ARCHITECTURE EVALUATION = RISK ASSESSMENT

- Suzanne Barber and Tom Graser

Why Evaluate an Architecture?

- Find problems early!!!!
- Remember architecture specifies
  - Components, relations, rationale
  - Sets the blueprint for
    - Configuration control libraries
    - Schedules
    - Budgets
    - Performance goals
    - Team structure
    - Documentation organization
    - Testing
    - Maintenance

Who's Involved in Architecture Evaluations?

☐ Evaluation team

☐ Stakeholders

  ❑ Vested interested in the architecture and the system built from that architecture

  ❑ Empowered to make decisions

  ❑ Project decision makers

    ▪ Can expend resources to affect change

    ▪ Typically not project staff that may lack objectivity

    ▪ Architect, component designers, project management

Architecture Evaluation Results

- Answers one of two types of Suitability Questions
  - Is this architecture suitable for the system for which it was designed?
  - Which of two or more competing architectures is the most suitable one for the system at hand?

- Suitability depends on:
  - Quality Goals: Does the architecture meet the designated goals?
  - Resources: Can the system be built with the allocated resources (people, schedule/time, budget)?
  - NOTE: if the client can not provide quality goals, then any architecture will do!!!

Methods and Attributes under Evaluation

Evaluation Method	Focus on Quality Attributes
SAAM	Modifiability (portability, subsetability, variability)
ARID	Suitability of design
ATAM	Not oriented to any particular quality, but historically emphasis on modifiability, security, reliability, and performance

A Risk statement includes the Risk, the Impact, the Consequences and the Rationale.

□ The rules for writing business log modules in the second tier of your three-tier client –server style are not clearly articulated (*a decision that has not been made*). This could result in replication of functionality, thereby compromising modifiability of the third tier (*a quality attribute response and its consequences – The What is impacted*). Unarticulated rules for writing the business logic can result in unintended and undesired coupling of components (*rationale for the negative effect – Why it matters*).

A Nonrisk

□ Assuming message arrival rates of once per second, a process time of less than 30 msec, the existence of one higher priority process (*the architectural decisions*), a one-second soft deadline seems reasonable (*the quality attribute response and its consequence – The What is impacted*) since the arrival rate is bounded and the preemptive effects of higher priority processes are known and can be accommodated (*the rationale – the Why it matters*).

Additional Evaluation Output from ATAM

☐ Approach-and Quality-Attribute-Specific Analysis Questions

☐ Sensitivity Points and Tradeoff Points

- ❑ Component property critical for achieving particular quality attribute response
  - ▪ Level of confidentiality in virtual private network might be sensitive to the number of bits of encryption
  - ▪ Latency for processing an important message might be sensitve to the priority of the lowest priority process involved in handling the message
  - ▪ Average number of person-days of effort it takes to maintain a system might be sensitive to the degree of encapsulation of its communication protocols and file formats
  - ▪ Level of encryption might improve security but increase processing time

Benefits of Architecture Evaluation

- Puts stakeholders in the same room
- Forces an articulation of specific quality goals
- Results in prioritization of conflicting goals
- Forces a clear explication of the architecture
- Improves the quality of architectural documentation
- Uncovers opportunities for cross project reuse
- Results in improved architecture practices

Costs of Architecture Evaluation

- Personnel Costs
- Opportunity Costs
- Costs are reduced for:
  - Reuse of "canonical scenarios" when building many systems in a domain

ATAM – A Method for Architecture Evaluation

ATAM Overview

- The Architecture Tradeoff Analysis Method
  - Reveals how well architecture satisfies quality goals
  - How goals interact
  - Draws inspiration from
    - Notion of architectural styles
    - Quality attribute analysis communities
    - Software Architecture Analysis Method (SAAM)

ATAM Phase 0 Activities

- Evaluation team is created and a partnership is formed between the evaluation organization and the organization whose architecture is to be evaluated
- Evaluation team roles and responsibilities:
  - Team leader
  - Evaluation leader
  - Scenario scribe
  - Proceedings scribe
  - Timekeeper
  - Process observer
  - Process enforcer
  - Questioner

ATAM Steps

- Phase 1: Presentation
  - exchanging information through presentations
- Phase 2: Investigations and analysis
  - Assessing key quality attribute requirements vis-avis architectural approaches
- Phase 3: Testing
  - Checking the results to date against the needs of all relevant stakeholders
- Phase 4: Reporting
  - Presenting the results of ATAM

Phase 1: Presentation

ATAM Step 1: Present the ATAM

- Objective:
  - Evaluation leader presents ATAM process to stakeholders
    - Elicitation and analysis techniques: utility generation, architecture approach-based elicitation and analysis, scenario brainstorming and prioritization
    - Evaluation outputs: prioritized scenarios, evaluation questions, prioritized driving architectural requirements, set of architectural approaches, risks/nonrisks, sensitivity points and tradeoffs

ATAM Step 2: Present the Business Drivers ...The Requirements and Constraints

- ☐ <u>Objective:</u>
  - ◻ Project decision maker (PM or system's customer) presents system overview from business perspective
    - ◼ Description of business environment, history, market differentiators, driving requirements, stakeholders, current needs and how the proposed system will meet those needs
    - ◼ Description of business constraints (e.g. time to market, customer demands, standards, costs, etc)
    - ◼ Description of technical constraints (e.g. COTS, interoperation with other system, required HW or SW platforms, reuse of legacy code, etc)
    - ◼ Quality attribute requirements and driving business needs
    - ◼ Glossary

ATAM Step 3: Present the Architecture

- <u>Objective:</u>
  - Lead architect presents architecture at "appropriate level"
    - Level of detail depends on degree to which architecture has been designed, time available, and requirements under consideration
    - Issues:
      - Technical constraints such as OS, HW, or middleware
      - Other systems with which system must interact
      - Architectural approaches for meeting quality reqs.
    - Present using appropriate views (functional, concurrency, physical)
  - Evaluation team begins to determine architectural approaches

Phase 2: Investigation and Analysis

ATAM Step 4: Identify the Architectural Approaches

- <u>Objective:</u>
  - Explicitly name identifiable approaches (e.g., styles, or heuristics) used that address quality attributes
    - Component types and topology (resulting from BB)
    - Pattern of data and control interactions
    - Technology Choices
  - Styles differentiate classes of designs by offering experiential evidence of how each class has been used with qualitative reasoning to explain why each class has certain properties and when to use it
    - Attribute-based Architectural Styles (ABAS)
- <u>Outputs:</u>
  - Approaches/decisions

ATAM Step 5: Generate the Quality Attribute Utility Tree

- Involves project decision-makers (architect team, managers, customer representatives)
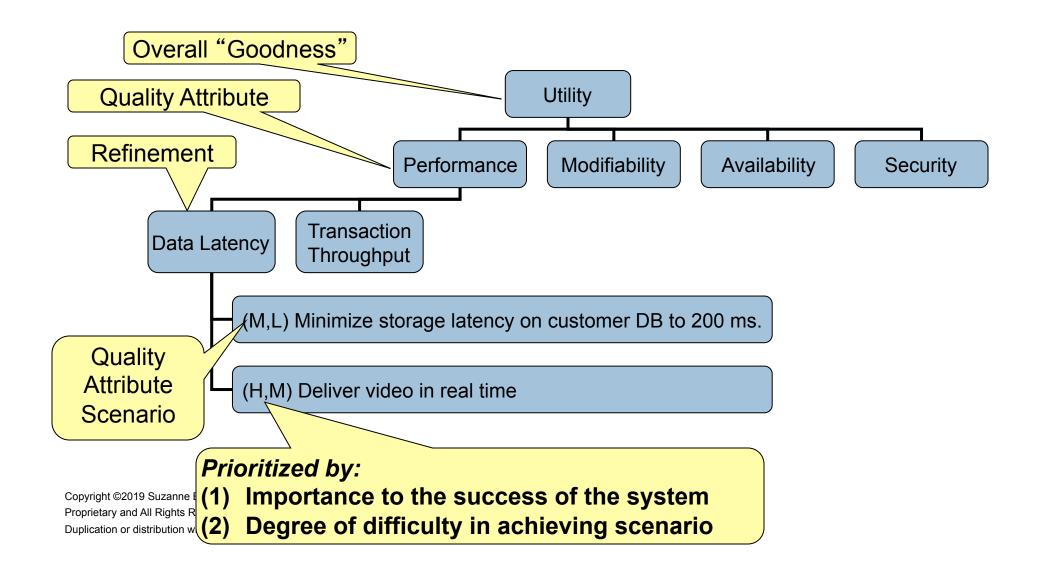- <u>Objective:</u>
  - Identify, prioritize, and refine the system's most important quality attribute goals
- <u>Outputs:</u>
  - Product of this step is a Utility Tree
  - Output from the utility tree is a prioritized list of "scenarios" that guides the remainder of the ATAM
    - Quality attribute requirements will be realized as scenarios

Sample Utility Tree

Overall "Goodness"

Quality Attribute

Refinement

Utility

Performance | Modifiability | Availability | Security

Data Latency | Transaction Throughput

Quality Attribute Scenario

(M,L) Minimize storage latency on customer DB to 200 ms.

(H,M) Deliver video in real time

Prioritized by:
(1) **Importance to the success of the system**
(2) **Degree of difficulty in achieving scenario**

Scenarios describe an interaction of one of the stakeholders with the systems.

- Scenario
  - Stimulus – Given some <u>Stimulus</u> ….
  - Environment – In the context of a given <u>Environment</u> …
  - **Response – the expected <u>Response</u> is** …
- Types
  - Use Case scenarios
    - How will customers use the system?
  - Growth scenarios
    - What kind of system changes should be anticipated? In terms of stimulus, or environment or response?
  - Exploratory scenarios
    - What are the boundary conditions of the current design? What are the ramifications of system changes that "push the envelope"?

ATAM Step 6: Analyze the Architectural Approaches

- Objective:
    - To review the selected architectural approaches (step 4) in light of the prioritized quality requirements (step 5)
    - What approaches realize what quality attributes?
- Outputs:
    - Approaches/decisions relevant to each high-priority utility tree scenario
    - Analysis questions under quality attributes and architect's responses
    - Documented architectural decisions, focusing on
        - Detailed application of approach in this instance
        - Risks and Non-risks (e.g., approach weaknesses)
        - Sensitivity points
        - Tradeoffs with other approaches
    - Example – Decision: assigning processes to a server
        - *Sensitivity* point w.r.t. response as measured in transactions per second
        - *Risk* of unacceptable value of this response
        - *Tradeoff* point, if decision is a sensitivity point of more than one attribute

Phase 3: Testing

ATAM Step 7: Brainstorm and Prioritize Scenarios

- <u>Objective:</u>
  - Brainstorm
    - Use case scenarios
    - Growth scenarios
    - Exploratory scenarios
  - Collect and prioritize scenarios
  - Merge scenarios addressing similar concerns
  - Stakeholders vote for important scenarios
  - Compare with utility tree
    - For scenarios not in the utility tree, it indicates that the architect may have failed to consider important quality attributes
- <u>Outputs:</u>
  - Prioritized scenarios
  - Revised utility tree

Utility Trees (Step 5) vs. Scenario Brainstorming (Step 7)

	Utility Trees	**Scenario Brainstorming**
Stakeholders	Architects, project leader	All stakeholders
Typical group size	Evaluators; 2-3 project personnel	Evaluators; 5-10 project-related personnel
Primary Goals	Elicit and prioritize quality attribute requirements	Foster stakeholder communication to validate quality attribute goals in utility tree
Approach	General to specific: Refine quality attributes until scenarios emerge	Specific to general: From scenarios, identify quality attributes they express

ATAM Step 8: Analyze the Architectural Approaches

☐ <u>Objective:</u>

    ⊡ Evaluation team guides the architect in the process of carrying out the highest-ranked scenarios from Step 7

    ⊡ Review the selected architectural approaches (step 4) in light of the prioritized quality requirements (step 7)

Phase 4: Reporting

Final report produced, follow-on actions are planned, and evaluation organization updates experience base

ATAM Step 9: Present the Results

- <u>Objective:</u>
  - Collect and summarize ATAM information and present to stakeholders

- <u>Output:</u>
  - Presentation and written report:
    - Architectural approaches
    - Scenarios and their prioritization
    - Attribute-based questions
    - Utility tree
    - Risks
    - Nonrisks
    - Sensitivity and tradeoff points

Cost vs. Benefit of ATAM Analysis

- Potential Benefits:
  - Puts stakeholders in the same room
  - Forces an articulation of quality goals
  - Results in prioritization of conflicting goals
  - Forces a clear explication of the architecture
  - Improves the quality of architectural documentation
  - Uncovers opportunities for cross-project reuse
  - Results in improved architecture practices
- Costs:
  - Personnel costs and opportunity costs related to personnel participating in evaluation instead of something else

Cost of ATAM Evaluation – Small Project

Participant Group ATAM Phase	Evaluation Team (assume 2 members)	Stakeholders	
		Project Decision Makers (assume architect, project manager, customer)	Other Stakeholders (assume 3)
Phase 0: Preparation	1 person-day by team leader	1 person-day	0
Phase 1: Initial evaluation (1 day)	2 person-days	2 person-days	0
Phase 2: Complete evaluation (3 days)	4 person-days	4 person-days + 2 person-days to prepare	6 person-days (most stakeholders present only for 2 days)
Phase 3: Follow-up	8 person-days	2 person-days to read and respond to report	0
TOTAL	**15 person-days**	**11 person-days**	**6 person-days**

Cost of ATAM Evaluation – Medium Project

		Stakeholders	
Participant Group ATAM Phase	Evaluation Team (assume 5 members)	Project Decision Makers (assume architect, project manager, customer)	Other Stakeholders (assume 8)
Phase 0: Preparation	1 person-day by team leader	1 person-day	0
Phase 1: Initial evaluation (1 day)	5 person-days	3 person-days	0
Phase 2: Complete evaluation (3 days)	15 person-days	9 person-days + 2 person-days to prepare	16 person-days (most stakeholders present only for 2 days)
Phase 3: Follow-up	15 person-days	3 person-days to read and respond to report	0
TOTAL	**36 person-days**	**18 person-days**	**16 person-days**

Summary

- Key factors when conducting architecture evaluations
  - Resources to conduct the evaluation
  - Evaluation focus
    - Questions to be answered
    - Risks to be assessed
  - The architecture artifact