



# Air Force Research Laboratory



***Integrity ★ Service ★ Excellence***

## Collaboration for the Future

16 June 2011

**Dr. Mikel M. Miller  
Chief Technologist  
Air Force Research Laboratory**



# Agenda



- **AFRL Mission**
- **Organization**
- **Resources**
- **MAV Example**
- **S&T Guidance**
- **Summary**



# AFRL Mission



**Leading** the **discovery**, development, and integration of **affordable** warfighting technologies for our air, space, and cyberspace force.



# AFRL Organization



**Commander**

**Maj Gen  
William N.  
McCasland**



**Executive  
Director**

**Mr. Joe  
Sciabica**



**Vice  
Commander**

**Col Daniel  
Morin**



**Chief Technology  
Officer (acting)**

**Dr. Mikel  
Miller**

**Air Force Office  
of Scientific Research**

**Propulsion**

**Directed Energy**

**Information**

**711th Human  
Performance Wing**



**Munitions**



**Sensors**



**Space Vehicles**



**Materials  
and Manufacturing**



**Air Vehicles**





# AFRL Core Technical Competencies



## Basic Research

- Basic Aerospace, Chemical, Aeronautical and Material Sciences

## Propulsion

- Turbine Engines
- High-Speed/Hypersonics
- Space and Missile Propulsion

## Directed Energy

- Lasers
- Beam Control
- High Power Microwaves

## Information

- Computing Architecture
- Information Exploitation
- Command and Control

## Human Performance

- Forecasting
- Training
- Decision Making

## Munitions

- Ordnance
- Advanced Guidance
- Munitions Systems

## Sensors

- RF Sensing and Warfare
- EO Sensing and Warfare
- Trust in Complex Systems

## Space Vehicles

- Defensive Space Control
- Responsive Space
- Space Situational Awareness

## Materials and Manufacturing

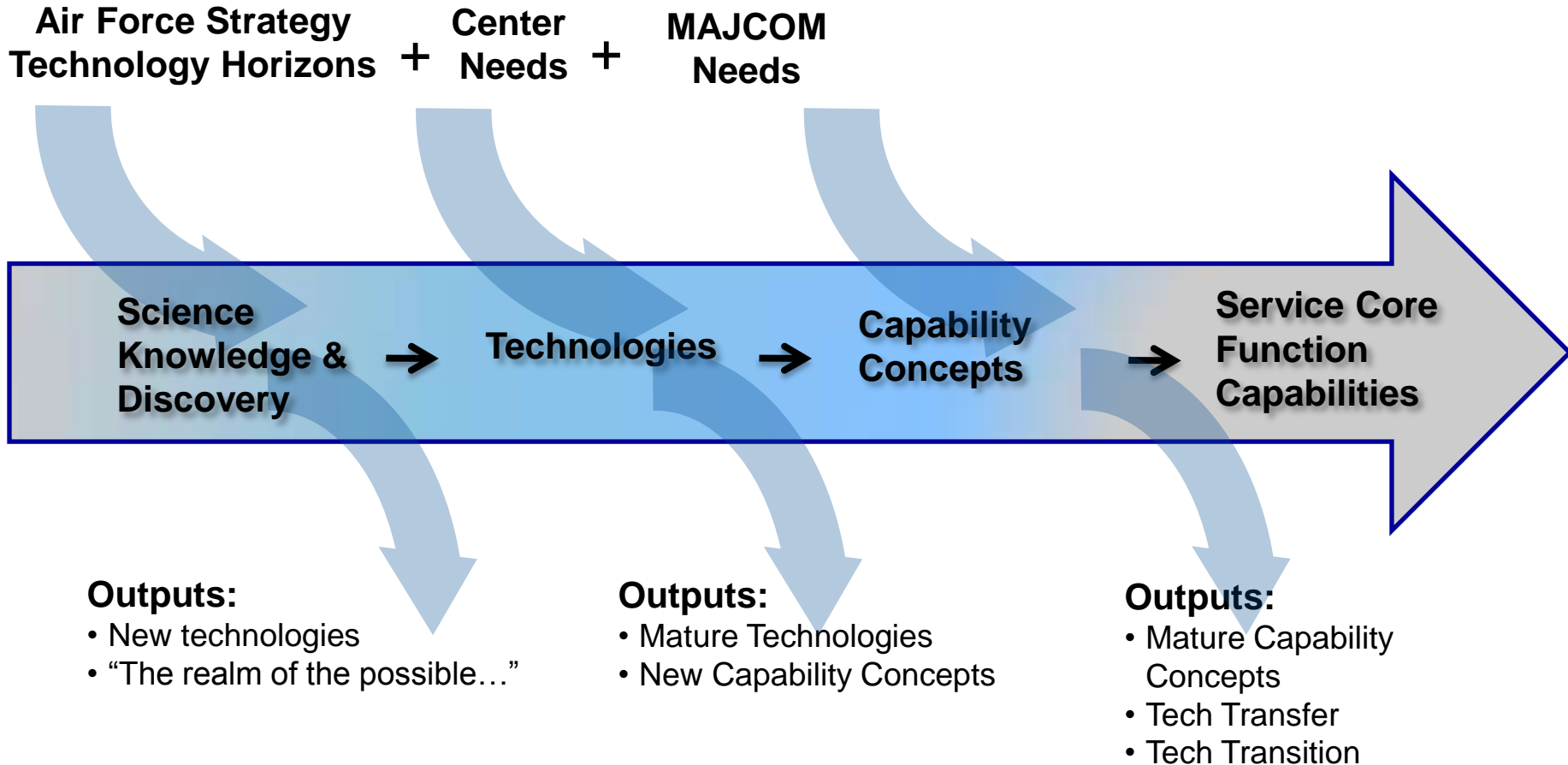
- Materials and Processes
- Materials Applications
- Manufacturing Technology

## Air Vehicles

- Integration
- Aeronautical Sciences
- Structural and Control Sciences



# Turn Science Into Capability

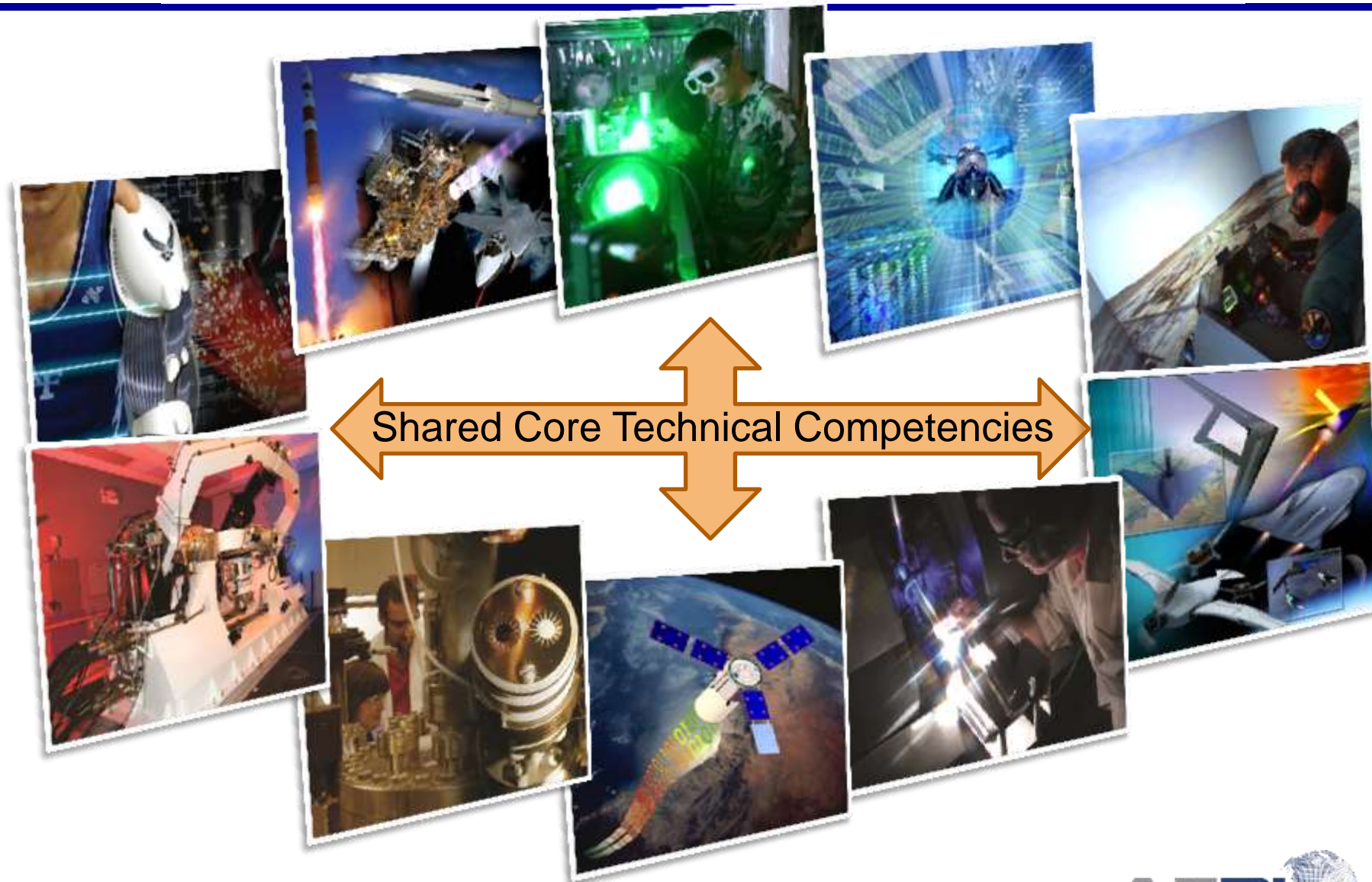


## Initial Operating Capability:





# Collaboration Trends



# **MAV – 2015**

## **AFRL's Vision for Bird Sized UAV**

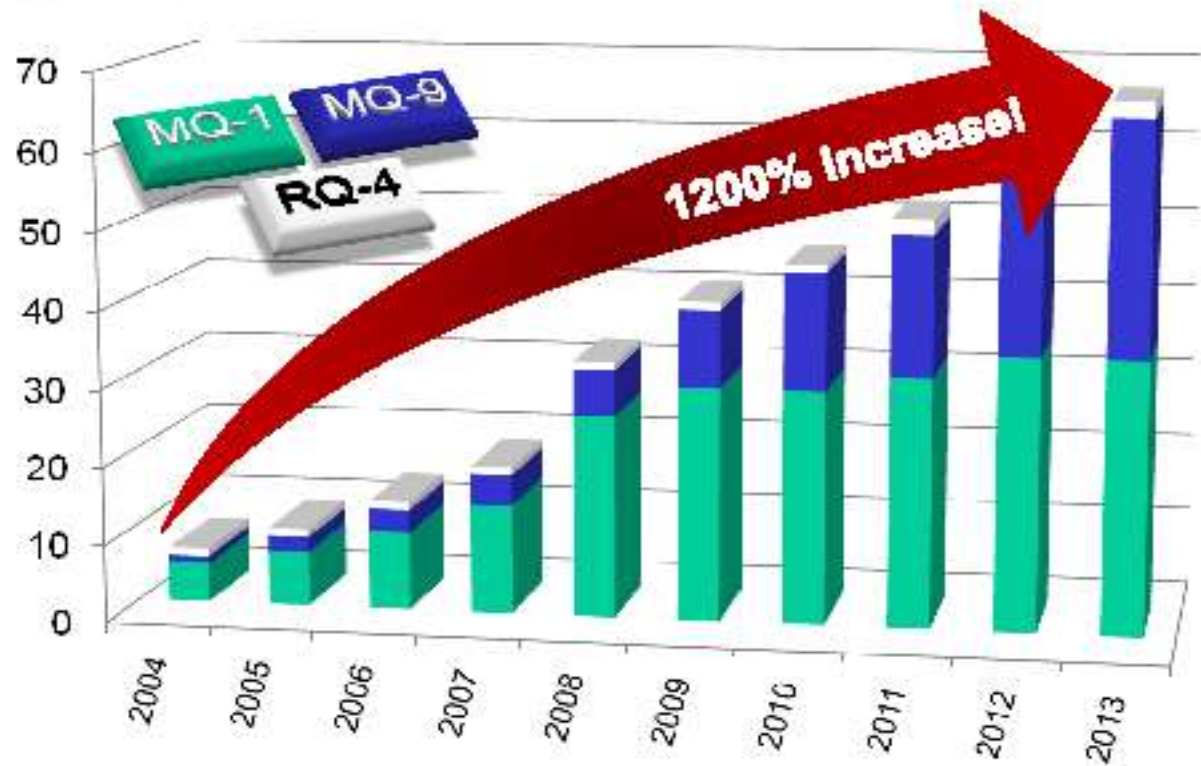


# AF Growth in RPAs



## Growth in RPA Combat Air Patrols

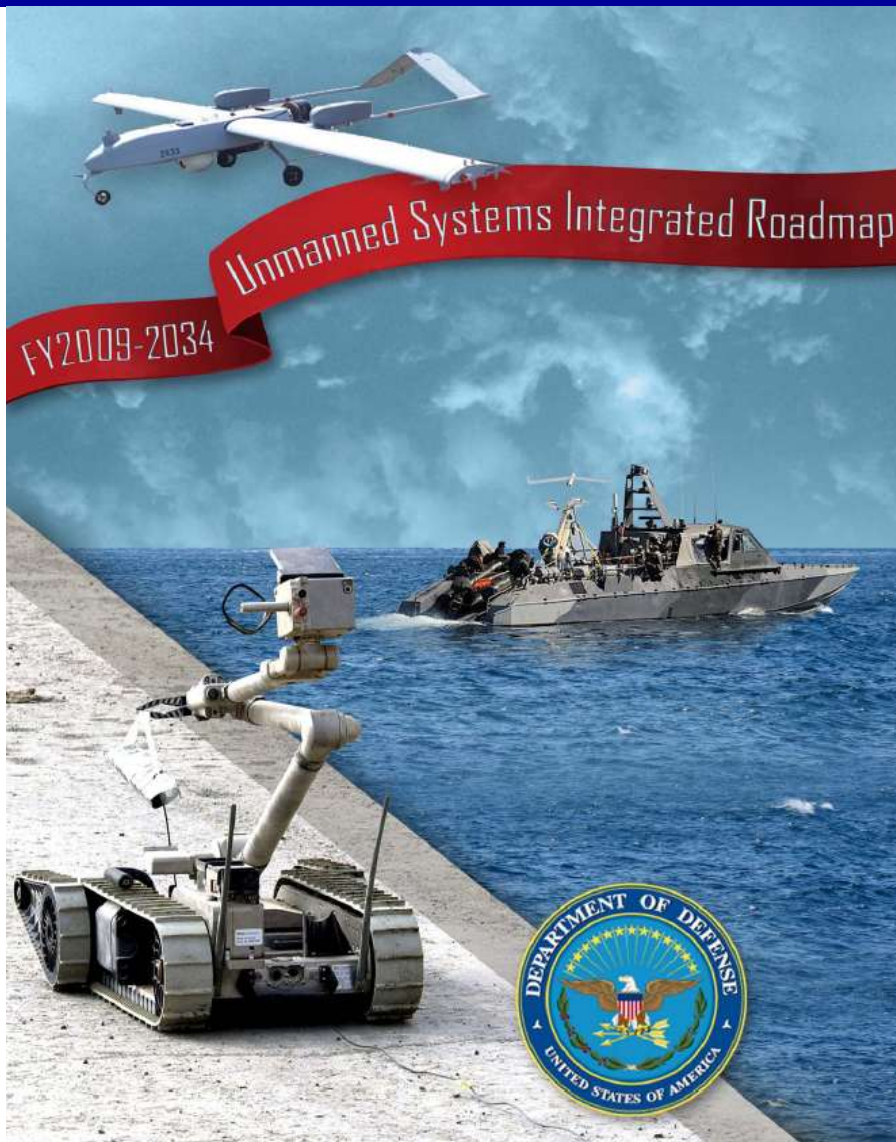
- 2004 = 6
- 2005 = 9
- 2006 = 12
- 2007 = 19
- 2008 = 34
- 2009 = 40
- Today = 47
- 2011 = 53
- 2013 = 69



**Revolutionary growth; 4QFY2013: 35x MQ-1, 30x MQ-9, 4x RQ-4**



# OSD Unmanned Systems Roadmap (2009 – 2034)



- Incorporates a vision and strategy for UAS, UGV, and UMS
- Focused on delivering warfighting capability, including:
  - Reconnaissance and Surveillance
  - Target ID and Designation
  - Counter-Mine and Explosive Ordnance Disposal
  - CBRN Reconnaissance



# AF RPA Flight Plan



“Unmanned aircraft systems and the effects they provide have emerged as one of the most “in demand” capabilities the USA provides to the Joint Force” - SECAF Donley

**UAS Flight Plan describes a family of unmanned aircraft:**

- **Small man-portable vehicles, including micro- and nano-sized**
- **Medium “fighter-sized” vehicles**
- **Large “tanker sized” vehicles**

**Concept is to build a common set of airframes that are interoperable, with modular “plug and play” payloads” with standard interfaces**

United States Air Force  
Unmanned Aircraft Systems Flight Plan



Headquarters, United States Air Force  
Washington DC  
February 09, 2009



# AF UAS Family of Systems



## Group I

0-20 Lbs < 1200' AGL  
< 250 KIAS

## Group II

21-55 Lbs < 3500' AGL  
< 250 KIAS

Group I & II (AL-SUAS)

## Group III

< 1320Lbs < 18,000' MSL  
< 250 KIAS

## Group IV

> 1320Lbs < 18,000' MSL  
< Any Speed

## Group V

> 1320Lbs > 18,000' MSL  
< Any Speed

NANO/MICRO

MANPORTABLE

AIR-LAUNCHED

MULTI-MISSION

MID-HIGH ALTITUDE MULTI-ROLE

WASP III/BATMAV

RAVEN B

PUMA AE

LETHAL SUAS  
Under Development

EXPENDABLE - RSTA  
EXPENDABLE-LETHAL

Under Development

RECOVERABLE - RSTA

Scan Eagle/  
TIER II  
STUAS

Legend

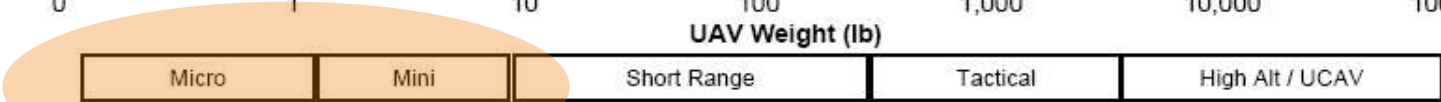
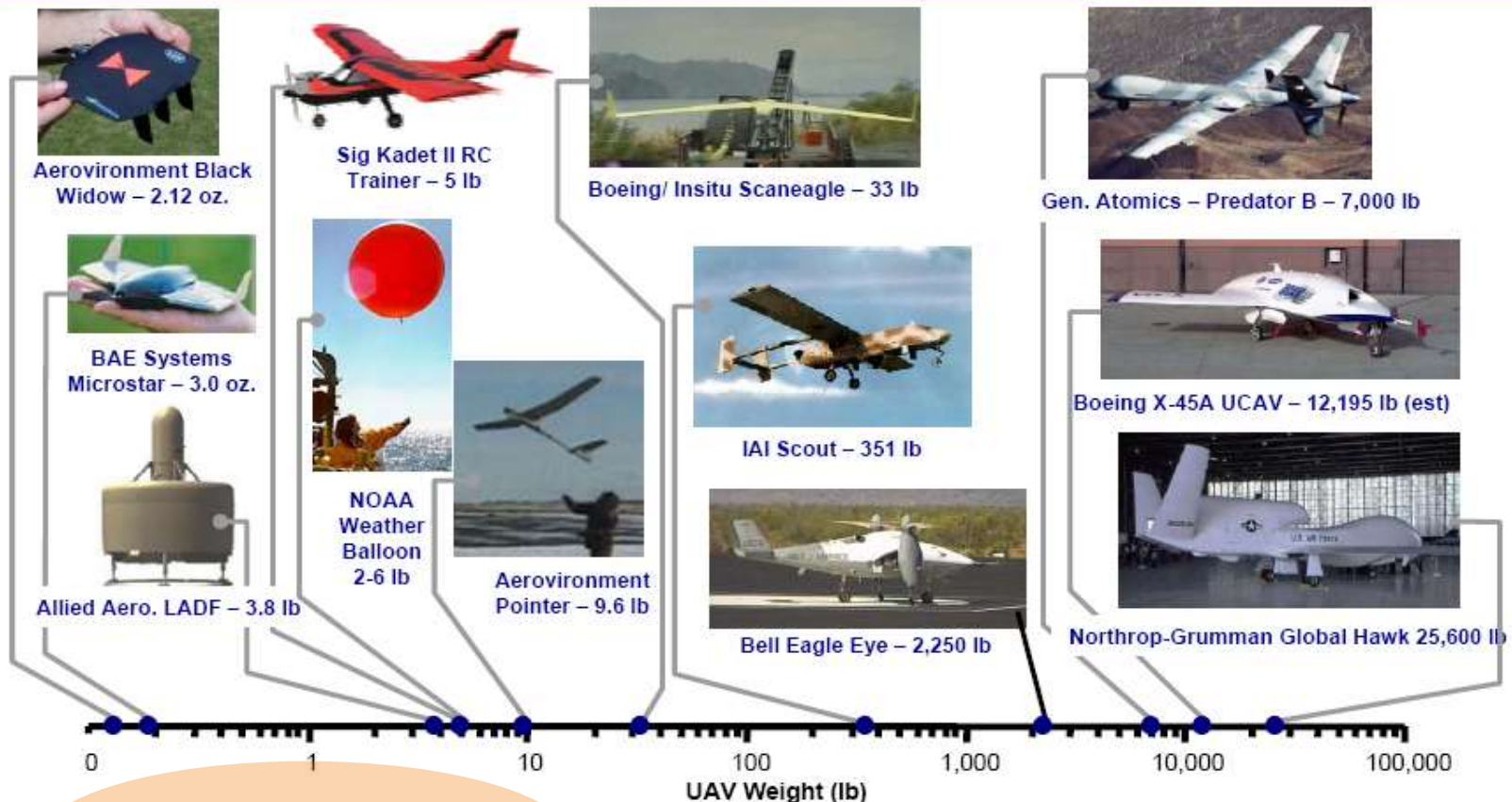
Program of Record

Small UAS

1320 Lbs



# Current UAVs



Greatest Research Needs!



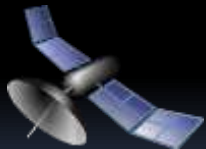
# AFRL MAV



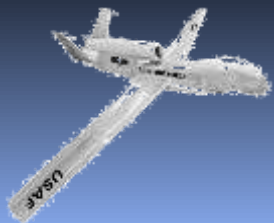
# Present Day Unmanned ISR...



Strategic



Tactical



Operational



Theater





# ...vs. Tomorrow's





# ...vs. Future ISR Capabilities





# MAV Definition



- **Definition:** *Air vehicles ranging from “medium bird” size to “large insect” size where conventional aerosciences are insufficient for design and development, and where the effects from scaling become predominant*
- **Specifications**
  - **Type:**
    - Fixed Wing (Conventional, Morphing, Perching)
    - Rotary Wing
    - Flapping Wing
  - **Weight:** grams – kilograms
  - **Size:** millimeters – centimeters



# AFRL Strategic Vision

## “Ubiquitous Sensors and Shooters”



### 2015

- **Demonstrate a biomimetic bird-sized UAV platform with weapons of mass destruction sensing capability capable of semi-autonomously operating for a week.**
- Demonstrate the ability to air deliver a number of small armed UAVs, and establish a cohesive integrated ISR network capable of persistent operation over an area and of detecting, tracking, targeting, and engaging multiple targets outdoors with lethal effects.

### 2030

- **Demonstrate a biomimetic insect-sized UAV platform with WMD sensing, tracking, and targeting capability capable of autonomous and persistent operations.**
- **Demonstrate the ability of lethal micro UAVs to detect, track, target, and engage multiple dynamic targets within an urban environment, as well as to detect, classify, and deliver lethal effects both inside and outside structures.**

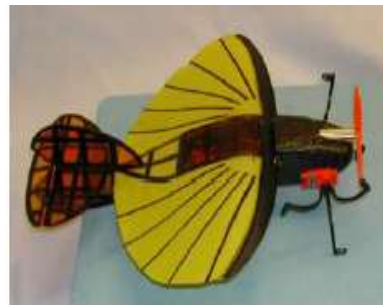


# AFRL's Strategic Vision: "Ubiquitous, Swarming Sensors & Shooters"

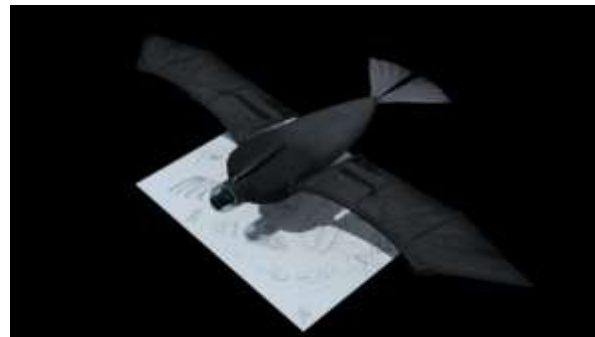
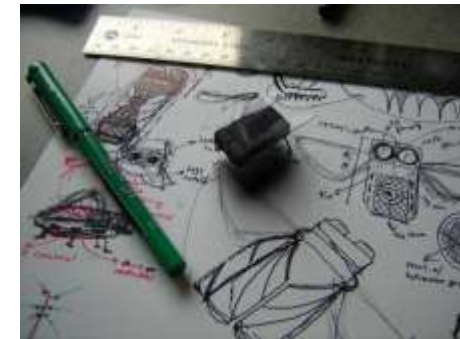


"Biomimetic *bird-sized* UAV platform, semi-autonomous operations with WMD sensing capability"

"Biomimetic *insect-sized* UAV platform with WMD sensing, tracking and targeting capability, capable of autonomous persistent operation"



*Artist concept of indoor 2030 MAV*



*Artist concept of outdoor 2015 MAV*



[micro.seas.harvard.edu](http://micro.seas.harvard.edu)

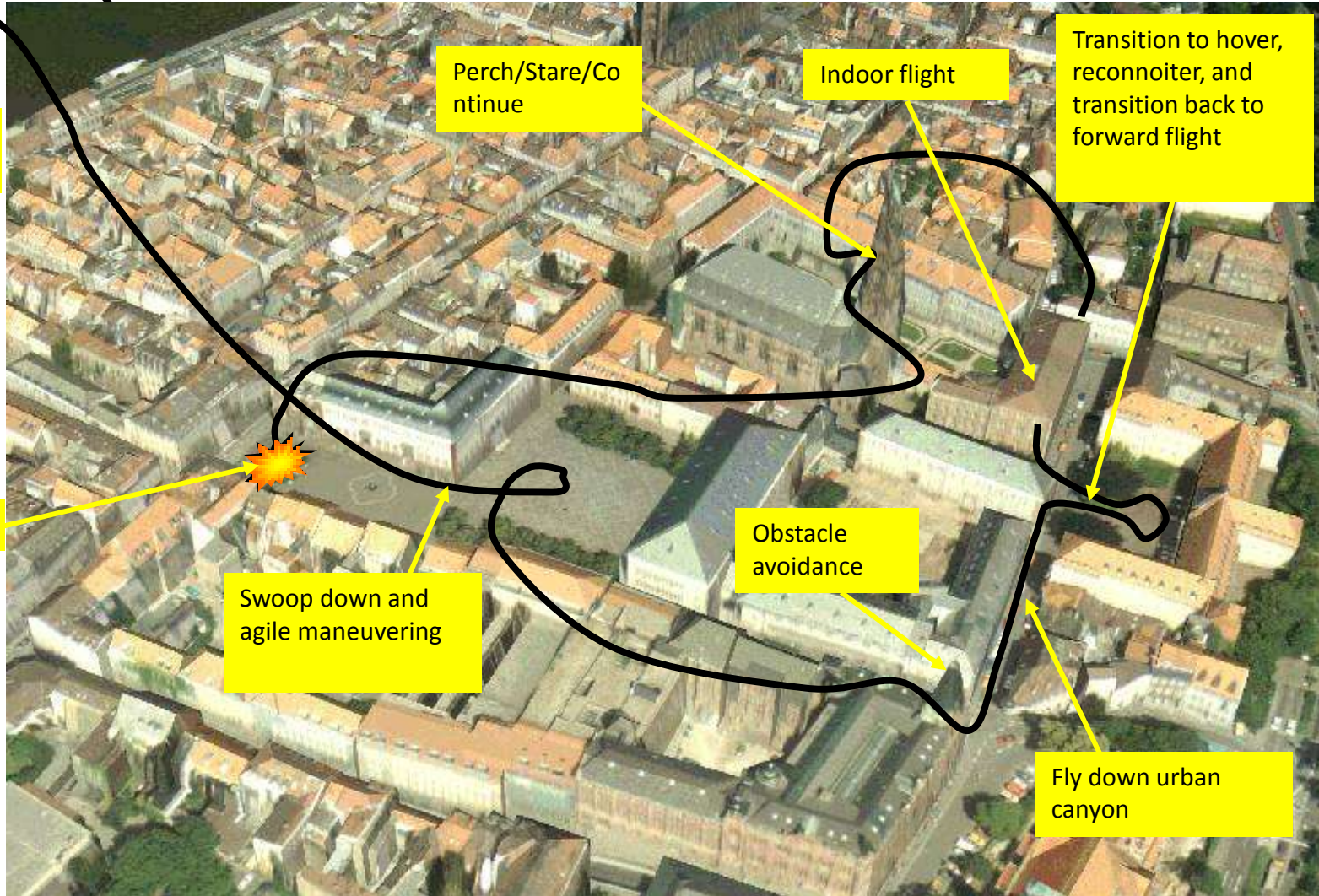
*Near Term*

*2015*

*2030*



# Idealized Challenge Mission





# Challenge: Integration



“How do we get this into orbit?”



“How much damage can it do?”



“What is it made out of?”



“What are the fundamental science issues?”



“What is it sensing?”



“Shouldn't the wings flap?”



“How fast and for how long can it fly?”



“How do we interface with it?”



“What is the baud rate?”

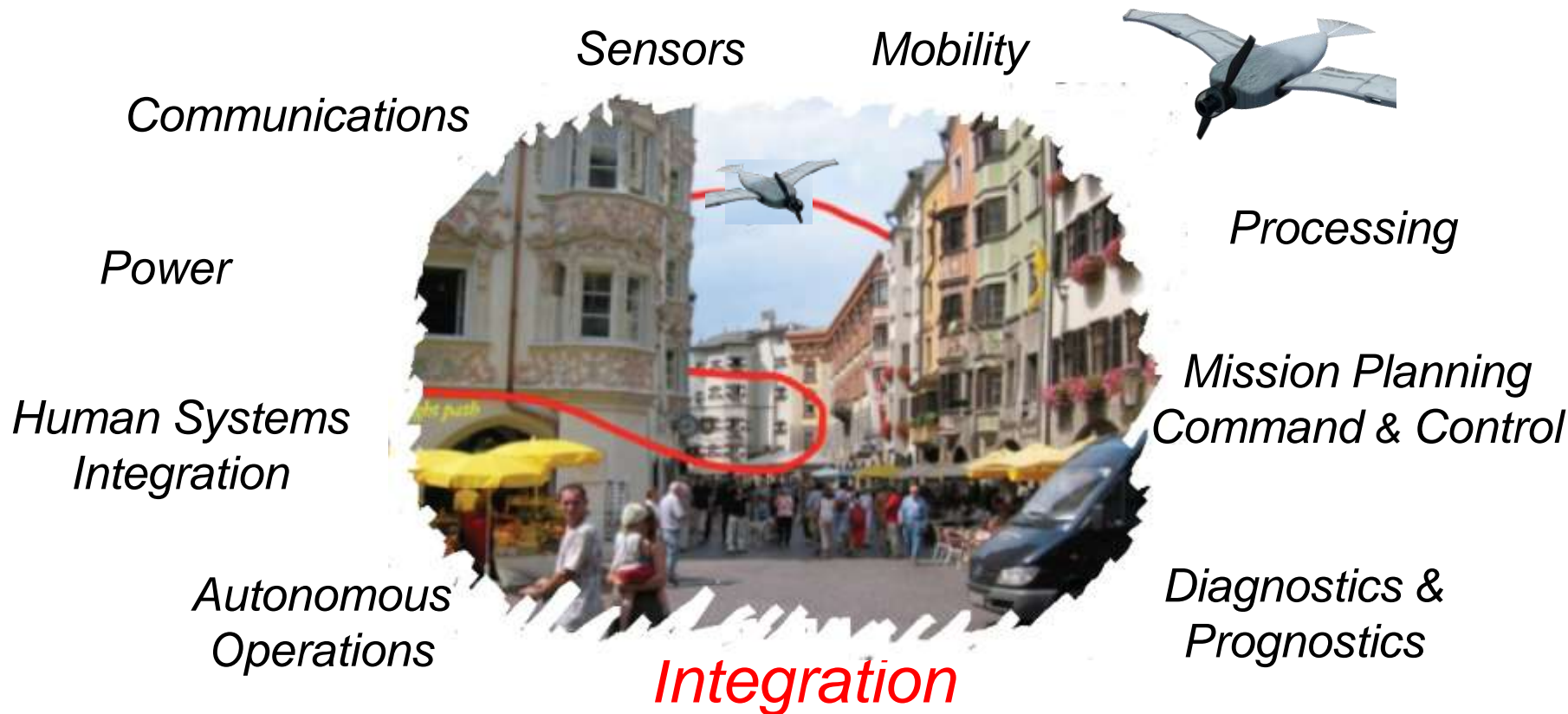


“How much energy is available for the laser?”



# MAV Future Capabilities

Future MAV Systems Will Integrate a Broad Range of Technology Advancements



*Long-Term Capabilities will be derived from a coordinated integration of diverse technologies*

# HOW DO WE GET TO THERE FROM HERE?



# AFRL Mission

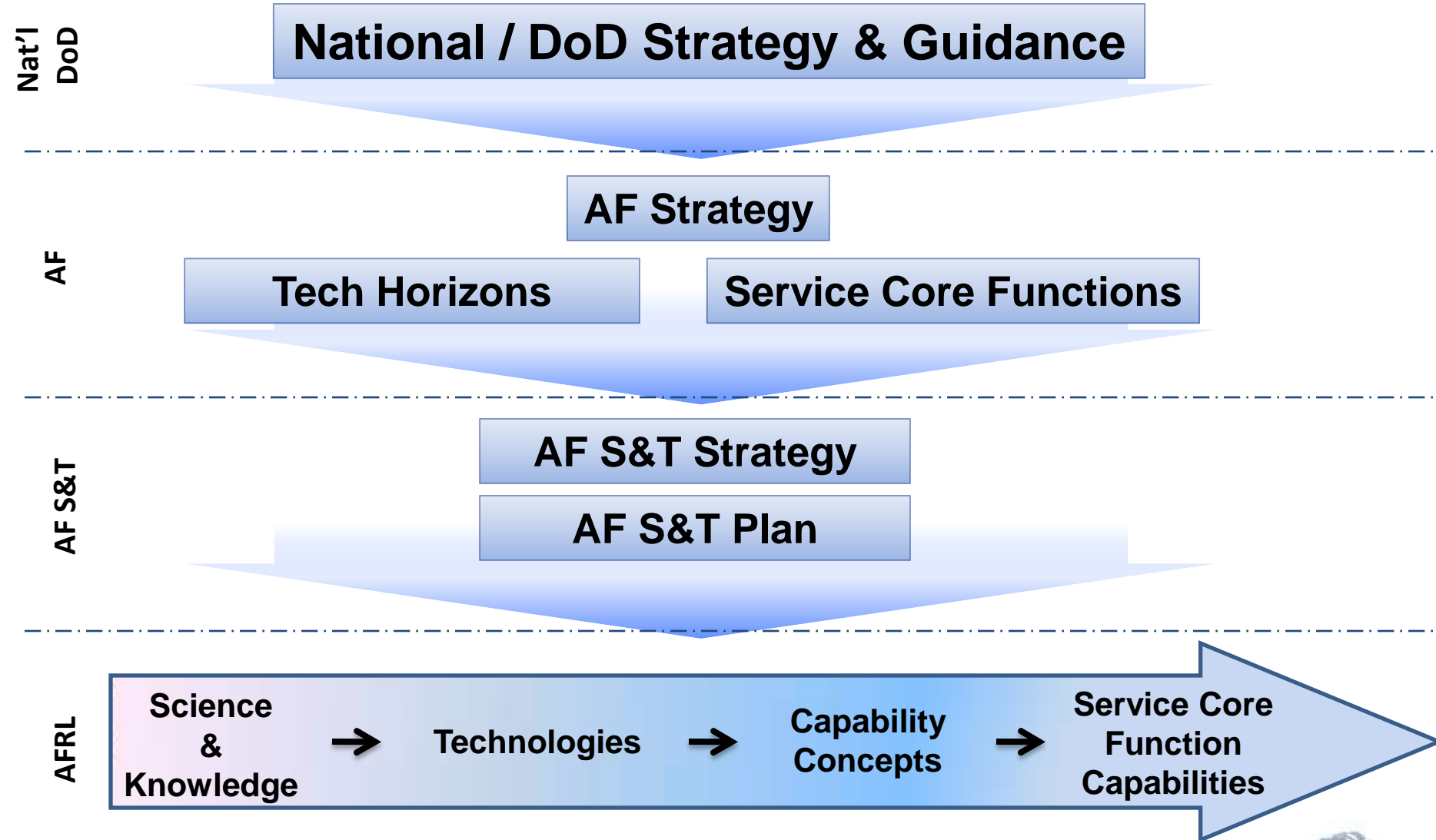


It's not just about the science...  
...it's about leadership in S&T

**Leading** the **discovery**, development, and integration of **affordable** warfighting technologies for our air, space, and cyberspace force.

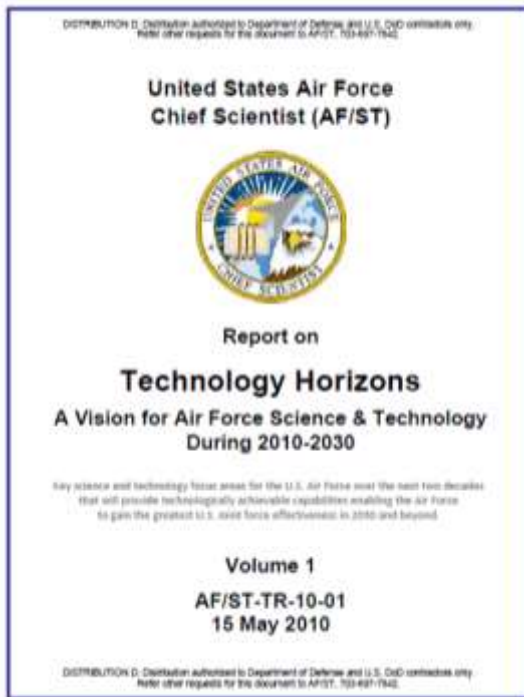


# AF S&T Guidance Hierarchy





# AFRL Guidance





# “Technology Horizons” Overarching Themes



*From decreased emphasis on this ...*

*To increased emphasis on this ...*

<b>1. From ... Platforms</b>	<b>To ... Capabilities</b>
<b>2. From ... Manned</b>	<b>To ... Remote-piloted</b>
<b>3. From ... Fixed</b>	<b>To ... Agile</b>
<b>4. From ... Control</b>	<b>To ... Autonomy</b>
<b>5. From ... Integrated</b>	<b>To ... Fractionated</b>
<b>6. From ... Preplanned</b>	<b>To ... Composable</b>
<b>7. From ... Single-domain</b>	<b>To ... Cross-domain</b>
<b>8. From ... Permissive</b>	<b>To ... Contested</b>
<b>9. From ... Sensor</b>	<b>To ... Information</b>
<b>10. From ... Operations</b>	<b>To ... Dissuasion/Deterrence</b>
<b>11. From ... Cyber defense</b>	<b>To ... Cyber resilience</b>
<b>12. From ... Long system life</b>	<b>To ... Expendable</b>



# “Technology Horizons” Major Findings



- **Highly adaptive autonomous systems**
- **Human performance augmentation**
- **Increased cyber resilience**
- **Precision navigation and timing in Global Positioning System — denied environments**
- **Electromagnetic spectrum warfare**
- **Processing-enabled intelligent sensors**
- **Directed energy for tactical strike/defense**
- **Next-generation high-efficiency gas turbine engines**
- **Persistent space situational awareness**
- **Rapidly composable small satellites**



# Summary



## AFRL will...

- **Focus on USAF needs**
- **Execute the AF S&T Plan**
- **Engage with customers via AFRL's corporate engagement process**
- **Develop & utilize healthy partnerships**
  - **Internal (cross-Directorate Core Technical Competencies)**
  - **External**



# Questions?

