

Processes Make Perfect – How Your Engineering and Management Practices Can Help Meet the Systems Assurance Challenge



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Outline

- System Assurance Defined
- The System Assurance Problem Space
- Software As A Root Cause Problem
- The Systems Engineering Challenge
- The CMMI[®] and Assurance
- Bang-For-The-Buck CMMI-DEV[®] Process Areas
- Guidance For Systems Assurance
- Standardization In Support Of Systems Assurance

System Assurance Defined

System assurance is the level of confidence that the system functions as intended and is free of exploitable vulnerabilities, either intentionally or unintentionally designed or inserted as part of the system.

System Assurance Problem Space

- Large-scale systems and systems of systems represent a complex supply chain integrating
 - Proprietary and open-source software
 - Legacy systems
 - Hardware
 - Firmware
- These systems are sourced from multiple suppliers who employ people from around the world
- Most systems we encounter today contain software elements and most depend upon software for a good portion of their functionality
- Technologies to build reliable and secure software are inadequate
 - Our ability to develop software has not kept pace with hardware advances
 - Cannot construct complex software-intensive systems for which we can anticipate performance
- **Assurance is a full life cycle systems-level problem**

are As A Root Cause Problem

- System risk has dramatically increased due to the simultaneous growth in software vulnerabilities and in threat opportunities
- Risk management processes inadequately address these threats and risks
- Threats presented by suppliers of software products and services are not adequately identified and analyzed
- Development and acquisition processes inadequately address software security
- There is a fundamental lack of both the scientific understanding of software risks and the capabilities to effectively diagnose and mitigate in the in a timely manner

Source: J. Jarzombek. DOD Software Assurance Initiative: Mitigating Risks Attributable to Software. DOD Software Assurance Forum, July 2004.

More Succinctly . . .

- There is a failure to assure correct, predictable, safe, secure execution of complex software in distributed environments
- Inadequate attention is given to the total life cycle issues, including impacts on life cycle cost and risk associated with the use of commercial or reused products and components



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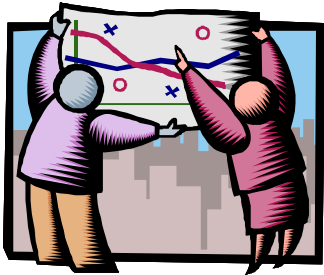
Systems Engineering Challenge

Integrating a heterogeneous set of globally engineered and supplied proprietary, open-source, and other software; hardware; and firmware; as well as legacy systems; to create well-engineered integrated, interoperable, and extendable systems whose security, safety, and other risks are acceptable . or at least tolerable.



System and Software Assurance through CMMI[®]-Compliant Processes

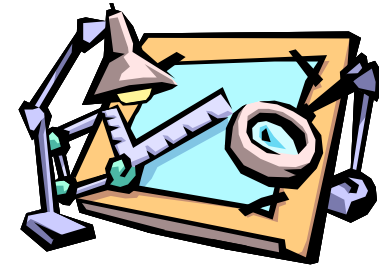
1. Understand Your Business Requirements for Assurance



5. Measure Your Results - Modify Processes as Necessary



4. Build or Refine and Execute Your Assurance Processes



2. Look to the CMMI[®] for Assurance-Related Process Capability Expectations



3. Look to Standards for Assurance Process Detail



CMMI[®] - DEV Assurance Shortfalls

- Inconsistent treatment of safety and security concerns
- Insufficient assurance detail in required and expected components
 - Specific goals
 - Specific practices
- Insufficient traceability to assurance source standards



CMMI® . DEV Process Areas and Assurance

Source: CMMI® for Development, Version 1.2, CMU/SEI-2006-TR-008, August 2006

Name	Abbr	Safety	Security
Requirements Management	REQM	√	√
Project Planning	PP	√	√
Project Monitoring and Control	PMC		√
Supplier Agreement Management	SAM		√
Measurement and Analysis	MA		√
Process and Product Quality Assurance	PPQA		
Configuration Management	CM	√	√
Requirements Development	RD	√	√
Technical Solution	TS	√	√
Product Integration	PI	√	√
Verification	VER		
Validation	VAL		
Organizational Process Focus	OPF		
Organizational Process Definition +IPPD	OPD +IPPD	√	√
Organizational Training	OT	√	√
Integrated Project Management +IPPD	IPM +IPPD	√	√
Risk Management	RSKM	√	√
Decision Analysis and Resolution	DAR	√	
Organizational Process Performance	OPP		
Quantitative Project Management	QPM		
Organizational Innovation and Deployment	OID		
Causal Analysis and Resolution	CAR	√	

Safety and Security Extensions for Integrated Capability Maturity Models . Take 1

1. **Ensure Safety and Security Competency**
2. **Establish Qualified Work Environment**
3. **Ensure Integrity of Safety and Security Information**
4. **Monitor Operations and Report Incidents**
5. **Ensure Business Continuity**
6. **Identify Safety and Security Risks**
7. **Analyze and Prioritize Risks**
8. **Determine, Implement, and Monitor Risk Mitigation Plan**
9. **Determine Regulatory Requirements, Laws, and Standards**
10. **Develop and Deploy Safe and Secure Products and Services**
11. **Objectively Evaluate Products**
12. **Establish Safety and Security Assurance Arguments**
13. **Establish Independent Safety and Security Reporting**
14. **Establish a Safety and Security Plan**
15. **Select and Manage Suppliers, Products, and Services**
16. **Monitor and Control Activities and Products**

Safety and Security Extensions
for
Integrated Capability Maturity Models

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Safety and Security Extensions Project Team

September 2004

Source Standards

Safety

- **Defence Standard 00-56**, Safety Management Requirements for Defence Systems, Ministry of Defence, United Kingdom, December 1996.
- **IEC 61508**, Functional Safety of electrical/electronic/programmable electronic safety-related systems, International Electrotechnical Commission, 1997.
- Military Standard System Safety Program Requirements, **MIL-STD-882C**, United States Department of Defense, January 1993.
- Standard Practice for System Safety, **MIL-STD-882D**, United States Department of Defense, February 2000.

Security

- **ISO/IEC 21827**, Systems Security Engineering Capability Maturity Model®, SSE-CMM®, Model Description Document, Version 3.0, June 15, 2003.
- **ISO/IEC 15408:1999**, Common Criteria for Information Technology Security Evaluation, Part 3: Security assurance requirements, Version 2.1, 1999.
- **ISO/IEC 17799:2000(E)**: Information technology . Code of practice for information security management, International Organization for Standardization, First edition 2000-12-01.
- Risk Management Guide for Information Technology Systems, **National Institute of Standards and Technology, Special Publication 800-30, 2001.**

Capability Maturity Models . Take 2

- Workshop on Assurance with CMMI[®], August 7, 2007
 - . Relationships between Models and Standards
 - . Industry experiences in extending models for assurance
 - Motorola's Secure Software Development Model
 - Lockheed Martin's Software Safety and Security Certification Best Practices
 - Booz Allen Hamilton's experience with multiple models
 - . Community of interest feedback on security extensions to the CMMI[®]
- Security Model Harmonization Working Group
 - . Harmonization of key security capability maturity models including but not limited to the SSE-CMM and the Motorola Secure Software Development Model (MSSDM)
 - . Prototyping Assurance as a Focus Area+
 - . Assurance beginning with Security in Phase I adding Safety and Dependability in Phase II

For-The-Buck CMMI®-DEV Project Management Process Areas

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RSKM

- . Identify, Evaluate, Categorize, and Prioritize Assurance Risks
- . Develop assurance risk mitigation strategies

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PP

- . Determine a technical approach for the project that supports the assurance requirements
- . Determine the level of security required for tasks, work products, hardware, software, personnel, and work environment

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PMC

- . Monitor significant changes in risk status
- . Monitor the security environment

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SAM

- . Evaluate COTS products for compliance with assurance requirements
- . Evaluate the trustworthiness of the supplier

For-The-Buck CMMI-DEV[®] Process Management Process Areas

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OT

- . Establish and maintain training capability to address assurance-related training needs
- . Provide training necessary to ensure the competency of individuals required to perform assurance-related roles effectively

For-The-Buck CMMI-DEV[®] Engineering Process Areas

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RD

- . Identify customer expectations for assurance
- . Define product assurance attributes

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TS

- . Identify and analyze alternative solutions based on proposed product architectures that address critical product qualities
- . Ensure that the detailed design adheres to applicable assurance standards and criteria

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VER

- . Select verification methods based on their ability to demonstrate that the work product properly reflects the specified assurance requirements
- . Establish and maintain the environment needed to support validation, including test tools and simulations

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VAL

- . Select validation methods based on their ability to demonstrate that customer expectations for assurance are satisfied
- . Establish and maintain the environment needed to support validation, including test tools and simulations

Over-The-Buck CMMI-DEV[®] Support Process Areas

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CM

- . Create a baseline that can be changed only through formal change control procedures
- . Perform reviews to ensure that changes have not compromised the safety, security, or dependability

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PPQA

- . Objectively evaluate the work products against the applicable assurance process descriptions, standards, and procedures

Assurance For Systems Assurance - 1

- ***Systems Assurance – Delivering Mission Success in the Face of Developing Threats***
 - . An NDIA guidebook intended to supplement the knowledge of systems (and software) engineers who have responsibility for systems for which there are assurance concerns

System Assurance Guidebook . mapped To ISO/IEC/IEEE 15288

■ Agreement Processes

- . Acquisition
- . Supply

■ Project Processes

- . Project Planning
- . Project Assessment
- . Project Control
- . Decision-making
- . Risk Management
- . Configuration Management
- . Information Management

■ Assurance Case Process

■ Enterprise Processes

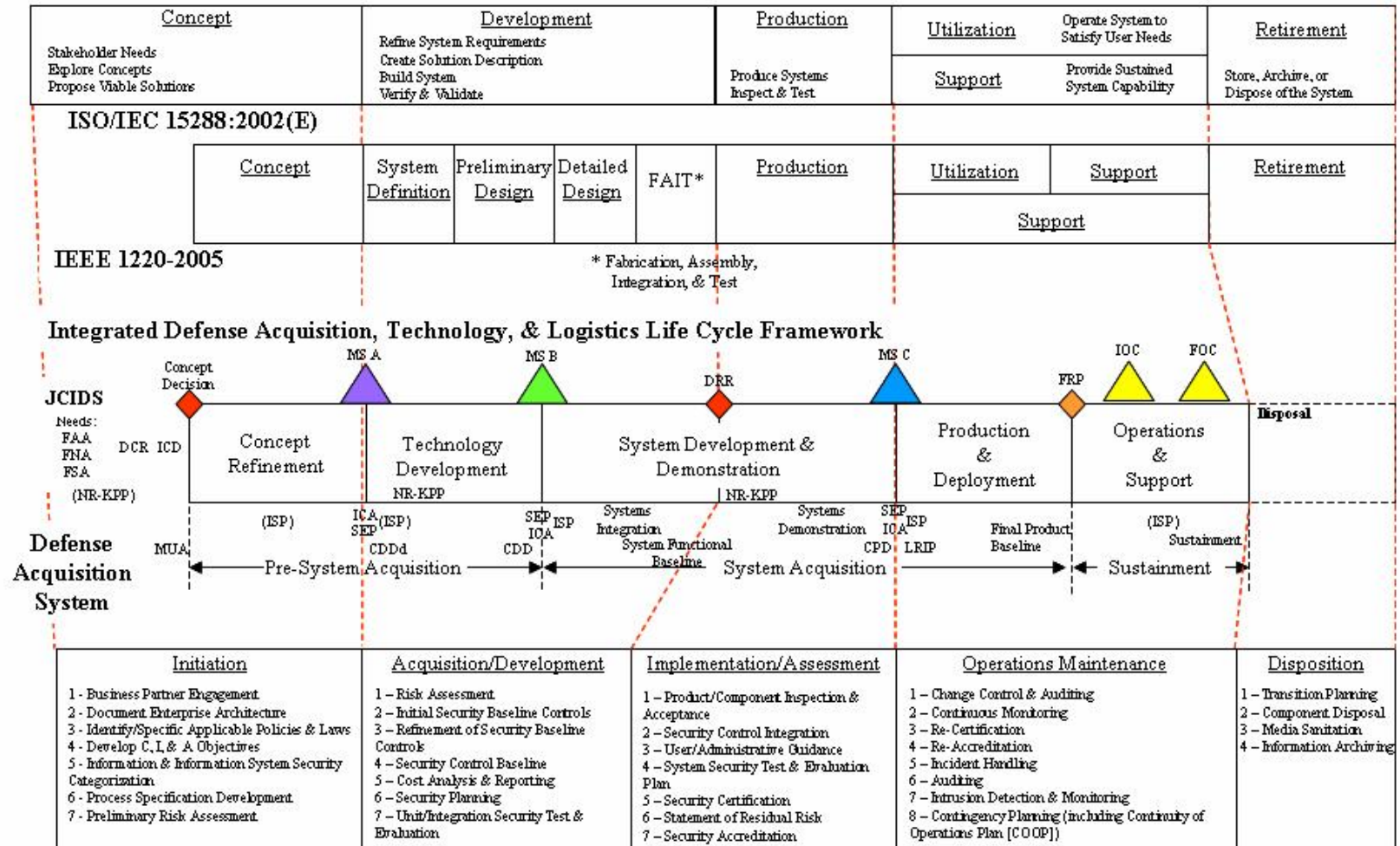
- . Enterprise Environment Management
- . Investment Management

■ Technical Processes

- . Stakeholder Requirements Definition
- . Requirements Analysis
- . Architectural Design
- . Implementation
- . Integration
- . Verification
- . Transition
- . Validation
- . Operation
- . Maintenance
- . Disposal

- . System Life Cycle Process Management
- . Resource Management [including human resource training]
- . Quality Management

of Standards In The Guidebook



NIST Information Security and the System Development Life Cycle

ance For Systems Assurance - 2

■ ***State of the Art Report on Software Security Assurance***

- . An IATAC/DACS report identifying and describing the current state of the art in software security assurance, including trends in:
 - Techniques for the production of secure software
 - Technologies that exist or are emerging to address the software security challenge
 - Current activities and organizations in government, industry, and academia, in the U.S. and abroad, that are devoted to systematic improvement of software security
 - Research trends worldwide that might improve the state of the art for software security

Assurance For Systems Assurance - 3

- ***Secure Software Assurance: A Guide to the Common Body of Knowledge to Produce, Acquire, and Sustain Secure Software***
 - . A DHS guidebook intended as a framework to identify workforce needs for competencies and leverage standards and best practices to guide software-related curriculum development

Guidance For Systems Assurance - 4

- ***Security in the Software Life Cycle:
Making Software Development
Processes – and the Software Produced
by Them – More Secure***
 - . An DHS report providing a compendium of methodologies, life cycle process models, sound practices, and supporting technologies that would, if adhered to, increase software security

Guidance For Systems Assurance - 5

- ***Software Assurance in
Acquisition: Mitigating Risks to
the Enterprise***
 - . A DHS report intended to provide guidance on enhancing supply chain management through improved risk mitigation and contracting for secure software

Information In Support Of Assurance . Programming Languages

- **ISO/IEC SC22 . OWG:
Vulnerabilities (OWGV)**
 - . Project 22.24772: Guidance for
Avoiding Vulnerabilities through
Language Selection and Use
 - Technical Report
 - Comparative guidance spanning multiple
programming languages
 - Goal: Avoidance of programming errors
that lead to vulnerabilities

Information In Support Of Assurance . IT Security Techniques

- ISO/IEC SC 27 IT Security Techniques
 - . ISO/IEC 15408, Common Criteria for IT Security Evaluation
 - . ISO/IEC 15443, FRITSA
 - Part 1: A framework for IT security assurance
 - Part 2: Assurance methods
 - Part 3: Analysis of assurance methods
 - . ISO/IEC DTR 19791, Assessment of Operational Systems
 - . ISO/IEC 21827, System Security Engineering Capability Maturity Model (SSE CMM) revision
 - . ISO/IEC 27000 series . Information Security Management System (ISMS)

ation In Support Of Assurance . Functional Safety

- IEC SC 65A, Functional Safety
 - IEC 61508, Functional Safety Of Electrical/
Electronic/Programmable Electronic Safety-related
Systems (7 parts)
 - Part 1: General requirements
 - Part 2: Requirements for
electrical/electronic/programmable electronic safety-
related systems
 - Part 3: Software requirements
 - Part 4: Definitions and abbreviations
 - Part 5: Examples of methods for the determination of
safety integrity levels
 - Part 6: Guidelines on the application of IEC 61508-2 and
IEC 61508-3
 - Part 7: Overview of techniques and measures
 - Risk-based approach for determining the required
performance of safety-related systems

ation In Support of Assurance . Dependability

- IEC 60300 Series, Dependability Management
- IEC 61713, Software dependability through the software life-cycle processes- Application guide
- IEC 60812, Analysis techniques for system reliability - Procedure for failure mode and effects analysis (FMEA)
- IEC 61025, Fault tree analysis (FTA)

Position In Support of Assurance . FISMA¹ Implementation

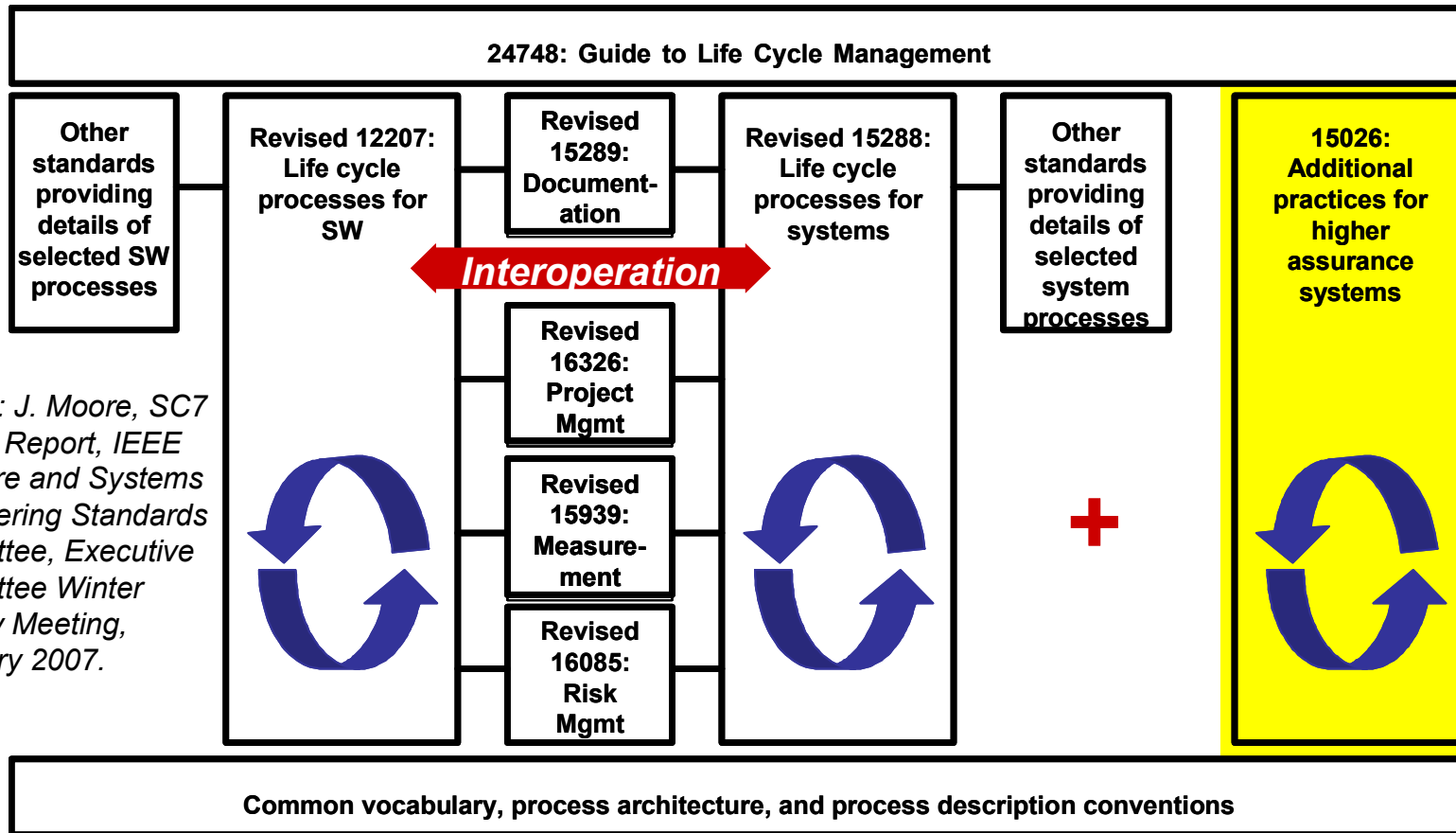
- **FIPS Publication 199**, Standards for Security Categorization of Federal Information and Information System
- **FIPS Publication 200**, Minimum Security Requirements for Federal Information and Federal Information Systems
- **NIST Special Publication 800-30, Revision 1**, Risk Assessment Guideline)
- **NIST Special Publication 800-37**, Guide for the Security Certification and Accreditation of Federal Information Systems
- **NIST Special Publication 800-39**, NIST Risk Management Framework
- **NIST Special Publication 800-53 Revision 1**, Recommended Security Controls for Federal Information Systems
- **NIST Special Publication 800-53A**, Guide for Assessing the Security Controls in Federal Information Systems
- **NIST Special Publication 800-59**, Guide for Identifying an Information System as a National Security System
- **NIST Special Publication 800-60**, Guide for Mapping Types of Information and Information Systems to Security Categories

¹Federal Information Security Management Act of 2002

Source: <http://csrc.nist.gov/sec-cert/ca-proj-phases.html>

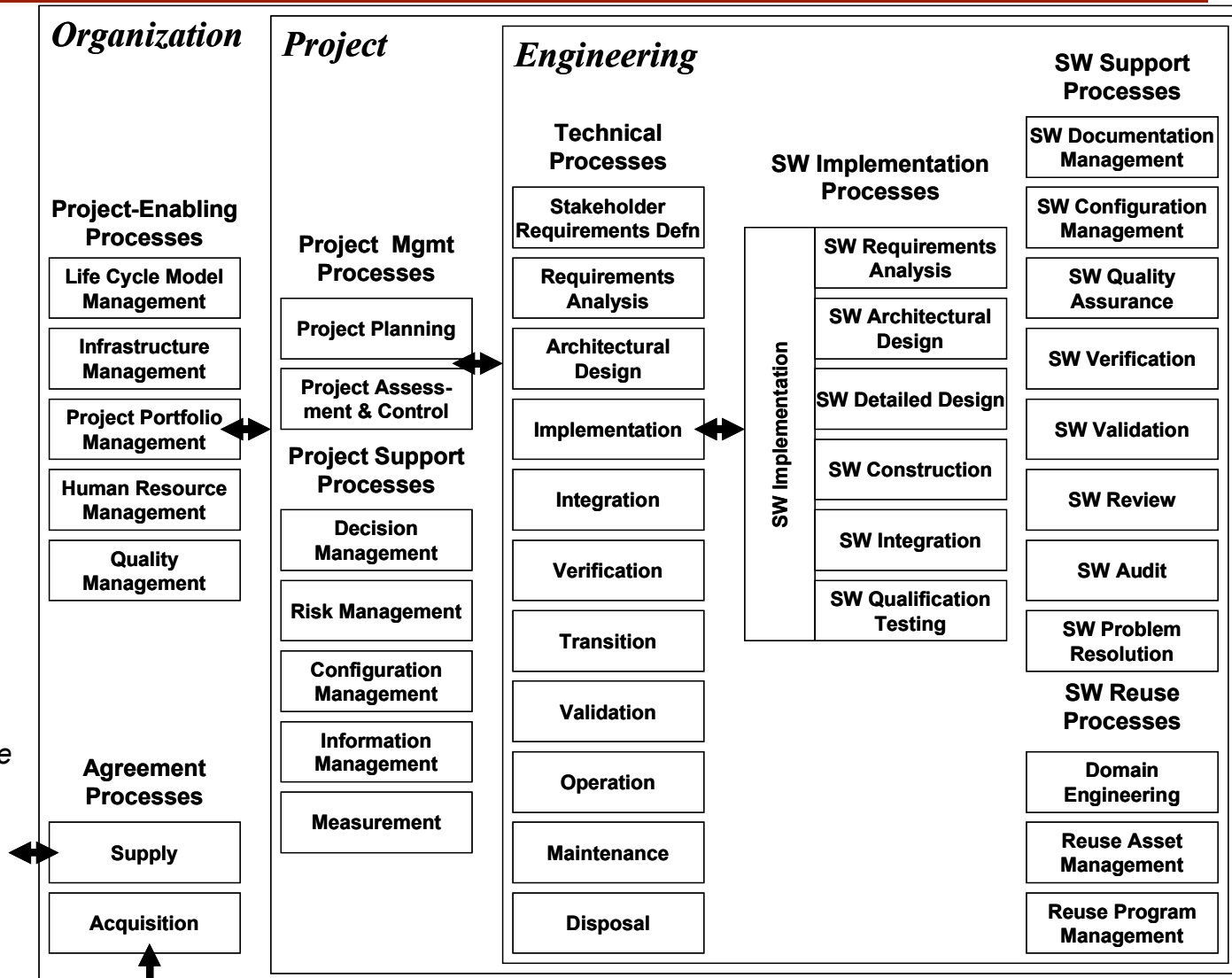
Contribution In Support Of Assurance . Life Cycle Processes

ISO/IEC/IEEE 15026, System and Software Assurance



Source: J. Moore, SC7 Liaison Report, IEEE Software and Systems Engineering Standards Committee, Executive Committee Winter Plenary Meeting, February 2007.

15288 And 12207 Life Cycle Processes



Source: ISO/IEC CD 15026/4 IEEE P15026/CD1, Systems and software engineering — Systems and software assurance



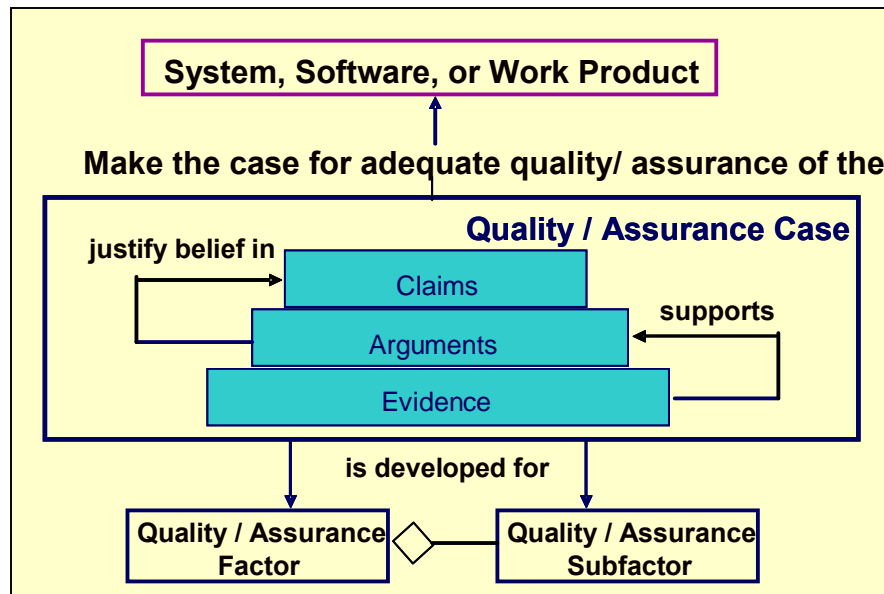
Of The Assurance Case

- **Set of structured assurance claims, supported by evidence and reasoning, that demonstrates how assurance needs have been satisfied.**

- Shows compliance with assurance objectives
- Provides an argument for the safety and security of the product or service.
- Built, collected, and maintained throughout the life cycle
- Derived from multiple sources

- **Sub-parts**

- A high level summary
- Justification that product or service is acceptably safe, secure, or dependable
- Rationale for claiming a specified level of safety and security
- Conformance with relevant standards and regulatory requirements
- The configuration baseline
- Identified hazards and threats and residual risk of each hazard and threat
- Operational and support assumptions



Attributes

- Clear
- Consistent
- Complete
- Comprehensible
- Defensible
- Bounded
- Addresses all life cycle stages

References

- CMMI® for Development, Version 1.2, CMU/SEI-2006-TR-008, Software Engineering Institute, Carnegie Mellon University, August 2006
- G. Draper (ed.), *Top Software Engineering Issues Within Department of Defense and Defense Industry*. National Defense Industrial Association, Arlington, VA, August 2006.
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More Information . . .

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