# SIMPAR 2025

## DANCERS: A Physics and Network Co-Simulator for Communicating Multi-Robot Systems

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# Agenda

1. Simulating FANETs

2. Architecture and features of DANCERS

3. Co-simulator evaluation

# 1. Simulating FANETs

# Flying Ad-hoc networks (FANETs)

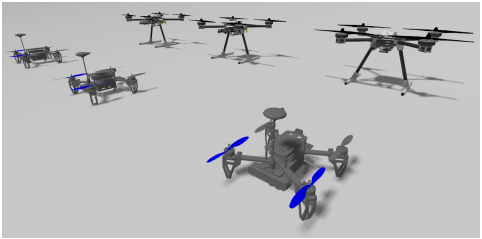
## Opportunities

- Robust, scalable, low-priced
- Achieve network-oriented tasks
- Payload versatility

## Challenges

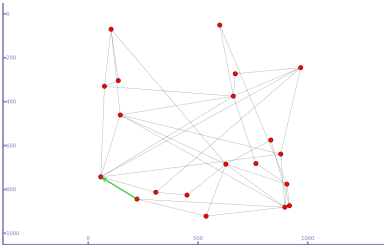
- Fleet coordination
- Unreliable wireless communication
- Collision avoidance
- Real-world experiments are hard

# Simulating FANETs



GAZEBO

**Multi-robot simulators lack communication protocols**




ns-3 NETWORK SIMULATOR

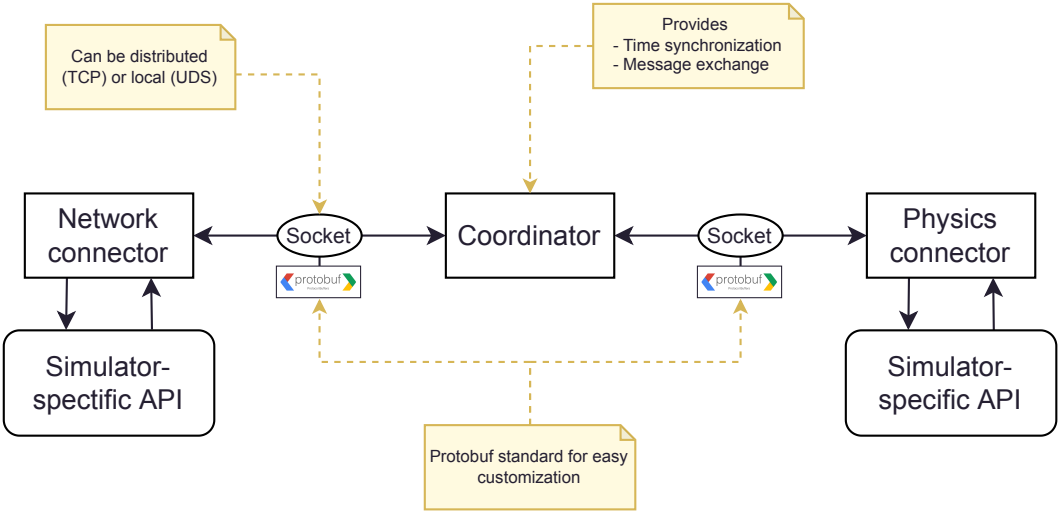
**Network simulators have limited physics models**

# Existing co-simulators

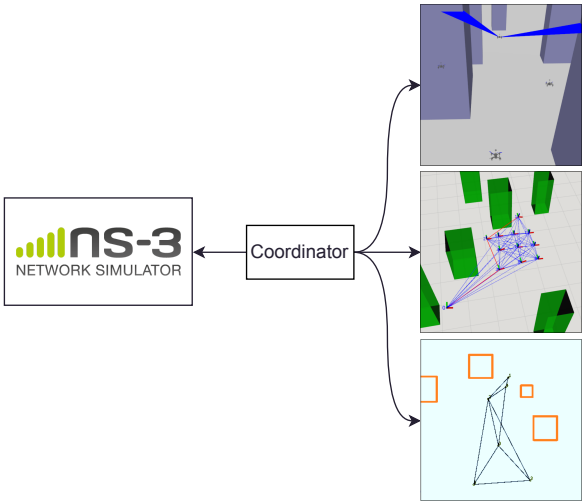
| Name | Physics Sim. | Network Sim. | Synchronization | Information Exchange | Year | Open-Source |
|---|---|---|---|---|---|---|
| **RoboNet-Sim** | ARGoS | NS-2 / NS-3 | Time-stepped (Bidirectional) | Socket (TCP et UDP) | 2013 | Yes |
| **FlyNetSim** | Ardupilot | NS-3 | Time-stepped (Bidirectional) | Message queue (ZMQ) | 2018 | No |
| **CPS-Sim** | Matlab Simulink | QualNet OMNeT++ | Variable time-stepped (Bidirectional) | Custom (SNSP) | 2018 | No |
| **GzUav** | Gazebo | NS-3 | Sequential | Unix Domain or TCP Socket | 2019 | Yes |
| **CORNET** | Gazebo | NS-3 | Variable time-stepped (Unidirectional) | Message queue (ZMQ) | 2020 | Yes |
| **ROS-NetSim** | Any | Any | Time-stepped (Bidirectional) | Unix Domain Socket | 2021 | Yes |
| **CORNET 2.0** | Gazebo | MiniNet | Variable time-stepped (Unidirectional) | Message queue (ZMQ) | 2022 | Oui |
| **Syn-chroSim** | Gazebo | NS-3 | Variable time-stepped (Bidirectional) | Not mentioned | 2022 | Non |

# 2. Architecture and features of DANCERS

# DANCERS' Architecture



# Using different physics simulators




Gazebo:

- \+ Realistic robot dynamic
- \+ Realistic collisions
- \- Requires an Autopilot
- \- Slow

Mini-dancers:

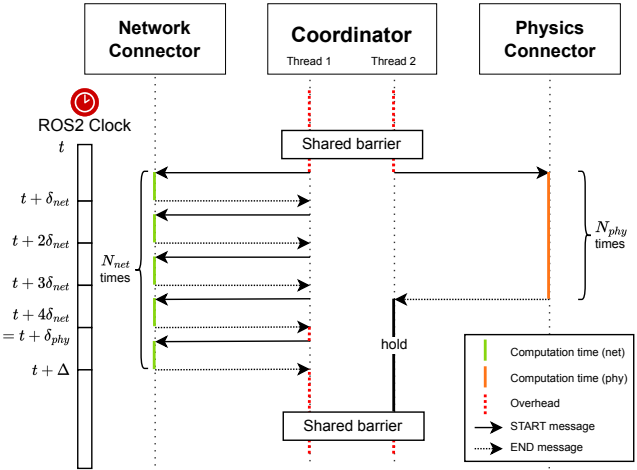
- \+ Realistic multi-rotor dynamics
- \+ Fast
- \- No collision engine

Robotsim:

- \+ Super fast
- \- Cinematic robot models
- \- C-based

# Customizable synchronization

- Each simulator has its own step-size
- Synchronization and information exchange occur between each iteration
- The ROS2 clock is updated with the smallest step-size



# 3. Co-simulator evaluation

# What does it cost ?

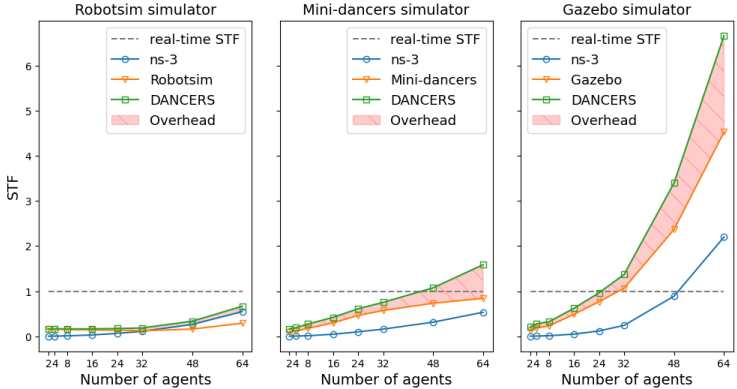



Figure: Simulation time factor for three different physics simulators with respect to number of simulated agents.

# 4. Simulations

1. Effect of obstacle attenuation on flocking
2. Network-based UAV relay tree creation

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