Looking out to the future

How geospatial technologies will change the way we think, plan and do

Charles Davies, CTO

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AUTOMOTIVE & LICENSING

PRINCIPAL BUSINESS

LOCATION TECHNOLOGIES FOR **CUSTOMERS** TO **INTEGRATE** INTO THEIR **APPLICATIONS**

KEY PRODUCTS

MAPS AND LIVE MAP FEEDS INCLUDING **TRAFFIC**, APIS FOR **SEARCH** AND **ROUTING**, DEVICE SOFTWARE AND SUPPORTING PRODUCTS

KEY CUSTOMERS

THROUGH OUR **AUTOMOTIVE** BUSINESS UNIT TO AUTOMOTIVE CUSTOMERS (MAINLY **OEMS**) AND THROUGH OUR **LICENSING** BUSINESS UNIT TO **OTHER THAN AUTOMOTIVE CUSTOMERS** SUCH AS APPLE, UBER AND **PUBLIC AUTHORITIES**

TELEMATICS

PRINCIPAL BUSINESS

FLEET MANAGEMENT SERVICES AND OTHER **CONNECTED CAR** SERVICES

KEY PRODUCTS

TELEMATICS SERVICE PLATFORM, **WEBFLEET**, DEVELOPER **INTERFACES**, TELEMATICS **DEVICES** AND DRIVER **TERMINALS**

KEY CUSTOMERS

VEHICLE **FLEET OWNERS** AND OTHER BUSINESSES NEEDING TO MANAGE VEHICLES SUCH AS CAR **DEALERS**, CAR **INSURANCE**, AND VEHICLE **LEASING** COMPANIES

CONSUMER

PRINCIPAL BUSINESS

CONSUMER **SPORTS** AND **NAVIGATION** DEVICES AND SERVICES

KEY PRODUCTS

SPORTS WATCHES AND ACTIVITY TRACKERS, **PNDS**, MOBILE **APPS**, ACTION CAMERAS

KEY CUSTOMERS

CONSUMERS

ALSO **PROGRAMMABLE DRIVER TERMINALS** FOR BUSINESSES
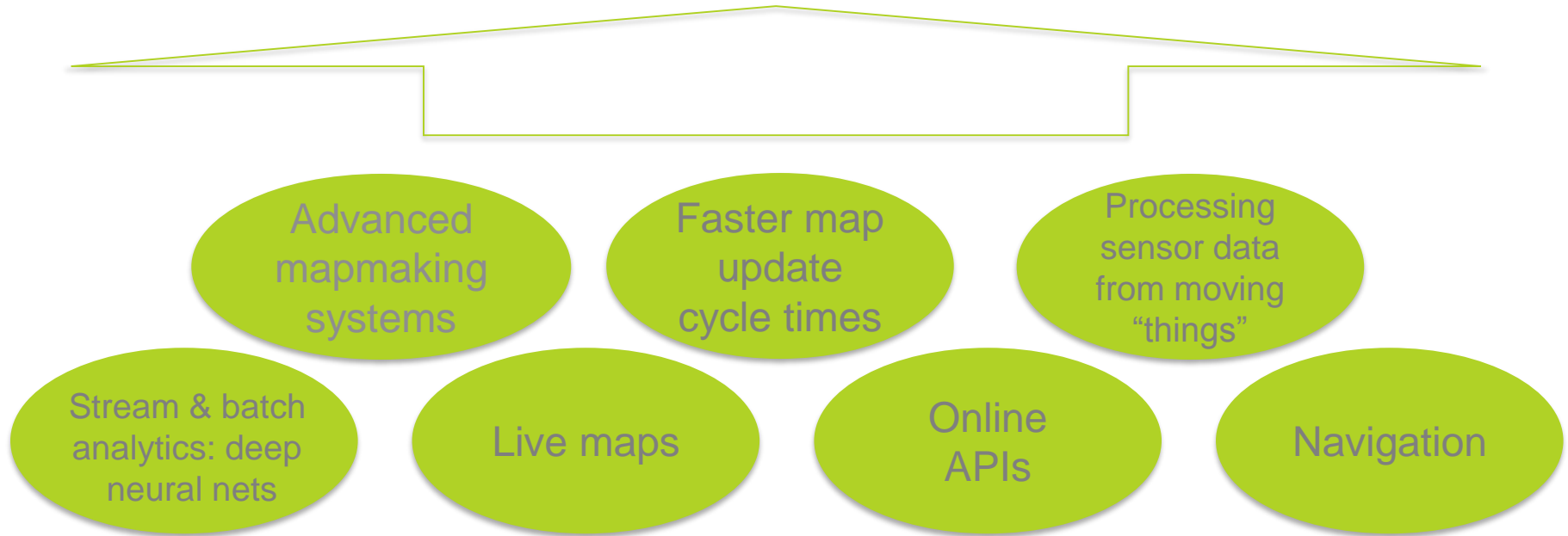
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TOMTOM IS TRANSFORMING MOBILITY

VISION TOMTOM IS WORKING TO

SELF-DRIVING CARS   MOBILITY SERVICES   SMART CITIES

Advanced mapmaking systems

Faster map update cycle times

Processing sensor data from moving "things"

Stream & batch analytics: deep neural nets

Live maps

Online APIs

Navigation

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MAP MAKING CONTEXT

Real world changes → Update our world map → Update application map

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FASTER MAP UPDATE CYCLE TIMES
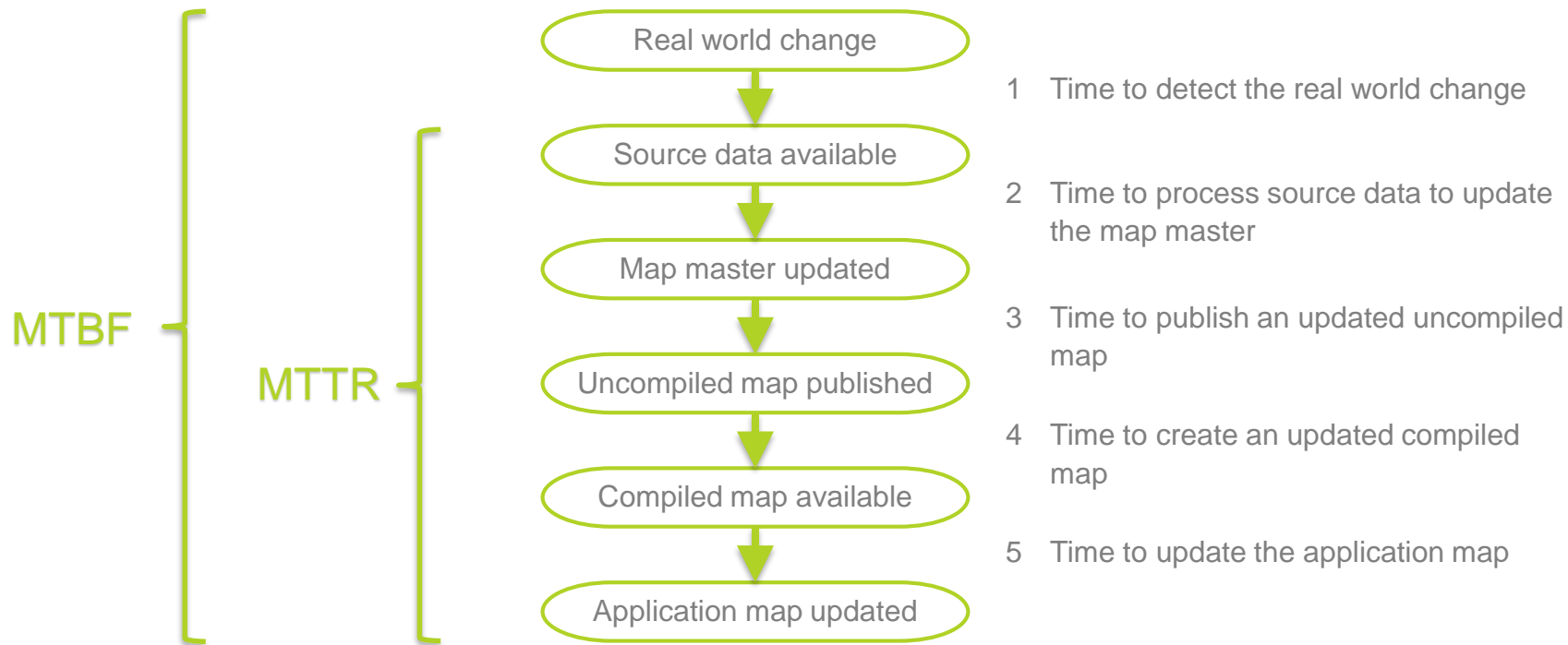
MTBF
(mean time between failure)

Longer time between application failures caused by an out-of-date map

MTTR
(mean time to repair)

Shorter wait between reporting a problem and the application being repaired

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MAP UPDATE CYCLE TIME OVERVIEW

MTBF

MTTR

Real world change

↓

Source data available

↓

Map master updated

↓

Uncompiled map published

↓

Compiled map available

↓

Application map updated

1   Time to detect the real world change

2   Time to process source data to update the map master

3   Time to publish an updated uncompiled map

4   Time to create an updated compiled map

5   Time to update the application map

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OUR TRADITIONAL AUTOMOTIVE BUSINESS…

Full connected navigation system (maps, traffic, navigation engine, UI, mobile, cloud)

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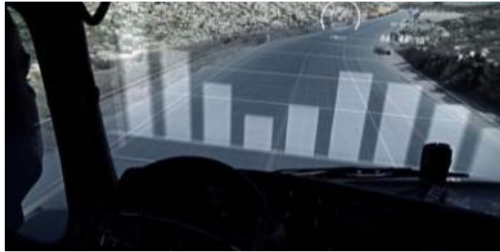# OUR NEWER AUTOMOTIVE BUSINESS…

Maps and other technologies for automated driving (also driver assistance)

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AUTOMATED DRIVING WILL TRANSFORM PEOPLE'S LIVES
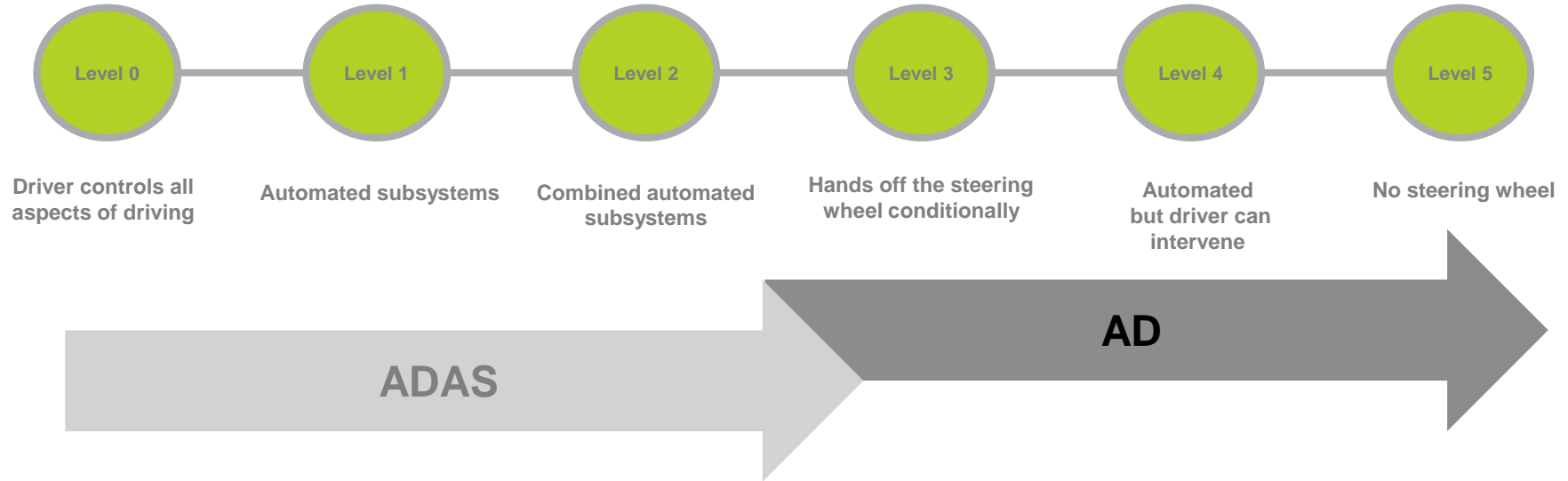

Car safety will increase

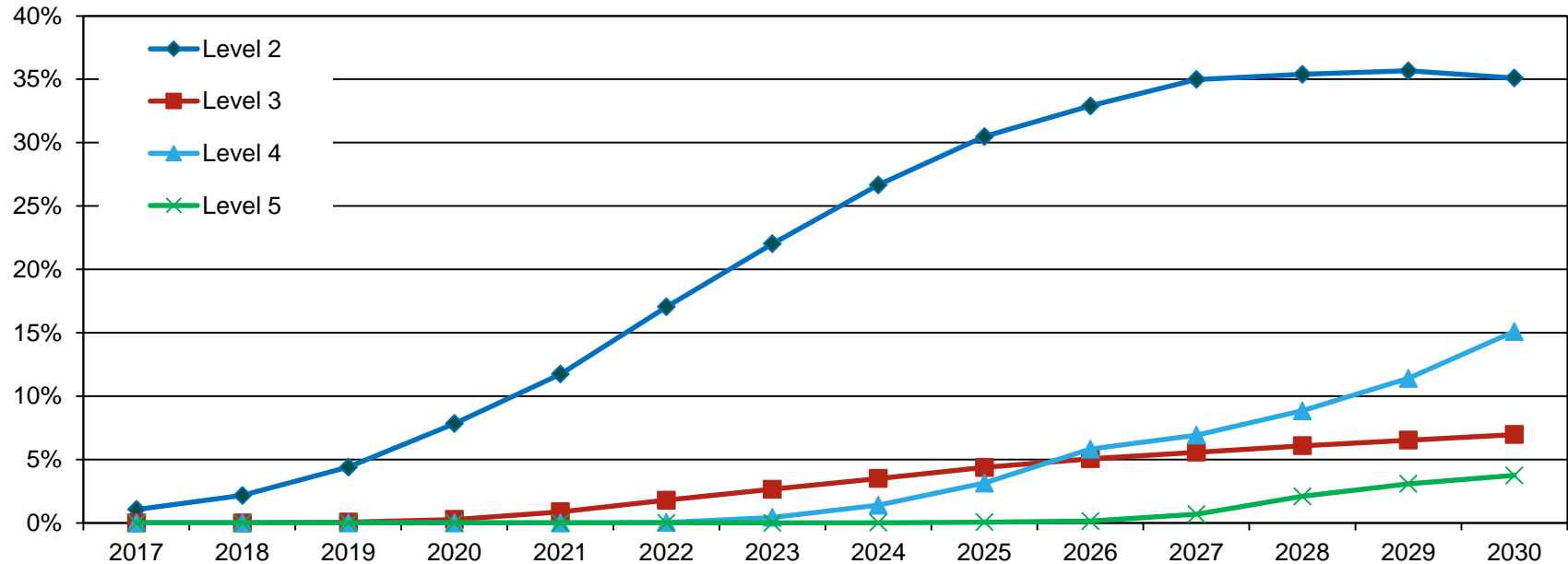Cars will become more efficient and consequently more eco-friendly

Images: Volvo

Drivers will have more freedom and new car comfort features will greatly improve the user experience

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FROM ADAS TO AUTONOMOUS DRIVING

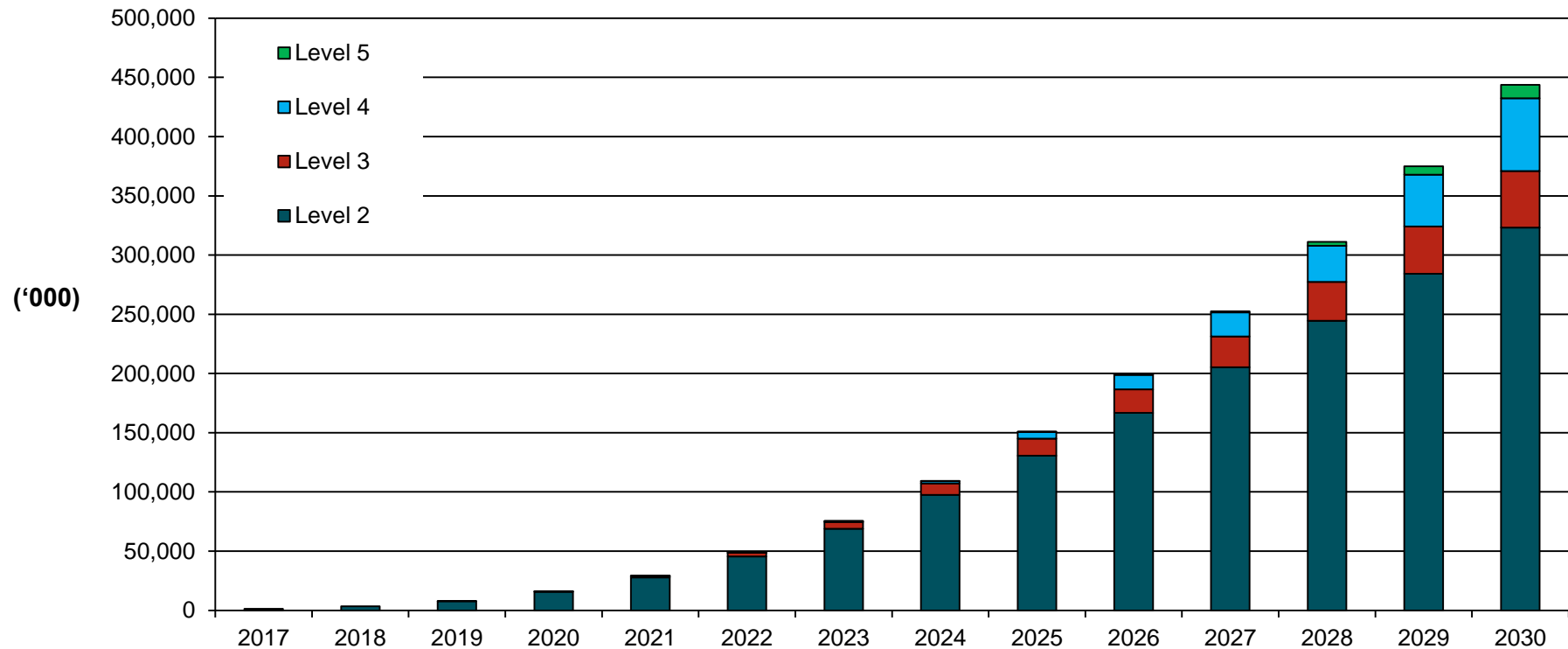| Level 0	Level 1	Level 2	Level 3	Level 4	Level 5
Driver controls all aspects of driving	Automated subsystems	Combined automated subsystems	Hands off the steering wheel conditionally	Automated but driver can intervene	No steering wheel

ADAS

AD

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AUTONOMOUS PENETRATION OF NEW VEHICLE SALES

Source: ABI Research

Note: vehicle sales are <u>not</u> counted twice (i.e. vehicles shipped with L3 autonomy are not also counted as having L2 autonomy)

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AUTONOMOUS VEHICLE PARK
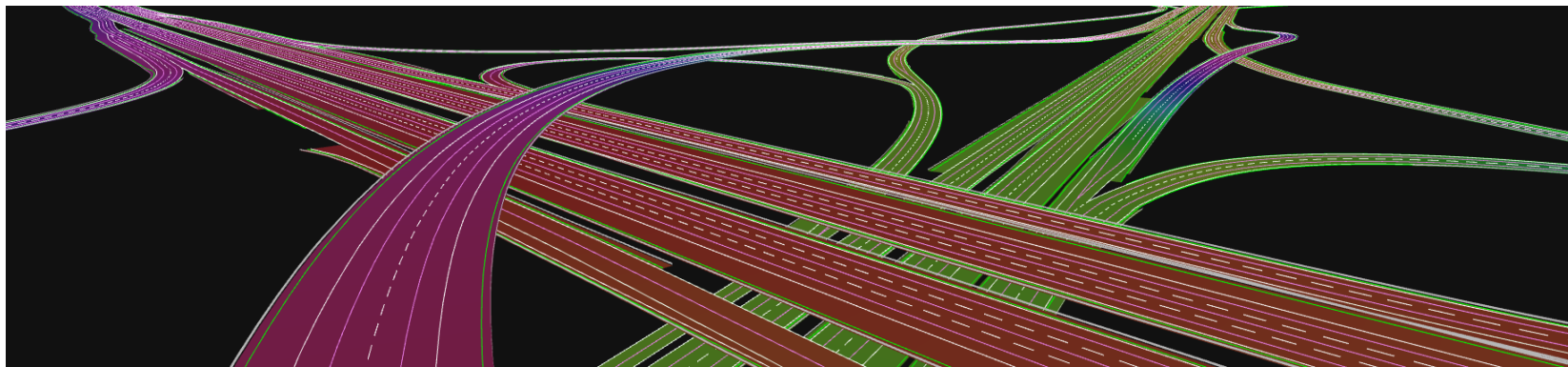

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A DRIVERLESS CAR "SEES" THE ROAD WITH ITS SENSORS

Our map augments the sensor-based reality to enable better localization, path planning and perception

Sensor-based observations help keep the map up to date

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HD MAP FOR AUTONOMOUS DRIVING

HIGHLY DETAILED

3D Lane Geometry
- Markings
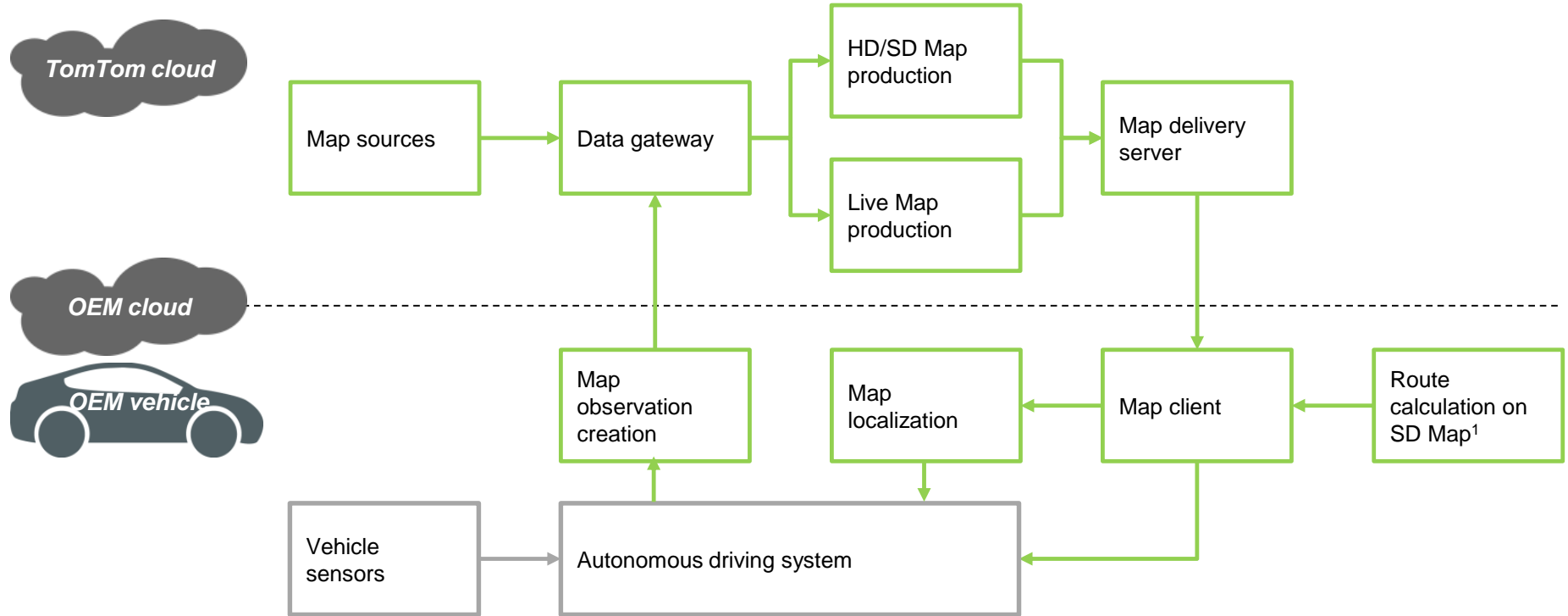- Centerlines
- Road boundaries

HIGHLY ACCURATE

Sub-meter absolute
Decimeter-level relative

RICHLY ATTRIBUTED

Lane-level attributes
Road signs

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PUTTING IT ALL TOGETHER…

TomTom cloud

OEM cloud

OEM vehicle

Map sources → Data gateway → HD/SD Map production / Live Map production → Map delivery server → Map client

Map observation creation

Map localization

Route calculation on SD Map[1]

Vehicle sensors → Autonomous driving system

1. Route calculation can be in the cloud or in the vehicle

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WHY WE ACQUIRED AUTONOMOS

Gives us an understanding of the full autonomous driving stack and the ability to validate our technologies in our own driverless cars

Computer vision technology for map-making (including stereo camera)

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SUMMARY

A digital map becomes valuable when integrated into an application

- Known and unknown new applications emerging

Providing applications with an up-to-date map requires new approaches to mapmaking and deep technological investments

- Transactional mapmaking with continuous delivery
- Big data, advanced analytics, IoT, machine learning
- Sensor-rich connected cars

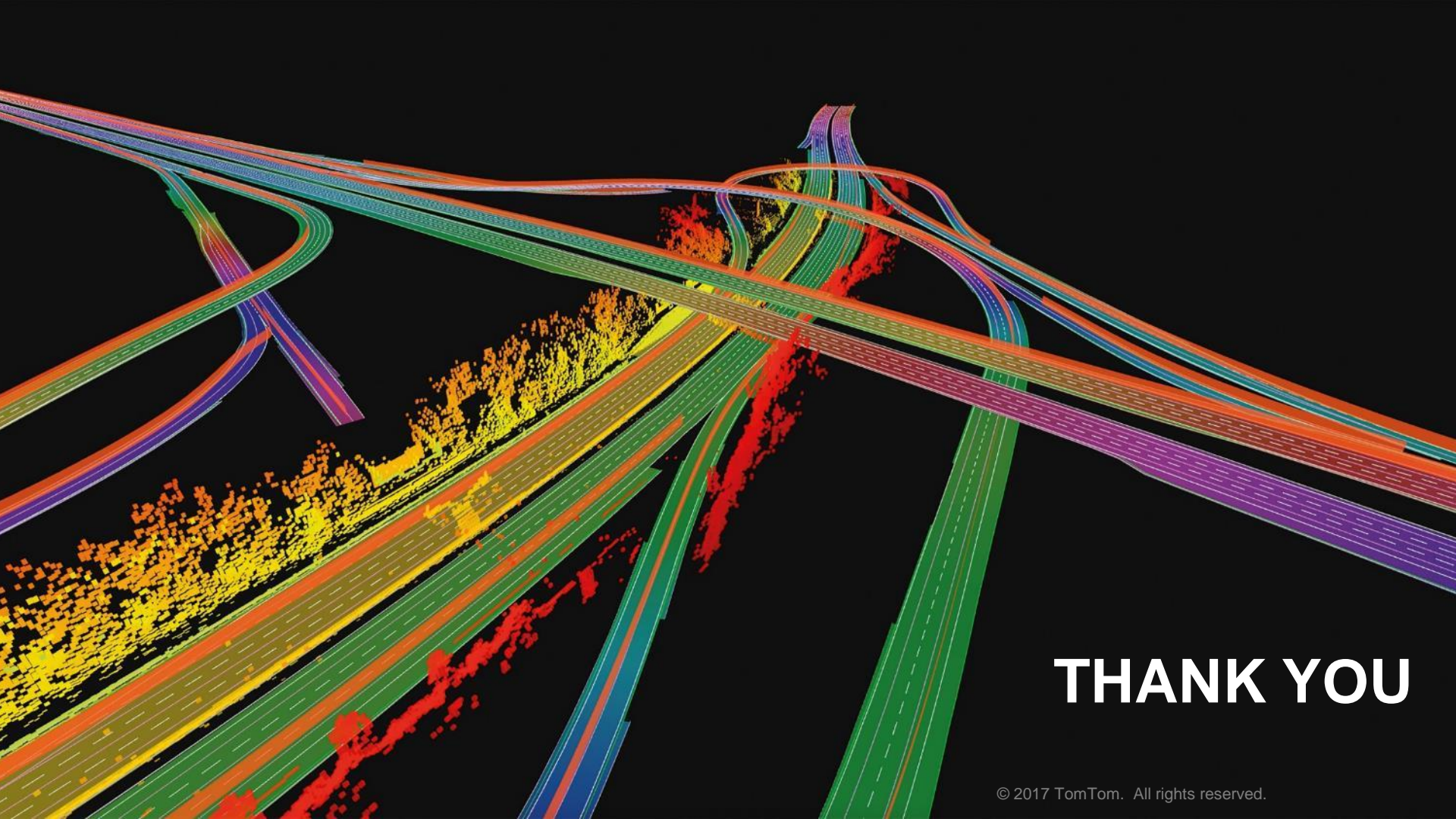Autonomous driving will transform people's lives

- Fewer deaths
- Environmentally cleaner
- Greater mobility

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AND FINALLY, SOME QUESTIONS…

Are NMAs in a similar situation to TomTom?
- Investing deeply in mapmaking technology and processes
- Improving map update cycle times

NMAs and commercial mapmakers like TomTom form a value network
Can that value network be improved?

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THANK YOU