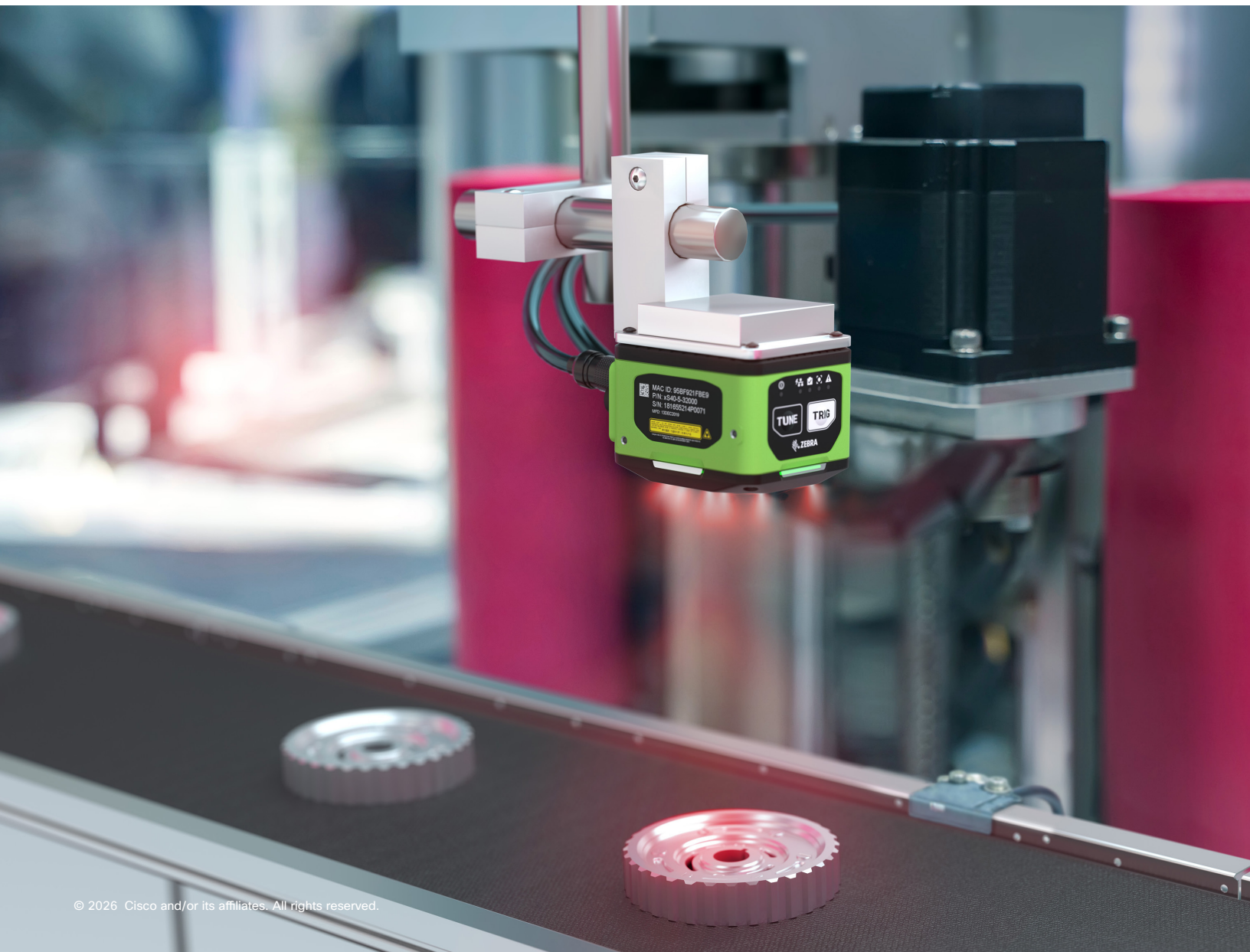


Zebra and Cisco Accelerating AI-Driven Machine Visioning

July 2026



Overview and Business Drivers for AI-Driven Machine Vision applications

Overview

Manufacturers globally are constantly looking to improve product quality, increase output and efficiency, and automate processes and activities wherever they can. Machine Vision systems are built into many production systems for these reasons. Machine Visioning in manufacturing production systems is used for a host of applications—product quality assessment, coordinating robotic operations (e.g., pick and place, tool/placement), scanning products or containers for text or barcodes, and safety for mobile assets. In addition, the vision sensors used in the cameras are also rapidly improving. The granularity with which images are produced is increasing and the speed at which the data can be produce is rising.

This is where Artificial Intelligence or Machine Learning (AI/ML) applications can improve Machine Visioning processes—enabling users to process more data, with more adaptability and with lower rates of false positives. AI/ML is significantly improving on the existing rules-based vision processing to AI/ML inferencing, enabling improved Area, 2-D, and 3-D scanning. Machine vision vendors such as Zebra are at the forefront of these innovations.

Cisco and Zebra are partnering to help manufacturing customers accelerate their AI/ML-driven machine vision applications. We tested and validated our products together and provide customers, system implementers, Original Equipment Manufacturers (OEMs), and partners deployment guidance and reference architectures so that they can confidently deploy these solutions. This guidance is intended to guide IT or OT personnel in deploying Cisco industrial networking and security capabilities for Machine Vision applications supplied by Zebra Vision—cameras, software, and cloud-based services.

Business drivers

Manufacturers are significantly increasing the number of cameras and vision systems they are deploying because they are driving significant business benefits, including:

- Improved **product quality** with finer detection of product and inventory anomalies
- Less **downtime and waste** with better handling of environmental variances leading to fewer false positives.
- Improved robotic **operations** with Machine Vision applications guiding and improving robotic operations such as pick-and-place and Autonomous Mobile Robots (AMRs)
- Increased **output** where AI/ML can process more vision data from multiple sources more quickly to speed up manufacturing processes.
- Decrease deployment costs and time by delivering communications, synchronization and power over a **single cable** to high-speed machine vision cameras

Critical challenges facing customers deploying AI-driven MV

Deploying these new AI-driven machine vision applications and cameras can pose significant challenges on existing industrial networks designed for low-bandwidth industrial automation systems. These new devices and applications face the following challenges:

- **Bandwidth.** As vision cameras get more sensitive, the amount of data they can produce increases, which requires faster network speeds. It is common that machine vision cameras operate at 1 Gb/s and are starting to move to multi-Gig support (2.5 Gb/s or higher). And even with cameras with on-board GPUs, the event data needs to be saved and archived. For example, in scan tunnel solutions you must capture and save live video feed when a “safety event” occurs. All this data movement requires more bandwidth from the industrial edge network.
- Average **cost** of Ethernet cable drop in North America is \$2500/per station. Customers want to consolidate data and optimize the drop locations they already have and use the connections more effectively.
- **Power.** Many of the cameras, especially with embedded AI compute technology, require significant power input to operate the camera, potentially leading to more cables and infrastructure
- Customers worry that the **amount and size of the vision data** communications will overwhelm and impact existing industrial automation traffic, driving up latency, jitter, and packet loss which leads to outages and downtime
- **Cybersecurity** is a growing concern, and the vision system data often represents significant intellectual property. Enterprise-level customers want to know how to integrate network and IT security without any risk to the vision systems and data.
- **Understanding** how to design and deploy Machine Vision applications is a key concern, especially on converged networks where a number of capabilities need to be configured and the operations teams have limited background/experience in networking.

Better Together: Zebra and Cisco

To help our customers with these challenges, Cisco and Zebra collaborated to develop, test and document how our technologies work best together. This guidance is found in Cisco’s [Machine Vision in Industrial Environments](#) Validated Design. Our technologies together were designed and tested to work integrated into modern industrial environments, not as stand-alone sub-systems. Together, we bring market leading machine vision systems into industrial networks also supporting modern industrial automation.

Zebra overview

Zebra is the foundation for intelligent operations. Zebra brings together connected frontline, asset visibility, and automation solutions to help manufacturers rise to the occasion, each and every day. That means information and knowledge at the operations team’s fingertips. That means less downtime, better customer service, and smarter decisions in an incredibly dynamic environment. We’re an indispensable partner to help you streamline workflows so operations run smoothly today—and are ready for what’s next.

Zebra specializes in high-bandwidth image processing for both high-speed and high-resolution machine vision applications in manufacturing environments that stretch from automotive to logistics, fast moving consumer goods, semiconduction and everything in between.

Our Solution and Reference Architecture for Machine Vision Systems

Key requirements for AI-driven Machine Visioning

- **Bandwidth:** The chips in machine vision cameras are improving rapidly—their sensitivity and ability to transfer data quickly increase the amount of data they can transmit. Currently 1 Gbps cameras are standard, and many vendors offer multi-gigabit or higher-speed cameras. The industrial network needs to support the higher data loads.
- **Decreased latency:** Cameras are producing more data, and the Machine Vision analytic applications are also drastically improving their ability to quickly process that data. Manufacturing processes operate at high speeds. Higher resolution images need to be processed ever faster. Network latency must be low and consistent to allow these systems to perform quickly and without error.
- **Power-over-Ethernet:** Often, the more capable the camera, the more power the camera consumes. Cameras with embedded compute capability to process and analyze the onboard data increase power budgets. Currently available network infrastructure that supports Power over Ethernet (PoE), PoE+, and 4-Pair Power over Ethernet (4PPoE) may be needed to reduce cable installation costs by supplying power over the same cable as the data connection.
- **Synchronization:** A critical aspect of the camera's function is capturing video or pictures at the right time in the manufacturing process. This signaling can be done over I/O, but requires more cabling, or directly over the data path via the network with support for IEEE 1588 Precision Time Protocol.
- **Prioritization in converged networks:** Machine Vision data must be processed quickly but can delay other more critical traffic or overload the network. Separate networks or directly-connected devices may alleviate this but are expensive and limiting. Converged networks can differentiate and prioritize critical traffic, lower costs, and increase flexibility. The Cisco Validated Design (CVD) covers several techniques to maintain low-latency and high-bandwidth connectivity for Machine Vision traffic, including Quality of Service (QoS), frame pre-emption, and support for Jumbo frames.
- **Security:** The images captured by Machine Vision systems are often considered intellectual property; they may represent key manufacturing processes or products and are critical aspects of the manufacturing process. The devices and the data need cybersecurity protection. The CVD outlines how TrustSec/Secure Group Tag (SGT) micro-segmentation can protect the Machine Vision systems and the data they produce.

Machine Vision reference architecture

Addressing the AI-driven Machine Vision requirements, the following solution architecture is recommended by Zebra and Cisco.

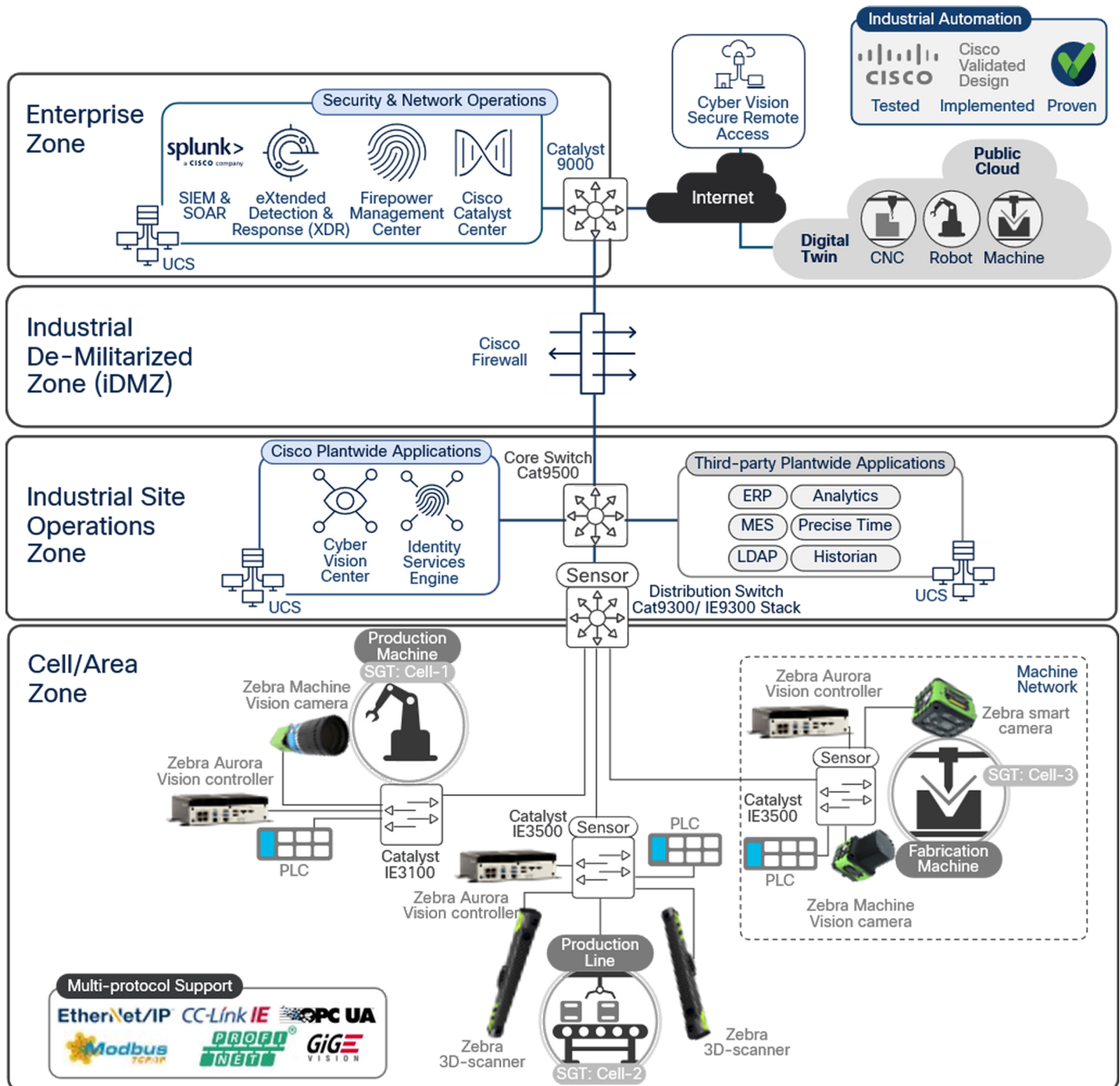


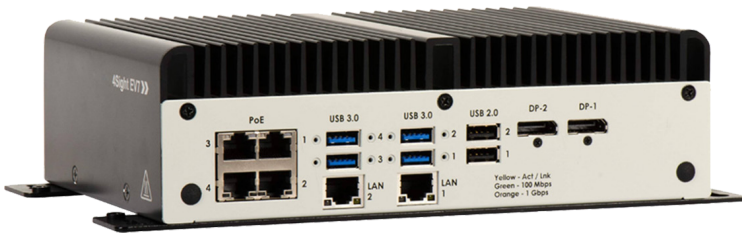
Figure 1. Zebra-Cisco Machine Vision network architecture

Key components

Zebra components include

Zebra 4Sight industrial vision controllers for demanding multi-camera applications

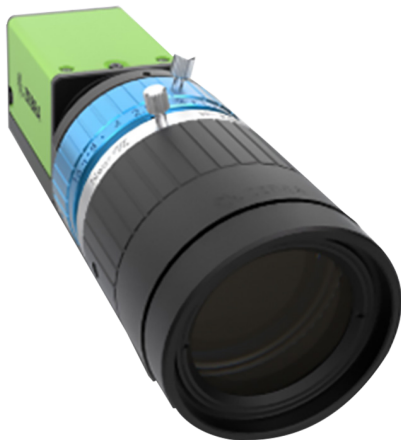
4Sight series vision controllers offer desktop-level performance and substantial expansion capabilities. Ideal for demanding single high-rate or multi-camera imaging and machine vision applications, Zebra's 4Sight vision controllers are backed by a proven track record of reliable performance. Integrated processors make these industrial PCs suitable for traditional Machine Vision and deep learning inference, while a specially configured model is available for deep learning training. The fanless design has multiple GigE Vision and USB3 Vision ports, facilitating connections to factory and enterprise equipment.



[Zebra 4Sight EV7 HighPerformance Vision Controller](#)

High-resolution Machine Vision cameras that deliver outstanding frame rates

Discover unparalleled precision and flexibility with the CV60 series machine vision cameras. Available with GigE Vision interfacing, the CV60 series offers superior performance for all industrial automation needs. Benefit from high-resolution imaging, robust build quality, and seamless integration into existing automation systems. Whether optimizing quality control or boosting operational efficiency, CV60 series cameras deliver exceptional results every time. Elevate machine vision capabilities with the reliable and versatile CV60 series.



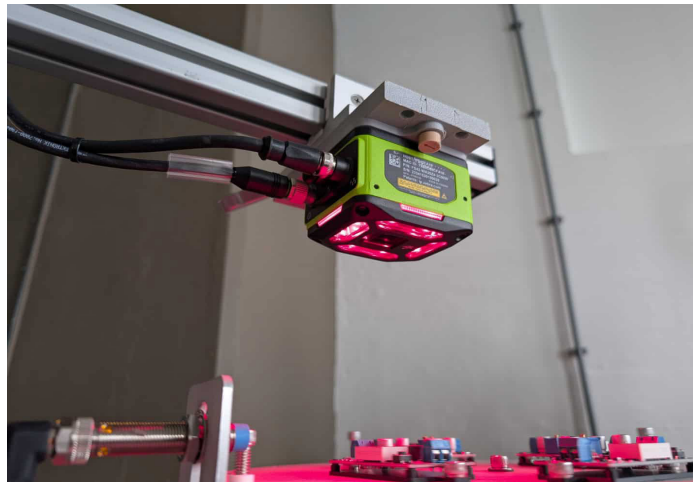
[CV60 High Resolution Area Scan Camera](#)

All-in-one high resolution smart camera

Purpose-built for running complex machine learning algorithms, the NS42 features out-of-the-box support for deep learning-based Optical Character Recognition (OCR) and anomaly detection tools to quickly and accurately solve challenging OCR tasks and inspection applications.

The NS42 excels with Deep Learning-based OCR (DL-OCR) tasks for fast and accurate text and character reads without training, and anomaly detection for finding abnormalities that could otherwise be missed with traditional inspection tools.

Smart cameras are compact, advanced imaging devices that integrate lighting, optics, image capture, processing, and communication into a single unit, facilitating automated vision tasks. Unlike traditional cameras, smart cameras have built-in processing capabilities for real-time image analysis and decision-making. By processing images on-device, smart cameras minimize the need for data transfer, resulting in faster processing times and immediate feedback. Their all-in-one design (camera, lighting and image processing) reduces the need for multiple separate devices, cutting down on hardware costs while simplifying system architecture and benefit from capable PoE networks.



[NS42 Smart Camera](#)

Cisco components

Cisco Industrial Ethernet (IE) switches: Available in DIN-rail, IP67-rated, and rackmount form factors, Cisco Catalyst® IE9300, IE3500, IE3100 Rugged Series and Cisco IE3500 Heavy Duty Series switches deliver high-speed ports including 1GE, 2.5GE, and 10GE options to support demanding industrial AI applications, and offer high-wattage PoE (up to 90W per port, up to 720W total per switch), enabling flexible deployment of cameras and sensors. They integrate robust security with Cisco's Trust Anchor, Cisco Cyber Vision for visibility, segmentation and secure remote access, SGT segmentation with Identity Services Engine. These switches offer high-capacity, low-latency Layer 2/3 switching, all managed by Cisco Catalyst Center.

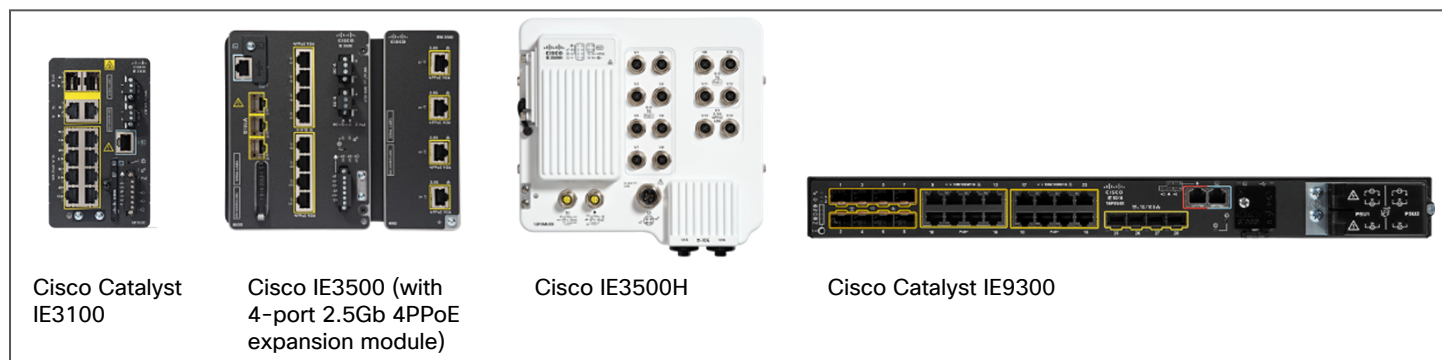


Table 1. IE Switches for Machine Vision cameras

IE Switch Family	Port Speeds (count)			PoE			Jumbo Frame	Cyber Vision, SGT
	10Gb	2.5Gb ¹	1Gb ¹	4PPoE	PoE/PoE+	Budget		
IE3500	3	0/4	8/24	12		480 W	Yes	Yes
IE3500H	2	2	12	2	12	240 W	Yes	Yes
IE9300	4	8	16	8	16	720 W	Yes	Yes
IE3100	-	-	10	2	6	240 W	Yes	No

¹ Number after the "/" indicates total ports available with module added to the base switch.

Cisco Cyber Vision: In an era of increasing cyberthreats, security cannot be an afterthought. Cisco integrates security directly into the network fabric, helping ensure that your vision systems are protected without compromising production availability.

Cisco Cyber Vision® combines the three OT security capabilities every industrial organization needs into a single, network native solution: continuous visibility into your OT security posture to help reduce the attack surface, AI-assisted network segmentation to protect industrial operations, and secure remote access to control risks from remote experts.

With Cyber Vision you can identify every camera, IPC, and server on the network and flag any anomalous behavior. Segmentation with Cyber Vision allows you to microsegment the network to help ensure that a camera can communicate only with its designated vision server. If a device were to become compromised, the threat would be unable to move laterally to other critical assets or production lines.

Systems integrators and vendors often need remote access to tune vision systems. Cyber Vision allows for auditable, role-based, and time-bound remote connections, eliminating the risk of uncontrolled access.

Cisco Identity Services Engine (ISE) is a comprehensive network security policy management platform that enables secure access control (via TrustSec in the network infrastructure) and visibility for users and devices across wired, wireless, VPN, and 5G networks.

Cisco Catalyst Center is a powerful network management system that leverages AI to connect, secure, and automate network operations. It simplifies the management of Cisco Catalyst network infrastructure including IE switches, ensuring a consistent user experience across wired and wireless networks.

Validation Highlights and Design Recommendations

Cisco and Zebra deployed the solution architecture and tested the technologies in Cisco Industrial Automation test bed. The testbed also supports a range of industrial automation and control vendors and protocols to represent manufacturing systems. We validated that key requirements were being met in realistic production scenarios. Higher resolution cameras are becoming more common among machine vision users. In these cases, an industrial PC or vision controller is expected to process the images, perform the inspection, and output results in milliseconds. This requires the network to operate extremely fast with high levels of redundancy.

Our observations included:

- Deterministic timing and synchronization—the cameras were able to process switch-provided Precise Time and perform their functions timely
- Low network latency and jitter for both industrial automation and Machine Vision traffic when the network is properly designed and configured and with the congestion
- Edge operations—the applications were deployed in our industrial access networks to process the large amount of vision traffic, but were able to communicate with local or remote applications
- Security segmentation and asset visibility—the GigE-Vision control data was processed by the industrial cybersecurity agents, and segmentation policies were applied without slowing or impacting the camera's operations

These validation observations demonstrate that AI-driven machine vision can behave as a predictable, secure, and scalable industrial subsystem when timing, traffic behavior, edge operations, and security are treated as first-class architectural concerns. Intentional system design enables organizations to move beyond experimentation and adopt machine vision with confidence in production environments.

Key design recommendations

Key network design considerations for AI-driven machine vision include:

- Use **high-bandwidth** network infrastructure that supports multiple 10 Gb interfaces for uplinks and 1 Gb or 2.5 Gb interfaces for camera connectivity, such as the IE3500, IE3500H, and IE9300. For lower speed camera connectivity, consider IE3100.
- Where supported, **PoE-capable** switches can power Zebra vision devices, reducing cable infrastructure and simplifying deployment.
- Use **Precision Time Protocol (PTP)** from the network to synchronize multi-camera systems.
- Apply **Quality of Service (QoS)** policies and **Frame Preemption** that prioritize PTP, control traffic, and image transfer.
- Use network infrastructure that supports **Jumbo Frames** such as the IE3500 for image transfer to lower latency and jitter.
- Place cameras and 4Sight image processing GPU/IPC servers in the **same, dedicated L2 domain/VLAN**.
- **Carefully plan the switch hop count in the vision path.** QoS and Frame Preemption help maintain low latency, but moving vision data farther may increase required bandwidth.
- Use Cisco's Secure Group Tag (SGT) technology to create **zones and conduits (micro-segmentation)** to manage communication flows into and out of the image processing VLANs/domains.

For more details, refer to the [Machine Vision in Industrial Automation Environments Design and Implementation Guide](#).



Summary

Cisco and Zebra have collaborated to help our joint customers accelerate their deployment of AI-driven Machine Vision applications. We have designed and tested our technologies working in a production-like system and validated the key application requirements were met. We have documented the results so that customers, system implementers, and machine builders can benefit from the knowledge we developed and confidently deploy machine vision applications in the production systems. AI-ready industrial networks from Cisco help to accelerate deployment of Zebra-based machine visioning systems by simplifying deployment, reducing the cost/time associated with extensive cable infrastructure and providing key design recommendations that improve chances for a successful deployment. In the end, our customers more quickly realize the key benefits: improved product quality, less downtime, improved operations, lower costs and increased output.