Effective software delivery
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Rational. software

# Improving outcomes with effective implementation of DoDAF.

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## Realizing the value of enterprise architectures for defense systems

The United States Department of Defense Architecture Framework (DoDAF) was launched to help rein in late and over-budget projects. It provides a means of evaluating architectures across multiple systems and offers a better way of integrating capabilities into large systems of systems—across an organization and across the Department of Defense. DoDAF can help contractors significantly improve business outcomes by streamlining development of compliant enterprise architectures for defense systems.

The challenge is, of course, how contractors integrate DoDAF into their operations. Without the right tools and processes in place, organizations can burn through a lot of time and money creating inconsistent and inaccurate models that do not comply with regulatory standards. Falling short of compliance is not the real loss, however. Organizations lose the competitive advantage of improving performance on defense contracts. Specific examples of how compliant enterprise architectures can improve the bottom line include the ability to:

- *Identify gaps and redundancies early in the systems development process when the effort to correct any issues is the least costly.*
- *Enhance efficiencies with a standard and automated approach to data sharing and reporting across the organization.*
- *Enable greater asset reuse by helping to ensure interoperability of systems and support for service-oriented architecture (SOA).*
- *Quickly evaluate design changes and communicate updates to teams working on the affected parts of a system, or system of systems.*
- *Reduce risk by performing quantitative as well as qualitative analysis on an architecture to determine feasibility and return on investment (ROI).*

This white paper highlights reasons why DoDAF is mandated and describes recent changes to the framework. Then it briefly describes how IBM Rational® solutions can help organizations realize greater value from adoption and ongoing use of DoDAF.

**Highlights**

***The long-term objective of DoDAF is to bring the benefits of model-based systems engineering to the acquisition community, helping to improve complex systems design and integration for significant savings in project effort and cost.***

**Why is DoDAF mandated?**

The U.S. Department of Defense (DoD) needed a consistent approach to understanding what initiatives are needed to support its mission. DoDAF was conceived as a way of providing a common means to specify systems architectures for DoD programs and link systems back to the capabilities and technologies that must be funded.

The DoDAF became an official standard in 2004 for architecture descriptions, although the models making up the standard have been used within the DoD since the 1970s. Many governments now employ DoDAF to solve the challenges of systems and capability development and management.

The immediate goal of adopting the DoDAF was to standardize on a conceptual modeling language for all DoD acquisition programs and projects. Such standardization would provide a common basis for systems analysis within organizations and across the DoD as a whole. It was also designed to promote efficiencies in the design effort by enabling artifact reuse and consistent descriptions across multiple architectures.

Over the longer term, the objective of DoDAF is to bring the benefits of general architecture—or model-based systems engineering—to the acquisition community. By helping to improve systems design and integration, DoDAF is expected to reduce the time and cost of successfully implementing very large systems of systems and to ensure deployment of the capabilities and technologies needed to meet current and future DoD requirements. The increasing size and complexity of projects, as well as the involvement of multiple contracts on many initiatives, requires an effective means for identifying gaps and duplication of effort.

**Highlights**

***Consistency in the required DoDAF data elements across teams and organizations facilitates comparison and gap analysis to improve DoD funding decisions.***

The DoDAF standard provides guidance on what architecture information needs to be captured, based on which stakeholders will be using the architecture. It also helps organize the data by views and then shows how to integrate those views.

DoDAF is used by program management and the acquisition community to determine the feasibility of a design as well as to manage and mitigate risk. It does not prescribe how to implement the architecture. Architects, engineers and designers are free to use their existing tools and processes for a project. The models required by the standard are not DoD specific; they are work products that any good systems engineer would create. Consistency in the required data elements across the teams and organizations working on an initiative facilitates comparison and gap analysis. The DoD is able to trace back to a required capability to properly evaluate and support funding for approved defense programs.

### Enhancement of DoDAF: making architecture more data driven

Since its adoption, there have been two updates of the DoDAF—DoDAF 1.5 and DoDAF 2.0. Both of these releases were designed to make architecture descriptions more data driven than artifact driven. These enhancements offer four significant benefits:

- *Allow architecture to more clearly address the needs of net centricity for Internet-based sharing of information among stakeholders as well as unanticipated users of the system*
- *Enable deployment of systems on the global information grid (GIG)*
- *Facilitate the sharing of architecture information across the DoD, no matter what implementation tools are used*
- *Provide support for SOA, a development approach not available when DoDAF 1.0 was introduced*

**Highlights**

***The DoDAF addresses three formal levels of architecture and is organized into views that contain work products.***

### Formal DoDAF levels of architecture

An architecture description is a representation of a current or postulated "real-world" configuration of resources, rules and relationships. It describes the parts of the configuration or system, what those parts do, how the parts relate to one another, and the rules and constraints under which the parts function. The DoDAF addresses three formal levels of architecture—department, capability or segment, and component:

- ***Department-level architecture***—*describes processes at the department or joint staff level and includes the GIG and DoD Information Enterprise Architecture (DoD IEA)*
- ***Capability/segment architecture***—*defines and describes specific capabilities required for business, procurement and tactical operations (referred to as a segment architecture in Office of Management and Budget [OMB] Circular A-130)*
- ***Component architecture***—*defines and describes the business and operational functions of components within the DoD*

### DoDAF views

DoDAF is organized into views that contain work products. The emphasis in each of these views is different and distinct, but they overlap to a significant degree. The views have been enhanced with each DoDAF release.

DoDAF 1.0 and DoDAF 1.5 have the following four views:

- ***All view (AV)***—*a description of the architecture being created, why it's being created and from whose viewpoint*
- ***Operational view (OV)***—*work products that depict the customer's viewpoint of the world (for example, how the customer operates)*
- ***System view (SV)***—*a description of how the system (or service) should, at a high level, be realized based on the OV work products; the SV should not address implementation except where it's imposed by the customer*
- ***Technical view (TV)***—*any technical standards set by the customer that constrain the design (for example, Microsoft® Windows Vista software is the operating system [OS] standard) as well as the forecast for emerging and retiring technologies*

**Highlights**

***Although the DoDAF views overlap to a degree, the emphasis in each of the views is different and distinct.***

DoDAF 2.0 eliminates the TV and expands to the following eight views, only three of which are the same as those defined above:

- ***All view (AV)***—*a description of the architecture being created, why it's being created and from whose viewpoint*
- ***Data and information view (DIV)***—*a description of the data used in the architecture usually depicted in data models and class diagrams*
- ***Standards view (StdV)***—*a view that captures operational, business, technical and industry policy, guidance, standards, constraints and forecasts (formerly the TV)*
- ***Capability view (CV)***—*a view that captures capability requirements, delivery and deployment*
- ***Operational view (OV)***—*work products that depict the customer's viewpoint of the world (for example, how the customer operates)*
- ***Services view (SvcV)***—*a description of how the system service should, at a high level, be realized based on the OV work products; the SvcV will eventually replace the SV*
- ***System view (SV)***—*based on the OV products, shows how the system should, at a high level, be realized; the SV should not address implementation except where it's imposed by the customer*
- ***Project view (PV)***—*a view that describes the relationships between operational and capability requirements for the projects being implemented*

**Highlights**

***Depending on the design project, one or more informal architecture tiers may be addressed within each of the three formal architectural levels.***

### Informal architecture tiers

In addition to the three formal levels of architecture, DoDAF 2.0 defines subsets, or informal tiers that can exist within the architecture (see figure 1). Depending on the architecture project, one or more of these tiers may be addressed.

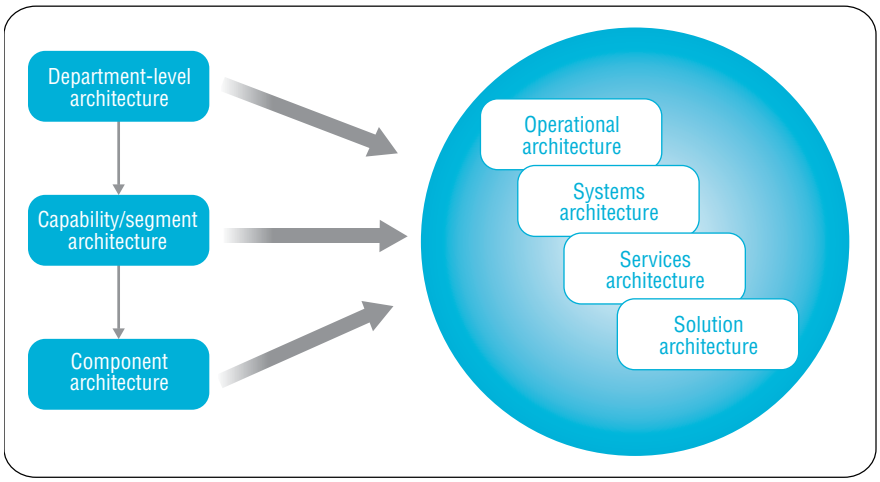


*Figure 1: One or more informal architecture tiers exist at every level of the formal DoDAF 2.0 architecture levels.*

The informal architecture types are defined in table 1. The table also shows how they are linked to the DoDAF models and views.

| Informal architecture type | Description | DoDAF 1.0 and 1.5 views | DoDAF 2.0 views |
|---|---|---|---|
| Operational | Describes major processes and activities that drive business/ tactical operations | AV, OV | AV, StdV, DIV, CV, OV, PV |
| Systems | Describes systems, networks and communications capabilities to support operations | AV, SV, TV | AV, StdV, DIV, CV, SV, PV |
| Services | Describes internal and external service capabilities | SV, TV | StdV, DIV, CV, SV, PV |
| Solution | Defines and describes future changes to a baseline architecture | AV, OV, SV, TV | AV, StdV, DIV, CV, OV, SV, SvcV, PV |

*Table 1: Informal architectures and their relationship to the DoDAF models and views.*

**Highlights**

***In the latest release of DoDAF, there is a greater focus on information-centric processes than product-centric processes with data aggregated in matrix views that summarize information derived from the graphical views.***

### DoDAF data matrices

In DoDAF 2.0, architecture development is more focused on information-centric processes than product-centric processes. Data is aggregated in matrix views to facilitate data exchanges, and requirements for sharing data across a federated environment are described.

The matrix views are summaries of information derived from the graphical views. Consider one of the many possible sequences that can be taken for artifact development (see figure 2).

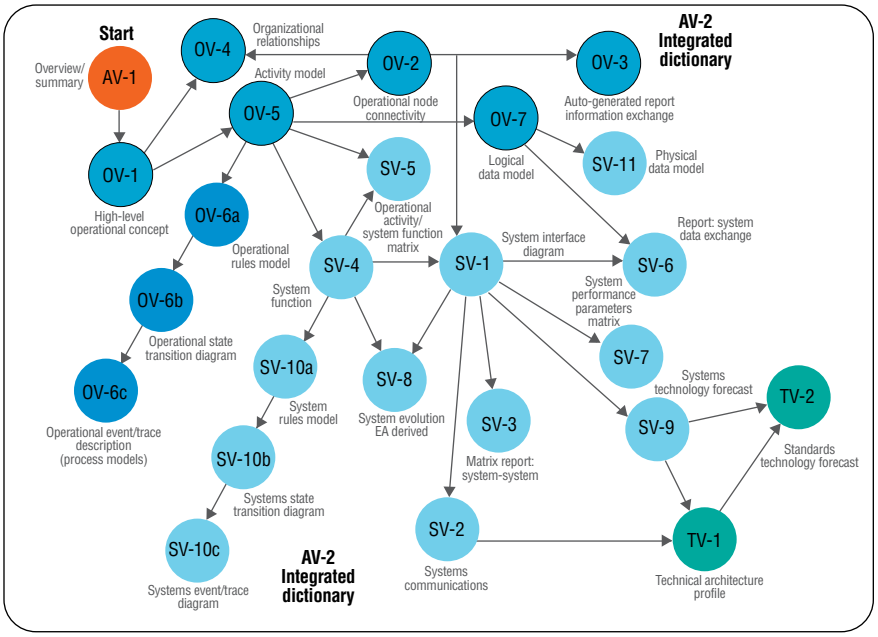


*Figure 2: This is one of many possible sequences that can be taken for artifact development using DoDAF.*

**Highlights**

***The information provided in the data matrices is what regulatory agencies need and can be time-consuming to derive from drawings without automated processes.***

Data matrices that can be created based on the interrelationships between the views shown in figure 2 include an OV-3, SV-6 and SV-5. These three matrices are described in detail in the following sections. The data that comes out of these and other matrices is what the regulatory agencies are looking for—data that is time-consuming to derive from drawings.

### OV-3 operational exchange matrix

The OV-3 is produced by combining data from the OV-5 (operational activities and their inputs and outputs) with data from the OV-2 (the location where those activities occur and the communication requirements between those locations). It is a summary of the two main products in the OV.

Additional data about the information exchanged between the locations can be added, such as the size and format of the data, the classification level and other information assurance attributes of the data, and whether it is internal or can be shared externally.

| Need Line | Information Exchange | Source Node | Source Owning Organization | Source Activity | Destination Node | Destination Owning Organization | Destination Activity |
|---|---|---|---|---|---|---|---|
| Observer - Surveillance | UAV Schedule Entry | Observer | Intelligence Unit | Manage UAV Mission Schedule | Surveillance Satellite | GPS Agency | Manage Camera Ops |
| Mission Control - Surveillance | UAV Position Data | Mission Control | Control | Manage UAV | Surveillance Satellite | GPS Agency | Manage Camera Ops |
| Operational Control (ext) - Mission | UAV Position | Operational Control (ext) | Control | Nominate Target (ext) | Mission Control | Control | Manage UAV |
| Surveillance Satellite - Mission | Target Data | Surveillance Satellite | GPS Agency | Manage Camera Ops | Mission Control | Control | Manage UAV |
| Surveillance Satellite - | Requested Target Data Set | Surveillance Satellite | GPS Agency | Manage Camera Ops | Operational Control (ext) | Control | Issue Fire Order (ext) |
| Operational Control (ext) - Observer | Data Acquisition Request | Operational Control (ext) | Control | Nominate Target (ext) | Observer | Intelligence Unit | Manage UAV Mission Schedule |

*Figure 3: The OV-3 operational exchange matrix is a summary of the two main work products in the operational view.*

**Highlights**

***The OV-3 data matrix, for example, helps analysts determine what data is critical to the mission, what can be shared with unanticipated users and what documentation is needed to support classified system certification.***

There are a number of valuable uses for the OV-3, including:

- *Determining what data is critical to the mission so it can be included in the business continuity management plan.*
- *Instantaneously determining what data can be shared with an unanticipated user external to the program.*
- *Preparing the required documentation to get a classified system certified.*
- *Estimating the potential bandwidth needs between locations, which is especially important if the information being transported is classified.*

#### SV-6 system data exchange matrix

The SV-6 is analogous to the OV-3 in that it summarizes information from other products in the SV. The SV-6 shows what system functions (from the SV-4) are assigned to what systems and where those systems are located (from the SV-1). It also takes the inputs and outputs of each system function and shows the interfaces to which the data is assigned.

The same characteristics assigned to the operational data (for example, classification and size) can be used to further describe the system data exchanges.

| Interface Name | System Data Exchange | Source System/ Element/ Component | Source System Function | Source System Node | Destination System/ Element/ Component | Destination System Function | Destination System Node |
|---|---|---|---|---|---|---|---|
| System_Interface 1 | camera schedule | camera pod posit sys | adjust camera pod | uav | camera mgt sys | take picture sequence | target control |
| System_Interface 2 | actuator position | uav mission sched sys | schedule picture taking | target control | camera mgt sys | take picture sequence | target control |
| System_Interface 3 | camera status | camera mgt sys | take picture sequence | target control | uav mission sched sys | schedule picture taking | target control |
| System_Interface 4 | optical data | camera mgt sys | take picture sequence | target control | camera mgt sys | display pictures | target control |
| System_Interface 5 | target data | camera mgt sys | control UAV system display pictures | target control | BANTER sys (ext) | issue fire order (ext) | C-130 hercules (ext) |
| System_Interface 6 | collection plan | BANTER sys (ext) | decide target priorities (ext) | C-130 hercules (ext) | camera mgt sys | control UAV system take picture sequence | target control |
| | picture taking request | BANTER sys (ext) | decide target priorities (ext) take picture sequence | C-130 hercules (ext) | camera mgt sys | control UAV system decide target priorities (ext) | target control |
| System_Interface 7 | picture taking order | camera mgt sys | take picture sequence | target control | camera pod posit sys | adjust camera pod | uav |
| System_Interface 8 | uav position | tracking sys | track position | target control | camera mgt sys | take picture sequence | target control |
| System_Interface 9 | track position | camera mgt sys | | target control | tracking sys | | target control |

*Figure 4: SV-6 system data exchange matrix shows which system functions are assigned to which systems.*

**Highlights**

***The SV-6 data matrix shows what system functions from the SV-4 are assigned to what systems and where those systems are located.***

Uses of the SV-6 include:

- *Sizing of the network.*
- *Understanding the impact of replacing a legacy system or adding a new system.*
- *Determining the effect of changing the format of data (for example, from a Microsoft Excel spreadsheet to XML).*
- *Developing the business continuity management plan so that only essential data and systems are replicated.*
- *Determining the different classification levels of the system and the required data segregation.*

### SV-5 operational activity to system function traceability matrix

The SV-5 is a matrix that shows the touch points between the operational environment and the system design. Its main purpose is to provide traceability from the customer's requirements to the design.

| System Function / Operational Activity | Issue Fire Order (ext) | Manage Camera Ops | Manage Stored Target Data | Manage UAV | Manage UAV Data Acquisition | Manage UAV Mission Schedule | Nominate Target (ext) |
|---|---|---|---|---|---|---|---|
| adjust camera pod | | x | | | | | |
| calculate target distance | | | | | | | |
| conduct self test | | | | x | | | |
| control UAV system | | | | | | | |
| decide target priorities (ext) | | | | | | | |
| display pictures | | x | | | | | |
| issue fire order (ext) | | | | | | | |
| schedule picture taking | | | | x | | x | |
| take picture sequence | | x | | | | | |
| track position | | | | x | | | |

*Figure 5: The main purpose of the SV-5 data matrix is to provide traceability from the customer's requirements to the design.*

**Highlights**

***One of the critical uses for the SV-5 data matrix is to enable analysts to determine gaps and overlap in the system design.***

Besides showing traceability, the SV-5 matrix can be used to:

- *Identify critical system functionality (any system function supporting a critical operational activity).*
- *Determine gaps and overlap in the system design.*
- *Ensure that the system is not overengineered (for example, many system functions that don't trace back to an operational activity).*
- *Find areas where automation could improve operations (for operational activities with no system function support).*

### Capability/operational activity to system/system function trace

The function trace matrix provides a way to show the status of a capability and the operational activity that is required to meet the capability as it relates to the system and system function that will provide some level of automation for the capability. The status is:

- ***Red**—functionality planned but not developed.*
- ***Yellow**—partial functionality provided.*
- ***Green**—full functionality provided.*


*Figure 6: Color-coded status indicators enable a rapid assessment of what needs to be done.*

**Highlights**

***Based on the IBM Rational software platform, the federal enterprise architecture solution from IBM offers methodologies, automated processes and tools to assist organizations in easing compliance with DoDAF and other requirements.***

## Easing compliance with DoDAF

Without automation, complying with DoDAF 2.0 can pose a significant hardship. The federal enterprise architecture solution from IBM offers methodologies, automated processes and tools to assist organizations in meeting DoDAF and other requirements. Based on the IBM Rational software platform, these tools share a central repository that enables many matrices, graphical views and compliance reports to be generated automatically from work artifacts. Organizations are able to derive the full value of a shared view into the architecture framework—without the administrative burden. In the process of performing their normal work, they can automatically extract the information that can help them address compliance requirements, create better architectures and implement better systems.

### Acquisition and procurement

For those concerned with acquisition and procurement, and for the specification of enterprise architectures, IBM Rational System Architect® for DoDAF Add On software is an easy-to-use and flexible tool with extensive reporting mechanisms to help address compliance needs. It enables organizations to more efficiently and quickly build DoDAF models and autogenerate DoDAF models and views. To help demonstrate ROI, business process enhancements can be simulated for what-if analysis to verify cost and efficiency benefits using activity-based costing for IDEF0 models.

Rules-check capabilities aid practitioners in creating methodology compliant models, and diagram support verifies that diagrams contain the required information. In addition, utilities are provided to help ensure that dependent data is integrated and traceable. Architecture information is stored in a shareable repository, allowing publication to audiences using automated Web site–generation facilities.

**Highlights**

***Using the IBM solution, organizations can easily communicate DoDAF architectures using standard notations and automatically produced documentation; the single repository for artifacts, together with automated, rules-based checking, helps ensure data consistency across the system.***

Systems development and deployment

For those who develop and deploy systems, IBM Rational Rhapsody® software and IBM Rational Software Architect software both have powerful DoDAF capabilities—the former designed for embedded and technical systems and the latter for Web and SOA systems. The solutions come with predefined profiles for the DoDAF standard, including the new Unified Profile for DoDAF/MODAF (UPDM) and DoDAF 2.0. Each offers a native set of DoDAF diagrams, a rich library of images and extensive reporting capabilities to use for defense-related applications. In addition, each of these tools can import model data from Rational System Architect software to provide a seamless transition from the enterprise level to systems and software development.

With IBM Rational software, organizations can easily communicate DoDAF architectures using standard notations and automatically produced documentation. The single repository for artifacts, together with automated rules-based checking, helps ensure data consistency across the system, including interface descriptions.

Organizations are able to create traceability links from DoDAF standards, products and specifications within the model to industry-standard requirements management tools such as IBM Rational DOORS® and IBM Rational RequisitePro® software. From this linkage, it is possible to automatically produce the traceability matrix for DoDAF. It is much faster and easier to identify requirements that have not been addressed by the design products and to find design elements not justified by a requirement.

In addition to taking the drudgery out of compliance reporting, organizations gain the full value of DoDAF best practices with the ability to:

- *Bring system models to life through requirements-based testing.*
- *Execute operational scenarios.*
- *Record the response of the architecture model to compare with expected results.*
- *Measure the ability of an architecture to meet its operational goals.*

To speed time to value, IBM Global Technology Services provides expert guidance. Experienced consultants can help organizations select the right combination of tools and quickly resolve issues with implementation and ongoing use.

### Beyond compliance

The DoD and the U. S. Government Accountability Office (GAO) have mandated the use of DoDAF to improve the integration and outcomes of defense projects, which have been prone to schedule and cost overruns for many years. However, organizations creating views and models using DoDAF face an array of challenges as they look to comply with requirements, prove the potential of designs, and align architects and other stakeholders within and outside the organization. Without the right tools and processes, DoDAF requirements become just one more cost of doing business with the government.

IBM offers the expertise, methodologies and tools that can help organizations go beyond simply complying with the DoDAF standard. Using IBM solutions, organizations can leverage DoDAF to their advantage in producing higher-quality systems in less time and at reduced cost. To learn more, visit:

**ibm.com**/services/learning/content/ites.wss/us/en?pageType=course_description&courseCode=QB135

### For more information

To learn more about how IBM can help you support and leverage the DoDAF standard, contact your IBM representative or IBM Business Partner, or visit:

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