European Global Navigation Satellite Systems Agency

PRoPART
Precise and Robust Positioning for Automated Road Transports

European Global Navigation Satellite Systems Agency
HORIZON 2020

PROPART FINAL DEMONSTRATION EVENT

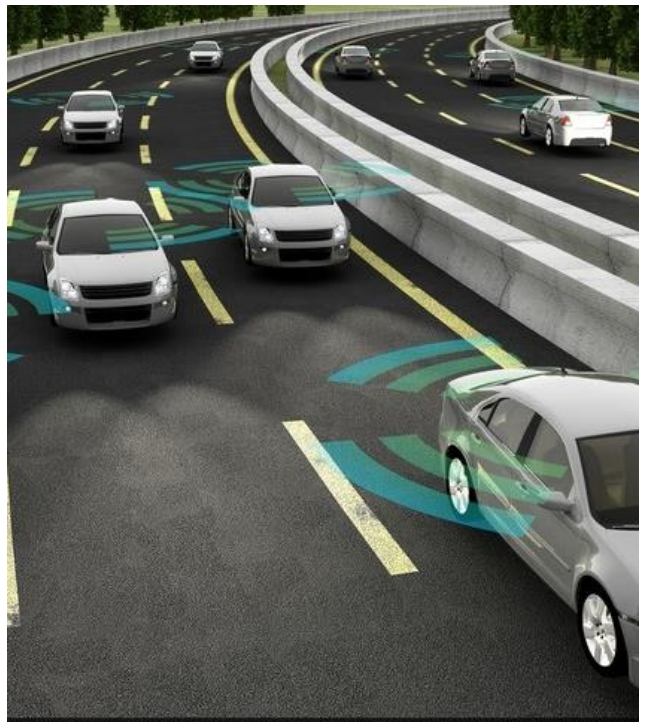
Cooperative Perception Concept

AstaZero, 2019-11-21

Andras Varadi, Liang Zhang

commsignia

BASELABS
Data Fusion Results



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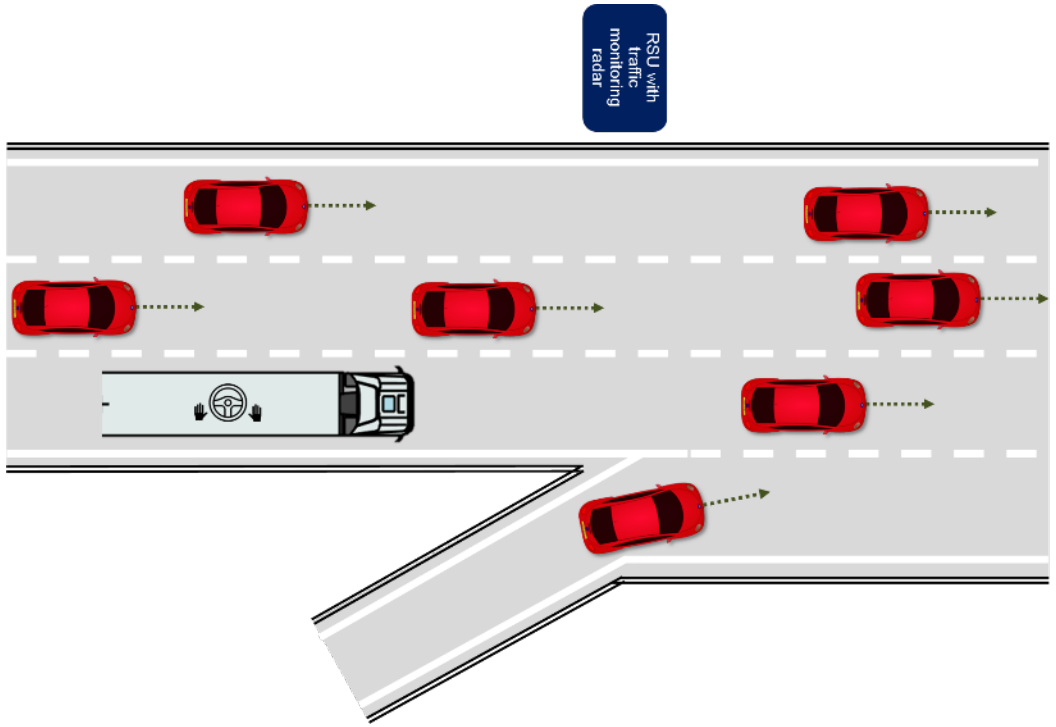
Recap

- Vehicle application to rely on the high availability positioning solution and use it to couple its ADAS system with V2X and aggregate information received from other connected vehicles and Road Side Units (RSU).



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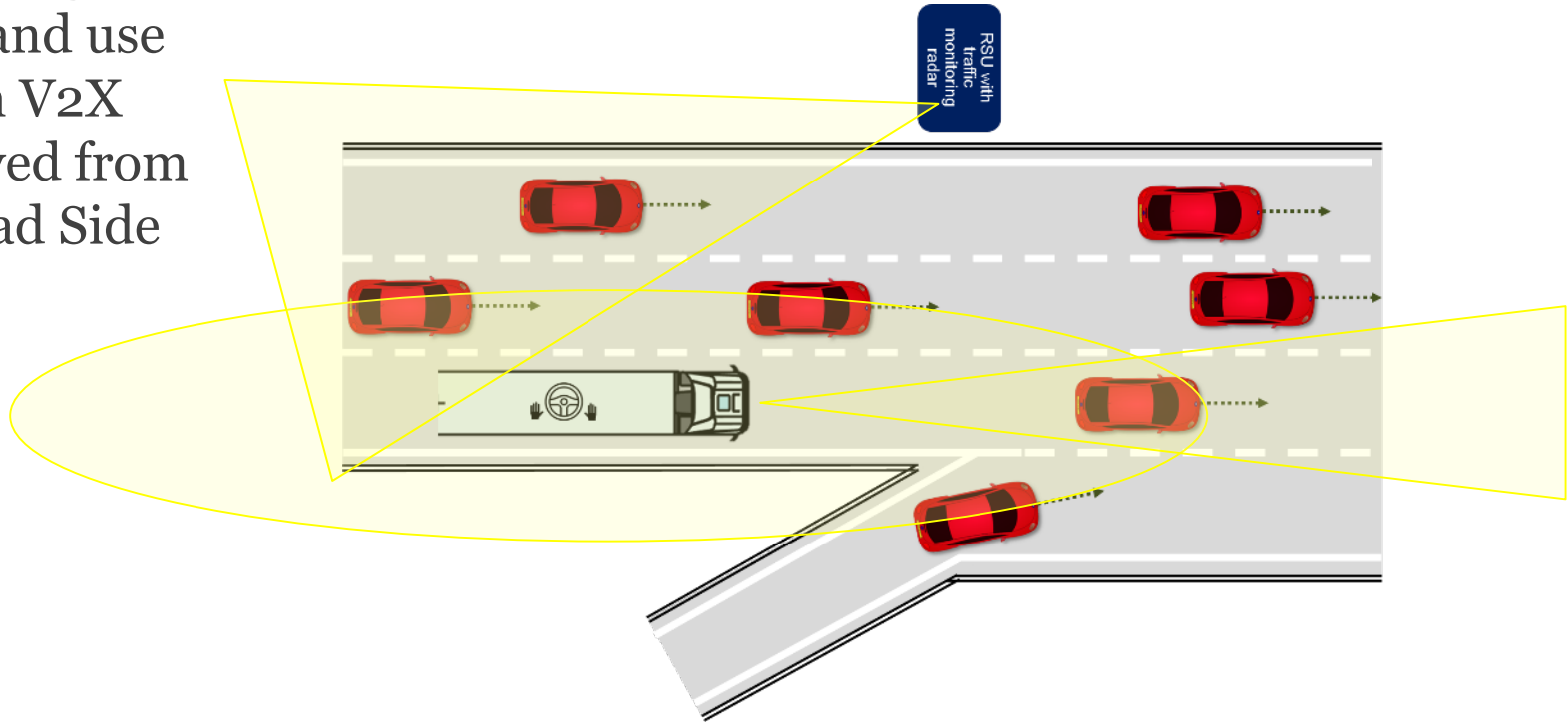

V2X general introduction

Standardized, Day1 services deployed in Europe today

- CAM
- DENM
- SPaT
- MAP

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Manouvering requirements on C-ITS

- Increase detection overlap by using external sensor services
- The chosen facilitator:
  - V2X due to its security, low latency and standard compliance
  - OTS Traffic **radar** for high reliability under most (environmental) circumstances
- V2X: early draft of the Collective Perception Service was able to share detected object information between ITS stations (V2V or I2V)

- **Investigation of the Collective Perception function: the expected outcome of the onboard sensor fusion is occupiable free space!**

Free space distribution

- However free space != areas with no objects
  (based on information from sensor providers)
- PRoPART identified the need to…
  - Investigate how free space can be extracted from external sensors
  - Developed a concept to share this information via V2X

- Extensive standardization throughout 2019,
  two iterations of implementation
  ETSI TR 103 562 V0.0.16 – final version
  (internal functions were aligned to become
  standard compliant – fixed interfaces for partners)

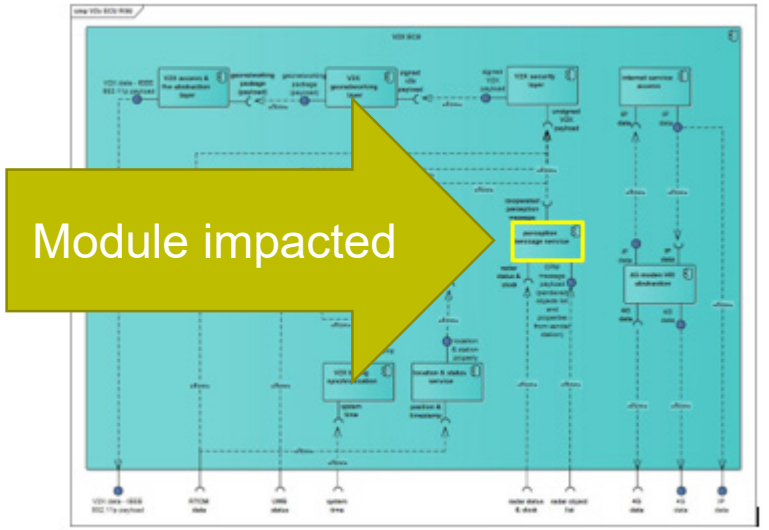
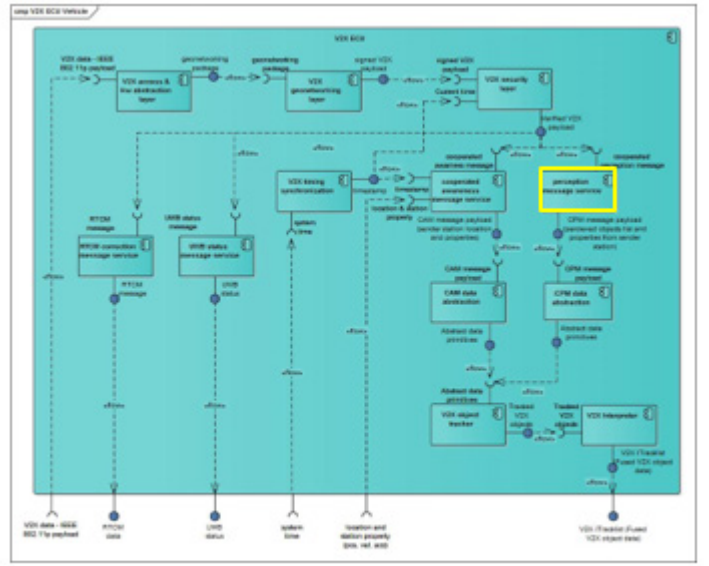


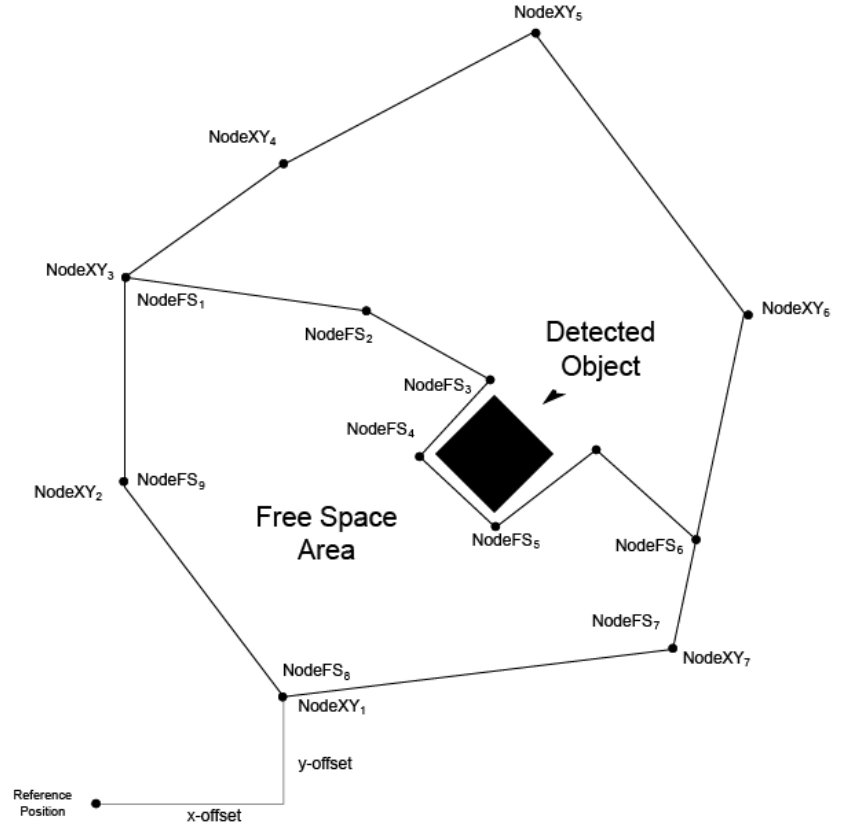
Figure 41: CP update to roadside-based functions of the V2X Communication



igure 518: CP update to the functions of the vehicle's V2X communication system and object tracking

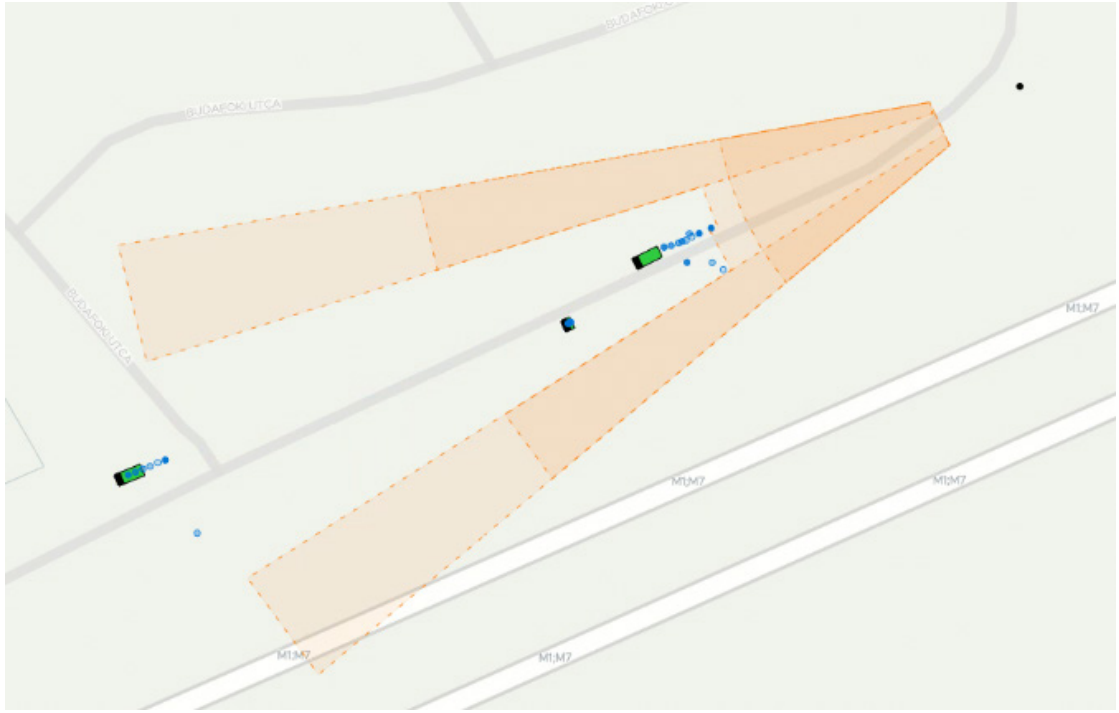
Collective Perception (current)

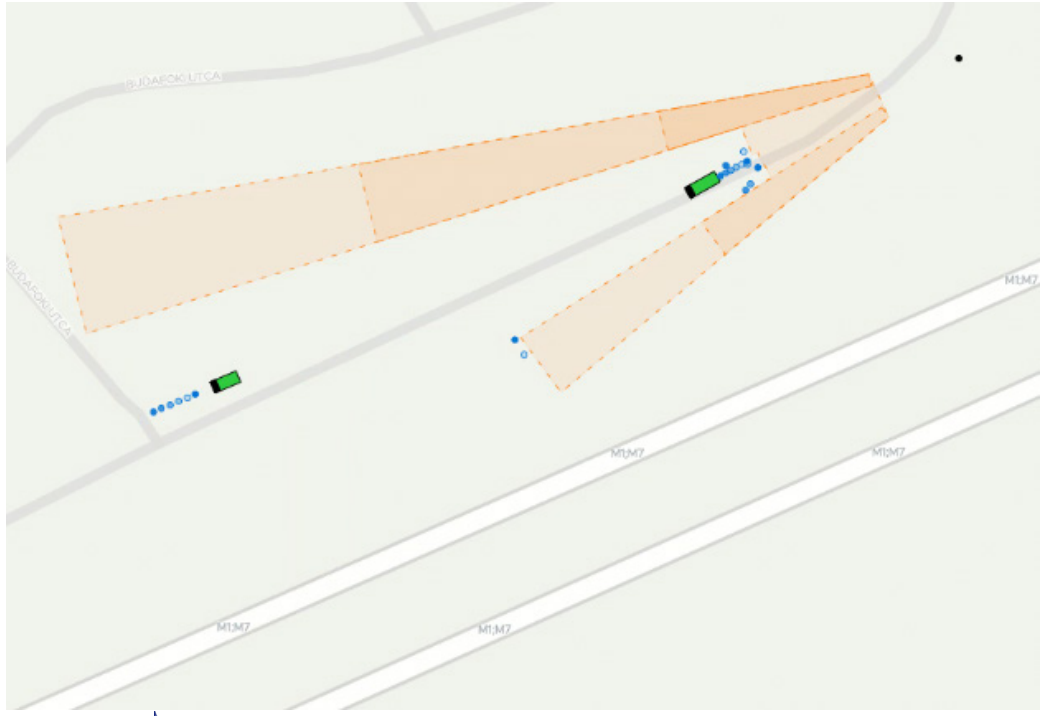
- Its a V2X service (message) to distribute environmental perception
- Detections may be represented by obstacles (objects) or free space
- A Collective Perception Message (CPM) contains:
  - Sensor Information (detection area, type, etc)
  - Object list (non connected vehicles, vulnerable road users, obstacles)
  - Confirmed free space a user may occupy safely
- CPM properties
  - Distributed at 1-10 Hz update rate
  - May be sent by any traffic entity like Vehicles or Roadside Units



PRoPART: Collective Perception Service deployed

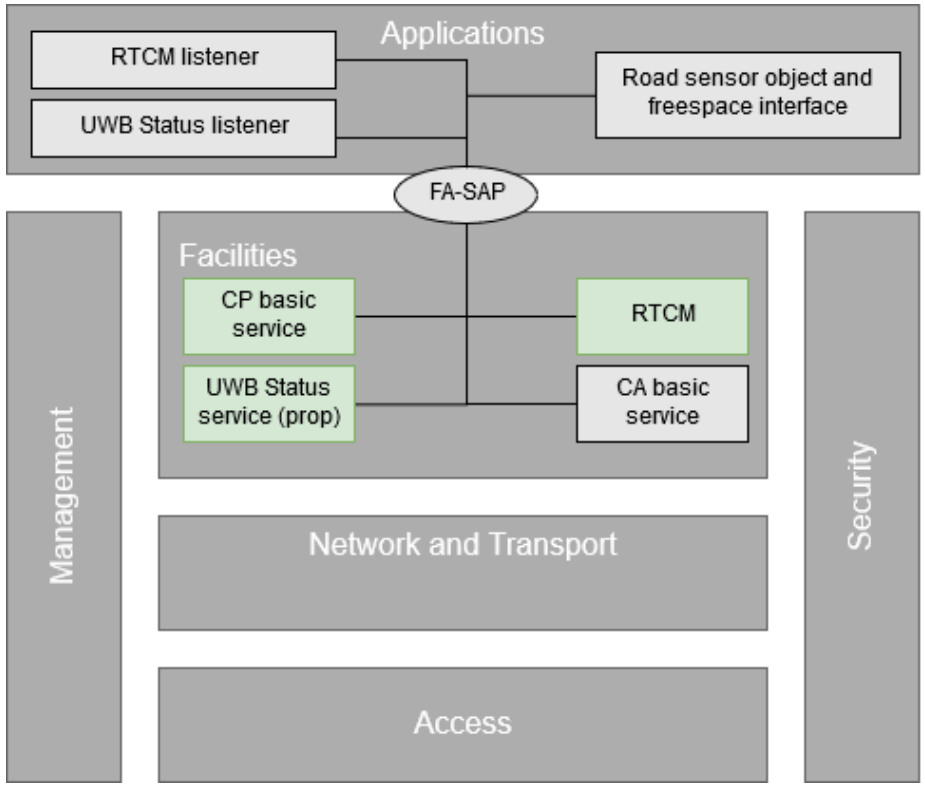
- Based on the traffic radar detections, objects are identified and translated into CPM objects
- Based on RAW sensor measurement, Commsignia developed a custom 3 stage area definition that relies on detection performance of the sensor. Within these areas the raw measurement results are validated and fused with detected objects to calculate confirmed free space.





Road Side Unit and Traffic Monitoring concept

- PRoPART also pilots several other new facility extensions to the current (Day 1) services.
  - UWB Status message: providing additional level of service reliability
  - Locally generated corrections service based on TS 103 301 for V2X RTCM distribution
- All services are decoded within the OBU and provided to respective onboard systems



(*)V2V and V2I communications are collectively known as V2X communication.

Novel services of V2X roadside infrastructure

Roadside GNSS correction service

UWB Status service

Traffic detection service

GOOSE RTK

UWB NODE

TRAFFIC RADAR

Base V2X services

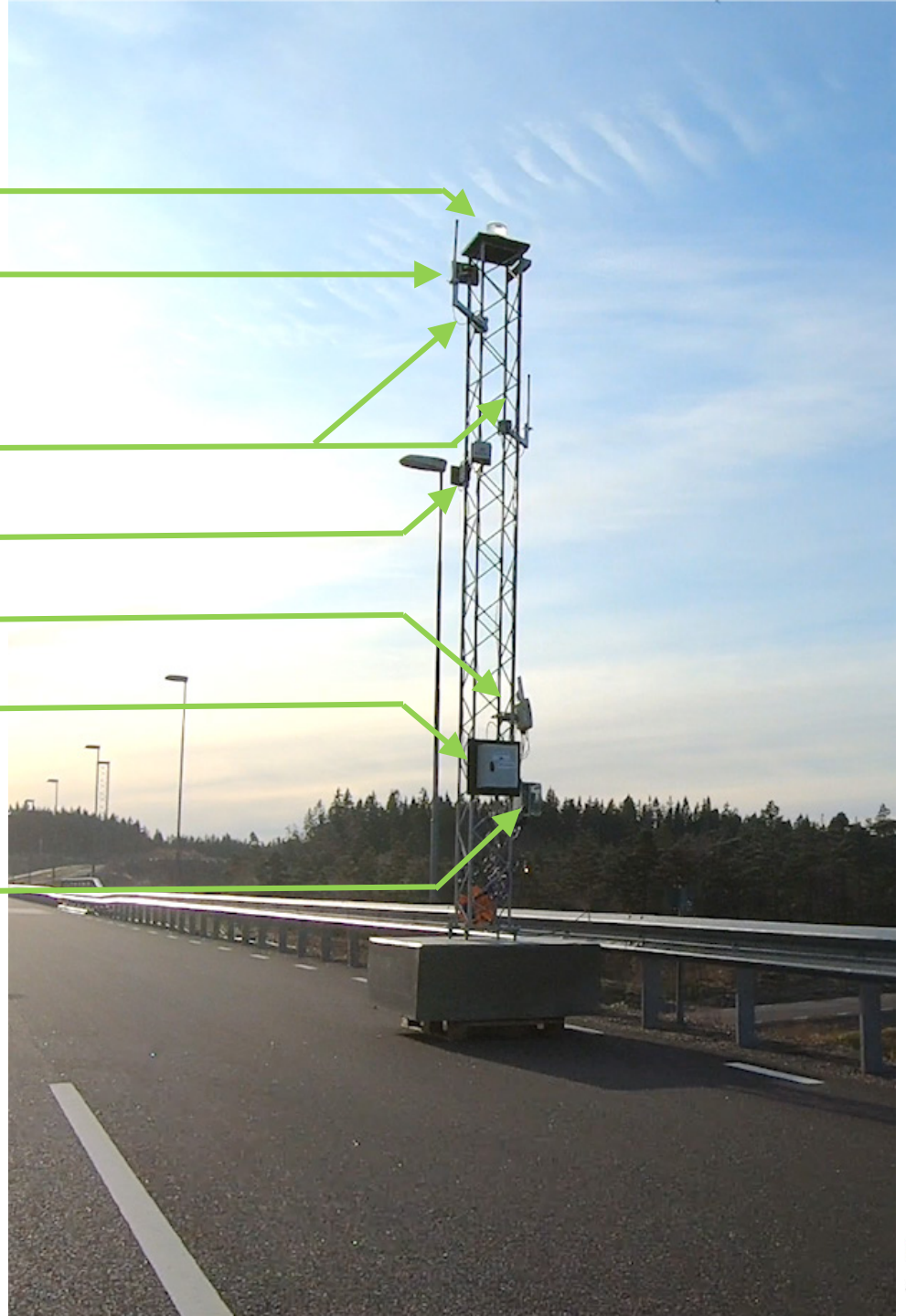
CAM, DENM, etc

Extended (novel) V2X services

CPM, RTCM, UWB

Roadside

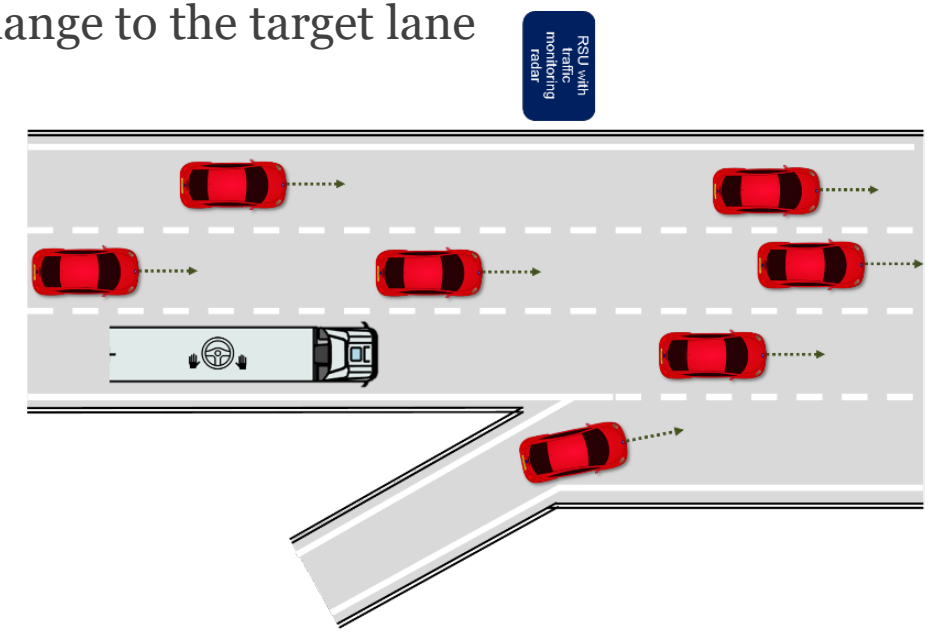
- GOOSE antenna
- Traffic radar
- V2X antenna
- UWB nodes and antenna
- V2X roadside unit
- GOOSE GNSS
- Power and network switch

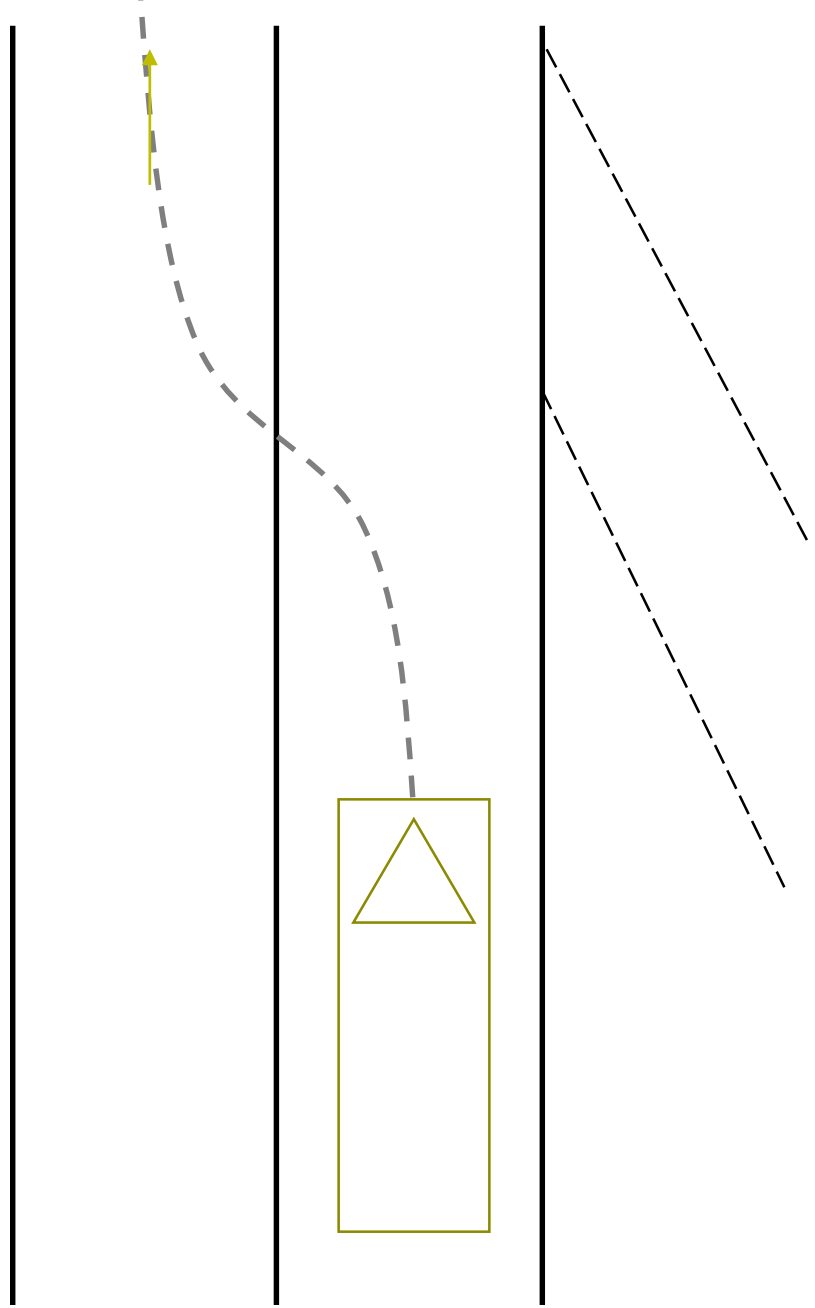


PRoPART

Demonstrator

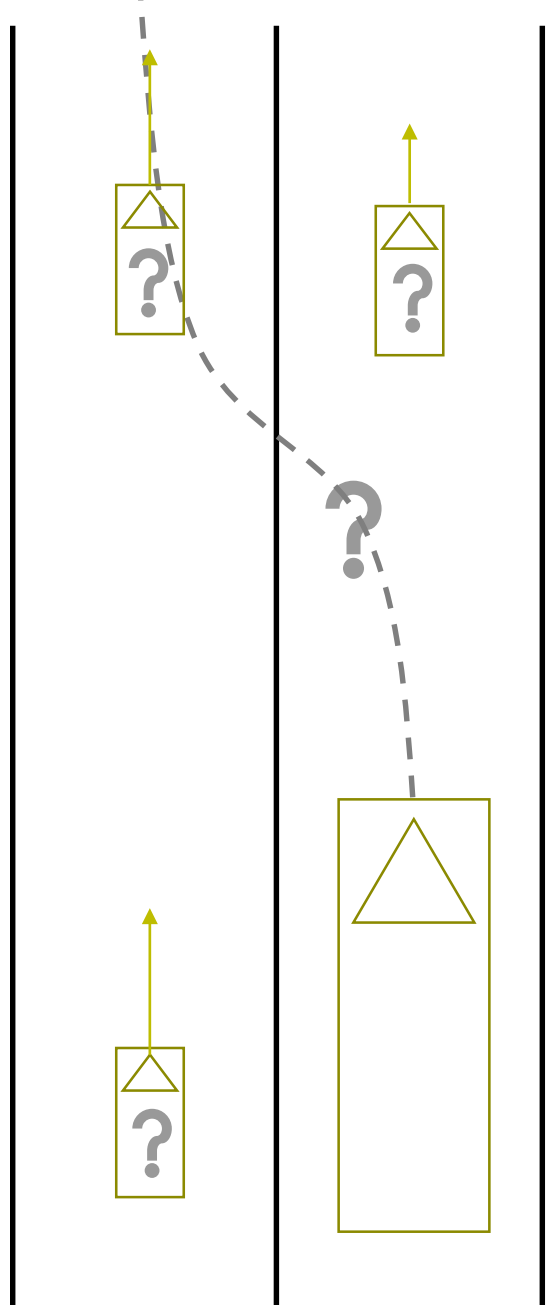
- Showing developed PRoPART system in specific use cases
  - Highway (before on-ramp)
  - Automated lane change for truck
- Simplification
  - Simulated on-ramp
  - 2 lanes
  - Only change to the target lane





Contribution of BASELABS

- Environmental Model
- Situation Assessment



Contribution of BASELABS

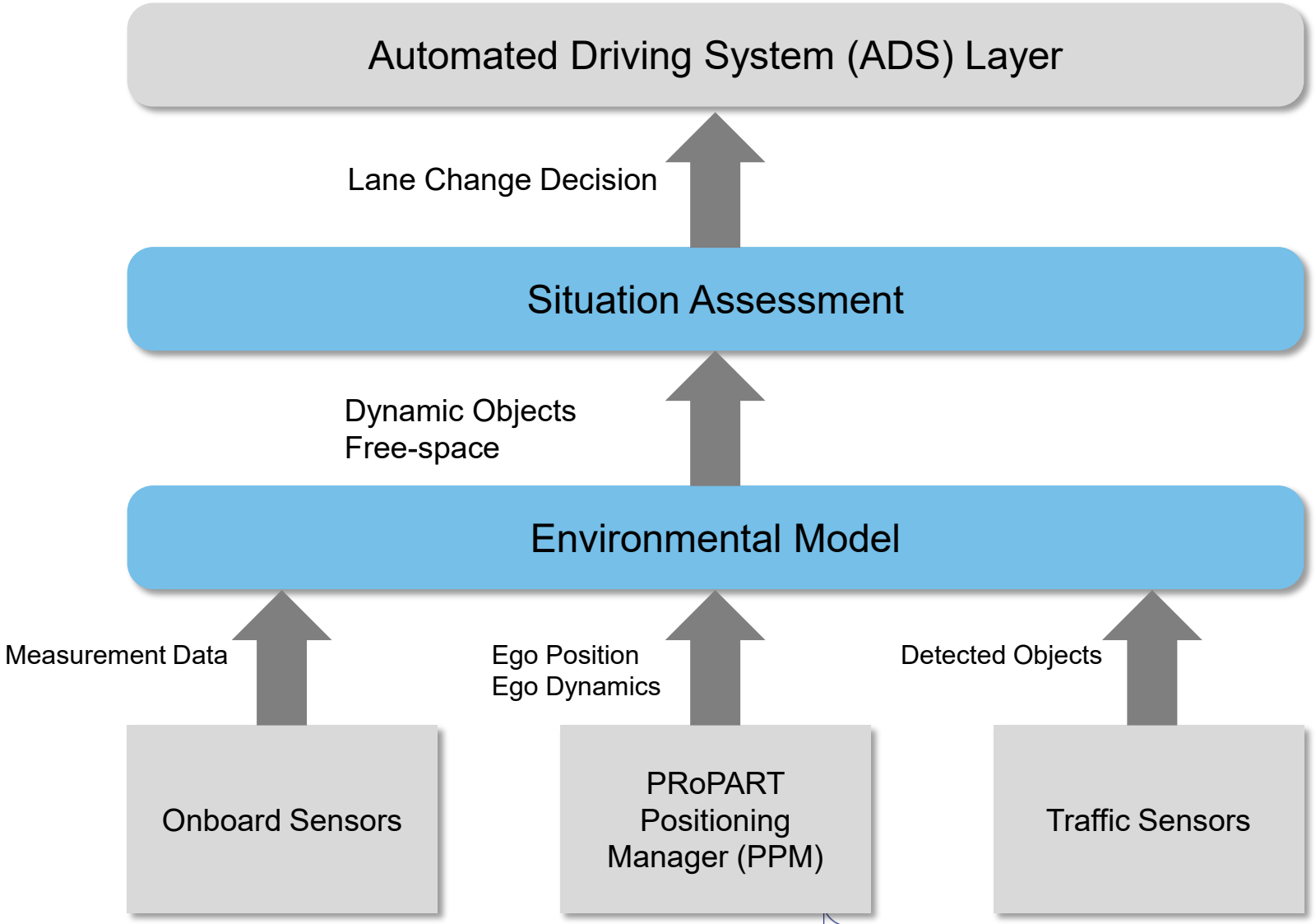
Automated Driving System (ADS) Layer

Onboard Sensors

PRoPART Positioning Manager (PPM)

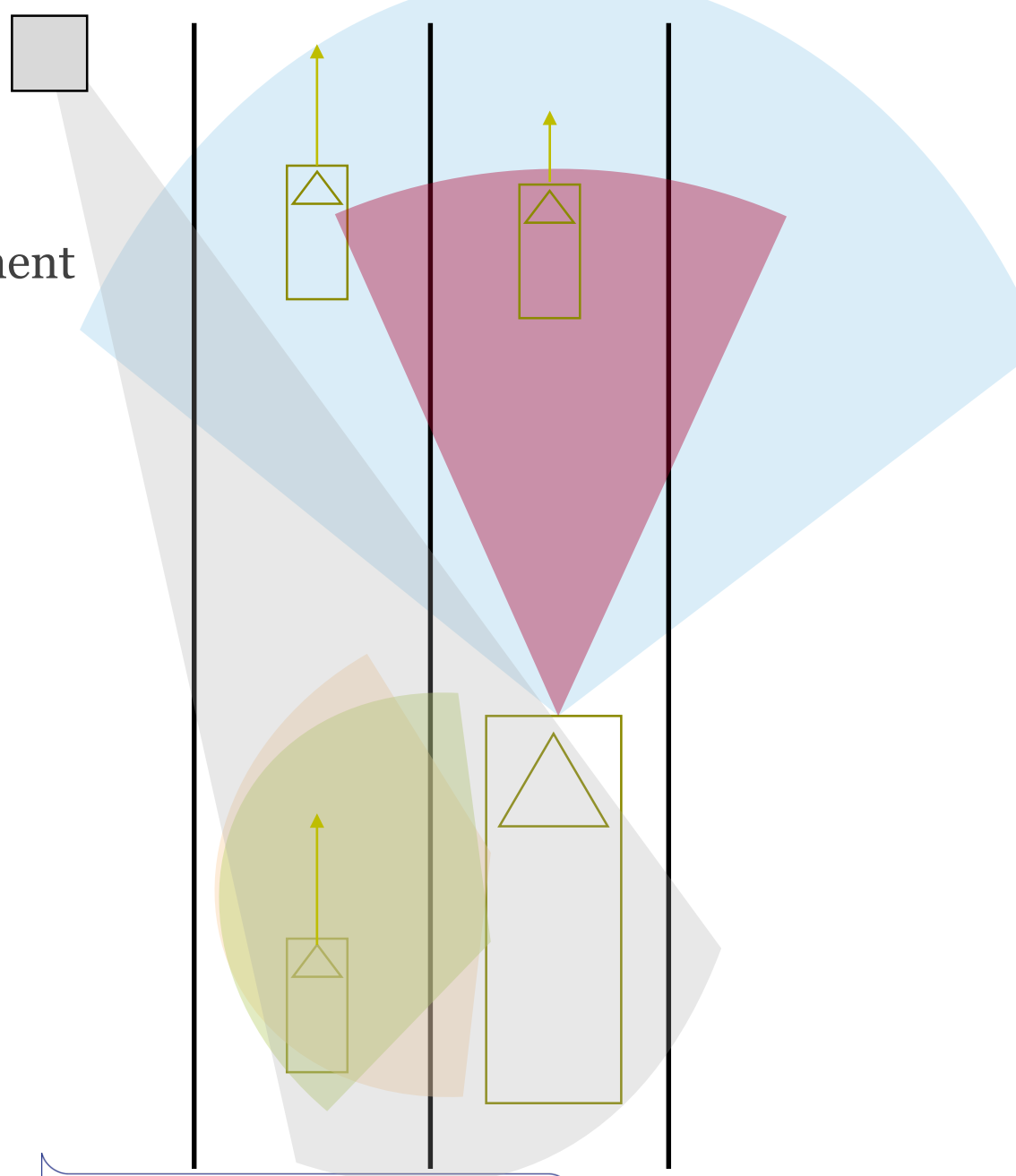
Traffic Sensors

Contribution of BASELABS



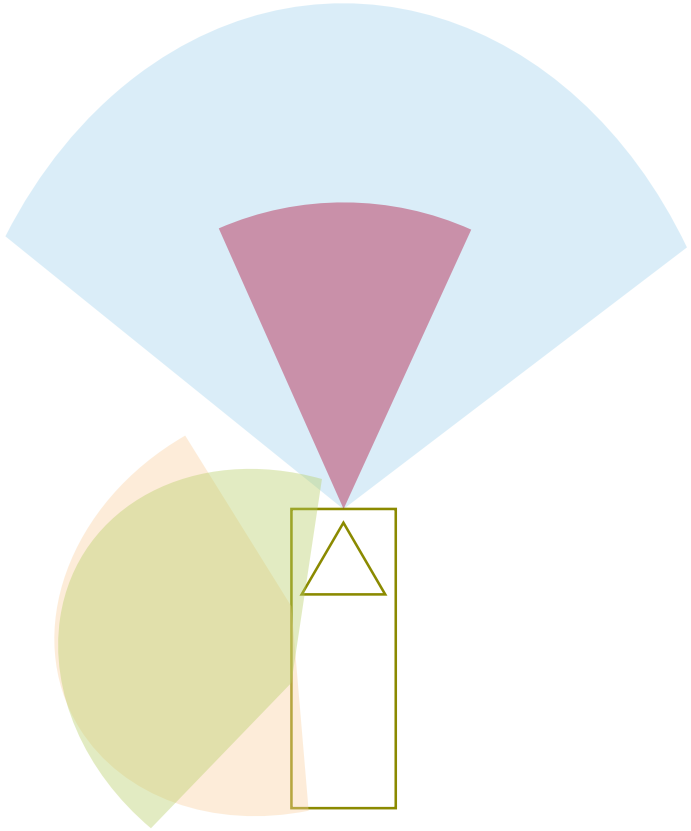
Environmental Model

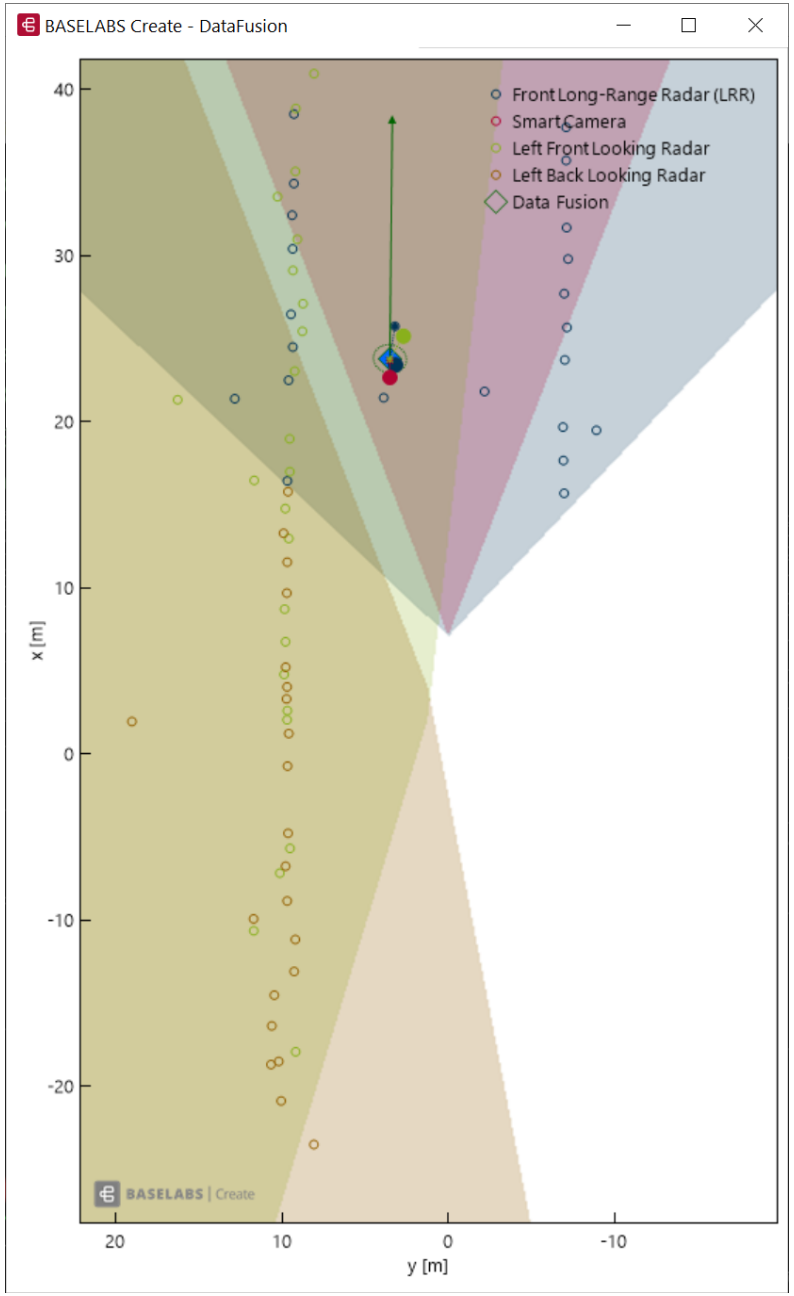
- A unified representation of the surrounding environment
- Created by fusing the data from
  - Truck perception sensors, radars, smart camera
  - Ego dynamics
  - Traffic sensors
  - Precise ego position is crucial
- Diverse data fusion approaches
  - Dynamic Object Fusion
  - Occupancy Grid



Environmental Model

- Dynamic Object Fusion
  - Front looking smart camera
  - Front looking radar
  - Left side-looking radars
- Estimated object states
  - Position
  - Velocity
  - Acceleration

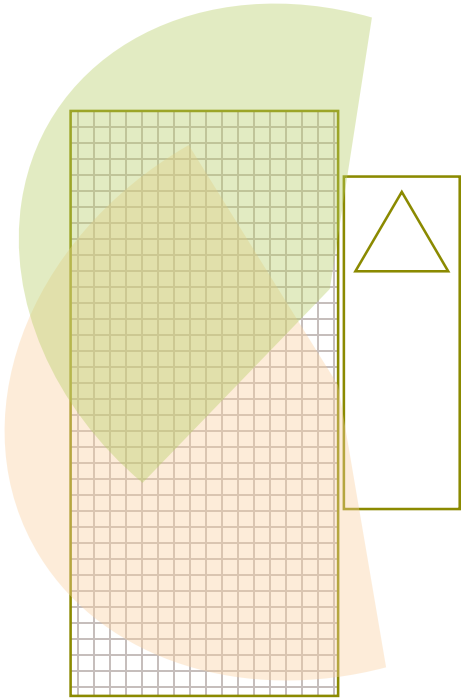


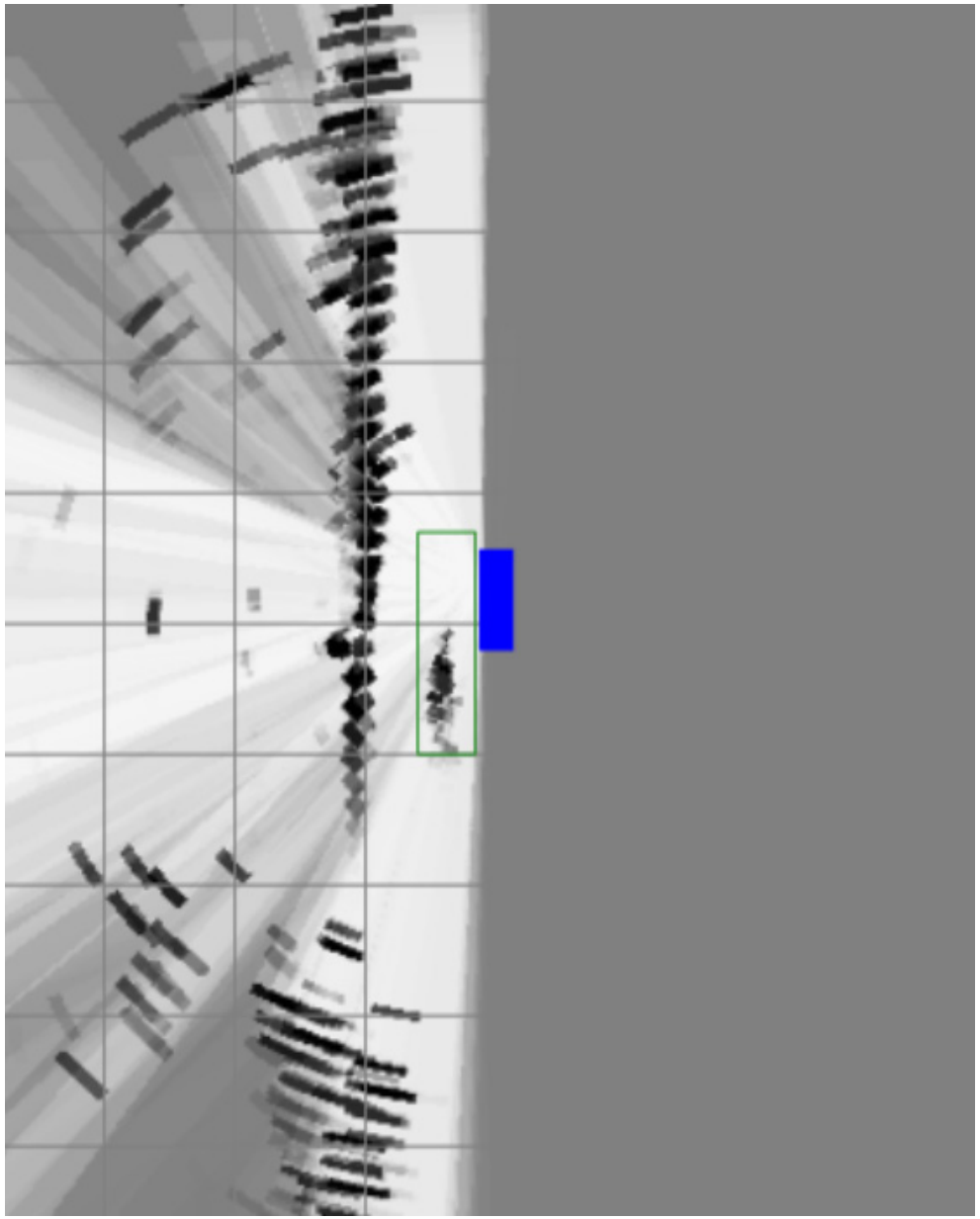


Environmental Model

Environmental Model

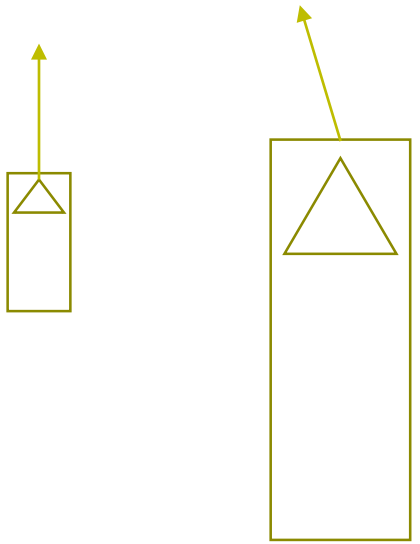
- Occupancy Grid
  - Left side-looking radars





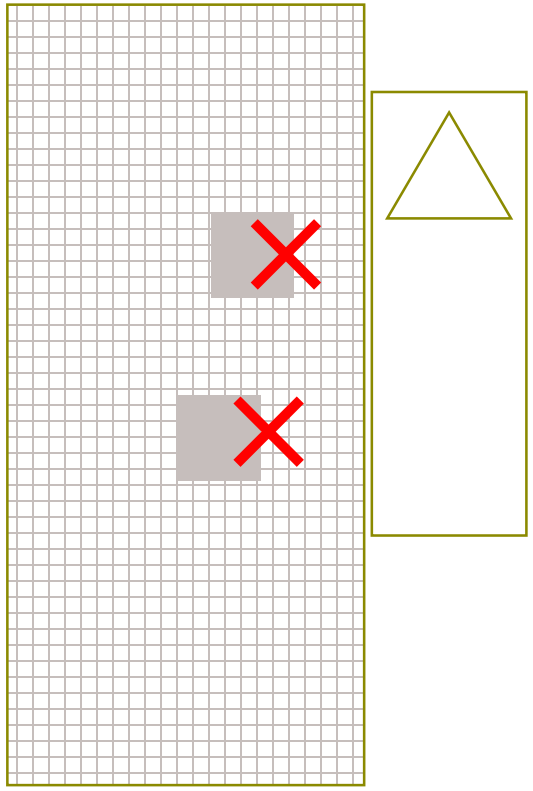
Situation Assessment

- Collision Detection for dynamic objects
  - For objects from the object fusion from the onboard sensors **and** from the V2X
  - Prediction required
  - Ego positioning required



Situation Assessment

- Static occupancy check
  - Adjacent region on the target lane
  - Current occupancy status only



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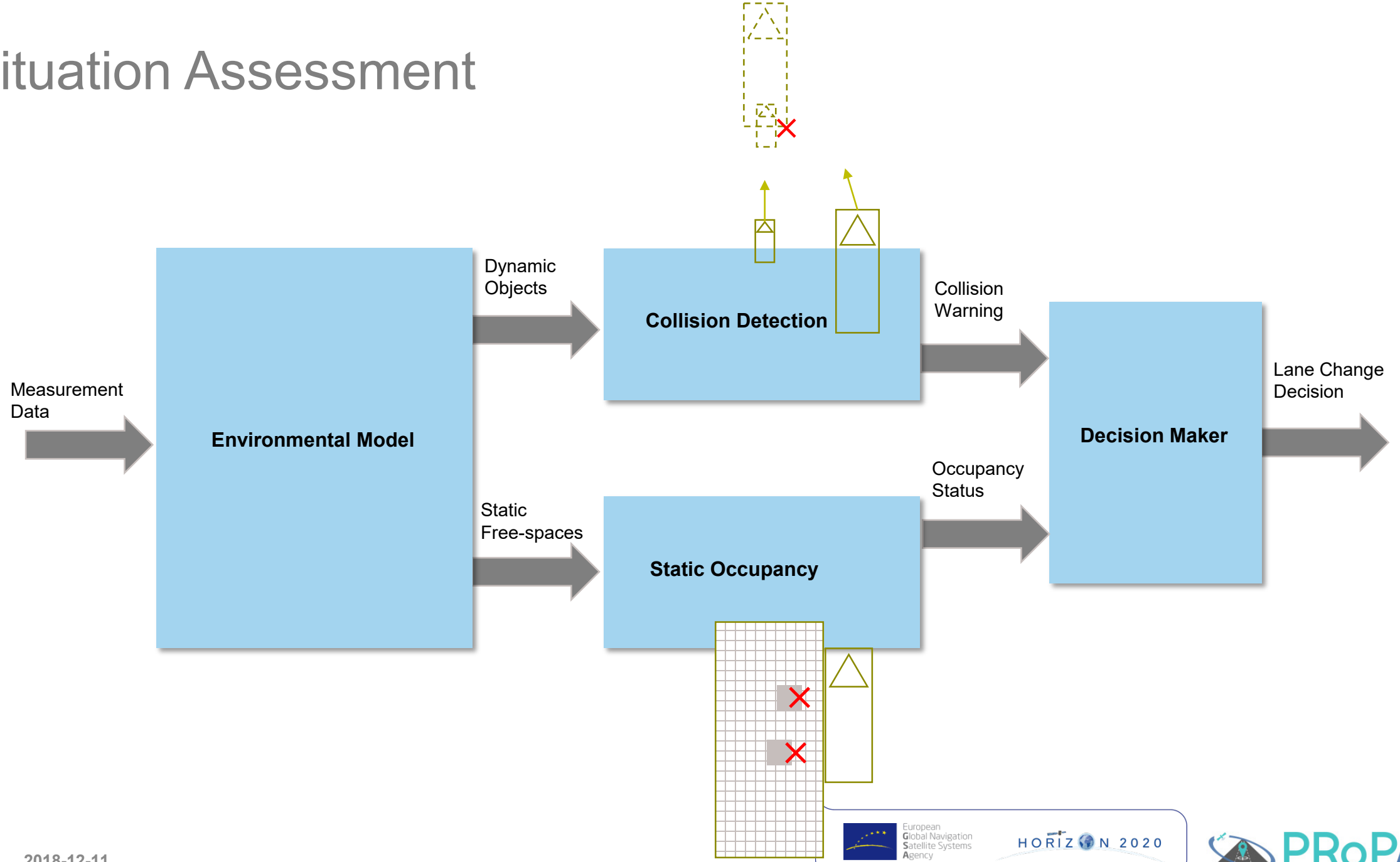

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THANK YOU

Stefan Nord

stefan.nord@ri.se

+46 70 511 5931

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RISE Measurement Science and Technology

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