



IoT Systems Deliver Value for Off-Road Mobile Equipment Today and Into the Future

By Clint Quanstrom, IoT GM, Parker Hannifin Motion Systems Group



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Early Value and Drivers of IoT

IoT systems for mobile and heavy off-road equipment have roots in telematics. The telematics industry is several decades old and was born out of the automotive sector when GPS became widely available. In the late 1990s, fleet management software and fleet tracking came into use in the on-road trucking industry. Within the past decade, larger Tier 1 OEMs in

the off-road market began rolling out telematics for their equipment as well as systems for onboard motion systems using hydraulics and pneumatics, which moves beyond telematics and into what is considered mobile IoT.

For OEMs, the data that they received back from their equipment in the field via telematics allowed

them to better serve their customers and gain service contracts. It created an opportunity for them to provide value-added services to their customers as well as enabled them to learn more about how their equipment operated in the field.

IoT Connectivity Delivering Value Today

Today, heavy equipment with embedded sensors and internet connectivity deliver value to manufacturers, contractors and fleet managers, by constantly collecting and analyzing data about usage, maintenance needs, downtime and more. Business

leaders are turning to IoT solutions to sense and adapt, improve operational visibility, address regulatory and compliance requirements, and respond to competitive pressures.

Although off-road mobile

equipment IoT systems have their roots in telematics most equipment manufacturers offer connected equipment that takes it a step further with IoT solutions that recommend or notify equipment operators on how to maximize performance and longevity.

Today's IoT solutions offer:

- **Remote diagnostics:** Answers to why a machine broke down without having to send a technician to a jobsite or the ability to send technicians with the right tools and parts on the first trip, which can reduce downtime, labor and travel costs.
- **Over the Air Updates:** Remotely download existing onboard programs, make adjustments, and upload them to the machine without having to send a technician to the field.
- **Smart Hydraulics:** Components with embedded electronics and sensors that provide critical insights into onboard hydraulics enabling superior uptime performance.

- **Data analysis:** Instant awareness of when each machine is due for maintenance before it fails, or data signifying the most efficient route of delivery and pick up.
- **Automated reports:** Generate customized reports at specific intervals you choose to save time on fleet administration and work reports.
- **Machine and personnel efficiency:** Check the efficiency of operation and detailed system settings and optimize parameter settings of remote machines in real-time such as monitoring everything from tire pressure to seatbelt enforcement.

Electrification is also a driver for today's IoT equipped machinery. "We're seeing a big push from OEMs toward electrification stemming from what is happening in the automotive world," said Neil Jessel IoT application engineer at Parker. "A lot of OEMs are turning to electrified solutions, working with a whole new power source. Working with turnkey electrified systems reduces their mechanical risk."

The integration of IoT systems for heavy equipment manufactures has become apparent as hybrid and electric versions have become available for excavators and similar machines. The use of batteries as a power source for propulsion and motion is common to both designs. Integrated IoT can easily transmit the voltage trends and charge state on a cell-by-cell basis to the manufacturers of the machines. In this manner, IoT is being used to optimize battery technology and for quality assurance and control.

As efficiency regulations and targets continue to expand within the industry, more OEMs and end users will seek out ways to avoid running diesel engines. Electrifying these systems will help them achieve those goals. IoT systems enable the necessary tracking and documentation that make electrifying systems a smart choice for OEMs and a sought-after capability by end users.



Specific Value to OEMs

For OEMs, the data that they receive back from their equipment in the field allows them to better serve their customers and gain service contracts. They can proactively engage the owner operators when they see that something is wrong and can service the machine when it needs it rather than when the calendar indicates it. Overall, this data drives service engagements and it allows them to capture replacement part revenue, lowers field service costs via remote diagnostic capabilities, reduces

warranty costs via preventative maintenance and increases customer satisfaction in regard to maintenance and repairs.

In addition to service benefits, OEMs are able to amplify their testing on equipment with IoT systems. They gain insight into what is happening within the machine when it is in operation, leading to benefits including early detection of product enhancements, data analytics and insights.

Specific Value to Fleet Owners and Managers

For fleet owners and managers, IoT systems offer increased fleet, operator and asset efficiency. Location and route optimization, fuel usage optimization, reduced International Fuel Tax Agreement (IFTA) reporting costs, remote software upgrade capabilities and real time operational data allow for fleets to be better allocated for greater effectiveness and efficiency. IoT systems enable fleet management to improve efficiency for their operators by decreasing accident risks, wear and tear, and third-party damage claims. It also enables pre-shift checklist compliance. Condition monitoring and alerts, along with increased up time and lower maintenance costs, help fleet assets be managed most efficiently.

Anywhere mobile equipment is used, **IoT** offer opportunities for higher levels of productivity improvement and cost efficiency. Mobile IoT solutions provide

insights for fleet maintenance, giving managers a fresh view into the mechanical health and utilization of expensive assets such as fuel costs, idle time, accidents, compliance violations and other contributors to fleet management costs. Therefore, fleet managers can be proactive and make equipment repairs before a breakdown happens, avoiding lost revenue.

Furthermore, IoT systems can help fleet managers bill for projects and bid on jobs more accurately. Because these systems allow for tracking equipment use down to the minute and monitor related costs such as fuel and maintenance, fleet managers can better calculate the cost of each project and create more accurate estimates for future projects.

IoT for off-road mobile equipment offers numerous safety improvements that are not always immediately obvious but can go

a long way to reducing the risk of accidents for both operators and coworkers. The value in the data is the ability to provide coaching opportunities for operators who may not be following company-established rules for job-site behavior, such as exceeding speed limits.

Additional safety data includes:

- **Tire pressure and temperature monitoring:** reduces the risk of machinery being operated in an unsafe manner
- **Third-party axle load monitors:** issues alerts if a vehicle is loaded over recommended capacity
- **Alerts for harsh braking, hard acceleration, excessive idling, and lack of seatbelt:** makes sure unsafe operating habits are flagged and tracked
- **Geofencing:** limits how close heavy vehicles can get to sensitive structures, such as pipelines



By using IoT solutions for off-road equipment as a safety technology, businesses can correct unsafe driving in real time and receive tools to coach and provide performance feedback to employees. The investment in the technology becomes incredibly worthwhile when considering the cost of an IoT solution versus the cost per accident.

In addition, running an environmentally friendly business can be difficult and very expensive, especially with a mobile workforce. IoT can positively impact environmental goals by providing data that can reduce emissions and idling for off-road equipment.

IoT can aid emission reduction and help maximize a fleet's routing and

travel efficiency. This will result in reduced mileage and time on the road, which subsequently reduces fuel usage and emissions released. Furthermore, if equipment is well maintained, the vehicle will drive more smoothly, use fuel more efficiently, and produce fewer emissions. IoT also allows for monitoring equipment idle time. Idling equipment burns fuel and give off pollutants the same way moving vehicles do. By monitoring idle time, you can identify employees that are prone to leaving their vehicles idling.

Today's IoT systems are as robust as the equipment they are installed on; the hardware components are designed to withstand harsh industrial and outdoor environments. When

new equipment installations are adopted, previously existing equipment can typically be retrofitted for IoT connectivity, allowing fleet owners to achieve targets and earn maintenance and analytics benefits for their equipment with retrofit rather than replacement. There's a lot of equipment out there operating that an end user would have to still pay to operate and maintain. There's no reason why they couldn't very easily implement an IoT solution for a vehicle that's been deployed to the field for a number of years and reap all of the same benefits they would from new equipment with IoT systems.

How IoT Systems Will Deliver Value in the Future

Bain's projections show that the IoT market will grow to \$520 billion in 2021. Specific to the construction market, **6.8 million connected heavy construction machines will be shipped** between 2018 and 2025. Although no one in the industry has a crystal ball, it is clear that the future of mobile IoT will be driven by machine learning and 5G networks to power further data collection and analysis, enable autonomous equipment operation and overall innovation in the field.

Hardware advancement which can analyze millions of points of data in real time, make decisions and report on the data as necessary will enable machine intelligence to begin moving from the cloud

to the machine itself. This is the contrast to the current method of telematics systems sending limited data to a server based on thresholds and events. And the intelligence of telematics is used to enhance machines, which is the groundwork for automation within the off-highway industry in the next several years. It will take time for this to occur, though, due to the uncontrolled environments in which off-highway equipment is typically used. More advanced AI will be required than what is currently available. The future of telematics lies in building the fully connected environment where all elements of the contractor's job are seamlessly integrated.



“With AI, users can learn patterns that lead to failures and make predictions such as construction equipment failing if it is not serviced after a certain amount of time,” **said Maciej Kranz**, IoT expert and VP of strategic innovation at Cisco. “The AI system might also recommend how to operate the equipment to maximize its useful life, offering trade-offs between performance and longevity.”

According to the Association of Equipment Manufacturers (AEM), AI will empower construction teams to handle critical task but there are challenges that must be overcome in order to achieve widespread adoption, including fear among workers of AI taking away their jobs, cultural resistance to new technologies and security. These are challenges that OEMs, suppliers and AI partners are already addressing in order to move their industries forward.

Embedded IoT systems rely on cellular communication technology. As 5G networks are being rolled out, it's clear that they will change the way that data is transmitted via IoT systems. **Volvo Construction Equipment's** vice president of technology, Patrick Lundblad, views

5G as having the biggest opportunity within industrial applications. When reviewing a bill of materials in this industry, the cellular charges are the largest line item, and that's currently with people sending a limited amount of data over their systems. Widespread 5G connectivity in the will directly impact this line item.

There are going to be a lot of different players in this market trialing 5G soon and they are mostly going to be tied to the potential for autonomous or driverless mobile equipment. 5G will be very impactful in growing that area. It is nearly impossible to do autonomous right now with so few data points going to the cloud. What's being sent to the cloud is a lot less, simply because of the cost to not only send it, but then to be able to store it, process it and then drive decisions with it. The promise of 5G is the ability to send a lot more data for the same or less money, which will enable more real time operations such as streaming video and the other necessary functions for autonomous mobile equipment.

In sectors like mining, **autonomous equipment is highly attractive**. It can take hours to properly ventilate an area after blasting to make it safe

for operators to enter. Removing humans from that equation will increase productivity and safety in operation.

But you need more than just 5G's fast networks to make autonomous happen. **For Volvo CE**, their journey towards autonomous construction machinery focus on increasing safety, productivity and uptime. Goals that every OEM working toward autonomous equipment and fleet owner looking to use autonomous equipment have in mind.

Although the push towards autonomous equipment follows in the path of the automotive industry, **the challenges for autonomous machines** in areas such as construction and agriculture differ from automotive. The environments these machines operate in lack lane lines, signage, sidewalks and other indicators that automotive vision systems rely on to guide cars. The additional “appendages” of booms and buckets must also be taken into account for their operation. This is where specialized sensors come into play for precise and safe operation.

A New Era

The complex mechanical, electronic and hydraulic systems used by mobile equipment and machinery, when supported by digital ecosystems, are ushering in a new era of mobile solution innovation. Mobile equipment

OEMs and their customers have immediate access to large and robust collections of data which can be acted upon quickly to improve functional efficiencies, operator wellness and productivity. Today's motion control enterprises

are leading the way toward safer, cleaner, more efficient and more reliable mobile equipment overall as well as catalyzing innovation for the next generations of connected equipment.

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