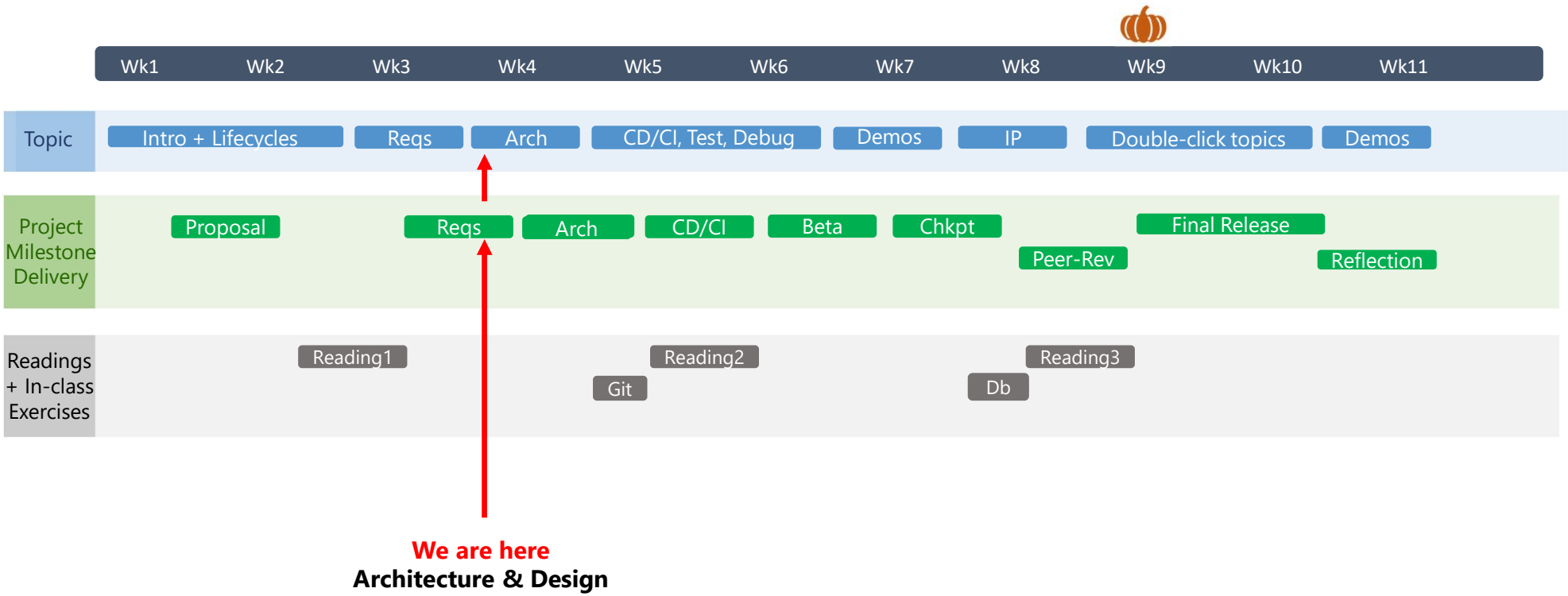
Architecture and Design

CSE 403 Software Engineering

Autumn 2023

We are moving through the SDLC components



Questions about GitHub

Class flow -> Requirements -> Architecture -> Version control (git), CD/CI

But in practice!

- Need to be doing some of github setup in parallel
- Public/private is your decision, but staff need to have access
- Resources, as well as your TAs:
  - **Projects tab** on class website
  - **Assignments**, especially **Git-Testing-CI** assignment
  - Great material online and videos, including
    - **Git, GitHub, and GitHubDesktop** for beginners (youtube) (https://www.youtube.com/watch?v=8Dd7KRpKeaE)
    - **Git tutorial** (https://git-scm.com/docs/gittutorial), and
    - **Becoming a Git Guru** (https://www.atlassian.com/git/tutorials)

Today's Outline

Architecture

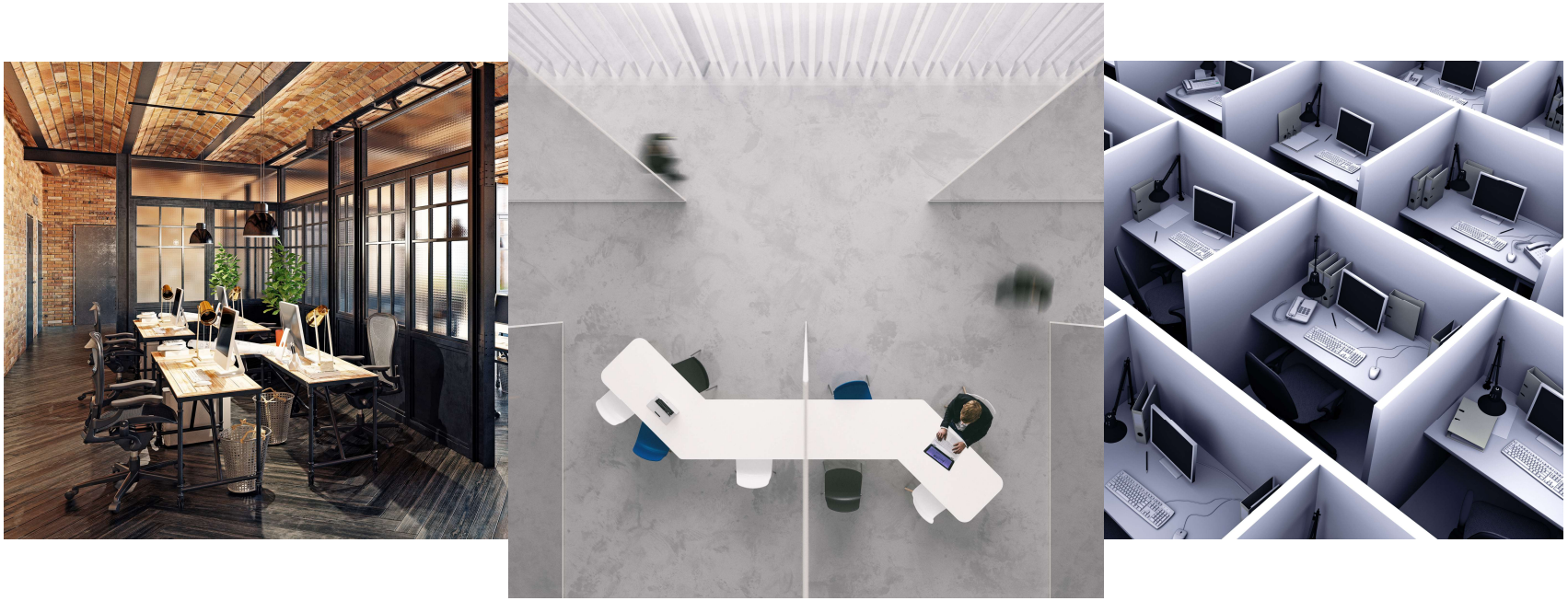
1. What do we mean by architecture
2. How does it differ from design
3. What are some common architectures used in software

What does "Architecture" make you think of?

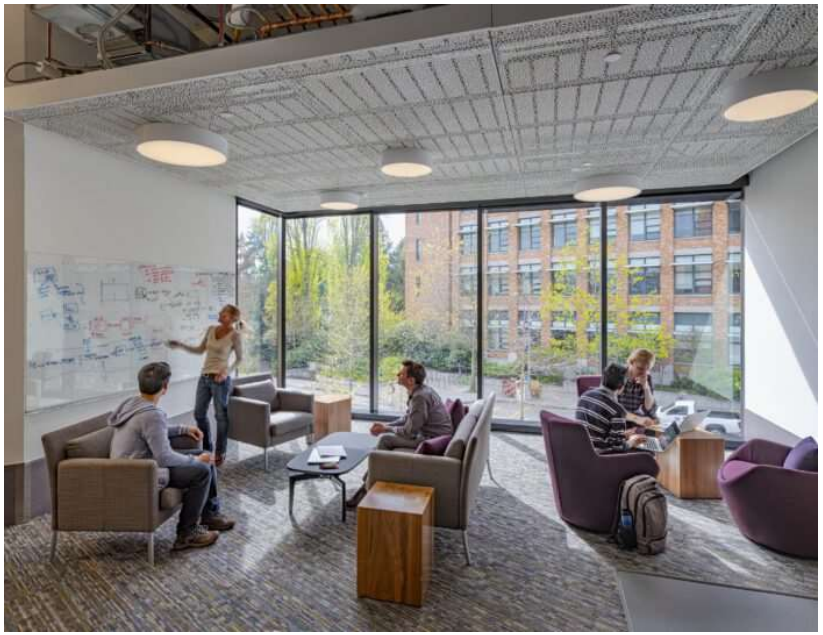
MIT Stata Center by Frank Gehry

Paul G. Allen Center by LMN Architects

In contrast, what comes to mind with “Design”?

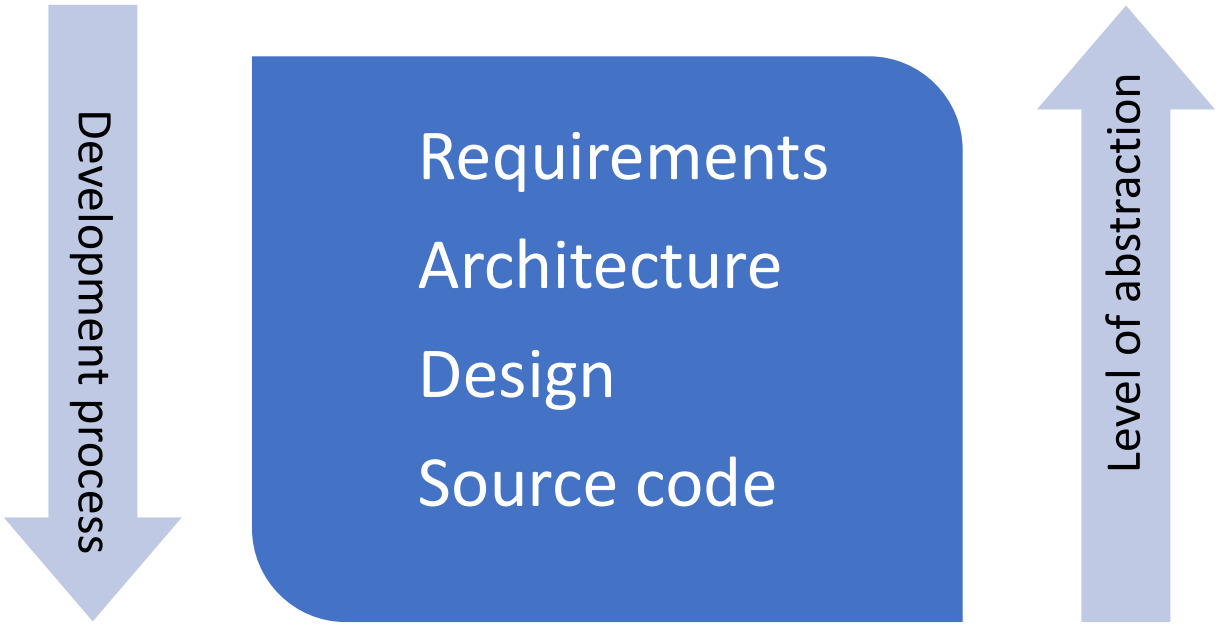


Here's another example close to home



Bill & Melinda Gates Center for UW CSE - LMN

Let's transition the ideas to software engineering



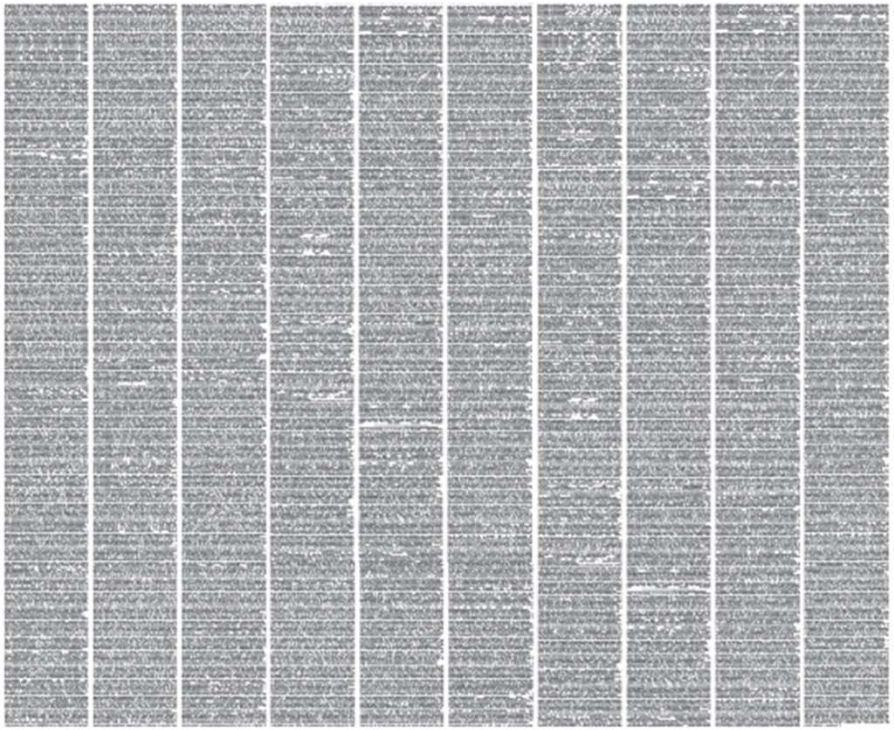
The level of abstraction is key

With both architecture and design, we're building an **abstract representation** of reality

- Ignoring (insignificant details)
- Focusing on the most important properties
- Considering modularity (separation of concerns) and interconnections

Case study – Linux kernel

Source code

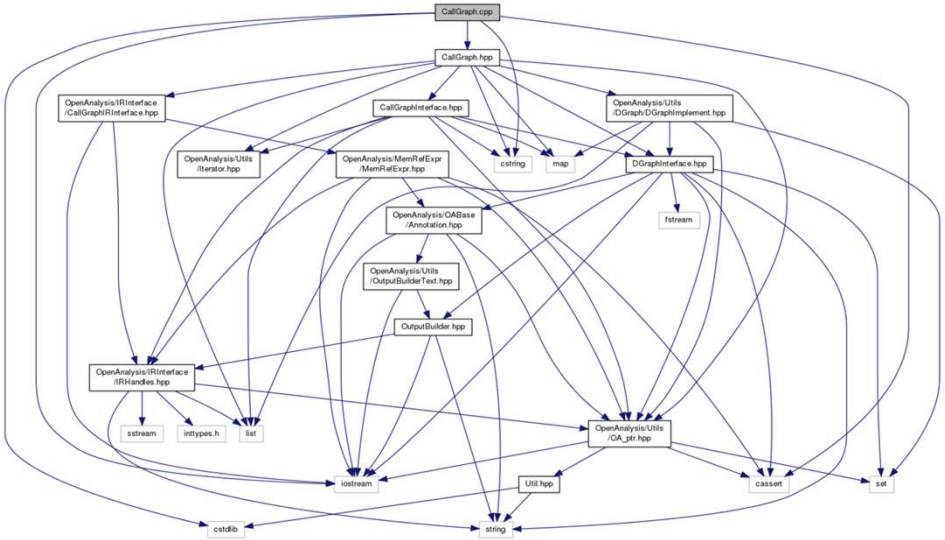


Suppose you want to add a feature
16 million lines of code!
Where would you start?

- **What does the code do?**

Case study – Linux kernel

Call graph



Suppose you want to add a feature

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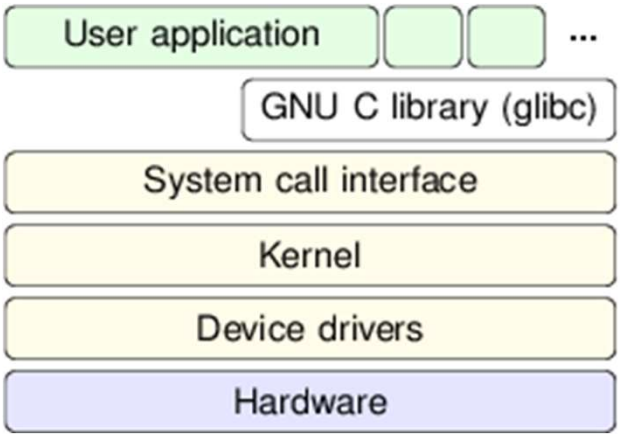
Where would you start?

- What does the code do?
- **Are there dependencies?**

Case study – Linux kernel

Layer diagram



Suppose you want to add a feature

16 million lines of code!

Where would you start?

- What does the code do?
- Are there dependencies?
- **What are the different components?**

How about some definitions

Architecture (what components are needed)

- High-level view of the overall system:
  - What components do exist?
  - What are the connections and/or protocols between components?

Design (how the components are developed)

- Considers individual components:
  - Data representation
  - Interfaces, class hierarchy

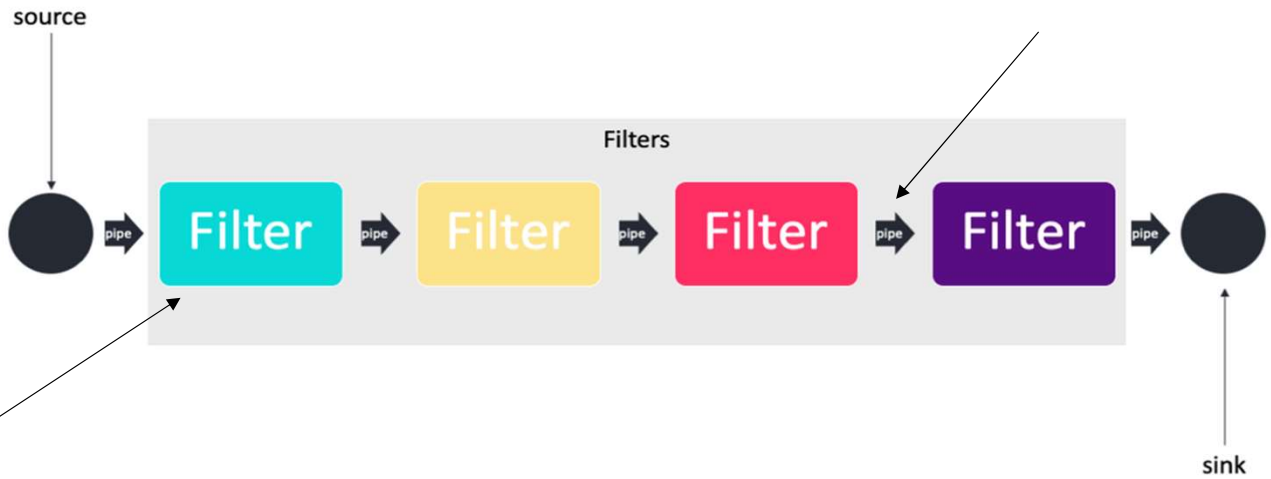
Today's Outline

Architecture

1. What do we mean by architecture
2. How does it differ from design
3. **What are some common architectures used in software** ← We are here

SW Architecture #1 – Pipe and filter

The **pipe-and-filter** architecture talks about the main components and the way they connect

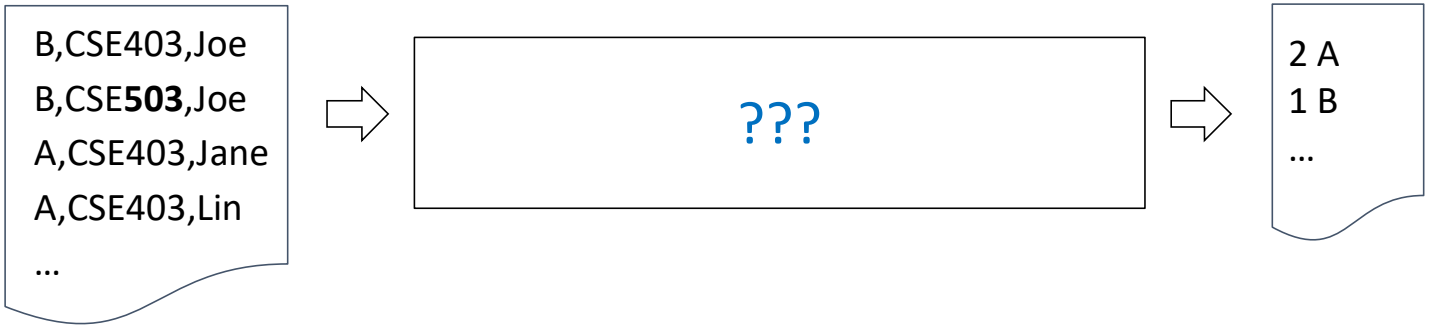


It doesn't specify the design or implementation details of the individual components (the filters)

SW Architecture #1 – let's try it out

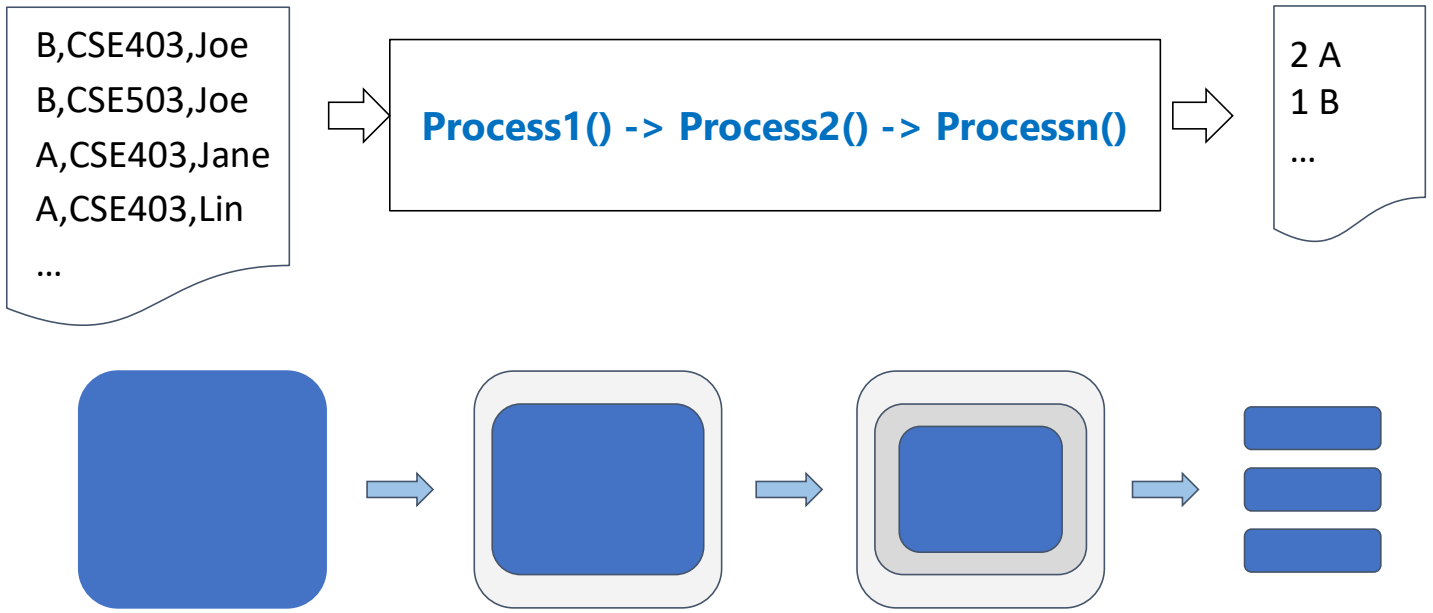
How would you attack this problem?

Count the CSE 403 letter grades



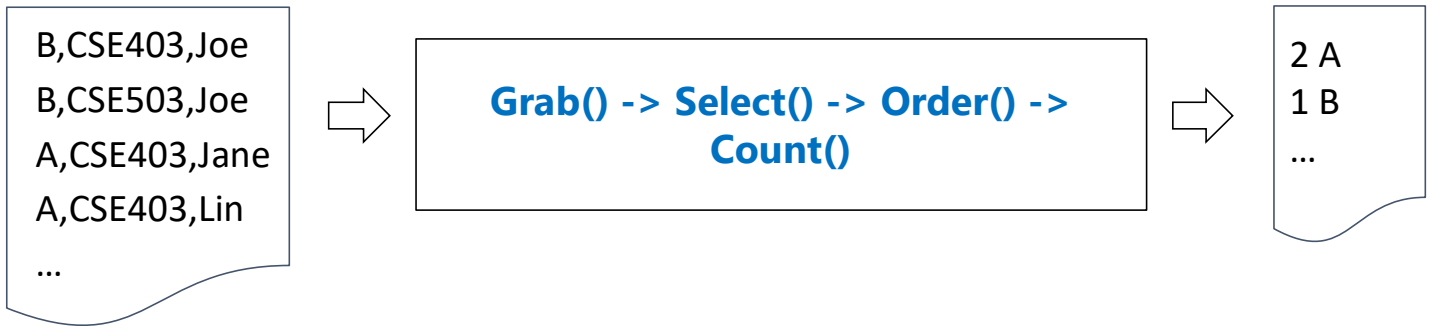
SW Architecture #1 – Pipe and filter

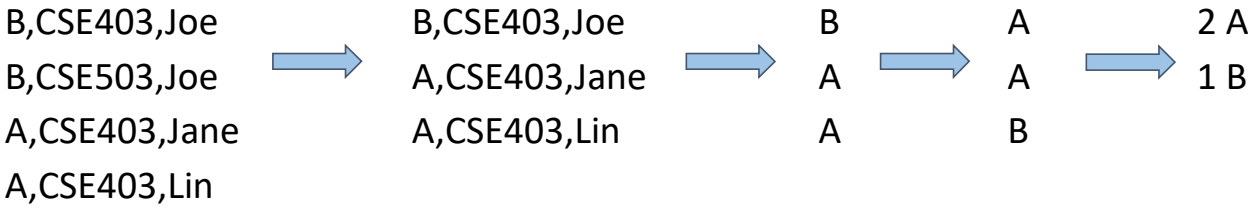
You might start by thinking of **components** and **successive filtering (architecture)**



SW Architecture #1 – Pipe and filter

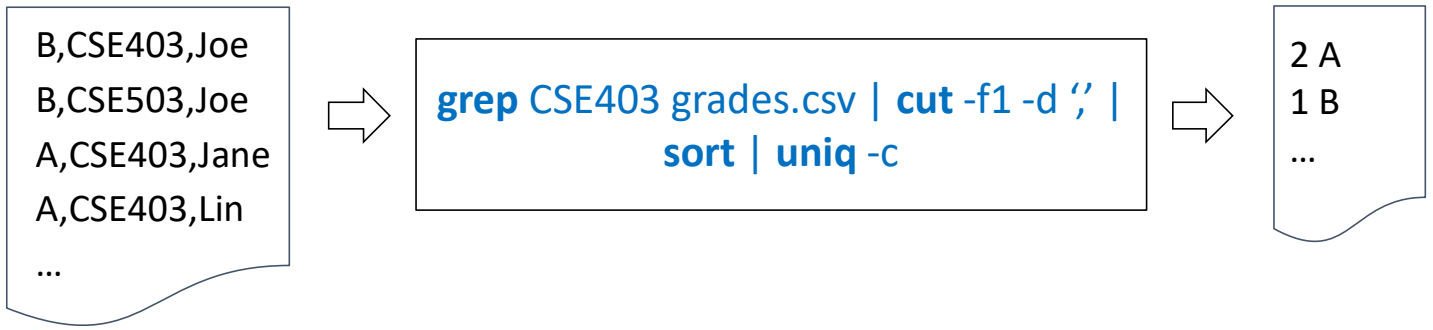
You might then consider the **components' inputs and outputs (design)**

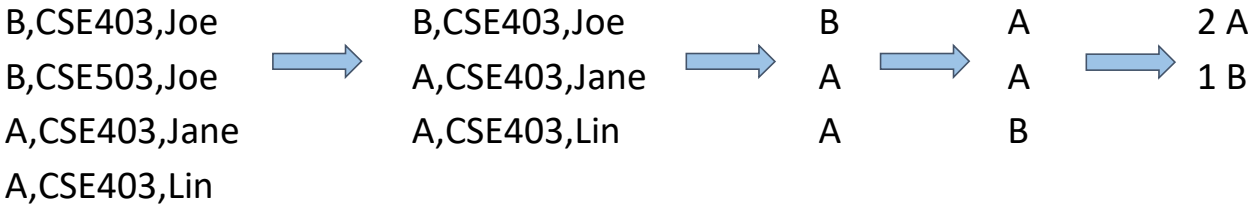




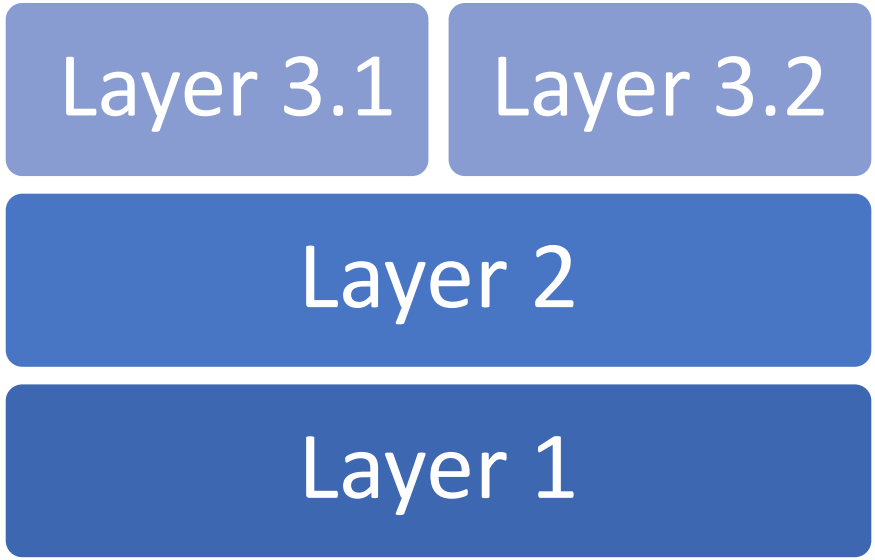
SW Architecture #1 – Pipe and filter

Finally, you get to **code**





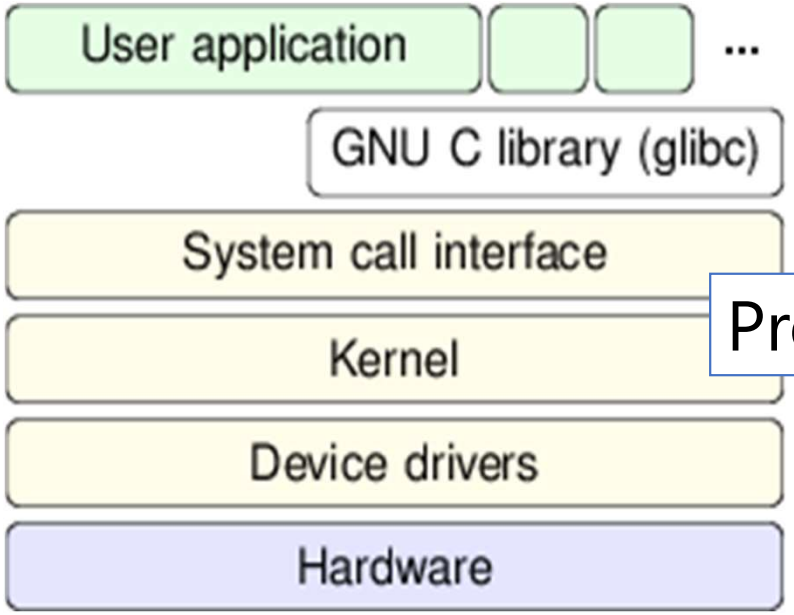
SW Architecture #2 – Layered (n-tier)



- Layers use services provided (only) by the layers directly below them
- Layers of isolation – limits dependencies
- Good modularity and separation of concerns

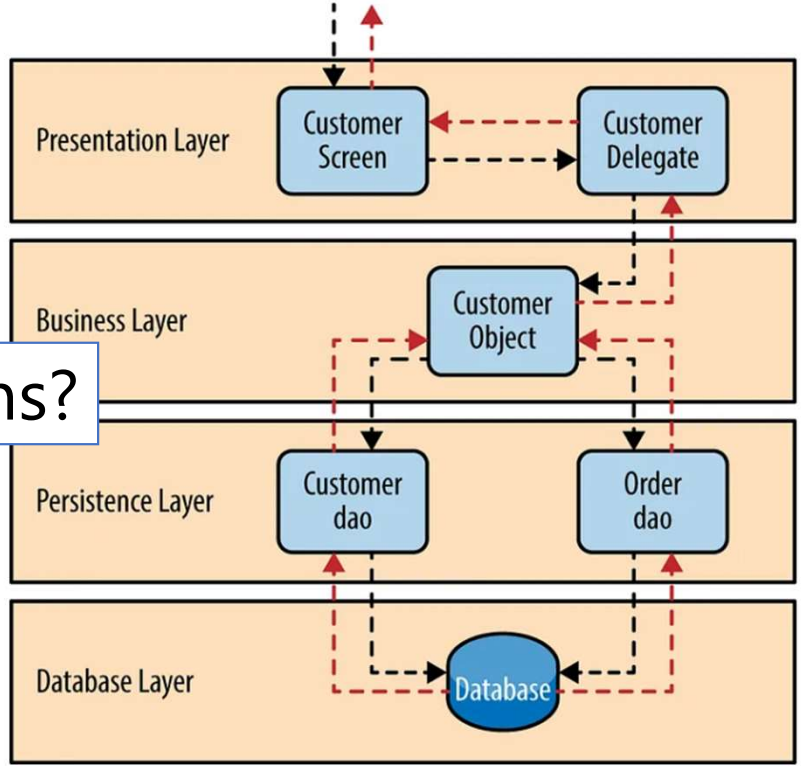
SW Architecture #2 – Layered

Linux Architecture



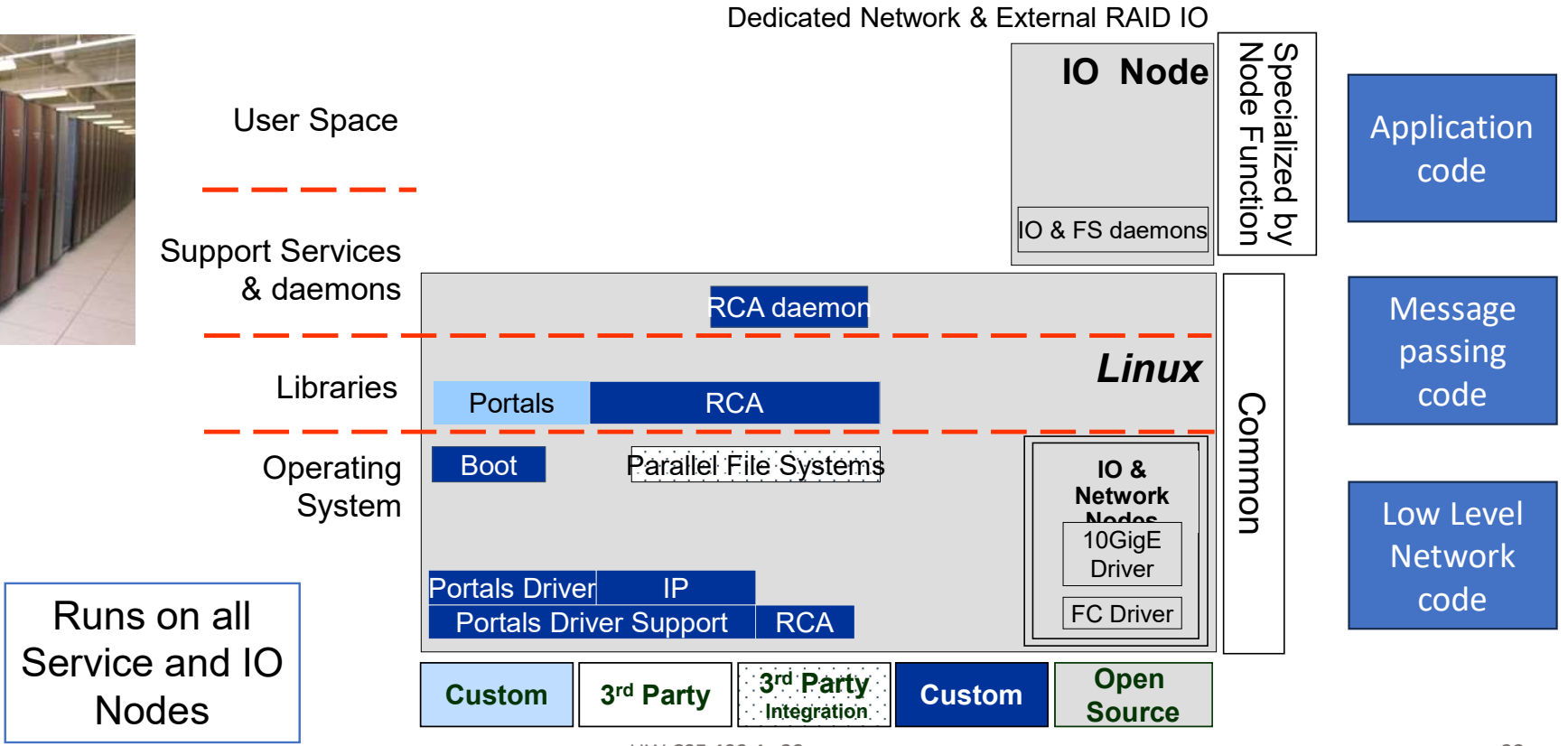
Pros / cons?

Enterprise System Architecture



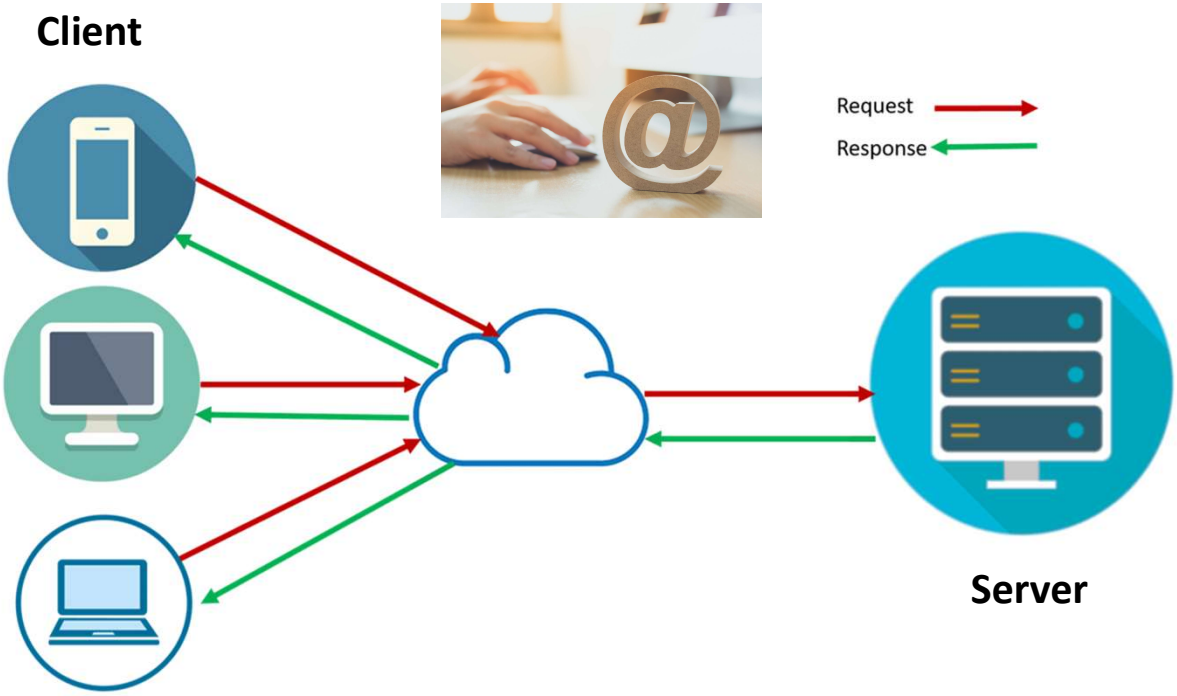
Source: https://www.oreilly.com/ideas/software-architecture-patterns/page/2/layered-architecture

SW Architecture #2 – Layered



Runs on all Service and IO Nodes

SW Architecture #3 – Client Server

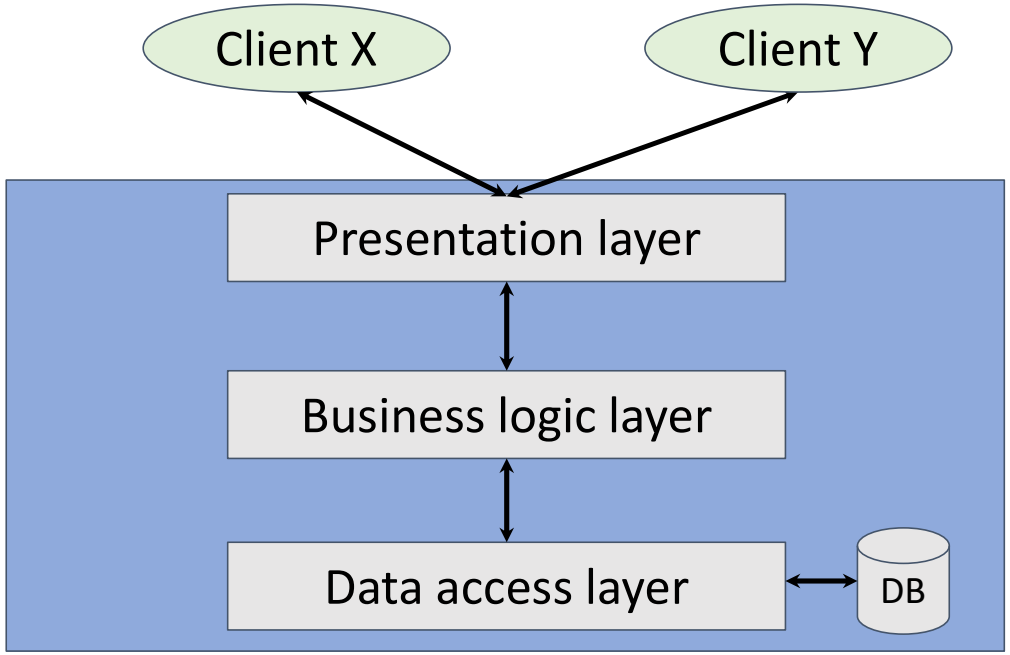


What might be a con of this and how might it be avoided?

Clients can be software that depends on a shared database/service

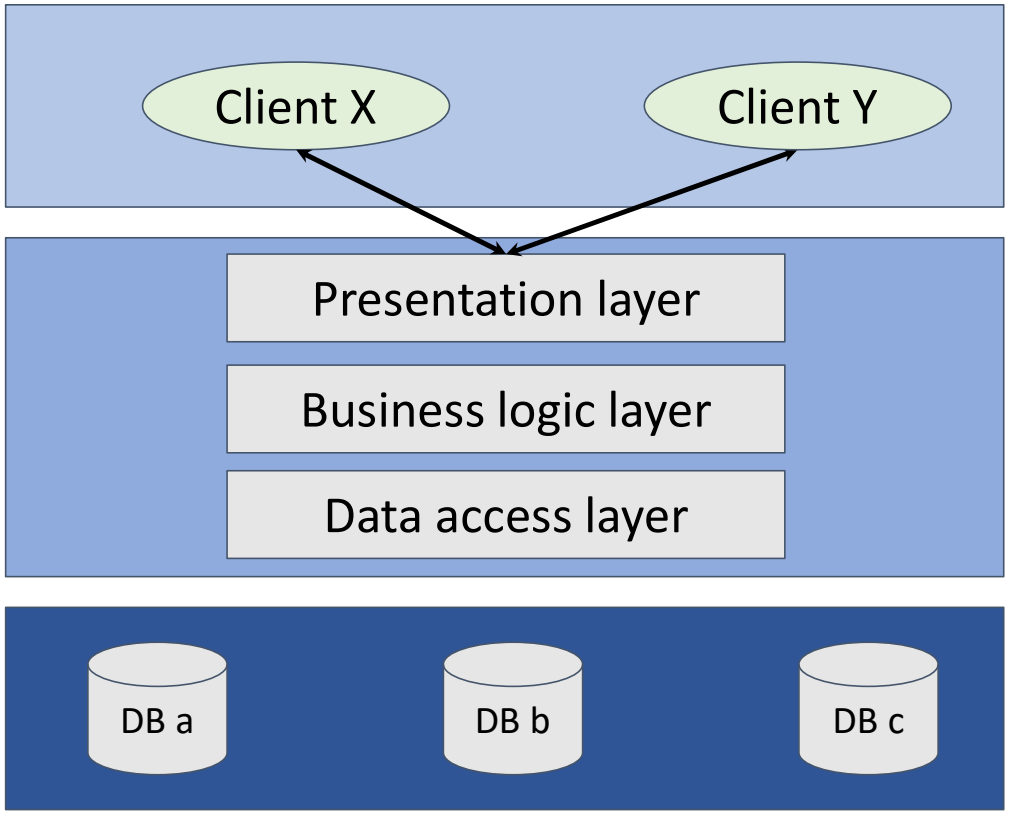
SW Architecture combinations!

Client-Server may be too high a level of abstraction for your purpose
Consider combining with other patterns (e.g., layered)



SW Architecture combinations^2

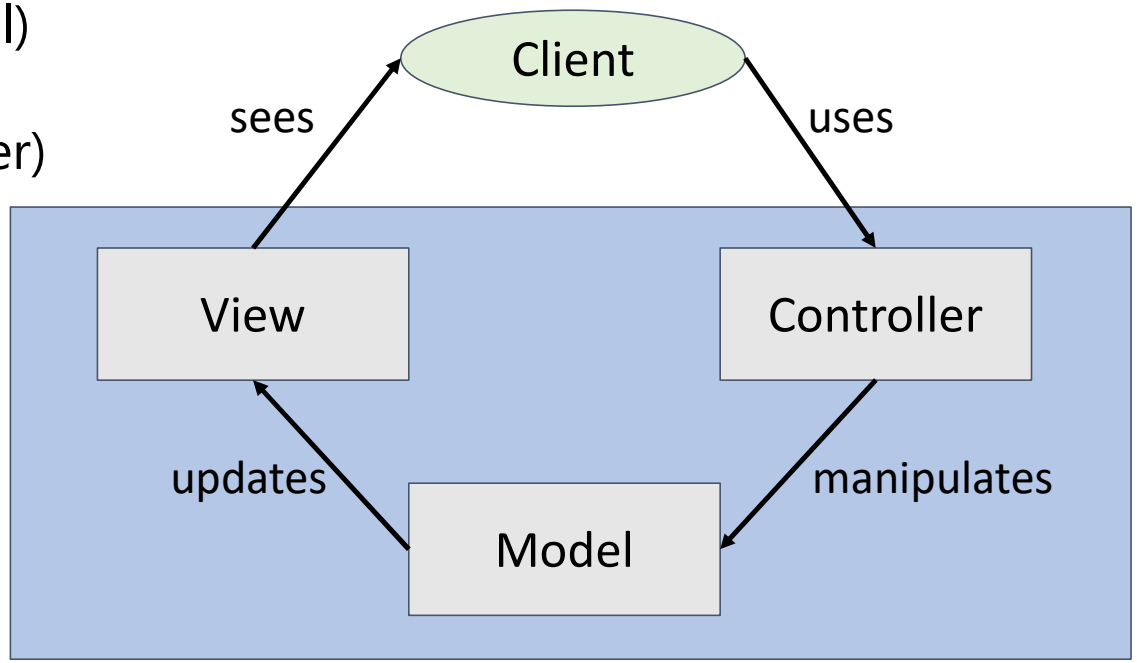
How detailed should an architecture description be?



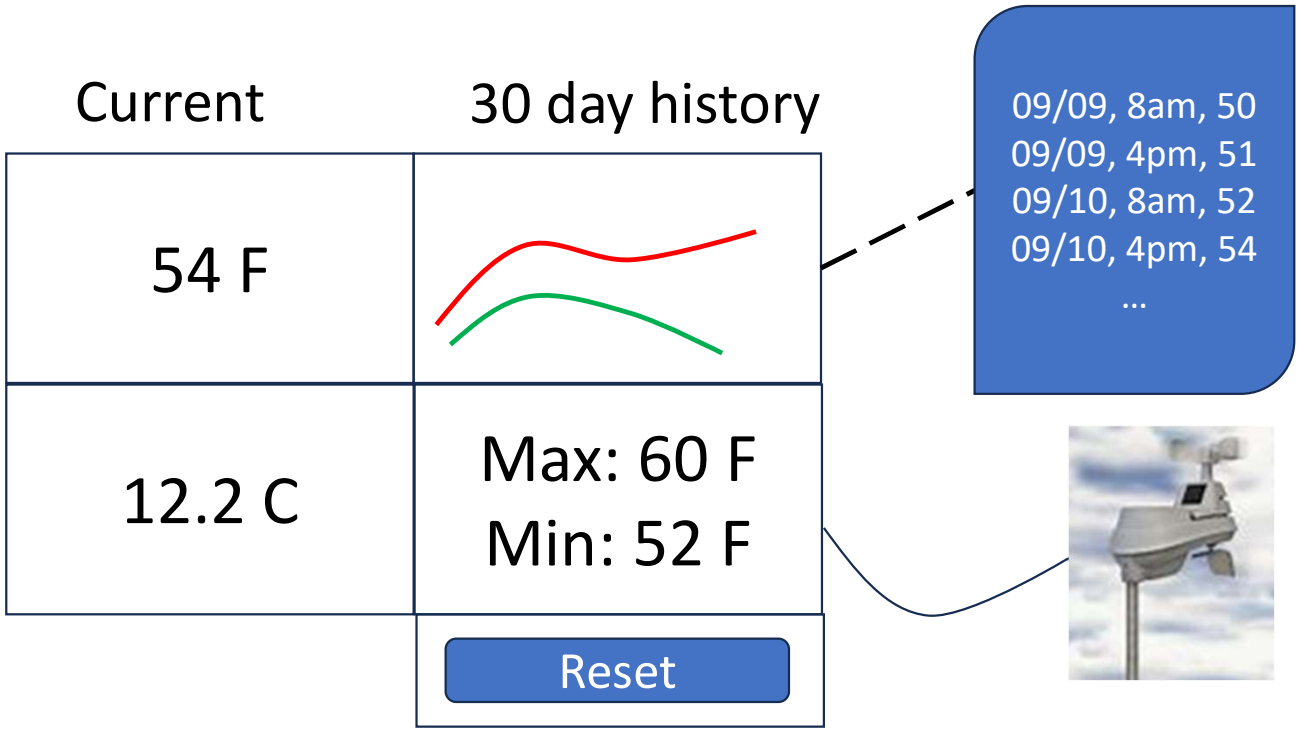
SW Architecture #4 – Model View Controller

Separates

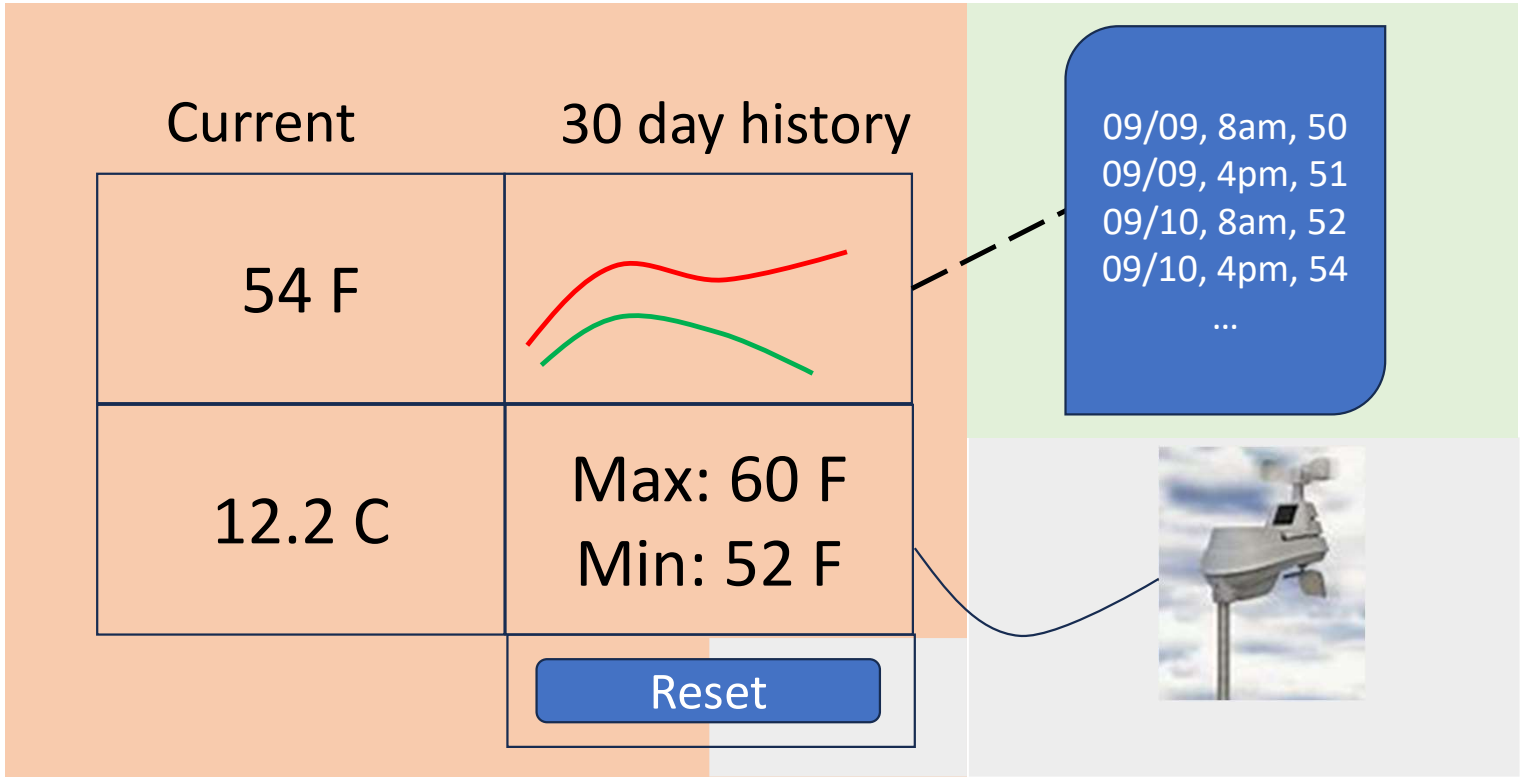
- data representation (Model)
- visualization (View)
- client interaction (Controller)



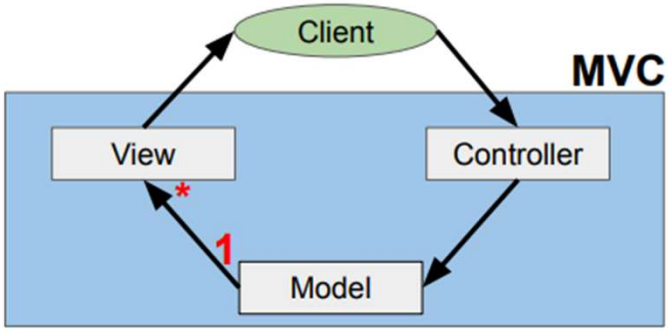
SW Architecture #4 – MVC Example

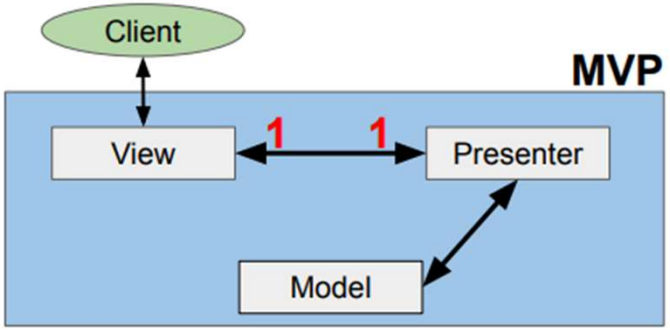


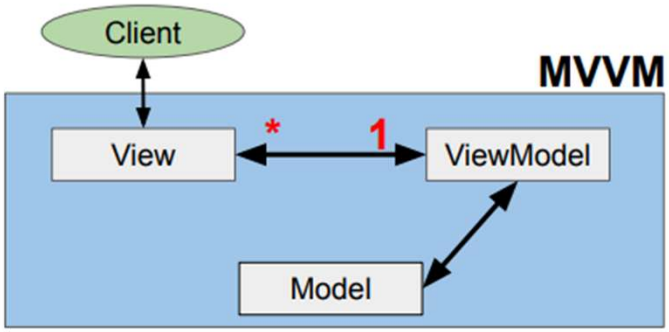
SW Architecture #4 – MVC Example



SW Architecture – many variants of MVC







Consider the connections (* == many)

As an architect (and designer), consider …

Level of Abstraction

- Components (modules) and their interconnections (apis)

Separation of concerns

- Strong cohesion – tight relationships within a component (module)
- Loose coupling – interconnections between components (module)

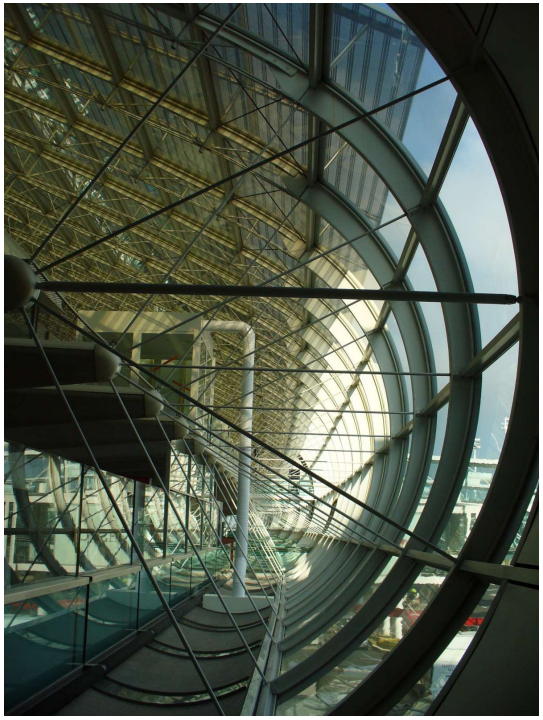
Modularity

- Decomposable designs
- Composable components
- Localized changes (due to requirement changes)
- Span of impact (how far can an error spread)

A good architecture is critical to success

Helps with:

- **System understanding**
  - components and their interactions
- Reuse
  - high-level view shows opportunity for reuse
- Development
  - breaks development down into manageable pieces; provides a path from requirements to code
- Management
  - helps understand scope of work and track progress
- **Communication, shared vision**
  - provides vocabulary; pictures say 1000 words



Questions?

Architecture

1. What do we mean by architecture
2. How does it differ from design
3. What are some common architectures used in software
    1. Pipe and filter
    2. Layer diagram
    3. Client – Server
    4. Model – View – Controller
    5. … Message passing …
    6. Many variations!

Use your project to get experience with defining an architecture

Discuss questions with your 403 TA (senior mgr/mentor)