BSQUARE

The business of IoT

Industrial IoT: Keeping Heavy-Duty Vehicles Moving

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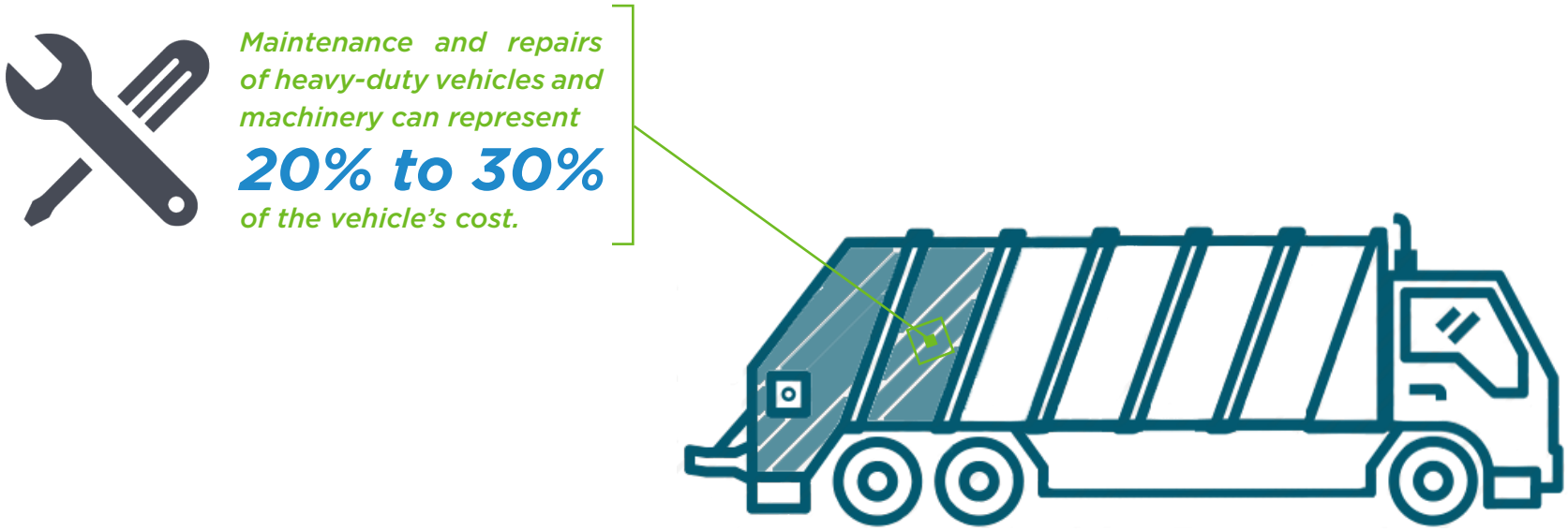
Improving Vehicle Uptime and Performance with IoT

Heavy-duty vehicles are vital to business operations in many industries, from commercial trucking to agriculture and construction. Maintenance and repair costs for these sophisticated, expensive assets can represent 20 to 30 percent of a vehicle's lifetime cost, incenting owners and operators to seek ways to save money on repairs to help improve profitability and productivity.

Manufacturers and fleet operators have broadly deployed telematics solutions in order to gain more insight into vehicle health; however, the usefulness of that insight is often limited due to connectivity constraints or lack of resources that can analyze the data generated by potentially hundreds of thousands of vehicles.

Industrial Internet of Things (IIoT) technology turns this data into a valuable business asset. In fact, a well-designed IIoT system can tap the entirety of data that vehicles produce – even without continuous connectivity – and examine it in conjunction with related data sources, such as braking and transmission subsystems, to provide deeper insight into vehicle condition. Ultimately, IIoT positively impacts vehicle operations by improving uptime, reducing mean time to repair, and more rapidly pinpointing the root cause of failures.



IoT Use Cases for Vehicles

Adaptive diagnostics

Diagnosing and fixing vehicle problems quickly and correctly can be one of the most effective ways to prune repair costs and increase uptime. Adaptive diagnostics detects and analyzes all active fault codes in concert with operating parameters to pinpoint the root cause of a fault. The results are used to dynamically generate accurate repair plans that reduce repair times and improve first-time fix rates. Detailed repair instructions allow service centers to bridge the technician experience gap and help get new technicians up to speed faster.

Condition-based maintenance

Maintenance based on actual usage and operating conditions specific to each vehicle can save money spent on too-frequent servicing, which can occur when vehicles are serviced based on mileage or elapsed time. It also extends vehicle useful life by scheduling service before failures occur, providing a better return on capital investment.

Predictive failure

Predictive reasoning can shrink emergency repair costs and boost vehicle uptime by analyzing real-time engine data in context with external and historical information from an entire fleet of connected vehicles. This contextual view allows pending failures to be predicted more accurately, and can help prevent a minor fault from setting off a cascade of failures that may be much more expensive and time-consuming to repair.

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IoT in Trucking

Most newer truck models are being manufactured with telematics pre-installed. This, coupled with IIoT, helps fleet operators and service centers gain an expanded view into truck health. Adaptive diagnostics can determine the parts and procedures required to repair a problem, and can interface with parts inventory and dealer systems to determine the nearest location with the required parts so that trucks get repaired quickly and correctly. Because error conditions are identified and reported more accurately, the incidence of false positives, where no problem is found, and false negatives, where a problem occurs but was not flagged, is greatly reduced.

Ongoing maintenance can be done when absolutely necessary based on actual operating conditions, which keeps trucks on the road and generating revenue instead of being in the shop at too-frequent intervals. Unexpected breakdowns and related emergency expenses are avoided by performing service before failures occur.

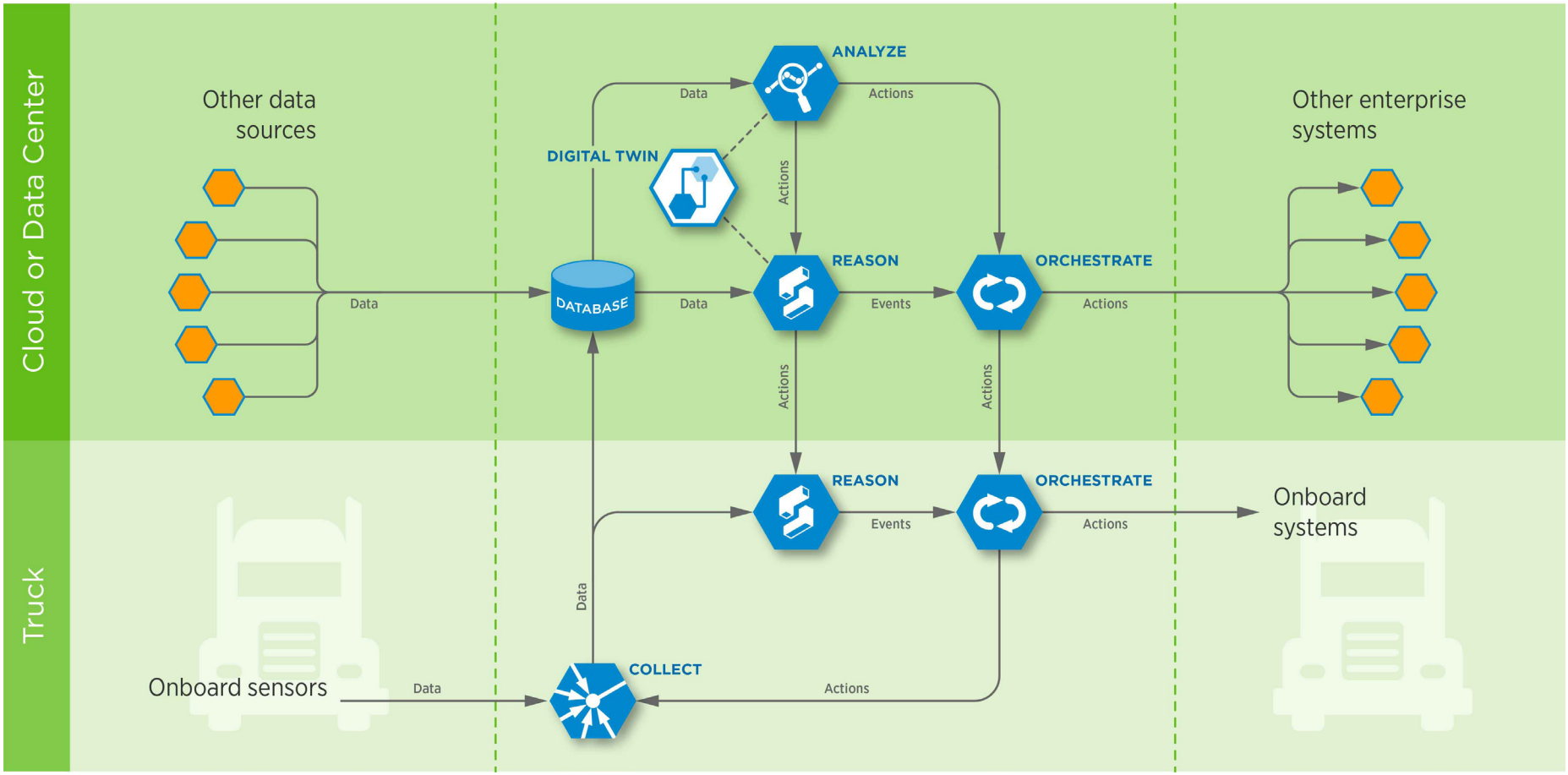
As the IIoT system becomes more intelligent over time through the application of machine learning and sophisticated analytics, predictive failure capabilities can help determine whether a truck needs service now or can wait until the end of the trip.

A Tale of Success

Peterbilt has significantly reduced Mean-Time-to-Repair (MTTR) and boosted first-time fix rates by implementing IIoT to help identify, diagnose, and repair failures. Existing telematics and remote diagnostic data from tens of thousands of trucks was combined with workflow automation software and historical repair records. Adaptive diagnostics was then applied to analyze these multiple data sources and generate detailed repair plans. Both diagnostics and repair plans are constantly refined as the system gains intelligence from the ever-expanding body of knowledge. Both Peterbilt and its service centers have benefitted from improved problem identification and more accurate, efficient repair processes.

This success isn't just the result of an ideal IIoT system. Rather, Peterbilt identified opportunities where IoT could help achieve business goals. They considered their existing technology, organizational readiness, desired outcomes, and established a plan where IoT could help them reach those goals.

Elements of an IoT system



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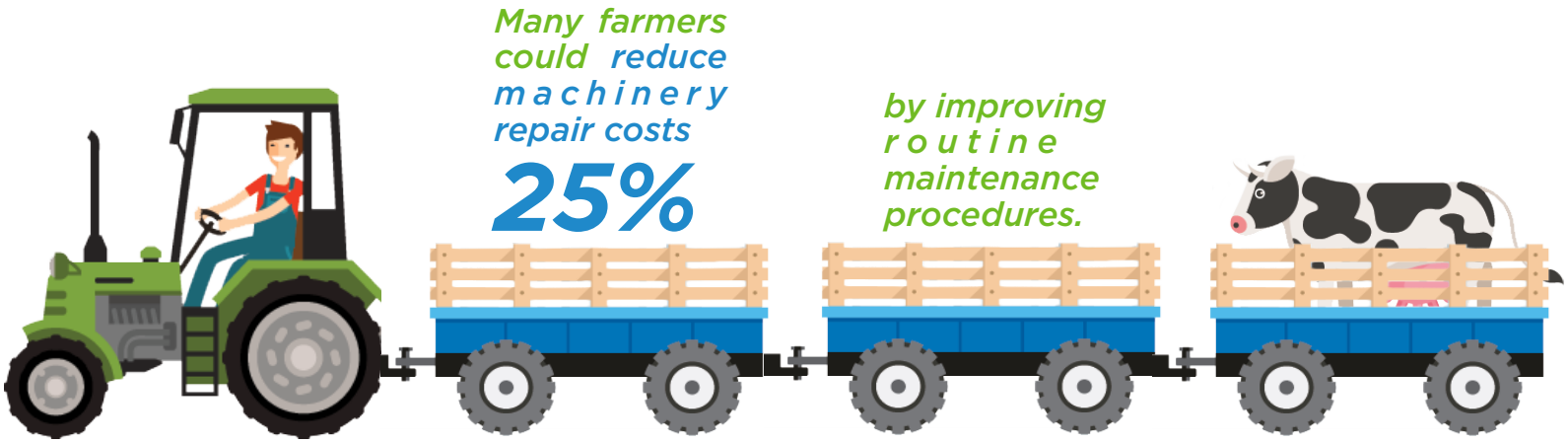
IoT in Agriculture

Example:
A $100,000 tractor can be expected to cost about $30,000 in repairs and maintenance over the course of its useful life.

A 25% reduction shrinks that cost to just under $22,500 by improving maintenance processes.

Farmers have been investing heavily in technology, including data collection and analysis, as a means to increase crop yields. Making sure large and expensive farming vehicles, from tractors and trucks to harvesters and combines, are in top operating condition is critical to ensuring crops can be planted, harvested, and delivered to market on time for the greatest revenue opportunity.

With repairs and maintenance representing a large portion of a vehicle's cost, farmers who reduce those costs can immediately improve profitability. A study of farmers in the Midwest showed that machinery repair costs could be reduced by 25% just by improving routine maintenance procedures. By expanding those savings across an entire fleet of equipment, savings can be significant.



IIoT can help farmers determine whether equipment is functioning optimally, and provide servicing dealers or maintenance companies with the necessary information to get repairs done quickly and correctly. By employing adaptive diagnostics to analyze multiple sources of information, from ag machinery engine data to repair and warranty records, the IIoT system can accurately determine the cause of a fault. Servicing dealers, who must often repair equipment in the field, receive detailed and accurate repair plans that let them know exactly what parts and technician expertise will be required to fix the problem right the first time and get machinery up and running as quickly as possible.

IIoT also tracks the actual operating conditions of equipment to facilitate condition-based maintenance. This significantly reduces the cost of ownership for machinery by servicing it only when actually necessary, yet making sure items requiring maintenance are identified for timely servicing.

Agricultural environments face several challenges in successful IoT adoption. One is the spotty or bandwidth-constrained connectivity present on many large and rural farms. To fully realize IIoT's benefits, a portion of the system should reside on the equipment to allow data to be examined and analyzed locally so that only that data necessary for further action must be transmitted.

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IoT in Construction

Construction vehicles and equipment often operate in fluid environments – jobsites change regularly and the inventory of equipment is unique to each site. Leasing companies that provide equipment to contractors have a strong business incentive to ensure their equipment is used only as and where it is supposed to be, and that it remains in excellent working order. In turn, contractors trust leasing companies with well-maintained, reliable equipment with their ongoing business.

By tapping the adaptive diagnostics capabilities of an IIoT system that collects and analyzes construction equipment engine data, operating and environmental conditions, maintenance and repair histories, and other contextual information, equipment faults can be repaired rapidly and correctly. The system uses multiple sources of data and complex event analysis to accurately determine the cause of a problem, and then generates repair plans that guide technicians with the parts and steps they need to fix the issue correctly the first time. Over time, the system gains knowledge and can help predict failures before they happen, maximizing uptime and heading off catastrophic failures.

IIoT can also help routine maintenance become more efficient by tracking duty cycles of operation, real-time engine data, and contextual information to identify when service is required based on the actual operating environment of each piece of equipment. With the insight provided by IoT, leasing companies and operators can then schedule maintenance when it has the least impact on a project. This reduces operational costs and extends equipment useful life, providing a better return on capital investment.

IIoT can also help enforce usage requirements through applications such as geo-fencing that only allow vehicle operation within the designated jobsite.

According to The Geaslin Group, there is an exponential cost increase for neglecting to repair a failing part. For example, continuing to operate a vehicle that needs a $40 brake block replacement can balloon to ***$1600 in mechanical and towing costs.***

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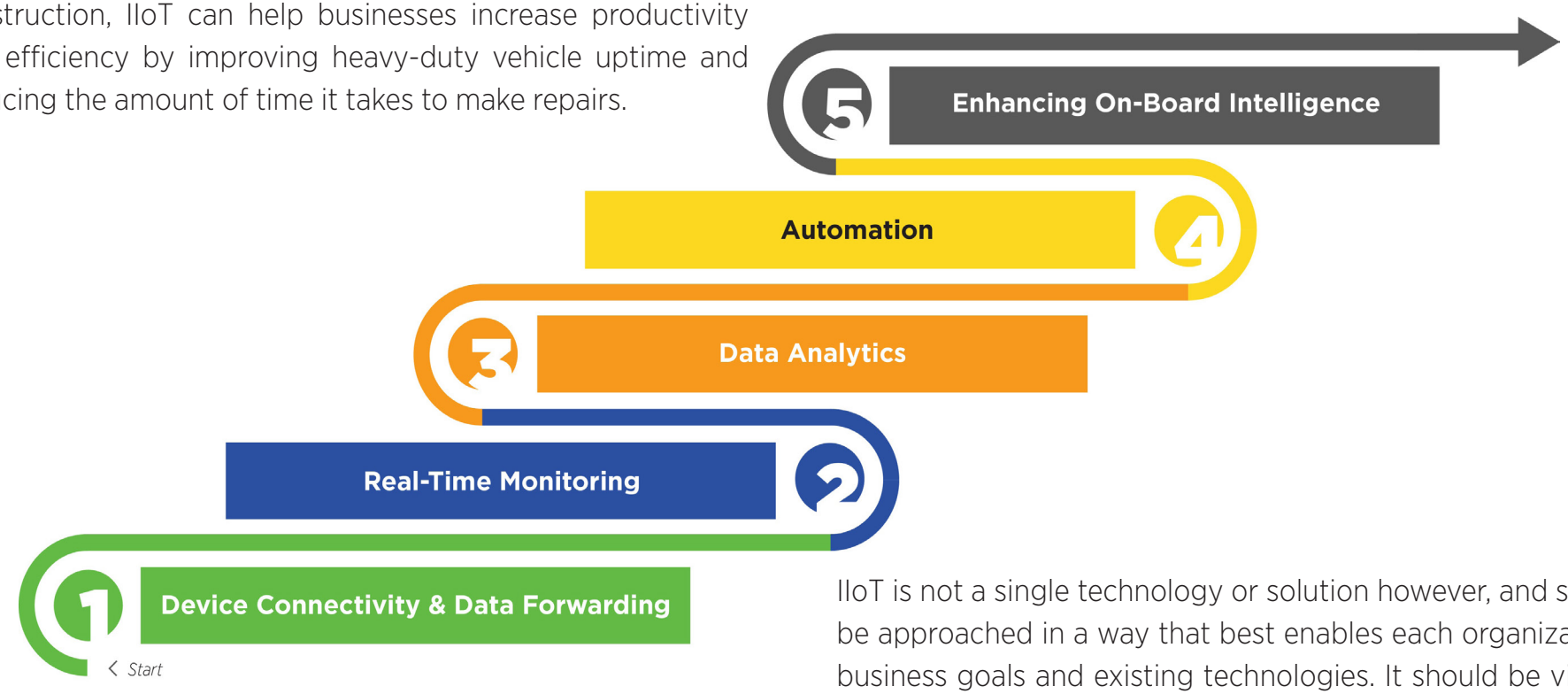
The 5 Stages of IoT Progression

Whether used in commercial trucking, agriculture, or construction, IIoT can help businesses increase productivity and efficiency by improving heavy-duty vehicle uptime and reducing the amount of time it takes to make repairs.



IIoT is not a single technology or solution however, and should be approached in a way that best enables each organization's business goals and existing technologies. It should be viewed as the basis for an overall strategy.

Stage 1: Device Connectivity & Data Forwarding

Today's sophisticated heavy-duty trucks, ag machinery, and construction equipment come outfitted with hundreds of sensors that collect myriad data and have a variety of connectivity options – from plug-in diagnostic reader ports to wireless modules. Previously, when problems arose, technicians had to physically plug in a laptop to review fault codes. From there, they'd attempt to troubleshoot the issue, which could take hours or days. Meanwhile, the vehicle sat idle; often inoperable for extended periods while parts were ordered and repairs made. Moreover, initial repairs often failed to resolve the issue – requiring even more downtime.

Now, connected engines provide that foundational first step of data collection and forwarding. However, investing in simple data collection and forwarding alone doesn't provide a corresponding business benefit. Realizing value from that data requires monitoring and alert capabilities. Further, network availability and bandwidth restrictions in highway, farm, and construction locations can frequently limit the amount of data that can be cost-effectively or efficiently forwarded.

Sensor data is transmitted and stored for analysis and action.

Stage 2: Real-Time Monitoring

Monitoring and visualizing connected engine data can deliver valuable performance insights. Either on site, or remotely via the cloud, dashboard systems display operational and environmental data in real time. This visibility allows companies to set alerts for faults or specific operating conditions. However, these notifications only indicate the symptom of a problem, not the root cause. Moreover, they still require someone take corrective action. Often, that's a time-consuming process involving steps like referencing a manual, ordering required parts, and coordinating repairs – either at a service center or on site.

Furthermore, many error conditions are not isolated, and often herald a larger issue. So without proper context, false positives and negatives threaten to either waste time on a nonexistent problem, or mask an issue until it becomes a large, unexpected failure. All of which underscores the limitations of basic dashboard solutions: the human element. Even the most experienced operators lack the sophisticated logic to handle the complexities and data volumes associated with modern heavy duty equipment. That said, they do provide a foundation organizations can build on to achieve their objectives.

Stage 3: Data Analytics

Analyzing complicated, multifaceted events, using multiple sources of data, is where IoT adds real business value. Applying complex event processing and adaptive analytics to vehicle data, plus multiple sources of historical and real-time complementary data, greatly enhances insight into the health of an entire fleet, and can reduce false positives by as much as 30 percent. Effective data analytics requires several elements: data discovery, machine learning, cluster analysis, and digital modeling. Together, they deliver valuable insight that drive better decision making.

When working to reduce repair costs and maximize uptime, just finding available technicians with the right expertise, and the right parts can be a challenge. So data insights that help identify underlying issues faster, and more accurately – improving first-time repair rates – are extremely valuable. Analytics can also help optimize repair plans, identify necessary parts, and guide less-experienced technicians. However, the massive amount of data fleets produce can overwhelm human minds, even with a dashboard, limiting the business benefit of analytics.

Delivers insight, predictions and optimization using many different types and formats of data. Reduces unnecessary false positives by an average of 25%.

Stage 4: Automation

Adaptive analytics provide a wealth of insight and awareness. Automation expands on this insight and allows the system to become progressively more intelligent by using dynamic rules to orchestrate complex actions across multiple areas of the organization, like service ticketing and inventory systems. Rules, such as those for data collection, are adaptable based on changing conditions.

For example, if a vehicle is operating normally, the system collects and transmits less data. But upon detecting an anomalous condition, it can execute a series of automated steps to correct the error. It can also automatically adjust a vehicle's operating parameters to keep it running, while minimizing damage, until repairs can be made. At the same time, it can generate work orders through the service ticketing system, order required parts, dispatch the closest and most qualified technician, and estimate repair time. At this stage, heavy-duty vehicle owners and operators can realize measurable business benefit from all of the use cases already outlined, including adaptive diagnostics, condition-based maintenance, and predictive failure.

Stage 5: Enhancing On-Board Intelligence

Adding intelligence and processing capabilities directly on board the vehicles themselves allows analytics and actions to take place at the network edge, even without connectivity. Bringing the logic to the data increases accuracy, conserves data storage and network bandwidth, and enables a wide range of additional use cases such as asset optimization. Plus farms, construction sites, and highways often have limited or highly constrained connectivity, such as cellular or satellite communications, so transferring large amounts of data can be cost-prohibitive.

By taking advantage of computing capabilities that already exist on many of today's heavy-duty vehicles, data analytics and automation can occur directly on board, in real time. This avoids data transfer challenges, while enabling powerful analytics capabilities to deliver all the benefits of a fully connected solution. Analyzing 100% of the data leads to faster, more accurate results, while eliminating the need, and associated costs, to transmit and store unnecessary data. Conserving bandwidth for communicating key results and any associated actions required beyond the vehicle.

Provides maximum ROI and business benefit from predictive failure, data-driven diagnostics, and device optimization.

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An Illustrated Example

Consider a scenario where engine coolant temperature is rising, most likely caused by a faulty water pump or broken drive belt. By monitoring and examining the HVAC system in addition to the engine, the IIoT system can recognize that the AC compressor is not turning, indicating that the drive belt is the likely cause. This information can be used to alert the servicing dealer so they can perform repairs quickly and accurately.

1 *Rising coolant temperature triggers a fault code. The system analyzes HVAC data in conjunction with the fault code and determines the AC compressor is not turning.*

2 *Identifying the drive belt as the probable cause, the system creates a detailed repair plan with step-by-step instructions and parts lists based on engine specification data, the vehicle's repair history, and historical information from the entire fleet.*

The repair plan is sent via workflow automation software to the servicing dealer, generating necessary parts orders. The dealer can then assign the appropriate technician to perform repairs.

3

The technician's status, location, and estimated time to repair is continually communicated to key stakeholders: the driver, the servicing dealer, and the fleet operator.

4

A junior technician armed with the repair plan and parts is dispatched to the vehicle and is able to replace the drive belt as correctly and quickly as a master technician.

5

The system updates its data repository with this new repair information and links to the dealer warranty system to initiate a claim.

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Summary

IIoT can unequivocally improve vehicle uptime – spelling greater productivity for heavy-duty trucks that are rolling revenue generators, farmers that are producing ever-increasing crop yields, and construction companies that must complete projects within budget and on time. And while the technology is a crucial element, a successful IIoT initiative is a cross-organizational effort with shared business goals that is best undertaken in stages, rather than an "all or nothing" approach. It is important to view IoT as a maturity progression as an organization's business needs and IIoT implementation evolve. The desired business outcomes will determine whether it is necessary to complete all five stages. The best way to determine where to start and finish an IIoT implementation is to have a clear strategy, plan for execution, and an understanding of what constitutes success.

About Bsquare:

For more than two decades, Bsquare has helped its customers extract business value from a broad array of assets by making them intelligent, connecting them, and using data collected from them to improve business outcomes. Bsquare software solutions have been deployed by a wide variety of enterprises to create business focused Internet of Things (IoT) systems that can more effectively monitor assets, analyze data, predict events, automate processes and, in general, optimize business outcomes. Bsquare couples innovative software with advanced professional services that can help organizations of all types make IoT a business reality.

To find out more about Bsquare and how your organization can best embrace IoT for maximum impact, please email sales@bsquare.com or call 425-519-5900.

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