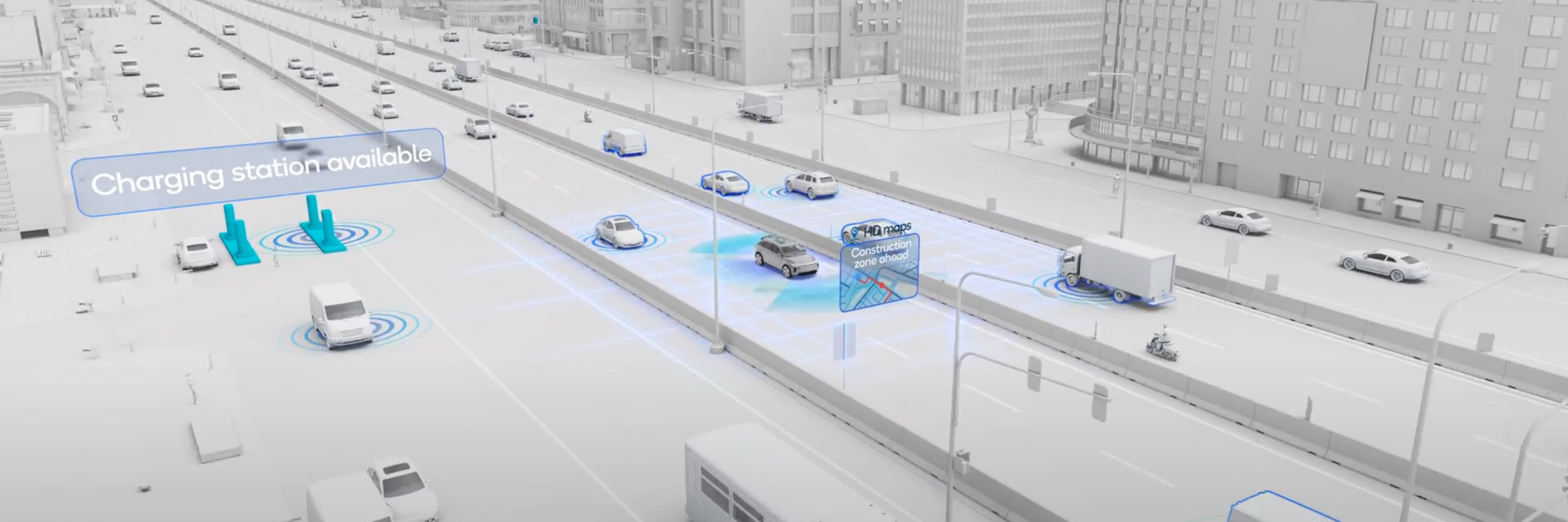
Qualcomm

Nakul Duggal

Sr. Vice President & General Manager, Automotive
Qualcomm Technologies, Inc.

@nakulduggal




Charging station available
HD maps
Construction zone ahead

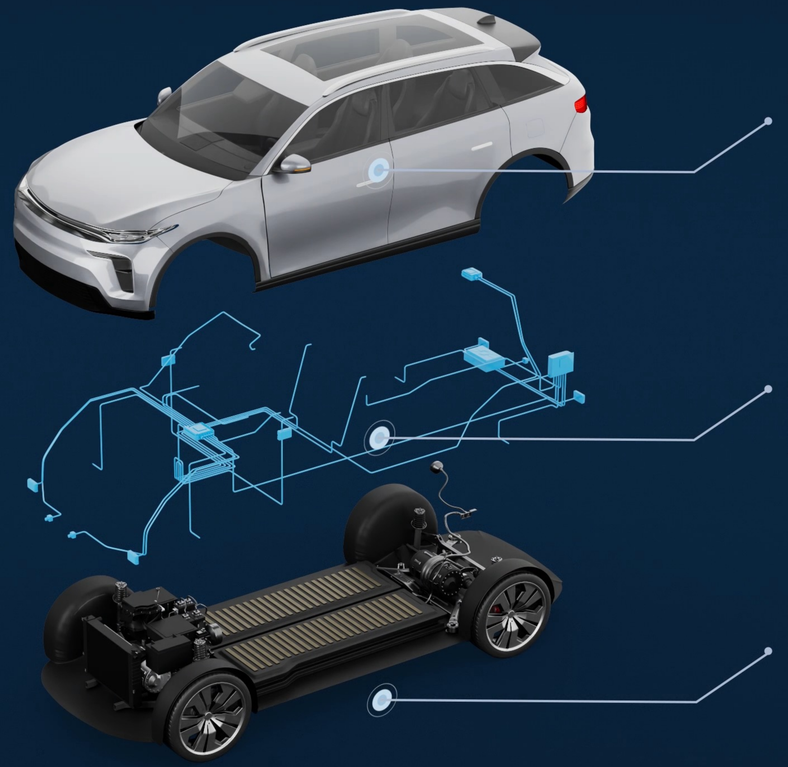
Industry evolving to a new architecture

Electrification is the accelerant

The car is ‘software defined’

Semiconductors at the center of innovation

Automakers becoming technology companies



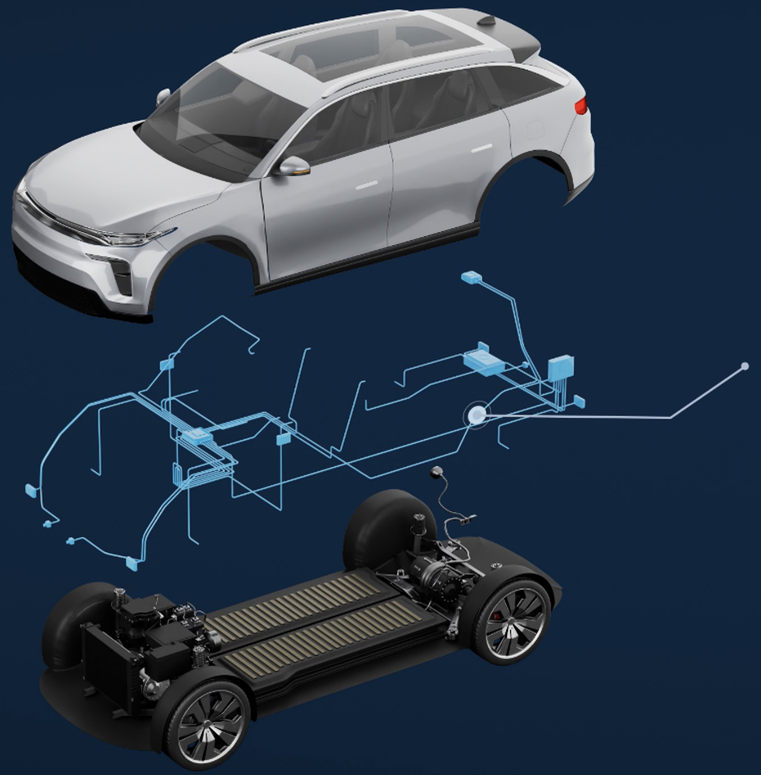
Upper body

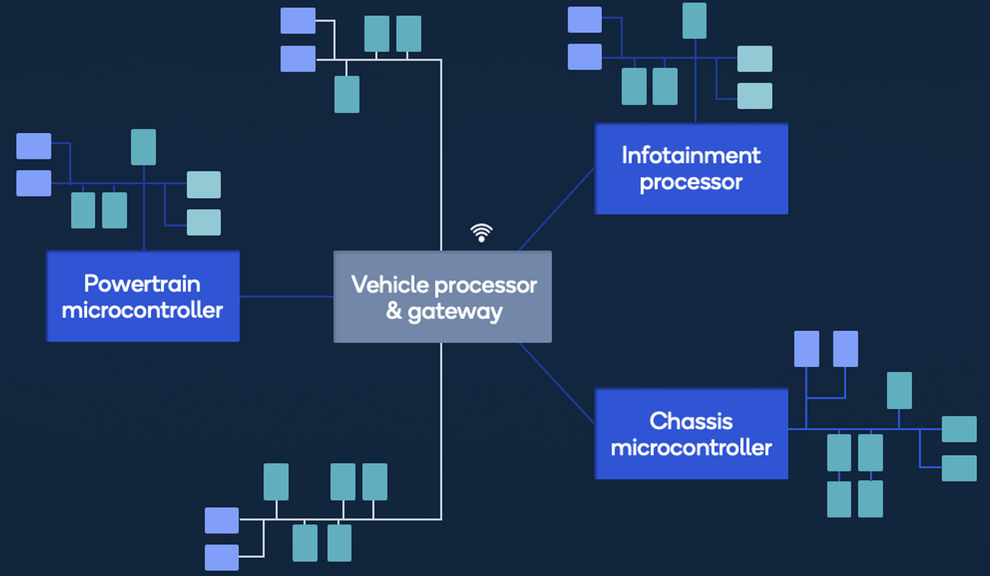
Electrical/electronic (E/E) architecture

Snapdragon® Digital Chassis™

EV/ICE chassis

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

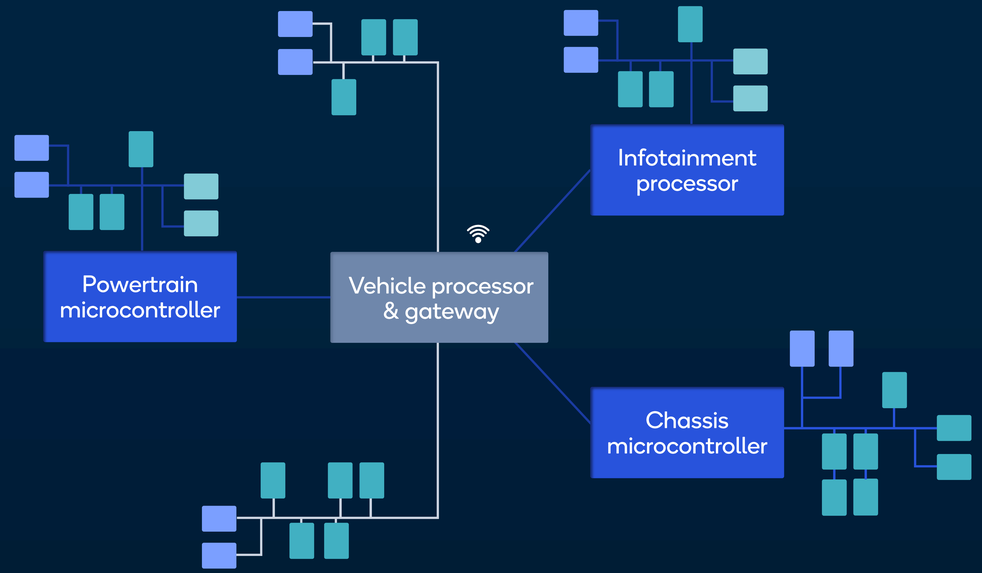




PAST

Distributed
Microcontroller centric

Industry rapidly adopting an integrated and simplified architecture



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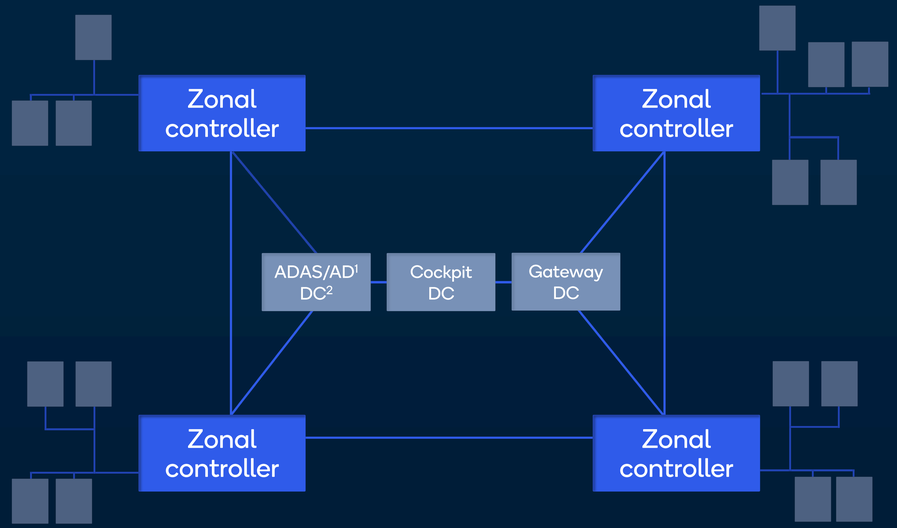
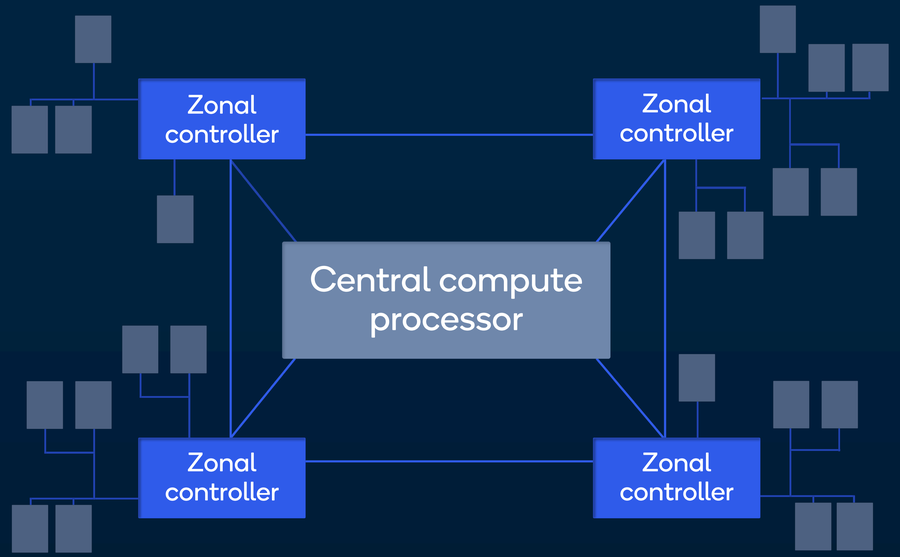


PRESENT

Domain controller centric
Zonal transition

1. ADAS/AD: advanced driver assistance system/automated driving; 2. DC: domain controller

The future is a high-performance, low-power architecture to deliver a Software Defined Vehicle



FUTURE

Centralized and integrated

Central compute clusters and zonal controllers

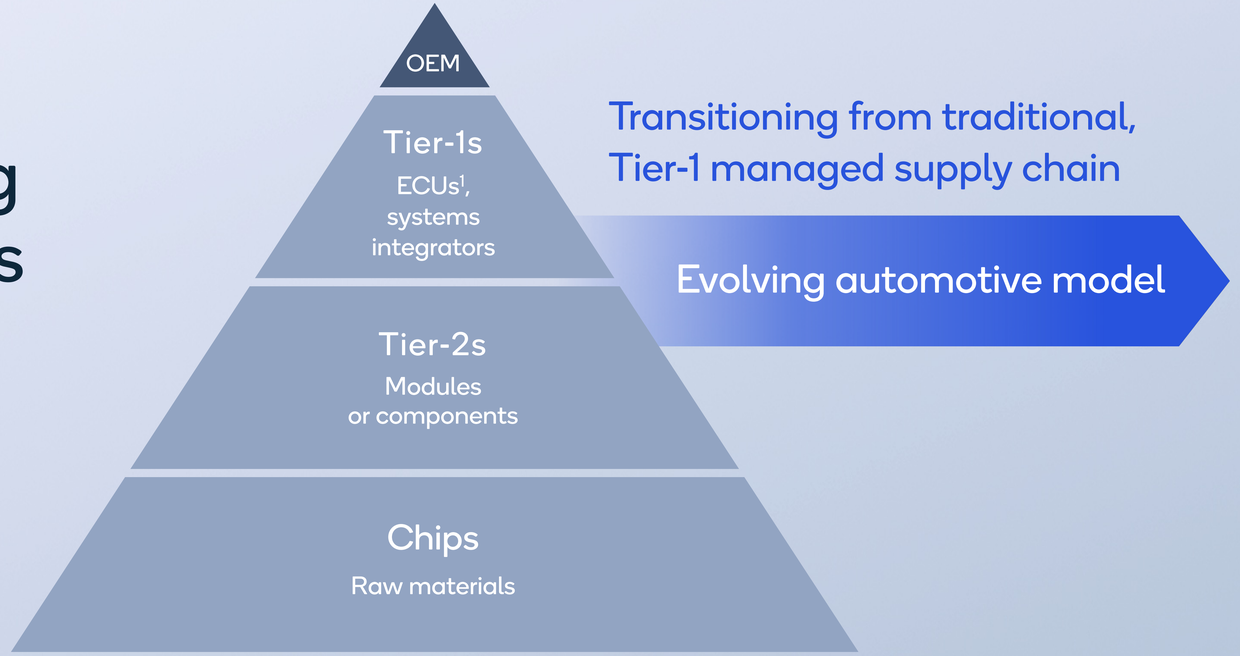
The Software Defined Vehicle is the future of the car platform

High reusability, agile development
Defines the digital brand of the automaker
Unlocks long-term services value
Hardware and software co-designed



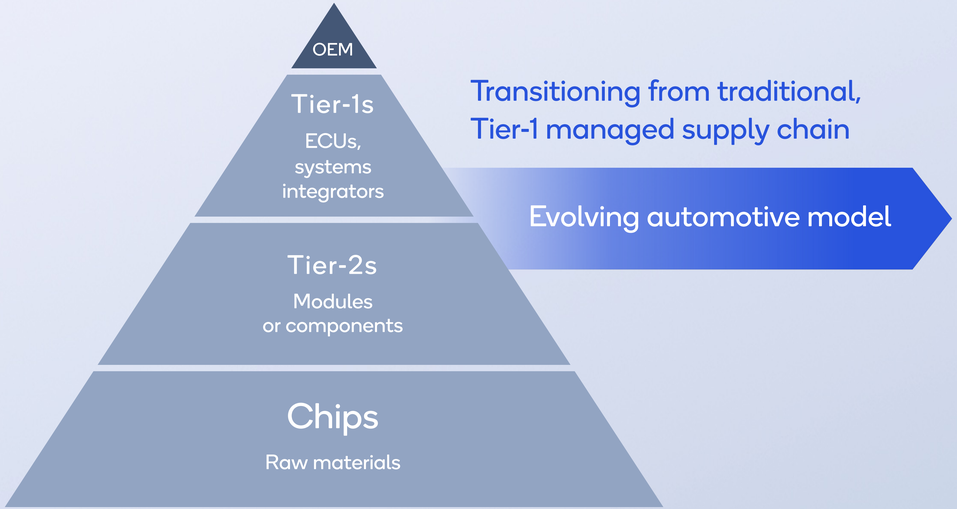
Automakers becoming technology companies

Industry embracing a new way to work



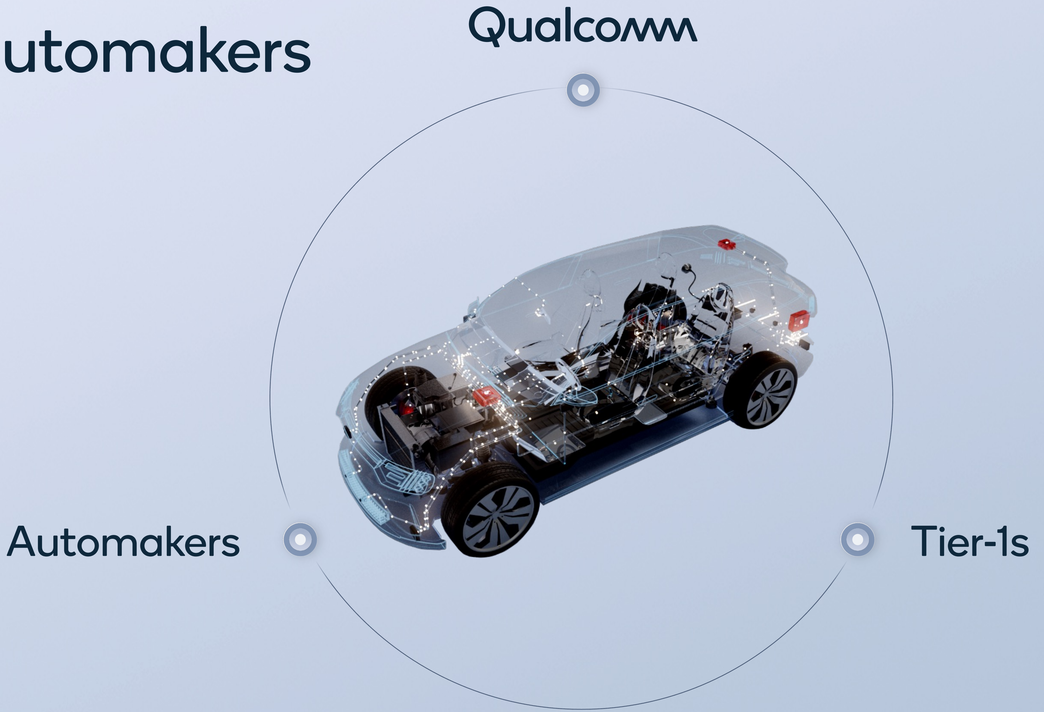
1. ECU: Electronic control unit

A new model of direct engagement with automakers



Transitioning from traditional,
Tier-1 managed supply chain

Evolving automotive model



Snapdragon Digital Chassis integrates all the essential technologies

Everything connected

- RF Front-End
- C-V2X
- App framework
- Wi-Fi
- Modem
- Bluetooth

High-performance, low-power

- Computer Vision
- Graphics
- Multimedia
- Energy Efficient Compute
- CPU
- Image Signal Processor (ISP)

Edge intelligence

- Machine learning
- Virtualization
- Security

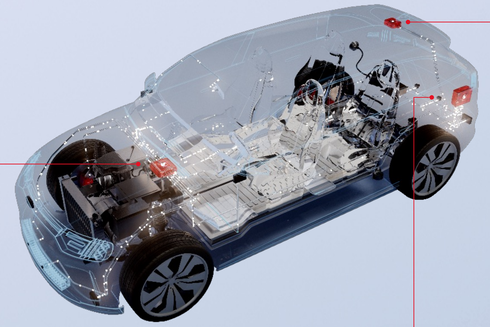
- Precision location
- Car2Cloud
- EV charging
- Automated Driving Stack
- Automated Driving
- Safety Island
- Hi-res display support
- Computer Vision
- Cybersecurity
- OS ecosystems

Snapdragon
digital chassis

A platform for the future of automotive

Snapdragon
car-to-cloud

Services platform



Snapdragon
auto connectivity platform

4G/5G cellular connectivity
In-car connectivity
Positioning
EV charging connectivity

Snapdragon
cockpit platform

In-car experiences
Instrument clusters
Navigation
Cameras
Displays
Audio and multimedia
Consumer and auto ecosystems

Snapdragon
ride platform

L1 to L4 Automated Driving SoC
with Ride Automated Driving stack

Snapdragon Digital Chassis, Snapdragon Car-to-Cloud, Snapdragon Cockpit Platform, Snapdragon Ride Platform and Snapdragon Auto Connectivity Platform are products of Qualcomm Technologies, Inc. and/or its subsidiaries


Snapdragon
digital chassis
ACURA
CHANGAN
CHERY
CHEVROLET
CHRYSLER
DODGE
EXEED 星途
飞凡汽车
GAC AION
GEELY
GWM
HAVAL
HiPhi
红旗
哪吒汽车
HYUNDAI
INFINITI
JAGUAR
Jeep
JETOUR
集度
KIA
LAND ROVER
LEAPMOTOR
LEXUS
LINCOLN
理想
LYNK&CO
MG
MINI
NIO
NISSAN
OPEL
ORA 欧拉
PEUGEOT
Polestar
ROEWE
smart
STELLANTIS
SUBARU
VOLVO
威马汽车
WEY
XPENG
ZEEKR
amazon
AT&T
BlackBerry QNX
BOSCH
cerence
中国移动 China Mobile
Continental
Deutsche Telekom
Elektrobit
Google
Green Hills SOFTWARE INC.
here
INNOVIZ TECHNOLOGIES
LG U+
maxim integrated
Micron
Microsoft
OPENSYNERGY
Red Hat
seeingmachines
Thundercomm
Valeo
VECTOR
veoneer
verizon
vodafone
WNC
ZongMu

Snapdragon
digital chassis

$100B

TAM opportunity by 2030e

$30B

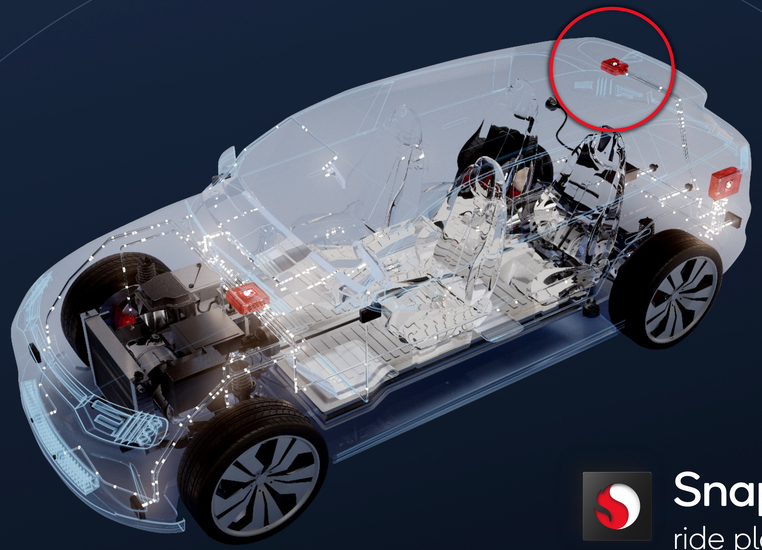
Design-win pipeline[1]

TAM: Total addressable opportunity. A combination of third-party and internal estimates for calendar year, as of September 22, 2022
1. The design-win pipeline reflects the current estimated future size of awarded automaker programs, based on forecasts provided directly by automakers and Tier-1 suppliers. Does not include $900 million of RF Front-End design-win pipeline

Snapdragon
digital chassis

Snapdragon
car-to-cloud

Snapdragon
cockpit platform



Snapdragon
auto connectivity platform

Snapdragon
ride platform

Snapdragon
auto connectivity platform

Snapdragon
car-to-cloud

On the road

Navigation/Maps

Smartphone connectivity/In-car hotspot

Safety/Emergency alerts

Fleet management

Cellular-V2X



Stationary

Charging station location

OTA updates

Remote lock/unlock and start

Predictive maintenance

Snapdragon
auto connectivity platform

The leader in auto connectivity[1]

Most comprehensive roadmap and portfolio

Multi-decade automotive connectivity leadership

Leadership[1] through research, standards and development

Global operator and infrastructure vendor partnerships



#1 Modem



#1 Wi-Fi/ Bluetooth®



#1 Position Location



#1 Powerline Communication



RF Front-End



Cellular V2X



Satellite Communication

Software services



Connectivity APIs



Car2Cloud CaaS[2]

1. Internal sales data; 2. Cloud-as-a-Service

Snapdragon
auto connectivity platform

250M+ Vehicles on the road with our cellular connectivity

Increasing rate of connected vehicles and transition to 5G

History of success

10+ product generations

400M+ Wi-Fi/Bluetooth® units sold

Making vehicles safer

Pioneered C-V2X

Deployments ramping

Connected vehicle platform

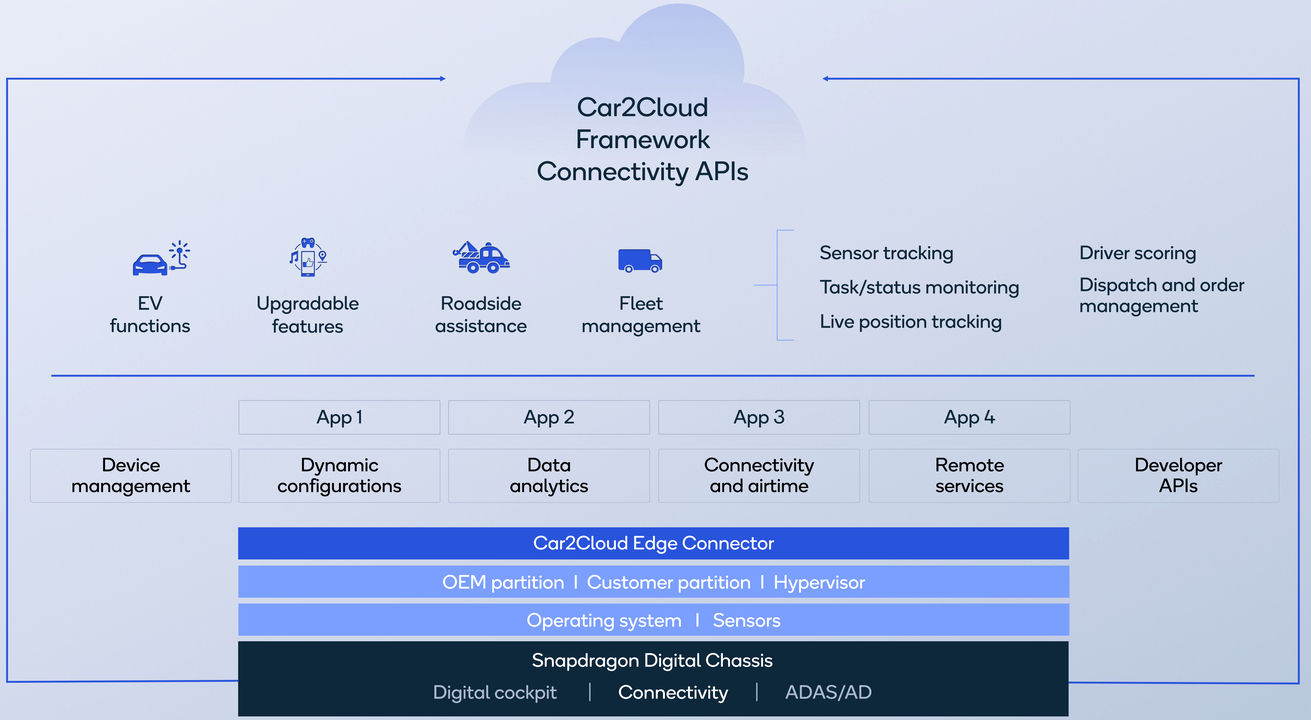
Connecting to cloud services to unlock new business models

Source: Internal data, as of September 22, 2022

Snapdragon
car-to-cloud

A unique connected vehicle service platform

Enabling services across the Snapdragon Digital Chassis

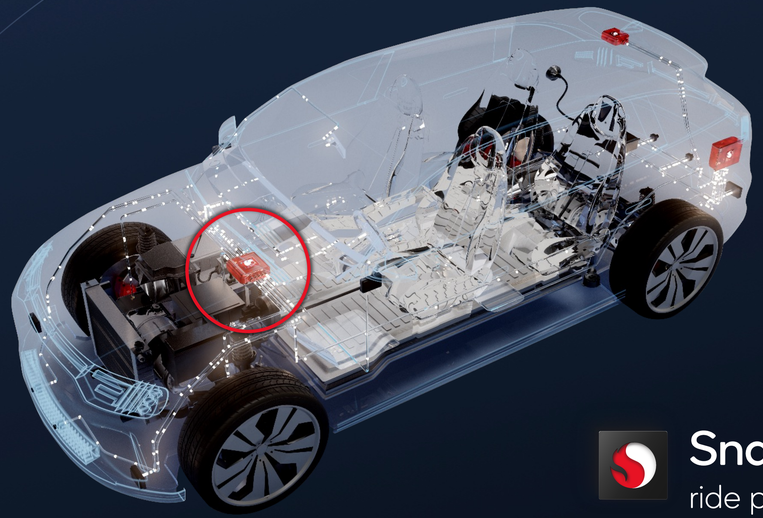


Across multiple verticals

Snapdragon
digital chassis

Snapdragon
car-to-cloud

Snapdragon
cockpit platform



Snapdragon
auto connectivity platform

Snapdragon
ride platform

Personalized in-car experiences for everyone



Snapdragon
cockpit platform

#1 in digital cockpit[1]

High-performance, low-power scalable platforms

Versatile, customizable, based on leading technology

4th generation solutions shipping now

Safe virtualization
Functional isolation

Qualcomm® Hexagon™ Tensor Processor
Machine learning

Secure processor
Auto cybersecurity

Qualcomm Spectra™ ISP
360° camera perception and fusion

Multi-OS support
Safety and general purpose apps

Display processing unit
Multi 4K display

Qualcomm® Adreno™ GPU
Graphics quality, parallel processing

Video and audio processor
Streaming media accelerator

SoftSKU
Cloud-based feature management

Embedded vision AI accelerator
Camera perception

CPU
Seamless user experiences

Safety Island
ADAS/AD workloads

1. Internal sales data, infotainment for production cars starting in 2020

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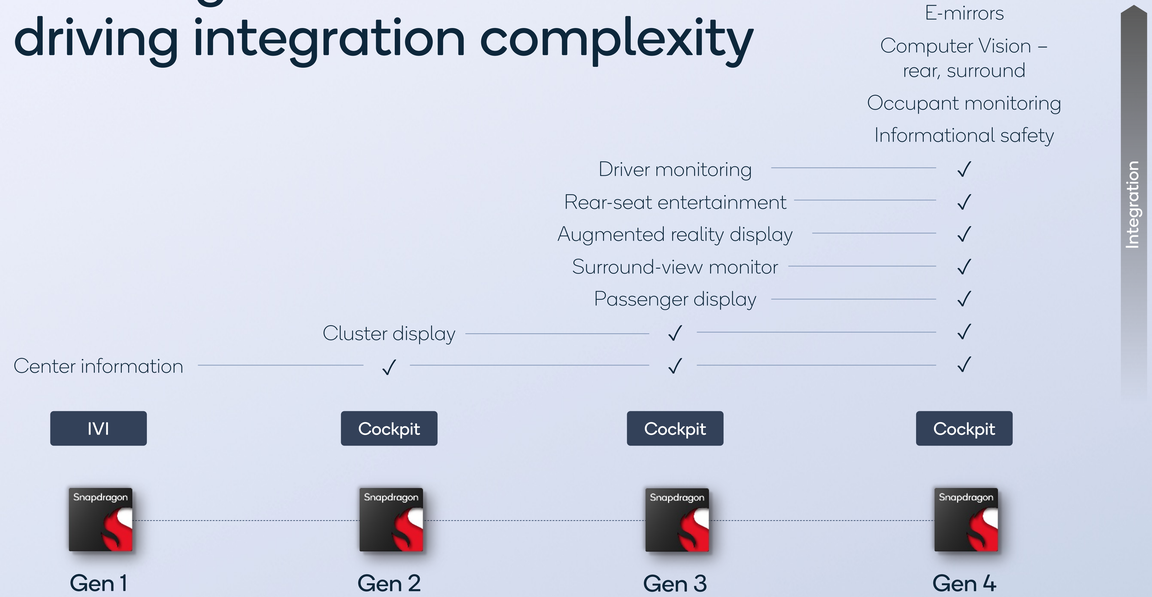
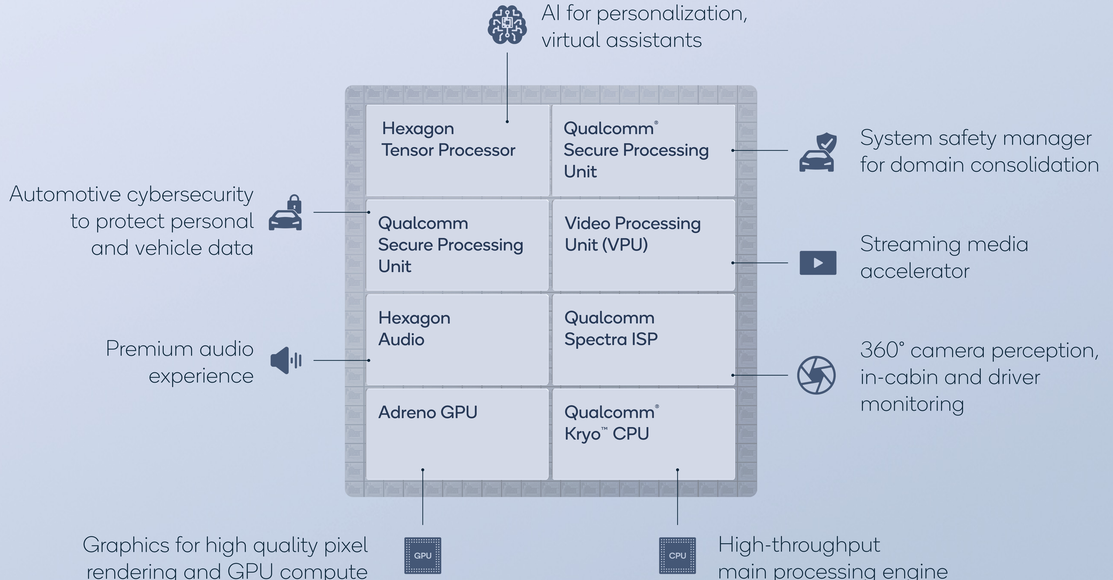
Growing number of use cases driving integration complexity





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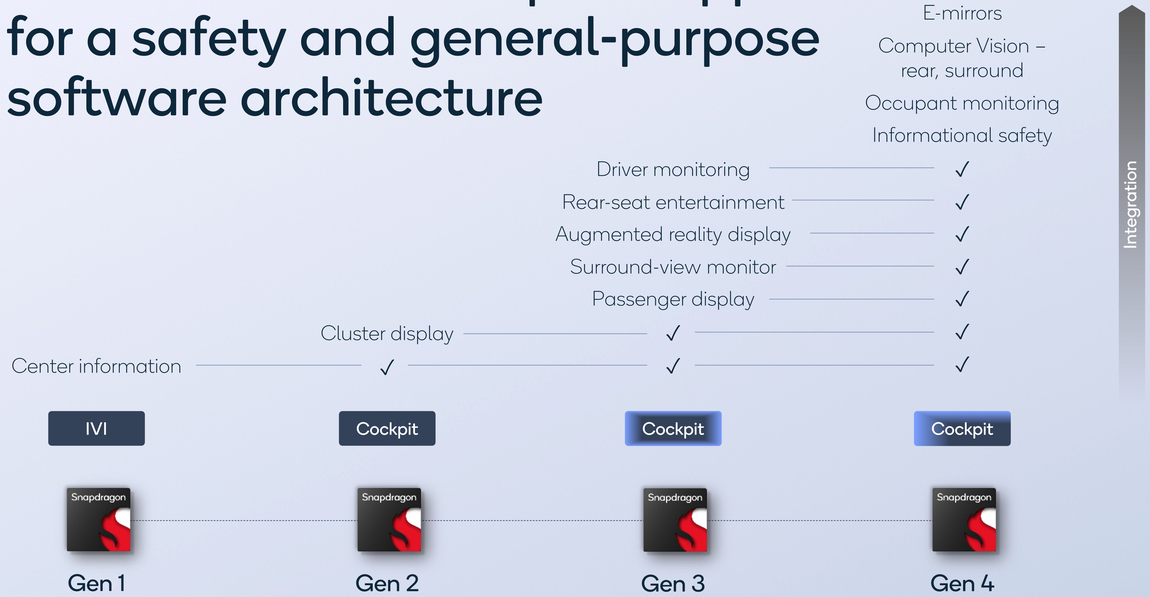
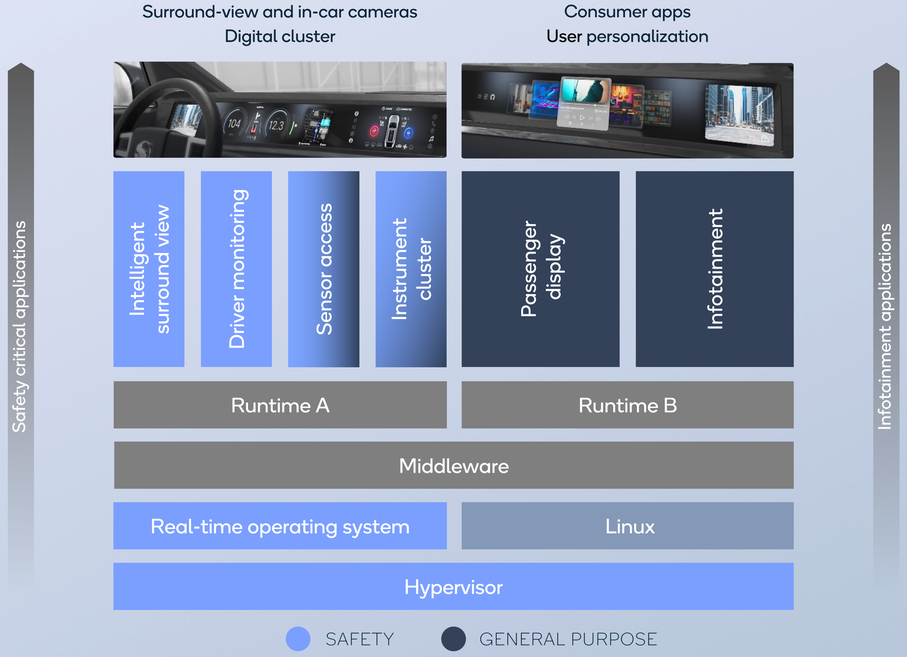
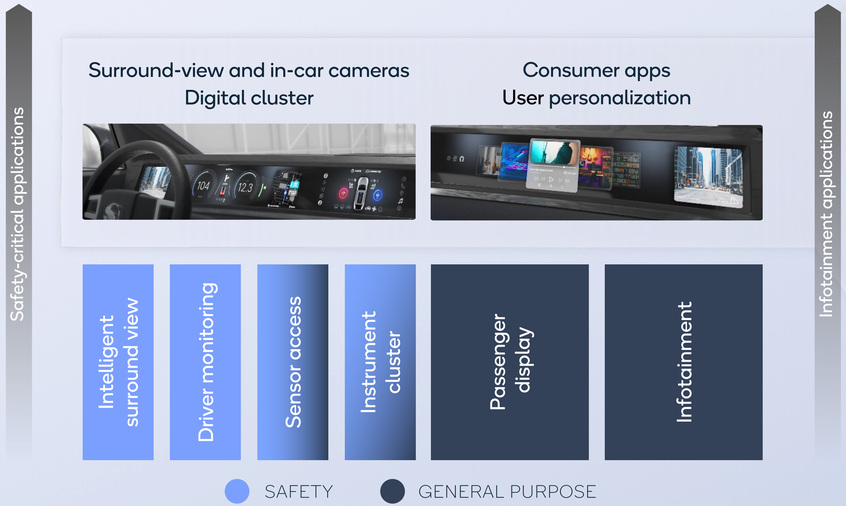
Diverse use cases require support for a safety and general-purpose software architecture





Snapdragon Cockpit enables diverse software ecosystems



OEM applications suite

Remote services
Emergency services
Customer loyalty programs

Ecosystems

Navigation, DMS, Cluster

Camera, graphics, 5G, location

Camera

Surveillance
Surround view
Driver/occupant monitoring
E-mirrors

Displays

Graphics, multimedia, gaming

App Store

Shop
Plan
Explore
Play

Productivity

Multimedia, audio, security

Brought-in smartphone

CarPlay

Graphics, multimedia, gaming

Premium Audio

Voice assistant

Snapdragon
cockpit platform

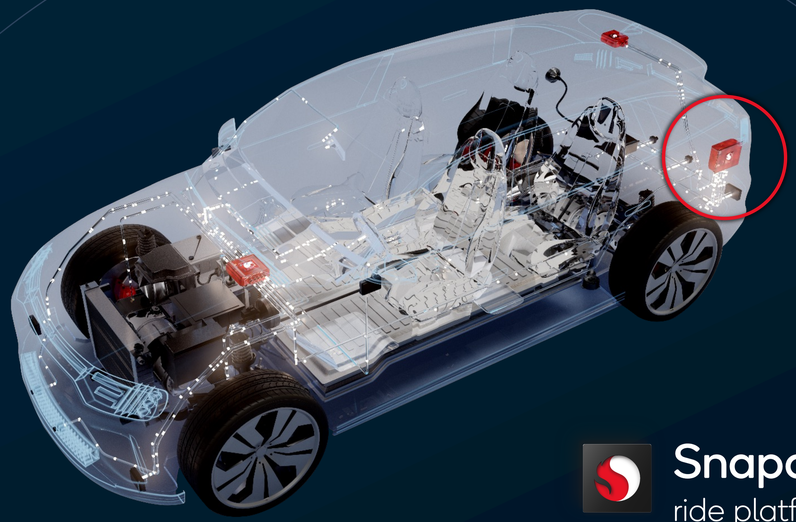
Selected by all major global automakers

Enabling stronger OEM brand identity



Snapdragon
digital chassis

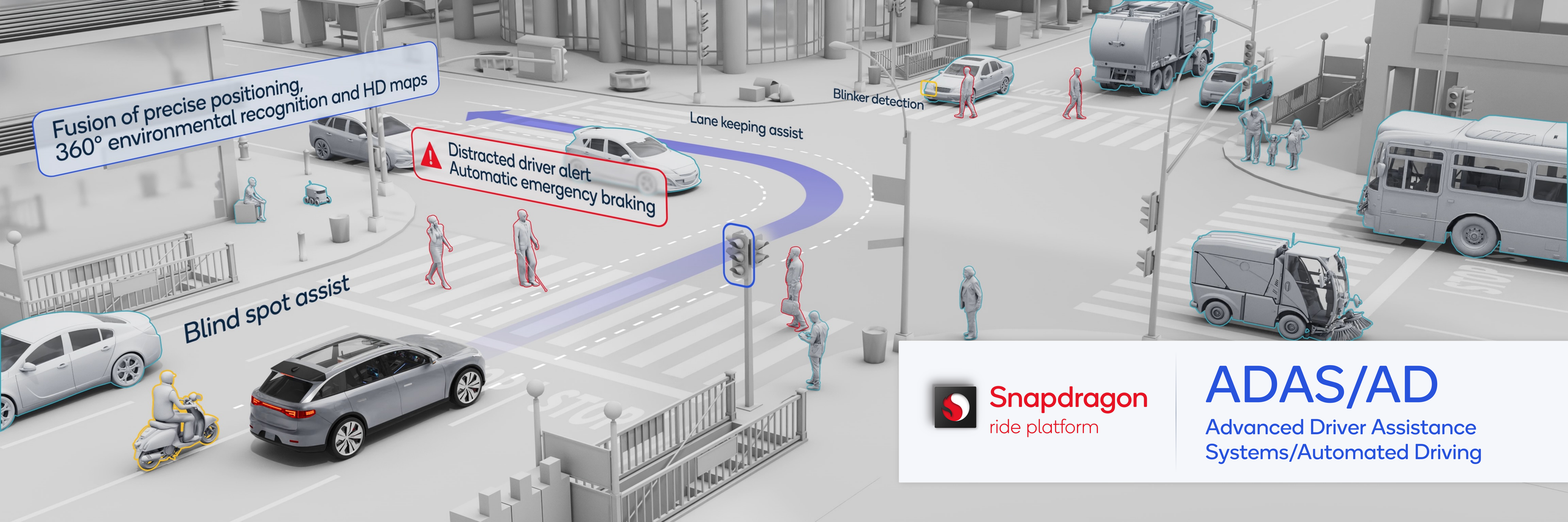
Snapdragon
car-to-cloud



Snapdragon
cockpit platform

Snapdragon
auto connectivity platform

Snapdragon
ride platform


Fusion of precise positioning,
360° environmental recognition and HD maps
Distracted driver alert
Automatic emergency braking
Lane keeping assist
Blinker detection
Blind spot assist
Snapdragon
ride platform
ADAS/AD
Advanced Driver Assistance
Systems/Automated Driving

Driver Assistance (ADAS) and Automated Driving (AD) landscape

4G/5G
C-V2X

POSITIONING

MAPS

SENSORS

CAMERA

RADAR

LIDAR



Safety

Mandate (NCAP[1])

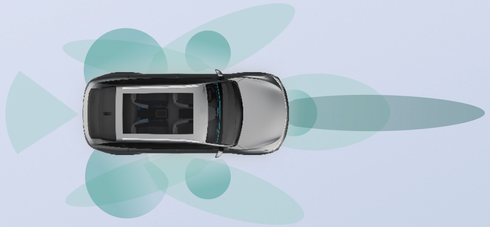
L1



Assisted driving

Convenience

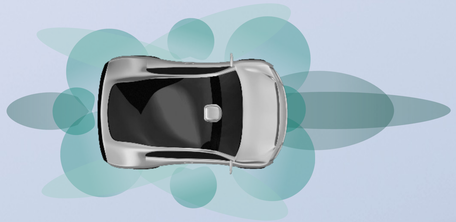
L2



Automated driving

Comfort

L2+/L3/L4



Robotaxi

Driverless

L4/L5

1. NCAP: New Car Assessment Program

Core technologies required for Driver Assistance and Automated Driving

Core SoC & SW Design

- Middleware
- Vehicle Gateway
- Multi-SoC
- OS ecosystems
- Service Oriented Software
- Virtual platform

Core Technology IP

- Computer Vision
- Graphics
- CPU
- Sensor Fusion
- Precision location
- Drive Policy
- ISP
- Radar and lidar processing

Core Platform IP

- Machine learning
- Virtualization
- Security
- Safety Island

Core System Design

- Automated Driving
- Drive Policy Stack
- Cybersecurity
- Hi-res display support
- Computer Vision
- Car2Cloud
- Energy-efficient compute
- Over-the-air update

Snapdragon ride platform

Building our Automated Driving portfolio











2017

Automated Driving software program launched

Focus - ground-up L3 stack

Computer Vision, Sensor fusion

AI development

Industry partnerships

Oct 2019

1st gen Snapdragon Ride SoC & AI Accelerator – awarded by General Motors

Super Cruise, Ultra Cruise

Jan 2021

Veoneer partnership announced; Veoneer creates Arriver

Computer Vision and Drive Policy software subsidiary for Qualcomm partnership

Oct 2021

Definitive agreement for acquisition of Arriver announced

Nov 2021

BMW selects Qualcomm for L3 Automated Driving

Joint development announced

Snapdragon Ride Vision System

Snapdragon Ride SoCs

Snapdragon Ride

A comprehensive solution for driver assistance and automated driving

① Snapdragon Ride SoCs

Qualcomm

- Safe OS | Drivers | Hypervisors
- SDK: Middleware, Tools & Libraries

SoC — Scalable L1 to L4

AI Accelerator — L3/L4 AD AI Accelerator

② Snapdragon Ride Vision System

Qualcomm + Arriver

- Front and surround vision
- Safe OS | Drivers | Hypervisors
- SDK: Middleware, Tools & Libraries

Vision SoC — Computer Vision System scales from L1 to L3

③ Snapdragon Ride Automated Driving Stack

Qualcomm + Arriver + BMW

- Drive Policy
- Maps[1]
- Parking[1]
- Driver monitoring[1]
- Safe OS | Drivers | Hypervisors
- SDK: Middleware, Tools & Libraries

SoC

AI Accelerator

1. Pre-integrated partner



Sensors

APTIV · BOSCH · Continental · LUMINAR · MOBIS · INNOVIZ TECHNOLOGIES

OmniVision · onsemi · SAMSUNG · SONY · Valeo · veoneer

Snapdragon
ride platform

1

Snapdragon Ride System-on-Chip

Leading edge high-performance, low-power, highly-scalable SoCs

Offering software compatibility across generations

Cutting-edge AI with Hexagon Tensor Processor and Qualcomm® AI Stack



Scalable L1 to L4

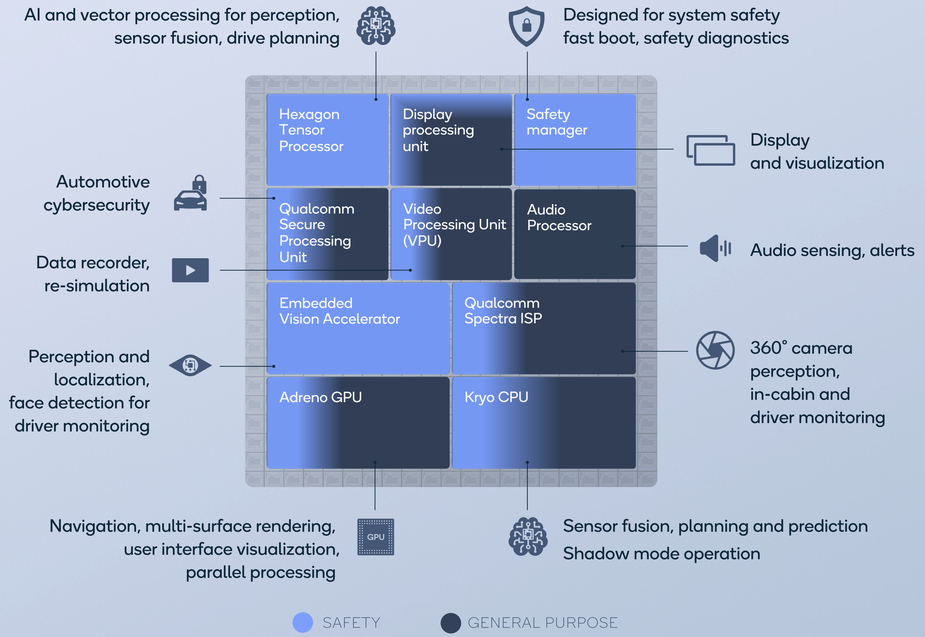


L3/L4 AD

Snapdragon Ride middleware, tools, SDK, libraries

Snapdragon Ride Safe OS

Snapdragon Ride Safe hypervisor



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Snapdragon
ride platform

2

Snapdragon Ride Vision System

Co-designed Computer Vision (CV) software and Vision SoC

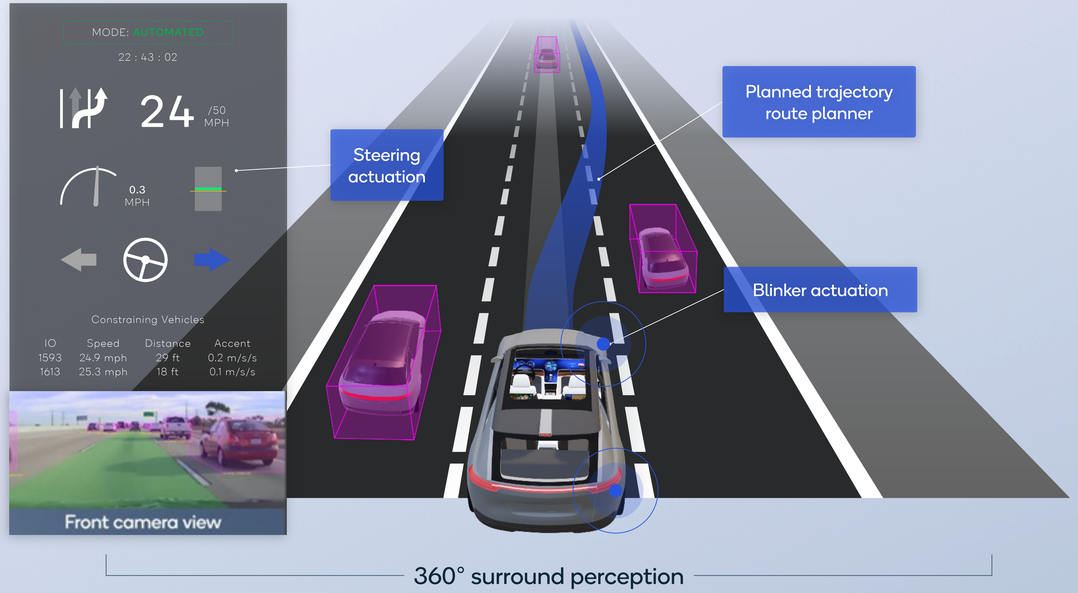
Supports L1 to L3 ADAS/AD

5th generation CV Stack

CV Stack compatible with AD Map creation

Hosts OEM Drive Policy, 3rd party driver monitoring, parking

Snapdragon Ride Vision Stack



Vision SoC

Front camera surround vision

Automatic emergency braking
Vulnerable road user
Lane keep assist
Intelligent speed assist
Adaptive cruise control
Speed limit information system
Lane following
Intelligent high beam control
Rear emergency braking

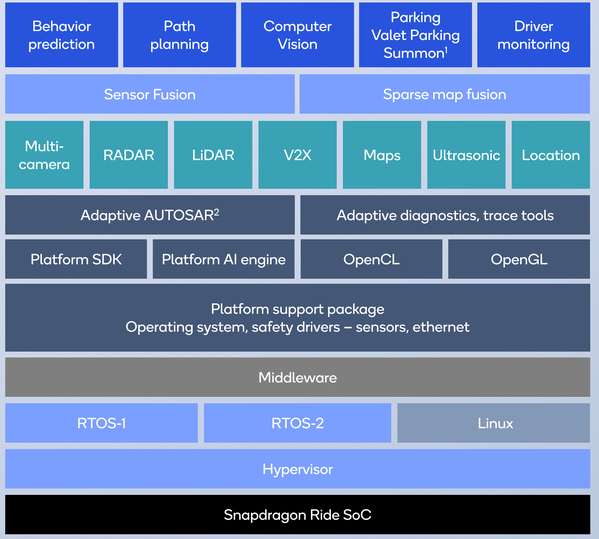
Snapdragon ride platform

Lead development partner

③

Snapdragon Ride Automated Driving Stack





- Calibration
- Profilers
- Simulators
- In-loop testing[3]
- Road testing
- Data collection
- Annotation

1. 3rd party partner; 2. AUTOSAR: Automotive Open System Architecture; 3. Software-in-the-loop; hardware-in-the-loop

Our modular portfolio is designed to support every customer engagement model

① Snapdragon Ride SoCs

Qualcomm

- Safe OS | Drivers | Hypervisors
- SDK: Middleware, Tools & Libraries

SoC — Scalable L1 to L4

AI Accelerator — L3/L4 AD AI Accelerator

② Snapdragon Ride Vision System

Qualcomm + ARRIVER

- Front and surround vision
- Safe OS | Drivers | Hypervisors
- SDK: Middleware, Tools & Libraries

Vision SoC — Computer Vision System scales from L1 to L3

③ Snapdragon Ride Automated Driving Stack

Qualcomm + ARRIVER + BMW

- Drive Policy
- Maps[1]
- Parking[1]
- Driver monitoring[1]
- Safe OS | Drivers | Hypervisors
- SDK: Middleware, Tools & Libraries

SoC

AI Accelerator

1. Pre-integrated partner



Sensors

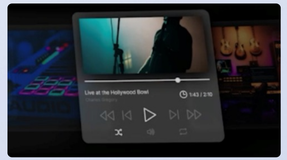
APTIV · BOSCH · Continental · LUMINAR · MOBIS · INNOVIZ TECHNOLOGIES
OmniVision · onsemi · SAMSUNG · SONY · Valeo · veoneer

Industry’s first integrated automotive super-compute class SoC

A unified automotive SoC architecture for mixed criticality workloads

Combines cockpit, driver assistance, automated driving and networking functions on the same SoC

Software Defined Vehicle-ready architecture





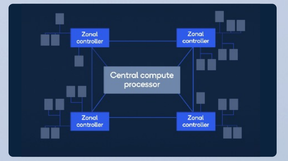
Infotainment
Digital life
Personalization

Cluster
Surround view
Driver monitoring
Safety domain
Instant-on

Computer Vision
Automated driving
Sensor fusion
Drive Policy
Maps

Networking
OTA
Cybersecurity

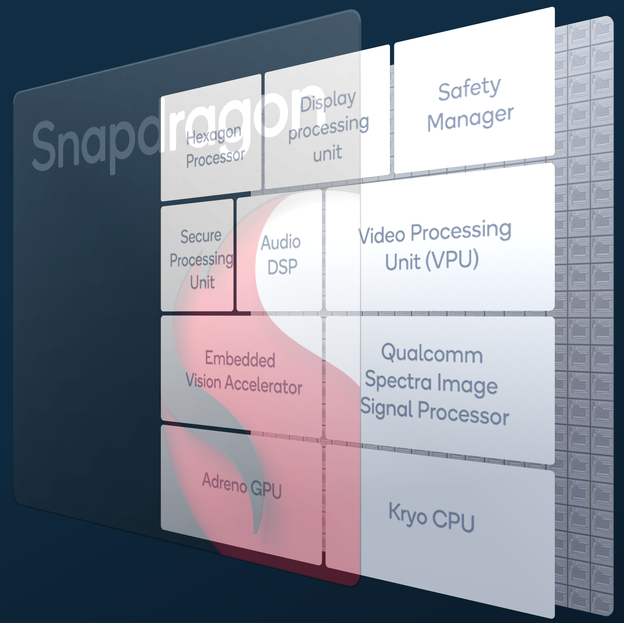




Announcement

Snapdragon Ride™ Flex SoC portfolio

Designs awarded at major global OEMs[1]



Industry's first automotive super-compute class solution with Flex SoC fabric

Field-proven software-aware SoC architecture for mixed criticality workloads

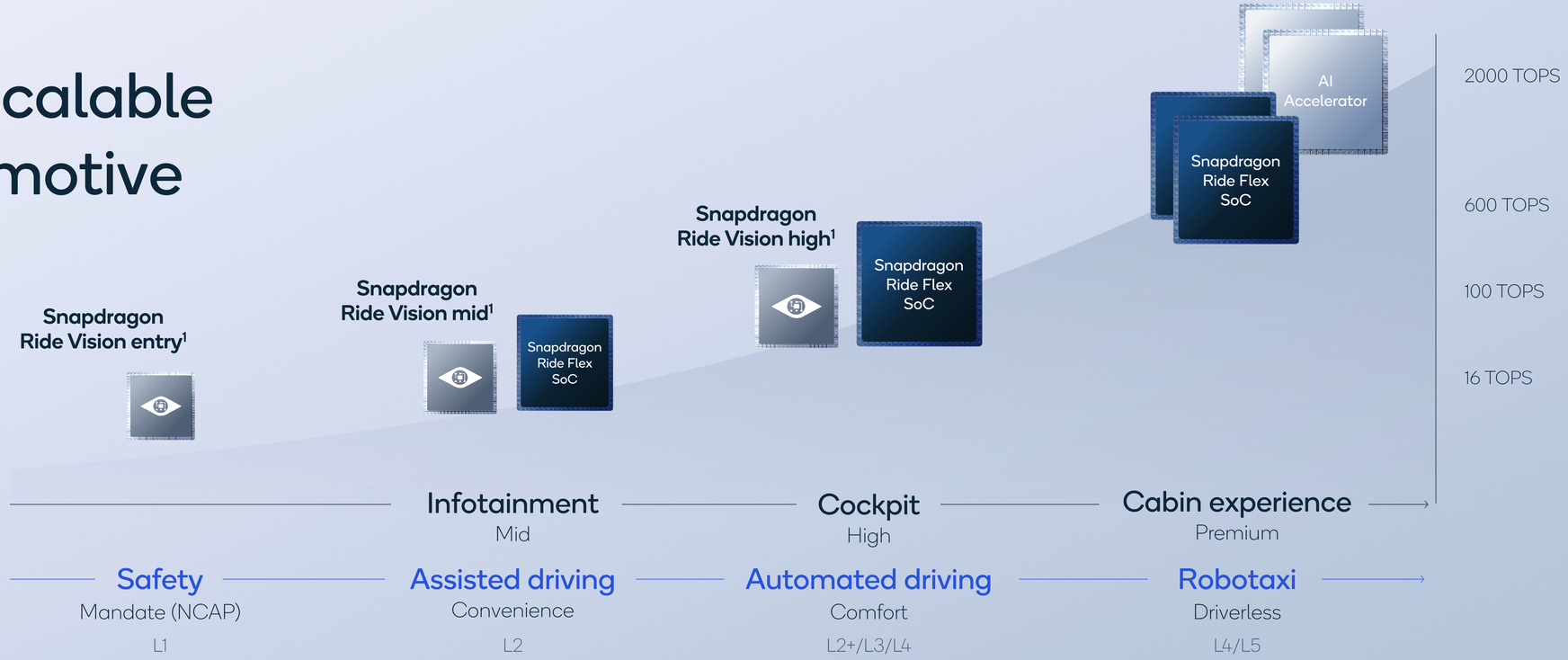
Integration of vision, digital cockpit, ADAS, AD and networking

Open, power efficient and co-designed with leading OEM partners for the Software Defined Vehicle

1. Reflected in design-win pipeline updates

Most complete and scalable architecture for automotive central compute

Vision systems
Infotainment and cockpit
Driver assistance
Automated driving



1. Snapdragon Ride Vision products offered as SoC and Perception Stack combination

Snapdragon
ride platform

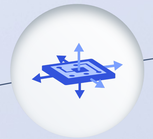
- SoCs and AI accelerators
- Drive Policy and Computer Vision stack
- Open platforms
- Flexible customer engagement strategy
- Cloud services
- Broad partner ecosystem
- Scalable platforms

BMW · gm · VW · GWM · Renault · STELLANTIS · Aston Martin · GEELY · BYD · VOLVO · Mercedes-Benz · Polestar

Incremental long-term opportunities

Domain controllers

Safety and zonal controllers for evolving car architecture



Two-wheelers and e-bikes

Extend Snapdragon Digital Chassis to new categories



Last-mile autonomy

Geo-fenced, low-speed autonomy applications





Winning the digital future of automotive

Connect the car to its environment and to the cloud

Create unique in-cabin experiences

Comprehensive assisted and automated driving

Cloud-connected, service-oriented architecture

Safe harbor

In addition to historical information, this presentation contains forward-looking statements that are inherently subject to risks and uncertainties, including but not limited to statements regarding: our business, product, technology, financial and acquisition strategies, priorities, plans, drivers, opportunities, outlook, estimates, targets and expectations; our growth opportunities, including in automotive, and our being well positioned to take advantage of those opportunities; our diversification strategy; our addressable market and addressable market expansion; our automotive design-win pipeline and revenue forecast; the digital transformation of automotive, automakers becoming technology companies, the car becoming software defined and similar statements; our technologies, technology leadership and technology roadmap; our products, product performance, product leadership, product pipeline and product roadmap; new product releases, announcements and design wins; the benefits of our technologies and products; our business and share trends, as well as market and industry trends and their potential impact on our business and our positioning to take advantage thereof; anticipated demand for our products and technologies; and our estimates, forecasts and guidance related to our financial results. Forward-looking statements are often identified by words such as "estimates," "forecast," "guidance," "future," "target," "expects," "anticipates," "intends," "plans," "believes," "seeks" and similar expressions. Actual results may differ materially from those referred to in the forward-looking statements due to a number of important factors, including but not limited to: the impact of the COVID-19 pandemic, and government policies and other measures designed to limit its spread; our dependence on a small number of customers and licensees, and particularly from their sale of premium-tier devices; our customers vertically integrating; a significant portion of our business being concentrated in China, which is exacerbated by U.S./China trade and national security tensions; our ability to extend our technologies and products into new and expanded product areas, and industries and applications beyond mobile handsets; our strategic acquisitions, transactions and investments, and our ability to consummate strategic acquisitions; our dependence on a limited number of third-party suppliers; risks associated with the operation and control of our manufacturing facilities; security breaches of our information technology systems, or other misappropriation of our technology, intellectual property or other proprietary or confidential information; our ability to attract and retain qualified employees, and to successfully operate under a hybrid working environment; the continued and future success of our licensing programs, which requires us to continue to evolve our patent portfolio and to renew or renegotiate license agreements that are expiring; efforts by some OEMs to avoid paying fair and reasonable royalties for the use of our intellectual property, and other attacks on our licensing business model; potential changes in our patent licensing practices, whether due to governmental investigations, legal challenges or otherwise; adverse rulings in governmental investigations or proceedings; our customers' and licensees' sales of products and services based on CDMA, OFDMA and other communications technologies, including 5G, and our customers' demand for our products based on these technologies; competition in an environment of rapid technological change, and our ability to adapt to such change and compete effectively; failures in our products or in the products of our customers or licensees, including those resulting from security vulnerabilities, defects or errors; difficulties in enforcing and protecting our intellectual property rights; claims by third parties that we infringe their intellectual property; our use of open source software; the cyclical nature of the semiconductor industry, declines in global, regional or local economic conditions, or our stock price and earnings volatility; our ability to comply with laws, regulations, policies and standards; our indebtedness; and potential tax liabilities. These and other risks are set forth in our Quarterly Report on Form 10-Q for the fiscal quarter ended June 26, 2022 filed with the Securities and Exchange Commission (SEC). Our reports filed with the SEC are available on our website at www.qualcomm.com. We undertake no obligation to update, or continue to provide information with respect to, any forward-looking statement or risk factor, whether as a result of new information, future events or otherwise.

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Thank you

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