



eBook: Dell Compute and Storage Solutions for the Modern Rugged Edge

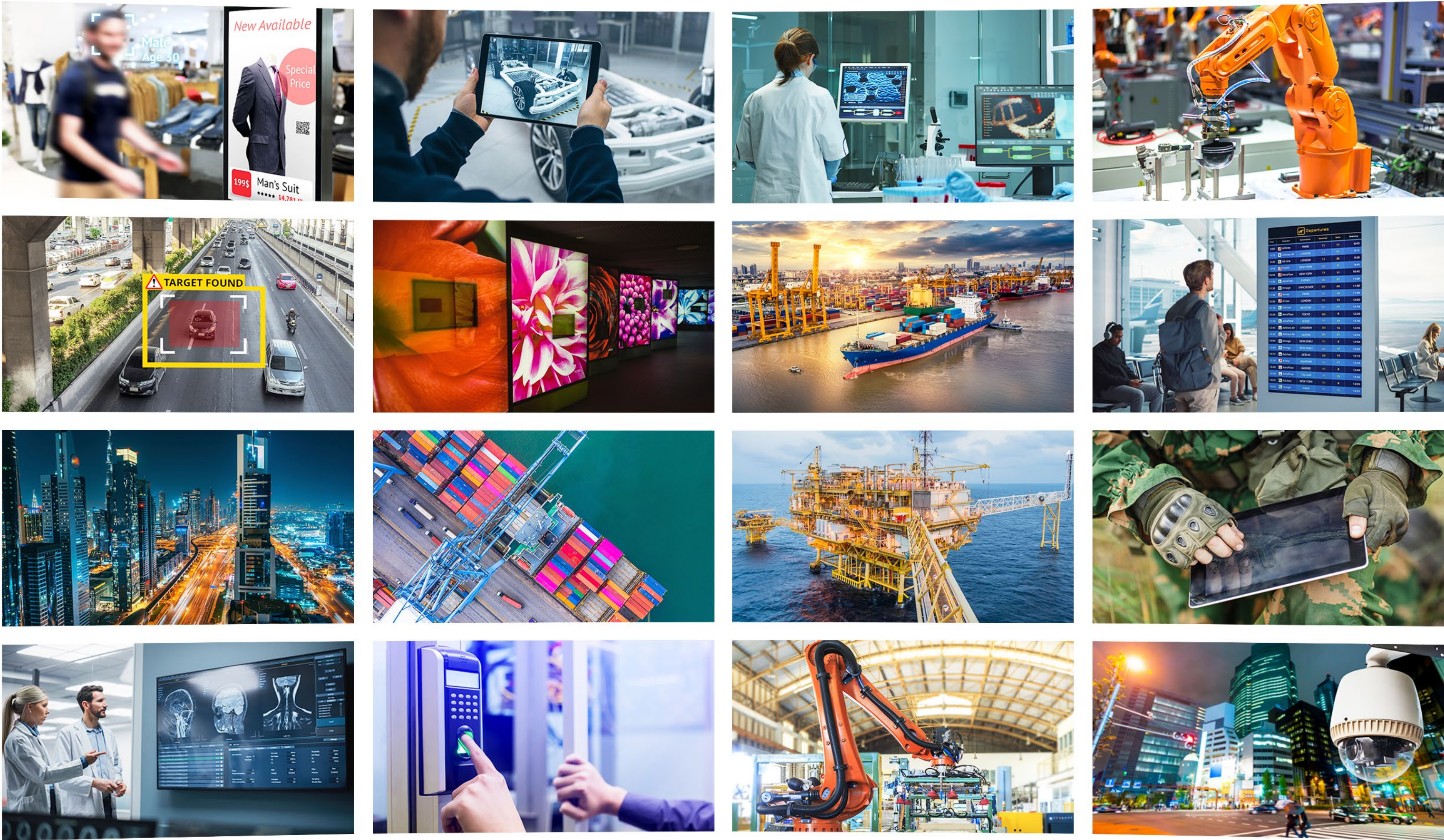
DELLTechnologies



The Modern Rugged Edge

Fueled by the explosion of AI and generative AI (Gen AI), the edge is vital for real-time decision making in modern applications, ensuring processing happens close to the source with minimal latency. This network edge concentrates compute, storage, and intelligence near the user, enabling low latency. As AI, particularly Gen AI, takes hold, the edge will be tasked with retrieving and processing ever-larger, more complex datasets at ever-increasing speeds, even in challenging environments.

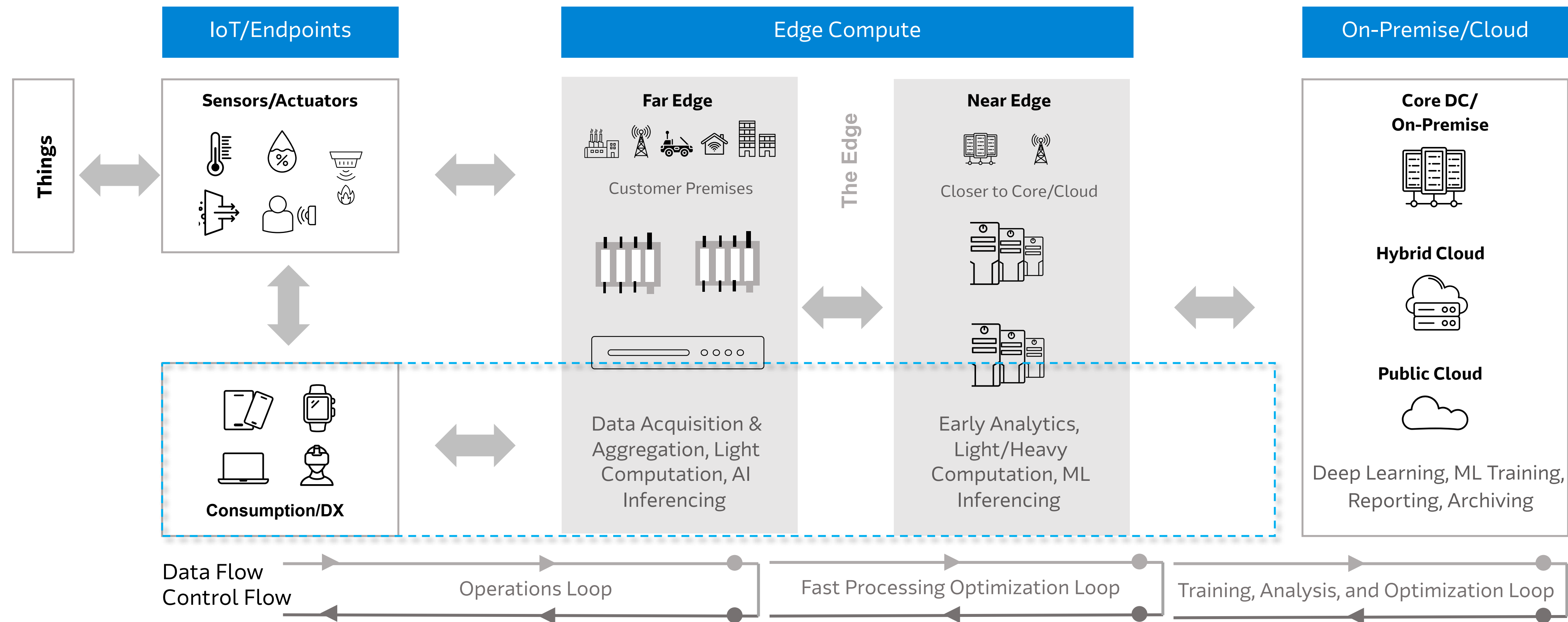
The edge infrastructure’s maturity and performance evolve to manage and scale alongside these emerging technologies and use cases. The fusion of mixed-modality data will usher in a new era of automation to groundbreaking levels of sophistication. This advancement hinges on the ability of the rugged edge to provide the necessary resources, powerful compute and storage, robust network communications, and unwavering security, all at the edge to support new data-intensive, ultra-low latency applications.



Operations from the Edge-to-the-Core

Data processing happens across a spectrum in modern applications, from devices to powerful data centers. At the farthest end, resource-constrained sensors and actuators reside at the far edge, closest to the physical world. Data is sent to the near edge, which might include local gateways or fog computing nodes for preliminary processing and filtering. Finally, the core/cloud, with its vast storage and computational power, handles complex analytics and long-term data storage.

This tiered approach to data processing not only optimizes data flow and reduces latency but also empowers real-time decision making for IoT applications.

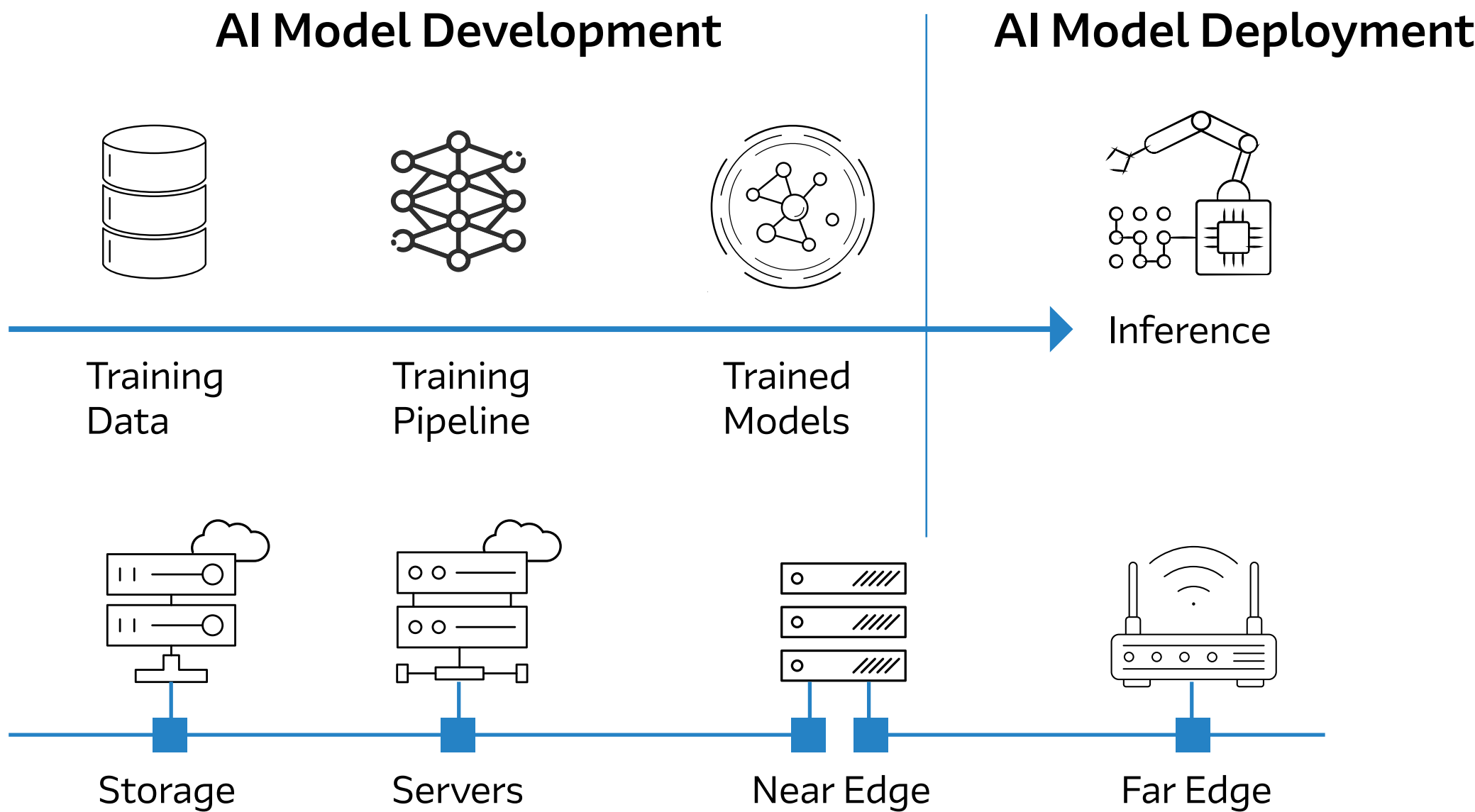


Role of AI at the Edge

AI at the edge is poised to be a game-changer, driving significant growth in the coming years. By processing data locally on devices and gateways, AI devices can respond instantly, optimizing efficiency and minimizing delays. This approach suits applications needing speed while reducing dependence on cloud processing, conserving bandwidth, and boosting data privacy.

AI involves training and inferencing. Training uses a data set, like images, to teach a model how to recognize and classify them. Due to high processing needs, this process usually takes place in data centers or the cloud.

Using trained AI models to analyze new data, inferencing requires acceleration techniques for fast results and is now an essential edge infrastructure function, providing rapid AI-based insights. Businesses are deploying edge devices with enhanced inferencing capabilities or allocating infrastructure for data analysis. Edge infrastructure equipped with parallel processing chips (GPUs) complements cloud-based AI engines and brings high-power computing right to the edge.



AI at the Edge Use Cases

Manufacturing

- Detect mechanical malfunctions on the shop floor
- Improve worker safety with computer vision
- Automate and speed up tasks with robotics

Retail

- Customize discounts and target product offerings for customers as they shop
- Enhance security with computer vision at self-checkout
- Increase customer loyalty with immersive, interactive experiences

Smart Cities

- Improve city-wide mobility with connected public transport systems that provide notifications
- Process/analyze video and sensor data for traffic safety and control
- Prepare for and respond to natural disasters with weather monitors, water-level sensors and SMS alerts

Military

- Deploy field-ready, remote support for field operations and reconnaissance
- Run mission-critical applications to patrol the battlefield
- Support real-time analytics, surveillance and communications

Edge Operating Environments

Given the numerous use cases for real-time processing, businesses today must depend on the far and near edge for compute, data, and storage close to or at the point of consumption. Stakeholders need to consider the physical environment where the edge infrastructure resides. A wide variation in environments puts constraints on the solutions deployed to match the computing demands at the edge. For example, an indoor store environment differs significantly from the harsh, corrosive environments in an industrial processing plant. Three categories or settings can organize most edge environments.

Controlled Environments

- Temperature control
- Restricted access

Server room, wiring closet, small data center



Semi-controlled Environments

- Semi-controlled temperature
- Low levels of dust
- Lacks restricted access

Open office, retail store, server closet, automated warehouse



Industrial & Harsh Environments

- Indoor or outdoor
- Wide range of temperature
- High risk of dust/water
- Lacks restricted access
- Noise can be a factor

Factory floor, outside, industrialized warehouse



As organizations look for solutions that can withstand the environments specific to their application location, a few common infrastructure characteristics are important.

- Resilience – the degree to which the edge infrastructure can withstand variations in environmental temperatures, humidity levels, and vibrations
- Autonomy – the degree to which the infrastructure can be operated without connectivity
- Security
- Footprint
- Remote-maintenance

Checklist for Selecting Edge Infrastructure

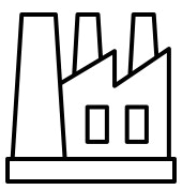
Building and deploying edge infrastructure that is stable and operates reliably requires careful planning and selection of technologies, platforms, and partnerships. Several characteristics are necessary for edge environments. Low footprint, resilience, power efficiency, and remote management are key features that keep costs down. These features make computing reliable in various locations outside the data center despite the lack of a controlled environment.

Arrow Electronics and Dell Technologies OEM Solutions, with their extensive experience and expertise, have created a preliminary checklist and tips to guide decisions on edge infrastructure.



Compute and Connectivity

- What are the latency requirements of the application?
- What is the data volume that needs to be captured and processed?
- What special capabilities are required for data analytics. Ex: artificial intelligence?
- What connectivity protocols are required to connect to the devices and the cloud?



Environmental

- Where will the infrastructure be deployed?
- In addition to temperature variations, will dust, noise, and humidity need to be considered?
- Will the application be in a fixed location or mobile?



Dimensional and Location

- What are the space constraints?
- Will deployment locations need special preparation?
- Are power and internet connectivity available?
- What are the airflow and cooling considerations?



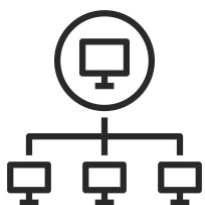
Storage

- How much of the data needs to be stored at the edge?
- What type of storage will offer the best performance-reliability-cost ratio?
- Can additional storage be added easily?



Security

- What security features does the edge infrastructure support to protect data, applications, and intellectual property?
- What access controls will be available for securing edge infrastructure?



Remote Management and Maintenance

- Does the edge infrastructure support central management – software/firmware upgrades, device provisioning, etc.?
- What resources are available for deployment and ongoing management and repairs?
- What type of product warranties are required?

Dell OEM Technologies Solutions for the Industrial Edge

Dell Technologies OEM Solutions offers the industry’s most comprehensive combination of servers, storage appliances, workstations, laptops, and gateways to build and deploy industrial-grade edge solutions across the globe.

Storage and Data Protection for the Edge

Store, protect, and get the most from your data



PowerVault



Unity XT



PowerStore



PowerScale



VxRail

PowerEdge XR Rugged Servers

Short-depth servers
purpose-built for the edge



XR4000R/XR4000Z



XR5610



XR7620



XR8000

Edge Gateways

Connecting OT/IT environments
and extracting value from data



Edge Gateway 3200, 5200

MEDIUM

DEGREE OF INDUSTRIAL RUGGEDNESS

HIGH

Industrialized PCs

Intelligent, industrial-grade desktops built for
ultimate stability, expandability, and performance



OptiPlex XE4 Tower and Small Form Factor

Rugged, Mobile Laptops & Tablets

Ultimate productivity in field and
harsh industrial environments

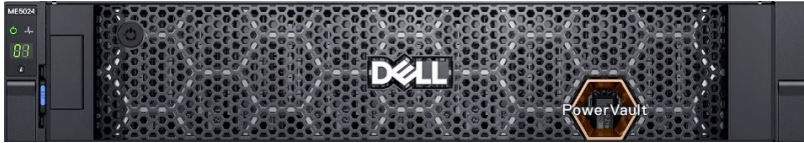


Latitude 7000, 5000

Storage Solutions for Industrial Environments

Dell offers storage solutions with industrial-grade durability, industry certifications/qualifications (can include Security Technical Implementation Guides [STIG] hardening, military, or DC NEBS/ETSI) or short-depth options.

Dell PowerVault
Block storage optimized for SAN, DAS, and edge workloads



- Key features**
- OEM-Ready (can ship as unbranded)
 - Custom hardware and software branding options available
 - Flexible deployments with hybrid or all-flash arrays
 - Lowest cost per GB
 - Includes CloudIQ for intelligent infrastructure insights
 - Single or dual controller models available
 - Expansion enclosures and JBOD available

- Industries/workloads**
- Healthcare and life sciences
 - Safety and security
 - Media, entertainment, and gaming
 - Industrial automation
 - Energy — oil and gas (HPC workloads)
 - Edge-based workloads

Dell PowerStore
Software-driven unified storage



- Key features**
- OEM-Ready (can ship as unbranded)
 - Custom hardware branding options available
 - Performance optimized with end to end NVMe design
 - Efficiency with always-on inline data reduction
 - Dynamic AppsOn
 - DC-powered NEBS-compliant option available
 - Scale-up and scale-out capability
 - Includes CloudIQ for intelligent infrastructure insights

- Industries/workloads**
- Healthcare and life sciences
 - Industrial automation
 - Public sector and defense
 - Financial technologies
 - Edge-based workloads

Dell Unity XT
No-compromise unified storage



- Key features**
- Hardware and software branding options available
 - Flexible deployments with hybrid, all-flash, or virtual storage array (VSA)
 - DC-powered NEBS-/ETSI-compliant options
 - Dual-active controller architecture
 - Includes CloudIQ for intelligent infrastructure insights

- Industries/workloads**
- Healthcare and life sciences
 - Industrial automation
 - Public sector and defense
 - Financial technologies
 - Edge-based workloads

Dell PowerScale
Modern, flexible scale-out file storage



- Key features**
- OEM-Ready (can ship as unbranded)
 - Custom hardware and software branding options available
 - All-flash, hybrid and archival nodes
 - Supports Dell PowerScale Cyber Protection
 - Includes CloudIQ for intelligent infrastructure insights and DataIQ for intelligent data discovery

- Industries/workloads**
- Healthcare and life sciences
 - Safety and security
 - Public sector and defense
 - Energy
 - Media, entertainment, and gaming

Dell VxRail
VMware-focused hyper-converged infrastructure (HCI)



- Key features**
- Hardware branding options available
 - Flexible configurations, including performance-optimized, cost-effective, compute-dense, storage-dense and military- and marine-certified options
 - Includes CloudIQ for intelligent infrastructure insights

- Industries/workloads**
- Healthcare and life sciences
 - Industrial automation
 - Safety and security
 - Public sector and defense
 - Energy
 - Edge-based workloads

Dell PowerEdge XR Servers: Edge Computing Solutions in Industrial Environments

Rugged PowerEdge XR servers are built to withstand the extreme heat, dust, shock, and vibration of factory floors, construction sites, mobile command centers, and other extreme environments.

Compact and Powerful



All-Purpose Compute in 1U



AI/ML at the Edge



Multinode Edge-to-Edge Compute



	XR4000R/XR4000Z	XR5610	XR7620	XR8000
Component expandability	Up to four PCIe Gen4 FHFL slots in rackable variant	- Front-and rear-facing I/O - Integrated 4 x25/10GbE LOM PTP - Up to 2 risers providing OCP 3.0 and/or 2 PCIe Gen5 x16 card slots	- Front-and rear-facing I/O - Up to 4x PCIe Gen4/5 slots - OCP 3.0 for network cards 1x LP slot	- Broad range of configurability supporting up to 4 nodes with flexible I/O sled options 2U modular front-accessible chassis with dual power supply to support up to 4 nodes 2U sled XR8620: 3x FHHL (Gen5) 1U sled XR8610: 1x FHHL (Gen5)
Latest accelerators	2x A2 or 1x A30 in the 2U sled configuration	Up to 2x SW GPUs	2x 300W (DW) or 4x 150W (SW)	1x 300W GPU per node
Storage	1U sled: 4x M.2 NVMe drives; up to 15Tb 2U sled: 12x M.2 NVMe drives; up to 46Tb	- Up to 4x 2.5" SAS/SATA SSDs or NVMe® SSDs - Internal: Internal BOSS-N1 (2x M.2 NVMe) for boot	4x 2.5" NVMe 4x 2.5" SATA\SAS with PERC11 8x E3.S NVMe 8x E3.S NVMe with PERC12	2x M.2 NVMe - Optional RAID - Up to 3.84TB, 22110 options
Other features	- XR4000Z stackable/mountable chassis can fit: 2x 1U sled or 1x 2U sled + 1 witness node - XR4000R rackable chassis can fit: 4x 1U sled or 2x 1U sled + 1x 2U sled or 2x 2U sled + 1 witness node - Certified rugged for operation in environmentally variant locations (MIL-STD and NEBS)	- Short-depth 1U - Certified rugged for operation in environmentally variant locations (MIL-STD and NEBS)	- Short-depth 2U - Dual socket - Certified rugged for operation in environmentally variant locations (MIL-STD and NEBS)	- Short-depth - Front-accessible 1U and 2U sled options - Extended temp (–20°C to 65°C) for select configurations - Both AC and DC power options - Full sled replacement for simplified field maintenance and service

Industrialized Client and Far Edge Solutions

Dell offers rugged laptops, tablets, and industrialized PCs and workstations to meet the requirements of industrial applications in terms of size, performance, and extended lifecycle.

Workstations		Desktops	Gateways	Laptop/Tablet
				
Precision 3280 Expandable compact form factor		OptiPlex XE4 Mini-tower and SFF Industrial PC	Edge Gateway 3200, 5200 Uncompromised connectivity at edge	Latitude 7000, 5000 Laptops and tablets with rugged mobility
- 10°C to 45°C - Dust filters - Filtered bezel - 2.6-year target life - MIL-STD tested - Tensor Core GPU support		- 5°C to 45°C - Dust filters - Filtered bezel - 3- to 5-year target life - Designed to MIL-STD-810G Certified: Marine DNV	- -20°C to 60°C, 0°C to 60°C - Fanless design - 5-year target life - Designed to MIL-STD-810G - IP rating of up to 40	- -29°C to 63°C - Fanless design - 2.5-year target life - Certified: MIL-STD-810G; up to IP-65; MIL-STD-461F

Arrow's Engineering Design Services for Edge AI

Arrow's comprehensive design engineering support covers the entire journey from concept to implementation. Leveraging the latest Edge AI technology advancements, we tailor solutions your industry's unique challenges and opportunities. With a focus on customization and scalability, our design engineering services for Edge AI enable you to harness the full potential of artificial intelligence, drive efficiency, and make data-driven decisions that fuel your organization's success.



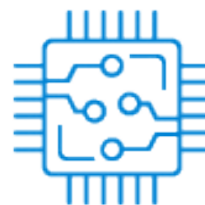
Edge AI Infrastructure Right Sizing

We guide Edge AI infrastructure selection ensuring the best performance and scalability without oversizing initial investments.



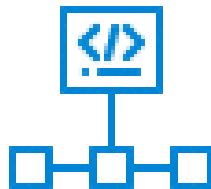
Performance Optimization

Optimize the efficiency and speed of your Edge AI applications through our benchmarking and analysis services for Edge AI workflows.



Hardware Validation

With state-of-the-art facilities, we validate hardware under various conditions, verifying performance and reliability.



Algorithm Development

We specialize in custom Edge AI algorithm development to suit specific industry requirements and use cases.



Machine Learning (ML) Data Services

With expert ML data management, businesses can optimize their machine learning workflows, fueling accurate and effective Edge AI-driven solutions.



Managed R&D Services

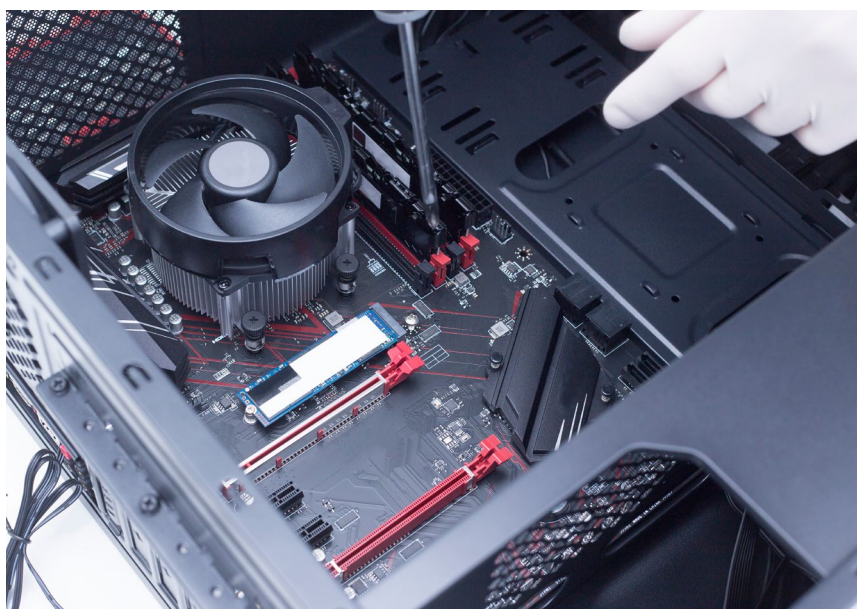
Accelerate innovation and efficiently bring cutting-edge products and solutions to market with Arrow's R&D services.

Arrow's Product Lifecycle Services

Streamline Manufacturing, Achieve Global Scalability, and Expand to New Markets

Arrow's design engineering support and services cover every step of your project, from concept to implementation, to ensure that you maximize business outcomes throughout the entire lifecycle of your product. Multiple service mechanisms can help OEMs succeed in new product initiatives, from ensuring the appropriate design trade-offs between cost and functionality to implementing field upgrades. At Arrow, we provide everything from manufacturing and supply chain services to financing and support.

Engineering Services



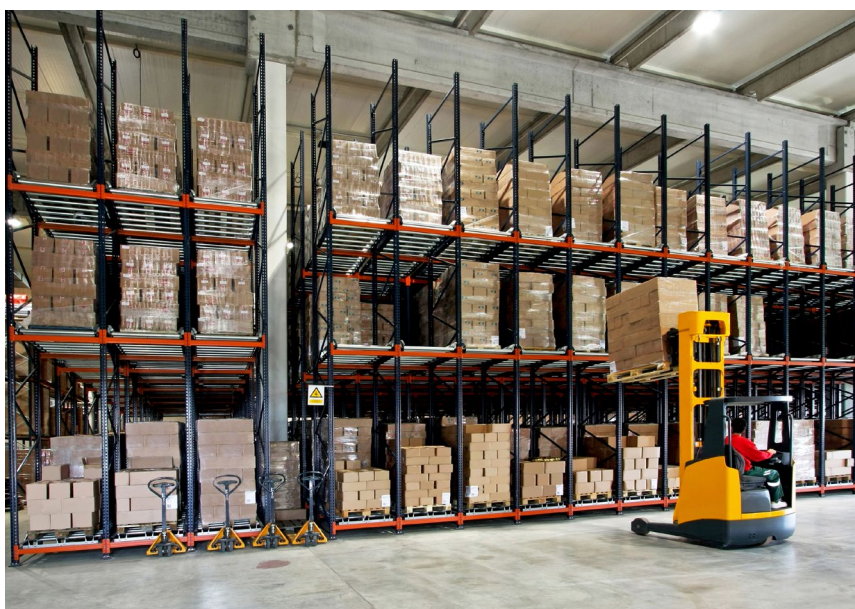
Shorten time to market through one-on-one collaboration with our expert engineering team.

Integration Services



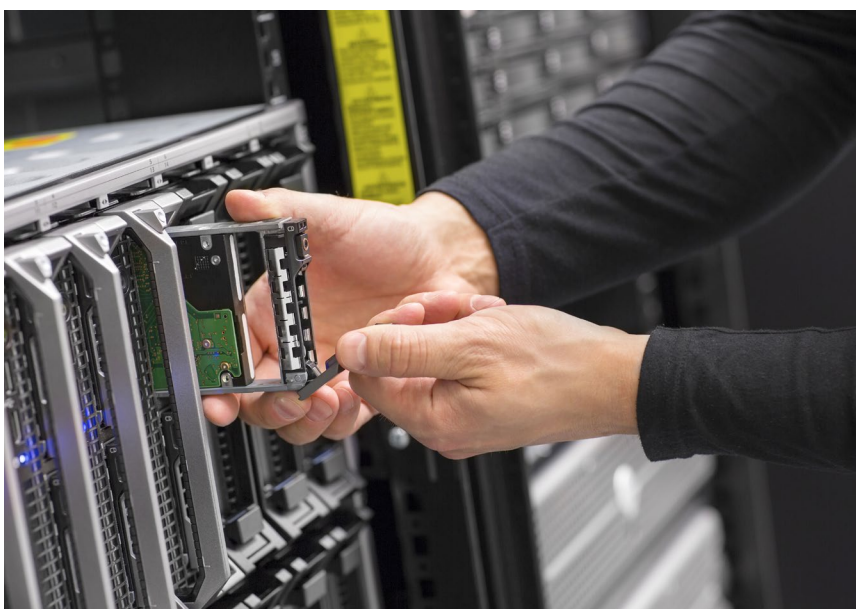
Worldwide manufacturing facilities and integration centers can get your products made fast, efficiently and cost-effectively.

Supply Chain Services



Unlock a world of opportunity to enhance the way you serve your customers.

Deployment and Support Services



Advanced deployment and support services that cover every need before, during, and after system installation.

With a footprint in **90+** countries, Arrow can support you from any location and help you expand to international markets. Scale globally with Arrow on several fronts-logistics, support, installations, compliance, and regulations.



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ARROW
Five Years Out

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