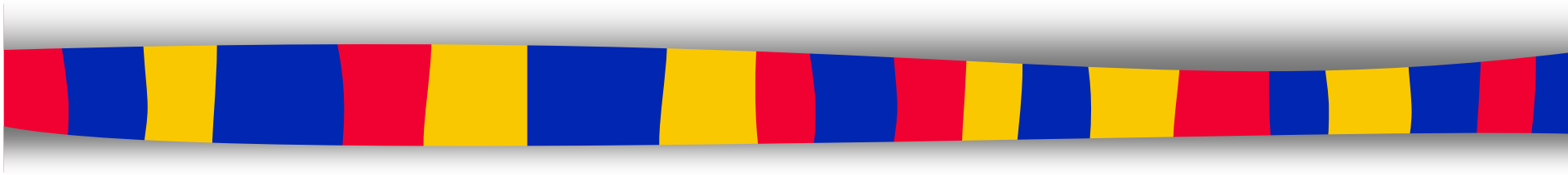
CISC 322

Software Architecture



Lecture 13:

Midterm Review

Emad Shihab

Course Content

- Requirements
- Architectural Styles
- Architecture Recovery
- Design Patterns
- Project Scheduling
- Software Estimation

Requirements

Software Requirements

- "*Requirements are…a specification of **what should be implemented**. They are descriptions of how the system should behave, or of a system property or attribute. They may be a constraint on the development process of the system.*"
(Sommerville and Sawyer 1997, Karl E. Wiegers 1999)

Where Do Requirements Come From?

- Requirements come from users and stakeholders who have demands/needs
- An analyst/requirement engineer:

1. **Elicits** these demands/needs (raw requirements)

2. **Analyzes** them for consistency, feasibility, and completeness

3. **Formulates** them as requirements and write down a specification

4. **Validates** that the gathered requirements reflect the needs/demands of stakeholders

Types of Requirements

- **Functional Requirements**
  - Specify the function of the system
  - F(input, system state) → (output, new state)

- **Non-Functional Requirements (Constraints)**
  - **Quality Requirements**
    - Specify how well the system performs its intended functions
    - Reliable, Portable, etc…
  - **Managerial Requirements**
    - Legal responsibilities
  - **Context / Environment Requirements**
    - Conditions in which the system should operate

Quality Attributes

Quality Attributes

- Architects are often told:
  - “My application must be fast/secure/scale”

Quality attributes

- We want **precise/measurable** goals

What are Quality Attributes

- Often know as –ilities
  - Performance
  - Scalability
  - Modifiability
  - Availability
  - …

Performance

- Different ways to measure performance:
  - Throughput
    - Transaction per min, Messages PM)
      - Average? (Video streaming)
      - Peak? (Bidding)
  - Response Time
    - Delay or Latency
      - Guaranteed? (VOIP)
      - Average? (Search)
  - Deadlines
    - Payroll task must complete by 2 AM

Scalability

- ‘How well a solution to some problem will work when the **size of the problem increases**’
  - Request Load (# of simultaneous requests)
  - Connections (# of simultaneous connections)
  - Data size (text vs. video messages)
  - Deployment (installation of new users)

Modifiability

- Modifiability measures how easy it **MAY** be to change an application
- Architect asserts likely change scenarios
- Some general rules
  - Minimizing dependencies
  - Avoid ripple effects!

Availability

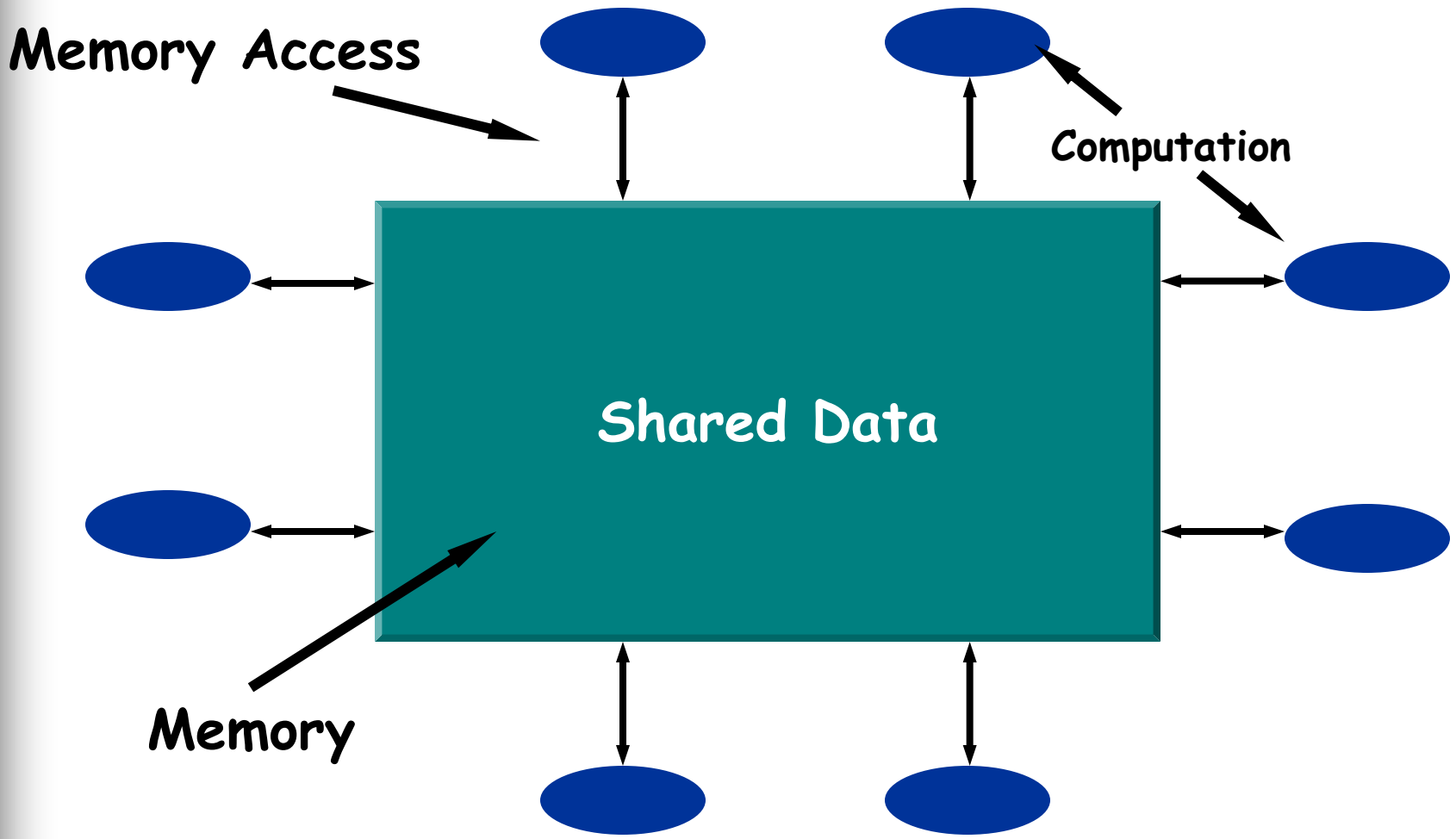
- The proportion of the required time the system is useable
  - E.g.,100% available during business hours
- Some general rules:
  - Eliminate single points of failure
  - Replication and failover

Security Approaches

- **Authentication**
  - Verify the identity of users
- **Authorization**
  - Access rights
- **Encryption**
  - Messages sent to/from application are encrypted
- **Integrity**
  - Contents are not altered in transit
- **Many others…**

Architectural Styles

Repository Style



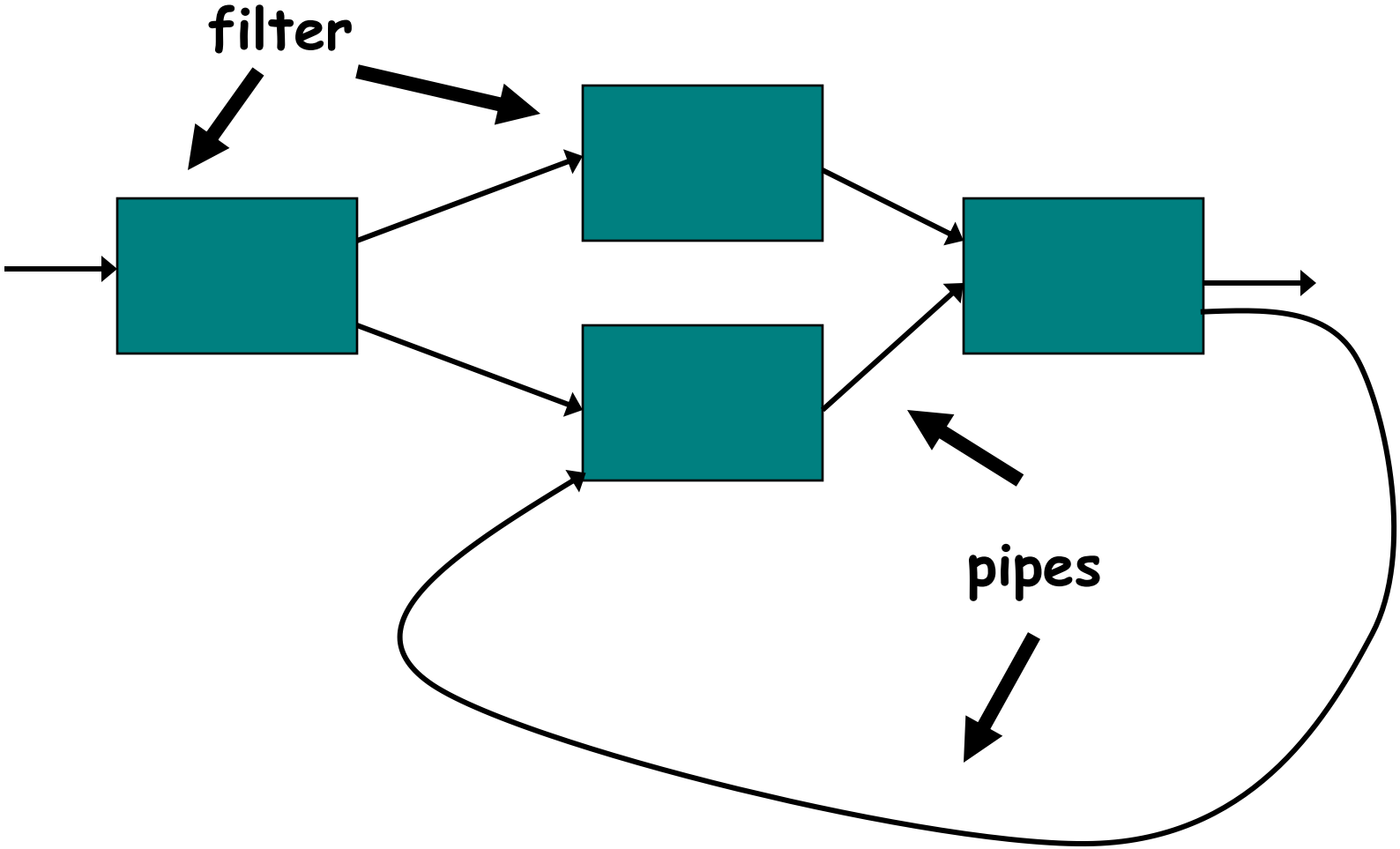
Repository Style Advantages

- Efficient way to store large amounts of data
- Can easily share data
- Centralized management:
  - Backup, security, etc…
- Solutions to complex problem do not have to be preplanned

Repository Style Disadvantages

- Must agree on a data model a priori
- Difficult to distribute data
- Changing data schema is expensive

Pipe and Filter Architectural Style



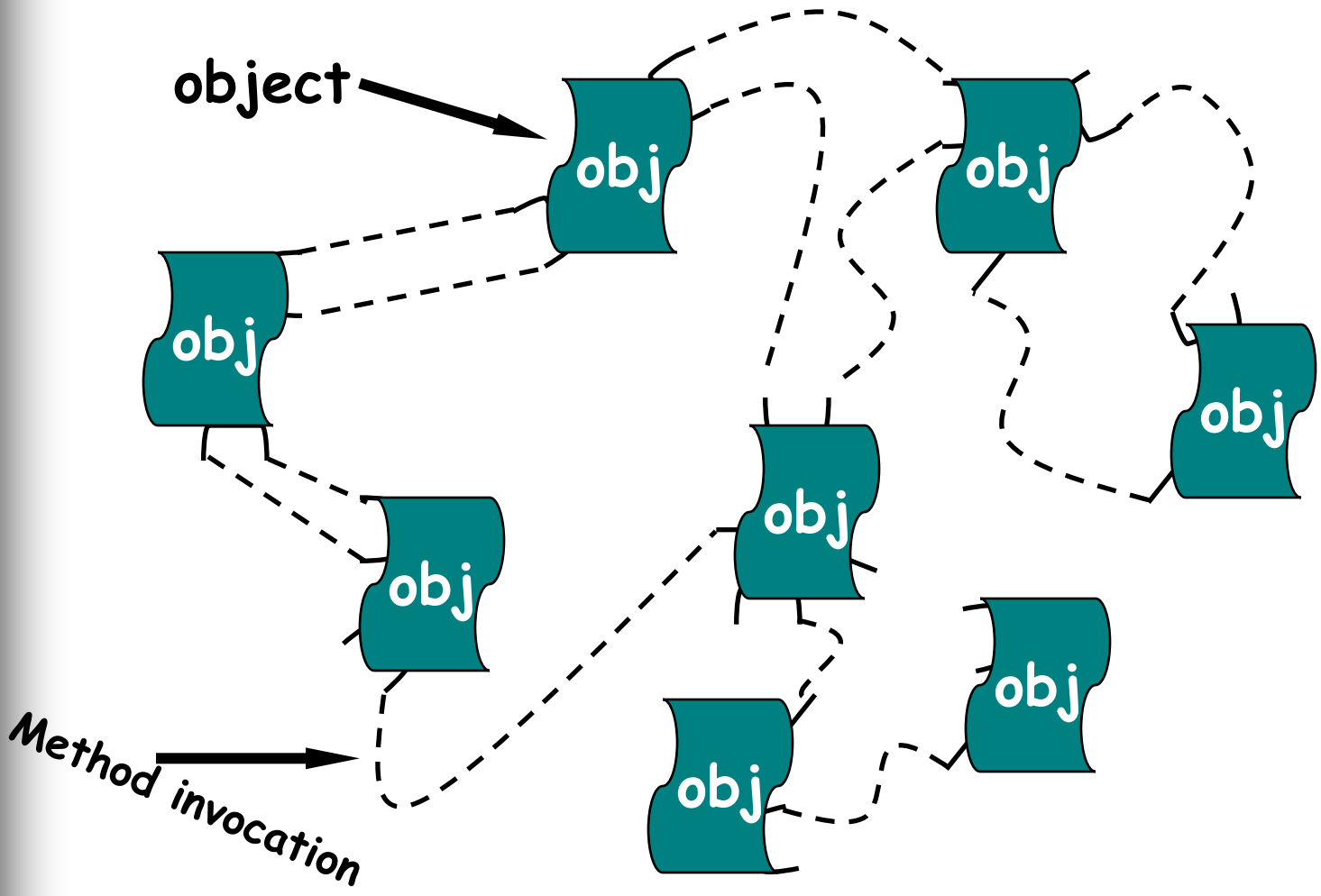
Pipe and Filter Advantages

- Easy to understand the overall input/output behavior of a system
- Support reuse since any two filters can be hooked together, provided they agree on the data that is being transmitted between them
- Systems can be easily maintained and enhanced - new filters can be added or old filters can be replaced

Pipe and Filter Disadvantages

- Not good choice for interactive systems, because of their transformational character
- Excessive parsing and unparsing leads to loss of performance and increased complexity in writing the filters themselves

Object-Oriented Style



Object-Oriented Advantages

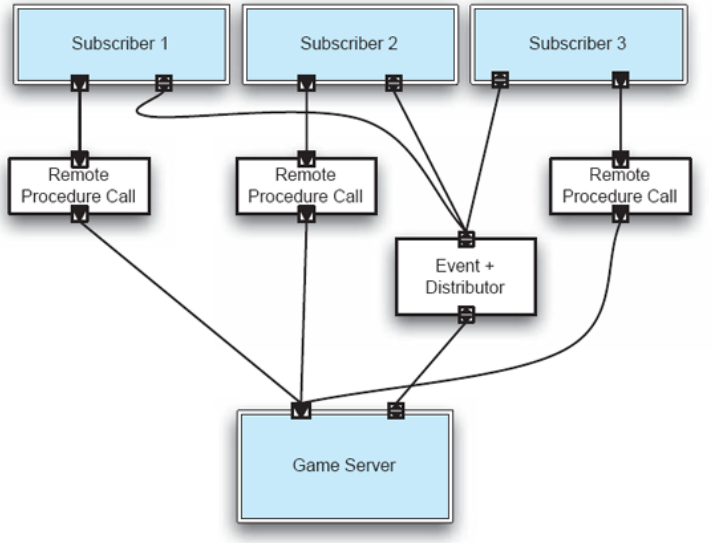
- Object can change the implementation without affecting its clients
- Can design systems as collections of autonomous interacting agents

Object-Oriented Disadvantages

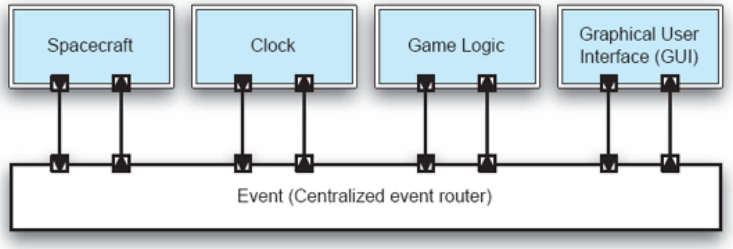
- Objects need to identify other objects they want to interact with
  - Contrast with *Pipe and Filter* Style
  - What if identity of an object changes?
- Objects cause side effect problems:
  - *E.g., A* and *B* both use object *C*, then *B*'s effects on *C* look like unexpected side effects to *A*.

Taylor et al. 2010

Implicit Invocation Style



Publish-Subscribe



Event Based

Implicit Invocation Advantages

- (PS) Efficient dissemination of one-way information
- Provides strong support for reuse
  - Any component can be added, by registering/subscribing for events
- Eases system evolution
  - components may be replaced without affecting other components in the system

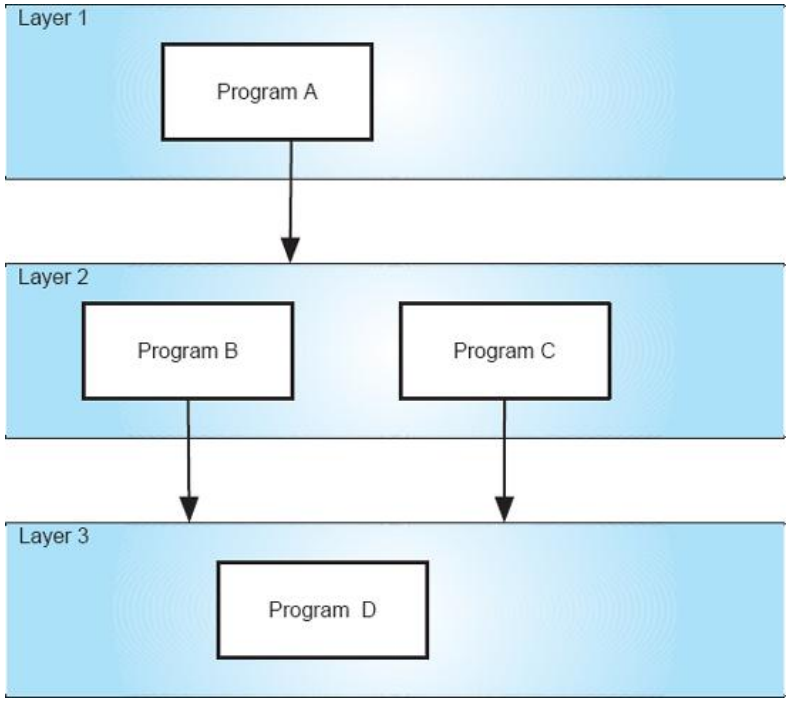
Implicit Invocation Disadvantages

- (PS) Need special protocols when number of subscribers is very large

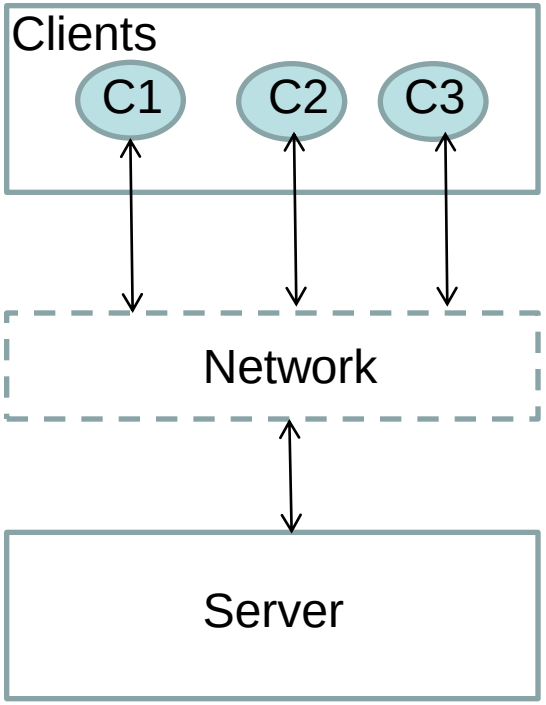
- When a component announces an event:
  - it has no idea what other components will respond to it,
  - it cannot rely on the order in which the responses are invoked
  - it cannot know when responses are finished

Adapted from
Taylor et al. 2010

Layered Style



Virtual Machine



Client-Server

Layered Style Advantages

- **VM**
  - Clear dependence structure
  - Upper levels immune to changes at lower levels
  - Lower levels are independent of upper levels
- **CS**
  - Centralization of computation and data at server
  - Single powerful server can serve many clients

Layered Style Disadvantages

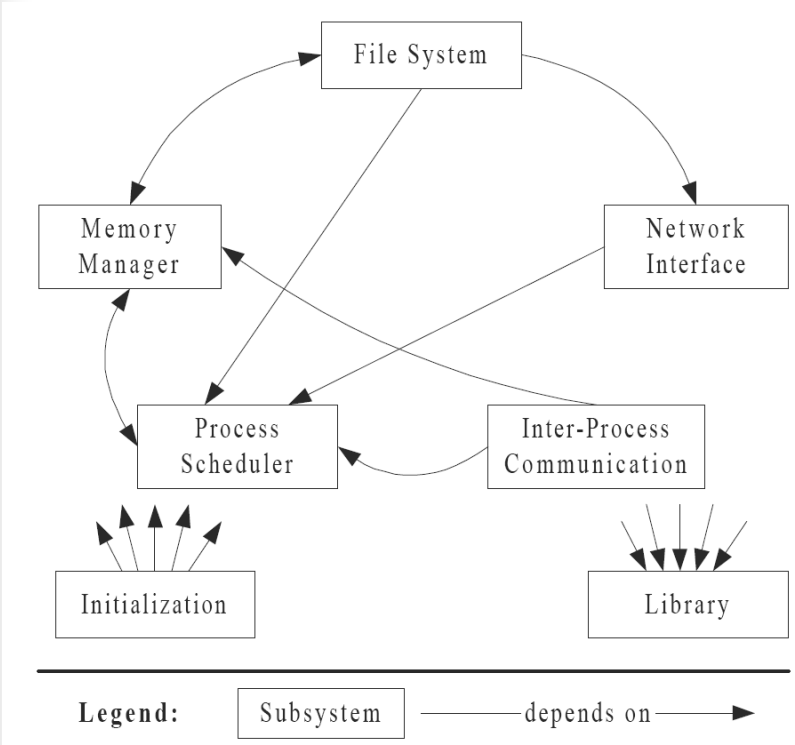
- **VM**
  - Having too many layers can be inefficient (may need to cross layers)
  - Not easy to divide software systems into layers
- **CS**
  - Heavy dependence on communication network

Architecture Recovery

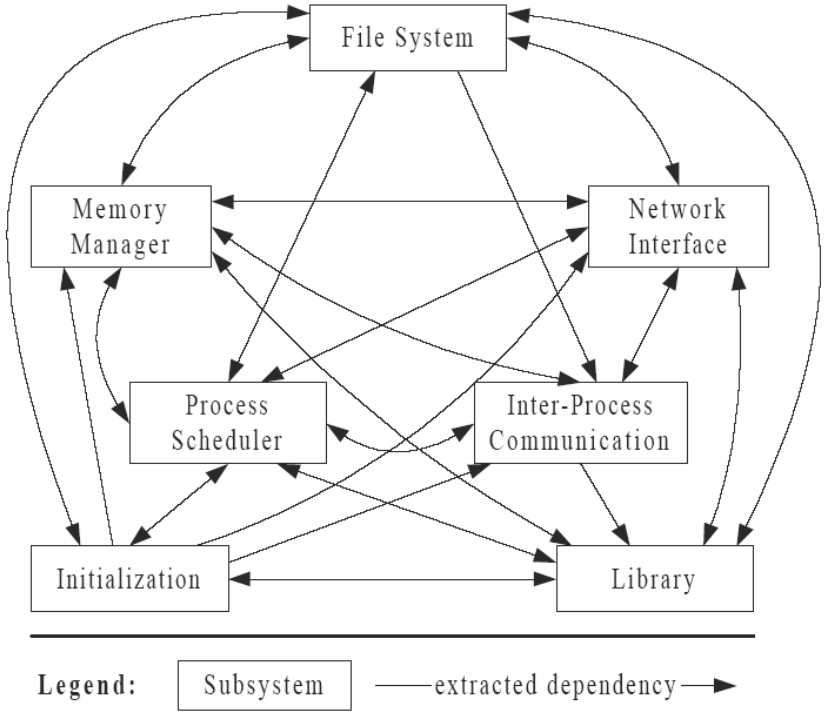
Conceptual vs. Concrete vs. Reference

- **Conceptual architecture**:
  - shows how developers think about a system
- **Concrete architecture**:
  - shows the actual relationships in the system
- **Reference architecture:**
  - General architecture for a specific domain

Linux Architecture



Conceptual Architecture

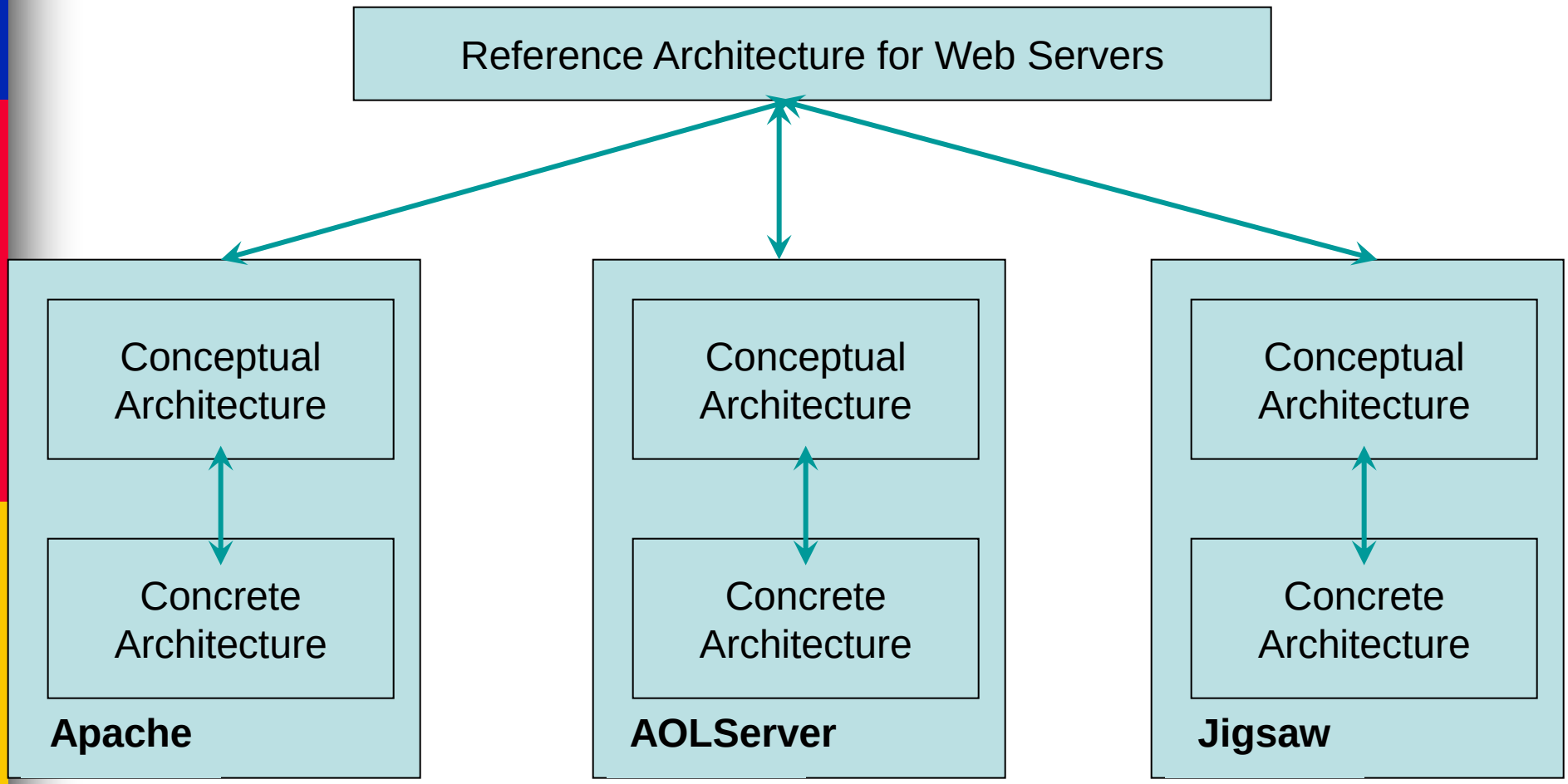


Concrete Architecture

Why the Extra Dependencies?

- Developers avoid existing interfaces to achieve better efficiency
- Expediency

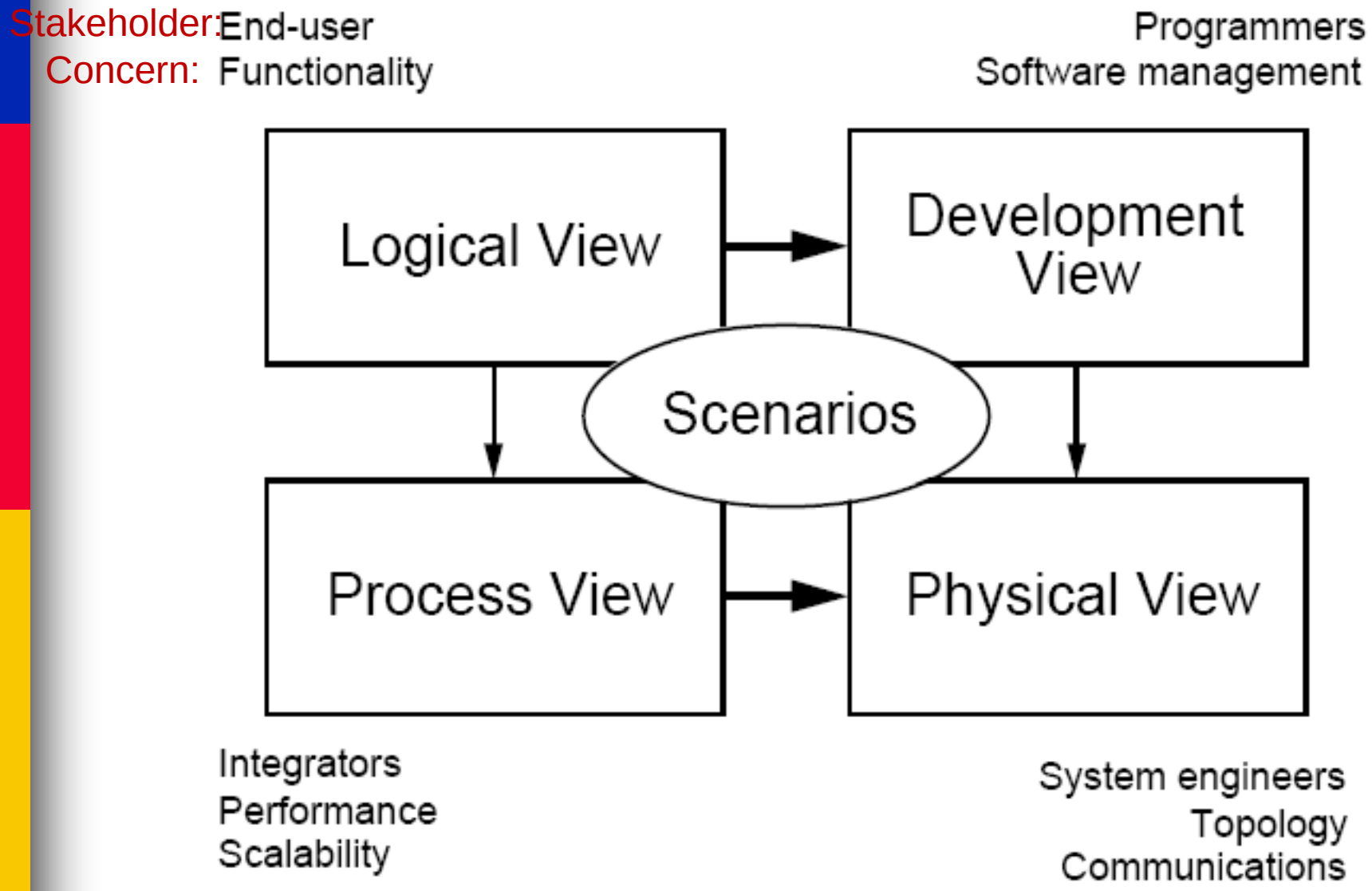
Reference Architecture Derivation Process



Architecture Views

- Various parts of the architecture have to be modeled using different approaches
- **View:** is a set of design decisions related to a common concern (or set of concerns)
- **Concern:** is an aspect of the system that a stakeholder cares about

Architectural Views



Midterm

- Friday, Oct 14, BIOSCI 1120
- 50 minutes
- 2 questions:
  - 1 short answers with 5 sub-questions
  - 1 architecture design
- 70 marks in total

Midterm

- Topics covered
  - Requirements (~15%)
  - Architectural styles (~55%)
  - Conceptual, Concrete and Reference architecture (~20%)
  - Architectural views (~10%)
- Review notes, readings, EOC questions, and class activities
- Email or come and see me if you have any questions