Introduction to Software Architecture

Reid Holmes

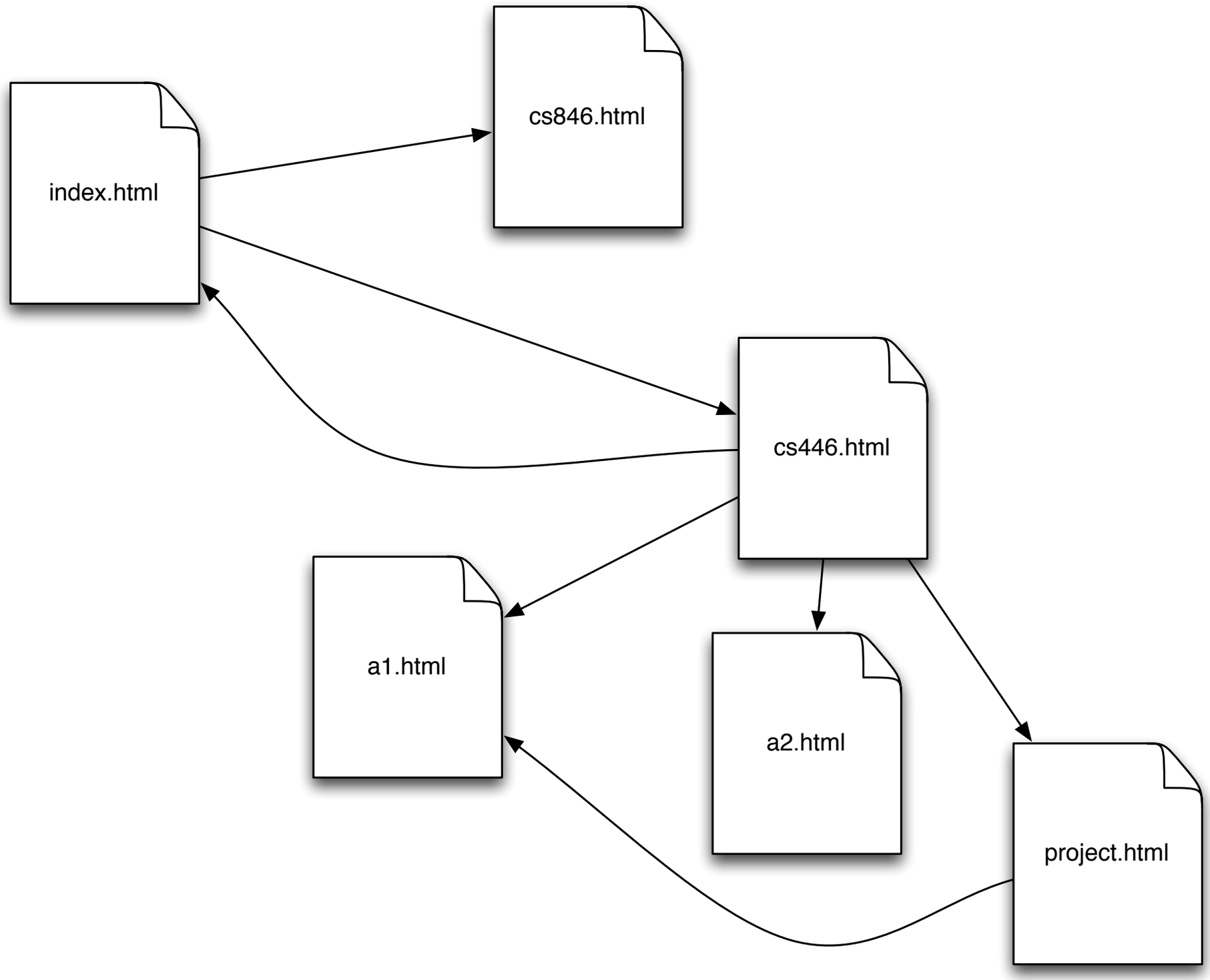
Architecture

- Architecture is:
  - All about communication.
  - What ‘parts’ are there?
  - How do the ‘parts’ fit together?
- Architecture is not:
  - About development.
  - About algorithms.
  - About data structures.

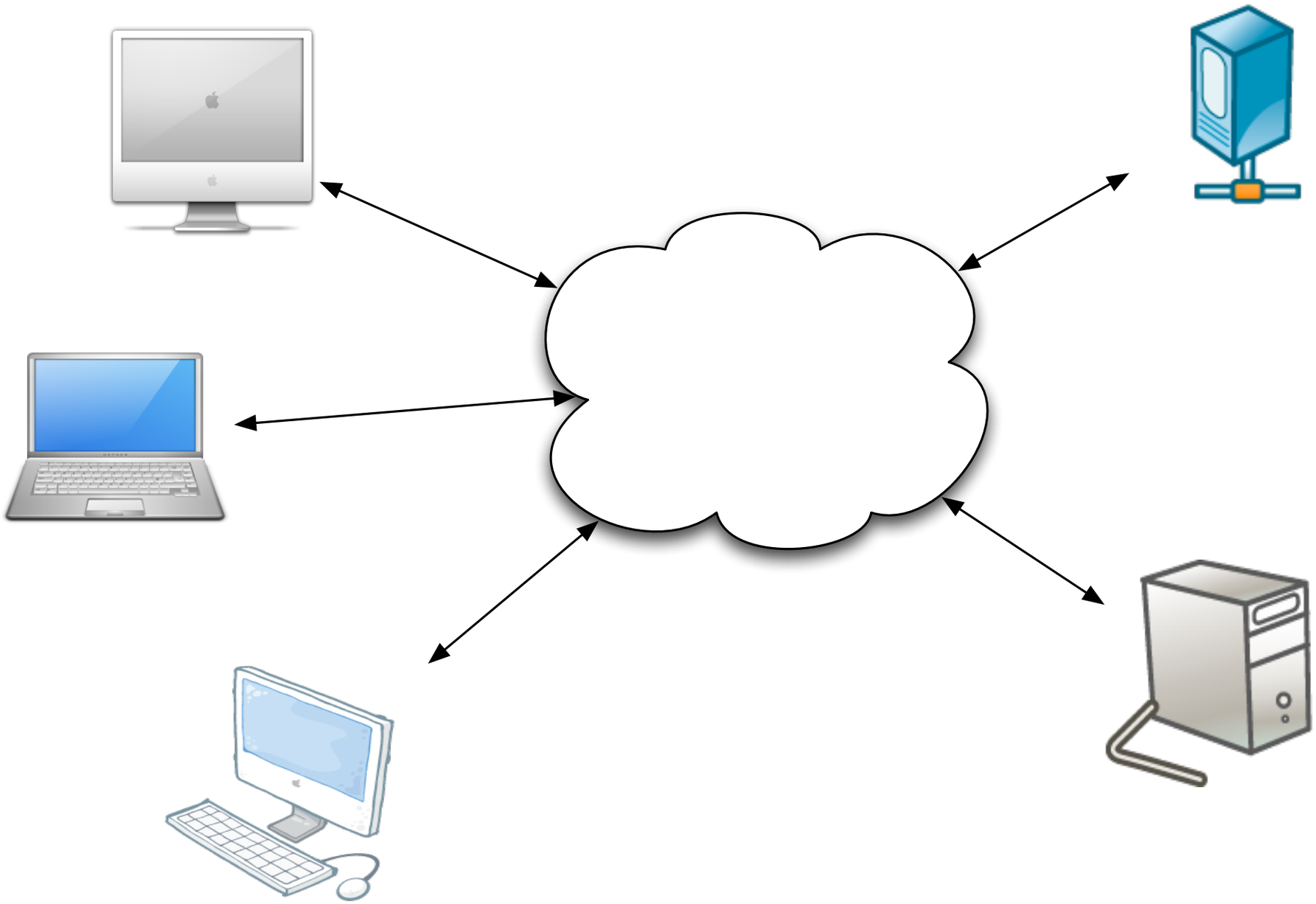
What is Software Architecture?

- The conceptual fabric that defines a system
  - All architecture is design but not all design is architecture.
- Architecture focuses on those aspects of a system that would be difficult to change once the system is built.
- Architectures capture three primary dimensions:
  - Structure
  - Communication
  - Nonfunctional requirements

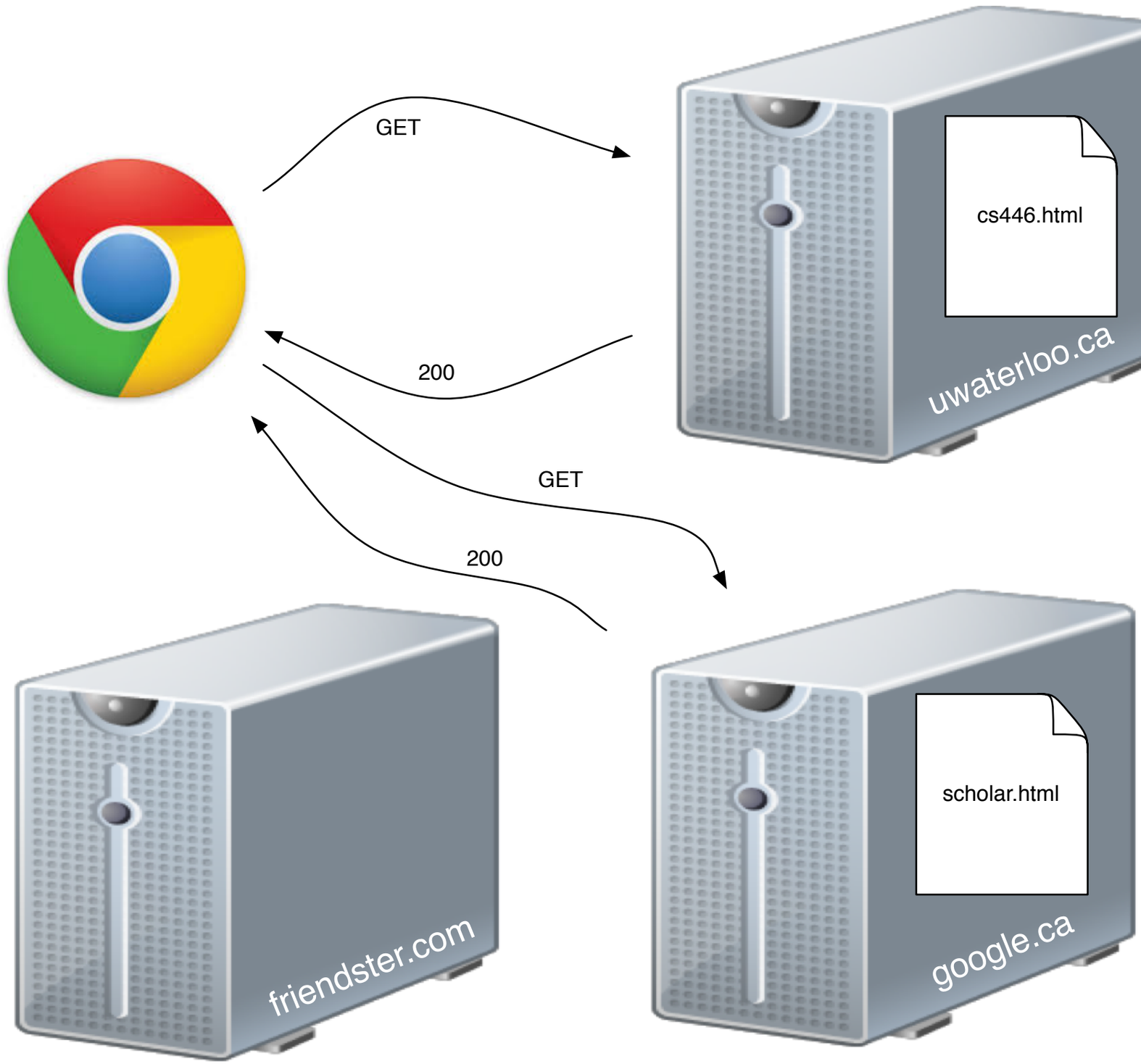
Logical Web Architecture



Physical Web Architecture



Dynamic Web Architecture



Non-functional requirements

- Technical constraints: restrictions made for technical reasons
- Business constraints: restrictions made for business reasons
- Quality attributes: e.g., the *'ilities'*
  - Scalability
  - Security
  - Performance
  - Maintainability
  - Evolvability
  - Reliability/Dependability
  - Deployability

ANSI/IEEE 1471-200

"Architecture is the fundamental organization of a system, embodied in its components, their relationships to each other and the environment, and the principles governing its design and evolution"

Eoin Woods

"Software architecture is the set of design decisions which, if made incorrectly, may cause you project to be cancelled."

Philippe Krutchen

"The life of a software architect is long (and sometimes painful) succession of sub-optimal decisions made partly in the dark.

So what?

- What makes building systems so hard?
  - Young field.
  - High user expectations.
  - Software cannot execute independently.
- Incidental difficulties [Brooks MMM].
  - Problems that can be overcome.
- Essential difficulties [Brooks MMM].
  - Those problems that cannot be easily overcome.

Essential Difficulties

- Abstraction alone cannot help.
  - Complexity
    - Grows non-linearly with program size.
  - Conformity
    - System is dependent on its environment.
  - Changeability
    - Perception that software is easily modified.
  - Intangibility
    - Not constrained by physical laws.

[TAILOR ET AL.]

Attacks on Complexity

- High-level languages.
- Development tools & environments.
- Component-based reuse.
- Development strategies.
  - Incremental, evolutionary, spiral models.
- Emphasis on design.
  - Design-centric approach taken from outset.

Architectural approaches

- Creative
  - Engaging
  - Potentially unnecessary
  - Dangerous
- Methodical
  - Efficient when domain is familiar
  - Predictable outcome
  - Not always successful

Design process

1. Feasibility stage:
    - Identify set of feasible concepts
2. Preliminary design stage:
    - Select and develop best concept
3. Detailed design stage:
    - Develop engineering descriptions of concept
4. Planning stage:
    - Evaluate / alter concept to fit requirements, also team allocation / budgeting

Abstraction

Definition:

> “A concept or idea not associated with a specific instance”

Top down

> Specify ‘down’ to details from concepts

Bottom up

> Generalize ‘up’ to concepts from details

Reification:

> “The conversion of a concept into a thing”

Level of discourse

- Consider application as a whole
  - e.g., stepwise refinement
- Start with sub-problems
  - Combine solutions as they are ready
- Start with level above desired application
  - e.g., consider simple input as general parsing

Separation of Concerns

- Decomposition of problem into independent parts
- In arch, separating components and connectors
- Complicated by:
  - Scattering:
    - Concern spread across many parts
      - e.g., logging
  - Tangling:
    - Concern interacts with many parts
      - e.g., performance