Outline

- Announcements
- Modularity and Layering (continued)
- Student Presentation
- More on Layering
- Student Presentation
- Components, Suppliers
Announcements

- Assignment 3 will be posted this week
  - Due November 14

- Database Assignment out this week on site
  - Due: November 21
  - Cut-off date: November 21 (30% penalty)
  - Deliverables:
    - Hardcopy of survey results & report
    - Report & MSAccess files via email

- Forum
  - You can participate in discussion topics
  - This will earn you extra participation points

Announcements

Forthcoming presentations

- 11/12
  - Nataljia Robinett (Sun case study)

- 11/9
  - Are you kidding?! That’s when we have our midterm!

- Reading for Monday
  - Messerchmitt Ch.7.2, 7.4.2 (pp.204-226)
  - Messerchmitt Ch. 15
  - MySQL Database Case
Quiz

1. What is a component?

2. Name the 3-tiers in the 3-tier architecture

3. Give 2 layers in a computer infrastructure

Another Interface Example:

Automatic teller machine (ATM)

What is the interface between this machine and the customer?
Steps

1. Identify interface building blocks

2. Define available actions

3. Define, for each higher level function, a protocol
   - Single action or a finite sequence of actions

1. Interface building blocks

Message on screen or printed
   - Menu of actions or returns from an action
   - Touch selection of action

Keypad
   - Input parameters to an action

Card reader
   - Authentication, input parameters

Money output slot
   - Returns money
2. ATM actions

A) Authentication
B) Account specification
C) Amount specification

A) Action: authentication

Parameters
- Identity (card in slot)
- Institution (card in slot)
- PIN (typed on keypad)

Internally, it contacts institution and matches against its database, institution noted for all subsequent actions (functionality)

Returns
- Screen message
  - “Invalid PIN”, or
  - Menu of available actions
B) Action: specify_account

Parameters
- Account (touch screen from menu of choices)

Internally, choice noted for all subsequent actions (functionality)

Returns
- None

C) Action: amount

Parameters
- Dollars_and_cents (typed on keypad)

Internally, amount noted

Returns
- Success or failure (state dependent, for example for a withdraw failure when dollars_and_cents exceeds balance)
Protocol: cash_withdrawal

- authentication → failure
- choose objective → other objectives
- account → no accounts
- amount → balance exceeded!

Student Presentations

Morgan Marie Hunt Bus Proj: Netflix
More on layering

by

David G. Messerschmitt

Interaction of layers

Layer above is a client of the layer below

Each layer provides services to the layer above….

….by utilizing the services of the layer below and adding capability

Layer below as as a server to the layer above
Example 1

Bob sends a letter to Alice

Bob

US Postal Service

Shipping Container

ABC Airlines

Alice

UK Royal Mail

Shipping Container

Major layers

Applications

Application frameworks and components

Middleware

Operating system

Network

Infrastructure
Layering

Elaboration or specialization

Layering builds capability incrementally by adding to what exists

Data and information

Application
Deals with information
Assumes structure and interpretation

Infrastructure
Deals with data
Ignores structure and interpretation
**Example 2**

- **Web server** to **Web browser**

- **Application**
  - File
  - Message

- **Operating system**
  - File system

- **Network**
  - **Fragmentation**
  - **Collection of packets**
  - **Assembly**

**Package = file or message**

- Infrastructure deals with a package of data (non-standard terminology)
  - collection of bits
  - specified number and ordering

- Infrastructure stores and communicates packages while maintaining **data integrity**
  - File for storage
  - Message for communication
Data integrity

- Nothing is lost/changed in the representation/recovery of information
- Retain the
  - values
  - order
  - number
  of bits in a package
- Also applies to more complicated forms of representation and data processing
  - E.g. Data Integrity in Databases

Example 3

HHC Server Application | Passenger Information | HHC Client Application
---|---|---
Windows OS | message | Palm OS
Networking Infrastructure (Contains: TCP/IP, WiFi) | Collection of Packets | Networking Infrastructure (Contains: TCP/IP, WiFi)
Example 3: Network Infrastructure Expanded

HHC Server Application
Windows OS
TCP transport layer
WiFi Link Layer
WiFi Physical Layer
Networking Infrastructure

Passenger Information
message

HHC Client Application
Palm OS
TCP transport layer
WiFi Link Layer
WiFi Physical Layer
Networking Infrastructure

Packets
Radio Signals

Example 4

HHC Server

Windows OS
Networking Infrastructure Layers within TCP/IP, WiFi
HHC Server Application
message

Airline Dataserver

HEADQUARTERS

"Send me today's flight information"

DBMS
Unix OS
Networking Infrastructure Layers within: TCP/IP, WiFi
Collection of Packets
message
Data and information in layers

- The infrastructure should deal with data, or at most minimal structure and interpretation.

- The application adds additional structure and interpretation.

- This yields a separation of concerns.

Information in the infrastructure

- Sometimes it is appropriate for the infrastructure to assume structure and interpretation for data:
  - to add capabilities widely useful to applications
  - to help applications deal with heterogeneous platforms, where representations differ

- Data types
**Major layers - Review**

![Layer diagram]

**Student Presentations**

- Warren Fung (Dell)
- Bryant Yang (Jawbone)
Components, Suppliers (cont’d)

Component: A subsystem purchased “as is” from an outside vendor

(Alternative – building your own subsystem)

A component implementation is encapsulated (although often configurable)

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Supplier Types

- Three types of infrastructure/application suppliers:
  - Component Suppliers
  - Custom Subsystem Developers
  - System Integrators
- (Some suppliers are 2 or even 3 of above.)

Two ways to sell Software

<table>
<thead>
<tr>
<th>Product</th>
<th>Service</th>
</tr>
</thead>
<tbody>
<tr>
<td>Customer installed and</td>
<td>Functionality provided</td>
</tr>
<tr>
<td>operated</td>
<td>over a wide-area network</td>
</tr>
<tr>
<td>Often (but not necessarily)</td>
<td>Often (but not necessarily)</td>
</tr>
<tr>
<td>sold or licensed at a fixed</td>
<td>sold by subscription</td>
</tr>
<tr>
<td>price</td>
<td></td>
</tr>
</tbody>
</table>

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Recall: Infrastructure and Applications

Infrastructure
- Equipment and/or software used by many applications

Applications
- Provide specific capabilities and features serving individual users.

Four possibilities (examples)

<table>
<thead>
<tr>
<th>Product</th>
<th>Service</th>
</tr>
</thead>
<tbody>
<tr>
<td>Microsoft Office</td>
<td>Hotmail</td>
</tr>
<tr>
<td>Application</td>
<td></td>
</tr>
<tr>
<td>Infrastructure</td>
<td></td>
</tr>
<tr>
<td>Microsoft Windows</td>
<td>Internet DNS</td>
</tr>
<tr>
<td></td>
<td>(Domain Name System)</td>
</tr>
</tbody>
</table>

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Application Service Providers (ASPs)

- Two types
  - Bundled
    - An infrastructure provider bundles applications with their infrastructure
      - Example: AOL, telephony service providers
  - Unbundled
    - A provider of an application service without providing an infrastructure service
      - Examples?

Examples of unbundled ASP model

- Web-based calendar (e.g. Yahoo, Google)
- Web-based email (e.g. Hotmail, Gmail)
- Web-based stock trading (e.g. Charles Schwab)
Application acquisition

Application

\[ \text{Develop internally} \quad \text{Buy as product} \quad \text{Contract development} \quad \text{Product w/ customization} \]

- Software supplier
- Outsource developer
- Supplier, consultants

The changing industry structure
Stovepipe vs. Integrated Infrastructure

**Stovepipe Architecture**

---or---

**Turnkey Solution**

- Single supplier provides all encompassing solution
- (complete with infrastructure)

**Integrated Infrastructure**

Separate infrastructure that can support many applications

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**From stovepipe to layering**

- Data
- Voice
- Video

Application-dependent infrastructure

Many applications

Integrated Infrastructure (Maybe broken into Additional layers.)

Application-independent
Stovepipe vs. Integrated Infrastructure

- What are some examples of each?

- What are the advantages of each approach?

Vertical Integration - Diversification

- Two approaches for companies wishing to expand their product offerings

- A company is *vertically integrated* when it makes rather than buys the subsystems in its products.

- A *diversified* company produces products across different industry segments.
Less Vertical Integration - More Diversification

- Why do customers favor less vertical integration?
  - Prefer competition amongst component suppliers
  - Mix and match components
  - Reduced lock in

- Disadvantages??
  - Customer needs to integrate components from different suppliers.

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Less Vertical Integration - More Diversification

- Why do customers favor diversification?
  - Reduce coordination costs by having to deal with fewer suppliers.