SYSE 505- Systems Architecture (SA)
Reading and Conference

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9/15/2012
Purpose of presentation

- To give an overview of the information gained during the Systems Architecture course.
- Transfer some knowledge to colleagues at KEO
- A way to say thank you to KEO for funding my studies.
Presentation Overview

- Section 1: What is Systems Architecture?
- Section 2: ConOps
- Section 3: Function to Form: notes from MIT OCW Course on Systems Architecture
- Section 4: Frameworks: DoDAF
Section 1: Systems Architecture

- What is systems architecture?
- A good answer to this question was found in:
  - “The Art of Systems Architecting”
    - Mark W. Maier, Eberhardt Rechtin
    - ISBN: 1420079131
- So what did The Art of Systems Architecting book teach us about systems architecting?
  - The differences between systems engineering and systems architecting.
  - The architectural paradigm
  - Heuristics as tools
  - Modeling methodologies
Section 1: The Art of systems Architecting

The differences between systems engineering and systems architecting:

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<thead>
<tr>
<th>Engineering</th>
<th>Architecture</th>
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<td>Engineering deals almost entirely with measurable using analytic tools derived from mathematics and hard science,</td>
<td>Architecting deals largely with un-measurable using non-quantitative tools and guidelines based on practical lessons</td>
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<td>Engineering is deductive.</td>
<td>Architecting is inductive</td>
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<td>Engineering is concerned with quantifiable costs.</td>
<td>Architecting is concerned with qualitative worth.</td>
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<td>Engineering aims for technical optimization.</td>
<td>Architecting aims for client satisfaction.</td>
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<tr>
<td>Engineering is more of a science</td>
<td>Architecting is more of an Art.</td>
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Section 1: The Art of systems Architecting

The Systems Architecture paradigm Part 1

- Architecting deals with ill-structured situations where neither goals nor means are known with much certainty.
- The requirements for the system have not been stated more than vaguely, and the architect cannot appeal to the client for a resolution as the client has engaged the architect precisely to assist and advise in such a resolution.
- Good architecture and good engineering are both the products of art and science. The weight will fall on heuristics and art during architecting.
- The nature of classical architecting changes as the project moves from phase to phase:
  - In the earliest phases of a project, it is a structuring of an unstructured mix of dreams, hopes, needs, and technical possibilities when what is most needed has been called an inspired synthesizing of feasible technologies. It is a time for the art of architecting.
  - Later architecting becomes an integration of, and mediation among, competing subsystems and interests.
  - Finally there comes certification to all that the system is suitable for use.
Section 1: The Art of systems Architecting

The architecture paradigm summarized:

• The architect is principally an agent of the client, not the builder.
• The architect works jointly with the client and builder on problem and solution definition. Systems requirements are an output of architecting, not really an input.
• The architect’s product, or “deliverable” is an architecture representation a set of abstracted designs of the system
• The architect’s product covers physical structure, behavior, cost, performance, etc.
• An initial architecture is a vision.
Section 1: The Art of systems Architecting

- Heuristics as tools
- An approach to a problem using guidelines, abstractions, and pragmatics generated by lessons learned from experience;
- Heuristic has a Greek origin meaning – “to find a way” or “to guide” in the sense of piloting a boat through treacherous shoals.
- Example heuristics:
  - Don’t assume that the original statement of the problem is necessarily the best, or even the right one.
  - In partitioning, choose the elements so that they are as independent as possible; that is, elements with low external complexity and high internal complexity.
  - Simplify, simplify, simplify
  - Build in and maintain options as long as possible in the design and implementation of complex systems. You will need them.
Section 1: The Art of systems Architecting

- Modeling methodologies:
- Models are the primary means of communication with clients, builders, and users; models are the language of the architect.
- Models used for communication become documentation of decisions and designs and, thus, vehicles for maintaining design integrity.

*Models, viewpoints, and views*
- There are three terms that are important in setting up a modeling framework:
  - A **model** is an approximation, representation, or idealization of selected aspects of the structure, behavior, operation, or other characteristic of a real-world process, concept, or system.
  - A **view** is a representation of a system from the perspective of related concerns or issues.
  - A **viewpoint** is a template, pattern, or specification for constructing a view.
Section 2: ConOps

- ConOps: What are ConOps?
  - Definition
  - Purpose
  - How to create ConOps
Section 2: ConOps

- ConOps Definition:

- IEEE 1362-
  - A ConOps is a user-oriented document that describes system characteristics for a proposed system from the users’ viewpoint.
  - The ConOps document is used to communicate overall quantitative and qualitative system characteristics to the user, buyer, developer, and other organizational elements.
Section 2: ConOps

- **ConOps Purpose:**

- The ConOps approach provides an analysis activity and a document that bridges the gap between the user’s needs and visions and the developer’s technical specifications.

- **In addition, the ConOps document provides the following:**
  - A means of describing a user’s operational needs without becoming bogged down in detailed technical issues
  - A mechanism for documenting a system’s characteristics and the user’s operational needs in a manner that can be verified by the user without requiring any technical knowledge beyond that required to perform normal job functions.
  - A place for users to state their desires, visions, and expectations without requiring the provision of quantified, testable specifications.
Section 2: ConOps

How to create ConOps:
Jack Ring says:
- By discovery of the problematic situation
- preparation of a meaningful artifact,
- verification that the artifact is fit for purpose and valuation of the worth of the artifact to those informed and guided by the artifact.

A ConOps is best prepared in four steps:
- (20% effort) examine the interplay between stakeholders and their problematic situation.
- (50% effort) key tensions between the ‘as is’ and ‘desired’ situation are resolved or, preferably, dissolved. Considering the key tensions helps the stakeholders discern the degree of challenge inherent in their desires thus tempers their demand.
- (35% effort) the whole system view of the stakeholders is elaborated – problem system- intervention system relationships
- (15% effort) producing, presenting, and ensuring that the ConOps artifact is effectively communicated.

What documentation standards are available?
- the ConOps document described by IEEE 1362 is very similar to the operational concept description (OCD) in MIL-STD-498.
- It is also very similar to the OCD included in J-STD-016-1995.
- ConOps are sometimes called OCD.
Architecture according to this course is the details of assignment of function to form, and the definition of interface and structure.

- A Function is Related by Concept To Form

Where:

- **Form** = **Elements** + **Structure**
- **Concept** = a vision, idea, notion, metal image. Includes principals of operation and abstraction of FORM, again it is a mapping between the form and function.
- **Structure**: The arrangement of and relations between the parts or elements of something complex
- **Functions** = what the system does.
- **Elements** = the parts, components, subsystems, etc
Section 4: DoDAF

- Department of Defense Architecture Framework (DoDAF)
  - The purpose of DoDAF?
  - What does DoDAF consist of?
  - How to use DoDAF
The purpose of DoDAF:
- Defines a common approach for DoD architecture description, development, presentation, and integration for both war fighting operations and business operations and processes as DoD moves toward net centric operations and warfare.
- DoDAF is used throughout the life cycle of the project to standardize, structure and integrate the approach.
What does DoDAF consist of?

**Viewpoints and models** – The viewpoints and models are a method to allow for focus on specific areas of interest while maintaining the bigger picture and presenting the information in a consistent manner.

There are multiple view points each with their own focus.

Examples of viewpoints in DoDAF v2.0 include:

- **All Viewpoint** – provides information which pertains to the entire architecture description rather than an acute viewpoint.

- **Capability Viewpoint** - addresses concerns of capability portfolio managers, specifically it describes capability classification and evolution. This allows for incremental acquisition and introduction of capabilities.

- **Data and Information Viewpoint** - details the data relationships and structure in the architecture. The information requirements are rules are portrayed in these viewpoints. This viewpoint is divided into three levels of abstraction which relate to the three models. Those levels are conception, logical, and physical

- **Operational Viewpoint** - describes operational scenarios, activities, tasks required to conduct operations, this should be independent of material.

- **Project Viewpoint** - describes how programs, projects, portfolios, or initiatives deliver capabilities, the organizations contributing to them, and dependencies between them.
How to use DoDAF:

1. Determine the intended use of the architecture
2. Determine the scope of the architecture
3. Determine the characteristics to be captured
4. Determine views and products to be built
5. Gather data and build the required products
6. Use architecture for intended purpose
Thank you!

Questions?

Next Class: SYSE 506- Masters Project