2020 embedded VISION summit®

Smarter Manufacturing with Intel's Deep Learning-Based Machine Vision

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Intel
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intel®

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Software and workloads used in performance tests may have been optimized for performance only on Intel microprocessors.

Performance tests, such as SYSmark and MobileMark, are measured using specific computer systems, components, software, operations and functions. Any change to any of those factors may cause the results to vary. You should consult other information and performance tests to assist you in fully evaluating your contemplated purchases, including the performance of that product when combined with other products. For more complete information visit www.intel.com/benchmarks.

Performance results are based on testing as of dates shown in configurations and may not reflect all publicly available updates. See backup for configuration details. No product or component can be absolutely secure.

Your costs and results may vary.

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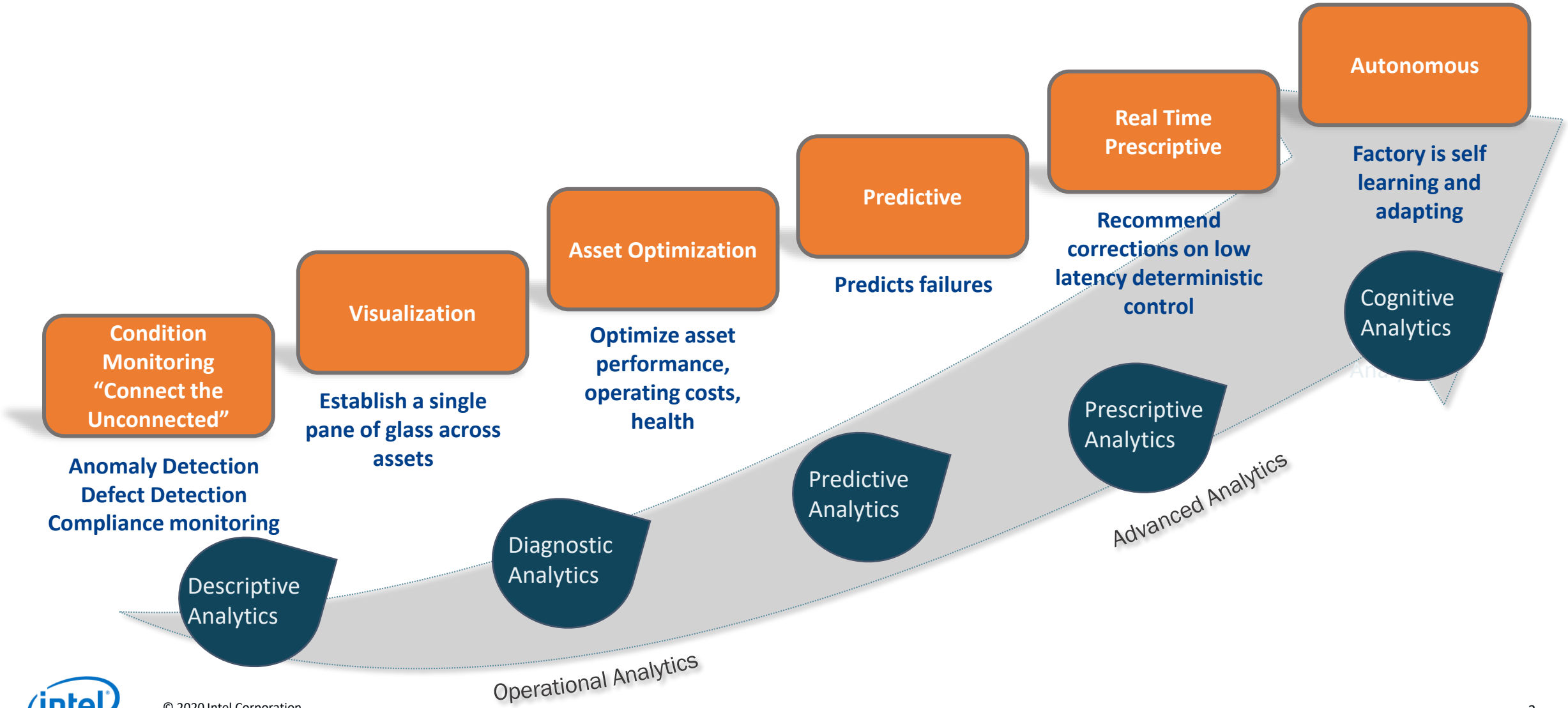
Industrial 4.0 Edge AI is driving the trends

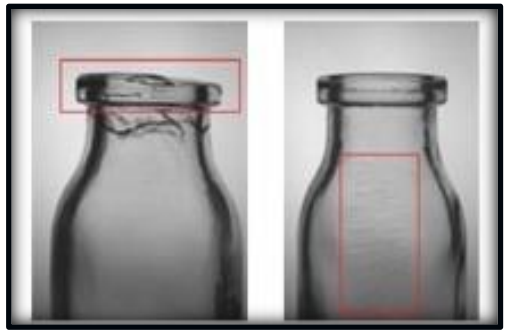


Industrial use case opportunities

How can I
meet rising requirement on
product quality?

How can I better
PREDICT AND Reduce
Downtime?

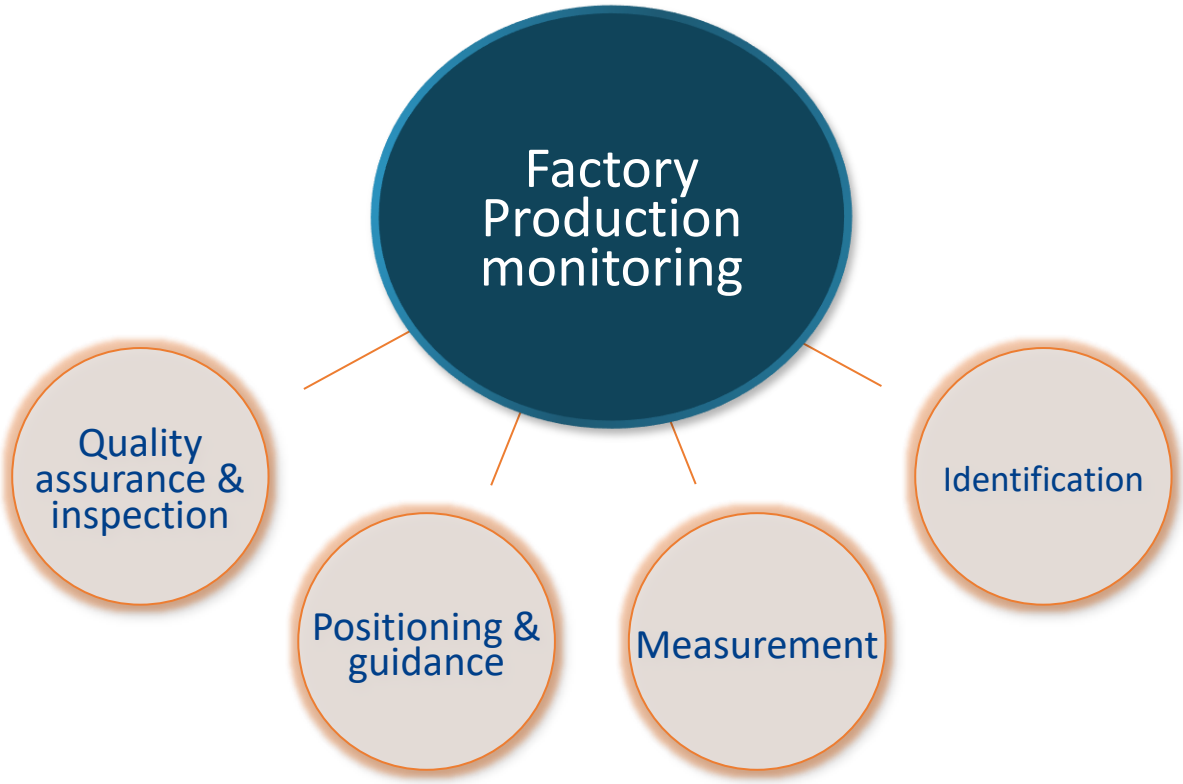
How can I
optimize factory
operation
for higher throughput?

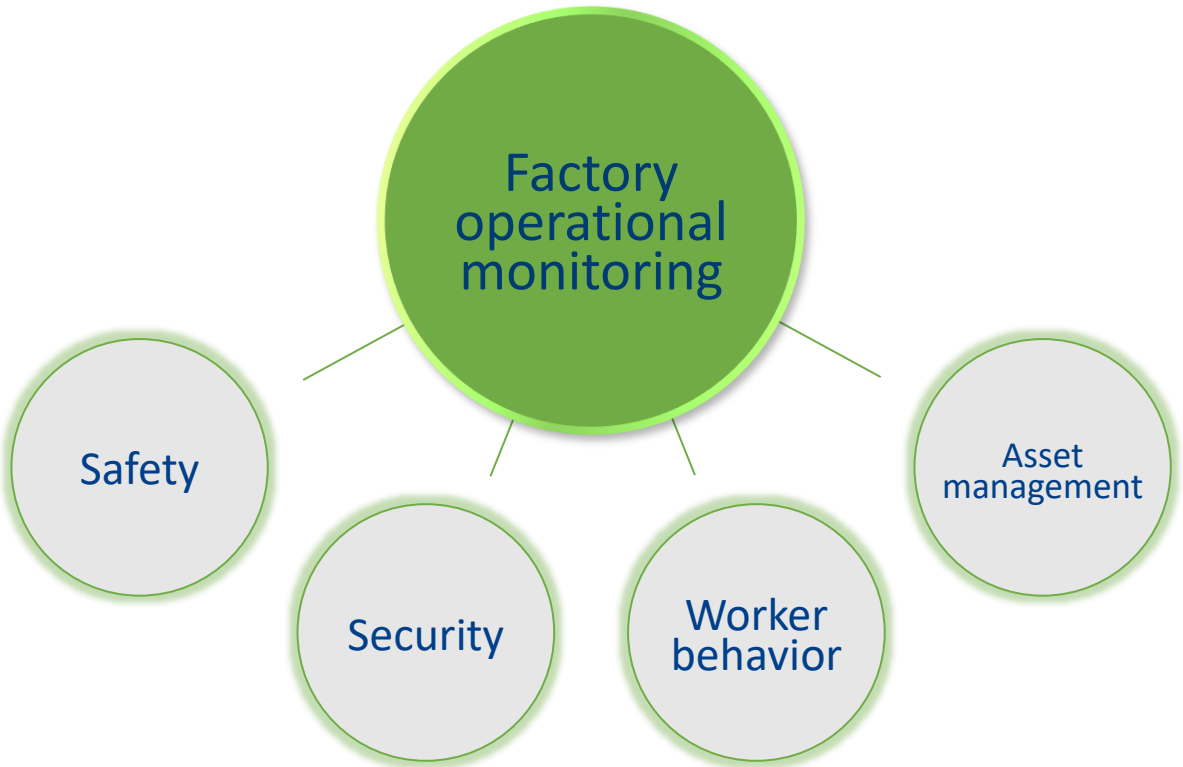


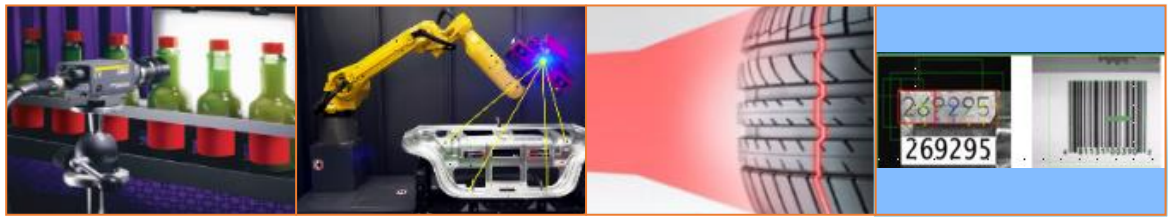
How can I leverage
Latest technology for
better business
outcomes?

How can I STAND OUT IN COMPETITION in my industry?

Industrial machine vision use cases







Arc Weld use case

Arc Weld defect detection

Common weld in heavy machinery manufacturing, Arc Welding uses electric arc with wire electrode to heat and melt metals and binding them when cooled

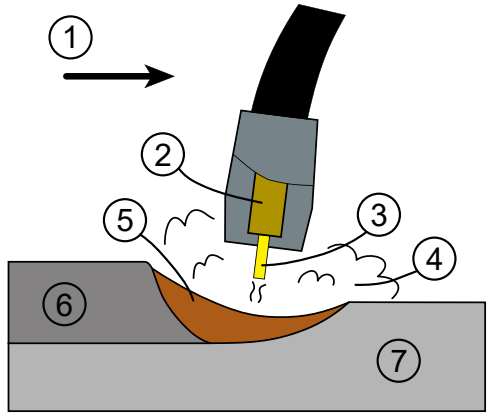
POROSITY – Most common weld defect

- Cavities in the weld metal caused by absorption of nitrogen, hydrogen, and oxygen in the molten weld pool
- Results in weaker, less ductile welds that cannot be shipped or pass inspection

INDUSTRY CHALLENGES

- Bad welds need rework causing production delays, scrappage and high costs
- Traditional manual defect detection requires expensive, hard to find highly skilled weld engineers and technicians using visual and auditory indicators
- Current manual weld defect detection are error prone as they generate lot of false positive

GMAW weld area



(1) Direction of travel, (2) Contact tube, (3) Electrode, (4) Shielding gas, (5) Molten weld metal, (6) Solidified weld metal, (7) Workpiece.

Below are approximations

- Factory temp is 50F - 90F ,Temp of weld pool is >2500F
- Temperature of weld plate ranges from 1500F near the weld zone to 500F away from main weld zone
- Weld Smoke and Fumes
- Weld Spark and Splatter

Real time vision-based weld quality inspection

- Weld pool monitored in real time
- CPU: Processor 9th Gen Intel® Core™ i7-9700E, 4.2G Hz
- OpenVINO™ - 2020 1.023.

Model	Accuracy	GFlops	Video stream
PyTorch action recognition	97.14%	3.636	30 fps

Source: Intel estimated based on factory deployments and Lab test

Software tools for Model development

Inference Workflow with Intel® Distribution of OpenVINO™ toolkit
Advanced capabilities to streamline deep learning deployments

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Model Optimizer

- What it is: Preparation step -> imports trained models
- Why important: Optimizes for performance/space with conservative topology transformations; biggest boost is from conversion to data types matching hardware.

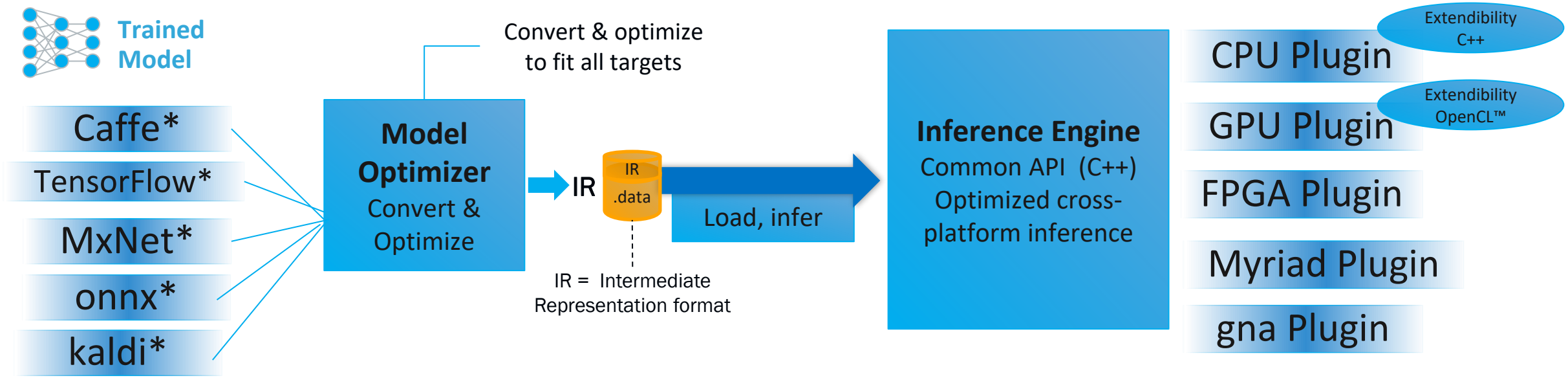
Inference Engine

- What it is: High-level inference API
- Why important: Interface is implemented as dynamically loaded plugins for each hardware type. Delivers highest level of performance for each type without requiring users to implement and maintain multiple code pathways.

1. Build

2. optimize

3. Deploy



GPU = Intel CPU with integrated graphics processing unit/Intel® Processor Graphics
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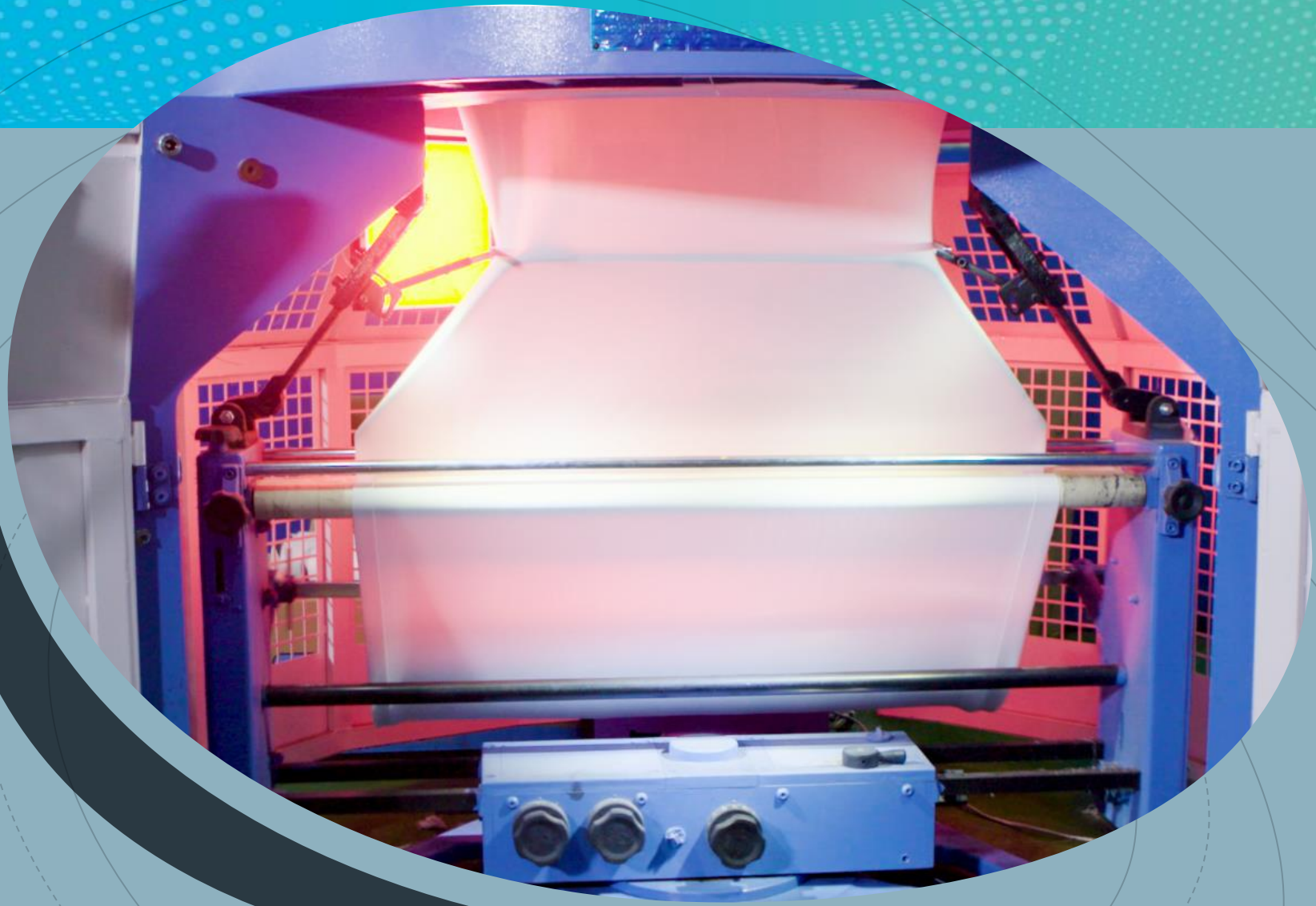


Textile Use Case

Textile defect detection

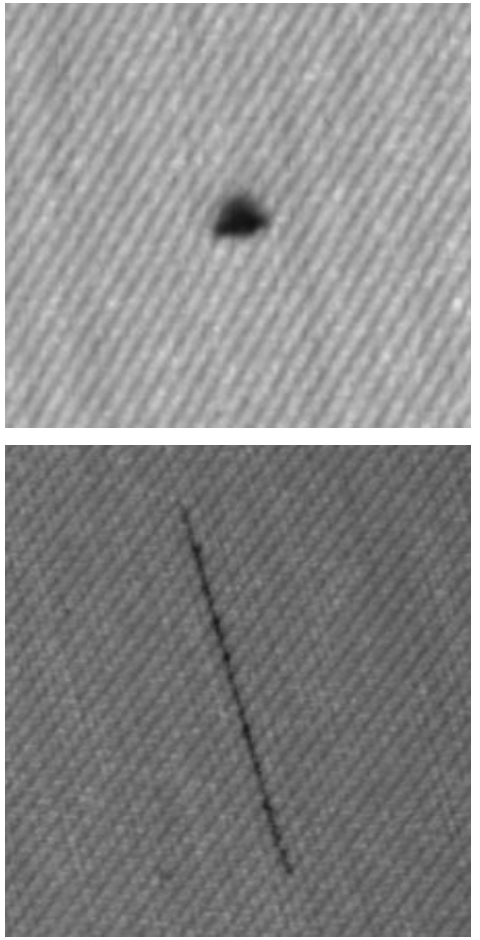
Current quality inspection in textile industry is generally a manual process

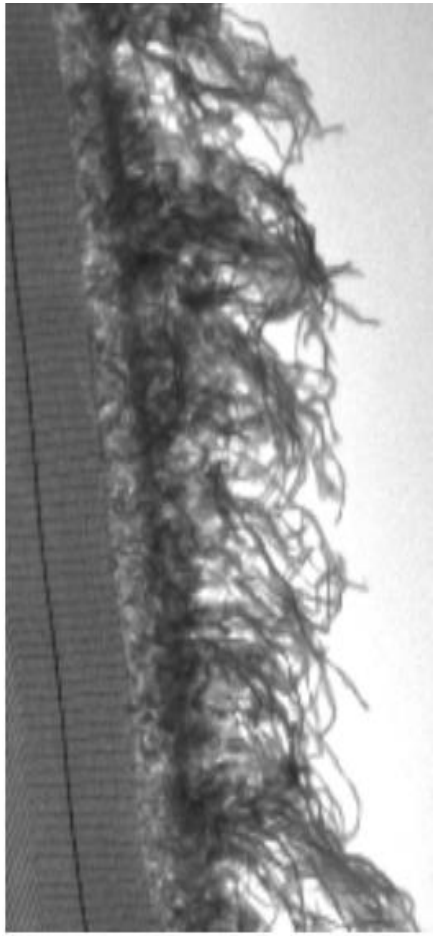
Fabric inspection is a laborious process
Requires the operator to inspect each piece of fabric, making repairs wherever possible, and marking the rest

Human visual inspectors are subject to a heavy workload
In addition to visual inspection being considered high-stress work, the skill level of visual inspectors can vary considerably

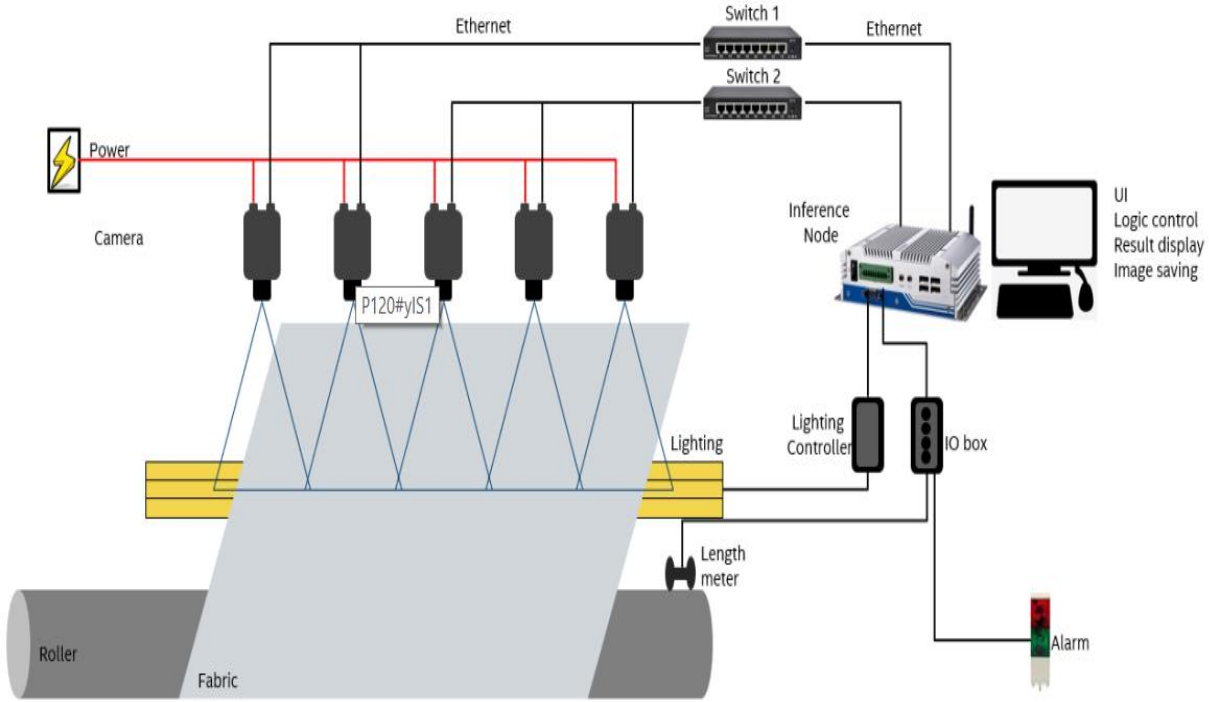
The defects vary and can be minute to be detected through human eye

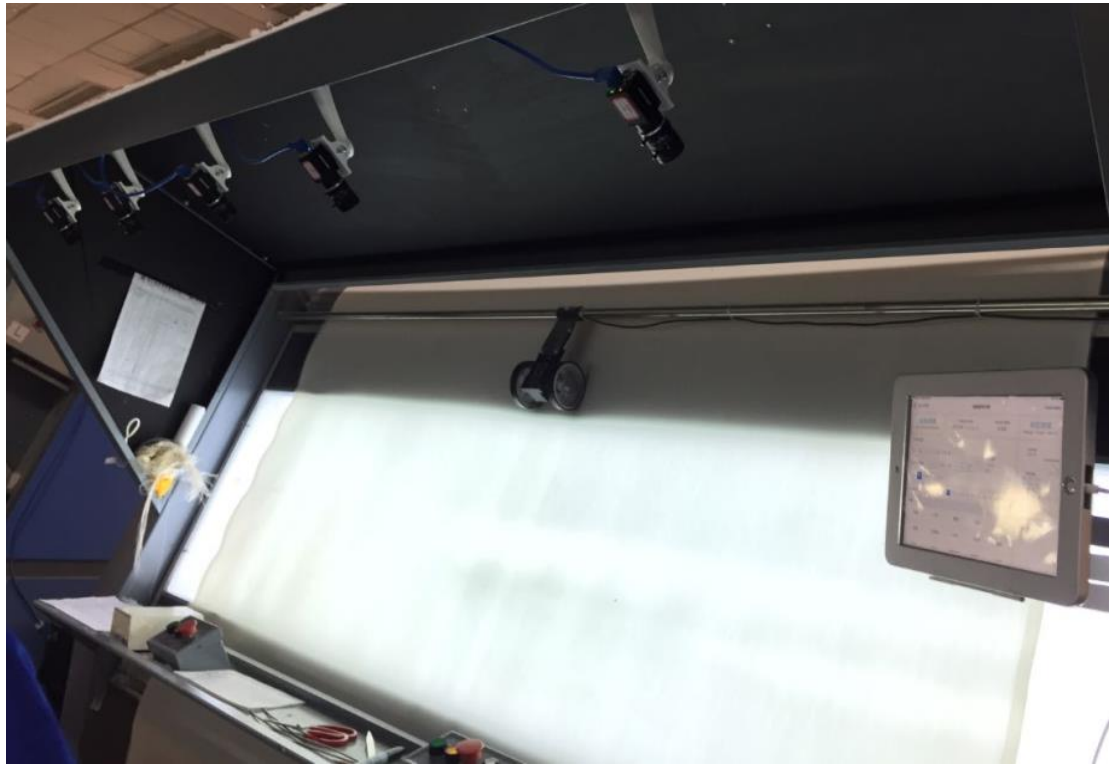
Deep-Learning Machine Vision
Offers a viable solution that can help to build a more intelligent textile factory





Textile defect detection solution





Accuracy & performance:

- CPU: Intel® Xeon® E5-2678 v3, 2.50 GHz
- OpenVINO™ - 2019.1.144
- Model: Segmentation MobileNetV1 based U-Net
- Input shape: 608x448x3
- Validated data: 320 images from fabric 1~9:

Model	Precision	Recall	Throughput
U-Net (MobileNetV1)	96.97%	90.14%	22.2 fps

Source: Intel estimated based on factory deployments and Lab test

Scale and deploy Industrial solution

Challenges for scaling AI solutions for industrial use cases

Market gaps with existing solutions

- Locked and proprietary, non-flexible
- High total cost of ownership
- Scalability performance requirements
- Data privacy
- Edge device Management

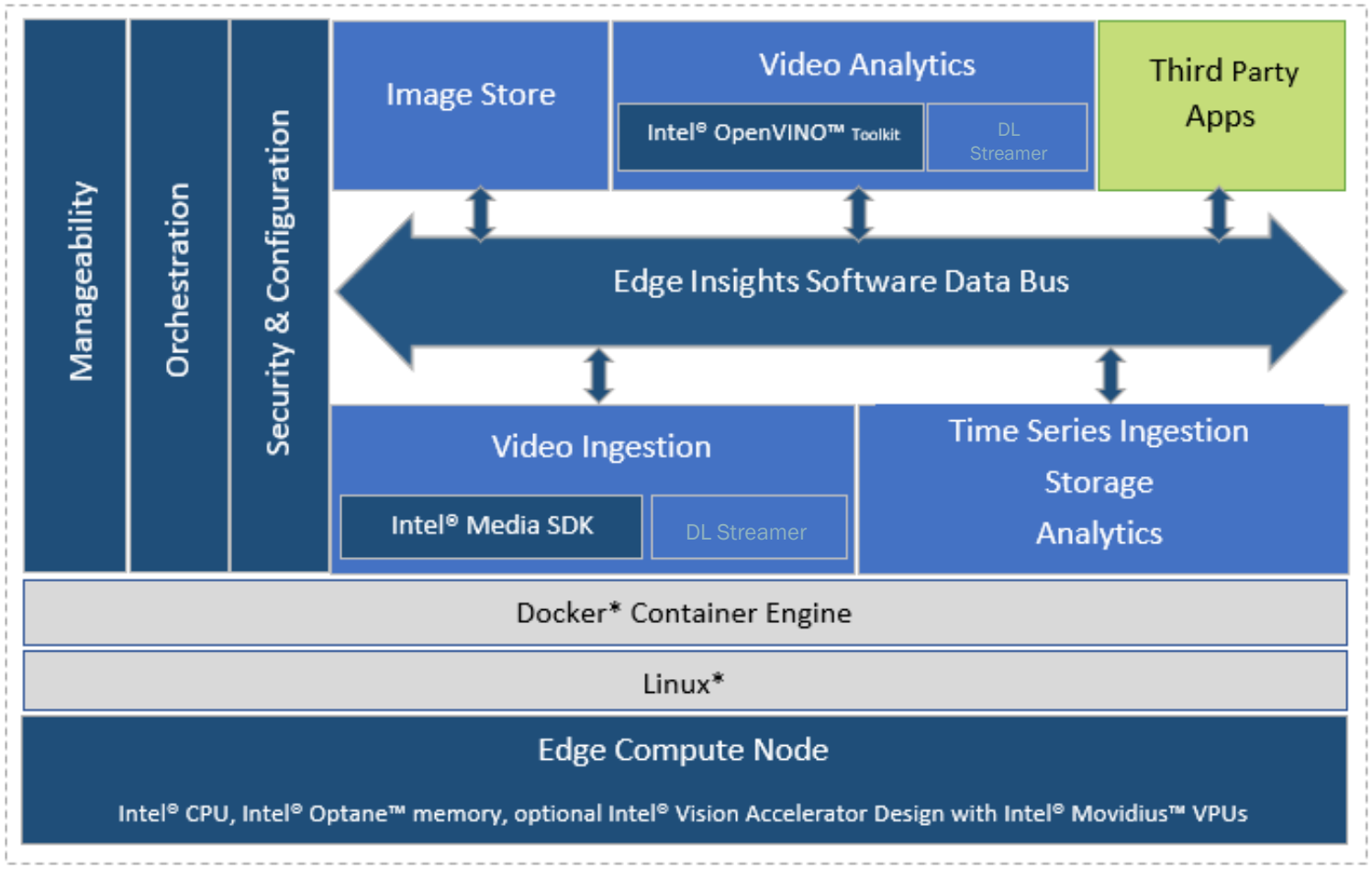
Solution Providers' pain points To BUILD

- Lack of general-purpose platform for multiple analytics use cases
- Lack of flexibility and modularity in base platform
- Closed existing proprietary systems – vendor locked
- Security requirements

The market seeks

An open and flexible base middleware stack on which to build industrial use cases

Edge Insights for industrial architecture overview



Intel Developed

Intel + Open Source/Third Party

Third Party Developed

AI AT THE EDGE

Ease of AI deployment at the edge

Ease of testing, optimizing and deploying AI at the edge with Intel and 3rd party developed algorithms for analytics

FASTER TIME TO MARKET

Flexible & Modular container based architecture

Mix and match services and applications to enable new services and experiences

ORCHESTRATION ENABLED

Define and optimize workflow

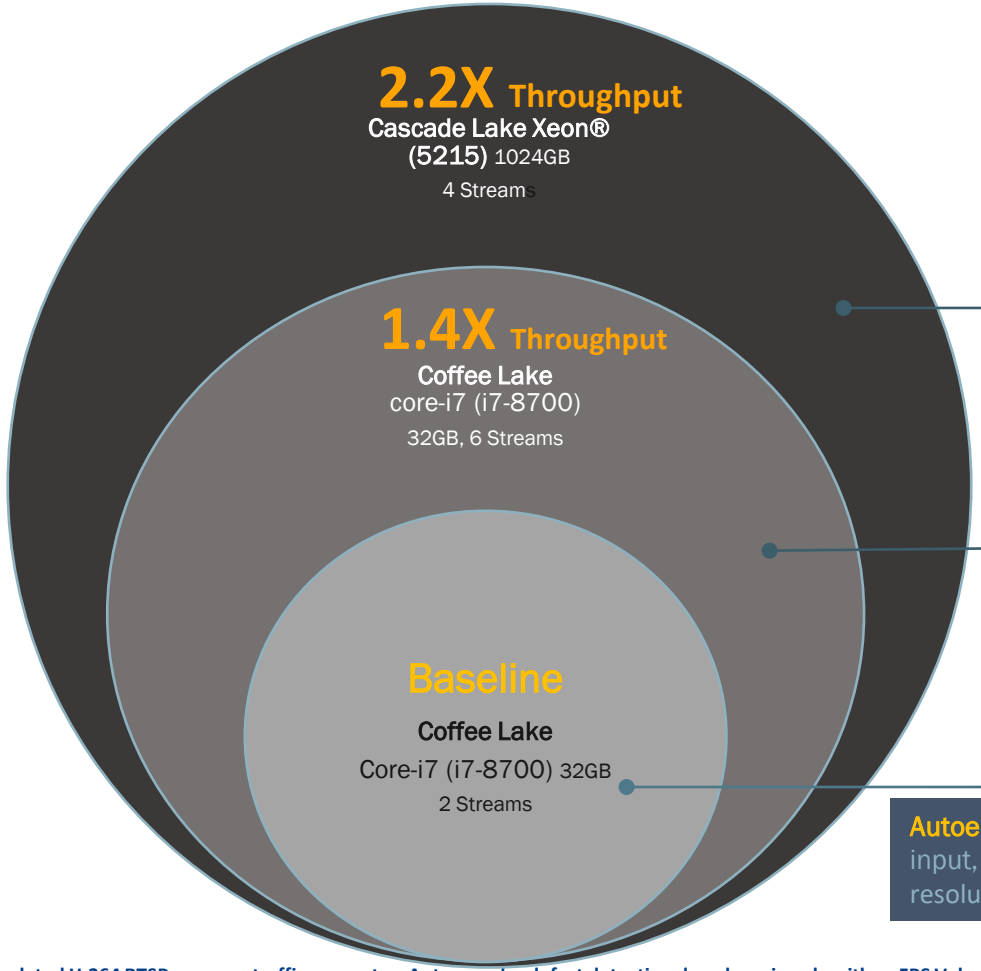
Enable solutions to automatically respond to changing environments

SCALABLE

Choose from Intel processor family

Intel processors' scalable performance for your unique needs

Scale your complex workload with powerful processors



CPU only
Xeon® Scalable (5215)

CPU and
Integrated GPU
Core-i7 (i7-8700)

Integrated GPU only
Core-i7 (i7-8700)

Edge Insights v2.1 +

For complex inference use cases, **Intel® Xeon®** systems deliver powerful performance.

CPU optimizations of the Xeon® Scalable system contribute more to performance than the integrated graphics of the Core™ i7 systems.

Autoencoder is a compute intensive deep learning algorithm for reconstruction of defect-free images using defective images as input, with ~10 times as many parameters as the PCB defect detection model. Its use cases include anomaly detection, super-resolution, and image restoration

Emulated H.264 RTSP cameras traffic generator. Autoencoder defect detection deep learning algorithm. FPS Values are data ingest (decode, resize and color space conversion) and edge inference. See backup for configuration details. For more complete information about performance and benchmark results, visit www.intel.com/benchmarks. Optimization Notice. Additional information is available at Edge Insights Software. Percentage increase shown is for FPS.

Systems under test

Config Required to be shown for benchmarking data

Atom™ System Configuration

System Name		Up square IoT Edge System
CPU	Product	Intel® Atom™ Apollo Lake SoC x7-E3950
	Frequency	1.6-2.0GHz
	Cores/ Threads	4 Cores/4 Threads
	Cache (MB)	2 L2
Graphics	Frequency	500 MHz
	Graphics core	Intel® HD Graphics P500
	EUs	18
Memory		
	Type	LPDDR3 @ 2400 MHz
	Size (GB)	8
Software	EIS	2.1 - PV
	OS	Ubuntu 18.04

Core® i5 System Configuration

System Name		HP EliteDesk 800 G4 DM
CPU	Product	Intel® Core™ i5-8500T
	Frequency	2.1GHz
	Cores/ Threads	6 Cores/12 Threads
	Cache (MB)	12
Graphics	Frequency	350 MHz-1.2GHz
	Graphics core	Intel® UHD Graphics P630
	EUs	24
Memory		
	Type	DDR4 DIMM @ 2666MHz
	Size (GB)	2x16
Software	EIS	2.1 -PV
	OS	Ubuntu 18.04

Core® i7 System Configuration

System Name		Dell Optiplex Tower 7060
CPU	Product	Intel® Core™ i7-8700
	Frequency	3.20GHz/4.60GHz
	Cores/Threads	6 Cores/12 Threads
	Cache (MB)	12
Graphics	Frequency	350 MHz-1.2GHz
	Graphics core	Intel® UHD Graphics P630
	EUs	24
Memory		
	Type	DDR4 DIMM @ 2666MHz
	Size (GB)	2x16
Software	EIS	2.1 -PV
	OS	Ubuntu 18.04

Xeon® SP System Configuration

System Name		Lenovo Cascade Lake Server
CPU	Product	Intel® Xeon™ Gold 5215
	Frequency	2.5GHz/3.4GHz
	Cores/Threads	10 Cores/20 Threads
	Cache (MB)	13.75
Graphics	Frequency	N/A
	Graphics core	N/A
	EUs	N/A
Memory		
	Type	DDR4 DIMM @ 2933 MHz DDR4 DIMM @2666 MHz
	Size (GB)	12x16 4x256 → DCPMM
Software	EIS	2.1-PV
	OS	Ubuntu 18.04

Xeon® E System Configuration

System Name		HP Z2 Tower G4 Workstation
CPU	Product	Intel® Xeon™ E – 2176G
	Frequency	3.7GHz
	Cores/Threads	6Cores/12 Threads
	Cache (MB)	12
Graphics	Frequency	350 MHz -1.2GHz
	Graphics core	Intel® UHD Graphics P630
	EUs	24
Memory		
	Type	DDR4 DIMM @2666 MHz
	Size (GB)	2x16
Software	EIS	2.1-PV
	OS	Ubuntu 18.04

Software tools for Model development – Myriad™ X VPU
Bring Your Next Computer Vision or Edge AI Project to Life

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The Intel® Movidius™ Myriad™ X VPU is Intel's first VPU to feature the Neural Compute Engine — a dedicated hardware accelerator for deep neural network inference.

Dedicated Neural Compute Engine

16 High Performance SHAVE Cores

Enhanced Vision Accelerator Suite

Flexible Image Processing and Encode

Support for Multiple VPU Configuration

Conclusion

Data analytics help reduce downtime, improve product quality, optimize operation

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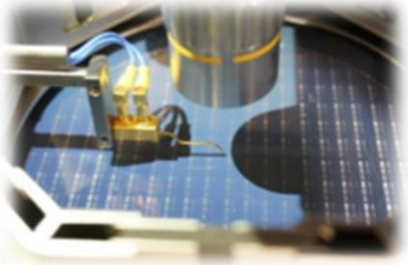
Unleash the value of all data types at the edge for truly smart and connected industrial systems

PEOPLE

- Worker safety
- Worker behavior

MACHINE

- Predictive maintenance
- Robotics Pick and Place



MATERIAL

- Product defect detection
- Raw material appearance inspection
- Asset management

PROCESS

- Factory operation optimization
- Optimization of raw material utilization
- Predictive Analytics

ENVIRONMENT

- Temperature optimization
- Humidity optimization

Structured Data	Time series	Image	Video	Text	Audio

Lengths of the bar indicates the comparative AI value impact by data type.

Resource: McKinsey Global Institute “NOTES FROM THE AI FRONTIER INSIGHTS FROM HUNDREDS OF USE CASES “”

Intel® ai solutions for end point, edge & cloud

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End Point

IOT SENSORS

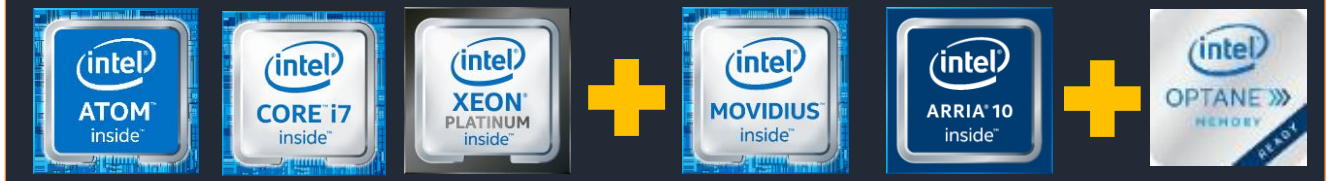
Vision & Inference

Low Latency, Privacy

Edge

GATEWAYS, IPCS, EDGE COMPUTE NODES, EDGE SERVER

Intel® Vision Accelerators



Edge Inference, Media & Vision

On Prem Discovery and Training, Analytics, ML/DL Servers

Best Efficiency, Lowest Power Mid/Small Memory Footprint

High Perf, Large/ Mid Memory Custom/ New HW Architecture

High performance Storage

Industrial PC (IPC)

Edge Insights for Industrial Software

Edge Controls Platform

High-end Edge Controls Platform

Intel® Media SDK

Data Center

SERVERS & APPLIANCES

Most Use Cases

Flexible & Memory Bandwidth-Bound Use Cases

DELIVER FAST, EFFICIENT, HIGH QUALITY COMPUTER VISION PROCESSING END-TO-END

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Intel is transforming the industrial landscape with leading partners

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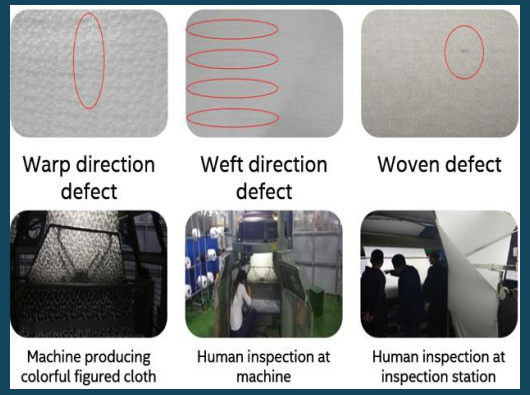
textile

Real time defect detection

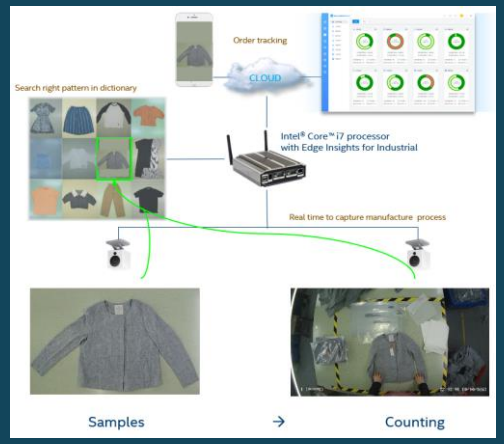


Target for pure color fabric inspection

- ❑ Total 80% defects can be detected
- ❑ Current accuracy result is over 97%

Garments

order tracking

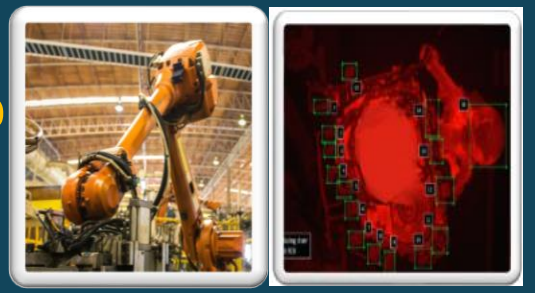


Order tracking in clothing factory

- ❑ Image Retrieval Top1 accuracy hits 90%
- ❑ Multi-cameras order tracking , counting and remote management
- ❑ Flexible hardware selection based on compute & power

Die Casting

Die-casting defect detection



High-precision computer vision algorithm for four kinds of defects. More deep learning algorithm on-going.

- ❑ 5x human labor efficiency improved
- ❑ ~100% detection rate

2
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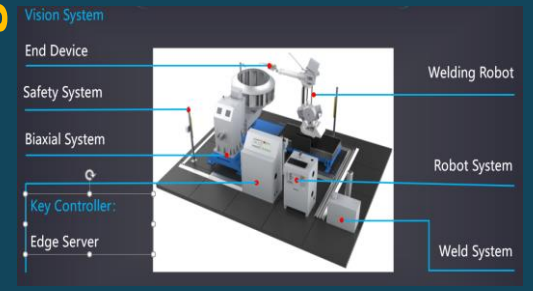
Robotic welding

intelligent welding system



Vision guided intelligent welding system to increase welding adaptability.

- ❑ Welding trajectory is guided by laser vision and a data feedback loop using Intel based edge server for image processing, data analysis and sending data to the cloud.
- ❑ Powerful IA CPU and OpenVINO toolkit enables processing of large workload and acceleration on the same platform.

Source: Intel estimated based on factory deployments and Lab test

Resources

INTEL OPENVINO TOOLKIT

Weld defect detection Model

https://docs.openvinotoolkit.org/latest/omz_models_intel_weld_porosity_detection_0001_description_weld_porosity_detection_0001.html

Pre trained models

https://docs.openvinotoolkit.org/2019_R1/_docs_Pre_Trained_Models.html

https://github.com/openvinotoolkit/open_model_zoo/blob/master/models/intel/index.md

INTEL INDUSTRIAL SOLUTIONS

Machine Vision

https://www.intel.com/content/www/us/en/manufacturing/machine-vision.html

Edge Insight for Industrial

https://www.intel.com/content/www/us/en/internet-of-things/industrial-iot/edge-insights-industrial.html

Edge Software Hub

https://www.intel.com/content/www/us/en/edge-computing/edge-software-hub.html