HIPERT

HAURA SOLUTION

Micaela Verucchi
micaela.verucchi@hipert.it

TYPICAL INCIDENTS OF AUTONOMOUS VEHICLES AND ADAS

When perception and decision-making fail

1. **REAR-END COLLISIONS (~50%)**
   a. The most frequent type of crash in AV testing
   b. Often caused by sudden or "phantom" braking (false positives of objects or pedestrians)
   c. Gap: faulty perception

2. **UNPREDICTABLE ACTIONS BY OTHER ROAD USERS (~30%)**
   a. Vehicles cutting in, suden pedestrians or cyclists, abnormal maneuvers
   b. AVs often fail to anticipate or interpret others' intentions
   c. Gap: behavior prediction and interaction with other road users

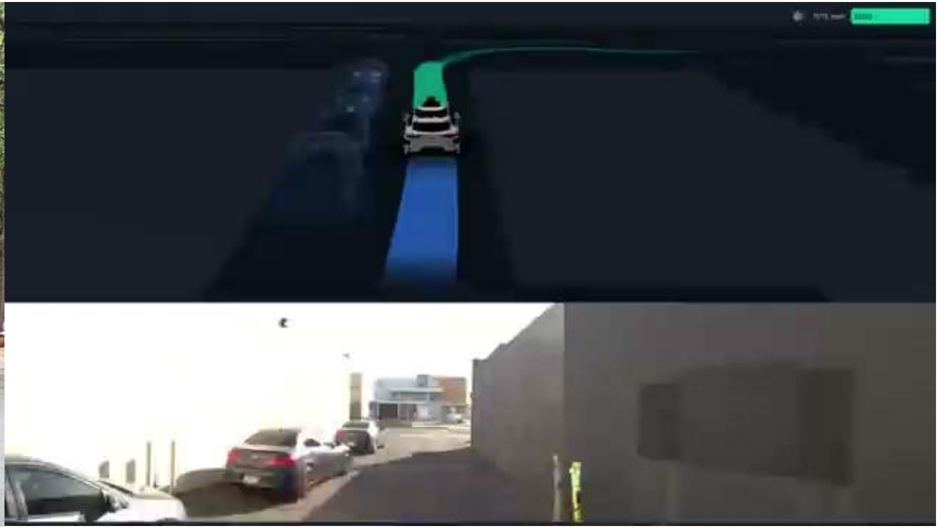
3. **PERCEPTION ERRORS (10–15%)**
   a. Undetected objects (false negatives) or misidentified objects (false positives)
   b. Lead to unnecessary braking, sudden steering, or missed stops
   c. Gap: sensor reliability under real-world conditions

4. **PLANNING AND CONTROL ERRORS (5–10%)**
   a. Incorrect trajectory choices, excessive caution or delayed reactions
   b. Common during maneuvers with poor visibility
   c. Gap: lack of extended context and infrastructural information

Source: *Cummings & Bauchwitz, "Identifying Research Gaps through Self-Driving Car Data Analysis", 2024.*

LIMITS OF AUTONOMOUS PERCEPTION

Infrastructural



"I think we could have had self driving cars much more quickly
if we had made offboard changes to our infrastructure,
rather than imagining that everything would be done onboard."

Rodney Brooks, former director of MIT CSAIL

SMART CITIES

How to create value, share it and exploit it

WHAT WE WANT

- Traffic Management
- Air Pollution
- Open Data
- Smart Environment
- Smart Street Lights
- Waste Management
- Electric Vehicle Charging
- Smart Parking
- Smart Energy
- Public Safety
- Internet of Things
- Connected vehicles
- Delivery bots
- Autonomous vehicles
- Bike & e-scooter sharing
- Smart public transport

SMART CITIES

How to create value, share it and exploit it

WHAT WE NEED

1. **Infrastructure**
   a. Edge & cloud computing resources
   b. Sensors
   c. Robust, capable and reliable telecommunication system
2. **Data analysis**
   a. Several models that elaborate all the needed information
3. **Real-Time capabilities**
4. **Governance & Standards**
   a. Privacy
   b. Security
   c. Laws
   d. Interoperability
5. **Scalable design**

SMART CITIES

How to create value, share it and exploit it

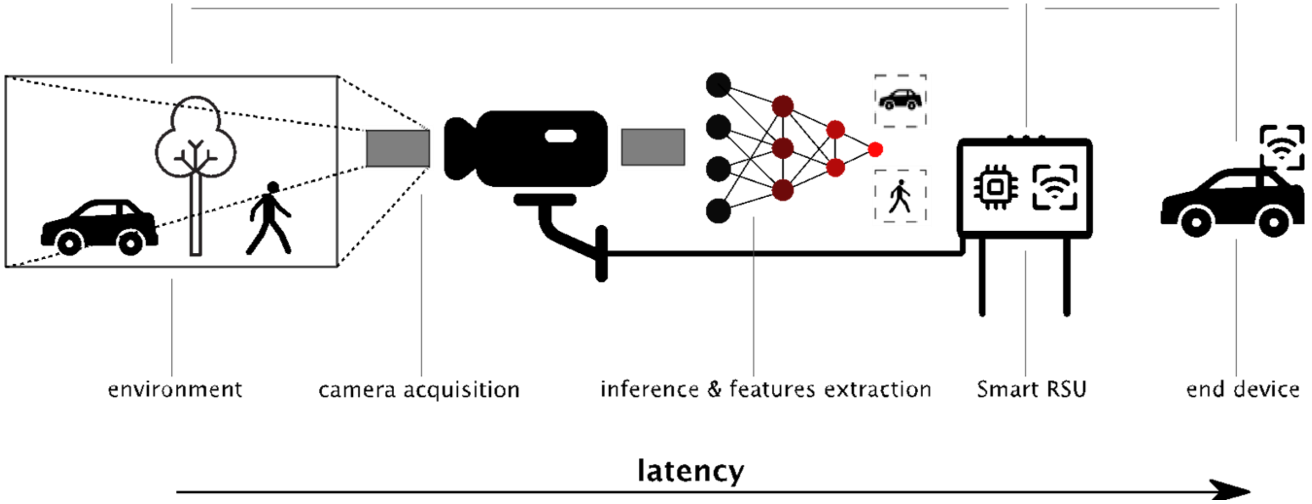
WHAT WE DID

HIPERT

UNIMORE
UNIVERSITÀ DEGLI STUDI DI MODENA E REGGIO EMILIA

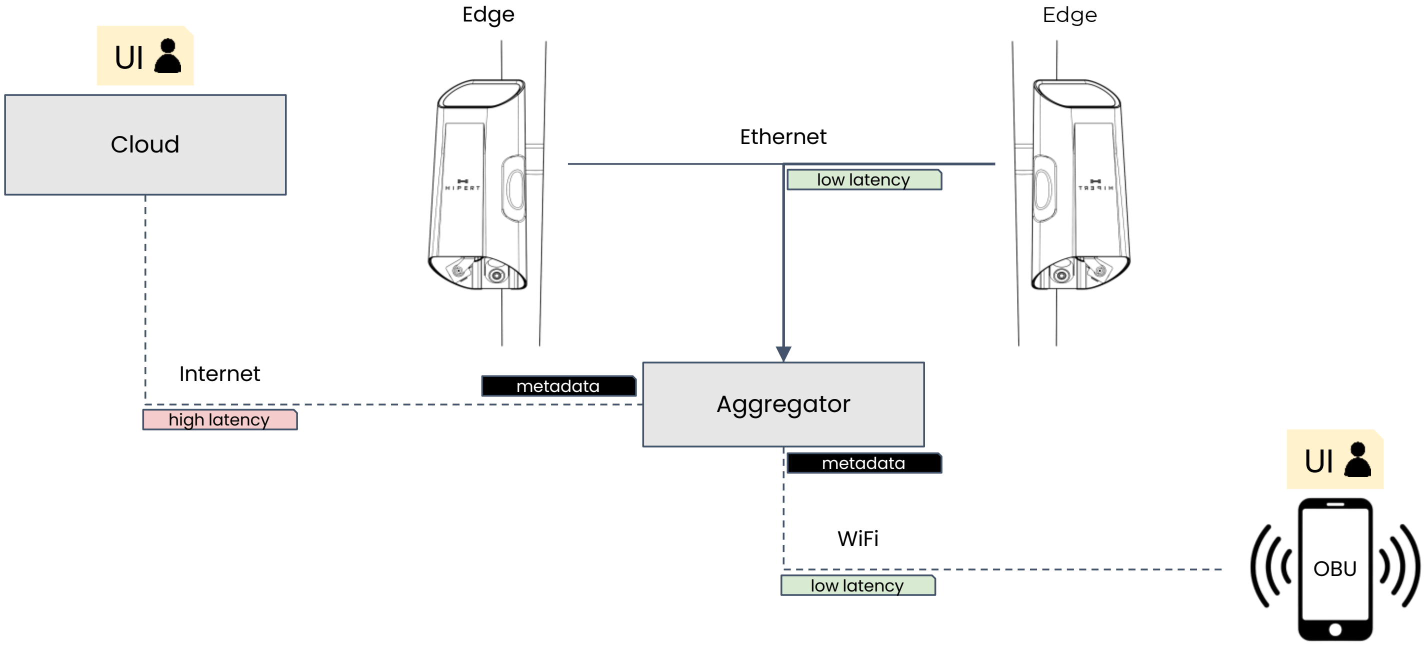
THE CHALLENGE: HARD REAL TIME

GOAL: end to end latency < 100 ms



HAURA ECOSYSTEM

Not only a device, but an infrastructure



HAURA EDGE

Smart Road Side Unit for Edge AI

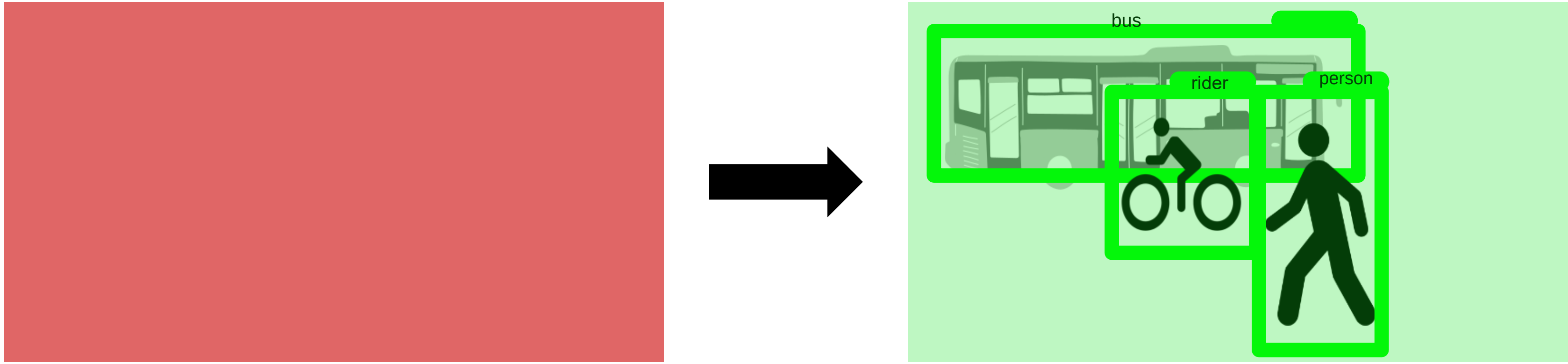
HW

- computing platform
- 2x WDR RGB cameras

SW

- real time detection of road users
- single camera tracking of the detected entities
- precise geolocalization
- data anonymization

DATA ANONYMIZATION

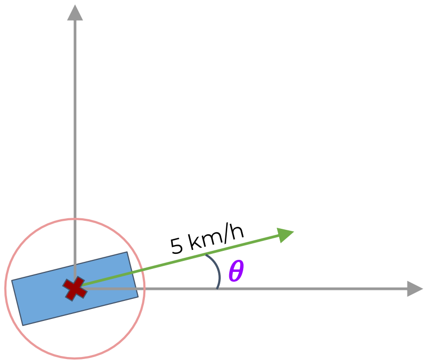


After the elaboration, the frame is destroyed

HAURA AGGREGATOR

THE AGGREGATOR IS RESPONSIBLE FOR

1. collect information from different sources
2. multi camera & multi device tracking and forecasting
3. send the metadata outside
4. collision check between different categories:
   - person - vehicle
   - vehicle - vehicle



METADATA

object category
latitude, longitude, altitude + position confidence
speed + speed confidence
heading + heading confidence
tracking ID

TYPICAL INCIDENTS OF AUTONOMOUS VEHICLES AND ADAS

When perception and decision-making fail

1. **REAR-END COLLISIONS (~50%)**

    a. HAura integrates infrastructural sensors and V2X connectivity to extend the vehicle's field of view, providing early warnings of rapidly approaching vehicles or sudden traffic jams.

2. **UNPREDICTABLE ACTIONS BY OTHER ROAD USERS (~30%)**

    a. HAura can help anticipate other users' maneuvers (turns, crossings, braking), improving behavior prediction and priority management.

3. **PERCEPTION ERRORS (10–15%)**

    a. HAura provides sensory redundancy and enhanced vision through infrastructure, compensating for onboard sensor limitations in challenging conditions.

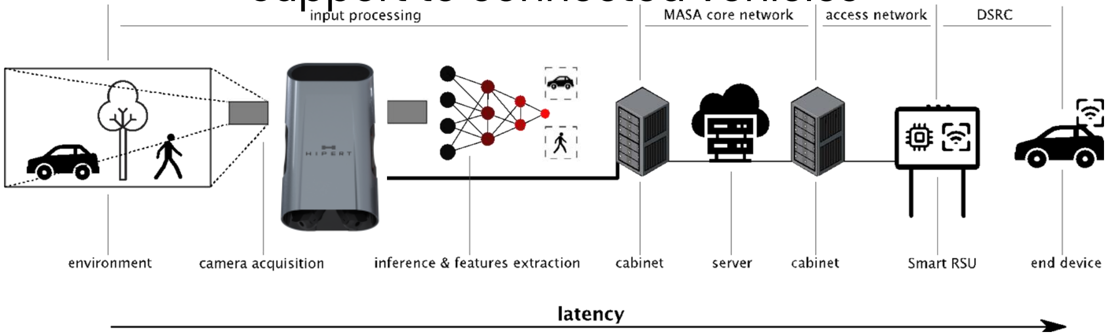
4. **PLANNING AND CONTROL ERRORS (5–10%)**

    a. HAura enriches situational context, enabling safer and more coordinated decision-making.

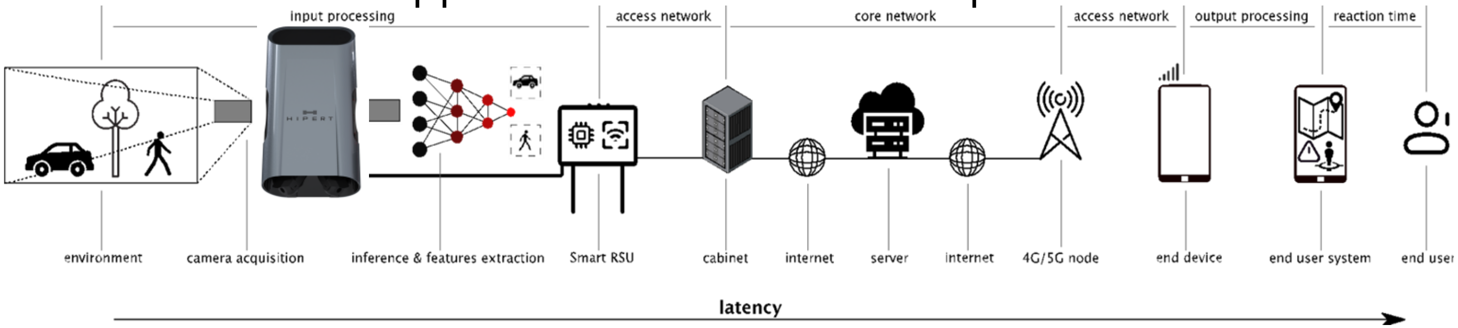
Source: *Cummings & Bauchwitz, "Identifying Research Gaps through Self-Driving Car Data Analysis", 2024.*

CURRENT MASA INFRASTRUCTURE

Support to connected vehicles



Support to citizens and municipalities



INTEGRATION WITH DASHBOARDS

HAura can communicate its elaborated metadata via MQTT JSON messages, enabling integration with external dashboards such as the Snap4City platform for monitoring areas, traffic, parking occupation, and other urban indicators.

Real-world event → HAura processing → (JSON anonym message) → MQTT Broker → (JSON anonym message) → SNAP4City dashboard

REAL-WORLD DEMONSTRATION

Safe, Resilient Transport and Smart Mobility Services

Modena's Pilot

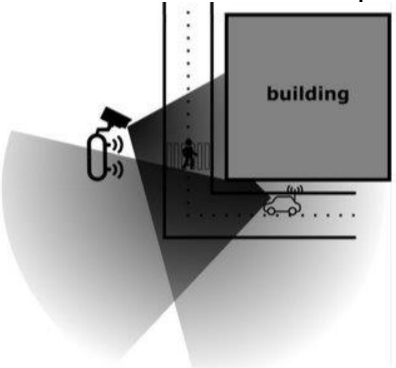
The **FRODDO** project aims to extend the Operational Design Domain (ODD) of autonomous vehicles through distributed perception, edge computing, and V2X cooperation in complex urban scenarios.

Hipert's objective: Improve the perception system of Connected and Autonomous Vehicles (CAVs) by leveraging the capabilities of intelligent infrastructure.

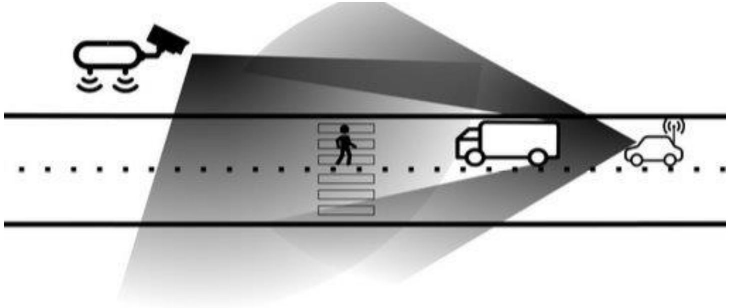
This project has received funding from the European Union's Horizon Europe research and innovation programme under grant agreement No. 101147819

Two Use Cases

- **Virtual mirror**
  a. Extends the —
  b. vehicle's field of view beyond the real line of sight, allowing it to "see around corners."
  c. Increases the ego vehicle's awareness of infrastructural blind spots.



- **Sight through**
  a. Demonstrates the importance of enhanced awareness provided by road infrastructure.
  b. Improves the ego vehicle's perception of other road users' blind spots.



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UC1: Smart City - Hard real-time requirements

Verses

MASA
Modena Automotive Smart Area

Verses

Hipert & INSAIT 1

UNIMORE 2

Road User
lat,lon,alt
vel
head
class
ID
timestamp

Parking
lat,lon,alt
occupation

Aegis Rider

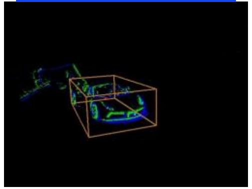
This project has received funding from the European Union's Horizon Europe research and innovation programme under grant agreement No. 101120726

UC1: Smart City - Soft real-time requirements

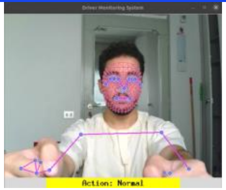
Verses → MASA Modena Automotive Smart Area

UCLM 3

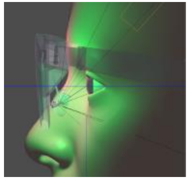
FRAUNHFOER 4



DFKI & UNIMORE 5



CSEM 6



Weapon
detected
confidence
3

6Dpose
trans, rot
class
4

DMS
status
eyes
mouth
5

Eye Gaze
left eye
right eye
6

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Smart City Expo

World Congress

2025 | Barcelona

READY. SAFETY. GO

THANK YOU

Micaela Verucchi
micaela.verucchi@hipert.it