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

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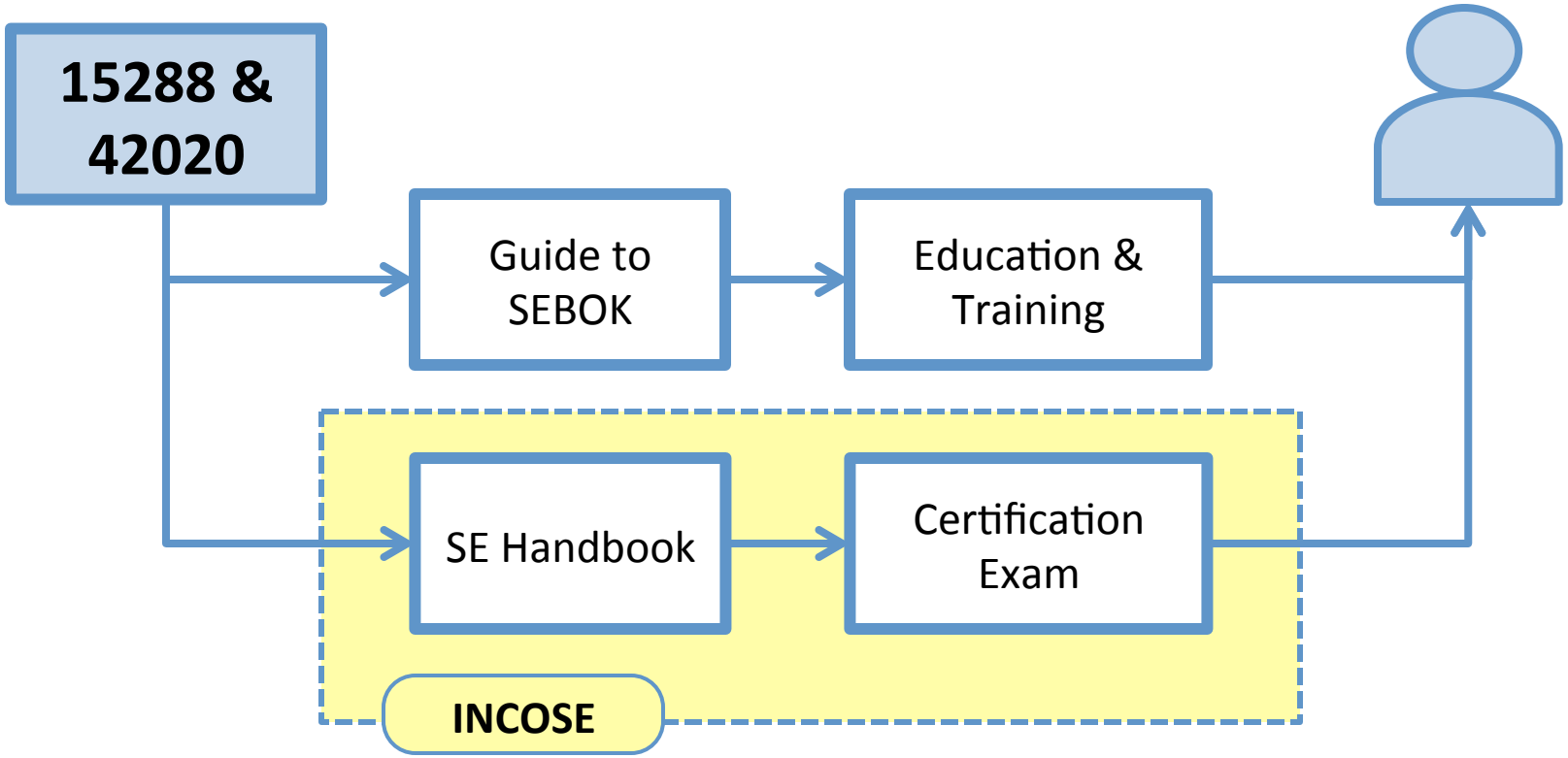
The Aerospace Corporation

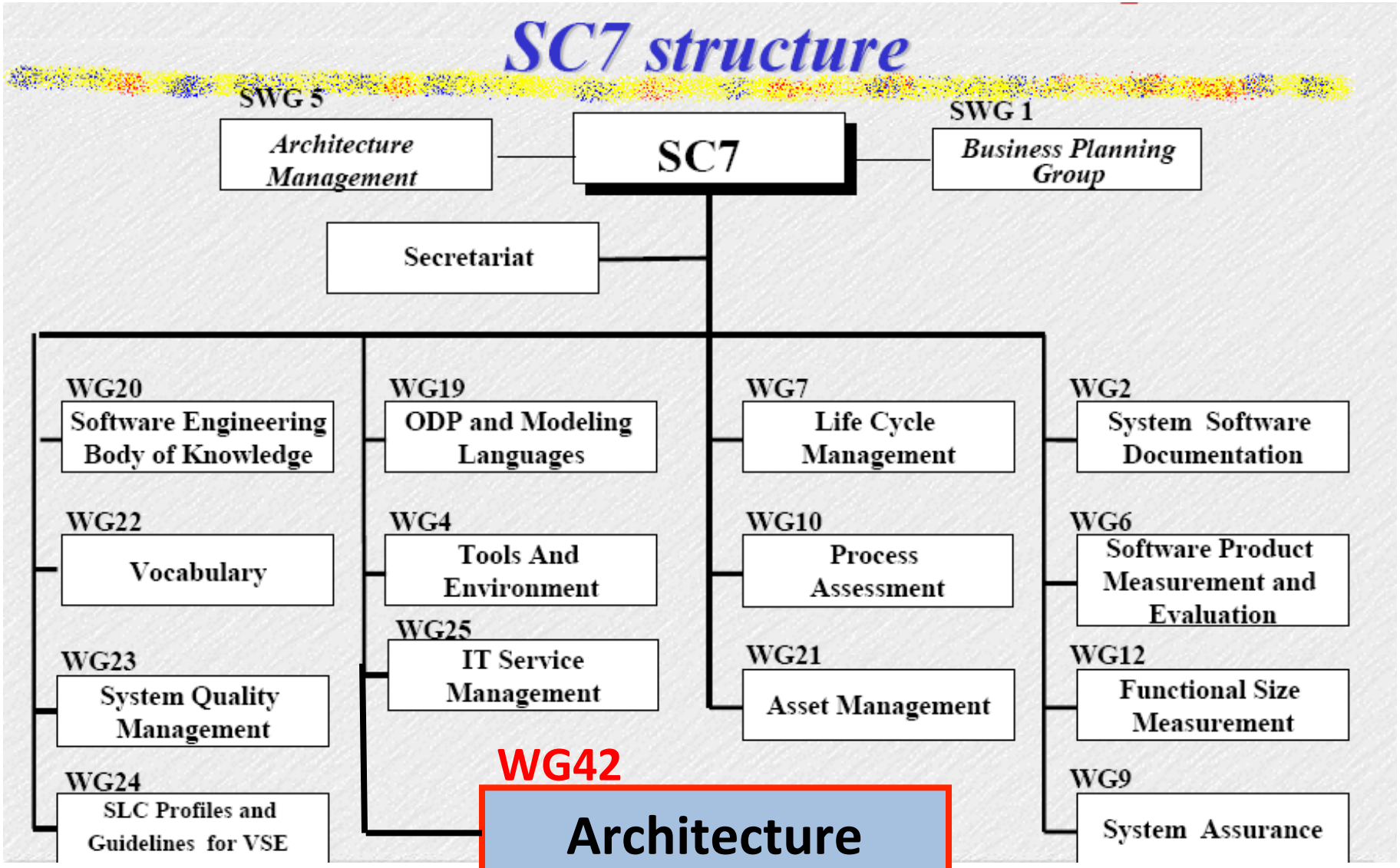
20 July 2016

Why use ISO standards?

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



Subcommittee for Systems & Software (SC7)



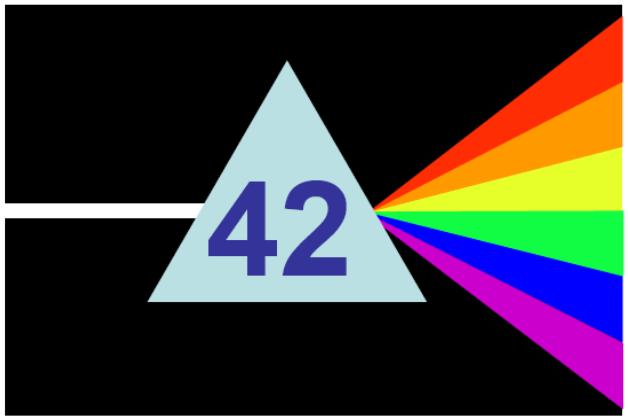
Who is involved in this ISO Standard?

(WG42 Architecture Working Group)

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

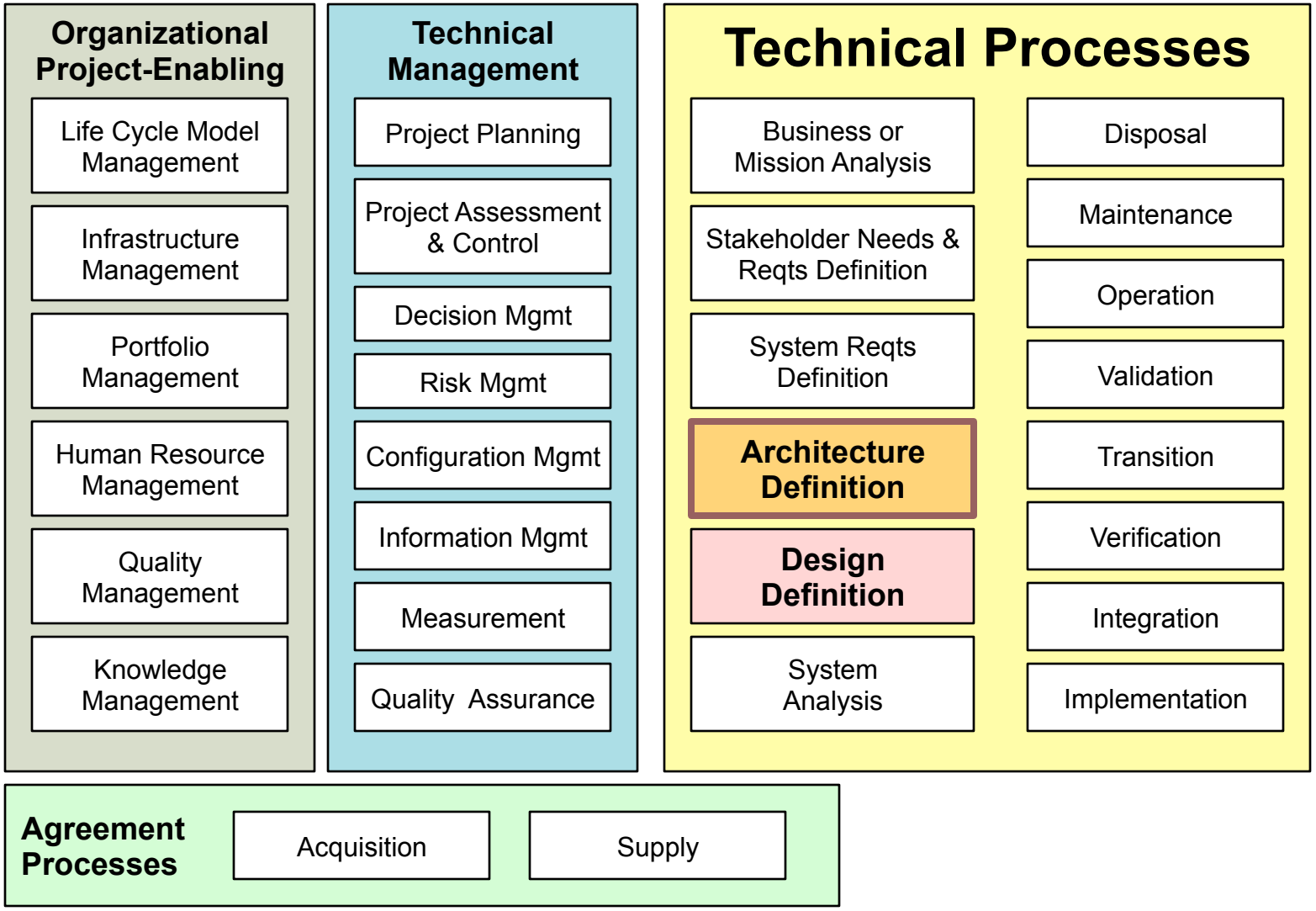
- International Liaisons
  - INCOSE
  - IEEE
  - Software Engineering Institute
  - Object Management Group

I am the INCOSE rep



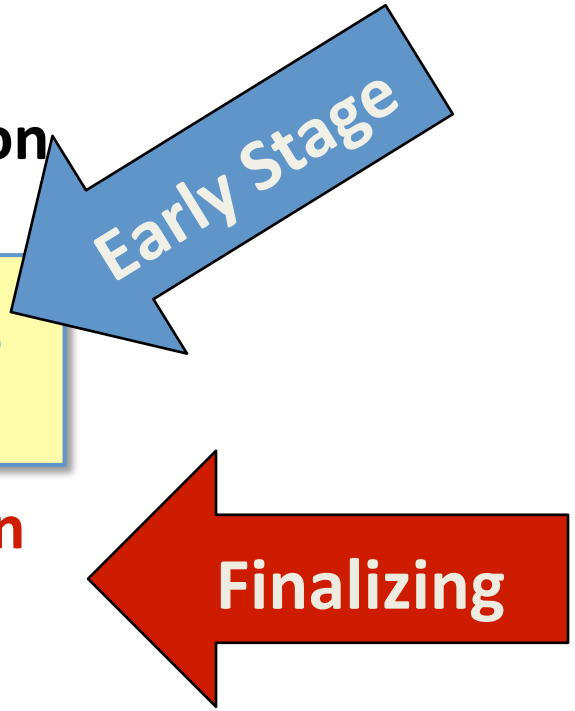
Architecture Working Group (WG42)

System Life Cycle Processes in 15288 (2015)

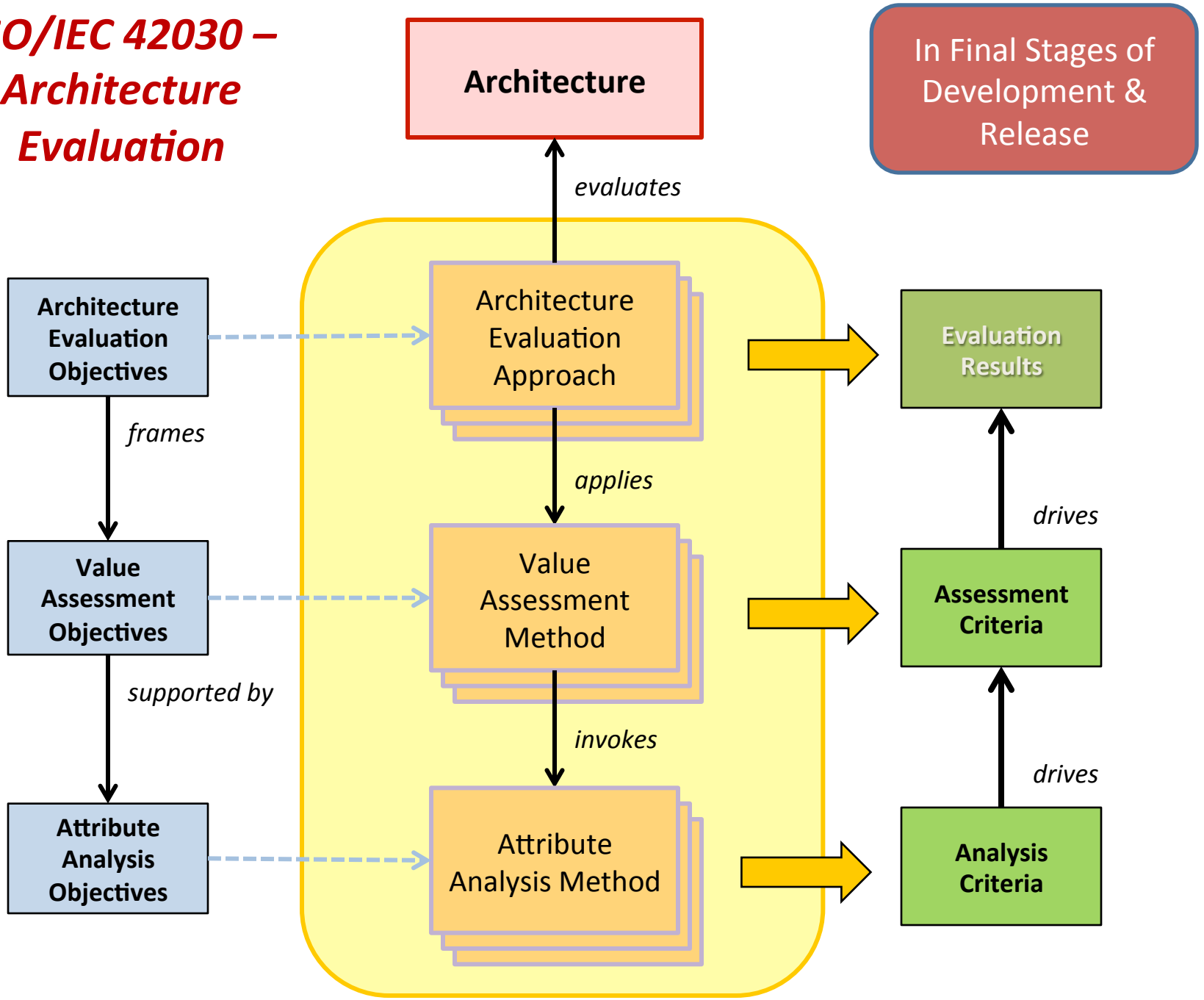


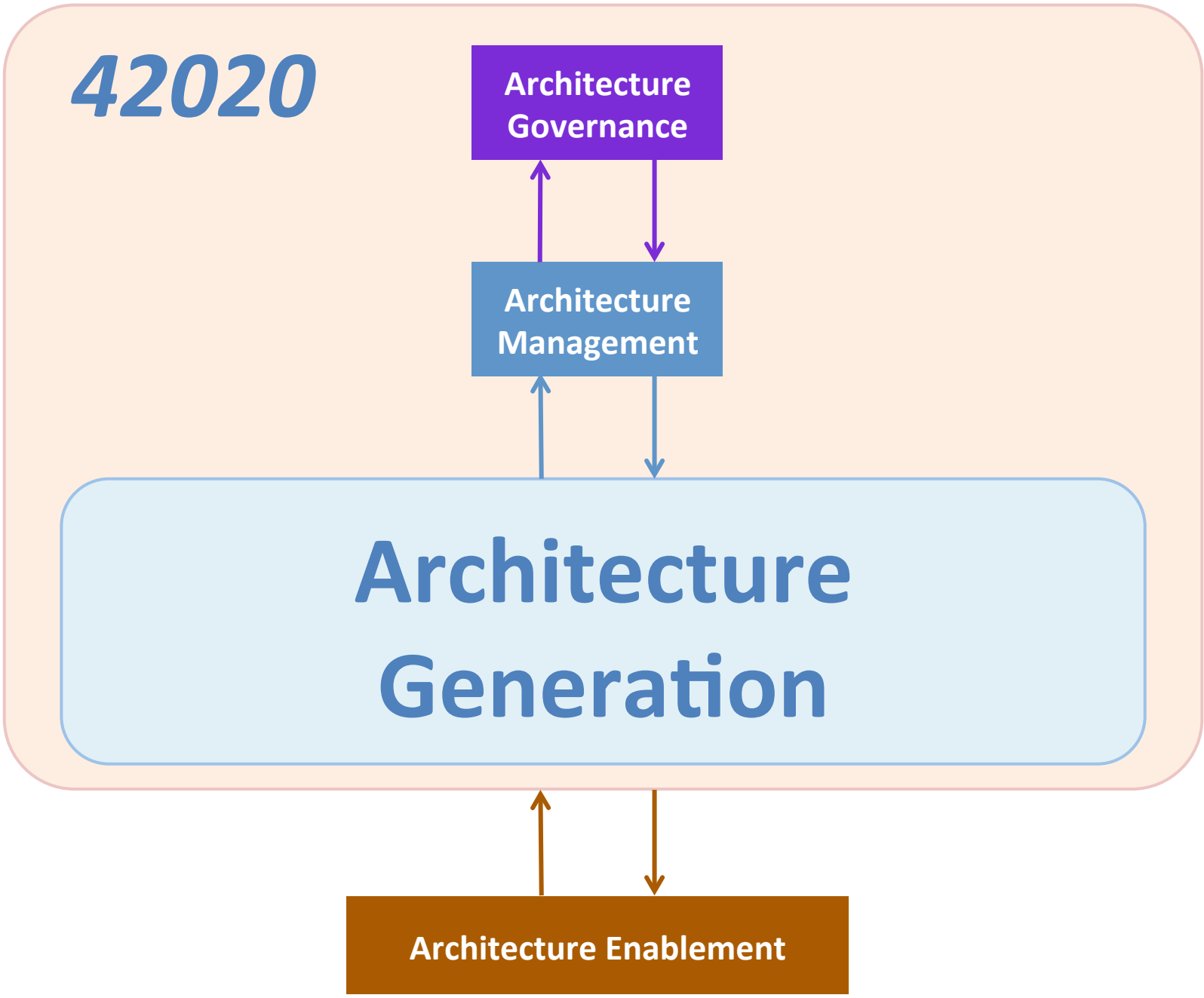
ISO Standards on Architecture

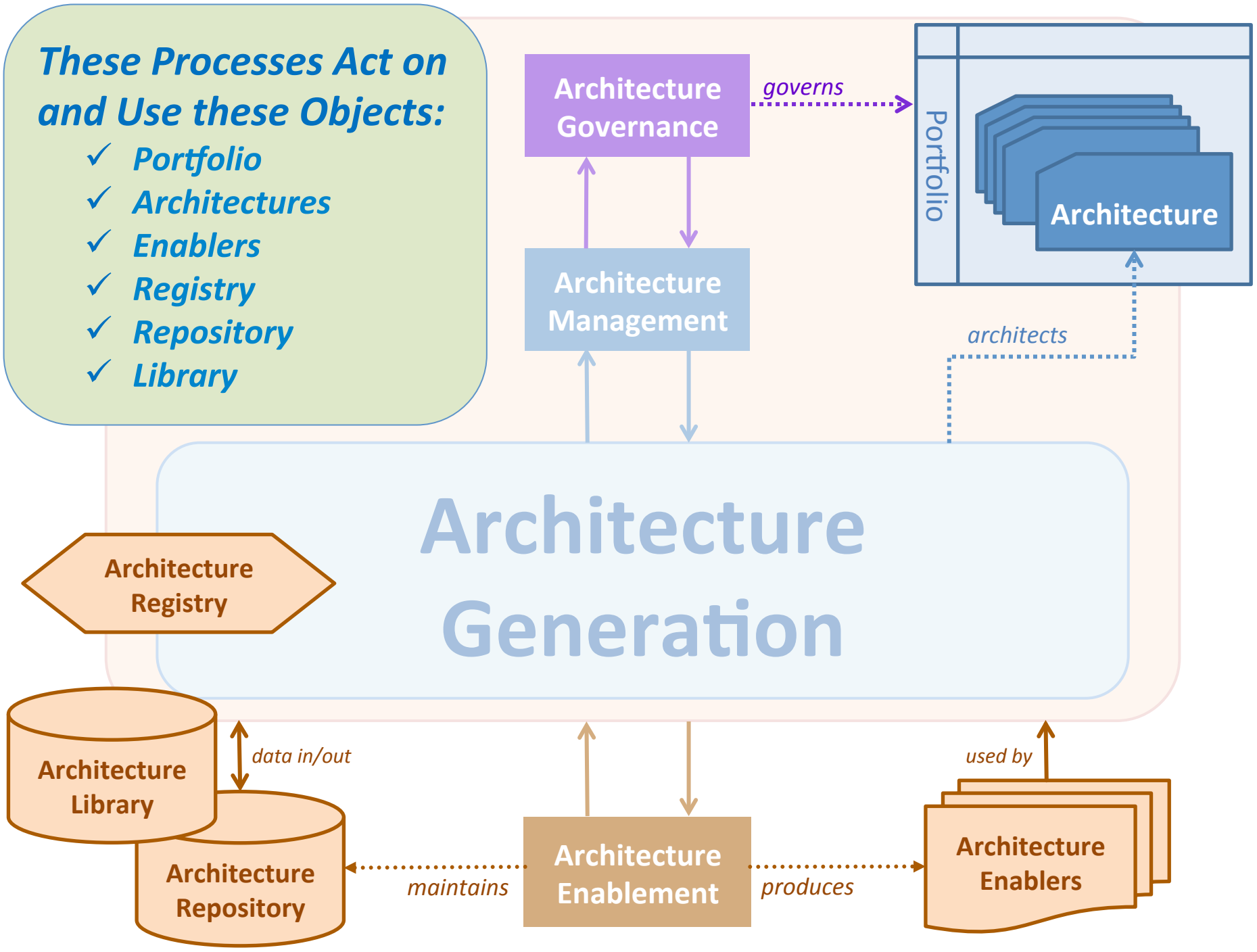
- **42010 – Architecture Description**
  - Published in 2011
- **42020 – Architecture Processes**
  - Start 2015 (finish by 2018)
- **42030 – Architecture Evaluation**
  - Draft now in review
  - To be published in 2017
- **42040 – Architecture Methods**
  - Future
- **42050 – Architecture Tools**
  - Future

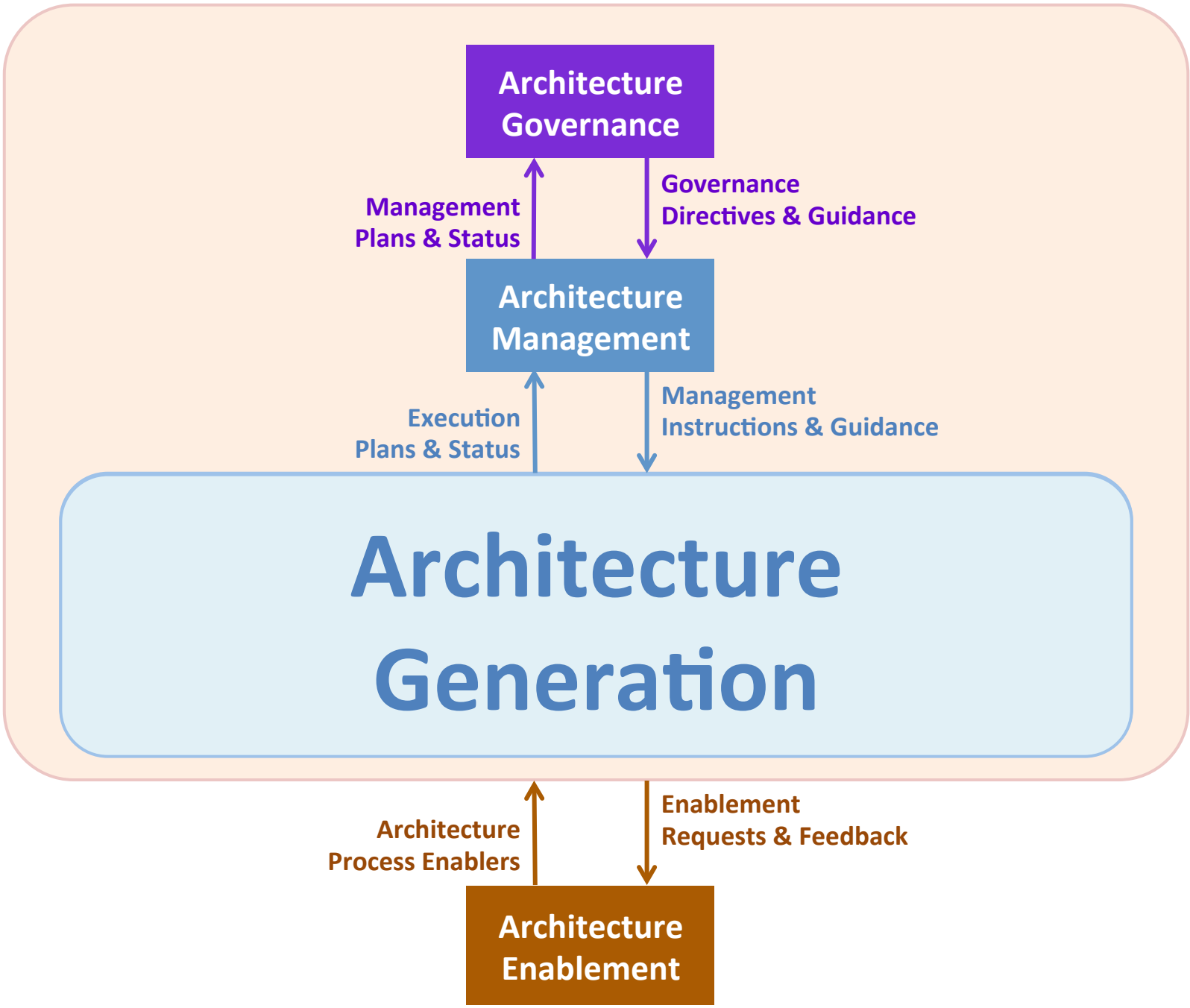


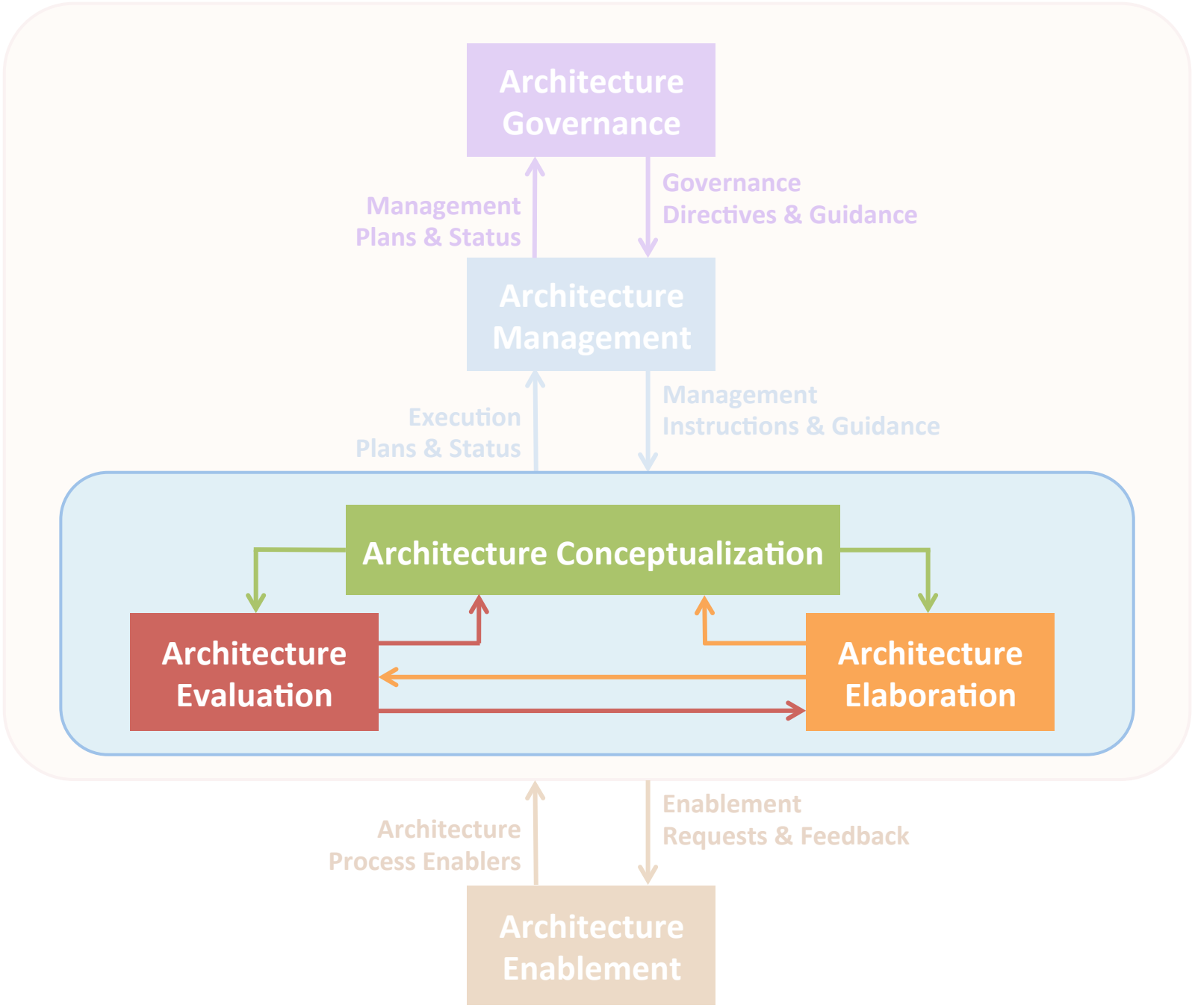
ISO/IEC 42030 – Architecture Evaluation




42020
Architecture Governance
Architecture Management
Architecture Generation
Architecture Enablement


These Processes Act on and Use these Objects:
✓ Portfolio
✓ Architectures
✓ Enablers
✓ Registry
✓ Repository
✓ Library
Architecture Governance
governs
Portfolio
Architecture
Architecture Management
architects
Architecture Generation
Architecture Registry
Architecture Library
data in/out
Architecture Repository
maintains
Architecture Enablement
produces
used by
Architecture Enablers


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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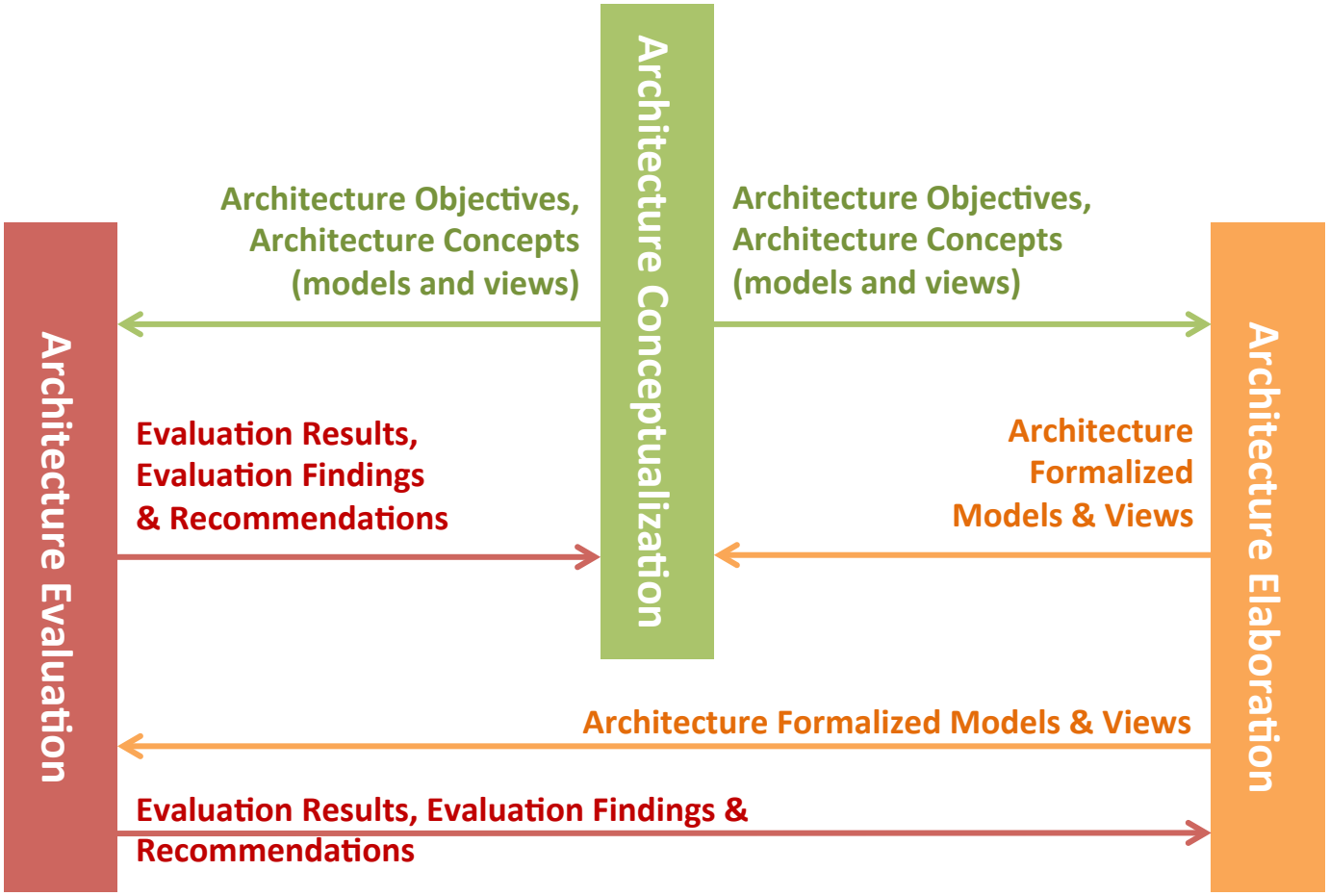
Architecture Enablement

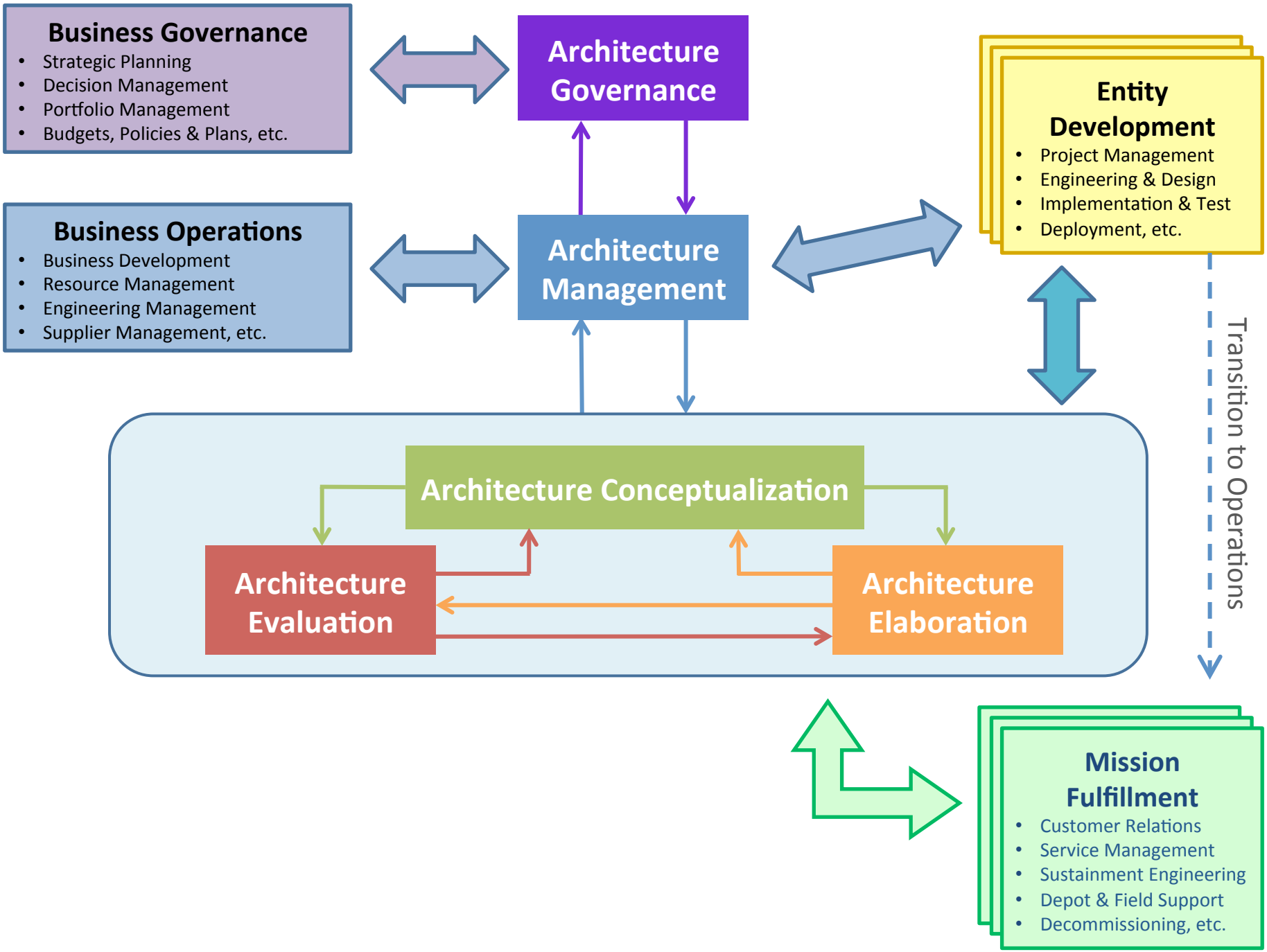
Interactions Between the Architecture Generation Processes

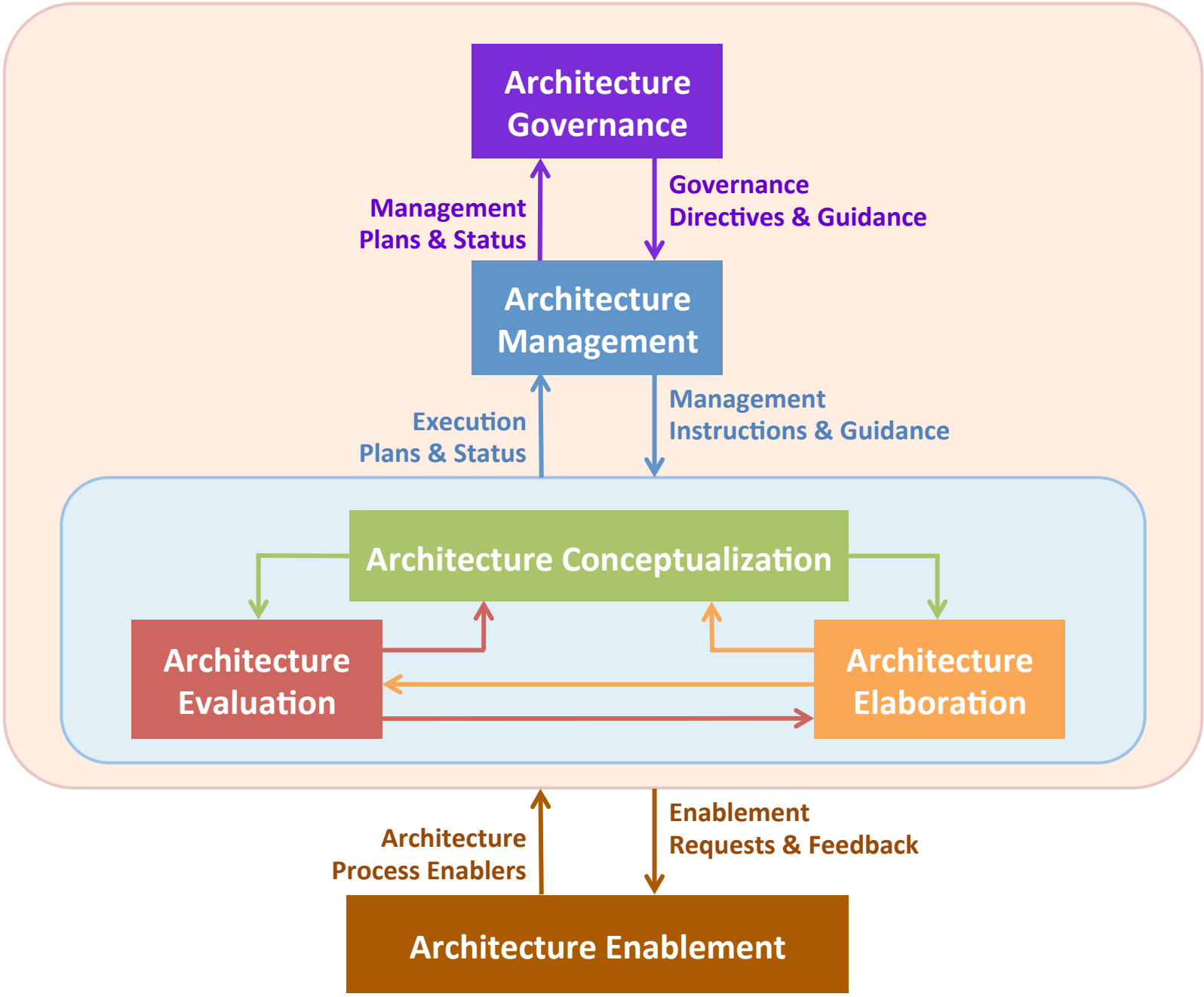


“Solutions” to be Architected…

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


Business Governance
Strategic Planning
Decision Management
Portfolio Management
Budgets, Policies & Plans, etc.
Architecture Governance
Entity Development
Project Management
Engineering & Design
Implementation & Test
Deployment, etc.
Business Operations
Business Development
Resource Management
Engineering Management
Supplier Management, etc.
Architecture Management
Transition to Operations
Architecture Conceptualization
Architecture Evaluation
Architecture Elaboration
Mission Fulfillment
Customer Relations
Service Management
Sustainment Engineering
Depot & Field Support
Decommissioning, etc.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Architecture Evaluation
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Architecture Process Enablers
Enablement Requests & Feedback
Architecture Enablement

Why Use these Architecture Processes?

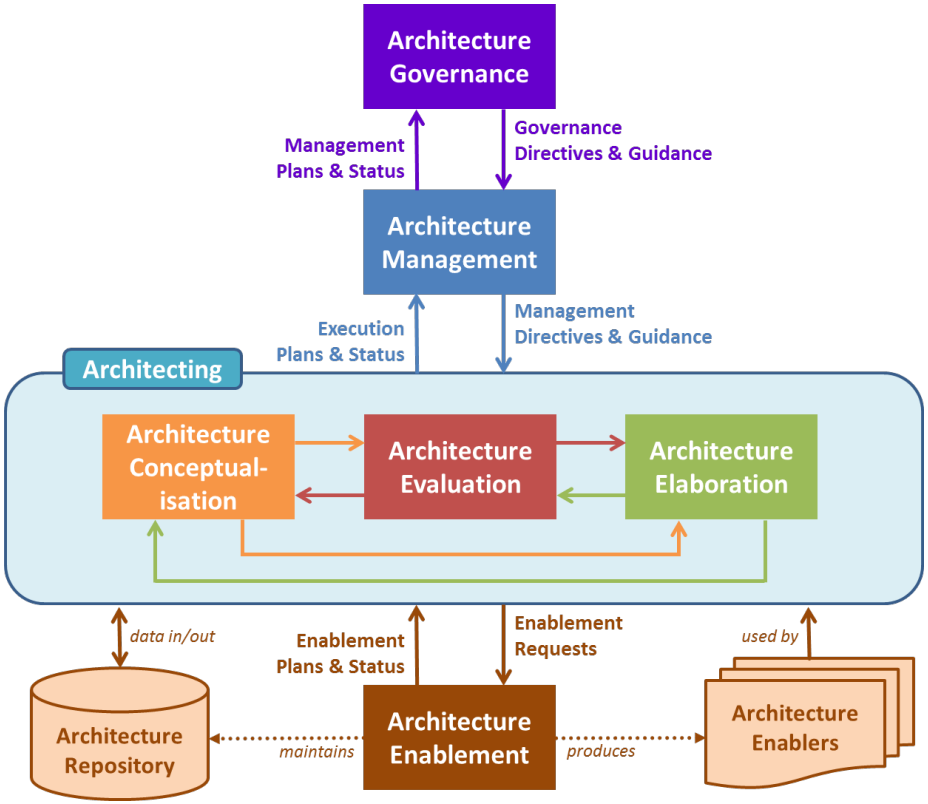
A. **Solution acquirers** to formalize the business context, evaluate providers proposals, identify alternatives, and make informed decisions

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



6 Processes → 37 Activities

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

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
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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
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6.6 Architecture Enablement Process

6.6.3.1 Prepare for and plan the architecture enablement effort
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6.6.3.3 Develop and establish enabling capabilities and resources
6.6.3.4 Deploy capabilities and resources for architecture enablement
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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

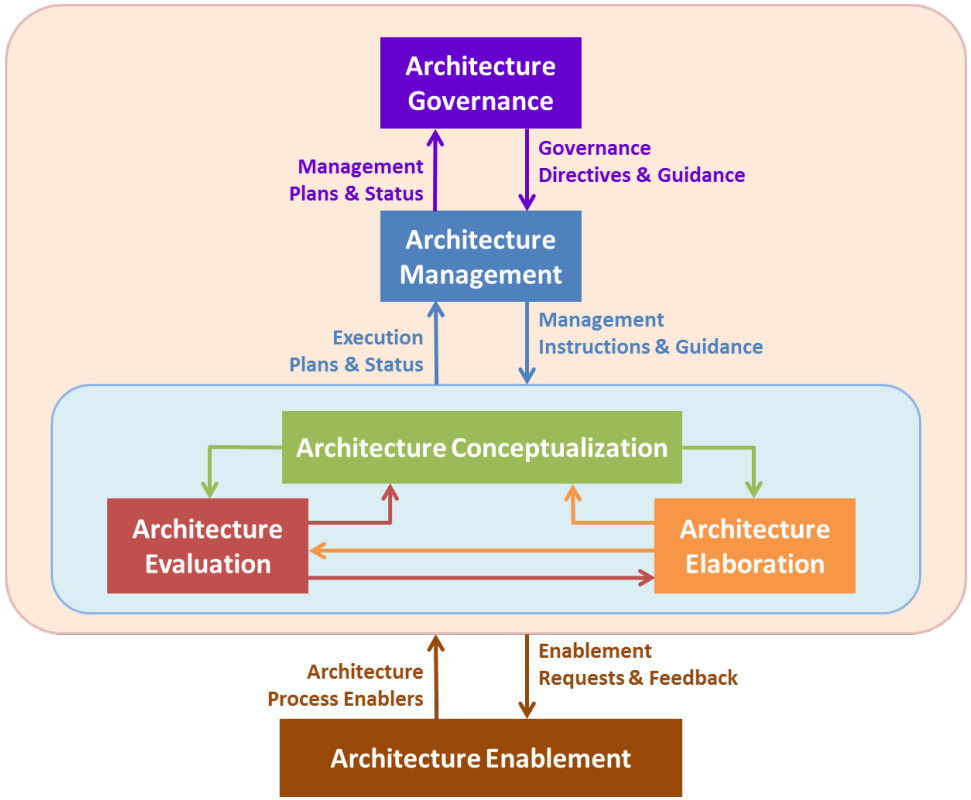
a) Identify current and projected situation(s) in the problem space.
b) Identify relevant aspects of the identified situation(s).
c) Identify problems or difficulties in the current and projected situation(s).
d) Identify stakeholders and their concerns corresponding to each of these problems or difficulties.
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



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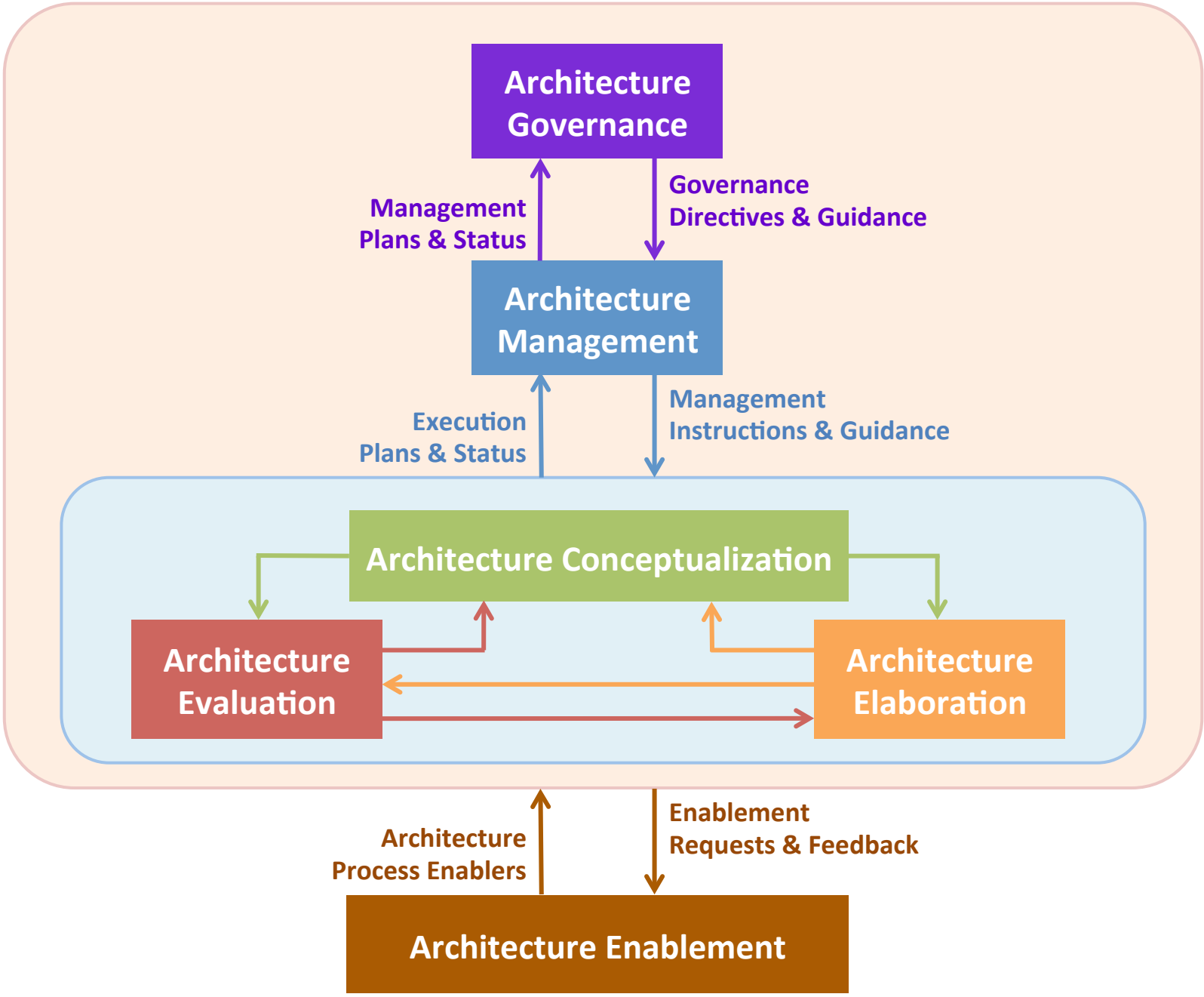
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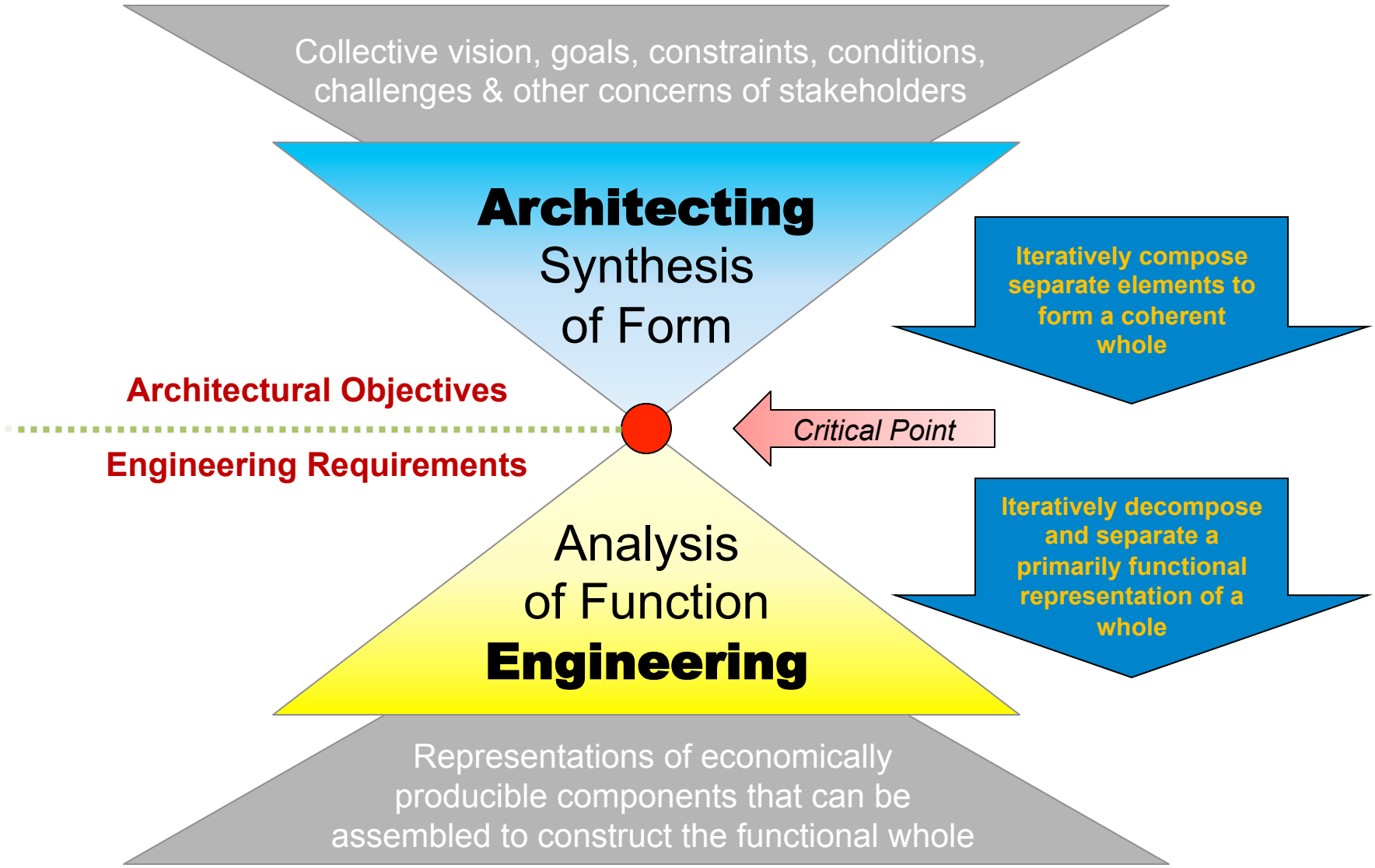
Summary

- 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

Architecting & Engineering – Two Sides of the Same Problem



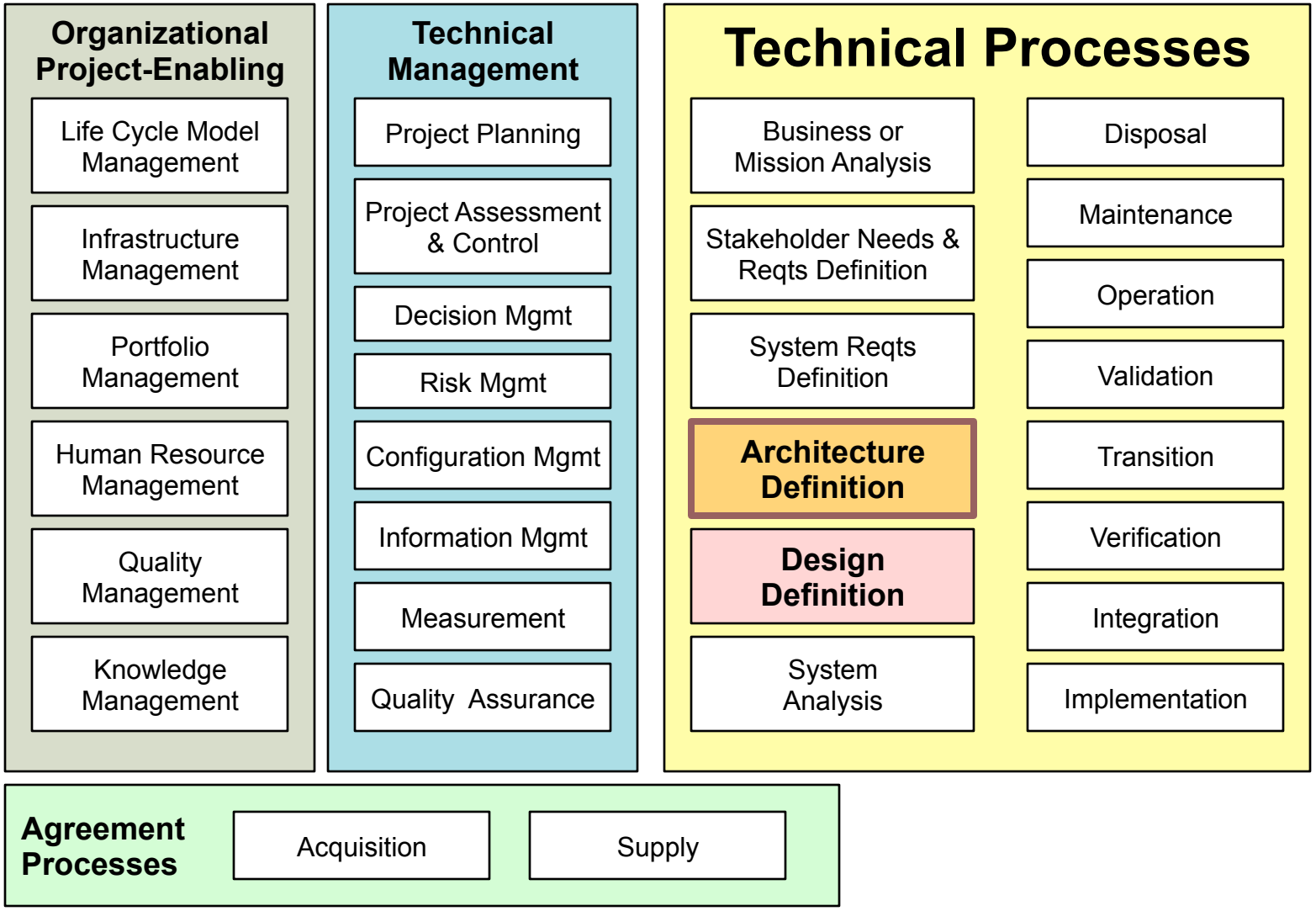
Adapted from: Walt Okon, DOD Architecture Training, 12 Dec 2007

Purpose & Scope

- **Purpose:** Provide a defined set of processes in the life cycle of an architecture or the life cycle of systems related to that architecture

- **Scope:**
  - Establishes a common framework of process descriptions for the development and use of architectures
  - Defines a set of processes and associated terminology for the architecting, managing, and governing of architectures, along with enabling activities in support of the architecting processes
  - Can be applied to either a problem situation or an opportunity pursuit situation

System Life Cycle Processes in 15288 (2015)



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

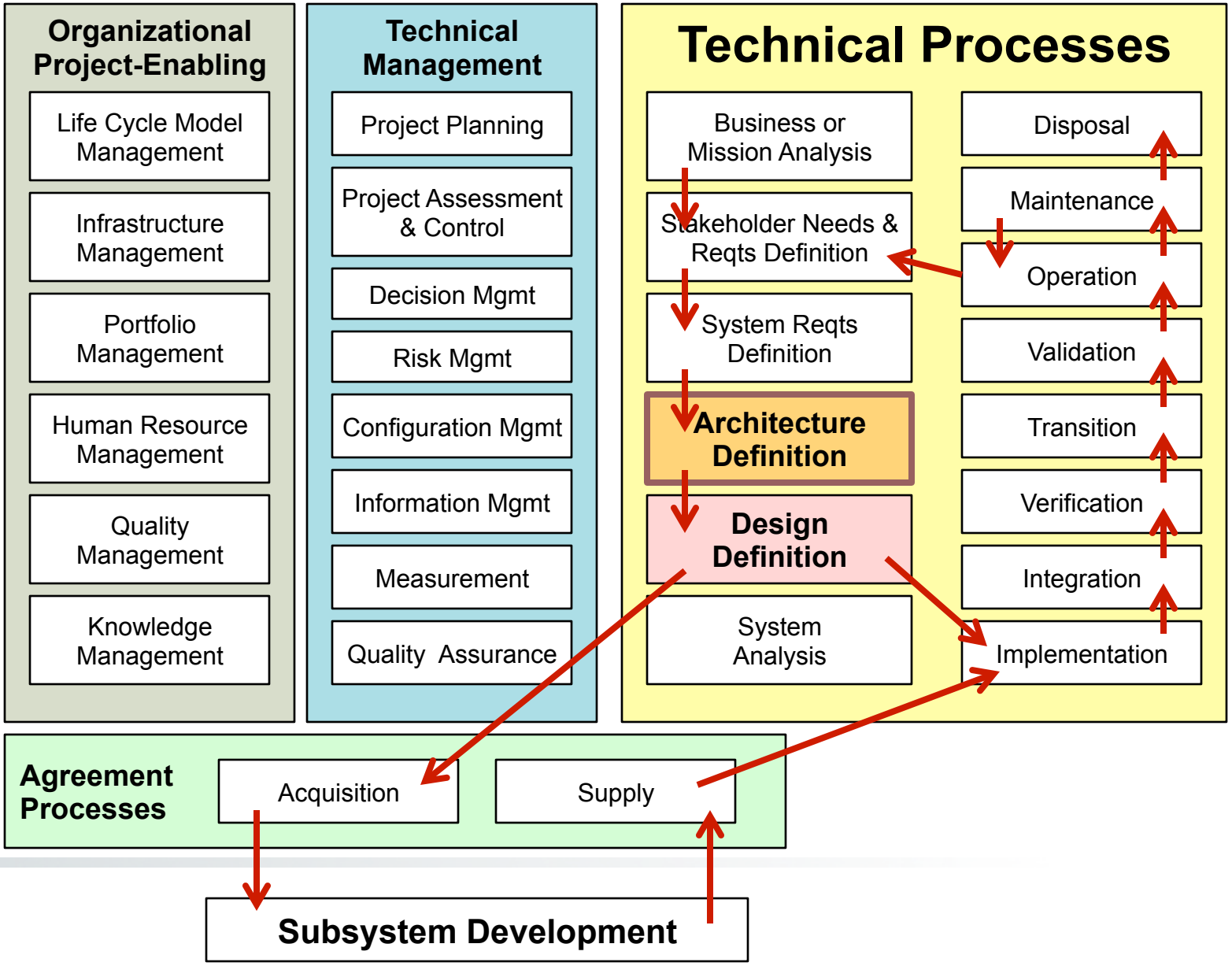
Design Definition

- Prepare for design definition
- Establish design characteristics and design enablers related to each system element
- Assess alternatives for obtaining system elements
- Manage the design

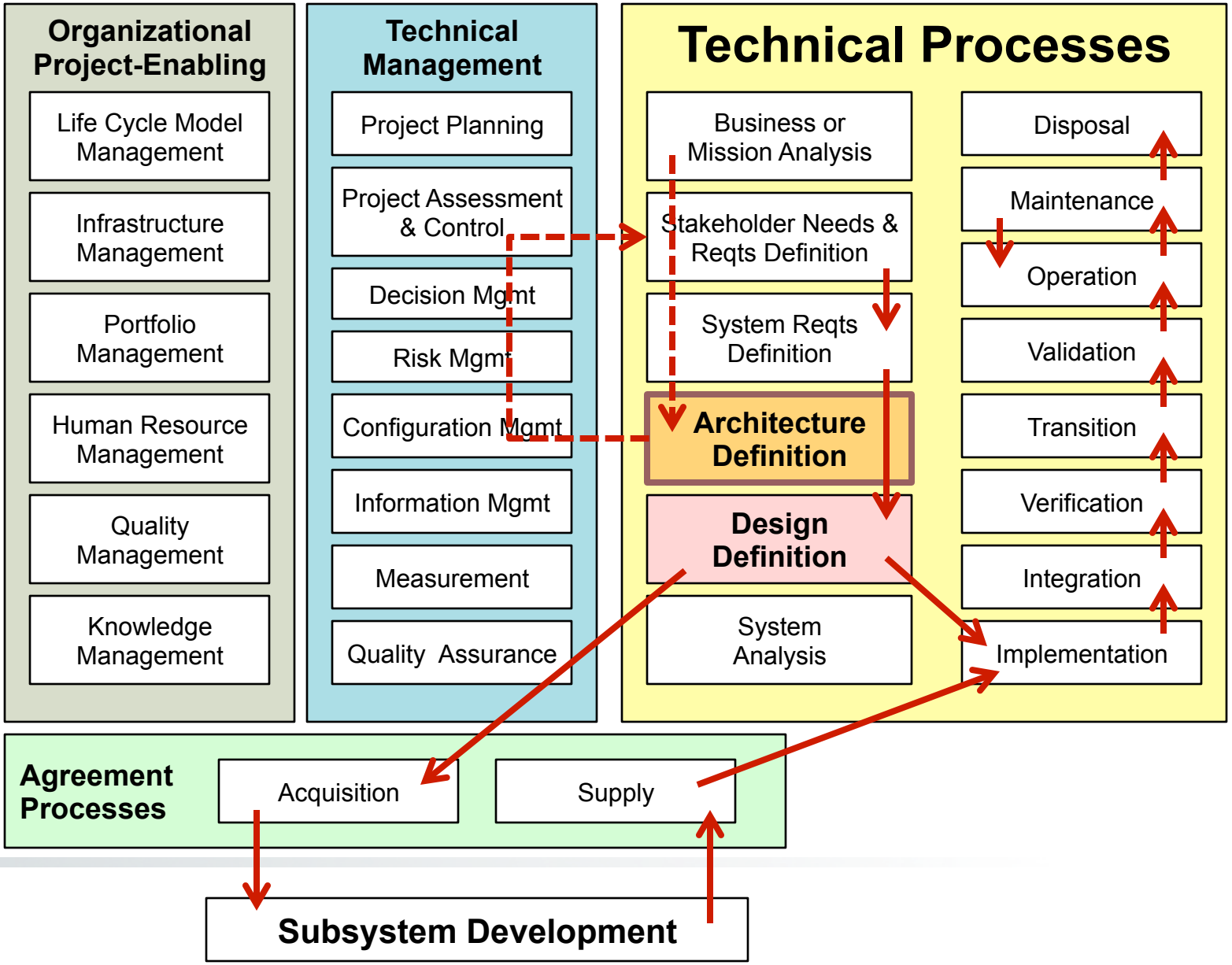
For each "system of interest" in the complete solution

For the complete solution and concerns of all stakeholders

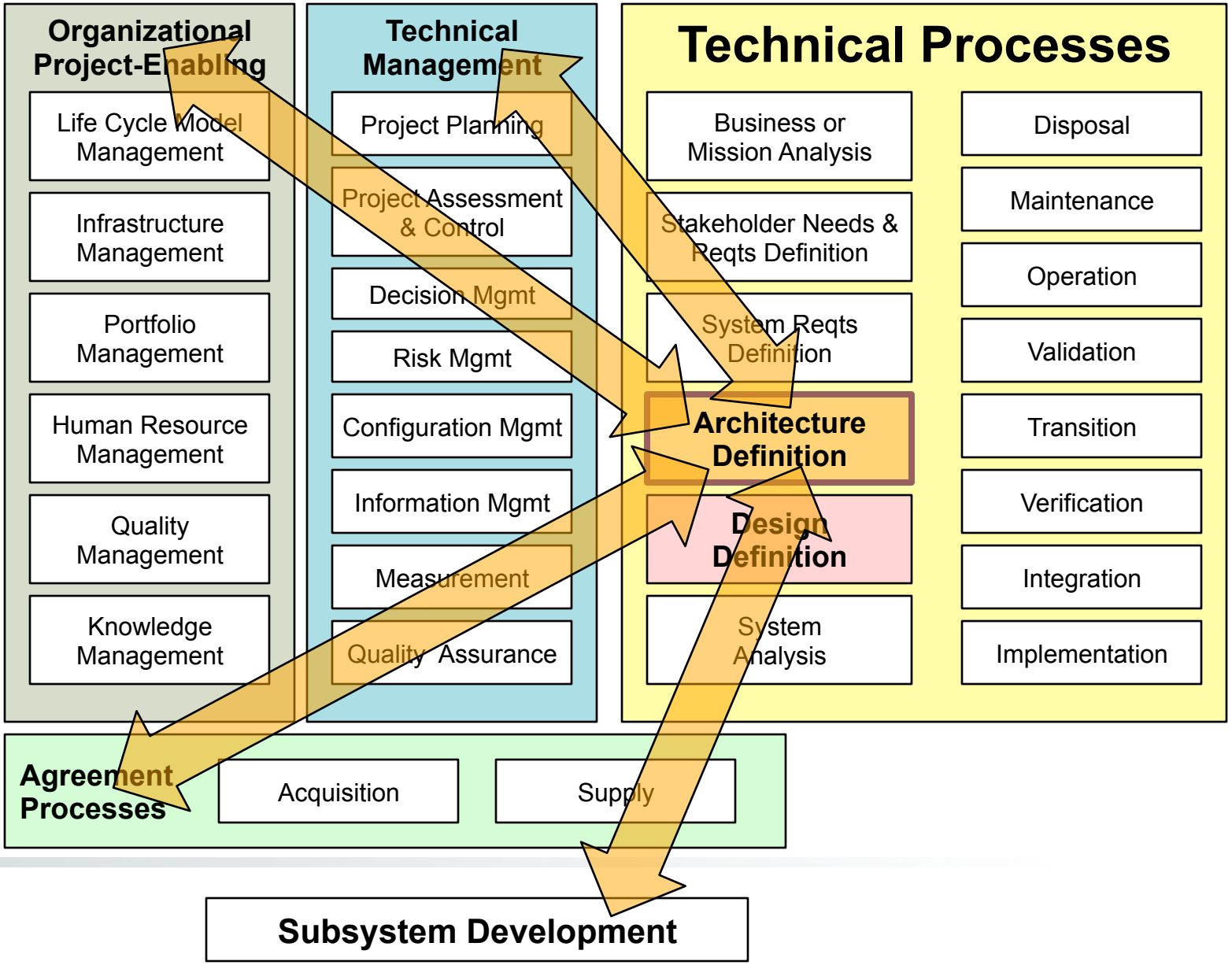
Traditional Top-Down System Development



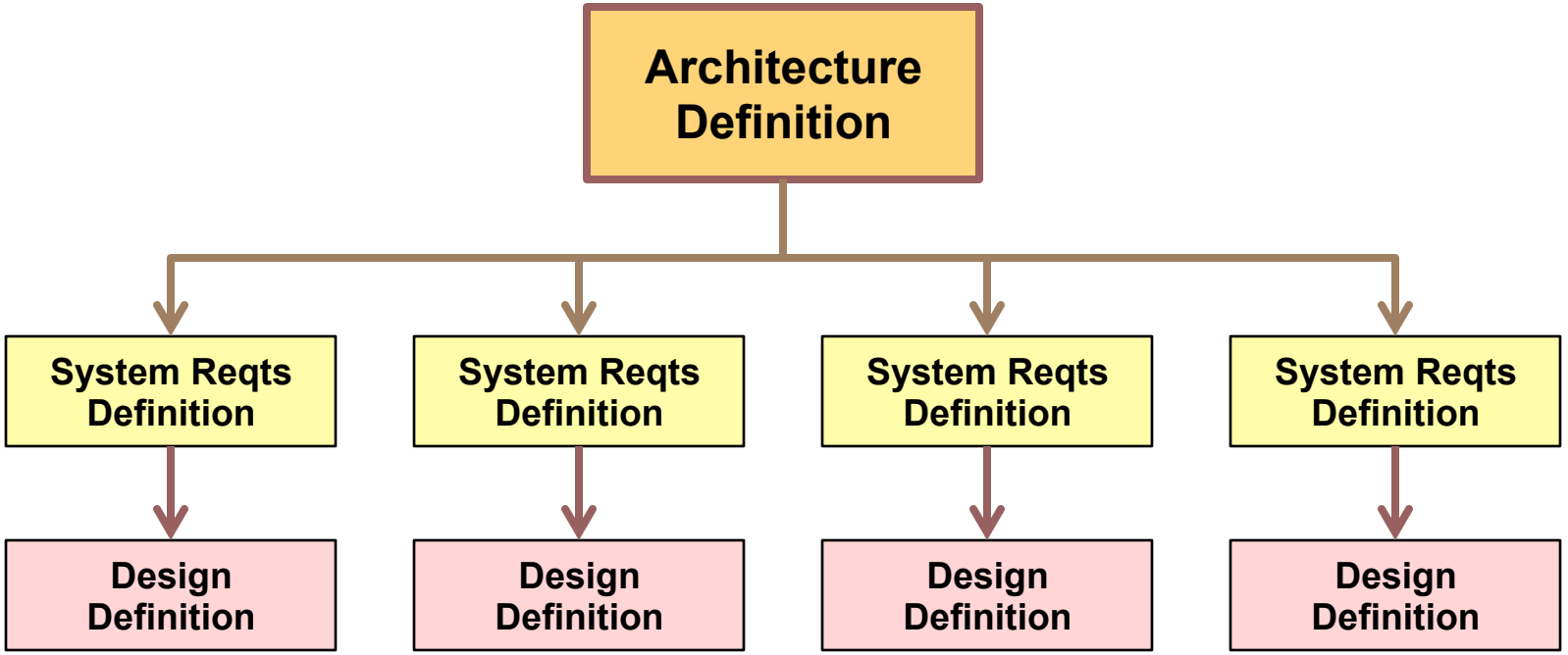
Architecture-Driven System Development



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

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