SOLUTION BRIEF

Intel® IoT
Industrial Wearables

Connected Workers: The IoT Industrial Revolution

IoT Solutions for Urban Firefighters and Industrial Workers

Connecting the industrial worker to the digital world via wearable intelligent sensors is now becoming a viable reality.

Industrial Wearables Keep Workers Safe, Productive

The IoT industrial revolution is under way. Innovation on this level is made possible through the convergence of global industrial systems with advanced technologies like big data analytics, low-cost sensing, energy-harvesting smart devices, and more. This is all fueled by new expectations associated with the rapidly and globally expanding demand for more connected things.

On the industrial level, the Internet of Things (IoT) revolution not only connects the unconnected to maximize operational efficiencies, but also dramatically improves the way people work by connecting them directly to their work environments.

WEARABLES FOR CONNECTED WORKERS

- Sensor-data fusion improves local intelligence
- Non-verbal gesture communication
- Activity detection

Connecting the industrial worker to the digital world via wearable intelligent sensors is now becoming a viable reality. This capability provides solutions that improve worker efficiency and safety, including hands-free operations of industrial equipment and worker activity detection.

Finding Value in Sensor Data

Just as collecting and analyzing factory-level data creates efficiency, boosts yields, and reduces downtime, fusing data with wearable sensor technology enables improved local intelligence as well as remote visualization of the most important assets—the workers.

Together, Honeywell and Intel have developed a IoT proof of concept (PoC) for the Connected Worker. The Connected Worker can take many forms—factory laborer, mine worker, first responder, firefighters and more. For each environment and worker role, a different selection of sensors may be appropriate to provide the most meaningful IoT-fueled dataset to represent that individual worker asset.

As with most IoT solutions, it is critical to avoid being overwhelmed by a steady stream of meaningless data. Rather, is essential to send select actionable intelligence to the cloud for visualization and customized alert notifications.

The downside is that data from individual wearable devices—if viewed independently—can potentially cause false alarms and contribute to inefficiencies in manpower as a result. Fusing sensor technology with big data processing (hub/gateway), analytics—all in the cloud—is the key to improving local intelligence as well as remote visualization of actionable intelligence.

Honeywell

Proof of Concept for the Connected Worker

The Connected Worker Proof of Concept (PoC) includes a wearable mobile hub providing the vehicle for unparalleled sensor-data fusion of worker-worn wearable devices. These wearable sensors include several solutions based on one of Intel's latest low-power edge processors, Intel® Quark™ SE microcontroller, which provides a sensor hub combined with pattern-matching technology for sensor data stream processing and pattern recognition as well.

In addition to the Intel-based wearable solutions, the PoC includes Honeywell's Self-Contained Breathing Apparatus (SCBA). This sends data via Bluetooth* Low-Energy (BLE) short-range wireless communication to a wearable mobile hub for sensor fusion and transmission of data via Wi-Fi or cellular to the cloud for data ingestion via Trusted Analytics Platform (TAP) and visualization on an AWS hosted central incident command application.

Plus, the wearable mobile hub provides highly accurate worker positioning data. With the combination of worker location, gesture communication, and activity detection, this solution provides true remote situational awareness.

Determining the accurate location of workers within a facility is made possible by Intel® WCS8270 Wi-Fi technology—providing indoor positioning based on IEEE 802.11mc Fine Time Measurement (802.11mc FTM). This is generated within the mobile hub while the 802.11mc FTM coverage is achieved by installed "802.11mc FTM Responder" devices throughout the building.

In the PoC, the "FTM Responder" devices are based on an Intel Quark SE microcontroller integrated with Intel Wi-Fi supporting 802.11mc FTM on Intel® Galileo Gen 2 Development Platform. The Mobile hub is comprised of an Intel based smartphone with Intel's Wi-Fi WCS8270 supporting 802.11mc FTM, running Android Lollipop*.

Inside the Intel Quark SE Microcontroller

The Intel Quark SE microcontroller contains three parallel processing elements:

1. Intel Quark core (minute IA-based host processor)
2. Sensor hub subsystem with ARC core (for sensor stream preprocessing)
3. Pattern matching technology, a hardware accelerator for fast, low-power pattern recognition of sensor data

The pattern matching technology feature available on the Quark SE microcontroller is unique in that it is not programmed using traditional instruction code, but rather is loaded with a memory array that embodies a set of sensor derived feature vectors which allow a highly parallel set of processing elements to classify live sensor datastreams against familiar patterns of interest. Using an Intel cloud analytics tool, a captured set of raw sensor training data is labeled to define distinct pattern classes and this training data is then used to configure the pattern matching technology with the desired patterns for detection. When a familiar pattern is recognized within a sensor data stream, the pattern matching technology will signal to the host processor that a pattern of interest has been detected.

For the industrial worker solution, the pattern matching technology plays an integral role in both gesture-based communication and activity identification. When initially programmed, the Intel Quark SE microcontroller gesture device is trained with a dictionary of gestures it should be capable of detecting and reporting back in real-time (the letters A, D, M, L, and U). For activity identification, the Smart Body Activity Device is similarly loaded with a dictionary of motions and activities that would provide meaningful insight to the remote reporting and visualization. Using the gesture device for example, when such a letter is recognized, the pattern matching technology alerts the processor in the gesture device that the specific letter has been seen. The host processor then communicates the gesture event detected over BLE to the mobile hub.

By handling the low-level sensor processing and gesture recognition locally on the Intel Quark SE microcontroller-based wearable device, wireless communication channel traffic can be reduced (from device to wearable and from mobile hub to cloud) by avoiding having to transmit a streaming feed of raw sensor data to the cloud for remote processing and gesture analysis.

This allows for real-time and localized feedback to the user in an efficient manner and reserves wireless bandwidth consumption for sensor fusion applications where analysis relies upon the aggregation of multiple devices by the mobile hub. The pattern matching technology provides advantage also in that it offloads its own host processor from having to perform gesture and activity processing in software. This allows for powerful pattern analysis while ensuring the necessary long battery life expected from edge sensing devices and additional memory and compute resources for the resident host application.

Cloud-Based Incident Command System GUI

The Incident Command System (ICS) GUI is a Java*-based web application hosted on the Amazon AWS* cloud, which allows a central incident commander to monitor and orchestrate the scene in real time and to assess the situation with greater efficiency, more information, and higher certainty.

Sensor data sent via BLE is aggregated by the wearable mobile hub and sent in real time to Trusted Analytics Platform (TAP). The Incident Command System uses TAP's capabilities for real-time analytics and stream processing to send alerts and visualization of the incidents.

There are two different implementations of the connected worker solution, showing the flexibility and interoperability in implementing full end-to-end solution.

This PoC uses Trusted Analytics Platform (Figure 2) for ingesting data from a large number of workers (and their associated mobile hubs) for real-time monitoring and alerting on the dashboard. With data being stored and analyzed in real time in TAP various IOT use cases can be enabled. Trusted Analytics Platform itself can be run on a public or private cloud and provides out-of-the box capabilities for real time data ingestion, processing, and analytics for various IoT applications.

In the second implementation, AWS cloud components are utilized. Data from mobile hubs is sent to an Amazon Kinesis* Data Stream (Figure 3) which triggers an Amazon Lambda*

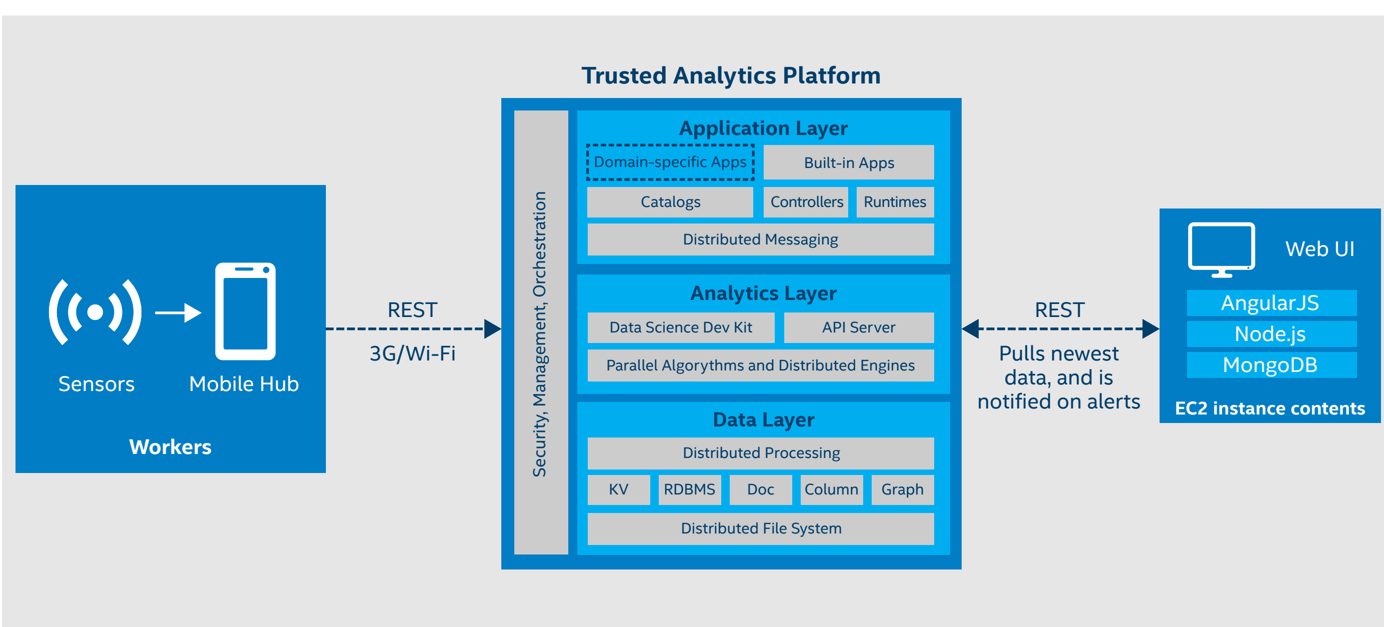

Figure 2. Trusted Analytics Platform (TAP)

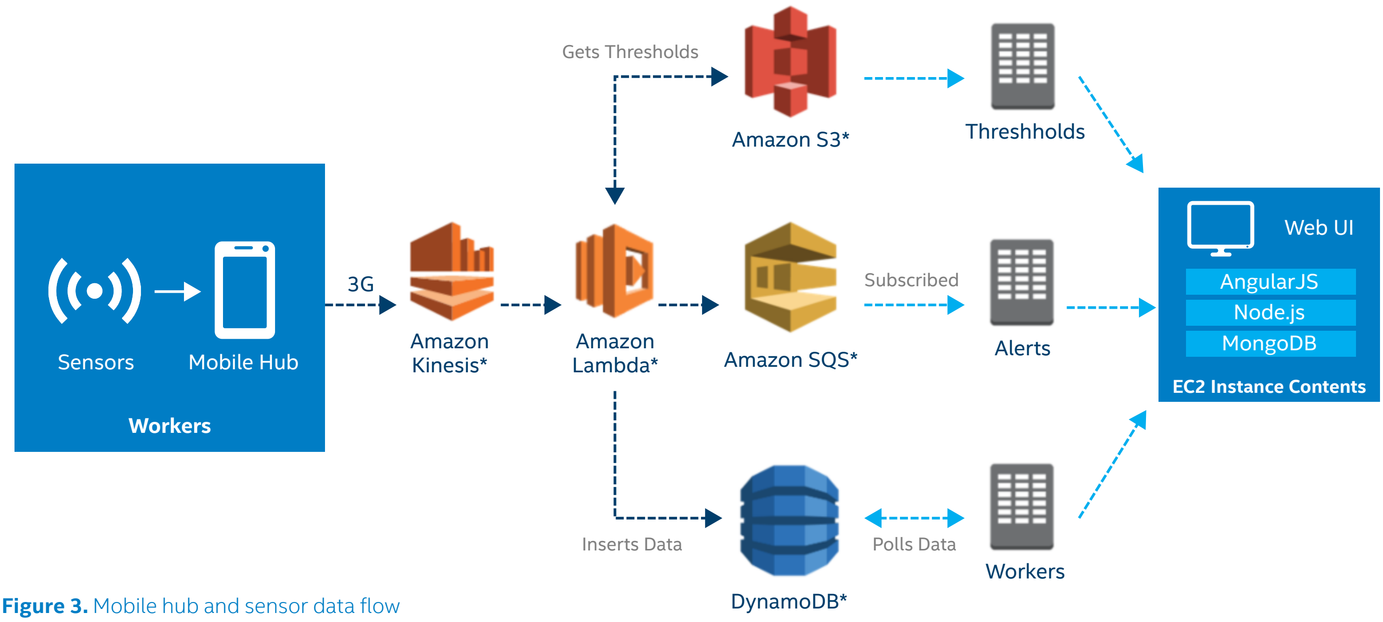

Figure 3. Mobile hub and sensor data flow

function that checks whether the sensor's data is within "good," "warning," or "danger" levels by fetching specified threshold values from Amazon S3*. If the data is not within acceptable levels, the data is sent to Amazon Simple Queue Service (SQS)* which is a fast, reliable, scalable, fully managed message queuing services, and is then displayed on the Web UI as a popup that will alert the Incident commander to the situation of the worker. Amazon Lambda also inserts the data into DynamoDB to be polled and displayed on the Web UI.

The Web UI can be run on any cloud connected device such as a PC or tablet and is designed to allow an incident commander to monitor and orchestrate the scene in real-time and to assess the situation with greater efficiency.

The UI provides comprehensive analysis of the current situation for multiple workers (Figure 4), providing visualization of independent worker sensor data in time series charts. The dashboard contains the sensors' data for each worker and is color coded to match their status.

The built-in map view displays all the workers in their respective positions and can be selected for a more detailed, zoomed-in view with worker sensor data available in gauges. In addition to biometric data (hear-rate and pulse), environmental temperature, SCBA battery and air level, the worker activity type is displayed (e.g. run, walk, lying prone).

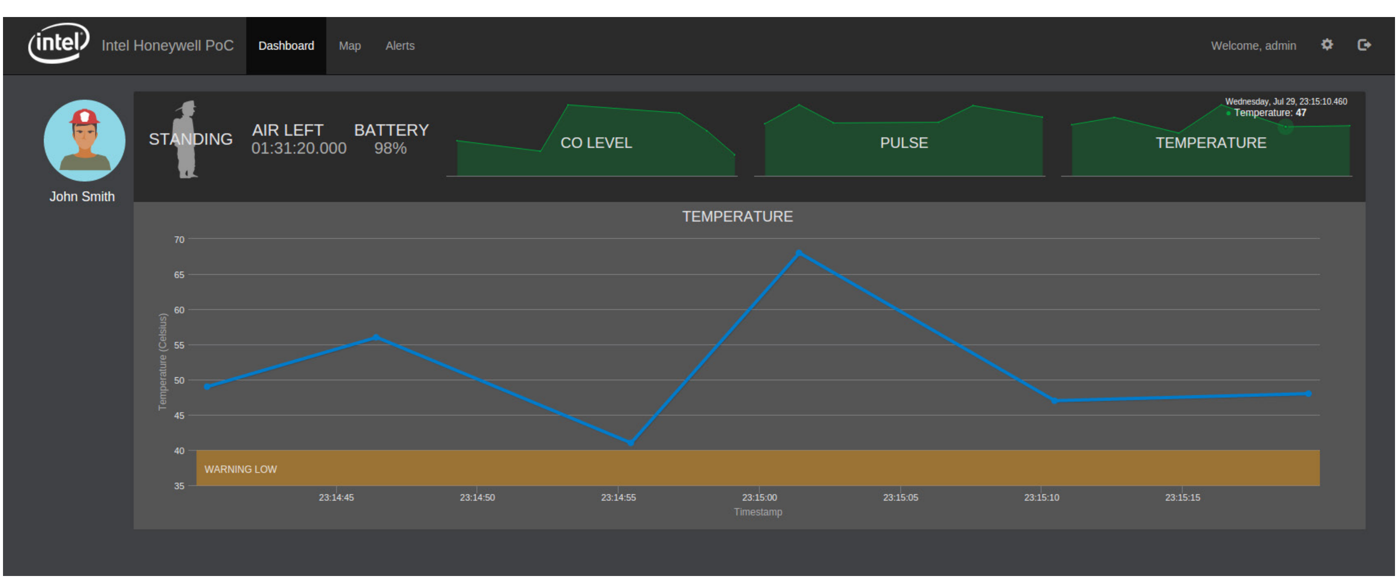

Figure 4. Comprehensive UI Provides Situational Analysis for All Workers

IoT Innovation for Industry

As the new industrial workplaces of the world become increasingly connected, IoT-enabled wearables—powered by innovative processing technology—are poised to transform the industries of tomorrow. Through a combination of sophisticated processing capabilities, next-generation data gathering tactics, real-time analytics, and sensor-based IoT technology, the workplaces of the future will be more efficient, safe, and productive than at any time in the history of industrial technology.

Learn More About IoT-enabled Industrial Technology

For more information about Intel® technologies in IoT, visit intel.com/iot.

To learn more about Honeywell, visit honeywell.com.

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