



HITCHHIKER GUIDE

to the

DIGITAL ENGINEERING “GALAXY”

Thomas A. Lockhart
12 Nov 2020



Hitchhiker Guide

AS WITH ARTHUR DENT (MAIN CHARACTER IN HITCHHIKER GUIDE TO THE GALAXY), A MILD MANNERED, OUT TO PROTECT HIS HOUSE..

SO ARE WE IN C

TODAY, WE (INCOSE), A COLLECTIVE THINKING GALAXY THAT NEEDS **NEW CROWD SOURCING** SATIRICAL LOOK AT THE



INEERING GALAXY”?

THE SYSTEM ENGINEERING OUTSIDE OUR (INCOSE) **DIGITAL ENVIROMENTS, AND** SELLS THROUGH A SHARPLY USIONS OTHER THAN THAT

WE ARE IN THE BEGINNING OF **OUR DIGITAL ENGINEERING JOURNEY.**

– THE ULTIMATE ANSWER is “42” –
WHAT IS THE QUESTION TO THE ULTIMATE ANSWER?

■ A Guide to the Guide

*** ***The Hitchhiker Guide the Digital Engineering Galaxy***

(Body of KNowledge (BOKN) – "1" Integrated Environments)

*** ***The Restaurant at the End of the Universe***

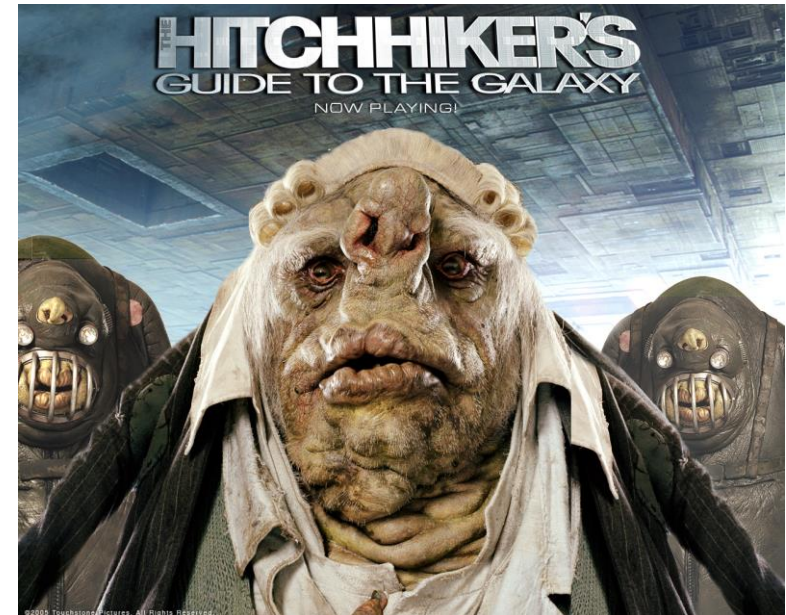
(BOKN - "2" - Framing Acquisitions)

*** ***Life, The Universe and Everything***

(BOKN - "3" Cultural)

*** ***So Long, and Thanks for All the Fish***

(BOKN - "3.14159" Exciting Future)



-A Guide to the Guide-

- **Workforce recruitment, coaching and advancement in critical digital skills, data science and modeling competencies**
 - **Strengthen engineering and all functional expertise, empowering tradespace exploration with early model-based assessments using mission analysis, for decision making at lowest level**
 - **Secure cloud-based modeling environment bringing together tools and communities for continuous operational, acquisition, and system analysis across the lifecycle**
 - **Enterprise data architecture with continuous Authoritative Source of Truth (ASOT) data sharing for paperless reviews; audits; certifications; decisions; and digital thread throughout product lifecycle and enable operations with artificial intelligence (AI) to improve accuracy at machine speed**
 - **Government and domain reference architectures for accelerated iterative development, enhanced competition, interoperability, system agility, and rapid tech insertion**
 - **Transform and optimize processes across assessments, systems engineering, intel, test and evaluation, and logistics and maintenance**
-

Lines of Effort Goals or Ley Lines

■ **LOE #0: Integrated Environment – IT Infrastructure**

- Provide overarching guidance to influence corporate IT improvement investments to enable a robust, secure infrastructure for the enterprise-wide Digital Campaign

■ **LOE #1: Integrated Environment – Models and Tools**

- Provide an Integrated Digital Environment (IDE) of models and tools for collaboration, analysis, and visualization across the functional domains of AF users

■ **LOE #2: Standards, Data and Architectures**

- Provide overarching guidance on the use of Government Reference Architectures (GRA) and related standards and datasets for use in an integrated digital environment for application at the enterprise and system levels

■ **LOE #3: Lifecycle Strategies and Processes**

- Develop Life Cycle Strategies and Processes for Technology Transition, System Acquisition and Product Support using an IDE, supporting lifecycle activities from concept development to disposal

■ **LOE #4: Policy and Guidance**

- Assess and define the required policy and guidance updates/changes to enable full implementation of the Digital Transformation

■ **LOE #5: Workforce and Culture**

- Drive culture change across the AFMC enterprise through training and change management, enabling a workforce well versed in Digital Engineering
-



The Hitchhiker Guide the Digital Engineering (DE) Galaxy

BOKN - "1"

What is DE Galaxy?

Big “4”

- ✓ **Model Based**
- ✓ **Product Management**
- ✓ **Analysis**
- ✓ **Visualization**

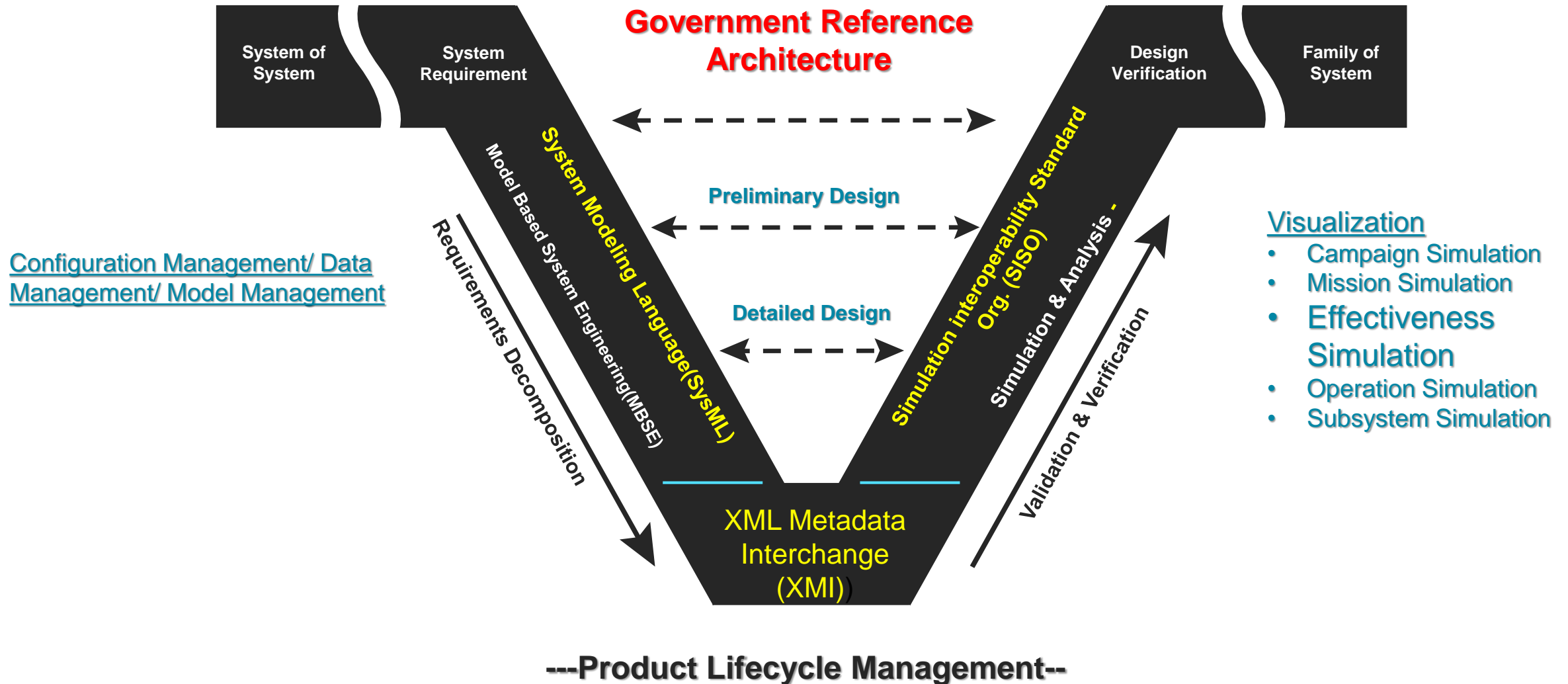
Multiple Tool Vendors
Interoperability w/Open Standards

- ❑ **Distributed Workforce**
- ❑ **Multi-Level Security**
- ❑ **Continuous Authority To Operate**
- ❑ **Own & Access to Program Baseline**

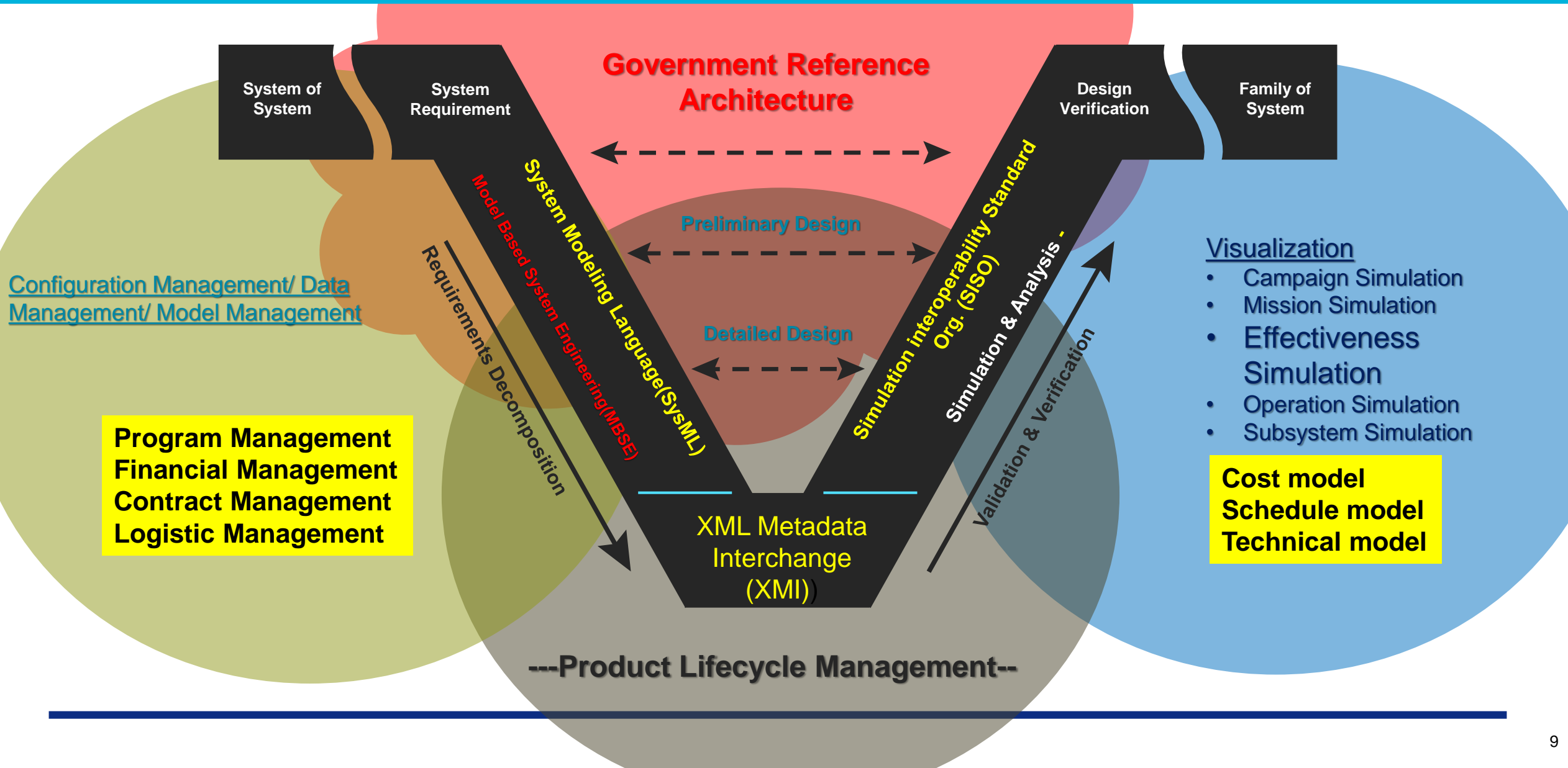
Complexity Science (DEV/*/OPS)



Bede Systems Engineering “Vee” Framework



Digital Galaxy



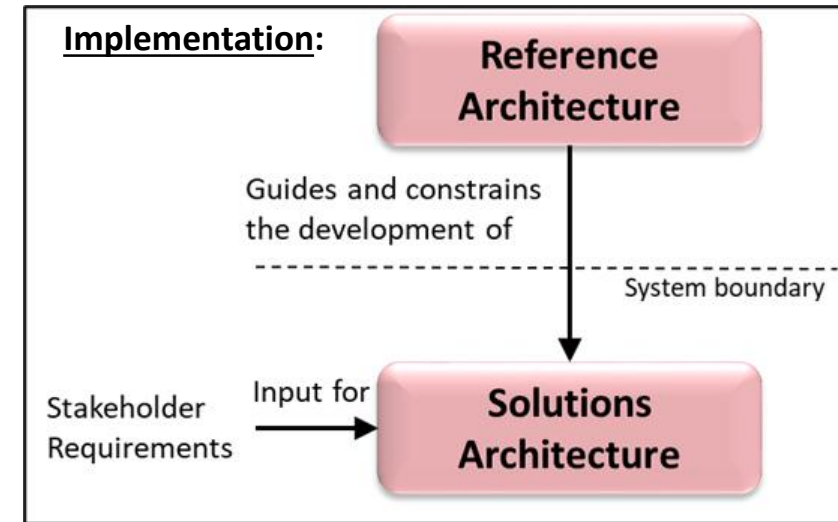
GALAXY Reference Architecture (GRA) - Gameboard

Reference Architecture:

- An authoritative source of information about a specific subject area that guides and constrains the instantiations of multiple architectures and solutions – **DoD Reference Architecture Description, June 2010**

Governance Reference Architecture: (Proposed)

The reference architecture provided by the government to guide the system design, development, production, and sustainment processes.



Purpose:

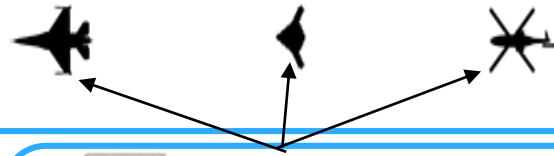
- **Provides Ontology**
- **Supports Model Reuse**
- **Supporting the validation of solutions against a proven Architecture**
- **Provides Style Guide and Standards**
- **Defines the business, regulatory, and technical boundaries**

Benefits:

- Increases speed
- Provides a starting point--across programs
- Removes ambiguity--reduced integration time
- Decreases requirements creep
- Sets standards for MBSE for effectiveness and efficiency
- Delivers Interoperability across users and providers of data

Government Reference Architecture (GRA) Example

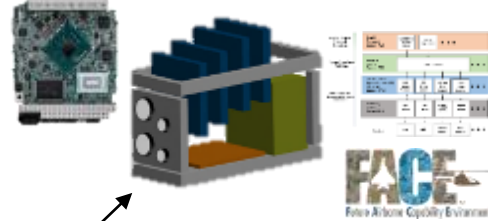
System Architecture
Final Design SWaP-c



40+
platforms
just PNT

Agile
Adaptable
Interoperable

Objective Architecture
Mission specific trades



Reusable, Shared Assets
Models, Services, Components,
S/W Applications

Government Reference
Architectures
Functional use cases

PNT GRA
R-EGI
OMS/UCI
FACE
SOSA H/W

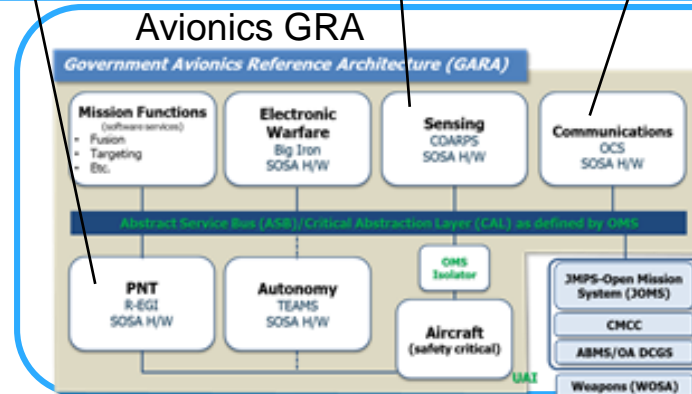
Sensor GRA
COARPS
OMS/UCI
FACE
SOSA H/W

Comm GRA
OCS
OMS/UCI
FACE
SOSA H/W

...

Avoids
engineering
duplication
of effort
across
platforms

Library of Government Reference
Architectures
Unifying Principals, Industry-
consensus frameworks,
and open standards



ABMS GRA ↔ ...

Weapons GRA
Mission Planning GRA
NC3 GRA
GBSD GRA...etc.

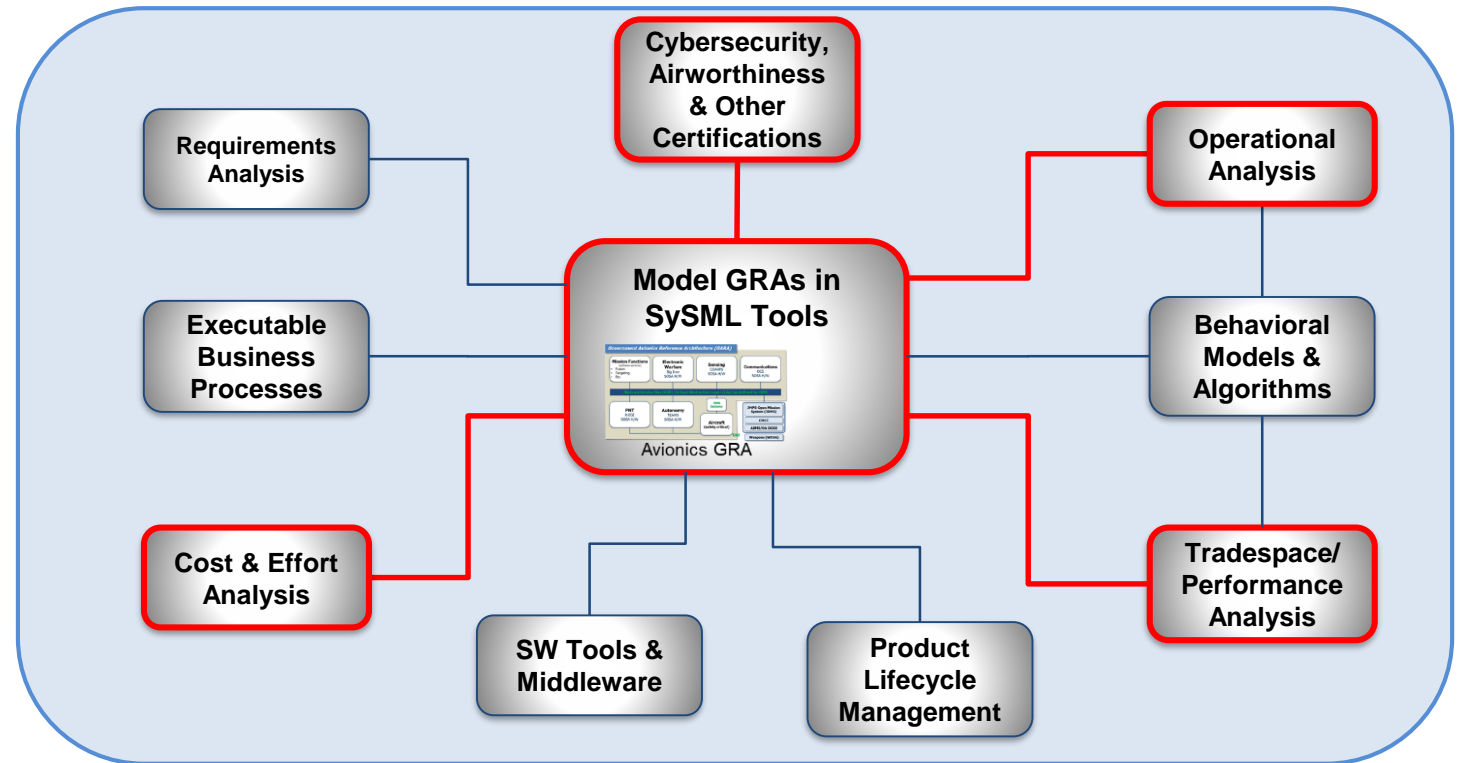
Speeds
Delivery

Saves \$Bs

Develop Library of GRAs Modeled in Systems Engineering Tools

- Leverage GRA & System Architecture for Architecture centric analysis
 - Entities
 - Attributes
 - Relationships
- Link Architecture to tools for **early, dynamic, & continual analysis** of requirements
- Connect other analytical tools via Application Programming Interfaces (API's)
 - API = a re-usable set of functions / subroutines used for software development
- **Enable Automation of Processes**
- **Enable Multi-Domain Analysis**
- **Tie Solution Architecture to DoD Enterprise Architecture**
- **Maintain authoritative source of truth**

An Example Digital Toolchain Galaxy



Build the Digital GALAXY Ecosystem **Data** Architecture



Align

Current MBSE work (best of the best)

DoD DevSecOps Reference Design

Real-time/Embedded Systems

Standardized data formats

Government Reference Architectures

Cultural and Mindset Changes



Leverage Cloud Infrastructure

CloudOne/PlatformOne Foundation

Leading edge agile software processes

Automate what we can

Machine Learning/Artificial Intelligence – New ways of handling/validating/managing/applying data



Development

Open Source/Common Tools

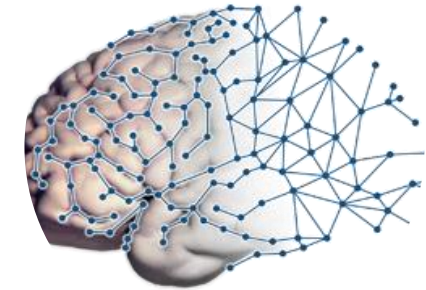
Configuration management, data health, data checking

Near Continuous Design Reviews

Understand SoS Level Interfaces

Assess System Performance

Virtual Dress Rehearsal Missions



Manage, Share, and Curate Data

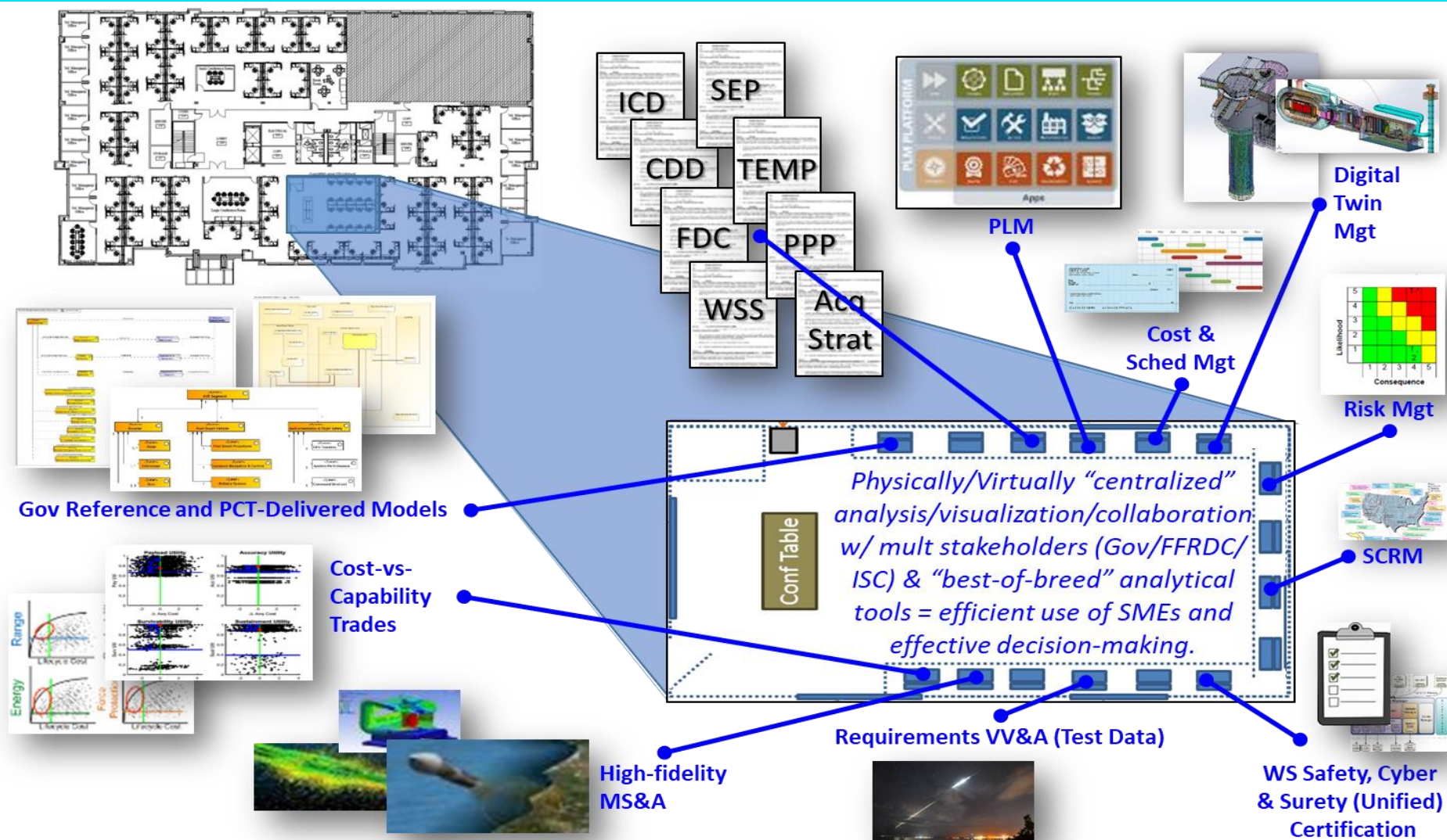
Make Data Accessible to the People Who Need It

Pre-program activities to program of record to operations

Living data repository – allows customization for program & Operational needs

Establish the pipeline to the warfighter!

Small Worlds, Makeup Large Galaxies



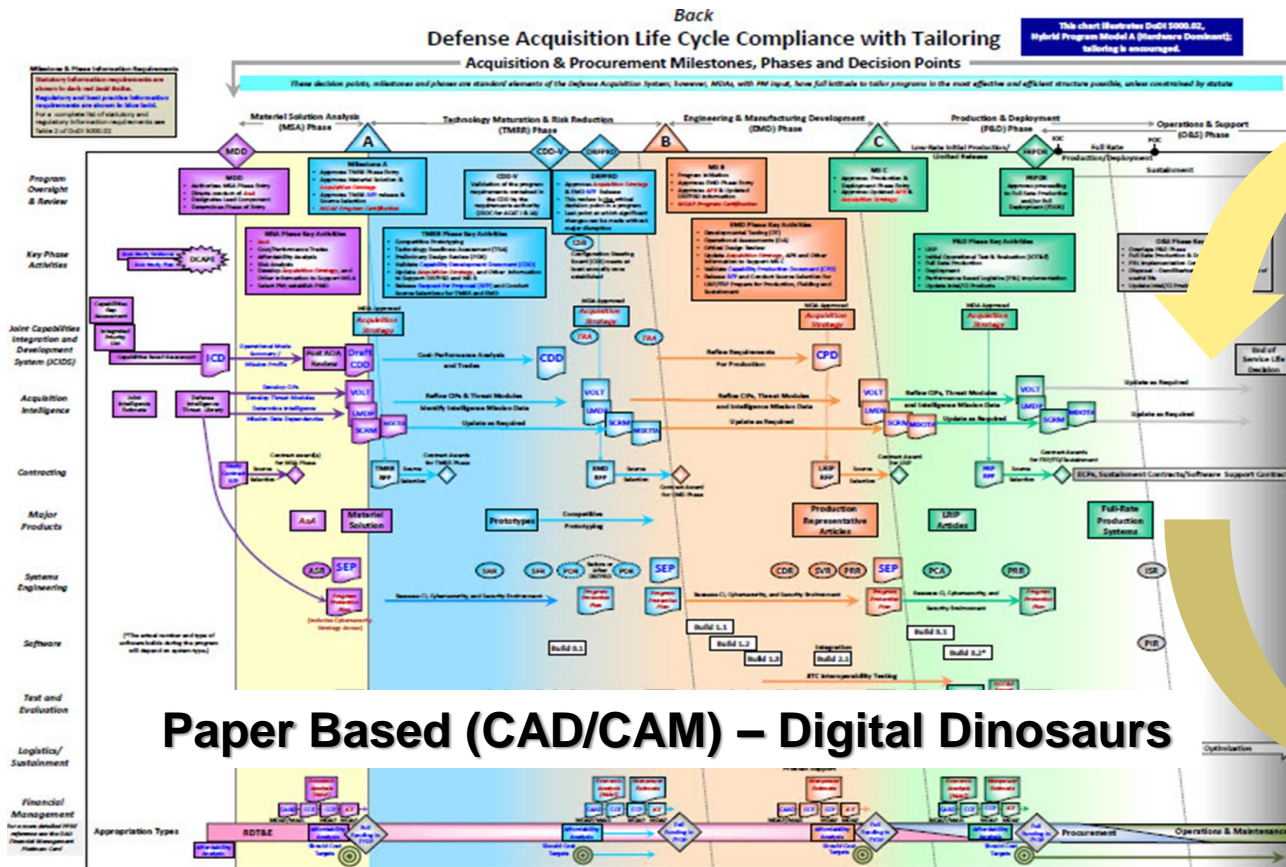
A person is shown from the chest up, wearing a VR headset and holding a controller. The image has a strong red and orange color cast. A white diagonal striped graphic is overlaid on the lower right. The text "The Restaurant at the End of the Universe" is in yellow, and "BOKN - '2'" is in blue.

The Restaurant at the End of the Universe

BOKN - "2"

Evolving Acquisition Processes

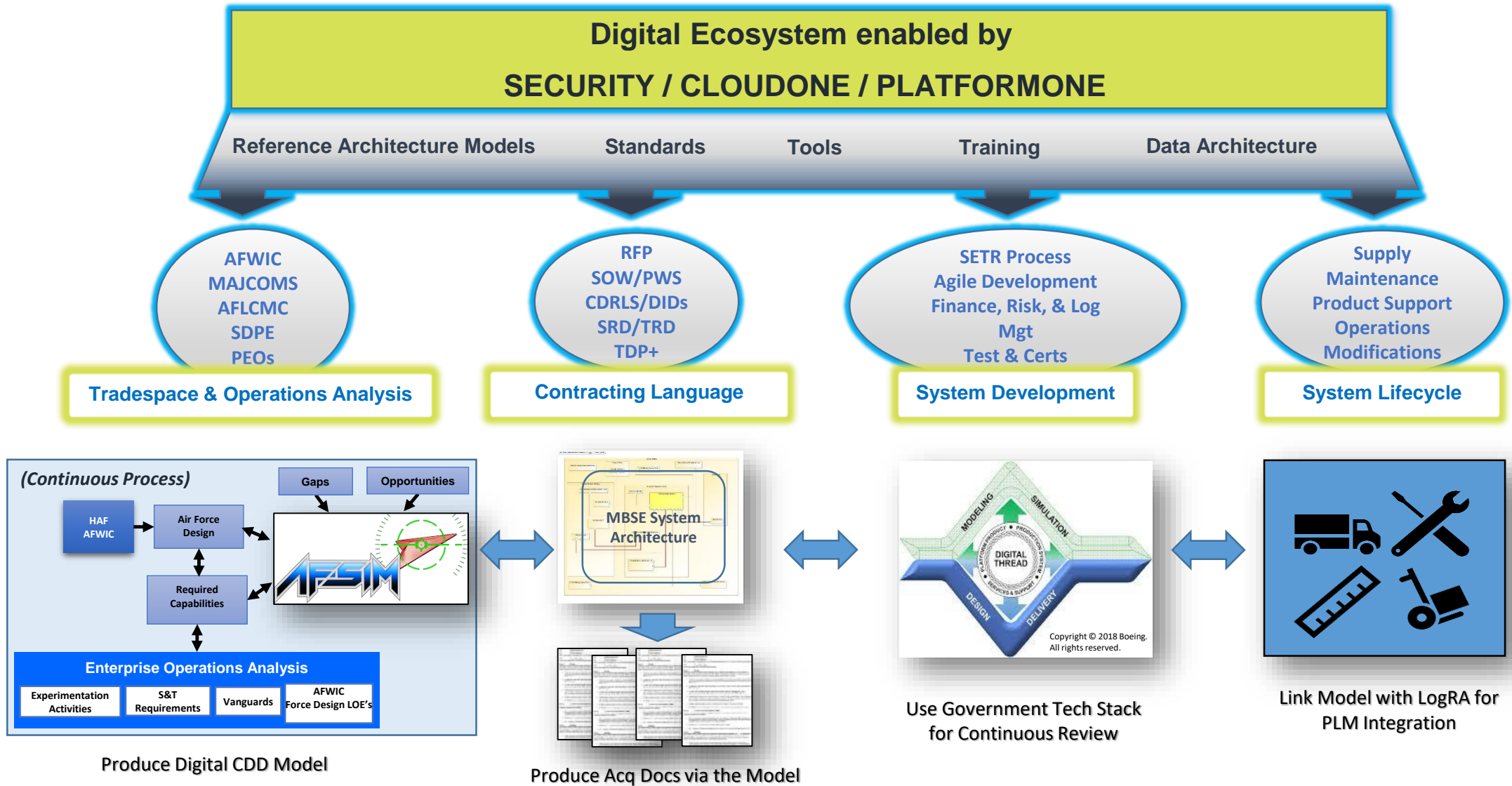
Strategy: Systematically identify and promote digital enhancements to acquisition processes using Agile methodology—data, tools, infrastructure, policy



Model Based– Digital Scouts and Native

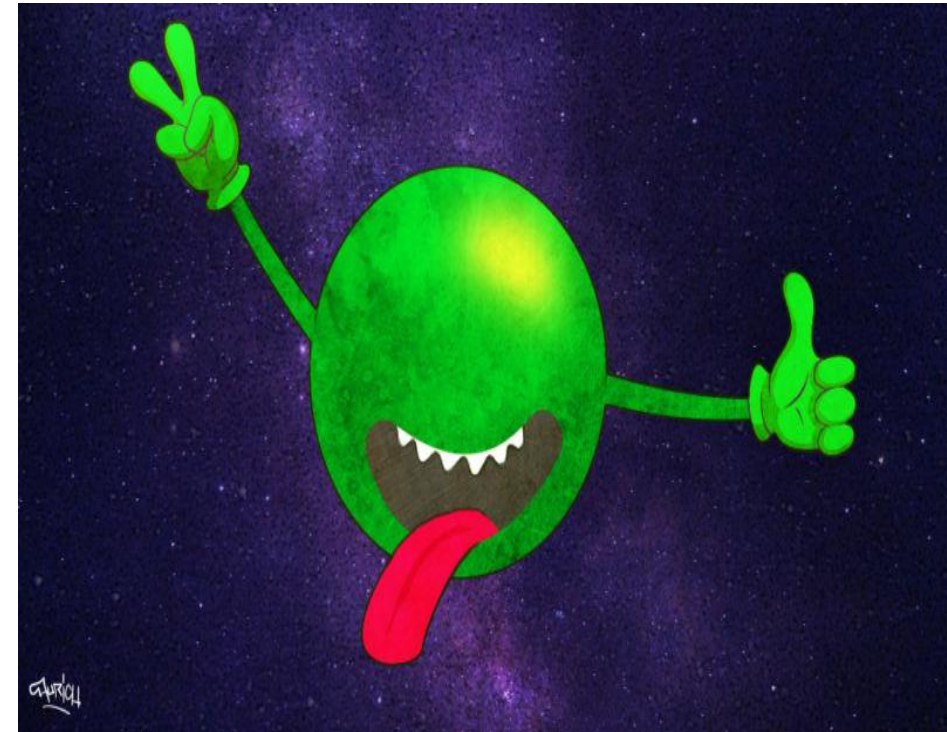
Encompass AF enterprise...from requirements generation through Operations and Sustainment

Integrated Digital Galaxy and Processes



Food For Thought: Data & Data Rights

- Evaluated as part of Policy and Guidance
- One of Five Focus Areas
 - Most complex area of the five
 - Imperative to balance contractor rights with government rights and needs
- Key Issues:
 - Determine optimal extent of data sharing in a digital ecosystem
 - Determine needed license rights
 - 10 USC § 2320(f): Preference for specially negotiated licenses
 - DFARS 215.470(b); DoDI 5000.85; DoD 5010.12-M: DD Form 1423s
- Recognition that current Data Rights regime had inception in hardware-centric world and we now live in a software-centric world
- Way Forward
 - Continue to assess necessary license rights to implement the USAF's digital transformation
 - USAF can't do this alone; we need open and transparent dialogue with industry



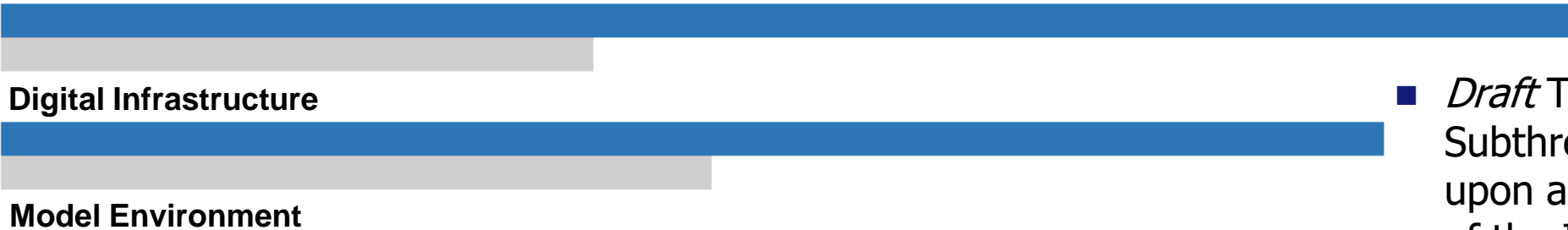
Notional AF Digital Transformation Galaxy Metrics

Digital Transformation: Target vs Baseline

■ Target

■ Baseline

Infrastructure



Modeling / Analysis



Process / Policy



Workforce / Culture



- *Draft* Threads & Subthreads based upon an AF adaptation of the INCOSE Capabilities Matrix

- To be applied periodically to engineering labs, centers, and programs



Galaxy – Digital Native, Digital Scout, & Digital Dinosaurs

-We need to explain that modeling isn't that bad to non-engineers-



A person is shown from the chest up, wearing a VR headset and holding a controller. The image is overlaid with a red and orange geometric design consisting of diagonal lines and a large 'V' shape. The text is positioned in the upper right area of the image.

Life, The Universe and Everything *BOKN* - “3”

Workforce and Culture: Digital Change Management

Shepherd the Command through the pivot of Digital Galaxy via deliberate change management; by conducting a **stakeholder analysis**, creating **messaging timelines/modes**, driving continual **leadership engagement**, and partnering with experts to identify and fill workforce **knowledge gaps**

Understand Process Baseline & Lessons Learned	Data Collection & Quick Wins	Resources & Metrics	Execution
<ul style="list-style-type: none">• Industry & Gov't Engagements<ul style="list-style-type: none">• Boeing• MITRE• Lockheed• Navy• Digital U• AFIT• Change Management Approach<ul style="list-style-type: none">• Prosi—ADKAR model• Build matrixed support team	<ul style="list-style-type: none">• Data Collection<ul style="list-style-type: none">• Stakeholder Analysis• Training• Evaluation/Criteria• Quick Wins<ul style="list-style-type: none">• Digital Engineering Landing Page• Matrixed Change Mgt Support in each Center• Dialogue w/workforce	<ul style="list-style-type: none">• POM Inputs<ul style="list-style-type: none">• IT tools, infrastructure, survey tools, manning, website• Metric Creation & Coordination<ul style="list-style-type: none">• Impact vs Activity• # of programs using digital tools• Efficiencies gained by going digital• Defining “success” and applying criteria to programs	<ul style="list-style-type: none">• Stand up Execution Office• Functional Communities<ul style="list-style-type: none">• A1, EN, others• Programmatic Communities<ul style="list-style-type: none">• PEOs• Clarify roles & responsibilities<ul style="list-style-type: none">• Enduring change team vs functionals vs leaders

Phase 0

Phase 1

Phase 2

Phase 3

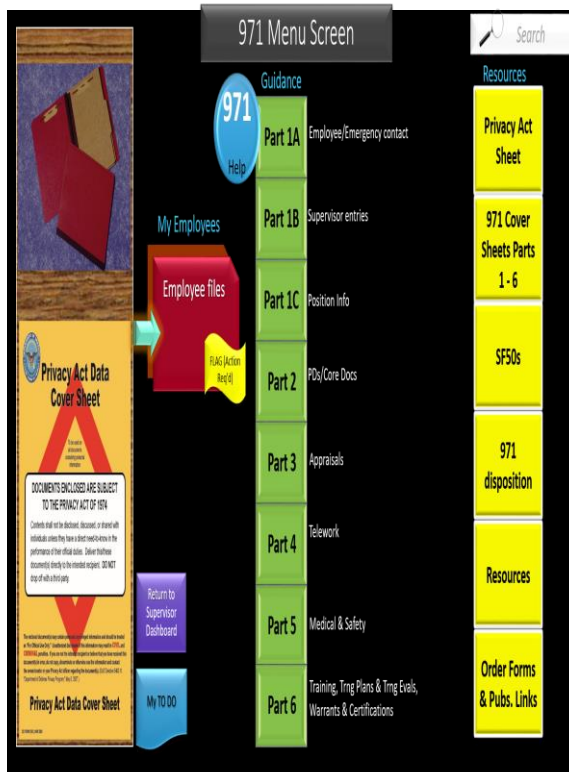
Workforce and Culture: Training

Provide a **menu of AF approved training** for “going digital” by determining level of expertise needed (basic, intermediate, expert), targeting specific **positions**, ensuring **multiple modes** for dissemination, and frequency, just-in-time training vs traditional approach for workforce across all functional organizations.



Workforce and Culture: Career and Leadership

Create a **single profile** for Command-wide workforce “career progression/leadership development”
Tracking workforce from **recruitment to retirement**.



A DIGITAL TWIN FOR ALL OF OUR DIGITAL AIRMEN

- “Digital 971” Employee Record
- Career Progression and Leadership Development
- Competency Management
- Repository of Knowledge Management



The background features several laptops, with the most prominent one in the foreground on the right. A semi-transparent blue rectangular area is overlaid on the right side of the image. A white rectangular box is positioned in the lower-left quadrant, containing a grid of glowing blue squares. The text "So Long, and Thanks for All the Fish" is written in a bold, yellow, sans-serif font across the upper portion of the image.

So Long, and Thanks for All the Fish

BOKN - "3.14159"

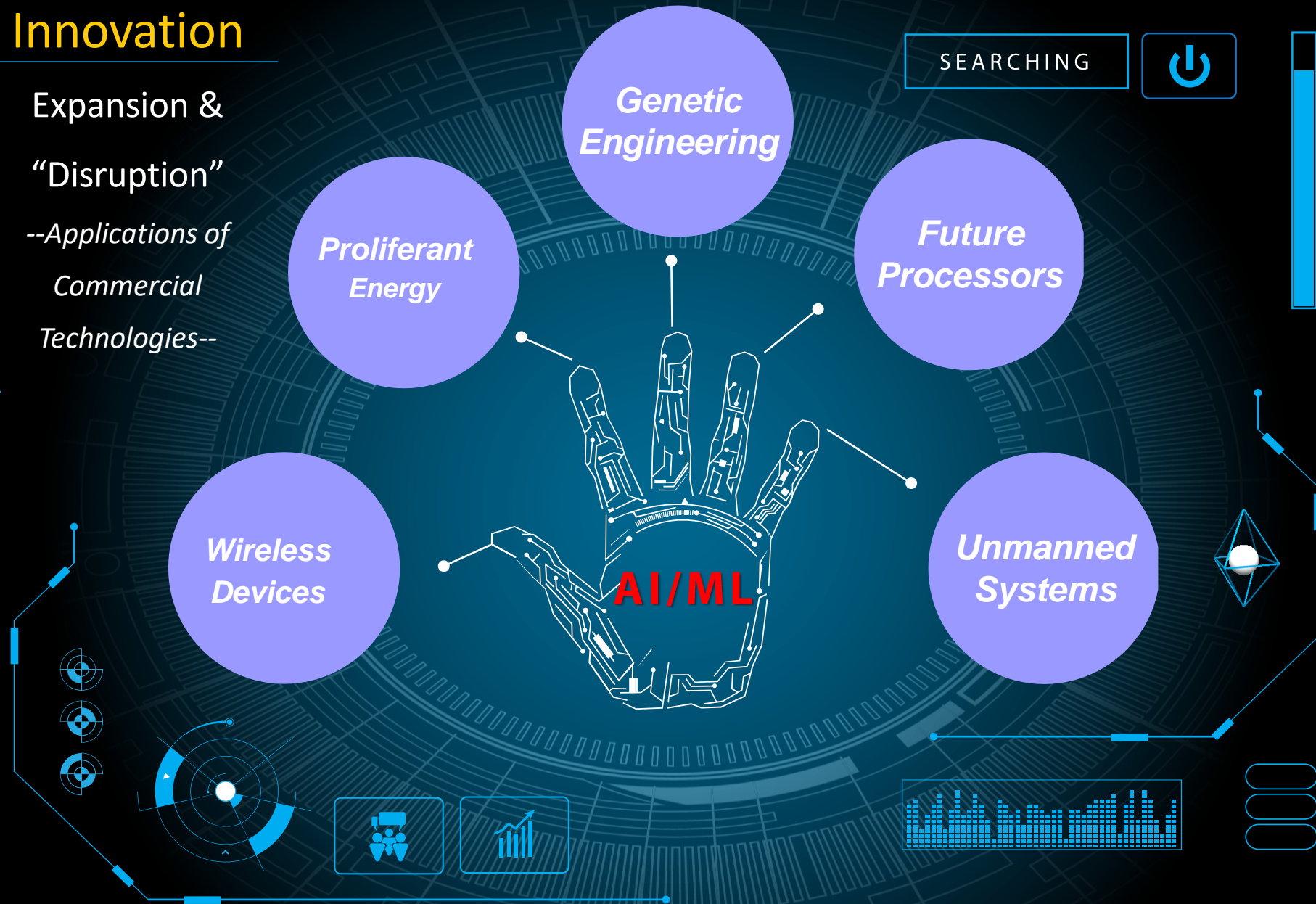
Digital Campaign

Innovation

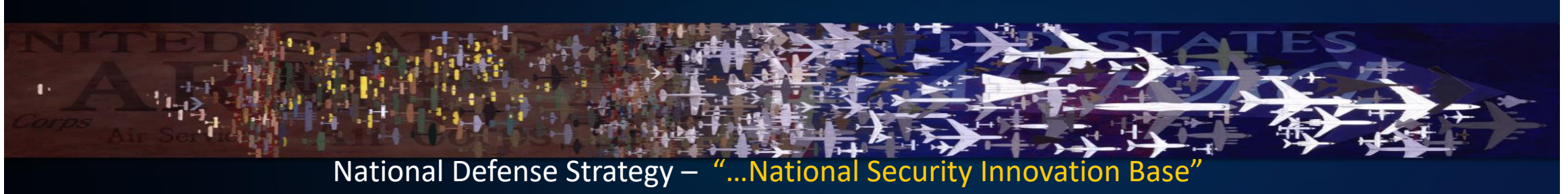
Expansion &

“Disruption”

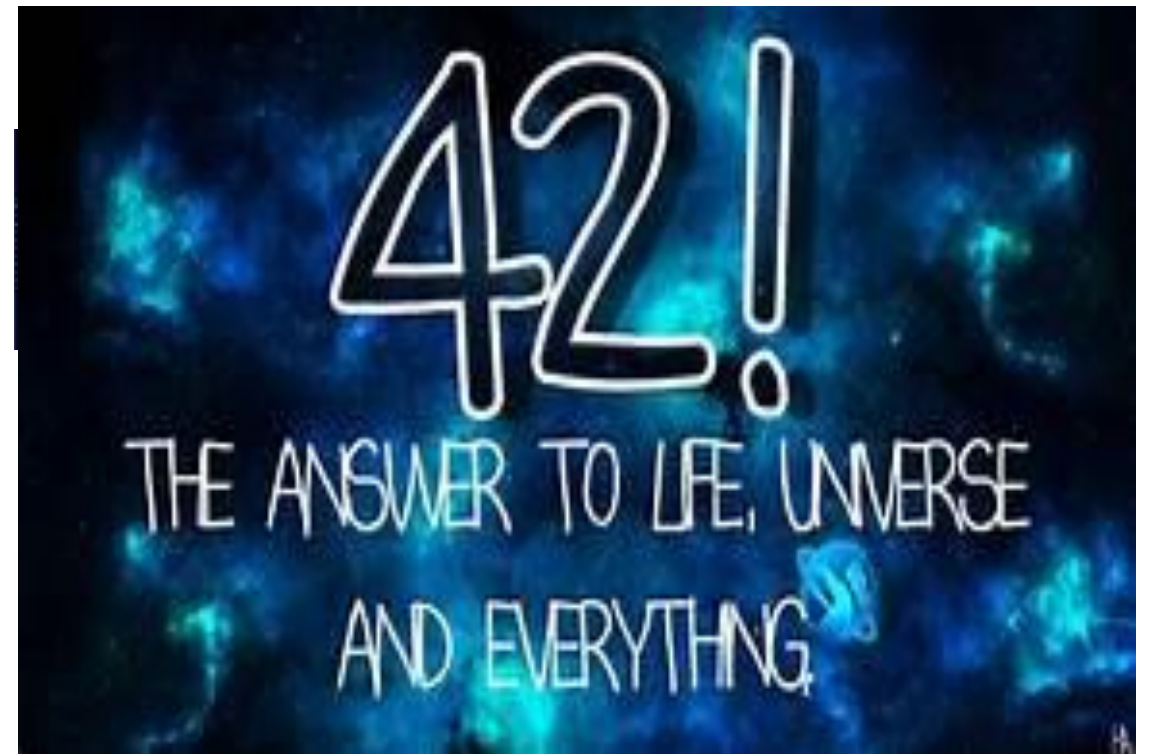
--Applications of
Commercial
Technologies--



The DE Galaxy is Changing



National Defense Strategy – "...National Security Innovation Base"



A grayscale photograph of a person wearing a VR headset and large headphones, looking upwards. The image is semi-transparent, serving as a background for the text.

Questions?

-Thanks-

Digital Campaign Points of Contact

MGen William Cooley, AFMC

william.cooley@us.af.mil

Chris Garrett, AFLCMC/EN-EZ

christopher.garrett.17@us.af.mil

Jeffrey Mayer, SAF/AQR

jeffrey.mayer@us.af.mil

John Morris, USSF, SMC/PCE

john.morris.1@us.af.mil

Mark Kassan, AFMC/ENS

mark.kassan.2@us.af.mil

LOE 0: Rich Kutter, AFLCMC/EN-EZ

richard.kutter@us.af.mil

LOE 1: Tom Lockhart, AFNWC/EN-EZ

thomas.lockhart@us.af.mil

LOE 2: Mitch Miller, AFLCMC/EZ

mitchel.miller@us.af.mil

LOE 3: Lansen Conley, AFLCMC/LG-LZ

lansen.conley.1@us.af.mil

LOE 4: Tom Doyon, AFMCLO/CL

thomas.doyon.1@us.af.mil

LOE 5: Jackie Janning-Lask, AFRL/RV

jacqueline.janning-lask@us.af.mil

The Science of "Creativity" – Unleashing Your Inner Genius

