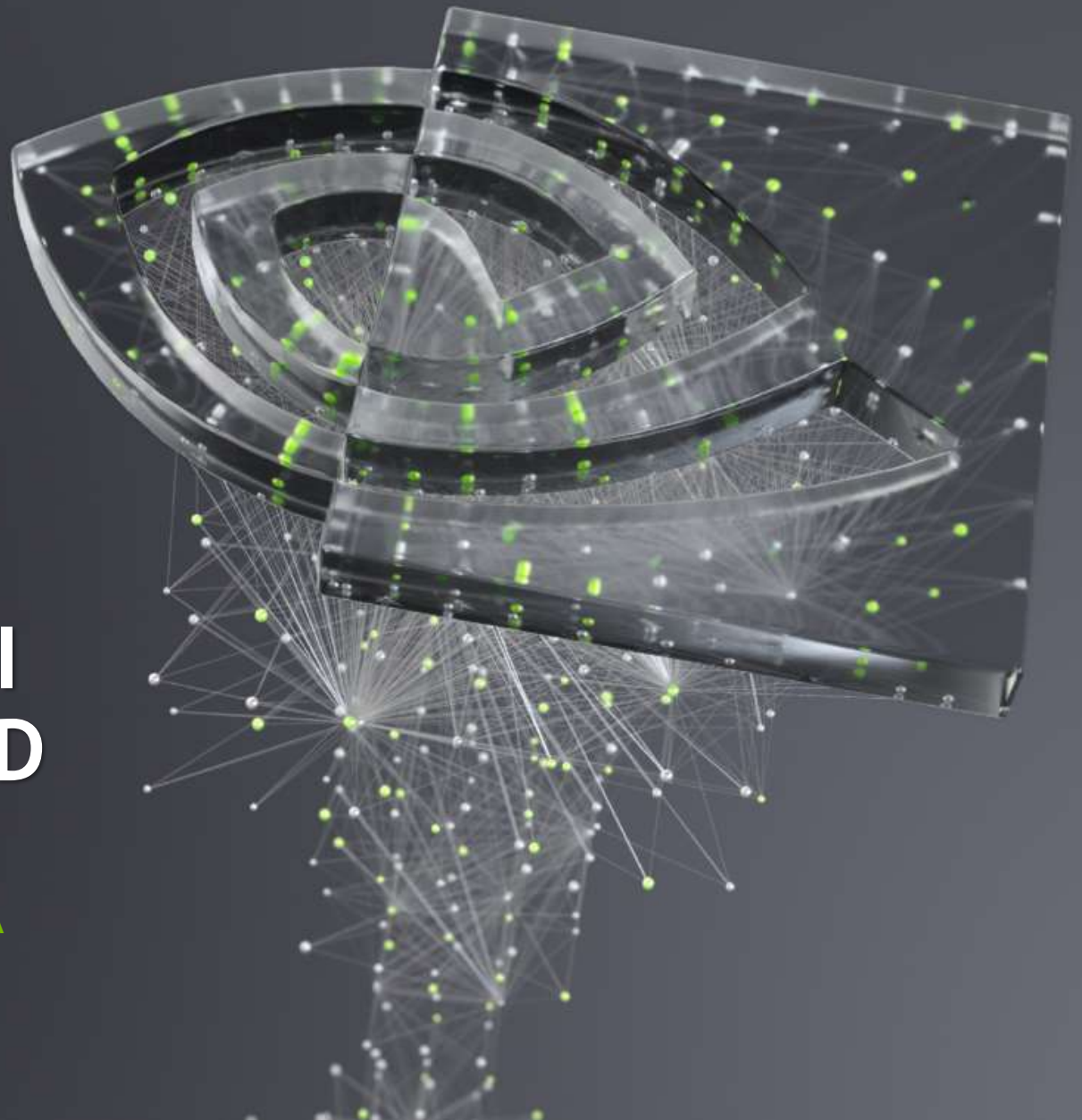
APPLICATIONS OF AI IN SMART CITIES AND INDUSTRY 4.0

Nicolas Walker, Senior Solutions Architect @ NVIDIA



INDUSTRY 4.0

MACRO TRENDS

Manufacturing & Industrial

	 Workforce	 Data Availability	 Quality	 Equipment Utilization	 Advanced Manufacturing	 Customization	 Supply Chain & Logistics
Trends	Aging Workforce Training Process automation	Proliferation of sensors	Rising customer expectations Distributed manufacturing scale	Condition-based asset management	Precision fabrication technologies Additive manufacturing	Smaller production lots Localized product requirements Growth of intl. markets	Complex dynamic international supplier networks Lean inventory Automated material handling
Impacts	Boost workforce productivity	Fuel for AI and data-driven models	Maximize return on capital Increase throughput Minimize scrap/rework	Maximize return on capital Maximize uptime	Differentiated product capabilities	Reduce time to market	Optimize scheduling & route planning Reduce lead time Minimize working capital

MANUFACTURING & INDUSTRIAL AI USE CASES

MANUFACTURING INSPECTION	PREDICTIVE MAINTENANCE	INTELLIGENT VIDEO ANALYTICS (IVA)	SUPPLY CHAIN & LOGISTICS	CONVERSATIONAL AI / NLP
				
Quality Inspection & Test	Monitoring and Diagnostics	Field Inspection	Supply/Demand Forecasting	Operational Process Automation
Yield and Throughput	Uptime	Health & Environmental Safety	Scheduling & Route Optimization	Work Scope Optimization

MANUFACTURING & INDUSTRIAL ECOSYSTEM

MANUFACTURING INSPECTION

COGNEX VIDI
SPYGLASS
MUSASHI
SMA SOFT
RUDOLPH TECHNOLOGIES
LANDING AI

PREDICTIVE MAINTENANCE

C3.ai
CONUNDRUM
sparkcognition
RS Reliability Solutions. The Art of Prediction
iguazio

INTELLIGENT VIDEO ANALYTICS (IVA)

Mobiliya
QUEST BORN TO ENGINEER
DATA MONSTERS
SFL SCIENTIFIC DISCOVER MORE

SUPPLY CHAIN & LOGISTICS

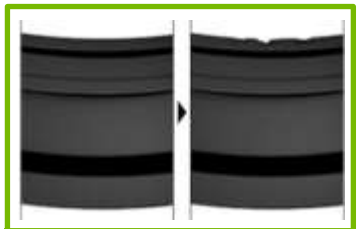
InstaDeep™
deepvu
E2OPEN
LOKAD Quantitative Supply Chain

CONVERSATIONAL AI / NLP

NUANCE
Microsoft

EXAMPLES: INSPECTION IN AUTOMOTIVE

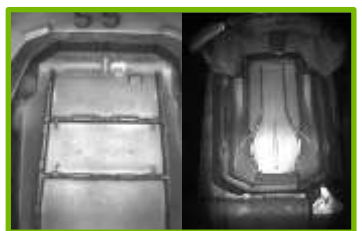
Sheet Metal Stamping



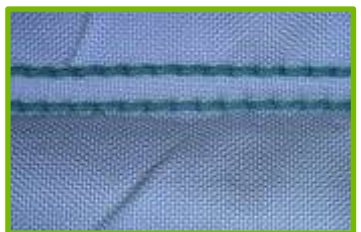
Cosmetic
Parts, Paint

Missing Components

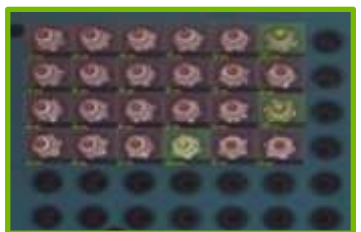
Optical Character
Recognition



Assembly Verification



Leather, Mesh, Textile



Kitting

Full Vehicle Final
Inspection

INDUSTRY 4.0 MANUFACTURING & LOGISTICS AT BMW

Customer Orders: “The Power of Choice”

100 options/car, over 40 BMW models

99% of orders are unique

2^{100} different possible configurations

Factory Logistics: “Raw Parts In, Parts Trays Out”

30M parts come in every day

1800 suppliers, to 31 factories in 14 countries

230K part numbers

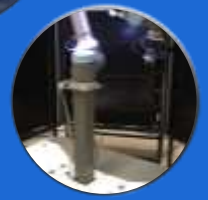
Manufacturing: “Just in Time, Just in Sequence”

One car every 56 seconds

One line can produce up to 10 different cars

Parts arrive at line in time, just in sequence

SplitBot



PickBot

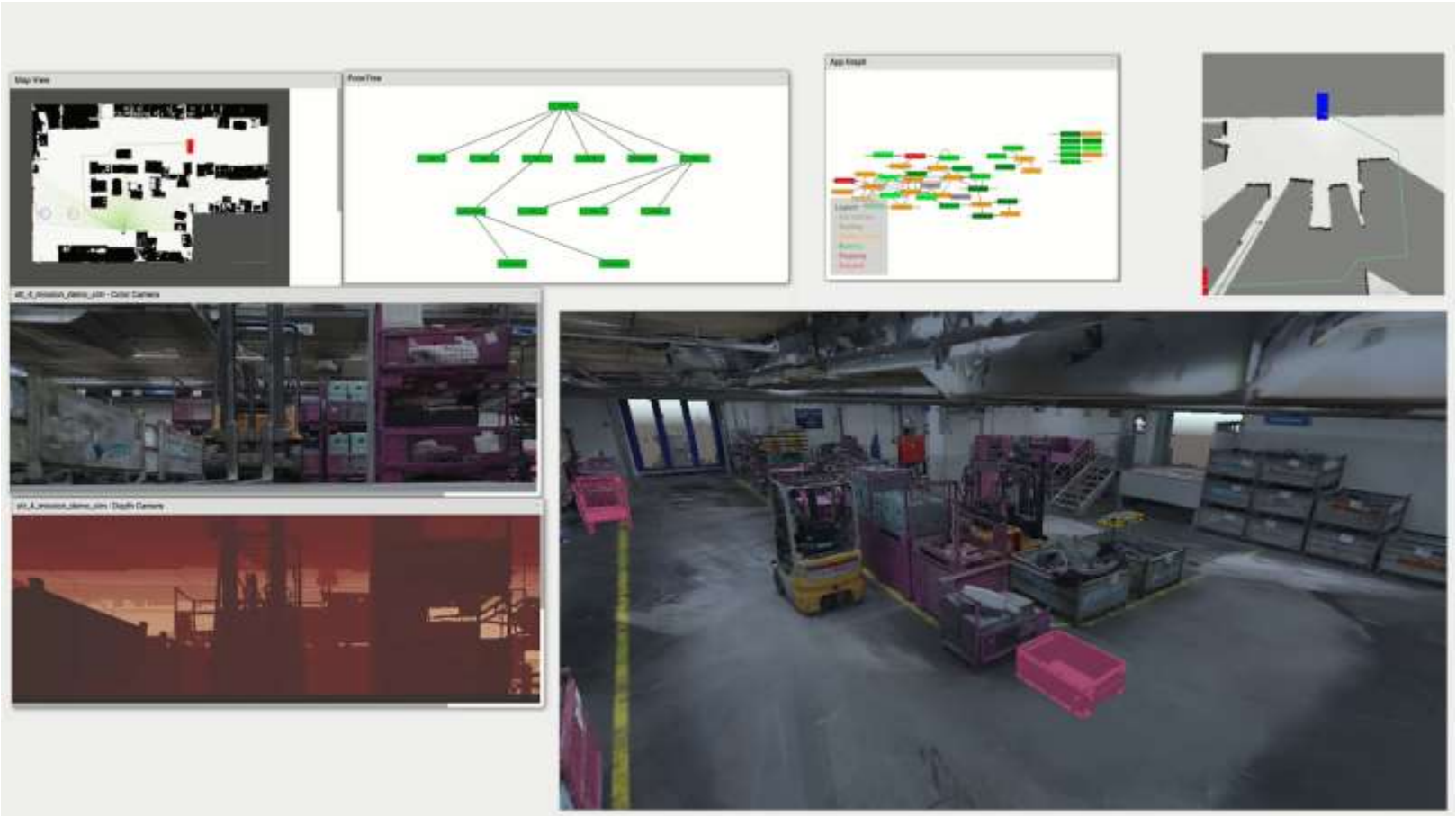
PlaceBot

Smart Transport Robot (STR)

SortBot

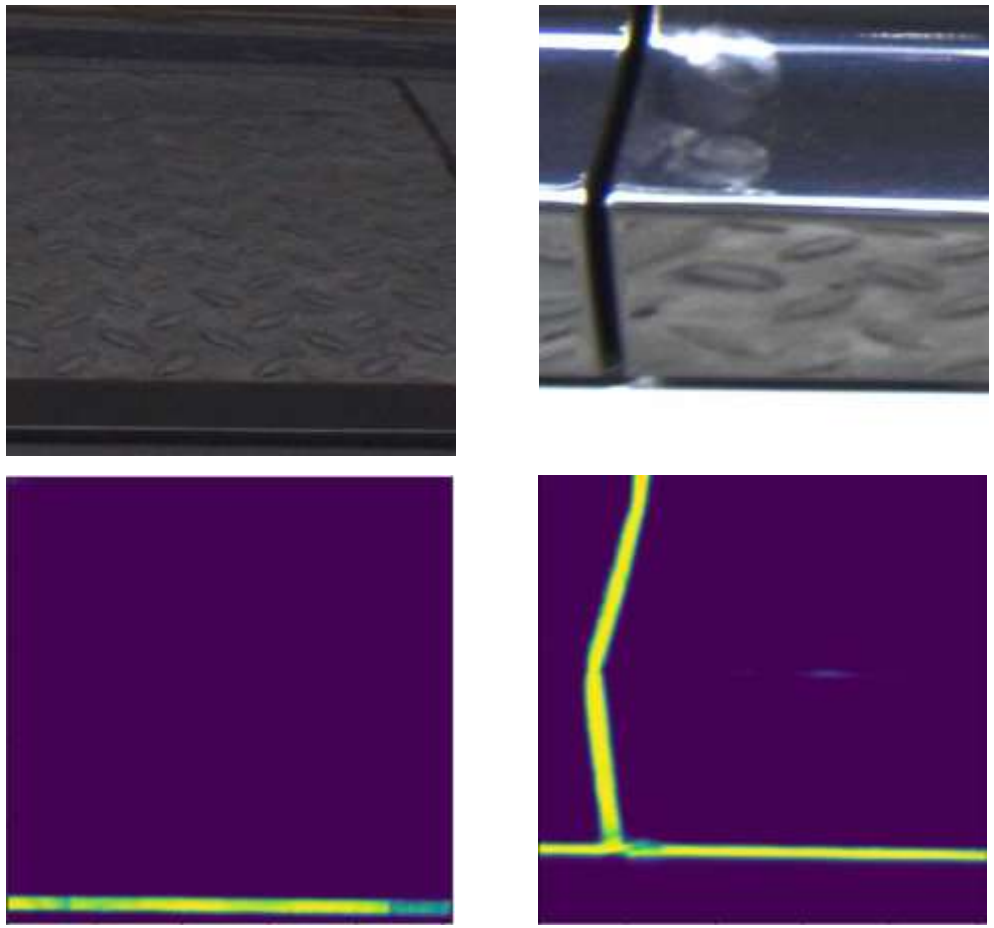
BMW SMART TRANSPORT ROBOT (STR) AND ISAAC PLATFORM

Leveraging NVIDIA's Technology for Ultimate Industrial Autonomous Transport Robot



EXAMPLE: REFLECTION ARTIFACTS

Gap Detection & Measurement



COMPLEX TEDIOUS INSPECTION MADE EASY

Converting complex, manual, repetitive and stressful inspection tasks creates a better work environment while delivering quick, accurate and reliable results. Optical inspection is 20% of the manufacturing workflow and 30% of the manufacturing costs.

A automotive gear supplier is deploying AI-powered optical inspection systems with NVIDIA TX2 and trained with NVIDIA DGX to **deliver 99% accurate inspection of 1mm defects on gears and 0.5mm defects on welding.**

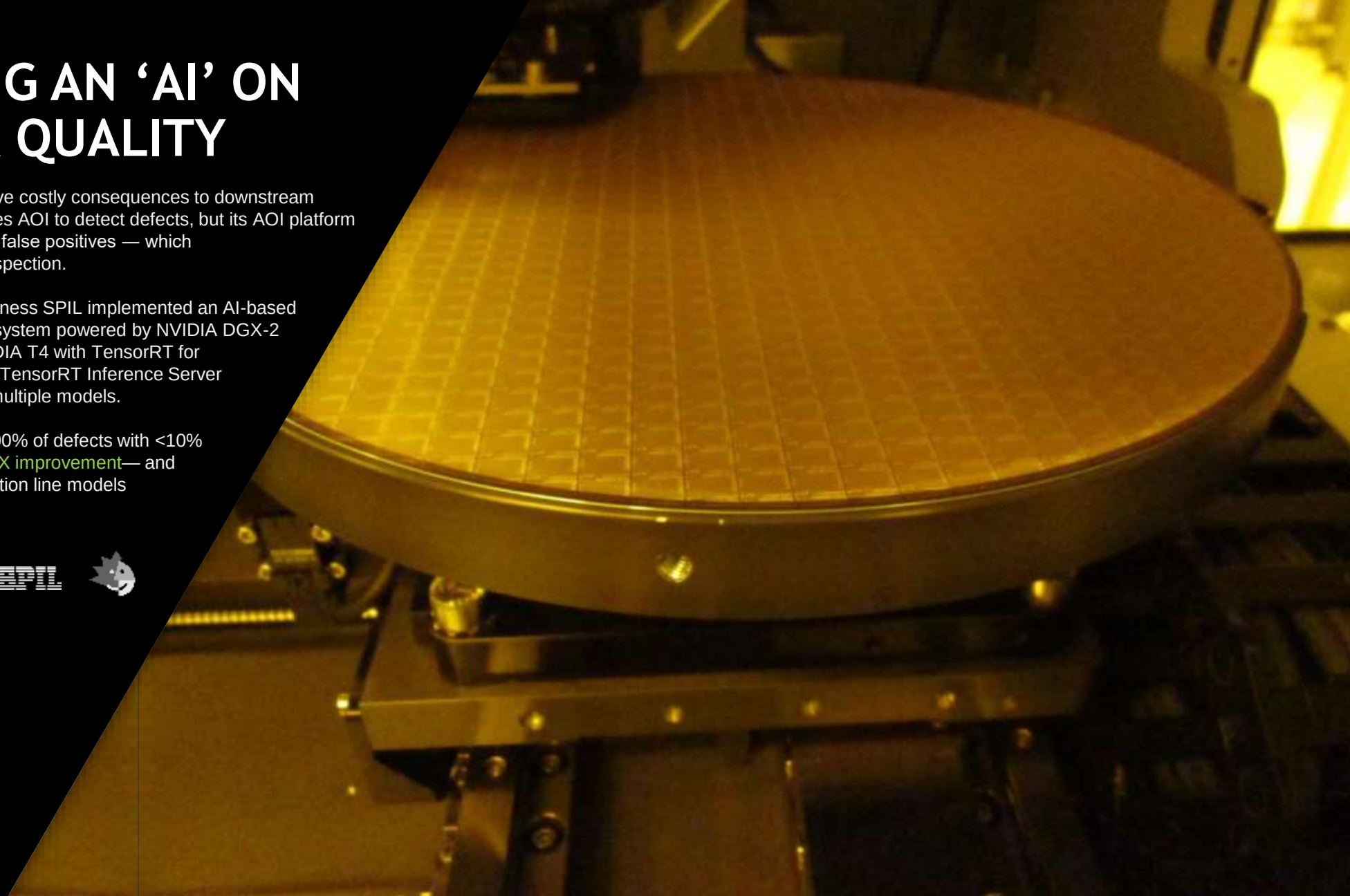
NVIDIA.

KEEPING AN ‘AI’ ON WAFER QUALITY

Defective wafers have costly consequences to downstream production. SPIL uses AOI to detect defects, but its AOI platform produces up to 70% false positives — which then require a 2nd inspection.

To improve effectiveness SPIL implemented an AI-based 2nd level inspection system powered by NVIDIA DGX-2 for training and NVIDIA T4 with TensorRT for inferencing. NVIDIA TensorRT Inference Server is used to manage multiple models.

SPIL now detects 100% of defects with <10% false positives —a 7X improvement— and easily scales production line models from 10 to 100.



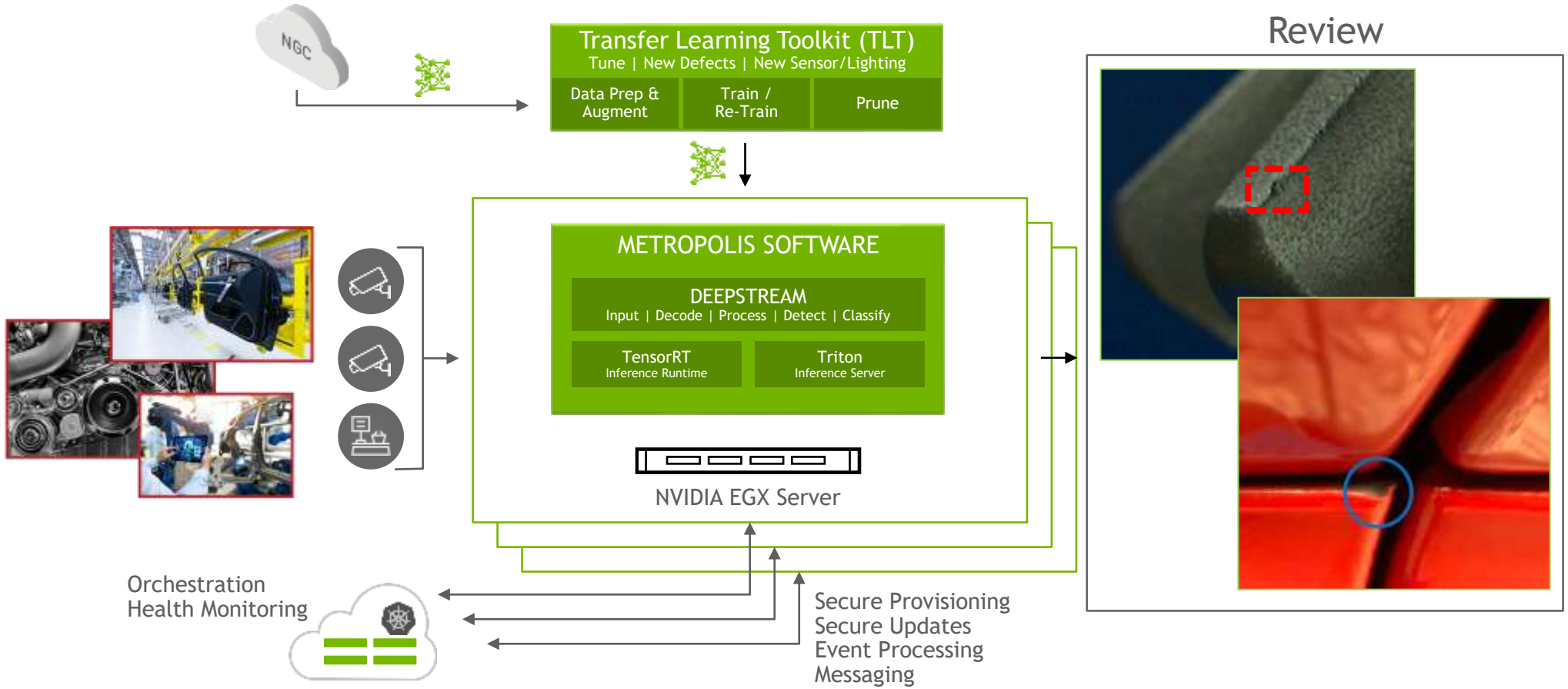
PREDICTING IMPURITY IN IRON-ORE MANUFACTURING

- **Objective**: Predicting impurities in ore based on manufacturing parameters and input materials
- **Data:** Sensor data pertaining to airflow, input amounts, pH levels, densities, and other snapshots of the manufacturing process over time
- **Approach**: Used time series Darwin to successfully build predictions on the data
- **Results**: Successfully identified 90% of impure batches solely based on manufacturing data
- **Impact:** Save process engineers from repeatedly performing a 1-hour lab measurement during manufacturing process

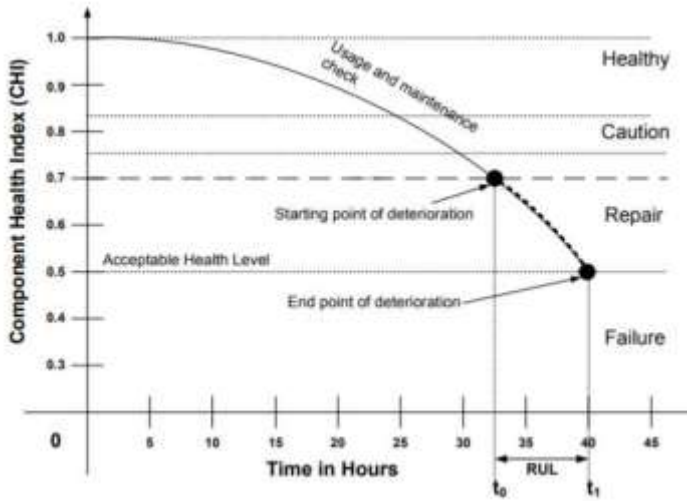
Transformed a common lab process from taking an hour to seconds with GPUs

END-TO-END INDUSTRIAL INSPECTION

EGX: Secure Deployment



PREDICTIVE MAINTENANCE WORKLOADS



Anomaly Detection & Classification
Timely Detection of Rare Events to Avoid Downtime

Usage Based Lifing
Estimating Remaining Useful Life of parts, systems or processes

Work Scope Optimization
Prescribing Workplan to Minimize Downtime and Asset Optimization

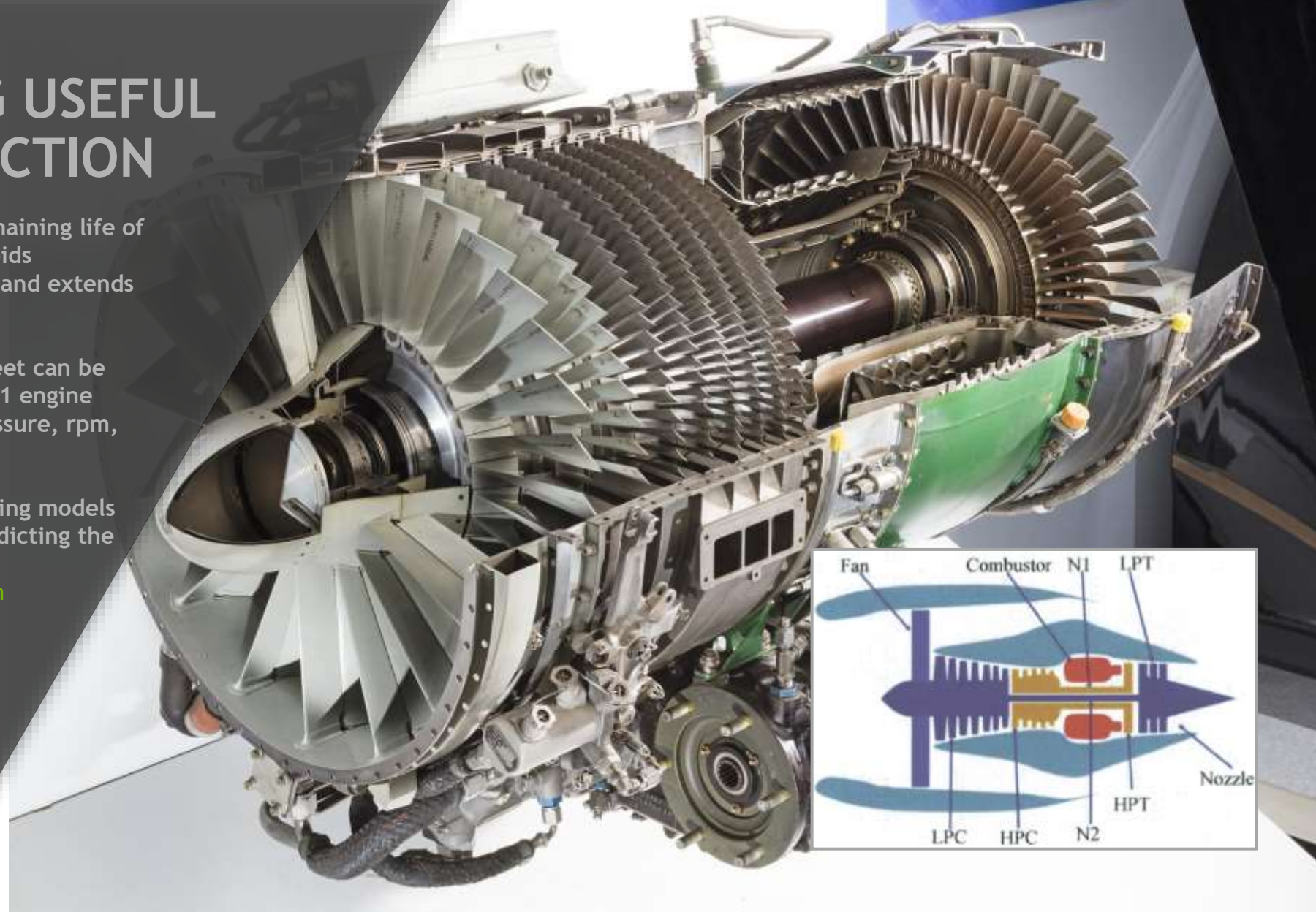
Digital Twin

REMAINING USEFUL LIFE PREDICTION

Reliably predicting the remaining life of mechanical equipment avoids unscheduled maintenance and extends equipment utility.

The health of an engine fleet can be modeled using data from 21 engine sensors (temperature, pressure, rpm, etc.).

State of the art deep learning models are proving capable of predicting the remaining useful life with 35-49% better accuracy than traditional methods.



CONUNDRUM

NVIDIA.

NASA engine dataset: Turbofan Engine Degradation Simulation Data Set https://ti.arc.nasa.gov/tech/dash/groups/pcoe/prognostic-data-repository/

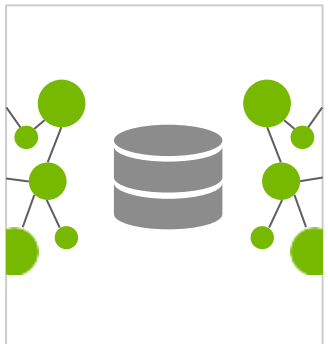
SMARTER INSPECTION SERVICES

In business, ensuring equipment uptime and meeting safety and regulatory compliance is non-negotiable. Using deep neural networks developed on NVIDIA DGX-1 in the data center that can easily extend to NVIDIA DGX Station in the field, Avitas Systems delivers inspection services using robotic-based autonomous inspection and advanced data analytics. In addition to safeguarding workers, Avitas Systems AI solutions can reduce inspection costs by 25% and reduce maintenance downtime by 15%.

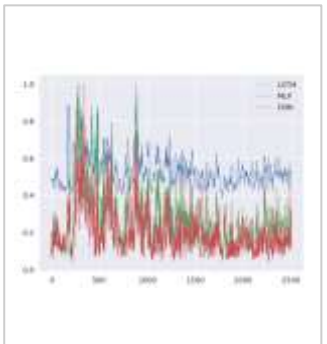
The robots can handle the heat and use infrared cameras and chemical and other sensing technologies to inspect assets under dangerous conditions and keep production running. Image credit: Avitas Systems

NVIDIA PLATFORM FOR PREDICTIVE MAINTENANCE

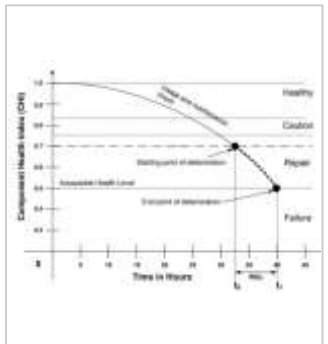
Data Management



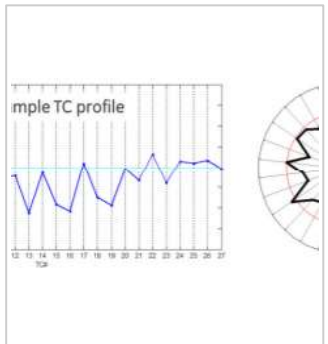
Anomaly Detection



Predicting Failures



Time Series Search



Work scope Opt.

Digital Twin

Partner AI Platform

C3.ai · CONUNDRUM · sparkcognition™ · iguazio · Reliability Solutions. The Art of Prediction

Edge Inference SDKs

On-Premise / Cloud Training SDKs

Inference GPUs



Jetson

T4

Training GPUs

Tesla

DGX

Data Center

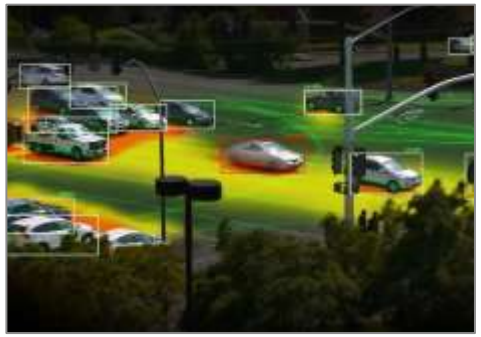
aws · Azure · Google Cloud

Cloud

SMART CITIES

AI REVOLUTION

Measuring Utilization of Space is More Critical Than Ever


Traffic Management


Retail


Factories


Public Safety & Health


Warehouse & Logistics

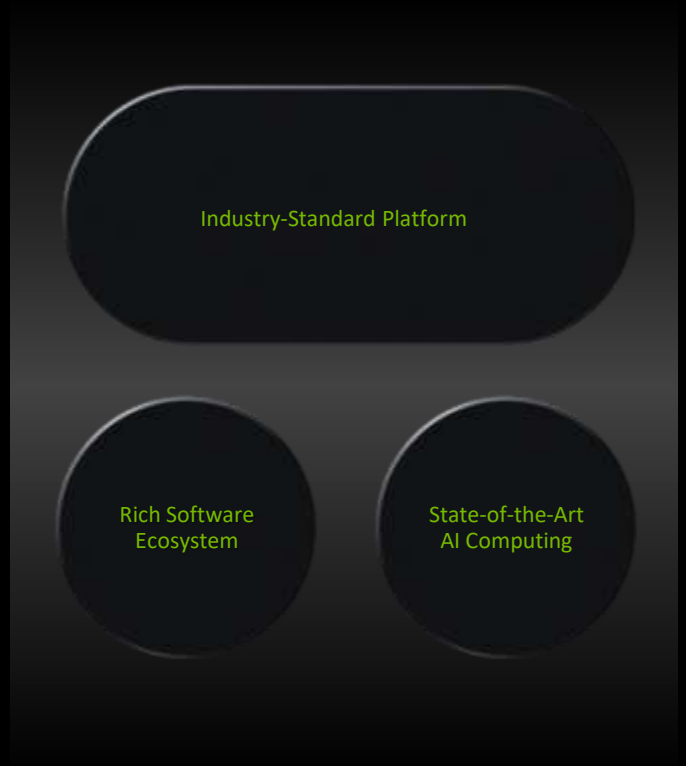

Stadiums & Casinos

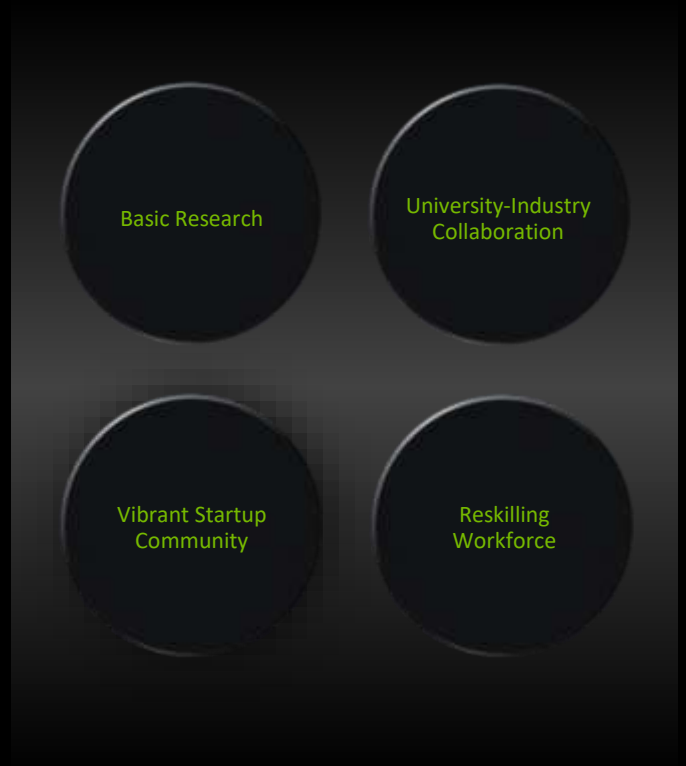

Access Control


Transportation Hubs

$2T INDUSTRY – Increase operational efficiency and safety across many industries using AI

PILLARS OF NATIONAL AI INITIATIVES





AI CENTERS OF EXCELLENCE

Starting the AI economy requires knowledge and skills, which require computing infrastructure, which can be afforded only if there is demand. Government can kick-start this virtuous cycle by providing access to large-scale AI computing infrastructure to its universities, startups, and industry.

SKILLING AND RESKILLING

AI will accelerate job growth, but harnessing it requires specific skills and expertise. Countries need to invest in training and education programs that add AI skills to their workforce.

INDUSTRY SOLUTIONS

By investing in key industries, countries have a unique opportunity to drive growth and solve their greatest social and economic challenges.

NVIDIA PARTNERSHIP FRAMEWORK FOR AI NATIONS

TECHNOLOGY & ECOSYSTEM

NVIDIA's AI computing hardware and software are the most advanced in the world. And our GPUs are offered by every computer maker and are in every cloud.

EXPERTISE & INVESTMENT

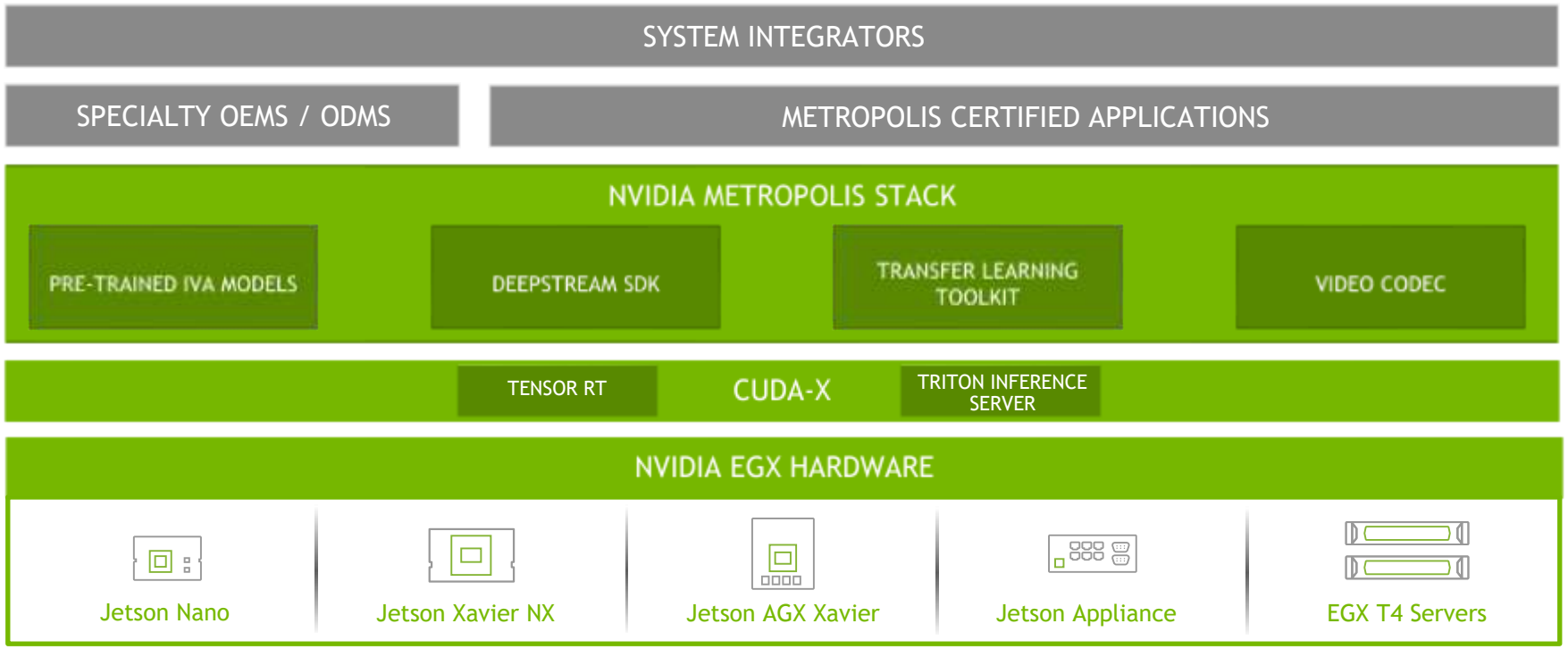
NVIDIA boasts some of the best minds in AI research. Our NVIDIA AI Lab (NVAIL) education program fosters AI in universities. Our Inception program fuels AI startups. Our Deep Learning Institute (DLI) trains individuals for the jobs that AI is creating.

INDUSTRY SOLUTION PLATFORMS

Our four industry platforms combine our technologies and ecosystems to help governments advance society's foundational industries.

NVIDIA METROPOLIS

AI Application Framework for Smart Sensors



COVID-19 RISK MITIGATION APP PACK

IntelliSite — Human-based Temp Detection

- Turnkey Solution
- Managed Service
- AI & GPU powered
- Personalized Portals

https://www.intellisite.io/solution/human-based-monitoring-hbm/

STADIUM, AIRPORT, CAMPUS APP PACK

1 Mitigate Risk at Entrance

Elevated Body Temp, Mask Detect

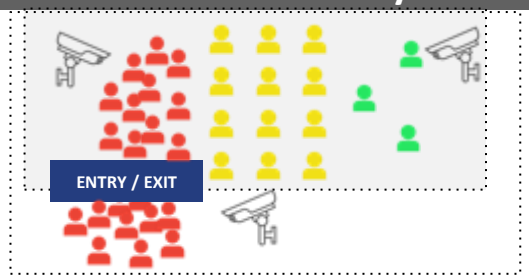
2 Better Customer Experience

Dwell times, Line Length

3 Maintain Secured Areas

Identity Validation & Monitoring

4 Customer Safety



Occupancy, Social Distancing

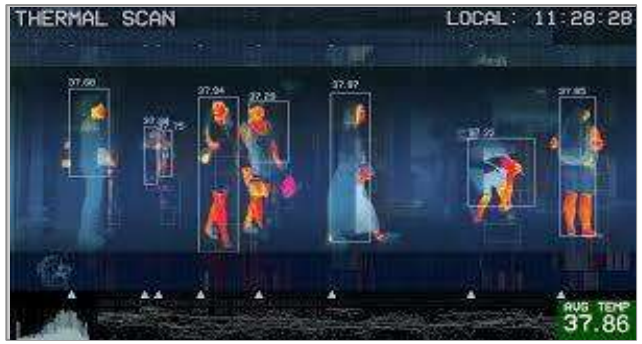
5 Customer Safety

Risk Behavior, Fights, Crowd Forming

6 Customer Safety

Weapon Detection, Abandoned Object

HOSPITAL APP PACK - CLARA GUARDIAN



Body Temperature Screening

Patient Monitoring

Surgery Analytics

Safe Social Distancing

Fall Prevention

Contactless Controls

RETAIL APP PACK

SAFETY, PPE, CROWDING

CONTACT TRACING

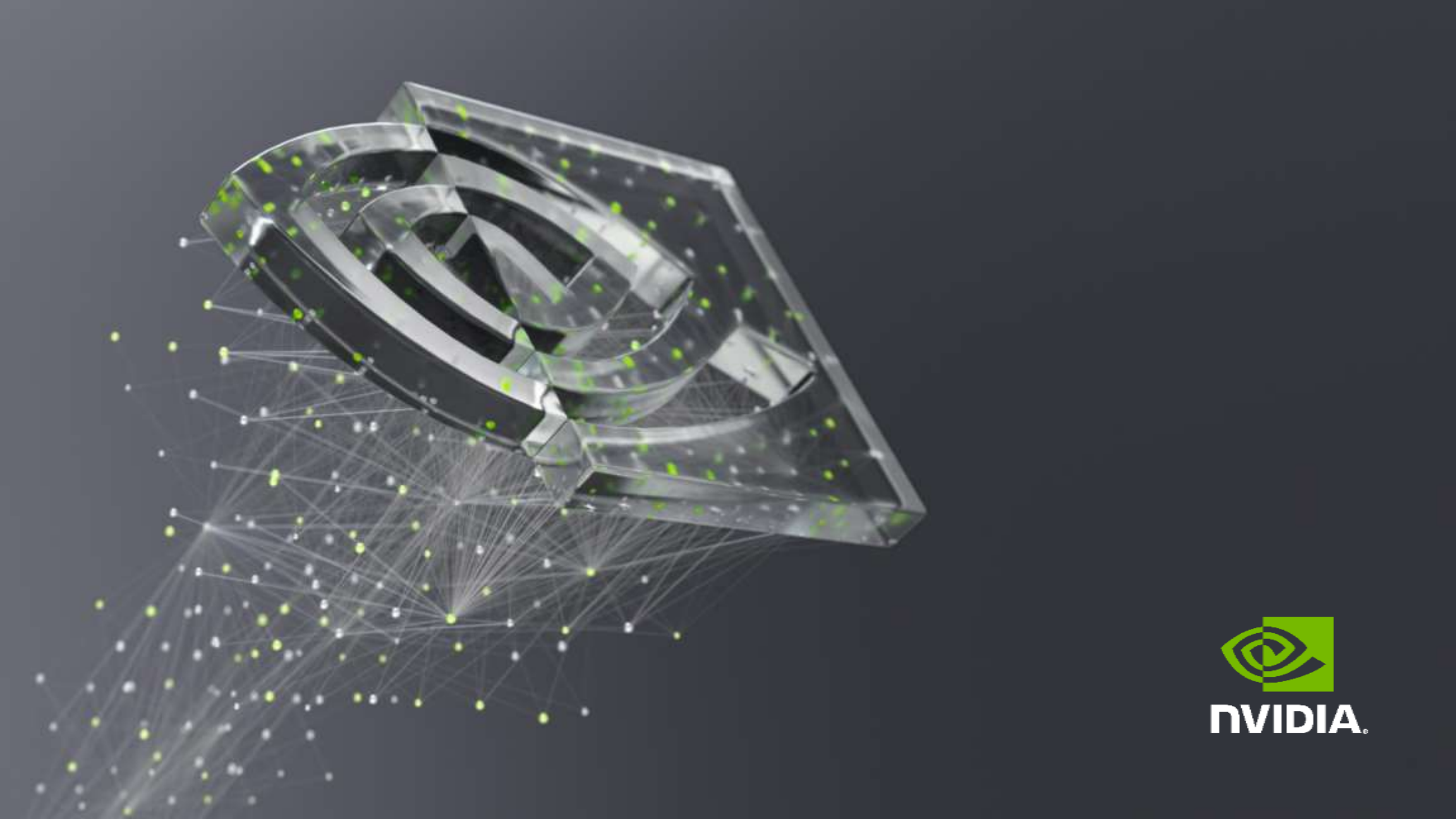
ASSET PROTECTION

STORE ANALYTICS

AUTONOMOUS SHOPPING

STOCK OUT & PLACEMENT

Q & A


NVIDIA

ADDITIONAL RESOURCES

Visit the NPN Partner Portal for additional trainings and content such as:

Metropolis Customer Stories

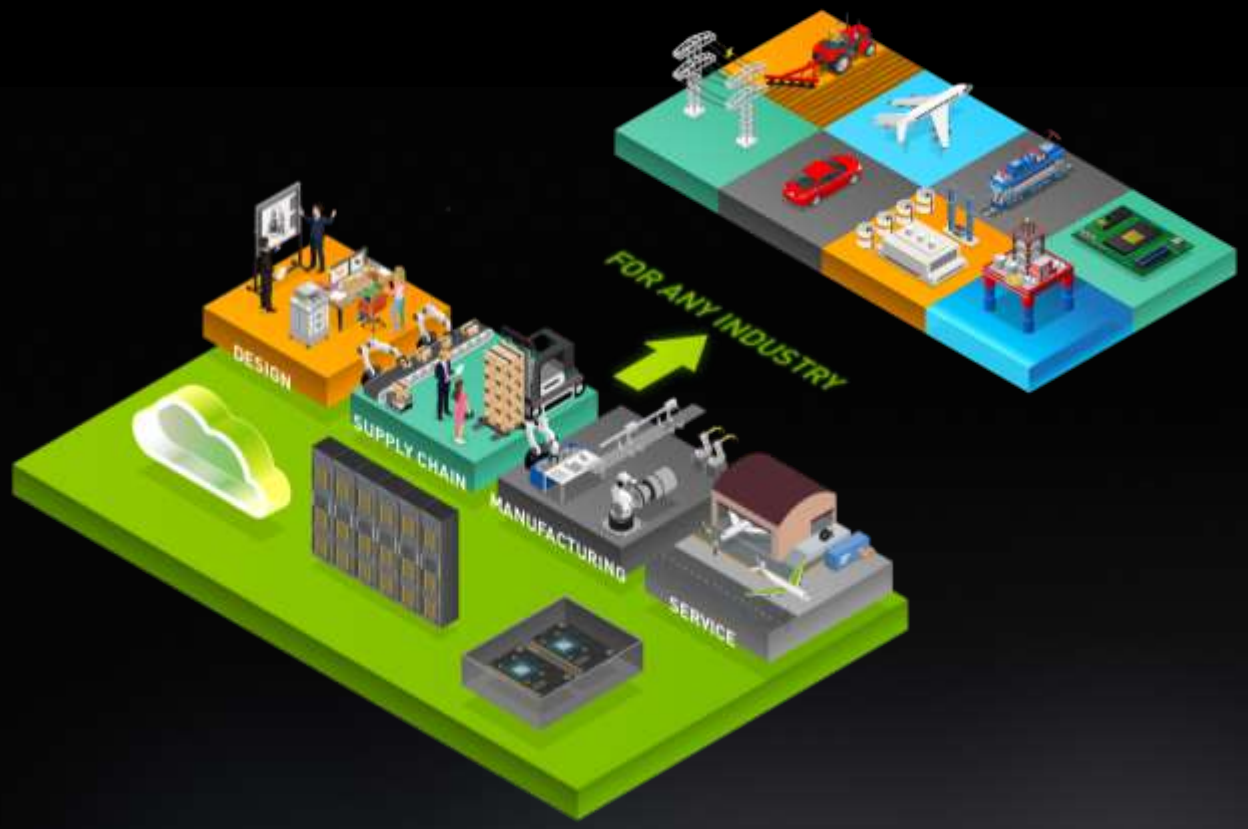
Link to NPN Portal | Internal NVIDIA Link

Metropolis ISV Ecosystem

Link to NPN Portal | Internal NVIDIA Link

BACKUP

ONE PLATFORM ACROSS INDUSTRIAL USE CASES



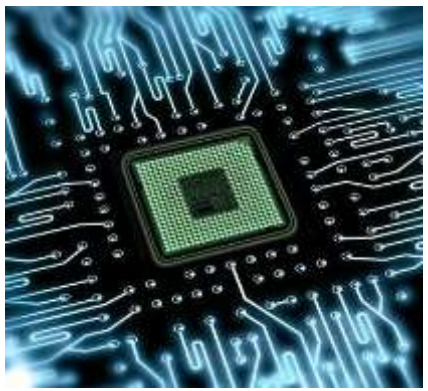
DESIGN
HPC
Modeling & Simulation
Design for Manufacturability

SUPPLY CHAIN
Forecasting & Inventory Management
Supply Chain Optimization
Robotics & Automation

MANUFACTURE
Robotics & Automation
Inspection
Predictive Maintenance
Process Control

SERVICE
Predictive Maintenance
Field Inspection
Logistics Optimization
Parts Inventory Management

MANUFACTURING INSPECTION BUSINESS VALUE



Semiconductor

1% in incremental yield adds $60 M in annual profit

Electronics

64% reduction in test escape, resulting in 1.5%+ yield increase through better capacity utilization

Component

Doubled throughout from 20-30 seconds to less than 9 seconds for defects as small as 50 µm

Assembly & Cosmetic

Each line averages 1 test escape per day. Reducing defect escapes, saves $50,000 per line per day

OPTIMIZING QUALITY INSPECTIONS WITH AI

Due to the increasingly sophisticated design of its cars and the high-quality standards at Audi, the company inspects all components —doors, engine hoods, fenders, etc.— in its press shop.

In addition to visual inspection by Audi employees, several small deep learning-based cameras trained on NVIDIA GPUs installed directly in the presses detect the finest cracks in sheet metal with the utmost precision in a matter of seconds.

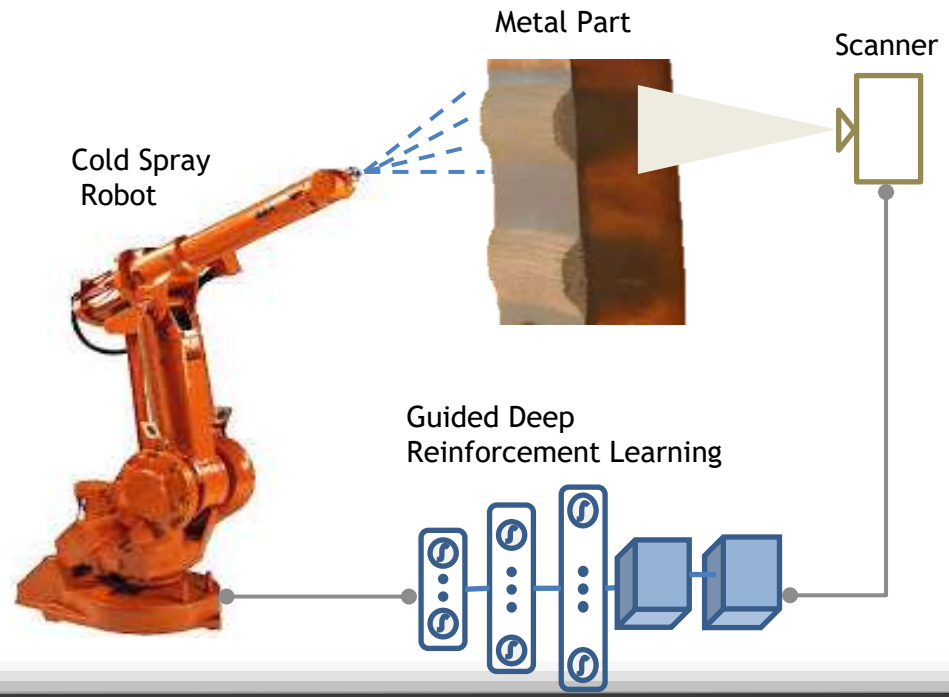
NVIDIA

INTELLIGENT MATERIALS DESIGN

The discovery of new materials is crucial to many industries but developing new materials either experimentally or computationally can take many years.

Researchers at Samsung are using GPU-powered deep learning to perform inverse design — using AI to propose new materials with the necessary properties for the development of blue phosphorescent OLED. With this approach Samsung can design new materials 52x faster than traditional methods and deliver results in only one month.

NVIDIA. SAMSUNG SAMSUNG ADVANCED INSTITUTE OF TECHNOLOGY



AI IMPROVES ADDITIVE MANUFACTURING

Additive Manufacturing (AM) — a method of building 3D objects by adding material — is versatile and minimizes waste.

Scientists at United Technologies Research Center (UTRC) are exploring AI-optimized cold spray AM applications, such as repairing cracks in equipment. Using the NVIDIA DGX-1 they've trained a neural network to automate the repair process end-to-end.

Cracks vary in size and shape, but UTRC's machine understands images and scanned data, and then determines the optimal velocity, movement, and nozzle angle needed to complete the task with precision. The AI-enabled automation could save hours of operator time, save a significant amount of metal scrap, and prolong equipment life.

NVIDIA

MACRO TRENDS

Manufacturing & Industrial

	 Workforce	 Data Availability	 Quality	 Equipment Utilization	 Advanced Manufacturing	 Customization	 Supply Chain & Logistics
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BOOSTING QUALITY CONTROL

Delivering impeccable quality is a great opportunity for high precision manufacturers to differentiate but raises the bar for accurate detection of the smallest micron-scale product defects.

Foxconn Interconnect Technology Group (FIT) is deploying AI-powered inspection systems with NVIDIA HGX-1, Tesla V100/P4, and Jetson TX2, and has improved its CPU socket defect detection escape rate from 4.3% to 0.015% - 287x

MANUFACTURING & INDUSTRIAL AI USE CASES

MANUFACTURING INSPECTION	PREDICTIVE MAINTENANCE	INTELLIGENT VIDEO ANALYTICS (IVA)	SUPPLY CHAIN & LOGISTICS	CONVERSATIONAL AI / NLP
				
Quality Inspection & Test	Monitoring and Diagnostics	Field Inspection	Supply/Demand Forecasting	Operational Process Automation
Yield and Throughput	Uptime	Health & Environmental Safety	Scheduling & Route Optimization	Work Scope Optimization

MANUFACTURING & INDUSTRIAL PLATFORM

MANUFACTURING INSPECTION

PREDICTIVE MAINTENANCE

INTELLIGENT VIDEO ANALYTICS (IVA)

SUPPLY CHAIN & LOGISTICS

CONVERSATIONAL AI / NLP

Partner AI Platform

EDGE INFERENCE SDKS

Inference GPUs (EGX)

Jetson

Tesla T4

ON-PREMISE / CLOUD TRAINING SDKS

Training GPUs

Tesla

DGX

Data Center

aws
Azure
Google Cloud
Cloud

OEM Partners

DELL
Hewlett Packard Enterprise
SUPERMICRO
Atos
Lenovo
ADLINK
ADVANTECH

METROPOLIS CERTIFIED APPLICATIONS

Partner	Elevated Body Temp	Face Recognition	Privacy Compliance	Anomaly Detection	People Analytics	Asset Monitoring & Loss Prevention	Search, Synopsis & Heat Maps	Weapon Detection
Anyvision	◉	◉			◉	◉	◉	
Aotu		◉			◉			
Brighter AI			◉				◉	
Deepvision	◉	◉			◉			
Graymatics		◉						
IronYun					◉	◉	◉	
Nodeflux		◉			◉		◉	
Ntech Lab		◉			◉	◉	◉	
Patriot One								◉
Qluevision								
SAFR		◉		◉	◉			
Uncanny Vision		◉			◉	◉		
Vedax					◉			
Veesion				◉		◉		
Videonetics				◉			◉	

RETURN TO PUBLIC SPACES - APP PACK

ISVs	SAFETY & PPE				CROWD MANAGEMENT			CUSTOMER EXPERIENCE			SECURITY & SAFETY			
Link to GTM Resources	Body Temp Screen	Face Mask Monitor	Contact tracing	Touchless Secure Access Control	Detecting Crowding & Alerting in Real-Time	Social Distancing Detection & Alerting	Occupancy of Spaces	Queue length	Attendee Heatmaps	VIP recognition	Weapon detection	Abnormal activity alerts (fights, crowds)	Video search & Synopsis	Person of Interest (face recognition)
SAFR	✓	✓	✓	✓	✓		✓		✓	✓		✓		✓
Deep North	✓	✓		✓	✓	✓	✓	✓	✓					
IntelliSite DeepVision	✓			✓				✓						✓
Ipsotek			✓	✓	✓	✓	✓	✓	✓			✓		
SmartCow		✓		✓	✓	✓	✓		✓					
RCE Systems					✓	✓	✓	✓	✓					
Alcatraz.AI				✓										
AnyVision	✓	✓	✓	✓	✓	✓	✓			✓			✓	✓
Ntech Lab				✓						✓			✓	✓
PatriotOne	✓										✓			

METROPOLIS ECOSYSTEM

SYSTEM INTEGRATORS & VALUE-ADD RESELLERS

Johnson Controls, Convergint Technologies, Securitas, Honeywell, Prosegur, Certis, Atos, Velasea, Pivot3, BCDVideo

GLOBAL SOLUTION INTEGRATORS

accenture, Deloitte, World Wide Technology, quantiphi, Quest, SFL Scientific

ISV / AI STARTUPS

anyVision, SAFR, DeepVision, NTech Lab, IronYun, nodeflux, Veesion, PatriotOne, Videonetics, BrighterAI

VMS – VIDEO MANAGEMENT SOFTWARE

milestone, Genetec, Qognify, avigilon, networkoptix

OEMS

Cisco, Motorola, avigilon, verizon, Hanwha Techwin, March Networks, miovision, Panasonic, SmartCow, alcatraz ai, MOD.CAM, netradyne, samsara

SYSTEM BUILDERS

DELL EMC, Hewlett Packard Enterprise, Cisco, inspur, Atos, Supermicro, ADVANTECH, ADLINK, AVerMedia

NVIDIA METROPOLIS STACK

NVIDIA EGX HARDWARE

AUTONOMOUS SHOPPING BY FRANCE'S LARGEST SUPERMARKET

French supermarket giant Carrefour is an early adopter of technology that sets it apart and boosts sales

Deployed checkout-free experiences at its grocery stores based on Nano Stores from AiFi

Carrefour can test promotions and new products in real time with AiFi's analytics on sales, inventory, and customer behavior

Customers enjoy a frictionless experience with the benefits of in-store and online shopping in one

NVIDIA Carrefour

AI TURNS SATELLITE IMAGES INTO VALUABLE INSIGHT

Satellite imagery has many uses including disaster recovery, crop yield prediction, urban planning, and national defense. Satrec Initiative Analytics (SIA) applies GPU-powered AI to turn satellite images into valuable data for its customers.

With the NVIDIA DGX Station to improve speed and efficiencies, object classification on a 30k*30k pixel image, which used to take 40 minutes, is completed in only 3 minutes.

NVIDIA SI ANALYTICS

CONTROLLING AIR TRAFFIC WITH AI

From autopilot systems to customer service to predicting weather, AI is transforming aviation. With Aimee, a GPU-powered framework for AI solutions from Searidge Technologies, Air Traffic Control no longer needs a direct sightline. Aimee analyzes video feeds from hundreds of cameras, enabling ATC to look past occlusions and “see” every runway, taxiway, tarmac, and gate without looking away from their workstations.

NVIDIA

SEARIDGE TECHNOLOGIES

AI TAKES A BITE OUT OF FOOD WASTE

Approximately one-third of all food harvested or produced goes to waste. The hospitality sector alone discards nearly $100B worth of food each year.

Winnow empowers commercial kitchens to reduce food waste. Winnow uses real-time deep learning and inference at the edge powered by the NVIDIA Jetson TX2 to automatically detect, identify, and measure food at the point it's thrown away—helping commercial kitchens save more than $30M in annualized food costs to date.

NVIDIA METROPOLIS

For System Integrators, Operations, IT teams

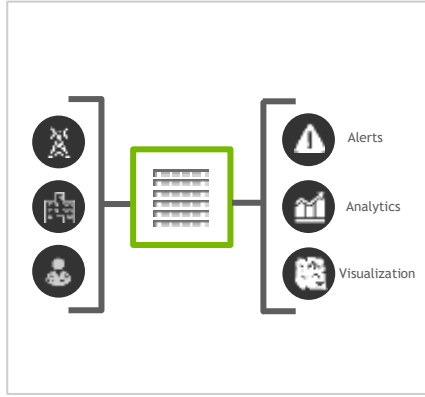
Real-time Insights

Maximum application performance by running AI at the edge

Applications

Broad range of trusted applications qualified on standard HW with consistent & scalable performance

Easy Deployment



Docker containers, Helm charts, and EGX enables managing fleets of devices and dashboarding from a centralized remote location

Service Delivery Partners

Custom Video analytics and data science engineering services

www.Metropolis.nvidia.com

VISUAL AI IN HEALTHCARE

Improving safety, care and efficiency with cloud and edge AI.

With increasing workloads and health risks, now amplified by Covid-19, how do providers leverage the promise of artificial intelligence to improve overall outcomes?

In partnership with NVIDIA, the flexible Chooch AI Platform provides high accuracy results with response times as little as 0.2 seconds. Chooch AI can now quickly deploy powerful models on NVIDIA Jetson Nano, Xavier and T4 GPUs integrated with the Clara Guardian Ecosystem.

The result is reduced risk in a wide range of healthcare scenarios. From ensuring that all hands are scrubbed and all gauzes are removed, to detecting coughs, absence of masks or fever in public spaces, Chooch AI and NVIDIA improve outcomes for everyone's health.

CHOOCH NVIDIA