SYSTEMS ENGINEERING NEWSLETTER

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5.2 Society for Risk Analysis Australia New Zealand

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5.4 National Institute of Standards and Technology (NIST) (USA)

5.5 Information Systems Audit and Control Association (ISACA)

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7.4 Tradeoff Decisions in System Design

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1. QUOTATIONS TO OPEN ON

"The only absolute system is the Universe. Every other system we talk about is a view of a part of the Universe that we choose to take to serve a purpose; it is an approximation to reality."

Robert John Halligan

"There are only two ways to live. One is as though nothing is a miracle.

The other is as though everything is."

Albert Einstein

"Think deeply, speak gently, love much,

laugh often, work hard, give freely,

and be kind."

Hallmark Greeting Card

2. FEATURE ARTICLE

2.1 A System of Systems Approach for Sustainable Innovations: Application to City Smart Traffic Management Challenges

by

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Abstract

System of Systems (SoS) has been successfully engineered in large Defense Industry Programs for decades, with the application of standards such as NAF, DODAF, or MODAF. The new Unified Architecture Framework (UAF) standard is now available and applicable to both defense and commercial domains. The main challenge today is that a given system is not isolated any more: it is connected with many other systems and organizations, and its behavior is strongly dependent on the states of other systems and interactions. Mastering the services provided by a SoS to the stakeholders is the main priority. In order to specify each system of the SoS, it is required to have a proper modeling approach and to experience all the scenarios upfront. After presenting the challenges and trends of this approach, this paper presents the UAF framework. It then explains how to engineer a SoS utilizing proper systems engineering methodology, followed by an illustration of the approach - a smart city traffic management system in which autonomous vehicles, traditional vehicles, and emergency vehicles interact.

1. The age of cyber-physical systems: connected systems, system of systems

Traditionally, any new product was essentially a purely mechanical system. The engineering then evolved to include multidisciplinary sub-systems that included a combination of mechanical, electrical, control engineering and software to make it a mechatronic System. Today, it is the age of the Cyber Physical Systems [CPS], Connected Systems and Enterprise /Systems of Systems (SoS). These are software intensive distributed systems, which are interacting together and making autonomous decisions.

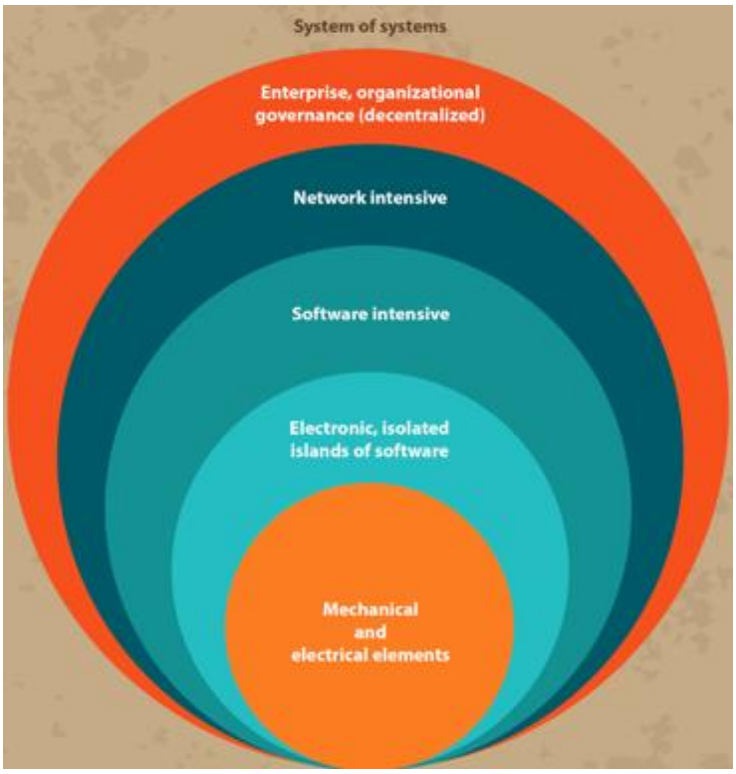

Figure 1: Growing Levels of System Complexity [INCOSE2025]

The complexity keeps on increasing, as we move from designing a component to designing a SoS with mobility services. This illustrates also the fact that the historical frontiers between industries (here:

‘Transportation and Mobility’, ‘Aerospace and Defense’ and ‘Information industries) are becoming porous and interrelated

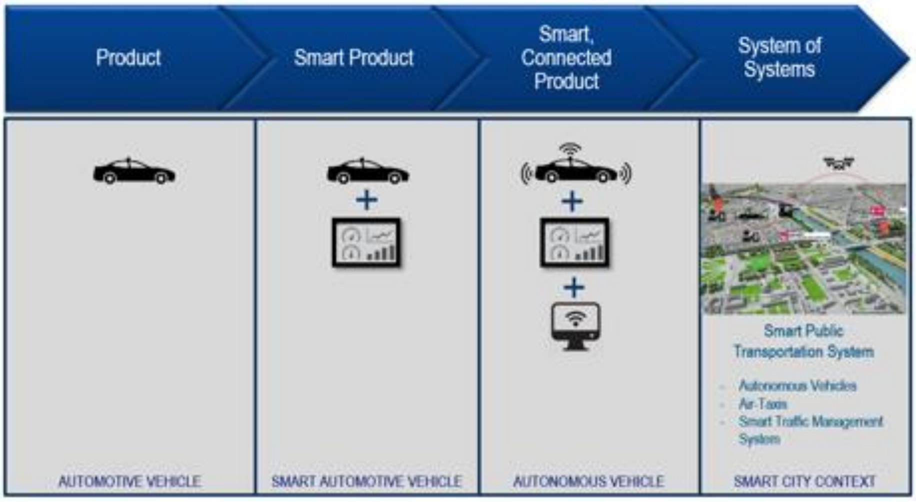

Figure 2: Mobility Experience

There are many pains that industry is facing while designing complex systems and SoS:

- Mission complexity is growing faster than our ability to manage it … increasing mission risk from inadequate specifications and incomplete verification [INCOSE2025].
- System design emerges from pieces, rather than from architecture … resulting in systems that are brittle, difficult to test, and complex and expensive to operate [INCOSE2025].
- Traditional engineering approaches based on requirements engineering are no longer sufficient to deal with these new paradigms.

What we also observe, essentially in the non-Defense market, is that SoS design is very often dealt with from a technology perspective … resulting in SoS that are more an assembly of system services, rather than new emergent and optimized services. This is perhaps one of the most challenging problems [Ring et al 2005]: incongruous effects that result from ‘unnatural juxtapositions’ of systems which inevitably lead to increased scope and complexity and thereby:

- Increase the “unknownness” of the reused systems and the “unknowability” of the SoS;
- Increase the chance of latent errors, bugs, or mismatches;
- Increase the number of ways the SoS can fail;
- Decrease the user’s ability to discern failures;
- Increase the negative ramifications of failures; and
- Increase the need for complex, adaptive, and self-adaptive kinds of systems.

Mastering a SoS is challenging. It requires a tools-intensive approach shared among all stakeholders, themselves belonging to different organizations that may have different backgrounds and cultures, and likely utilize different systems engineering practices.

The collaboration between the stakeholders and the use of a common modeling language are essential for successful SoS engineering. Simulation capability of the SoS is another key capability required to execute the SoS model, to understand the operational scenarios, and to identify the relevant systems of SoS solution to be acquired or developed.

2. Unified Architecture Framework (UAF)

The paradigm shift from a document-centric systems engineering approach to a model-based systems engineering (MBSE) approach revealed gaps in the MBSE approach, one of which was that no standardized methodology was available for SoS. The belief that Systems Modeling Language [OMG 2015] was the ultimate solution did not prove to be correct. To apply a language such as SysML successfully, various questions must be answered, including how to structure the model, what views to build, which artifacts to deliver, and in what sequence. Every company deals with these issues differently. Organizations not complying with a standardized approach end up having differently structured models with different sets of views, resulting in loss of the capability to exchange data, loss of the capability to communicate with other teams, overhead in tool customization, and the need for specific training [Morkevicius et al. 2017].

The scope of UAF compared to its predecessor Unified Profile for DoDAF and MODAF (UPDM) is expanded beyond defense architectures. It is genericized to be applicable to architecting SoS of any domain [Hause et al. 2016]. One of the mandatory requirements for UAF was “Architecture Modeling Support for Defense, Industry, and Government Organizations”. As a response to this requirement, UAF version 1.0 is industry domain agnostic [OMG 2013]. It is targeted to model systems of systems, including enterprises and IoT systems.

The UAF standard consists of three main components (all UAF components are shown graphically in Figure 3):

- Framework – a collection of domains, model kinds, and viewpoints,
- Metamodel – a collection of types, tuples, and individuals used to construct views according to the specific viewpoints,
- Profile – SysML based implementation of the metamodel to apply model-based systems engineering principles and best practices while building the views.

Two supplementary components are: (i) a traceability guide to other existing EAFs and UPDM; and (ii) an example model based on a search & rescue case study. For the context of this paper we are interested in the framework and profile components.

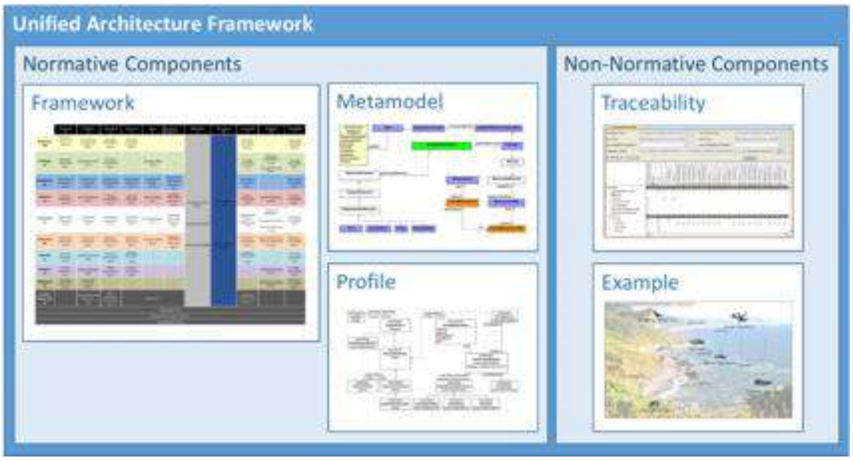

Figure 3: UAF Components

UAF Framework. The grid format is the best to describe the framework component of the UAF. It is organized into rows and columns, where rows are domains and columns are model kinds. The intersection of a row and column is called a view specification. In the context of simulation, it is important to understand how different view specifications are related and what questions at every aspect of the framework can be answered by the model execution. For example, one of the major tasks in the SoS engineering is to perform a trade-off analysis trying to determine which resource configuration is the best for the defined operational scenario. The trade-off can be parametrical or topological, and can be performed in the analytical or test-based approach. Such practices are not defined as a part of UAF specification and depend on the implementation of the framework.

	Taxonomy Tx	Structure Sr	Connectivity Cn	Processes Pr	States St	Interaction Scenarios Is	Information If	Parameters Pm	Constraints Ct	Roadmap Rm	Traceability Tr
Metadata Md	Metadata Taxonomy Md-Tx	Architecture Viewpoints [a] Md-Sr	Metadata Connectivity Md-Cn	Metadata Processes [a] Md-Pr	-	-			Metadata Constraints [a] Md-Ct		Metadata Traceability Md-Tr
Strategic St	Strategic Taxonomy St-Tx	Strategic Structure St-Sr	Strategic Connectivity St-Cn	-	Strategic States St-St	-			Strategic Constraints St-Ct	Strategic Deployment, St-Rm Strategic Phasing St-Rm	Strategic Traceability St-Tr
Operational Op	Operational Taxonomy Op-Tx	Operational Structure Op-Sr	Operational Connectivity Op-Cn	Operational Processes Op-Pr	Operational States Op-St	Operational Interaction Scenarios Op-Is			Operational Constraints Op-Ct	-	Operational Traceability Op-Tr
Services Sv	Service Taxonomy Sv-Tx	Service Structure Sv-Sr	Service Connectivity Sv-Cn	Service Processes Sv-Pr	Service States Sv-St	Service Interaction Scenarios Sv-Is	Conceptual Data Model,	Environment Pm-En	Service Constraints Sv-Ct	Service Roadmap Sv-Rm	Service Traceability Sv-Tr
Personnel Pr	Personnel Taxonomy Pr-Tx	Personnel Structure Pr-Sr	Personnel Connectivity Pr-Cn	Personnel Processes Pr-Pr	Personnel States Pr-St	Personnel Interaction Scenarios Pr-Is	Logical Data Model,		Competence, Drivers, Performance Pr-Ct	Personnel Availability, Personnel Evolution, Personnel Forecast Pr-Rm	Personnel Traceability Pr-Tr
Resources Rs	Resource Taxonomy Rs-Tx	Resource Structure Rs-Sr	Resource Connectivity Rs-Cn	Resource Processes Rs-Pr	Resource States Rs-St	Resource Interaction Scenarios Rs-Is	Physical Data Model	Measurements Pm-Me	Resource Constraints Rs-Ct	Resource evolution, Resource forecast Rs-Rm	Resource Traceability Rs-Tr
Security Sc	Security Taxonomy Sc-Tx	Security Structure Sc-Sr	Security Connectivity Sc-Cn	Security Processes Sc-Pr	-	-			Security Constraints Sc-Ct	-	Security Traceability Sc-Tr
Projects Pj	Project Taxonomy Pj-Tx	Project Structure Pj-Sr	Project Connectivity Pj-Cn	Project Processes Pj-Pr	-	-			-	Project Roadmap Pj-Rm	Project Traceability Pj-Tr
Standards Sd	Standard Taxonomy Sd-Tx	Standards Structure Sd-Sr	-	-	-	-			-	Standards Roadmap Sd-Rm	Standards Traceability Sd-Tr
Actuals Resources Ar		Actual Resources Structure, Ar-Sr	Actual Resources Connectivity, Ar-Cn	Simulation [b]					Parametric Execution/ Evaluation [b]	-	-
Dictionary * Dc											
Summary & Overview Sm-Ov											
Requirements Req											

Figure 4: UAF Grid

The UAF consists of 13 Domains [OMG 2017a]:

1. Metadata - captures meta-data relevant to the entire architecture, e.g. principles, metamodel extensions, views to be built, processes of developing architecture, etc.

2. Strategic - describes capability taxonomy, composition, dependencies, and evolution.
3. Operational - describes the requirements, operational behavior, structure, and exchanges required to support (exhibit) capabilities.
4. Services - shows Service Specifications and required and provided service levels of these specifications required to exhibit a Capability or to support an Operational Activity.
5. Personnel - enables an understanding of the human role in systems/enterprise architectures. It provides a basis for decisions by stakeholders by providing a structured linkage from the engineering community to the manpower, personnel, training, and human factors communities.
6. Resources - captures a solution architecture consisting of resources, e.g. organizational, software, artifacts, capability configurations, and natural resources that implement the operational requirements.
7. Security - illustrates the security assets, security constraints, security controls, families, and measures required to address specific security concerns.
8. Projects - describes projects and project milestones, how those projects deliver capabilities, the organizations contributing to the projects, and dependencies between projects.
9. Standards - shows the technical, operational, and business Standards applicable to the architecture.
10. Actual Resources - illustrates the expected or achieved individual resource configurations and actual relationships between them.
11. Dictionary - provides definitions for all elements in the architecture.
12. Summary and overview - provides executive-level summary information in a consistent form that allows quick reference and comparison between architectural descriptions.
13. Requirements - used to represent requirements, their properties, and relationships (trace, verify, satisfy, refine) to each other and to UAF architectural elements of different domains.

Metamodel. A UAF Domain metamodel (DMM) is organized according to view specifications. Thus, it is easy to understand which elements (including types, individuals, and tuples1) can be used to build a specific view. The categorization of elements into types, individuals, and tuples is taken from IDEAS. In general, a UAF metamodel is a simplified version of complex 4D IDEAS ontology [IDEAS 2012]. Although it is simplified, it is still powerful compared to the majority of existing enterprise modeling languages and methodologies.

UAF Profile. Profile, in the context of UML, defines limited extensions to a reference metamodel with the purpose of adapting the metamodel to a specific platform or domain. The UAF profile defines UML extensions to support a UAF metamodel. It is also dependent on a SysML profile, which is another extension to UML. Dependencies to SysML are in the form of inheritance relationships. The purpose of

[1] A tuple is a relationship between two or more things. Tuples are identified by their places (i.e. the ends of the relationship). Examples: * The year 2004 is after the year 2001 * My car is an instance of the type "VW Golfs" * The type "VW Golfs" is a subtype of the type "Cars".

this inheritance is to inherit SysML graphical notation, and engineering analysis techniques applicable to SysML (e.g. parametric analysis).

Standards-based Execution of UAF Models

Foundational subset for executable UML models defines a subset of UML elements and a clear semantic of how to execute a UML model made of elements within this subset. The subset includes classes, signals, signal receptions, instance specifications, and almost complete UML activity model (OMG, 2017b). The execution of other subsets of UML are defined by two extensions of fUML:

- The Precise Semantics of UML Composite Structure (PSCS) specification, which defines an extension of fUML syntax and semantics to enable modeling and execution of UML composite structures (OMG, 2018). The term "composite structures" refers to the ability of UML classes to be structured (OMG, 2017c).

- The Precise Semantics of UML State Machines (PSSM) specification is an extension of fUML that defines the execution semantics for UML state machines. This specification extends fUML with a (large) subset of the abstract syntax of state machines as given in the UML standard. At the same time, PSSM is also an extension of PSCS. PSSM is not yet a finalized specification. It is currently in beta 1.0 version (OMG, 2017d).

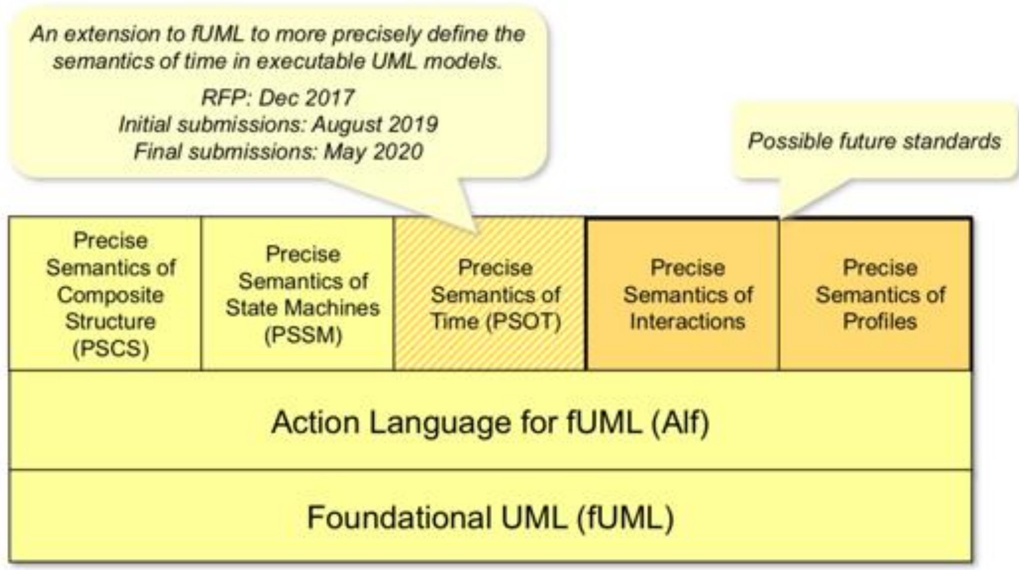

Figure 5: Executable UML Standards Landscape [Seidewitz 2018].

fUML, PSCS, and PSSM all together forms a powerful foundation to execute UML models. Moreover, there is an RFP issued for Precise Semantics of Time for Foundational UML standard in OMG. Figure 5 depicts all existing, currently under development, and planned to be developed standards related to execution of UML models. Executing UML models theoretically means that the same foundation applies for UML extensions, like SysML, UAF, etc.

UAF profile is the only standards-based implementation of UAF and it is an extension of UML. It has also a dependency from the SysML profile. UAF elements like *Capability* and *OperationalPerformer* are inherited from SysML *Block*. It means they inherit all the features SysML Block has plus all the analysis techniques that are based on SysML, for example, SysML parametrics.

UAF model can be executed at a different layer of abstraction, so called domain. All models describing domains that can have behavioral models created can be executed. They are operational, services, resources, personnel, projects, security, and actual resources. For example, operational domain has model kinds such as processes, states, and interaction scenarios defined. The same applies to services, resources, and personnel. Projects and security domains have only processes model kind, which means that execution of the models describing projects and security domains are limited to UML Activity execution semantics.

As the resource domain is the most likely to be executed according to our research, we will analyze it in more detail to explain the semantics of UAF model execution. In terms of semantics the same applies to other executable domains.

3. System of Systems approach: methodological concepts

Understanding UAF is not sufficient to engineer a SoS. UAF grid contains many views (see figure 4), and all of them maybe not useful for a given program.

It is important to apply the key systems engineering concepts when designing a system of system. Below are listed some of these key concepts:

- System: a set of elements organized to achieve one or several declared results. A system is a scope of responsibility within a project
- System of Interest: the system that we want to develop, modify or acquire. It provides services in its operational environment.
- Black box vs White box: black box is the view of the system from the outside. It describes the WHAT: the missions to achieve, the operational scenarios, the interface with the environments (considering all lifecycle phases), the provided services. The White box is the view of the system from the inside. It describes the HOW: the solution to satisfy the WHAT, the functions and components (hardware, software), their interfaces.
- Function: a transformation of inputs to outputs with a behavior. The function behavior is related to a given state of a system. A function behavior can be defined in static, with requirement representation, or in dynamic with equation model representation. Most of the time, functional behavior is described with requirements.

SoS Definition

There are many definitions of a SoS. The systems engineering handbook [INCOSE] provides a comprehensive definition:

- Two or more systems that are separately defined but operate together to perform a common goal [Checkland99].
- An assemblage of components which individually may be regarded as systems, and which possess two additional properties:

    - Operational Independence of the Components: If the system-of-systems is disassembled into its component systems, the component systems must be able to usefully operate independently. That is, the components fulfill customer-operator purposes on their own.
    - Managerial Independence of the Components: The component systems not only can operate independently but are managed independently. The component systems are separately acquired and integrated but maintain a continuing operational existence independent of the system-of-systems [Maier98, 267-284].
- System‐of‐systems applies to a system‐of‐interest whose system elements are themselves systems; typically, these entail large scale inter‐disciplinary problems with multiple, heterogeneous, distributed systems [INCOSE 2012].

To summarize, a SoS is composed of technical and human systems. All systems from the SoS have different lifecycle stages (existing, under development, or to be developed later). They are developed with different development methods (waterfall, spiral, evolutionary, agile…). They are characterized by their operational and managerial independence. Needs are evolving all along the SoS development. They may even not be available at the beginning of the program. The stakeholders that develop the systems are geographically distributed and in different organizations.

Thus, designing a SoS is not just assembling systems together or describing existing process. It is about defining common goals of the SoS among stakeholders, defining standardized viewpoints for SoS definition and analysis, and establishing progressive integration from a virtual architecture to the real integrated system.

This highlights also the importance of the traceability and the consistency in an environment in perpetual evolution.

Abstraction layers

From a methodological point of view, considering the outside of the SoS (black box) before the inside (white box) is a key concept to apply when engineering a SoS. It may seem basic or obvious, but as well as when you design a single system, it is even more important for a SoS. The smart traffic example in the next section will illustrate that. Indeed, engineering a SoS requires even more abstraction than engineering a system. Not stating the problem properly may lead to later misalignment of the SoS solution to operational needs.

This black box vs white box distinction leads to define a framework with abstraction layers:

- Strategic layer: Enterprise Architecture
- Operational layer: Logical Architecture
- Resource layer: Solution Architecture

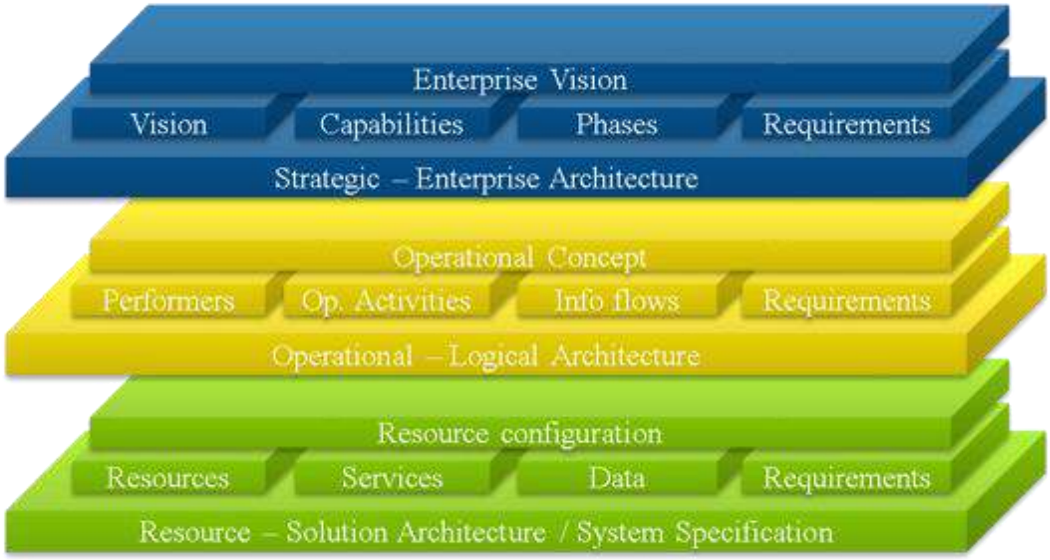

Figure 6: SoS Layers of Abstraction

Strategic Layer

This layer addresses defining the Why: in other words, we define the strategy where we define the enterprise goals, capabilities, and capability requirements. A goal is a high-level requirement, which is stable over time. Capability is the ability for the enterprise to achieve a desired effect realized through a combination of ways and means, along with specified measures. Each capability can be decomposed into elementary capabilities {UAF Capability taxonomy}. Capabilities are described with requirements {UAF Capability Requirements}. Capability requirements measurement is achieved with the definition of parameters. Capabilities are planned over time {UAF Strategic Structure}. It can also be important at this stage to identify the involved organizations for each phase in engineering the SoS.

Operational Layer

This layer addresses defining the What: what operations need to be carried out to achieve desired goals. This level, however, does not address the How. It is focused on abstract, business objects and business processes. The operational scenario defines the business objects and their exchange {UAF Operational taxonomy}: it describes a high-level view of the problem.

These scenarios are achieved by what are identified as performers or roles (usage of performers in a particular context) {UAF Operational structure}. Performers are conceptual entities that exchange information {Operational connectivity]: we do not yet know what system or solution that will participate into the scenario: the exchanged information is expressed in terms of need. Each of the scenarios describe the process flow with roles, their related functions, identified as operational activity and exchanged information {UAF Operational process}.

Resource layer

This layer addresses defining the How: the participating systems and organizations that are candidates for providing the performers/roles. Systems can be pure hardware, pure software, or hardware with software. Resources achieve services {UAF Service structure}. In this layer are defined multiple and different resource configurations. Trade-off analysis is executed {UAF Resource state} to figure out which one is the best for the given operational scenario, having in mind high-level capability requirements.

4. Smart city traffic management system example

Today with the greater awareness on system engineering, systems are designed and developed in their context. While modelling systems, context is considered as static. This type of approach is appropriate for the systems where context evolution doesn't affect the system performance and operation of systems beyond acceptance level. Let's consider an example of Traffic Management System. Until the current date, context didn't change for centuries. But what about the near future?

The innovation pace is at the peak, which introduces continuously evolved systems or new systems, thereby making context of the Traffic Management System dynamic and making it obsolete. This continuously delays deployment of a new generation of the system, due to the reactive approach rather than a proactive approach.

Figure 7: System of Systems Evolving Context

Automobile OEMs are struggling to deploy new innovations such as autonomous cars. Traditional or manually driven cars together with deployment of autonomous cars, will create a hybrid environment results, creating many issues including functional safety. This suggests that the transportation infrastructure system is constraining the design of Autonomous Vehicles.

With the new generation of Cyber Physical Systems, the systems are getting smarter and more tightly integrated. This leads to continuous change in the context of the system and thereby increases the dependencies on each other. This then influences the design, deployment and various other factors. Hence it is essential to use an approach that helps in engineering the future rather than anticipating the future. Let us examine how to architect such a complex Enterprise in Unified Architecture Framework (UAF) using a finite amount of resources and focusing on junction crossing and prioritizing the emergency vehicles/services.

Strategic Layer:

The effort starts with defining the vision for the enterprise. Enterprise phases are then established which satisfy the goals incrementally to realize the vision in a phased manner.

Figure 8: Strategic vision

Capability Analysis is then performed to understand how goals could be accomplished in an efficient manner. This could be characterized by defining different views, for example Strategic Taxonomy.

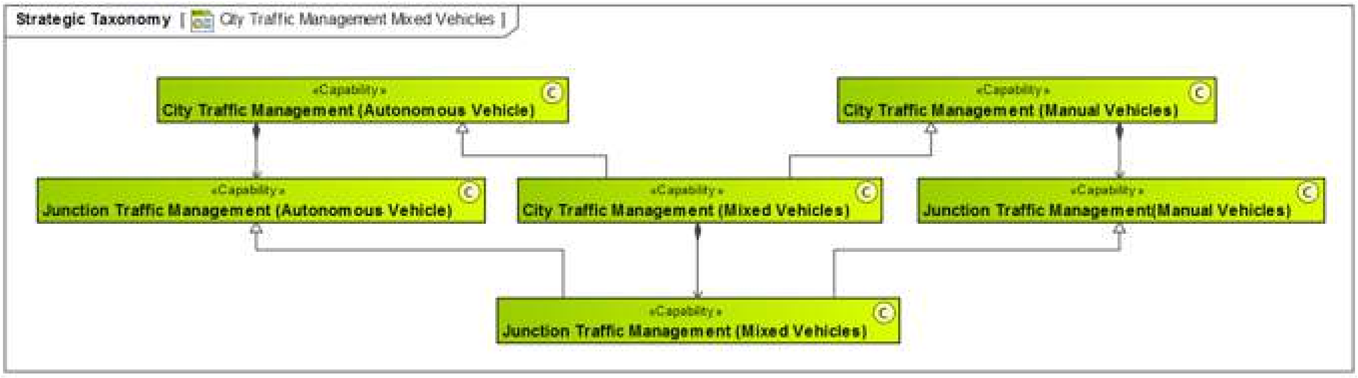

Figure 9: Capabilities

An essential strategic aspect is to capture the Actual Organizations contributing to each enterprise phase.

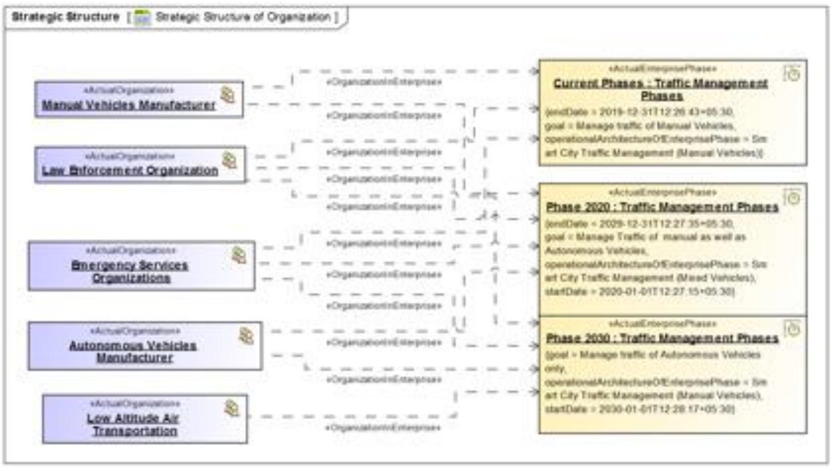

Figure 10: Involved Organizations

Strategic aspects could be further elaborated in consideration of Strategic Connectivity, Strategic Roadmaps, Strategic Traceability, etc.

Operational Layer:

The Operational Layer describes the logical Architecture of the Enterprise. It presents the user's operational perspective by being solution independent.

Operational Architectures are defined to identify operational performers and information that is exchanged between them, in the context of the operational roles they play.

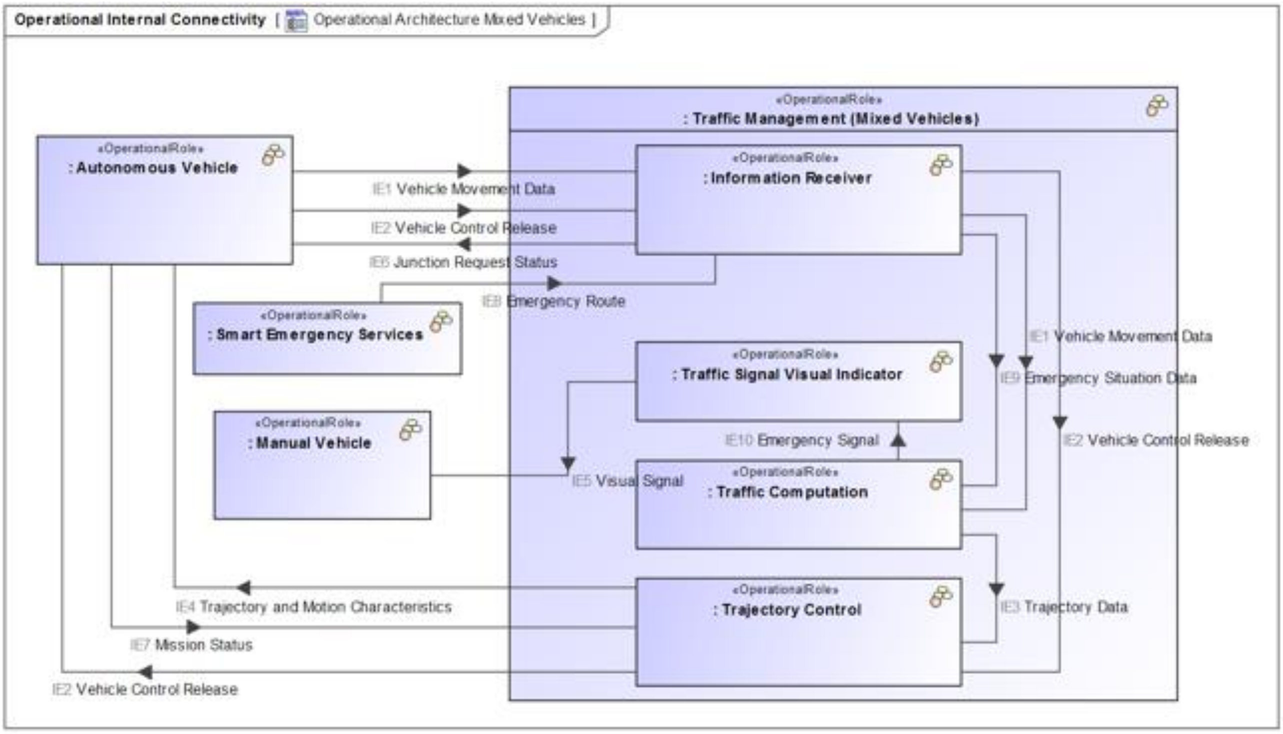

Figure 11: Operational Architecture

Operational Constraints are specified to provide consistent operational processes.

Criteria
Scope (optional): Operational Constraints ... Filter:

#	Applies To	Name
1	Emergency Services	No shoulder Lane is available
2	Emergency Services	Smart Emergency Services will be using Autonomous Vehicles Lanes
3	Autonomous Vehicle Manual Vehicle	Autonomous Vehicles and Manual Vehicles have designated individual Lanes

Figure 12: Operational Constraints

In order to perform information exchanges, operational performers need to do different operational activity actions. Key logical decisions are thereby handled, for example, if an autonomous vehicle should share control or in what ways and specific conditions when they should share control.

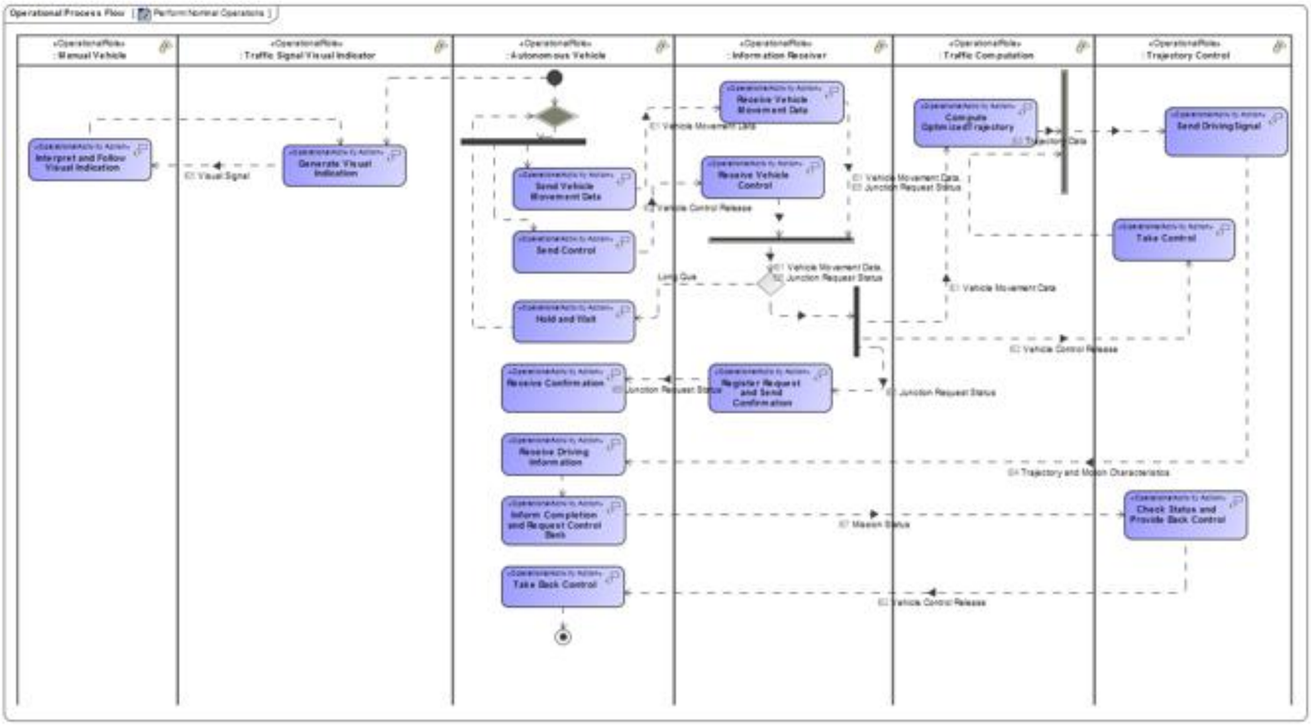

Figure 13: Operational Processes

Operational aspects could be further elaborated in terms of Operational States, Traceability, Interaction scenarios, etc.

Resources Layer:

The Resources layer deals with the implemented solution architecture consisting of resources, e.g. software, system artifacts, and capability configurations that implement the operational requirements.

Each resource has its own behavior and based on the information exchanged, the behavior is changed. In other words, resources change their states based on the information received from the functions.

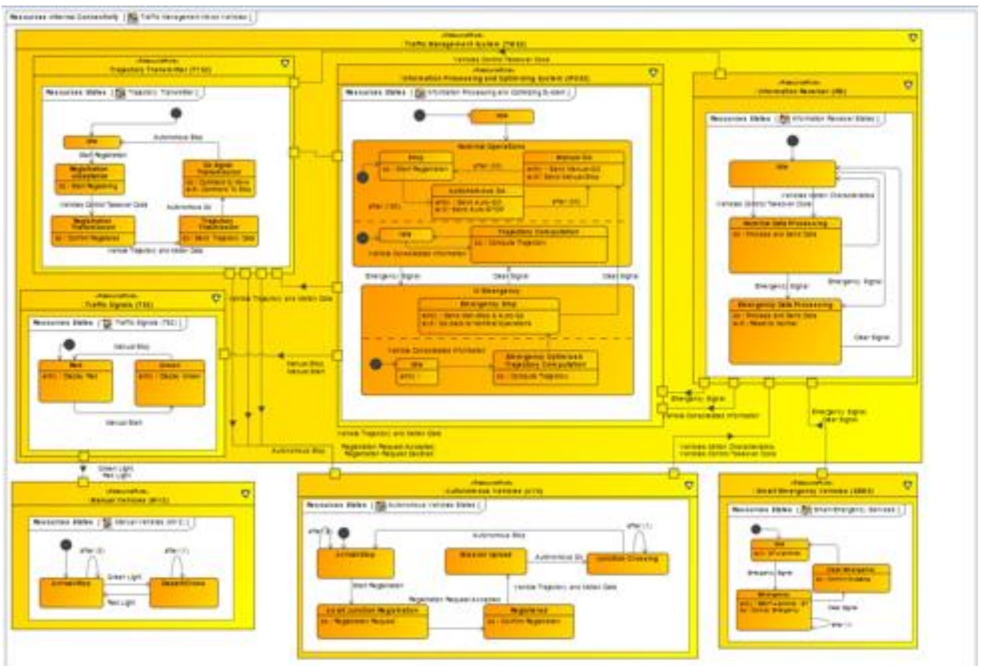

Figure 14: Resources Behavior

Creating multiple capability configurations constructed on different characteristics of resources also enables alternative trade-offs based on operational scenarios by executing models (PSCS & PSSM extension of fUML).

The research is enhanced by the UI created in 'Cameo Enterprise Architecture' tool, now called 'Magic Systems of Systems Architect' in Dassault Systèmes' portfolio. This demonstrates how powerful the simulation can be given combined UI prototyping. The User Interface could be developed taking a form of a dashboard for monitoring critical parameters and system behaviors or an interactive user interface, or it could be a combination of both.

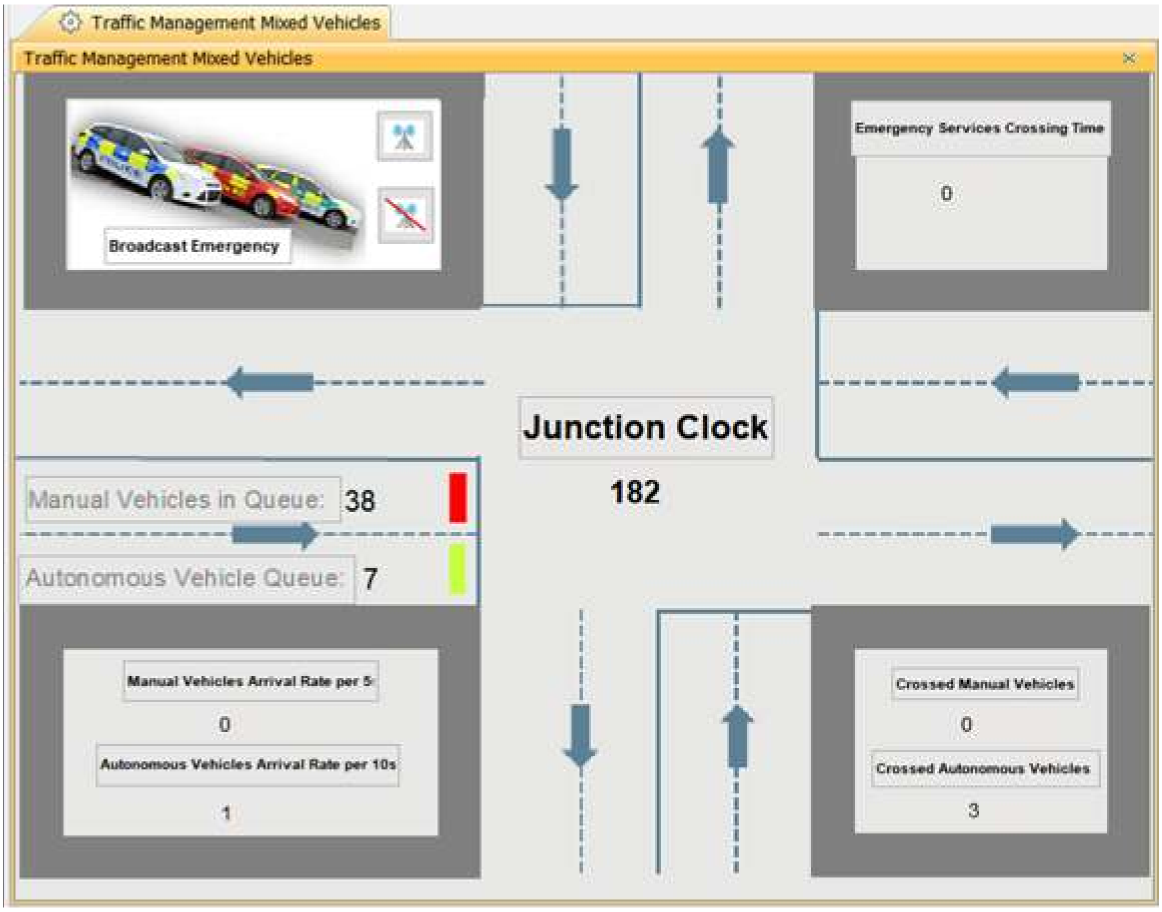

Figure 15: Interactive Dashboard

The advantage of the SoS simulation is that hundreds of alternative solutions are assessed, by checking that the SoS behavior satisfies the goals and key requirements of the SoS (e.g. cost, traffic jam length, travel time, emergency vehicle crossing time, etc.) by automatic requirements verification. These trade-offs enable the identification of the best configuration based on operational needs and capability requirements. The output of the SoS analysis is a consistent and robust specification of the constituent systems of the SoS.

5. Conclusion

Systems are increasingly connected. Barriers between Industries are now porous. If technology is a large part of today's system innovation, innovation of tomorrow will be hinged on providing added-value services. Specifying systems in a traditional way by eliciting the stakeholder needs is now becoming, in most cases, insufficient.

Companies that will stand out in the crowd, in this uberization of the economy, will be the ones that will master SoS. Mastering SoS means mastering systems which are independent and operatable, and which are networked together for a period of time to achieve a certain higher goal [Jamshidi2008].

Unified Architecture Framework (UAF) provides a standardized framework for engineering SoS across multiple organizations. If this is necessary, it is not sufficient to achieve efficient SoS. An organization shall define a SoS methodology with layers of abstraction (why, what, how) and relevant UAF views. This methodology shall be shared and agreed between all the participating organizations.

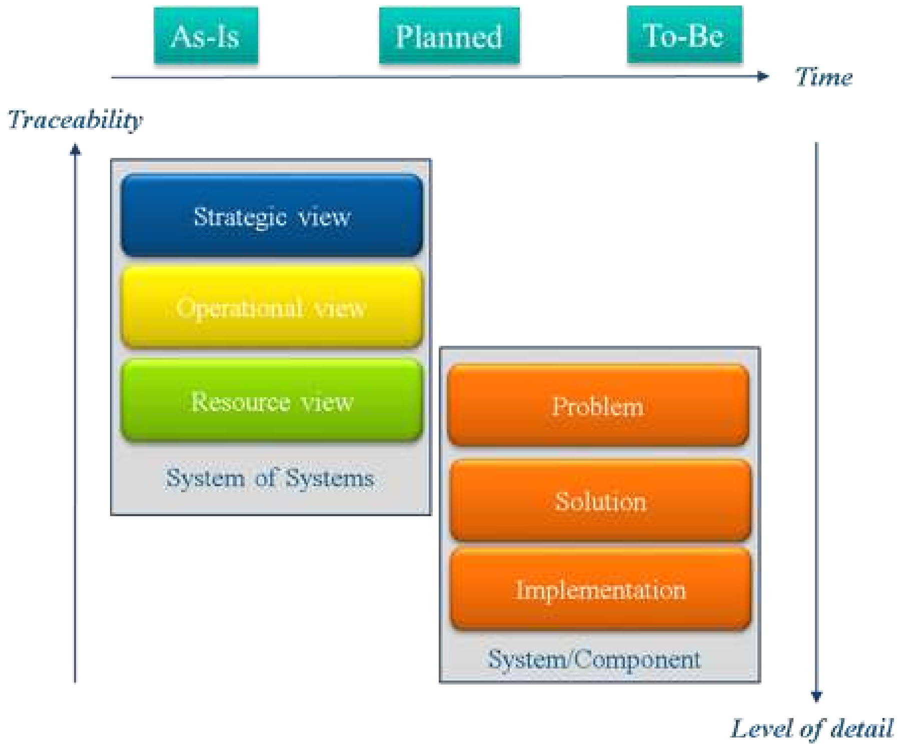

Figure 16: From SoS to System

If SoS engineering is an efficient way to specify the needs of each of the systems of the SoS, an organization shall also ensure digital continuity and traceability throughout the design and implementation of a product. An organization shall also put in place the change and configuration management activities to master the consistency of the evolving needs and the systems developed or under development.

SoS engineering requires an open business platform such as the **3D**EXPERIENCE Platform to enable the collaboration between all the stakeholders, in a role based approach. The simulation of a SoS is a mandatory component to support trade-off analysis and identify upfront the relevant systems in an architecture to be acquired or developed.

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Authors

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Aurelijus Morkevicius is OMG® Certified UML, Systems Modeling and BPM professional. Currently he is a Head of Solutions at No Magic Europe and a leader of CATIA CoE for MBSE for EMEAR region. He has more than 10 years expertise of model-based systems and software engineering (mostly based on UML and SysML) and defense architectures (DoDAF, MODAF, NAF, UAF). Aurelijus is working with companies such as BAE Systems, Airbus, Deutsche Bahn, Ford, General Electric, SIEMENS, ZF, etc. Aurelijus represents No Magic at INCOSE, NATO Architecture Capability Team, and OMG. He is a chairman and one of the leading architects for the current OMG UAF (previously known as UPDM) standard development group. In addition, Aurelijus is actively involved in academia. He received a PhD in Informatics Engineering from the Kaunas University of Technology in 2013. Aurelijus is also a lecturer, author of multiple articles, and a speaker in multiple conferences.

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Himanshu Upadhyay has over 10 years of experience in Systems Engineering. His has expertise in domains of ModSim, tailoring SE methods and developing SE cobots. He works at Dassault Systemes as Portfolio Technical Manager in Cyber Systems team. His responsibilities involve developing and demonstrating seamless integration of Systems Engineering application. He is an active member of INCOSE and APCOSE.

Editorial note: The term "system of systems" is used inconsistently in the engineering community, as addressed in the above paper under "SoS Definition". One use of the term is the literal meaning, attributed in the paper above to [Checkland99]. The other use can be condensed to "systems of autonomously managed systems". See [Maier98]. Under this second use of the term "system of systems", the engineer of the parent system has little or no authority to define requirements for the subsystems and demand that they be met. So negotiation, bribery, vertical and horizontal co-planning, and management of the stakeholders in the subsystems (especially reconciliation of conflicting stakeholder interests) become the tools of trade. This subject of the language distinction between "systems of systems" in general and the "autonomous" version is addressed in PPI SyEN #47 available here.

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3. ADDITIONAL ARTICLE

3.1 Gartner Report: Innovation Insight for Hybrid Integration Platforms

by

Massimo Pezzini

Distinguished VP Analyst

Application leaders are under pressure to reshape their integration platform strategy in order to tackle the pervasive integration challenges of Digital Transformation.

The Hybrid Integration Platform (HIP) is rapidly becoming the framework of choice in the design of modern integration infrastructure.

This Gartner report will help application leaders plan their hybrid integration strategy, taking into account both well-established and emerging technologies.

Download the Complimentary Report

EDITORIAL

3.2 INCOSE IS 2019 Reflections

by

René King

Senior Systems Engineer and Managing Editor of PPI SyEN

The 29th INCOSE International Symposium was a remarkable waypoint on my journey in systems engineering. The theme of the symposium was System Applications for Global Challenges which reverberated throughout the various plenaries, presentations, workshops, and meetings, each geared towards addressing the wide variety of engineering challenges in our modern world.

As with all INCOSE symposiums and workshops, there was a heavy emphasis on Model-Based Systems Engineering (MBSE), particularly MBSE as a steppingstone to achieving full digital engineering capability: that is, the creation, capture, and integration of data in a fully digital environment. This emphasis results from a growing need to streamline the product development processes in our complex world. The call for applying a risk-reducing, objective-achieving methodology (i.e. systems engineering) to the fields of transportation, artificial intelligence, healthcare, communications, environmental challenges and leadership was echoed throughout the conference. The brilliance of the conference was bolstered by its timing being concurrent with the 50th anniversary of the landing on the moon. The coincidence of the two events provided much fodder for discussion, particularly around whether the sophistication in engineering that was demonstrated in 1969 still holds true in 2019.

One response to this dialog was that the zero-error mindset of the project members that enabled the 'impossible' to transpire in 1969 seems to have been lost in this modern era of 'trial of error'. Despite having advanced methods and technologies available at our fingertips to enable seamless project development, this age of instant gratification prevents the fruition of this reality, since cheaper, more immediate results seem to be preferred over more reliable, effective, cost-efficient solutions. In order to coordinate the moon landing in 1969 with the resources that were available at the time, engineers and project leaders had to adopt a culture of 'perfect the first time' (or as far as possible) as the modus operandi in order to achieve the unachievable. This 2019 INCOSE Symposium called into question our philosophy as engineers, imploring us to adopt the habit of applying a structured process (a systems engineering process) to reach an optimal creative solution: the ultimate merging of art and science.

A noticeable and vital aspect of the conference was the emphasis on integration within the SE world on a global scale. The conference provided many opportunities for synergies between nations, sectors, and industries via a multitude of meetings and networking opportunities. In essence, the INCOSE IS 2019 did much to highlight challenges and opportunities associated with living in a world populated by dynamic, nondeterministic, and highly interactive systems to bring comprehensive, interoperable and adaptable system solutions. The conference agenda aligned well with INCOSE's Future of Systems Engineering (FuSE) roadmap: to evolve the practice, instruction, and perception of systems engineering by creating a clear vision for the future and aligning efforts of the INCOSE SE community to fulfill this vision. Gauging from the response of the attendees, I know I speak for many when I say that the conference was one of the most prolific INCOSE events to date. One could not help but walk away with a feeling of joy and gratitude to be a part of such a forward-thinking, passionate, and caring community. A huge thank you to each person who visited us at the PPI booth, stopped us in the hallways for a chat, and impacted us through demonstrations of expansive thinking in a range of forms. This symposium has inspired us to work even harder than ever before to see the proliferation of SE on a global scale. Systems engineering has the capacity to change lives. May you go on to fulfill this capacity through your daily work.

4. SYSTEMS ENGINEERING NEWS

4.1 Asia Oceania Input to the PPI Systems Engineering Newsletter

by Serge Landry, ESEP

Director, INCOSE Asia Oceania Sector

3 September 2019

Greetings,

The International Symposium of INCOSE has come and gone. It is timely (even if a bit late) for the lucky few who had the chance to be there in Orlando to share their experience with other fellow engineers who could not attend.

This article intends to provide a glimpse of the International Symposium (IS) 2019, held in Orlando, Florida during July, as seen through my perspective. The IS is always an intense experience, to be recommended to any INCOSE member and because there are so many activities happening concurrently in and around the Symposium, each and every attendee comes back with different stories to tell.

It usually takes effort and dedication to go for an International Conference in a faraway place.

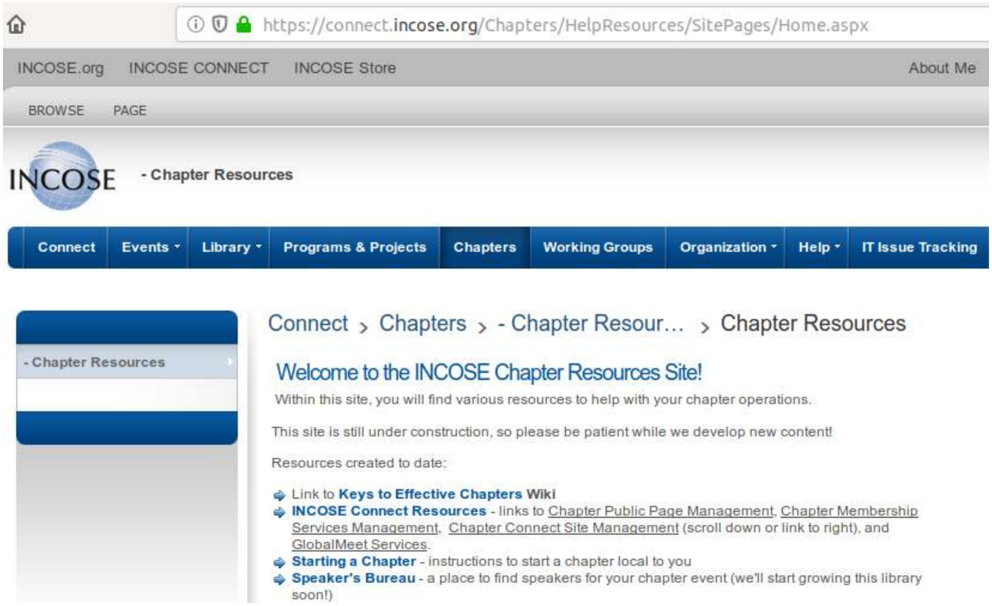
As an illustration of this, here is a photo of one of our Japanese attendees, Junji, taking a rest at a US airport after his flight was cancelled because of a storm. It took him more than 30 hours to reach the conference. Now, that's dedication! When I met with him at the conference, he was all smiles, proof that it was all worth it.

During INCOSE Leaders Strategy Day, on 19 July:

- I participated in the morning session 'Developing a Value Proposition', where we brainstormed on ideas to refine the INCOSE Value Proposition to be consistent with INCOSE's most recent Value Streams.

- I assisted during the 'Re-energizing chapters' afternoon session, led by Tony Williams (Director of Sector 1) with the help of Paul Schreinemakers (Director of Sector 2) and myself. We debated and captured the challenges and opportunities as seen and experienced from the various Chapters and Sectors of INCOSE.

On Saturday 20 July, I co-led a session on 'What makes a chapter successful' where we (new as well as seasoned volunteers) reviewed and debated, the content of the 'Chapter Resources' site in the INCOSE intranet (also known as INCOSE Connect), in particular the wiki section called 'Keys to Effective Chapters', which is a treasure of good practices captured and refined over the years by our dedicated volunteers. This is available in the member only section of the INCOSE intranet.



On 22 July, I contributed to the session 'President's Invited Content – Embarking on a Grand Challenge', led by Kerry Lunney, where the audience was:

- Introduced to the grand challenge by Patrick Godfrey and Michael Pennotti in a presentation called "Evolving Systemic Approaches for Complex Challenges: Launching a Learning Journey";

- Encouraged to discuss the topic in a café style workshop; then

- Enticed to vote on specific Questions and Answers.

The background of this initiative is for INCOSE to contribute to one of the United Nation's Grand Challenges.

On 22 July, I managed to engage with first time attendees of the International Symposium at the 'New Member Lunch' session, an opportunity to welcome onboard the newcomers to the Symposium.

On 22 July, afternoon, I contributed to the session 'President's Invited Content – Panel Discussion – Professional Development of System Engineers: Evolving today's engineers for change'. That session was organized and lead by Don Gelosh and Marilyn Pineda, with contributions from Ed Moshinsky, Duncan Kemp, and Nicole Hutchison. Each of the speakers described his/her own experience about what they thought made them successful in their career so far and provided relevant recommendations for the development of the engineers of the future.

Sector 3 Asia-Oceania leaders meetings were held on 20th and 22nd July with good attendance from Australia, India, Japan, Mongolia, and Singapore. Special guests included Garry Roedler, Kerry Lunney, and Kayla Marshall (Secretary of INCOSE). This was our regular opportunity to get together face to face and brainstorm ideas to influence our future roadmap.

Sector 3 held its usual Informal networking dinner to renew and strengthen the bond between chapters of Asia-Oceania.

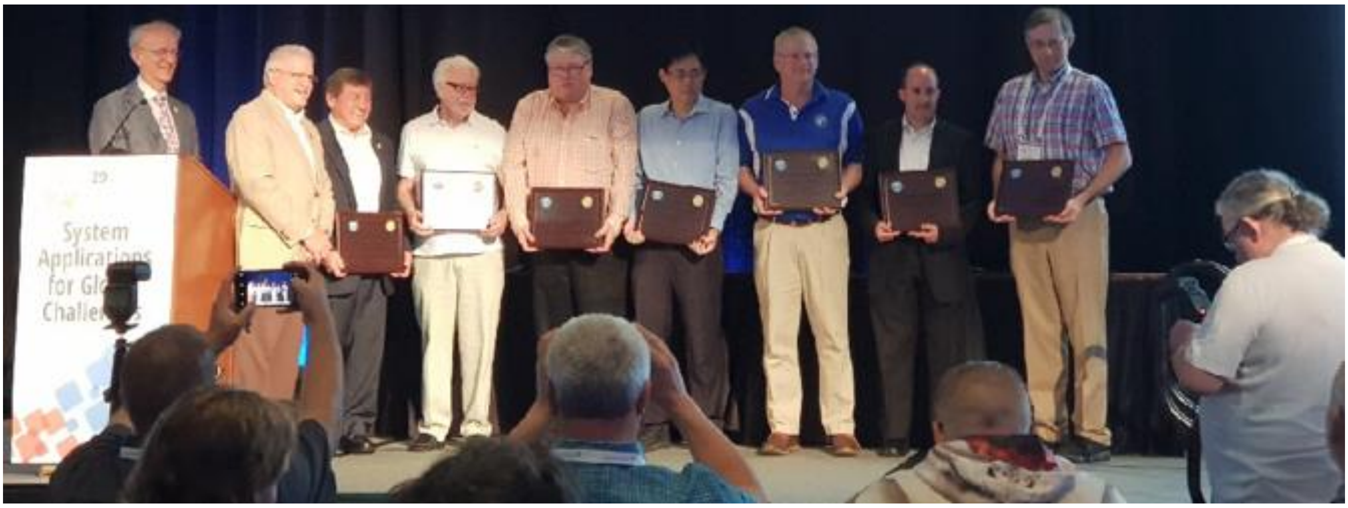



We had the privilege to welcome a Keynote speaker from India, M. Prashant Dhawan, who delivered a presentation about Bio-Mimicry[2]. This presentation is available at the INCOSE You Tube channel: https://www.youtube.com/watch?v=oMqXuQ2MwpU.

In the photo below, Prashant Dhawan (center) with Stueti Gupta (on the right), the President of the Indian Chapter and Ramakhrisnan Raman (on the left), Assistant Director for INCOSE Sector 3.

Chapter awards were delivered to Australia (Gold), India (Silver) and Singapore (Gold): well done to all!

2 Biomimicry is the design and production of materials, structures, and systems that are modeled on biological entities and processes.

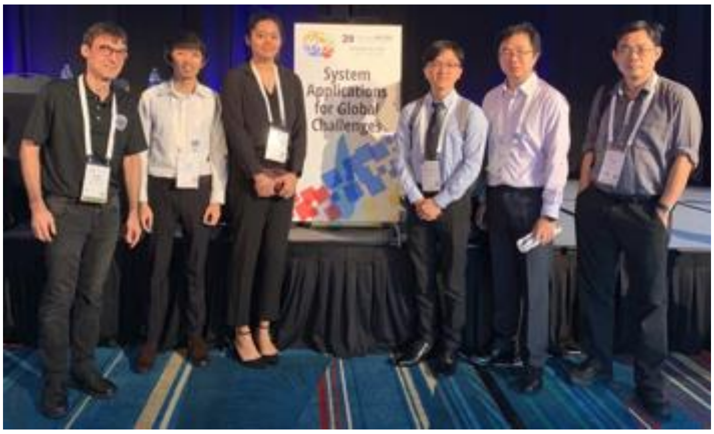


Chapter award review discussions were held to capture feedbacks from chapter leaders on the current effort to transform the Chapter Award scheme.

I participated to the Technical Leadership Institute (TLI) brainstorming session to define the TLI response to the Grand Challenge.

The President (Liew Pak an on the right) and President Elect (Tham Ming Wah on the left) of the Singapore chapter could not resist their moment of fame with Capt. Winston Scott, another famous keynote speaker.

A group of four System Engineering students from Singapore Institute of Technology (SIT) attended the International Symposium (see photo below).



On the 23 July, I participated in the 'Early Career Professionals' (ECP) session lead by Ali L. Raz, Kayla Marshall and Don Boyer. During the ECP Task Team meeting, we brainstormed a number of ideas and initiatives that will aid INCOSE in educating, nurturing and growing the career systems engineering professionals from early on.

This is only a glimpse of what went on during the Symposium, a great event to connect with the Systems Engineering Community and to create lasting friendships.

4.2 Azad M. Madni Receives Prestigious Awards from Orange County Engineering Council

From the INCOSE website

Azad M. Madni has received the prestigious Pioneering Educator Award from the Orange County Engineering Council and the William B. Johnson International Inter-professional Founders Memorial Award from the San Fernando Valley Engineers' Council. Madni was recognized for being a "unique engineering educator, with a non-conventional way of challenging students" and for exemplifying the leadership, fortitude and compassion of William B. Johnson, one of the founders of the San Fernando Valley Engineers' Council.

"Azad's contributions to the advancement in education of astronautical engineering and his exemplary qualities as an engineer make him deserving of these distinguished awards," said INCOSE President Garry Roedler. "It's an honor to have Madni as an INCOSE Fellow and we thank him for bettering the engineering community."

Madni is a professor of astronautical engineering and the technical director of the Systems Architecting and Engineering Program at University of Southern California's Viterbi School of Engineering. He is the founder and CEO of Intelligent Systems Technology, Inc., a high-tech company specializing in game-based educational simulations, and methods, processes and tools for complex systems engineering. He pioneered the meta-discipline of transdisciplinary systems engineering to exploit the convergence of systems engineering with other disciplines and is the creator of model-driven storytelling, a transdisciplinary approach that integrates model-based engineering with interactive storytelling in virtual worlds to enhance stakeholder participation in upfront engineering.

Madni also gives frequent career counseling lectures to student members of Society of Hispanic Professional Engineers (SHPE) and National Society of Black Engineers (NSBE). His key tenet is "everyone is an expert at something; we need to capitalize on that." Madni inspires students to make significant and innovative contributions to the engineering field by challenging students to think critically and providing them with the tools and requisite skills to succeed.

Among Madni's numerous career achievements, he founded IEEE Systems, Man and Cybernetics Society's (SMCS) Technical Committee, an award-winning committee for model-based systems engineering. He authored "Transdisciplinary Systems Engineering: Exploiting Convergence in a Hyper-Connected World" and co-authored "Tradeoff Decisions in System Design." To learn more about Madni, visit: www.azadmadni.com

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4.3 INCOSE Proposes Updated Definitions of "Systems Engineering", "An Engineered System", and "Systems"

Editor's Note: See the article in Section 7.1 concerning this document,

A 2019 Document developed by the Fellows Initiative on System and Systems Engineering Definitions presents the final proposals from the initiative. Updated definitions are provided for "Systems Engineering", "An Engineering System", and "System". Aspects of current systems engineering practice are A Transitory Approach (described in Wikipedia as an approach which "crosses many disciplinary boundaries to create a holistic approach"; An Integrative Approach (The integrative approach has long been used in systems engineering and usually involves either interdisciplinary (e.g.. integrated product teams) or multi-disciplinary (e.g.. joint technical reviews) methods); Systems Principles and Concepts (the ways that systems thinking and the systems sciences infuse systems engineering); and Engineering An Engineered System (An engineered system is a system designed or adapted to interact with an anticipated operational environment to achieve one or more intended purposes while complying with applicable constraints).

A particularly useful discussion is provided in the Appendix to the Document, **Typical Features of Systems Engineering**. A discussion of ten key activities of systems engineering is provided.

Download the Document from the INCOSE Store

4.4 Object Management Group Releases Practical Guide to Cloud Governance

Editor's Note: See also Section 7.6 Object Management Group: Best Practices for Developing and Growing a Cloud-Enabled Workforce.

The Cloud Working Group of the Object Management Group® (OMG®), an international, open membership, not-for-profit technology standards consortium, has published version 1.0 of the *Practical Guide to Cloud Governance.* The purpose of the Guide is to help cloud adopters put in place the framework, policies, roles and responsibilities required to ensure success. The new guide is freely available at www.omg.org/cloud/deliverables/practical-guide-to-cloud-governance.

A governance program is necessary in most business and IT initiatives to ensure smooth operations and has proven to improve results; with cloud computing, the presence of critical external providers makes it even more vital to establish good governance. With this new deliverable, OMG answers the question of

how to define, plan, launch, and sustain such a program in collaboration between IT executives and their counterparts in the C-suite and lines of business.
The Guide is organized in seven steps:

- Understand cloud governance
- Benchmark
- Establish a framework
- Align corporate governance and cloud governance
- Establish a cloud governance program
- Establish governance measures and metrics
- Sustain success

4.5 Assist 2 Develops Systems Engineering Challenge for NASA

Background

Mission architects mostly start from scratch to build model elements representing the functional and physical architecture of a system in SysML. There are a few beginning libraries, but these are also local to a program or group. A common library will save system engineers a large amount of time, will allow project stakeholders to recognize common graphics and quickly understand the architecture options.

Overview

This is a pilot challenge to find creative space architecture representations and system decomposition using SysML elements for a Model-Based Systems Engineering (MBSE) library. NASA mission architects need a library of SysML elements for common physical and functional elements that is consistent across NASA. This will be a prize contest open to individuals as well as university students to create a habitat-related architecture library of model elements.

Objectives

Decompose habitat physical and functional architecture in a model, organized as a library of elements, rather than as a habitat design project

- Create elements that contain all the required attributes in a way that allows easy analysis of an architecture made of these elements through roll-up analysis or parametric diagrams
- Create elements using graphics that communicate the element easily in relatively small file size
- Create many elements for the library, especially those that can be used in other types of projects

More Information

Watch the 6-minute video explaining the context of the challenge here.

4.6 Enterprise Integration Summit – An Online Event

Enterprise Integration Summit is an Online Event where eight leaders in Enterprise Integration will present their solutions for Digital Transformation. Vendors demonstrating their integration technologies include IBM, Software AG, Attunity, InfluxData, Dell Boomi, OutSystems, CData and Actian.

Date: October 24, 2019

Time: 10am PT/1pm ET

Topics included:

1. **Microservices & Continuous Integration:** Give your apps continuous access to crucial cloud assets, Microservices with CI and Smart Containers
2. **Hybrid Integration, Enterprise Grade:** On-prem-to-Cloud Integration for apps, data and GRC that is foolproof, and fault-tolerant, at last
3. **Blockchain to the Edge**: AI-powered integration to expand your ecosystem for Blockchain, Edge computing, B2B and 3rd party services
4. **Instant Integration:** Low-Code productivity and Point-and-Click integration with 100s of apps, data sources
5. Analytic Pipelines**: Smart Data Streams and Pipes that unify all your diverse data sources for deeper insights**
6. **Legacy Modernization:** Safely extend your mission-critical Data Warehouse for high-value operations

Download slides, analyst reports, white papers and register for the event here.

4.7 Jama White Paper: Systems Engineering and Development

A resource provided by Jama Software featuring essays by authors Christer Fröling, Michael Jastram, and Lou Wheatcraft.

As we look forward to a new decade of innovation in product development, one of the biggest trends remains the rapidly expanding complexity of systems, organizations, processes, and supply chains.

It's systems engineers who are uniquely suited to overcome these obstacles and ensure strong products emerge as a result.

Jama Software believes systems engineering will only play a larger role in product development moving forward, so we asked three experts for some thoughts on topics related to this interdisciplinary, integrated field of engineering.

In this white paper, you'll find essays on topics related to systems engineering, including:

1. "The Reliance on Requirements Management Tools as the Engineering Messiah" by Christer Fröling

2. "Myths about the V-Model" by Michael Jastram

3. "The Difference Between Verification and Validation" by Louis S. Wheatcraft

Download the paper here.

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5. FEATURED ORGANIZATIONS

5.1 International Association for the Engineering Modeling, Analysis, and Simulation Community (NAFEMS)

NAFEMS is a not-for-profit organization which was established in 1983. Its principal aims are to:

- Improve the professional status of all persons engaged in the use of engineering simulation.
- Establish best practice in engineering simulation.
- Provide a focal point for the dissemination and exchange of information and knowledge relating to engineering simulation.
- Promote collaboration and communication.
- Act as an advocate for the deployment of simulation.
- Continuously improve the education and training in the use of simulation techniques.
- Be recognized as a valued independent authority that operates with neutrality and integrity.

NAFEMS focuses on the practical application of numerical engineering simulation techniques such the Finite Element Method for Structural Analysis, Computational Fluid Dynamics, and Multibody Simulation. In addition to end users from all industry sectors, stakeholders include technology providers, researchers, and academics.

More Information

5.2 Society for Risk Analysis Australia New Zealand

The purpose of the Society for Risk Analysis - Australia & New Zealand (SRA-ANZ) is to provide an opportunity for an inclusive, broad-based society that promotes communication between disciplines, a breadth of tools and viewpoints, and platforms for training, workshops, and conferences. The objectives of the Society are:

1. To serve as the focal point for interaction of members of the Society and other interested individuals and organizations in Australia and New Zealand.

2. To further understanding, awareness, and appropriate applications of risk analysis, and to promote an exchange of ideas and practical experiences among members of the academic, professional, industrial, and regulatory communities involved in risk analysis and risk management in Australia and New Zealand.

3. To hold scientific and educational meetings.

More Information

5.3 CESAM Community

CESAM COMMUNITY

The CESAM Community is a French group that shares good practices in enterprise architecture and systems architecture in order to promote architecture as a key tool for business competitiveness. CESAM is a systems architecture and modeling framework, developed since 2010, by the CESAMES Association, in strong interaction with major industrial players. This framework, intended for system architects, engineers and designers, aims to help them master the complex integrated systems on which they work on a daily basis. CESAM has 4 specificities that make it a valuable tool for companies:

1. **CESAM has mathematical foundations** that allow to have a shared and rigorous understanding of all the architectural concepts that it presents which creates a real and effective understanding between the different stakeholders involved in the design of a system. On this basis, the **architectural vision proposed by CESAM represents the "just necessary" to model any integrated system**. This specificity guarantees the completeness of a system model developed according to the CESAM method while ensuring that there is no unnecessary modeling work done.

2. **CESAM is easy to make operational by system architects but also by system modelers**. CESAM has already shown substantial positive results on numerous types of systems in various sectors of activity including aeronautics, automobile, defense and security, energy and transport.

3. The CESAM architecture framework, thanks to its right level of abstraction, **can be implemented and used with all system modeling frameworks and software tools on the market**.

4. CESAM's objective is to propose a generic architecture framework but also, in fine and gradually, to offer frameworks of high-level systems architectures, specific to the main industrial fields of application (the first will be Aerospace and automotive). This is to facilitate the work of system architects within these activities. The CESAM Community offers a downloadable pocket guide titled "CESAMES Systems Architecting Method".

Through the CESAMES Association, the CESAM community:

- Expands the use of architecture in companies and communicates the results of its implementation.
- Develops and shares the best systems architecture practices in industry and services: through publications and guides and thanks to the sharing of feedback between architects and system engineers during events of the community.
- Offers a framework of generic architecture but also, in fine, frameworks of systems architectures of high level, in specific to industrial fields of application.
- Facilitates access to the CESAM method, and develops its use internationally.
- Enhances the expertise of its members thanks to state certifications.

The CESAM Community recently shared an article, "Five Enterprise Architecture Practices that Add Value to Digital Transformations", authored by Sven Blumberg, Oliver Bossert, and Jan Sokalski of McKinsey Digital, available here.

Join the community to take part in the discussion and to stay informed of the latest news.

5.4 National Institute of Standards and Technology (NIST) (USA)

NIST National Institute of Standards and Technology U.S. Department of Commerce

The National Institute of Standards and Technology (NIST) was founded in 1901 and is now part of the U.S. Department of Commerce. NIST is one of the nation's oldest physical science laboratories. Congress established the agency to remove a major challenge to U.S. industrial competitiveness at the time — a second-rate measurement infrastructure that lagged behind the capabilities of the United Kingdom, Germany, and other economic rivals.

From the smart electric power grid and electronic health records to atomic clocks, advanced nanomaterials, and computer chips, innumerable products and services rely in some way on technology, measurement, and standards provided by the National Institute of Standards and Technology.

Today, NIST measurements support the smallest of technologies to the largest and most complex of human-made creations—from nanoscale devices so tiny that tens of thousands can fit on the end of a single human hair up to earthquake-resistant skyscrapers and global communication networks.

See the NIST web site to learn about current projects, to find out how you can work with NIST, or to make use of NIST products and services.

5.5 Information Systems Audit and Control Association (ISACA)

As an independent, nonprofit, global association, ISACA engages in the development, adoption, and use of globally accepted, industry-leading knowledge and practices for information systems. Previously known as the Information Systems Audit and Control Association, ISACA now goes by its acronym only, to reflect the broad range of IT governance professionals it serves.

ISACA provides guidance, benchmarks, and other tools for enterprises that use information systems. Through its guidance and services, ISACA defines the roles of information systems governance, security, audit, and assurance professionals worldwide. The COBIT framework and the CISA, CISM, CGEIT and CRISC certifications are ISACA brands respected and used by these professionals for the benefit of their enterprises.

More Information

6. NEWS ON SOFTWARE TOOLS SUPPORTING SYSTEMS ENGINEERING

6.1 Tom Sawyer Software announces the release of Tom Sawyer Perspectives 9.0.0 First Beta

To help customers save time, this release includes schema extraction for Microsoft Excel data sources in Tom Sawyer Graph and Data Visualization. In addition, customers can enjoy greatly reduced edge crossings in orthogonal layout.

For customers who have advanced Model-Based Systems Engineering (MBSE) needs, Tom Sawyer Model-Based Engineering now has many more customization options including the ability to filter diagrams through persistence, special rendering for bus nodes, and the ability to group elements by attribute and place into a nested graph structure. The Tom Sawyer Model-Based Engineering web application can now be used without access to the internet.

Tom Sawyer Business Process can now automatically create lanes based upon the departments or roles of task owners. And, Tom Sawyer Graph Database Browser has improved appearance rules and a user-friendly embedded query editor.

To try a free demonstration, click here.

More Information

6.2 Jama Connect 8.42 Goes Live

This release improves the usability and compliance of **Review Center**, making the setup process more efficient and adding signer roles for E-Signatures. Jama has also made enhancements to **Baselines** by improving searchability, labeling, and more signature protection.

With 8.42 users can now access upcoming changes in the Velocity reporting process. Jama is releasing a new version of the velocity engine to enhance security and simplify report creation. Learn more about how to activate these new reports in the Jama User Community.

Find the complete list of updates and resolved issues in the Jama Software User Community Release Notes.

6.3 CATIA Systems Engineering V2

Our engineering challenges are more challenging every day. The need to be able to stand back and have a holistic view of the problem as well as the solution development process is ubiquitous. Engineers need to master requirements engineering, systems architecture definition, detailed modelling and simulation of complex systems and the development of embedded software in the context of the development of complex solutions.

The Systems Engineering solution from Dassault Systèmes is a development platform that fully integrates the cross-discipline modelling, simulation, verification and business process support needed for developing complex 'cyber-physical' products. Such an ability allows organizations to quickly respond to requests for changes or develop new products variants or complete new systems, using a systems engineering approach that reduces the overall cost of system and product development.

Key benefits:

- A model-based system development platform to accelerate the development and validation of complex systems and products.
- Enabling compliance with stakeholder needs and requirements while improving time-to-market and reducing costs.
- Collaborate across all disciplines to define a systems architecture most efficient in meeting the stakeholder perception of value through multiple operational, functional and physical views.
- Verify the behavior of complex cross-disciplinary designs, through the use of Modelica based modelling and simulation.
- Integrate embedded systems and 3D product design processes in the 3DEXPERIENCE simulation of complex mechatronic products and systems.

More Information

7. SYSTEMS ENGINEERING PUBLICATIONS

7.1 INCOSE Systems Engineering and System Definitions

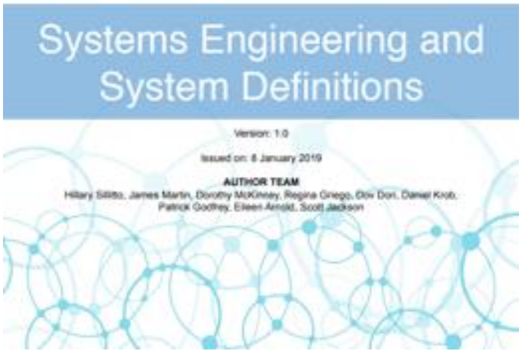

Image Source

Executive Summary

The Fellows Initiative on System and Systems Engineering Definitions was established in 2016, to:

1. Review current INCOSE definitions of SYSTEM and SYSTEMS ENGINEERING; and
2. Recommend any changes necessary to align the definitions to current practice and to the aspirations of INCOSE's 2025 Vision.

This 2019 document presents the final proposals from the initiative. It takes into account the extensive comments received during the review of the previous draft in September 2018. The review was open to all INCOSE members, and attracted over 350 individual comments and suggestions.

The three key recommendations – for definitions of systems engineering, engineered system, and a general definition of system - are presented below, with a very brief contextual explanation. After the table of contents, the main body of this document provides more explanation of these definitions, and also defines other specific system types and categories that are important for the systems engineering community.

Systems Engineering is a **transdisciplinary** and **integrative** approach to enable the successful realization, use, and retirement of **engineered systems**, using **systems principles and concepts**, and scientific, technological, and management methods.

The terms “engineering” and “engineered” are used in their **widest sense**: “the action of working artfully to bring something about”. “**Engineered systems**” may be composed of any or all of people, products, services, information, processes, and natural elements.

An **engineered system** is a system designed or adapted to interact with an anticipated operational environment to achieve one or more intended purposes while complying with applicable constraints.

Thus, an “engineered system” is a system – not necessarily a technological one - which has been or will be “systems engineered” for a purpose.

7.2 Mastering AWS [Amazon Web Services] Cost Optimization: Real-World Technical and Operational Cost-saving Best Practices

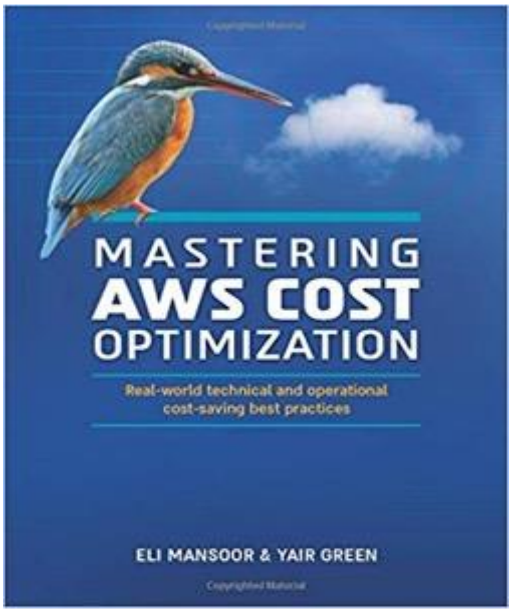

Image Source

by

Eli Mansoor and Yair Green

From the Amazon.com Website;

The book *Mastering AWS Cost Optimization* is intended to support you in overcoming one of the top challenges that organizations face in their journey towards public cloud: the challenge of cost control and optimization. Reading this book will give you a better understanding of both the technical and operational aspects of the process. This ensures that you will succeed in taking advantage of advanced technology for building innovative products, while doing so in an optimized and cost-effective manner. This book contains many proven technical, operational, and applications-related best practices. All are real-life best practices that were implemented in the efforts of controlling and reducing the costs of Amazon’s own cloud infrastructure as well as that of Amazon’s customers.

Topics

- Amazon's Compute (EC2, Lambda, Container Services), Storage (S3, Glacier, EBS, and EFS), and Networking services pricing models.

- Best practices for architecting and operating your cloud environments for cost optimization and efficiency.
- How to build applications that are lightweight from the perspective of resource requirements.
- How to leverage AWS operational services (Service Catalog, Config, Budgets, Landing Zone, Tagging, CloudWatch, and others) for ensuring continuous governance and on-going cost efficiency.

The KAO™ Methodology

The KAO™ (Knowledge, Architecture, and Operation) methodology was developed to provide a structured approach towards optimizing the costs of any cloud service you will consume – even services not covered within this book. This methodology will lay the foundation needed for addressing any cost-optimization task and provide a structured approach for each optimization effort.

It is recommended that everyone involved in a cloud project read this book. This includes those undergoing their first cloud transformation project ("moving workloads to the cloud") through early adopters in "born-to-the-cloud" companies. Cloud computing represents much more than new technology and tools. The costs of cloud computing are related to new pay-per-use pricing models, new consumption models, new operational methodologies, new tracking and reporting systems, and more. Traditional approaches to cost analysis and optimization simply do not apply to public cloud computing.

Table of Contents

Format: Paperback

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ISBN:

ISBN-10: 965572803X

ISBN-13: 978-9655728033

More Information

7.3 Transdisciplinary Systems Engineering: Exploiting Convergence in a Hyper-Connected World

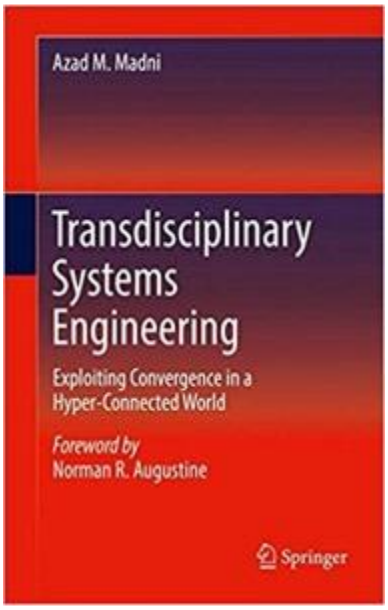

Image Source

by

Azad M. Madni

From the Amazon.com Website:

This book explores the ways that disciplinary convergence and technological advance are transforming systems engineering to address gaps in complex systems engineering: Transdisciplinary Systems Engineering (TSE). TSE reaches beyond traditional disciplines to find connections—and this book examines a range of new methods from across such disparate areas of scholarship as computer science, social science, human studies, and systems design to reveal patterns, efficiencies, affordances, and pathways to intuitive design. Organized to serve multiple constituencies, the book stands as an ideal textbook supplement for graduate courses in systems engineering, a reference text for program managers and practicing engineers in all industries, and a primary source for researchers engaged in multidisciplinary research in systems engineering and design.

Format: eTextbook, Hardcover, Paperback

Publisher: Springer; 1st ed. 2018 edition (October 7, 2017)

ISBN:

ISBN-10: 3319621831

ISBN-13: 978-3319621838

More Information

7.4 Tradeoff Decisions in System Design

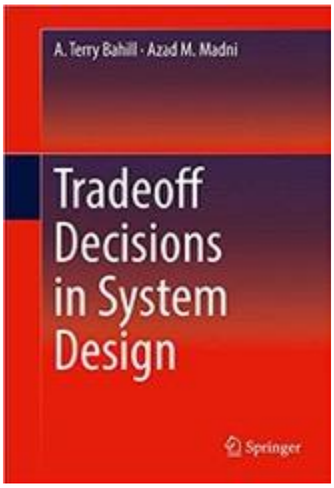

Image Source

by

A. Terry Bahill and Azad M. Madni

From the Amazon.com Website:

This textbook is about three key aspects of system design: decision making under uncertainty, trade-off studies and formal risk analyses. Recognizing that the mathematical treatment of these topics is similar, the authors generalize existing mathematical techniques to cover all three areas. Common to these topics are importance weights, combining functions, scoring functions, quantitative metrics, prioritization, and sensitivity analyses. Furthermore, human decision-making activities and problems use these same tools. Therefore, these problems are also treated uniformly and modeled using prospect theory. Aimed at both engineering and business practitioners and students interested in systems engineering, risk analysis, operational management, and business process modeling, *Tradeoff Decisions in System Design* explains how humans can overcome cognitive biases and avoid mental errors when conducting trade-off studies and risk analyses in a wide range of domains. With generous use of examples as a common thread across chapters this book.

Format: eTextbook, Hardcover, Paperback

Publisher: Springer; 1st ed. 2017 edition (December 16, 2016)

ISBN:

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ISBN-13: 978-3319437101

More Information

7.5 INSIGHT Practitioners Magazine

Volume 22 Issue 2

Editor's Note: Following is a summary of the contents of INSIGHT Practitioners Magazine, Volume 22, Issue 2 that contains several interesting articles concerning Product Line Engineering. Links are provided to access the articles. This issue also provides two book reviews of interest to senior systems engineers: First, Lawrence Pohlmann, a founding member of INCOSE, who passed away on July 3, 2019 after submitting his review of Advances in Manufacturing and Processing of Materials and Structures. This article was edited by Yoseph Bar-Cohen and had 67 contributing authors. Second, INCOSE Fellow Azad Madni's 2018 book that is highly relevant to the future of systems engineering, Transdisciplinary Systems Engineering: Exploiting Convergence in a Hyper-Connected World, with a forward by Norman R. Augustine.

***INSIGHT* Summary (by the *INSIGHT* Editor)**

INSIGHT is published in cooperation with John Wiley & Sons as a magazine for systems engineering practitioners. *INSIGHT's* mission is to provide informative articles on advancing the state of the practice of systems engineering. The intent is to accelerate the dissemination of knowledge to close the gap between the state of practice and the state of the art as captured in *Systems Engineering*, the Journal of INCOSE, also published by Wiley. The focus of the August issue of *INSIGHT* is Product Line Engineering. We thank Matthew Hause for originally proposing this PLE-themed issue and contributing several peer-reviewed articles that he co-authored. We thank Drew Stovall, work products chair of the INCOSE Product Line Engineering Working Group, who served as theme editor coordinating the selection and review of articles with strong support from other working group leaders: co-chairs Hugo Guillermo Chalé Góngora and Rowland Darbin; Paul Clemenents for outreach; Charles Kreuger, the ISO committee representative; and of course Matthew Hause, working group liaison for the transport domain as well as for the model-based systems engineering (MBSE) initiative.

- "Product Line Engineering Comes to the Industrial Mainstream" by Paul Clements defines PLE as "a systems engineering discipline to engineer a portfolio of related products in an efficient manner, taking full and ongoing advantage of the products' similarities while respecting and managing their differences. Managing a portfolio as a variable single entity, as opposed to multiple separate products, brings enormous efficiencies in production and maintenance." Paul's article shows how PLE matured in practice as demonstrated in the aerospace, defense, and automotive domains.

- "Where the Big Bucks Will Come From: Implementing Product Line Engineering for Railway Rolling Stock" by Hugo Guillermo Chalé Góngora and François Greugny presents a mid-term return of PLE experience in railroad rolling stock. They describe the journey to implement and structure PLE, with challenges and the manner to define a profitable reuse strategy.

- "The Best of Both Worlds: Agile Development Meets Product Line Engineering at Lockheed Martin" by Susan Gregg, Rick Scharadin, and Paul Clements details the introduction of large-scale agile development practices on one of that company's largest product line engineering efforts.

- "An Enterprise Feature Ontology for Feature-Based Product Line Engineering" by Charles Krueger and Paul Clements" documents the emergence and maturation of feature-based PLE based in an ontology for features that involves an automation-supported configuration of engineering and operations artifacts from across an enterprise to reflect the feature choices a product embodies.

- "Model-based Product Line Engineering-Enabling Product Families with Variants" by Matthew Hause and James Hummell brings MBSE using the Systems Modeling Language (SysML) and the Unified Modeling Language (UML) to model product lines in industry standard formats. These standards provide model-based product line engineering (MB-PLE), providing significant return on investment.

- "Decision-Driven Product Development" by Matthew Hause and Andreas Korff makes the case for adoption MB-PLE early in the development life cycle to identify cost savings and commonality and provide a natural means for product evolution. Orthogonal variability modeling (OVM) provides a natural decision set allowing engineers to perform trade-offs for specific customers and guide system development along the most effective route. The authors illuminate MB-PLE with automotive examples.

- "Model-Based Product Line Engineering to Plan and Track Submarine Configuration" by Matthew Hause and Jon Hallett explores the use of MBSE coupled with PLE and OVM to provide a means to plan, track, manage, and evaluate an individual submarine's configuration over time in the context of the ship class, whilst simultaneously highlighting the wider application in the submarine enterprise and beyond.

- "Model-Based Engineering and Product Line Engineering: Combining Two Powerful Approaches at Raytheon" by Bobbi Young and Paul Clements reinforces the mashup of MBSE and PLE. MBSE employs models as an integral part of a system's engineering stream, providing a formality and semantic rigor that lends itself to analysis and prediction, thus enabling earlier detection of problems. PLE is a way to engineer a portfolio of related products in an efficient manner, taking full advantage of the products' similarities while respecting and managing their differences.

We review two books in the August *INSIGHT*. Lawrence Pohlmann, a founding member of INCOSE, passed away on July 3 after submitting his review of *Advances in Manufacturing and Processing of Materials and Structures*, edited by Yoseph Bar-Cohen with 67 contributing authors. The book is tailored for engineers and scientists in diverse fields addressing state-of-the-art of manufacturing and processing methods in the digital era. Specific topics of particular interest to the reviewer include bio-fabrication and bio-inspired manufacturing techniques, manufacturing via 3D printing and 4D with functionality, medical applications for 3D printing, and guidelines for making ionic polymer-metal composite (IPMC) materials as artificial muscles.

The second book review by your editor is INCOSE Fellow Azad Madni's 2018 book that is highly relevant to the future of systems engineering, *Transdisciplinary Systems Engineering: Exploiting Convergence in a Hyper-Connected World*, with a forward by Norman R. Augustine. Madni takes on the growing convergence between engineering and other disciplines and how to exploit this convergence to enable transdisciplinary systems engineering. He defines transdisciplinary systems engineering as an integrative thematic discipline that reaches beyond engineering to other disciplines to identify and leverage new concepts and relationships that can potentially make complex system problems tractable and amenable to cross-disciplinary solutions. Madni envisions transdisciplinary systems engineering as a disruptive transformation of systems engineering into a broader, more inclusive discipline capable of addressing scientific and societal problems of national and global significance.

Feedback from readers is critical to the quality of *INSIGHT*. We encourage letters to the editor at insight@incose.org. Please include "letter to the editor" in the subject line. We hope you continue to find *INSIGHT*, the practitioners' magazine for systems engineers, informative and relevant.

Instructions for viewing

The entire issue of INSIGHT Volume 22, No. 2 is now available for viewing in the INCOSE Connect Library INSIGHT Practitioners Magazine (must be logged in to the INCOSE Website to use this link).

INSIGHT Volume 22 No. 2 will be available later on the Wiley Online Library.

Both of these options and instructions for accessing INSIGHT are available on the INCOSE website.

7.6 Object Management Group: Best Practices for Developing and Growing a Cloud-Enabled Workforce

The aim of this guide is to provide a practical reference to assist enterprise Information Technology (IT) managers and business decision makers with best practices for developing and growing a “cloud-enabled” next generation IT workforce.

Cloud computing and related technologies like blockchain, data science, and AI are transforming the nature of IT, resulting in skill shortages in some domains and staffing surpluses in others. Demand is increasing for cloud-knowledgeable solution IT architects, operations staff, and DevSecOps teams to apply cloud services and related technologies to these challenges for increased agility and efficiency.

Now that cloud computing is a mainstream initiative within most enterprises and large organizations, it is an opportune time to embrace training and knowledge-sharing.

This paper outlines:

- the business reasons for developing a skilled cloud-enabled workforce
- a strategic framework for meeting today's and tomorrow's skill needs
- best practices for cloud skills training, employee development and career growth
- a survey of available cloud training and certification programs

Read the paper here

7.7 Capability Maturity Model Integration V2

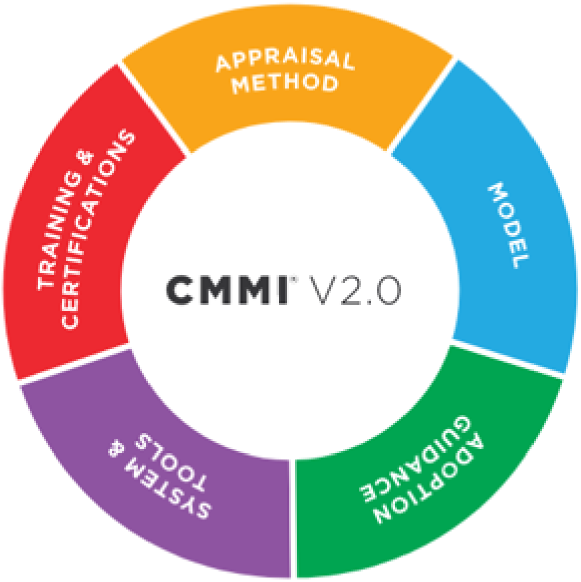

Image Source

Capability Maturity Model Integration (CMMI) is a process improvement training and appraisal program and service that was developed by Carnegie Mellon University (CMU) and is required by many DoD and U.S. Government contracts, especially in software development. CMU claims CMMI can be used to guide process improvement across a project, division, or an entire organization. (Wikipedia)

The CMMI Institute recently released V2.0 of the CMMI. Designed to meet the challenges of the changing global business landscape, CMMI V2.0 addresses business performance through building and benchmarking key capabilities.

In 2018, the CMMI Institute was acquired by ISACA, the global non-profit association helping professionals to realize the positive potential of technology. Both companies share a vision for advancing organizational performance across a spectrum of functions and industries.

The core of CMMI V2.0 is a set of global best practices organized by critical business capabilities which improve business performance. These critical capabilities address the challenges common to any organization, including:

- Ensuring Quality
- Engineering and Developing Products
- Delivering and Managing Services
- Selecting and Managing Suppliers
- Planning and Managing Work
- Managing Business Resilience
- Managing the Workforce

- Supporting Implementation
- Sustaining Habit & Persistence
- Improving Performance

More Information

8. EDUCATION AND ACADEMIA

8.1 Systems Engineering at the University of California Berkeley (USA)

The focus of the Systems Engineering Program is understanding complex large-scale systems and developing tools for their design and operation. Such systems encompass built elements in the broad sense (infrastructures transportation, structures, etc.), societal systems (social networks, populations enterprises), and natural systems (land water, air). These systems are at the core of Civil and Environmental Engineering of the 21st Century.

The understanding of how such systems work requires knowledge about the constitutive laws that govern them, such as traffic flow, fluid mechanics, structural mechanics, and smart networks. It also requires an understanding of the theoretical paradigms that are used to model, control and optimize such systems. These include the theories of computation, control theory, optimization, behavioral economics, sensor networks, statistics, and signal processing.

In response to these challenges, the Systems Program provides courses that cover both field knowledge and technical/theoretical tools. This is reflected in the curriculum. We offer masters and doctoral degree programs providing the key skills, e.g., technological, mathematical, or social scientific, as well as the knowledge for a broad range of engineering domains. Our graduates lead the next generation of research, start-ups, industrial corporations, and public-sector organizations.

The systems degree programs are flexible, and students can tailor their programs in consultation with a graduate adviser in any of a variety of areas of interest. Students have to get their curriculum approved by the Systems graduate adviser. Below are a few examples of the types of areas of interest that can be pursued.

- Computational Intelligence in Natural Systems
- Control Theory
- Energy Systems
- Intelligent Infrastructure
- Systems Reliability, Risk Assessment and Decision
- Intelligent Transportation Systems
- Mobile sensing

- Nano-seismology
- Smart Cities
- People in Complex Systems
- Water Informatics

This structure and its inherent flexibility enables the program to accommodate the needs of a diverse population of students. Students come from a wide variety of backgrounds: civil, mechanical and electrical engineering; physics, mathematics, computer sciences, architecture, economics, aerospace, and more. Graduates have gone on to leading positions in green consulting firms, various start-ups, NASA, companies such as Apple, Facebook, IBM, and Google, and major universities such as MIT, University of Michigan, University of Illinois, Georgia Tech, Purdue, Texas A&M.

More Information

8.2 Master's in Product and System Design at the

Norwegian University of Science and Technology (NTNU)

This Master's in Product and System Design at NTNU focuses on how to approach design when dealing with complex systems. The degree places a lot of emphasis on team work so that students gain experience with working in multidisciplinary teams in developing systems that are adaptable to change. The university collaborates with organizations such as Statoil and Systems to bring solutions to real problems such as designing efficient wind farms.

This program of study focuses on the design of ship equipment and maritime systems. Despite the focus on the maritime, the applied design methods are generic, and can be applied to other industries. The program is open to both international and Norwegian students.

You can contact NTNU student advisers by email: studier@iv.ntnu.no or telephone: (+47) 73 59 37 00 if you have any questions about the program.

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9. SOME SYSTEMS ENGINEERING-RELEVANT WEBSITES

Ptolemy Project – Cyber Physical Systems

This page provides a detailed concept map as well as access to valuable resources on cyber physical systems. Resources include talks on the intellectual challenge of cyber physical systems and work product from activities by CHESS (the Center of Hybrid and Embedded Software Systems).

https://ptolemy.berkeley.edu/projects/cps/

Project Management.com – Transformation Management

A blog by Rob Llewellyn containing several articles dedicated to managing transformation catering to project managers and managers in general. Taken from the site:

The digital economy has fueled executive appetite for transformation. This blog highlights the challenges and opportunities of orchestrating digital business transformation successfully. It covers a broad range of transformation topics—from digital business models and innovation, through to transformation mindsets and value creation.

10. STANDARDS AND GUIDES

10.1 Standards Topics at the National Institute of Standards and Technology (NIST) (USA)

The NIST provides a set of standards and guides on a range of topics, outlined below. To access the information available on each topic, click on a topic of interest.

Accreditation

Calibration services

Certification

Commercial standards

Conformity assessment

Documentary standards

Frameworks

Reference data

Reference instruments

Reference materials

Standards education

10.2 Standards and Governance Organizations for Cloud Computing

Cloud Security Alliance (CSA)

A not-for-profit organization with a mission to promote the use of best practices for providing security assurance within Cloud Computing, and to provide education on the uses of Cloud Computing to help secure all other forms of computing. The CSA is led by a broad coalition of industry practitioners, corporations, associations and other key stakeholders. Relevant guidance materials include:

- Security Guidance for Critical Areas of Focus in Cloud Computing v.3.0
- Cloud Controls Matrix v.1.2

European Network and Information Security Agency (ENISA)

The European Union's response to cybersecurity concerns. It is therefore a pacesetter for the security of information in Europe and a center of expertise. Their objective is to make ENISA's website the European hub for exchange of information, best practices, and knowledge in the field of information security. Relevant guidance materials include:

- Cloud Computing Risk Assessment
- Cloud Computing Information Assurance Framework

ISACA

An independent, non-profit, global association that engages in the development, adoption and use of globally accepted, industry-leading knowledge and practices for information systems. Relevant guidance materials include:

- IT Control Objectives for Cloud Computing
- Controls and Assurance in the Cloud: Using COBIT 5
- Cloud Computing: Business Benefits with Security, Governance and Assurance Perspectives.

11. SOME DEFINITIONS TO CLOSE ON

11.1 Virtual Desktop Infrastructure

In computing, a virtual desktop is a term used with respect to user interfaces, usually within the WIMP[3] paradigm, to describe ways in which the virtual space of a computer's desktop environment is expanded beyond the physical limits of the screen's display area through the use of software. This compensates for a limited desktop area and can also be helpful in reducing clutter.

11.2 Biomimicry

The imitation of natural biological designs or processes in engineering or invention.

Source: Merriam-Webster

3 In human–computer interaction, **WIMP** stands for "windows, icons, menus, pointer", denoting a style of interaction using these elements of the user interface. It was coined by Merzouga Wilberts in 1980. Other expansions are sometimes used, such as substituting "mouse" and "mice" for menus, or "pull-down menu" and "pointing" for pointer. Although the term has fallen into disuse, some use it as an approximate synonym for *graphical user interface (GUI)*. Any interface that uses graphics can be called a GUI, and WIMP systems derive from such systems. However, while all WIMP systems use graphics as a key element (the icon and pointer elements), and therefore are GUIs, the reverse is not true. Source: Wikipedia.

12. CONFERENCES AND MEETINGS

For more information on systems engineering related conferences and meetings, please go to our website.

The featured event for this edition is:

SERC Research Review

18-19 November, 2019 – Washington, DC, U.S.A

This two-day event unites the government, industry, and university systems engineering research community in order to share research progress and discuss the most challenging systems engineering issues facing the Department of Defense (DOD) as well as other federal departments and agencies.

Systems Thinking Workshop (Day 1)

SystemiTool is a systems thinking method and tool for mapping complex systems using "Systemigrams." This workshop will introduce the newly updated SystemiTool, as well as a look back over the past 30 years at systems thinking and Systemigrams.

NOTE: Registration for this workshop will be limited to the first 40 seats. Workshop attendees should bring their personal laptop in order to explore the full aspect of this tool.

SERC Doctoral Students Forum (Day 1)

The SERC Doctoral Students Forum (SDSF) provides an opportunity for SERC Doctoral Fellows and other doctoral students conducting highly relevant, systems engineering-related research at any of the SERC collaborating universities to present their research in an open forum.

SERC Sponsor Research Review (Day 2)

The SSRR program and sessions focus on the latest research results from SERC researchers aligned with emerging and critical sponsor research needs.

Program tracks include:

- Mission Engineering
- Digital Engineering Transformation
- AI/Autonomy and Systems Engineering
- System Security Engineering
- System Engineering for Velocity
- Human Capital Development

More Information

13. PPI AND CTI NEWS

13.1 CTI Pilots CSEP3D

PPI's subsidiary company, CTI (Certification Training International) has just added a 3-day INCOSE ASEP/CSEP exam preparation training course to its portfolio. The 5-day version of the course has been delivered over 100 times to almost 2000 delegates in over 32 countries and has an overall average score of 9.1 out of 10.

The major difference between the 5-day and the 3-day courses is that the 3-day course is focused solely on passing the exam while the 5-day version expands on this primary objective. The 5-day course contains activities and workshops to help integrate and apply the knowledge of the INCOSE Systems Engineering Handbook V4 (the sole subject of testing for the exam) to one's day job. The 3-day course is suitable for time- and resource-strained engineers looking to fast track the exam preparation required to get ASEP or CSEP certified.

The 3-day course was piloted in Melbourne in early October 2019 with superb results (the course was delivered by Clive Tudge – see 13.2 below). To find out more information about the 3-day or 5-day course or to request a CTI course in your city please contact rking@certificationtraining-int.com.

13.2 Clive Tudge Reaches 100!

Not years! It is with delight that we congratulate Clive Tudge on his 100th course delivered for PPI and CTI. Since June 2010, Clive has delivered 45 courses in Australia, 25 courses in Europe, 13 in the United States, 6 in the Middle East, 4 in South Africa, 4 in New Zealand and 1 each in Canada, Zimbabwe and China. We think this is quite an impressive catalog to have built up in this time and centennial celebrations are definitely in order. Well done, Clive!

13.3 Berlin Added to PPI's SE Training Program

PPI has just added Berlin to the list of cities having received systems engineering training or consultation with the company. This brings the total number of German cities in which PPI has delivered its SE training to 9. We look forward to adding more locations to our map in the next few months.

13.4 Robert Halligan and INCOSE Poland

PPI Managing Director Robert Halligan on 22 October was privileged to speak in Wroclaw to the Polish Chapter of INCOSE. Robert's topic was "**A Framework of Knowledge, Skills and Attitudes Conductive to High Performance Engineering".** The event, hosted at the Wroclaw University of Science and Technology by Polish Chapter President Aleksander Buczacki (center front in the picture, blue jacket), was attended by 35 engineers, engineering academics and students studying systems engineering at the University.

14. PPI AND CTI EVENTS

On-site systems engineering training is delivered worldwide throughout the year. Below is an overview of public courses. For a full public training course schedule, please visit https://www.ppi-int.com/course-schedule/

Systems Engineering 5-Day Courses

Upcoming locations include:

- Berlin, Germany (P006-790)

  14 Oct – 18 Oct 2019

Requirements Analysis and Specification Writing 5-Day Courses

Upcoming locations include:

- Pretoria, South Africa (P007-494)

  11 Nov – 15 Nov 2019

Systems Engineering Management 5-Day Courses

Upcoming locations include:

- San Francisco, California, USA (P1135-177)

  26 Dec – 06 Dec 2019

Systems Engineering Overview 3-Day Courses

Upcoming locations include:

- Chantilly, Virginia, United States of America (P884-15)

  09 Dec – 11 Dec 2019

Requirements, OCD and CONOPS in Military Capability Development 5-Day Courses

Upcoming locations include:

- Melbourne, Australia (P958-62)

  17 Feb – 21 Feb 2020

Engineering Successful Infrastructure Systems (ESIS5D)

Upcoming locations include:

- Las Vegas, Nevada, United States of America (P2005-3)

  02 Dec – 06 Dec 2019

Architectural Design 5-Day Course

Upcoming locations include:

- London, United Kingdom (P1768-23)

  11 Nov – 15 Nov 2019

CSEP Preparation 5-Day Courses (Presented by Certification Training International, a PPI company)

Upcoming locations include:

- Chantilly, Virginia, USA (C002-88)

  18 Nov – 22 Nov 2019

Medical Device Risk Management 3-Day Course

Upcoming locations include:

- San Francisco, California, United States of America (P1848-4)

  18 Nov – 20 Nov 2019

Other training courses available **on-site** only include:

- Project Risk and Opportunity Management 3-Day
- Managing Technical Projects 2-Day
- Integrated Product Teams 2-Day
- Software Engineering 5-Day

15. UPCOMING PPI PARTICIPATION IN PROFESSIONAL CONFERENCES

PPI will be participating in the following upcoming events. We support the events that we are sponsoring and look forward to meeting old friends and making new friends at the events at which we will be exhibiting.

INCOSE UK Annual Systems Engineering Conference 2019

(Exhibiting)

Date: 19 – 20 November, 2019

Location: Leeds, United Kingdom

The INCOSE International Symposium 2020

(Exhibiting)

Date: 18 – 23 July, 2020

Location: Cape Town, South Africa

Add

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