



Automatic Air Collision Avoidance System

Auto-ACAS

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Overview



Auto-ACAS Provides the “Avoidance” for See and Avoid

- **A Common Architecture for UAVs & Piloted Aircraft**
- **Industry Advancement**
 - Address UAV Equivalency for See & Avoid in U.S. Airspace
 - Imbedded Flight Rules for Avoidance Onus
 - Enable UAV Swarming (Multiple UAVs in Close Proximity)
 - Prevent Midair Mishaps in Piloted Aircraft (*JAS-39 Grippen*)
- **Architecture**
 - Algorithm
 - Collision Prediction
 - Best Escape Determination
 - Sensor Integration
 - Cooperative – Datalink/Transponder
 - Non-Cooperative – Optical/IR
 - Fusion





Goals & Objectives



- **Goals**

- Allow Safe Operation of Multiple UAVs and Manned Aircraft in Close Proximity
- Military Application with Commercial Sector Potential
- Define a Design Process/System Architecture
 - **Broad Application**
 - **Ease Adaptation to Any Platform**
- Independent from TCAS
 - **Initiates with feet/seconds of separation not miles/minutes**
 - **Higher level of redundancy than TCAS**

- **Objectives**

- Develop and Demonstrate a “Nuisance Free” System
- Demonstrate Collision Avoidance





Auto-ACAS Design

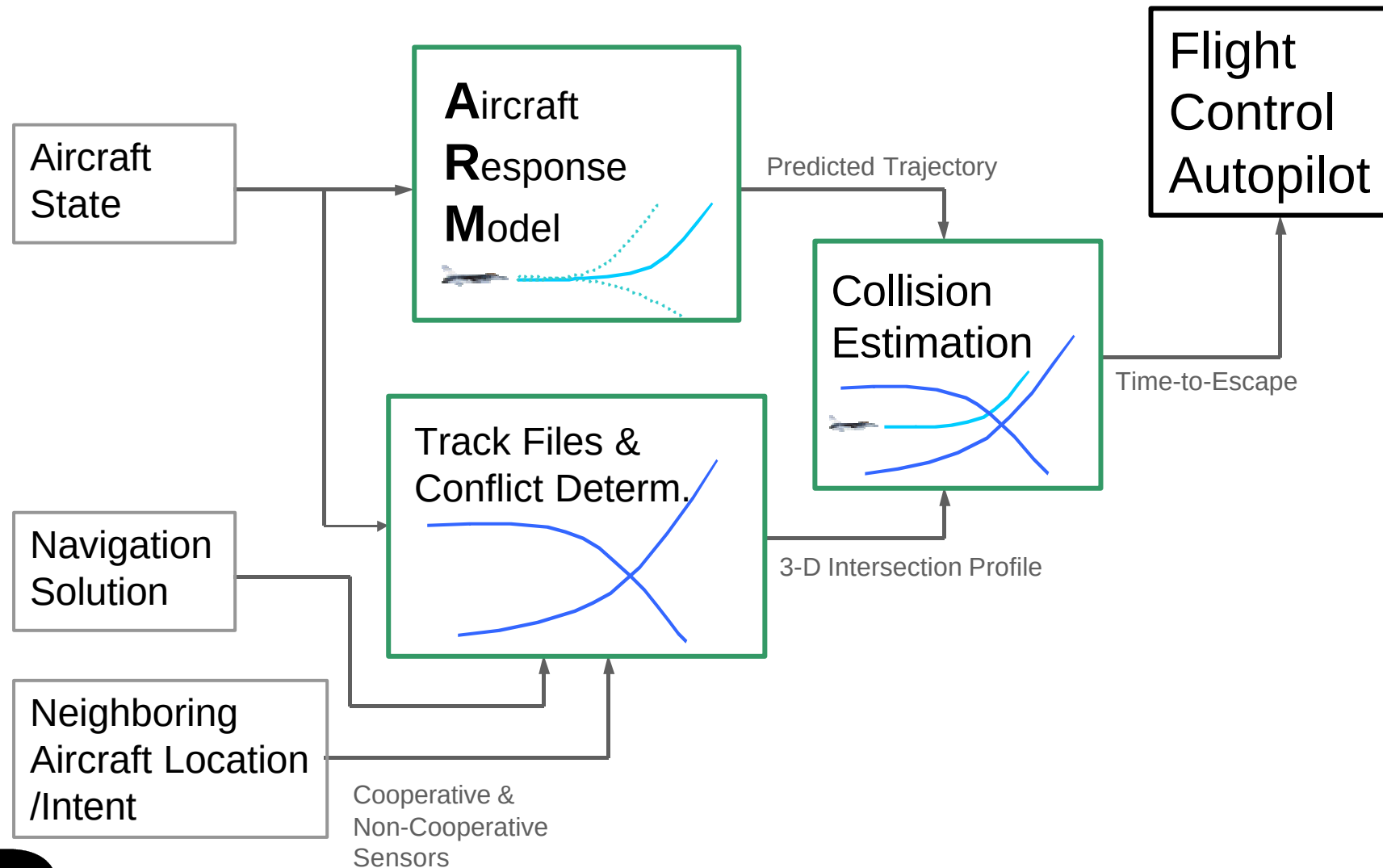


- **Algorithm for Avoidance Decision**
 - Predicts Recovery Flight Path
 - Evaluates Other Neighboring Aircraft Flight Paths
 - Determines Minimum Approach of “Best Escape” Maneuver
- **Auto-Pilot Executing Avoidance Maneuver**
 - Aggressive Maneuver Relative to Aircraft Limits
 - Roll to Best Escape Bank Angle
 - Pull to 5g/*AOA-limits*
 - Disengage As Soon As Flight Paths De-Conflict
- **Technology Heritage**
 - Automatic Ground Collision Avoidance (Auto-GCAS)
 - Sensor Fusion/System Wide Integrity Management
 - Aircraft Response Model
 - Auto-Pilot Architecture
 - Lower Technical Risk



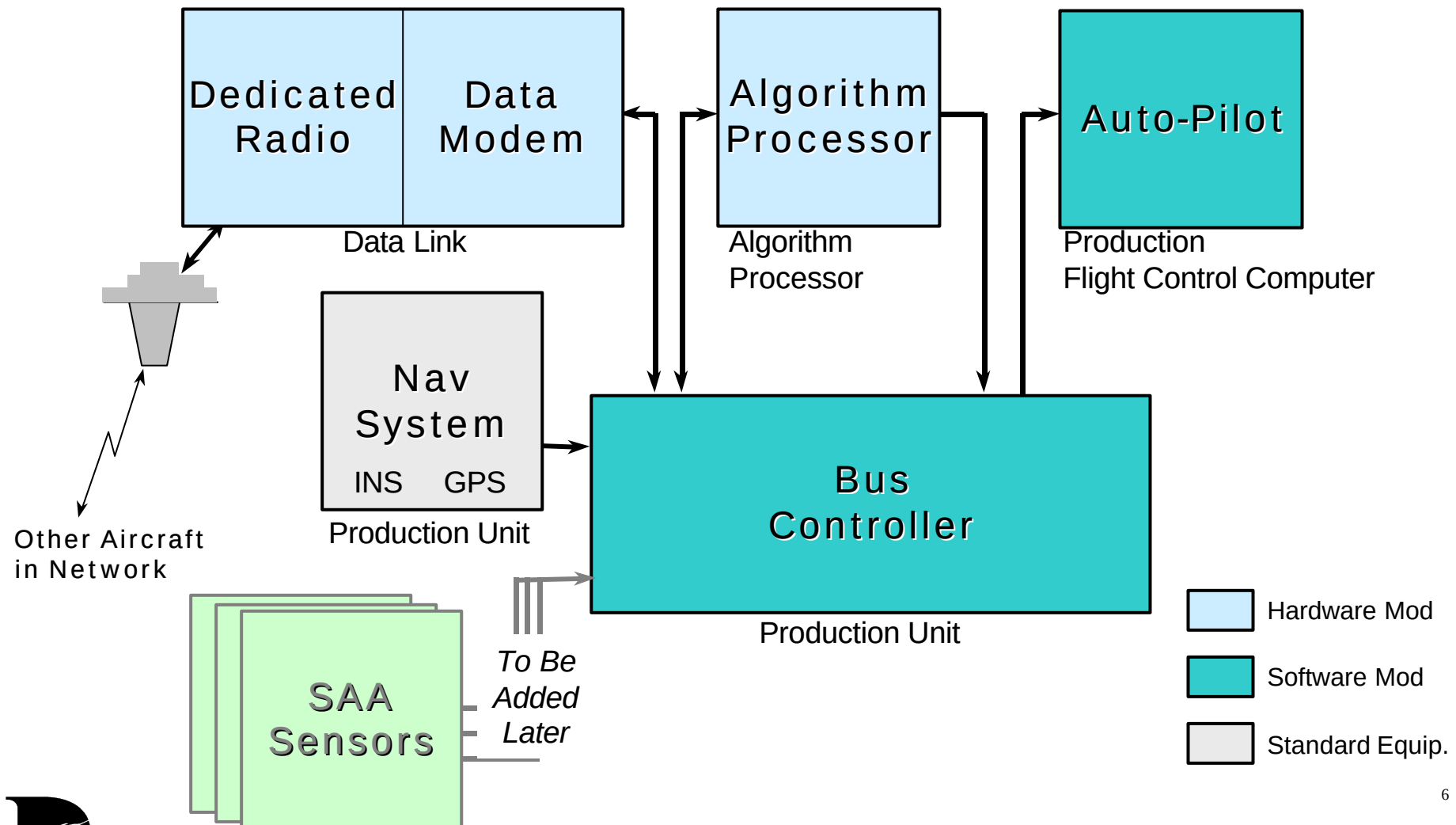


Auto-ACAS Algorithm Architecture





Auto-ACAS System Block Diagram





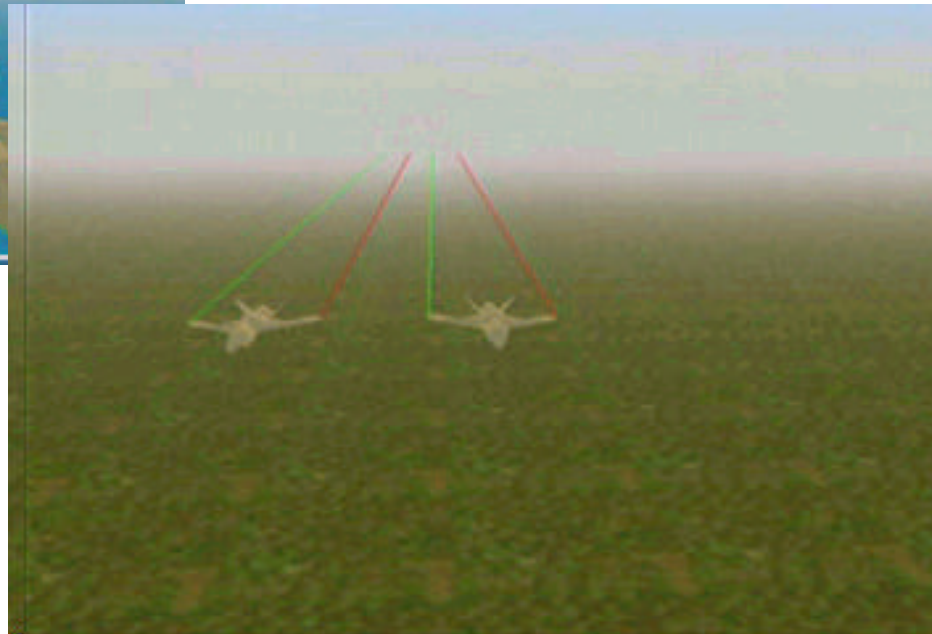
Auto-ACAS Operation



Overtaking Opponent



Scissors Maneuver



7





Heritage

Auto-GCAS History



Nuisance Potential

- Flight Test
 - Began in
 - Over 220
 - Flight
 - Over 700
 - Recovery
 - 30+ Eval
 - Most Lik
 - the AFTI





Project Description

Program Plan



- **Phase 1** (May 00 to Mar 01)
 - Concept Study
- **Phase 2** (3Qtr FY01 to 4Qtr FY03)
 - Focus on Vehicle Control not Sensors
 - **Data Link is Primary Sensor**
 - Develop & Flight Demonstrate Technology
 - **2 Piloted Fighter Aircraft**
 - **Flight Demonstration of Minimum Clearance Penetration Prevention**
 - **Buildup for Unmanned Testing**
 - **Demonstrate UAV Avoidance of Manned Aircraft**
 - Identify Sensor & System Requirements
- **Follow-On Phase : Full Integration**
 - UAV/ROA Flight Test
 - See-and-Avoid Sensor Integration
 - Auto Ground Collision Avoidance Integration





Questions?



Dryden Flight Research Center

AutoACAS