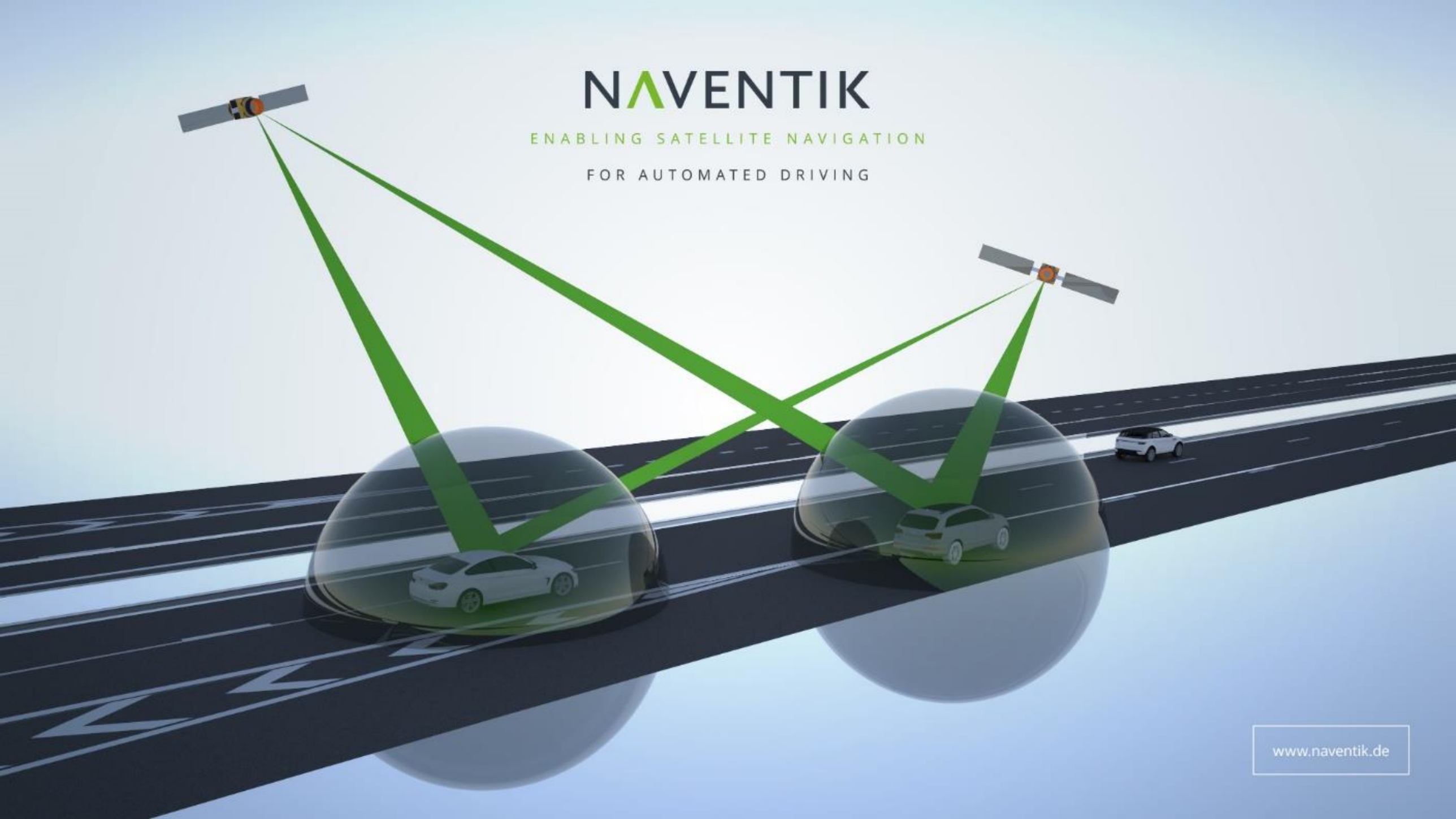
NAVENTIK

ENABLING SATELLITE NAVIGATION

FOR AUTOMATED DRIVING



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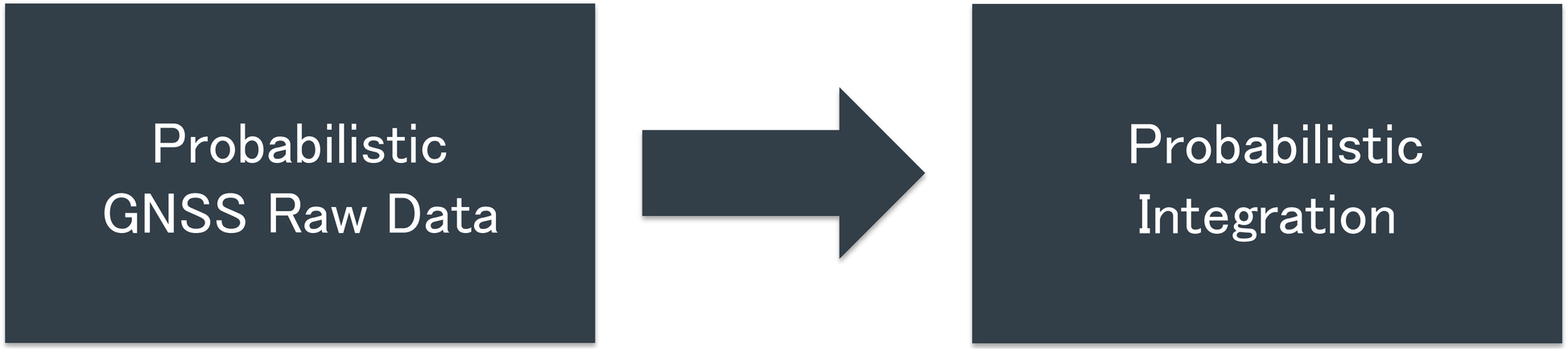
NAVENTIK ENABLING SATELLITE NAVIGATION FOR AUTOMATED DRIVING

Satellite Navigation for Safety-Critical Applications of Automated Driving

Robin Streiter, NAVENTIK GmbH, Germany

Sensor Fusion



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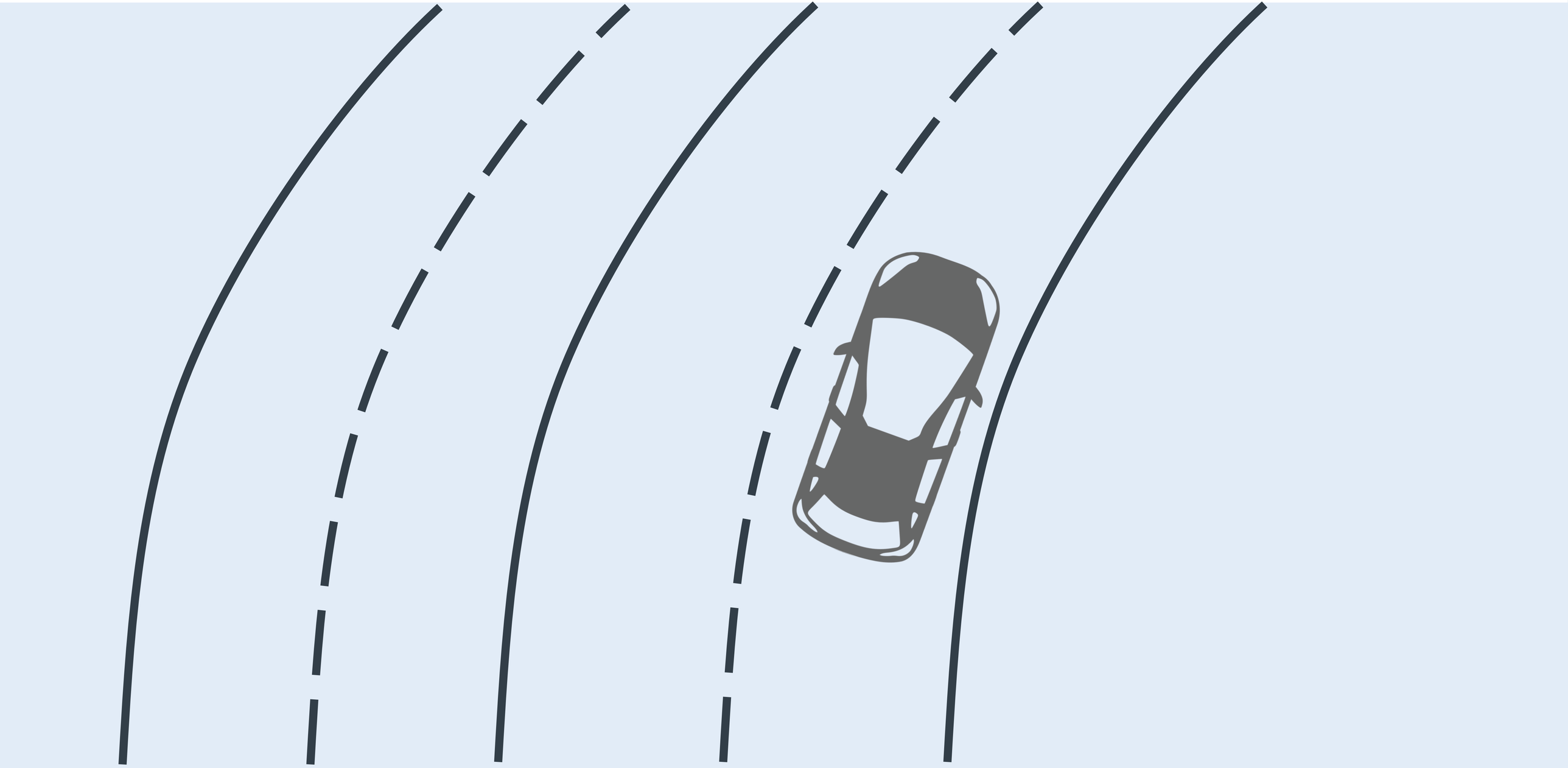

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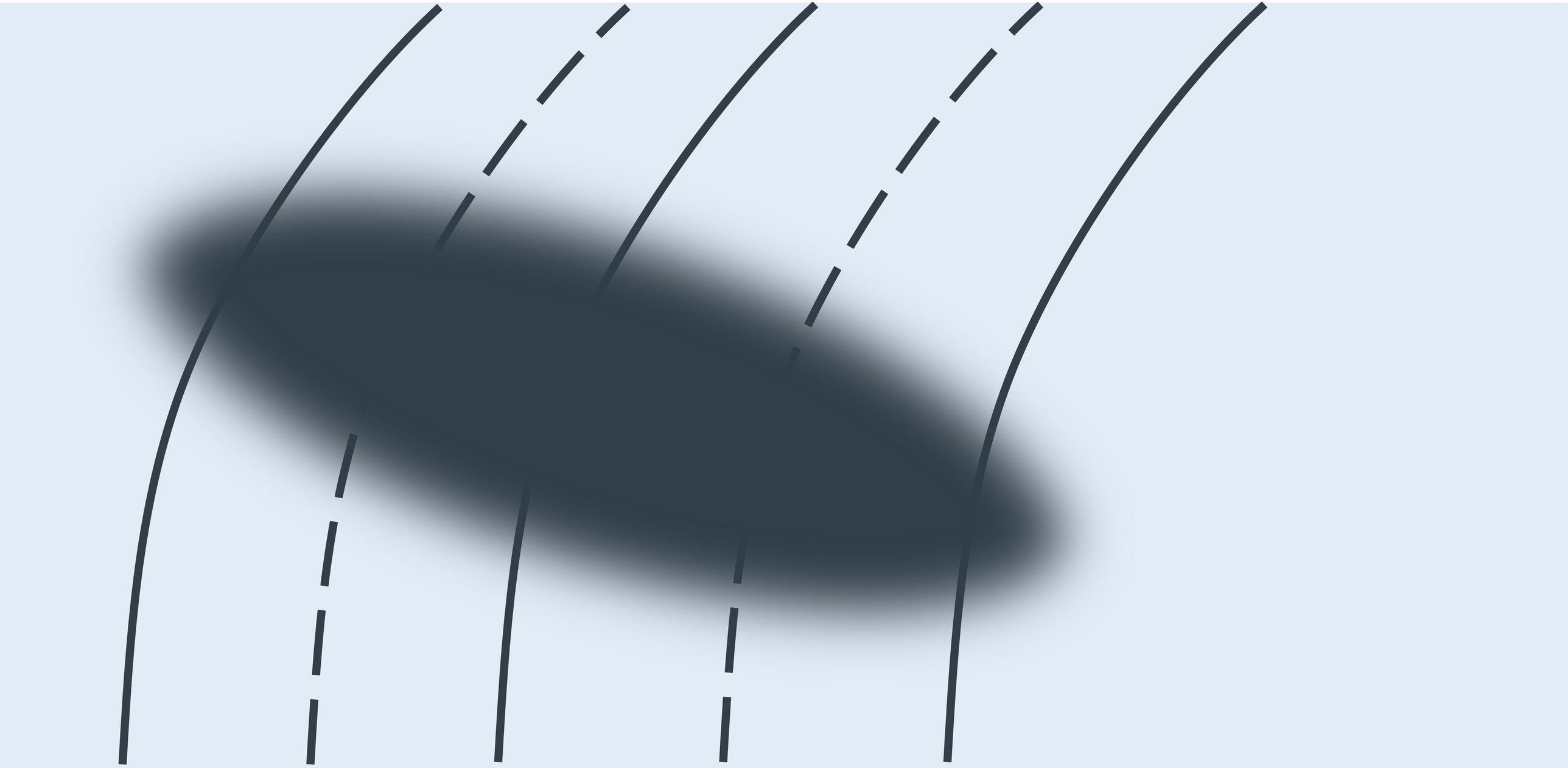

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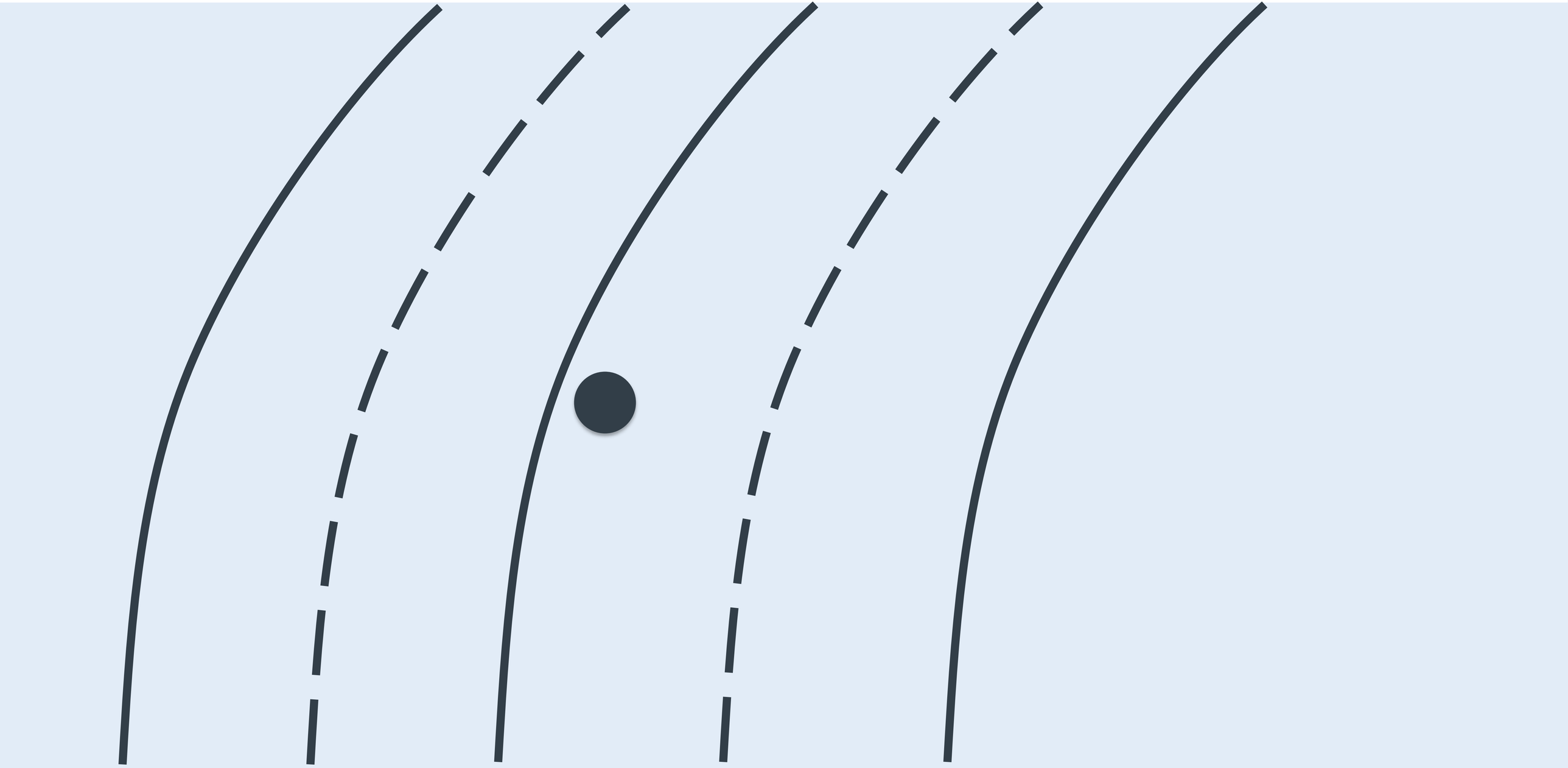

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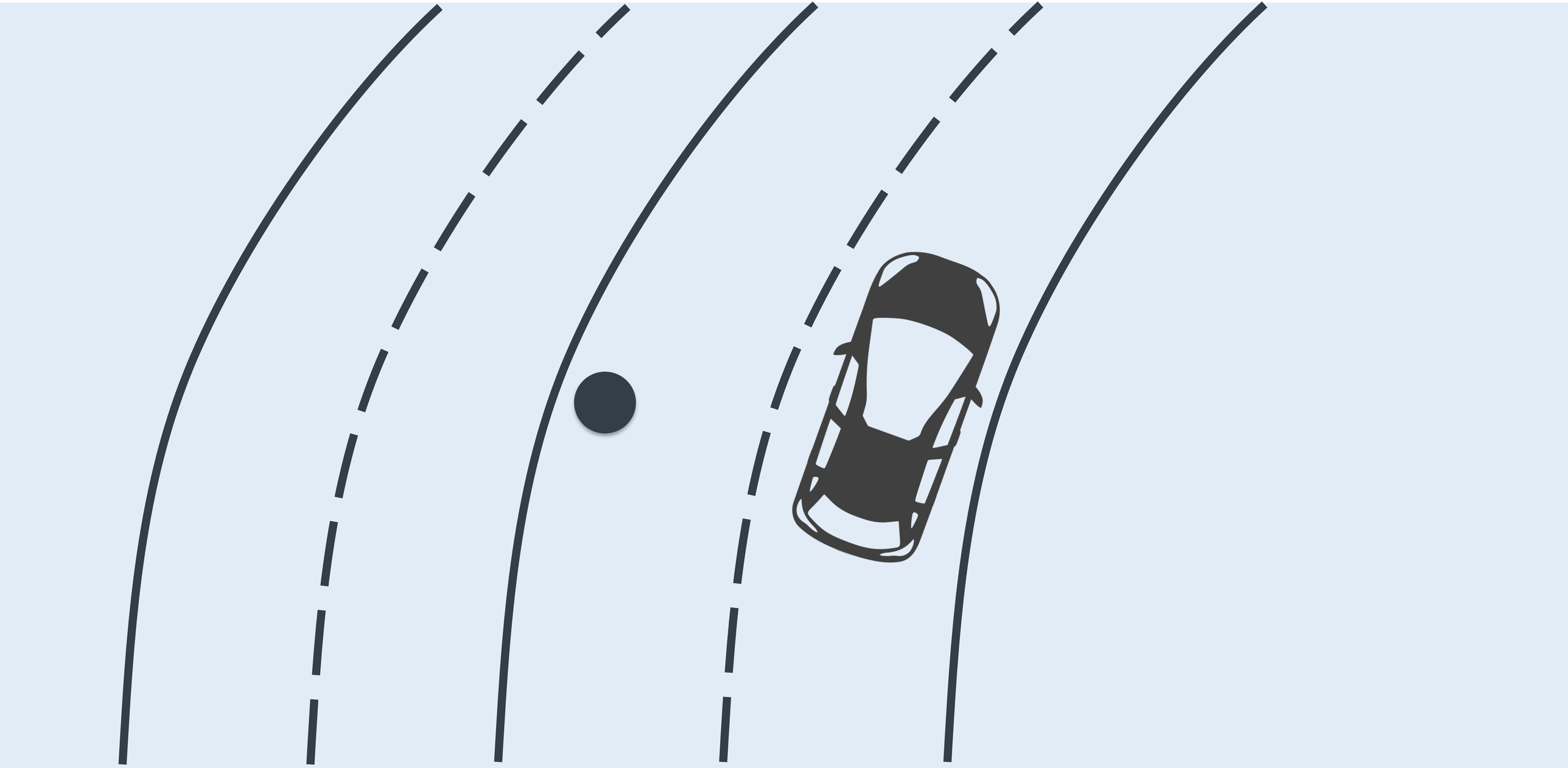

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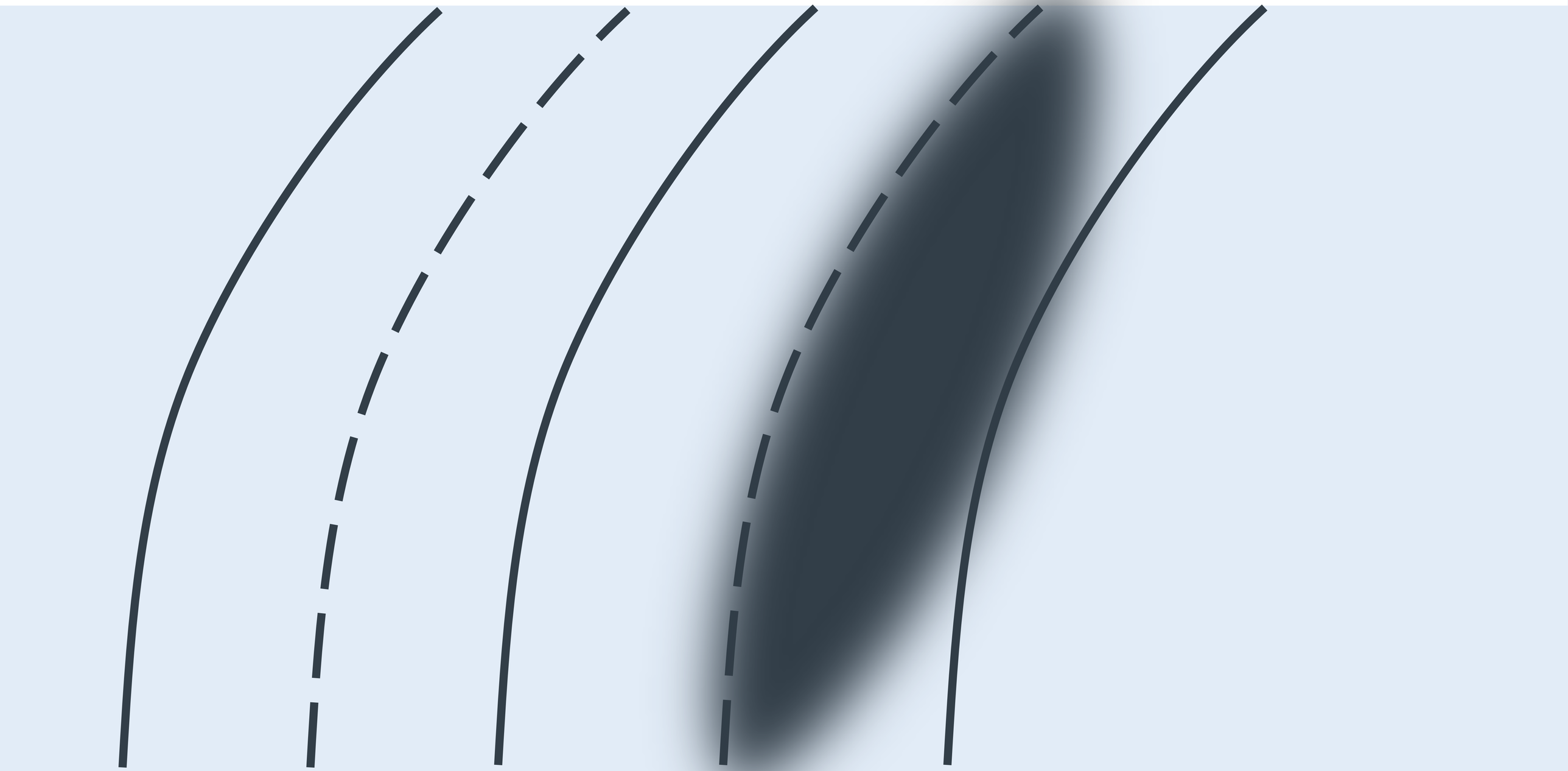

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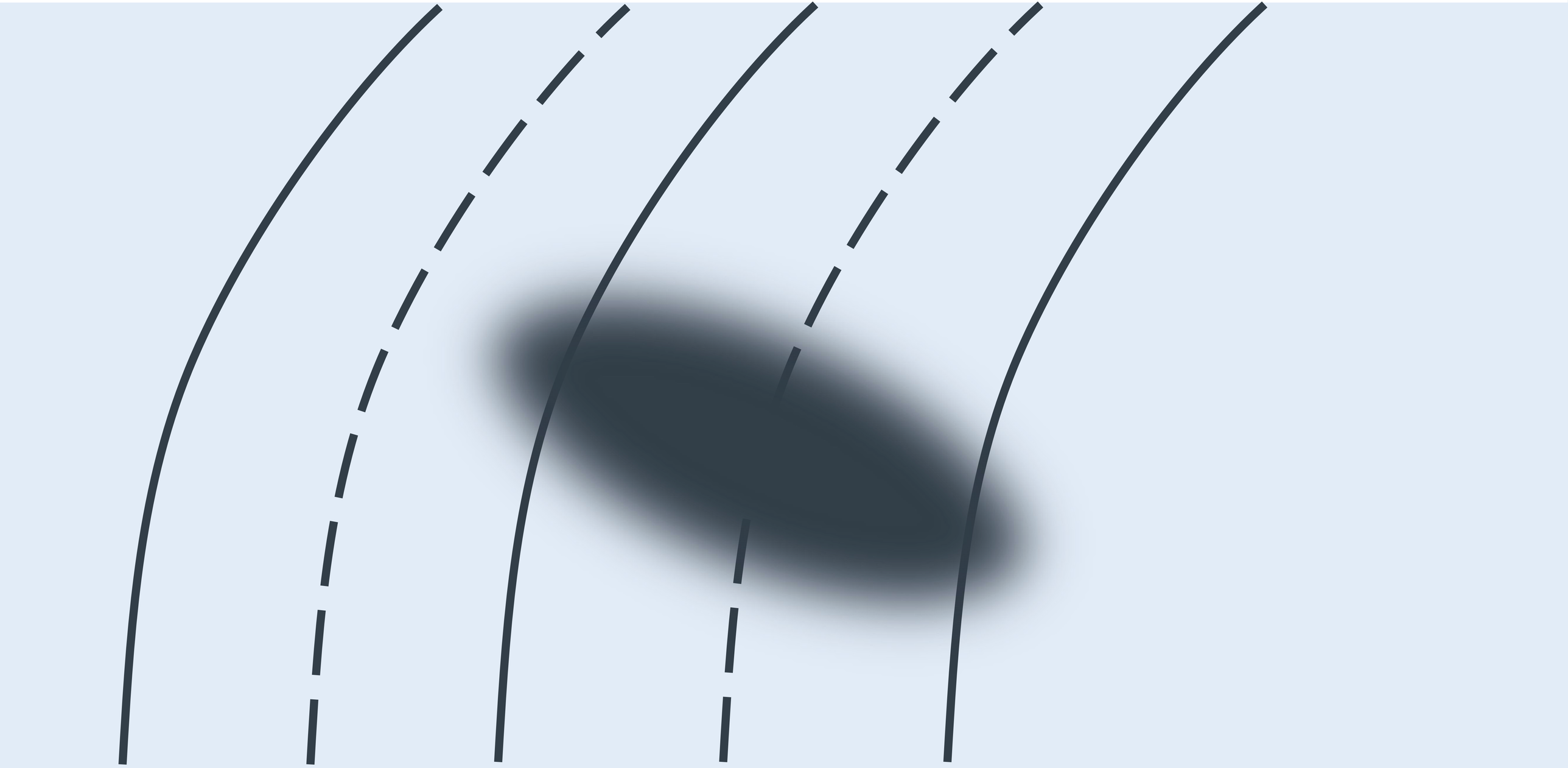

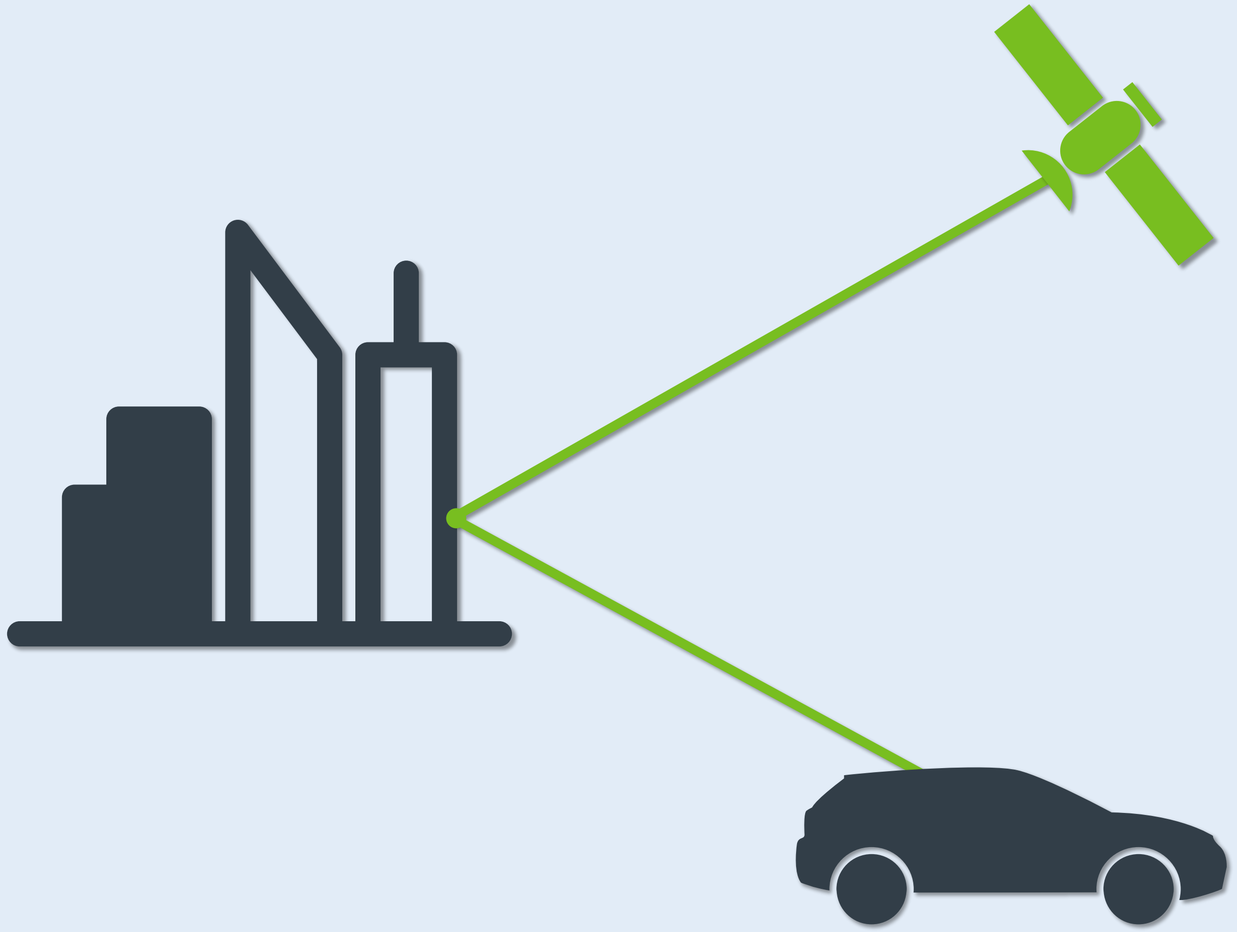

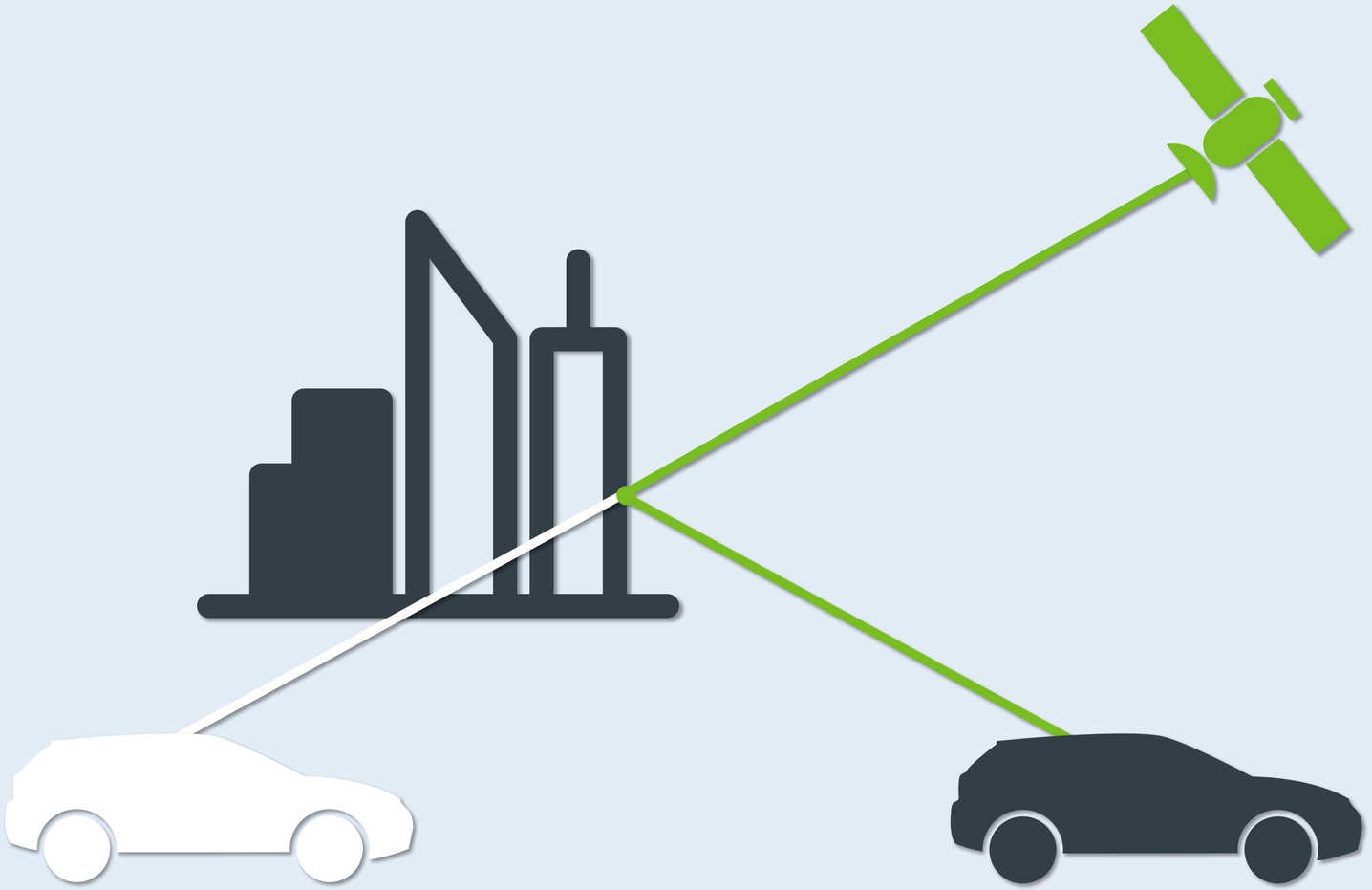

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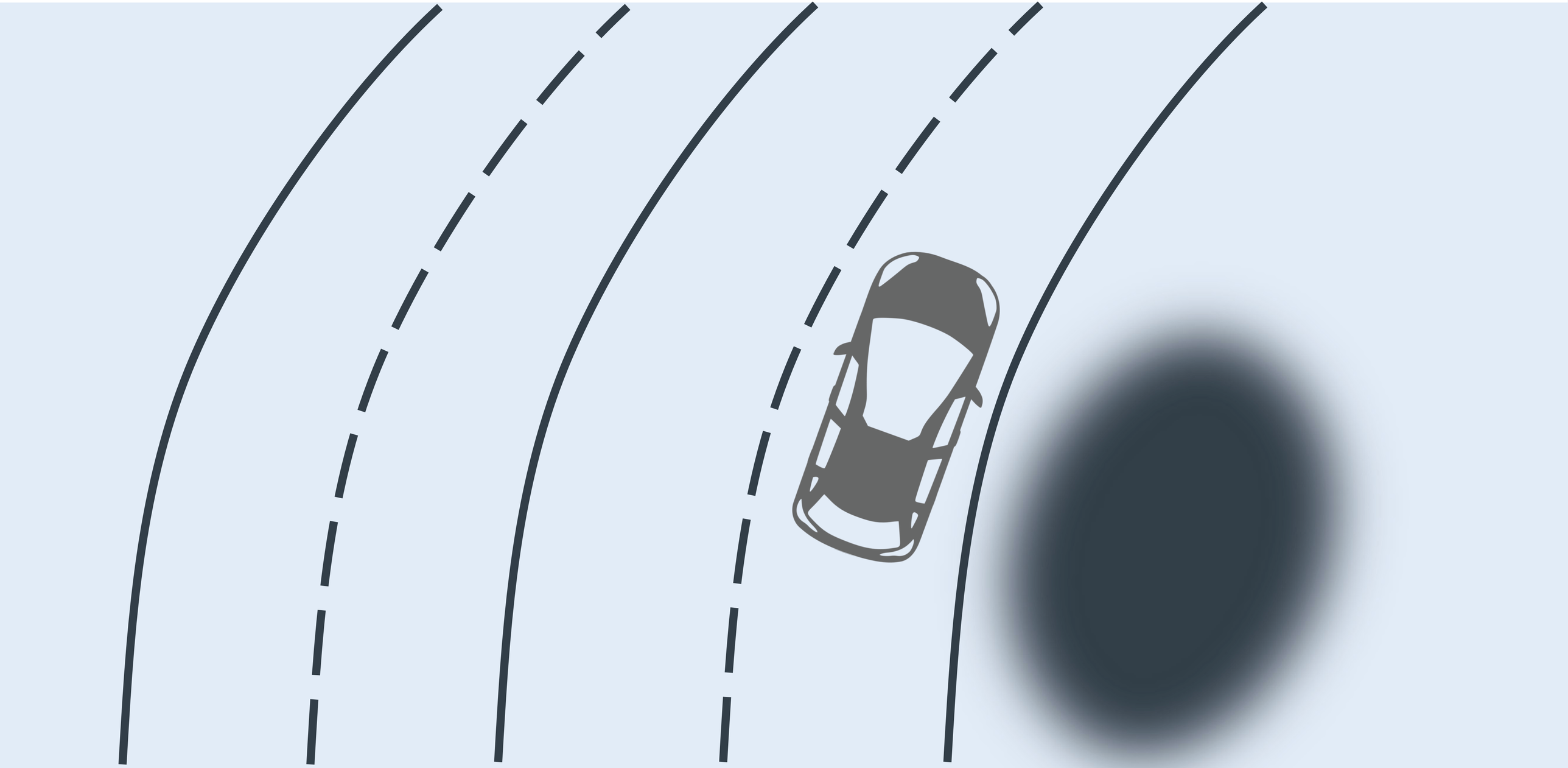

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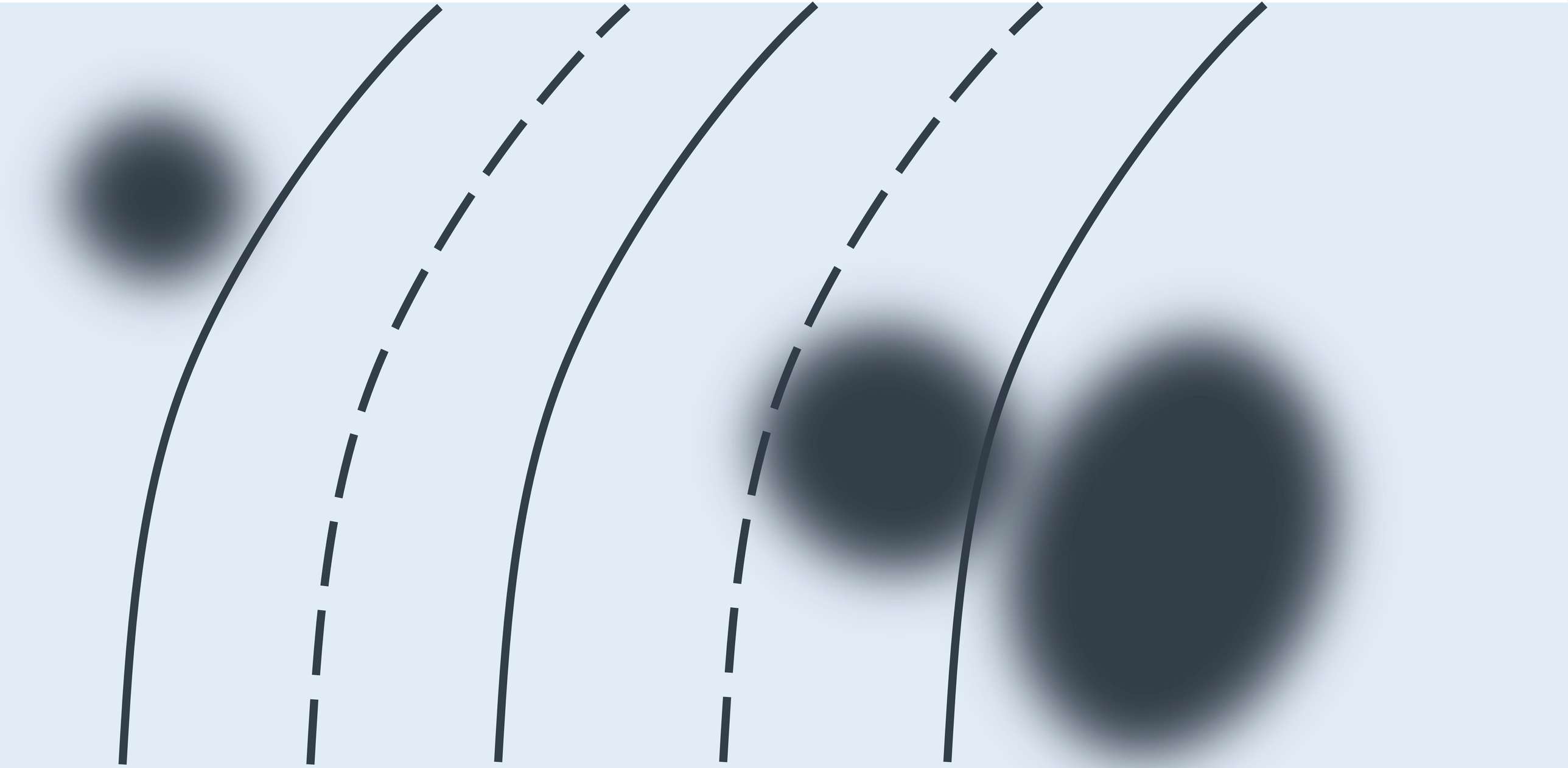
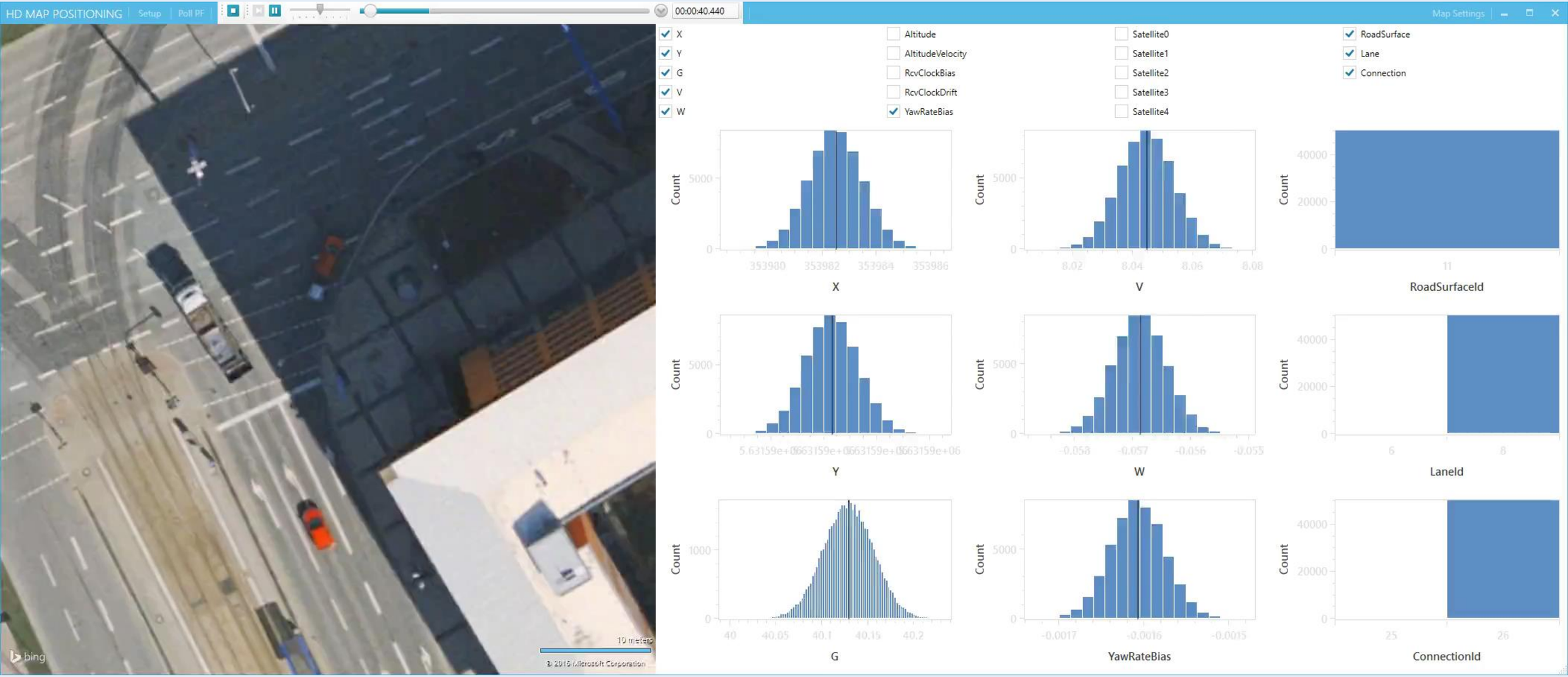


Example

NAVENTIK ENABLING SATELLITE NAVIGATION FOR AUTOMATED DRIVING



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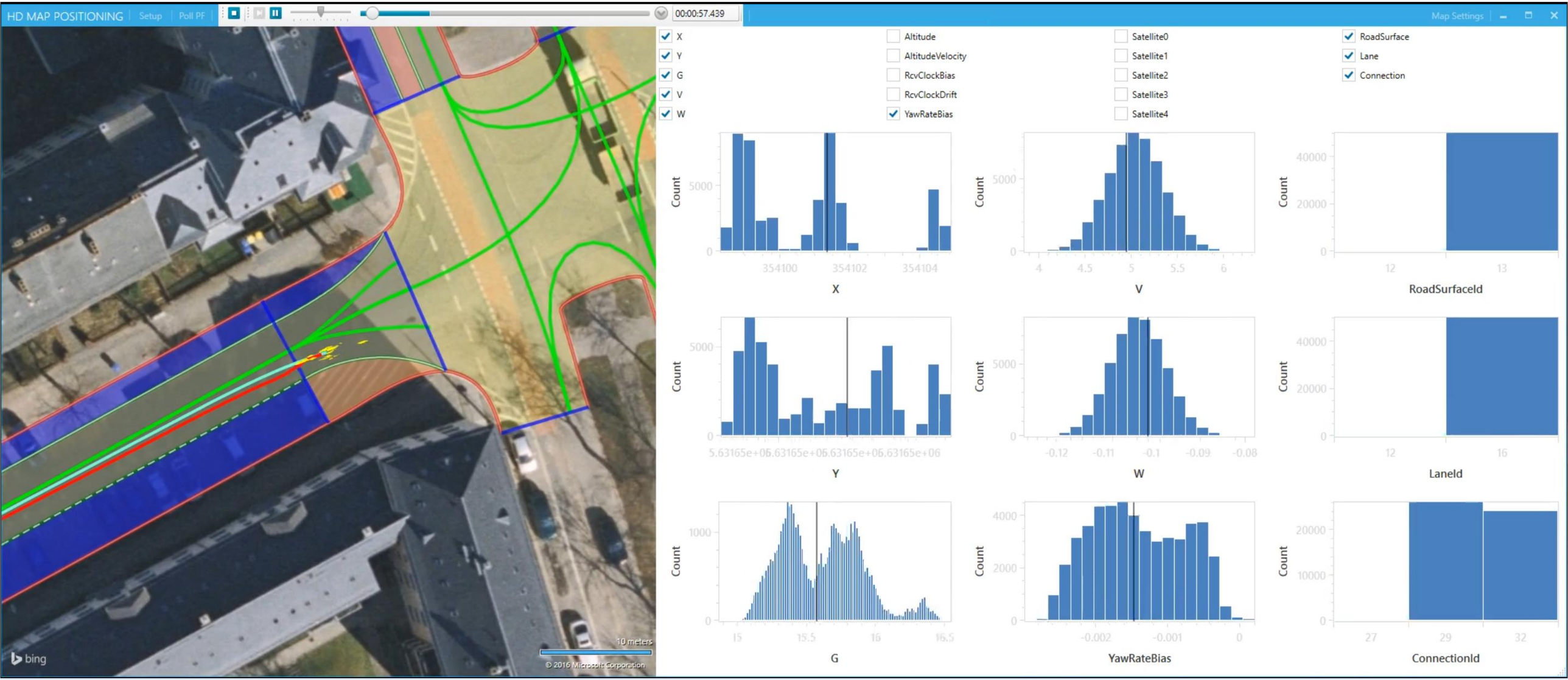
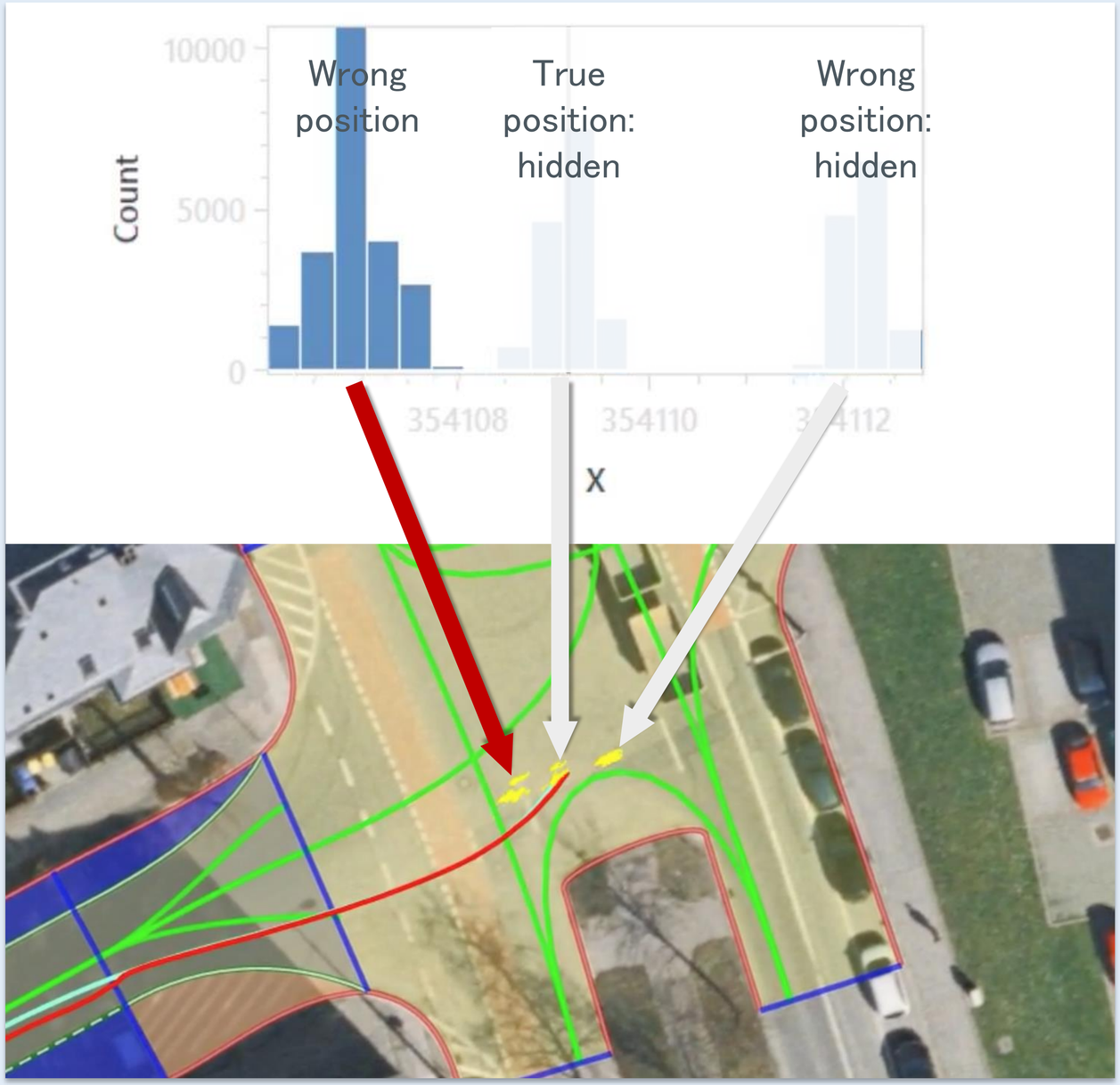
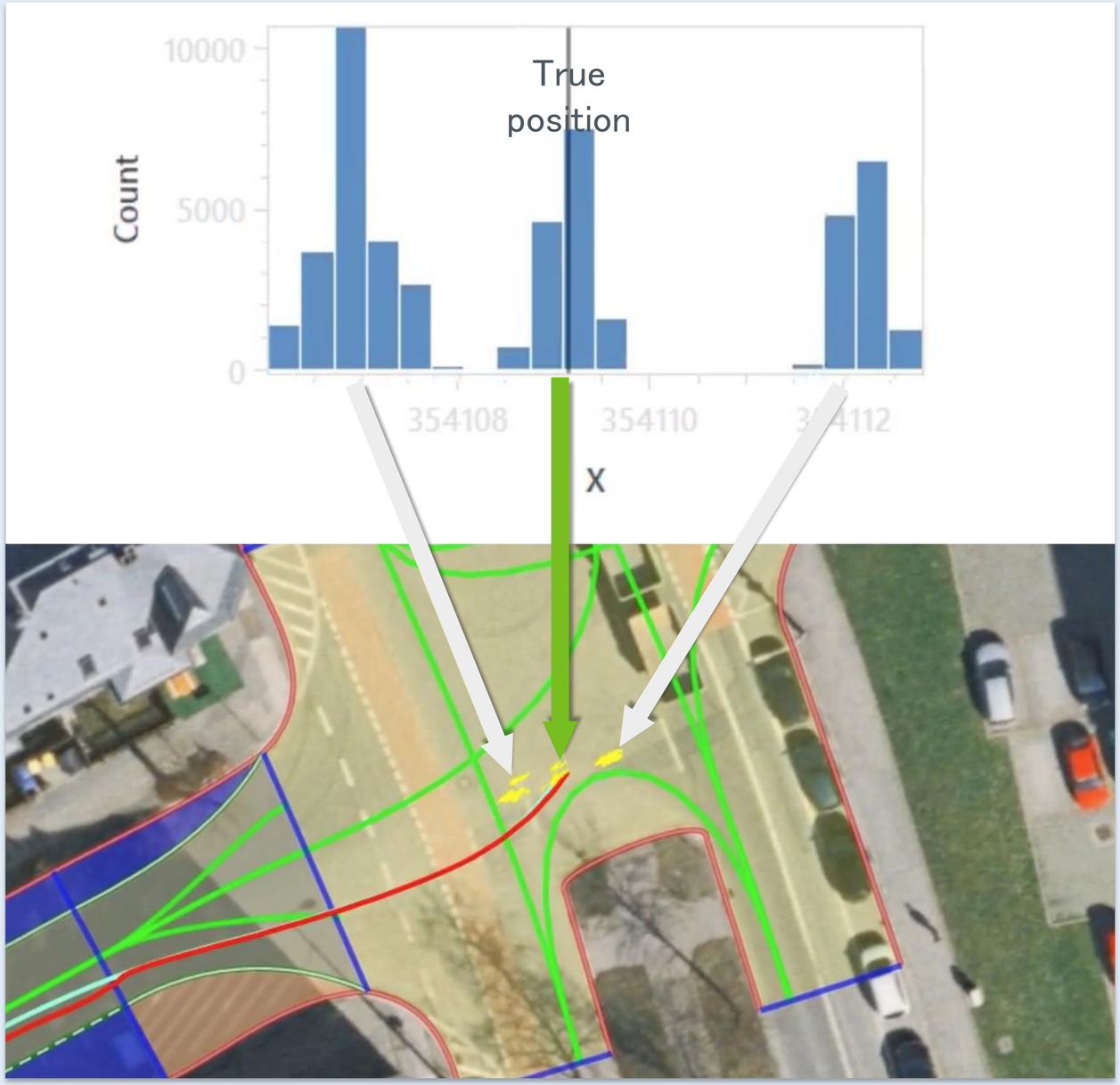


[Please click here, to start the video from YouTube.]



- Without NAVENTIK: **The reflected multipath signal gives the** wrong position.



- With NAVENTIK: **The** true position **is given along with the additional errors from the signal reflections**

→ Key technology for sensor fusion and safety-critical applications

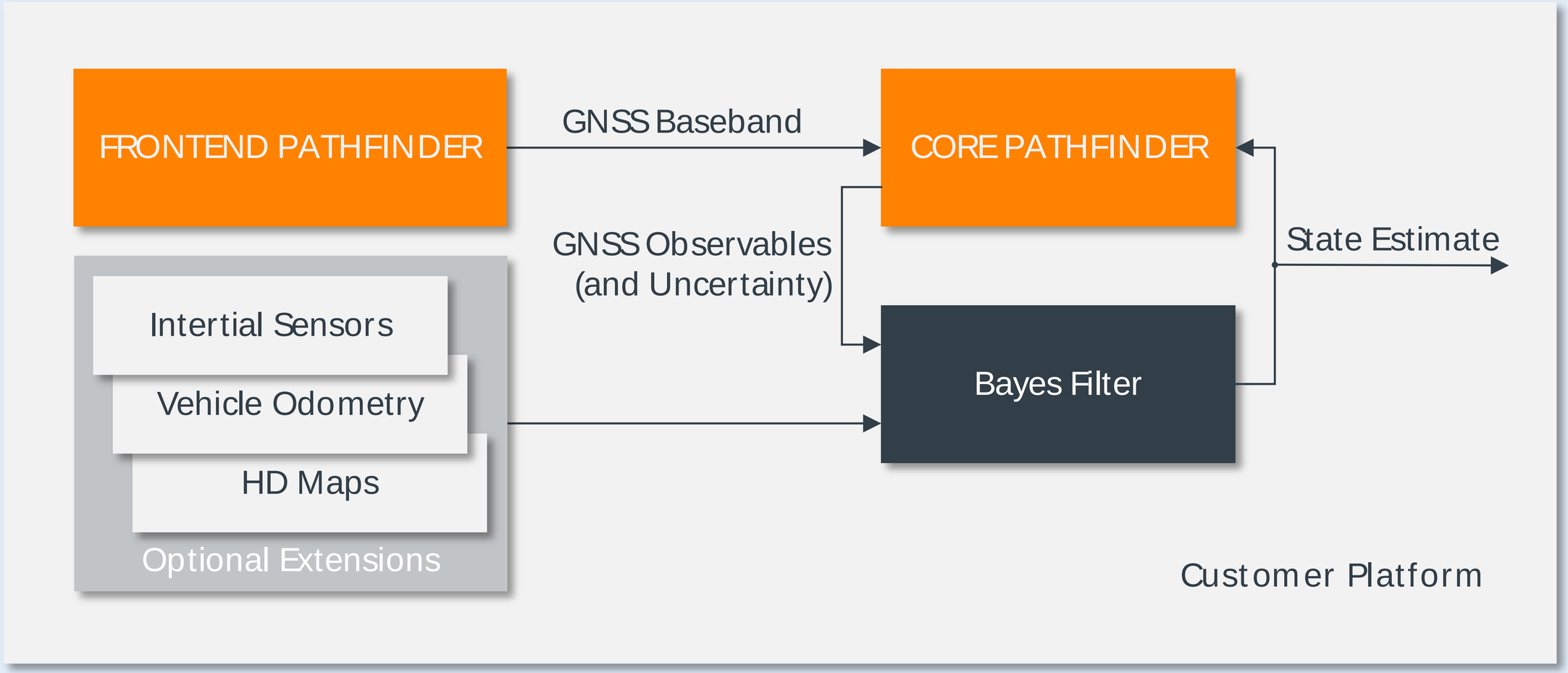
NAVENTIK

CORE PATHFINDER

Automotive GNSS Positioning IP Core

GNSS Navigation for Demanding Automotive and Mobile Applications

PATHFINDER Components



NAVENTIK ENABLING SATELLITE NAVIGATION FOR AUTOMATED DRIVING

Technology developed during research projects co-funded by the European Commission and the GSA within the 7th Framework Programme and under Horizon 2020

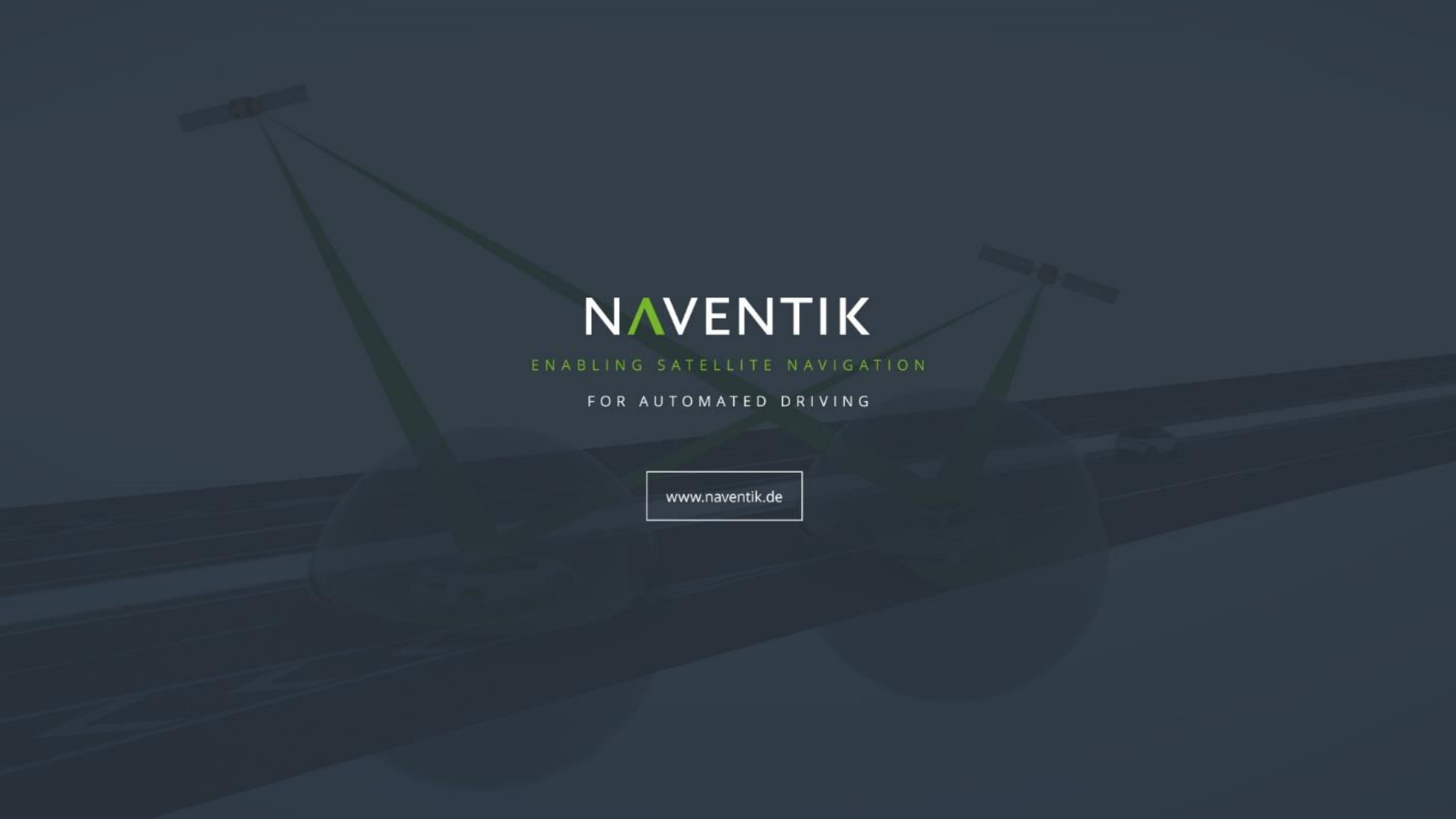
CoVeL
Cooperative Vehicle Localization

GAIN
Galileo for Interactive Driving

InDrive
High-Integrity Applications

SEVENTH FRAMEWORK PROGRAMME

European Global Navigation Satellite Systems Agency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RTK

EGNOS

L1 L2 L5

PPP

Galileo

Sensorfusion

DGPS

GLONASS

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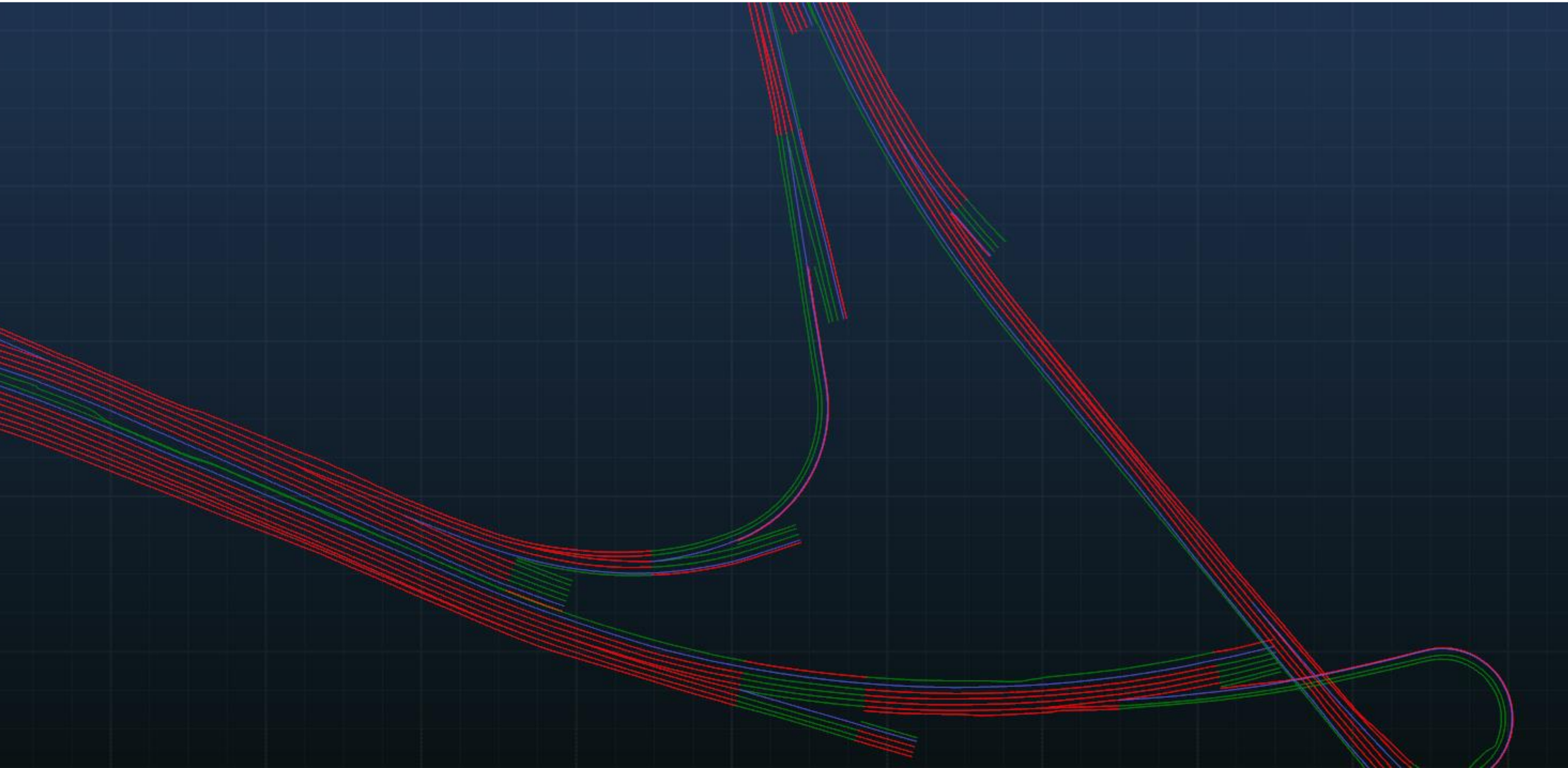
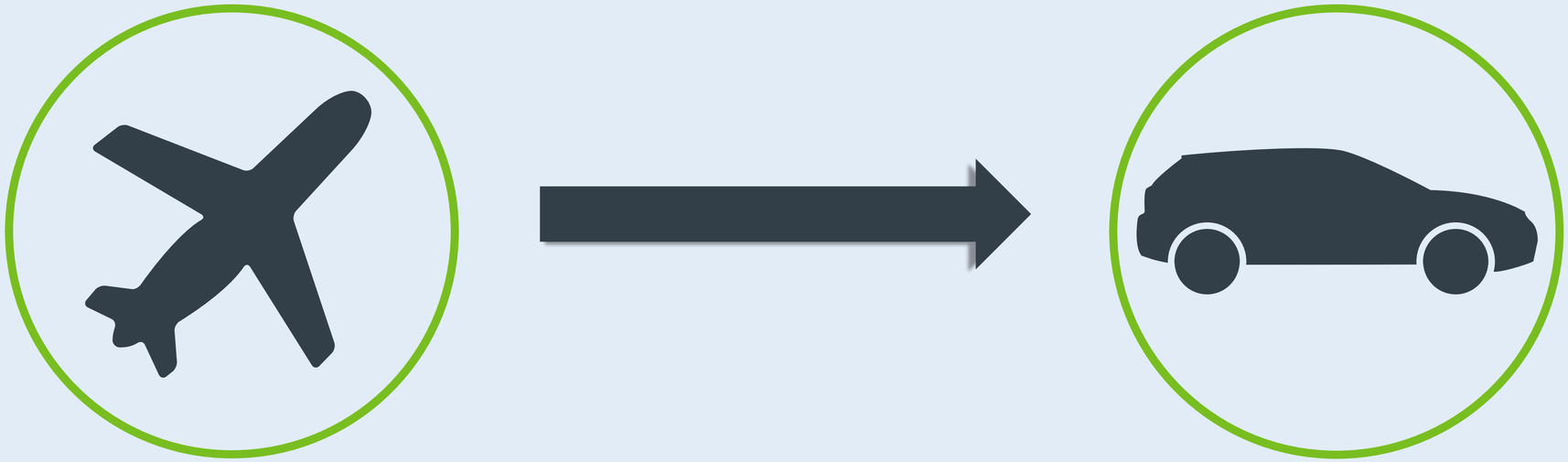
NAVENTIK ENABLING SATELLITE NAVIGATION FOR AUTOMATED DRIVING

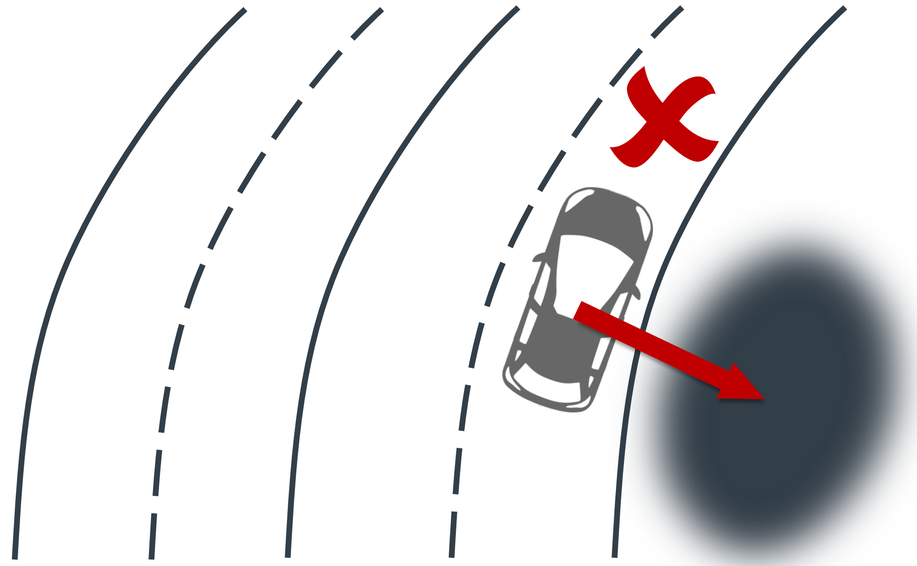


NAVENTIK Approach

→ Adapting the philosophy of the safety-concept from aviation applications to the requirements of automotive applications.



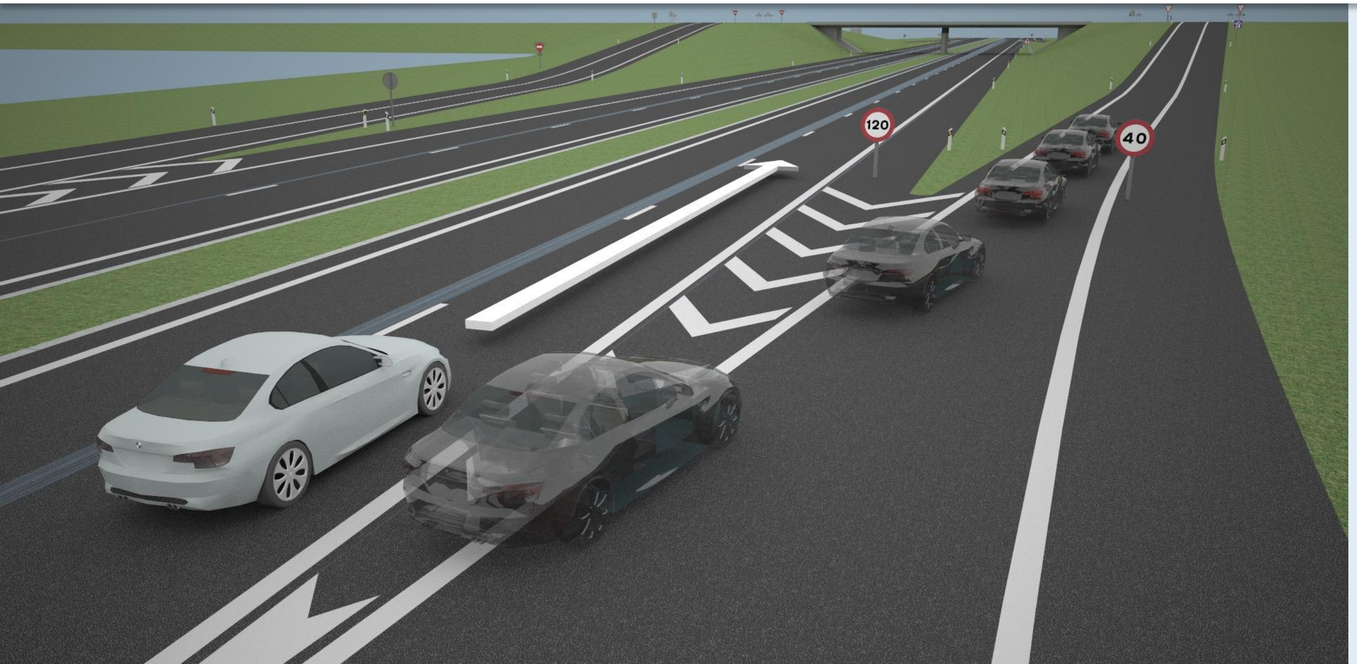
Safety Concept



Legacy approach: **Position error in urban environments.** →Integrity is violated

NAVENTIK: **Signal reflections are statistically tracked in the receiver.** The true vehicle position is covered by the multimodal error envelope.
→Positioning integrity

Applications



- NAVENTIK provides the key technology for safe lane-level navigation.

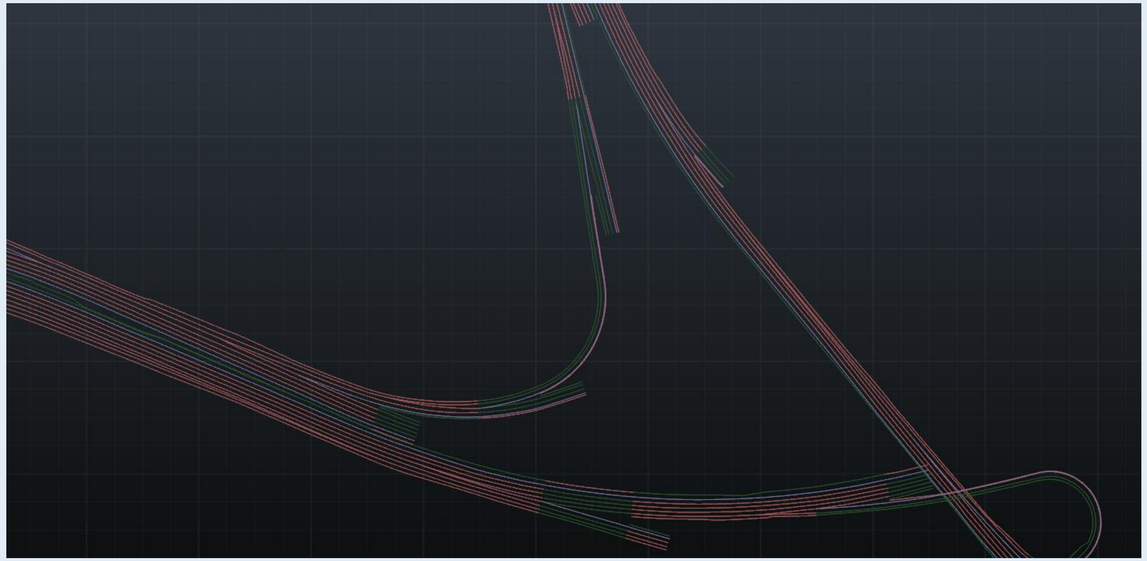
  The vehicle can be mapped to the highway or the exit ramp. As the whole system is based on Bayesian statistics, the application can safely start vehicle actuation based on the position information.

High Definition Maps

- PATHFINDER provides the interface for the probabilistic integration of digital High Definition Maps – the last bottleneck of nowadays high performance applications.

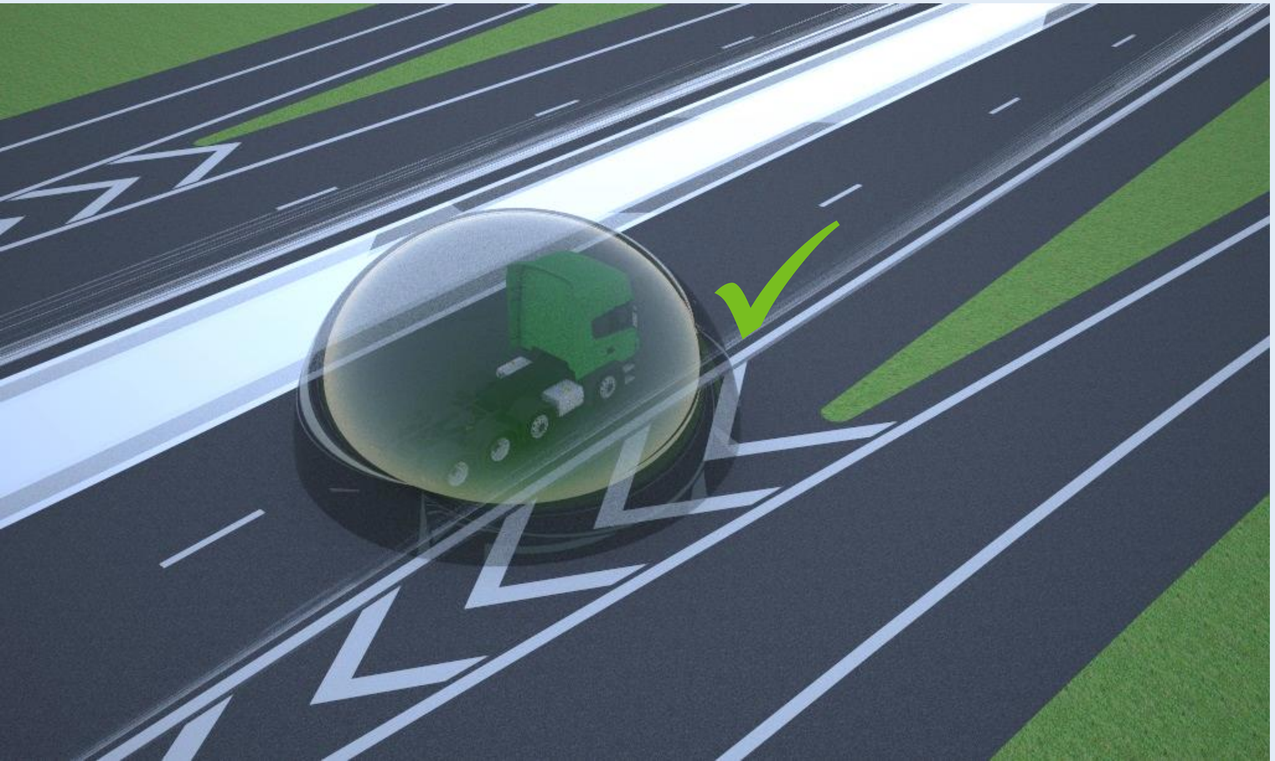
- The parametric description of the vehicle's position on the road, on the lane and the longitudinal offset on the road segment are part of the state space

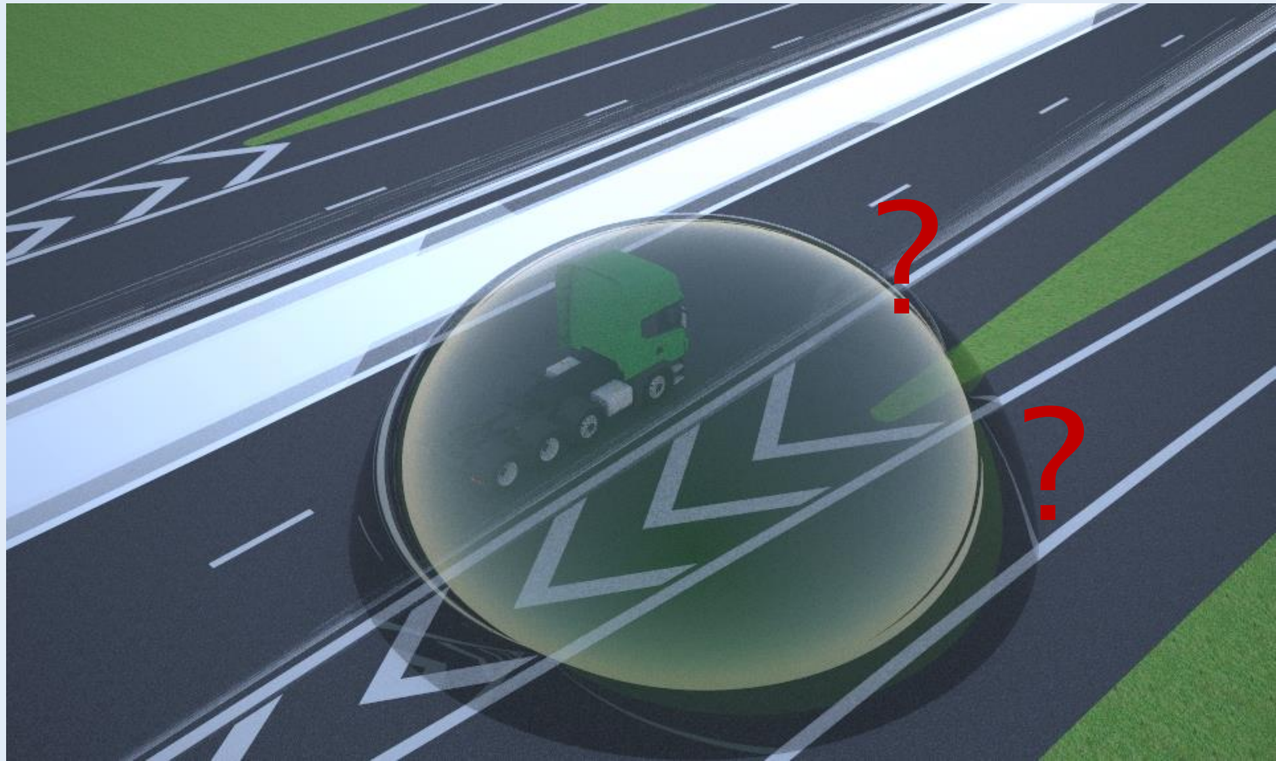
- →The NAVENTIK approach for map matching: Lane level localization – Reliable and statistically proven.



Advanced Driver Assistance Systems

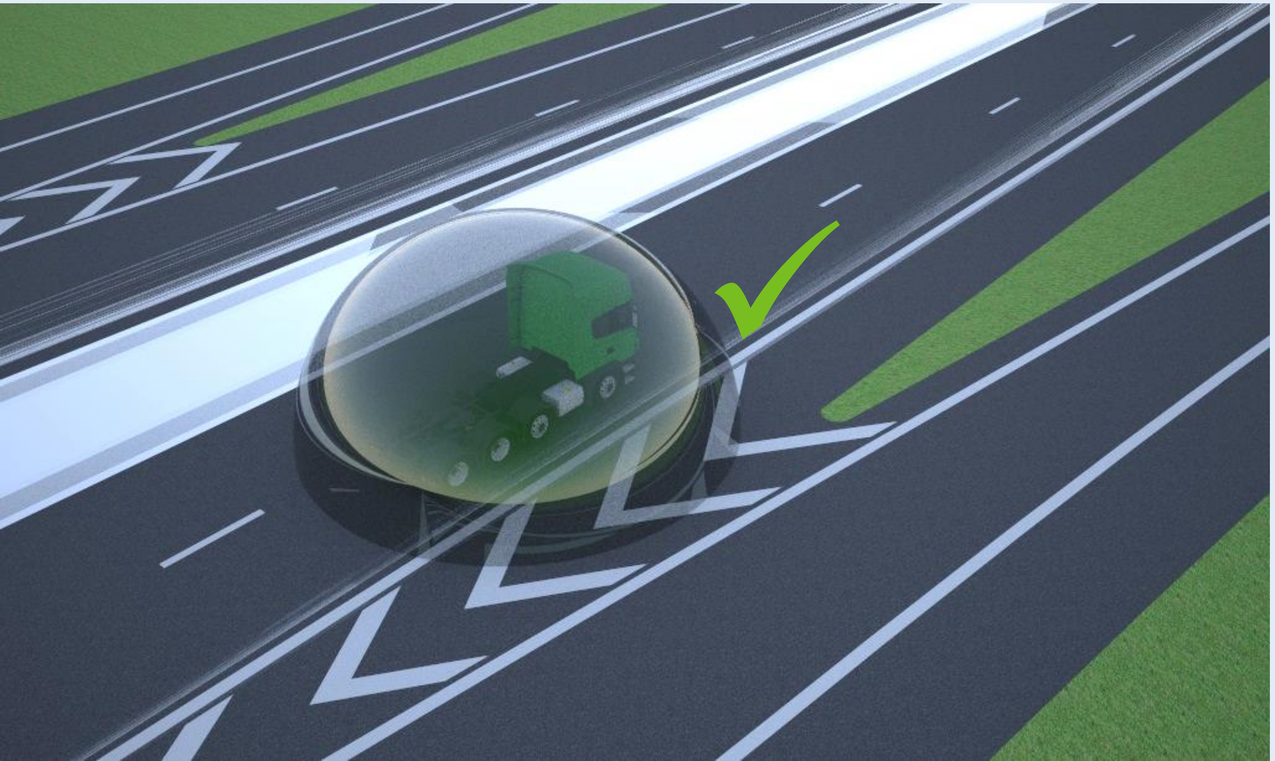
- Lane keeping assistants can improve the performance and user acceptance by integrating GNSS in order to avoid false alarm decisions under degraded visual conditions or missing lane markings. .

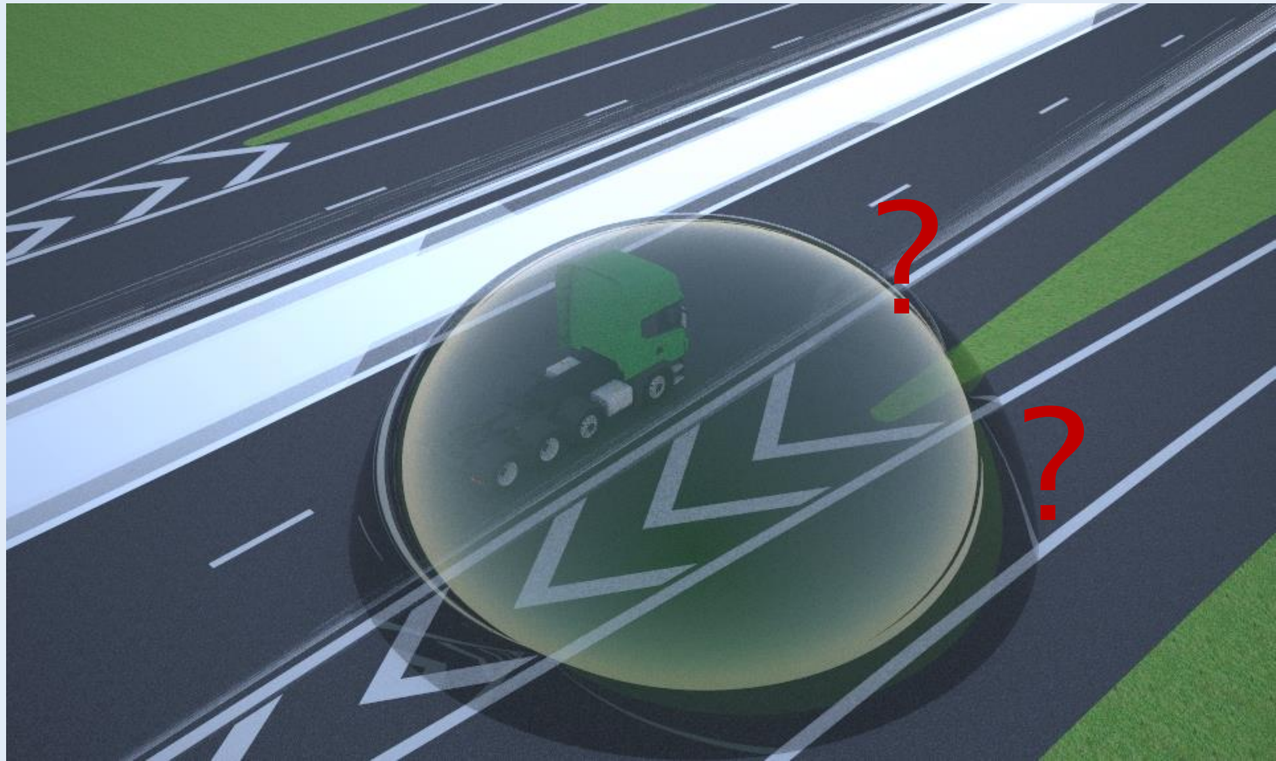




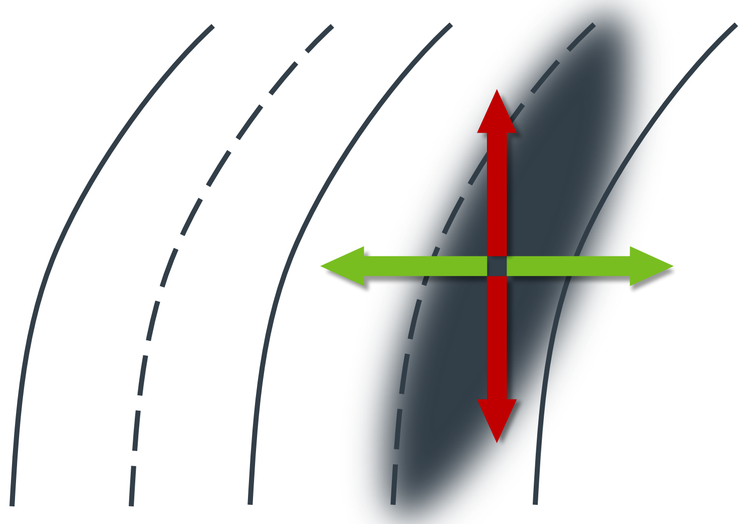
Tolling / Insurance Telematics

- Considering the NAVENTIK confidence, you can precisely determine the correct lane according to specified false alarm rates.



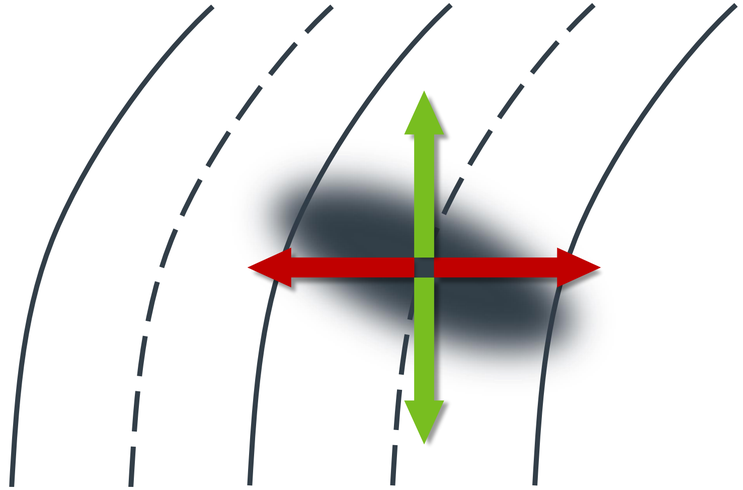


Lane Level Navigation



High confidence in lateral direction: **Position can safely be mapped to the correct lane even with high uncertainty in driving direction.**

“Please switch to the left lane and then turn left at the next intersection.”

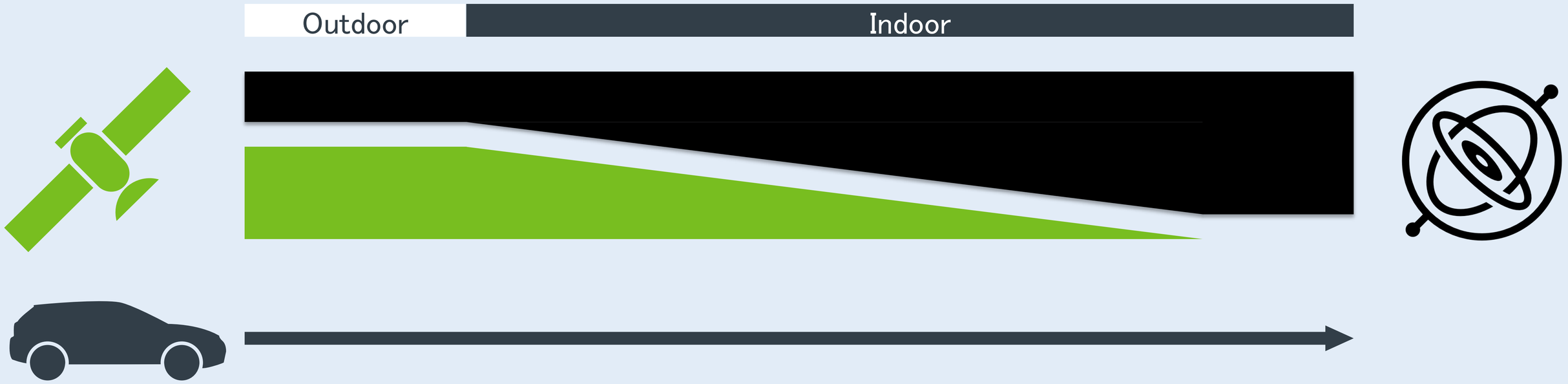


High confidence in driving direction: **Driving instructions can be precise in terms of distance to the next event but should not provide lane level recommendations.**

“Please make sure you are on the left lane and then turn left in 30m.”

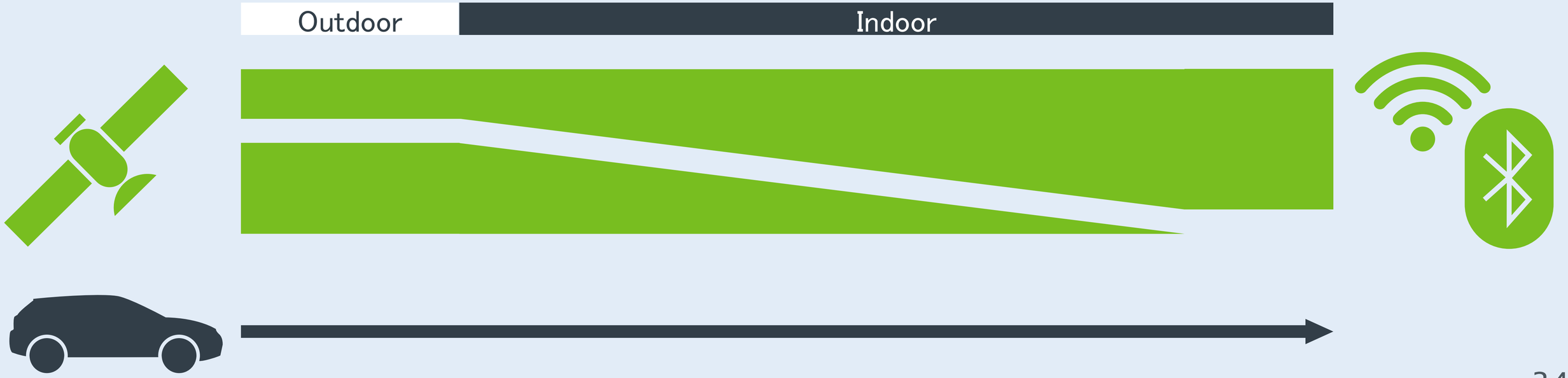
Indoor/ outdoor Hybrid Navigation

- With reducing signal strength of GNSS signals, the NAVENTIK system enables the seamless transmission to inertial sensors like gyroscope or acceleration sensors.



Adaption to other Time-of-Flight Localization systems

- The Technology of probabilistic signal tracking can be applied to potentially all time-of-flight based, one-way localization systems.
- Wi-Fi or Bluetooth-based indoor navigation suffers strongly from multipath propagation that can be mitigated by PATHFINDER.
- The software-defined approach can be adopted without additional hardware.



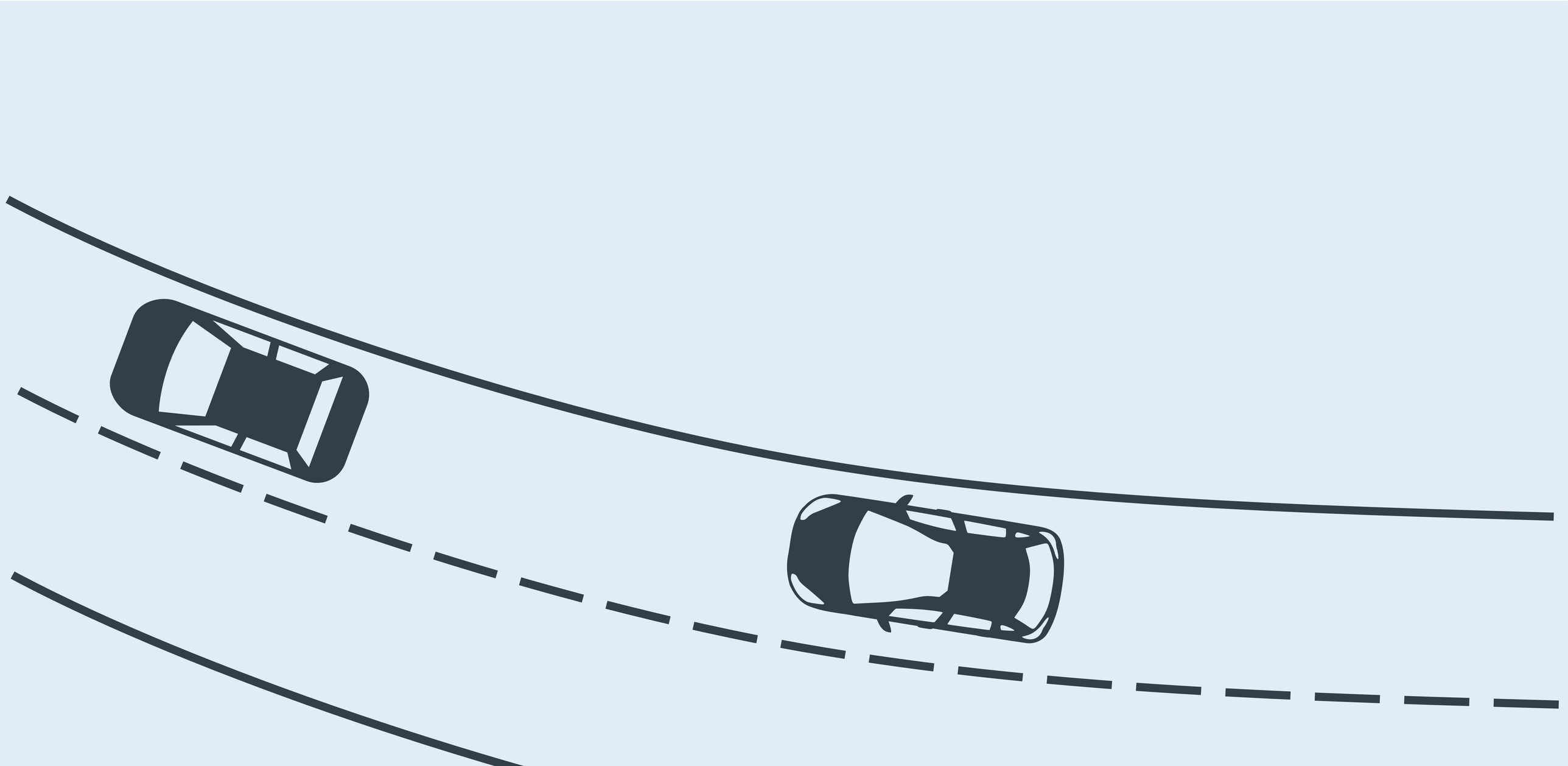
Outlook to further Applications

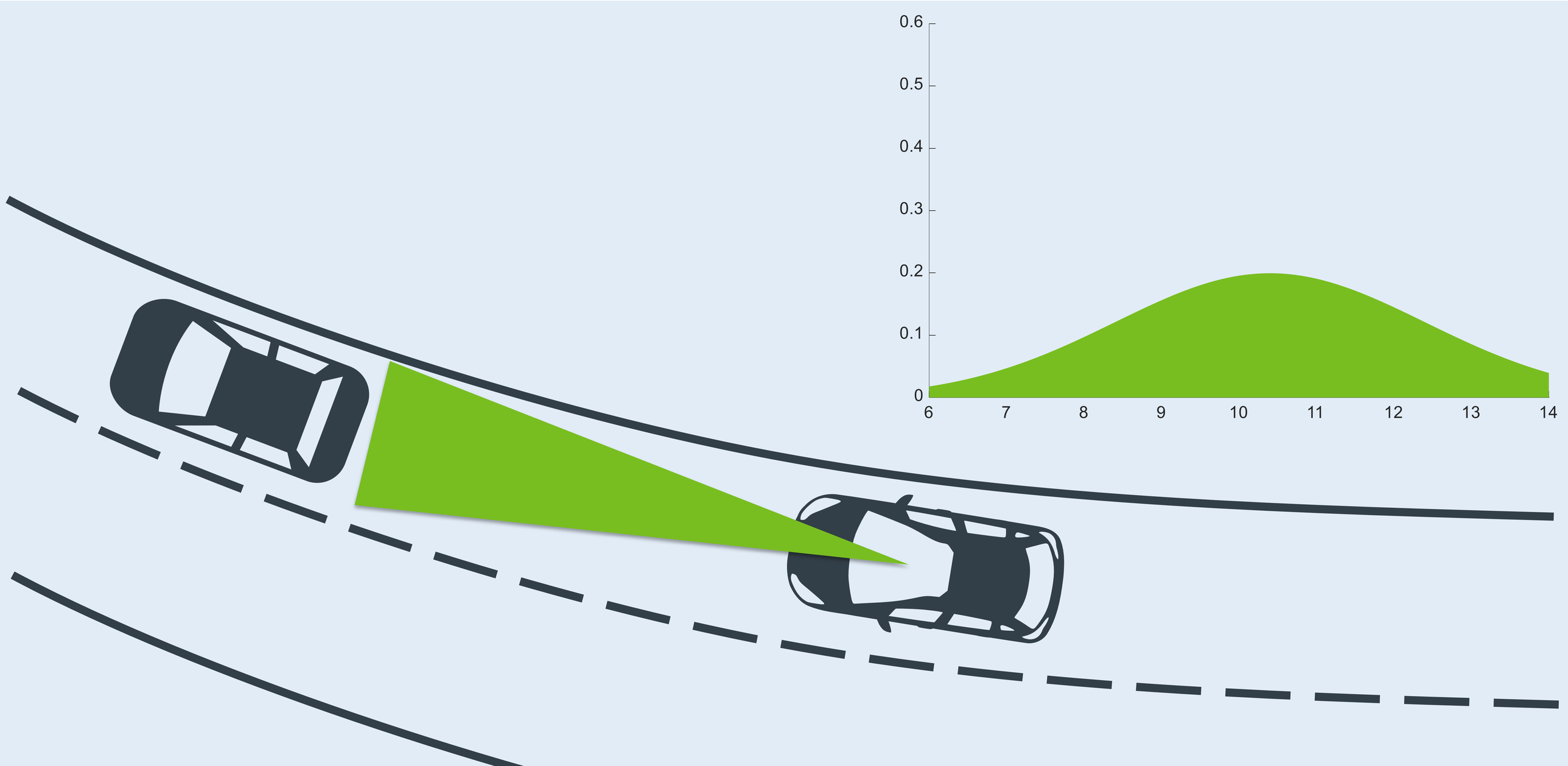
Basically, applications need to utilize the confidence estimate in order to adopt different automation levels and user interaction according to the performance of the system. That enables the compliance to false alarm specifications for automated applications and improved user acceptance for passive systems.

- Automotive (Advanced Driver Assistance Systems and Autonomous Driving)
  - Safe and seamless integration in probabilistic data fusion frameworks (Bayes filter)
  - Initialization of visual perception systems, Trajectory planning

- Unmanned aerial vehicles (UAV)
  - Deep integration to embedded perception systems on drones (24 computing cores for image and signal processing are available on todays consumer drones)

- Mobile Devices
  - Cloud services will be possible, like the correct localization of the user in urban canyons.
  - Providers for On-Demand taxi services suffer from false position information of passengers in urban areas

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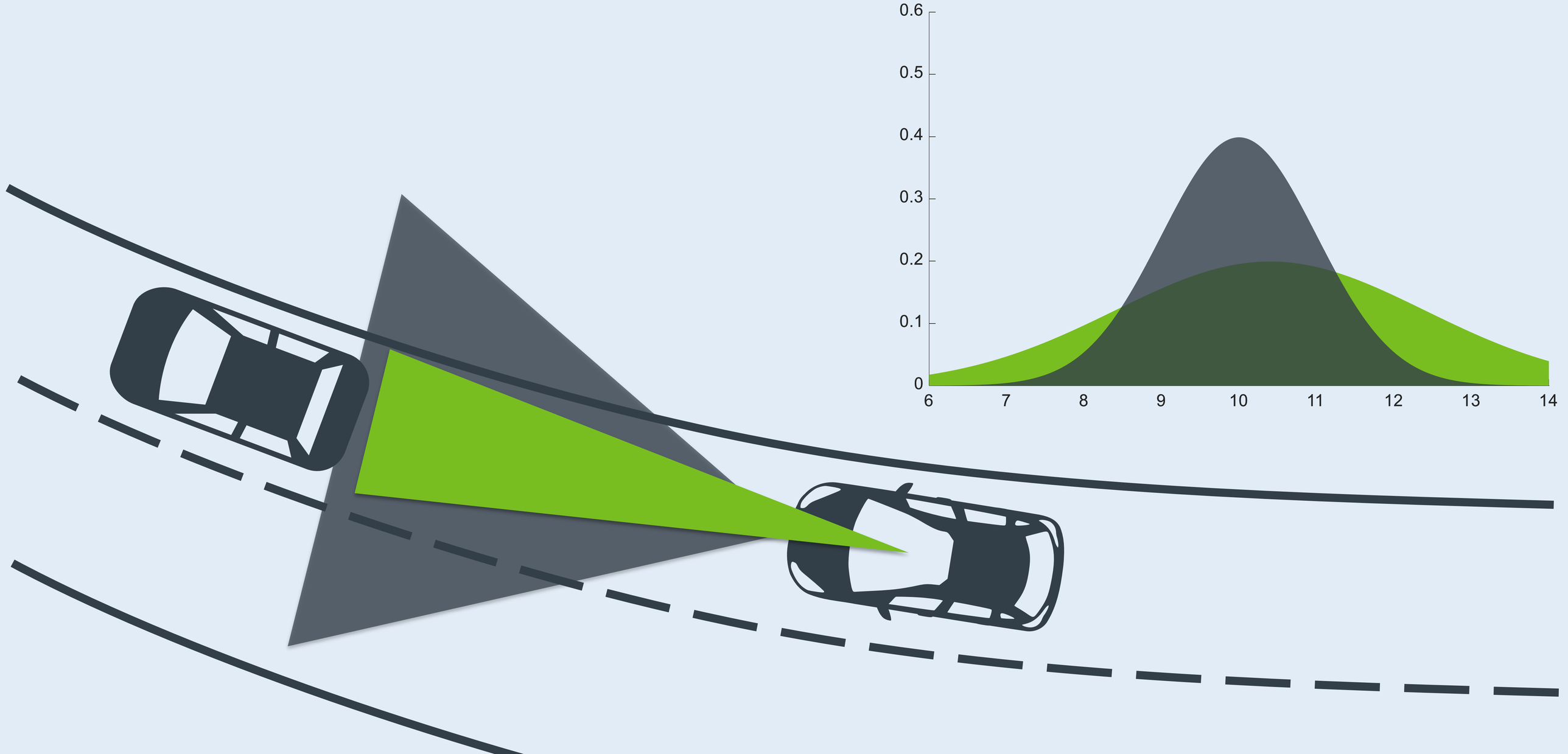

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