From Requirements to Architectures

“It was the best of times, it was the worst of times”

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Software Architectures

• “it was the best of times…”
• Tremendous advances in software-architecture research and practice
  – Three-tier, n-tier, and the layered-architecture pattern
  – Enterprise and Service-Oriented Architecture
  – Architectural models and Description Languages (ADLs)
  – Architectural style
  – Components, connectors, and interface specifications
  – Alternative architectural approaches and design choices
The Requirements-Architecture Gap

• “it was the worst of times…”
• A stubborn gap persists…
• Lack of significant progress in
  – Mapping software requirements to software architectures
  – Verifying and validating said architectures against said requirements
Software Requirements

• “it was the best of times…”

• Useful advances in requirements engineering
  – Functional/behavioral requirements
    • Use cases
    • Scenarios
    • State-based models, etc.
  – Non-functional
    • The “NFR Framework”
    • Methods and models for specific NFRs
      – Safety, security, reliability, availability, performance, etc.
Why the Gap Exists

• “it was the worst of times…”
• Traditional problems
  – Traditional software process/lifecycle models
    • Waterfall, phased development, “over the fence”
  – Isolation of requirements and architecture
    • Different tools, methods, “over the fence”
• New problems
  – Software architects ignoring or incorporating requirements
  – Requirements engineers ignoring or incorporating architectures
    • “from use cases to code”
Spanning the Requirements-Architecture Gap

• “it was the best of times…”
• Work on architecture-generation methods based on refinement of requirements
  – ATAM (Architecture Trade-off Analysis Method)
  – CBSP (Component-Bus-System-Property)
• Work on architecture analysis and evaluation methods based on requirements
  – SAAM (Scenario-based Architecture Analysis Method)
  – PASA (Performance Assessment of Software Architecture)
• Must all be evaluated against subject systems!

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Looking for Subject Systems

• 17 candidate subject systems
  – Varying sources
  – Different characteristics (domain, size, etc.)

• All 17 were incomplete!

• 4 types of incompleteness
  – Detailed requirements and sketchy architecture
  – Detailed architecture and sketchy requirements
  – Sketchy requirements and architecture
  – Toy systems with detailed requirements and architecture

• “Case Study, Interrupted: The Paucity of Subject Systems that Span the Requirements-Architecture Gap”
  – Diallo, Sim, Alspaugh, 2007

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A Requirements-based Architecture-evaluation Approach

- **Step 1**: Requirements specification using scenarios and ontology
  - `typedEvents` (scenarios) → `eventTypes` (ontology)
- **Step 2**: Mapping ontology elements to architectural components
  - `eventTypes` (ontology) → `components` (architecture)
- **Step 3**: Architecture evaluation against scenarios – **Walkthrough**
- “Evaluating Software Architectures Against Requirements-level Scenarios”
  - Diallo, Naslavsky, Ziv, Alspaugh, Richardson, 2007 & 2008
Summary

• **Mind your Requirements**
  – *Much of software-architecture today*
    • Ignores requirements
    • Attempts to absorb or incorporate requirements

• **Mind your Architecture**
  – *Much of requirements-engineering today*
    • Ignores *(mapping to)* architectures
    • Attempts to absorb or circumvent architectures
      – “from use cases to code”

• **Mind the Gap!**
  – *Gap exists, persists*
    • Need “spanning” methods from requirements to architectures
    • Need to analyze and evaluate, verify and validate architectures

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