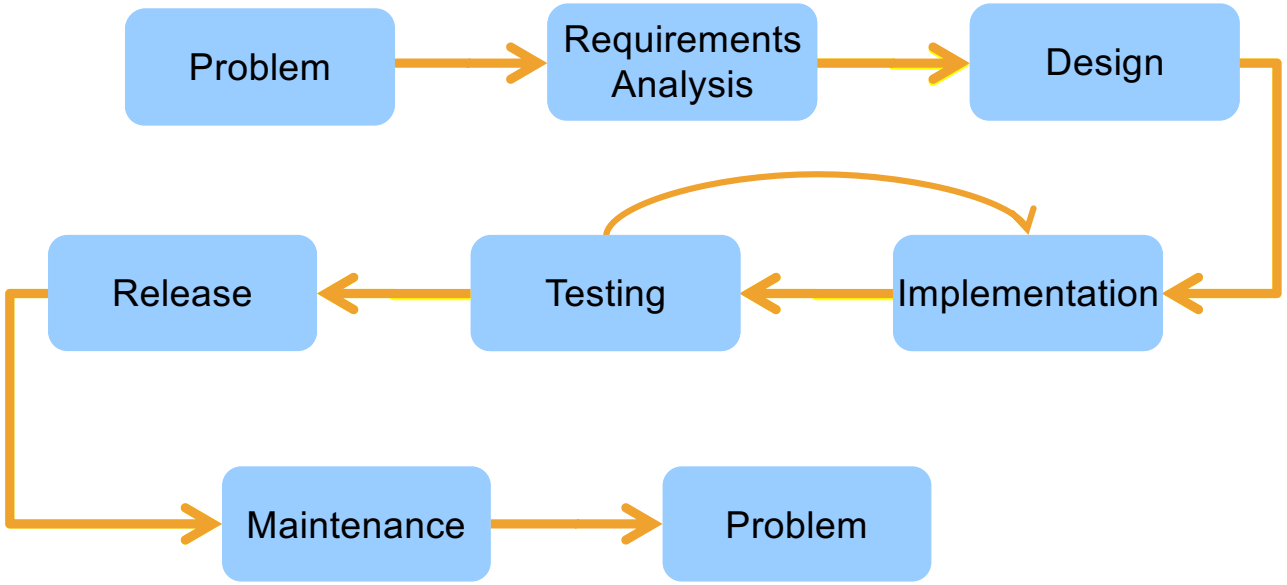
CS 4320 / 7320 Software Engineering

Design

What is the SDLC?
Where does Design fit?



Software Design Process

Two-step Process:

1. Architectural design describes how software is organized into components
2. Detailed design describes the desired **behavior** of these components

Architectural Design

1. System Architecture
    1. High level physical systems involved
    2. Connections between systems
    3. Identify dependencies
2. Data Architecture
    1. High level (Entity) descriptions of data
    2. Show the data structure (conceptual) at the entity level
    3. Illustrate critical data flows
3. Process Architecture
    1. Integrate business or user process practices into the architecture
    2. Show the touchpoints between process and technology
4. Software Architecture
    1. Software components
    2. Connections between components
    3. Key Software Subsystems (i.e., messaging hubs, databases, software components)
    4. Some of these components may also show up in the system architecture

Detailed Design

1. Software components
2. Connections between them
3. Describe behavior down to methods
4. Possibly stub methods out
5. Could include writing test cases for methods

Software Design Principles

Key notions

that are the basis for many different

software design approaches and concepts.

Software Design Principles

1. Abstraction
    - By Parameterization
    - By Specification
        - *Procedural Abstraction*
        - *Data Abstraction*
        - *Control (Iteration) Abstraction*

Software Design Principles

2. Coupling and Cohesion

   Aiming for Appropriate Coupling and High Cohesion

3. Decomposition and Modularization

   Separate functionalities and responsibilities

   Well defined interfaces

Software Design Principles

4. **Encapsulation and Information Hiding**
   Packaging implementation details together
   Restricting direct access to a component's details

5. **Separation of Interface and Implementation**
   Public interface separate from implementation details

Software Design Principles

6. **Sufficiency, Completeness, and Primitiveness**

   All important abstraction characteristics

   but nothing more

   Design based on patterns that are easy to implement

7. **Separation of Concerns**

   Architectural views specific to a group of stakeholders

Key Issues in Software Design

Important issues that cut across the whole system

1. **Concurrency**

   Think about order, sequence of actions

   Concerns: efficiency, atomicity,
   synchronization, scheduling.

Key Issues in Software Design

2. **Control and Handling of Events**
   Organize data and control flow
   Handle reactive and temporal events

3. **Data Persistence**
   How to handle long-lived data

Key Issues in Software Design

4. **Distribution of Components**
   - How to distribute software across hardware (computer and network)
   - How components communicate
   - How middleware deals with heterogeneous software

Key Issues in Software Design

5. **Error and Exception Handling and Fault Tolerance**
   Prevent, tolerate, and process errors
   Deal with exceptional conditions

6. **Interaction and Presentation**
   Structure and organize user interaction
   How to present information

Key Issues in Software Design

7. **Security**

   Prevent unauthorized disclosure, creation, change, deletion of information

   Avoid denial of access to authorized users

   How to respond to attacks

   Access control and proper use of cryptography

Software Structure and Architecture:
Architectural Design:

A problem-solving, creative process
with decisions involving trade-offs,
often on quality attributes

Software Structure and Architecture: *Architectural Styles*

General structures: layers, pipes, filters

Distributed systems: client-server, 3-tiered, broker

Interactive systems: Model-View-Controller,

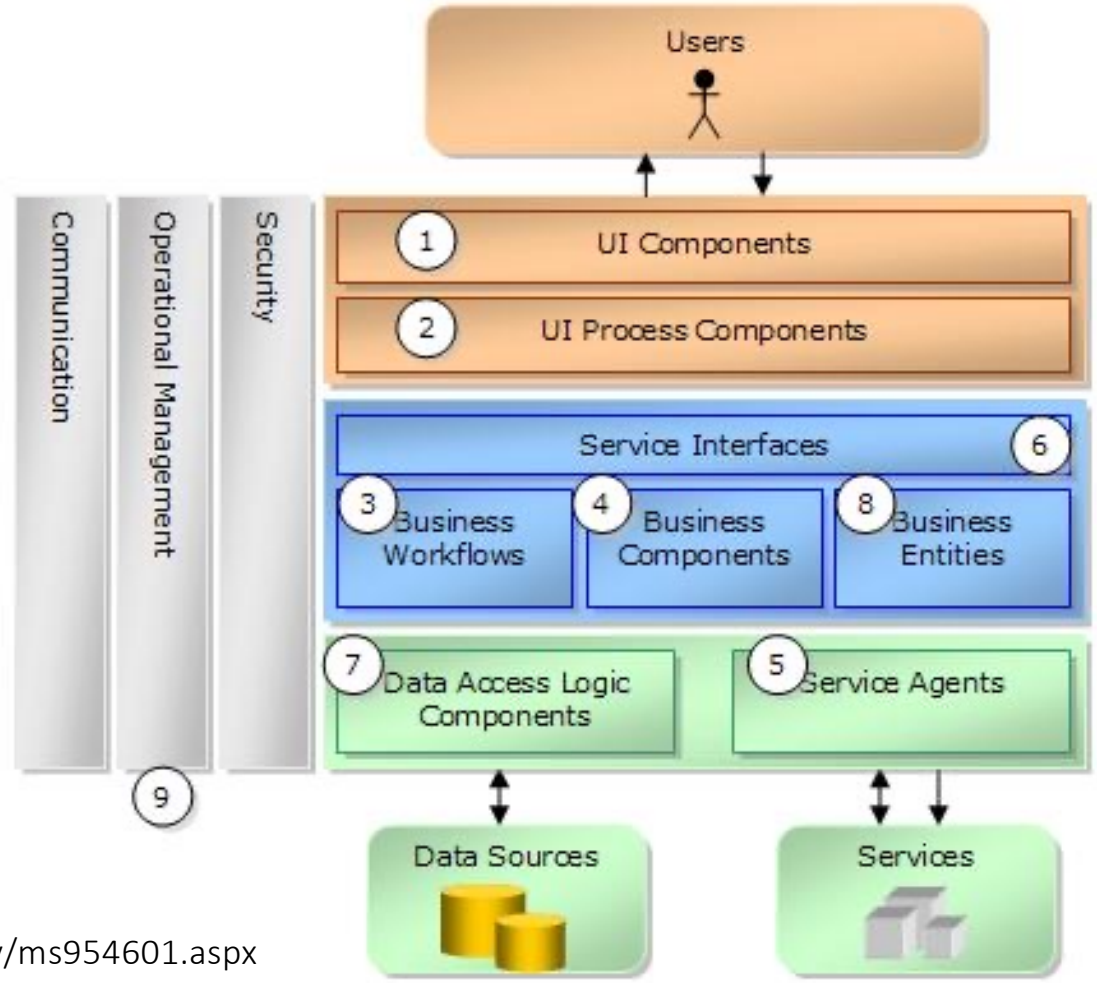
Presentation-Abstraction-Control

Others…

Software Structure and Architecture: *Architectural Styles*

What do you know about architecture styles for a typical web application?

Typical Layered Design



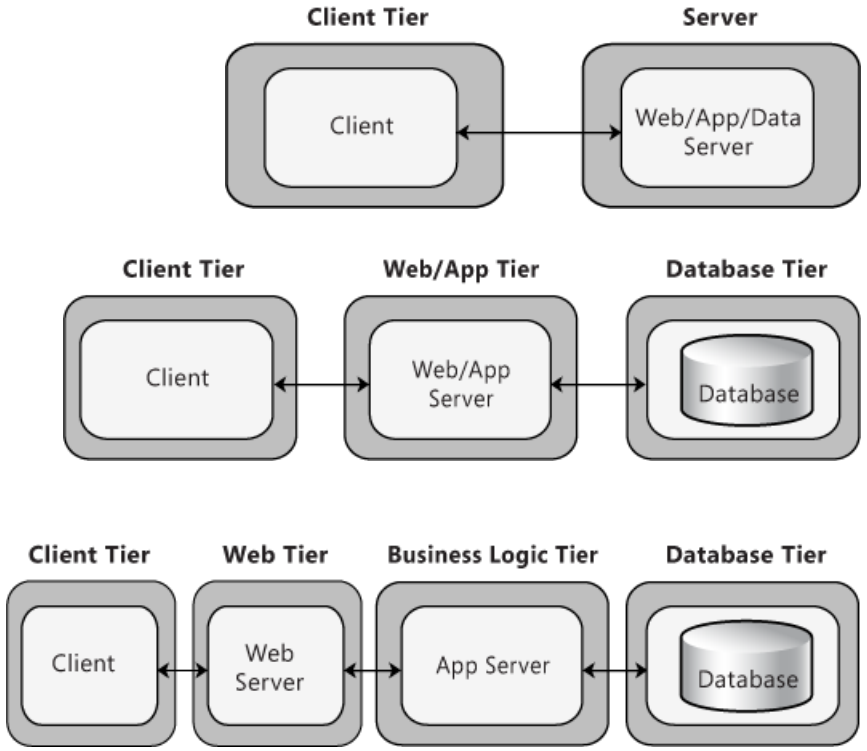
Source: https://msdn.microsoft.com/en-us/library/ms954601.aspx

Distributed Deployment Patterns

Client-Server

3-tier

4-tier



Source: https://msdn.microsoft.com/en-us/library/ee658120.aspx

Software Structure and Architecture: *Architectural Styles*

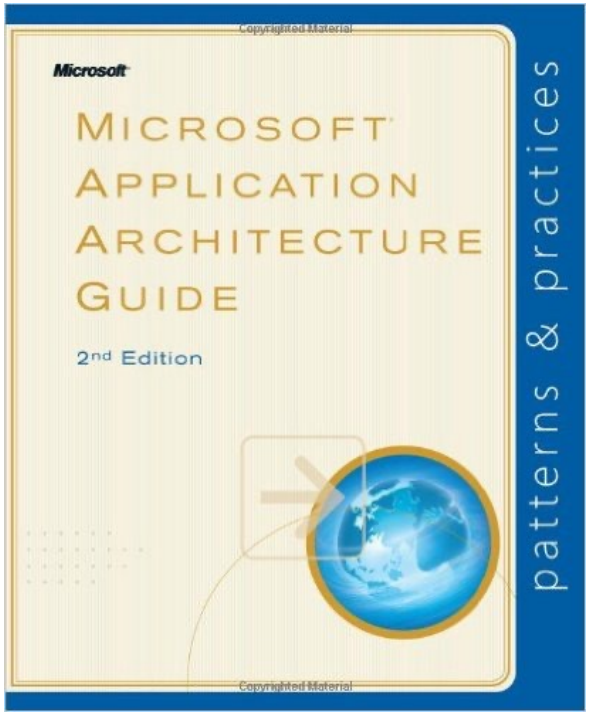
Microsoft Application Architecture Guide, 2nd Edition by Microsoft Patterns & Practices Team

ISBN-13: 978-0735627109 ISBN-10: 073562710X

Publisher: Microsoft Press (November 22, 2009)

Online Book: https://msdn.microsoft.com/en-us/library/ff650706.aspx

Chapter 3: Architectural Patterns and Styles



Software Structure and Architecture: *Design Patterns*

Common solutions to a common problem

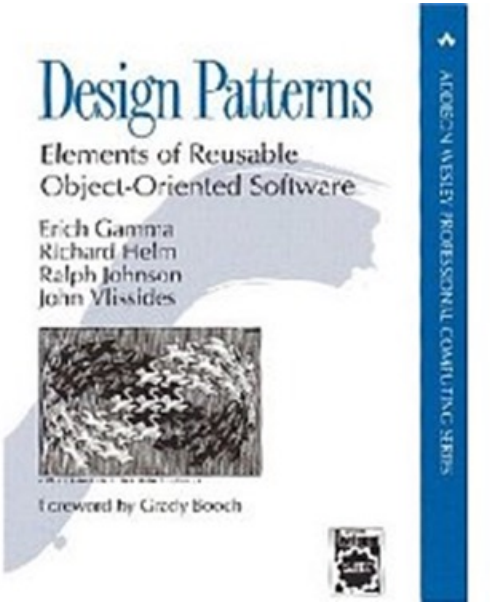
Object-oriented design patterns

- Creational: builder, factory, prototype, singleton
- Structural: adapter, bridge, composite, façade, proxy
- Behavioral: command, interpreter, iterator, observer

Software Structure and Architecture: *Design Patterns*

Design Patterns: Elements of Reusable Object-Oriented Software by ErichGamma, RichardHelm, RalphJohnson, and JohnVlissides (the GangOfFour)
ISBN 978-0201633610, ISBN 0-201-63361-2
Publisher: AddisonWesley Professional (November 10, 1994)

http://wiki.c2.com/?DesignPatternsBook



Software Structure and Architecture: *Frameworks*

Framework:

A software system providing some generic functionality to facilitate development of software solutions.

Examples: Sprint MVC (java), .Net Framework (Microsoft), Django (python), Bootstrap (html, css, js), *many, many, more….*

User Interface Design: *General Principles*

First, know your users. Then consider…

- Learnability
  - User familiarity
    - Consistency
      - Minimal surprise
        - Recoverability (from errors)
          - User guidance (feedback)
            - User diversity (accessibility)

User Interface Design:

https://www.usability.gov/what-and-why/user-interface-design.html

https://www.w3.org/WAI/intro/accessibility.php

References

P. Bourque and R. E. Fairley, Eds., SWEBOK v3.0: Guide to the Software Engineering Body of Knowledge, IEEE, 2014.