CMSC 635

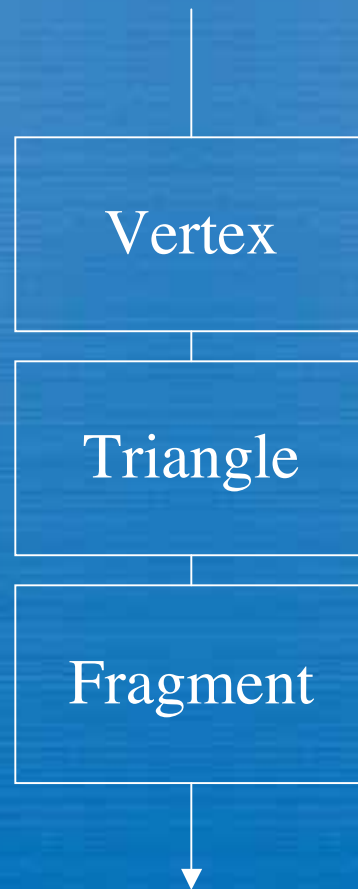## Graphics Hardware

A Graphics Pipeline

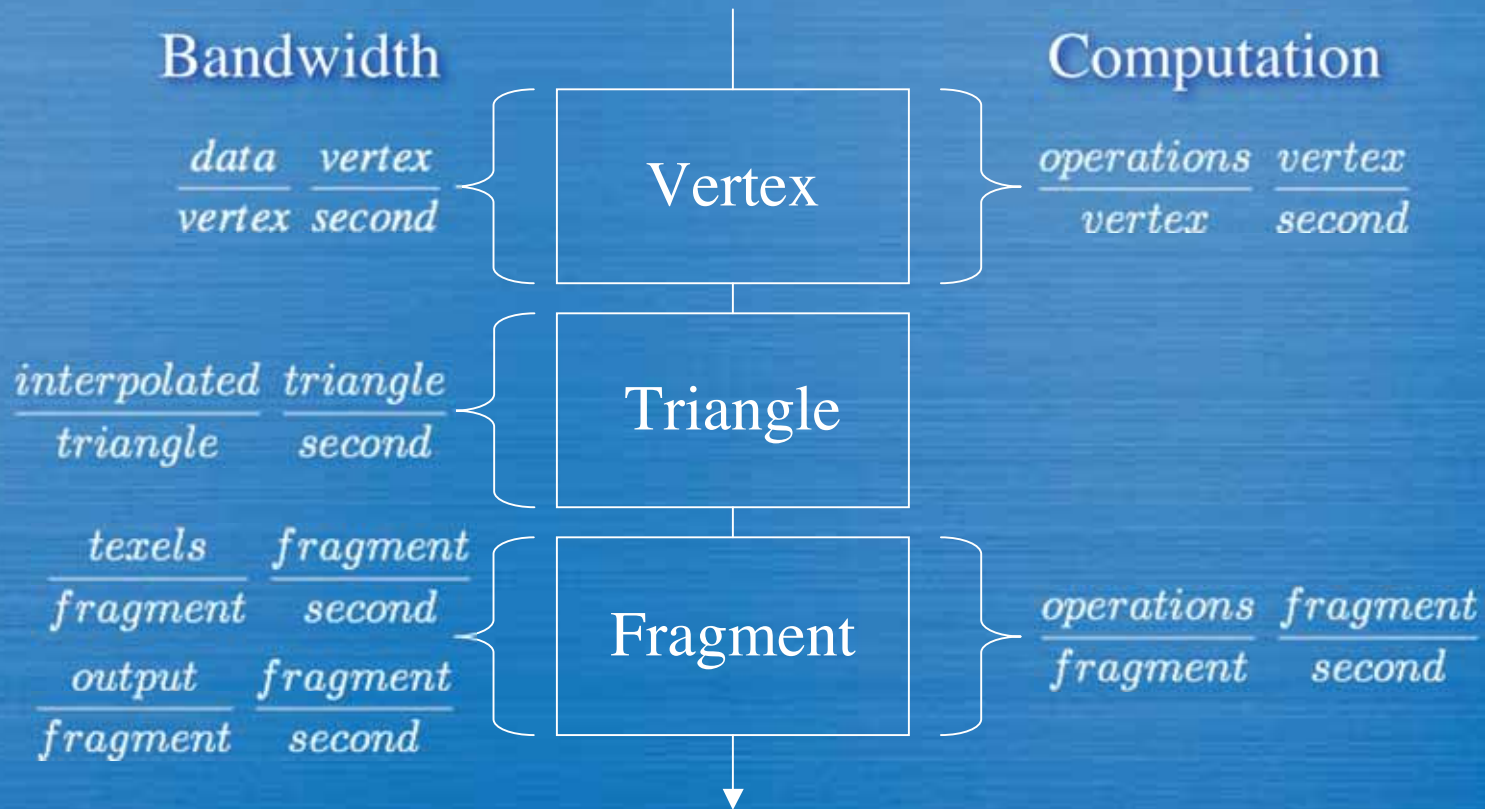# Fragment vs. Pixel

- OpenGL terminology
- Pixel = on-screen RGBA+Z
- Fragment = proto-pixel
  - RGBA + Z + Texture Coordinates + …
  - Multiple Fragments per Pixel
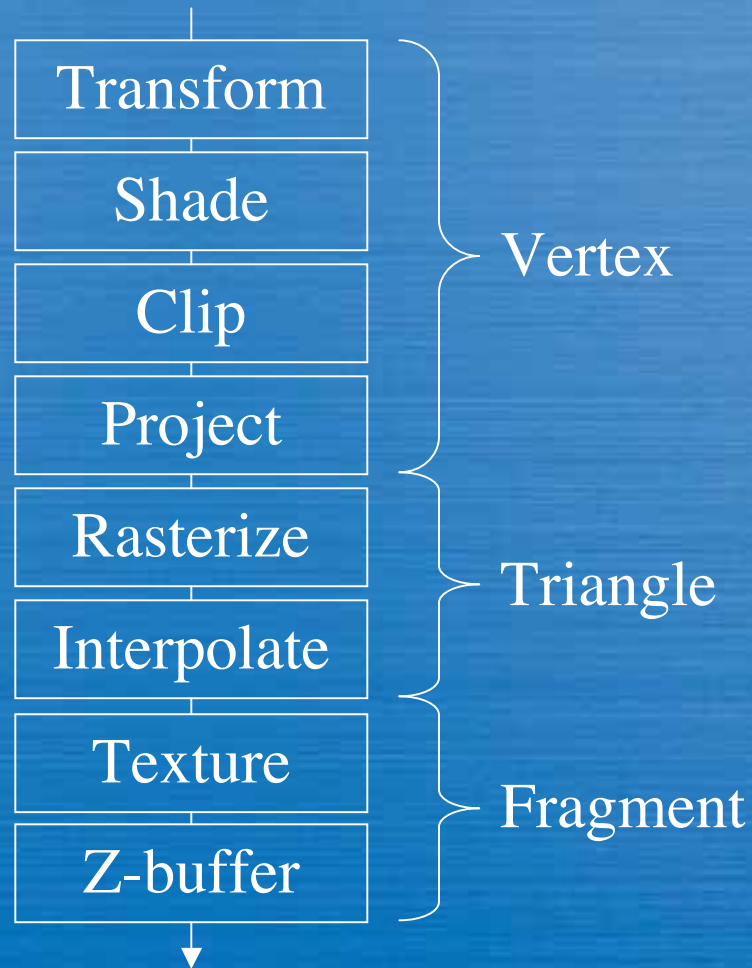   - *Depth Complexity*
    - *Supersamples*

Computation & Bandwidth

Bandwidth

$$\frac{data}{vertex} \quad \frac{vertex}{second}$$

Vertex

Computation

$$\frac{operations}{vertex} \quad \frac{vertex}{second}$$

$$\frac{interpolated}{triangle} \quad \frac{triangle}{second}$$

Triangle

$$\frac{texels}{fragment} \quad \frac{fragment}{second}$$

$$\frac{output}{fragment} \quad \frac{fragment}{second}$$

Fragment

$$\frac{operations}{fragment} \quad \frac{fragment}{second}$$

$$\frac{fragment}{second} = \frac{fragment}{triangle} \frac{triangle}{second}$$
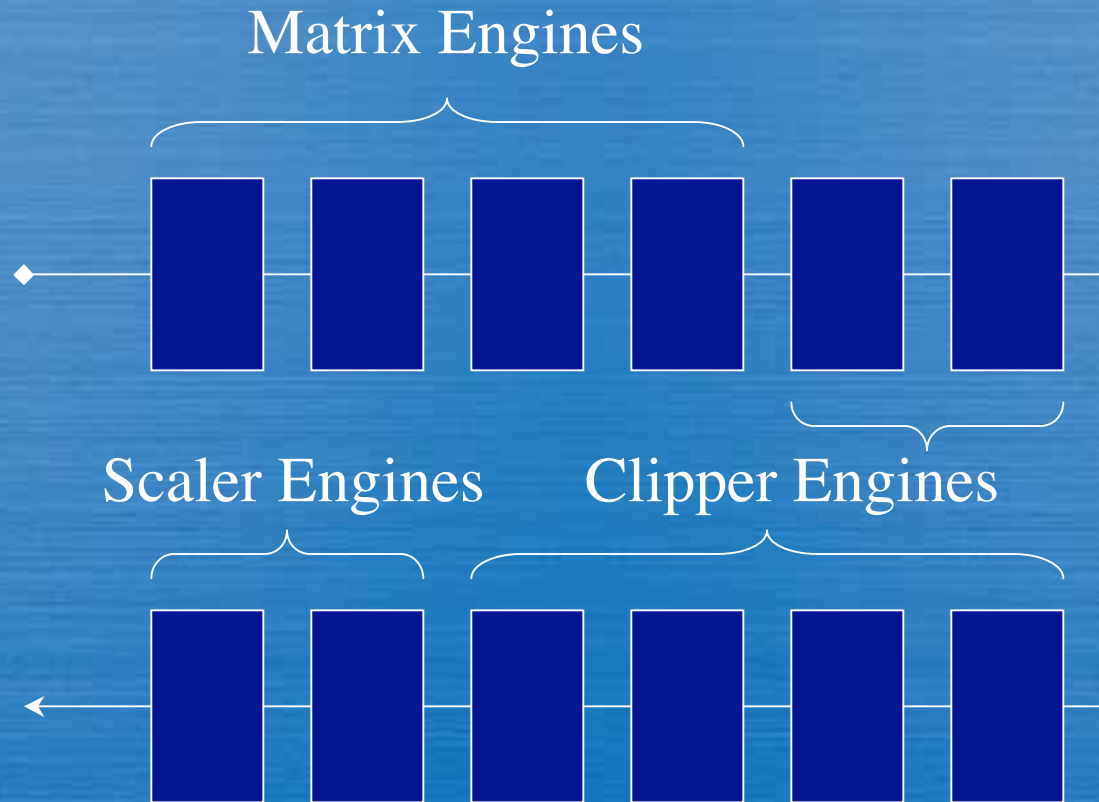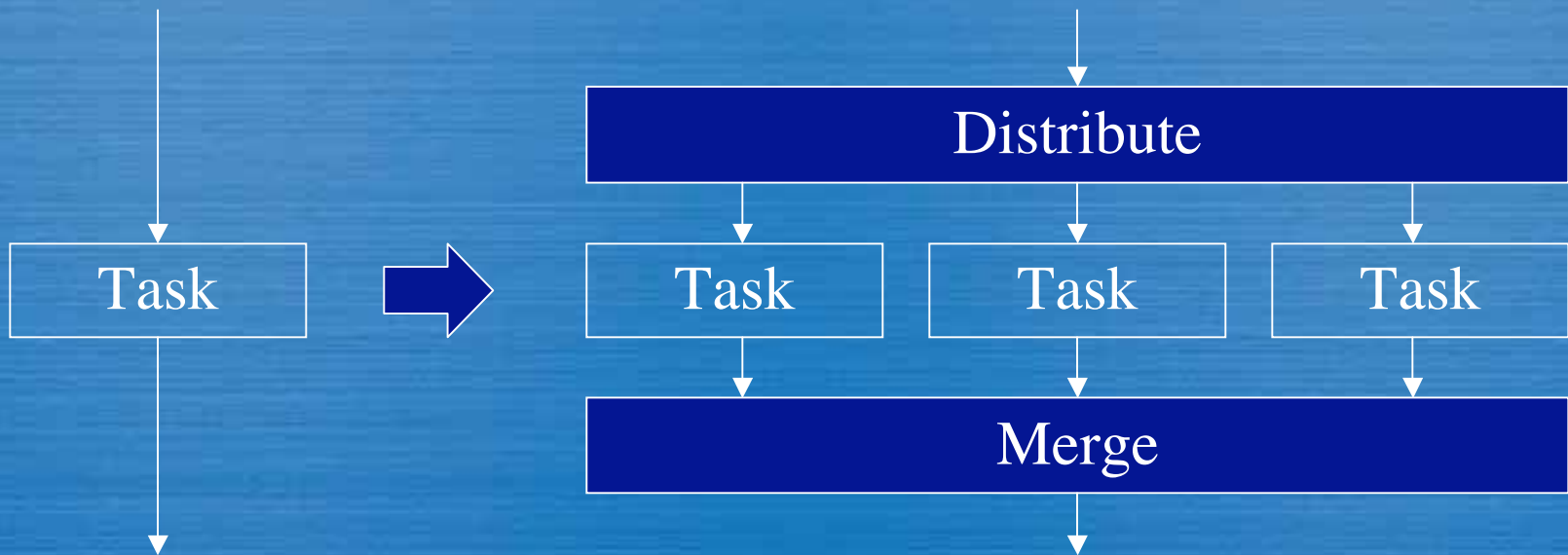$$= pixels \cdot supersamples \cdot depth\_complexity$$
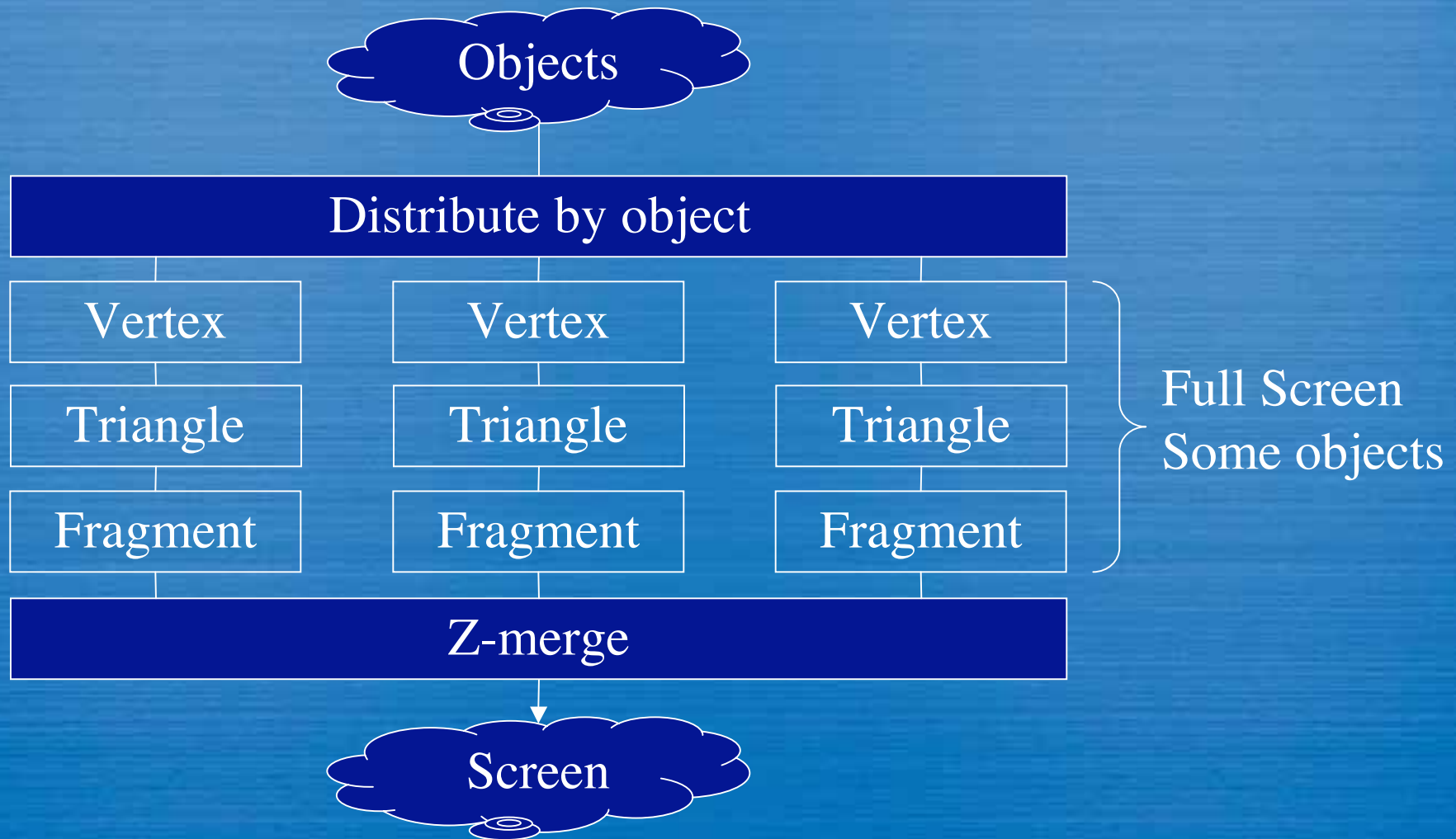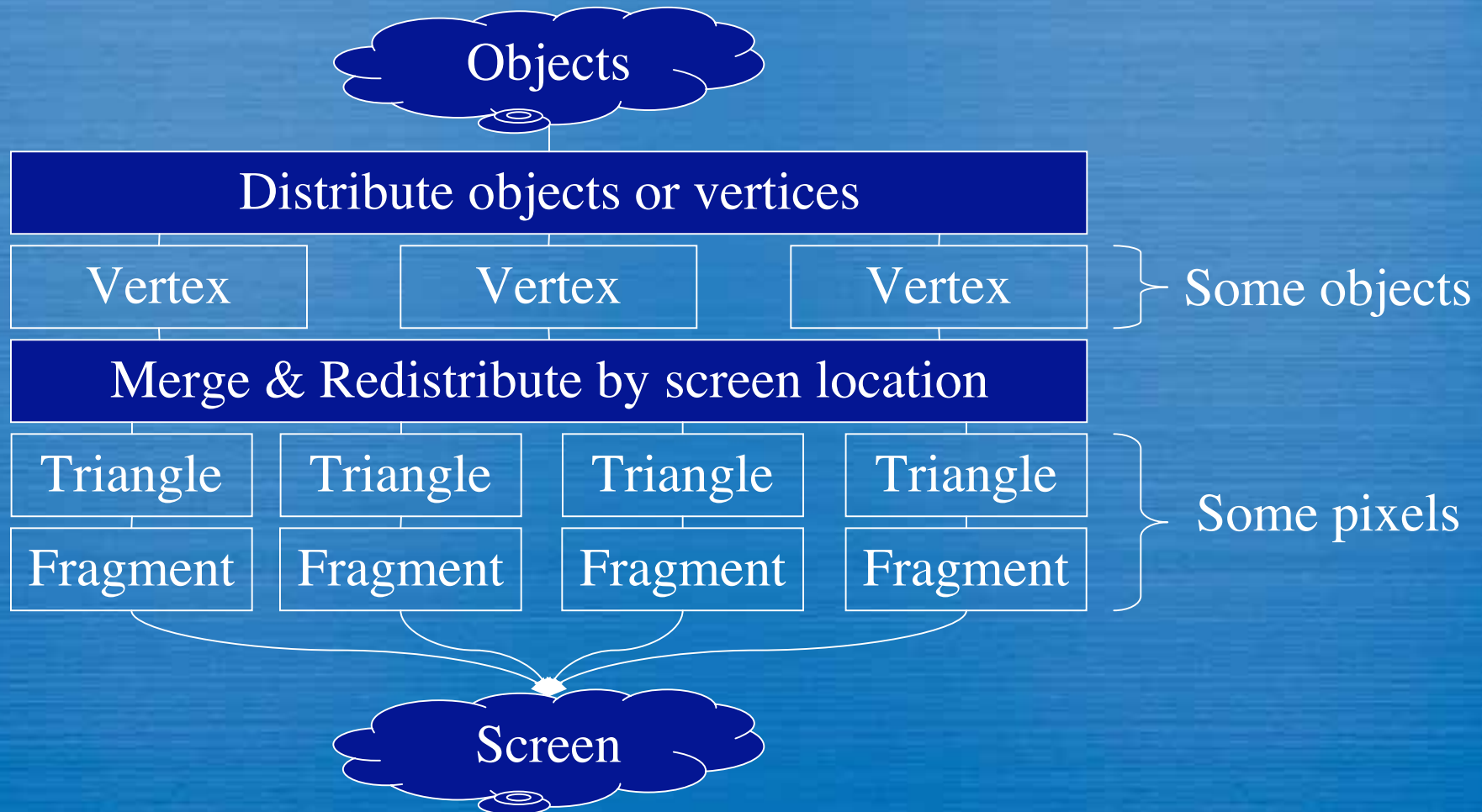
Pipeline
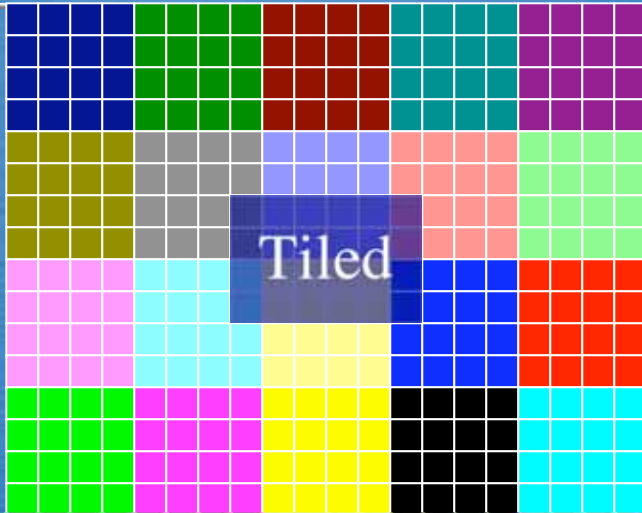
Pipeline: Geometry Engine

Data Parallel

Graphics Data Organization

Object Order

Vertex

Triangle

Fragment

Screen Order

Sort Last

Sort Middle

Objects

Distribute objects or vertices

| Vertex | Vertex | Vertex |

Some objects

Merge & Redistribute by screen location

| Triangle | Triangle | Triangle | Triangle |
| Fragment | Fragment | Fragment | Fragment |

Some pixels

Screen

Screen Subdivision

Footprint

Tiled

Scan-Line Interleaved

Interleaved

Column Interleaved

Sort First