Software Engineering

Session 7 – Main Theme From Analysis and Design to Software Architectures (Part I)

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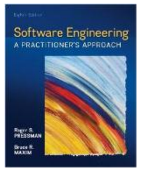
Agenda

What is the class about?

- Course description and syllabus:
  - » http://www.nyu.edu/classes/jcf/g22.2440-001/
  - » http://www.cs.nyu.edu/courses/spring16/G22.2440-001/

- Textbooks:



  - » ***Software Engineering: A Practitioner's Approach***
    Roger S. Pressman
    McGraw-Hill Higher International
    ISBN-10: 0078022126, ISBN-13: 978-0078022128, 8th Edition (01/23/14)
  - » Recommended:
    - » Code Complete: A Practical Handbook of Software Construction, 2nd Edition
    - » The Mythical Man-Month: Essays on Software Engineering, 2nd Edition

Icons / Metaphors

Information

Common Realization

Knowledge/Competency Pattern

Governance

Alignment

Solution Approach

Agenda

1 Introduction

2 Architectural Design

3 Pattern-Based Design

4 Summary and Conclusion

Why Architecture?

The architecture is not the operational software. Rather, it is a representation that enables a software engineer to:

(1) analyze the effectiveness of the design in meeting its stated requirements,

(2) consider architectural alternatives at a stage when making design changes is still relatively easy, and

(3) reduce the risks associated with the construction of the software.

Why is Architecture Important?

- Representations of software architecture are an enabler for communication between all parties (stakeholders) interested in the development of a computer-based system.
- The architecture highlights early design decisions that will have a profound impact on all software engineering work that follows and, as important, on the ultimate success of the system as an operational entity.
- Architecture “constitutes a relatively small, intellectually graspable mode of how the system is structured and how its components work together”.

Architectural Descriptions

- The IEEE Computer Society has proposed IEEE-Std-1471-2000, *Recommended Practice for Architectural Description of Software-Intensive System*, [IEE00]
  - » to establish a conceptual framework and vocabulary for use during the design of software architecture,
  - » to provide detailed guidelines for representing an architectural description, and
  - » to encourage sound architectural design practices.
- The IEEE Standard defines an *architectural description* (AD) as a "a collection of products to document an architecture."
  - » The description itself is represented using multiple views, where each *view* is "a representation of a whole system from the perspective of a related set of [stakeholder] concerns."

Architectural Genres

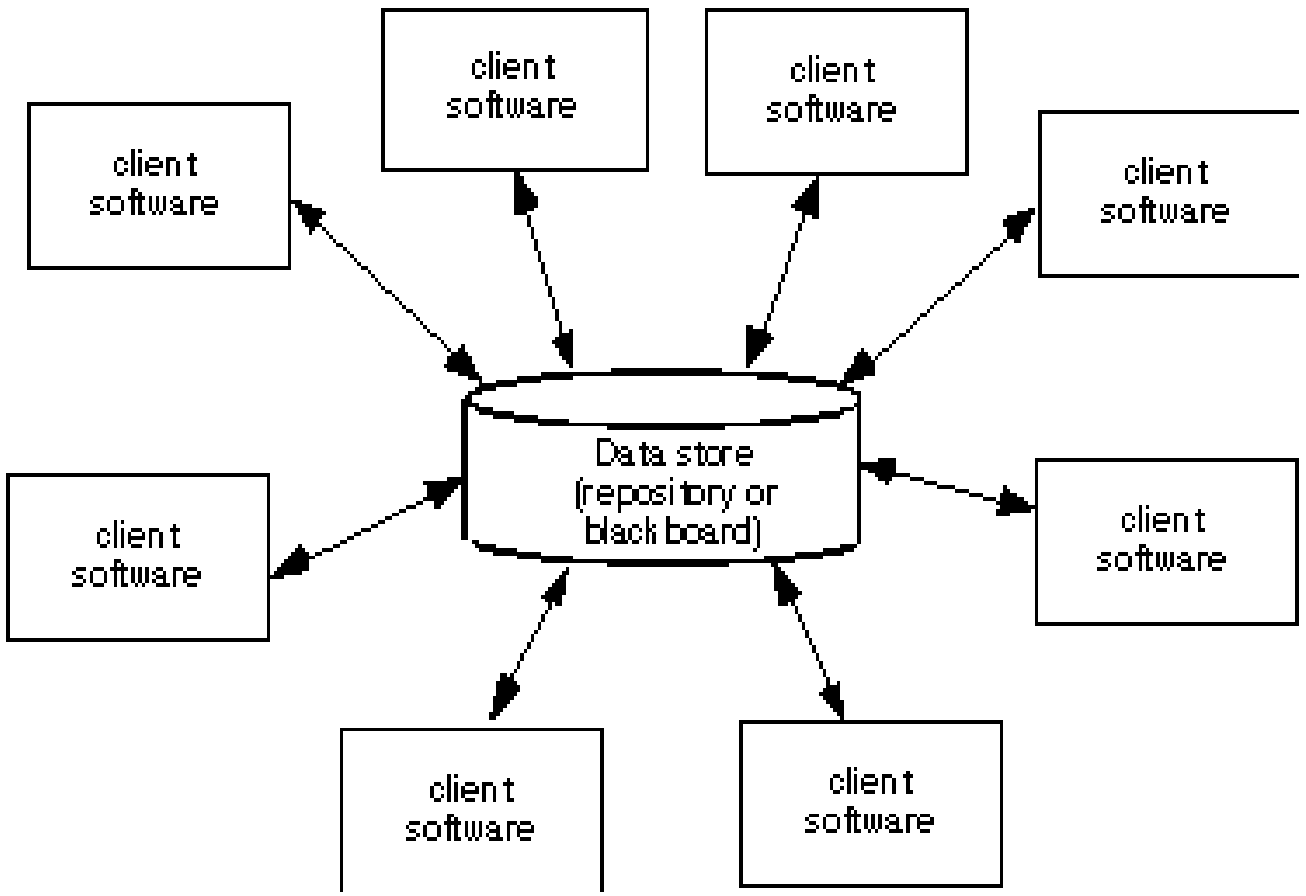
- *Genre* implies a specific category within the overall software domain.
- Within each category, you encounter a number of subcategories.
  - For example, within the genre of *buildings*, you would encounter the following general styles: houses, condos, apartment buildings, office buildings, industrial building, warehouses, and so on.
  - Within each general style, more specific styles might apply. Each style would have a structure that can be described using a set of predictable patterns.

Architectural Styles

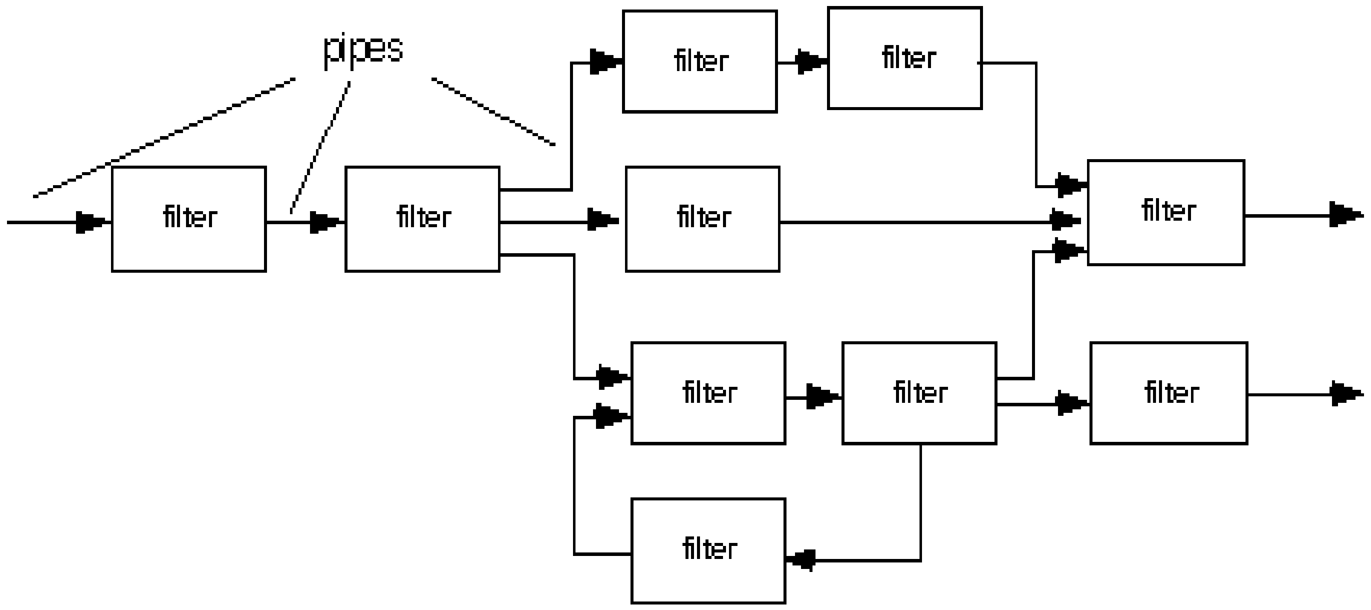
Each style describes a system category that encompasses: (1) a **set of components** (e.g., a database, computational modules) that perform a function required by a system, (2) a **set of connectors** that enable "communication, coordination and cooperation" among components, (3) **constraints** that define how components can be integrated to form the system, and (4) **semantic models** that enable a designer to understand the overall properties of a system by analyzing the known properties of its constituent parts.

- Data-centered architectures
- Data flow architectures
- Call and return architectures
- Object-oriented architectures
- Layered architectures

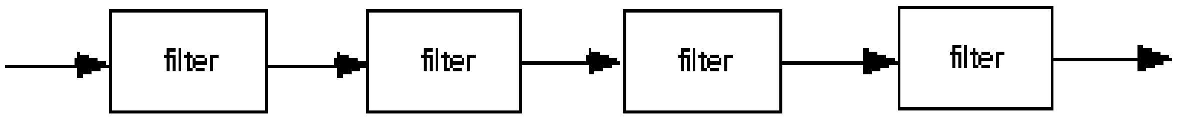
Data-Centered Architecture



Data Flow Architecture

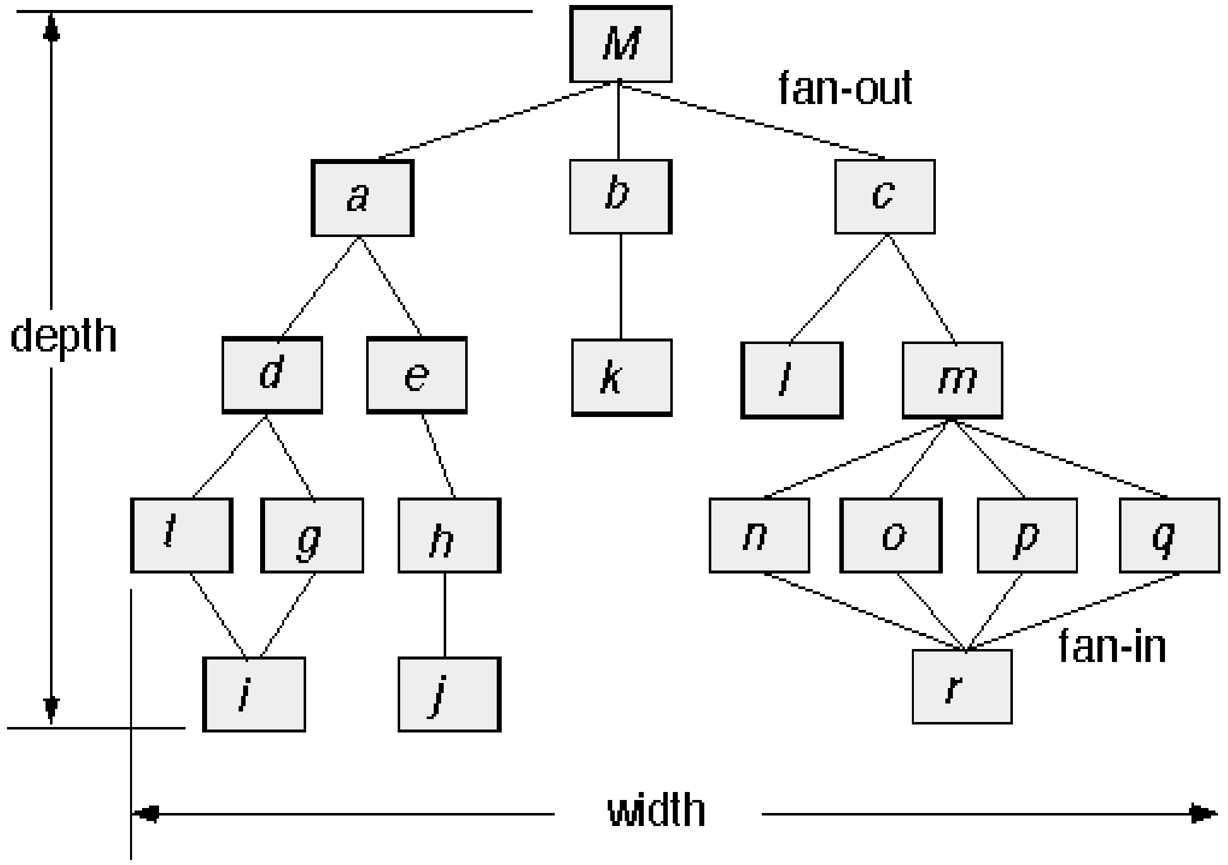


(a) pipes and filters

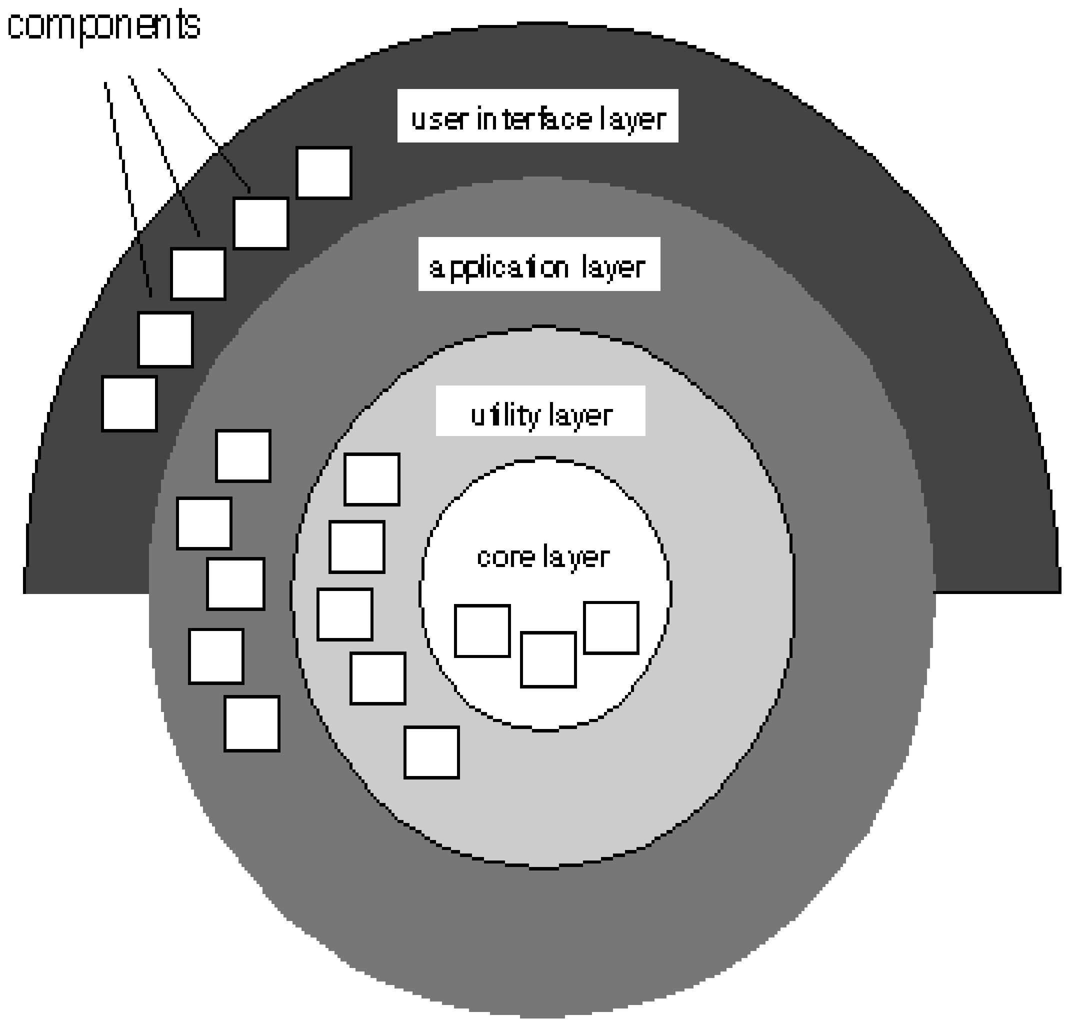


(b) batch sequential

Call and Return Architecture



Layered Architecture



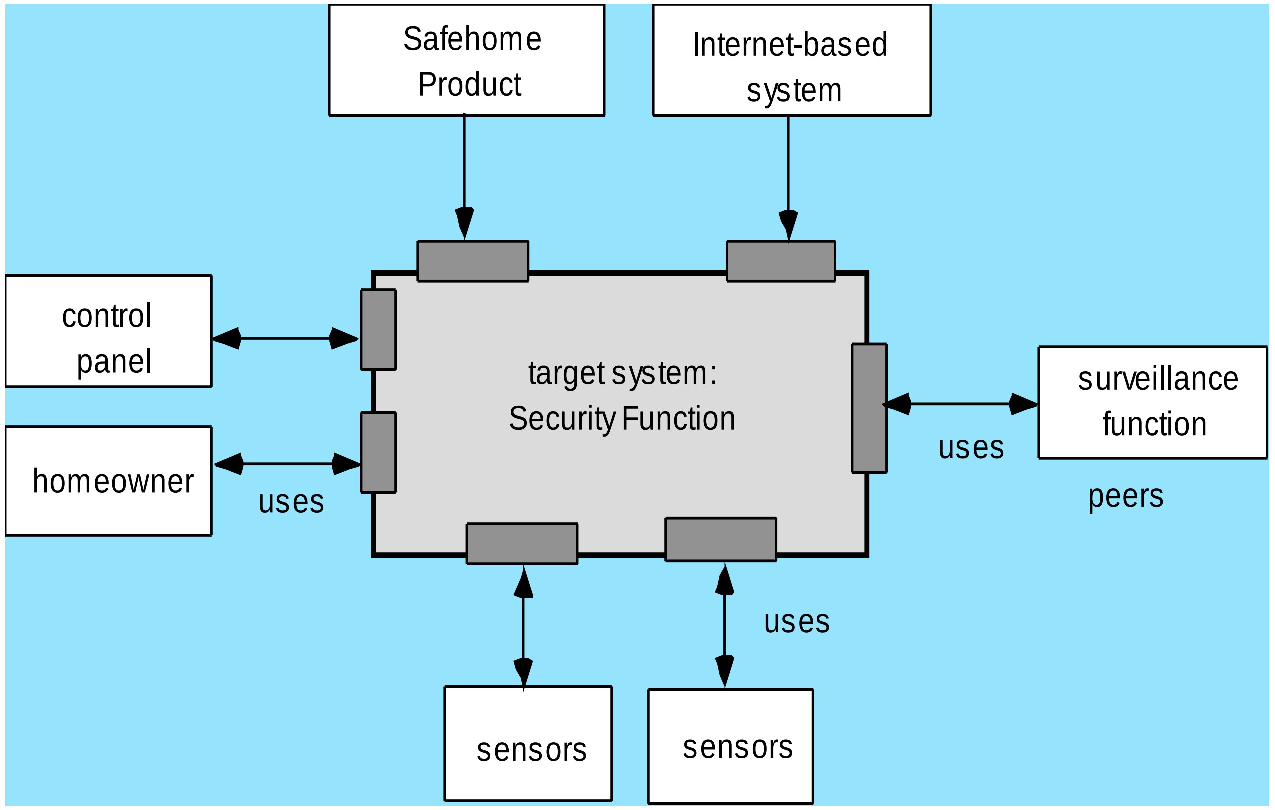
Architectural Patterns

- Concurrency—applications must handle multiple tasks in a manner that simulates parallelism
  - *operating system process management* pattern
  - *task scheduler* pattern
- Persistence—Data persists if it survives past the execution of the process that created it. Two patterns are common:
  - a *database management system* pattern that applies the storage and retrieval capability of a DBMS to the application architecture
  - an *application level persistence* pattern that builds persistence features into the application architecture
- Distribution— the manner in which systems or components within systems communicate with one another in a distributed environment
  - A *broker* acts as a 'middle-man' between the client component and a server component.

Architectural Design

- The software must be placed into context
  - » the design should define the external entities (other systems, devices, people) that the software interacts with and the nature of the interaction
- A set of architectural archetypes should be identified
  - » An *archetype* is an abstraction (similar to a class) that represents one element of system behavior
- The designer specifies the structure of the system by defining and refining software components that implement each archetype

Architectural Context



Archetypes

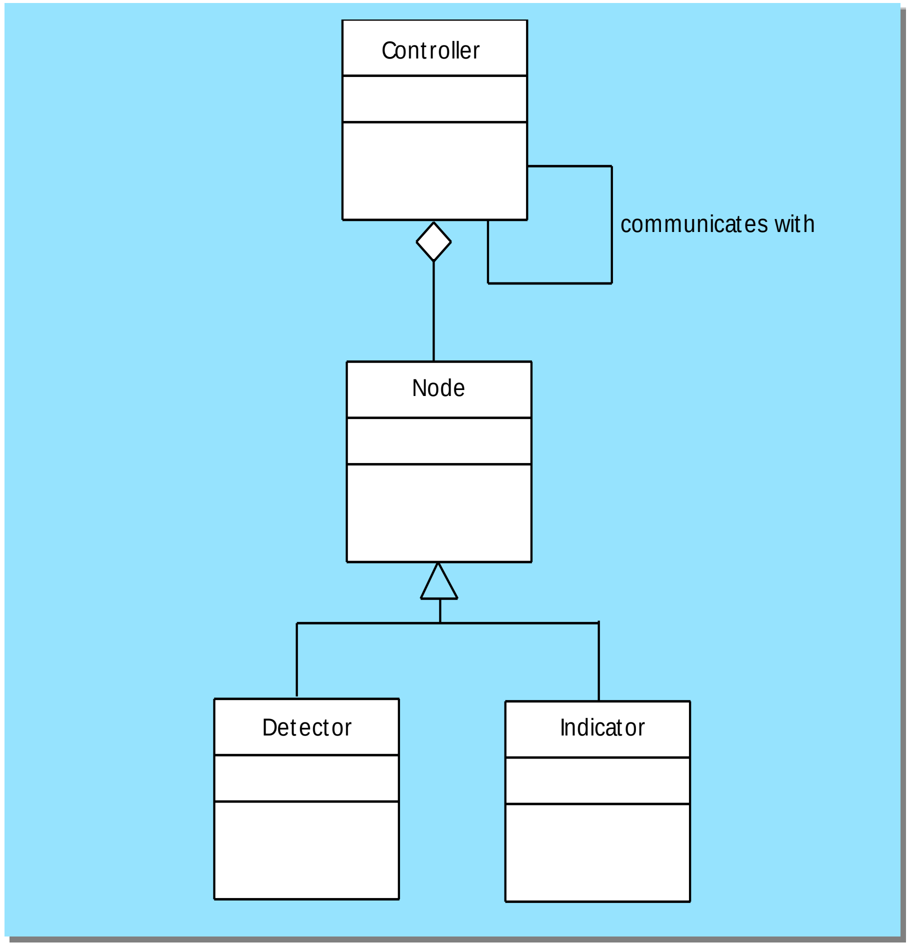


Figure 10.7 UML relationships for SafeHome security function archetypes (adapted from [BOS00])

Agenda

Bibliography…

- « A System of Pattern » Bushmann et All
- « Design Patterns » Gamma et All
- « Concurrent Programming in Java » D. Lea.
- « Distributed Objects » Orfali et All
- « Applying UML and Patterns » Larman

Patterns…

- « Patterns help you build on the collective experience of skilled software engineers. »
- « They capture existing, well-proven experience in software development and help to promote good design practice »
- « Every pattern deals with a specific, recurring problem in the design or implementation of a software system »
- « Patterns can be used to construct software architectures with specific properties… »

Becoming a Chess Master

- First learn rules and physical requirements
  - e.g., names of pieces, legal movements, chess board geometry and orientation, etc.
- Then learn principles
  - e.g., relative value of certain pieces, strategic value of center squares, power of a threat, etc.
- However, to become a master of chess, one must study the games of other masters
  - These games contain patterns that must be understood, memorized, and applied repeatedly
- There are hundreds of these patterns

Becoming a Software Designer Master

- First learn the rules
  - e.g., the algorithms, data structures and languages of software
- Then learn the principles
  - e.g., structured programming, modular programming, object oriented programming, generic programming, etc.
- However, to truly master software design, one must study the designs of other masters
  - These designs contain patterns must be understood, memorized, and applied repeatedly
- There are hundreds of these patterns

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Software Architecture

- A software architecture is a description of the subsystems and components of a software system and the relationships between them.
- Subsystems and components are typically specified in different views to show the relevant functional and non-functional properties of a software system.
- The software system is an artifact. It is the result of the software design activity.

Component

- A component is an encapsulated part of a software system. A component has an interface.
- Components serve as the building blocks for the structure of a system.
- At a programming-language level, components may be represented as modules, classes, objects or as a set of related functions.

Subsystems

- A subsystem is a set of collaborating components performing a given task. A subsystem is considered a separate entity within a software architecture.
- It performs its designated task by interacting with other subsystems and components…

Architectural Patterns

- An architectural Pattern expresses a fundamental structural organization schema for software systems. It provides a set of predefined subsystems, their responsibilities, and includes rules and guidelines for organizing the relationships between them.

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Design patterns

- A design pattern provides a scheme for refining the subsystems or components of a software system, or the relation ships between them. It describes a commonly-recurring structure of communicating components that solves a general design problem within a particular context.

Idioms

- An Idiom is a low-level pattern specific to a programming language. An idiom describes how to implement particular aspects of components or the relationships between them using the features of the given language.

Framework

- A framework is a partially complete software (sub-) system that is intended to be instantiated. It defines the architecture for a family of (sub-) systems and provides the basic building blocks to create them. It also defines the places where adaptations for specific functionality should be made.

Design Patterns

- Each of us has encountered a design problem and silently thought: *I wonder if anyone has developed a solution to for this?*
  - What if there was a standard way of describing a problem (so you could look it up), and an organized method for representing the solution to the problem?
- *Design patterns* are a codified method for describing problems and their solution allows the software engineering community to capture design knowledge in a way that enables it to be reused.

Design Patterns

- *Each pattern describes a problem that occurs over and over again in our environment and then describes the core of the solution to that problem in such a way that you can use the solution a million times over without ever doing it the same way twice.*

  – Christopher Alexander, 1977

- “a three-part rule which expresses a relation between a certain context, a problem, and a solution.”

Basic Concepts

- *Context* allows the reader to understand the environment in which the problem resides and what solution might be appropriate within that environment.
- A set of requirements, including limitations and constraints, acts as a *system of forces* that influences how
  - » the problem can be interpreted within its context and
  - » how the solution can be effectively applied.

Effective Patterns

- Coplien [Cop05] characterizes an effective design pattern in the following way:
  - *It solves a problem:* Patterns capture solutions, not just abstract principles or strategies.
  - *It is a proven concept:* Patterns capture solutions with a track record, not theories or speculation.
  - *The solution isn't obvious:* Many problem-solving techniques (such as software design paradigms or methods) try to derive solutions from first principles. The best patterns *generate* a solution to a problem indirectly--a necessary approach for the most difficult problems of design.
  - *It describes a relationship:* Patterns don't just describe modules, but describe deeper system structures and mechanisms.
  - *The pattern has a significant human component (minimize human intervention).* All software serves human comfort or quality of life; the best patterns explicitly appeal to aesthetics and utility.

Generative Patterns

- *Generative patterns* describe an important and repeatable aspect of a system and then provide us with a way to build that aspect within a system of forces that are unique to a given context.
- A collection of generative design patterns could be used to “generate” an application or computer-based system whose architecture enables it to adapt to change.

Kinds of Patterns

- *Architectural patterns* describe broad-based design problems that are solved using a structural approach.
- *Data patterns* describe recurring data-oriented problems and the data modeling solutions that can be used to solve them.
- *Component patterns* (also referred to as *design patterns*) address problems associated with the development of subsystems and components, the manner in which they communicate with one another, and their placement within a larger architecture
- *Interface design patterns* describe common user interface problems and their solution with a system of forces that includes the specific characteristics of end-users.
- *WebApp patterns* address a problem set that is encountered when building WebApps and often incorporates many of the other patterns categories just mentioned.

Kinds of Patterns

- *Creational patterns* focus on the "creation, composition, and representation of objects, e.g.,
  - **Abstract factory pattern**: centralize decision of what factory to instantiate
  - **Factory method pattern**: centralize creation of an object of a specific type choosing one of several implementations
- *Structural patterns* focus on problems and solutions associated with how classes and objects are organized and integrated to build a larger structure, e.g.,
  - **Adapter pattern**: 'adapts' one interface for a class into one that a client expects
  - **Aggregate pattern**: a version of the Composite pattern with methods for aggregation of children
- *Behavioral patterns* address problems associated with the assignment of responsibility between objects and the manner in which communication is effected between objects, e.g.,
  - **Chain of responsibility pattern**: Command objects are handled or passed on to other objects by logic-containing processing objects
  - **Command pattern**: Command objects encapsulate an action and its parameters

Frameworks

- Patterns themselves may not be sufficient to develop a complete design.
  - In some cases it may be necessary to provide an implementation-specific skeletal infrastructure, called a *framework*, for design work.
  - That is, you can select a "*reusable mini-architecture* that provides the generic structure and behavior for a family of software abstractions, along with a context … which specifies their collaboration and use within a given domain." [Amb98]
- A framework is not an architectural pattern, but rather a skeleton with a collection of "plug points" (also called *hooks* and *slots*) that enable it to be adapted to a specific problem domain.
  - The plug points enable you to integrate problem specific classes or functionality within the skeleton.

Describing a Pattern

- *Pattern name*—describes the essence of the pattern in a short but expressive name
- *Problem*—describes the problem that the pattern addresses
- *Motivation*—provides an example of the problem
- *Context*—describes the environment in which the problem resides including application domain
- *Forces*—lists the system of forces that affect the manner in which the problem must be solved; includes a discussion of limitation and constraints that must be considered
- *Solution*—provides a detailed description of the solution proposed for the problem
- *Intent*—describes the pattern and what it does
- *Collaborations*—describes how other patterns contribute to the solution
- *Consequences*—describes the potential trade-offs that must be considered when the pattern is implemented and the consequences of using the pattern
- *Implementation*—identifies special issues that should be considered when implementing the pattern
- *Known uses*—provides examples of actual uses of the design pattern in real applications
- *Related patterns*—cross-references related design patterns

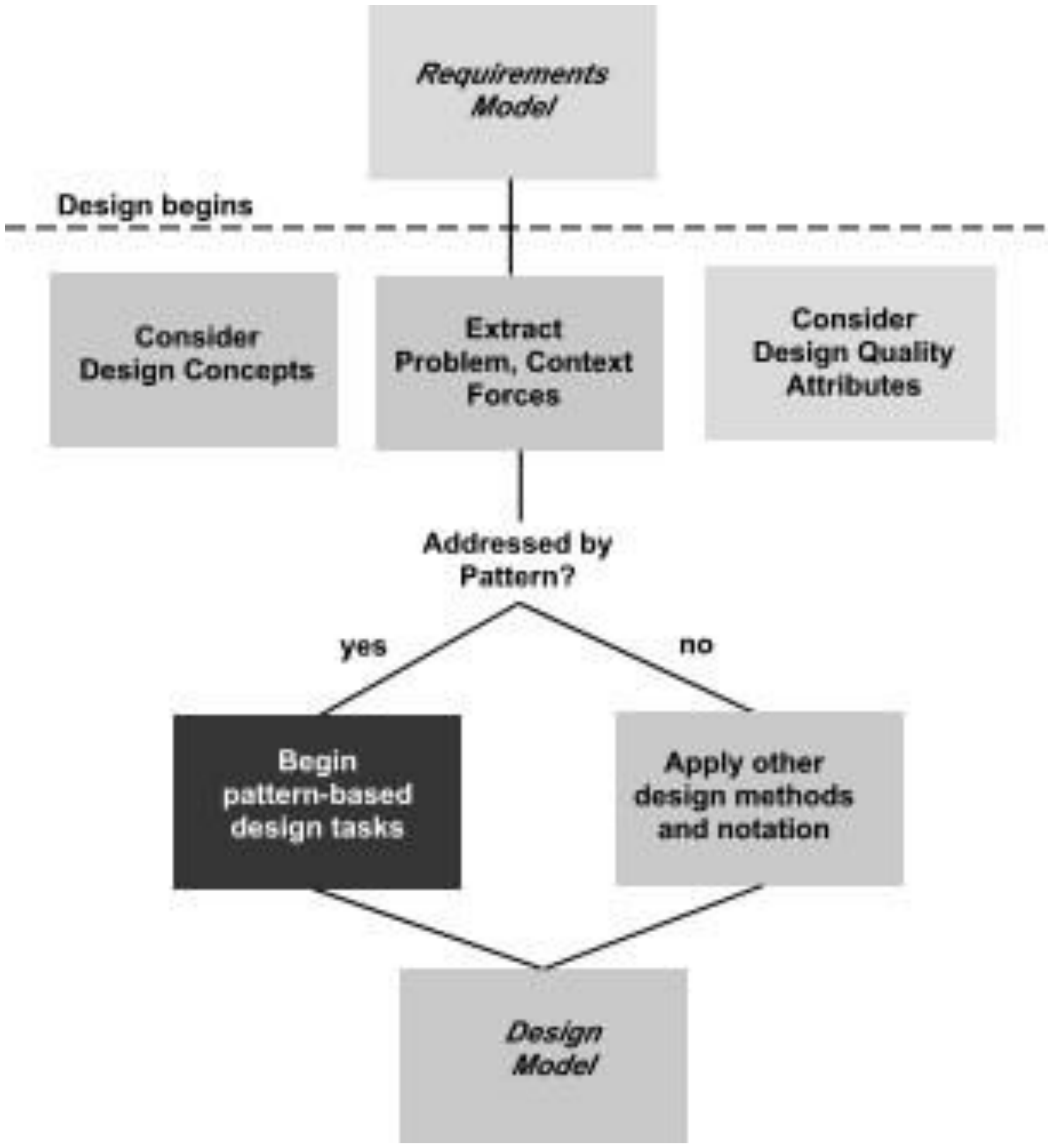
Pattern Languages

- A *pattern language* encompasses a collection of patterns
  - each described using a standardized template and
  - interrelated to show how these patterns collaborate to solve problems across an application domain.
- a pattern language is analogous to a hypertext instruction manual for problem solving in a specific application domain.
  - The problem domain under consideration is first described hierarchically, beginning with broad design problems associated with the domain and then refining each of the broad problems into lower levels of abstraction
  - http://www.corej2eepatterns.com/

Pattern-Based Design

- A software designer begins with a requirements model (either explicit or implied) that presents an abstract representation of the system.
- The requirements model describes the problem set, establishes the context, and identifies the system of forces that hold sway.
- Then …

Pattern-Based Design



Requirements Model
Design begins
Consider Design Concepts
Extract Problem, Context Forces
Consider Design Quality Attributes
Addressed by Pattern?
yes
no
Begin pattern-based design tasks
Apply other design methods and notation
Design Model

Thinking in Patterns

- Shalloway and Trott [Sha05] suggest the following approach that enables a designer to think in patterns:
  - 1. Be sure you understand the big picture—the context in which the software to be built resides. The requirements model should communicate this to you.
  - 2. Examining the big picture, extract the patterns that are present at that level of abstraction.
  - 3. Begin your design with 'big picture' patterns that establish a context or skeleton for further design work.
  - 4. "Work inward from the context" [Sha05] looking for patterns at lower levels of abstraction that contribute to the design solution.
  - 5. Repeat steps 1 to 4 until the complete design is fleshed out.
  - 6. Refine the design by adapting each pattern to the specifics of the software you're trying to build.

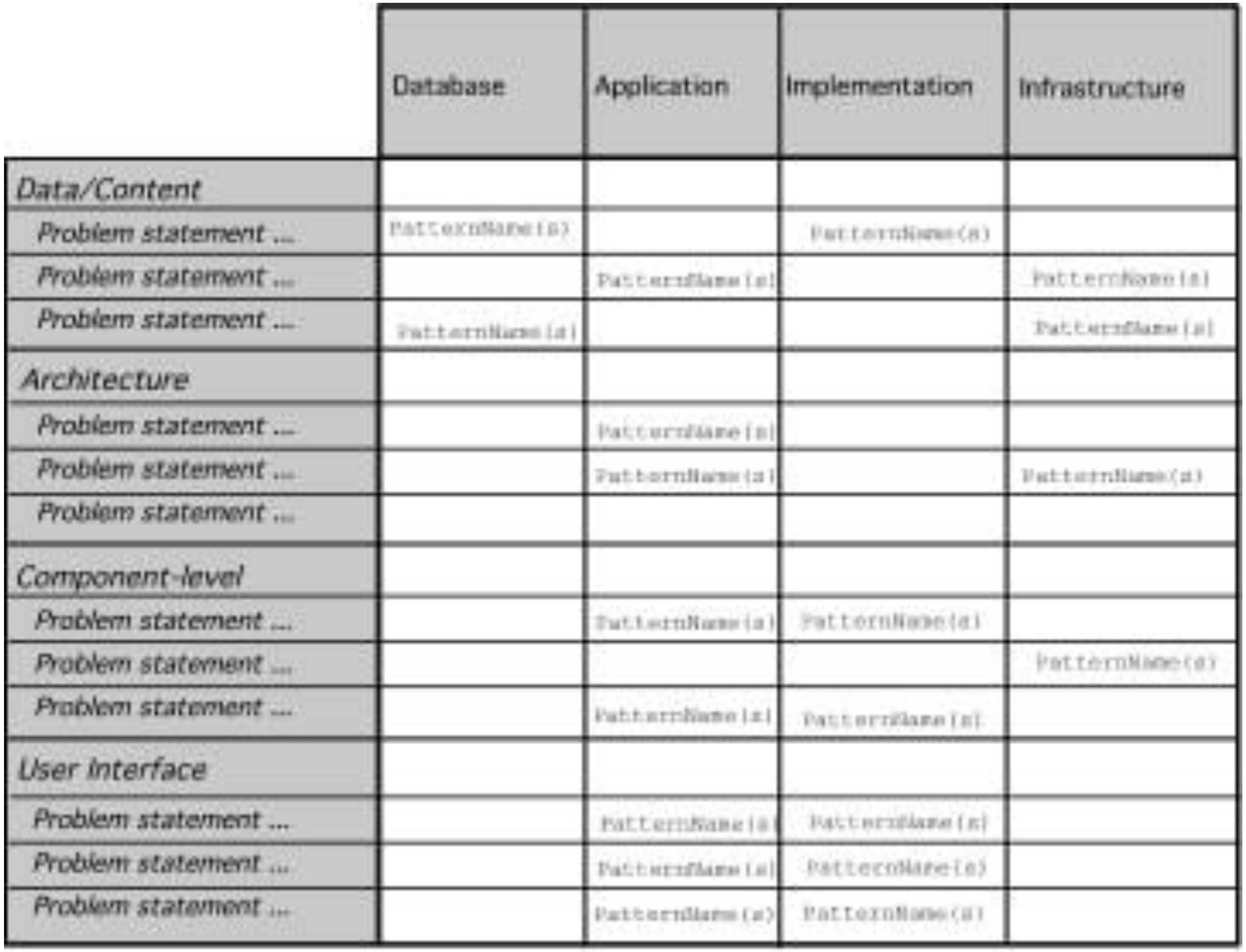
Design Tasks—I

- Examine the requirements model and develop a problem hierarchy.
- Determine if a reliable pattern language has been developed for the problem domain.
- Beginning with a broad problem, determine whether one or more architectural patterns are available for it.
- Using the collaborations provided for the architectural pattern, examine subsystem or component level problems and search for appropriate patterns to address them.
- Repeat steps 2 through 5 until all broad problems have been addressed.

Design Tasks—II

- If user interface design problems have been isolated (this is almost always the case), search the many user interface design pattern repositories for appropriate patterns.
- Regardless of its level of abstraction, if a pattern language and/or patterns repository or individual pattern shows promise, compare the problem to be solved against the existing pattern(s) presented.
- Be certain to refine the design as it is derived from patterns using design quality criteria as a guide.

Pattern Organizing Table



	Database	Application	Implementation	Infrastructure
Data/Content				
Problem statement ...	PatternName(s)		PatternName(s)	
Problem statement ...		PatternName(s)		PatternName(s)
Problem statement ...	PatternName(s)			PatternName(s)
Architecture				
Problem statement ...		PatternName(s)		
Problem statement ...		PatternName(s)		PatternName(s)
Problem statement ...				
Component-level				
Problem statement ...		PatternName(s)	PatternName(s)	
Problem statement ...				PatternName(s)
Problem statement ...		PatternName(s)	PatternName(s)	
User Interface				
Problem statement ...		PatternName(s)	PatternName(s)	
Problem statement ...		PatternName(s)	PatternName(s)	
Problem statement ...		PatternName(s)	PatternName(s)	

Common Design Mistakes

- Not enough time has been spent to understand the underlying problem, its context and forces, and as a consequence, you select a pattern that looks right, but is inappropriate for the solution required.
- Once the wrong pattern is selected, you refuse to see your error and force fit the pattern.
- In other cases, the problem has forces that are not considered by the pattern you've chosen, resulting in a poor or erroneous fit.
- Sometimes a pattern is applied too literally and the required adaptations for your problem space are not implemented.

Architectural Patterns

- Example: every house (and every architectural style for houses) employs a **Kitchen** pattern.
- The **Kitchen** pattern and patterns it collaborates with address problems associated with the storage and preparation of food, the tools required to accomplish these tasks, and rules for placement of these tools relative to workflow in the room.
- In addition, the pattern might address problems associated with counter tops, lighting, wall switches, a central island, flooring, and so on.
- Obviously, there is more than a single design for a kitchen, often dictated by the context and system of forces. But every design can be conceived within the context of the 'solution' suggested by the **Kitchen** pattern.

Patterns Repositories

- There are many sources for design patterns available on the Web. Some patterns can be obtained from individually published pattern languages, while others are available as part of a patterns portal or patterns repository.
- A list of patterns repositories is presented in the sidebar (see section 12.3 of textbook)

Component-Level Patterns

- Component-level design patterns provide a proven solution that addresses one or more sub-problems extracted from the requirement model.
- In many cases, design patterns of this type focus on some functional element of a system.
- For example, the **SafeHomeAssured.com** application must address the following design sub-problem: *How can we get product specifications and related information for any SafeHome device?*

Component-Level Patterns

- Having enunciated the sub-problem that must be solved, consider context and the system of forces that affect the solution.
- Examining the appropriate requirements model use case, the specification for a *SafeHome* device (e.g., a security sensor or camera) is used for informational purposes by the consumer.
  - » However, other information that is related to the specification (e.g., pricing) may be used when e-commerce functionality is selected.
- The solution to the sub-problem involves a **search.** Since searching is a very common problem, it should come as no surprise that there are many search-related patterns.
- See Section 12.4 of textbook

User Interface (UI) Patterns

- **Whole UI.** Provide design guidance for top-level structure and navigation throughout the entire interface.
- **Page layout.** Address the general organization of pages (for Websites) or distinct screen displays (for interactive applications)
- **Forms and input.** Consider a variety of design techniques for completing form-level input.
- **Tables.** Provide design guidance for creating and manipulating tabular data of all kinds.
- **Direct data manipulation.** Address data editing, modification, and transformation.
- **Navigation.** Assist the user in navigating through hierarchical menus, Web pages, and interactive display screens.
- **Searching.** Enable content-specific searches through information maintained within a Web site or contained by persistent data stores that are accessible via an interactive application.
- **Page elements.** Implement specific elements of a Web page or display screen.
- **E-commerce.** Specific to Web sites, these patterns implement recurring elements of e-commerce applications.

WebApp Patterns

- **Information architecture patterns** relate to the overall structure of the information space, and the ways in which users will interact with the information.
- **Navigation patterns** define navigation link structures, such as hierarchies, rings, tours, and so on.
- **Interaction patterns** contribute to the design of the user interface. Patterns in this category address how the interface informs the user of the consequences of a specific action; how a user expands content based on usage context and user desires; how to best describe the destination that is implied by a link; how to inform the user about the status of an on-going interaction, and interface related issues.
- **Presentation patterns** assist in the presentation of content as it is presented to the user via the interface. Patterns in this category address how to organize user interface control functions for better usability; how to show the relationship between an interface action and the content objects it affects, and how to establish effective content hierarchies.
- **Functional patterns** define the workflows, behaviors, processing, communications, and other algorithmic elements within a WebApp.

Design Granularity

- When a problem involves "big picture" issues, attempt to develop solutions (and use relevant patterns) that focus on the big picture.
- Conversely, when the focus is very narrow (e.g., uniquely selecting one item from a small set of five or fewer items), the solution (and the corresponding pattern) is targeted quite narrowly.
- In terms of the level of granularity, patterns can be described at the following levels:

Design Granularity

- **Architectural patterns.** This level of abstraction will typically relate to patterns that define the overall structure of the WebApp, indicate the relationships among different components or increments, and define the rules for specifying relationships among the elements (pages, packages, components, subsystems) of the architecture.
- **Design patterns.** These address a specific element of the design such as an aggregation of components to solve some design problem, relationships among elements on a page, or the mechanisms for effecting component to component communication. An example might be the *Broadsheet* pattern for the layout of a WebApp homepage.
- **Component patterns.** This level of abstraction relates to individual small-scale elements of a WebApp. Examples include individual interaction elements (e.g. radio buttons, text books), navigation items (e.g. how might you format links?) or functional elements (e.g. specific algorithms).

Agenda

Summary – From Analysis and Design to Software Architecture (Part I) – 1/2

- All design work products must be traceable to software requirements and that all design work products must be reviewed for quality
- Software projects iterate through the analysis and design phases several times
- Pure separation of analysis and design may not always be possible or desirable
- There are many significant design concepts (abstraction, refinement, modularity, architecture, patterns, refactoring, functional independence, information hiding, and OO design concepts)
- Design changes are inevitable and that delaying component level design can reduce the impact of these changes

Summary – From Analysis and Design to Software Architecture (Part I) – 2/2

- The goal of the architectural model is to allow the software engineer to view and evaluate the system as a whole before moving deeper into design
- At the architecture level, data design is the process of creating a model of the information represented at a high level of abstraction (using the customer's view of data)
- An architectural style is a transformation that is imposed on the design of an entire system

Course Assignments

- Individual Assignments
  - Reports based on case studies / class presentations
- Project-Related Assignments
  - All assignments (other than the individual assessments) will correspond to milestones in the team project.
  - As the course progresses, students will be applying various methodologies to a project of their choice. The project and related software system should relate to a real-world scenario chosen by each team. The project will consist of inter-related deliverables which are due on a (bi-) weekly basis.
  - There will be only one submission per team per deliverable and all teams must demonstrate their projects to the course instructor.
  - A sample project description and additional details will be available under handouts on the course Web site

Team Project

- Project Logistics
  - Teams will pick their own projects, within certain constraints: for instance, all projects should involve multiple distributed subsystems (e.g., web-based electronic services projects including client, application server, and database tiers). Students will need to come up to speed on whatever programming languages and/or software technologies they choose for their projects - which will not necessarily be covered in class.
  - Students will be required to form themselves into "pairs" of exactly two (2) members each; if there is an odd number of students in the class, then one (1) team of three (3) members will be permitted. There may <u>not</u> be any "pairs" of only one member! The instructor and TA(s) will then assist the pairs in forming "teams", ideally each consisting of two (2) "pairs", possibly three (3) pairs if necessary due to enrollment, but students are encouraged to form their own 2-pair teams in advance. If some students drop the course, any remaining pair or team members may be arbitrarily reassigned to other pairs/teams at the discretion of the instructor (but are strongly encouraged to reform pairs/teams on their own). Students will develop and test their project code together with the other member of their programming pair.

Team Project Approach - Overall

- Document Transformation methodology driven approach
  - Strategy Alignment Elicitation
    - Equivalent to strategic planning
      - i.e., planning at the level of a project set
  - Strategy Alignment Execution
    - Equivalent to project planning + SDLC
      - i.e., planning a the level of individual projects + project implementation
- Build a methodology Wiki & partially implement the enablers
- Apply transformation methodology approach to a sample problem domain for which a business solution must be found
- Final product is a wiki/report that focuses on
  - Methodology / methodology implementation / sample business-driven problem solution

Team Project Approach – Initial Step

- Document sample problem domain and business-driven problem of interest
  - Problem description
  - High-level specification details
  - High-level implementation details
  - Proposed high-level timeline

Course Project

- Project Logistics
  - Teams will pick their own projects, within certain constraints: for instance, all projects should involve multiple distributed subsystems (e.g., web-based electronic services projects including client, application server, and database tiers). Students will need to come up to speed on whatever programming languages and/or software technologies they choose for their projects - which will not necessarily be covered in class.
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Sample Project Methodology
Very eXtreme Programming (VXP)

- After teams formed, 1/2 week to Project Concept
- 1/2 week to Revised Project Concept
- 2 to 3 iterations
- For each iteration:
  - » 1/2 week to plan
  - » 1 week to iteration report and demo

Sample Project Methodology
Very eXtreme Programming (VXP) - (continued)

- Requirements: Your project focuses on two application services
- Planning: User stories and work breakdown
- Doing: Pair programming, write test cases before coding, automate testing
- Demoing: 5 minute presentation plus 15 minute demo
- Reporting: What got done, what didn’t, what tests show
- 1st iteration: Any
- 2nd iteration: Use some component model framework
- 3rd iteration: Refactoring, do it right this time

Revised Project Concept (Tips)

1. Cover page (max 1 page)
2. Basic concept (max 3 pages): Briefly describe the system your team proposes to build. Write this description in the form of either user stories or use cases (your choice). Illustrations do <u>not</u> count towards page limits.
3. Controversies (max 1 page)

First Iteration Plan (Tips)

- Requirements (max 2 pages):
- Select user stories or use cases to implement in your first iteration, to produce a demo by the last week of class
- Assign priorities and points to each unit - A point should correspond to the amount of work you expect one pair to be able to accomplish within one week
- You may optionally include additional medium priority points to do “if you have time”
- It is acceptable to include fewer, more or different use cases or user stories than actually appeared in your Revised Project Concept

First Iteration Plan (Tips)

- Work Breakdown (max 3 pages):
- Refine as *engineering tasks* and assign to pairs
- Describe specifically what will need to be coded in order to complete each task
- Also describe what unit and integration tests will be implemented and performed
- You may need additional engineering tasks that do not match one-to-one with your user stories/use cases
- Map out a *schedule* for the next weeks
- Be realistic – demo has to been shown before the end of the semester

2nd Iteration Plan (Tips): Requirements

- Max 3 pages
- Redesign/reengineer your system to use a component framework (e.g., COM+, EJB, CCM, .NET or Web Services)
- Select the user stories to include in the new system
  - » Could be identical to those completed for your 1st Iteration
  - » Could be brand new (but explain how they fit)
- Aim to maintain project velocity from 1st iteration
- Consider what will require new coding vs. major rework vs. minor rework vs. can be reused “as is”

2nd Iteration Plan (Tips): Breakdown

- Max 4 pages
- Define engineering tasks, again try to maintain project velocity
- Describe new unit and integration testing
- Describe regression testing
  - » Can you reuse tests from 1st iteration?
  - » If not, how will you know you didn't break something that previously worked?
- 2nd iteration report and demo to be presented before the end of the semester

2nd Iteration Report (Tips): Requirements

- Max 2 pages
- For each engineering task from your 2nd Iteration Plan, indicate whether it succeeded, partially succeeded (and to what extent), failed (and how so?), or was not attempted
- Estimate how many user story points were actually completed (these might be fractional)
- Discuss specifically your success, or lack thereof, in porting to or reengineering for your chosen component model framework(s)

2nd Iteration Report (Tips): Testing

- Max 3 pages
- Describe the general strategy you followed for unit testing, integration testing and regression testing
- Were you able to reuse unit and/or integration tests, with little or no change, from your 1st Iteration as regression tests?
- What was most difficult to test?
- Did using a component model framework help or hinder your testing?

Project Presentation and Demo

- All Iterations Due
- Presentation slides (optional)

Assignments & Readings

- Readings
  - Slides and Handouts posted on the course web site
  - Textbook: Part Two-Chapters 6-8

- Individual Assignment (due)
  - See Session 5 Handout: “Assignment #2”
- Individual Assignment (assigned)
  - See Session 8 Handout: “Assignment #3”
- Team Project #1 (ongoing)
  - Team Project proposal (format TBD in class)
  - See Session 2 Handout: “Team Project Specification” (Part 1)
- Team Exercise #1 (ongoing)
  - Presentation topic proposal (format TBD in class)
- Project Frameworks Setup (ongoing)
  - As per reference provided on the course Web site

Any Questions?

Next Session: From Analysis and Design to Software Architecture (Part II)