How ISR Complements Precision Weapons & The Unmanned Systems Integrated Roadmap

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Briefing to Precision Strike Tech Symposium on 15 Oct 2013

Example of Bad ISR

In 1999, during Operation Allied Force, five US JDAM bombs hit the People's Republic of China embassy in Belgrade, Yugoslavia, killing three Chinese reporters.

- A warehouse for a Yugoslav government agency suspected of arms proliferation activities targeted
- Target was checked against 'no-strike' databases
- NATO and US officers who had checked the databases the morning after the attack found the embassy listed at its correct location
- SECDEF: one of our planes attacked the wrong target because the bombing instructions were based on an outdated map (CIA built target folder/staffed to President)

http://en.wikipedia.org/wiki/U.S._bombing_of_the_Chinese_embassy_in_Belgrade

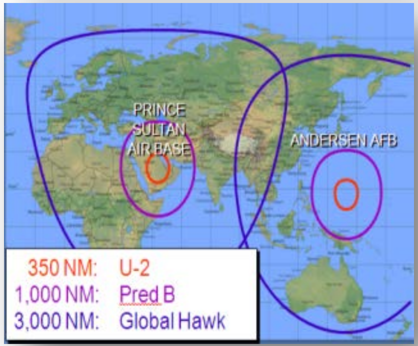
Lessons Learned

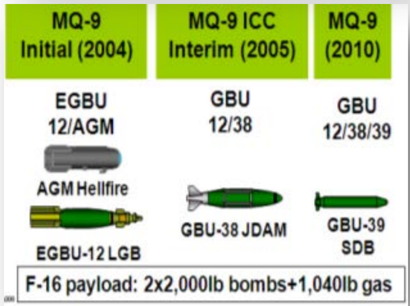
- **Need to put precision weapons on target**
- **Must have good ISR to do so:**
  - Requires accurate georeference digital data
  - Impacts everything from target mission development maps to GPS
  - Current imagery (still and video), moving target, and data exploitation
  - Location updates (situational awareness and environmental understanding)

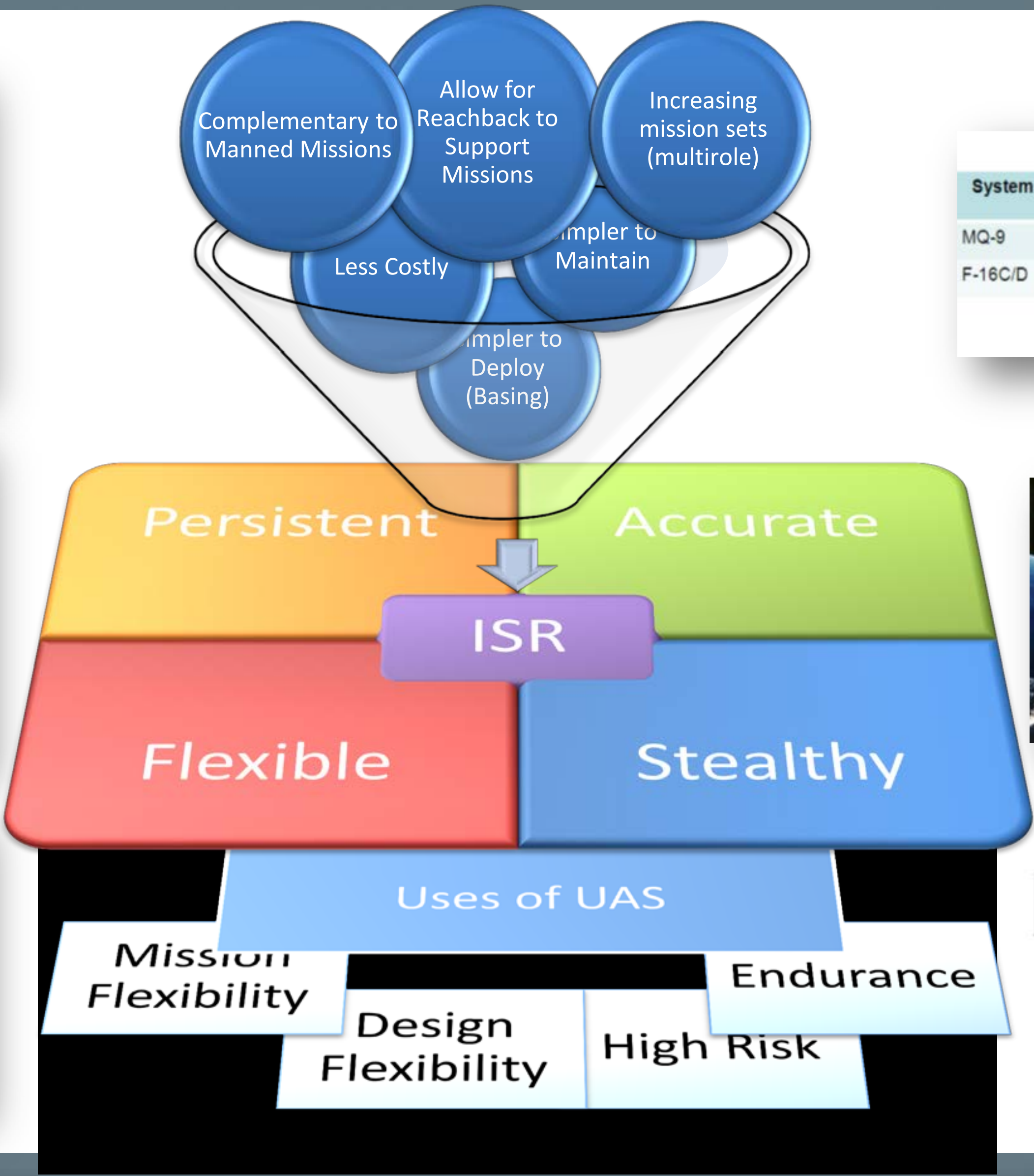
The Good News

UAS can conduct ISR missions
to improve our knowledge in these areas

Benefits of Unmanned Systems







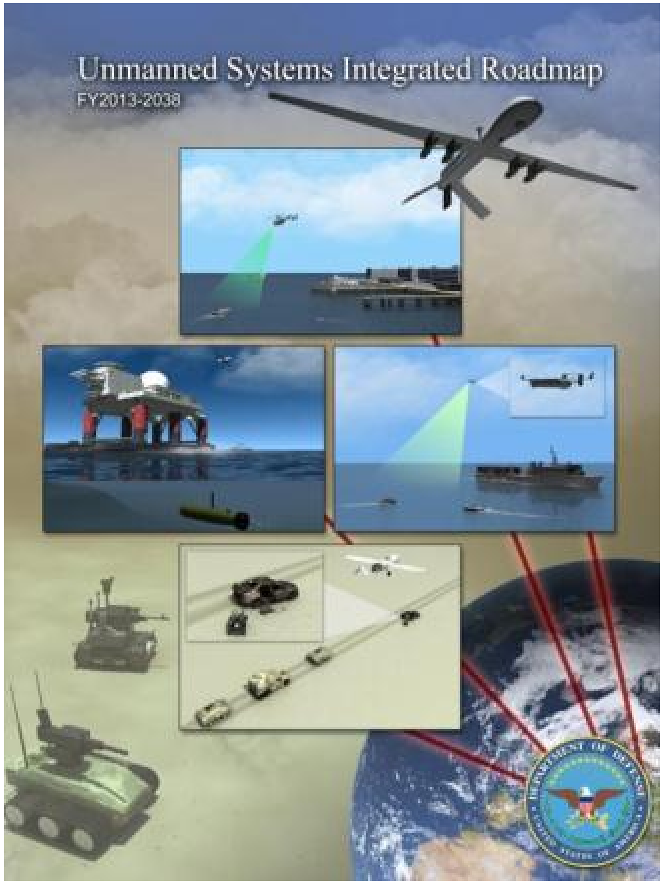
Cost

System	PAUC	APAUC	$ / Flt Hr
MQ-9	$28M	$26M	$ 3,500
F-16C/D	N/A	$18.8M	$20,000

Unmanned Systems Have Challenges
Unmanned Systems Integrated Roadmap

OVERVIEW

- Vision and Scope
- Budgetary Environment
- Policy Considerations
- Unmanned Missions
- Technologies for Unmanned Systems
- Operating Environment
- Logistics and Sustainment
- Unmanned Training
- International Cooperation
- Summary and Final Thoughts



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Why This Matters?

Unmanned Aircraft Systems are vital components for Combatant Commanders.

This is due to:

- Dramatic increases in battery life, computer processing power, and communications abilities
- Reduction in size and complexity of sensors
- Improvements in reliability, maintainability, autonomy, and operator interfaces

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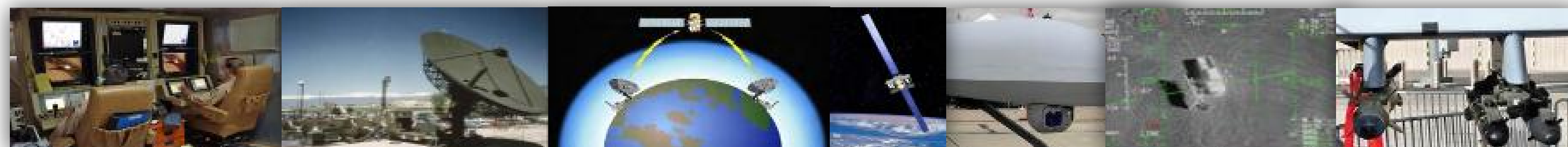


Roadmap Vision and Scope

UAS TF Chartered Goal:
Serve as Department of Defense's lead activity for development and promulgation of Unmanned Systems Roadmap

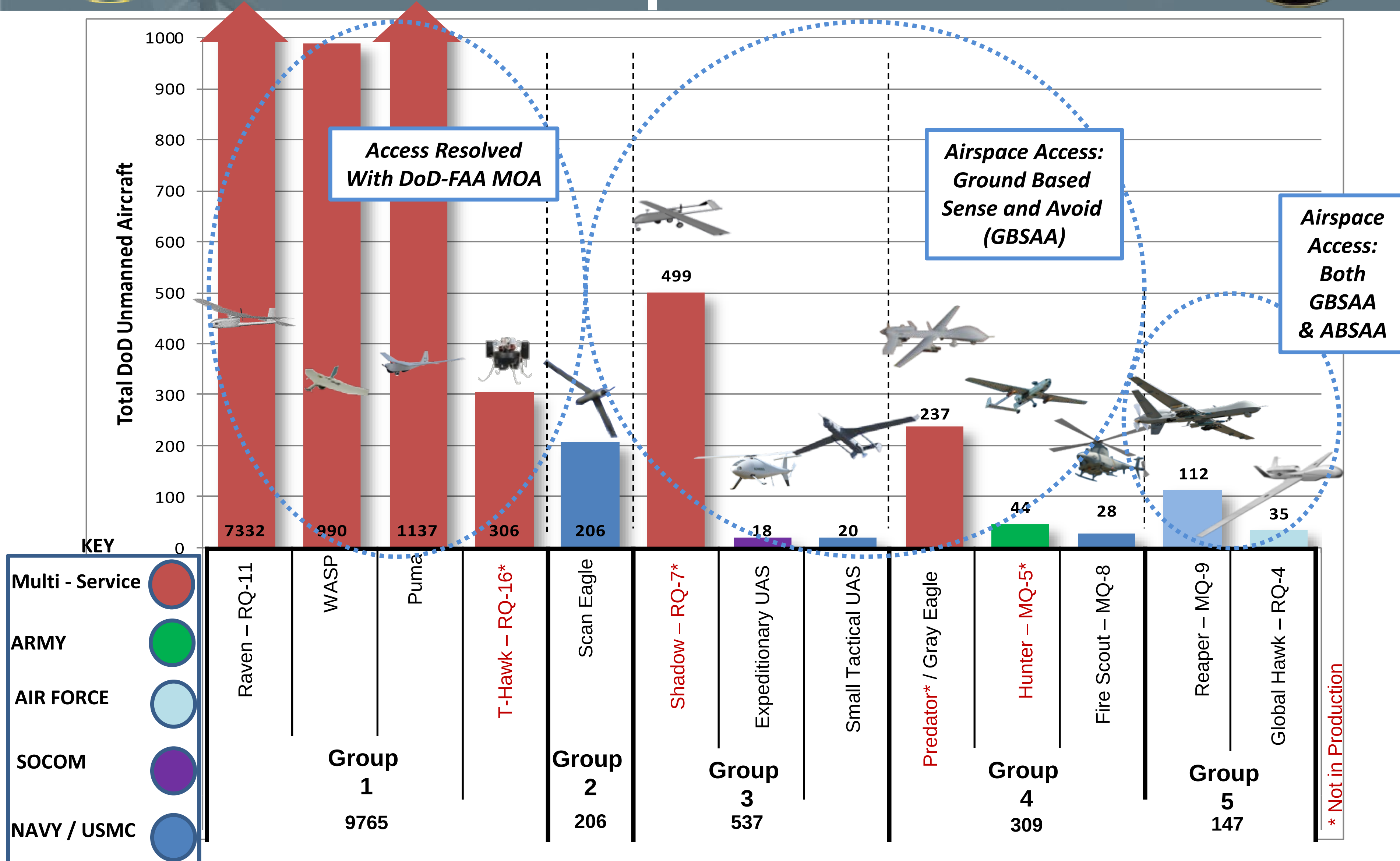
- A technical vision outlining the next 25 year span
- Overall goal: *Sustained, affordable, rapid integration and application of unmanned systems*
- Outlines technologies and timelines for DoD and industry to pursue in technical challenge solution and capability development

DoD Unmanned Systems 2014 PB (Presented in Roadmap)

Unmanned Funding ($ Mil/PB14)

FYDP		2014	2015	2016	2017	2018	Total
Air	RDTE	1189.4	1674.0	1521.4	1189.4	1087.9	6662.2
	Proc	1505.5	2010.2	1843.5	1870.7	2152.8	9382.7
	OM	1080.9	1135.2	1102.7	1156.9	1178.5	5654.1
Domain Total		3775.9	4819.4	4467.6	4217.0	4419.3	21699.1
FYDP		2014	2015	2016	2017	2018	Total
Ground	RDTE	6.5	19.1	13.6	11.1	10.6	60.9
	Proc	6.5	27.9	30.7	42.6	55.4	163.1
	OM	0.0	0.0	0.0	0.0	0.0	0.0
Domain Total		13.0	47.0	44.3	53.7	66.0	223.9
FYDP		2014	2015	2016	2017	2018	Total
Maritime	RDTE	62.8	54.8	66.1	81.0	87.2	351.9
	Proc	104.0	184.8	160.1	158.1	101.1	708.2
	OM	163.4	170.3	182.4	190.5	193.6	900.2
Domain Total		330.2	409.8	408.6	429.7	381.8	1960.2
FYDP		2014	2015	2016	2017	2018	Total
All Unmanned Systems	RDTE	1,258.7	1,747.9	1,601.1	1,281.5	1,185.7	7,075.0
	Proc	1,616.0	2,222.9	2,034.3	2,071.4	2,309.3	10,253.9
	OM	1,244.3	1,305.4	1,285.1	1,347.4	1,372.1	6,554.3
Domain Total		4,119.1	5,276.2	4,920.5	4,700.4	4,867.1	23,883.2

Unmanned Aircraft by Grouping And Airspace Access



Policy Considerations

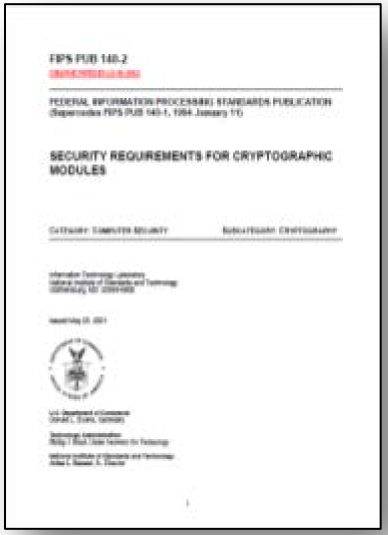
Autonomy

- A system operating under human control is not autonomous
- The potential for improving capability and reducing cost through automation presents great promise, and also raises challenging questions when applying automation to specific actions or functions
- Human-systems engineering is being rigorously applied to decompose, identify, and implement effective interfaces to support responsive command and control for safe and effective operations
- Unmanned systems must be designed and tested to perform tasks in a safe and reliable manner, and operate seamlessly
- Autonomous functions in UAS include critical flight operations of automated takeoff and landing, and recognition of lost communication requiring implementation of return to base procedures
- For armed platforms, DoD Directive 3000.09,22 *Autonomy in Weapon Systems*, establishes policy for development and use of autonomous capabilities

Policy Considerations

Encryption

- **Critical for protecting UAS operations, data, and other information**
- DoD specifies encryption and key management for UAS C2 communications and both still and motion imagery
- Type 1 validated encryption is required for processing classified communications, and Federal Information Processing Standard (FIPS) 140-2 validated encryption at a minimum must be used for processing unclassified communications
- DoD Instruction (DoDI) S-4660.04 *Encryption of Imagery Transmitted by Airborne Systems and Unmanned Aircraft Control Communications* also specifies further encryption and key management methods, such as the use of keys provided by the National Security Agency (NSA), to enable interoperability
- Future: quicker and interoperable--Suite B cryptography is defined by NSA: http://www.nsa.gov/ia/programs/suiteb_cryptography/index.shtml

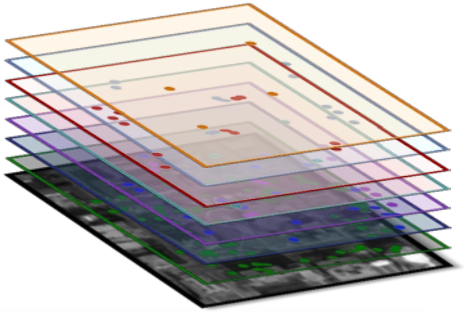


FIPS 140-2

Policy Considerations

Data Exploitation

- Data and sensor resolution and availability are increasing
  - Rapid analysis is a necessity—many analysts
- Challenge—need capability to timely exploit large data volume
  - While exacerbated by both ends of transmission link
  - Huge volumes must be downsized before transmission or data highway must be increased in size and speed
- Analysts need formatted and prioritized archived data
  - Allows tool use to take advantage of data standardization
- Data must be immediately accessible
  - By both anticipated and unanticipated analysts and consumers



Policy Considerations

Innovation

- National Military Strategy and Joint Plans
  - Innovation
  - Affordability
- To meet mission needs
  - Fund capability innovative improvements to indigenous technologies
  - As simple as modifying a sensor to improve data flow or applying standard architectures for interoperability
- Development CONOPS pursuing:
  - Smaller, Lighter, Faster, and m
  - More maneuverable systems that take on higher risk missions

Policy Considerations

Manned-Unmanned Teaming

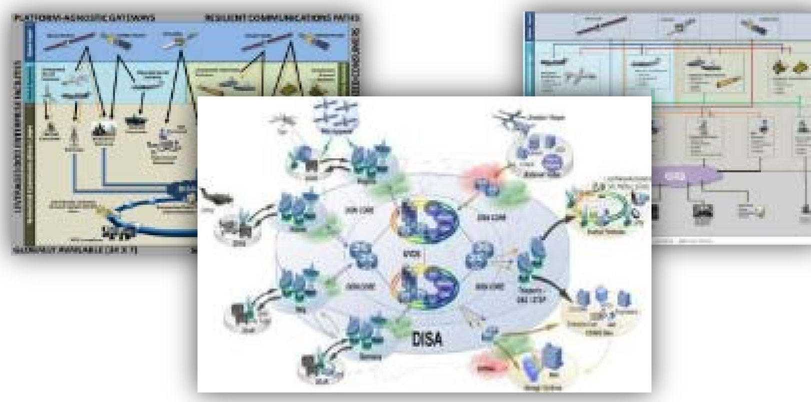
- A smaller, more agile manned-unmanned systems force of the near future will enable the DoD to mobilize quickly to deter and defeat aggression by projecting power despite A2/AD challenges.
- Key MUM-T capabilities will include:
  - Defeating explosive ground surface, sub surface (tunnel), and sea hazards from greater standoff distances.
  - Assuring mobility to support multiple points of entry.
  - Enabling movement and maneuver for projecting offensive operations.
  - Establish and sustain the shore lines of communications (LOC) required to follow forces and logistics.
  - Protection for austere combat outposts.
  - Persistent surveillance to detect and neutralize threats and hazards within single to triple canopy and urban terrain.




Areas for Technical Improvement & Enhancement

Six Areas reflecting shift in strategic priorities and emphasis on unmanned system lifecycle cost

- Interoperability and Modularity
- Communication systems, spectrum, and resilience
- Security (research & intelligence/technology protection (RITP))
- Persistent resilience
- Autonomy and cognitive behavior
- Weaponry



Interoperability

Problem	Solution

Problem

- Processing and algorithm development outpaces ability to transition upgrades to fielded platforms
- Continuous sensor/comm evolution due to leveraging commercial process and standards
- Technology refresh presents intra-platform (modularity) and inter-platform challenges (interoperability) to enduring systems

Solution

- Opportunity to minimize future lifecycle costs, reduced force structure requirements and adapt rapidly to changing threats or new available technologies through:
  - Interoperable interfaces for enhanced modularity
  - Interoperable cross domain data sharing

Modularity

Problem

- Upgrading existing proprietary components may be both expensive and logistically unfeasible
- Closed development approaches result in unfavorable characteristics that impede technical progress and the adoption of new capabilities

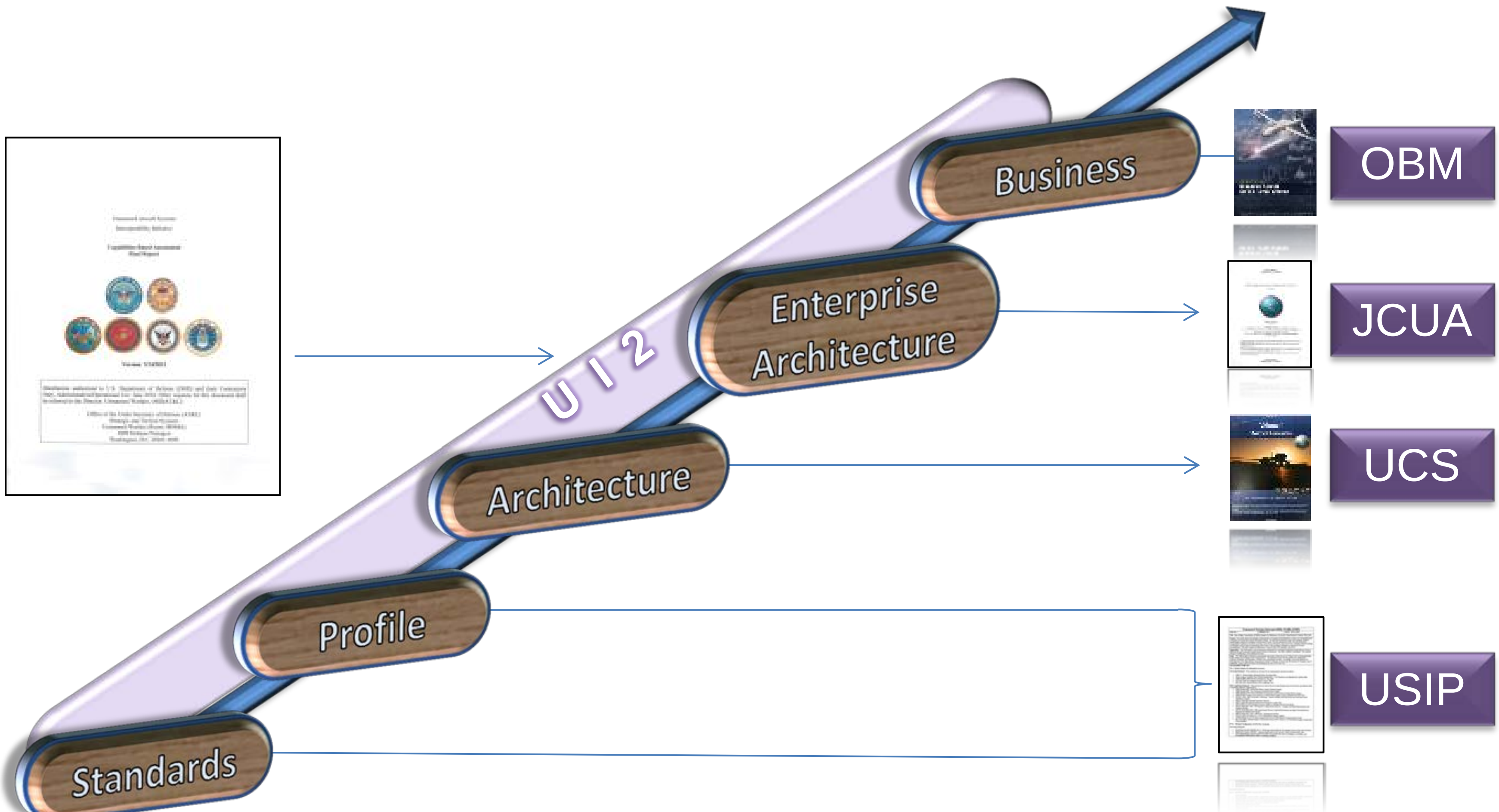
Solution

- Unmanned systems must be modular so the same or at least similar components can be used in the same type or different systems
- Plug-and-play use of different sensors on the vehicle and supporting systems

Unclassified

UAS Enterprise Interoperability

Comprehensive Approach



Multilayered approach required to enable enterprise interoperability
UI2 identifies joint requirements across all layers

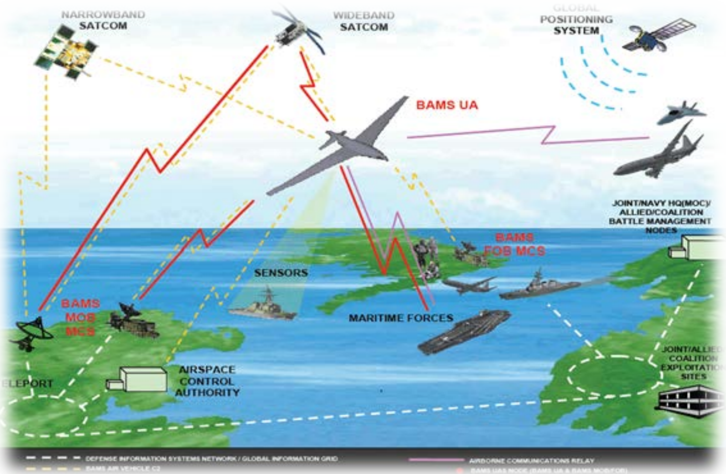
Areas for Technical Improvement & Enhancement

Unclassified

Communication Systems, Spectrum, and Resilience

Problem--communication challenges:

- UAS Bandwidth--Data Volume
- Electromagnetic Spectrum--Spectrum Assignment
- C2 Link Availability--Radio Frequency Resilience



Environment--Infrastructure Issues:

- Poor Global Connectivity
- Costly Satellite and Network Contracts
- Stovepipe Infrastructures
- Poor Information Sharing

Areas for Technical Improvement & Enhancement

Communication Systems, Spectrum, and Resilience

Key Assumptions:

- Programmed Resources Will Be Limited
- C4 Infrastructure Demand Is Growing
- Operating Environment Will Be Challenged
- Open Standards Improve Interoperability
- Enterprise Capabilities Improve Efficiency
- Representatives maintain equities in national and international forums
- Continue requirements management for communication resilience technologies

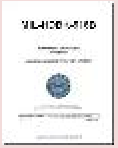
Solution:

- Centralizing unmanned systems enterprise management
- Interoperability through enforcement of a wider use of open standards (e.g., CDL) and interface definitions
- Standardize on common IP modems
- Improved procurement of commercial COMSAT services (e.g., FSCA leases, point-of-presence access to commercial gateways)
- Deepen pool of communication resources through use of WGS systems and leveraging aerial networking capabilities (e.g. JALN and its GIG injection points.)
- Improved resiliency through use of multiband terminals and common interfaces
- Specific planned technology advances shown in figure.

Operating Environment

Technical areas such as automation, maneuver, communication options, etc. so as to accomplish the mission. Emphasis that every aspect of the operating environment, including the ***physical and regulatory***, should be ***incorporated in all acquisition life cycle stages***. Guidance is currently available from each of the military departments although the requirements and standards must still be developed to support new capabilities.

Airworthiness Certification by TAA/TAE



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Qualified Army Operators

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GBSAA technology

Example: Ground-based Sense and Avoid at Fort Hood, TX; a success story for UAS operating capability

"Units always had to go somewhere else to fly. This is normalizing UAS operations in this airspace."

-Lt. Col. Dave Rogers, deputy brigade commander, 21st Cav., 6 March 2013

Safe Navigation through NAS

Endstate

- Accomplishing Training Mission
- Reduced Training Costs
- Improved Soldiers Morale

Logistics and Sustainment

Working to transition from supporting the warfighters' immediate capability requirements to creating an affordable, long-term sustainment environment utilizing a flexible blend of original equipment manufacturer (OEM), other contractors, and organic support to meet logistics support objectives.

Challenges:

- Sustaining Non-Programs of Record
- Limited RAM Data
- Delayed core logistics capability requirements
- Transition from Contract Logistics Support for Life to Organic capabilities
- Immature or lack of lifecycle sustainment planning

UAS Organic Depot Maintenance Sources of Repair Approved Consolidations

Commodity	CCAD	LEAD	TYAD	FRC E	FRC SE	FRC SW	OC-ALC	WR-ALC	OO-ALC
Airframes/Composite	A				N	N		N, AF	A, AF
Engine/Engine Components	A			N	N		A, N, AF		
Sensors (Electro-optic)			A		A, N, AF			AF*	
Sensors (Infared)			A		A, N, AF			AF*	
Hydraulics	A			N	N	N	AF		A, N, AF
Pneumatics	A			N			A, N, AF		A
Landing Gear	A			N	N	N			A, N, AF
Ground Station	A	A	A, N, AF			N		AF	AF
Ground Data Link			A, N, AF			N		AF	AF
Avionics			A	N	N	N		A, N, AF	AF*
Environmental		A		N	N	N	A, N, AF		
Fuel System Components	A			N	N	N	A, N, AF	AF	
Flight Controls	A			N	N	N		A, N, AF	
Targeting			A		A, N, AF				
Targeting (laser)			A		A, N, AF				
Radar (ground)			A, N, AF						
Radar (air)			AF			N		N, AF	
Software			RSA		NAWC			AF	AF
Communications (Ground)			A, N, AF			N		AF	
Propellers	A							A, N, AF	

Service Workload Designations: A = Army AF = Air Force N = Navy * = workloads fall in on existing repair capability

Sources of Repair					Highlights:
Army	CCAD = Corpus Christi Army Depot	LEAD = Letterkenny Army Depot	TYAD = Tobyhanna Army Depot	RSA = Redstone Arsenal	Green = Approved
Navy	FRC E = Fleet Readiness Center East	FRC SE = Fleet Readiness Center Southeast	FRC SW = Fleet Readiness Center Southwest	NAWC = Naval Air Warfare Center	Red Circle = Considering
Air Force	OC-ALC = Oklahoma City Air Logistics Complex	OO-ALC = Ogden Air Logistics Complex	WR-ALC = Warner Robins Air Logistics Complex	AF = Air Force Sustainment Activity	Current: 1/30/13

- Example: Organic Depot Maintenance Sources of Repair Approved Consolidations

Training

Training issues are similar to the logistics environment. Proper mix among the live, virtual, and constructive domains must be put into place to ensure that the asymmetric advantages offered by unmanned systems can be employed in future operations.

Goals	2013 2014 2015 2016	2017 2018 2019 2020	2021 2022 2023 2030+
Technology Projects	**Near-Term**: Improved simulator fidelity & integration of payloads onto surrogate platforms.	**Mid-Term**: Integration of commonality efforts with simulator development.	**Far-Term**: Integration of simulators and surrogates into the livr, virtual, and constructive training environments.
Capability Needs	**Near-Term**: Develop and implement DoD UAS Training Strategy; develop doctrine to support use of UAS operations; inform acquisition of surrogates and simulators; identify airspace requirements.	**Mid- & Long-Term**: Continue implementation and refine DoD UAS Training Strategy; refine UAS training programs to adjust for changes in doctrine; monitor acquisition for incorporation into training programs.	

Challenges:

- Resource Availability
- Policy
- Regulatory

Example: UAS Training Study and subsequent UAS Training Strategy are in progress.

Summary

- **Fiscal Expectations**
- **Roadmap Release**
- **Final Thoughts**

SUMMARY TIMELINE

Tech vs Capability (2013 2014 2015 2016 2017 2018 2019 2020 2021 2022 2023 2030+)	Near Term	Mid Term	Far Term
Technology Projects	Maximize metadata, compression, and format standards compliance	Reprogrammable universal interfaces	Advanced MIMO Configurations
	Migrate candidates to open interfaces	Federated Mission Computing	Advanced Mission Computing
	Improved self protection & security and structures & materials	Improved Micro Technology	Overcome Extreme Environmental Conditions
	Improved power, engine, & guidance technologies	Improved Power and Density	Improved Storage & Energy Harvest
	Integration of weapons technologies	Unmanned Specific Weapons Design	Nano Energetics
	GBSAA Solutions	GBSAA plus ABSAA Solutions	GBSAA, ABSAA, and integrated NextGen
	Multi-Sensor/Multi-MissionSensor Miniaturization & Interoperability	Sensor Modularity	Sensor Data Cross Domain Sharing
	Link connectivity & common communication architectures	Enterprise Gateways	Communication Gateway Points-of-Presence
	Improved simulator fidelity & integration of payloads onto surrogate platforms	Integration of commonality efforts with simulator development	Integration of simulators and surrogates into the live, virtual, and constructive training
OVER ARCHING INNOVATION GOALS			
Desired Capabilty	Increased interoperablity		
	Efficient and affordable developments		
	Increased survivability and communication reslilience		
	Improved persistence		
	Additional of increased lethality		
	Incremental increases in airspace integration		
	Increased autonomy and maintainabilty		
	Improved Training		

Visiting http://www.acq.osd.mil/sts/organization/uw.shtml for the latest updates.

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National Strategy Expanded

Primary Warfighting Goals

- **Goal 1** – Prevail in Today's Wars.
- **Goal 2** – Prevent and Deter Conflict
- **Goal 3** – Prepare to Defeat Adversaries and Succeed in a Wide Range of Contingencies.

Supporting Goals

- **Goal 4** – Preserve and Enhance the All-Volunteer Force.
- **Goal 5** – Reform the Business and Support Functions of the Defense Enterprise.

Roadmap Tech Timeline Expanded

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OVER ARCHING INNOVATION GOALS			
	Increased interoperablity	→	→

SUMMARY TIME

Areas for Technical Improvement & Enhancement

Communication Systems, Spectrum, and Resilience

Communications, Networks, and Electromagnetic Systems

2013 2014 2015 2016 2017 2018 2019 2020 2021 2022 2023 2030+

Desired Capabilty	Near Term: Unmanned System connectivity to Teleport sites supporting Africa and Pacific, Global UVDS capabilities, Secure Micro Digital Datalink, DSA,WNaN, Chip Count reduction, Ka-band terminals, Single Chip T/R, GaN technology, Eff. FEC, "Dial-a-rate" CDL, Adv. MIMO, consolidated gateway sites under common communications architecture, aggregate COMSATCOM leasing under FCSA.	Mid-Term: Multi-focused, Super-cooled Antennas, Conformal phased array antennas, standard multi-band transceivers, cloud-enabled enterprise data centers, transition BLOS gateway capabilities to enterprise gateway sites supplemented with dedicated gateways outside coverage areas, tech refresh terminal upgrades to Ka-Band or multi-band hardware.	Long Term: Adv. Error Control, Further Adv. MIMO configurations, Network Path Diversity, Optical Communications, commercial gateway points-of-presence with Digital IF inter-facility transport.