Introduction to Operating Systems

What are Operating Systems?

Slides created by
Matthew Tancreti
for COM S 352
Iowa State University

What are Operating Systems?

Question: What do you think of when you hear Operating System?

Example Program

A made-up simple program that reads from a file

```
public void readFromFile(String fileName) throws IOException {
  FileReader fr = new FileReader(fileName);
  String str;

  while ((str = read(fr)) != null)   {
    System.out.print(str + " ");
  }

  fr.close();
}

public String read(FileReader fr) throws IOException {
  fr.read(charBuff);
  return new String(charBuff);
}

...
```

Problem: What to Do When Waiting for I/O?

Many programs and a single (or limit number) of CPU core(s)

When one program waits for I/O (e.g., read from disk), what should the CPU be doing?

Could another another program run on the CPU?

A “Cooperative” Program Waiting for I/O

```
public void readFile(String fileName) throws IOException {
  FileReader fr = new FileReader(fileName);
  String str;

  while ((str = read(fr)) != null)   {
    System.out.print(str + " ");
  }

  fr.close();
}

public String read(FileReader fr) throws IOException {
  while (!fr.readyToRead()) {
    // not ready, find some other process that is ready to run
    for (var p : processes) {
      if (p.readyToRun()) {
        p.run();
      }
    }
  }

  fr.read(charBuff);
  return new String(charBuff);}
}

...
```

While waiting for I/O, the “cooperative” program lets some other process run

But Programmers don’t want to write code like this!!!

Problem: How to Stop Process Hogging CPU?

What happens to the other programs when one program is taking a really long time to finish?

A “Cooperative” Program Yielding in Loop

To keep for hogging the CPU, the “cooperative” program lets some other process run

```
public void readFile(String fileName) throws IOException {
  FileReader fr = new FileReader(fileName);
  String str;

  while ((str = read(fr)) != null)   {
    System.out.print(str + " ");

    // check if some other process that is ready to run
    for (var p : processes) {
      if (p.readyToRun()) {
        p.run();
      }
    }
  }

  fr.close();
}

public String read(FileReader fr) throws IOException {
  fr.read(charBuff);
  return new String(charBuff);
}

...
```

But Programmers don’t want to write code like this!!!

CPU Virtualization

Programs are written with the assumption they are the only thing running on the CPU

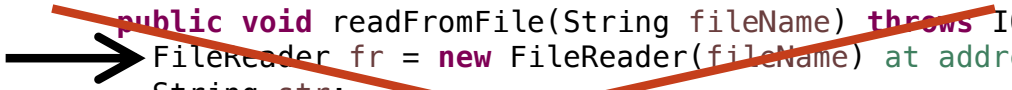
The OS presents the illusion of (virtualizes) a dedicated CPU to the program

A major topic of this class will be how the OS provides CPU virtualization

Problem: Where are Variables in Memory?

Example Program with Memory Allocation

What if Java let you tell where the new object should be located in physical memory?



```
public void readFromFile(String fileName) throws IOException {
  FileReader fr = new FileReader(fileName) at address 0x0000FFAABB9900;
  String str;

  while ((str = read(fr)) != null)    {
    System.out.print(str + " ");
  }

  fr.close();
}

public String read(FileReader fr) throws IOException {
  fr.read(charBuff);
  return new String(charBuff);
}

...
```

But Programmers don't want to write code like this!!!

Memory Virtualization

The OS presents the illusion of one big memory that is controlled only by the program

Reality: a program's memory may be split up, moved around, and even pushed to a disk at any time while the program is running!

A topic of this class will be how the OS provides memory virtualization

Take away:

Operating Systems are complex, so programs can be simple