

Using Metamodels to Improve Enterprise Architecture

By Lynn Uzzle

Abstract

This case study article describes the rationale for the development, use, and benefits of a metamodel to provide the underlying data model for Enterprise Architecture (EA) content. The case study uses the “EA3 Framework” (Bernard 2004, 2005) to illustrate these points. Metamodels enable integration among models and other artifacts that constitute most EA content. Integrated EA content enables repeatable and reliable analysis and reporting, mapping content to frameworks or reference models, and transitions among EA tools for upgrades or conversions. The initial publication of the EA3 Framework in did not define a metamodel or prescribe artifact content in detail. Artifact content and examples were added in the second edition of the EA3 Framework in 2005, including 46 artifact types that document the five layers and three thread areas of this framework. Though the relationships between the layers and threads were described in the 2nd edition of the EA3 Framework, this case study article provides the first detailed meta-model. The proposed EA3 Metamodel that is described in conceptual and diagrammatic form was developed to support the use of the EA3 approach by the author within a federal government agency using a bottom-up approach based on tool capabilities and reporting obligations. The metamodel described in this case study has been implemented using a commercially-available modeling toolset, and required no tool customization.

Keywords

enterprise architecture models, framework, data model, metamodel, EA3

INTRODUCTION

Since the inception of Enterprise Architecture (EA) as a discipline, many frameworks have been developed and thereafter have evolved. Their purpose is to shape the domain of concern by defining the concepts of interest. Although these frameworks all point in the same general direction, they do not all address the same set of problems. Their differences and similarities can be at least partially explained by motivational and organizational differences in their origins.

The Zachman (1989) and Department of Defense Architecture (DoDAF – 2007) frameworks focused initially on systems architecture although they have both been adopted as EA frameworks. Zachman’s work was inspired by the need to manage complexity in information systems.

The Command, Control, Communications, Computers, Intelligence, Surveillance, and Reconnaissance (C4ISR) Architecture

framework, predecessor to the DoDAF, was driven by the need for comparable architecture descriptions to improve interoperability among command and control systems supporting military and intelligence operations.

Spewak’s Enterprise Architecture Planning (EAP), 1992, while not a framework *per se*, influenced many frameworks and related methodologies with its emphasis on identifying the current (“as-is”) state, the target (“to-be”) state, and the transition from current to target.

The Federal Enterprise Architecture Framework (FEAF) (CIO Council, 1999), derived from the Zachman framework and EAP, was motivated by the need to ensure alignment of federal IT to business goals and added both the notion that the architecture evolves, driven by changes in both business needs and technology, and that an enterprise architecture could be approached in segments as a way to manage the size and complexity of the problem.

The Open Group Architecture Framework (TOGAF) 2009 has historically focused on the architecture development methodology and ongoing concerns such as governance (TOGAF Version 9, released in February 2009, now includes a metamodel).

Likewise, the National Association of State Chief Information Officers (NASCIO) architecture framework (NASCIO, 2004) also focuses on the methodology and includes governance. Of these frameworks, only the DoDAF specifies the precise information content of conforming architecture descriptions.

DoDAF prescribes information content by defining the data content of specific architecture work products in terms of its underlying Core Architecture Data Model (CADM). Many of the DoDAF products are model-based including business process, data, and technical solution functions. Other DoDAF products are inventories of information some of which is available from the models. Additional products represent the results of analysis combining content from other products.

Reference models, such as the Federal Enterprise Architecture (FEA) Reference Models (OMB, 2007B) and the Network-Centric Operations and Warfare related guidance (see DISA) provide additional scope and focus to their respective domains. In the communities to which these reference models apply, the reference models provide common terminology and organization to extremely broad enterprises. The common ground that these reference models provide will help to ensure coherent evolution among independent enterprises within communities.

Other guidance, including The Practical Guide to the FEA (Thomas, 2001), the FEA Practice Guidance (OMB 2007a), and the Federal Segment Architecture Methodology (FSAM) (CIO Council, 2008) builds on the foundation provided by frameworks and enhances their meaning and value.

All of these frameworks and associated guidance have contributed to a growing body of knowledge and experience concerning EA development and use. All are intended to support architects in identifying and describing the elements of concern; they help to shape the conversation about those elements. All of them

highlight the inherent relationships among business, data, and technology, but most of them remain at a conceptual level. Greater precision requires deeper specification of the exact content of business, data, and technology models which would enable their interconnection.

Of the publicly available frameworks, the DoDAF is the most precise in terms of the information content needed to support EA. By defining both a product set and its underlying data model, the CADM, the DoDAF points to a critical element that has yet to be fully realized within the EA discipline. The underlying data model for EA content, or metamodel, is critical for defining both information content and interrelationships among architecture work products. The term, "metamodel" will be used in this article to distinguish the data model for EA content from enterprise-specific data models to be found within that EA content.

Bernard's (2005) Enterprise Architecture Cube Framework (EA3), as an evolutionary descendant of DoDAF, EAP, and Zachman, addresses information content, the evolutionary nature of EA as driven by strategic planning as well as technological change, and the importance of security and the workforce in the mix. Many of the artifacts described in EA3 are based on similar DoDAF products. EA3 does not, however, adopt the CADM or specify an underlying data model for architecture work products. This article describes an initial version of an EA3 Metamodel.

PROBLEM STATEMENT

In the absence of a standard, prescriptive, and rigorous definition of the work products that represent EA content, organizations must create their own. Without one, individual architects and engineers will generate models and other *ad hoc* content using the tools and techniques with which they are most familiar, or to which they have easy access. In the worst case, organizations will find their EA content to be ill-defined and un-integrated. An enterprise in which more than one organization participates will have the same problems multiplied by the number of organizations involved. Ill-defined and un-integrated EA content impedes communication, cannot be reliably analyzed, and cannot be used to support investment

decision making. When organizations enter new collaborative arrangements driven by mergers, new business initiatives, or changes in mandate, ill-defined EA content offers little or no value to investment decision-makers, solution planners, or designers. Ironically, an EA program can recreate exactly the kinds of problems within its own work products that it purports to help resolve for the business and IT communities: un-integrated, un-interoperable work products, redundant data, and unreliable results.

Not only must organizations identify the content of models and other work products that define their EA content, they also need to establish the types of interrelationships needed among the work products so that they can be integrated. Integration among models allows architects to capture and reflect the complexity inherent in the EA content. Integration allows architects to identify and to make explicit the issues arising from a lack of integration among actual business processes, data, and technical solutions. Alignment, via interrelationships among model components of different categories of concern (known as views in the DoDAF), enables architects to demonstrate the presence or absence of integration within the enterprise. The ability, for example, to link performance goals to the business activities, roles, information flows, applications, and infrastructure that support achieving those goals enables valuable communication among architects and business owners who make investment and technical solution decisions.

Modeling tools employ metamodels for well-known modeling formalisms such as those in the Unified Modeling Language (UML) (OMG, 2007) and UML-based profiles such as SysML (OMG, 2008), various structured methodologies based on data flow concepts such as IDEF-0 (NIST, 1993), structured analysis, and methodologies that support object oriented analysis and design. Most tools support integration among the models they produce by enabling explicit relationships among their components. Many products also support user-defined extensions to their data models as well as to their analysis and reporting capabilities.

Useful integration among EA work products requires an understanding of the metamodels underlying the modeling formalisms to be used and insight into the relationships that will integrate them. For example, the metamodel for

Business Process Modeling Notation (BPMN) allows an activity in a BPMN model to be associated with data objects defined in that same BPMN model. To integrate the process model with a relevant supporting data model, the BPMN data objects must somehow be connected to entities or classes in a separate data model. A new relationship type must be created in the metamodel to provide that connection between BPMN models and Entity-Relationship or other types of data models. Similarly, activities represented in a BPMN model may be supported by human-machine interactions. New relationship types are needed to connect the activities to model components describing the supporting tools or applications. These inter-model relationships are analogous to the interrelationships between business and IT that EA is intended to identify and strengthen, or create within the enterprise.

Additional benefits of an EA metamodel include improved clarity in communication among EA team members. The EA team can communicate better with business owners based on a deeper understanding of the information being collected, modeled, and analyzed. The metamodel clarifies the expectations to be met by EA content developers and providers, and establishes scaffolding for EA content. Architects can derive consistency and completeness criteria from the metamodel to evaluate and improve model quality. The increased rigor in EA content supported by a well-defined metamodel enables automated analysis to answer predictable business questions. Finally, a metamodel facilitates mapping EA content to reference models or other frameworks for reporting, training, or content conversions.

APPROACHES TO DEFINING A METAMODEL

In the abstract, a metamodel consists of concepts and their interrelationships. A metamodel, for an actual EA, must specify how the EA concepts and interrelationships are represented. For many organizations, much of the metamodel may be determined by the environment. A framework and one or more tools may already be in place. Defining an explicit metamodel can help to unify an EA program and can provide the benefits outlined previously.

As an example, a Zachman-based framework defines categories of stakeholder concerns (owner, planner, designer) in its rows, and interrogatives (what, how, where, when, who, why) through its columns. The row-column intersections (cells) imply the concepts (things produced, data managed, business processes performed). Within a cell, one or more modeling formalisms can usually support content representation, but relationships between concepts in different cells are not addressed by the framework.

Unfortunately, it is exactly those relationships that need to be exposed to demonstrate integration (or its absence) within the enterprise. For example, content for the “owner/what” cell can be supplied by any number of data modeling tools that support conceptual or semantic models. The “designer/how” cell content can be supplied by tools that support business process modeling (IDEFO, BPMN, or UML Activity models). Relationships between a process and the data it uses or generates are not represented in either cell. Other missing relationships include those between the process and the technical solutions that support it, the components of the workforce that perform it, and the organizational goals that it supports. A metamodel based on this framework would be completed with specifications of those missing relationship types, the entities and relationships defined by desired modeling formalisms, and the tools to be used to produce conforming content, and a way to manage all of the model data.

A metamodel definition encompasses:

- a set of layers or categories of concern as defined by a framework (such as strategy, business, data and applications)
- the concepts pertinent to each layer (such as goals, objectives, and initiatives for the strategy layer)
- the interrelationships among the concepts that populate each layer (such as “objective helps meet goal” or “initiative fulfills objective”)
- the interrelationships that connect concepts in different layers (such as business process “supports” goal, or entity “produced” by process)

Although the frameworks cited earlier differ in many details, they all include categories or

layers representing business, data, and applications. The core metamodel concepts within a layer can be identified by bottom-up analysis of existing tool capabilities or of existing reporting obligations. An alternative is a top-down conceptual analysis based on stakeholder concerns and information needs. Once the per-layer metamodel is established, specific business questions can be examined to identify the kinds of inter-layer relationships that can be used to answer them.

Bottom-Up Approach

A bottom-up approach to developing the metamodel could use a combination of reporting needs and tool capabilities. Essentially, a bottom-up approach tries to match information needs with available data. Additional data needs can be met as required. In many organizations, regular reviews of program and enterprise performance are based on whatever is of interest to leadership and oversight organizations. The information needs of such reviews provide clues to help identify the important business questions to be answered. In the public sector, for example, program effectiveness and budgets are common areas of concern that are rich in reporting obligations.

Measures of effectiveness can be derived from analyses of business models, defined as model elements, and built into data collection mechanisms. Data management and manipulation capabilities in modeling tools also provide clues to practical metamodel development. A first consideration is the data that the tools produce. Then, how is that data useful? Does it, or can it be made to relate to other models produced by different tools? Are there conventions or more automated mechanisms that could enable this data to be reused?

Many modeling tools provide some sort of interface including scripting languages or import/export capabilities to provide users access to model content. Many tools support multiple modeling formalisms and support integration among the models they produce. UML tools, for example, support many different kinds of models, and are designed to support data-level integration among related models. Such support enables modelers to create models that share data elements, thus enabling a model element to be defined once yet be usable in different contexts.

Top-Down Approach

A top-down approach to metamodel definition could derive metamodel relationships based on analyses of the concepts and relationships embodied in stated principles and goals and embedded in the information needs of EA stakeholders. For example, a frequently-stated goal of EA is to improve IT support for business needs. Related concepts include business processes, their information flows, requirements for information retention, and process cycle time. Investment decision makers are interested in comparing proposed technical solutions in terms of how well they meet the business requirements that drive these and similar concepts.

To identify additional business questions that expose metamodels concepts and relationships through all EA layers, it could be helpful to consider the roles that EA fills in supporting various classes of EA stakeholder, particularly those that also bridge the mission-IT gap, including:

Capital Planning and Acquisition - EA often provides or supports analyses of alternatives for new or to-be-enhanced IT investments. Supporting content includes assessments of gaps (such as interoperability, performance, or functional) and duplications among existing assets.

IT Strategic Planning - EA can provide supporting detail for strategic IT initiatives during their planning and execution.

Solution Designers and Developers - EA often supports business owners in developing business processes, rules, and requirements for new business activities.

Continuity of Operations (COOP) and Disaster Recovery planners - While supporting business owners, EA can help them to identify and separate essential from non-essential business functions and their corresponding infrastructure needs to help with planning for undesirable events.

Auditors - EA can meet the information needs of external data calls, and help to fulfill specific criteria embodied in security, financial management, and mission effectiveness assessments.

Other Stakeholders - While exploring business level needs, EA practitioners are able to identify

many pieces of information useful to workforce training staff and other stakeholders interested in institutional knowledge capture, harvesting, and use.

A purely bottom-up approach can cover foreseeable EA content needs, but may miss considering unforeseen needs that may emerge in the future. An entirely top-down approach may produce more satisfactory coverage, but risks overkill by covering too much, specifying a too-capable solution that may be costly to develop and hard to maintain. A hybrid approach is probably best to help meet foreseeable requirements with a comprehensive solution that can be extended as unforeseen needs emerge.

A BASIC METAMODEL FOR THE EA3 ARCHITECTURE FRAMEWORK

The initial publication of the EA3 Framework (1st edition - Bernard, 2004) did not define a metamodel or prescribe artifact content in detail. Artifact content and examples were added in the second published edition of the EA3 Framework (Bernard, 2005) including 46 artifacts that document the five layers and the three thread areas. Though the relationships between the layers and threads were described in the 2nd edition of the EA Framework, this case study article provides the first detailed meta-model. The proposed EA3 Metamodel that is described hereafter in a conceptual and diagrammatic form was developed to support the use of the EA3 approach by the author within a federal government agency using a bottom-up approach based on tool capabilities and reporting obligations. The basic metamodel described here has been implemented using a commercially-available modeling toolset, and required no tool customization.

Reporting obligations for the agency in which this metamodel has been used include information required by the federal budget process (OMB, 2008b), an EA assessment process (OMB, 2008a), mission performance assessment (PART), financial management reporting (OMB, 2004 and 2009) and IT Security reporting (OMB 2000). The budget process focuses on investments and the related reporting requirements including information about IT services used or produced, and performance measures of associated initiatives. EA assessment is focused on the architecture's

completeness, utilization for performance improvement, capital planning, and IT governance. Mission performance assessment measures the effectiveness of agency programs against their statutory requirements.

Overview of the EA3 Framework

The EA3 Framework has five major sub-architecture areas that are referred to in this article as layers. Each layer is focused on a specific set of concerns and encompasses several artifacts that describe the concerns of the layer. The layers defined in the EA3 Framework are:

- Strategic Goals and Initiatives
- Business Products and Services
- Data and Information
- Systems and Applications
- Networks and Infrastructure

There are also three “threads” that affect and involve all five of the sub-architecture layers:

- Security
- Standards
- Workforce

Each layer and thread is described briefly the following section in terms of its conceptual basis, the EA3 products or artifacts supported in the metamodel, and the related portions of the metamodel. Not all of the EA3 products are visible in the metamodel as described below. The subset of artifacts that is included was chosen to meet a design goal of avoiding tool customization whenever possible. Future versions of the metamodel may include additional products.

Strategic Goals and Initiatives Layer

In the EA3 Metamodel, the Strategic Goals and Initiatives layer contains information from the work products of strategic planning and performance measurement planning. Complete EA3 Strategic Goals and Initiatives artifacts such as the Strategic Plan or Concept of Operations are not explicitly represented in the strategy layer. Instead, elements of those artifacts, especially elements of the S-1 Strategic Plan, are collected and interrelated using the concepts described below and illustrated as entities or classes in Figure 1.

- The Strategic Goals and Initiatives layer concepts include:
- Strategic Goal – a statement of organizational intent.
- Objective – an achievable, measurable increment of progress towards fulfilling one or more strategic goals.
- Initiative – a project or program to be executed to meet one or more objectives.
- Investment – a business case, budget, and related items needed to execute one or more initiatives.
- Performance Measure – a quantifiable indicator applied to one or more initiatives that helps the organization to determine the extent to which its investments are properly supporting its initiatives and the extent to which the initiatives are effective in achieving objectives to meet goals.

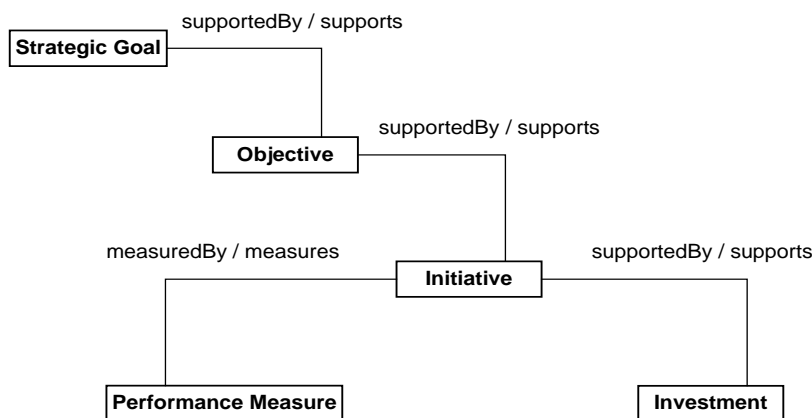


Figure 1. EA3 Strategic Goals and Initiatives Layer Concepts and Interrelationships

Strategy Layer concepts can be related to concepts in other layers. Some relevant examples include:

- A Strategic Goal or Objective can be assigned to a Workforce Layer Organizational Unit.
- An Investment can be managed by a Workforce Layer Organizational Unit.
- An Initiative, Investment, or Performance Measure can be mapped to business layer concepts which it supports.
- A Performance Measure can be mapped to a measurement plan or an external model such as the FEA Performance Reference Model.

Business Layer

The EA3 Framework's Business Layer encompasses business processes and the flow of information to and from external stakeholders and within the organization. The EA3 artifacts at the Business Layer which are supported by the metamodel proposed in this article include:

- B-2 Node Connectivity Diagram – implemented as simple node objects with interconnections to represent needlines (a needline is an abstraction of one or more information exchanges between nodes).
- B-3 Swim Lane Process Diagram – implemented using tool support for Business Process Modeling Notation (BPMN) or UML activity models.
- B-4 Business Process/Service Model – implemented as a hierarchy of process areas in which leaf-level nodes correspond to BPMN models.
- B-5 Business Process/Product Matrix – implemented as a matrix mapping processes to persistent data objects or information products, with matrix cells indicating input and output relationship types.

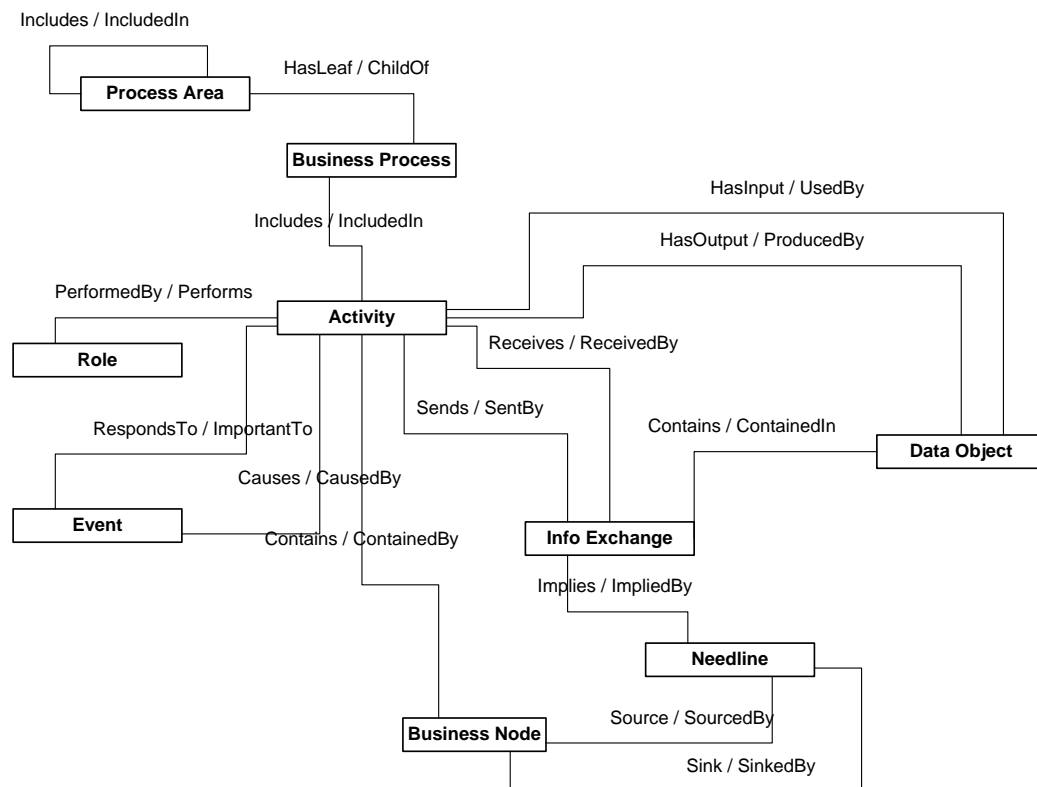


Figure 2. EA3 Metamodel Business Layer Concepts

The concepts embodied in these Business Layer artifacts include:

- A “Process Area” represents a collection of Business Processes. The set of Process Areas for the enterprise represent a taxonomy of business functions for the enterprise.
- The “Business Process” is a set of activities, events, roles, inputs, outputs which may use and produce data or information and may depend on the use of applications.
- “Information Exchanges” are flows of information between activities within or between business processes which may cross organizational boundaries.
- Persistent “Data Objects” are those which are produced and used by activities which are retained by the enterprise.
- A “Business Node” in the B-2 Node Connectivity Diagram represents a collection of Activities and connects to other nodes via Needlines.
- A “Needline” in the B-2 Node Connectivity Diagram represents a collection of Information Exchanges.

Business Layer concepts can be related to concepts in the Strategy, Data, and Systems and Application Layers as follows:

- A Process Area can be the responsibility of an Organizational Unit from the Workforce Layer.
- A Process area can be the focus of a Strategy Layer Investment or Performance Measure.
- A Process Area can be mapped to an external model such as the FEA Business Reference Model.
- A Role can be mapped to one or more Organizational Units or Positions from the Workforce Layer.
- An Activity can be mapped to supporting application(s) from the Systems/Applications Layer.
- An Information Exchange is represented in a D-2 Information Exchange Matrix in the Data Layer.
- A Data Object (in a BPMN model) can be described by one or more Data Layer classes or entities.

Data Layer

The EA3 Data Layer includes conceptual, logical, and physical representations of the persistent information managed by the enterprise. There are explicit connections to both the Business and Systems and Applications Layers.

EA3 data artifacts currently supported in the EA3 Metamodel include:

- D-2 Information Exchange Matrix – mapping needlines to sending and receiving process activities and supplying additional attributes such as frequency, format, and security/privacy requirements.
- D-5 Logical Data Model – identifying the entities/classes, their attributes, and relationships
- D-6 Physical Data Model – identifying the mapping of logical data model components onto relational or other data management technologies.

Data Layer concepts include:

- Entity (class) – a category of data to be managed that typically has inherent aspects to be managed as attributes.
- Attribute – a property of an entity (class) such as name, size, color.
- Relationship – an explicit connection between entities or classes.
- Table – a physical data model component in which entities or relationships are stored.
- Column – a component of tables used to house attribute values.

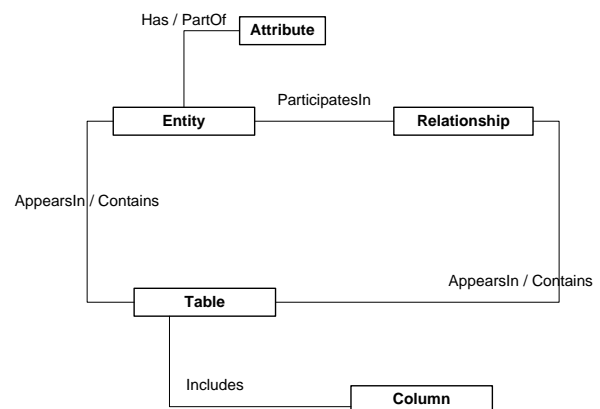


Figure 3. EA3 Metamodel Data Layer Concepts

Data layer concepts can be related to Business Layer and System Layer concepts in the following ways:

- Entities can be contained within Data Objects defined in the Business Layer.
- Entities can be included in or mapped to the Enterprise Data Models based on the FEA Data Reference Model.
- Tables can be managed by Applications.

Systems and Applications Layer

The Systems and Applications Layer contains information which describes function, structure, and organization.

EA3 systems and application artifacts currently supported in the EA3 Metamodel include:

- SA-1 System Interface Description illustrating logical or physical interconnections among systems or applications.
- SA-2 System Communications Description augments the SA-1 with specific communications technology assignments.
- SA-3 System-System Matrix identifies the status of planned or existing interfaces among systems or applications.
- SA-4 System Data Flow Diagram decomposes systems into applications and applications into communicating functions.
- SA-5 System/Operations Matrix maps functions from the SA-4 models to activities from the B-3 models.

The Systems and Applications Layer concepts include:

- Application – a unit of functionality (which could be available as a service accessible to other applications or as a traditional application accessible to humans).
- System – a collection of applications.
- Data Flow – a relationship representing one or more data exchanges among applications.
- Solution Component – a part of an application, system, or data store that may be managed separately (such as a COTS product used by one or more applications or systems).

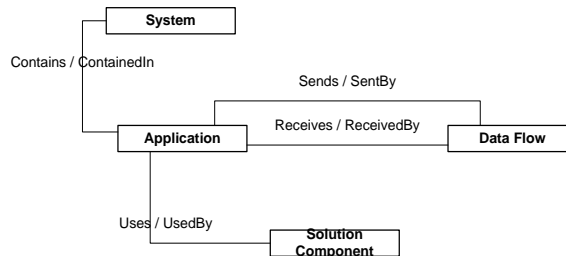


Figure 4. EA3 Metamodel System/Application Layer Concepts

Concepts in the Systems and Application Layer can be related concepts in other layers as follows:

- Applications and Systems can be provided by Investments that are defined in the Strategy Layer.
- Applications can be used by Activities in the Business Layer.
- Applications can manage data in Tables defined in the Data Layer.
- Applications and Systems can be hosted on platforms in the Networks and Infrastructure layer.
- Solution Components can be dependent upon or built using technologies identified in the Standards Layer.

Networks and Infrastructure Layer

The Networks and Infrastructure Layer documents planned and actual physical infrastructure components. The EA3 artifacts supported in the metamodel include:

- NI-1 Network Connectivity Diagram – illustrating physical network connections and device types in the network.
- NI-2 Network Inventory – enumerating actual instances of hardware and software installed on the network.

Networks and Infrastructure concepts include:

- Device Type – a category of device such as server or router.
- Device Instance – a specific item of a particular device type such as the desktop PC named “DTXXX123.”
- Device Interconnection – a physical connection such as LAN or wireless.

- Device Location – a geographic or facility location for a device.

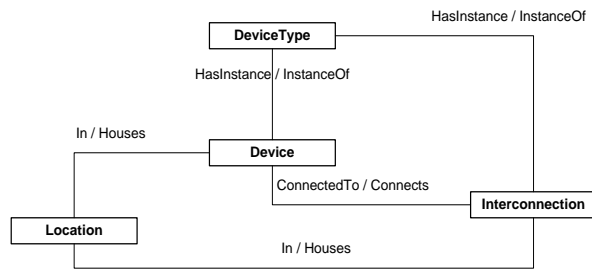


Figure 5. EA3 Metamodel Networks and Infrastructure Layer

Workforce Thread

The Workforce “Thread” a major element of the EA3 framework that affects and involves all five layers (Strategy, Business, Data, Systems, Networks) describes the structure, organization, and skills needs of the enterprise from the human resources perspective. EA3 Workforce Thread artifacts include:

- W-1 Workforce Plan describing an organization’s plans for hiring, retaining, and developing its workforce.
- W-2 Organization Chart depicting the reporting structure of the organization.
- W-3 Knowledge and Skills Profile mapping positions within the Organization Chart to required levels of knowledge, skills, abilities, and other qualifications.

Workforce Thread concepts include:

- Organizational Unit.
- Position.
- Knowledge, Skill, Ability, or Other Qualification (KSAO).

Workforce Thread concepts may be related to many concepts in the Strategy and Business layers, including:

- Organizational Units may be assigned responsibility for specific strategic goals, objectives or initiatives, and may manage specific investments
- Positions may fulfill roles described by the activities they perform in the Business Layer.

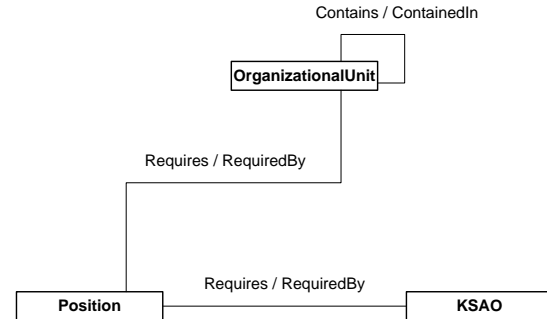


Figure 6. EA3 Metamodel Workforce Thread

Security Thread

The EA3 Security Thread includes security and privacy plans, a catalog of security solutions, COOP and DR plans, and the security assessment documentation for deployed systems and applications. The EA3 Metamodel contains only a security solution description type corresponding to the SP-2 Security Solutions Descriptions artifact. Security solution instances represent the security controls identified by the National Institute of Standards (NIST 2009). The metamodel supports relationships between applications and implemented security controls.

Standards Thread

The EA3 Standards Thread identifies relevant technology standards and their forecasted evolution as it pertains to the enterprise needs. Only the ST-1 Technology Standards Profile is supported in the metamodel at this time using a relationship between solution components in the Systems and Applications layer and technologies in the Standards Thread.

METAMODEL USE AND FUTURE PLANS

As indicated earlier, the EA3 Metamodel has been in use for just under a year at one federal agency. A full view of the metamodel with mappings to the EA3 artifacts that are at least partially represented in the metamodel is provided in Figure 7 on the next page.

Although the metamodel is often invisible to most EA stakeholders, it is the basis for organizing “composite” (Zachman, 1989) artifacts such as “storyboards” that provide a comprehensive view of an organizational service from a business process, data exchange, and infrastructure viewpoint.

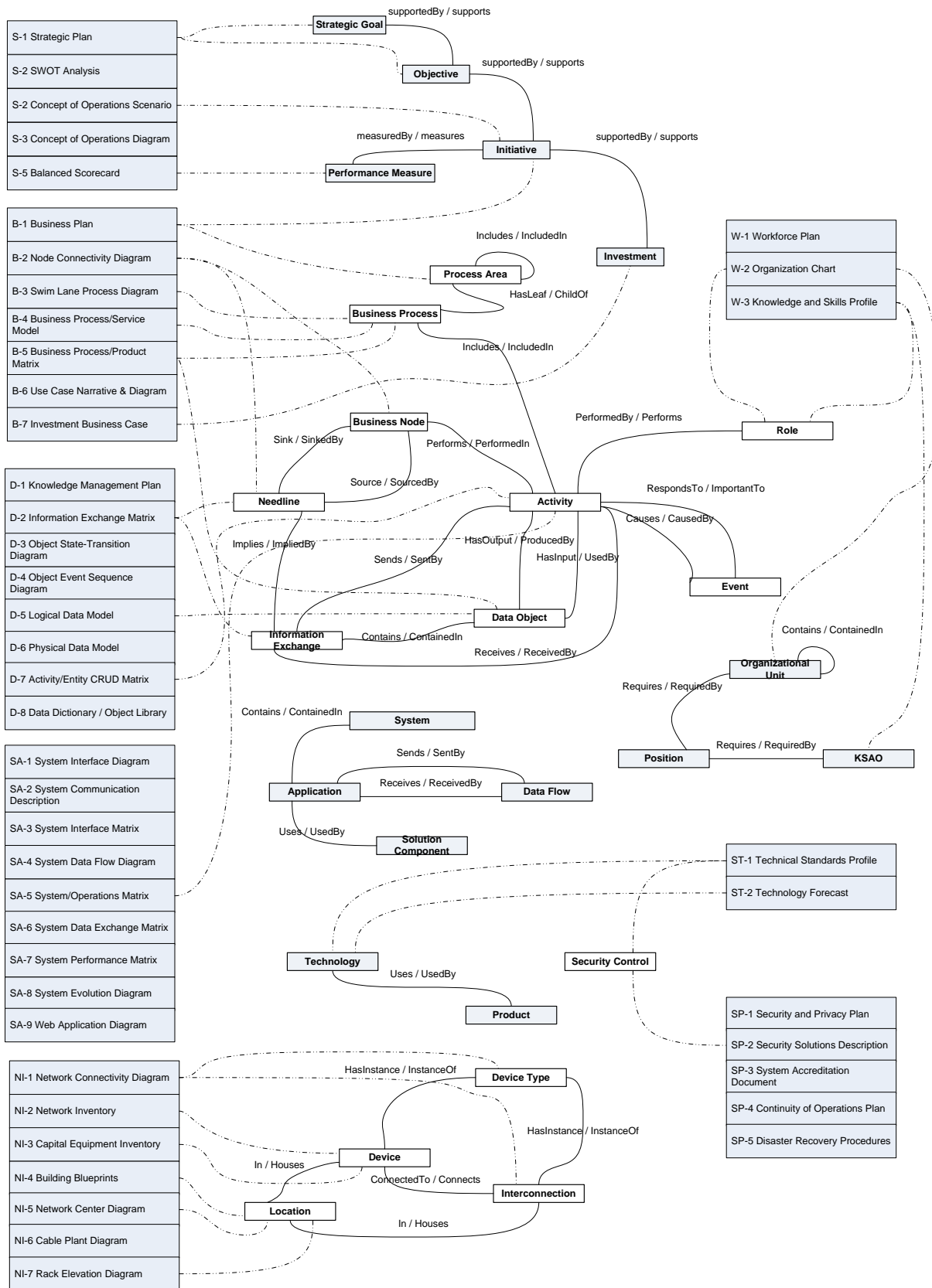


Figure 7. Mapping the EA3 Metamodel to Selected EA3 Artifacts

SUMMARY AND CONCLUSIONS

The EA3 Metamodel that has been described in this case study was developed to enhance the use of the EA3 Framework and associated artifacts at a federal agency in the U.S. Government. The EA3 Metamodel has already been implemented and was able to be supported with commercially-available tool set, which reflects one of the initial design goals for the metamodel, which was to avoid tool customizations. With a sufficiently feature-rich tool set, meeting this goal has not been difficult. Further evolution of this metamodel, however, will drive tool customization to define additional concept and relationship types to support a more robust subset of the EA3 framework's artifacts. Other changes that are envisioned include enhanced analysis and reporting capabilities.

EA content is the information that fuels the evolution engine for an enterprise. As a discipline, EA is evolving and maturing. More innovation is needed to help organizations adopt and adapt so that they may more easily treat EA content development and maintenance with as much rigor as any other engineering project. Specific innovations needed include better tool support for integrated models and extensible metamodels. Additional standardization of concepts and improved modeling formalisms could also help make EA development easier and the resulting architectures more powerful. EA content must be accurate, precise, and well-integrated to fully realize its mission to support decision making by leadership, business, and engineering components within the enterprise. Metamodels encourage precision and integration in EA content, which in turn supports improved communication, analysis, and defensible decision-making.

AUTHOR BIOGRAPHY

Lyn Uzzle is a practicing senior enterprise architect with Citizant, Inc., a government solutions provider with Enterprise Architecture, Program Management, and Application Development expertise, headquartered in Chantilly, VA. She currently supports enterprise architecture engagements with federal and defense agencies. Lyn Uzzle can be reached at luzzle@citizant.com.

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