

CARSENSE

Detection of Car Environment at Low Speed Driving

Clermont-Ferrand, June 2001

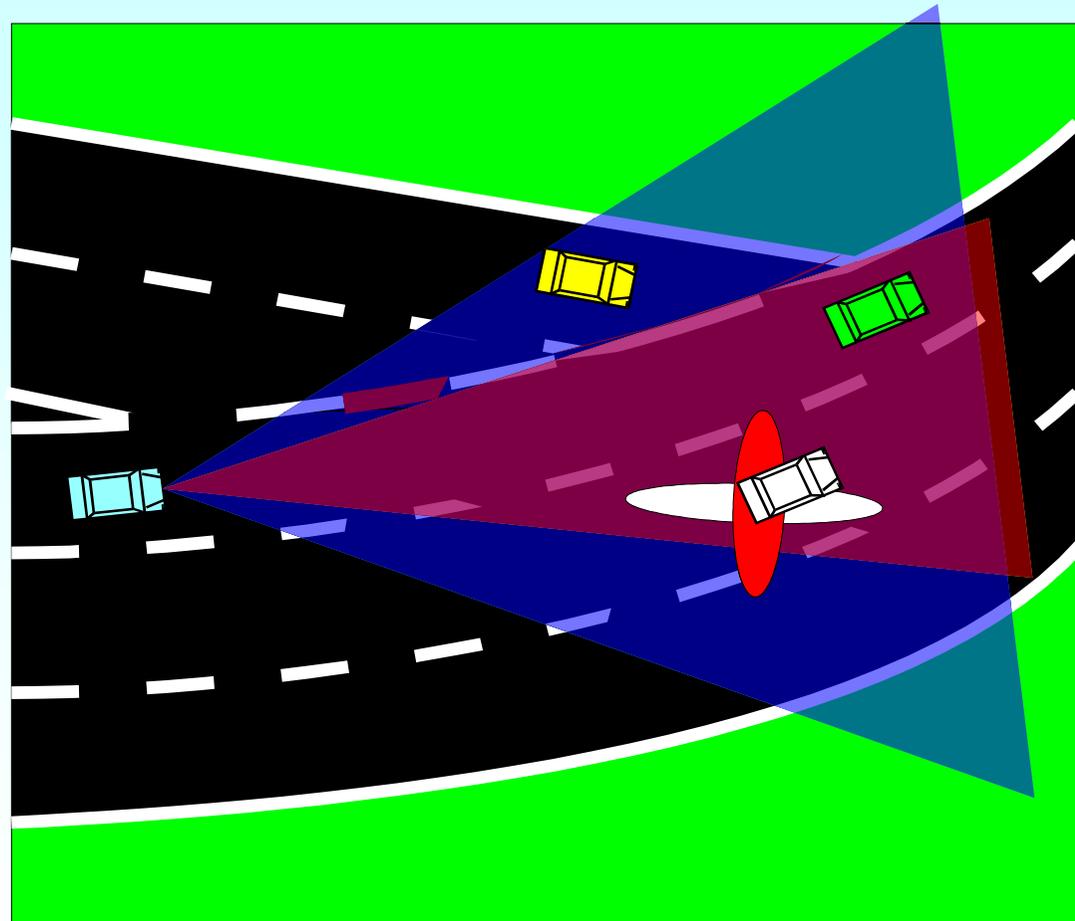
Introduction

- **General Idea and CARSENSE Partners**
- **Requirements**
- **Sensors**
- **Data Fusion**
- **Architecture**
- **Test Vehicle**
- **Tests and Validation**
- **Conclusion**

Complementary Technologies

The combination of *processed* information from the three sensors results in increased :

- Redundancy & Robustness
- Coverage
- Measurement Accuracy
- Confidence



CARSENSE - General Idea and Partners

General Idea

- Improvement of Sensors to reasonable performance limits
- Data Fusion in order to achieve higher system performance
- Harmonisation of Interface

BMW

RENAULT

CRF

THALES AS (THOMSON-CSF)

IBEO

INRETS

ENSMP

TRW

AUTOCRUISE

JENA-OPTRONIK

INRIA

LCPC

Reasons for Data Fusion

- Economic Benefits (reduced design costs, costs for modifications)
- Technical Benefits (Improvement of single sensor performance)
- System Benefits (redundancy, information reliability)
- User Benefits (more performance of driver assistance systems)

Definition of a Reference Application

Project scope

- No specific CARSENSE application
- But an application as a reference to define sensor requirements

Application properties

- General frame work: low speed driving
- Qualitatively more complex than basic ACC on motorways or urban express ways.
- It should require handling of a larger number objects
- Include stationary objects
- Complex behaviour of objects

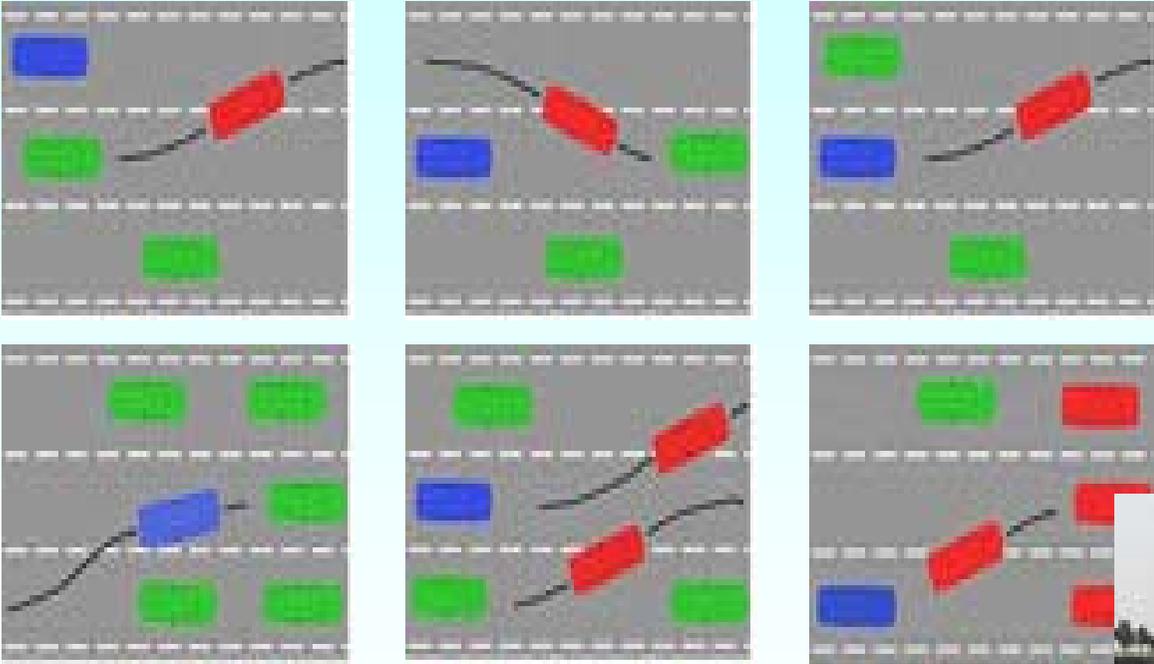
Resulting application

- **ACC Stop & Go**

Important selected scenarios

- Cut in/out, lane changes

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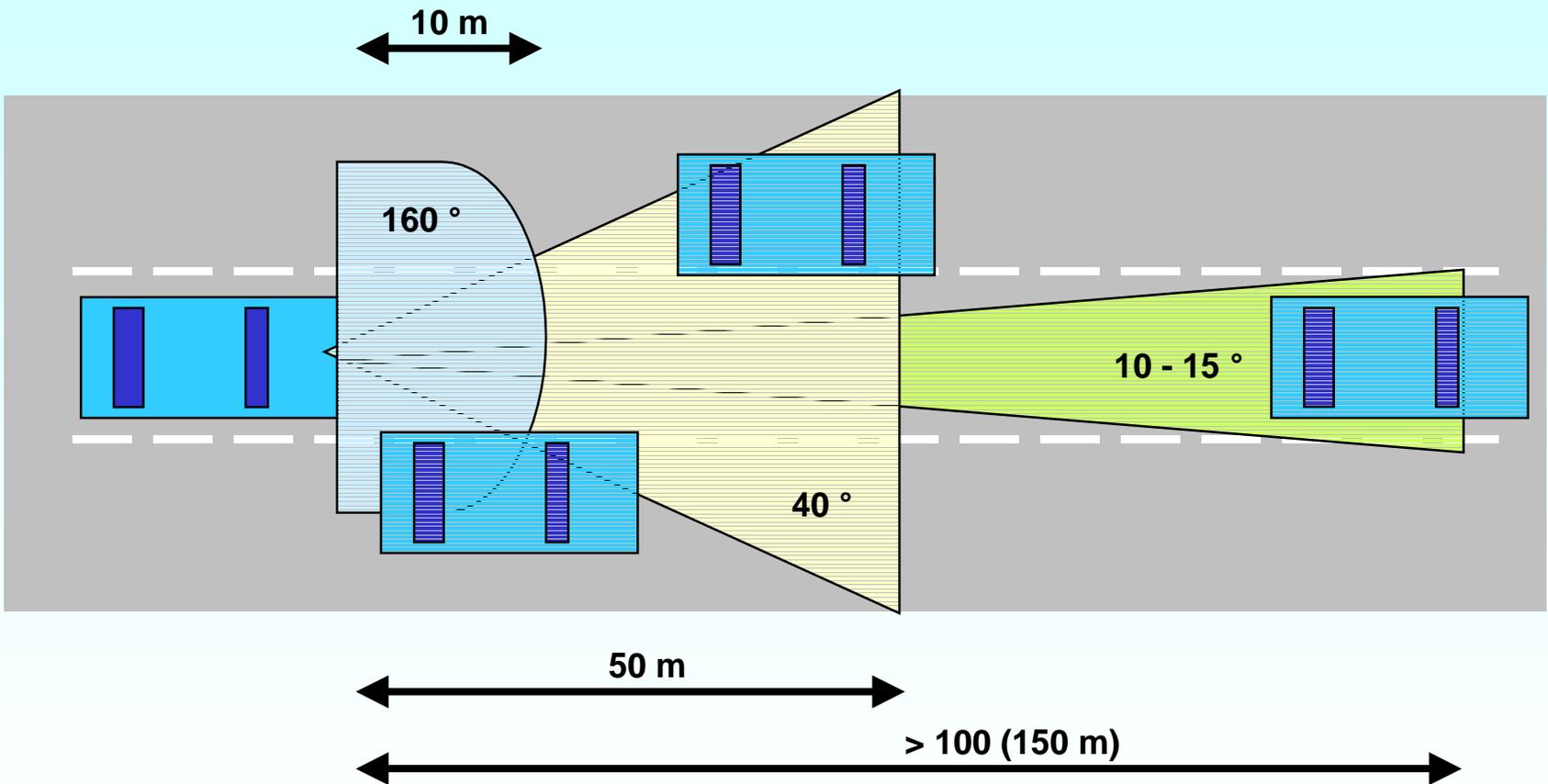


Over head objects



Definition of information requirements (a priori)

SATCAR CF.ppt



Definition of information requirements (a priori)

Classes of Information

- Information on own vehicle
- Detection range
- Object type to detect (cars, trucks, ...)
- Object properties (height, width, length, distance, ...)
- Road properties

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		Near range	Middle range	Far range
Range	Maximum	10m	50m	> 100m (150m)
Velocity	Range	-20 m/s to 20m/s	-20 to +20m/s	-20 to +20m/s
	Accuracy	0.2m/s	0.5m/s	0.5m/s
Angle	Horizontal	160	40	10-15

Long Range & Short Range Radar Sensor

L/R radar sensor :

- *Distance range : 150 m*
- *Viewing angle : 11°*



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S/R radar sensor :

- *Distance range : 10/15 m at 25°
to 60 m in straight line*
- *Viewing angle : ± 25°*



Laser scanner:

- *Distance Range: 100 m*
- *Viewing angle: 270°*
- *Eyesafe: laser class 1*

Specification (main characteristics) :

Sensor	Type	B/W CMOS-Sensor
	<i>Resolution</i>	640 x 480 pixel
	<i>Spectral range</i>	400 – 800 nm
	<i>Pixel rate</i>	10 MHz
	<i>Window rate</i>	> 25 Hz
	<i>Dynamic range</i>	120 dB (logarithmic)
Optics	<i>Hor. / Vert. FOV</i>	45° / 35°(Pentax C815B)
Interfaces	<i>Data interface</i>	Digital I/F (CameraLink-LVDS)
	<i>Camera Control</i>	CAN I/F for each camera
	<i>Synchronisation</i>	Stereo vision

Status of CC-II development



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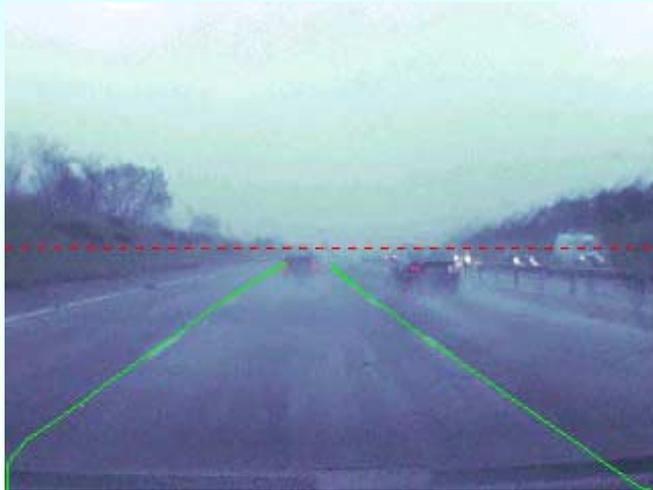
Perception Modules

Video Sensor - Algorithm Development

Robust Algorithms for Embedded Implementation

- Real time - running at frame rate (25fps)
- Robust performance - performs in poor light / bad weather etc.

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Lane Curvature Prediction



Stereo Obstacle Detection

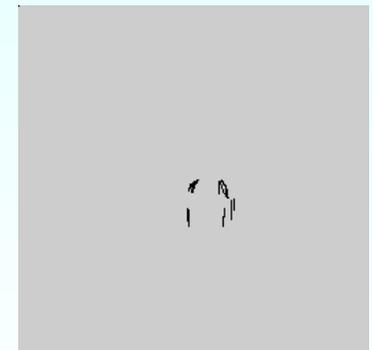
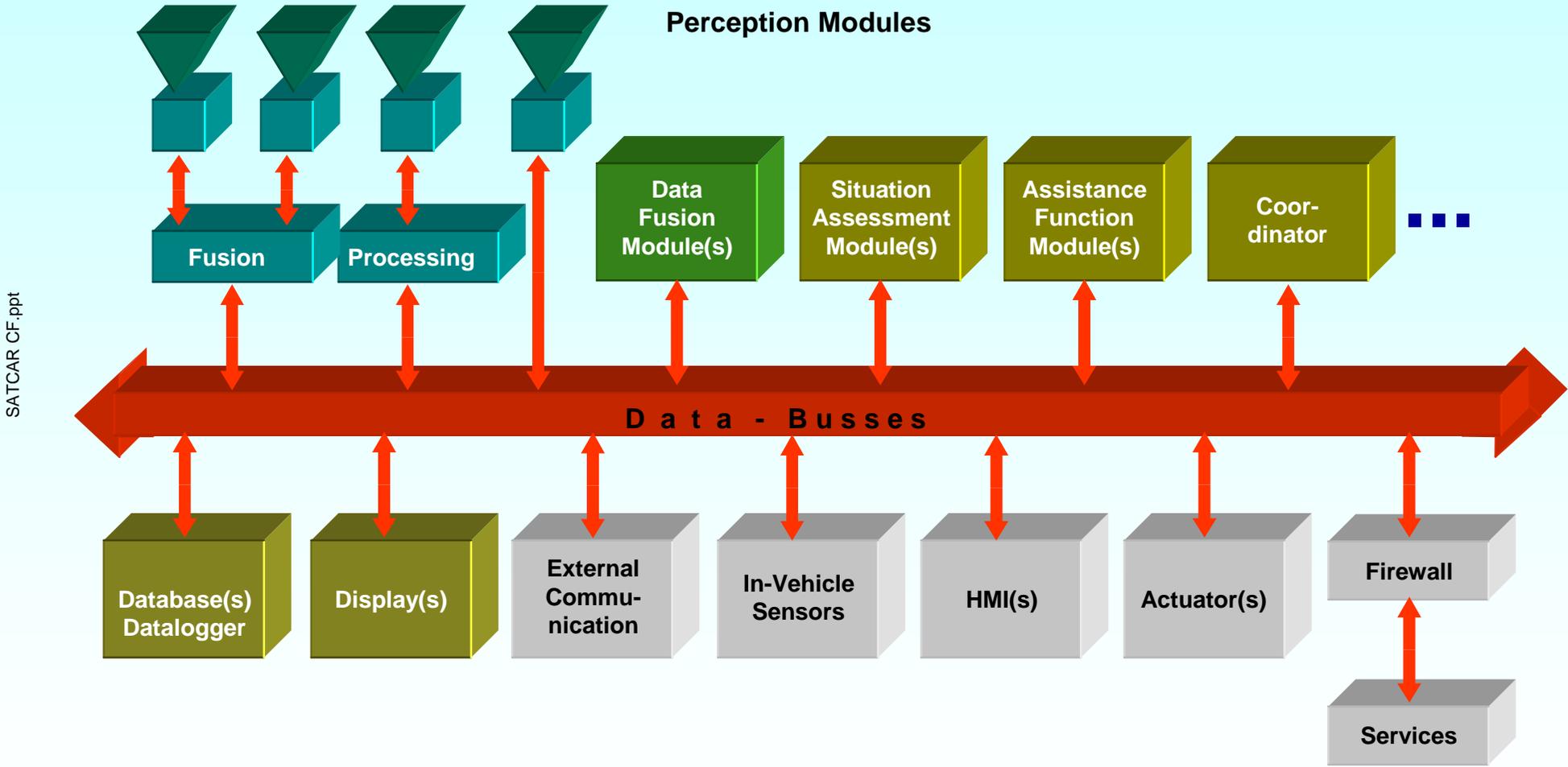


Image primitives of the object detected above the road plan

Architecture

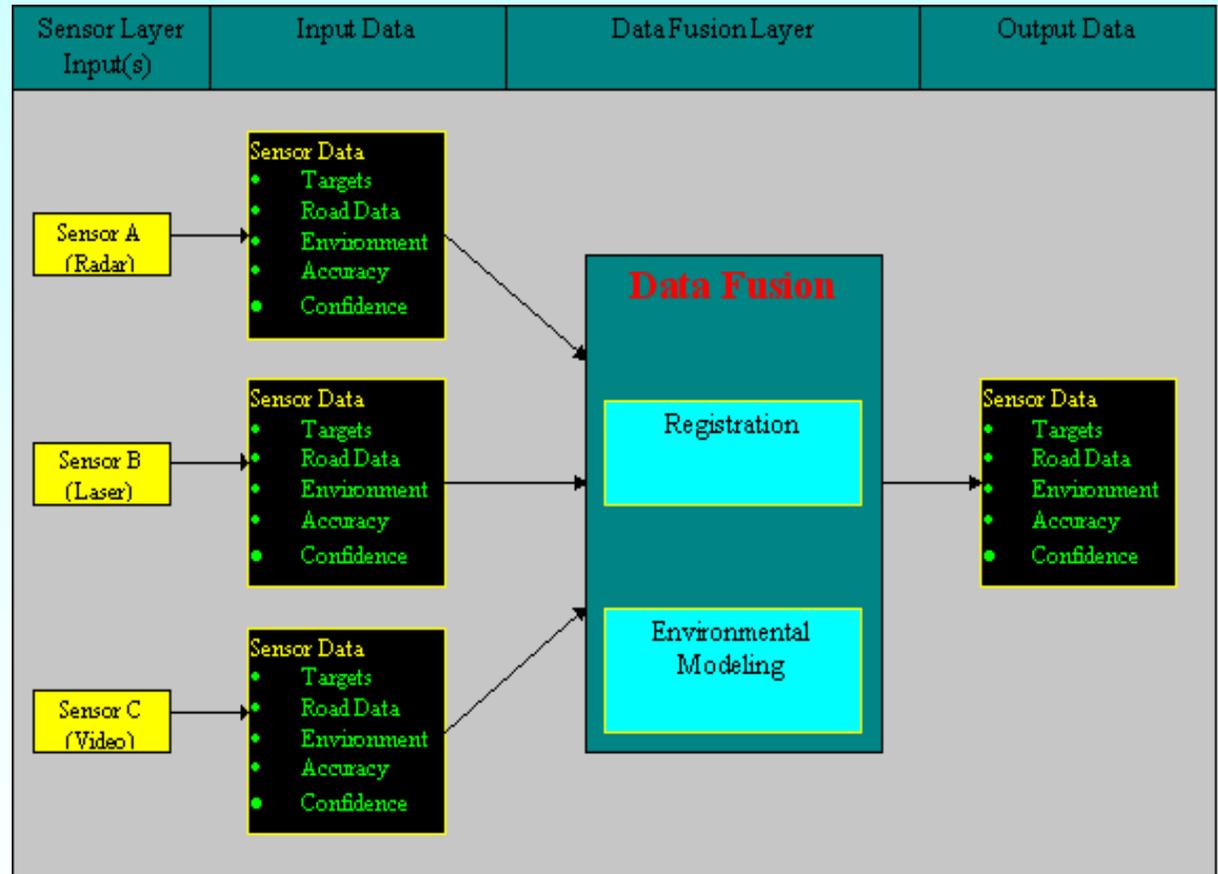


Architecture

Final Data Fusion Architecture

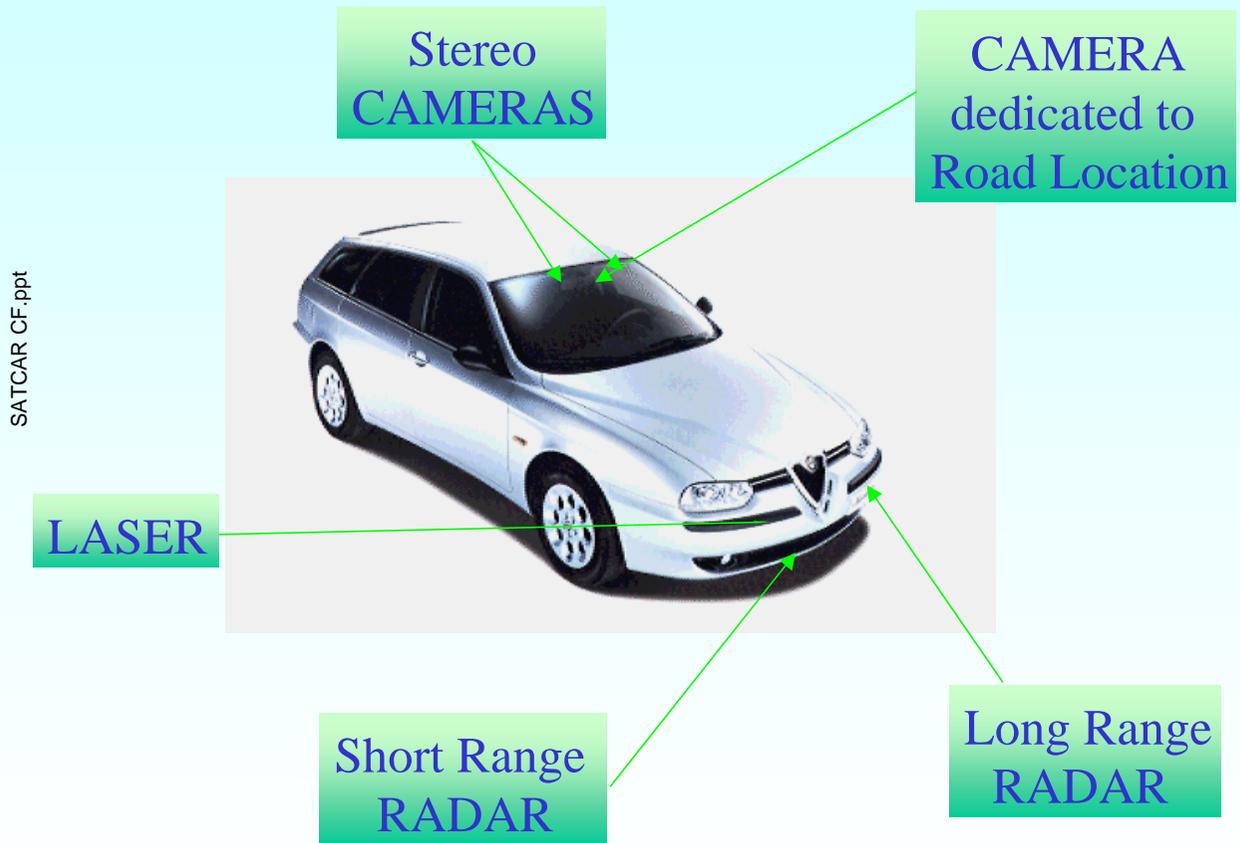
- Standard CAN protocol
- object oriented approach
- sensor data being defined as a standard object
- Modification of external sensors
- Plug & Play architecture
- Flexible
- Graceful Degradation
- Platform Independence

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Vehicle presentation with sensor position

Alfa 156 SportWagon 2.0 Selespeed - CARSENSE Vehicle



VEHICLE CHARACTERISTICS

- Engine 2000 Twin Spark with 155 hp
- Robotic and/or automatic gear
- ABS sensors
- Yaw-Rate sensor
- Steering angle sensor

Data Fusion

High Bandwidth Datalogger

Captures Synchronised Data from

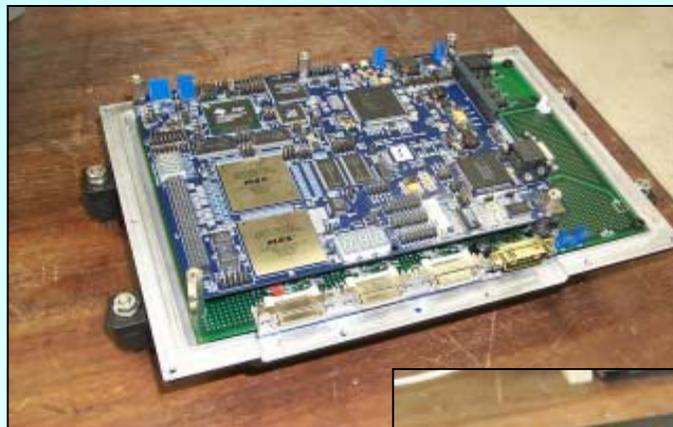
- 3 Cameras (raw)
- 3 Sensor CAN Buses (processed sensor output)

Enables development of sensor fusion algorithms using a PC environment

- Database of scenarios (see WP6)
- Visualisation of Fused Sensor output



Data Fusion Unit (TRW)



Embedded Image Processing & Fusion Unit

Test sites

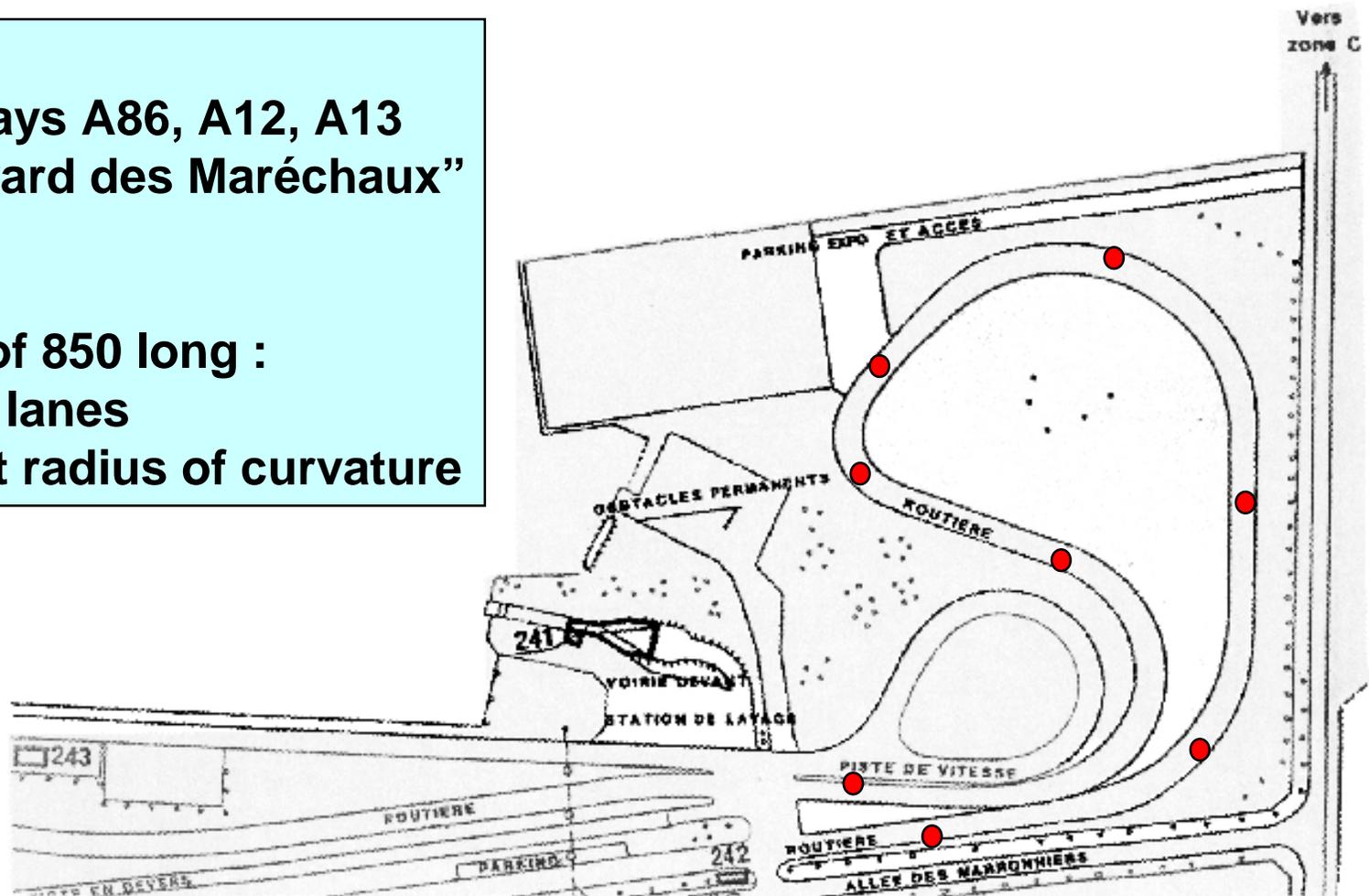
Open roads :

- Motorways A86, A12, A13
- “Boulevard des Maréchaux”

Tracks

A circuit of 850 long :

- straight lanes
- different radius of curvature



Conclucision

- CARSENSE is now at its mid-term of schedule
- Harmonisation of Interfaces was the most difficult task until now
- Small problems (connectors, power supply,...) and sensitive prototypes made work until now difficult; solved; car running
- Thus CARSENSE on track with good results and highly motivated partners