Agenda

- Qualcomm Computer Vision Research

- Qualcomm Automotive Solution

- Qualcomm Snapdragon Automotive Cockpit Platform

- Qualcomm Driver Monitoring System

- Qualcomm Snapdragon Ride Platform

- Qualcomm ADAS and Autonomous Driving

- Qualcomm Automotive Development Environment

- Conclusion

Qualcomm Computer Vision Research

Biometrics

User authentication
- 3D Face Authentication

- Ultrasonic Fingerprint Authentication
- Both are *certified* by FIDO

Security-Rich, Built in Anti-spoof protection

3D Vision
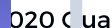
View 3D world from 2D camera
- SLAM in extended reality (XR), car and robot navigation

3D human face reconstruction
- From a 2D image to a persona-lized 3D face mesh with texture

Human-centric Vision
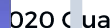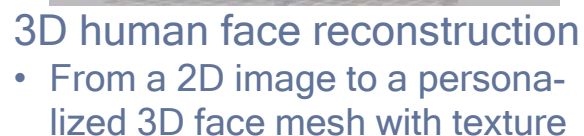
Perception of faces and bodies
- Semantic segmentation
- Face detection, recognition, etc.

Driver Monitoring System
- Drowsiness and distraction

ADAS & Autonomous Driving
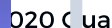
Multi-modal vision
- Camera + radar perception

- Localization
- Sensor fusion and road visualization
- Intelligent behavior planning
- From ADAS to Autonomous Driving
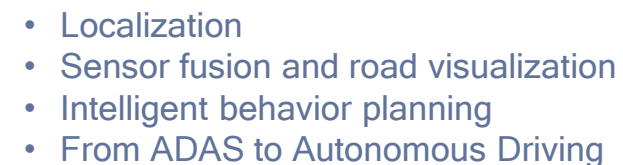
Qualcomm Computer Vision Demos

Qualcomm® Snapdragon™ Automotive Cockpit Platform and Qualcomm® Snapdragon Ride™ Platform

Qualcomm Automotive: Four Key Areas

Snapdragon Telematics

C-V2X apps   Telematics Apps   Security

5G   4G LTE   3G

MF-GNSS, Dead Reckoning, VEPP, IMS, Voice over NR eCall, NG eCall
Aerolink V2X Security

Scalable Reference Designs incl. MDMs, C-V2X modules
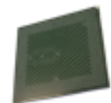
Qualcomm
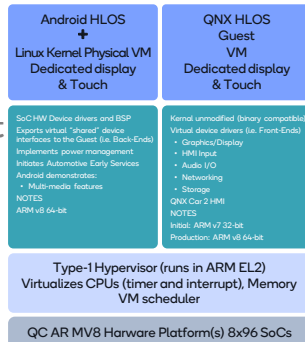
Snapdragon Cockpit

Surround View   Driver Monitoring   QNX

Audio   Virtual Assistant   fire OS 6

AUTOMOTIVE GRADE LINUX

amazon   INTEGRITY MULTIVISOR   LXC

IVI Cockpit

Qualcomm Module

Android HLOS + Linux Kernel Physical VM Dedicated display & Touch	QNX HLOS Guest VM Dedicated display & Touch
SoC HW Device drivers and BSP Exports virtual "shared" device interfaces to the Guest (i.e. Back-Ends) Implements power management Initiates Automotive Early Services Android demonstrates: • Multi-media features NOTES ARM v8 64-bit	Kernel unmodified (binary compatible) Virtual device drivers (i.e. Front-Ends) • Graphics/Display • HMI Input • Audio I/O • Networking • Storage QNX Car 2 HMI NOTES Initial: ARM v7 32-bit Production: ARM v8 64-bit

Type-1 Hypervisor (runs in ARM EL2) Virtualizes CPUs (timer and interrupt), Memory VM scheduler

QC AR MV8 Harware Platform(s) 8x96 SoCs

Snapdragon Ride

Hardware platforms
Scalable and Thermally efficient

Family of SoCs and Accelerator

Qualcomm ADAS application processor   Qualcomm ADAS application processor   Qualcomm Autonomous driving accelerator

Stack

Radar   HD map   C-V2X   Lidar

Snapdragon Ride Autonomous Stack
Hybrid Deep learning + Computer Vision approach
30+ Concurrent Deep Learning Networks
Advanced RADAR perception w/ Deep learning
Hybrid RL based Prediction & Planning

Camera   *Localization*   *Ultrasonic*

Qualcomm VEPP + Map Fusion

Car-to-Cloud Services

Qualcomm Car-to-Cloud Platform

C2C agents
• SoftSKU
• Feature activation
• App & content enablement
• Regionalization

Dynamic Feature Licensing

C2C PaaS
• MVNO
  • SIM Management
  • Differentiated billing
• OTA
• Security
• Analytics

PaaS / month

MNOs/MVNOs (Airtime)
Bring your own plan – consumer
Sponsored data – 3rd party
Subsidy of HW for long term contract – MNO
Subsidy of airtime – MNO
Subsidy of data – Qualcomm
Platform Bundled with Airtime

Packaged with Platform

Content, Apps, Car Services Rear Seat Entertainment

Content and Apps Providers
• Music
• Video
• Audiobooks
• Games
• Maps

Services Providers
• Wi-Fi
• Telematics
• Parking
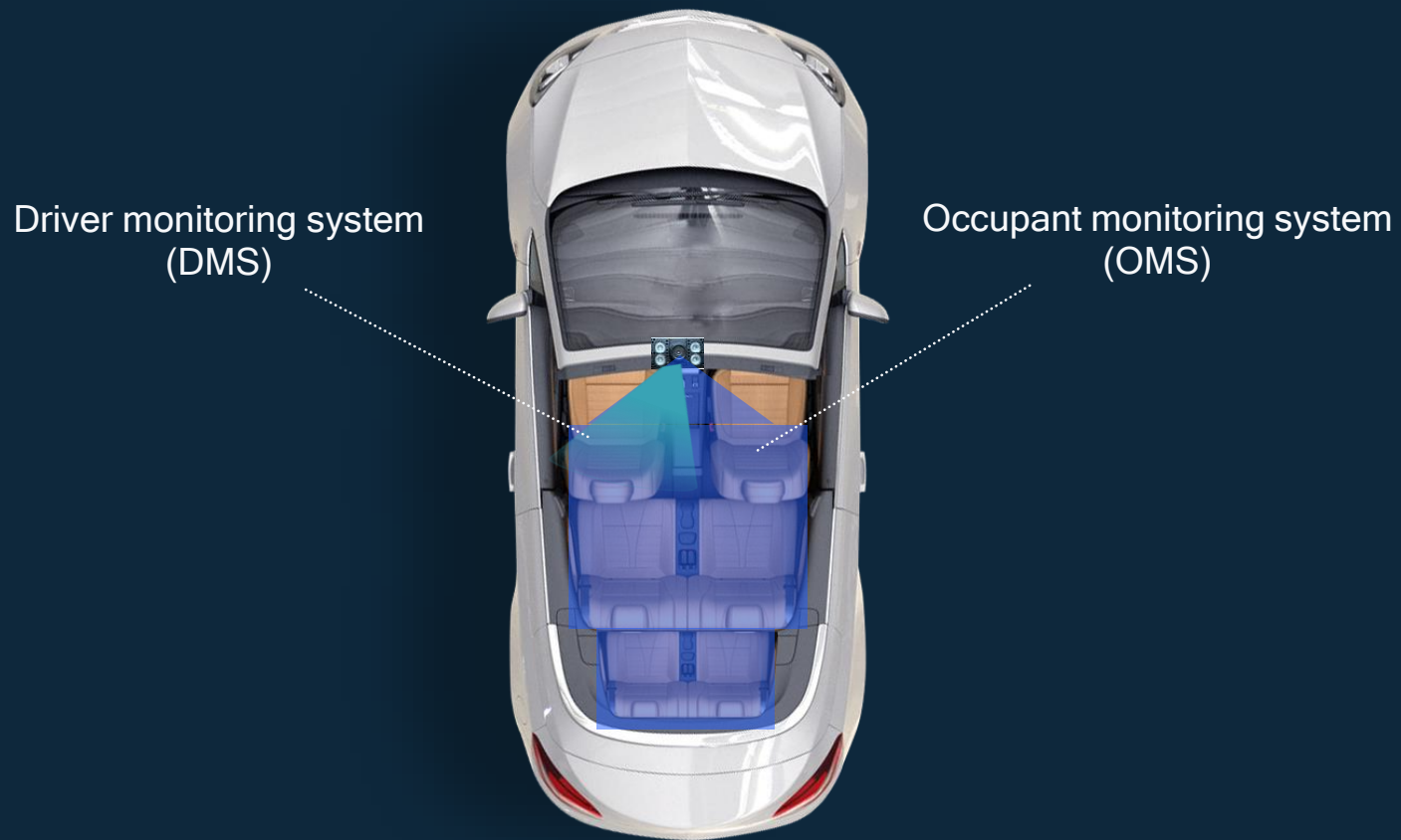• Safety

Pre-integrated in Platform

audible   prime video   music   Google   LG webOS

© 2020 Qualcomm

6

Qualcomm Snapdragon Automotive Cockpit Platform

Demoed in CES 2020

Driver monitoring system (DMS)

Occupant monitoring system (OMS)

Driver authentication

Passenger counting

Baby and toddler safety

Driver distraction

Driver drowsiness

Interactive UI

Qualcomm Snapdragon is a product of Qualcomm Technologies, Inc. and/or its subsidiaries

Snapdragon Automotive Cockpit Platform

Surround View

Driver Monitoring

Audio

Virtual Assistant

QNX | Android | fire OS 6

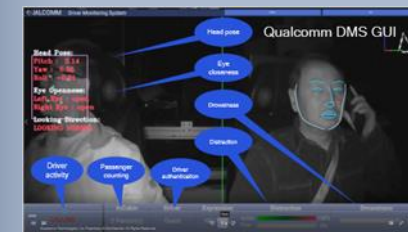### Contextual safety with DMS

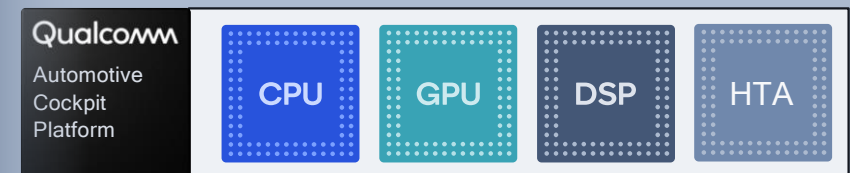QDMS with driver authentication, drowsiness and distraction detection

QOMS with passenger counting and baby/toddler detection

Visual computing with SoC acceleration

Qualcomm Automotive Cockpit Platform

CPU	GPU	DSP	HTA
Qualcomm® Kryo™ CPU	Qualcomm® Adreno™ GPU	Qualcomm® Hexagon™ DSP	Qualcomm® Hexagon™ Tensor Accelerator

Qualcomm Driver Monitoring System Demo

Qualcomm Driver Monitoring (QDMS) System

Application (CPU)

- 2D/3D camera manager
- QDMS configuration
- QDMS display

API (CPU)

- QDMS event monitor (Drowsiness/Distraction)
- QDMS manager
- QDMS wrapper

Event metadata

Face detection

- Driver activity recognition
- 3D facial landmarks/pose estimation
- Face recognition
- Facial expression recognition
- Gaze and eye closeness detection

QDMS engine with Snapdragon heterogenous computing (DSP, HTA)

Qualcomm

Qualcomm Snapdragon Ride Platform

Front camera view

360 surround perception

Sensor coverage for 360° environmental recognition complemented by HD maps and V2X

Long range radar
Long range rear camera
Mid range radar
CV2X
Localization
Rear side camera
Mid range radar
Rear side camera
Front side camera
Mid range camera
Mid range radar
Long range camera
Front side camera
Mid range radar
Long range radar
Mid range radar
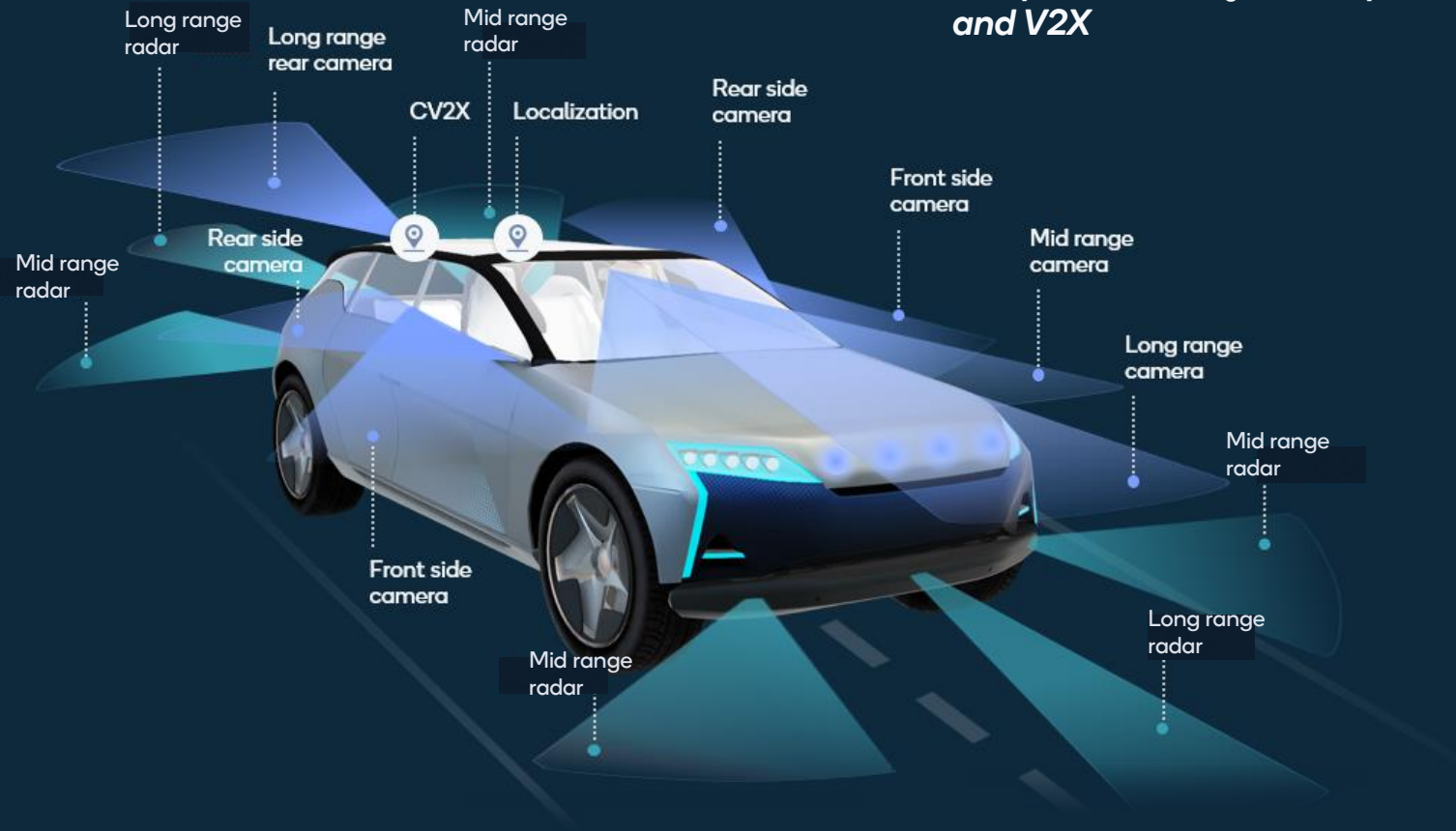
Traffic light
Traffic sign
Pedestrian
Bicycle
Vehicles
Lane detection

SPEED LIMIT 65

Snapdragon Ride Platform

Radar *HD-Map* *C-V2X* *Lidar*

Snapdragon Ride Autonomous Stack

Hybrid Deep learning + Computer Vision approach
30+ Concurrent Deep Learning Networks
Advanced RADAR perception w/ Deep learning
Hybrid RL based Prediction & Planning

Camera *Localization* *Ultrasonic*

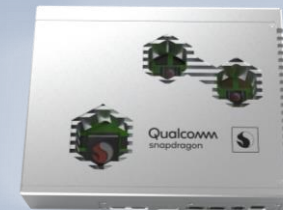Qualcomm VEPP + Map Fusion

Family of SoCs and Accelerator

Qualcomm
ADAS application processor

Qualcomm
ADAS application processor

Qualcomm
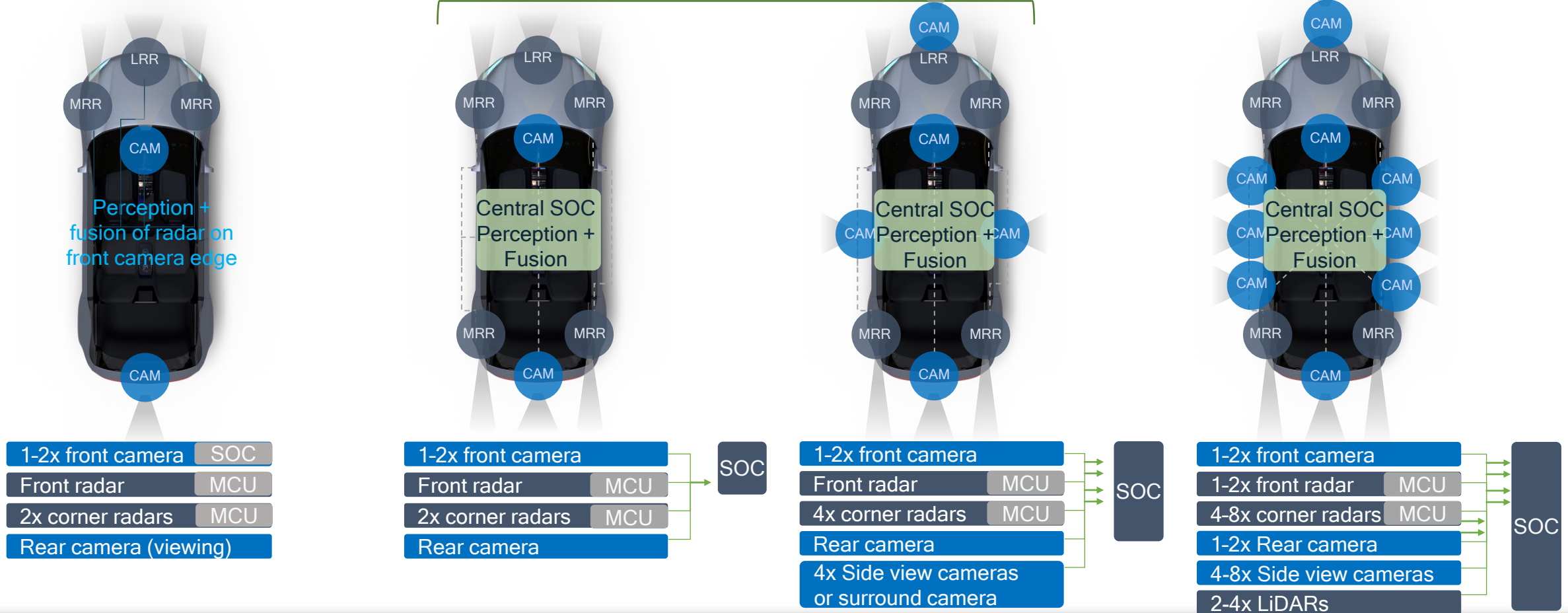Autonomous driving accelerator

Hardware platforms

Scalable and Thermally efficient

Qualcomm snapdragon

Autonomous Levels of Driving and Complexity Trends

Highway autopilot systems

Perception + fusion of radar on front camera edge

Central SOC Perception + Fusion

Central SOC Perception + Fusion

Central SOC Perception + Fusion

NCAP / L1	Level 2	Level 2+/ L3	Level 4+
1-2x front camera — SOC	1-2x front camera	1-2x front camera	1-2x front camera
Front radar — MCU	Front radar — MCU	Front radar — MCU	1-2x front radar — MCU
2x corner radars — MCU	2x corner radars — MCU	4x corner radars — MCU	4-8x corner radars — MCU
Rear camera (viewing)	Rear camera	Rear camera	1-2x Rear camera
	SOC	4x Side view cameras or surround camera — SOC	4-8x Side view cameras
			2-4x LiDARs — SOC

Both Level 2 and Level 2+ are generalized as Highway Autopilot systems but there is a broad range of KPIs, features that scale with different levels of complexity and performance needs and thus enabling different levels of safety and convenience experience
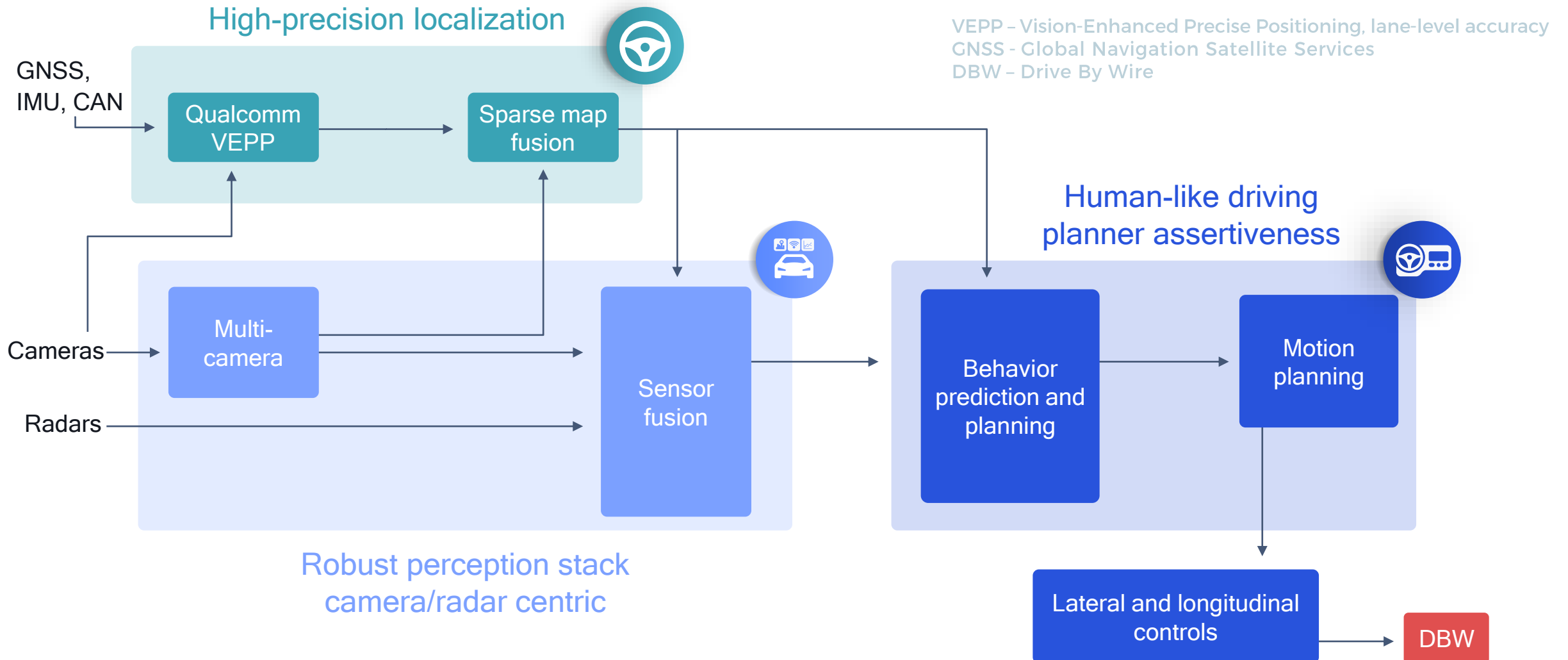
Qualcomm Snapdragon Ride Platform Demo

Snapdragon Ride Autonomous Stack

High-precision localization

VEPP – Vision-Enhanced Precise Positioning, lane-level accuracy
GNSS - Global Navigation Satellite Services
DBW – Drive By Wire

GNSS, IMU, CAN

Qualcomm VEPP

Sparse map fusion

Human-like driving planner assertiveness

Cameras

Multi-camera

Radars

Sensor fusion

Behavior prediction and planning

Motion planning

Robust perception stack camera/radar centric

Lateral and longitudinal controls

DBW

Qualcomm

© 2020 Qualcomm

15

Proven Development Environment

Features

Camera perception

Radar perception

Behavior planning

Intelligent data record

Continuous learning

Tools

GLOW Compiler	TensorFlow Compiler	Performance monitoring

Profilers	Debuggers	Network optimizers	Quantizers

Runtimes

PYTORCH

ONNX RUNTIME

TensorFlow

Frameworks

PYTORCH

Keras

mxnet

Cognitive Toolkit

PaddlePaddle

TensorFlow

Qualcomm snapdragon

Qualcomm

Conclusion

Advancing visual computing by Snapdragon

- Snapdragon Automotive Cockpit Platform – Infotainment + QDMS

- Snapdragon Ride Platform – ADAS and autonomous driving

Advantages of Qualcomm's automotive solution

- Telematics in 4G/5G with integrated C-V2X and HP GNSS technologies

- Car-to-Cloud Services

- Integrated computer vision by AI across automotive applications

- Scalable and thermally efficient chip design

More information go to

- https://www.qualcomm.com/products/automotive

Qualcomm

Thank you