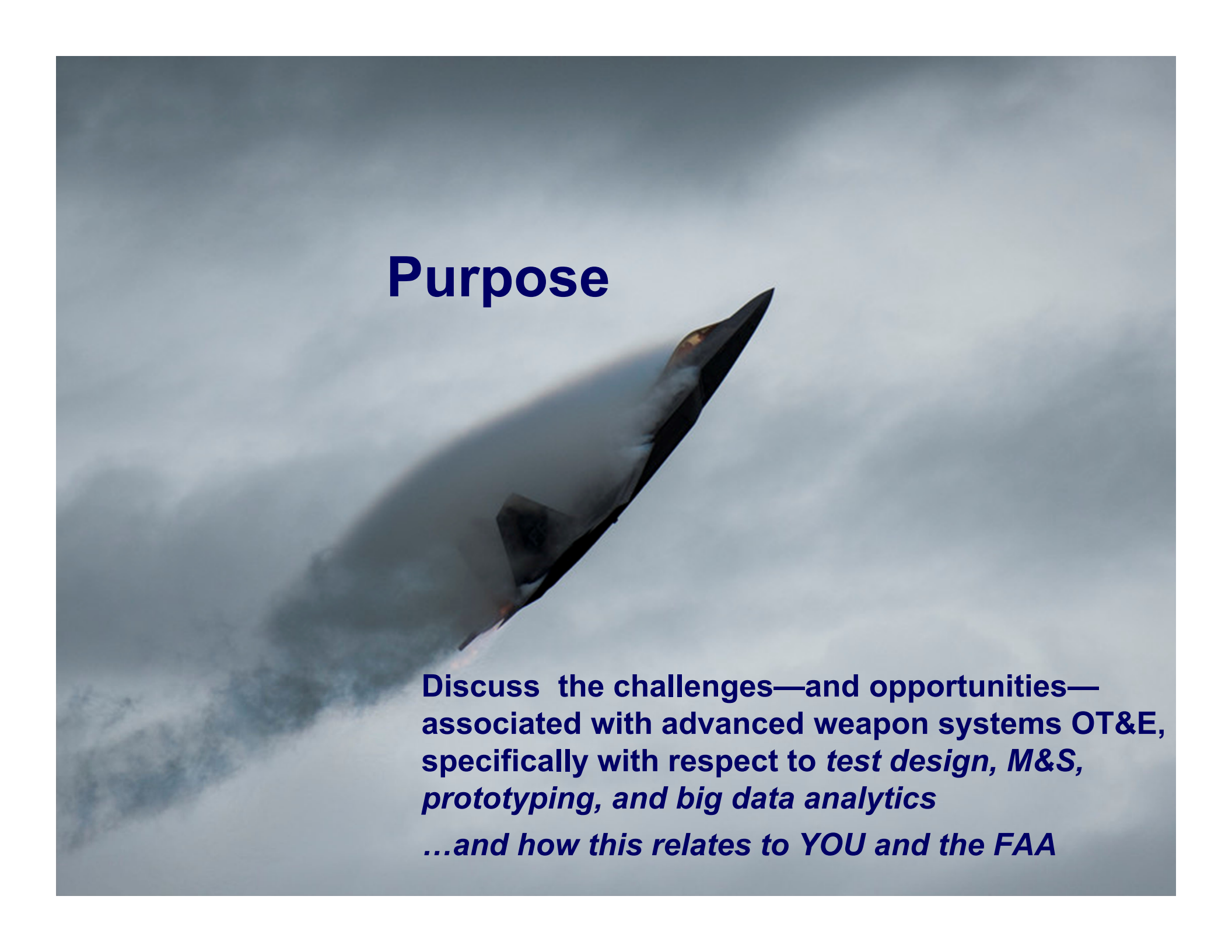


A photograph of an F-35 fighter jet in flight, viewed from the side and slightly from below. The jet is dark grey and has a stealthy, angular design. It is flying over a body of water, and there is a visible wake or spray of water behind it. The background is a clear blue sky. In the top right corner, there is a small, faint logo that looks like a stylized 'A' or a compass rose.

5th Gen Weapon Systems Testing

...an Elixir for Systems Thinking

Maj Gen (ret) Matt “Zap” Molloy, USAF
Veritas Solutions LLC

A stealth fighter jet, likely an F-35, is shown in flight against a backdrop of a cloudy sky. The aircraft is dark and angular, with its wings and fuselage blending into the background. It is positioned diagonally across the frame, pointing towards the upper right. The clouds are soft and grey, providing a textured background for the dark aircraft.

Purpose

Discuss the challenges—and opportunities—associated with advanced weapon systems OT&E, specifically with respect to *test design, M&S, prototyping, and big data analytics*

...and how this relates to YOU and the FAA

Flight Plan

- **My Background**
- **Intro to the Complex Systems Environment of Advanced Weapons**
 - “Systems Thinking Thinking”: Crafting a 5th-Gen, Systems-of-Systems Test Design
 - 3 Pillars of Complex Systems Thinking
 - M&S developmental work
 - Big data analytics; Knowledge Management
 - Prototyping
- **Closing Thoughts & Discussion**



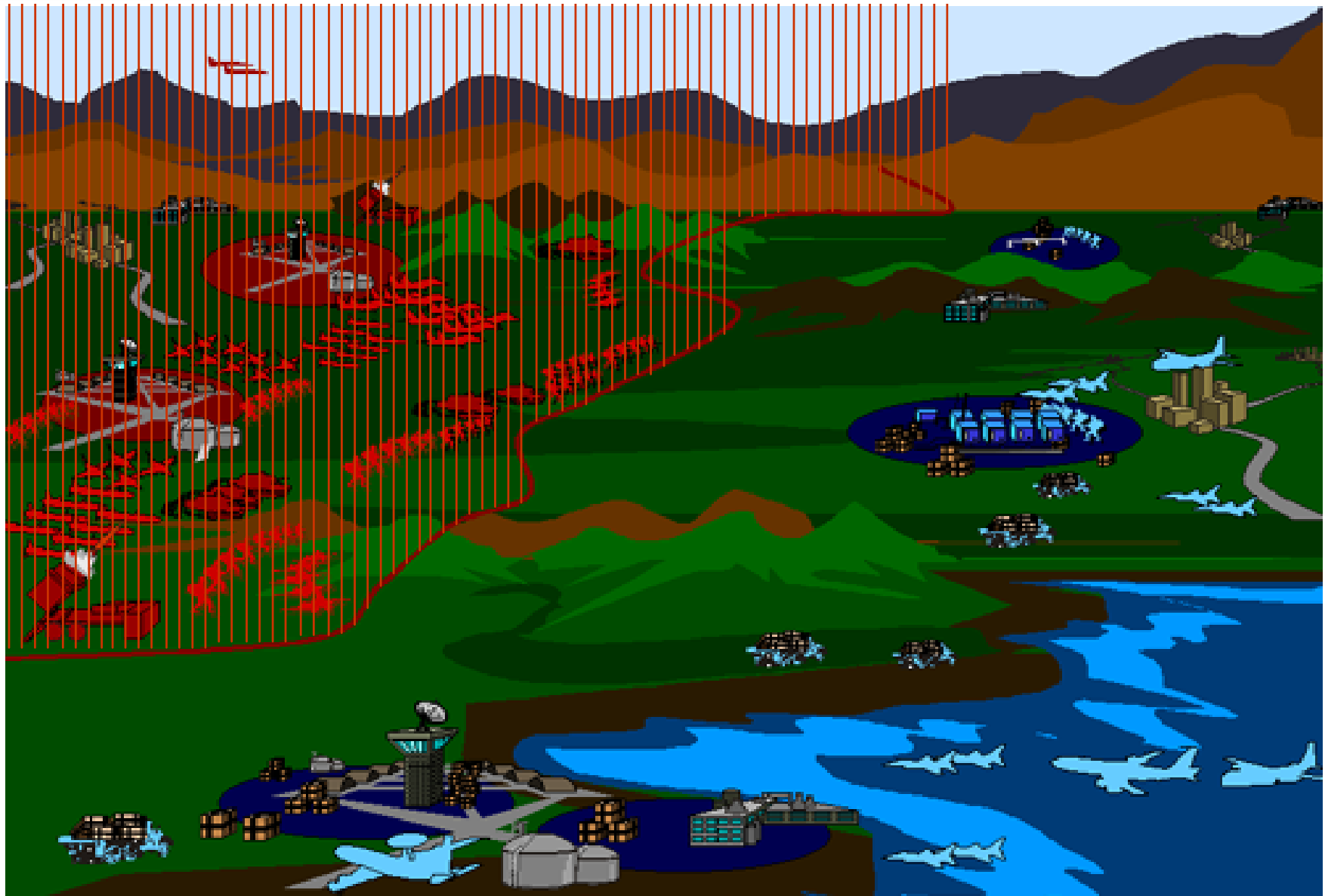


TESTING 5TH GENERATION WEAPON SYSTEMS ROUND 2: THE F-35

5TH GEN WEAPONS



This is our Situation...“A2/AD”



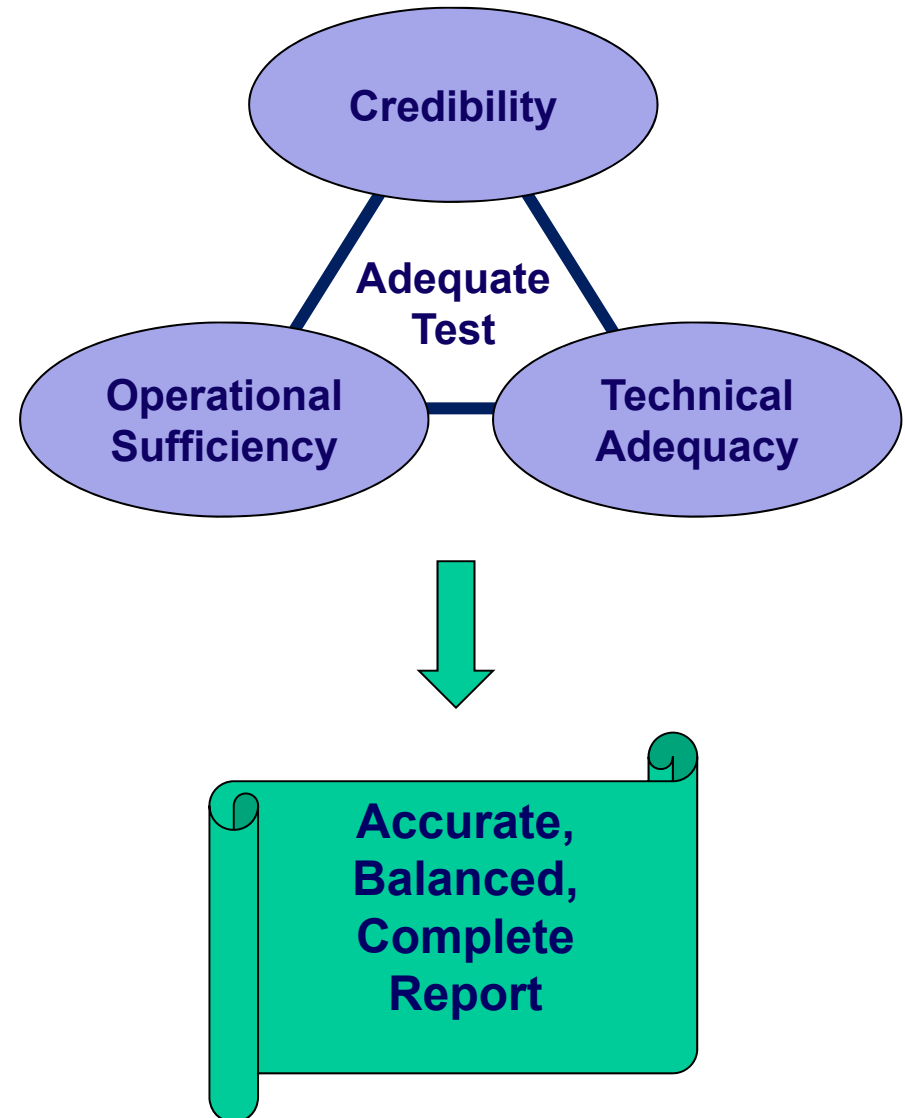
5th Gen Stealth....



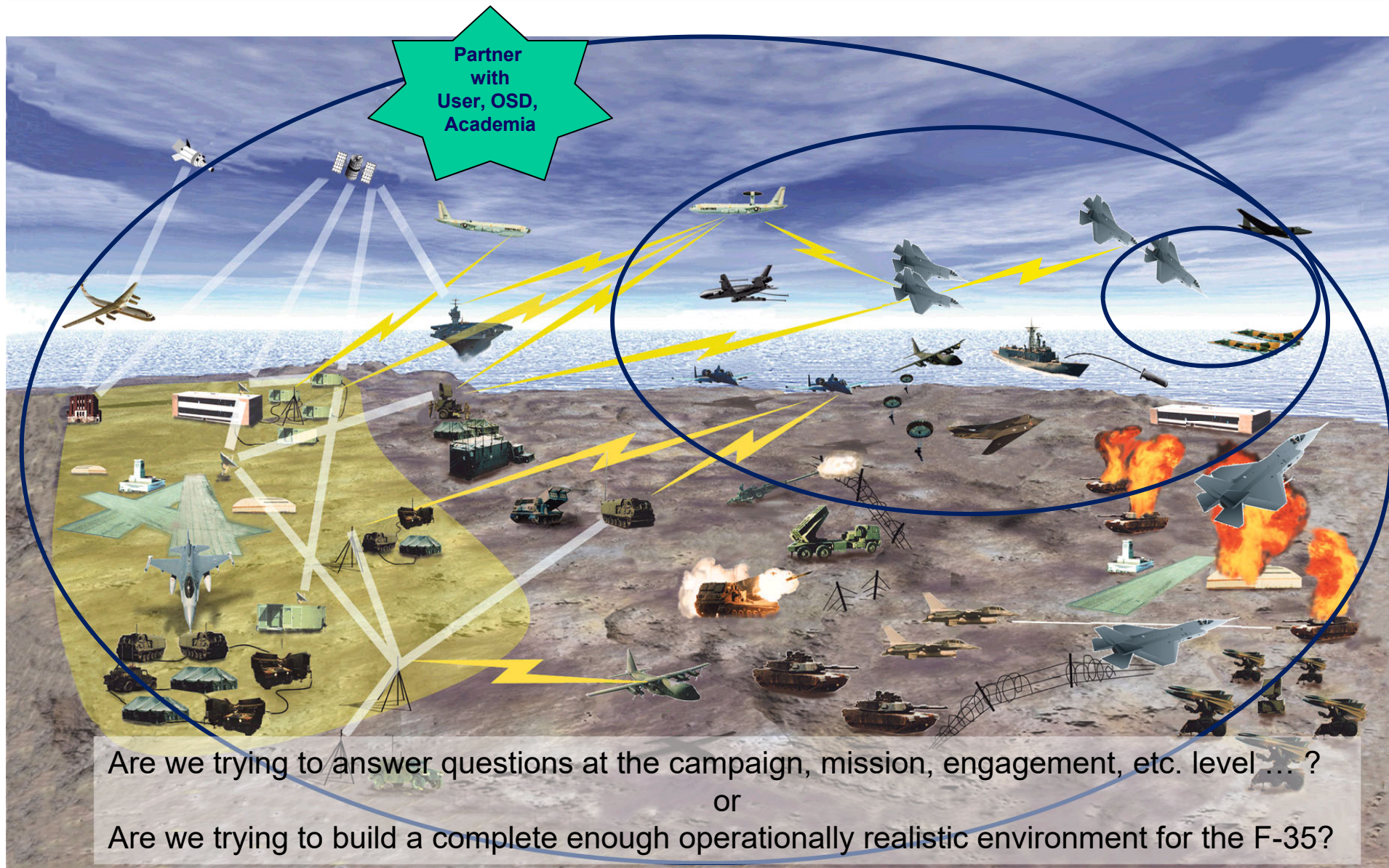
Constructing an F-35 Test



What is to be tested? Mission Capability Effectiveness and Suitability Requirements Satisfied
Understand: System Under Test Operations Battlespace Conditions
Test Design Characterize, ID Problems, Thresholds Scientific Test & Analysis Techniques Measures
Resources OAR, M&S, Instrumentation, Assets, INFO!
Execute Operational realistic
Analyze/Evaluate
Report



F-35 Battlespace



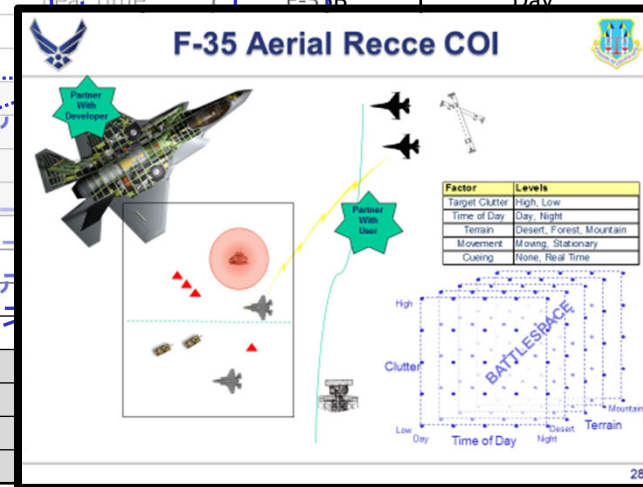
F-35 Test Design



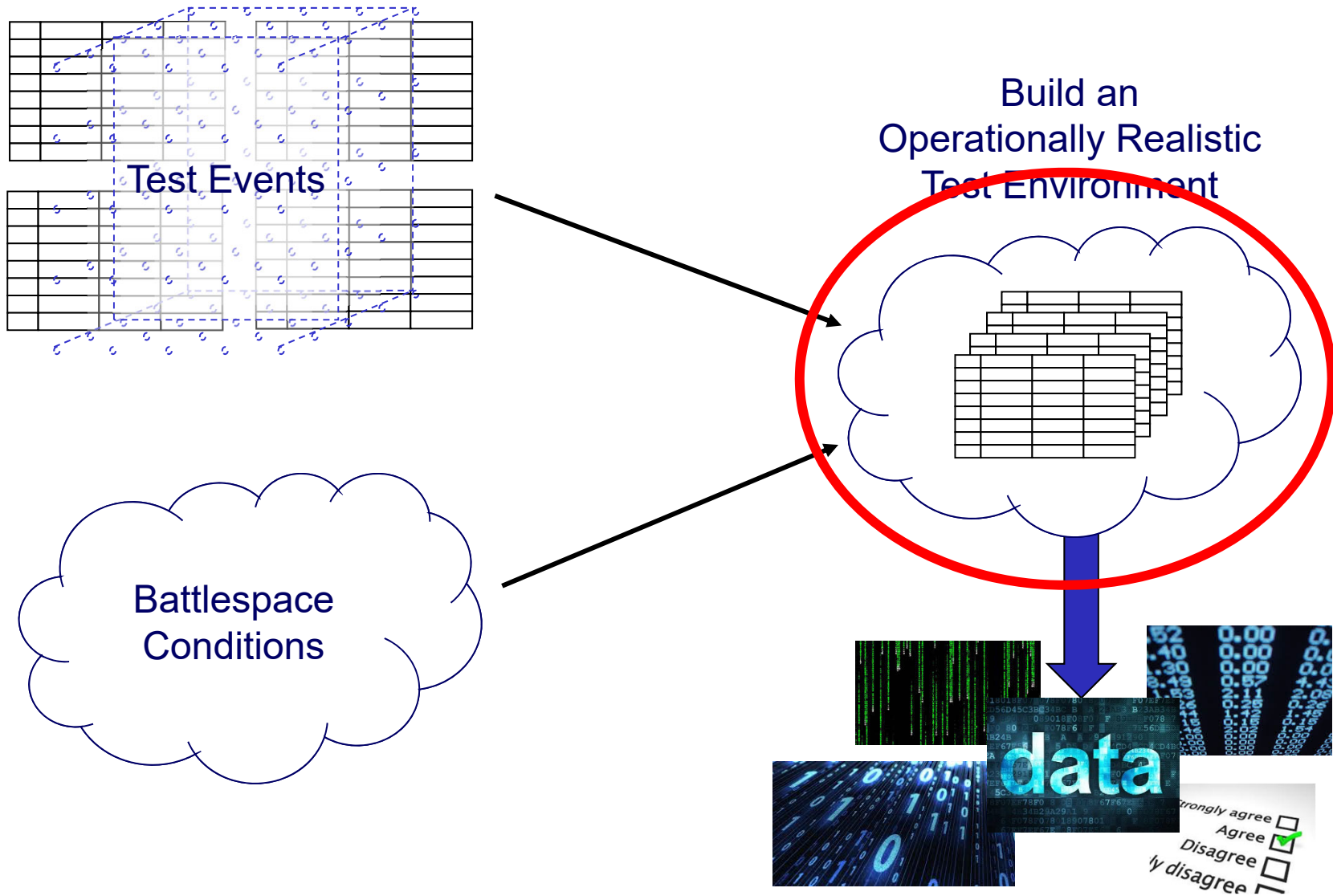
Test Trial	Design Point	Target Clutter	Priority Target Movement	Cueing	F-35 Variant	Time of Day
1	1	High	Stationary	None	F-35A	Night
	2	Low	Stationary	Real Time	F-35A	Night
	3	Low	Moving	None	F-35A	Night
	4	High	Stationary	Real Time	F-35A	Night
2	5	High	Moving	None	F-35A	Day
	6	High	Stationary	Real Time	F-35A	Day
	7	Low	Stationary	Real Time	F-35A	Day
	8	Low	Stationary	None	F-35A	Day
3	9	High	Stationary	Real Time	F-35B	Night
	10	Low	Stationary	None	F-35B	Night
	11	High	Stationary	None	F-35B	Night
	12	Low	Moving	Real Time	F-35B	Night
4	13	Low	Stationary	Real Time	F-35C	Day
	14	Low	Stationary	None	F-35C	Day
	15	High	Moving	Real Time	F-35C	Day
	16	High	Stationary	None	F-35C	Day
5	17	Low	Moving	Real Time	F-35B	Day
	18	High	Stationary	Real Time	F-35B	Day
	19	Low	Stationary	Real Time	F-35B	Day
	20	High	Stationary	Real Time	F-35B	Day
6	21	Low	Stationary	Real Time	F-35B	Day
	22	Low	Stationary	Real Time	F-35B	Day
	23	High	Moving	Real Time	F-35B	Day
	24	High	Stationary	Real Time	F-35B	Day
7	25	High	Stationary	Real Time	F-35B	Day
	26	Low	Moving	Real Time	F-35B	Day
	27	Low	Stationary	Real Time	F-35B	Day
	28	High	Stationary	Real Time	F-35B	Day
8	29	Low	Stationary	Real Time	F-35B	Day
	30	High	Moving	Real Time	F-35B	Day
	31	High	Stationary	Real Time	F-35B	Day
	32	Low	Stationary	Real Time	F-35B	Day

Partner
With
Academia

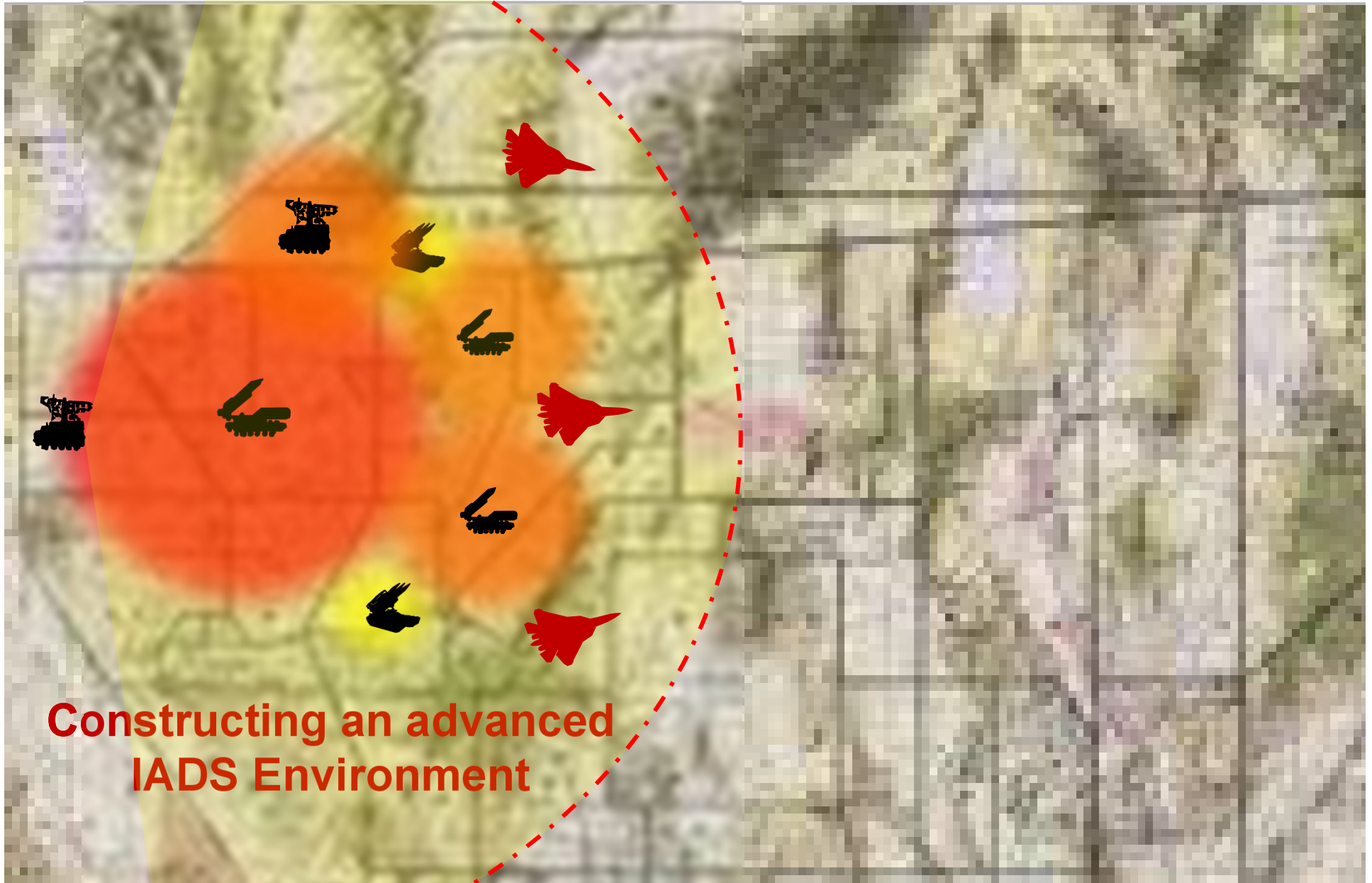
Partner
With
OSD



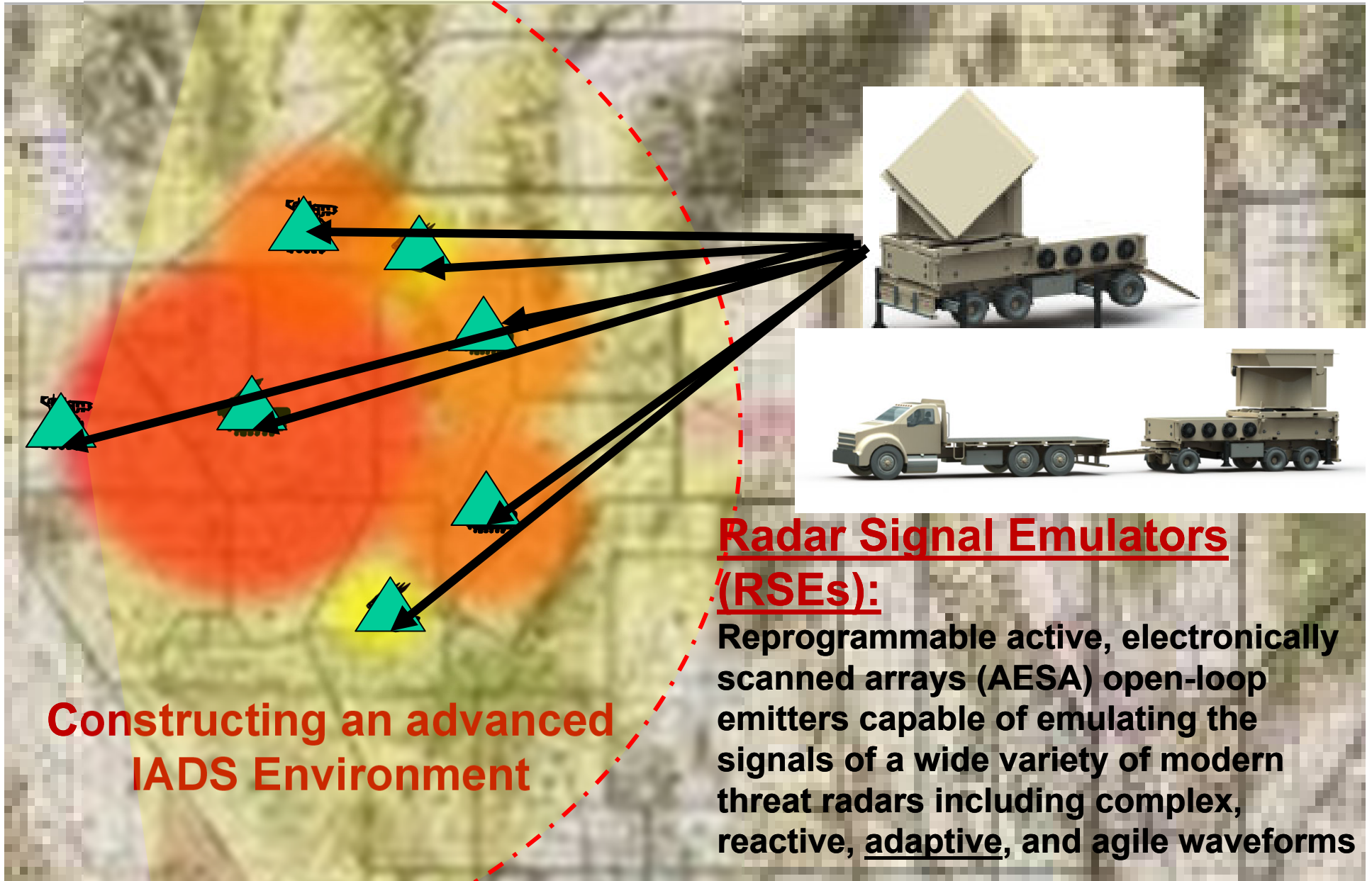
Realistic Test Environment



Operationally Realistic Test Environment



Constructing a Synthetic Realistic Threat



Constructing a Synthetic Realistic Threat



Target/Objective

Have we detected all the factor threats?

Where are the:

- Long-range SAMs?
- Medium-range SAMs?
- Short-range air defense systems?
- Non-shooter radars

What do I need to attrit or suppress to get to the target area?

Constructing an advanced IADS Environment

RSEs bring the detect/ID/geolocate and tactical employment challenges of modern, mobile SAMS into OT missions

5th-Gen Testing Challenges



- **F-22 Raptors & F-35 Lightnings have voracious appetites; they chew through the adversary with volume & velocity...**
- **Creating a complex, threat-dense environment is key to an effective 5th-gen IOT&E and for accurately quantifying operational risk**
- **Open-air testing constraints**
- ***How do we crack this nut???***

5th Gen Modeling & Sim

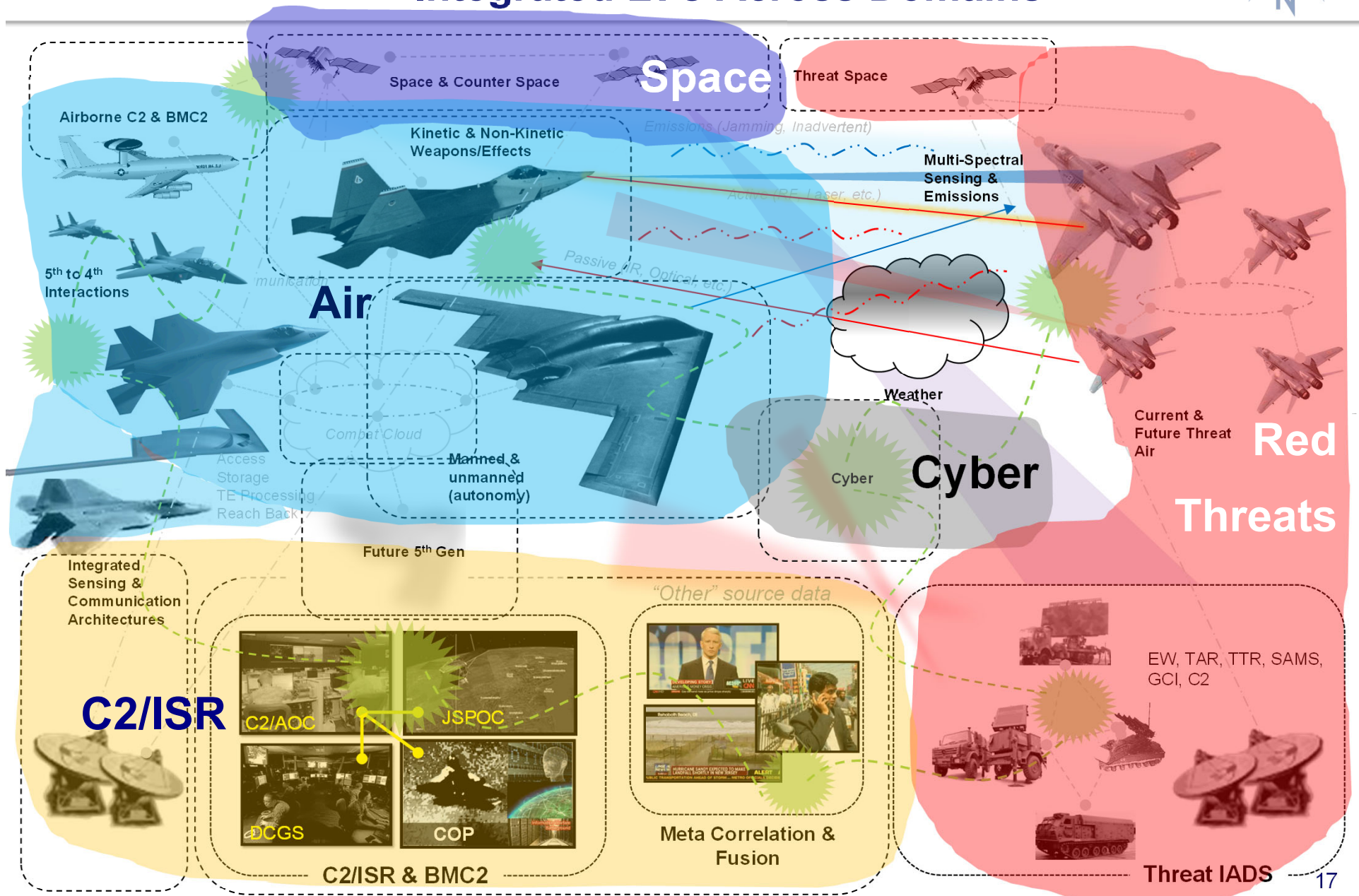


- **Creating this environment is key to an effective 5th-gen IOT&E**
 - **It allows us to fully “stress” the system under test**
- **Creating an advanced modeling & simulation environment**
 - **There are tough challenges posed by 5th-gen M&S:**
 - Creating the virtual battlespace and how the stealthy air vehicle dynamically interacts within it
 - Accurately modeling advanced threats
 - Inserting blue forces into the virtual battlespace



Modeling & Simulation

Integrated LVC Across Domains



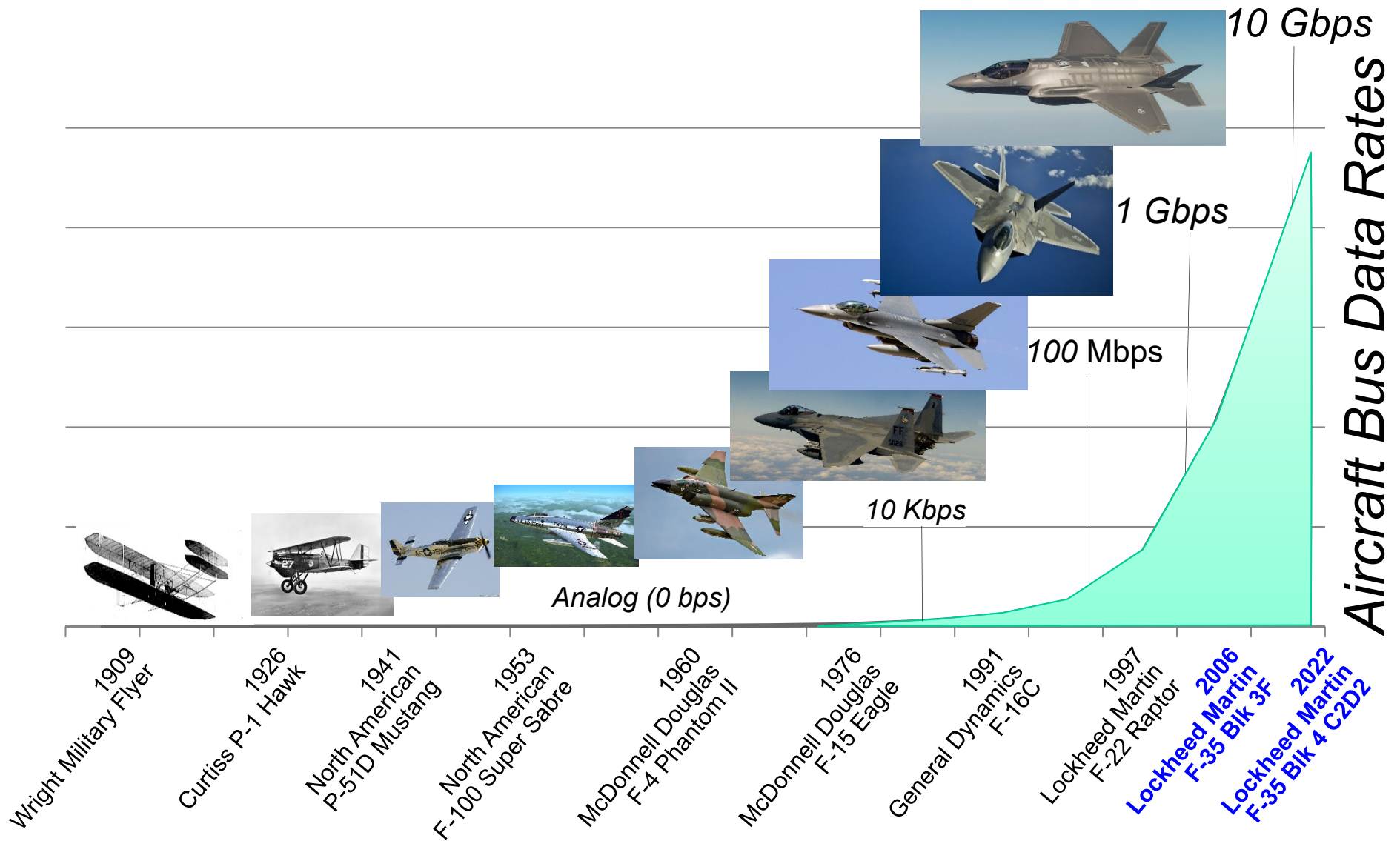
Big, well...big-ish Data



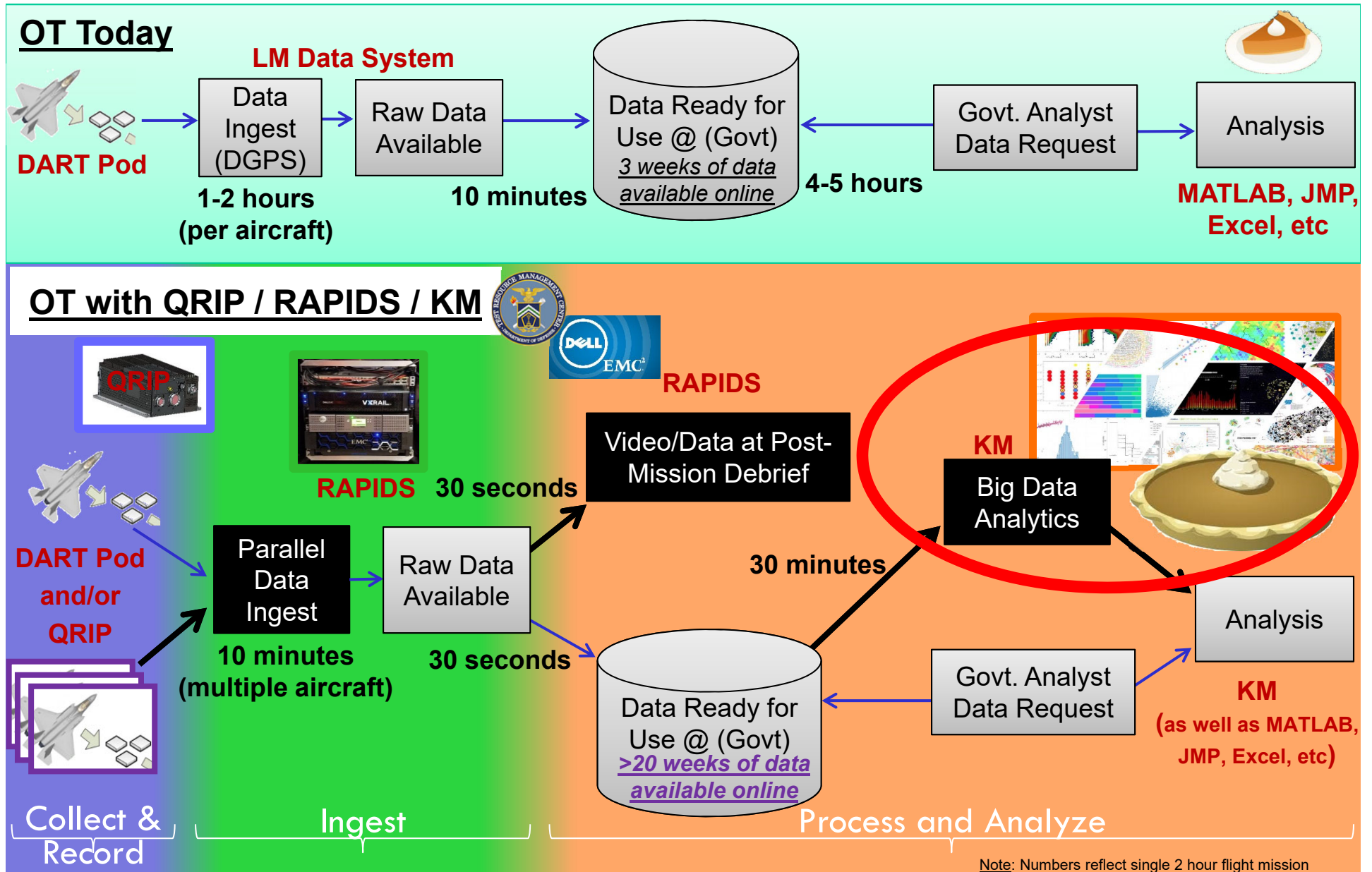
- Terabytes of data flow from F-35 OT&E sorties
...same for the M&S environment, but with potentially dozens of
“runs for score” for one test event....
- Big data analytics/knowledge management is a growth
area for 5th-Gen/3rd Offset Strategy weapons systems



Exponential Growth of Aircraft Bus Data Rates



JSF Data Evolution



Building a Big Data Strategy



- We must be prepared to adequately test emergent cyber-driven, technology-infused weapons systems leveraging the latest in techniques

- Crafting a strategy
 - Starts with a clear understanding of the problem, followed by a supporting data strategy
 - Goal is to move from siloed data bases, to a common integrated data platform to an advanced analytic environment
 - Will incorporate:
 - *Data mining*
 - *Predictive analysis*
 - *Cyber security tools*
 - *Cloud enterprise*
 - *Machine learning*
 - *Dashboards*
 - *Human capital*
 - *Education*

Big Data & Data Strategy



Federal Aviation
Administration

Data Sharing

Terminal Flight Data Manager
(TFDM)

Performance Based
Navigation
(PBN)

Next**GEN**

NEXTGEN PRIORITIES



Federal Aviation
Administration

Destination2025

Executive Summary

The Destination 2025 vision captures the ideal future we strive toward – a transformation of the Nation's aviation system in which air traffic will move safely, swiftly, efficiently, and seamlessly around the globe. Flights will take off and land on time, every time, without delay and there will be no fatal accidents. Air travel will be routine and uneventful for everyone involved: passengers, crews, ground support, and communities. Costs will be contained for both operators and passengers, and there will be no negative impact to the environment. Manned and unmanned flights will each achieve safe flight, as will commercial launches to space. This is a vision that captures the future we will strive to achieve – to transform the Nation's aviation system by 2025.

Delivering Aviation Access through Innovation

Our Goal

Enhance the flying experience of the traveling public and other users by improved access to and increased capacity of the nation's aviation system. Ensure airport and airspace capacity are more efficient, predictable, cost-effective and matched to public needs.



Experimentation & Prototyping



- Acquisition history has shown competitive system prototyping, followed by live experimentation on the ranges and quick iterations on system design helped earlier defense systems evolve quickly



Experimentation & Prototyping



Searching for a Threat-Representative Aerial Target



Introducing “5GAT”

- **5th-Generation Aerial Target, “5GAT”**
 - DOT&E-led prototyping effort, focused in innovative and disruptive technologies, tools, and business processes with the goal of delivering two 5th generation, unmanned targets for advanced test and training needs:
 - ✓ Representative: *size, stealthiness, speed, maneuverability, EA*

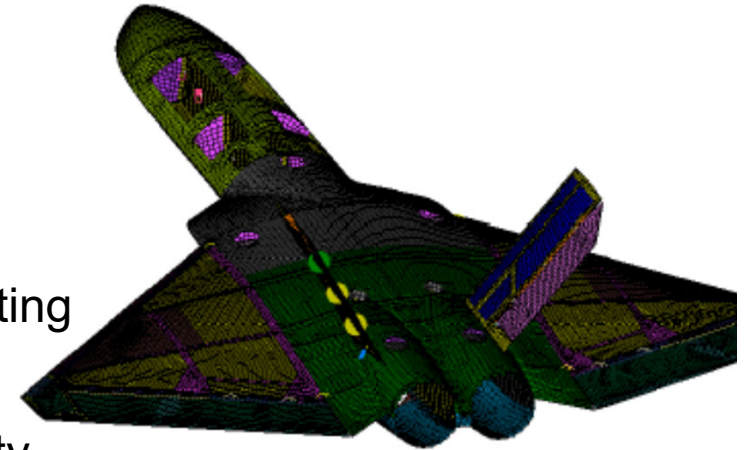


5GAT Prototype

- **“Old School” Approach:**

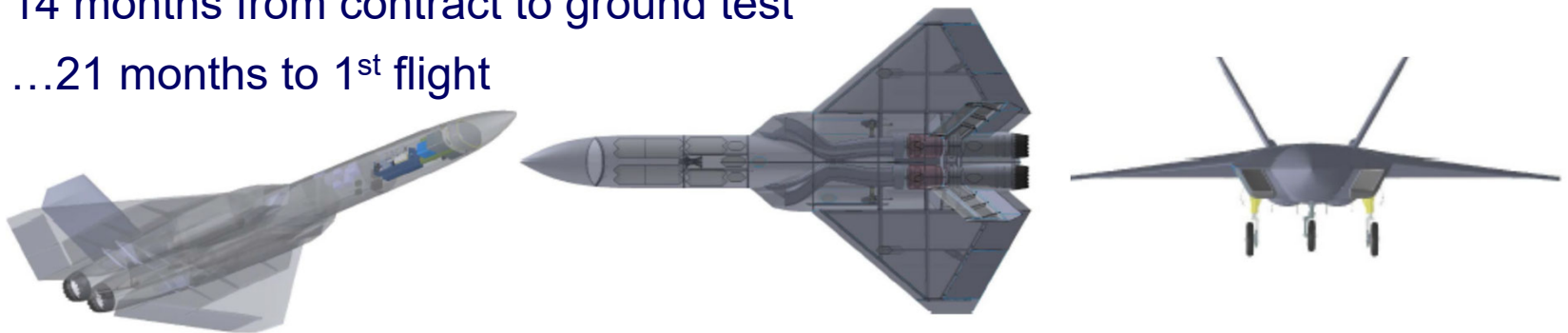
- **Stable & demo-focused requirements:**

1. High confidence cost data
2. Meet RCS goals for advanced 5th gen testing
3. Demonstrate required aero performance
4. Integrate and demo advanced EA capability



- **Agile Contracting**

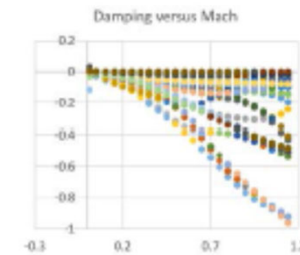
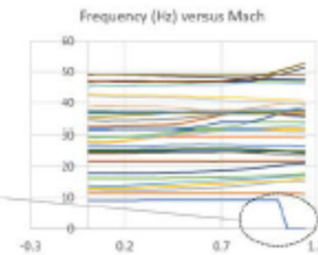
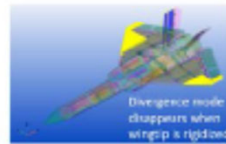
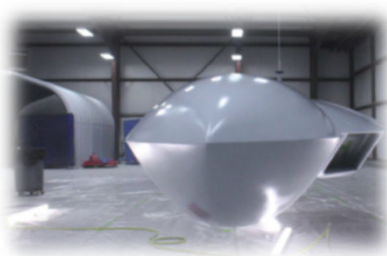
- 14 months from contract to ground test
 - ...21 months to 1st flight



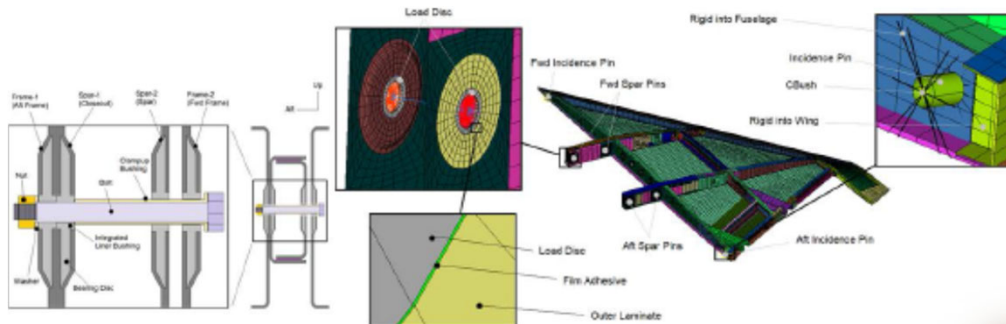
5GAT Prototype

- “Old School” Approach:

- Entirely gov’t owned design, tools, data, & code



- Simple parts & reduced number of tools

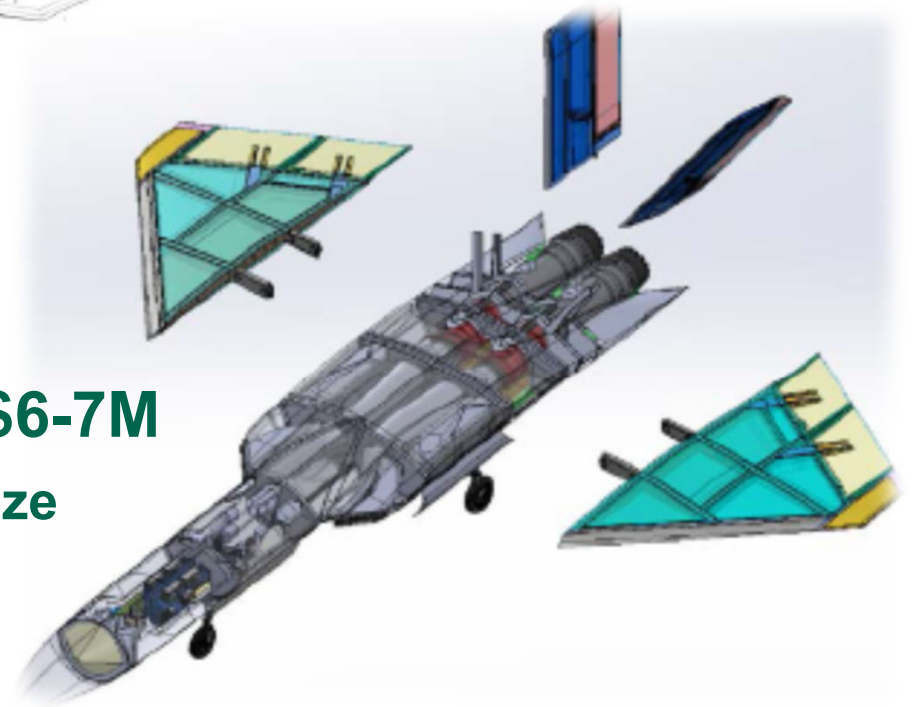
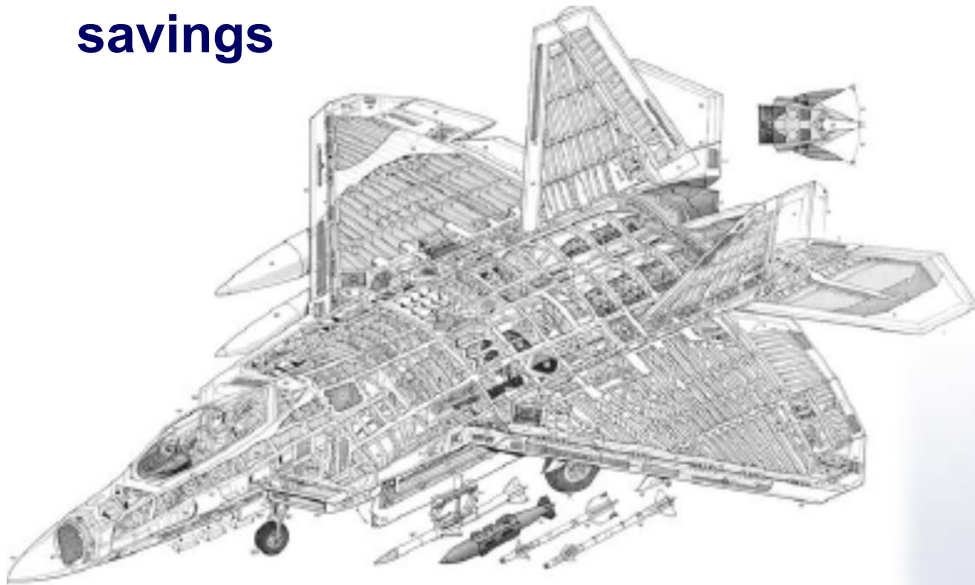


- Design simplicity & soft tooling



5GAT Prototype

- “Old School” Approach:
 - Reduced parts, simple parts, soft tooling = Order of magnitude savings



- Cost Estimate: \$6-7M
 - Full scale, F-16 size

How Does this Apply?



Governmental agencies should embrace more entrepreneurial & experimental approaches

- ✓ **Involvement will likely be non-traditional**
- ✓ **Integrated (labs/developers/testers/users)**



Take-Aways Prototyping & Experimentation



- Focus: To learn...*quickly*
- Remove the **Acq red tape**...fund fast (inside the POM)
- Fail Forward...*Fast*
- Gov't needs to “own it” (risk, tools, data)
- Integrated testing (labs, developer, DT, OT, operators)
- Fly before you buy...
- Go for the 80% solution

Overall Take-Aways

Complex systems thinking



- ✓ Don't over think it... “old school's good school” wrt test design
- ✓ Setting an appropriate analysis aperture is critical
- ✓ M&S will play an ever-increasing role wrt system analysis
- ✓ Big data will continue to get bigger...how's your data strategy??
- ✓ Prototyping & experimentation are useful acquisition tools
- ✓ Integrated testing (CT/DT/OT....Agile-type) may help meet the pace of need

Questions and Comments

