Load-Time Relocation

- Operating System
- Process 3
- Process 6
- Process 1
Base & Bounds Example

Process Virtual Address Space

<table>
<thead>
<tr>
<th>Address</th>
<th>Content</th>
</tr>
</thead>
<tbody>
<tr>
<td>2000</td>
<td>RETURN</td>
</tr>
<tr>
<td>1420</td>
<td>...</td>
</tr>
<tr>
<td>140</td>
<td>...</td>
</tr>
<tr>
<td>66</td>
<td>...</td>
</tr>
<tr>
<td>62</td>
<td>CALL 140</td>
</tr>
<tr>
<td>0</td>
<td></td>
</tr>
</tbody>
</table>

SP
x86-64 Address Translation

64-bit Virtual Address

- PML4 (Page Directory Pointer Table)
  - PML3 (Page Directory)
    - PML2 (Page Table)
      - Page Frame

52-bit Physical Address

- 40 bits for page frame
- 12 bits for offset
Accessing User Memory

write(fd, buffer, length)
OS and User in Same Address Space

- **Operating System**
- **Code**
- **Data**
- **Stack**

**Process 1**

- **Shared Code**
- **Private Data/Stack**

**Process 2**

- **Shared Code**
- **Private Data/Stack**

The diagram illustrates the separation of operating system code, data, and stack within the same address space for both Processes 1 and 2.