



eBook: Gaining an Edge in Retail

DELLTechnologies

ARROW



Table of Contents

Why Edge Computing for Retail 04

Edge Applications for Retail..... 06

Store of the Future 08

Role of Retail Edge Infrastructure10

Infrastructure Solutions for the Retail Edge.....12

Checklist for Selecting Edge Infrastructure14



Introduction

Retailers are facing a complex set of technological and market factors. With the pandemic-related recessionary environment subsiding, consumers are starting to spend again, ushering in positive market sentiment for the retail sector. Despite these developments, brick-and-mortar retailers are increasingly under pressure as consumer preferences have shifted to online shopping during the pandemic and are continuing to accelerate. Yet predictions of the imminent death of retail are premature. Less than 20% of retail sales occur online today, and the proportion of retail sales happening online is expected to be 21% in 2023*. Shoppers indicate that they want engaged in-store experiences with deep personalization and smooth transitions between online and physical stores – an omnichannel experience. The retail store is highly relevant for many shoppers as it affords a visceral experience and provides instant gratification on a purchase impulse. The ability to touch and feel a product before buying and taking it home are key factors for many shoppers – as indicated by the fact that just 5% of grocery sales occur online. While the retail store is here to stay, the nature of shopper-seller interactions is undergoing profound change.

The entire customers’ buying journey is fundamentally changing – retailers who are in tune with these trends and are making investments to prepare for this future will be rewarded amply.

*Source: [Statista](#)

Why Edge Computing for Retail

Technology is accelerating the transformation of the retail store on many dimensions. Cutting-edge innovations driven by sensors, connectivity, advanced processing, artificial intelligence (AI), and data-driven insights enable both incumbent retailers and upstart ventures to better compete for customer loyalty and achieve superior cost outcomes.

Retailers rely on a variety of systems to conduct business. Besides the point of sale (POS) systems, the store's operating infrastructure such as lighting, air conditioning, utilities, refrigeration, doors, and security are also networked into store control systems and 3rd party service provider networks. All these systems are increasingly interconnected and complex. In addition to the infrastructure that is required to run the store, there are often a variety of IT systems that tie into enterprise resource planning systems (ERPs), logistics systems, customer management systems, and office networks that allow the individual store to operate independently while being an integral part of the retail chain. While connected to centralized headquarter infrastructure, these store systems need to work independently of the central network as store operations need to continue even if the central systems are down. To make this possible most retailers have local systems that afford compute resources. These resources form the edge infrastructure for retail.

In-store systems have been transforming for years as retailers have been trying to give customers better in-store experiences. For example, during the pandemic, scan-and-go technologies that bypass human interactions and provide an integrated online/offline experience have come to the fore front. While such systems have increased customer conveniences, they also pose theft risks for the stores. Retailers are supplementing scan-and-go systems with cameras and security systems to reduce the risk of abuse.

Several technologies are gaining relevance and becoming critical store infrastructure including, augmented and virtual reality for higher customer engagement, logistical robots and smart shelving solutions for helping to manage store inventories, robots for cleaning and maintaining stores, digital signage/smart screens for advertising/promotions, and AI-based store security systems. The internet of things (IoT), machine learning (ML) algorithms, and mobile applications are also ushering in rapid changes to the in-store experience for store personnel and customers.

Supporting new customer expectations, improving store personnel productivity, and reducing operating costs are key business objectives of these technology deployments. Since these new technologies are data-hungry and often cannot tolerate latency of information going back and forth between the store and cloud infrastructure, store-level compute at the edge has become a priority. The retail edge infrastructure's reliability, scalability, and manageability are critical for uninterrupted store operations and differentiated customer experiences. Demands on edge infrastructure are likely to keep increasing as retailers combat omnichannel competitors with new robust digital infrastructure solutions and upgrades to current equipment.

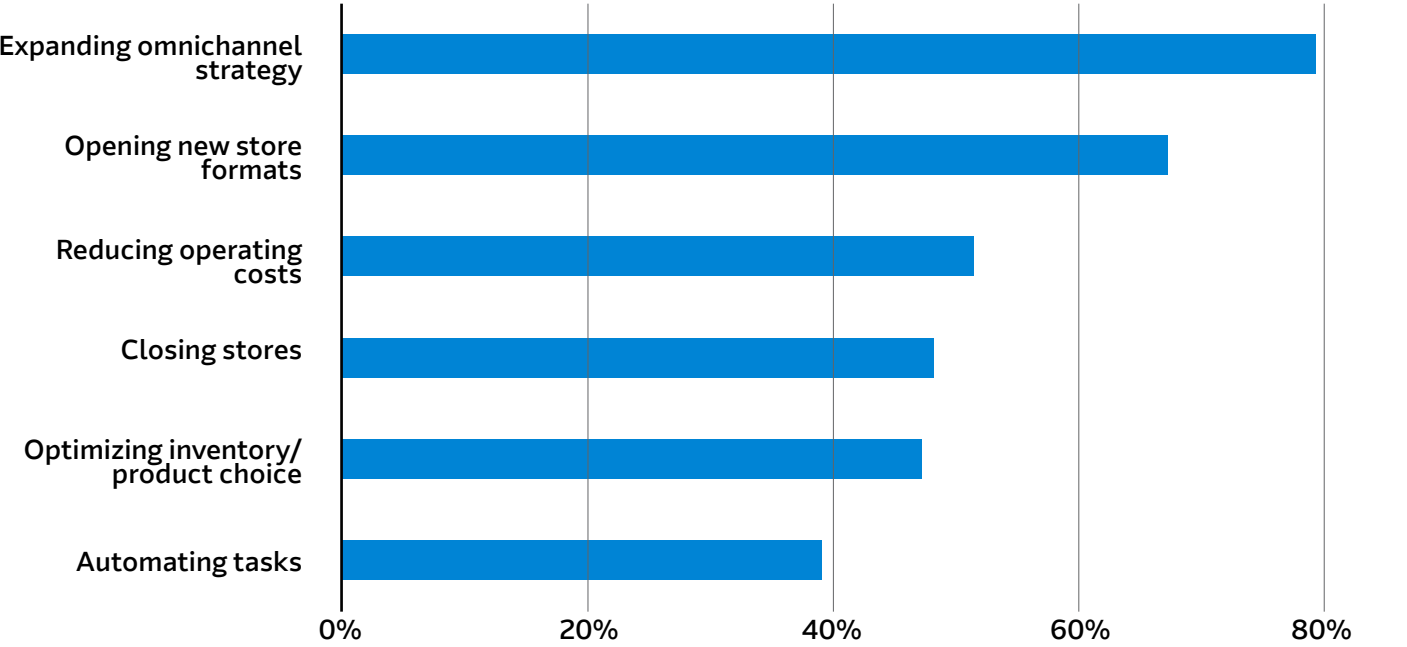
Technology has also brought in an unprecedented ability to track and trace goods across borders, stores, and logistical steps, helping retailers better match the in-store inventory with demand trends. Further, the entire checkout experience is transforming due to the increasing acceptance of e-wallets and digital credit cards complemented by self-scan and automatic visual sensing technologies that identify the items the customer is purchasing.

Retail stores that survive and thrive in the coming years will be those that use technology to deliver a superior customer experience and improve operational efficiency. Edge infrastructure is critical to ensuring availability and simplifying management of in-store technology.

Customer Expectations from Retail Stores



Retailer Priorities



Source: MIT Technology Review

Edge Applications for Retail

More than ever before, retailers are investing in technology that harnesses data to drive customer engagement, satisfaction, and the store bottom line. Interconnecting the physical and online retail experiences and tracking the entire buying journey as one integrated purchase experience are key priorities. The retail edge has become a critical element to drive new modes of customer engagement, operational efficiency, facility security, and business insights.

Customer Engagement

The quest to develop loyal customers by understanding unmet needs and buying motivations is every marketer's dream. By integrating omnichannel interactions and in-store decisions, marketers can pinpoint customer micro-segments and target advertising and promotional pricing. Retailers are increasingly enlisting the customer to share her buying journey by providing interactive screens, augmented vision systems, and hyper-personalized interfaces right at the store. These systems must constantly be in sync, up to date, always-on, and highly reliable. Technologies soon to be in every store include:

- **Integrated Online – Physical Store:** Allowing customers to buy online and pick up in-store (BOPIS) dramatically increases convenience and allows the customer to get the product faster.
- **Responsive Analytics:** Consumers leave a trail of data as they make choices based on complex criteria. All this data can be powerful in helping meet the customers buying criteria when integrated and processed to offer a superior customer experience.
- **Hyper-Personalized Signage:** Signage that changes to promote customized offerings (ex: special pricing on specific products), increases engagement and sales. Such systems adjust to a known customer's preferences and the store context.
- **Virtual Immersion:** Digital mirrors allow customers to visualize different apparel without physically trying them on. Other forms of augmented and virtual reality technologies aim to provide truly immersive shopping experiences.

Operational Efficiency

The retail industry is characterized by hyper-competition, razor-thin margins, and high employee attrition. The pandemic brought on new challenges by drastically reducing store traffic and shifting to a different cost model enabled by technology. Many retailers are now exploring ways to optimize their store operations further. Some retailers are even considering an automated store experience with almost no human interaction. A few ways digital technologies are enabling higher operational efficiencies are:

- **No-Touch Checkout Systems:** Scanning and integrated POS technologies with options to pay with a smartphone are proliferating. These technologies save costs and offer a superior customer experience.
- **Logistical Automation:** Robots are lessening the need for humans to process incoming and outgoing shipments. Automatic inventory replenishment systems minimize losses due to stock-outs. Such automation allows retailers to operate stores at lower costs and maximize sales.
- **Condition Based Maintenance:** Key facility equipment like air conditioning, refrigeration, lighting, and other devices now come with special algorithms to predict failures before they happen and trigger maintenance events, saving costs by avoiding disruptions.
- **Energy Management:** Most retail stores are equipped with controls technologies that can sense motion, occupancy, and outside weather, enabling the automatic on/off operation of lights and other energy devices to save operating costs.

Dramatic technology-driven changes to the in-store experience, retail operations, and customer interaction have created a new opportunity for retailers to entice customers, satisfy unique needs and enhance profitability. In effect, the future of retail is about delivering a shopping experience responsive to the presence and conditions of its shoppers.

Security and Safety

The more automated a store becomes, the higher the risks of theft and abuse. To prevent such incidents, retailers employ a variety of camera-based solutions and fraud detection systems to protect premises and reduce losses to theft or spoilage.

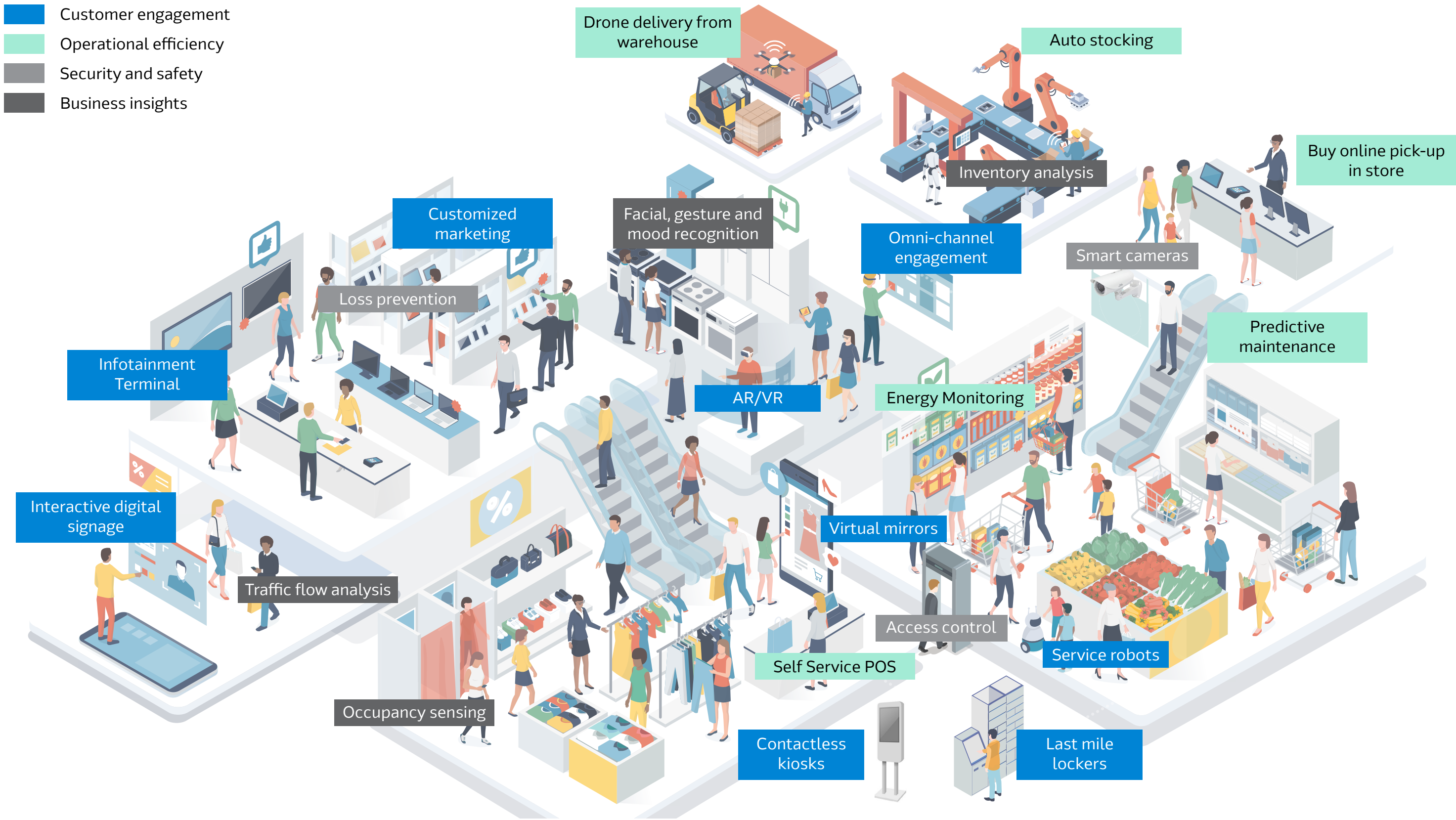
- **Remote Monitoring:** Almost all aspects of the store are monitored remotely by collecting log data and exception information from controls. Alarms and alerts are typically processed, and personnel or service dispatches occur when issues arise.
- **Loss Prevention:** RFID tags and scanners combined with camera technologies are helping retailers prevent theft and pilferage. These technologies monitor bad customers and ensure that store personnel adheres to strict codes of conduct.
- **Surveillance:** Video surveillance has been in use for a long time in retail stores. Today's advanced imaging systems are augmented by AI algorithms that can perform facial recognition, do temperature scans and identify people even when in disguise. These surveillance mechanisms are deployed inside stores and parking areas to afford customers peace of mind and protect store property.

Business Insights

The most prominent application for edge infrastructure in retail is the ability to garner business insights by collecting data about a plethora of store operating metrics.

- **In-store Traffic Analytics:** Collecting data on metrics like footfalls, occupancy, the effectiveness of promotions and sales by time of day, etc. are very powerful in guiding a retailer's in-store strategy. Collecting these data and acting on insights in real-time gives progressive retailers an edge over the competition.
- **Real-time Inventory Moves:** No retailer wants to be out-of-stock when a customer wants an item. Real-time inventory tracking and advanced analytics of demand patterns can be a powerful tool for retailers to match any specific store demand with the right inventory levels.
- **Customer Feedback:** Instant reactions to new product introductions and specific promotional campaigns can help retailers understand customer feedback and adjust to avoid costs and product failures.
- **Advanced Operational Insights:** data is not limited to the storefront or customers. Operational data on equipment in the store, personnel behavior, and surveillance measures are all sources of business insight. Retailers who can take advantage of these insights save costs and improve customer satisfaction.

Store of the Future



Role of Retail Edge Infrastructure

Edge infrastructure has been growing in importance over the last decade, largely due to the increasingly sophisticated deployment of technology solutions at the store level. Several key requirements at the edge are essential considerations for retail stakeholders.

Low Latency

Latency of data transmission from cloud infrastructure to retail is a big challenge. Latency can affect the customer's purchase decisions while in the store and adversely impact the overall in-store experience. As retailers integrate omnichannel experiences and offer advanced shopper engagement technologies, customers expect seamless and speedy interactions. Edge infrastructure solves the latency issues and makes store experiences rapid and less reliant on network uptime/ efficiency.

AI-Based Automation

Retailers see AI-based insights as valuable information to predict customer behavior and improve/automate store operations. The edge plays a crucial role in driving prediction and pattern recognition - vital raw materials for AI. AI algorithms operate in a distributed pattern and can take significant compute resources. New approaches that accelerate AI data processing using parallel processors (GPUs) are now being deployed at the edge. While this processing can also occur in the cloud, the latency and transmission costs make edge infrastructure better suited and more efficient. Facility management, store operations, inventory management, surveillance, and customer service are all areas likely to benefit from AI.

Centralized Management of Different Assets

Retail operations are networked organizations managed using a hub and spoke approach. Fast food restaurant menus and advertising promotions are typically created and pushed to individual stores dynamically and implemented at the store-level systems. Edge infrastructure needs to support the rapid pace of change and dynamic adjustments that are common in retail.

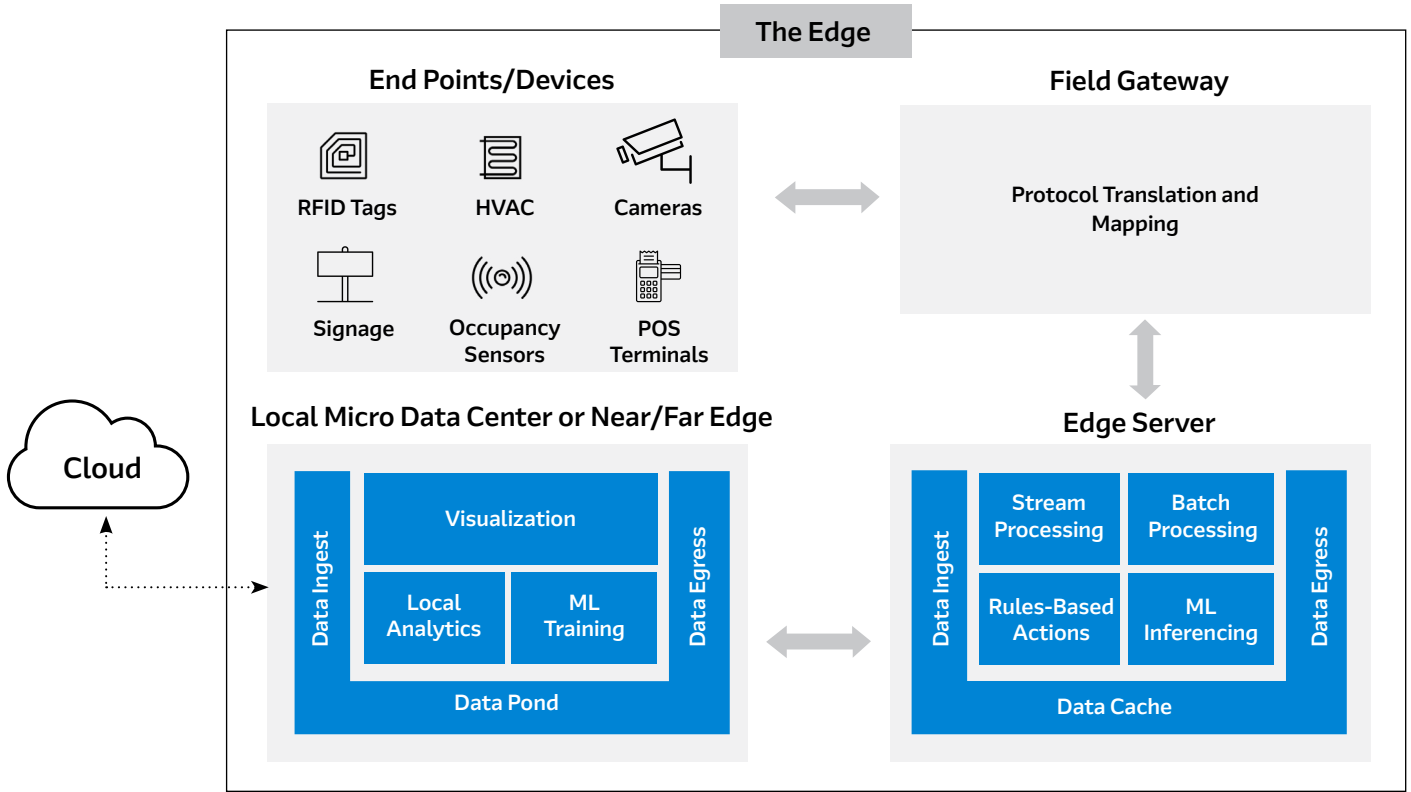
Optimize Network Bandwidth and Usage

The proliferation of edge devices in the retail store has dramatically increased network traffic. Disparate data from store systems covering multiple operational domains make for a very complex data management challenge. The deployment of edge computers allows local data storage and processing to alleviate the data volume on the cloud. With high-performance processors and large amounts of storage right at the edge, expensive cloud computations and storage needs can be minimized. In addition, pre-processing of data at the edge ensures that mission-critical data is processed in real-time right at the store.

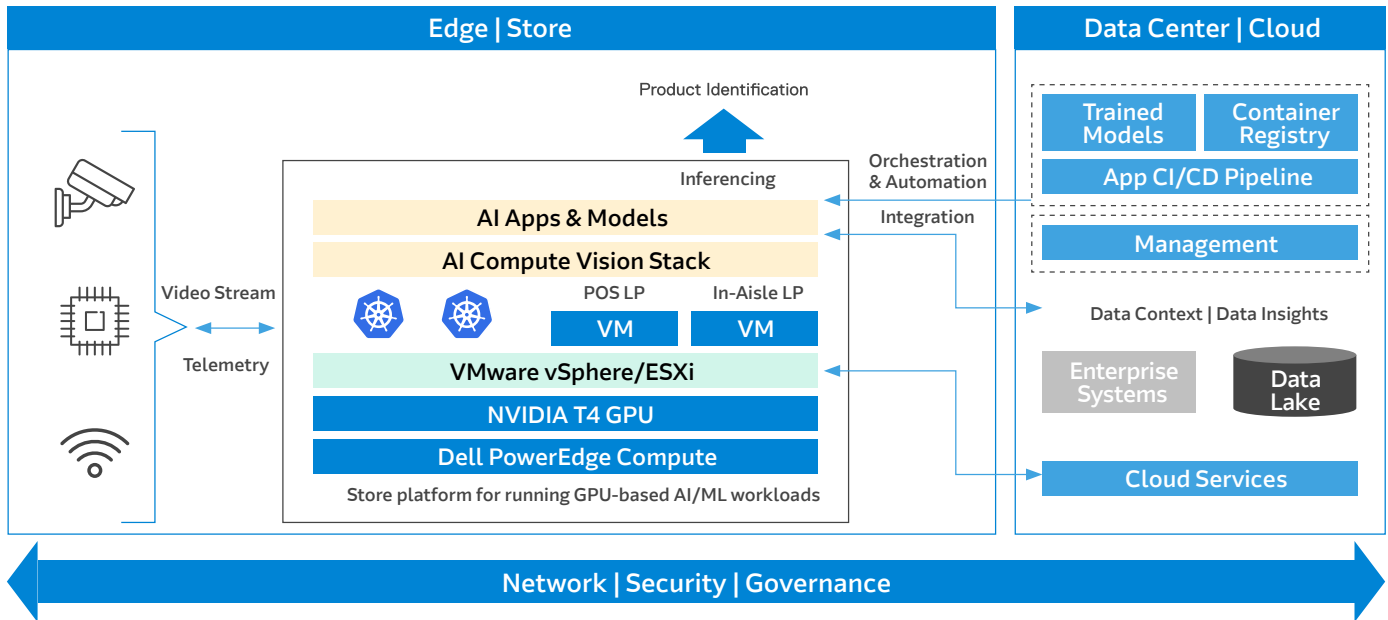
Minimize Reliance on Network Availability

Retail store security systems, access controls and inventory tracking still need to operate when the network is down. Remote retail settings are particularly susceptible to network disruptions. Edge computing obviates the need for constant connectivity by managing and analyzing data without needing constant connectivity to the cloud, and only uploading data to the cloud when connectivity takes place. Further edge devices have multiple modes of connectivity and can switch from one mode to another to send/receive critical data when connectivity issues arise.

Edge Infrastructure for Retail



Example of a Vision-Based AI Edge System to Protect Retail Assets and Generate Data-Driven Insights



Infrastructure Solutions for the Retail Edge

In prior sections, we have delineated the importance, function, and characteristics of retail edge computing. As competitors race to provide infrastructure elements for the retail edge, several feature sets and capabilities need careful consideration.

Resilience

Ruggedized server and networking infrastructure versions are essential for retail businesses to operate without issues in semi-controlled or uncontrolled environments. Choosing edge systems that work reliably and are resistant to heat, dust, corrosion, and withstand natural elements should be of high priority. Resilient retail infrastructure is critical to delivering an end-to-end customer experience. Stakeholders risk the loss of revenue and market share while incurring significant repair costs when infrastructure breaks down.

Heat Dissipation

Another element of retail edge infrastructure, particularly in semi-controlled environments is the ability to dissipate the heat generated by servers. Retail workloads, primarily applications that harness AI for real-time insights, demand forecasting and smart checkouts, require power-intensive computing. A significant proportion of the input power dissipate as heat. Properly managing the heat with adequate cooling infrastructure is crucial.

Autonomy

Retail use cases such as personalized customer engagement, smart inventory management, and store traffic insights need real-time compute and data access. Dependency on off-premise servers or the cloud leads to delays in service delivery and compromise customer satisfaction. Retail edge infrastructure should be able to continue operation without connectivity.

Security

Retail organizations can suffer massive financial loss and brand damage due to data breaches. A more significant risk is losing customer trust when personal and financial data is exposed to bad actors. If not protected with multi-factor authentication systems, POS systems and edge devices pose potential security threats for cyber attacks. Robust security features with black/white-listing capabilities need to be embedded into retail infrastructure to ensure that only authorized personnel, systems, and network connections have access.

Size and Footprint

In retail environments, space comes at a premium. It is imperative that POS systems, kiosks, digital signage, and self check-in systems do not occupy large areas in retail infrastructure. A variety of hardware and server options are now available in small form factors that can not only fit in space-constrained retail settings but can meet the most demanding compute requirements.

Remote Maintenance

A common challenge of retail edge infrastructure is that there is no personnel on-site to resolve issues when they occur. This problem becomes acute when physical intervention is needed. Pre-loaded remote interfaces and self-healing mechanisms can avoid expensive remediation by technicians and loss of customer confidence and reputation when retail systems don't function as expected.

Lifecycle

Deploying retail edge infrastructure is time-consuming and labor-intensive. Stakeholders need the infrastructure to be stable and without disruption for a long time, as any manual intervention is expensive. Infrastructure choices that offer long lifecycles lower total cost of ownership. Stakeholders need to prioritize the overall cost of ownership rather than upfront costs with edge infrastructure.

Types of Edge Infrastructure

Embedded Computers and Gateways

Embedded computers, also referred to as fanless PCs or industrial PCs, are used across many commercial and industrial applications. From complex machine reliability systems performing quality assurance in a pharmaceutical manufacturing process to simple passenger ticketing systems in train stations, embedded computers pervade a variety of everyday edge applications. Often based on Arm® Cortex® or Intel x86 Atom/Core architectures, these computers perform protocol translation, consolidate workloads, and provide real-time insights.



Dell Latitude 5424 Rugged

Ruggedized Edge Servers

Edge servers are ideal for complex workloads that need fast processing and AI capabilities. Typically based on Intel Xeon or equivalent processors, edge servers give companies the compute options and tools to run even the most complex workloads from the data center to the edge.

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



Dell PowerEdge XR12 and XR11 Servers

Storage Solutions

Data creation at the edge is growing exponentially. By putting compute, storage, and analytics where data is created, data insights can be delivered in real-time and create new business opportunities. Unique storage solutions at the edge allow for archiving of structured and unstructured data and ensure that all data is logged to feed machine-learning algorithms.




Dell EMC PowerStore

Checklist for Selecting Edge Infrastructure

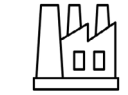
Building and deploying retail edge infrastructure that is stable and operates reliably requires careful planning and selection of technologies, platforms, and partnerships. Several characteristics are necessary for retail edge environments. Low footprint, resilience, power efficiency, and remote management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

Arrow Electronics and Dell Technologies OEM Solutions have created a preliminary checklist and tips to guide decisions on retail 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, 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?
- Is power and internet connectivity available?
- What are the airflow and cooling considerations?



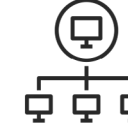
Storage

- 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

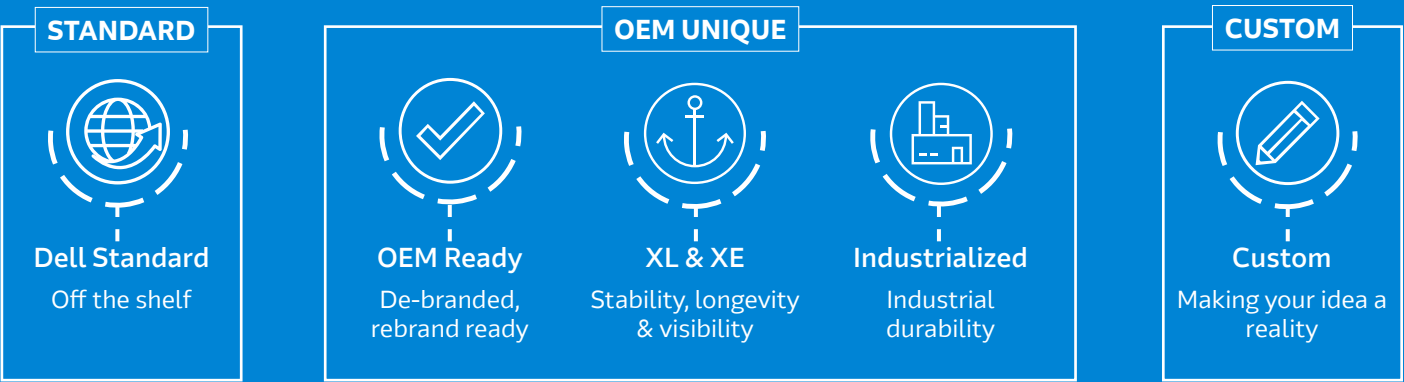
- Does the edge infrastructure support central management – software/firmware upgrades, device provisioning, etc.?
- What resources are available for deployment and on-going management and repairs?
- What type of product warranties are required?

Build Reliable Retail Edge Infrastructure with Arrow Electronics and Dell Technologies OEM Solutions

Arrow Intelligent Solutions and Dell Technologies OEM Solutions offer the industry's most comprehensive combination of edge products, services, and support to build and deploy solutions across the globe. From initial consultations to design expertise, Arrow and Dell Technologies bring technical depth and implementation experience in digitization and in-store retail infrastructure.

Together, we provide a technology portfolio that supports the next generation of edge infrastructure with a combination of off-the-shelf and custom products with branding flexibility, an extended life, and operating in rugged, harsh environments.

OEM Solutions Offerings



Services to Simplify Product Development and Deployment

Arrow Intelligent Solutions helps simplify your technology lifecycle experience, enabling you to bring your edge infrastructure to market faster and grow your business. Services include:

- Design engineering services
- Integration and manufacturing services
- Fulfillment services
- Professional services
- Support services



Arrow Electronics guides innovation forward for over 180,000 leading technology manufacturers and service providers. With 2020 sales of \$29 billion, Arrow develops technology solutions that improve business and daily life.

Online

www.arrow.com/ais/dell-oem-solutions/xr11-and-xr12

Arrow Electronics, Inc.

9201 East Dry Creek Road
Centennial, CO 80112 USA

©2021 Arrow Electronics, Inc.
Arrow and the Arrow logo are registered trademarks of Arrow Electronics, Inc. Other trademarks and product information are the property of their respective owners.

V_10222021

ARROW
Five Years Out