INCOSE UK FRAMEWORK

Systems Engineering Competencies Framework



INCOSE UK

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Acknowledgements

The 'Systems Engineering Competencies Framework' (Phase 1 Working Group) and 'Guide to Competency Evaluation' (Phase 2 Working Group) have been produced from the output of a number of INCOSE UK workshops. Phase 3 of the Working Group updated both documents using feedback from implementation. The Working Groups were attended by the following people:

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Contents

Introduction

"Systems Engineering is an interdisciplinary approach and means to enable the realisation of successful systems. It focuses on defining customer needs and required functionality early in the development cycle, documenting requirements, and then proceeding with design synthesis and system validation while considering the complete problem:

- *Cost and Schedule;*
- *Performance;*
- *Test;*
- *Manufacturing;*
- *Training and Support;*
- *Operations;*
- *Disposal.*

Systems Engineering integrates all the disciplines and specialty groups into a team effort forming a structured development process that proceeds from concept to production to operation. Systems Engineering considers both the business and the technical needs of all customers with the goal of providing a quality product that meets the user needs."
Definition of the International Council on Systems Engineering (INCOSE).

An issue identified by the INCOSE UK Advisory Board (UKAB) was the inability of individuals and enterprises to identify the competencies that are required to conduct 'good systems engineering'. The objective determined by the INCOSE UKAB was 'to have a measurable set of competencies for systems engineering which will achieve national recognition and will be useful to the enterprises represented by the UKAB'.

The main body of this document describes the systems engineering competencies, defined by the resultant INCOSE UKAB Working Group. They are provided to help people understand what is needed by individuals and teams who do systems engineering, and they should be tailored to meet the needs of the individuals and enterprises who use them.

Scope

The main body of this document describes the systems engineering competencies, defined by the resultant INCOSE UKAB Working Group. They are provided to help people understand what is needed by individuals and teams who do systems engineering and are based on the following systems engineering standards:

- International Standards Organisation ISO15288;
- Capability Maturity Model Integration;
- EIA731;
- INCOSE Systems Engineering Body of Knowledge and Handbook;
- NASA Handbook;
- IEE/BCS Safety Competency Guidelines.

The competencies described are those predominantly associated with Systems Engineering, rather than those which overlap with other areas, for example Project Management. These overlapping competencies are already defined by their respective professional bodies, for example the Association of Project Managers (APM), but may require tailoring to meet the needs of Systems Engineering.

Structure of the Framework

Systems Engineering ability comprises four key elements:

- Competencies;
- Basic Skills and Behaviours;
- Supporting Techniques;
- Domain Knowledge.

These key elements are described in more detail in the relevant sections of this document namely The Systems Engineering Competencies, Basic Skills and Behaviours and Supporting Techniques. Domain Knowledge will vary from industry to industry. Domain Knowledge acknowledges that industrial context, the specific commercial environment and types of supply chain have a big impact on the systems engineering being conducted and that this will be specific to particular industrial fields. It is therefore difficult to produce a generic set of competencies for domain knowledge and will be left to the enterprise implementing these competencies to define what domain knowledge is required.

This framework is supported by a Guide to Competency Evaluation which provides general guidance on how to evaluate individuals against the competencies defined herein, including contributory types of evidence for each competency level.

Usage of the Framework

This Systems Engineering competency framework is generic in purpose. It can be applied in the context of an application, a project, an organisation, an individual and/or a training programme or training development. This framework cannot be specific for all these potential (and different) situations, and hence a degree of tailoring (see Tailoring the Framework page 6) is necessary. However, it is expected that to get a more holistic and balanced view as an individual, these competencies would be combined with other complimentary competency and capability frameworks (e.g. Aerospace, Civil Engineering and Programme Management) and other relevant skills and behaviours tailored to their particular role or area in which they operate.

As a stand-alone document this framework focuses on the competencies and skills that when linked with processes, organisations and infrastructure capabilities create successful Systems Engineering applications. Therefore, depending upon circumstances, sub-sets of this framework may be selected and used independently. When using the indicators for levels of competency the indicators accumulate – i.e. to reach practitioner level all the indicators for the levels below apply.

Organisations

For an organisation, the framework needs to be combined with the terminology, processes and job roles that exist when the framework is applied. Therefore the framework can be used to:

- Identify what Systems Engineering competencies are embedded in each of the different roles in the organisation;
- Redefine the roles to ensure suitable Systems Engineering competencies are included;
- Define new roles that apply Systems Engineering competencies that are not currently implicit in the organisation – or to make more explicit the need to exploit these competencies;
- Guide changes to the processes, organisation etc. (its capability) to exploit Systems Engineering competencies;
- Review the status / strength of Systems Engineering, and prioritise organisation improvements and / or training programmes;
- Provide a better understanding of Systems Engineering by explaining what it is people do when undertaking Systems Engineering;
- Support Enterprise profiling;
- Support Team profiling;
- Support Recruitment;
- Measure and benchmark the state of Systems Engineering in the organisation;
- Identify gaps in skill base.

This competency definition is non-prescriptive, and so organisations need to consider the size and complexity of their products and services when using and tailoring this definition to roles in their organisation. Therefore comparison between different roles or different organisations needs to consider the specific complexity of the domain, to ensure comparisons are "like with like".

Project or Application

For a project or application the scope of the work will determine which part of the framework need to be focused upon. This will particularly depend on what section of the lifecycle is being addressed.

Individual

An individual can use the Framework to assess their level of Systems Engineering competency. Then, in conjunction with an understanding of the roles in an organisation, a review of their Systems Engineering strengths and weaknesses can be carried out to plan on-going professional development, both in terms of deepening and broadening their skill. This can be done in preparation for a new task or role, or in reflection after a particular activity.

Academic Institutions / Training Providers

The competencies for Systems Engineering can also be used by academic institutions and training providers to develop educational programmes in Systems Engineering that will provide the raw material for enterprises.

The guide to measuring competency can be used to ensure that the level of Systems Engineering competency an education or training programme takes an individual to is clearly understood – i.e. the depth of the course is understood. The framework can be used to determine the number of competencies covered in any course – i.e. the breadth of the course.

These competencies can also be used by Engineering Institutions to assess and accredit Systems Engineering courses, as well as generally understanding expected levels of competence in professional engineers working in a "Systems Engineering" field.

Tailoring of the Framework

There are many on-going and lively debates about specific aspects of Systems Engineering. It is beyond the scope of this framework to provide definitive answers or a single route to applying Systems Engineering. As a general principle Systems Engineering has been defined as the overall discipline, which has specific roles contained within it, e.g. System Designer, Capability Engineer, Architect, Enterprise Architect, Requirements Engineer, and Operational Analyst. Given the complex nature of organisations and the variation in approach and role definition it may be that different terminology and/or a different hierarchy of roles is appropriate.

Systems Engineering is a broad discipline that interacts with all other engineering disciplines and as such can be deployed in a variety of ways. To support this, the framework can be tailored to make it relevant and appropriate to the specific use. The terminology for the different levels of competency may be relabelled as needed (e.g. to remove any reference to specific roles).

The range of competencies encompassed by the Systems Engineering framework is very large and it is not expected that an individual will be "expert" in more than a few of these competencies.
It is important therefore that this framework be used as the common starting point for tailoring the description of Systems Engineering relevant to an organisation and individual. It is expected that an organisation will have a set of roles, each with a profile against these competencies (or a tailored sub-set), with different levels of competence needed. These roles may well include requirements for expertise in other engineering skills and domain specific knowledge / experience. An important check for the enterprise will be to ensure that the roles are balanced (expertise not diluted and all key competencies covered) and the means of communication and integration of the roles understood – so that the "team" is appropriately competent in Systems Engineering.

Individual Professional Development

Individuals should tailor the competency based on their specific or proposed future roles, and their current level of competency. This allows them to identify career progression exploiting their identified strengths and identification of personal development plans.

Enterprise Ability Development

In order to use the competency framework (see Usage of Framework page 5), an Enterprise will need to review their requirements for the different competencies and competency level and generate a scope for the skills required across the enterprise, in generic roles, within teams and at an individual level. These role specifications can then be mapped to existing and potential employees. These competencies provide a framework for career development and recruitment processes by setting out the Systems Engineering skill requirements for a role.

This may require some specific tailoring of the competencies to suit the needs of the enterprise. This can include:

- Combination of the competencies into definitions relevant / appropriate to the enterprise;
- Use of a sub-set of the competencies depending on the specific activities of the organisation.

An organisation may wish to trace the tailoring back to this original framework, to enable benchmarking against other organisations, and to update in-line with changes to this source framework.

This framework can be adapted and integrated with other frameworks to describe specific roles in the organisation. It is important that roles are profiled to define requirements, and then individuals assessed against / matched to the role, rather than starting with the individual.

Although this competency framework requires tailoring to individual Enterprises, this framework provides a general definition and common source of Systems Engineering. Therefore it is intended that whilst there are enterprise-specific adaptations and implementations of Systems Engineering, there is a core understanding of what the full potential range of competencies is. A general test for role definitions within an organisation is to check whether the full scope of the Systems Engineering competencies is covered (within the scope of the Enterprise's activities).

System Engineering Competencies

Competency Framework

The competencies that are predominantly associated with Systems Engineering are listed below and expanded in full in a series of competency tables. The competencies are grouped into three themes; Systems Thinking, Holistic Lifecycle View, and Systems Engineering Management.

Systems Thinking contains the underpinning systems concepts and the system/super system skills including the enterprise and technology environment.

Holistic Lifecycle View contains all the skills associated with the systems lifecycle from need identification, requirements through to operation and ultimately disposal.

Systems Engineering Management deals with the skills of choosing the appropriate lifecycle and the planning, monitoring and control of the systems engineering process.

The distinguishing feature of Systems Engineering is its interdisciplinary nature. All these competencies may be present in single discipline individuals, for example, Software Systems Engineers. However, to be a “Systems Engineer” requires the definition and integration of a system solution that comprises a number of discipline areas, for example mechanics, electronics, software, including specialist disciplines such as human factors and electromagnetic compatibility.

Competency Table Format

Each competency table provides:

- A description
- Why it matters
- Effective indicators of knowledge and experience
  - Awareness
  - Supervised Practitioner
  - Practitioner
  - Expert

Description explains what the competency is and provides meaning behind the title. Each title can mean different things to different individuals and enterprises.

Why it matters indicates the importance of the competency and the problems that may be encountered in the absence of that competency.

Effectiveness indicators of knowledge and experience given in the tables are detailed below and are designed to be entry level requirements, i.e. an individual must satisfy all the effective indicators for a particular level to be considered competent at that level. The time-lapse involved since a particular effectiveness indicator was last met should be taken into consideration.

Each competency should be assessed in terms of the levels of comprehension and experience defined by “Awareness” through to “Expert”.

Awareness
The person is able to understand the key issues and their implications. They are able to ask relevant and constructive questions on the subject. This level is aimed at enterprise roles that interface with Systems Engineering and therefore require an understanding of the Systems Engineering role within the enterprise.

Supervised Practitioner
The person displays an understanding of the subject but requires guidance and supervision. This level defines those engineers who are “in-training” or are inexperienced in that particular competency.

Practitioner
The person displays detailed knowledge of the subject and is capable of providing guidance and advice to others.

Expert
The person displays extensive and substantial practical experience and applied knowledge of the subject.

Competency Titles

The competencies of systems engineering are:

Systems Thinking

- Systems Concepts
- Super System Capability Issues
- Enterprise and Technology Environment

Holistic Lifecycle View

- Determine and Manage Stakeholder Requirements
- System Design:
  - Architectural Design
  - Concept Generation
  - Design for …
  - Functional Analysis
  - Interface Management
  - Maintaining Design Integrity
  - Modelling and Simulation
  - Select Preferred Solution
  - System Robustness
  - Systems Integration and Verification
  - Validation
  - Transition to Operation

Systems Engineering Management

- Concurrent Engineering
- Enterprise Integration
- Integration of Specialisms
- Lifecycle Process Definition
- Planning, Monitoring and Controlling

Design issues related to in-service support and disposal are addressed as part of the 'Design for…' and 'Transition to Operation' competencies with requirements for in service support and disposal addressed in 'Determine and Manage Stakeholder Requirements'. A separate competency for carrying out support and disposal is not required as these activities will be conducted by specialisms and not systems engineering. Integrating these specialisms as part of the system's lifecycle is covered by the Systems Engineering Management competency of 'Integration of Specialisms'. The design of support equipment, infrastructures and services can be considered as another systems engineering design activity and this whole set of competencies is equally applicable.

COMPETENCY AREA - Systems Thinking: System Concepts

Description:
The application of the fundamental concepts of systems thinking to systems engineering. These include understanding what a system is, its context within its environment, its boundaries and interfaces and that it has a lifecycle.

Why it matters:
Systems thinking is a way of dealing with increasing complexity. The fundamental concepts of systems thinking involves understanding how actions and decisions in one area affect another, and that the optimisation of a system within its environment does not necessarily come from optimising the individual system components.

EFFECTIVE INDICATORS OF KNOWLEDGE AND EXPERIENCE

AWARENESS	SUPERVISED PRACTITIONER	PRACTITIONER	EXPERT
Is aware of the need for systems concepts Aware of the importance of: ■ system lifecycle ■ hierarchy of systems ■ system context ■ interfaces ■ interactions amongst systems and their elements	Understands systems concepts Understands the system lifecycle in which they are working Understands system hierarchy and the principles of system partitioning in order to help manage complexity Understands the concept of emergent properties Can identify system boundaries and understands the need to define and manage the interfaces Understands how humans and systems interact and how humans can be elements of systems	Able to identify and manage complexity with appropriate techniques in order to reduce risk Able to predict resultant system behaviour Able to define system boundaries and external interfaces Able to assess the interaction between humans and systems, and systems and systems Able to guide supervised practitioner	Able to review and judge the suitability of systems solutions and the planned approach Has coached new practitioners in this field Has championed the introduction of novel techniques and ideas in this field which produced measurable improvements Has contributed to best practice

COMPETENCY AREA - Systems Thinking: Super System Capability Issues

Description:
An appreciation of the role the system plays in the super system of which it is a part.

Why it matters:
A system is not successful unless it meets the needs of the super system of which it is a part. Capturing the complete set of system requirements is not possible unless the context of the super system is fully appreciated. Failure to do this can result in sub-optimisation

EFFECTIVE INDICATORS OF KNOWLEDGE AND EXPERIENCE

AWARENESS	SUPERVISED PRACTITIONER	PRACTITIONER	EXPERT
Understands the concept of capability Understands that capability requirements can be satisfied by a system of systems approach Understands that super system capability needs impact on the system development Appreciates the difficulties of translating super system capability needs into system requirements	Can describe the environment and super system into which the system under development is to be delivered Identifies, with guidance, the super system capability issues which will affect the design of a system	Able to identify the super system capability issues which will affect the design of a system and translates these into system requirements Able to assess extent to which the proposed system solution meets the super system capability, and provide advice on trade-offs Able to guide supervised practitioner.	Has reviewed and advised on the suitability of systems solutions Has coached new practitioners in this field Has championed the introduction of novel techniques and ideas in this field which produced measurable improvements Has contributed to best practice

COMPETENCY AREA - Systems Thinking: Enterprise and Technology Environment

Description:
The definition, development and production of systems within an enterprise and technological environment.

Why it matters:
Systems Engineering is conducted within an enterprise and technological context. These contexts impact on the lifecycle of the system and place requirements and constraints on the Systems Engineering being conducted. Failing to meet such constraints can have a serious effect on the enterprise and the value of the system.

EFFECTIVE INDICATORS OF KNOWLEDGE AND EXPERIENCE

AWARENESS	SUPERVISED PRACTITIONER	PRACTITIONER	EXPERT
Aware of the influence the enterprise (environment, objectives, social, political, financial, cultural, research) has on the definition and development of the system Aware of the influence technology has on the definition and development of the system Aware of the influence the system has on the enterprise Aware of the influence the system has on technology	Can identify, with guidance, the various enterprise issues (markets, products, policies, finance, technologies etc.) which interact with the system to be developed Can contribute, with guidance, to the technology plan Can contribute, with guidance, to the enterprise improvement plan	Identifies the enterprise and technology issues which will affect the design of a system and translates these into system requirements Able to produce and implement a technology plan that includes technology innovation, risk, maturity, readiness levels and insertion points Able to contribute to delivery of enterprise improvements to enable better system development Able to guide supervised practitioner	Influences and maintains the technical capability and strategy of their enterprise Recognised as an authority in technology planning and management Has coached new practitioners in this field Has championed the introduction of novel techniques and ideas in this field which produced measurable improvement Has contributed to best practice

COMPETENCY AREA – Holistic Lifecycle View: Determining and Managing Stakeholder Requirements

Description:
To analyse the stakeholder needs and expectations to establish and manage 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). Managing the requirements throughout the lifecycle is critical for implementing a successful system.

EFFECTIVE INDICATORS OF KNOWLEDGE AND EXPERIENCE

AWARENESS	SUPERVISED PRACTITIONER	PRACTITIONER	EXPERT
Understands that there are different types of requirements e.g. functional, non functional, business etc. Understands the need for good quality requirements Able to identify major stakeholders Understands the importance of managing requirements throughout the lifecycle Understands the need to manage all types of requirements	Able to identify all the stakeholders and their sphere of influence Can support the elicitation of requirements from stakeholders Understands the characteristics of good quality requirements Understands methods used in requirements gathering Understands the need for traceability in the requirements process Understands the relationship between requirements and acceptance Able to establish acceptance criteria for simple requirements Understands the relationship between design and requirements	Has successfully elicited and validated stakeholder requirements Has written good quality, consistent requirements Able to derive requirements from analysis of the super system design Able to establish acceptance criteria for requirements for the system of interest Able to resolve and negotiate requirement conflicts in order to establish a complete and consistent requirement set for the system of interest Identifies areas of uncertainty and risk when determining requirements Able to challenge appropriateness of requirements in a rational way Able to define and document an approach for requirements elicitation and management Can assess the impact of changes to requirements on the solution and programme Able to guide supervised practitioner	Acknowledged as an authority in the elicitation and management of requirements Reviews and judges the suitability of the approach to requirements elicitation and management Reviews and judges the suitability and completeness of the requirements set Advises on the sensitive requirements negotiations on major programmes Has coached new practitioners in this field Has championed the introduction of novel techniques and ideas in this field which produced measurable improvements Has contributed to best practice

COMPETENCY AREA – Holistic Lifecycle View: Systems Design – Architectural Design

Description:
The definition of the system architecture and derived requirements to produce a solution that can be implemented to enable a balanced and optimum result that considers all stakeholder requirements (business, technical....).

Why it matters:
Effective architectural design enables systems to be partitioned into realisable system elements which can be brought together to meet the requirements

EFFECTIVE INDICATORS OF KNOWLEDGE AND EXPERIENCE

AWARENESS	SUPERVISED PRACTITIONER	PRACTITIONER	EXPERT
Understands the principles of architectural design and its role within the lifecycle Aware of the different types of architecture Aware that architectural decisions can constrain and limit future use and evolution	Able to use techniques to support architectural design process Able to support the architectural design trade-offs Able to contribute to alternative architectural designs that are traceable to the requirements Able to interpret an architectural design	Able to generate alternative architectural designs that are traceable to the requirements Able to assess a range of architectural designs and justify the selection of the optimum solution Able to define a process and appropriate tools and techniques for architectural design Able to choose appropriate analysis and selection techniques Able to partition between discipline technologies and derive discipline specific requirements Able to guide supervised practitioner	Can demonstrate a full understanding of architectural design techniques and their appropriateness, given the levels of complexity of the system of interest Reviews and judges the suitability of architecture designs Has coached new practitioners in this field Has championed the introduction of novel techniques and ideas in this field which produced measurable improvements Has contributed to best practice

COMPETENCY AREA – Holistic Lifecycle View: Systems Design – Concept Generation

Description:
The generation of potential system concepts that meet a set of needs and demonstration that one or more credible, feasible options exist.

Why it matters:
Failure to explore alternative options may result in a non-optimal system. There may be no viable option (e.g. technology not available).

EFFECTIVE INDICATORS OF KNOWLEDGE AND EXPERIENCE

AWARENESS	SUPERVISED PRACTITIONER	PRACTITIONER	EXPERT
Understands the need to explore alternative and innovative ways of satisfying the need Understands that alternative discipline technologies can be used to satisfy the same requirement	Can contribute candidate concepts (no matter how radical) Can support assessment of the feasibility of concepts	Understands the strengths and weaknesses of relevant technologies in the context of the requirement Able to create and be open to a range of alternative and innovative interdisciplinary concepts Able to down select to a number of possible alternative options and demonstrate that credible, feasible options exist Able to guide supervised practitioner	Able to guide and advise practitioners in techniques for concept generation Reviews down selected concepts for credibility, feasibility, etc. Has coached new practitioners in this field Has championed the introduction of novel techniques and ideas in this field which produced measurable improvements Has contributed to best practice

COMPETENCY AREA – Holistic Lifecycle View: Systems Design – Design for…..

Description:
Ensuring that the requirements of all lifecycle stages are addressed at the correct point in the system design. During the design process consideration should be given to the design attributes such as manufacturability, testability, reliability, maintainability, safety, security, flexibility, interoperability, capability growth, disposal ,cost, natural variations etc.

Why it matters:
Failure to design for these attributes at the correct point in the development lifecycle may result in the attributes never being achieved or achieved at escalated cost.

EFFECTIVE INDICATORS OF KNOWLEDGE AND EXPERIENCE

AWARENESS	SUPERVISED PRACTITIONER	PRACTITIONER	EXPERT
Understands the need to design for the requirements of all lifecycle stages	Can describe the design attributes and how they influence the design Supports the identification and balancing of these design attributes throughout the design process	Able to identify and balance these design attributes throughout the design process Able to work with appropriate specialists to ensure that the design effectively addresses these attributes at the correct time Able to guide supervised practitioner	Able to review and judge the suitability of plans for the incorporation of all lifecycle design attributes at the correct point within the design process Able to advise on complex issues and resolve conflicting design requirements Has coached new practitioners in this field Has championed the introduction of novel techniques and ideas in this field which produced measurable improvements Has contributed to best practice

COMPETENCY AREA – Holistic Lifecycle View: Systems Design – Functional Analysis

Description:
Analysis is used to determine which functions are required by the system to meet the requirements. It consists of the decomposition of higher-level functions to lower-levels and the traceable allocation of requirements to those functions.

Why it matters:
Functional Analysis is a way of understanding what the system has to do. Failure to carry out this activity may result in a solution that fails to meet its key requirements.

EFFECTIVE INDICATORS OF KNOWLEDGE AND EXPERIENCE

AWARENESS	SUPERVISED PRACTITIONER	PRACTITIONER	EXPERT
Understands what functional analysis is Understands the need for functional models Understands the relevance of the outputs from functional analysis and how these relate to the overall system design	Able to use appropriate tools and techniques to conduct functional analysis Has contributed to functional analysis activities	Able to define the strategy and approach to be adopted for the functional analysis of the system Has performed functional analysis Able to define a process and select appropriate tools and techniques for functional analysis Able to guide supervised practitioner	Can demonstrate a full understanding of the techniques and their appropriateness, given the levels of complexity of the system of interest Reviews and judges the suitability of functional analyses Has coached new practitioners in this field Has championed the introduction of novel techniques and ideas in this field which produced measurable improvements Has contributed to best practice

COMPETENCY AREA – Holistic Lifecycle View: Systems Design – Interface Management

Description:
Interfaces occur where system elements interact, for example human, mechanical, electrical, thermal, data, etc. Interface Management comprises the identification, definition and control of interactions across system or system element boundaries.

Why it matters:
Poor interface management can result in incompatible system elements (either internal to the system or between the system and its environment) which may ultimately result in system failure or project/programme overrun.

EFFECTIVE INDICATORS OF KNOWLEDGE AND EXPERIENCE

AWARENESS	SUPERVISED PRACTITIONER	PRACTITIONER	EXPERT
Understands the need for interface management and its impact on the integrity of the system solution Understands the possible sources of complexity in interface management, e.g. multinational programmes, multiple suppliers, different domains, novel technology, etc.	Able to follow interface management procedures Able to identify and define simple interfaces	Able to define a process and appropriate techniques to be adopted for the interface management of system elements Able to identify, define and control system element interfaces Able to describe the sources of complexity for the interface management of the system, e.g. multinational programmes, multiple suppliers, different domains, novel technology, etc. Able to liaise and arbitrate where there are conflicts in the definition of interfaces Able to identify consequences of changes to interfaces on the system elements, system and/or system of systems e.g. a change to a mechanical interface may impact thermal performance Able to guide supervised practitioner	Has demonstrated expertise in interface management Reviews and judges the suitability of interface management strategies Able to negotiate on the issues of interface complexity Has coached new practitioners in this field Has championed the introduction of novel techniques and ideas in this field which produced measurable improvements Has contributed to best practice

COMPETENCY AREA – Holistic Lifecycle View: Systems Design - Maintain Design Integrity

Description:
Ensuring that the overall coherence and cohesion of the “evolving” design of a system is maintained, in a verifiable manner, throughout the lifecycle, and retains the original intent.

Why it matters:
Failure to maintain design integrity throughout the lifecycle can result in a system that fails to meet its stakeholder requirements, contains unnecessary design features or exhibits unexpected behaviours.

EFFECTIVE INDICATORS OF KNOWLEDGE AND EXPERIENCE

AWARENESS	SUPERVISED PRACTITIONER	PRACTITIONER	EXPERT
Understands the need to maintain the integrity of the design	Ability to track specific aspects of the design to the original intent Supports remedial actions and change control Understands the process of change control and configuration management	Able to identify parameters to track critical aspects of the design Relates the current design to the original intent throughout the supply chain Takes remedial actions in the presence of inconsistencies Able to establish a system which allows the tracking of specific aspects of the design Able to manage and trade technical margins both horizontally and vertically through the hierarchy Able to guide supervised practitioner	Reviews and judges the suitability of the complete set of critical parameters that allows the tracking of the system design Influences system trade-offs Able to advise on the allocation of technical margins Has coached new practitioners in this field Has championed the introduction of novel techniques and ideas in this field which produced measurable improvements Has contributed to best practice

COMPETENCY AREA – Holistic Lifecycle View: Systems Design – Modelling and Simulation

Description:
Modelling is a physical, mathematical, or logical representation of a system entity, phenomenon, or process.
Simulation is the implementation of a model over time. A simulation brings a model to life and shows how a particular object or phenomenon will behave.

Why it matters:
Modelling and Simulation provides an early indication of function and performance to enable risk mitigation as well as supporting the verification and validation of a solution. Modelling and Simulation also allows the exploration of scenarios outside the normal operating parameters of the system.

EFFECTIVE INDICATORS OF KNOWLEDGE AND EXPERIENCE

AWARENESS	SUPERVISED PRACTITIONER	PRACTITIONER	EXPERT
Understands the need for system representations Understands the scope and limitations of models and simulations, including definition, implementation and analysis Understands the different types of modelling and simulation	Able to use modelling and simulation tools and techniques to represent a system or system element Understands the risks of using models and simulations which are outside the validated limits	Able to define an appropriate representation of a system or system element Has used appropriate representations of a system or system element in order to derive knowledge about the real system Able to implement the strategy and approach to be adopted for the modelling and simulation of a system or system element Able to guide supervised practitioner	Demonstrates a full understanding of complex simulations for a system or system element Able to advise on the suitability and limitations of models and simulations Able to define the strategy and approach to be adopted for the modelling and simulation of a system or system element Has coached new practitioners in this field Has championed the introduction of novel techniques and ideas in this field which produced measurable improvements Has contributed to best practice

COMPETENCY AREA – Holistic Lifecycle View: Systems Design – Select Preferred Solution

Description:
A preferred solution will exist at every level within the system and is selected by a formal decision making process.

Why it matters:
At some point in the development lifecycle a single solution must be identified in order to engineer it. Determination of a "preferred" solution which best matches the diverse requirements is critical to achieving stakeholder satisfaction.

EFFECTIVE INDICATORS OF KNOWLEDGE AND EXPERIENCE

AWARENESS	SUPERVISED PRACTITIONER	PRACTITIONER	EXPERT
Understands the need to select a preferred solution Understands the relevance of comparative techniques (e.g. trade studies, make/buy, etc.) to assist decision processes	Able to participate in the selection of preferred solutions	Able to define selection criteria, weightings of the criteria and assess potential solutions against selection criteria Able to choose the appropriate tools and techniques for selecting the preferred solution, e.g. trade analysis, make/buy analysis Able to perform trade analysis and justify the result chosen in terms that can be quantified and qualified Able to negotiate trades Able to guide supervised practitioner	Able to guide and advise practitioners in techniques for selection of preferred solutions Reviews selected solutions and the criteria for selecting the solution Able to act as an arbitrator in marginal cases Able to carry out sensitivity analysis on selection criteria Able to negotiate complex trades Has coached new practitioners in this field Has championed the introduction of novel techniques and ideas in this field which produced measurable improvements Has contributed to best practice

COMPETENCY AREA – Holistic Lifecycle View: System Design: System Robustness

Description:
A robust system is tolerant of misuse, out of spec scenarios, component failure, environmental stress and evolving needs.

Why it matters:
A robust system gives greater availability in practice.

EFFECTIVE INDICATORS OF KNOWLEDGE AND EXPERIENCE

AWARENESS	SUPERVISED PRACTITIONER	PRACTITIONER	EXPERT
Understands how the design, throughout the lifecycle, affects the robustness of the solution Aware of analytical techniques and the importance of design integrity, legislation, whole life costs and customer satisfaction	Able to use tools and techniques to ensure delivery of robust designs Able to support robustness trade-offs Understands the relationship between reliability, availability, maintainability and safety	Able to define the strategy and approach to be adopted for ensuring system robustness Able to select the appropriate techniques for ensuring system robustness Understands the operational environment and underlying domain specific issues related to robustness Able to perform robustness trade-offs Able to use scenarios to determine robustness Able to specify procurement of system elements in terms of reliability, availability, maintainability and safety Able to guide supervised practitioner	Able to predict evolving needs and their impact on the system Reviews and advises on trade-offs between non-functional requirements, cost and schedule Able to define scenarios to determine robustness Has coached new practitioners in this field Has championed the introduction of novel techniques and ideas in this field which produced measurable improvements Has contributed to best practice

COMPETENCY AREA – Holistic Lifecycle View: Systems Integration and Verification

Description:
Systems Integration is a logical process for assembling the system. Systems Verification is the checking of a system against its design – "did we build the system right?" Systems integration and verification includes testing of all interfaces, data flows, control mechanisms, performance and behaviour of the system against the system requirements; and qualification against the super system environment (e.g. electro magnetic compatibility, thermal, vibration, humidity, fungus growth, etc).

Why it matters:
Systems Integration has to be planned so that system elements are brought together in a logical sequence in order to avoid wasted effort.
Systematic and incremental integration and verification makes it easier to find, isolate, diagnose and correct problems. A system or system element that has not been verified cannot be relied on to meet its requirements. Systems Verification is an essential pre-requisite to customer acceptance and certification.

EFFECTIVE INDICATORS OF KNOWLEDGE AND EXPERIENCE

AWARENESS	SUPERVISED PRACTITIONER	PRACTITIONER	EXPERT
Understands the importance of verification against the system requirements Understands the need to integrate the system in a logical sequence Aware of the need to plan for systems integration and verification Aware of the relationship between verification and acceptance	Able to conduct system integration and test according to the plan Able to write an integration and verification plan for a small non-complex system Able to diagnose simple faults, document, communicate and follow up corrective actions	Able to trace verification requirements back to system requirements and vice versa Able to write an integration and verification plan for a complex system, including identification of method and timing for each activity Can demonstrate effective management of systems integration and verification activities Able to write detailed integration and verification procedures Able to diagnose complex faults, document, communicate and follow up corrective actions Able to plan and prepare evidence for customer acceptance and certification Able to identify the integration and verification environment Able to guide supervised practitioner	Acts as an authority in the development of systems integration and verification strategies. Reviews and judges the suitability of systems integration and verification plans Able to lead complex systems integration and verification activities Has coached new practitioners in this field Has championed the introduction of novel techniques and ideas in this field which produced measurable improvements Has contributed to best practice

COMPETENCY AREA – Holistic Lifecycle View: Validation

Description:
Validation checks that the operational capability of the system meets the needs of the customer/end user – "did we build the right system?"

Why it matters:
Validation is used to check that the system meets the needs of the customer/end user.
Failure to satisfy the customer will impact on future business. Validation provides some important inputs to future system development.

EFFECTIVE INDICATORS OF KNOWLEDGE AND EXPERIENCE

AWARENESS	SUPERVISED PRACTITIONER	PRACTITIONER	EXPERT
Understands the purpose of validation Aware of the need for early planning for validation	Able to conduct system validation activities according to the plans Able to collate validation results	Able to focus on customer needs and communicate in the terminology of the customer/user Able to trace validation requirements back to user needs and vice versa Able to write validation plans for a complex system, including identification of method and timing for each activity Able to write detailed validation procedures Has demonstrated effective management of systems validation activities Able to assess validation results Able to plan and prepare evidence for customer acceptance Able to guide supervised practitioner	Acts as an authority in the development of validation strategies Able to write validation plans for a highly complex system Reviews and judges the suitability of validation plans Able to lead the validation activity Able to advise the customer on validation issues Conducts the sensitive negotiations in the terminology of the customer/end user Has coached new practitioners in this field Has championed the introduction of novel techniques and ideas in this field which produced measurable improvements Has contributed to best practice

Systems Engineering Competencies Framework

COMPETENCY AREA - Holistic Lifecycle View: Transition to Operation

Description:
Transition to Operation is the integration of the system into its super system. This includes provision of support activities for example, site preparation, training, logistics, etc.

Why it matters:
Incorrectly transitioning the system into operation can lead to misuse, failure to perform, and customer/user dissatisfaction. Failure to plan for transition to operation may result in a system that is delayed into service/market with a consequent impact to the customer. Failure to satisfy the customer will impact on future business.

EFFECTIVE INDICATORS OF KNOWLEDGE AND EXPERIENCE

AWARENESS	SUPERVISED PRACTITIONER	PRACTITIONER	EXPERT
Aware of the need to carry out transition to operation Aware of the type of activities required for transition to operation	Able to plan simple transition to operation activities Able to conduct transition to operation activities according to a plan Aware of the system's contribution to the super system	Able to communicate in the terminology of the user Understands the system's contribution to the super system Able to plan and oversee a transition to operation activity Able to guide supervised practitioner	Able to plan and oversee highly complex transition to operation activities Has successfully transitioned a system to operation Has coached new practitioners in this field Has championed the introduction of novel techniques and ideas in this field which produced measurable improvements Has contributed to best practice

COMPETENCY AREA – Systems Engineering Management: Concurrent Engineering

Description:
Managing concurrent lifecycle activities and the parallel development of system elements.

Why it matters:
Systems Engineering lifecycles involve multiple, concurrent processes which must be co-ordinated to mitigate risk and prevent nugatory work, paralysis and a lack of convergence to an effective solution. Concurrency may be the only approach to meeting customer schedule or gaining a competitive advantage. Performance can be constrained unnecessarily by allowing individual system elements to progress too quickly.

EFFECTIVE INDICATORS OF KNOWLEDGE AND EXPERIENCE

AWARENESS	SUPERVISED PRACTITIONER	PRACTITIONER	EXPERT
Aware that lifecycle activities and the development of systems elements can occur concurrently	Able to describe the systems engineering lifecycle processes that are in place on their programme	Able to identify which system elements can be developed concurrently	Known as an authority in systems engineering management
Aware of the advantages and disadvantages of concurrency	Able to support co-ordination of concurrent engineering activities	Able to manage the interactions within a systems engineering lifecycle	Able to develop new strategies for concurrent engineering
		Has co-ordinated concurrent activities and dealt with emerging issues	Able to advise customers and senior programme managers on concurrency issues and risks
		Able to contribute to the Systems Engineering Management Plan	Reviews and judges the suitability of Systems Engineering Management Plans
		Able to advise on concurrency issues and risks	Able to influence the implementation of concurrent engineering within the enterprise
		Able to guide supervised practitioner	Has coached new practitioners in this field
			Has championed the introduction of novel techniques and ideas in this field which produced measurable improvements
			Has contributed to best practice

Systems Engineering Competencies Framework

COMPETENCY AREA – Systems Engineering Management: Enterprise Integration

Description:
Enterprises can be viewed as systems in their own right in which Systems Engineering is only one element. System Engineering is only one of many activities that must occur in order to bring about a successful system development that meets the needs of its stakeholders. Systems Engineering Management must support other functions such as Quality Assurance, Marketing, Sales, and Configuration Management, and manage the interfaces with them.

Why it matters:
As enterprises become larger, more complex and the functions within the enterprise more insular, the interdependencies between the functions should be engineered using a systems approach at an enterprise level to meet the demands of increased business efficiency.

EFFECTIVE INDICATORS OF KNOWLEDGE AND EXPERIENCE

AWARENESS	SUPERVISED PRACTITIONER	PRACTITIONER	EXPERT
Is aware that an enterprise is a system in its own right Is aware that other functions of the enterprise have inputs to and outputs from the systems engineering process	Understands the other functions (e.g. quality assurance, marketing, sales, strategic management, configuration management, research, human resources) and relationships that make up an enterprise Able to manage the creation of systems engineering products required by other functions	Able to manage the relationship between the systems engineering function and other elements of the enterprise Able to identify systems engineering products required by other functions and vice versa Able to use systems engineering techniques to contribute to the definition of the enterprise Able to identify the constraints placed on the systems engineering process by the enterprise Able to guide supervised practitioner	Acts as a consultant on business organisations Able to advise on the effectiveness of the enterprise as a system Able to review the impact of systems engineering capability within a business context Able to review the impact of inputs from other functions on the systems engineering process Has coached new practitioners in this field Has championed the introduction of novel techniques and ideas in this field which produced measurable improvements Has contributed to best practice

Systems Engineering Competencies Framework

COMPETENCY AREA – Systems Engineering Management: Integration of Specialisms

Description:
Coherent integration of Specialisms into the project/programme at the right time. Specialisms include Reliability, Maintainability, Testability, Integrated Logistics Support, Producability, Electro Magnetic Compatibility, Human Factors and Safety.

Why it matters:
Specialisms support the systems engineering process by applying specific knowledge and analytical methods from a wide variety of disciplines to ensure the resulting system is able to meet its stakeholder needs. The technical effort of Specialisms must be integrated in terms of time and content to ensure project/programme goals are met and the outputs generated add value commensurate with their costs.

EFFECTIVE INDICATORS OF KNOWLEDGE AND EXPERIENCE

AWARENESS	SUPERVISED PRACTITIONER	PRACTITIONER	EXPERT
Aware of the different specialisms Aware of the importance of integrating specialisms into the project/programme and that this is a potential source of conflict Understands that the specialisms can affect the cost of ownership	Understands the role and purpose of the specialisms Able to work with appropriate specialists to support trade-offs	Able to manage the integration of specialisms within a project/programme Able to conduct trade-offs involving conflicting demands from the specialisms Understands how the specialisms affect the cost of ownership Able to identify the constraints placed on the system development by the needs of the specialisms Able to guide supervised practitioner	Understands primary tasks of each specialism Has successfully applied integration principles across a number of specialisms Able to resolve conflicts involving specialisms Able to estimate the combined effect of the specialisms on the cost of ownership and the system development Able to advise on the organisation of specialist functions Has coached new practitioners in this field Has championed the introduction of novel techniques and ideas in this field which produced measurable improvements Has contributed to best practice

COMPETENCY AREA – Systems Engineering Management: Lifecycle Process Definition

Description:
Lifecycle Process Definition establishes lifecycle stages and their relationships depending on the scope of the project/programme, super system characteristics, stakeholder requirements and the level of risk. Different system elements may have different lifecycles.

Why it matters:
Lifecycle forms the basis for project/programme planning and estimating. Selection of the appropriate lifecycles and their alignment has a large impact on and may be crucial to project/programme success. Ensuring co-ordination between related lifecycles at all levels is critical to the realisation of a successful system.

EFFECTIVE INDICATORS OF KNOWLEDGE AND EXPERIENCE

AWARENESS	SUPERVISED PRACTITIONER	PRACTITIONER	EXPERT
Aware of the different types of systems lifecycles Aware of the different types of lifecycle models Understands the need to define an appropriate lifecycle process model	Understands systems engineering lifecycle processes Able to support lifecycle definition activities Able to describe the systems engineering lifecycle processes that are in place on their project/programme	Able to identify the project/programme, enterprise and technology needs that affect the definition of the lifecycle Able to influence the lifecycle of related super system elements Able to identify dependencies and align the lifecycles of different system elements Able to guide supervised practitioner	Acts as an authority on lifecycle definitions and the implication of the lifecycle on the project/programme Able to resolve conflicts between lifecycles Reviews and judges the suitability of the definition of multiple concurrent lifecycles Able to advise programme management on the implication of lifecycle issues including project/programme and commercial Has successfully determined and documented lifecycles matched to the needs of the project/programme Has coached new practitioners in this field Has championed the introduction of novel techniques and ideas in this field which produced measurable improvements Has contributed to best practice

Systems Engineering Competencies Framework

COMPETENCY AREA – Systems Engineering Management: Planning, Monitoring and Controlling

Description:
Establishes and maintains a systems engineering plan (e.g. Systems Engineering Management Plan) which incorporates tailoring of generic processes .The identification, assessment, analysis and control of systems engineering risks. Monitoring and control of progress.

Why it matters:
It is important to identify systems engineering needs and coordinate activities through planning. The alternative to planning is chaos.
Failure to plan and monitor prevents adequate visibility of progress and, in consequence, appropriate corrective actions may not be identified and/or taken when the project/ programme's performance deviates from that required.

EFFECTIVE INDICATORS OF KNOWLEDGE AND EXPERIENCE

AWARENESS	SUPERVISED PRACTITIONER	PRACTITIONER	EXPERT
Understands the importance of planning, monitoring and controlling systems engineering activities Understands that change is inevitable and so needs to be carefully managed	Understands the role of systems engineering planning as part of an overall project/programme plan Able to monitor progress against the systems engineering plan Able to assist in the management of systems engineering risks Able to assist in the management of systems engineering changes	Able to plan systems engineering activities as part of an overall project/programme plan Able to identify, assess, analyse and control systems engineering risks Able to anticipate, identify, assess, analyse and control systems engineering changes Able to influence project/programme management in order to secure the systems engineering needs of the project/programme Able to control systems engineering activities by applying necessary corrective actions Able to tailor systems engineering processes to meet the needs of a specific project/programme Able to guide supervised practitioner	Has successfully planned, monitored and controlled complex systems engineering activities Reviews and judges the suitability of systems engineering plans Able to advise on systems engineering risks and their mitigation Able to define appropriate generic systems engineering processes for the enterprise Able to influence the relationship between systems engineering and project/programme management at the enterprise level Able to advise on potential areas and implications of engineering change Has coached new practitioners in this field Has championed the introduction of novel techniques and ideas in this field which produced measurable improvements Has contributed to best practice

Example List of Basic Skills and Behaviours

This list is not exhaustive.

Basic Skills and Behaviour	Specific Techniques
Abstract Thinking	Ability to see multiple perspectives, ability to see the big picture
Knowing when to ask	Asking for advice, engaging an expert, peer review, requesting training
Knowing when to stop	Pareto, 80:20 rule, decision making skills
Creativity	Lateral thinking, brainstorming, TRIZ, six thinking hats
Objectivity	Reference of policy, baselining, viewpoint analysis
Problem solving	TQM tools (Cause/effect, force field, pareto etc.), SWOT analysis, PESTEL analysis, decision trees, logical reasoning
Developing others	Coaching, mentoring, training
Two way communicating	Listening skills, verbal and non-verbal communication, body language, writing skills, presentation skills
Negotiating	Win-win, bartering, diplomacy, cultural awareness, stakeholder management, management of expectations
Team working	Belbin Team Roles, Meyers-Briggs Type Indicator, TQM tools (Cause/effect, force field, pareto etc.)
Decision making	Risk/benefit analysis, pareto analysis, pair-wise comparison, Decision Trees, Force field analysis, six thinking hats

Example List of Supporting Techniques

This list is not exhaustive.

Category	Supporting Techniques	Specific Techniques
Analysis and Design	Operational Analysis	
	Behavioural Analysis	Event Simulation Transaction Analysis
	Logical Analysis	
	Physical Analysis	N^2 Partitioning DSM Axiomatic Design
	Functional Analysis	Functional Decomposition
	Structured Methods	Yourdon Quality Function Deployment – QFD SSADM Agile Methods OOAD
	Decision Analysis and Resolution	Trade Studies
	Failure Analysis	FMECA FTA FMEA
	Lean Design	
	Management of Margins	
	Six Sigma Design	Statistical Analysis
Systems Thinking	System Definition	SSM Seven Samurai

Continues on next page >

Example List of Supporting Techniques

This list is not exhaustive.

Category	Supporting Techniques	Specific Techniques
Management	Estimating	COCOMO COSYSMO
	Budgeting	Earned Value Management
	Scheduling	Material Requirements Planning (MRP) Manufacturing Resource Planning (MRP II)
	Planning	Network Analysis Schedule Analysis Critical Path Analysis
	Change Management	
	Configuration Management	
	Progress Monitoring	Earned Value Management Critical Parameter Management
	Technical Risk and Opportunity Management	PESTEL, SWOT, Delphi Technique
	Technology Planning	TRL SRL DML
Specialist	Human Factors	Hierarchical Task Analysis
	Availability Reliability	Reliability Availability Maintainability (RAM) analysis
	Maintainability Analysis	Reliability Availability Maintainability (RAM) analysis
	Reliability Analysis	Reliability Availability Maintainability (RAM) analysis
	Testability Analysis	
	Safety Analysis	FMECA, FMEA, HAZOPS
	Security Analysis	
Modelling and Simulation	Mathematical Modelling	
	Graphical Modelling	
	Physical Modelling	
	Synthetic Environments	

Glossary

This glossary defines words/phrases in the context of use within the 'Systems Engineering Competencies Framework' and 'Guide to Competency Evaluation'. Several sources have been provided in some cases to aid explanation. The entries are either full definitions or informative notes.

Architecture

1. The fundamental organisation of a system embodied into its constituent parts, their relationships to each other, and to the environment, and the principles guiding its design and evolution. The architecture associated with a system of interest is conceptual, and is realised through an architectural description. [Based on IEEE-1471] (INCOSE UK AWG)
2. Architectures can be of different types, e.g. hardware, software, or system and can be domain specific e.g. networking (SEI)
3. The organisational structure and associated behaviour of a system. An architecture can be recursively decomposed into parts that interact through interfaces, relationships that connect parts, and constraints for assembling parts. [OMG UML] (INCOSE UK AWG)

Architecting

1. The activities of defining, documenting, maintaining, improving, and certifying proper implementation of an architecture. [IEEE-1471] (INCOSE UK AWG)
2. An analytical, inventive and creative process to understand the domain problem and opportunities and to create a suitable architectural design and measure set. It is driven by the sponsor's needs and critical success factors and takes into account other stakeholder needs and requests. It considers both the problem and solution space and, critically, the relationship between them. Architecting is concerned with developing satisfactory and feasible system concepts, maintaining the integrity of those system concepts through development, certifying built systems for use, and assuring those system concepts through operational and evolutionary phases. (INCOSE UK AWG)

Authored – actually wrote (not just signed front page)

Best Practice – recognised by others as good practice

Capability

1. An expression of a system, product, function or process' ability to achieve a specific objective under stated conditions. (INCOSE Handbook)
2. The operational need that is satisfied by the deployment of an operational system integrated with other co-operating systems. [Mil Std 499B]

Coaching – Helping, supporting, advising, explaining, demonstrating, instructing and directing others resulting in transfer of knowledge and skills

Competence – The measure of specified ability

Competency – A specified ability

Competent – Having a specified level of competence.

Complexity (of a Project) – Difficulty. Complexity is context dependent and should be defined appropriately for the situation. Parameters that contribute to the complexity of a project can potentially include; number of sub systems, number of requirements, number of interfaces, type of technology used, size of team, number of stakeholders, type of contract, number of partners, number of suppliers etc.

Discipline – Area of expertise e.g. systems, software, hardware, programme management, quality assurance etc.

Domain – Area of application e.g. land, sea, radar, health service, transport, etc.

Enterprise
1. Organisation, company, business etc.
2. An organisation (or cross organisational entity) supporting a defined business scope and mission that includes interdependent resources (people, organisations and technologies) that must coordinate their functions and share information in support of a common mission (or set of related missions). (INCOSE UK AWG)

Enterprise Asset – (as applied to a person) known by reputation to be a leader in the field, highly valued, highly regarded. Recognised by the community outside employer organisation (e.g. asked to be on conference panel, government advisory board etc.)

Project/Programme – Interchangeable and according to local practice.

Recent – Within last 5 years

Specialty – A specific area of Engineering knowledge e.g. reliability, availability, maintainability, human factors, safety, security etc.

Stakeholder
1. (System) A party having a right, share or claim in a system or in its possession of characteristics that meet that party's needs and expectations. [ISO15288]
2. (System) An individual, team, or organisation (or classes thereof) with interests in, or concerns relative to, a system. [IEEE-1471]

Stage (Lifecycle Stage) – A period in the lifecycle of a system that relates to the state of the system description or the system itself [ISO 15288]

Sub system – the level below the system of interest

Super system - the level above the system of interest

System of Interest - the system whose life cycle is under consideration. (INCOSE Handbook)

System of Systems
1. A System of Systems contains systems which have purpose and are viable, independent of the System of Systems, but which can when acting together perform functions unachievable by the individual systems acting alone. (UK MOD Defence Industrial Strategy)
2. A set or arrangement of independent systems that are related or connected to provide a given capability. The loss of any part of the system will degrade the performance or capabilities of the whole. [DoDAF]
3. A generic term applied to the grouping of a number of separate systems (including people, products and processes) to achieve desired emergent properties. System of systems activities take place at a level of abstraction above those that deliver individual systems. [Mil Std 499B]

Annex A – Guide to Competency Evaluation

Note: The Guide to Competency Evaluation is published as a separate document.