System Design & Software Architecture

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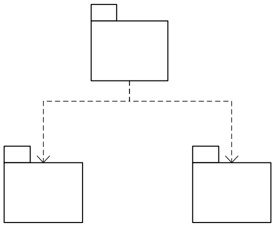
System Design

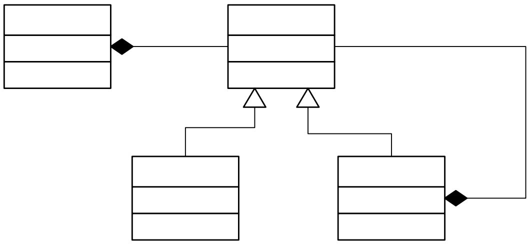
A system is decomposed in to subsystems



System Decomposition

- A *subsystem* provides a set of *services* to the system.
- A set of related operations that share a common purpose
- The set of services available to other systems form the subsystem interface
- Application Programmer Interface (API) includes name of operations, parameters/types, and return types
- System design focuses on defining services

(sub) System Model



System ***Part*** *

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Software Architecture

- Shaw & Garlan ’96
- The use of standard patterns and styles of design is pervasive in many engineering disciplines
- What standard style are used in software at the architectural level?

lass **Subsystem** #parts

+service() 1

Architectural Style

- An *architectural style* defines a family of systems in terms of a pattern of structural organization
  - Components (e.g., client, server, DB)
  - Connectors (e.g., procedure call, pipe, event broadcast)
- Vocabulary of components and connectors
- Constraints on how they are combined

Common Architectural Styles

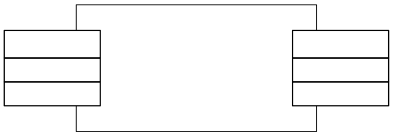
- Dataflow systems
  - Pipe and filter
  - Batch Sequential
- Virtual machines
  - Rule based systems
  - Interpreters
- Repository
  - Databases
  - Hypertext systems
  - Blackboards
- Independent components
  - Peer-to-Peer
  - Client Sever
  - Model / View / Controller
  - Event systems
- Call and return systems
  - Main program and subroutine
  - Layered Systems
  - Object oriented systems

Pipe and Filter Architecture

- Subsystems are called filters and associations between the filters are called pipes
- Filters only know the content and format of data being received and produced – nothing about the other filters in the system
- Filters are executed concurrently and synchronization is done via pipes
- Very reconfigurable
- Transformational systems, Info. Mang. Sys.

Pipe and Filter Example

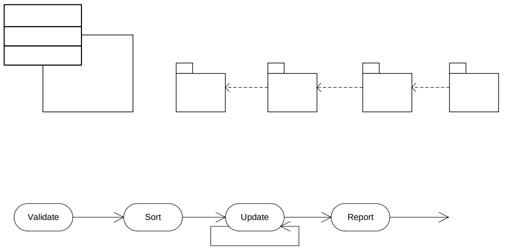
- Unix shell
- ps auxwww | grep maletic | sort | more



Batch Sequential Architecture

- Small number of large stand alone subsystems
- Must be executed in a fixed sequential ordering (batch)
- Typically work on large flat files, transforming the file into a new format or ordering so the next subsystem can work on the data
- Subsystems are tightly coupled through the shared file
- No real time feedback, no concurrency

Batch Sequential Example



Layered Architecture

- A hierarchical decomposition of a system into subsystems (layers) with each providing a higher level of services provided from lower level subsystems
- Closed architecture – each layer can only depend on the layer(s) immediately below
- Open architecture – each layer can access any layer below

Subsystem +input

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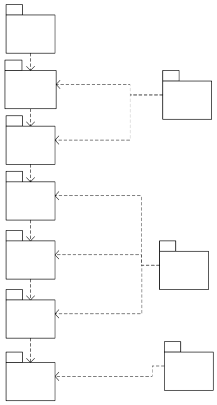
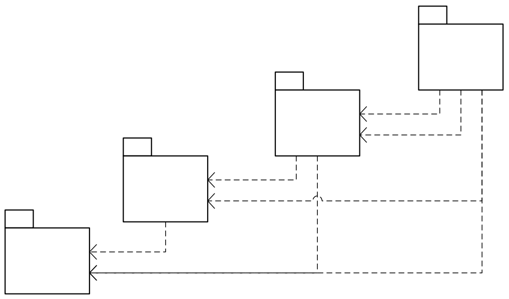
-output 1

Validate Sort Update Report

Closed Architecture OSI Network Model

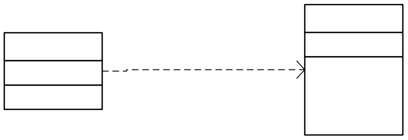


Open Architecture: Motif Library



Repository Architecture

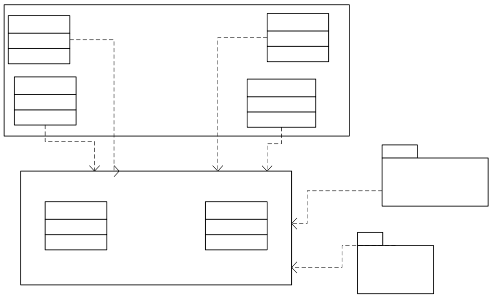
- Subsystems are independent and interact by a central repository
- Examples: Payroll or banking system, Modern IDE/Compiler, Blackboard



Application

Motif

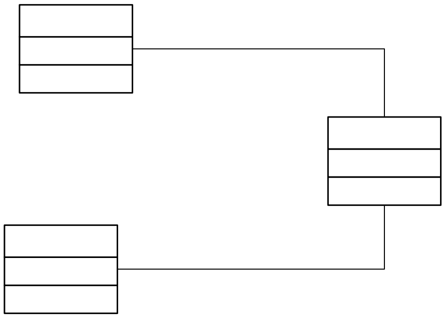
Repository Example



Model / View / Controller

- Subsystems
  - Model subsystems are responsible for maintaining domain knowledge
  - View subsystems are for displaying knowledge to the user
  - Controller subsystems manage the interactions with the user
- Model subsystems do not depend on view or controllers.
- Changes in model state is propagated via a subscribe notify protocol
- Examples: File system, database

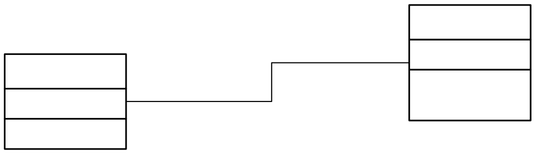
MVC



Client/Sever Architecture

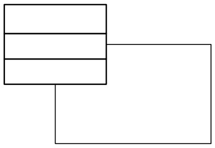
- Subsystems:
  - – Server provides one or more services to instances of clients
  - – Clients ask for services and clients interact with users
- Information system with a central DB is an example
- Web servers (multiple servers)

Client/Server

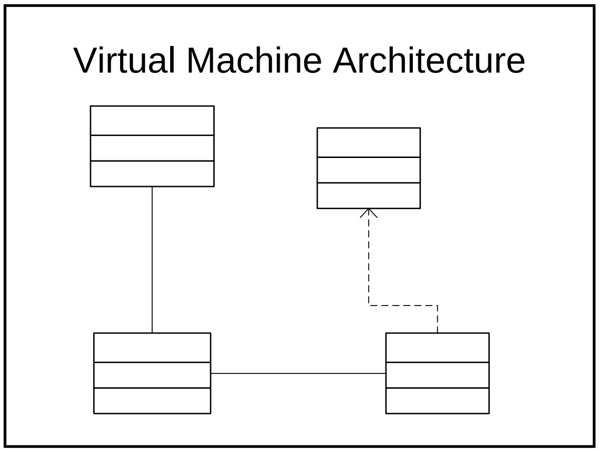


Peer-to-Peer Architecture

- Generalization of client/server, clients can be servers and vice versa
- The control flow of each subsystem is independent from others except for synchronization of requests.



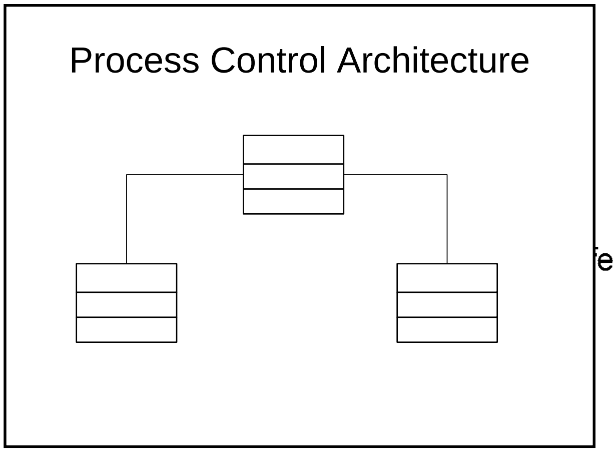
+provider **Server**



Virtual Machine Architecture

WorkingMemory

Program



Process Control Architecture

fetch

-inst fetch -store Interpreter

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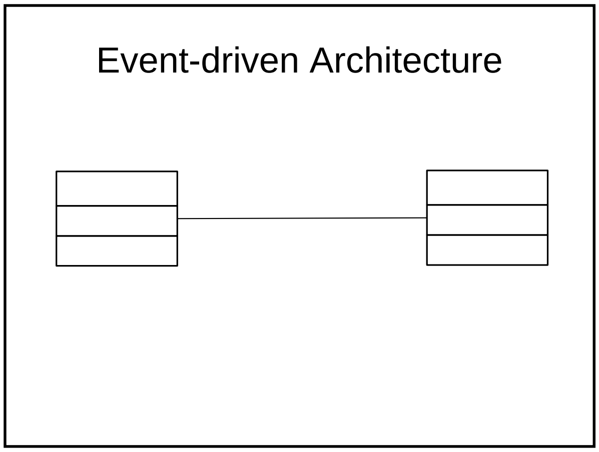

Event-driven Architecture

Controller

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action * * feedback