RAJANT HEALTH

Cowbell

Edge AI Hub

Features, Benefits, and Exemplary Use Cases

January 2023

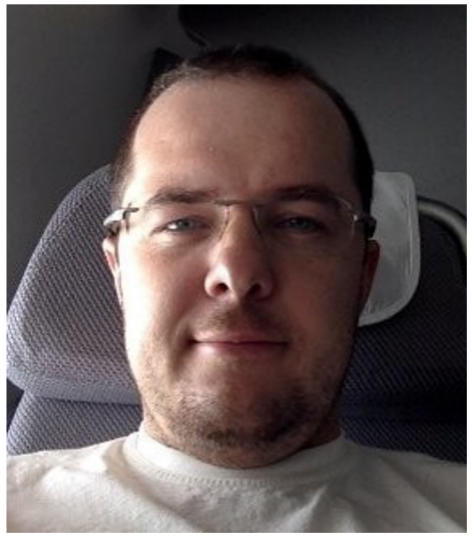
Steven Griggs

VP Sales Engineering

Rajant Corporation

Webinar Host

Presenters



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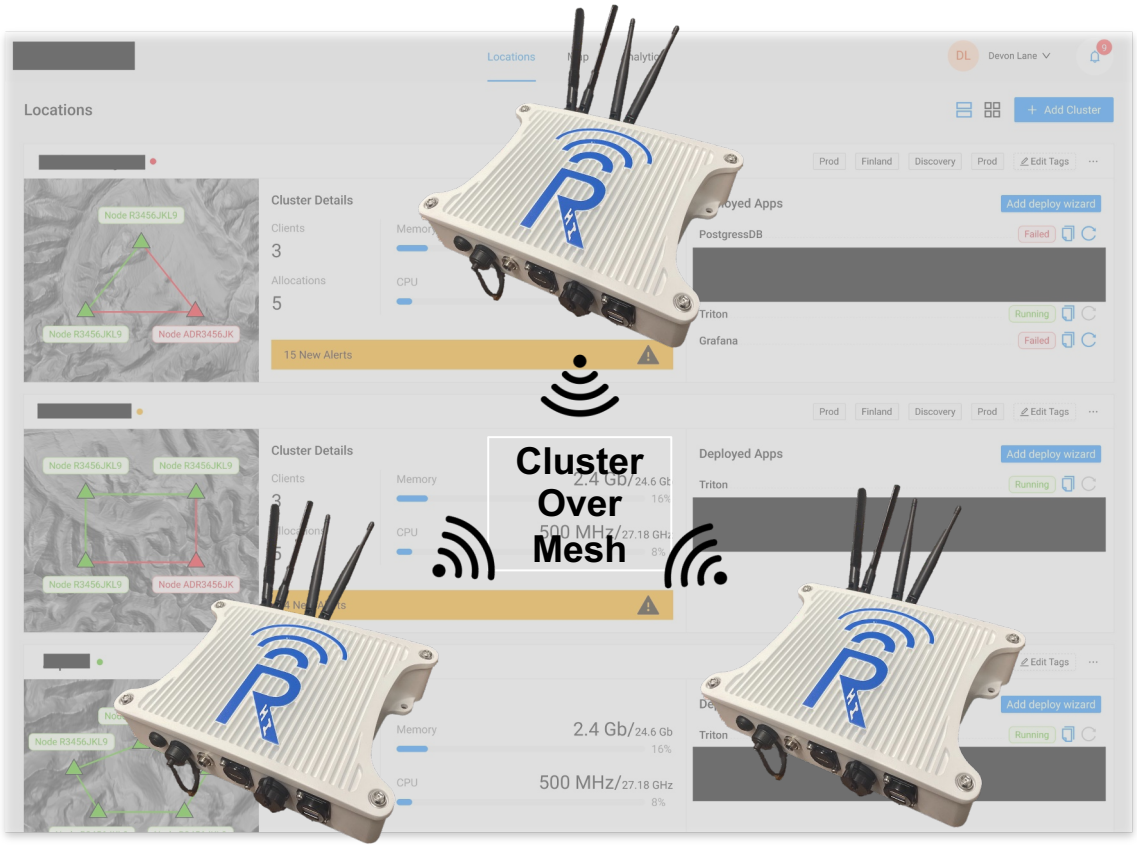
Cowbell – Distributed Edge AI Hub



The Cowbell is a **distributed** computing **hub** and **Platform-as-a-Service** to **SIMPLIFY** the delivery and management of **AI solutions** at the edge.

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Platform Added Values

Integrated UI for Cluster, Applications, User, and Peripheral Management

Cloud-native technologies without Vendor Lock-In!

- **Simplifies** development, deployment and management of AI solutions at edge
- **Decreases** costs, associated with IT development and infrastructure maintenance
- **Improves** ROI for existing and new onsite initiatives
- **Makes** client data at worksites safe from hardware failures

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Where Cowbell Fits in the Picture?

Wearables/Instrumentation
- Wearables
- IoT Sensors
- Human Operators
- External conditions
- Other Data

Field

Vitals/Data

Commands

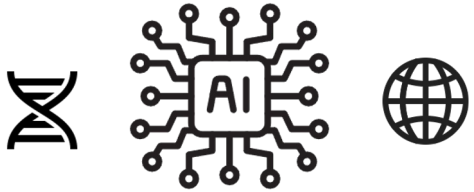
Cowbell

Edge Applications
- Runs applications that turns data into actionable insights
- Ensures constant business applications stability
- Hub for IoT peripherals
- Cluster management

Edge (On Site)

Data

Models



Centralized processing
- ML Training
- Data Analytics
- AI Model Development Services
- Company central data storage

On-Premises/Cloud

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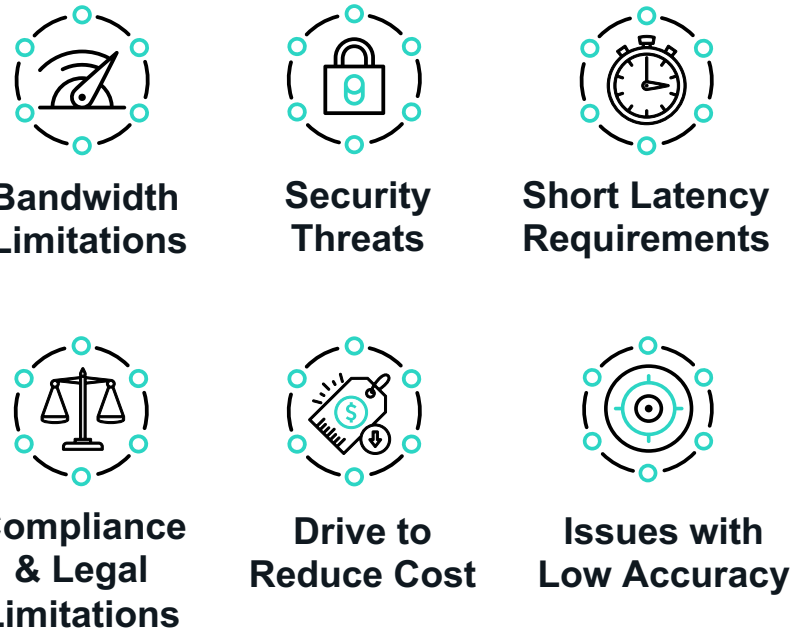
Why Edge?

Don’t Let Cloud Usage Limit Your Operations

Limitations Include:

- The cloud can’t handle the exponential growth of data at the edge.
- For the last 15 years, the industry married the cloud and IoT together, and it worked. Now, it doesn’t.
- Why?
  - Not all data is relevant.
  - Traditional cloud computing results in 400x more data transmitted versus edge computing.
  - On the flipside, you may not be sending all necessary data due to limited bandwidth.



Think Globally, Act Locally. Formulate a global top-down strategy that centralizes control, breaks silos, and creates coordination between projects across the organization for success.

Gartner, 5 Top Practices of Successful Edge Computing Implementers, Bob Gill, Mohini Dukes, Ajeeta Malhotra, 28 February 2023.

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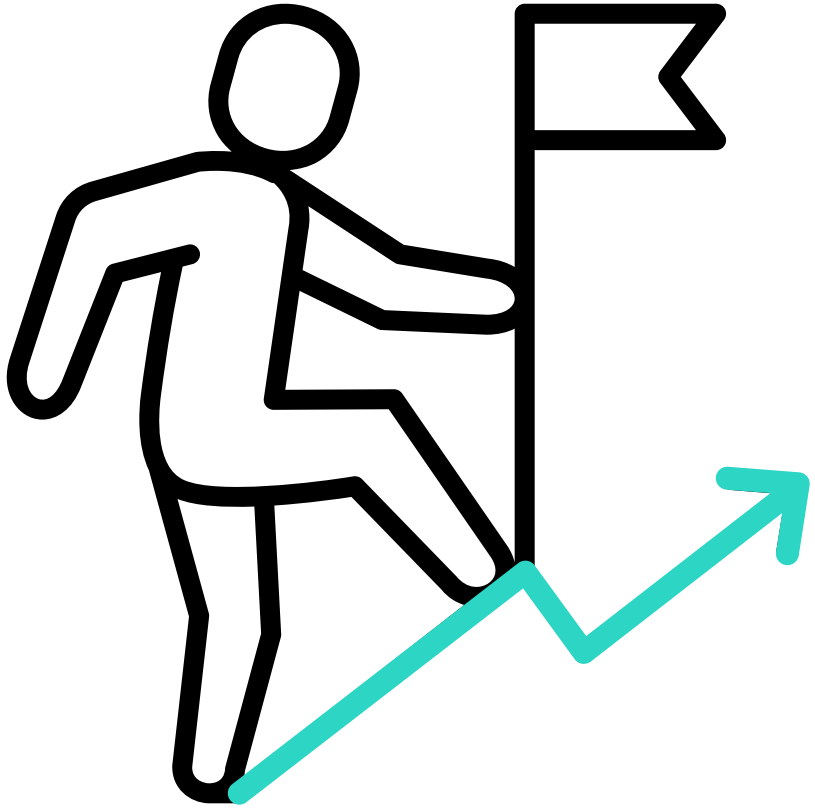
Challenges of Edge Deployments

Need for Reliable HW Infrastructure

Limitations Include:

- Complex cost structure
  - CapEx for hardware procurement
  - OpEx for data management licenses
  - Additional vendors for virtualization software
  - Third party integrators for technical setup and maintenance
- Networking limitation and isolation expense w/ IT involvement
- Runs out of resources - lacks extensibility and scalability
- Application survivability, failure tolerance, and redundancy



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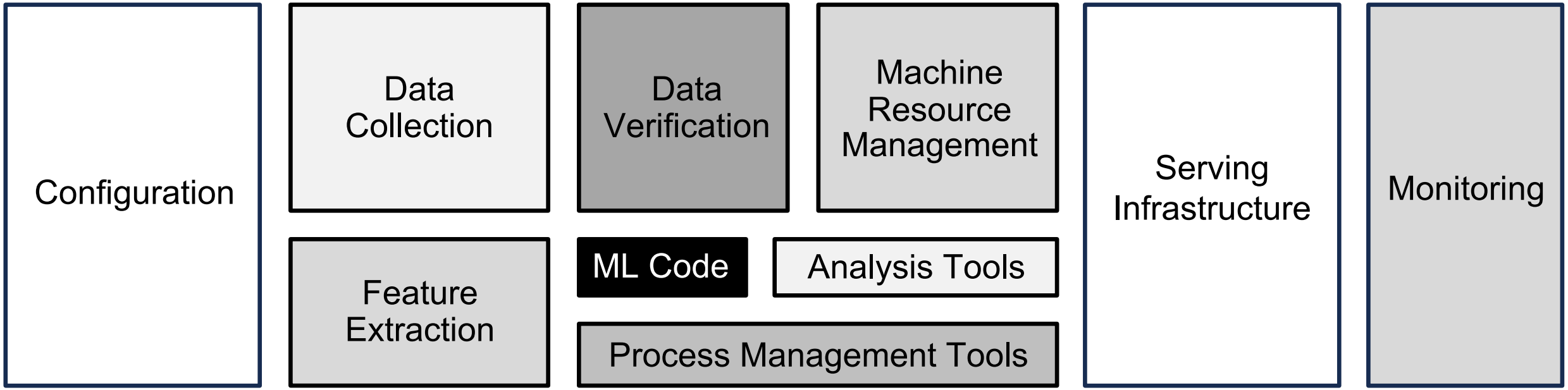
Productionizing AI is Hard



Only a small fraction of real-world ML systems is composed of the ML code, as shown by the small black box in the middle. The required surrounding infrastructure is vast and complex [2].

[1] Wikipedia | MLOps
[2] Whitepaper | Hidden Technical Debt in ML Systems

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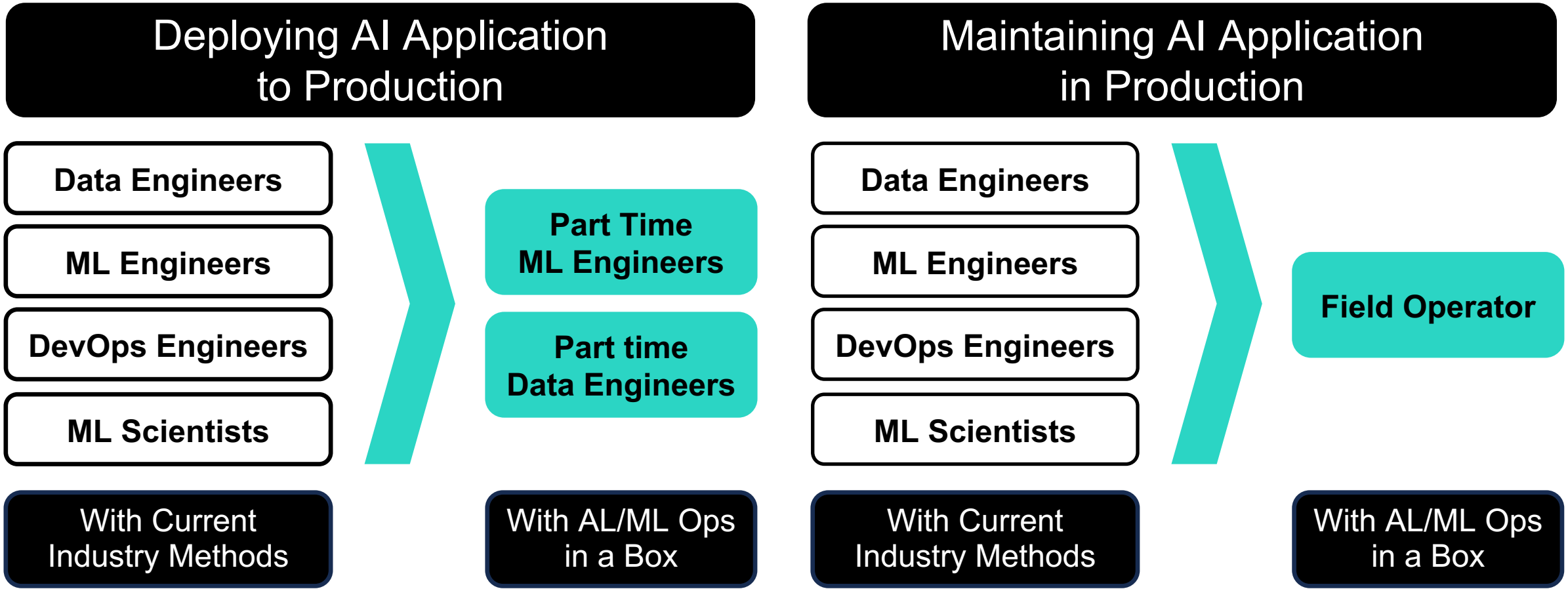
Skills To Bring AI into Production



Less Employees Needed to Design & Support = $$$ Saved

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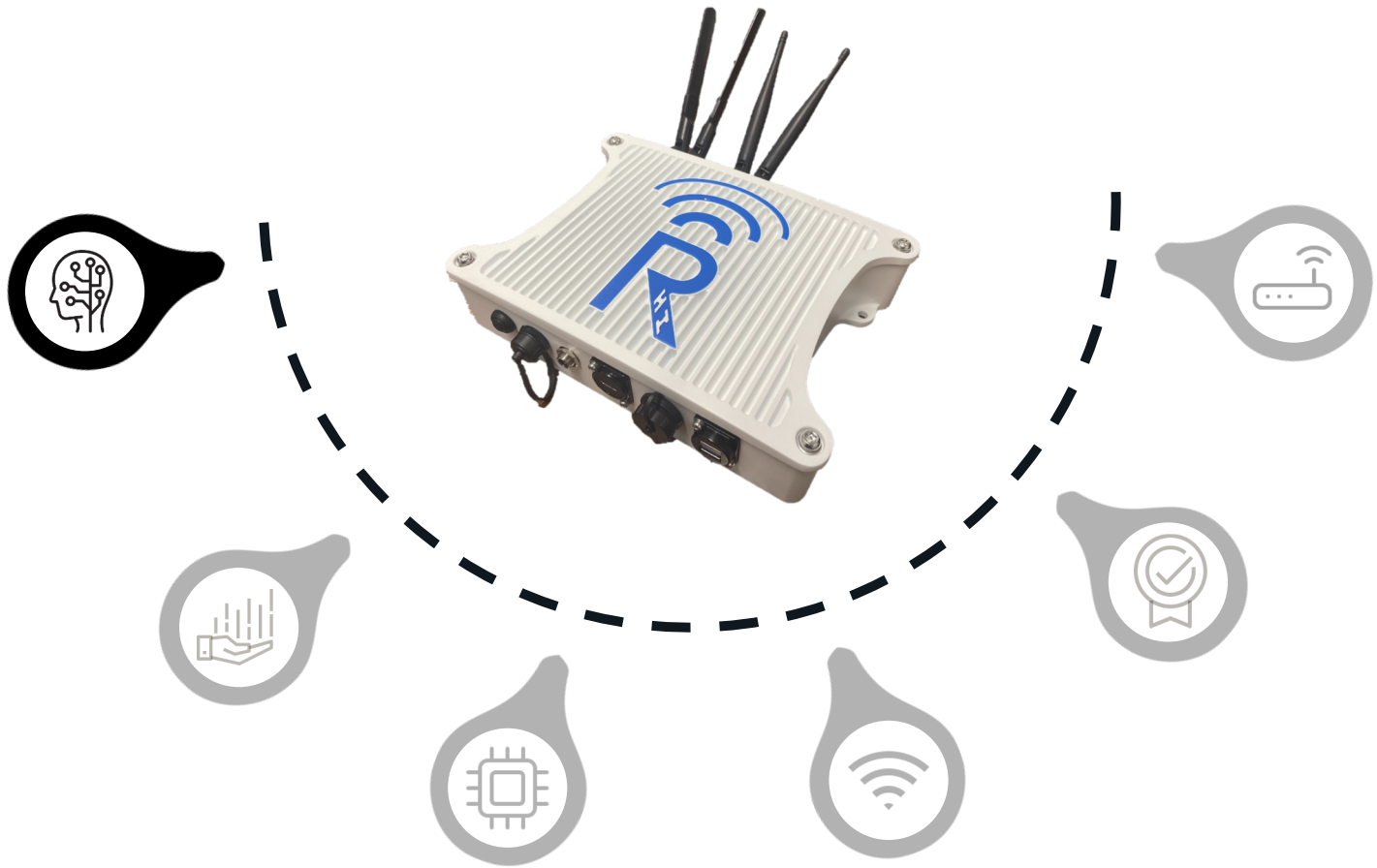
Cowbell Features

Edge AI & MLOps-in-a-Box

- Allows low-latency actionable insights at the Edge and reduced data transfer costs
- 1-click deployment and orchestration of BYO AI apps with a simplified UI
- Out-of-the-box support for data pipelines with MQTT/ROS
- Application-level metrics dashboard and management



Novel Feature or Implementation

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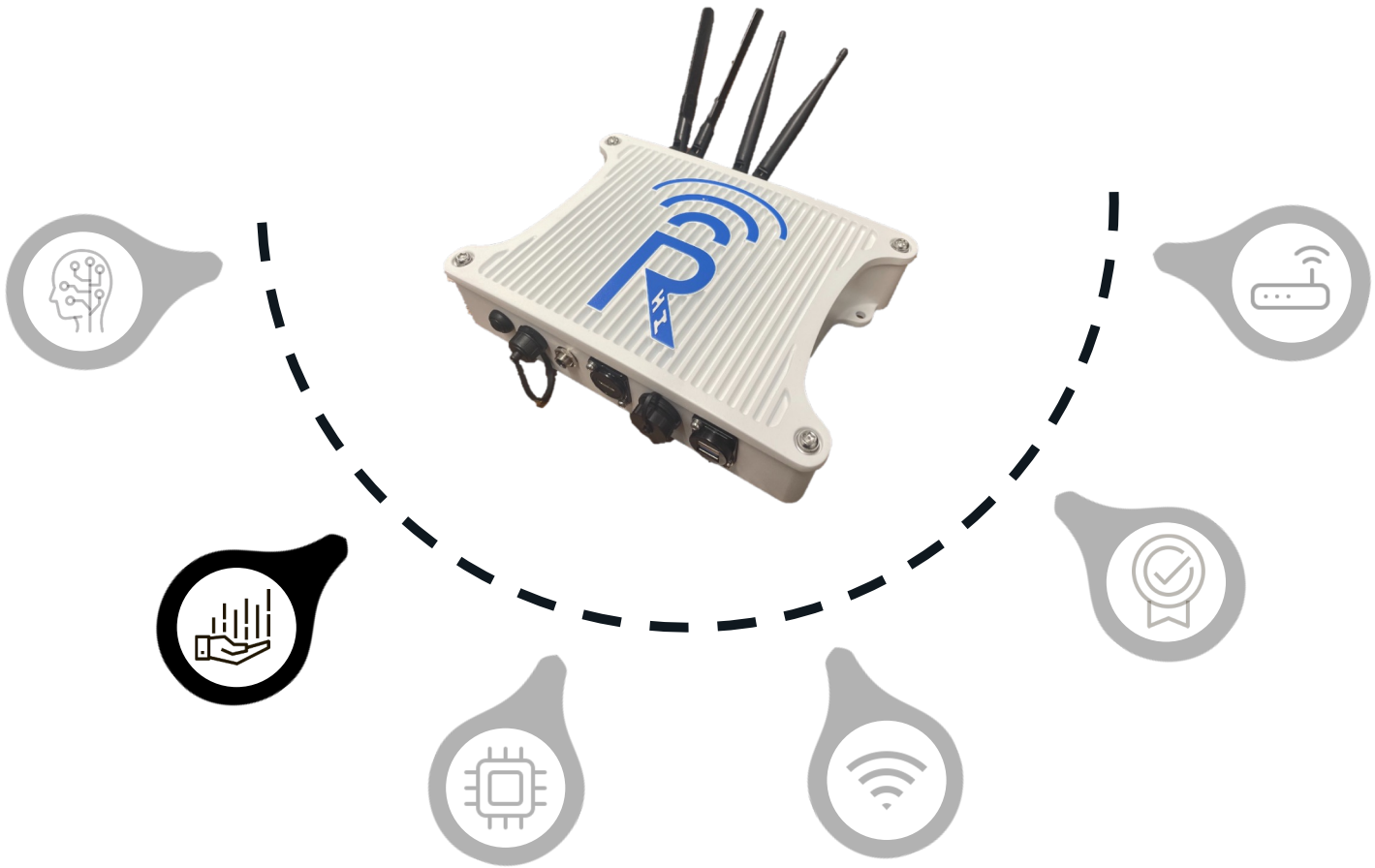
Cowbell Features

Distributed Edge Cluster, Provisioning & Management

- Allows extensible, fault-tolerant nodes with minimal chatter
- Integrated UI for provisioning & management of a multi-cluster organization and multiple tenants – “BC Commander” for Cowbell!
- OTA OS & firmware updates
- Multi-tenant subscription management with RBAC



Novel Feature or Implementation

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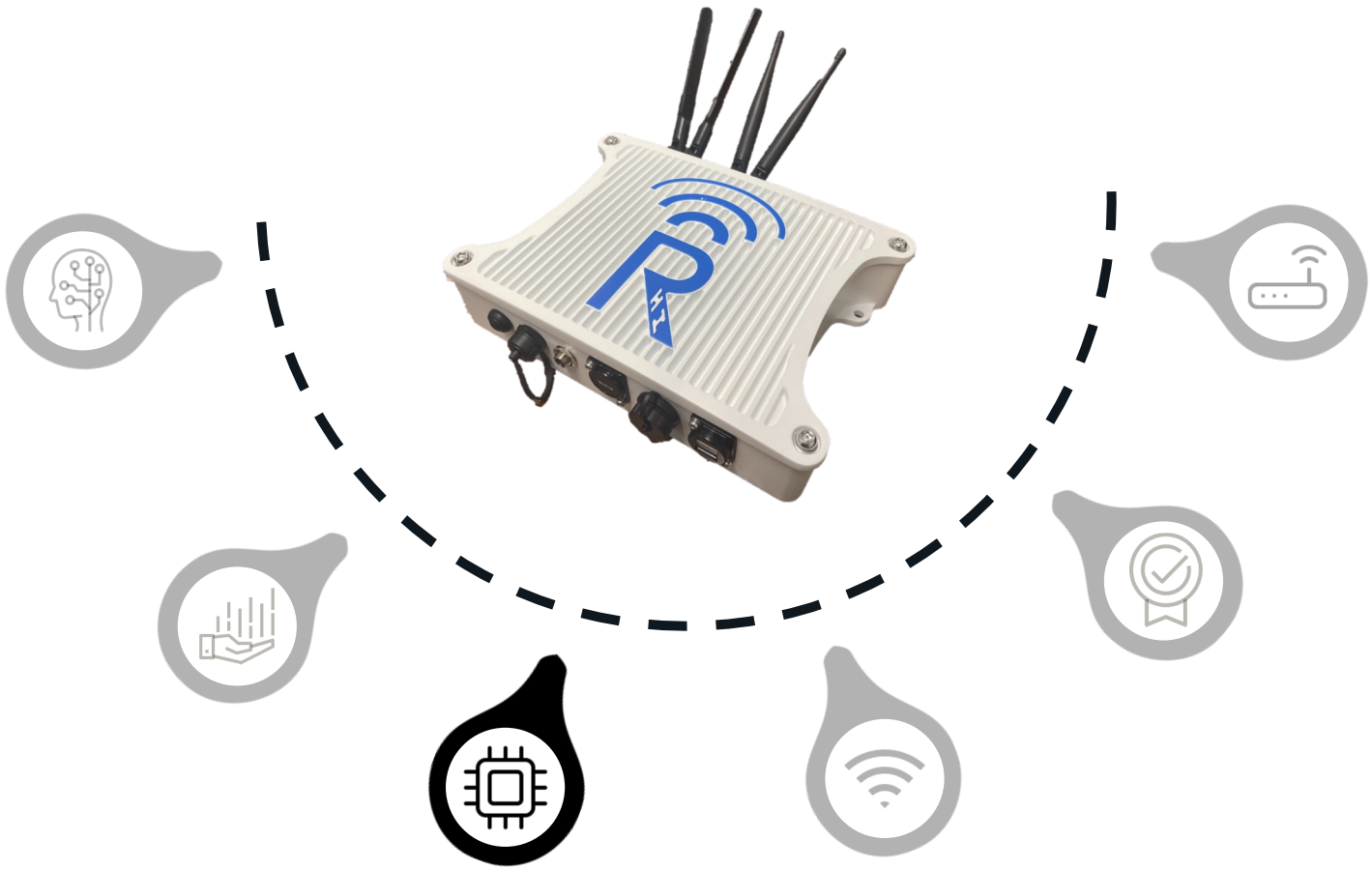
Cowbell Features

Modular Hardware Architecture

- Rugged IP-67 rated enclosure for indoor and outdoor use
- Passive Cooling
- Ambient Temp Rating: -25 C to 85 C
- Well-suited for mobile deployments – low power!
- Integrated CPU and GPU from NVIDIA Jetson Orin
- Expandable storage up to 8TB



Novel Feature or Implementation

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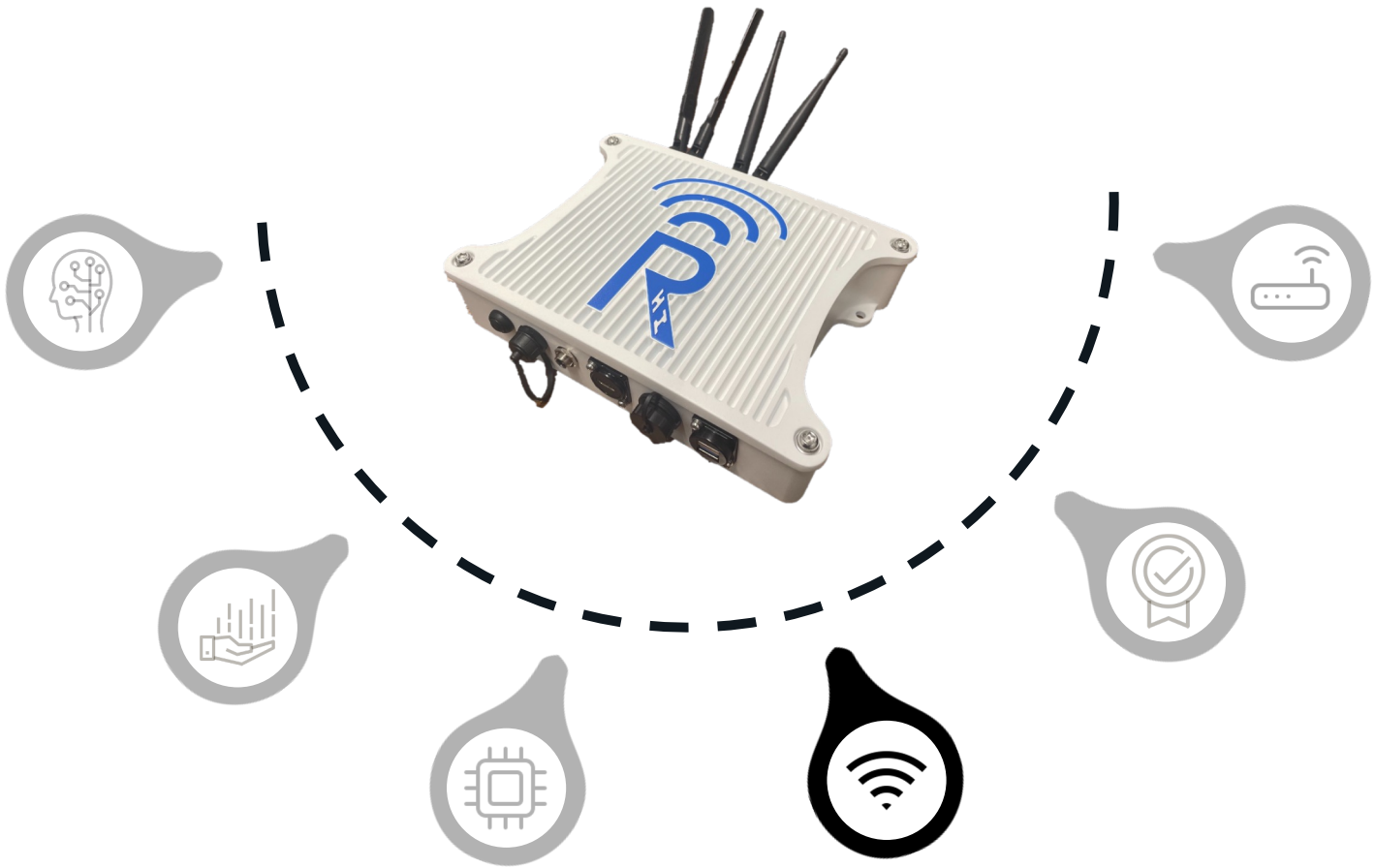
Cowbell Features

Low-Latency Mesh Connectivity

- Leverages Rajant's Kinetic Mesh Tech
- Rajant Cardinal BreadCrumb inside!
- Rajant Secure Network Transport



Novel Feature or Implementation

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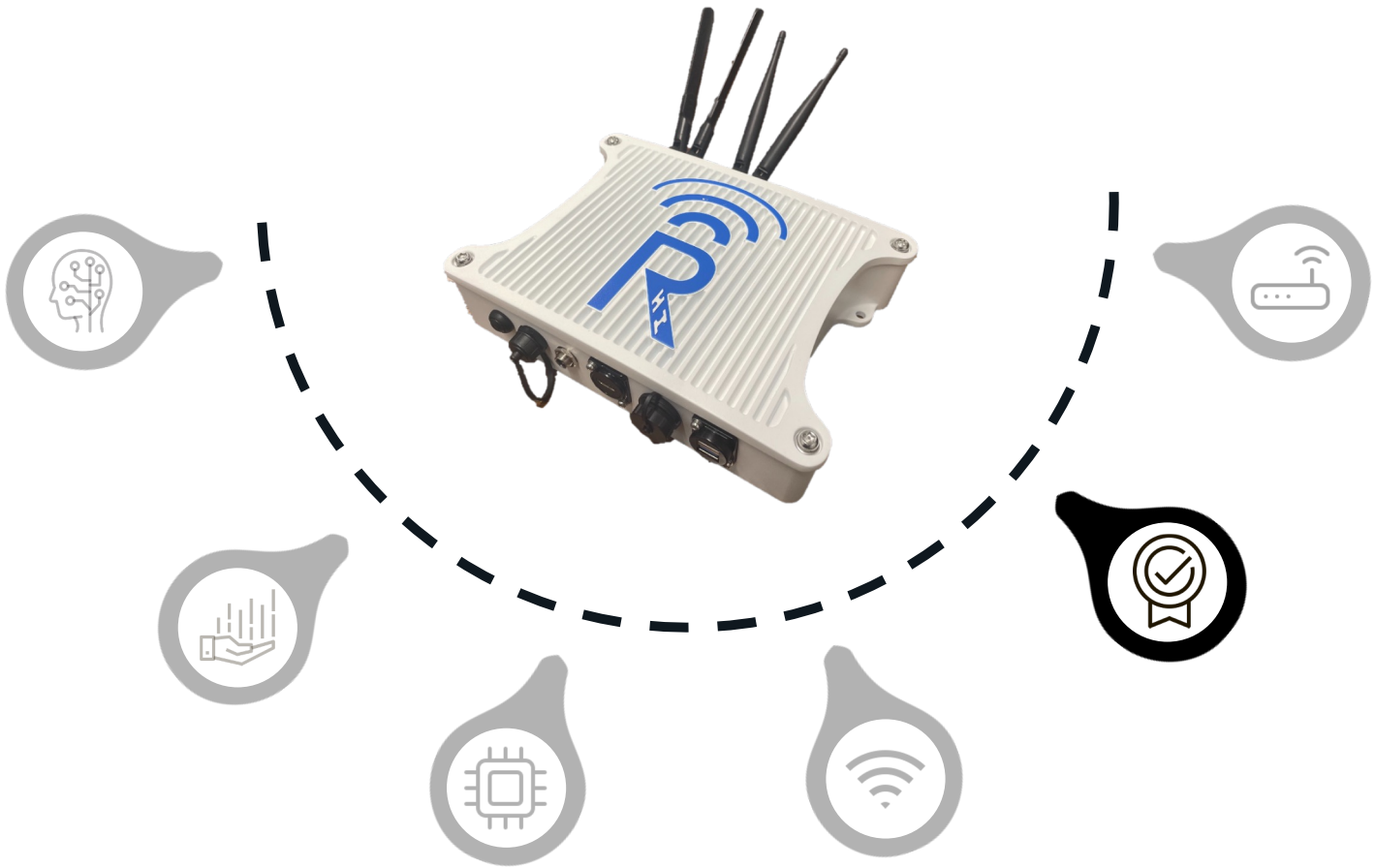
Cowbell Features

Networks, Security, & Compliance

- Provides complete network isolation with Mesh
- NSA-grade security add-on available
- Contains FCC, CE, RoHS* certified components
- Secure edge data storage
- Encrypted data both at rest and during transport
- Secure remote access to Edge Cluster for maintenance with VPN or USB-based certificate injection

Novel Feature or Implementation



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Cowbell Features

Wearable/IoT Hub & Device Management

- Hub for wireless (BT, WiFi) and wired peripherals (Serial/ETH)
- LoRa add-on available
- Native Q-Stat wearable provisioning and support
- Integrated UI for peripheral management and application deployment with RBAC

Novel Feature or Implementation

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Exemplary Use Cases & AI-Enabled Solutions

Monitoring – Personnel Safety, Wellness, & Environment

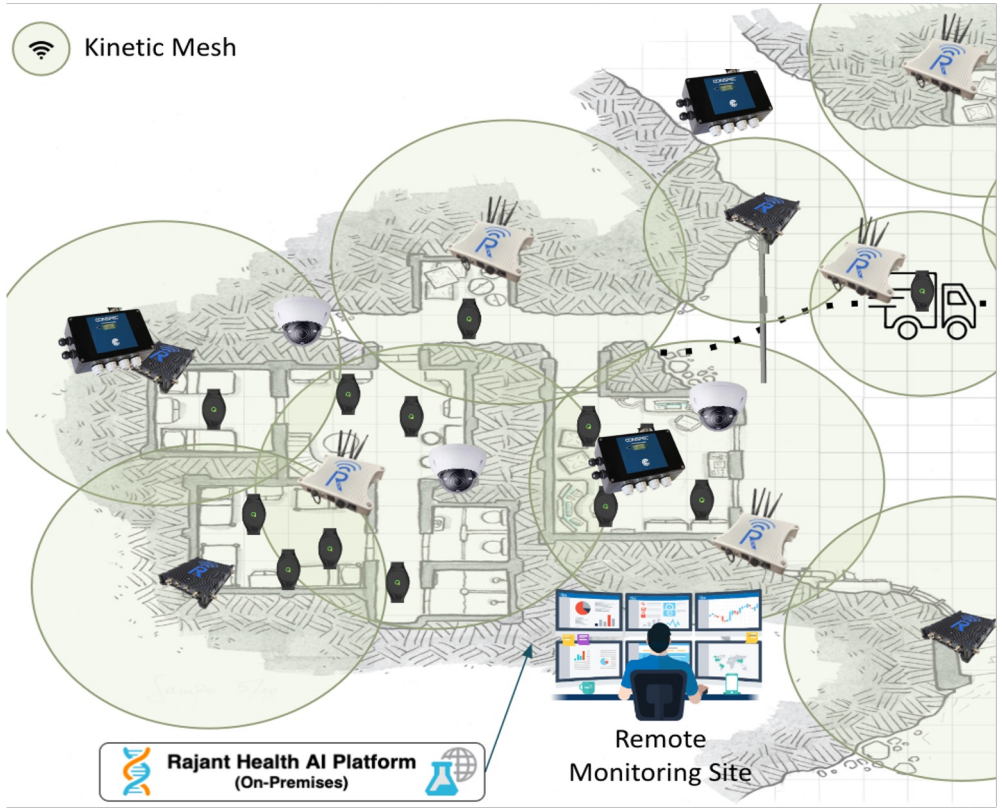
Markets:

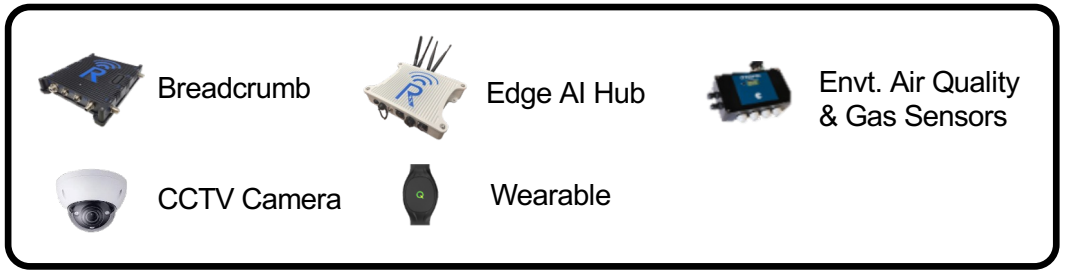
Oil & Gas, Construction, Ports, Mining, Public Safety

Functions:

- Health Vitals Tracking
- Proximity Detection
- Asset Tracking (GPS, RTLS)
- Incident Management – Haptics/Voice, Messaging
- LoRa Network Server Application
- AI-Enabled PPE Safety Detection & People Counting
- Harmful Gas Exposure & Tracing
- AI-enabled Anomaly Detection & Forecasting

"Blast Blocker" application in mines
Mobile equipment tracking
Soldier/Worker health and safety





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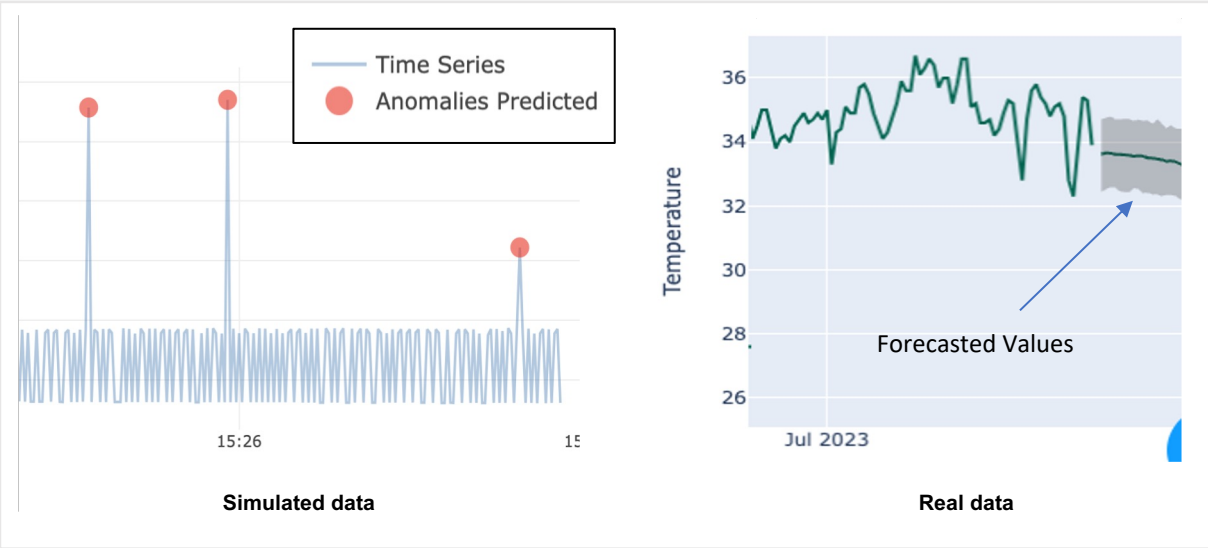
Monitoring – Personnel Safety, Wellness, & Environment

Time Series Anomaly Detection & Forecasting



Simulated data **Real data**

Camera02

PPE Detection (CCTV Cam)

Video Feed

Camera02

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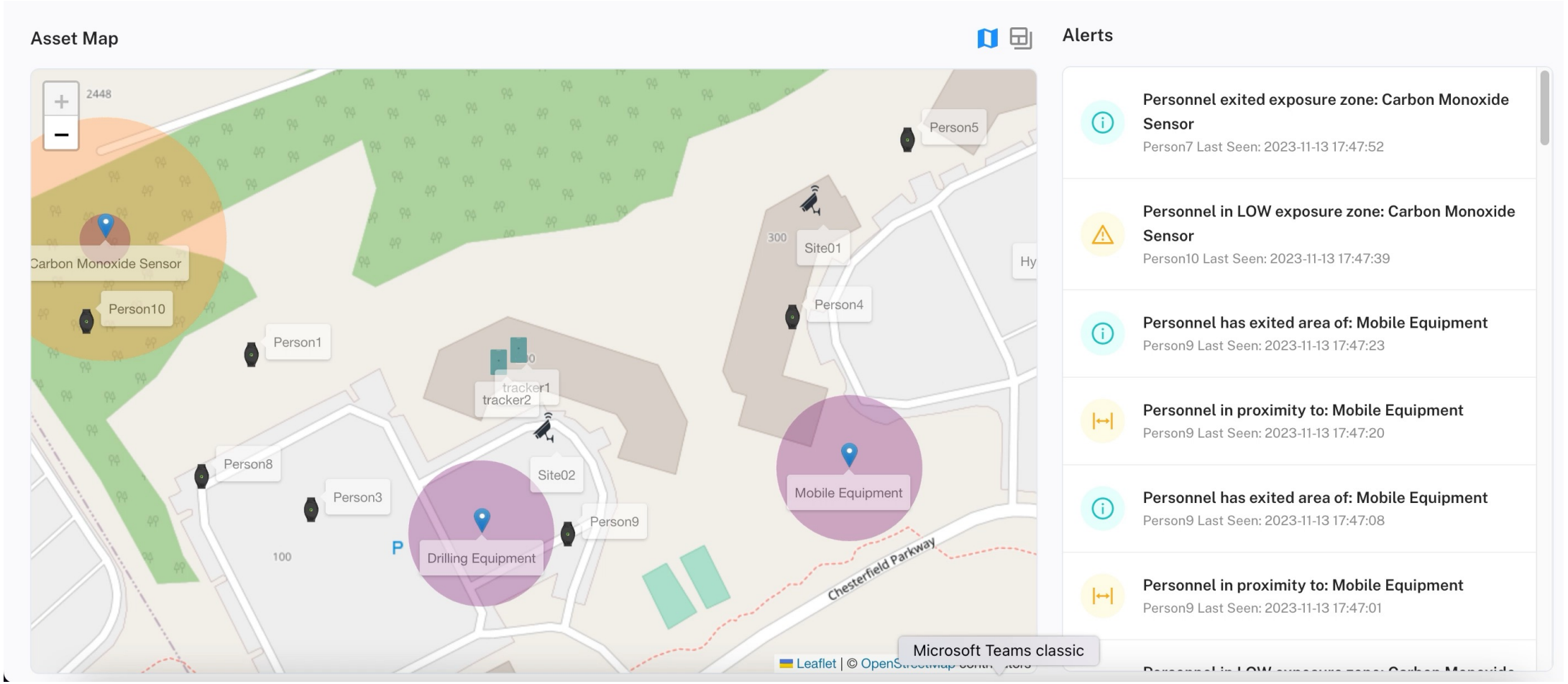
Monitoring – Personnel Safety, Wellness, & Environment

Markets:
Oil & Gas, Construction, Ports, Mining, Public Safety



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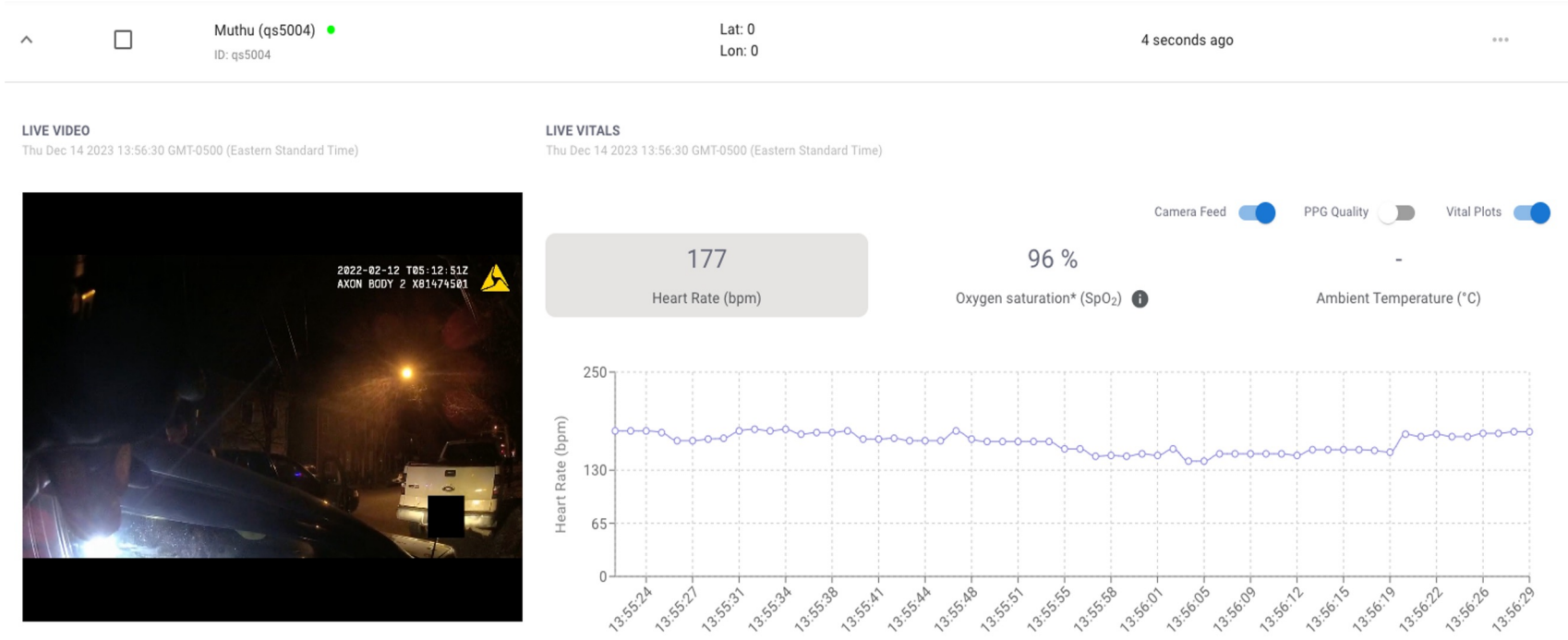
Public Safety & Occupational Wellness Solution

Markets:

Public Safety, Law Enforcement, Oil & Gas

Functions:

- Health Vitals Tracking
- Personnel Tracking (GPS)
- Body Cam Streaming
- Network-Resilient Data Archival
- Automated Analytics Report Generation
- Remote Wearable Provisioning & Management



Wearable & Live Body Cam

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Multi-Robot Automated Inventory Management Solution

Markets:

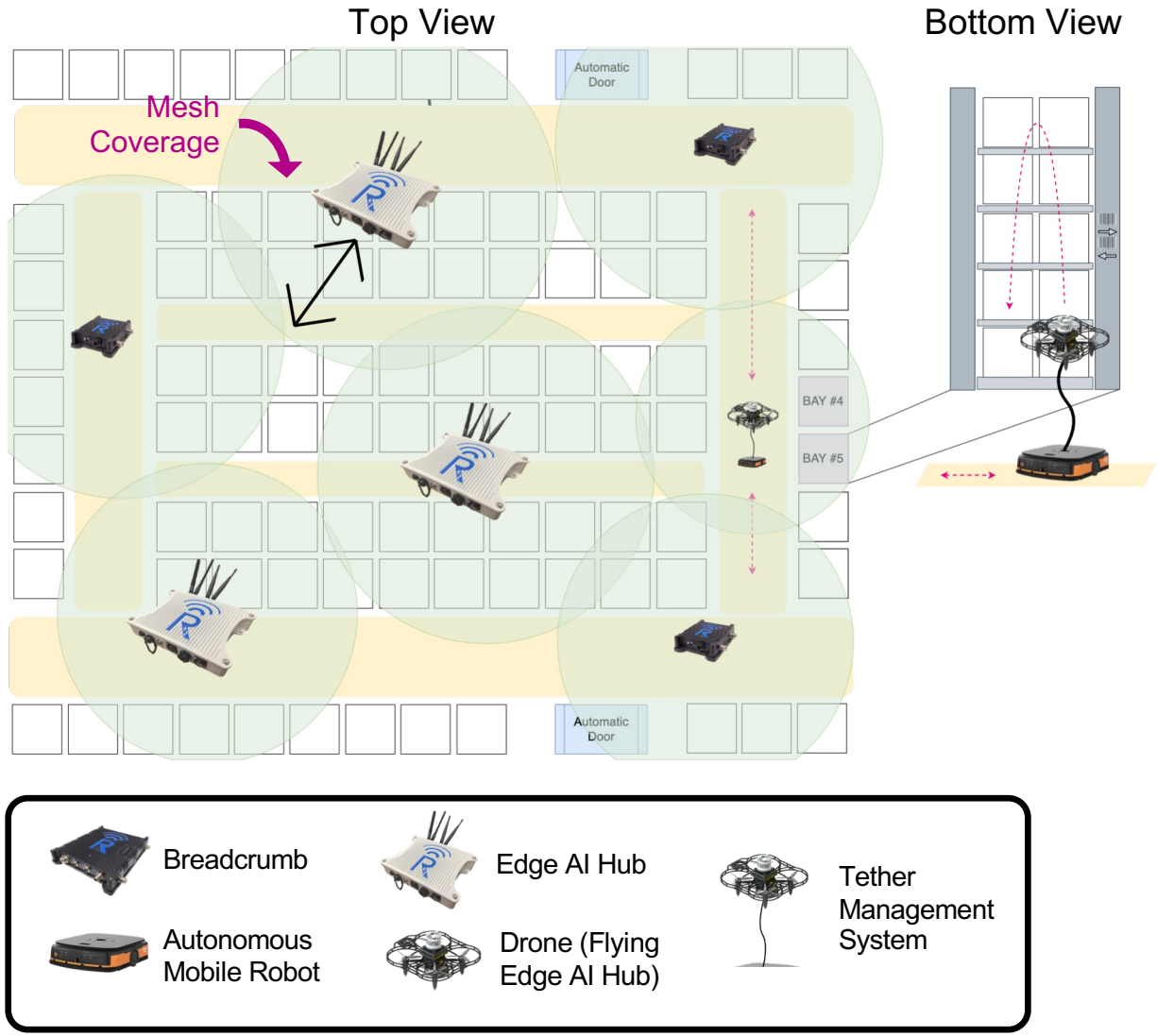
Warehouses, Drones and Robots

Functions:

- AI-Enabled Robot Navigation & Tracking
- Fleet Mission Planner
- AI-Enabled Pallet Barcode Detection, Tracking & Counting

Benefits

- Reduced labor costs
- Improved inventory consistency and reduced human-error
- Extended and continued operation in very low temperatures
- Integrated AI models for barcode, pallet and box detection, tracking and counting



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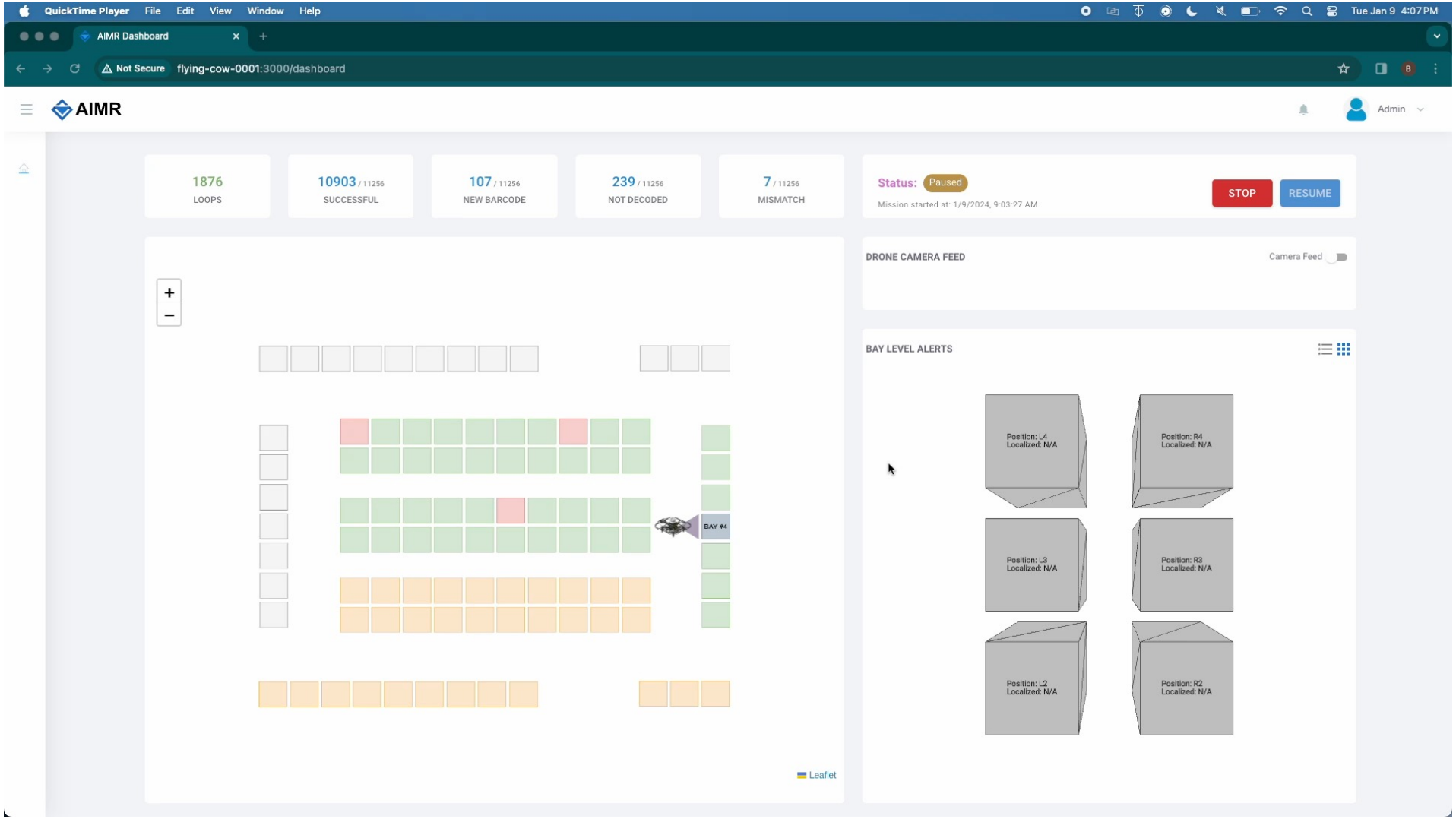
Multi-Robot Automated Inventory Management



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Mobile-Robot Automated Inventory Management

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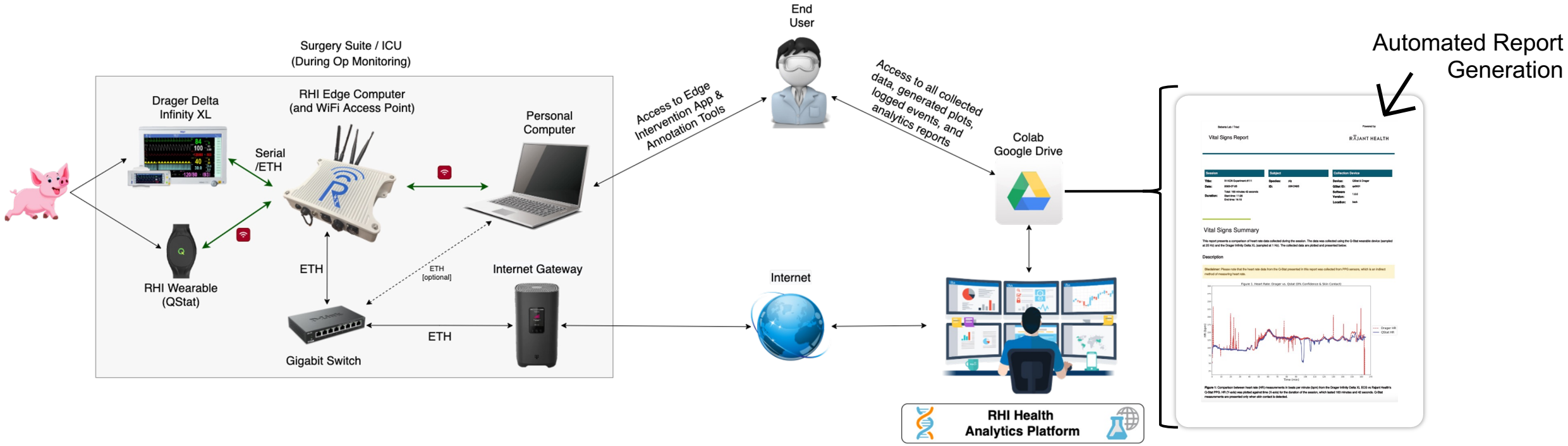
Pilot – Remote Large Animal Monitoring



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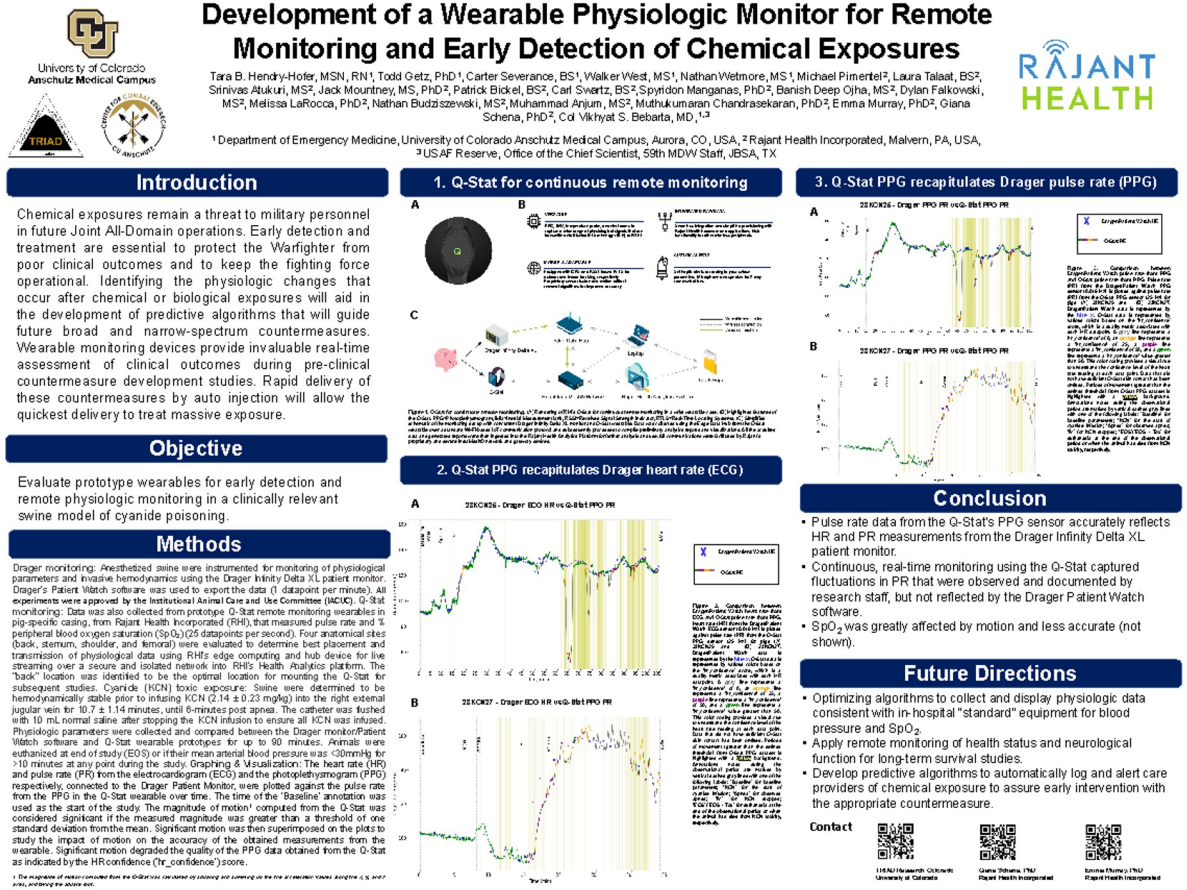
Pilot – Remote Large Animal Monitoring

- System deployed at a translational laboratory at University of Colorado
- Data presented at **Military Health System Research Symposium** August 2023 (Kissimmee, FL)

"The RHI Large Animal Monitoring system, featuring Q-Stat and Cowbell, has allowed us to detect second-by-second physiological changes in our clinically relevant swine models. Detecting these changes provides us with a better understanding of injury progression and allows us to better identify therapeutic targets."

- CU Center for COMBAT Research



Development of a Wearable Physiologic Monitor for Remote Monitoring and Early Detection of Chemical Exposures

Tara B. Hendry-Hofer, MSN, RN[1], Todd Getz, PhD[1], Carter Severance, BS[1], Walker West, MS[1], Nathan Wetmore, MS[1], Michael Pimentel[2], Laura Talaat, BS[2], Srinivas Atukuri, MS[2], Jack Mountney, MS, PhD[2], Patrick Bickel, BS[2], Carl Swartz, BS[2], Spyridon Manganas, PhD[2], Banish Deep Ojha, MS[2], Dylan Falkowski, MS[2], Melissa LaRocca, PhD[2], Nathan Budziszewski, MS[2], Muhammad Anjum, MS[2], Muthukumaran Chandrasekaran, PhD[2], Emma Murray, PhD[2], Giana Schena, PhD[2], Col Vikhyat S. Bebarta, MD,[1,3]

[1] Department of Emergency Medicine, University of Colorado Anschutz Medical Campus, Aurora, CO, USA, [2] Rajant Health Incorporated, Malvern, PA, USA, [3] USAF Reserve, Office of the Chief Scientist, 59th MDW Staff, JBSA, TX

Introduction

Chemical exposures remain a threat to military personnel in future Joint All-Domain operations. Early detection and treatment are essential to protect the Warfighter from poor clinical outcomes and to keep the fighting force operational. Identifying the physiologic changes that occur after chemical or biological exposures will aid in the development of predictive algorithms that will guide future broad and narrow-spectrum countermeasures. Wearable monitoring devices provide invaluable real-time assessment of clinical outcomes during pre-clinical countermeasure development studies. Rapid delivery of these countermeasures by auto injection will allow the quickest delivery to treat massive exposure.

Objective

Evaluate prototype wearables for early detection and remote physiologic monitoring in a clinically relevant swine model of cyanide poisoning.

Methods

Drager monitoring: Anesthetized swine were instrumented for monitoring of physiological parameters and invasive hemodynamics using the Drager Infinity Delta XL patient monitor. Drager's Patient Watch software was used to export the data (1 datapoint per minute). All experiments were approved by the Institutional Animal Care and Use Committee (IACUC). Q-Stat monitoring: Data was also collected from prototype Q-Stat remote monitoring wearables in pig-specific casing, from Rajant Health Incorporated (RHI), that measured pulse rate and % peripheral blood oxygen saturation (SpO_2) (25 datapoints per second). Four anatomical sites (back, sternum, shoulder, and femoral) were evaluated to determine best placement and transmission of physiological data using RHI's edge computing and hub device for live streaming over a secure and isolated network into RHI's Health Analytics platform. The "back" location was identified to be the optimal location for mounting the Q-Stat for subsequent studies. Cyanide (KCN) toxic exposure: Swine were determined to be hemodynamically stable prior to infusing KCN (2.14 ± 0.23 mg/kg) into the right external jugular vein for 10.7 ± 1.14 minutes, until 6-minutes post apnea. The catheter was flushed with 10 mL normal saline after stopping the KCN infusion to ensure all KCN was infused. Physiologic parameters were collected and compared between the Drager monitor/Patient Watch software and Q-Stat wearable prototypes for up to 90 minutes. Animals were euthanized at end of study (EOS) or if their mean arterial blood pressure was <30mmHg for >10 minutes at any point during the study. Graphing & Visualization: The heart rate (HR) and pulse rate (PR) from the electrocardiogram (ECG) and the photoplethysmogram (PPG) respectively, connected to the Drager Patient Monitor, were plotted against the pulse rate from the PPG in the Q-Stat wearable over time. The time of the "Baseline" annotation was used as the start of the study. The magnitude of motion[1] computed from the Q-Stat was considered significant if the measured magnitude was greater than a threshold of one standard deviation from the mean. Significant motion was then superimposed on the plots to study the impact of motion on the accuracy of the obtained measurements from the wearable. Significant motion degraded the quality of the PPG data obtained from the Q-Stat as indicated by the HR confidence ("hr_confidence") score.

[1] The magnitude of motion computed from the Q-Stat was calculated by summing the squares of the accelerometer values along the x, y, and z axes, and taking the square root.

1. Q-Stat for continuous remote monitoring

2. Q-Stat PPG recapitulates Drager heart rate (ECG)

3. Q-Stat PPG recapitulates Drager pulse rate (PPG)

Conclusion

- Pulse rate data from the Q-Stat's PPG sensor accurately reflects HR and PR measurements from the Drager Infinity Delta XL patient monitor.
- Continuous, real-time monitoring using the Q-Stat captured fluctuations in PR that were observed and documented by research staff, but not reflected by the Drager Patient Watch software.
- SpO_2 was greatly affected by motion and less accurate (not shown).

Future Directions

- Optimizing algorithms to collect and display physiologic data consistent with in-hospital "standard" equipment for blood pressure and SpO_2.
- Apply remote monitoring of health status and neurological function for long-term survival studies.
- Develop predictive algorithms to automatically log and alert care providers of chemical exposure to assure early intervention with the appropriate countermeasure.

Contact

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Pilot – Remote Large Animal Monitoring

Benefits*

- Configuration-based application deployment
- Serial/ETH connectivity for direct interface with patient monitor
- Instantaneous and automated report generation at the edge
- Network isolation provided by Kinetic Mesh and Internet Gateway
- Seamless extensibility to a multi-node deployment for post-op surveillance
  - Automated compute cluster formation
  - Automated mesh formation
- Future proofing infrastructure for enabling config-based 1-click ML model deployment for potential future projects including but not limited to:
  - Real-time Arrhythmia detection and logging
  - Camera-based pig detection and tracking
  - Camera-based pig activity detection and tracking

** Non-industrial version with a DX2 BreadCrumb module and an NVIDIA Orin Nano 8GB was used for this study*

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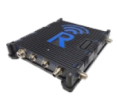
Hospital Ops Use Cases

Deployment Legend


Breadcrumb

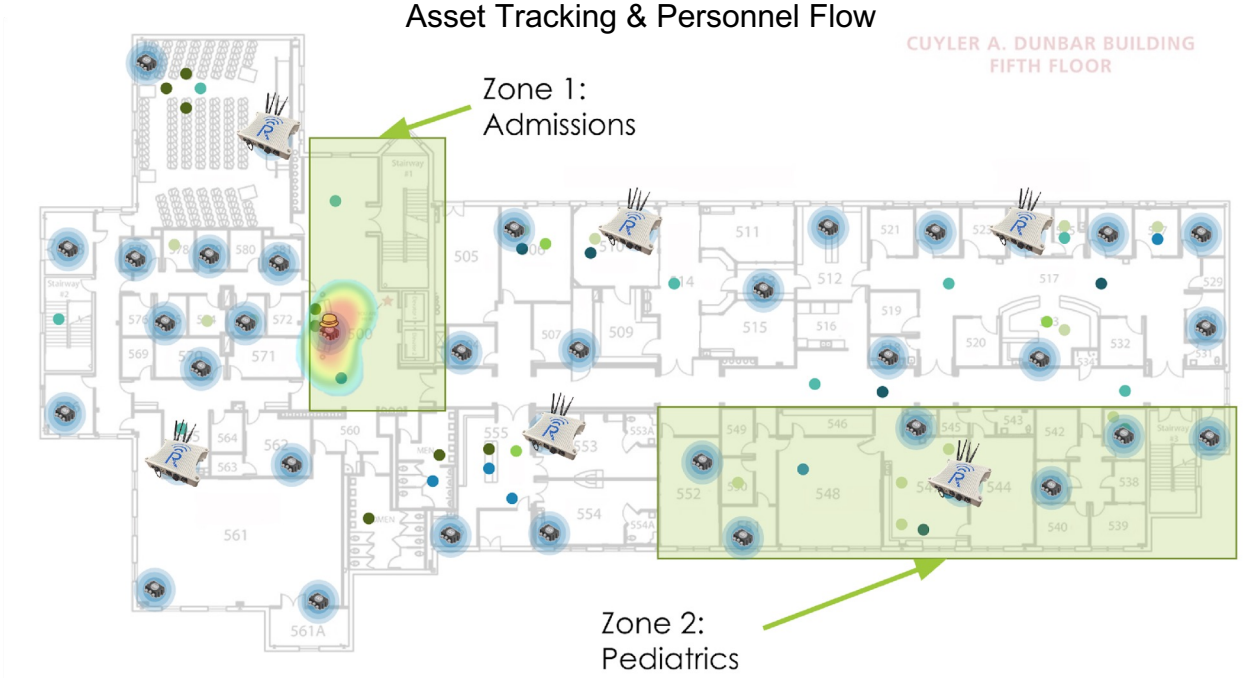

Edge AI Hub


Generic Asset Tags


CCTV Camera


QStat

Asset Tracking & Personnel Flow



Smart Patient Suite

Smart Surgery Suite

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Questions?

Have an application you want to bring into the Cowbell Platform?

Let's do it!

Pilot Units Available Now!

(first-come, first-serve basis)

Contact Your Sales Representatives
Or Email Us For More Details
(including early adopter/demo pricing!)