TI *Live!* INDIA AUTOMOTIVE SEMINAR

JOHN SMRSTIK

JACINTO™ 7 AUTOMOTIVE PROCESSORS

Agenda

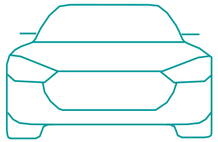
- ✓ Major automotive trends impacting car architectures and designs
- ✓ Introduction to TI’s DRA8x and TDA4x processors
- ✓ Example use cases
- ✓ Getting your evaluation and development started

The automotive world is changing

~1.35 MILLION

people die each year as a result of road traffic crashes

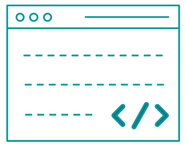
– World Health Organization (WHO)



50% FEWER

front-to-rear crashes equipped with FCW and AEB ADAS technology compared with cars without the systems

– Insurance Institute for Highway Safety (IIHS)



15x INCREASE

in lines of software code in cars, from about 10 million in 2010 to roughly 150 million in 2016

– McKinsey & Company

Major automotive trends

Connected cars	• Ride sharing • Insurance tracking • Post-sale services	**72% of vehicles** will be connected in 2027
Autonomous driving	• Safety • Efficiency • Productivity	**$56 Billion** of ADAS system demand in 2027
Hybrid electric & electric	• Green • Fuel cost	**40% of vehicles** will be HEV or electric in 2027

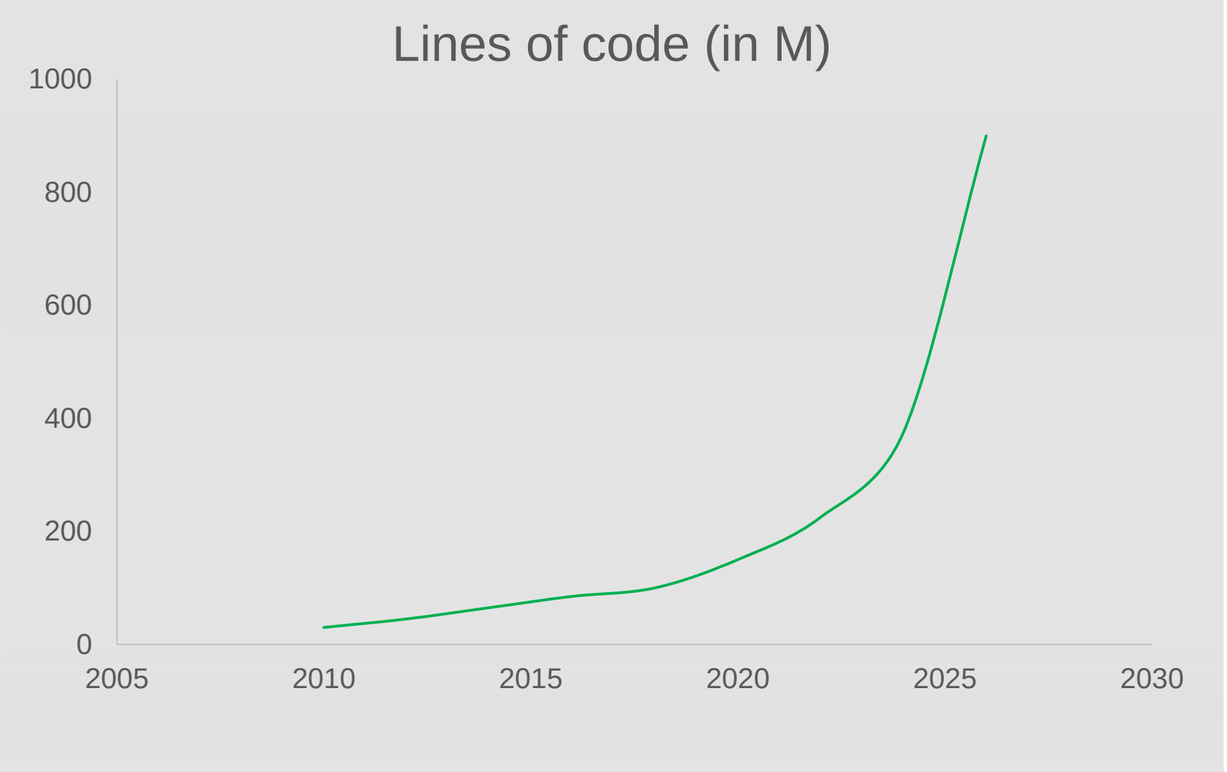
Source: Strategy Analytics

Data is the new fuel for cars

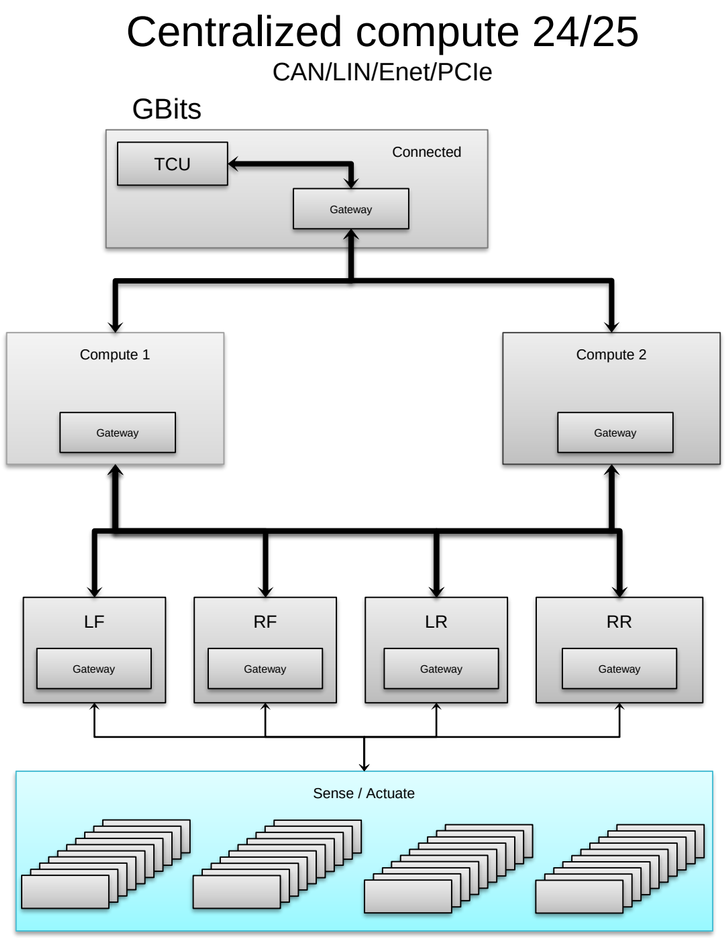
Software driving architectural changes

Increasing data → increasing software code, resulting in:

- New software architectures
- Hardware abstraction
- Simplified maintenance and upgrades



Why centralized compute



- >3 Kilometers of wire in a high-end vehicle
- >100 ECUs in a high-end vehicle
- Multi-$M to validate the software of one ECU
- Specialized compute is expensive for a fraction of use case time
  (i.e. automated parking)

- 15–20% wiring harness reduction
- Fewer boxes and connectors, lower system cost
- Service oriented architecture
- Re-use compute resources enables lower system cost

Centralized architectures allow software benefits

Business advantages

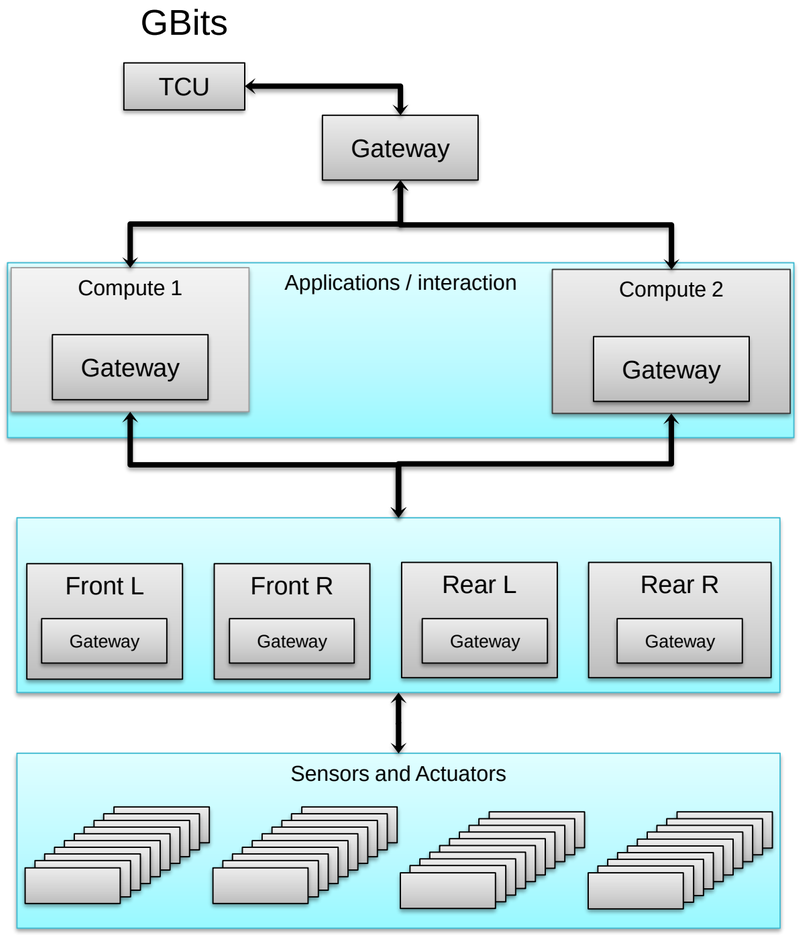
- Enables new business models
  - Emerging technology
  - Software enabled as a premium feature
  - Ride sharing
  - Advanced data exchange
  - Insurance incentives

User experience

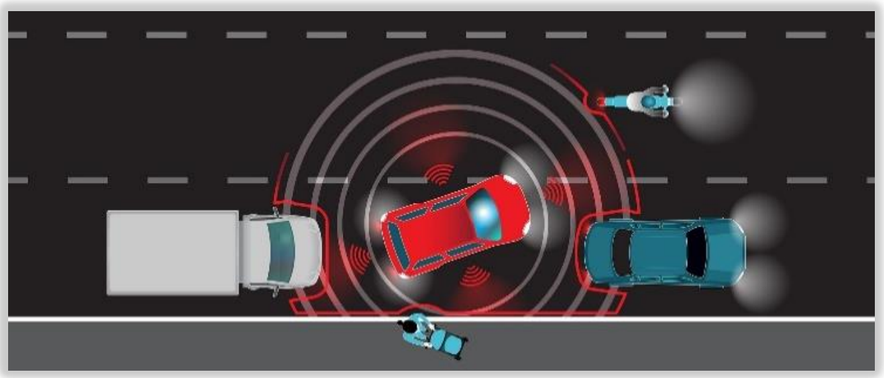
- Add features to the vehicle faster and cheaper
- Add features to the vehicle after it leaves the dealership

Engineering efficiency

- Higher software reuse and portability
- Enables cloud computing and the features associated
- Layered security
- Vehicle level power management
- Easier to include partner software



Automotive Market | Megatrends – Acceleration of ADAS



Mass deployment of ADAS technologies:

- More advanced ADAS in more cars
- New innovations for greater automation
- Migration towards fully autonomous

Parking — Surround View >> Park Assist >> Automated Parking

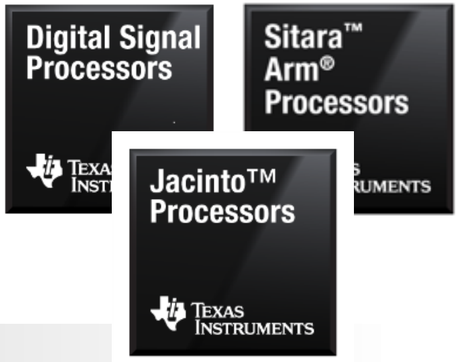
Driving — AEB, Adaptive Cruise >> L2 + Assist >> Automated Driving

Interior — Driver Monitor >> Occupant Monitor >> In-cabin Sensing

Jacinto™ 7 Processor Platform

Overview

Processors overview



Scalable, cost-optimized portfolio with accelerators, analog integration, robust connectivity, security and functional safety designed for automotive and industrial markets

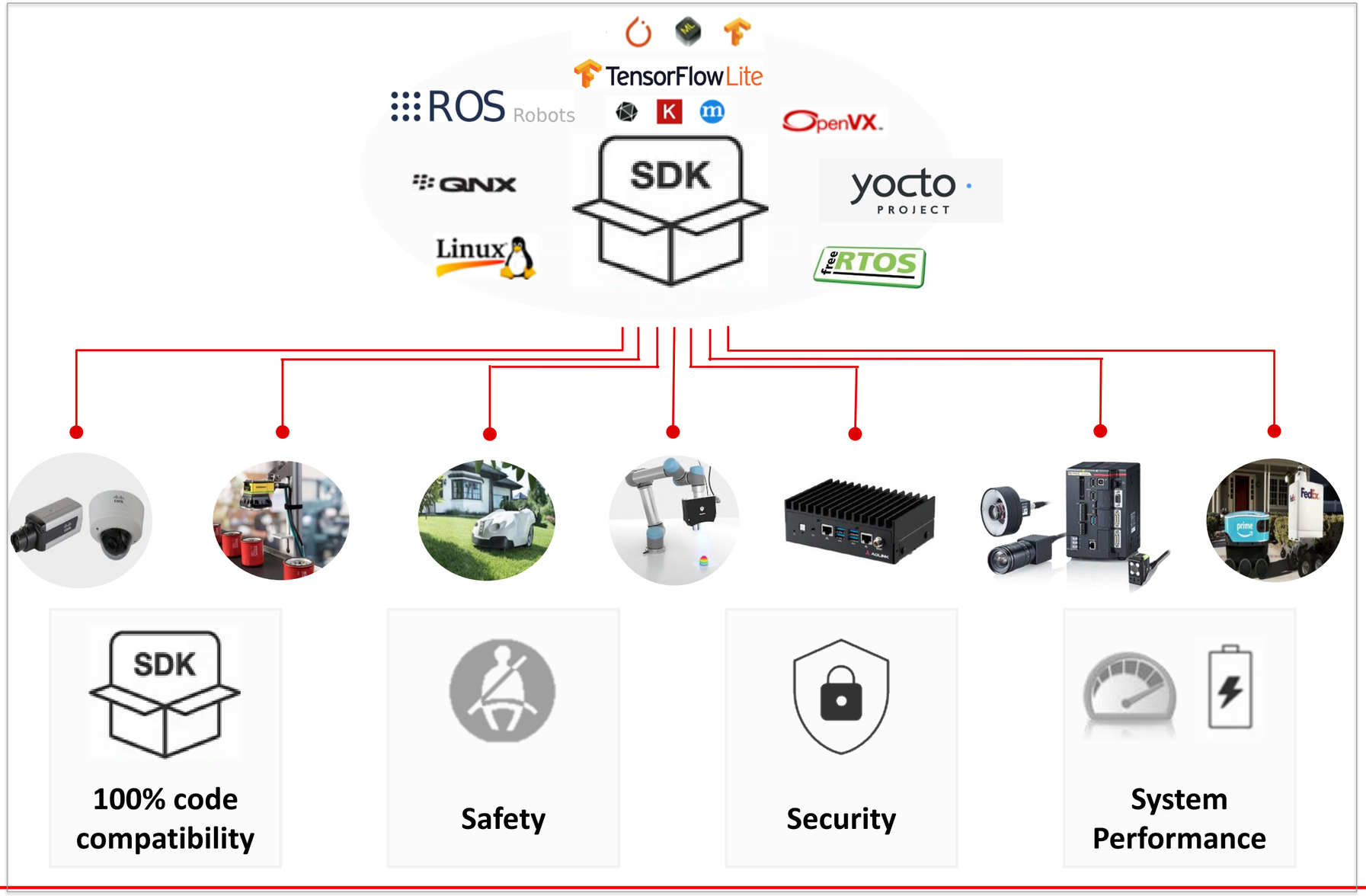
SoCs

Single-core to quad-core **Arm Cortex-A53** and **A72 cores**	**Compute**	**Control**	Dual-core to quad-core **Arm Cortex-R5F** with optional Lock-Step support
Secure-boot, run-time security, tamper protection and **high-security modules**	**Functional Safety & Security**	**Analog**	High-level integration of high-performance **ADC, DAC, comparators** and **PWM**
Power-optimized **neural network accelerators, audio DSP,** and **GPU**	**Deep Learning & Accelerators**	**Connect**	**USB3, PCIe Switch, Ethernet Switch, Industrial Protocols, CAN-FD,** and more
Open source device enablement for **Mainline Linux, RTOS** and **Bare Metal** 3P software support – **AUTOSAR**, **QNX**, …	**Unified Software Platform**		Simplified tools (**SysConfig**) and libraries (**DSPLIB**, **TIDL, ...**) to accelerate development and performance entitlement

Power-optimized design | **ASIL-B/D and SIL2 functional safety** | **-40 to 125C temperature range** | **Q100 automotive qualified options**

Scalable platform with common software development kit and pin-to-pin compatibility in common packages

Jacinto Processors unified software platform



- Common to **all TI processors** and hardware
- Built on common foundation of drivers, frameworks, libraries/codecs, and development tools
- Industries best mainline LINUX support
- Quarterly updates to SDK
- Enables customers and 3P partners on all operating systems

NRE-free and royalty-free software!
Extensive support on e2e.ti.com

Jacinto™ 7 | Helping make technology more accessible in vehicles

Jacinto™ 7 processor platform

- Built to support the needs of an entire vehicle lineup
- Designed for automotive
- Architected with analytics in mind

Jacinto™ 7 | Products to meet the road ahead

Jacinto™7 TDA4 family SoCs

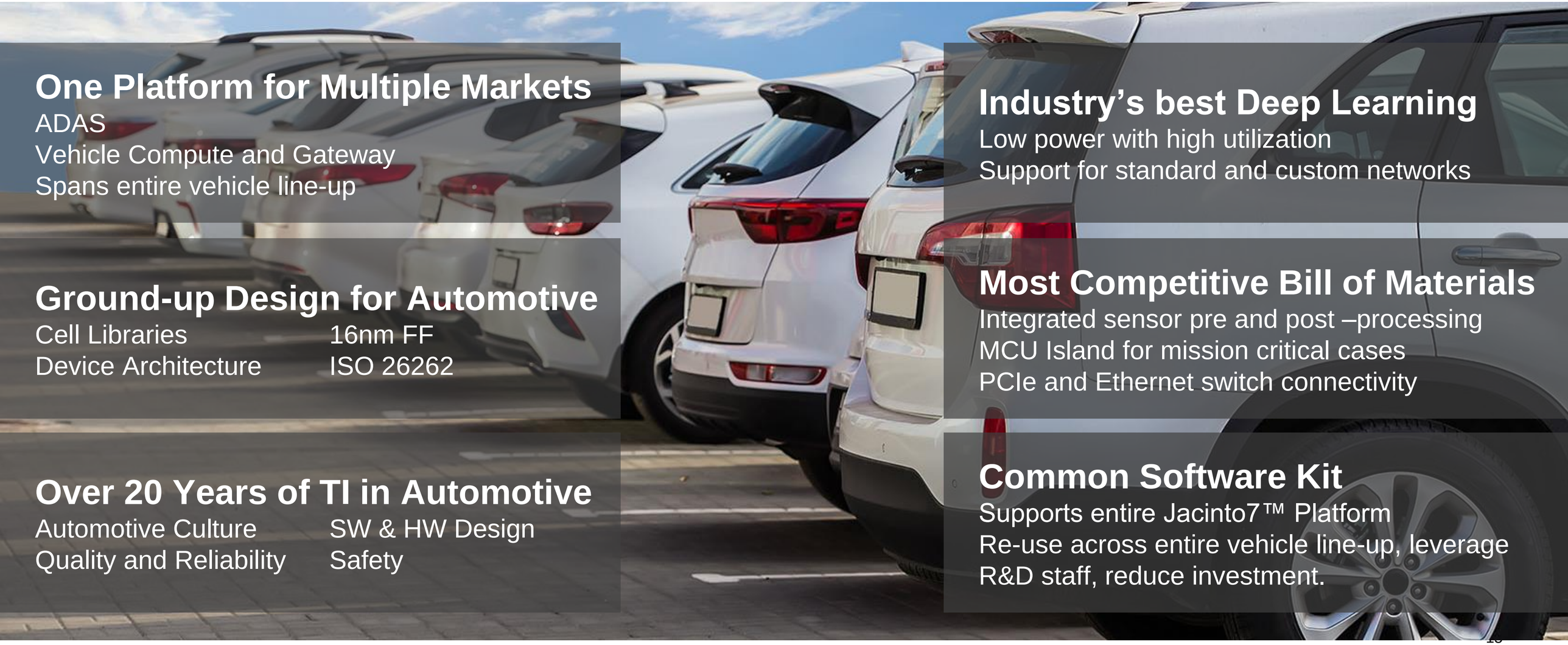
Improving awareness of the car's surroundings for a better driving experience

Jacinto™ 7 DRA8 family SoC's

Accelerating the data highway and paving the way for the software-defined car

Unified automotive platform that flexes to support the needs of your entire vehicle lineup

Jacinto 7™ | The automotive processor platform



One Platform for Multiple Markets

ADAS
Vehicle Compute and Gateway
Spans entire vehicle line-up

Ground-up Design for Automotive

Cell Libraries 16nm FF
Device Architecture ISO 26262

Over 20 Years of TI in Automotive

Automotive Culture SW & HW Design
Quality and Reliability Safety

Industry's best Deep Learning

Low power with high utilization
Support for standard and custom networks

Most Competitive Bill of Materials

Integrated sensor pre and post –processing
MCU Island for mission critical cases
PCIe and Ethernet switch connectivity

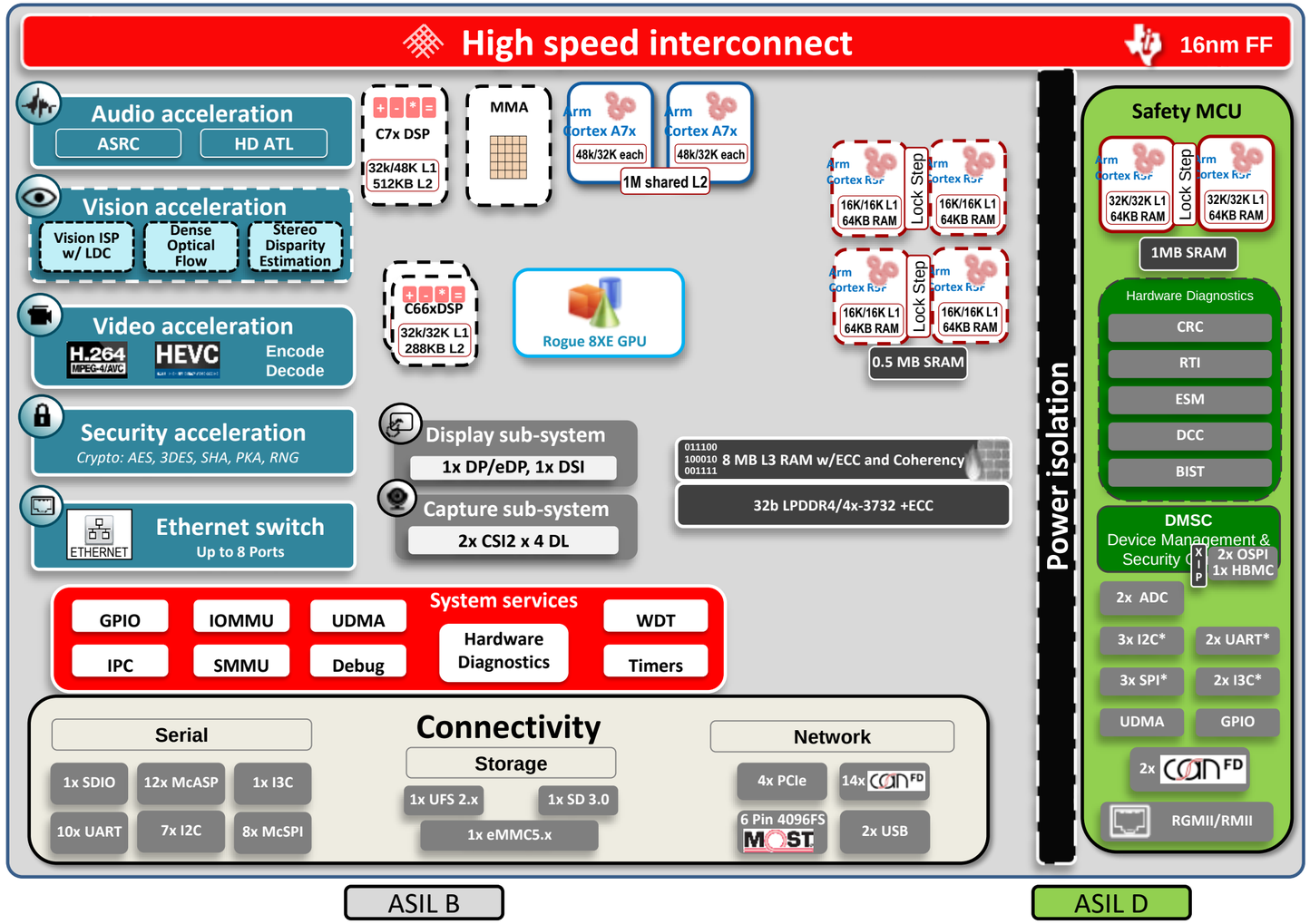
Common Software Kit

Supports entire Jacinto7™ Platform
Re-use across entire vehicle line-up, leverage R&D staff, reduce investment.

Jacinto™ 7 | Platform SoC Technologies

Key Features and Benefits

- Heterogeneous processing cores
- Application-specific hardware accelerators
- Device management architecture
- Memory architecture and data movement
- Safety and isolation features
- Virtualization features
- Security features
- Power management features
- Network connectivity
- Flash and storage
- Serial connectivity



TDA4VM Block Diagram Example

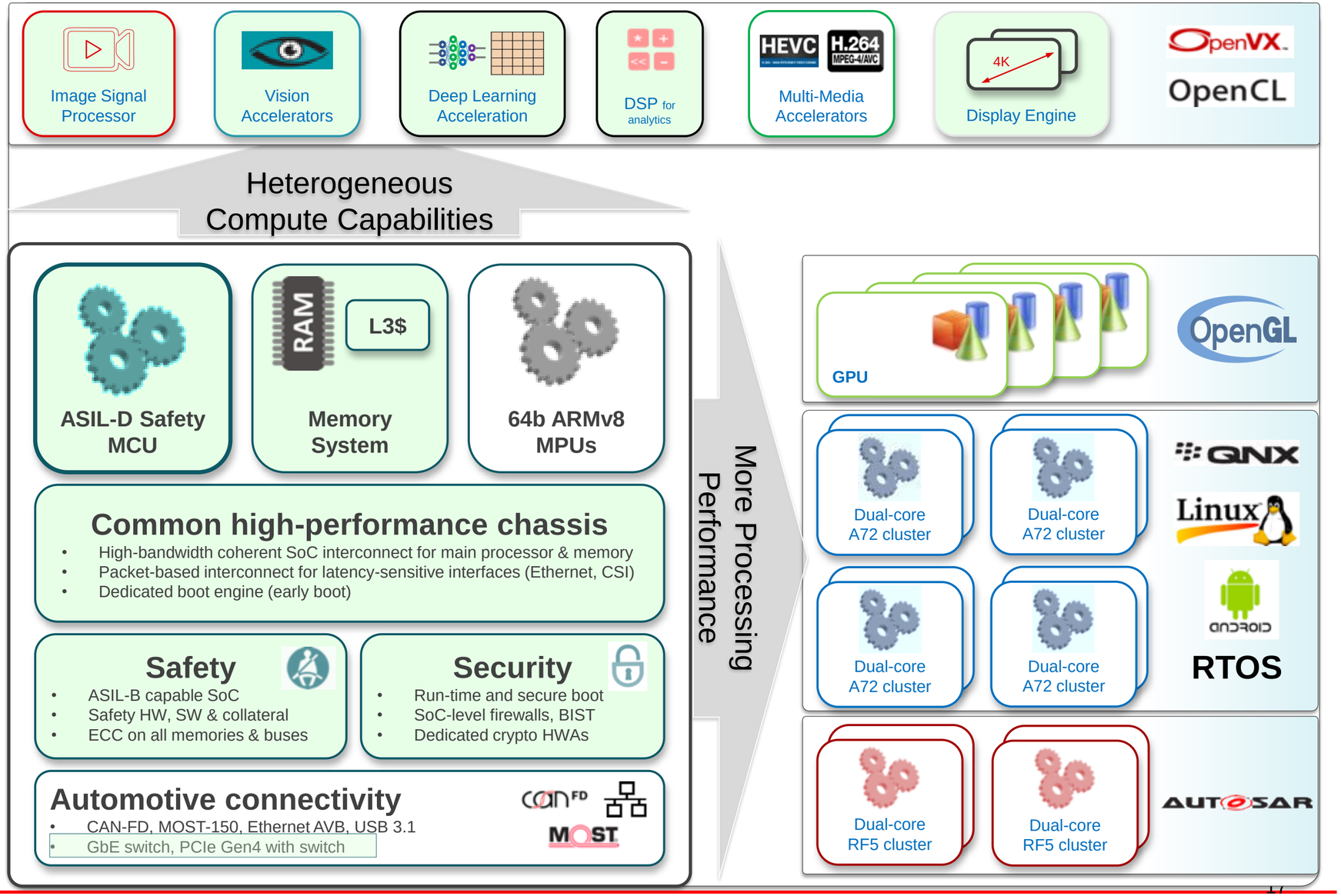
Jacinto™ 7 | Heterogeneous compute platform

Unique TI innovation

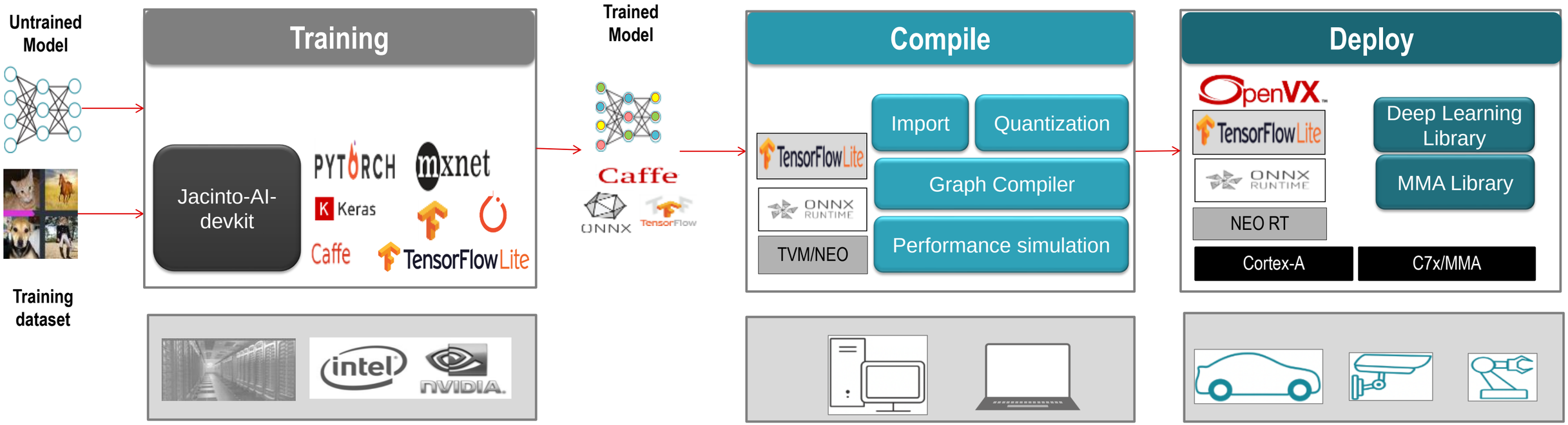
Choose the right core
for the right job

Optimize entire platform around programmer productivity on the MPUs

Offload the majority of “work” to specialized processors. Provide tools & SW to manage complexity



TDA4x deep learning tools make porting easy & accurate



Easy and Accurate Translation of Trained Networks
Full Performance at a Fraction of the Power & DDR Bandwidth

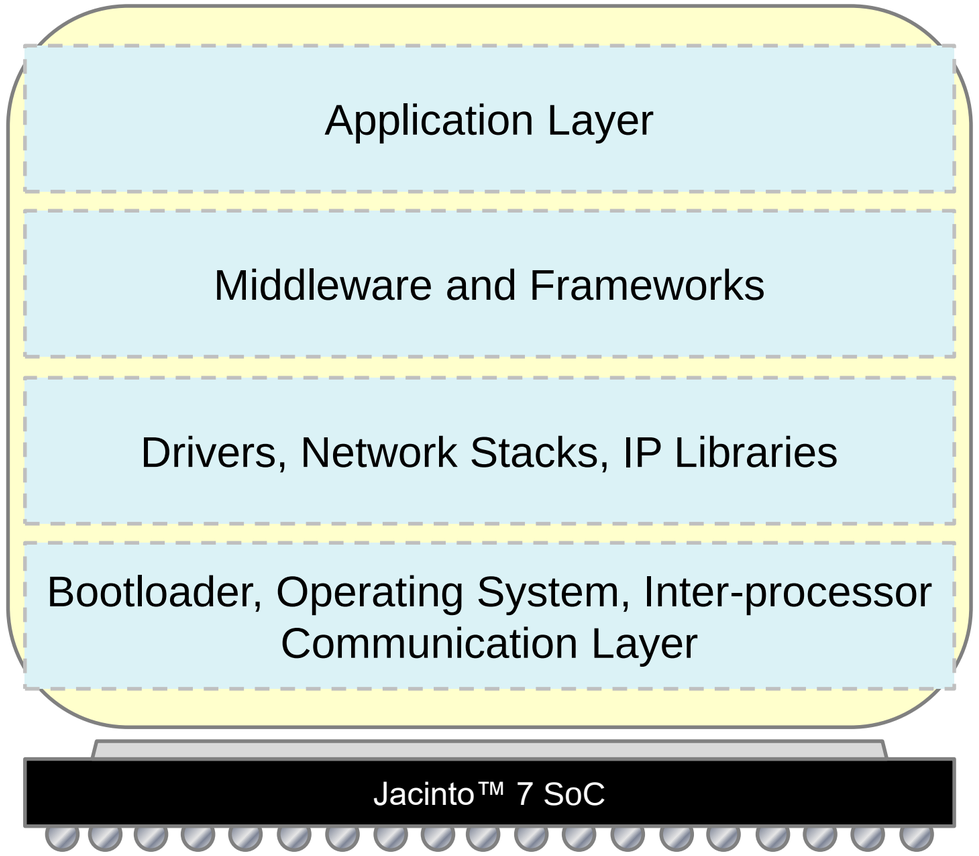
Train on PC/GPU

Inference: Translate and Deploy on TDA4x

TDA4x SoC
Automotive Production
Texas Instruments

TI Processor SDK | at a glance

Complete SW kit developed and delivered by TI



Demos and examples that show how kit is used

TI developers as beta users of the kit

Build system expertise, deliver continuous improvement

Infrastructure to make the platform easier to use

Multimedia, Graphics, OpenVX, OpenCL

Core foundational components

- Hardware abstraction for SoC capabilities
- Deliver performance entitlement

CV and Deep Learning libraries

MCAL drivers, Ethernet AVB, USB….

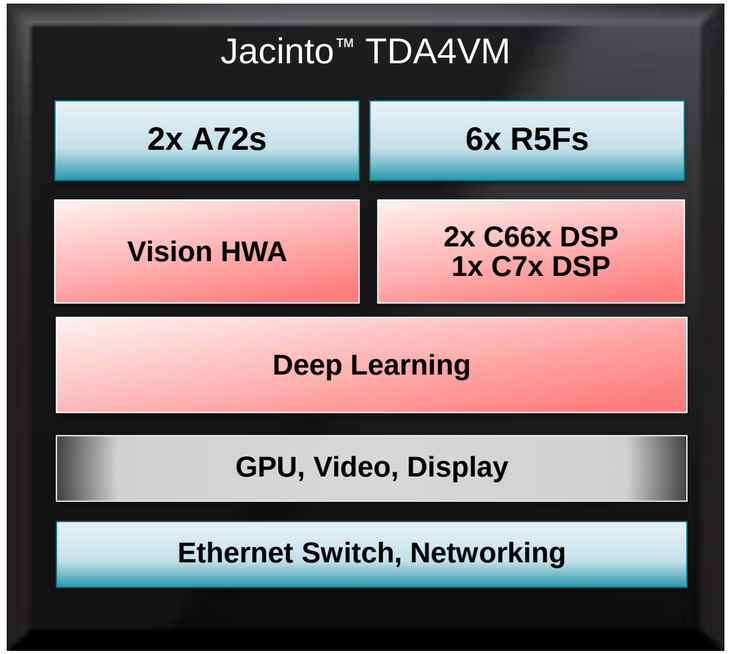
Linux and TI-RTOS Operating systems

NO NRE, NO ROYALTY for TI Delivered SW

Jacinto™ Edge Analytics | TDA4VM

TDA4VM | SoC for ADAS and Edge Analytics

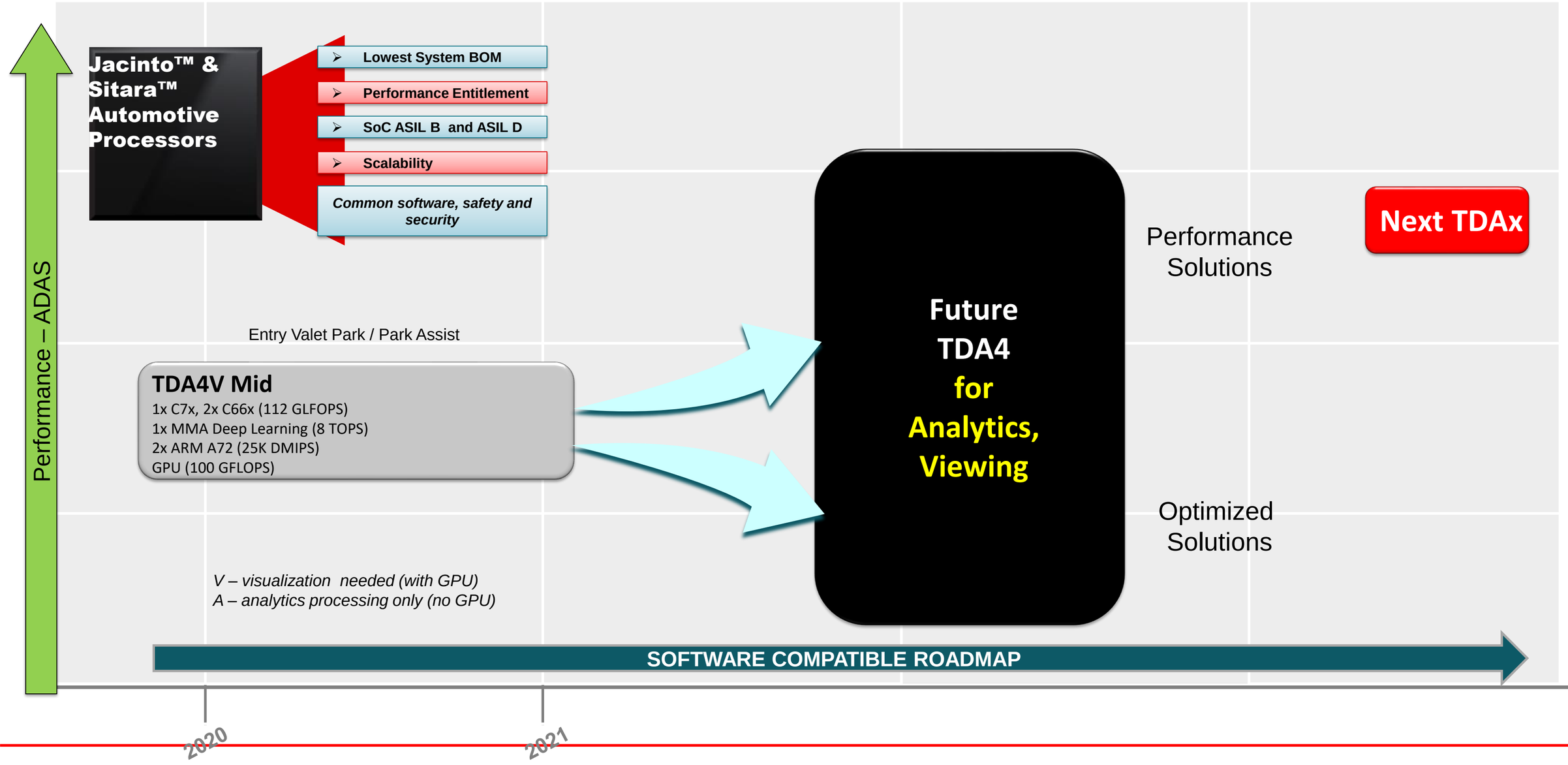
- Dual Arm Cortex-A72 MPUs for HLOS and applications
- 6x Arm Cortex-R5F MCUs to offload real time communication and fast boot
- Highly efficient deep learning with our C7x+MMA
- GPU integration for your video/display needs.
- Integrated 8-port Gb Ethernet switch for BoM savings
- PCIe, USB, and other peripherals
- Secure boot & crypto hardware accelerators
- 20x CAN-FD
- Option for ASIL-D/SIL-3 functional safety support
- **Full Production! Available on ti.com**



Linux

freeRTOS

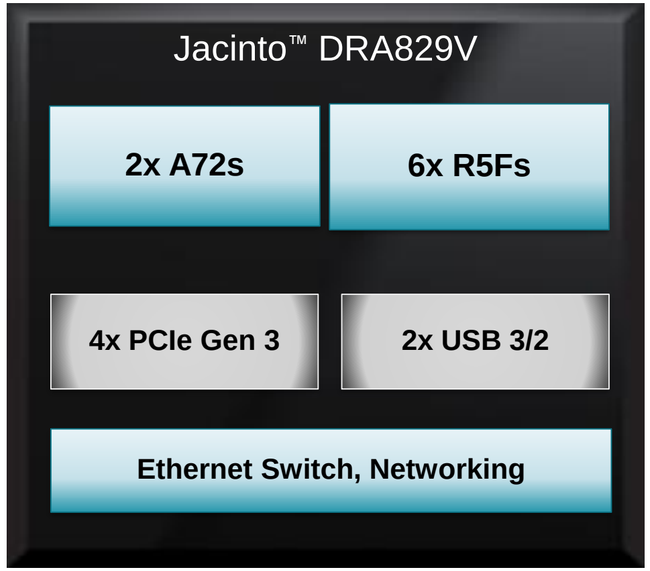
Jacinto™ 7 | TDA4x ADAS roadmap



Jacinto™ Edge Compute | DRA829V

DRA829V | SoC for Auto and Edge Compute Applications

- Dual Arm Cortex-A72 MPUs for HLOS and applications
- 6x Arm Cortex-R5F MCUs to offload real time communication and fast boot
- Integrated 8-port Gb Ethernet switch for BoM savings
- PCIe, USB, and other peripherals
- Secure boot & crypto hardware accelerators
- 20x CAN-FD
- Option for ASIL-D/SIL-3 functional safety support
- **Full Production! Available now on ti.com**



Linux TI-RTOS

Jacinto™ Edge Compute | DRA821U

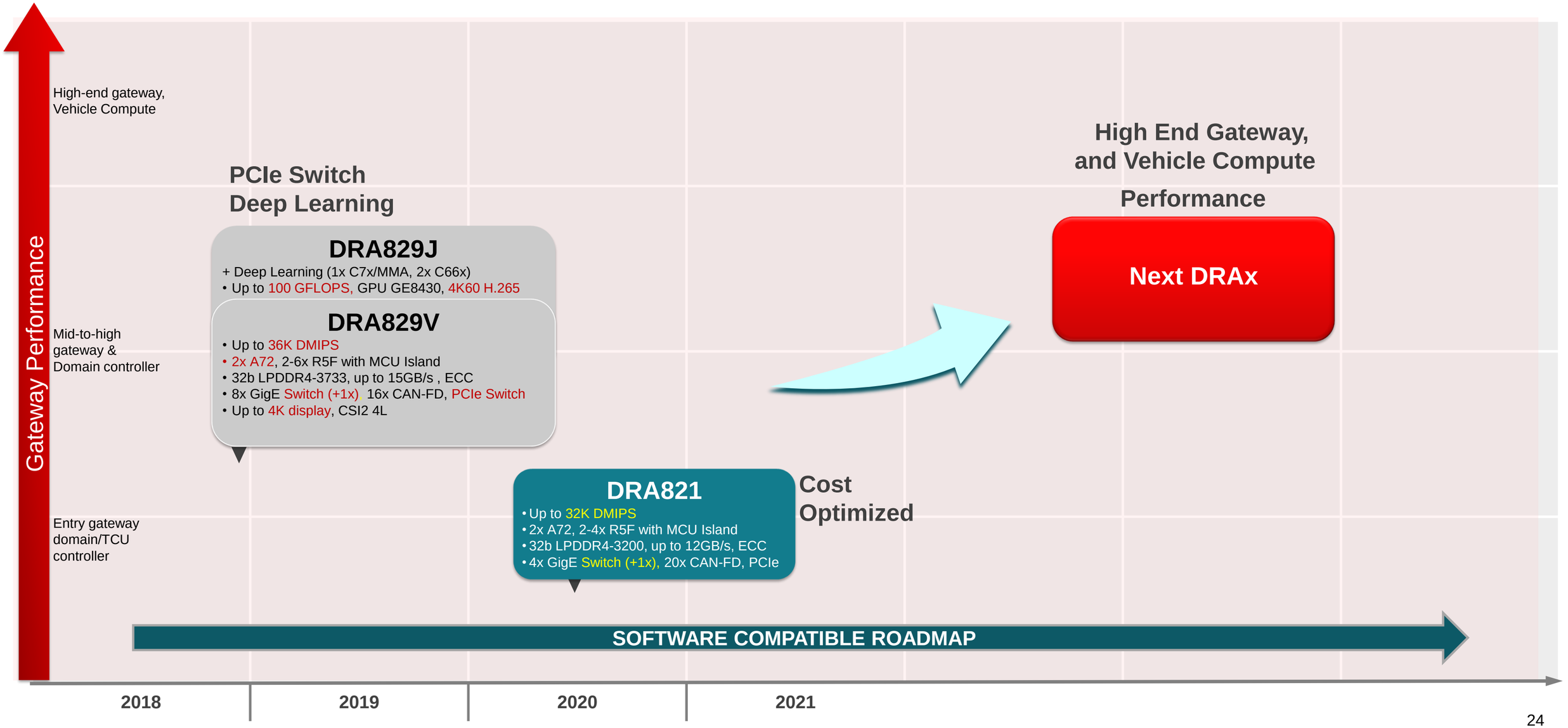
DRA821 | SoC for Auto Gateway, Networking and Edge Compute

- Dual Arm Cortex-A72 MPUs for HLOS and applications
- Up to 4x Arm Cortex-R5F MCUs to offload real time communication and fast boot
- Integrated 4-port Gb Ethernet switch for BoM savings
- PCIe, USB, and other peripherals
- Secure boot & crypto hardware accelerators
- 20x CAN-FD
- Option for ASIL-D/SIL-3 functional safety support
- **Samples available now, RTM 3Q22**

Linux TI-RTOS

Jacinto™ 7 Gateway Processor Roadmap

Production
Sampling
Concept



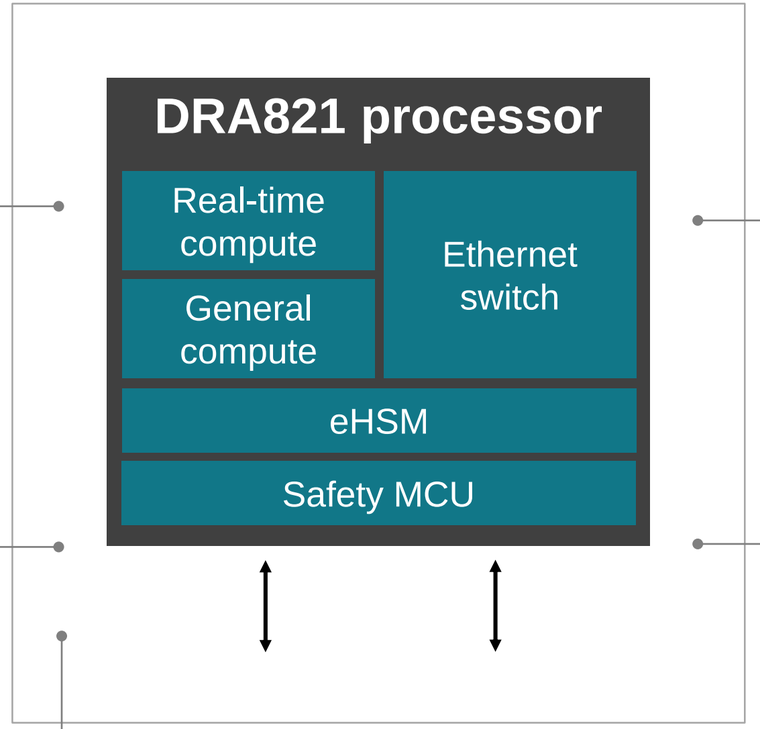
Example use cases for Jacinto™ 7 Processors

DRA821 | Real-time control & low-latency communication

Real-time communication
CAN-FD and LIN legacy interfaces

Functional safety
Integrates safety-critical and non-safety-critical capabilities

Scalable Performance
Integrated multicore MCU and application processor for future computing needs

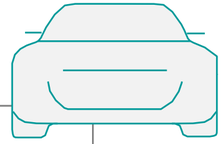


High-speed networking
4-port, 1-Gb TSN Ethernet switch

Power efficiency
Operates at 7 Watts or less

Seamless Integration – use DRA821 for:
- Direct replacement of existing MCU-based gateways
- Add-on companion for increased computing needs

DRA821 | Connected cars demonstration overview

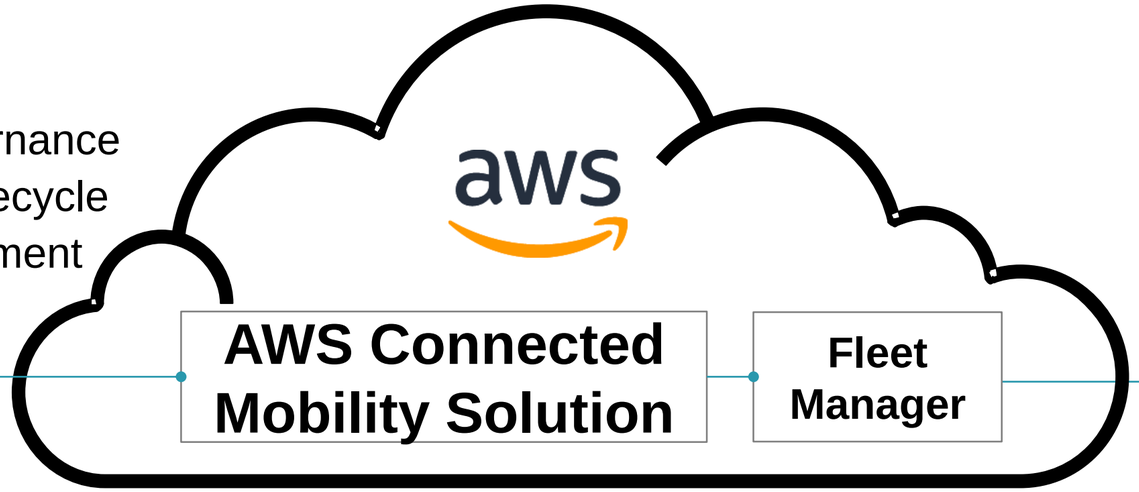


DRA82x vehicle compute platform ➲ DRA821 EVM

- AWS IoT Greengrass
- Connected car data simulator

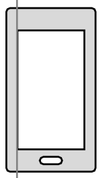
Filtered, secure data ingestion (location, speed, fuel/battery level, diagnostics)

Data governance
Vehicle lifecycle management



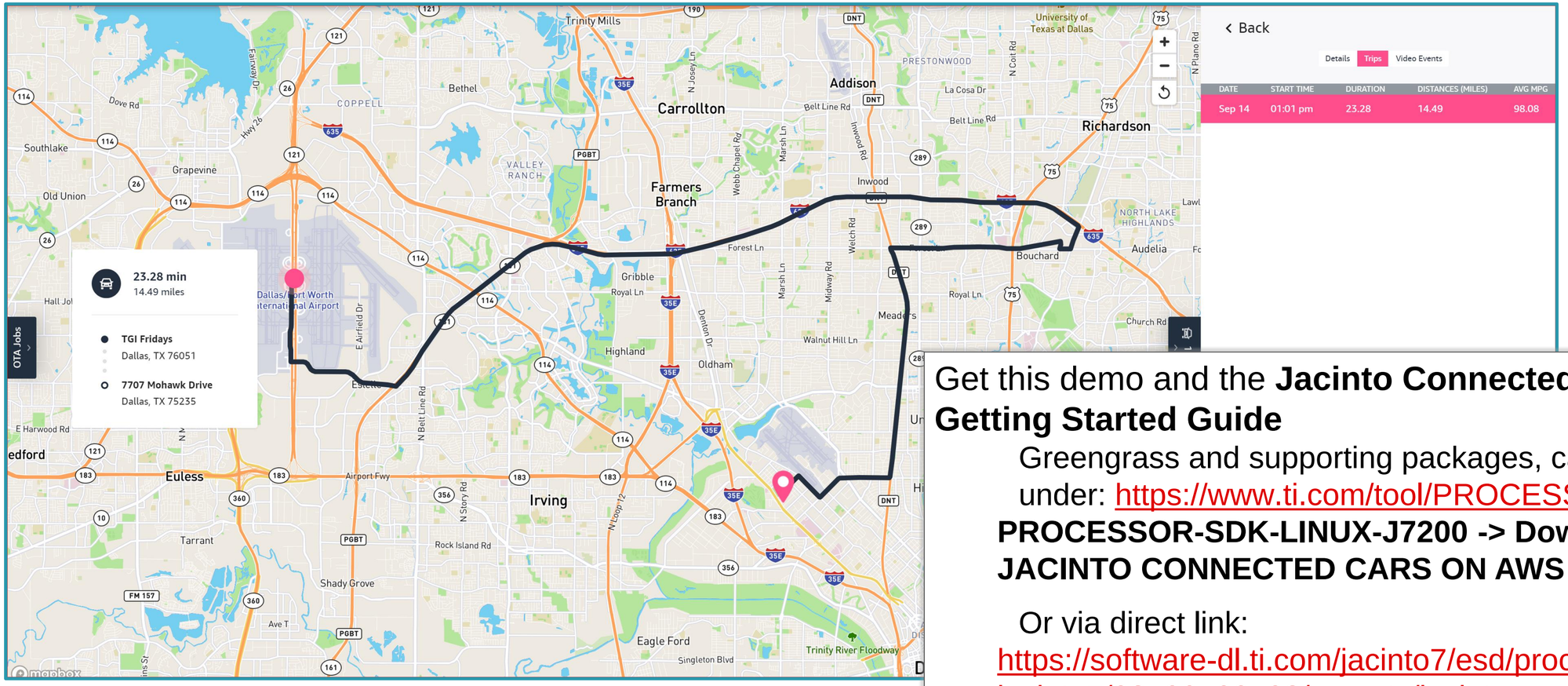
User's web browser

- DRA82x connected cars overlaid on mapbox
- Vehicle diagnostic data



Example fleet management application

Fleet Manager with DRA821 EVM (J7200XSOMXEVM)



Get this demo and the **Jacinto Connected Cars on AWS: Getting Started Guide**

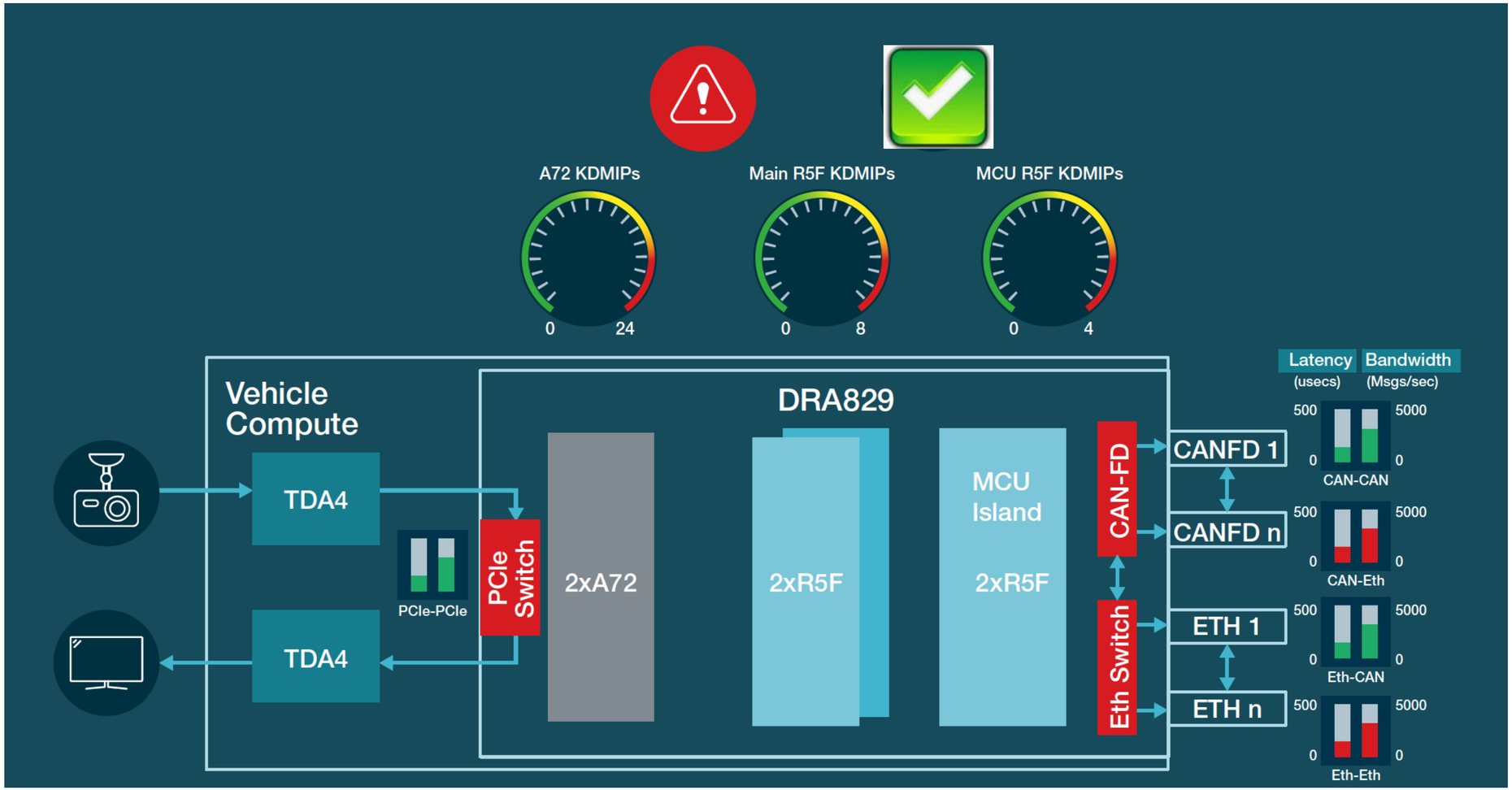
Greengrass and supporting packages, can be downloaded now under: https://www.ti.com/tool/PROCESSOR-SDK-J7200

PROCESSOR-SDK-LINUX-J7200 -> Download Options -> JACINTO CONNECTED CARS ON AWS ADD-ON PACKAGE:

Or via direct link: https://software-dl.ti.com/jacinto7/esd/processor-sdk-linux-jacinto7/08_00_00_08/exports/jacinto-connected-cars-on-aws-2.4.0.zip

Jacinto 7 DRA829 Vehicle Compute Gateway Demo

- Fast Linux Boot
- Vehicle Micro integration
  - Early CAN response
- Safety
  - PCIe Switch with no load on MPU
  - 8-port Gbit Ethernet L2 switching support on hardware
  - CAN to CAN, CAN to Ethernet and Ethernet to CAN bridging
    - Aux MPU for control and network stack



TI Software and Ecosystem | Example demonstrations for TDA4x

Smarter Driving with TDA4

momenta

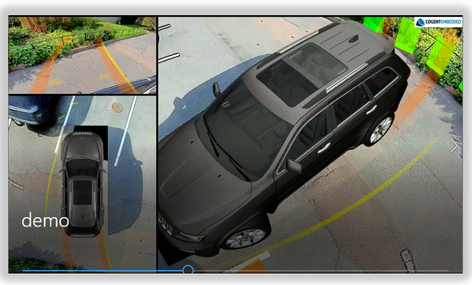
8MP Front Camera Perception and Localization

- NCAP ready multi-class object detection using TIDL Libraries and C7x+MMA
- Fusion with IMU and GPS for Localization
- Concurrent applications on one TDA4VM SoC

STRADVISION

- Deep learning based algorithms use TIDL Libraries and C7x+MMA
- Multi-class object detection includes cars, trucks, motorcycles, bikes, pedestrians and more.
- Freespace detection, lane/road marking ID, street sign ID and light source ID for traffic signals.

Smarter Parking with TDA4



COGENTEMBEDDED

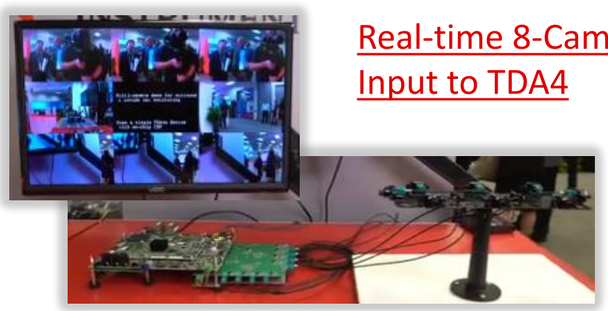
Surround View with Analytics

- High-quality 3D Animated Car Model, overlays for projected path and distance warning.
- Transparent car view using history
- Object Detection, Lane ID, Parking spot ID using DSP based algorithms.

Auto Valet Park and Surround View

- AVP with Semantic segmentation, object and parking spot detection based on TIDL
- Simultaneous Real-time 4x 2MP camera Surround view with 3D car model.
- All code freely available in TI's Processor SDK

TDA4: Multi-Camera, Car Ready



Real-time 8-Camera Input to TDA4

- Eight 2MP cameras feeding single TDA4VM.
- All camera images pre-processed by single ISP in real-time
- All code freely available in TI's Processor SDK

D3 Engineering

DesignCore Rugged Vision Platform for TDA4VM

- Ruggedized Development platform for applications on TDA4VM SoC.
- Multi-sensor interfaces: camera, radar, lidar…
- Software compatible with TI EVM based on Processor SDK

TI Ecosystem | Complete system of experienced partners for AD/ADAS

Operating Systems and Security

Green Hills Software
QNX
mentor embedded
WIND
vector

Safety Software, Certification

MCAL
AutoSAR Classic
Adaptive AutoSAR

vector
KPIT
Elektrobit

ADAS Algorithms

Surround and Auto Parking
Front Camera and Autonomous Drive
DMS and In-Cabin Monitoring

momenta
COGENTEMBEDDED
STRADVISION
PHANTOM AI
eyeris
seeingmachines
XPERI
FotoNation
smart eye
JUNGO

Camera Sensors, Modules and Tuning Services

SONY
SAMSUNG
ON Semiconductor
OmniVision
MMSolutions
HIVE
D3 Engineering
APPRO.PHO
Leopard Imaging

Engineering Services

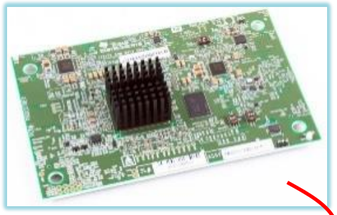
Algorithm Porting and Optimization
Driver Development
Hardware Design
System Testing

wipro
SCS super computing systems
KPIT
RT-RK
MISTRAL
SVT SVTRONICS, INC.
PATHPARTNER
D3 Engineering

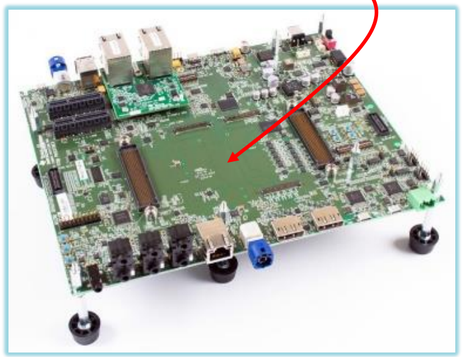
Getting Started

Jacinto™ DRA829x/TDA4VM | EVM Orderable Details (SOM and Processor Board)

Baseline Hardware Kit



- Processor SOM
- P/N:J721EXSOMXEVM



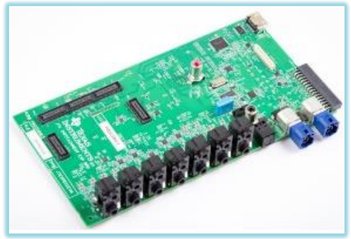
- Common Baseboard
- P/N:J721EXCPXEVM

Modular Development System

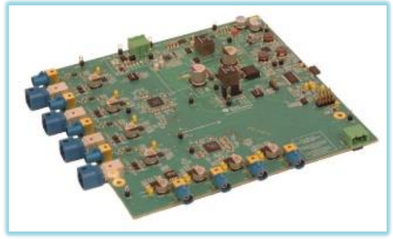
- Provides complete access to Jacinto™ SoC
- HW platform for SDK Validation
- New SOM for each Jacinto™ 7 SoC Variant
- Common Baseboard compatible with all Jacinto™ 7 SoC Variants
- On-board XDS110 JTAG for debug via CCS
- XDS560v2 for advanced debug and trace
  http://www.ti.com/tool/TMDSEMU560V2STM-U
- Software SDK Available at:
  http://www.ti.com/tool/PROCESSOR-SDK-DRA8X-TDA4X

Ethernet switch expansion card
P/N:J7EXPCXEVM

Audio and Display Expansion Card
P/N: J7EXPEXEVM



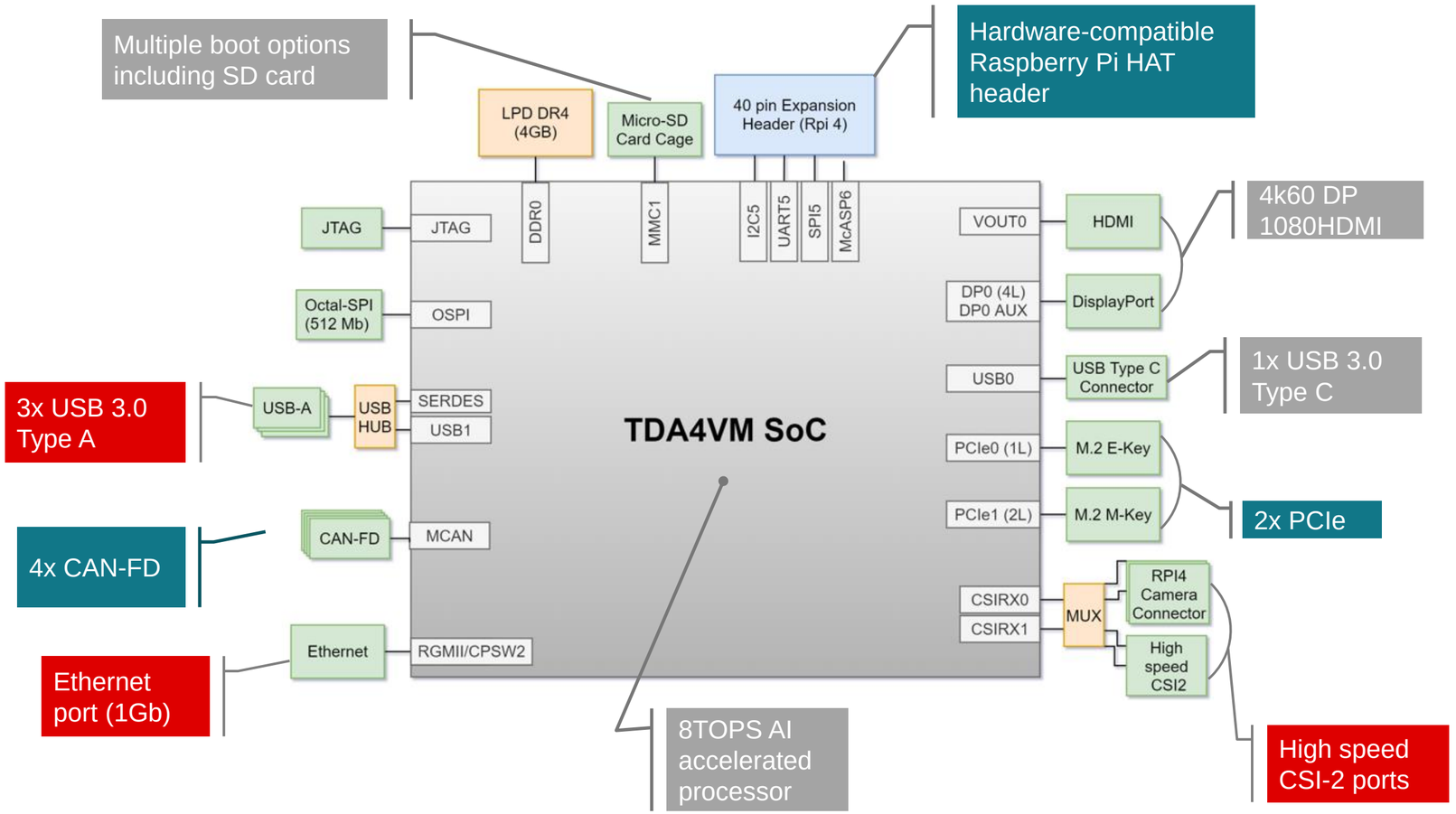
Fusion Application Board
P/N:EVM577PFUSION-V1-0



Additional expansion cards planned

Optional Expansion cards for application needs

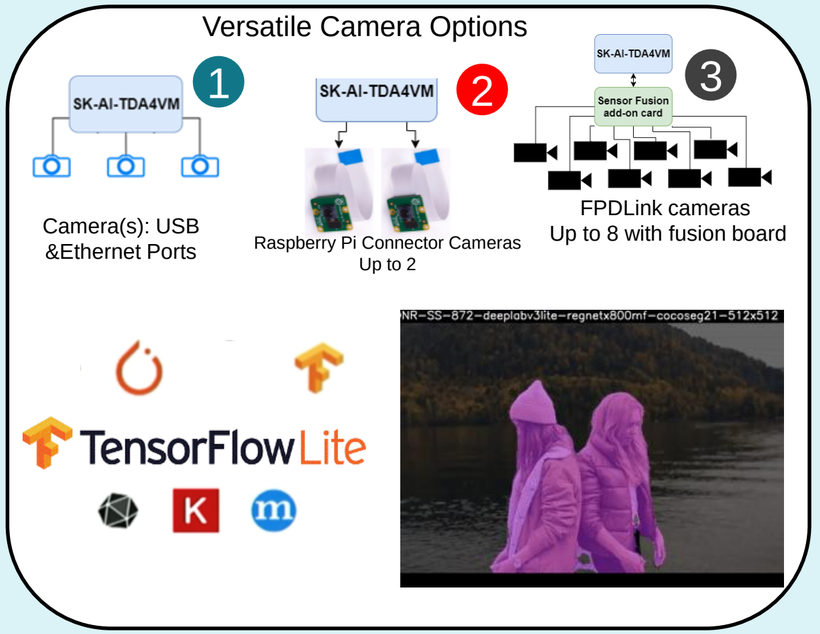
Edge AI Starter Kit | Jacinto™ TDA4VM processor



Fast out-of-box Edge AI demo:

1. Insert programmed SD card*
2. Plug-in all peripherals
3. Run demo in under an hour!

** Follow instructions in Edge AI Devkit to program SD card*



Part number: SK-TDA4VM | **Price:** $199 | **Order:** On ti.com today

Camera options 2 and 3 do not work simultaneously

DRA821 EVM

Ethernet Switch Expansion Card

Common Processor Board

DRA821 SOM

GESI* Board

Board	Part # & Link
CP Board + QSGMII board	J721CP01EVM
DRA821 SOM	J7200XSOMG01EVM
GESI board	J7EXPC01EVM

*** Gateway/Ethernet Switch/Industrial (GESI) Expansion Kit**

Jacinto™ 7 Family | Development Tools

- Start SW Development using TDA4VM or DRA8x Evaluation Module – Available today.
  - Modular: Can replace processor SOM as other Jacinto™ 7 SoCs are introduced.
- Download Processor SDK Linux and RTOS for Automotive
  - https://www.ti.com/tool/PROCESSOR-SDK-DRA8X-TDA4X
  - Free, no NRE and no royalty.
- Download Code Composer Studio Integrated Development Environment
  - https://www.ti.com/tool/CCSTUDIO
  - Free, no NRE and no access fees.
- Optional: GNU Compiler Collection for Cortex A72 development
  - https://gcc.gnu.org/

Start your evaluation today

Reference design

Use our 8-layer PCB reference design to get your gateway application to market faster and at lower cost.

Download design

EVM

Our system-on-module solution, when paired with a common processor board, lets you fully evaluate DRA821, DRA829 or TDA4VM processors.

Buy on TI.com

Data sheet

Explore the features and benefits of DRA821 processors, which tailor-made for gateway systems.

View datasheet

White papers

Dive deeper into automotive trends and explore innovative integrated circuit solutions.

Download design

Get your questions answered 24/7 on the Processors E2E Forum

https://e2e.ti.com/support/processors-group/

Summary

- The Automotive market is undergoing transformation as:
  - the amount of electronics per automobile increases
  - architectures become more software oriented
  - ADAS features become more pervasive across all types of vehicles

- TI has been a leader in this revolution, supplying key technology in our Jacinto family processors
  - The current Jacinto™ 7 family is purpose built for:
    - gateways common in domain and zonal architectures (DRA8x family)
    - ADAS features for parking, driving and cabin applications (TDA4x family)
  - A common software platform, Processor SDK, helps achieve scale, reuse and efficiency in development.

- First products are in market TODAY. More products are on the way!

TEXAS INSTRUMENTS

IMPORTANT NOTICE AND DISCLAIMER

TI PROVIDES TECHNICAL AND RELIABILITY DATA (INCLUDING DATA SHEETS), DESIGN RESOURCES (INCLUDING REFERENCE DESIGNS), APPLICATION OR OTHER DESIGN ADVICE, WEB TOOLS, SAFETY INFORMATION, AND OTHER RESOURCES “AS IS” AND WITH ALL FAULTS, AND DISCLAIMS ALL WARRANTIES, EXPRESS AND IMPLIED, INCLUDING WITHOUT LIMITATION ANY IMPLIED WARRANTIES OF MERCHANTABILITY, FITNESS FOR A PARTICULAR PURPOSE OR NON-INFRINGEMENT OF THIRD PARTY INTELLECTUAL PROPERTY RIGHTS.

These resources are intended for skilled developers designing with TI products. You are solely responsible for (1) selecting the appropriate TI products for your application, (2) designing, validating and testing your application, and (3) ensuring your application meets applicable standards, and any other safety, security, regulatory or other requirements.

These resources are subject to change without notice. TI grants you permission to use these resources only for development of an application that uses the TI products described in the resource. Other reproduction and display of these resources is prohibited. No license is granted to any other TI intellectual property right or to any third party intellectual property right. TI disclaims responsibility for, and you will fully indemnify TI and its representatives against, any claims, damages, costs, losses, and liabilities arising out of your use of these resources.

TI’s products are provided subject to TI’s Terms of Sale or other applicable terms available either on ti.com or provided in conjunction with such TI products. TI’s provision of these resources does not expand or otherwise alter TI’s applicable warranties or warranty disclaimers for TI products.

TI objects to and rejects any additional or different terms you may have proposed.

Mailing Address: Texas Instruments, Post Office Box 655303, Dallas, Texas 75265