HOW TO IMPROVE LOGISTICS OPERATIONS WITH EDGE INTELLIGENCE

COGNEX

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Modern logistics operations are transforming themselves as technology and customer demands change. But even as they are trying to adapt, they find that they lack the detailed data about their operations that they need to plan effectively. Their inventory numbers are inaccurate, their control over delivery expectation accuracy inadequate, and their ability to ensure vendor compliance is limited. In the absence of reliable data, it is difficult to accurately identify which factors are the largest contributors to missed and delayed shipments, and thus what investments should be made to improve delivery speed and accuracy.

Barcode readers improve the situation by providing an identification and tracing solution. They produce data such as no-read images and code location, that can be used as a proxy for machine and process health. However, analyzing the root cause of no-read images or trends in code quality; whether it is coming from printing, label application, or packaging, is still a challenge using isolated barcode readers.

Edge computing technology provides a significantly more granular view of all events in the distribution center, make it easy to identify the cause of each no-read, and allow a transparent view of the supply chain. Edge computing allows the data from all lines and stations to flow seamlessly to other systems in the distribution center and warehouse, while simplifying device management and upgrades.

THE COMING TRANSFORMATION OF LOGISTICS OPERATIONS

Consumer demands are putting increasing stress on retail supply chains. Major e-commerce platforms are competing for market share by offering faster delivery, improved on-time delivery accuracy, and more granular tracking services to show en-route package locations in near real-time.

The competitive environment of retail distribution and e-commerce continually demands faster, more reliable, and more trackable delivery. COVID-19, with its quarantines and restrictions on brick-and-mortar businesses, has led to a vast increase in buying from home, accelerating these existing trends.

This has led logistics operations to invest heavily in new technologies, including automated guided vehicles (AGVs), system automation, and advanced machine vision cameras, but, more significantly, in technologies that improve data creation, processing, and management. As the level of automation increases, so does the need for more accurate data across the supply chain.

Logistics managers are hungry for data that will highlight previously invisible inefficiencies in the supply chain so that they can be fixed, improving delivery expectation and inventory accuracy, and so providing a better customer experience.

The new Cognex Edge Intelligence (EI) platform works in coordination with machine vision systems and other third-party components to enable improvements in many crucial areas of logistics.

Three significant areas that are driving the need for EI are inventory accuracy, order fulfillment accuracy, and vendor compliance.

Inventory accuracy

Historically, all supply chains have suffered from inventory accuracy problems. Inventory accuracy at distribution centers has ranged from 89 percent up to 99 percent, but in retail stores it has often been below 60 percent, because inventory management and stocking has been largely manual.
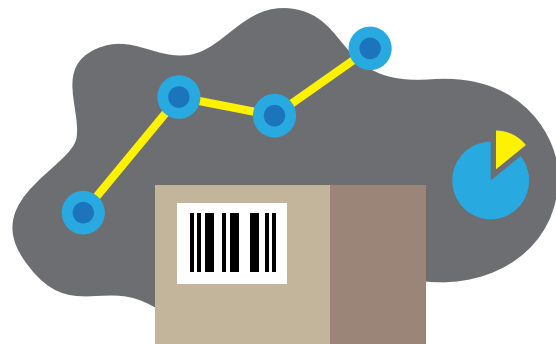
The requirements of omnichannel shopping are putting these inventory levels online for all to see at the same time that increased range of purchasing channels, including online, curbside or traditional stores, and POS checkout, has made it even harder to track inventory.
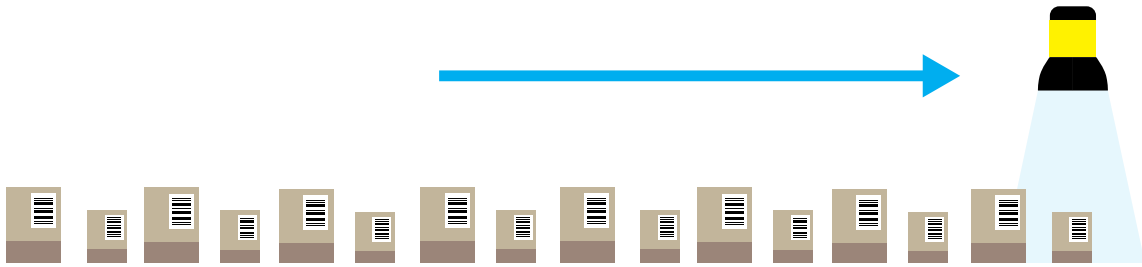
Delivery expectation and order fulfillment accuracy

The proliferation of digital technology and fast shipping options from e-commerce platforms, such as Amazon, have shaped consumers' need for immediate gratification. Under pressure from online retailers, brick and mortar retailers have responded with omni-channel strategies such as buy online and pick up in-store (BOPIS) that offer fast turnaround to compete for market share more effectively.

Retailers must also provide the ability to track current product location in near-real-time and guarantee the delivery of the exact stock-keeping unit (SKU) ordered.

Vendor compliance

Large retailers deal daily with many vendors, and so institute vendor compliance guidelines to ensure that products adhere to standards, including tracking labels and box construction, to ensure that incoming products can be reliably scanned, sorted, and tracked in inventory. Barcode quality problems are a common reason vendors incur fines for noncompliance, called chargebacks.

Property	Value	Grade		Average
⊟ ISO/IEC 15416 * (UPC/EAN: 6942023334844-OG:C,SC				
Symbol Grade		C	✅	
Symbol Contrast	+0.625	B	✅	B
Modulation	+0.537	C	✅	C-
Minimum Reflect...	+19.400	A	✅	A
Edge Contrast M...	+0.337	A	✅	A
Edge Determinat...	+60.000	A	✅	A
Defects	+0.149	A	✅	A
Reference Deco...		A	✅	D
Decodability	+0.585	B	✅	C

Irregularities
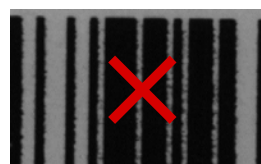
Bar Width Growth/
Loss or Distortion

How to Improve Logistics Operations with Edge Intelligence

LOGISTICS 4.0: HOW LOGISTICS AUTOMATION IS FOLLOWING FACTORY AUTOMATION

Industry 4.0 is the culmination of automation, big data, cloud computing, and connected machines that has transformed industrial and manufacturing operations. The Industrial Internet of Things (IIoT) enables machines with data capturing sensors to connect to the internet, each other, and larger systems.

The data generated by these sensors is integrated and analyzed, delivering insights that are used to optimize manufacturing operations. Machine vision systems play a large role in this process by providing real-time performance data and images that assist with operational decision-making.

Logistics, with its complex, highly manual processes, has been more resistant to automation than other industries, such as manufacturing. But demands for greater speed, volume, and accuracy are now bringing about what is increasingly called Logistics 4.0.

The goal of Logistics 4.0 is to acquire trustworthy real-time supply chain data, make moment-by-moment decisions based on that data, and then instantly and flexibly implement those decisions in the distribution center, while complying with all regulations and guaranteeing worker safety.

Technological innovations such as robotics, autonomous vehicles, increasingly automated systems, and sophisticated machine vision systems are having a significant effect, but even more important are the advances in data creation, processing, and management technologies.

With smaller lot sizes, changing production sequences, and complex line-feeding systems, the need for quicker decisions at lines and workstations is growing, a need that will be met by distributed data collection from image-based barcode readers, dimensioning systems, and other smart devices, a process called edge computing.

Barcodes are the foundation of all tracking, monitoring, and decision making in a distribution or fulfillment center, and the first step to Logistics 4.0 is the propagation of barcode readers, particularly image-based barcode readers, to every corner of the facility.

USING EDGE INTELLIGENCE TO TRANSFORM LOGISTICS OPERATIONS

Linking image-based barcode readers to edge computing processors in the distribution center (DC) provides managers on the floor with real-time visibility into DC operations so that they can quickly identify problems and fix them, increasing overall equipment efficiency (OEE) without having to replace or upgrade any existing equipment.

Real-time performance monitoring

The number and variety of barcode readers and other devices in DCs have increased dramatically. Scan points have become more complex, with a large number of readers in a scan tunnel, and the image-based barcode readers and other cameras are themselves vastly more capable.

The number and variety of packages to be processed have also risen at the same time as requirements for accurate on-time delivery and fast processing of returns are becoming stricter. Maintaining performance and accurately reporting on what has gone through the line requires accurate real-time monitoring.

Most DC managers have access to aggregate performance numbers which are of limited use in tracing and fixing specific problems. A real-time monitoring system, by collecting fine-grained performance data, can deliver detailed insights into read rate trends and causes of no-reads to the DC managers. Armed with this information, they can notice issues and take corrective action, sometimes even before they have significant operational impact.

What caused the no-read?

The cause of a no-read can be surprisingly difficult to identify, particularly at the speeds of modern sorting lines. But by continuously picking up every one of the many kinds of data from every camera, Edge Intelligence provides continuous and detailed monitoring of performance, and combines and normalizes it all to form a detailed historical record of conditions on the line.
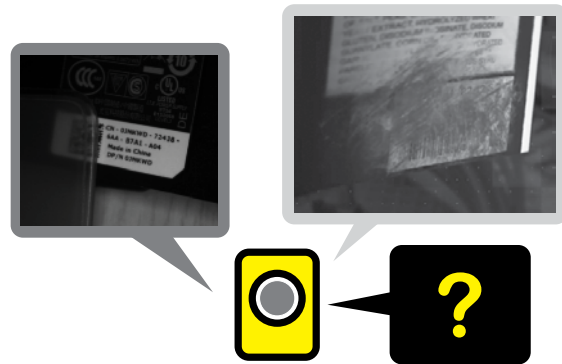
Are labels being creased in box flaps, or is some new employee putting packages on the line upside down?

No-read problems such as labels creased in box flaps, packages put on the line upside down, and package gaps being too small leading to two packages being read as one.

If read rates have dropped because labels are being creased in box flaps, that cause can quickly be distinguished from the fact that a new employee is putting boxes on a line upside down. And if they have dropped because of a change in package gap, there is no need to make any changes to barcode readers or labeling because the cause is some problem with material handling, whether wear in the conveyor, a problem with a trigger, or a bad encoder.

Every time no-reads start showing up, the manager could look back to see if any anomalies preceded that event. Eventually, it becomes possible to spot the first signs of a possible problem and take action to prevent it. And all no-read images are collected and can be analyzed for performance metrics and to provide a record if there are regulatory or audit concerns.

Predictive maintenance and OEE

Lines run 24x7 at high speeds, so unanticipated equipment problems that cause line shutdown can result in slowdowns throughout the supply chain, with significant costs. Analyzing device data over time can reveal potential issues. If increasing wear causes a printer to misplace labels so they tear, or one station tends to orient boxes incorrectly, or a certain vendor's boxes tend to show problems, it becomes possible to link causes and effects, ensure that service is performed when needed, and keep the line operating by anticipating problems.

If a conveyor or system is running a bit slower and is getting overloaded, product can be quickly rerouted to another line that is having better performance. The data on the problem goes up to cloud applications for long-term aggregated analysis, and the system can be taken out of operation when things slow down to be maintained and repaired.

Changes in volumes over time can identify when peaks and valleys occur and tie those to events outside of line operations, to vendors, delivery schedules, or other circumstances.
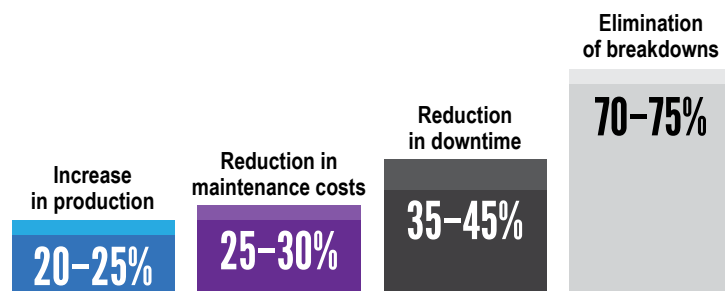
Edge Intelligence provides the ability to drill down to one specific reader in a tunnel and examine it in detail, seeing if there are issues with it, and if there have been any adjustments made to it—workers on the line sometimes tweak readers to correct immediate problems, but creating hard-to-trace performance issues for the entire system. EI makes it straightforward to drill down to the root cause of performance problems.

Overall equipment efficiency is the biggest driver for any e-commerce, retail, or parcel post operation, and this ability to anticipate device failures and to pinpoint problems quickly and fix them promptly has a strong effect on OEE.

Improved analytics and reporting

Over time, it becomes possible to detect the first signs of upcoming failure long before there is any effect on performance.

Independent surveys of energy companies indicated the following industrial average savings resulting from a functional predictive maintenance program:

Elimination of breakdowns
70–75%

Reduction in downtime
35–45%

Reduction in maintenance costs
25–30%

Increase in production
20–25%

Source: US Department of Energy O&M Best Practices Guide, August 2010

Edge Intelligence makes it easy to automatically generate and push reports at regular intervals, providing managers with all necessary metrics at times convenient for making decisions about them.

Alerts can be set for immediate notification if the performance of a device or function drops below a predetermined threshold.
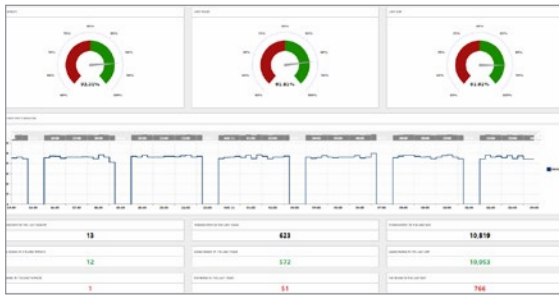
Performance dashboards

Read rate trends

The costs of inefficiency

With extremely high-volume operations even a small error rate can result in a large number of packages diverted to the hospital lane. But because of the large number of different reasons for those rejections, there may still be no cost-effective way to deal with them without costly manual work.

At a 99 percent read rate, a distribution center that handles 230,000 packages a day will have ~2,300 no-reads that need to be processed manually. Operators who make $15/hour and require 1.5 minutes of rework for each no-read package cost over $300,000 annually. Lost or delayed packages also incur an estimated $400,000 in additional customer retention costs.

Increasing that rate to 99.9 percent reduces the number of no-reads to 230, and the estimated annual cost of operators to $30,188, an annual saving of over $270,000, with additional savings in customer retention costs of $360,000.

Table 2. High-volume Distribution Center Read Rate/Labor Cost Analysis

| Read Rate	No-Reads	Maximum Number of Packages/Day	Total Rework Time (Man Hours/Day)	Number of Operators Required to Handle Rework	Cost of Operators (USD/Year)
97%	6,878	222,385	171.95	21.5	$902,737.50
98%	4,586	224,678	114.65	14.3	$601,912.50
99%	2,293	226,971	57.33	7.2	$300,956.25
99.5%	1,147	228,117	28.68	3.6	$150,543.75
99.9%	230	229,034	5.75	0.7	$30,187.50

Table 3. High-volume Distribution Center Read Rate/Customer Retention Cost Analysis

Read Rate	No-Reads	Maximum Number of Packages/Day	No-Reads That Become Lost/Late to Customer	Daily Customer Retention Cost for Lost/Late Pkgs	Customer Retention Cost for Lost/ Late Pkgs (USD/Year)
97%	6,878	222,385	688	$3,439	$1,203,650
98%	4,586	224,678	459	$2,293	$802,550
99%	2,293	226,971	229	$1,146	$401,275
99.5%	1,147	228,117	115	$574	$200,725
99.9%	230	229,034	23	$115	$40,250

With the large volumes handled by distribution and fulfillment centers over a year, even seemingly small gains in efficiency can result in significant labor and other savings. Edge computing is an investment that pays off quickly and has a significant effect on the bottom line in a competitive industry.

Device management

As the number of different devices involved in scanning, sorting, and routing has increased, the problems of setting them up, updating them, and monitoring them have become increasingly complex. With a handful of devices, a setup tool that walked the user through a series of steps was easy enough to use.
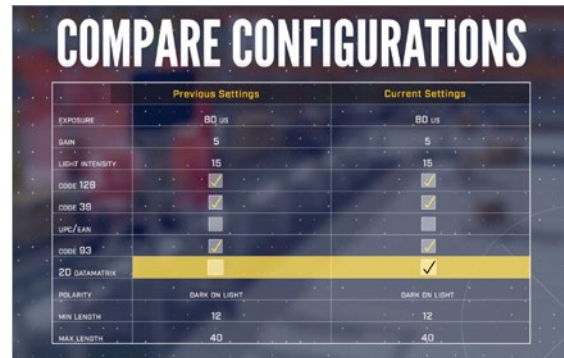
Now a tunnel can contain a large number of readers, along with a range of other sensors and devices. Over time, the software version on each camera can diverge from others, making diagnostics almost impossible.
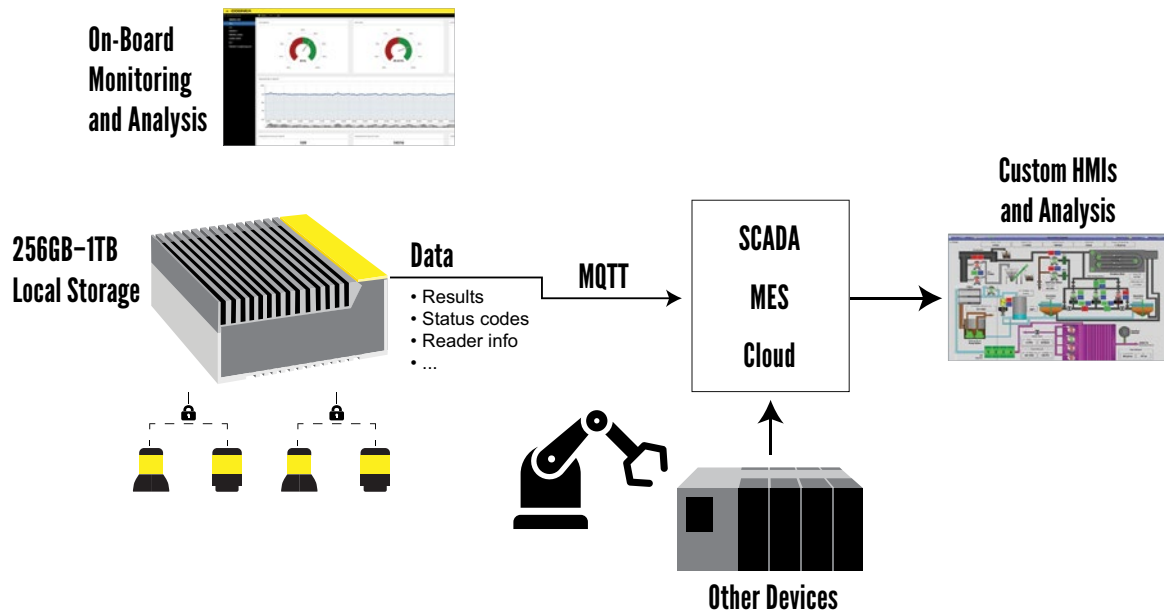
Edge intelligence sets IP addresses, loads firmware, and installs configuration files for multiple cameras simultaneously, ensuring that each has exactly the same features and software, and that throughout their deployment there is no variation in software from one to the other. It also provides a log of all configuration changes in case a software change negatively affects performance and needs to be rolled back.

Data transportability, connectivity, interoperability, and security

In addition to real-time performance monitoring, Edge Intelligence data serves as an input to WMS, ERP, MES, SCADA, and SCM, and other analytics software such as Ignition. EI can generate data in a wide range of formats usable by other systems, and uses the robust Message Queuing Telemetry Transport (MQTT) service for transporting data where it can be used for decision-support.

In addition to connecting to customer back-end systems, EI provides out-of-the box connectivity to cloud services, allowing access to image and device data. This provides users greater opportunities to boost operational efficiencies with analytics across multiple lines with rich contextualized data. It opens the possibility of providing new tools and value-added services, such as remote support, accessible not only in the DC, but also by other key personnel, who may be working in another facility..

The rich data that EI collects has tremendous value to an organization. EI protects the data it gathers with secure local storage. When forwarding data to other systems for analytics purposes, EI uses the built-in encryption capabilities of MQTT to ensure data is secured while in route.

On-Board Monitoring and Analysis

256GB–1TB Local Storage

Data
• Results
• Status codes
• Reader info
• ...

MQTT

SCADA
MES
Cloud

Custom HMIs and Analysis

Other Devices

Solving the key problems of logistics

Automating inventory stocking and supporting inventory management with Edge Intelligence tracking of every touchpoint dramatically increases inventory accuracy.

The supply chain transparency that comes with widely deployed image-based barcode readers and EI reduces the number of lost packages and misidentified products, ensures that items move through the DC at maximum rates, and minimizes the number of packages that miss getting on a truck.

For vendor compliance, EI makes it possible for retailers to instantly determine the barcode quality and accuracy in any incoming shipment and vendors to ensure the quality of the barcodes they put on their outgoing shipments. In case of dispute as to where damage or inadequacy occurred, both benefit from acquiring and storing barcode and product images.
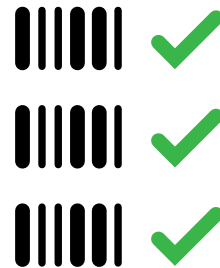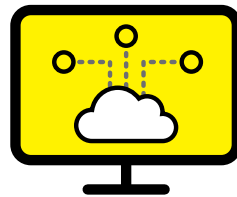
EDGE INTELLIGENCE: THE LOGISTICS-SPECIFIC EDGE COMPUTING SOLUTION

A good Industry 4. 0 solution for logistics will have several key characteristics.

• It will be easily installed without interfering with DC workflow and show immediate benefits. There are so many unidentified no-reads and missing packages in even the best-run of distribution centers, that access to information about root causes should allow for quick process improvements. Analytics and reporting will identify issues with devices, tunnels, and the facility.

• It will give accurate control over all devices, making it straightforward to update the software on multiple devices, control tunnels as single devices, and guarantee that all devices contain the same software version.

• An edge computing solution provides compute power right at the edge. It should provide means to not just aggregate, but also enrich the diverse set of incoming

data streams (data, images) and therefore, provide highly contextualized insights and analysis for informing DC and WMS operations. Examples include: improved rating of vendors, identification of bottlenecks, and planning for switching from conveyors to autonomous mobile robots (AMRs), replacing employees with other forms of automation, and a wide range of other decisions.

• It should not require users to learn about vision systems, statistics, protocols, or interface design. The interfaces and software tools should be specific to logistics use cases and show an awareness of the specific needs of logistics operations.

Improving speed and accuracy in the distribution or fulfillment center requires greater visibility into what is happening on the line in real-time. Edge computing provides that visibility to logistics managers.

The Cognex Edge Intelligence Platform brings smart data collection and real-time performance metrics to the distribution center. It is fully integrated with Cognex fixed-mount devices and logistics tunnels and uses the full range of data from these devices to provide a logistics-specific visual dashboard of real-time system performance. It will support expansion and integration across the supply chain and existing software systems.

BUILD YOUR VISION

2D VISION SYSTEMS

Cognex machine vision systems are unmatched in their ability to inspect, identify and guide parts. They are easy to deploy and provide reliable, repeatable performance for the most challenging applications.

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3D VISION SYSTEMS

Cognex In-Sight laser profilers and 3D vision systems provide ultimate ease of use, power and flexibility to achieve reliable and accurate measurement results for the most challenging 3D applications.

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BARCODE READERS

Cognex industrial barcode readers and mobile terminals with patented algorithms provide the highest read rates for 1D, 2D and DPM codes regardless of the barcode symbology, size, quality, printing method or surface.

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COGNEX

Companies around the world rely on Cognex vision and barcode reading solutions to optimize quality, drive down costs and control traceability.

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