Lecture 11: Requirements II

Lecture goals

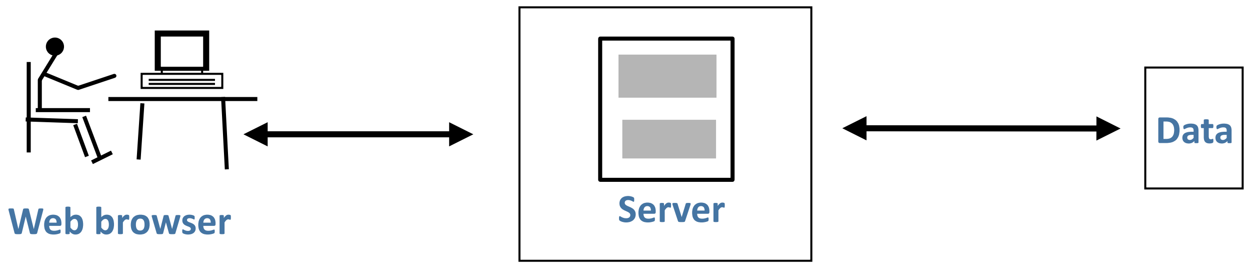
- Identify common architectural styles (continued)
    - Three tier architecture
    - Model-view-controller
- Encapsulate deployments using virtualization

Architectural styles

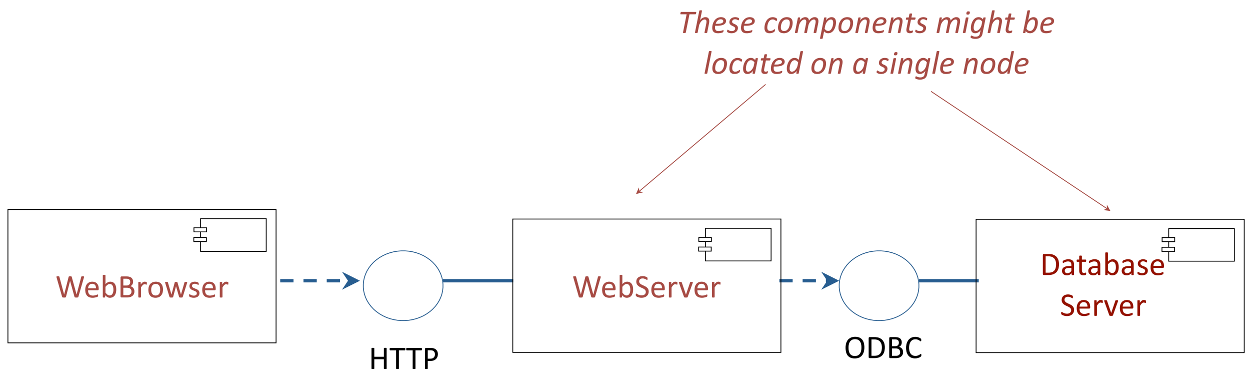
Three tier architecture

- Extension of client/server model
- Commonly used for small-medium web sites
    - Classic example: LAMP stack

Extend basic website with data store



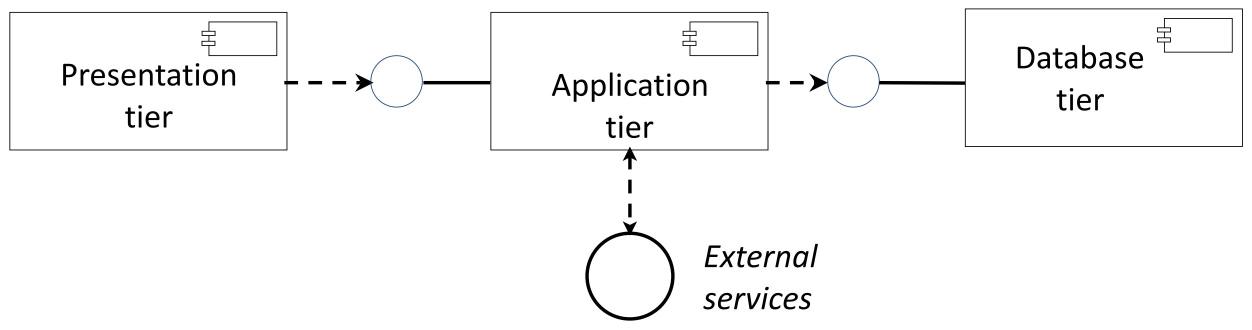
Component diagram



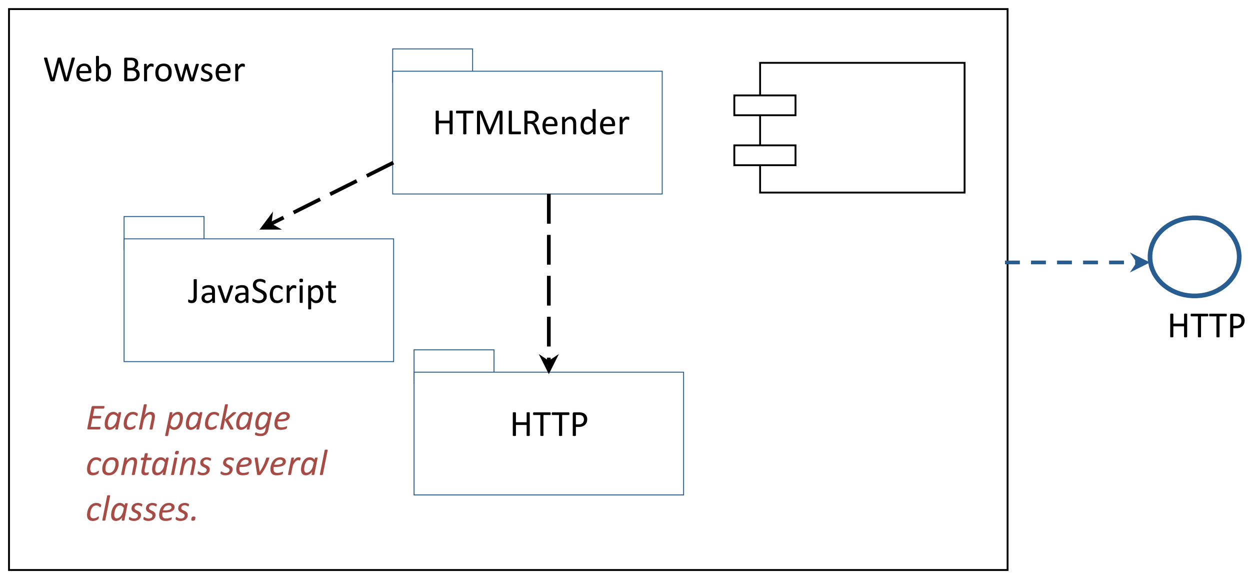
Significance of components (replaceable binary elements):

- Any web browser can access the website
- Database can be replaced by another that supports the same interface

Three tier architectural style



Internal complexity



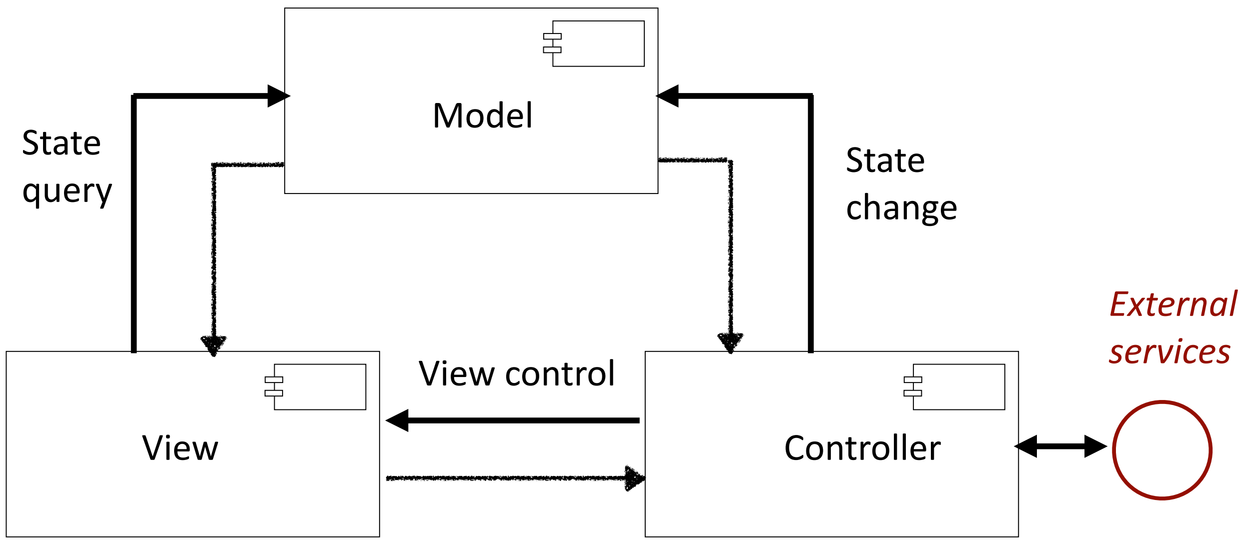
Presentation tier may house internal complexity, but as long as it supports the same interface, it is still a binary-replaceable component

Model view controller

- Beware: many variations
    - Some are architectural styles: system-level responsibilities partitioned into different components
        - Example: Play Framework
    - Some are program design patterns: functionality divided between different classes
        - Focus on reusable controls
        - Example: Swing widgets
        - Variation on which logic is widget-level vs. form-level (MVC vs. MVP)
        - Variation on which classes communicate directly (MVC vs. MVA)

- Variations in model storage (domain objects, DB record sets, immutable store)

Component diagram



Features of MVC

- Separated presentation
  - Decouple model and view (replaceable components)
  - Multiple (possibly simultaneous) views supported

Example: “mission control” terminal

View

- Presents application state and controls to user
- Typically subscribes to model for notifications of state changes
  - "Observer pattern"
- Responsible for rendering to a particular interface
  - Drawing graphics, generating HTML, printing text
- Sends user input to controller
- A single model can support multiple views
  - Example: web app, native app

Model

- Records state of application and notifies subscribers
  - Responds to instructions to change state (from controller)
- Does not depend on either controller or view
- State may be stored in objects or databases

- May be responsible for some application logic (e.g. input validation)

Controller

- Manages user input and navigation
- Defines application behavior
- Maps user actions to changes in state (model) or view
- May interact with external services via APIs
- May be responsible for some application logic (e.g. input validation)
- Variety in distribution of duties between model and controller

Publish-subscribe

- Event-driven control
    - Application responds to external stimuli and timeouts
    - No centralized orchestration
- Very loose coupling – components communicate via message broker
    - Easy to extend
    - Difficult to analyze (observer pattern)
        - No control over what (if any) code responds to an event
        - Potential for conflicts (multiple components respond in incompatible ways)
        - Potential for silently dropped events
        - Call stacks may not reflect causality

Activity: system decomposition

- What happens when I tap "send" in a mail app on my phone?
    - Draw a hardware block diagram
    - Draw layers of system software

Closing remark

- Beware software architectures that resemble corporate hierarchy
    - Refactoring more disruptive than reorgs
    - Be aware of and accommodate political context, but architecture should serve the application more than the developer

Virtualization

Deployment concerns

- Dependency conflicts
- Configuration, data sprawl
- OS portability
- Unintended interactions
    - Filesystem has same problems as global variables
- Solution: Encapsulation; but...
    - Deploying on separate machines risks under-utilization

Virtual machines

- Multiple OS instances running on one machine
    - Real hardware is managed by host OS or hypervisor
- Improves hardware utilization, reduces cost
    - Avoids energy consumption by redundant hardware
- Stateful – still risks data sprawl
    - Address with automated administration
- High overhead – software redundancy
- Examples: VMware, VirtualBox, Xen, Hyper-V

System configuration management

- Automate deployments
    - Installing dependencies
    - Configuring OS
    - Configuring application
- Combat sprawl
- Examples: Ansible, Puppet, Chef, Vagrant

Containers

- Trade OS heterogeneity for reduced redundancy
- Still isolate filesystem, network without duplicating OS
- Lightweight – new instances start quickly
    - Improves elasticity

- Often encapsulates a single application
- Often treated as stateless (don't write to filesystem)
- Examples: Docker, LXC

“Serverless”

- Computation nodes are stateless, ephemeral, and event-triggered
    - Data store services still persist state, but are application-agnostic
- Application decomposed into event-handler functions
    - Event dispatch, container lifetime managed by platform

Three tier vs. serverless

https://martinfowler.com/articles/serverless.html

Microservices

- Components encapsulate services and expose them via standard interfaces. Are ideally binary-replaceable
    - In practice, many frameworks for managing modular applications are language-specific (e.g. OSGi for Java)
    - OOP abstractions like objects, methods are complicated at language boundaries and distributed deployment
- Microservices constrain component definition to reduce coupling
    - Language-agnostic protocols (e.g. RESTful HTTP)
    - Independently deployable