Information-Acquisition-as-a-Service for Cyber-Physical Cloud Computing

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The JAviator

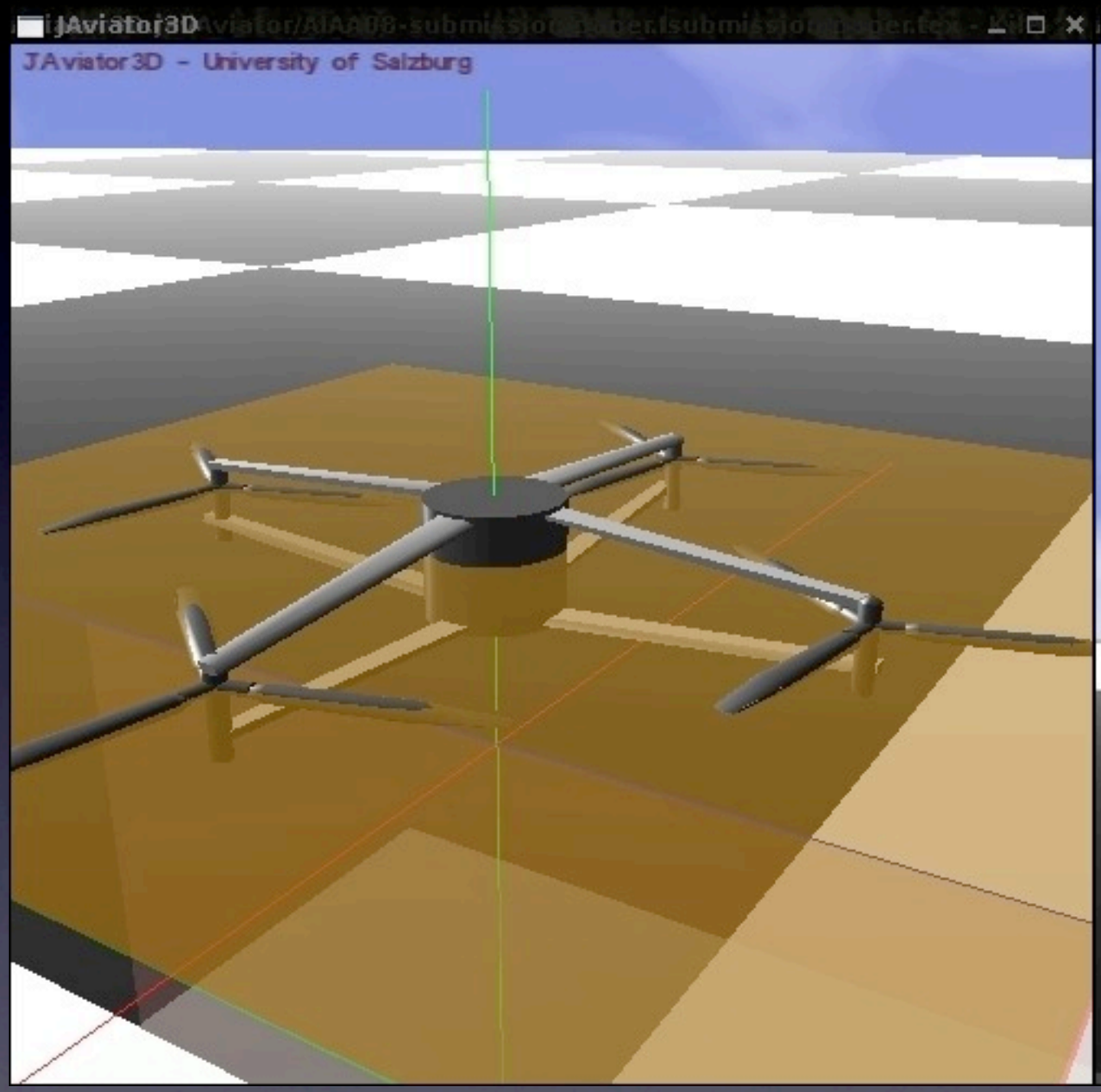
javiator.cs.uni-salzburg.at

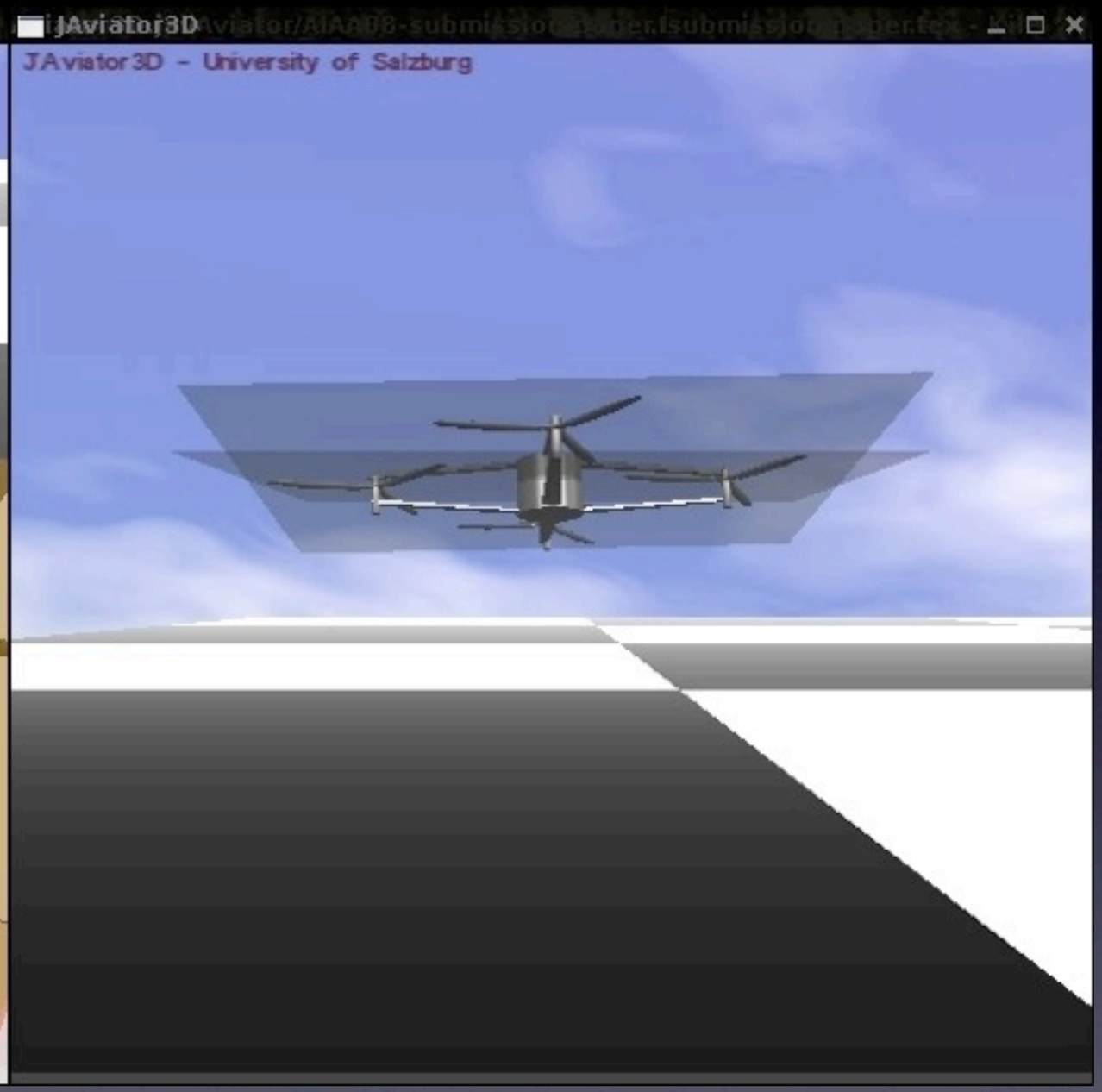
Quad-Rotor Helicopter

- all carbon, titanium, aluminum design
- custom motors

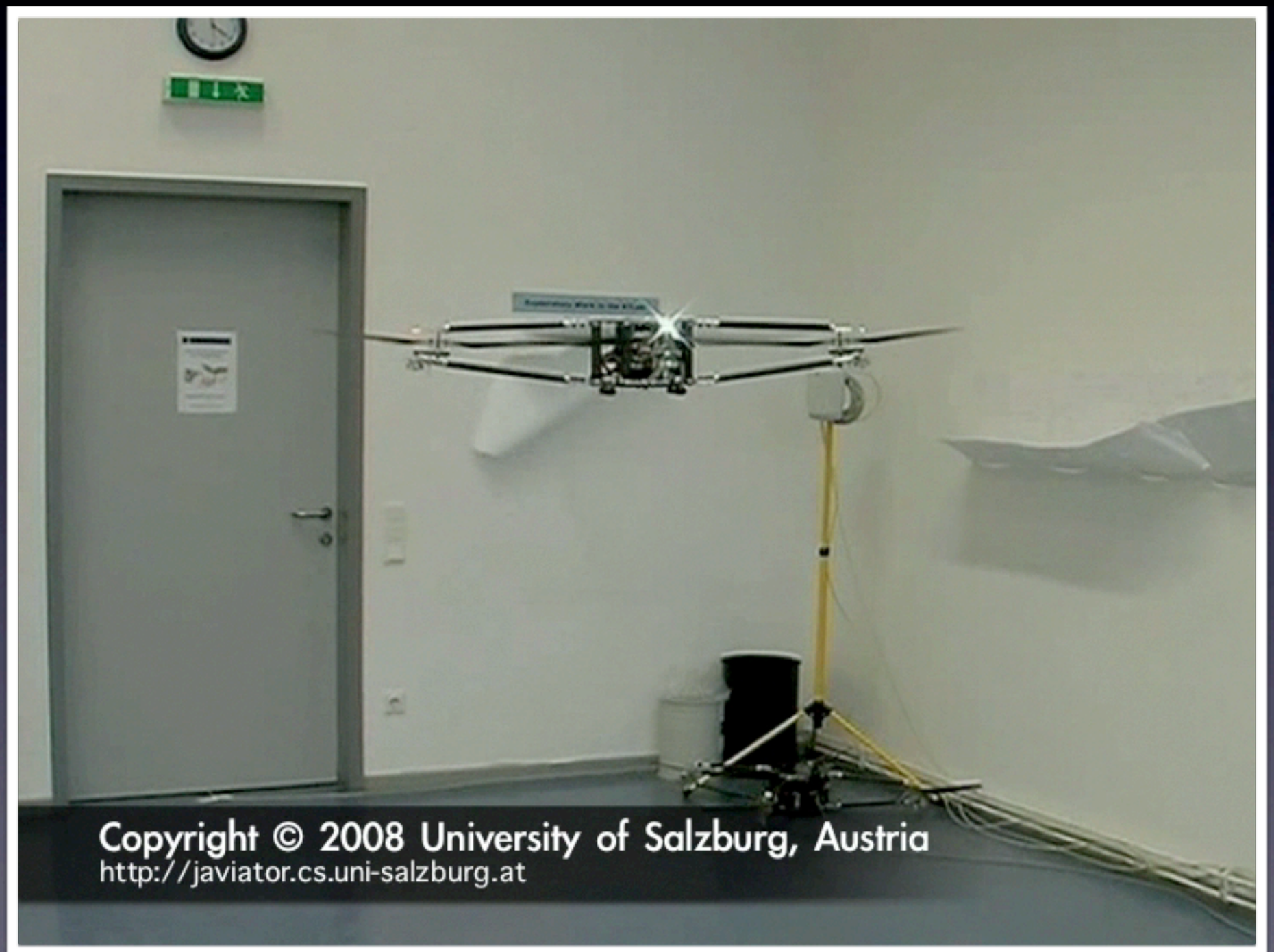
- ~2.2kg weight
- +2kg payload

- ~40min (empty)
- ~10min (full)





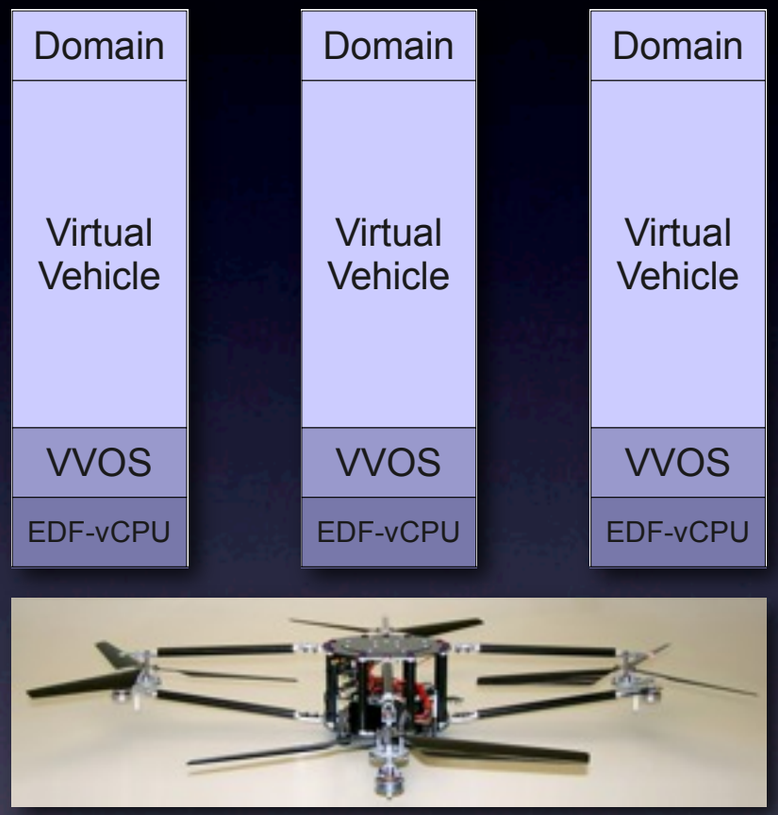
Indoor Flight
STARMAC Controller



Outdoor Flight Salzburg Controller

A Cyber-Physical Server

- IP address
- location
- capabilities
- motion



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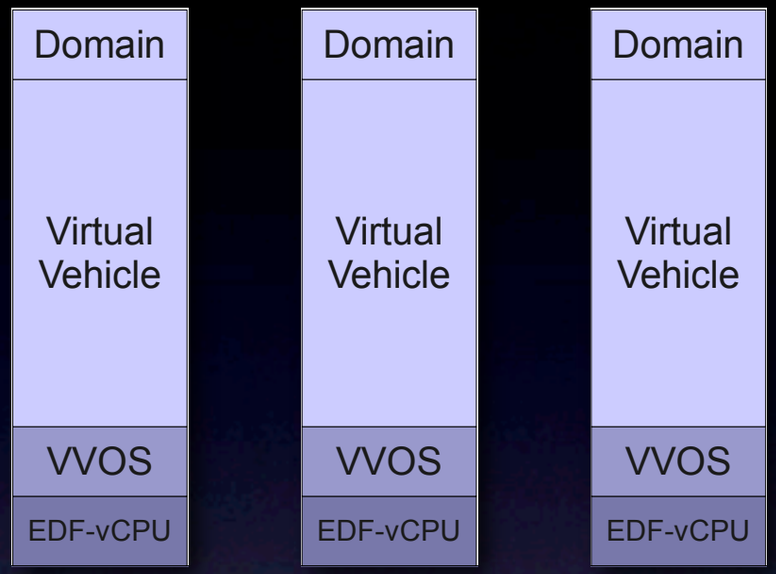
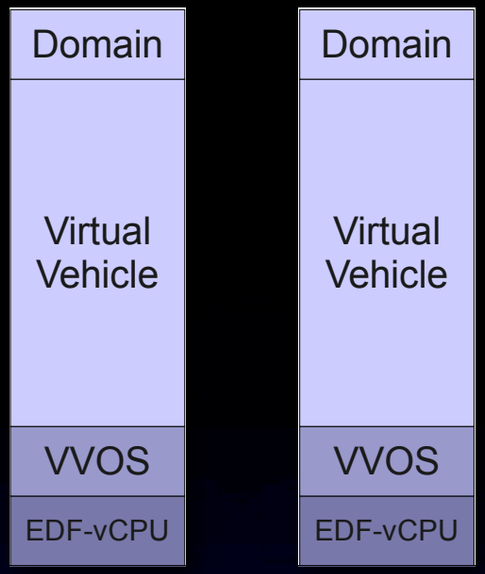
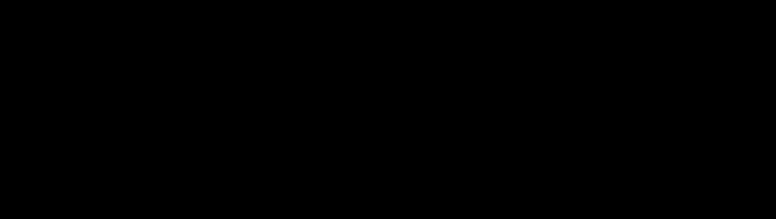
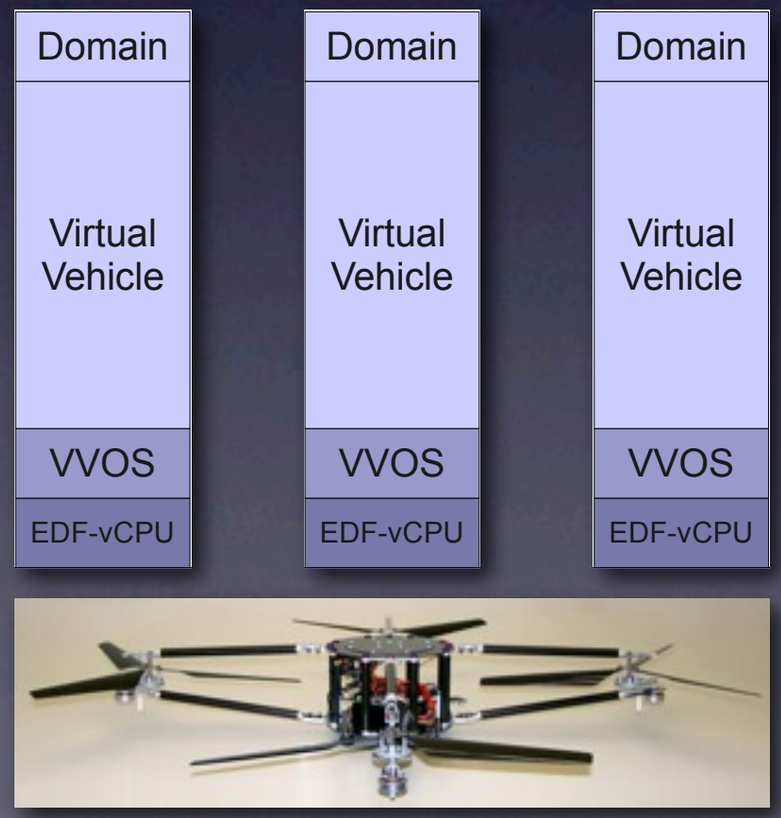




migration
=
flying



A Cyber-Physical Cloud



Goals

- Multi-provider (10s):
  - heterogeneous operations
- Multi-vehicle (100s):
  - heterogeneous systems
- Multi-task (1000s):
  - heterogeneous missions

Real Vehicle

- Real sensors:
  - Webcam, Laser, Ultrasonic, Gyro, Accelerometer, Magnetometer
- Real server (work-in-progress):
  - small form factor, less emphasis on I/O
  - >1 Core, >1GHz, >1GB RAM, SSD, WiFi
- Real actuators:
  - Rotors (stabilized camera is future work)

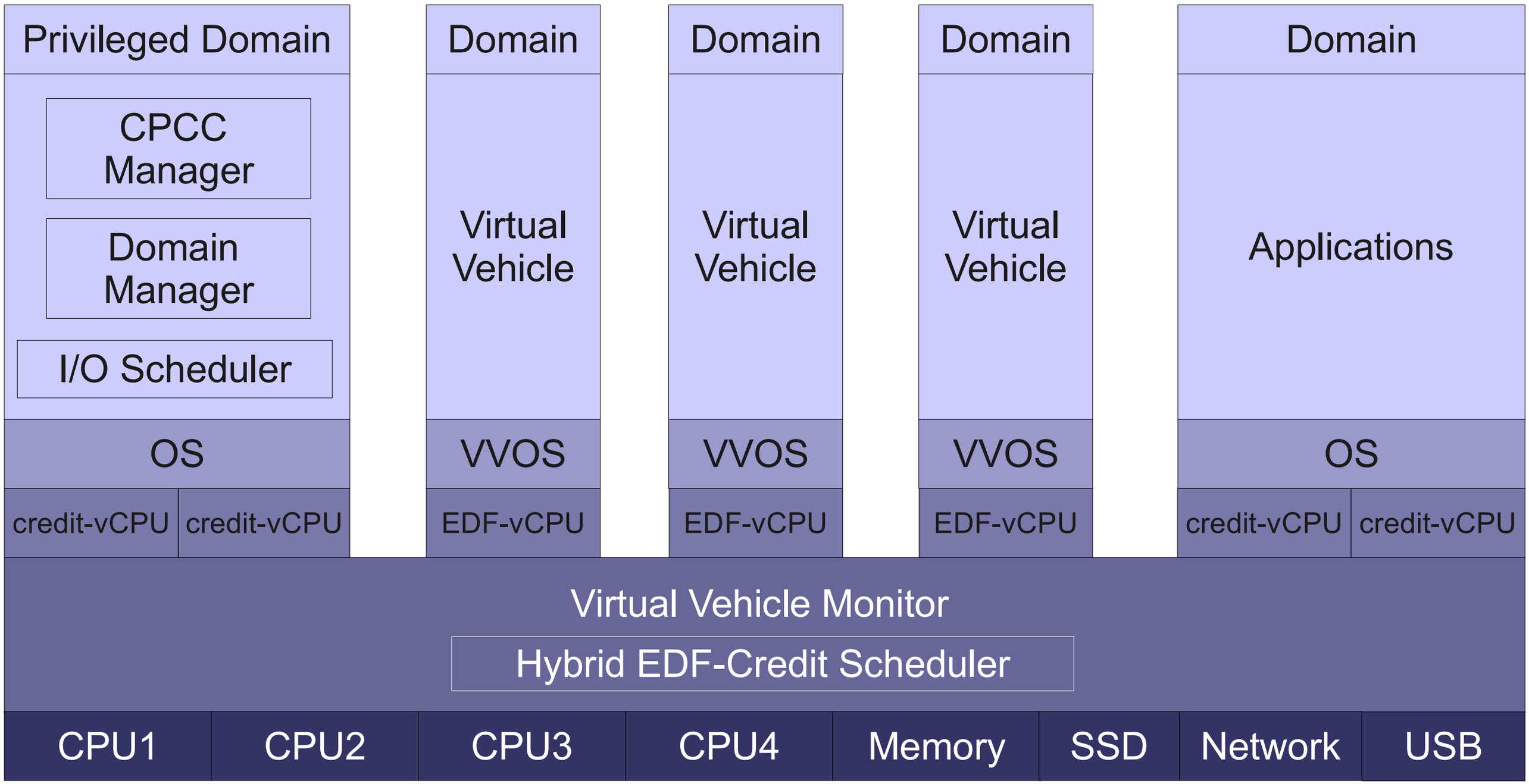
Virtual Vehicle

- Virtual sensors (work-in-progress):
  - Webcam (w/ position, orientation)
- Virtual processors (work-in-progress):
  - EDF-vCPU, VVOS, scripting engine
- Virtual actuators (future work):
  - Pilot of real and virtual vehicles

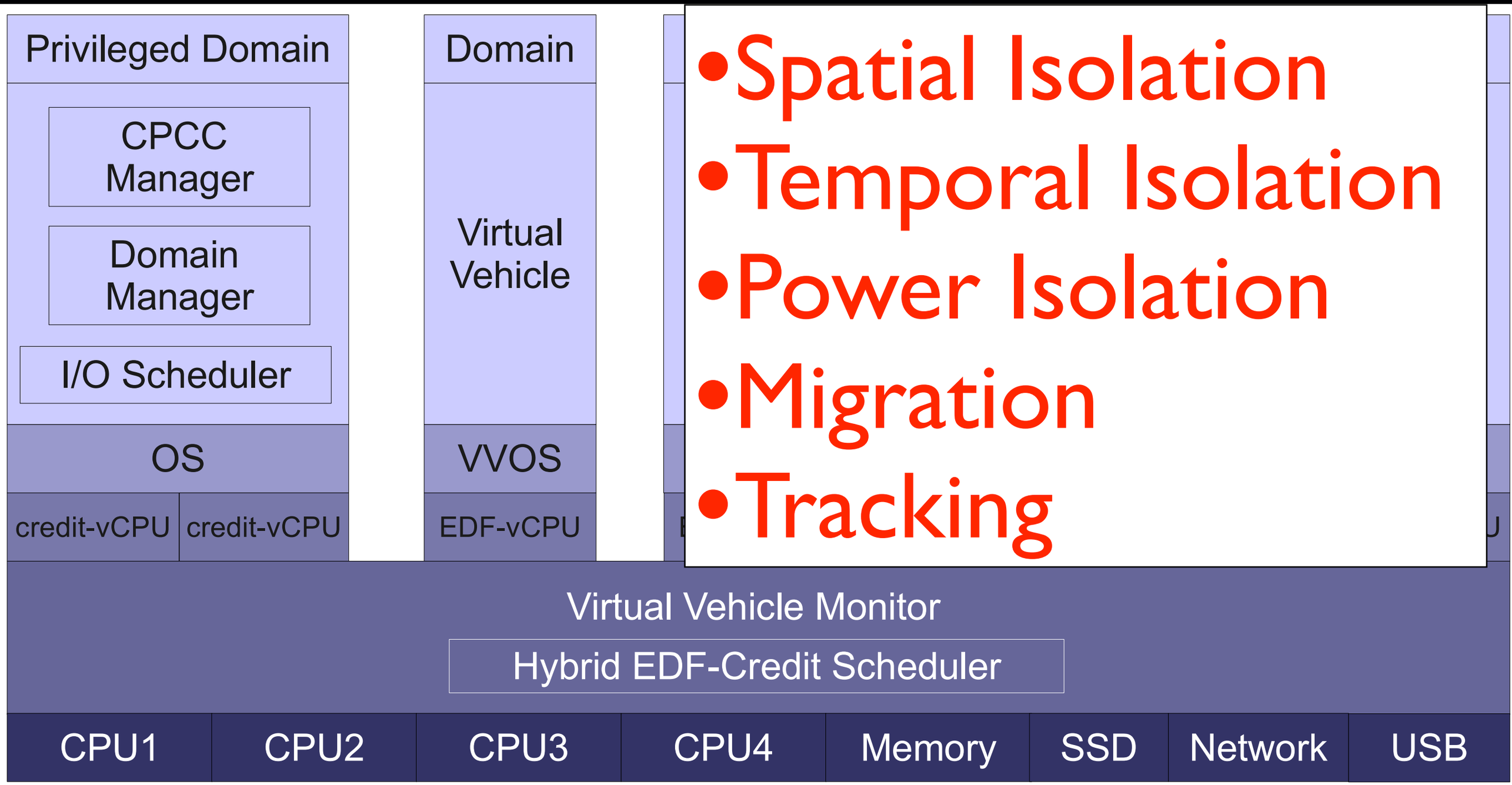
Challenges

- Virtualization Infrastructure
  - Salzburg
- Collaborative Control
  - Berkeley
- Programming Language
  - Berkeley, Salzburg

Virtualization Infrastructure



Virtualization Infrastructure



- Spatial Isolation
- Temporal Isolation
- Power Isolation
- Migration
- Tracking

Collaborative Control

- Read-only flight plans for real vehicles
  - Virtual-to-real vehicle allocation problem
    - Evaluation metrics: mission/vehicle flight (execution) time, power consumption
- Read-write flight plans for real vehicles
  - Real-to-virtual vehicle allocation problem

Programming Language

- Collaborative Sensing Language (CSL) [RTAS 2009]
- CSL specifies dynamically changing missions of virtual vehicles (work-in-progress)
- Key challenge is to handle concurrent and changing sets of real and virtual vehicles
- CSL programs compile into mission controllers (feedback loop: real vs. virtual vehicles)
- CSL runtime estimates state and allocates vehicles

Thank you

Check out:
eurosys2011.cs.uni-salzburg.at