Operating Systems

A more in-depth look at OS

Multi-programming

• Multiprogramming
  • Also known as multitasking
  • Memory is expanded to hold three, four, or more programs and switch among all of them

Multi-programmed Batch Systems

• There must be enough memory to hold the OS (resident monitor) and one user program
  • When one job needs to wait for I/O, the processor can switch to the other job, which is likely not waiting for I/O

<table>
<thead>
<tr>
<th></th>
<th>Run</th>
<th>Wait</th>
<th>Run</th>
<th>Wait</th>
</tr>
</thead>
<tbody>
<tr>
<td>Program A</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Program B</td>
<td>Wait</td>
<td>Run</td>
<td>Wait</td>
<td>Run</td>
</tr>
<tr>
<td>Combined</td>
<td>Run A</td>
<td>Run B</td>
<td>Wait</td>
<td>Run A</td>
</tr>
</tbody>
</table>

Time

(c) Multiprogramming with two programs

Time-Sharing Systems

• Can be used to handle multiple interactive jobs
  • Processor time is shared among multiple users
  • Multiple users simultaneously access the system through terminals,
    • with the OS interleaving the execution of each user program in a short burst or quantum of computation
Batch Multiprogramming vs. Time Sharing

<table>
<thead>
<tr>
<th>Batch Multiprogramming</th>
<th>Time Sharing</th>
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<tbody>
<tr>
<td>Principal objective</td>
<td>Maximize processor use</td>
</tr>
<tr>
<td>Source of directives to operating system</td>
<td>Job control language commands provided with the job</td>
</tr>
</tbody>
</table>

Table 2.3  Batch Multiprogramming versus Time Sharing

Major Achievements

- Operating Systems are among the most complex pieces of software ever developed

  Major advances in development include:
  - processes
  - memory management
  - information protection and security
  - scheduling and resource management
  - system structure

Process

- Fundamental to the structure of operating systems

A process can be defined as:
A program in execution
A unit of activity characterized by a single sequential thread of execution, a current state, and an associated set of system resources

Process Management

- The entire state of the process at any instant is contained in its context.
- New features can be designed and incorporated into the OS by expanding the context to include any new information needed to support the feature.

Figure 2.8  Typical Process Implementation
Memory Management

- The OS has five principal storage management responsibilities

- Process isolation
- Automatic allocation and management
- Support of modular programming
- Protection and access control
- Long-term storage

Virtual Memory

- A facility that allows programs to address memory from a logical point of view

- Conceived to meet the requirement of having multiple user jobs reside in main memory concurrently

Paging

- Allows processes to be comprised of a number of fixed-size blocks, called pages

- Program references a word by means of a virtual address
  - consists of a page number and an offset within the page
  - each page may be located anywhere in main memory

- Provides for a dynamic mapping between the virtual address used in the program and a real (or physical) address in main memory

Scheduling and Resource Management

- Key responsibility of an OS is managing resources

- Resource allocation policies must consider:
The nature of the threat that concerns an organization will vary greatly depending on the circumstances. The problem involves controlling access to computer systems and the information stored in them.

Main issues:
- availability
- authenticity
- confidentiality
- data integrity

Different Architectural Approaches

- Demands on operating systems require new ways of organizing the OS

**Different approaches and design elements have been tried:**
- microkernel architecture
- multithreading
- symmetric multiprocessing
- distributed operating systems
- object-oriented design

Microkernel Architecture

- Assigns only a few essential functions to the kernel:

  - address spaces
  - interprocess communication (IPC)
  - basic scheduling

  - The approach:
  - simplifies implementation
  - provides flexibility
  - is well suited to a distributed environment
Multithreading

- Technique in which a process, executing an application, is divided into threads that can run concurrently

Thread
- dispatchable unit of work
- includes a processor context and its own data area to enable subroutine branching
- executes sequentially and is interruptible

Process
- a collection of one or more threads and associated system resources
- programmer has greater control over the modularity of the application and the timing of application related events

Symmetric Multiprocessing (SMP)

- Term that refers to a computer hardware architecture and also to the OS behavior that exploits that architecture
- Several processes can run in parallel
- Multiple processors are transparent to the user
  - these processors share same main memory and I/O facilities
  - all processors can perform the same functions
- The OS takes care of scheduling of threads or processes on individual processors and of synchronization among processors

SMP Advantages

- Performance: more than one process can be running simultaneously, each on a different processor
- Availability: failure of a single process does not halt the system
- Incremental Growth: performance of a system can be enhanced by adding an additional processor
- Scaling: vendors can offer a range of products based on the number of processors configured in the system

Other architectures

Distributed Operating System
- Provides the illusion of
  - a single main memory space
  - single secondary memory space
  - unified access facilities
- State of the art for distributed operating systems lags that of uniprocessor and SMP operating systems

Object-Oriented Design
- Used for adding modular extensions to a small kernel
- Enables programmers to customize an operating system without disrupting system integrity
- Eases the development of distributed tools and full-blown distributed operating systems