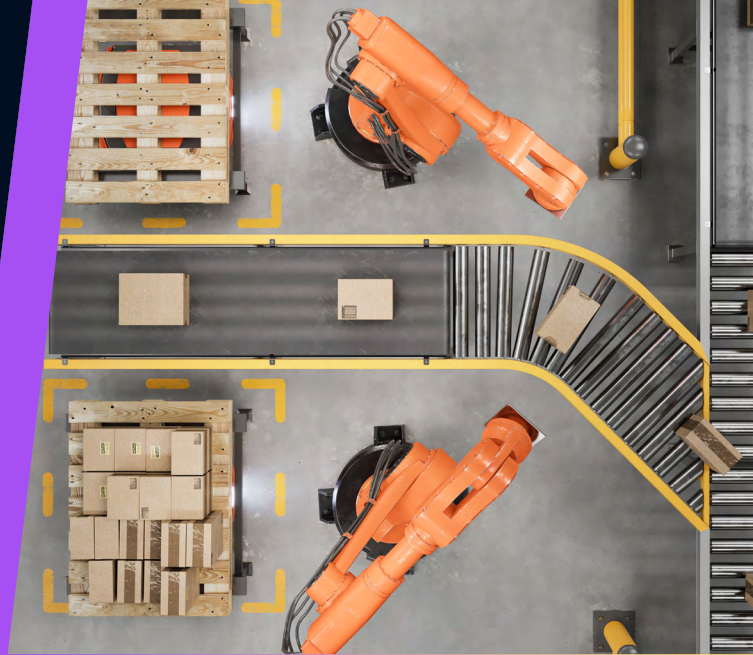


Reinventing shopfloor safety with physical AI

Belden, Accenture and NVIDIA

Solution Brief

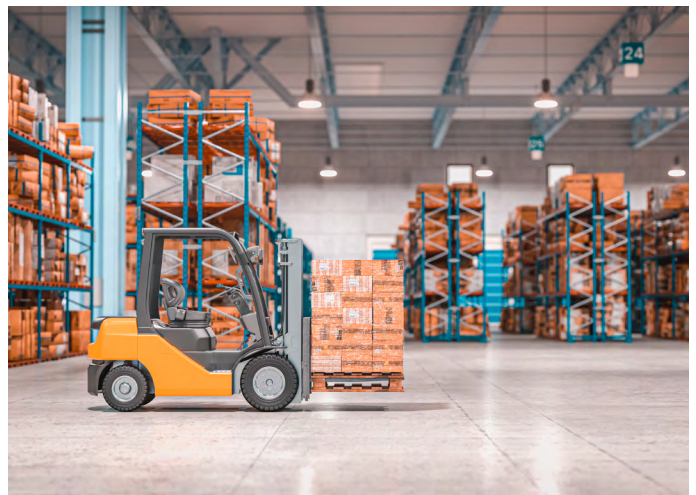
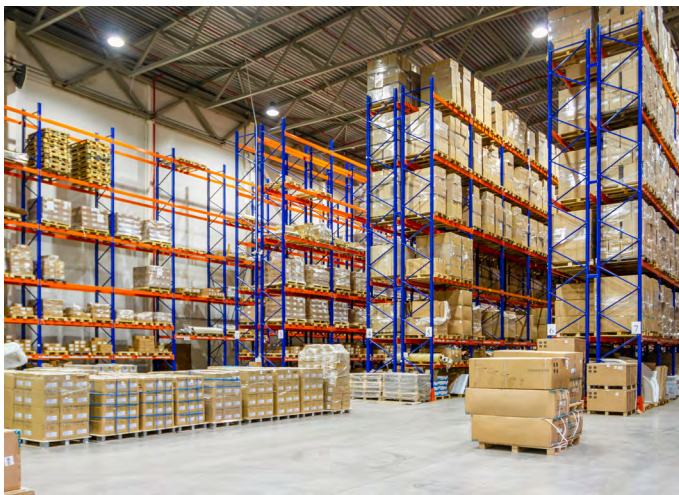


Production environments and warehousing and logistics operations face growing pressure to ensure workplace safety. Traditional approaches to monitoring safety often face challenges such as high latency, limited visibility, and lack of integration between OT and IT systems.

Belden provides the trusted industrial data layer that makes Physical AI possible. Together, Belden, NVIDIA, and Accenture deliver a comprehensive Edge AI solution that combines industrial networking, AI simulation, and real-time analytics. Leveraging Belden's deterministic networking and closed-loop action for real-time control, NVIDIA's GPU-powered AI and digital twin capabilities, and Accenture's industry integration expertise, this solution enables manufacturers to predict, prevent, and respond to incidents and safety issues in real time. The result is a safer shopfloor aligned with the vision of zero-incident operations.

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Current state and typical challenges

Modern production and warehousing and logistics environments are increasingly complex, with people, machines, and automation systems sharing the same physical space. Ensuring both safety and quality across these dynamic environments presents multiple challenges:

- **Mixed zones** where pedestrians, vehicles, and robots operate simultaneously.
- **Limited real-time visibility** into hazardous or high-traffic areas.
- **Difficulty enforcing PPE compliance**, restricted zones, and safety protocols.
- **Time-consuming** manual quality inspection **processes** prone to human error.
- **Fragmented data** and delayed analytics limiting proactive intervention.
- **Labor shortages and high turnover** put more less-experienced workers on the shopfloor, increasing the need for injury-prevention systems.

Traditional camera-based systems provide passive monitoring but lack contextual intelligence, automation, and the closed-loop responsiveness required for real-time control.

Physical AI helps operations understand human-machine interactions, predict hazards earlier, simulate high-risk scenarios safely, and continuously improve models with real-time data.

Safety issues impact in manufacturing



Source:

1. www.bls.gov/iif/fatal-injuries-tables/fatal-occupational-injuries-table-a-9-2023.htm
2. www.bls.gov/news.release/pdf/osh.pdf
3. injuryfacts.nsc.org/work/costs/work-injury-costs/

Addressing key priorities

An operations safety solution matters because it protects people while directly safeguarding business performance—reducing injuries and fatalities, avoiding millions in direct and indirect costs, minimizing downtime, and strengthening operational resilience, reputation, and long-term profitability.

EHS / Safety Manager • Reducing incident rates & injury costs • Hazard identification & control • Compliance & reporting	Plant Manager • Minimizing downtime & productivity loss • Linking safety to operational performance • Cost of safety vs. business impact	Maintenance Manager • Inspection effectiveness & machine safety • Integration with maintenance workflows • Predictive insights
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Example of motorized vehicle and pedestrian safety on a manufacturing site



Motorized vehicles monitoring

- Vehicle operation areas & proximity risks**
Track available space around each moving vehicle and identify possible collisions & proximity risks with pedestrians/ vehicles/ assets
- Vehicle restricted areas**
Track respect of pedestrian aisles and guard high-risk zones from vehicles presence
- Driving behavior & speed limitations**
Track speed limit violations & identify driving risky behaviors



Pedestrians & workers anonymous safety monitoring

- PPE detection & alerts**
Check PPE/ HSE compliance per area / activity for anonymous statistics per area. Check presence of possible unauthorized visitors.
- Tracking of restricted areas due to equipment risks**
Ensuring worker safety in machinery and robotics areas (ex: lifting cranes, palletizing robots, etc.)
- Worker counting with min/max controls in specific areas**
Mitigating potential risks linked to workers overcrowding or understaffed
- Identification of risky behaviors**
Identify risky behaviors in indoor warehouse & shopfloor areas

Value drivers

Long-term profitability

Strengthening operational resilience

Minimizing downtime

Compliance & reporting

Positive outcomes

- Protect reputation**
High injury rates impair recruitment, customer relationships, and community standing, affecting long-term competitiveness.

- Shield culture**
Frequent injuries destroy trust, engagement, and teamwork, creating negative spirals affecting all performance metrics.

- Improve quality**
Facilities experiencing frequent injuries show 25-40% higher defect rates due to inexperienced replacements and reduced morale.

- Reduce liability**
Serious injuries trigger OSHA investigations, lawsuits, and settlements averaging \$500,000-2M per severe incident.

Solution overview



Solution powered-by

accenture  **Belden**  **NVIDIA OMNIVERSE**

Integrated safety platform for pedestrians and PIVs

This solution delivers an integrated safety platform ensuring safer interactions between pedestrians and Powered Industrial Vehicles (PIVs).

Key components:

- 1 **AI-enabled edge vision system:**
Leverages Belden's OT network for real-time pedestrian detection and incident prevention.
- 2 **Dynamic safety alerting & zoning:**
Provides instant notifications to operators and PIVs about potential safety breaches.
- 3 **NVIDIA Omniverse Digital Twin:**
Simulates complex, hazardous scenarios to train AI models when real-world testing isn't practical.
- 4 **Accenture's expertise:**
Integrates network, compute, AI, and digital twin technologies for intelligent industrial operations.

How it works:

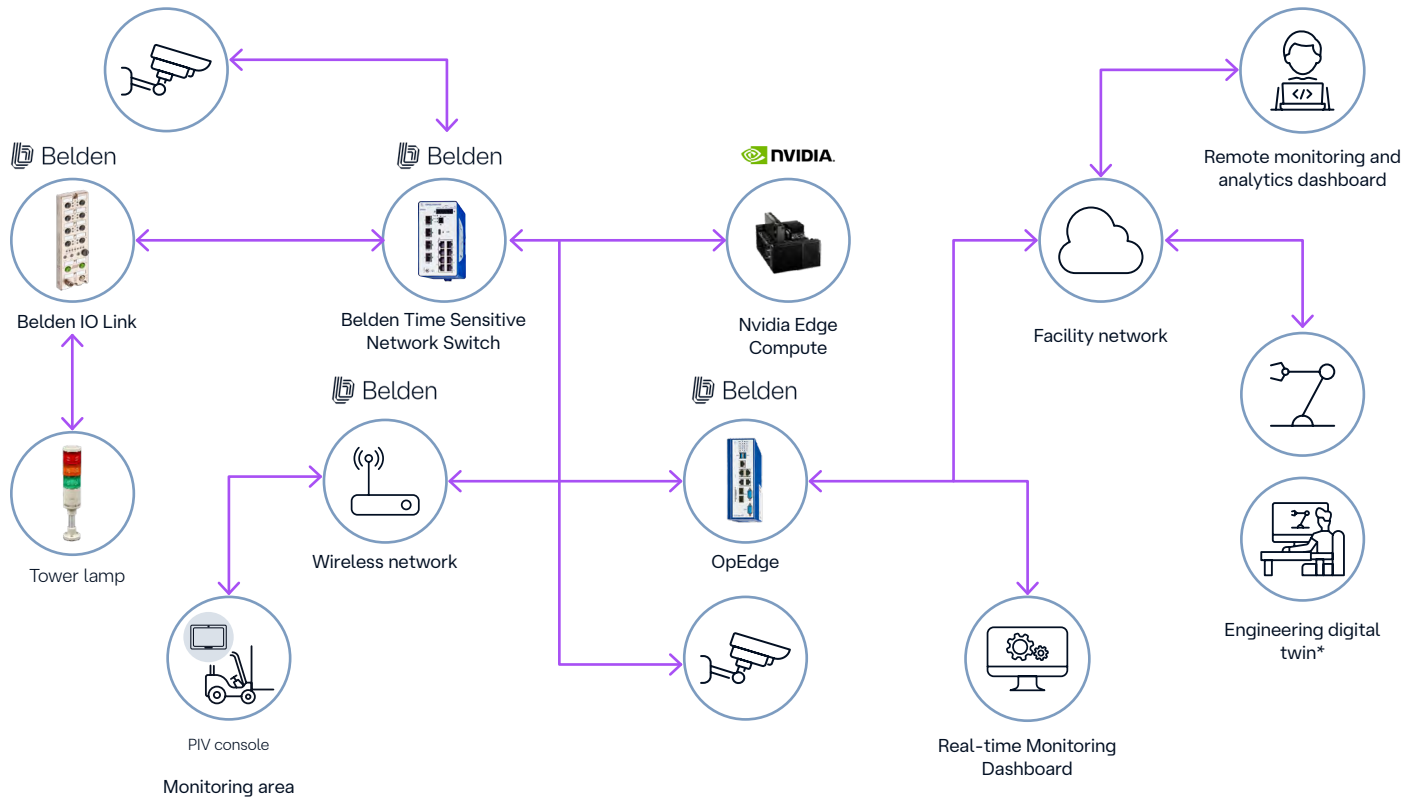
- Digital twin technology simulates scenarios to develop hazard detection algorithms.
- Edge cameras and sensors monitor pedestrian and operator movements.
- Integrated hardware detects hazards, providing immediate visual and audible alerts.

Additional features:

- Real-time data capture and historical logging for compliance.
- Seamless integration into existing infrastructure.



Solution architecture



Person movement detection at edge

- >>> **Edge-deployed vision AI** continuously monitors operator movement and posture in real-time, using a network of synchronized multi-angle cameras
- >>> **Virtual safety fence replaces** static cages by dynamically adjusting safety boundaries based on machine state and human proximity
- >>> **TSN (Time Sensitive Networking)** enables reliable, deterministic data transfer between OT sensors and closed-loop action for real-time control, supporting concurrent safety and process communication with minimal latency

Proximity breach detection and alert

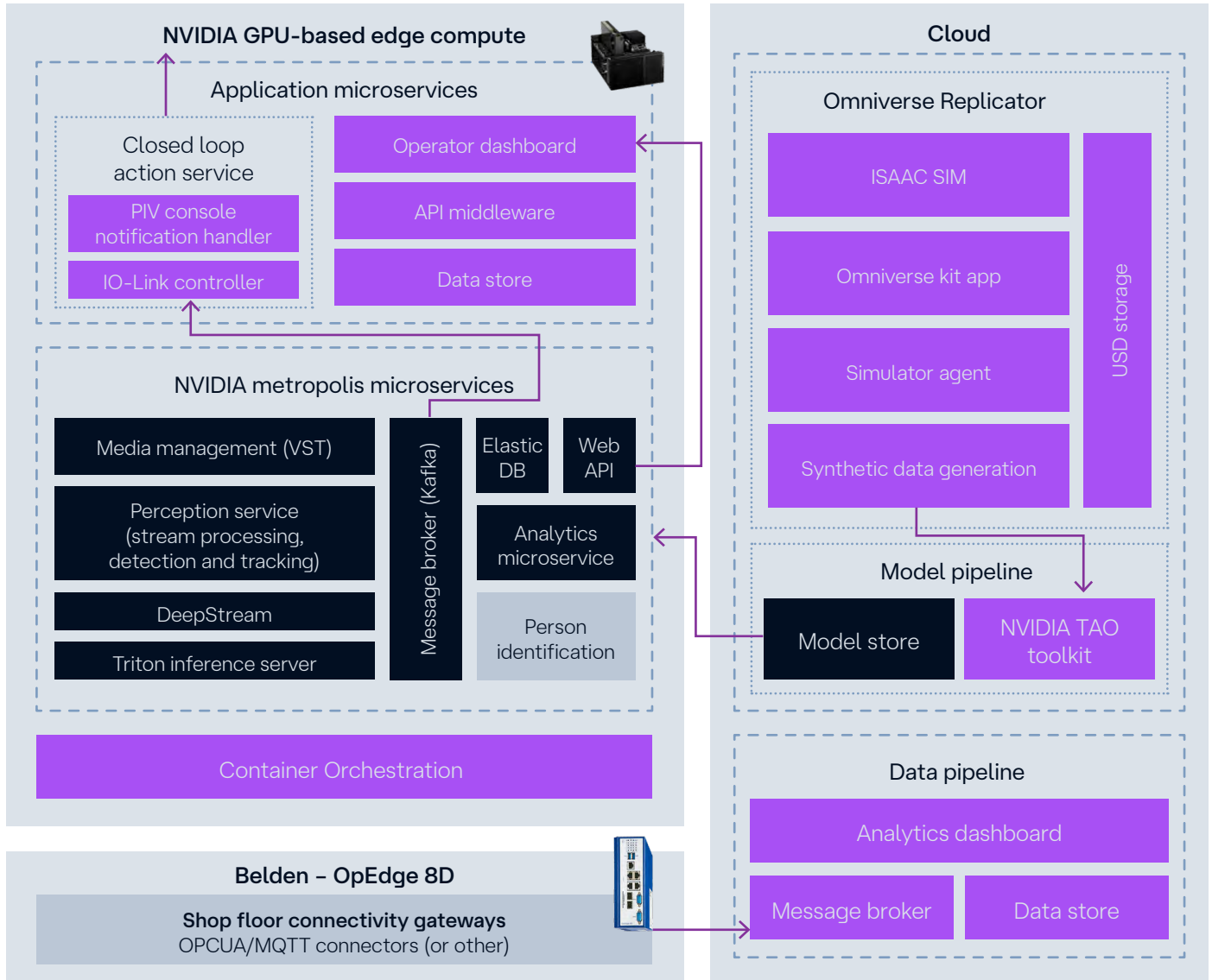
- >>> **AI-powered violation detection** recognizes proximity breaches in high-risk zones, with instant alerts
- >>> **Automated intervention protocols** can include visual or audible warnings or emergency stop triggers to prevent injury
- >>> **Event logging & evidence capture** ensures that every detected incident is documented with annotated images, timestamps, & zone data—critical for compliance, audits, & operator feedback

Continuous monitoring

- >>> **Edge-to-cloud integration** facilitates the collection of all historical data recorded at the source, enabling more extensive analysis during the engineering phase.
- >>> **Safety insights dashboard** offers a trend view of violations segmented by operator, machine, shift, or safety zone to drive targeted training and operational changes
- >>> **Digital twin & simulation** allows virtual validation of new safety configurations or equipment layouts without impacting live operations, enhancing design agility and uptime

* The setup of a digital twin is utilized only for simulation and the creation of synthetic data for vision AI model finetuning.

Solution architecture



- » **Synthetic data generation and model training:** Nvidia Omniverse Replicator in the Cloud simulates the operations floor environment and generates synthetic datasets. These are used with the Nvidia TAO Toolkit to train AI models, which are then deployed to the Nvidia GPU based Edge Device.
- » **Closed loop execution:** Events generated by Metropolis analytics are published to a Kafka message broker and consumed by the Closed Loop Action Service. Based on these events, actions are triggered through the Sensor Controller to control the robotic arm, stopping or slowing down the movement to activate the alarm system.
- » **Edge deployment and real-time inference:** Camera feeds from the operations floor are processed by Nvidia Metropolis components—DeepStream and Triton Inference Server—for perception and inference. Real-time analytics such as behavior analysis and person detection are performed, generating events based on defined business rules.
- » **Cloud integration and analytics visualization:** The OpEdge device publishes event data to the Cloud, where it is processed by the analytics pipeline. The results are visualized on dashboards for real-time monitoring, insights, and continuous optimization.



Solution Brief



Contact us to learn more about this solution

About Belden

Belden Inc. delivers the infrastructure that makes the digital journey simpler, smarter and secure. We're moving beyond connectivity, from what we make to what we make possible through a performance-driven portfolio, forward-thinking expertise and purpose-built solutions. With a legacy of quality and reliability spanning 120-plus years, we have a strong foundation to continue building the future. We are headquartered in St. Louis and have manufacturing capabilities in North America, Europe, Asia, and Africa.

For more information, visit us at:
belden.com

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