US Air Force Digital Enterprise

Col Paul Harmer, PhD

Deputy Director Engineering, AFMC

Dr Paul Hartman

Former Director, Ctr Ops Analysis, AFIT

BOEING is a trademark of Boeing Management Company
Copyright © 2018 Boeing. All rights reserved.
Copyright © 2018 Northrop Grumman Corporation. All rights reserved.

Colonel Paul K. Harmer, PhD

Colonel Paul K. Harmer is the Deputy Director of Engineering and Technical Management, Headquarters Air Force Materiel Command, Wright-Patterson Air Force Base, Ohio. In this capacity he assists in leading the force development, training, processes, procedures, and tool deployment for 14,000 military and civilian scientists, technicians, and engineers who ensure the technical rigor of weapons system programs totaling $60 billion. Additionally, Col. Harmer drives digital enterprise and weapons system cyber initiatives across the Command.

Col Harmer has served the Air Force and Joint warfighting community in a broad array of air, space, and cyberspace assignments. He holds a BS and PhD in Electrical Engineering and an MS in Computer Engineering. Additionally, he is a graduate of the U.S. Air Force Test Pilot School. Col Harmer has flown over 35 aircraft types including F-15D/E, F-16B/D, T-38A/C, B-17G, B-52H, and KC-135R.

DISTRIBUTION A. Approved for public release, distribution unlimited.

BOEING is a trademark of Boeing Management Company
Copyright © 2018 Boeing. All rights reserved.
Copyright © 2018 Northrop Grumman Corporation. All rights reserved.

Dr. Paul L. Hartman

Global Product Data Interoperability Summit | **2018**

Dr. Paul L. Hartman is Executive Vice President, RGBSI Federal. In this capacity, Dr. Hartman is responsible for all RGBSI executive-level client engagement across the United States Federal Government. Dr. Hartman has more than 30 years of professional experience supporting the United States Federal Government, most recently as Director, Center for Operational Analysis where he led a team of more than 100 multi-disciplinary Ph.D.'s and analyst focused on providing quantitatively defensible solutions to some of the United States Federal Government's most complex issues. Dr. Hartman's education includes B.S. from the University of Maryland, M.A. from the University of Dayton, both M.S. and Ph.D. from the Air Force Institute of Technology Graduate School of Engineering and Management, and a Certificate in Executive Leadership Development from the University of Notre Dame. Dr. Hartman's honorarium includes five United States Department of Defense Meritorious Service Medals and the Department of the Air Force Meritorious Civilian Service Award.

BOEING is a trademark of Boeing Management Company
Copyright © 2018 Boeing. All rights reserved.
Copyright © 2018 Northrop Grumman Corporation. All rights reserved.

Air Force Materiel Command

US Air Force Digital Enterprise

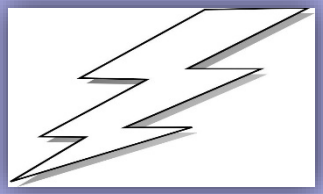
Col Paul Harmer, PhD
HQ AFMC/EN

Dr Paul Hartman
AFIT COA

Sep 2018

DISTRIBUTION A. Approved for public release, distribution unlimited. AFMC-2018-0355

Welcome to the Revolution

1st Industrial Revolution	2nd Industrial Revolution	3rd Industrial Revolution	4th Industrial Revolution
			

"Artificial intelligence is the future... It comes with colossal opportunities, but also threats that are *difficult to predict*. Whoever becomes the leader in this sphere will become the ruler of the world."

-Russian President Vladimir Putin

- Internet of things
- Cloud computing
- Artificial Intelligence

Industry 4.0

DISTRIBUTION A. Approved for public release, distribution unlimited.

OSD's Digital Engineering Strategy

1. Formalize the **development, integration and use of models** to inform enterprise and program decision making
2. Provide an enduring **authoritative source of truth**
3. Incorporate **technological innovation** to link digital models of the actual system with the physical system in the real world
4. Establish supporting **infrastructure and environments** to perform activities, collaborate, and communicate across stakeholders
5. Transform a **culture and workforce** that adopts and supports Digital Engineering across the lifecycle

https://www.acq.osd.mil/se/initiatives/init_de.html

Distribution Statement A –. Distribution is unlimited.

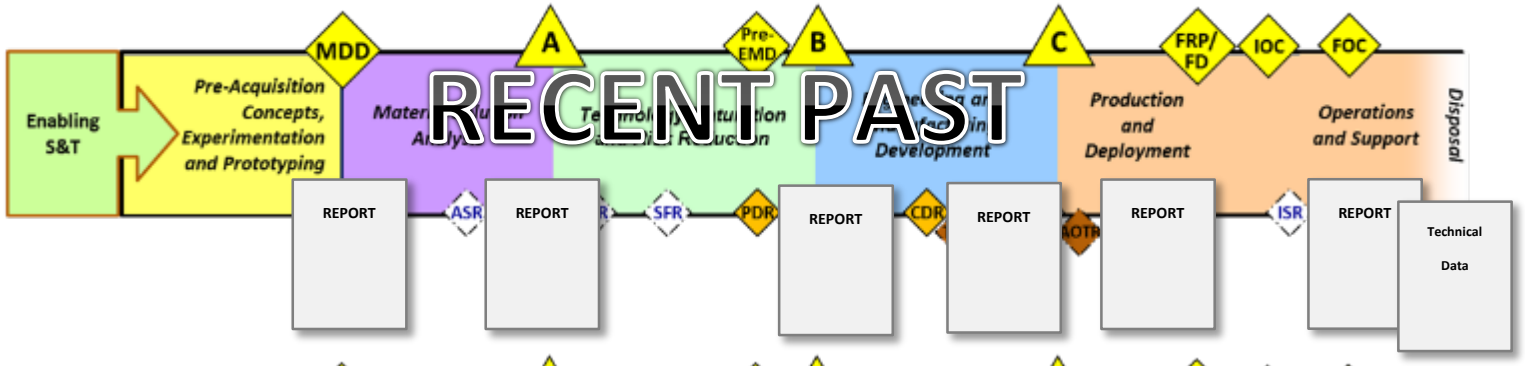
Digital Engineering Strategy: Five Goals

OSD DE video:
https://www.acq.osd.mil/se/initiatives/init_de.html

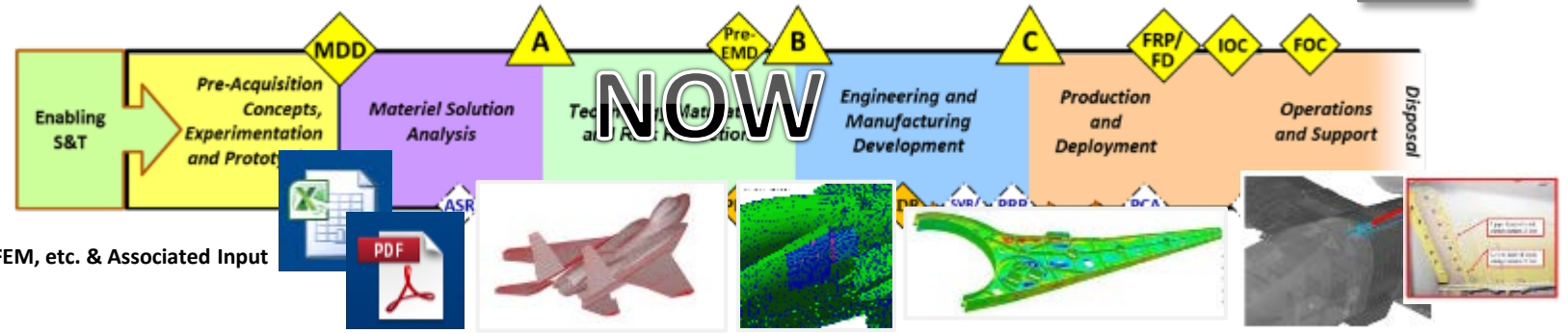
Distribution Statement A –. Distribution is unlimited.

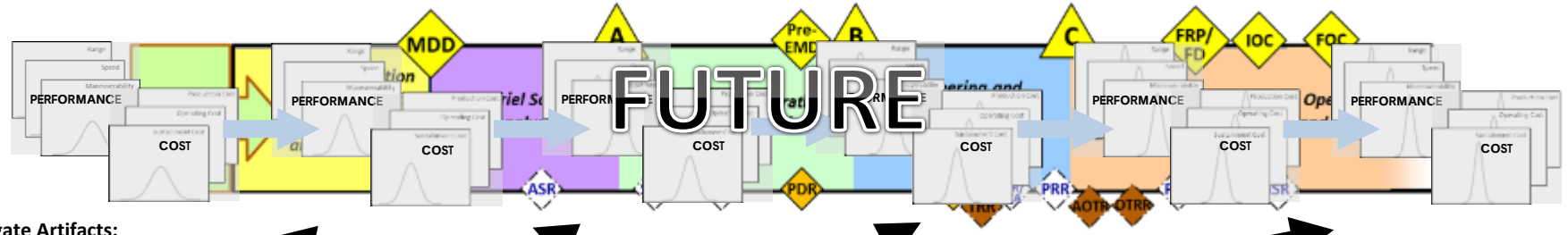
AF Digital Enterprise Journey

Paper or Digital Artifacts:
Reports & Technical Data



Model-centric Artifacts:
Spreadsheets, CAD, CFD, FEM, etc. & Associated Input & Results Files/Reports



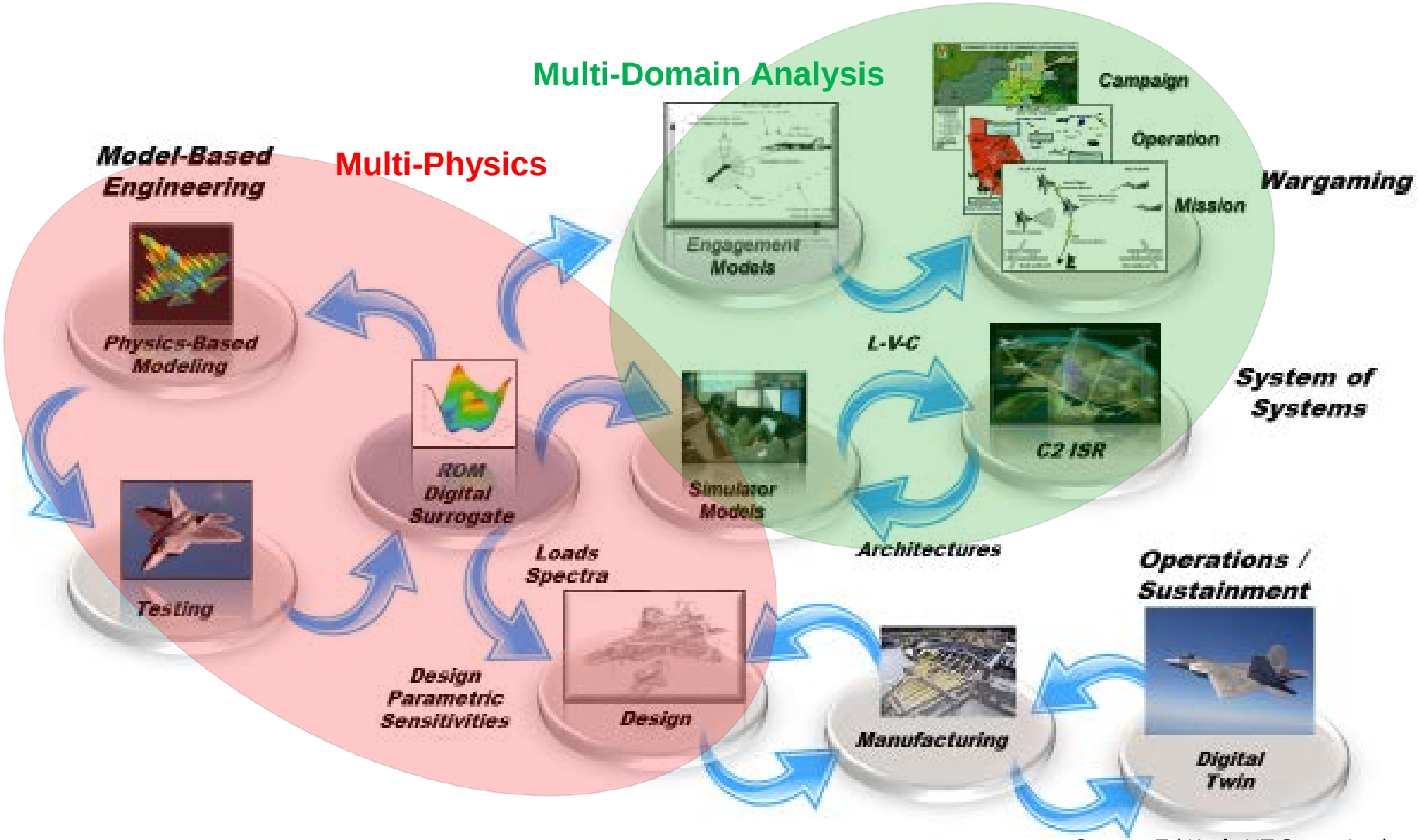


Digital Surrogate Artifacts:
Interoperable, validated surrogate models of system and subsystems at multiple levels of abstraction

Authoritative Data Source

DISTRIBUTION A. Approved for public release, distribution unlimited.

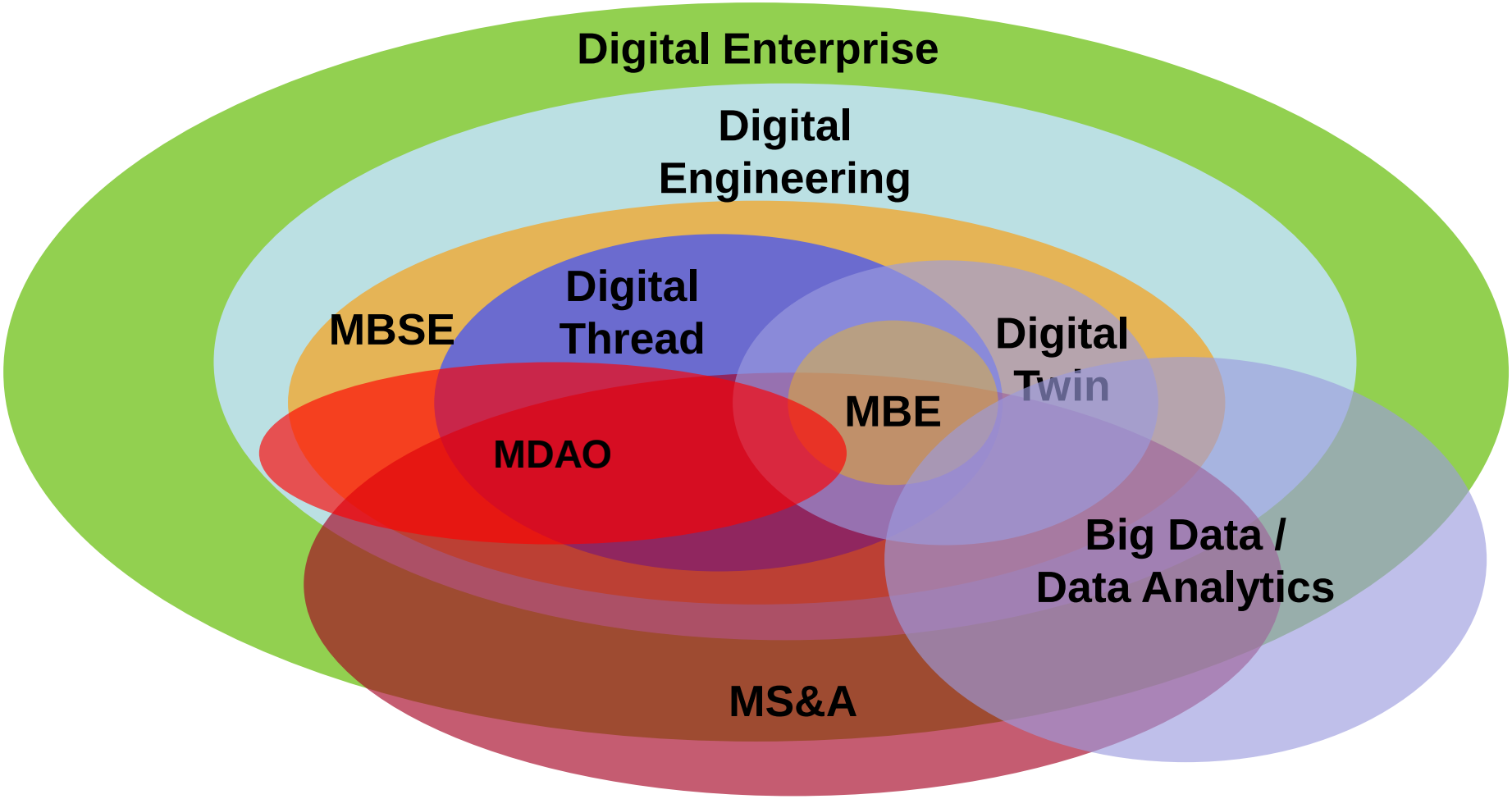
Multi-Discipline Analysis & Optimization



Source: Ed Kraft, UT Space Institute

DISTRIBUTION A. Approved for public release, distribution unlimited.

Digital Enterprise Ecosphere



DISTRIBUTION A. Approved for public release, distribution unlimited.

NOT TO SCALE

Some On-Going Efforts

- **OSD – Digital Engineering Strategic Guidance**
- **EEEC – MITRE Sprint I, II and III, AFSERC, CREATE Demo**
- **AFRL – Agile Pod, LCAAT, MRB Process, Tech Data Needs, DTh/DTw**
- **AFLCMC – DEATHSTARs, AM, CD Sprints, PLM-CI, CBM+**
- **AFSC – Reverse Engineering and Critical Tooling (REACT)**
- **AFNWC – Ground-Based Strategic Deterrent (GBSD)**
- **AFTC – Application of Digital Thread to Flight Test**

The future is here. It is just not evenly distributed

- William Gibson

DISTRIBUTION A. Approved for public release, distribution unlimited.

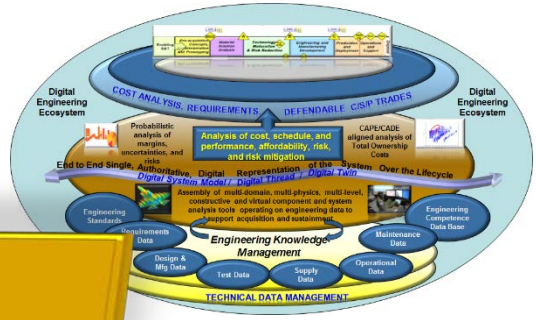
Enterprise DE State of the Union

Governance

Policy

Data Rights

Tools



Informed Flightplan for AF Digital Enterprise

DEE Project Cloud
Discovery, Facilitation

Proj 1, Proj 2,
AFRL, OSD
Proj 3, Proj …,
XZE, **Navy, Army**
CREATE Demo

Coalition of the Willing

DISTRIBUTION A. Approved for public release, distribution unlimited.

Digital Enterprise Flightplan

U.S. AIR FORCE

	FY18	FY19	FY20	FY21	FY22+	Desired End State
Manage the Data						- Data is accessible, understood, actively shared across the enterprise, and is sufficiently trustworthy to drive informed decisions
Man… th… Proc…						- A data driven process for all … data … als
Provi… Mana… Resou…						…g right
Provide Standards, Architecture, & Framework						- Consistent framework for developing, defining, & evaluating 1-n list digitally - Architectures allow use of tools across classification
Address Culture						- "We all just do it" - Common understanding of DE capabilities/risk/terminology - "On Demand" reviews

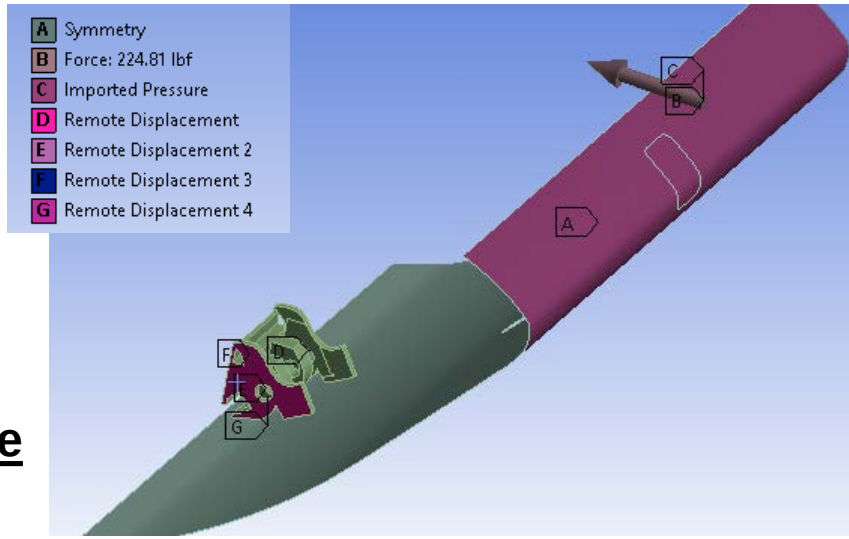
This just in:

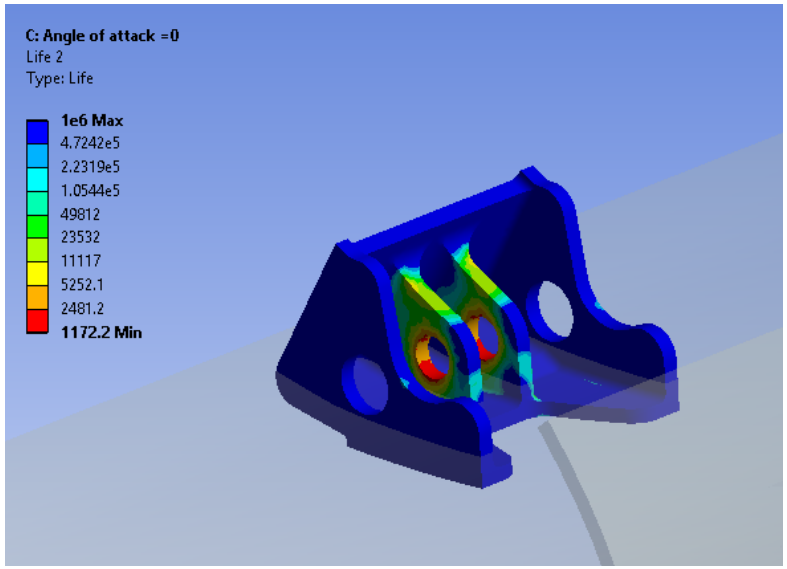
- **SAF/AQ Rapid Prototyping Memo, 13 Jun 18**
  - **Calls for use of Digital Enterprise, Agile SW, etc.**
  - **Go Faster *with* rigor**
- **SAF/AQ DoDI 5000.02 and Rapid Acquisition Memo, 10 Aug 18**
  - **"We get what we reward…"**
  - **"…reward things like speed and digitization"**

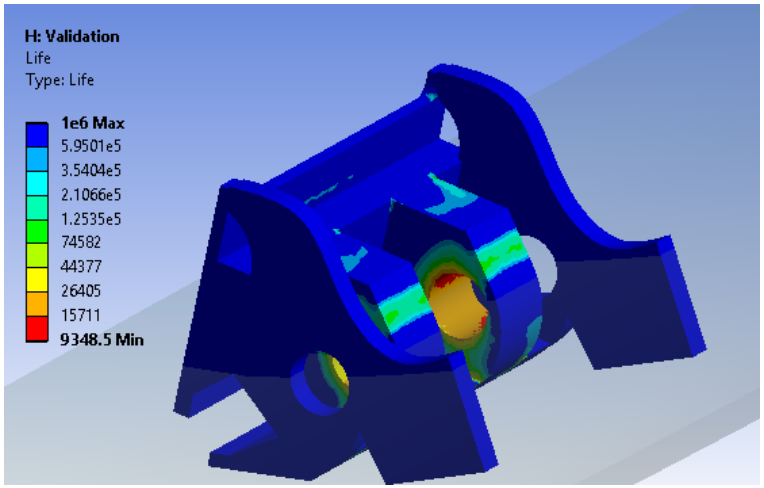
DISTRIBUTION A. Approved for public release, distribution unlimited.

A-10 Multi-Physics Demo

- CFD for external aero loading
- Inertial loads from slat actuation
- Combine loading scenarios for fatigue analysis
- Shape & topology optimization
- Mass from 2.5 to 2.2 lbs.
- <u>Life from 1100 to 9300 cycles, 8x increase</u>



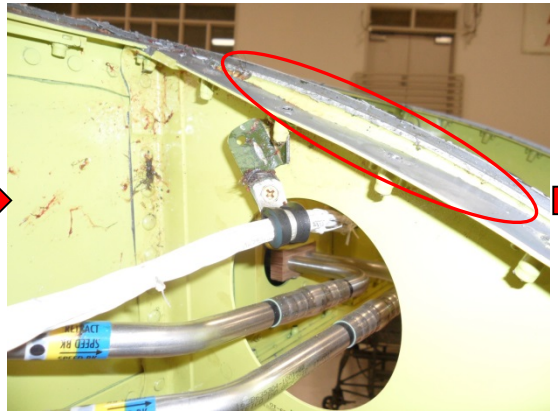




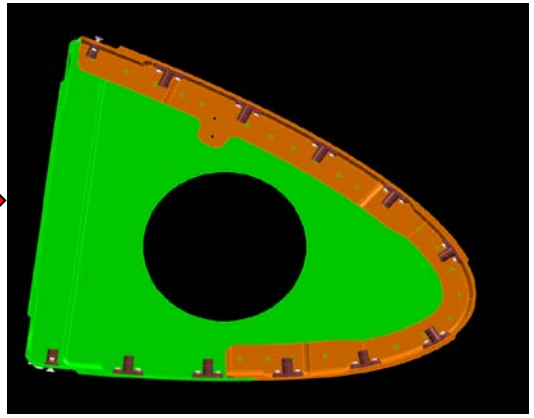
DISTRIBUTION A. Approved for public release, distribution unlimited.

Technical Data Package Demo

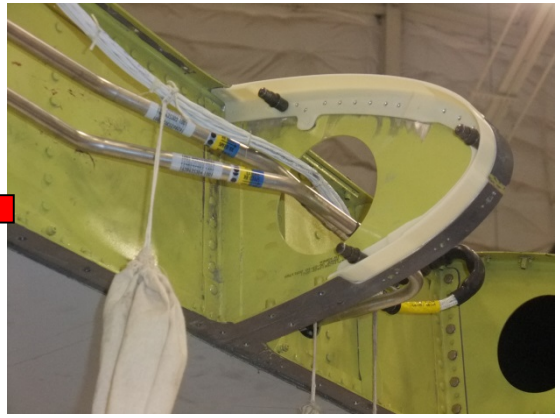
Bird Strike Area



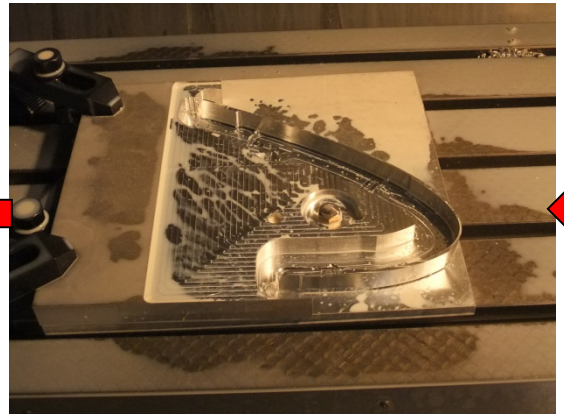
Damage to Leading Edge



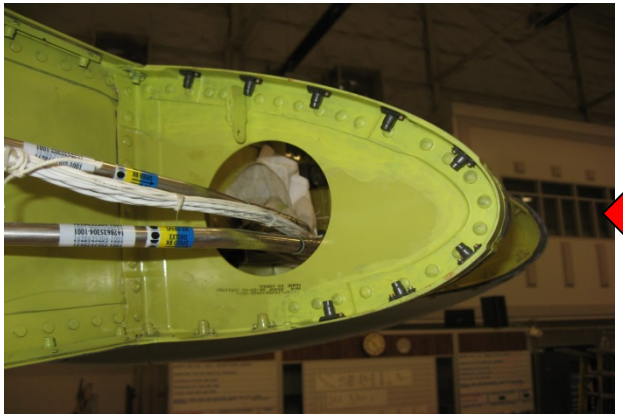
CAD Model of Repair



Test fit of 3D Printed Repair Part



CNC Milling of Repair Part



Final Installed Repair

DISTRIBUTION A. Approved for public release, distribution unlimited.

Augmented Reality for Aircraft Maintenance

Inside the HoloLens

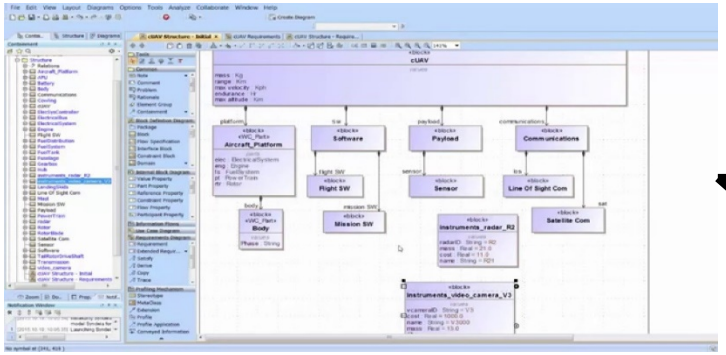
1. Camera
2. Computer
3. Lenses
4. Vent
5. Sensor
6. Buttons

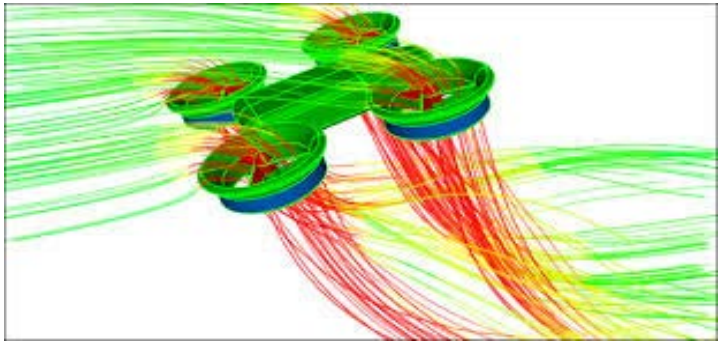
Augmented reality leveraging a Digital Thread ecosystem to improve maintenance execution & data collection

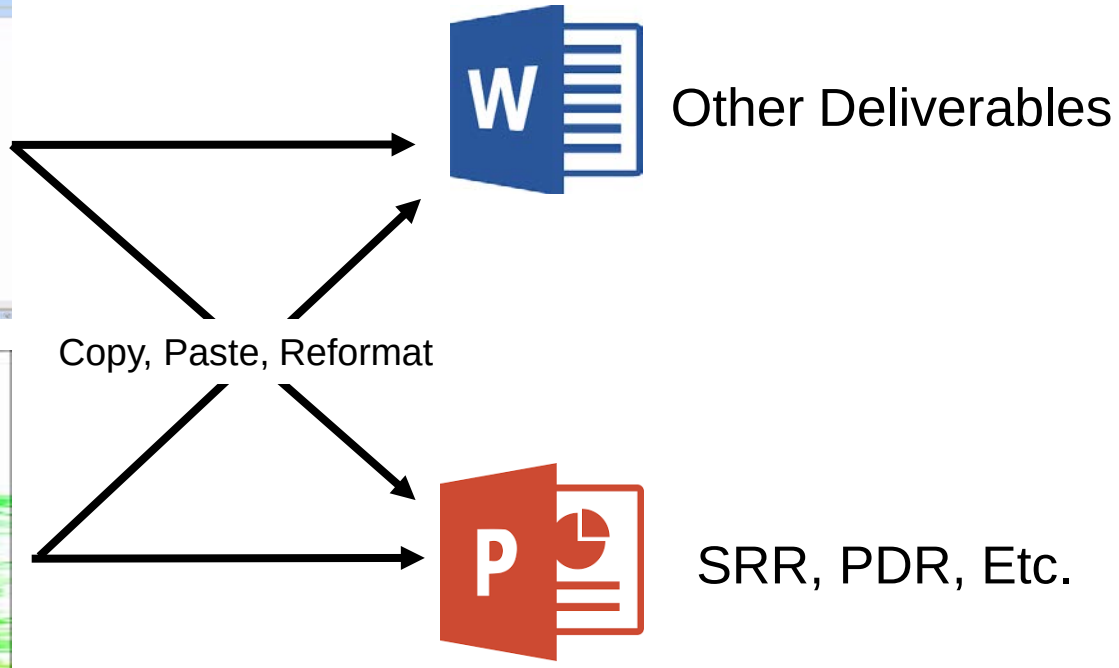
DISTRIBUTION A. Approved for public release, distribution unlimited.

Challenges

- Major Primes are implementing model-based processes
  - “Dumbing down” deliverables per contracts







Stop Double Work (Creating Models *AND* Digital Artifacts)

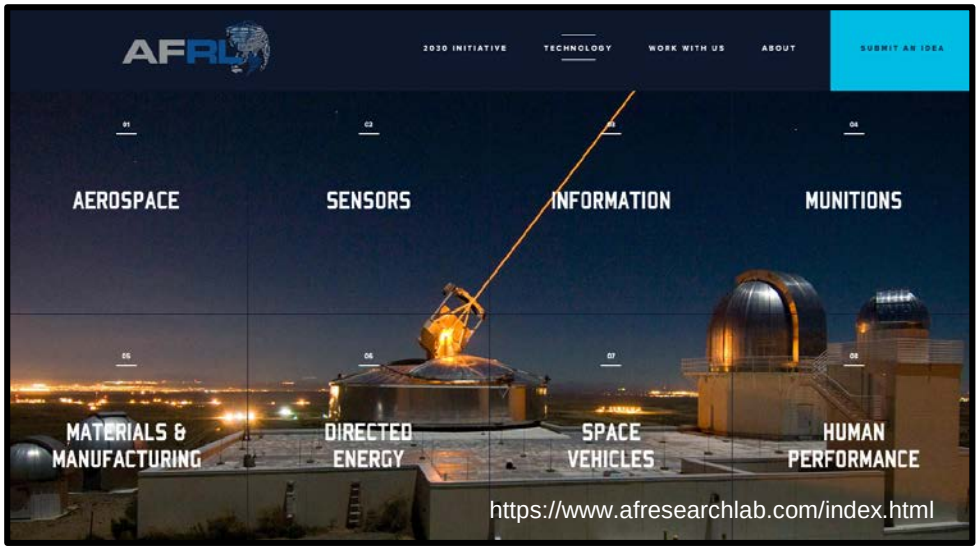
Get Engineers back to doing Engineering

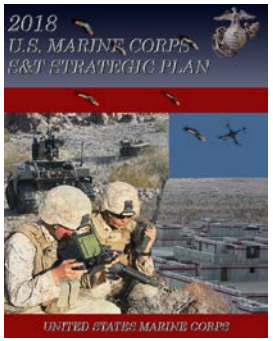
DISTRIBUTION A. Approved for public release, distribution unlimited.

The Race to 'Innovate'

AFIT
AIR FORCE INSTITUTE OF TECHNOLOGY

The AFIT of Today is the Air Force of Tomorrow.





"We live in a time of global access to technology and scientific talent. This easy access is part of the reason we can no longer claim clear U.S. technological superiority within the world. In a world with near equal access to technology, speed is becoming a discriminator. ***Not just speed of discovery, but speed of delivery. How fast we can develop, adopt, or leverage technology to meet the warfighter's needs*** and get it into their hands, will determine our ability to outpace our adversaries."

MS. MARY J. MILLER, PRINCIPAL DEPUTY, ASSISTANT SECRETARY OF DEFENSE FOR RESEARCH AND ENGINEERING
Armed Services Subcommittee on Emerging Threats and Capabilities (14 March 2018)

Office of Naval Research
USN
ONR
Science & Technology

DARPA
DEFENSE ADVANCED RESEARCH PROJECTS AGENCY

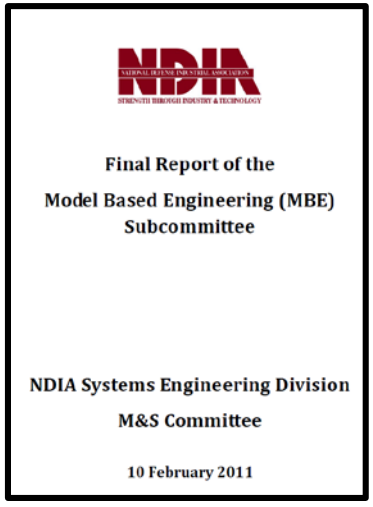
DISTRIBUTION A. Approved for public release, distribution unlimited.

Digital Engineering Environment

Understanding the DE Landscape

AFIT Air Force Institute of Technology

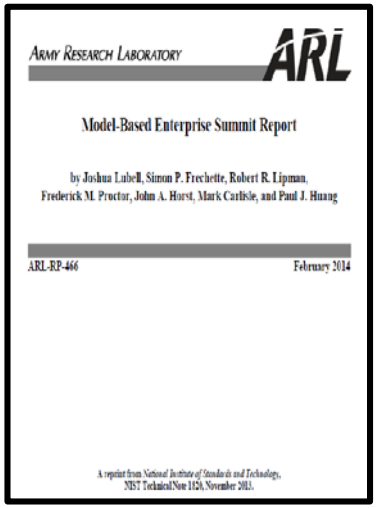
The AFIT of Today is the Air Force of Tomorrow.


NDIA

Final Report of the
Model Based Engineering (MBE)
Subcommittee

NDIA Systems Engineering Division
M&S Committee

10 February 2011

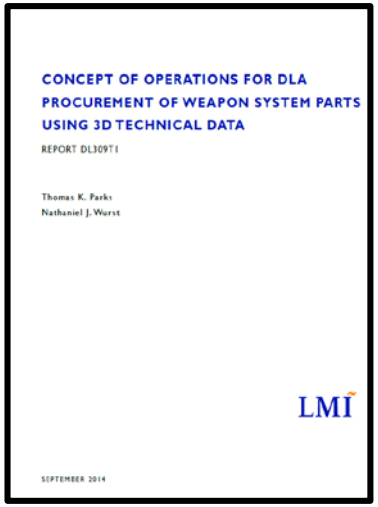

Army Research Laboratory ARL

Model-Based Enterprise Summit Report

by Joshua Lubell, Simon P. Frechette, Robert R. Lipman, Frederick M. Proctor, John A. Horst, Mark Carlisle, and Paul J. Huang

ARL-RP-466 February 2014

A reprint from National Institute of Standards and Technology, NIST Technical Note 1826, November 2013.

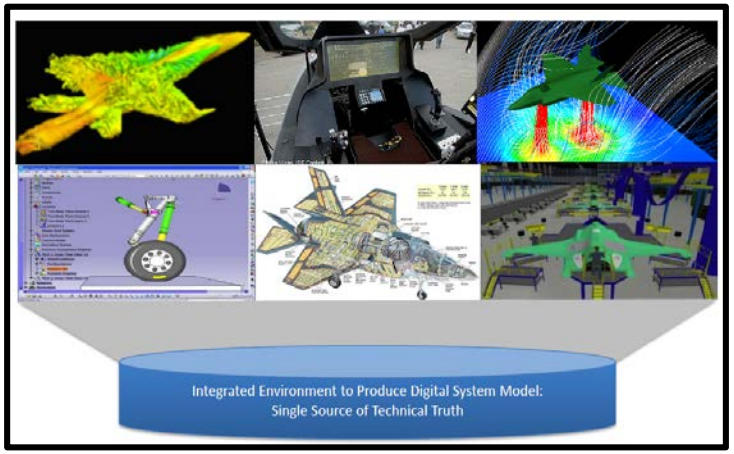

CONCEPT OF OPERATIONS FOR DLA PROCUREMENT OF WEAPON SYSTEM PARTS USING 3D TECHNICAL DATA

REPORT DL309T1

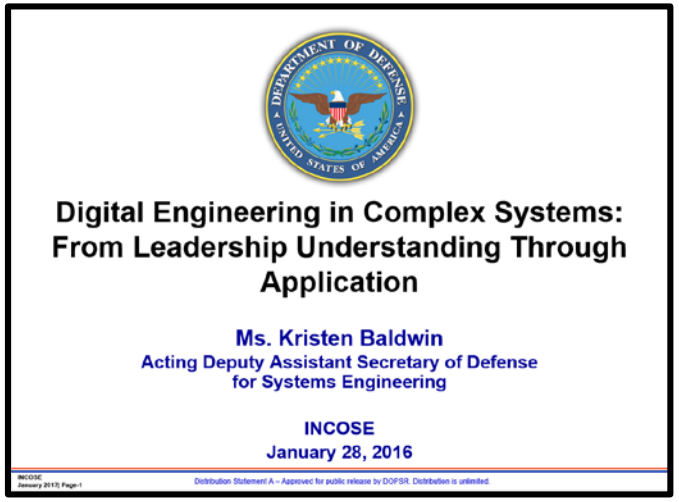
Thomas K. Parks
Nathaniel J. Wurst

LMI

SEPTEMBER 2014



m.plm.automation.siemens.com, mosimtec.com, www.defenseindustrydaily.com, www.darkgovernment.com


Digital Engineering in Complex Systems: From Leadership Understanding Through Application

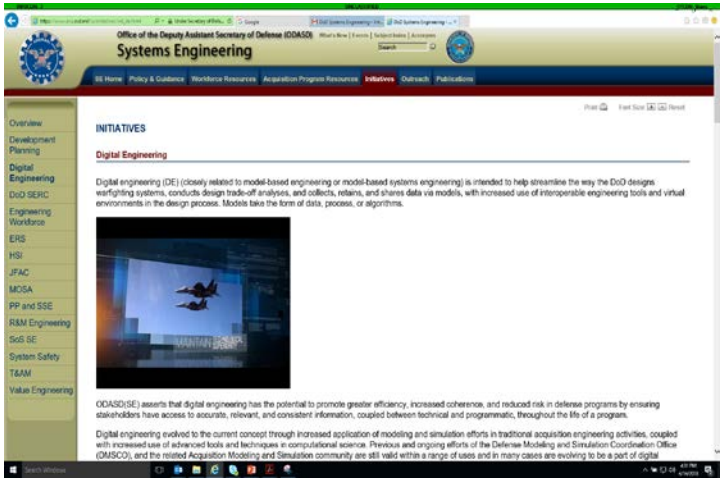
Ms. Kristen Baldwin
Acting Deputy Assistant Secretary of Defense for Systems Engineering

INCOSE
January 28, 2016

INCOSE January 2017| Page-1

Distribution Statement A – Approved for public release by DOPSR. Distribution is unlimited.

1. Develop and maintain a ***culture*** and ***workforce*** that adopts, supports and applies Digital Engineering across the lifecycle
2. Formalize development and use of models for providing an enduring ***authoritative source of truth***
3. Foster the integration of models and data sources across functional disciplines to inform enterprise and program decision making
4. Establish supporting ***infrastructure & environments*** to perform engineering activities, collaborate, &communicate across stakeholders
5. Leverage advanced tools, computing power, and advanced capabilities to improve system capabilities, automate workflow processes (as applicable) and generate digital artifacts and deliverables using models



https://www.acq.osd.mil/se/initiatives/init_de.html

DISTRIBUTION A. Approved for public release, distribution unlimited.

The COA DE Future-state Prototype Is NOT Another 'Study' or 'Research Report'

The Prototype Answers The 'How?' Questions In The White Space Of Previous Documents

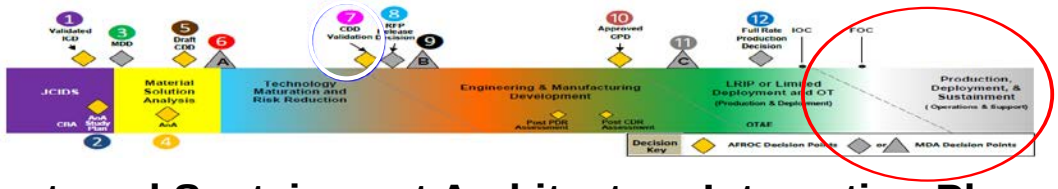
Architecting the DEE Future-state

AFIT
AIR FORCE INSTITUTE OF TECHNOLOGY

The AFIT of Today is the Air Force of Tomorrow.

Prototype Desired Outcomes

1. **Identify DOTMLPF-P Implications**
2. **Inform Scalable Strategy Decisions**
3. **Develop 1-12 + Production, Deployment, and Sustainment Architecture Integration Plan**



Data Integration

Structured / Unstructured / Meta; Dissimilar File Structures; Open Source Models; Real-time Collaboration; Discoverable – Publishable; Authoritative

BigData FUTURE

Engineering Workflow Management

Tool Integration

AUTOCAD · CATIA · creo · NX · SolidWorks

Platform Integration

ANSYS · DASSAULT SYSTEMES · ptc · SIEMENS

Architecture Integration

amazon web services · Microsoft Azure

Impact Analysis

AFRL DSRC DoD Supercomputing Resource Center

DoD Partners

DISA

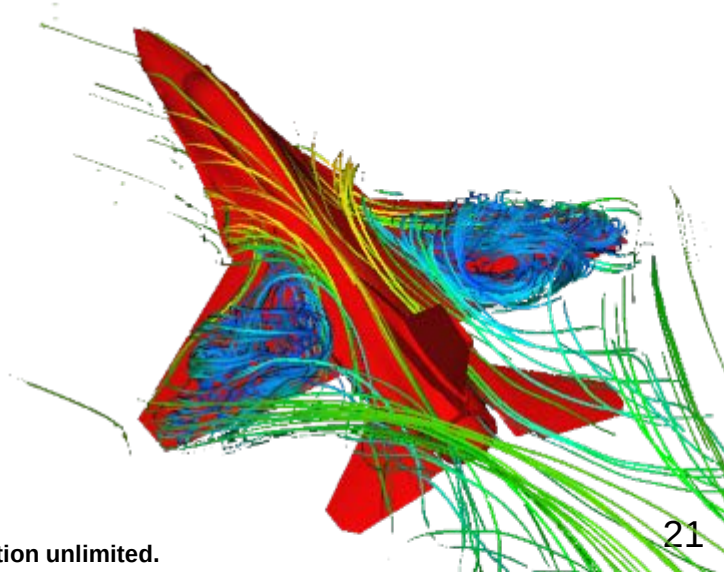
GCSS-AF

Industry Partners

DISTRIBUTION A. Approved for public release, distribution unlimited.

More Challenges

- **Cyber Security**
  - Need to protect our information
- **Data**
  - Size – Estimated petabytes at rest for large body aircraft
  - LOTAR – LOng Term Archive and Retrieval
- **Personnel**
  - Culture
  - Training
- **Industry Partnerships**
  - Data rights
  - Contracting language
  - Standards



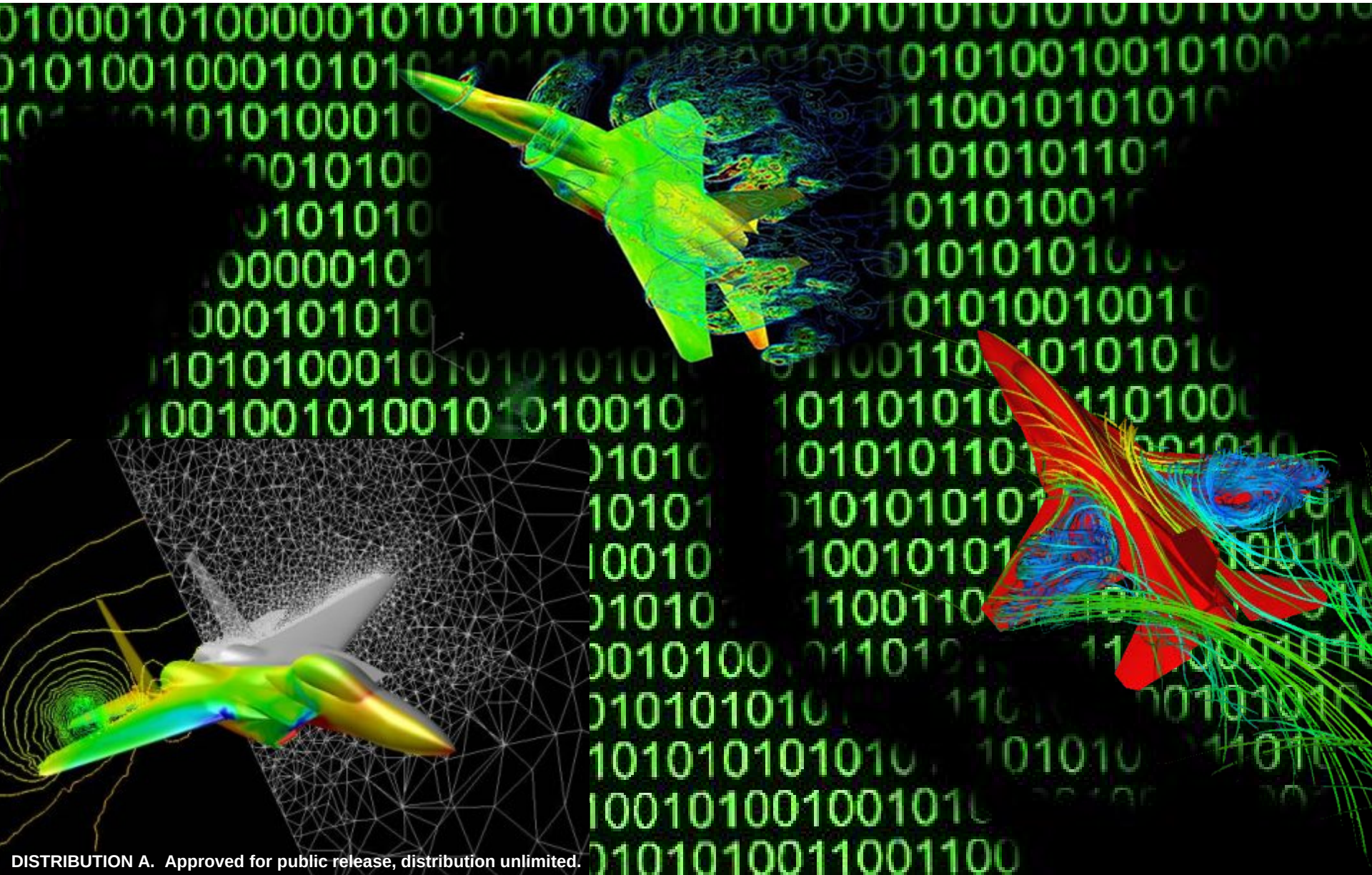
DISTRIBUTION A. Approved for public release, distribution unlimited.

Why we do this

Give ‘em the best! Bring ‘em home safe!

DISTRIBUTION A. Approved for public release, distribution unlimited.

Questions



DISTRIBUTION A. Approved for public release, distribution unlimited.