Italian education on ITS: from research outcomes to a modernized education

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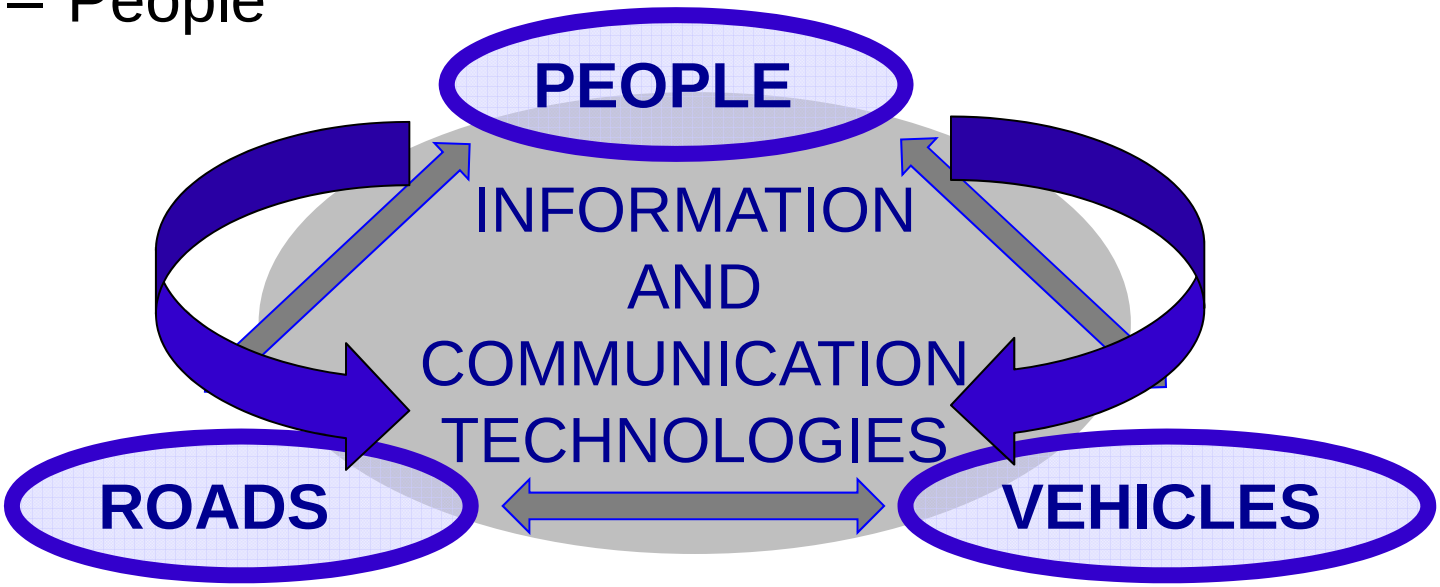
Definition of Intelligent Transport Systems

- 'Intelligent Transport Systems' (ITS) integrate ICT technologies with transport engineering in order to plan, design, operate, maintain and manage transport systems.
- *Technologies* are *enabling elements*.
- Their application is not a sufficient condition for the system be intelligent
- Intelligence requires the system can adapt its operational characteristics to external conditions
- Technologies, users and decision-makers are elements of such an adaptive system.

Components of the transport system

- Traditional definition of the transport system:
  - Roads
  - Vehicles
  - People

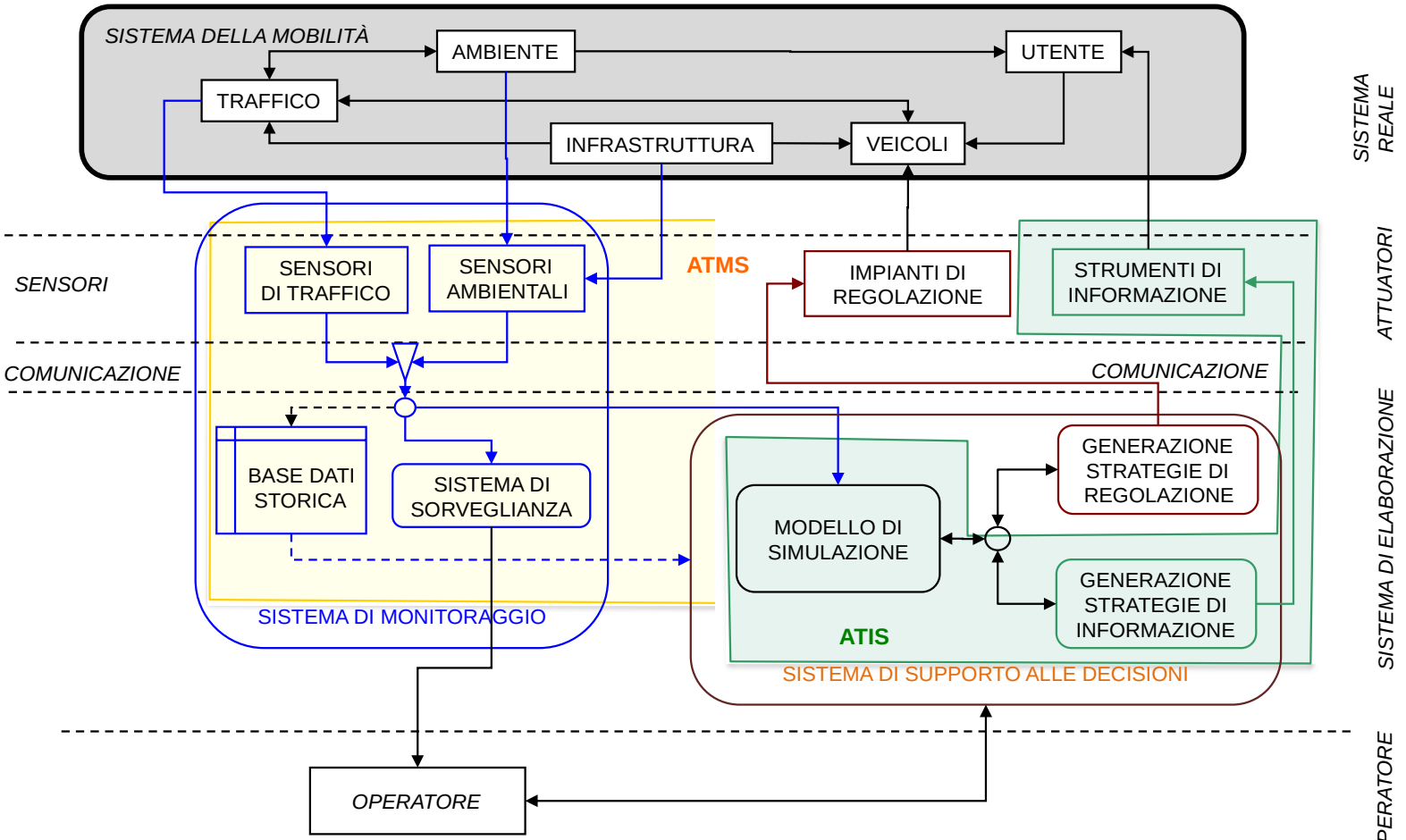
ICT allows components communicating each others and increases the information on near and far environment



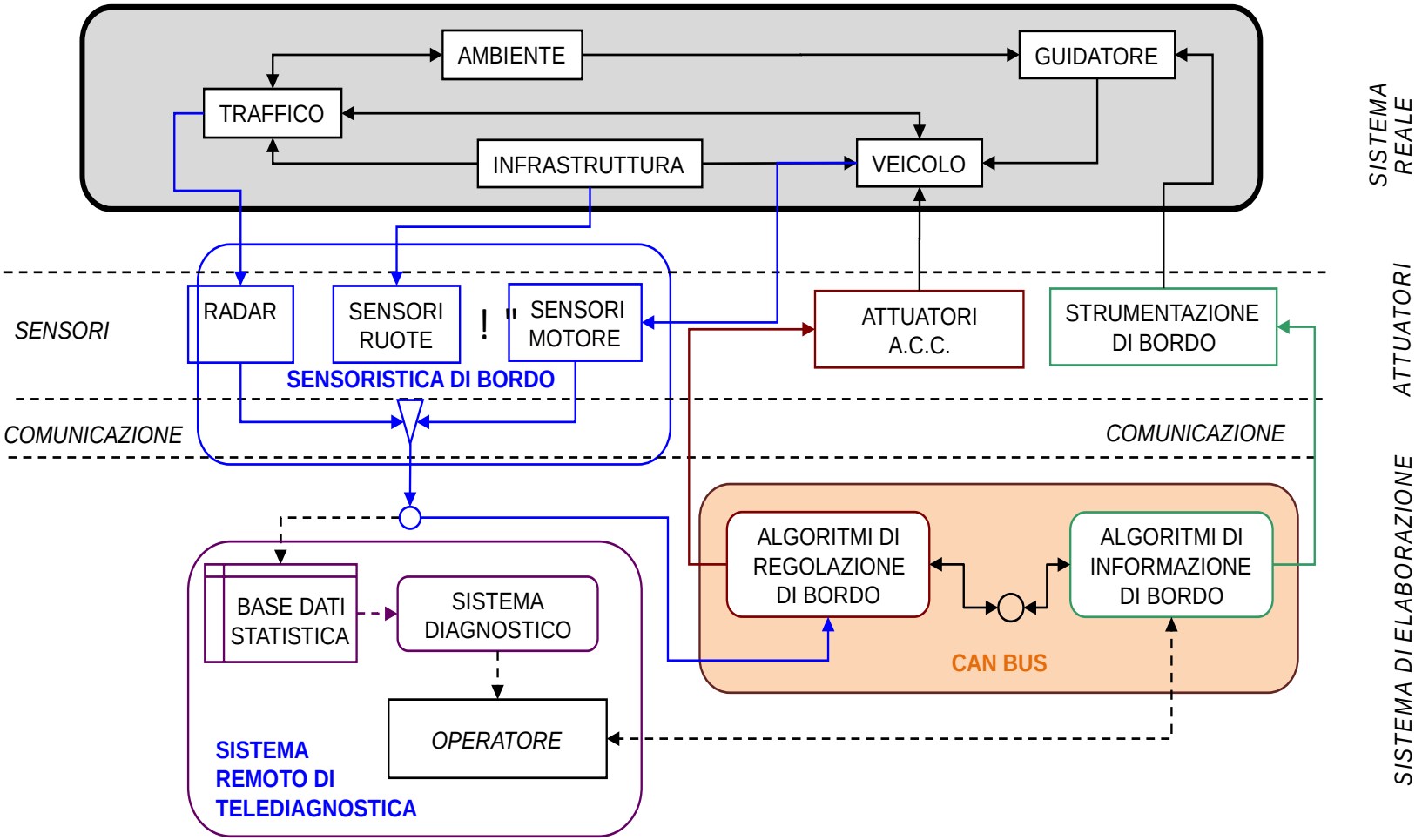
Conditions for ITS be intelligent

- Indeed, it is the design of functions and technologies applied to achieve predefined objectives efficiently that encompasses the intelligence of the system.
- Two conditions are required:
- The first is the definition of a desired state of the system under control.
- The second is that ITS functions and technologies:
  - enable the system to react to unpredicted perturbations *automatically* or
  - provide users and decision-makers with an improved knowledge of the system, thus *enabling them* to perform appropriate actions.

ITS for the road network



ITS for the vehicle



Education needs on ITS

- Different applications, a unique framework
  - Dynamic interactions man-road-vehicle-environment
  - Needs for Control and Information on the system
- Multidisciplinarity:
  - Transport system theory
  - ICT
  - Automatic control
- Theoretical skills:
  - Modeling dynamic systems
- Engineering:
  - Design
  - Test cases

Graduate Programs in Engineering at Sapienza University of Rome

- Aeronautics
- Biomedical
- Chemical
- Civil Engineering
- **Transport Systems**
- Safety and Civil Protection
- Nanotechnologies
- Electrical
- Energy
- Mechanical
- Environmental
- Space and Astronautics
- Computer Science
- Information Systems
- Telecommunications
- Electronics
- Management Engineering
- Automatic Control
- Management Statistics
- Statistics, economy and society
- Statistics, economy, finance and insurances

Graduate Program in *Transport Systems Engineering*

- Transport Systems Models
- Freight Transport and Logistics
- Design of Transport Terminals
- Traffic Engineering → **Intelligent Transport Systems**
- Design of Railway Systems
- Transport Policies
- Maritime Transport
- Road Transport → **Intelligent Transport Systems**

Course of Intelligent Transport Systems

- Traffic Flow Theory
- Fundamentals of Automatic Control
- Traveler Information Systems
- Technologies for Traffic Monitoring and Tracking
- Dynamic Freeway Traffic Management
- Dynamic Traffic Signal Control
- Public Transport Management Systems
- Advanced Logistic Systems
- Advanced Vehicle Control Systems
- Models for Intelligent Transport Systems Design
- Application to case studies

Course of Intelligent Transport Systems

- Objective of the course is to provide students with the following skills:
  - Understand functional principles of ITS
  - Learn technical characteristics of single components
  - Be skilled at methods for analysis and design of ITS.
- Rationale of the course:
  - Integrate disciplines and competencies
  - Unifying theory
  - Common Methods
  - Example applications
  - From “Know How” to “Know Why”

Course of Intelligent Transport Systems: stages

- Accenture (ICT Company)
- Almaviva (ICT Company)
- Automobile Club of Italy (Public Body)
- ENEA (National Agency for Energy)
- Roma Servizi per la Mobilità (Mobility Agency of Rome)

Master on Applied Telematics (sponsor: Register of Hauliers)

- Theoretical background:
  - Freight Transport and Logistics Models
  - Intelligent Transport Systems for Logistics
- Seminars by Industry senior experts:
  - Magneti Marelli
  - Elsag Datamat
  - CEVA Logistics
  - Bridgestone
- Case study:
  - Design an urban freight distribution system (case study: Padua)

Education & Research on ITS

- Intelligent Transportation Systems arise from technology advances in ICT
- Research activities produce a continuous evolution of ITS applications as far as:
  - Technology
  - Models
  - Methods
- Education on ITS needs be updated by outcomes of research continuously

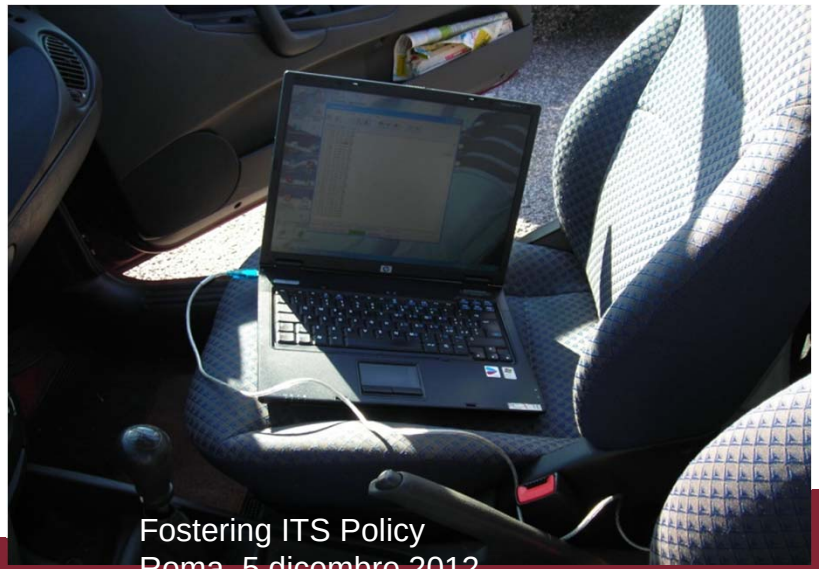
Research & Education: few examples

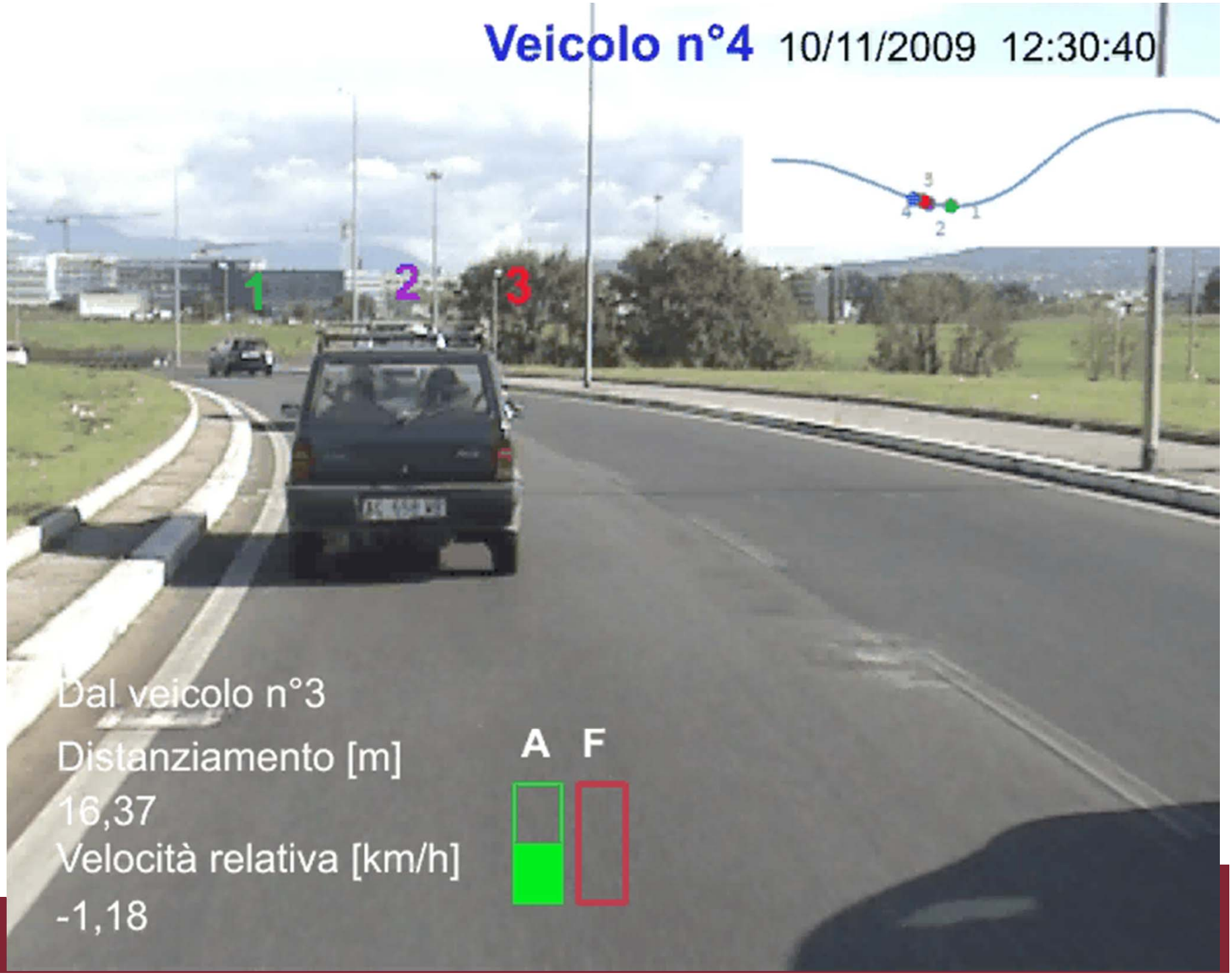
- Experiments on car drivers behavior
- Analysis of Floating Car Data
- Safety conditions for transport of dangerous goods
- GPS travel time monitoring for assessment of traffic signal plans
- Microscopic traffic simulation-assignment model
- Advanced methods for transit network design

Experiments on driver behavior

- Objectives of the experiment:
  - Observe drivers' behavior within a traffic stream on different roads
  - Assess state-of-the art car following models
  - Develop new models suitable for ITS applications
- Equipments: 4 high frequency GPS receivers
- Data processing: data post processed through reference station MOSE
- Team: Prof. Gaetano Fusco, Dr. Chiara Colombaroni, Eng. Stefano Lo Sardo, Eng. Giorgio Sinibaldi

Pictures of experiments



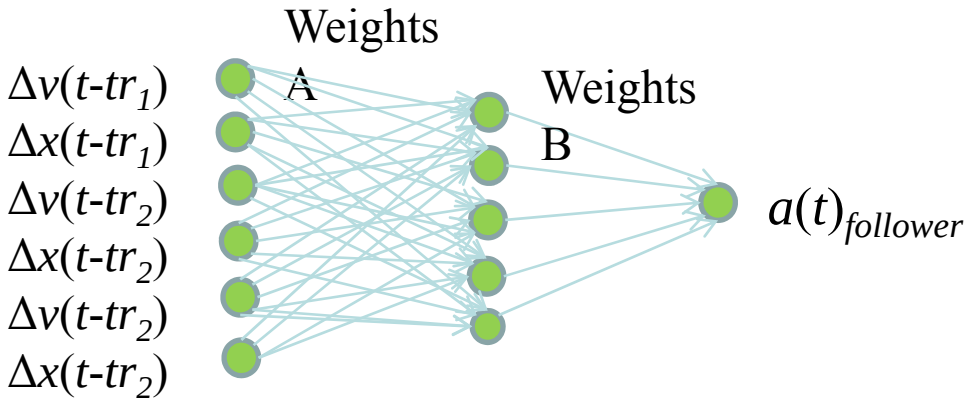

Veicolo n°4 10/11/2009 12:30:40
1
2
3
Dal veicolo n°3
Distanziamento [m]
16,37
Velocità relativa [km/h]
-1,18
A F

Example of Neural Network model

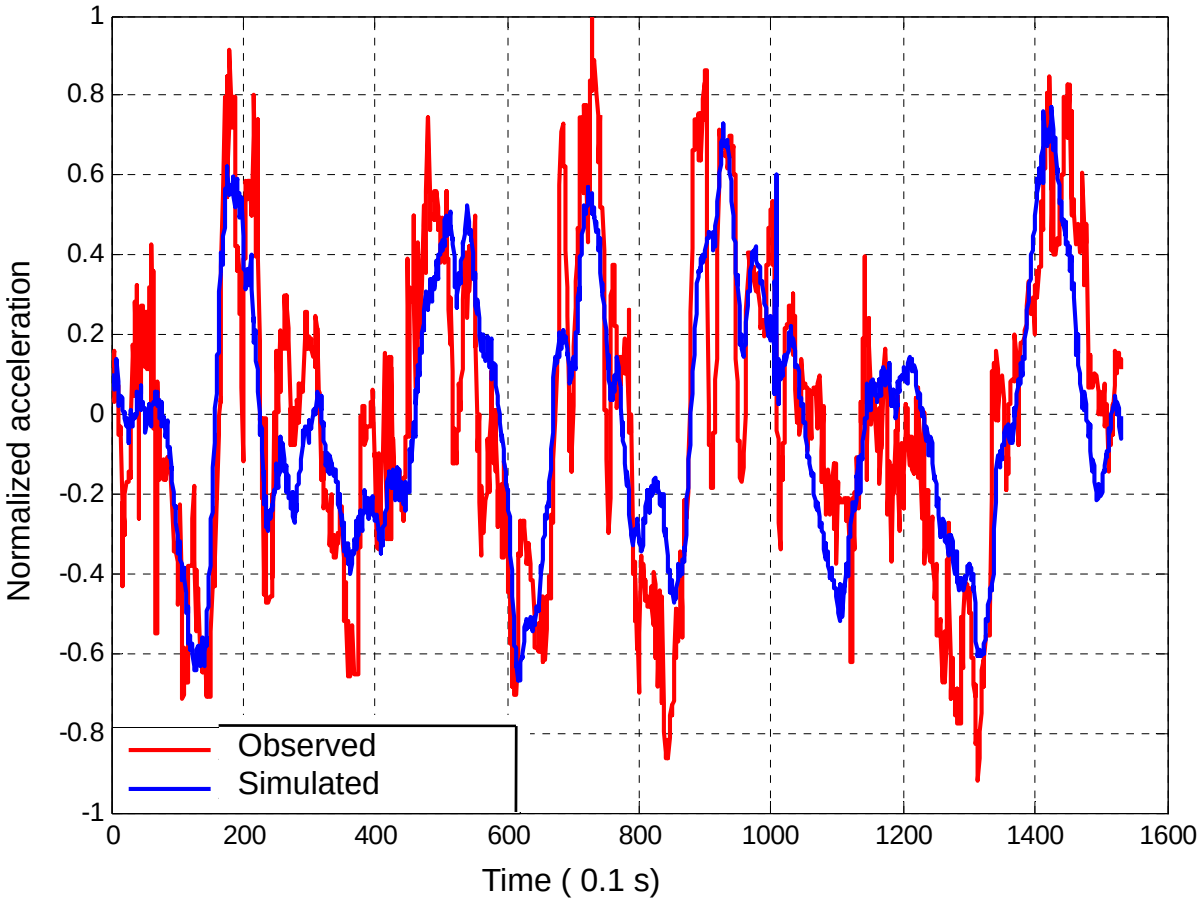
General Motors car following model (Gazis et al.1959)

$$a_n(t) = c\frac{[v_n(t)]^m}{[s(t-\tau_n)]^l}\Delta v(t-\tau_n)$$

Artificial Neural Network (Colombaroni and Fusco, 2011)



Observed vs. simulated acceleration



Requisites for ITS Professionals

- ITS are continuous changing and growing matter
- Interdisciplinary skills
- Capability to understand, analyze and model a complex system (interaction roads-people-vehicles-environment)
- Capability to envision, design, test and validate ITS applications
- This means: Conceive rational, efficient and effective applications consistent with predefined objective
- Technologies are necessary, not sufficient for ITS!