This Talk

- Overview
  - Software architecture has emerged as an important area of concern for practitioners and researchers.
  - Considerable progress has been made in developing an engineering basis for architectural design.
  - The changing face of software technology raises some exciting new challenges and opportunities
- Talk Outline
  - The role of Software Architecture -- what it's good for.
  - Evolution of the field -- forces that have shaped its development.
  - Challenges and opportunities -- new forces for change.

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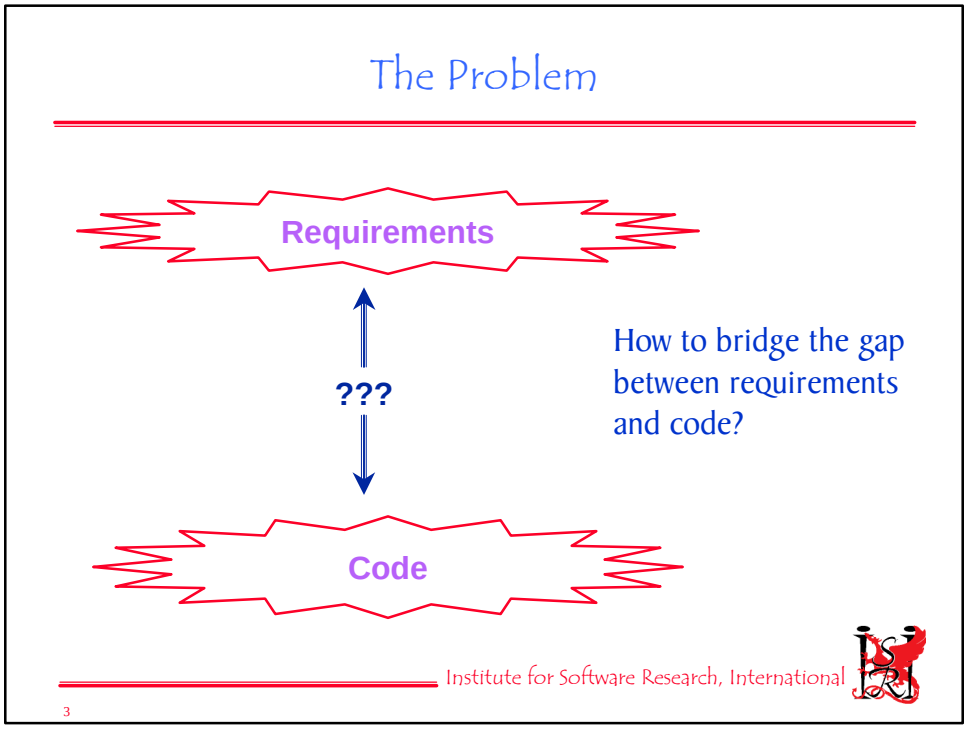
The Problem
Requirements
???
Code
How to bridge the gap between requirements and code?
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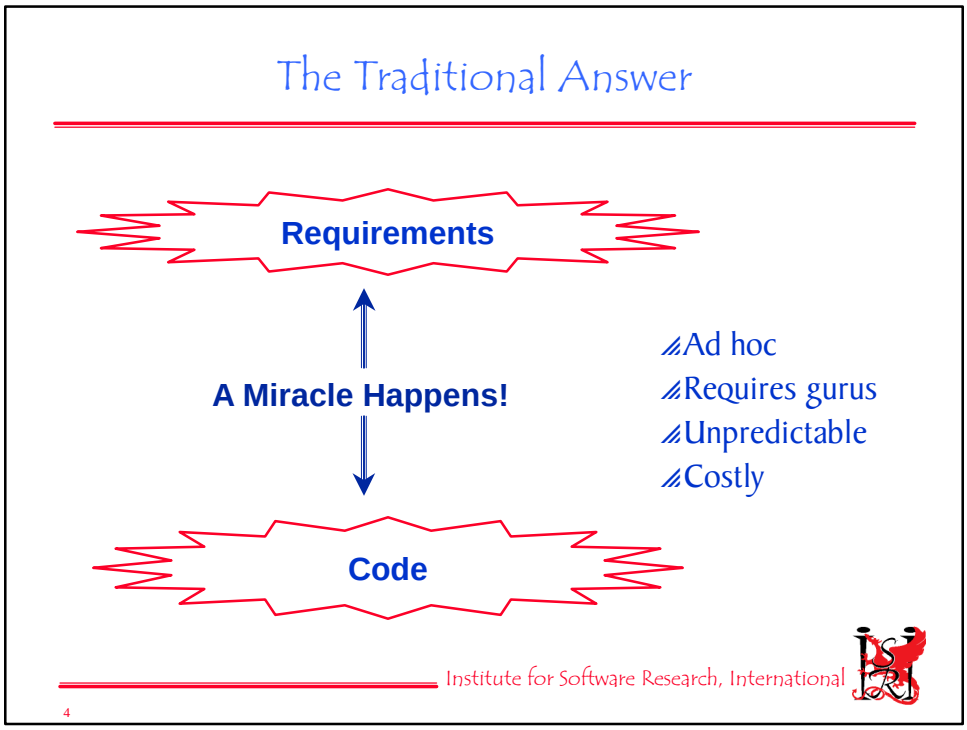
The Traditional Answer
Requirements
A Miracle Happens!
Code
Ad hoc
Requires gurus
Unpredictable
Costly
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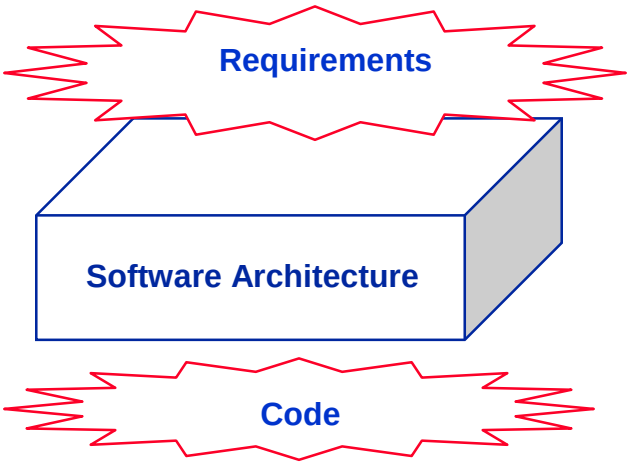
The Role of Software Architecture



- Composition of large-scale components
- System-level abstractions
- Reuse of system-level design idioms

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Issues Addressed by an Architectural Design

- Gross decomposition of a system into interacting components
  - typically hierarchical
  - using rich abstractions for component interaction (or system "glue")
  - often using common design idioms/styles
- Emergent system properties
  - performance, throughput, latencies
  - reliability, security, fault tolerance, evolvability
- Rationale and assignment of function to components
  - relates requirements and implementations
- Envelope of allowed change
  - "load-bearing walls", limits of scalability and adaptation
  - design idioms and styles

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How Should a Software Architecture Help?

- Understanding
  - vocabulary for structure, system constraints
- Reuse
  - of components, and also of patterns for organization
- Construction
  - partial blueprint, compilation/construction instructions
- Evolution
  - allowable envelope of change
- Analysis
  - system-level analysis that exploits structural constraints
- Management
  - evaluation-ready milestone

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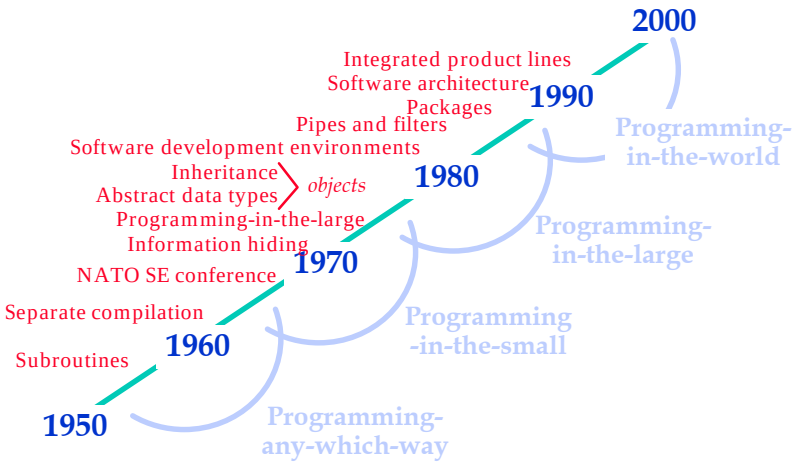
Antecedents of Software Architecture



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Evolution of the Field

- 1980's
  - Informal use of box and line diagrams
  - Ad hoc application of arch expertise
  - Diverse, uncodified use of architectural patterns and styles
- 1990's
  - Recognition of the value of architects in software development organizations
  - Processes that require architectural design reviews and explicit architectural documentation
  - Emerging use of product line architectures, commercial architectural standards, component integration frameworks
  - Codification of vocabulary, notations & tools for architectural design
  - Books/courses on software architecture

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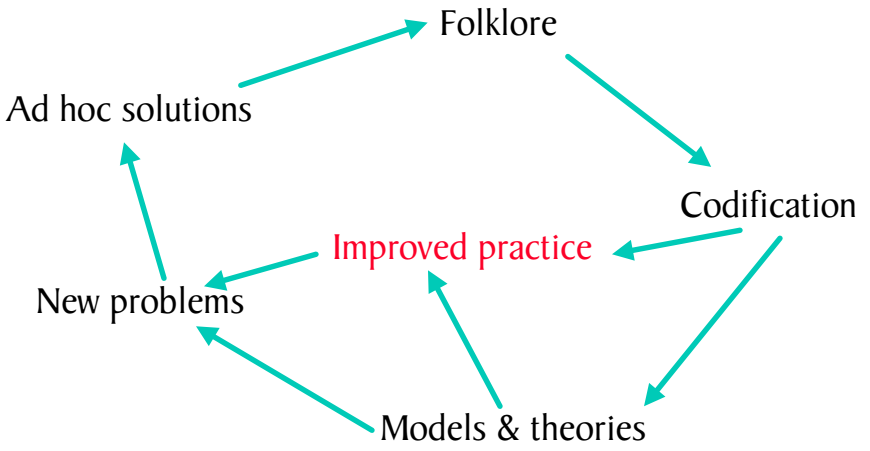
Maturity: Progressive Codification Cycle



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Forces for Change: Economic

- Changing build-vs-buy balance
  - Time-to-market pressures often make construction from scratch infeasible
  - Successful component frameworks enable rapid construction from third-party parts (e.g., Visual Basic)
  - Industrial standards encourage uniform packaging and provide standard APIs (e.g., Enterprise JavaBeans)
  - Emerging standards raise level of abstraction, promise a basis for compliance (e.g., HLA)

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Forces for Change: Technical

- Pervasive Computing
  - Proliferation of computing devices (e.g., toasters, entertainment systems, cars), many with dedicated embedded processors
  - Heterogeneous capabilities (e.g., toasters vs PDAs vs cell phones vs high-end workstations)
  - Mobile computing (e.g., in cars and airplanes)
- Network-centric Computing
  - Enabled by increasing connectivity of systems and information
  - PCs become front ends to services & information available on the net
  - Tasks performed by coalitions of resources enlisted by the user
  - Coalitions must be reconfigured dynamically as resource mix changes

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Example: Network-Centric Computing

- Internet provides rich variety of resources
  - information, calculation, communication, services
  - Autonomous, heterogeneous, interactive
- Inevitably, these will be incorporated in systems
  - Coalitions, not true systems--open-shop, not closed shop development
  - Specifications scanty and less than reliable
  - Resources subject to unannounced change
  - Problems brittleness get worse
- Research opportunities
  - How to identify and validate a resource, then incorporate it
  - How to determine what a coalition does and keep it doing that
  - How to make it possible for nonexperts to recruit coalitions

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Research Challenges and Opportunities

- Better principles, notations,tools for integration frameworks
  - not just APIs
- SW architectures that scale with size/variability of the Internet
  - millions of nodes, frequent reconfiguration, many formats/protocols
- Open, dynamic resource coalitions
  - no longer under control of single organization or proprietor
- Techniques for bridging architectural mismatch
  - heterogeneous data formats, component technologies
- Ensuring suitable properties for distributed system configurations
  - even though absolute correctness is not achievable
- Architectures for mobility
  - resource-aware, highly dynamic, multi-device

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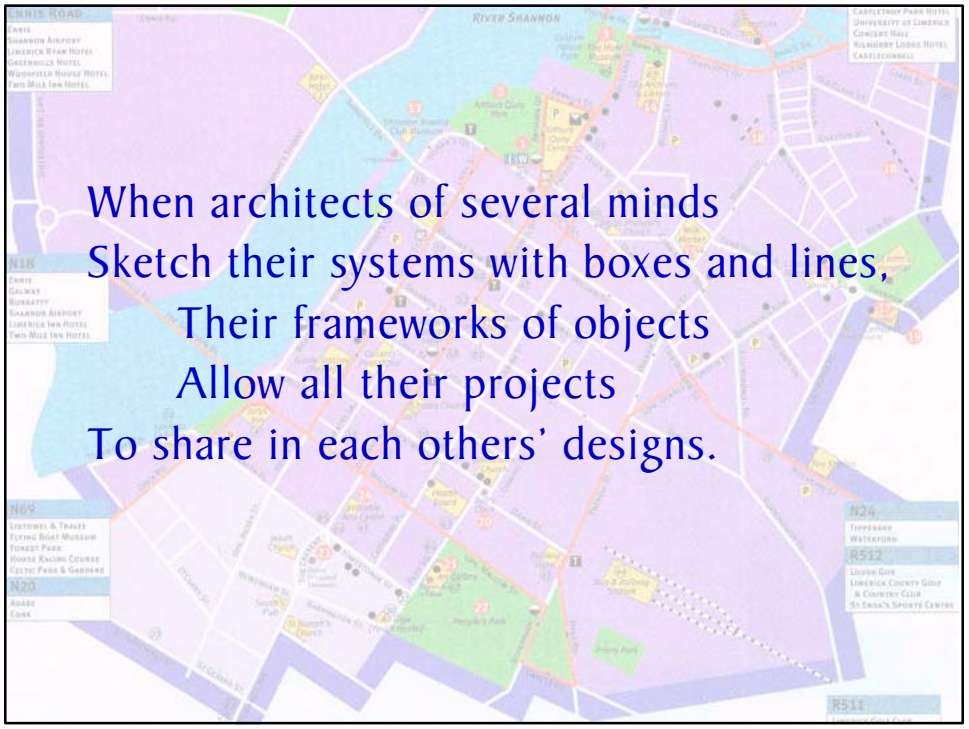
When architects of several minds
Sketch their systems with boxes and lines,
Their frameworks of objects
Allow all their projects
To share in each others' designs.