

Bluebox Deep Dive – NXP's AD Processing Platform

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SECURE CONNECTIONS
FOR A SMARTER WORLD

1.3 million

Road traffic deaths occur every year



Pedestrian survival rate if hit by car

Travelling at



1 out of 10 pedestrians survive

Travelling at



9 out of 10 pedestrians survive

Out of all accidents 90% are caused by Human Error



Enabling Self-driving Cars

Better senses than the human driver.

Automation of driving decisions.

SENSE



THINK



ACT



Architecting the Car of the Future

More than a brain on four wheels.
The core of safe and secure mobility.



SENSE



THINK



ACT

Leveraging
Leadership in processing, security and
mobile



Higher Levels of Automation: Higher Computation, Storage & Sensors

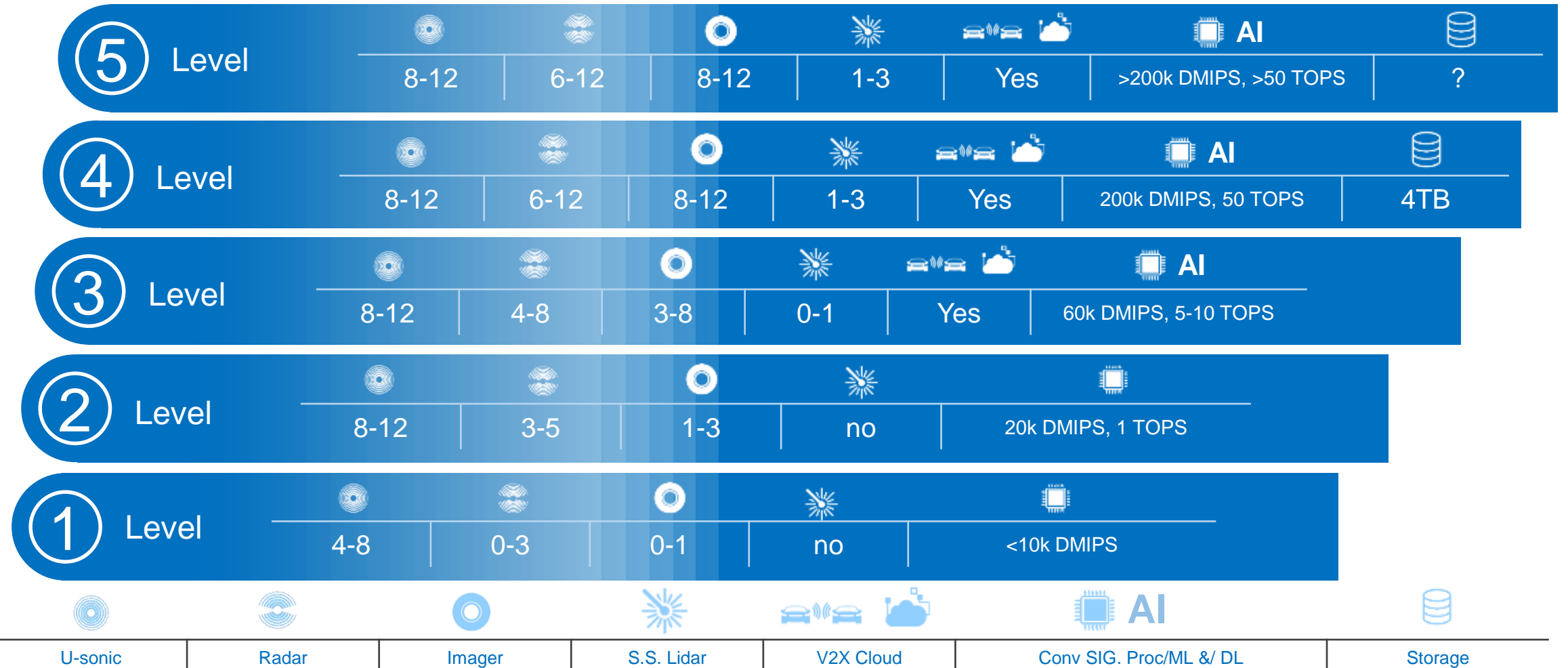


Semi Content per Car increase (TAM) vs Level 0
Source: Strategy Analytics; IHS; Evercore; ABI Research; NXP



Higher Levels of Automation

Higher Computation, Storage & Sensors – Typical Vehicle Architecture





NXP Core Values to Solve the Current Challenges of the Market

Computation Performance

Lead the heterogeneous compute performance with purpose built processors, optimized for power

Safety

No compromise on safety. Progression from ASIL to enhanced dependability and fail operational modes support

Ease of Use

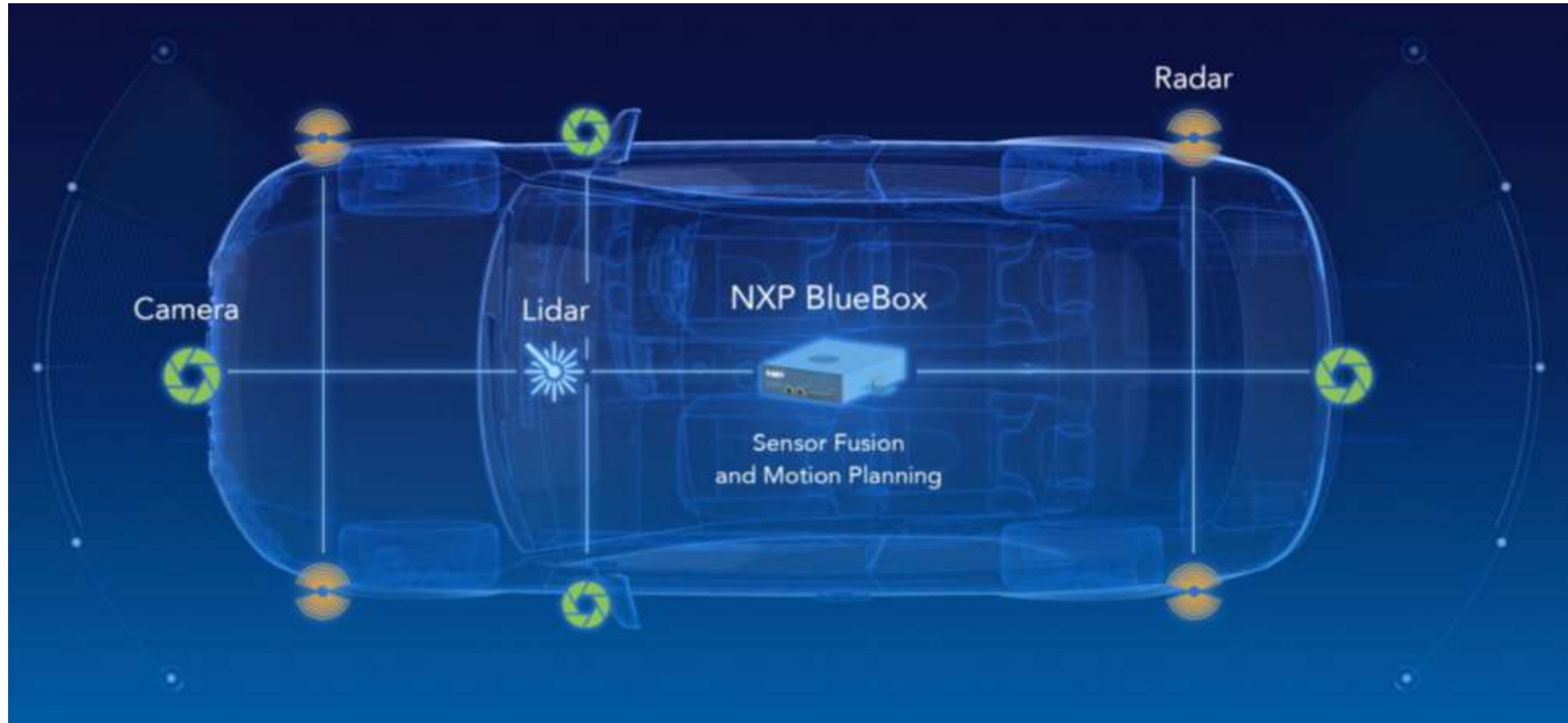
Based on OPEN standards, portable and relocatable

Modularity Scalability

Built on 'clear functionally separated extensible' entities

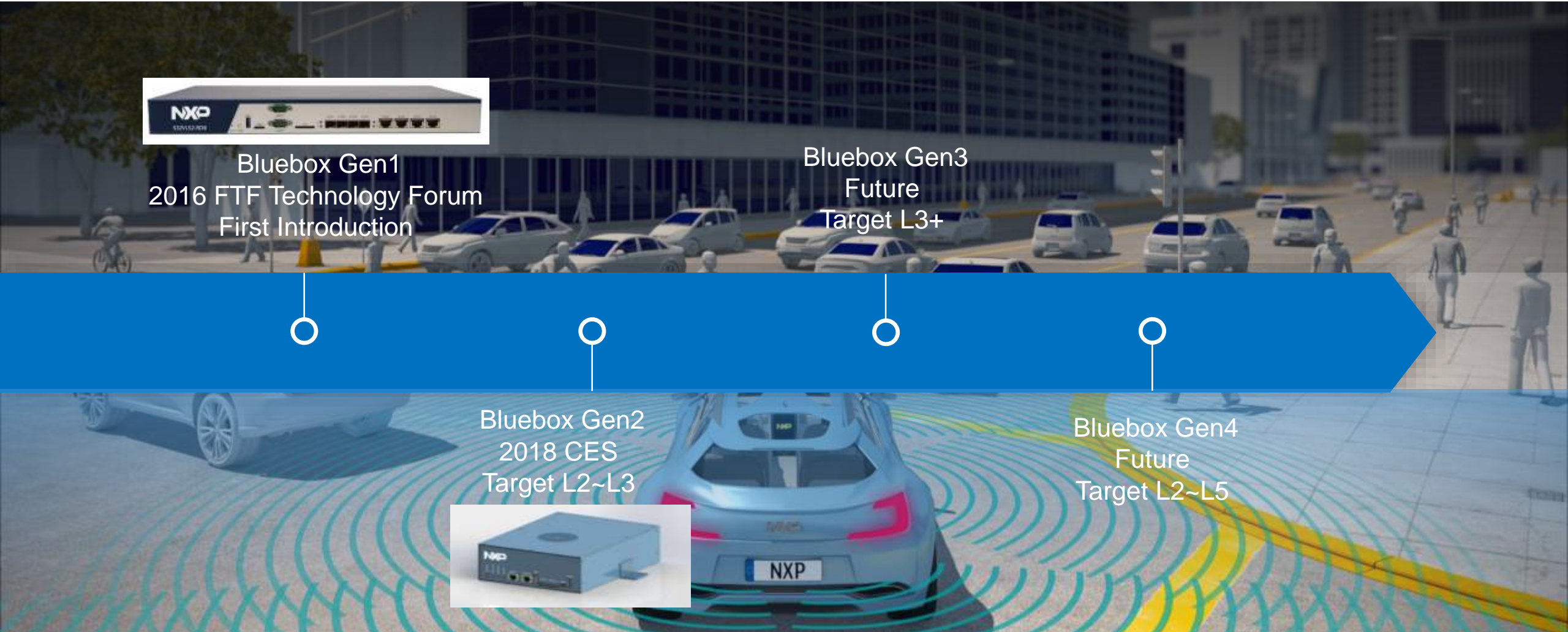
NXP BlueBox

Autonomous Driving Development Platform



A development platform for Automated Drive and Sensor Fusion applications, with functional safety, vision acceleration and automotive interfaces

Bluebox Timeline: Enabling Autonomous Driving to Reality



Bluebox2 Architecture

S32V234 Automotive Computer Vision Processor

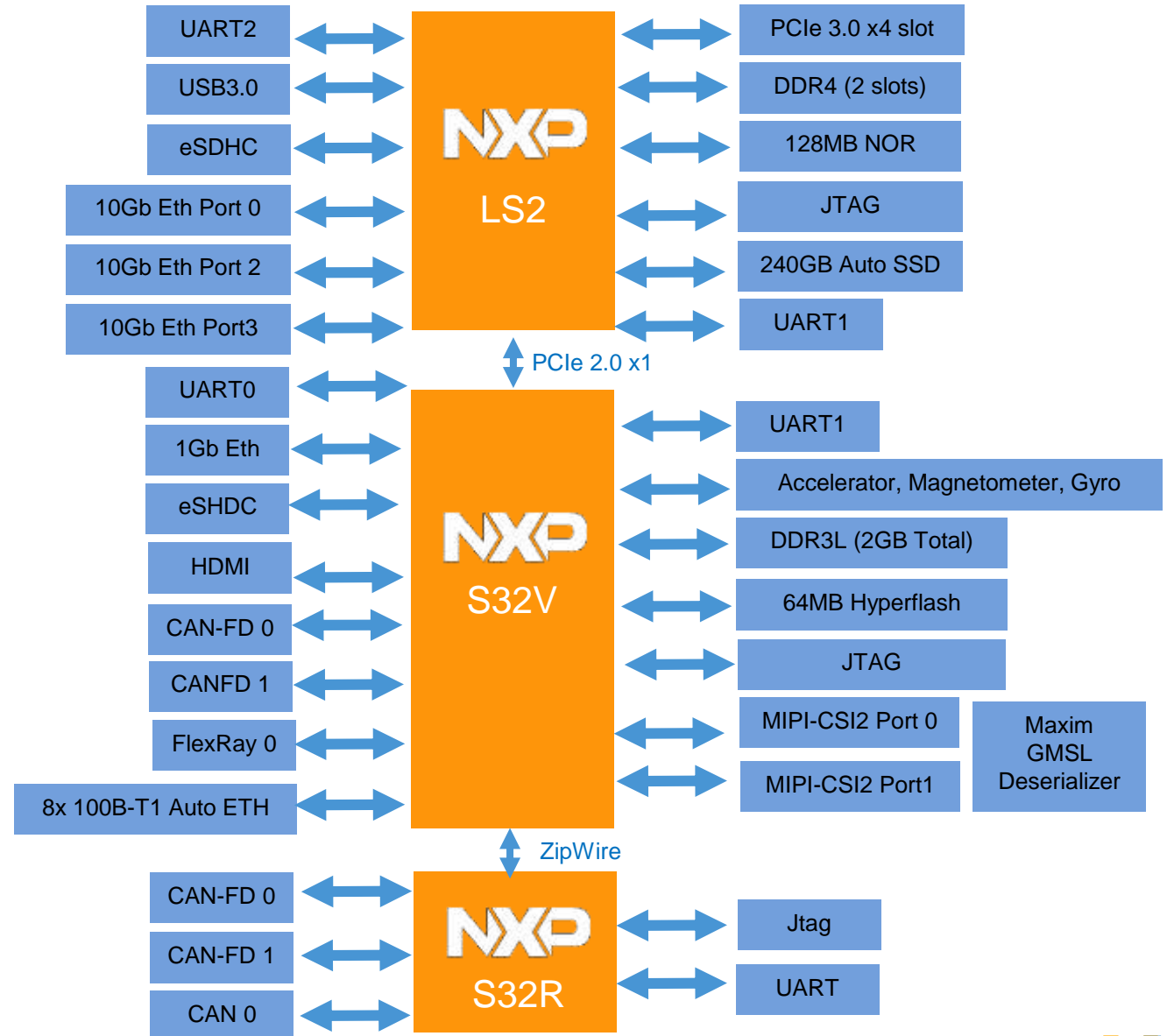
- 4x ARM A53 @ 1.0GHz
- DDR3L (2GB)
- Vivante GC3000 GPU
- NXP APEX2 advanced SIMD

LS2084A High Performance Processor

- 8x ARM A72 cores @ 2.0GHz
- DDR4 (16GB installed)
- PCIe 3.0 expansion slot

S32R274 ASIL-D Microcontroller

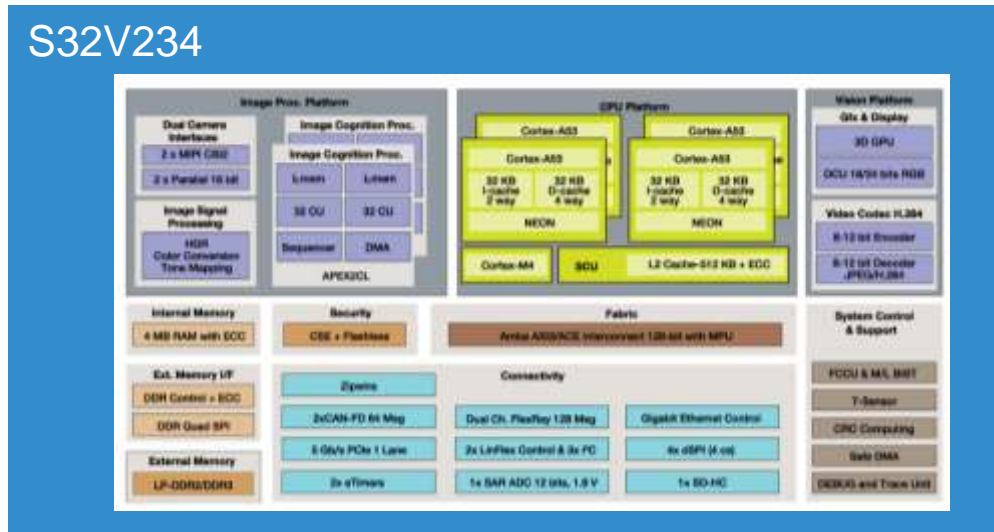
- PowerPC cores 2x e200Z7, 1x e20074



S32V234 Value Proposition

Highlights

- Computation Cores – Quad ARM A53 cores + M4 Functional Safety core
- Optimized Dual APEX Vision Acceleration to maximize performance/watt
- On-chip Image Signal processor (ISP)
- Integrated GPU with H.264 codec
- Automotive Safety - Designed for ASIL-B/C applications
- Security Enabled - Embedded cryptographic security engine



4 x ARM® Architecture A53 Cores

4x A53 cores (800 MHz), M4 functional safety core

System Memory

Up to 4MB internal SRAM plus a 32bit LPDDR2/DDR3 memory controller for external memory support

Vision Processing

MIPI-CSI2 (4 data lanes), $\Sigma\Delta$ -ADC (4x 12-bit, 10 MSps) and DAC (10 MSps), Signal Processing Toolbox SPT 2.0

Functional Safety and Security

Arm M4 functional safety core, ISO 26262 up to ASIL B/C, Cryptographic Services Engine (CSE), ECC, BIST, Voltage & Clock Monitoring

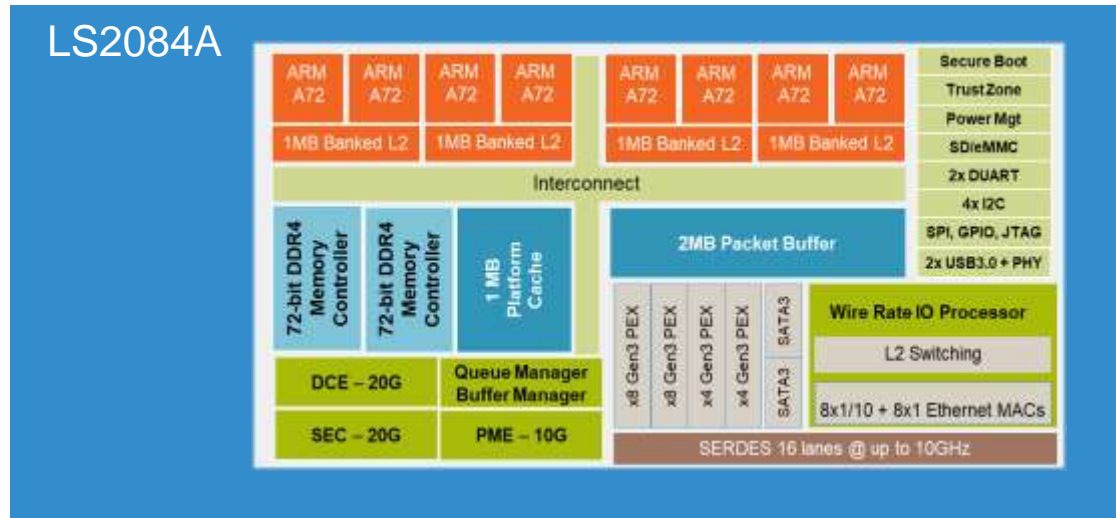
Connectivity

2x CAN-FD (Flexible Data Rate) with enhanced payload and data rate, PCIe, Ethernet, FlexRay™, Zipwire, 1 SAR-ADCs, 4x SPI, 1x SD

LS2084A Value Proposition

Highlights

- Computation Cores - Octal ARM A72 High performance cores
- Flexible Configurable Multiple High Speed IP - Allowing various system configurations
- Scalable Family of Solutions – SW compatibility with next generation LayerScape LX2 family
- Automotive Quality – AEC Q100 Grade 3 with 15 years product longevity
- Security Enabled - Embedded cryptographic accelerator with Trust Architecture



8 x ARM® architecture A72 cores

8x A72 cores (1.8 GHz)

System Memory

2x72b (wECC) DDR4 @ 1.8GTs up to 28.8GB/s memory bandwidth

High Speed IO

Multiple PCIe Gen3 controller, Multiple Ethernet MACs (up to 10G) – L2 Switching, SATA3

Functional Safety and Security

ECC protected memories, Fault localization, containment and recovery, Soft lockstep with determinism, Excellent support for virtualization, containerization

Cryptop acceleration, Trust Architecture

Connectivity

SD/eMMC, 2x DUART, 4x I2C, SPI, GPIO, 2x USB3.0

S32R27/37 Value Proposition

Highlights

- Computation Cores - Dual Power Architecture e200z7 32-bit CPU compatible to MPC5775K and S32R27
- Optimized RADAR Signal Processing Acceleration to maximize performance/watt
- Scalable Family of Solutions - Pin compatible with S32R37
- Automotive Safety - Designed for ASIL-D applications
- Security Enabled - Embedded cryptographic security engine

2 x Dual Power® Architecture e200z Cores

2x e200z7 32-bit CPU (240 MHz), 2x Power Architecture® e200z4 32-bit CPU (120 MHz) with checker core

System Memory

Up to 2 MB Flash and up to 1.5 MB SRAM for radar app. storage, message buffering and radar stream handling

RADAR I/F & Processing

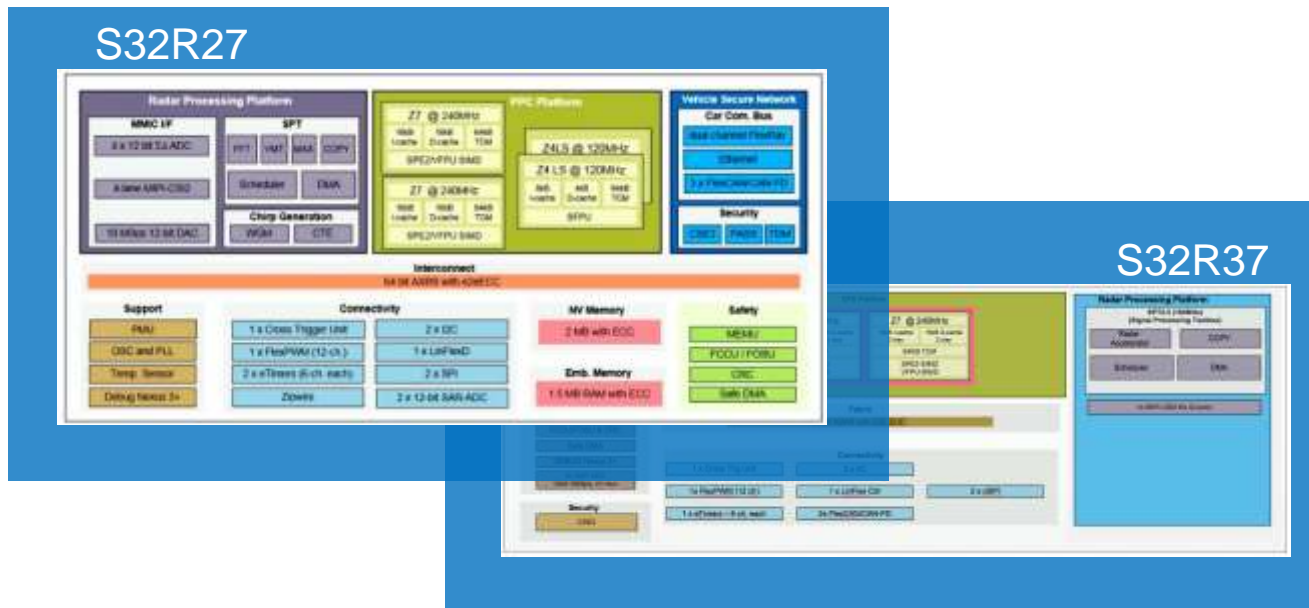
MIPI-CSI2 (4 data lanes), $\Sigma\Delta$ -ADC (4x 12-bit, 10 MSps) and DAC (10 MSps), Signal Processing Toolbox SPT 2.0

Functional Safety and Security

2x e200z7 & 2xe200z4 (lock-step), ISO 26262 up to ASIL D, Cryptographic Services Engine (CSE2), ECC, BIST, MPU, Voltage & Clock Monitoring

Connectivity

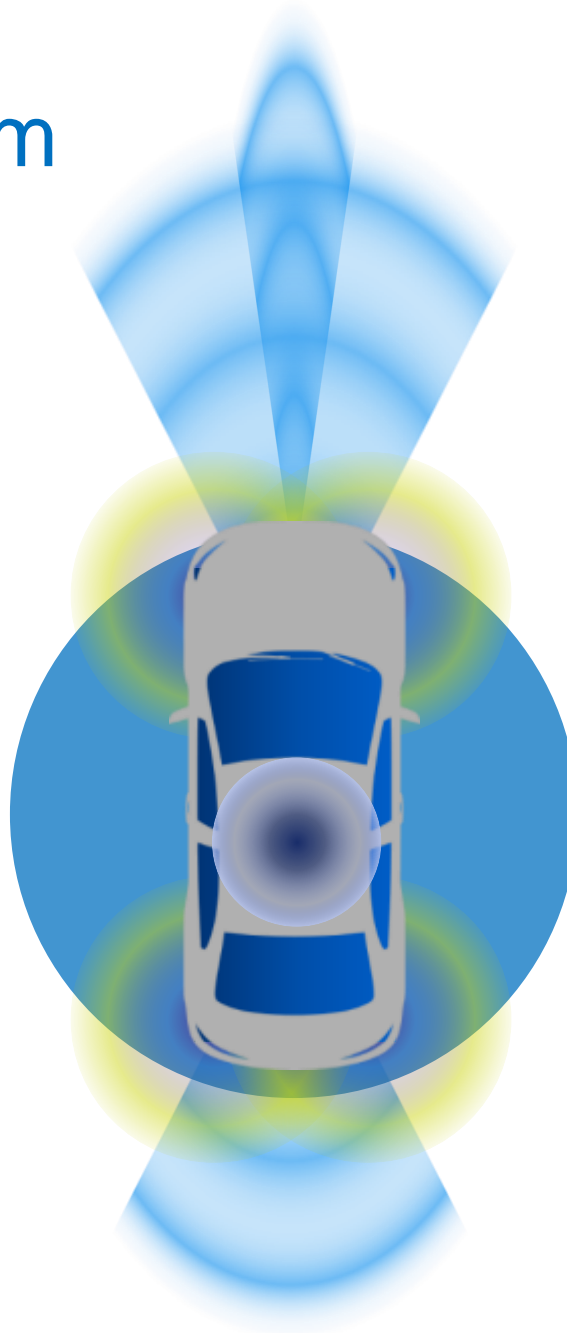
3 FlexCAN incl. 2x CAN-FD (Flexible Data Rate) with enhanced payload and data rate, Ethernet, FlexRay™, Zipwire to connect to a radar ASIC, 2 SAR-ADCs, 2x SPI, 2xI2C, LINFlexD



Broadening Ecosystem

Software Ecosystem

- RTOS
 - ✓ QNX
 - ✓ Green Hills
- Middleware
 - ✓ Elektrobit
 - ✓ Polysync
 - ✓ Baidu
 - ✓ Autoware
 - ✓ Renovo
 - ✓ CyberRT
 - ✓ ...
- Algorithm
 - ✓ Momenta
 - ✓ Embotech
 - ✓ Berkeley DD
 - ✓ CEA Tech
 - ✓ Intempora
 - ✓ ...



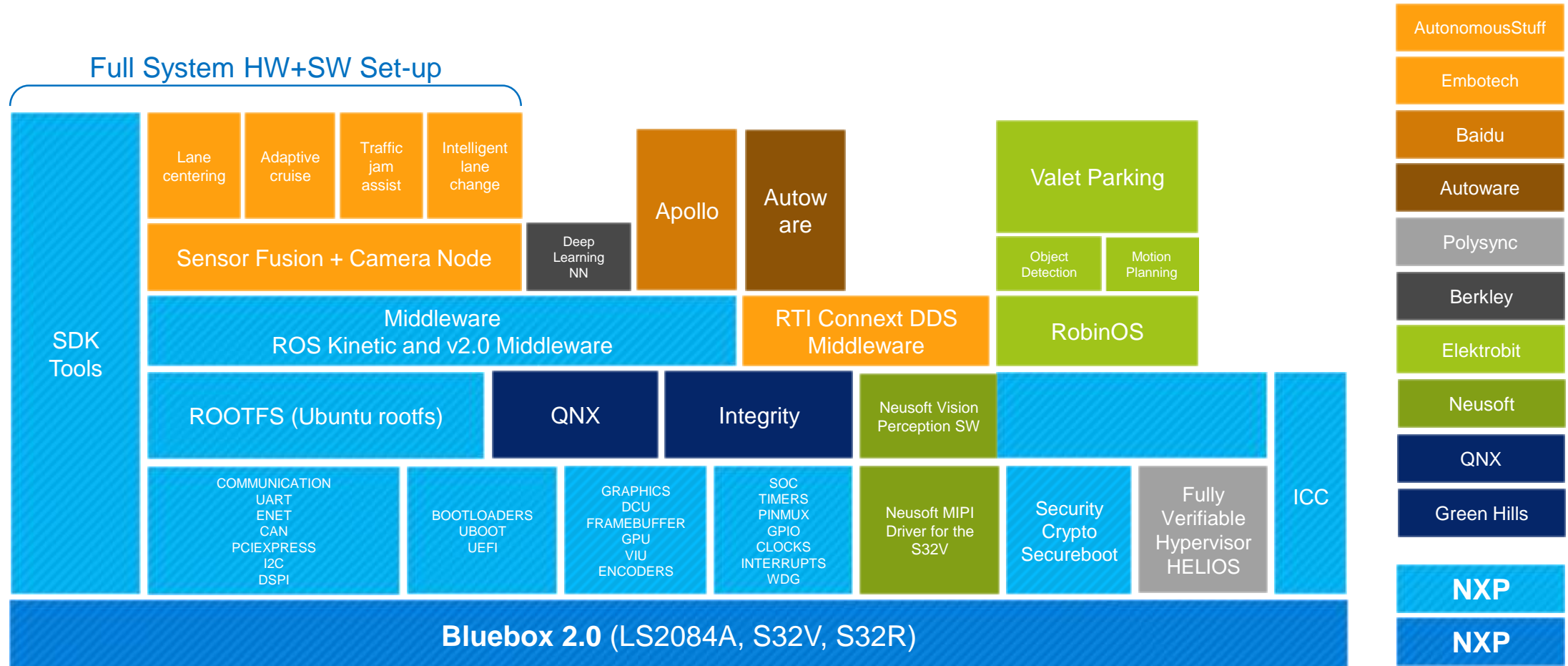
Drive By Wire

- AutonomousStuff
- Torc Robotics

Testing

- dSpace
- VSI Lab

Bluebox + Software Ecosystem



NXP Partners with Kalray to Bring Automotive-grade Development for Autonomous Driving

Kalray

Perception & Modeling

Kalray

- MPPA high performance AI accelerator: Bostan & Coolidge portfolio up to 100 Tops
- Baidu Apollo 3.0 perception software

NXP

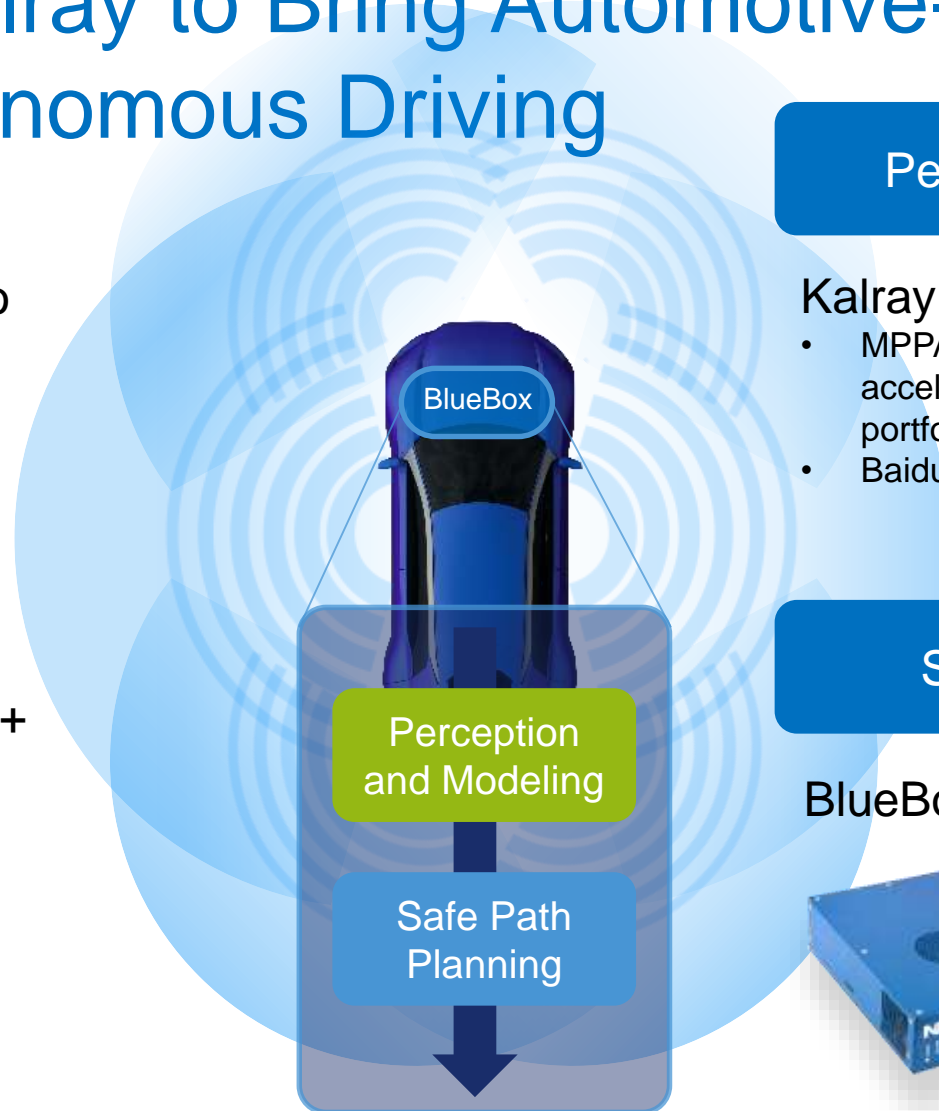
Safe Path Planning

BlueBox 2.0

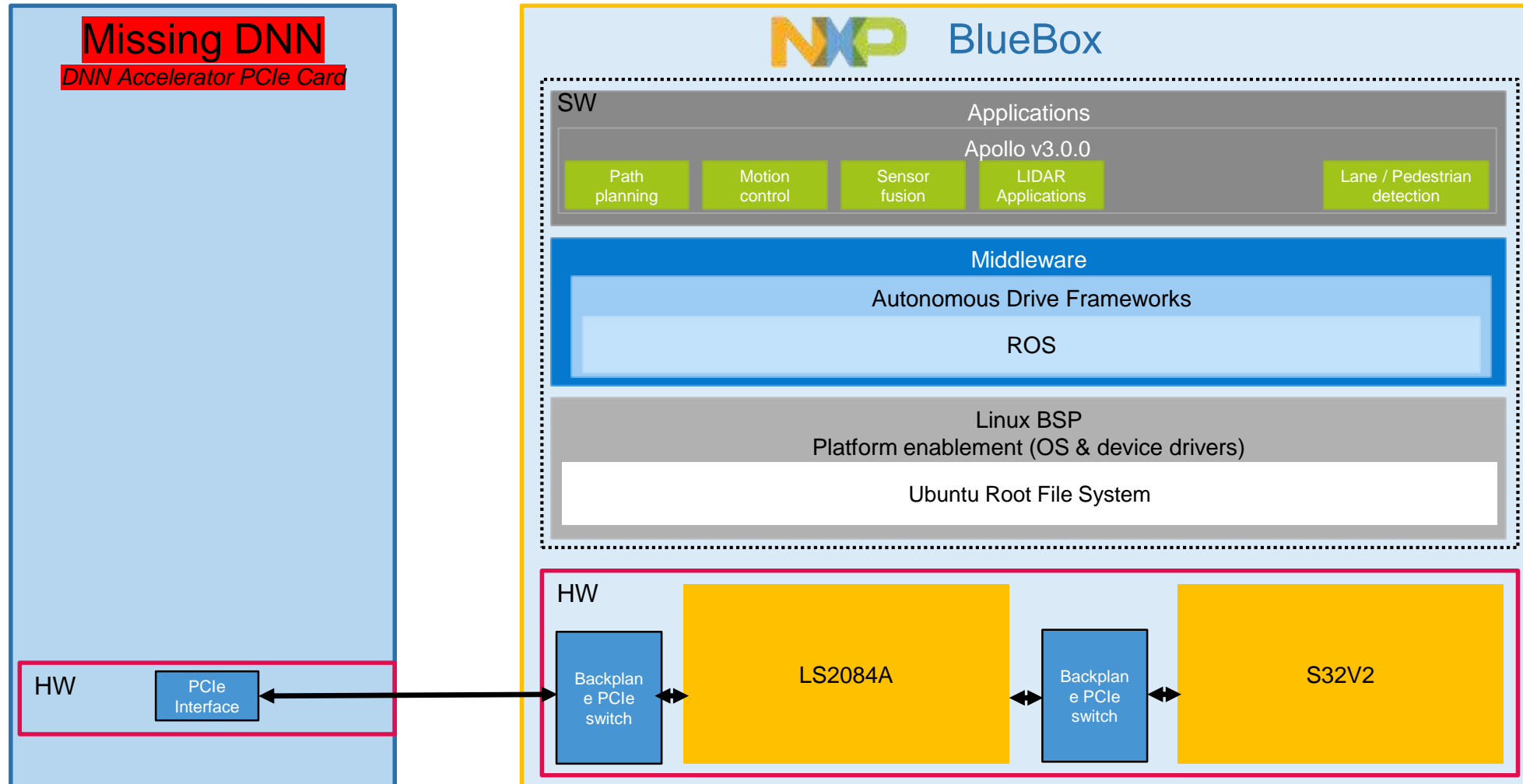


- Safe embedded AI Processor: S32V2
- High performance embedded processor: LS2084A
- Baidu Apollo 3.0 path planning software

- ✓ System partitioning allowing multi-dimensional modularity & scalability to address architectures from L2+ to L5
- ✓ Modular ASIL-B / ASIL-D for smart Safety decomposition
- ✓ High Performance to address from L2+ to L5
- ✓ Open Platform and Standard API
- ✓ End-to-End Automotive-Grade SoC's



What the NXP Automated Drive Kit Looks Like (Currently)



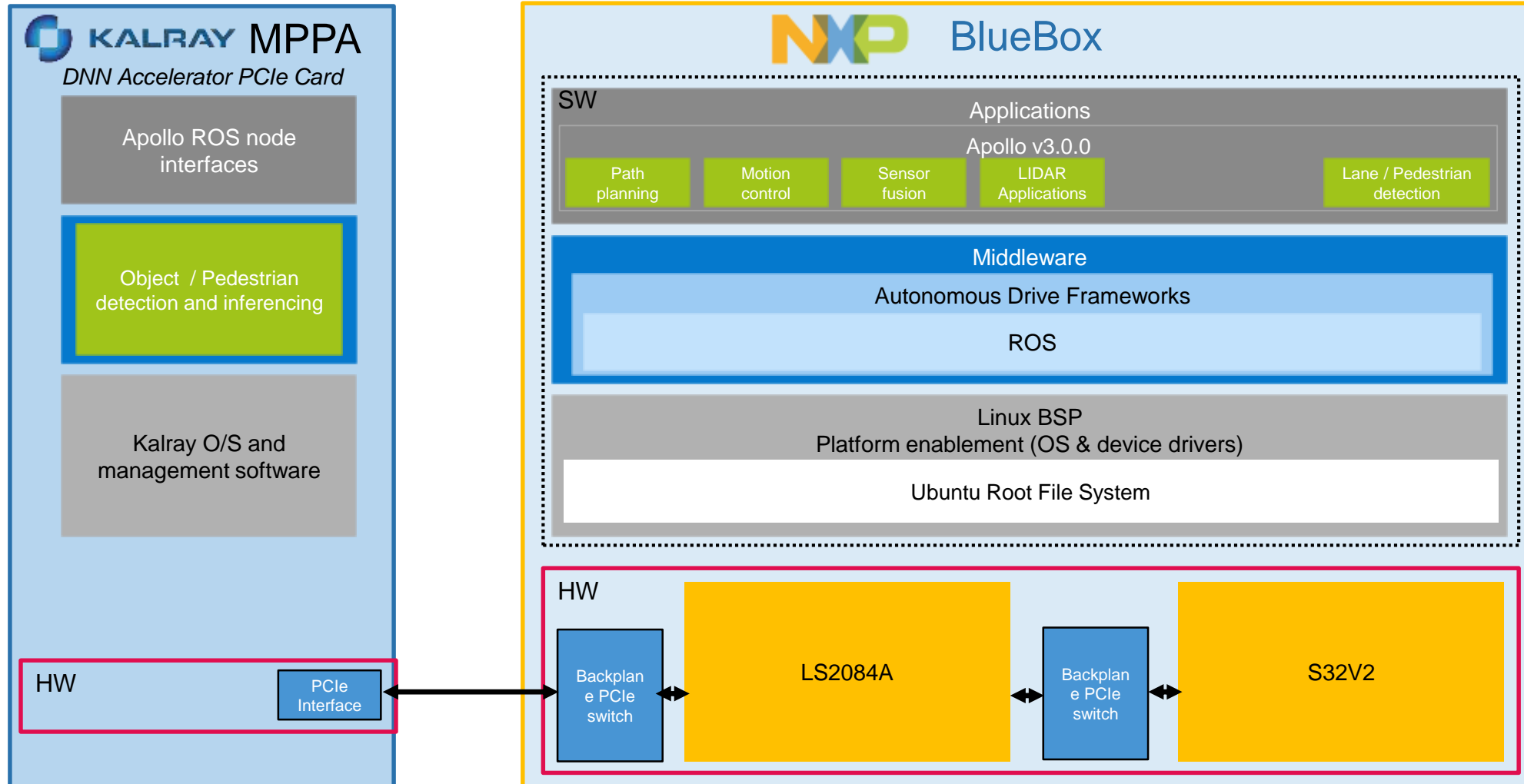
What is the NXP Automated Drive Kit (Release 1)



The Phase 1 kit will contain the following:

- Computing: NXP BlueBox 2.0, BLBX2-DB
- Vision: Neusoft Front Camera SW running on S32V234 (inside BLBX2-DB) with Truly MIPI CSI2 Camera
- LiDAR: Selection of Lidars supported
- Long Range Front Facing RADAR
- IMU & Integrated GPS
- O/S: Auto SDK Linux + Ubuntu RFS + Veth SW
- Middleware: ROS (Robot Operating System)

What the NXP + Kalray POC Looks Like



Proposed Development Options 2019

Autonomous Driving development solution using NXP BlueBox with Kalray MPPA PCIe Acceleration card for the customer evaluation and prototyping

Bluebox2 + Bostan2 MPPA card



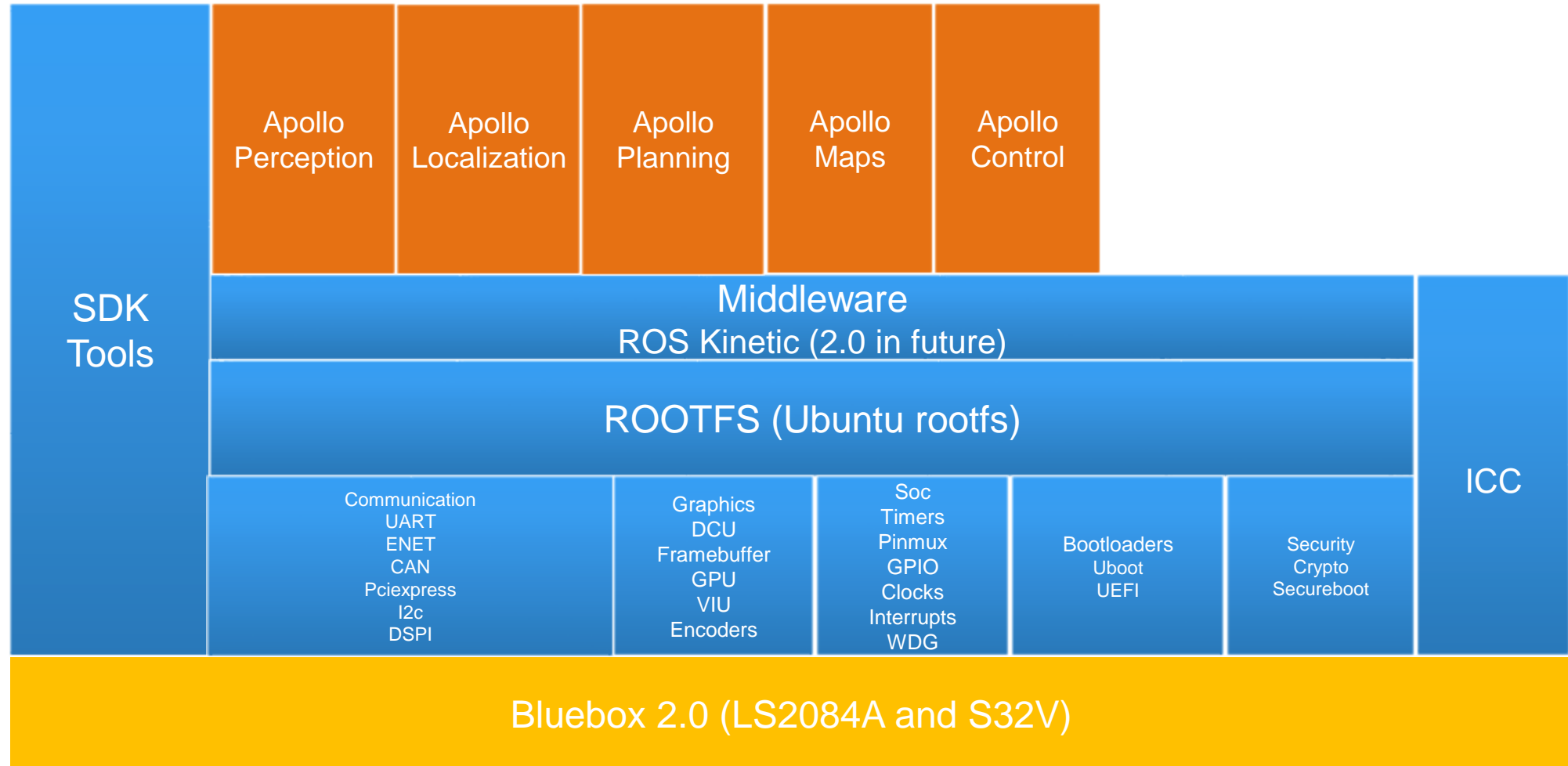
- Bluebox2 + Bostan2 MPPA card
 - Reference design available
- Demonstrated at CES
- Support Baidu Apollo
- Other Middleware under investigations depending on customer interest
- MPPA used in Acceleration Mode
- Kalray Application Framework (kAF)
- Karaly Neural Network engine (KaNN)

Bluebox2 + Coolidge MPPA card

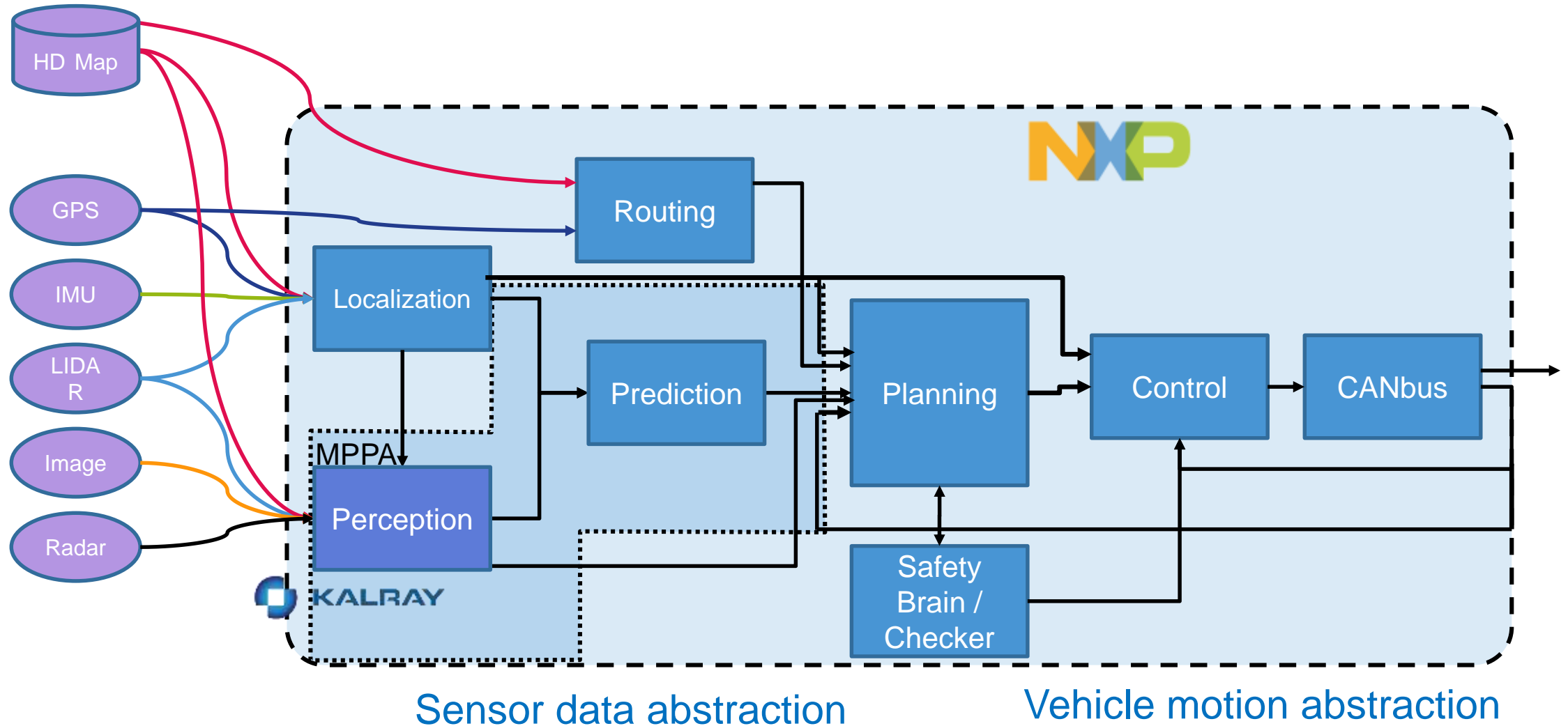


- Reference design target Q4 2019
- Bluebox2 + Coolidge MPPA Accelerator

Apollo + Auto BSPs Ubuntu + BLBX2



Kalray MPPA in Apollo v3.0 AD Vehicle Processing and Dataflow



KaNN for Bostan and “Coolidge”

KaNN (Kalray Neural Network): code generation tool developed and designed specifically for MPPA® manycore architectures, which allows deep learning inference to be run on the processor.

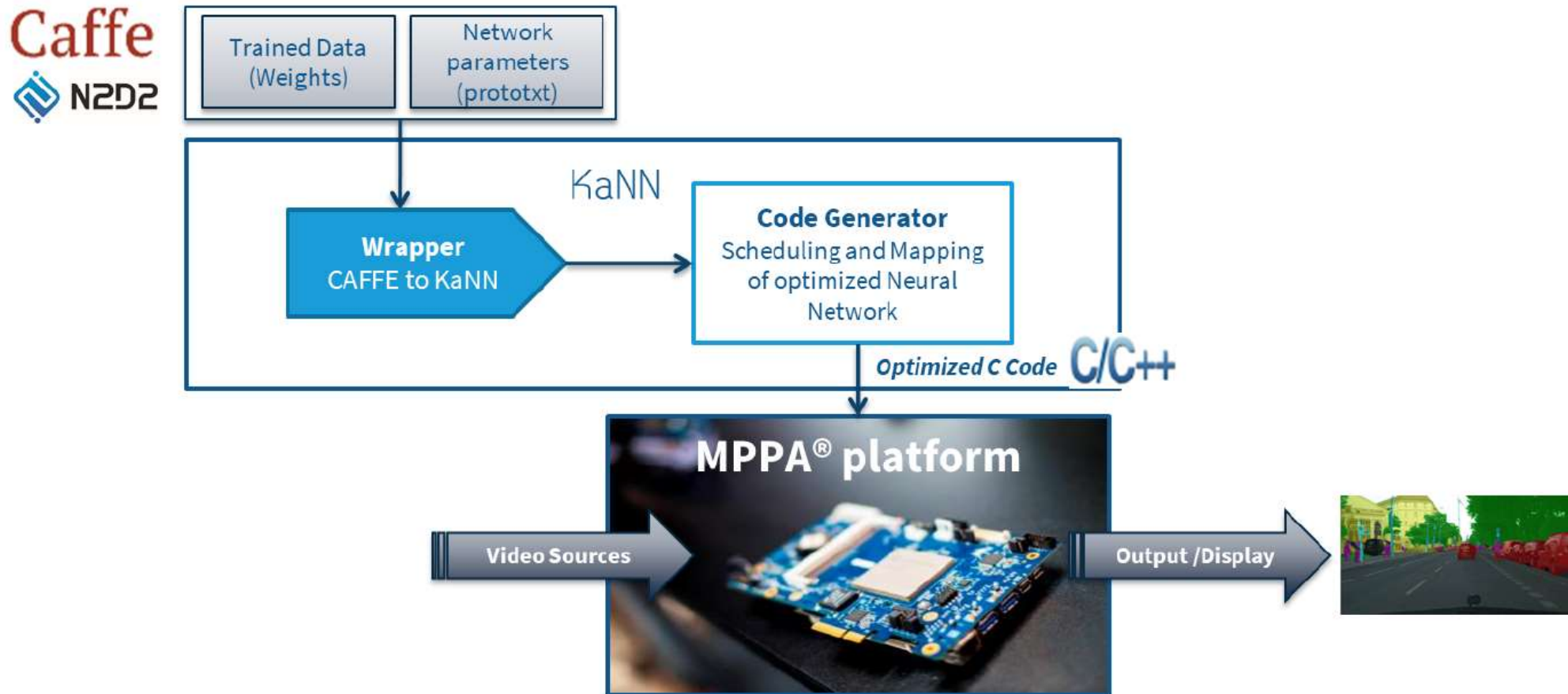
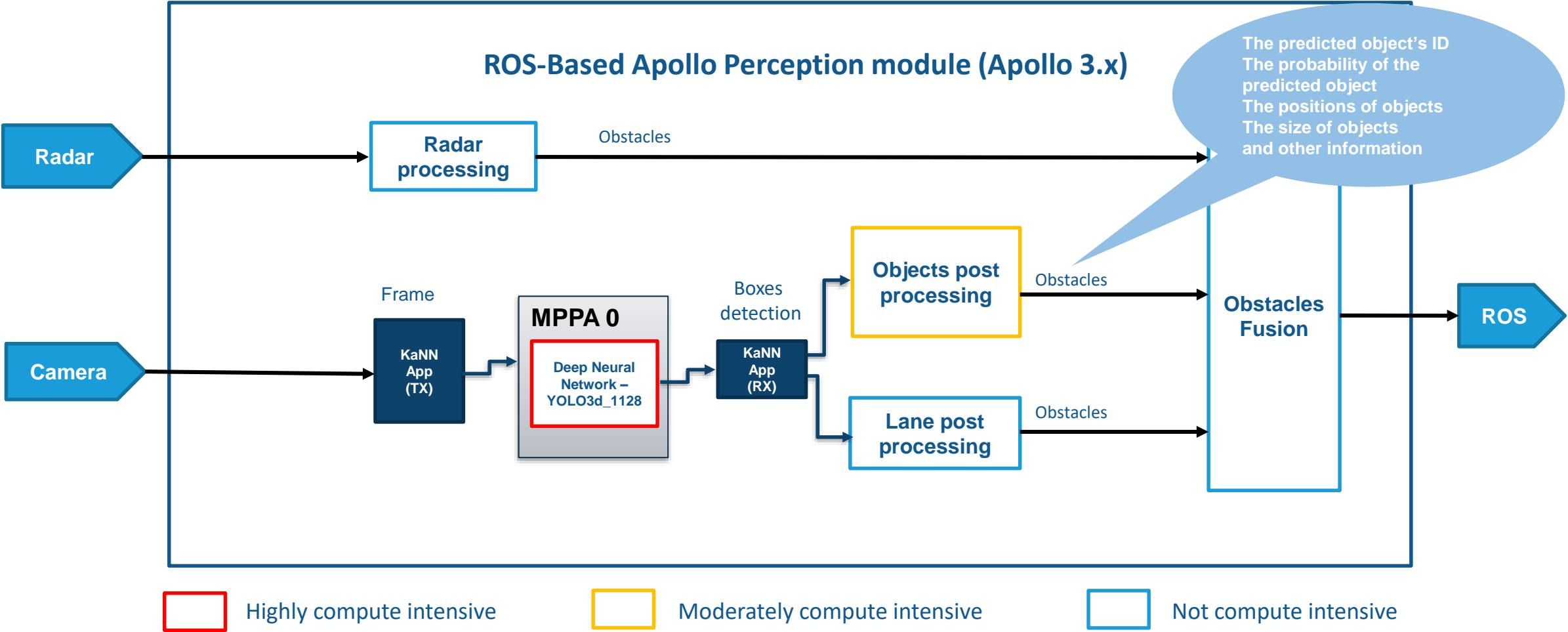
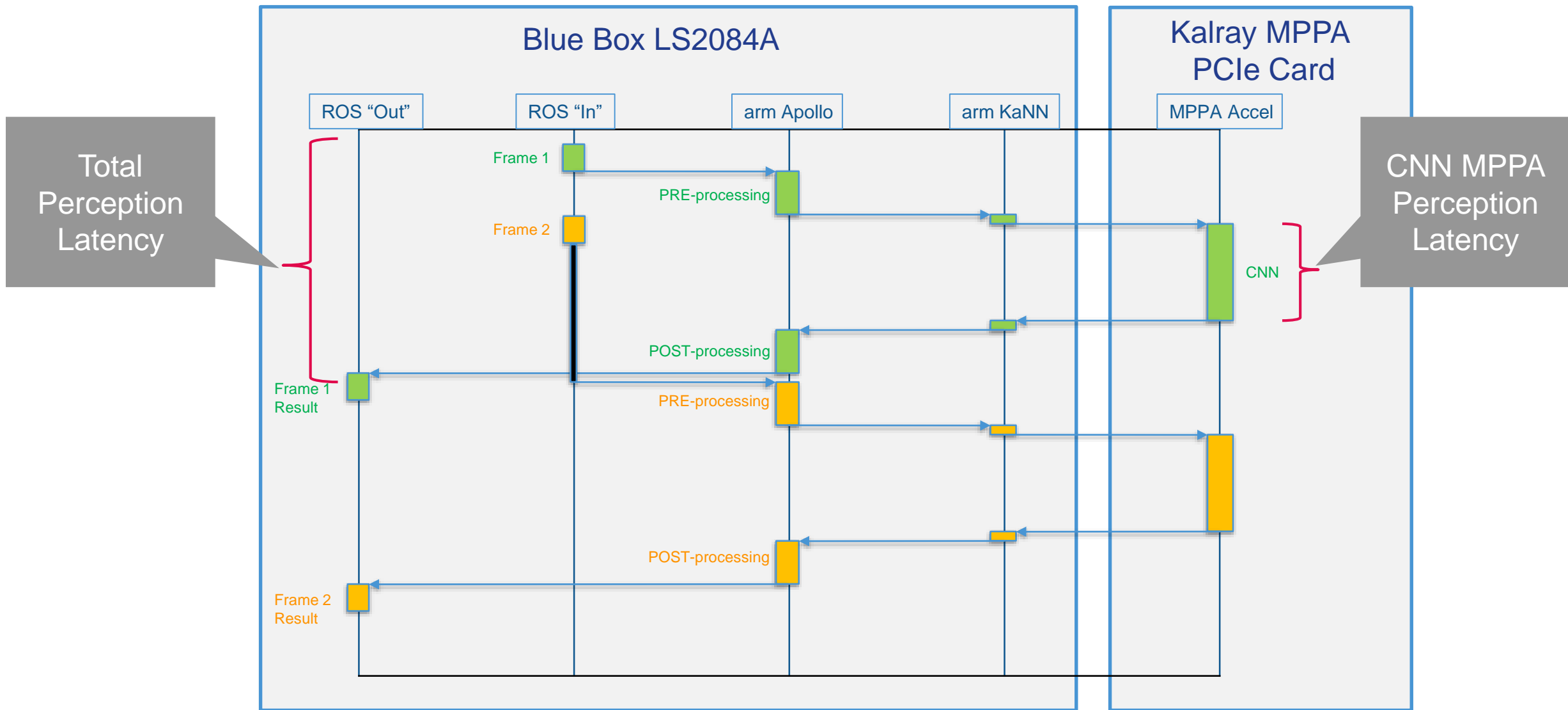


Figure 6 - KaNN operating Caffe to run CNN network on MPPA®

BLBX2 (Blue Box) + Kalray MPPA under Apollo Demo

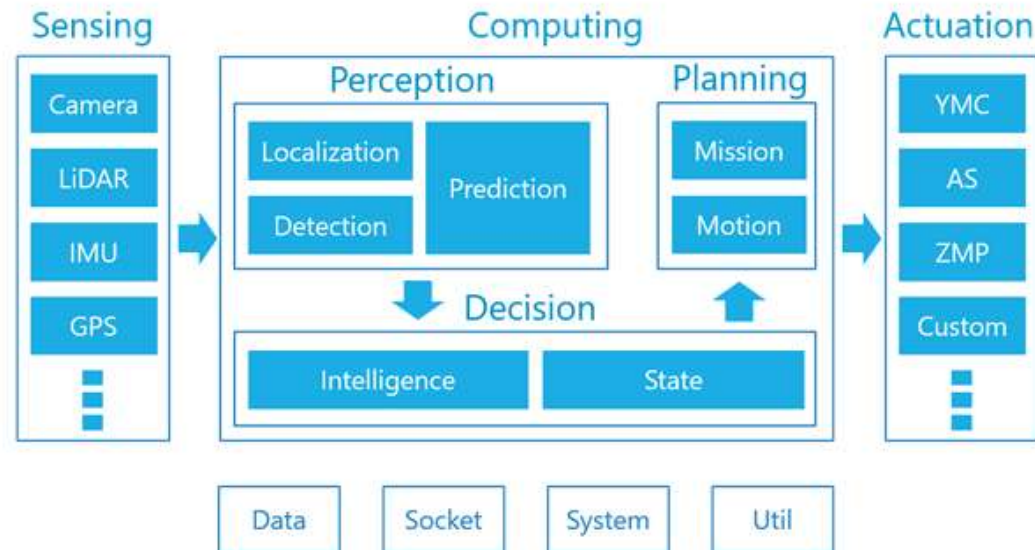
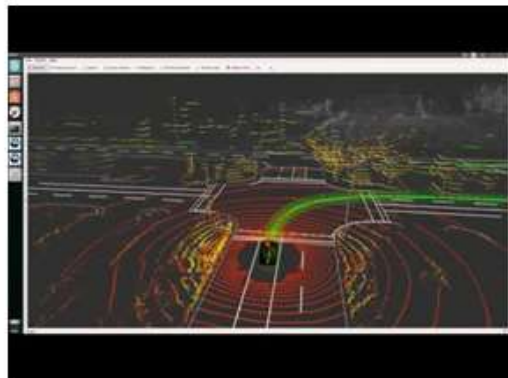


Software Transfer between LS2 and then MPPA



Support for AutoWare

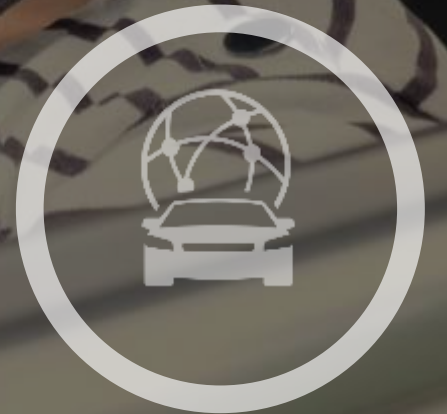
- "All-in-One" open-source software for autonomous driving technology
 - Full Localization, maps, planning and prediction
 - Similar to Apollo
 - LiDAR, Camera, RADAR GNSS and IMU sensor support
 - POC supported under Kalray MPPA
- Ported v1.10 and v1.11 to the LS2 on the Blue Box v2.0



Safe and Secure Mobility

At the heart of autonomous driving

NXP





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FOR A SMARTER WORLD**