IAC Global Networking Forum Plenary

Systems Architecting and Realization - Key Success Competencies

Multi-disciplinary life-cycle architecting brings together expertise from different specialty domains to tackle new mission or project ideas and explore technical and programmatic realization options against the objective to set programs up for success. Technology advances, market pressures, and growing interdependence between in-orbit and ground-based space systems drive solutions towards increased complexity and a "system of systems" approach. Meeting divers stakeholder and functionality requirements remains a challenge.

Today's space programs use systems which are software-driven, artificial intelligence (AI) supported, cyber-secure autonomous solutions and engineered by way of extensive models, simulations, and virtual reality.

However, there is a shortage of skilled system architects and engineers and they are in high demand!

This plenary will recommend actions with global applicability that could help prevent, or at least mitigate, an impending crisis regarding the availability of the space systems workforce which can realize our future ambitions.

CALL for ACTION

System Needs and Context

1. *Multi-disciplinary system workforces are key to the success of space programs. These competences are scarce and require continuous development.*
2. *Civil and defense space systems have become complex, interdependent, interconnected ecosystems, an accelerating trend. To generate lasting societal and/or market value requires early integration of social, environmental, business, regulatory, engineering, and technology competencies to align stakeholder perspectives and create viable program realization plans.*
3. *Success of suppliers and integrators depends increasingly on system competencies across the supply chain and the system life-cycle. Space products have many layers involving assemblies, sub-systems, systems, and system of systems. Most all are interconnected and interdependent and need extensive systems analysis and design across their many interfaces.*

Systems Architecting and Design

4. *Early phases architecting is critical to program success in that it creates trust in solutions for critical life-cycle implementation issues, such as risks, cost, schedule, system interdependencies, sustainability, and societal impact.*
5. *Hardware and software system teams must be integrated from the outset of architecture development to ensure desired system performance, behavior, and sustained operations. The rapid growth of software intensive, AI supported cyber-secure autonomous solutions drives the need for "end-to-end" system architectures and realization plans.*
6. *Space systems employ an extensive inventory of modelling, simulation, and virtual reality tools for development and operations. Data exchanges across tools remain cumbersome. Additional efforts and R&D by universities, industry and agencies is encouraged to create generic vender agnostic tool infrastructures which support seamless data exchanges between specialty disciplines and system layers throughout the life-cycle.*
7. *Systems management and engineering processes can at times become overly prescriptive. Periodic reviews by experienced system developers are recommended. They should be tasked to focus upon pragmatic, problem solving and value driven approaches while ensuring that enabling digital technologies are utilized.*
8. *Space systems acquisition processes are demanding and involve substantial documentation. Transformation efforts embracing state of the art digital engineering and management practices should be advanced. This implies a. o. jointly adopted tool suites, well-defined information exchanges and access rights, as well as data-based proposal evaluations and project reviews. Improved visibility and efficiency gains for customers, system primes and suppliers are likely to result.*

How to ensure the Availability of System Competencies?

9. *Acquiring systems architecting and engineering competencies is a life-long journey! Systems understanding and judgement are rooted in domain and specialization competencies. Coupling these with technological acumen, innovative curiosity, pragmatism, and effective team cooperation is essential for success.*
10. *Embedding a systems mindset from an early age in schools with supporting interdisciplinary problem solving exercises are recommended enablers for developing early system thinking.*

11. *System fundamentals should be taught in most fields at universities at undergraduate level to generate basic systems knowledge and team capabilities. System teachers should receive periodic trainings on recent developments in the field.*

12. *System competencies are best acquired by engaging students and professionals in multi-disciplinary "real world" problem solving practices, e.g. via capstone projects while applying state-of-the-practice tools. Periodic system-level reviews by experienced staff should accompany the learning process and question cross cutting system issues.*

13. *Practicing system engineers should strive to remain current on their systems competencies on the job and exercise curiosity in adopting evolving technologies, tools, and system practices. Industry and government system employers should encourage continued learning by offering internal and/or external opportunities designed to deepen or broaden employees systems knowledge and experience.*

14. *System careers can take many different paths. They often evolve from special disciplines, to subsystems, and system integration competencies. Eventually they can lead to subsystem or system engineer, system architect, chief engineer, project or program manager, chief technical officer, or similar. A combination of domain, system and team competencies are ingredients for career advancements.*

15. *A paradigm shift is needed in schools, universities, industry and governments to ensure the availability of our future space systems workforce. Adapting curricula and training concepts, generating additional post-graduate offerings for practicing system professionals should be implemented with priority.*

In Summary this Call for Action appeals to academia, industry, government agencies and professional organizations to join forces and implement the recommendations to ensure that the space systems architecting and engineering workforce will be available for our future space ambitions.

Note 1: System competencies are multi-disciplinary skills involving assessment of customer(s) and/or market needs, development of system architectures, implementation options and requirements, evaluation of suitable technologies, system definition & design, prototyping, digital twins, manufacturing, testing and service. They include end-to-end systems & project/program management skills.

Note 2: This "Call for Action" draws upon the conclusions of the first ever international Summit on Systems Workforces held in October 2024 in Delft, The Netherlands [*https://systems-workforce.eu/summit-results/*](https://systems-workforce.eu/summit-results/)

This Call for Action is endorsed by the IAC GNF Plenary Participants

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