# Towards Dependable Emergent Ensembles of Components:

# The DEECo Component Model

http://d3s.mff.cuni.cz

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CHARLES UNIVERSITY IN PRAGUE

faculty of mathematics and physics

# The Scope

- ASCENS EU project
  - FP7 IP FET
  - 14 partners
  - Goal: Self-aware, self-adaptive systems from components
  - Case-studies:
    - Self-aware and autonomous robots
    - Resource management in cloud computing
    - Intelligent navigation of electric vehicles (VW)

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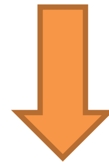
# Challenges

- Dynamic & changing environment, open system
- Massively distributed, ad-hoc networks
  - components appear/disappear
  - connections formed to reflect current „physical“ situation
  - communication is unreliable
  - no notion of the global state of the system



Classical approaches to component architectures **do not scale**

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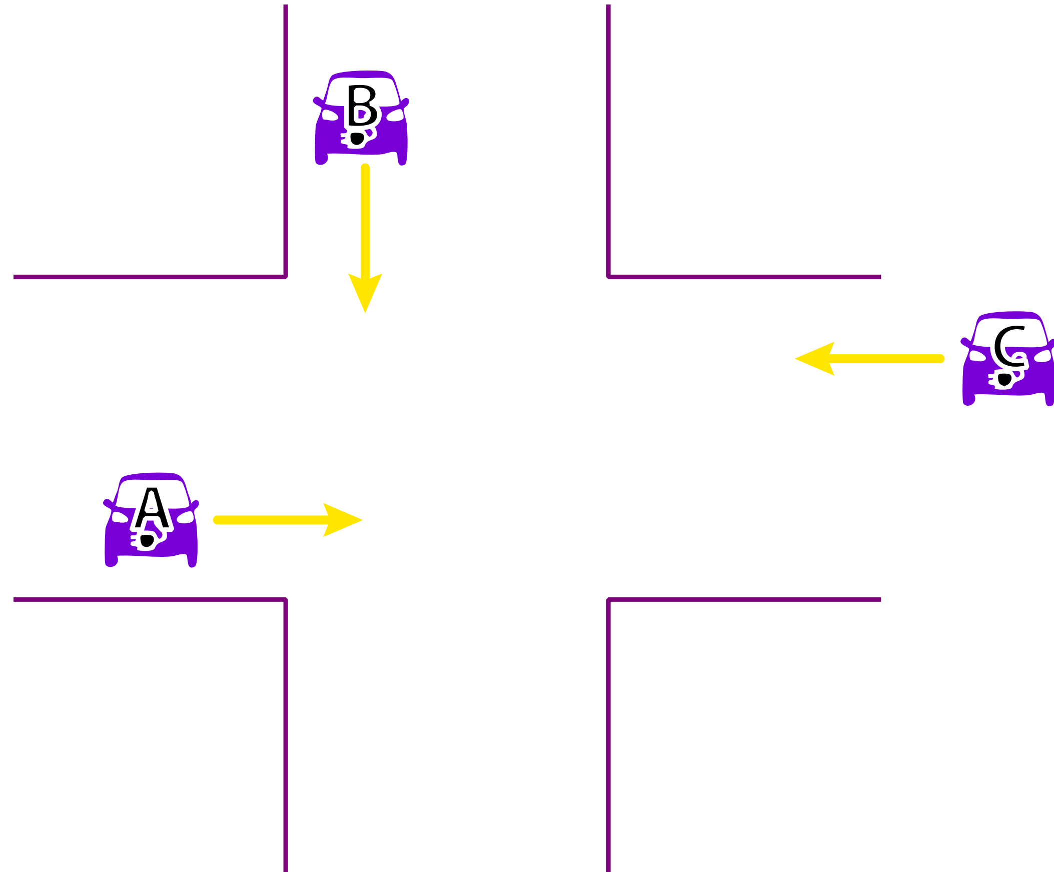
# Example

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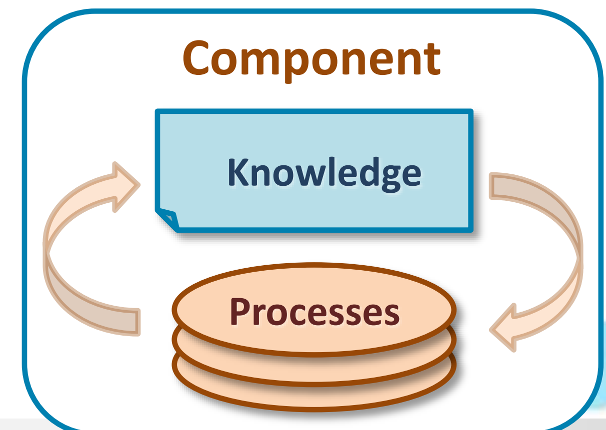
# Solution – DEECo component model

- Component
  - independent autonomous unit responsible for computation and sensing/actuating
  - local knowledge (tree data structure)
  - processes (periodic or event-based) performing computation over the local knowledge
  - **no proactive** (message or procedure call-based) **communication** with other components



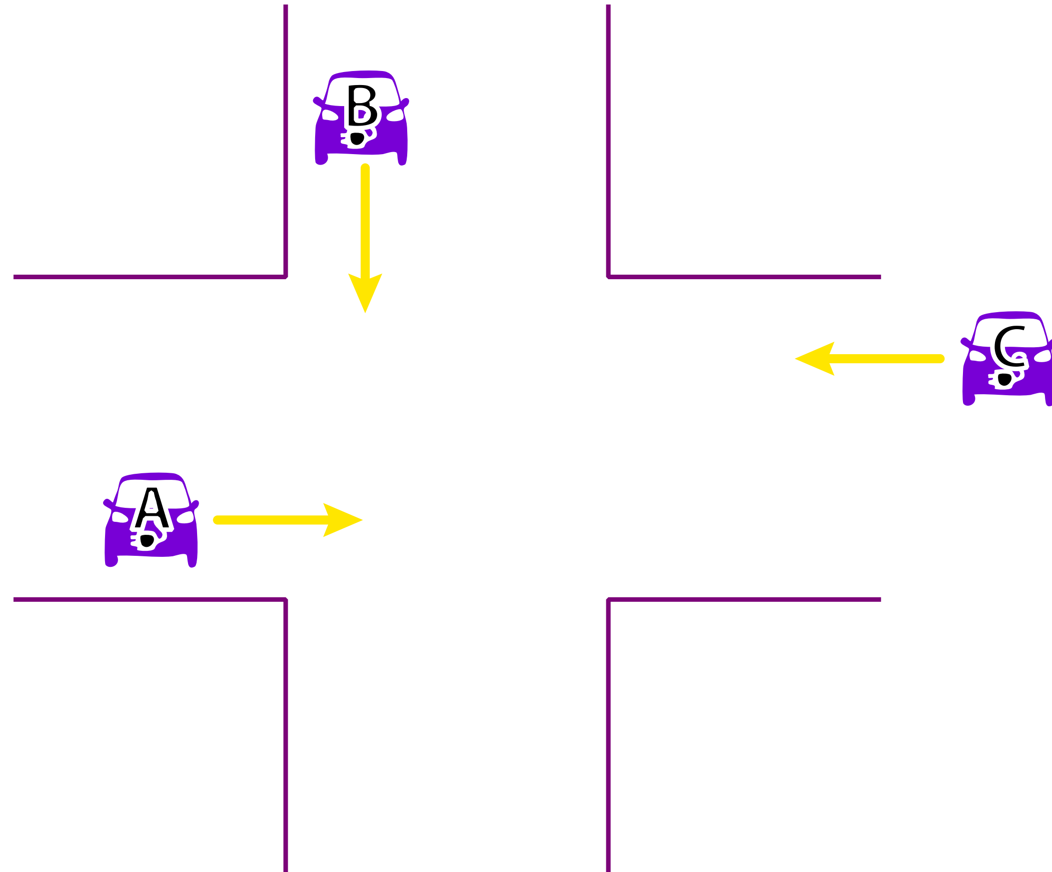
# Example

```
component CarA = {

Knowledge
    id: CarId = "A";
    info: CarInfo = {
      position: Position;
      path: list Position;
    };
    otherCars: map CarId -> CarInfo;

Processes
    /* Driving according to common
       traffic rules */
    step: Process = {
        function = fun(inout i: CarInfo,
               in o: map CarId->CarInfo) { ... } ;
        input=[info, otherCars];
        output=[info];
        scheduling = PERIODIC(100ms);
    };

};
```

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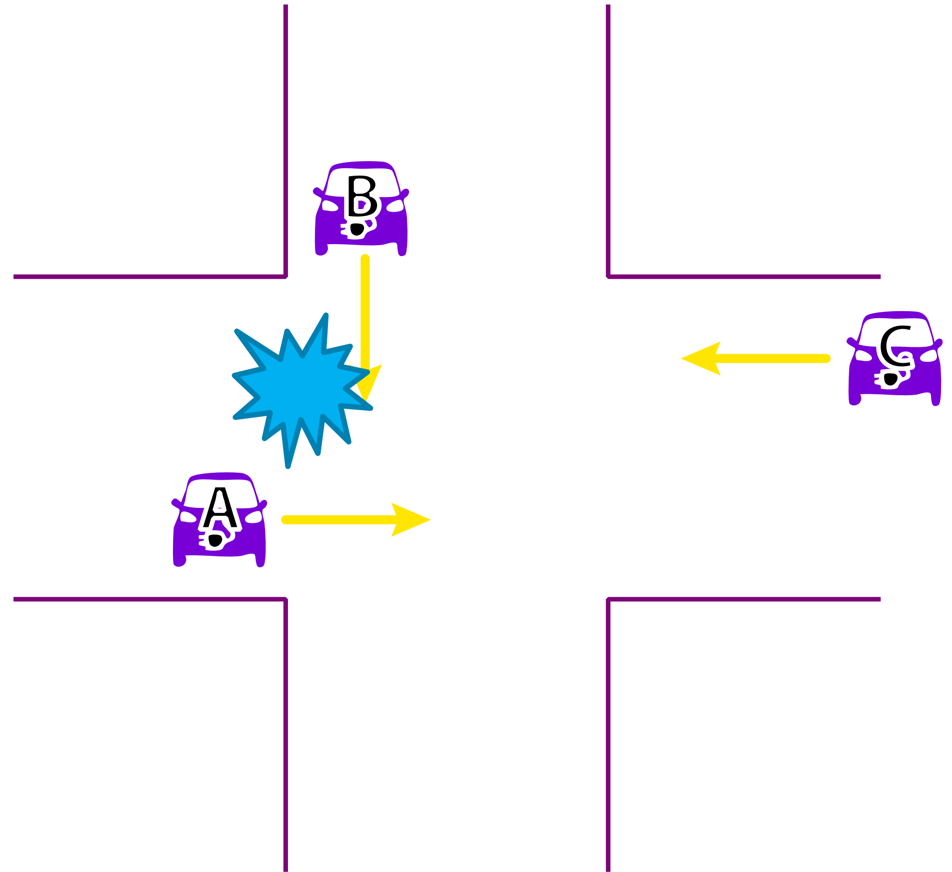


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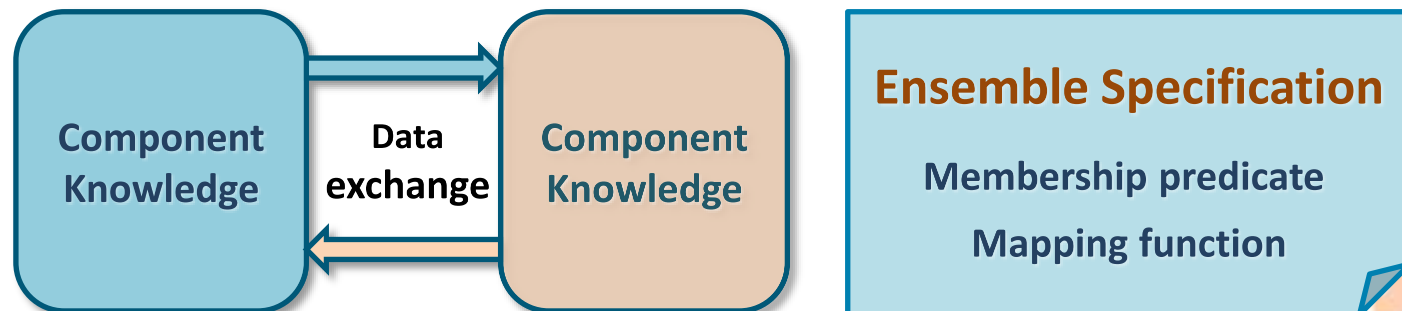
# Solution – DEECo component model

- Ensemble
  - group of components cooperating for a common goal
  - formed dynamically based on predicate over components' knowledge
    - membership
  - synchronizes parts of components' knowledge
    - periodic / triggered



# Example

```
ensemble CarsInCrossingEnsemble {

    membership: fun(in r: ICar, in c: ICar,
                    out ret: Boolean) = {
      ret = bothCarsCloseToSameCrossing(
            r.info.position,
            m.info.position,
            TRESHOLD);
    };

    mapping: fun(inout m: ICar,
                 inout c: ICar) = {

        m.otherCars=m.otherCars.merge(
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        c.otherCars[m.id] = m.info;
    };

};
```
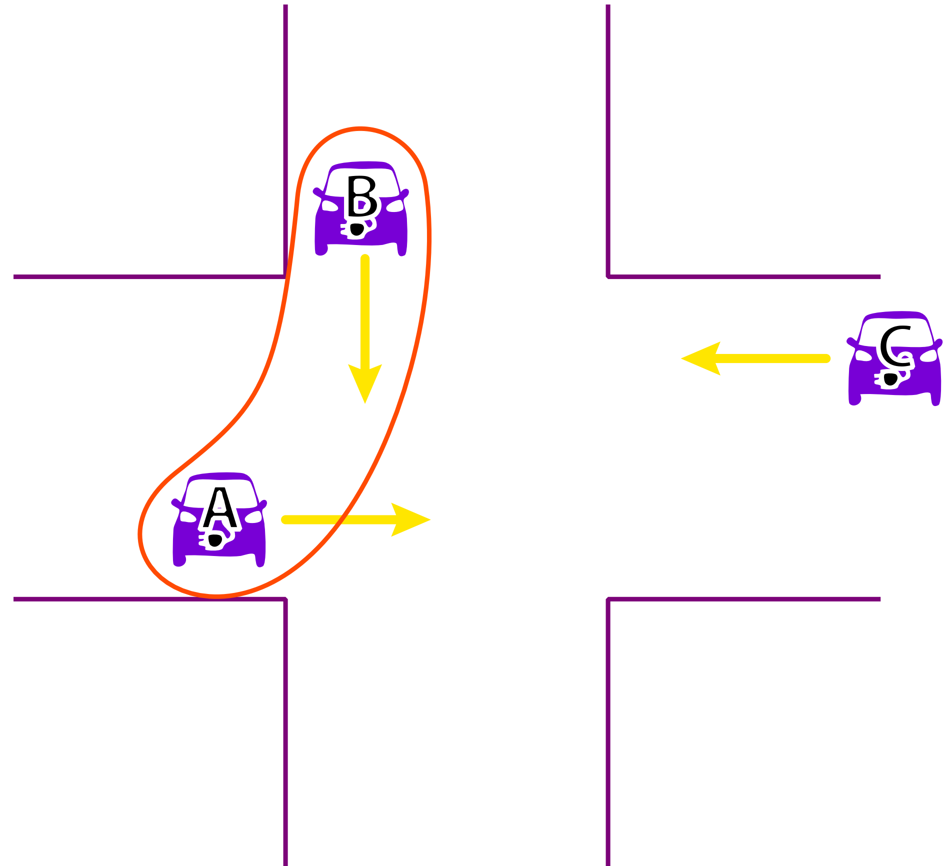

Membership

Synchronization

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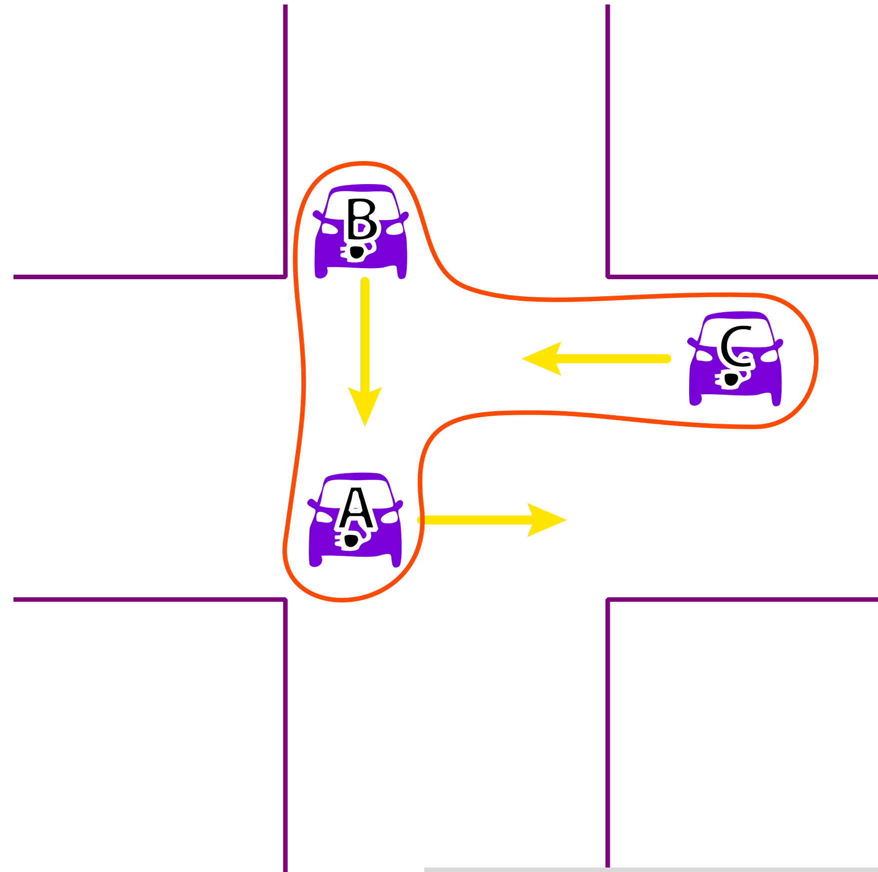


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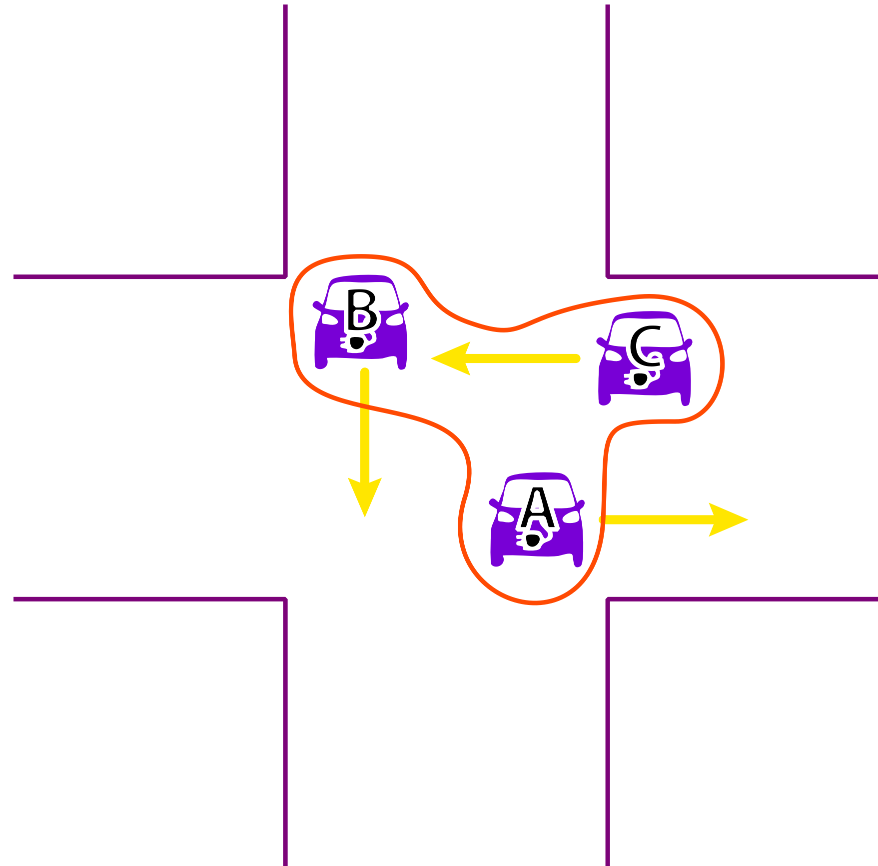


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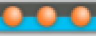

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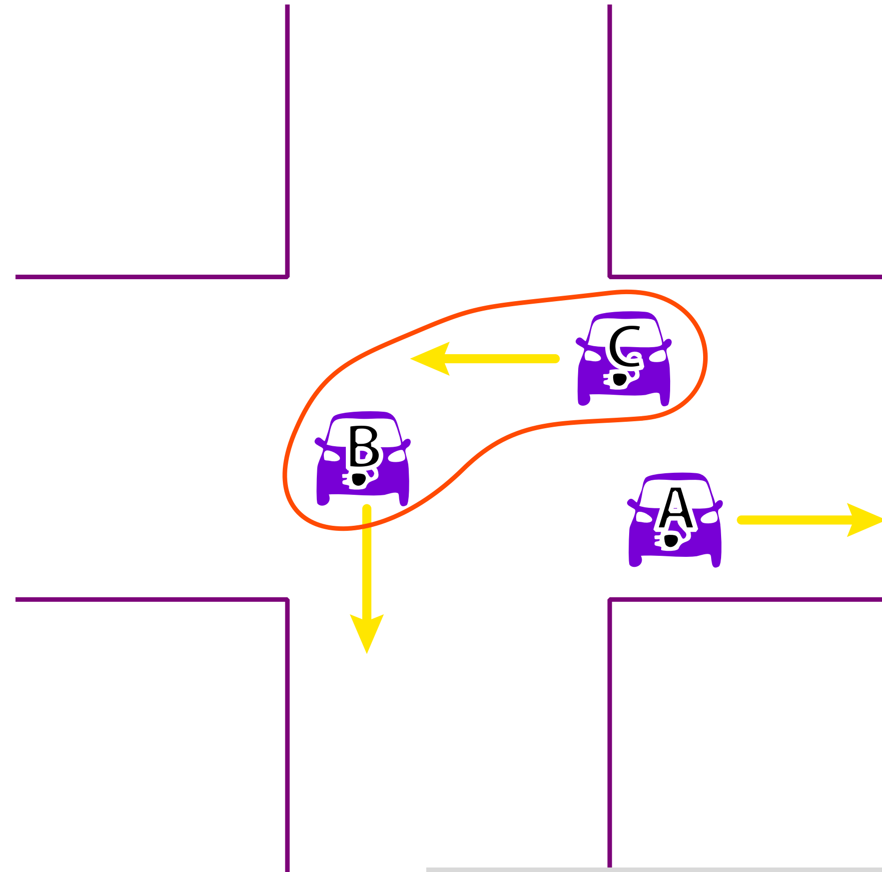


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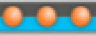

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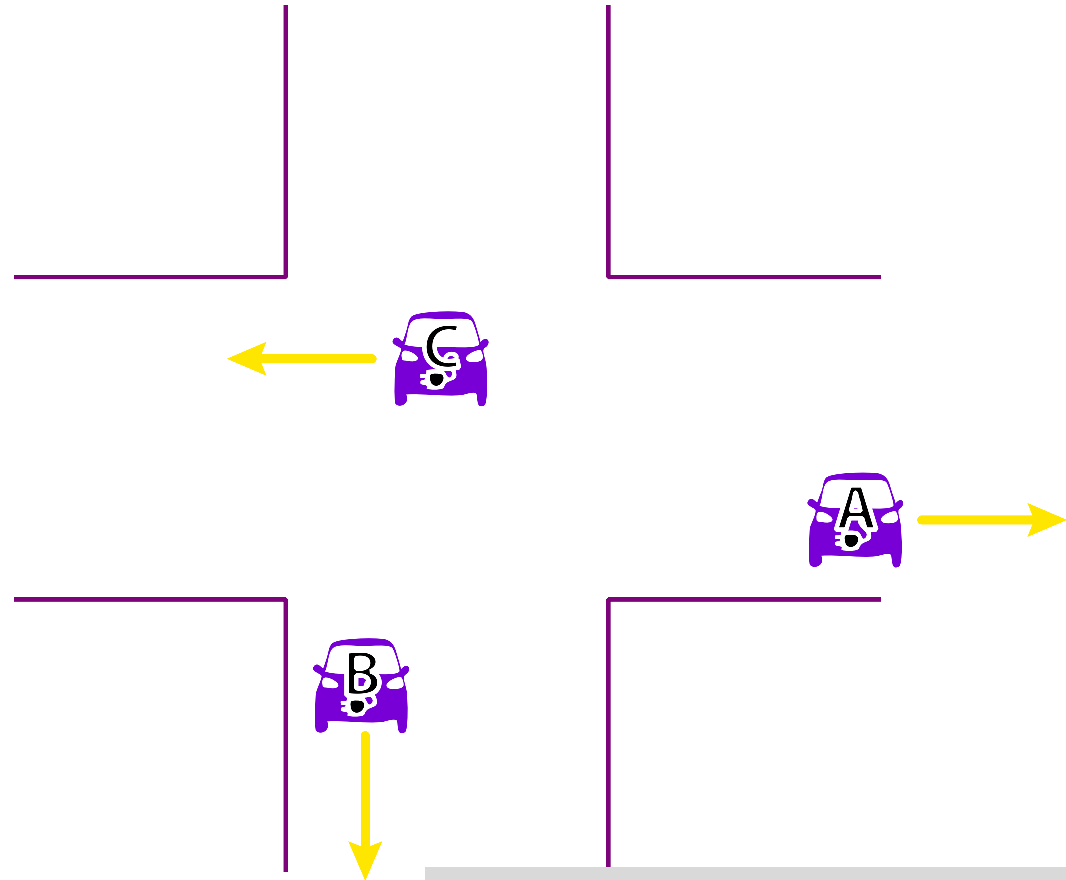


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# Conclusion & Future Directions

- DEECo highlights
  - separation of **autonomous computation** x **communication**
  - more resilient to communication failures
  - inherent support for partial belief of the system
  - facilitates development of highly distributed open systems

- Ongoing work
  - Formalization of the behavior
    - SCEL (formal model used in ASCENS)
    - Stochastic model-checking
  - Distributed Java runtime
    - Using JavaSpaces (LINDA-like middleware)
    - https://github.com/d3scomp/JDEECo
  - UML-based system-level design
    - https://github.com/d3scomp/UMLDEECo

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