The JAviator Project

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Computational
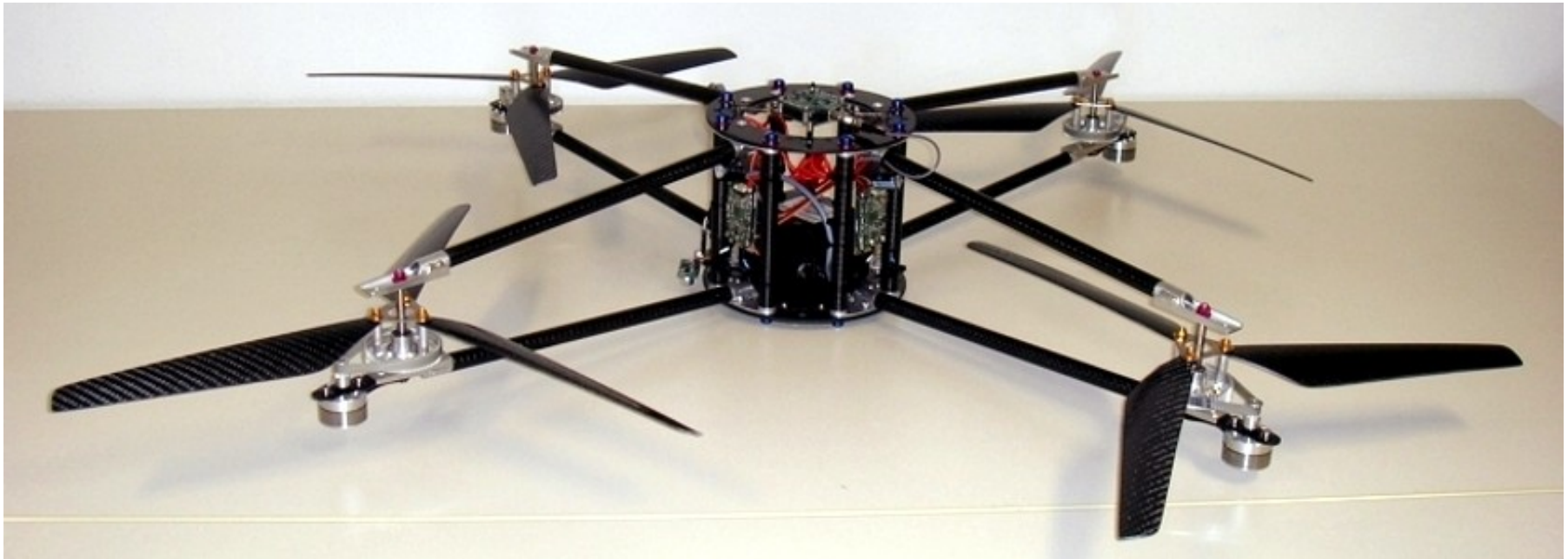Systems Group

Introduction

- Collaborative research project of the
  - Computational Systems Group, Department of Computer Sciences, University of Salzburg
  - IBM T. J. Watson Research Center, Hawthorne, New York, USA

- Primary project goals are to
  - develop high-level real-time and concurrent programming abstractions for Java
  - provide an infrastructure that is time-portable
  - verify system on UAV (unmanned aerial vehicle)

Project Issues

- Design and build elaborate UAV platform

- Develop Java-based real-time control system

- Provide required Java real-time capabilities

- Provide time-portability among platforms

- Verify entire system to achieve project goals

- Quadrotor model helicopter
  - ➢ built of high-quality materials like carbon fiber, aircraft aluminium, and medical titanium
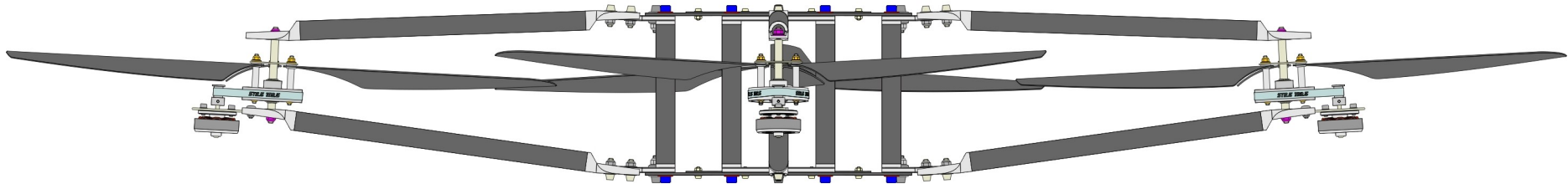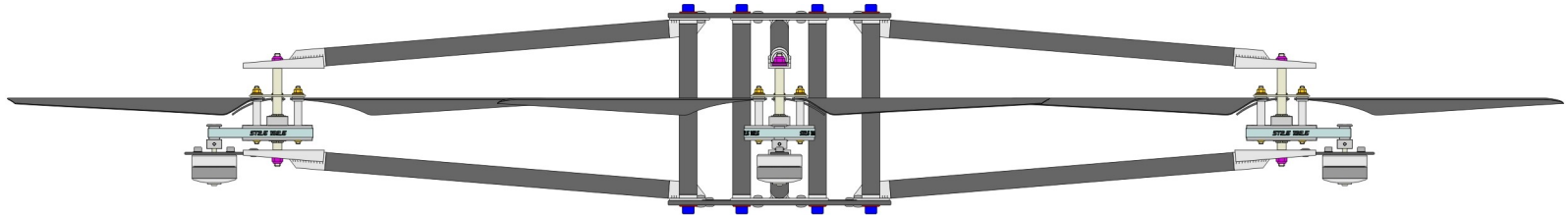 - ➢ equipped with custom-made 3-phase motors

- Bicycle-wheel concept
  - ➢ as underlying frame design pattern
  - ➢ offers extremely high mechanical stability
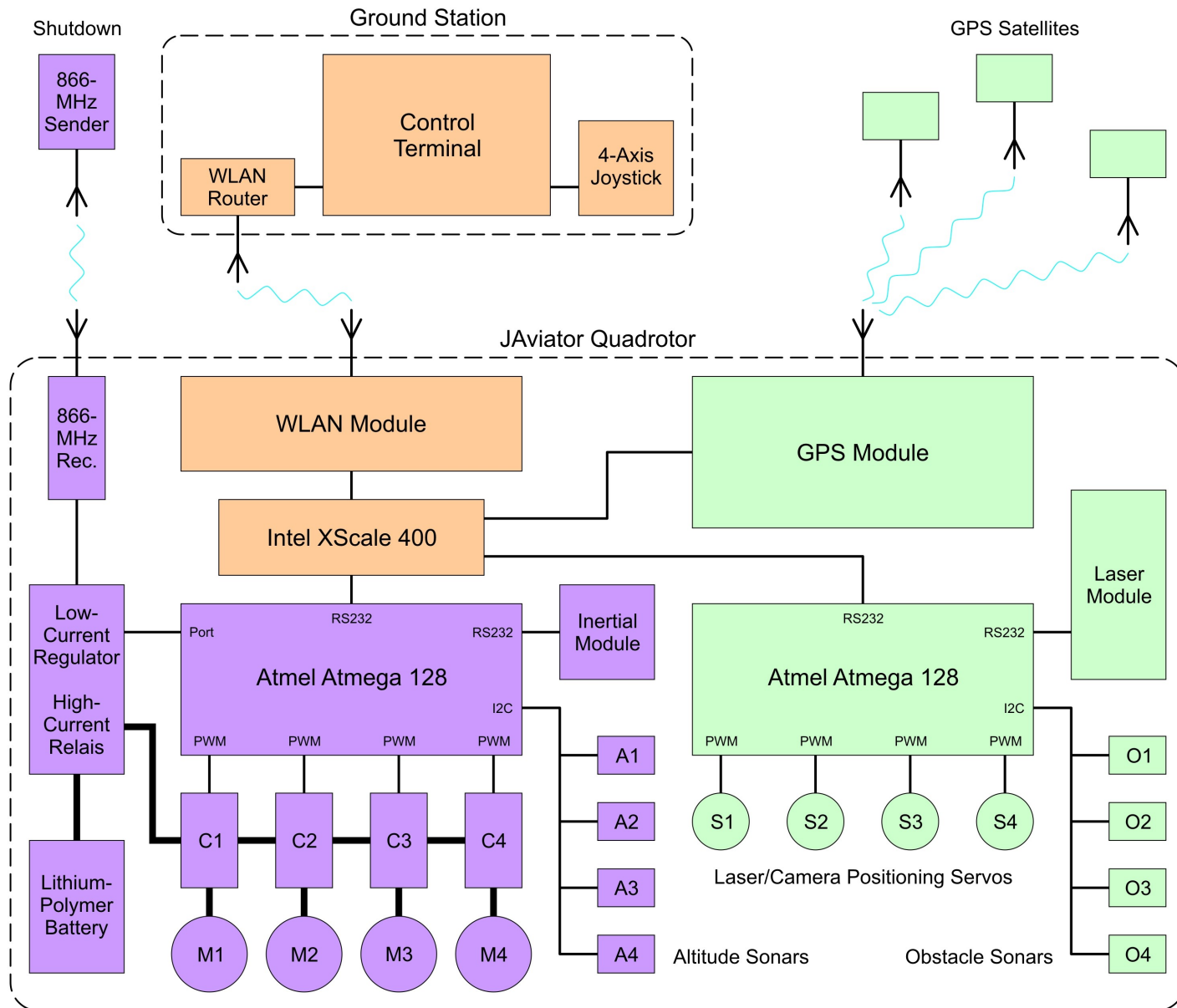 - ➢ enables the usage of very thin and light materials

JAviator V1 vs. JAviator V2

Control System Design

- Requirements:
  - 4 independent controllers to stabilize roll, pitch, yaw, and altitude
  - Controller period in the range of milliseconds
  - Hard real-time software
  - Reliable remote connection between JAviator and ground station
  - Sufficient computing power for autonomous flight
    - Onboard navigation
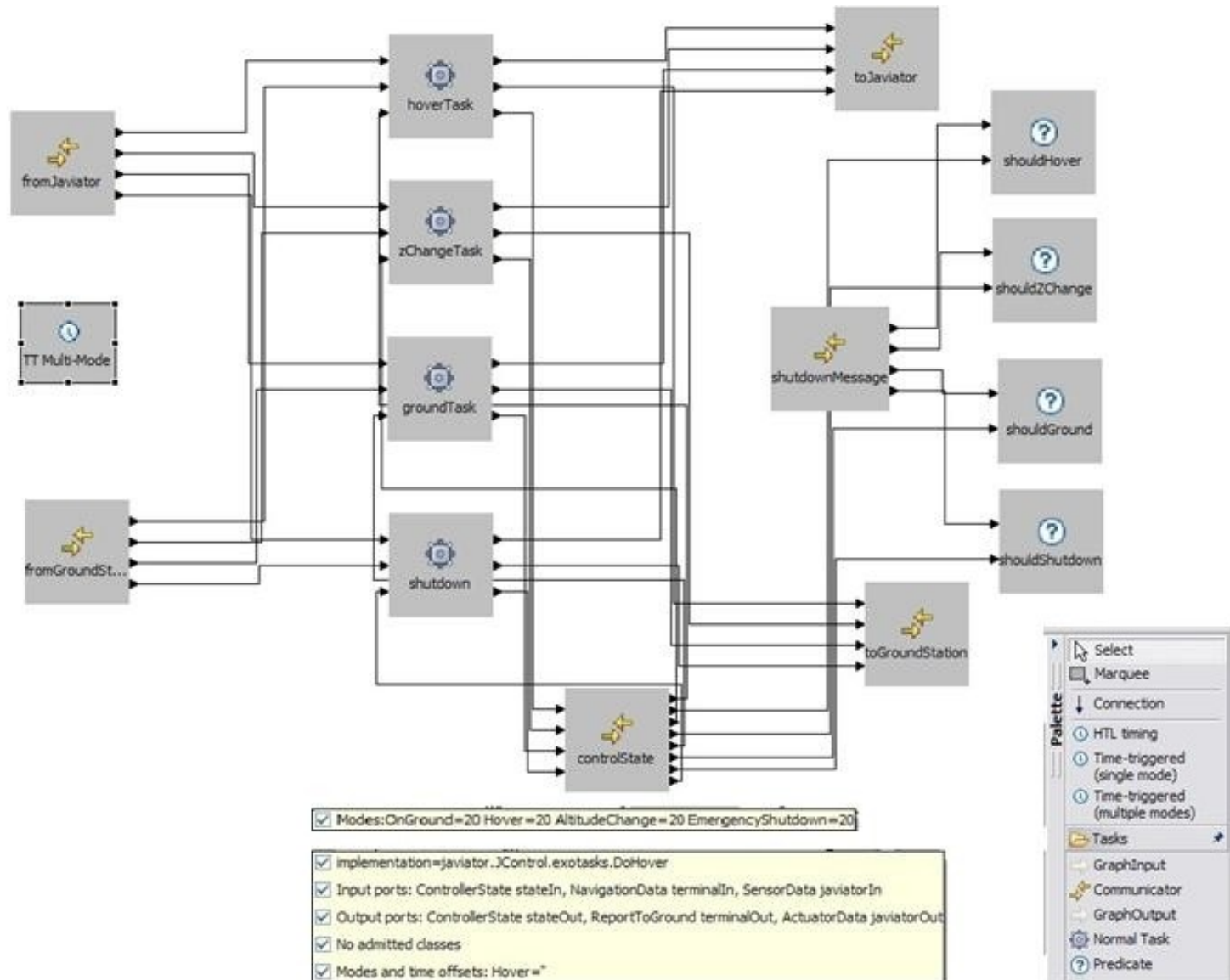   - Trajectory control
    - Obstacle recognition

Embedded System
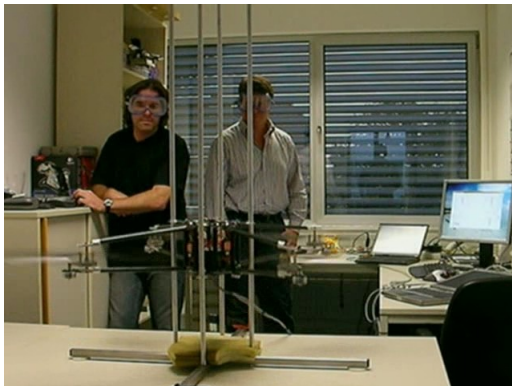
Control Software Design

- Atmega-based C software
  - Time-triggered sensing and actuating
  - Fully deterministic controller behavior

- Exotask-based Java software
  - Real-time software infrastructure
  - Each exotask has its own memory space
  - Each exotask has its own garbage collector
  - Exotask system provides time-portability
  - No change of original Java semantics
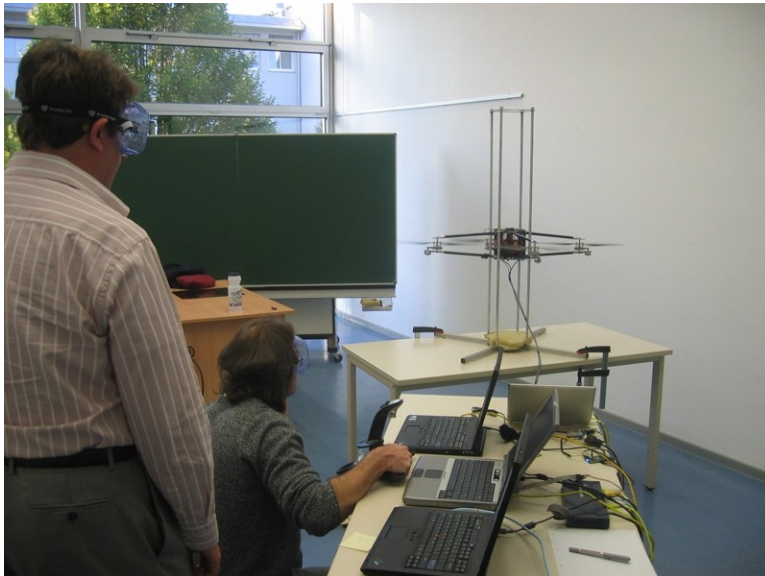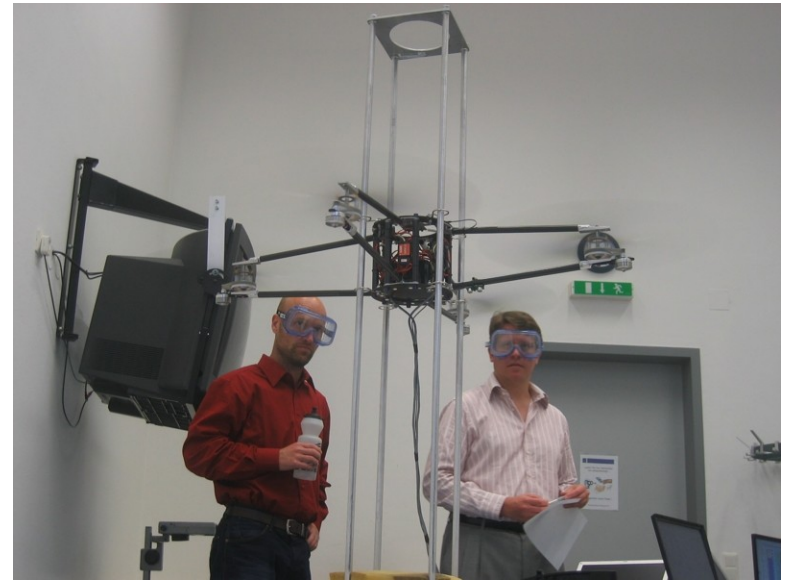
The Exotask Editor

First All-Java Flight

- Oct 4, 2006:
  - Spontaneous software test
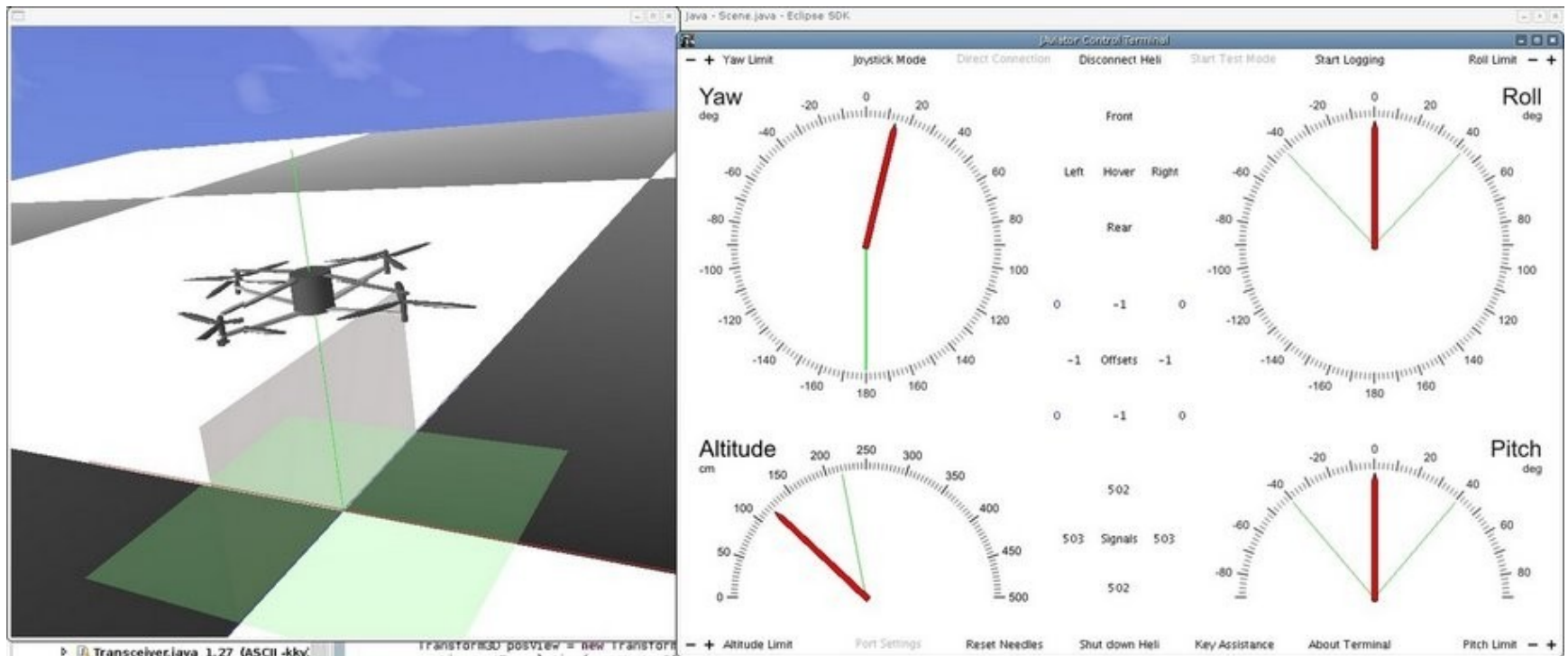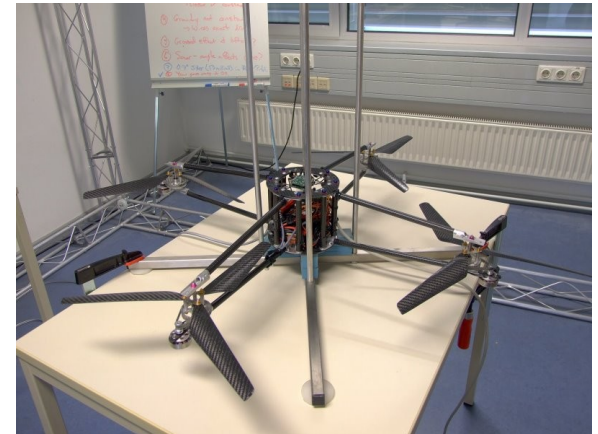 - System fully operational
  - First Java-based flight!

1st IBM Demo Session

- Oct 5, 2006:
  - Official demo flights with IBM
  - Real-time tracing of entire system

2nd IBM Demo Session

- May 24, 2007:
  - Demos with improved state-observer controller
  - 3-D environment added

Work In Progress

- Hardware: JAviator version 2
  - ➢ Laser for altitude and additional electronics
  - ➢ CNC-machined rotor and connecting parts
  - ➢ Custom-built high-precision rotor blades

- Software: Trajectory controller
  - ➢ Carrier-phase-GPS-based position recognition
  - ➢ Ultrasonic-based acquisition of obstacle data
  - ➢ Fully autonomous navigation and control

Thank You!

- Project Home Page:

  javiator.cs.uni-salzburg.at

- Published Paper:

  J. Auerbach, D.F. Bacon, D.T. Iercan, C.M. Kirsch, V.T. Rajan, H. Röck, and R. Trummer. Java Takes Flight: Time-Portable Real-Time Programming with Exotasks. In *Proc. ACM SIGPLAN/SIGBED Conference on Languages, Compilers, and Tools for Embedded Systems (LCTES)*. ACM Press, 2007.