Atomic page flip and mode setting
Hardware structure and abstraction
Atomic “page flip”

The hardware will compose the final image from two layers.
Atomic “page flip”

Animating the scene
Atomic “page flip”

There are problems with animating the scene.
Double buffered registers

- Hardware maintains two register files
- First register file is written by the CPU
- Second register file is latched from the first one at vblank start
Double buffered registers

Problem: Hardware doesn't guarantee atomicity
Double buffered registers

Solution: Prevent CPU from writing to registers near vblank start
Kernel API

Transactional vs. one-shot

VS.
Possible issues with transactional API
Kernel API

```
count_props  prop_value

<table>
<thead>
<tr>
<th>obj_id</th>
<th>prop_id</th>
<th>blob_ptr</th>
</tr>
</thead>
<tbody>
<tr>
<td>2</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3</td>
<td></td>
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<tr>
<td></td>
<td>60</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>80</td>
</tr>
<tr>
<td></td>
<td></td>
<td>80 bytes</td>
</tr>
<tr>
<td>80 bytes</td>
<td></td>
<td></td>
</tr>
<tr>
<td>60 bytes</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
```
Kernel internal API

begin();
  set();
  set();
  set();
  ...
check();
commit();
end();
Completion events

$\text{fps} \leq \text{vertical refresh rate}$
Completion events

fps > vertical refresh rate
Atomic mode setting

- Total shared resource available: \( 3N \)

Starting conditions:
- Display 1 resource requirement: \( N \)
- Display 2 resource requirement: \( N \)

\[
N + N \leq 3N
\]
Atomic mode setting

Step 1: Change mode on display 1

- Display 1 resource requirement: $2N$
- Display 2 resource requirement: $N$

$2N + N \leq 3N$
Atomic mode setting

Step 2: Change mode on display 2

- Display 1 resource requirement: $2N$
- Display 2 resource requirement: $2N$

$$2N + 2N > 3N$$

Need to roll back mode change on display 1.
Solution: Combine steps 1 and 2 into a single step.

The final state can be checked before the hardware state is clobbered, and thus there is no need for rolling back.