Software Design and Architecture

Decomposition Principles

Agenda

- what is decomposition
- how – principles
  - coupling and cohesion
  - information hiding
  - Conway’s law

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Revisit: 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

principle design decisions

Architectural Entity Terminologies

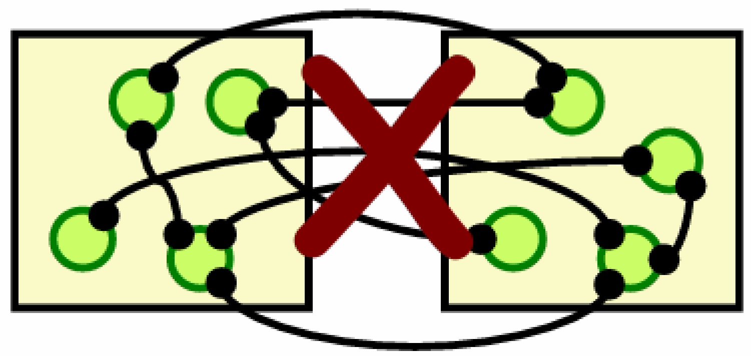
- Subsystem
  - larger “component” in the IEEE definition
  - explicit interface
  - ➡️ project, module, set of packages
- Component
  - smaller “component” that compose a subsystem
  - ➡️ package, set of classes
- Connector
  - interaction mechanisms between subsystems
  - ➡️ method call, RPC (remote procedure call), network connection, etc.
- Configuration (Topology)
  - a set of specific associaitons between the subsystems and connectors

Decomposition

- The top-down abstraction process of…
  - break down problem into subsystems -> components
  - decide their connectors and configuration
- with the goals of…
  - manage complexity (reason about parts, not the whole)
  - encapsulate domain knowledge about obvious partitions
  - parallel development and clear ownership
  - independent/localized evolution of parts
  - etc.

Coupling and Cohesion

- Minimize coupling between subsystems
  - the less that subsystems know about each other, the better
  - make future change easier (maintenability)
- Maximize cohesion within each subsystem
  - one subsystem should be responsible for one logical service
  - components of each subsystem are strongly inter-related
    (they really do belong together)



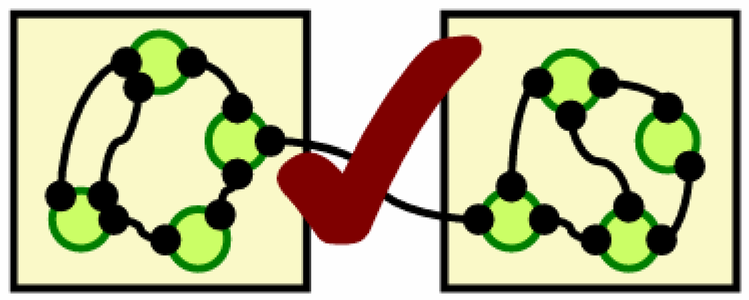
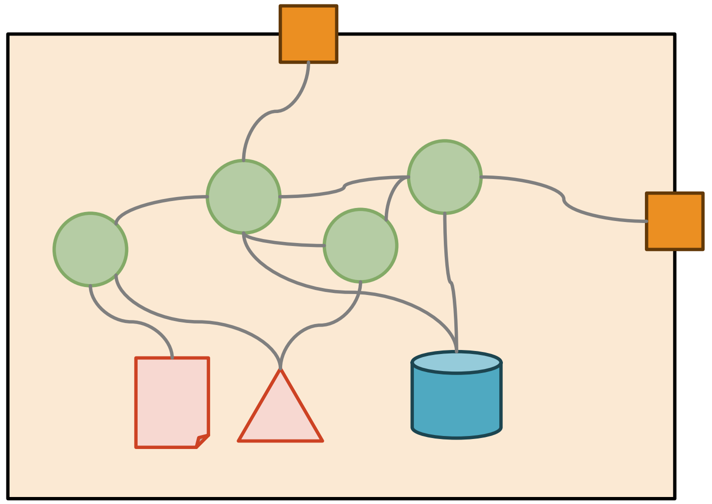


figure source: https://www.cs.toronto.edu/~sme/CSC302/notes/04-package-diagrams.pdf

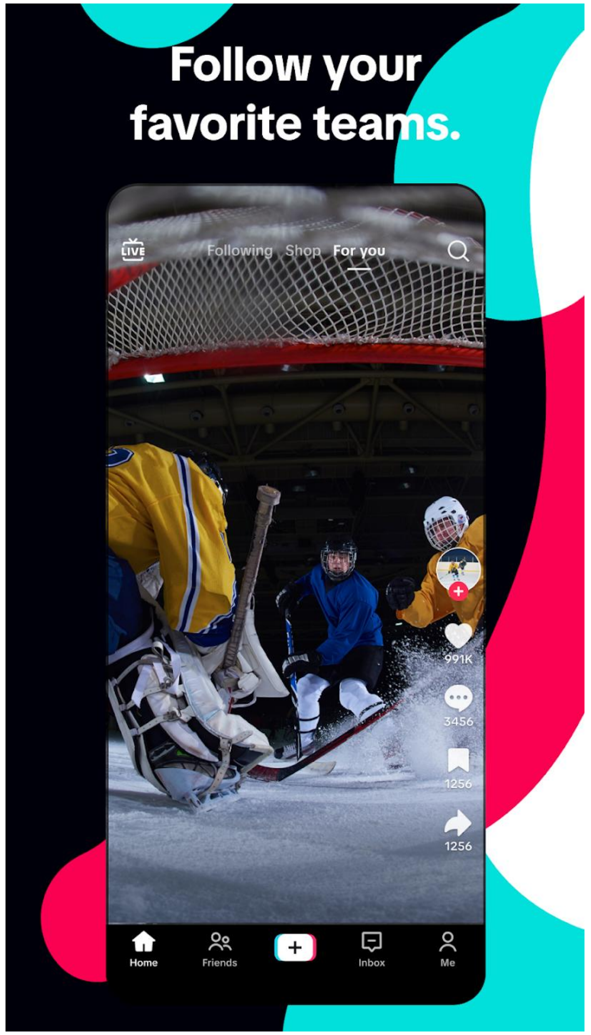
Information Hiding

- Subsystem: encapsulate a set of functionalities, hiding secrets about implementations
  - components, data representations, algorithms, databases…
- Interface connects to the outside under contracts
- Users of interfaces should not depend on the secrets



Practice: Decomposition driven by Domain

- Short video app
  - content creators: create and upload short videos
  - content consumers: home feed (recommendation), favorite, bookmark
  - user following, commenting, messaging, etc.
- How should we docompose the app (including its backend)?
  - think about subsystems and their interfaces
  - sketch a component diagram
  - adjust the boundary to minimize coupling + maximize cohesion
  - follow the information hiding principle



Conway’s Law

- The software architecture often mirrors the team’s communication structure
- Align team ownership with subsystem boundaries to reduce coordination cost

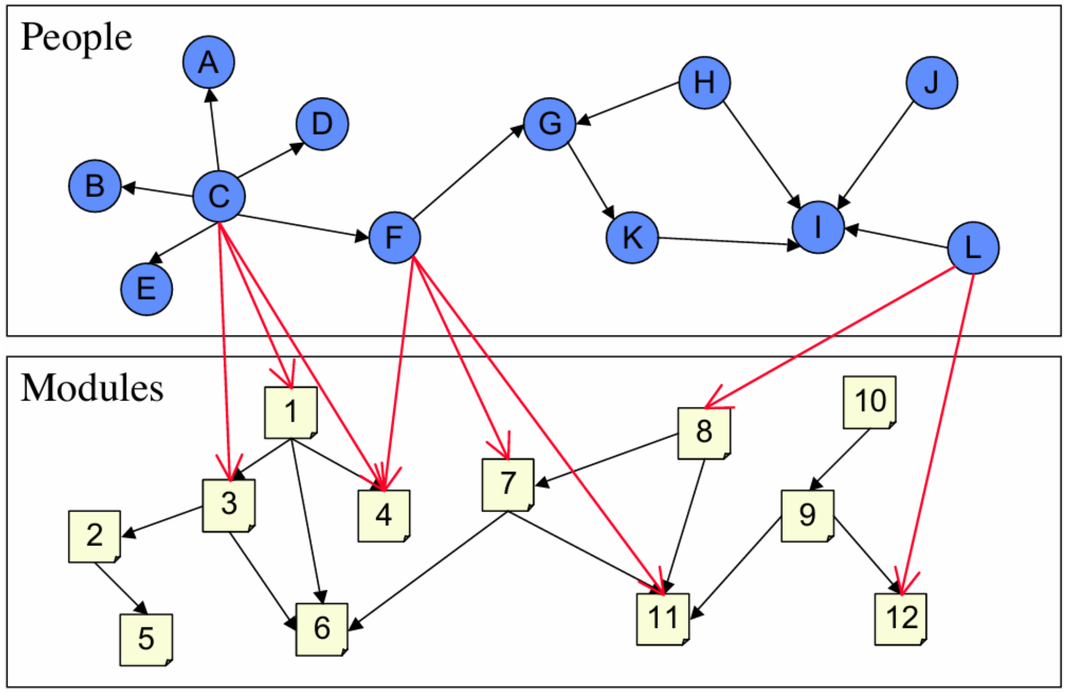


figure source: https://www.cs.toronto.edu/~sme/CSC302/notes/04-package-diagrams.pdf

“

The concept of Amazon’s two-pizza teams is straightforward: no team should be big enough that it would take more than two pizzas to feed them.

”

- decrease communication overhead
- increase ownership and empowerment
- increase employee satisfaction

Two-Pizza Team @ Amazon

Recap

- Decomposition: top-down abstraction into subsystems/components
- Principles
  - minimize coupling and maximize cohesion
  - information hiding
  - Conway's law (team organization)
- And more tradeoffs to consider…
  - overhead of integration and coordination
  - security, tracability (logging), complexity, etc.