



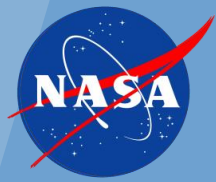
“Transformative Benefits”
emerging from
NASA OSMA’s
Data Centric and Model-Based
Frameworks

PSAM 2022

PRESENTED BY: Tony DiVenti, NASA R&M Technical Fellow

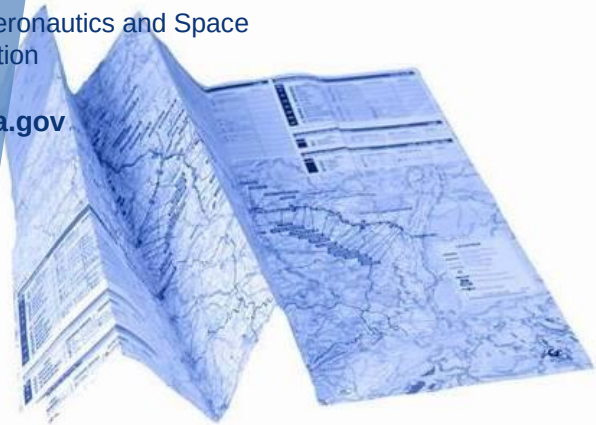
CONTRIBUTORS: Matt Forsbacka, Nancy Lindsey, Jeannette Plante, Kevin Rainbolt, Steve Cornford (JPL), & many others 😊





Outline

- **Background – The Perfect Storm**
 - Why is NASA here?
 - NASA's Digital Transformation Program
 - NASA's emerging Interoperable Environment
 - Conditions “ripe” for Transformation Changes
- **OSMA's adoption of a Transformative Vision build upon Data and Model-Centric principles and technologies**
 - Eliminate the N-1 Problem
 - OSMA's SMA Digital Transformation Roadmap
 - Building a Digital Framework
- **Transformational Activities and Emerging Benefits underway**



Background



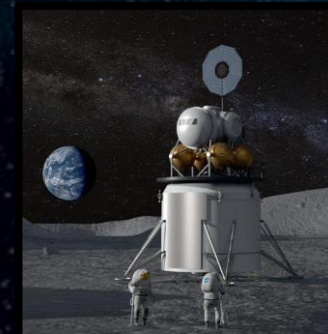
REACH
—NEW—
HEIGHTS



BENEFIT
—ALL—
HUMANKIND



REVEAL
—THE—
UNKNOWN

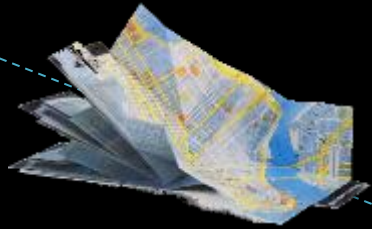


Digital Transformation (DT)

[dij-i-tl trans-fer-mey-shuhn] noun:

Employing digital technologies to change a process, product, or capability so dramatically that it's unrecognizable compared to its traditional form.

TRADITIONAL



DIGITIZED

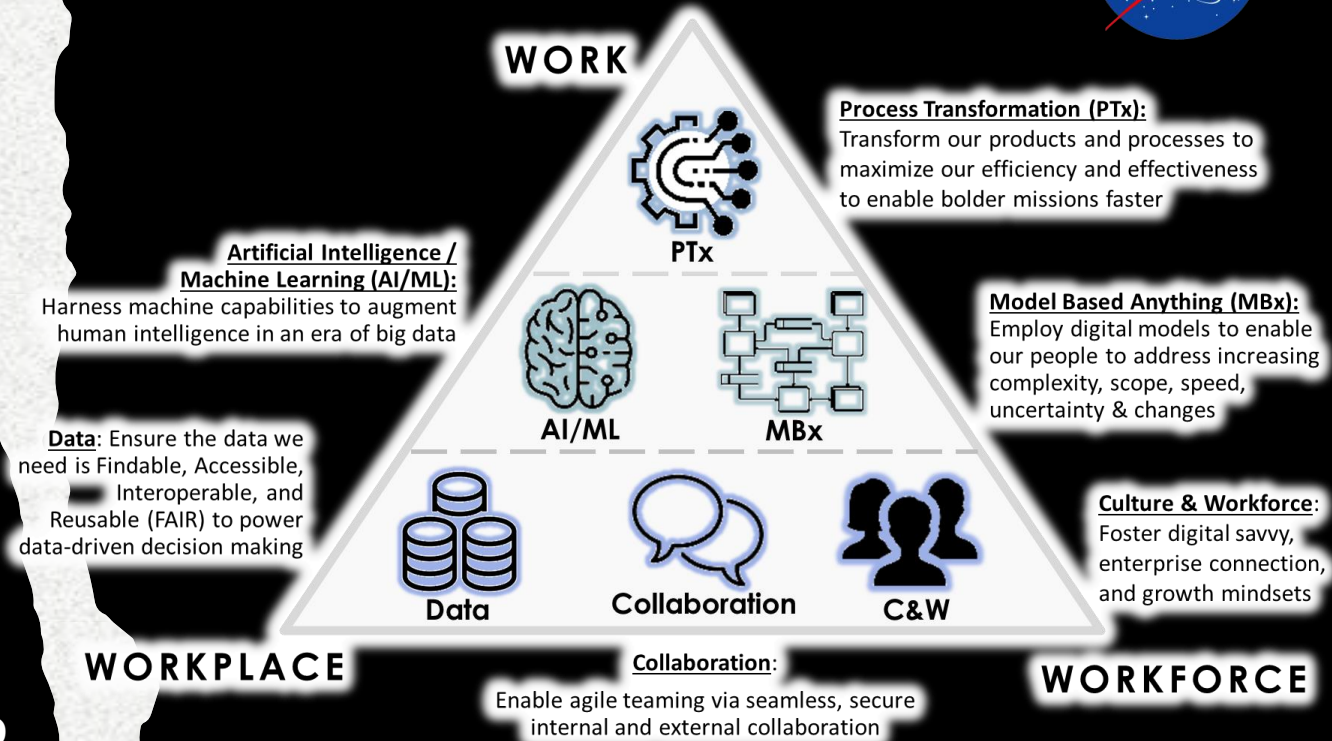


TRANSFORMED



From Maps to Apps...

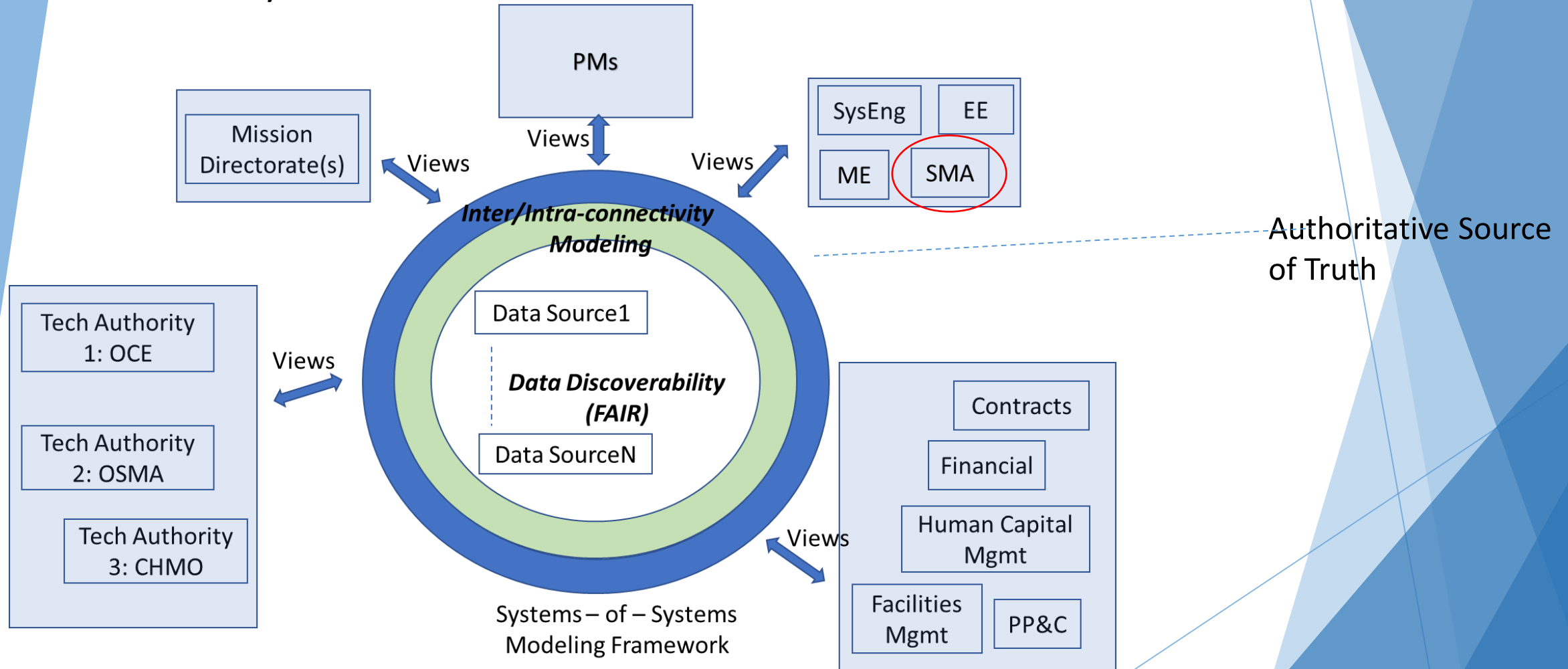
Digital Transformation has already changed our world



NASA DT
6 Foundational Elements

Interoperability

Everyone has a Seat at the TABLE





Conditions “ripe” for transformational change

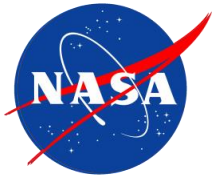
- Our missions are increasingly complex and integrated with industry, on constrained budgets & timelines.
- The aerospace industry, and the world, is transforming around us
- 21st century business processes are outpacing our legacy systems
- Top talent is expecting to work in a digitally-enabled workplace

NASA must transform...



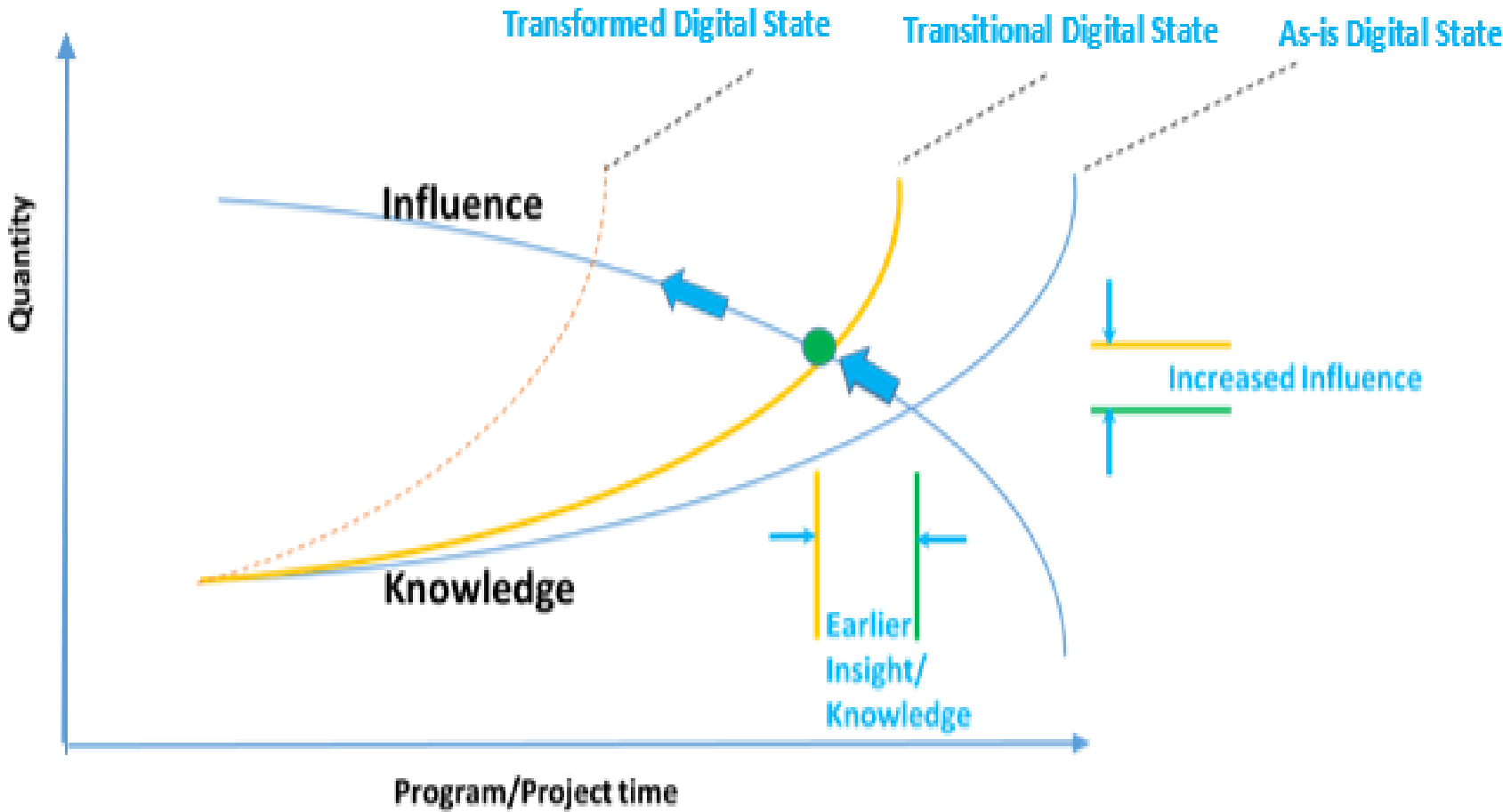


OSMA's adoption of a Transformative Vision built upon Data and Model-Centric principles and technologies

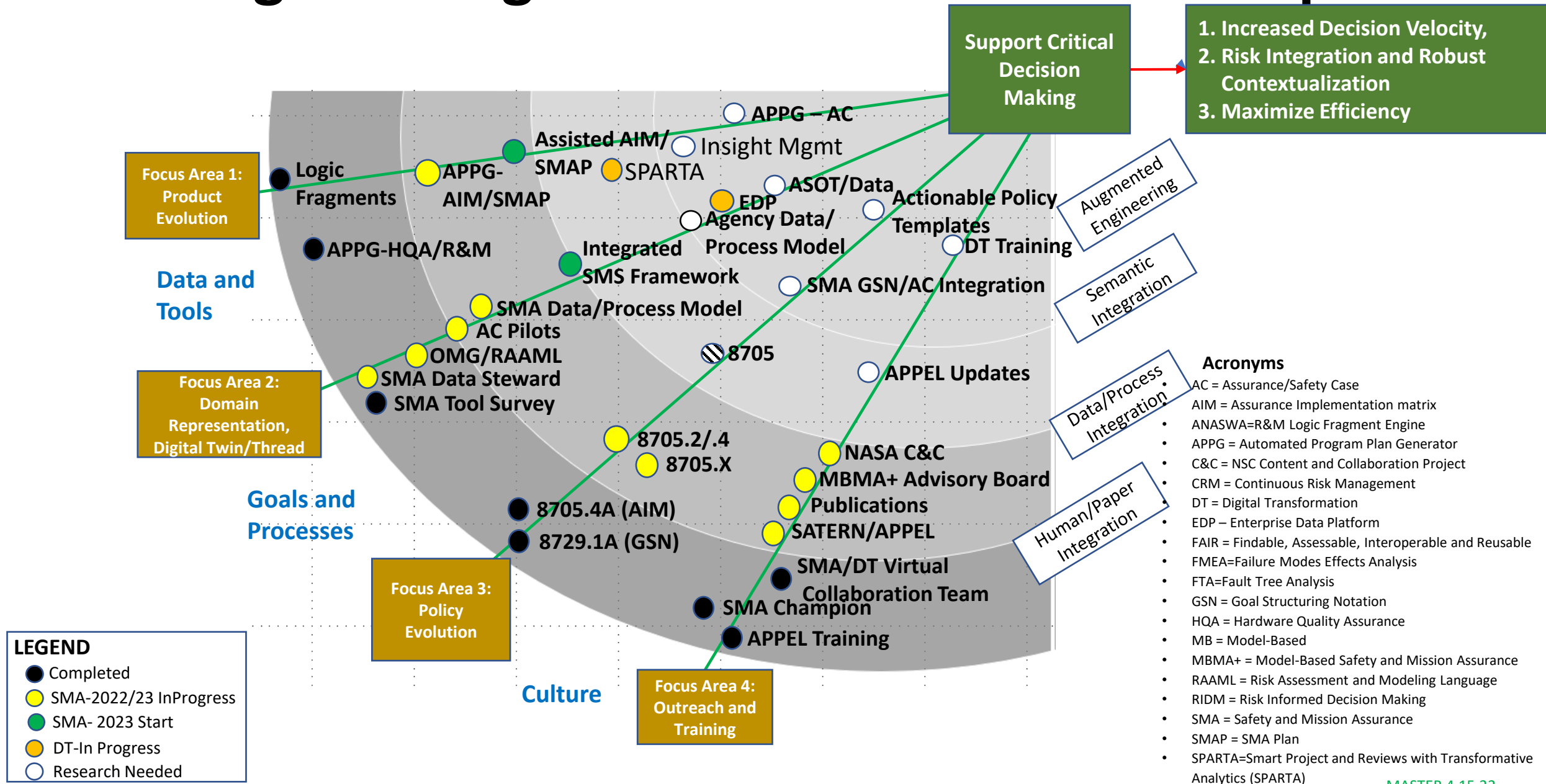


Knowledge vs Influence Curve

SMA Impact on “Critical Decision Making”



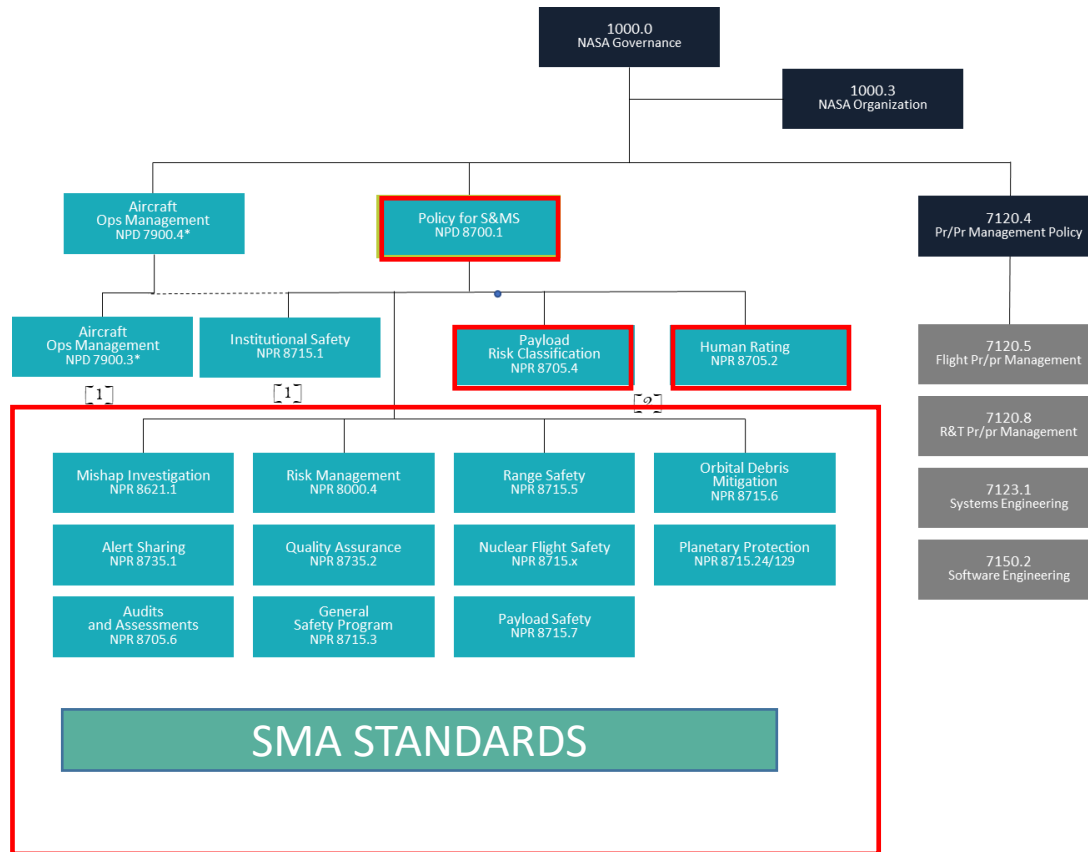
Evolving SMA Digital Transformation Roadmap



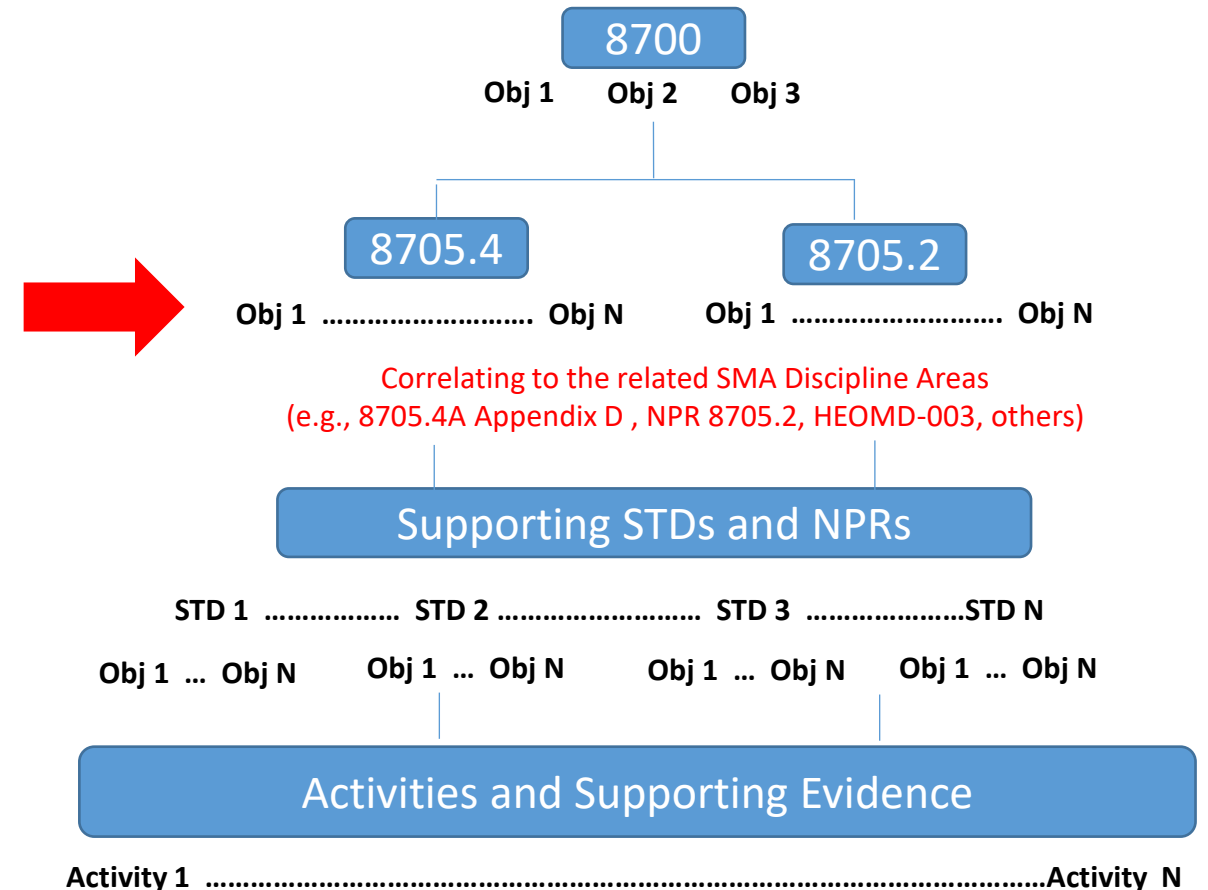
Policy Enabled Objectives Hierarchy

On-Ramp for SMA Interoperability

SMA's Policies and STDs



SMA's Objectives Hierarchy

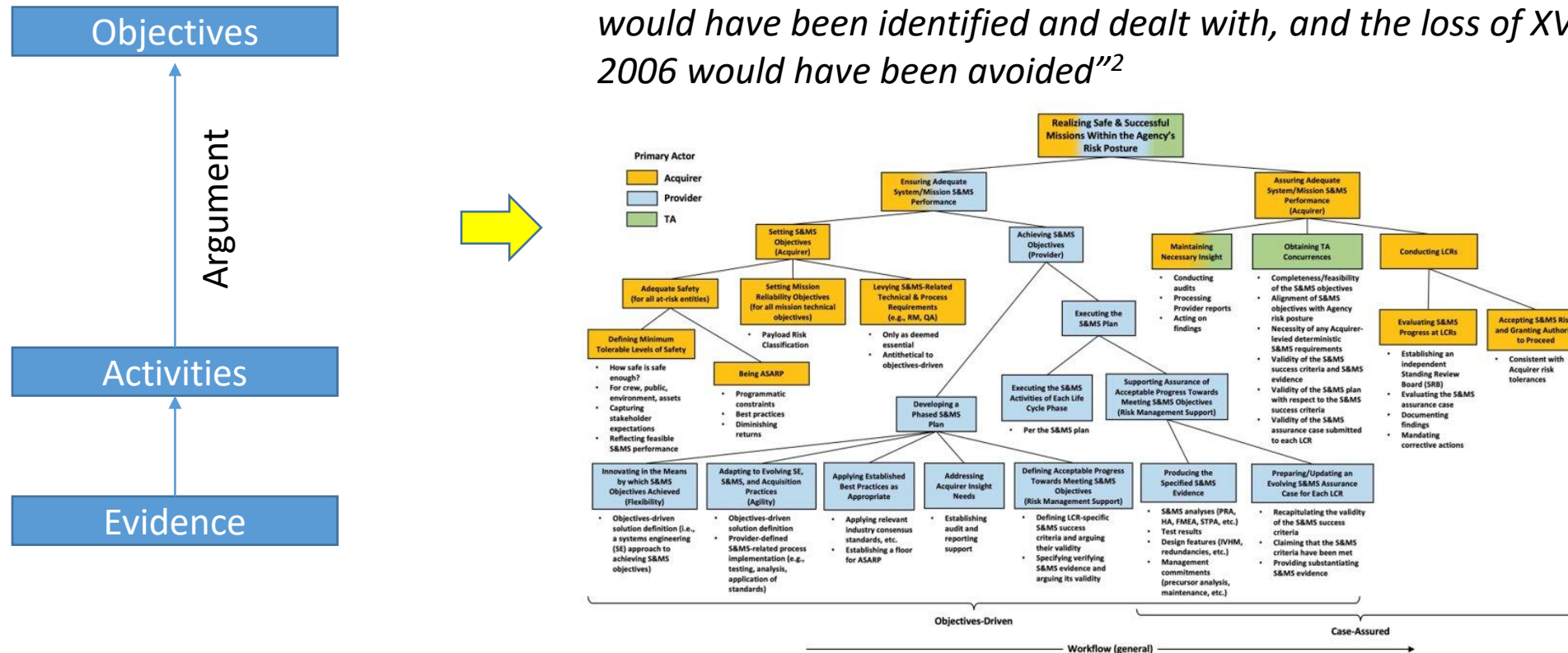




SMA Transformational Activities and Emerging Benefits

They contrast with “prescriptive” requirements (must do X, Y, Z)

*“The Nimrod Safety Case represented the best opportunity to capture the serious design flaws ...which had lain dormant for years. **If the Nimrod Safety Case had been drawn up with proper skill, care, and attention,** the catastrophic fire risks ..., would have been identified and dealt with, and the 2006 would have been avoided”²*



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Definitions and Shaping Concepts

Safety Case (reference Wikipedia) – A **structured argument, supported by evidence**, intended to justify that a system is acceptable safe for a specific application in a specific operating environment.

NASA System Safety Handbook- Vol 1 (2011), (H. Dezfuli et al) – “The safety case concept has also been extended to **apply to additional system attributes beyond just safety**, resulting in **“Assurance Cases”** and “Dependability Cases”

Assurance Case (reference “A Short Introduction to Assurance Cases, University of York, 2013) – A **reasoned and compelling argument**, supported by a body of evidence, that a *System*, Service, or organization **will operate as intended for a defined application in a defined environment.**

New Tool for Developing Safety Assurance Case Arguments (OSMA Article, 2020), (Ewen Denny and Ganesh Pai/ARC’s KBR Wyle Services) –

“Traditionally, a safety case is a static thing,” said Denney. “But really, what **it should be is an active document** you use to govern your activities, so you update it when you learn more about your hazards and the effectiveness of your mitigations and so on”

“The **structured arguments** are given in a graphical notation called **Goal Structuring Notation (GSN)**, which has elements for capturing claims, reasoning strategies, evidence and contextual information. GSN-based arguments have close connections to the **objective hierarchy's** approach promulgated by NASA’s Office of Safety and Mission Assurance.”

“AdvoCATE [an ARC developed Tool] connects all the pieces. It provides hazard analysis and risk assessment, safety and assurance requirements, structured argument development, safety architecture and development, traceability and consistency, and evidence management and analytics through dashboards.”

Automated Project Plan Generator (APPG) Engine

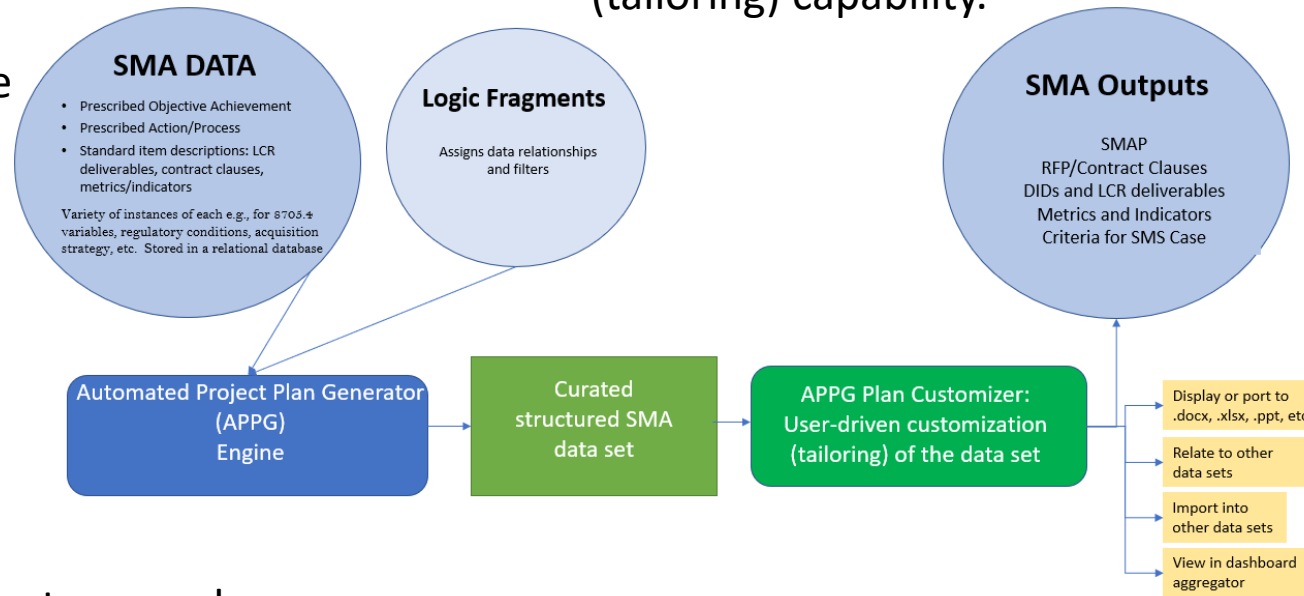
Repeatable, SME-curated,
OSMA-endorsed
recommendations on demand

OJT: Learn as tool is used

Project experts have
direct access to editing
(tailoring) capability.

Project personnel only
spend time tailoring, not
building content from
the ground up.

Authoritative Source
traceable to OSMA
Policy



Data architecture can be
expanded over time:
attach templates, related
policy statement*, etc.

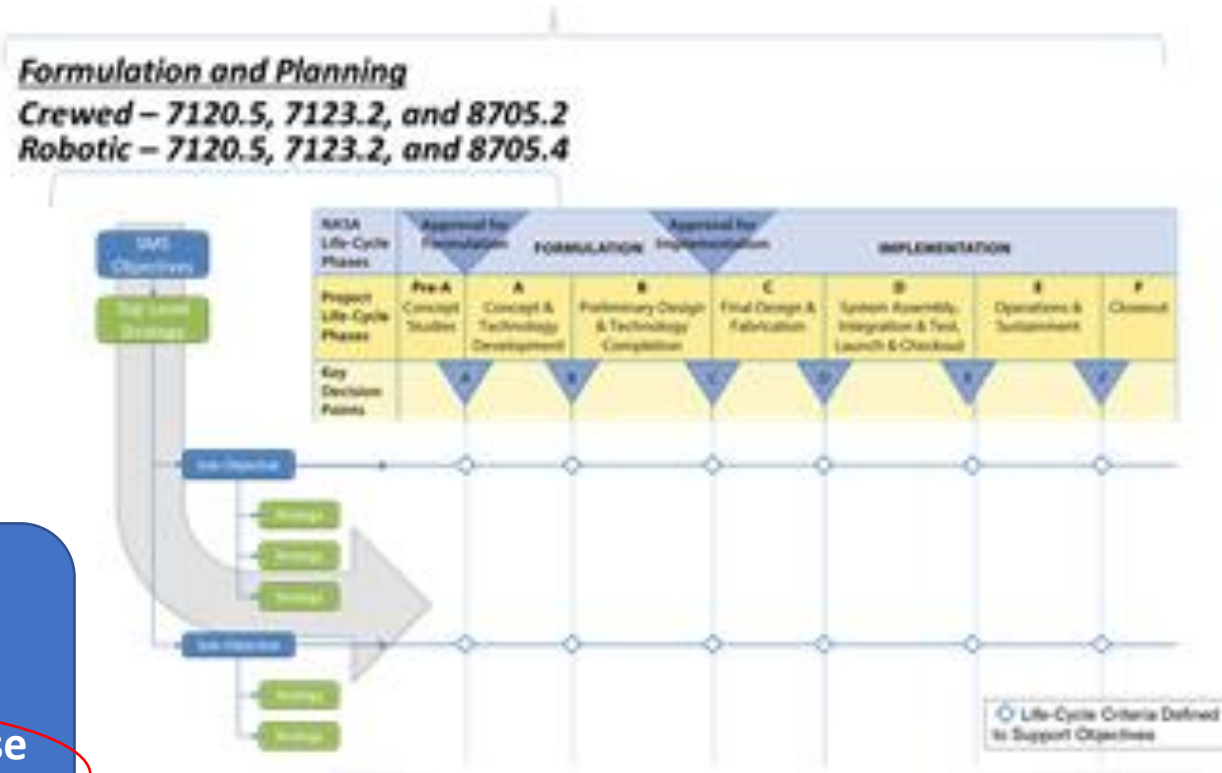
Content held as a data set.
Can be related to other
data sets and support
analytics.

Back-end analysis of data
sets for improvements,
trends, risk awareness

SMA Digital Future – Objectives Hierarchy/Assurance Case Framework

Objectives Hierarchy
Objective Driven Reqts & Accepted STDs

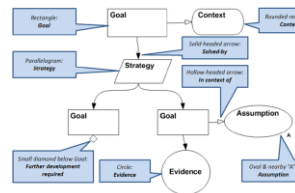
APPG SMA Plan Generation
(part of Project Plan)
INITIAL Assurance Case Argument



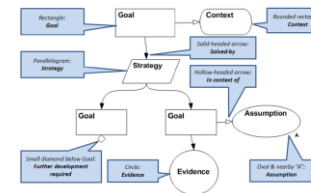
Design Assurance Case



I&T Assurance Case



Implementation Assurance Case



OPERATIONAL Assurance Case

Assurance Case Evolution



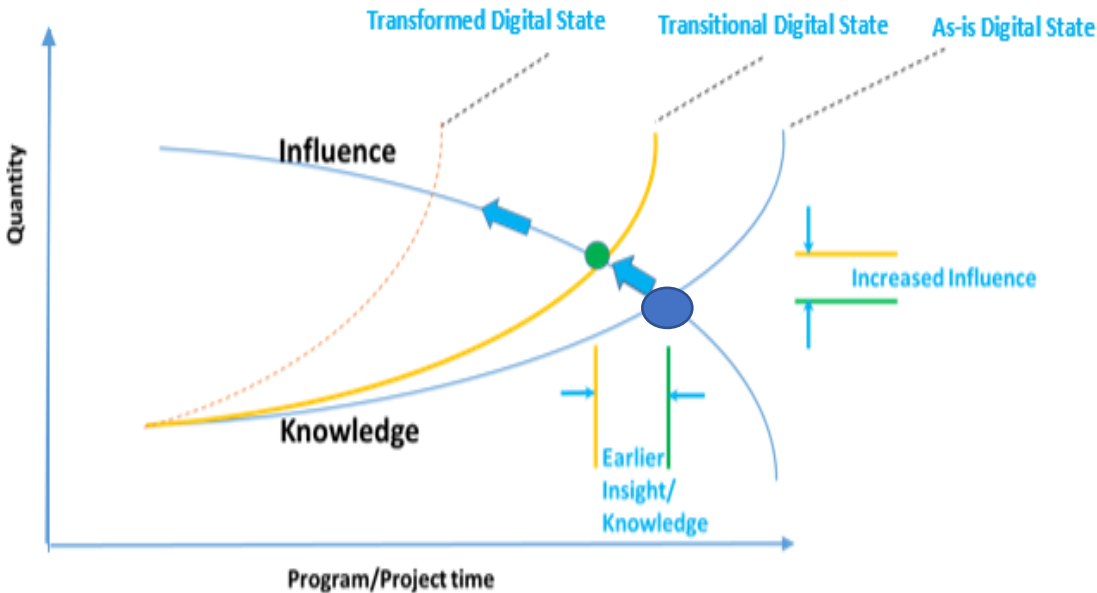
Data Survey/ Data Interconnectivity



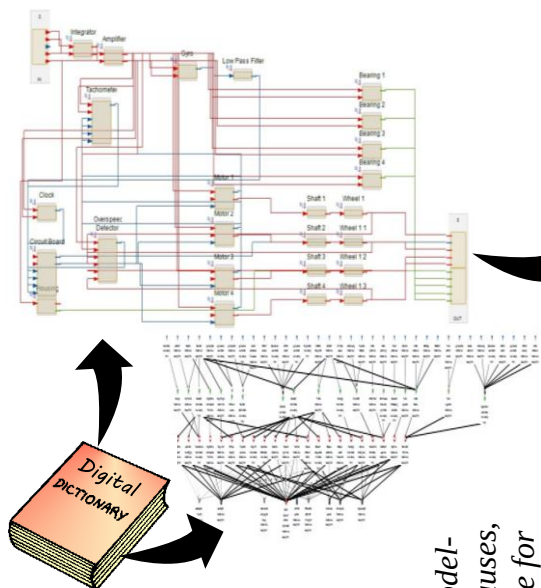
In the 2020 R&M Data Survey in which it was discovered there are many failure mode and other data sources for analysts to leverage.

With Current State data structures these data are virtually impossible to individually digest given desired response times

Traditional Analyses still depend greatly on robustness and depth of information available



MB Integration/Risk Informed Decision Making



Digital Dictionaries can be used to create Model-Based Libraries of NASA components.

With libraries of NASA Components in Model-based tools Failure Modes (mechanisms, causes, local effects) can be automatically populate for consideration.

RMA Factors

Perform Model-Based Failure Analyses

- FMECA/FMEA
- FTA
- Etc.

Mission Risk Mgt

Communicate Risks of Failure

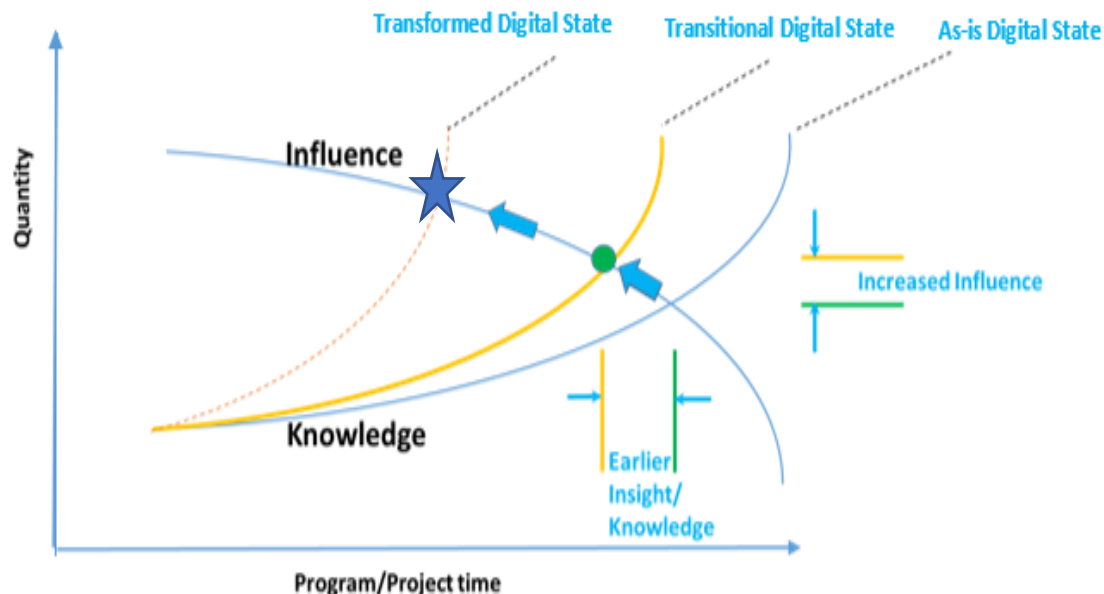
- Manage
- Mitigate
- Track
- Etc.

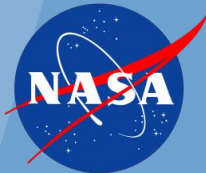
Design Refinement

Optimized Design/Ops for the Mission



Model-Based RMA Analyses can leverage NASA-wide Knowledge for potential failure postulation. Analyses are timelier, sync'd with SEs/Engineering more, and have greater influence on missions.





Physics of Failure (PoF)

