

The State-of-Practice of Systems Architecting: Where Are We Heading?

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1. Introduction

Seven companies and two institutes discussed the state-of-practice of systems architecting during a two-day forum. The objective of the forum has been formulated as follows:

The forum will have an emphasis on practical systems architecting and the application of architectural information and knowledge. The objective is to provide a venue for the exchange of practical experience in the realm of development, implementation and management of system and enterprise architectures. This shall in turn be a platform for the exchange of ideas for improved practices in the above areas as well as the goal-oriented use of architectural knowledge and information in various life cycle phases and enterprise functions.

Participants in the System Architecture Forum are selected to be non-competitive and from different domains. In this first meeting the following domains were present:

Defense, Government and Space systems, Power infrastructure, Healthcare equipment, Measurement equipment, Consumer electronics, Telecommunications and semiconductors. The representatives of the participating companies are either practitioners themselves or managers that have lots of practical experience.

While discussing the state-of-practice of systems architecting it becomes immediately clear that:

- Most companies are moving from discrete products to more integrated solutions - a systems view is of increasing importance
- Most companies seem to be taking increased responsibility of a larger portion of the life cycle of their products
- The discipline of systems architecting is not sharply defined.
- Systems architecting as a discipline can be recognized by sharing many practical examples.
- All companies are struggling with systems architectures.
- Most companies have recognized its importance, but it is often a difficult sell both upwards and downwards
- Most of the system architecting related problems and drivers were similar across all the participating companies
- Systems architecting is a young discipline with plenty of room for improvements.
- Capturing best practices and heuristics can trigger these improvements.

- Standards may further consolidate this know-how
- The use of tools for systems architecting is an area that triggers many discussions.

The forum participants have agreed that the research fellows from the initiating institutes will start the codification of systems architecting know-how by producing theme-based white papers and by capturing best practices and heuristics, based on the discussions during the forum.

2. Exploring the discipline of systems architecting

System architecting is applied recursively at multiple levels of abstraction. This can range from multiple systems and systems of systems at the enterprise level all the way down to subsystems and components. The forum pointed out that the focus is more business-oriented at the higher levels and more implementation and technology-oriented further down. The value of architecting and architectures, the role of the architect, and architectural descriptions are applicable at all of these abstraction levels.

2.1. Discussion on the value of architecting and architectures

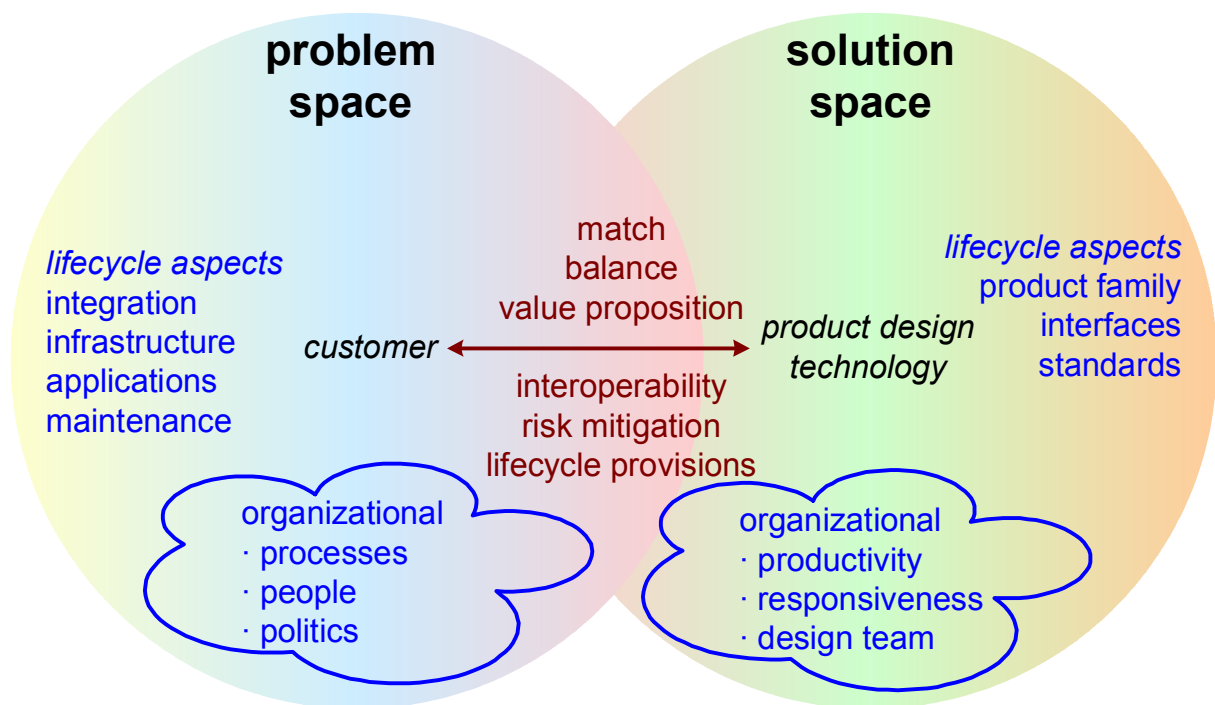


Figure 1. The Value Of Architecting.

The value proposition of architecting, visualized in Figure 1, is to connect the problem space (customer needs and constraints) with technology-based system design. An effective connection of problem and solution becomes increasingly valuable due to the increasing complexity of both spaces.

Architecting supports the customer lifecycle: ongoing integration of the customer environment, expensive and hence inert evolution of infrastructure, increasing application demands and operational needs (such as maintenance). Architecting supports the development lifecycle in the solution space: evolution and extension of product families, evolution and migration of interfaces and standards. Architecting is also crucial to support the organization: increased productivity and responsiveness and facilitating design teams.

The direct value of architecting is to connect solution space know-how with problem space understanding, and provide fundamental structure and guidance for development and implementation. The main elements of this connection are:

- Matching customer needs and constraints with technological possibilities
- Balancing multiple, often conflicting, customer requirements and determining a balanced product design direction
- Providing an architectural design for the product/system with a clear value proposition
- Providing a solution that interoperates well in the customer environment, now and in the future
- Detecting risks and designing measures to cope with these risks
- Lifecycle provisions in the product, both for the operational product life at the customer, as well as for the development lifecycle at the developing organization(s)

2.2. Discussion on the role of the architect

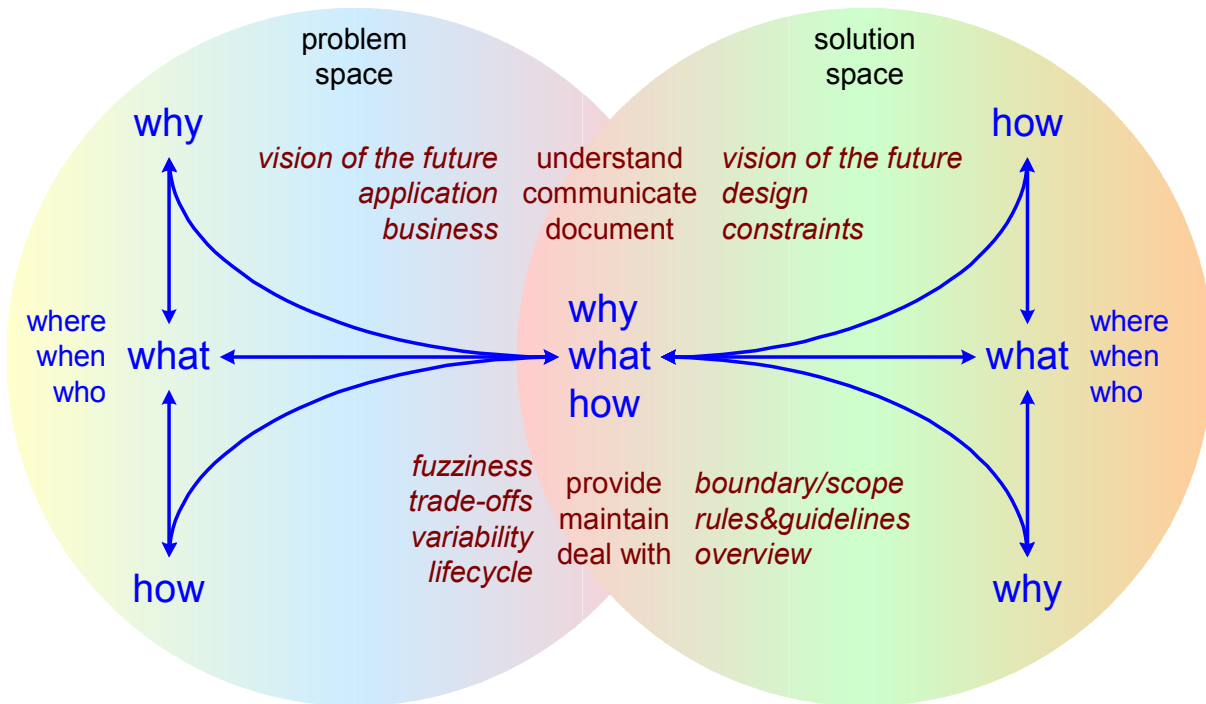


Figure 2. Role of the architect.

The role of the architect is visualized in Figure 2. Connecting *why*, *what* and *how* in the problem and solution spaces is core in the role of the architect. When we zoom in the following elements can be seen in the role of the architect:

- Understand how a design works and also why, both from a technical and business point of view
- Understand, describe and communicate relationships and interfaces
- Deal with “fuzzy” -ilities requirements and trade-offs
- Deal with variability in the design-parameter space.
- Be the pathfinder both from a technical and business standpoint
- Be aware of constraints the architecture puts on downstream design/implementation activities as well as business opportunities
- Provide, maintain and communicate a vision of the future
- Improve architectural understanding among upper management as well as the R&D team
- Define boundary/scope
- Provide rules and guidelines - driven by (explicit or implicit) overriding value proposition

- Communicate clearly, “up and down” senior architects more towards the business side, junior architects more to the technology side.
- Focus on the end result: a well functioning system in its context.
- Communicate and document the “why, what, how” and “when, where and who”, with an external as well as internal focus, considering the whole life cycle.

An interesting discussion when it comes to the role of the architect is the tension between creative synthesis and architectural standards and rules and more formally managed architectural assets. How much “artistic” freedom should the architect have? The discussion about creative synthesis resulted in the following statement that will be the first of a collection of best practice statements at

<http://www.architectingforum.org/bestpractices.shtml>:

One of several prerequisites for architecture creative synthesis is the definition of 5-7 specific key drivers that are critical for success, along with the rationale behind the selection of these items.

Another interesting aspect is the formal role and authority of the architect. What role and position does the architect have in the organization? To be effective, he has to be respected by the technical side and business side alike. Is this respect enough in itself, or will the architect need a more formal authority? In the latter case, how does he relate to an environment where there are several programs going on? Is architecting a “line-task”? Does each project have its own architect? How is a certain architectural style or consistency maintained? Does the architect split himself up between the different projects?

Is there ONE architect, or is “architect” a metaphor of an “emergent property” of whoever in the organization does architecturally relevant tasks and makes decisions that eventually result in the architecture of the system or product?

2.3. Discussion on the role of architectural descriptions and models and users of these

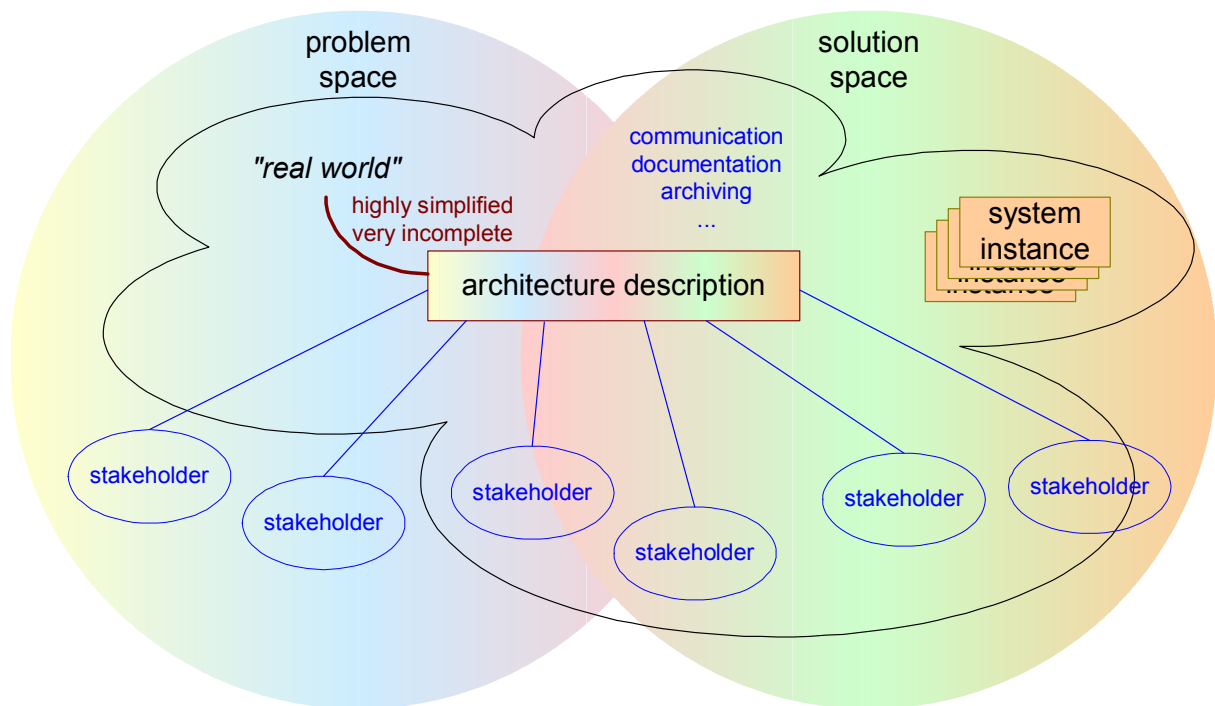


Figure 3. Role of Architecture descriptions.

The architect produces an architecture description to facilitate communication and as means for documentation and archiving, see Figure 3. Due to the complexity and size of the problem and solution spaces such a description has to be highly simplified. The description must capture the essence of the architecture. The notion of architecture description is elaborated in the ANSI/IEEE 1471 standard. This standard, shown in Figure 4, relates stakeholders with their concerns to the architecture description consisting of views and models.

The role of a system architecture description can be formulated as:

- Guiding and constraining framework
- Spanning from opportunity exploration via development, manufacturing to support and retirement
- Supporting communication and decision-making
- Providing an audit trail from problem/opportunity to solution

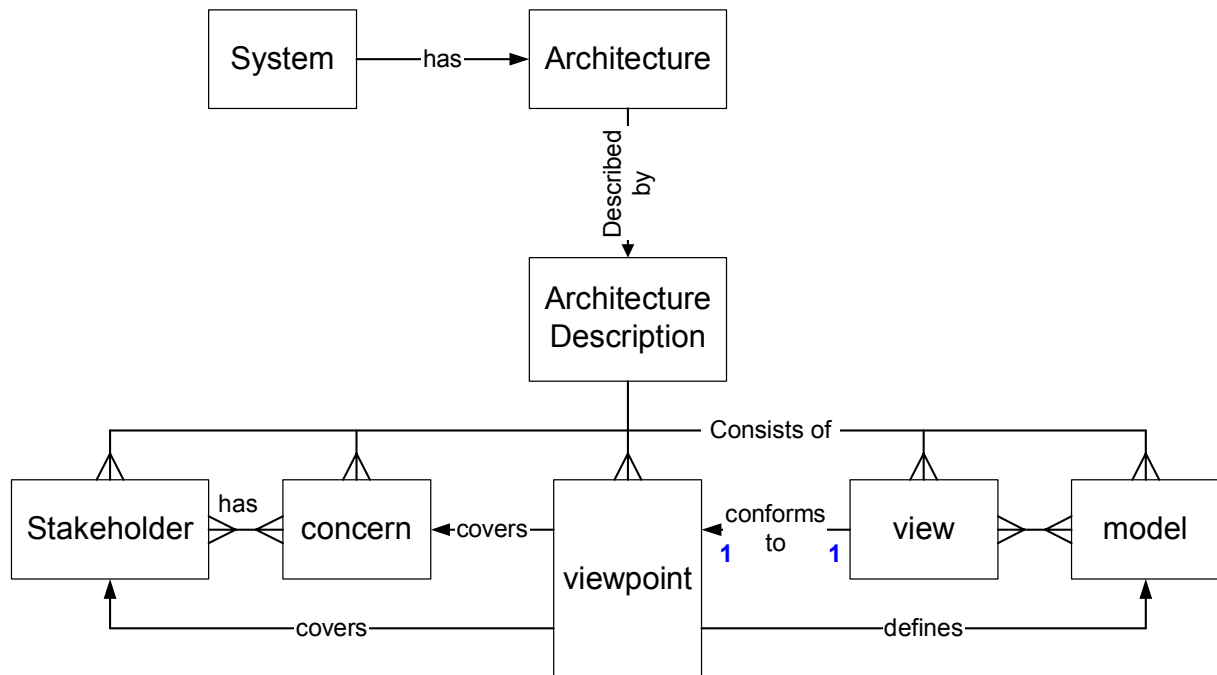


Figure 4. Simplified diagram of ANSI/IEEE 1471

Keywords for contents of the architecture description are:

- Partitioning
- Allocations
- Interfaces
- Relationships
- Interactions
- Multiple viewpoints

Figure 5 shows that architecture is broad, intangible and unbounded. The architect is only aware of part of the actual architecture. Parts of the architecture are captured in texts and diagrams in an architecture description.

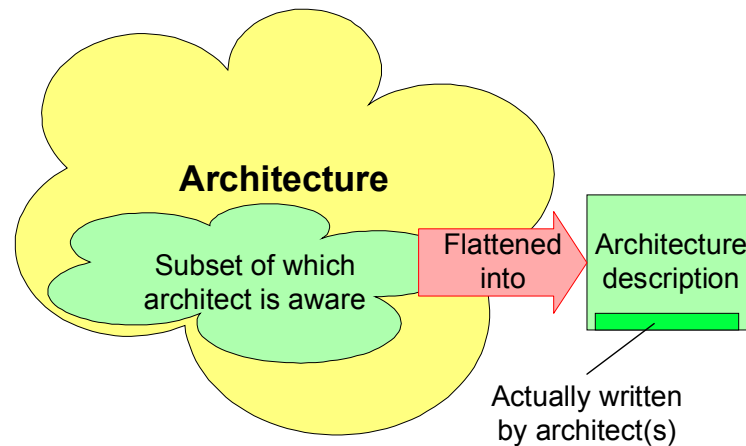


Figure 5. The Architect's Scope of Awareness.

3. Future needs for the improvement of the discipline

Figure 6 shows the outcome of the brainstorm question: "What is the needed future value of systems architecting?" The participants made an individual list before discussing the results in plenum. The results were afterwards clustered in the categories: business and market, architecture, process, people skills, and innovation and evolution.

It was quite remarkable that facilitating innovation and evolution were the most significant areas where systems architecting was perceived to provide future value. Architecting is seen as one of the main instruments to address flexibility, responsiveness, short time to market needed for innovation on one side, as well as guiding long product and development lifecycles, and get a handle on ever increasing legacy problems, many variations and configurations needed for evolution on the other side.

It is also remarkable that the category architecture itself, the main subject of architecting, is nearly empty! At conferences, such as INCOSE, it is clear that systems-of-systems, and the related interoperability of heterogeneous systems is a hot architecture topic. Probably this category scores low due to the focus on value in the brainstorm question.

Supporting business and market is the bottom-line goal of the architecting activity. It is clear that we can improve the current status quo of this support: more impact on the business, better communication with the customer, more strategic impact, better fitting products.

Architecting and processes are clearly related. Architecting and architectures should enable processes that are reliable, repeatable, support innovation, support collaboration and outsourcing. These processes must be sufficiently agile, but penetrate to any relevant detail.

Architecting and related processes must start early, long before an actual project has been started.

A great need for better and more architects is being seen. This requires more growth opportunities for architects. A need is signaled to be less dependent on experience. A concern is that more emphasis on architecting may result in *architecture overload* (like analysis paralysis in requirements engineering). The trend to more and more complex systems and systems of systems requires architects that can operate further from the realization and handle higher levels of complexity. This will also require enhanced skills with respect to communication with management and other stakeholders.

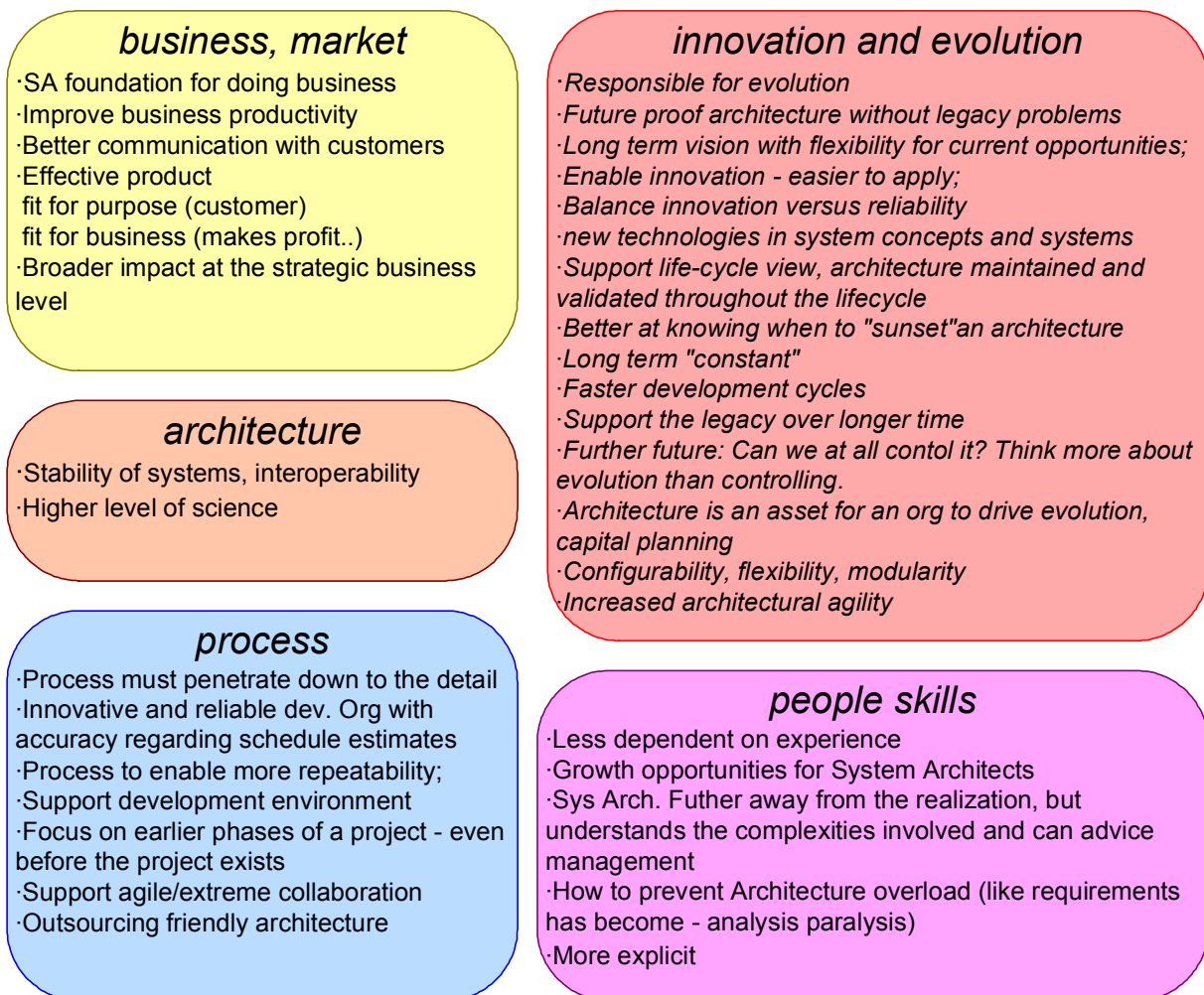


Figure 6 Results of Brainstorming Session

4. Conclusion

Systems architecting is recognized as a discipline that connects customer needs and constraints (“problem space”) with feasible technology-based solutions (“solution space”). The forum agreed that systems architecting will play an important role to handle the challenges of future complex adaptive systems. This discipline is still very young; its practitioners are experienced people who have grown into the job, and its methods are to a large extent based on heuristics, best practices and personal experience. It is one goal of the forum to capture and codify these. The exchange of experience between the practitioners from different domains provides an overview of the status quo of systems architecting.

The discussion about the future direction of the discipline of systems architecting sparks a lot of interaction about innovation and evolution. The general opinion is that systems architecting in the future will provide more support, and hence value, for both evolution as well as innovation.