The Problem with DoDAF Models

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Bringing Rigor and Consistency to DoDAF Artifacts

Problem

- Programs receive DoDAF artifacts that often are not fully reviewed due to the effort involved
- Static artifacts may not facilitate agile development / set-based design
- Architecture gaps lead to downstream errors, rework, and cost/schedule overruns

Solution

- The NomoGraph process was developed (by Mark Gibson, former Engility) as an Excel-based method to assess DoDAF artifact quality
- The improved NomoGraph process uses MagicDraw, a system modeling tool, to:
  - Reduce the costs associated with analyzing DoDAF artifacts
  - Increase the number of analyses available
  - Allow for automated validation rules and error-checking
- Similar validation rules can be applied to any DoDAF/UAF products before submission to improve the quality of deliverables

The Problem

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The Law of Conservation of Systems Engineering

"The amount of systems engineering required for a given project is fixed. You don't get to choose how much systems engineering you do. You simply get to choose when you do it (up front, or during integration and testing), how much positive impact it has, and how much it costs."

— James Long, FINCOSE

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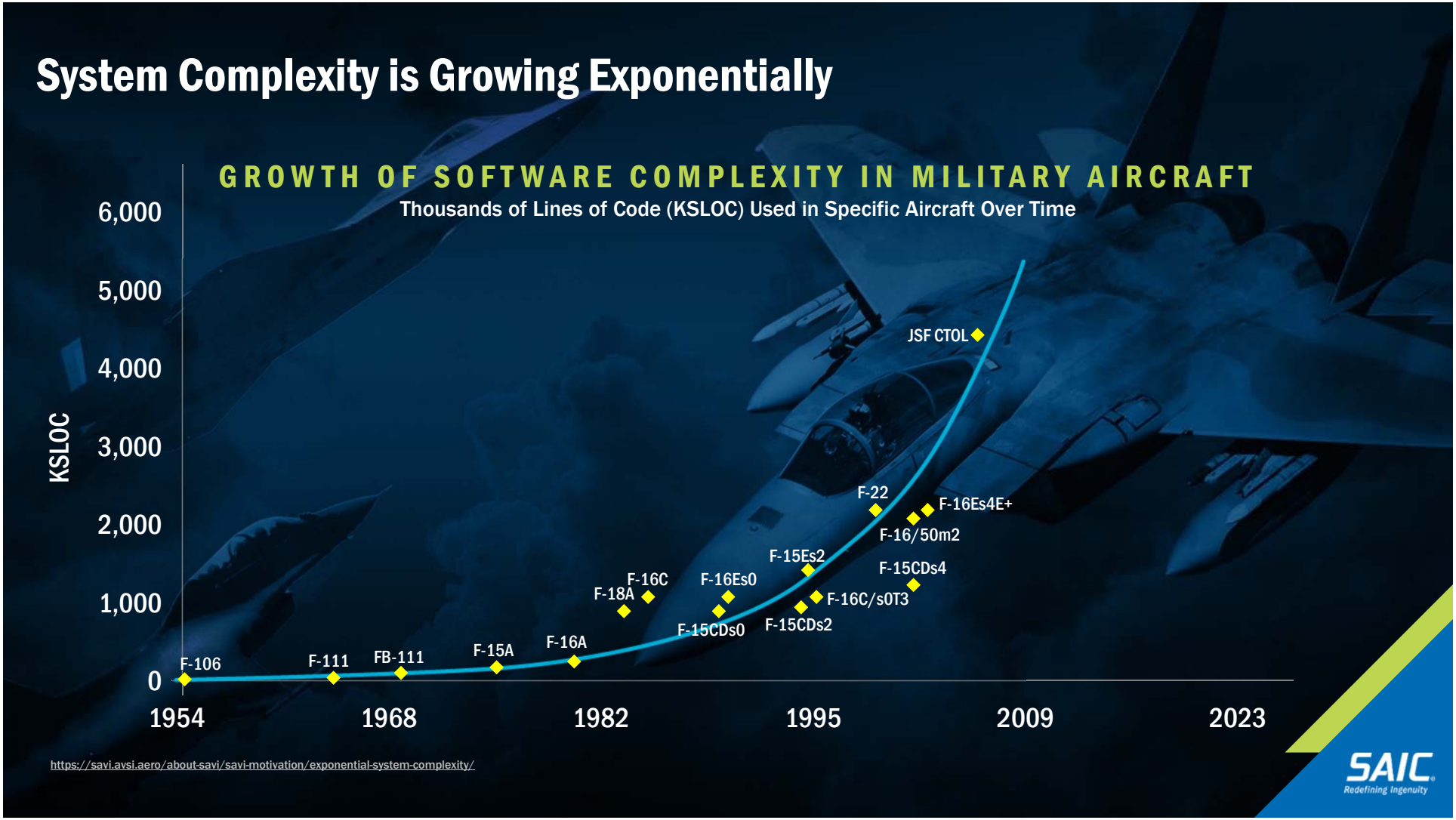
System Complexity is Growing Exponentially



https://savi.avsi.aero/about-savi/savi-motivation/exponential-system-complexity/

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The Department of Defense Recognizes Current Approaches Cannot Manage This Explosion in Complexity

> *"Our current defense acquisition system applies industrial age processes to solve information age problems."*
>
> — LtGen Robert D. McMurray, AFLCMC/CC

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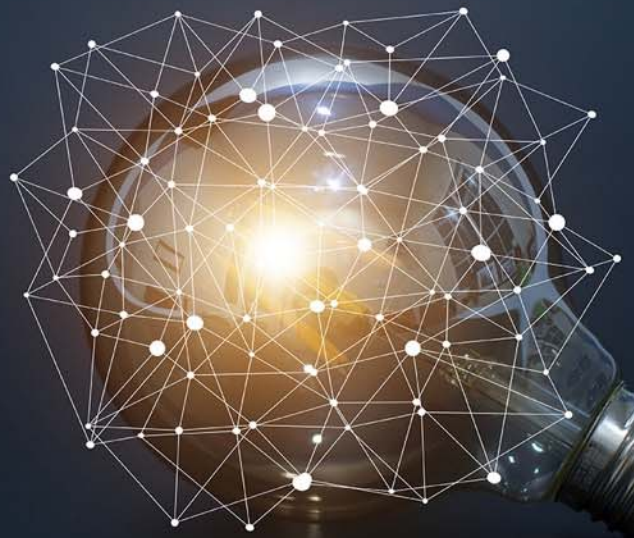
The Solution: Rigor At the Speed of Relevance

rigor noun

rig·or | \ ˈri-gər \

The quality or state of being very exact, careful, or strict.

– Merriam-Webster, 2017



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The Solution: Rigor At the Speed of Relevance

rigor noun

rig·or | \ ˈri-gər \

Scrupulous adherence to established standards for conduct of work

– NASA Final Report of the Return to Flight Task Group, Appendix A.2, 2005

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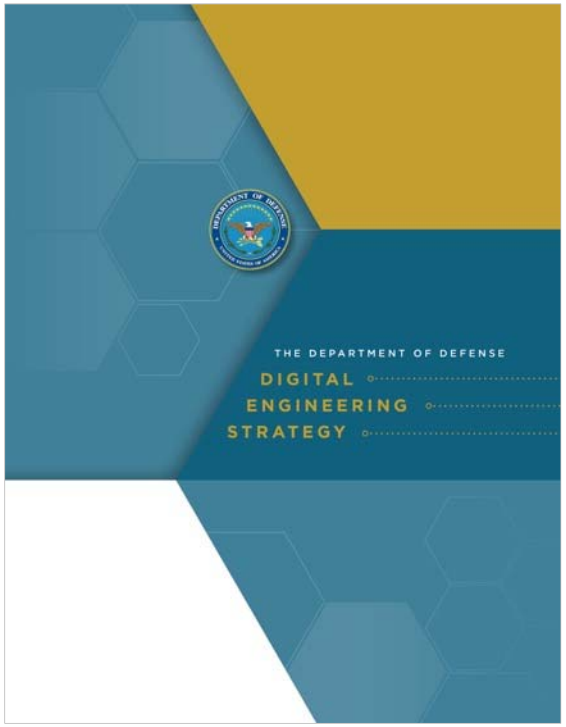
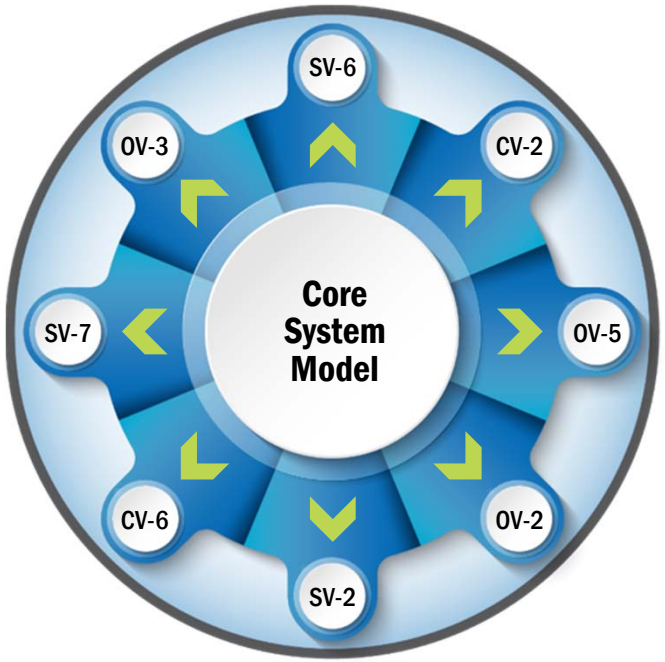
DoD Vision: Gain Rigor via Digital Engineering (DE) And Accelerate Technical Integration by Connecting Data



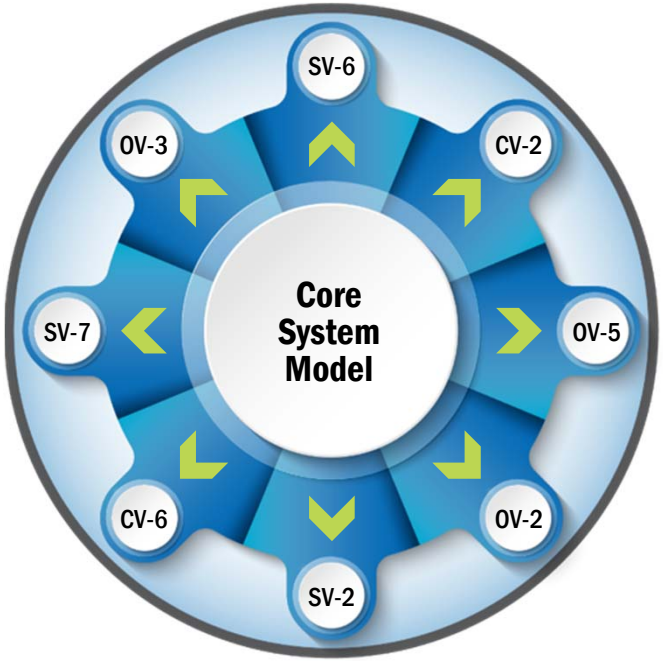
DOD DIGITAL ENGINEERING STRATEGY
(June, 2018)

MODEL BASED ENGINEERING (MBE) ENVISIONED



The Problem With DODAF Application

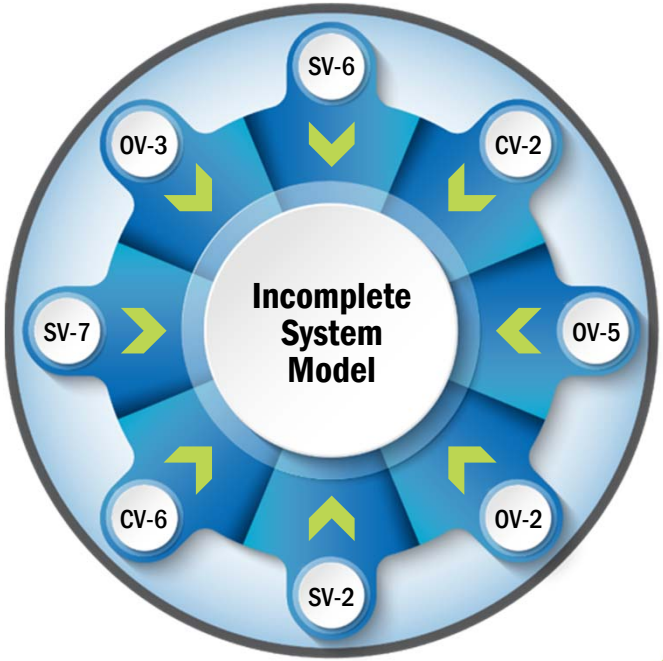
MODEL BASED ENGINEERING (MBE) ENVISIONED



Complete Model Builds Consistent Viewpoints

Contractors/PM's only Build/Deliver Required Viewpoints on a Compliance Checklist

MODEL BASED ENGINEERING (MBE) PRACTICED



Limited Number of Viewpoints Cannot Build Complete Model

Courtesy Mark Gibson, SAIC Technical Fellow

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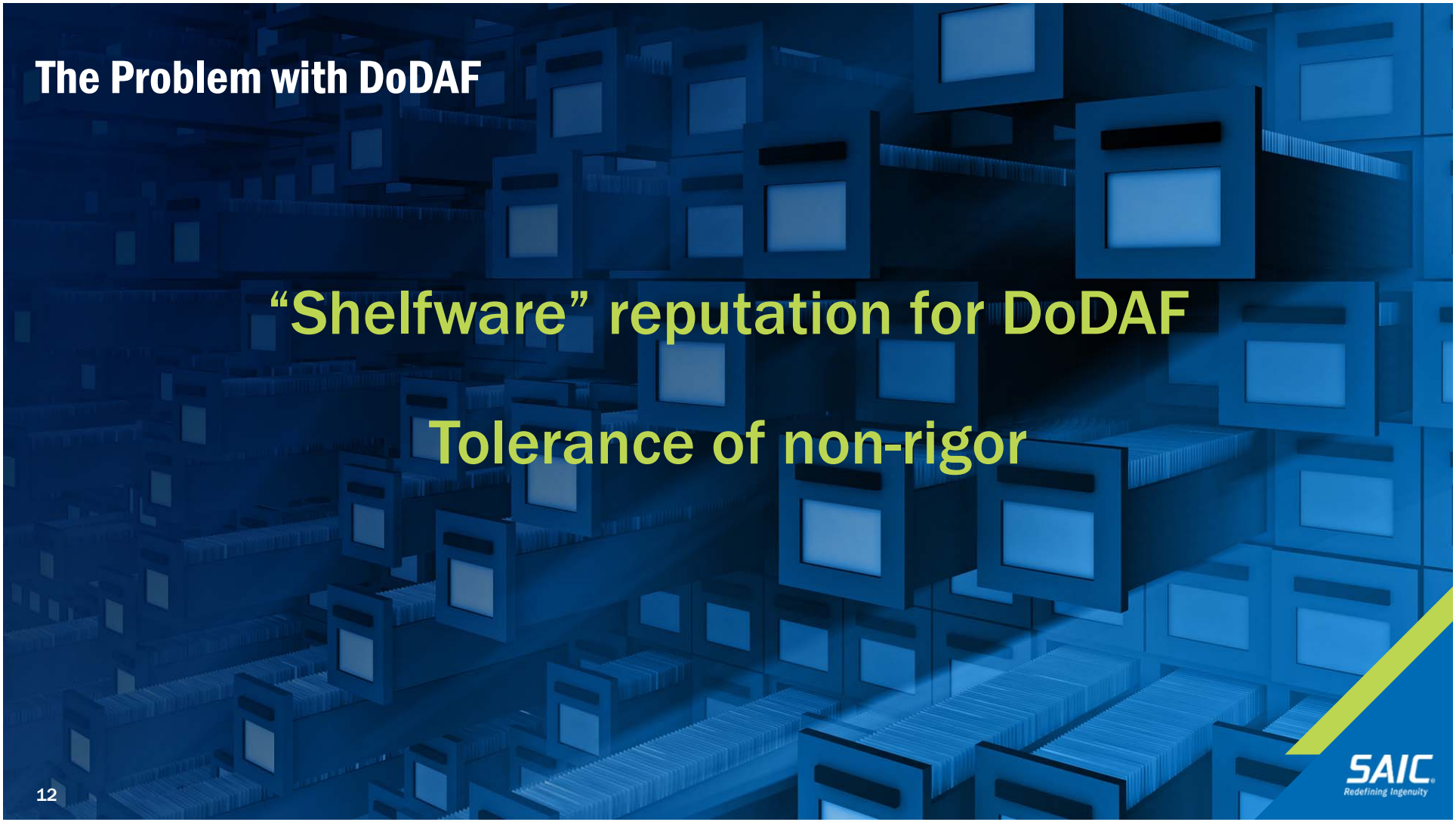
The Problem with DoDAF

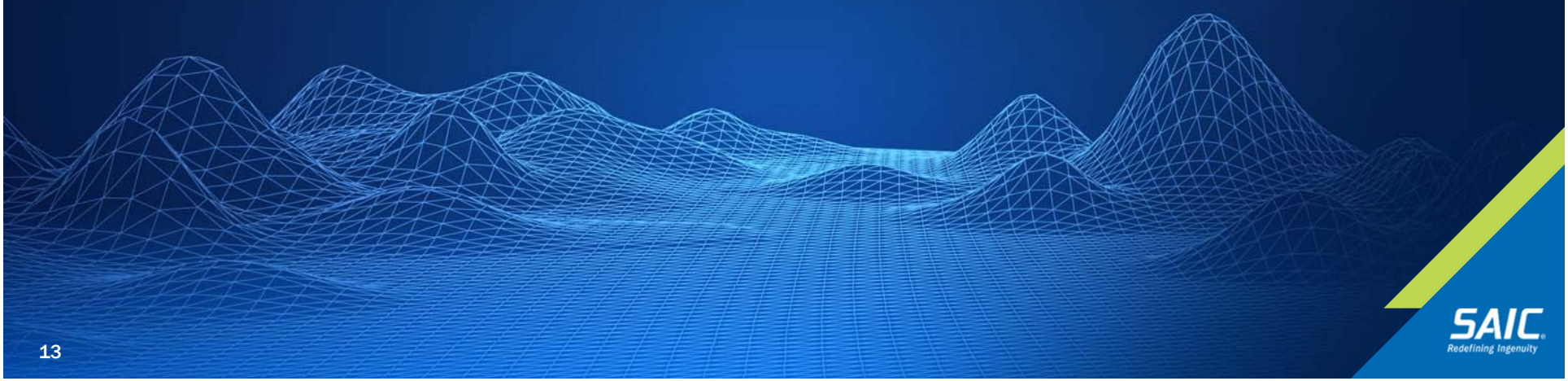
- Intended as an architectural framework
- Leads to siloed, disconnected views of system
- No guarantee of consistency between views
- Often delivered as PDFs, Excel, or other disjointed artifacts
- Recipients cannot or do not review thoroughly

The Problem with DoDAF



Expectations > Current Reality

> *Architecting defines what to design, while design defines what to build.*
>
> — **Hillary Sillitto**, *Architecting Systems: Concepts, Principles, and Practice*



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Expectations > Current Reality

Failure to assess architecture quality results in:

- Cybersecurity vulnerabilities
- Design errors
- Test failures
- Increased costs (especially integration)
- Negative schedule impact

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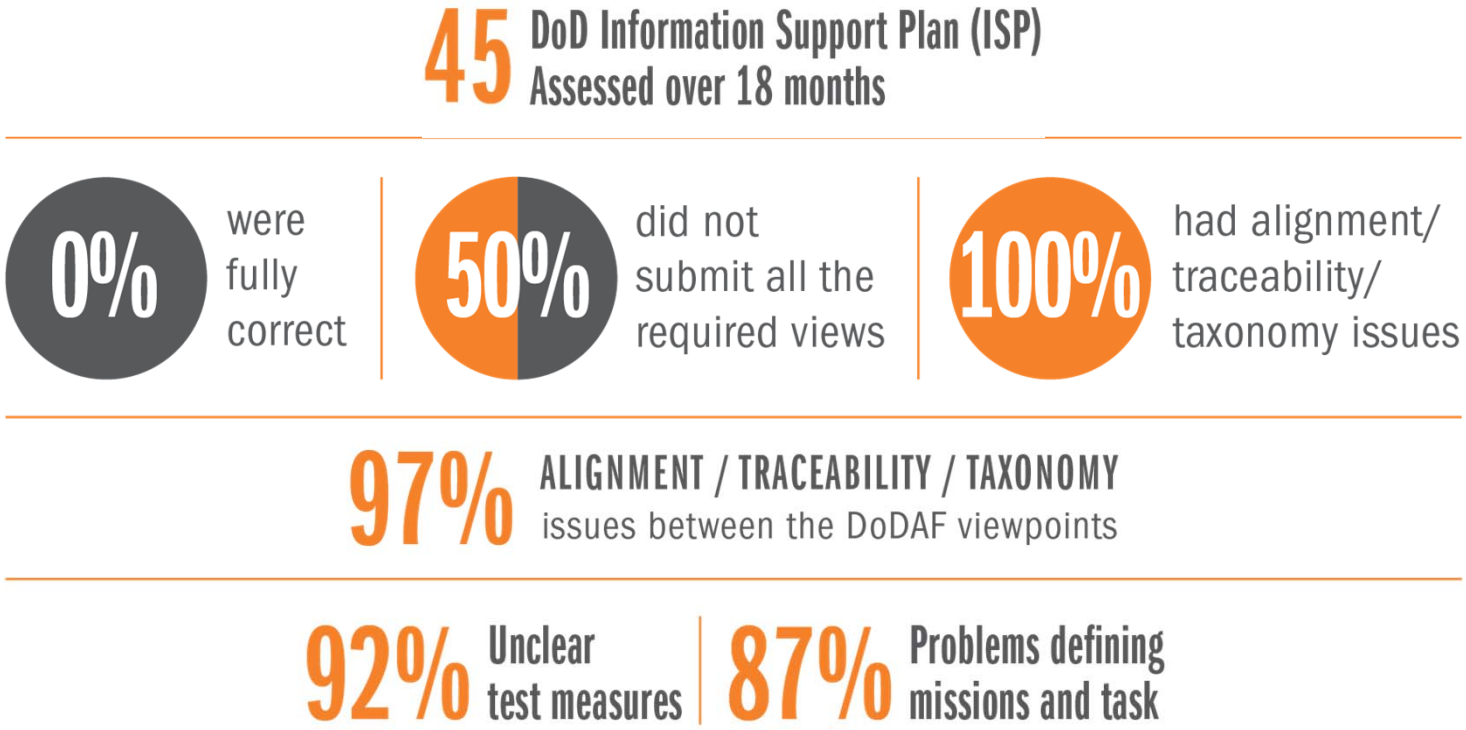
A Customer Example:

Government Program (Head Start) Findings



Courtesy Mark Gibson, SAIC Technical Fellow

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The Approach

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The NomoGraph Approach

How do you determine if an architecture package is complete, consistent, and traceable?

Courtesy Mark Gibson, SAIC Technical Fellow

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The NomoGraph Approach

What type of review is done for contractor deliverables before submission for review in IAMS?

Courtesy Mark Gibson, SAIC Technical Fellow

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The NomoGraph Approach

Is the Taxonomy consistent across viewpoints?

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The NomoGraph Approach

Do the Viewpoints (Models) have all the required fields to ensure Viewpoint (Model) traceability?

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The NomoGraph Approach

Have you verified and validated your models before giving them to down stream users?

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The NomoGraph Approach

Do you contract for DoDAF Core Model Delivery or for DoDAF Viewpoints?

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The NomoGraph Approach

Are the DoDAF Models altered by hand ("Hand Jamming") after being generated by Modeling Software?

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What is an Architecture NomoGraph?

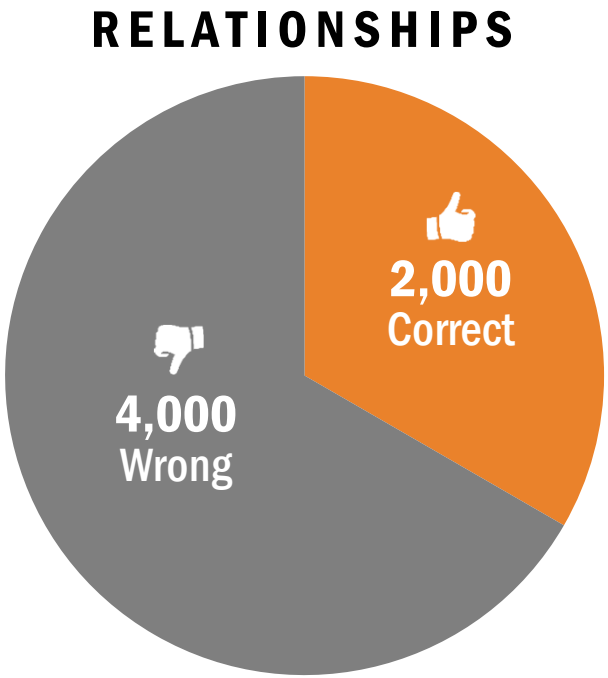
- Multi-dimensional Relational Analysis using a series of aligned tables that relate design parameters
- Graphically displays errors with relationships of model elements.
- Relates multiple operational and system parameters to check consistency

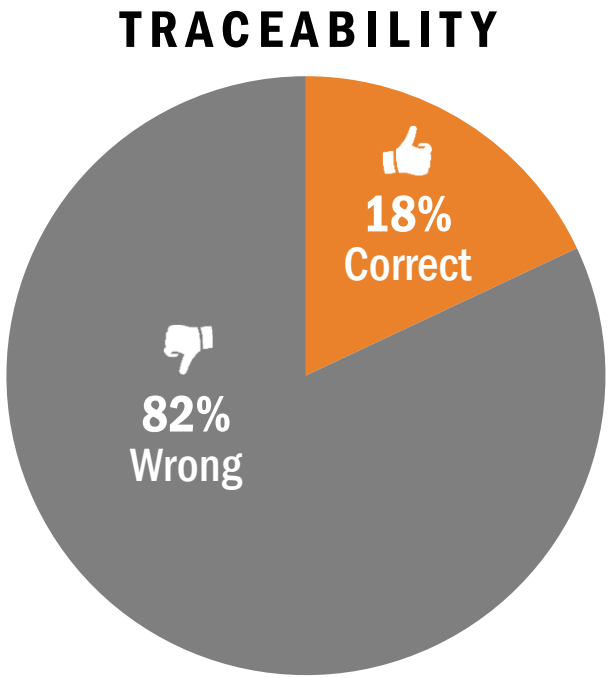
While it is effective, it is labor intensive.

Traceability NomoGraph

	Operational Exchange			
Table One	OE 1	EO 2	OE 3	OE …
Task/Activities				
T1				
T2				
T3				
T…..				
Table 2	OE 1	EO 2	OE 3	OE …
Networks				
N1				
N2				
N3				
N…..				
Table 3	OE 1	EO 2	OE 3	OE …
System Resource				
SRI 1				
SRI 2				
SRI 3				
SRI …				
Table 4	OE 1	EO 2	OE 3	OE …
From Performer				
PP 1				
PP 2				
PP 3				
PP …				
To Performer				
CCP 1				
CCP 2				
CCP 3				
CCP …				

Extreme Example of Errors Relating OV-3 and SV-6 DoDAF Viewpoints





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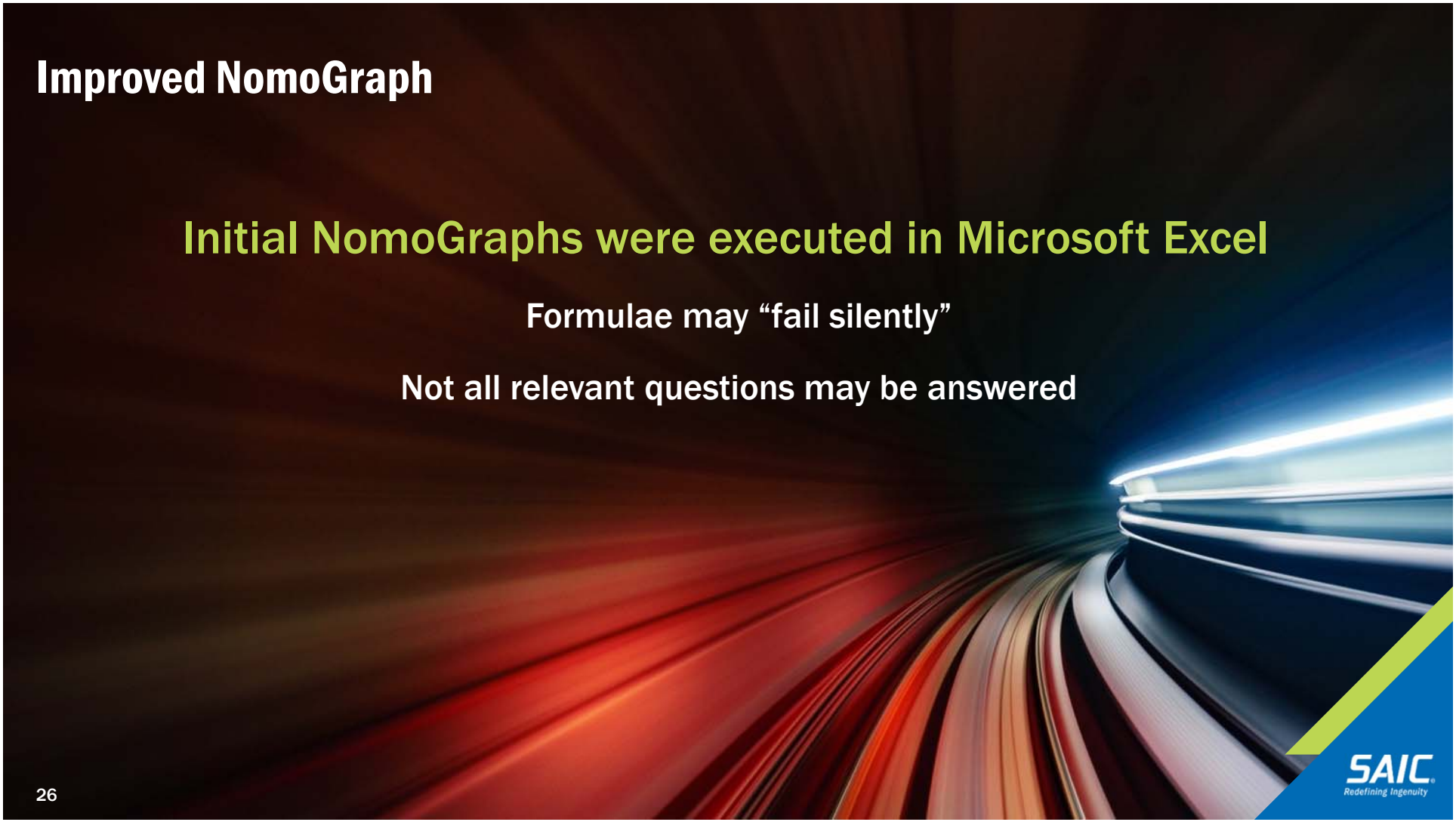
Improved NomoGraph

Initial NomoGraphs were executed in Microsoft Excel

Formulae may “fail silently”

Not all relevant questions may be answered

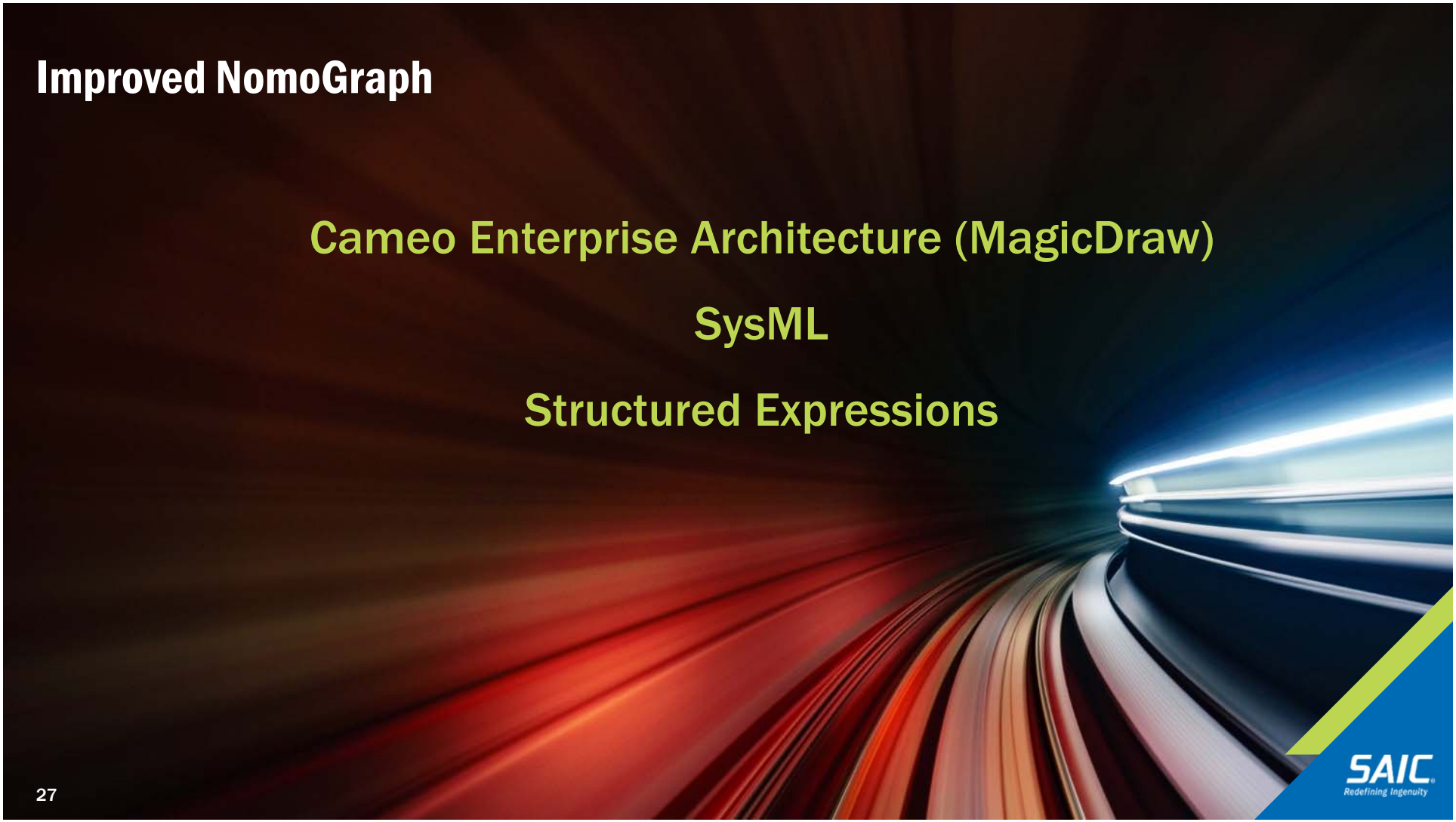


Improved NomoGraph

Cameo Enterprise Architecture (MagicDraw)

SysML

Structured Expressions



Improved NomoGraph

Guiding Principles

Fastest, least customized approach to import, connect, and analyze information

Do not create what can be unambiguously inferred

The Solution

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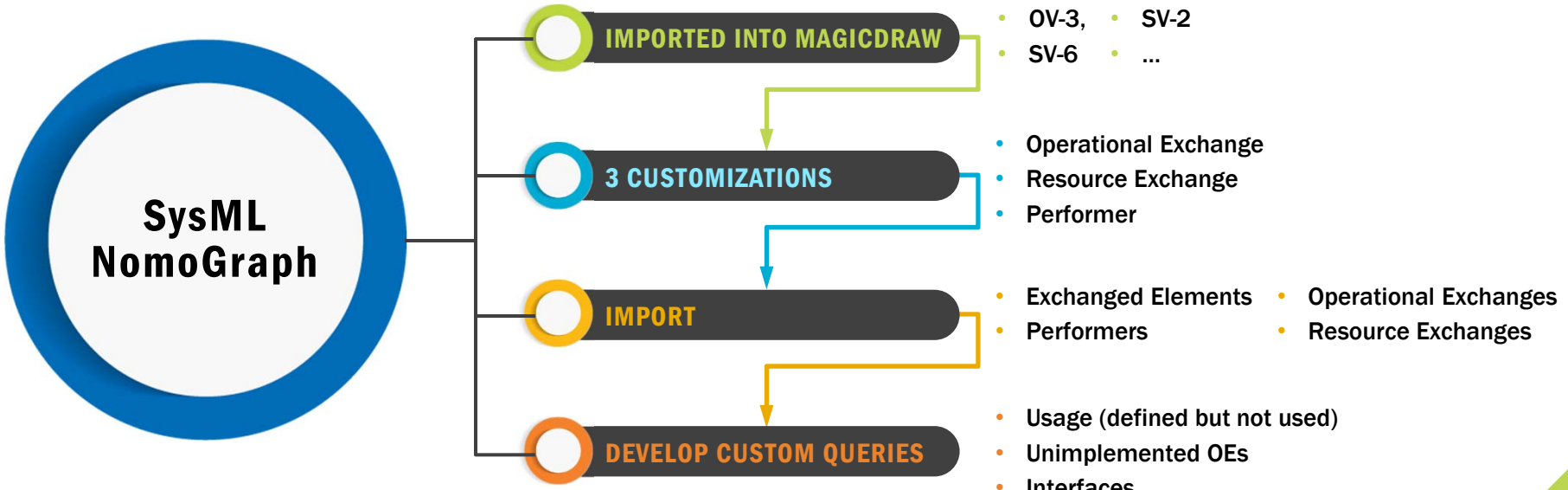
Proof of Concept: Analysis Rules



Tables

Matrices

Validation Suites

Conclusion

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Rapid Analysis Is Possible

- DoDAF artifacts can be converted into SysML elements for analysis using structured queries and validation rules
- This allows key advantages of MBSE to be realized without the burden of recreating every DoDAF view and artifact
- Time to complete this analysis: <16 hours (some of that was invested in method development)
- Other projects can leverage the custom queries and modeling pattern to produce improved NomoGraphs
- Using MagicDraw allows additional queries to be created using the established relationships and elements

Value can be rapidly extracted even if descriptive system model is not available

Benefits

Improved NomoGraph evaluation process can be applied to:

- Internal DoDAF/UAF work
- Delivered CDRLs and artifacts

The Outcome:

- Improved:
  - Rigor
  - Speed of delivery
  - Support for agile / set-based design
  - Program outcomes
  - Error detection
  - Cybersecurity and integration
- Programs succeed at lower cost and with reduced schedule slippage

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