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# **SiReSS: A Reconfiguration approach and their utilization into Systems of Systems (SoS)**

Presentation for Research School

v1

26-Nov-2019

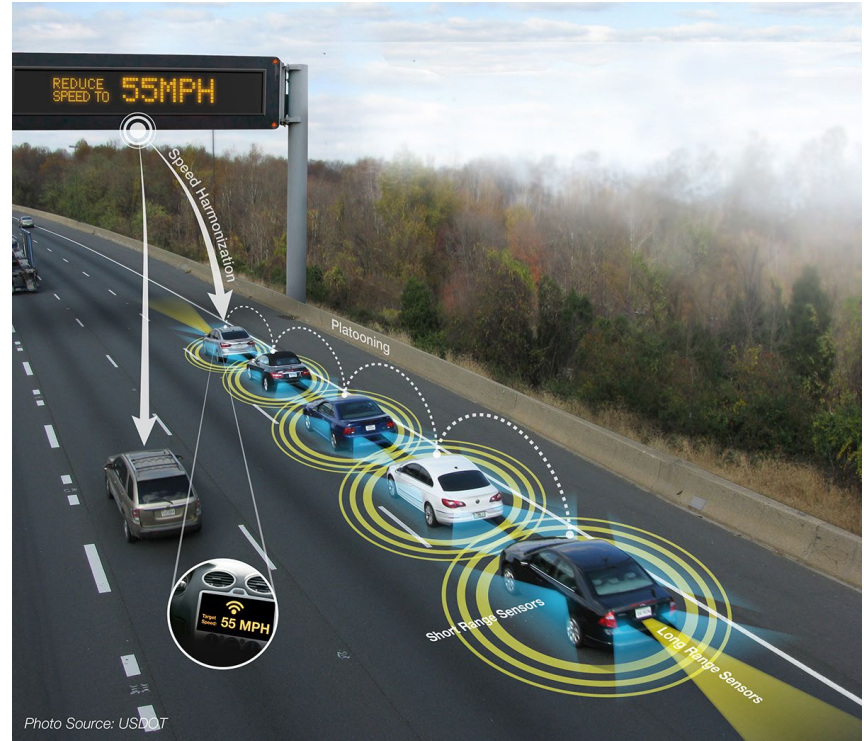
# Agenda

1. SiReSS Project and Partners
2. Introduction to Systems of Systems (SoS)
3. Reconfiguration
4. Reconfiguration for SiReSS

# SiReSS Project and Partners

## Introduction

- System of autonomous systems collaborate in group
- Interaction and collaboration to accomplish given tasks
  - Minimization of time and work
  - Maximization of usability



Source: <https://de.wikipedia.org/wiki/Platooning>

# SiReSS Project and Partners

## Project definition

### Definition of the project:

- The project aims to develop an approach to enable the reconfiguration of cooperating systems
- Main focus on safety relevant reconfigurations
- Reconfiguration should be done by every autonomous system in communication of other system members

# SiReSS: Project and Partners

## Partners

- The project is funded by IFAF Berlin (Institute for applied science Berlin)



- Two research institutes :

- HTW Berlin University of Applied Sciences (Leader)
- Beuth University of Applied Sciences



- Three industrial partners

- Expleo (automotive)
- InSystems (industrial automation)
- Samoconsult (automotive)



# Systems of Systems

## Introduction

<b>Properties</b>	<b>System</b>	<b>Systems of Systems</b>
Autonomy	Consists of one autonomous System	Consists of a set of autonomous Systems
Belonging	Acting autonomously	Acting as group and get benefit from other members
Connectivity	Built up on design time	Built up dynamically
Emergence	Built up as they are designed	Can not be foreseen in design time

# Systems of Systems

## Application Focus

- System of interest = Autonomous mobile hardware units  
System of systems = Group of mobile hardware units
- System of interest = Computerized controller  
System of systems = Network of controllers
- System of interest = Software service  
System of systems = Service oriented architecture of Software systems



Focus for SiReSS

# Reconfiguration

## Introduction

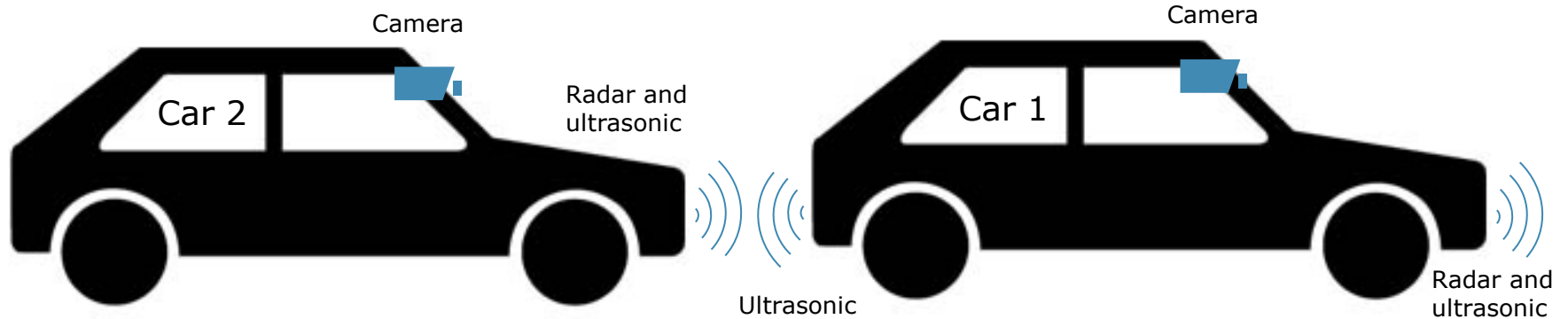
Reconfiguration is the ability to change an already developed and operating System for:

1. Adaption of new requirements
2. Extending functionality
3. Elimination of Errors
4. Improvement of quality characteristics



# Reconfiguration

## Introduction C2C reconfiguration



1. Adaptation of new Requirements:  
Integration of new System Member

2. Extend functionality:  
Exchange of car 2 radar data and back ultrasonic sensor to reduce air resistance by reducing C2C distance

3. Elimination of Errors:  
Car 2 can't use camera → Car 2 use camera data of car 1

4. Improvement of Quality:  
Connect camera data of car 1 with radar data of car 2 → adapt distance for secure drive

# Reconfiguration

## Introduction

Divided into Programmed and Ad-hoc reconfiguration:

### **Programmed Reconfiguration:**

Changes that can be predicted at design time.

Example: Rain detection sensor is broken → Windscreen wipe automatic is switched to interval mode

### **Ad-hoc Reconfiguration:**

Changes that cannot be predicted at design time

Example: Additional sensors comes available through other System members → Sensor data could be used to extend the functionality or to replace failed sensors

# Reconfiguration Methods

Tree search system:

- Most common programmed reconfiguration method
- Method divided in:
  - Logical operator tree
  - Goal driven

Graph transformation

- Rule defining through corner points

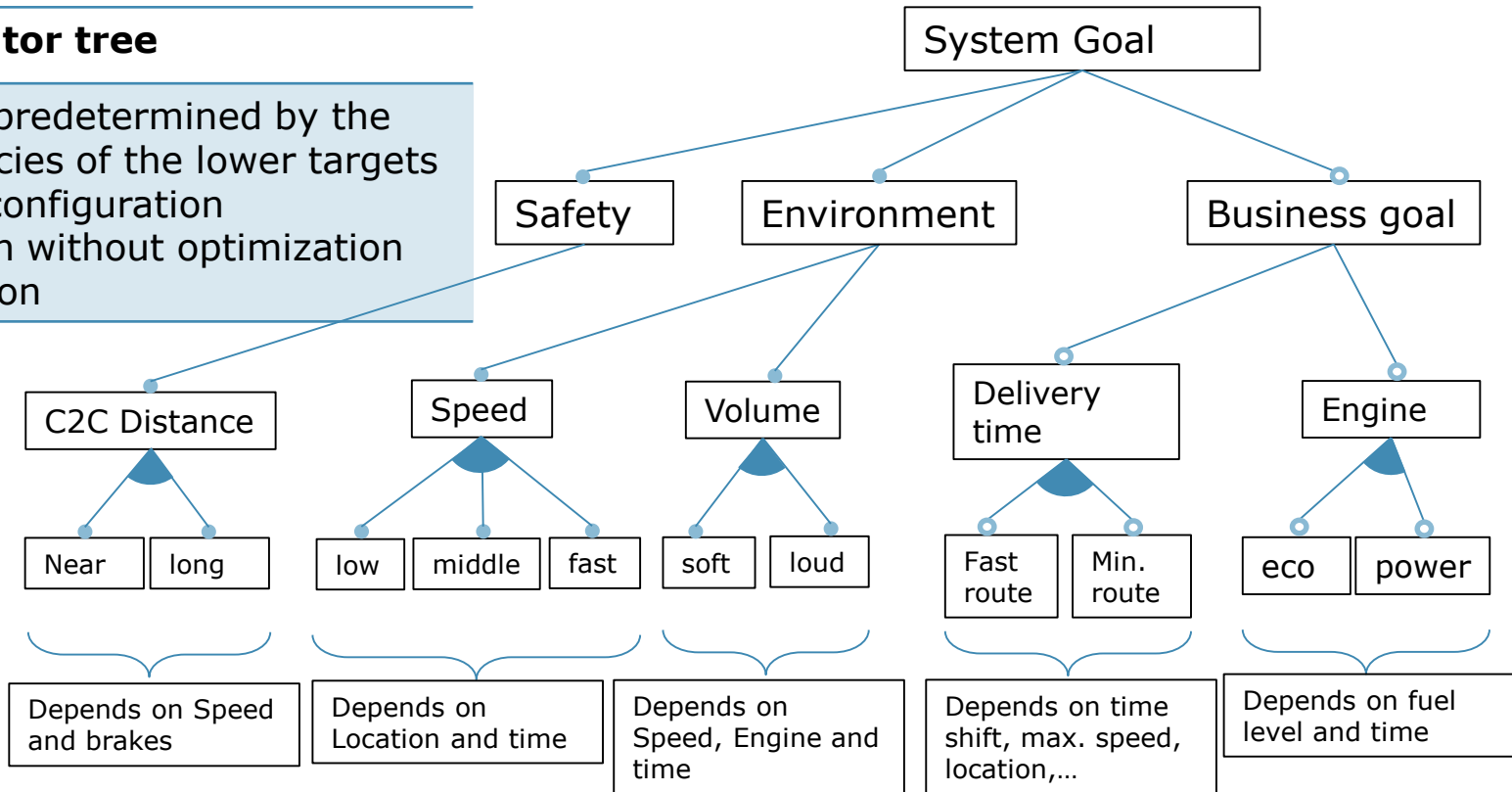
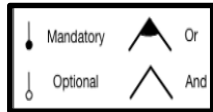
# Reconfiguration

## Tree search

### Logical operator tree

Couplings are predetermined by the interdependencies of the lower targets  
Situational Reconfiguration  
Reconfiguration without optimization and classification

#### Legend



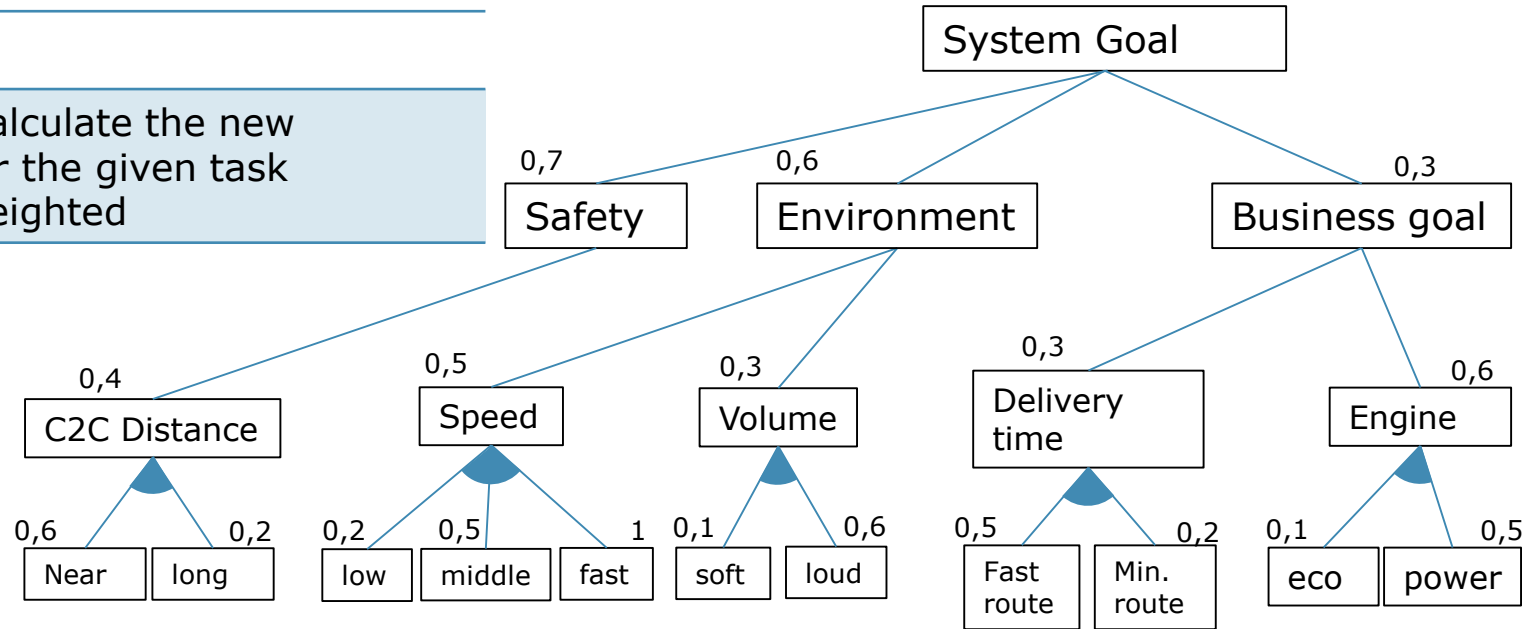
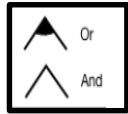
# Reconfiguration

## Tree search

### Goal driven

Wining points calculate the new configuration for the given task  
Subgoals are weighted

Legend



# Reconfiguration

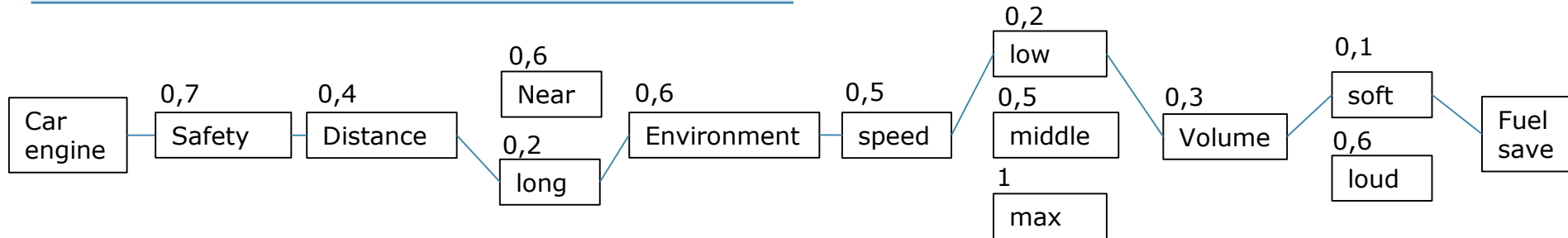
## Graph transformation

### Graph transformation

Consist of left and right hand side definition

- Left hand side define where reconfiguration should be done
- Right hand side define what should be done

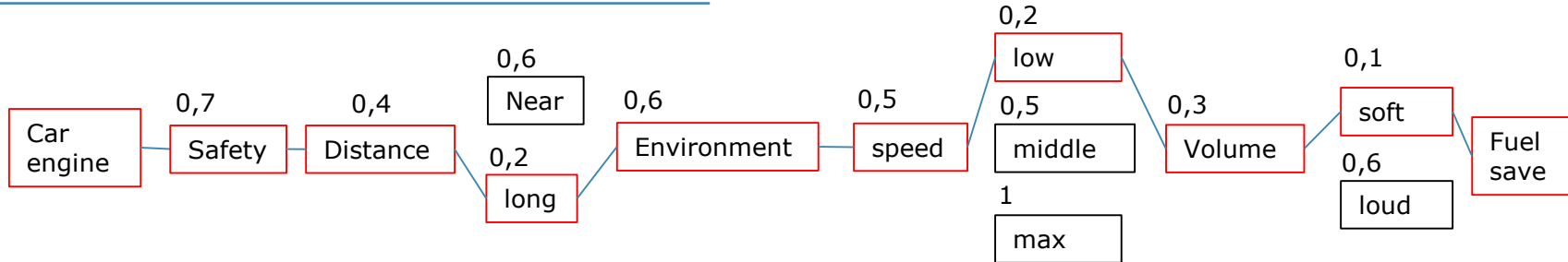
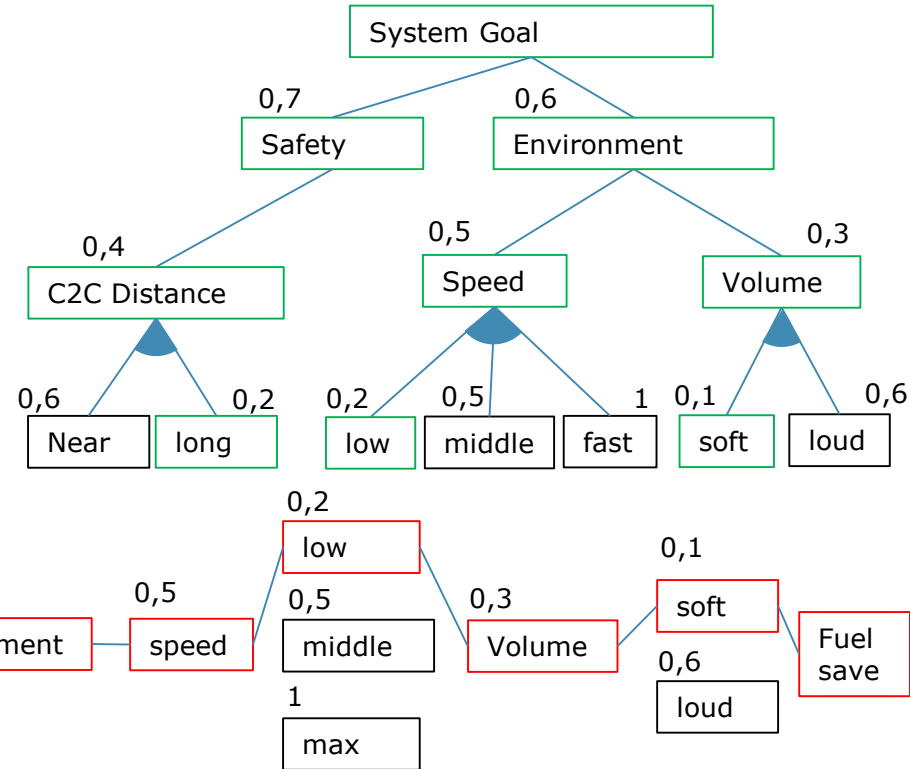
The reconfiguration algorithm is directed through corner points



# Reconfiguration

## Goal driven tree search vs. goal driven graph transformation

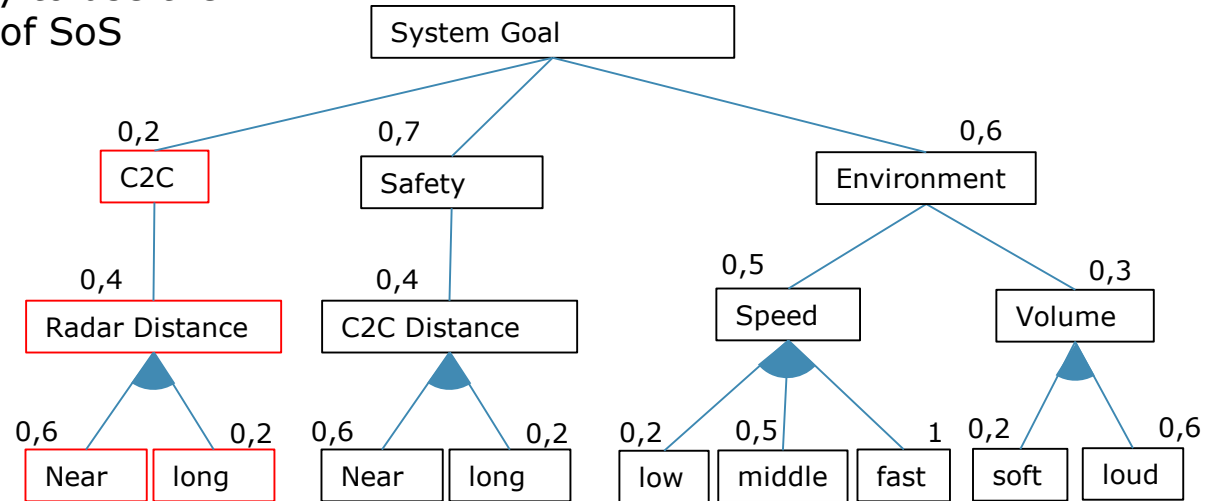
	Goal driven tree search	Graph transformation
Goal	Fuel saving configuration	
Math. result	$100.8 \cdot 10^{-6}$	$100.8 \cdot 10^{-6}$
Reconfiguration	Parallel operation	Singular operation
Reconfiguration part	Whole System	component by component



# Reconfiguration for SiReSS

## Next steps for SiReSS

- Ad-hoc Reconfiguration
- Reconfiguration with the ability to use the system structure of members of SoS

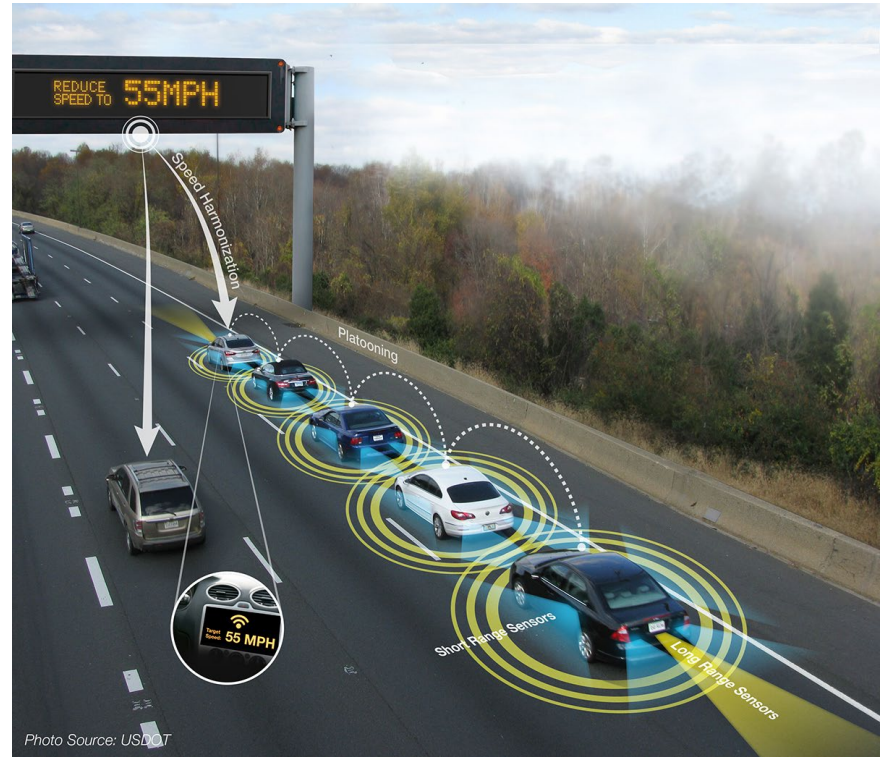




# Reconfiguration for SiReSS

## Use case automotive

- Reconfiguration of Platooning car system
- Short Range Sensor of single Car is broken → platoon system should be reconfigured to increase security:
  - Broken sensor in middle car of platoon:
    - Broken system member collect data from other near members
    - calculates distance based on collected data
  - Broken sensor at first or last member:
    - New positioning of Member in platoon
    - Broken system member collect data from other near members
    - Calculates distance based on collected data



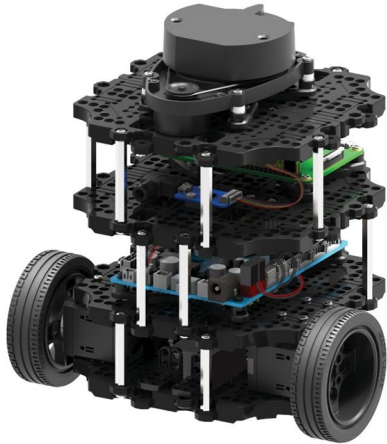
Source: <https://de.wikipedia.org/wiki/Platooning>

# Reconfiguration for SiReSS

## Use case industrial automation

- Reconfiguration of robot system
  - Sensor of robot is broken → other system members help with their sensor data

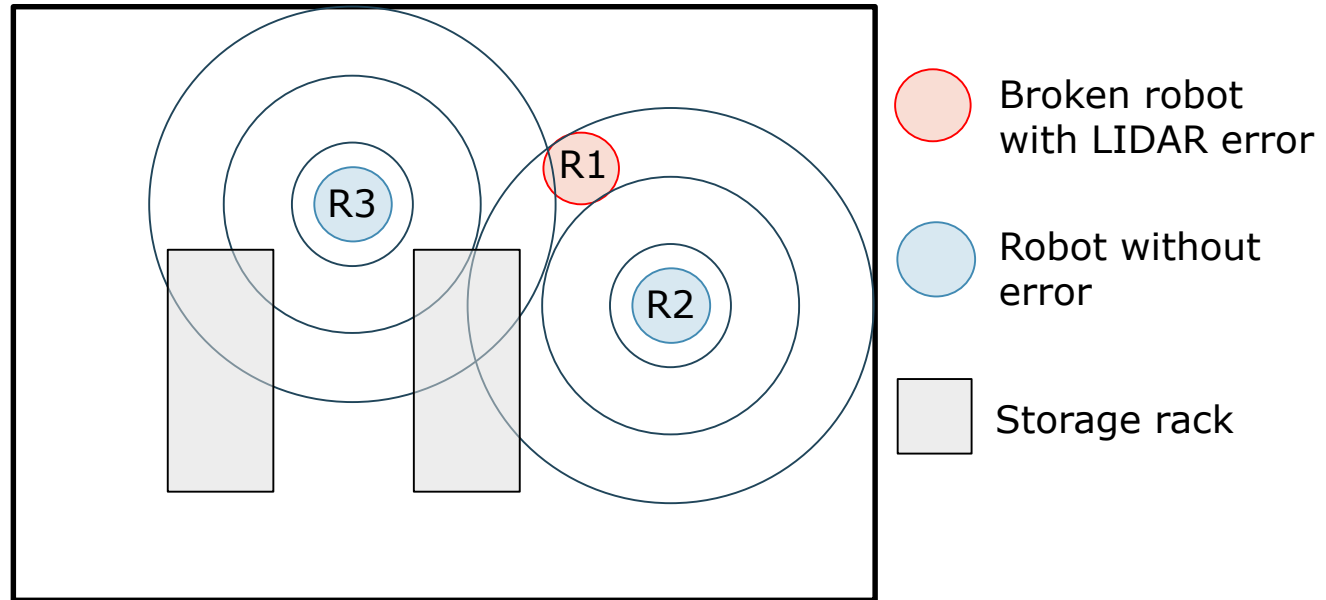
LIDAR



TurtleBot 3



Source: <https://www.turtlebot.com>





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