



# **Unmanned Vehicle Activities**

## **DLR Institute of Flight Systems Systems Automation**

**SAE Aerospace  
Guidance & Control Committee Meeting  
02 - 04 March 2005  
Joerg Dittrich**

# ARTIS Research UAV



- ▶ **Project initiated in Fall 2002**
- ▶ **Initial development complete - capable of autonomous flight**
- ▶ **Vehicle is now being used for experiments**

▶ **Collision Avoidance in Unknown Flight Environments**

▶ **Stereo camera**

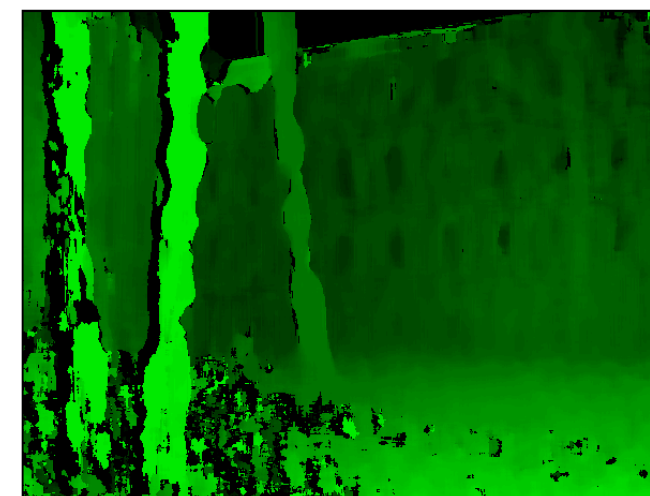
- Eye distance ( 8 cm – 20 cm )
- Resolution: 640 x 480
- Up to 30 frames per second
- FOV 65° x 51°

▶ **Software**

- Online processing of the two camera images

▶ **Depth Map**

- Computation of the disparities on the on-board Graphics PC



# Manned Unmanned Teaming Scenarios



EC 135 FHS



Reconnaissance Task



Live Camera Signal



ARTIS

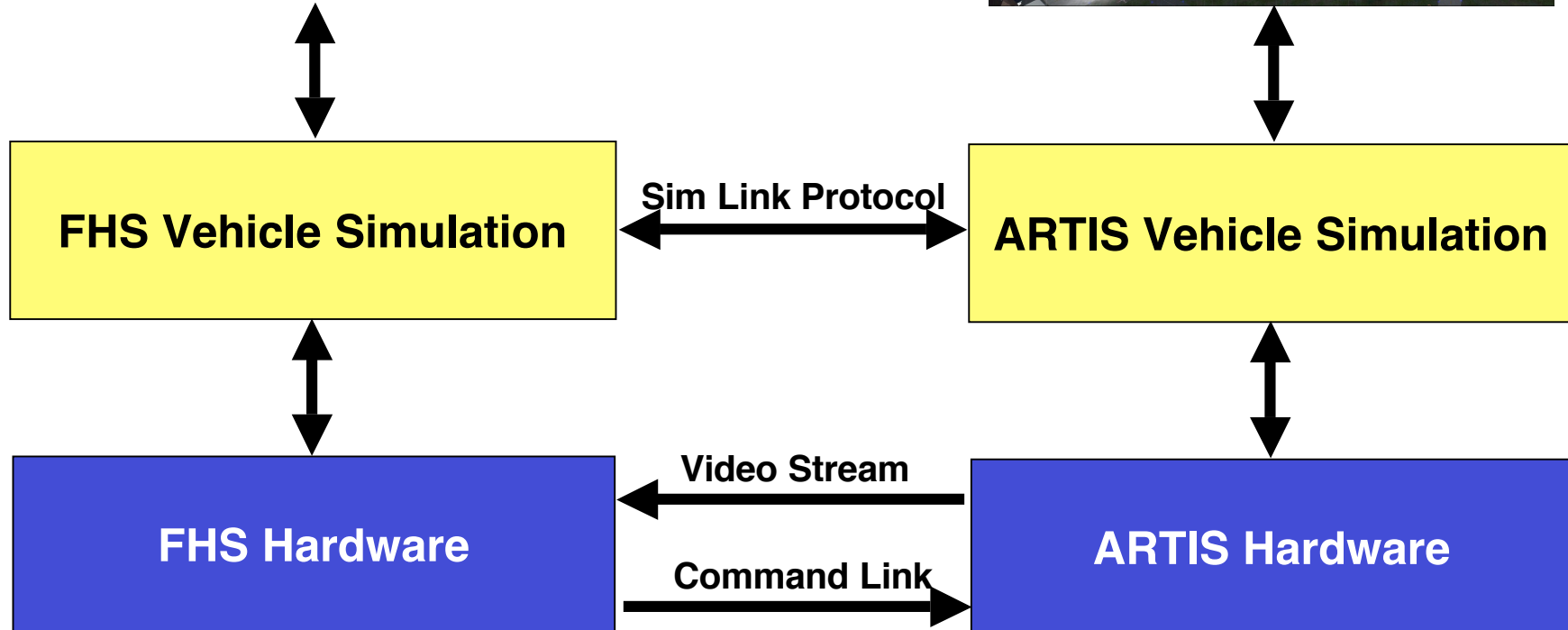
# First Teaming Experiments



- ▶ **Waypoint Control Mode**
  - Predefined trajectories from Mission Planning
  
- ▶ **Easy Handling Control Mode**
  - Fine adjustments of UAV's position
  - Direct control through 3-axis control stick
  
- ▶ **Image Centered Control Mode**
  - Select a target on a map/camera image
  - UAV will track that target with its camera system

**Future Goal: A companion UAV that acts as an electronic wingman**

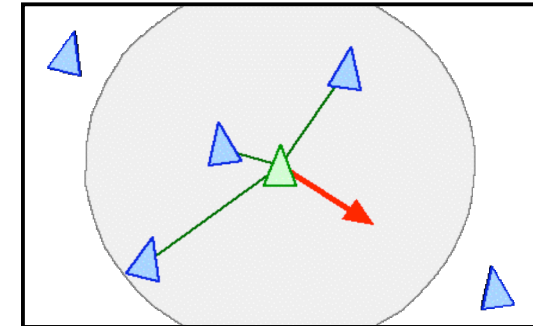
# Starting Point: Joint Simulation Capabilities



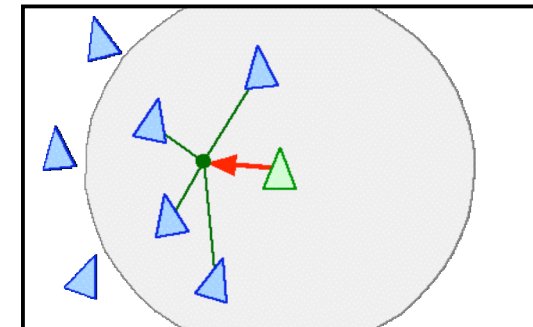
- ▶ **Current development to enhance the capabilities of ARTIS**
  
- ▶ **Comprised of**
  - **Health Monitoring**
  - **State Machine / Flight Management System**
  - **Decision System**
  
- ▶ **Inputs to the Decision System:**
  - **Standard Sensors**
  - **Vision System**
  - **Operator Commands**
  
- ▶ **Enables to perform in complex mission scenarios**
  - **Independently find and track targets**
  - **Obstacle detection and automatic evasion maneuvers**
  - **And more!**

- ▶ **Simulation of a swarm based on point-mass models**
- ▶ **Classical swarming rules**
- ▶ **Algorithms for collision avoidance and trajectory tracking**
- ▶ **Extendable Simulation Environment**
- ▶ **To come:**
  - **Teaming with Manned Systems**
  - **Cognitive System**
  - **Application to ARTIS UAV**

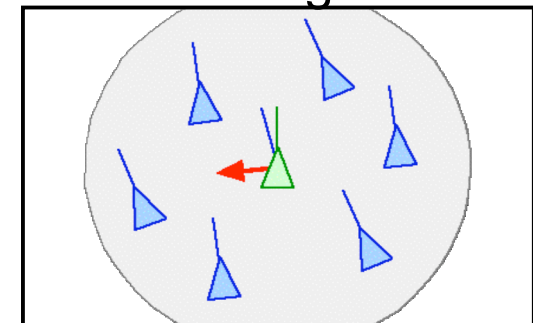
Collision Avoidance



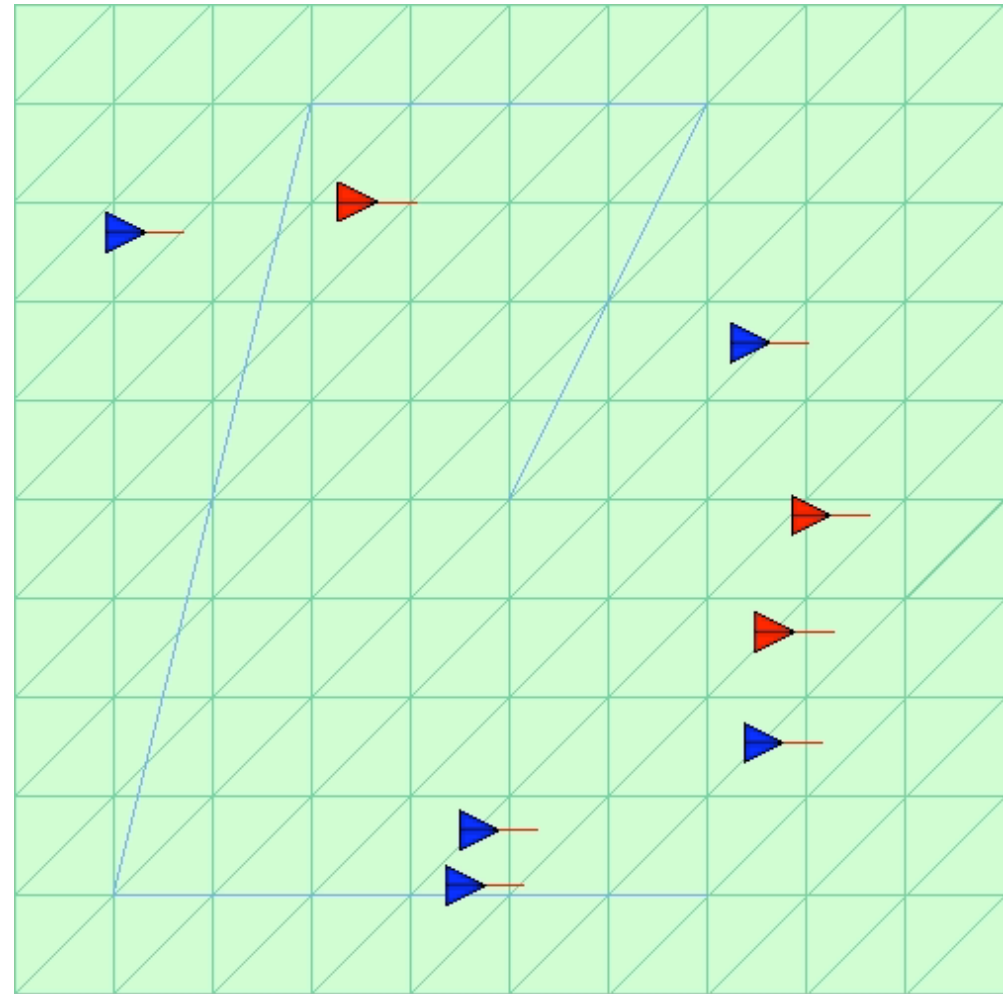
Cohesion



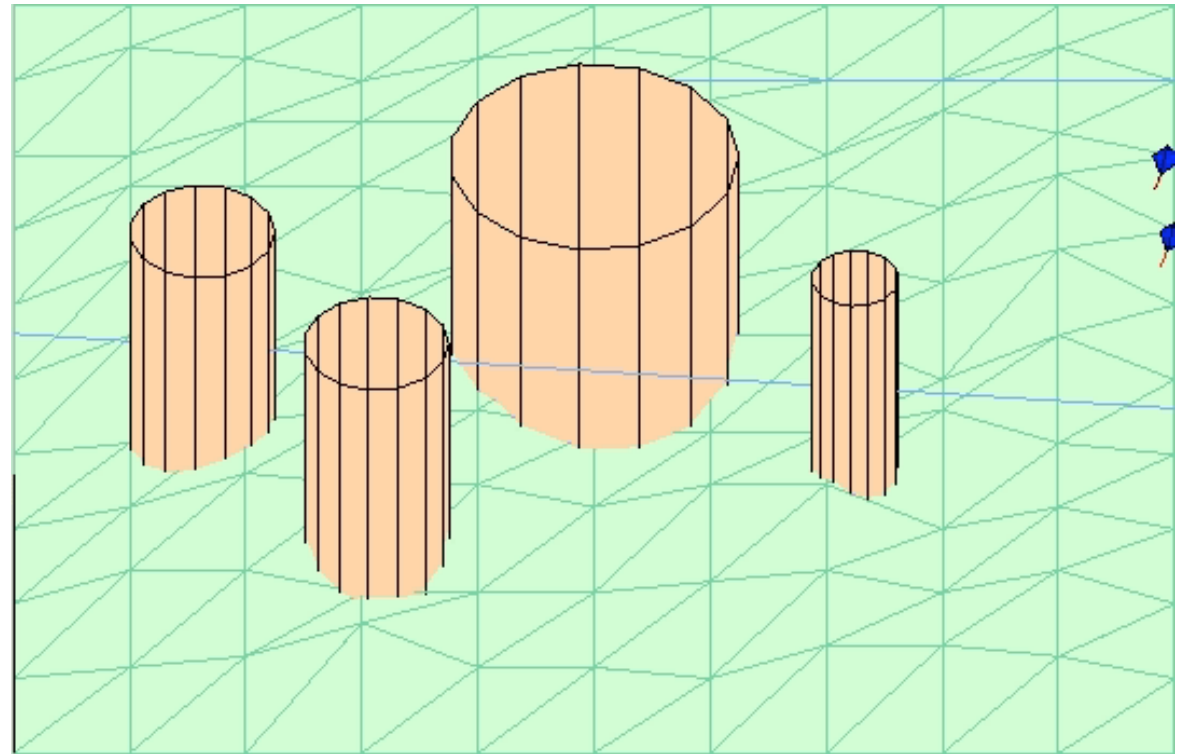
Swarm Alignment



- ▶ **Random starting points for all agents**
- ▶ **Programmed waypoints**
- ▶ **Formation of two independent swarms**



- ▶ **Separation of the swarm**
- ▶ **Swarm regroups**
- ▶ **Separates again to evade the last obstacle**



- ▶ **ARTIS Research UAV is operational**
- ▶ **Experiments in passive sense and avoid**
- ▶ **On-board Decision System**
- ▶ **Use of simulation capabilities (FHS ground simulator and ARTIS system simulator) to study operational issues of Manned-Unmanned-Teaming**
- ▶ **Multiple UAV Simulation, Swarming Behavior**