Announcements

- Read Messerschmitt Ch 7 for Thursday.
- Folio 2 due Thursday (if you are doing a folio!)

Student Talks

A system is decomposed into interacting subsystems

Each subsystem may have a similar internal decomposition

Architecture

Three elements of architecture

System examples

Let's quickly look at some system decomposition examples

- Quick tour of information technology systems
Time sharing

Two-tier client/server

Three-tier client/server

Networked computing infrastructure

Layering

Example of Layering: networking
Software Layering

- Application
- Middleware
- Operating System

Operating system functions

- Graphical user interface (client only)
- Hide details of equipment from the application
- Multitasking
- Resource management
  - Processing, memory, storage, etc
- etc

Middleware Functions

- Capabilities that can be shared by many applications, but that is not part of OS
  - Example: Database Management System (DBMS)
- Hide details of OS from application
  - Java Virtual Machine
- More purposes we'll talk about later.

What's a database?

Database
  - File with specified structure
  - Example: relational table

A Database

<table>
<thead>
<tr>
<th>Year</th>
<th>City</th>
<th>Accommodation</th>
<th>Tuition</th>
</tr>
</thead>
<tbody>
<tr>
<td>2002</td>
<td>Turks</td>
<td>Hotel</td>
<td>$45</td>
</tr>
<tr>
<td>2002</td>
<td>Turks</td>
<td>Resort</td>
<td>$100</td>
</tr>
<tr>
<td>2002</td>
<td>Turks</td>
<td>Hotel</td>
<td>$345</td>
</tr>
<tr>
<td>2002</td>
<td>Turks</td>
<td>Resort</td>
<td>$25</td>
</tr>
<tr>
<td>2003</td>
<td>Turks</td>
<td>Hotel</td>
<td>$50</td>
</tr>
<tr>
<td>2003</td>
<td>Turks</td>
<td>Resort</td>
<td>$150</td>
</tr>
<tr>
<td>2000</td>
<td>Albany</td>
<td>Camping</td>
<td>$8750</td>
</tr>
<tr>
<td>2000</td>
<td>Albany</td>
<td>Hotel</td>
<td>$7425</td>
</tr>
<tr>
<td>2000</td>
<td>Albany</td>
<td>Resort</td>
<td>$52</td>
</tr>
<tr>
<td>2003</td>
<td>Turks</td>
<td>Hotel</td>
<td>$25</td>
</tr>
<tr>
<td>2003</td>
<td>Turks</td>
<td>Resort</td>
<td>$200</td>
</tr>
<tr>
<td>2003</td>
<td>Turks</td>
<td>Hotel</td>
<td>$7500</td>
</tr>
<tr>
<td>2003</td>
<td>Turks</td>
<td>Resort</td>
<td>$47500</td>
</tr>
<tr>
<td>2003</td>
<td>Turks</td>
<td>Hotel</td>
<td>$1750</td>
</tr>
<tr>
<td>2003</td>
<td>Turks</td>
<td>Resort</td>
<td>$2750</td>
</tr>
</tbody>
</table>

Storage Middleware example: DBMS

- Database Management System (DBMS)
  - Manage Multiple databases
  - Allow multiple applications to access common databases
  - Implement standard data "lookup" (query) functions.
The Internet

by
David G. Messerschmitt

Intranet

*Private* internet

Often connected to Internet

- Firewall creates a protected enclave

Extranet

An **Extranet** is composed of

- Intranets connected through an unprotected domain (typically the Internet)
- Encryption and other security technologies used to
  - protect proprietary information
  - prevent imposters, vandals, etc

What is the Internet?

- An **internet** is a "network of networks"
- Interconnect standard for LANs, MANs, and WANs
- **Internet** = the major global internet
- A private internet is called an **intranet**
- An **extranet** is an interconnection of intranets through the Internet

Client-Server Architecture

(continued)
Client Server Example

Client

"I want to see www.google.com."

Server

Client Server Example - Layers Revealed

Client

Server

3-Tier Client Server Architecture example

Client

Application Server

3-Tier Client Server Architecture example

Client

Application Server

3-Tier Client Server Architecture example

Client

Application Server

3-Tier Client Server Architecture example

Client

Application Server
### Relational Database

<table>
<thead>
<tr>
<th>Customer</th>
<th>Balance</th>
<th>Customer Class</th>
</tr>
</thead>
<tbody>
<tr>
<td>Alice</td>
<td>$527</td>
<td>Silver</td>
</tr>
<tr>
<td>Bob</td>
<td>$0.50</td>
<td>Bronze</td>
</tr>
<tr>
<td>Charles</td>
<td>$1000000</td>
<td>Gold</td>
</tr>
</tbody>
</table>

### DBMS Responsibilities

- Hide Changes in the Database hardware from the Application
- Standard operations on the data, including searches, such a search is called a **query**.
- Separate Database Management from Applications, so that many applications can access the same data.
- Security, Integrity, Backup, fault tolerance, etc..

### 3-Tier Client Server Architecture in General

- Takes inputs from client
- Decides what to be done next
- Decides what shared data to access and manipulates it
- Processes shared data

- Accepts instructions from user
- Makes requests of server
- Displays responses of server

- Support multiple applications with common data
- Protect critical data
- Decouple data administration and application administration

### Sun Case

(continued)
### Sun N-tier case

- What does Sun make?
  - Workstations
  - Servers
  - Software

### How Successful had Sun been up to 1998?

- Founded in 1982
- Open Standards Workstation
  - Unix Operating System (Solaris)
  - TCP/IP networking
- 1988 – Revenues $1 billion
- 1993 – Market value $3.0 billion

### How Successful had Sun been up to 1998?

- 1993 – "The network is the computer."
- 1994 – Internet explodes in popularity

### Microsoft mid to late 90s

- Dominated Desktop software
  - Users familiar with Windows, Office, etc.
- NT servers
  - Fine for small intranets, "not industrial strength"

### Sun N-Tier Case

- What is Java?
  - Programming Language
  - Portable between computers with different operating systems
  - Easy to write programs in
  - Easier re-use
  - But, programs are slow

### What problems did the micro era produce?

- Desktops are expensive to maintain
  - TCO for windows PC $9900!
- Every PC had a lot of software that had to be maintained
  - Office, Windows, etc...
- Small differences, like the order in which software is installed, could make different PCs behave differently!
Sun's Vision

- Thin Client model.
- Application Servers with Applications written in Java.
- NCs could retrieve applications from the application server as needed.
- Applications compatible with any NC hardware and OS.
- Applications could be fixed, added, or updated at the server level, rather than maintaining each PC.

Microsoft Vision

- Keep "fat-client" model
- Add some features to Windows to reduce administration costs

Sun's Performance

- Net Revenue
- Net income
Today

- 3-tier model common.
- Sun's version of 4-tier model not-common.
- N-tier model where Webserver and Application Server on separate equipment also common.
- Sun's hardware business not strong.
  - Linux on cheap PCs most common servers
  - Microsoft desktops replacing Sun workstations

Sun's Performance

What could have Sun done?
- Compete on price with cheap PC servers running Linux?
- Sell a fat-client workstation that runs Windows and is price competitive with Dell, HP PCs, etc...
- Sell workstations at a price premium over PCs, focus on software reliability, run some Microsoft application, build brand cachet.
- Focus on Java based software and IT services for enterprises, withdraw from low-end hardware...
- Something else?

Today

- Java
  - Common in Server implementations
    - Example: Java Servlet implementing application logic in a banking application.
  - Often used to push simple applets onto client
  - Not common
    - For "big" desktop applications
    - Office Suite in Java not popular
  - Microsoft is still in business...