VERTIV WHITE PAPER

# Enabling Computing in Harsh Environments

Infrastructure Considerations for Manufacturing and Other IIoT Applications

## Executive Summary

Enterprises today are adding intelligence to factories, warehouses, and other industrial environments to better compete in the global marketplace. These emerging edge use cases are helping drive improvements in asset utilization, equipment availability, and process efficiency. According to McKinsey, factories and other production environments have the potential to realize the biggest financial impact from the application of the Internet of Things (IoT). They predict the Industrial Internet of Things (IIoT), also known as Industry 4.0, will generate an economic value between $1.2 to $3.7 trillion by 2025.

However, the conditions where computing is being deployed in these environments must be carefully considered when configuring the infrastructure that supports reliable operation of IT systems. This paper examines infrastructure requirements for edge IIoT applications in harsh environments and provides recommendations for IT network infrastructure deployed there.

## The Growing Industrial Edge

Over the past few years, investments in smart manufacturing technologies, enabled by the IIoT, were growing steadily as manufacturers sought to capture and maximize the efficiency of their production lines and facilities.

The pandemic interrupted that momentum, but there are signs of recovery. Analyst firm MarketsandMarkets projects smart manufacturing technologies will grow from $181.3 billion in 2020 to $220.4 billion in 2025, a compound annual growth rate (CAGR) of 4%.

In the warehouse, the pandemic created a spike in direct-to-consumer shipments that drove increased demand for automation. It also jump-started e-commerce in the grocery industry, which saw huge spikes in click-and-pick and home delivery. Grocers and other retailers are now looking to expand their distribution networks by opening automated micro fulfillment centers close to their customers. LogisticsIQ is projecting an installed base of 2000 micro fulfillment centers by 2026 if the technology and concept prove effective.

## The Need for Local Computing

The IIoT connects a mesh of sensors, equipment, controls, and industrial computing platforms to provide visibility into and control of the equipment and processes upon which warehouses and factories depend. Two applications, in particular, are driving IIoT deployments in these industries: condition-based monitoring and digital twins.

Condition-based monitoring collects operating data from industrial equipment to enable enterprises to implement proactive service strategies based on the actual condition of components. Using condition data maintenance intervals can be driven by need rather than set time schedules, and vulnerable components can be replaced before they fail.

A digital twin is a virtual representation of a real-world physical asset, product, process, or system. Using data from multiple sources, a digital twin continuously learns and updates itself to represent the current working condition of the object or process, enabling organizations to optimize processes and adapt to change by evaluating the impact of different solutions before they are implemented.

The sensors and other devices that enable these applications generate large volumes of data in a given time period, which is why Vertiv classifies IIoT edge use cases as data-intensive. In data-intensive applications, the key driver for local computing assets is data volume. With high volumes of data, bandwidth and latency issues make it impractical to rely exclusively on the cloud to support the real-time analytics and decision making these applications require.

## Understanding the Network Computing Challenges

What's different about IIoT applications compared to some other data-intensive edge use cases is the environments in which edge computing is deployed.

Whether in a factory, warehouse, or micro fulfillment center, edge computing supporting IIoT may lack the precisely controlled conditions of a data center and often operates in particularly harsh conditions.

Failing to account for the specific power, environmental, and management challenges that exist in manufacturing and warehouse environments can result in edge equipment failures and reduced network performance.

### Power Continuity and Quality

As with any edge location, dedicated power backup is essential for preventing disruptions in utility power from impacting system availability. This protection is provided by connecting IT equipment to an uninterruptible power supply (UPS), which in edge applications, is typically mounted in the IT equipment rack.

Edge computing deployed in smart manufacturing and automated warehousing may not be supported by a backup generator, and in that case, the UPS battery system determines how long equipment and applications can continue to function in the event of an outage.

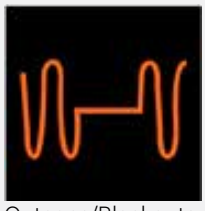
Typical runtimes for rack-mount UPS systems range between 2 and 6 minutes at full load. Runtimes will be longer at partial loads and can be extended to over two hours using additional battery packs. In most industrial applications, extended runtimes are not required because a prolonged utility outage will shut down production. In these situations, the battery just has to provide enough runtime to ensure a graceful shutdown of IT systems.

The other key function of the UPS is power conditioning. This can be extremely important in industrial environments because industrial machinery can generate electrical noise capable of disrupting or damaging IT equipment. Different types of UPS solutions employ different approaches to power conditioning, and the type of UPS selected will determine how effective it is at removing various power disturbances.

The power conditioning capabilities of a UPS are largely determined by its "topology" or internal design. Two main topologies are used in edge UPS solutions: line interactive and online double conversion. In harsh environments where industrial equipment may be creating power disturbances, an online double conversion UPS will usually be the best choice as it protects against more types of power disturbances than a line interactive UPS. These UPS solutions also do not rely on the battery system for power conditioning, preventing UPS battery capacity from being used to compensate for power anomalies.

Online UPS systems also help protect sensitive IT equipment from power variations that may be created by a backup generator. A generator can produce inconsistencies and fluctuations in voltage and frequency ranges that aren't corrected by a line interactive UPS. An online double conversion UPS converts the generator output into a clean, consistent AC waveform without relying on battery power, ensuring reliable IT operation when the generator is engaged.

**Power Problems Addressed by Online Double Conversion UPS Technology**


Outages/Blackouts


Sags/Brownouts


Surges


Spikes


Noise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Under-Voltage


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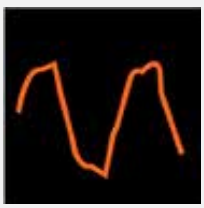
Harmonics

## Rack Power Distribution

One other consideration in regard to powering IT equipment is the need for power distribution within the equipment rack. In most cases, the UPS will not have enough outlets to support all the equipment in the rack.

Basic rack PDUs (rPDUs) are available in a variety of electrical and receptacle configuration, but serious consideration should be given to the value provided by an intelligent rPDU with remote monitoring capabilities. These PDUs enable a comprehensive view of power usage at the rack or via remote access. Intelligent, switched rPDUs are also available and can deliver added value. In addition to monitoring, they provide the ability to remotely cycle equipment on and off through the rPDU or turn off certain outlets to protect against overloading.

## Temperature and Humidity Management

OIn controlled data center environments, significant investments are made in thermal management systems designed to precisely control temperature and humidity within the room, ensuring IT equipment operates within manufacturers' specifications. Even in general office environments, building air conditioning can provide some cooling for low density racks. But, in manufacturing and warehouse environments, temperatures are likely to be more variable and more extreme, creating the risk of premature failure due to overheating.

Consequently, dedicated cooling should be considered an essential component in industrial edge infrastructure. There are a variety of solutions available for cooling IT systems in small spaces, such as wall-mount and ceiling-mount systems. But these systems aren't applicable in the large, open spaces of a warehouse or factory. When there is a need to put edge computing on the factory or warehouse floor, dedicated cooling should be integrated with IT equipment via a rack system or side-mount unit.

When using dedicated cooling integrated with the rack, you'll need to decide whether heat from the rack can be exhausted directly into the space, removed by ducting the rack to the building HVAC system, or rejected via direct expansion technology using an outdoor condenser. This will be determined by the size and environmental conditions of the building, whether a building air conditioning is present, and the location of the rack within the building.

Integrating cooling into the rack also has the advantage of enabling a self-contained environment within the rack that is not exposed to airborne contaminants. Most factory environments have a relatively high concentration of airborne dust and particulates that can impact the reliability and life expectancy of IT equipment if they are pulled into the equipment by server fans. With dedicated cooling integrated in the enclosure, a clean, temperature-controlled environment can be maintained.

IEC standard 60529 for Ingress Protection (IP) classifies and rates the level of protection against water and airborne particulates of an enclosed system. Enclosures can be matched to the application environment using this standard.

### Preventing Unauthorized Access

The core philosophy of edge computing is to locate computing and storage close to the people and equipment it supports. In manufacturing, that typically means having IT equipment where it is vulnerable to access by unauthorized personnel. Lockable cabinets can help prevent unauthorized access. A variety of locks can be procured that fit one of the two industry-standard door cutouts. Another best practice is to deploy sensors on the door that trigger alerts, log events, and even capture video when the door is open.

### Gaining Visibility into Network Infrastructure

Most edge computing sites are located in environments where dedicated technical resources are scarce. Remote monitoring capabilities give centralized IT administrators visibility into equipment performance and environmental conditions, allowing them to ensure equipment is operating as intended within manufacturer specified ranges. When equipped with additional sensors, remote monitoring can also generate alerts for situations that could put equipment at risk, such as elevated temperatures, water intrusion, or unauthorized access.

Remote monitoring used to be a fairly complex undertaking, but today has been simplified. Smart, connected equipment, simple sensors, and web-based monitoring solutions are easy to install and provide a single interface to multiple edge locations. These systems provide alerts and notifications by text and email when an unexpected event occurs, protecting IT equipment and allowing for rapid issue resolution.

Connected UPS, power distribution, and rack systems also enable power and environmental data to be integrated into existing building management systems (BMS) or data center infrastructure management (DCIM) systems.

Managed Service Providers (MSP) can also be used to support remote monitoring of edge infrastructure. They manage the remote monitoring platform and can ensure only critical alerts are escalated, freeing up IT teams to focus on other business priorities.

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## Micro Data Centers for Harsh Environments

Organizations implementing smart manufacturing and warehousing technology can specify individual components that address each of these challenges and “build” a solution capable of handling the demands of these environments. But the preferred approach is to procure a complete integrated micro data center solution that was designed and pre-tested to provide superior performance and reliability.

These micro data center solutions leverage standardized IT-grade components to enable fast and repeatable deployments of edge computing in industrial environments. They feature integrated cooling, intelligent power distribution, and remote management in a protected, lockable enclosure that can also support a range of UPS systems depending on the capacity and degree of power conditioning required.

When evaluating micro data center solutions make sure the solution has the application flexibility to support the approach to heat rejection that best fits the application, whether that is rejecting heat to the open space, overhead ducts, or exhausting to an outside condenser. It’s also beneficial to select solutions that support monitoring multiple data points from a single IP address. This can greatly simplify management as the edge network expands, and it keeps the costs down because there is a real cost for every IP address used in a network.

Finally, be sure to establish a maintenance and service plan that covers regular maintenance tasks such as replacing UPS batteries or addressing unexpected events like equipment failures. The combination of remote monitoring and a service contract with a vendor capable of quickly responding to on-site maintenance requirements can greatly minimize the risk of system downtime.


## Protecting Your Edge

Smart manufacturing and warehousing are among the most exciting use cases for edge computing as they enable enterprises to increase the value of existing assets and resources. But the factory or warehouse application can be hard on IT equipment without the proper protection. Integrated micro data centers with remote monitoring capabilities provide an ideal solution for these applications.

To learn more about leading network infrastructure and micro data center products and solutions, contact your local Vertiv representative or visit our website to find the representative nearest you.


**Vertiv.com | Vertiv Headquarters, 505 N. Cleveland Ave, Columbus, OH, 43082, USA**



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