



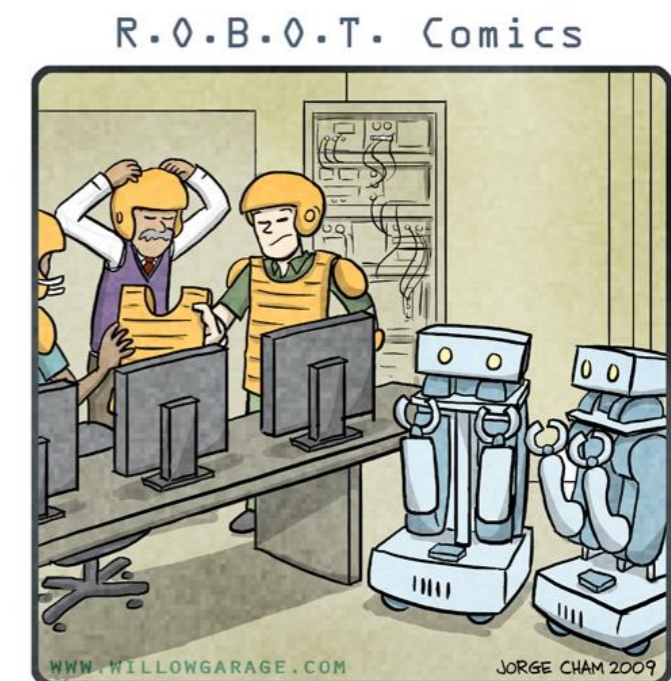
# From simulation to real robots



# Introduction

Simulation vs. real robot

- Simulations allow
  - Easy and fast development
  - Save operation of untested algorithms
  - Repeatability
- But suffer from
  - Simulation accuracy
  - Real world dynamics and timing
  - Often different interfaces compared to real robots



"I HAVE A BAD FEELING  
ABOUT THIS DEMO."

- WHAT MUST WE DO TO BRING SIMULATION CLOSE TO REAL ROBOTS?



## Choosing Simulation environment

- Player/Gazebo – free but lacks e.g. multi camera support
- Webots – commercial, very expensive
- Deltra3D – free but it seems to be fairly inactive
- USARSim – free, used by e.g. the RoboCup

=> USARSim chosen



# USARSim

A high-fidelity simulator

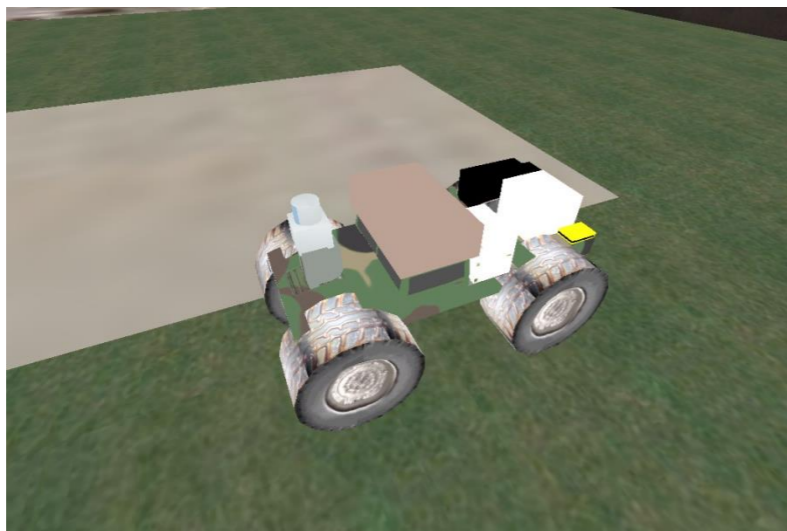
- Based on Unreal Tournament game engine
- moderate hardware requirements, high speed physics engine and rendering capabilities
- Simulation of all important types of robots with adjustable parameters:
  - Wheeled robots - Car-like (2WD and 4 WD), Differential drive, ...
  - Arial robots – Quadrocopter, ...
- Simulation of most important sensors:
  - Range (LODAR, sonar, IR)
  - Position (INS, GPS, Wheel sensors)
  - Camera (Multi camera views)



# How to integrate a real robot in USARSim?

## USARSim setup

- Setting up robot using existing USARSim models and sensors
- Adjusting parameters to fit the real robot



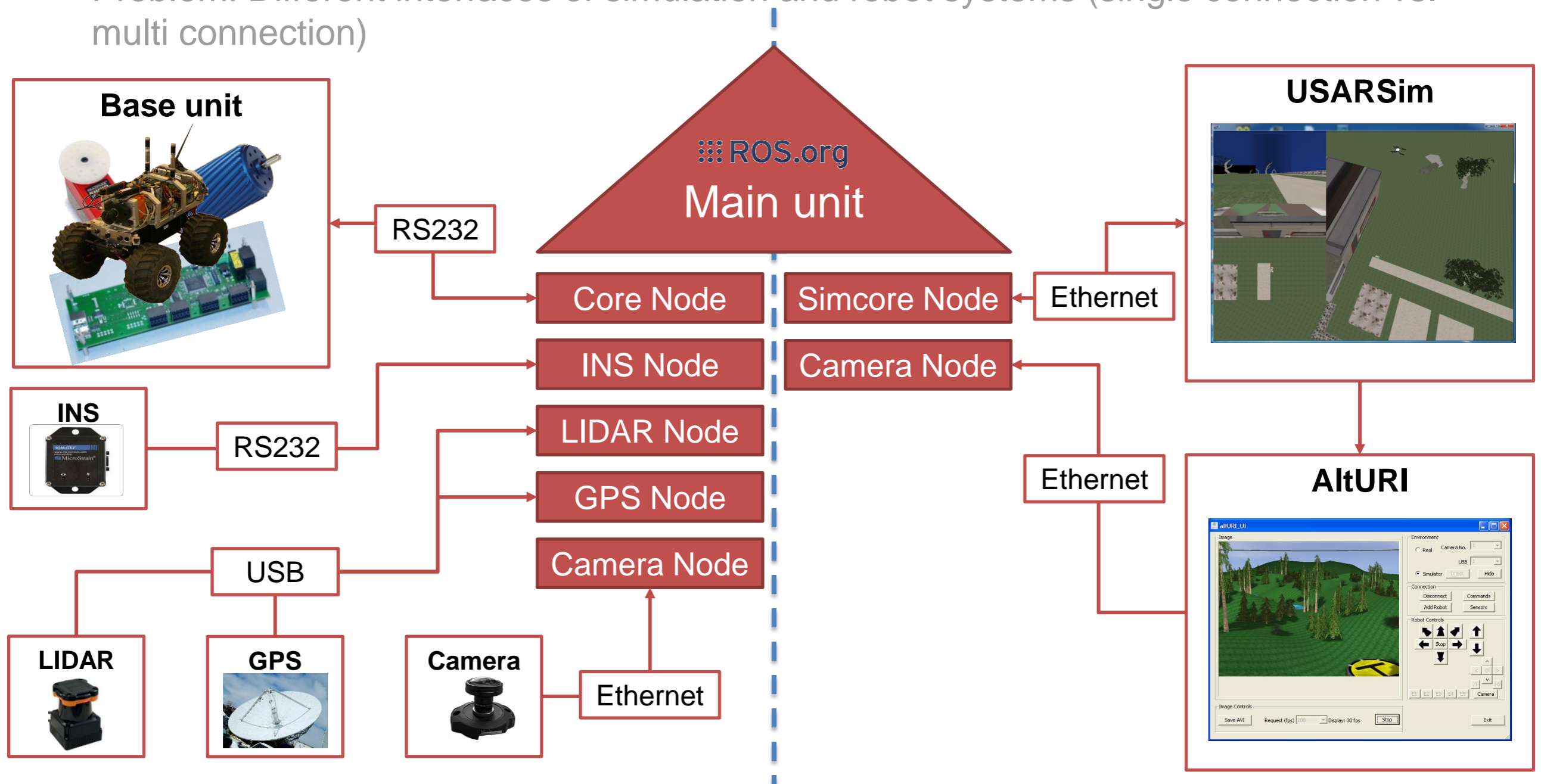
- Develop maps according to real facilities





# How to integrate a real robot in USARSim?

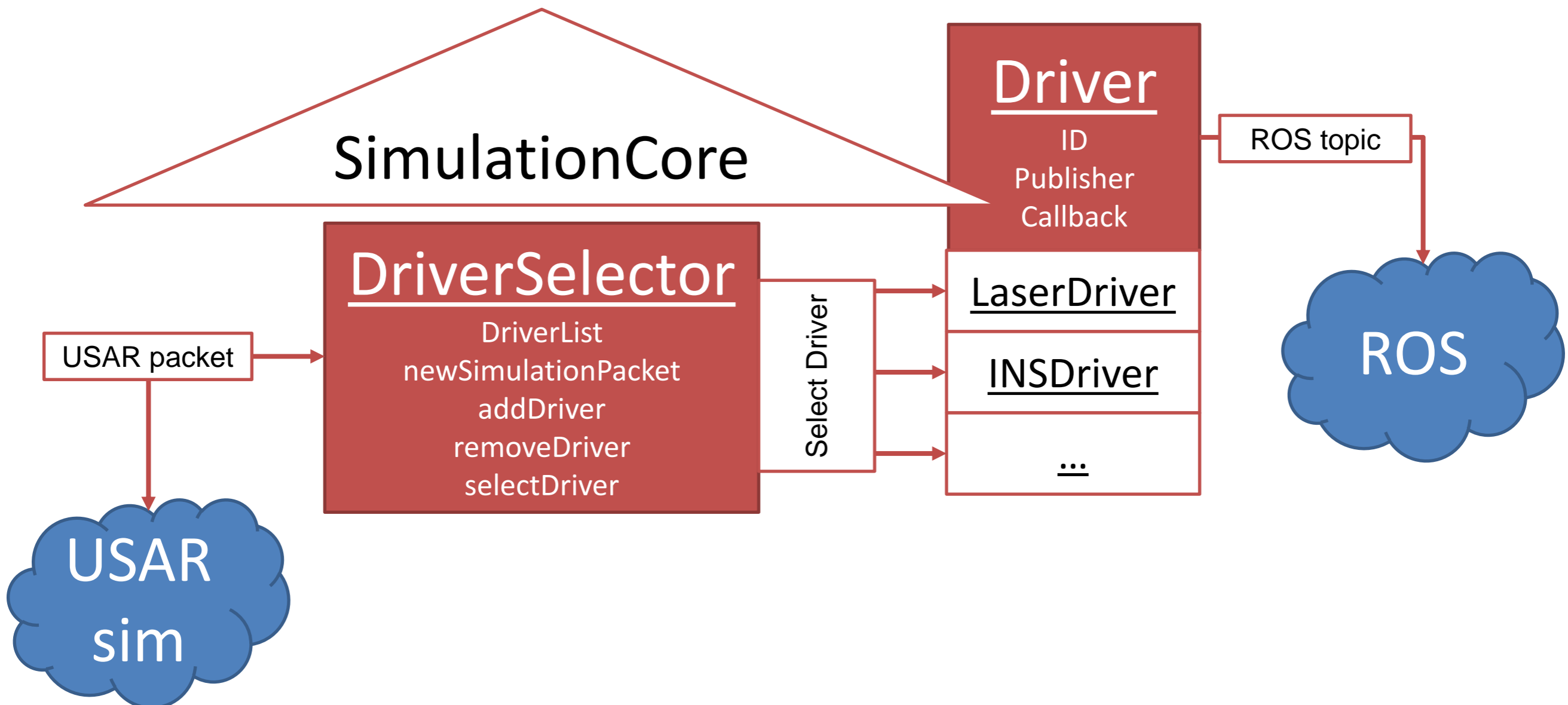
Problem: Different interfaces of simulation and robot systems (single connection vs. multi connection)





# How to break the single simulation connection?

Overview





## How to enable multi-node architecture?

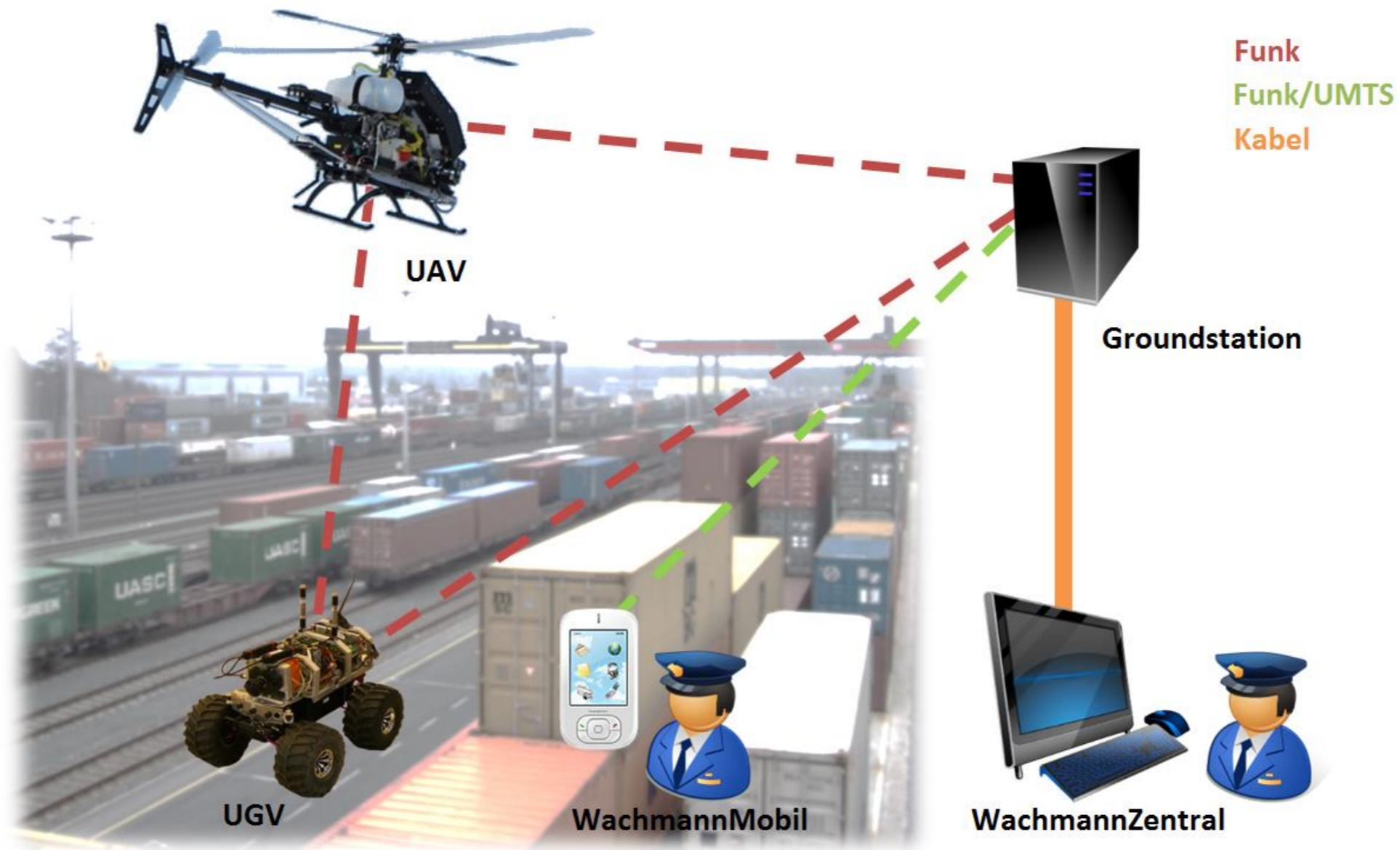
- SimulationCore extended by service registerExternalDriver
  - Special extDriver added to DriverSelector once services is called
  - No processing of data and publishing as normal ROS data types by extDriver
  - Data serialized and published over special extDriverPublisher
- ExternalDriverNode
  - Calls registerExternalDriver service (sets extDriverPublisher topic)
  - Subscribe to extDriverPublisher topic
  - Deserialize data, and do all processing (existing drivers may be foundation)





# Use-Case: SiNafaR overview

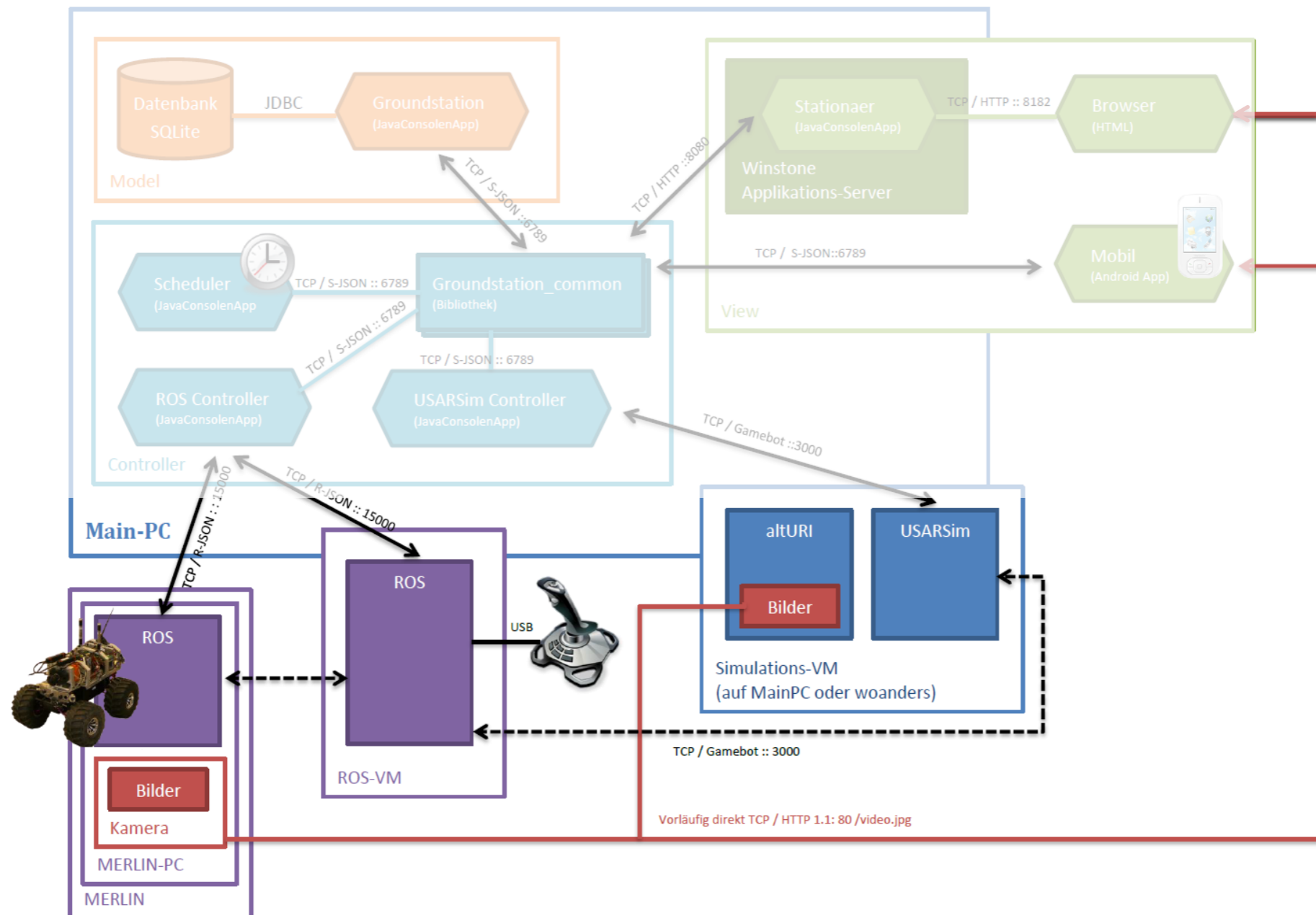
The rough...





# Use-Case: SiNafaR overview

.. And the fine view





... and a screenshot of the GUI

The screenshot displays a software interface with three main components:

- KartenView:** A satellite map view showing a building and surrounding area. A path of blue dots is overlaid on the map, with a scale bar indicating 8.63 m. A compass rose is visible in the bottom right corner of the map area.
- VideoViewJS (top):** A video feed titled "Roboter: Merlin18" showing a first-person perspective of a robot on a grassy field.
- VideoViewJS (bottom):** A video feed titled "Roboter: Flug" showing a top-down perspective of a robot on a grassy field.
- WachbuchEintrag:** A log table with the following data:
 

id	aufgetreten	info	guiMes	antwort	bestaetigt	objekts da
11	2013-04-24 10:54:20	Der Trigger Versteck wurde ausgelost	null	null	null	null
10	2013-04-12 14:23:57	Der Trigger Versteck wurde ausgelost	null	null	null	null
9	2013-04-12 14:16:29	Der Trigger Versteck wurde ausgelost	null	null	null	null
8	2013-04-12 10:11:47	Der Trigger Versteck wurde ausgelost	null	null	null	null



## Conclusion

- Benefits of using simulation in aspects of cost, efficiency, ...
- Complete and dynamic integration of USARSim simulation environment into ROS and ROSenabled robots
- Easy change between simulation and real robots (matter of exchanging one module)
- Multi node architecture in simulation and reality
- Reuse of existing driver code in simulations
- Use of the stockpile of ROSs modules possible



## Future Work

- Bidirectional communication between externalDriverNodes and Simulation
- Configuration of robot sensor systems using launchfiles
- Analysis of overhead of the presented system
- Calibration of simulated cameras



Thank you!

Questions?