

Wipro Smart Factory Brings Real-time Immersive Field Monitoring

The Wipro Smart Factory solution improves performance for remote surveillance engineers, with fast and easy access to multiple factory locations, within a real-time and immersive environment.



Rapid technology advancements, shorter product lifecycles, and increasing demand for personalized products are causing industries to shift their manufacturing bases closer to end-users. To compete in today's technology-driven business environment, manufacturers must leverage digital transformation of their production lines. Doing so will unlock a value chain of capabilities within distributed facilities that bring smart factory operational efficiencies and competitive advantages.

Three digital technologies enable the smart factory:

- **Connectivity:** Leveraging industrial IoT (IIoT) to collect data from existing equipment via sensors.
- **Intelligent automation:** Utilizing tools including advanced robotics, machine vision, distributed control, and drones.
- **Cloud-scale data management and analytics:** Including predictive analytics via artificial intelligence (AI).

Effectively monitoring remote production and storage facilities presents a very real and ongoing challenge. The difficulty lies in coalescing multiple, individual systems to obtain a comprehensive 360-degree view for monitoring, analyzing, and action implementation.

The requirement for a more holistic user experience has given rise to a distributed factory setup, where the monitoring device can be thousands of miles away from production and manufacturing facilities. While this approach is beneficial for materials sourcing and end-product delivery, it creates a huge managerial burden on production, as it becomes increasingly difficult to monitor and manage production lines with factory setups distributed around the world.

A specific challenge is managing, at scale, the remote monitoring of production and storage facilities in real time.

Wipro's smart factory leverages the OpenVINO™ toolkit for real-time media analytics on a live video stream. The solution delivers the following:

- A comprehensive 360 degree/planar view of the factory floor: three 120-degree fields of vision are recorded, then played on a planar surface to enable monitoring, analyzing and taking action.
- Detection of unauthorized people entering restricted areas with the help of face recognition.¹
- Analytics inference that also helps identify unused spaces in storage facilities for inventory management.

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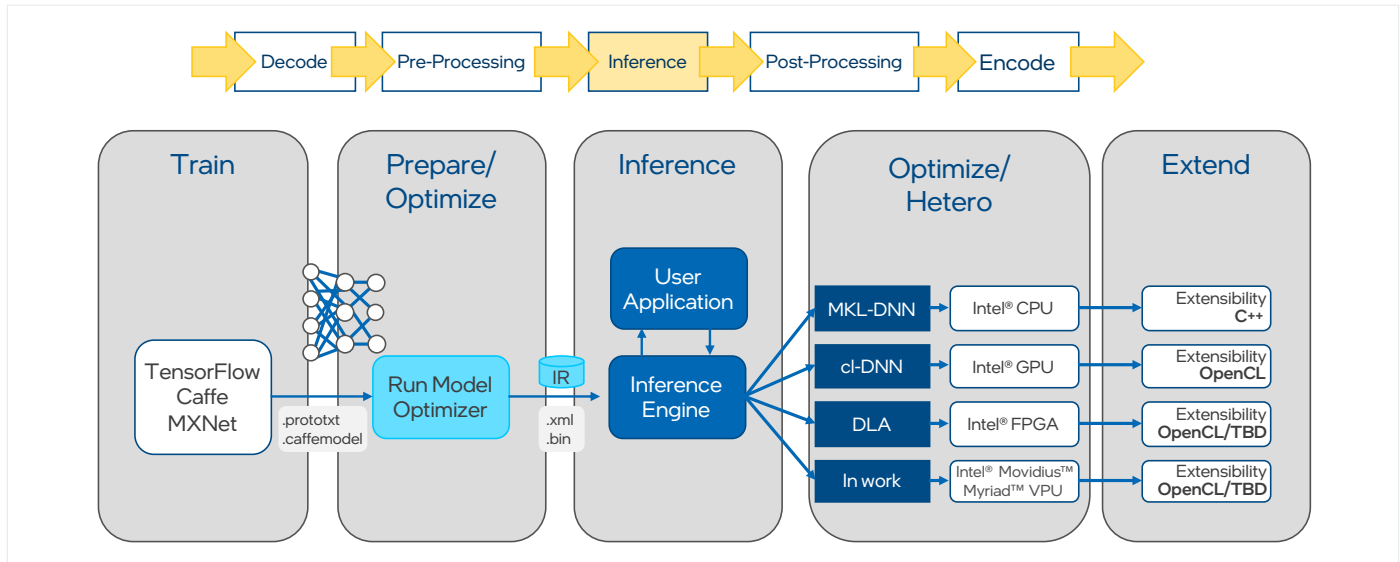


Figure 1. OpenVINO™ toolkit overview.

Intel® Network Builders ecosystem partner Wipro has used its system integration and technology development expertise to create a smart factory solution using edge networking technologies to support low latency requirements in addition to complex, high bandwidth, compute-centric video analytics. Critical elements of the Wipro Smart Factory solution include the OpenVINO™ toolkit for video analytics and Intel® Smart Edge Open for edge networking.

OpenVINO™ Toolkit Overview

The OpenVINO™ toolkit is built upon artificial neural networks, like convolutional, recurrent, and attention. It is deployed for executing intelligent tasks that require AI and deep learning, such as human vision, automatic speech recognition, natural language processing, recommendation systems, and more. It enables fast and efficient development of applications that scale across accelerated outputs, optimized results, and deep learning inferences with an easy-to-use library for computer vision (Figure 1).

The Wipro Smart Factory solution leverages the OpenVINO toolkit for real-time media analytics running on 360 degree and planar video streams to implement two important factory use-cases: detection of unauthorized personnel entering restricted areas, via face recognition; and detection of empty/unused spaces in storage facilities, via object recognition, for inventory management.

Intel® Smart Edge Open Overview

Intel Smart Edge Open is a royalty-free edge computing software toolkit that enables highly optimized and performant edge platforms to on-board and manage applications and network functions with cloud-like agility across any type of network.

Smart factory multimedia and video analytics services are offloaded to an Intel Smart Edge Open-powered edge node. Intel Smart Edge Open provides one-click deployment of content and management of its lifecycle. The media and video analytics services run locally to the edge node for greater performance.

Intel Smart Edge Open provides the following benefits for smart factories:

- Support for multiple access technologies, including 5G, LTE, Wi-Fi, and wired networks.
- Edge orchestration: Exposes northbound APIs to a central orchestrator, such as Open Network Automation Platform (ONAP), for edge orchestration.
- Range of deployment: Can be implemented either at the on-premises edge or the network edge.

An Intel Smart Edge Open system consists of one or more edge nodes, which support edge applications and network functions, and a controller, which manages the lifecycles of the edge nodes and provides common services for Intel Smart Edge Open edge nodes.

An Intel Smart Edge Open edge node (see Figure 2) hosts a set of building blocks, edge compute applications, and network functions. Edge applications may run natively on an edge node, or may run on an external platform linked by a local breakout port. Traffic from an end-user is steered to edge applications on an edge node via policies configured in the network and routing within the edge node.

The Intel Smart Edge Open controller (see Figure 2) enables management of potentially massively distributed edge platforms. The Intel Smart Edge Open controller manages the lifecycles of edge nodes and schedules the execution of network functions and applications across available edge nodes. The controller can take advantage of network topology and system load, as collected from telemetry, to schedule functions and applications in an optimal manner. The controller may be hosted locally or in an enterprise or public cloud.

The immersive content processing function of the Wipro smart factory solution pre-processes 360-degree/planar video streams from cameras on the factory floor to allow OpenVINO-powered detection applications to operate on the streams, and forwards the video streams along with detection events to remote factory monitoring staff. The smart factory solution allows applications to be deployed as subscription-based services.

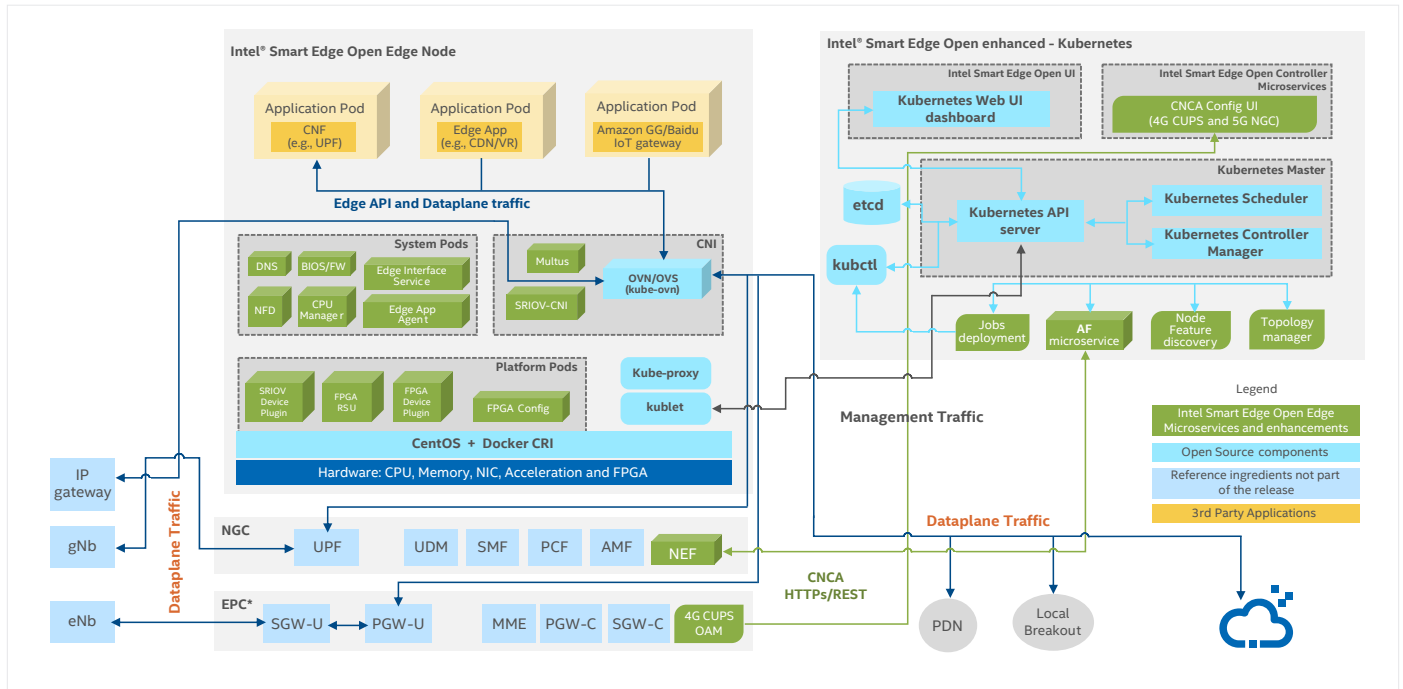


Figure 2. Intel Smart Edge Open architecture used for a smart factory application.

The edge node has four functions for remote smart factory implementations:

- 1. Intel Smart Edge Open data plane services:** Steers traffic toward applications running on the edge node or the local breakout port. Traffic policies are configured on the Intel Smart Edge Open edge controller and pushed to the data-plane services. Traffic steering redirects traffic to edge applications for further processing or passes packets through the downstream interface to the packet core for traffic forwarding.
- 2. Intel Smart Edge Open enhanced platform awareness microservices:** Building blocks include edge authentication agent (EAA), edge virtualization agent (EVA), edge lifecycle agent (ELA), syslog, domain name system (DNS), and others. They manage application lifecycle, DNS resolution, application enrollment, and more.
- 3. Evolved Packet Core (EPC):** The edge node is attached to the SGi interface of an EPC. Traffic from the EPC arrives as IP traffic, and is steered as needed to edge applications. The EPC combines user and control planes.
- 4. Smart factory application:** The media manipulation engine and video analytics engine run either as VMs or as Docker containers.

Intel Smart Edge Open supports containerized applications. The Wipro smart factory solutions provides container templates that users can use to customize applications, or develop new applications, which can then be deployed by Intel Smart Edge Open.

Overview of Smart Factory by Wipro

Wipro's smart factory solution (see Figure 3) provides comprehensive and unified 360-degree/planar visibility of remote factory production and storage facilities, and automates inventory management by checking unused spaces and detecting unauthorized entry. The smart factory solution consists of the following elements:

- **Immersive Content Processing:** This block converts 360-degree videos into MPEG-DASH format for easy and real-time access over the web. This also eliminates end-device compatibility issues as the DASH videos can be streamed from an HTTP web server to a browser-based media player.
- **Media Manipulation Engine:** This block stitches video streams across multiple cameras and renders the stitched view to the end user device.
- **Content Caching Block:** This block is responsible for archiving and retrieving the 360-degree/planar live video streams.
- **Video Analytics Engine:** A video analytics engine based on a convolutional neural net (CNN) model from the OpenVINO toolkit. It allows surveillance engineers to monitor and detect unauthorized access and unused inventory space.

The Wipro Smart Factory solution enables organizations to monitor a factory or field from remote locations with an immersive capability. Remote surveillance engineers have an efficient unified and complete view of the factory and peripheral facilities.

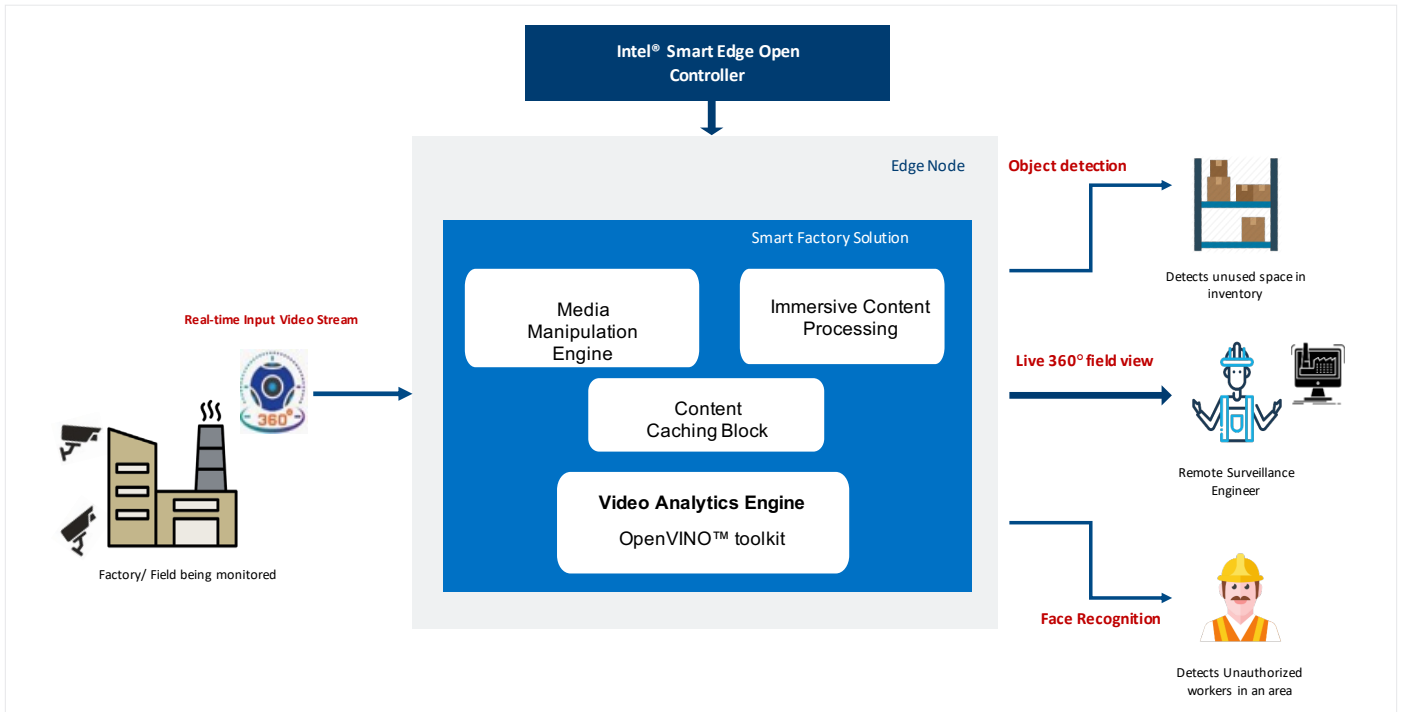


Figure 3. Wipro's Smart Factory solution.

End-to-End Solution Architecture

The OpenVINO toolkit provides pre-trained models and optimizers. A core component is the model optimizer, a cross-platform command-line tool that converts a trained neural network from its source framework to an open-source nGraph-compatible intermediate representation (IR) for use in inference operations. The other core component of the

OpenVINO toolkit for smart factories is the inference engine, which manages the loading and compiling of the optimized neural network model, runs inference operations on input data, and outputs the results.

The video analytics block (using the OpenVINO toolkit) provides inference output to other blocks of RCS as shown in Figure 4.

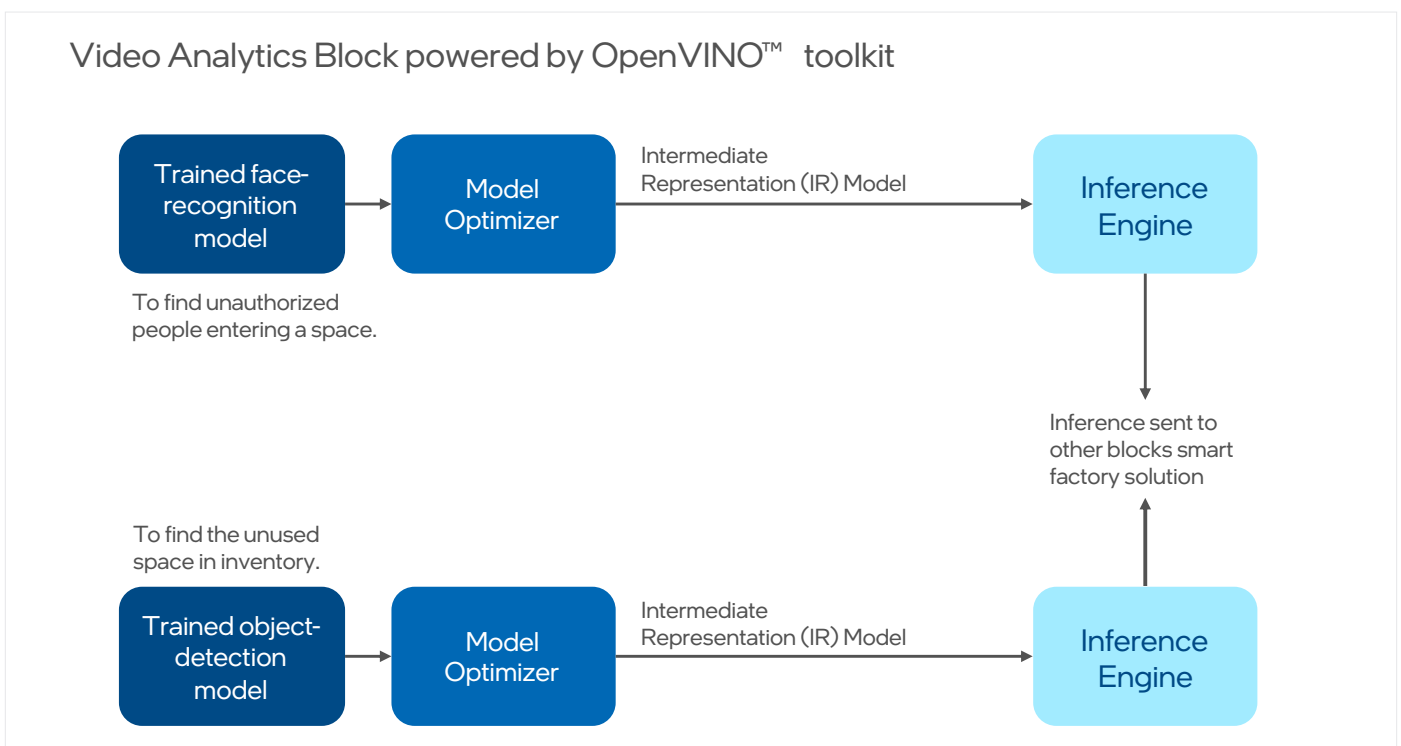


Figure 4. OpenVINO™ toolkit with Wipro Smart Factory solution.

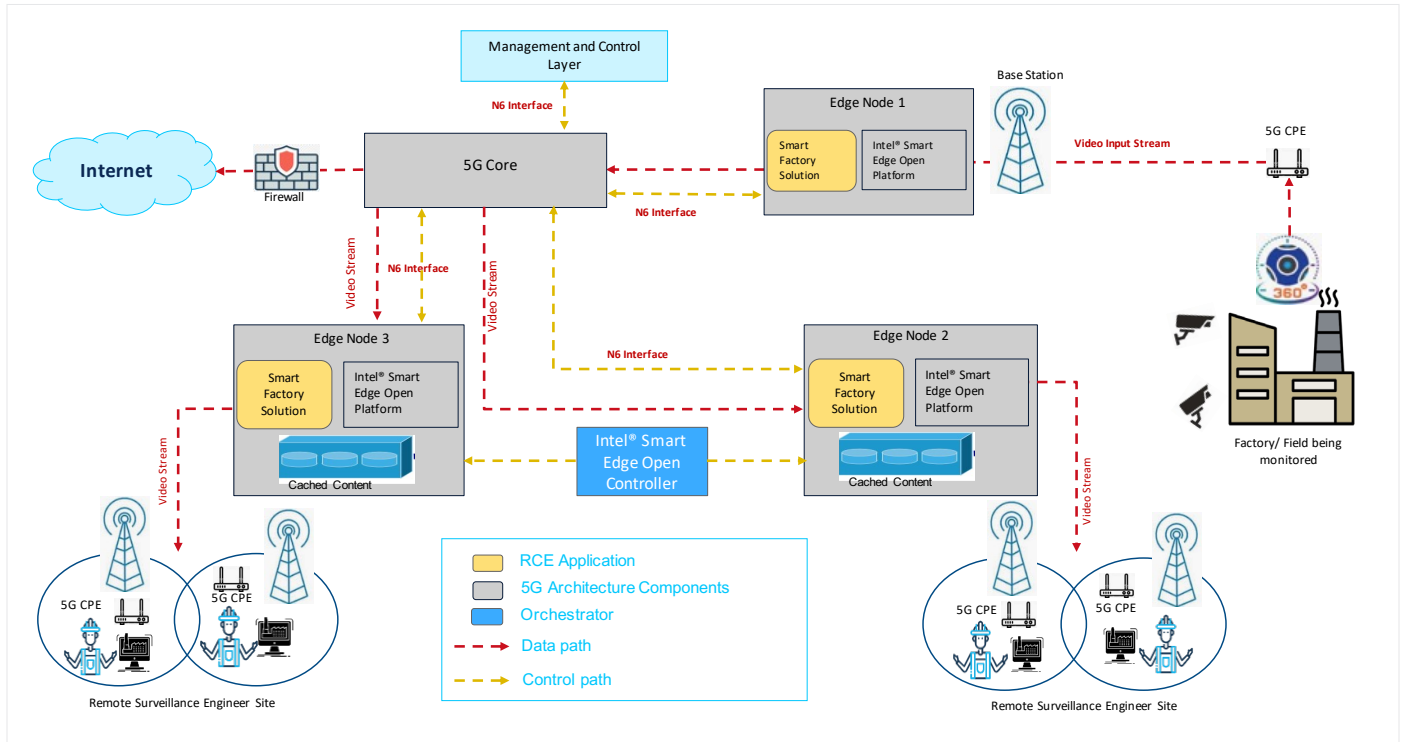


Figure 5. Wipro Smart Factory solution interfacing with 5G architecture leveraging Intel Smart Edge Open.

As shown in Figure 5, the smart factory solution is packaged as a Docker container that is then onboarded into the Intel Smart Edge Open edge node via the Intel Smart Edge Open controller. The upstream interface is connected to the video feed from the factory. The downstream interface is connected to the remote surveillance/engineering site.

Figure 6 shows how the smart factory is deployed on the edge node. Once the interfaces are declared as user plane interfaces, the smart factory application VM is deployed on the edge node using the controller user interface. When the

smart factory VM status is changed to running state, the source filter is applied to the smart factory VM to redirect traffic to the smart factory application. The processing required for analytics (e.g., face recognition for unauthorized personnel, object detection for unused space in inventory, and remote monitoring) is offloaded to the nearest edge computing node, and only a lightweight analytics report is communicated back to the remote engineer. This approach reduces traffic on the backhaul network, improving latency.



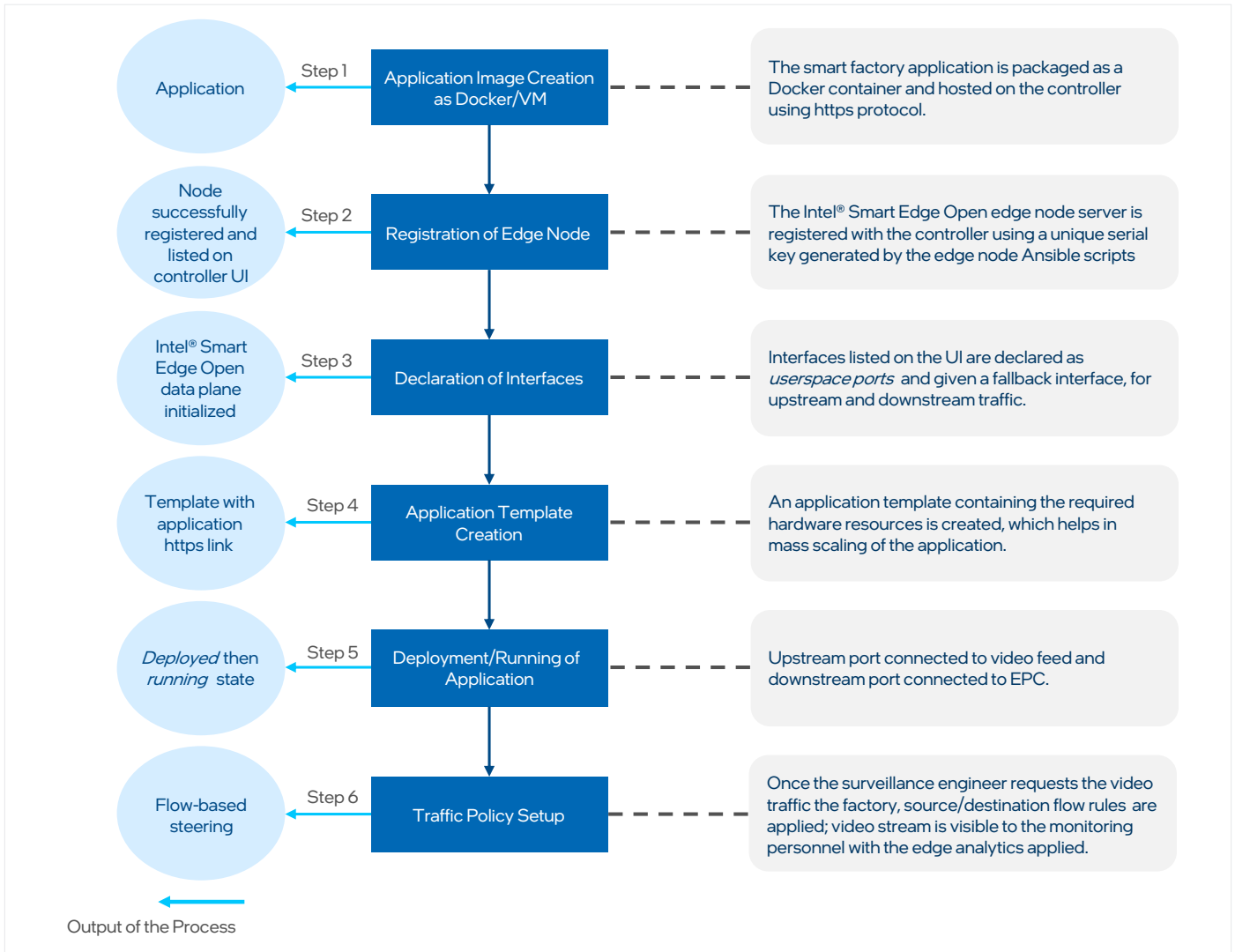


Figure 6. Flow diagram for application deployment on edge.

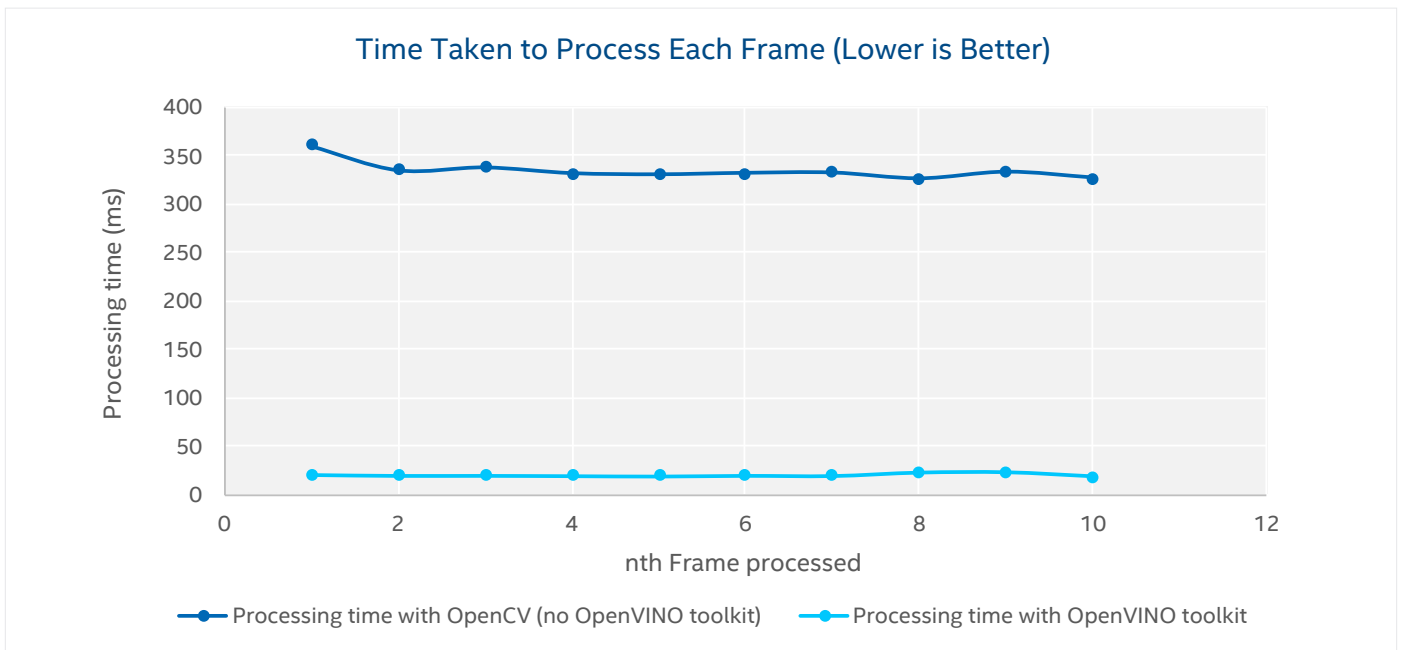


Figure 7. Graph depicting variation of processing time per frame with and without the OpenVINO toolkit.

Model Performance with and without the OpenVINO toolkit²

To demonstrate the performance advantage of the OpenVINO toolkit, Wipro conducted tests of frame-by-frame face detection performance of Smart Factory using OpenVINO against an alternative, open source convolutional neural network (CNN) model. This approach uses the OpenCV deep neural network (DNN) and an Open Neural Network Exchange (ONNX) format-based model on a fixed-sized frame.

As seen in Figure 7, the OpenVINO toolkit provides faster execution of the deep learning model used for face recognition. Across all frames, the performance of OpenVINO is orders of magnitude higher than the OpenCV configuration.

Both software stacks used a sequence of neural networks and the “face-detection-adas-0001,” pre-trained model from OpenVINO toolkit Open Model Zoo.

Conclusion

The Wipro Smart Factory solution extends well beyond the four walls that enclose the machines of a typical factory. The smart factory solution is the amalgamation of technologies that efficiently monitor and fetch data from remote production and storage facility setups. The solution provides intelligent security decision-making capabilities and reduces the time spent checking on unused storage spaces on an inventory floor. The Wipro Smart Factory solution provides an immersive remote experience that saves time, effort, and resources. The solution includes intelligence for recognizing all people entering and exiting a location, and it provides data about unauthorized personnel present on a floor.

The Wipro Smart Factory solution leverages the OpenVINO toolkit and Intel Smart Edge Open edge platform to improve the performance curve for remote surveillance engineers. It brings all the facilities within reach, with fast and easy access, within a real-time immersive environment.

Learn More

[Wipro Limited](#)

[Wipro Smart Factory](#)

[Intel® Network Builders program](#)

TABLE OF ABBREVIATIONS

3GPP	3rd Generation Partnership Project
API	Application programming interface
EAA	Edge Application Agent
EDA	Edge Data plane Agent
ELA	Edge Life-Cycle Agent
EPC	Evolved Packet Core
EVA	Edge Virtualization Agent
IIoT	Industrial Internet of Things
OpenVINO	Open Visual Inference and Neural network Optimization



Notices & Disclaimers

¹ Policies related to the collection, retention, use and sharing of facial recognition data will be set by the end customer.

² Tests conducted by Wipro in April 2021: Device under test was a server powered by dual 2.4 GHz 1st Gen Intel Xeon Gold 6148 processor (microcode 0x2000064). Intel® Hyper-Threading Technology was turned on and the BIOS version was 1.6.13. Two network adapters were used: a Broadcom S720 and an Intel XL710 Dual port 40G QSFP+. Total memory equaled 256GB. The OS was Ubuntu 18.04.3 LTS with a Linux 5.3.0-24-generic x86_64 kernel.

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