

# INCOSE Systems Engineering Competency Framework

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## TASKING & PURPOSE

- The INCOSE Competency Working Group was tasked to define a global standard for those competencies regarded as central to the practice and profession of Systems Engineering, together with a set of indicators which can be used to verify attainment of those competencies.
- The purpose of the Competency Framework is to provide a set of competencies for Systems Engineering within a framework that provides guidance for both beneficiaries and practitioners to identify knowledge, skills, abilities and behaviors important to Systems Engineering effectiveness in the domain for which the competency model is applied.

## COMPETENCE GROUPS

- The Systems Engineering Competencies are grouped into five themes which are summarized in the table below:

Competence Groups	Descriptions
Core Systems Engineering Principles	Covers core principles which underpin engineering as well as systems engineering.
Professional	Covers behavioral competencies which are all well-established within the Human Resources (HR) domain. Definitions of these competencies were taken from internationally-recognized sources to facilitate alignment with wider HR frameworks used in larger organizations.
Technical	Covers the competencies needed to perform a series of tasks associated with the Technical Processes identified in the INCOSE SE Handbook 4th Edition.
Systems Engineering Management	Covers the competencies needed to perform tasks associated with controlling and managing systems engineering work.
Integrating	Covers the systems engineering competencies required to understand and integrate the viewpoints and perspectives of others into the overall picture.

## COMPETENCY AREAS

- The 36 Competency Areas are shown in the table below:

<b>Core Systems Engineering Principles:</b>	<b>Professional:</b>
<ul style="list-style-type: none"><li>Systems Thinking</li><li>Lifecycles</li><li>Capability Engineering</li><li>General Engineering</li><li>Critical Thinking</li><li>Systems Modelling and Analysis</li></ul>	<ul style="list-style-type: none"><li>Communications</li><li>Ethics and Professionalism</li><li>Technical Leadership</li><li>Negotiation</li><li>Team Dynamics</li><li>Facilitation</li><li>Emotional Intelligence</li><li>Coaching and Mentoring</li></ul>
<b>Technical:</b>	<b>Systems Engineering Management:</b>
<ul style="list-style-type: none"><li>Requirements Definition</li><li>System Architecting</li><li>Design for...</li><li>Integration</li><li>Interfaces</li><li>Verification</li><li>Validation</li><li>Transition</li><li>Operation and Support</li></ul>	<ul style="list-style-type: none"><li>Planning</li><li>Monitoring and Control</li><li>Decision Management</li><li>Concurrent Engineering</li><li>Business &amp; Enterprise Integration</li><li>Acquisition and Supply</li><li>Information Management</li><li>Configuration Management</li><li>Risk and Opportunity Management</li></ul>
<b>Integrating:</b>	
<ul style="list-style-type: none"><li>Project Management</li><li>Finance</li><li>Logistics</li><li>Quality</li></ul>	

## COMPETENCE ASSESSMENT APPROACHES

- Organizations can implement Competence assessments with one of three approaches (or combinations) described in the table below:

Method	Description	Benefits	Disadvantages
Self-Assessment	Individuals are provided with a formal description of each competence area and competence level indicator by the organization, and independently determine what they believe their competence levels to be.	Reasonably cost-effective. Effort of assessment is split across the organization. Requires little support from the organization. Individuals can include experience which may not be well-known within their current organization. Can be used by individuals in organizations for career planning where Systems Engineering is not well-established.	Individuals may not understand the full scope of the competence, leading to potential overstating of their own competence. Equally individuals may also understate their competence, due to lack of awareness or self-confidence in competency areas. Organizational consistency is hard as individuals may self-assess to different standards. Individuals reluctant to accept Systems Engineering may over-score themselves to demonstrate they do not need development in this area.
Manager Assessment	Managers are provided with a formal description of each competence area and competence level indicator, and independently determine the individual competence levels of staff members for the purpose of training or job assignments. This could be with or without interview of the individual concerned.	Cost-effective. If managers understand the competencies and know their staff well, assessment can be a quick process. If managers use an interview-based technique this can be very accurate. The consistency of organizational assessment can be good, if managers are prepared well. Can be aligned well to organizational strategies – implemented through managers.	May be a burden to managers with large numbers of staff, or if the manager formally interviews individuals. If managers do not understand the full scope of the competencies, errors in ratings can occur (e.g. if a manager is not an expert in Systems Engineering). If managers do not know their staff well, assessment can be erroneous. Individuals may feel uncomfortable admitting a lack of competence to their manager or may feel stressed at the idea of assessment, which may influence accuracy. Managers may exhibit bias for/against an individual influencing outcome. Managers may not be aware of experience gained by individuals before they worked for the manager.
Independent Assessment	Independent trained assessors (from inside or outside the organization) formally interview individual staff members to assess their competence.  This is commonly deployed with two assessors to provide consistency and results analysis but can be achieved with just one or indeed three.	The use of trained assessors ensures candidates are put at ease, helping to ensure complete and honest responses. The use of trained assessors ensures an accurate reflection of the scope of competence areas and indicators in the framework.  There is unlikely to be any subjective bias from knowing the history or circumstances of a candidate. The assessment is fact-based.  Two or more assessors can further ensure consistency against the defined standards than one alone.	Can be quite expensive, especially if assessors are formally trained internally as part of the initiative to ensure their full understanding of the framework. Administration required to set-up interviews can be time consuming. Individuals may feel uncomfortable admitting a lack of competence if they feel they are being “judged” or may feel stressed at the idea of independent assessment, both of which may influence accuracy.

## TYPICAL COMPETENCY DESCRIPTION

### COMPETENCY AREA – Technical: Requirements Definition

#### Description:

To analyze the stakeholder needs and expectations to establish the requirements for a system.

#### Why it matters:

The requirements of a system describe the problem to be solved (its purpose, how it performs, how it is to be used, maintained and disposed of and what the expectations of the stakeholders are).

#### EFFECTIVE INDICATORS OF KNOWLEDGE AND EXPERIENCE

AWARENESS	SUPERVISED PRACTITIONER	PRACTITIONER	LEAD PRACTITIONER	EXPERT
Describes different types of requirements (e.g. functional, non-functional, business etc.).	Identifies all stakeholders and their sphere of influence.	Defines governing requirements elicitation and management plans, processes and appropriate tools and uses these to control and monitor requirements elicitation and management activities.	Recognized, within the enterprise, as an authority in requirements elicitation and management techniques, contributing to best practice.	Recognized, beyond the enterprise boundary, as an authority in requirements elicitation and management techniques.
Explains why there is a need for good quality requirements.	Assists with the elicitation of requirements from stakeholders.	Elicits and validates stakeholder requirements.	Defines and documents enterprise-level policies, procedures, guidance and best practice for requirements elicitation and management, including associated tools.	Contributes to requirements elicitation and management best practice.
Identifies major stakeholders and their needs.	Describes the characteristics of good quality requirements and provides examples.	Writes good quality, consistent requirements.	Reviews and judges the tailoring of enterprise-level requirements elicitation and management processes to meet the needs of a project.	Influences key stakeholders beyond the enterprise boundary in support of requirements elicitation and management.
Explains why managing requirements throughout the lifecycle is important.	Describes different mechanisms used to gather requirements.	Derives requirements by analyzing beyond the boundary of the system of interest.	Challenges appropriateness of requirements in a rational way.	Advises on the suitability of the approach to elicitation and management of requirements.
Explains why there is a need to manage all types of requirements.	Explains why there is a need for traceability in the requirements process.	Establishes acceptance criteria for requirements.	Reviews and judges the suitability and completeness of the requirements set.	Advise and arbitrates on complex or sensitive requirements-related issues.
Describes the relationship between requirements and acceptance.	Assists with establishment of acceptance criteria for requirements.	Resolves and negotiates requirement conflicts in order to establish a complete and consistent requirement set for the system of interest.	Influences key stakeholders to address identified enterprise-level requirements elicitation and management issues.	Champions the introduction of novel techniques and ideas in requirements elicitation and management, producing measurable improvements.
	Identifies potential requirement conflicts within the requirement set.	Assesses the impact of changes to requirements on the solution and program.	Coaches new and experienced practitioners in requirements elicitation and management.	Coaches lead practitioners in requirements elicitation and management.
	Explains how requirements affect design and vice versa and provides examples.	Guides supervised practitioners in requirements elicitation and management.		
	Assists with the establishment and maintenance of requirements traceability information.			

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