Experience with the Architecture Improvement Workshop

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I've Evaluated My Architecture. Now What?

You sold me on doing an ATAM evaluation of my architecture.

The "Architecture Paratroopers"

- landed
- did an ATAM evaluation
- gave me a list of risks
- pulled out

What do I do with this information?

Answer: Conduct an Architecture Improvement Workshop.

Agenda

The ATAM and its Outputs
The Architecture Improvement Workshop
Some Experiences with the Architecture Improvement Workshop
Extensions to the Architecture Improvement Workshop
Conclusion

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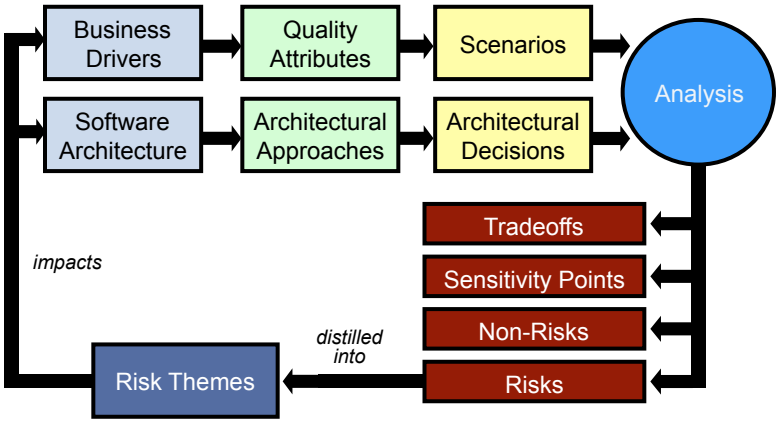
Conceptual Flow of the ATAM



Outputs of an ATAM Evaluation

The outputs of an ATAM evaluation include

- a utility tree
  - a hierarchical view of important system qualities including operational definitions of what these qualities mean
- a set of stakeholder-generated scenarios
  - describing how the architecture responds to important system uses, including those that stretch or expand the design space
- sets of risks, non-risks, tradeoffs, and sensitivity points
- a set of risk themes that summarize the risks and their impact the system's mission or business drivers
- better communications among stakeholders
- (often) better software architecture documentation

These serve as key inputs to the Architecture Improvement Workshop.

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Comparison of AIW and E²AIW

Focus: Improve architecture in near term

AIW

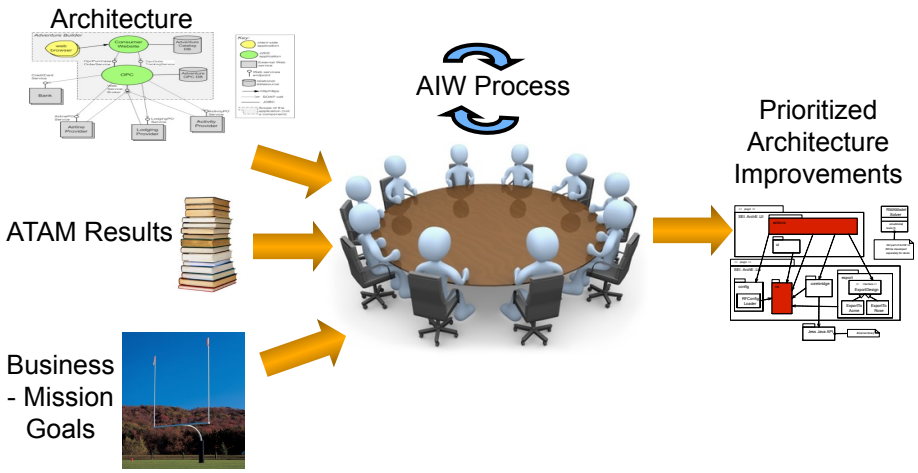
1. Review *business goals*.
2. Review *utility tree, scenarios*.
3. Complete the analysis of any critical *scenarios*.
4. Brainstorm *architectural strategies*.
5. Analyze proposed *architectural strategies*.

Focus: Position architecture for improvement in a less-certain future

E²AIW

1. Characterize *business goals* and constraints.
2. Characterize *quality attribute scenarios*
3. Characterize *quality attribute scenario utility* and *uncertainty*
4. Brainstorm *architectural options*.
5. Associate an "Expected Value-for-Cost" measure with *architectural options.*

Overview of the Architecture Improvement Workshop (AIW)



Conducting an AIW

Participants

- architect
- additional key technical and managerial stakeholders (just a few)
- facilitator, recorder

Steps

1. Review business goals
2. Review utility tree and scenarios.
3. Complete the analysis of critical scenarios.
4. Brainstorm architectural strategies.
5. Analyze proposed architectural strategies.

Can package into about 2 days

- Steps 1-4 conducted in one session
- (optional break for off-line confirmation of priorities, investigation of details)
- Step 5 conducted in one session

Steps 1 – 3: Review, Refine Key ATAM work

1. Review Business Goals
2. Review Utility Tree, Scenarios
3. Complete the analysis of any critical scenarios

Didn't I already do this during the ATAM?

Yes, but

- It may have been awhile since the ATAM.
- Sometimes in the rush to complete the ATAM some things may be less polished than they need to be for more detailed work.

Participants should do this review prior to the AIW and come prepared to refine as necessary.

Step 4: Brainstorm Architectural Strategies

i. Review the high priority scenarios from the ATAM. With these in mind brainstorm a list of architectural strategy options that might address issues in one or more of the scenarios.
ii. Cluster, refine, and prioritize the options.
iii. For each option record:
   - an identifying name, a high level description, business drivers, applicable scenarios, qualities and concerns
   - postulate a set of tactical decisions to address the option
   - identify the components impacted and how
   - identify any constraints, assumptions, and derived requirements
   - defer more detailed analysis.

ADVICE: Don't get bogged down on identifying details. Make an action item list to identify any necessary off-line work.

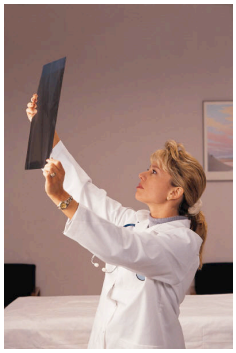
Off-line Work Between Sessions

Address any action items.

Complete option details, particularly

- scenarios affected by the design options
- impact on the scenario if the design option is implemented

Confirm or adjust priorities.



Step 5: Analyze Proposed Architectural Strategies

Discuss each architectural strategy option in priority order in detail.

Make rough effort/cost estimates if possible to help prioritize.

ADVICE:

- While an in-depth discussion is appropriate, again use an action item list to avoid bogging down.
- Remember the purpose is to provide sufficient insight to the architect and managers to proceed.

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SSNAM: Space Surveillance Network Analysis Model - Overview

SSNAM is

- part of a space-sensor force-structure decision process
- uses a high-fidelity simulation model to assess operational impact of changes to the space sensor network (SSN)
- uses operational code to produce credible results

SSNAM is very complex to set up and run.

- takes 16-18 hours to run in a lower fidelity mode on a 16-PC cluster
- takes 4-5 days to run in high fidelity mode on a 16-PC cluster
  - or about 1 day on the MHPCC (Maui High Performance Computing Center) 50-node Hoku cluster

Business / mission goals for upgrading SSNAM

- increasing the ease of use
- making it easier for government personnel to run the system without contractor support
- improve understandability of the output
- decreasing run-time
- decreasing time to incorporate new sensor models

SSNAM Improvement Examples - 1

Many high-priority scenarios pointed to reliability problems. Failures could occur at a number of points and cause the loss of an entire run.

The process led to the design option named “check-point restore framework.”

Analysis revealed that in addition to comprehensive changes, there were several opportunities for immediate, inexpensive improvements (“low hanging fruit”).

Improved heartbeat monitoring and status polling was implemented.

Results

- Better status reporting has led to earlier error detection and recovery, and better machine utilization.
- Most failures (typically environmental) that are out of the control of the SSNAM team have been mitigated.
- Failure recovery to the previous simulated day is now possible without the performance impact of check-pointing

SSNAM Improvement Examples - 2

Other architecture improvements were identified along with cost estimates and were prioritized for future implementation. These included architectural restructuring to

- remove redundant computations
- add front-end data preparation tools to reduce busted runs
- provide better back-end analysis tools
- build generic sensor models to allow more rapid network composition analysis

Bottom Line:

- The Air Force Space Command customer, the supporting contractor, and their collaborators at the High Performance Computing Software Applications Institute for Space Situational Awareness (HSAI-SSA) were all very happy with the process and the results.

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E²AIW

1. Characterize *business goals* and constraints.
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Extended Evolutionary AIW (E^2AIW)

We are now working on E^2AIW: An Extended Evolutionary Architecture Improvement Workshop

An E^2AIW considers both evolution (multiple future states), as well as multiple possible characterizations of each state, according to the *uncertainty* surrounding each.

In response to these future states the E^2AIW proposes *architectural options* and a way of characterizing the costs, benefits, and uncertainty of each.

E^2AIW Steps

1. Characterize Business Goals and Constraints
2. Characterize Quality Attribute Scenarios
3. Characterize Quality Attribute Scenario Utility and Uncertainty
4. Brainstorm Architectural Options
5. Associate an “Expected Value-for-Cost” measure with Architectural Options

1. Characterize Business Goals and Constraints

What is the future value of moving to a more flexible architecture today? Can it help to contain future costs, for example?

Some possible future states to consider:

- increase in number of users and new types of users?
- increase in number of information resources and types?
- increase in number of new types of systems and interactions among systems? New missions? Modifications to missions from doctrinal changes?

1. Characterize Business Goals and Constraints

Delineate the constraints under which the proposed evolution will take place, for example:

i. COTS
ii. Budget
iii. Schedule
iv. Legacy systems
v. Legacy interfaces

2. Characterize Quality Attribute Scenarios

Conduct an *extended* QAW to

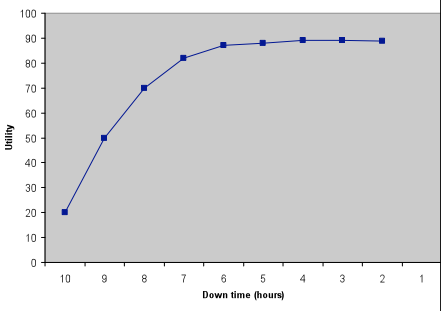
i. understand and characterize the base state in terms of QAs
ii. brainstorm scenarios representing future states: interoperability, performance, portability, availability, security scenarios, etc.
iii. group similar/related scenarios
iv. attempt to enumerate future states in terms of groups of the most important QA requirements

An extended QAW collects multiple response goals for each scenario.

3. Characterize Quality Attribute Scenario Utility and Uncertainty - 1

Associate "utility" with the current state and with the requirements of future states in terms of response goals, e.g.

- how useful it is to accommodate a technology insertion in 6 person weeks? 4 weeks? 1 week?
- how useful is it to have an average latency in degraded communications mode of 2 seconds? 1 second? 0.5 seconds?



3. Characterize Quality Attribute Scenario Utility and Uncertainty - 2

Characterize the "envelope of uncertainty".

- such a characterization will be accomplished using Likert scales; no attempt at precisely capturing uncertainty will be made at this stage.

Prioritize the scenarios according to expected Δutility

4. Brainstorm Architectural Options - 1

Consider *architectural options* that address the high priority QA scenarios representing future states (the "evolution" scenarios)

Determine the expected response levels of each architectural option with respect to the scenarios

i. these "expected" levels may be determined by: estimation, guesses, analogy, analysis, prototyping/experiments, qualification/certification

ii. along with each determination, attempt to assess the degree of uncertainty of the estimate, even if this is crude (e.g. a guess is more uncertain than a paper-and-pencil analysis, which is more uncertain than prototyping/experiments)

4. Brainstorm Architectural Options - 2

Estimate the cost of each architectural option

Consider *portfolios* of architectural options, including a consideration of the side-effects of architectural options in terms of both costs and benefits

5. Associate an "Expected Value-for-Cost" measure with Architectural Options

For each option, the potential future states, along with their uncertainty, can be used to calculate an expected value.

For each option, estimate the cost, along with its envelope of uncertainty

- both up-front and ongoing costs will need to be elicited as these may distinguish among the architectural options.
- on-going costs may be split into base costs and the costs of exercising options.

Make Decisions

Decisions (choosing a staged set of architectural options) can now be undertaken that take into account future states, response levels, costs, and uncertainty.

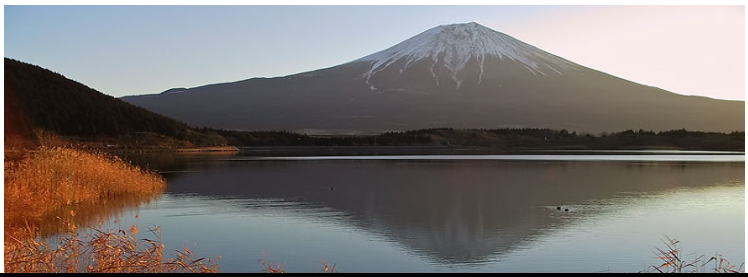
This will require iterating on steps 4-5 as architectural options will have dependencies that will influence their costs and benefits.

Reflection

The E^{2}AIW is a “heavier” method than the AIW.

It must be so, for it is attempting to make an architecture “future-proof” and that is a complex task with many variables and much uncertainty.

However, it is grounded in proven existing techniques: the AIW, the CBAM, and the theory of real options.



Status

The AIW is road-tested and can be applied anywhere that an ATAM can be applied.

The E^{2}AIW is now in the process of moving from the lab to the field.

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Appendix

AIW Brainstorm Template

Option Name			
Business Goals Addressed			
Technical Description			
Scenarios Affected	**Scenario**	**Attribute/Concern**	**Impact**
			Current State:
			Option Impact:
	. . .	. . .	. . .
			. . .
Components Affected	**Component**		**How Affected**
	. . .		. . .
Constraints			
Assumptions			
Derived Architectural Requirements			

AIW Analysis Template

Option Name			
Business Goals Addressed			
Technical Description			
Scenarios Affected	**Scenario**	**Attribute/Concern**	**Impact**
			Current State:
			Option Impact:
			. . .
	. . .	. . .	. . .
Components Affected	**Component**		**How Affected**
	. . .		. . .
Constraints			
Assumptions			
Derived Architectural Requirements			
Testing Required			
Risks			
	. . .		
Est. Cost			
Est. Time to Complete			

Utility Curve Elicitation Template

Scenario	Votes	Utility Scores for Response Measure Goals				
			Worst	Current	Desired	Best
1		Response Measure Goal				
		Utility				
2		Response Measure Goal				
		Utility				
3		Response Measure Goal				
		Utility				
4		Response Measure Goal				
		Utility				

Expected Response / Architecture Strategy Template

AS	AS Name	Scenarios Affected	Current Response	Expected Response
1		1		
		2		
		3		
		4		
2		1		
		2		
		3		
		4		
3		1		
		2		
		3		
		4		

Benefit Calculation Template

AS	Scenario	Benefit Δ Utility = Utility $_{expected}$ – Utility $_{current}$	Votes	Normalized Benefit (Benefit x Votes)	Total Benefit Σ Scenario $_{Normalized\ Benefit}$
1	1				
	2				
	3				
	4				
2	1				
	2				
	3				
	4				
3	1				
	2				
	3				
	4				

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