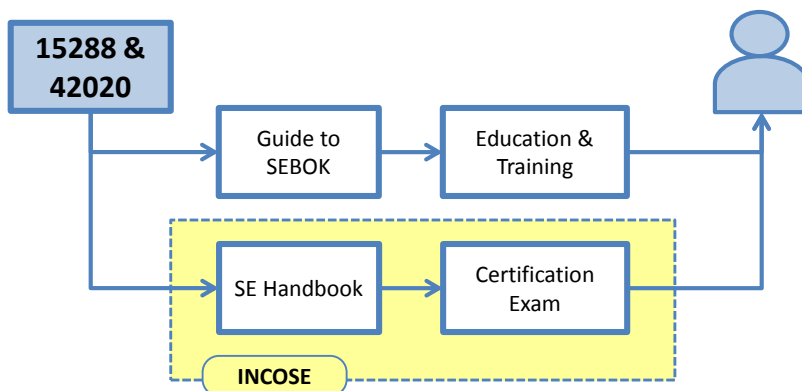# Overview of an Emerging Standard on Architecture Processes – ISO/IEC 42020

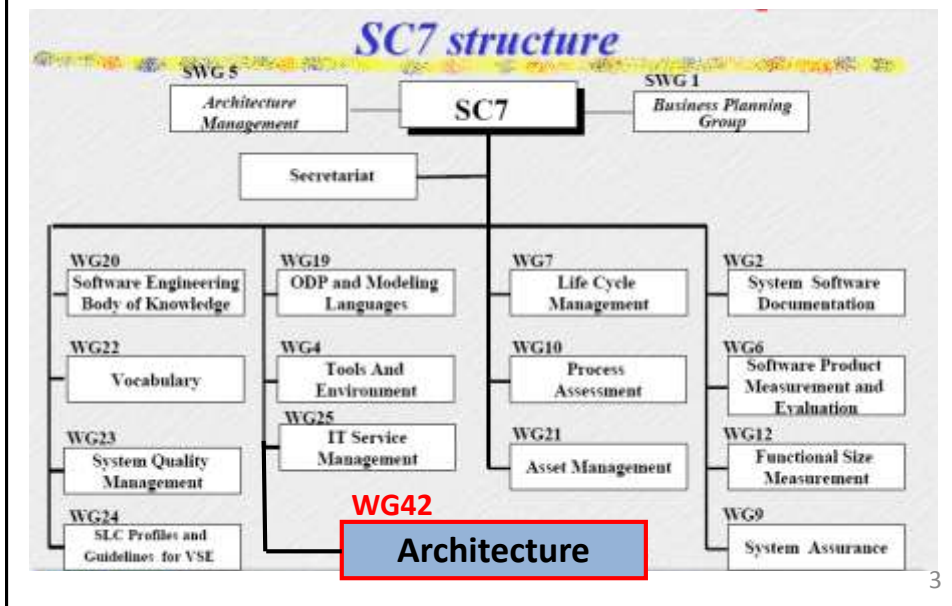James N Martin

The Aerospace Corporation

19 October 2016

Why use ISO standards?

- ISO/IEC 15288 – System Life Cycle Processes (March 2015)
- ISO/IEC 42020 – Architecture Processes (~2017)

Subcommittee for Systems & Software (SC7)

Who is involved in this ISO Standard?
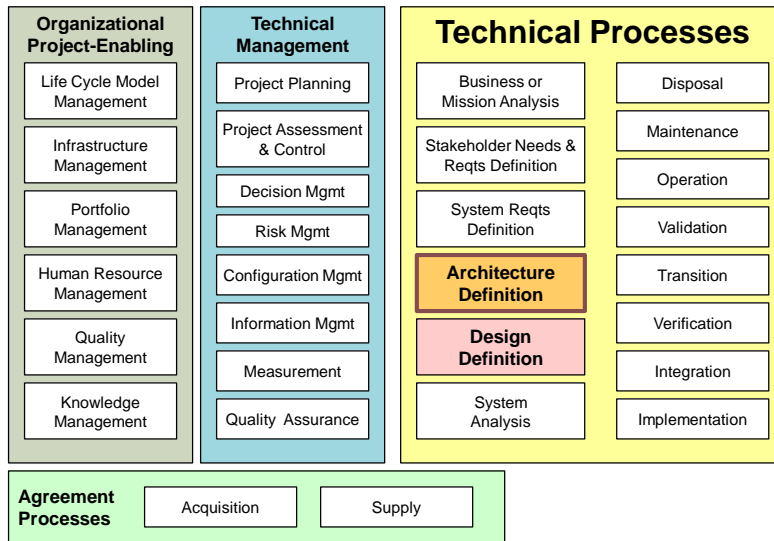*(WG42 Architecture Working Group)*

- National Bodies
  - USA
  - Sweden
  - France
  - UK
  - India
  - Germany
  - Australia
  - Canada
  - Japan
  - … and potentially about 50 other countries

- International Liaisons
  - INCOSE
  - IEEE
  - Software Engineering Institute
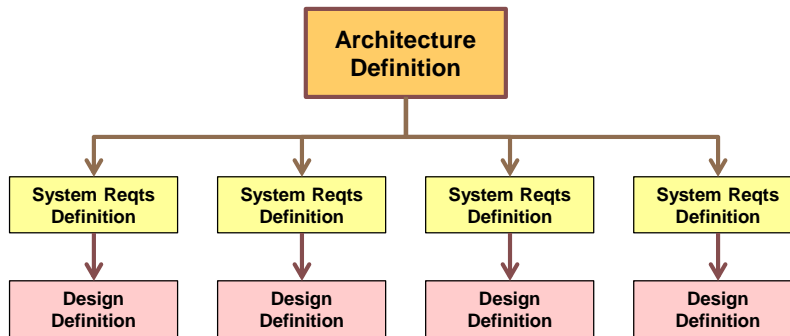 - Object Management Group

I am the INCOSE rep

Architecture Working Group (WG42)

System Life Cycle Processes in 15288 (2015)

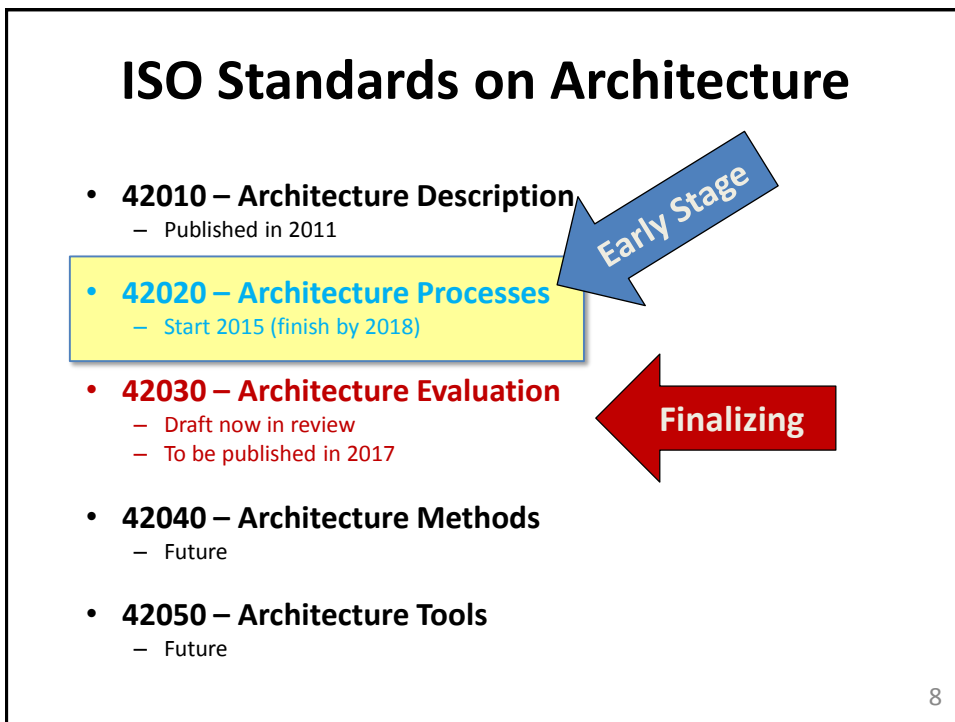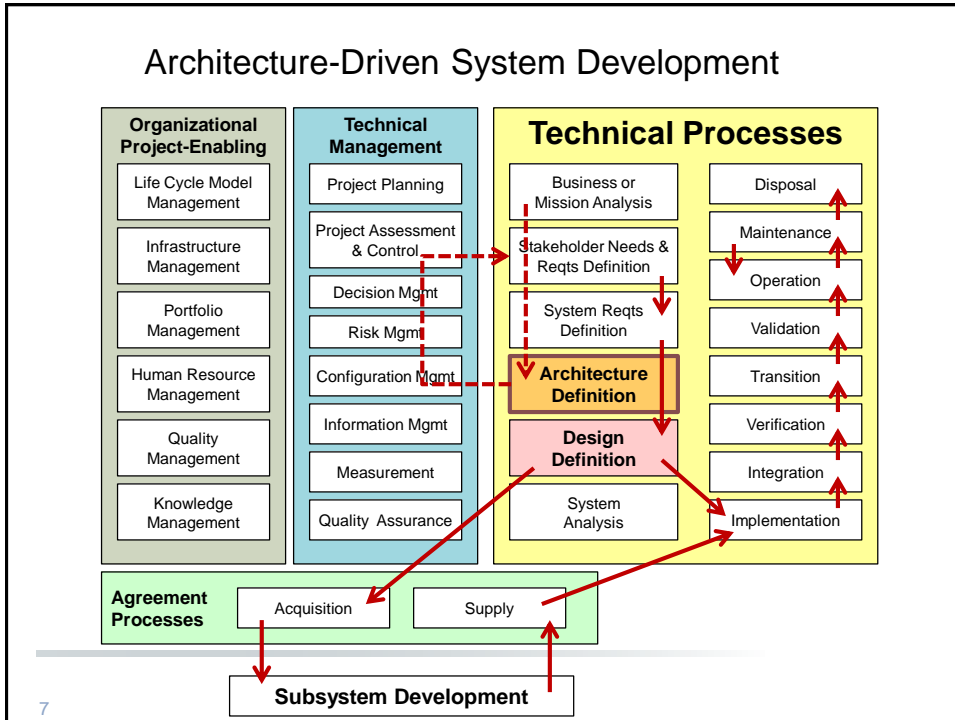| Organizational Project-Enabling	Technical Management	Technical Processes	
Life Cycle Model Management	Project Planning	Business or Mission Analysis	Disposal
Infrastructure Management	Project Assessment & Control	Stakeholder Needs & Reqts Definition	Maintenance
Portfolio Management	Decision Mgmt	System Reqts Definition	Operation
	Risk Mgmt		Validation
Human Resource Management	Configuration Mgmt	Architecture Definition	Transition
Quality Management	Information Mgmt	Design Definition	Verification
	Measurement		Integration
Knowledge Management	Quality Assurance	System Analysis	Implementation

Agreement Processes — Acquisition — Supply

5

Architecture Can Drive Several Different Systems

Architecture Definition

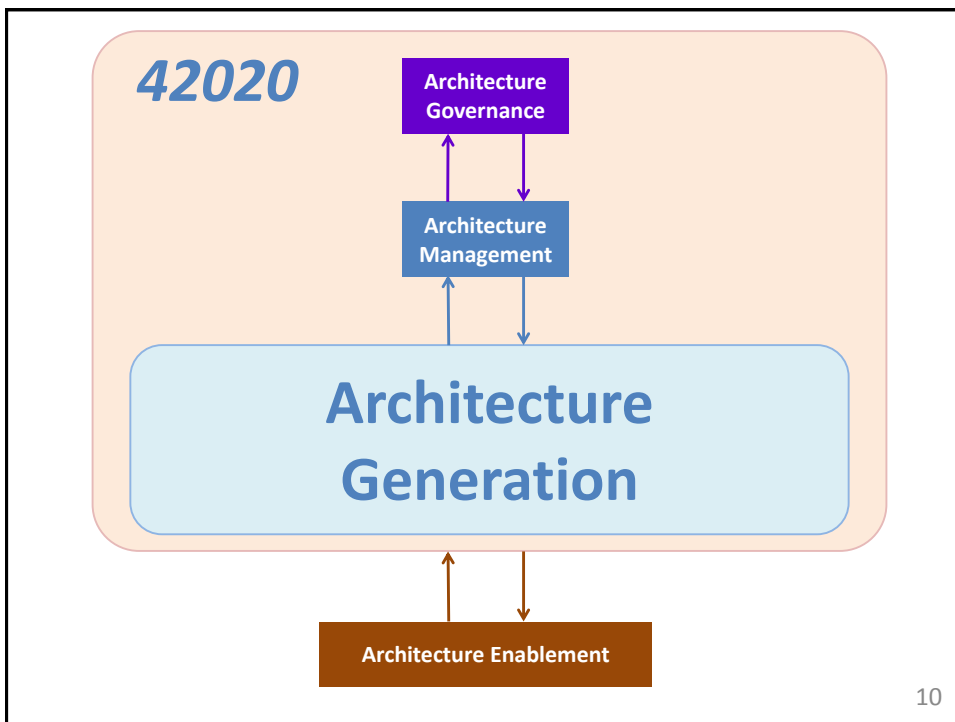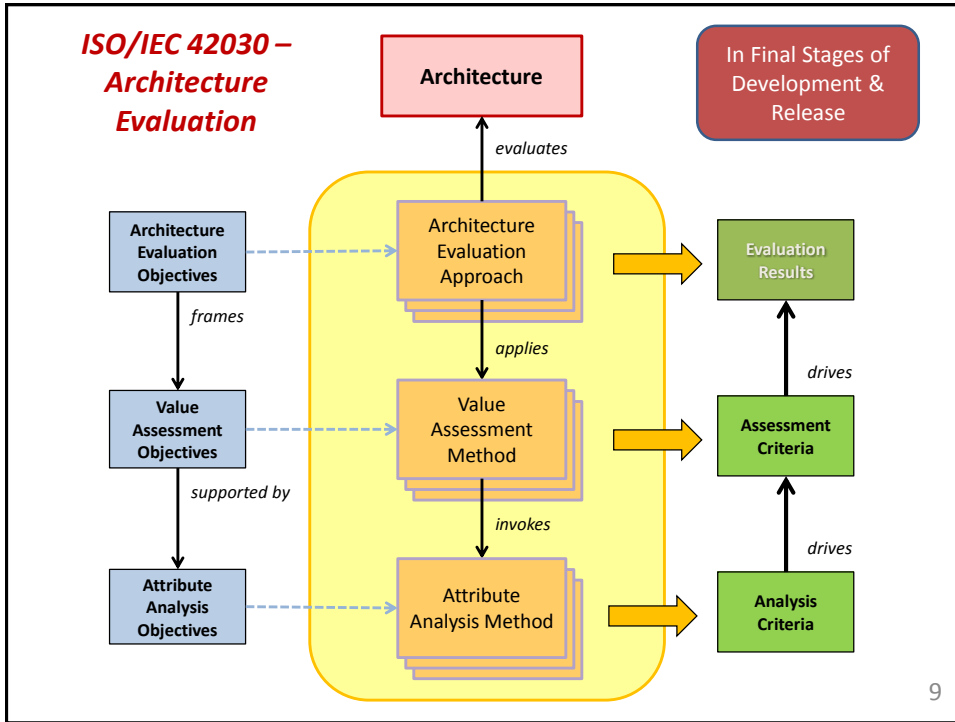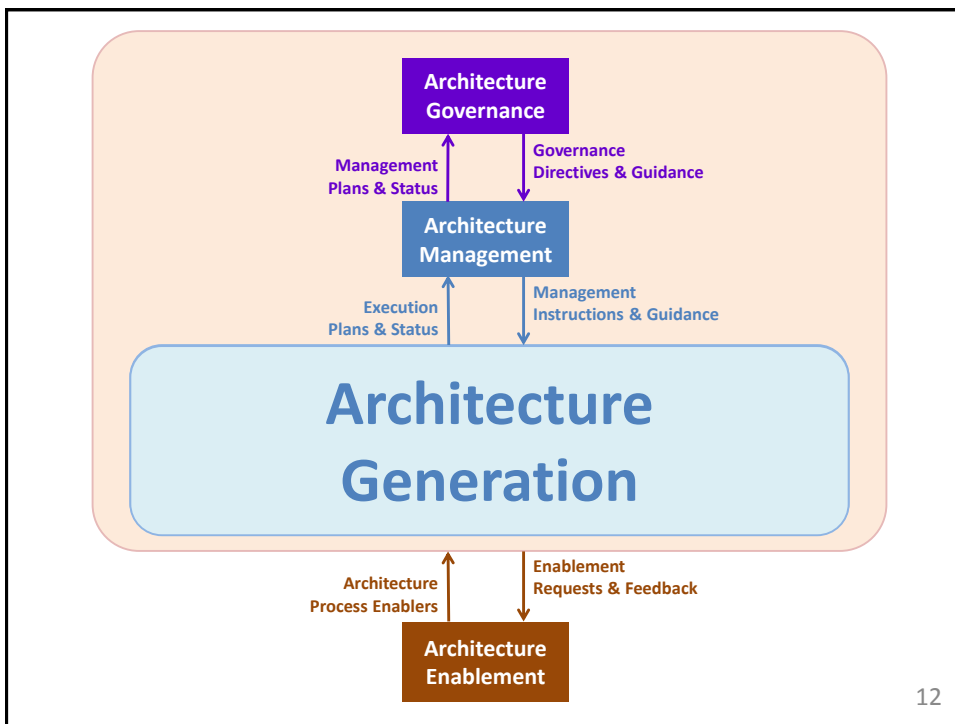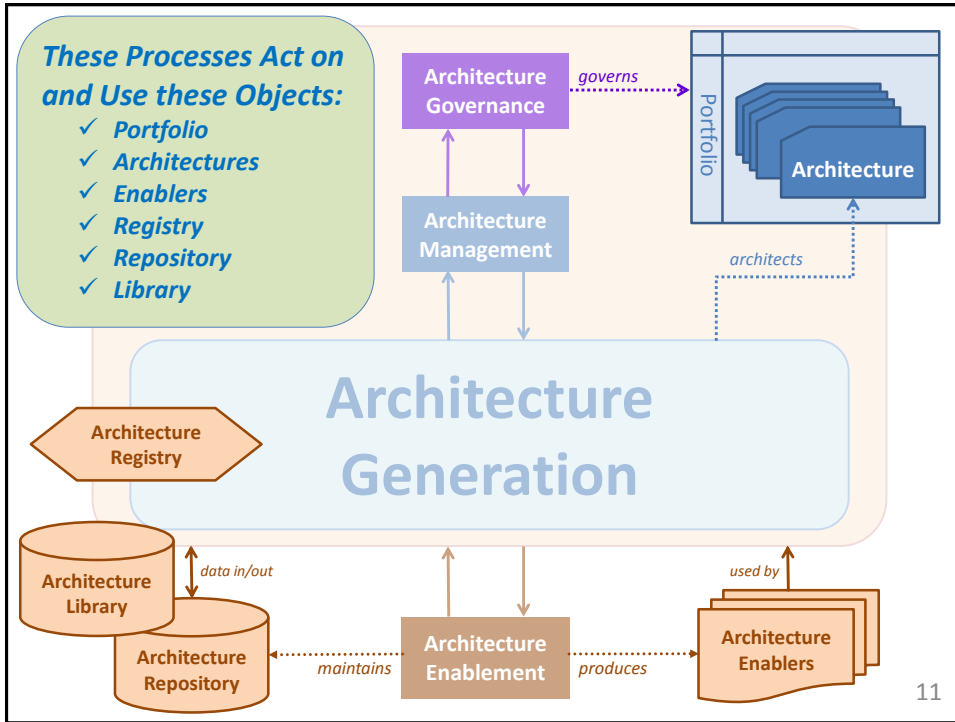| System Reqts Definition	System Reqts Definition	System Reqts Definition	System Reqts Definition
Design Definition	Design Definition	Design Definition	Design Definition

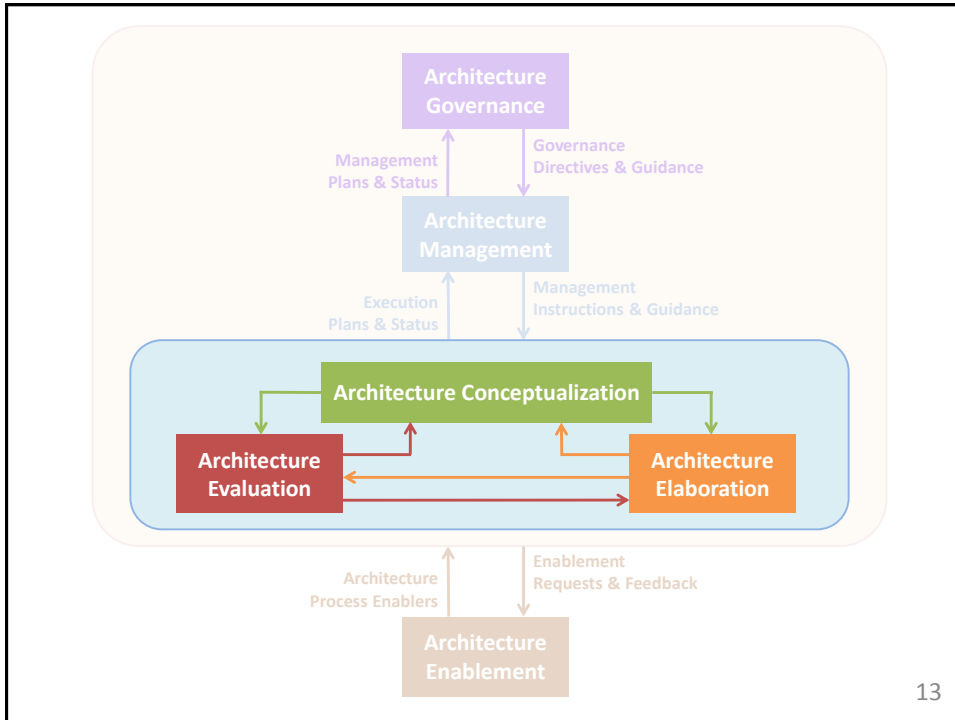**Can address several different cases:**
- Architecture of total solution with multiple systems
- Product line of systems for different markets, users, etc
- System of Systems with separately managed and operated systems
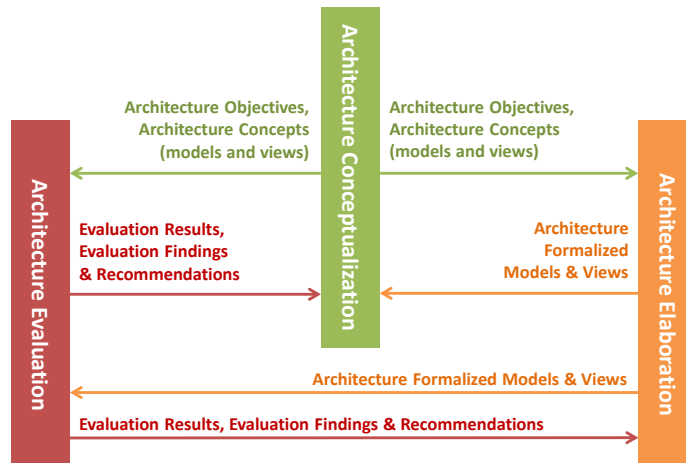
6

3

Architecture-Driven System Development

Organizational Project-Enabling	Technical Management	Technical Processes	
Life Cycle Model Management	Project Planning	Business or Mission Analysis	Disposal
Infrastructure Management	Project Assessment & Control	Stakeholder Needs & Reqts Definition	Maintenance
Portfolio Management	Decision Mgmt	System Reqts Definition	Operation
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Knowledge Management	Information Mgmt	Design Definition	Verification
	Measurement		Integration
	Quality Assurance	System Analysis	Implementation

Agreement Processes — Acquisition — Supply

Subsystem Development

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ISO Standards on Architecture

- **42010 – Architecture Description**
  - Published in 2011

Early Stage

- **42020 – Architecture Processes**
  - Start 2015 (finish by 2018)

- **42030 – Architecture Evaluation**
  - Draft now in review
  - To be published in 2017

Finalizing

- **42040 – Architecture Methods**
  - Future

- **42050 – Architecture Tools**
  - Future

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4

ISO/IEC 42030 – Architecture Evaluation

Architecture

In Final Stages of Development & Release

evaluates

Architecture Evaluation Objectives → Architecture Evaluation Approach → Evaluation Results

frames

applies

Value Assessment Objectives → Value Assessment Method → Assessment Criteria

supported by

invokes

drives

Attribute Analysis Objectives → Attribute Analysis Method → Analysis Criteria

drives

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42020

Architecture Governance

Architecture Management

Architecture Generation

Architecture Enablement

10

These Processes Act on and Use these Objects:
- Portfolio
- Architectures
- Enablers
- Registry
- Repository
- Library

Architecture Governance — governs → Portfolio / Architecture

Architecture Management

Architecture Generation

Architecture Registry

Architecture Library — data in/out

Architecture Repository — maintains

Architecture Enablement — produces → Architecture Enablers — used by

architects

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Architecture Governance

Management Plans & Status

Governance Directives & Guidance

Architecture Management

Execution Plans & Status

Management Instructions & Guidance

Architecture Generation

Architecture Process Enablers

Enablement Requests & Feedback

Architecture Enablement

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13

Interactions Between the Architecture Generation Processes

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"Solutions" to be Architected…

1. enterprise
2. system of systems
3. collection of systems
4. class of systems
5. family of systems
6. product line
7. individual system
8. portion of a system

9. product
10. service
11. individual hardware or software item
12. any other entity that is amenable to architectural definition *(eg, data, doctrine, organization, process, method, technique, policy, facilities, etc)*

Solution = System + Non-System Elements

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17
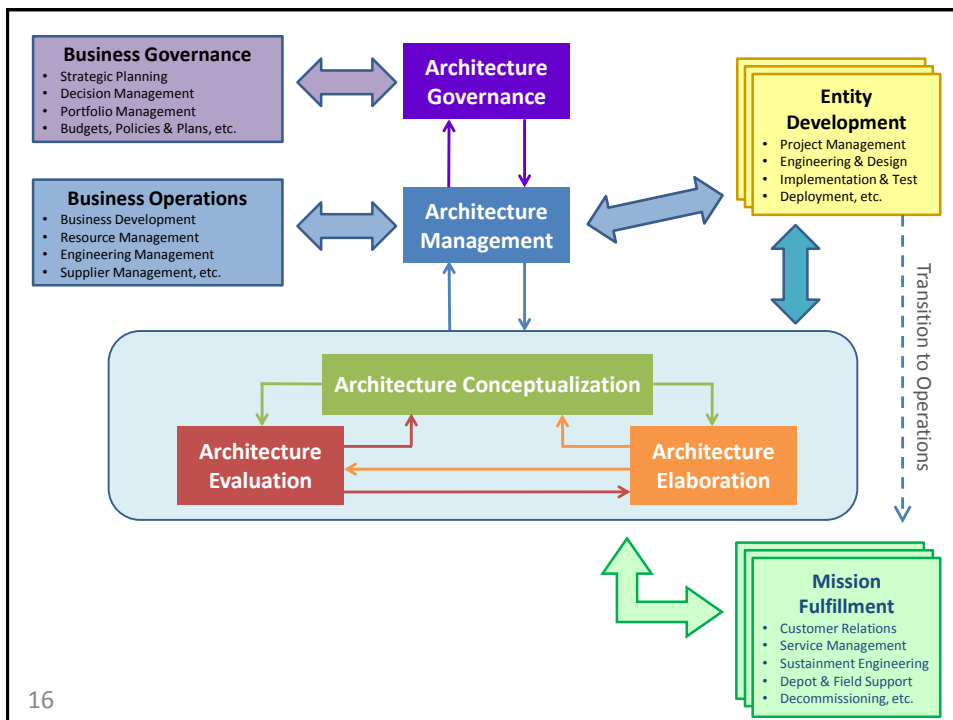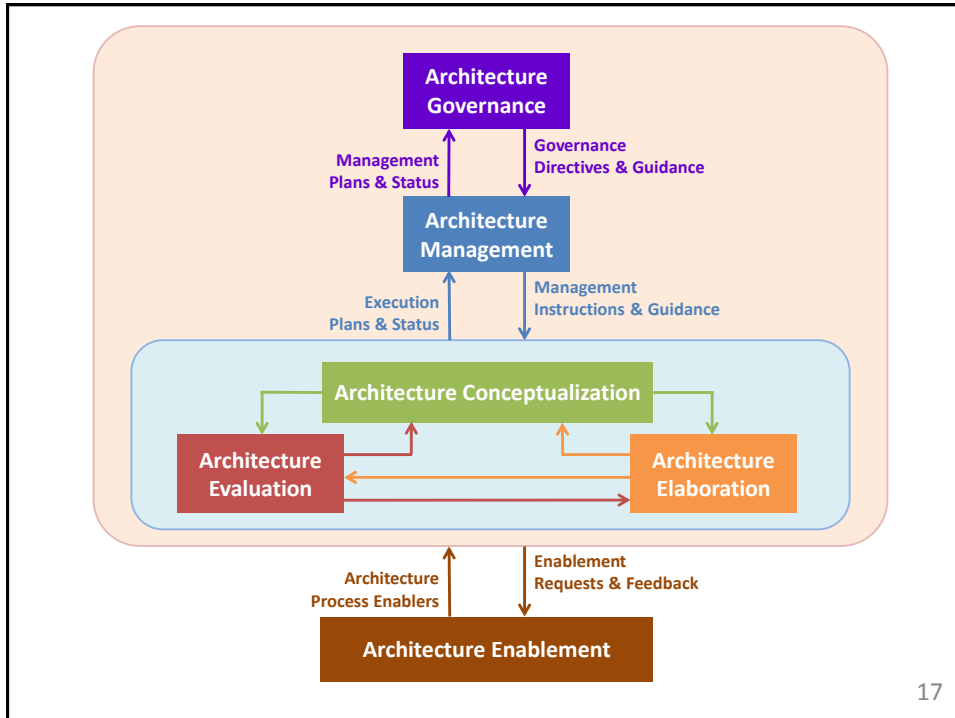
Why Use these Architecture Processes?

A. **Solution acquirers** to formalize the business context, evaluate providers proposals, identify alternatives, and make informed decisions

B. **Solution providers** to understand the problem/request, elaborate a proposal in their solution space, and define and justify their deliveries

C. **Solution users** to express the operational context, formalize their needs, and evaluate providers' proposals in their solution space

D. **Decision makers** to use architectures as a source of information and rationale for the decisions to be made

E. **Other bodies** such as legal, safety and security authorities, to assess compliance with standards, policies, directives, treaties, regulations, and laws

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6 Processes → 37 Activities
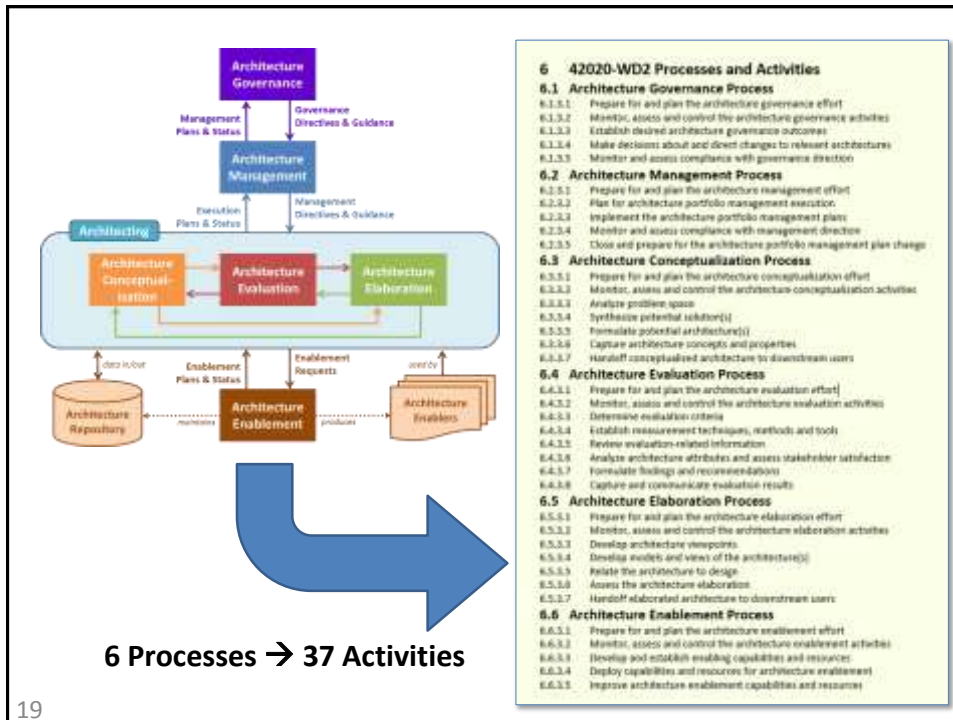
19

6   42020-WD2 Processes and Activities

6.1 Architecture Governance Process
6.1.3.1   Prepare for and plan the architecture governance effort
6.1.3.2   Monitor, assess and control the architecture governance activities
6.1.3.3   Establish desired architecture governance outcomes
6.1.3.4   Make decisions about and direct changes to relevant architectures
6.1.3.5   Monitor and assess compliance with governance direction

6.2 Architecture Management Process
6.2.3.1   Prepare for and plan the architecture management effort
6.2.3.2   Plan for architecture portfolio management execution
6.2.3.3   Implement the architecture portfolio management plans
6.2.3.4   Monitor and assess compliance with management direction
6.2.3.5   Close and prepare for the architecture portfolio management plan change

6.3 Architecture Conceptualization Process
6.3.3.1   Prepare for and plan the architecture conceptualization effort
6.3.3.2   Monitor, assess and control the architecture conceptualization activities
6.3.3.3   Analyze problem space
6.3.3.4   Synthesize potential solution(s)
6.3.3.5   Formulate potential architecture(s)
6.3.3.6   Capture architecture concepts and properties
6.3.3.7   Handoff conceptualized architecture to downstream users

6.4 Architecture Evaluation Process

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6.3.3.7   Handoff conceptualized architecture to downstream users

6.4   Architecture Evaluation Process

6.4.3.1   Prepare for and plan the architecture evaluation effort
6.4.3.2   Monitor, assess and control the architecture evaluation activities
6.4.3.3   Determine evaluation criteria
6.4.3.4   Establish measurement techniques, methods and tools
6.4.3.5   Review evaluation-related information
6.4.3.6   Analyze architecture attributes and assess stakeholder satisfaction
6.4.3.7   Formulate findings and recommendations
6.4.3.8   Capture and communicate evaluation results
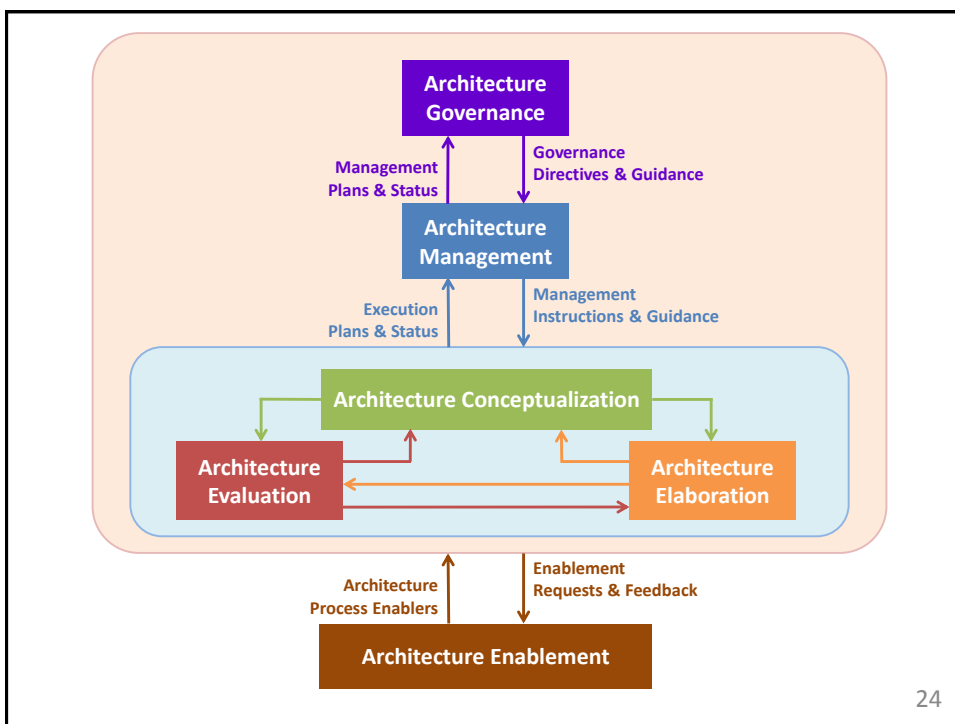
6.5   Architecture Elaboration Process

6.5.3.1   Prepare for and plan the architecture elaboration effort
6.5.3.2   Monitor, assess and control the architecture elaboration activities
6.5.3.3   Develop architecture viewpoints
6.5.3.4   Develop models and views of the architecture(s)
6.5.3.5   Relate the architecture to design
6.5.3.6   Assess the architecture elaboration
6.5.3.7   Handoff elaborated architecture to downstream users

6.6   Architecture Enablement Process

6.6.3.1   Prepare for and plan the architecture enablement effort
6.6.3.2   Monitor, assess and control the architecture enablement activities
6.6.3.3   Develop and establish enabling capabilities and resources
6.6.3.4   Deploy capabilities and resources for architecture enablement
6.6.3.5   Improve architecture enablement capabilities and resources

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Sample Activities & Tasks

1.   Prepare for and plan the architecture conceptualization effort
a)   Identify the potential problem area(s) that can be addressed by an architecture.
b)   Define the expected purpose, scope, objectives, and level of detail of the architecture conceptualization effort.
c)   Define one or more architecture conceptualization approaches that are consistent with the architecture governance and management directions and are consistent with the purpose, scope and objectives of this effort.
d)   Select or develop the requisite architecture conceptualization techniques, methods and tools.
e)   Plan the architecture conceptualization effort.
f)   Establish metrics for the architecture conceptualization effort.
g)   Collect the data and information needed for the architecture conceptualization effort.
h)   Obtain access to enablers needed for the architecture conceptualization effort.
i)   Ensure personnel are trained in the use of identified techniques, methods and tools.

2.   Monitor, assess and control the architecture conceptualization activities
a)   Report architecture conceptualization activity plans and status.
b)   Monitor and assess whether architecture governance directives and guidance are being followed.
c)   Monitor and assess whether architecture management instructions and guidance are being followed.
d)   Monitor and assess metrics for the architecture conceptualization effort.
e)   Identify and assess risks and opportunities associated with the architecture conceptualization effort.
f)   Maintain traceability of architecture conceptualization results to the source material used during the process.
g)   Ensure that relevant technical, project and organizational processes are properly using architecture conceptualization products.
h)   Ensure that relevant enterprise processes are properly using architecture conceptualization products.

3.   Analyze problem space
a)   Identify current and projected situation(s) in the problem space.
b)   Identify relevant aspects of the identified situation(s).
c)   Identify problems or difficulties in the current and projected situation(s).
d)   Identify stakeholders and their concerns corresponding to each of these problems or difficulties.
e)   Identify quality attributes associated with these stakeholder concerns.
f)   Understand how the problems or difficulties affect different stakeholders and their priorities in addressing them.
g)   Understand complexities of each problem or difficulty, its cause and effect, and how it is being addressed currently in each of the identified situations.
h)   Determine bounding conditions, root causes, and relevant scenarios for each identified problem or difficulty.

i)   Determine gaps or shortfalls of current or planned solutions in addressing the problem.
j)   Identify relevant assumptions, degrees of freedom, constraints, conditions and challenges.
k)   Develop an inference network showing the cause and effect relationships for the identified problem(s) or difficulties.
l)   Formulate a clear statement of the problem(s).
m)   Identify and define architecture objectives that address the problem(s).
n)   Define evaluation criteria that can be used to assess the degree to which the problems(s) are resolved and to inform exploration and selection of alternatives.

4.   Synthesize potential solution(s)
a)   Develop an objectives view by reformulating the elements in the inference network as conditions and levels to be achieved in addressing the problems revealed by the inference network.
b)   Identify problem mitigation strategies that can achieve these conditions and levels and serve as potential solution(s).
　　1)   Perform technology scan for relevant technologies.
　　2)   Perform problem/solution pattern scan for relevant solutions to similar problems.
　　3)   Perform natural system metaphor scan for possible naturally occurring solutions to similar problems.
c)   Review the resulting relationships between problem mitigation strategies and problem causes to assure the completeness of the potential solution(s).
d)   Formulate purpose statement(s) for each potential solution.
e)   Identify needs, wants and expectations for each potential solution.
f)   Identify relevant critical success factors and key performance indicators.
g)   Understand stakeholders' value creation context and formulate value propositions for each potential solution.
h)   Identify strengths, weaknesses, opportunities and threats for each potential solution.
i)   Identify other important aspects related to each potential solution, including but not limited to the following.
　　1)   Identify and characterize risks for each potential solution.
　　2)   Identify assumptions with respect to each potential solution.
　　3)   Identify additional problems that might be caused by each potential solution.
　　4)   Determine remaining gaps or shortfalls after implementing the proposed solutions.
j)   Harmonize elements of each potential solution to ensure that it can be realized in a coherent and cohesive manner.
k)   Formulate a roadmap for implementing the proposed solution(s).
l)   Define evaluation criteria that can be used to assess the degree to which the proposed solution(s) address the specified problem(s) and to inform exploration and selection of alternatives.

5.   Formulate potential architecture(s)
a)   Establish and capture the desired functional and non-functional characteristics based on the potential solution(s) with respect to the purpose of each solution that correspond to the quality attributes identified during problem space analysis.
b)   Etc...

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6 Processes → 37 Activities

Summary

- Emerging standard on architecture
  - Can be adopted by your organization
  - Useful for personal mastery of architecting
  - Will be basis for SE training and certification

- Architecture is about more than…
  - Architecture products
  - "System" solutions

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Two Types of Architecture

Enterprise Architectures

utilize these
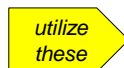
Solution Architectures

- **Vision & Goals**
- **Policies & Practices**
- **Mission & Business Elements**
  - Capabilities
  - Segments
  - Execution Threads
  - Organizations
  - Resources

- **System Solutions**
  - Hardware
  - Software
  - People
- **Non-System Solutions**
  - Process
  - Policy
  - Education & Training
  - Organizations
  - Facilities

Slide 1 - 26

"Solutions" to be Architected…

1. enterprise
2. system of systems
3. collection of systems
4. class of systems
5. family of systems
6. product line
7. individual system
8. portion of a system

9. product
10. service
11. individual hardware or software item
12. any other entity that is amenable to architectural definition *(eg, data, doctrine, organization, process, method, technique, policy, facilities, etc)*

Solution = System + Non-System Elements

27
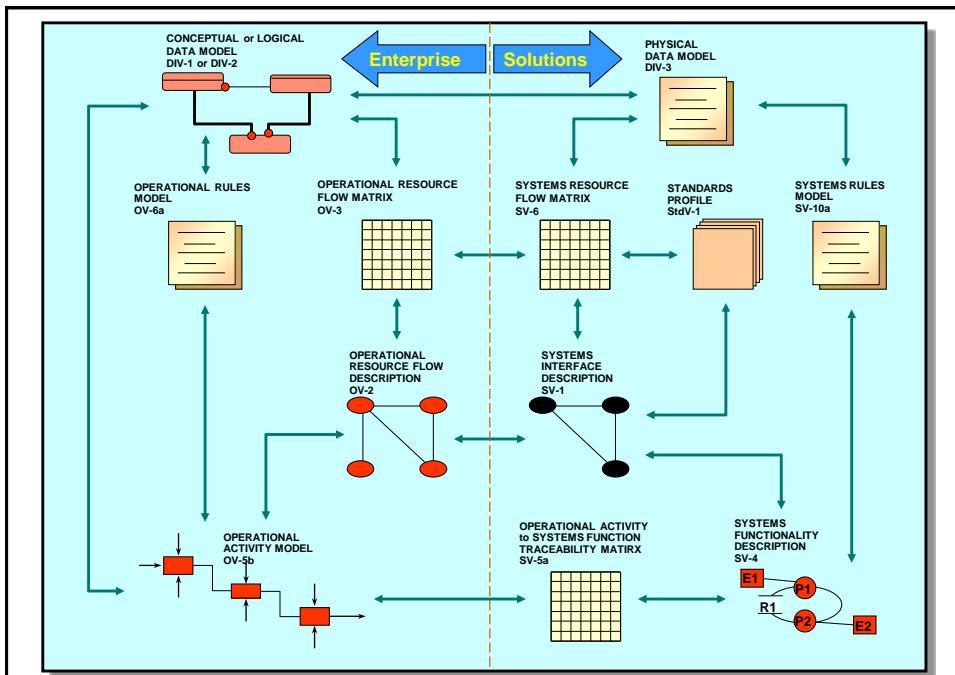
Copyright 2003-13
James N Martin

Enterprise & Solution Architecture Models

Slide 2 - 28

Different Things to Communicate

Enterprise Perspective	**Solutions Perspective**
• **Missions & Activities** • **Organizations & People** • **Drivers & Outcomes** • **Information Flows & Characteristics**	• **Systems, Services & Functions** • **Hardware & Software** • **Inputs & Outputs** • **Data Flows & Characteristics**

Slide 2 - 29

From Needs to Architecture

Needs
- **What needs are we trying to fill?**
- **What is wrong with the current situation?**
- **Is the need clearly articulated?**

Operations Concept
- **Who are the intended users?**
- **How will they use our products?**
- **How is this different from the present?**

Functional Capabilities
- **What specific capability will we provide?**
- **To what level of detail?**
- **Are element interfaces well defined?**

Architecture
- **What is the overall plan of attack?**
- **What elements make up the overall approach?**
- **Are these complete, logical, and consistent?**

Slide 2 - 30

Architecture Governance

Management Plans & Status

Governance Directives & Guidance

Architecture Management

Execution Plans & Status

Management Instructions & Guidance

Architecture Conceptualization

Architecture Evaluation

Architecture Elaboration

Architecture Process Enablers

Enablement Requests & Feedback

Architecture Enablement

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Full-Day Tutorial

Morning Topics

- Frameworks Overview (1 hour)
  – RM-ODP Fwk & TOGAF
  – Dept of Defense Arch Fwk (DODAF)
  – Federal Enterprise Arch Fwk (FEAF)
  – The Rail Architecture Framework (TRAK)
  – Zachman Framework

- Architecture Development (2 hrs)
  – What is Architecture?
  – Architecture Views & Modeling
  – DODAF Views & Models
  – DODAF Conceptual Data Model

Afternoon Topics

- Architecture Models (3 hrs)
  – Capability & Project Viewpoints
  – All & Operational Viewpoints
  – Systems & Services Viewpoints
  – Data/Info Viewpoint
  – Standards Viewpoint

- Architecture Evaluation (1 hour)
  – Value Chain Analysis
  – Enterprise vs Systems
  – Modernization Process
  – Analysis of Alternatives

More complete training on this topic is available.
Please contact me at MartinQZX@gmail.com

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Architecting & Engineering – Two Sides of the Same Problem

Collective vision, goals, constraints, conditions, challenges & other concerns of stakeholders

Architecting
Synthesis
of Form

Iteratively compose separate elements to form a coherent whole

Architectural Objectives

Engineering Requirements

Critical Point

Analysis
of Function
Engineering

Iteratively decompose and separate a primarily functional representation of a whole

Representations of economically producible components that can be assembled to construct the functional whole

Adapted from: Walt Okon, DOD Architecture Training, 12 Dec 2007

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System Life Cycle Processes in 15288 (2015)

Organizational Project-Enabling	Technical Management	Technical Processes	
Life Cycle Model Management	Project Planning	Business or Mission Analysis	Disposal
Infrastructure Management	Project Assessment & Control	Stakeholder Needs & Reqts Definition	Maintenance
Portfolio Management	Decision Mgmt	System Reqts Definition	Operation
	Risk Mgmt		Validation
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Knowledge Management	Quality Assurance	System Analysis	Implementation

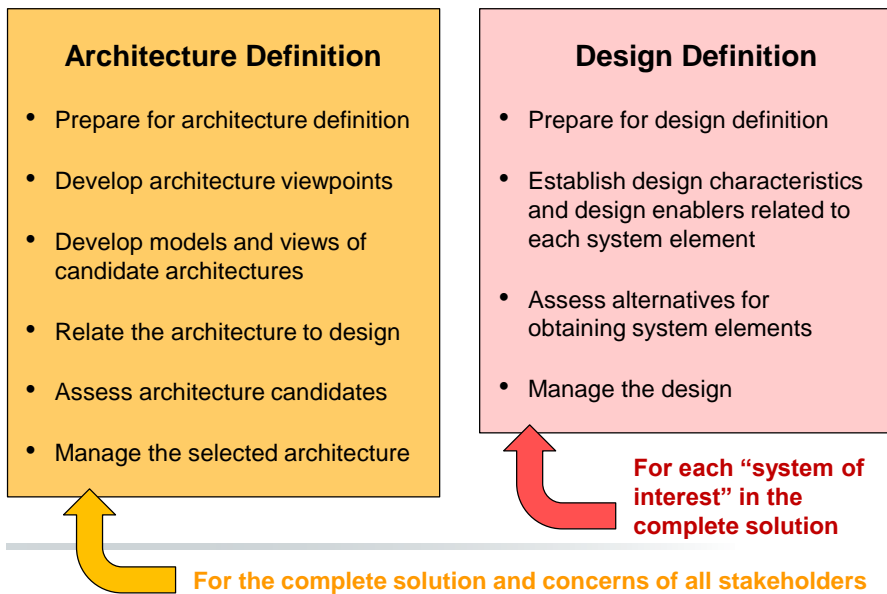| Agreement Processes	Acquisition	Supply

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Purpose of the Architecture Definition Process

- Purpose
  - *Generate system architecture alternatives*
  - *Select one or more alternatives that frame stakeholder concerns and meet system requirements*
  - *Express this in a set of consistent views*

- Effective Architecture
  - *… is design-agnostic to maximum extent possible to allow for maximum flexibility in the design trade space*
  - *… highlights and supports trade-offs for the Design Definition process*
    - … as well as for other processes, such as Portfolio Management, Life Cycle Management, Project Planning, System Requirements Definition, Verification, Operations, etc
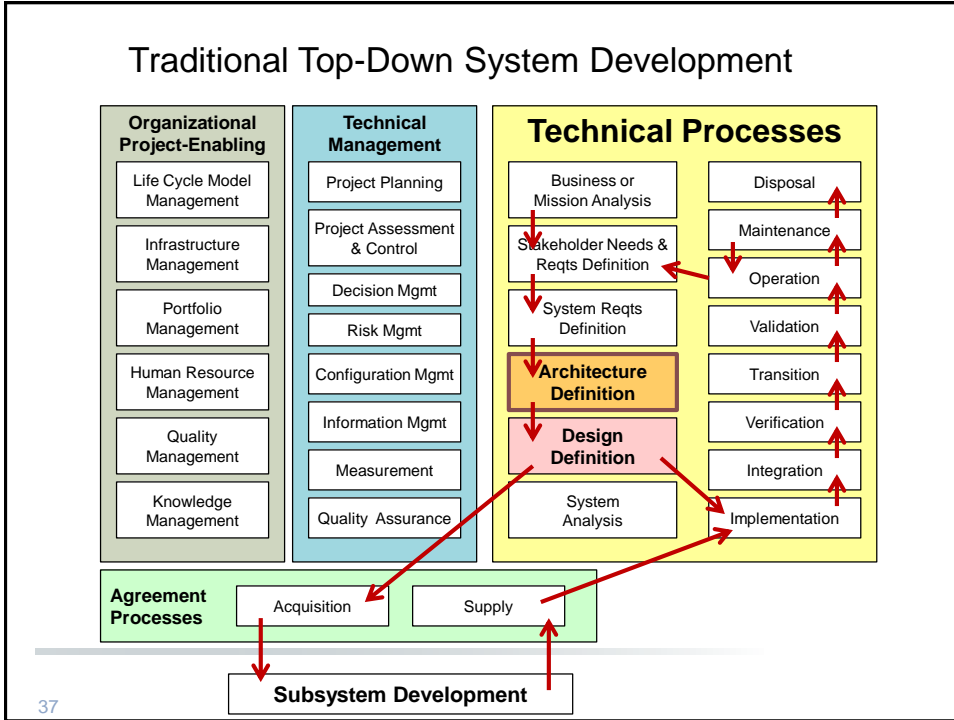
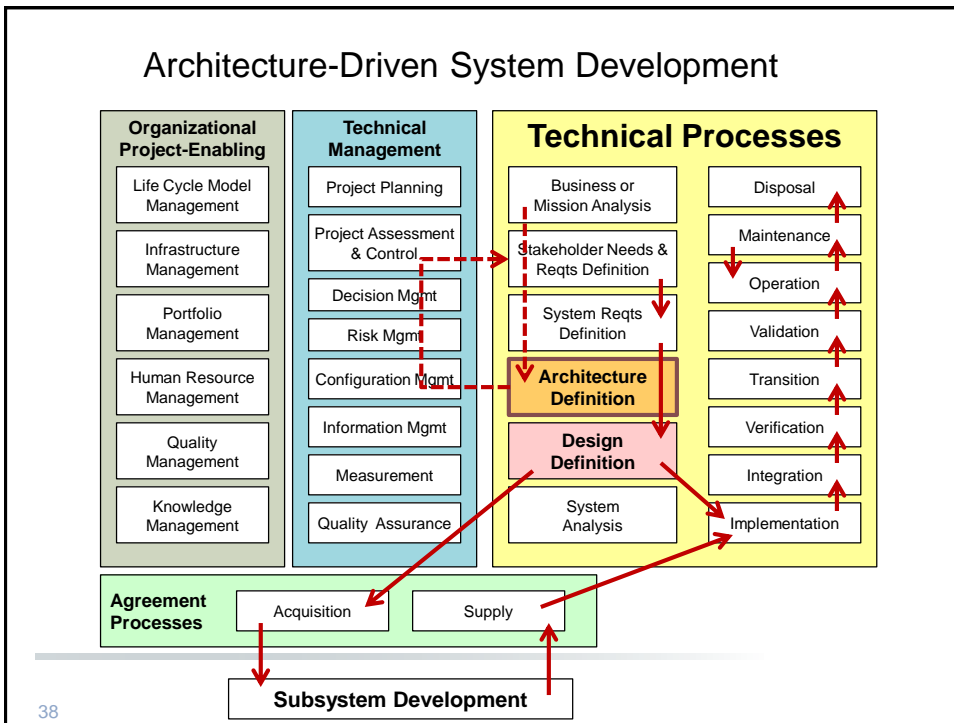35

Separation of Architecture & Design Processes (2015)

Architecture Definition

- Prepare for architecture definition

- Develop architecture viewpoints

- Develop models and views of candidate architectures

- Relate the architecture to design

- Assess architecture candidates

- Manage the selected architecture

Design Definition

- Prepare for design definition

- Establish design characteristics and design enablers related to each system element

- Assess alternatives for obtaining system elements

- Manage the design

For each "system of interest" in the complete solution

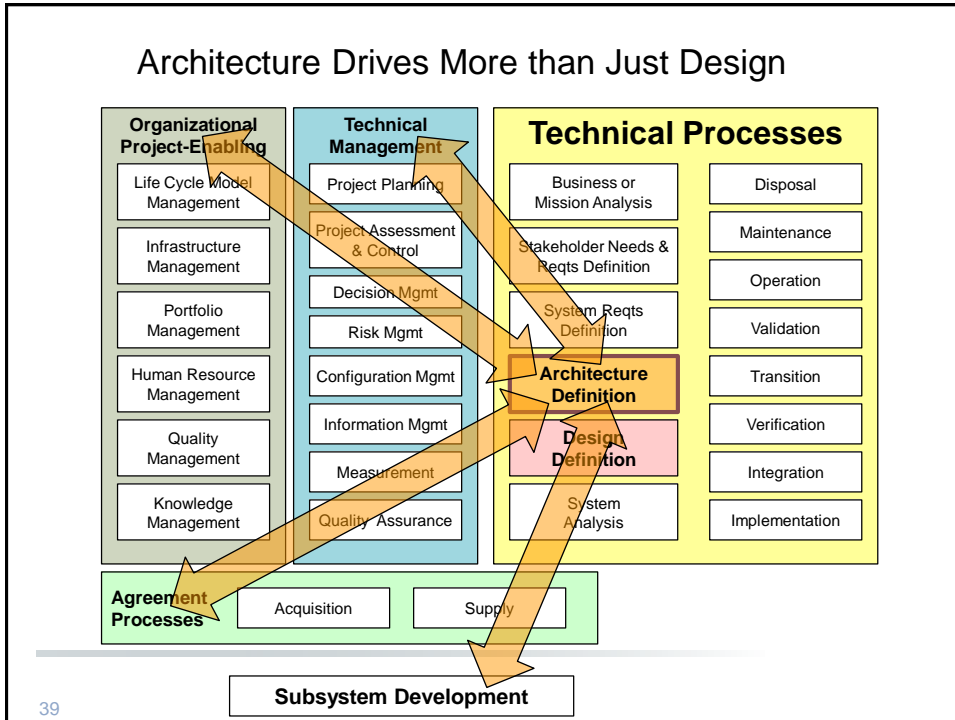**For the complete solution and concerns of all stakeholders**

36

Traditional Top-Down System Development

Architecture-Driven System Development

Architecture Drives More than Just Design

Architecture Can Drive Several Different Systems

Can address several different cases:
• Architecture of total solution with multiple systems
• Product line of systems for different markets, users, etc
• System of Systems with separately managed and operated systems