CDT413: Advanced Software Engineering
Software Architecture Evaluation

Software Architecture Analysis
- Background and Motivation
- Architecture Trade-off Analysis Method (ATAM)

Software Architecture Analysis
- Reasoning about the properties of a system based on information about its architecture
- In particular the quality attributes of the system
- Analysis of architectures before the system is built
  - Discovering problems early is cost-effective

Software Architecture Evaluation
- “Evaluation” is a special case of “analysis”
- Aims to determine how “good” an architecture is
- Effort invested in evaluation should be justified by the potential savings from finding problems early

Architecture Trade-Off Analysis Method
- Overview
- Participants
- Outputs
- Phases and steps

ATAM Overview
- A method for software architecture evaluation
- Based on defining and “testing” scenarios
- Typically requires about 36 person-hours
Participants of the ATAM

- Evaluation team – external to the project, typically 3-5 people
- Project decision makers – including architect, project manager, customer representative, ...
- Architecture stakeholders – developers, testers, integrators, maintainers, users, ...

Outputs of the ATAM

- A concise presentation of the architecture
- Articulation of the business goals
- Quality requirements as a collection of scenarios
- Mapping of architectural decisions to quality requirements
- A set of sensitivity points and tradeoff points
- A set of risks and nonrisks
- A set of risk themes
- Secondary outputs
  - Tangible
  - Non-tangible

Phases of the ATAM

- Phase 0: Partnership and preparation
- Phase 1: Evaluation steps 1 through 6
- Phase 2: Evaluation steps 7 through 9
- Phase 3: Follow-up

ATAM Phase 0: Partnership and Preparation

- Evaluation team leader(s) and key project decision makers
- Proceeds informally as needed, perhaps over a few weeks
- Evaluation team leaders learn about the project
- Agree on practical and formal issues, including a preliminary list of named stakeholders
- Architects and managers are prepared for phase 1

ATAM Phase 1: Evaluation

- Evaluation team and project decision makers
- Typically one full day
- Steps 1 through 6 of the evaluation
- Present the ATAM
- Present business drivers
- Present the architecture
- Identify architectural approaches
- Generate quality attribute tree
- Analyze architectural approaches

ATAM Steps 1-3: Presentations

- The ATAM is presented by the evaluation team
- The business drivers are presented by project manager or customer representative
  - Including the architectural drivers, i.e. the most important quality requirements that shape the architecture
- The architecture is presented by the architect
- Each presentation typically takes about one hour
ATAM Step 4: Identify Architectural Approaches

• The evaluation team has studied architectural documentation and heard the architecture presentation in step 3.
• The architect should explicitly name the tactics and patterns used.
• The evaluation team tries to spot approaches not explicitly named.
• A catalog of approaches is identified and written down.

ATAM Step 5: Quality Attribute Utility Tree

• The architectural drivers were presented in step 2.
• The quality attribute utility tree is a technique for refining quality requirements.
  • Such that they are sufficiently specific to allow analysis.
• The root of the tree is called “Utility.”
• A branch is created for each of the most important quality attributes.
  • The architectural drivers + others named by the participants.

ATAM Step 5: Quality Attribute Utility Tree

• Level 2: Important quality attributes
  • E.g. performance, modifiability, security, usability, availability.
  • Participants are free to name attributes using their own terminology.
• Level 3: Refined quality attributes
  • E.g. performance can be refined into data latency and transaction throughput.
• Level 4: Quality attribute scenarios

Quality Attribute Scenarios

• Source of stimulus
• Stimulus
• Environment
• Artifact
• Response
• Response measure

Example Performance Scenario

• Web-based financial system
• “Users initiate 1000 transactions per minute stochastically under normal operations, and these transactions are processed with an average latency of two seconds.”

Example Performance Scenario

• Source of stimulus: Users
• Stimulus: Initiate transactions
• Environment: Normal operation
• Artifact: The system
• Response: Transactions are processed
• Response measure: Average latency of 2 s
Quality Attribute Scenarios in ATAM Step 5

- Uses a simplified format
  - Stimulus – inputs to the system
  - Environment – the state the system is in when the stimulus arrives, e.g. “normal operation” or “during development”
  - Response – how the system should respond to the stimulus, expressed quantitatively
- Phase 1 is typically scheduled to be completed in one day

Example of Quality Attribute Utility Tree

- Utility
  - Performance
    - Storage latency on customer database not exceeding 20 ms
    - Deliver 20 frames/second video in real-time
    - Transaction throughput
  - Modifiability

ATAM Step 5: Quality Attribute Utility Tree

- Level 4: Quality attribute scenarios
  - Simplified form (stimulus, environment, response)
  - Participants assign priorities to each scenario
    - E.g. (high, medium, low)
- Participants estimate difficulty in ensuring the behavior of the scenario
  - E.g. (high, medium, low)
  - Now each scenario has a (priority, difficulty) pair

ATAM Step 6: Analyze Architectural Approaches

- Inspect the highest ranked scenarios
- Architect explains how the quality attribute is addressed
  - Identify sensitivity points, trade-off points, risks and nonrisks

ATAM Phase 2: Evaluation

- Evaluation team, project decision makers and architecture stakeholders
- Typically two full days
- Steps 7 through 9 of the evaluation
  7. Brainstorm and prioritize scenarios
  8. Analyze architectural approaches
  9. Present results

ATAM Step 7: Brainstorm and Prioritize Scenarios

- Inform stakeholders about Step 1
- Brainstorm to come up with new scenarios or request some old ones are revisited
  - Prioritize Scenarios by stakeholder voting
ATAM Step 8: Analyze Architectural Approaches

- Inspect the highest ranked scenarios
- Architect explains how the quality attribute is addressed
- Identify sensitivity points, trade-off points, risks and nonrisks

ATAM Step 9: Present Results

- Verbal presentation