1.7 Graphics Architectures
Combination of hardware and software that implements the functionality of the API.

- Early Graphics system:

![Diagram](host-dac-output-device)

Here the host system runs the application and generates vertices of the image.
Display processor architecture:

![Diagram](host-display-processor-output-display-list)

- Relieves the CPU from doing the refreshing action

- Display processor assembles instructions to generate image once & stores it in the Display List. This is executed repeatedly to avoid flicker.
- The whole process is independent of the host system.

1.8 Programmable Pipelines
E.g. An arithmetic pipeline
Terminologies:
- Latency: time taken from the first stage till the end result is produced.
- Throughput: Number of outputs per given time.

Graphics Pipeline:

![Graphics Pipeline Diagram]

- Process objects one at a time in the order they are generated by the application
- All steps can be implemented in hardware on the graphics card
Vertex Processor

- Much of the work in the pipeline is in converting object representations from one coordinate system to another
  - Object coordinates
  - Camera (eye) coordinates
  - Screen coordinates
- Every change of coordinates is equivalent to a matrix transformation
- Vertex processor also computes vertex colors

Primitive Assembly

Vertices must be collected into geometric objects before clipping and rasterization can take place

- Line segments
- Polygons
- Curves and surfaces

Clipping

Just as a real camera cannot “see” the whole world, the virtual camera can only see part of the world or object space

- Objects that are not within this volume are said to be clipped out of the scene

Rasterization:

- If an object is not clipped out, the appropriate pixels in the frame buffer must be assigned colors
- Rasterizer produces a set of fragments for each object
- Fragments are “potential pixels”
  - Have a location in frame buffer
  - Color and depth attributes
- Vertex attributes are interpolated over objects by the rasterizer
Fragment Processor:

- Fragments are processed to determine the color of the corresponding pixel in the frame buffer
- Colors can be determined by texture mapping or interpolation of vertex colors
- Fragments may be blocked by other fragments closer to the camera
  - Hidden-surface removal