Software Design & Architecture

Introduction to Software Architecture & Stakeholders

Agenda

- Software architecture: what, why, who, how
- Stakeholders

Winter 2026. Instructor: Pengyu Nie.
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What is Architecture?

"both the process and the product of planning, designing, and constructing buildings or any other structures"

-- Encyclopedia Britannica

- Durability (firmitas): a structure should stand up robustly and remain in good condition
- Utility (utilitas): a structure should be suitable for the purposes for which it is used
- Beauty (venustas): a structure should be aesthetically pleasing

-- *De Architectura* by Roman architect Vitruvius (1st century AD)

Image source: The Metropolitan Museum of Art

Why do we Need Architecture? (Building)

Image sources: How to build a DIY dog house – Home Depot (left); CN tower – Wikipeia (right)

Why do we Need Architecture? (Software)

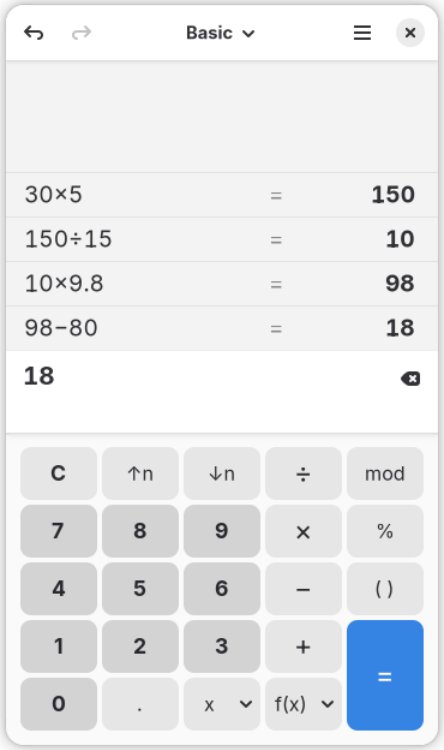


Image sources: Calculator – apps for GNOME (left); Wikipeia (right)

Building vs. Software Architecture: Anology

- Focus on stakeholders' needs
- Iterate on representations: blueprints vs. diagrams/prototypes
- Improve + degrade certain properties
- Reuse of proven patterns

Building vs. Software Architecture: Differences

- Maturity: software standards still evolving
- Material: abstract, changeable, scalable
- Delivery: dev (development) + ops (operations)

The Architect Role

- Designated role for making architectural decisions
- Requires broad knowledge/training
  - coding skills
  - domain understanding
  - cross-team communication
- Benefits:
  - conceptual integrity
  - early risk surfacing
  - decision rationale for future evolution

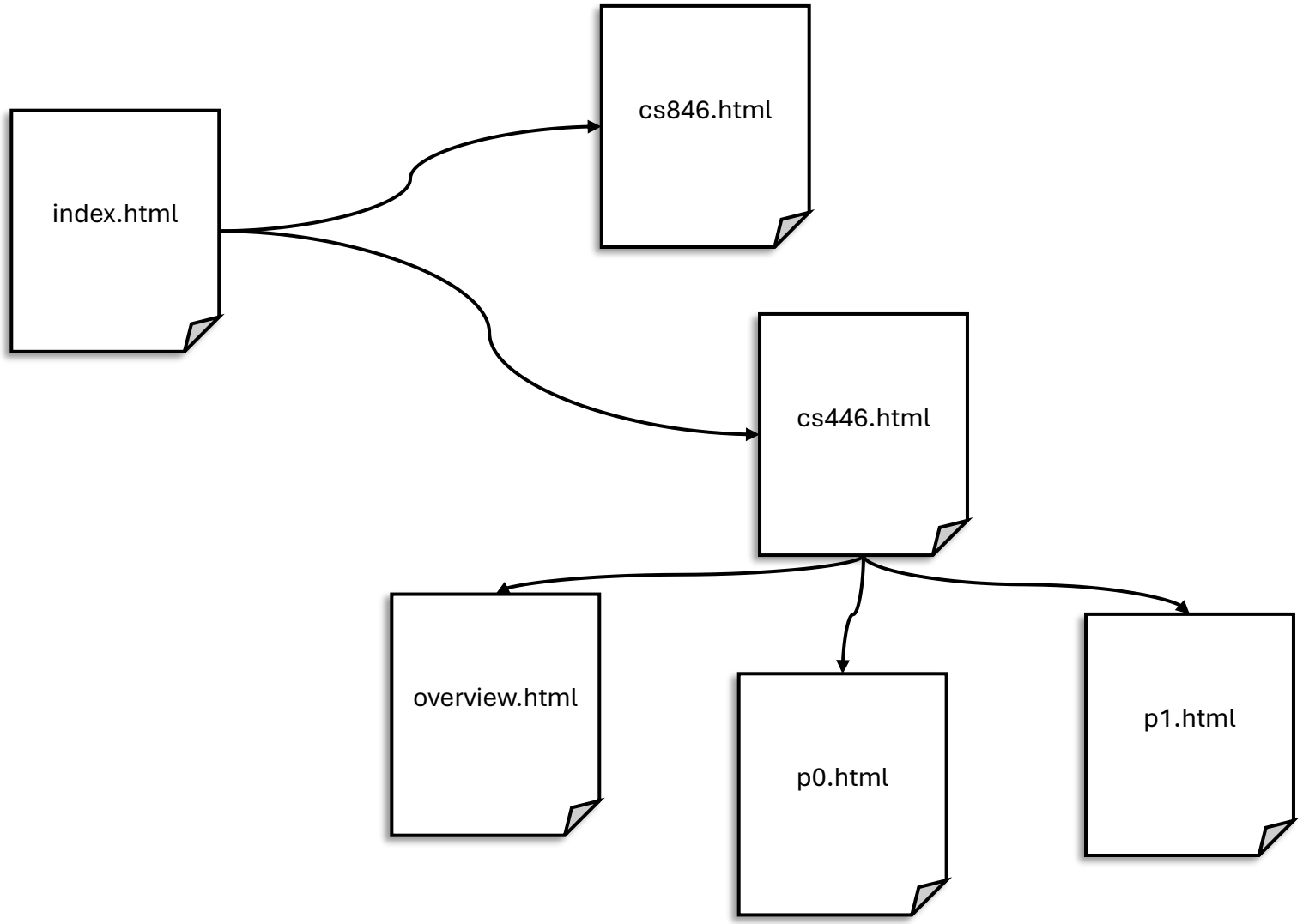
What is Software Architecture?

- “Architecture is the fundamental organization of a system, embodied in its components, their relationships to each other and the environment, and the principles govering its design and evolution”

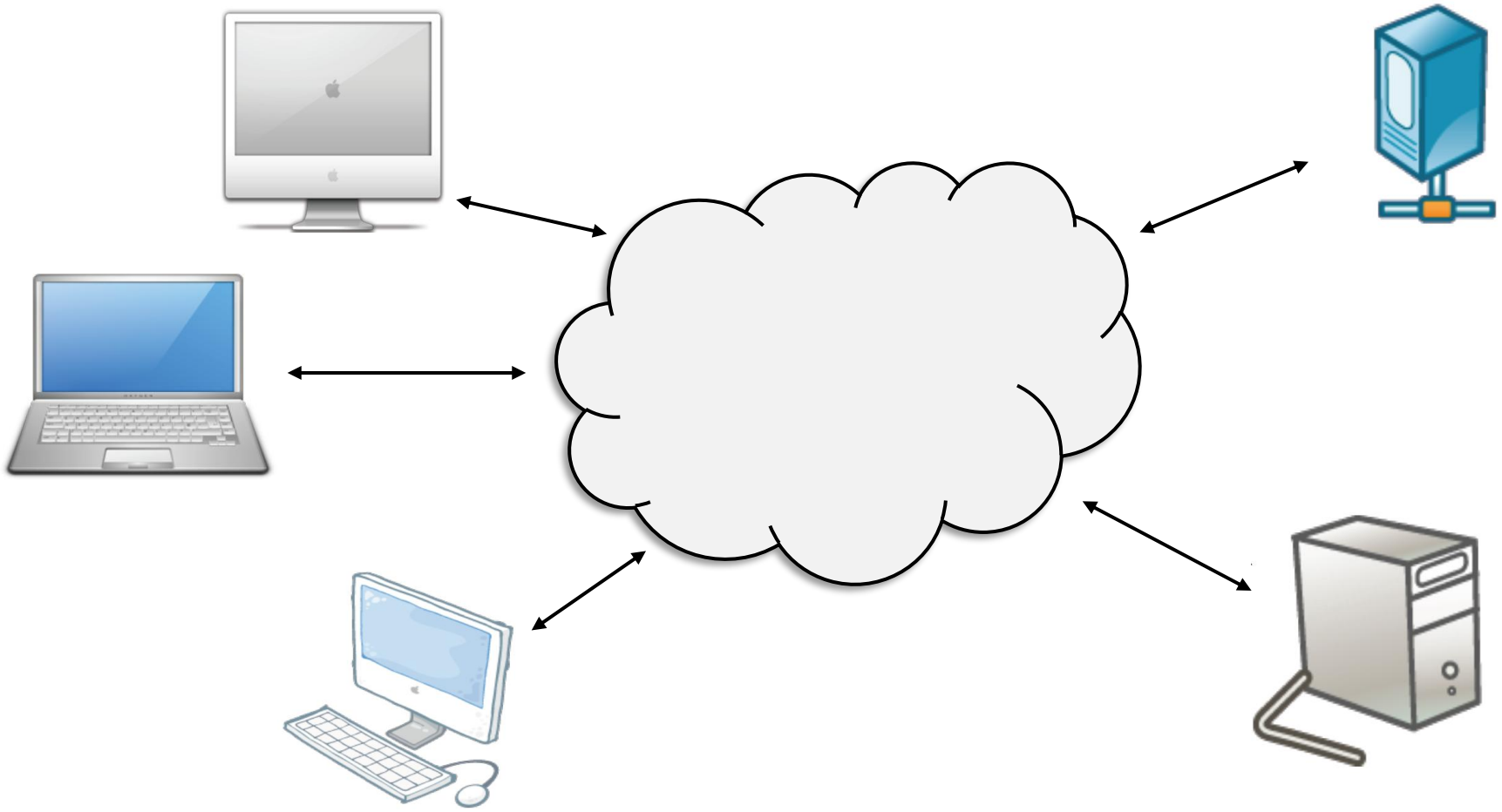
-- ANSI/IEEE 1471-2000

- Three primary dimensions:
  - Structure (components, subsystems, modules)
  - Communication (relationship -> data flow, control flow, dependency, etc.)
  - Non-functional requirements

Logical Web Architecture

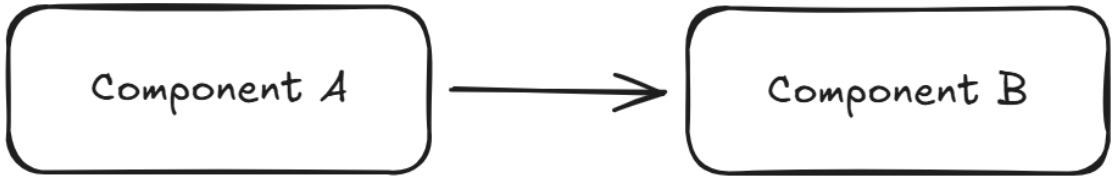


Physical Web Architecture



Exercise: Architectural Sketching

- Sketch the architecture for a web browser (e.g., Chrome, Firefox)
  - Step 1: enumerate its components, draw each of them in a box
  - Step 2: connect the components that need to communicate



- Have your favourite drawing tool launched
  - ExcaliDraw https://excalidraw.com/
  - draw.io https://app.diagrams.net/
  - Microsoft whiteboard https://whiteboard.office.com
  - Mermaid (in plain text) https://mermaid.live/edit

Stakeholders

- Definition: a person with an interest or concern in something
- Broadly speaking
  - The customers who use the system

  - Software developers who build the system

Stakeholder in the Architecture

- “A stakeholder in the architecture of a system is an individual, team, organization, or classes thereof, having an interest in the realization of the system.”

  -- Rozanski & Woods

- Customers using the software; software developers; …other people?

Running Example

- ION light rail's ticket vending machine
- Who have an interest in it?

Customer-side Stakeholders

- The customers buying tickets
  - paying by cash
  - paying by credit card
  - buying one time ticket
  - buying a refillable card
- The Region of Waterloo
  - that paid for the system

Developer-side Stakeholders

- Software developers
- User interface designers
- Testing (Quality Assurance) engineers
- Release engineers
- Operators
- Maintenance engineers
- Managers

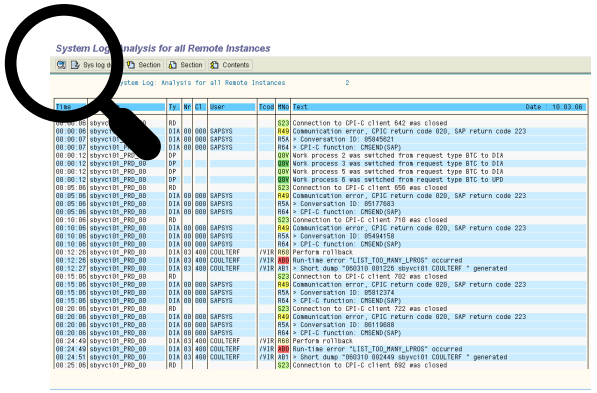
And more...

- The person who installs the system in the stations
- The person who inspects the systems
- The person who collects money from the machines
- Network engineers who keep the machine connected
- The electricians who set up power for it
- Customer service operators who deal with complaints
- City officials who liaison with the company to manage fixes and upgrades

TL;DR

- Systems are more complex than you initially think
- There are more stakeholders than one can initially think
- While their stake in the system varies, every one of them has a say in how some part of the system is designed and built

Why do we need to care about stakeholders?



Inspectors who audit the machines

has sufficient data for inspection/debugging?
leaks private user data (e.g., credit card numbers)?
…

- Different stakeholders have different concerns that may not be compatible with each other
- It is impossible to talk to all stakeholders;
  at least, consider who they might be and what their concerns may be

Exercise: Where is the line?

- ION light rail's ticket vending machine
- Discuss whether or not the following candidates should be stakeholders

Security staff at the ION stations where vending machines reside
Drivers of ION vehicles
The spouses of the developers of the ION fare vending machine
The CEO of the software firm that was hired to develop the ION fare vending system
The firm hired to lay the rails for the ION vehicles
A sight-impaired ION rider

Recap

- Software architecture: what, why (vs. building architecture)
- who: Architect
- how: components+communication, diagrams
- Stakeholders: customers, developers, and more