Internet of Things (IoT) technologies enable data analysis and decision-making in close proximity of products throughout their journey

Overview

“Intel ships over 170,000 tons of goods and materials every year. Imagine the possibilities when these shipments are smart and connected. The data gathered and communicated en route will help us improve numerous business decisions like rerouting if demand shifts or intercepting a damaged shipment. By analyzing data from thousands of shipments, we'll be able to predict and avoid routes where damage or delays are likely, establishing a more reliable distribution network. I'm especially proud that my supply chain team partnered with Intel's Internet of Things Group to develop this solution,” says Tony Romero, Vice President, General Manager, Customer Fulfillment, Planning, and Logistics, Intel Corporation.

A transformational process improvement that could give a service provider a significant competitive advantage is to increase shipment visibility (e.g., location, condition (temperature, humidity, shock, tilt) and integrity (e.g., tampering, theft) of shipments as they move through the supply chain to their final destination. Shippers can save shipping costs through early detection of damaged products, allowing them to be rerouted to avoid the cost of a complete round-trip journey. Increased product visibility can also reduce freight claim liability through a better understanding of the conditions that cause damage, making it possible to mitigate future damage and reduce the number of claims. Moreover, damage detection gives the customers of service providers a jump start on implementing a recovery plan.

With IoT technologies as a baseline, Intel is working with solution providers to enable logistics and asset management solutions that deliver near-real-time visibility and insights from data analytics. This solution brief describes how this is achieved using Intel's cost-effective shipment, trailer, and inventory visibility solutions that feature a hub-and-spoke architecture.

Solution overview

In many industries, such as manufacturing, retail, and energy, IoT technologies are being used to digitize and automate processes with the goal of decreasing operations costs. Intel is now bringing these technologies to the logistics and transportation industry in the form of a platform upon which original equipment manufacturers (OEMs), original design manufacturers (ODMs), cloud service providers (CSPs), and other solution providers can build product tracking applications.

The solution has low-cost sensor tags, gateways, and cloud components, as shown in Figure 1. A one-time-use sensor tag attaches to a package, collects package data (e.g., temperature), and sends it to a gateway over a proprietary wireless sensor protocol. The battery-powered gateway analyzes the data, sends alerts to logistics personnel when warranted, and communicates with cloud-based tracking applications, which are developed by solution providers.
Logistics and asset management solutions enabled by Intel’s shipment, trailer, and inventory visibility solutions overcome several key challenges, including:

**Package-level data**
The location, condition (temperature, humidity), and handling (tilting, dropping, shock, vibration, open box) of packages can be tracked on an individual basis (Figure 2).

**High deployment cost**
Sensor tags communicate via a relatively low-cost proprietary wireless sensor network (compared to a 3G/4G network), making their bill of materials (BOM) rather inexpensive and in the range of USD 15.

**Sensor tag communications**
Hundreds of sensor tags can communicate with the gateway via a low-power, proprietary wireless sensor network. The bill of materials (BOM) of the sensor tags is cost optimized by transferring expensive parts such as GPS and modem, etc. to the gateway.

**Wireless interference**
If communication between a sensor tag and the gateway is blocked, such as when a package is buried under other packages, messages are routed through the other tags, establishing a secondary link to the gateway, thereby establishing a detour link to the gateway.

**Poor mobile network coverage**
Gateways in trailers and cargo containers can make decisions and send predictive alarms without conferring with the cloud, which is critical when shipments are out of range of mobile networks (3G/4G).

**Logistics service provider and shipper benefits**
Using Intel’s solution, service providers can benefit from a high level of scalability and vendor choice, and low deployment costs through economical sensor tags. Other advantages include:

**Improved tracking of packages and trailers**
The solution enables cost-effective and continuous monitoring of shipments, providing feedback when their location or condition changes unexpectedly and informing about the location, condition, and loading of trailers. In near-real time, alerts can be sent when packages are damaged, opened, stolen, or handled outside guidelines (e.g., tilting, temperature, humidity), allowing for quick remediation.

**Data protection throughout a package’s journey**
Confidential asset information contained in shipping data is protected through encryption from sensor tag to gateway to cloud. The gateway itself is protected against attack with a combination of hardware- and software-based security technologies that establish layers of security mechanisms to further safeguard the device.

**Thorough assessment of package condition**
The solution analyzes sensor-tag data to evaluate package handling and condition, such as distinguishing whether a package was carefully taken off the truck, fell off the truck, or was carried off by a thief. Thoroughly analyzing the data, the gateway can minimize costly false positives (alerts of nonexistent problems) and send predictive alarms about imminent issues, like spoilage due to refrigeration failure.

**Reverse logistics cost**
In the future, the use of sensor tags and fixed, permanently installed gateways in warehouses, trucks, planes, ships, and trains will greatly simplify reverse logistics, which is the management of return of the gateways.

**Solution provider benefits**
Intel’s solution is based on a flexible IoT architecture that was designed to help solution providers reduce the time and cost needed to develop logistics and asset management solutions. The architecture integrates scalable Intel® processor-based computing platforms, Intel reference design-based sensing tags, Intel® Security software, Wind River development environment, and an Intel-developed wireless sensor network.
protocol, among other building blocks. This standards-based approach improves interoperability and time to market for solution developers and service providers.

**High level of scalability and interoperability**
Based on a road map of scalable Intel® architecture processors, the solution can be cost-effectively sized to meet a wide range of deployment scenarios. An Intel-developed wireless sensor protocol supports hundreds of packages by giving sensor tags a defined communication window to avoid inundating the gateway with simultaneous messages. If a sensor tag cannot communicate with the gateway due to an obstruction (e.g., concrete wall or a large liquid container), its messages can be passed along by another sensor tag.

Because it’s standards based, the solution makes it easier to add new sensor tags and features. Standards also promote interoperability, which Intel and other Open Connectivity Foundation (OCF) members are advancing by creating open, standardized software protocols for use in IoT solutions.

**Reduced effort to implement security mechanisms**
The Intel solution has built-in security mechanisms to lower the effort needed to design in robust security. As a result, it takes less effort for solution providers to incorporate security features, allowing them to spend more time on developing logistics and asset management applications.

**Opportunities to differentiate**
The gateway has sufficient computing power to run sophisticated, differentiated vendor applications at the edge. A rules engine enables the gateway to make decisions and act on its own, such as initiating local alerts, even when it has temporarily lost communication with the cloud.

**Solution architecture**
Intel’s shipment, trailer, and inventory visibility solutions can help reduce solution cost with its hub-and-spoke architecture, as shown in Figure 3. A mobile or fixed gateway (hub) connects to the cloud and runs applications locally, allowing expensive components (e.g., 4G radio) to be taken out of the sensor tags (spokes). Sensor tags provide product movement and condition data that is ingested and analyzed by gateways and applications running in the cloud. The architecture supports edge intelligence and high data fidelity to reduce false alarms.

An application program interface (API) simplifies communications between cloud applications and gateways. A typical application example is sending an alert to a logistics company so it can quickly respond to unexpected conditions a package encounters. Other application software possibilities are process tracking, inventory location tracking, and replenishment notifications.

**Take advantage of digital transformation**
Solution providers can take advantage of Intel’s shipment, trailer, and inventory visibility solutions to develop applications that improve efficiency and reduce operations costs for the logistics and transportation industry. Intel’s approach helps reduce the cost of sensor tags while putting computing power at the edge to enable innovative features and services. For more information about Intel’s solutions, contact your Intel sales representative.

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