

2.2 System Calls

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Concept

System calls are the mechanisms that allow user applications to request services from the operating system. They act as intermediaries between user programs and the OS, enabling programs to perform operations such as file management, process control, and device communication. System calls provide a controlled interface for user applications to interact with hardware and system resources.

How System Calls Work

- 1. **Invocation:** An application requests a service by making a system call.
- 2. **Context Switch:** The CPU transitions from user mode to kernel mode to execute the request.
- 3. **Execution:** The operating system performs the required operation.
- 4. **Return:** The result of the system call is sent back to the application, and the CPU returns to user mode.

Types of System Calls

1. Process Control

| System Call | Description | Example Use |
|-----------------------|--|---|
| <code>fork()</code> | Creates a new process by duplicating the current one. | Used to start a new process. |
| <code>exec()</code> | Replaces the current process image with a new program. | Executes a different program within the same process. |
| <code>exit()</code> | Ends a process and returns an exit status. | Terminates the current process. |
| <code>wait()</code> | Waits for a child process to terminate. | Synchronizes the end of a process with its parent. |
| <code>getpid()</code> | Retrieves the process ID of the current process. | Obtains the unique identifier of the process. |

2. File Management

| System Call | Description | Example Use |
|---------------------|---|---|
| <code>open()</code> | Opens a file and returns a file descriptor. | Used to access a file for reading or writing. |

| System Call | Description | Example Use |
|-----------------------|--|--------------------------------------|
| <code>read()</code> | Reads data from a file into a buffer. | Retrieves data from a file. |
| <code>write()</code> | Writes data from a buffer to a file. | Saves data to a file. |
| <code>close()</code> | Closes an open file descriptor. | Releases file resources. |
| <code>unlink()</code> | Deletes a file or removes a file link. | Removes a file from the file system. |

3. Device Management

| System Call | Description | Example Use |
|----------------------|---|---|
| <code>ioctl()</code> | Controls device parameters or performs specific operations. | Configures hardware devices. |
| <code>read()</code> | Reads data from a device. | Retrieves data from a device such as a disk or network interface. |
| <code>write()</code> | Writes data to a device. | Sends data to a device such as a printer or network card. |
| <code>open()</code> | Opens a device file for communication. | Accesses a device for operations. |
| <code>close()</code> | Closes the device file descriptor. | Ends communication with the device. |

4. Information Management

| System Call | Description | Example Use |
|-----------------------------|--|--|
| <code>gettimeofday()</code> | Retrieves the current time and date. | Provides the system time for applications. |
| <code>uname()</code> | Returns system information like OS name and version. | Provides details about the operating system. |
| <code>sysinfo()</code> | Retrieves system statistics such as memory usage. | Gives performance metrics of the system. |

5. Communication

| System Call | Description | Example Use |
|-----------------------|--|---|
| <code>pipe()</code> | Creates a unidirectional data channel between processes. | Allows inter-process communication. |
| <code>socket()</code> | Creates a network socket for communication. | Sets up network connections. |
| <code>bind()</code> | Associates a socket with a specific address and port. | Prepares a socket for network communication. |
| <code>listen()</code> | Marks a socket as listening for incoming connections. | Accepts connection requests from other networked devices. |

| System Call | Description | Example Use |
|-----------------------|---|---|
| <code>accept()</code> | Accepts an incoming connection request on a socket. | Establishes a connection with a client. |

Example Questions

| Question | Answer |
|--|--|
| What is the role of system calls in an operating system? | System calls provide a way for applications to request services from the OS, such as file operations and process management. |
| How do system calls facilitate communication between user applications and the OS? | They act as a controlled interface for user applications to perform operations that require OS-level privileges. |
| Name a system call used for file management. | <code>open()</code> or <code>read()</code> |
| What does <code>fork()</code> do in process control? | It creates a new process by duplicating the current process. |
| How does <code>pipe()</code> support inter-process communication? | It creates a channel through which data can be exchanged between processes. |