

# Future Traffic Management Concepts and Challenges



**Prof. Markos Papageorgiou**

Dynamic Systems and Simulation Laboratory,  
Technical University of Crete, Chania, Greece



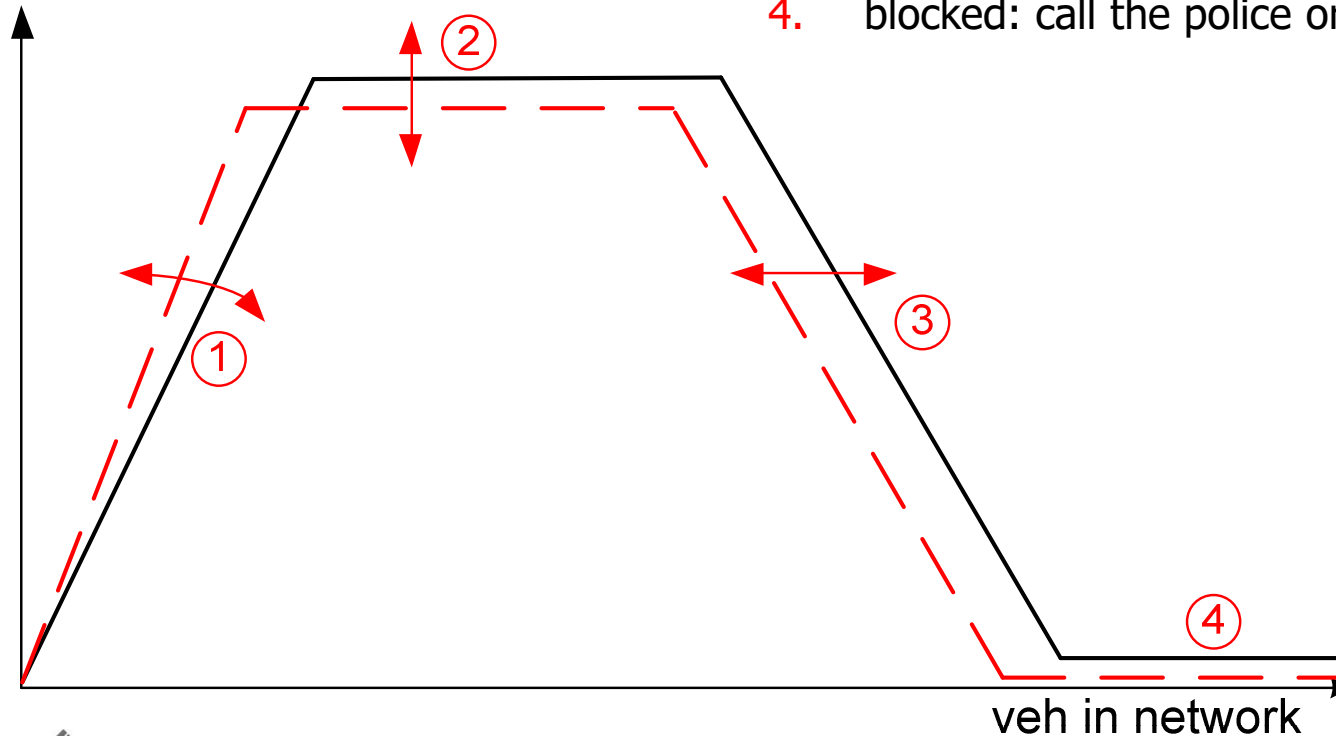
# 1. WHY TRAFFIC MANAGEMENT (TM)?

- Motorised road vehicle: A highly influential invention ➡ **Vehicular traffic**
- Vehicles share the road infrastructure among them, as well as with other (vulnerable) users: **TM needed**
- Few vehicles: **Static TM for safety**
- Many vehicles: **Dynamic TM for efficiency**
- Too many vehicles (congestion): **Dynamic TM for protection from degradation**

# Network Fundamental Diagram (NFD)

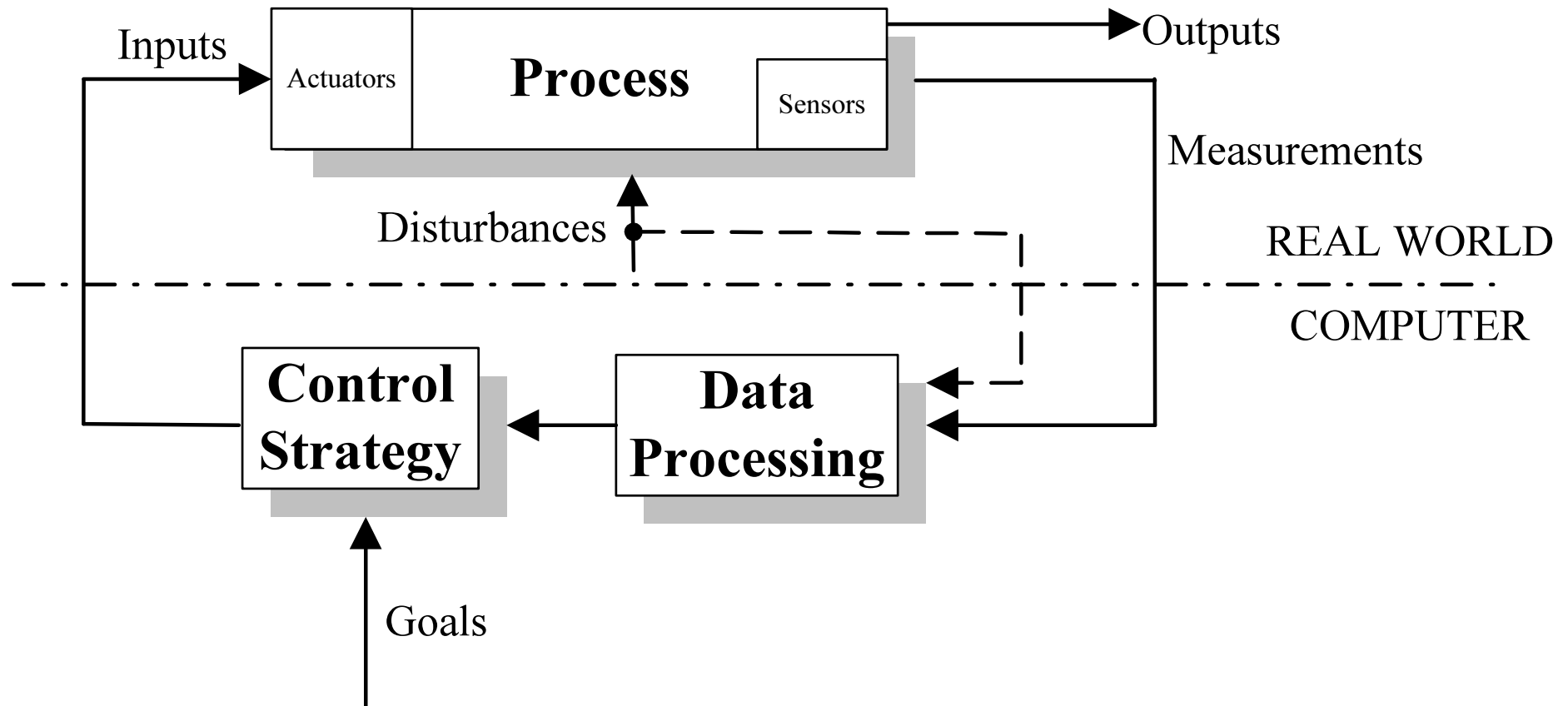
(Fahri, 2008; Geroliminis & Daganzo, 2008; Helbing 2009)

total network flow or  
flow of exiting  
vehicles (veh/h)



1. undersaturated; maximise speeds!
2. saturated: maximise capacity!
3. oversaturated: queue management, metering!
4. blocked: call the police or walk home!

# Basic elements of an automatic control system



**Technology** (Sensors, communications, computing, actuators): **Skeleton**

**Methodology** (Data processing, control strategy): **Intelligence**

# Current TM Systems (ITS)

- **Process:** vehicle flow
- **Sensors:** spot sensors
- **Communications:** wired
- **Computing:** central, decentralised, hierarchical
- **Actuators:** road-side

# Future TM Systems (C-ITS)

- **Process:** enhanced-capability vehicles
- **Sensors:** vehicle-based
- **Communications:** wireless, V2V, V2I, I2V
- **Computing:** central, massively decentralised, hierarchical
- **Actuators:** in-vehicle

Implications/Exploitation for traffic flow efficiency?

## 2. MAIN CURRENT TRAFFIC MANAGEMENT TOOLS ...

### (a) Motorways

- **Ramp Metering**: Few successful installations; Most (even metropolitan) motorways uncontrolled
- **Variable Speed Limits**: Great for safety; No efficiency improvement due to simplistic control strategies

**Current Status**: No capacity flow anywhere/anytime on uncontrolled (or badly controlled) motorways.



## (b) Urban Road Networks

- **Traffic Signal Control**: Good progress (but also possible improvements) in non-saturated conditions; No operational system for over-saturated conditions
- **Public Transport Priority**: Very significant advances/ implementations

**Current Status**: Reasonable performance but strong degradation when network overloaded.










## (c) Driver Information and Route guidance

- **Variable Message Signs:** Many installations
- **On-board navigators:** Infancy period

**Current Status:** Virtually no predictive systems;  
Serious route guidance strategies needed with  
increasing penetration

| Ventetid via  |   |
|---|---|
|  Tunnel ↑ 10 min |  Fr.havn ↗   |
|  Bro ↗ 5 min     |  Løkken ↗    |
|   |  Nr.sundby ↗ |



## **(d) Integrated Traffic Control**

- Urban/Motorway
- Within Motorway
- Guidance/Control

**Current Status:** Virtually no integration/synergy

# ... AND DIFFICULTIES

## **(a) Organizational**

- Reduced TM awareness
- Reduced TM funding
- Research-Practice gap

## **(b) Operational**

- Sensor density/type/reliability/maintenance
- Control strategy advances/deployment
- Closed off-the-shelf systems
- Difficult field comparison
- Integrated traffic control

# 3. EMERGING VACS (Vehicle Automation and Communication Systems)

- **Significant efforts:** Automotive industry, Research community, Government agencies
- Mostly vehicle-centric
- **Implications/Exploitation** for traffic flow efficiency?
- **TRAMAN21:** TRAffic MANAgement for the 21<sup>st</sup> Century (ERC Advanced Investigator Grant)  
<http://www.traman21.tuc.gr/>
- **Review** identified 88 different VACS
  - 46 safety related
  - 12 urban traffic
  - 30 motorway traffic



# 4. POTENTIAL CONTRIBUTIONS OF VACS ...

- Traffic safety: **Great benefits**
- V2V and V2I communication: **What to communicate?**
- Abundant/new information (e.g. mobile sensors, OD information): **How to use it with benefit?**
- Increased capacity (e.g. headway control, platooning, lane changing): **Under what conditions?**
- On-board, in-vehicle actuators (e.g. route guidance, speed limits): **Best usage?**
- Increased control granularity (e.g. by lane, by destination, flow splitting): **Increased opportunities**
- Efficient lane assignment
- Improved incident detection and management

# ... AND RELATED CHALLENGES

- Modified traffic flow characteristics: **New/extended traffic flow models**
- New/extended control strategies: **Exploit the new opportunities**
- Very large-scale systems: **Design, actors, reliability, vulnerability, security**
- Driver involvement: **What role? Acceptance?**
- Penetration level: **Moving target**
- Infrastructure investment: **Chicken or egg?**
- New operators role/generation?
- Long, evolutionary and uncertain process; contradictory development scenarios
- Legal aspects, liability, privacy, standardisation, ...

## 5. THE WAY FORWARD

- **Connect VACS and TM communities** (no need to re-discover the wheel)
- **VACS by function**: Potential TM applications?
- **TM by tool**: Potentially useful VACS functions?
- Co-evolution
- **TM continues to be vital while VACS are emerging**

**TRAMAN21 Workshop 2013:**

<http://www.traman21-workshop2013.tuc.gr/>

