Client Design

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Topics

- **Concurrency in client**
  - **Concepts**
  - **Approaches**
- **TCP timed echo example**

Why Use Concurrency in *Servers* ?

- **Improved response time**
- **Can be used to eliminate deadlocks**
- **Simplifies implementation of multiprotocol and multiservice servers**
- **Threads work on uniprocessors, but can take advantage of multiprocessors**

Except for multiprocessor execution, none of these reasons directly applies to *clients.*

Why Use Concurrency in *Clients* ? (1)

- **Can separate functionality into distinct components, with advantages for code design and maintenance**
  - **Requester (sends requests)**
  - **Receiver and processor**
  - **User interface**
  - **Control**
- **Client can simultaneously contact multiple servers**
  - **Distributed search**
  - **Compound documents with elements on multiple servers**

Why Use Concurrency in *Clients* ? (2)

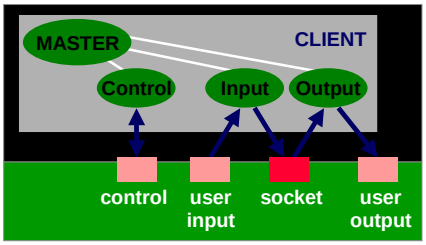
- **Allows interaction while a request is in progress**
  - **Status checks**
  - **Abort operation**
  - **Modify parameters**
- **Potential performance advantage for overlapping operations**
  - **Processing, file I/O, and network I/O**
  - **Overlap operations on multiple connections**
- **Provides asynchrony**
  - **Set of multiple tasks can be performed without the imposition of a strict ordering**

Implementing Concurrency in Clients

- **Two approaches (as for servers)**
  - **Multiple threads, using pthread_create()**
  - **Apparent concurrency, using select()**
- **Multiple threads**
  - **Each thread performs a distinct set of tasks, or**
  - **Each thread performs a separate request or other task, or**
  - **Some combination of the above**
- **Apparent concurrency**
  - **Single thread uses select() for asynchronous I/O**
  - **Time-outs should be included to prevent client deadlock**

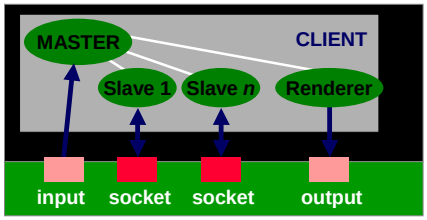
Multithreaded Client (1)

- Single network socket (TCP or UDP)
- Functional decomposition



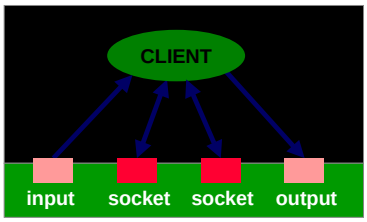
Multithreaded Client (2)

- Multiple network sockets
- Hybrid approach, since there is also functional decomposition



Single-Threaded Concurrent Client

- Single thread uses select() call to find active socket and file descriptors
- Decomposition by socket and functions



TCPtecho Example (1)

- TCPtecho
  - Single client that accesses multiple servers (in this case, ECHO servers)
  - Utility is to simultaneously measure network throughput between the client and multiple servers
- Basic tasks
  - Make connections to each server -- main()
  - Send data until all data is sent -- writer()
  - Receive data until all data is received -- reader()

TCPtecho Example (2)

- writer()
  - For a given host …
    - Send as much data as possible up to total amount to send
    - Reduce amount left to send by amount actually sent
    - If all is sent, shutdown connection for send with shutdown()
  - writer() called when a socket is ready for send()
  - Since data to be sent may be larger than what can be sent, sockets are set to "non-blocking" to ensure that send() won't block
    - ioctl(fd, FIONBIO, &one)

TCPtecho Example (3)

- reader()
  - For a given host …
    - Receive as much data as possible, up to buffer size
    - Reduce amount received from amount to receive
    - If all is received close the connection with close()

ioctl()

- ioctl(socket, command, arg_ptr)
- Commands
  - FIONBIO: enable non-blocking mode
  - FIONREAD: determine amount of data pending in the network's input buffer
  - SIOCATMARK: determine whether or not all out of band data has been read
- In TCPtecho
  - u_long one = 1
  - ioctl(fd, FIONBIO, &one)

Getsockopt() and Setsockopt()

- setsockopt() and getsockopt() also used to monitor and control socket operation
- For example, to force TCP to immediately send data

```
int optval = 1;
setsockopt( sock, IPPROTO_TCP,
  TCP_NODELAY, (const char *)
  &optval, sizeof(int));
```

You should now be able to …

- Describe the need for concurrency in a client
- Describe approaches to making a client concurrent
- Analyze and design a simple concurrent client
- Use ioctlsocket() to control socket options