ICT - Emissions

Development of a methodology and tool to evaluate the impact of ICT measures on road transport emissions

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SEVENTH FRAMEWORK PROGRAMME

Project Partners

CENTRO RICERCHE FIAT

Telematics
Technologies
Transport
Traffic
Turin

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Contents

- Background
- Objectives
- Structure
- ICT Categories of interest
- Methodological approach

Guided by clear and ambitious objectives for a 50% more efficient European Road Transport System by 2030

Achieving the objectives requires collaborative and synchronised action by public and private partners

	Indicator	Guiding objective
Decarbonization	Energy efficiency: urban passenger transport	+80% *
	Energy efficiency: long-distance freight transport	+40% *
	Renewables in the energy pool	Biofuels: 25% Electricity: 5%
Reliability	Reliability of transport schedules	+50% *
	Urban accessibility	Preserve Improve where possible
Safety	Fatalities and severe injuries	-60% *
	Cargo lost to theft and damage	-70% *

* = versus a 2010 baseline

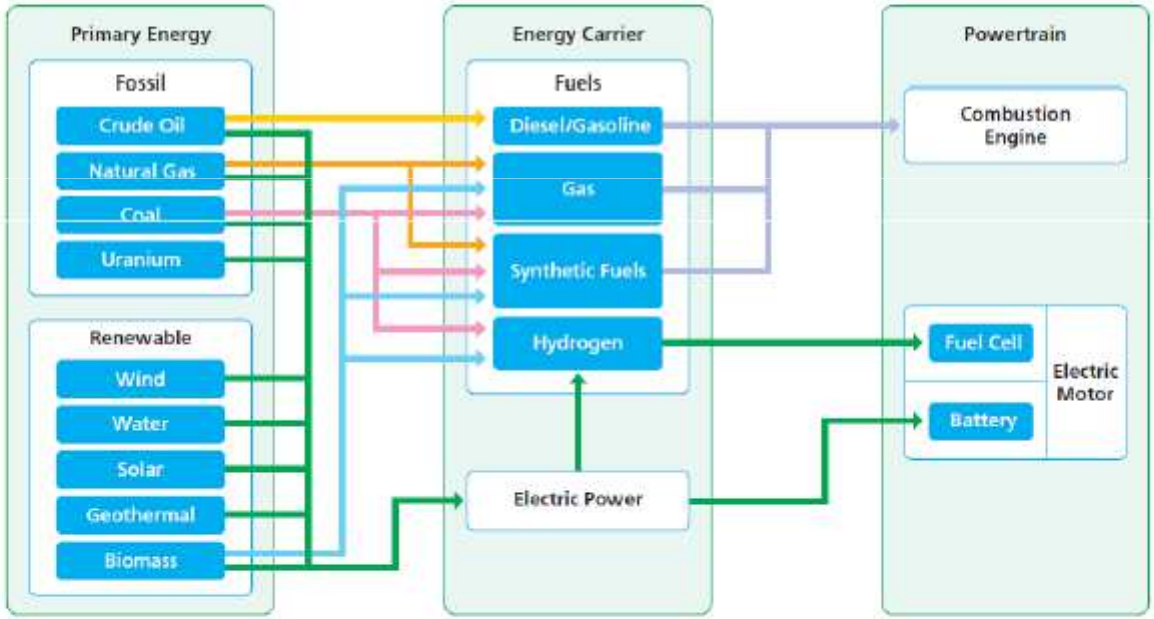
Following an Integrated Approach is Paramount

Target of ICT-Emissions

- To answer questions such as:
  - How does an ICT measure affect the driving pattern of single vehicles?
  - How is the average driver's behaviour affected by the measure?
  - How does the technology of different vehicles respond to the modified driving pattern?
  - What kind of shifts (intermodal and other), at fleet level, does the measure induce?

Decarbonisation: Key Research Priorities

- **Powertrains: Electric and Advanced Internal Combustion Engines**
  - Integrated Drivelines
  - Battery and Energy Storage Systems
  - Energy Management
  - High Performance from More Abundant Materials



- **Biofuels and Advanced Fuels Production**
- **Integrated information and Communication Technologies**
  - Vehicles, Infrastructure, and Services

- Main concept of the project:
  - Develop an integrated methodology that can be used to quantify the CO_2 emissions of ICT solutions for road transport with a view to the future

Steps

1. Develop/adapt vehicle simulators to calculate CO_2 emissions of cars when operating in ICT regimes
2. Use commercial traffic models to simulate the impact of ICT measures at the micro and macro scales, and link them to vehicle simulators
3. Validate the methodology on measured real-world ICT application cases
4. Collect the impact of ICT measures on traffic, energy and emissions in a library
5. Issue recommendations and implementation guidelines for use of best-practice ICT measures

Application range & boundary conditions

1. Passenger cars are the primary target and will be dealt with at both micro and macro scale
2. Trucks will be addressed only at the macro level
3. Urban scale
4. All current and future technologies of passenger cars
5. Buses and PTWs in a simplified manner

ICT categories of interest

Eco-driving and ADAS

Safety systems

Traffic management and control

Logistics and fleet management

Navigation and travel information services

Demand and access management

ICT-Emissions

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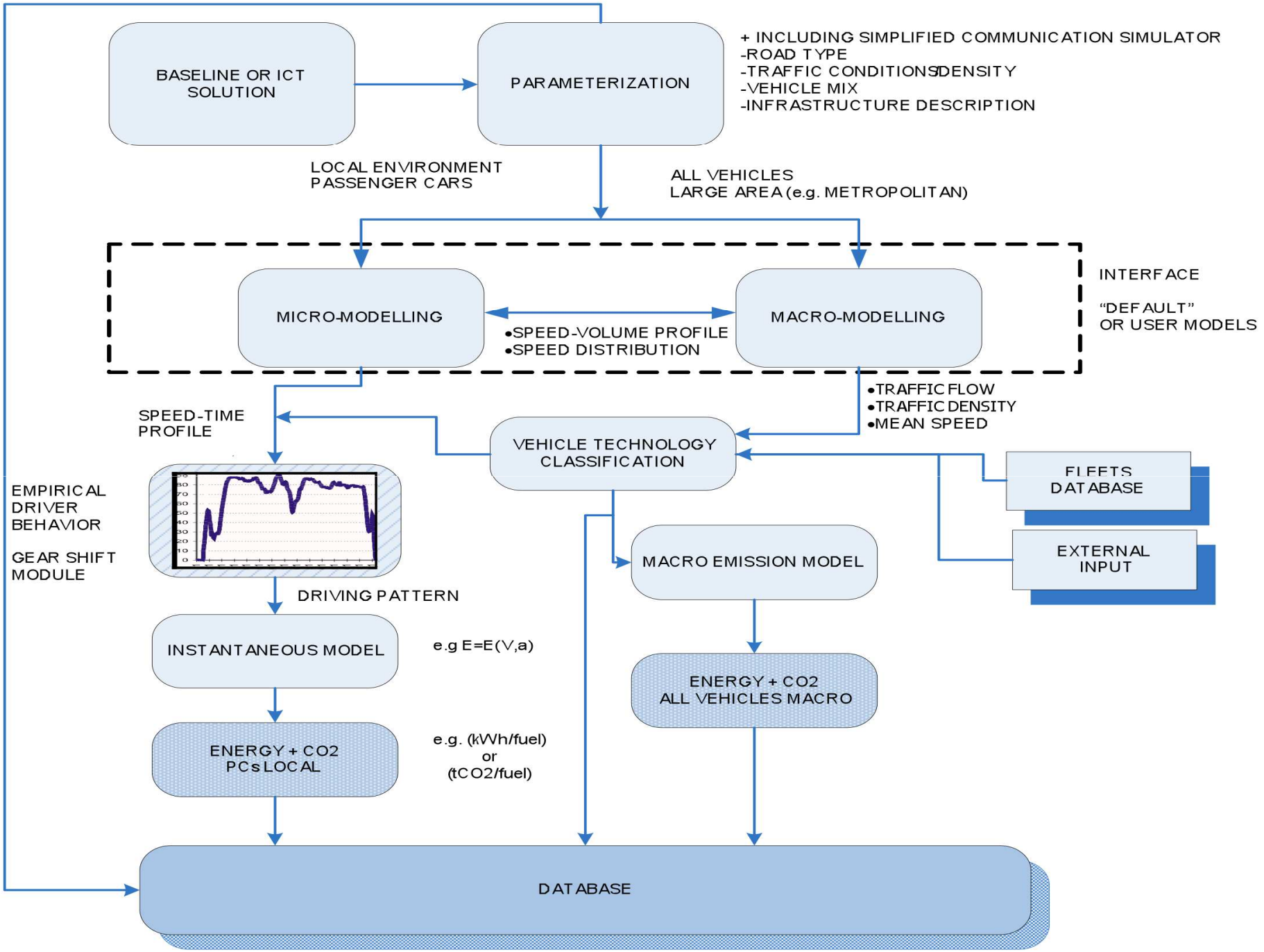
Beyond the State-of-the-art (1/3)

- The ICT-EMISSIONS project attempts to establish the missing links between traffic and emission modelling at the micro and the macro scale
- It will also develop an instantaneous emission model best suited to be linked to traffic micro-scale models

A flowchart of the methodology to realize this progress beyond the state of the art is given to the next slide

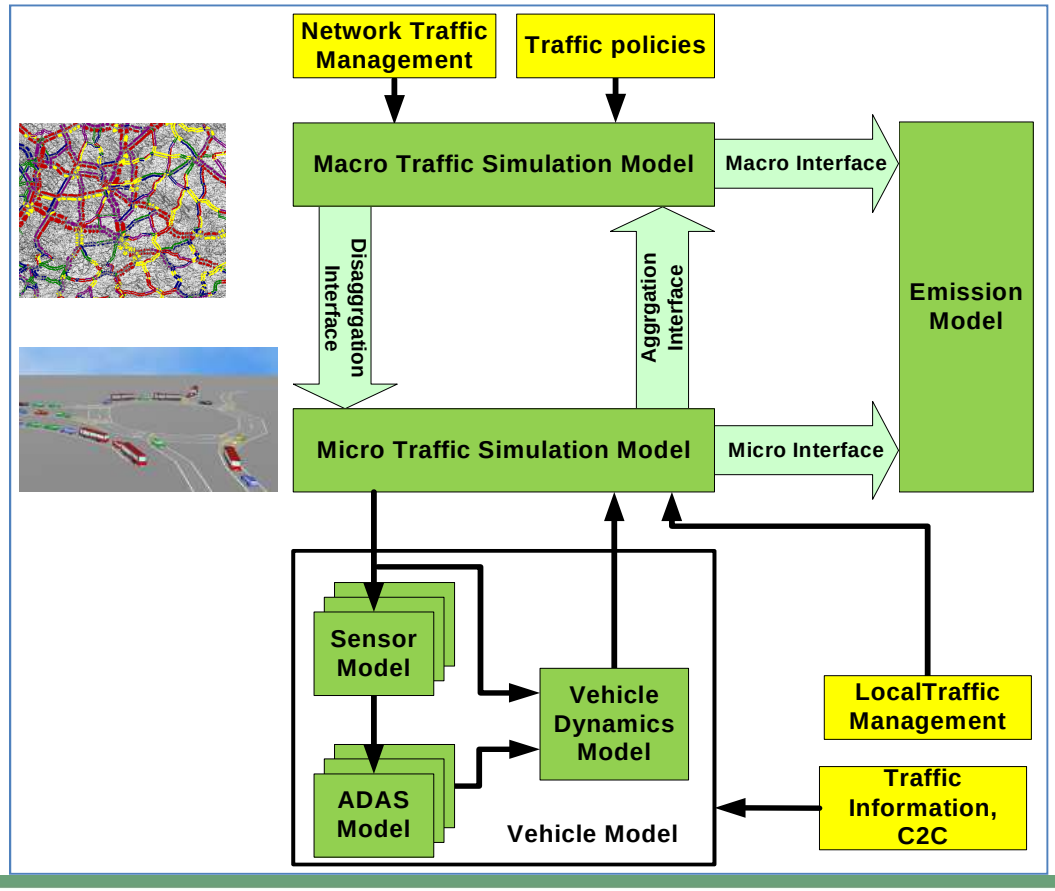

BASELINE OR ICT SOLUTION
PARAMETERIZATION
+ INCLUDING SIMPLIFIED COMMUNICATION SIMULATOR
-ROAD TYPE
-TRAFFIC CONDITIONS/DENSITY
-VEHICLE MIX
-INFRASTRUCTURE DESCRIPTION
LOCAL ENVIRONMENT
PASSENGER CARS
ALL VEHICLES
LARGE AREA (e.g. METROPOLITAN)
MICRO-MODELLING
MACRO-MODELLING
•SPEED-VOLUME PROFILE
•SPEED DISTRIBUTION
INTERFACE
"DEFAULT"
OR USER MODELS
•TRAFFIC FLOW
•TRAFFIC DENSITY
•MEAN SPEED
SPEED-TIME PROFILE
VEHICLE TECHNOLOGY CLASSIFICATION
FLEETS DATABASE
EXTERNAL INPUT
EMPIRICAL DRIVER BEHAVIOR
GEAR SHIFT MODULE
MACRO EMISSION MODEL
DRIVING PATTERN
INSTANTANEOUS MODEL
e.g E=E(V,a)
ENERGY + CO2 ALL VEHICLES MACRO
ENERGY + CO2 PCs LOCAL
e.g. (kWh/fuel) or (tCO2/fuel)
DATABASE

Beyond the State-of-the-art (3/3)

- Cooperative Solutions /Combination of traffic measures with vehicle technology (ADAS)

- Three sub-models:
  - Sensor model
  - Vehicle dynamics model
  - ADAS model

Micro-macro simulation in the case of ADAS



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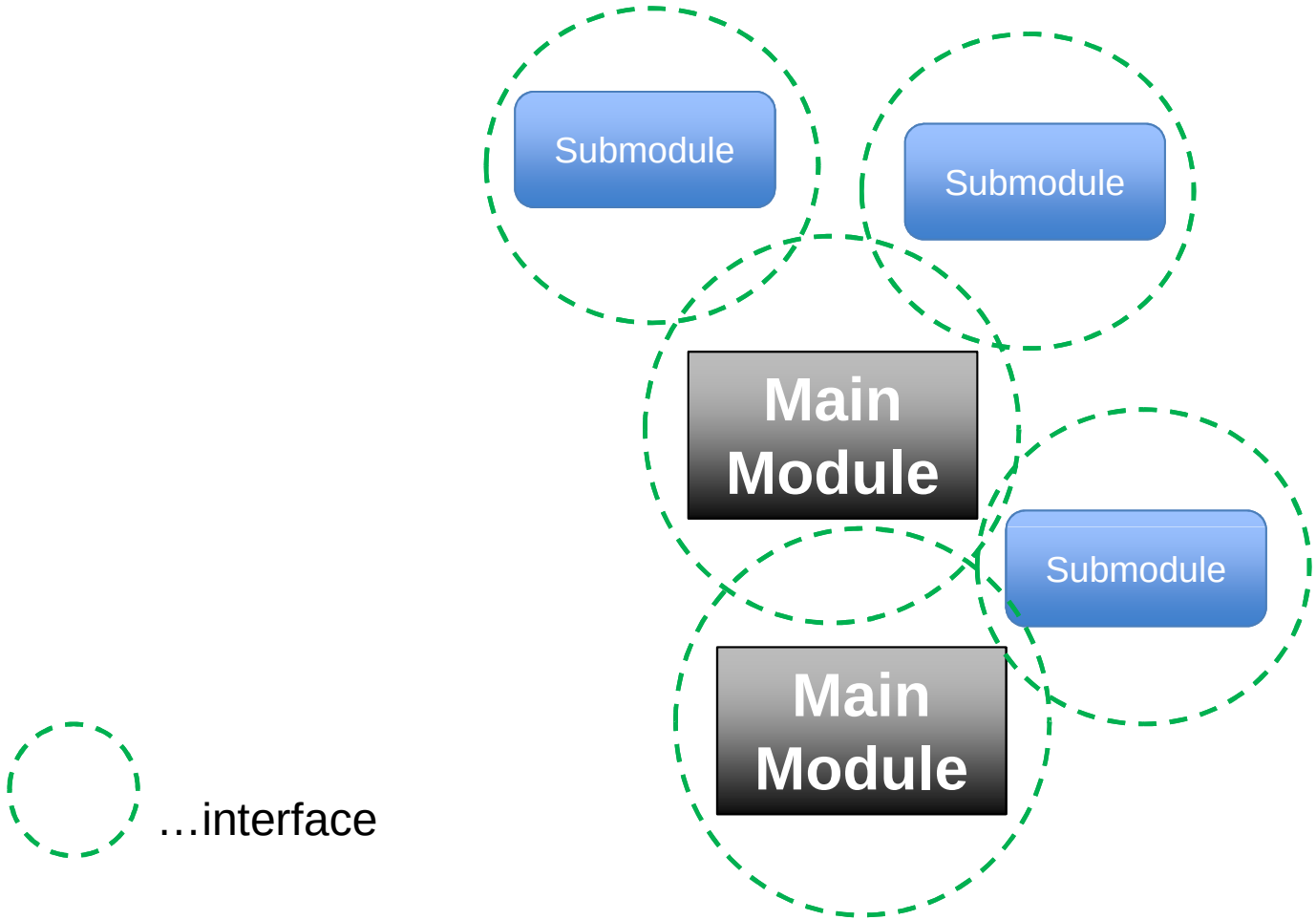
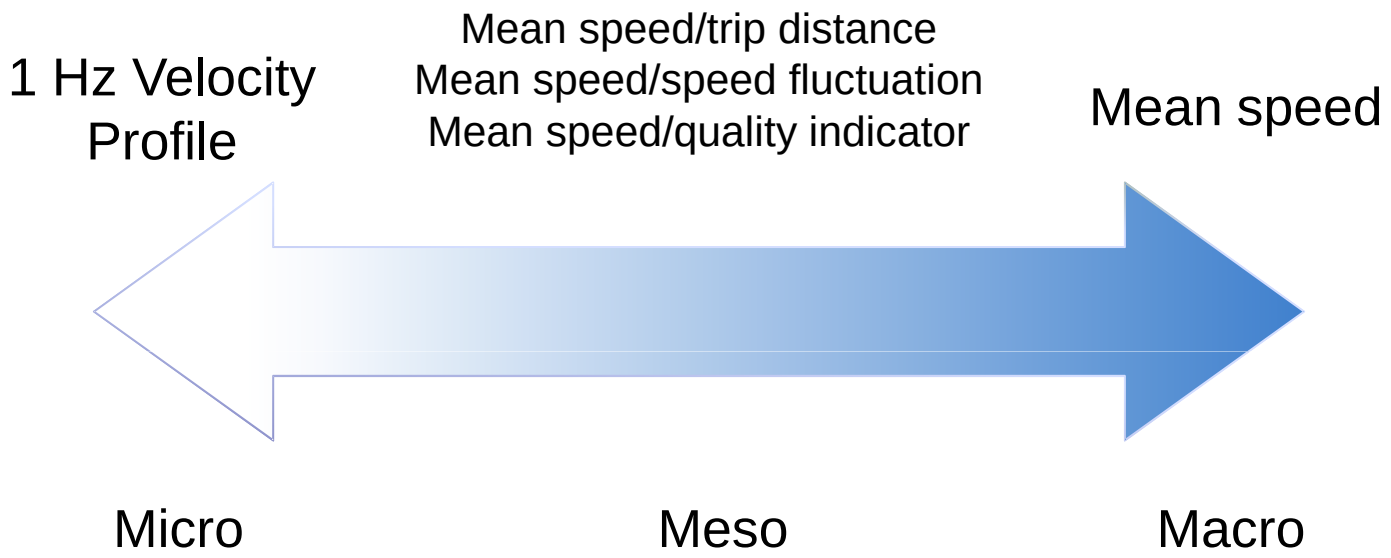

Submodule
Submodule
Main Module
Submodule
Main Module
…interface

Main Modules

- Traffic
  - Micro, Macro, Meso
- Emission/Energy
  - Instantaneous, Macro, Hybrid

Extensions/revisions that both need

Scales


1 Hz Velocity Profile
Mean speed/trip distance
Mean speed/speed fluctuation
Mean speed/quality indicator
Mean speed
Micro
Meso
Macro

Submodules

- Driver (eco, average, aggressive)
  - ADAS
  - Gear shift
- Vehicle choice
  - Category
  - Technology
- ‘Simplified’ communicator
  - Time lag
  - Precision
- Parameterization

Structure
&
Operation

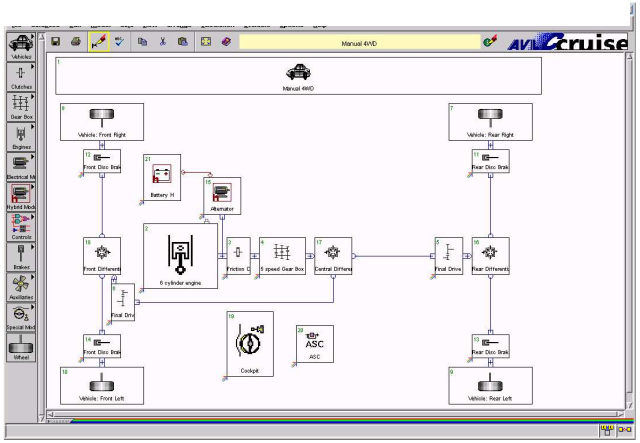
ICT-Emissions Traffic Models

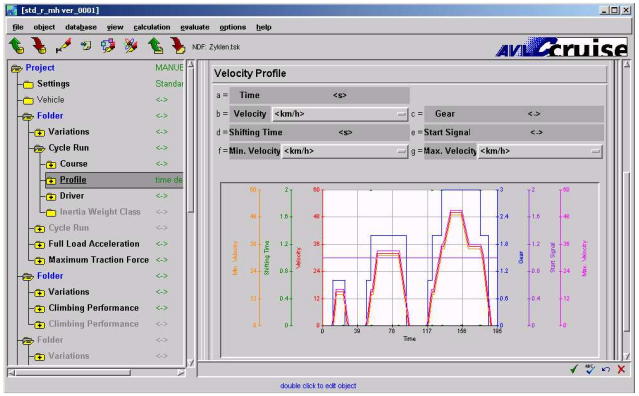
- Macro scale:
  - MT.Model
  - Vissum
- Micro scale
  - Aimsun
  - Vissim
- ADAS/Driver model
  - Messina based Berner & Mattner

ICT-Emissions Emissions Models

- COPERT: An average speed – macro scale model and
- CRUISE: a modal – micro emission model

Micro scale emissions model

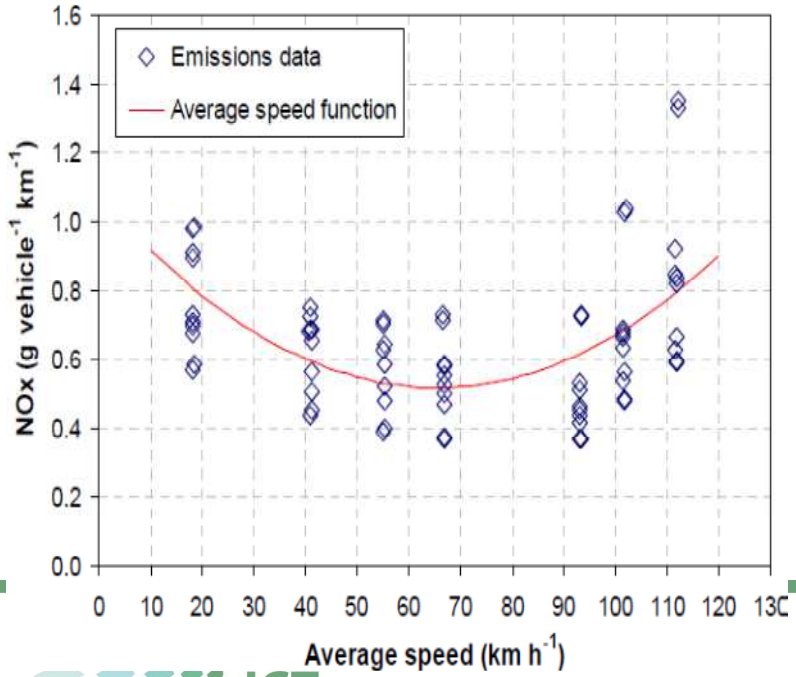




Vehicle simulation AVL CRUISE

- Prediction of fuel consumption, emissions and vehicle performance
- Designed for modelling any kind of vehicle powertrain configurations
- Intuitive component based powertrain models
- Driver model for closed loop control of vehicle
- Fully implemented vehicle test procedures
- Coupled with AVL BOOST engine, cooling/lubrication & aftertreatment models

Macro scale emissions model



- We will use and base our development on COPERT 4, the EEA's average speed model
- We will also use the FLEETS database with detailed data for European fleets

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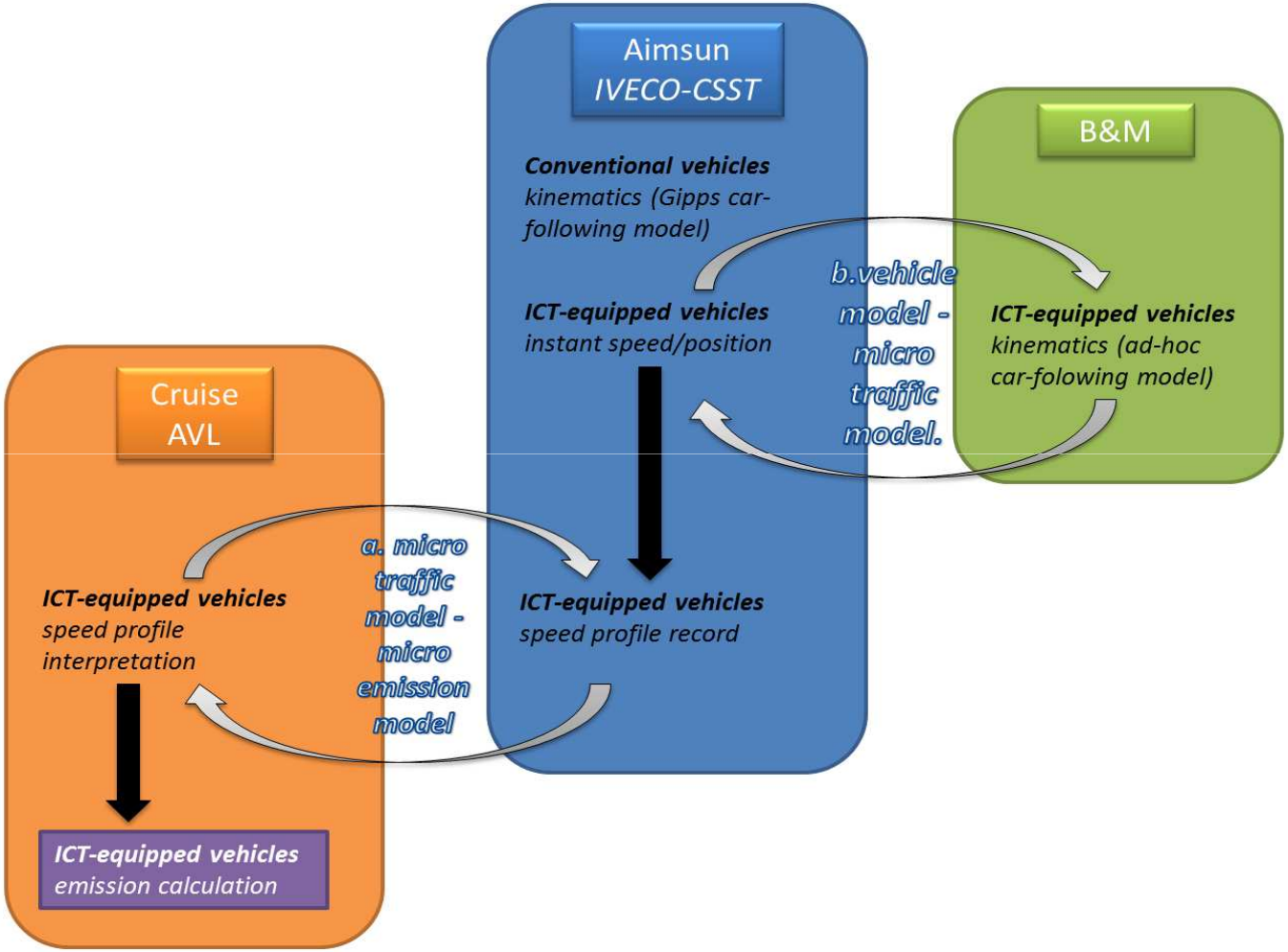
Model integration at Micro level



Extended COPERT

- Aggregate micro-models over predefined driving patterns to build COPERT-type functions for new vehicle categories
- Extend capability by introducing one more parameter
  - level of aggressiveness, power ratio
- Calibration based on ERMES database / New Measurements for conventional vehicles

Conventional vehicle types

- Market segments:

Segment	Name	Typical Models
A	Micro-size	Fort Ka, Smart Fortwo, Toyota iQ
B	Mini-size	Nissan Micra, Renault Clio, Skoda Fabia
C	Compact	Ford Focus, Opel Astra, Volvo S40
D	Medium	Alfa 156,Citroen C5, Saab 9-3
E	Large	Audi A6, BMW 5-series, Lexus GS
F	Luxury	Audi A8, BMW 7-series, Mercedes S-class
G	2-seater sports	Audi TT, Mercedes SLK, Porsche 911
H	Box	Citroen Berlingo, Renault Kangoo, VW Caddy
VAN	Vans	Citroen C8, Renault Espace, VW Sharan
MPV	Multi-purpose	Citroen C4 Picasso, Fiat Multipla, Renault Scenic

- Efficiency categories, e.g. Euro 3, Euro 5
- Fuels: Gasoline, Diesel

Advanced vehicle types

- Start-and-stop (+recuperation)
- GSI (dynamic, eco), Manual, TCT, Torque Converter, CVT
- Hybrid
- Plug-in hybrid
- Battery-electric

Real world driving patterns

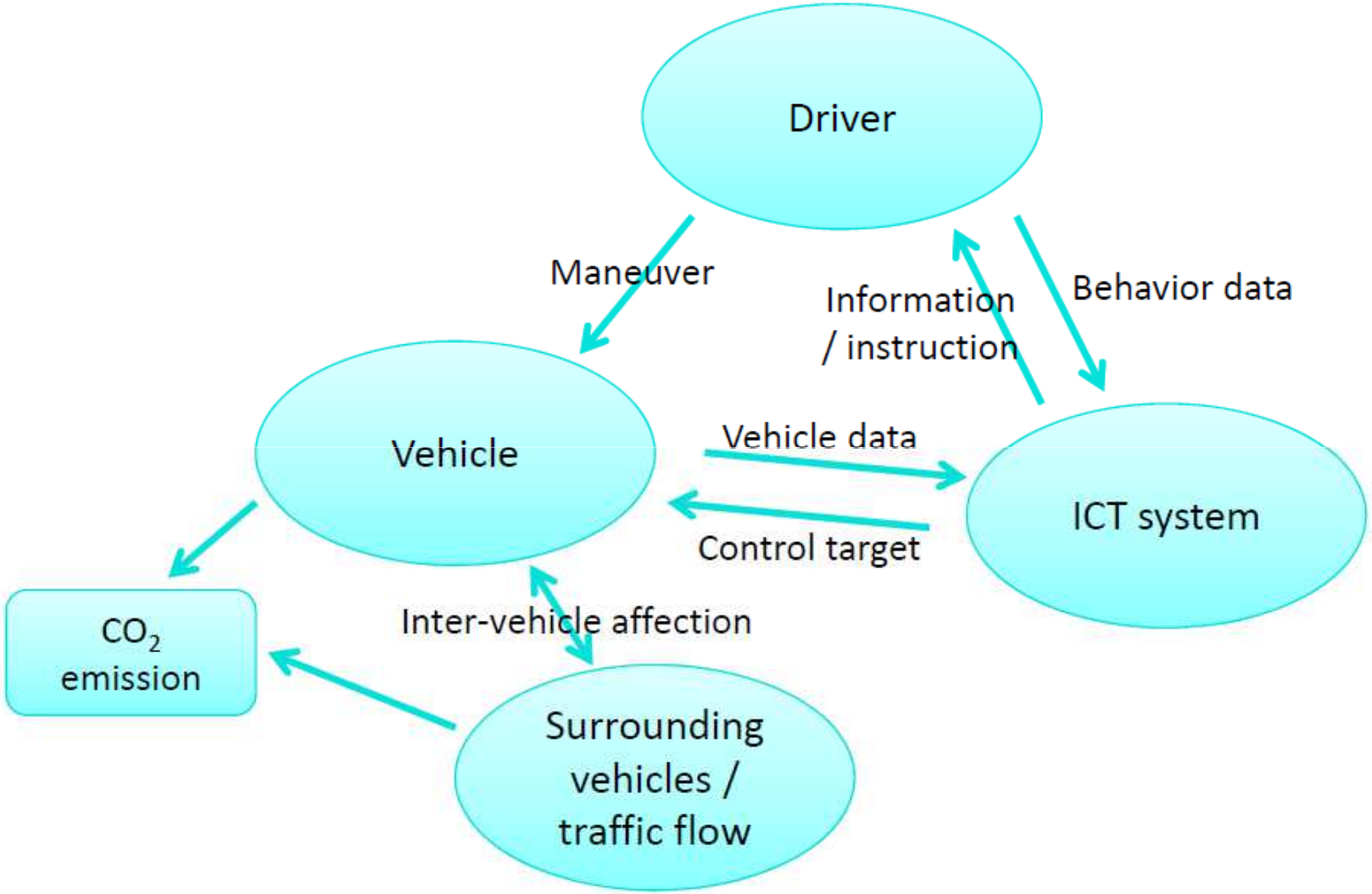
- World wide Light Duty Driving Cycle (WLTC) ~ 500,000 km from across Europe
- FIAT's eco:drive data

Validation

- Internal validation (consistency check), i.e. the model should reproduce the measurement

- Validation with GPS equipped vehicles with on-board fuel consumption measurement
  - At least 4 vehicles measured over different traffic scenarios

Common Reference Model for Category#1
~ Improving Driving Behavior



Thank you for your attention!

http://www.ict-emissions.eu/