# V-REP Integrated Paparazzi Simulation

November 30, 2018

# Overview

# Project goals

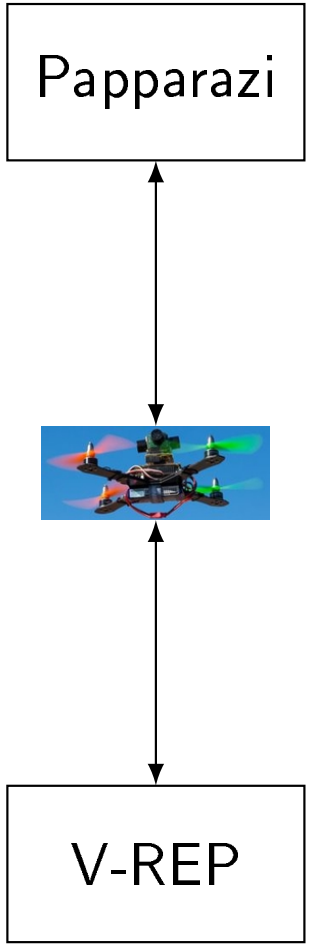
- Creation of a simulation environment for the SwarmLab copters
- Use existing Paparazzi infrastructure
- Should be easy to use and extend

# Why do we even need a Simulation?

- TODO: insert picture of broken copter part
- Simulation allows experiments without risking potentially expensive hardware
- Exploration of a wide range of potential environments and conditions
- Scalability

# Project idea

- Idea: V-REP plugin providing communication between Paparazzi and V-REP
- V-REP provides the copter state, Paparazzi the corresponding commands
- Main advantage: same code and infrastructure usable on simulated and real copters



# Why a new framework?

- Multiple simulators for (swarm) robotics already exist
- None of them provide all needed functionality/convenience

| JSBSim | Gazebo | ARGoS |
|---|---|---|
| no swarm capability | no GUI | only 2D |

# Base Architecture

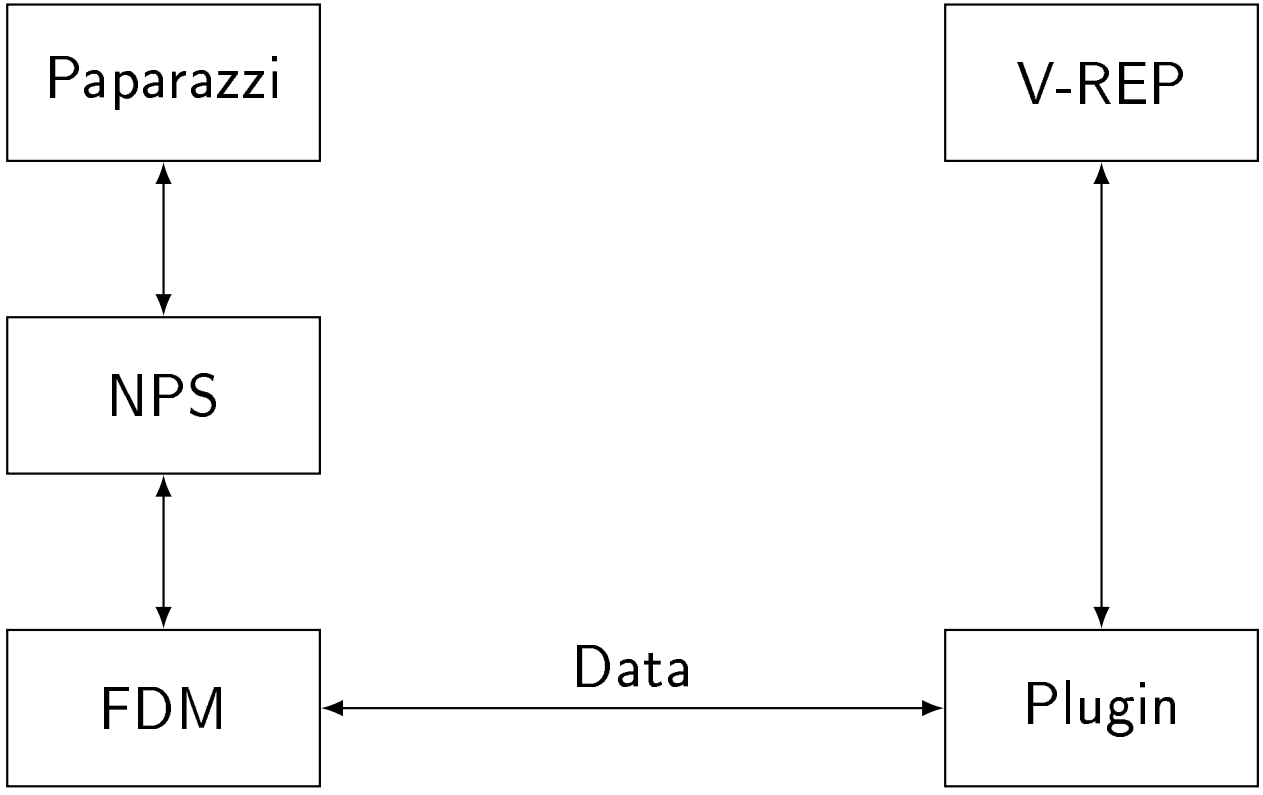
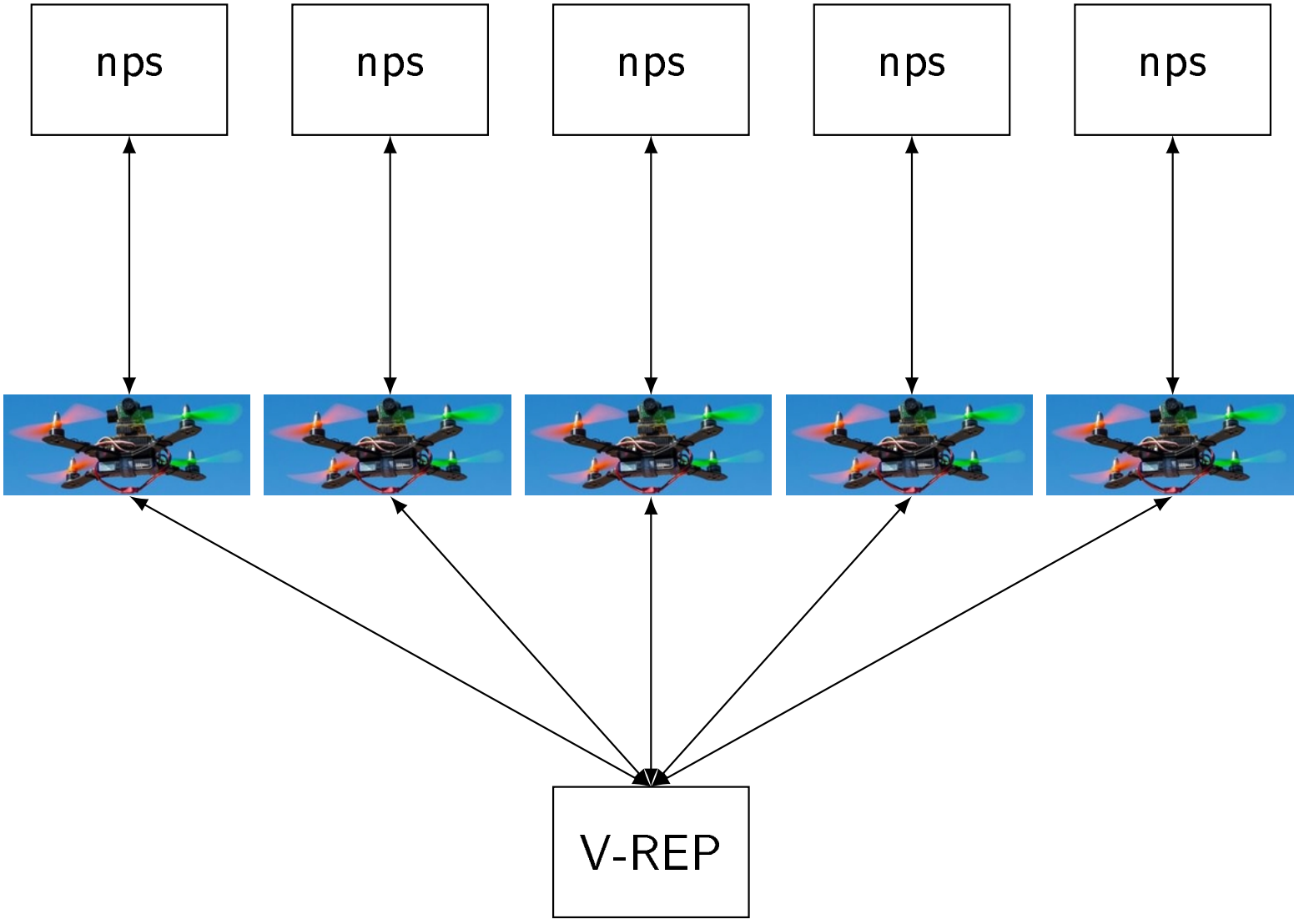



Figure 1: Basic simulation architecture

# Connection Architecture



# Loop overview

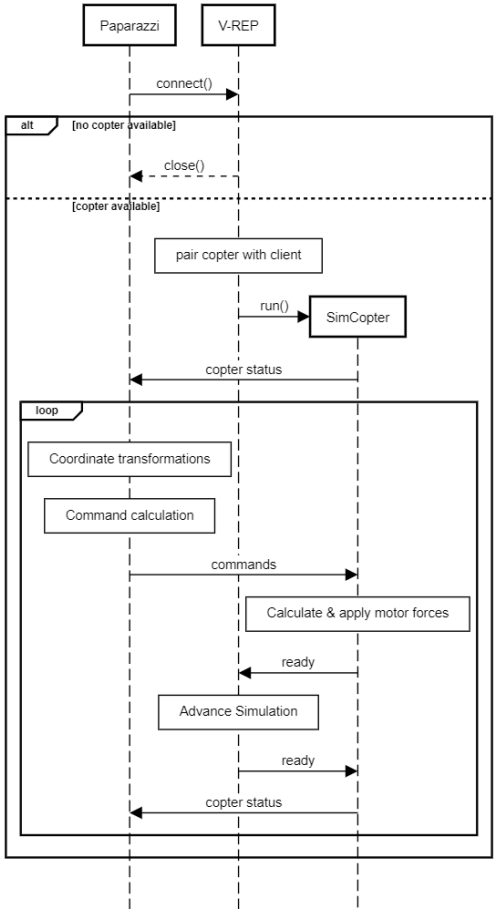



Figure 2: Simulation sequence overview

# Exchanged data: V-REP

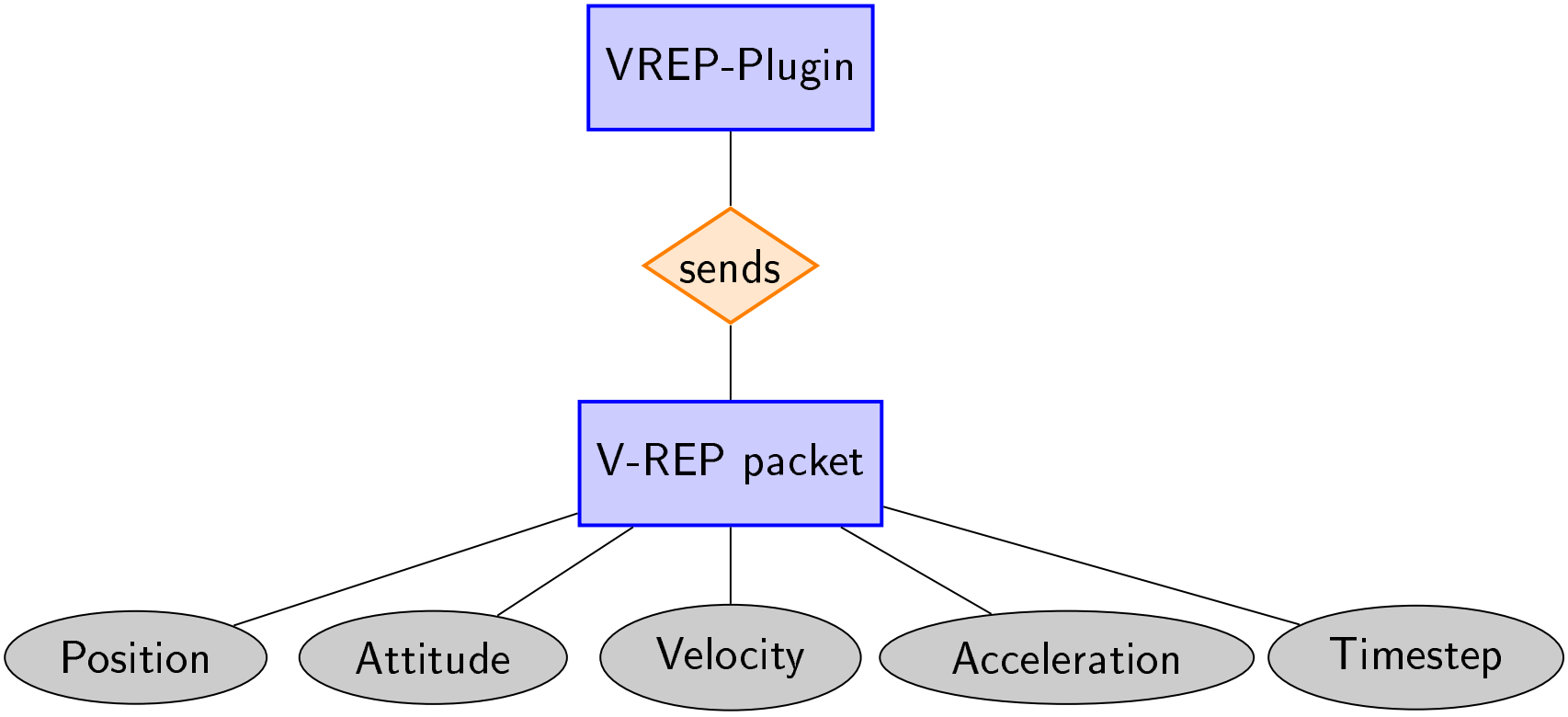



Figure 3: Data sent by V-REP to Paparazzi

# Exchanged data: Paparazzi

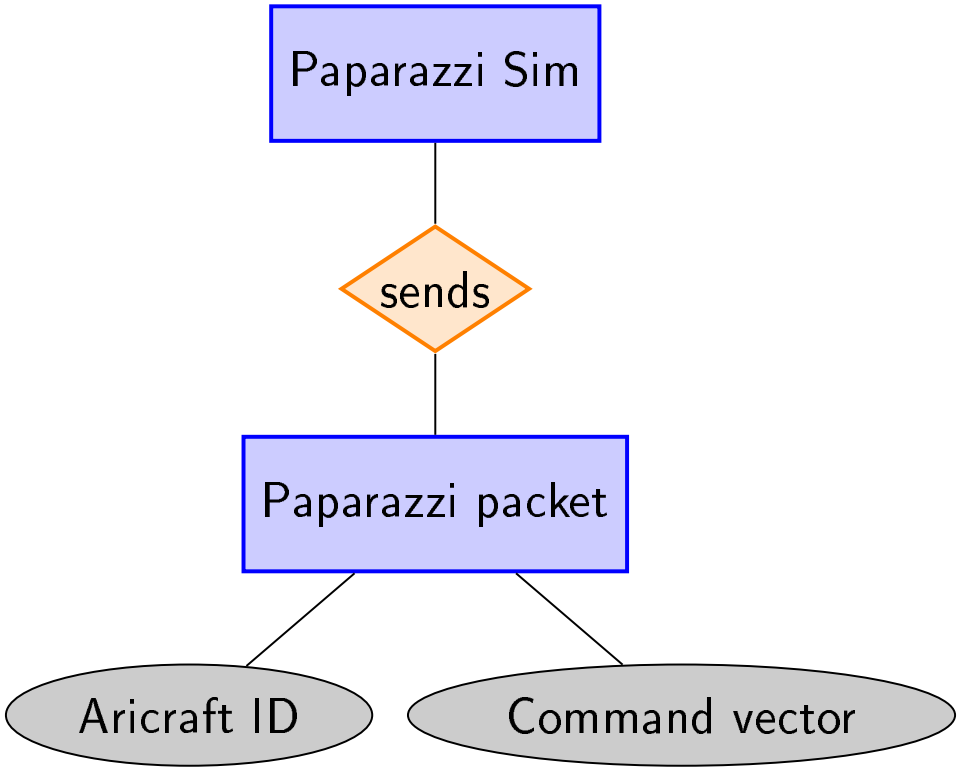



Figure 4: Data sent by Paparazzi to V-REP

# Problems

- Coordinate transformations
- Connection stability

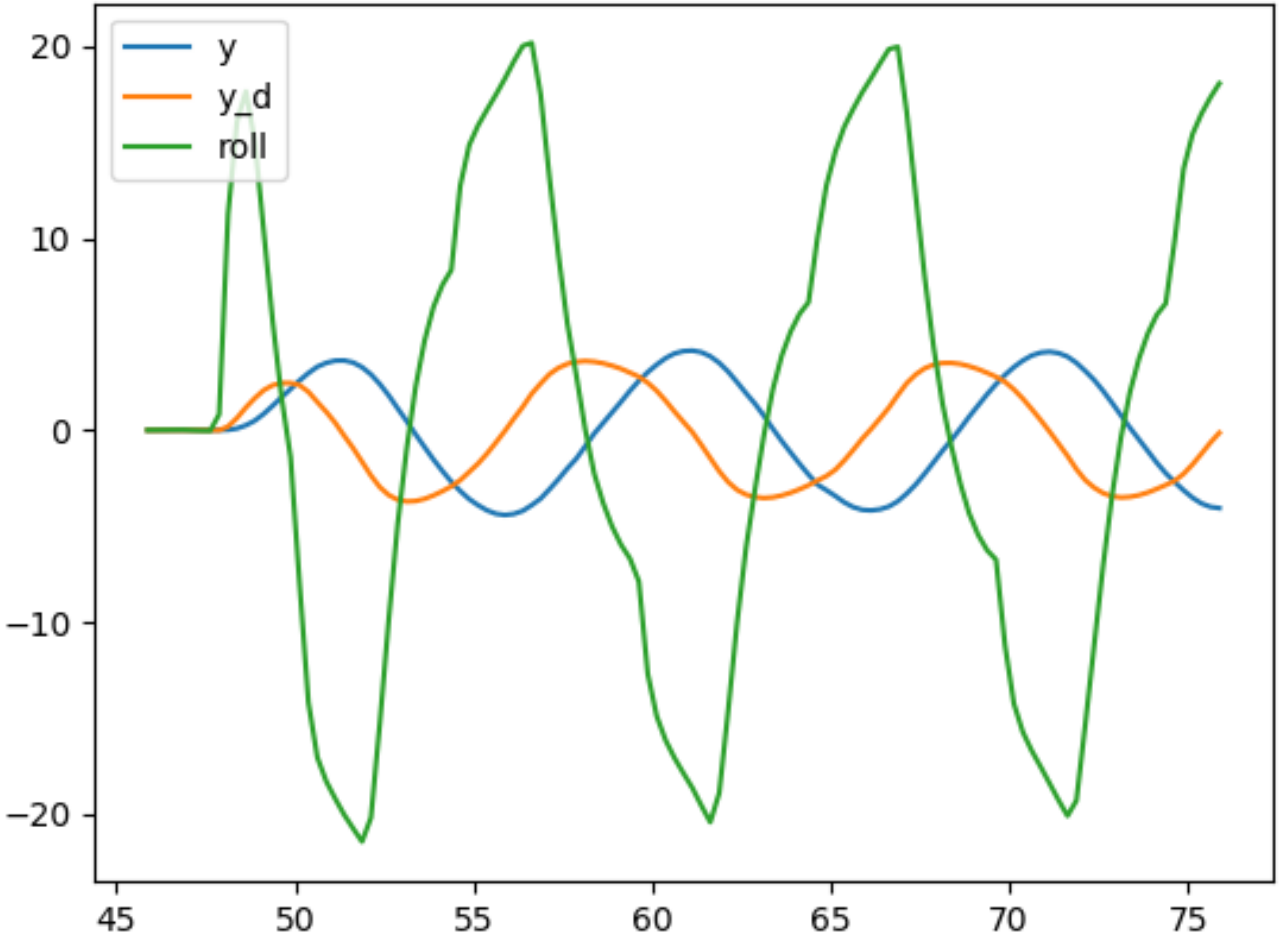
# Coordinate transformations

- Paparazzi and V-REP use different coordinate systems
- V-REP coordinates conform to ENU, Paparazzi uses various systems
- $\rightarrow$ multiple interdependent sources of errors, difficult to debug

# Connection stability

- Connection failure should not crash the entire simulation
- Correctly track connected and unconnected copters
- "Ghost Copters" lead to crashes

# Evaluation: Simple flight plan



# Statistics: Eight-shaped flight plan

| checkpoint | $std_x$ | $std_y$ | $var_x$ | $var_y$ |
|---|---|---|---|---|
| A | 0.09 | 0.08 | 0.008 | 0.006 |
| B | 0.03 | 0.07 | 0.0008 | 0.004 |
| C | 0.07 | 0.03 | 0.05 | 0.001 |
| D | 0.04 | 0.08 | 0.001 | 0.007 |
| E | 0.08 | 0.08 | 0.007 | 0.006 |
| F | 0.06 | 0.1 | 0.004 | 0.012 |

# Demo

# Thanks for your attention

- Special thanks: Christoph for always helpful advice and bug-hunting expertise

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