



Enabling the next stage in retail checkout convenience with AI-powered autonomous shopping

Dell Technologies and NVIDIA solutions for retail bring together an integrated ecosystem of innovative computer vision and AI capabilities to help retailers implement a completely frictionless autonomous shopping experience.

Tech-savvy retail customers and those desiring a contactless environment are increasingly demanding a frictionless shopping experience. Leading retailers are delivering the desired grab-and-go environment to their customers by investing in AI technology. With intelligent data-driven systems, retailers can enable autonomous shopping while leveraging insights to drive better business outcomes, including operational savings, more efficient stock control, and increased revenue and margins.

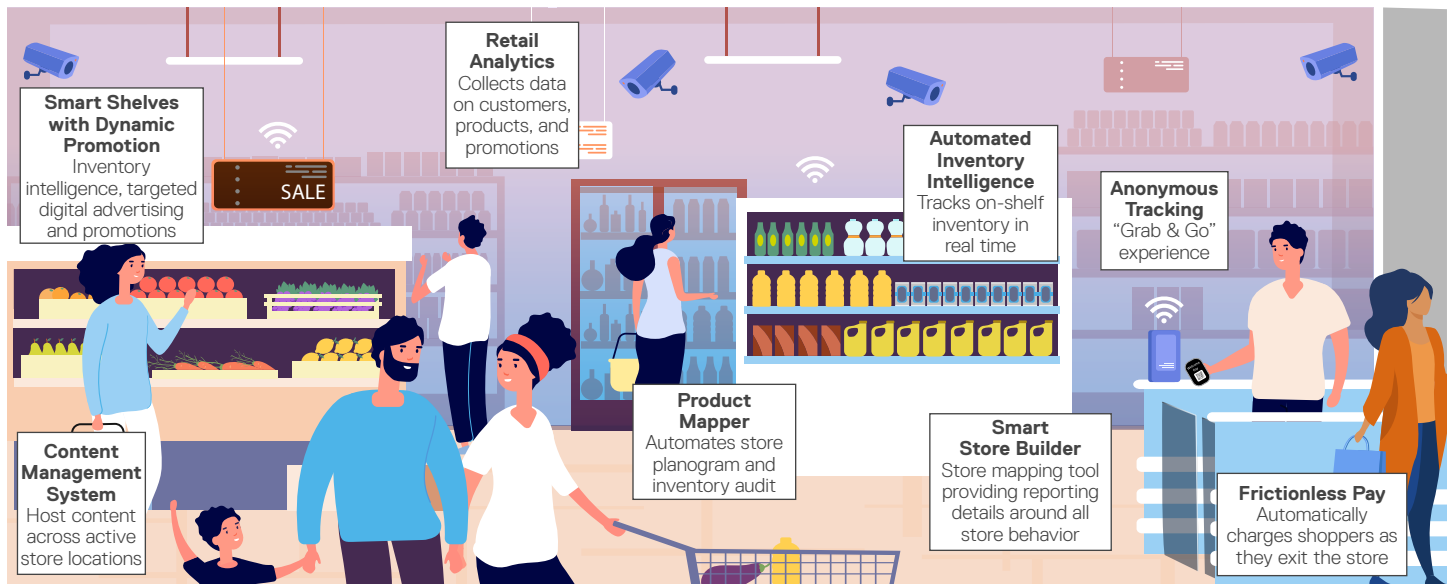
Autonomous checkout represents a new era in shopper convenience. True autonomous shopping environments go beyond self-checkout or mobile scan and pay systems to combine sophisticated shopper and product detection using AI-powered computer vision. In-aisle cameras and sensors in smart carts and shelves combine with edge compute and advanced analytics to automatically capture and record what customers place in their cart or bag. As they exit the store, an automated checkout process charges predefined customer accounts for a fast and frictionless experience.

Dell Technologies in partnership with NVIDIA provides an expansive portfolio of AI-driven, validated computer vision solutions that retailers can leverage to help deliver an autonomous shopping experience. Our best-of-breed hardware and software combine to deliver high-performance and scalable IT infrastructure. Together, we deliver essential and proven solutions for all stages of your AI journey, whether deploying smart cabinets, nanostores, or full-scale autonomous stores.

KEY SOLUTION BENEFITS AND VALUE

- Lower investment risk:**
 Dell Technologies and NVIDIA bring together fragmented components into a consolidated, streamlined autonomous shopping solution to drive profitable outcomes and minimize investment risk.
- Increased operational agility:**
 Our extensive portfolio of validated computer vision and advanced analytics solutions including NVIDIA's Metropolis video analytics framework powered by industry-leading Dell EMC PowerEdge servers and partner solutions are designed to scale as your autonomous shopping ecosystem grows.
- Faster time to value:**
 Our global network of subject matter experts are available to help guide you in selecting the right mix of infrastructure and data management solutions, including video workloads, workflows, and data governance.

Figure 1: An end-to-end retail automation environment for autonomous shopping locations.



Improve the customer experience with AI-driven, autonomous shopping workflows

Dell Technologies and NVIDIA solutions enable retailers to provide a frictionless shopping experience by bringing together the right combination of AI and computer vision technologies and workflows. Together, we provide full orchestration of intelligent video, IoT, compute, storage, networking, analytics, and cloud technologies in an end-to-end ecosystem that delivers desired business results (Figure 1). In addition to providing true autonomous shopping, retailers can boost sales, eliminate out-of-stock reduction, and leverage insights such as dwell times, aisle traffic, and demographics to deliver a personalized shopping experience like no other.

With this autonomous shopping solution, retailers can capitalize on the following AI-powered capabilities:

- **Anonymous shopper tracking:** Enable shoppers to walk in, shop as usual, and exit retail locations without having to wait in line for checkout. Deep learning AI accelerated by NVIDIA GPUs running on local Dell EMC PowerEdge servers power every step of the shopper's journey. At entry, the shopper can either scan a QR code when passing through an entry gate to connect their purchasing account to their identity, or launch a mobile app to automatically check in as they enter the store. From that point on the system identifies and begins capturing customer-specific data in real time. Each customer is assigned a random ID that links them to their account, and tracks them between cameras as they move through the store. Facial redaction helps to ensure their privacy.
- **Product detection:** Alongside anonymous shopper tracking, the autonomous shopping system also tracks inventory. The system is trained to recognize products, providing recognition in under a second. This can even include tracking of machines dispensing food items such as fountain drinks, accounting for multiple refills by the

same customer. As customers take items from shelves and place them in their shopping carts, the system's deep learning AI tracks the change in the product's position and determines the action. If the product is subsequently taken back out of the cart and replaced on the shelf, or even another shelf, this item will then be disassociated with the customer ID.

- **Smart shelves:** Sensors, smart scales, and cameras built into shelves augment the capabilities of aisle cameras to detect products accurately. These can be retrofitted to any existing shelf in any format. Allied with the store stock database, the shelf system can keep a count of how many of a particular product remain on shelves, providing automatic notifications to staff when products run low or run out completely to facilitate quick restocking. Digital pricing and product information can be updated in real time to indicate product status. The system can also be configured when the overall stock of a product reaches a certain level so that new orders can be placed across the supply chain. Retailers using this type of automated inventory analysis have experienced increased sales simply by maintaining stocked shelves.
- **Dynamic promotions:** Electronically-enabled smart shelving aligned with customer tracking in a Dell Technologies and NVIDIA environment can also be used for dynamic promotions to improve the customer experience while boosting sales. Immersive video linked to a nearby product can be used to inform customers of promotional offers. Content can dynamically update as the proximity of a particular customer to the product changes, going from a general ad to a more informative overview as the shopper nears. Pricing information on shelves can also be updated dynamically to reflect price changes without requiring staff to laboriously update every price tag. Being electronic, retailers can opt to include greater detail about the product than most traditional tagging. Digital content screens can be tailored to demographics of current store occupants, the time of day, and even the weather outside the store. For example, a promotion for items aimed at cold weather can be triggered when the weather fits this criterion.

- **Frictionless checkout:** At the end of their visit, shoppers no longer need to wait in long queues or receive a paper receipt. Using frictionless payment, their accounts will be billed and digital receipts will be stored in the retail app or emailed to them. The system can also leverage online smartphone-oriented payment systems such as Visa Checkout or PayPal, giving shoppers the ability to keep all their expenses in one place and track their own purchases more effectively.

In all instances, data protection and privacy are of the utmost importance. Our software partners do not collect personally identifiable information and take proactive measures such as face redaction to ensure privacy and compliance.

An edge-to-core-to-cloud portfolio for autonomous shopping

Reaping the benefits from an autonomous shopping environment requires a technology partner that can help retailers overcome the complexities of sizing, designing, integrating, and configuring these systems. Dell Technologies and NVIDIA have partnered to simplify and streamline the deployment process with solutions that span the entire AI ecosystem—including support for autonomous shopping workloads with holistic security and management.

We provide the right mix of technology and subject matter expertise, making it easy for you to deploy, manage, and scale a solution designed for your specific needs. Our edge-to-core-to-cloud integration approach ensures system continuity across in-store, data center, and cloud services to help lower overall total cost of ownership while maximizing the value of your investment whether for use in nanostores or for large retail locations (Figure 2).

Together with our validated ecosystem of industry partners, our solutions bring together:

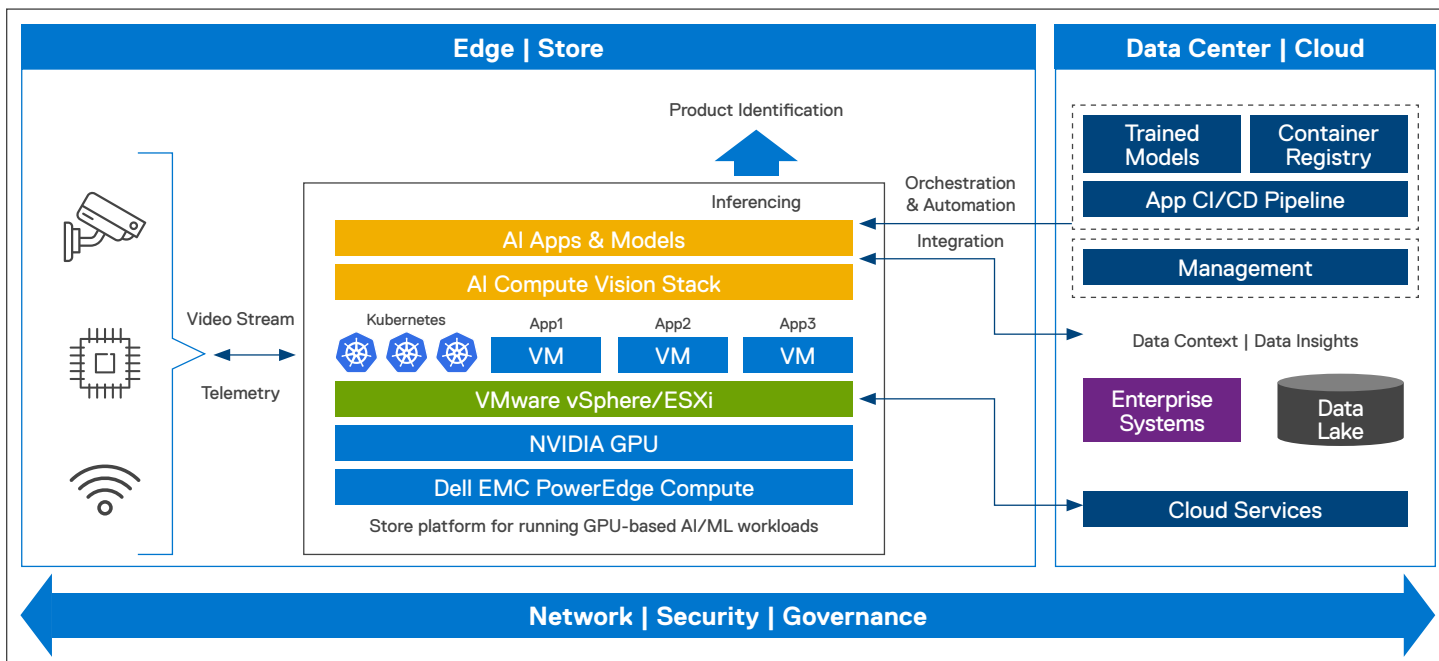
- **Real-time edge compute and analytics:** Dell Technologies family of in-store compute platforms host NVIDIA GPU acceleration with partner software to capture, analyze, and gain insights from video cameras and other sensing devices for real-time data analytics and machine learning. With our computer vision partners and a choice of bare-metal to hyperconverged infrastructure, retailers gain access to an ecosystem of validated solutions suited to their application needs that provide even more assurance and risk mitigation to their investment.

NVIDIA Metropolis video analytics platform is an edge-to-cloud platform and SDK that powers the AI and deep learning required to implement the right autonomous shopping configuration. NVIDIA Metropolis includes an integrated and tested solution based on NVIDIA GPUs running on Dell EMC PowerEdge servers. The platform delivers unprecedented performance for shopper insights and in-store journey tracking, as well as product recognition and processing for AI models. The containerized Docker solution works with NVIDIA GPU Cloud (NGC) for download and installation of software applications to deploy multiple intelligent video analytics algorithms on a single server across as many GPUs as needed.

With NVIDIA's latest GPUs running on Dell EMC PowerEdge servers, retailers can reduce their hardware infrastructure footprint, making the technology much more affordable and compact which is especially beneficial for space-constrained nanostores and smart cabinets.

- **The software-defined data center:** With Dell Technologies next-generation storage and data protection solutions, you can manage current data and future workloads with efficiency, security, and scalability. Our hyperconverged infrastructure combines servers, storage, networking, and virtualization into one cloud-ready solution to achieve true application deployment flexibility.

Figure 2: Autonomous shopping ecosystem from the edge to the data center to the cloud





- ♦ **Data integration across a multi-cloud environment:** Customer, product, planogram, and campaign data all come together via real-time analytics from the autonomous shopping system to provide in-depth, actionable insights. As you expand your AI capabilities using multiple cloud-native workloads, a VMware vSphere or ESXi platform combines into one pre-engineered ready-to-run platform to eliminate silos of operation with service management, governance, security, automation, and orchestration tools. In this environment, multiple video analytics applications from anonymous tracking to intelligent inventory to customer engagement can coincide on a single server in a containerized manner, making it easy to deploy, manage, and scale. Likewise, video stream and telemetry data collected from a variety of edge systems can be fed into cloud services hosting deep learning models and data lakes to achieve more meaningful and profitable outcomes. For more advanced systems, updated models can be pushed back to the edge for further inferencing and product identification, providing a distinct competitive advantage for retailers.
- ♦ **Secure, resilient IT:** Dell Technologies helps customers mitigate cybersecurity risks and protect critical data through intrinsic security that is built into the system at every touch point. Our industry-leading hardware and partner offerings help address network complexities and governance requirements in an end-to-end autonomous shopping solution deployment.
- ♦ **A comprehensive, lab-validation test approach:** To help deliver to your organization an autonomous shopping solution that works from day one, Dell Technologies and NVIDIA align validation standards with our partners to test hardware and software in extreme, real-world scenarios in order to reduce deployment risk. Our global labs and NVIDIA research lab enable our customers to have confidence in our solutions and gain access to the latest capabilities on the market.

Revolutionizing Retail with Dell Technologies and NVIDIA

Autonomous shopping is the next big revolution in retail after self-checkout and self-scanning, and it is now ready for roll out across every store type and size. What was once a novelty for automated kiosks can now deliver massive benefits across the gamut of shopping scenarios.

Dell Technologies and our partners, like NVIDIA and AWM, provide the solutions and expertise, scaling to your needs across convenience, grocery, and big box superstores and even beyond retail environments to healthcare, hospitality, education, and more.

Other autonomous shopping use cases include airport retail concessions, where speed is of the essence, delivering a more efficient and convenient shopping experience for passengers rushing to make a flight. Where supply chain efficiency has given the most successful retailers the edge over the last few decades, autonomous shopping brings this efficiency right into the store, aisle, and shelf. A lost sale due to an empty shelf can be a thing of the past, as shelves can be stocked much more proactively, and depleted lines reordered in a timelier fashion. Loss prevention can also be implemented much more effectively because it will be much harder for a store visitor to take a product off a shelf without being tracked. Overall inventory management will be markedly improved.

Dell Technologies and NVIDIA deliver a complete, end-to-end solution backed by a joint commitment to guide our customers through their digital transformation journeys. Working with your organization, we can make the transition as seamless as possible, tailored to your business needs. Our solutions portfolio and expertise help reduce the risk, cost, and complexity of implementation by leveraging comprehensive solutions that are aligned to your specific business requirements. Built with next-generation technologies, our autonomous shopping solutions are designed for maximum business agility, addressing your business needs today and scaling as market demands and opportunities evolve.



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