

GNC for Rendezvous in Space with an Uncooperative Target

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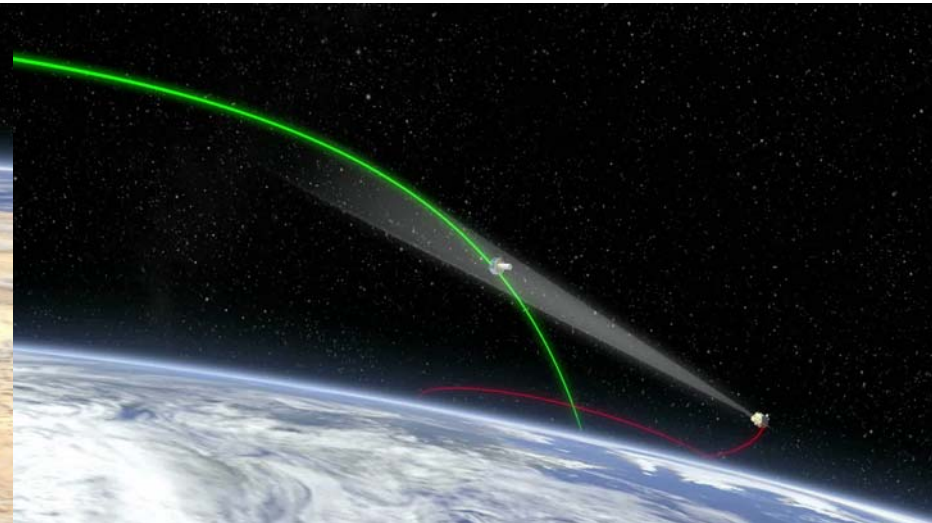
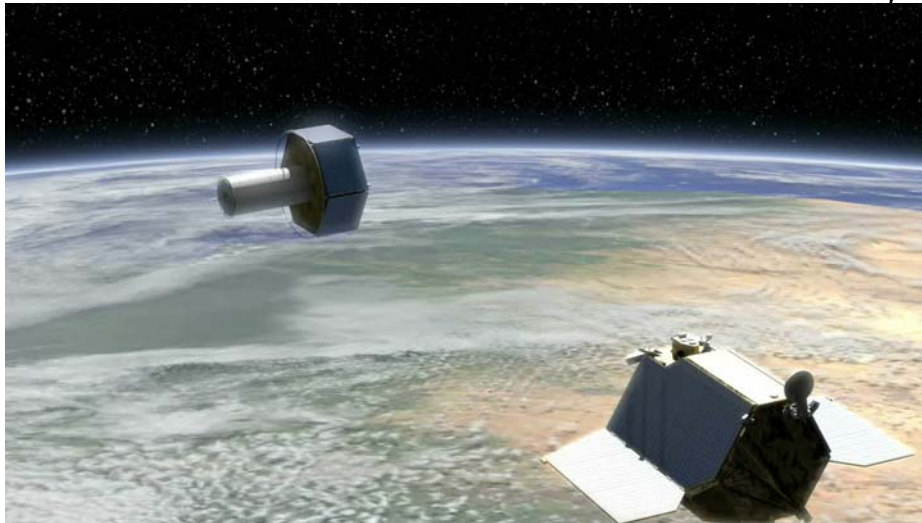
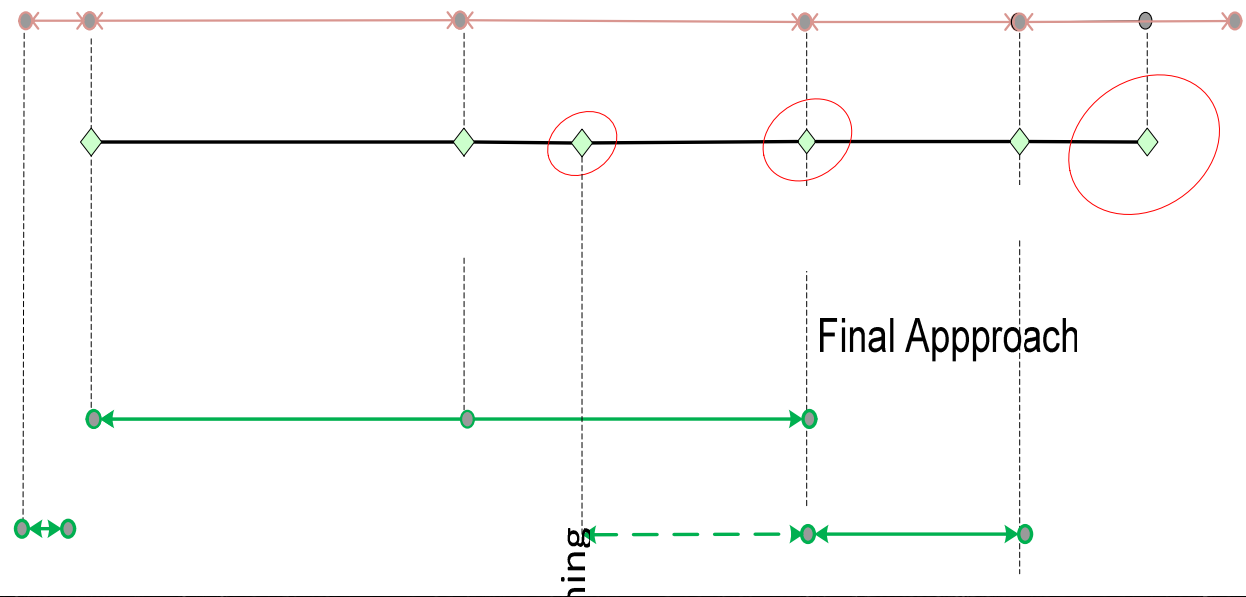


Overview

Goal: Development of GNC System Layout for Rendezvous with an Uncooperative Target

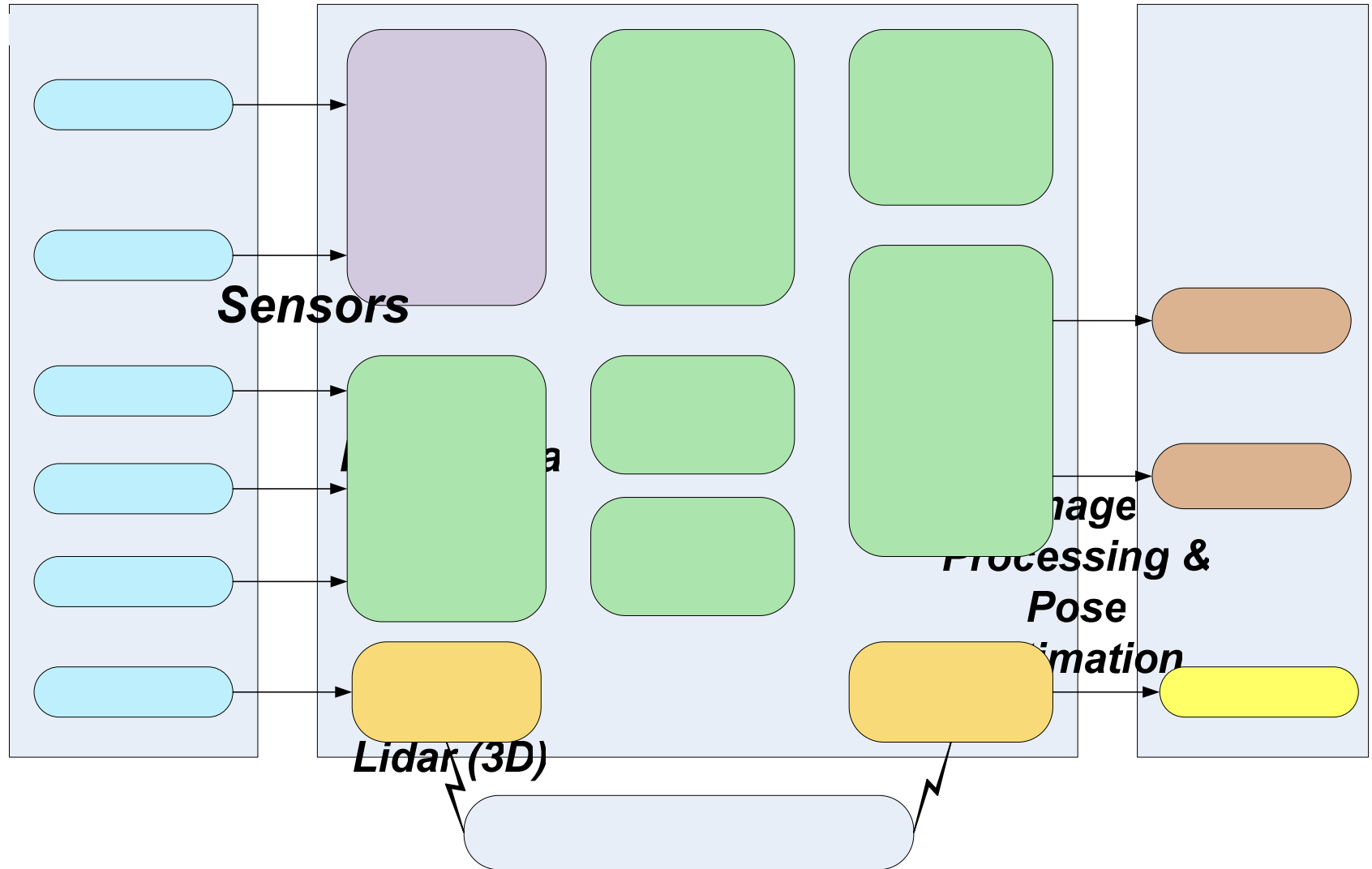
- Reference Mission for GNC System Layout
- Reference System
- Vision-Based Navigation for Far-, Mid-, and Close-Range
- Guidance & Control
- GNC S/W Development and Verification
- Summary

Reference Mission



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Reference System



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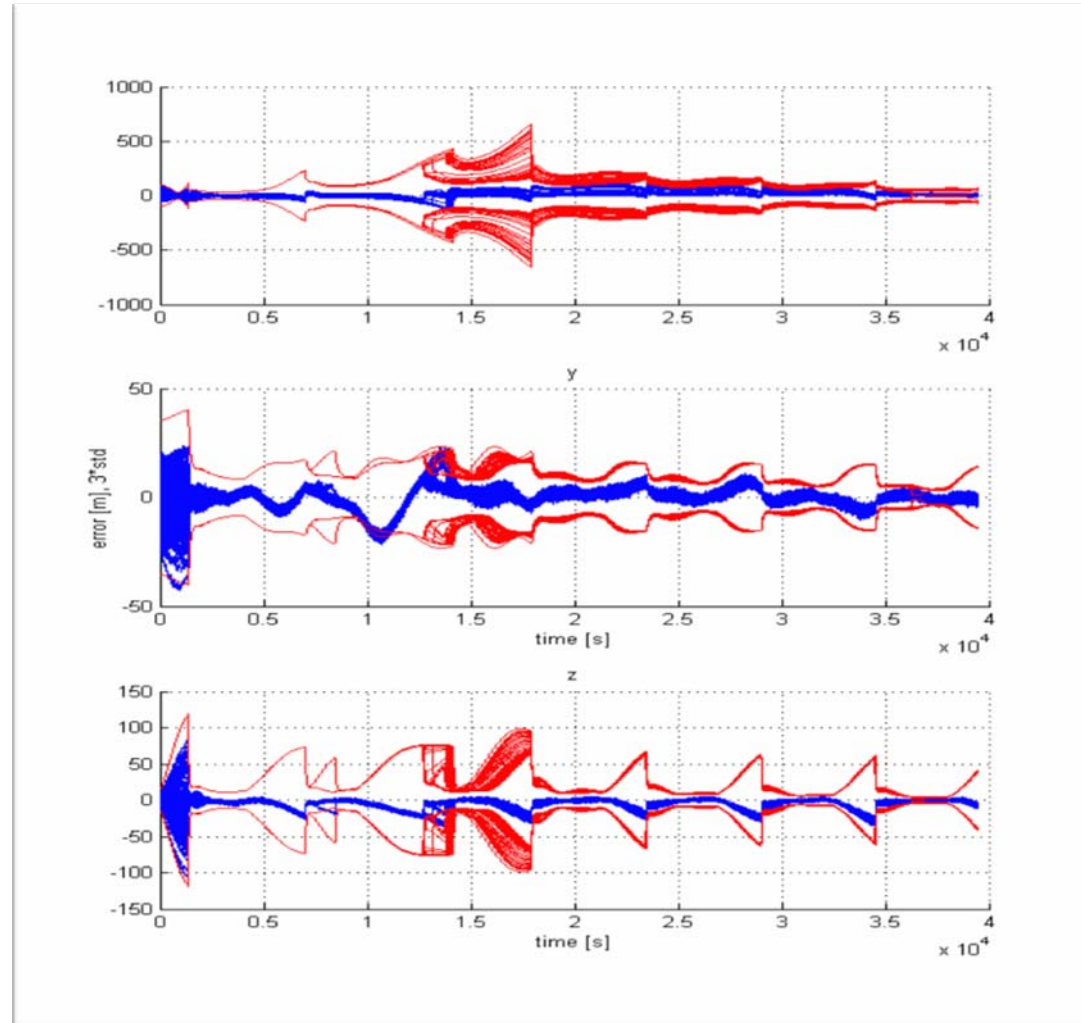
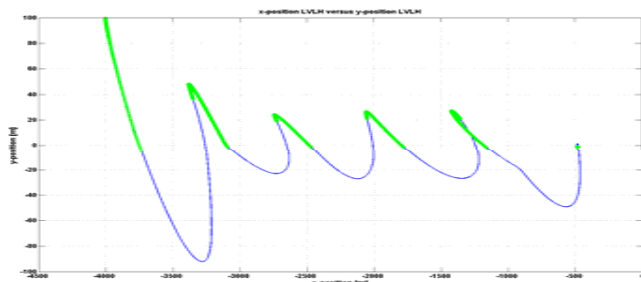
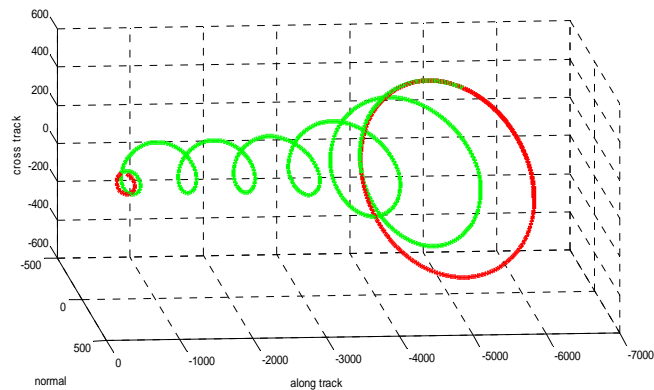
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Vision-Based Navigation

- Different Technologies for Different Ranges:
 - Far-Range:
 - Beyond the distances of range-sensors, typically $> 1\text{km}$
 - Usage of a monocular monochromatic camera as LOS-only sensor.
 - Mid-Range:
 - Available line-of-sight & range measurements from e.g. 3D-LIDAR
 - Close-Range:
 - Need for full 6D-pose-estimation and
 - tumbling motion estimation.
 - Complex 3D-LIDAR and matching between 3D point clouds and a priori target object knowledge

Vision-Based Navigation

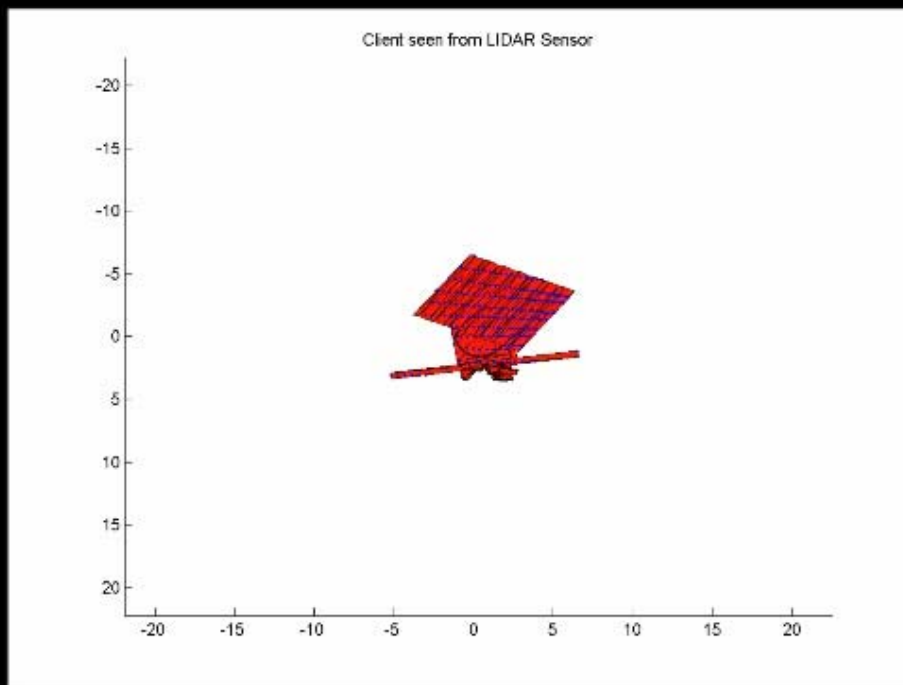
- Far-Range-Navigation: Based on LOS measurements during Visibility
 - Observability assured by spiral approach:



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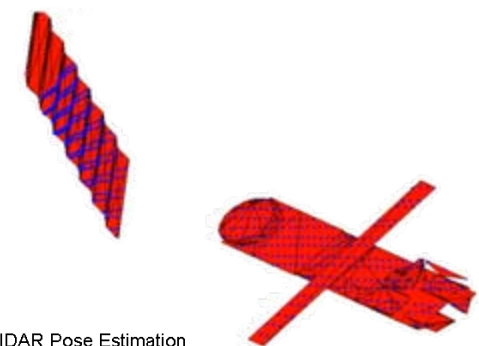
Vision-Based Navigation

- Close-Range-Navigation: Based on raw measurements from a 3D-LIDAR
 - LIDAR provides dense 3D point cloud
 - Model-knowledge of target object used for initial coarse pose-estimation followed by pose-refinement and tracking

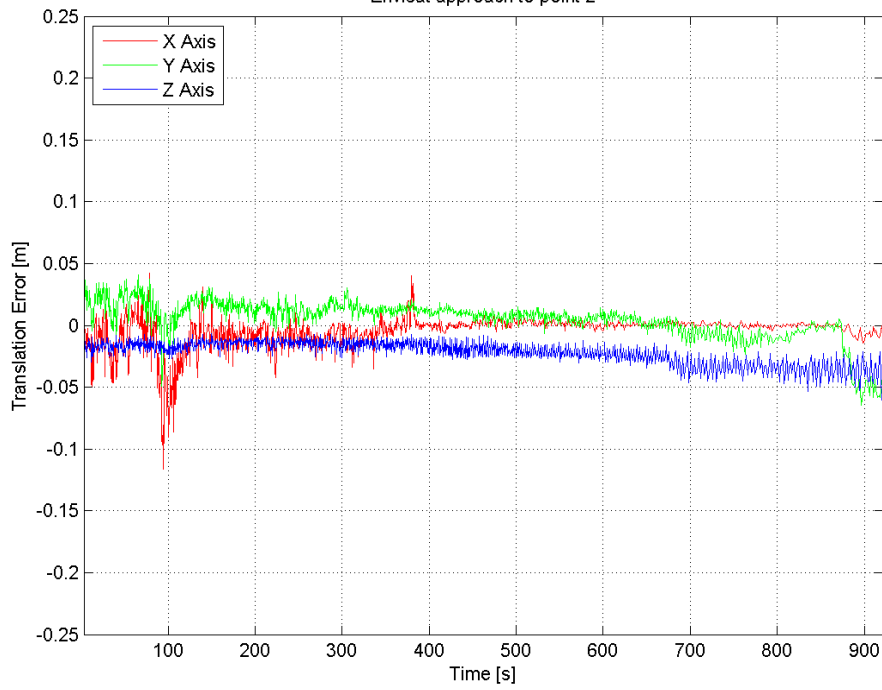


Vision-Based Navigation

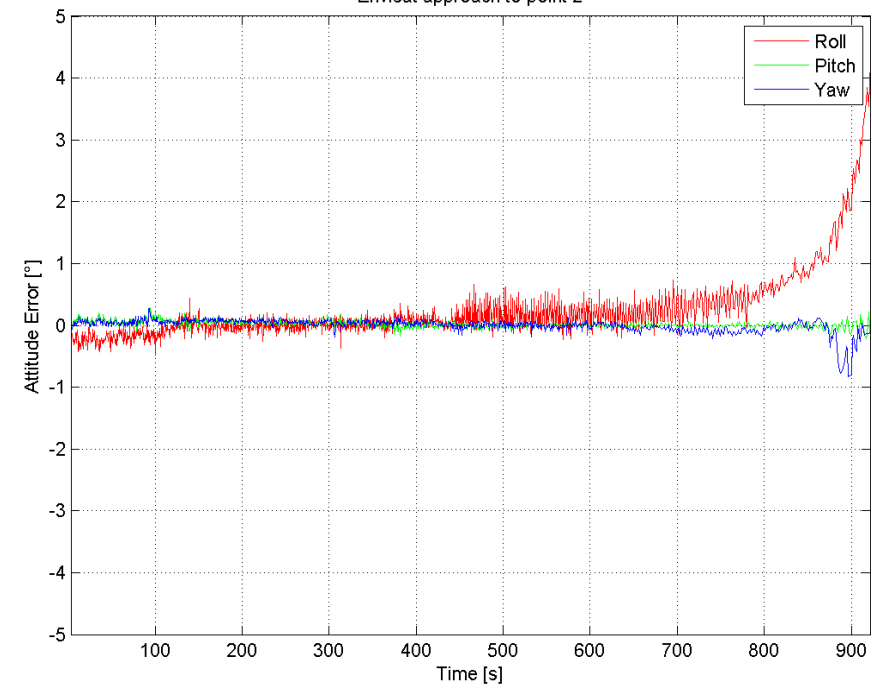
- Close-Range-Navigation:
 - Simulation results of an application to ENVISAT approach trajectory.



LIDAR Pose Estimation
Envisat approach to point 2



LIDAR Pose Estimation
Envisat approach to point 2

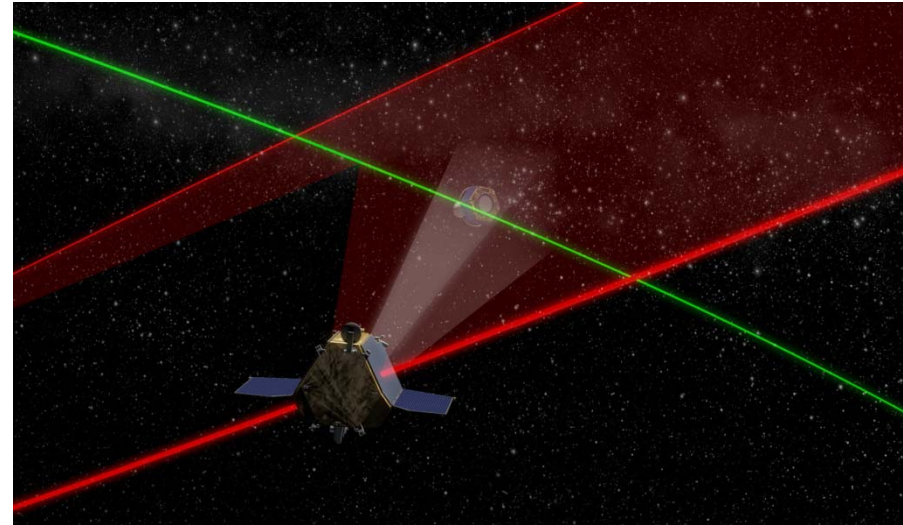


Guidance & Control

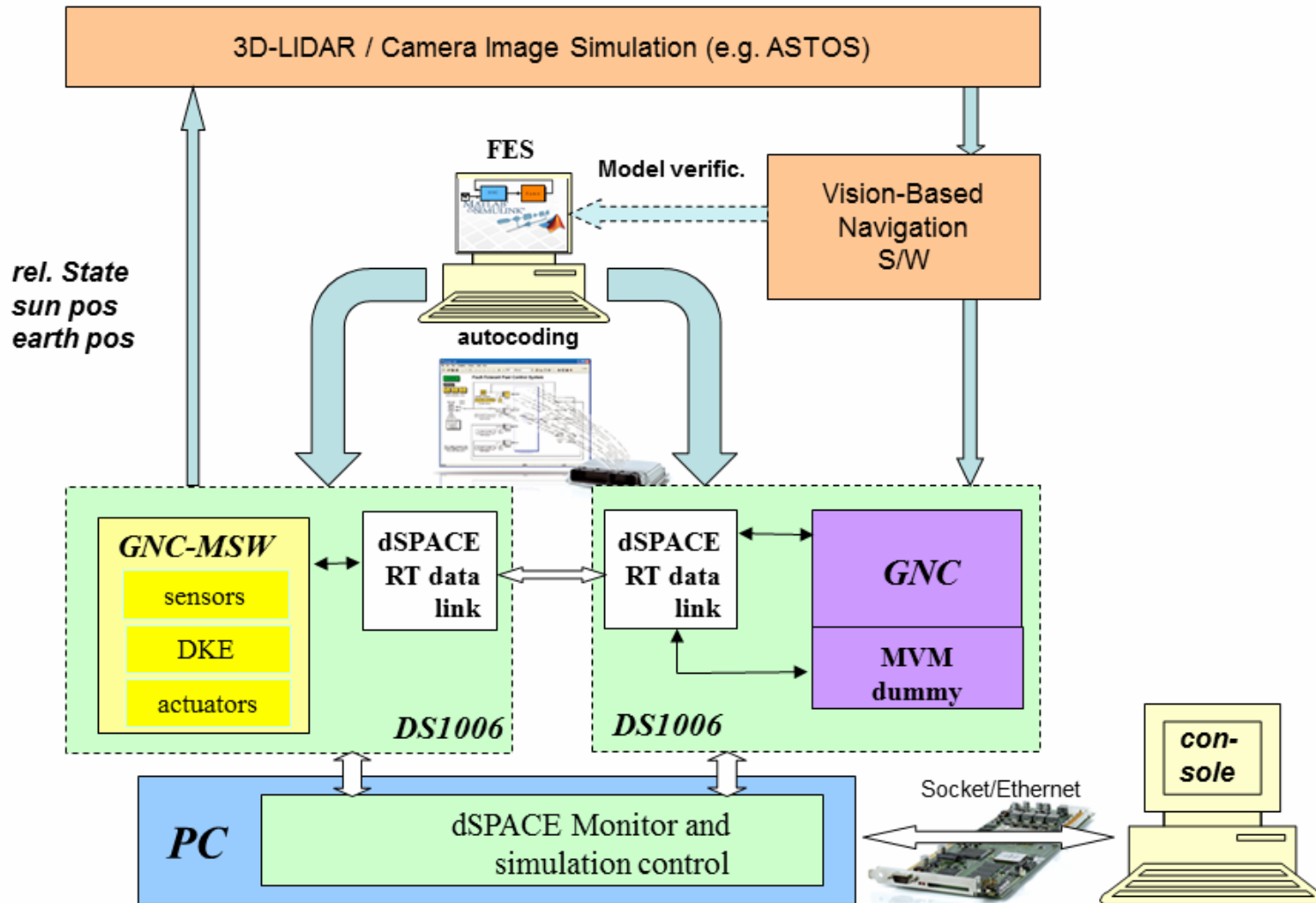
- Far-Range:
 - Spiral Approach (based on relative orbit elements (ROE))
 - Passive Safety
 - Target Pointing

- Mid-Range:
 - Spiral Approach (ROE)
 - Target Pointing
 - Passive Safety
 - Optional Inspection

- Close-Range:
 - Linear trajectories forced motion.
 - Collision Avoidance Maneuver (CAM)



GNC-S/W Development & Verification



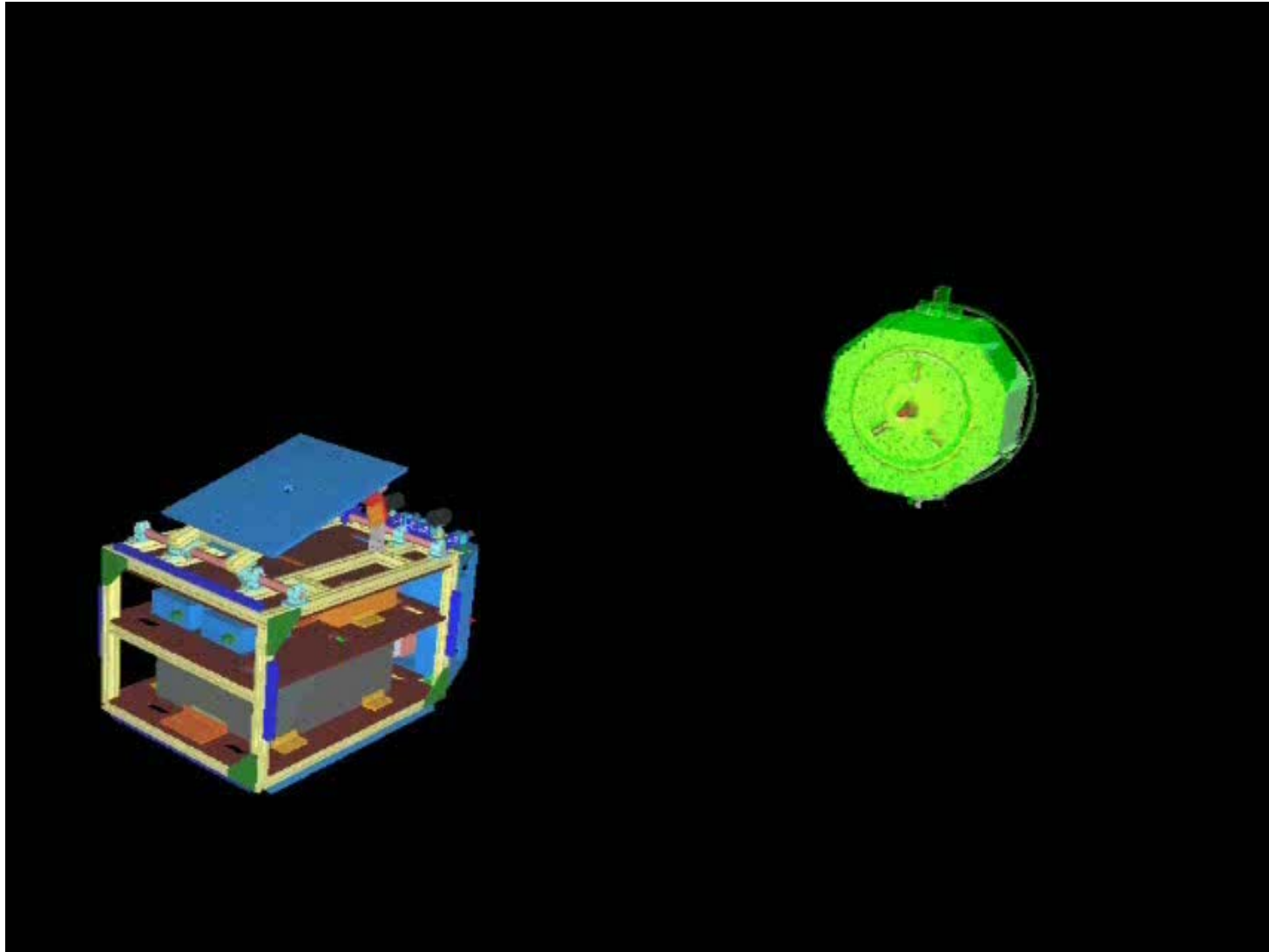
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GNC-S/W Development & Verification



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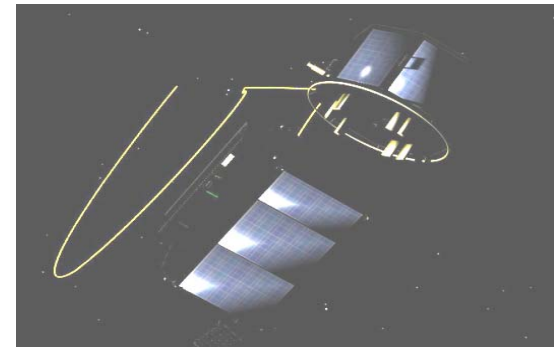
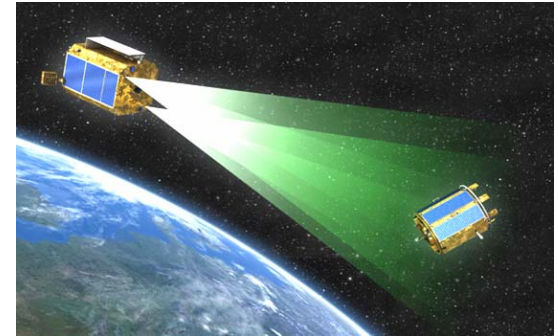
GNC-S/W Development & Verification



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Summary

- Navigation
 - No RGPS
 - Use of camera for far-range in combination with spiral approach trajectory
 - Use of active ranging (3D-LIDAR) for mid-range
 - Tumbling client requires 3D image processing in close range
- Guidance & Control
 - Passive safety trajectories for far- and mid-range,
 - active collision avoidance in close range
- High degree of autonomy is required due to short contact periods.





Thank you for your attention

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