into manufacturing processes. Overall, connected tools can help create smart and adaptive manufacturing environments.

Security management

Despite the many benefits connected tools have brought in recent years, they have also raised privacy and data security issues for employees and organizations alike.

Since these tools continuously transmit location data, robust privacy policies and security measures should be in place to protect employee confidentiality and integrity. In addition, using connected tools may require adjustments to work routines and expectations, as the constant monitoring of location data may impact notions of autonomy and flexibility.

In relation to the security of companies, cellular technology offers features that enhance security at different levels, providing encryption, authentication, and secure boot and firmware updates. These features contribute to secure transmissions from connected tools to the cloud.

u-blox solutions

Cellular and Wi-Fi technologies can solve two fundamental aspects for a company: finding the location of a connected tool and getting its data reliably and quickly. Technology's primary role is to fulfill these daily tasks and increase productivity, sustainability, and safety. On the other hand, Bluetooth remains the technology for nearfield connectivity.

The u-blox portfolio can meet the demands of a construction or assembly site in terms of these two aspects in a variety of ways. Investments in own IP (indoor/outdoor location, cellular silicon, 5G-NR RedCap), long-term availability, customized features, seamless integration of cellular modules, SIM cards, IPD coverage for Wi-Fi, and enterprise services all contribute to reliable and fast communications within these sites. They also reduce total solution cost and minimize power consumption.

The industry's most robust IPR protection portfolio for cellular modules significantly reduces business risk. u-blox manufactures at a European level, and with the support of local distributors, capable engineers, and trained teams, it reaches a global market.

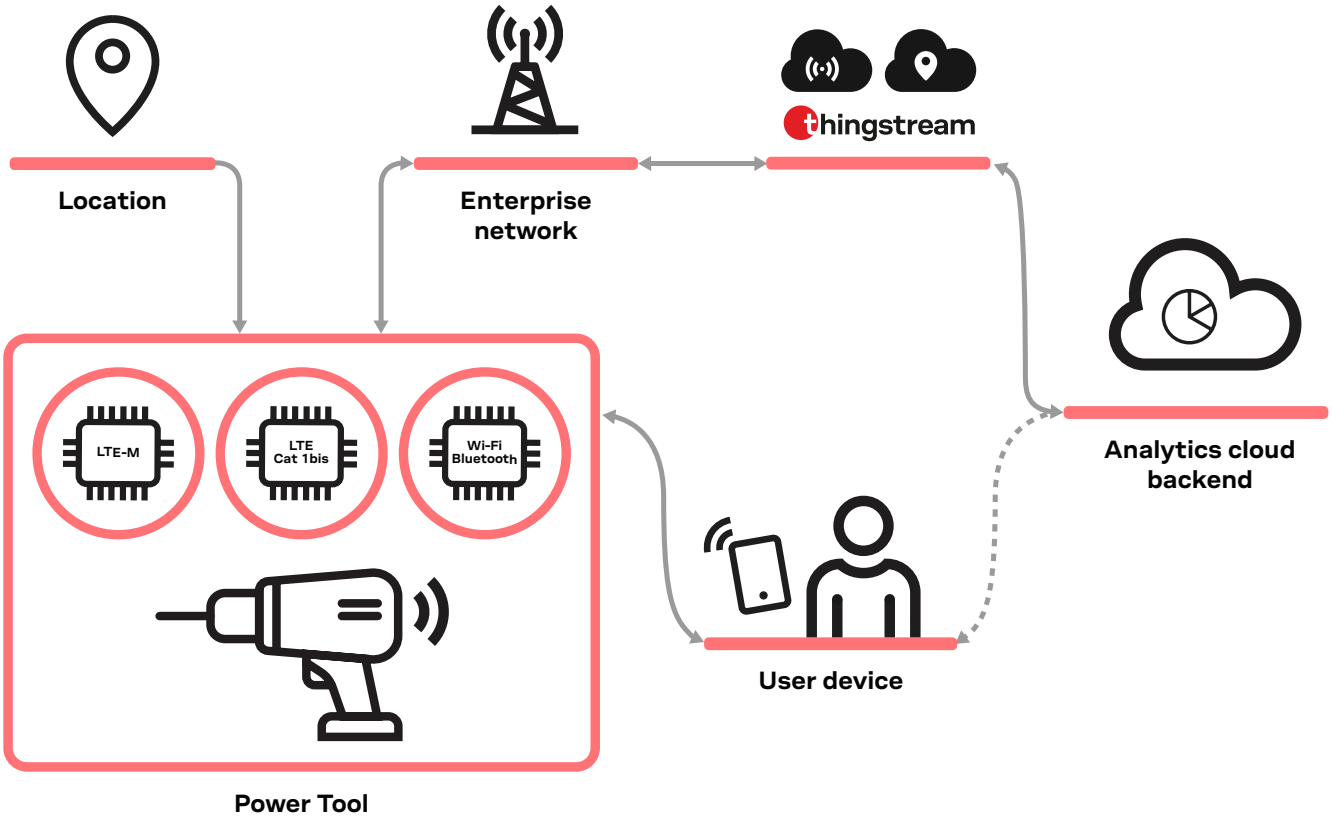

Figure 5. Power tools connecting to the cloud

Final takeaways and future trends

Due to multiple factors, factories and construction sites are changing more than ever. Flexibility is paramount to navigating these evolving scenarios, which is partially provided by the use of battery-powered and connected tools. Connected tools are, therefore, becoming the most valuable assets in these industries.

Digitalization is at the root of this change in perspective. It has revolutionized how these workplaces operate, bringing location features and data that can benefit companies and businesses in various ways.

While Bluetooth showed how to take advantage of digitalization, it could never overcome a critical practical aspect. For this reason, other technologies are now taking its place when referring to connected tools.

Connectivity and location are the key features that enable connected tools to interact seamlessly with other components of the production chain. Companies should consider their business needs to make clear choices about the right technology to facilitate this.

Connectivity is becoming essential for OEMs to create new business models, such as pay-per-use, maintenance, and workforce management. These are just a few examples of the many more on the horizon. The common denominator is that they all depend on connected tools and the data they can provide.

The future of connected tools looks promising. Like the cells of an organism, connected tools have proven their value by being vital to the proper functioning of entire workplaces, such as construction and assembly sites. And like any organism, when the cells function correctly and are well-connected to other systems, the result is an organism – or organization – in good shape.

About the authors

Ludger Boeggering, Senior Principal Application Marketing EMEA, Energy and Industry 4.0, u-blox.

Ludger Boeggering is responsible for the regional growth strategy of the key market segments energy, automation, and “Industrie 4.0” at u-blox.

Ludger joined u-blox in 2015, driven by the conviction that communication in the industrial environment would significantly impact businesses and services, with u-blox perfectly positioned to meet emerging needs in IoT and “Industrie 4.0” both today and in the future.

During the ten years prior to joining u-blox, Ludger held a position in marketing & sales for smart metering and M2M communication products at Sagemcom Dr. Neuhaus GmbH. There, he worked with multinational energy, automation, and telecommunications providers such as Vattenfall, Panasonic, Siemens, and Vodafone.

Ludger has more than 15 years’ experience in the energy and industrial automation markets.

He holds a licensed engineering degree in telecommunications (Dipl. Ing. Nachrichtentechnik) from the University of Applied Science in Aachen, Germany.

About u-blox

u-blox (SIX:UBXN) is a global provider of leading positioning and wireless communication technologies and services for the automotive, industrial, and consumer markets. Their solutions let people, vehicles, and machines determine their precise position and communicate wirelessly over cellular and short range networks. With a broad portfolio of chips, modules, and a growing ecosystem of product supporting data services, u-blox is uniquely positioned to empower its customers to develop innovative solutions for the Internet of Things, quickly and cost effectively. With headquarters in Thalwil, Switzerland, the company is globally present with offices in Europe, Asia, and the USA.

u-blox AG
Zuercherstrasse 68
8800 Thalwil
Switzerland

www.u-blox.com