

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

Silviu Craciunas, Andreas Haas
Christoph Kirsch, Hannes Payer
Harald Röck, Andreas Rottmann
Ana Sokolova, Rainer Trummer

Joshua Love
Raja Sengupta

Universität Salzburg

UC Berkeley



HotCloud Workshop, Boston, June 2010



The JAviator

javiator.cs.uni-salzburg.at

Quad-Rotor Helicopter

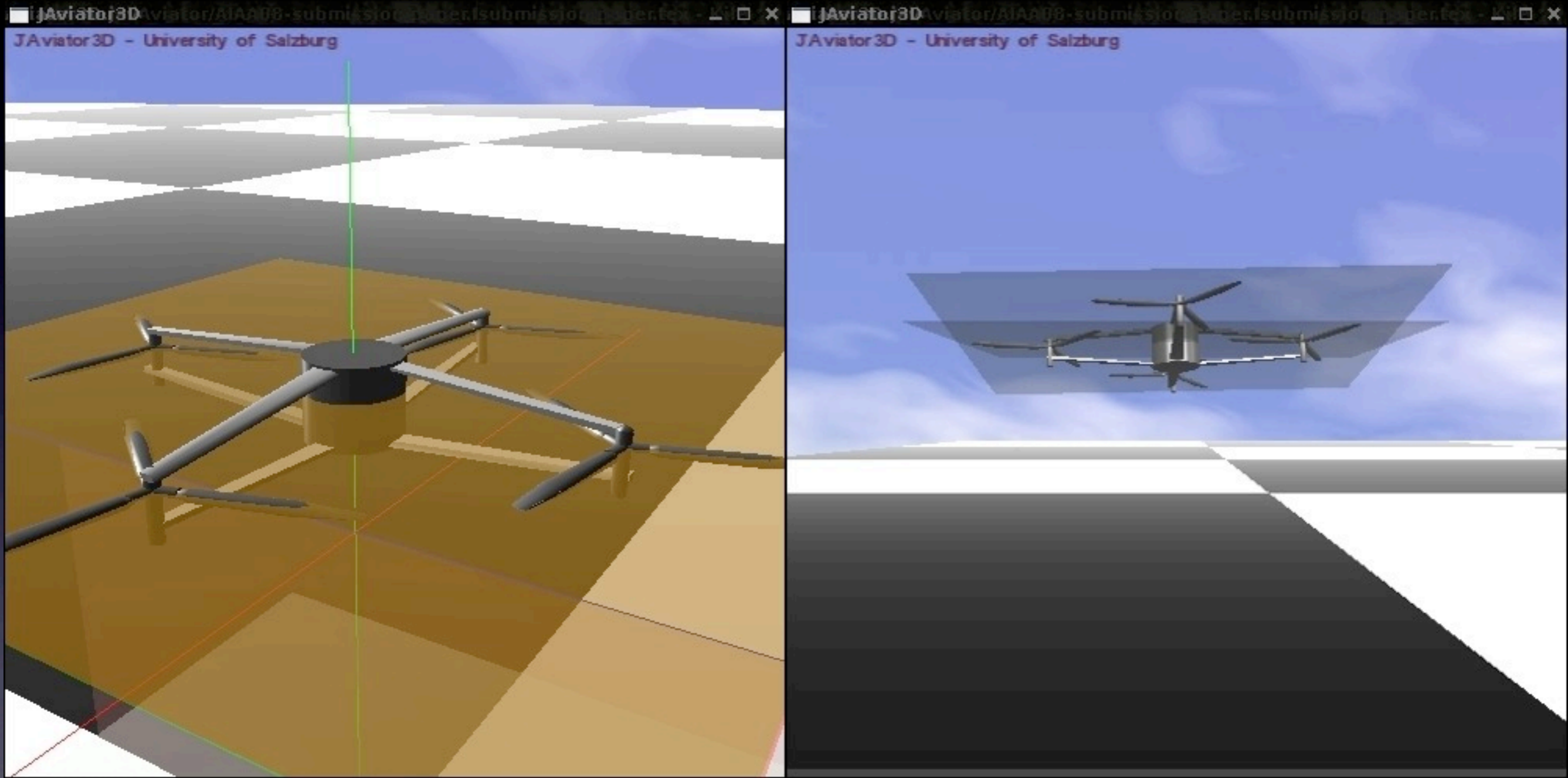


- all carbon, titanium, aluminum design
- custom motors

- ~2.2kg weight
- +2kg payload

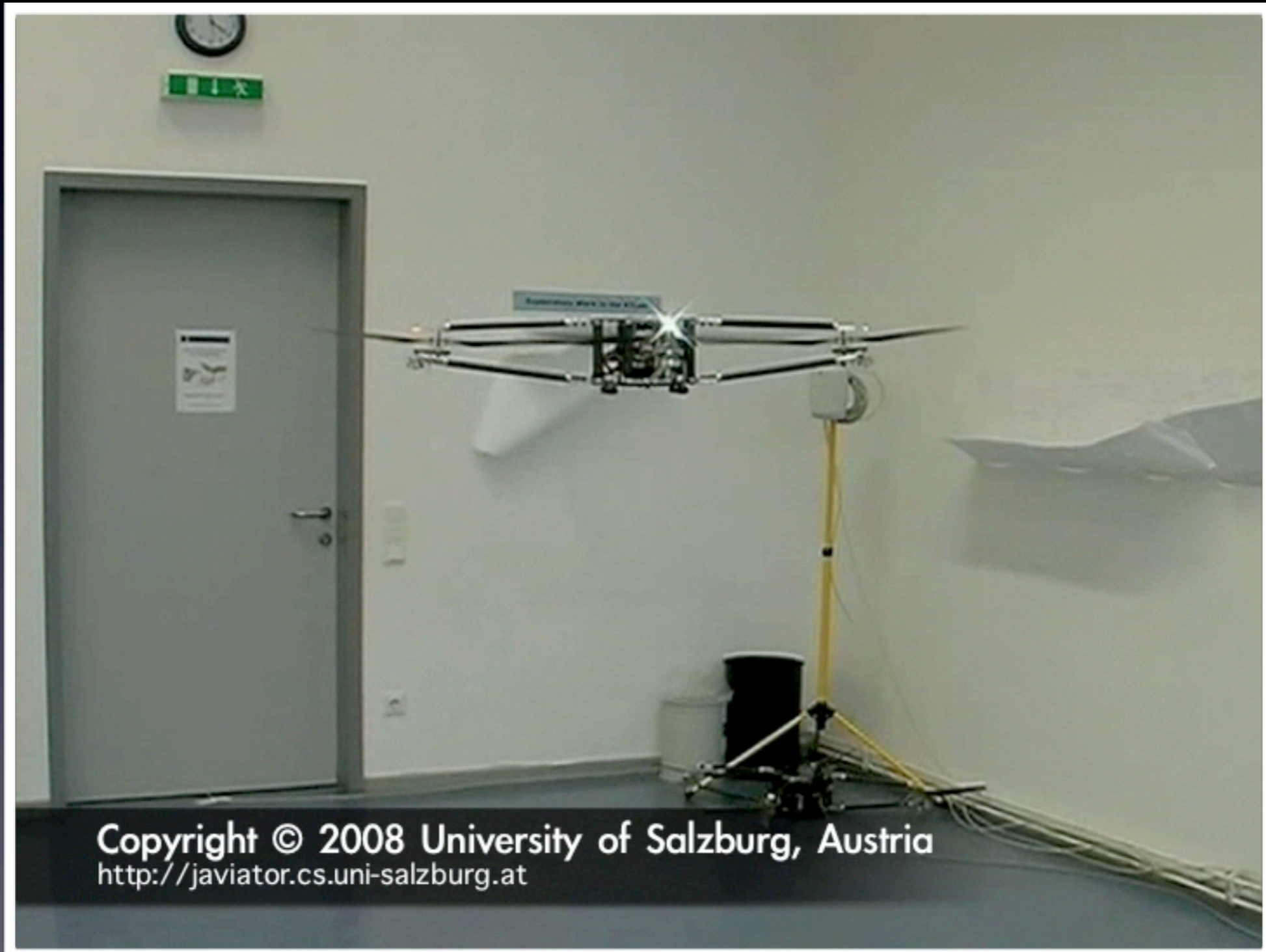
- ~40min (empty)
- ~10min (full)







Indoor Flight STARMAC Controller



Copyright © 2008 University of Salzburg, Austria
<http://javiator.cs.uni-salzburg.at>

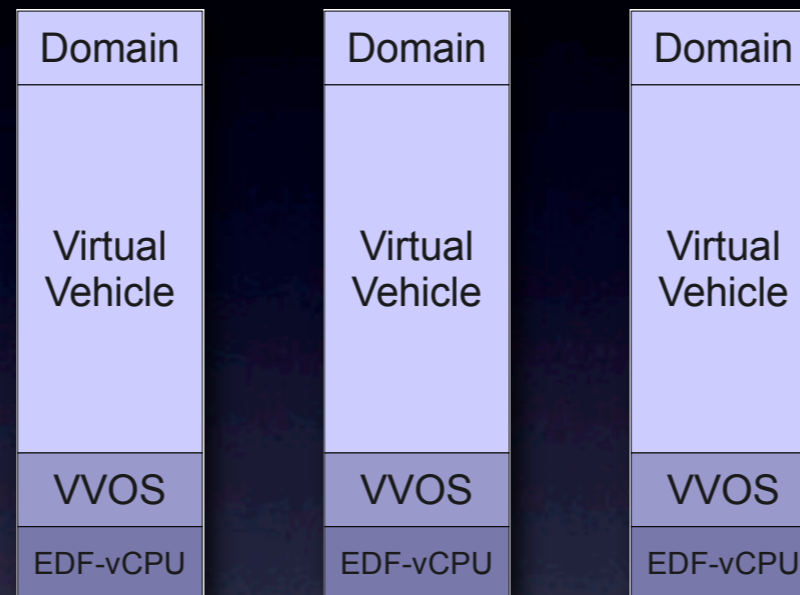
Outdoor Flight Salzburg Controller



Copyright © 2008 University of Salzburg, Austria
<http://javiator.cs.uni-salzburg.at>

A Cyber-Physical Server

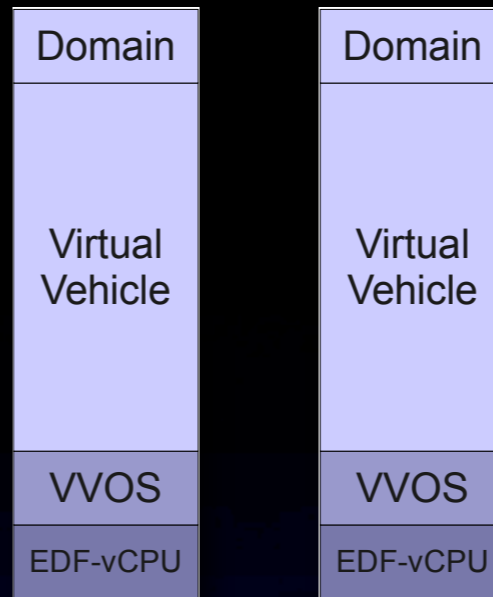
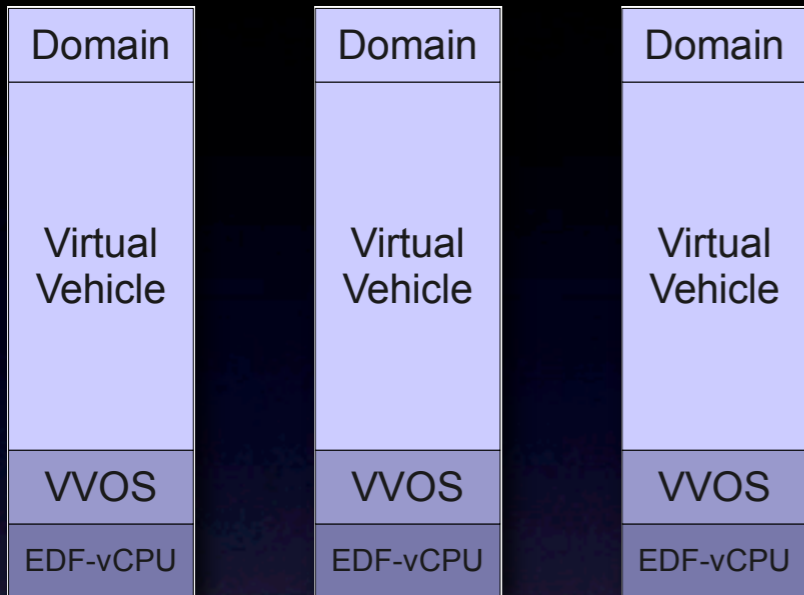
- IP address
- location
- capabilities
- motion



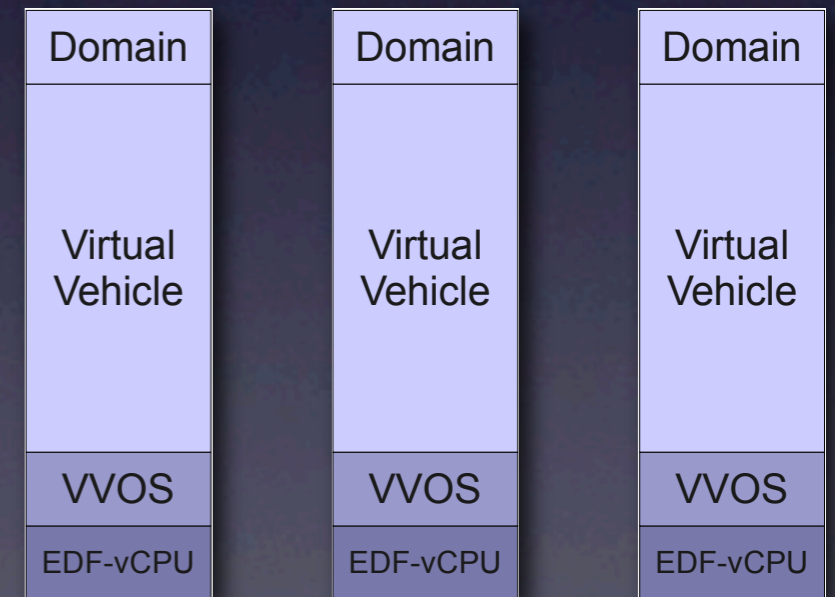
- IP address
- location
- capabilities
- motion



- IP address
- location
- capabilities
- motion



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, >1 GHz, >1 GB RAM, SSD, WiFi
- Real **actuators**:
 - Rotors (stabilized camera is future work)

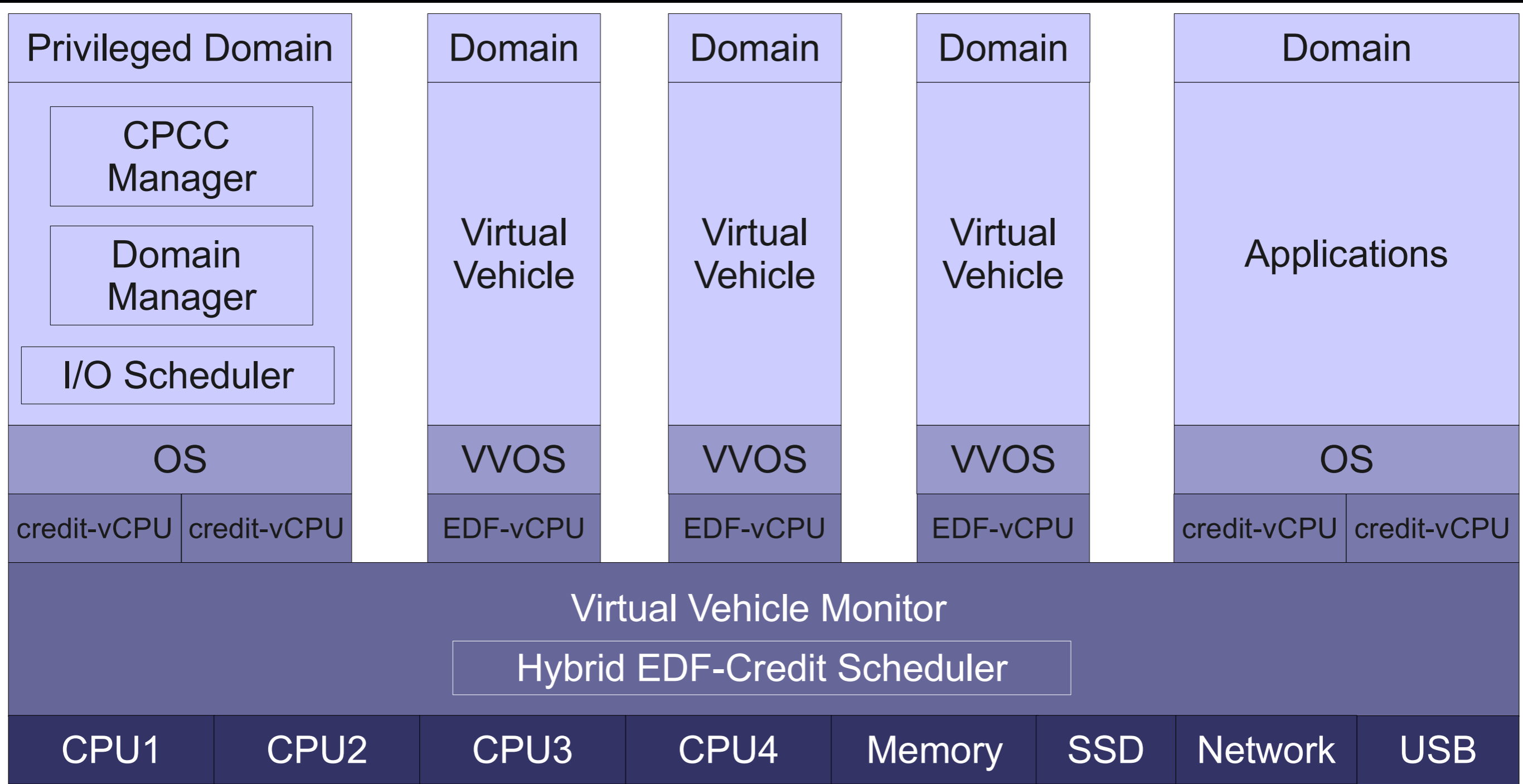
Virtual Vehicle

- 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

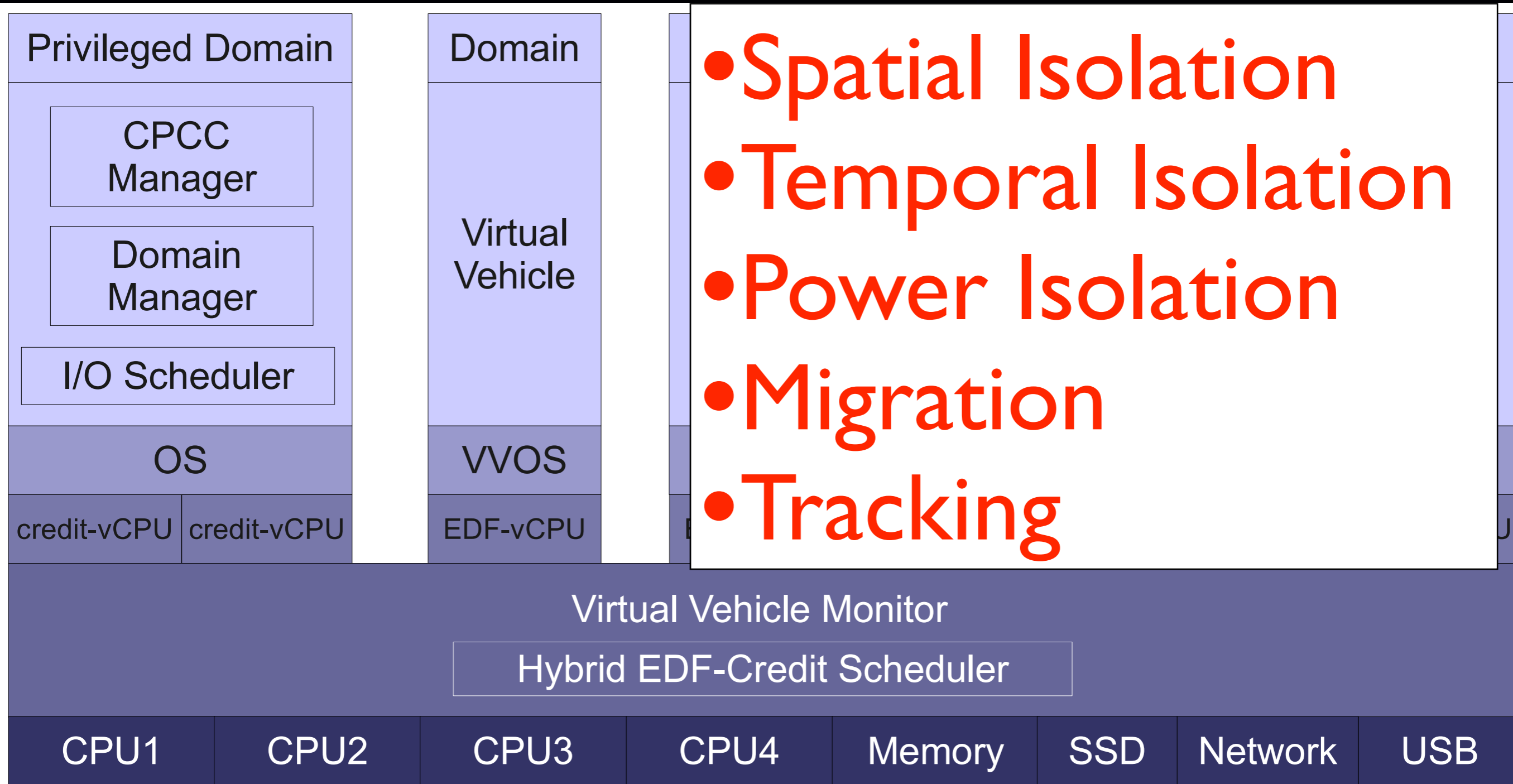
Challenges

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

Virtualization Infrastructure



Virtualization Infrastructure



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