2020 IT 21
Global Conference
Digital New Deal
Technology Essentials
디지털 뉴딜 기술 핵심

Session 3-3

5G 버티칼 서비스 (스마트 교통)

박성일 상무 (한국퀄컴)

[요약문]

5G 시대가 도래하였고 상용화가 시작되었다. 현재는 이동통신 분야에서만 5G 가 잘 활용되고 있으나 다른 많은 분야에도 5G의 적용이 필요한 시대가 되었다. 이에 5G 의 적용분야를 살펴보고 가능한 Service의 종류를 살펴본다. 또한, 이중에서 스마트 교통에 관해 어떤 서비스와 미래 기술이 적용되는 지를 살펴본다.

[발표자 약력]

1998년 한국과학기술원 공학박사

1999년 삼성전자 통신연구소 책임연구원

2005년~퀄컴 표준팀 상무

관심분야 : 이동통신

September, 2020 Korea

Qualcomm

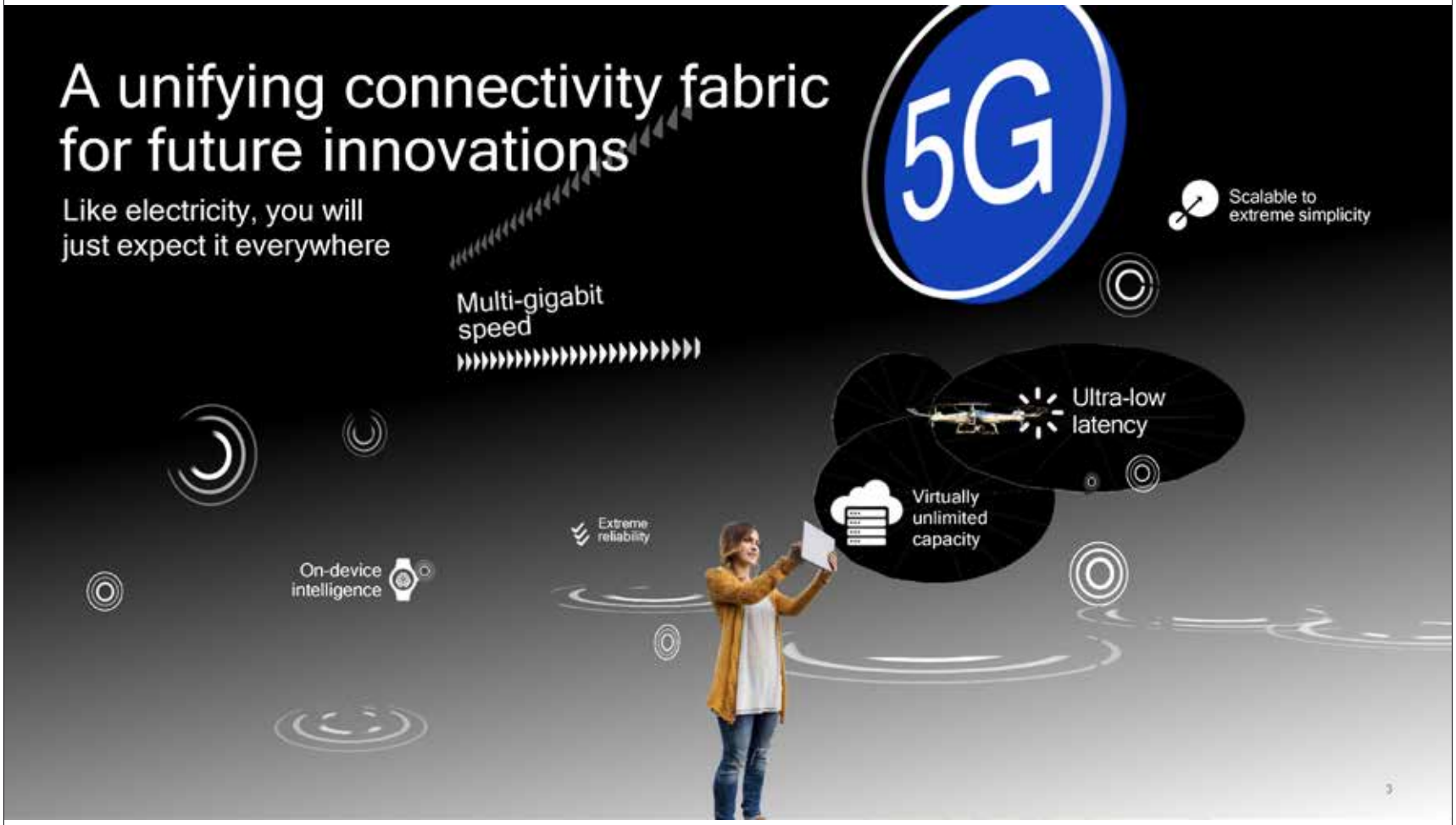
5G – Vertical Service View

(Smart transportation)

Michael Park
Director, Qualcomm

Working with South Korea for 25+ years

1. GSMA Intelligence, July 2018, excluding licensed cellular IoT

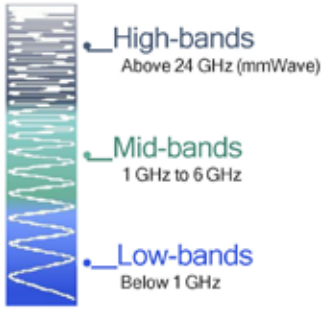

A unifying connectivity fabric for future innovations
Like electricity, you will just expect it everywhere
5G
Scalable to extreme simplicity
Multi-gigabit speed
Ultra-low latency
Virtually unlimited capacity
Extreme reliability
On-device intelligence

5G NR is a unified, more capable 5G air interface

Expanding the reach of mobile beyond mobile broadband

Diverse services

Scalability to address an extreme variation of requirements



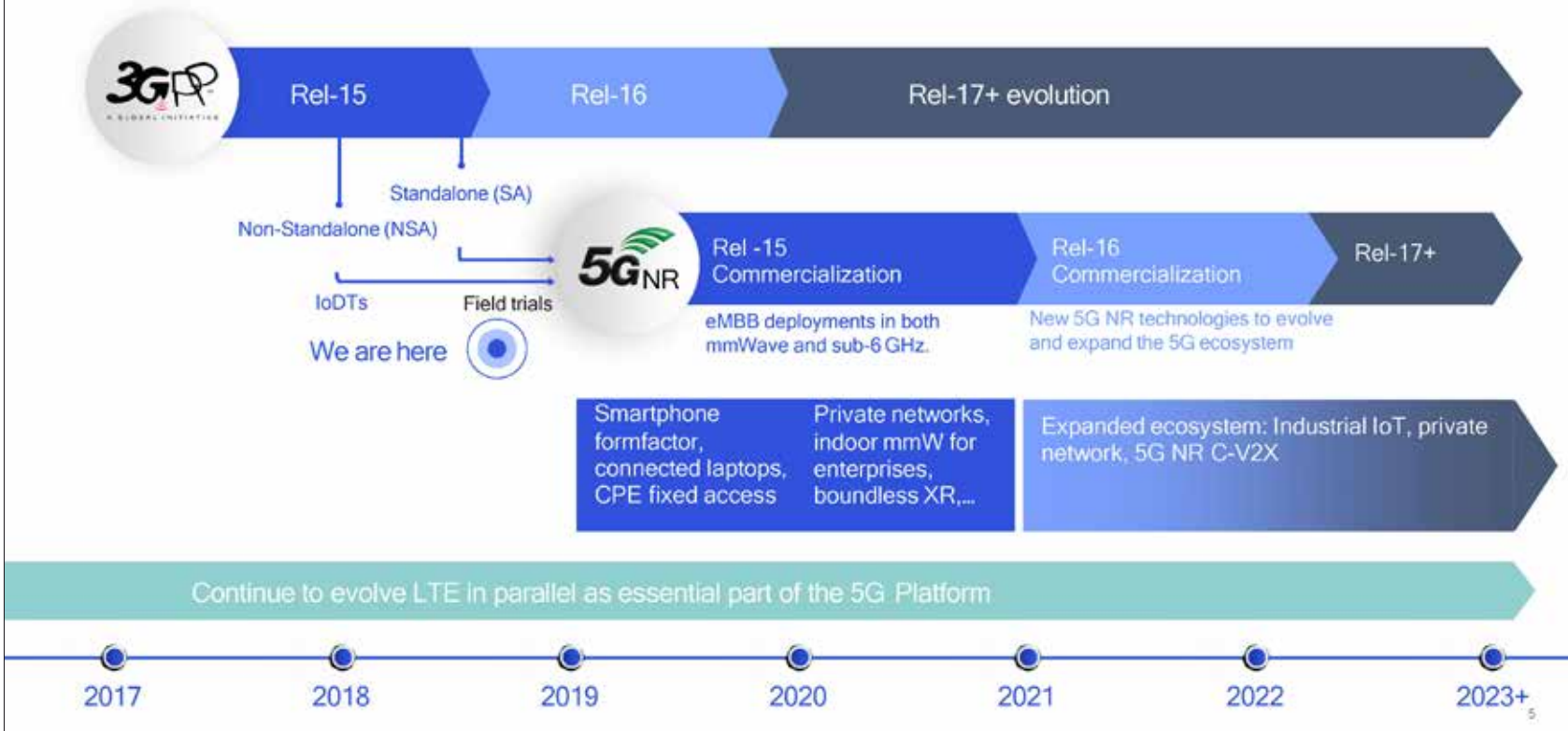
Diverse spectrum

Getting the most out of a wide array of spectrum bands/types

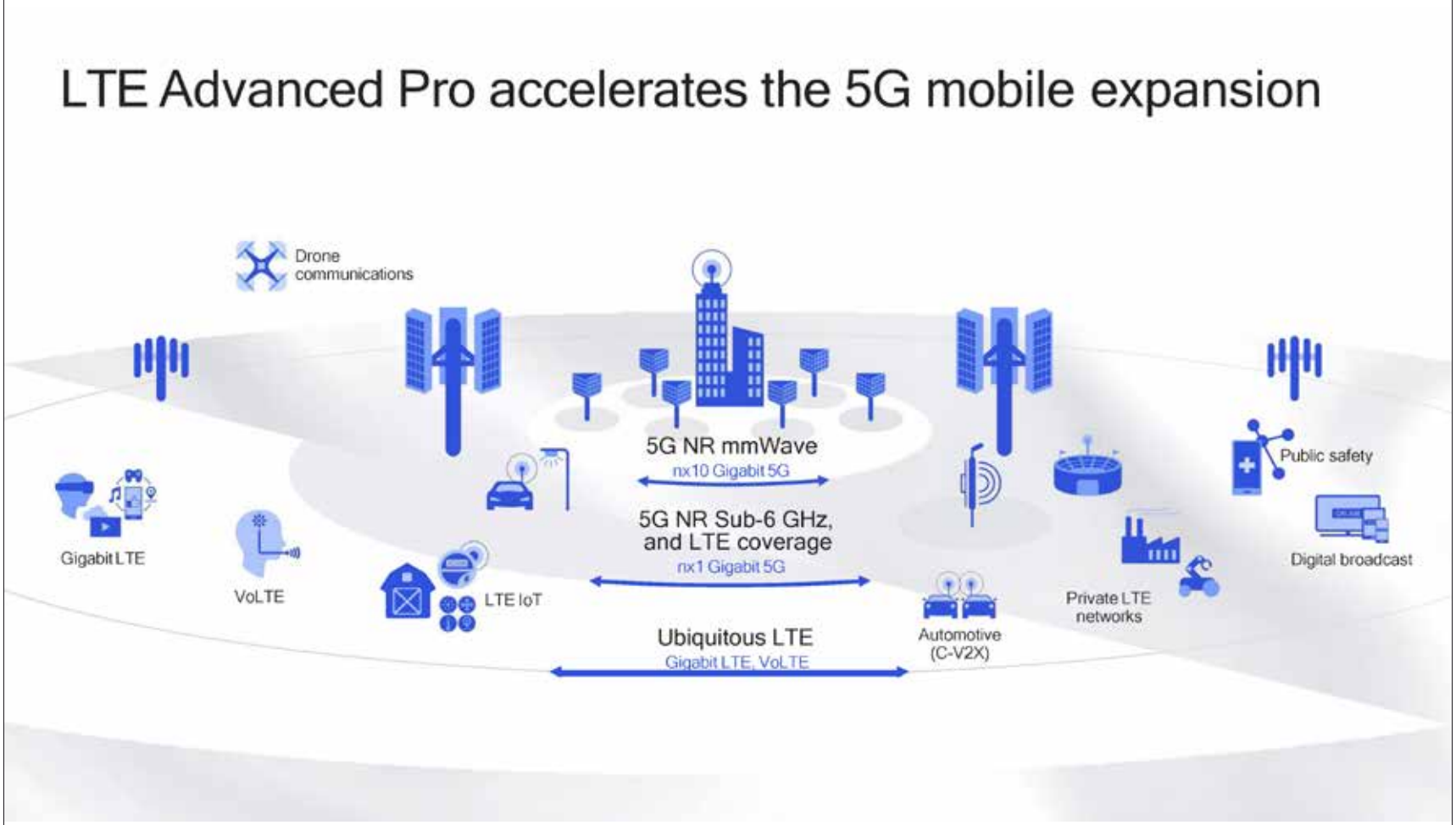
Diverse deployments

From macro to indoor hotspots, with support for diverse topologies

Driving the 5G roadmap and ecosystem expansion



LTE Advanced Pro accelerates the 5G mobile expansion



Enabler to the factory of the future

Efficient use of energy and utilities

Safer, autonomous transportation

Private networks for logistics, enterprises, industrial,...

Reliable access to remote healthcare

Sustainable smart cities and infrastructure

Precision agriculture

Digitized logistics and retail

5G

5G will expand the mobile ecosystem to new industries

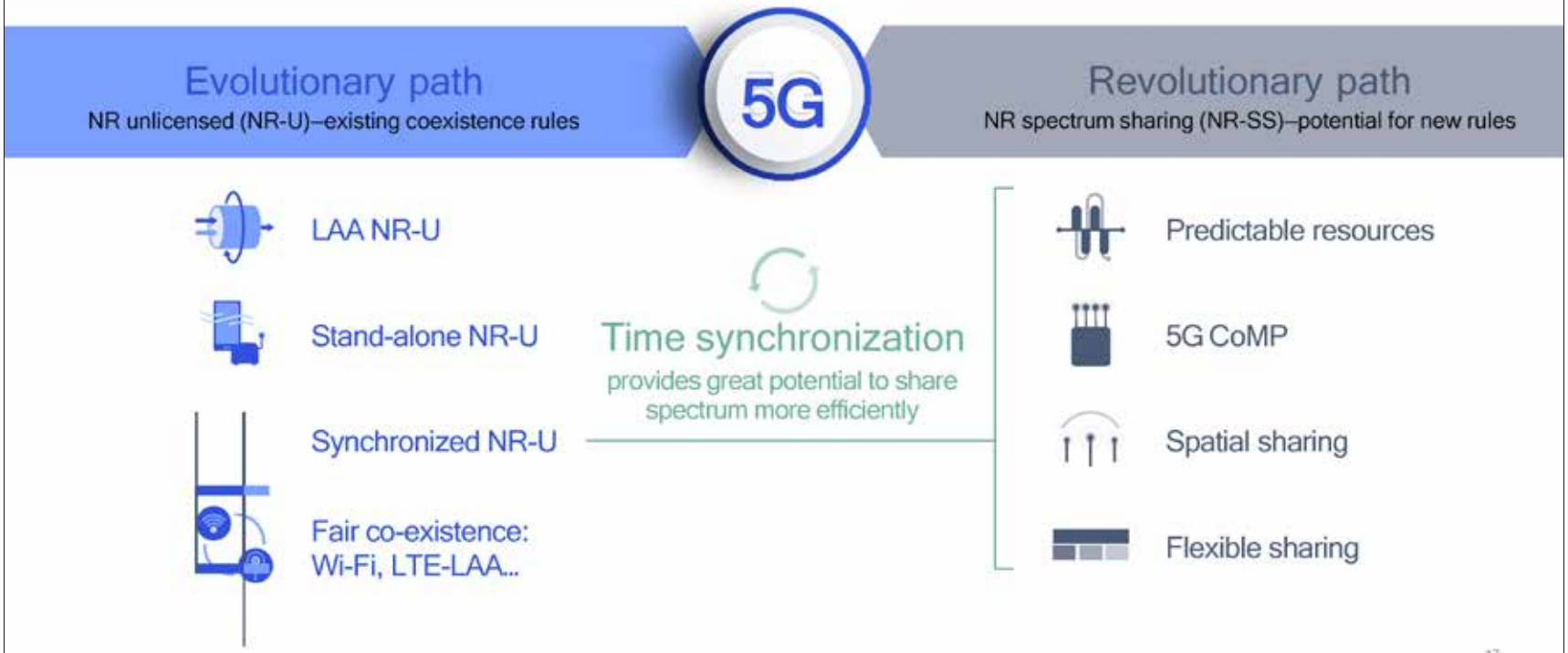
Powering the digital economy

>$12 Trillion

In goods and services by 2035*

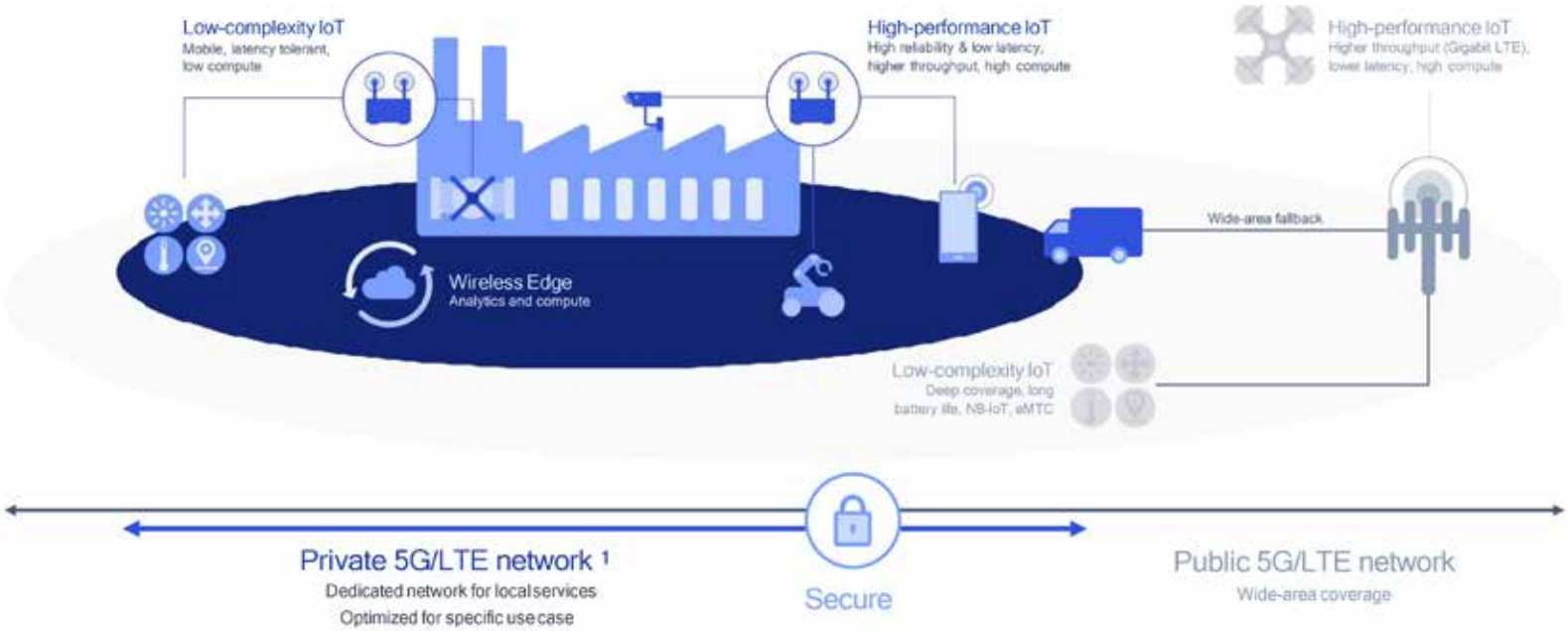
* The 5G Economy, an independent study from IHS Markit, Penn Schoen Berland and Berkeley Research Group, commissioned by Qualcomm

Opportunity to introduce new spectrum sharing paradigms



Private 5G networks: dedicated, local and optimized

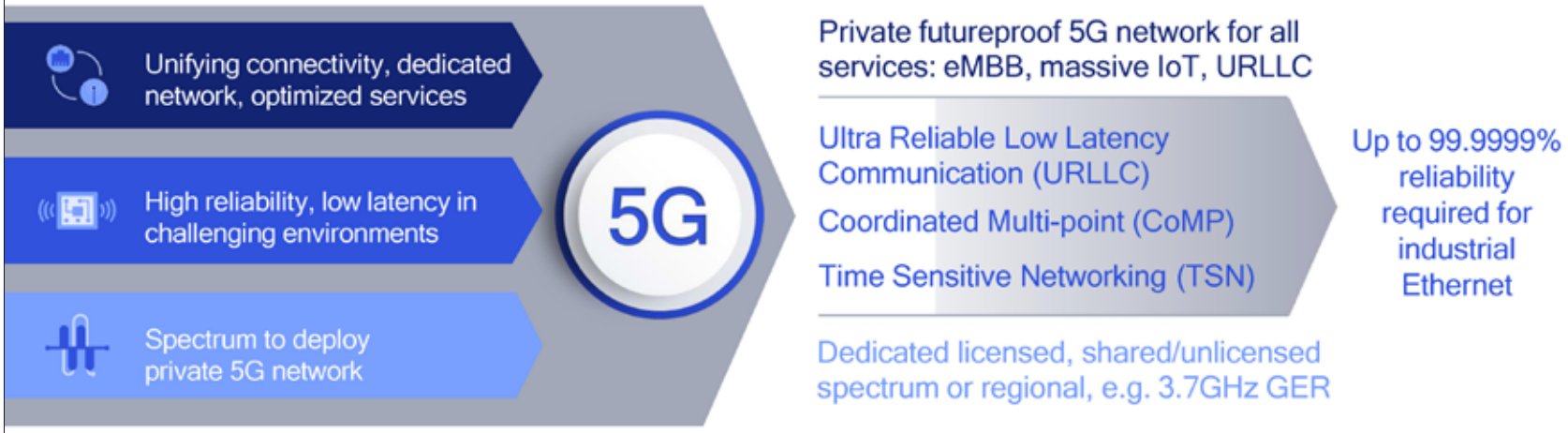
Opportunity for both licensed and unlicensed spectrum



1) A private 5G/LTE network can also support generic traffic as a neutral host, for example at an hospital it can provide dedicated services for employees/equipment and also operate as a neutral host for visitors.

Designing 5G to meet industrial IoT requirements

Key challenge: wireless industrial Ethernet for reconfigurable factories



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Boundless mobile XR – experience the best XR anywhere

On-device processing,
access to rich content

Premium XR anywhere

Efficient on-device processing to deliver immersive XR

Utilize connectivity for less time-sensitive content and downloads

We are doing this today

Photorealistic graphics and visuals

Enhanced experience where possible with new split-rendering architecture

On-device processing augmented by compute located at cloud edge over 5G connectivity

We are working with the ecosystem to enable this

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Instant access to media and entertainment

Connected cloud computing

Low latency online multiplayer gaming

The basics: responsive web browsing

Interactive venue experiences like live 360° streaming

Rich real-time user-generated content, like video sharing

Mobile immersive experiences

Distributed processing for boundless photorealistic XR

5G

- Fiber-like data speeds
- Low latency
- Uniform performance
- Massive capacity

+

- Content/control closer to user
- Realization of low latency
- Customized local value
- Augment on-device processing

= Enhanced and entirely new experiences

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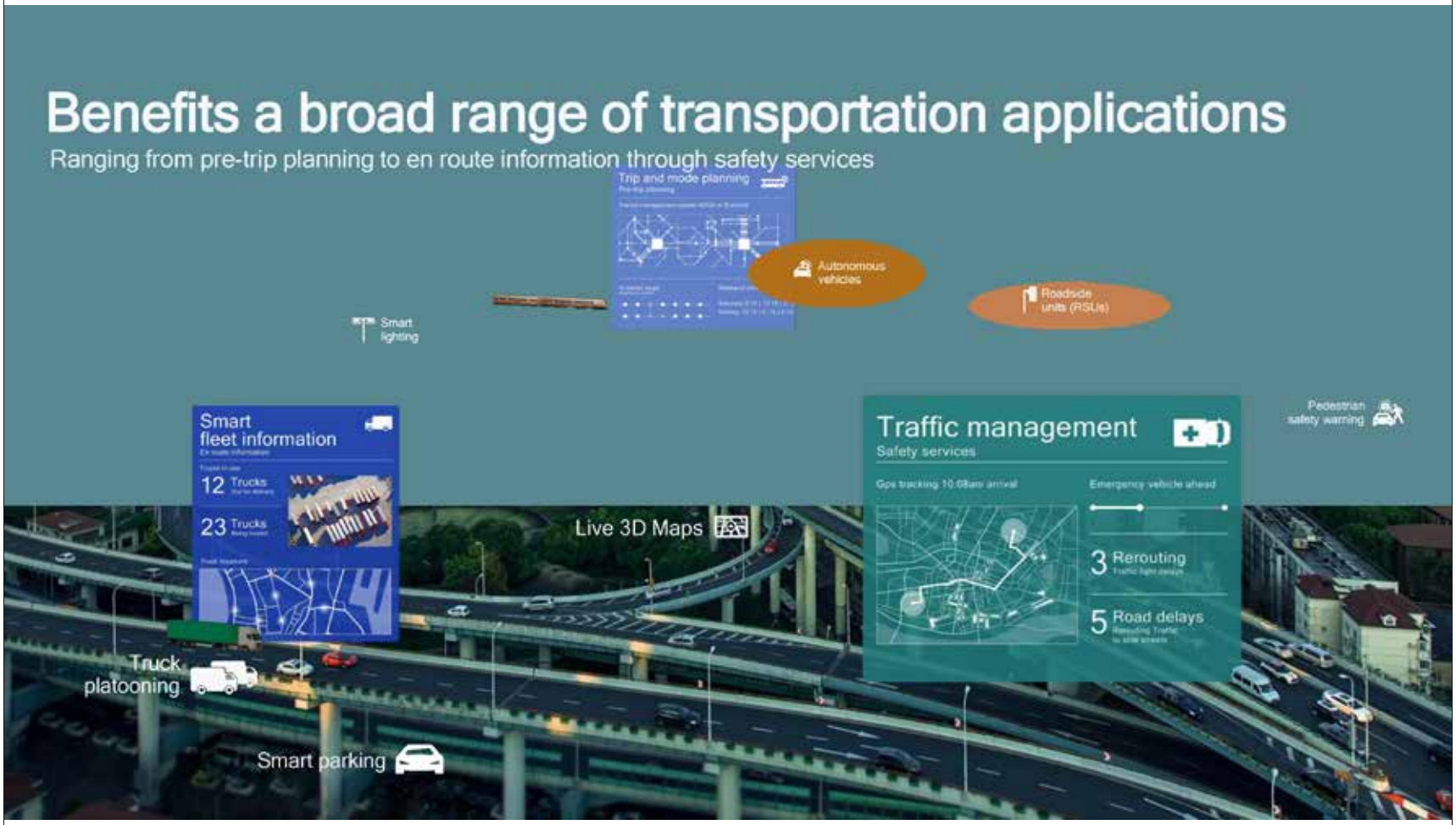
Shaping a new era of smart transportation

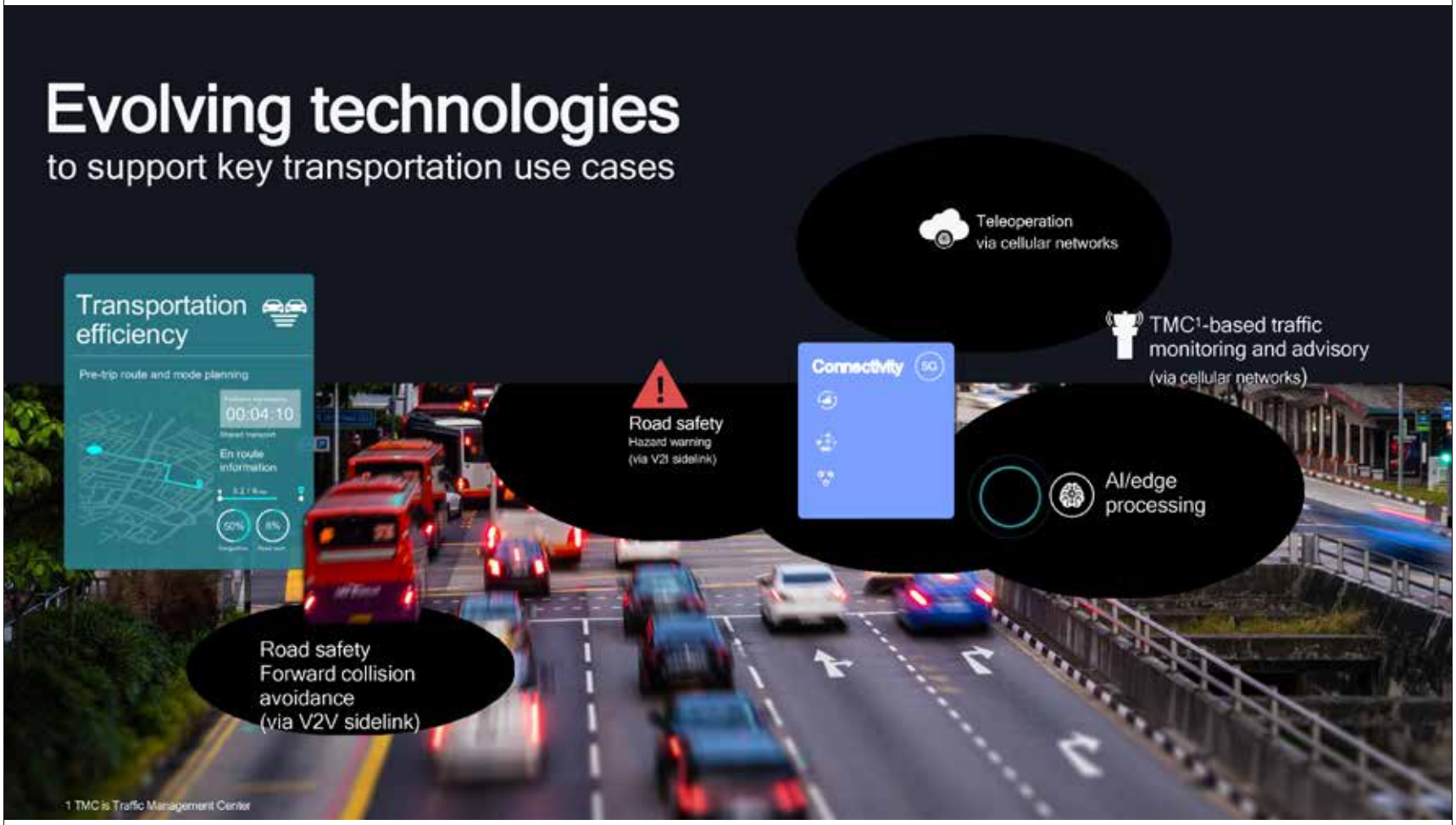
Smart transportation can benefit from connected systems – roads, vehicles, and infrastructure

Cellular and transportation networks, in partnership, can deliver efficient smart transportation solutions

Smart transportation can tap quantifiable benefits to for everyone

With our technology leadership, rich 5G roadmap, and proven AI capabilities, we are shaping a new era of smart transportation for a cleaner environment and sustainable future


Benefits a broad range of transportation applications
Ranging from pre-trip planning to en route information through safety services
Trip and mode planning
Autonomous vehicles
Roadside units (RSUs)
Smart lighting
Smart fleet information
12 Trucks
23 Trucks
Traffic management
Safety services
Gps tracking 10:08am arrival
Emergency vehicle ahead
3 Rerouting
5 Road delays
Pedestrian safety warning
Live 3D Maps
Truck platooning
Smart parking


Evolving technologies
to support key transportation use cases
Teleoperation
via cellular networks
TMC[1]-based traffic
monitoring and advisory
(via cellular networks)
Transportation
efficiency
Pre-trip route and mode planning
00:04:10
En route
information
Road safety
Hazard warning
(via V2I sidelink)
Connectivity
5G
AI/edge
processing
Road safety
Forward collision
avoidance
(via V2V sidelink)
1 TMC is Traffic Management Center

Reshaping our neighborhoods

Cellular + Transportation networks

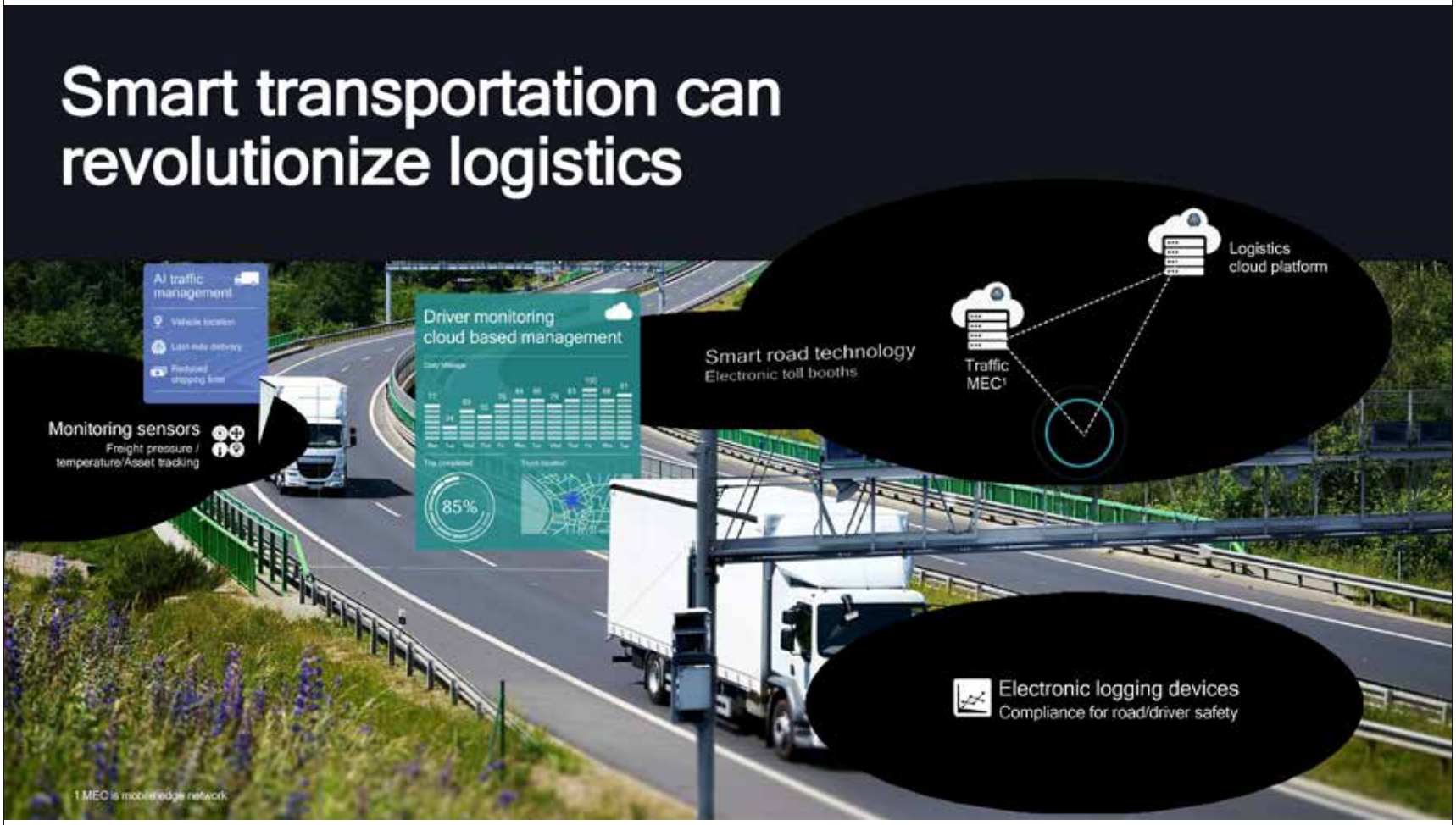
Safer walking and bicycling conditions

Reducing cut-through traffic Contribute

to city-level traffic planning

Pre-trip information and multi-modal choices

Greening opportunities


Smart transportation can revolutionize logistics
AI traffic management
Vehicle location
Last-mile delivery
Reduced shipping time
Monitoring sensors
Freight pressure / temperature/Asset tracking
Driver monitoring cloud based management
85%
Smart road technology
Electronic toll booths
Traffic MEC1
Logistics cloud platform
Electronic logging devices
Compliance for road/driver safety
1 MEC is mobile edge network

Maximizing

Efficiency

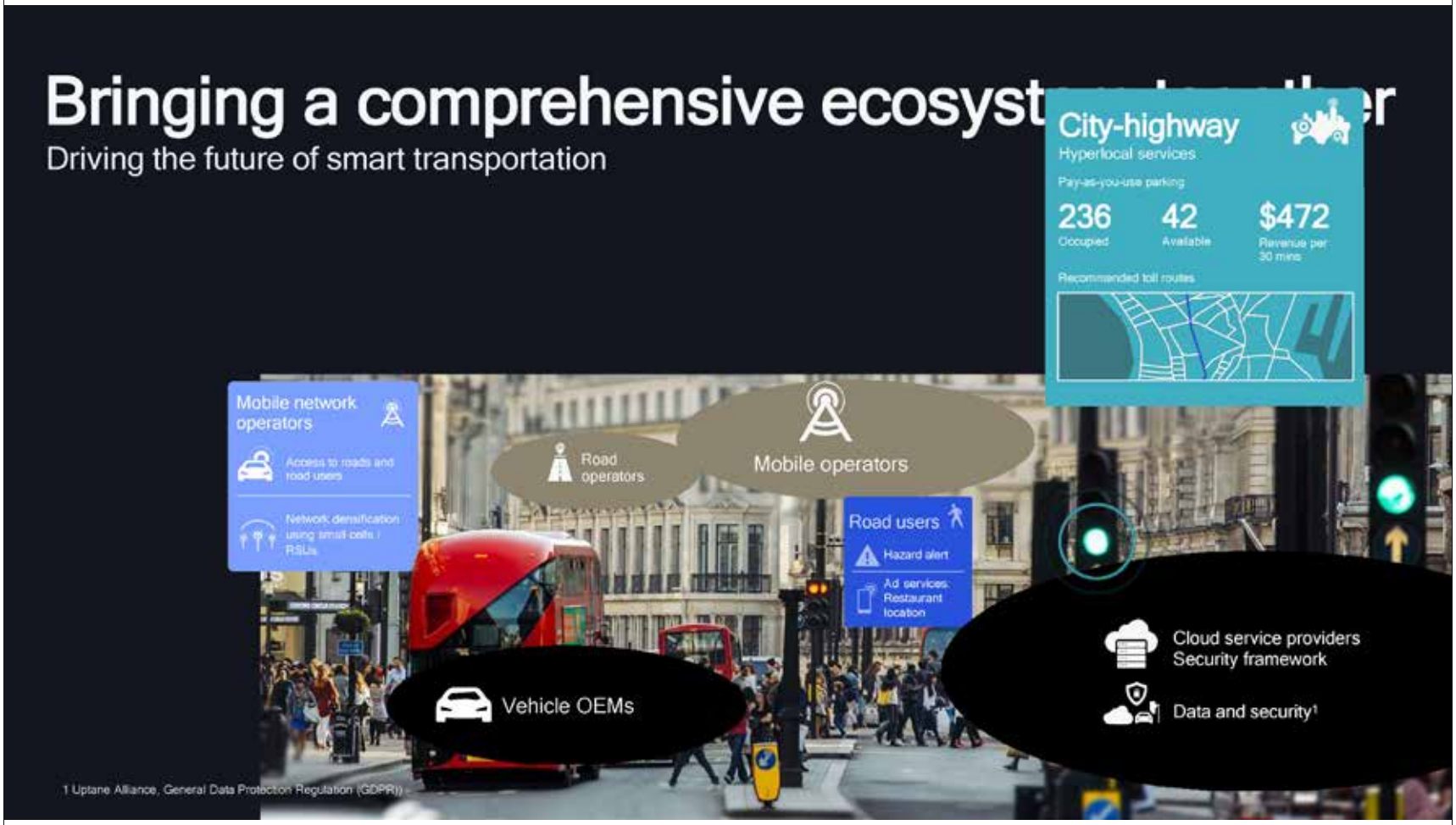
with shared transit and mobility on demand

Safety

Affordability

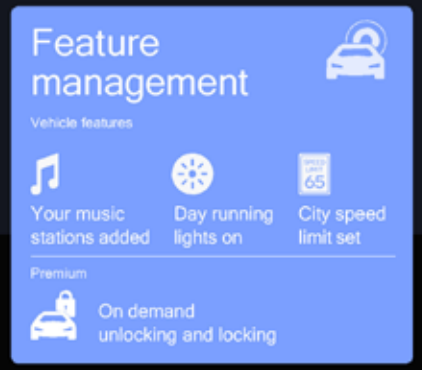
Reliability

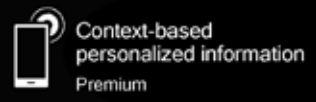
Availability to all

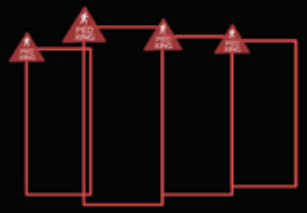

Bringing a comprehensive ecosyst
Driving the future of smart transportation
City-highway
Hyperlocal services
Pay-as-you-use parking
236
Occupied
42
Available
$472
Revenue per 30 mins
Recommended toll routes
Mobile network operators
Access to roads and road users
Network densification using small cells / RSUs
Road operators
Mobile operators
Road users
Hazard alert
Ad services. Restaurant location
Vehicle OEMs
Cloud service providers
Security framework
Data and security[1]
1 Uptane Alliance, General Data Protection Regulation (GDPR)

Facilitating multi-tiered services

Pedestrian detection
AR-based navigation
Virtual assistant



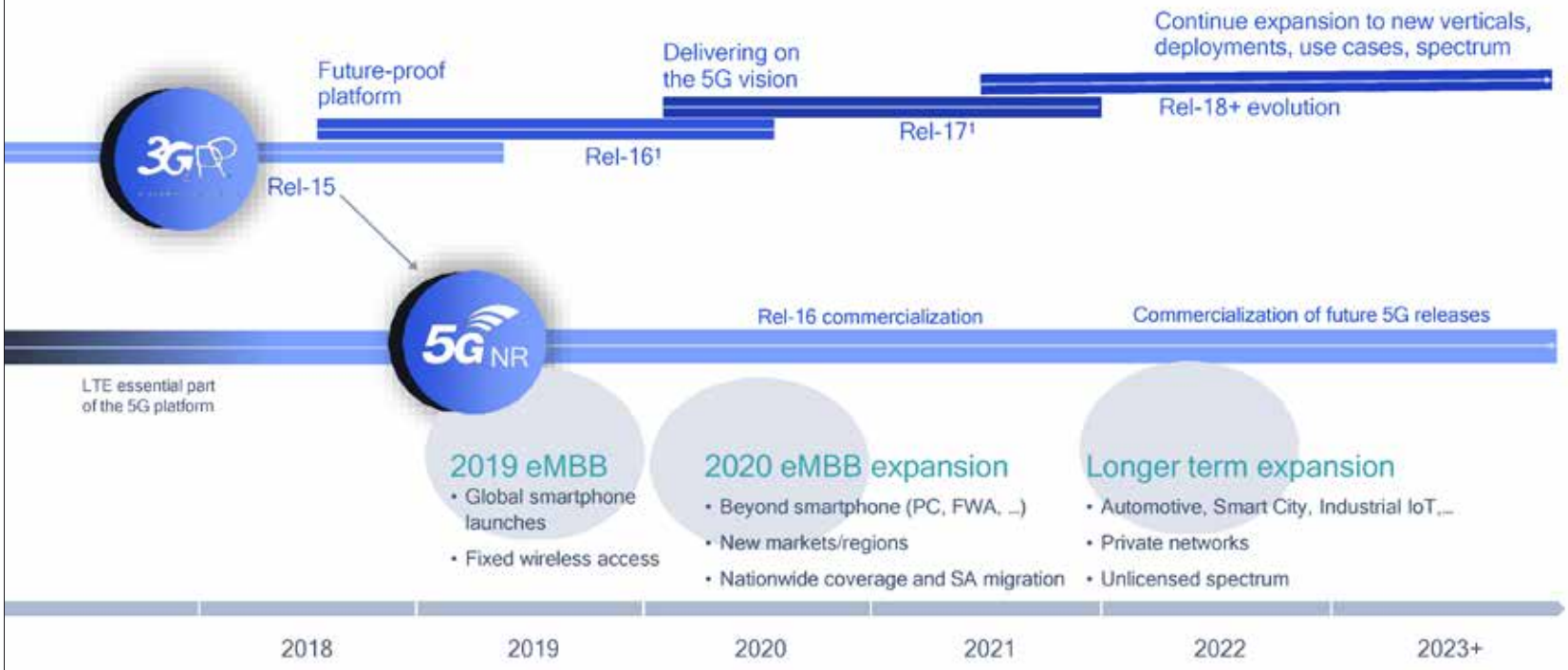




Road safety comes free
Pedestrian 10ft ahead

Backups
Shaping a new era of smart transportation

Driving the 5G technology evolution



1. 3GPP start date indicates approval of study package (study item->work item->specifications), previous release continues beyond start of next release with functional freezes and ASN.1

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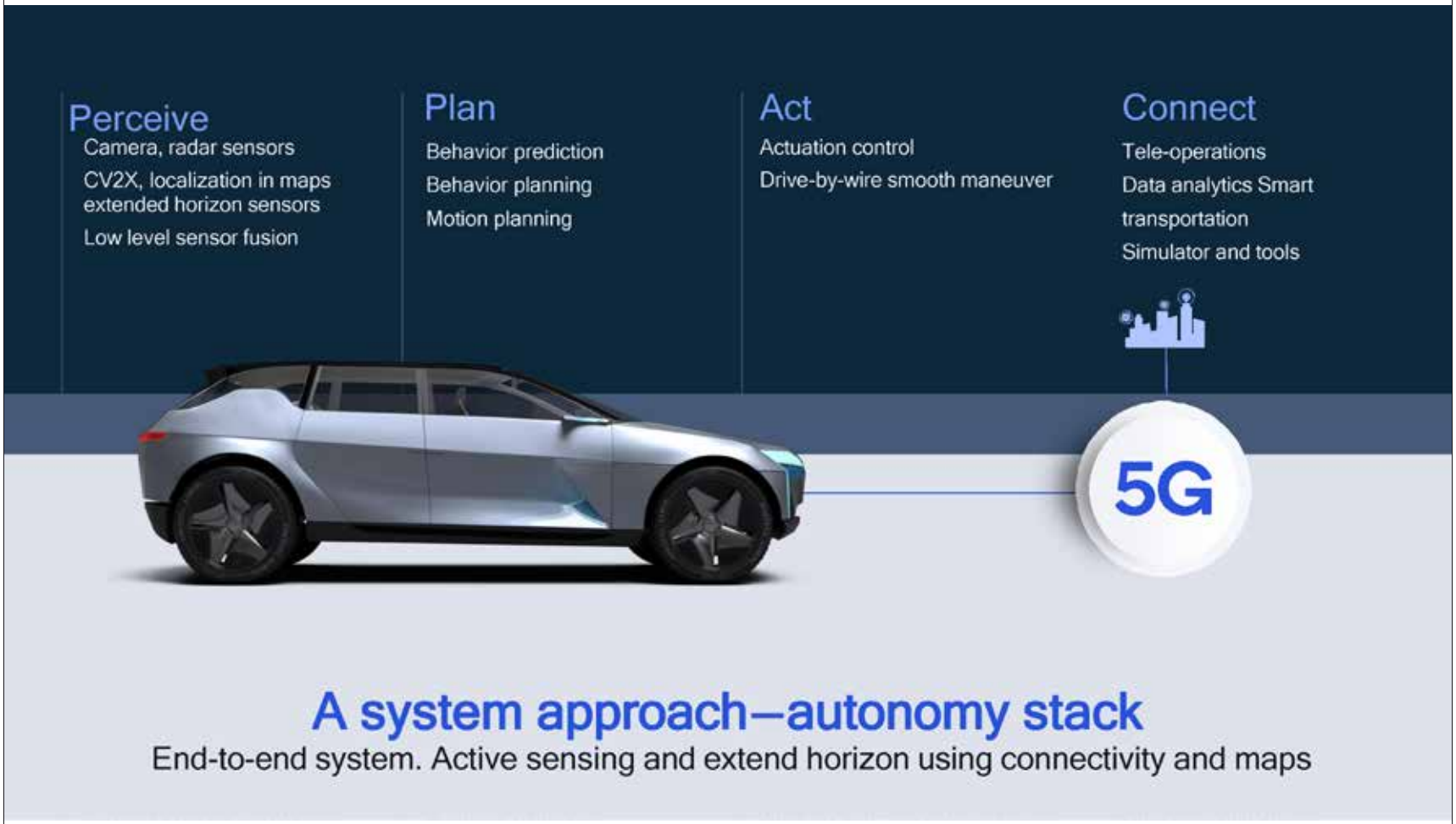

Perceive
Camera, radar sensors
CV2X, localization in maps extended horizon sensors
Low level sensor fusion
Plan
Behavior prediction
Behavior planning
Motion planning
Act
Actuation control
Drive-by-wire smooth maneuver
Connect
Tele-operations
Data analytics Smart transportation
Simulator and tools
5G
A system approach–autonomy stack
End-to-end system. Active sensing and extend horizon using connectivity and maps

5G brings several features to autonomous driving

Autonomous driving

Autonomous driving

Perception

Sharing of high throughput sensor data and real world model

Path planning

Intention and trajectory sharing for faster, yet safe maneuvers

Real-time local updates

Real-time sharing of local data with infrastructure and other vehicles (e.g. 3D HD maps)

Coordinated driving

Exchanging intention and sensor data for more predictable, coordinated autonomous driving

Benefits

Safer roads

Truck platooning, driver monitoring, minimizing manual operations to substantially human error

Clean environment

Reduced emission and shorter travel time

Enhanced personal mobility

Mobility services, assistive technologies, route planning

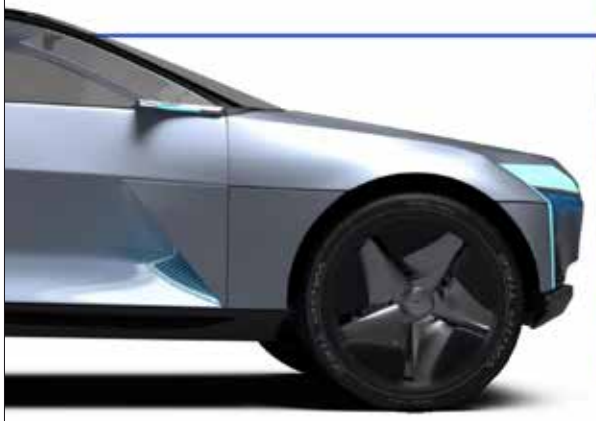
New business opportunities

Parking services, mapping services, fleet management, etc.

C-V2X + Autonomous Driving + Car-to-Cloud

For the next generation of intelligent transportation systems

Bringing richer applications, content, and services management



Car-to-Cloud platform

Future-proof designs

On demand/OTA updates, soft-SKU

Driver monitoring

Improved safety

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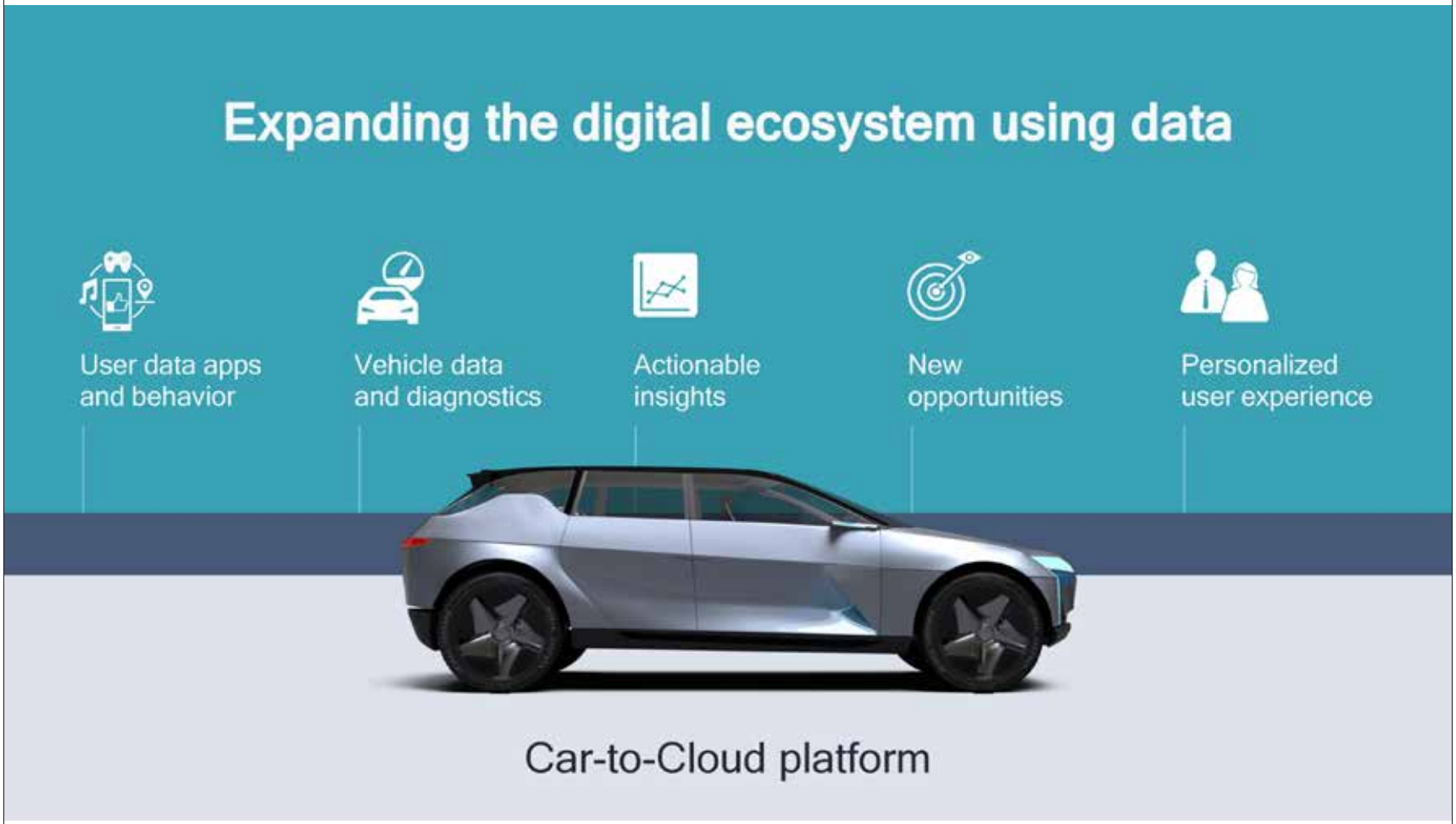
Expanding the digital ecosystem using data
User data apps and behavior
Vehicle data and diagnostics
Actionable insights
New opportunities
Personalized user experience
Car-to-Cloud platform

C-V2X

Standards complete, commercially available, deployment begun

Broad industry support with 5GAA

Initial focus on basic safety use cases

5G roadmap expands functionality

Rich sensor sharing
Vehicles share intent and perception

On-the-fly connectionless groups
Enabled by reliable multicast

Benefits in addition to safety
Coordinated driving brings reduced congestion, shorter trip time, and energy savings

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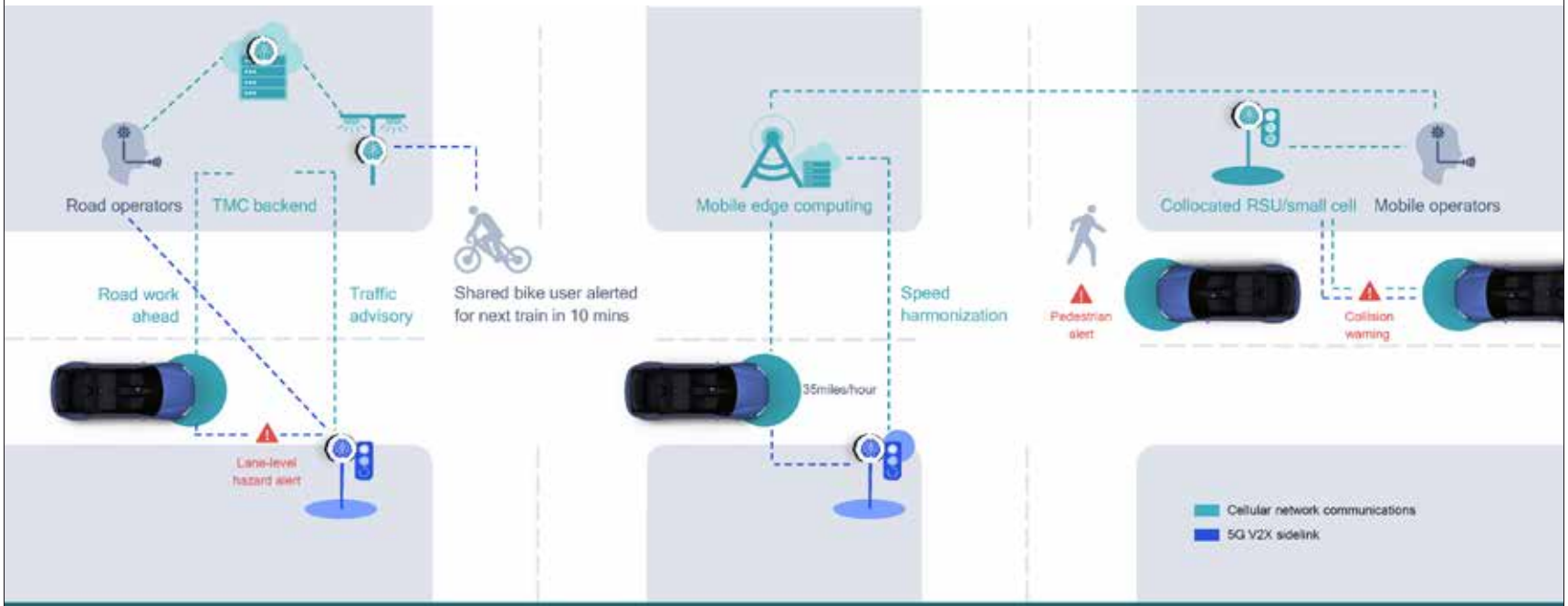


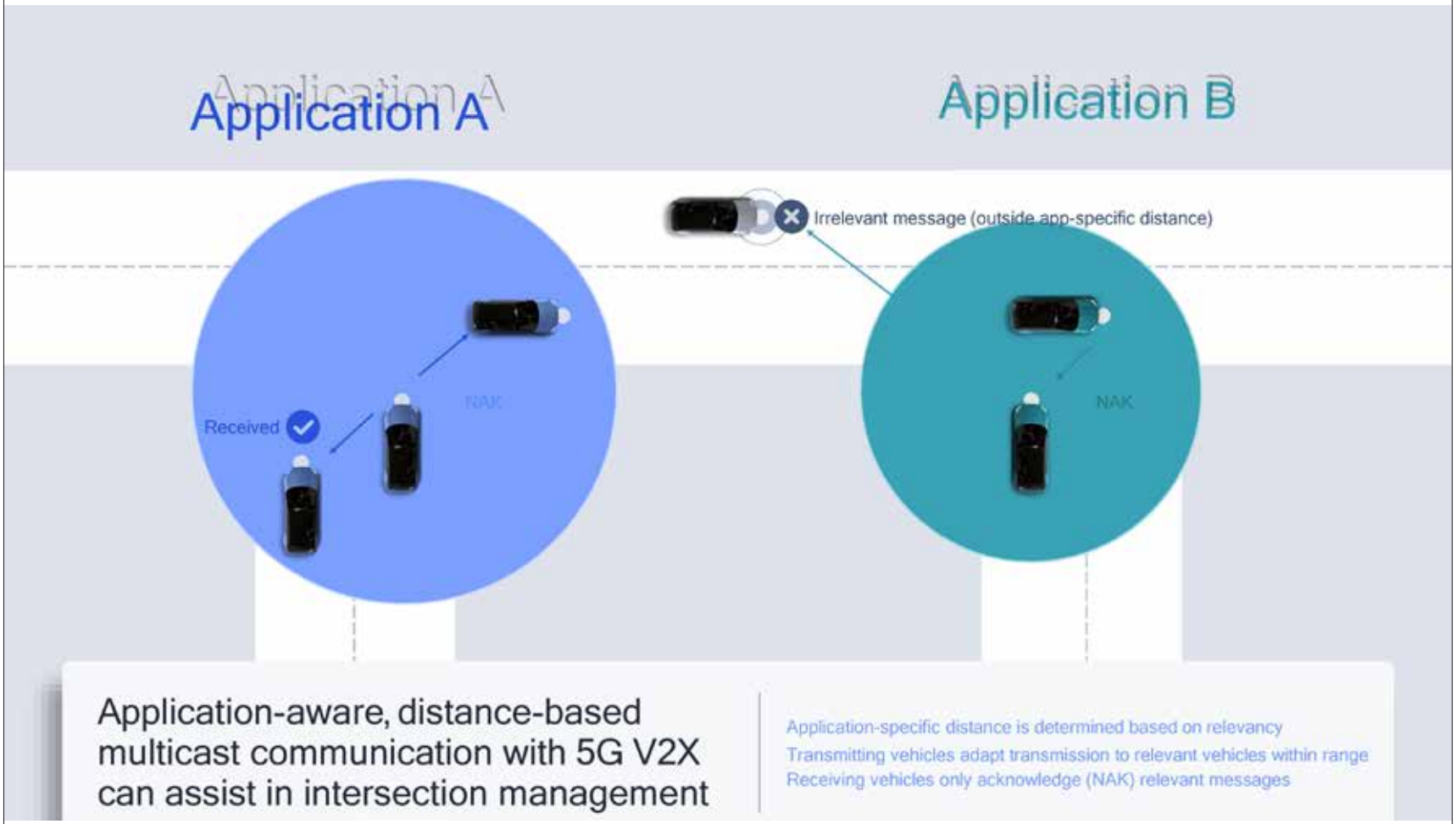
5G V2X sidelink can complement wide-area networks

Managing intersections with 5G V2X

5G V2X sidelink
(collision avoidance and coordinated driving)

Cellular networks
(TMC-based traffic monitoring and advisory)

Edge/on-device AI
(AI-based traffic sensors for speed harmonization)


Application A
Application B
Irrelevant message (outside app-specific distance)
Received
NAK
NAK
Application-aware, distance-based multicast communication with 5G V2X can assist in intersection management
Application-specific distance is determined based on relevancy
Transmitting vehicles adapt transmission to relevant vehicles within range
Receiving vehicles only acknowledge (NAK) relevant messages

Smart RSUs with on-device processing can complement edge cloud

Central cloud

Traffic management center

Big data, AI training, less delay sensitive content, storage,..

Compute intensive, real-time data

Edge cloud

Neighborhood/city/highway

Compute/processing, context, control, storage, closer to vehicular network

Vehicular networks are highly dynamic

On-device intelligence

Smart RSUs

Sensing, processing, security, intelligence

- Realize 5G's low latency
- Scalability
- Performance
- Additional resources
- New deployments, (private networks)

Latency could be over 100s ms today ← Cooperation between road operators, MNOs[1], infra vendors, cloud providers,.. → Latency as low as 1 ms

- 5G value maximizes from operators and city services
- Deliver enhanced and new services
- Host, content, processing,.. for 3rd party
- Local analytics, management, security

- Immediacy–tasks on device
- Efficient use of bandwidth
- Scalability

1 MNO is mobile network operator

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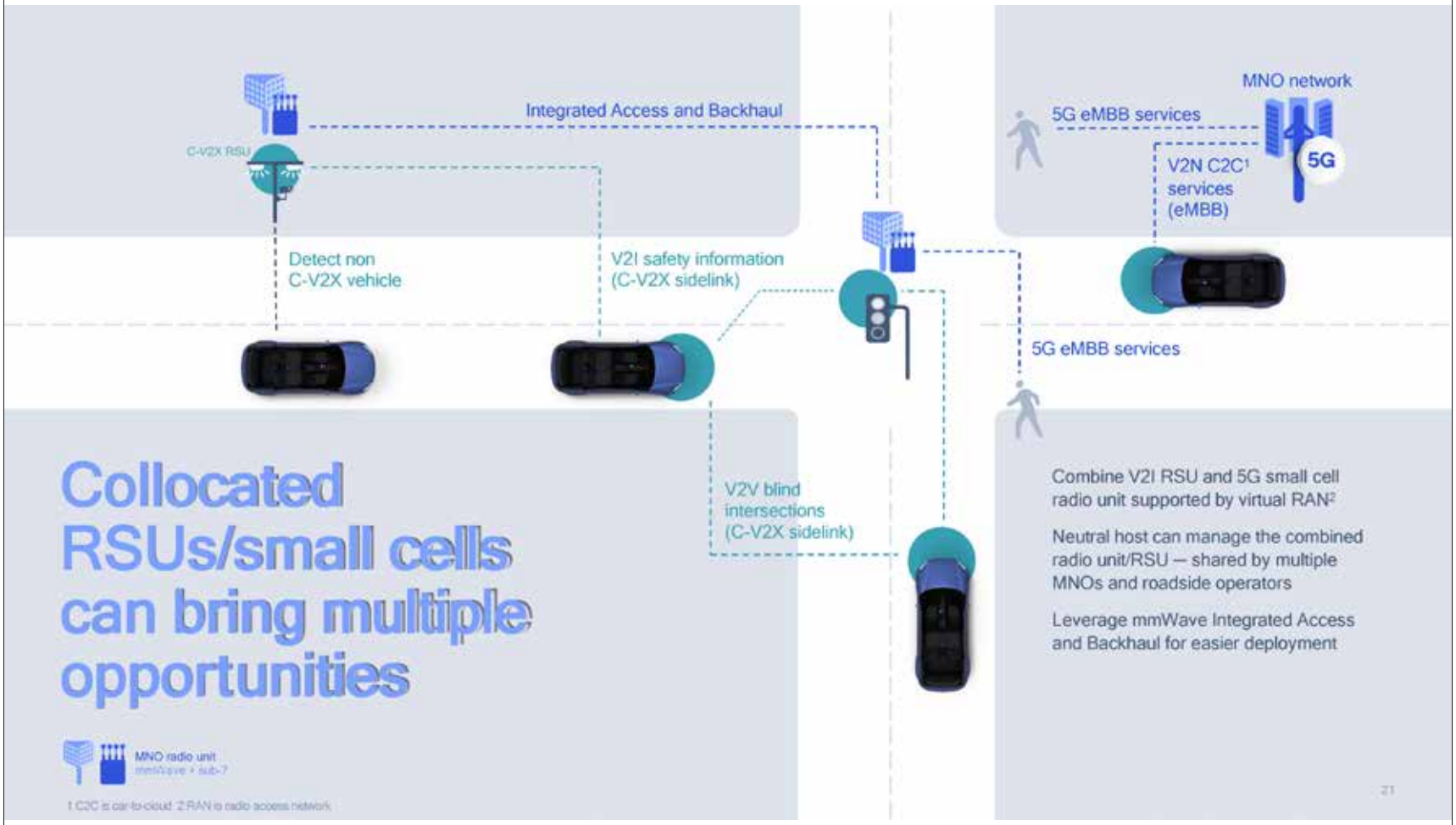
Integrated Access and Backhaul
C-V2X RSU
Detect non
C-V2X vehicle
V2I safety information
(C-V2X sidelink)
V2V blind
intersections
(C-V2X sidelink)
MNO network
5G eMBB services
V2N C2C[1]
services
(eMBB)
5G
5G eMBB services
Collocated RSUs/small cells can bring multiple opportunities
MNO radio unit
mmWave + sub-7
Combine V2I RSU and 5G small cell radio unit supported by virtual RAN[2]
Neutral host can manage the combined radio unit/RSU – shared by multiple MNOs and roadside operators
Leverage mmWave Integrated Access and Backhaul for easier deployment
1 C2C is car-to-cloud 2 RAN is radio access network
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Smarter transportation infrastructure creates new opportunities
Road world model SW stack
Perception, sensor fusion
Compute
Heterogeneous computing and AI accelerator for perception/sensor fusion
Communications
V2I (sidelink) via C-V2X
Cellular communication via 4G/5G
C-V2X
Localization
Radar
Multiple cameras
V2I
Basic safety and mobility services
Today
Advanced safety applications
Smarter RSUs, collocated RSUs and small-cells
Tomorrow
Roadside access can generate new revenue models
Future

Sharing roadside access can generate additional value for the ecosystem

Build an integrated data sharing system to provide personalized services

Leverage collocated smart RSUs/small-cells to expand MNOs cellular coverage

Leverage network acceleration effect to expand C-V2X benefits in initial deployments

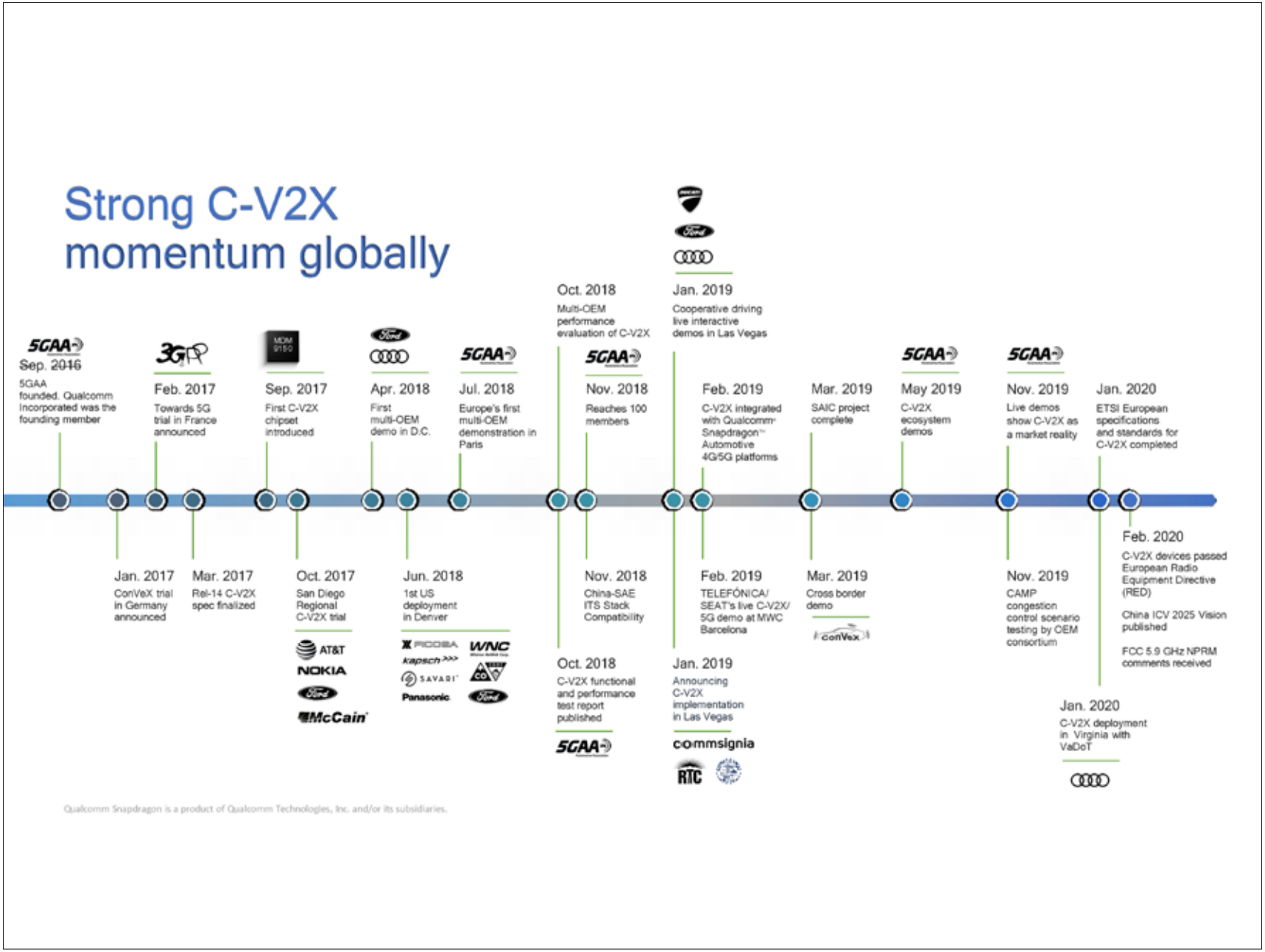
Improve collaboration for enhanced road management

Today

Tomorrow

Future

Driving digitally enabled end-to-end solutions for smart transportation


Strong C-V2X momentum globally
Sep. 2016
5GAA founded. Qualcomm Incorporated was the founding member
Jan. 2017
ConVeX trial in Germany announced
Feb. 2017
Towards 5G trial in France announced
Mar. 2017
Rel-14 C-V2X spec finalized
Sep. 2017
First C-V2X chipset introduced
Oct. 2017
San Diego Regional C-V2X trial
AT&T
NOKIA
McCain
Apr. 2018
First multi-OEM demo in D.C.
Jun. 2018
1st US deployment in Denver
Jul. 2018
Europe's first multi-OEM demonstration in Paris
Oct. 2018
Multi-OEM performance evaluation of C-V2X
Oct. 2018
C-V2X functional and performance test report published
Nov. 2018
Reaches 100 members
Nov. 2018
China-SAE ITS Stack Compatibility
Jan. 2019
Cooperative driving live interactive demos in Las Vegas
Jan. 2019
Announcing C-V2X implementation in Las Vegas
commsignia
Feb. 2019
C-V2X integrated with Qualcomm Snapdragon™ Automotive 4G/5G platforms
Feb. 2019
TELEFÓNICA/ SEAT's live C-V2X/ 5G demo at MWC Barcelona
Mar. 2019
SAIC project complete
Mar. 2019
Cross border demo
May 2019
C-V2X ecosystem demos
Nov. 2019
Live demos show C-V2X as a market reality
Nov. 2019
CAMP congestion control scenario testing by OEM consortium
Jan. 2020
C-V2X deployment in Virginia with VaDoT
Jan. 2020
ETSI European specifications and standards for C-V2X completed
Feb. 2020
C-V2X devices passed European Radio Equipment Directive (RED)
China ICV 2025 Vision published
FCC 5.9 GHz NPRM comments received
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Over a decade of innovation and core R&D

Autonomous stack

Investing for multiple years in R&D to develop a comprehensive autonomous highway pilot stack

ADAS SoC and accelerator

Automotive Safety compliant scalable HW - SoCs and Accelerators, with SDK, framework, tool chain

Dimensioning purpose-built IP

Workload and HW sizing for optimized, purpose-built HW, SW, compilers, optimizers and algorithms

HW and SW proof-of-concept

Developed prototypes including camera perception, radar deep learning, localization, sensor fusion, path, maneuver and behavior planning; and related AI/ML, tools

Continuous road and offline testing

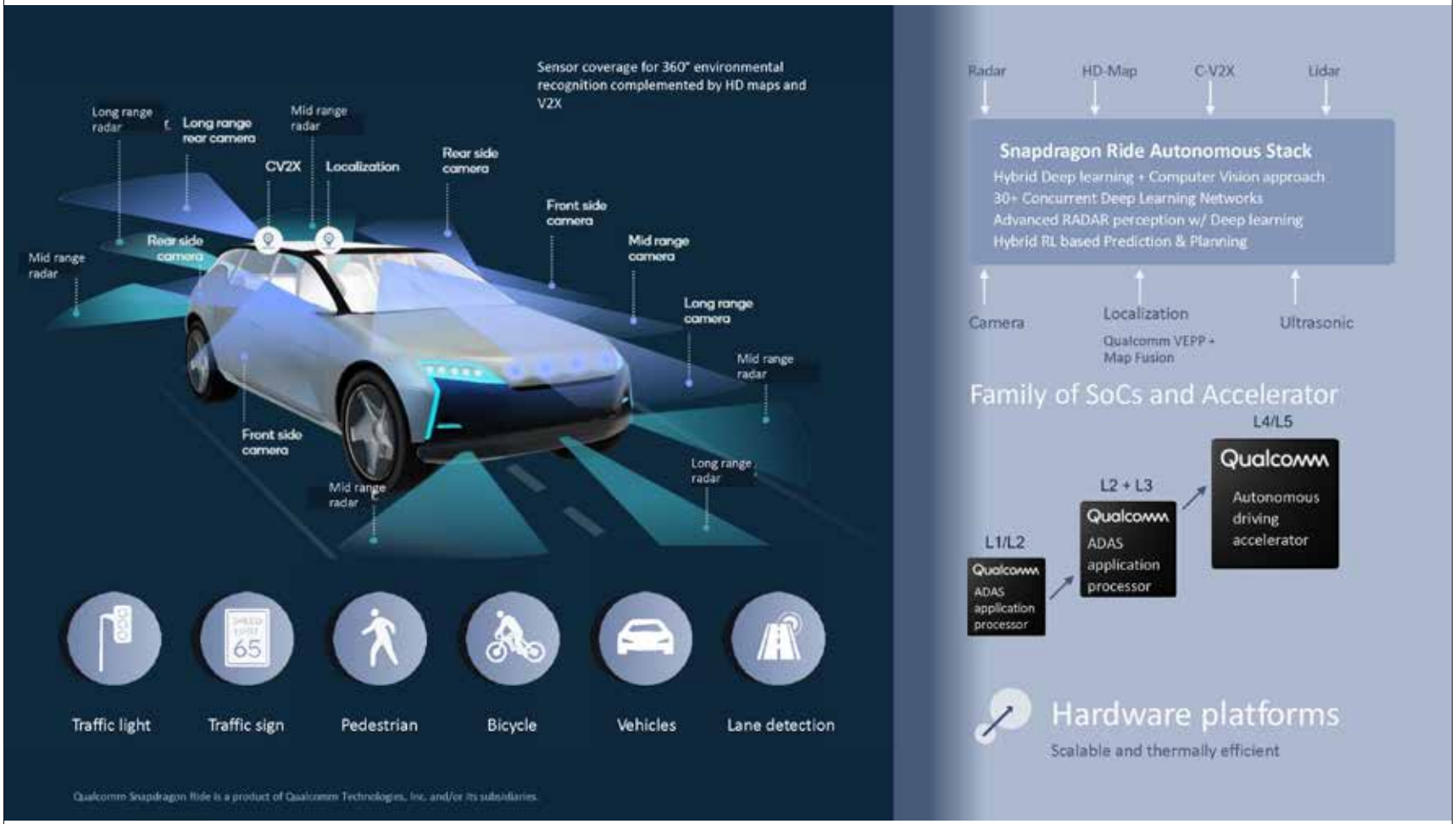
Software-In-Loop and Hardware-In-Loop tests, real-world simulations

Embedded testing/optimization/tools

Using existing hardware to test and optimize the system on embedded platform

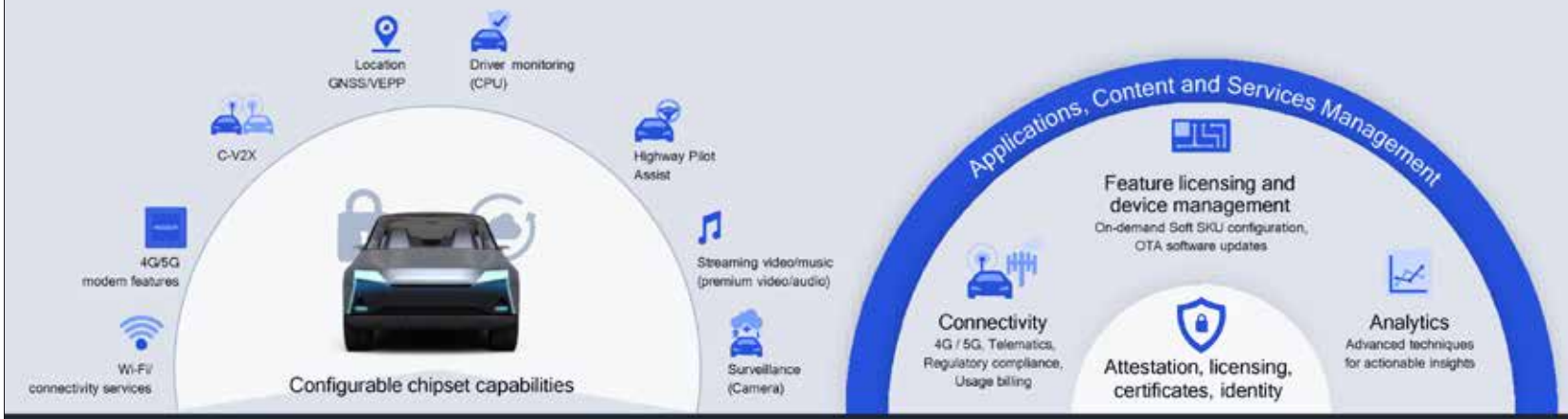
Qualcomm Technologies' holistic approach

to solving autonomous driving system challenges


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
Front side camera
Mid range camera
Long range camera
Mid range radar
Front side camera
Mid range radar
Long range radar
Mid range radar
Traffic light
Traffic sign
Pedestrian
Bicycle
Vehicles
Lane detection
Qualcomm Snapdragon Ride is a product of Qualcomm Technologies, Inc. and/or its subsidiaries.
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
Qualcomm VEPP + Map Fusion
Ultrasonic
Family of SoCs and Accelerator
L1/L2
Qualcomm
ADAS application processor
L2 + L3
Qualcomm
ADAS application processor
L4/L5
Qualcomm
Autonomous driving accelerator
Hardware platforms
Scalable and thermally efficient

Snapdragon Automotive Cockpit, 4G/5G Wireless Platform, ADAS and Car-to-Cloud Platform

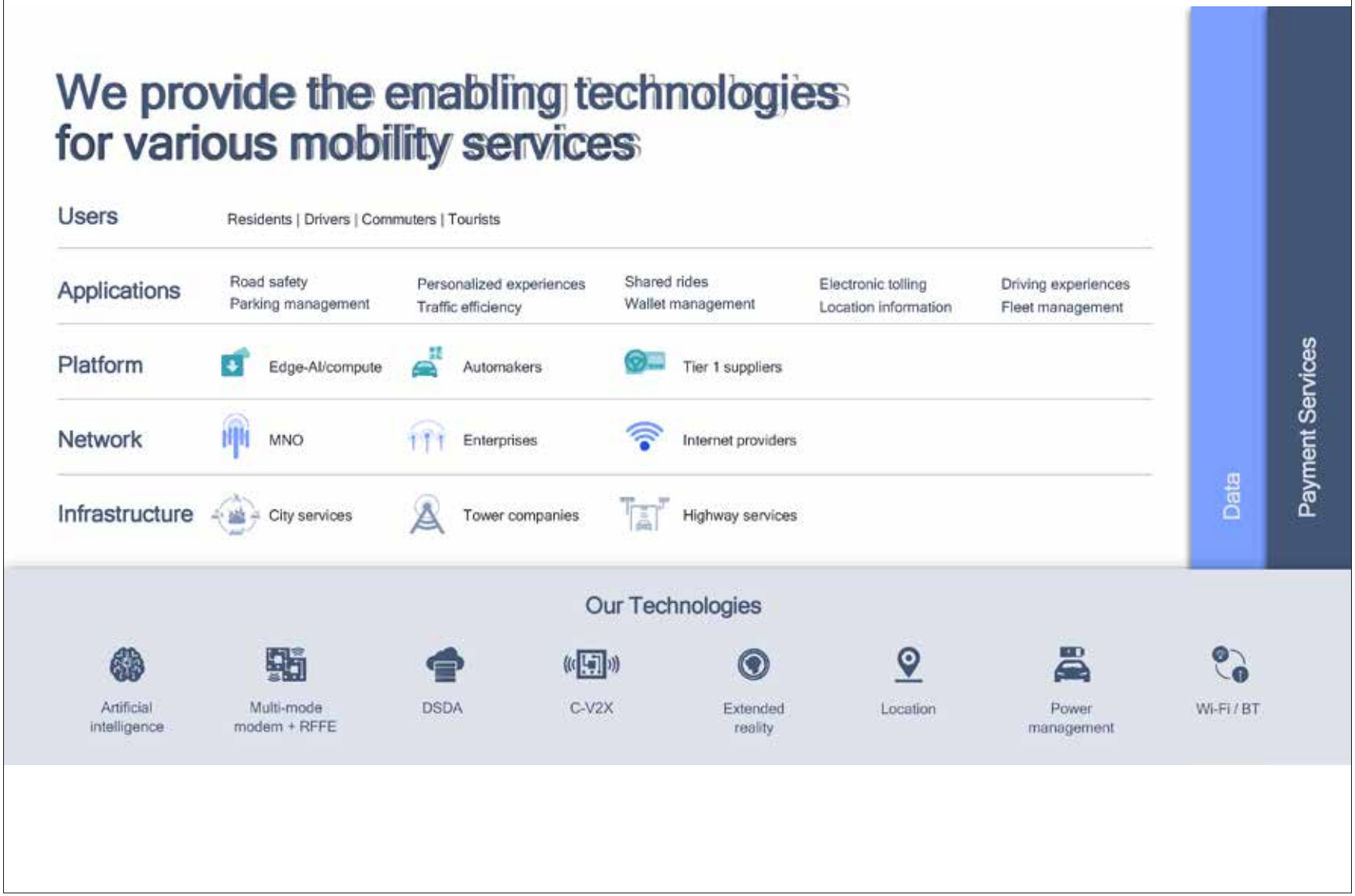
Secure, connected-car services and lifecycle management

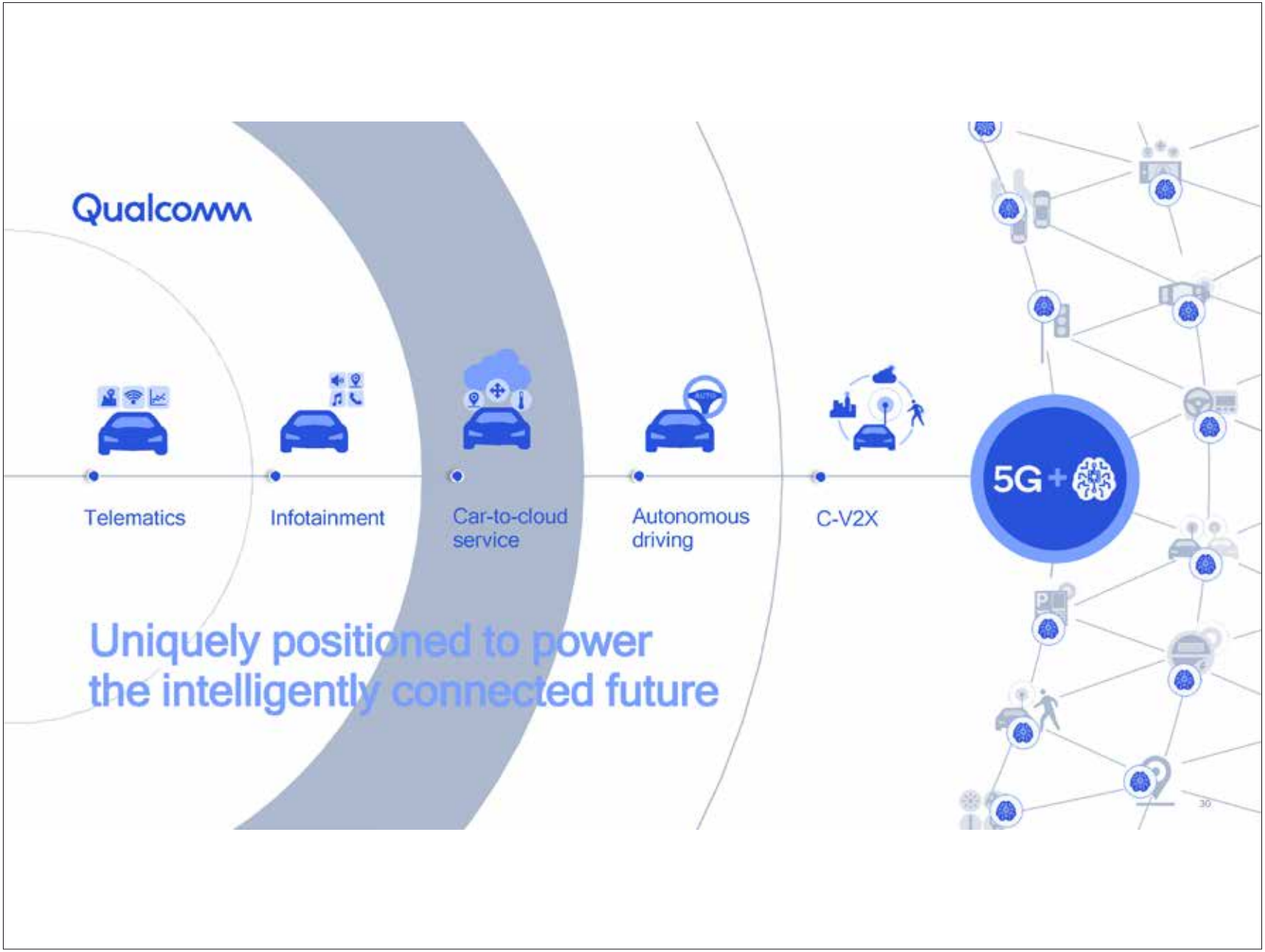


On-demand hardware/capabilities

Qualcomm® Car-to-Cloud Platform

Qualcomm Car-to-Cloud is a product of Qualcomm Technologies, Inc. and/or its subsidiaries.


We provide the enabling technologies for various mobility services
Users
Residents | Drivers | Commuters | Tourists
Applications
Road safety
Parking management
Personalized experiences
Traffic efficiency
Shared rides
Wallet management
Electronic tolling
Location information
Driving experiences
Fleet management
Platform
Edge-AI/compute
Automakers
Tier 1 suppliers
Network
MNO
Enterprises
Internet providers
Infrastructure
City services
Tower companies
Highway services
Data
Payment Services
Our Technologies
Artificial intelligence
Multi-mode modem + RFFE
DSDA
C-V2X
Extended reality
Location
Power management
Wi-Fi / BT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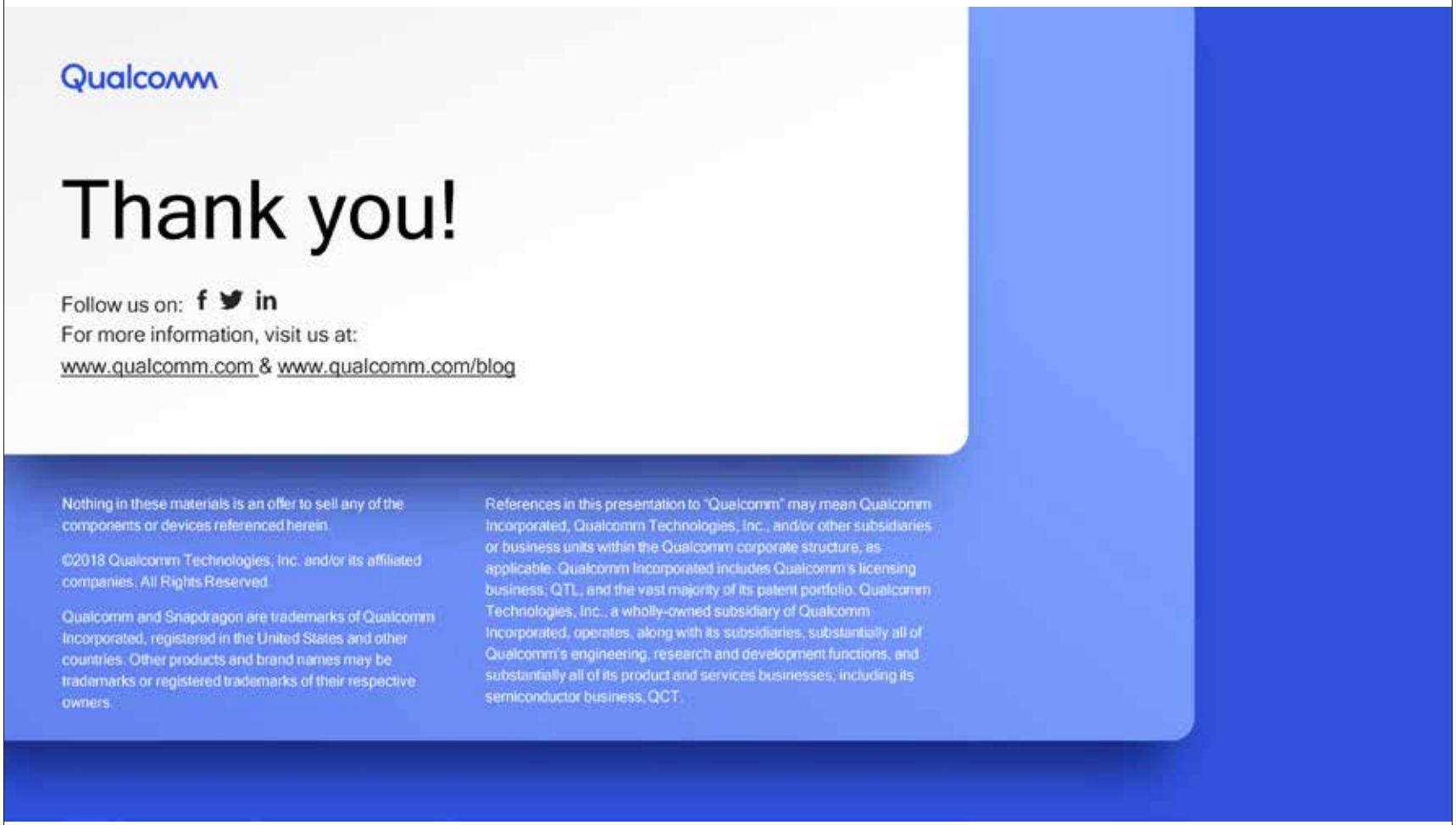
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