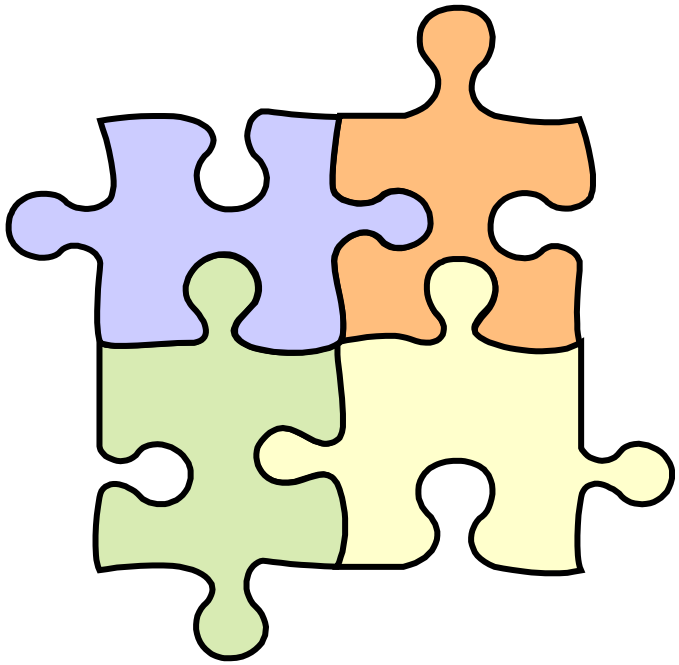


HARMONIZATION OF KEY SYSTEMS ENGINEERING RESOURCES

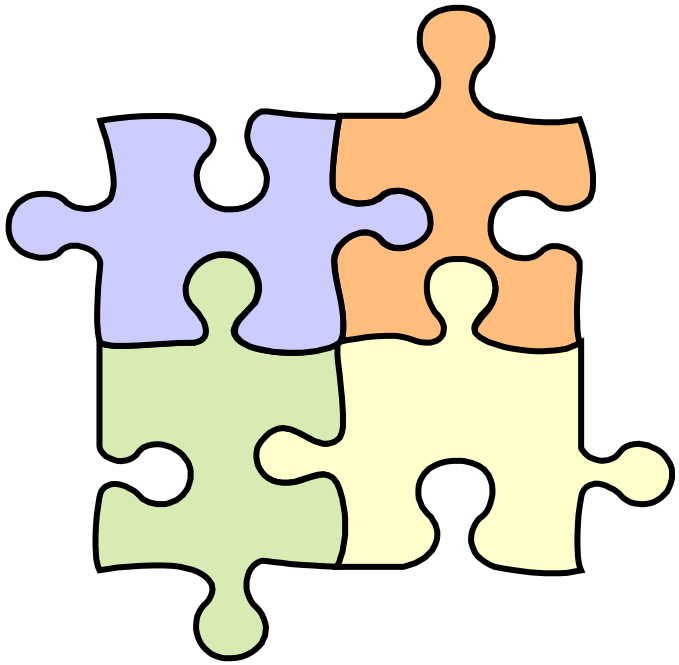
Garry Roedler, ESEP
LM Fellow

15th Annual NDIA Systems Engineering Conference
San Diego, CA | October 25, 2012

Note: This presentation is being given from the perspective of the industry association roles held by the presenter.

AGENDA

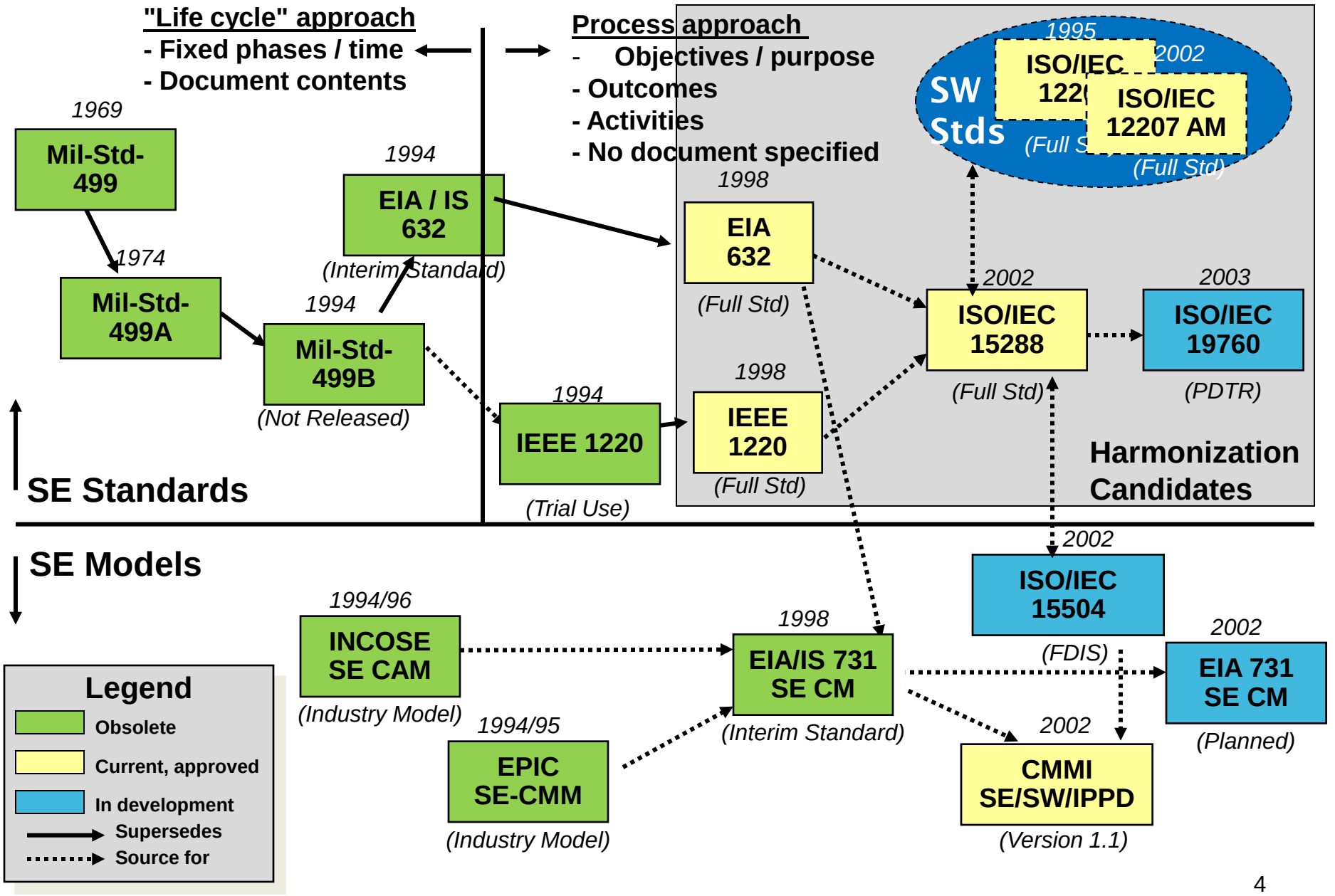
- **SE Standards Background**
- **Steps Taken Towards Harmonization**
- **Current Key SE Resources and Projects**
- **Planned Changes for Further Harmonization**
- **Application and Tailoring of Standards for Very Small Entities**



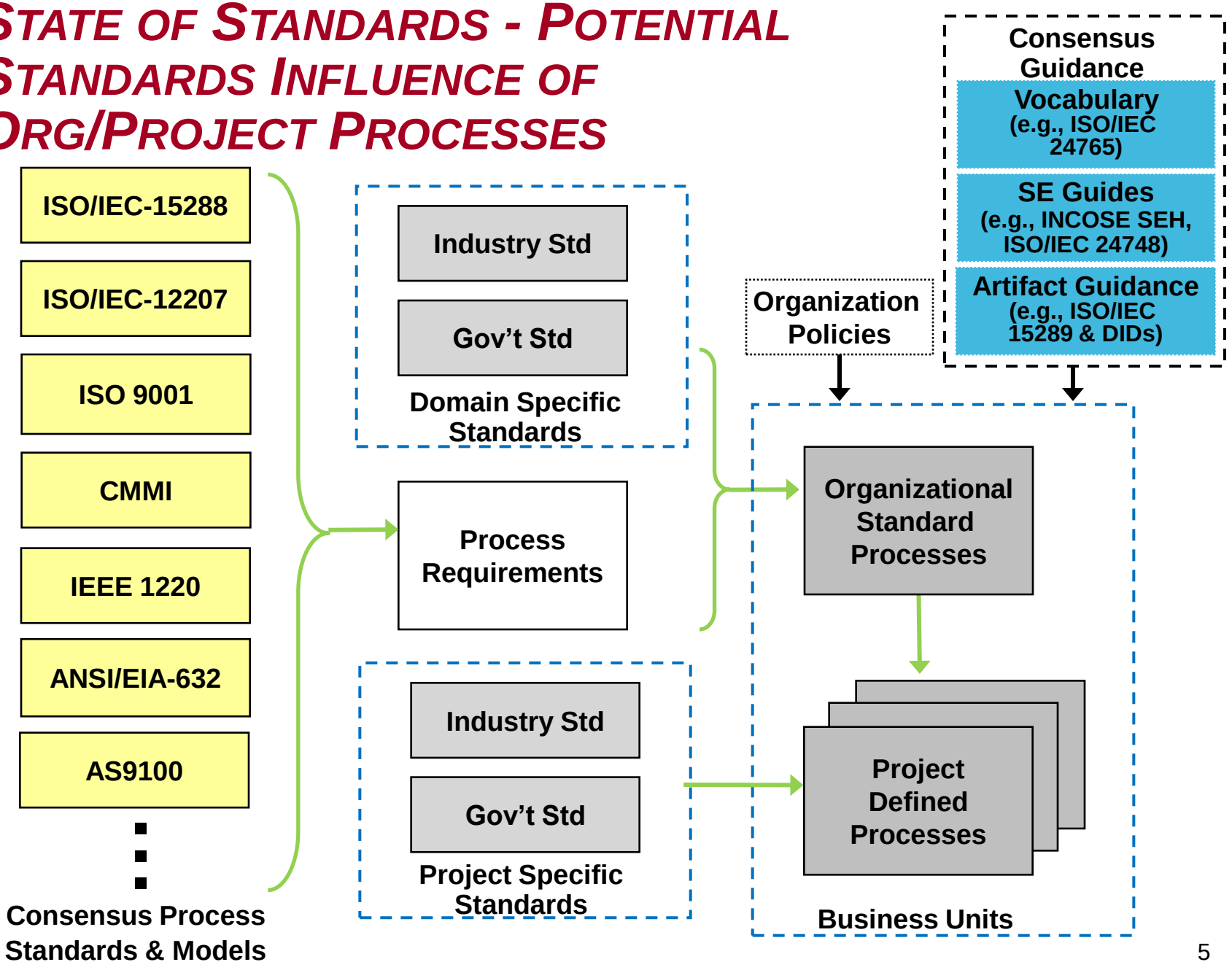
SE Standards Background

Framing the Situation

HERITAGE OF SE STANDARDS & MODELS AS OF 2002



State of Standards - Potential Standards Influence of Org/Project Processes

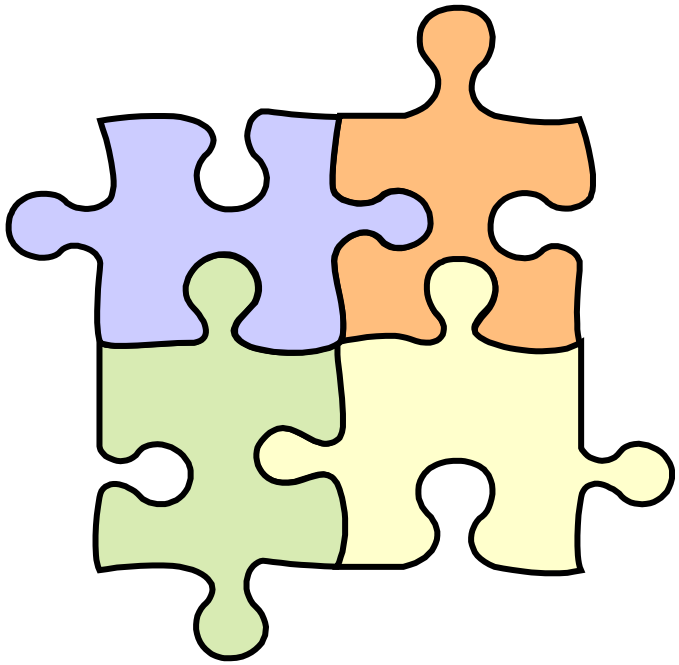


PAST PROBLEMS

- **Systems and Software standards have had different:**
  - **Terminology**
  - **Process sets**
  - **Process structures**
  - **Levels of prescription**
  - **Audiences**

- **These differences have been both between Systems and Software, and to some extent within each**

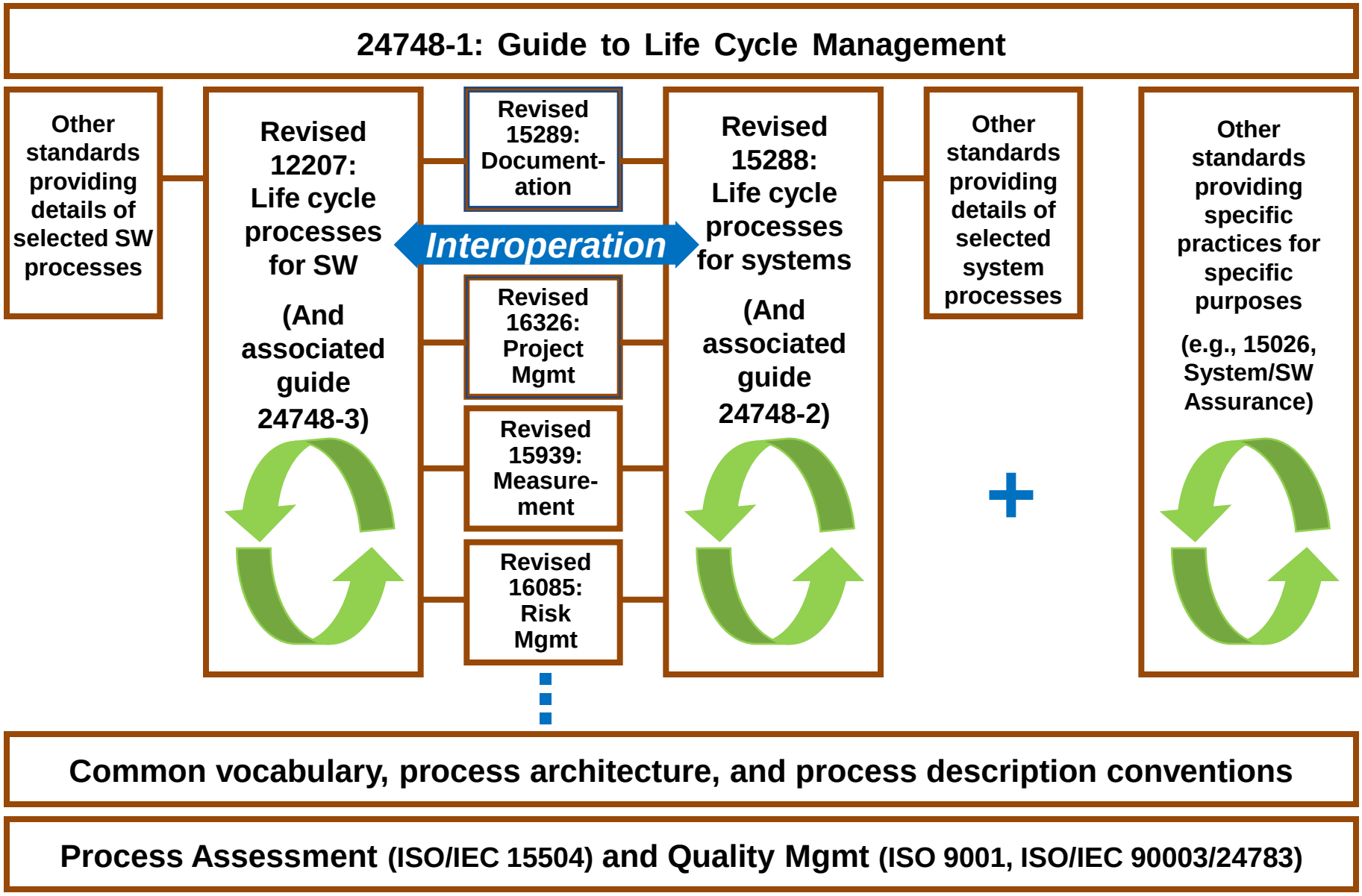
- **The problem has been exacerbated by competing standards, in whole or part**



STEPS TAKEN TOWARDS HARMONIZATION

A Look at the Journey for a Highly Effective Set of Standards

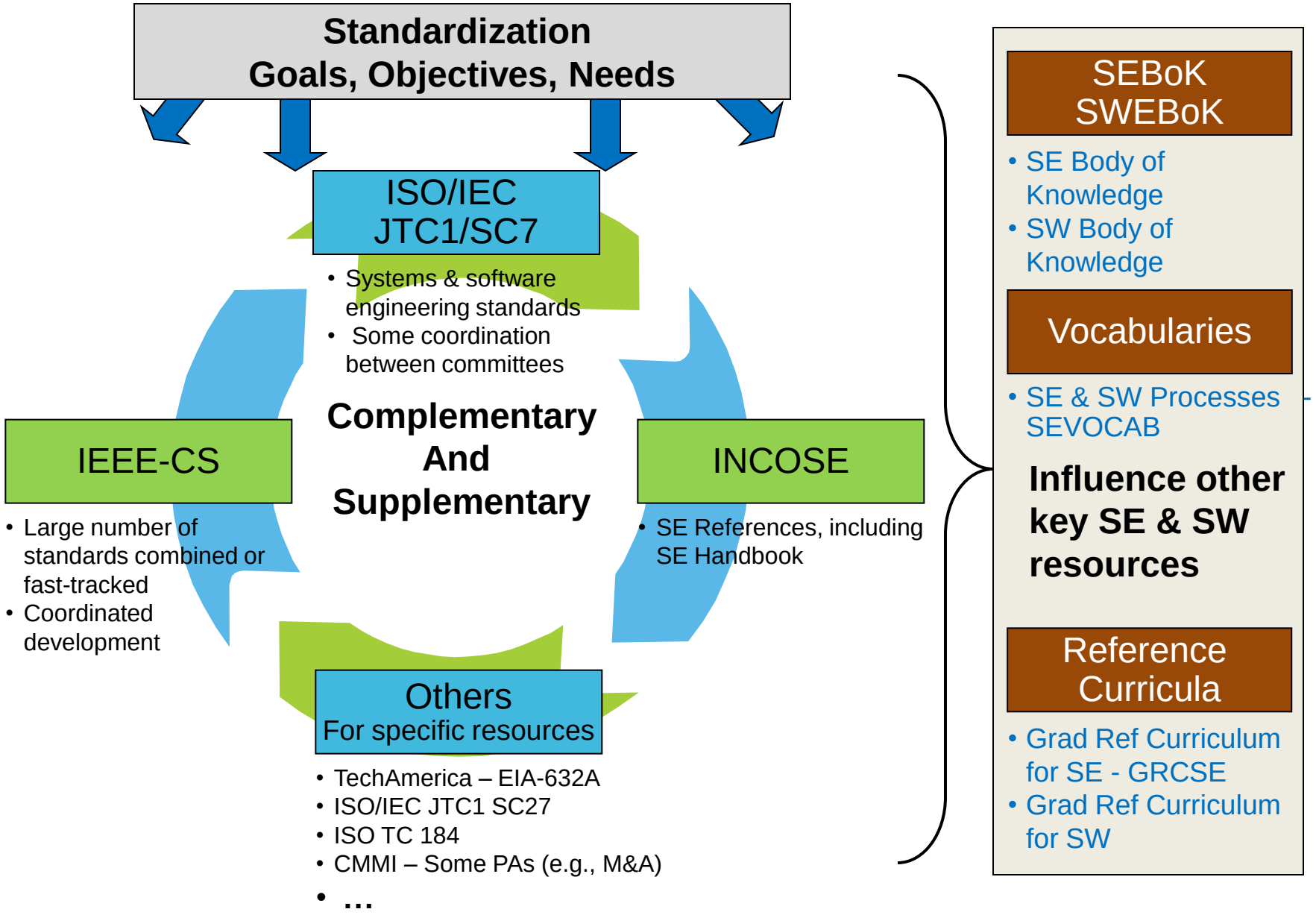
Intended Relationships of Key System & Software Engineering Process Standards After Alignment



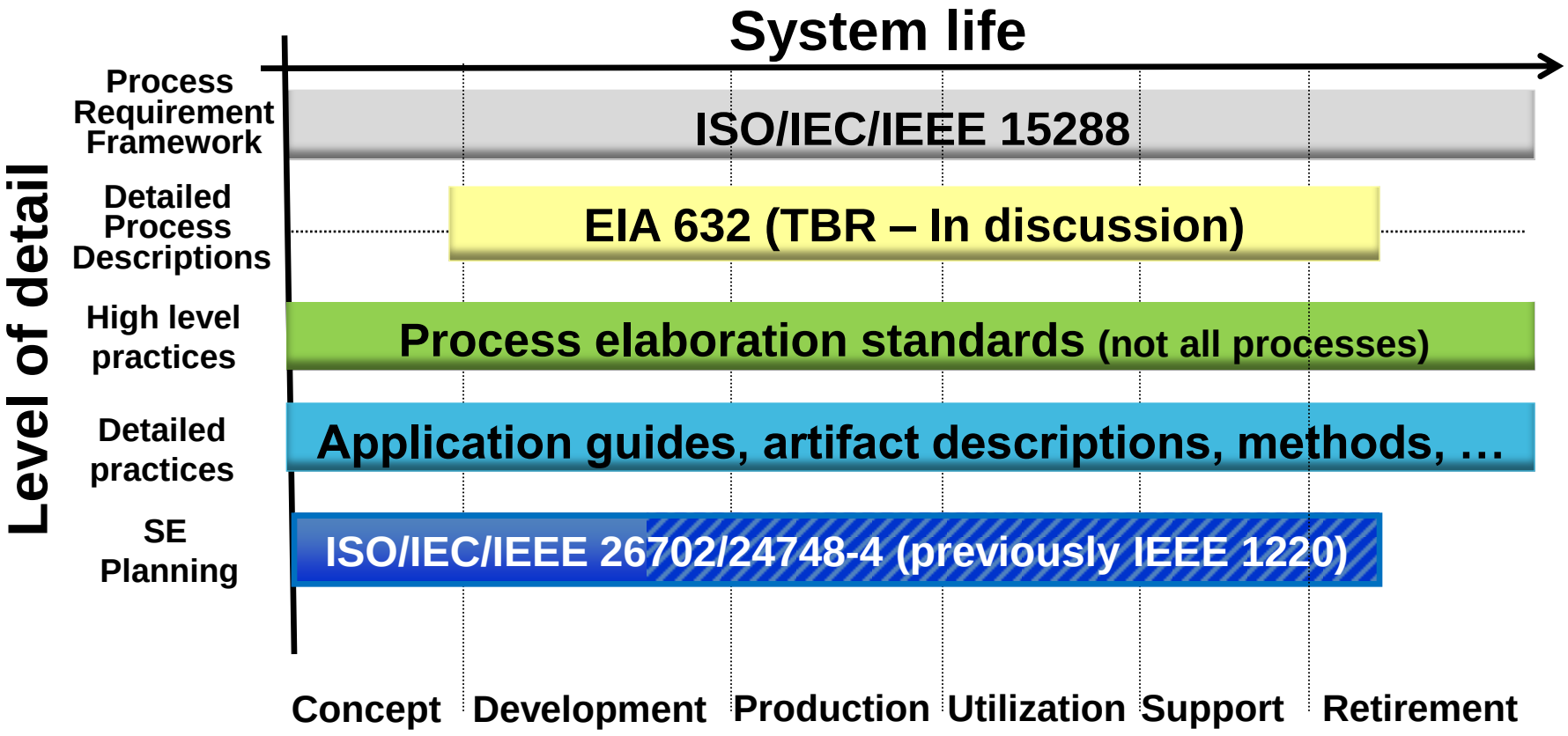
Source: Adapted from chart of James Moore, MITRE Corp. by Garry Roedler, Lockheed Martin. Used with permission from James Moore.

MITRE

GROWING INDUSTRY COLLABORATION

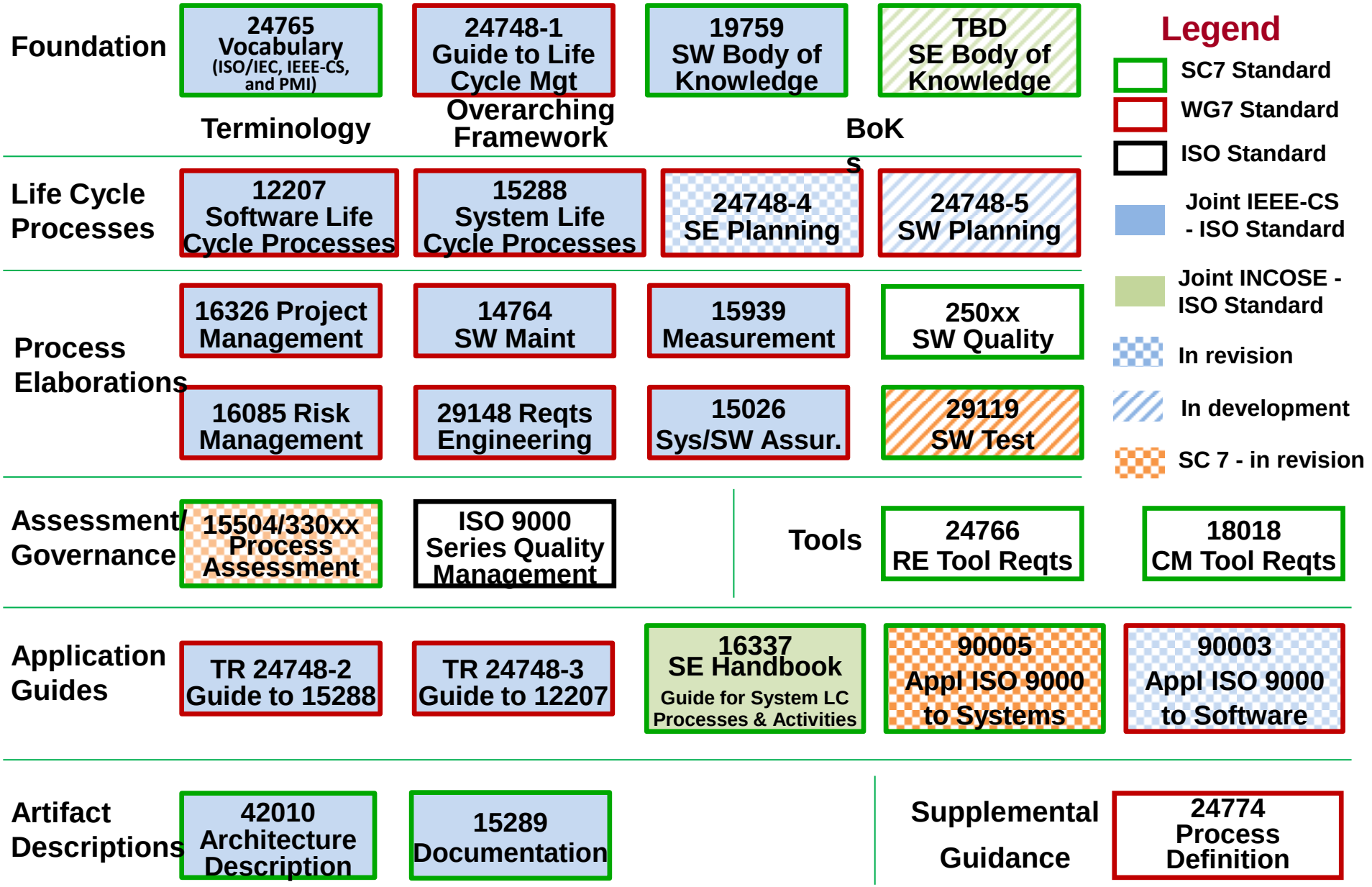


Breadth and Depth of Key SE Standards - 2012



Working to ensure a set of complementary and supplementary standards and resources

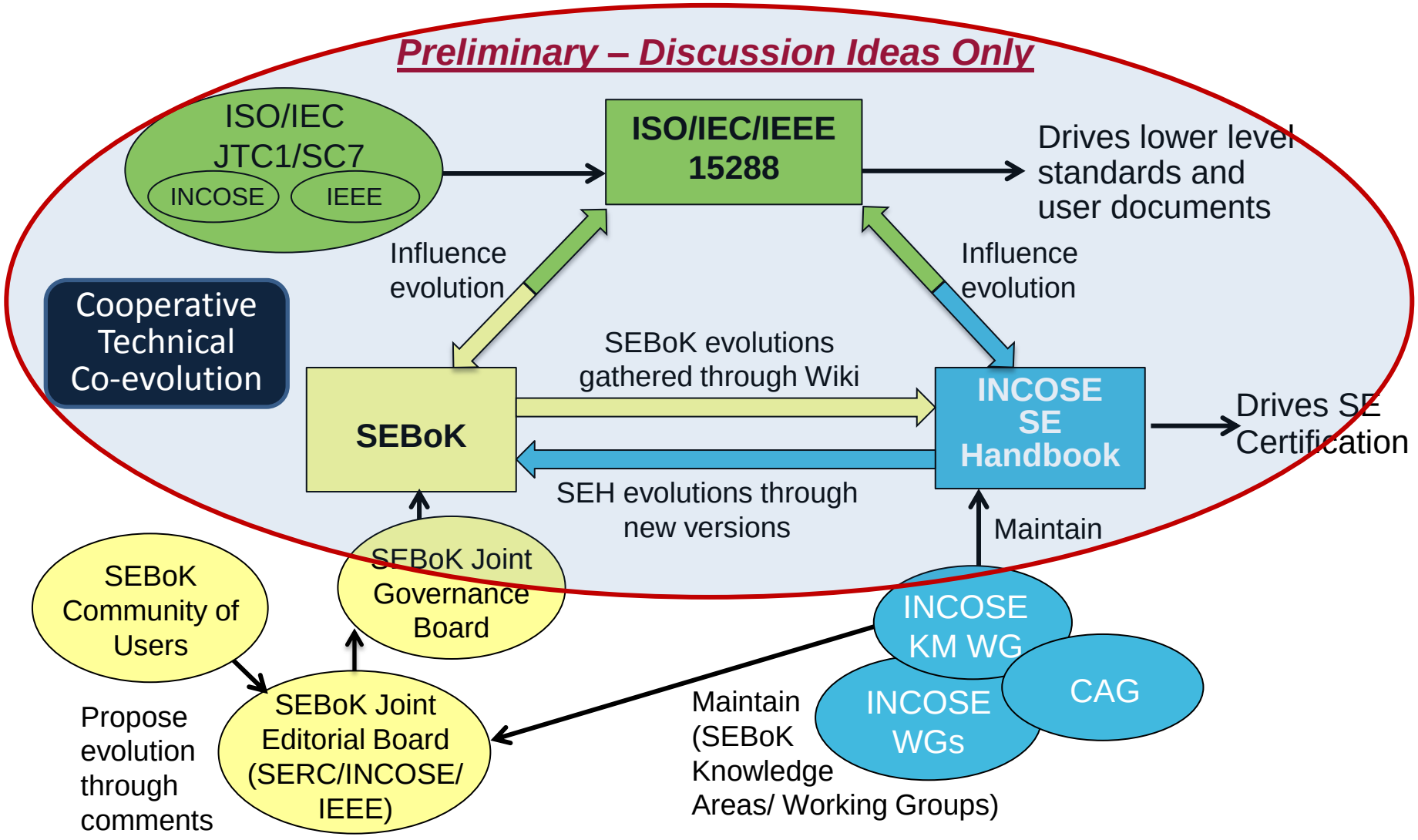
Alignment / Integration Status (2012-09-01)

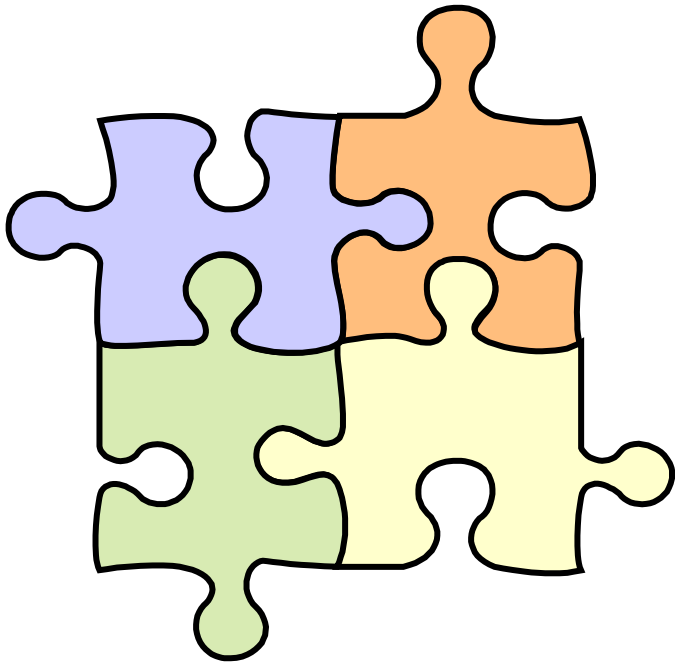


All Standards are ISO/IEC unless noted

RELATIONSHIP OF KEY SE RESOURCES

Possible interaction/relationships between SEBoK, INCOSE SEH, and ISO/IEC/IEEE 15288





Current Key SE Resources and Projects

KEY SE RELATED STANDARDS & GUIDES

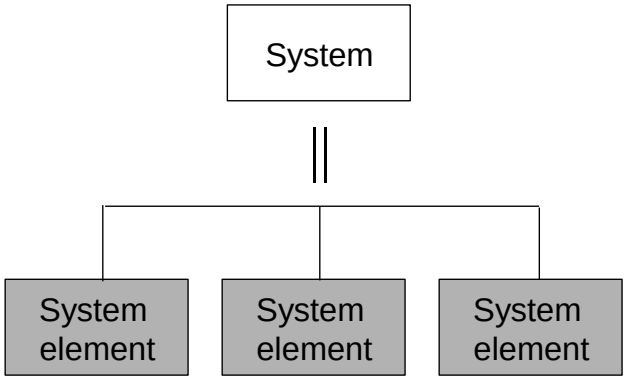
Document ID	Document Title	Comment
ISO/IEC/IEEE 15288	System Life Cycle Processes	Wide adoption including NATO, DoD, INCOSE …
ISO/IEC/IEEE 12207	Software Life Cycle Processes	SW viewed as System Element
ISO/IEC/IEEE 42010	Architecture Description	42030 in development – Architecture Evaluation
ISO/IEC/IEEE 24765	Systems and Software Engineering Vocabulary	Includes terms and definitions from ISO/IEC, IEEE, PMI
ISO/IEC/IEEE 24728-1	Guide for life cycle management	Framework Document – free at www.jtc1.org
ISO/IEC/IEEE 24748-2	Guide to 15288	Part 3 is Guide to 12207
ISO/IEC/IEEE 15026	System Assurance	4 part standard
ISO/IEC 2700x	SW Security Standards	E.g., 27001 – Security Mgt System
SEH	INCOSE SE Handbook	Serves as guide to 15288 & basis for SE Cert.
SEBoK	SE Body of Knowledge	Released in Sep 2012
DAG	Defense Acquisition Guidebook	Especially Chapter 4
ISO/IEC/IEEE 26702 (will be 24748-4)	Management of the Systems Engineering Process	Aka IEEE Std 1220 – under revision – SE Planning and SEMP focus
EIA 632	Engineering of a System	Under revision
CMMI	Capability Maturity Model – Integ.	
ISO/IEC TR 2655x	Tools & Methods for Product Lines	Tech Rpt series under development
Various others for elaboration/guidance	Subset of lower level process stds, document descriptions and guides	E.g., ISO/IEC/IEEE15939, 29148, 16085, …; NATO AAP-48

ISO/IEC/IEEE 15288 SCOPE

- **Provides a common, comprehensive & integrated framework for describing and managing the full life cycle of systems for:**
  - **Small, medium and large organizations**
  - **Internal self-imposed use, as well as providing a basis for contractual arrangements (i.e., any agreement)**
  - **Applicable to most domains**
- **Defines a set of processes and associated terminology**
  - **Can be applied at any level in the hierarchy of a system across its life cycle**
- **Applies to man-made systems configured with one or more of the following:**
  - **Hardware, software, humans, or processes**

Source: Adapted from ISO/IEC JTCI/SC7/WG7 presentation on ISO/IEC 15288.

System-of-Interest Structure

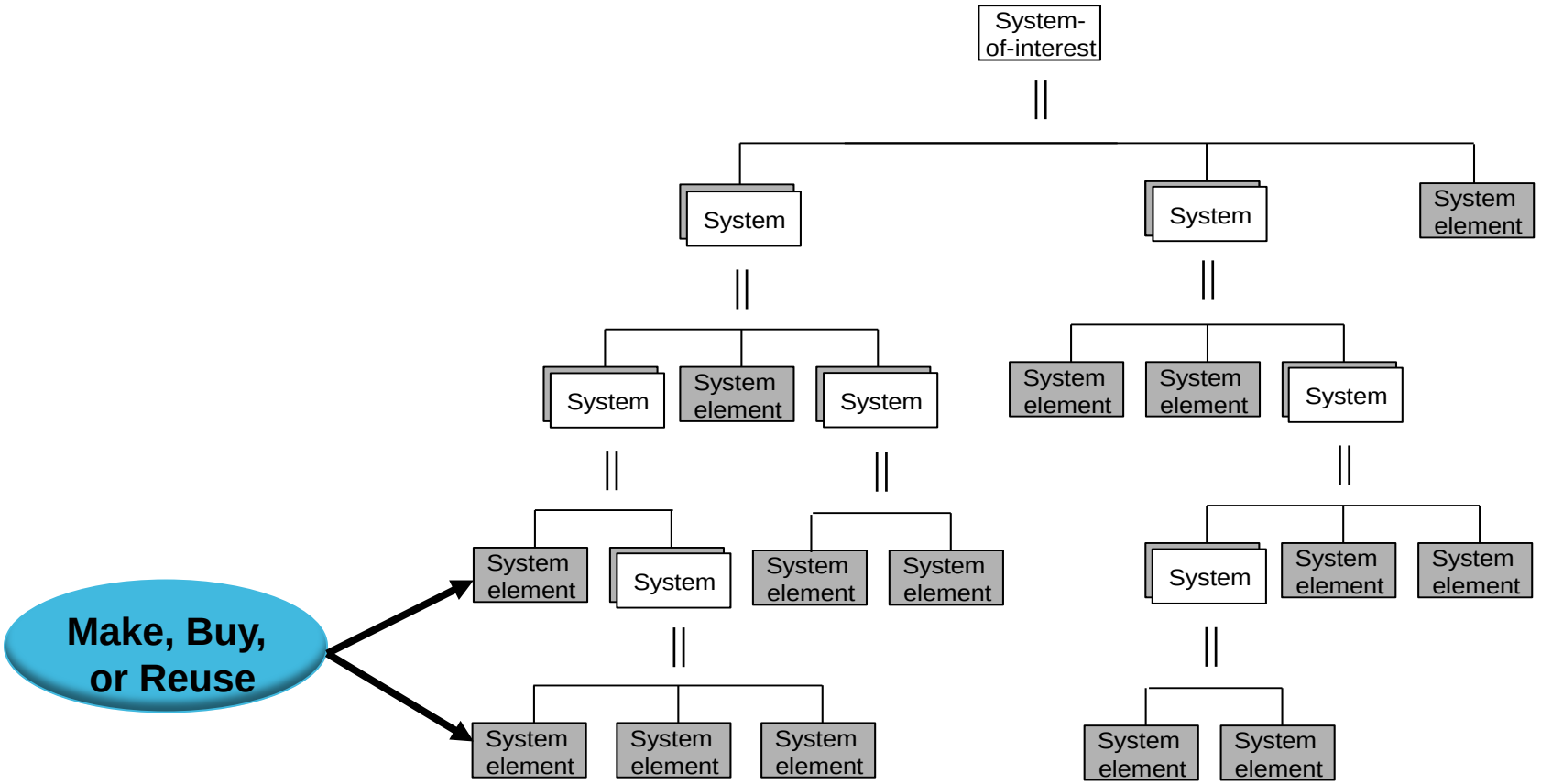


A system

is completely composed of

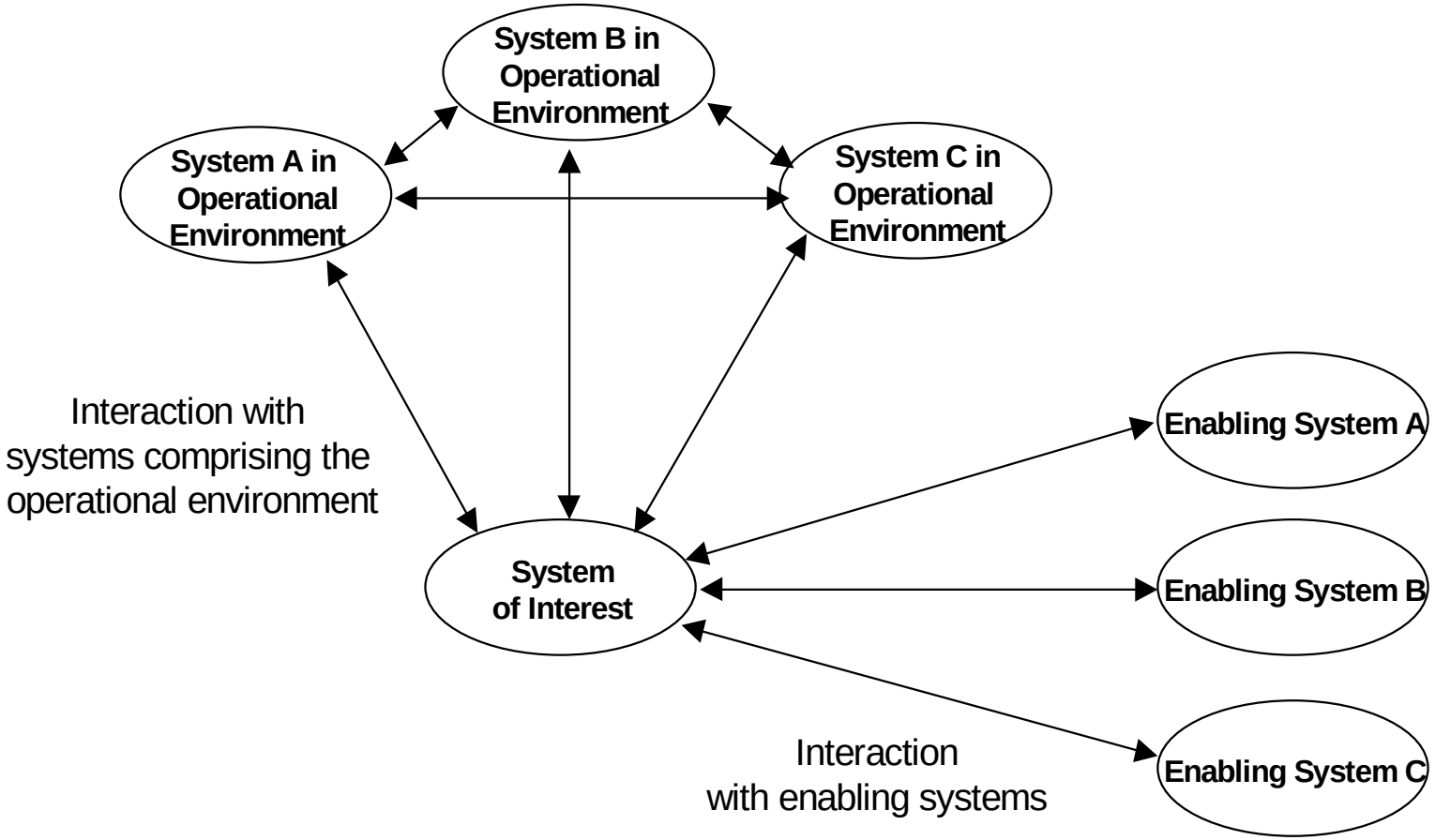
a set of interacting

system elements

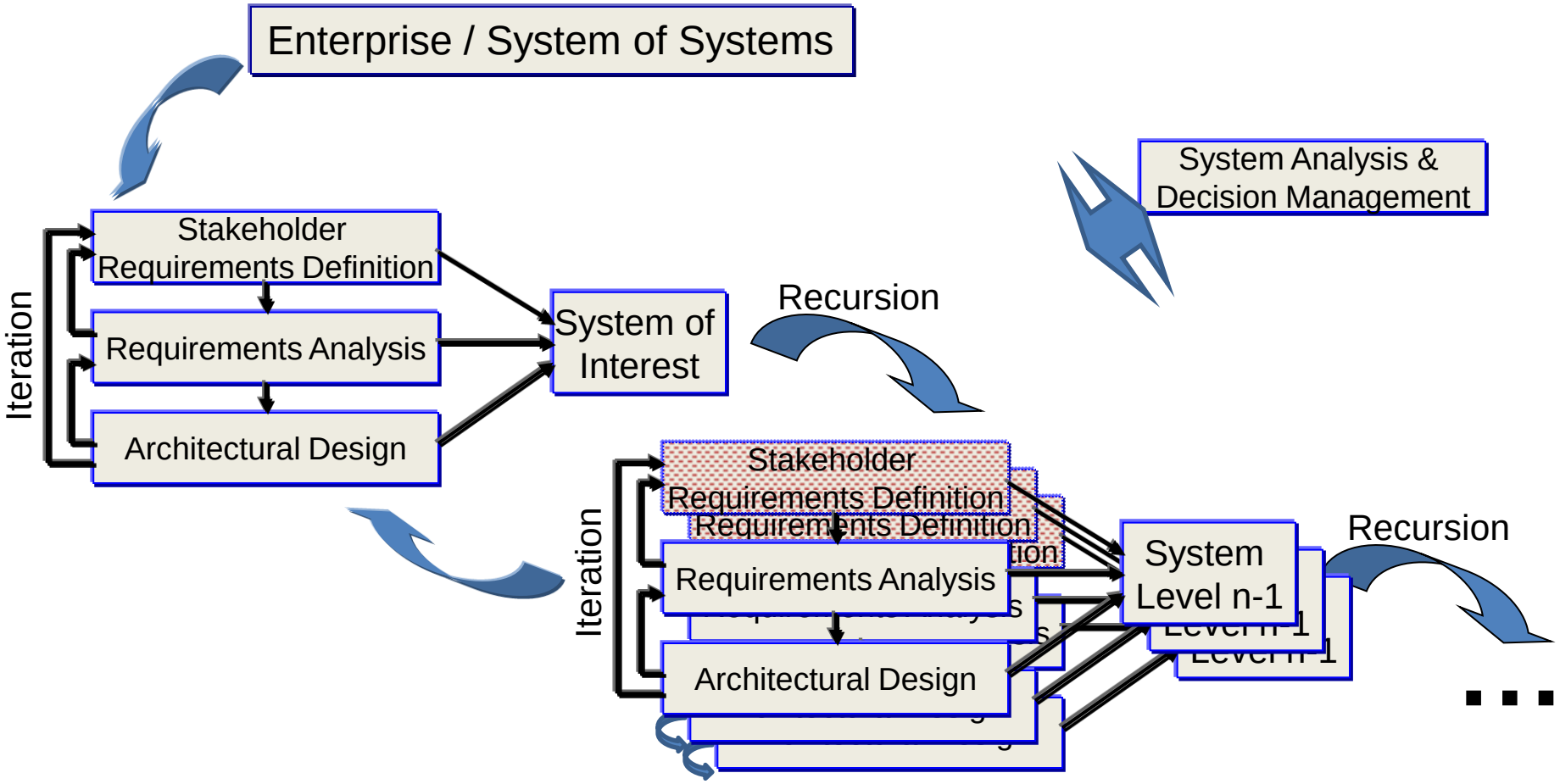


Source: ISO/IEC 15288.

System-of-Interest, Operational Environment, and Enabling Systems



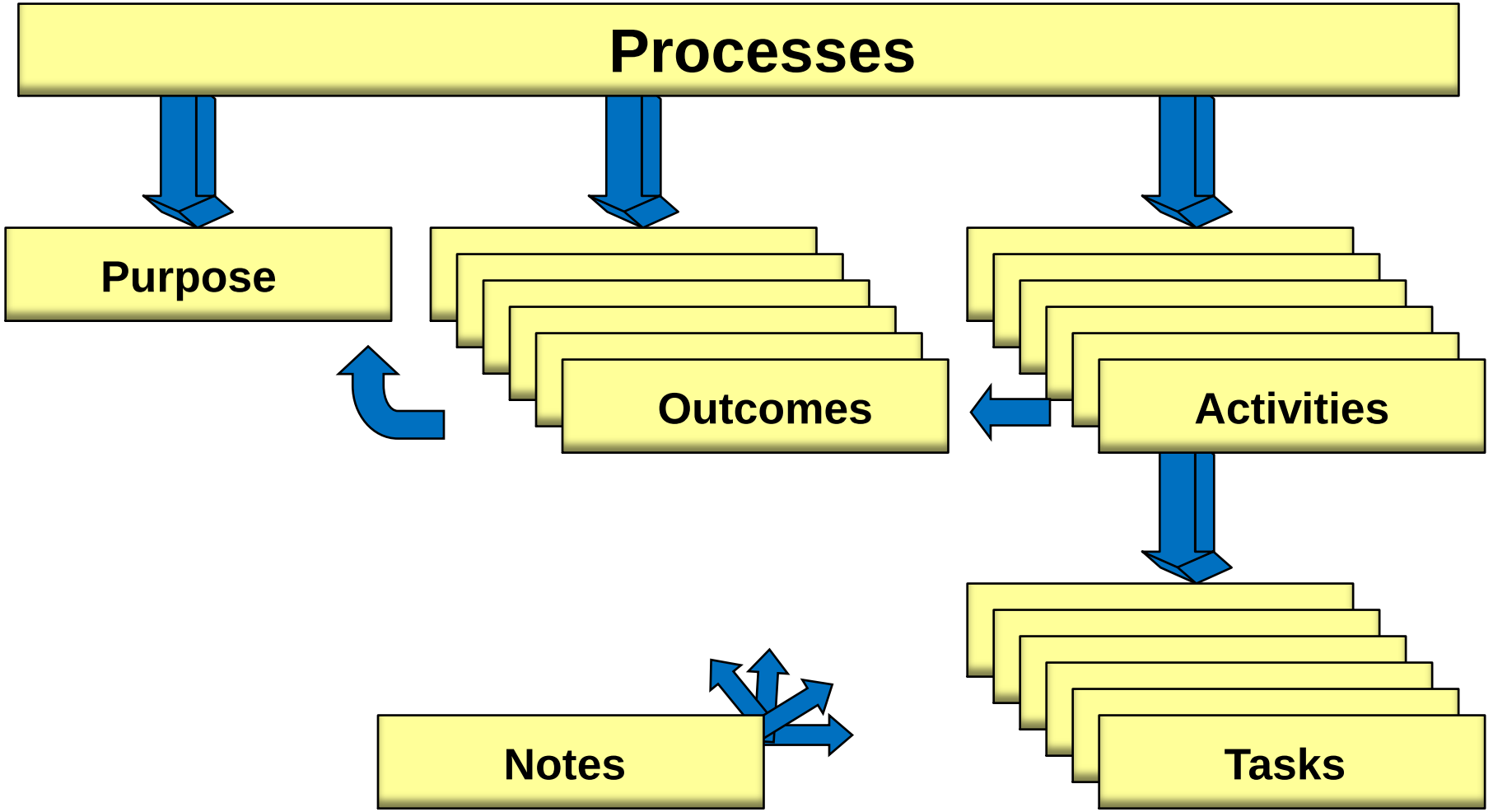
Source: ISO/IEC 15288.



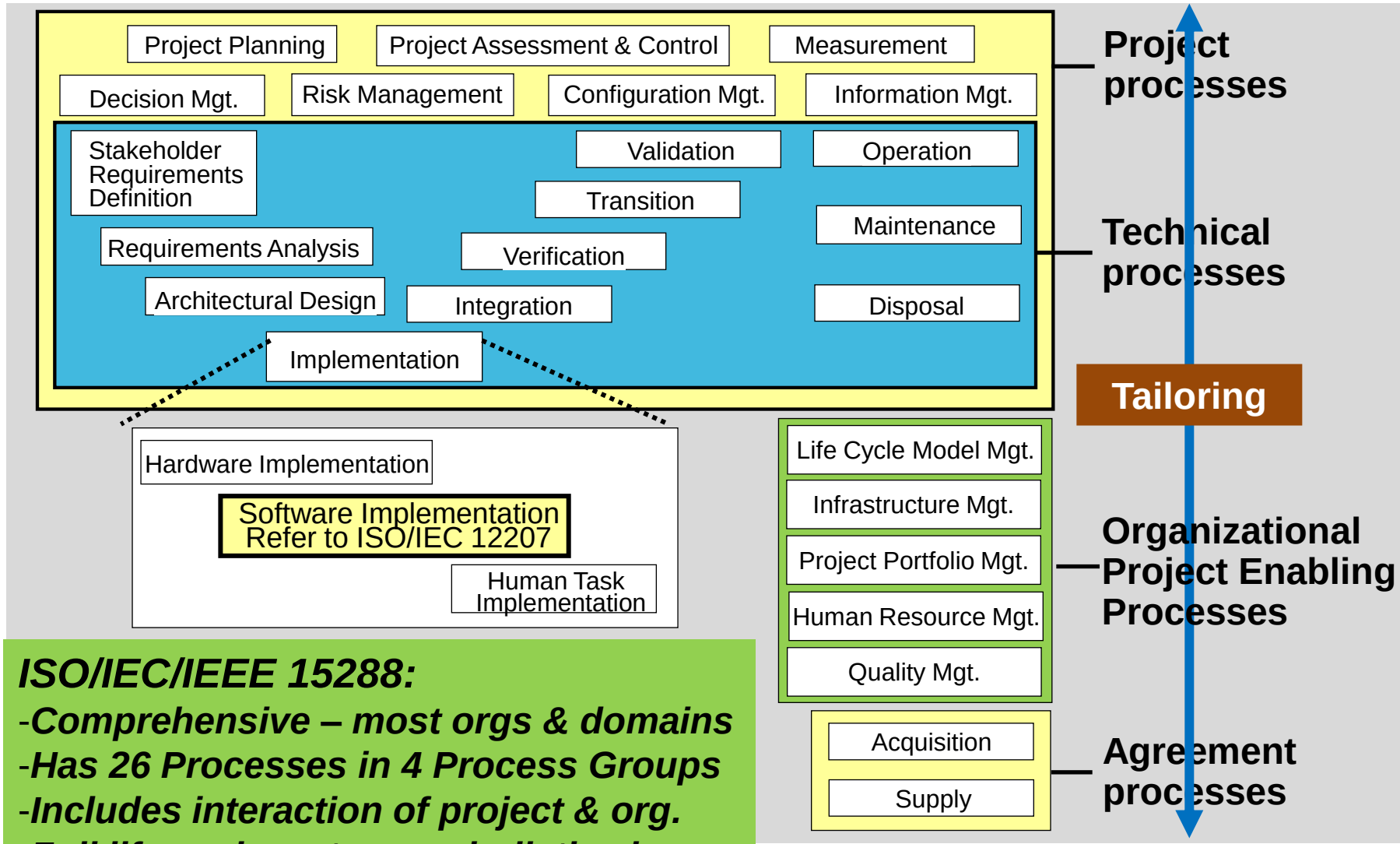
- **Iteration needed to:**
  - **Accommodate stakeholder decisions and evolving understanding**
  - **Account for architectural decisions/constraints**
  - **Resolve trades for affordability, adaptability, feasibility, resilience, etc.**
- **Recursive application for each lower level of the system hierarchy**

Adapted from ISO/IEC/IEEE 15288

ISO/IEC/IEEE 15288 Process Structure



ISO/IEC/IEEE 15288 Processes and Structure



ISO/IEC/IEEE 15288:

- ***Comprehensive – most orgs & domains***
- ***Has 26 Processes in 4 Process Groups***
- ***Includes interaction of project & org.***
- ***Full life cycle – stages – holistic view***
- ***Based on proven practices***

Source: Adapted from ISO/IEC JTCI/SC7/WG7 presentation on ISO/IEC 15288.

Industry Adoption of 15288 and Aligned Products

- **ISO/IEC/IEEE 15288, System Life Cycle Processes**
  - **INCOSE**
    - Adoption for processes and organization of SE Handbook
    - Referred to for SE Certification
  - **US DoD**
    - Adoption of ISO/IEC 15288 as acceptable standard for system life cycle processes
    - Defense Acquisition Guide (chap 4) aligns to and leverages
  - **NATO**
    - Adopted as an acceptable standard; created addendum AAP-48
  - **US Dept of Transportation / CA Dept of Transportation**
    - Referenced and leveraged in Systems Engineering Guidebook for Intelligent Transportation Systems
  - **Swedish Defence Material Administration and Swedish Armed Forces**
    - Process standard for their value added production
  - **Dutch Dept of Transportation**
  - **Defense companies**
    - Adopted by many defense companies
    - Used to form process requirements
  - **Many others**
    - Many presentations on usage from various type and size companies

WHAT IS BKCASE™?

- **Project to create:**
  - **Guide to Systems Engineering Body of Knowledge (SEBoK) – scope is engineered and socio-technical systems; implemented as a wiki**
  - **Graduate Reference Curriculum in Systems Engineering (GRCSE™)**
- **Started Sept 2009; publications expected in Sep/Dec 2012**
- **Intended for world-wide use – all products free**
- **Community-based authorship and review**

Location	Number
United States	44
Europe (UK, France, Sweden)	11
Asia-Pacific (Singapore, Japan, China, Australia)	7
Latin America (1 country)	1

Segment	Number
Academia	30
Industry	24
Government	3
Professional Societies	6

Sponsors / Investigators

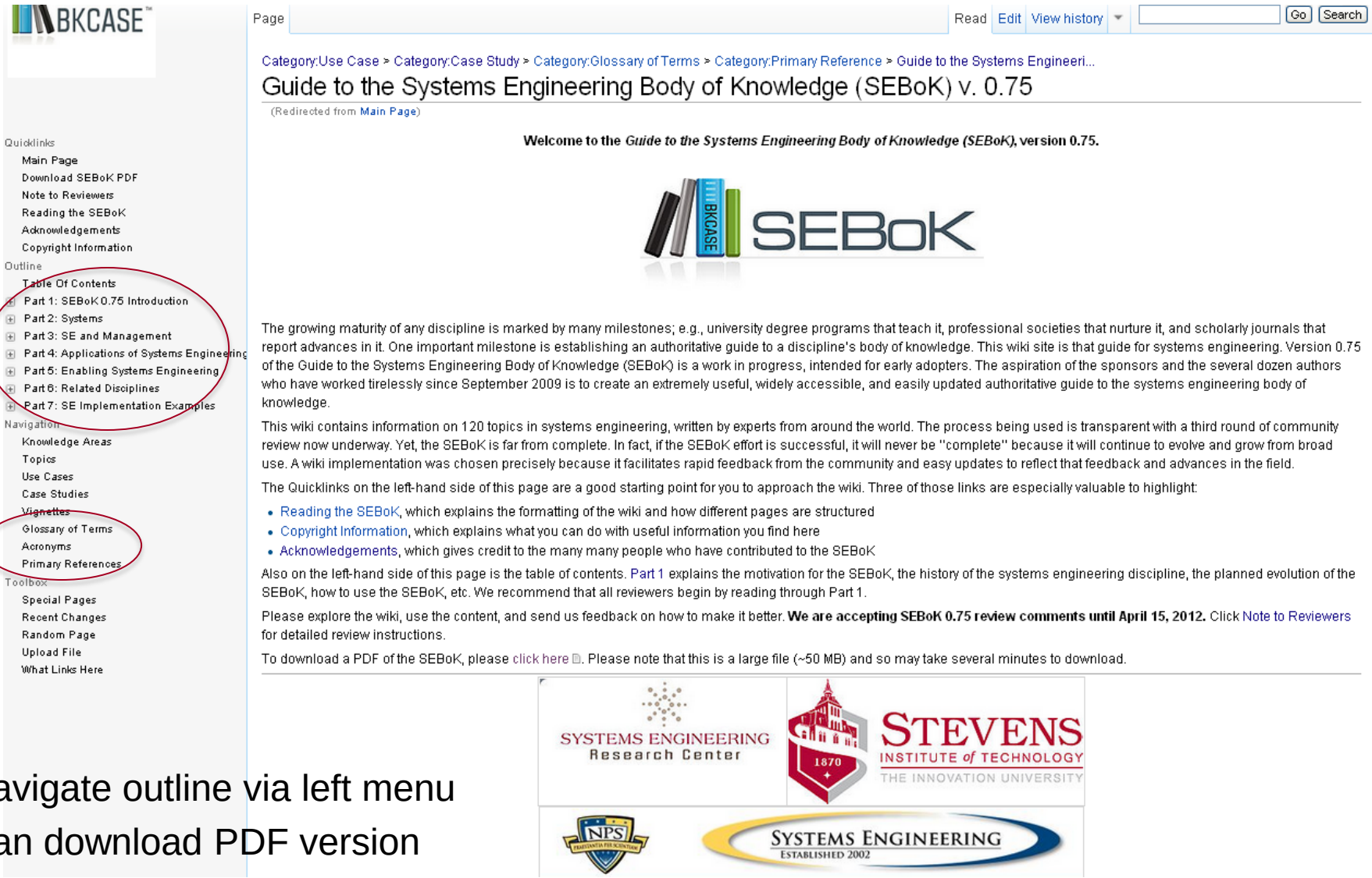
Supporters / Stewards

Other Supporters

SEBoK Table of Contents

Part 1:	A guide to the SEBoK itself; e.g., Why does it exist? What is in it? How will different people use it?
Part 2:	A guide to knowledge about systems; e.g., What types of systems exist? What fundamental principles help explain systems?
Part 3:	A guide to knowledge about generic SE practice; e.g., How is SE performed? What are typical SE activities?
Part 4:	A guide to knowledge about the application of SE in products, services, enterprises, and systems of systems; e.g., how is the generic information in Part 3 tailored when applying to different system types?
Part 5:	A guide to knowledge about enabling SE; e.g., When is SE performed? Who performs it? How does culture affect it?
Part 6:	A guide to knowledge about related disciplines and specialties; e.g., How are software engineering, industrial engineering, and project management related to SE? How do safety, reliability, and other “ilities” relate to SE?
Part 7:	Implementation examples; e.g., What do existing case studies and vignettes reveal about SE knowledge and practice? How does SE practice vary by domain and system type?

WWW.SEBOKWIKI.ORG



- Navigate outline via left menu
- Can download PDF version
- “Note to reviewers” in the left menu

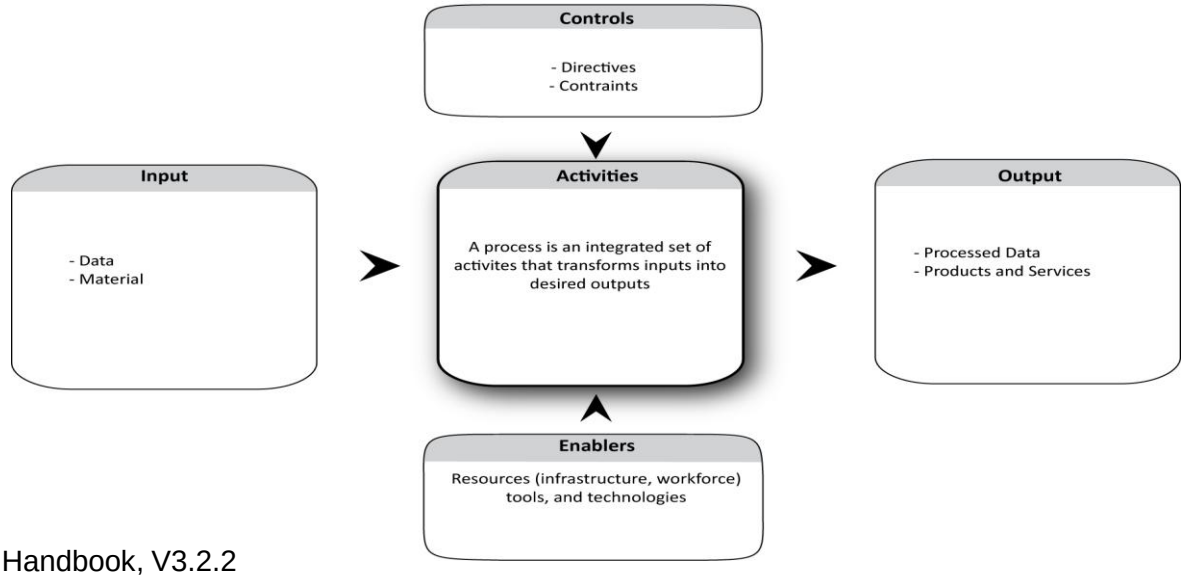
INCOSE SE HANDBOOK (SEH) OVERVIEW

- **Purpose**
  - **Defines the discipline and practice of systems engineering (SE)**
  - **Provides an authoritative reference**
- **Application**
  - **Consistent with ISO/IEC 15288:2008 – Systems and software engineering – System life cycle processes**
    - **Further elaborates the processes and activities to execute the processes**
  - **Ensures usefulness across a wide range of application domains – man-made systems and products, as well as business and services**
  - **Serves as a reference to practices and methods that have proven beneficial to the SE community at large**
  - **Tailoring guidelines provided**

Source: Adapted from INCOSE SE Handbook, V3.2.2

INCOSE SEH - PROCESS CONTENTS

- Process Overview
- Purpose (from 15288)
- Description
- Inputs
  - +Controls & Enablers
- Outputs
- Process Activities
- Common approaches and tips
- Process Elaboration
- Detail on topics related to the process
- Endnotes w/additional readings



Source: INCOSE SE Handbook, V3.2.2

INCOSE SEH - Other Contents

- **Life Cycle Model Concepts and Guidance**
- **Analysis Techniques**
- **Process Mappings to Key SE-related Standards & References**
  - **ISO/IEC/IEEE 15288**
  - **ISO/IEC/IEEE 26702**
  - **EIA 632**
  - **CMMI**

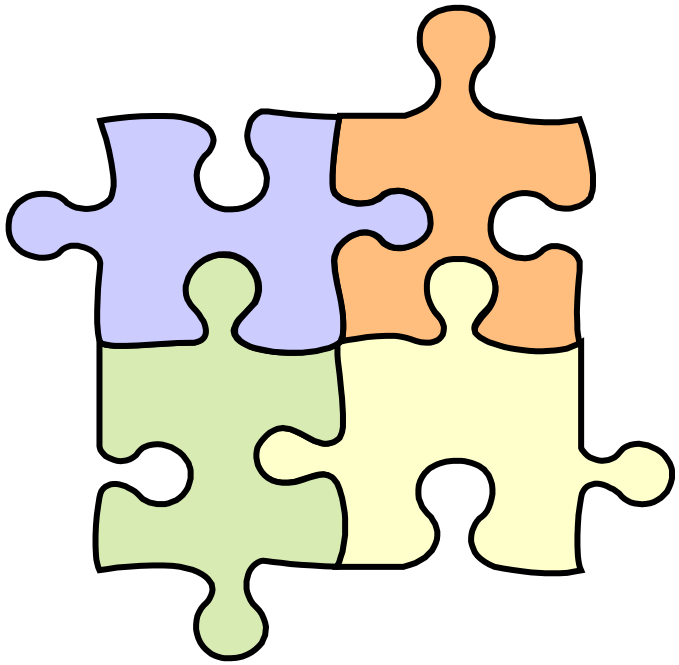
NATO – DESCRIPTION OF AAP-48

- **AAP-48 created to provide supplemental guidance for 15288**
  - **Steps through 15288 clauses without repeating text**
  - **Indicates what clauses or parts apply**
  - **Provides additions and discussion for clauses**
  - **Identifies other NATO references that apply**
  - **Provides 2 additional processes (Through-life Traceability and Support)**
- **Purpose**
  - **"The NATO Policy for Standardisation calls for the use of civil standards to the maximum practicable extent. ISO/IEC 15288:2008, "Systems Engineering – System Life Cycle Processes", is already in use in several Nations and provides a general framework that is neutral to existing individual Nations' Acquisition Processes. Following this guidance, NATO will use ISO/IEC 15288:2008 as the basis for implementing SLCM. This allows for traditional acquisition or iterative developments and procurement cycles for the realisation of required capabilities."**

Source: NATO AAP-48

Other Resources Worth Noting

- **ISO/IEC/IEEE 24748 series**
  - **Part 1: Guide to Life Cycle Management**
    - **Freely available at:**
    - **http://standards.iso.org/ittf/PubliclyAvailableStandards/c050502_ISO_IEC_TR_24748-1_2010.zip**
  - **Part 2: Guide to ISO/IEC/IEEE 15288, System Life Cycle Processes**
  - **Part 3: Guide to ISO/IEC/IEEE 15288, Software Life Cycle Processes**
  - **Part 4: System Engineering Planning**
    - **Will replace IEEE 1220/ISO/IEC 26702**
- **ISO/IEC/IEEE 24765, System/Software Engineering Vocabulary**
  - **Also online as SEVOCAB at: http://pascal.computer.org/sev_display/index.action**



PLANNED CHANGES FOR FURTHER HARMONIZATION

Approach for Next Phase of Harmonization

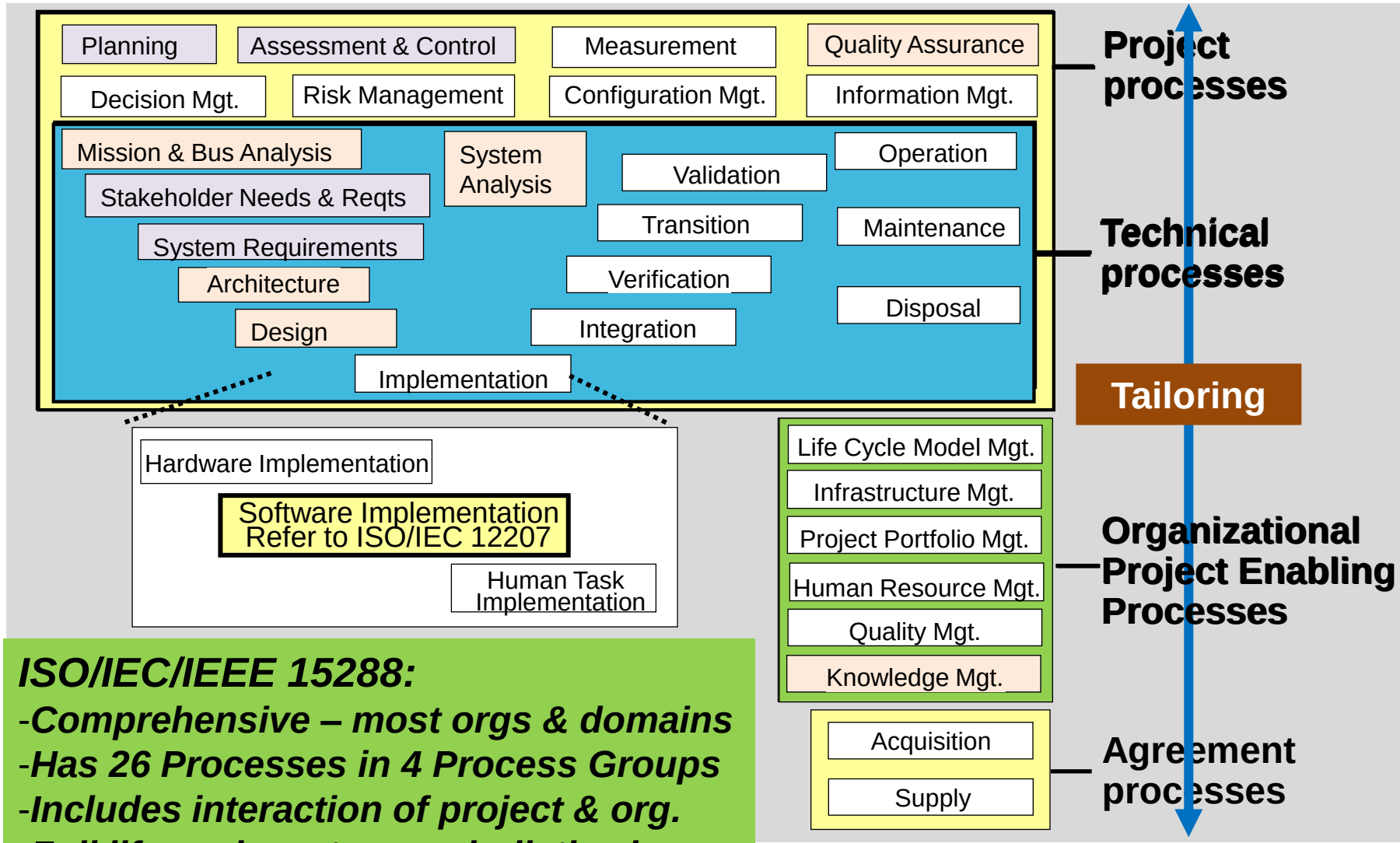
- **Conduct Study Group within ISO/IEC JTC1/SC7**
  - **Collect information from other Standards Dev Orgs and Industry Associations**
  - **Establish common objectives**
  - **Determine common core process set, terminology and concepts**
  - **Develop and process revisions**

- **Coordinate concurrent revisions across multiple key resources**
  - **ISO/IEC/IEEE 15288 and 12207**
  - **EIA 632A**
  - **INCOSE SE Handbook**
  - **SEBoK**

Drivers of Proposed Changes to 15288 (and 12207)

- **Considered the following:**
  - **V&V Study Group Report**
  - **Feedback from Users**
  - **Current direction of related industry guidance (e.g., SEBoK, INCOSE SEH, 632, …)**
  - **Modeling of 15288 and 12207**
  - **SWG5 Common Process Set spreadsheet**
  - **Related ISO/IEC/IEEE Standards**
  - **Various discussions, including with WG42**
- **Next several charts include describe the planned scope of change for 15288**

ISO/IEC/IEEE 15288 Processes and Structure



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- ***Full life cycle – stages – holistic view***
- ***Based on proven practices***

Source: Adapted from ISO/IEC JTCI/SC7/WG7 presentation on ISO/IEC 15288.

PLANNED REVISION OF ISO/IEC/IEEE 15288

- **Most Significant Change is in Technical Processes**
  - **Improve focus on Concept Definition**
    - **New Business and Mission Process**
    - **Clarify Development and Transformation of Needs and Requirements**
  - **Improve Requirements Process – transformation and management**
  - **Split single Architectural Design process into separate Architecture and Design processes**
  - **Add new System Analysis process**
  - **Improve IV&V processes per study group findings**
  - **Add detail to Transition, Maintenance, and Operations**
  - **Throughout – address Trusted Supply Chain issues (e.g., ties to assurance, security and anti-counterfeit)**
- **Enabling Processes (name change)**
  - **Add Knowledge Management Process – include Domain Engineering and Reuse**
  - **Expand scope of Portfolio Management**
- **Minor improvements to Project Processes**
- **No significant changes to Agreement processes**

Opportunities for Influence and Change

- **ISO/IEC/IEEE 15288, System Life Cycle Processes and 12207, Software Life Cycle Processes are planning revision**
  - **Opportunity to influence processes, requirements, structure and content**
- **DoD work with SDOs for application guide of industry standards for defense contracts**
  - **Focused on information requirements and analysis, not specific formatting**
- **INCOSE SE Handbook (SEH) is planning revision**
  - **Opportunity to influence processes, structure and content**
  - **SEH serves as guide for 15288 and is basis of SE Certification**
- **EIA 632, Engineering of a System is currently in revision**
  - **Opportunity to influence processes, requirements, structure and content**
- **SEBoK is about to release final draft for review**
  - **Opportunity to influence processes, structure and content**

NATO – HARMONIZATION WITH AAP-48

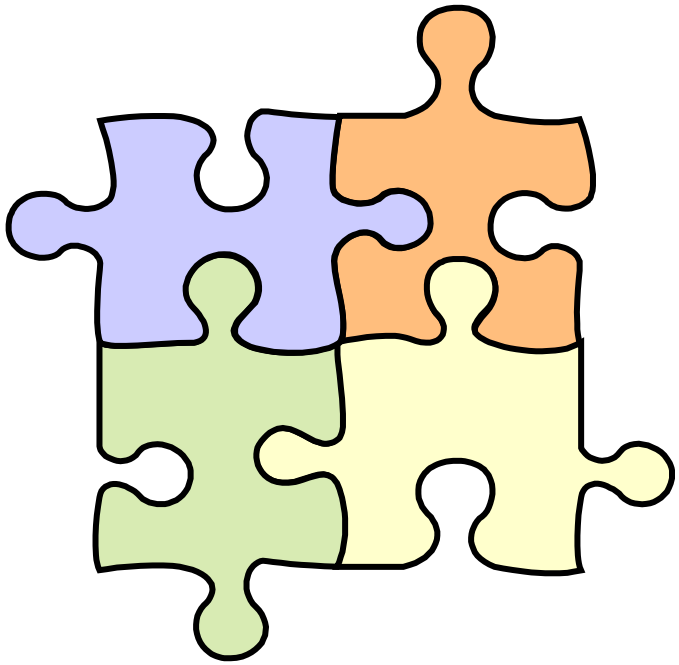
- **Discussion has started regarding revision to 15288**
- **Continued harmonization is a joint goal**
- **Approach may be a possibility for DoD**

TechAmerica – Status of Harmonization between ISO/IEC/IEEE 15288 and EIA 632

- **Recent engagements**
  - **Met with TechAmerica Team in June**
  - **Conducted briefing and discussion session in September**
    - **Reviewed details of planned revision to 15288, including changes for alignment**
- **Progress**
  - **Very positive engagements and desire to work towards better alignment to allow concurrent usage**
  - **Convergence on many terms and concepts**
    - **Still some differences to resolve**
- **Next Steps**
  - **Review current draft of EIA 632 and provide additional recommendations**
  - **Provide draft of ISO/IEC/IEEE 15288 revision to TechAmerica team following ISO/IEC SC7 meeting in November**

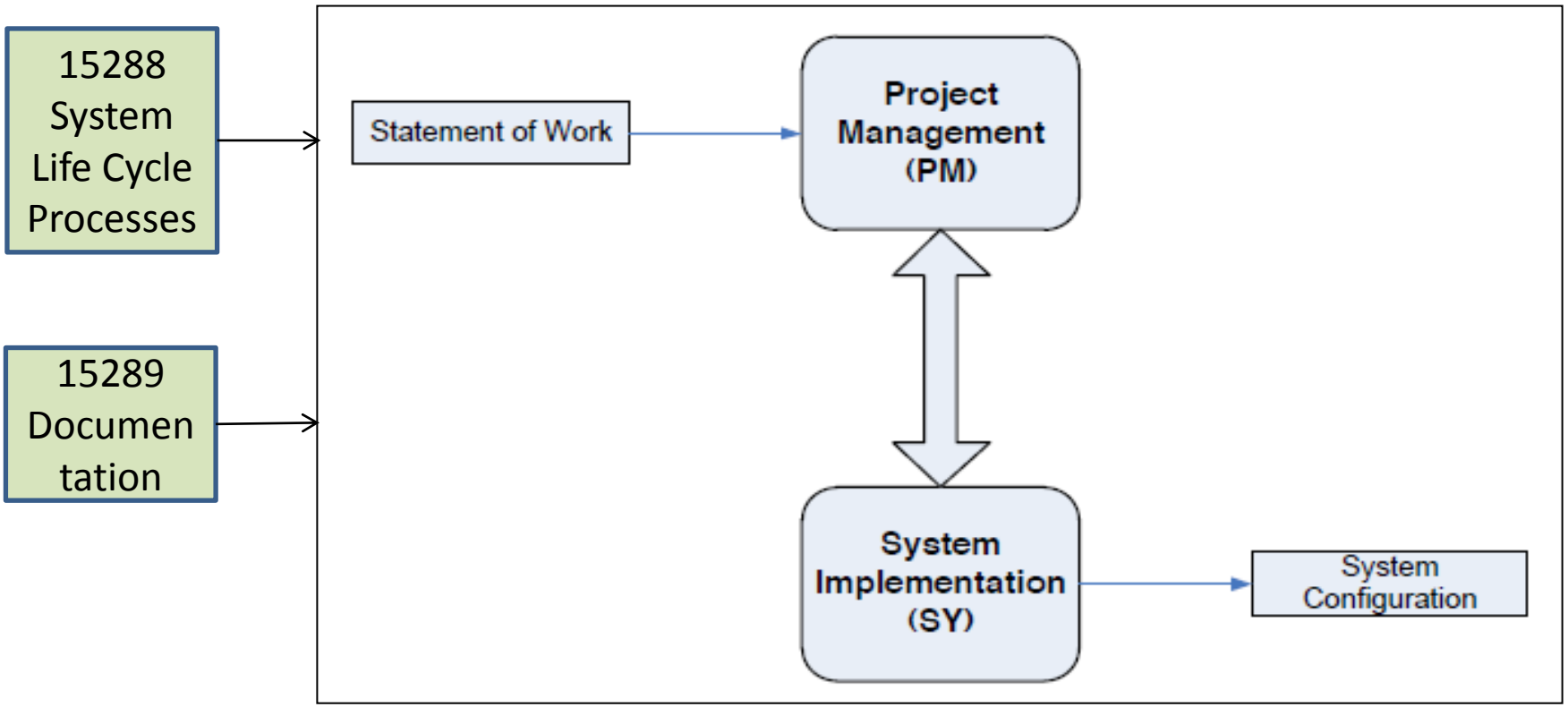
HARMONIZATION WITHIN DOD

- **Revision to the Defense Acquisition Guide, Chapter 4, Systems Engineering**
  - **Intend to continue alignment with 15288 and other key resources**
  - **Draft in review now**
- **Currently investigating options for developing defense guidance for the industry standards on SE, CM, and Technical Reviews**

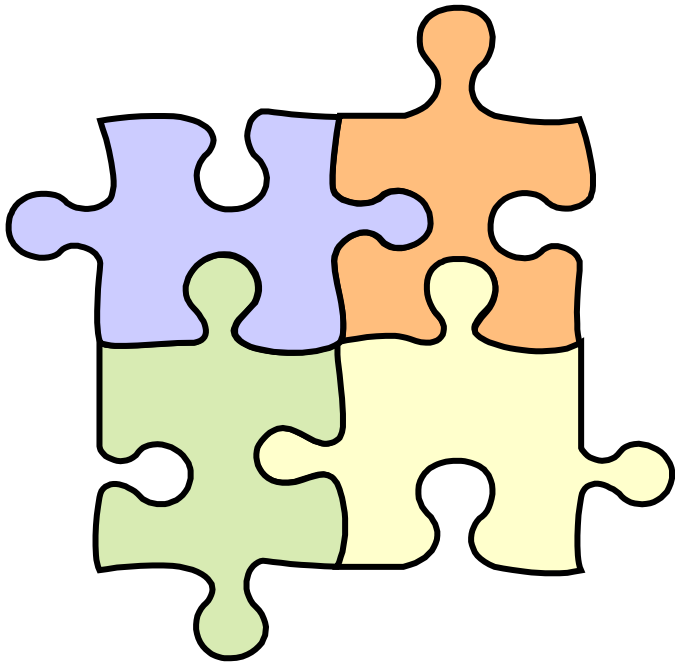


Application and tailoring of standards for Very Small Entities

STANDARDS TAILORING AND APPLICATIONS FOR VSES



- **Includes a subset process activities/outcomes in ISO/IEC/IEEE 15288 and products in ISO/IEC/IEEE 15289**
- **Considered most essential activities based on VSE profile (<25 people)**
- **Applies to VSEs who do NOT develop critical system products**

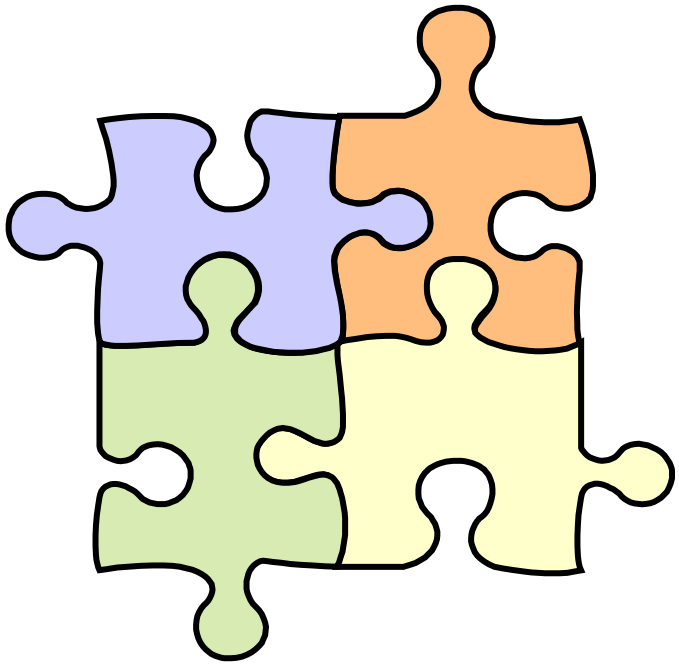


SUMMARY

SUMMARY

- **Great progress has been made in the harmonization of key SE resources**
- **Collaboration among Industry Associations has made this possible**
- **Plans are in place to continue the harmonization through “Technical Co-evolutiuon”**


Questions?



BACK-UP CHARTS

BENEFITS OF USING ISO/IEC 15288

- **Full life cycle approach to systems engineering and systems management**
  - **Built on proven experience and lessons learned**
  - **Life cycle modeling of systems – stage-based**
  - **A holistic view of engineering the system (software, hardware, humans, and processes)**
- **Provides the basis for improving:**
  - **Communication and integration among system**
  - **Quality of the product**
  - **Productivity**
  - **Customer satisfaction**
- **A process framework that:**
  - **Is easy to tailor to meet project/organization needs**
  - **Reduces risk across the life cycle**
- **Part of an aligned set of standards**

Source: Adapted from ISO/IEC JTCI/SC7/WG7 presentation on ISO/IEC 15288.

THE PROBLEM

- **In the past, Systems and Software standards have had different:**
  - **Terminology**
  - **Process sets**
  - **Process structures**
  - **Levels of prescription**
  - **Audiences**
- **These differences have been both between Systems and Software, and to some extent within each**
- **The problem has been exacerbated by competing standards, in whole or part**

Lack of integration both within and across Standards Development Organizations

THE CAUSE

- **Culture**
  - **"We're different"**
  - **"Not invented here"**
- **Organizational**
  - **Different teams, committees, etc.**
- **Competition**
  - **Many Standards Development Organizations**
- **Domains**
  - **Focused, narrow view often doesn't look beyond the domain for commonality**

Many obstacles; some real, some perceived, some self-made

THE IMPACT

- **Less effective/efficient processes**
  - **Not focused on leveraging commonalities – causes redundancy**
  - **Has resulted in incompatibilities, inconsistencies**
- **Less effective solutions**
  - **Not focused on a common approach to solve a problem/need**
- **Obstacle for:**
  - **Communicating (at all levels – disciplines, teams, etc.)**
  - **Working in integrated teams**
  - **Leveraging resources**
- **Stove-piping due to:**
  - **The incompatibilities, inconsistencies**
  - **Lack of leveraging commonalities**

Impacts effectiveness and efficiency of the team

THE OBJECTIVE

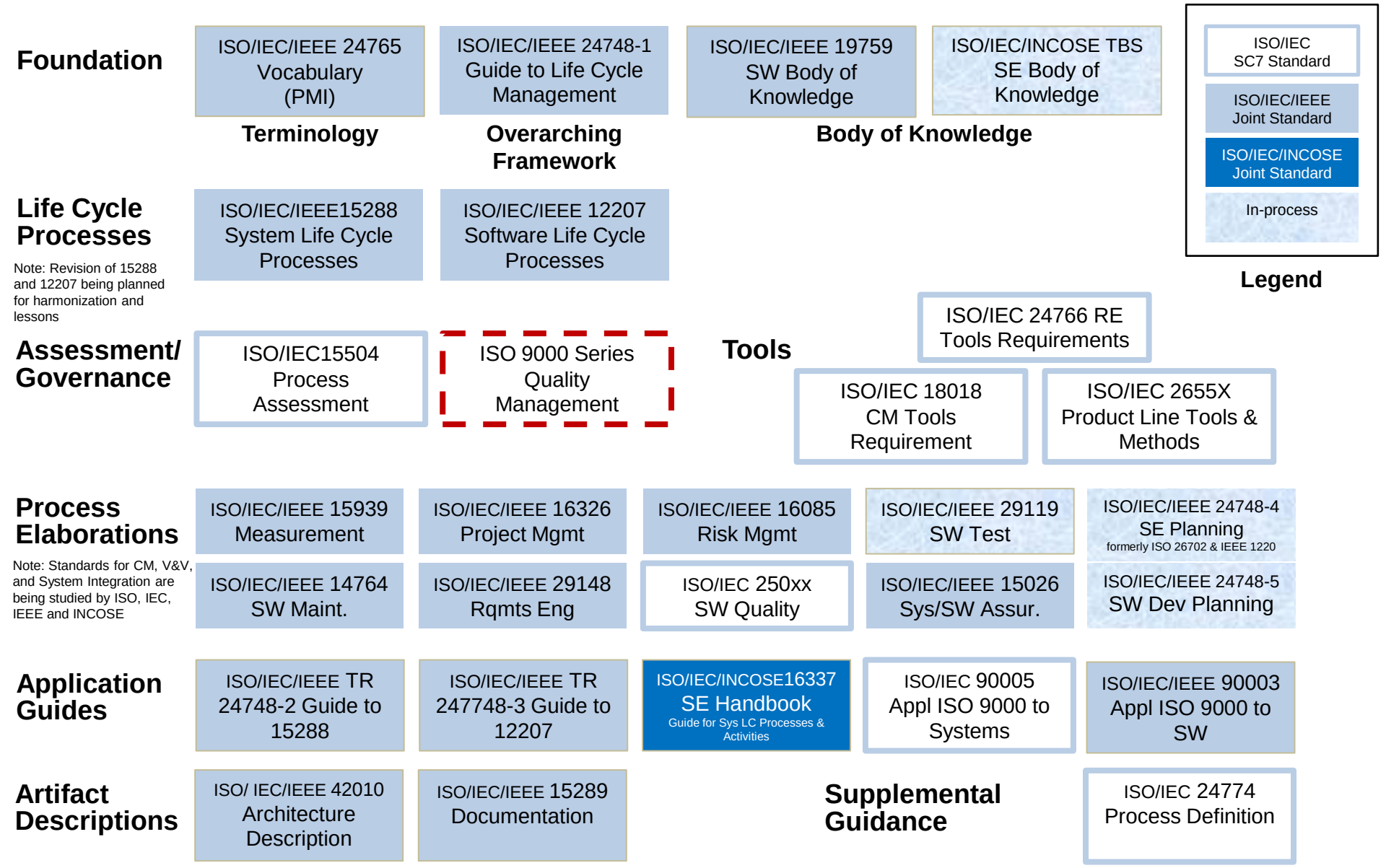
- **The objective is to make the standards more usable together by achieving:**
  - **Common vocabulary**
  - **Single, integrated process set**
  - **Single process structure**
  - **Jointly planned level of prescription**
  - **Suitable across the audiences**
  - **Accounts for considerations in wide range of domains and applications**

Work to a common vision, agreements, and general process concepts

BUT IS THIS ENOUGH?

- **Advantages**
  - **Drives to a more consistent set of standards**
  - **Provides for "interoperability" of these standards**
  - **Creates a better foundation for collaboration between Standards Development Organizations (SDOs)**
    - **Work towards common or complementary/supplementary standards**
    - **Model has worked well with IEEE-CS and INCOSE**
- **But some issues still remain**
  - **Still allows for significant redundancy**
  - **Still need to account for specialized needs**
  - **Alignment does not ensure an integrated set of processes that can be chosen as needed**
    - **Integration phase must be completed to gain this benefit**
    - **Significant coordination/negotiation needed to drive more industry buy-in**

CURRENT ALIGNMENT/INTEGRATION STATUS



Status as of 1 June 2012