Universal Replacement Autopilot (URAP) Program

Jon Bruns
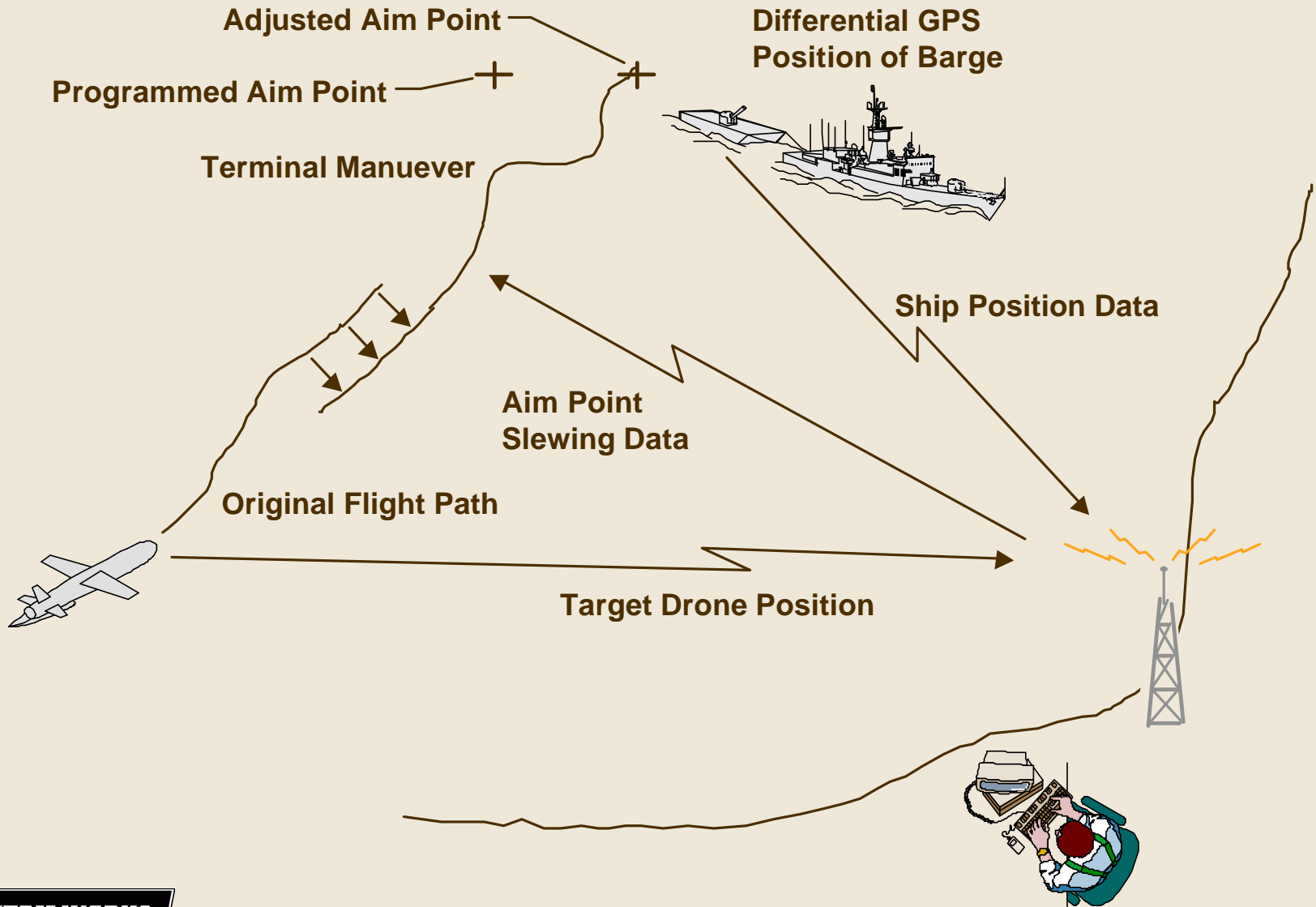
Boeing Phantom Works - Advanced Tactical Missiles

(636) 925-6437
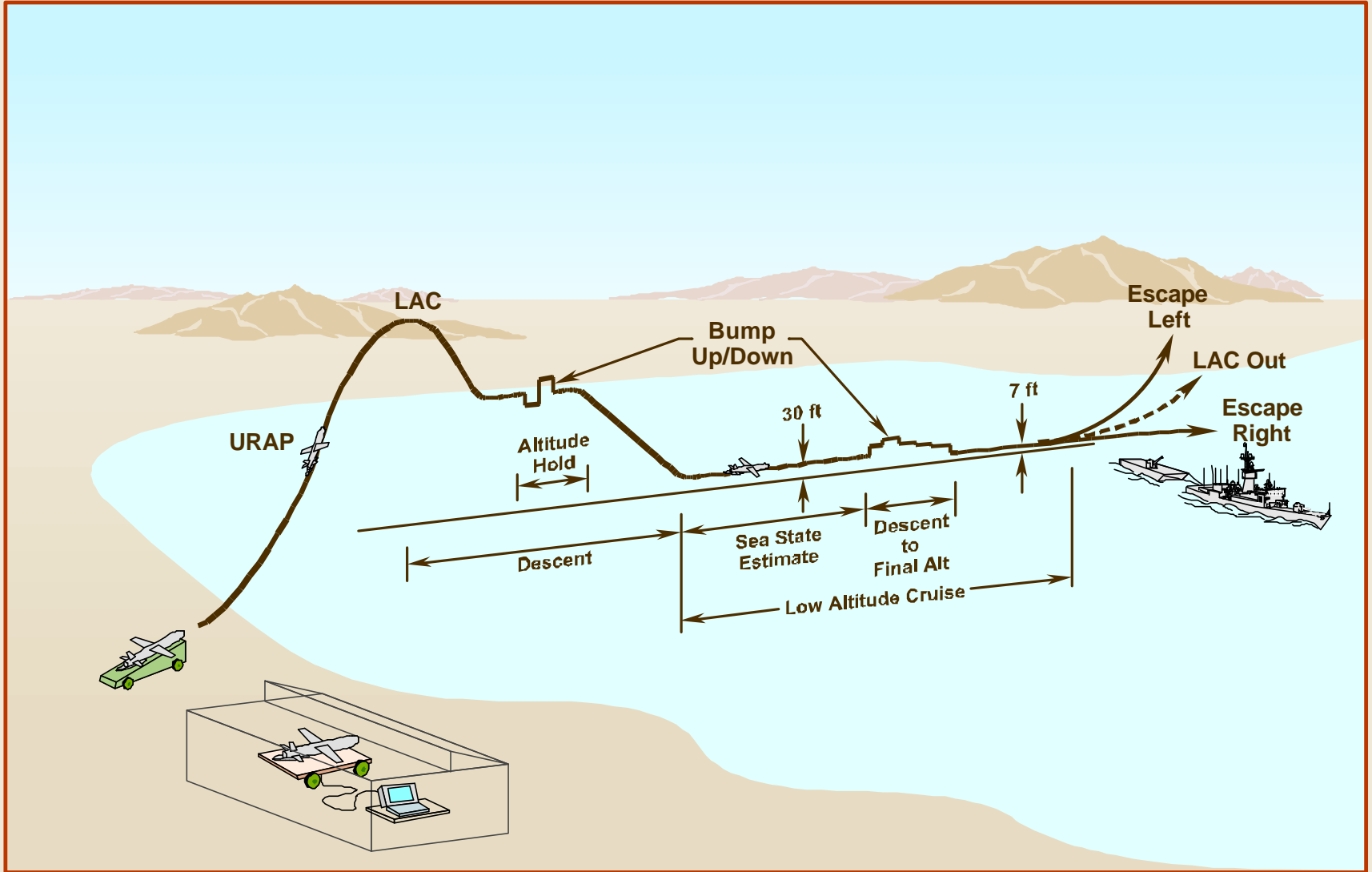
jon.bruns@boeing.com

PHANTOM WORKS

BOEING

Moving End Point Capability

Adjusted Aim Point

Programmed Aim Point

Differential GPS Position of Barge

Terminal Manuever

Ship Position Data

Aim Point Slewing Data

Original Flight Path

Target Drone Position

Low Altitude Sea Skim Capability

Concept of Operations

In-Flight Operator Commands

In Programmed Flight:
- Instant Recovery
- Delayed Recovery
- Payloads
- Mission Selection (8)
- Manual Takeover
- Moving End Point
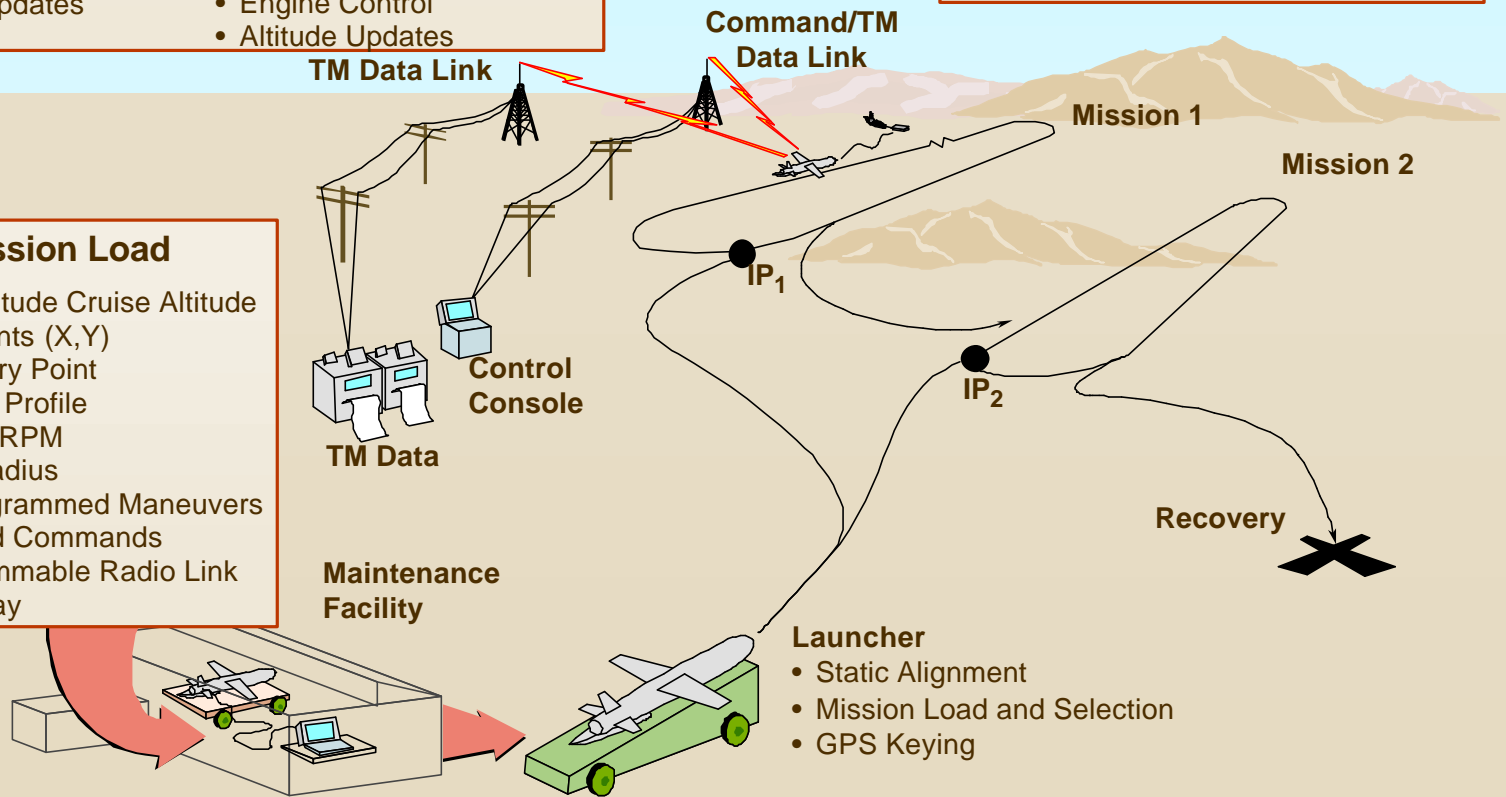- Altitude Updates

In Manual Flight:
- Radio Pitch & Roll Control
- Heading Hold
- Altitude Hold
- Return to Automatic
- Mission Selection (8)
- Preplanned Maneuvers
- Engine Control
- Altitude Updates

Preplanned Maneuvers
- Low Altitude Cruise/Sea Skimming
- Weave
- Pop-Up
- Escape Left/Right
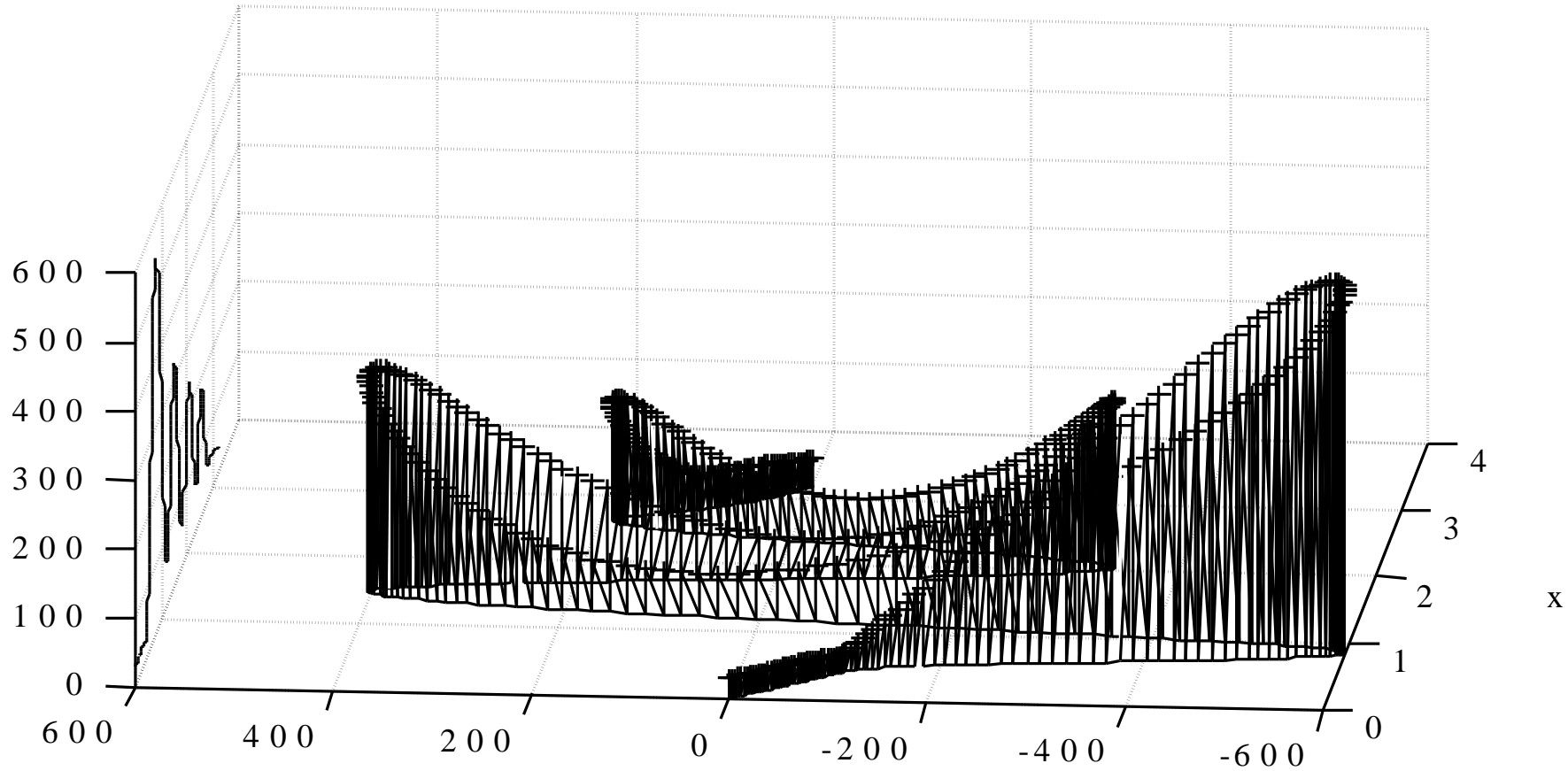- Delayed Recovery
- Instant Recovery

Mission Load
- Low Altitude Cruise Altitude
- Waypoints (X,Y)
- Recovery Point
- Altitude Profile
- Engine RPM
- Turn Radius
- Preprogrammed Maneuvers
- Payload Commands
- Programmable Radio Link Loss Delay

Command/TM Data Link

TM Data Link

Mission 1

Mission 2

IP$_1$

IP$_2$

Control Console

TM Data

Recovery

Maintenance Facility

Launcher
- Static Alignment
- Mission Load and Selection
- GPS Keying

Demonstrated Low Altitude Weave Maneuver

URAP Flight 10 Weave 4

URAP Guidance Set

- **Repackaged JDAM GPS/INS Mission Computer Guidance Set With Added Board for Analog, Digital and additional Serial I/O**
- **Compatible With ITCS and VEGA Control Systems**
- **Provides Autonomous or Manual Flight Control**
- **Mission Planning Allows Special Maneuvers and Flight Profiles**
- **Low Cost**
- **BQM-74 Enhancements Flight Demonstrated**

Leveraging off JDAM to provide a low cost solution for improved target performance and threat simulation.
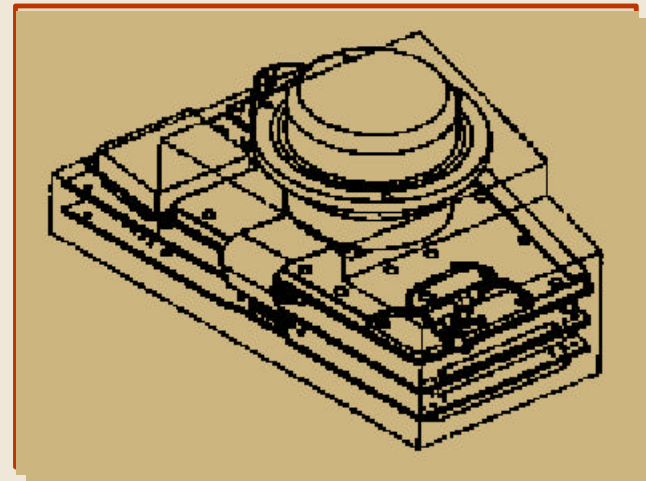
PHANTOM WORKS

BOEING

JDAM Provides a Low Cost, Proven, Sustainable Basis for URAP

- **High volume/low cost production base (87000 Units)**

- **Common Software Maintenance and Upgrades**

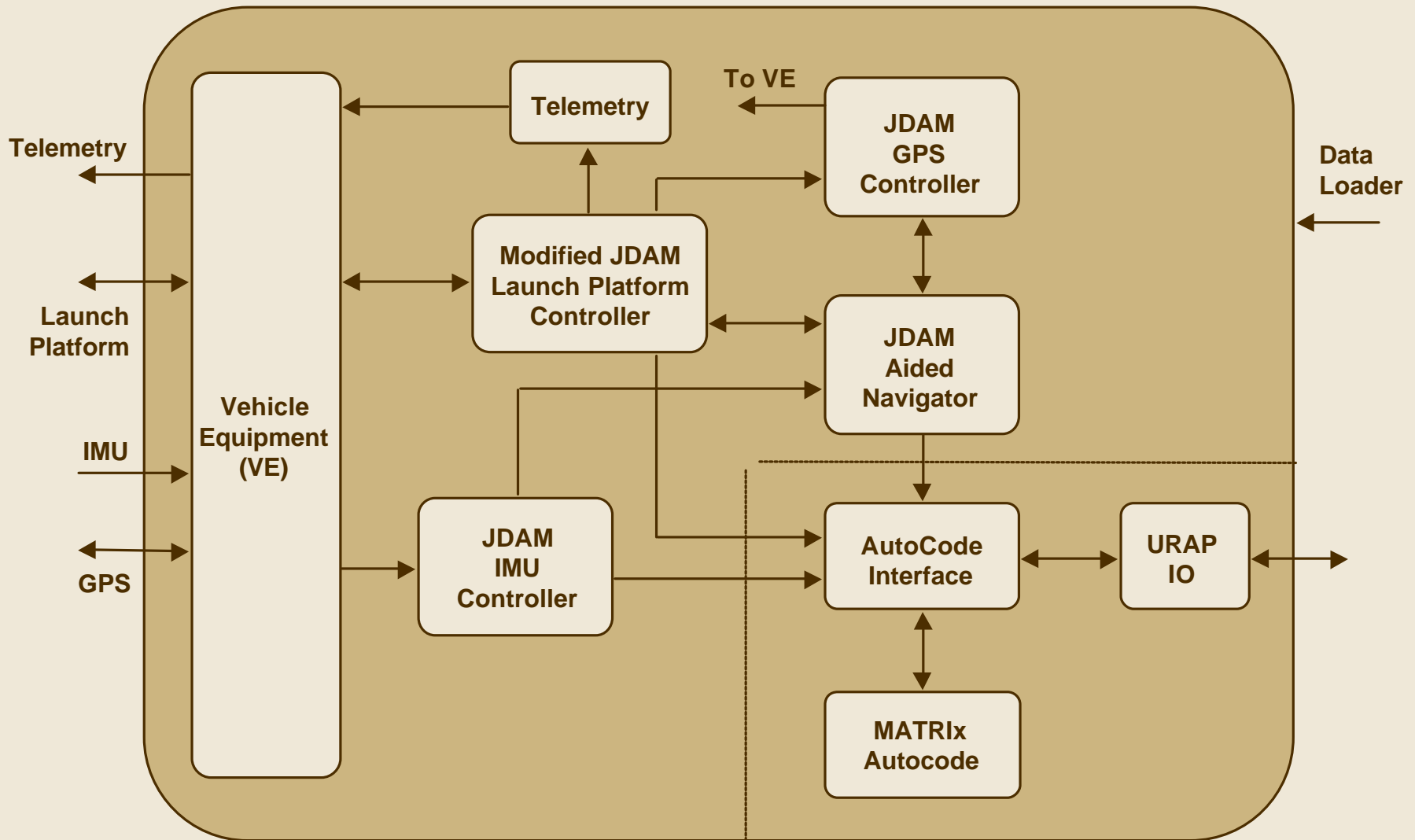- **Common Hardware Design Support and Upgrades**

- **Flight Proven Reliability**

JDAM GCU

URAP GCU and IO
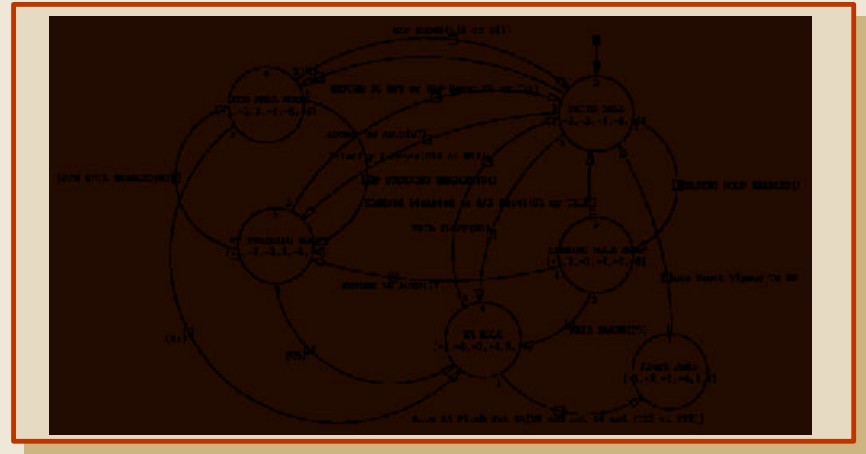
PHANTOM WORKS

BOEING
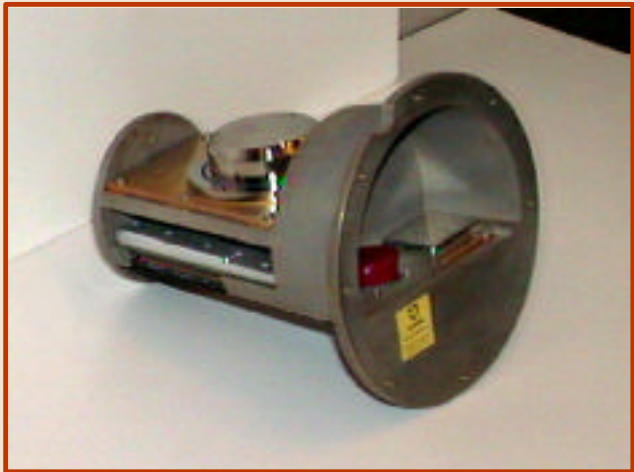
Software Structured For Reuse

Matrix-X Provides Flight Simulation

Flight Simulator

Logic Analyzer

Control Loop Generation

Software Auto-Coding

MATRIX-x Enables Efficient Re-host and Modification of Guidance Laws

- **Validate Existing Control Loops and Vehicle Logic**

- **Develop New Control Loops and Vehicle Logic**

- **Complete Simulation of System - Ground Control Segment and Vehicle Segment**

- **Software Generation (Autocode)**

- **Software Validation**

- **Software Documentation**

- **Software Module Reuse**

> *MATRIX-x Is a Significant Labor Saving Tool That Allows Rapid Development/Changes to Flight Software*

URAP Program Status

- **24 Kits Built for BQM-74 Target Drone**

- **17 BQM-74 Flights Performed Successfully Demonstrating:**
  - INS/GPS Navigation
  - Manual & Autonomous Flight Control
  - Manual to Autonomous & Autonomous to Manual Handover
  - In-Flight Mission Selection
  - Altitude and Heading Hold
  - Low Altitude Sea Skimming
  - Weave Maneuver with Moving End Point
  - Recovery (Manual and Autonomous)
  - Left & Right Escape Maneuvers
  - In Flight Updates of Programmed Altitudes (Bump Up/Down)

- **Delivery of 37 more units in CY 2000**

PHANTOM WORKS

BOEING

Summary - URAP Benefits

- **Reduced Cost for GPS/INS Capability**

- **Flexibility to Modify Flight Profiles to User Requirements**

- **Compatible with Existing Ground Stations**

- **Autonomous and Manual Flight Control**

- **Uniform and Repeatable Flight Profiles with Accurate Time, Space and Attitude Data**

- **Single Set of Tools/ Processes/Simulations for Multiple Vehicles**