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Corridor for new Mobility Aachen – Düsseldorf

Test Field Setup for the Development and Testing of Automated Mobility

16.11.2021

Laurent Kloeker



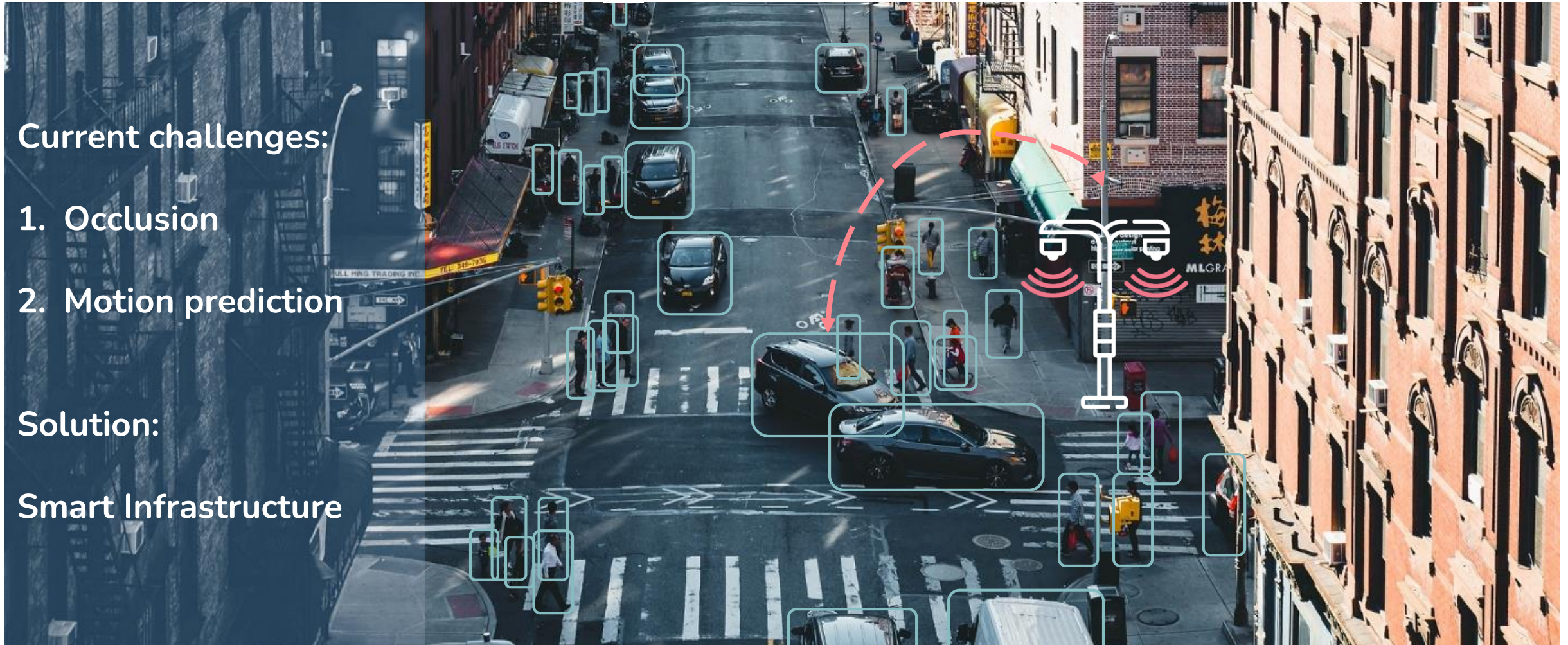
Motivation

Current challenges:

1. Occlusion
2. Motion prediction



Motivation



Current challenges:

1. Occlusion
2. Motion prediction

Solution:

Smart Infrastructure

ACCORD

Supported by:



on the basis of a decision
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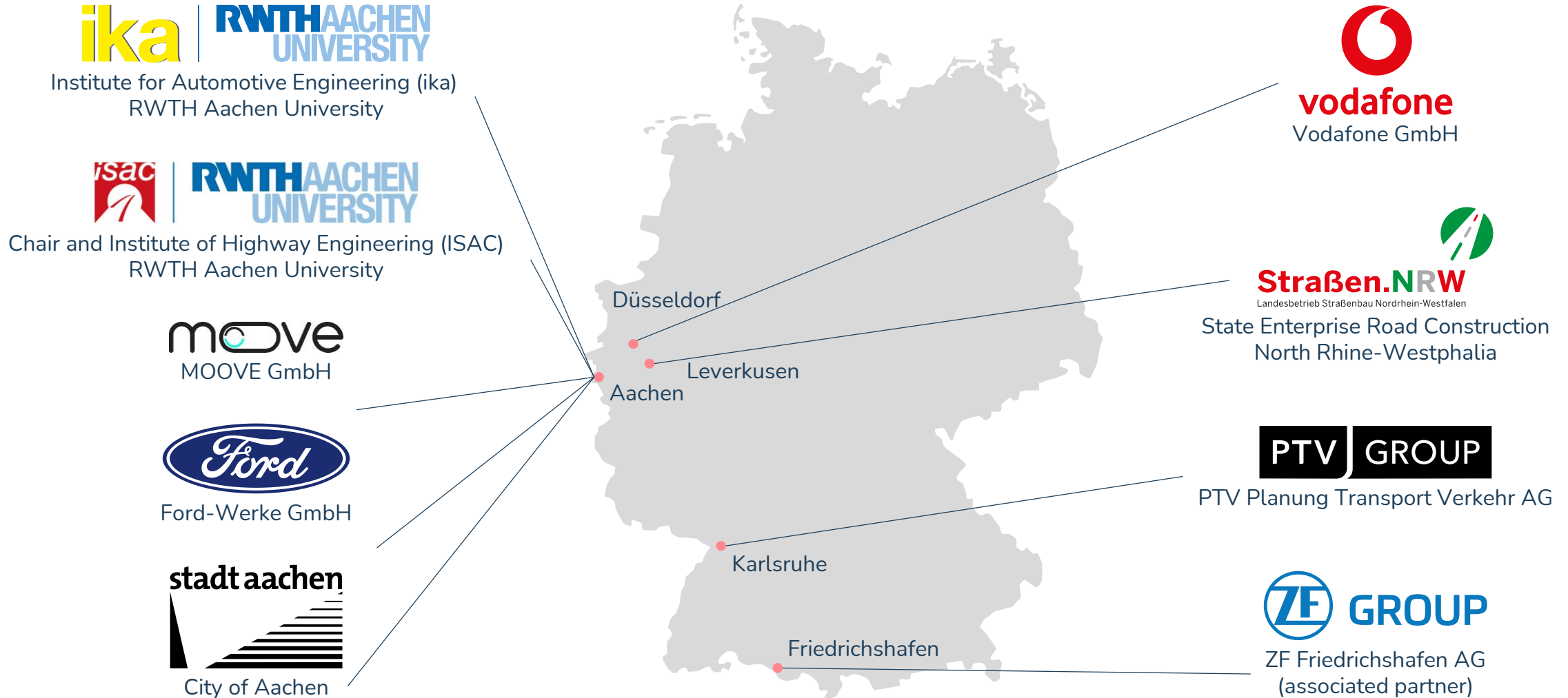
Corridor for New Mobility Aachen - Düsseldorf

Total Volume: 11.11 million €

Funding: 9.67 million € (BMVI)

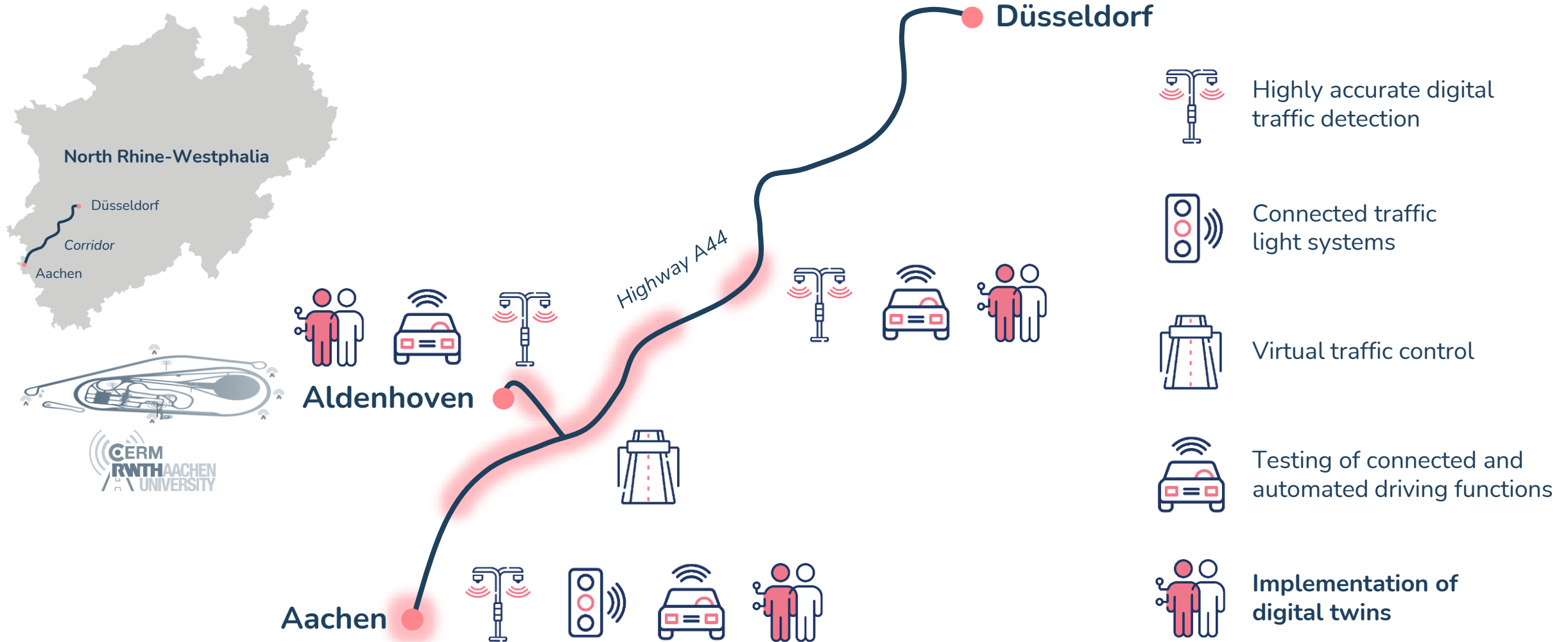
Duration: January 2020 – March 2022

Project Partners

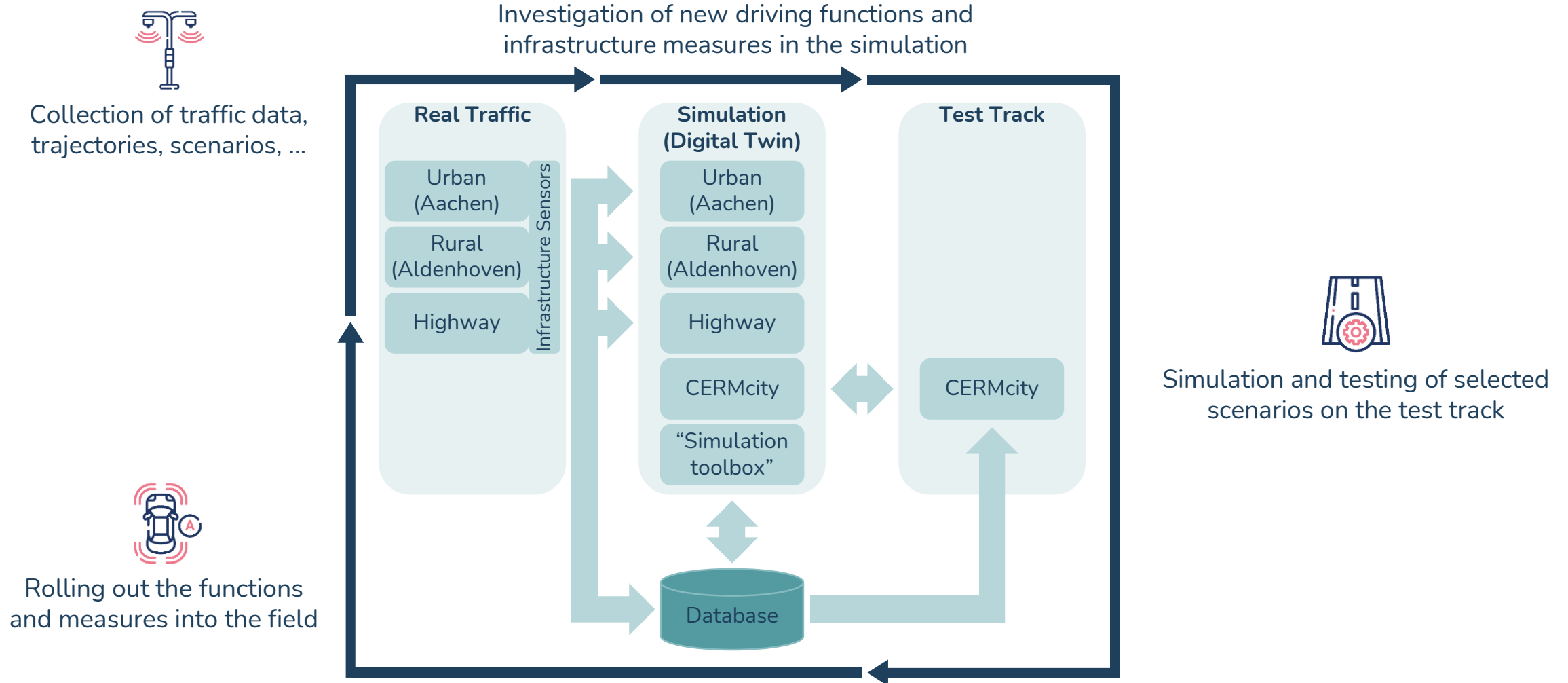


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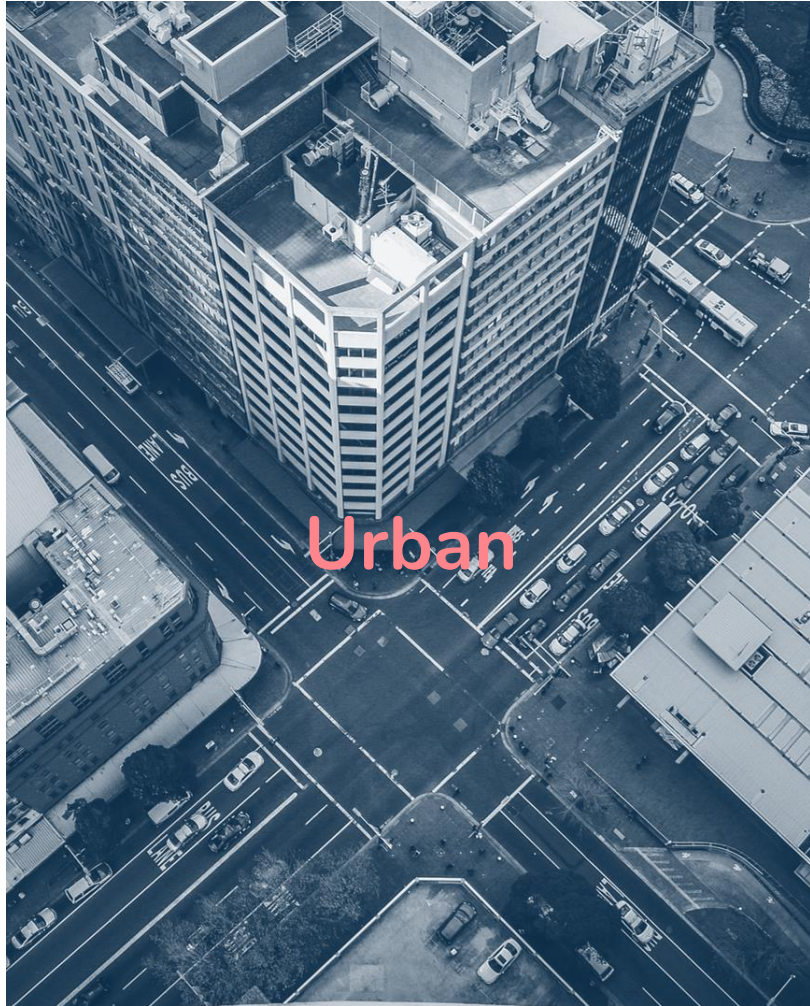
Overall Objective of the Project



Overall Objective of the Project



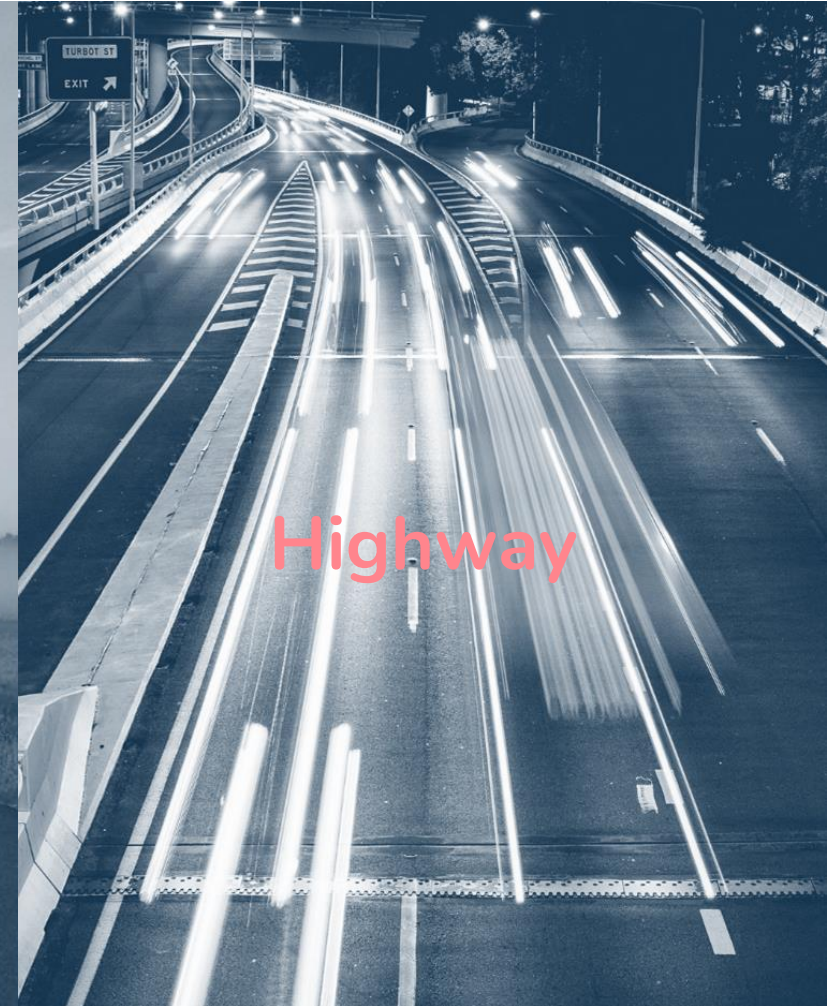
Test Fields for Automated and Connected Mobility



Urban

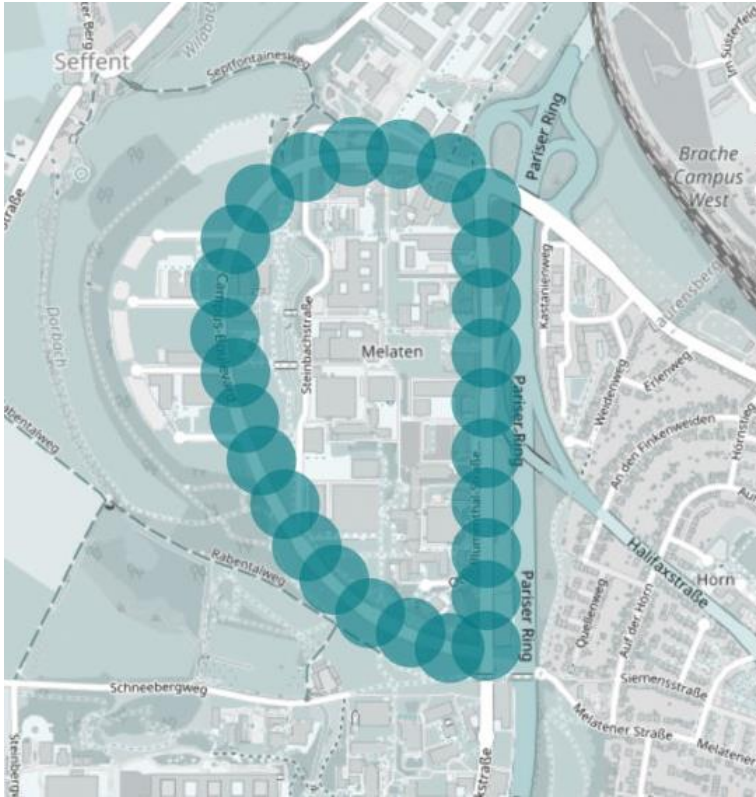


Rural

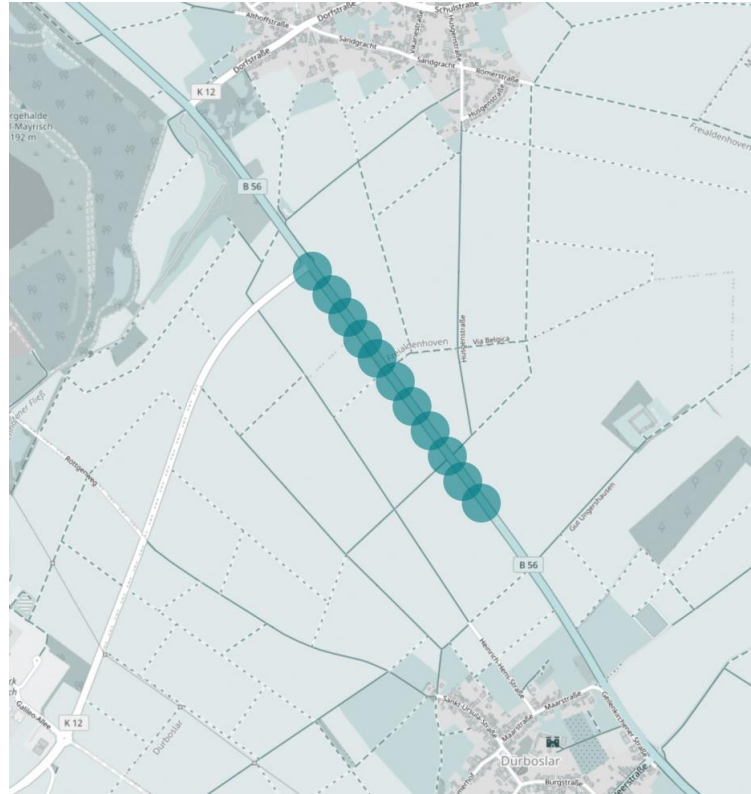


Highway

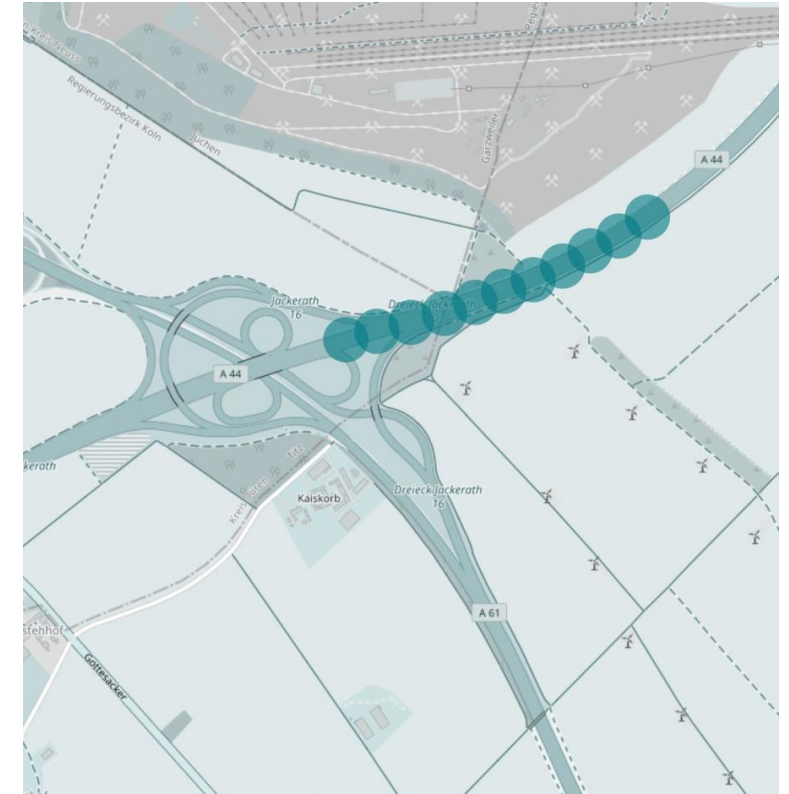
Test Fields for Automated and Connected Mobility



Urban
Campus Melaten, Aachen
2.4 km, 46 Road Side Units

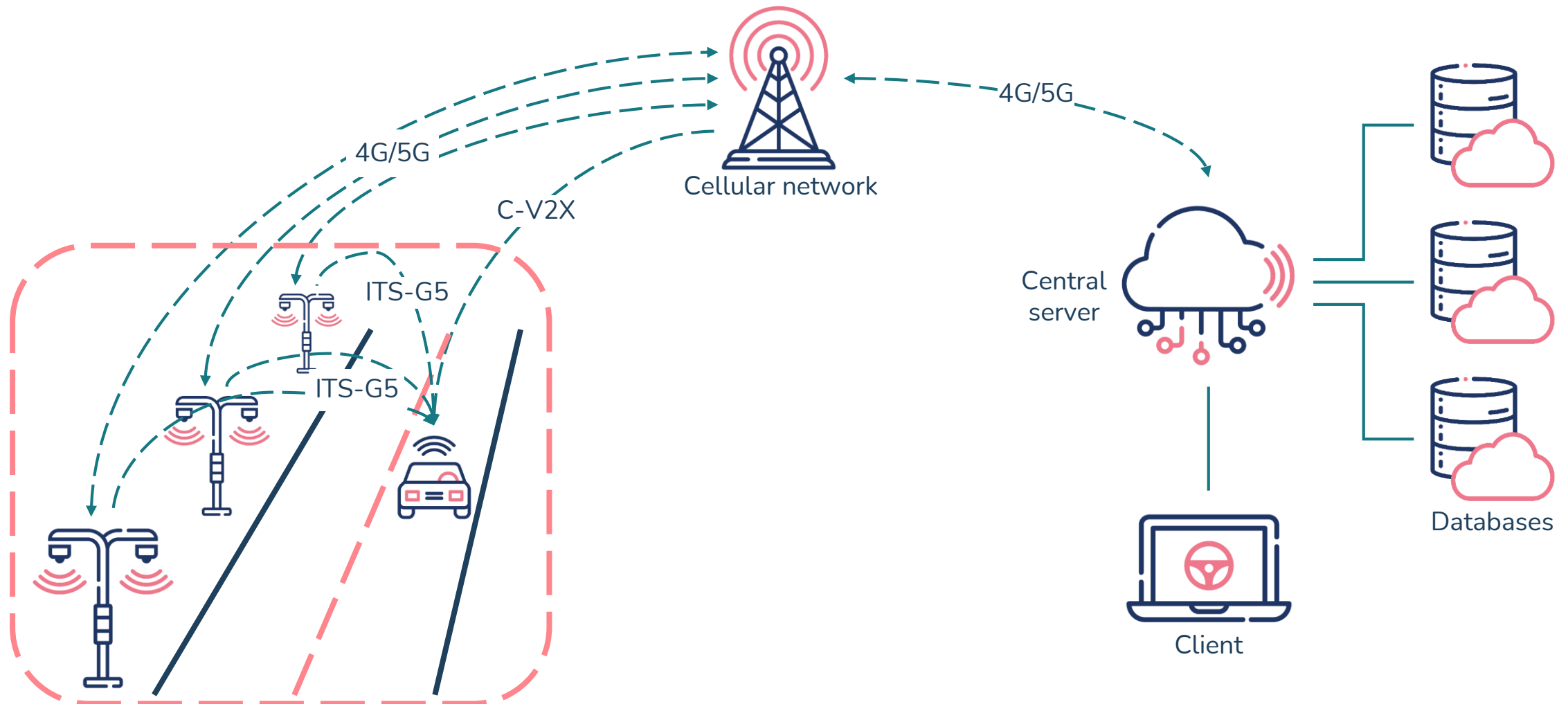


Rural
B 56, Aldenhoven
1 km, 11 Road Side Units

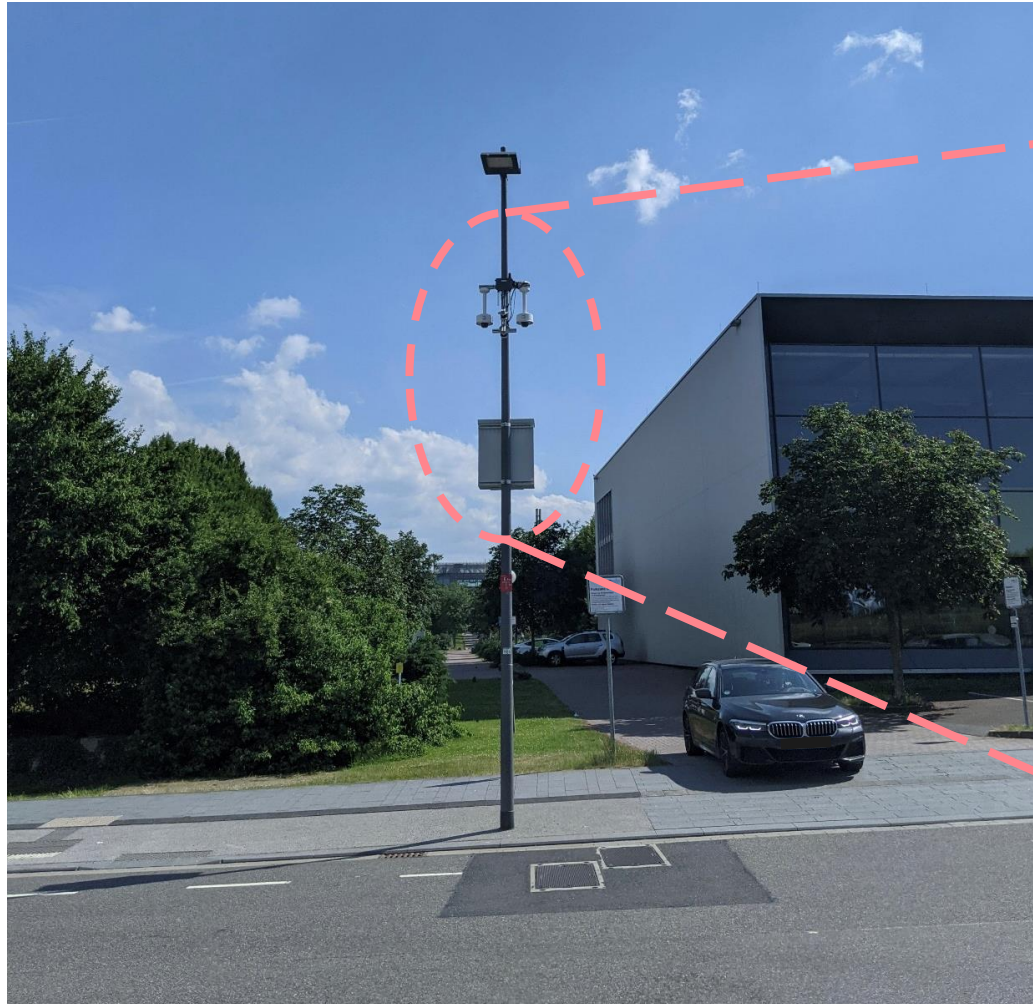


Highway
A 44, Jackerath
1 km, 11 Road Side Units

Traffic Detection Concept



Stationary Smart Roadside Infrastructure Sensors



V2X road side unit
(ITS-G5/802.11p)



2 LiDAR sensors
(128 vertical layers)



2 Camera sensors
(4K resolution)



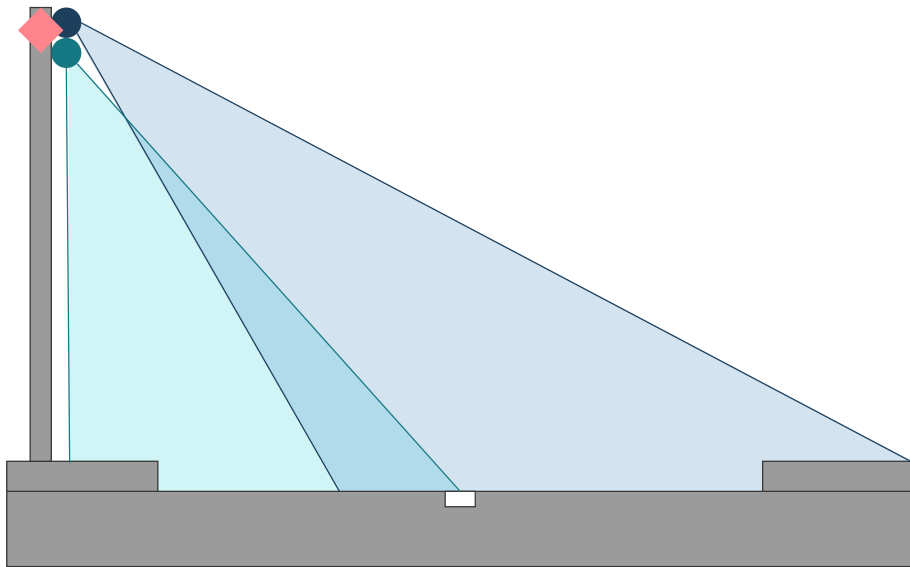
Sensor data processing unit



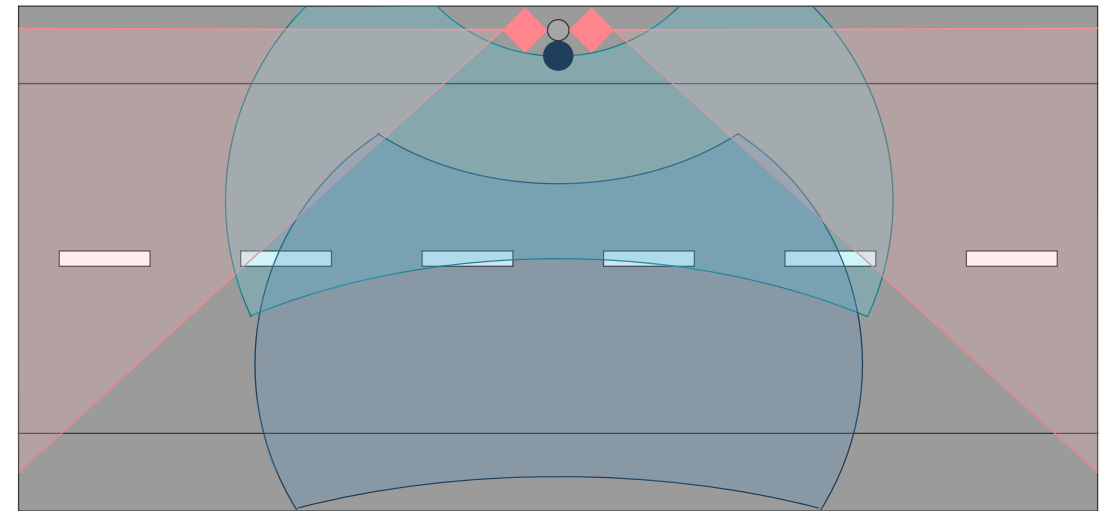
Multiband antenna
(GNSS/Wi-Fi/4G/5G)

Sensors' Fields of View for Each RSU

Side view



Top view*



● LiDAR 1

● LiDAR 2

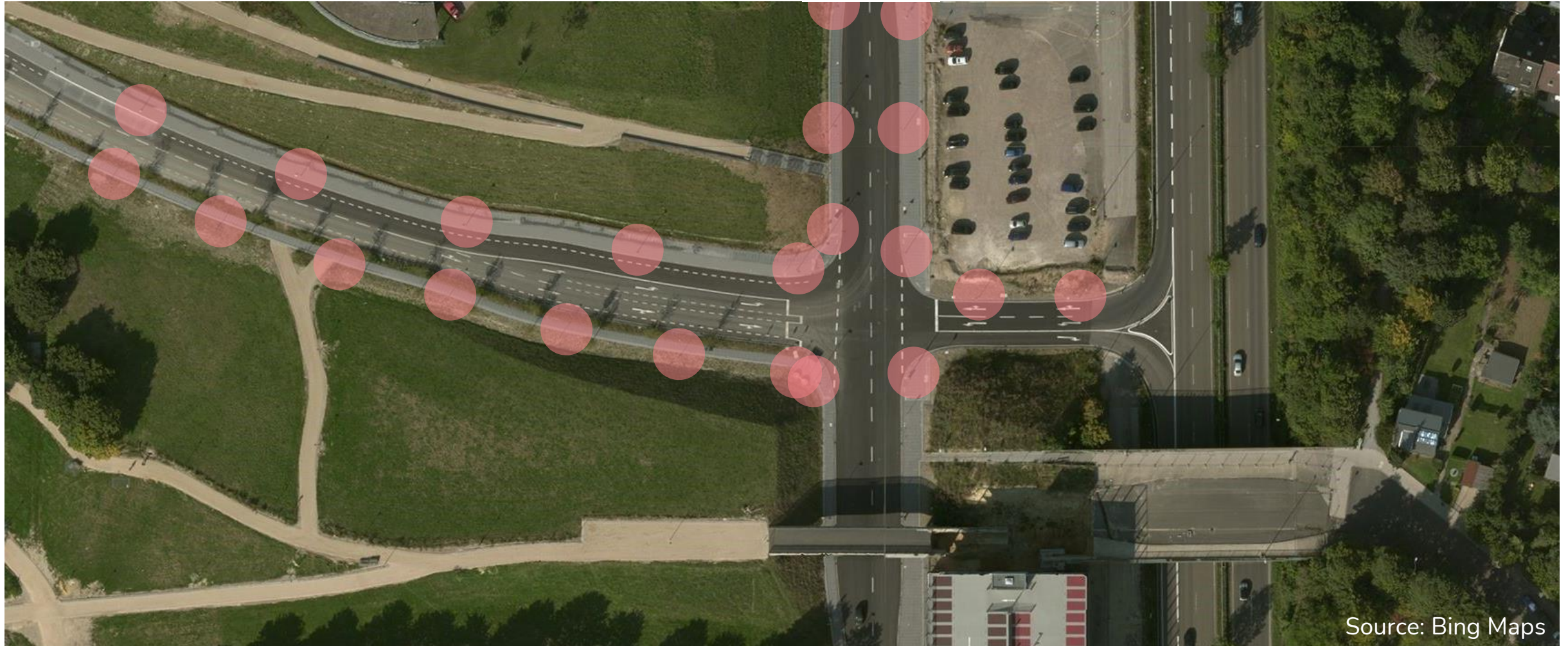
◆ Camera 1

◆ Camera 2

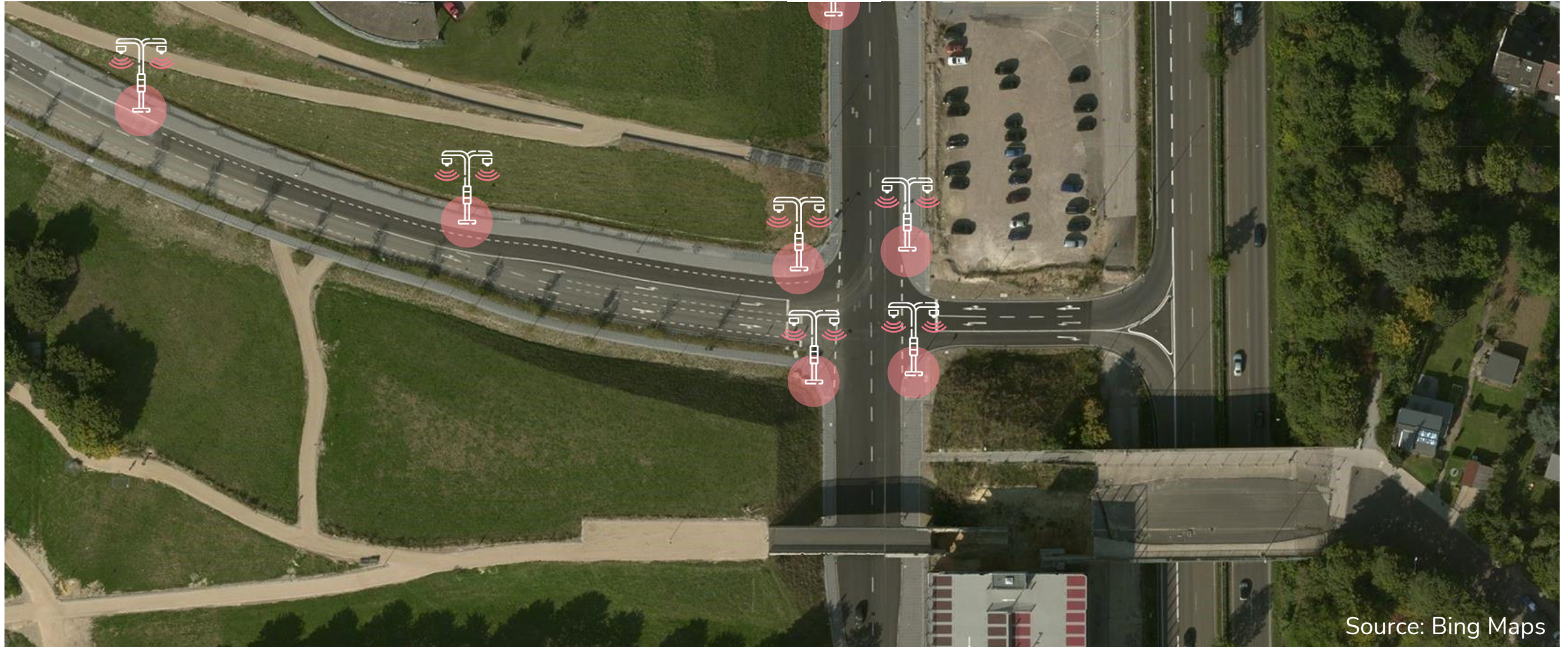
***Scales shown are not true to reality!**





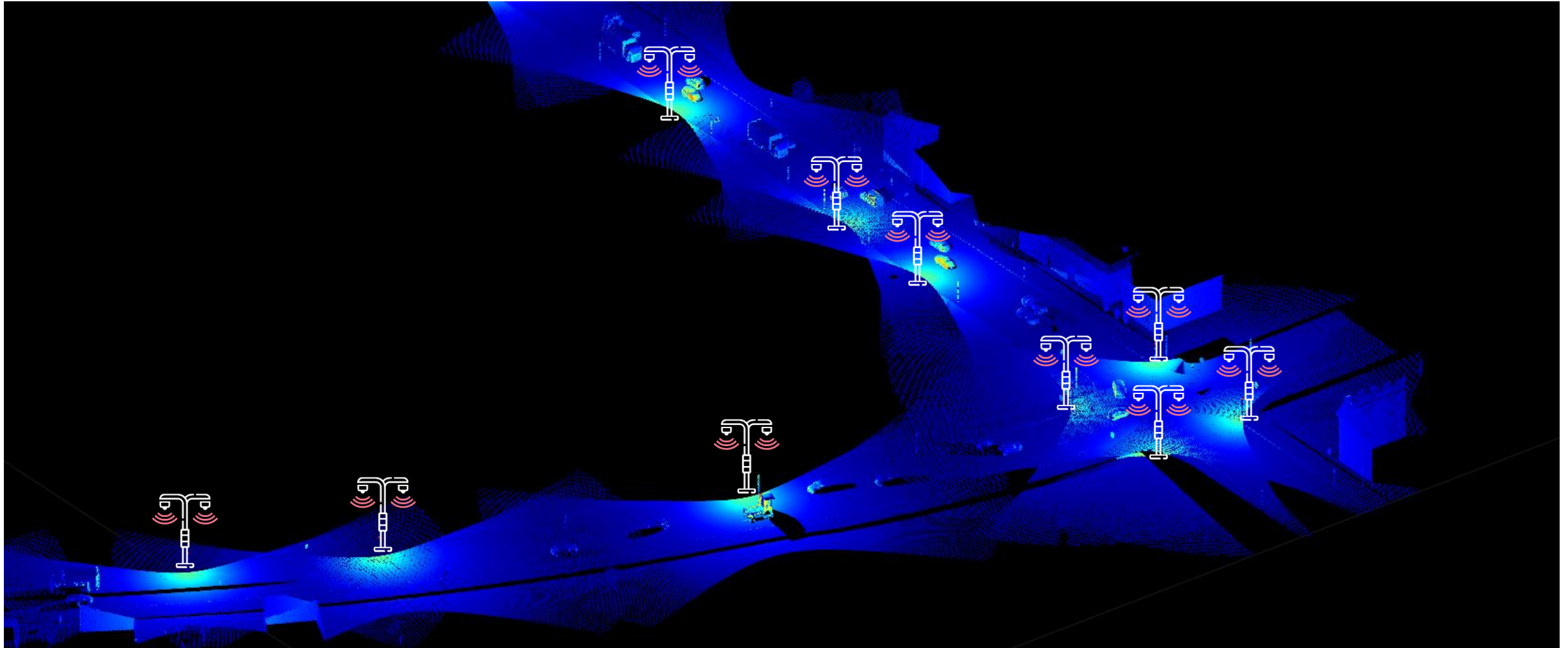


Source: Bing Maps



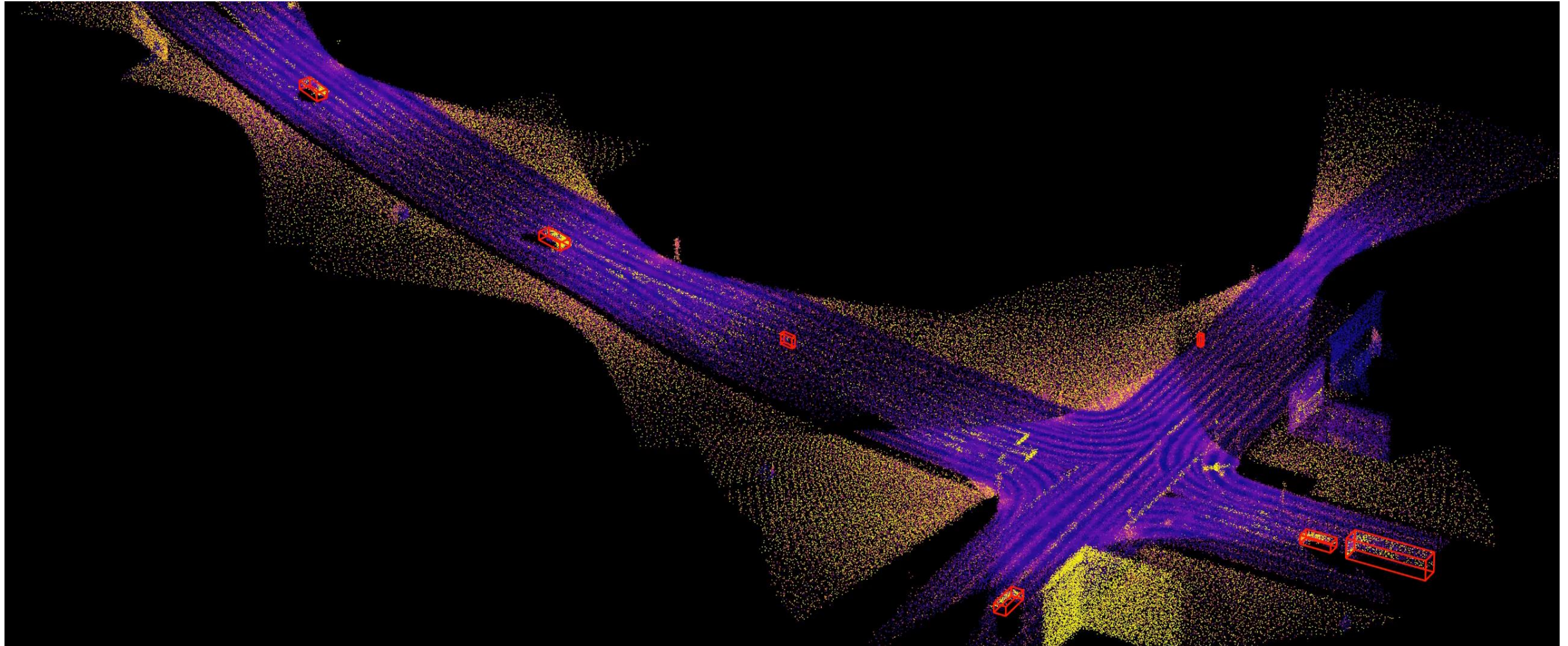
Source: Bing Maps

Global Fused LiDARs' Fields of View



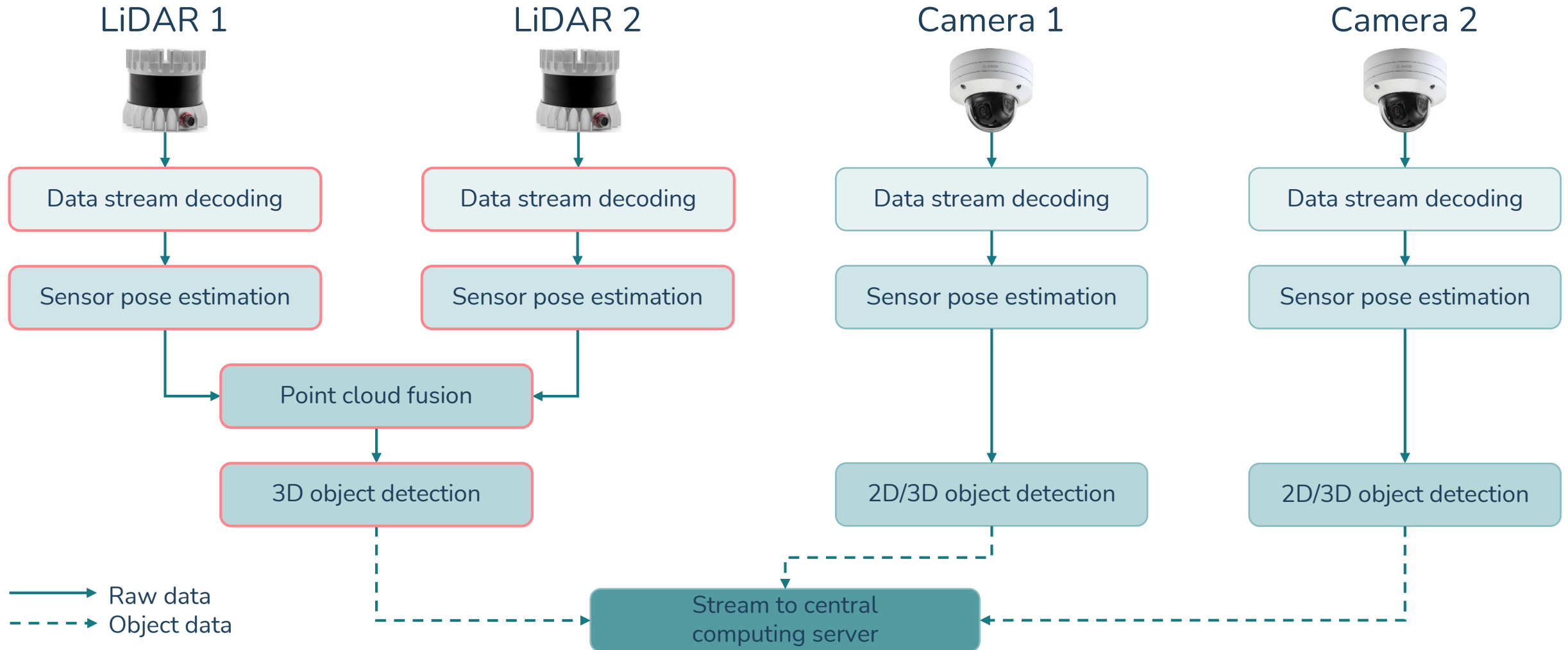
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Global Fused LiDARs' Fields of View

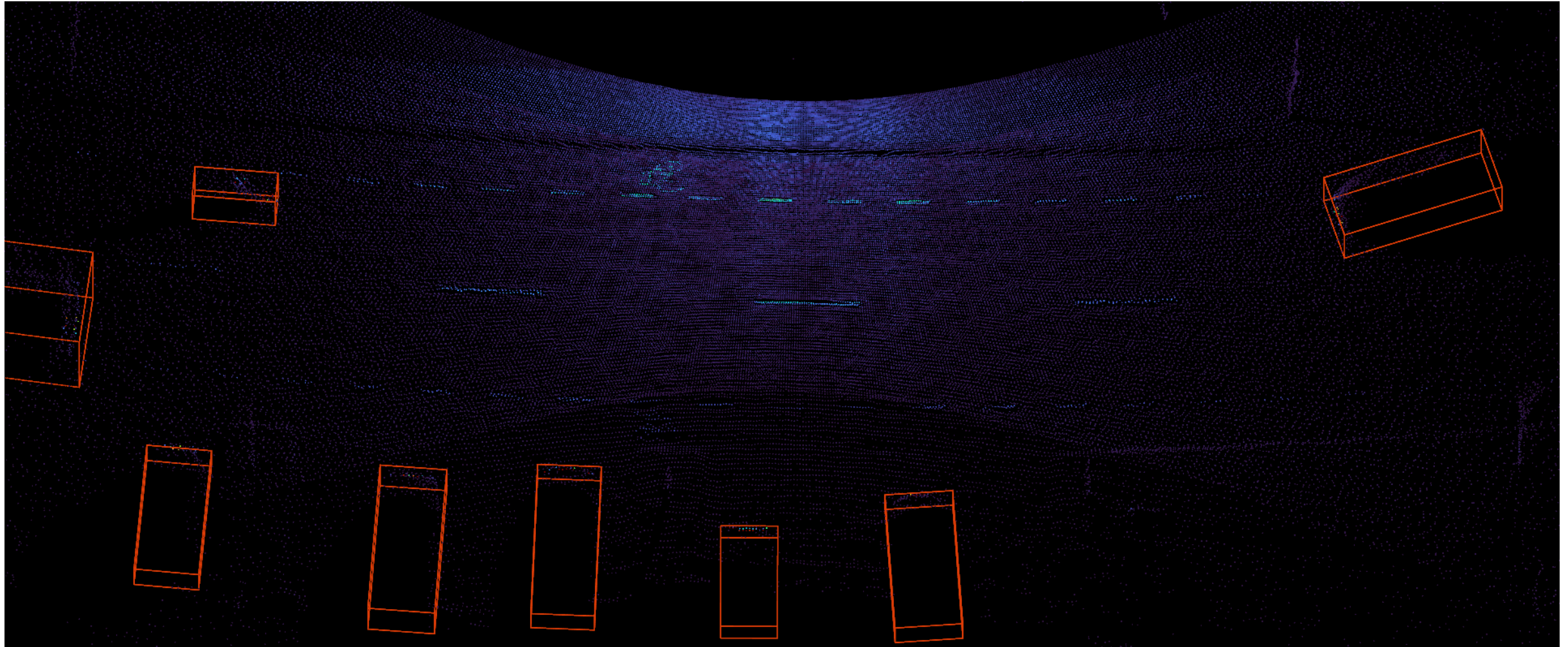


Corridor for new Mobility Aachen – Düsseldorf – Test Field Setup for the Development and Testing of Automated Mobility

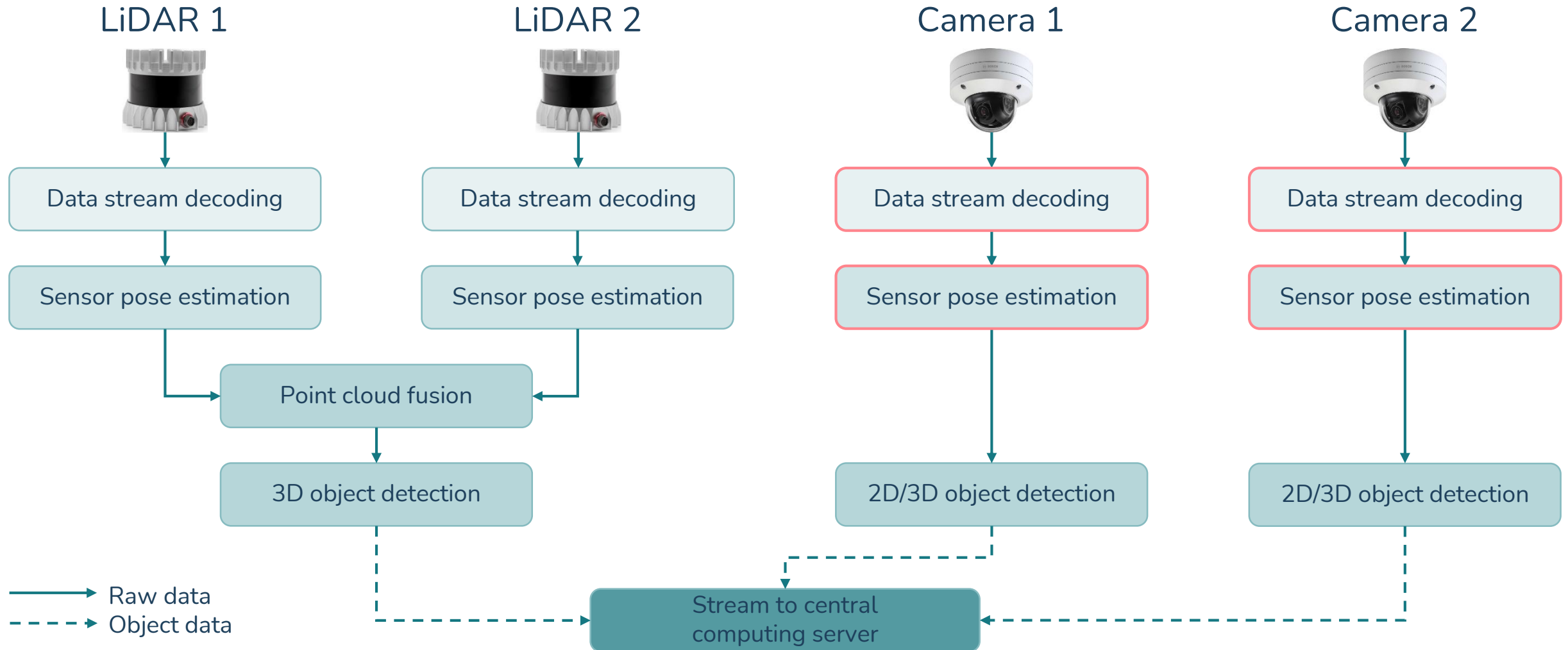
Data Processing Pipeline for Each Road Side Unit

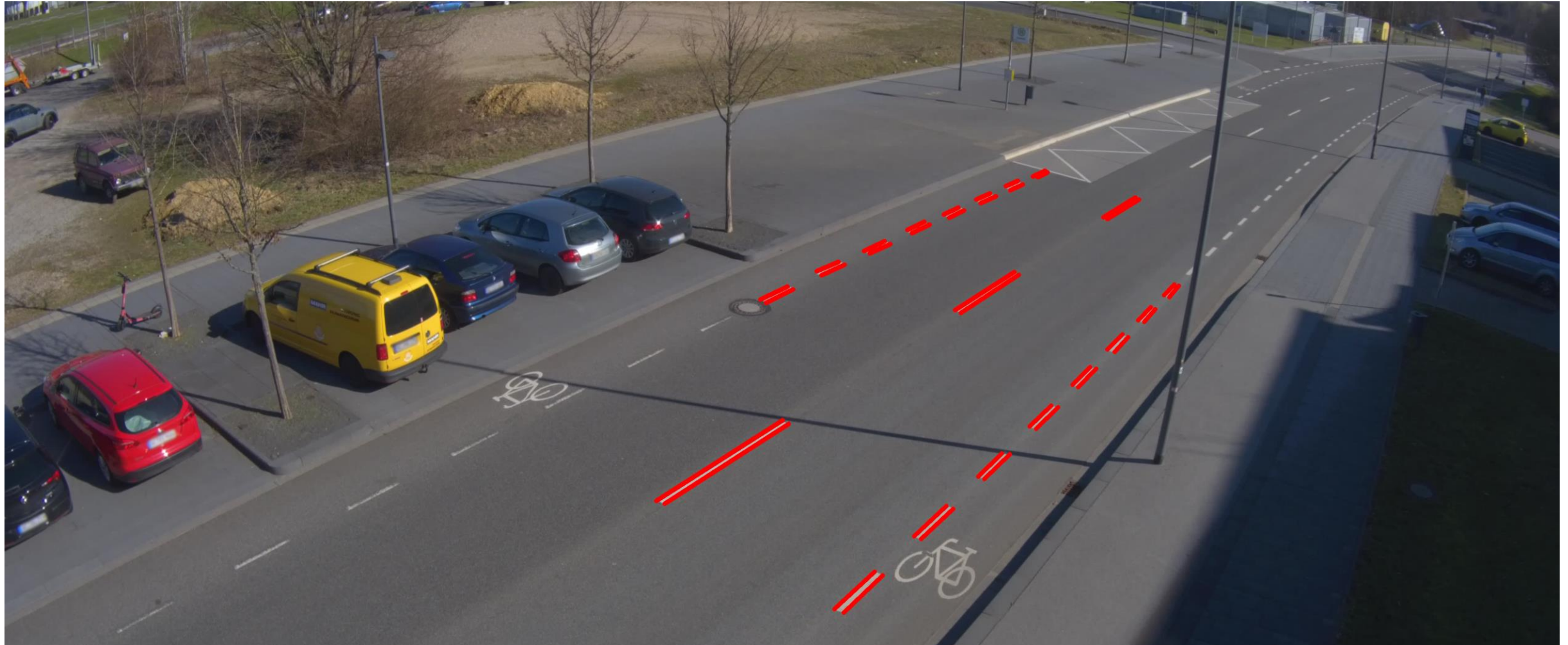


LiDAR Point Cloud Fusion for Each Road Side Unit

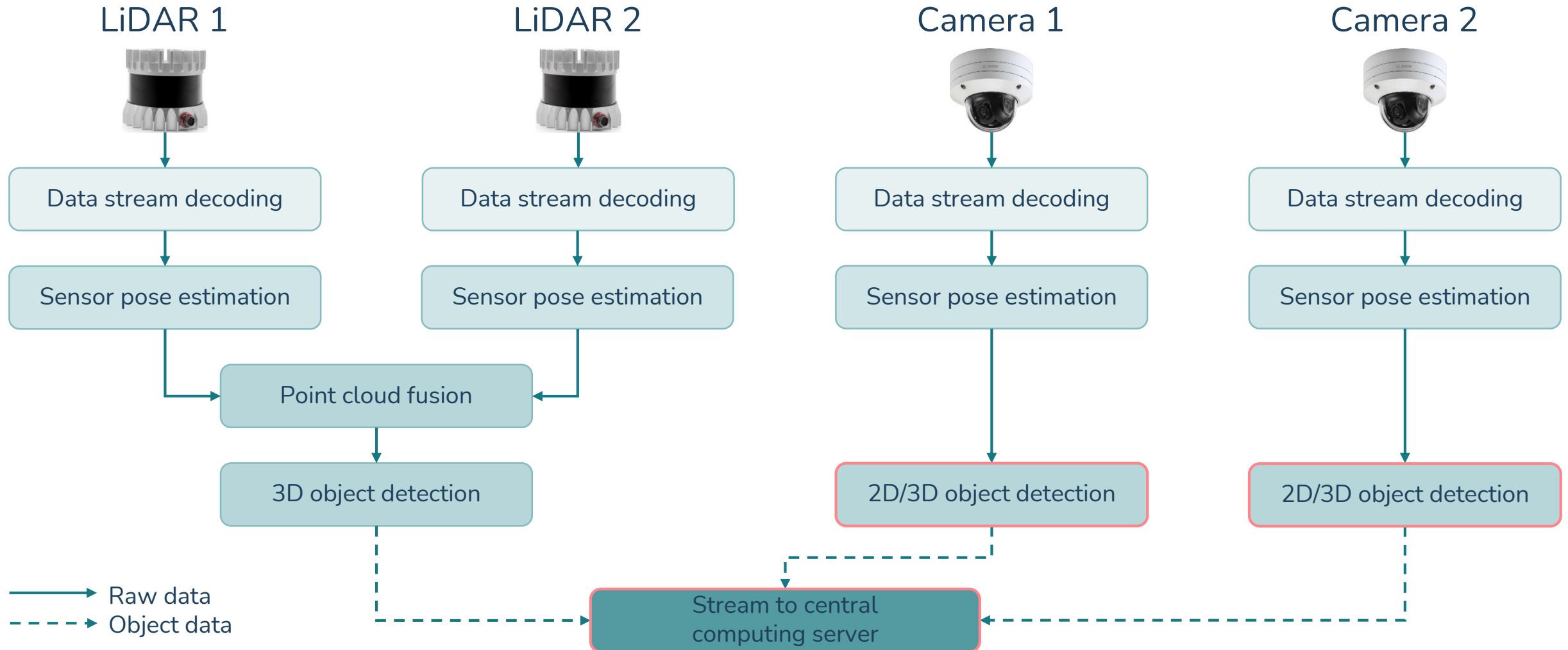


Data Processing Pipeline for Each Road Side Unit





Data Processing Pipeline for Each Road Side Unit



Object Data Format

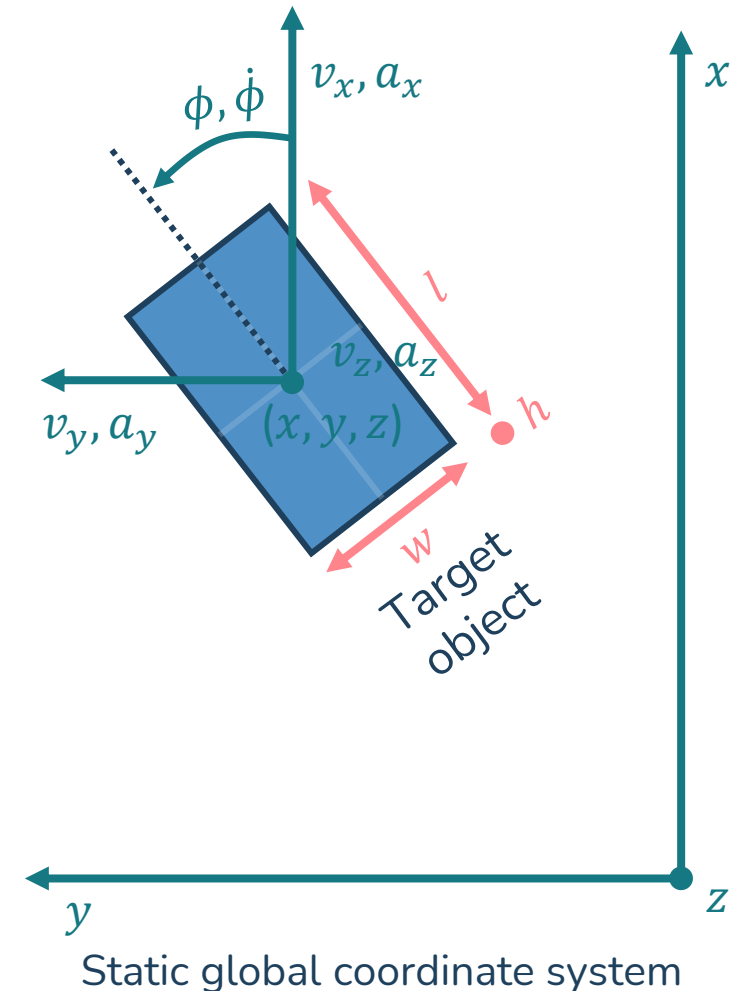


$$\begin{aligned} \mathbf{O} &= (\mathbf{O}_1 \ \mathbf{O}_2 \ \dots \ \mathbf{O}_N)^T && \text{(object list)} \\ \mathbf{O}_i &= (\hat{\mathbf{x}} \ \mathbf{P} \ \mathbf{d} \ \mathbf{d}_{\sigma^2} \ p(\exists \mathbf{x}) \ \mathbf{c})^T && \text{(complete object)} \\ \hat{\mathbf{x}} &= (x \ y \ z \ v_x \ v_y \ v_z \ a_x \ a_y \ a_z \ \phi \ \dot{\phi})^T && \text{(estimated state)} \end{aligned}$$

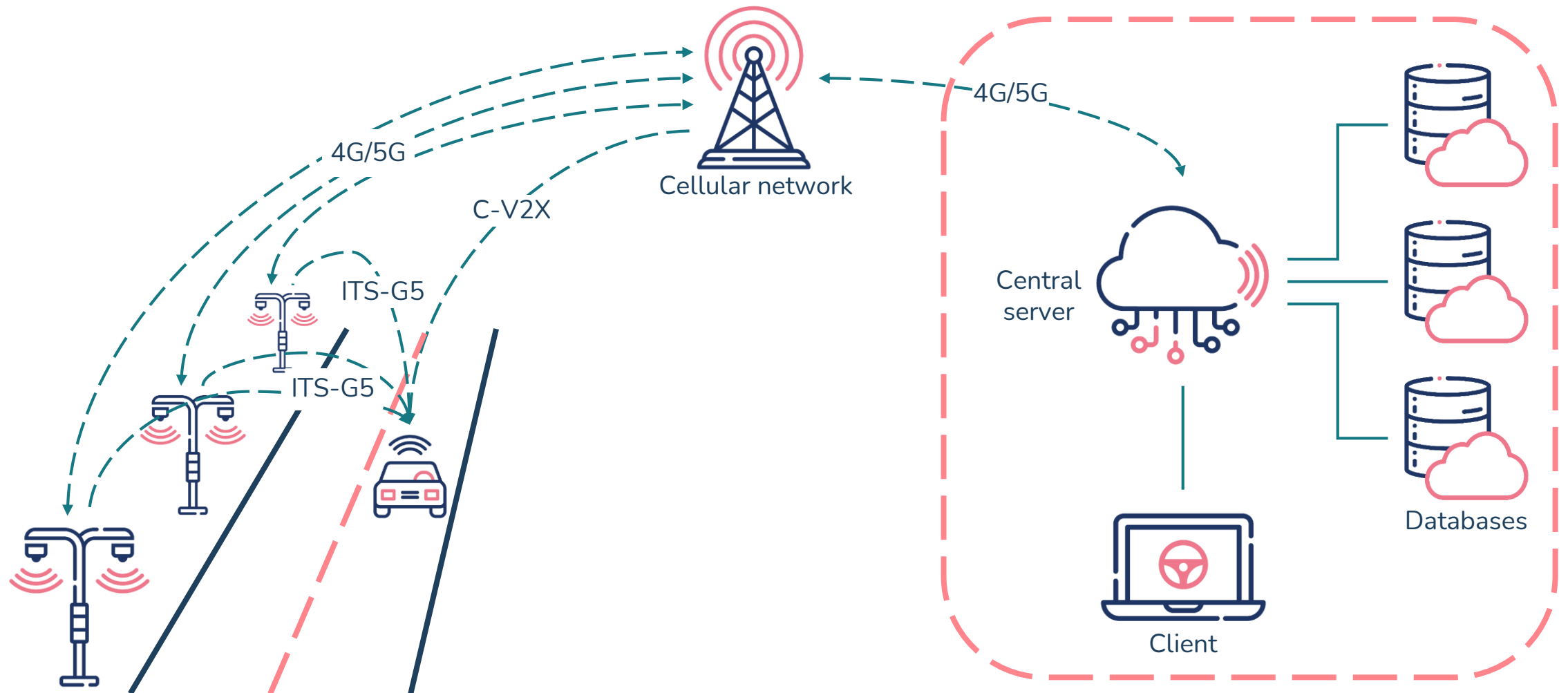
with

$$\mathbf{P} = \text{cov}(\hat{\mathbf{x}}_{err}, \hat{\mathbf{x}}_{err}) \quad \text{(uncertainty of state; as an estimate of its error covariance matrix)}$$

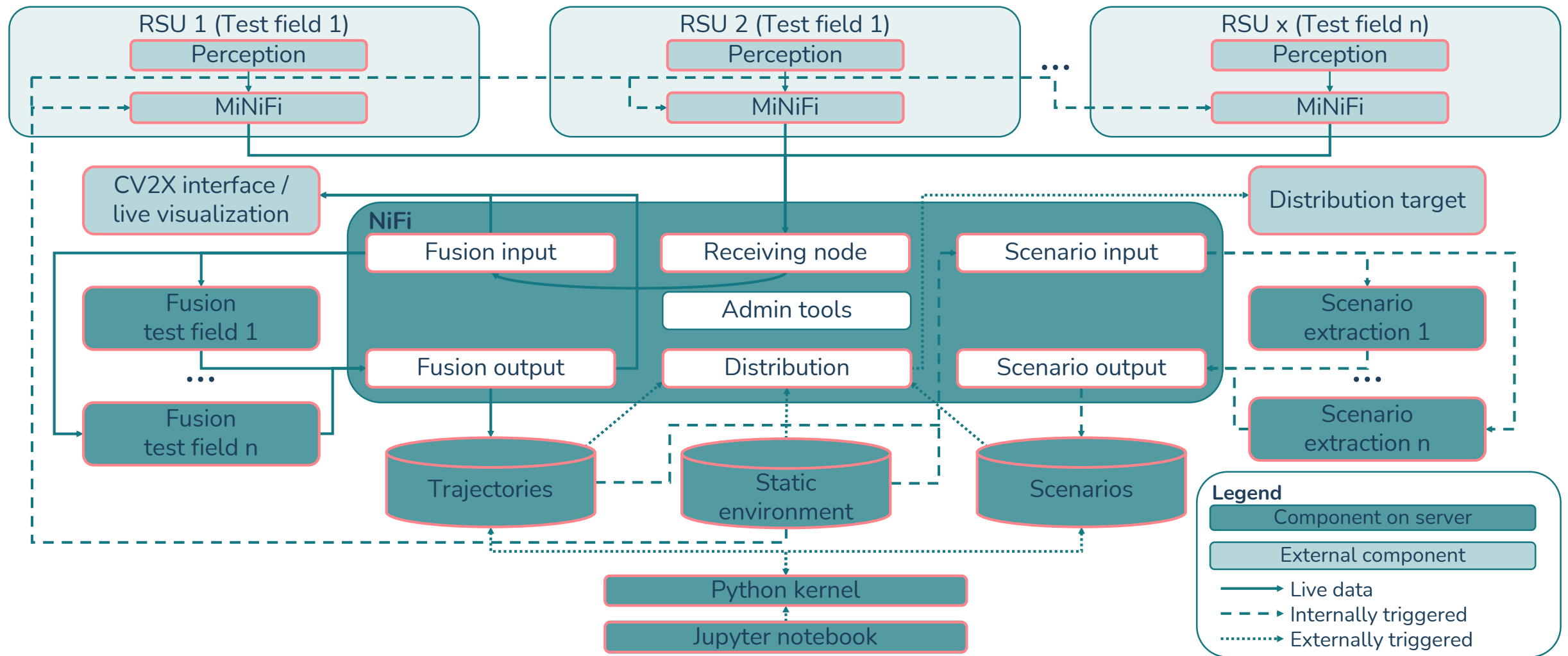
x, y, z	(position)
v_x, v_y, v_z	(velocity)
a_x, a_y, a_z	(acceleration)
$\phi, \dot{\phi}$	(heading or yaw angle and its rate)
$\mathbf{d} = (l, w, h)^T$	(dimensions / sizes)
$\mathbf{d}_{\sigma^2} = \text{var}(\mathbf{d})$	(variances of dimension)
$p(\exists \mathbf{x})$	(existence probability scalar)
\mathbf{c}	(classification vector: car, truck, ...)



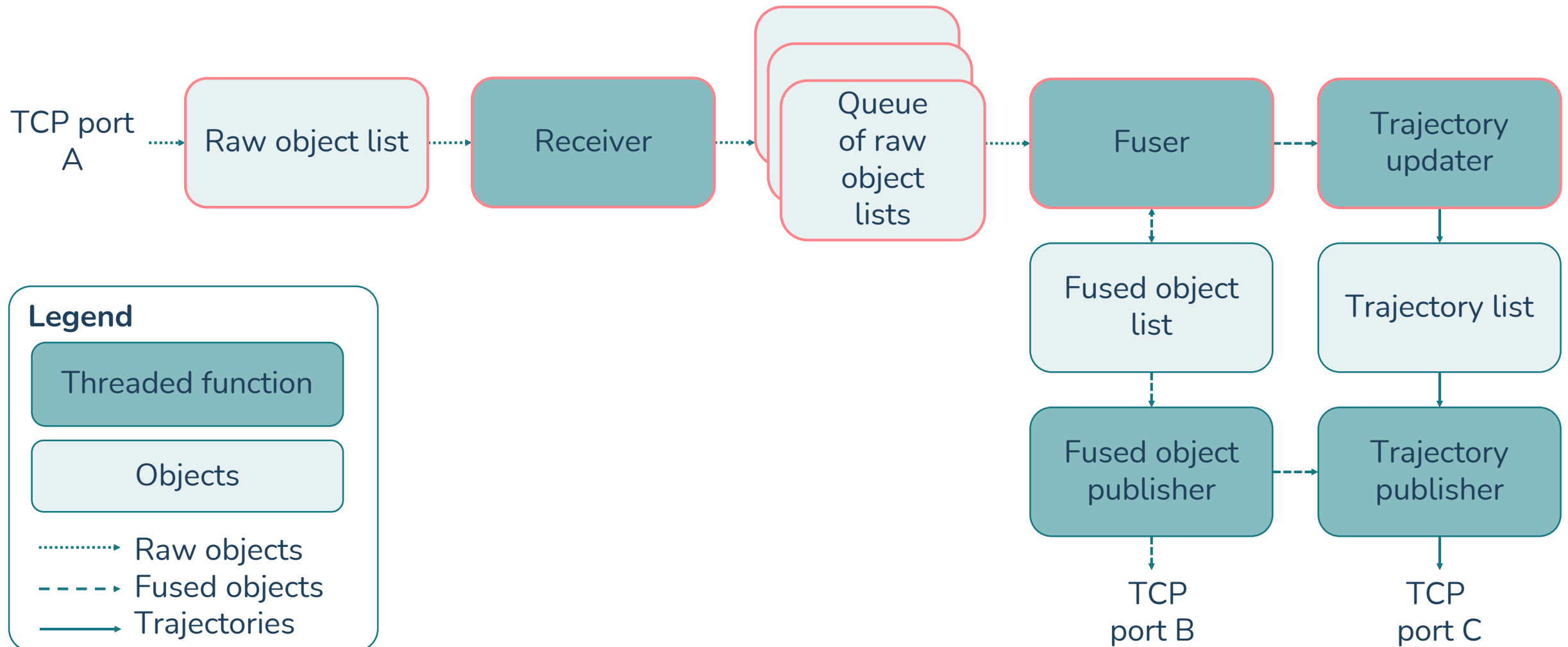
Traffic Detection Concept



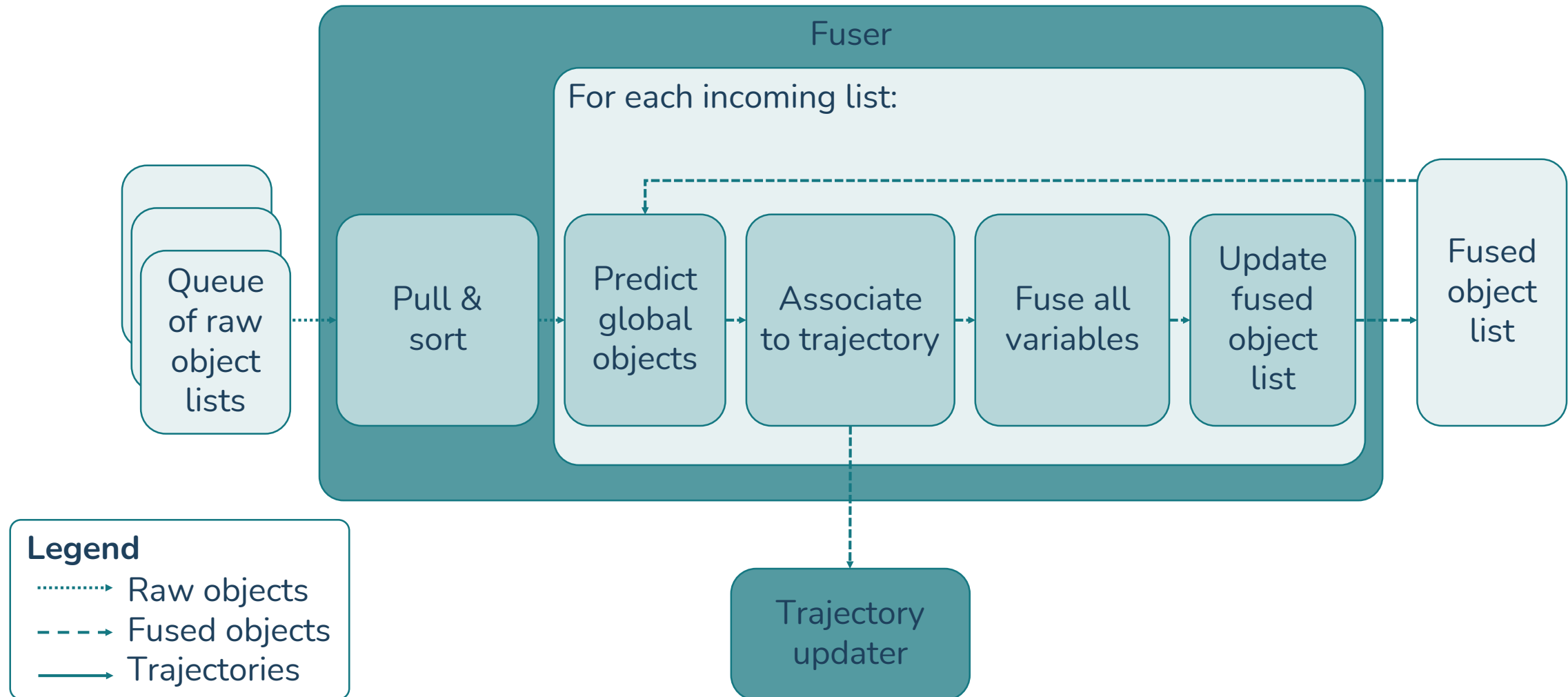
Data Management Concept



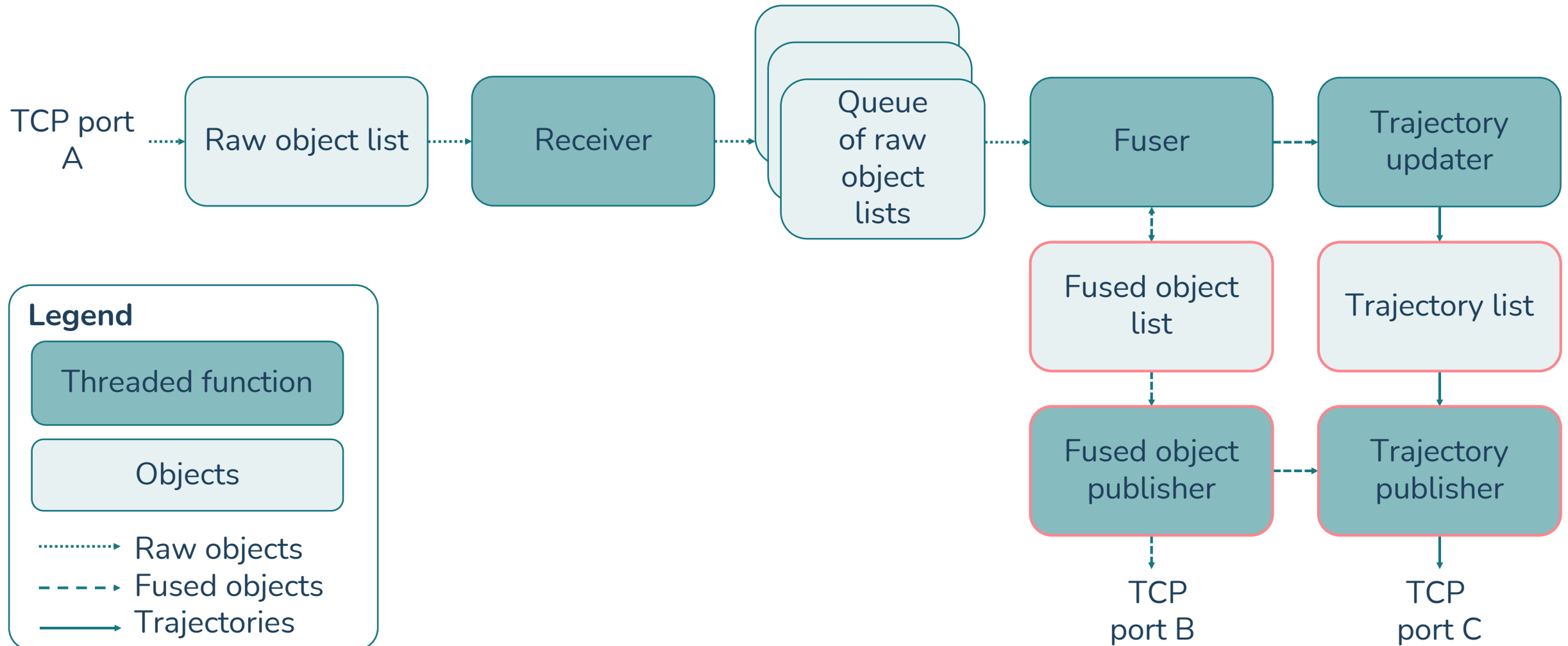
Data Processing Pipeline of Fusion Function



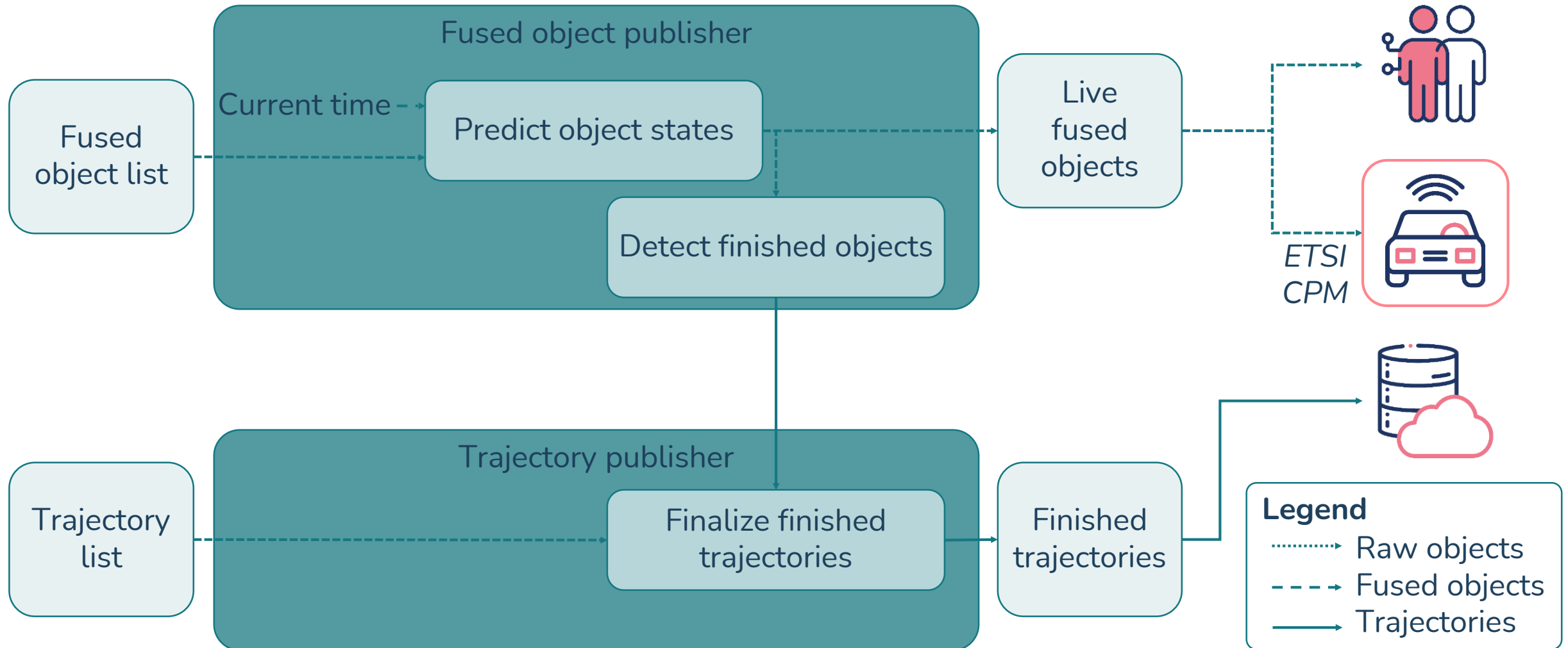
Data Processing Pipeline of Fusion Function



Data Processing Pipeline of Fusion Function

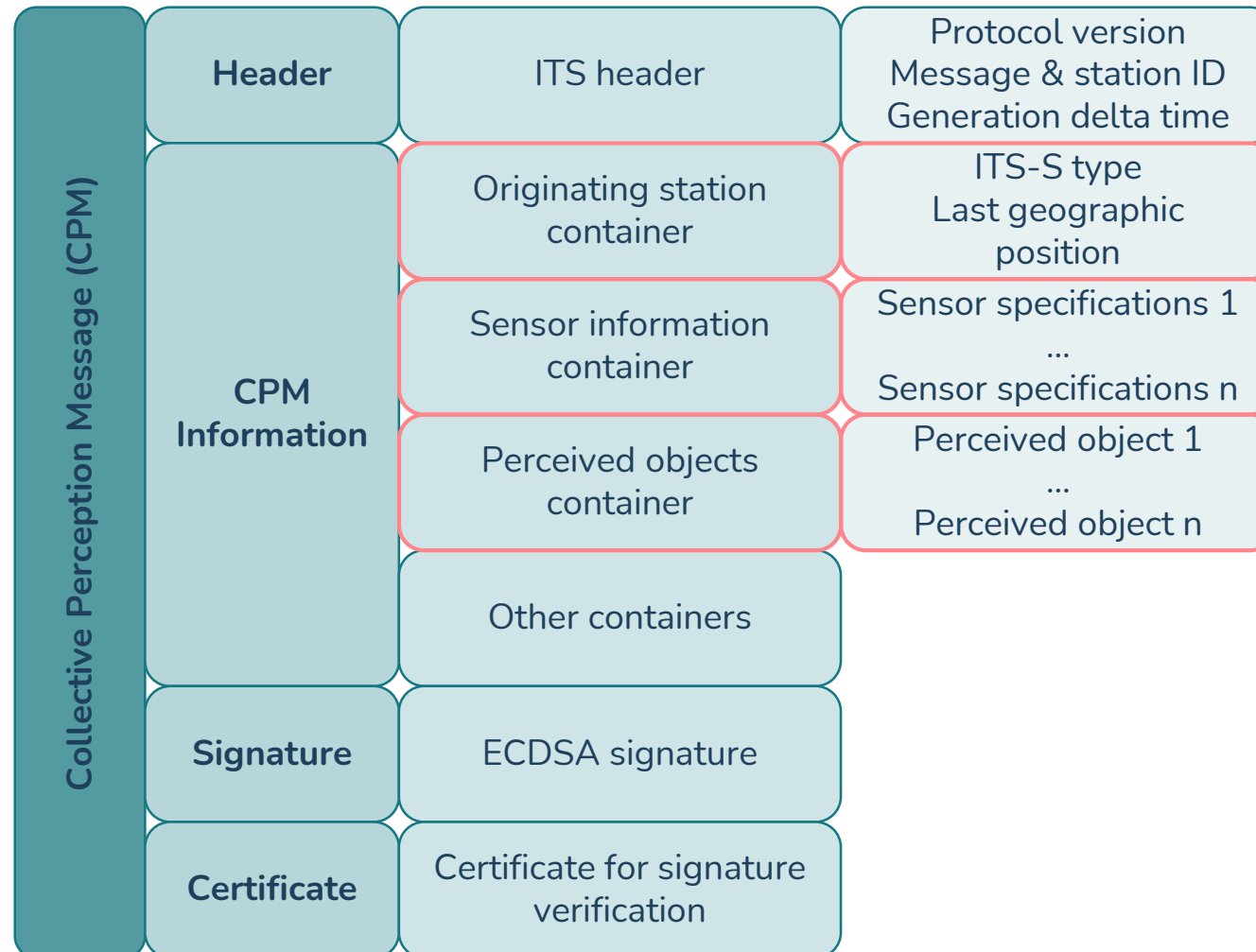


Data Processing Pipeline of Fusion Function

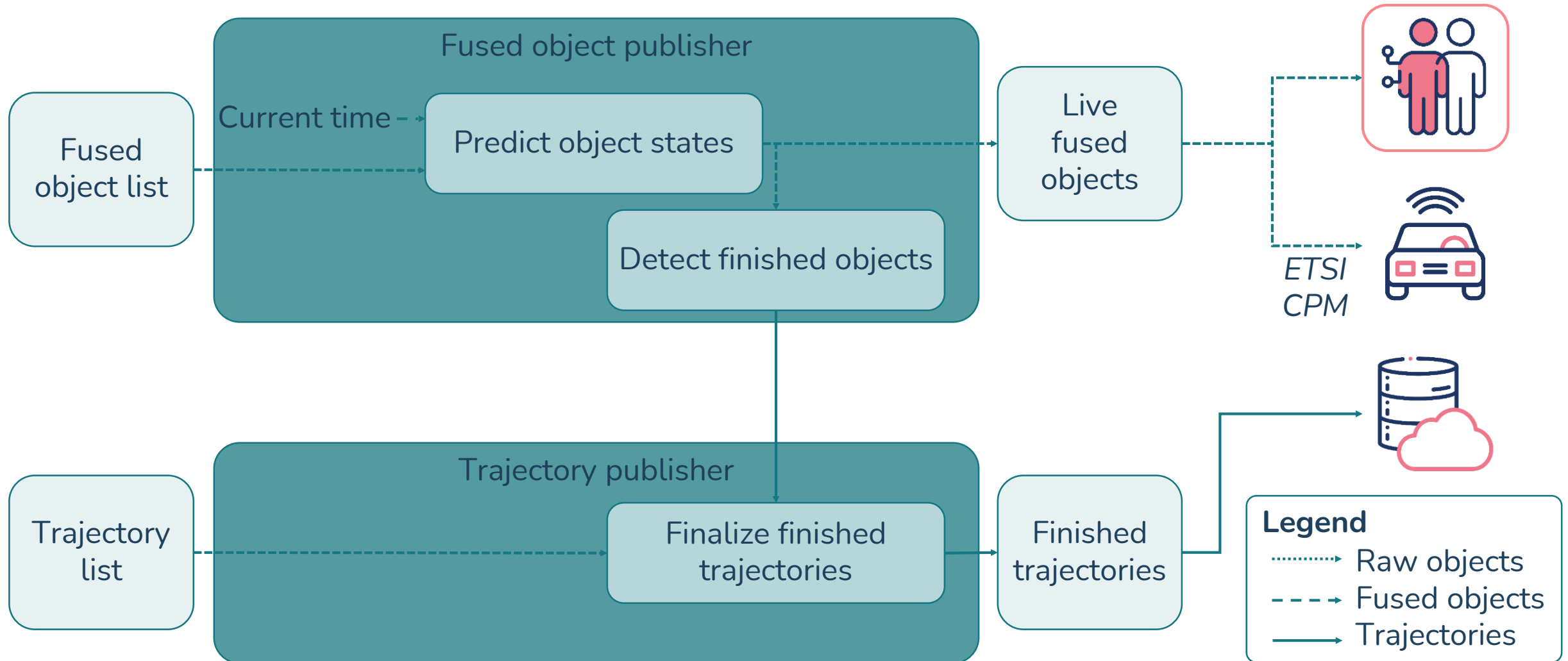


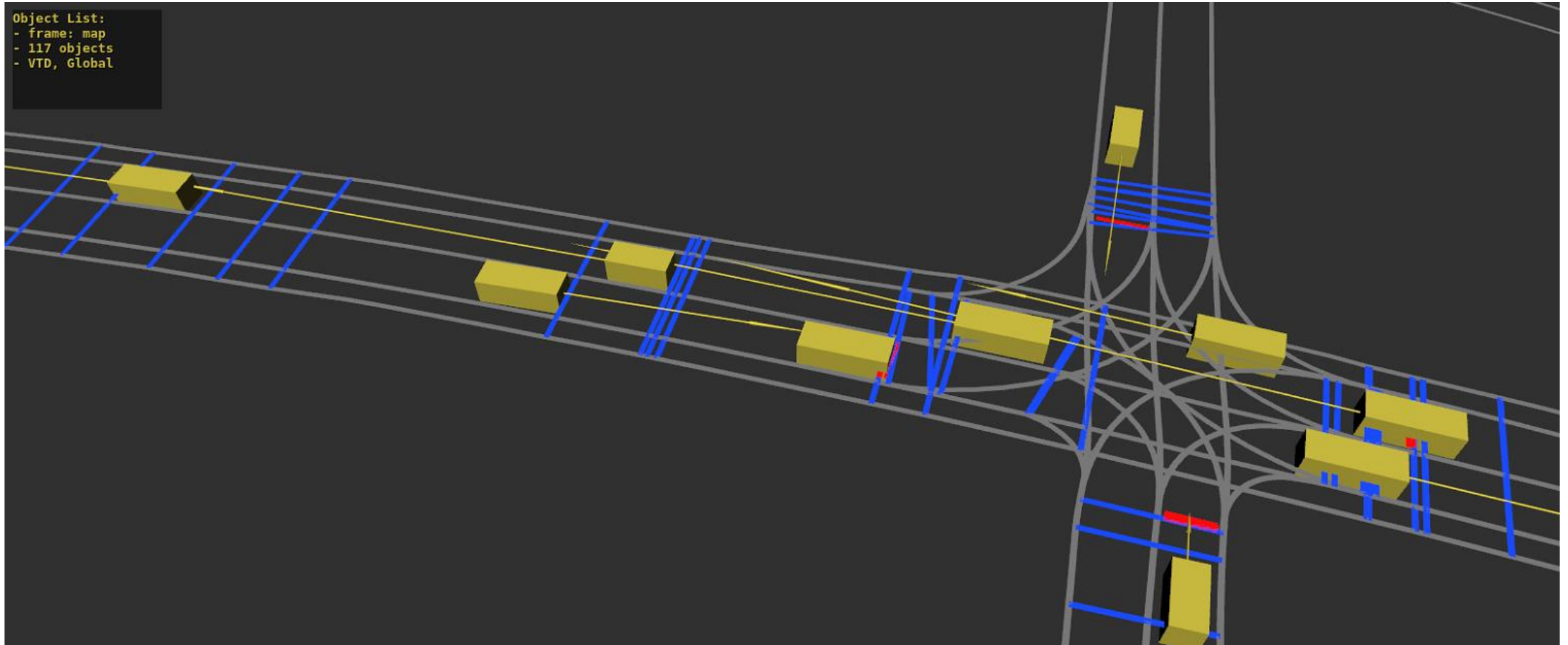
European Telecommunications Standards Institute (ETSI)

Collective Perception Message (CPM)



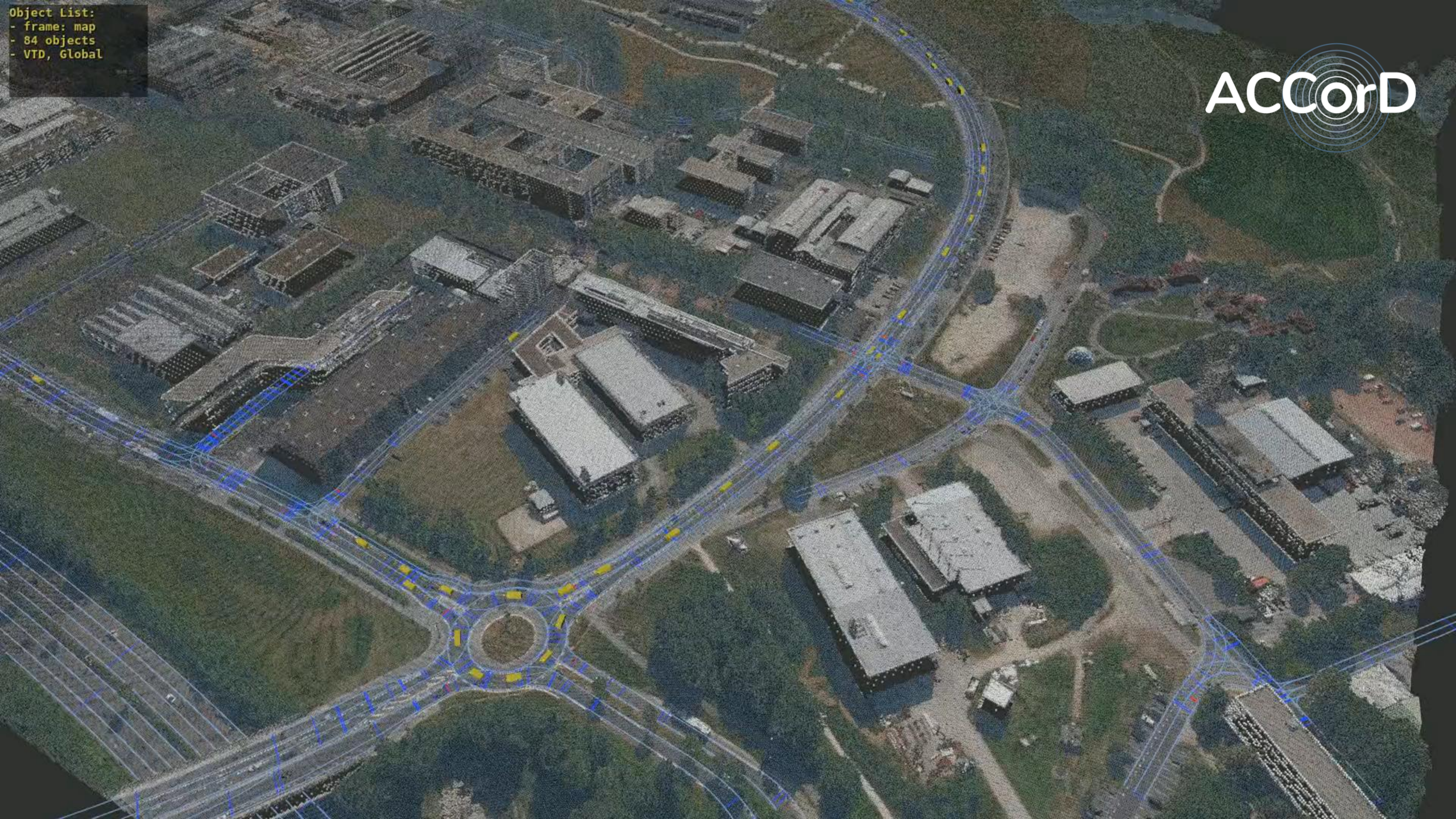
Data Processing Pipeline of Fusion Function





Object List:
- frame: map
- 84 objects
- VTD, Global

ACCord





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