DoDAF Implementation in Teamcenter Systems Engineering (TcSE)

Teamcenter Systems Engineering Services
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Topics

- Scope of DoDAF
- TcSE Support for DoDAF Processes
- Transition to TcSE Project Capture
- MS-Word Support in TcSE
- TcSE / MS-Visio support for DoDAF
- Creating DoDAF Data Elements
- MS-Excel Support in TcSE
Scope of DoDAF

- DoD Enterprises
  - Operational Command
  - Operational Command
  - Business/Operation Procedures

- Commands
  - Operational Command
  - Operational Command
  - Missions/Command Architectures

- System of systems
  - System
  - System
  - System
  - Communications Architecture

- Traditional SE
  - System
TcSE Support for DoDAF Processes

- TcSE uses commonly known tools
  - Inherent requirements management / traceability
    - Look and feel of Windows
  - Graphical interface
    - MS-Visio stencils enabled for TcSE represent processes
  - Text interface
    - MS-Word is used to edit all text objects and Word formats
  - Table and data editing
    - MS-Excel supports data import/export and data extraction
- TcSE is process enabling, not process driving
Notional DoDAF Process

Architecting Process
- DoD Enterprises
- DoD Commands
- Mission Need
- Arch Concept Definition
- Arch Interfaces
- Arch Requirements
- System Requirements
- System Definition
- System Development

DoDAF Products
- OV-1
- OV-2
- OV-3
- OV-4
- OV-5
- OV-6
- OV-7
- SV-1
- SV-2
- SV-3
- SV-4
- SV-5
- SV-6
- SV-7
- SV-8
- SV-9
- SV-10
- SV-11
- TV-1
- TV-2

TcSE Support at all levels
- Document Inputs
- Traceability
- Requirements Management
- Enabled Stencils
- Modeling Support
- Word Object Formats
- Architectures

OV - Operational View
SV - System View
TV - Technical View

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TcSE Flexible Process Support

- Different SE levels require different processes
  - Each Visio stencil can be a different process
  - Stencil icons can be tied to TcSE object subtypes
- TcSE accommodates any of these processes
  - Visio stencils are easily adapted to a process
- Users use processes they know
  - No “bending” of processes to fit the tools
- Data is captured for export to documents
  - Simple MS-Word and MS-Excel templates
- Multiple organizations can merge multiple views of multiple architectures and cross-link
## DoDAF Standard Products

<table>
<thead>
<tr>
<th>DoDAF View</th>
<th>Suggested methods</th>
</tr>
</thead>
<tbody>
<tr>
<td>OV1 - Operational Concept</td>
<td>Visio graphics, text, use cases</td>
</tr>
<tr>
<td>OV2 - Operational Node Connectivity</td>
<td>Structure diagram, data flow, UML Collaboration Diagrams</td>
</tr>
<tr>
<td>OV3 - Information Exchange</td>
<td>Tables extracted from OV-2/5 search, use Excel templates</td>
</tr>
<tr>
<td>OV4 - Org. Relationships</td>
<td>Visio graphics, IDEF0 node diagrams</td>
</tr>
<tr>
<td>OV5 - Operational Activity Model</td>
<td>Enabled Visio graphic, IDEF0 template, activity diagrams</td>
</tr>
<tr>
<td>OV6 - Operation states, rules</td>
<td>Enabled Visio state charts, sequence diagrams</td>
</tr>
<tr>
<td>OV7 - Logical data model</td>
<td>Enabled Visio graphic, ERD and UML structure diagram stencil</td>
</tr>
<tr>
<td>DoDAF View</td>
<td>Suggested Methods</td>
</tr>
<tr>
<td>------------------------------------</td>
<td>--------------------------------------------</td>
</tr>
<tr>
<td>SV1 - Systems I/F Description</td>
<td>Enabled Visio structure diagram</td>
</tr>
<tr>
<td>SV2 - Systems Communications</td>
<td>Enabled Visio graphic, tables, UML structure diagram I/F</td>
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<tr>
<td>SV3 - Systems - Systems Matrix</td>
<td>Tcl enabled Excel matrices</td>
</tr>
<tr>
<td>SV4 – Systems functionality</td>
<td>Enabled Visio graphic, Data Flow Diagram stencil</td>
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<tr>
<td>SV5 - Operational Activity Model</td>
<td>Tcl enabled Excel matrices</td>
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<tr>
<td>SV6 – System Data Exchange</td>
<td>Export via search and Excel templates</td>
</tr>
<tr>
<td>SV7 - Logical data model</td>
<td>Excel Live output requirements and properties.</td>
</tr>
<tr>
<td>DoDAF View</td>
<td>Suggested Methods</td>
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<td>-----------------------------------------------------------------------------------</td>
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<tr>
<td>SV8 - Systems Evolution</td>
<td>Visio graphic, tables, text</td>
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<tr>
<td>SV9 - Systems Tech Forecast</td>
<td>Visio graphic, tables, text</td>
</tr>
<tr>
<td>SV10 - Systems Rules, States, Event Traces</td>
<td>Enabled Visio State Chart and Sequence Diagram stencils</td>
</tr>
<tr>
<td>SV11 – Physical Schema</td>
<td>UML Class Diagrams</td>
</tr>
<tr>
<td>AV1 - Overview and Summary</td>
<td>Enabled Visio graphic</td>
</tr>
<tr>
<td>AV2 - Integrated Dictionary</td>
<td>Tables, TcL enabled Excel, Word templates for object types</td>
</tr>
<tr>
<td>TV1 - Technical Stds Profile</td>
<td>Visio graphic, tables, text</td>
</tr>
<tr>
<td>TV2 - Technical Stds Forecast</td>
<td>Visio graphic, tables, text</td>
</tr>
</tbody>
</table>
The Magic of Subtypes

Building blocks are like Lego’s, they can represent anything

- Physical object
- Functions
- Organizations
- Data Structure
- Network Nodes
- Platforms

Trace links are equally versatile

- Requirements Trace
- Logical flows
- Relationships
- Physical connections

Each subtype can have unique, user defined properties
Each subtype can have a unique icon
The search engine can key only on requested subtypes
SE Process: TcSE Applied

Products:
- ICD
- Functional Block Diagrams
- Matrices
- DODAF Views
- Etc.
Visio – TcSE – Word Interactive interfaces

TcSE Interactive interface MS-Visio

Saved Drawings Auto-update in MS-Word
SV-2 Dataflow with TcSE Stencil

SV-4 Dataflow Diagram

Connected Subtypes
TcSE / Visio support for DoDAF

- Graphical objects in DoDAF products (e.g. OV-5, SV-1, SV-4 etc.) can be converted into objects in the TcSE database via the Visio interface
- Export TcSE enabled objects to MS-Visio diagrams
- Capture Visio connections and objects in TcSE
- Export summaries of requirements and architectures using TcSE to MS-Excel interface
- Export data dictionaries drawn in MS-Visio to MS-Word
- Manage trace links between requirements, architecture objects, and supporting documentation
High Level Operational Concept Graphic (SV-1)

Shapes in this Visio diagram are interactive with the objects in the TcSE Architecture in the next slide.
Architectural approaches

A) Organize the architecture in TcSE first using the building blocks
   - Create a hierarchy, set properties
   - Then Export to Visio to add connections

B) Start in MS-Visio and work graphically
   - Enabled Visio stencils create the objects in TcSE
   - Properties can be modified in MS-Visio

TcSE supports either approach
Data Control Flow diagrams

Data_Control_Flow_Stencil.vss

Object Types - Subtypes
- Building Block - Process
- Building Block – Group
- Building Block – CSpec

Connection Types - Subtypes
- Connection – Data Flow
- Connection – Control Flow

Add custom TcSE enabled Icons

Can be used for:
- OV-1 High Lever Operational View
- OV-2 Product Elements (Needlines / Interfaces)
- SV-4 System Functionality Descriptions
IDEF0 Diagrams

Object Types - Subtypes
- Building Block – Activity
- Building Block – Node
- Title Box - not TcR enabled (Simple border)

Connection Types - Subtypes
- Connection – 1 Legged Connector
- Connection – Solid Connector
- Trace Link – IDEF0 Connector
- Trace Link – Dynamic connector
- Label - not TcR enabled

Can be used for:
- OV-1 High Lever Operational View
- OV-2 operational Node Connectivity
- OV-4 Organizational relationship Chart
- OV-5 Operational Activity model
Entity Relationship Diagrams

TcR_ERD_Diagram_Stencil.vss

Object Types - Subtypes

Building Block – Entity

Week Entity - not TcR enabled

Building Block – Node

Connection Types - Subtypes

Connection – Aggregation *

Connection – Association *

Connection – Dependency *

Connection – Generalization *

* = Multiple arrow styles
Default Stencil

Default Stencil.vss
All base type objects as indicated
Relationships creates trace links

Used for:
Small organizational data charts
Document flow of traceability
SySML Requirements View Diagram
UML Stencil

Object Types - Subtypes
- Package is incompatible type
- Building Block – Class
- Building Block – Use case
- Building Block – Actor

Connection Types - Subtypes
- Connection – Generalization *
- Connection – Dependency *
- Connection – Composition *
* = Multiple arrow styles
- Connection – Interface
- Note - not TcR enabled

Used for:
- OV-4 Organizational relationships
- OV-5 Operational Activity Models
- OV-6 Activity Diagram
- OV-7 Class Diagram
- SV – Use Case, Class Diagrams
- Sv-11 Class Diagrams
TcSE Enabled Existing stencils

Mili_tcr_std252b.vss
Object Types - Subtypes
Modified as desired

Used for desired ways to communicate system and operational workings graphically
User Created stencils

User_created.vss

An .xml file is modified to assign TcSE mapping to object subtypes

Object Types - Subtypes

Created in the Admin area as desired with additional user defined properties.

Used for desired ways to communicate system and operational workings graphically
Visio with the user Defined Stencil

New stencil can be TcSE enabled and enhanced

Optional Backgrounds and Titles
TcSE Entity and Connection Objects

Entities Captured as Objects

Connection Objects From Visio
SV-1 Objects in TcSE / MS-Visio Diagrams

User Defined TcSE Icons

TcSE Enabled MS-Visio Stencils
Navigable Traceability Paths

Current object

Trace link path upward

Trace link path downward

Connections flow within architectures
MS-Word Support in TcSE

- All text objects are edited in MS-Word
  - Requirements, document paragraphs, notes, templates
- Text objects can contain any MS-Word construct
  - Tables, graphics, special characters, hyperlinks
  - Text objects (of mixed subtypes) are hierarchic
- Each document folder may have a style sheet
  - When viewed, text objects always appear in final print form
- Existing MS-Word documents load easily into TcSE
- Users have more control over document export
  - Optional user defined formats for *any* object subtypes
Concept of Operations Summary

Describe what mission areas this capability contributes to, what operational outcomes it affects, what it must produce to achieve those outcomes, how it complements the integrated warfighting force and what enabling capabilities are required to achieve its desired operational outcomes.
For many OV and SV views, data elements are defined as building blocks or connections between them.

The data element attributes can be defined as TcSE properties, which are assigned to the subtype.

Use TcSE building block versions of these data elements in architectures and MS-Visio diagrams.

The search engine can help assemble data dictionaries for export to MS-Word.

Data dictionaries may be generated with user defined MS-Word templates for each subtype.
Data Element Definitions

Create Subtype called <Platform>

Add Property Description*
Turn-key Data Dictionary Generation

- MS-Word Templates for Each Data Element
- Document Prints Data Dictionary
- Architecture Copied as 'short-cut'
- Object Property Values

Artillery Instance

<table>
<thead>
<tr>
<th>Name</th>
<th>Artillery</th>
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</thead>
<tbody>
<tr>
<td>Echelon</td>
<td>Brigade</td>
</tr>
</tbody>
</table>

Stryker Instance

<table>
<thead>
<tr>
<th>Name</th>
<th>Stryker M</th>
</tr>
</thead>
<tbody>
<tr>
<td>Echelon</td>
<td>Battalion</td>
</tr>
<tr>
<td>Service</td>
<td>Marines</td>
</tr>
</tbody>
</table>
The predefined MS-Word Templates for each subtype format the element property values in the prescribed data structure format.

**Data Dictionary**

The data dictionary for the proposed system.

<table>
<thead>
<tr>
<th>HUMMY Instance</th>
<th>Name</th>
<th>C&amp;C</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Echelon</td>
<td>Battalion</td>
</tr>
<tr>
<td></td>
<td>Service</td>
<td>Army</td>
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</table>

<table>
<thead>
<tr>
<th>Satellite Instance</th>
<th>Name</th>
<th>Comm Sat 2</th>
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</thead>
<tbody>
<tr>
<td></td>
<td>Channels</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Security</td>
<td>Unclassified</td>
</tr>
</tbody>
</table>
MS-Excel Support in TcSE

- MS-Excel is used two ways in TcSE
  - Select objects and properties for exported to MS-Excel
    - Set up the content window and create summaries of requirements, architectures, etc.
  - MS-Excel templates combine search and formatting
    - If objects of a certain subtype are found in the search, here’s how I want them to appear in MS-Excel
    - TcL can enhance this capability
  - MS-Excel Live allows further work offline
### TcSE Exports to MS-Excel

#### Update it offline

#### Merge it back in the DB later

![Screenshot of TcSE Exports to MS-Excel](image)

**Table Example:**

<table>
<thead>
<tr>
<th>Home</th>
<th>Name</th>
<th>Number</th>
<th>ROIN</th>
<th>Subtype</th>
<th>Approval Status</th>
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<tbody>
<tr>
<td>2</td>
<td>B2 Strike Lethality</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>340 Requirement</td>
</tr>
<tr>
<td>3</td>
<td>JSTARS Role</td>
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<td>0</td>
<td>2</td>
<td>0341-2 Requirement</td>
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<td>Fire Coordination</td>
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<td>0</td>
<td>1</td>
<td>342 Requirement</td>
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<tr>
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<td>Method of Coordination</td>
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<td>1</td>
<td>343 Requirement</td>
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<td>0</td>
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<tr>
<td>7</td>
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<td>0</td>
<td>363 Requirement</td>
</tr>
<tr>
<td>8</td>
<td>Squadron Requirements</td>
<td></td>
<td>0</td>
<td>0</td>
<td>287 Requirement</td>
</tr>
</tbody>
</table>

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MS-Excel templates combine search and format

<table>
<thead>
<tr>
<th>A</th>
<th>B</th>
<th>C</th>
<th>D</th>
<th>E</th>
<th>F</th>
<th>G</th>
<th>H</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Folder</td>
<td>Task 1-1</td>
<td>Task 1-2</td>
<td>Task 1-3</td>
<td>Task 1-4</td>
<td>Task 2-1</td>
<td>Task 2-2</td>
</tr>
</tbody>
</table>
| 2  | <start>            | (%)Activator
                   Relation_Matrix%Task 1-1 | (%)Activator%
                   Relation_Matrix%Task 1-2 | (%)Activator%
                   Relation_Matrix%Task 1-3 | (%)Activator%
                   Relation_Matrix%Task 1-4 | (%)Activator%
                   Relation_Matrix%Task 2-1 | (%)Activator%
                   Relation_Matrix%Task 2-2 | (%)Activator%
                   Relation_Matrix%Task 2-3 |
| 3  | %Name              | Before the this tag every thing will be considered as Header information/Constant not |
| 4  | <end>              | (%)Activator%
                   Relation_Matrix%Task 1-1 | (%)Activator%
                   Relation_Matrix%Task 1-2 | (%)Activator%
                   Relation_Matrix%Task 1-3 | (%)Activator%
                   Relation_Matrix%Task 1-4 | (%)Activator%
                   Relation_Matrix%Task 2-1 | (%)Activator%
                   Relation_Matrix%Task 2-2 |
| 5  | (%)Name            | Below the end tag every thing will be considered as Footer information/Constant not |
| 6  |                    |                    |                    |        |                    |        |                    |
| 7  |                    |                    |                    |        |                    |        |                    |

### Desired Properties

- B4: (%%Activator%Relation_Matrix%Task 1-1)
- B5: (%%Activator%Relation_Matrix%Task 1-2)
- B6: (%%Activator%Relation_Matrix%Task 1-3)
- B7: (%%Activator%Relation_Matrix%Task 1-4)
- B8: (%%Activator%Relation_Matrix%Task 2-1)
- B9: (%%Activator%Relation_Matrix%Task 2-2)
- B10: (%%Activator%Relation_Matrix%Task 2-3)

### Optional TcL calls

- Before the this tag every thing will be considered as Header information/Constant not
- Below the end tag every thing will be considered as Footer information/Constant not
Operational Task to System Function Mapping (SV-5)

For the condition where Operational Tasks determine needed System Services, the defining Trace Links locate the “X” in the Trace Matrix (Next Slide).

The data is captured in a TcSE table and exported to MS-Word or to MS-Excel via the built-in TcSE MS interface tools.
## Sample System Function Traceability Matrix (SV-5)

<table>
<thead>
<tr>
<th></th>
<th>A</th>
<th>B</th>
<th>C</th>
<th>D</th>
<th>E</th>
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### Many Architectures

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</table>

### Many Interfaces

<p>| | | | | | | |</p>
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Export search results via MS-Excel template for properties and format information

This Excel template can be applied to the results window of a search after doing a search for connections in Visio drawings.

Begin a search using the script below in the folder below the folders containing all the Visio drawings. The script should be composed in the Advanced search window.

10. Select Building Blocks
11. For each Building Block
12. Add connections
13. Remove Building Blocks
### Resulting Formatted Interface Table

#### Table of Interfaces

<table>
<thead>
<tr>
<th>Interface Name</th>
<th>Band Width</th>
<th>Message Source</th>
<th>Message Destination</th>
<th>I/F Direction</th>
<th>Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>Designate LOS</td>
<td>Voice only</td>
<td>Spotter 1</td>
<td>Hostile 2</td>
<td>Uni-Directional</td>
<td>Connection</td>
</tr>
<tr>
<td>CF Net</td>
<td>Voice only</td>
<td>Spotter 1</td>
<td>Decision Maker</td>
<td>Bi-Directional</td>
<td>Connection</td>
</tr>
<tr>
<td>Sensor LOS</td>
<td>Voice only</td>
<td>Spotter 2</td>
<td>Hostile 1</td>
<td>Uni-Directional</td>
<td>Connection</td>
</tr>
<tr>
<td>FAST Net</td>
<td>Voice only</td>
<td>Spotter 2</td>
<td>Decision Maker</td>
<td>Uni-Directional</td>
<td>Connection</td>
</tr>
<tr>
<td>Arty Net</td>
<td>Voice only</td>
<td>Decision Maker</td>
<td>Shooter 2</td>
<td>Bi-Directional</td>
<td>Connection</td>
</tr>
<tr>
<td>Net</td>
<td>Voice only</td>
<td>Decision Maker</td>
<td>Shooter 1</td>
<td>Bi-Directional</td>
<td>Connection</td>
</tr>
<tr>
<td>EPLRS</td>
<td>Voice only</td>
<td>Spotter 1</td>
<td>Shooter 2</td>
<td>Uni-Directional</td>
<td>Connection</td>
</tr>
<tr>
<td>SINGARS</td>
<td>Voice only</td>
<td>Spotter 1</td>
<td>Commander</td>
<td>Uni-Directional</td>
<td>Connection</td>
</tr>
<tr>
<td>Spotter 1 -&gt; Commander</td>
<td>Voice only</td>
<td>Spotter 1</td>
<td>Commander</td>
<td>Uni-Directional</td>
<td>Connection</td>
</tr>
<tr>
<td>EPLRS</td>
<td>Voice only</td>
<td>Spotter 2</td>
<td>Shooter 1</td>
<td>Uni-Directional</td>
<td>Connection</td>
</tr>
<tr>
<td>SINGARS</td>
<td>Voice only</td>
<td>Spotter 2</td>
<td>Commander</td>
<td>Uni-Directional</td>
<td>Connection</td>
</tr>
</tbody>
</table>
Some architectures are co-dependent on other architectures

Multiple architectures may be defined in the TcSE database as separate projects

Cross project trace links can be used to show relationships between architectures

Searches on these trace links are a means of demonstrating compliance
Provide DoDAF Application Workshop
- How-to Instruction
- Hands On Exercises
- DoDAF Schema Starter Kit Included
  - MS-Visio Stencils
  - MS-Excel Templates
  - MS-Word Templates
  - Search scripts/utilities
  - User Cookbooks
- Tailorable to customer wants and needs
Summary

- TcSE is a capable and competitive SE tool
- Easy import of DoDAF artifacts
- Constructs allow for manipulation of requirements and architecture
- Many DoDAF compliant tables, data dictionaries, and diagrams can be directly exported from TcSE
- Designers can do most of the creative system design graphically while TcSE automates much of the product generation