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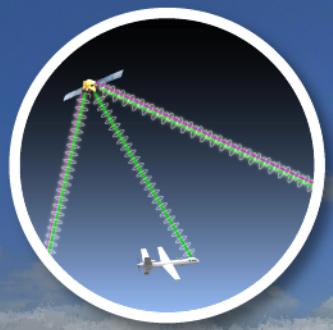


Unmanned Aircraft Systems (UAS) Integration in the National Airspace System (NAS) Project

Detect and Avoid

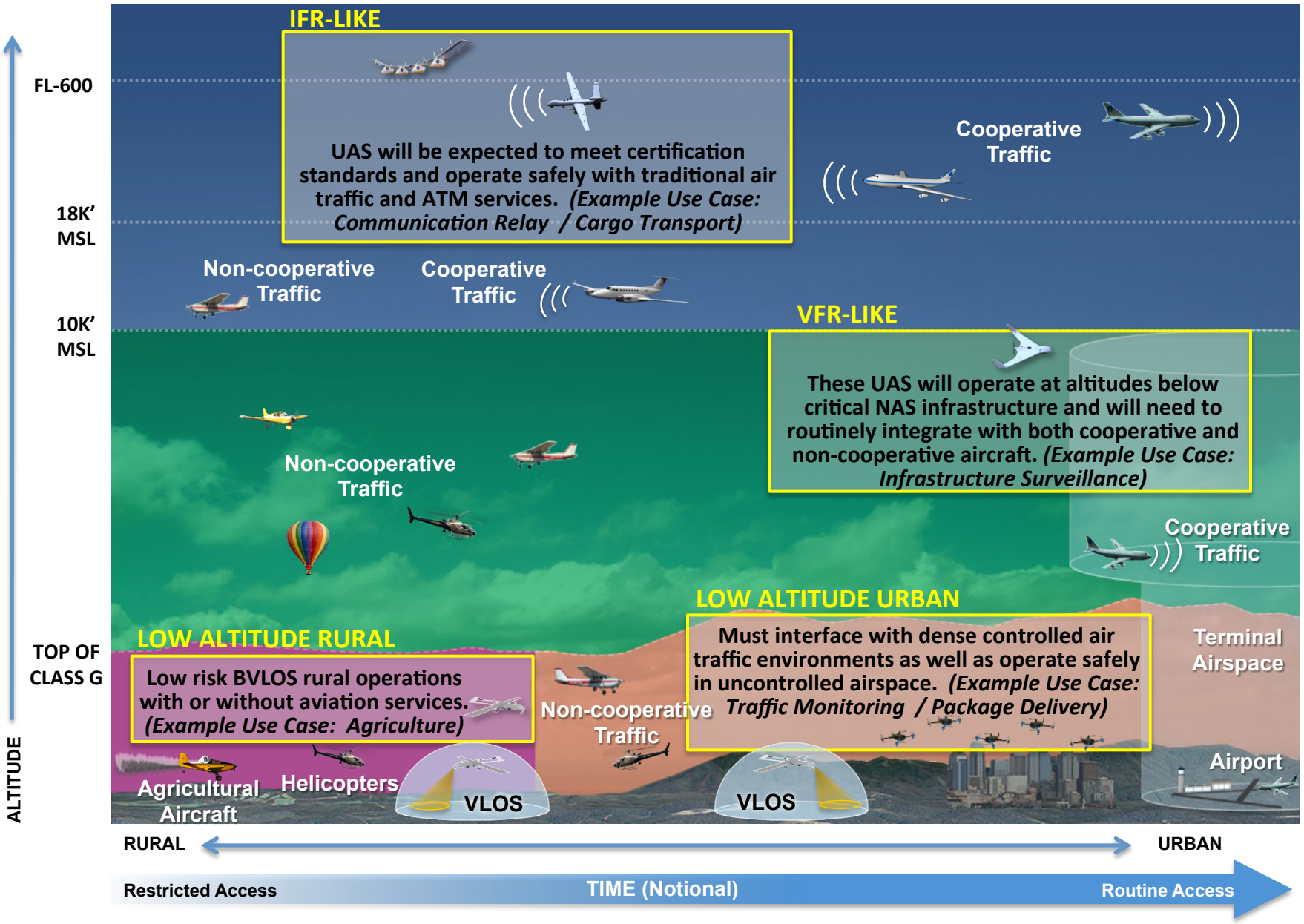
UAS INTEGRATION IN THE NAS

Jay Shively
DAA Sub-Project Manager

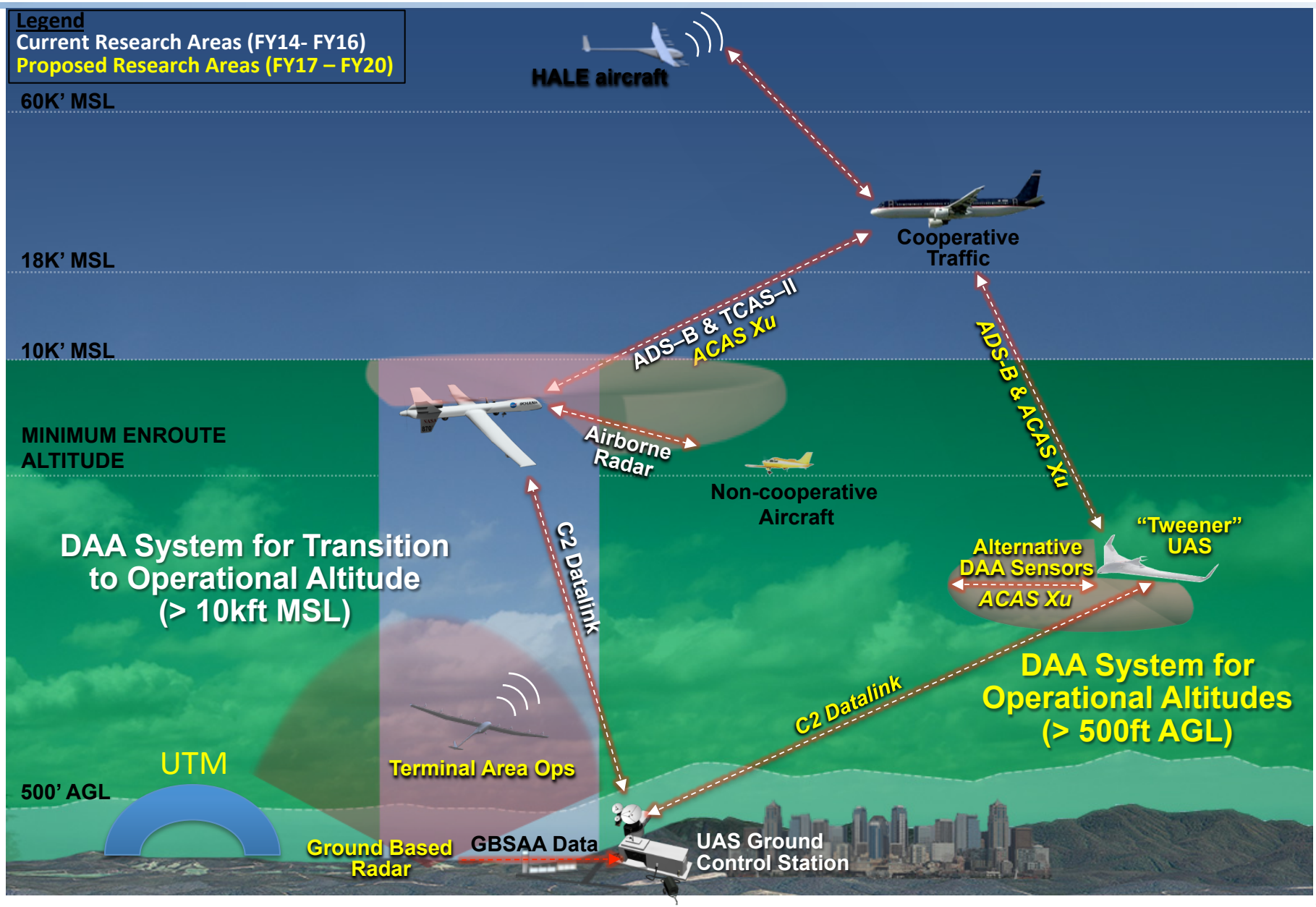
Full UAS Integration Vision of the Future

Manned and unmanned aircraft will be able to routinely operate through all phases of flight in the NAS, based on airspace requirements and system performance capabilities.

Future Civil UAS Airspace Environment



DAA Operational Environments



Demand for UAS Integration

- Several civil/commercial markets are poised to take full advantage of the capabilities UAS offer

Demand Scenario	Automation Assisted	Highly Automated	Autonomous
Low Altitude Rural	Aerial Photography	Wildlife Surveillance	Precision Agriculture
IFR-Like	Broad Area Surveillance	Cargo Transport	Communication Relay
Low Altitude Urban	Search and Rescue	Traffic Monitoring	Local Package Delivery
VFR-Like	Horizontal Infrastructure	Passenger Transport	Cargo Delivery

- growth until the barriers and challenges, currently preventing full integration, are addressed

"For every year integration is delayed, the United States loses more than $10B in potential economic impact ($27.6M per day)." *– AUVSI Economic Report 2013*

UAS-NAS Phase 2
Project Organization Structure

PROJECT OFFICE LEVEL

Project Leadership

Project Manager (PM)	Laurie Grindle, AFRC
Deputy PM	Robert Sakahara, AFRC
Deputy PM, Integration	Davis Hackenberg, AFRC
Chief Engineer	William Johnson, LaRC

Project Support: Project Planning & Control

Lead Resource Analyst	April Jungers, AFRC
Resource Analysts	Winter Preciado,
AFRC	
	Warcquel Frieson, ARC
	Julie Blackett, GRC
	Pat O'Neal, LaRC
Scheduler	Irma Ruiz, AFRC
Risk Manager	Jamie Turner, AFRC
Change/Doc. Mgmt	Lexie Brown, AFRC
Admin	Sarah Strahan,
AFRC	

Project Support: Technical

Staff Engineer	Dan Roth, AFRC
Systems Eng Lead	TBD, TBD

SUBPROJECT LEVEL

Command and Control (C2)

Subproject Manager
Mike Jarrell, GRC
Subproject Technical Lead
Jim Griner, GRC

Detect and Avoid (DAA)

Subproject Manager
Jay Shively, ARC
Subproject Technical Leads
Confesor Santiago, ARC; Lisa Fern, ARC; Tod Lewis, LaRC

Integrated Test & Evaluation

Subproject Manager
Heather Maliska, AFRC
Subproject Technical Leads
Jim Murphy, ARC; Sam Kim, AFRC

ELEMNET/ TWP LEVEL

Technical Work Packages (TWP): Terrestrial Extensions, Ka-band Satcom, Ku-band Satcom, C-band Satcom

Technical Work Packages (TWP): Alternative Surveillance, Well Clear, ACAS Xu, External Collaboration, Integrated Events

Technical Work Packages (TWP):, Integration of Technologies into LVC-DE, Simulation Planning and Integration, Integrated Flight Test

See and Avoid: FAR Sec. 91.113

General. When weather conditions permit, regardless of whether an operation is conducted under instrument flight rules or visual flight rules, vigilance shall be maintained by each person operating an aircraft so as to see and avoid other aircraft. When a rule of this section gives another aircraft the right-of-way, the pilot shall give way to that aircraft and may not pass over, under, or ahead of it unless well clear.

Piloted “see and avoid” = UAS “detect and avoid”

Pilots vision replace by sensors (on- or off- board or both)

Pilot judgment of well clear = mathematical expression of well clear

Horz Miss Distance = 4000ft; Vert Miss Distance = 450ft;
modTau = 35sec; DMOD = 4000ft

Research Areas to support DAA:

Define operational environment (CONOPS)

Develop well clear definition

Develop algorithms for guidance

Develop sensor requirements

End to end timelines
- Human response
- A/C response
- Datalink latencies

Develop guidance displays, alerting logic and presentation

Ensure interoperability with TCAS/ACAS

Alerting

Symbol	Name	Pilot Action	Buffered Well Clear Criteria	Time to Loss of Well Clear	Aural Alert Verbiage
	TCAS RA	• ***Immediate action required*** • Comply with RA sense and vertical rate • Notify ATC as soon as practicable after taking action	*DMOD = 0.55 nmi *ZTHR = 600 ft *modTau = 25 sec	0 sec (+/- 5 sec) (TCPA approximate: 25 sec)	"Climb/Descend"
	DAA Warning Alert	• ***Immediate action required*** • Notify ATC as soon as practicable after taking action	DMOD = 0.75 nmi HMD = 0.75 nmi ZTHR = 450 ft modTau = 35 sec	25 sec (TCPA approximate: 60 sec)	"Traffic, Maneuver Now" x2
	Corrective DAA Alert	• On current course, ***corrective action required*** • Coordinate with ATC to determine an appropriate maneuver	DMOD = 0.75 nmi HMD = 0.75 nmi ZTHR = 450 ft modTau = 35 sec	55 sec (TCPA approximate: 90 sec)	"Traffic, Avoid"
	Preventive DAA Alert	• On current course, corrective action **should not be required** • Monitor for intruder course changes • Talk with ATC if desired	DMOD = 0.75 nmi HMD = 1.0 nmi ZTHR = 700 ft modTau = 35 sec	55 sec (TCPA approximate: 90 sec)	"Traffic, Monitor"
	Guidance Traffic	• **No action required** • Traffic generating guidance bands outside of current course	Associated w/ bands outside current course	X	N/A
	None (Target)	• **No action required** • No coordination required	Within surveillance field of regard	X	N/A

* These values show the Protection Volume (**not well clear volume**) at MSL 5000-10000ft (TCAS Sensitivity Level 5)

Operational Foci

Phase 1:

SC 228 DAA MOPS Phase 1

Class A, transitioning through E

Larger UAS capable for carrying an on-board DAA sensor and performing in an IFR environment

Users: DoD, DHS, NASA, public agencies

Phase 2:

SC 228 Phase 2 MOPS

Terminal Operations

Smaller, less payload A/C

Alternative Sensors

New Well Clear Definition

Airspace down to UTM

Users: Police, Fire, BLM, Forestry, Public Utilities, Fisheries, Agriculture

Customers

- SC 228
- SC 147
- DoD
- ICAO
- Industry
- FAA

Questions ?