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A way of automatic driving under complex traffic conditions (Human-machine cooperation)

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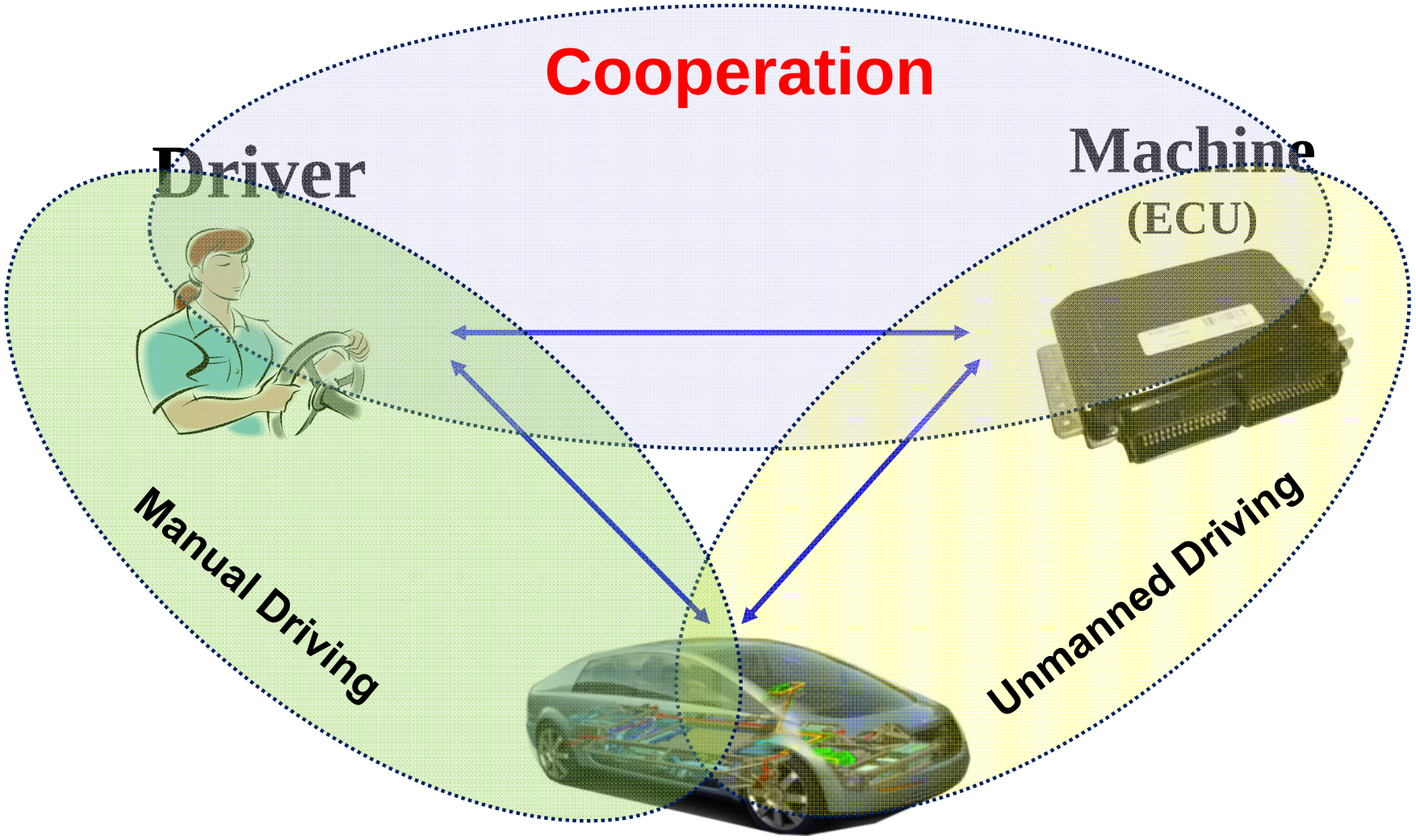
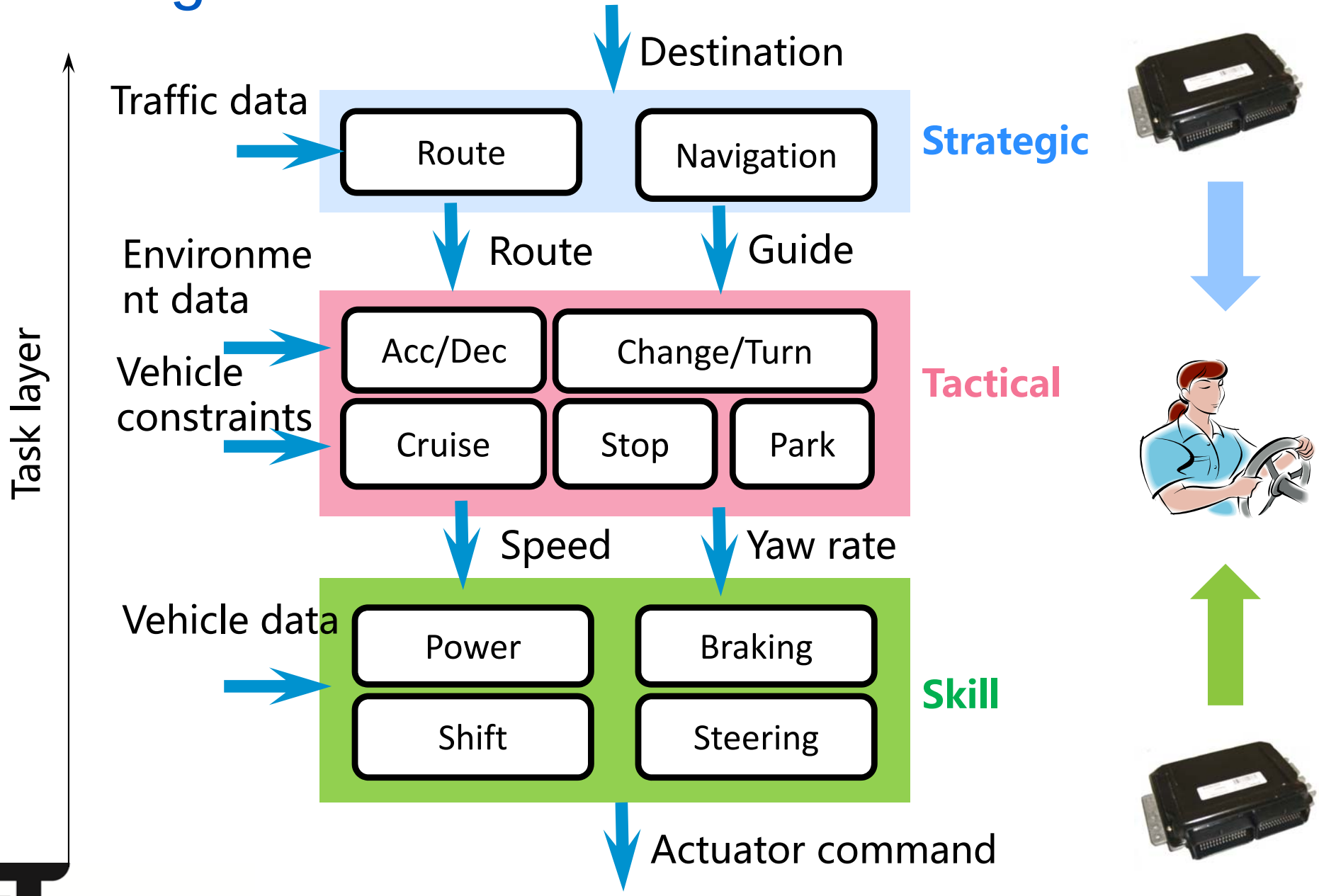
Driving evolution



Driving task



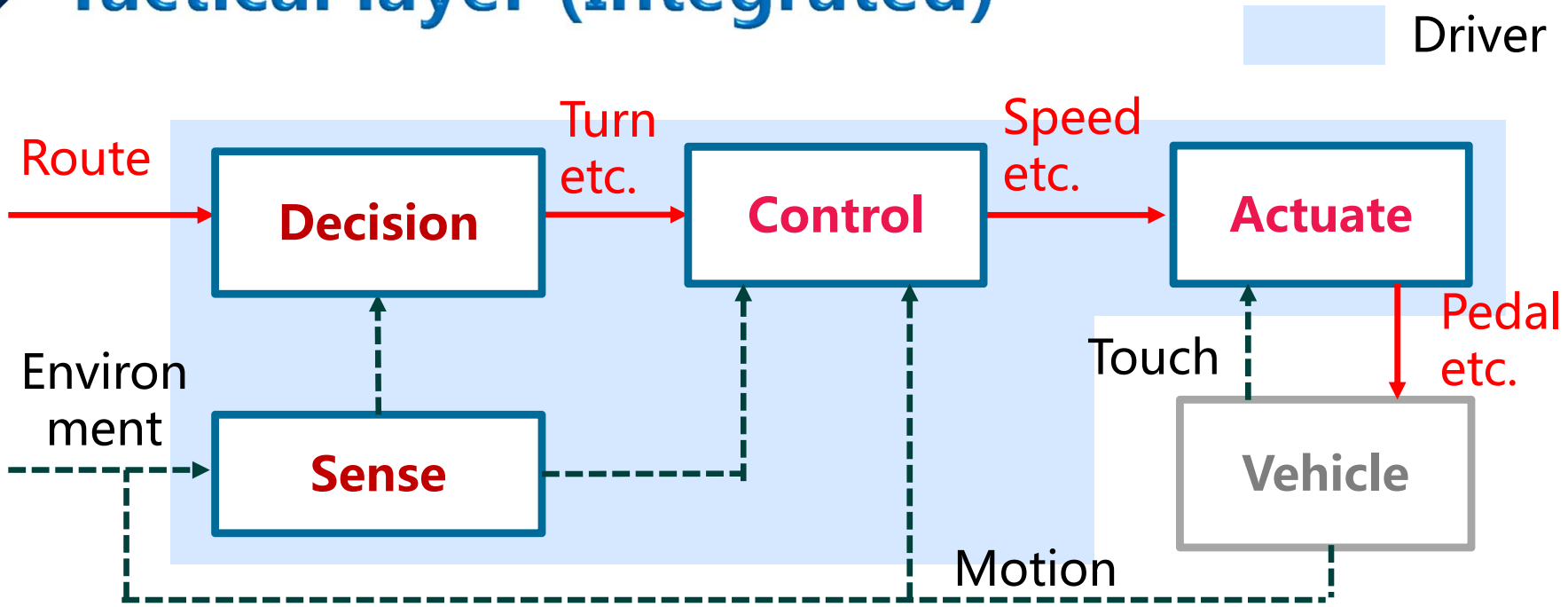
State of the art

- **Strategic layer (Traffic)**
  - Considering global traffic
  - Human provides destination
  - High automation level
- **Skill layer (Vehicle)**
  - Considering vehicle dynamics
  - Human provides desired states
  - High automation level (X-by-wire)

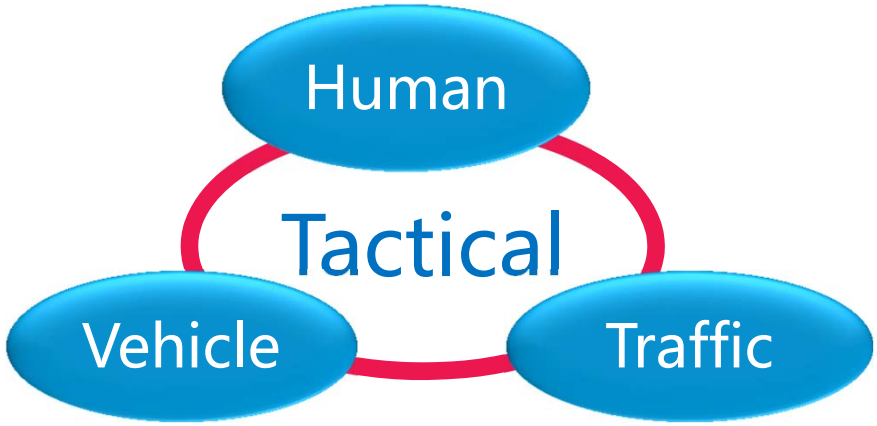
Improving performances, e.g. efficiency, safety, comfort!

State of the art

Tactical layer (Integrated)



- Complexity of traffic information → Sense
- Uncertainty of road user behavior, and ethical issues → Decision



AI and automatic driving

Artificial Intelligence

+

Driver

Specific Road

Complex Traffic

Traffic complexity

- Traffic rules and behavior are fuzzy
- Road users violate traffic rules
- Real time requirement for driving

Most accidents are caused by human!

Human vs. machine

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Human

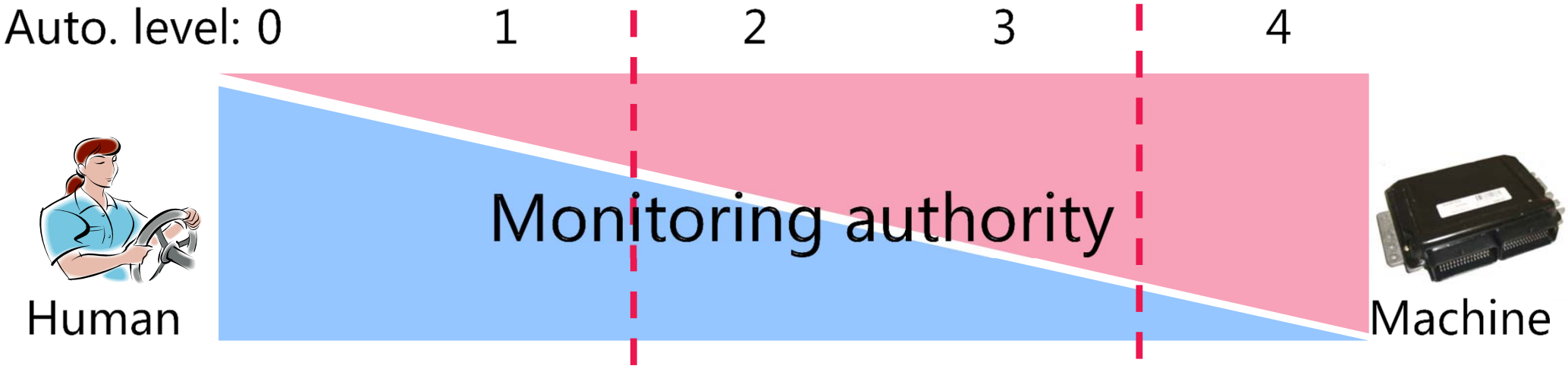
- User of vehicle
- decision of fuzzy problems
- Recognition from complex backgrounds
- Rely on experience under critical conditions
- Easily affected

Machine

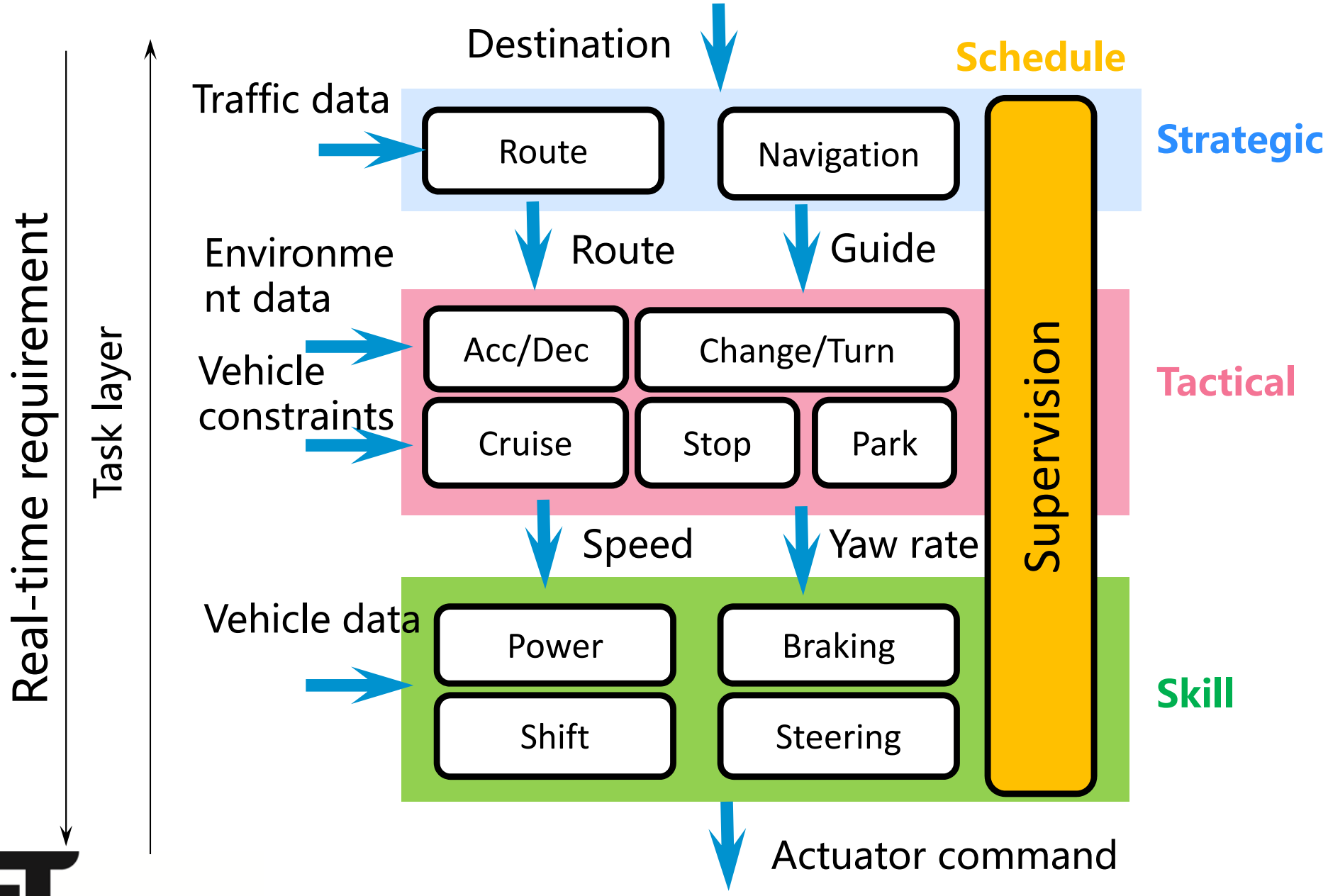
- Accurate sensing and actuation
- Fast response to requests
- Optimization of multi-objectives
- Big data process
- Performances consistency

Automation level

Level 0	No automation	Human is in complete control at all times.
Level 1	Function-specific automation	Human has complete authority, cedes limited control to machine in certain normal or crash imminent situations.
Level 2	Combined function automation	Automation of at least two control functions in certain situations. Driver is responsible for monitoring and available at all times to resume control.
Level 3	Limited self-driving	Machine controls all functions under certain conditions. Human cedes monitoring authority to machine.
Level 4	Full self-driving	Machine controls and monitors the entire trip. Human provides destination. Responsibility for all operations rests solely on machine.

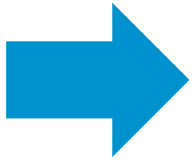


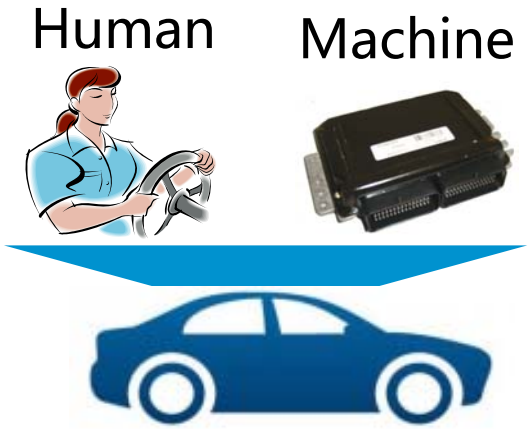
Driving process



Technical roadmap

One vehicle

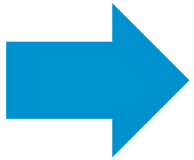


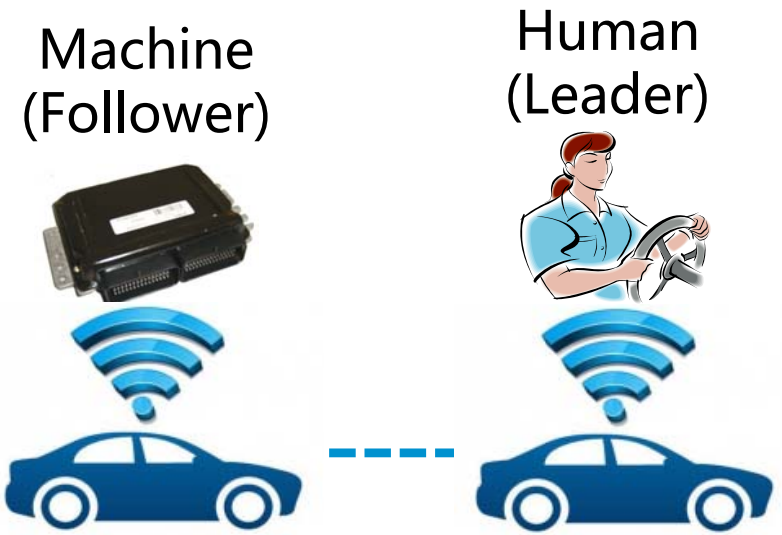


Autonomous driving

Wireless communication

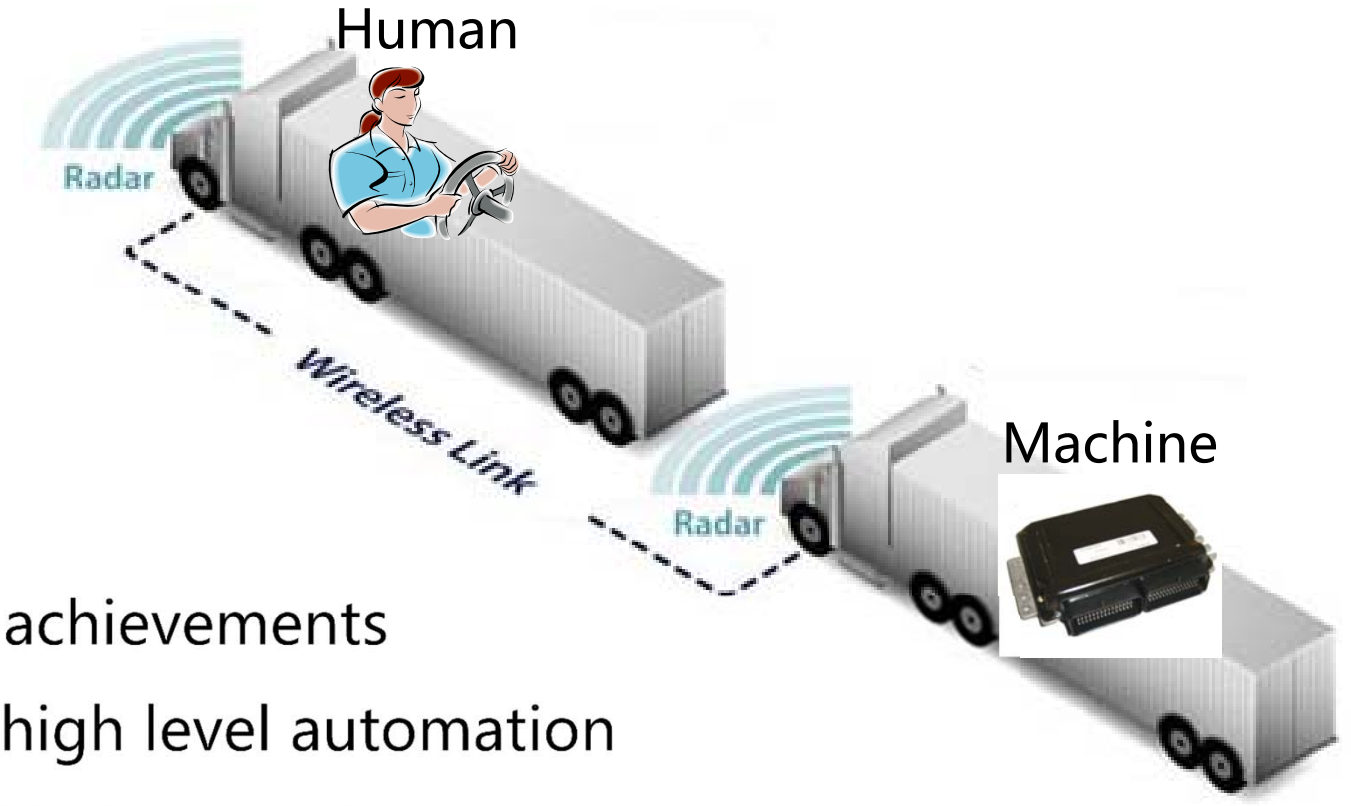
Multi- vehicle





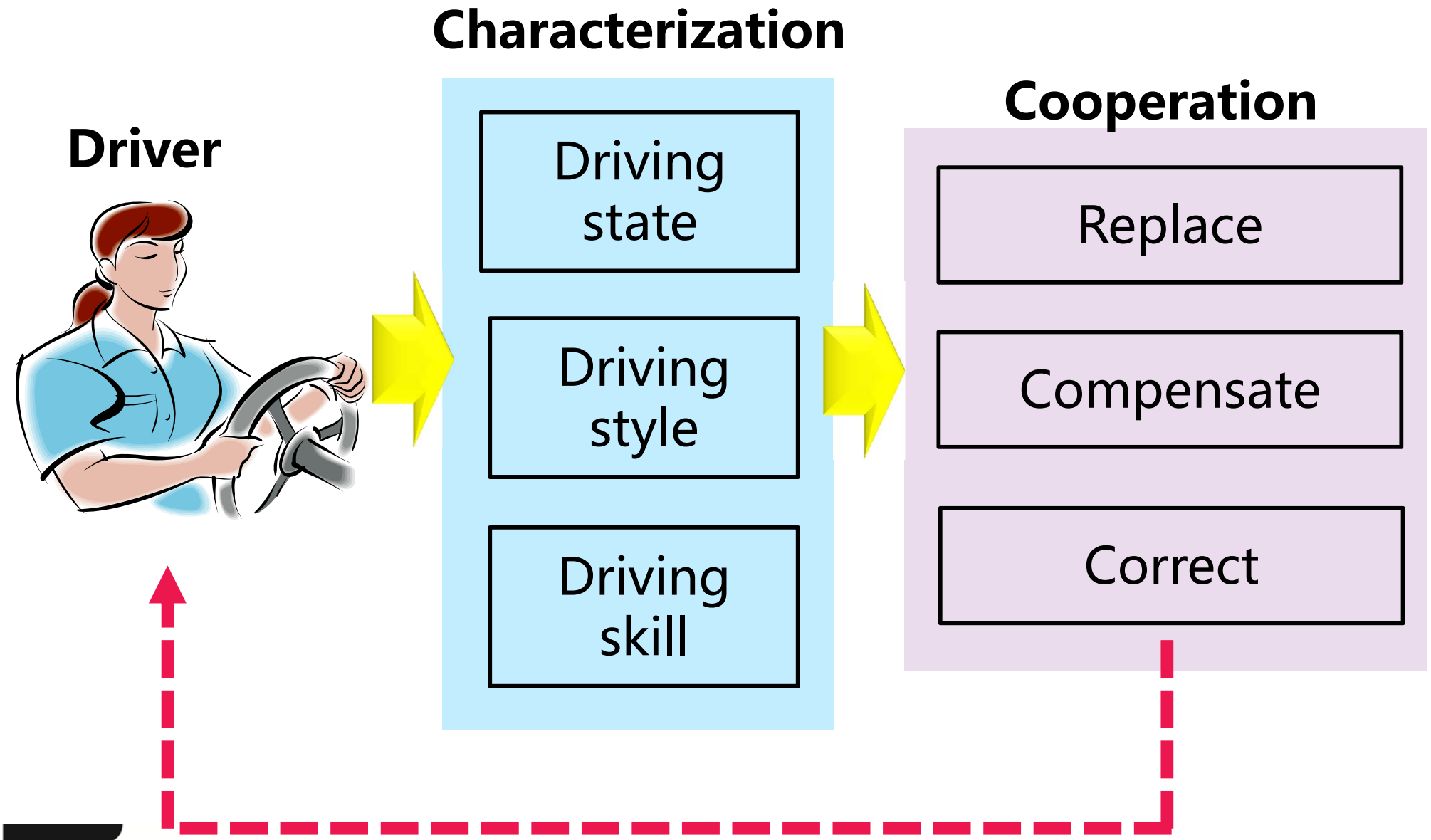
Platoon driving

Platoon driving

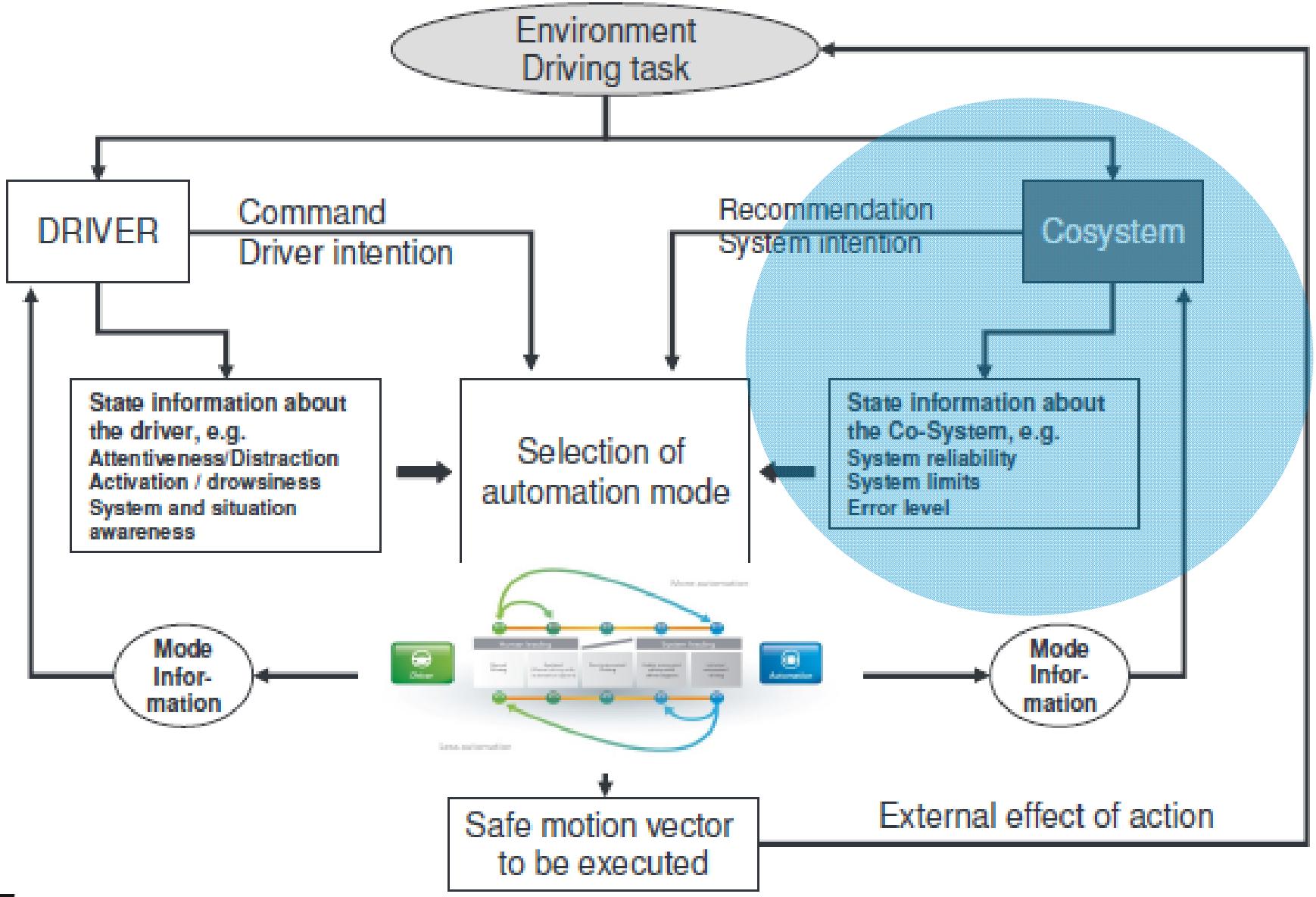


- Inherit previous achievements
- Followers reach high level automation
- Lower sense and judge requirements
- Enhance safety, economy, comfort, efficiency
- Particular useful for commercial vehicles on highway

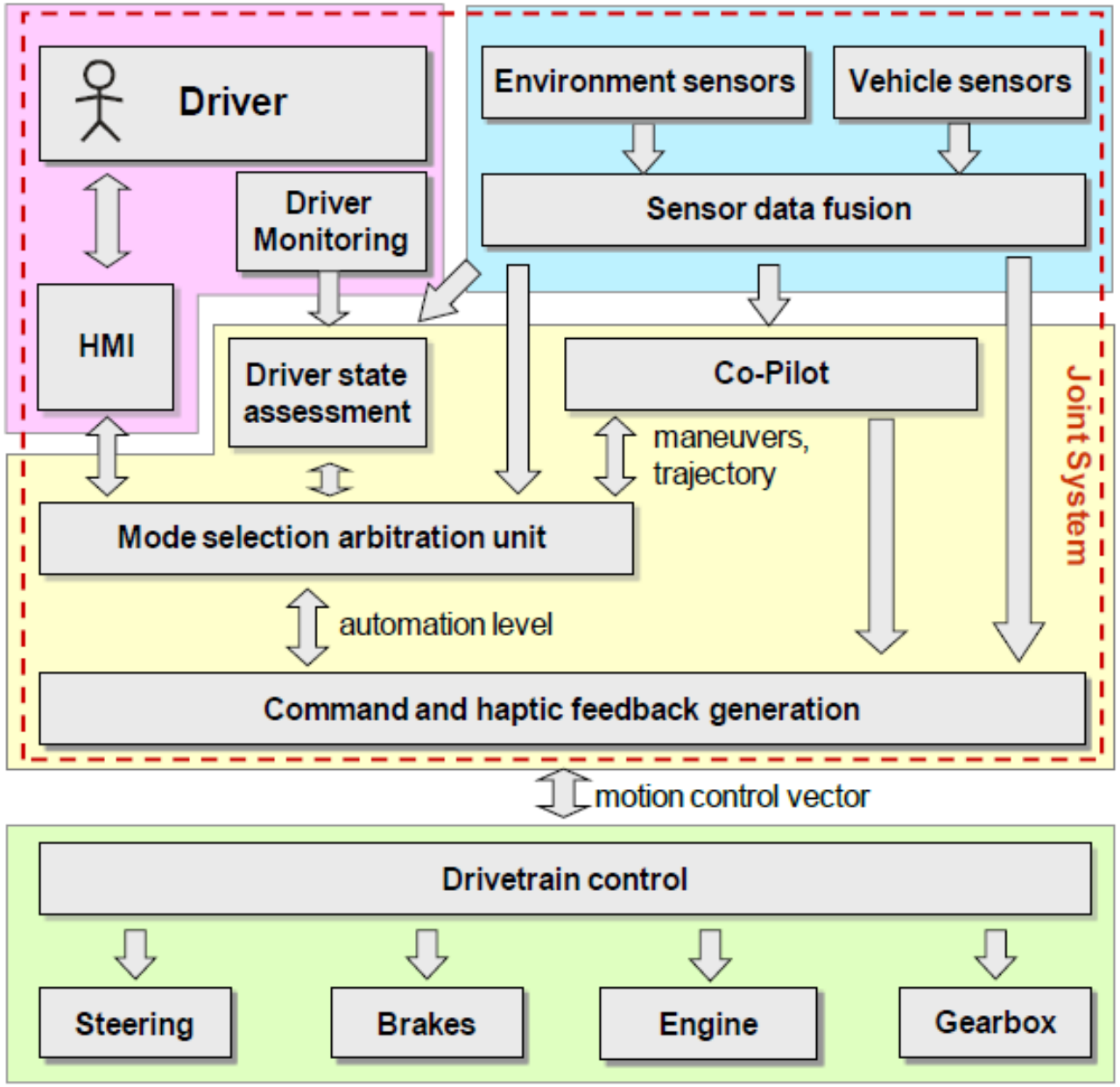
Auto. I: human centered



Auto. II: automated allocation



II: Automated allocation



HMI

Sense

Cooperation

Actuation

II: Risk field based evaluation

$$J = \min_{x_s \in \mathbb{C}} \sum_i \alpha_i R_i(x_i - x_s)$$

Injury

The collision damage (Energy and attribute) of controlled vehicle, other vehicles and humans.

Law

What is the maximum speed ? Can change lane ? Can turn left ? Is the travel direction right ?

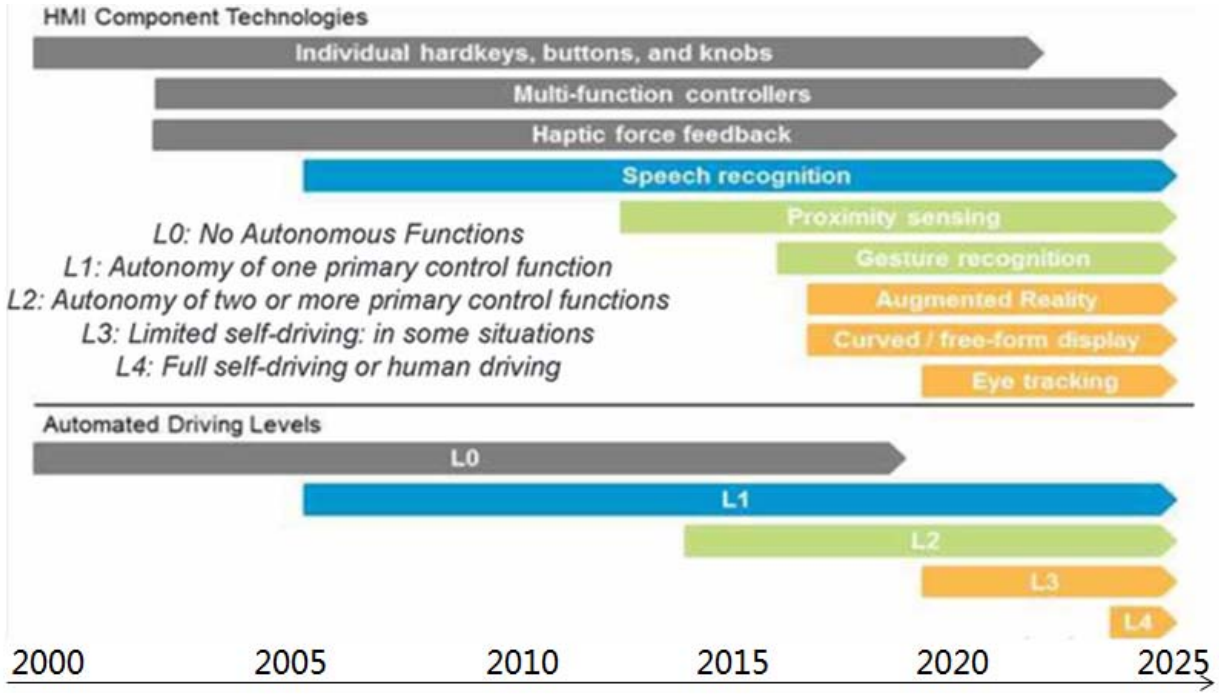
Feeling Require

The following distance is ? The acceleration/deceleration process is ? Always keeping in one lane ? The driving speed is fast enough ?

Priority

Other key technologies

- Sensing of environment, driver
- Human machine interface
- ……



Question & Answer

Thanks!

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