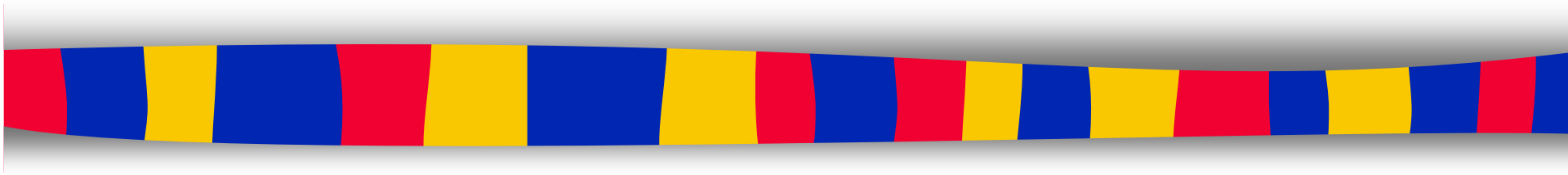
CISC 322
Software Architecture



Lecture 09:
Architecture Styles (4)

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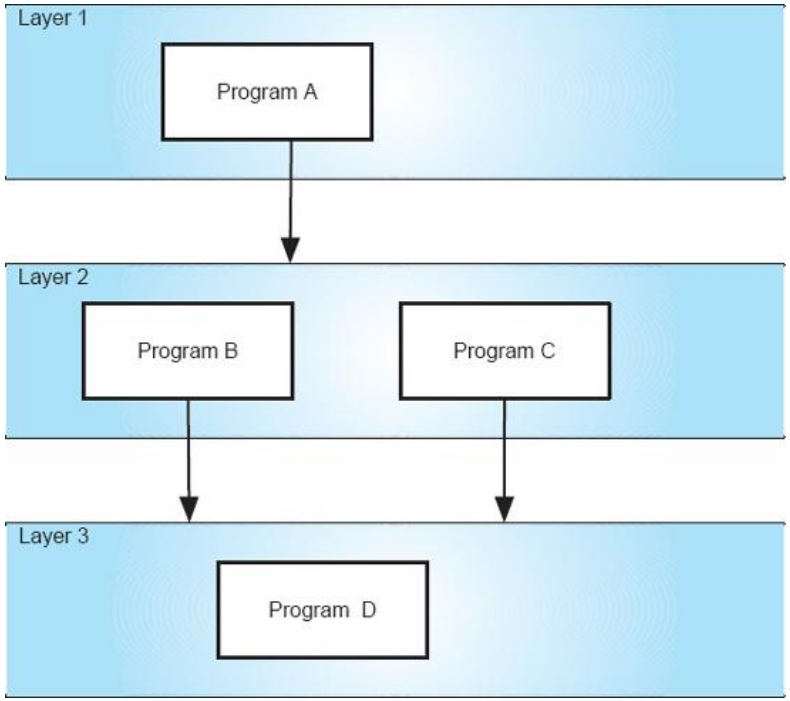
Adapted from Ahmed E. Hassan and Spiros Mancoridis

Recap of Last Class

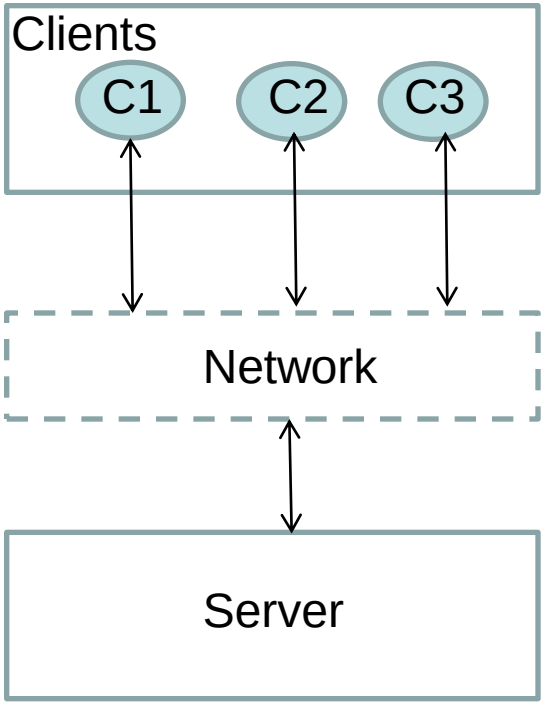
- Automated Stock Trading System
- Two architectures
  - Pipe-and-Filter + Repository + (EB) Implicit Invocation
  - Object Oriented + Repository + (PS) Implicit Invocation

Adapted from
Taylor et al. 2010

Layered Style



Virtual Machine



Client-Server

Layered Style

- Architecture is separated into ordered layers
  - A program in one layer may obtain services from a layer below it

Layered Variants

- **Virtual Machine**
  - An ordered sequence of layers
  - Each layer services the layer above it
- **Client-Server**
  - Clients send service request to server
  - Server replies as needed with requested information

Layered Style

- **Components**
  - VM: Layers (comprised of one or more programs)
  - CS: Client and Server
- **Connectors**
  - VM: Procedure calls
  - CS: Remote procedure calls

Layered Style

- **Topology**
  - VM: Linear; cross layer in special cases
  - CS: Two-level; client-to-client communication prohibited

Layered Style Advantages

- **VM**
  - Clear dependence structure
  - Upper levels immune to changes at lower levels
  - Lower levels are independent of upper levels
- **CS**
  - Centralization of computation and data at server
  - Single powerful server can serve many clients

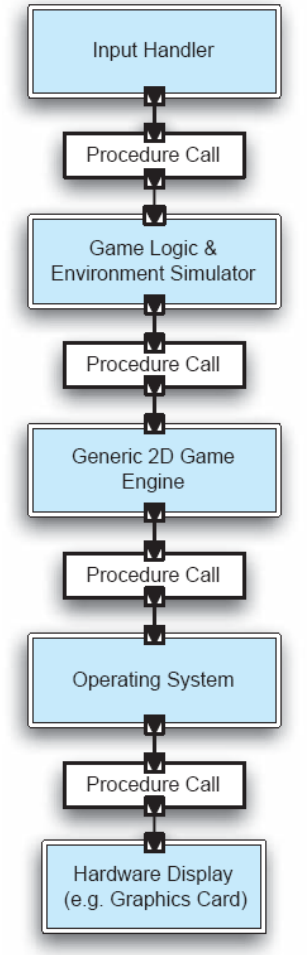
Layered Style Disadvantages

- **VM**
  - Having too many layers can be inefficient (may need to cross layers)
  - Not easy to divide software systems into layers
- **CS**
  - Heavy dependence on communication network

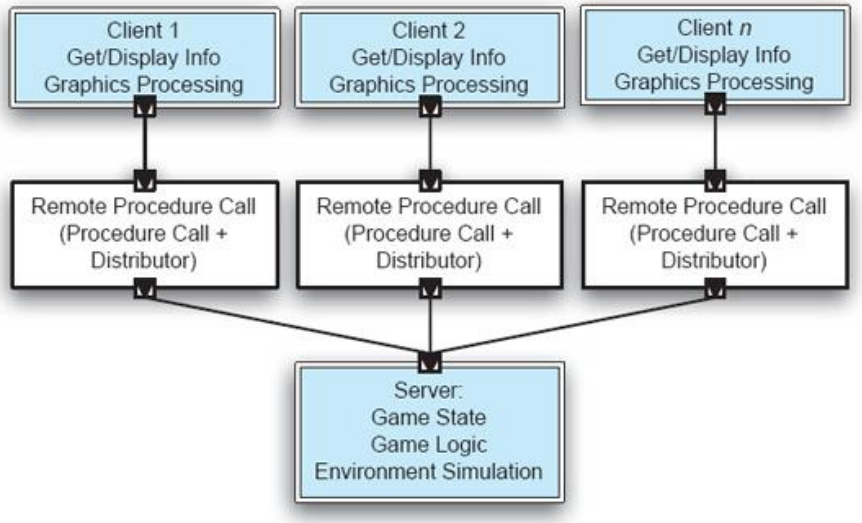
Layered Style Examples

- **VM**
  - Operating systems
  - Network protocol stack
- **CS**
  - Business applications

Layered Style Example



Virtual Machine



Client-Server

QA evaluation of Layered Style

- **Performance**
  - VM: In some cases need to cross layers
  - CS: May be restricted by network capacity
- **Availability**
  - VM: lower layers vs. higher layers?
  - CS: Failure at server affects all clients
- **Modifiability**
  - Change to a layer will affect, at most, 2 layers
- **Portability?**

Architectural Styles Wrap Up

Adapted from
Taylor et al. 2010

Repository

Summary	Use it when…	Avoid it when…
Independent programs, access and communicate exclusively through a global repository	order of processing dynamically determined and data-driven	interactions between the independent programs require complex regulation

Taylor et al. 2010

Pipe-and-Filter

Summary	Use it when…	Avoid it when…
Separate programs, aka filters, executed, potentially concurrently. Pipes route data streams between filters	problem easily formulated as a set of sequential, severable steps	interaction between components required

Adapted from
Taylor et al. 2010

Object Oriented

Summary	Use it when…	Avoid it when…
Objects encapsulate state and accessing functions	many complex and interrelated data structures	strong independence between components necessary.

Adapted from
Taylor et al. 2010

Implicit Invocation

Summary	Use it when…	Avoid it when…
(PB) Publishers broadcast messages to subscribers	subscription data is small and efficiently transported.	middleware to support high-volume data is unavailable.
(EB) Independent components asynchronously emit and receive events communicated over event buses	components are concurrent and independent	guarantees on real-time processing of events is required

Taylor et al. 2010

Layered

Summary	Use it when…	Avoid it when…
(VM) Virtual machine, or a layer, offers services to layers above it.	many applications can be based upon a single, common layer of services	1. many levels are required (causes inefficiency)
(CS) Clients request service from a server.	centralization of computation and data at a single location (the server) promotes manageability and scalability	network bandwidth and reliability are limited