SE SOFTWARE ENGINEERING

RWTH AACHEN UNIVERSITY

Multi-Target Code Generation

12.06.2018

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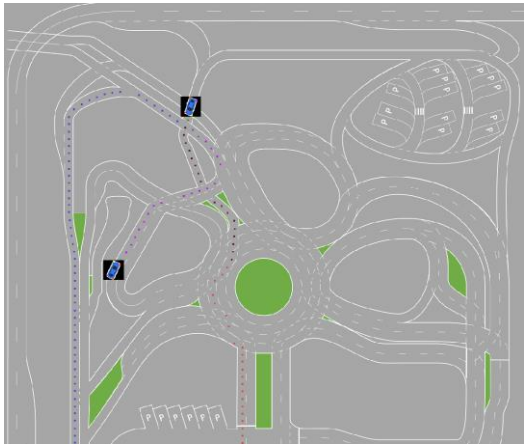
Simulatoren

TORCS / OpenDaVINCI

Gazebo / ROS

Simulink



How to get models into a simulator?

VDrift / OpenDaVINCI

MontiSim

Veins

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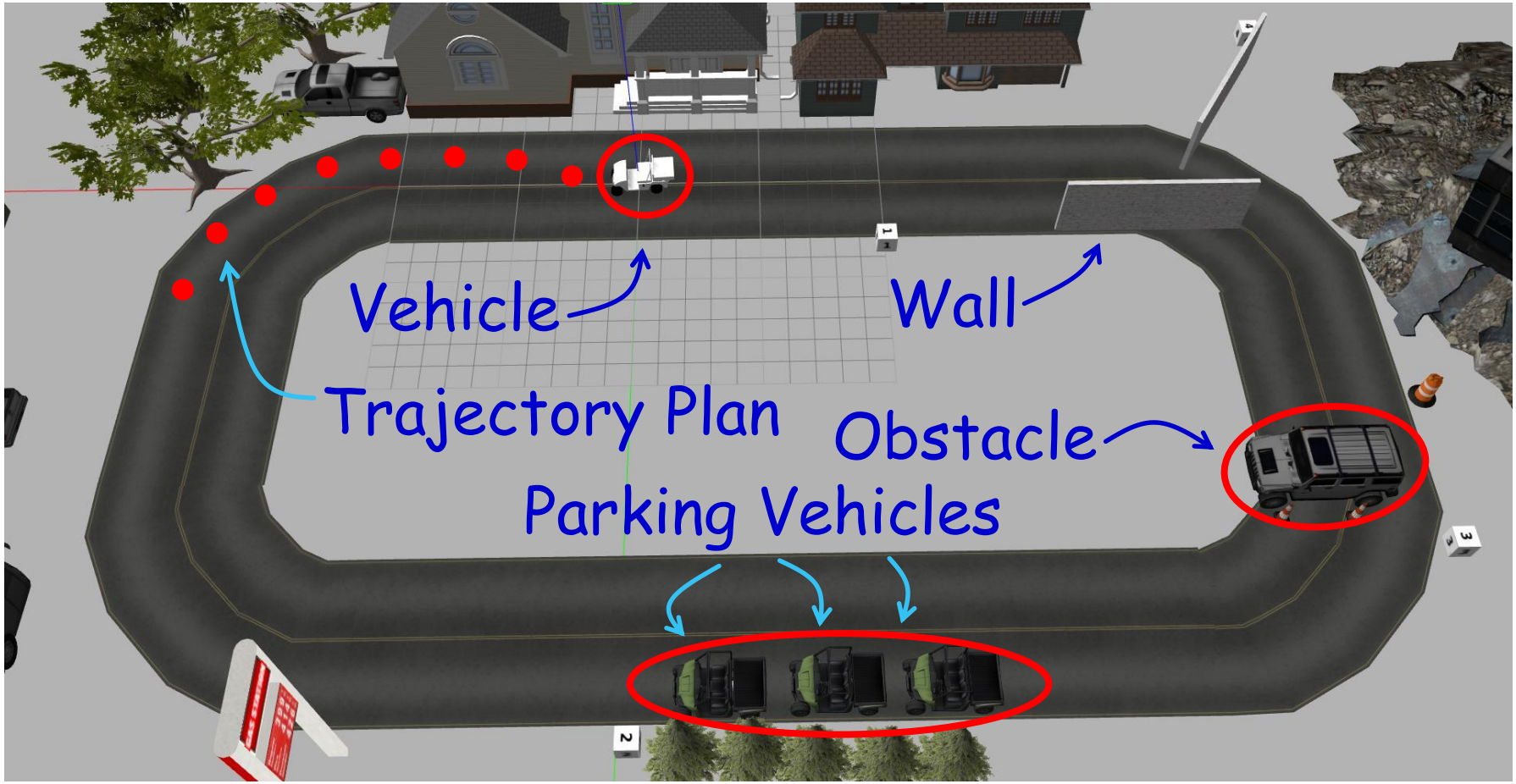
Gazebo Self-Driving Vehicle Example



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EmbeddedMontiArc Model

```
1  component TrajectorySystem{
       direction  type     name
2    ports in     Map      map,
3          in Position pos,
4          in SensorSignal senSig,
5          out Trajectory desiredTraj;

     instances of subcomponents defined in other artifacts
6    instance ObstacleDetection obsDetection;
7    instance Filter filter;
8    instance Planner planner;

         source port      target port
9    connect map   ->  planner.mapIn;
10   connect pos   ->  planner.posIn;
11   connect planner.trajOut -> desiredTraj;
12   connect obsDetection.obstacles -> planner.obsIn;
13   /* other connections */ }
```

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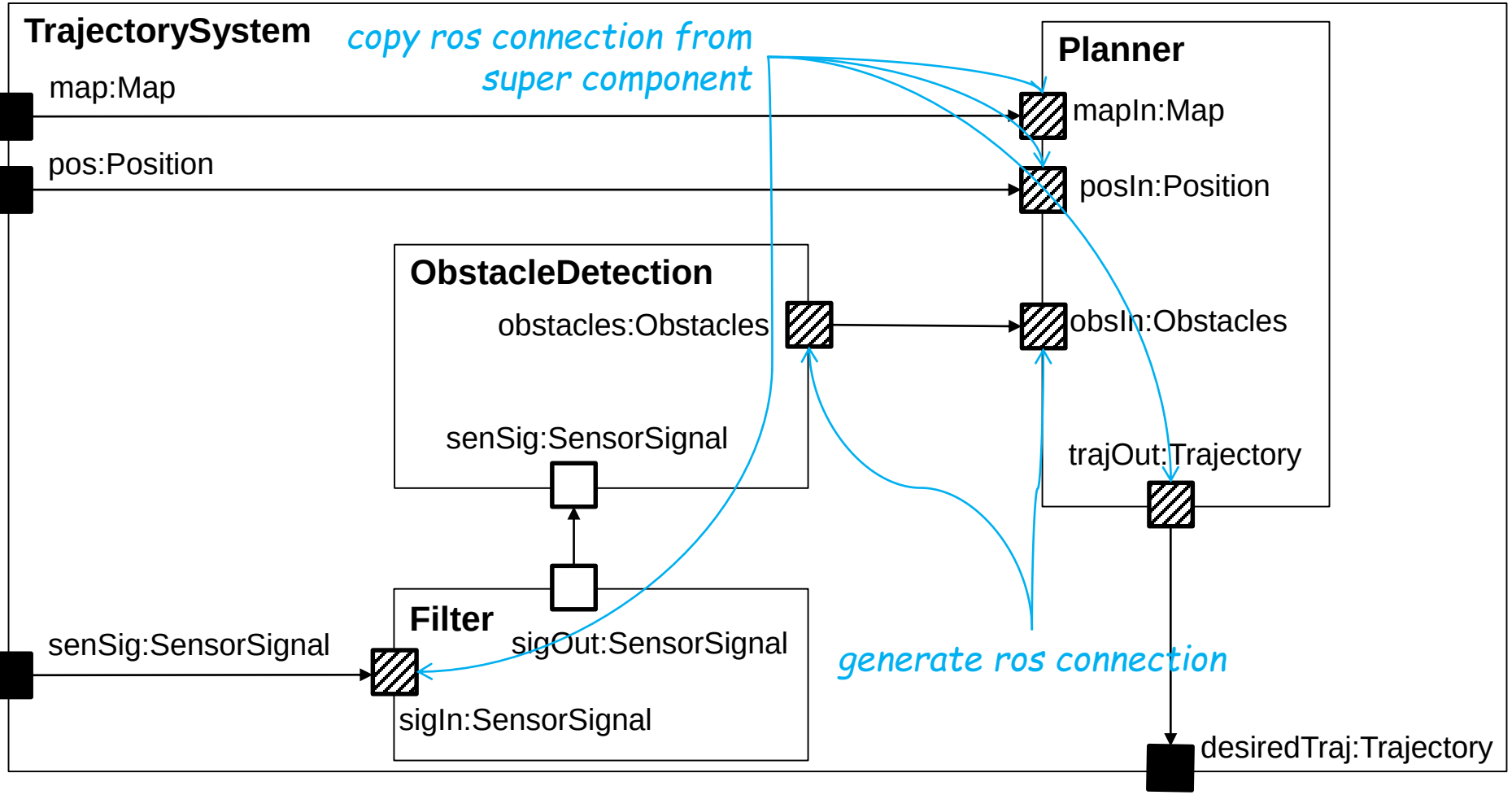
EMAM Diagram



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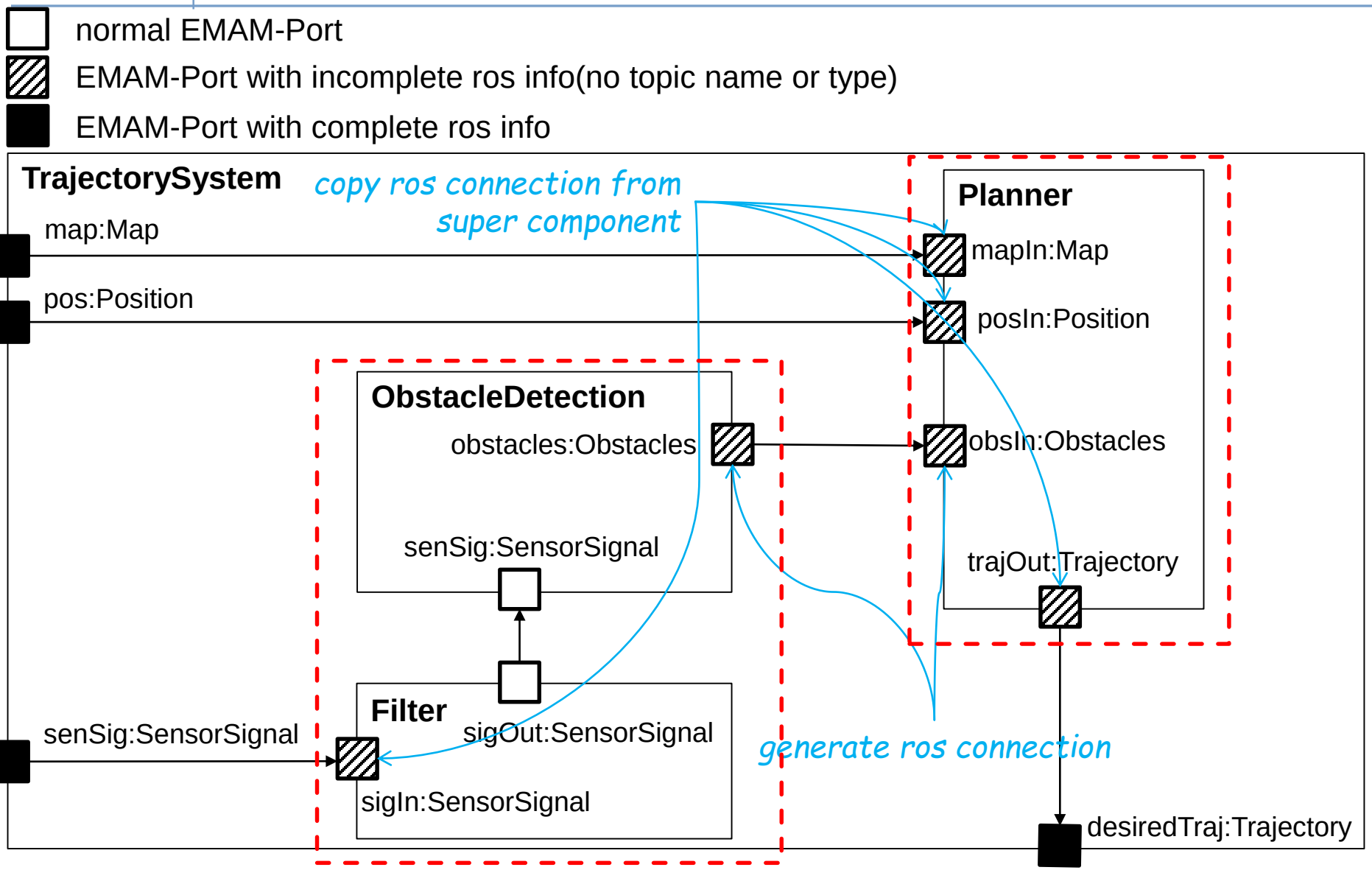
EMAM Diagram + Port Tagging



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Tagging Model

```
1 tags RosTags{
2 tag trajectorySystem.map with RosConnection =
    {topic= (name=/map, type=struct_msgs/Map)};
3 tag trajectorySystem.desiredTraj with RosConnection =
    {topic= (name=/desiredMotion, type=struct_msgs/Trajectory)};
4 tag trajectorySystem.planner.mapIn with RosConnection;
5 tag trajectorySystem.planner.obsIn with RosConnection;
6 [...]}
```

tagged symbol

tag type

tag value

RosConnection with complete information( )

RosConnection with incomplete information( )

```
1 struct Position{
2   Q      ( -90° : 0.000001° :  90° ) longitude;
3   Q      ( -180° : 0.000001° : 180°) latitude;
4   Q      ( -10km : 10cm : 10km) altitude;}
```

type

min value

step size

max value

name

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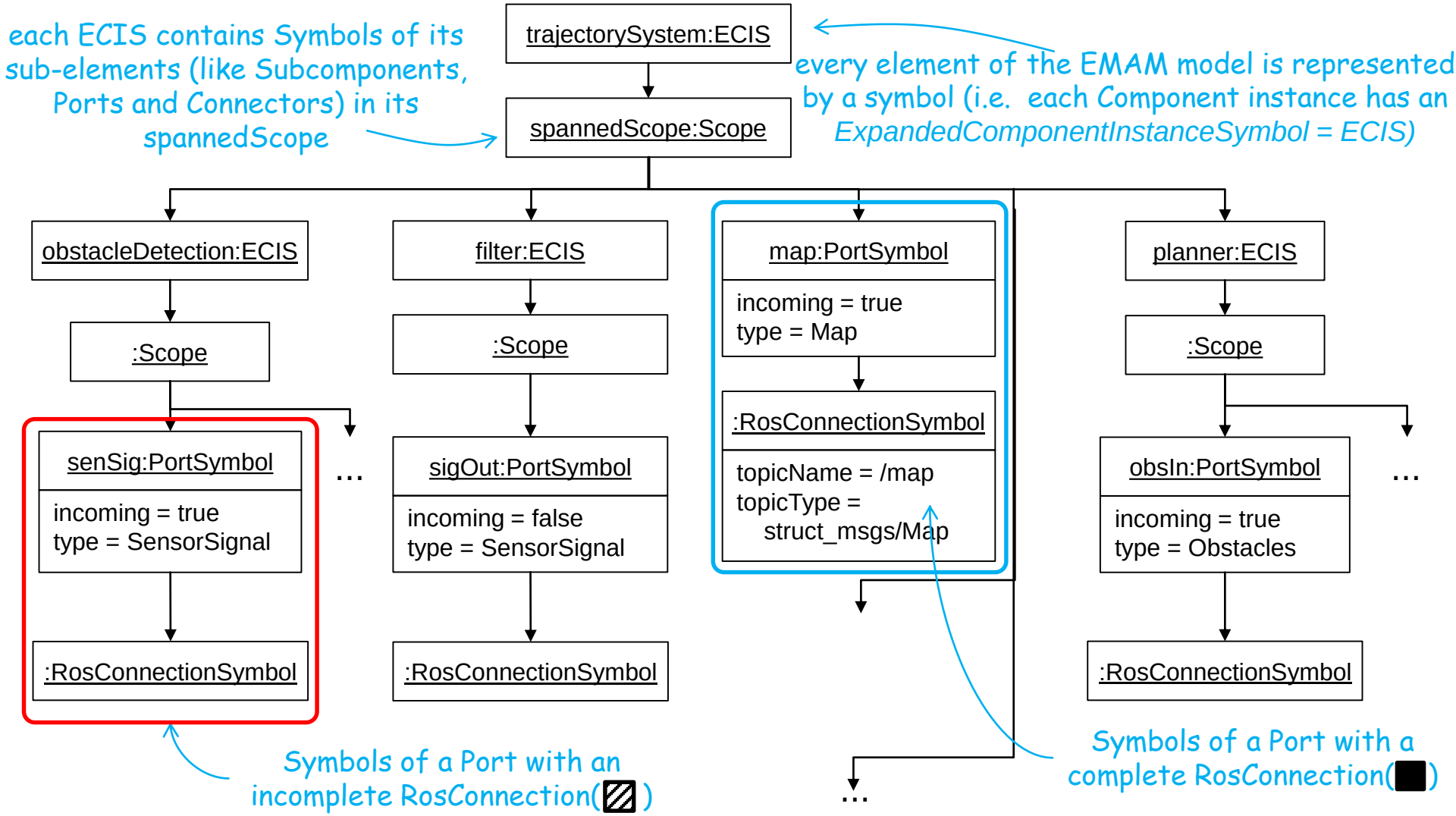
Symbol Table



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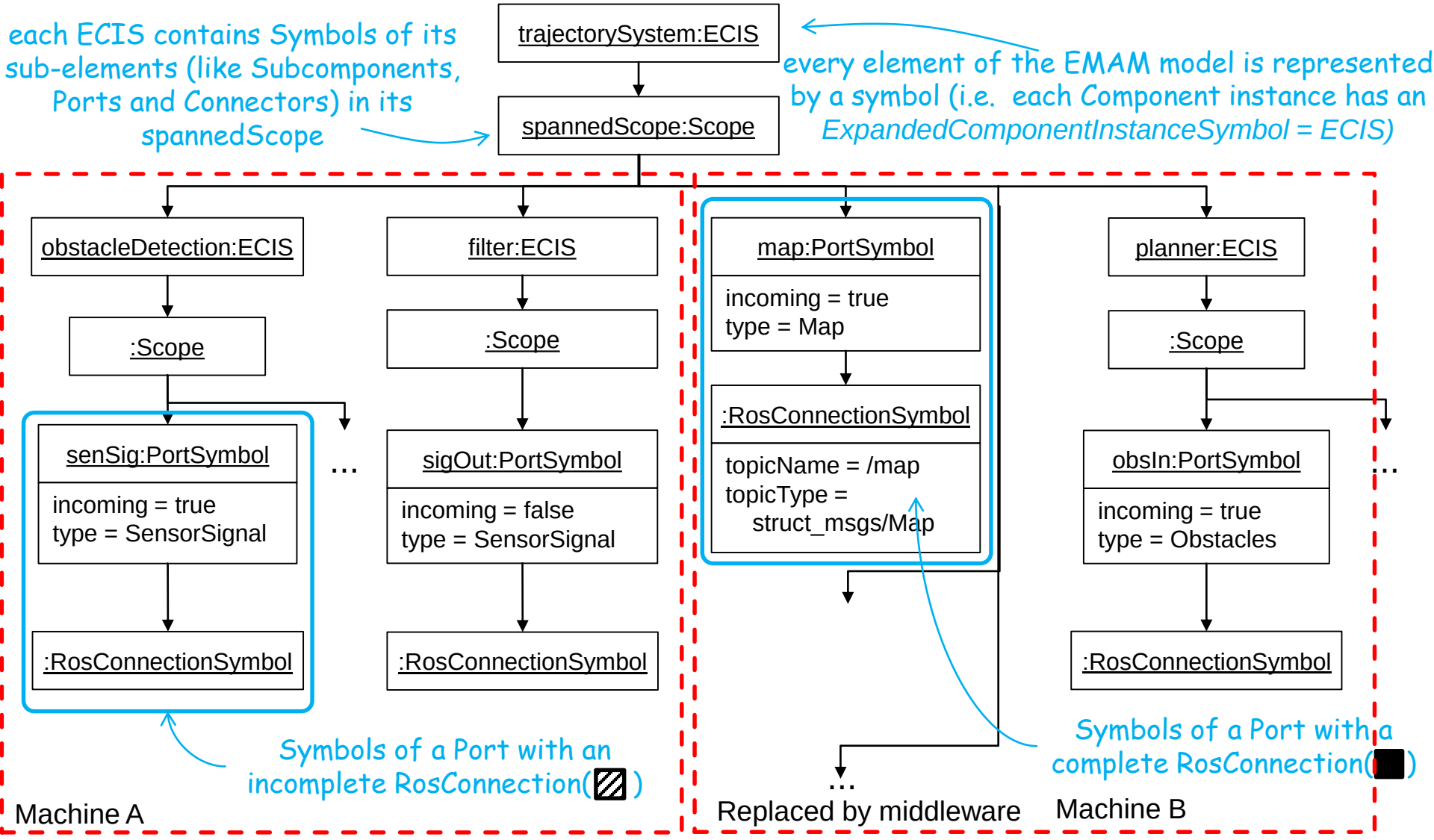
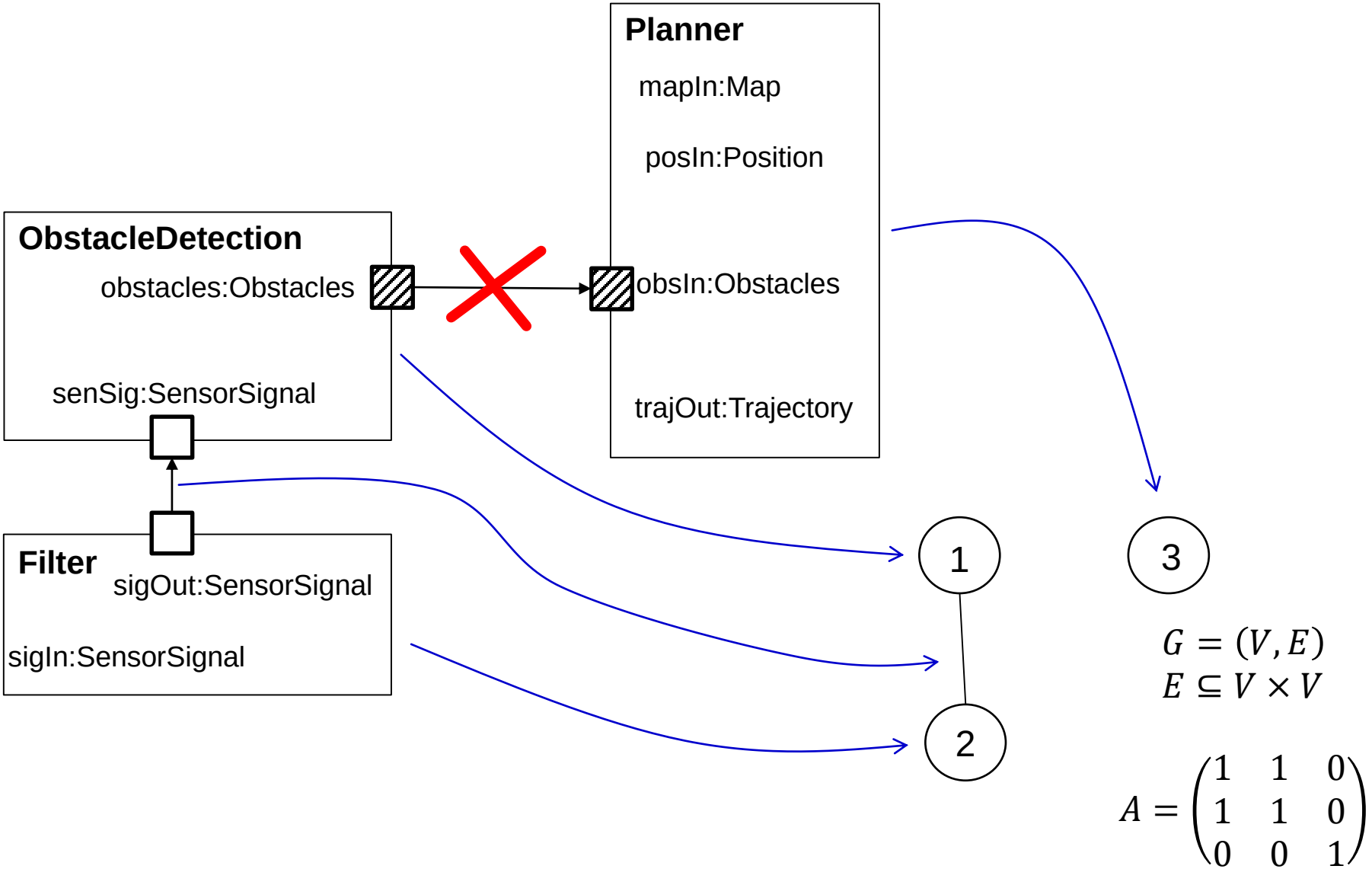
Clustered Symbol Table



Exkurs Machine Learning in SE



$$G = (V, E)$$
$$E \subseteq V \times V$$

$$A = \begin{pmatrix} 1 & 1 & 0 \\ 1 & 1 & 0 \\ 0 & 0 & 1 \end{pmatrix}$$

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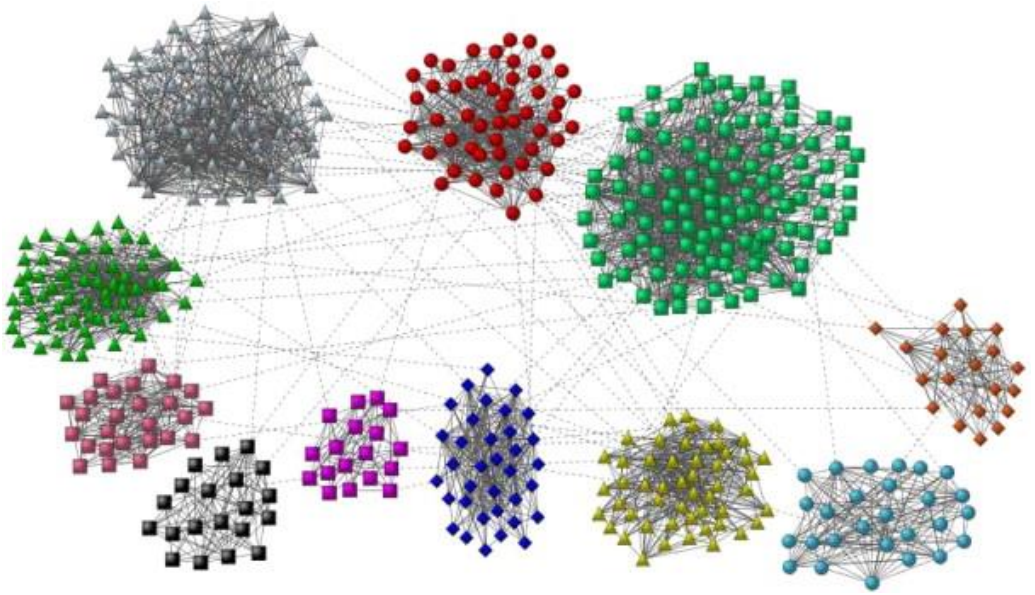
Spectral Analysis

- Solve the eigenproblem
  - $Av = ev$
- For our example:
  - $v_1 = \begin{pmatrix} 1 \\ 1 \\ 0 \end{pmatrix}$
  - $v_2 = \begin{pmatrix} -1 \\ 1 \\ 0 \end{pmatrix}$
  - $v_3 = \begin{pmatrix} 0 \\ 0 \\ 1 \end{pmatrix}$



- Non-zero entries appearing in the same ev designate clusters which need to e dedployed on the same machine (no middleware communication)
- Potential: Spectral Methods can help us distribute code to a predefined number of machines
- We use the same technique for error pattern detection for BMW

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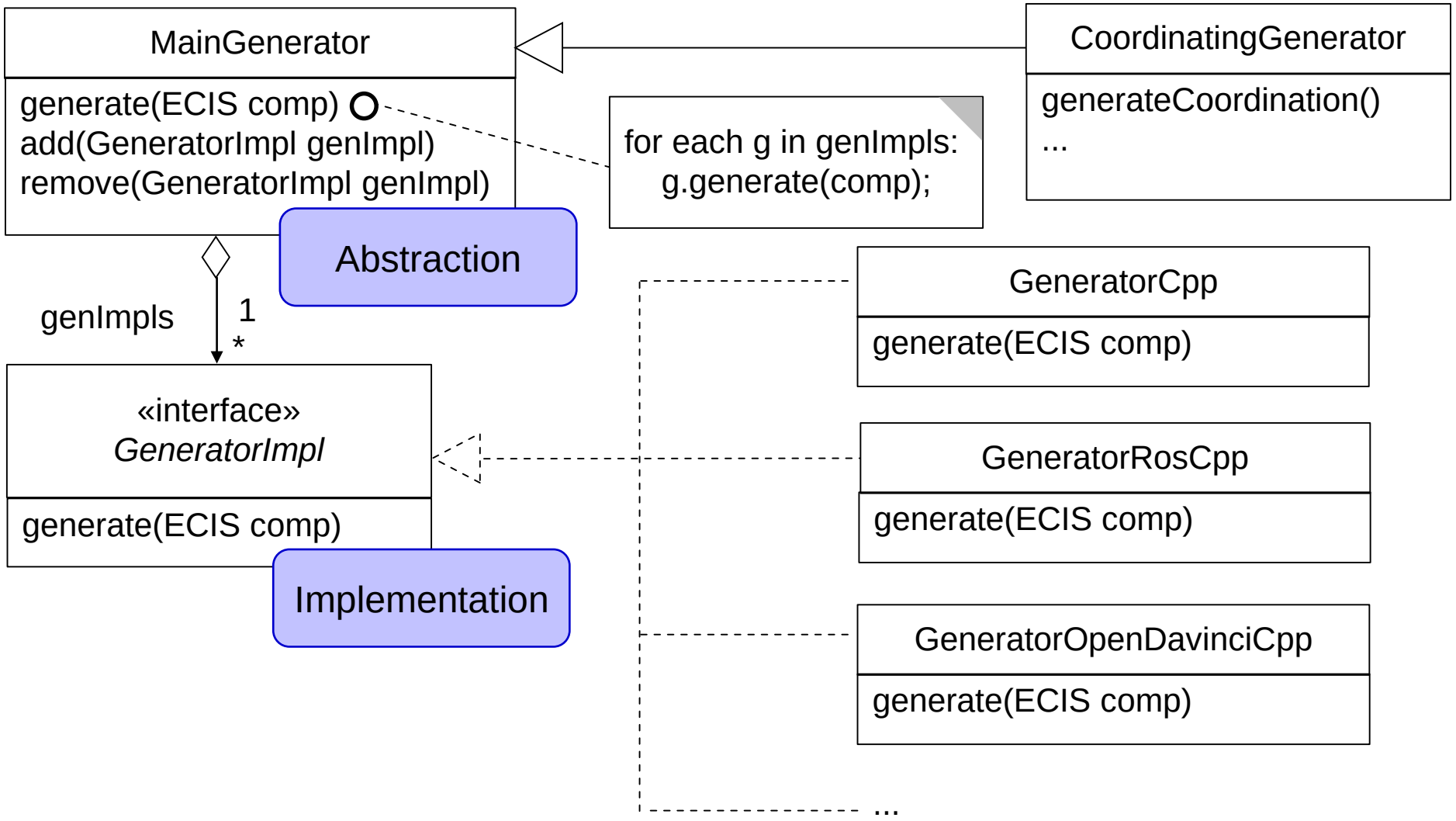
*-Bridge Generator Composition



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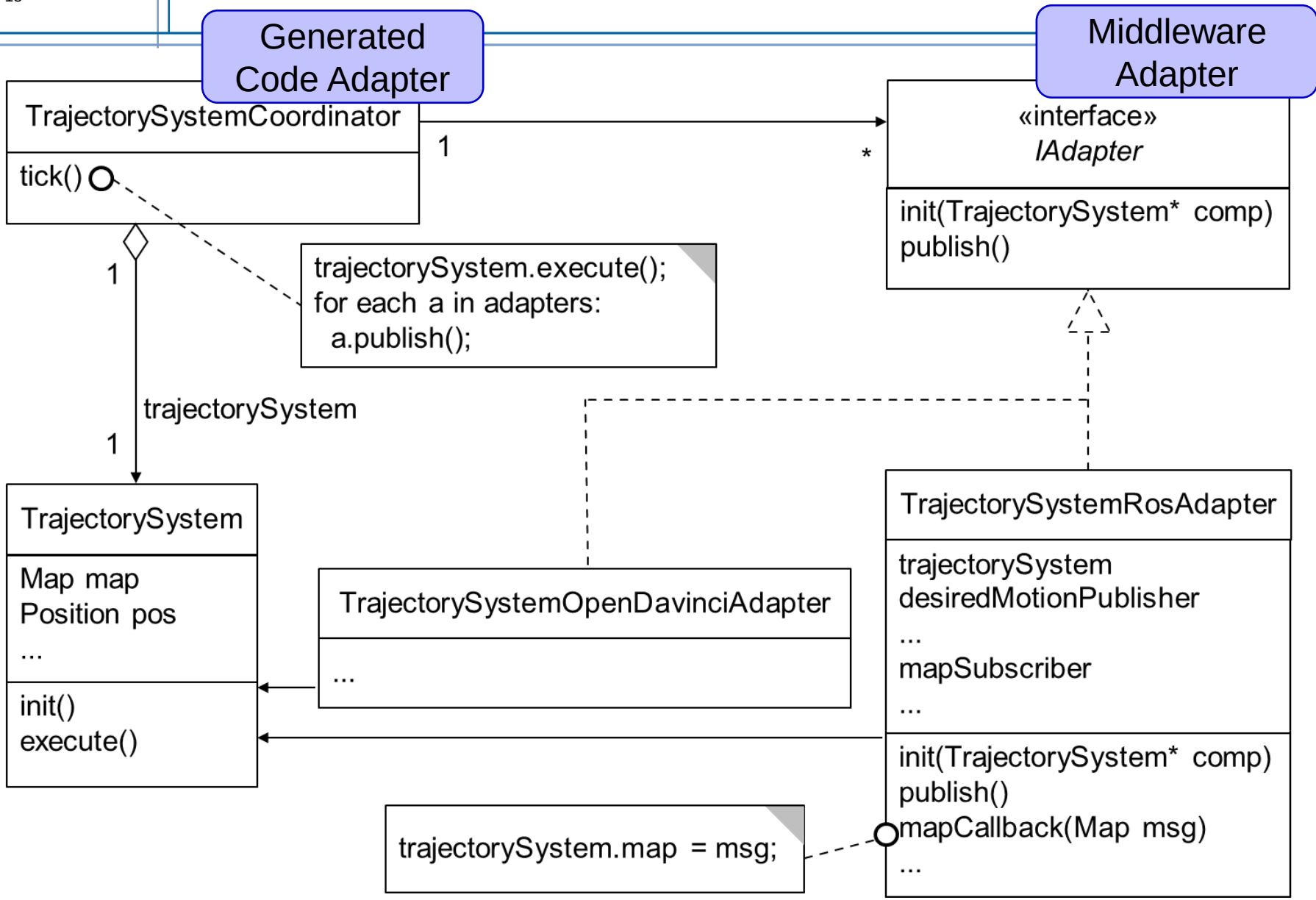
Generated System incl. Adapter



Generated Artifacts

Generator	Generated files
CoordinatingGenerator	├── CMakeLists.txt ├── coordinator │ ├── CMakeLists.txt │ ├── TrajectorySystemCoordinator.cpp │ └── IAdapter.h
GeneratorCpp	├── cpp │ ├── CMakeLists.txt │ └── TrajectorySystem.h
GeneratorOpenDavinciCpp	├── opendavinci │ ├── CMakeLists.txt │ └── TrajectorySystem │ OpenDavinciAdapter.h
GeneratorRosCpp	└── roscpp ├── CMakeLists.txt └── TrajectorySystemAdapter.h

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Generated Adapter

```
1  #include "TrajectorSystem.h"
2  [...] /* other includes*/
3  class TrajectorySystemRosAdapter : public IAdapter{
4    TrajectorySystem* trajectorySystem;
5    ros::Subscriber mapSubscriber;
6    ros::Publisher desiredMotionPublisher;
7
8    public:
9    void init(TrajectorySystem* comp){
10     trajectorySystem = comp;
11     /*init publishers, subscribers and start ROS thread*/
12     [...]
13   }
14   void publish(){
15     struct_msgs::Map tmpMsg =
                 msgFromStructMap(trajectorySystem->desiredTraj);
16     desiredMotionPublisher.publish(tmpMsg);
17   }
18
19   void mapCallback(struct_msgs::Map& msg){
20     trajectorySystem->map = structFromMsgMap(msg);
21   } [...] };
```

instance shared between the coordinator and other adapters

called once by TrajectorySystemCoordinator

called in a defined interval by TrajectorySystemCoordinator

called by ROS every time a message is published on the topic **/map**