Achieving System Qualities Through Software Architecture

What is “software architecture?”
Role in determining system qualities

Working Definition

“The software architecture of a program or computing system is the structure or structures of the system, which comprise software components, the externally visible properties of those components, and the relationships among them.”

From Software Architecture in Practice, Bass, Clements, Kazman

Remember as: Components, Interfaces, and Relations

Examples

- An architecture comprises a set of
  - Software components
  - Component interfaces
  - Relationships among them

Examples

<table>
<thead>
<tr>
<th>Structure</th>
<th>Components</th>
<th>Interfaces</th>
<th>Relationships</th>
</tr>
</thead>
<tbody>
<tr>
<td>Calls Structure</td>
<td>Programs, Program interface</td>
<td>Program interface and parameter declarations, Invokes with parameters (A calls B)</td>
<td></td>
</tr>
<tr>
<td>Data Flow</td>
<td>Functional tasks, Data types</td>
<td>Data types or structures, Sends-data-to</td>
<td></td>
</tr>
<tr>
<td>Process</td>
<td>Sequential program, (process, thread, task)</td>
<td>Scheduling and synchronization constraints, Runs-concurrently, with, excludes, precedes</td>
<td></td>
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</tbody>
</table>

Implications of the Definition

- Systems typically comprise more than one architecture
  - There is more than one useful decomposition into components and relationships
  - Each addresses different system properties or design goals
- It exists whether any thought goes into it or not!
  - Decisions are necessarily made if only implicitly
  - Issue is who makes them and when
- Many “architectural specifications” aren’t
Is it Architecture?

Control Process (CP)

Prop Loss Model (MODP)
Reverb Model (MODR)
Noise Model (MODN)

Typical (but uninformative) architectural diagram
- What is the nature of the components?
- What is the significance of the link?
- What is the significance of the layout?

The Role of Architecture

Which system or development characteristics are determined by architecture?
What is the source of requirements?

Fit in the Development Cycle

"...The earliest artifact that enables the priorities among competing concerns to be analyzed, and it is the artifact that manifests the concerns as system qualities."

Effects of Architectural Decisions

- What kinds of system and development properties are and are not affected by architecture?
- System run-time properties
  - Performance, Security, Availability, Usability
- System static properties
  - Modifiability, Portability, Reusability, Testability
- Production properties? (effects on project)
  - Work Breakdown Structure, Scheduling, time to market
- Business/Organizational properties?
  - Lifespan, Versioning, Interoperability
Importance to Stakeholders

- Which stakeholders have a vested interest in the architectural design?
  - Management, marketing, end users
  - Maintenance organization, IV&V, Customers
  - Regulatory agencies (e.g., FAA)

- There are many interested parties (stakeholders) with many diverse and often conflicting interests

- Important because their interests defy mutual satisfaction
  - There are inherently tradeoffs in most architectural choices
  - E.g., Performance vs. security, initial cost vs. maintainability

- Making successful tradeoffs requires understanding the nature, source and priority of these constraints

Role of Architecture in Disciplined Development

Product Development Cycle and Architecture

SW Engineering of Software Architecture

- What are we trying to gain/maintain control of in the Architectural Design phase?
  - Profoundly effect system and business qualities
  - Requires making tradeoffs

- Control implies achieving system qualities by choice not chance
  - Understanding what the tradeoffs are
  - Understanding the consequences of each choice
  - Making appropriate choices at appropriate times
Implications for the Development Process

Implies need to address architectural concerns in the development process:
- Understanding the "business case" for the system
- Understanding the quality requirements
- Designing the architecture
- Representing and communicating the architecture
- Analyzing or evaluating the architecture
- Implementing the system based on the architecture
- Ensuring the implementation conforms to the architecture

Related Design Questions

- Create business case for the system
  - What is the "business" rationale or goal?
- Understanding the requirements
  - What is the design goal?
- Creating or selecting the architecture
  - What are appropriate components and relations?
  - What are the decomposition principles?
- Representing and communicating the architecture
  - How are the components and relations represented?
- Analyzing or evaluating the architecture
  - How do we decide if the architecture is any good?

Summary

- Earliest set of design decisions – hence, most influential and hardest to change
- Determines a wide range of critical system, production, and business properties
- A product of tradeoffs between conflicting demands by different stakeholders
- Requirements come from product/business goals and subsequently affect them
- Implication: good design is a balance of technical, business and social influences
  - Must understand the context
  - Must communicate effectively
  - Must negotiate the requirements
  - Must think strategically about the effects of decisions

Assignments

- Read Ch. 11 on Architecture
- Project 2 proposals
Questions