Direct3D Programming

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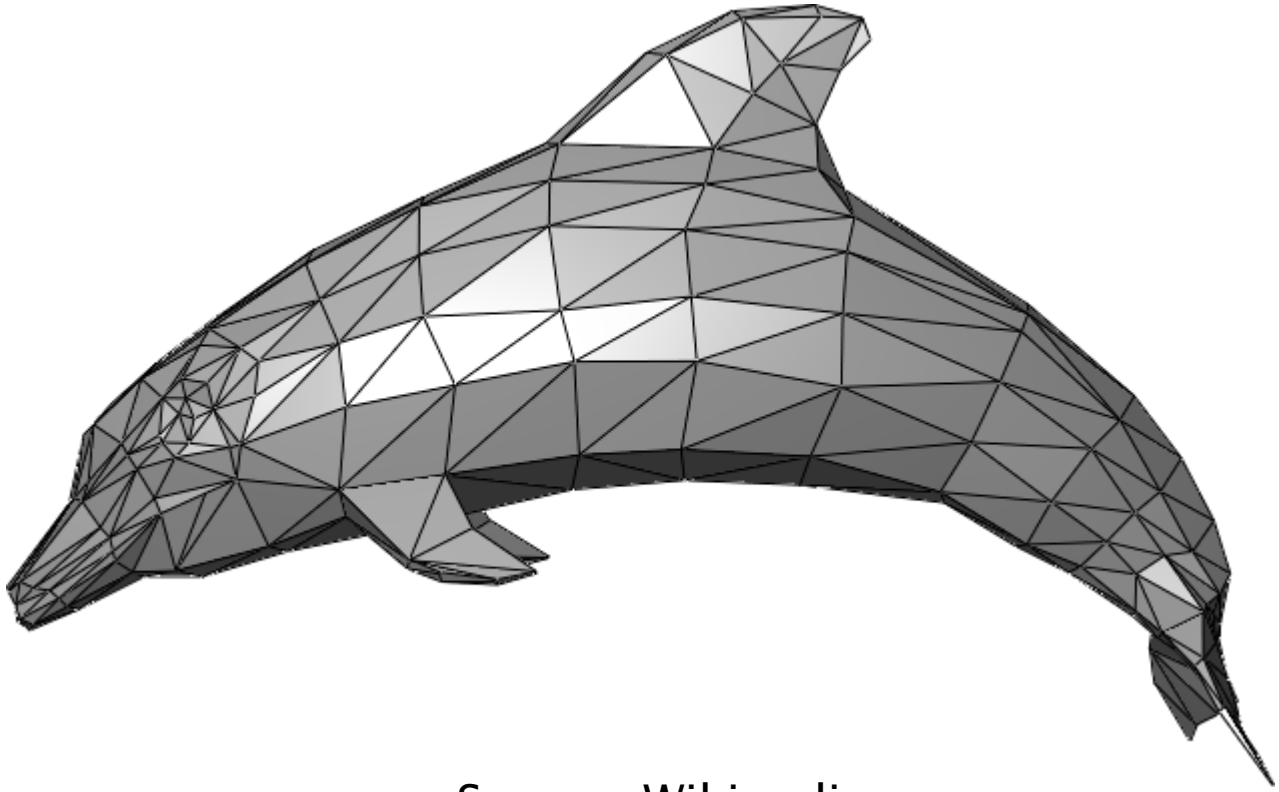
Some Prelimenaries

Triangles

- For efficiency, the graphics card will render objects as triangles
- Any polyhedron can be represented by triangles
- Other 3D shapes can be approximated by triangles

A Dolphin

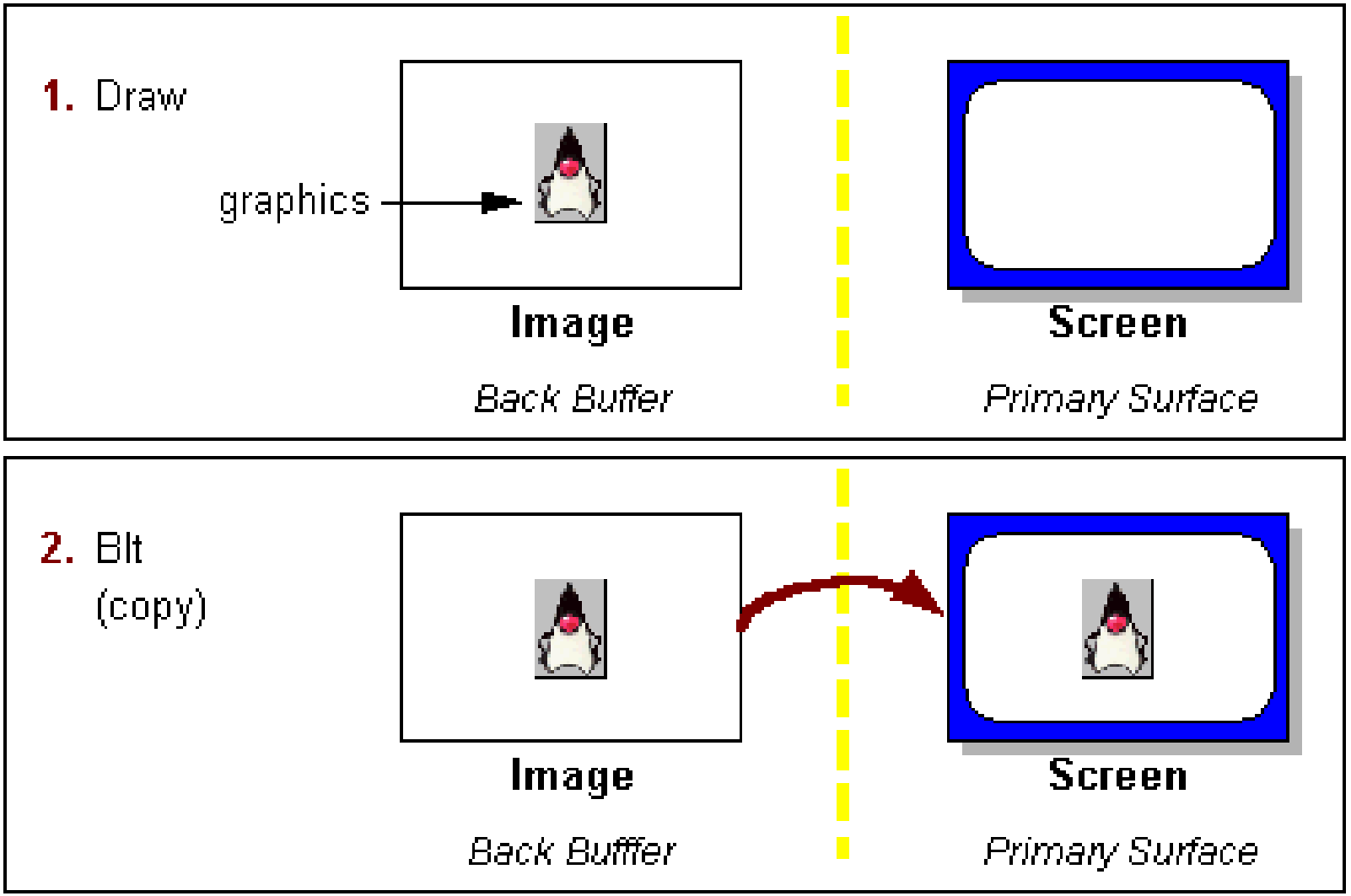


Source: Wikipedia

Double Buffering

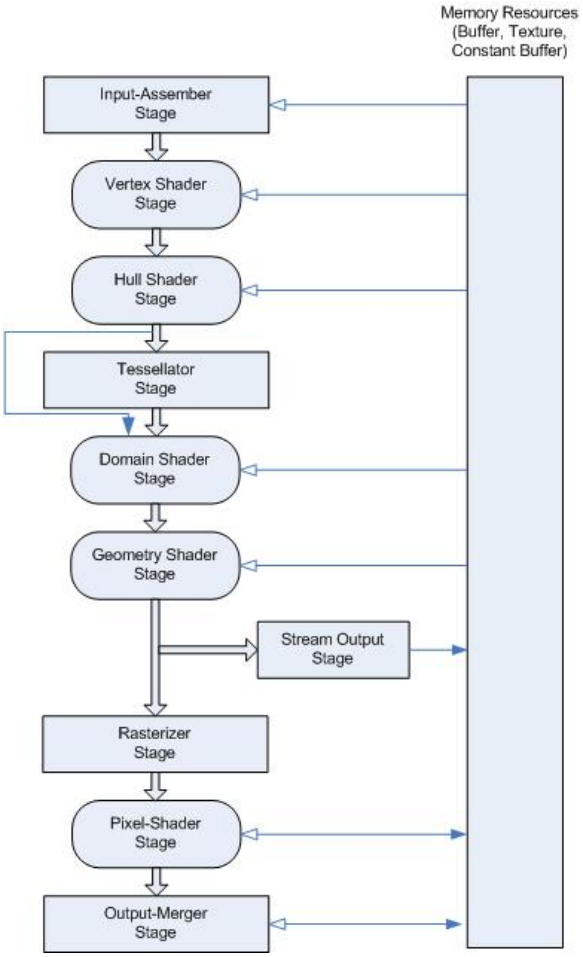
- Don’t want to draw objects directly to the screen
- The screen could update before a new frame has been completely drawn
- Instead, draw next frame to a buffer and swap buffers when complete.

Double Buffering



Source: Oracle

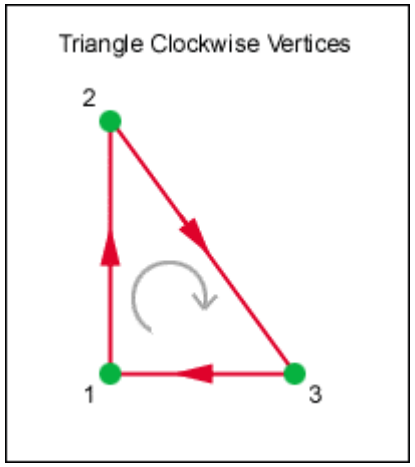
Direct3D 11 Pipeline



Source: Microsoft

Culling

- In order to avoid rendering vertices that will not be displayed in the final image, DirectX performs ‘culling’
- Triangles facing away from the camera will be culled and not rendered
- By default, DirectX performs ‘Counter-Clockwise culling’
- Triangles with vertices in a counter-clockwise order are not rendered
- The order of vertices is therefore important
- Left hand rule



A Windows 8 SharpDX App

Based on the Toolkit - MiniCube

App.xaml

- The App definition
- Specifies the namespace you will be working in
- Specifies application resources

App.xaml.cs

- The first file loaded by your App

```
sealed partial class App : Application
```

- Extends the Application class, allowing your program to interact with Windows (e.g. receive events)

```
Public App()
{ this.InitializeComponent();
This.Suspending += OnSuspending; }
```

- Initializes XAML elements
- Registers the `OnSuspending` function as an event handler for the `Suspending` event

OnLaunched

```
protected override void OnLaunched(...)
    var swapChainPanel = new MainPage()
    Window.Current.Content = swapChainPanel
    Window.Current.Activate();
```

- Overriden from the Application class
- Loads the state if necessary from a suspended execution
- Creates the XAML element we will be drawing to (`MainPage`)
- Sets `MainPage` as our current Window

OnSuspending

```
private void OnSuspending(...) {
    var deferral = e.SuspendingOperation.GetDeferral
    // Do Something
    deferral.Complete
```

- Defers the suspending operation until your code has had a chance to complete
- Use this function to save state information as necessary.

MainPage.xaml

- Contains (Modern Style) XAML elements, which are overlayed onto your rendered scene
- Can use these elements for user interaction
  - Buttons
  - Sliders
  - Text
  - Etc…
- Contains one key element: `SwapChainBackgroundPanel`
- This is the collection of buffers that will be rendered to
- More on this in later labs

MainPage.xaml.cs

```
public MainPage()
        InitializeComponent();
        game = new MiniCubeGame();
        game.Run(this);
```

- Initializes the `MainPage` XAML elements
- Creates the new Game
- Runs the game
- Also use this class to specify input / output functions for XAML elements rendered on `MainPage` – More on this in later labs

MiniCubeGame.cs

- ```
  Public class MiniCubeGame : Game
      private GraphicsDeviceManager graphicsDeviceManager;
      private BasicEffect basicEffect;
      private buffer<VertexPositionColor> vertices;
      private VertexInputLayout inputLayout
  ```
- Extends the toolkit Game class, which contains many helpful functions
- Sets up device, context, etc…
  ```

LoadContent

- `Protected override void LoadContent()`
- Called on the creation of the Graphics Device
- Sets up initial resources such as models and effects

BasicEffect

```
basicEffect = ToDisposeContent(new BasicEffect(GraphicsDevice) {
      VertexColorEnabled = true,
      View = Matrix.LookAtLH(new Vector3(0, 0, -5), new Vector3(0, 0, 0), Vector3.UnitY),
      Projection = Matrix.PerspectiveFovLH((float)Math.PI / 4.0f,
(float)GraphicsDevice.BackBuffer.Width / GraphicsDevice.BackBuffer.Height, 0.1f, 100.0f),
       World = Matrix.Identity });
```

- BasicEffects model transformations, effects, texturing, lighting, etc... That will be applied to objects

Vertex Definitions

```
vertices = ToDisposeContent(Buffer.Vertex.New(GraphicsDevice, new[] {
new VertexPositionColor(new Vector3(-1.0f, -1.0f, -1.0f), Color.Orange),
new VertexPositionColor(new Vector3(-1.0f,  1.0f, -1.0f), Color.Orange), ...
```

- Similar to the definitions in Labs 1 & 2
- Note that the vertex definitions here are typed, not just a series of floats
- This allows the input layout to be extracted from the vertex definition without needing to be specified explicitly

InputLayout

- `inputLayout = VertexInputLayout.FromBuffer(0, vertices);`
- Specifies the meaning of the vertex definitions
- Avoids the need to specify explicitly as was done in the labs:
- `layout = new InputLayout(d3dDevice, vertexShaderByteCode, new[]`

```
{ new InputElement("POSITION", 0, Format.R32G32B32A32_Float, 0, 0),
new InputElement("COLOR", 0, Format.R32G32B32A32_Float, 16, 0)}); }
```

Update

- `protected override void Update(GameTime gameTime)`
- Called 60 times per second (unless you change this)
- Performs necessary game calculations

Draw

```
protected override void Draw(GameTime gameTime)
    { GraphicsDevice.Clear(Color.CornflowerBlue);
    GraphicsDevice.SetVertexBuffer(vertices);
    GraphicsDevice.SetVertexInputLayout(inputLayout);
    basicEffect.CurrentTechnique.Passes[0].Apply();
    GraphicsDevice.Draw(PrimitiveType.TriangleList,
vertices.ElementCount);
    base.Draw(gameTime); }
```

- Called on each frame
- Clears the screen
- Sets the vertex buffer & input layout
- Applies the basic effect
- Draws the scene

Finding out more

- F12
- http://sharpdx.org/documentation
- https://github.com/sharpdx/SharpDX
- Anything on XNA (use with care)