ITS: Cooperative Situation Awareness

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ICS and their application, Montevideo, 2015

1. Motivation

2. Research

3. People

Motivation

Driving Car is never risk free

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Contextual information cannot be measured, must be inferred from sensors

Perception

Communication V2V

Communication V2I

Cooperation

They dramatically will change the way that we will design and will use vehicles and transport

A First Stage…

Cooperative ITS applications with the introduction V2V y V2I

Vehicles retrofitted with standard communication capabilities and internal and external perception sensors will be part of a particular vehicle functionality

A Second Stage…

Fully autonomous vehicles

Interaction with all existing road users

High-level understanding of the traffic scene

Information is a challenging task

Vulnerable User

All trips end and/or start with a walk

Recently, more bicyclist are using roads

Motorcycles, pedestrian and young people are the most vulnerables

In almost a half of fatalities…
were involved VU (CESVI)

Research

Situation awareness

Is the capacity of a vehicle to understand its surroundings analysing

Its own state

The state of other agents

Traffic and environmental conditions

Cooperative Situation awareness

Involves the sharing of information between local groups of vehicles to improve the understanding of the current scenario.

Multimodal perception

Complex scenario comprehension

Intention and dynamic models

Position Requirements

Accuracy and uncertainty depend on the task

Global (5m, 1-5s)

Street (1.5m, 1s)

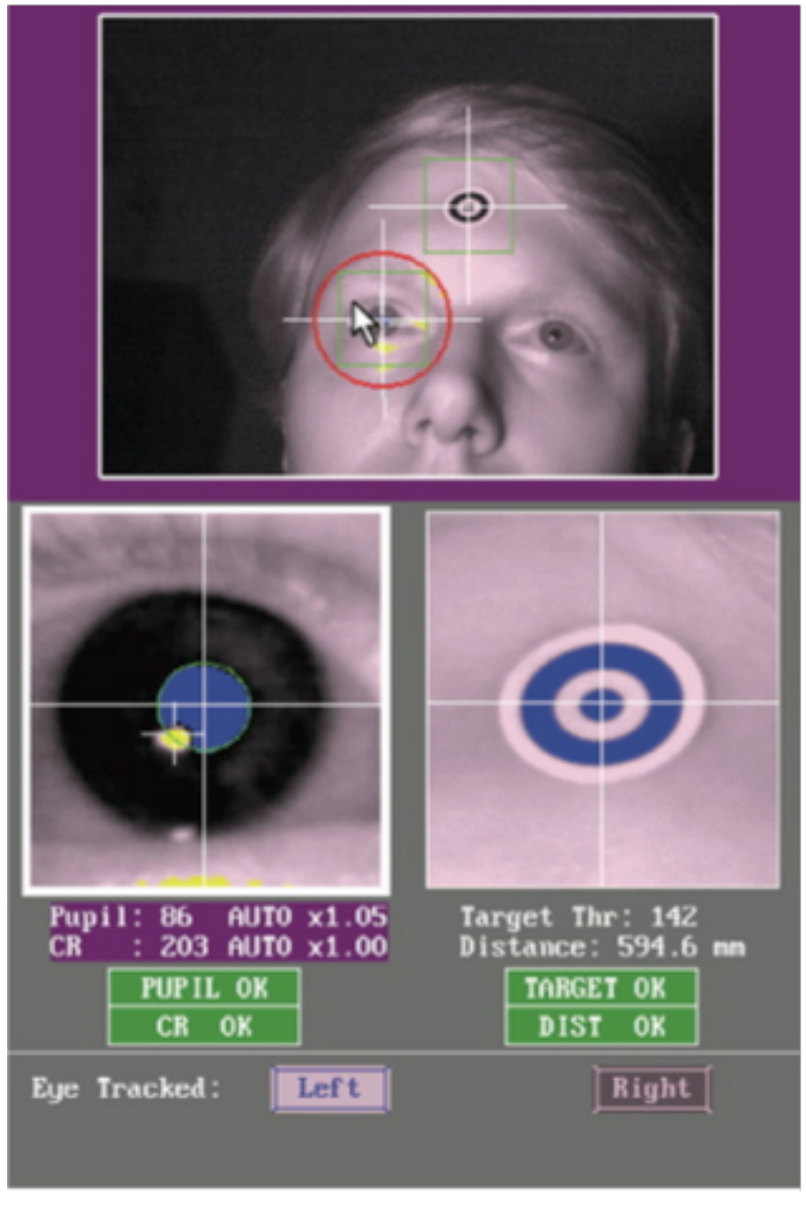
Lane (<1m, 0.1s)

Perception

Ability of a system for sumarizing complex data sources in a symbolic and dense representation

Incorporating visual information

Incorporating visual information



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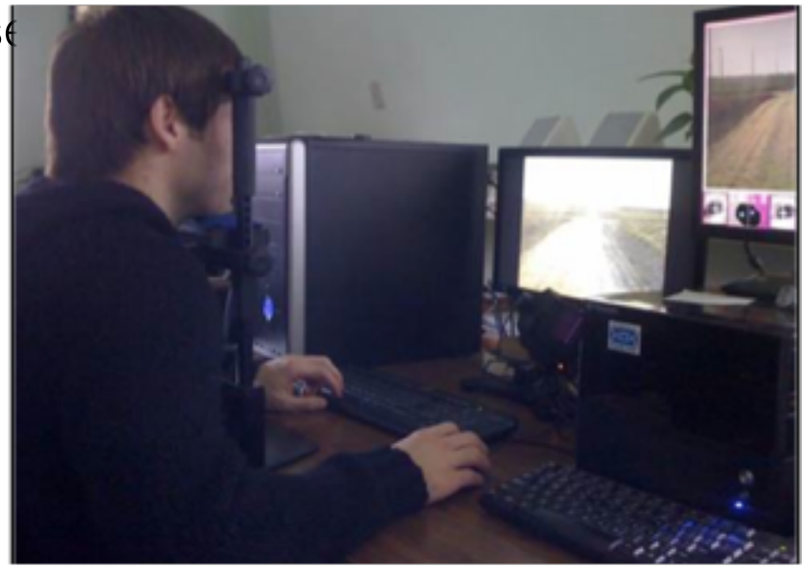
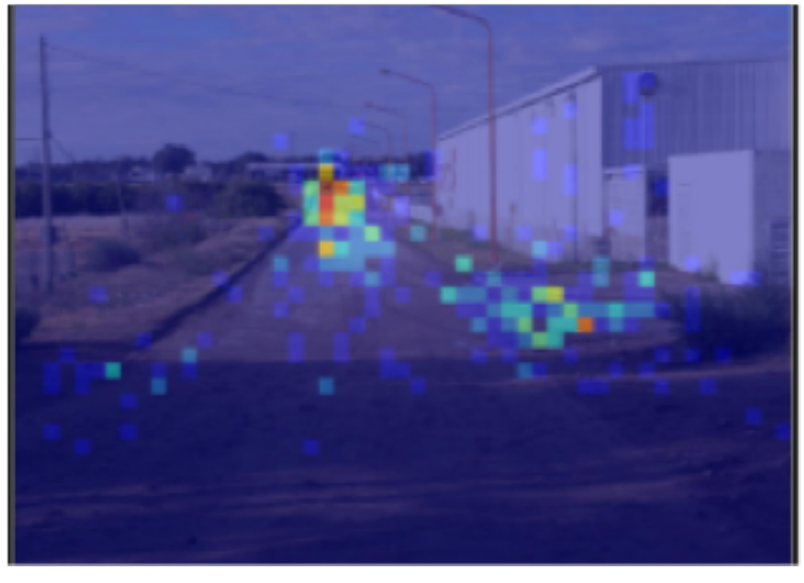




Incorporating visual information

Scene Comprehension

Main goal: Consider a vehicle...

Prediction

The ability to project the state of a system into the future

Dynamic Modelling

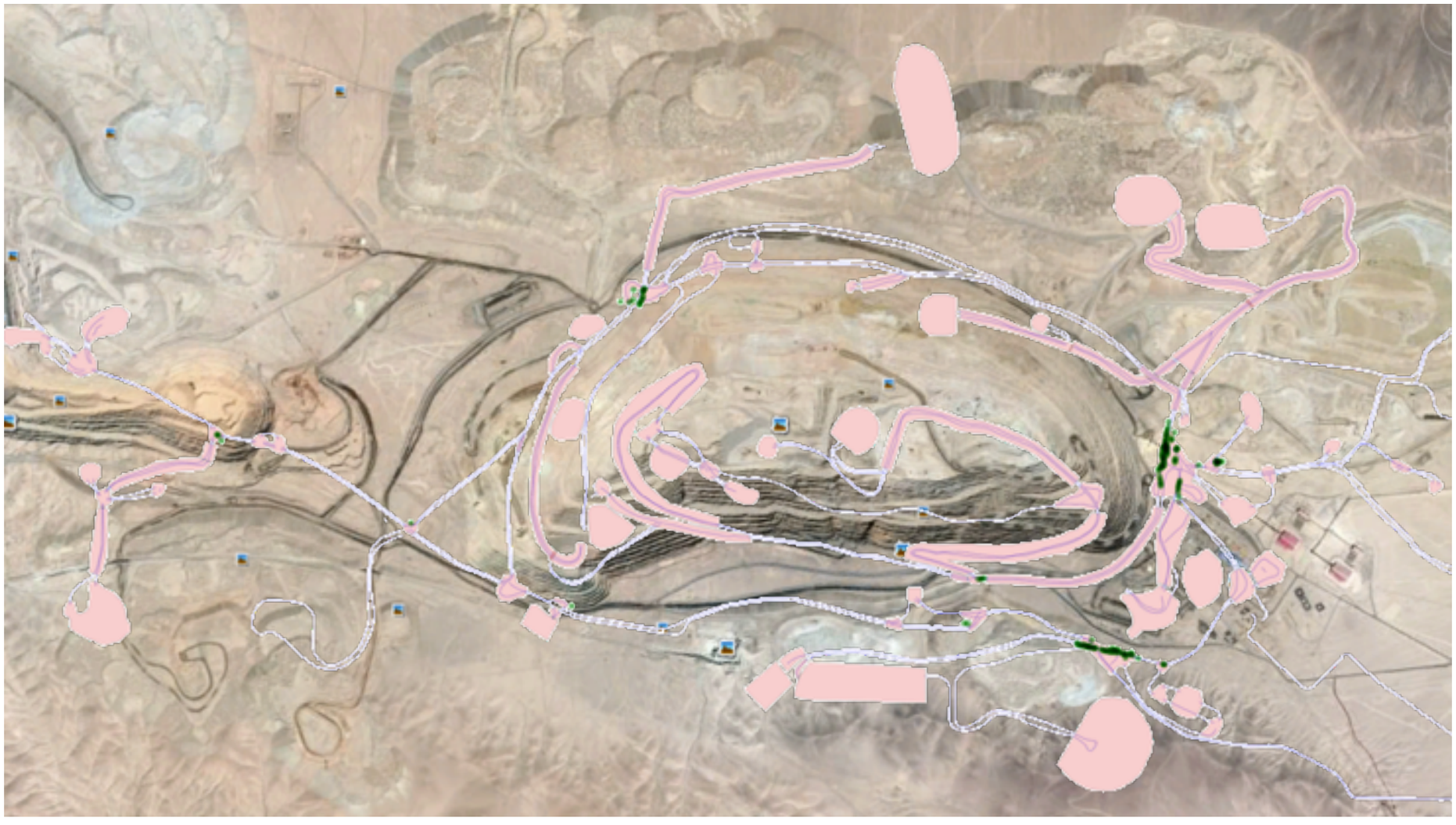
Driver Intent


Rules
Localization
Camera
Interaction
V2I
Fusion
Velocity
Data
Models
Automation
Time to Interaction
Safety
HMI
Detection
Failure
Communications
Driver
Road
Perception
Threat
Learning
Time to Collision
V2V
Integrity

Research Areas

Situation Awareness	Sensing	Ego State Information	Environment Modelling	Driver / Pedestrian Intention	Transition to Automation	
Perception	**Data Collection**	**Localisation** Sensor fusion, affordable sensing		**Behaviour Learning and Analysis** driver semantics, velocity and acceleration profiles, road rules, rules of safe operation, driver performance	**Human Machine Interfaces**	**Automation and Augmentation**
Comprehension	**Intrinsic Detection** radar, camera, laser, sensor fusion, sensor design (Vehicle, Pedestrian, Bicycles)	**Extrinsic Detection** ego localisation, communication (V2V, V2I, P2V, P2I) Localisation for Pedestrian / bicycles	**Road and Area Learning** Geometric properties, trajectories		**Integrity** persistence, fault detection, uncertainty	
Prediction	**System Failure Identification** interoperability	**Threat Assessment** Time to Collision, Time to Interaction		**Threat Assessment** deviation from normal behaviour, anomaly detection		

Experience in mining



Vulnerable Users

Situation awareness for VU

Fusing perception form multiple sources

Exploiting portable sensing

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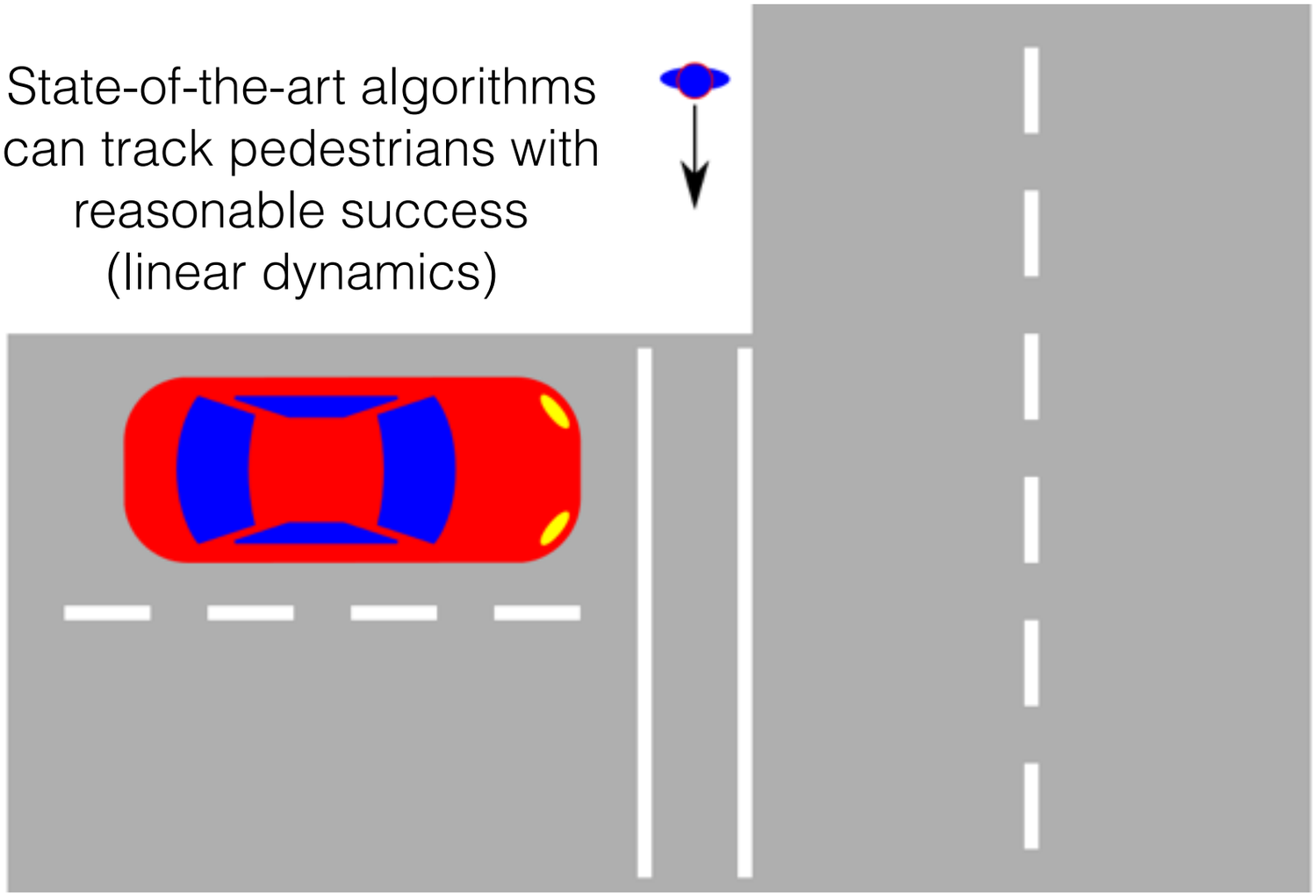
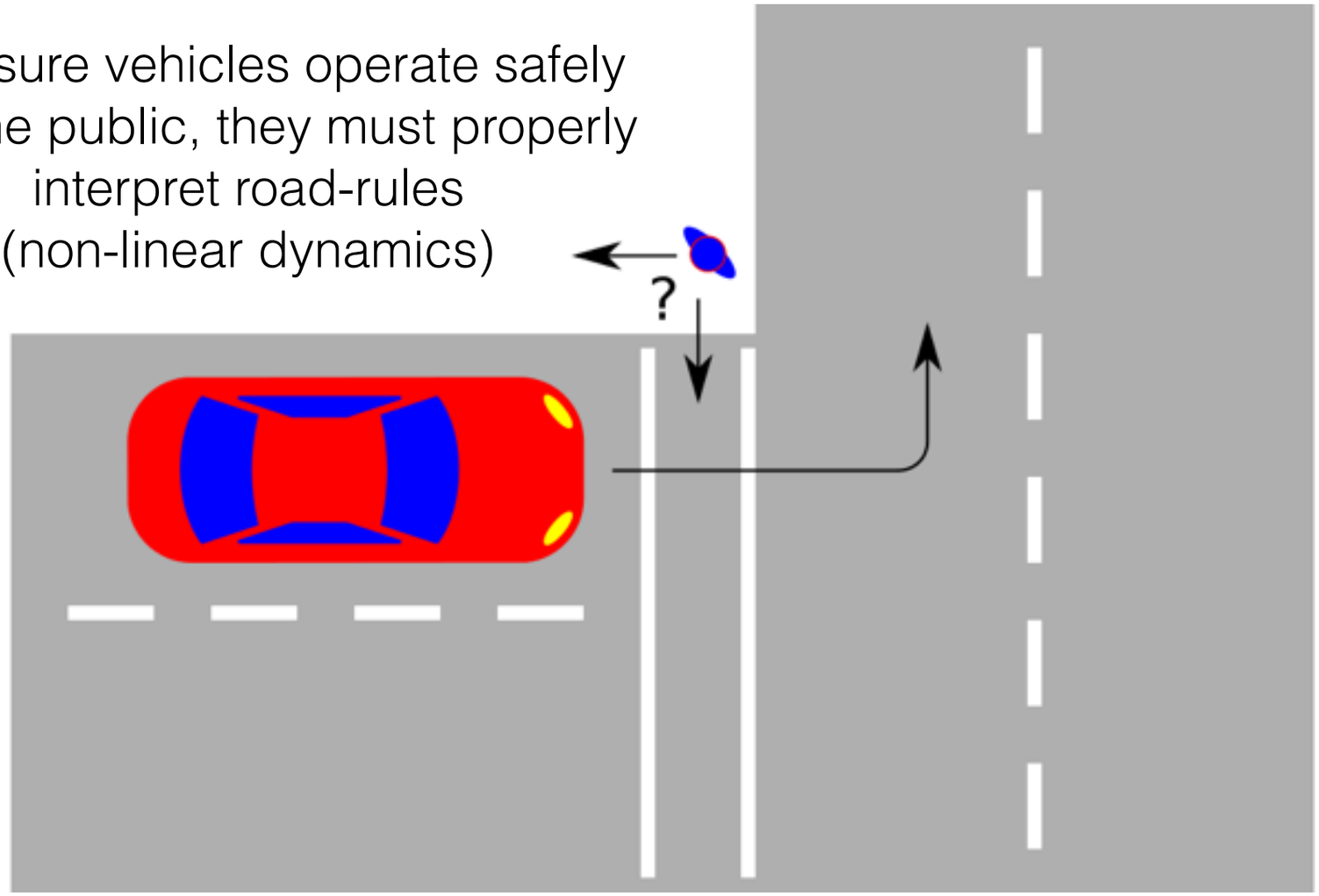
Vulnerable Users Intent

State-of-the-art algorithms can track pedestrians with reasonable success (linear dynamics)



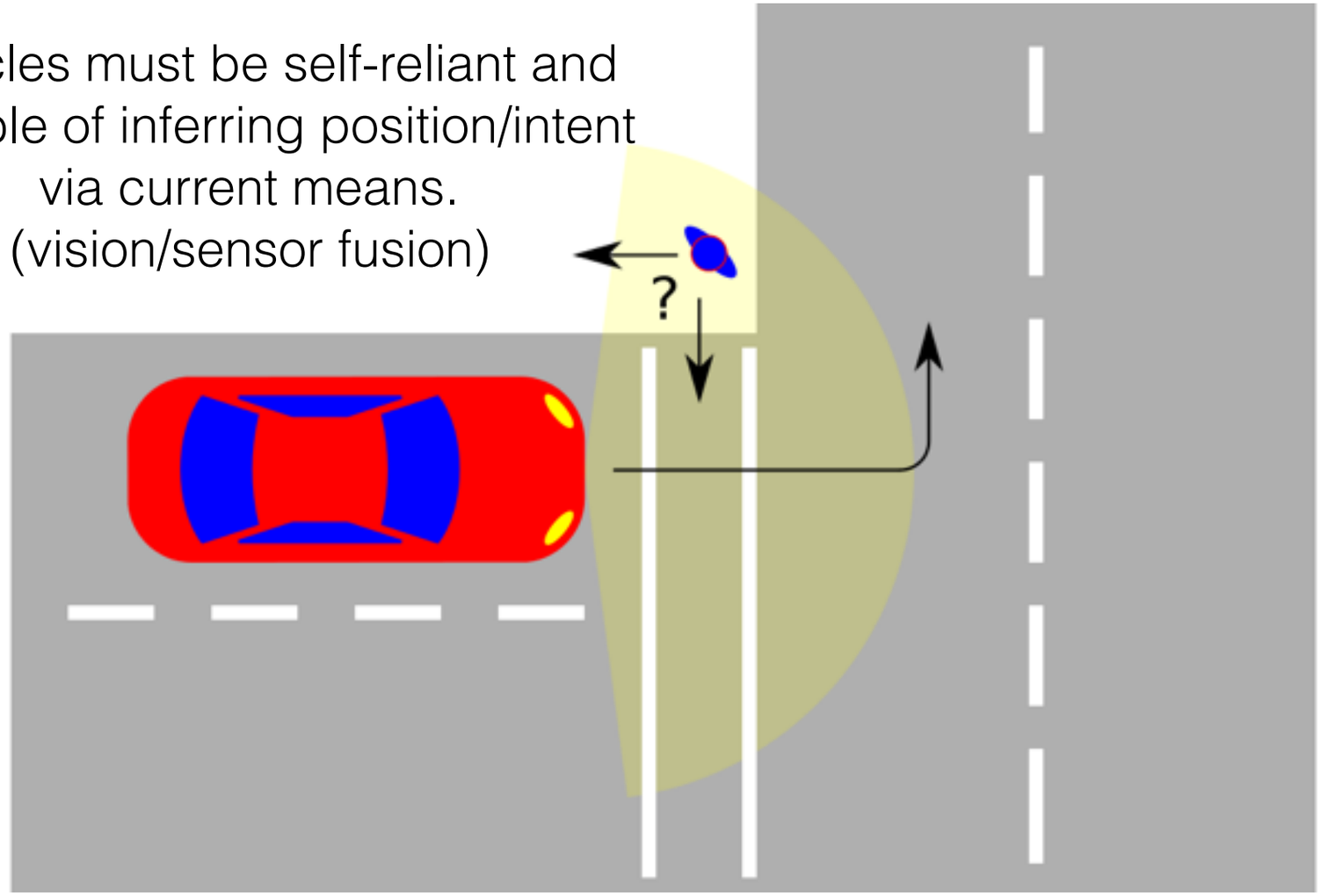
Vulnerable Users Intent

To ensure vehicles operate safely with the public, they must properly interpret road-rules (non-linear dynamics)



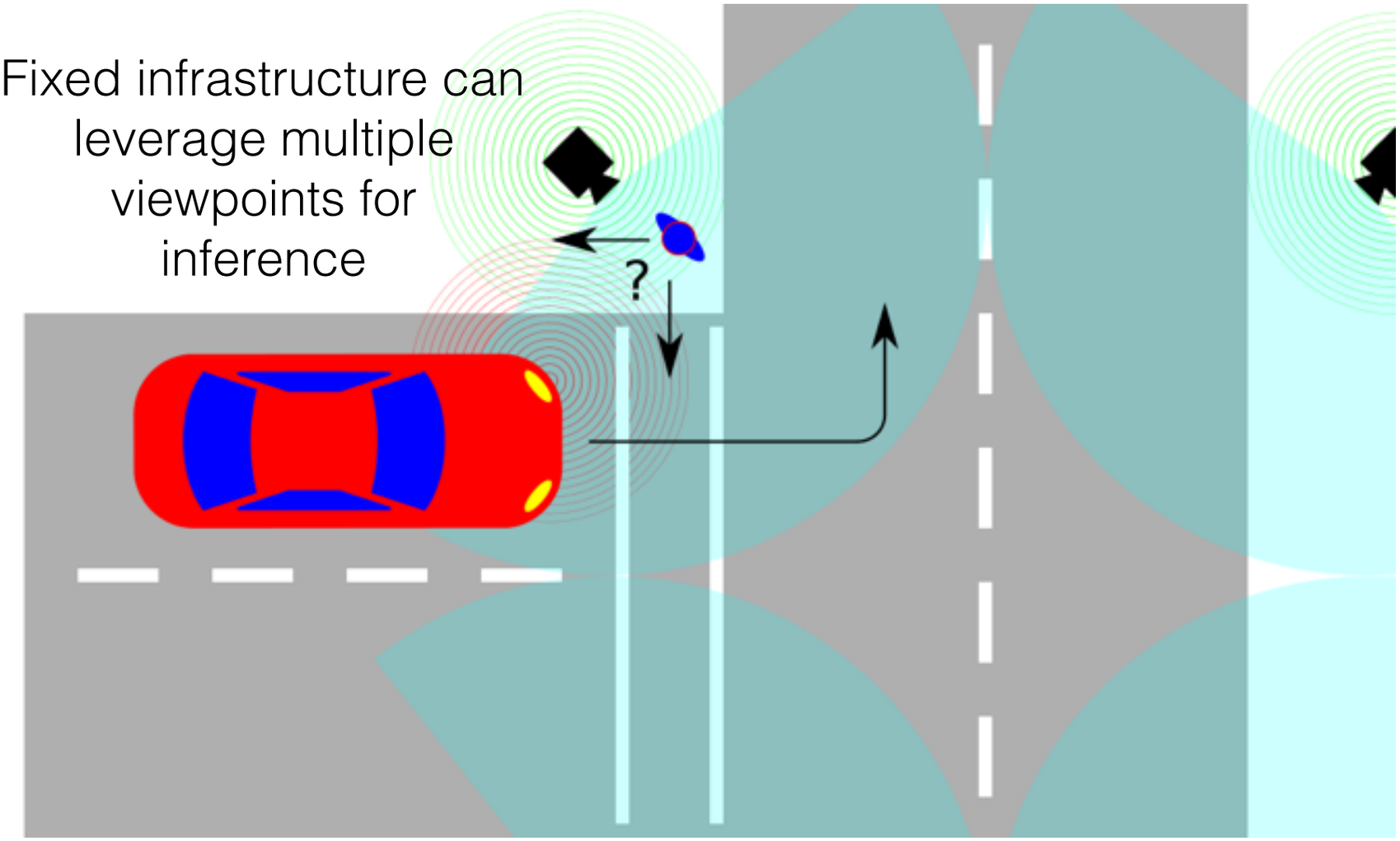
Vulnerable Users Intent

Vehicles must be self-reliant and capable of inferring position/intent via current means. (vision/sensor fusion)



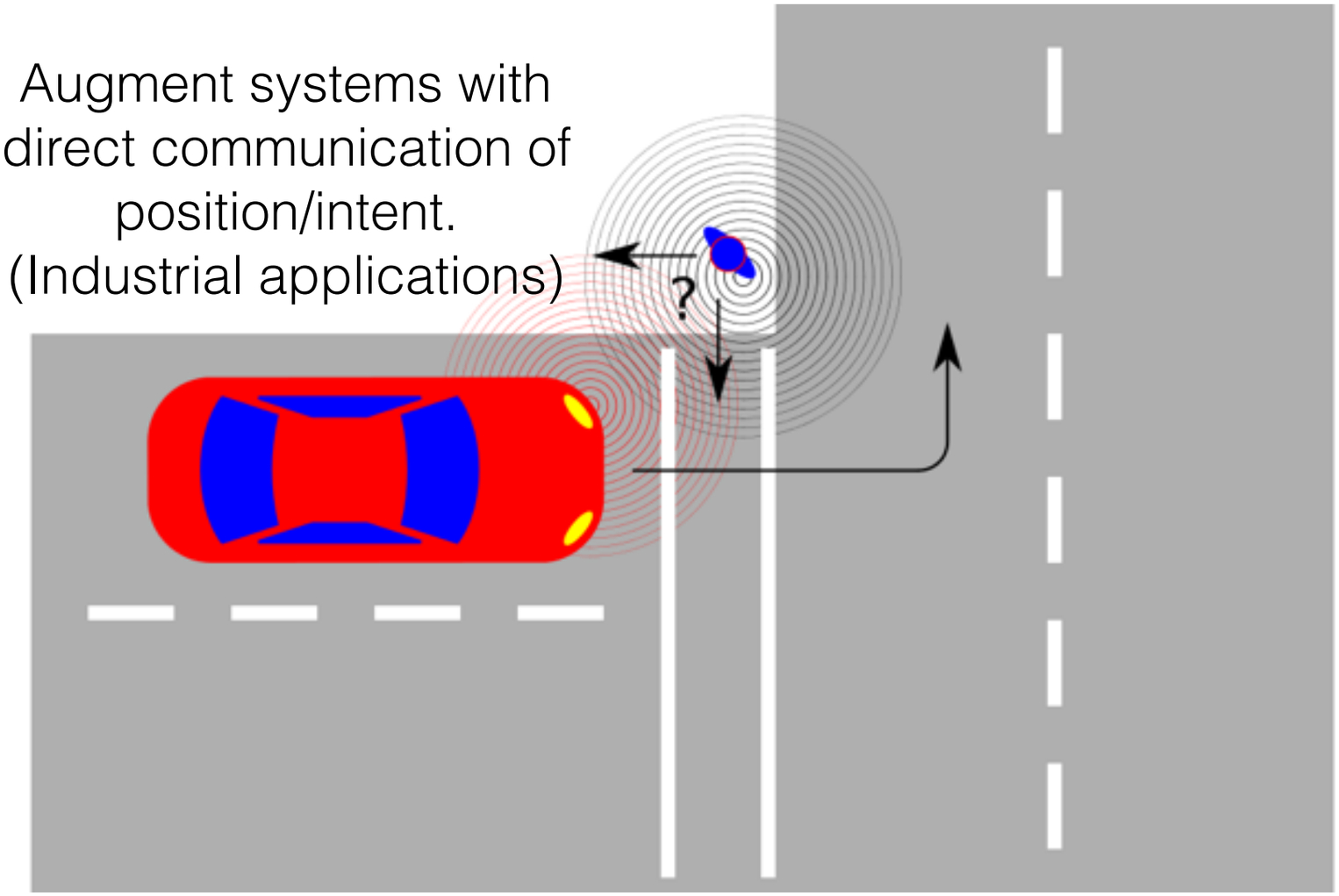
Vulnerable Users Intent

Fixed infrastructure can leverage multiple viewpoints for inference



Vulnerable Users Intent

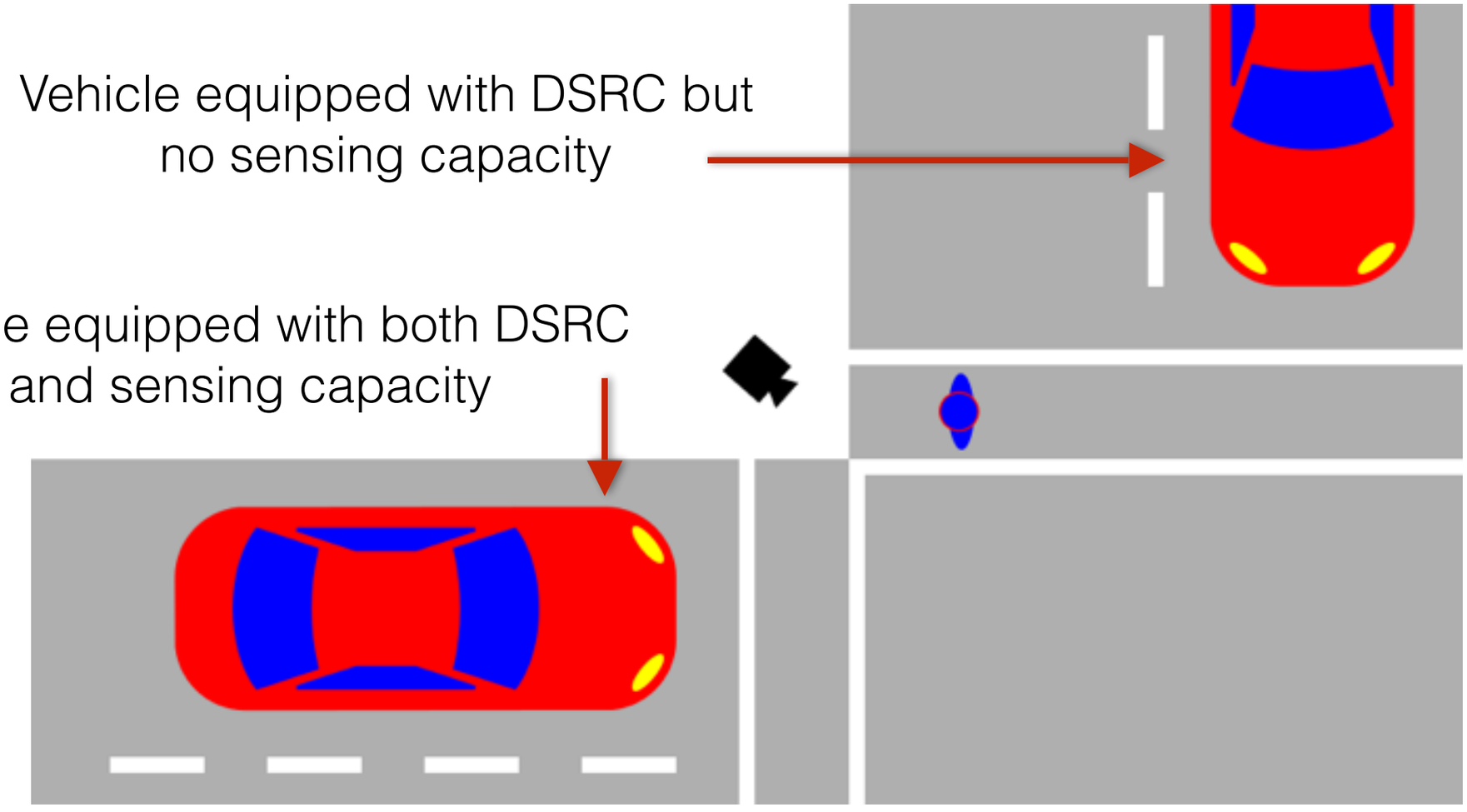
Augment systems with direct communication of position/intent. (Industrial applications)



Cooperative Perception

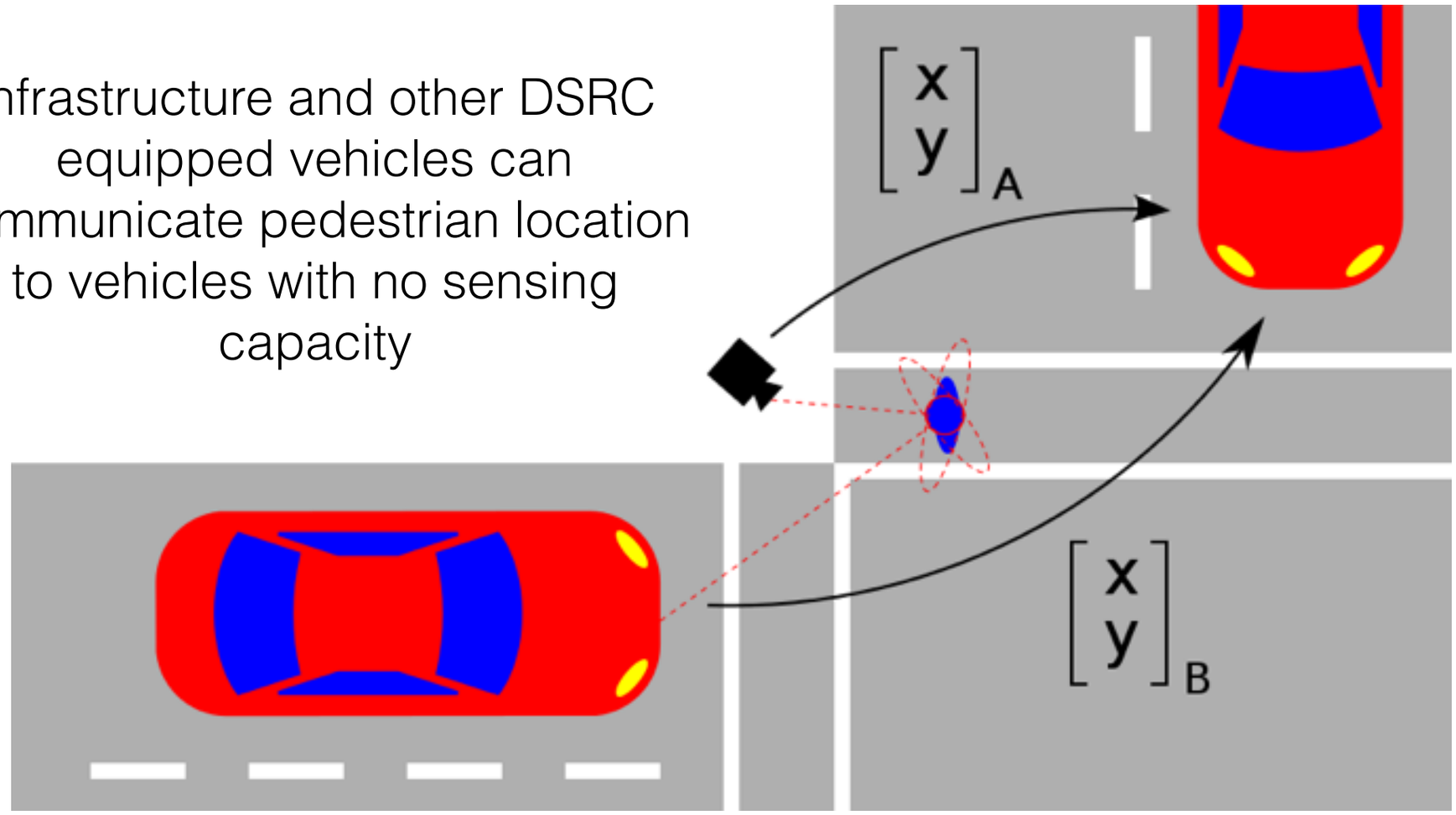
Vehicle equipped with DSRC but no sensing capacity

Vehicle equipped with both DSRC and sensing capacity



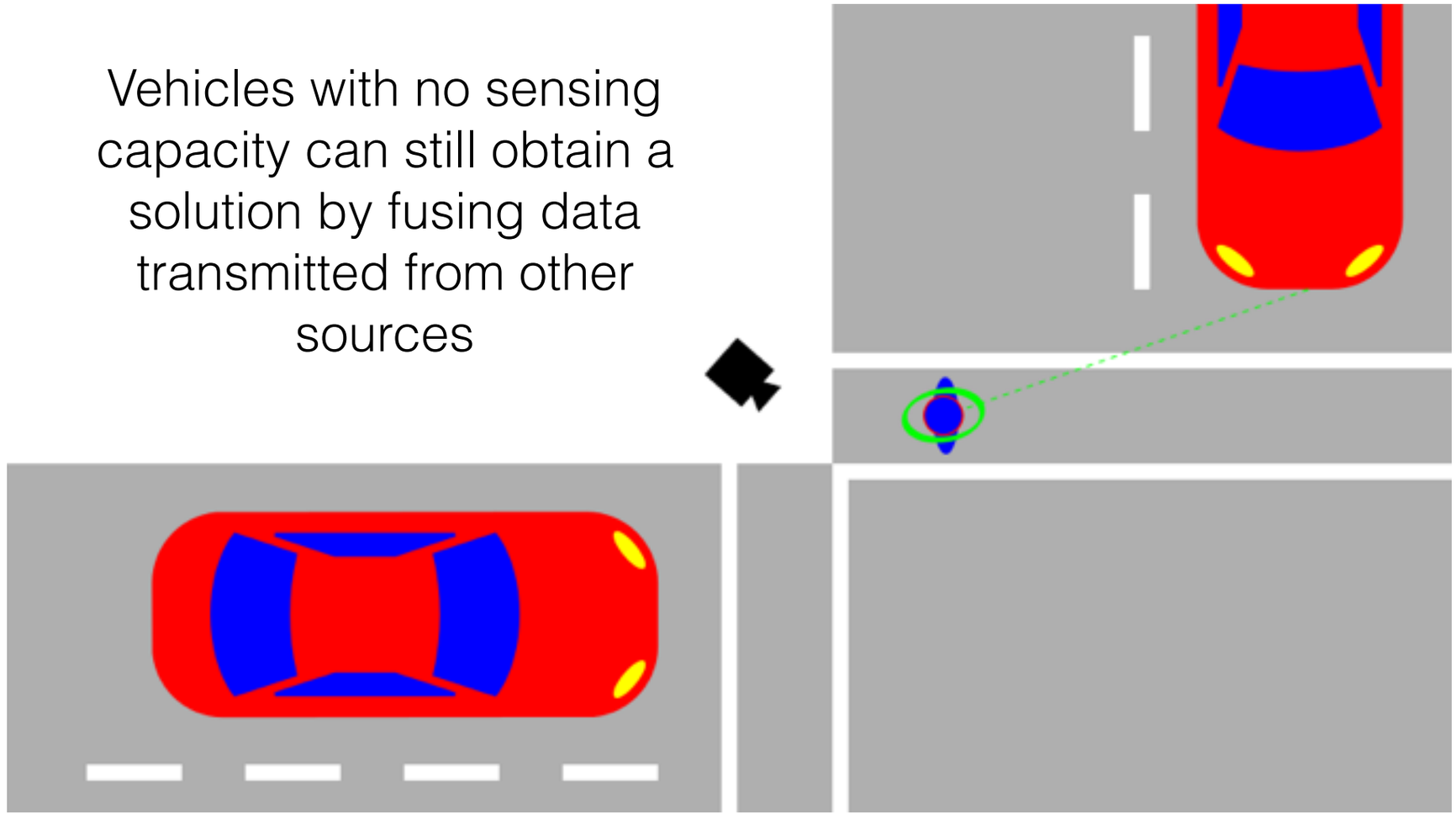
Cooperative Perception

Infrastructure and other DSRC equipped vehicles can communicate pedestrian location to vehicles with no sensing capacity



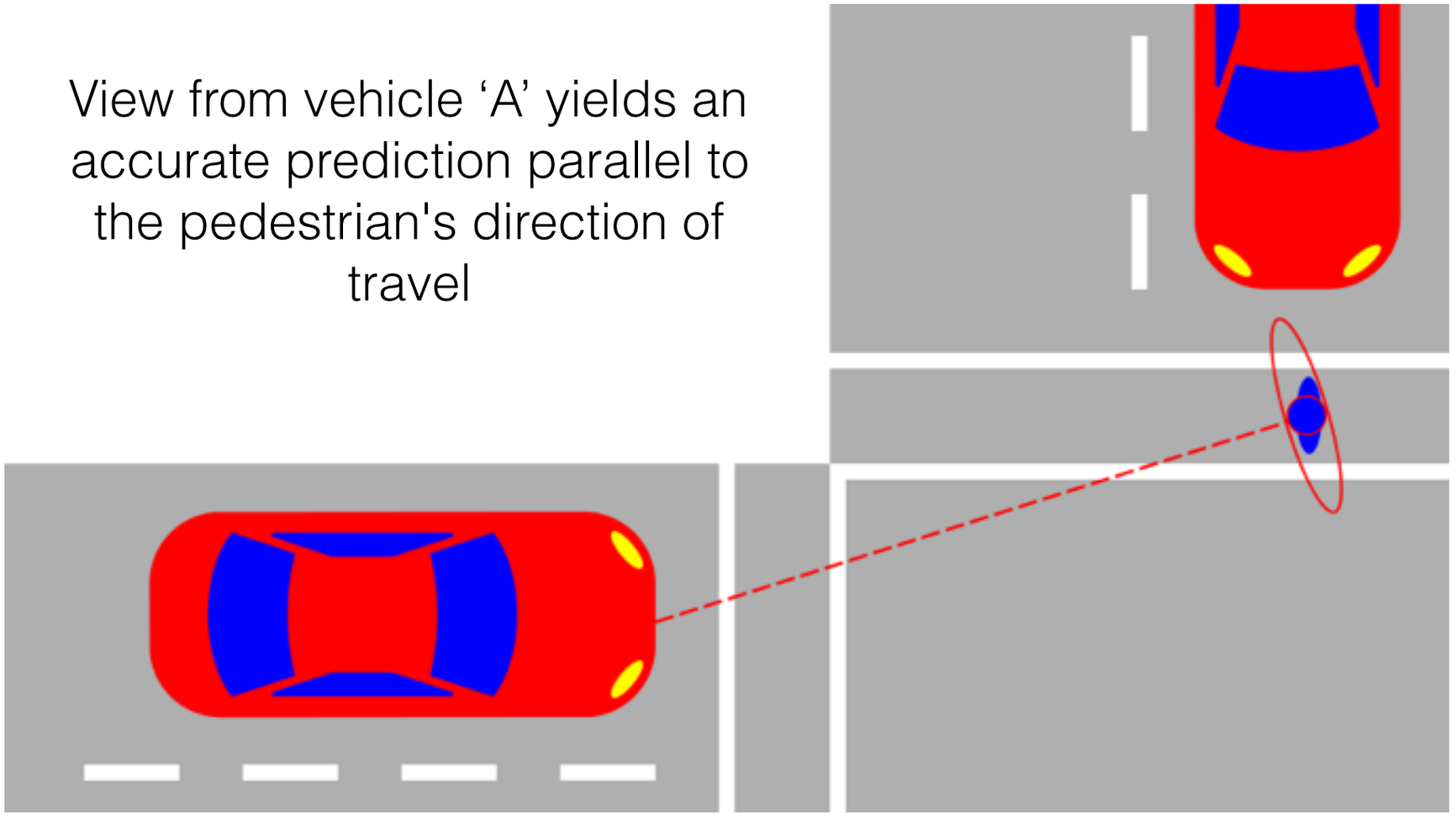
Cooperative Perception

Vehicles with no sensing capacity can still obtain a solution by fusing data transmitted from other sources



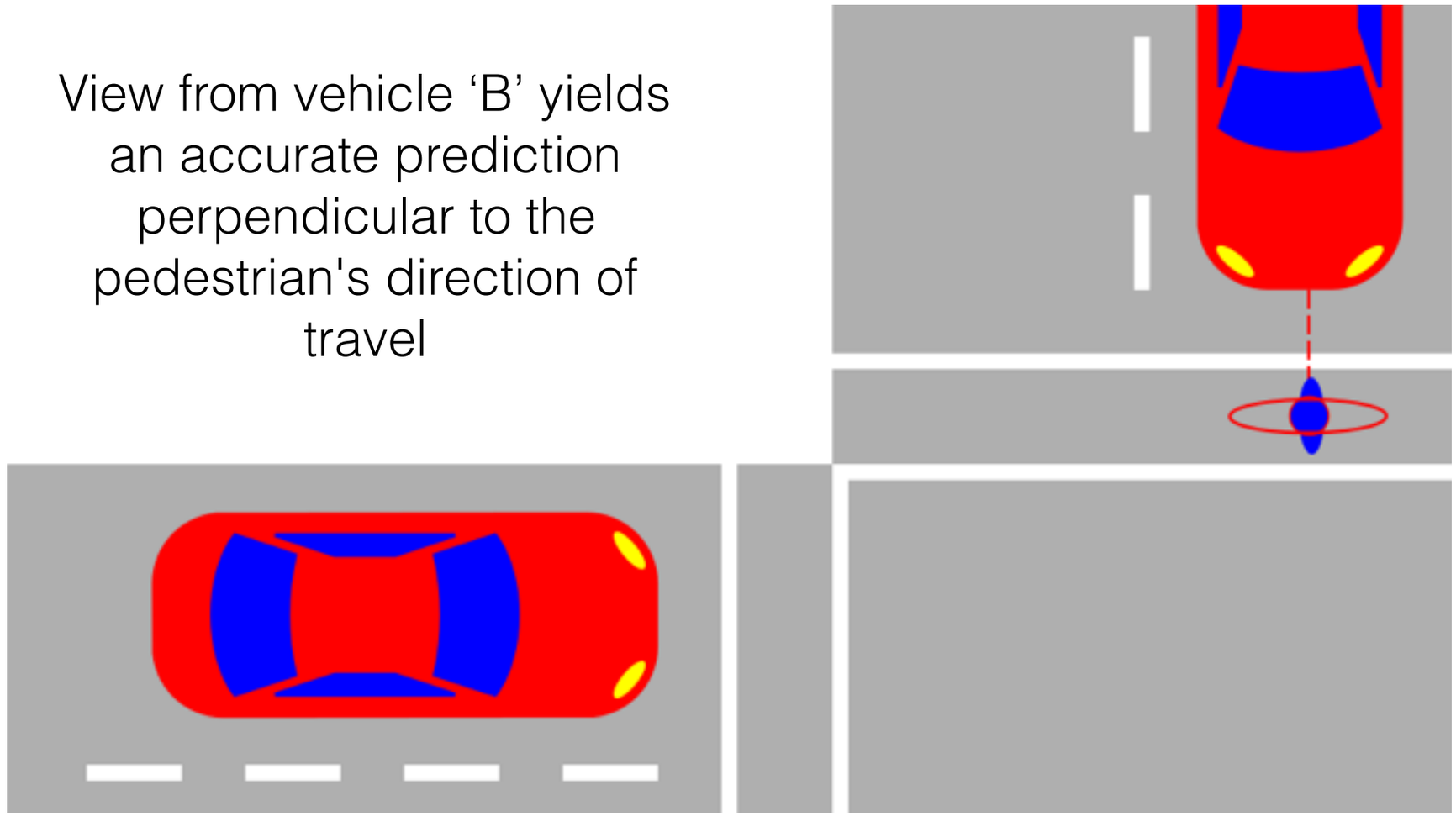
Cooperative Perception

View from vehicle ‘A’ yields an accurate prediction parallel to the pedestrian's direction of travel



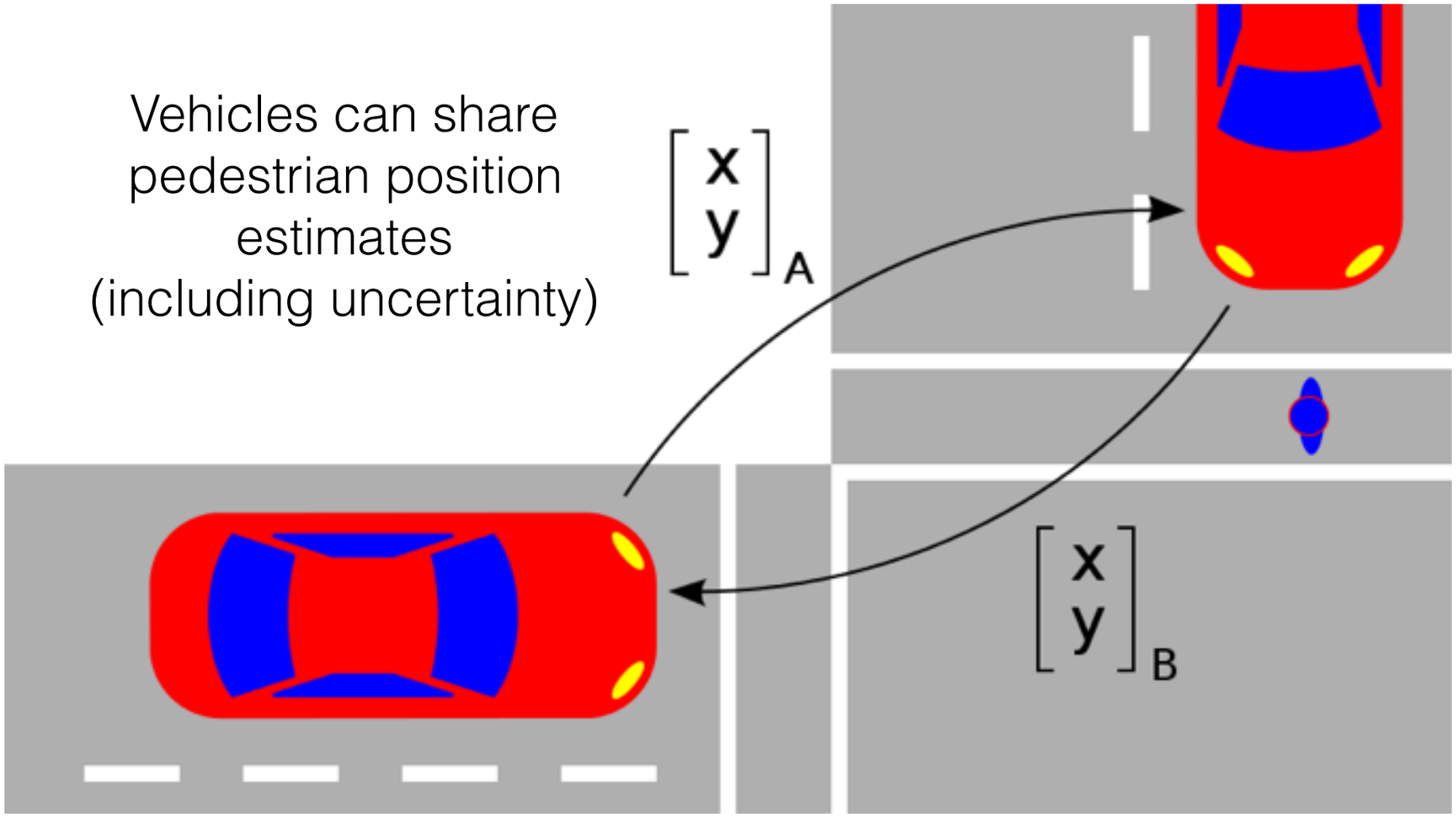
Cooperative Perception

View from vehicle ‘B’ yields an accurate prediction perpendicular to the pedestrian's direction of travel



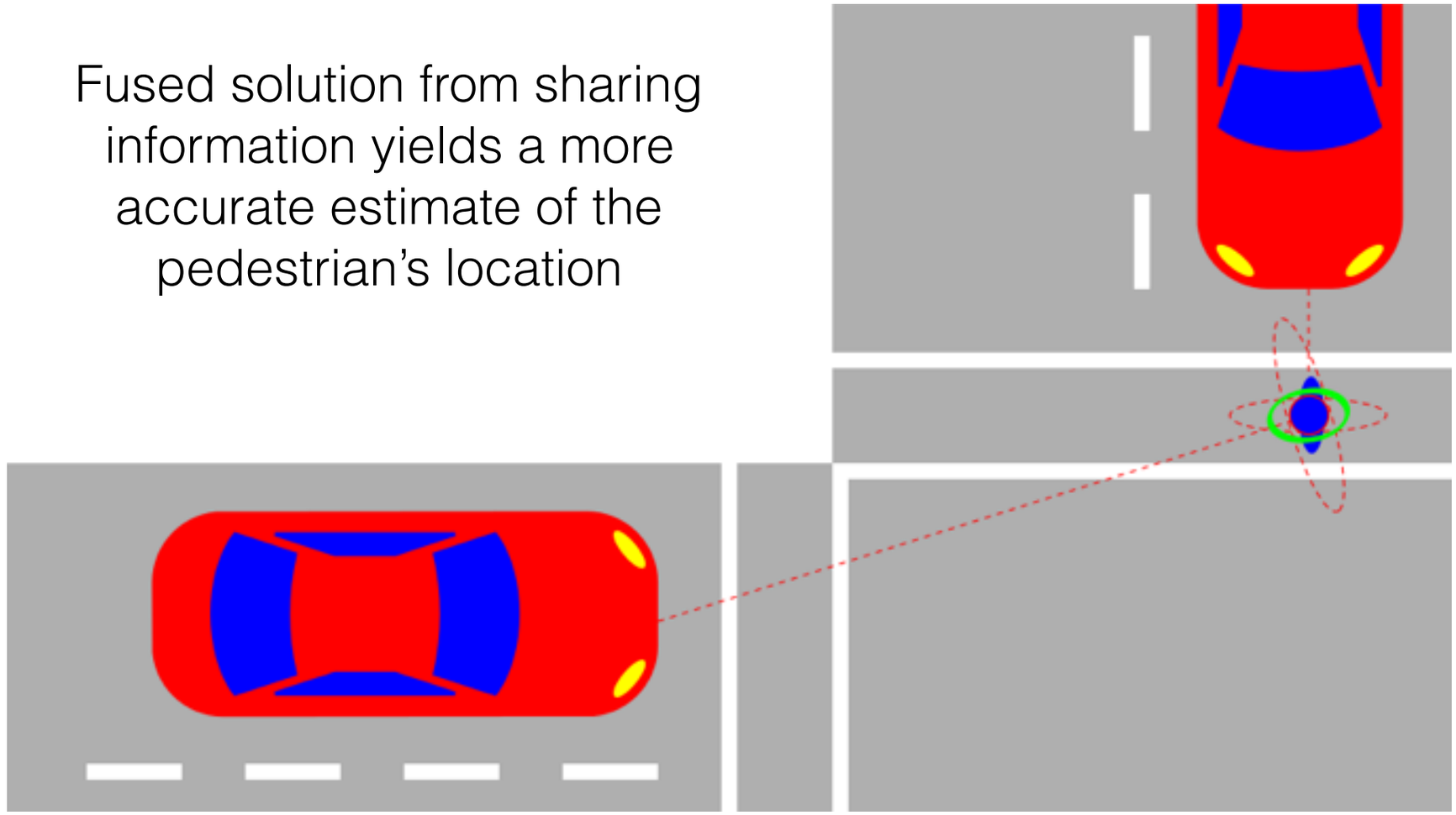
Cooperative Perception

Vehicles can share pedestrian position estimates (including uncertainty)



Cooperative Perception

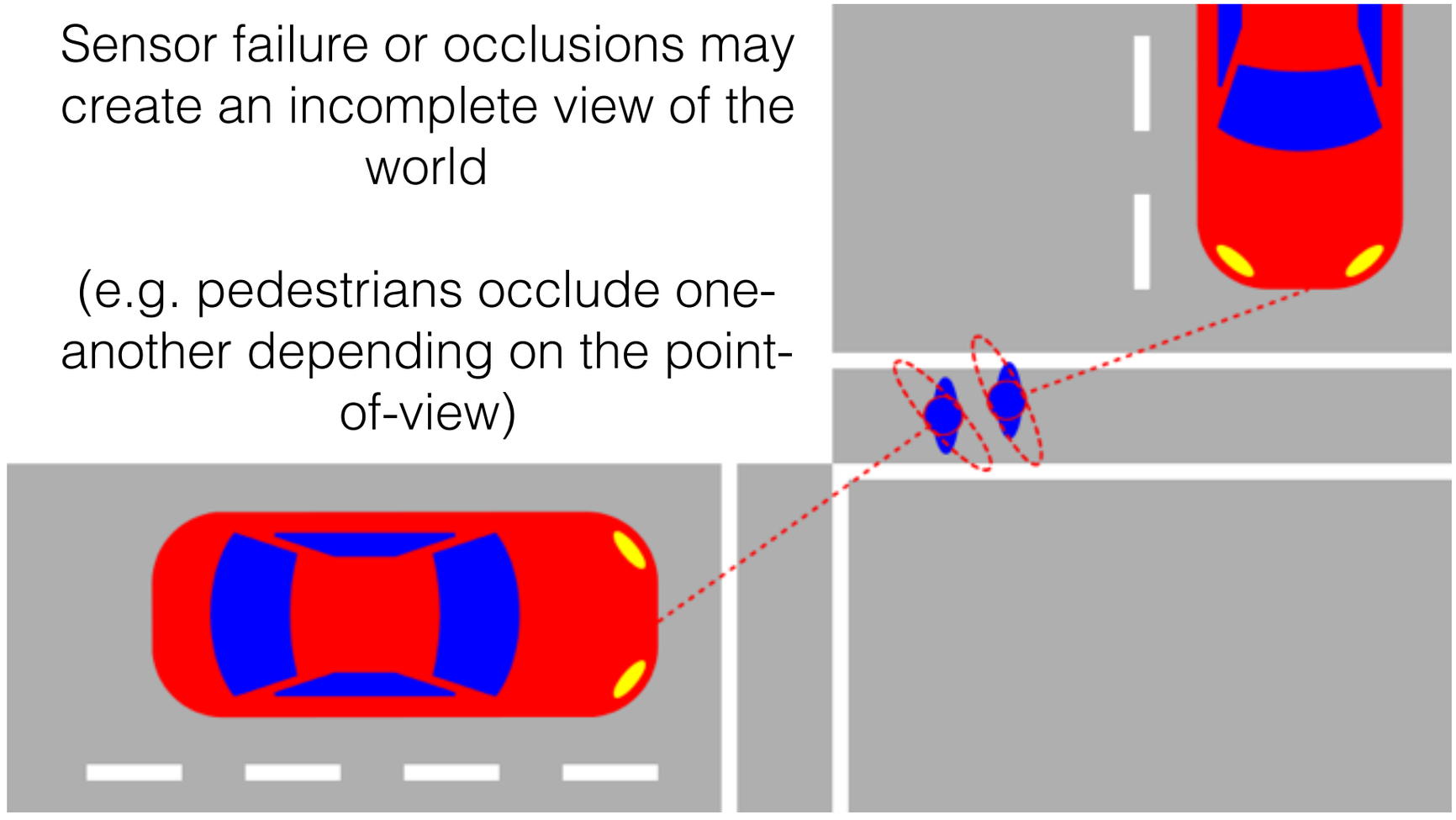
Fused solution from sharing information yields a more accurate estimate of the pedestrian's location



Cooperative Perception

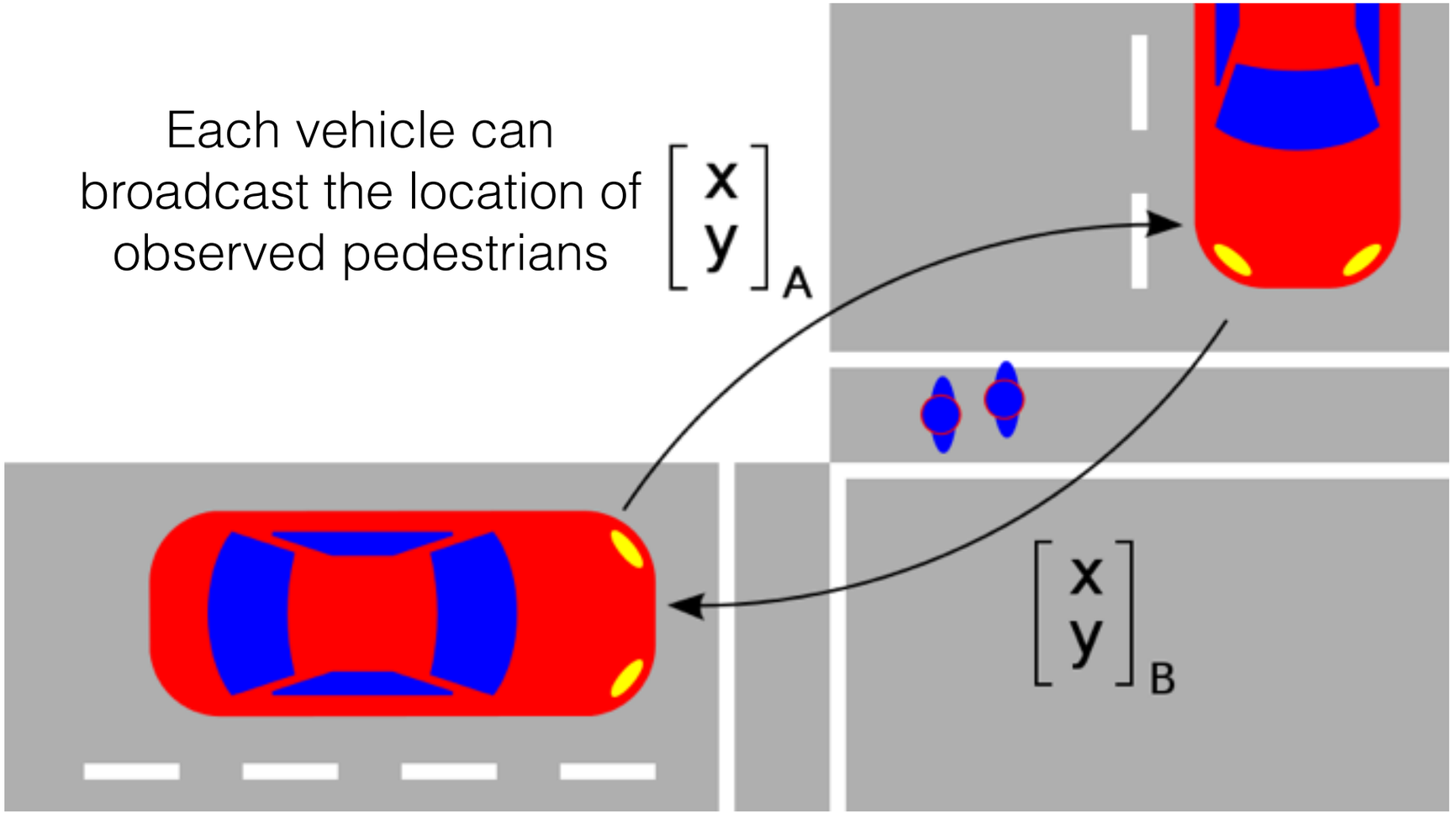
Sensor failure or occlusions may create an incomplete view of the world

(e.g. pedestrians occlude one-another depending on the point-of-view)



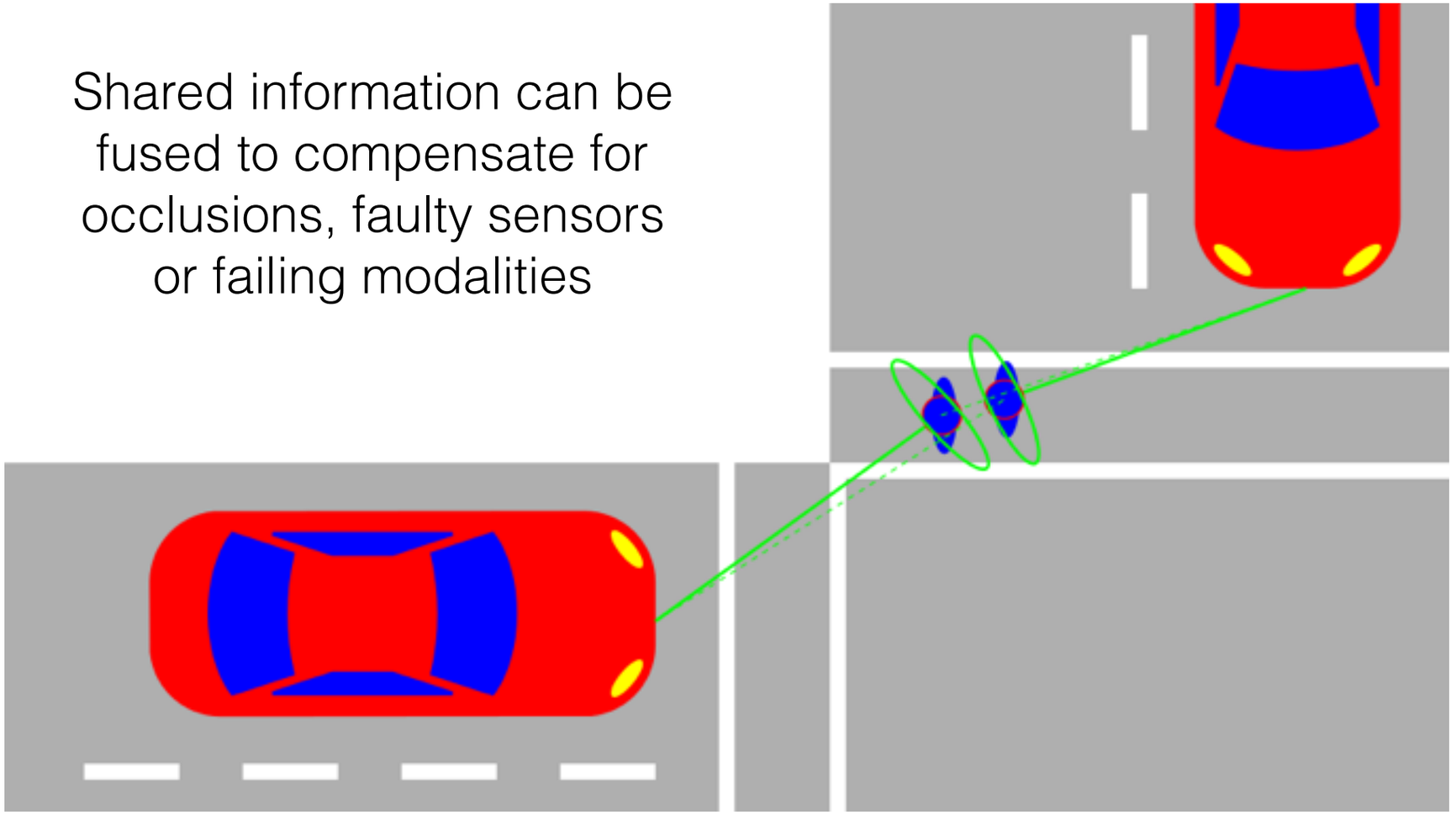
Cooperative Perception

Each vehicle can broadcast the location of observed pedestrians



Cooperative Perception

Shared information can be fused to compensate for occlusions, faulty sensors or failing modalities



Fundamental Challenges

Representation of information

Data Asociation and Data Fusion

Compression of information and network utilization

New sensors: visual processors

People

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Funds

3M USD from government

1M USD from private companies

300k USD from foreing institutions

Last 5 years

Milestones

First technological Insitute in Argentina

Researcher of the Nation

One of ten Bicentennial project funded

Eleven posgraduate thesis

Las 5 years

Milestones

First spin off company

Leader of the factibility analysis and posterior develop of a SOC for Smart TV

First Solar Generator connected to the grid

R&D with more than 10 small companies



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Thanks for your time

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