



Joint Unmanned Combat Air Systems



Capability Demonstration Program

- Overview -

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Director
March 31, 2004



Overview

- **Background/History**
- **Program Direction**
- **Vision/Missions**
- **Common Operating System**
- **J-UCAS Program Elements**
 - **Common Systems & Technologies**
 - **Boeing X-45 Systems**
 - **Northrop Grumman X-47 Systems**
- **Operational Assessment**
- **Conclusion**

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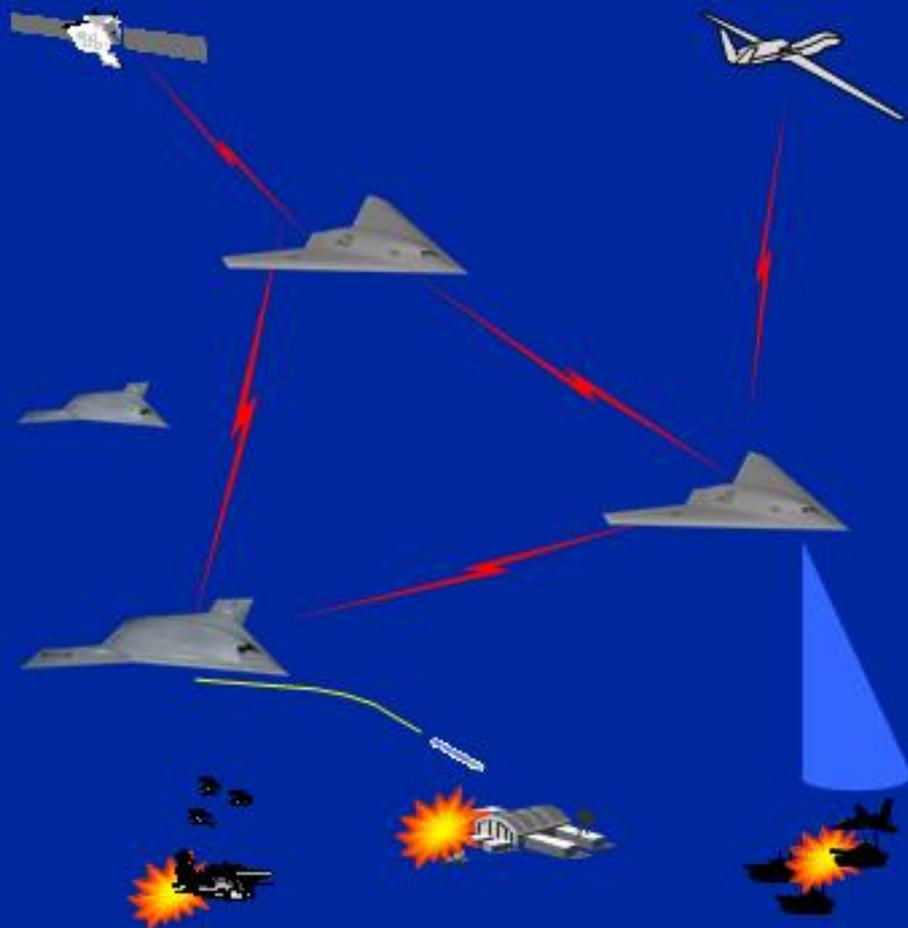
Joint Unmanned Combat Air Systems -- Unique Joint Program

- **DARPA-Air Force-Navy Development – Effective 1 Oct 2003**
 - Program Office in Arlington, VA
- **Outgrowth of Earlier DARPA Programs**
 - Uninhabited Tactical Aircraft (UTA)
 - DARPA-USAF Unmanned Combat Air Vehicle (UCAV)
 - DARPA-Navy Unmanned Combat Air Vehicle (UCAV-N)
 - 2 Prime Contractors -- Boeing (X-45), Northrop Grumman (X-47)
- **Network-based System-of-Systems**
 - Focus on Specific Mission Applications
- **Atypical Program Architecture**
 - Spiral Development ... Cutting Edge Technology ... ATDs
 - Operational Systems Focus ... Operational Assessment
 - Aggressive Timeline
- **Large Program - \$Multi-B over the FYDP**

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Collaborative Operations



Improve System Performance

- **Reduced Target Location Time**
- **More Assured Target Identification**
- **Sustain Ground Tracking**
- **Improve Targeting Precision**
- **Rapid Battle Damage Assessment**

Increase System Versatility

- **Multiple Engagement Options**
- **Deep/Denied Environments**
- **Diverse Missions**

Enhance Survivability

- **Group Self Defense Tactics**
- **Novel CONOPS (e.g. Bi-static Ops)**
- **Graceful System Degradation**

J-UCAS Program Origins



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DARPA Perspective --

Uninhabited Tactical Aircraft (UTA) -- 1994-96



DARPA's Motivation

- Decades of DARPA Information Technology
- High Performance Aircraft Experience
- UAV Program History
- Dept of Defense Warfighting Vision
- Versatile, Affordable Power Projection Potential

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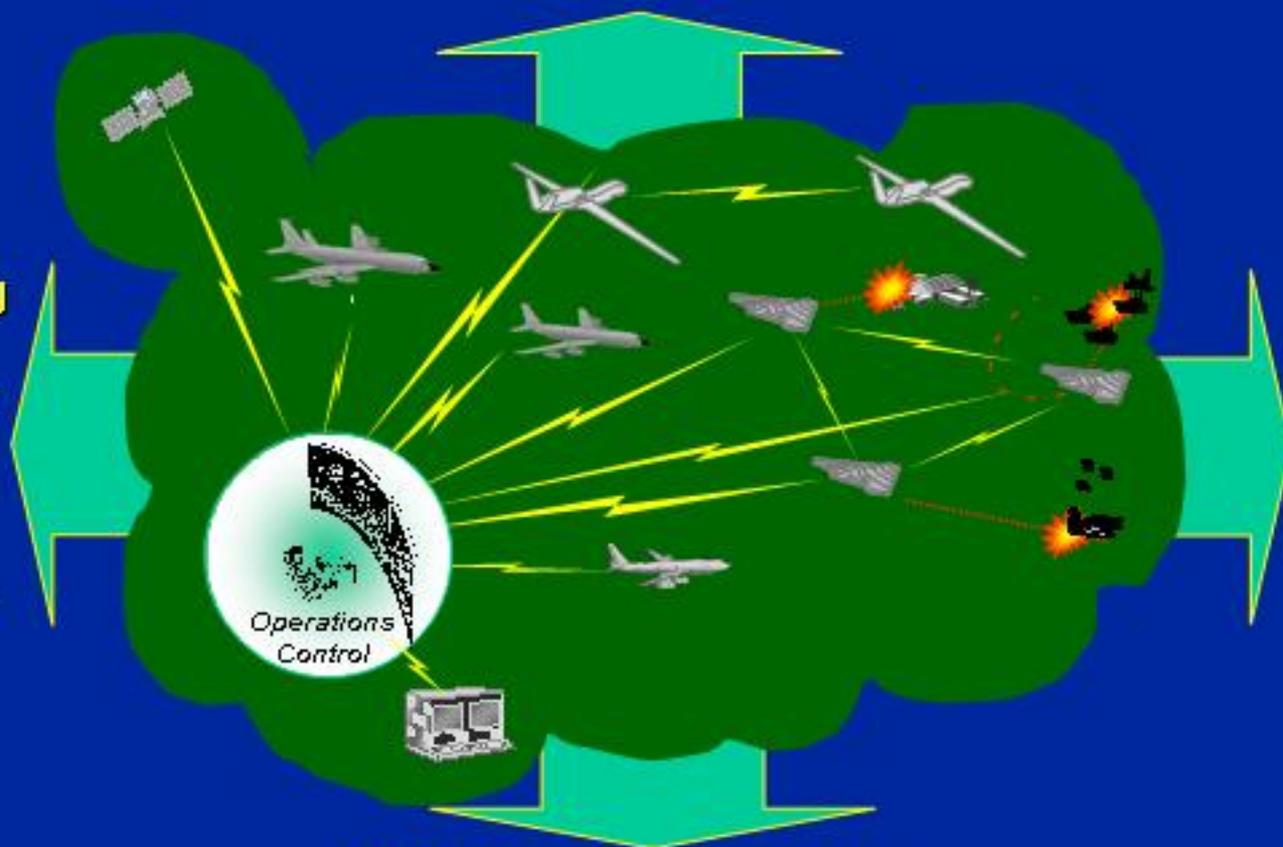
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Uninhabited Tactical Aircraft -- Program Architecture Implications

High End, Survivable Platforms
Increase Mission Versatility

Demanding
Timelines
Favor High
Levels of
System &
Platform
Autonomy



Lethal
Capabilities
Demand
Human
Decisions/
Involvement

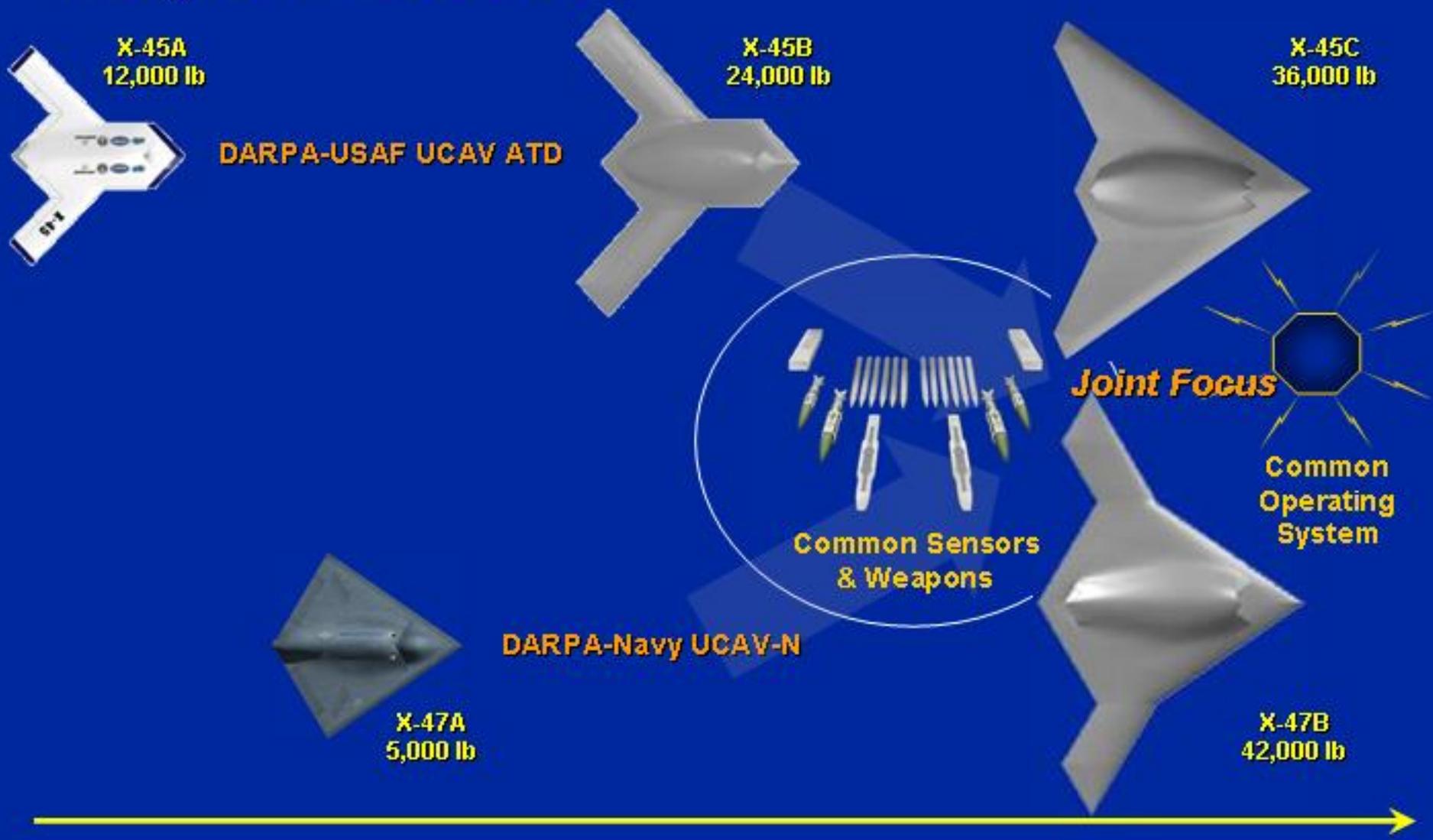
Attritable Platforms Offer Low
Acquisition and O&M Costs

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Program Evolution



FY99

FY00

FY01

FY02

FY03

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Program Direction & Expectations

- **OSD Objectives (23 Jun 03 USD/AT&L Memorandum)**
 - Demonstrate feasibility & flexibility of the J-UCAS concept
 - Conduct Joint Operational Assessment of J-UCAS capabilities
 - OA in FY07-09 timeframe ... facilitate early service decision
 - Maintain competitive environment throughout the program
- **Service OA Expectations (OA Capability Statements)**
 - Diverse mission priorities
 - USAF – SEAD / Electronic Attack
 - Navy – Persistent Surveillance / Reconnaissance
 - Demanding air vehicle characteristics
 - Range / radius / endurance
 - Payload options – type / weight / volume
 - Signature – Affordable LO to the next level
 - Carrier suitability (Navy)
 - Air refueling

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Program Planning Considerations -- *Assumptions, Constraints, Other Factors ...*

- **Aggressive Timeline**
 - FY07 OA start date
- **Competition Mandated**
- **Focus on “Shadows On Ramp”**
- **Services Driven Missions & Vehicle Requirements**
- **OA Capabilities Statements**
- **Sensor/Payload Developments Staggered**
 - Balance Service Needs And Technology Maturity
 - Driven By Available Funding
 - Common Elements, Where Possible (Cost Savings)
- **Common Operating System Assumed**
 - Development Initiated In FY04
- **Current Air Vehicle Designs Have Matured**
 - Key To Meeting Timeline
 - X-45C Passed Mid-term Design Review
 - X-47B Passed Systems Requirements Review

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Joint Unmanned Combat Air System -- The Vision

- **Versatile Combat Capability**

- Global Operations
- Suppression of Enemy Air Defenses (SEAD)
- Electronic Attack
- Persistent Surveillance
- Deep Strike

- **Manned Force Augmenter**

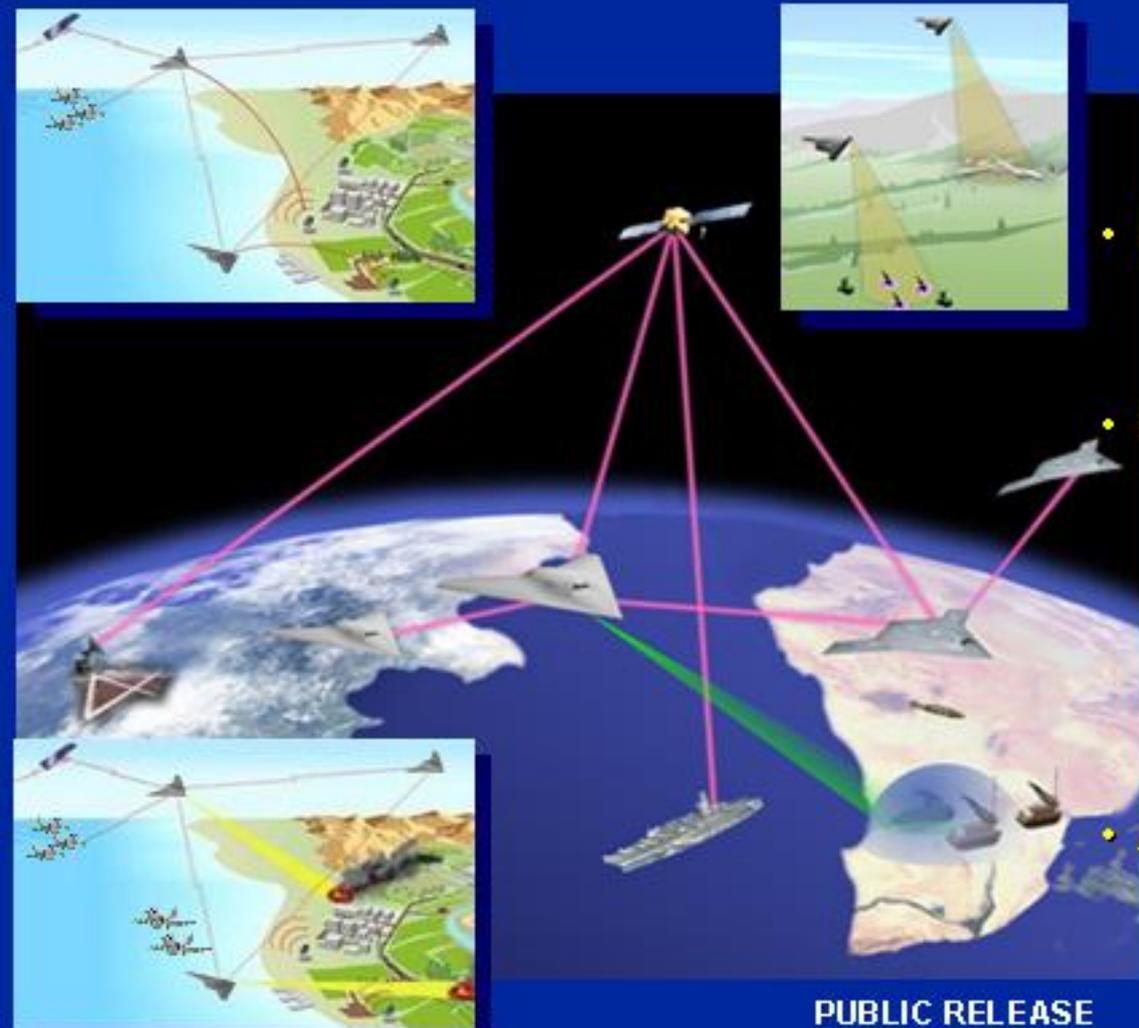
- Unique, Difficult Missions
- Operational Synergy
- Force Amplification

- **Network-Centric Operations**

- Network-based Architecture
- Multi-Vehicle Collaboration
- High Levels of Autonomy
- Flexible Human Intervention
- Enhanced Situation Awareness
- Dynamically Adaptive System
- Predictable Battlefield Effects
- ... Unpredictable Tactics

- **Affordable System-of-Systems**

- Common Operating System
- Air Vehicle Compatibility
- Reduced Support Costs



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J-UCAS Program (Fall 2003)



Then

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J-UCAS Program (Spring 2004)



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Way Ahead

- **Redefine Program Effort**
 - Reflect Prioritized Objectives
 - Capture New Program Emphasis & Balance ... Common Lexicon
 - Time-Phased Development ... Synchronize Events & Milestones
 - Integrate Risk Mitigation Approach
- **Initiate Common Systems Developments**
 - Common Operating System (Technical & Business Plans)
 - Other Common Elements (Sensors, Comms, ...)
- **Redistribute Resources**
 - Modify Existing Contracts to Reflect Redefinition, as Needed
- **Integrate Government Support Team**
 - DARPA-USAF-Navy-SETA Team
 - Reduce Redundancy ... Increase Collaboration
 - Allocate Tasks – JPO, Service Elements, Integrated Teams

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J-UCAS System Elements

Operational Infrastructure

- Communications Relay
- Navigation
- Sustainment
- Transport



Platform/Vehicle(s)

- Mission-Tailored Design
- Vehicle Management
- Vehicle Autonomous Functions

Communications

- Secure Links/Network
- LOS or BLOS Ops



Operating System

- System C2 & Interfaces
- Comms Management
- Mission Planning
- Autonomous Functions
- Health/Status
- Logical HSI ...

Control Station(s)

- Physical HSI (Displays, I/O, ...)
- Launch/Recovery Control
- Vehicle-Payload Operations
- Human Crew



Payload Systems

- Sensor(s)
- On-Board Processing
- Data Relay
- Weapons



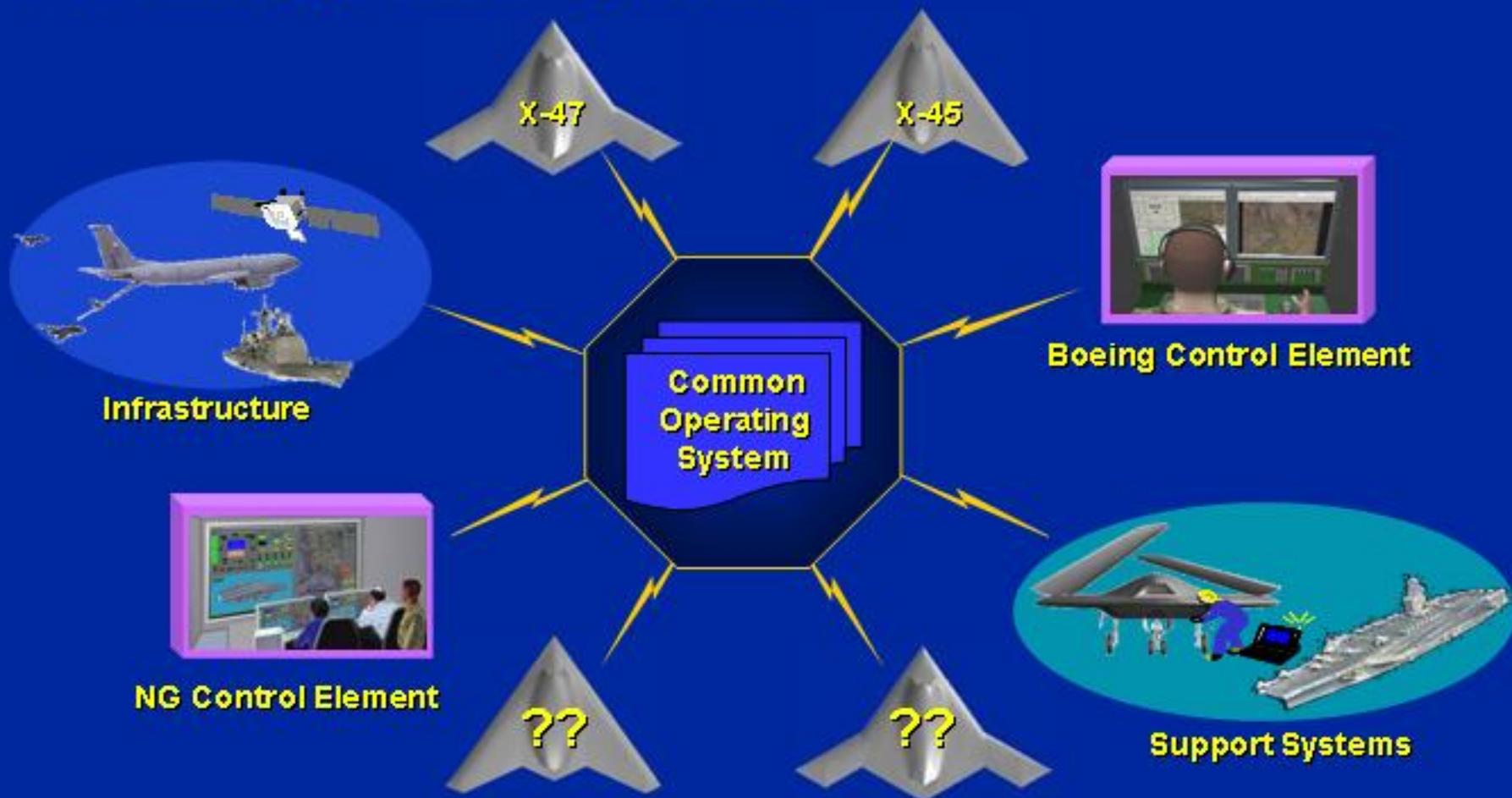
Direct Support

- Maintenance
- Logistics
- Launch/Recovery Infrastructure



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The Integrated System



- ***Intra- and inter-operable elements ... GIG-compliant network***
- ***Flexible autonomy and H-I-L operations ... Dictated by mission***
- ***Range-payload performance dictated by platform selection***

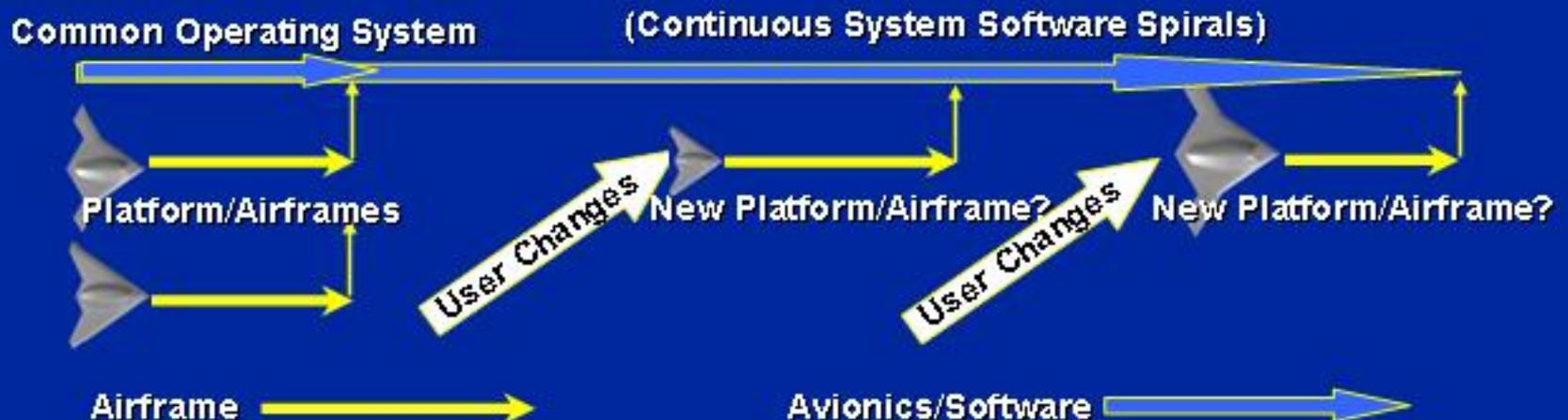
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Decoupling the Operating System

Traditional System Development



J-UCAS System Development Concept





Common Operating System

Rationale

- **Ensures Common Architecture, Protocols, and Interfaces**
- **Decreases Complexity Of System-of-Systems Integration**
- **Assures Intra- and Inter-operability of J-UCAS Elements**
- **Enables Autonomous Collaborative Operations**
- **Decouples Air Vehicle & Other Hardware From System's Information Technology Component**

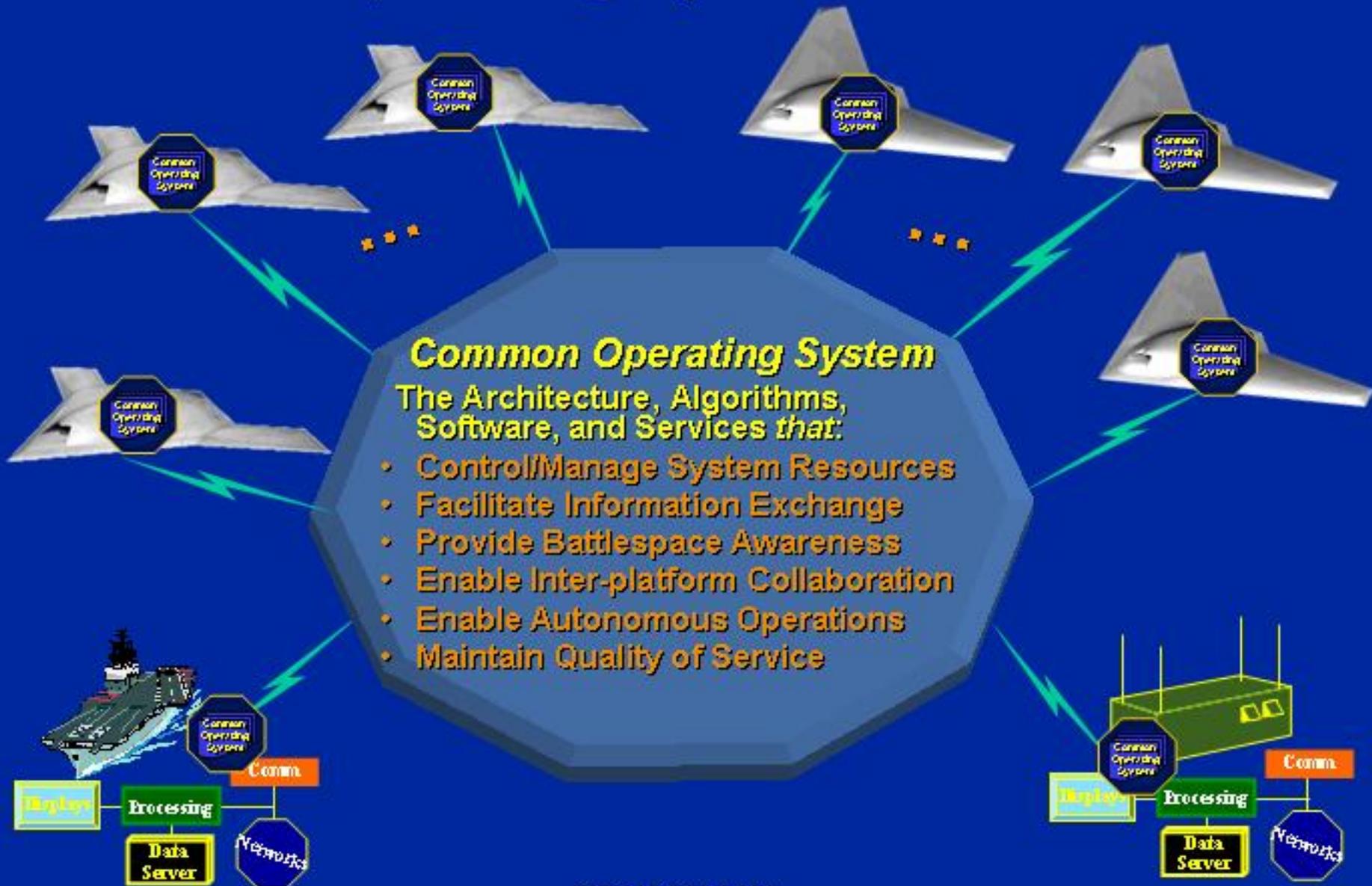
Impact

- **Not dependent on single contractor**
- **Reduces cost of entry for new technologies**
- **More rapid fielding of capabilities**
- **Improves ability to upgrade/modify**
- **Enables inter-vehicle collaboration**
- **Enables information exchange with external entities (e.g. platforms, C2)**
- **Increases op tempo & network centric warfare capabilities**
- **Improves battle-space awareness**
- **Minimizes impact of platform changes on system development**
- **Provides mechanism for evolutionary system improvements**

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Common Operating System



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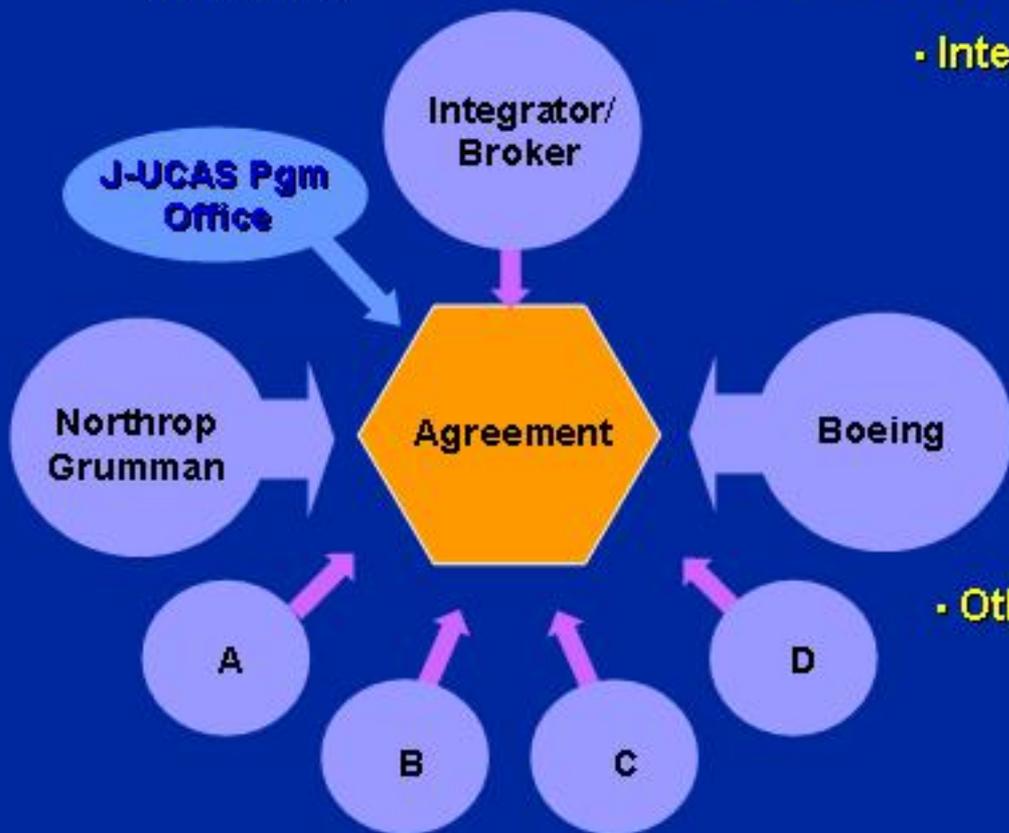
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Common Operating System

3 Levels

Consortium-like Business Arrangement



• Integrator/Broker/Observer

Unique Role ... Not an LSI ... No Other Integrator ... Facilitator ... Referee
No Intellectual Property

• Program Primes – Key Stakeholders

Fractional Ownership
Platform Integrators – Physical, Functional
S/W Developers
COS Collaborators

• Other Contributors

... Based on Potential Contribution(s)
Small Houses
Other Primes
Traditional Subs
Commercial Providers

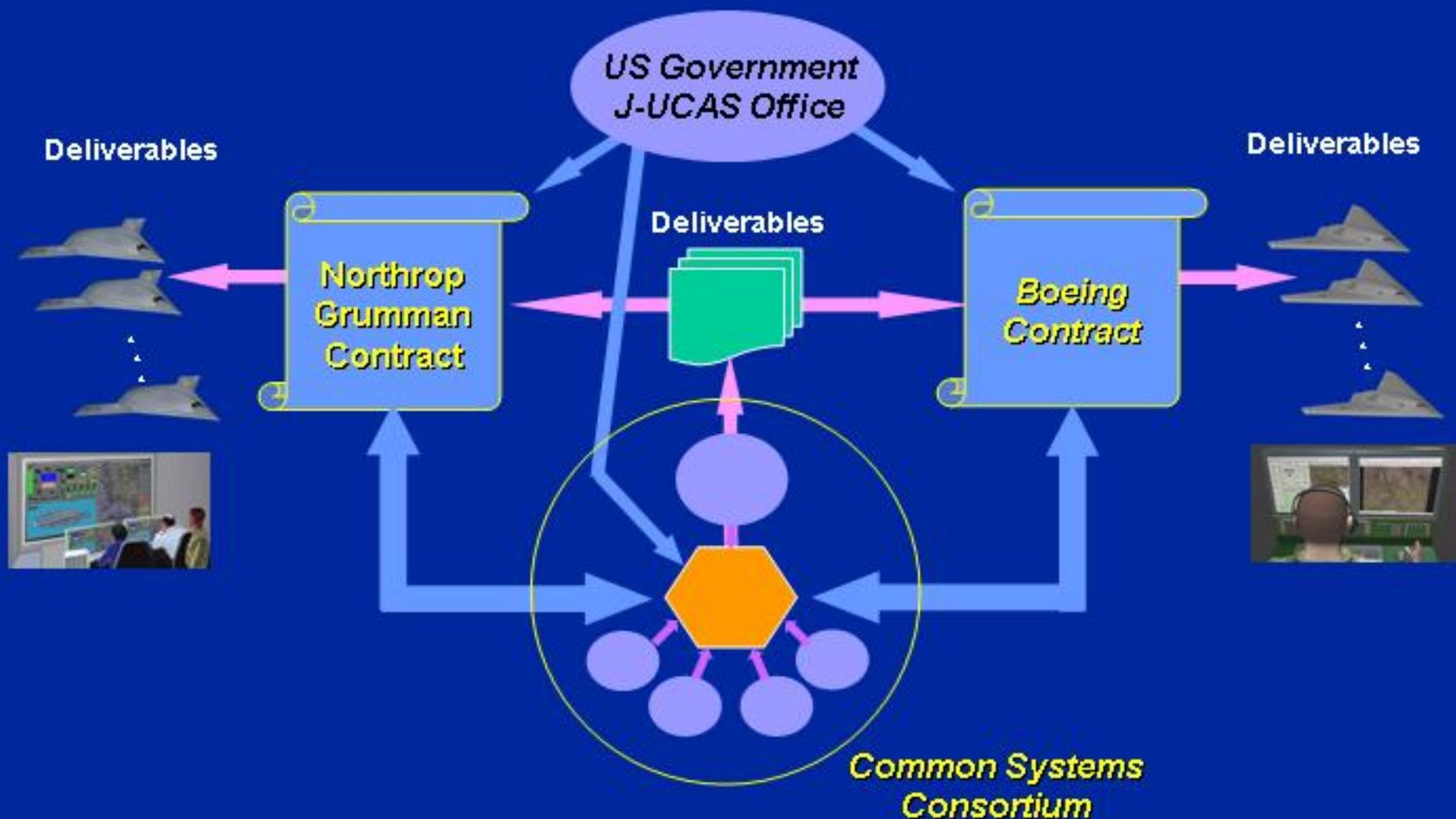
**Business dynamics promote competition & ownership ...
Increased idea pool decreases technology risk**

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Program Relationships



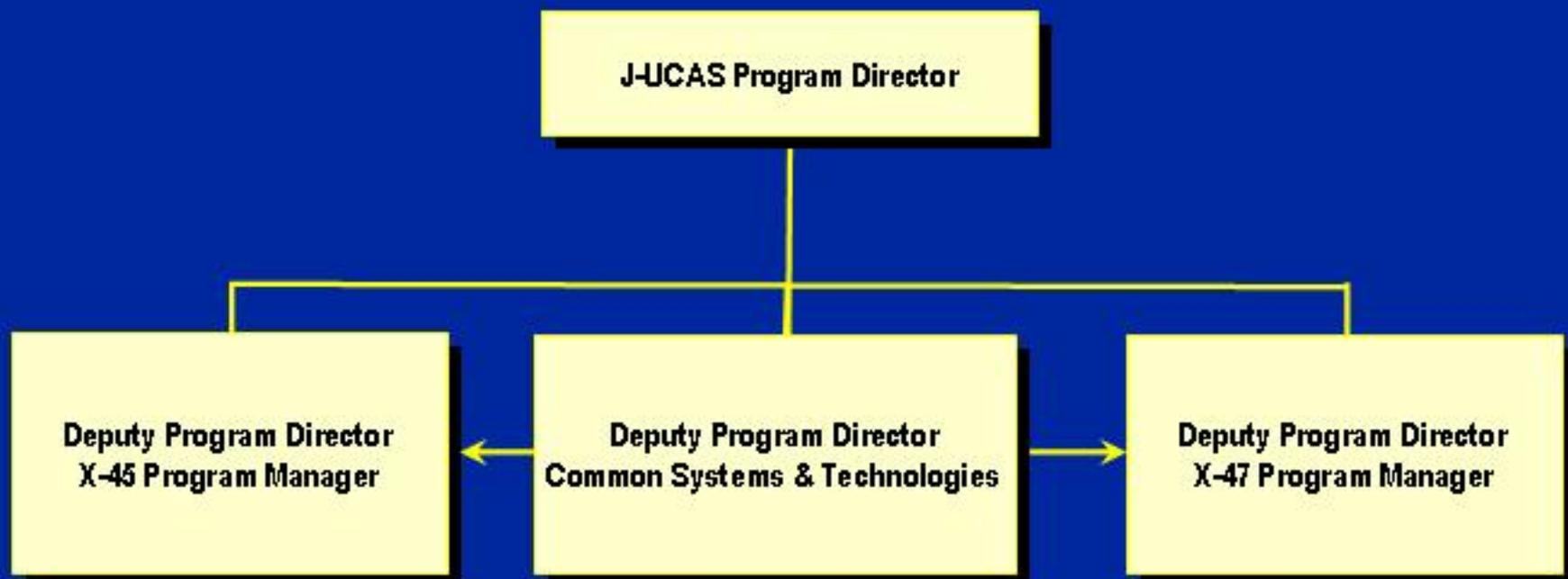
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J-UCAS Office Structure

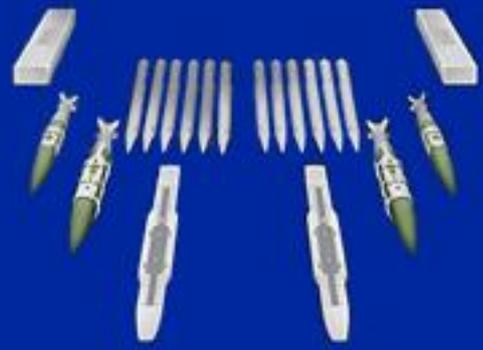
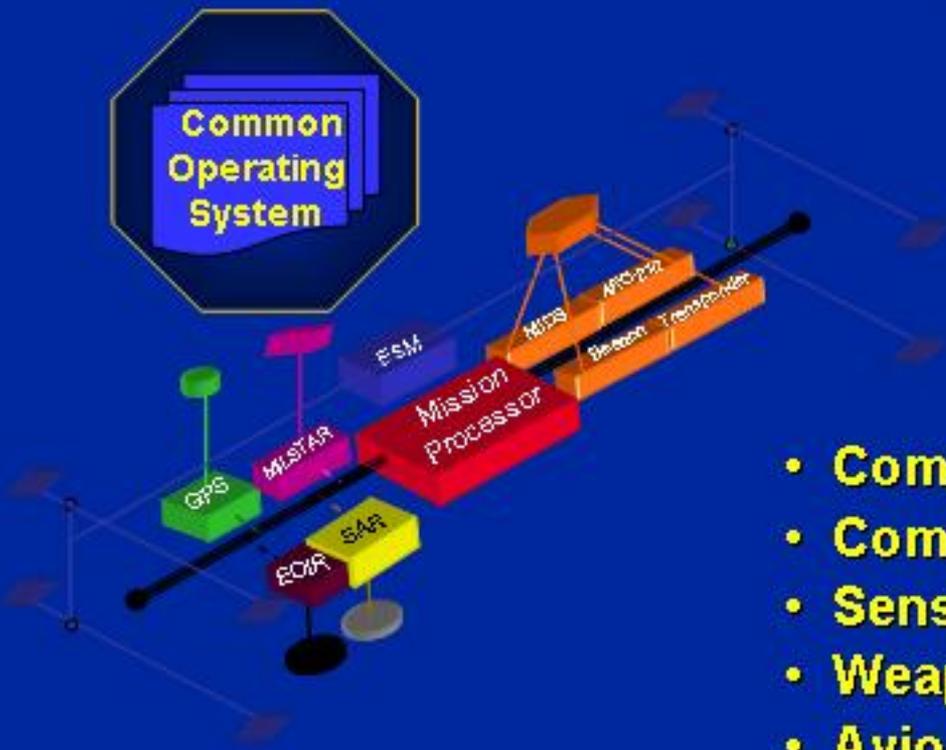
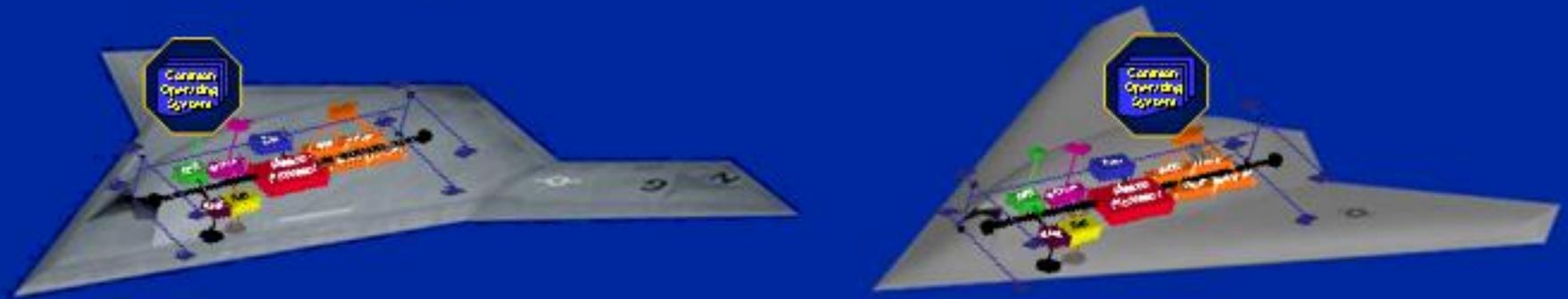
3 Major Elements



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Common Systems & Technologies



- **Common Operating System**
- **Communications Capability**
- **Sensors**
- **Weapons**
- **Avionics Hardware (e.g. Processors)**

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Sensors

Potential Surveillance Sensors

- SAR/GMTI
- ESM
- EO/IR



Key Issues:

- Distributed Control Of Onboard Sensors
- Bandwidth Requirements & Agility
- Integration Of Apertures W/ Platform
- Sensor-to-shooter Issues
- Autonomy In Mission Planning & Execution

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Boeing X-45A Progress & Plans

- **System Demo Program**
 - Two X-45A air vehicles
 - Software development assets
 - T-33 Surrogate test bed
- **Demonstration Plans**
 - Block 2 flights include critical J-UCAS functionality
 - Inert weapons drop
 - SATCOM control/hand-offs
 - Multi-vehicle operations
 - Block 3 integrates intelligent system infrastructure on the air vehicle
 - Block 4 adds intelligence and on-board dynamic mission planning / autorouting

X-45A Inert Weapons Drop Demo



First inert weapon drops conducted in March 04

X-45A Multi-Vehicle Artist's Concept



Multi-vehicle flights expected to be completed in Spring 04

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Boeing X-45C Design Progress

- **Demo Program**
 - Two air vehicles
 - Provisions for sensors, etc
 - Survivability, carrier suitability, & weapons release part of demo plan
- **Program Participants**
 - General Electric supplying F404 engines & integration
 - Leveraging X-45A software development and lessons learned
- **X-45C Carrier Suitable Derivative Design Studies Continue**
- **Other Program Participants**
 - General Electric Supplying F404 Engines & Integration



- **X-45C System Milestones**
 - Design start date – Jan 03
 - MCS shelter delivered – Dec 03
 - Mid-Term Design Rvw – Dec 03

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Northrop X-47A System Development

- **X-47A Pegasus demonstrator leverages Global Hawk and Fire Scout Experience**
- **X-47A Accomplishments**
 - **Flight Demo – May 03**
 - **Simulated a tailhook arrestment point on a carrier flight deck by landing near a predesignated touchdown point**
 - **Utilized shipboard-relative global positioning satellite (SRGPS) system as the primary navigation source for increased landing precision**



Northrop X-47B Design Progress

- **Demo Program**
 - Two air vehicles
 - Provisions for sensors, survivability, etc
 - Carrier suitability based demo plan
- **Program Participants**
 - Lockheed-Martin providing expertise
 - Pratt & Whitney supplying F100 engines & integration
 - Leveraging Global Hawk and Fire Scout experience



- **X-47B System Milestones**
 - Design Start Date – Apr 03
 - System Req't Rvw – Dec 03
 - JPALS Demo on USS Truman w/ F-18 surrogate



Operational Assessment (OA) Capability Statements

- **Tasked by OSD(AT&L) Memo of 23 Jun – Due Dec 03**
 - **Prioritized capabilities & measures of effectiveness**
- **AF Prioritized Missions (Lethal Strike Inherent In All)**
 - **Info Ops**
 - **Focus on EW (Electronic Attack, Electronic Warfare Support)**
 - **Augment reconnaissance capabilities**
 - **Air and Space Superiority - Offensive counterair (SEAD)**
 - **Aggressive LO levels stipulated to facilitate all missions**
 - **Signed by requirements organization vice CSAF**
- **Navy Prioritized Missions**
 - **Persistent, survivable Surveillance / Reconnaissance**
 - **Lethal and non-lethal SEAD**
 - **Long range strike in anti-access environment**
 - **Carrier suitability stipulated to facilitate all missions**
 - **Signed by requirements organization vice CNO**
- **Developing A Formalized Iterative Process For
“Requirements” Support During Development And OA**

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Toward Operational Air Vehicles

X-45C Concept



X-47B Concept

Challenging Objectives

- **Long Range – Combat Radius**
 - 1300 nm with 4500 lb Payload
- **Significant Endurance/Persistence**
 - Demo System: 1000 nm / 2 hrs loiter
 - Objective System: 1000 nm / 3.5 hrs loiter
- **Sizable Payload**
 - Size / Volume & Weight (4500 lb - 2 JDAMs)
 - Multiple Weapons / Sensor Pallets
- **High Platform Survivability**
 - Affordable LO to the Next Level
- **Versatile Sensor Suite**
 - ESM Capability
 - Synthetic Aperture Radar
 - EO / IR Sensor
 - EW / Electronic Attack Payload
- **Carrier Suitability**
 - Catapult Launch
 - Arrested, 3rd Wire Landing
- **Global Operations**
 - Air Refuelable
 - Civil Airspace Compatible

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Program Challenges

- **Maintain a Continuous Level of Accomplishment**
 - Build Program Momentum & Customer Enthusiasm
- **Create a Competitive Environment**
 - ... by the End of the OA
 - ... without Losing Program Momentum
- **Create an Accepted, Viable Common Operating System**
 - Extensible, Flexible, Open Systems Architecture
 - Best-of-Breed (Industry-wide) Algorithms ... Reach the Vision
 - Effectively Integrated System
- **Complete Program within Available Resources**
 - Clever Allocation of Funds ... Mitigate Known Risks
 - Incentivize Innovation & Invention

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Conclusion

- **J-UCAS Program Objectives**
 - Demonstrate Feasibility & Flexibility Of The J-UCAS Concept
 - Conduct Joint Operational Assessment Of J-UCAS Capabilities
 - **OA In FY07-09 Timeframe ... Facilitate Early Service Decision**
 - Maintain Competitive Environment Throughout The Program
- **Key System Components**
 - Boeing X-45 Air Vehicle Family
 - Northrop Grumman X-47 Air Vehicle Family
 - Common Systems ... *Common Operating System*
- **Planned Demonstrations**
 - Distributed Adaptive Control Technology / Robust Communications
 - Battlespace Interoperability
 - Affordable LO To The Next Level

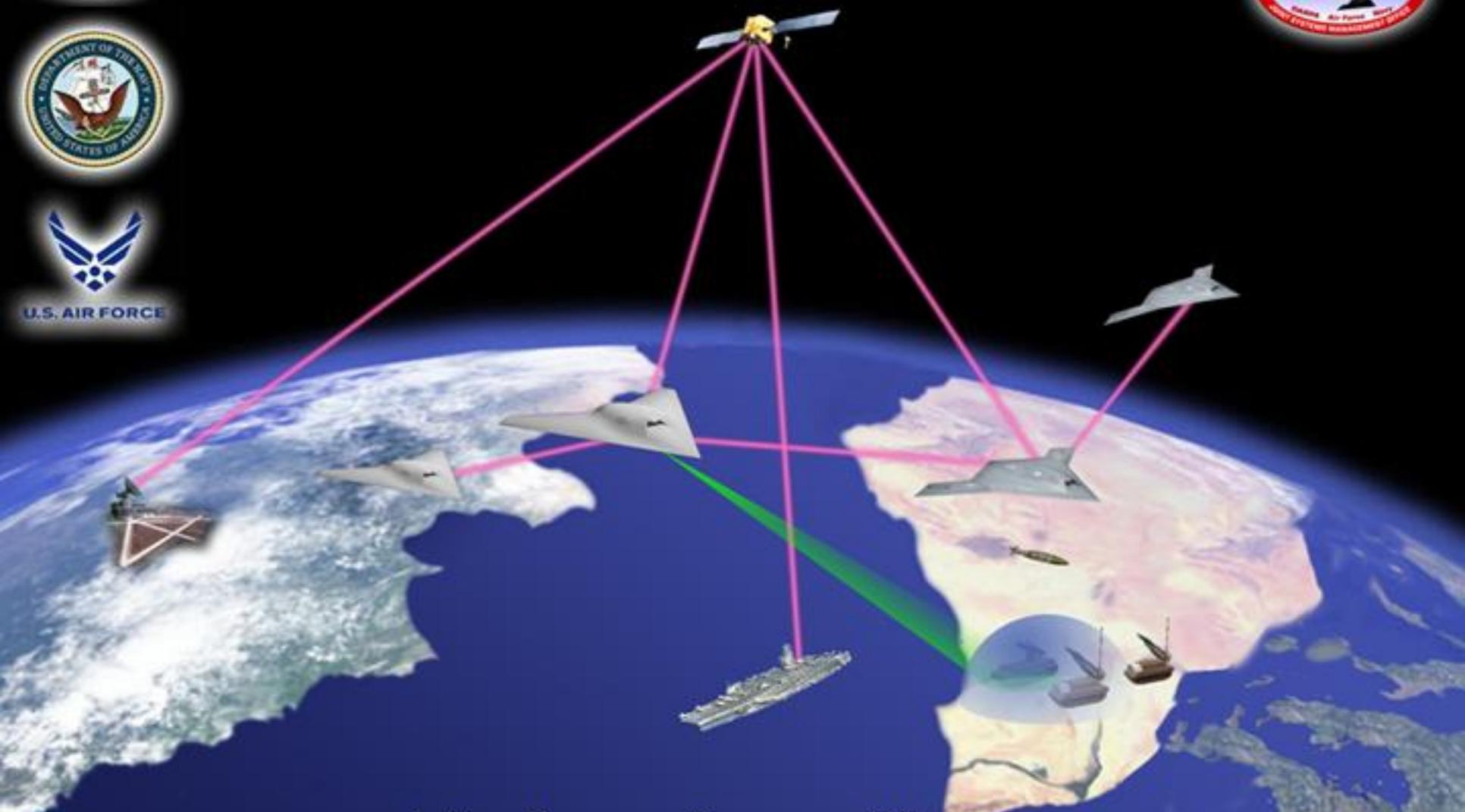
A Transformational System For The Warfighter

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Questions?



<http://www.darpa.mil/j-ucas>