ARCHANGEL PROJECT
Architecture NomoGraph Evaluation Tool

Mark Gibson, Engility Corp.

Frank Diaz, Joint Interoperability Test Command (JITC)

ENGILITY
Engineered to Make a Difference

Presentation Outline

- Bottom Line Up Front (BLUF)
- Joint Interoperability Test Command (JITC) Pilot Program "Head Start"
- Problem Being Addressed
- Architecture NomoGraph Definition
- The Role of the Architecture NomoGraph in Architecture Maturity
- Success stories
- Questions and answers
- Points of contact

Bottom Line Up Front (BLUF)

- The DoDAF Viewpoints (VP) in Information Support Plans (ISP), submitted for Joint Interoperability (IOP) Testing are Inconsistent, Not Traceable and Incomplete
  - Validation of DODAF Models lacking

- The Architecture NomoGraph (ANG) Visualization Tool provides a degree of DODAF Model Validation
  - 3-5 day, 120 Man-Hour effort for most ISP packages
  - Multi-Dimensional Visual Stacked Table Product Presents Inconsistencies, Patterns and orphan (Joint mission/task, networks and Information Exchanges)

- Every JITC Customer (>50) Wants More ANG assessment at Next Product Iteration

- The Joint Interoperability Test Command has implemented the Traceability NomoGraph as a standard evaluation tool.

- Finding Design Issues Early can Reduce overall Program Costs

ENGILITY
Engineered to Make a Difference
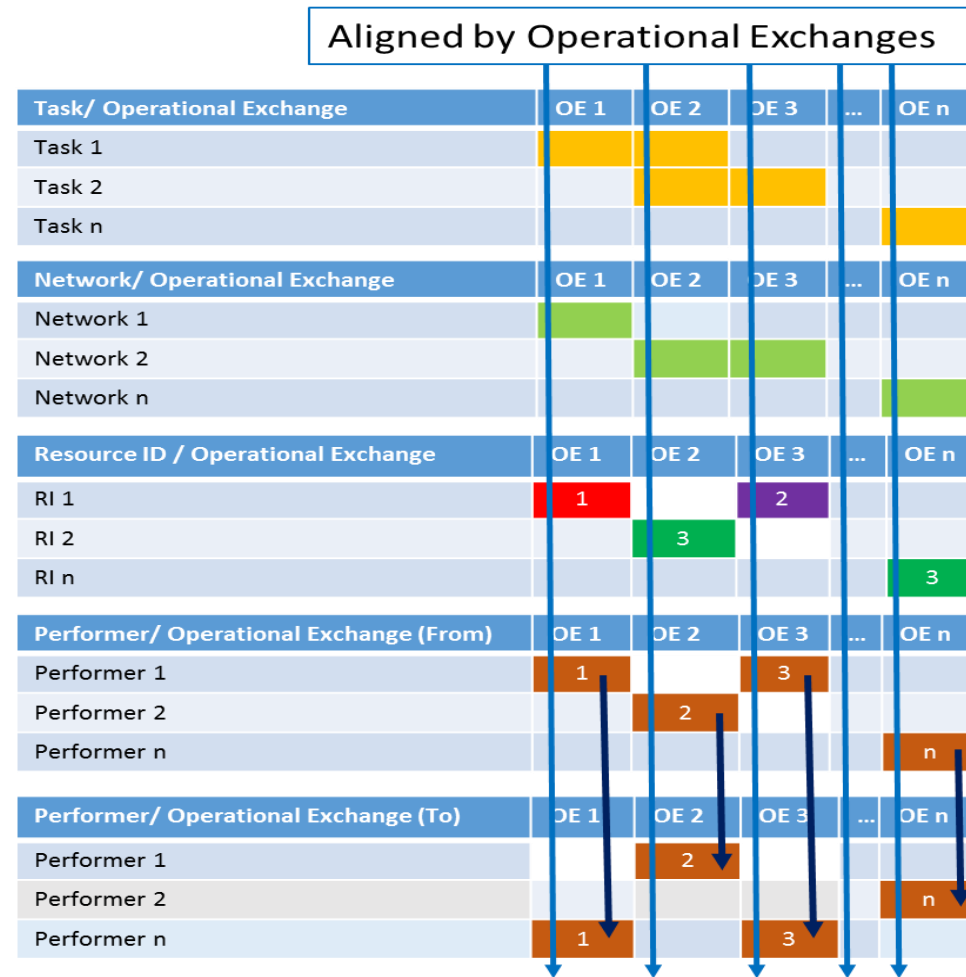
JITC Pilot Program (Head Start) Findings

- 45 DoD Information Support Plans (ISP) Assessed over18 months.

- All had some issue with their DoDAF Viewpoints.

- 50% did not submit all the required viewpoints IAW the JITC IPG, which identifies the required viewpoints for Joint IOP test plan development.

- All had DODAF Viewpoint alignment/traceability issues.

- 97% had an alignment/traceability issue between the NR KPP and the DoDAF viewpoints.

- 92% had unclear test measures.

- 87% had problems defining missions and task (activities).

ENGILITY
Engineered to Make a Difference

What Problem is Addressed

- All phases of engineering development and execution require accurate DoDAF architecture products to support downstream engineering processes like Interoperability (IOP) Test Planning

- DoDAF architecture viewpoints are of varying quality
  - Traceability, Alignment, Consistency, and Completeness

- Architecture NomoGraph (ANG) provides rigorous review and visual indicators of problems
  - Are the DoDAF viewpoints traceable?
    - Necessary information is traceable from one DODAF viewpoint to another, such as OV-2 to OV-3, OV-3 to SV-6, OV-5a/b to OV-3, etc.
  - Are the critical documents complete and conform to DoD CIO/Joint Staff Architecture Standard?
    - Required information fields are present in the DODAF viewpoints
  - Are the DoDAF viewpoints aligned and consistent?
    - Is there a common thread such as the operational exchanges or activities that can tie the viewpoints together?
    - Are the same data sets and definitions used between viewpoints?
    - Are the architecture viewpoints consistent with the Information Support Plan (ISP), Net-Ready Key Performance Parameter (NR KPP), and other sources?

ENGILITY
Engineered to Make a Difference

What is an Architecture Nomograph?

- Relational analysis using a series of aligned tables that relate design parameters

- Developed by an Engility team for JITC to assess the consistency and traceability of system and operational architecture viewpoints

- Relates many operational and system parameters to many other parameters in an aligned multi-table Visual format

- DODAF Model Validation analysis that addresses the relationships between Capabilities, Activities, Resources, Performers, Information Exchanges and Networks
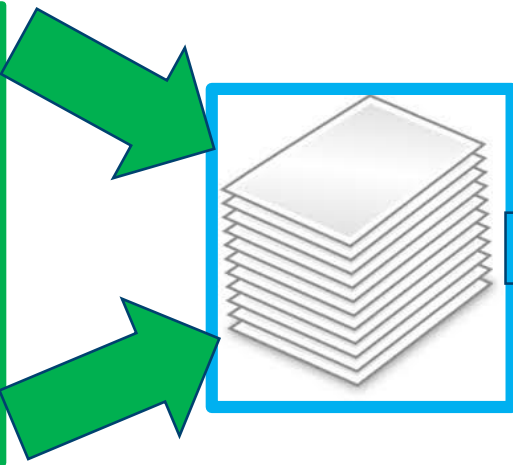

Aligned by Operational Exchanges

Task/ Operational Exchange	OE 1	OE 2	OE 3	...	OE n
Task 1					
Task 2					
Task n					

Network/ Operational Exchange	OE 1	OE 2	OE 3	...	OE n
Network 1					
Network 2					
Network n					

Resource ID / Operational Exchange	OE 1	OE 2	OE 3	...	OE n
RI 1	1		2		
RI 2		3			
RI n					3

Performer/ Operational Exchange (From)	OE 1	OE 2	OE 3	...	OE n
Performer 1	1		3		
Performer 2		2			
Performer n					n

Performer/ Operational Exchange (To)	OE 1	OE 2	OE 3	...	OE n
Performer 1		2			
Performer 2					n
Performer n	1		3		

A GRAPHIC, VISUAL, DETAILED DEPICTION OF ARCHITECTURE ISSUES

ENGILITY
Engineered to Make a Difference

NomoGraph Reflects Program Documentation Through DoDAF Viewpoint Lens

Program Documentation

DoDAF Viewpoints

Nomograph

Error Feedback

Error Feedback
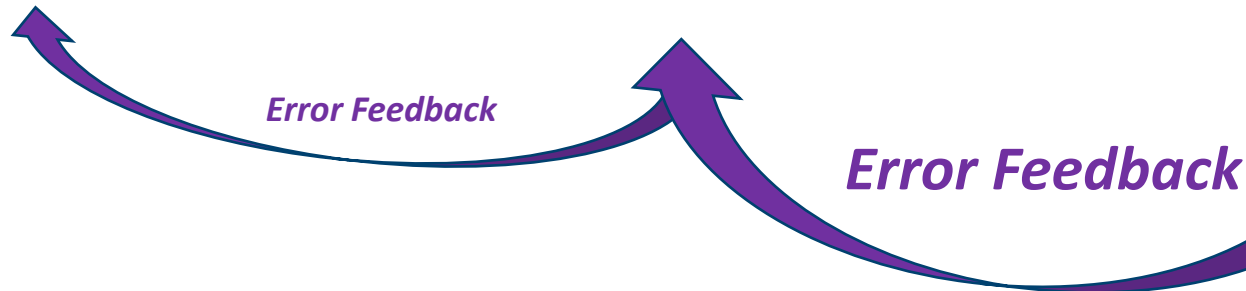
When errors are found using the NG, are those issues just in the DoDAF viewpoints or do they present issues with the core design?

Architecture NomoGraph (ANG)

Traceability Nomograph

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 …				

CARP Nomograph

Table One	A 1	A 2	A 3	A …
Capability				
C1				
C2				
C3				
C…..				

Table 2	A 1	A 2	A 3	A …
Operational Resources				
ORI1				
ORI2				
ORI3				
ORI…..				

Table 3	A 1	A 2	A 3	A …
System Resource				
SRI 1				
SRI 2				
SRI 3				
SRI …				

Table 4	A 1	A 2	A 3	A …
Performer				
P 1				
P 2				
P 3				
P …				

….

RAAP SHEET or Fit for Purpose

Relational
Analysis of
Architecture
Products

Simple To Use
Heuristics Built in
Errors Clearly Identified
Error Patterns Obvious
Timely Development (3-5 days)

ENGILITY
Engineered to Make a Difference

Architecture Nomograph Example

- Visually identifies issues
  - Identified missing tasks/activities
  - Traceability issues identified between OV-3 and SV-6
- Provides a rigorous external review of Model-Based Systems Engineering products prior to other downstream activities
- Catches problems early
- Determines if DoDAF viewpoints:
  - Conform to DoD CIO architecture standard
  - Present the required information/fields
  - Are Aligned
  - Trace from one to the other
  - Contain consistent ontology

GOAL: OPERATIONAL AND SYSTEM INFORMATION ARE ALIGNED, TRACEABLE, AND CONSISTENT

ENGILITY
Engineered to Make a Difference

Enlarged NomoGraph

TABLE 1

	IE xx	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
TASK from the OV-5A	OExx	01	02	03	04	05	06	09	10	11	12	13	15	16	17	18	20	21	22	23	25	26	27	28	29
Task 1: NTA 2.1 - Plan and Direct Intelligence Operations		■	■	■			■						■												
Task 2: NTA 2.2 - Perform Collection Operations and Management							■											■					■		■
Task 3: NTA 2.3 - Process and Exploit Collected Information and Intelligence		■	■	■			■			■			■	■			■			■	■			■	
Task 4: NTA 2.4 - Conduct Analysis and Produce Intelligence		■	■	■			■			■											■				
Task 5: NTA 2.5 - Disseminate and Integrate Intelligence		■	■	■			■	■			■	■	■	■			■				■				
Task 6: NTA 2.6 - Evaluation Intelligence Operations																									
Mission 1: NTA 2 - Develop Intelligence									■		■	■					■								

TABLE 2

		01	02	03	04	05	06	09	10	11	12	13	15	16	17	18	20	21	22	23	25	26	27	28	29
Networks																									
Network 1: SPIRNet		1	1	1	1	1	1	1	1	1	1			1	1						1	1	1	1	1
Network 2: JWICS		2	2	2	2	2	2		2		2	2	2	2	2	2	2	2	2				2	2	2
Network 3: Unclassified																									
Network 4: BICES																									
Network 5: Network Tactical Common Data Link (NTCDL)/Common Data Link (CDL)																									5

TABLE 3

	IE #	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
OE to RI Mapping	OE#	01	02	03	04	05	06	09	10	11	12	13	15	16	17	18	20	21	22	23	25	26	27	28	29
	RI001D																								
	RI002D																								
	RI003D																							3	
	RI004D																								
	RI005D																								
	RI006D																								
	RI007D																								
	RI008D																								
	RI009D																								
	RI010D																								
	RI011D																				3				
	RI012D																							1	

Legend

1	**Indicates a relationship from the OV-3**
2	**Indicates a relationship from the SV-6**
3	**Indicates a relationship from both the OV-3 and SV-6 (The views Match)**

ENGILITY
Engineered to Make a Difference

ANG Extreme Example of Errors Relating OV-3 and SV-6 DoDAF Viewpoints
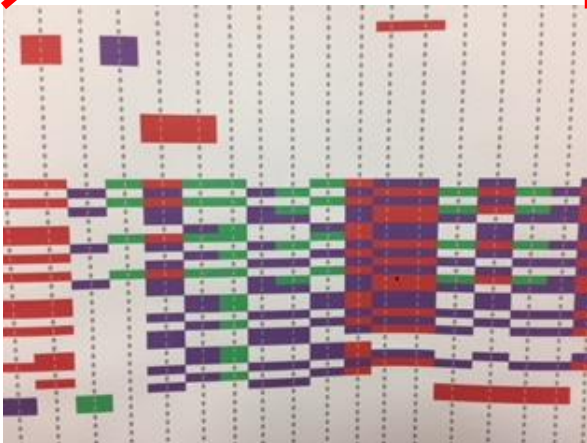
- One of Four Tables in ANG, 15 feet long graphical Relational Model
- The colored blocks depict identified relationships (*Green*, *Purple*, *Red*)
- Over 6,000 Identified Relationships
- Over 4,000 are Incorrect (*Purple* or *Red*)
- Only 18% of relationships were properly traceable and consistent between the OV-3 and SV-6 (*Green*)

Viewpoints Generated by MBSE Tool

Traceability NomoGraph Pilot Project Summary

Table 3 of the Traceability Nomograph provides a visual representation of the traceability between the Operational Viewpoint (OV-3) and the Systems Viewpoint (SV-6), which are both viewpoints JITC requires to perform joint IOP Test Planning.

Traceability Errors From Operational View to System View

- Total number of errors in SV-6 where requirement appears in OV-3: 1,779
- Average per review: 74 (Based on 2-sigma normalized data)
- Total number of errors in OV-3 where requirement appears in SV-6: 1,101
- Average per review: 46 (Based on 2-sigma normalized data)

ENGILITY
Engineered to Make a Difference

Architecture NomoGraph 5-Day Development Process

System Document Package → Data Conditioning → Viewpoint/Document Information Terminology Compilation → Relational Analysis → Architecture Nomograph

ENGILITY
Engineered to Make a Difference
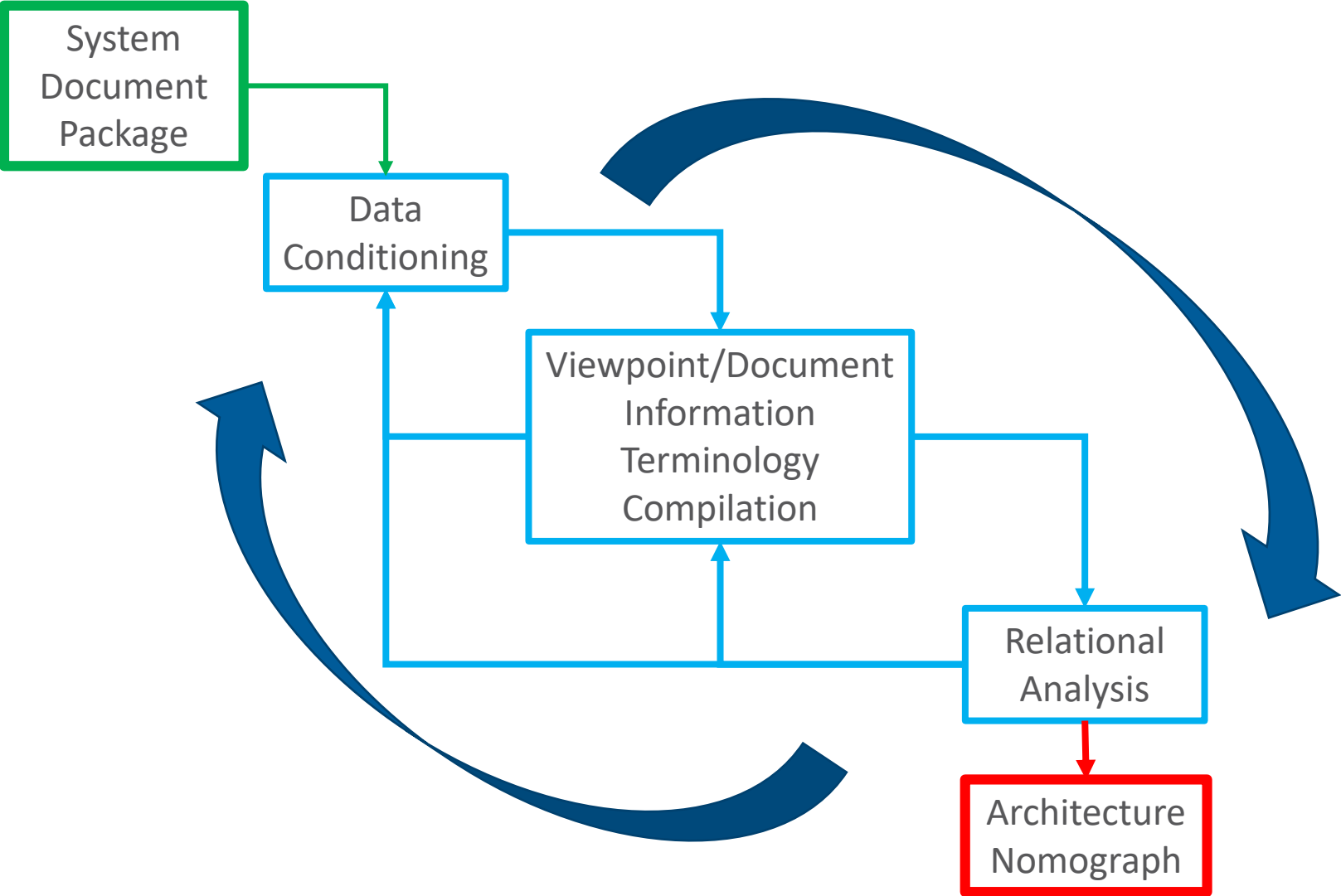
Application Throughout the SE Process

DESIGN AND DEVELOPMENT

VERIFICATION AND TESTING

The Architecture Nomograph (ANG) can be applied throughout the DOD systems engineering diagram or "V" model.

The RAAP Process, in all its variations, is designed to be used iteratively over a system's entire lifecycle, starting at the first versions of DODAF architecture products.

ANG can be used at any stage of development because it relies on the specific information in DoDAF viewpoints.

Why Produce an ANG?

- Provides check and balance for accuracy/traceability of the presented architecture products (e.g., DoDAF viewpoints).
    - Aids in forming comments for ISP assessments.
    - OV-3 to SV-6, operational exchanges to systems resources
        - Finds inconsistences between documents that must be corrected
    - ISP activities to OV-5 task and to OV-3 operational exchange correlation problems are found
    - Provides high level mapping and issues identification between critical test development resources (DoDAF viewpoints).

- Provides statistics for the scope of testing required and where emphasis should be placed.

- Provides an iterative assessment of architecture information traceability and accuracy to aid downstream activities.

- Finds Problems early when they are cheaper to fix.

ENGILITY
Engineered to Make a Difference

Success Story: Intelligence System 1 Review

- **Iterative Improvement of Architecture for system upgrade**

- **August 24, 2016:** NomoGraph presented to government customer during briefing on findings. Government customer responded positively to presentation of relationships between the SV-6 and OV-3.

- **September 12, 2016:** NomoGraph presented to program office system engineer during conference call. The system engineer thanked Engility's team for its work, which showed where the architecture can be improved.

- **October 21, 2016:** Engility team followed up with system engineer who had:
  - Corrected the SV-6 and OV-3 using the nomograph's findings.
  - Found the NomoGraph and the information it presented useful
  - Asked if we could use the NomoGraph to check his future architectural viewpoints.

- **September 2017:** Performed system Increment 2 assessment.
  - Significant reduction in errors were discovered for architecture products

ENGILITY
Engineered to Make a Difference

Success Story 2: Intelligence System 2 Review

- **Iterative Improvement of Architecture for system upgrade**

- Engility created an architectural NomoGraph and reported these findings on 6,865 operational to system relationships between the OV-3 and SV-6

  - **2,848 (41%)** were only shown in the OV-3
  - **2,848 (41%)** were only shown in the SV-6
  - Only **1,169 (18%)** were correctly related between the SV-6 and OV-3

- System program office updated its OV-3 and SV-6. Engility team found there was now a reduction of relationships to 4,096 (6,865 to 4,096) of which:

  - **63 (1.5%)** were shown only in the OV-3
  - **18 (0.4%)** were only shown in the SV-6
  - **4,015 (98%)** were correctly related between the OV-3 and SV-6

<div style="border:2px solid red; color:red; font-weight:bold; text-align:center;">
All programs evaluated to date want more of this kind of analysis
</div>

ENGILITY
Engineered to Make a Difference

Success Story 3: SBIRS Architecture Working Group

- Engility team reviewed DOD Overhead Persistent Infrared (OPIR) Enterprise Architecture (DOEA) To-Be 2025-2040 products in November 2017.
    - Tested ANG's usefulness during the architecture development process
    - Performed by two people within 5 days
    - Provided 7 custom ANGs, including visual representations that included capabilities, activities, performers, systems, and resources
    - Provided insight to Engility's Architecture Working Group for future iterations of the DOEA products and products for other program's currently in development

- Engility confirmed ANG's usefulness in early architecture design phases.

- Engility Architecture Working Group members believe the ANG's visual approach will help them quickly pinpoint and correct problems in the architecture products.

- Engility determined ANG is a validation method for DoDAF products.

ENGILITY
Engineered to Make a Difference

Questions and Answers

Contact Us

Our website:

www.engilitycorp.com

Contact Information:

Mark Gibson

Systems and Test Engineer
Tech Fellow
Engility Corporation
PO Box 903 Hereford, Arizona
(703) 946-0475
Mark.Gibson@engility.com

Frank Diaz

Strategy, Plans, & Policy
JITC, JT4A
Fort Huachuca, AZ
(520) 538-4628
frank.g.diaz.civ@mail.mil

ENGILITY
Engineered to Make a Difference