

Intelligent Store - Video Analytics for Smart Retail with Deep North

July 2022

White Paper

Abstract

This White Paper provides an overview of Dell Validated Design (DVD) with Independent Software Vendor (ISV) Deep North to enable smart store with video analytics to achieve retail-related outcomes.

Dell Technologies Validated Design

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Introduction

Executive summary

The Dell Validated Design for Retail Edge with Deep North, is a purpose-built Dell Validated Edge Solution to help retailers gather critical data points and actionable insights, available through their existing CCTV cameras and other type of video equipment to differentiate and succeed through digital transformation. Validated solution focus on providing intelligent video analytics, insights, and generating real time alerts with wide variety of use cases such as.

1. People counting, queue length, conversion ratios, and dwell time.
2. Customer demographics
3. Employee to customer engagement durations
4. Customer to product interaction

Document purpose

The purpose of this document is to provide a brief overview of Dell Validated Design for Retail with Deep North

Audience

This document is intended for solution architects, IT admin, system administrator, and technical decision makers.

Business challenges

Market Environment

In today's market retailers need IT solutions to differentiate through digital transformation across 4 main categories.

1. Brick and mortar customer experience competitive with ecommerce
2. End to end inventory accuracy and supply chain resiliency
3. Health, safety, security, and compliance
4. Cost realignment and workforce automation

The Value Proposition

Dell Retail Edge Solutions will help retailers realize profitable outcomes by meeting their current digital maturity level and successfully guiding them through their own digital transformation journey. Using scalable, proven, distributed cloud IT architecture at the edge on purpose-built platforms, and products, Dell Retail Edge Solutions bring cloud IT and operational efficiencies down to the ground as on-premises deployments. Validated stacks with key software providers allow for rapid deployment and realization of valuable real-time insights, unlocking opportunities to improve overall store performance.

Solution overview

Dell Validated Design for Retail Edge with Deep North

The Dell Validated Design for Retail Edge with Deep North builds on top of the Dell Validated Design for Retail Edge with VMware. It utilizes the same underlying architecture, consisting of validated hardware, hypervisor layers, firmware, BIOS, and drivers. Now, it further introduces a validated Deep North virtual machine and application layer to perform retail business analytics.

Deep North technology is designed to connect with existing, on-premises camera, network video recorder (NVR) deployments. The system taps into existing video streams, using a Real-Time Streaming Protocol (RTSP) supported by most IP modern cameras and NVR systems. To avoid disturbing existing NVRs, Deep North establishes a parallel RTSP session into the video feeds, to decode and perform computer vision inferencing / analytics.

Deep North's analytics include gathering foot fall counts and shopper demographics such as gender and relative age brackets. It can also track the paths of customers throughout the store to generate shopper paths, heatmaps, and dwell times. All of this is done anonymously without facial recognition or personally identifiable information. The content and the metadata never leave the site. This feature simplifies compliance with regional privacy laws because there are no identifying markers that persist over time, with nothing duplicated off-site.

Additionally, Deep North allows retailers to combine their analytics with other data sources to extract deeper insights. A count of people combined with POS transaction logs suddenly reveals conversion ratios. A count of people outside the store vs inside can reveal walk-by rates. A count of people in a region can determine line length. Path tracking and dwell time can be combined with planogram data to determine item interest and interaction times.

Dell brought together VMware and Nvidia to work closely with Deep North to optimize their solution to run on the Dell Validated Design for Retail Edge. By enabling the Deep North virtual machine (VM) to directly access the underlying physical Nvidia Graphics Processing Unit (GPU) using GPU Passthrough technology, Deep North is able to harness the full performance of Nvidia's GPUs and CUDA libraries, while simultaneously providing the abstraction and manageability benefits of running in a virtual machine. The net result is retailers get the added benefits of cluster failover, centralized management, and hot migration.

This means that retail customers can run Deep North on-prem at the edge with confidence. In case of hardware level failure, the workload can be migrated to another node seamlessly enabled by the VMware Edge Compute Stack. As application software patches or updates are released, they can be managed by performing a Snapshot, just like any virtual machine up in the cloud. It makes software application management much more transparent and uniform even across an entire fleet of stores. All of this while also providing failover along with the hardware performance that retail customers would expect from the VMware Edge Compute Stack.

This solution includes following use cases

Foot fall / Demographics

The Deep North intelligent video analytics can detect customer traffic pattern and demographic in real time. Historically, it was done indirectly through surveys or keeping an employee to physically track the customers. The software captures multiple data points such as store exits, occupancy age/gender, repeat vs unique, and peak time. The result is that retailers get clear picture of male to female shopper ratio, as well as the impact of marketing campaigns on store footfall and store occupancy trends.



Figure 1. Foot fall and Demographics

Zone Analytics

Retailers always try to optimize their shelf space and try to identify customer traction in different store sections. Deep North solution collects store zone footfall, occupancy, dwell time, and can alert at high zone occupancy. Zone analytics can help retailers understand customer behaviors and pattern in different store sections. Retailers can then better assign associates based on those traffic zones.

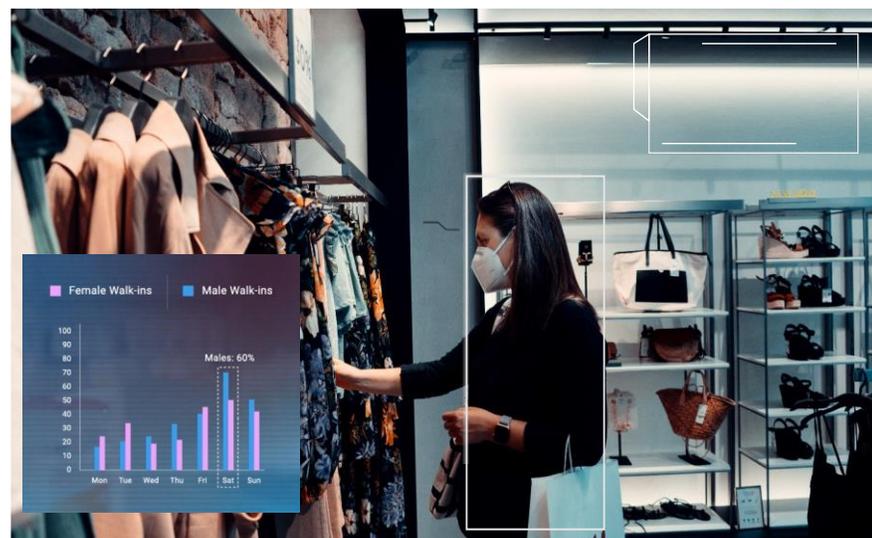


Figure 2. Zone Analytics

Customer Journey

Understanding of customer journey is a critical part of a retail setting, it consists of the dominant path which a customer follows, heat mapping and dwell time. Deep North provides these insights in real-time that can assist retailers to plan store layout and merchandising in an optimized fashion.



Figure 3. Customer Journey

Product Engagement

Customer product interactions can now be measured to show product engagement. Deep North software can derive this information from the combination of demographic, age, gender, sentiment and repeat vs unique customers. Which is key to measure the level of interest in brands and products.



Figure 4. Product Engagement

Prevent Line Abandonment

Line abandonment is a major concern for retailers. Queue length and wait time are major factors for a customer decision to purchase any item. Long wait time degrades the customer experience. Deep North application provides metrics such as line length/wait time, check out time. With line abandonment alerts, retailers can add additional cashiers to open, preventing revenue loss, and providing faster check out times.

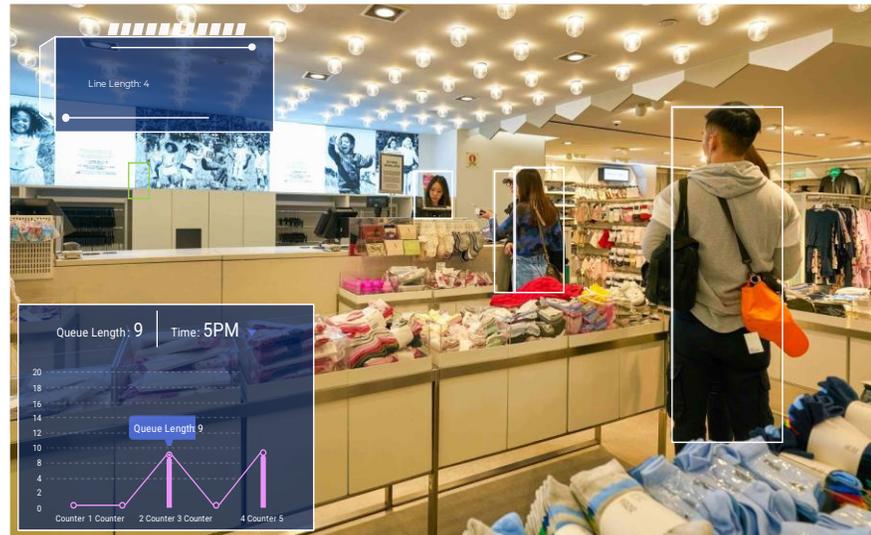


Figure 5. Prevent Line Abandonment

Checkout IQ

Checkout IQ gives retailer's visibility into the number of items in customers basket vs scanned items. Deep North solution also captures matrices such as number of self-checkout customers per day, transaction time and can immediately alert when discrepancies between basket item vs scanned items occur. This improves retailers' profitability with reduction of shrinkage.



Figure 6. Checkout IQ

Employee Customer Interaction

Employee customer interaction plays a critical role in a customer journey. It has a heavy impact on sales. The Deep North software captures metrics such as length of interaction between customer and associate, staffing presence and POS conversion. This helps retailers by tracking order time, sales conversion percentage and check-out time on an individual associate basis. Hence, it increases sales with ideal employee/customer interaction times.



Figure 7. Employee Customer Interaction

Note: Some of these use-cases are not validated as a part of this Dell Validated Design

Partner overview

Deep North

Deep North is a computer vision / artificial intelligence (AI) based startup specializing in Retail, Manufacturing, Transportation etc. Their mission and cachet is to provide retailers and enterprises with actionable in-store insights derived from video data. Deep North leverages existing customer cameras for data inferencing which reduces overhead of putting new camera infrastructure.

Solution architecture

High Level Overview

The solution architecture uses an award-winning hyperconverged infrastructure Dell EMC VxRail or edge-hardened Dell EMC PowerEdge servers to offer a scalable, unified technology architecture that is validated to work with VMware Edge Compute Stack, Nvidia GPU and Deep North. Together, these technologies support the multiple use cases and various workloads for smart retail outcomes.

Dell Validated Design with Deep North takes advantage of a validated design with VMware under the hood. Deep North software resides on a virtual machine running on Dell hardware with VMware hypervisor layer. This approach further provides a platform and opportunity for a retailer to migrate/consolidate other workloads already running on-site onto the same hardware. Thus simplifying systems management across a retail fleet. Deep North's VM will have direct access to the Nvidia GPU using pass-through functionality to accelerate its computer vision and machine learning algorithms.

This solution includes the following components:

Dell Hardware

As a part of this validated design, Deep North application has been well tested and verified on Dell EMC Power Edge and VxRail.

Dell EMC Power Edge: For scenarios where HA is not required at the edge, the solution can run on a single Dell EMC PowerEdge server running VMware Edge Compute Stack. Validated Dell EMC PowerEdge XR11 and XR12 ruggedized servers offer deployment flexibility for solutions outside of the data center and closer to the retail store.

Dell EMC VxRail: The VxRail hyperconverged infrastructure (HCI) offers a turnkey edge deployment with maximum flexibility for high availability (HA), scale and consolidation of retail workloads and applications.

Nvidia GPU

Nvidia GPUs are an essential component to run the Deep North application. It provides hardware acceleration to process multiple camera feeds and accelerate computer vision / machine learning algorithms.

VMware Edge Compute Stack

The VMware Compute Stack provides a consistent edge platform that enables customers to build, run, manage, connect, and protect their retail workloads at near and far edge. While leveraging consistent infrastructure and consistent operations across their data centers and cloud. VMware Edge Compute Stack is a purpose-built integrated stack for small scale VM and container compute, with edge HCI. VMware's edge optimized stack leverages their ESXi hypervisor as an abstraction layer validated to run on Dell hardware. It provides virtual access to compute and other resources to workloads from a single management plane. The solution leverages vSphere, vSAN, and Tanzu Standard (Tanzu Kubernetes Grid and Tanzu Mission Control).

Deep North

The validated software stack resides in a virtual machine running on Dell hardware with VMware hypervisor layer. It leverages underlying Nvidia GPUs and CUDA libraries to run computer vision and machine learning algorithms.

High Level Architecture

The diagram below illustrates the high-level architecture of DVD with Deep North. The Dell hardware consisting of Dell EMC PowerEdge, VxRail equipped with Nvidia GPU. VMware Edge Compute Stack runs on top of Dell's hardware. This facilitates consolidation of existing workloads in VM or Container format that will run alongside with the Deep North video analytics VM. The software requires GPU to accelerate computer vision and machine learning algorithms, leveraging the Nvidia GPU pass-through feature.

This feature enables virtual machines to have direct access to internal Peripheral Component Interconnect (PCI) GPU. Once the VM has direct access to the internal GPU, it can inference large amount of camera feed to produce meaningful Key Performance Indicators (KPI).

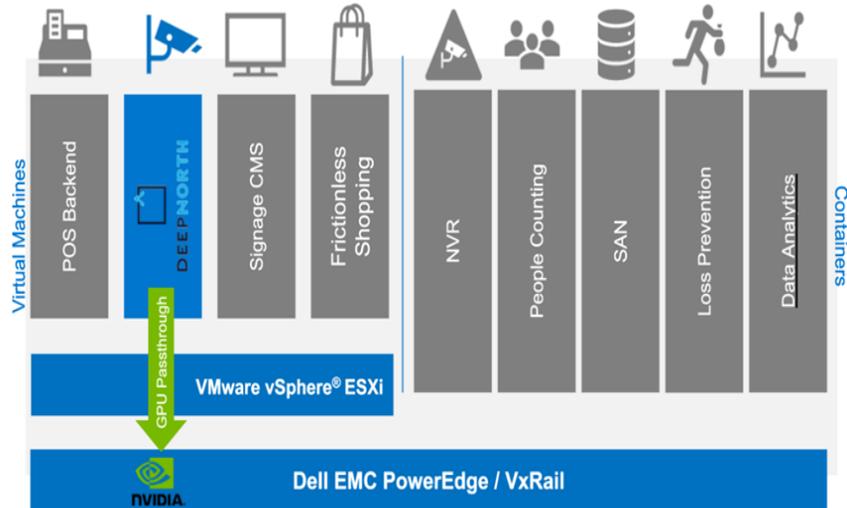


Figure 8. DVD High Level Architecture

Solution Dataflow

The below picture represents the overall data flow within the Dell Validated Design with Deep North. The video data from various cameras around the store network streamed using standard Real-Time Streaming Protocol (RSTP). The Deep North Software application running on Dell Hardware captures the video stream and apply multiple computer vision and machine learning algorithm to analyze the video feeds and derive KPIs. These KPIs are converted into Business Insights and presented in real-time data visualization reports and alerts.

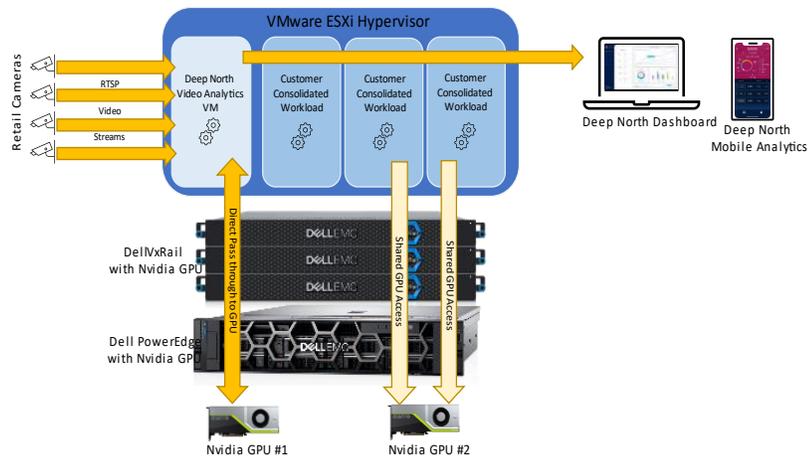


Figure 9. Solution Data Flow

Conclusion

This Dell Validated Design for Retail Edge with Deep North describes a recommended solution of Dell EMC PowerEdge or VXRail Server Node with VMware Edge Compute Stack supporting the deployment of a Deep North video analytics VM within a retail edge location. Additionally, this solution provides the ability to consolidate existing retail workloads into lifecycle managed virtual environment to support ease of deployment and management. With Deep North providing video analytics you can realize those outcomes and transform the retail experience, right at the Edge.

We value your feedback

Dell Technologies and the authors of this document welcome your feedback on the solution and the solution documentation. Contact the Dell Technologies Solutions team by [email](#) or provide your comments by completing our [documentation survey](#).

Note: For links to additional documentation for this solution, see [Dell Edge Website](#)

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References

Dell Technologies documentation

The following Dell Technologies documentation provides additional and relevant information. Access to these documents depends on your login credentials. If you do not have access to a document, contact your Dell Technologies representative.

- [Dell EMC PowerEdge](#)
- [Dell EMC VxRail](#)
- [DVD with Deep North Solution Brief](#)

VMware documentation

The following VMware documentation provides additional and relevant information

- [VMware Edge Compute Stack](#)
- [VMware ESXi](#)

NVIDIA documentation

The following NVIDIA documentation provides additional and relevant information

- [Nvidia GPU](#)

Deep North documentation

The following Deep North documentation provides additional and relevant information

- [Deep North](#)

