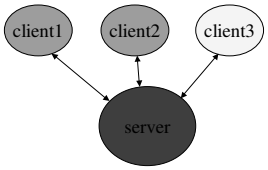
Systems Architecture

Client-Server Systems

Client/Server

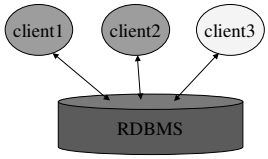
- In general, any application where multiple clients connect to a single server.



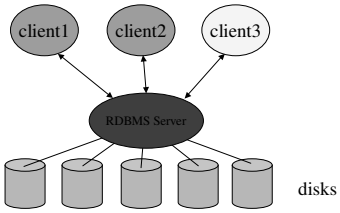
- one client program (most typical)
  or
- multiple client programs

Relational Databases

- Most common client/server program is where the server is a relational database server.
  - warning: some use the term client/server to refer to this usage exclusively (we won't).



Relation Database Implementation



IPC

- "Inter-Process Communications"
  - How processes will communicate and synchronize with one-another.
  - communications mechanisms:
    - shared memory
      - very fast
      - can't use over a network
        - » well, you can
    - message passing
      - can use over a network
      - slower
        - » well, not always
  - will consider only message passing (most important)

IPC Protocols

- Basic message-passing mechanisms provide for a byte-stream only.
- Must implement various protocols on top of this
  - sockets
  - RPC (remote procedure call)
  - DO (distributed objects)

Sockets code example

```
public class Server {
    public static void main(String[] args) throws Exception {
        ServerSocket server = new ServerSocket(1234);
        Socket client = server.accept();
        BufferedReader fromClient = new BufferedReader(
                 new InputStreamReader(client.getInputStream()));
        System.out.println(fromClient.readLine());
    }
}


public class Client {
    public static void main(String[] args) throws Exception {
        Socket server = new Socket("penny", 1234);
        DataOutputStream toServer = new DataOutputStream(
                 server.getOutputStream());
        toServer.writeBytes("hello server");
         server.close();
    }
}
```


Performance

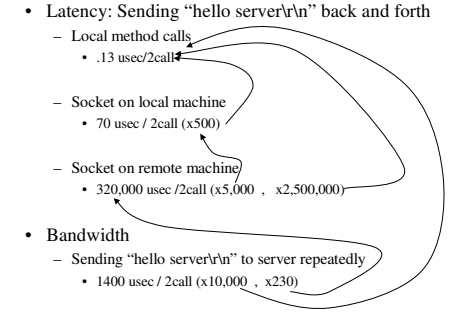
- Latency
  - The time to go back and forth
- Bandwidth
  - The amount of data that can be sent
- Analogy from ocean lines
  - Bandwidth of QE2 is high (can carry a lot)
  - Latency is bad (takes a long time for a round trip).

Test System

- Windows 2000 Java Server
  - Network
    - 100 Mbit/s ethernet
  - CPU
    - dual 1GHz processors
  - Memory
    - 1 GByte
- Windows 98 Java Client
  - Network
    - 100 Mbit/s ethernet
  - CPU
    - 366 MHz
  - Memory
    - 96 MByte

Java/Windows Performance Measures

- Latency: Sending “hello server\r\n” back and forth
  - Local method calls
    - .13 usec/2call
  - Socket on local machine
    - 70 usec / 2call (x500)
  - Socket on remote machine
    - 320,000 usec /2call (x5,000 , x2,500,000)
- Bandwidth
  - Sending “hello server\r\n” to server repeatedly
    - 1400 usec / 2call (x10,000 , x230)



Performance

	In Process	Network
Latency	1	2,500,000
Bandwidth	1	10,000

C/Windows Performance Measures

- Latency: Sending “hello server\r\n” back and forth
  - Local method calls
    - .01 usec/2call (10x Java)
  - Socket on local machine
    - 12 usec / 2call (6x Java)
  - Socket on remote machine
    - 840 usec /2call (380x Java)

Performance

	In Process	Network
Latency	1	84,000

Performance Implications

- Do as few calls as possible over the net
- Prefer asynchronous approaches
  - problem: success/failure indications
  - send lots of stuff, then synchronize
- Use bigger transactions
- Prefer one call with lots of data to many calls with the same amount of data
  - but not by much
- Send as little data as possible