

Chapter 13

Contexts and Challenges: Toward the Architecture of the Problem

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ABSTRACT

Historically, architecture has been about the structure of the solution, focused on the components that make up a system and the connectors which enable their coordinated interaction. Given this solution focus, systems, enterprise, and software architecture evolved in different directions. During the past 15+ years, architectural theory and practice have been undergoing a gradual, but significant, shift in focus. Five trends which highlight this shift are: decision rationale, challenges vs. requirements, systems-of-systems, contextual analysis, and design cognition. Each of these trends facilitates a necessary shift from the architecture of the solution to the architecture of the problem. In addition to enabling a clearer link between the problem and solution, these trends also help to unify systems, enterprise, and software architecture by providing a common foundation for collaboration on complex problems.

INTRODUCTION

This chapter discusses an evolution in architectural thinking which has been taking place over the past 20 years. The first section, titled Background, discusses trends in five areas of activity. The common denominator for these areas is the focus on a solution – on the creation of a solid architectural definition that can serve as the backbone of a system. None of these areas: decision rationale, design concerns, systems-of-systems, contextual analysis, and design cognition are considered

revolutionary. However, when combined, they shift architectural focus from the solution to the problem. The second section, titled Synthesis, discusses the synergy that results from the combination of these areas. Finally, the chapter concludes with discussions of Issues and Problems, Future Research Directions and Conclusions.

Two concepts are fundamental to this shift: context and challenges. In this chapter, the term context refers to a collection of stakeholders who share a similar set of perceptions, priorities, and desired outcomes and are subjected to a similar

set of forces. Challenge refers to a situation where one or more limiting factors make it more difficult to satisfy one or more value expectations.

These two concepts, in turn, lead to three important considerations. First, because value (unlike benefit) is subjective, challenges, priorities, risks and tradeoffs are inherently contextual, and the architect must treat context as a first-class concern. Second, the priority of challenges within a context needs to drive architectural decision making. Addressing the highest priority challenges first improves the quality tradeoffs and increases degrees of freedom. Third, while different contexts may pose similar challenges, frequently, the priorities of challenges vary among contexts. Tradeoffs between challenges in a context are often subordinate to tradeoffs between similar challenges across contexts.

The architecture of the solution is largely about resolving forces within a system. The architecture of the problem is about understanding contexts deeply and balancing the solution to overcome challenges both within and across contexts. While in theory, this may sound like a simple shift, in practice the impact is much more significant.

BACKGROUND

For over 20 years, enterprise, systems, and software architecture each have been making significant contributions to the development of complex systems that enrich our lives every day. These three disciplines share a similar mission, as evidenced by their common adoption of the architecture definition in IEC 42010 (2007, pg. 10), “the fundamental organization of a system embodied in its components, their relationships to each other, and to the environment, and the principles guiding its design and evolution.”

While these disciplines share a common mission, their focus and practice differ in important ways. Maier (2009, pg. 425) defines a system as “a collection of things or elements that, working

together, produce a result not achievable by the elements alone.”

These definitions of system and architecture lead to a broad view of systems architecture, as shown in Figure 1.

With its focus on managing business information and enabling business processes, enterprise architecture is a specialization of systems architecture according to problem focus. By contrast, with its focus on manipulating computational abstractions which represent real world entities, software architecture is a specialization of system architecture on a different axis: solution mechanism.

Software, systems and enterprise architecture intersect in the region where computational abstractions manage the storage and flow of business information and model the behavior of business processes and workflows. Realtime control systems, such as medical devices, automotive and avionics are areas where software and systems architecture overlap, with a somewhat lesser concern for enterprise architecture. However, all one need do is step outside the boundary of a medical device and strong evidence of electronic medical records and hospital information systems (enterprise architecture) will be present. Virtually the same statement can be made for any other realtime control system.

Areas where enterprise and system architecture overlap with a lesser influence of software architecture are more difficult to find. Complex networks, which on the surface, appear to be composed entirely of radio transmission, bundles of wire enclosed in cable, and computer hardware have significant amounts of software controlling transmission, routing, service provisioning, and error recovery. Similarly, the racks of server blades and RAID drives that make up most compute centers require complex operating system and device driver software to run.

So what this strongly suggests is that enterprise, systems, and software architecture are more alike and interdependent than it might seem. Yet, the

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