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Descartes
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Please Obey My Plan: How To Optimise Decentralised Self-Adaptive Systems

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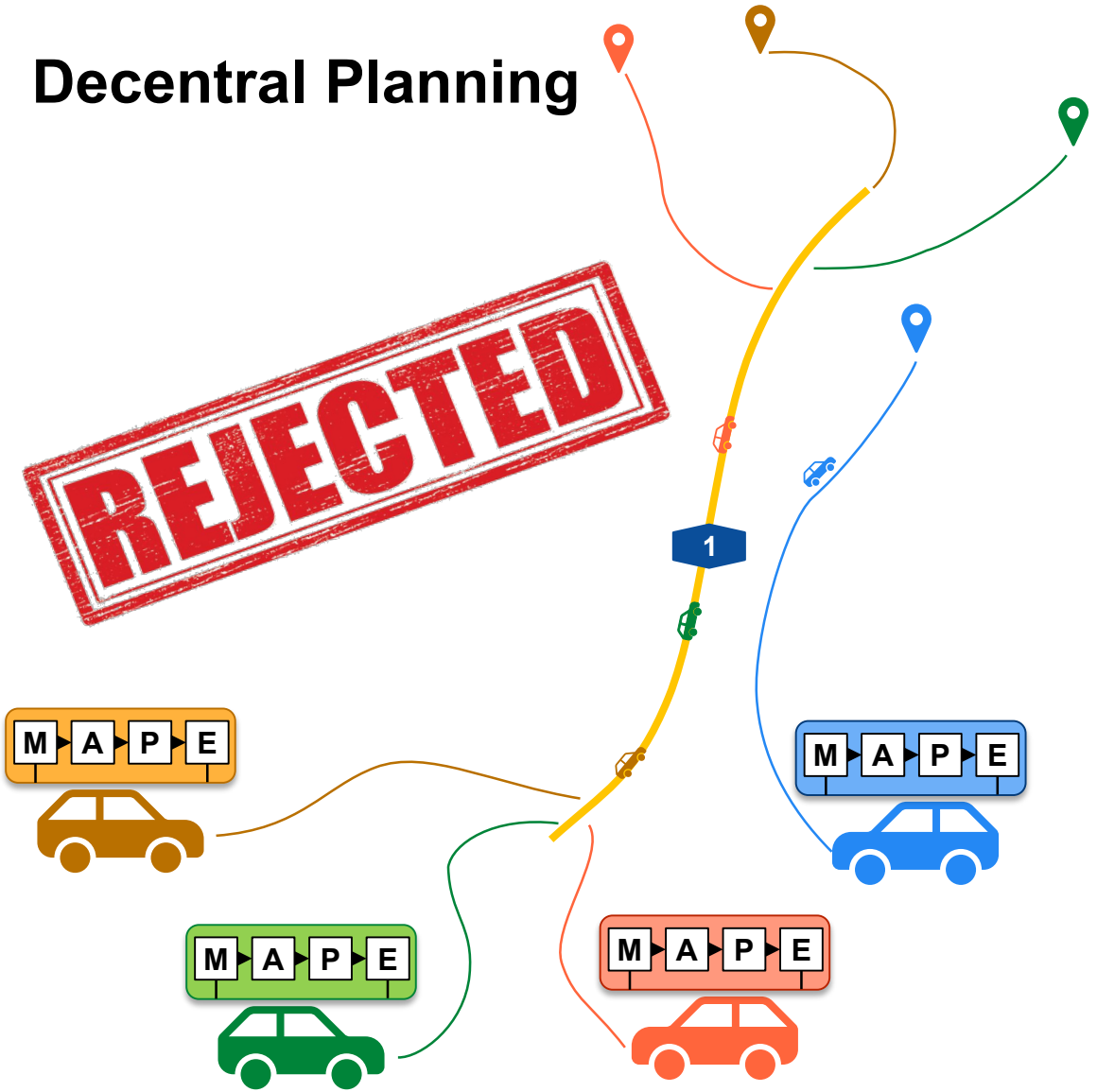
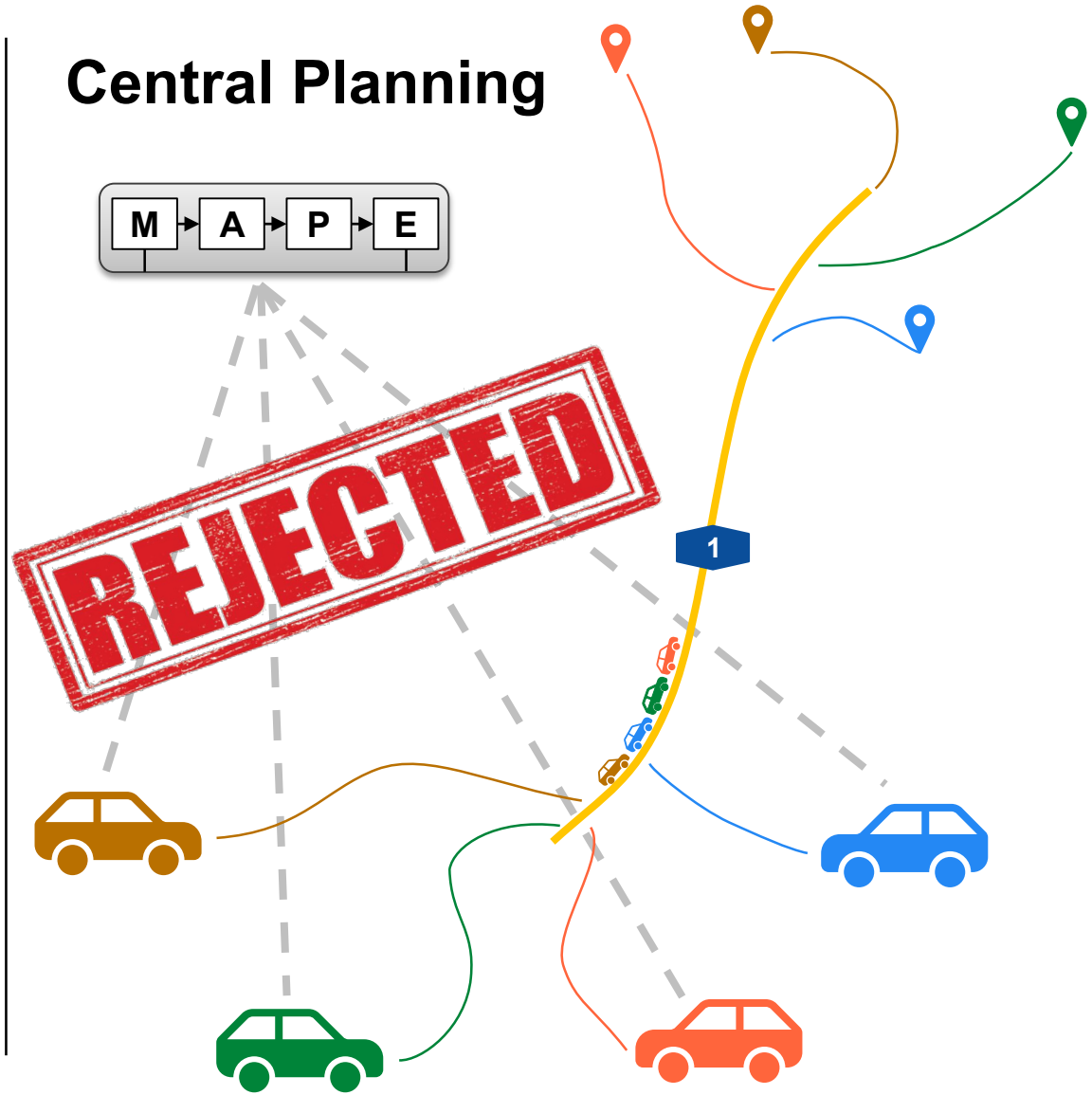
Platooning Coordination

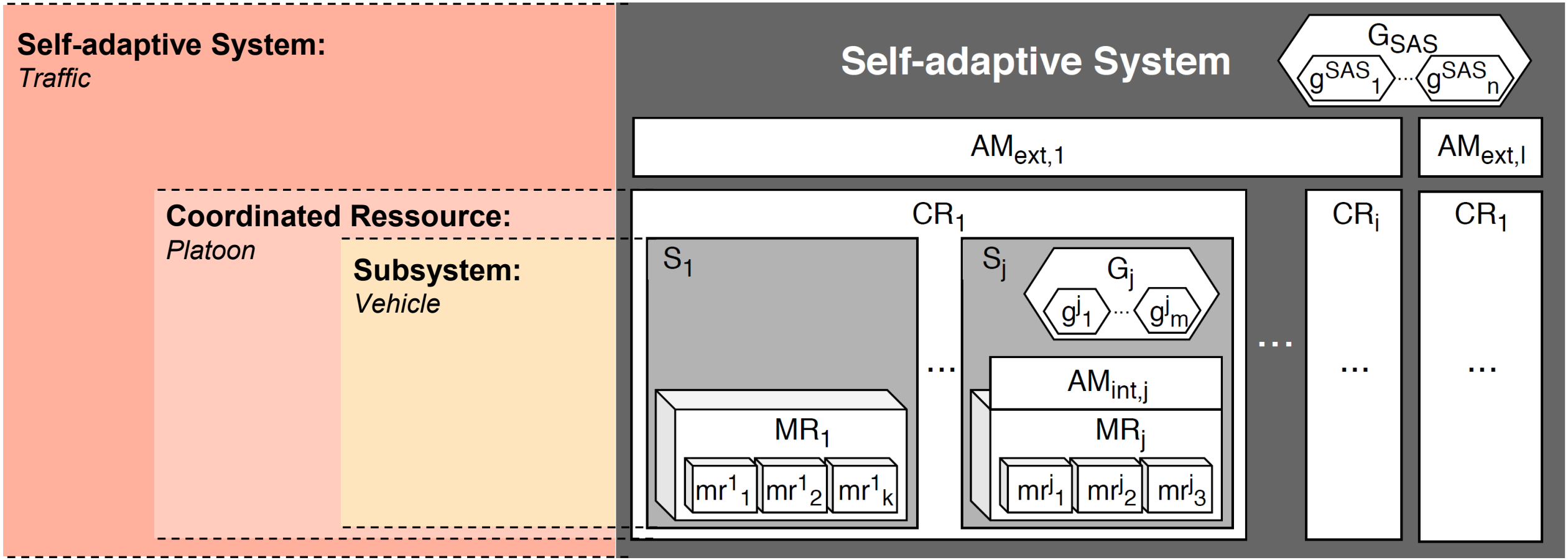
Decentral Planning



Central Planning

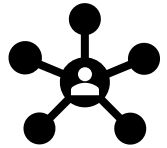


System Model

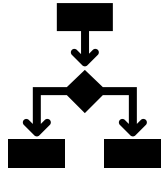


Objectives

1) Development of a centralised optimisation mechanism that balances conflicting goals and constraints



2) Improving robustness of solution by providing degrees of freedom, alternative solutions and incentives for execution-enforcement



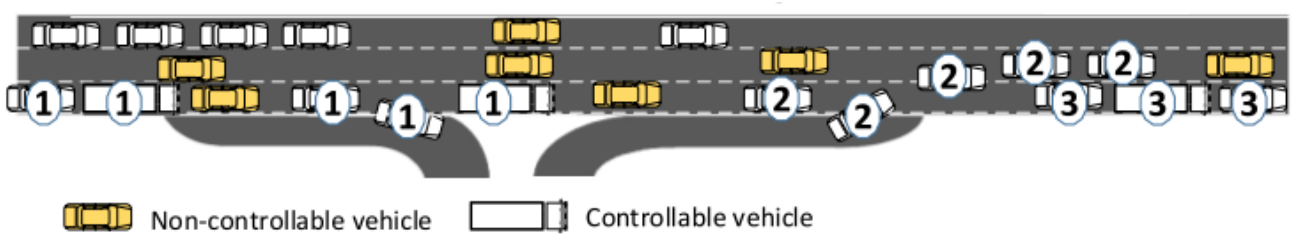
3) Investigation of a subsequently distributed adaptation execution algorithm that controls the application of the plan within a set of autonomous entities by making use of the provided freedom

4) Analyse the relations of autonomic vs. heteronomic decisions of entities on the optimisation procedure

5) Design and implementation of a support process for developers

Platooning Coordination Use Case

- Platooning: Self-driving vehicles in coordinated convoys
- Self-driving vehicles act autonomously
- Individual preferences of the driver
- Environment with specified interaction rules

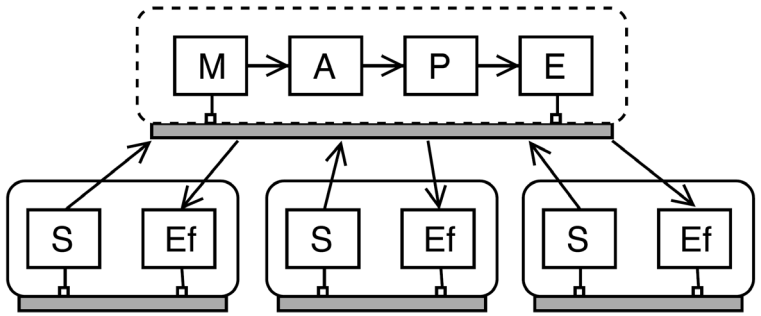


- Decentralised planning
  - Collect information about platoons
  - Requires vehicle to vehicle communication
  - Locally optimised
  - Results in conflicts (position in platoon)
- Centralised planning
  - Intermediary system collects information about vehicles and platoons
  - Balances interests of vehicles, platoons, global traffic
  - No guarantee that instructions are executed by autonomous vehicles

Challenges – C 1

Central Plan.  Decentral Plan.

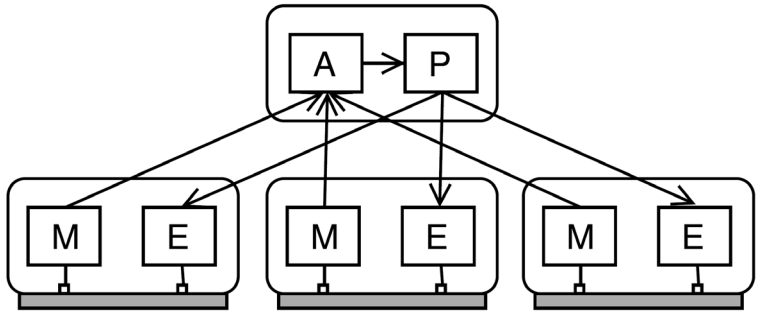
- Multi-objective central optimisation with constraints
  - Goal: Runtime-applicable heuristic, rather “good enough” solutions than “optimal” ones.
  - Choice of optimiser
  - Time vs optimality
  - Incorporation of constraints



Challenges – C 2

Central Plan.  Decentral Plan.

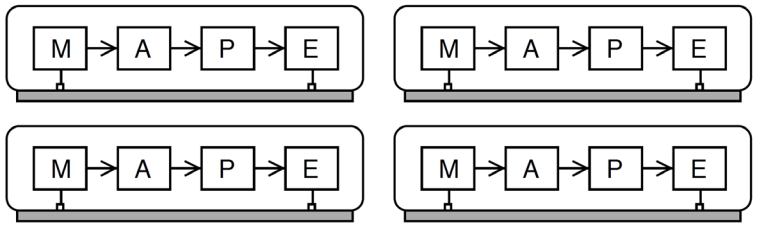
- Multi-objective central optimisation with adaptation freedom
  - Goal: Provide solutions with alternative realisations and decision freedom for the adaptation execution.
  - Definition of ranges of allowed configurations
  - Coordination of execution
  - Introduction of feedback loop



Challenges – D 1

Central Plan.  Decentral Plan.

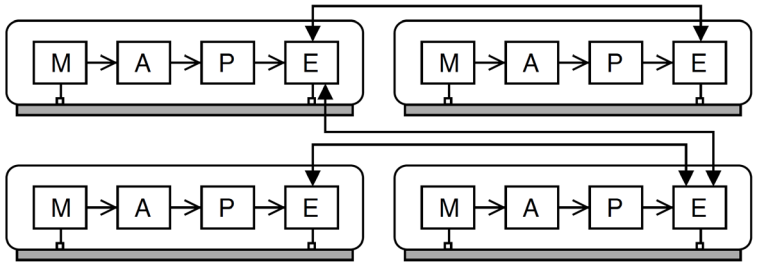
- Decentralised non-coordinated optimisation
  - Goal: Negotiate solutions in open collections of autonomous entities
  - Prevention of unstable behaviour and oscillations
  - Handle information sub-sets
  - Incorporation of multiple goals



Challenges – D 2

Central Plan.  Decentral Plan.

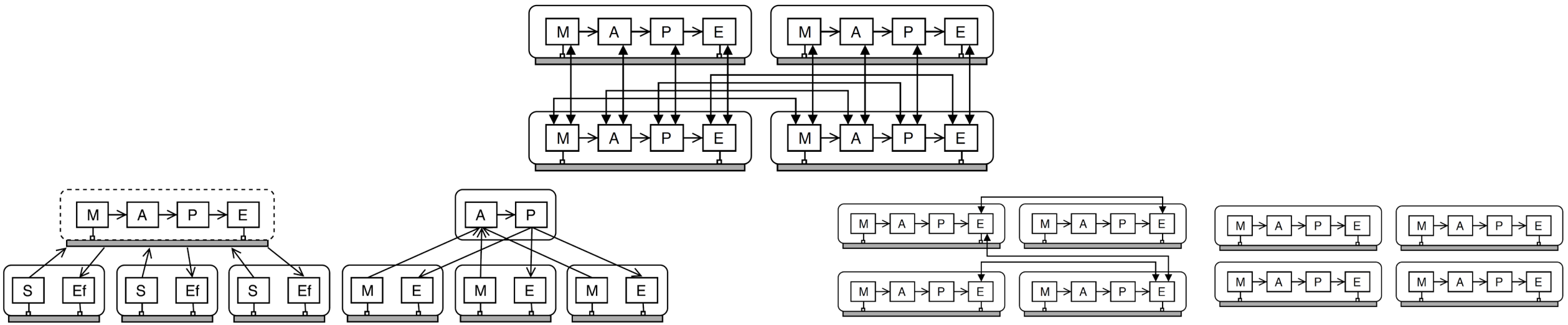
- Decentralised coordinated multiobjective optimisation
  - Goal: Negotiate solutions in open collections of autonomous entities
  - Identification of important aspects
  - Integration of local constraints
  - Incentivation



Challenges - HY

Central Plan. — Decentral Plan.

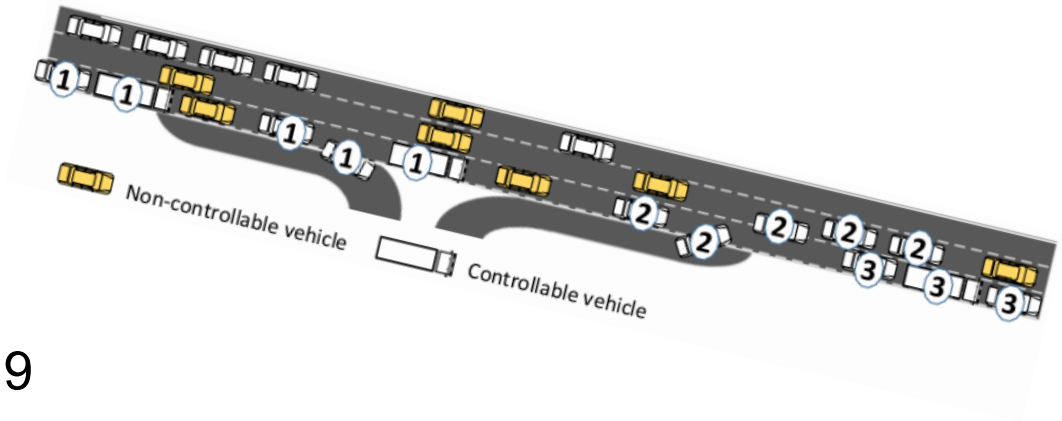
- Distributed global multi-objective optimisation
  - Goal: Coupling of global planning and local execution
  - Effective coordination of autonomous agents
  - Execution enforcement



Wrap-Up

- Two common approaches for optimising self-adaptive systems
  - Decentral planning
    → Local optimal but conflicting decisions may occur
  - Central planning
    → Global optimal but single point of failure, systems may refuse execution of plan
- Hybrid Approach is desired
  - Combines advantages
  - Reduces drawbacks of both extremes
- Challenges to achieve a hybrid approach are identified
- Running example platooning coordination for all challenges

Thank you for your attention



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