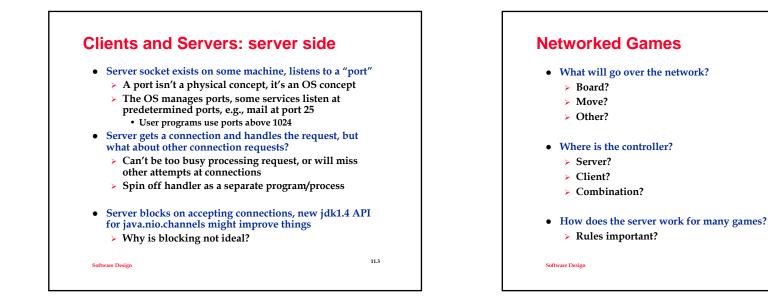
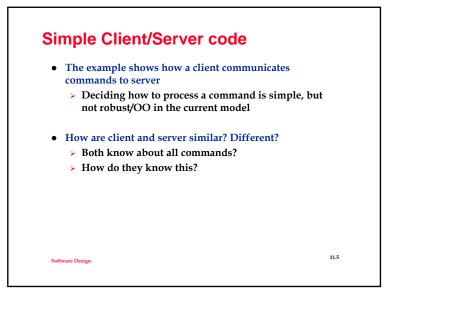
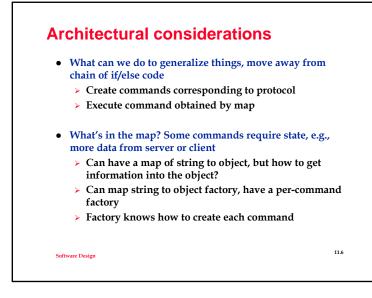


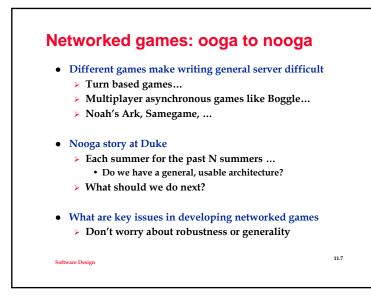
## Client/Server Communication 9. The Java stream hierarchy is a rich source of options 9. Object streams, Data streams, Buffered Readers, ... 9. Often these convert between bytes and characters 9. What's the story with Unicode? (e.g. compared to ASCII) 9. FileStream, BufferedReader, ...; 9. We can read and write objects over sockets 9. Otsadvantages compared to lower-level protocols? 9. Disadvantages? 9. Menere do objects "live", are classes different? 9. Subclass/Superclass issues 9. What about connection issues (where, how, knowledge)

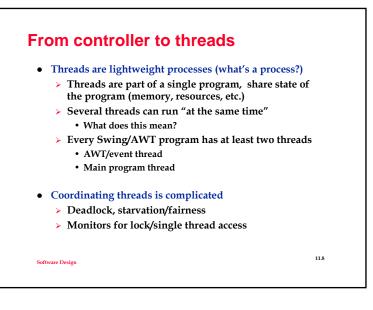
11.4













- Typically must have method for ensuring atomic access to objects
  - > If different threads can read and write the same object then there is potential for problems
    - ThreadTrouble.java example
    - Consider getting x and y coordinates of a moving object
  - > If an object is read-only, there are no issues in concurrent programming
    - String is immutable in Java, other classes can have instance variables be defined as final, cannot change (like const)
- In Java, the keyword synchronized is the locking mechanism used to ensure atomicity
  - > Uses per-object monitor (C.A.R. Hoare), processes wait to get the monitor, it's re-entrant

11.9

Software Design

## Using synchronized methods

- Methods can be synchronized, an object can be the argument of a synchronized block, a class *cannot* be synchronized
  - Every object has a lock, entering a synchronized method of the object, or using the object in a synchronized block, blocks other threads from using synchronized methods of the object (since the object is locked)
  - If a synchronized method calls another synchronized method on the same object, the lock is maintained (even recursively)
  - Another thread can execute any unsynchronized method of an object O, even if O's lock is held
  - > A thread blocks if it tries to execute a synchronized method of an object O if O's lock is held by a different thread

Software Design

11.10

