

# **Version 0.75 of the Proposed INCOSE Competency Framework**

**Don S. Gelosh, Ph.D., CSEP-Acq**  
**Director, Systems Engineering Programs**  
**Worcester Polytechnic Institute**

**24 October 2016**

- The NDIA SE Division's Education and Training (E&T) Committee is conducting this project in collaboration with the INCOSE Competency Working Group (CWG) to develop a common approach to the definition of an overall SE Competency Framework.
- This presentation describes Version 0.75 of the Competency Framework.

# E&T/CWG Leadership Team

**John R. Snoderly**  
**Defense Acquisition University**  
**Ft. Belvoir, VA**

**Ken Nidiffer**  
**Software Engineering Institute**  
**Pittsburgh, PA**

**Mimi Heisey**  
**Lockheed Martin Corporation**  
**Manassas, VA**



# ***INCOSE SE Role-Based Competency Framework***

# Outline for ICF V0.75

- Introduction
  - Purpose
  - Scope
- Competency Framework
- Systems Engineering Roles Descriptions
- How to Use the Competency Framework
  - Use Cases
  - Tailoring, Extending and Scaling the Framework
  - Competency Model Assessments using the Framework
- Future Evolution of the Competency Framework
- References
- Appendices
  - Guide to Competency Evaluation
  - Alignments to other Initiatives
  - Domain Based Competency Model Examples
- Glossary



# INCOSE SE Role-Based Competency Framework Taxonomy

SE Role	A collection of interrelated and interdependent activities assigned to a person in a contextual environment such as Systems Engineering
Activity	A specified pursuit defined by a set of essential functions and desired outcomes that enable the successful accomplishment of one's role
Category	A grouping of closely related competencies considered essential to an individual's ability to successfully perform an activity
Competency	An observable and measurable pattern of knowledge, skills, abilities, behaviors, and other characteristics that an individual needs to successfully perform an activity
Description and Why It Matters	A depiction of the competency that clearly defines its essential function, desired outcomes and reasons for why the competency is needed
Knowledge Skills Abilities Behaviors	The measurable characteristics of proficiency that make up a competency

# Version 0.75 Competency Framework (1 of 2)

Level 1	Level 1 Concept	Level 2
COMPETENCE GROUPS	DESCRIPTION	CORE COMPETENCE AREAS
Core Principles	<i>This competence group covers core principles which underpin engineering as well as systems engineering.</i>	<ul style="list-style-type: none"> <li>Systems Thinking</li> <li>Lifecycle Principles</li> <li>General STEM Engineering Principles</li> <li>Critical Thinking</li> <li>Systems Fundamentals / Concepts</li> <li>Modelling ( Simulation and Analysis)</li> </ul>
Professional Competencies	<i>This competence group covers behavioural competencies which are all well-established within the HR domain. It is important that the definition of these competencies would be taken from well-established, internationally-recognised definitions rather than partial or complete re-invention by INCOSE. This will facilitate alignment with wider HR frameworks used in larger organisations.</i>	<ul style="list-style-type: none"> <li>Communications</li> <li>Ethics</li> <li>Leadership</li> <li>Negotiation</li> <li>Team Dynamics</li> <li>Facilitation</li> <li>Emotional Intelligence</li> <li>Mentoring</li> </ul>
Technical Competencies	<i>This competence group relates to the ability to perform a series of tasks associated with the Technical Processes identified in INCOSE SE Handbook at Version 4. As a result, there needs to be a clear relationship (does not need to be 1-1 however) against the handbook / ISO 15288.</i>	<ul style="list-style-type: none"> <li>Requirements Definition</li> <li>(System) Architecture Definition</li> <li>Design for...</li> <li>Robust and Resilient Design</li> <li>Implementation</li> <li>Integration</li> <li>Interfaces</li> <li>Verification</li> <li>Validation</li> <li>Transition to Operation</li> <li>In-Service Support</li> </ul>

# Version 0.75 Competency Framework (2 of 2)

Level 1	Level 1 Concept	Level 2
COMPETENCE GROUPS	DESCRIPTION	CORE COMPETENCE AREAS
Technical Management Competencies	<i>This competence group relates to the ability to perform tasks associated with controlling and managing Systems Engineering work. Once again it is desirable for these to be a clear relationship to Management processes identified in INCOSE SE Handbook at Version 4. However, this does not need to be 1-1 as these tasks also could be utilised for other activities.</i>	Planning  Monitoring and Control Decision Management Concurrent Engineering Business & Enterprise Integration Acquisition and Supply Information Management Configuration Management Change Management Risk, Opportunity and Uncertainty Management
Cross-Discipline Understanding	<i>This competence group recognises the fact that Systems Engineering is an integrating discipline, joining activities and thinking from specialists in engineering or other disciplines in order to create a coherent whole. It covers the systems engineering competencies required to understand and integrate the viewpoints and perspectives of others into the overall picture</i>	Safety  Reliability, Availability & Maintainability Security Project Management Human Factors Cost and Finance Environment
Enterprise Competencies	<i>This competence group relates to the ability to understand, describe and optimize how the system or capability of interest fits into the overall enterprise, strategy, business model and mission of the organization.</i>	Knowledge Management Business Analysis Mission Analysis Enterprise Strategy



# ***SE Based Roles Descriptions***

*Courtesy of Richard Beasley, 2016*

- Purpose is to describe how to use the INCOSE Competency Framework to create generic role statements, thus embedding Systems Engineering competencies into the people that make up the enterprise.
- Role statements can be considered the “requirements” for the individuals (components) who make up the enterprise (the system).
- A role statement must be a combination of describing what the role does (activities) and the competencies (knowledge, skills, abilities & behaviors) that the individual needs to perform the activities.
- This document is only a guide – the definitions of Systems Engineering roles must be consistent with the HR policies of the organization.

1. Summary of issues to consider when utilising INCOSE material for company role definition
2. Resources needed to create company role profiles – from company and INCOSE
3. Standard role definition
4. Detailed steps to link company roles, competency and process to INCOSE process and competency

# Recognising Differences Between Companies

## Recognise all companies are different

- In their purpose / organisation / language / history
- In the way (and the extent) they use Systems Engineering
- The purpose of their role statements

## Consider particularly

- Specific jobs versus generic role statements
- Specific Systems Engineering versus “overall” Engineering, and how Systems Engineering deployed in company
- Any tailoring / adaptation of INCOSE process / competencies (in terms of scope / detail / language
- Purpose of role statement – entry qualification, development targets
- Linkage of pay / reward to role / job
- Difference between management (technical and / or resource) and “doing” roles

**INCOSE does not define recommended roles, and application of SE is different in all areas – so this is only a guide to application – in each application the specific approach will need to be defined.**

## From Company

- Company (Systems) Engineering Process
- Company roles – for which competency based role profiles are wanted
- Company competencies
  - Any “tailoring” of INCOSE SE competencies
  - Additional competencies required / used by company

## From INCOSE

- Standard SE processes – SE Handbook 4<sup>th</sup> ed.
- INCOSE competency list (from competency framework)
- Mapping of INCOSE processes to INCOSE SE competencies
- Mapping of **ARCIFE** levels to competency levels

# ARCIFE vs ICF Levels

## ARCIFE levels:

- Accountable
- Responsible
- Consulted
- Informed
- Facilitator / Coach
- Expert

## ICF Proficiency Levels:

- Awareness
- Supervised Practitioner
- Practitioner
- Lead Practitioner
- Expert

# Standard Role Definition

## Standard Structure

<b>Role Name</b>	
<b>Role Purpose</b>	
<b>Activities performed</b>	
<b>Competency class</b>	<b>Competency and level required</b>
<b>Other constraints / qualifications required</b>	

## Definitions

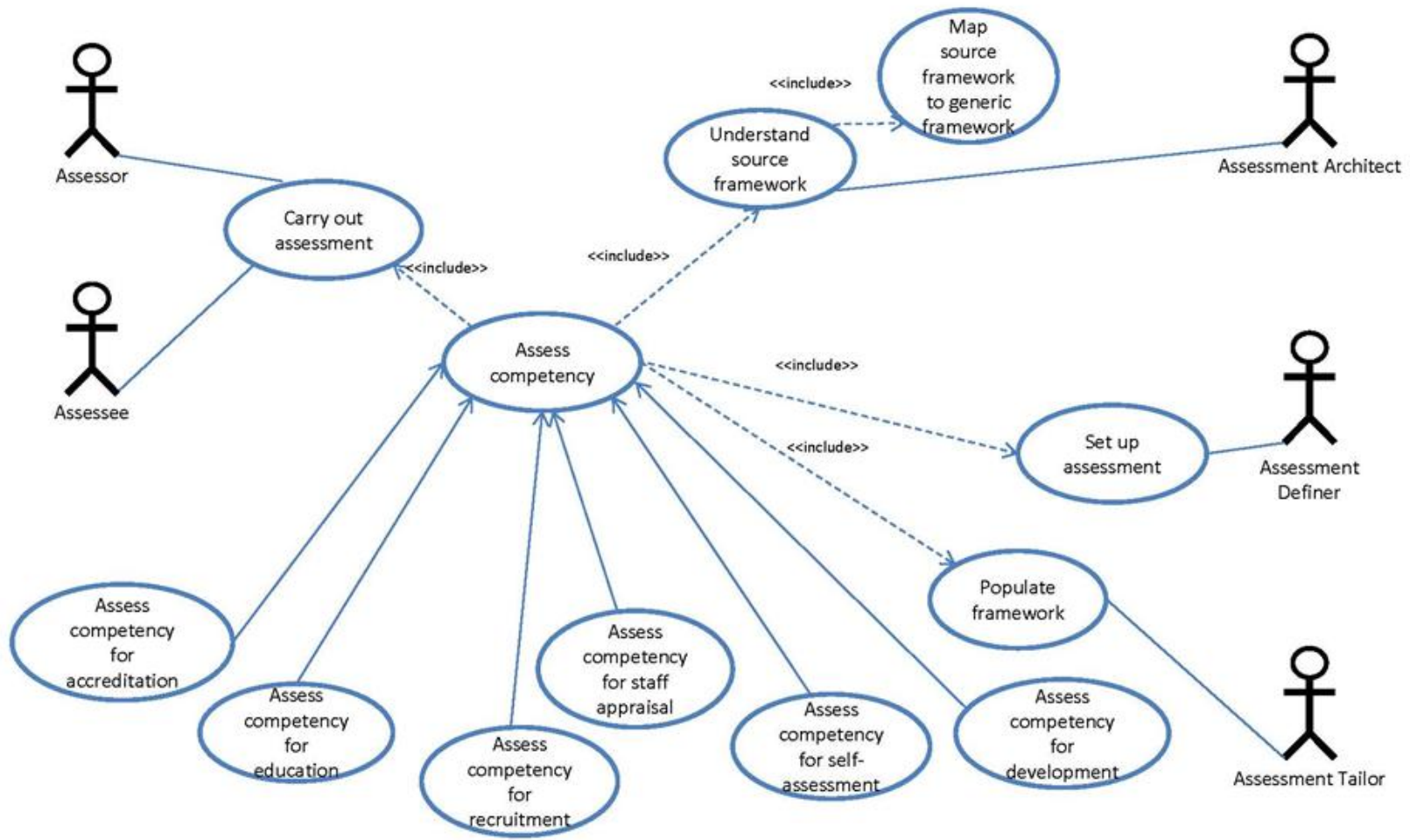
- **Role Name** – title of role
- **Role Purpose** – job summary / one sentence description (operational requirement)
- **Activities Performed** (aka “accountability statement”) – key activities from processes that role accountable or responsible for
- **Competency** – the named competency (list divided into classes) and the level required
- **Other** – statements on licences, qualification or other constraints on the role

# *Use Cases*

*Courtesy of Heidi Hahn, 2016*

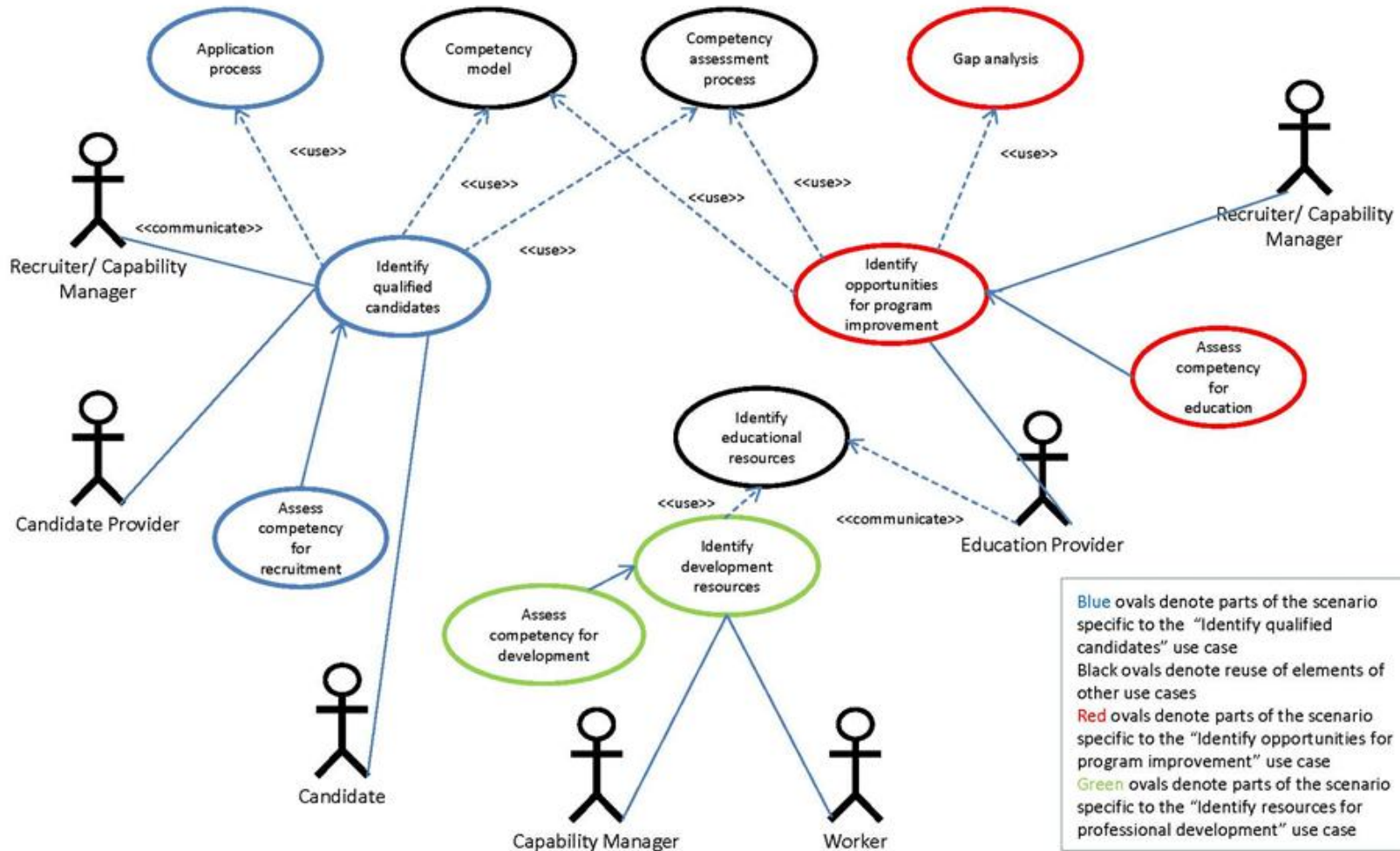


# Various Use Cases for ICF



Universal Competency Assessment Model (adapted from Holt and Perry, 2011)

# Education Interaction Use Case Models



# Narrative Description of Professional Development Use Case

Use Case Name	Identify resources for professional development
Preconditions	Use cases “Set up competency model” and the variant of “Assess competency for education” called “Identify education resources” have been successfully completed
Actors	<ul style="list-style-type: none"> <li>• Worker</li> <li>• Capability Manager (CM)</li> <li>• Education Provider</li> </ul>
Triggers	Worker or CM determines need for professional development
Primary flow of events	<ol style="list-style-type: none"> <li>1. The use case begins when the Worker or CM decides to initiate professional development</li> <li>2. Worker or CM reviews the offerings of Education Provider against the competency model and selects development resources</li> <li>3. Worker completes selected professional development activities and this use case ends, transitioning to a use case on documenting competencies obtained</li> </ol>
Alternate flow	<p>At Step 3, CM assigns workers to complete selected professional development</p> <p>Worker resumes as Step 4</p>
Issues	The use case must account for professional development providers other than academia

# Narrative Description of Recruitment Use Case

Use Case Name	Identify qualified candidates
Preconditions	Use cases “Set up competency model” and the variant of “Assess competency for recruitment” called “Identify sources of candidates” (which may or may not include the variant of “Assess competency for education” called “Identify schools with capable programs”) have been successfully completed
Actors	<ul style="list-style-type: none"> <li>• Recruiter/Capability Manager (CM)</li> <li>• Candidate Provider (CP) (may include representatives of workforce placement services, internal or external job board services, educational institution faculty or administrators)</li> <li>• Candidate</li> </ul>
Triggers	Application window for identified vacancy is about to open
Primary flow of events	<ol style="list-style-type: none"> <li>1. The use case begins when the CM decides to begin recruiting and posts vacancies</li> <li>2. CM communicates competency model to CP, along with application deadlines and other pertinent information</li> <li>3. CP compares skills of potential applicants in their candidate pool to competency model</li> <li>4. CP encourages qualified Candidates to apply</li> <li>5. Candidate decides whether to apply and submits application</li> <li>6. CM accesses their organization’s vacancy posting system to generate an applicant listing and this use case ends, transitioning to a use case on applicant selection</li> </ol>
Alternate flow	<p>At Step 3, CP provides competency models to Candidate, who self-assesses skills</p> <p>Step 4 may be omitted in cases where automated systems that are used for candidate processing lack referral capability</p>
Issues	The use case must account for the situation in which no qualified candidates are identified
Post condition	A list of qualified applicants

# Narrative Description of Education Program Improvement Use Case

Use Case Name	Identify opportunities for program improvement
Preconditions	Use cases “Set up competency model” and the variant of “Assess competency for education” called “Identify schools with capable programs” including “Perform gap analysis” have been successfully completed
Actors	<ul style="list-style-type: none"> <li>• Employer Recruiter/Capability Manager (CM)</li> <li>• Education Provider (Faculty/Administrators)</li> </ul>
Triggers	Relationship between Employer and Education Provider established
Primary flow of events	<ol style="list-style-type: none"> <li>1. The use case begins when the Education Provider requests dialog re: employer needs</li> <li>2. Education Provider contacts Employer and arranges for a visit with Faculty/Administrators</li> <li>3. CM communicates competency model and identified gaps to Education Provider</li> <li>4. Education Provider validates gaps</li> <li>5. Education Provider determines actions needed to address gaps and this use case ends</li> </ol>
Alternate flow	<p>At Step 3, CM communicates competency model only</p> <p>At Step 4, Education Provider performs self-assessment against competency model to identify gaps</p>
Issues	The use case must account for the situation in which the Education Provider refutes the Employer’s gap analysis
Post condition	Program improvement action list

# *Tailoring, Extending and Scaling the Competency Framework*

# INCOSE SE Role-Based Competency Framework Taxonomy

SE Role	A collection of interrelated and interdependent activities assigned to a person in a contextual environment such as Systems Engineering
Activity	A specified pursuit defined by a set of essential functions and desired outcomes that enable the successful accomplishment of one's role
Category	A grouping of closely related competencies considered essential to an individual's ability to successfully perform an activity
Competency	An observable and measurable pattern of knowledge, skills, abilities, behaviors, and other characteristics that an individual needs to successfully perform an activity
Description and Why It Matters	A depiction of the competency that clearly defines its essential function, desired outcomes and reasons for why the competency is needed
Knowledge Skills Abilities Behaviors	The measurable characteristics of proficiency that make up a competency

# Competency Framework Table

Systems Engineering Roles Framework				
Role – Title of the Role				
<b>Role Description:</b> explains the role and provides meaning to the role				
<b>Why it matters:</b> indicates the importance and value of the role and the problems that may be encountered in the absence of that role				
List of Activities	Activity Description	Category	Competency	Recommended Proficiency Level
Name of the activity	Explains the activity, the value of the activity and how it supports the role.	Core Principles	Competency Title	Proficiency Level
			Competency Title	Proficiency Level
		Technical Management	Competency Title	Proficiency Level
			Competency Title	Proficiency Level
		Technical	Competency Title	Proficiency Level
			Competency Title	Proficiency Level
		Professional	Competency Title	Proficiency Level
			Competency Title	Proficiency Level
		Cross-Discipline Understanding	Competency Title	Proficiency Level
			Competency Title	Proficiency Level
		Enterprise	Competency Title	Proficiency Level
			Competency Title	Proficiency Level



# Proficiency Level Table

<b>Systems Engineering Competency Model – Proficiency Level Table</b>				
<b>COMPETENCY AREA – Category: Competency</b>				
<b>Description:</b> explains the competency and provides meaning behind the title.				
<b>Why it matters:</b> indicates the importance of the competency and the problems that may be encountered in the absence of that competency.				
<b>EFFECTIVE INDICATORS OF KNOWLEDGE, SKILLS, ABILITIES AND EXPERIENCE</b>				
<b>AWARENESS</b>	<b>SUPERVISED PRACTITIONER</b>	<b>PRACTITIONER</b>	<b>LEAD PRACTITIONER</b>	<b>EXPERT</b>
The person is able to understand the key issues and their implications. They are able to ask relevant and constructive questions on the subject.	The person displays an understanding of the subject but requires guidance and supervision.	The person displays detailed knowledge of the subject and is capable of providing guidance and advice to others.	<p>The person displays both in-depth and broad knowledge of the subject based on practical experience.</p> <p>The person is capable of leading others to create and evaluate solutions to complex problems in the subject.</p>	The person displays extensive and substantial practical experience and applied knowledge of the subject.

# *Seeking Alignments*

# Alignments with ...

- DoD's Better Buying Power 3.0 & Acquisition Workforce Qualification Initiative
- Defense Acquisition University Engineering Competency Model
- US Navy's Systems Engineering Competency Career Model (SECCM)
- INCOSE Systems Engineering Handbook 4<sup>th</sup> ed.
- INCOSE Systems Engineering Professional (SEP) Program
- INCOSE Professional Development Initiative
- INCOSE Vision 2025 Roles and Competencies
- Systems Engineering Research Center's Helix Study
- Systems Engineering Body of Knowledge (SEBoK Part 5)
- Information Technology Body of Knowledge (ITBoK)

# *Next Steps*

- Coordinate and Align with:
  - INCOSE PMI Working Group
  - Other models (i.e., CMMI, etc.) and how they may impact the framework
- Develop and Finalize Use Cases
- Develop an Assessment Methodology
  - Consider how to support an Individual / Supervisor Assessment of Competence
- Examine competencies outside traditional SE to provide breadth
- Consider including foundational systems principles

# Questions?



# *Don's Contact Info*

---



**Don S. Gelosh, Ph.D., CSEP-Acq**  
**Director, Systems Engineering Programs**  
**Worcester Polytechnic Institute**

Corporate and Professional Education

540-349-3949

dsgelosh@wpi.edu

cpe.wpi.edu