Day 6 — N Governed Objects with Priority Buckets

1. Introduction

Day 5 of the VRAM Governor introduced priority-aware and spike-aware control, but it was restricted to three fixed panels: Low, Normal, and High. Day 6 generalizes this concept to an arbitrary number of governed objects. Each object now has its own priority, bias, and state, allowing the governor to manage many textures, meshes, or volumes dynamically.

2. Data Model

The core of Day 6 is the `GovObject` structure:

```cpp
struct GovObject {
    int      id;
    Priority priority;   // Low / Normal / High
    float    bias;       // current blur strength
    float    biasMin, biasMax;
    bool     visible;
    float    estMB;      // estimated memory footprint
    int      gridX, gridY; // placement for demo grid
};
```

All governed objects are stored in:

```cpp
std::vector<GovObject> objects;
```

3. Buckets

Objects are grouped into three buckets according to their priority: - `bucketLow` - `bucketNorm` - `bucketHigh`

This grouping is rebuilt every tick. Within each bucket, objects are sorted by estimated memory usage (`estMB`), largest-first. This allows the governor to target the most memory-intensive objects first when escalating blur.

4. Governor Logic

The governor runs periodically (every ~0.25s) and performs the following steps:

1. **Measure VRAM**
   Uses telemetry if available (NVX/ATI extensions), otherwise falls back to a software counter.

2. **Detect Spikes**
   If free memory drops by more than the spike threshold (e.g., -256 MB),

the governor applies an immediate "tourniquet" by raising the bias of Low-priority objects sharply.

3. **Hysteresis Band**
Target free VRAM is maintained around 1024 MB with a ±128 MB band.

   - Below the band: escalate blur.

   - Above the band: de-escalate (sharpen).

   - Inside the band: hold.

4. **Escalation**
Blur order: Low → Normal → High.
Bias increments are applied in this sequence until the per-tick budget is spent.

5. **De-escalation**
Sharpen order: High → Normal → Low.
Bias decrements are applied in reverse order.

6. **Step Budget**
Each tick, only a fixed number of objects (e.g., 4) may change bias. This prevents large pops and keeps changes gradual.

5. Spike Handling ("Tourniquet")

When a spike is detected, the governor applies a stronger bias increment (`stepSpike`, e.g., +1.25) immediately to Low-priority objects. This is the "tourniquet" response, designed to rapidly relieve VRAM pressure by sacrificing less important visuals first.

6. Mapping Bias to Rendering

- **Meshes**: Each object's bias is passed to the shader uniform `uBias`, which offsets the mipmap level during texture sampling.
- **Volumes**: The bias can be mapped to volume rendering parameters such as sample distance or resolution.
- **HUD**: Displays per-object bias values, free VRAM, and current telemetry mode.

Example shader usage:

```
uniform sampler2D uTex;
uniform float uBias;
vec3 c = texture(uTex, vUV, uBias).rgb;
```

7. Example Behavior

- **Press B**: Allocates a pad (~256 MB), freeMB drops. Governor escalates Low bucket first.

- **Press Shift+B**: Frees a pad, freeMB rises. Governor de-escalates High bucket first.

- **Spike event**: Large sudden drop triggers a strong bias increase on Low objects.

- **Recovery**: Bias decreases in High → Normal → Low order.

8. Policy Variations

Inside each bucket, selection policy can be adapted: - **Largest-first**: target memory hogs first.
- **Round-robin**: rotate among objects fairly.
- **Visibility-aware**: skip hidden objects.
- **Weighted**: use float importance weights instead of fixed Low/Normal/High.

9. Advantages of Day 6

- Scales from 3 to many objects.

- Maintains smooth control with step budgets.

- Keeps important objects sharper for longer.

- Provides flexibility for future dynamic priority (Day 7).

10. Conclusion

Day 6 extends the VRAM Governor into a true multi-object manager. Objects are grouped into buckets by priority, and the governor applies escalation and recovery policies across these groups with spike handling and hysteresis. This forms the foundation for Day 7, where dynamic factors (screen-space size, distance, focus) will influence object priorities in real time.