

Bashar Al-Ani, BMW AG

12 MAY 22

FINAL EVENT



IMAGinE



Further Approaches For Cooperation

OUTLINE

Concerns and advancement of architecture

Cooperation concept comparison criteria

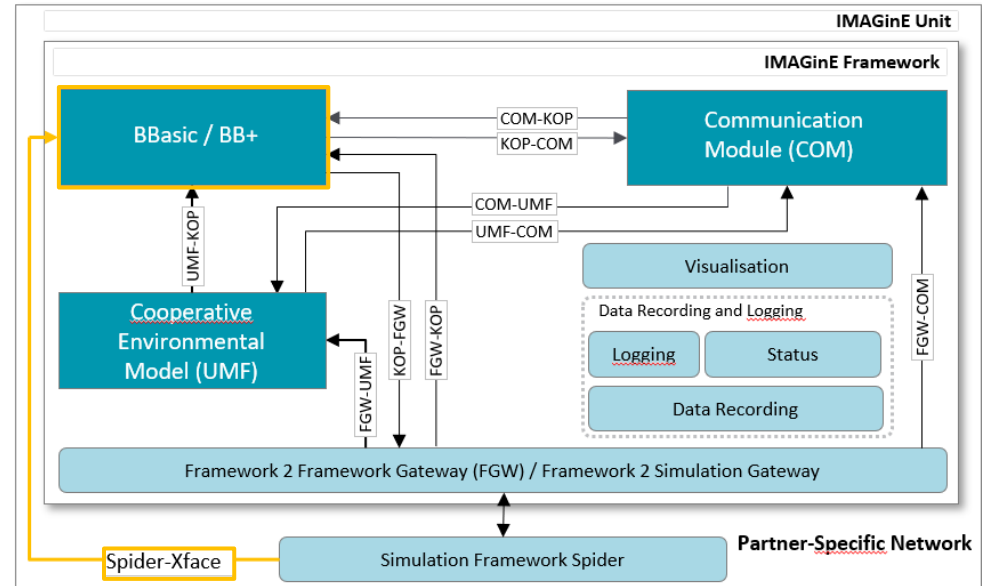
BMW BBasic cooperation concept

BMW BB+ cooperation concept

Cooperation concept comparison

Concerns and advancement of architecture

- Decentralized planning with event-based cooperation:
 - Lower communication bandwidth
 - More scalability
 - Less computational resources
 - Access to simulation infrastructure compatible with human behavior (spider)



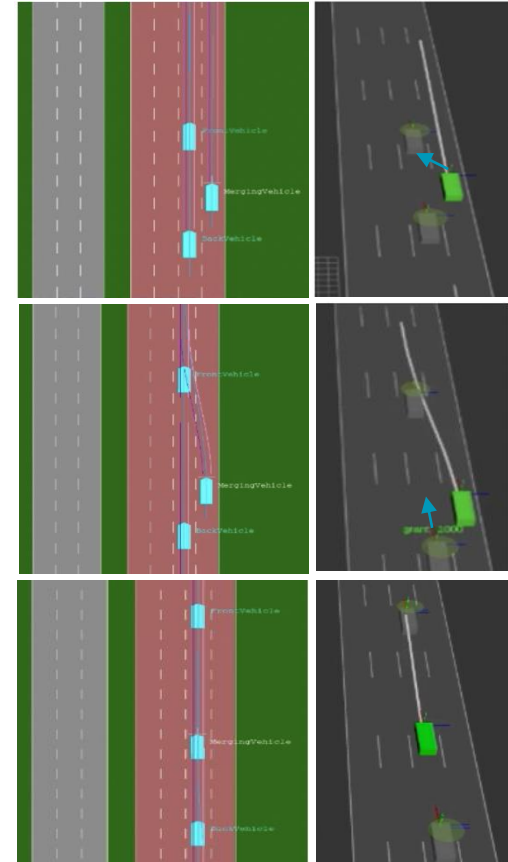
Cooperation concepts comparison criteria

- Generation of driving change request
- Content of transmitted cooperation request
- Cooperation confirmation

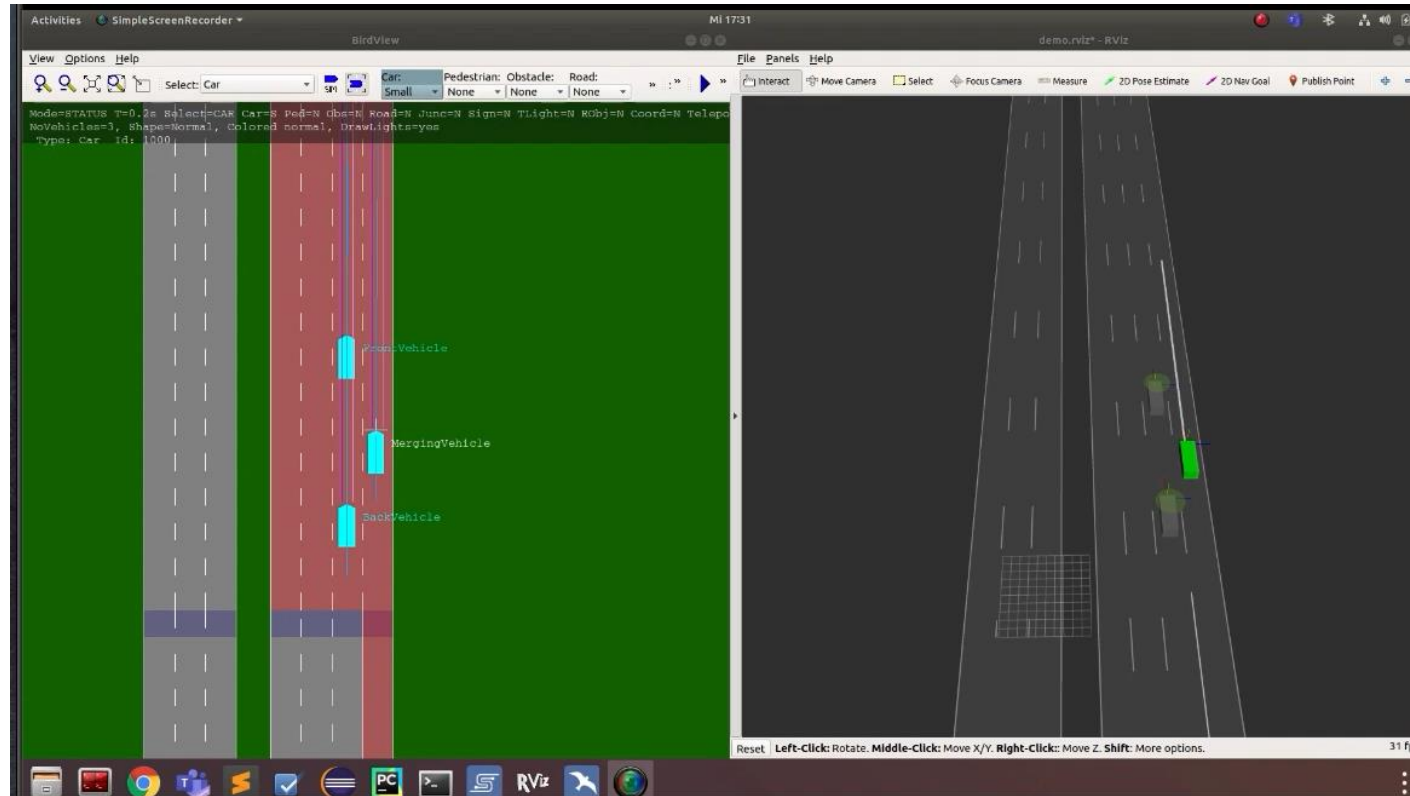


BMW BBasic cooperation concept

- Principle trajectory wish is transmitted directly as an intention
- A cooperating vehicle grants cooperation and commitment cyclically: “For this maneuver I grant you priority”
- Request and confirmation remain cyclical until the confirmation is completed or the commitment is withdrawn (according to the StVO)
- Time gap to advancing vehicle is reduced “normally” during merge and afterwards extended again (“Wiedemann” distance model)



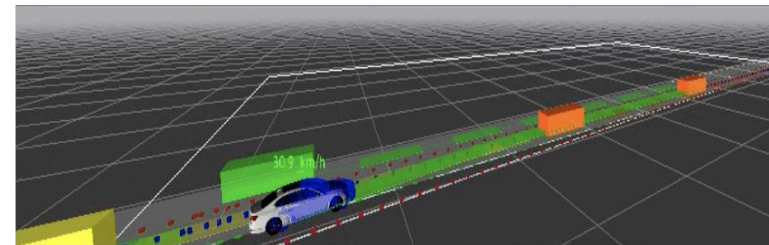
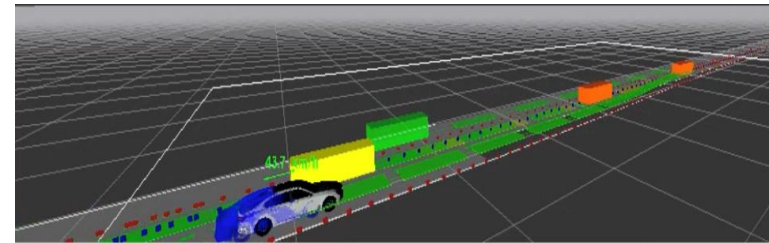
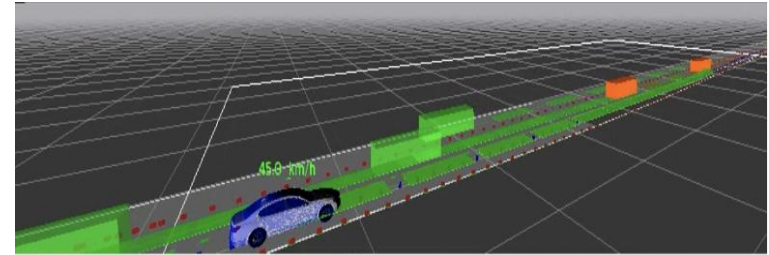
Video - BBasic with IMAGinE F1 - merge



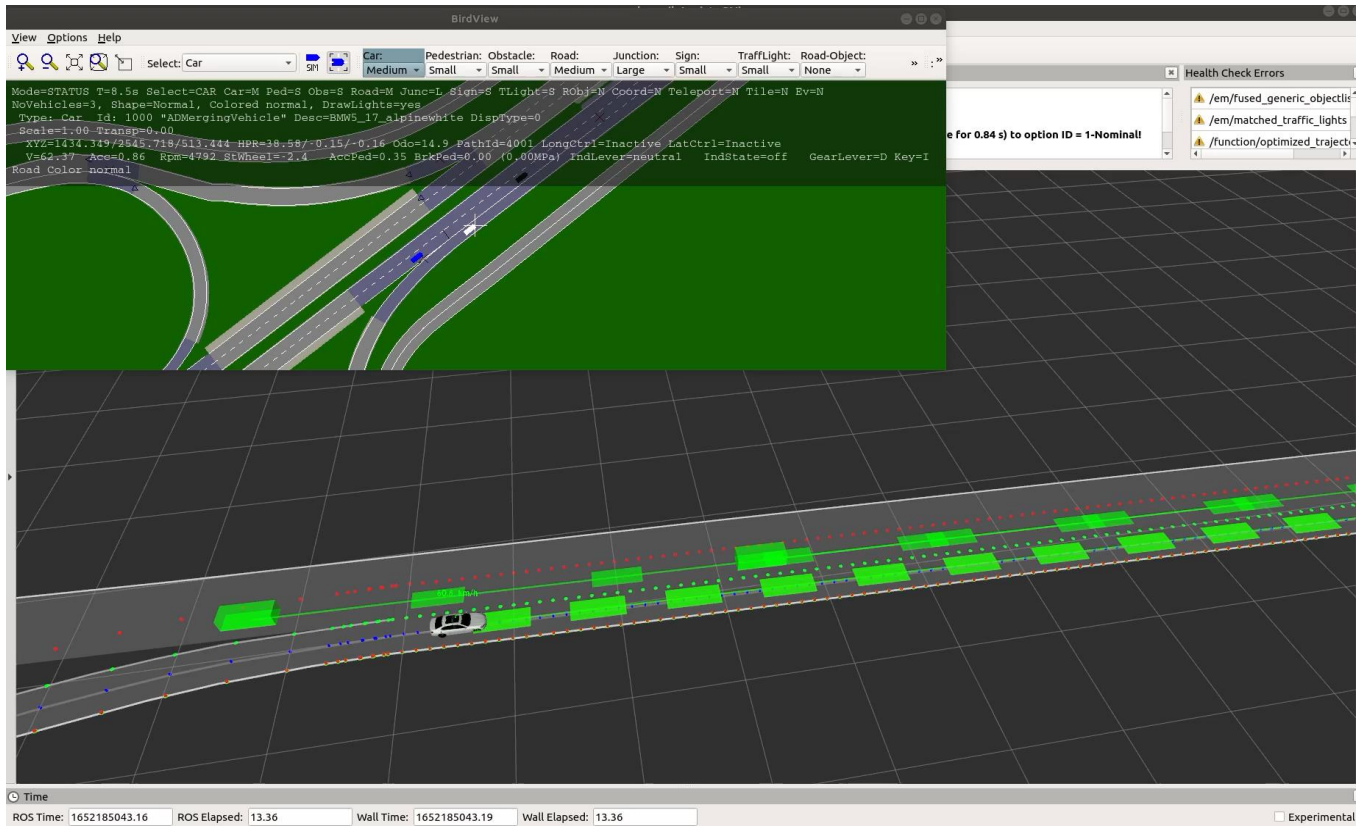
BMW BB+ Cooperation Concept



- Safe, comfortable and traffic rules compliant geometric area Maneuver is transmitted to surrounding vehicle directly as intention
- A „Software Blinker“ only faster and unambiguous with confirmation
- In addition, recipients can be addressed via IMAGinE compliant attributes
- Cooperation takes place as in BBasic cooperation concept



Video - BB+ F1 – initiate cooperative merge



Videos - BB+ F1 – reaction to cooperative merge



The screenshot displays a simulation interface with a top toolbar, a central 3D view of a road merge, and a bottom-left panel showing the car's state. The top toolbar includes a search icon, a dropdown menu set to "Car", and various filter buttons for "Pedestrian", "Obstacle", "Road", "Junction", "Sign", "TrafficLight", "Road-Object", "Coordinate", "Teleport", "Tile", "Events", and "Set All to". The central 3D view shows a blue car on a road with a green background, with a speed indicator of "4.2 km/h". The bottom-left panel shows the following state information:

```
Mode=STATUS T=2.8e-6 Select=CAR Car=M Ped=S Obs=S Road=M Junc=S Sign=S TLight=S Robj=N Coord=S Teleport=S Tile=N Ev=N  
NoVehicles=3, Shape=Normal, Colored normal, DrawLights=yes  
Types: Car ID: 0 "SimVehicle" Desc=BMW5_17_carbonblack DispType=0  
Scale=1.00 Transp=0.00  
XYZ=1393.760/2518.207/513.520 HPR=38.05/0.10/-0.13 Ode=0.1 PathId=4001 LongCtrl=Inactive LatCtrl=Inactive  
V=2.12 Acc=1.34 Rpm=1116 StWheel=78.8 AccPed=0.07 BrkPed=0.00 IndLever=neutral IndState=off GearLever=N Key=0  
Road Color normal
```

The bottom-left panel also shows several status indicators:

- AdModeDisplayAdMode: **STATE ON** (last off reason: exceedingTrajMessageTimeout)
- GapNotifierDisplayGapNotifier: **AUTOMATIC**
- StopLineDisplayStopline
- SpeedLimitDisplaySpeedLimit

The bottom of the interface shows a "Time" section with the following values:

ROS Time:	1644339168.52	ROS Elapsed:	675.72	Wall Time:	1644339168.55	Wall Elapsed:	675.63
-----------	---------------	--------------	--------	------------	---------------	---------------	--------

An "Experimental" checkbox is located at the bottom right of the interface.

Cooperation concepts comparison



Criteria	Continuous Cooperation Concept	BBasic	BB+
Generation of driving change request	Local decision	Calculation of lane compliance on the basis of road legislation (right-hand drive, etc.)	Sending vehicle uses a combination of geometric areas and trajectory costs to generate cooperation request
Content of transmitted cooperation request	Trajectory	Principle trajectory or FLAG (yes/no information) on spec. question e.g. change track, alternatively trajectory possible but more complex	Maneuver intent + trajectory
Cooperation confirmation	Implicitly and explicitly via trajectory matching	Explicitly via sending the message of the cooperating vehicle	Implicitly via trajectory matching and explicitly as a cooperation message

THANK YOU

Bashar Al-Ani

BMW AG

bashar.al-ani@bmw.de

www.imagine-online.de

Images: IMAGinE, Unsplash

12/05/2022

IMAGinE FINAL EVENT

Supported by:



Federal Ministry
for Economic Affairs
and Climate Action

on the basis of a decision
by the German Bundestag