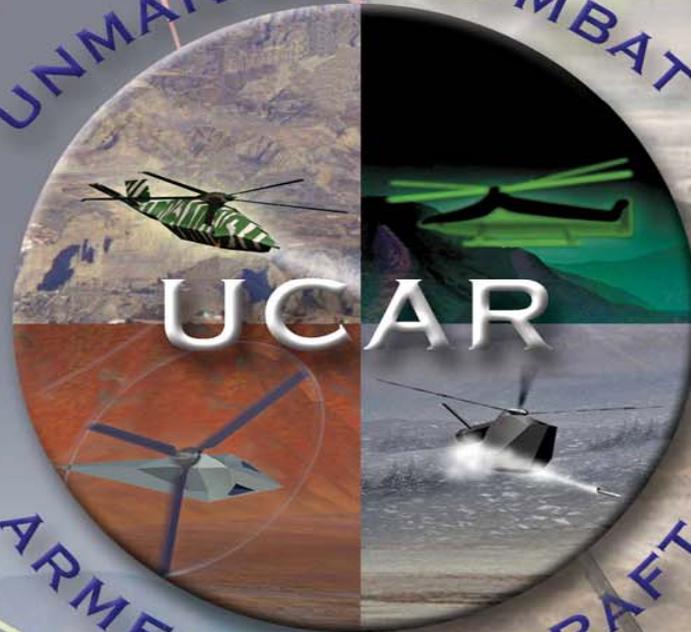




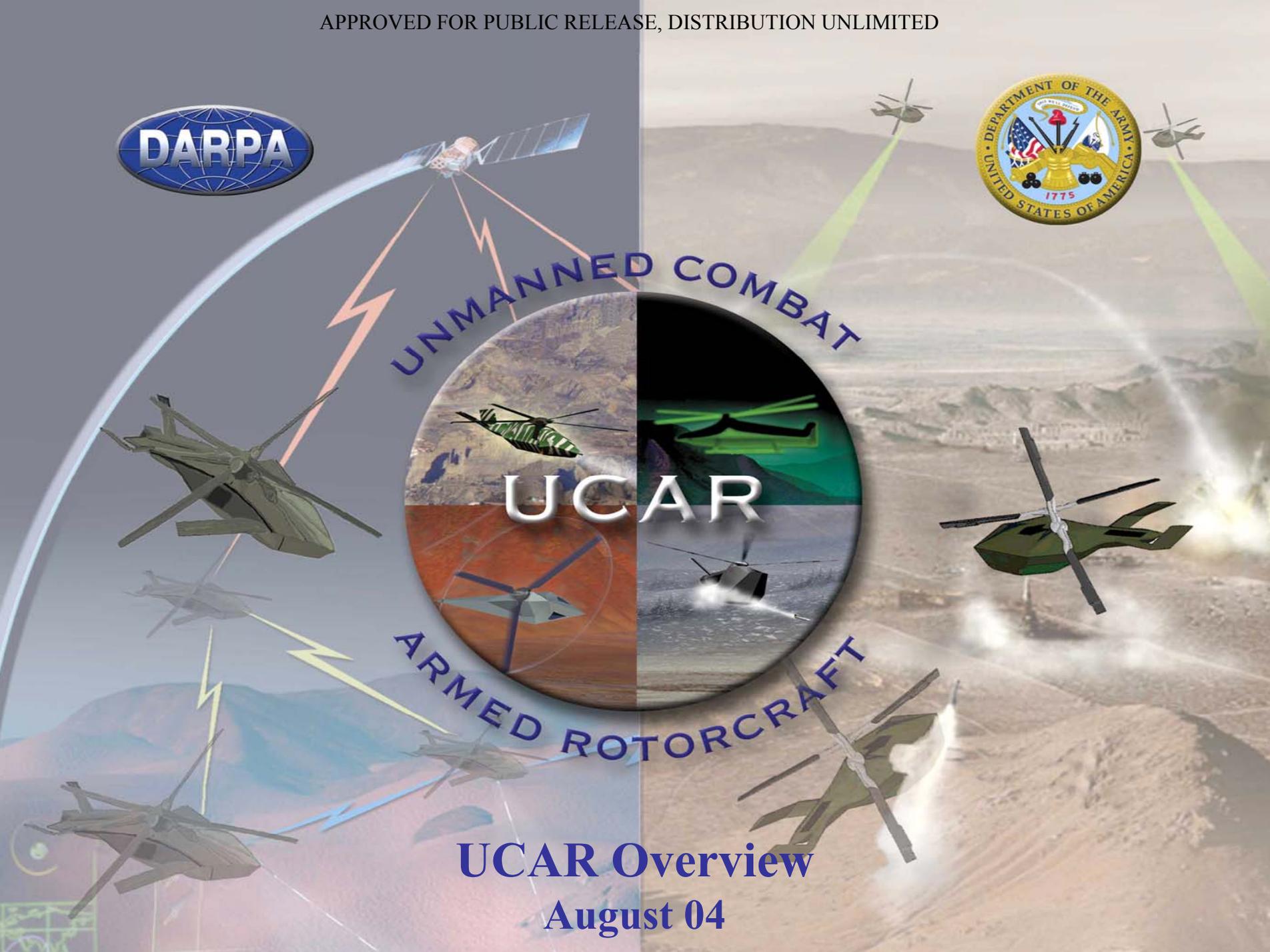
UNMANNED COMBAT



ARMED ROTORCRAFT

# UCAR Overview

August 04





# UCAR Goals & Objectives



Demonstrate the capability to affordably and effectively identify and prosecute masked ground targets at ranges that limit threat capability to engage friendly forces

- Develop Key Technologies
  - Key technologies to enable the next generation of autonomous & collaborative operations, enhanced survivability at altitudes above nap-of-the-earth, low-altitude autonomous flight, and standoff target identification

*Technologies that are broadly applicable to Future Force manned and unmanned aviation systems*
- Demonstrate
  - The capabilities represented by the key technologies in a UCAR demonstration system in FY06 (Phase III)
- Mature
  - If the capability offered by UCAR is compelling
    - Demonstrate the capability to perform armed reconnaissance, attack, and other core aviation missions in a Future Force system-of-systems environment
    - Mature the UCAR system capability to a level that is suitable for entry into SDD



# UCAR System Concept

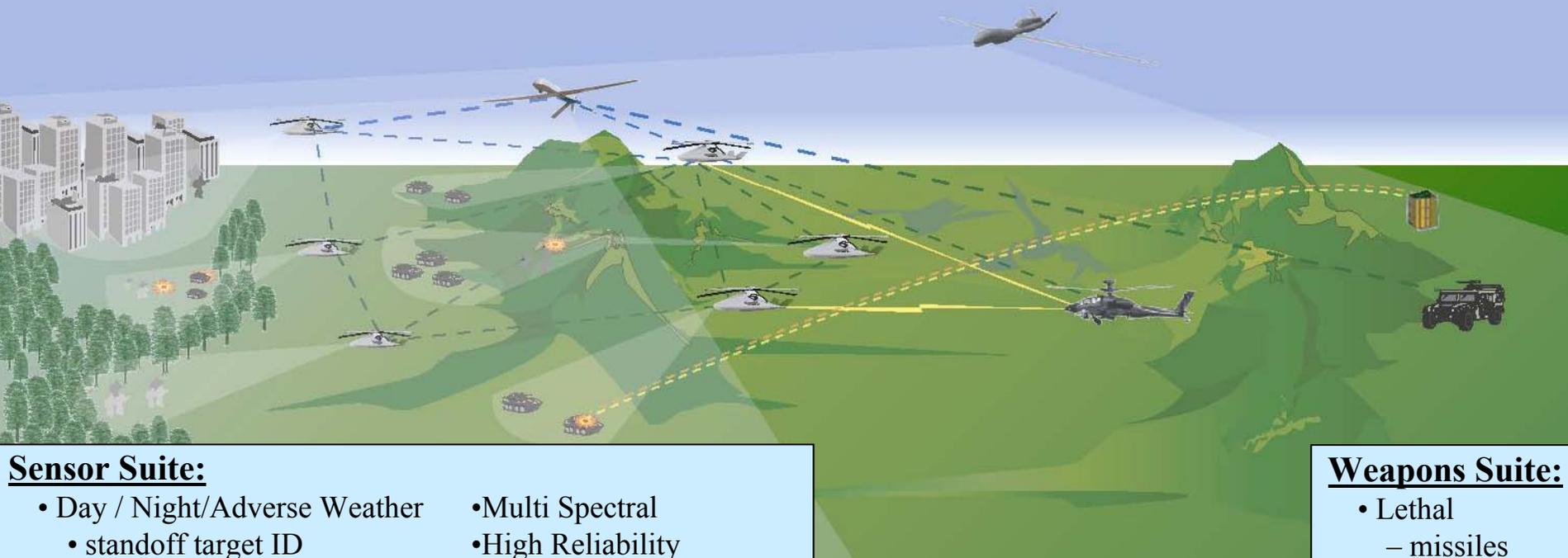


## Command & Control:

- Platform
  - Top-level mission planning
  - Dynamic retasking
  - Autonomous operation
  - Collaborative mission execution
  - Low altitude autonomous flight

## Air Vehicle:

- Day / Night & Adverse Weather
  - Similar capability to manned system
- Modular Payload
- Survivable
  - Enhance team survivability
- Performance – range, speed, endurance
  - Compatible w/manned system
- Affordable
  - Flyaway cost
  - O&S cost
- Robust Capability



## Sensor Suite:

- Day / Night/Adverse Weather
- standoff target ID
- BDA, IFF
- Distributed / cooperative
- Multi Spectral
- High Reliability

## Weapons Suite:

- Lethal
  - missiles
  - rockets/gun
- Non-Lethal



# Challenges



- Technology Challenges
  - Autonomous operation & collaborative execution by teams of heterogeneous systems
  - Low altitude autonomous flight
  - Affordable and robust survivability solutions
  - Substantial improvement in target ID & target recognition ranges
- Affordability Goal
  - \$4-8M flyaway cost including payload
  - 10 % to 40 % of Apache O&S cost



# Tactical Technology Office UAV Legacy

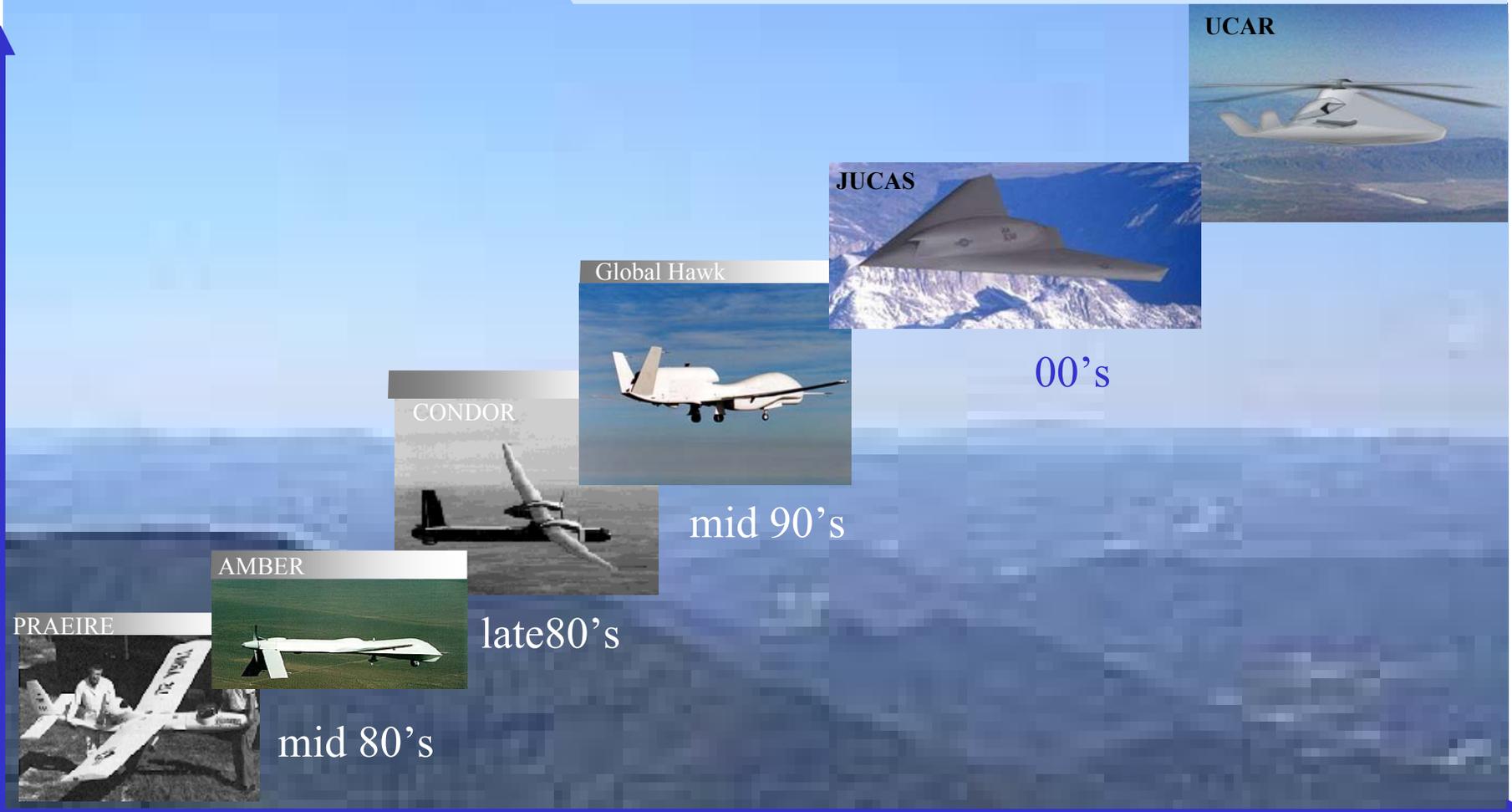


**EMPHASIS ON PERFORMANCE**

**EMPHASIS ON AFFORDABILITY**

**EMPHASIS ON MISSION EFFECTIVENESS & AFFORDABILITY**

Level of Autonomy



70's

mid 90's

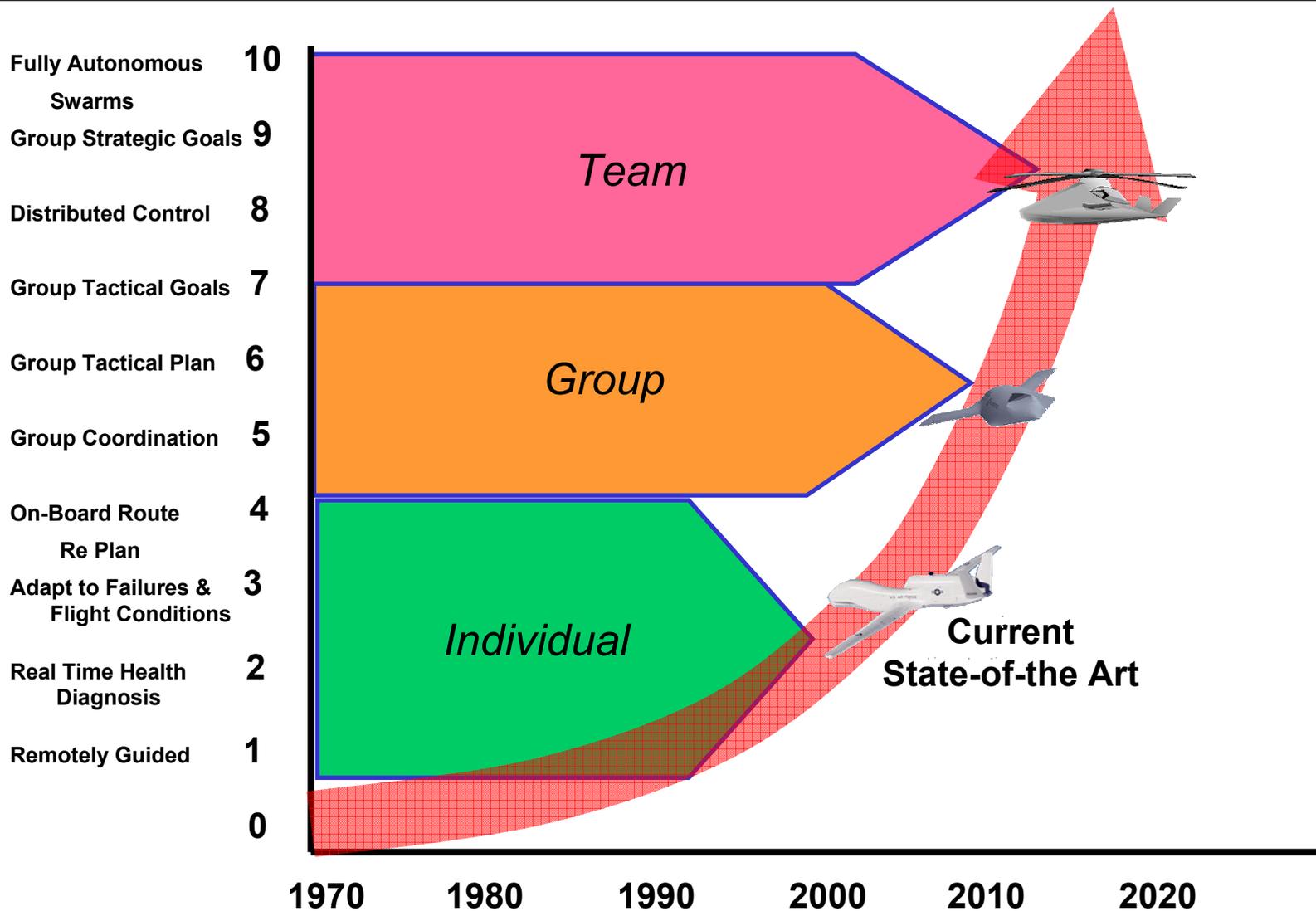
00's

late 80's

mid 80's



# Autonomous Control Levels





# Command & Control



## Current Capability



### Ground Control Station

- 1:1 GCS to UAV in FY03
- 1:2 GCS to UAV in FY06

## UCAR Capability



FCS TOC



Laptop



PDA



A<sup>2</sup>C<sup>2</sup>S



Longbow

### Battle Command on the Move

- Operator Interacts with UCAR as a team
- 1:N C<sup>2</sup> to UAV

*Highly Autonomous Capability Enables MUM Teaming and Efficient C<sup>2</sup>*

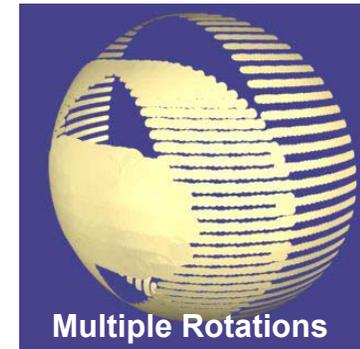
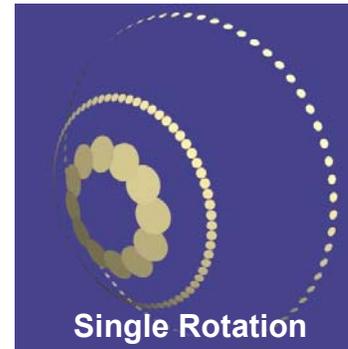


# Obstacle Avoidance System

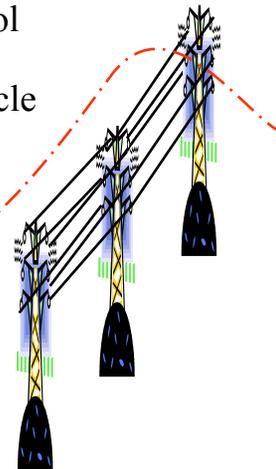
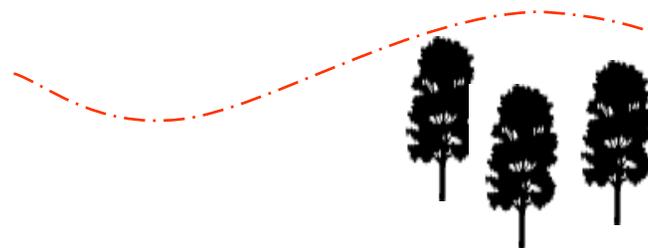


## Obstacle Avoidance System (OAS)

- **Required for autonomous flight**
- Enables day / night, rough terrain, takeoff & landing / low level, contour & NOE flight / collision avoidance / see and avoid
- Provides 360° spherical situational awareness
- Reduces UAV attrition rates (peace/war)
- Phase I activity:
  - Two OAS concepts were explored
  - Single, multifunction sensor architecture
  - Multiple, redundant, fused sensors architecture
- Phase II activity:
  - OAS concept modeled and flown within NVESD digital terrain environment
  - Completed preliminary design of an autonomous OAS based upon a multifunction sensor architecture
  - Development of an OAS flyable brassboard initiated - to be flown in FY05



- Detect 10 mm wet wires at 400 m
- Detect aircraft at 1.0 km
- Fiber optically coupled remote  $\mu$  slab transmit/receive electronics
- ZnS Optics (Small Size)
- 3" Scanner & radial lens / cover
- 3 Colors, eye safe @ aperture
- Beam and radiated power control
- Cost effective, fail soft, multi-functional architecture w/ obstacle memory





# Survivability Enables Performance



**Standoff Ranges and NOE  
Flight Limit Mission  
Effectiveness**

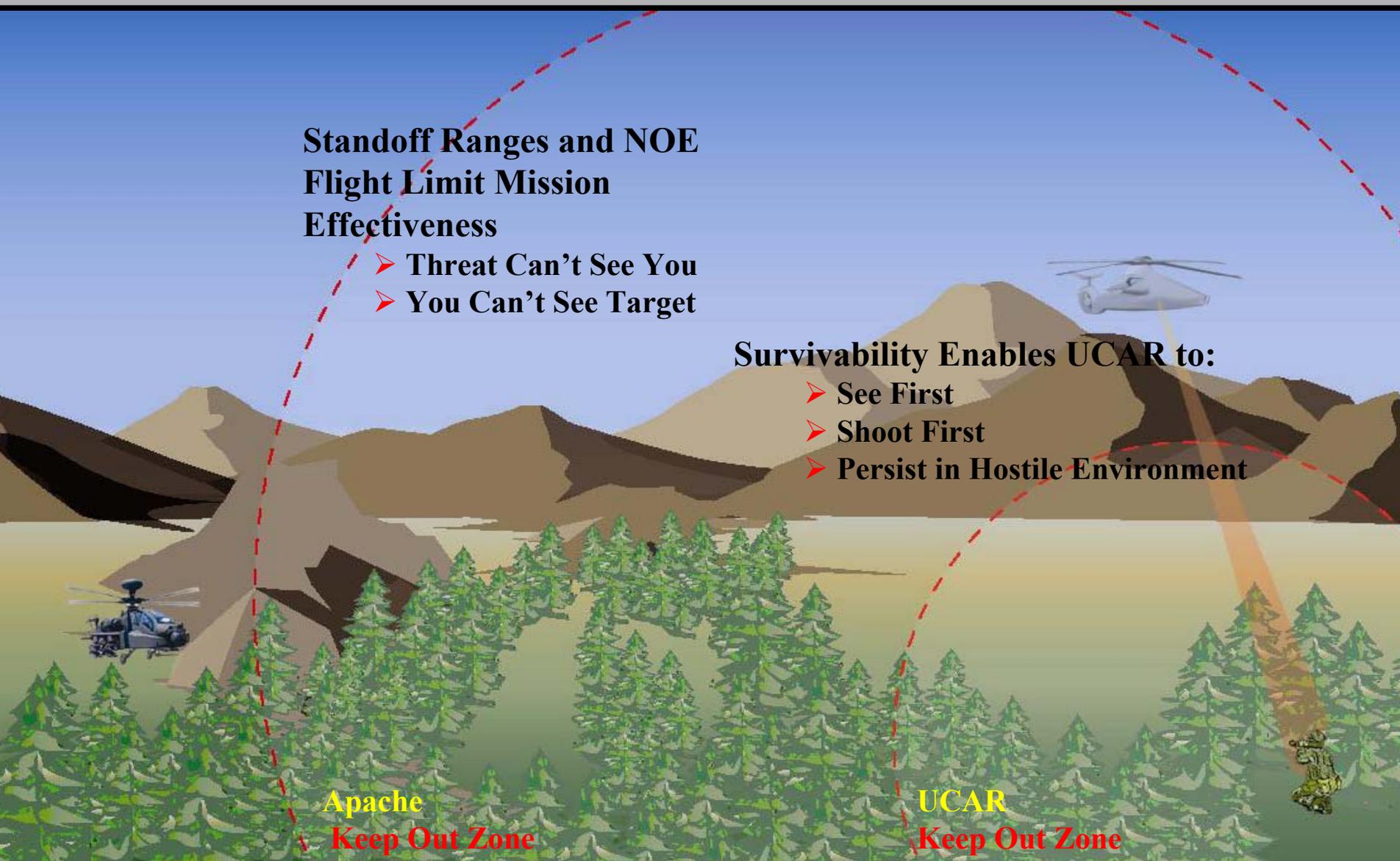
- Threat Can't See You
- You Can't See Target

**Survivability Enables UCAR to:**

- See First
- Shoot First
- Persist in Hostile Environment

**Apache  
Keep Out Zone**

**UCAR  
Keep Out Zone**





# Target Acquisition/Engagement with Enhanced ID Capabilities

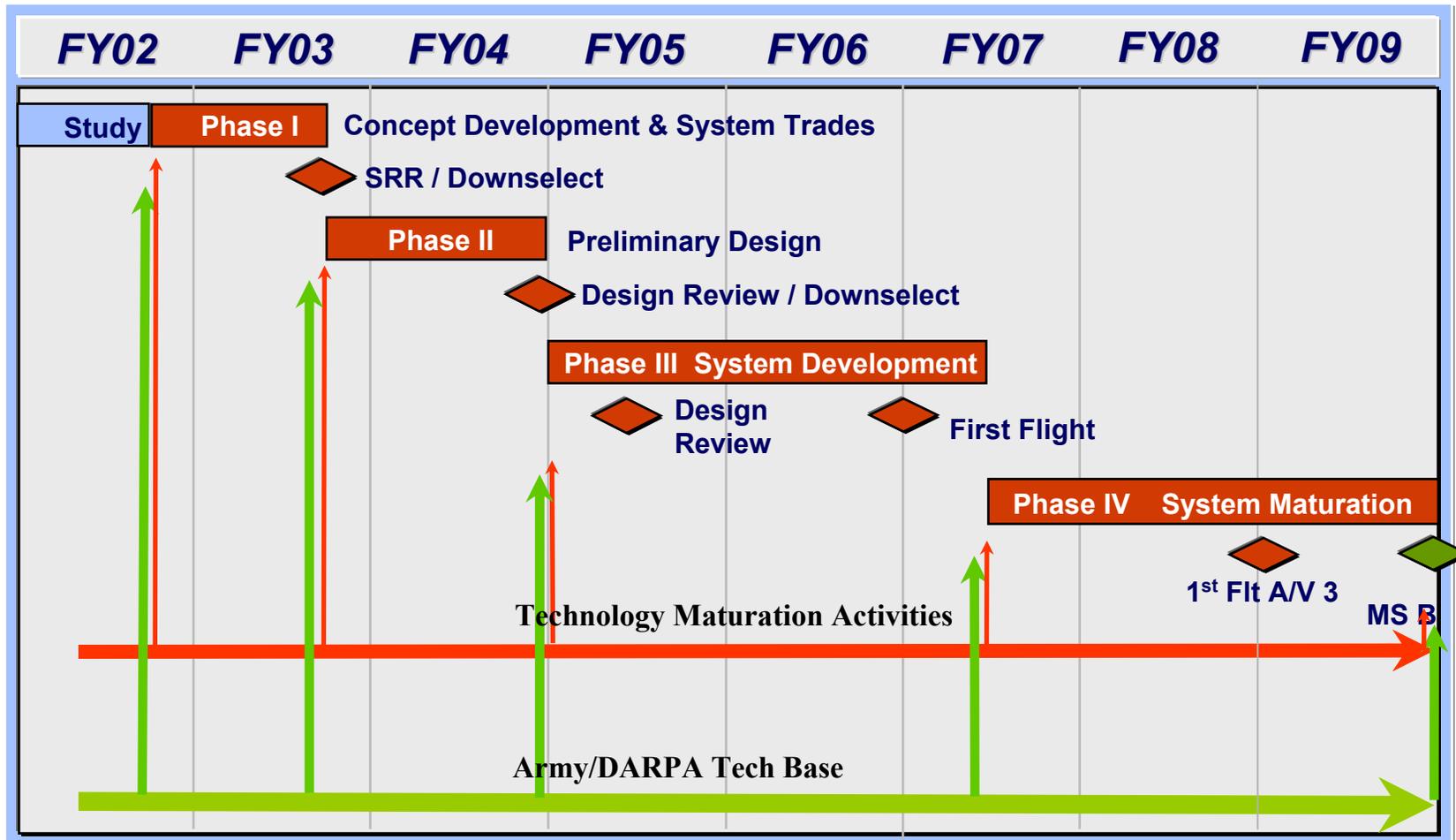


- Leverage tech base investments in sensor technologies to enable standoff ID of camouflaged and concealed dismounted targets
  - Capability to differentiate combatants from noncombatants
- Operating at altitudes where reliable target ID is possible enables timely weapons release decisions
- Precise target location (low TLE)
- Integrated in Joint C4ISR network
- Tailor sensors for Army Aviation core competency missions, and incorporate
  - Reliability
  - Affordability

**Unique Capability to Identify Combatants at Standoff Range**



# Program Schedule



Phase I – 4 teams, Phase II – two teams, Phase III & IV – one team



# Firm Requirements (not tradable)



- Non-expendable, survivable, lethal VTOL air vehicle using heavy fuel/JP-8
- Global deployment and operations with the Army initial entry force package
- System integrity consistent with safe operations over populated areas and in controlled airspace
- Command and control from the air and ground without the need for a dedicated command and control node
- Operational Availability not less than 90%
- Compatibility and interoperability with the Future Force C4ISR architecture



# Phase I





# UCAR Phase I Teams



*Integrated Systems*



communications



CarterCopters, LLC



The Saber Group, LLC

# LOCKHEED MARTIN



# Sikorsky

A United Technologies Company

# Raytheon



*Nascent, Inc.*



# Phase I Trade Studies

## System of System Architecture

- Total Composition of Air Assets
- Mission Range, Flight Profile and Loiter Time
- Number and Mix of Aircraft Per Sortie
- System Availability
- Survivability and Vulnerability
- Timeline for Generating Targeting Information
- Integration of On-board & Off-board Information
- Communications Architecture and Weapon System Req'ts
- Weapons Standoff and Targeting Accuracy Requirements
- Operations and Support Concepts
- System Reliability  
(Non-Combat Attrition Rates)
- Counter IW Techniques & Tactics

## Mission Control

- Mission Control Concept of Operations
- Mission Console Configuration
- Ratio of Air Vehicles to Mission Control Consoles / Personnel
- Level of Vehicle Autonomy
- Human-Computer Function Allocation
- Level of Situational Awareness
- Location and Sizing of Mission Control Console
- Human Interface and Intervention Modality
- Processing Requirements, Growth and Modularity

## **Basis for UCAR Design Decisions**

## **All Trades Conducted vs. Mission Effectiveness & Affordability**

## Air Vehicle

- Combat Range
- Speed, Altitude and Endurance
- Multi-Spectral Survivability
- Munitions Size, Loadout, Standoff Range
- Payload Modularity
- Aircraft Size & Weight
- Avionics, Sensors & Communications Requirements
- Level of Control System Robustness and Redundancy
- Hardening Against EMI/EMC/High Power Generation & Emission

## Support

- Reduced Maintenance Technologies
- Redundancy & Condition Based Maintenance
- Operational Availability & Turnaround Time vs. Maintenance Concept
- Deployment Timelines
- Self Deployment vs. Transport
- Storage Technologies vs. Vehicle Performance vs. Deployment Readiness
- Peace vs. War-Time Personnel Requirements
- Maintainer and Operator Training and Proficiency Requirements
- Maintenance Diagnostic Tools
- LO Maintenance vs. Field Verification vs. Performance



# Phase I Products



- Documented exploration of the systems trade space
  - Quantification of the value of the primary trade parameters, e.g. trade of speed, altitude, payload including sensor suite, survivability attributes, reliability, and cost
- Conceptual UCAR system architecture
  - UCAR Concept Design Review
  - UCAR Objective System Capability Document
  - End-to-End Employment Definition
- Effectiveness and affordability validated through constructive analysis
- UCAR demonstration system requirements with substantiating data
  - Formal UDS System Requirements Review
- Initial Risk Management & Mitigation Plan
  - Identification of the key technologies needing maturation
  - Definition of Building Blocks and demonstration functions required to mature UCAR UDS to UOS

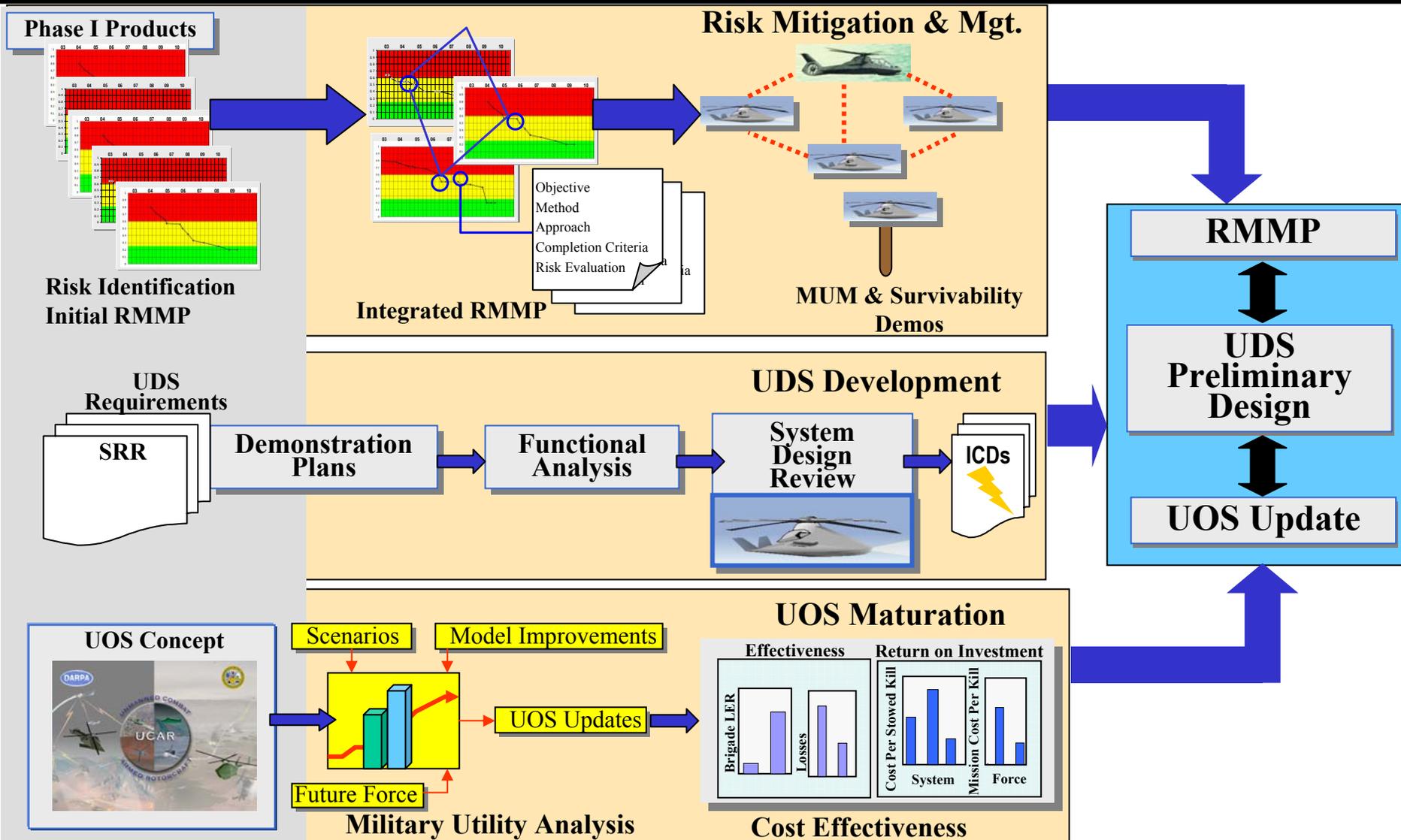


## Phase II



# Phase II Activities

## Detailed Definition of the Demonstration Program





# UCAR Phase II Teams



## ***NORTHROP GRUMMAN***

*Integrated Systems*

- System of Systems Integration
- Systems Engineering
- UAV Autonomy
- Mission Management & Control
- System Survivability
- Affordability & Effectiveness

## ***NORTHROP GRUMMAN***

*Electronic Systems*

- Adv Sensors & Electronics
- Navigation Systems

## ***NORTHROP GRUMMAN***

*Mission Systems*

- Future Force CONOPS
- Advanced Army Logistics

## ***NORTHROP GRUMMAN***

*Information Technology*

- Collaboration Tools and Technologies (IIS)

## ***NORTHROP GRUMMAN***

*Space Technology*

- Radio Systems
- High Energy Lasers



**Sikorsky**

A United Technologies Company

- Helicopter Design & Analysis
- Helicopter Survivability
- Advanced Rotorcraft Technologies
- Supportability
- Intermeshing Rotor Propulsion
- Commercial Production
- Rapid Prototyping Environment
- Non-Traditional Supplier



**Grove**

*Aircraft Company*

- Comms/Data Links



communications



- Autonomous System Software

**BAE SYSTEMS**

- Advanced Mission Management



The Saber Group, LLC

- Army Aviation CONOPS

**LOCKHEED MARTIN**



A Textron Company



**Raytheon**



# Phase II Products



- UCAR Demonstration System (UDS) Preliminary Design
  - Tailored 1521B PDR
  - Software development plan
  - UDS development plan
  - UDS functional analysis review
  - ICDs defined
  - System design review
- Risk Management & Mitigation Plan
  - UCAR demonstrations defined
  - Phase III & IV critical path analysis
- Demonstrations
- Effectiveness & Affordability Performance Update
  - Army validation of effectiveness
- Refined UCAR Objective System (UOS)
  - UOS Phase II-IV refinement plan
  - Updated UOS design, end-to-end employment concept
  - UCAR architecture



# Demonstrations



## Phase II Demos linked to Key Technical Challenges

- Autonomous operation & collaborative execution by teams of heterogeneous systems
  - MUM Teaming Demonstration
  - Algorithm Demonstrations
- Low altitude autonomous flight
  - OAS physics based digital simulation
  - OAS brassboard development (Demo in Phase III)
- Affordable and robust survivability solutions
- Substantial improvement in target ID & target recognition ranges
  - Surrogate sensor data collection
- Other



# Phase III Objectives



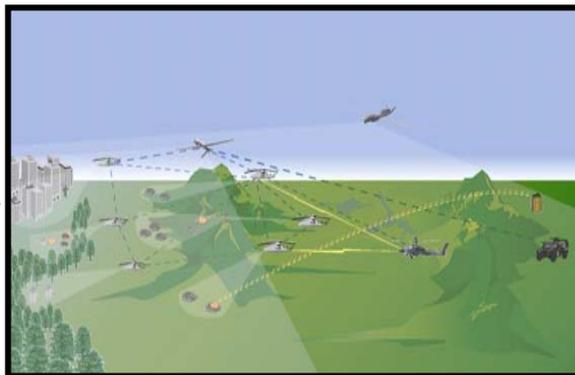
# Definition of the Demonstration Program



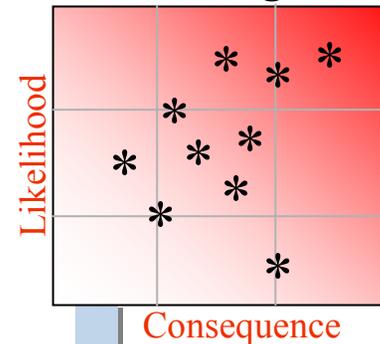
## Quantified Trade Studies



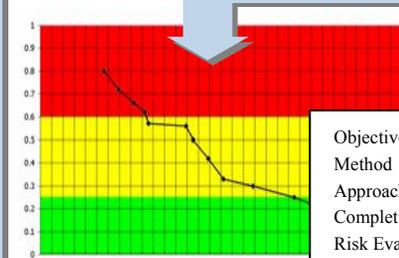
## Objective System Concept



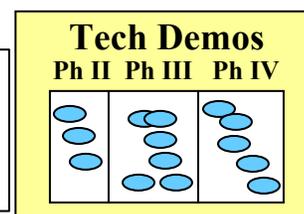
## Assess Critical Risks & Technologies



## Develop Risk Mitigation Demonstrations

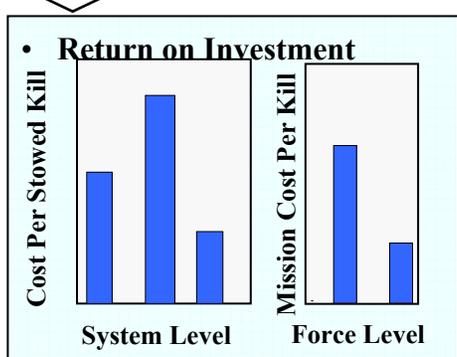
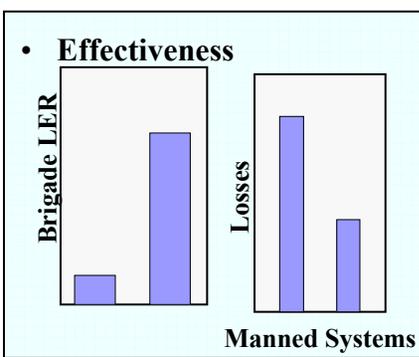


Objective Method  
Approach  
Completion Criteria  
Risk Evaluation



TRL 7

Demonstration System



Modeling & Simulation to Validate Effectiveness & Return on Investment at the System Level



# Phase III Products



- **Risk Management & Mitigation**
  - Risk Reduction Demonstrations
    - Technology and system capability maturation
    - Early demonstration of solutions to hard problems
- **UCAR Demonstration System (UDS)**
  - Tailored 1521B CDR for “A” Model System
  - Rolling PDR/CDRs for Software Builds
  - Detailed Design & Fabrication
  - Two ‘A’ Model Demonstrators
  - Demonstrate integrated system capabilities at a TRL of 5/6
- **UDS “B” Model PDR**
  - Tailored 1521B PDR for “B” Model System
- **Refined UCAR Objective System (UOS)**
  - Effectiveness & Affordability
  - Design & CONOPS
  - UCAR Architecture



# Unmanned Combat Armed Rotorcraft - A Transformational System -



## REVOLUTIONARY LEVELS OF AUTONOMY

- Task Unmanned Systems Like a Human
- Autonomous Planning and Replanning
- Command and Control at the Team Level
- Limited Requirements for Human Interaction
  - Mission Objectives
  - Weapons Release Decisions / Rules of Engagements
  - Approval to Deviate from Mission Constraints
- No Dedicated Ground Station

## SEAMLESS MANNED/UNMANNED MISSION EXECUTION

- Fully Collaborative Operations
- Exploit the Strengths of All Systems
- Reduce Risk to Manned Platforms
- One Command & Control Architecture for Manned & Unmanned Systems

## NEW TACTICAL CAPABILITES

- Stand off ID of Camouflaged & Concealed Targets
- Penetration & Pursuit in Hostile Environments
- Seamless MUM Teaming
- Autonomous Low Altitude Flight