An Introduction to Architecture(s)

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Chair, INCOSE Architecture Working Group
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Topics

Part 1: Some Fundamentals

- What is it?
- Why do it?
- The language

Part 2: Doing The Work

- Synergies
- Standards

Part 3: Ecosystem

- Role & skills
- Professional organizations
- Credentials

Part 4: Next Steps

- Learning more…

Part 1: Some Fundamentals

An Introduction to Architecture(s)

Architecture is about…

Structure

Behavior

Blueprints

-ilities

Partitioning

Rules

Interfaces

Relationships

And what are –ilities?

(aka, 'architecturally significant requirements')

(PARTIAL) LIST OF SYSTEM QUALITY ATTRIBUTES

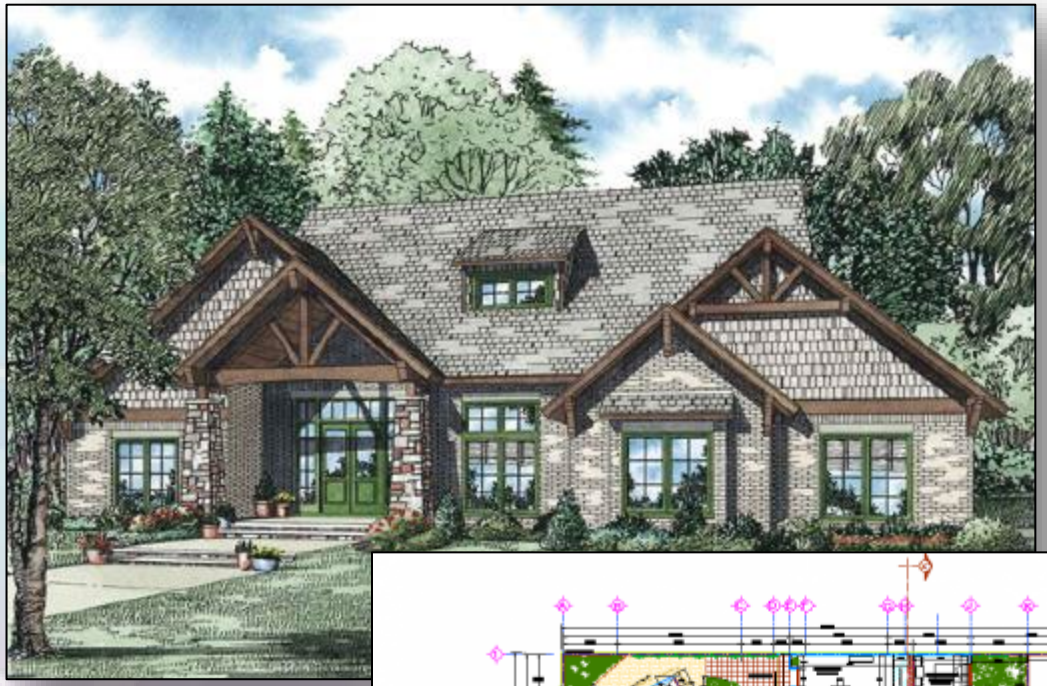
accessibility	composability	deployability	flexibility	modifiability	recoverability	seamlessness	timeliness
accountability	confidentiality	discoverability	inspectability	modularity	relevance	self-sustainability	traceability
accuracy	configurability	distributability	installability	observability	reliability	securability	transparency
adaptability	correctness	durability	integrity	operability	repeatability	simplicity	ubiquity
administrability	credibility	effectiveness	interchangeability	orthogonality	reproducibility	stability	understandability
affordability	customizability	efficiency	interoperability	portability	resiliency	standards compliance	upgradability
agility	debuggability	evolvability	learnability	precision	responsiveness	supportability	usability
auditability	degradability	extensibility	localizability	predictability	reusability	survivability	vulnerability
autonomy	determinability	failure transparency	maintainability	process capabilities	robustness	sustainability	
availability	demonstrability	fault-tolerance	manageability	producibility	safety	tailorability	
compatibility	dependability	fidelity	mobility	provability	scalability	testability	

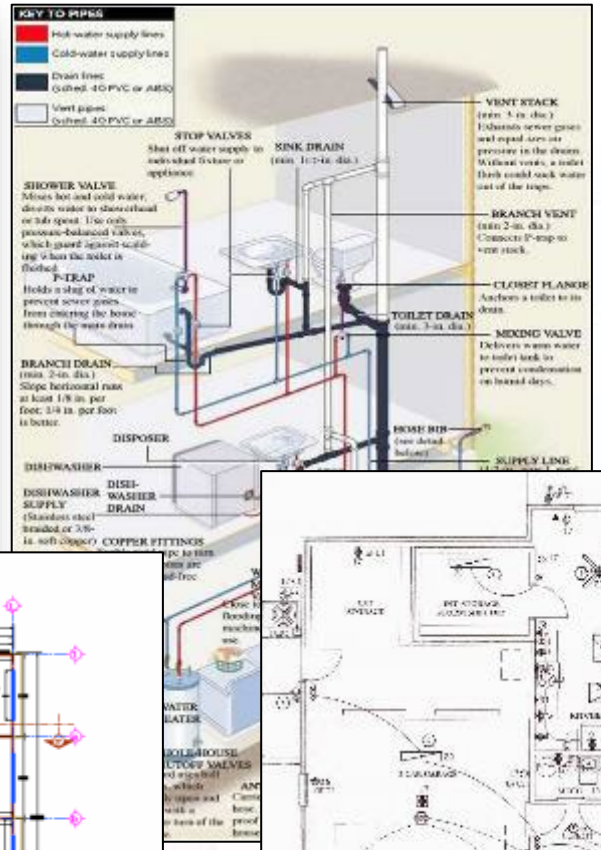
Ref: https://en.wikipedia.org/wiki/List_of_system_quality_attributes

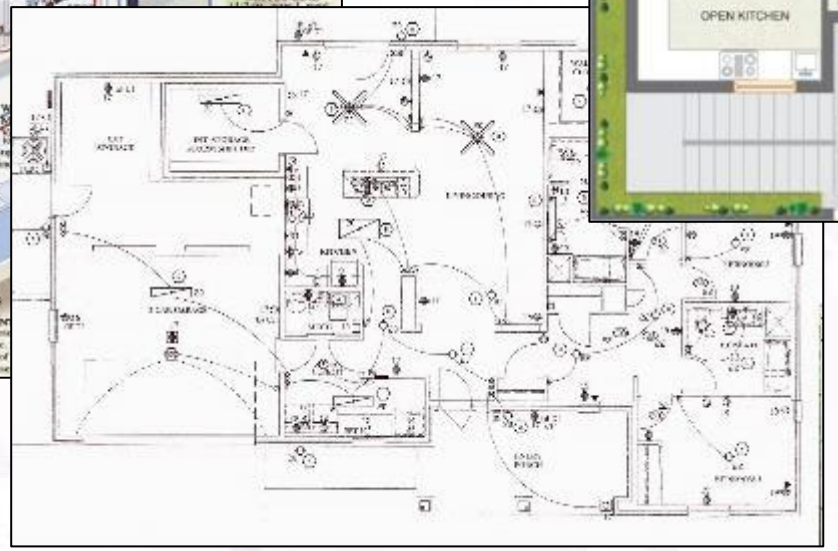
Some flavors of architecture

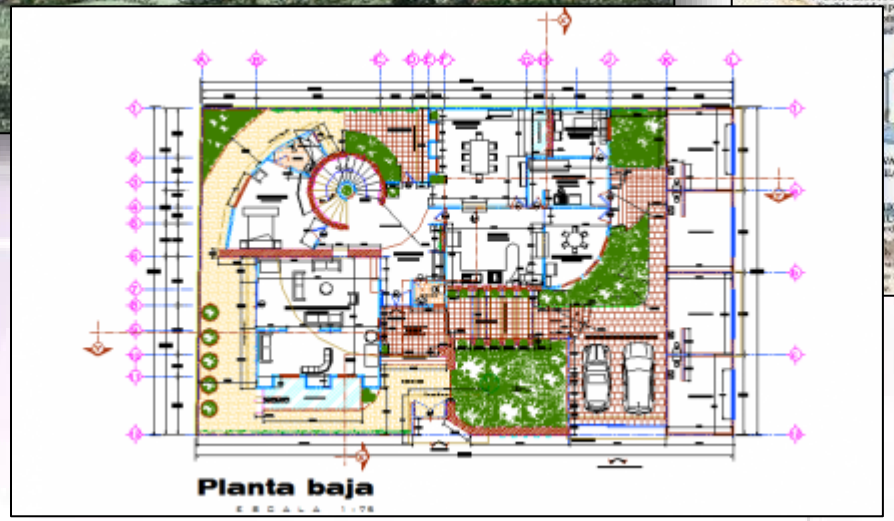
Software	Data	Contextual
System/SoS	Application	Conceptual
Enterprise	Network	Operational
Business	Security	Logical
Mission	Technical	Physical
…	…	…

A partial look: civil architecture









A partial look: software architecture

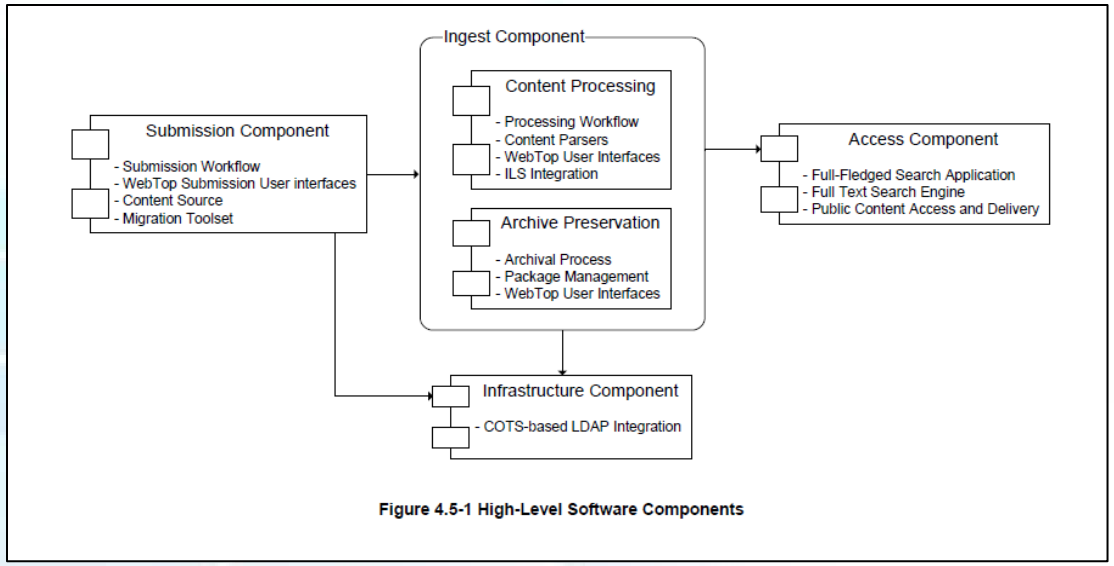


Figure 4.5-1 High-Level Software Components

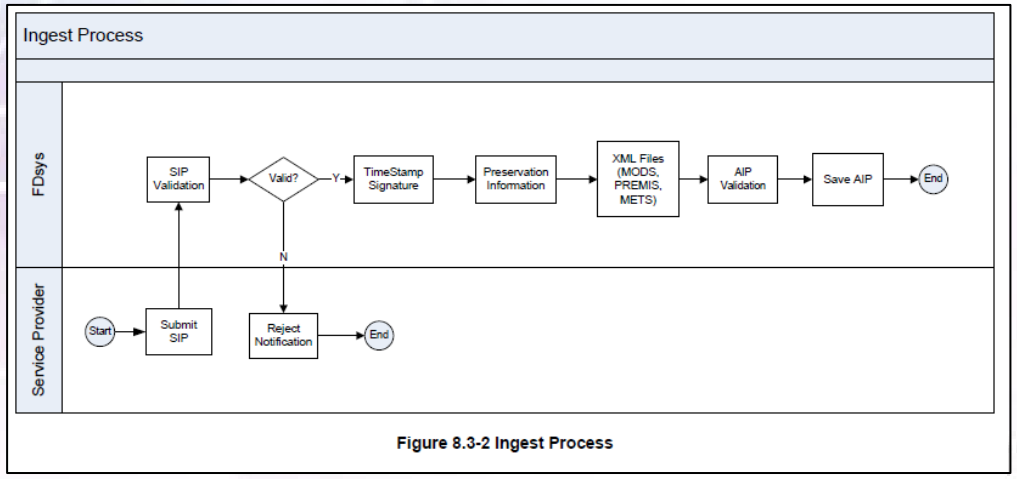


Figure 8.3-2 Ingest Process

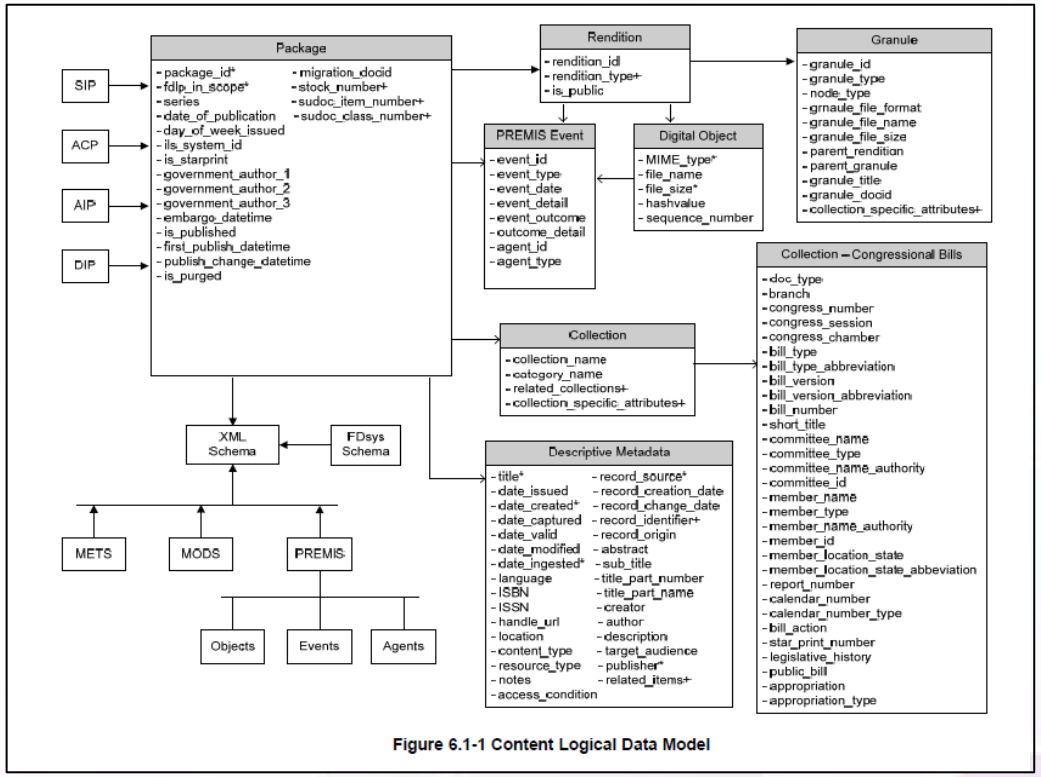


Figure 6.1-1 Content Logical Data Model

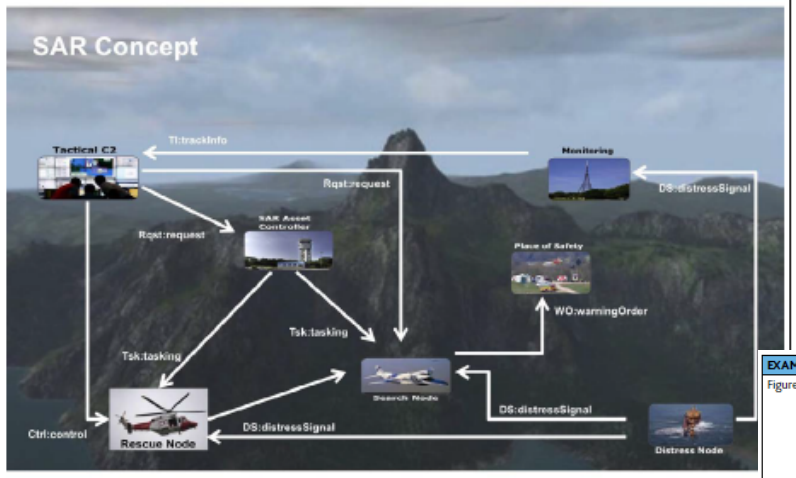
ref: https://www.govinfo.gov/media/FDsys_Architecture.pdf

A partial look: systems architecture

EXAMPLE

Example below shows a concept diagram displaying the key elements (e.g. Tactical C2 and Monitoring) and interactions in a Search and Rescue Scenario.

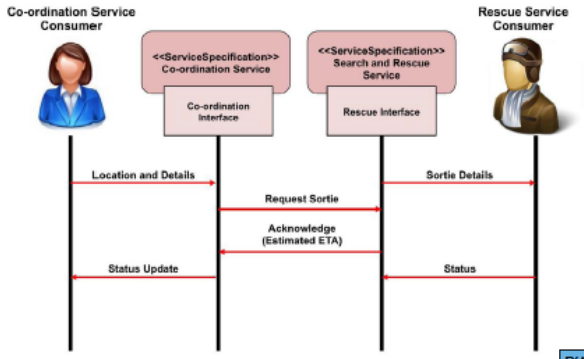
Figure 3-28: Example L2-L3 View



EXAMPLE

Example below shows a service, two service consumers and their interactions.

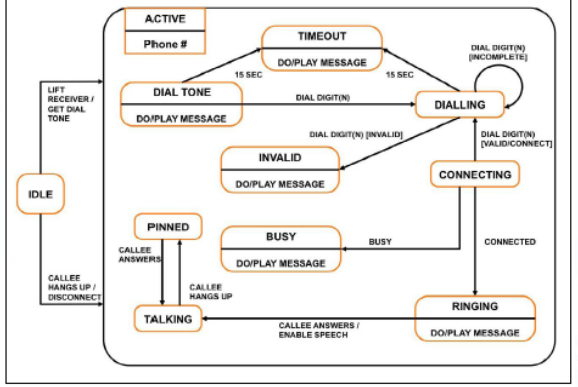
Figure 3-14: Example S6 View



EXAMPLE

Example below shows a state diagram with states and state transitions.

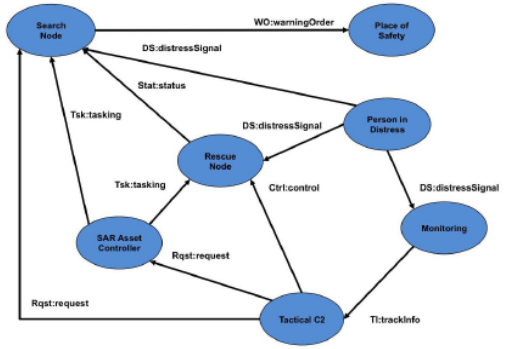
Figure 3-33: Example P5 View



EXAMPLE

Figure 3-20 shows interactions between nodes, in this case flows of information between the nodes.

Figure 3-20: Example L2 View



EXAMPLE

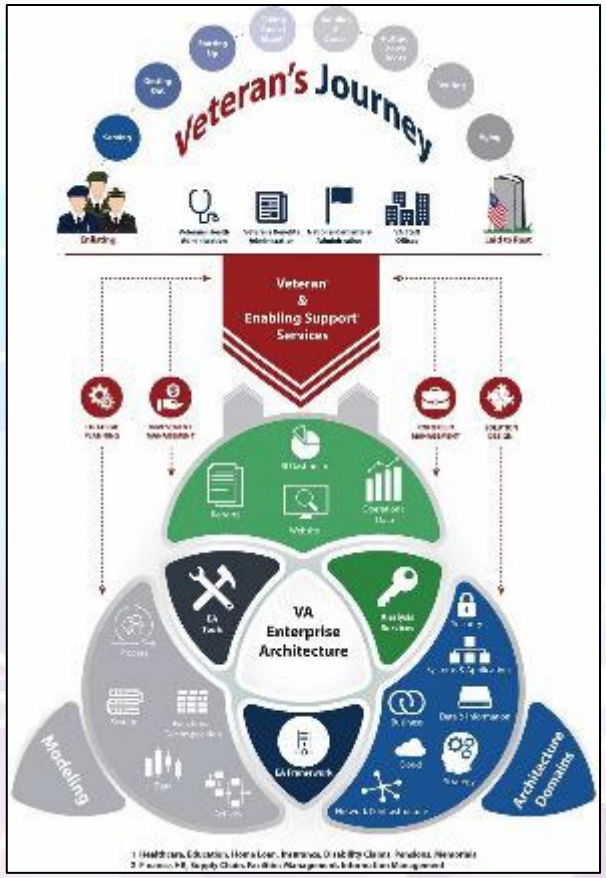
Example below shows a table detailing information flows with source and target node of the flow, and additional properties (e.g. media type) or measures (e.g. availability).

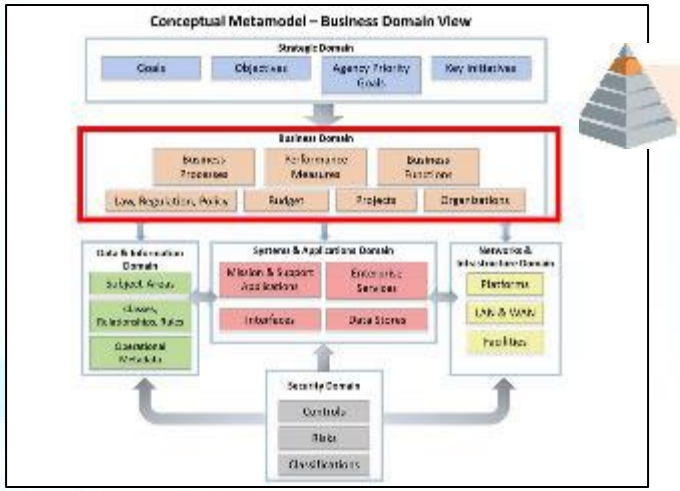
Figure 3-21: Example L3 View

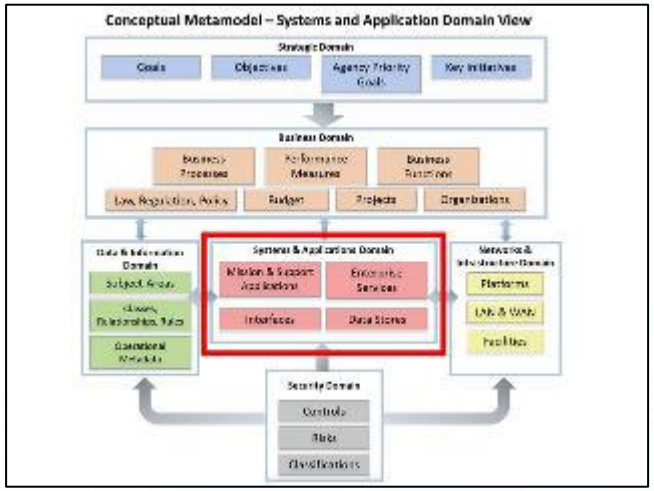
	Purpose	Source	Target	Transaction Type	Media Type	Interoperability Level Required	Availability	Associated Collaborations	Information Element is conveyed by Information Exchange
Ctrl:control	control rescue	Tactical C2	Rescue Node		Voice	Level 3	95	Ice:Controls	Assignment Search Object
DS:distressSignal	signal rescue node	Person in Distress	Rescue Node		Voice			Ice:DistressSignal	Last Known Position
DS:distressSignal	signal monitoring station	Person in Distress	Monitoring					Ice:DistressSignal	Last Known Position
DS:distressSignal	signal search node	Person in Distress	Search Node					Ice:DistressSignal	Last Known Position
Rqst:request	request search	Tactical C2	Search Node					Ice:Request	SAR Operation
Rqst:request	asset required	Tactical C2	SAR Asset Controller					Ice:Request	SAR Operation
Stat:status	status update	Rescue Node	Search Node					Ice:Status	Search Status
Tl:trackingInfo	tracking information	Monitoring	Tactical C2					Ice:Tracking	Last Known Position
Tsk:tasking	task search	SAR Asset Controller	Search Node					Ice:Tasking	Assignment
Tsk:tasking	task rescue	SAR Asset Controller	Rescue Node					Ice:Tasking	Assignment
WO:warningOrder	warning	Search Node	Place of Safety					Ice:WarningOrder	Search Object

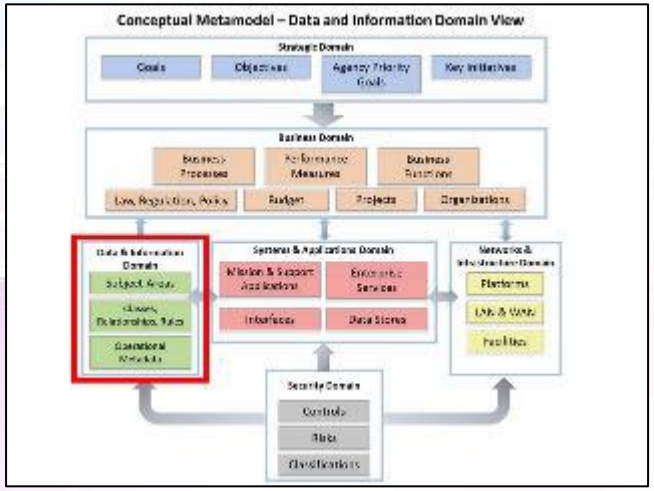
ref: NATO Architecture Framework Version 4 (2018)

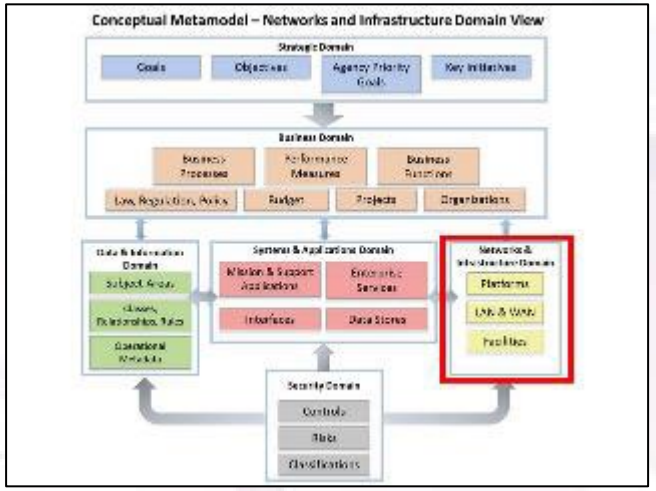
A partial look: enterprise architecture











ref: https://www.ea.oit.va.gov

So, we architect to…

MANAGE COMPLEXITY

MANAGE CHANGE

MANAGE RISK

The architect's dictionary* (a sampling)

TERM	DEFINITION
architecting	conceiving, defining, expressing, documenting, communicating, certifying proper implementation of, maintaining and improving an architecture throughout the life cycle of an entity of interest
architecture	fundamental concepts or properties related to an entity in its environment and governing principles for the realization and evolution of this entity and its related life cycle processes
architecture description	work product used to express an architecture
architecture description framework	conventions, principles and practices for the description of architectures established within a specific domain of application or community of stakeholders
architecture view	information item, governed by an architecture viewpoint, comprising part of an architecture description
architecture viewpoint	conventions for the creation, interpretation and use of an architecture view to frame one or more concerns

*Ref: ISO/IEC/IEEE 42010:2022, *Software, systems and enterprise — Architecture description*
Available from ISO website or through IEEE Xplore subscription (if your company/org has this)

Building blocks beyond ‘the language’…

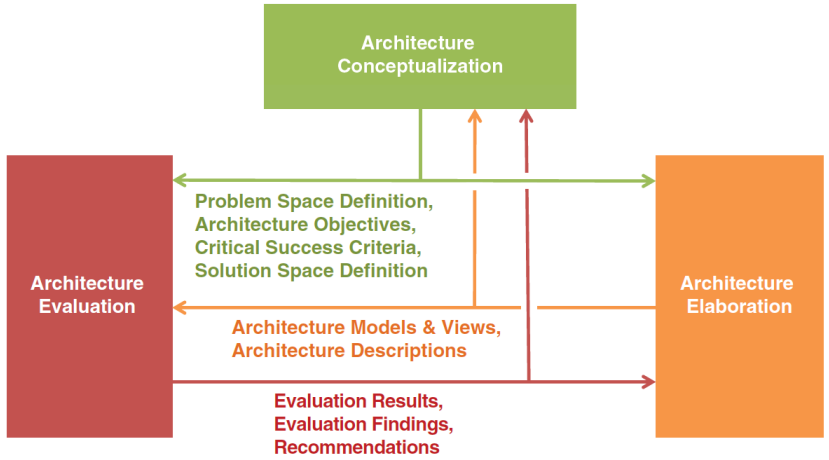
- Architecture approaches
- Architecture viewpoints & models
- Architecture frameworks
- Architecture standards
- Heuristics
- …and more

But so many frameworks… so little time

Abbrev.	Framework	Focus Area
ACTIF	Architecture cadre des Transports intelligents en France [Framework Architecture for Intelligent Transport in France]	Methodology, Reference Architecture
AF-EAF	(US) Air Force Enterprise Architecture Framework	Development/Investment Guide
ASAM	Applied Systems Architecting Method	Methodology (general); "Art of Systems Architecting"
CAF	(US) C4ISR Architecture Framework (*superceded by DoDAF*)	Model Descriptions, Metamodel
DAF	(Australian) Defence Architecture Framework	Model Descriptions, Metamodel
DoDAF	(US) Department of Defense Architecture Framework	Model Descriptions, Metamodel
DNDAF	(Canadian Forces) Defence Architecture Framework	Model Descriptions, Metamodel
E2AF	Extended Enterprise Architecture Framework	Classification, Methodology
FEAF	(US) Federal Enterprise Architecture Framework	Components, Levels
IAF*	Integrated Architecture Framework (Capgemini)	Methodology
--	Gartner Group Framework	Classification/Organization
--	Index Architecture Framework	Classification/Organization
MODAF	(UK) Ministry of Defence Architecture Framework (retired)	Model Descriptions, Metamodel
NAF	NATO Architecture Framework	Model Descriptions, Metamodel
TEAF	(US) Treasury Enterprise Architecture Framework	Development/Investment Guide
TISAF	(US) Treasury Information Sys Architecture Framework	Development/Investment Guide
TOGAF	The Open Group Architecture Framework	Methodology, Metamodel
UAF	Unified Architecture Framework	Model Descriptions, Metamodel
Zachman	Zachman Framework for Enterprise Architecture	Classification/Organization/Ontology

And, let's not forget our INCOSE resources

- Systems Engineering Handbook
  - ***Architecture:*** conceptualization, elaboration, evaluation (per ISO 42020; reproduced there with permissions)
- INCOSE Architecture Working Group (US)
- INCOSE Architecture Working Group (within INCOSE UK, aka ifSE)
  - Ref: INCOSE UK AWG books in their bookstore

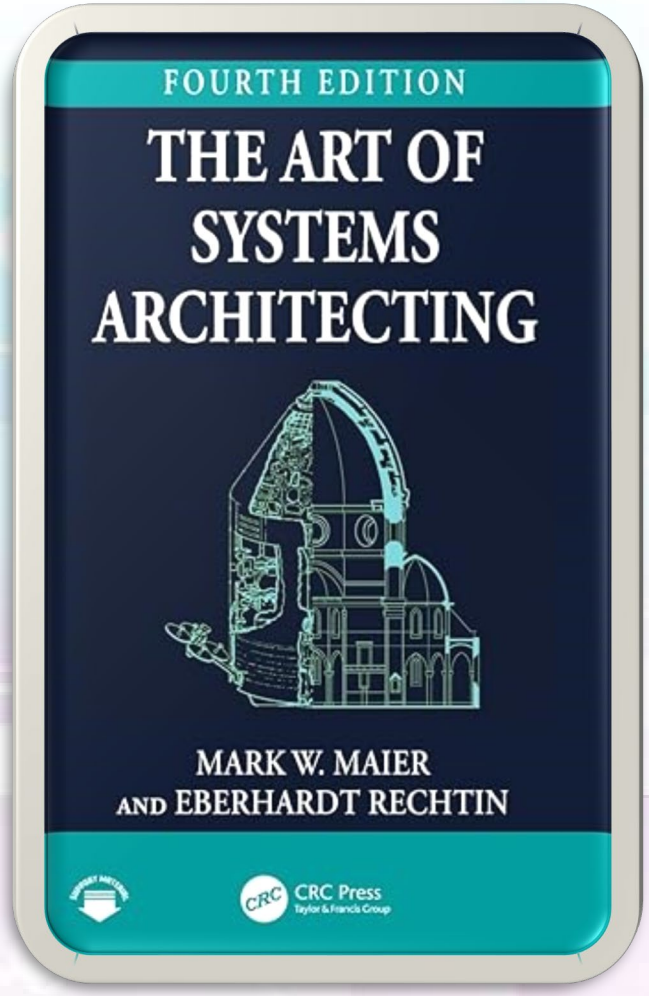


Part 2: Doing The Work

An Introduction to Architecture(s)

The Art of Systems Architecting

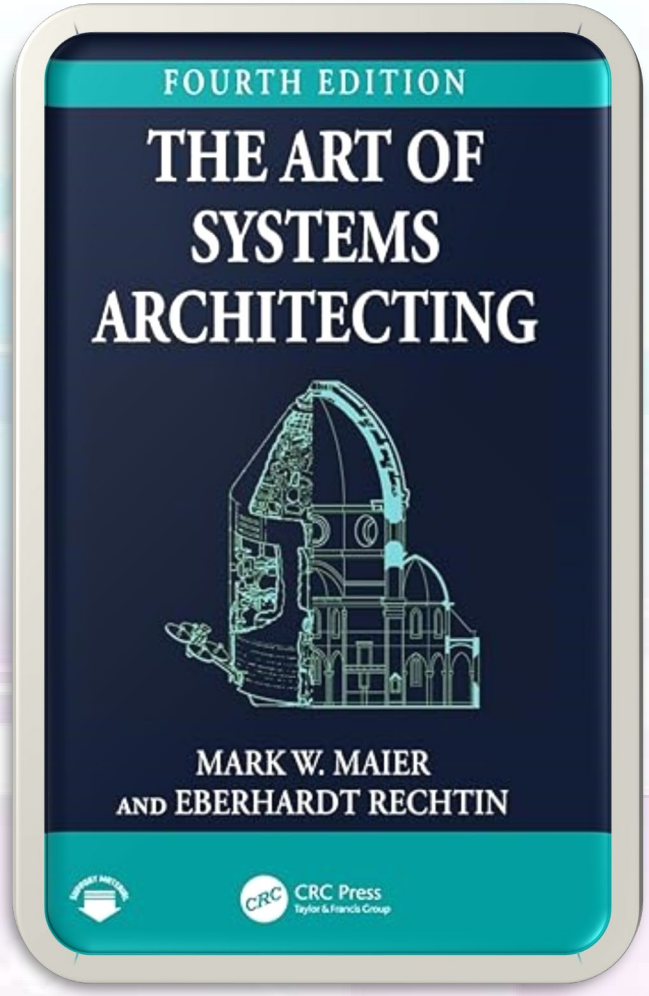
(new edition)



"…structured heuristics to improve the least structured, most art-like elements of systems design."

- Dr. Mark Maier
- Dr. Eberhardt Rechtin
- **Heuristics Categories**
  - Multitask, Scoping and Planning, Modeling, Prioritizing, Aggregating, Partitioning, Integrating, Certifying, Assessing, Rearchitecting
- **A glance at Chapter 13: The Political Process and Systems Architecting**
  - Dr. Brenda Forman, Lockheed-Martin Corporation (retired)
  - Facts of Life
    - Politics, not technology, sets the limits of what technology is allowed to achieve.
    - Cost rules.
    - A strong, coherent constituency is essential.
    - Technical problems become political problems.
    - The best engineering solutions are not necessarily the best political solutions.

The Art of Systems Architecting
(new edition)

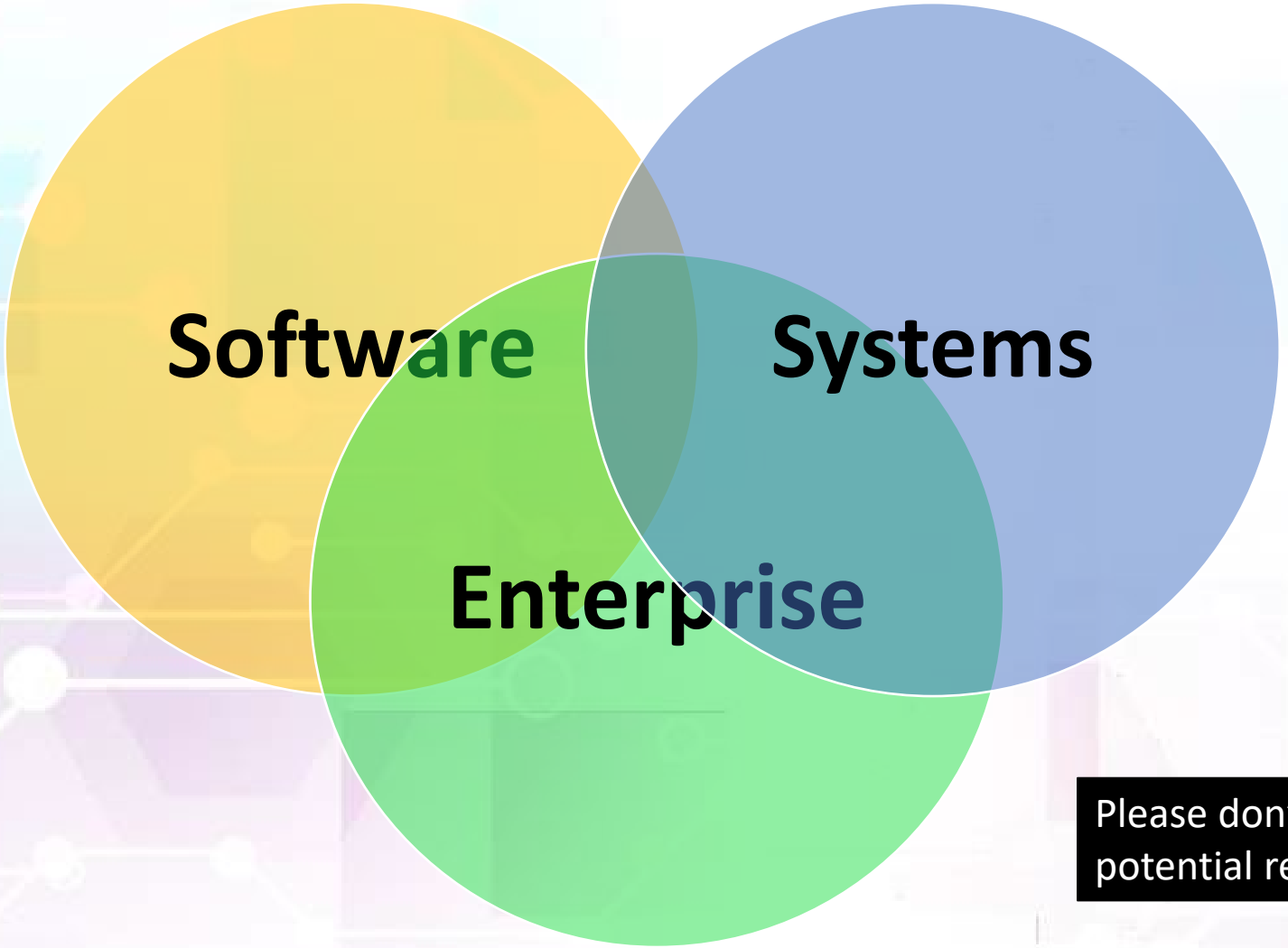


Appendix A: Sampling from ~180 Heuristics

Type	Heuristic
Multitask	The first line of defense against complexity is simplicity of design.
Scoping	The beginning is the most important part of the work.*
Modeling	The eye is a fine architect. Believe it.
Integrating	Relationships among the elements are what give systems their added value.
Certifying	As time to delivery increases, the threat to functionality increases.
Assessing	If you think your design is perfect, it's only because you haven't shown it to someone else.
Rearchitecting	If you don't understand the existing system, you can't be sure you're rearchitecting a better one.

*Plato, 4th century B.C.

Synergies



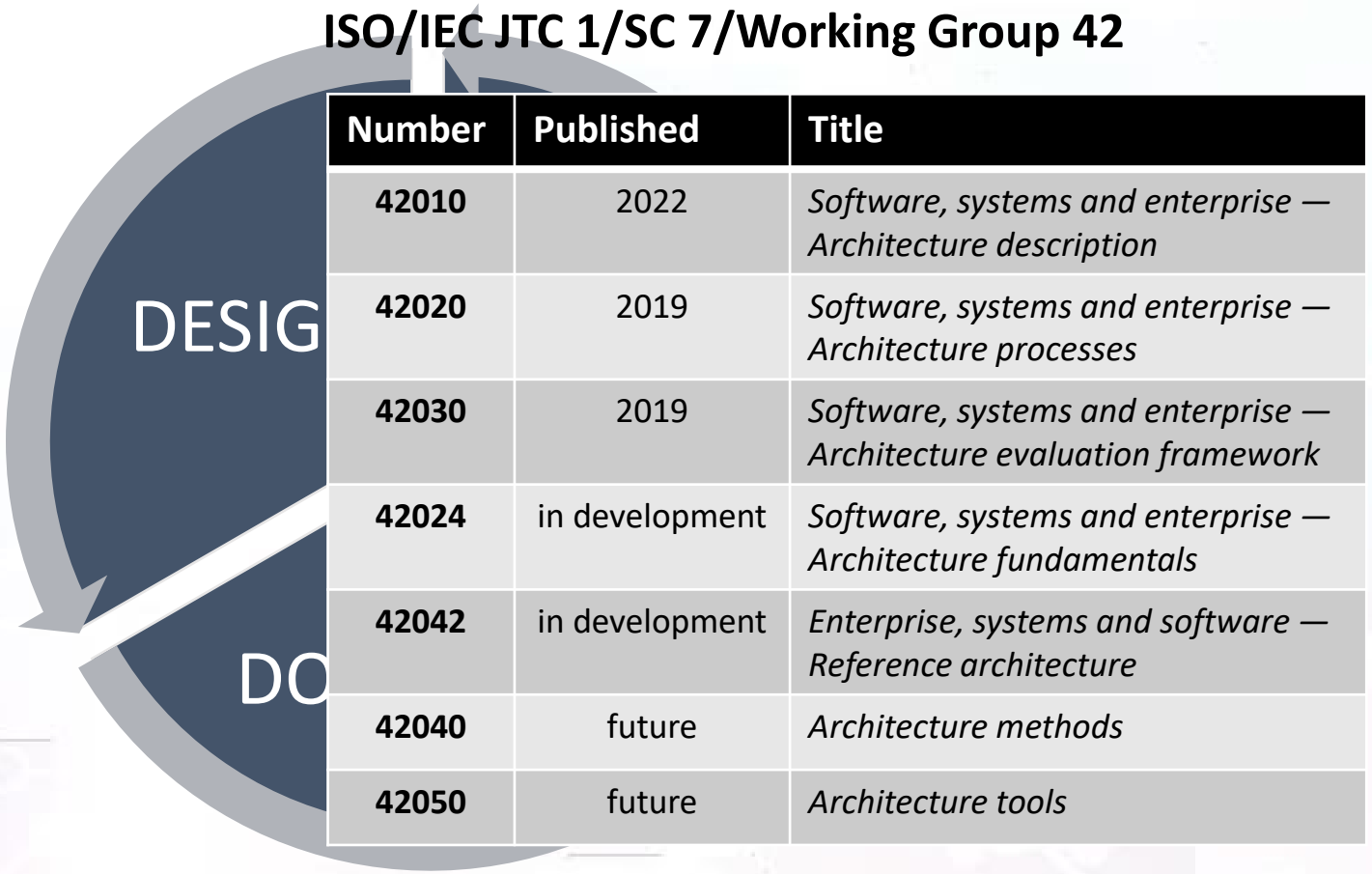
Important: different 'architecture domains' have synergies across their enablers, including:

- Design / Process
- Documenting / Modeling
- Assessment
- Notation
- Tools
- Standards

…and the list goes on

Please don't be (negatively) biased by a potential resource's name, or its terminology.

An architect's key needs



ISO/IEC JTC 1/SC 7/Working Group 42

Number	Published	Title
42010	2022	*Software, systems and enterprise — Architecture description*
42020	2019	*Software, systems and enterprise — Architecture processes*
42030	2019	*Software, systems and enterprise — Architecture evaluation framework*
42024	in development	*Software, systems and enterprise — Architecture fundamentals*
42042	in development	*Enterprise, systems and software — Reference architecture*
42040	future	*Architecture methods*
42050	future	*Architecture tools*

An architect's key needs: Designing

Resource: "Recognized Methods for Architecture" (The Open Group)

- ~40 approaches across numerous industries have this credential, e.g., …
  - The Open Group Architecture Development Method (ADM)

Resource: Software Engineering Institute

- Attribute-Driven Design (ADD)
  - SEI Series text> *Designing Software Architectures: A Practical Approach*

Resource: Design [Dependency] Structure Matrix (DSM)

- DSM Community
- MIT text> *Design Structure Matrix Methods and Applications*

Resource: Zachman Framework for Enterprise Architecture

- *Interrogatives* meet *Reification*; an ontology to structure your thinking
  - Articles by John Zachman @ zachman-feac.com
  - More articles by John Zachman @brcommunity.com

An architect's key needs: Documenting

Resource: US Department of Defense Architecture Framework (DoDAF)

- 52 architecture models organized under 8 architecture viewpoints
- DoDAF was the foundation for many other architecture description frameworks
  - UK Ministry of Architecture Framework (MODAF; now retired), NATO Architecture Framework (NAF), Australian Defence Architecture Framework (AUSDAF), Department of National Defence and Canadian Forces Architecture Framework (DNDAF)
  - Object Management Group's Unified Architecture Framework (UAF)

Resource: Unified Architecture Framework (UAF)

- Consolidation of 'core elements' of various Defense/Defence-centric frameworks
- UAF fact sheet

Resource: The Open Group Architecture Framework

- Architecture Content: Chapter 2: TOGAF Content Framework and Enterprise Metamodel

An architect's key needs: Assessing

Resource: Software Engineering Institute

- Architecture Tradeoff Analysis Method (ATAM®)
- Various technical reports posted in the SEI Digital Library

Resource: The Open Group Architecture Framework

- Chapter 6: Architecture Compliance
  - Section 6.4: Compliance Review Process
  - Section 6.5: Compliance Review Checklists
    - Hardware, O/S, Services, Middleware, Applications, Security, System Management, Systems Engineering, SE Methods & Tools

On Standards: a few suggestions…

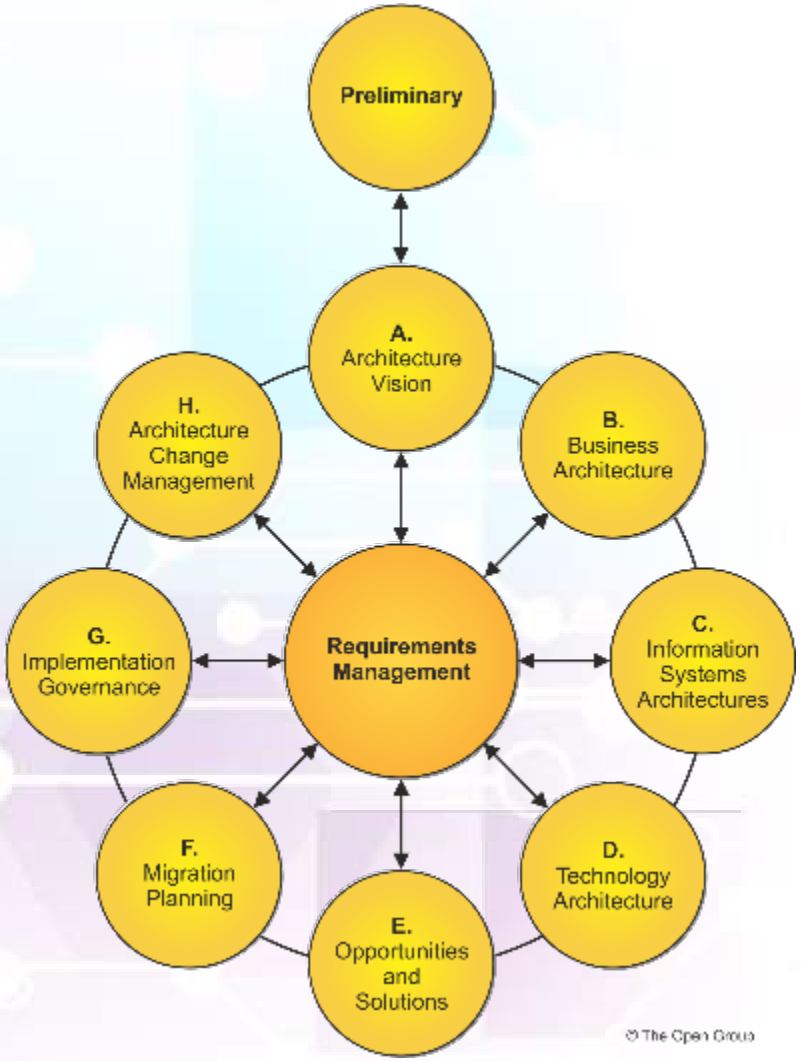
There are many architecture-related standards & established techniques which can be leveraged.

The upcoming slides touch on a few of these.

TOGAF®

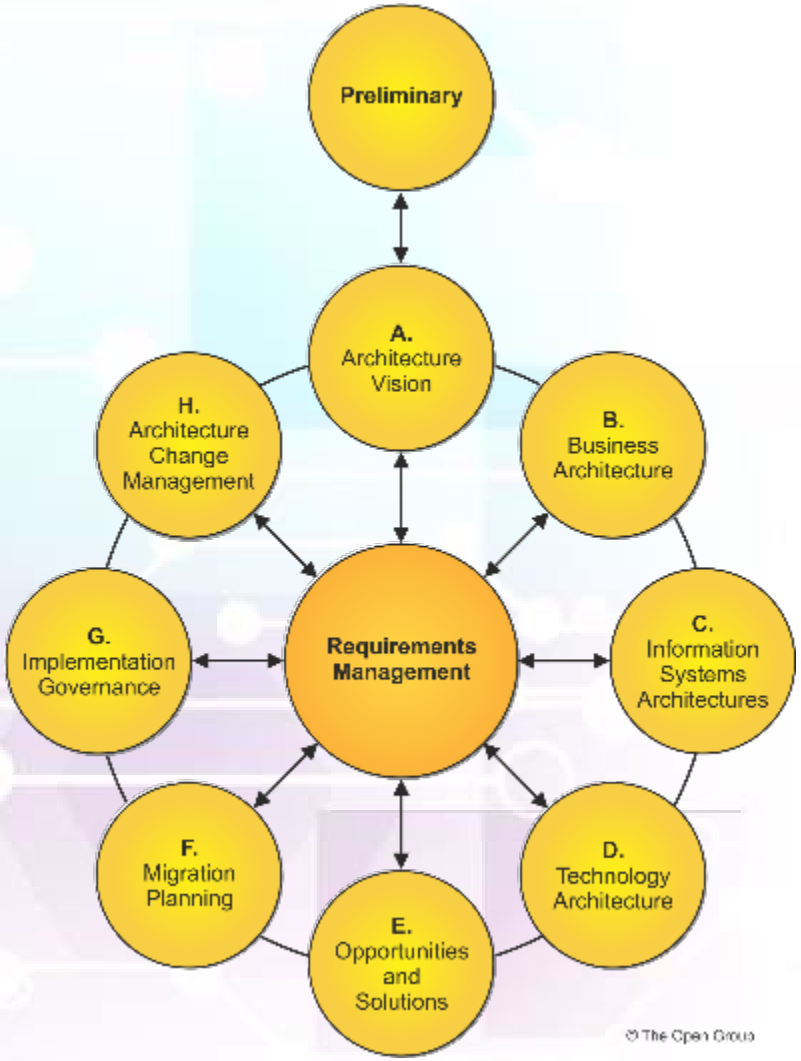
ZACHMAN INTERNATIONAL®
ENTERPRISE ARCHITECTURE

A glimpse at: TOGAF (history & structure)



- Originally developed as the US Department of Defense *Technical Architecture Framework for Information Management*
- Transitioned to The Open Group in 1995
- Includes the *Architecture Development Method*, a methodology organized in a series of phases (graphic on left) and documented in two major areas:
  1) *Fundamental Content*
  2) *TOGAF Series Guides*, detailed guidance on how to use the TOGAF framework

A glimpse at: TOGAF (references)



- **TOGAF home page:**
  https://www.opengroup.org/togaf
- **TOGAF 10 digital edition:**
  https://www.opengroup.org/togaf/10thedition
- **TOGAF 10 fundamental content:**
  https://pubs.opengroup.org/togaf-standard/introduction/index.html
- **TOGAF library:**
  https://publications.opengroup.org/togaf-library

IMPORTANT NOTE:
If you wish to use the TOGAF Standard for commercial purposes, then your organization must have a current TOGAF Standard Annual Commercial License. This applies to both members and non-members of The Open Group Architecture Forum.

Ref: https://www.opengroup.org/togaf-standard-10th-edition-commercial-license

A glimpse at: DoDAF (history)

CAF 2.0/ DoDAF 1.0

4 Views

- All (AVs)
- Operational (OVs)
- Systems (SVs)
- Technical Standards (TVs)

26 Products

DoDAF 1.5

4 Views

- All (AVs)
- Operational (OVs)
- Systems (SVs)
- Technical Standards (TVs)

29 Products

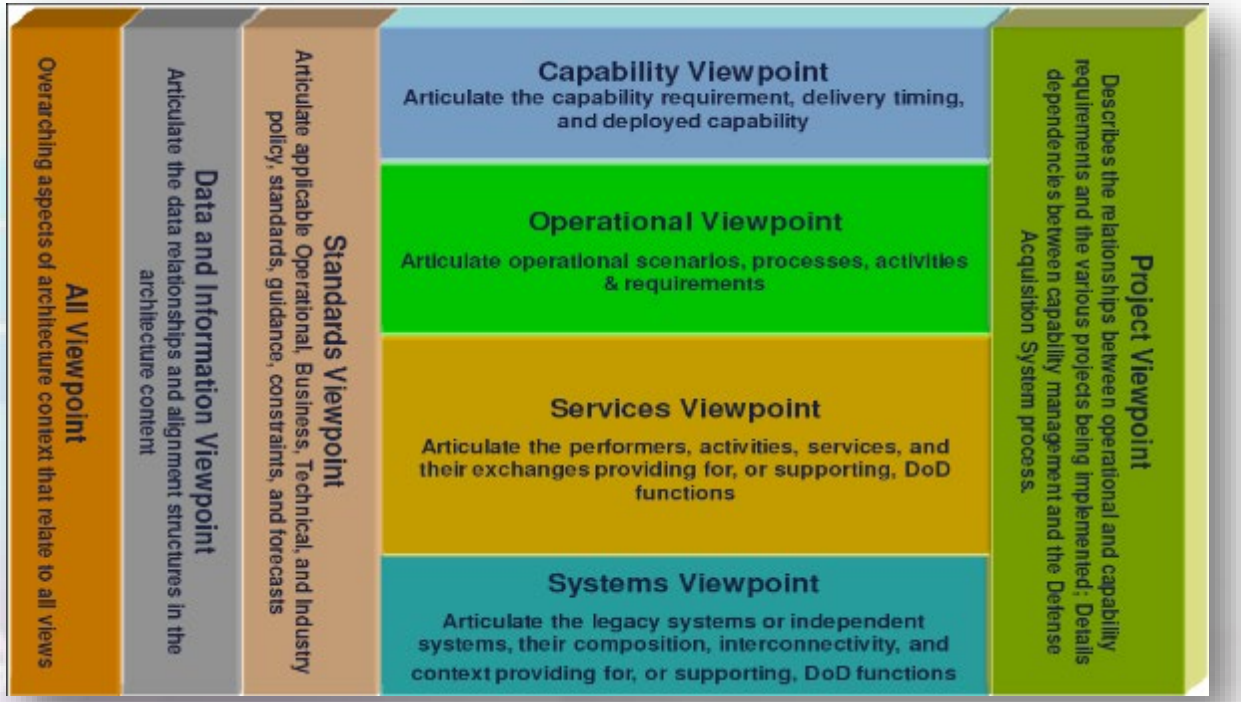
DoDAF 2.02

8 Viewpoints

- All (AVs)
- Capability (CVs)
- Data & Information (DIVs)
- Operational (OVs)
- Project (PVs)
- Service (SvcVs)
- Standards (StdVs)
- Systems (SVs)

52 Products

A glimpse at: DoDAF (structure)



- **Important note:** Don't be distracted (misled) by the 'DoD' acronym in its name
- Originally developed as the C4ISR Architecture Framework (CAF) in 1996
- A series of architecture description models collected into various viewpoints
- Includes a metamodel to convey the models' constructs/underpinnings
- Does >not< include guidance on how to develop each model

A glimpse at: DoDAF (the models)

Viewpoint	Framework Model	Framework Model Name	General Description
All	AV-1	Overview and Summary Information	Describes a Project's Visions, Goals, Objectives, Plans, Activities, Events, Conditions, Measures, Effects (Outcomes), and produced objects.
All	AV-2	Integrated Dictionary	An architectural data repository with definitions of all terms used throughout the architectural data and presentations.
Capability	CV-1	Vision	The overall vision for transformational endeavors, which provides a strategic context for the capabilities described and a high-level scope.
Capability	CV-2	Capability Taxonomy	A hierarchy of capabilities which specifies all the capabilities that are referenced throughout one or more Architectural Descriptions.
Capability	CV-3	Capability Phasing	The planned achievement of capability at different points in time or during specific periods of time. The CV-3 shows the capability phasing in terms of the activities, conditions, desired effects, rules complied with, resource consumption and production, and measures, without regard to the performer and location solutions.
Capability	CV-4	Capability Dependencies	The dependencies between planned capabilities and the definition of logical groupings of capabilities.
Capability	CV-5	Capability to Organizational Development Mapping	The fulfillment of capability requirements shows the planned capability deployment and interconnection for a particular capability phase. The CV-5 shows the planned solution for the phase in terms of performers and locations and their associated concepts.
Capability	CV-6	Capability to Operational Activities Mapping	A mapping between the capabilities required and the operational activities that those capabilities support.
Capability	CV-7	Capability to Services Mapping	A mapping between the capabilities and the services that these capabilities enable.
Data and Information	DIV-1	Conceptual Data Model	The required high level data concepts and their relationships.
Data and Information	DIV-2	Logical Data Model	The documentation of the data requirements and structural business process (activity) rules.
Data and Information	DIV-3	Physical Data Model	The physical implementation format of the Logical Data Model entities, e.g., message formats, file structures, physical schema.

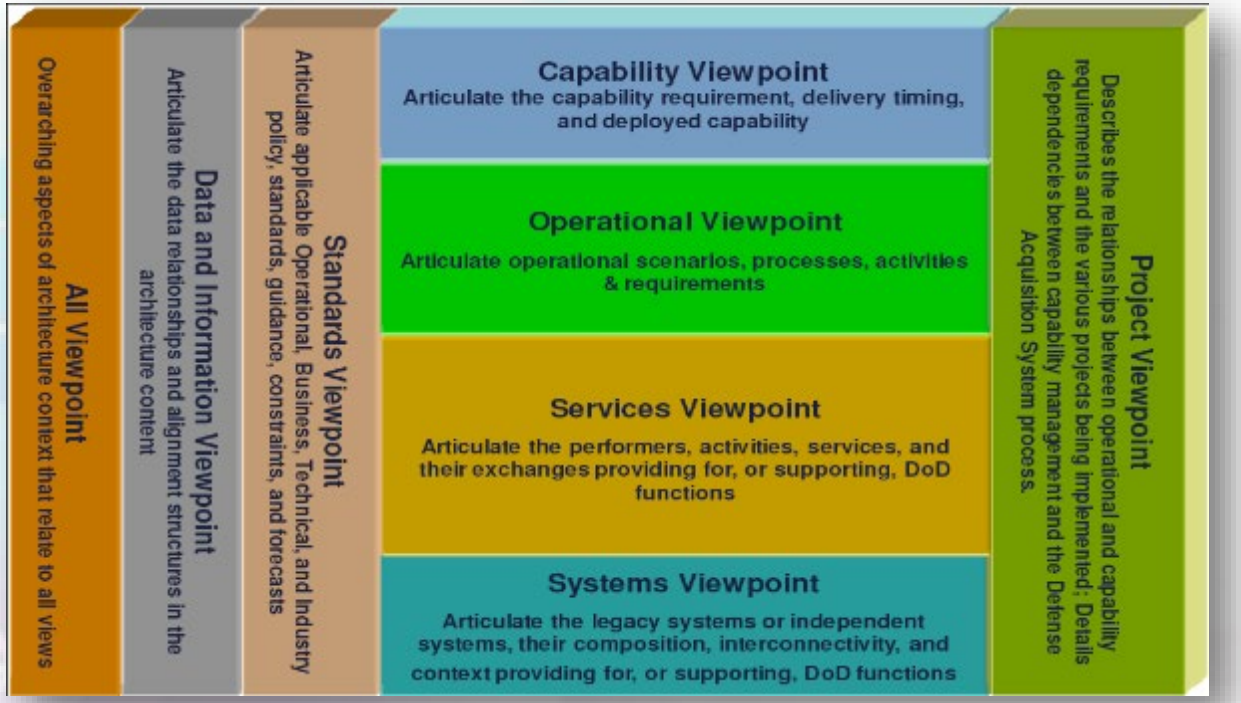
Operational	OV-1	High Level Operational Concept Graphic	The high-level graphical/textual description of the operational concept.
Operational	OV-2	Operational Resource Flow Description	A description of the resource flows exchanged between operational activities.
Operational	OV-3	Operational Resource Flow Matrix	A description of the resources exchanged and the relevant attributes of the exchanges.
Operational	OV-4	Organizational Relationships Chart	The organizational context, role or other relationships among organizations.
Operational	OV-5a	Operational Activity Decomposition Tree	The capabilities and activities (operational activities) organized in an hierarchal structure.
Operational	OV-5b	Operational Activity Model	The context of capabilities and activities (operational activities) and their relationships among activities, inputs, & outputs; additional data can show cost, performers or other pertinent information.
Operational	OV-6a	Operational Rules Model	One of three models used to describe activity (operational activity). It identifies business rules that constrain operations.
Operational	OV-6b	State Transition Description	One of three models used to describe operational activity (activity). It identifies business process (activity) responses to events (usually, very short activities).
Operational	OV-6c	Event-Trace Description	One of three models used to describe operational activity (activity). It traces actions in a scenario or sequence of events.
Project	PV-1	Project Portfolio Relationships	Describes the dependency relationships between organizations and projects and the organizational structures needed to manage a portfolio of projects.
Project	PV-2	Project Timelines	A timeline perspective on programs or projects, with the key milestones and interdependencies.
Project	PV-3	Project to Capability Mapping	A mapping of programs and projects to capabilities to show how the specific projects and program elements help to achieve a capability.
Standards	StdV-1	Standards Profile	The listing of standards that apply to solution elements.
Standards	StdV-2	Standards Forecast	The description of emerging standards and potential impact on current solution elements, within a set of time frames.

A glimpse at: DoDAF (the models)

Systems	SV-1	Systems Interface Description	The identification of *systems*, system items, and their interconnections.
Systems	SV-2	Systems Resource Flow Description	A description of resource flows exchanged between *systems*.
Systems	SV-3	Systems-Systems Matrix	The relationships among *systems* in a given Architectural Description. It can be designed to show relationships of interest, (e.g., *system*-type interfaces, planned *vs.* existing interfaces).
Systems	SV-4	Systems Functionality Description	The functions (activities) performed by *systems* and the system data flows among system functions (activities).
Systems	SV-5a	Operational Activity to Systems Function Traceability Matrix	A mapping of system functions (activities) back to operational activities (activities).
Systems	SV-5b	Operational Activity to Systems Traceability Matrix	A mapping of systems back to capabilities or operational activities (activities).
Systems	SV-6	Systems Resource Flow Matrix	Provides details of system resource flow elements being exchanged between systems and the attributes of that exchange.
Systems	SV-7	Systems Measures Matrix	The measures (metrics) of Systems Model elements for the appropriate timeframe(s).
Systems	SV-8	Systems Evolution Description	The planned incremental steps toward migrating a suite of systems to a more efficient suite, or toward evolving a current system to a future implementation.
Systems	SV-9	Systems Technology & Skills Forecast	The emerging technologies, software/hardware products, and skills that are expected to be available in a given set of time frames and that will affect future system development.
Systems	SV-10a	Systems Rules Model	One of three models used to describe system functionality. It identifies constraints that are imposed on systems functionality due to some aspect of system design or implementation.
Systems	SV-10b	Systems State Transition Description	One of three models used to describe system functionality. It identifies responses of systems to events.
Systems	SV-10c	Systems Event-Trace Description	One of three models used to describe system functionality. It identifies *system*-specific refinements of critical sequences of events described in the Operational Viewpoint.

Viewpoint	Framework Model	Framework Model Name	General Description
Services	SvcV-1	Services Context Description	The identification of services, service items, and their interconnections.
Services	SvcV-2	Services Resource Flow Description	A description of resource flows exchanged between services.
Services	SvcV-3a	Systems-Services Matrix	The relationships among or between systems and services in a given Architectural Description.
Services	SvcV-3b	Services-Services Matrix	The relationships among services in a given Architectural Description. It can be designed to show relationships of interest, (e.g., service-type interfaces, planned *vs.* existing interfaces).
Services	SvcV-4	Services Functionality Description	The functions performed by services and the service data flows among service functions (activities)
Services	SvcV-5	Operational Activity to Services Traceability Matrix	A mapping of services (activities) back to operational activities (activities).
Services	SvcV-6	Services Resource Flow Matrix	It provides details of service resource flow elements being exchanged between services and the attributes of that exchange.
Services	SvcV-7	Services Measures Matrix	The measures (metrics) of Services Model elements for the appropriate time frame(s).
Services	SvcV-8	Services Evolution Description	The planned incremental steps toward migrating a suite of services to a more efficient suite or toward evolving current services to a future implementation.
Services	SvcV-9	Services Technology & Skills Forecast	The emerging technologies, software/hardware products, and skills that are expected to be available in a given set of time frames and that will affect future service development.
Services	SvcV-10a	Services Rules Model	One of three models used to describe service functionality. It identifies constraints that are imposed on systems functionality due to some aspect of system design or implementation.
Services	SvcV-10b	Services State Transition Description	One of three models used to describe service functionality. It identifies responses of services to events.
Services	SvcV-10c	Services Event-Trace Description	One of three models used to describe service functionality. It identifies service-specific refinements of critical sequences of events described in the Operational Viewpoint.

A glimpse at: DoDAF (references)

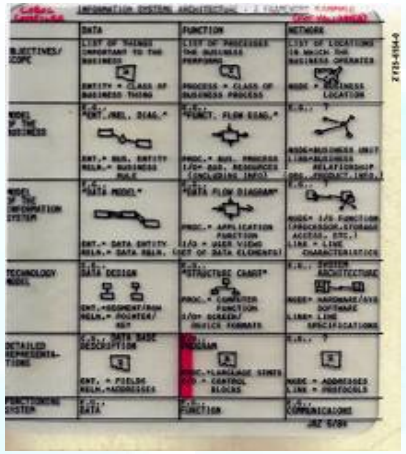


- **DoDAF home page:** https://dodcio.defense.gov/library/dod-architecture-framework
- **Viewpoints & Models:** https://dodcio.defense.gov/Library/DoD-Architecture-Framework/dodaf20_viewpoints
- **Archives of PDF versions:** https://dodcio.defense.gov/Library/DoD-Architecture-Framework/dodaf20_archives

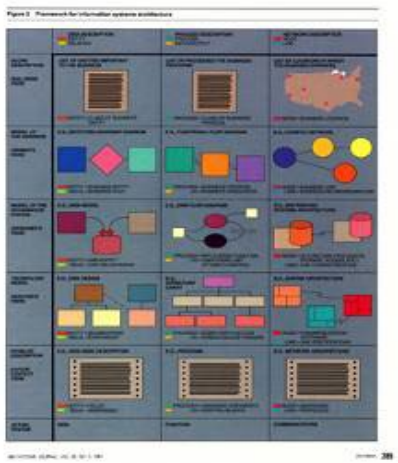
FYI: UAF is a superset of DoDAF, et. al. See OMG's fact sheet at https://www.omg.org/intro/UAF.pdf.

A glimpse at: Zachman Framework (history)

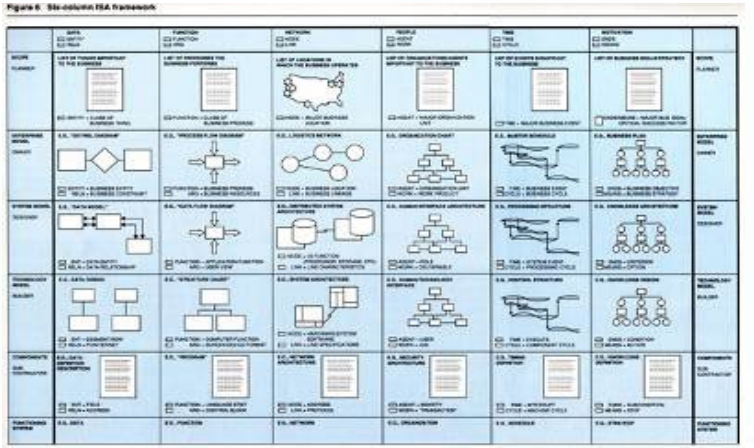
1984



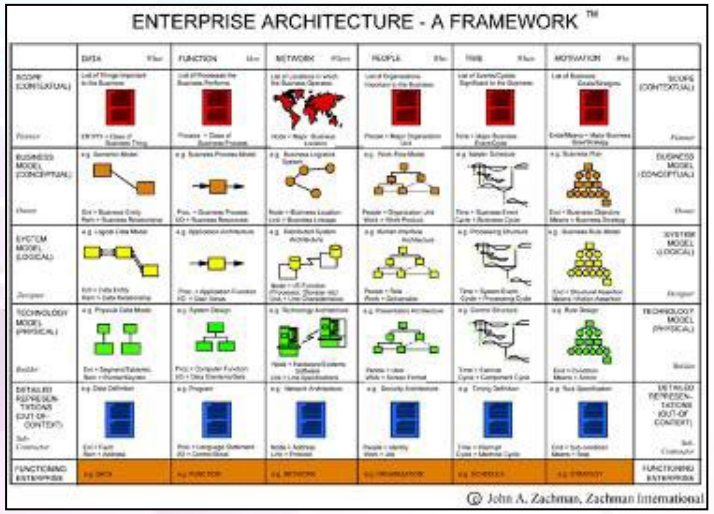
1987



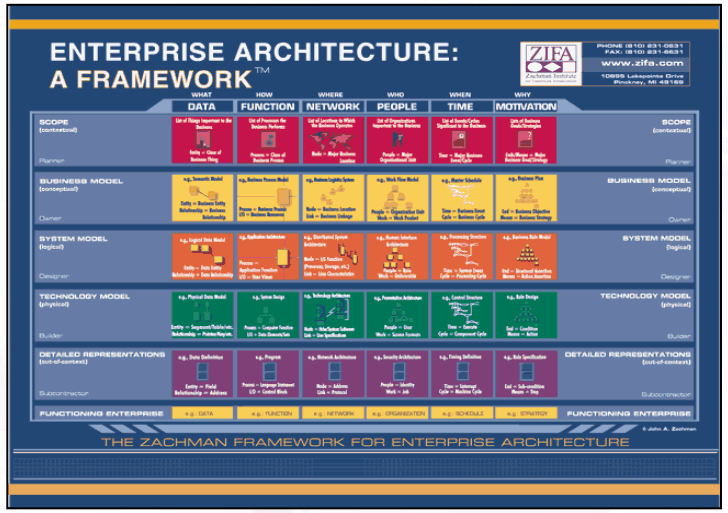
1992



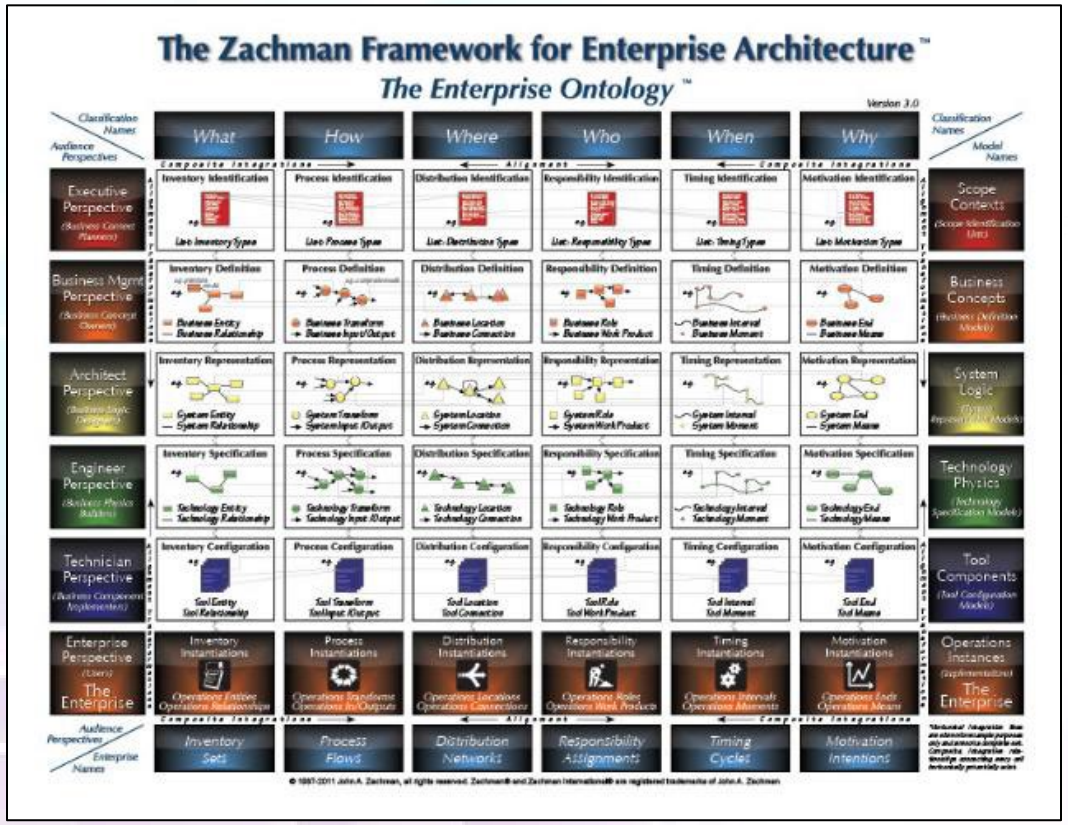
2001



2003

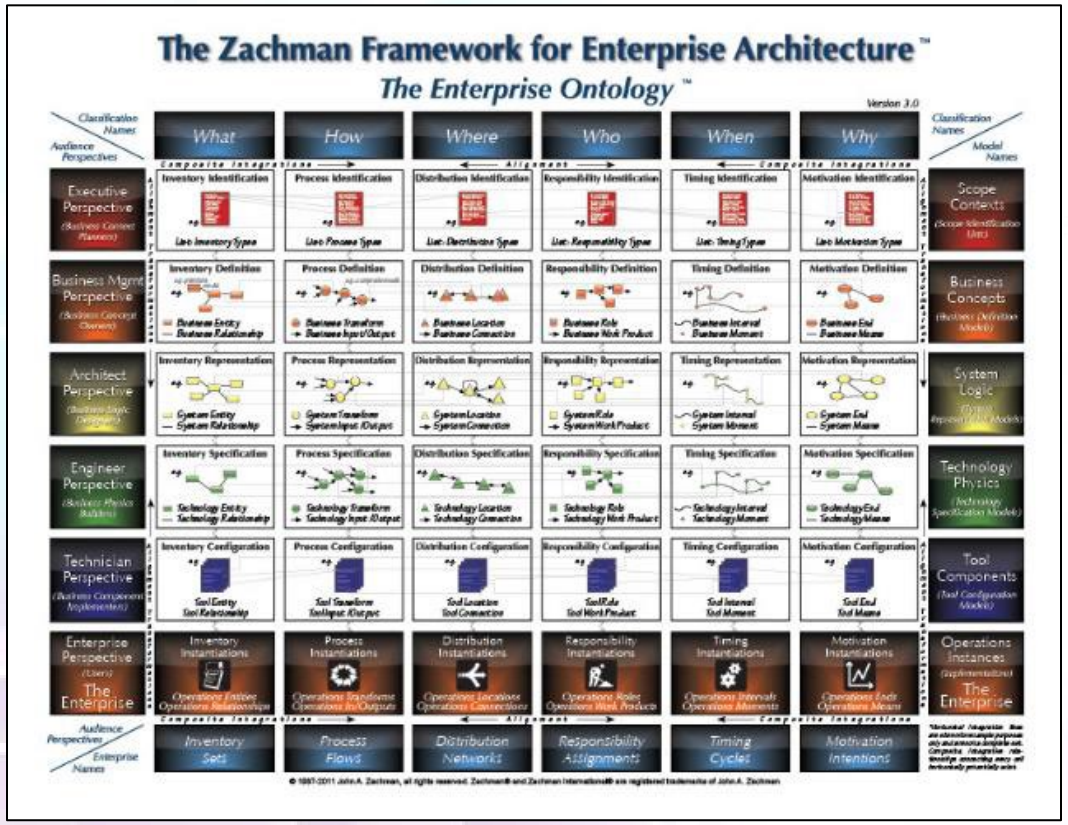


A glimpse at: Zachman Framework (structure)



- First published by John A. Zachman in the IBM Systems Journal, 1987
- A generic schema to describe any complex entity (airplane, skyscraper, information system, …)
- Categorization of ‘architecture primitives’ through the intersection of interrogatives (columns) and perspectives (rows)
  - Interrogatives are not presented in a specific sequence
  - Reification phases, top-down, spanning the different stakeholders / perspectives
- No prescribed models or methodology

A glimpse at: Zachman Framework (the rules)

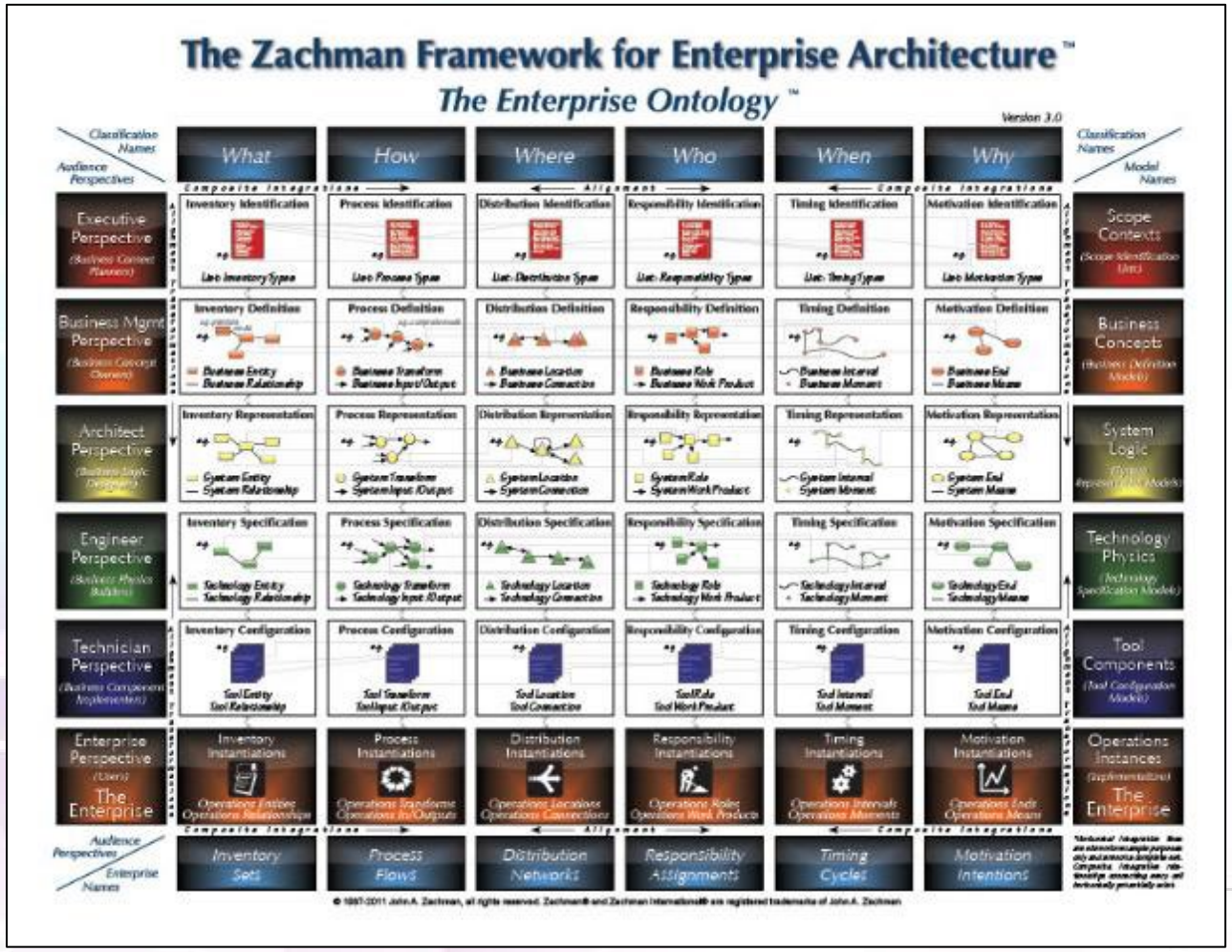


Framework Rules*

- The columns have no order.
- Each column has a simple, basic model.
- The basic model of each column must be unique.
- Each row represents a distinct, unique perspective.
- Each cell is unique.
- The composite or integration of all cell models in one row constitutes a complete model from the perspective of that row.
- The logic is recursive.

*John Zachman, J.F. Sowa; *Extending and Formalizing the Framework for Information Systems Architecture*, IBM Systems Journal, Vol. 31, No. 3 (1992); IBM Publication G321-5488

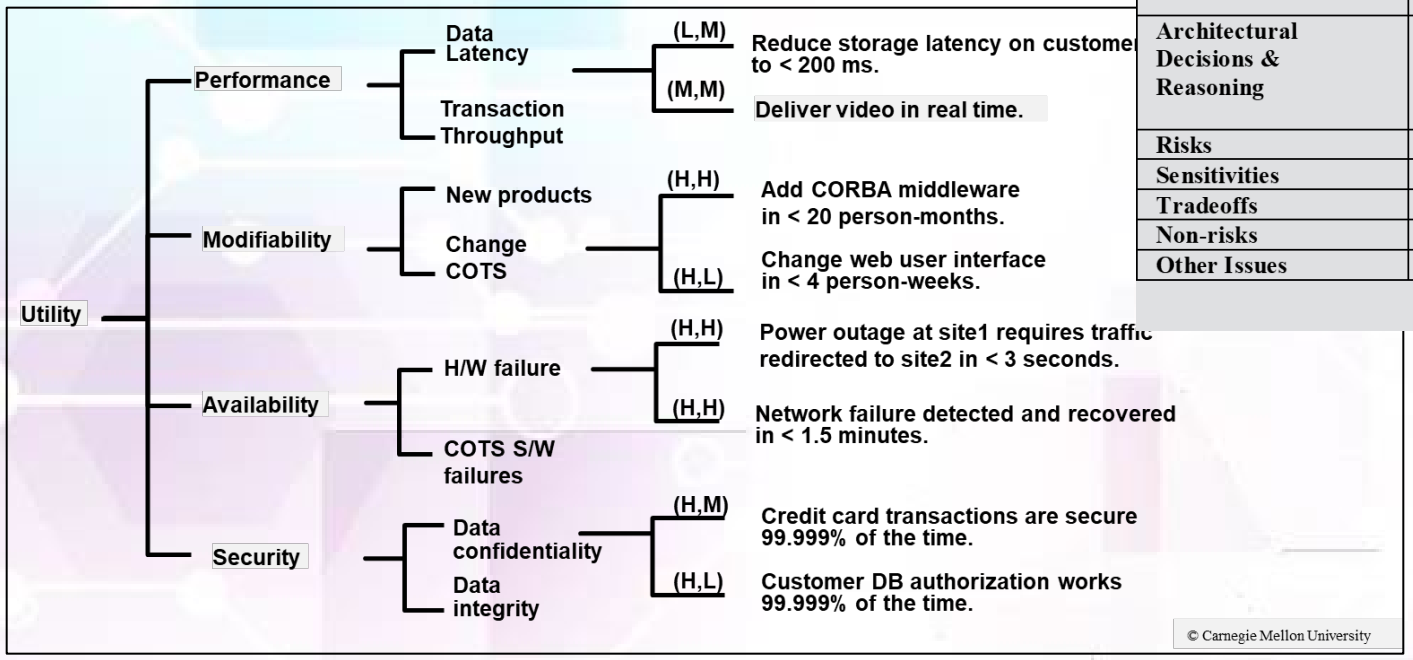
A glimpse at: Zachman Framework (references)



- **Zachman home page:** https://zachman-feac.com
- **Zachman articles:** https://zachman-feac.com/resources/ea-articles-reference
- **Zachman video library:** https://zachman-feac.com/index.php?option=com_spsimpleportfolio&view=items&Itemid=997

A glimpse at: ATAM (history, constructs)

- Developed 1997-2000 by Software Engineering Institute at Carnegie-Mellon University
- *Evaluating Software Architectures* [Clements, et. al.] published by Pearson Education, 2001



Scenario	Cut and paste scenario here. In Phase 1, scenarios will be cut-and-pasted from Utility Tree template. In Phase 2, scenarios will be cut-and-pasted from the Phase 2 Scenario template.	
Business Goal(s)	List those business goals that this scenario affects.	
Attribute	Applicable in Phase 1, cut-and-paste from Utility Tree template.	
Attribute Concern	Applicable in Phase 1, cut-and-paste from Utility Tree template.	
Scenario Refinement	**Stimulus**	Condition affecting the system/artifact
	Stimulus Source	Entity generating stimulus
	Environment	Conditions under which stimulus occurred
	Artifact	Part of system stimulated (can be whole system)
	Response	Activity undertaken after arrival of stimulus
	Response Measure	Testable measure of the activity taken after the arrival of the stimulus
Architectural Decisions & Reasoning	List the architectural decisions relevant to this scenario that affect quality attribute response and a discussion of the qualitative and/or quantitative rationale for why the architectural decisions contribute to meeting the quality attribute response requirement.	
Risks	List any risks discovered	
Sensitivities	List any sensitivities discovered	
Tradeoffs	List any tradeoffs discovered	
Non-risks	List any non-risks discovered	
Other Issues	List any issues discovered	

A glimpse at: ATAM (approach)

Presentation

1. Present the ATAM®
2. Present business drivers
3. Present architecture

Investigation / Analysis

4. Identify architectural approaches
5. Generate quality attribute tree
6. Analyze architectural approaches

Testing

7. Brainstorm and prioritize scenarios
8. Analyze architectural approaches

Reporting

9. Present results

First-glance reading suggestions

- **The Open Group Architecture Framework**
  - Digital edition: Getting Started
- **Department of Defense Architecture Framework**
  - Table of the 52 models: DoDAF Version 2, Table 3.4.2.9-1 (p39)
  - Background: Introduction and What's New
  - Viewpoints and Models
- **Zachman Framework for Enterprise Architecture**
  - Overview: A Concise Definition of the Zachman Framework
  - First article (1987): A Framework for Information Systems Architecture
  - Second article (1992): Extending and Formalizing the Framework for Information Systems Architecture

And let's not forget 'governance'

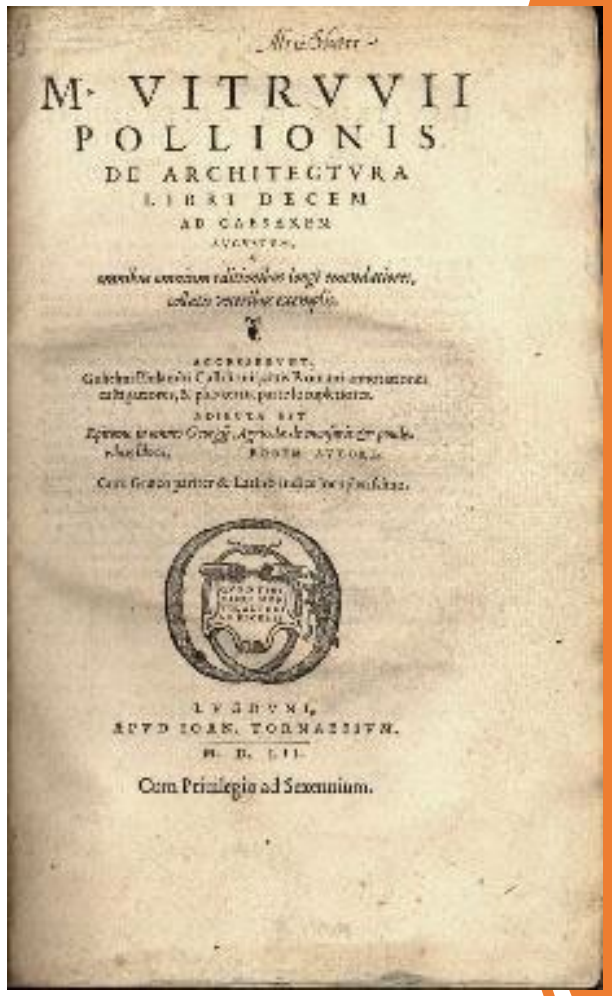
- Architecture decisions
- Project/program/org
- Implementation
- Architecture changes
- Companywide architecture enablers

GOVERNANCE

Part 3: Ecosystem

An Introduction to Architecture(s)

Role & skills


M· VITRVVII
POLLIONIS
DE ARCHITECTVRA
LIBRI DECEM
AD CÆSAREM
AVGVSTVM.
ACCESSERVNT,
ADIECTA SVNT
LVGDVNI,
APVD IOAN. TORNÆSIVM.
Cum Priuilegio ad Sexennium.

The ideal architect should be…

- a person of letters,
- a skillful draftsman,
- a mathematician,
- familiar with historical studies,
- a diligent student of philosophy,
- acquainted with music,
- not ignorant of medicine,
- learned in the responses of jurisconsults,
- familiar with astronomy and astronomical calculations.

– Vitruvius, De Architectura (~25 BC)

Role & skills

Competencies

- **(software) Software Engineering Institute**
  - Videos on the role of software architects:
    - *What Makes a Good Software Architect?*
    - *Becoming a Better Software Architect*
    - *Where Software Architects Make a Difference*
    - *…and more*
- **(software) Dana Bredemeyer**
  - *Architect Competency Framework*
- **(systems) Gerrit Muller**
  - *The Role and Task of the System Architect*
- **(enterprise) The Open Group**
  - Architecture Skills Framework

Professional organizations & consortia*

- **INCOSE**
  - Architecture Working Group
- **Object Management Group**
  - C4I Domain Task Force (regarding UAF)
- **The Open Group**
  - Architecture Forum, ArchiMate Forum, Service-Oriented Architecture Work Group
  - Future Airborne Capability Environment (FACE) Consortium
  - Sensor Open Systems Architecture (SOSA) Consortium
- **Association of Enterprise Architects**
  - Global community; regional Chapters, Journal of Enterprise Architecture; work groups and special interest groups
- **National Defense Industrial Association (NDIA)**
  - Architecture Committee under their Systems Engineering Division

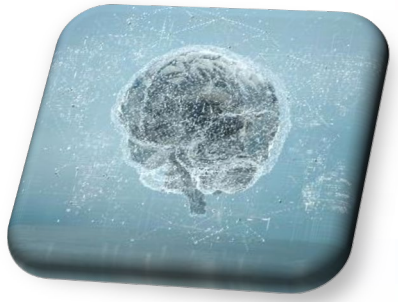
*Not comprehensive

Certifications: affirming your credentials

Some Considerations

- Open Certified Architect
- The Open Group Architecture Framework (TOGAF)
- Certified Professional for Software Architecture (CPSA)
- IASA Certified IT Architect
- FEAC Institute: Certified Enterprise Architect
- Zachman Certified Enterprise Architect
- Certified SAFe® Architect

Now about AI…



- **Some Opportunities**
  - Autogenerated, pedigreed architecture baselines
  - Autogenerated reference architectures
  - Reducing time, saving money, improving quality…maybe
- **Some Challenges**
  - Learning datasets are coming from…where?
  - Retraining your workforce to ‘architect with AI’
  - Will there be vendor/tool support in place to address your context and your needs?
- **Or perhaps more practically…**
  - AI-assisted architecting
  - AI-generated ‘slivers’ of architecture enablers

Part 4: Learning More…

An Introduction to Architecture(s)

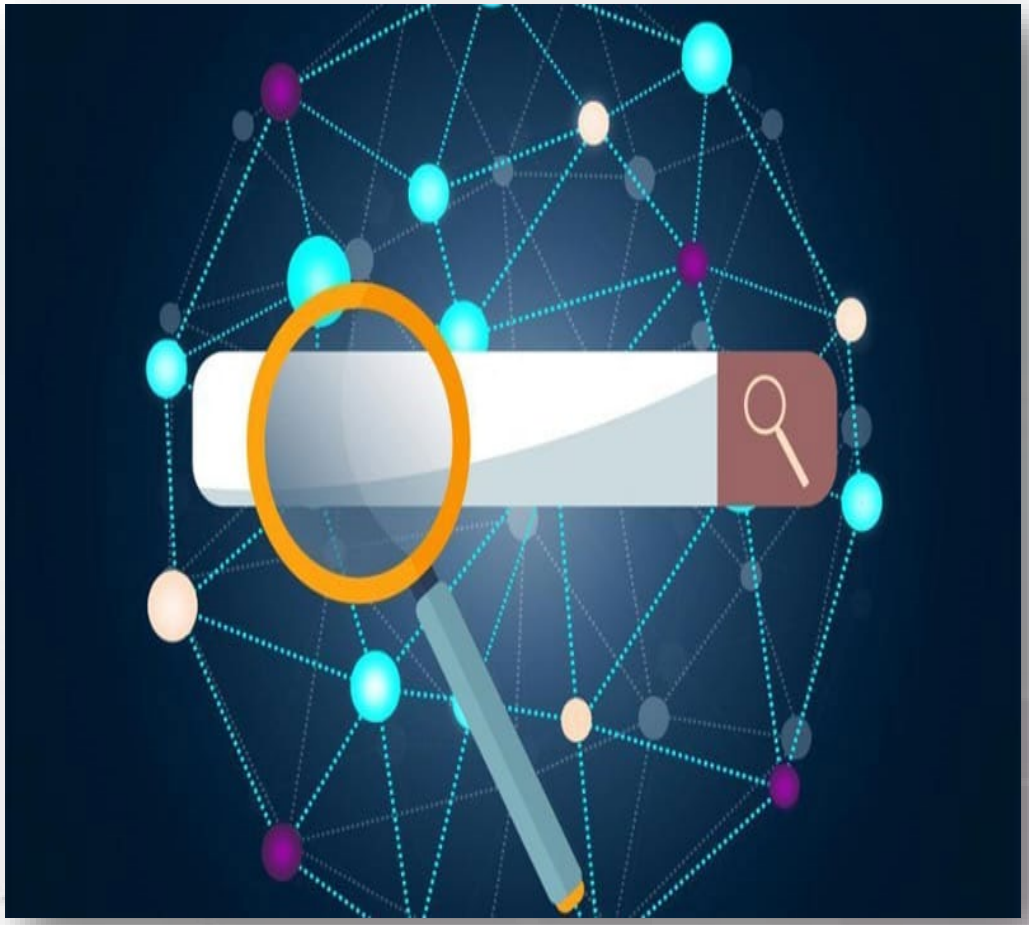
Learning about…'art'

"If you want to be a writer, you must do two things above all others: read a lot and write a lot."

Stephen King
On Writing: A Memoir of the Craft

So where to find ‘architectures’?

- Unfortunately, the answer is not just a Google search away
- Brace yourself for older examples…if you can find examples
- **>Not<** an endorsement, but here are some options:
  - Udemy: Software Architecture Case Studies
  - US Government Publishing Office Federal Digital System: System Architecture
  - India Digital Ecosystem Architecture
  - US Internal Revenue Service Enterprise Architecture
  - US Department of Agriculture: Enterprise Architecture Division (note how ‘thin’ some info can be)



Where to learn more on ‘architecture’?

TEXTS

- **Software Architecture in Practice**
  - 4th edition; 2021; SEI Series in SW Engineering
- **The Art of Systems Architecting**
  - 4th edition; 2025; Maier & Rechtin
- **An Introduction to Holistic Enterprise Architecture**
  - 4th edition; 2020; Dr. Scott Bernard, past Federal Chief Enterprise Architect, Executive Office of the President of the United States

ON-LINE READING

- **SEI Software Architecture Organization**
  - Check out: Quality Attribute Workshops and explore their other offerings
- **Grady Booch**
  - Handbook of Software Architecture: papers
- **System Architecture Forum**
  - Variety of white papers posted for public access
- **The Open Group Library** (enterprise architecture, and more)
  - Many publications are accessible with a free account

LISTENING / WATCHING

- **Software Engineering Institute (SEI) Podcasts**
  - https://www.sei.cmu.edu/publications/podcasts
- **YouTube**
  - Making Architecture Matter (Martin Fowler)
  - Architecting the Unknown (Grady Booch)
  - Business Architecture: A Lego Story (US Army)
  - Benefits of Enterprise Architecture (John Zachman)

PROFESSIONAL CERTIFICATE PROGRAMS

- **Carnegie Mellon:** Software Engineering Institute: Software Architecture Professional Certificate
- **MIT:** Architecture & Systems Engineering Certificate Program
- **University of South Australia:** System Architecting & Integration Professional Certificate
- **Penn State University:** Enterprise Architecture Graduate Certificate

In summary, please remember…

1. **An architect's key needs**
   - Guidance for designing, documenting, evaluating
2. **Some important standards & techniques**
   - ISO/IEC/IEEE WG42 outputs
   - DoDAF, UAF, TOGAF:ADM, Zachman Framework
   - ADD, DSM, QAW
3. **Don't miss an enabler opportunity!**
   - Many of them can support different architecture contexts
4. **Read…and then read some more.**
5. **Get involved.**

Wrap up

Thank you for your time and your interest!

My contact Info:

- rolf.siegers@rtx.com
- Rolf Siegers | LinkedIn

Supplemental Charts

Acronyms

ADD	Attribute-Driven Design
ADM	Architecture Development Method
ASAM	Applied Systems Architecture Method
ATAM	Architecture Tradeoff Analysis Method (from SEI)
AUSDAF	Australian Defence Architecture Framework
C4I(SR)	Command, Control, Communications, Computers, Intelligence, Surveillance, Reconnaissance
CAF	C4ISR Architecture Framework (predecessor to DoDAF)
DNDAF	Department of National Defence and Canadian Forces Architecture Framework
DoDAF	(US) Department of Defense Architecture Framework
DSM	Design [Dependency] Structure Matrix
EA	Enterprise Architecture
FACE	Future Airborne Capability Environment
IBM	International Business Machines
IEC	International Electrotechnical Commission
IEEE	Institute of Electrical and Electronics Engineers
ifSE	Institute for Systems Engineering
ISO	International Organization for Standardization
JTC	Joint Technical Committee
MODAF	Ministry of Defence Architecture Framework (UK)
NAF	NATO Architecture Framework
NATO	North Atlantic Treaty Organizations
O/S	Operating System
QAW	Quality Attribute Workshop
RUP	Rational Unified Process
SC	Subcommittee
SEI	Software Engineering Institute (@ Carnegie Mellon University)
SoS	System of Systems
SOSA	Sensor Open Systems Architecture
SW	Software
Sys	System
TOGAF	The Open Group Architecture Framework
UAF	Unified Architecture Framework
UK	United Kingdom
US	United States
VAP	Visual Architecting Process
WG	Working Group

About the speaker

Rolf Siegers; Technical Fellow; RTX Corporation

Rolf Siegers is a Chair of INCOSE's Architecture Working Group. He leads RTX's Mission Architecture Program and RTX's Technology Networks organization.

The Mission Architecture Program is a group of enterprise-wide initiatives to establish and evolve software, systems, and enterprise architecture expertise across the company. Its scope includes architecture process, training and certification, governance, assessment, reference architectures, and collaboration with government, industry, academia, and standards organizations.

Rolf previously led multi-disciplinary architecture teams for restricted, C5ISR, large-scale, software-intensive programs for U.S. and international customers.

Rolf has been recognized for his career work in systems architecture (NDIA's Lt. General Thomas R. Ferguson Jr. Systems Engineering Award), software architecture (SEI's Linda M. Northrop Software Architecture Award), and enterprise architecture (inducted into FEAC's Enterprise Architecture Hall of Fame).

Rolf attended Auburn University at Montgomery, Auburn University, and Huntingdon College. He holds degrees in Computer Science and Mathematics with Honors. He has professional certificates in systems architecture from MIT and software architecture from Carnegie Mellon University.

Rolf resides in Dallas, Texas with his wife and three children. He is an avid cyclist, finishing in the Top 10 and Top 5 of two Dallas/Fort Worth Craft Brewery Distance Challenges, cycling 5,000 miles in 7 months. Rolf's volunteer activities include NorthPark Presbyterian Day School Board Chair, Dallas Vickery Meadow Food Pantry, and North Dallas Regional Science Fair Judge.