Navy Unmanned Combat Air System Carrier Demonstration (UCAS-D) Overview

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X-47B UCAS Demonstration

- Tailless, autonomous unmanned system under development by the U.S. Navy and Northrop Grumman

- Will be used to demonstrate first carrier-based launches, recoveries of an autonomous, LO-relevant aircraft

- Will be used to mature relevant carrier landing and integration technologies, and demonstrate autonomous aerial refueling
UCAS-D Air Vehicle System (X-47B) in Focus

- **Design**: Tailless, cranked-kite
- **Planform**: LO relevant features
- **Structure**: Carrier approved
- **Take-off gross weight (demo)**: 44,000 lbs
- **Engine**: PW F100-PW-220U
- **Twin Internal Weapons Bays**: 4,500 lbs payload
- **Aerial refueling provisions**: USN / USAF style
- **CV launch OPWOD**: +2.2 knots
- **CV recovery WOD**: +7.2 knots
- **Spot factor (F/A-18C)**: 0.87
UCAS-D Program Overview

Air Vehicle Segment
- Includes Deck Handling, Maintenance and Unique Support Equipment

Mission Control Segment
- Including Mission Planning, Mission Control and Related Functions

Support Segment
- AAR Segment
- CV Segment
- Government Controls Interface

Includes Shore Based and Shipboard Facilities, Work Centers, Shipboard Equipment and Common Support Equipment
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Ship Suitability Requirements:
UCAS vs Manned Aircraft

Comparison to JSF Ship Suitability

Structural Interface
- Launch and Recovery Clearances
- Hangar clearances
- Launch bar, holdback
- Hook

Vehicle Characteristics
- Structural
- Spot factor
- Tipback and Turnover
- Propulsion
- Wing Fold
- Tie Downs
- Landing Gear
- Lighting

Physical Requirements Unchanged

Technologies: Unmanned Tailless LO Planform, Guidance and Control

60% New or Modified Requirements for UAS

40% Common Requirements with Manned Systems

Autonomous Operations
- Deck/ Taxi
- Flight Operations (Launch, Departure, Marshal, Approach, Landing, Bolter, Waveoff)

External (RF) Interfaces
- Command and Control
- Navigation & Landing
- Identification and Monitoring

Internal Interfaces
- Voice and Intercom
- AV Monitoring Data
- CVN Data
- Ship Operator Data (CATCC, Primary, LSO)

Flight Deck Interface
- Deck Operator Equipment
- Communications

New or Modified Requirements for UAS

Technologies: PGPS, TTNT, IP-Based Interface

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Enabling Technologies

- Precision GPS Navigation (PGPS)
  - Ship-relative precision navigation
  - High Accuracy, Integrity, Continuity

- Low Latency Datalink
  - Tactical Targeting Network Technology (TTNT)

- IP Based Interface

- Applications:
  - Triple-Redundant Guidance, Navigation and Control to support unmanned operations
  - Unmanned Carrier Deck Operations
  - Autonomous Air Traffic Control Operations in the Carrier Control Area
  - Autonomous Precision Landing
  - Catapult Launch
X-47 Mission Control Segment (MCS) has aircraft- and ship-based components
- Aircraft-based: Mission Management System (MMS)
- Ship-based: Mission Control Element (MCE) housing Mission Operator Stations (MOS)

CV human command nodes interface with AV, which can respond autonomously
- Carrier Air Traffic Control Center (CATTC)
- Primary Flight Control (Pri-Fly) or “Air Boss”
- Landing Signal Officer (LSO)

CV command nodes/MCE linked to AV by Tactical Targeting Network (TTNT) datalink
CV command nodes and MCE networked via Ship Interface Processor (SIP)
CV Segment Installation

X-47B / CV
Unique I/O
Internal CV Network
Airborne Network Data
Intercom
ADMACS-LAN

Internal CV Electronic Interfaces
External CV Electronic Interfaces

Backup C2 Data and Voice Relay
C2 Data PGPS
C2 Data and Voice Relay
X-47B MCE
PGPS
TTNT
UCAS LAN
ADMACS LAN
Pickle Switch Signal
SIP
PriFly
LSO Platform
SATCC Switch
CATCC
Shipboard Operators and Workcenters
Flight Deck Officers
Hydra System
Crash and Salvage
Maintenance Control

ADMACS
Crash
and Salvage
Flight Deck Officers
Shipboard Operators and Workcenters

C2 Data and Voice Relay
X-47B MCE (Remotely Located)
UCAS-D Aircraft Carrier Command and Control

Mission Operator Station

Tower ("Pri Fly")

CATTC

LSO Station

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2. When abeam the LSO platform at pattern altitude and on speed the aircraft will begin a left turn to intercept the glideslope.

3. At approximately 3/4 nm, the aircraft sends “BALL CALL”. The LSO responds with “ROGER BALL”.

1. After the break turn is completed, the aircraft will descend to pattern altitude, maintain patternairspeed and dirty up. The aircraft will slow to on speed when passing abeam the bow. Heading will be adjusted so as to arrive abeam the LSO platform at 1 to 1.25 nm.

4. The aircraft continues on glideslope to touchdown and trap. Upon trapping, “TRAP” message is sent.
UCAS-D Manned Surrogate Test Activity

- Autonomous Arrested Landing with a F/A-18D Manned Surrogate 2 July 2011

- An interim step to demonstrate landing technology and unmanned autonomous operations with the safety/redundancy of a man in the cockpit

- USS Eisenhower testing:
  - 36 approaches
  - 16 touch and go landings
  - 6 coupled approaches to arrested landings

Successful Testing Reduces Risks, Builds Confidence for X-47B Carrier Landings in 2013
Recent X-47B Flight Test Activity

- 16 Envelope Expansion Flights completed Feb – Nov 2011
  - Cleared envelope to 15,000 ft MSL altitude, 200 knots
  - X-47B system checkout
  - Validated:
    - Air vehicle aerodynamic performance;
    - Guidance, navigation & control models; mission planning and command/control functionality
  - Operations in all modes: ground, takeoff, cruise, approach
  - Validate X-47B PGPS/TTNT landing system functionality

Demonstrating good X-47B aerodynamic, datalink and PGPS performance
Complete Demonstration of USN (Probe-Drogue) and USAF (Boom-Receptacle) AAR methods by FY14

- Transfer 3000 lb to X-47B via each method
Upcoming UCAS-D Activities

- Air Vehicle 1 testing at NAS Patuxent River, Md.
- Air Vehicle 2 continued envelope expansion at Edwards AFB
- Shore carrier suitability testing (2012)
- X-47B carrier landings (2013)
- Autonomous Aerial Refueling (2014)

Navy UCAS Seamless Integration
- X-47B Airworthiness
- Certification of Installed Carrier Systems
- Certification of PGPS Navigation performance
Questions?