SYSTEMS ENGINEERING RESEARCH CENTER

Georgia Institute of Technology

THE UNIVERSITY OF ALABAMA IN HUNTSVILLE

The Authoritative Source of Truth

Enterprise Systems-of-Systems Model for Digital Thread Enabled Acquisition

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NDIA Systems Engineering Conference
October 23, 2018
www.sercuarc.org

Agenda

- Introduction
  - Methodology: Multi-level Sociotechnical Modeling & Enterprise Systems Analysis
  - Context Background: DE Transformation; Authoritative Source of Truth
  - Systemigram
  - Outcomes & Next Steps

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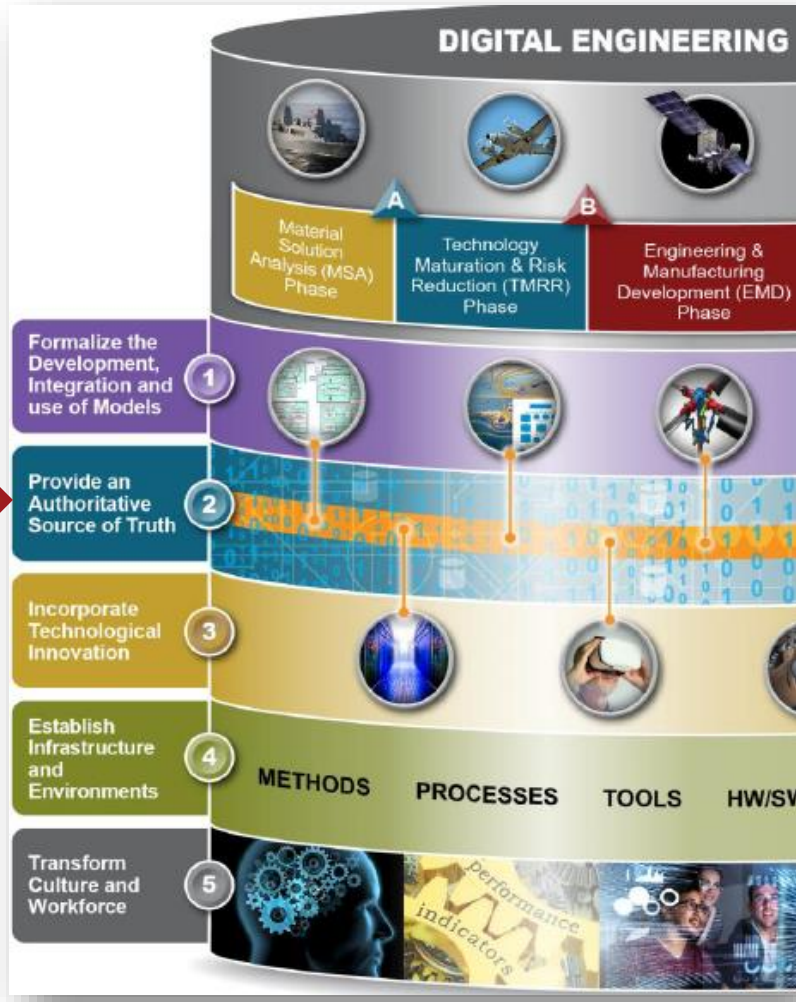
SERC Project RT-182 Digital Thread Enabled Acquisition



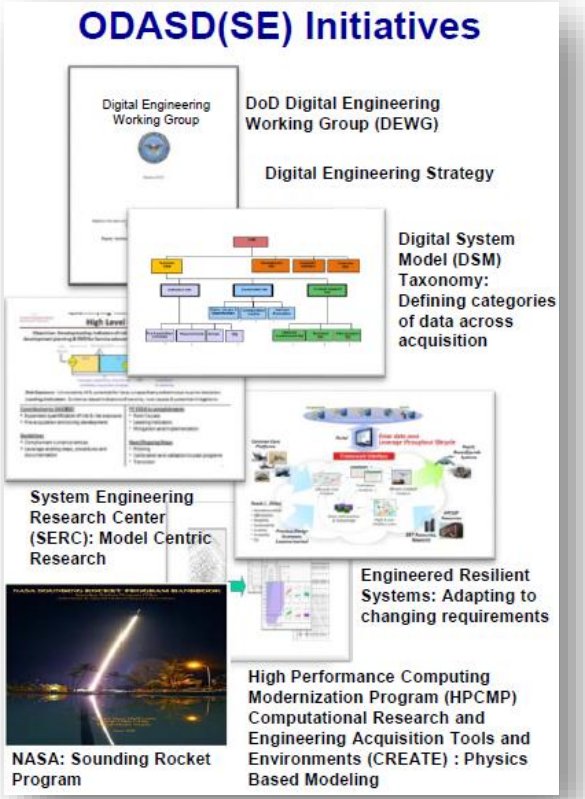
SERC Project RT-182 Digital Thread Enabled Acquisition

This research was conducted to evaluate the impacts of DE on current DoD acquisition enterprise processes. The following questions guided the research:

- What changes are likely to emerge from the transition to DE processes, methods, and tools?
- What are the enablers and barriers to such innovation in the DoD acquisition enterprise?
- What stakeholders will be affected and how will they likely embrace or oppose change?
- How might stakeholders be incentivized to embrace innovation and how will this be measured?
- What are the leading and long-term indicators of change?
- How might the value of such changes be predicted and measured?

Specific Questions of Interest

- How will DE help the acquisition enterprise respond to the realm of the possible with warfighter needs?
- What are the opportunities that can be gained from deeper information in the authoritative source of truth?
- How will DE make the acquisition process more efficient and reduce rework?
- Can DE make it easier to ingest new processes and incorporate acquisition expertise into acquisition tools?
- How do DE documented architecture principles add value to development and acquisition processes?
- How will DE environments capture and maintain lessons learned within and across programs?
- How can DE improve the performance of the acquisition workforce, at every skill level?



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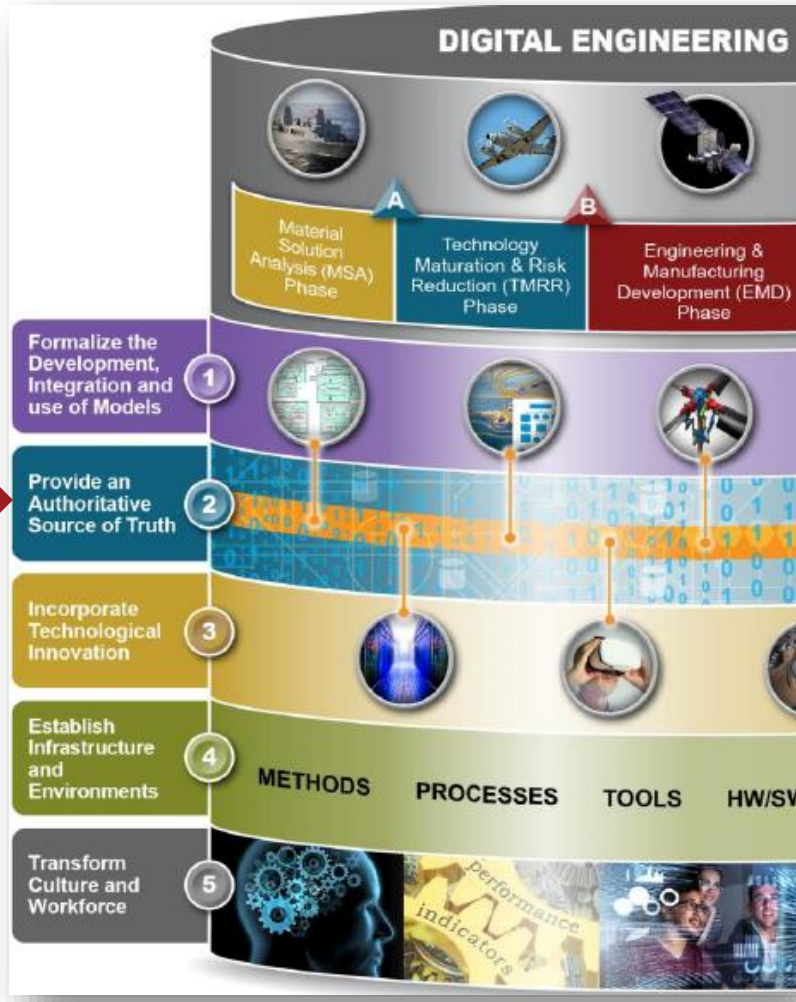

Enterprise SoS Process

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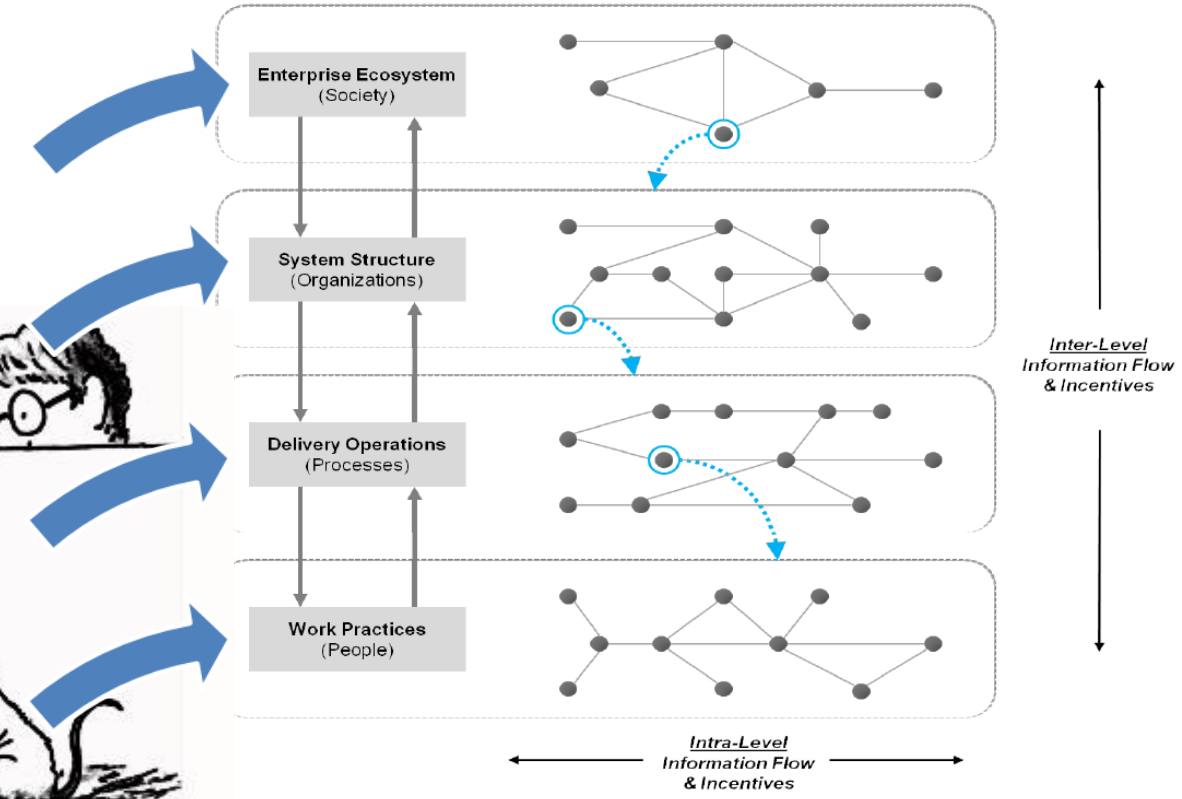
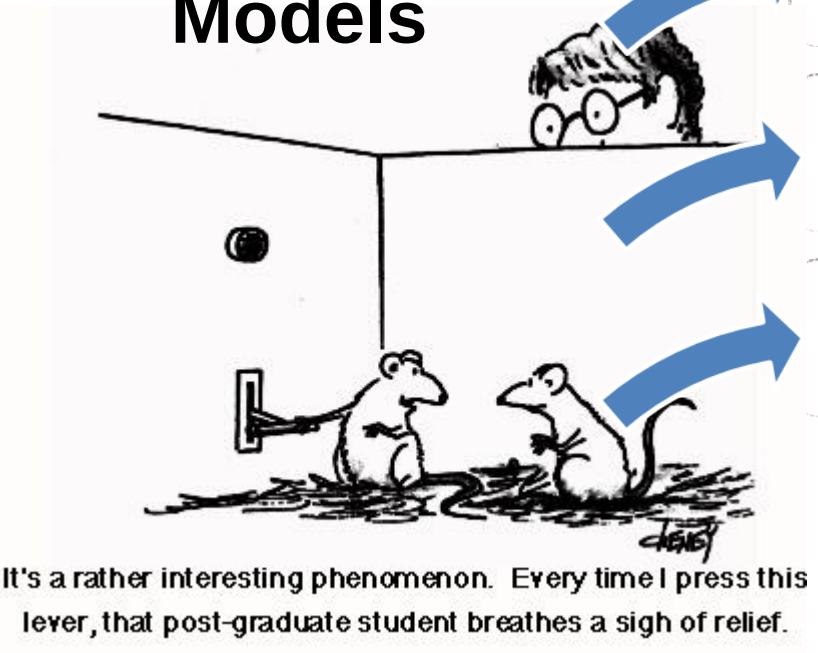
Multi-Level Models



Graphic: W. Rouse & M. Pennock, Complex Enterprise Systems, 5th Annual SERC Sponsor Research Review February 25, 2014

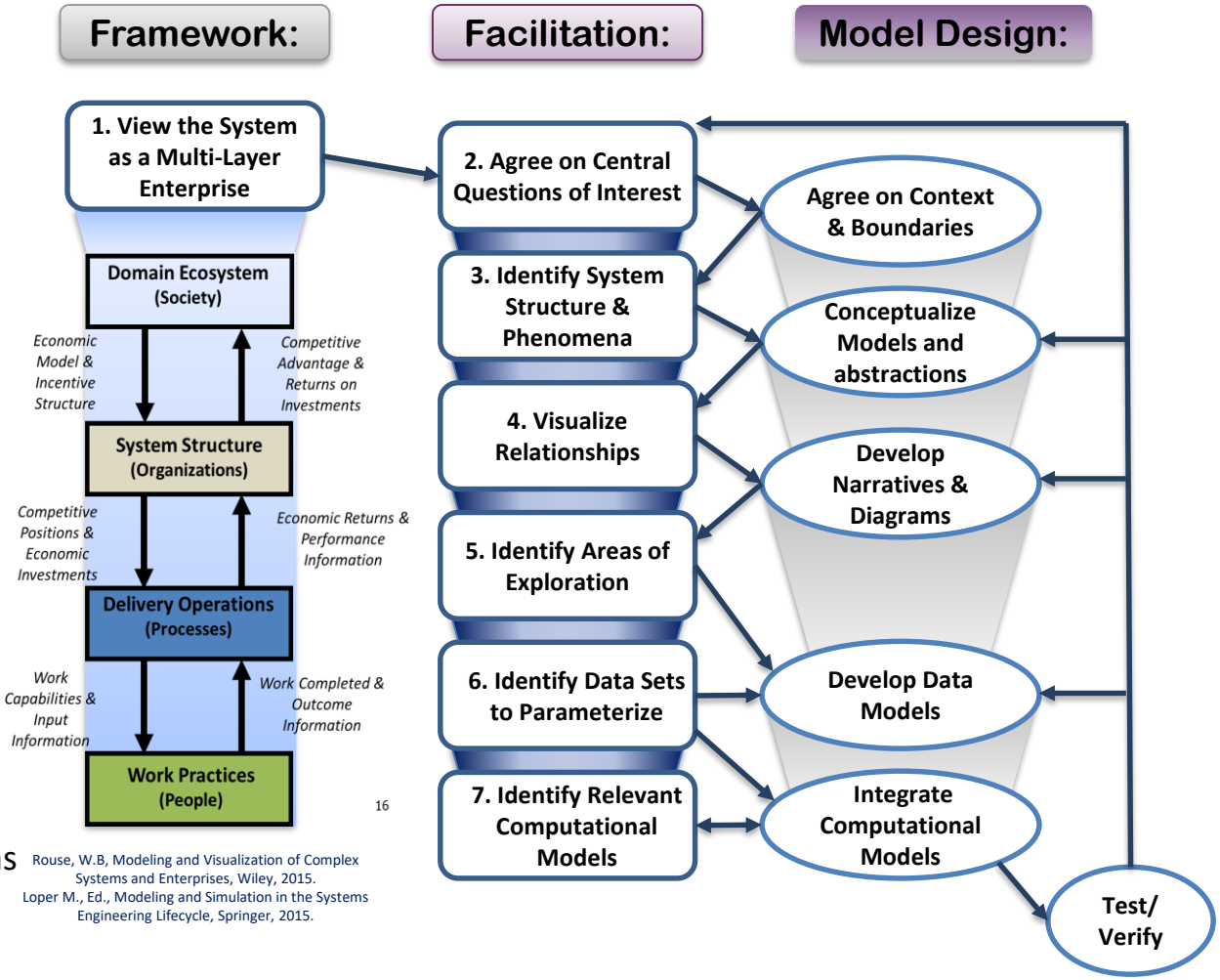
Descriptive Models



Graphic: smumn.edu/facpages/~dbucknam/rat_cartoon.jpg

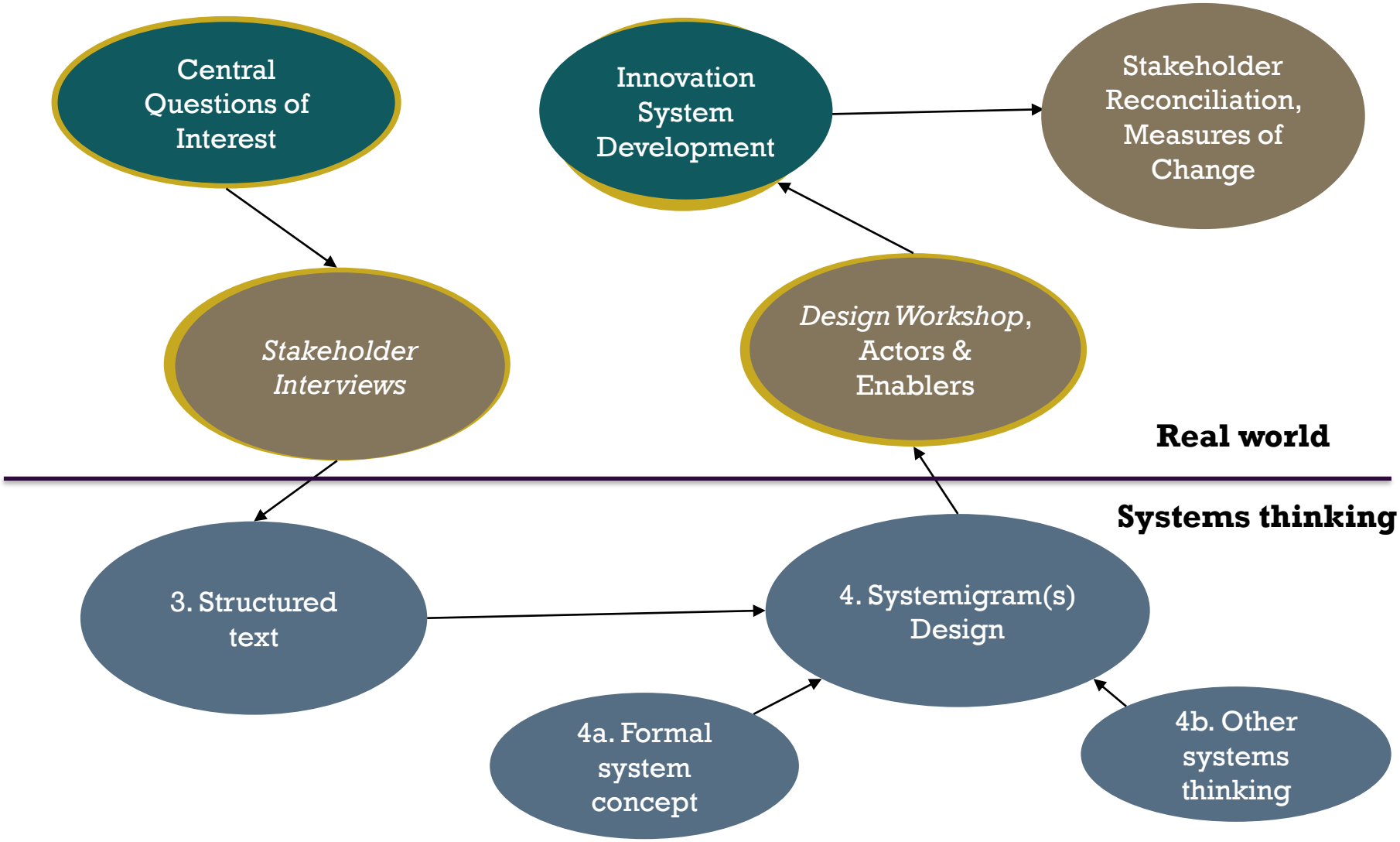
Full Process & Project Scope

1. **Context Analysis**
2. **Central Questions of Interest**
3. **Identify System Structure & Phenomena**
   - Background Research
   - Interviews
4. **Visualize Relationships**
   - Systemigram Narratives & Diagrams
5. **Identify Areas of Exploration**
   - Innovation System Analysis
   - Key stakeholders
   - Critical enablers & barriers to change
6. **Identify Data Sets to Parameterize**
   - What are the measurement areas that will drive change?
   - What measures are collected versus what should be collected



Rouse, W.B, Modeling and Visualization of Complex Systems and Enterprises, Wiley, 2015.
Loper M., Ed., Modeling and Simulation in the Systems Engineering Lifecycle, Springer, 2015.

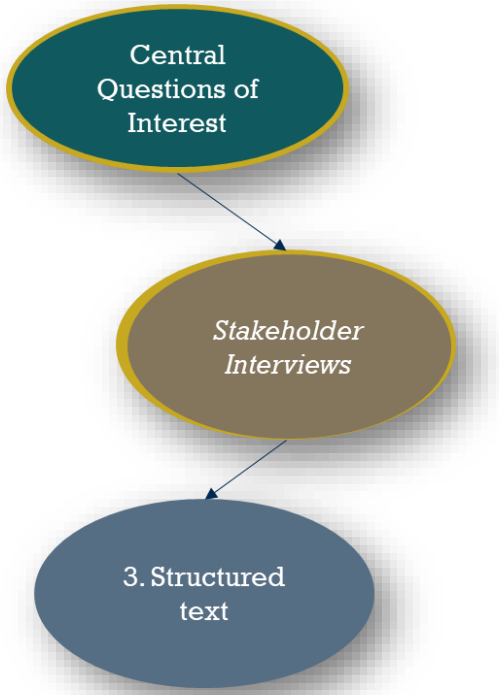
In Practice: Enterprise Systemigrams



A qualitative stakeholder-driven process to produce quantitative goals

Stakeholder Interviews & Research

- 15 Project Visits Completed, 25 People Interviewed
  - DASD/SE
  - Aerospace Corp
  - JHU APL
  - SAF/AQ
  - Army PM-Aviation
  - Army Future Vertical Lift Program Office
  - Ground-Based Strategic Deterrent Program Office
  - SPAWAR San Diego
  - TARDEC
  - J8 JCIDS office
  - DOT&E
  - NASA-Langley
  - NASA-Marshall
  - JPL



- Also:
  - ~50 documents reviewed
  - 6 facilitated meetings with DASD/SE team

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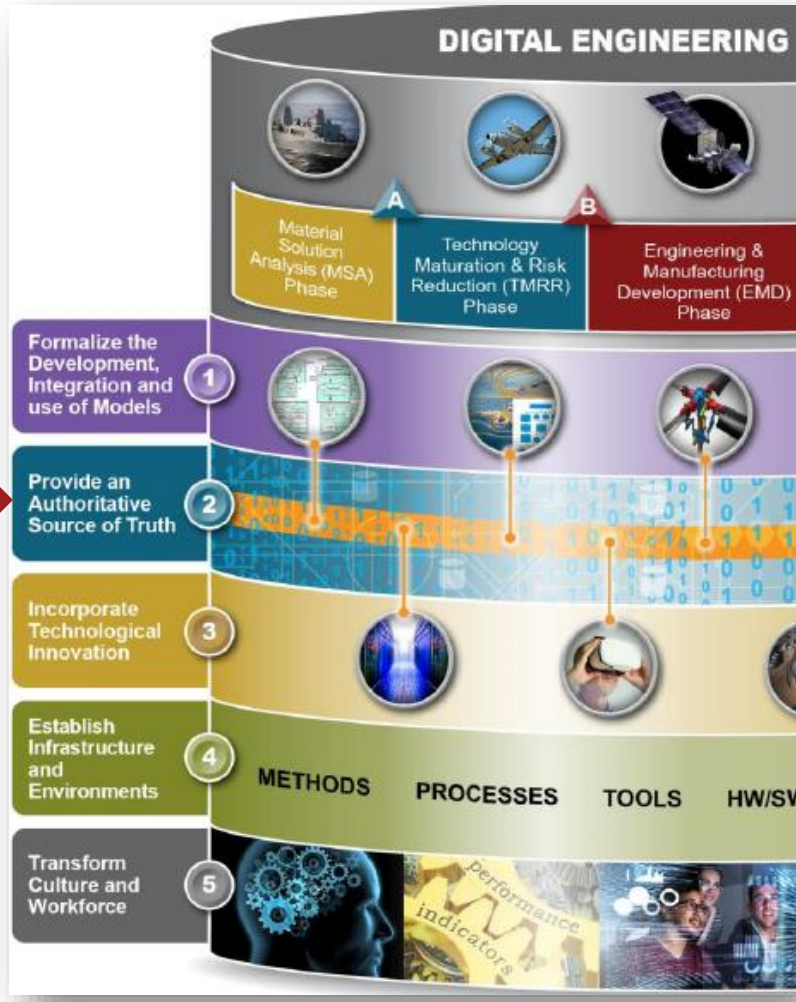
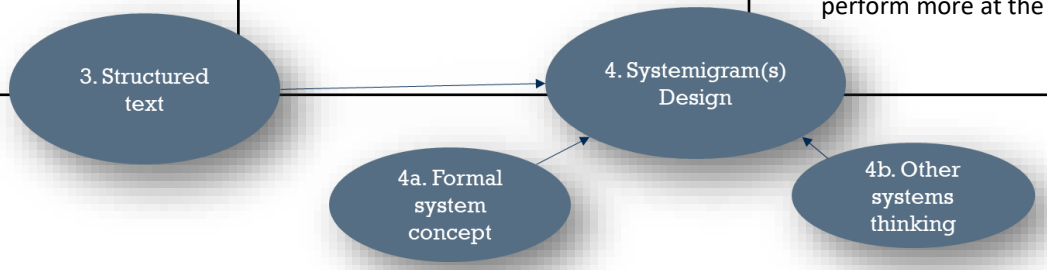


Context Analysis (Selected Phrases)

	Enabling Environment	Key Actors & Resources	Interactions/Activities	Outcomes/Outputs
Domain	• Operational Context – increasing complexity • DoD DE Strategy	• Manufacturing 4.0 drivers • Global innovation in DE	• Curate models across domains, fidelity, phases and the lifecycle	• **Goal 1: Formalize the development, integration and use of models to inform enterprise and program decision making** • Map the realm of the possible with warfighter needs
Institutions	• Develop, mature, and use IT infrastructures • Define and govern authoritative source of truth	• INCOSE and other professional organizations	• Digital program documents • Enterprise owns the ontology and data layer for analytical approaches • Libraries of reusable models • Pay once for data, reuse everywhere	• **Goal 2: Provide an enduring authoritative source of truth (AST)** • **Goal 4: Establish a supporting infrastructure and environment**
Processes	• Lexicon, taxonomies, ontologies • Paperless system and technical information	• Communities: Standards, guides • Communicators/ matchmakers • Model governance/version control mgmt. • Better informed Decision makers	• Digital twin that injects data back into the models • System data accessible from a single portal • Eliminate human process of finding and using data • Everything needed is on desktop, what's been done before is there to reuse	• **Goal 3: Incorporate technical innovations to improve the engineering practice** • opportunities that can be gained from deeper information in the AST • make the process more efficient and reduce rework • capture and maintain lessons learned
People	• Comfort with technology • Usability of DE methods & tools • Organizational and cultural resistance • Learning systems that adapt to individual abilities	• Leadership & messaging • Older vs younger workforce • Human capital - skills • A-Teams & B/C-Teams - performance	• Enhance collaboration • Humans can focus on creative work and machines can take care of mundane tasks • Understand incremental value of all trades, done dynamically	• **Goal 5: Transform Culture and Workforce** • easier to ingest new processes and incorporate acquisition expertise into the tools • make the B-team and C-team players perform more at the A-Team level



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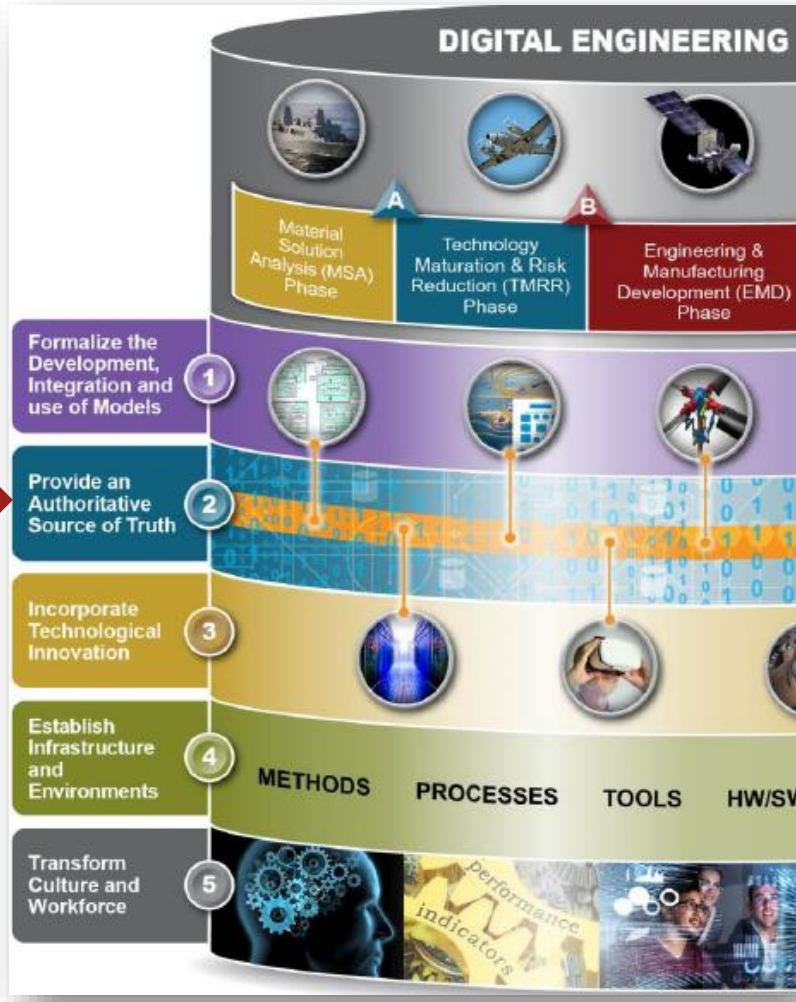


DE Transformation Systemigrams

Workforce and Culture

Much of the discussions around digital thread and digital engineering focuses on the technological and modeling aspects. While those are integral to the changing dynamics and processes, often overlooked is the human role and associated changes, and how it will shift and might change over time, as the broader system seeks to become more agile.

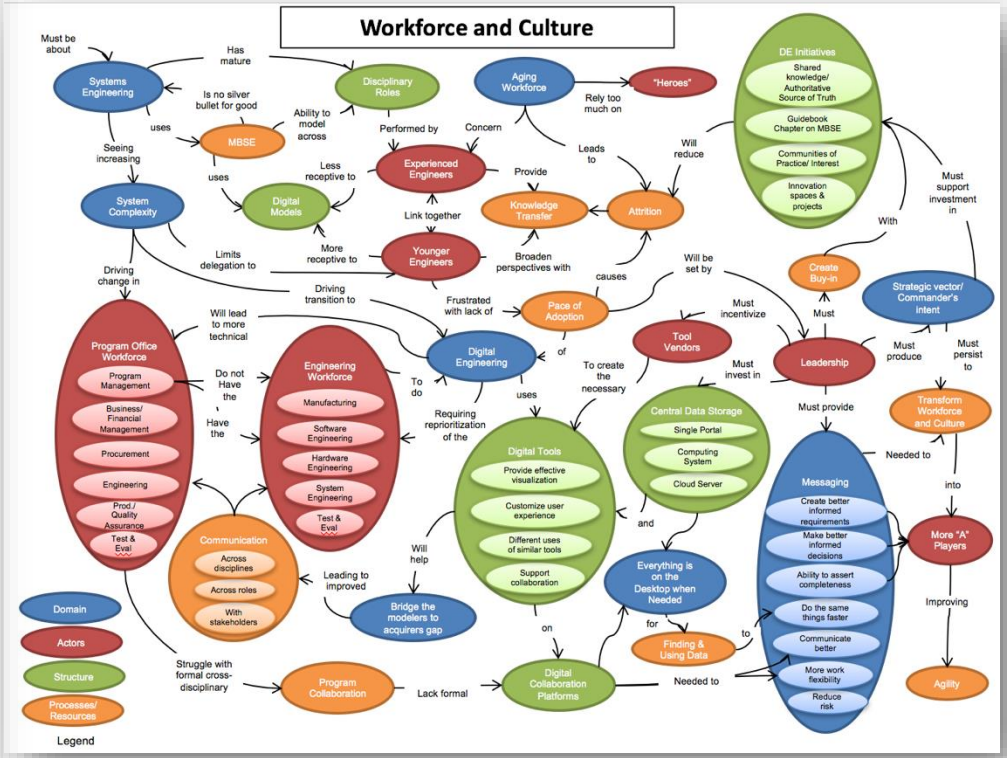
Most stakeholders and experts do agree there is a cultural change at play, along with needs for the workforce to adapt and change with the broader trends at play as well. There are divergences in perspective in regards to what this might look like, the change in the "old guard" to "new guard", whether or not there are workforce capabilities and the "talent" will look like.

DE is a cultural change in and of itself. There are the new tools which bring in digital natives and will be a merger of new technology and existing experience. As such, the workforce shift will be substantial. There will be big struggles to learn new ways. The goal is having the models to feed the decision processes, which requires training of modelers and a new breed of decision makers. However, it's a challenge to get a large group of people to change. Culture change is not done without resistance or done overnight. There is an extraordinary advantage to maintain the status quo and temptation to "do it like how we did last time". Culture change is organizationally dependent and unchangeable.

One of the bigger points of diversion amongst stakeholders is whether or not there is a workforce in place to grapple with the changes at play, and if so, whether there are capabilities to address the changes. On the one hand, DE is done today often times without the realization that is being applied. People who do models do it without thinking about it. However, there lacks the process and culture to bring together the emerging digital natives with grizzled veterans and their domain knowledge.

On the other hand, there is the belief that much of the workforce is an aged workforce that looks back at the way things were done rather than looking to the future. The younger group coming in also has shortfalls. The younger workforce is more skilled in a single discipline rather than a broad perspective. There needs to be an effort to better train the younger workforce to oversee multiple different domains to provide a more robust understanding of digital environment. However, bureaucracy and paperwork make it hard to train due to time constraints. Additionally, there is not enough money or time to train older workforce to train them how to use new tools as well.

This squeeze on resources also impacts the focus on SE, as discipline workforces are less and less SE focused and system implications. Labor is expensive and systems are expensive to implement. There are no expectations to think about larger system aspects from the onset. Hiring managers are worried about finding MBSE workers, but there should be more of an effort place finding systems engineers.



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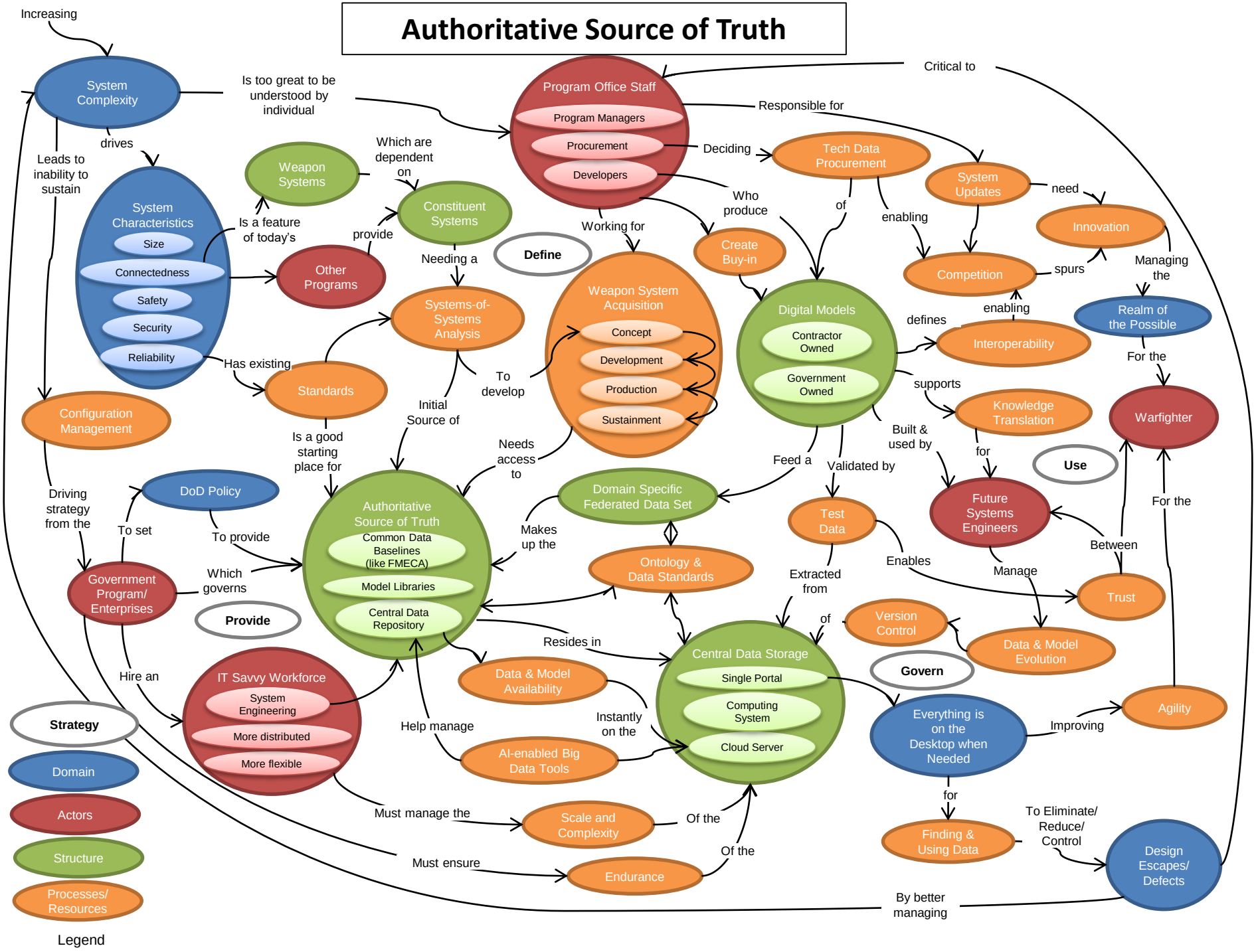

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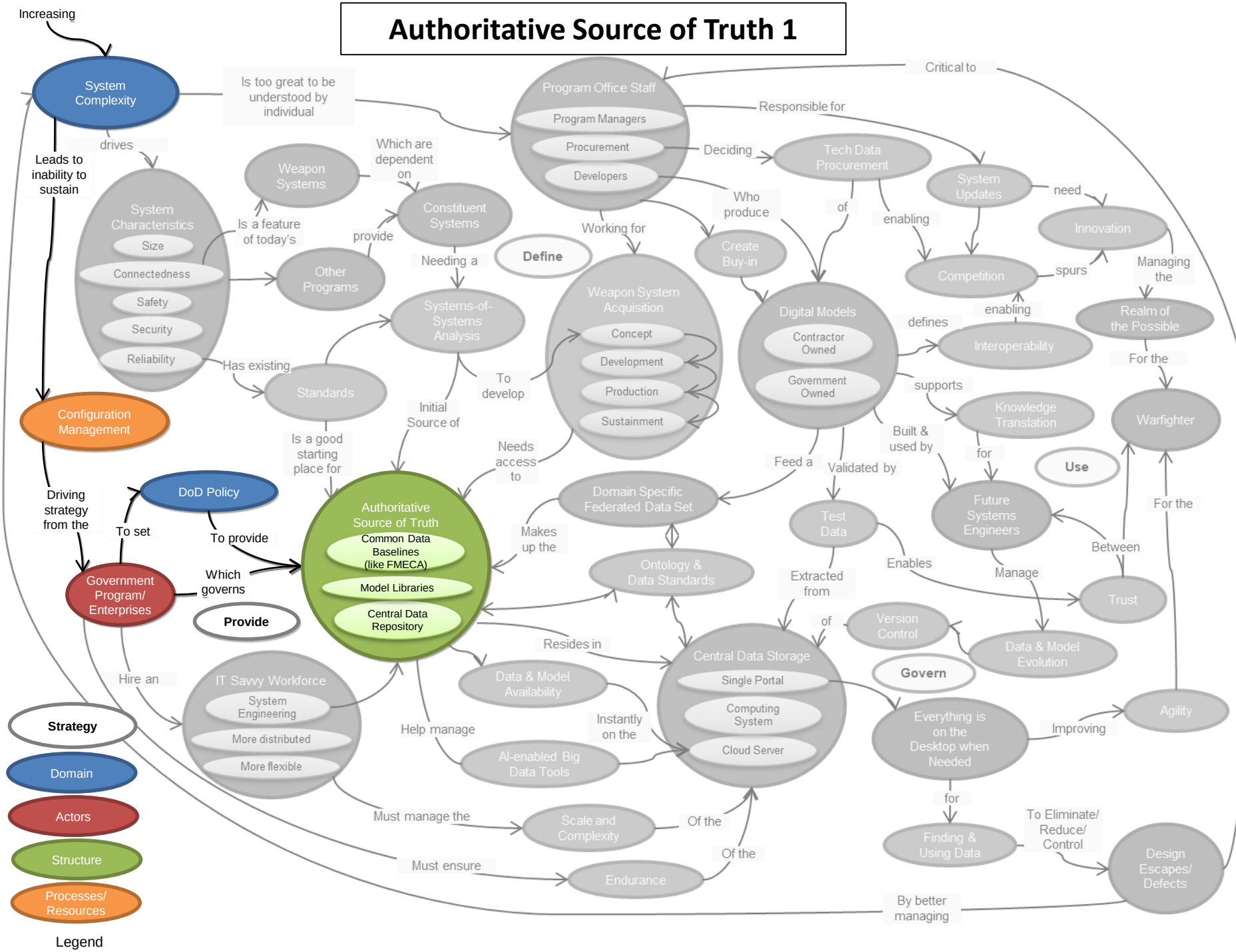

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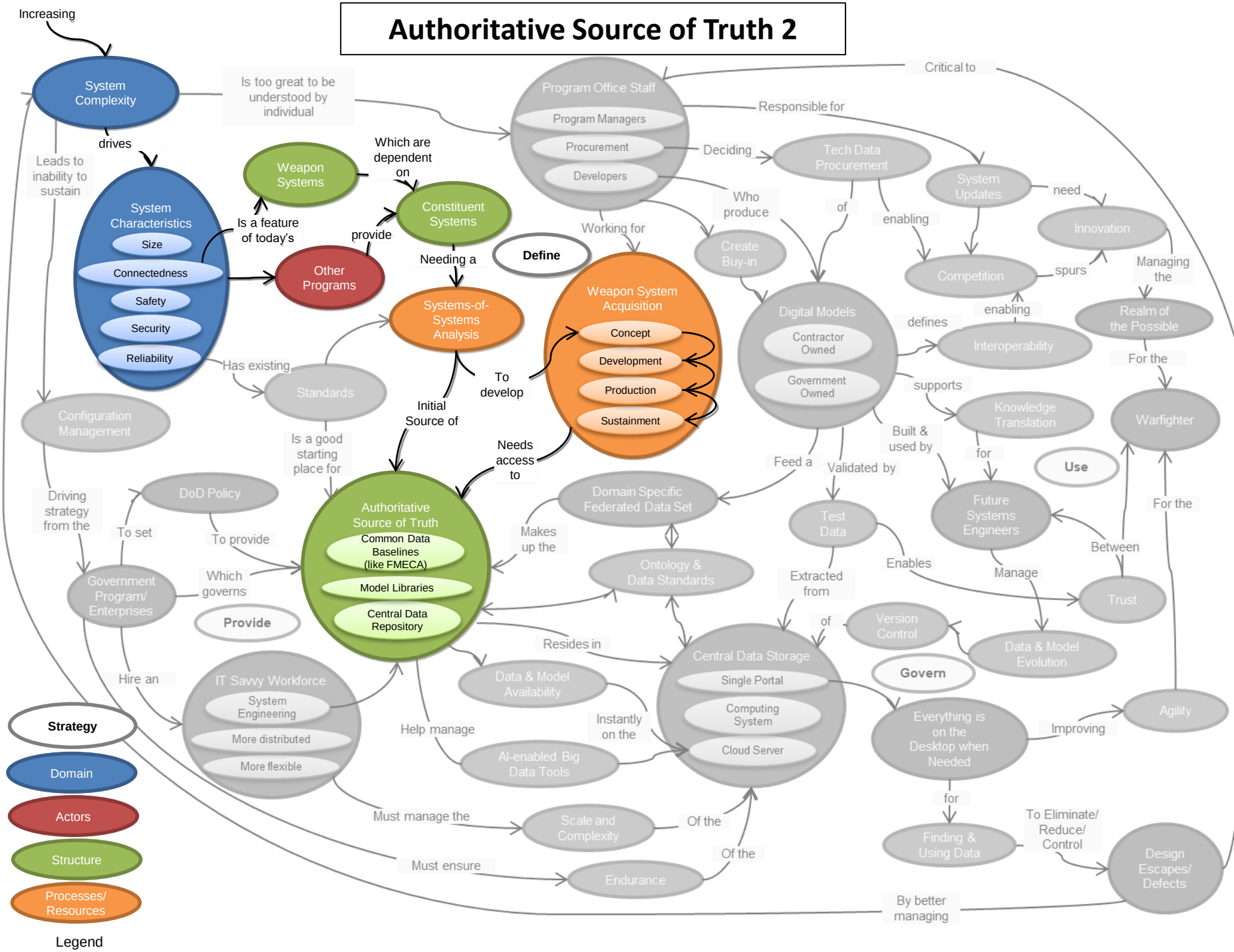

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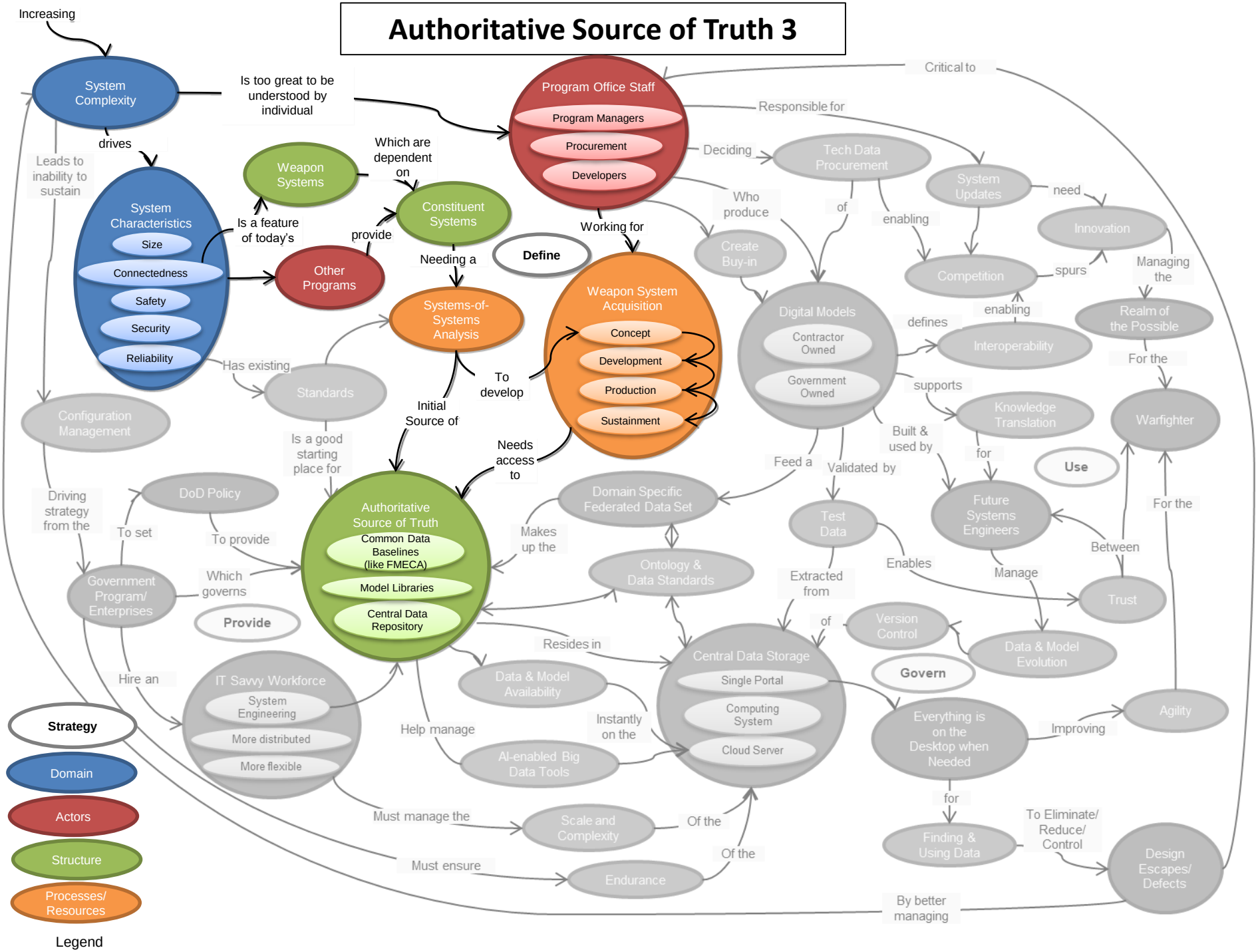

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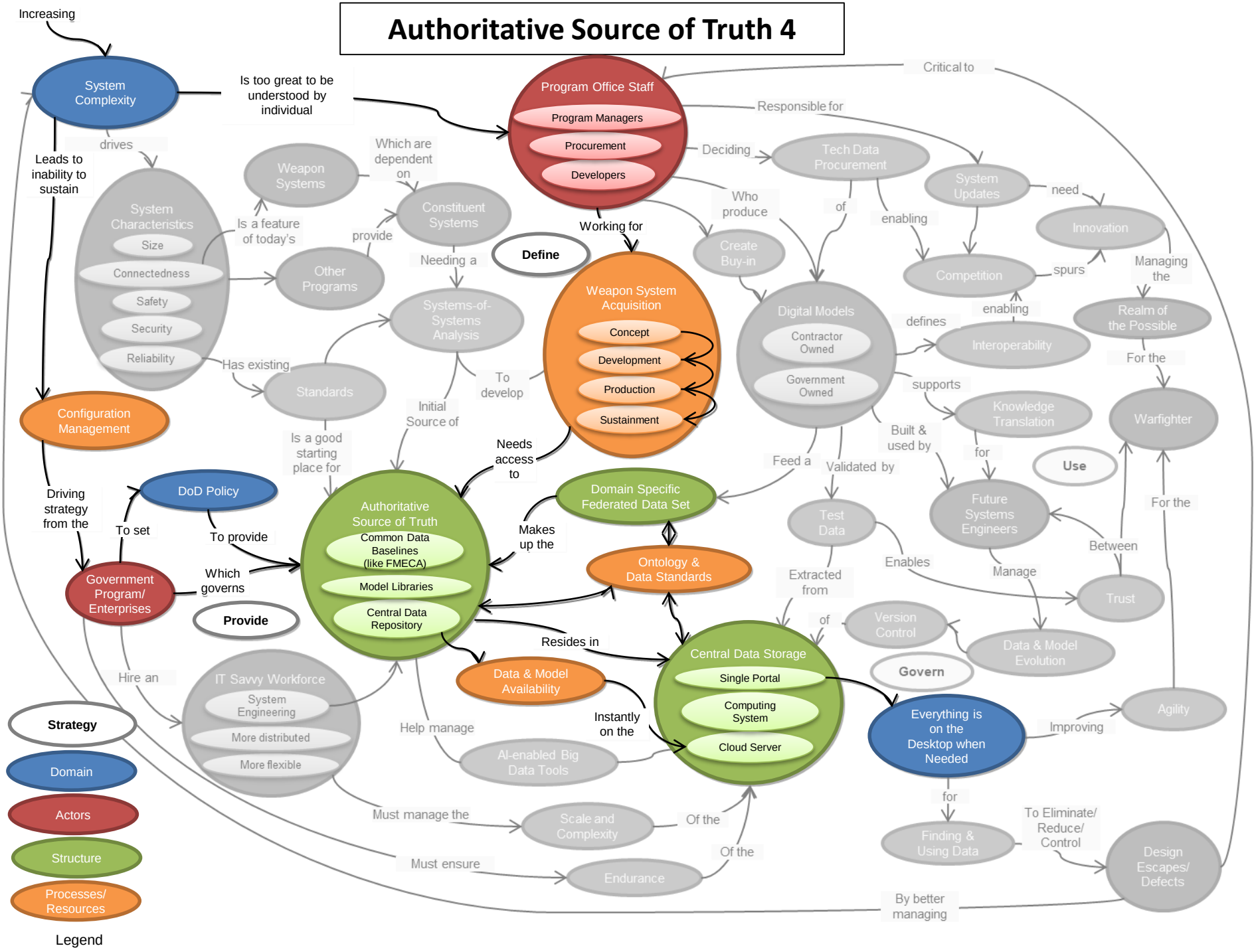

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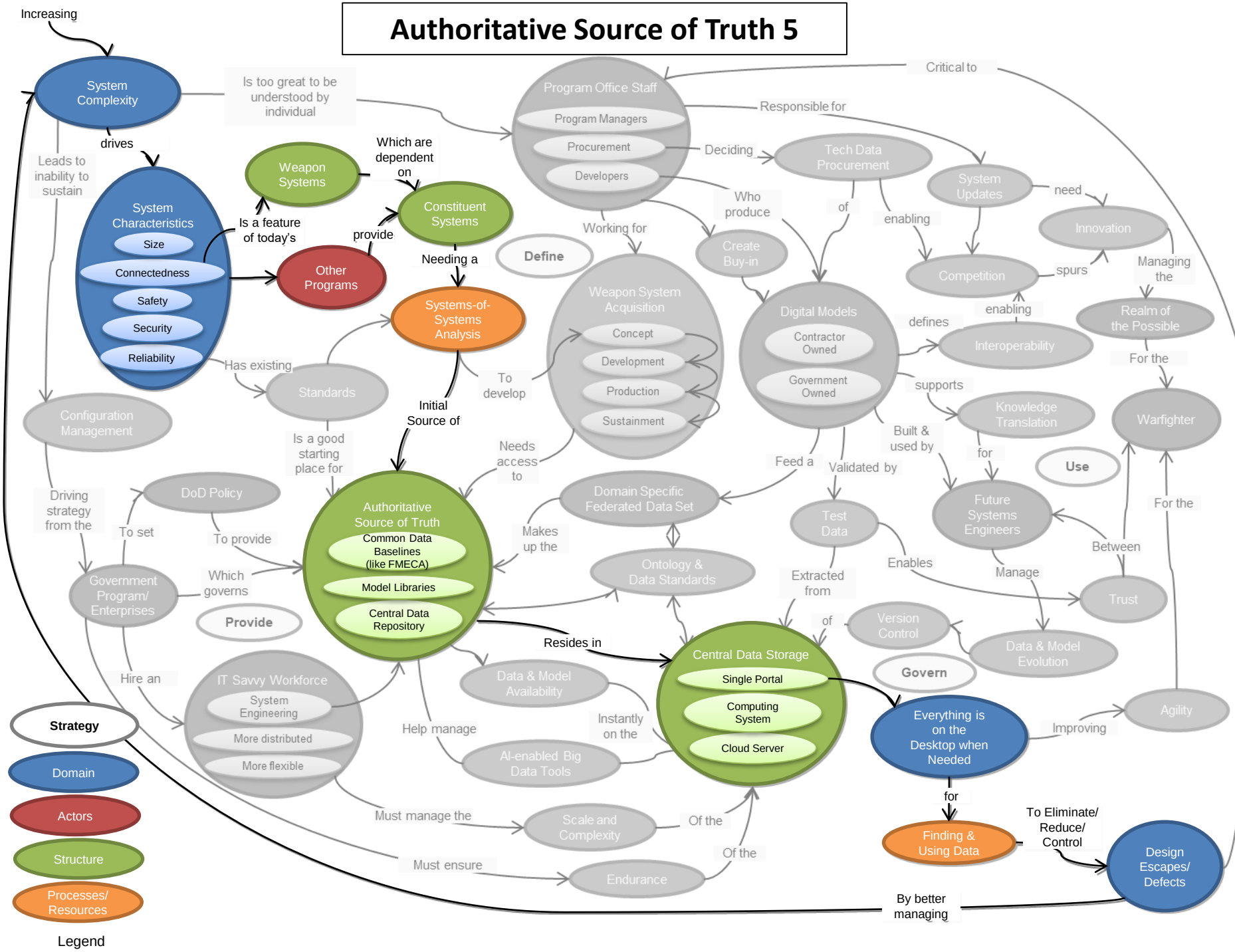

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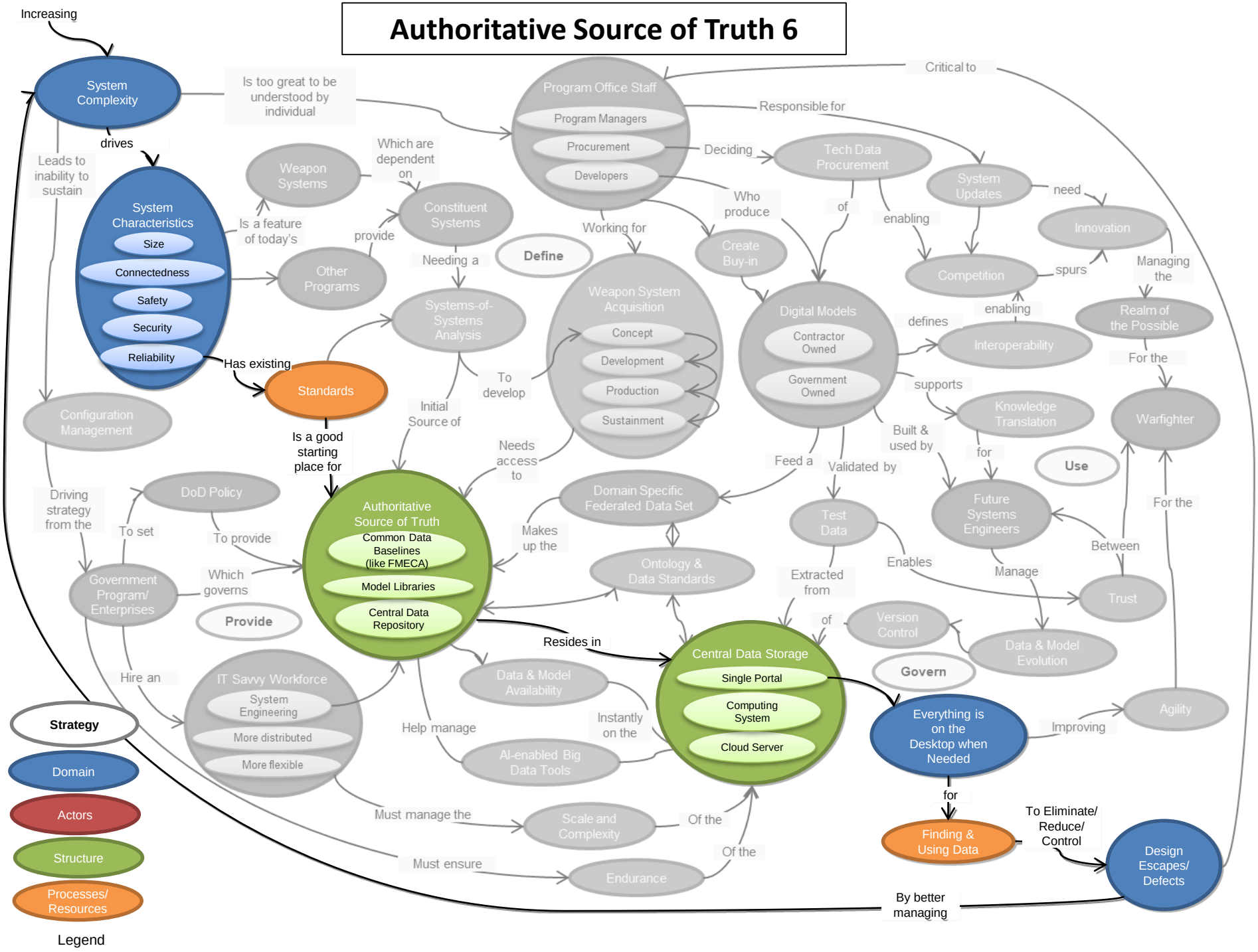

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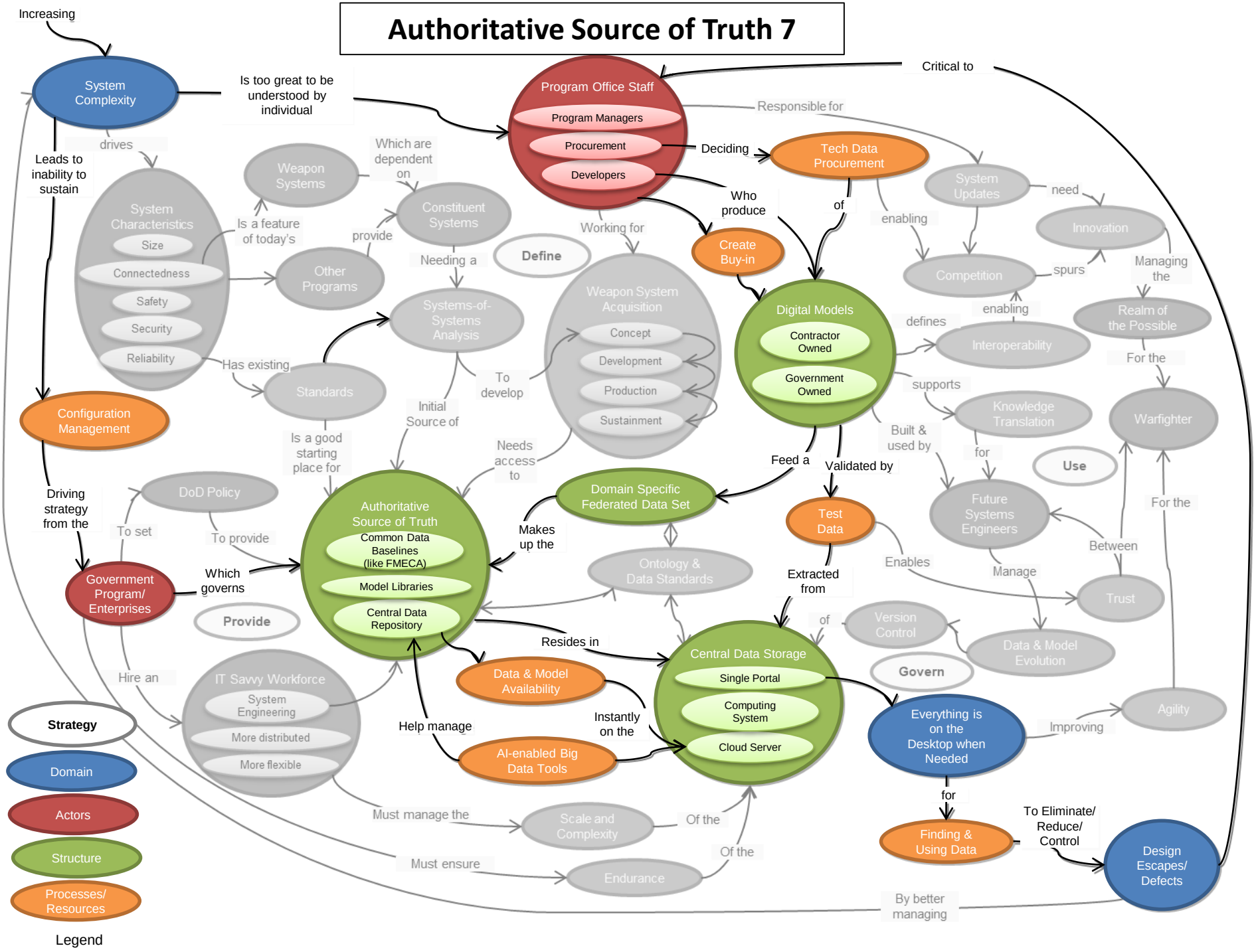

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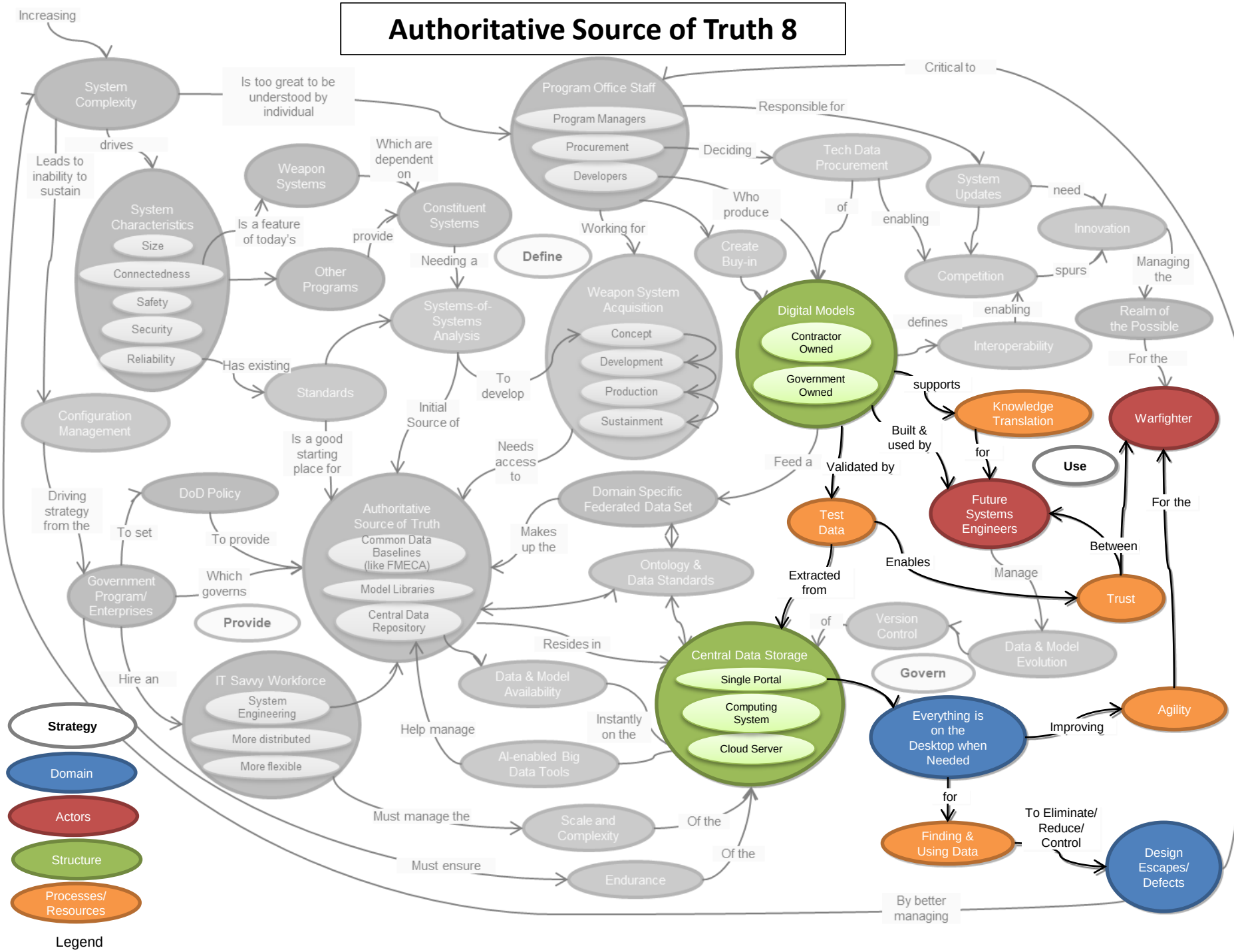

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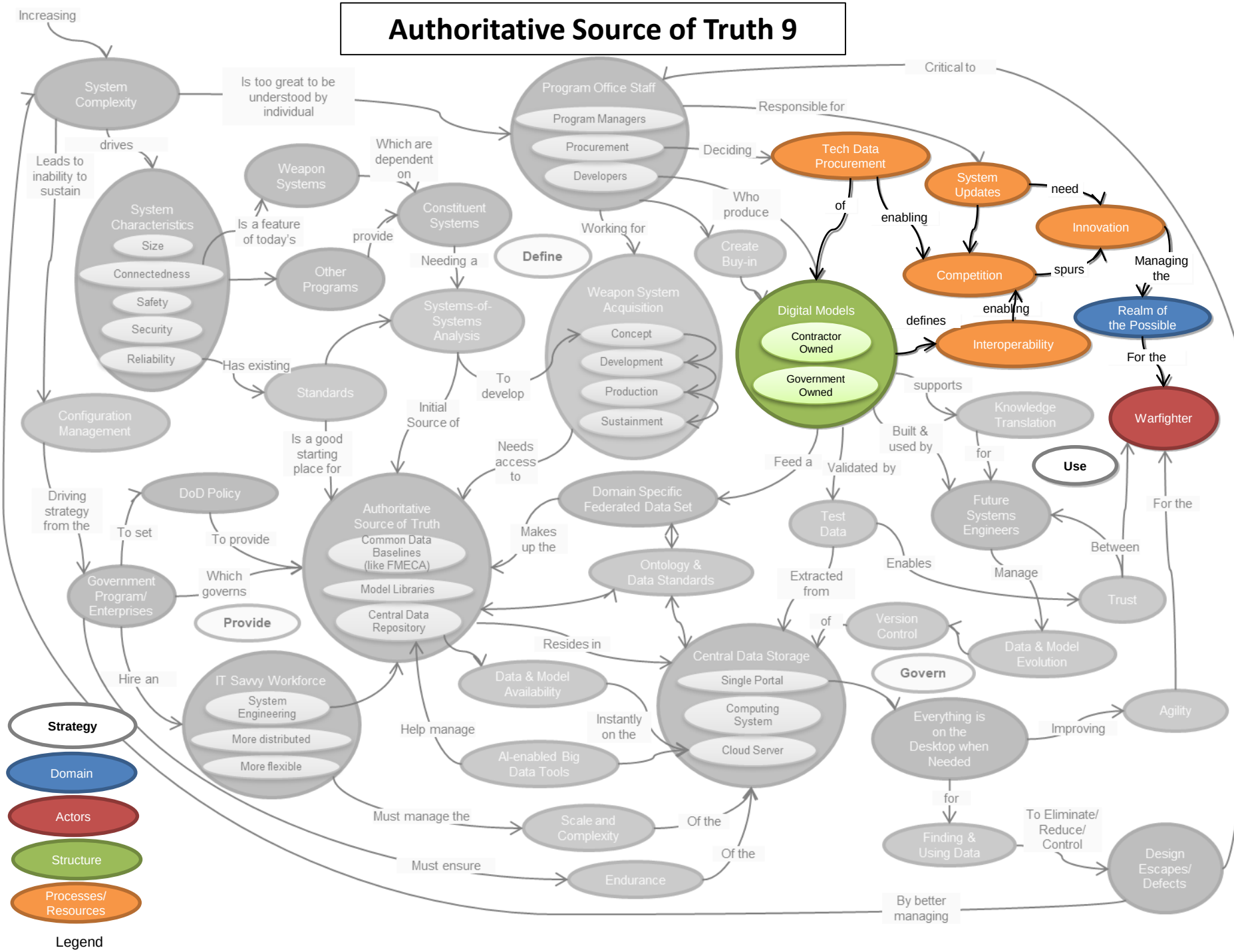

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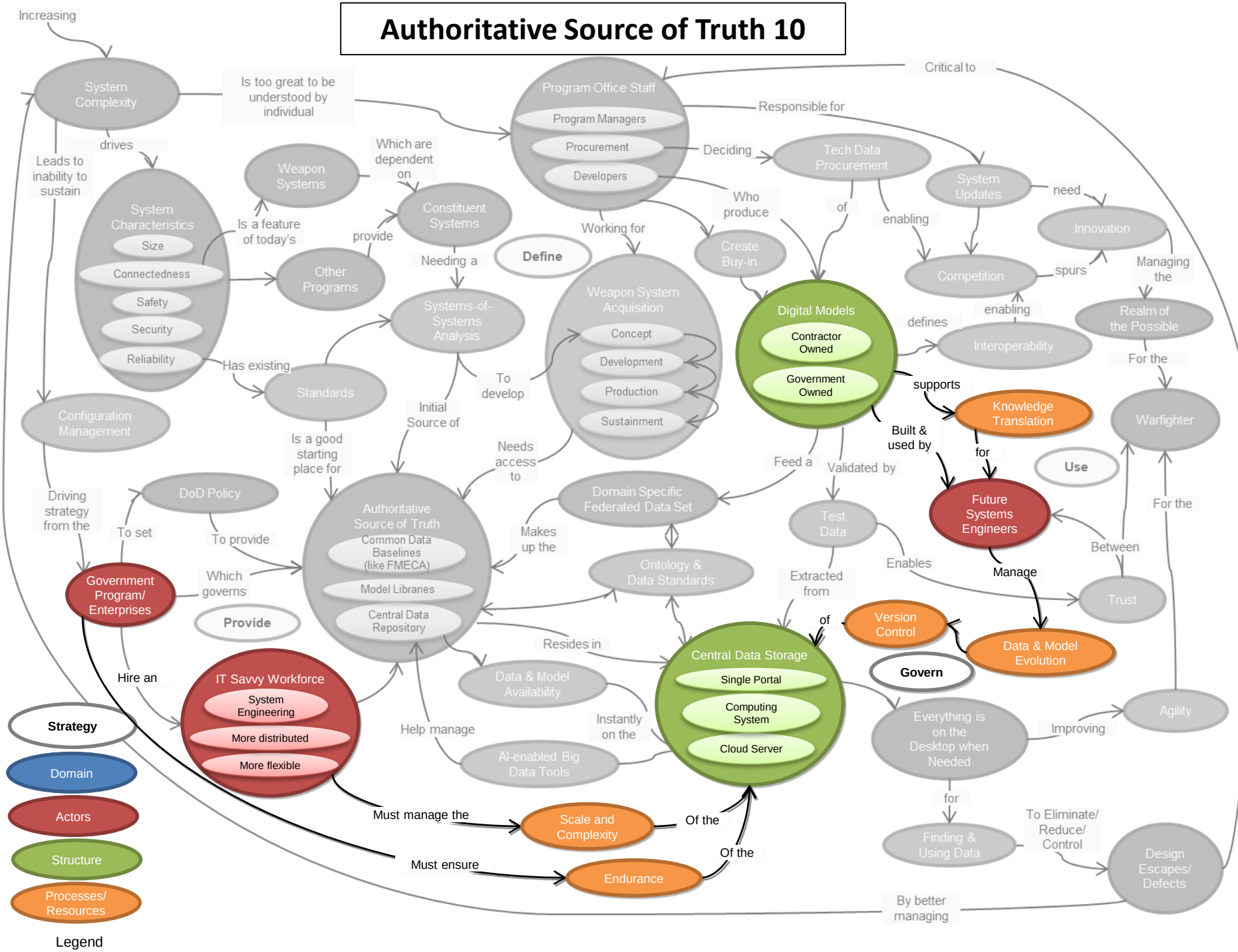

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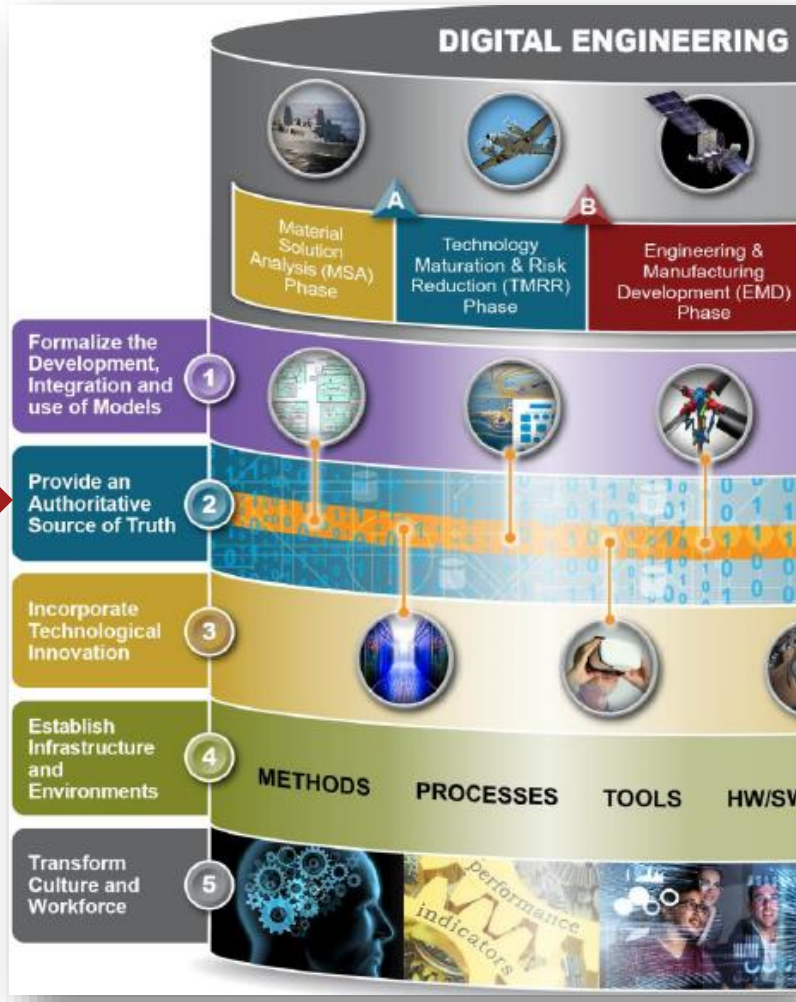
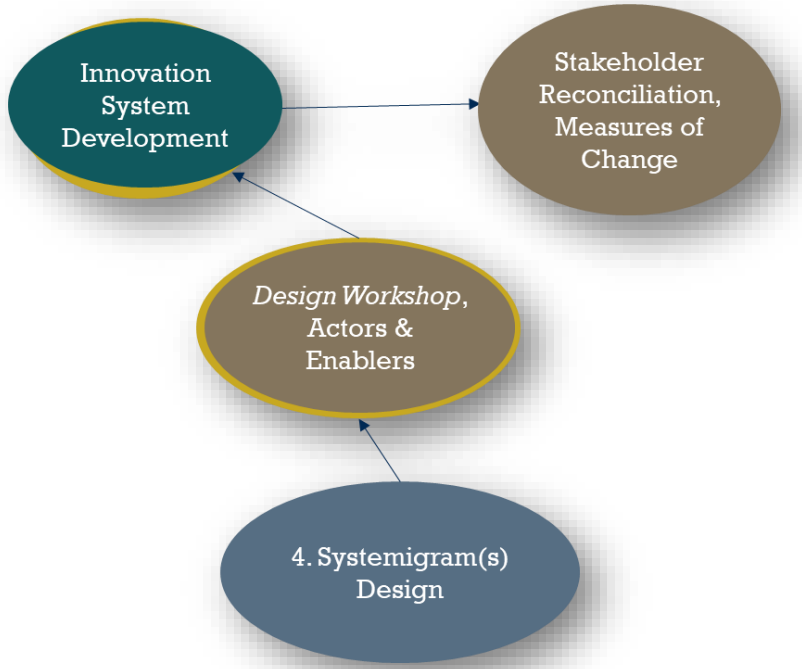


Outcomes and Next Steps

- Created holistic model of DoD Acquisition Enterprise change as DE is gradually adopted
- Good agreement across stakeholders on the nature of the strategy
- Descriptive modeling process reveals scope of change
- Testing insights in multiple forums using Systemigrams
- Next steps:
  - —What do program offices need to emphasize?
  - —What are the short and long-term metrics for success?



Questions?

Thank you!