

NVIDIA GTC Conference April 2021



TomTom: Accelerating a digital map that scales across all AD levels



NVIDIA GTC Conference

Willem Strijbosch

April 2021



TOMTOM 

AUTOMATED DRIVING IS CHANGING FAST...



Expanding coverage



New technologies



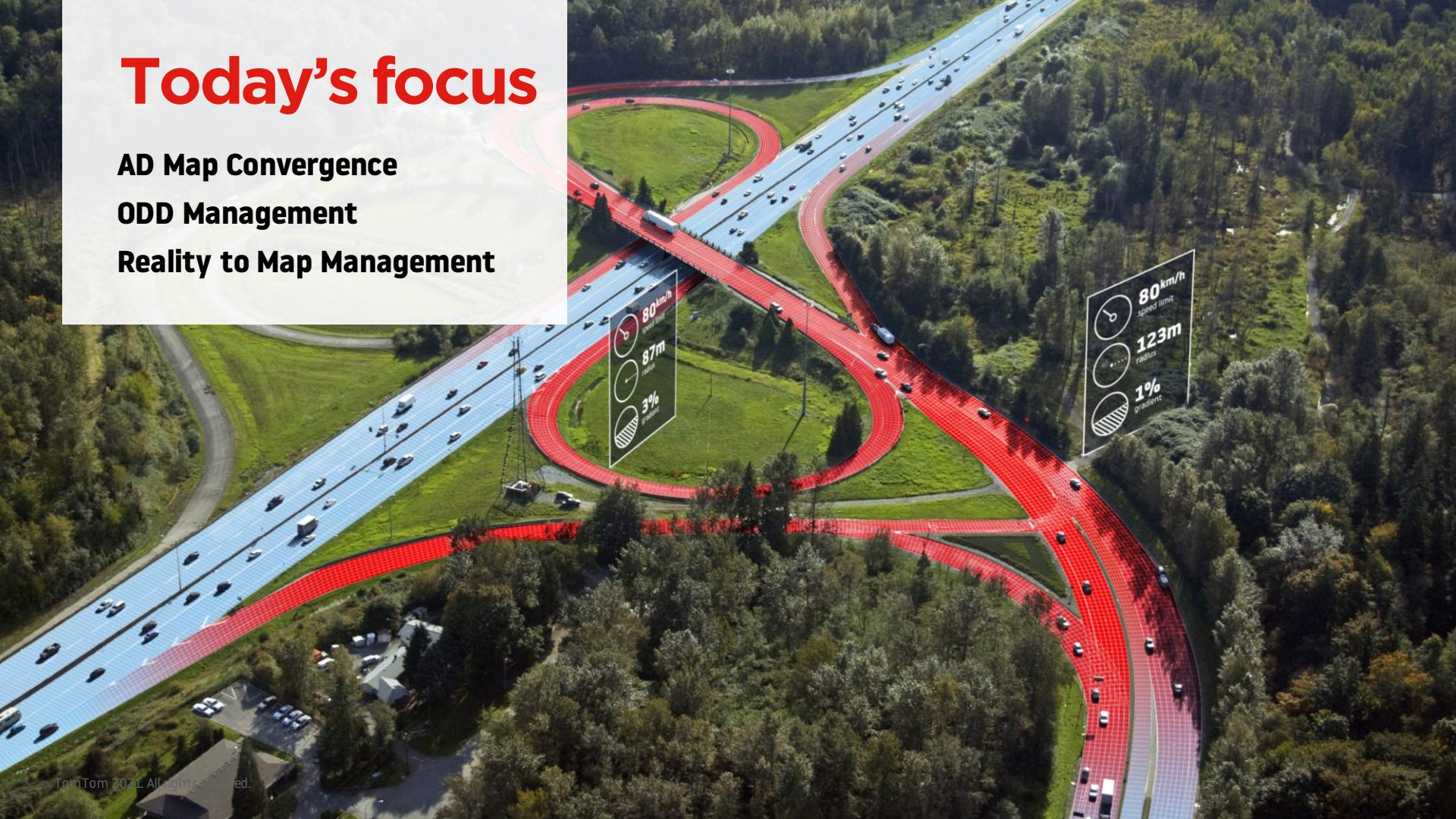
New Legislation

Today's focus

AD Map Convergence

ODD Management

Reality to Map Management



The Pillars of Automated Driving



MAPPING



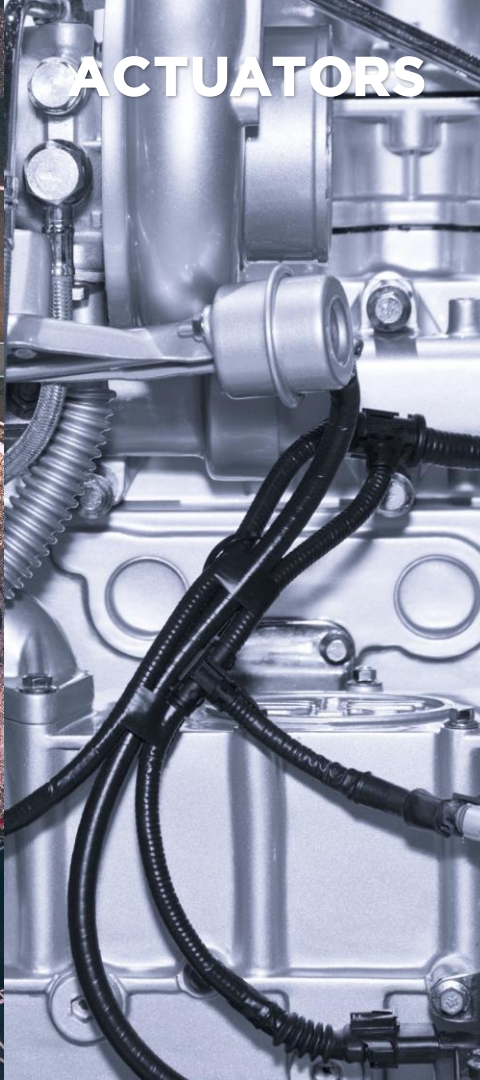
SENSING



**DRIVING
POLICY**



ACTUATORS



The Role of Maps in Automated Driving



PERCEPTION



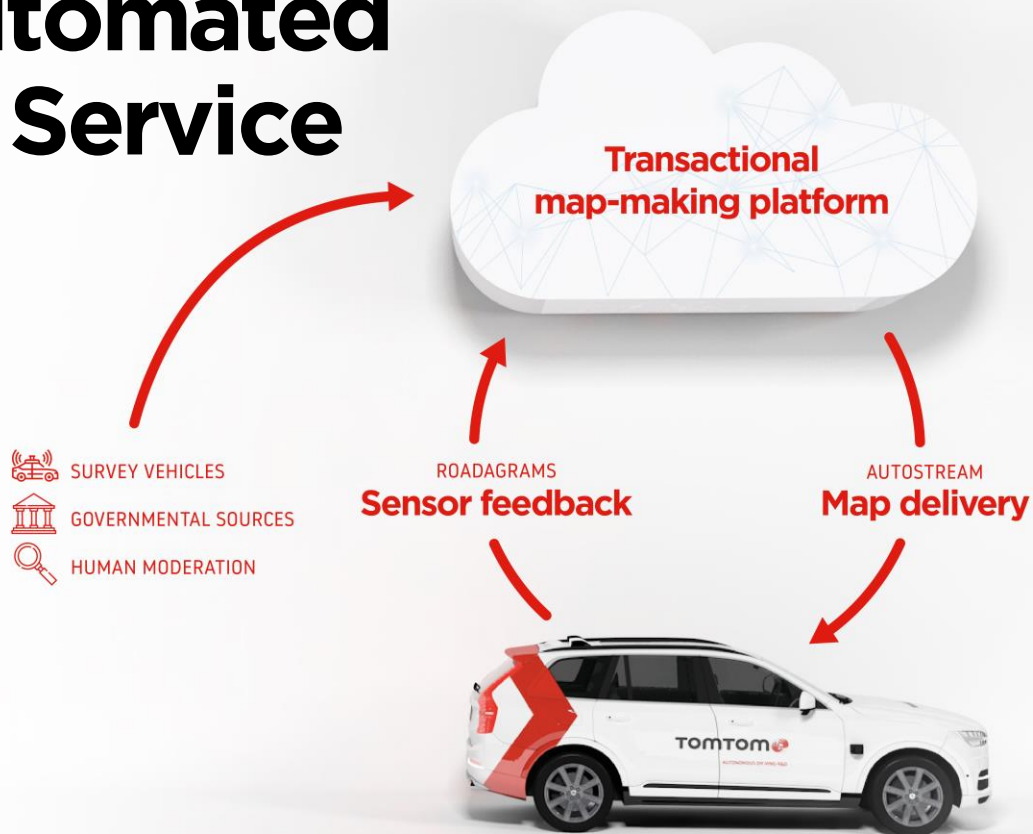
LOCALIZATION



PATH PLANNING



TomTom Automated Driving Map Service



TomTom is a leader in mapping for AD

ADAS Map

TomTom ADAS Map is used by over 3 million vehicles on the road today to power L1-L2 automated driving functions, tripling in 2 years.

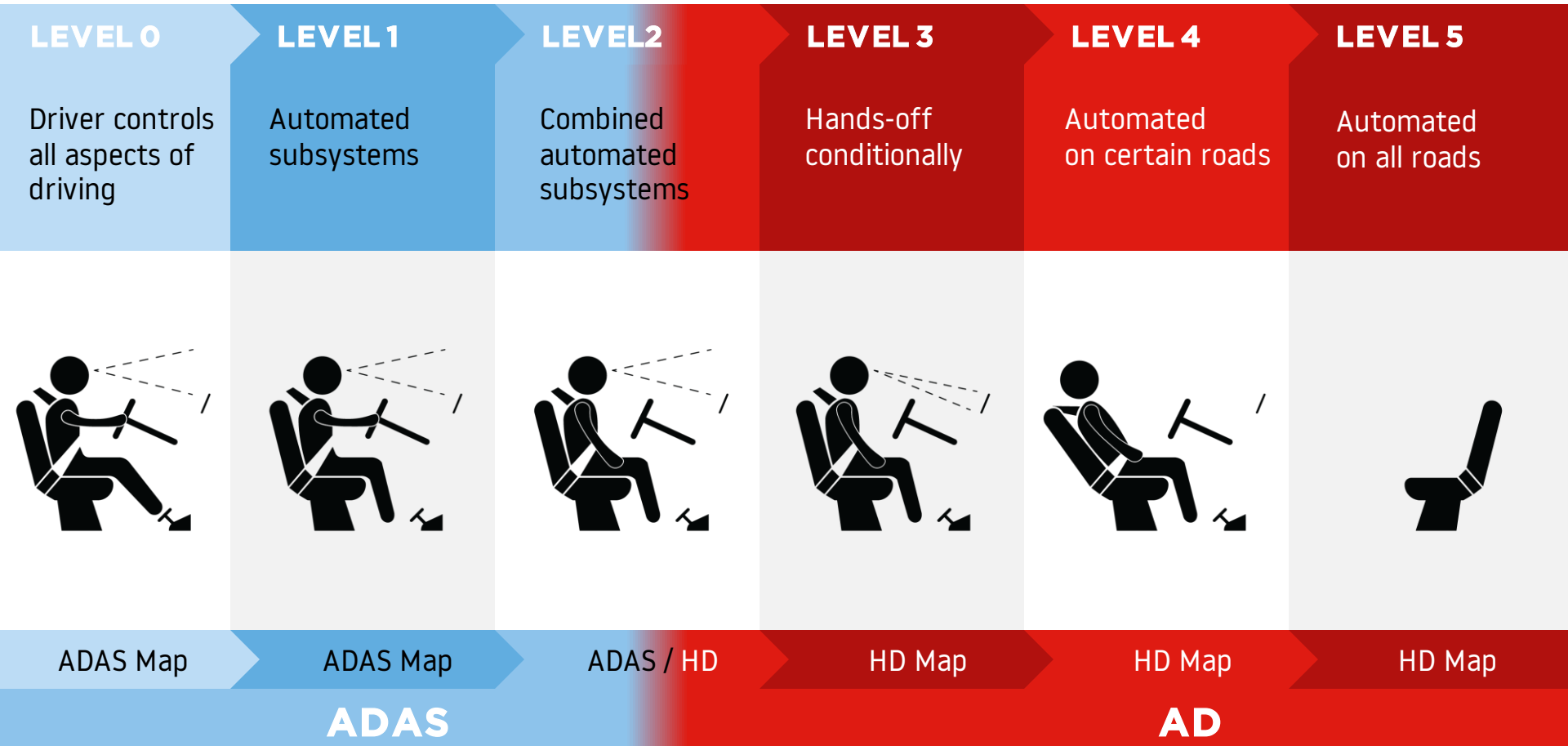


HD Map

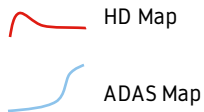
TomTom has been awarded 3 HD Map projects with top-5 global OEMs and is in advanced discussions with four more OEMs



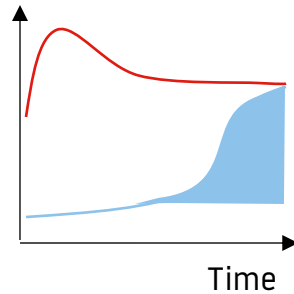
TomTom Maps for Automated Driving



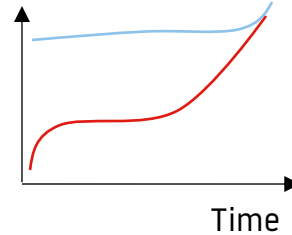
ADAS and HD Maps are converging



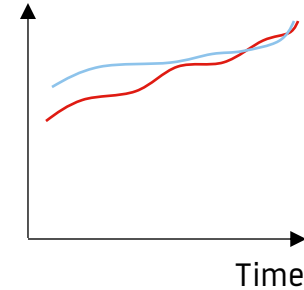
Positional accuracy



Coverage



Attribution



The market is moving to

- > Single 3D, lane-level driving geometry
- > Fit-for-purpose positional accuracy per attribute
- > Cost-effective to reach mass coverage *and* mass volume vehicles
- > Rich road-level and lane-level attribution

TomTom Maps for Automated Driving

LEVEL 0

Driver controls
all aspects of
driving

LEVEL 1

Automated
subsystems



LEVEL 2

Combined
automated
subsystems



LEVEL 3

Hands-off
conditionally



LEVEL 4

Automated
on certain roads



LEVEL 5

Automated
on all roads

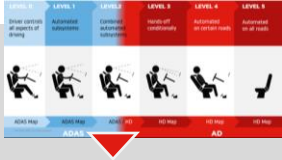


One Upgradable Automated Driving Map

ADAS

AD

A single AD map allow flexible application of features based on use case needs



Schematic

Flexible and adaptable AD features increase with complexity

AD use cases

Possible use cases	Intelligent speed assist Driver warnings	Predictive ACC	Lane change on highway	Advanced L2 off highway	Advanced highway L2/L3
Possible features	Speed restrictions Signs	Gradient & Curvature	Lanes Drivable lane geometry	Complex and specialized situations incl. intersections	Localization tools Non- drivable lanes

+

Increased potential of navigation and augmented reality

Navigation use cases

Possible use cases	Lane Guidance	Lane level navigation
Possible features	Lanes	Drivable lane geometry

TomTom's provides a flexible and adaptable portfolio

AutoStream



Hazard Warnings



RoadCheck



RoadCheck addresses the problem *where* automated driving can be activated



Managing Operational Design Domain

The concept of 'informed safety'



- Ensuring that the introduction of driving automation is done safely, securely and legally;
- Building public and consumer trust and acceptance of the technology.



- “Informed safety”
 - Conveying the capabilities and limitations of the technology to its users.

The first step in defining the capability of a driving automation system is the definition of its Operational Design Domain (ODD). RoadCheck makes TomTom’s deep competences on map-making domain accessible to its customers for ODD management.

RoadCheck allows OEMs to quickly adapt to changes in the road

You are in control...

ODD geofences are created based on TomTom map attributes and OEM data sources, via web application...

Delivered to where needed...

...and reach to the OEM or directly to the vehicles via safe and secure TomTom delivery products.

Flexibility enables advancement...

The geofences are easily maintained and updated to ensure safety over the lifetime of the vehicles







How do we capture
an ever changing
road system?

1 change every day for every 700km of German Highway

Roads must be constantly mapped to have the highest map quality

**Camera based
systems enable a
quickly scalable
solution...**

**...but lack the
context required for
safe automated
driving**



How to interpret lane markers?



France



Belgium



Misclassification of signs



Misclassification of signs





HD Maps help AD systems understand complex environments

TomTom's **scalable AD Map Services** provides **context to camera**

based systems via, for example, "Hinting" e.g. telling the camera where it should most optimally look for signs or road changes

AD Maps create **foundational layer of high quality and highly detailed understanding of complex situations**



Safe automated driving requires scalable multi-sensor approaches



- TomTom, with partners such as Nvidia, Hella Aglaia, Zenuity, Denso, ..., defined a format for compressed snippets of camera feedback called Roadagrams
- Combining the highly detailed map generated using survey vehicles with Roadagrams creates a unique and highly accurate system which can be quickly processed and sent back to TomTom

TomTom PoCs have a proven integration capability with several video processing software providers

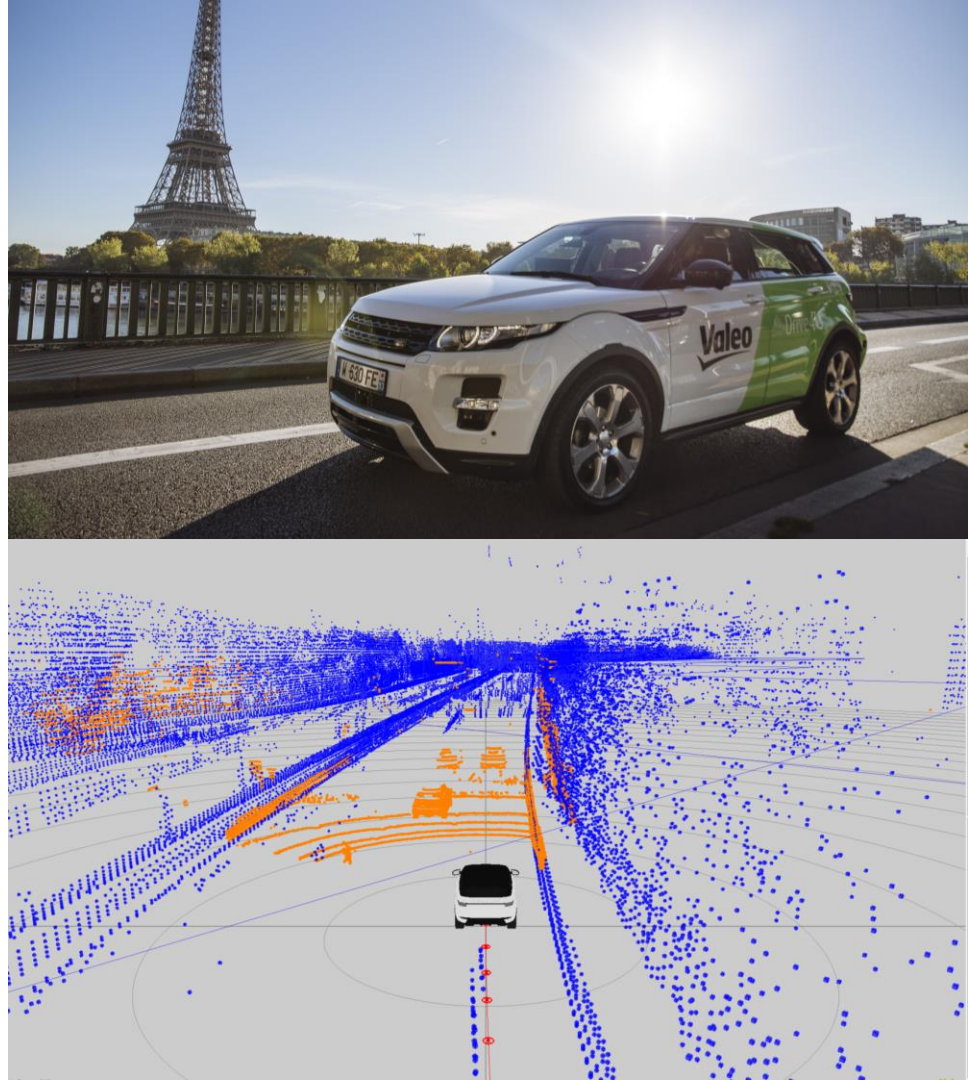


DENSO



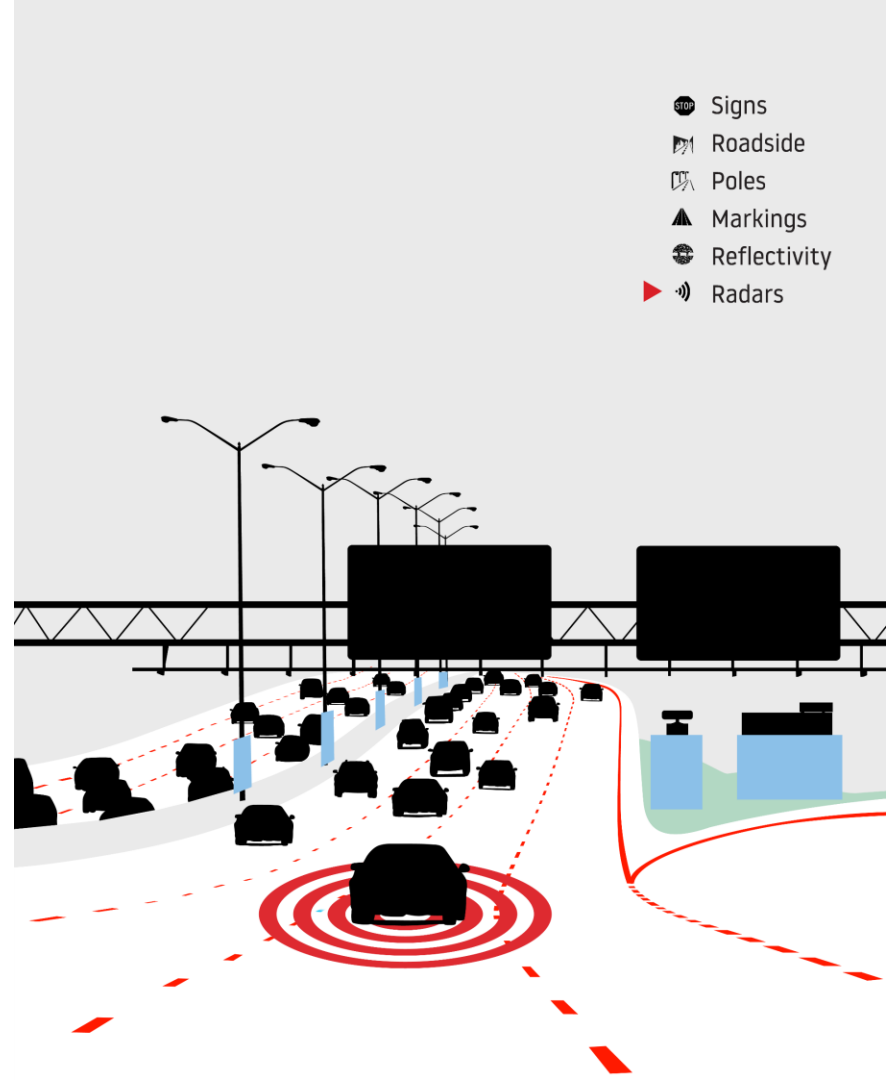
TomTom and Valeo partner for scalable multi-sensor PoC

- Proof of Concept (PoC) in Tokyo, Paris, and San Francisco with different vehicles using different camera and LiDAR positions proving **scalable multi-sensor localization**
- Using TomTom HD Map & RoadDNA localization suite in combination with **Valeo SCALA® 3D LiDAR** for centimeter level localization
- Offers scalable and cost effective PoC with Map and LiDAR features which can be used across several applications



TomTom RoadDNA suite

POWERS SENSOR-AGNOSTIC LOCALIZATION

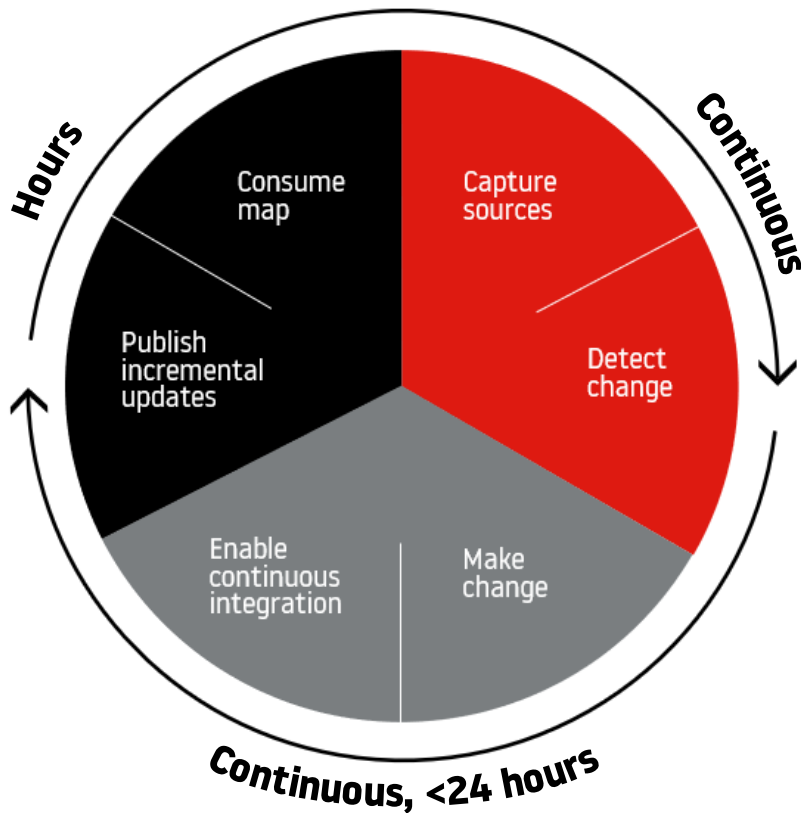


Transactional mapmaking

Enables TomTom to keep pace with reality

Rapid integration into the AD map and delivery to vehicle via AutoStream streaming solution

Continuous integration ensures dependencies between features are maintained and map changes are harmonized with the rest of the database



GPS measurements
Sensor Derived
Observations



Community input,
partners & media leads



Mobile mapping



Satellite/Aerial imagery



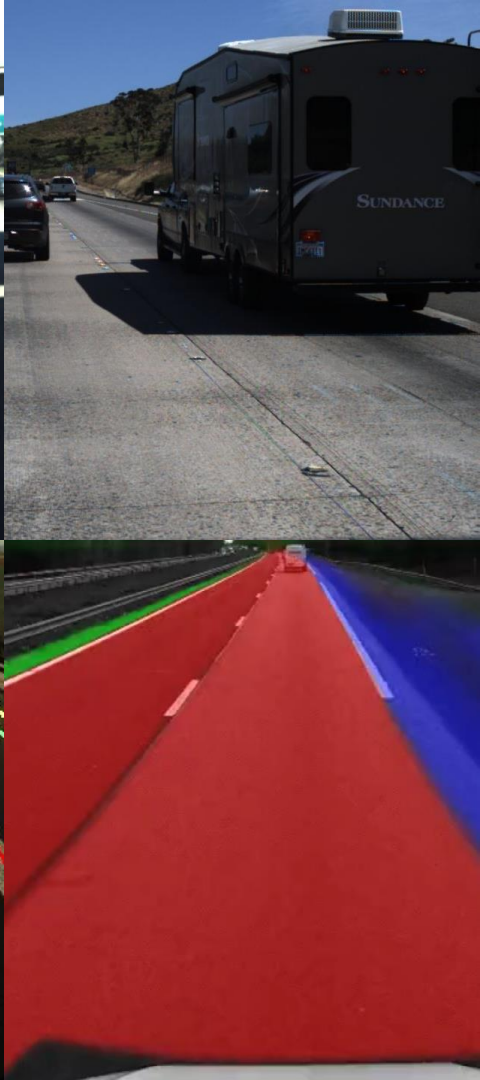
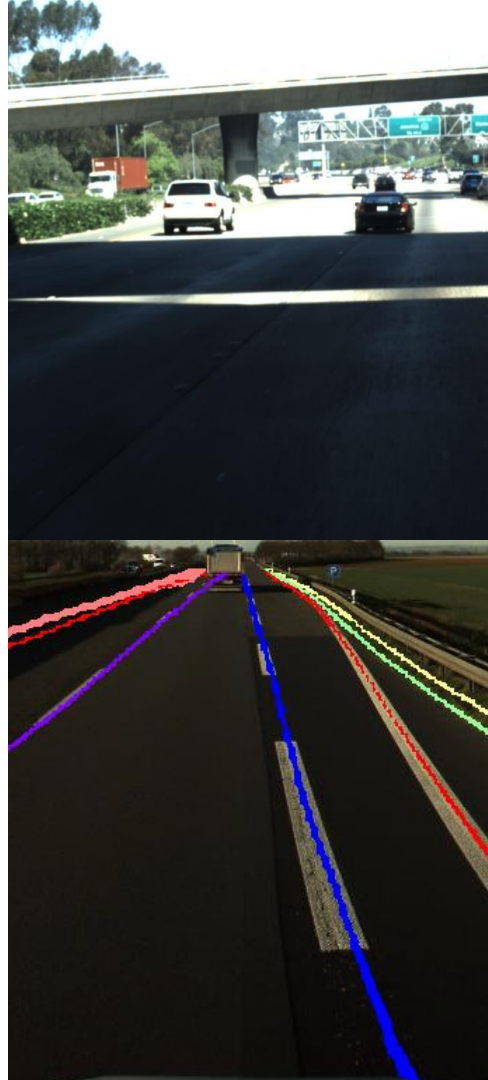
Authoritative sources



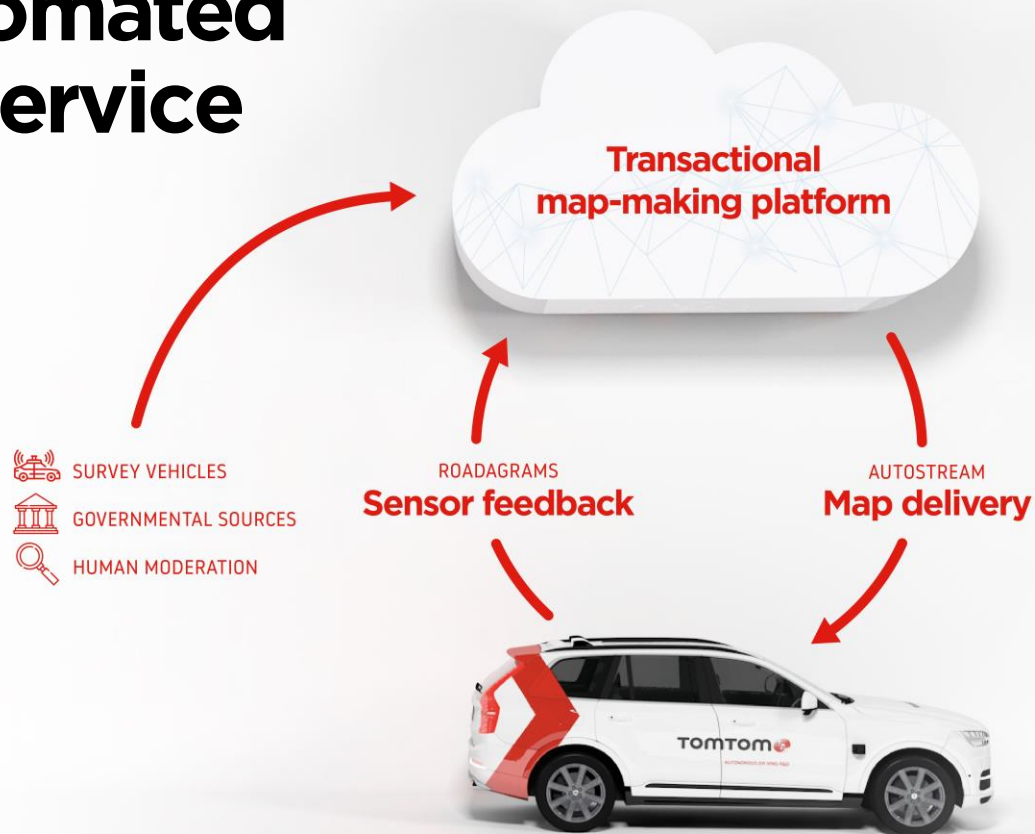
Quality checks and
change execution
ensuring freshness and
reliability

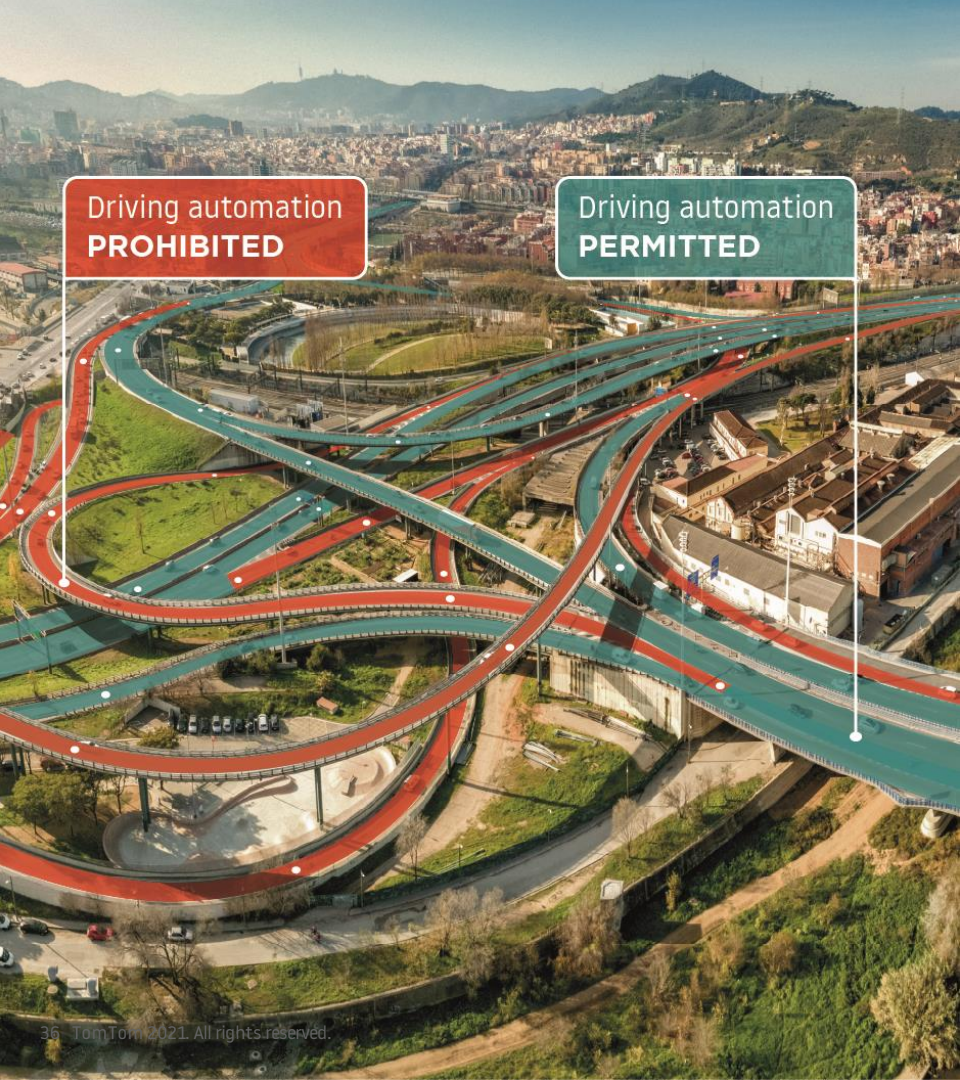
TomTom AI processes millions of images into a highly accurate AD map

- A single roundabout takes ~30 seconds to map, but provides ~6.4 million lidar points that must be integrated
- Millions of images are analyzed and converted automatically using machine learning and probabilistic models (>98% accuracy)
- Challenges arise when views are obstructed, not well marked, or road rules change



TomTom Automated Driving Map Service



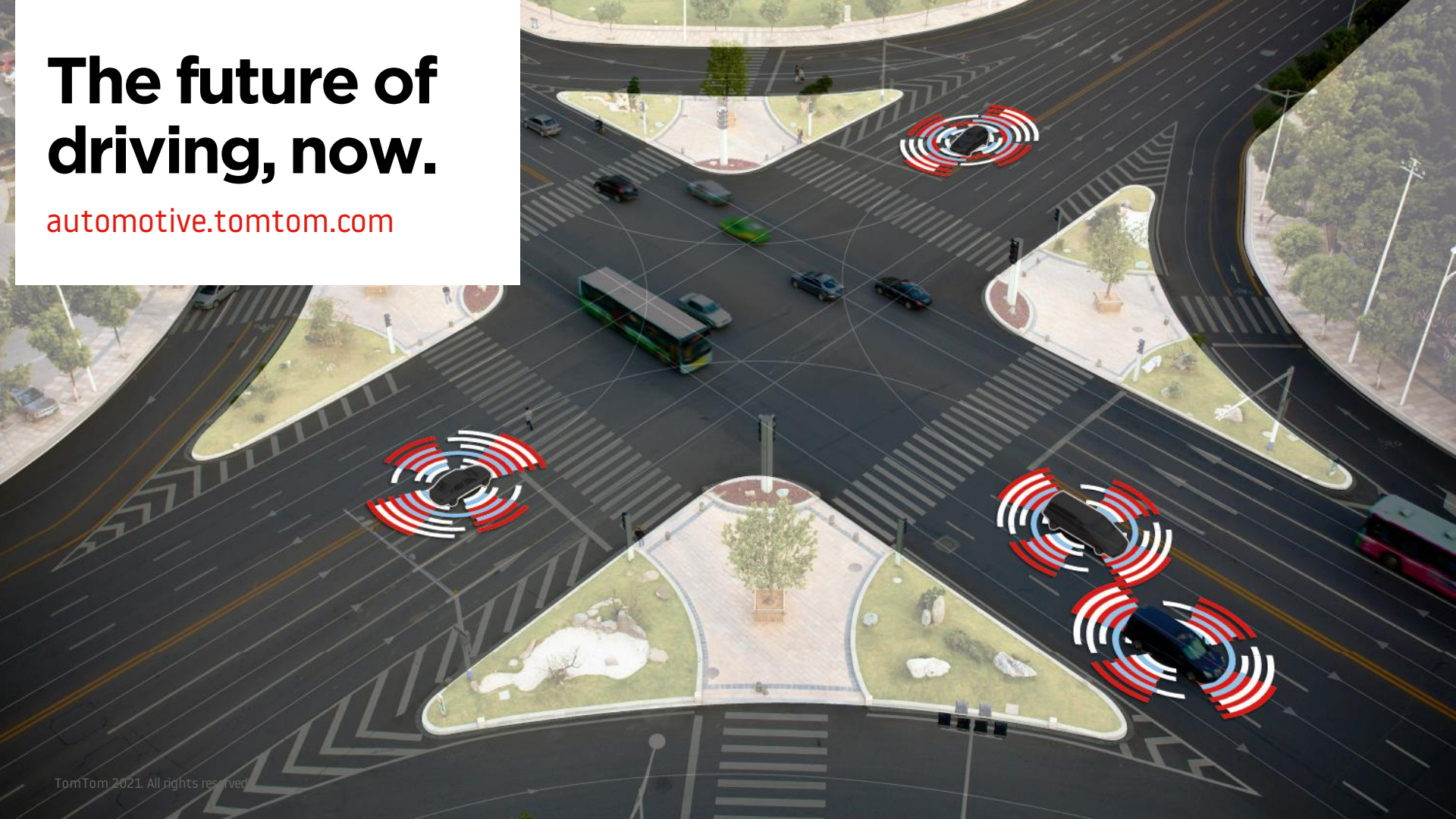


Conclusion

- Leading end2end HD Map service for safe AD
- Single upgradable map
- Safety and trust with TomTom Roadcheck
- Scalable and rapid updates ensuring shortest Reality2Map time

The future of driving, now.

[automotive.tomtom.com](https://www.automotive.tomtom.com)



An aerial view of a multi-lane highway interchange with red guardrails. The road surface is dark blue with white lane markings. Numerous semi-transparent blue and pink rectangular blocks are scattered across the road, representing traffic flow or data points. A red arrow graphic is on the left side of the road.

Thank you

*For more information
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TOMTOM 

Q&A Holder

- Much of the news has been around a certain camera based competitor – how do you compare to them and where do you see a major difference?
 - Alternative: How would TT AD Maps compare to purely crowdsourced maps?
- What is TomTom's perspective on expanding coverage and how will you do this?
- What are the Customers you already have on the road?
- Can Roadcheck be used in conjunction with dynamic events [e.g. hazardous weather, unplanned construction] to manage ODD?
- How does TT's scalable AD maps fit into the customer/OEM applications? Can you elaborate?
- How do TT's products contribute to the overall functional safety of the AD system?
- Tell us a bit more about your partnership with NVIDIA