Build Smarter, Safer and Efficient Autonomous Robots and Mobile Machines

Manisha Agrawal, Product Marketing
Texas Instruments

Agenda

- Introduction
- Key challenges
- Key care-abouts
  - Sensing
  - System design and performance
  - Functional safety
- Development

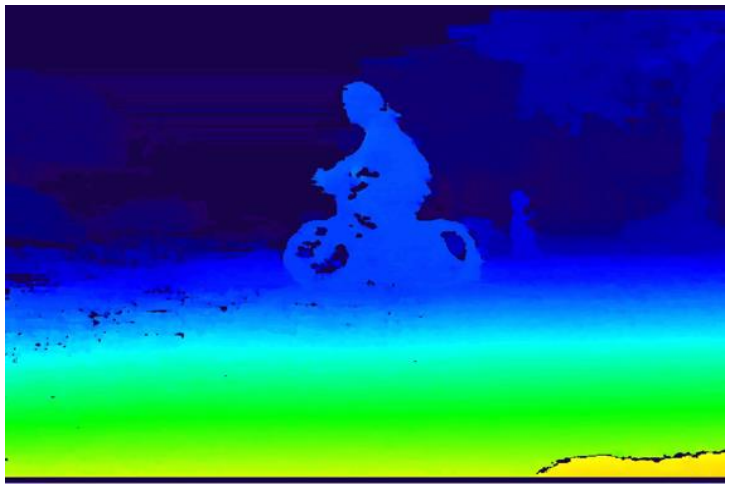
Introduction | Smarter, more efficient, safer

Autonomous mobile robots

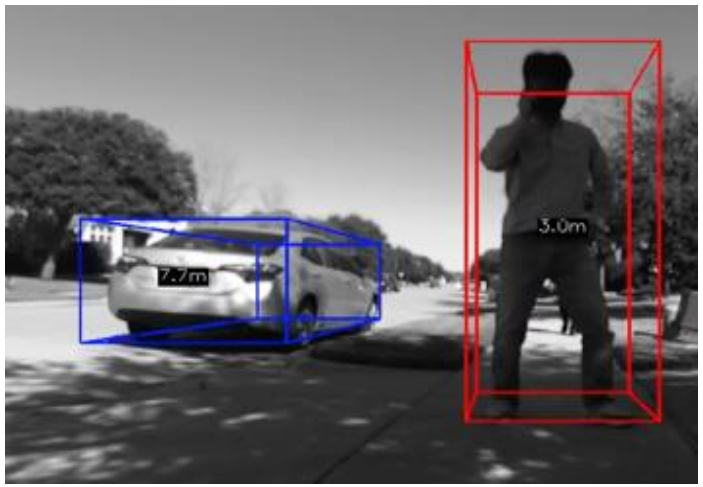
Autonomous delivery robots

Construction, excavation, agriculture

Introduction | Technology enablers



3D perception



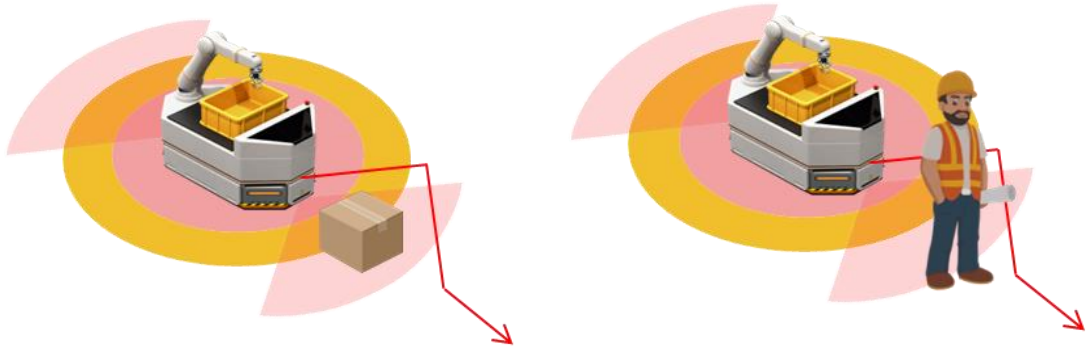
Artificial intelligence

Functional safety

Key Challenges

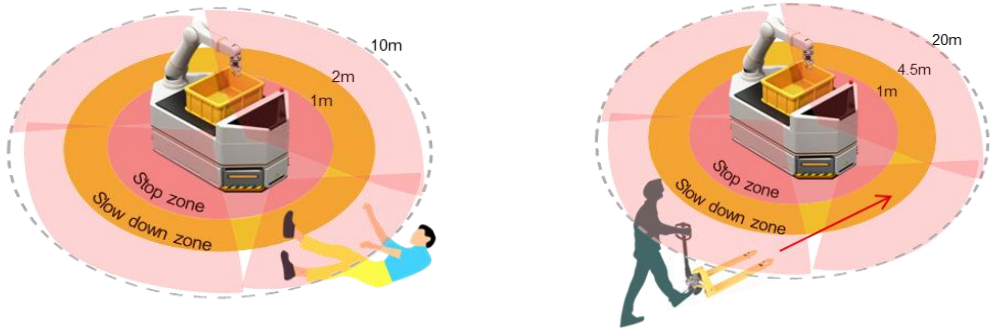
Key challenges | Safe operation

Collision Avoidance



- Detect humans and obstacles
- Navigate around them

Human Presence Detection



- Stop when people are in the safety bubble
- Resume when people are out of the safety bubble

Key challenges | Accurate & affordable sensing

Radar

Pros:

- Cheaper
- Works in all weather

Cons:

- Poor angular resolution

Lidar



Pros:

- Better precision and accuracy

Cons:

- Costly, consumes more power
- Poor results in bad weather
- 2D Lidar has poor resolution

Vision

Pros:

- Cheapest and best resolution
- Classify objects & scenes well

Cons:

- Computationally intensive
- Requires good light sources

Key challenges | System design and complexity

System challenges

- High-performance / low-latency processing at low-power
- Small form-factor, ruggedized design
- Cost-optimized design

Application challenges

- Programming of hardware accelerators
- AI development
- Functional safety software

Key care abouts

Key care-abouts | Sensing with mmWave radar

TI mmWave	Robotics Benefits
3D presence detection	• True 3D information (range, velocity and angle) of objects vs. LIDAR/ToF used mainly for distance measurement • Quickly detect and prevent possible collisions minimizing machine downtimes
Up to IEC 61508 SIL-2 compliant	• Helps enable human presence detection that has traditionally been solved by expensive safety certified LiDAR sensors
Accurate glass detection	• Improve reliable detection of glass walls/doors over existing sensors that "see" through them
Wide azimuth area coverage	• Create 360-degree detection zones around the robot to prevent collisions with humans to minimize injury and reduce machine downtimes
Robust in challenging environments	• Increase reliability over existing vision/LiDAR based sensors in conditions such as rain, dust, smoke, complete darkness or in the glare of sunlight

Complement or displace established sensor solutions with up to SIL-2 certified TI mmWave sensors

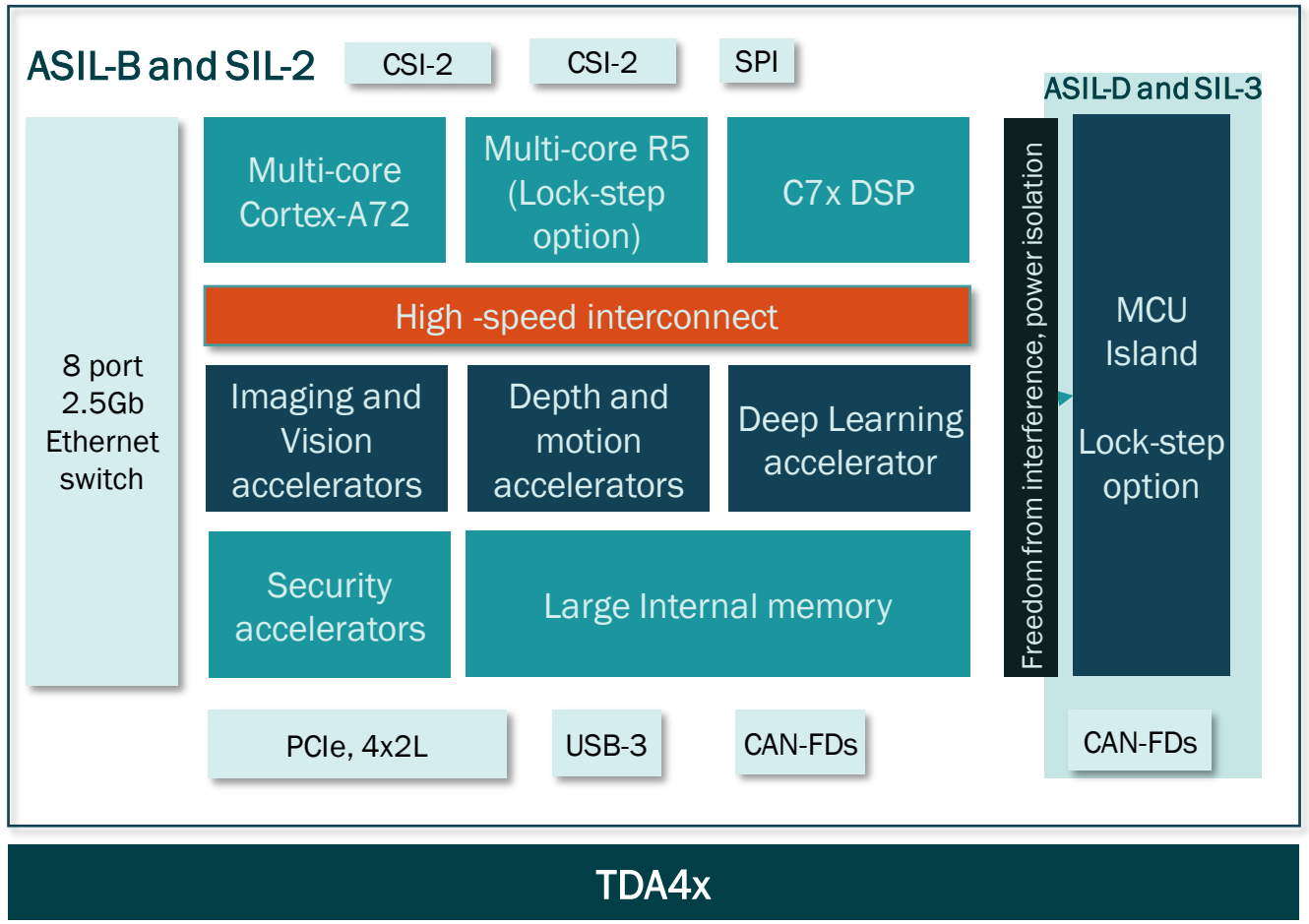
Key care-abouts | System design with TDA4x

Enhanced Safety
- Hardware and software solutions enabling up to SIL-3 and ASIL-D designs

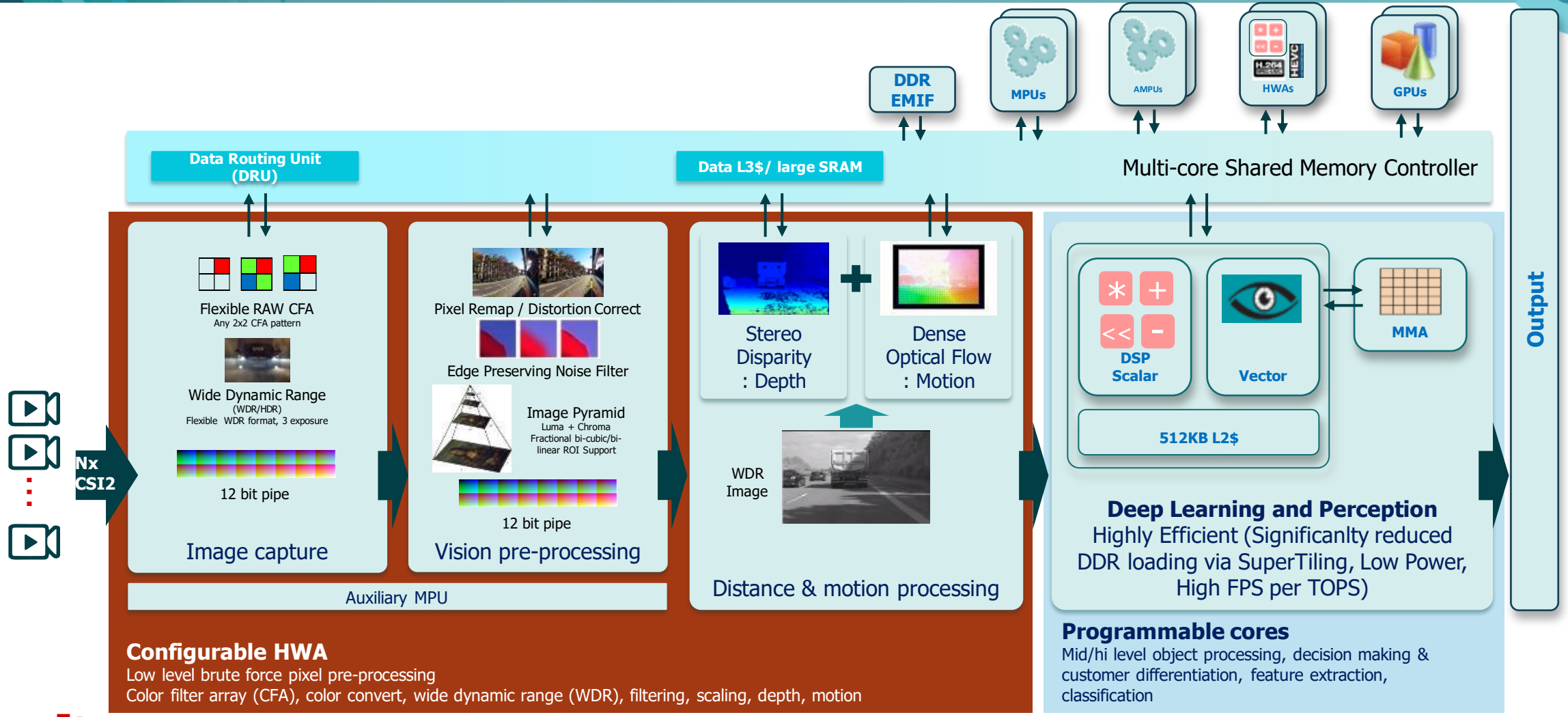
Energy efficient AI & sensor fusion
- Computer vision, deep learning accelerators & DSP cores delivering_industry-leading performance at low power

Affordable design
- High levels of integration in a single chip reduces system complexity and cost.

Faster development
- Open-source software, tools, SOM and eco-system enable faster-time-to-market



Key care-abouts | System performance with TDA4x



Key care-abouts | Functional safety with TDA4x

Architecture

- Independently certified safety development process for ISO26262 and IEC 61508
  - ASIL-D/SIL-3 systematic capability
- Built-in hardware diagnostics
- Peripherals and architectures designed for end system safety capabilities

Software

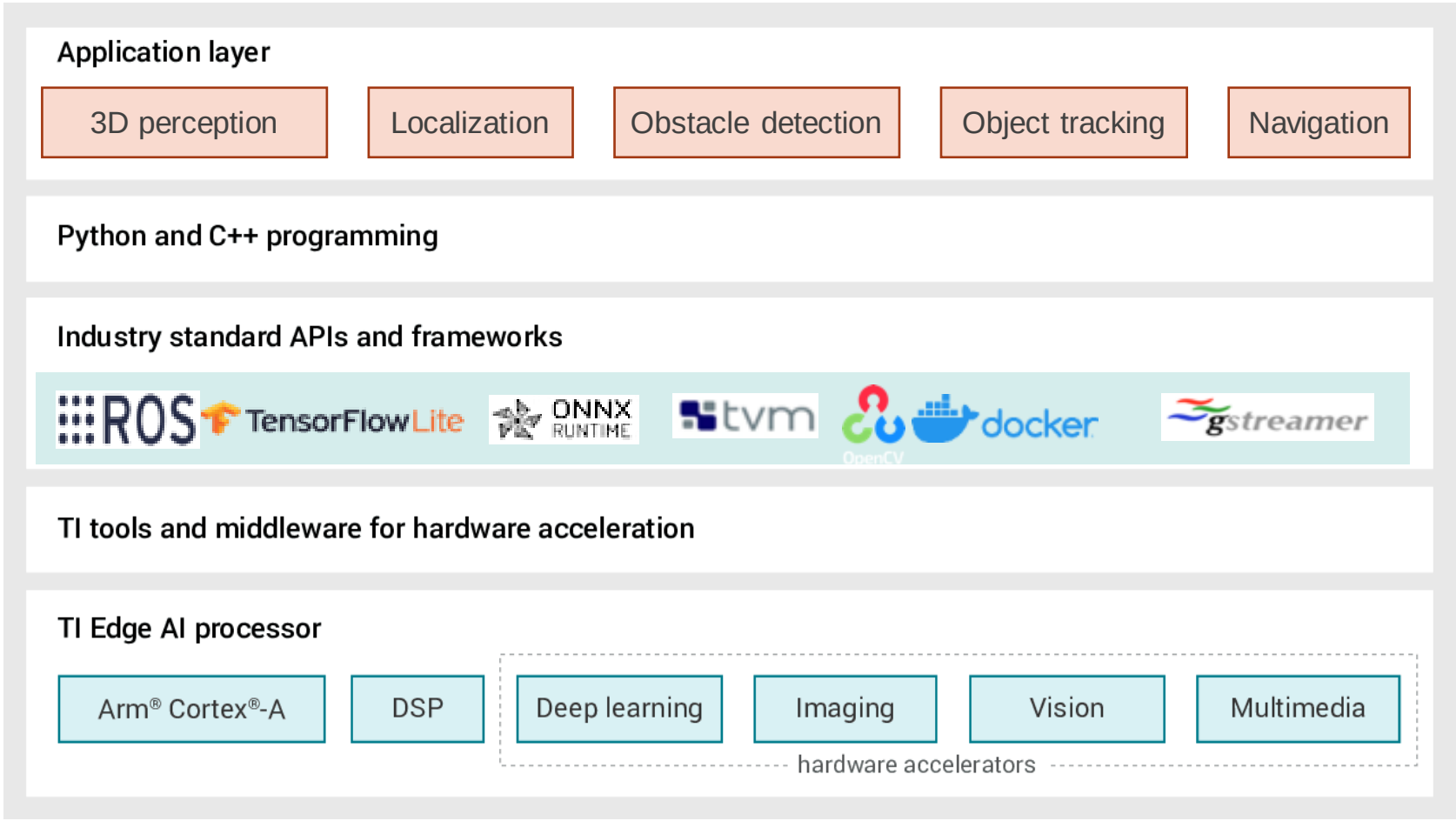
- Scalable across products
- TUV certified safety software process
- Safety diagnostic library
- Safety diagnostics reference and examples
- Self test libraries
- SW FMEDAs, code coverage, traceability reports
- Compliance support packages
- Compiler qualification kit
- FreeRTOS to SafeRTOS
- AutoSar and MCAL support

Collateral

- Device safety manual
- Configurable FMEDA
- Safety analysis report
- Safety assessment certificate
- Trainings
- White papers and application notes
- Safety-enabled demos

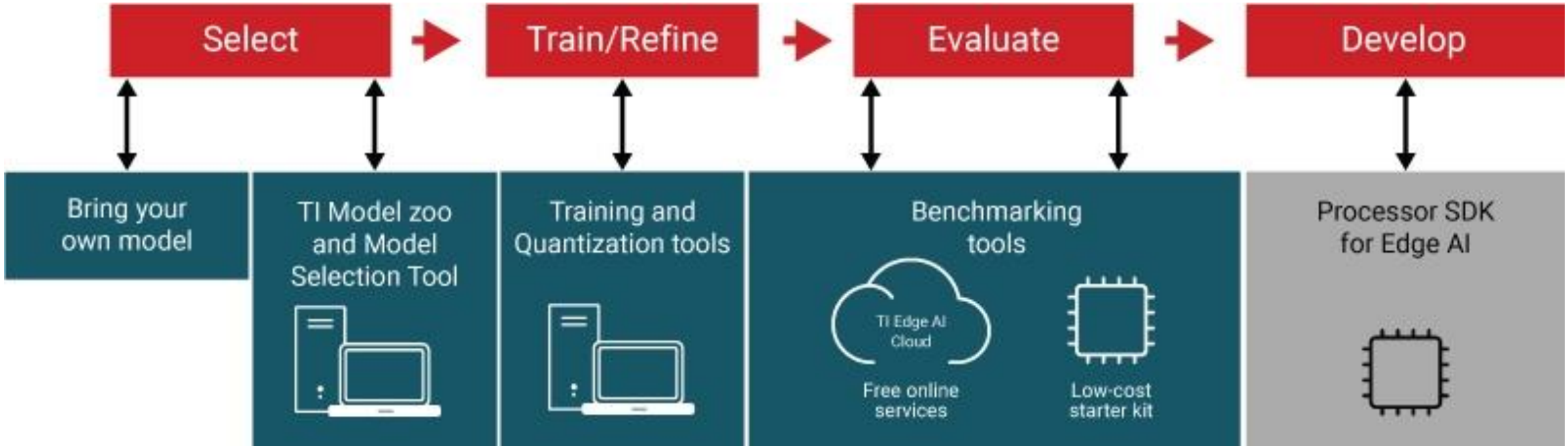
Development

Easy development with industry standard frameworks



Full software from TI makes applications development much easier!

TI Edge AI | Extensive tools from TI for faster DL model development and deployment



Free end-to-end TI proprietary tools for faster AI model development and deployment

TI Edge-AI cloud | Free on-line service for deep-learning model selection, deployment and benchmarking

Welcome to TI Edge AI Cloud

You are now connected to a **Jacinto™ TDA4VM processor** evaluation module.

Find your model

Learn performance statistics

Compare model performance

Find the model that best meet your performance and accuracy goals on TI Processor from TI Model Zoo. Learn current performance statistics of models such as FPS, Latency, Accuracy & DDR bandwidth.

Model selection tool

Get model benchmarks

The following Notebooks let you access benchmarks for pre-compiled and custom models

Model performance

Using a pre-compiled model from TI Model Zoo, this example notebook lets you run inference on a TI Edge AI processor to get **latency, FPS, DDR bandwidth and power benchmarks**

Select task:

- (•) Classification
- ( ) Detection
- ( ) Segmentation

Select runtime engine:

- (•) TensorFlow lite
- ( ) ONNX runtime
- ( ) TVM

Open notebook

Model accuracy

Using a pre-compiled model from TI Model Zoo, this example notebook lets you run inference on a TI Edge AI processor to get **accuracy benchmarks**.

Open notebook

Custom models

This notebook lets you compile your own model and run inference on a TI Edge AI processor to get **latency, FPS, DDR bandwidth, power and accuracy benchmarks**.

Select runtime engine:

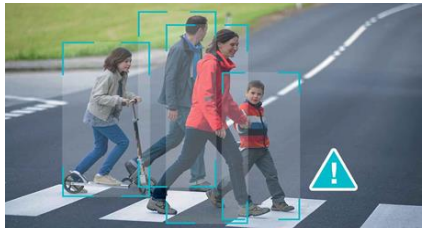
- (•) TensorFlow lite
- ( ) ONNX runtime
- ( ) TVM

Open notebook

Faster deployment with out-of-box demos and production ready components

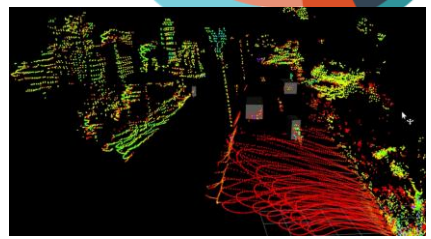
3D perception and navigation

- ROS, ROS2 based, hardware and DSP accelerated demos
- Production ready GStreamer plugins, OpenVX and ROS nodes for offloading to hardware
- Functional safety complaint low-level drivers
- Community eco-system

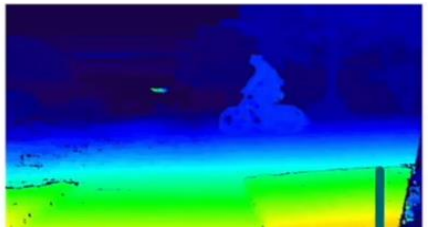


2D Object detection

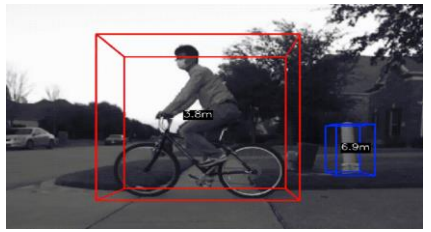
Semantic segmentation



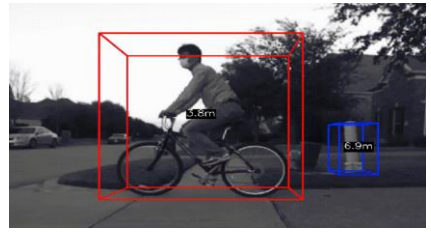
3D Point Cloud



Stereo depth estimation

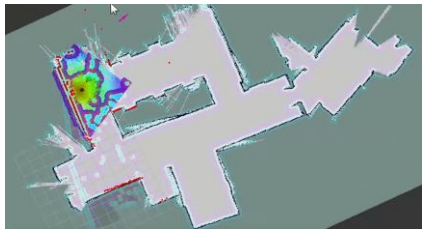


3D obstacle detection

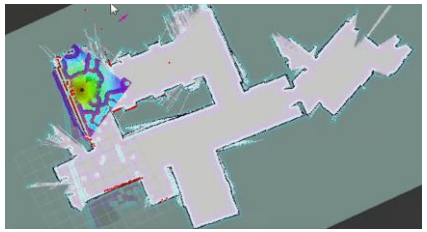


Pose estimation

AI-based localization

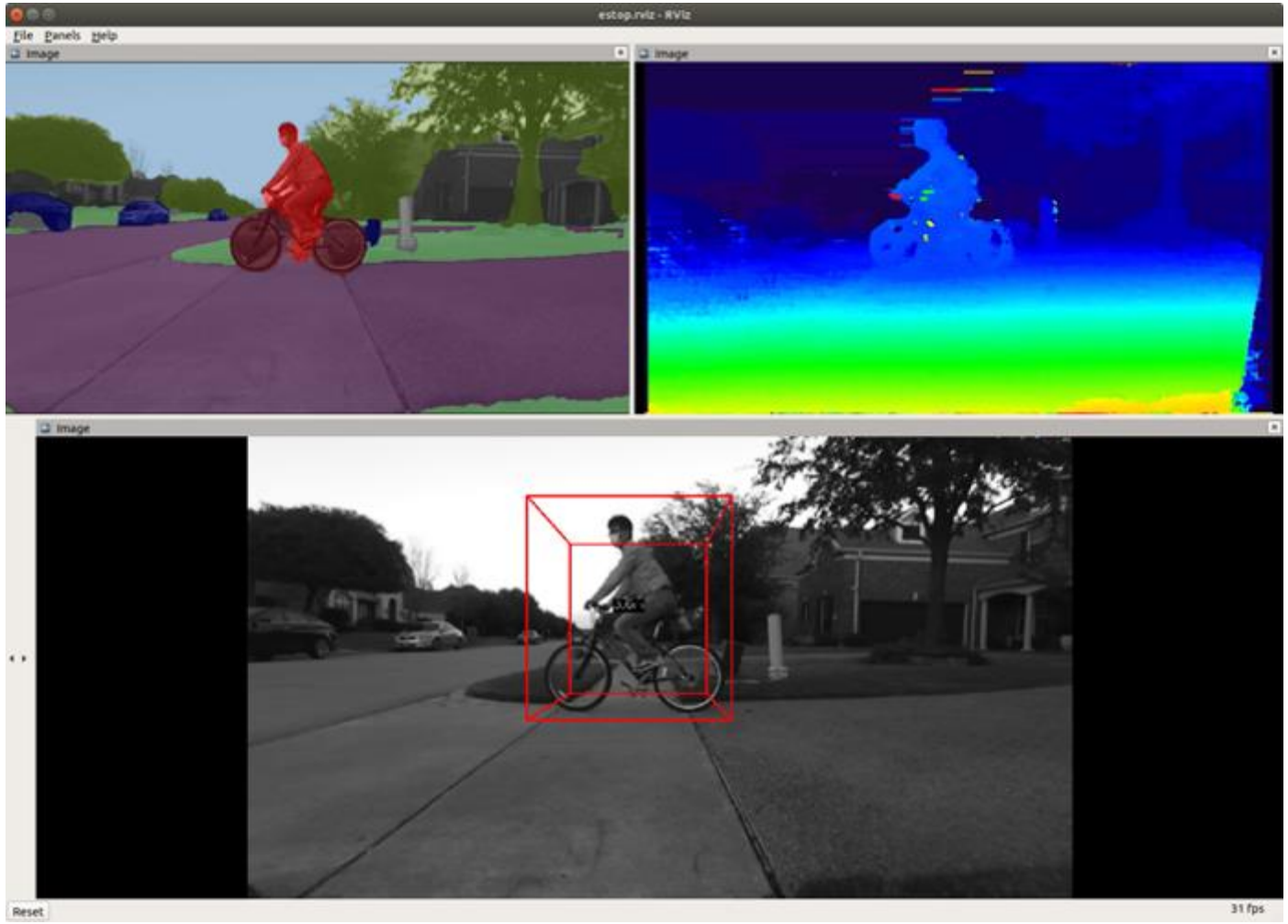


ORB SLAM



Autonomous navigation

Autonomous navigation and collision avoidance video



https://training.ti.com/functionally-safe-autonomous-navigation-and-collision-avoidance-demo-using-tda4x-processors

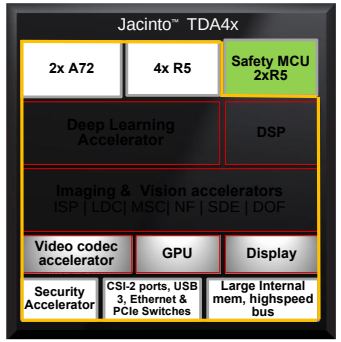
Conclusion

- Autonomous machine co-existing with humans are increasing productivity in all spheres of life
- Key technology enablers are 3D perception, AI and functional safety
- TI’s functional safety compliant mmWave radar sensor increases reliability in seeing the obstacle where other sensors fails
- TI’s TDA4x processor enable energy-efficient, functionally safe compliant sensor-fusion ad AI powered autonomous mobile machines and robots.

Getting Started Resources

Development | Open-source software & tools

Processor for practical edge AI



ti.com/edgeai

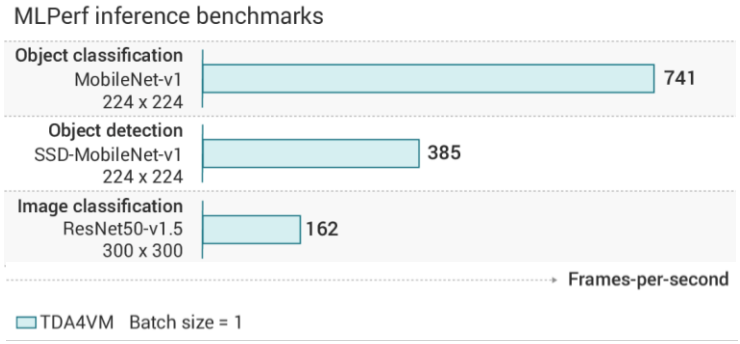
Learn with free cloud tool

ti.com/edgeaicloud

Build with 8 TOPS starter kit

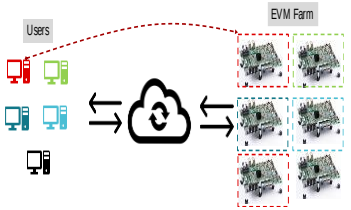
P/N: SK-TDA4VM: $249

Energy efficient AI architecture

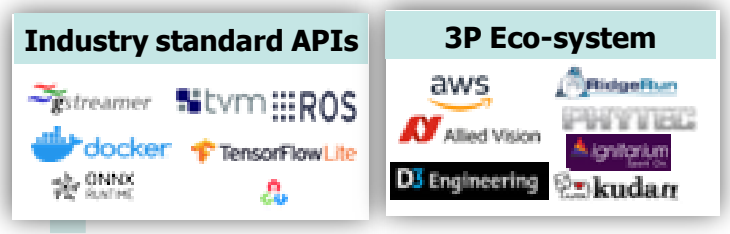


Get started for free

- Example scripts
- TI Model Zoo
- Training videos



Fast Development Cycle



Development | TDA4x processors

Edge AI evaluation	https://dev.ti.com/edgeai https://dev.ti.com/edgeaicloud https://dev.ti.com/edgeaiprojects
Full development	Product Folder: https://www.ti.com/product/TDA4VM Starter Kit : https://www.ti.com/tool/SK-TDA4VM TDA4 EVM: http://www.ti.com/tool/TDA4VMXEVM
Software development kits	TI Processor SDK for edge AI – Seamlessly reuse and migrate Linux, https://www.ti.com/tool/download/PROCESSOR-SDK-LINUX-SK-TDA4VM#downloads http://www.ti.com/tool/PROCESSOR-SDK-DRA8X-TDA4X
Support	https://e2e.ti.com

Learn on https://training.ti.com/process-monthly-webinar-series

Development | TI mmWave radar

Evaluation modules	IWR6843 ISK (60 GHz) IWR6843 AOP (60 GHz Antenna on package) IWR1843 BOOST (77 GHz)
Reference examples/labs	Sense and avoid lab for collision avoidance 360º safety bubble with ROS lab for safe human presence detection
Accelerate path to production with 3P network	Designing TI mmWave made easier using 3rd party ecosystem Industrial mmWave third-party search tool