1

Physical Devices

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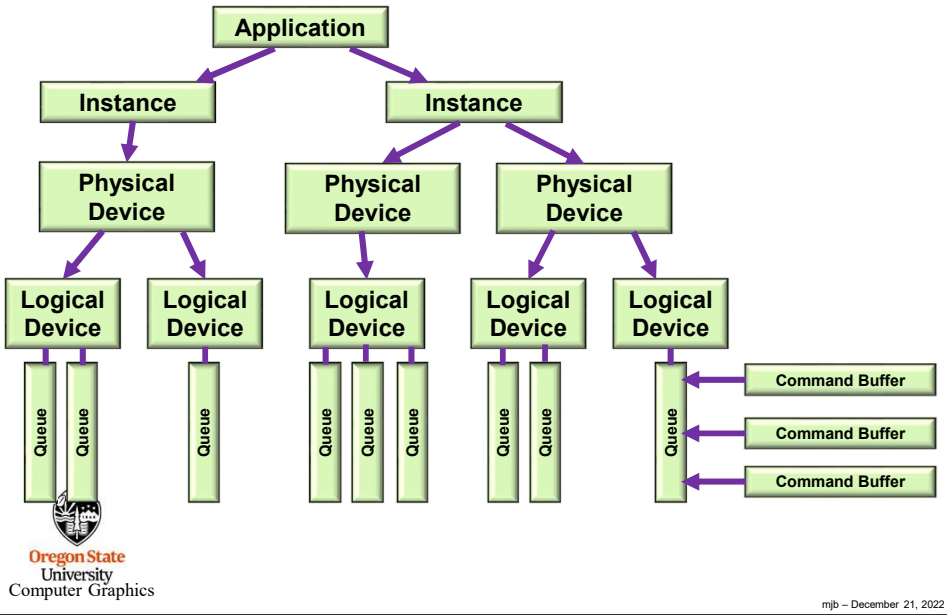
2

Vulkan: Overall Block Diagram



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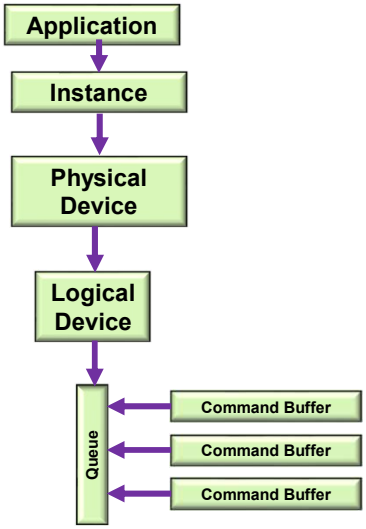
Vulkan: a More Typical (and Simplified) Block Diagram

3



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Querying the Number of Physical Devices

4

```
uint32_t  count;
result = vkEnumeratePhysicalDevices( Instance, OUT &count, OUT (VkPhysicalDevice *)nullptr );

VkPhysicalDevice * physicalDevices = new VkPhysicalDevice[ count ];
result = vkEnumeratePhysicalDevices( Instance, OUT &count, OUT physicalDevices  );
```

This way of querying information is a recurring OpenCL and Vulkan pattern (get used to it):

How many total there are

Where to put them

```
result = vkEnumeratePhysicalDevices( Instance,   &count,          nullptr   );

result = vkEnumeratePhysicalDevices( Instance,   &count,       physicalDevices );
```

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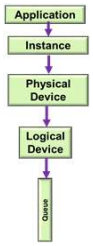
Vulkan: Identifying the Physical Devices




```
VkResult result = VK_SUCCESS;

result = vkEnumeratePhysicalDevices( Instance, OUT &PhysicalDeviceCount, (VkPhysicalDevice *)nullptr );
if( result != VK_SUCCESS || PhysicalDeviceCount <= 0 )
{
	fprintf( FpDebug, "Could not count the physical devices\n" );
	return VK_SHOULD_EXIT;
}

fprintf(FpDebug, "\n%d physical devices found.\n", PhysicalDeviceCount);

VkPhysicalDevice * physicalDevices = new VkPhysicalDevice[ PhysicalDeviceCount ];
result = vkEnumeratePhysicalDevices( Instance, OUT &PhysicalDeviceCount, OUT physicalDevices  );
if( result != VK_SUCCESS )
{
	fprintf( FpDebug, "Could not enumerate the %d physical devices\n", PhysicalDeviceCount );
	return VK_SHOULD_EXIT;
}
```

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Which Physical Device to Use, I


```
int discreteSelect   = -1;
int integratedSelect = -1;
for( unsigned int i = 0; i < PhysicalDeviceCount; i++ )
{
	VkPhysicalDeviceProperties vpdp;
	vkGetPhysicalDeviceProperties( IN physicalDevices[i], OUT &vpdp );
	if( result != VK_SUCCESS )
	{
		fprintf( FpDebug, "Could not get the physical device properties of device %d\n", i );
		return VK_SHOULD_EXIT;
	}

	fprintf( FpDebug, " \n\nDevice %2d:\n", i );
	fprintf( FpDebug, "\tAPI version: %d\n", vpdp.apiVersion );
	fprintf( FpDebug, "\tDriver version: %d\n", vpdp.apiVersion );
	fprintf( FpDebug, "\tVendor ID: 0x%04x\n", vpdp.vendorID );
	fprintf( FpDebug, "\tDevice ID: 0x%04x\n", vpdp.deviceID );
	fprintf( FpDebug, "\tPhysical Device Type: %d =", vpdp.deviceType );
	if( vpdp.deviceType == VK_PHYSICAL_DEVICE_TYPE_DISCRETE_GPU )		fprintf( FpDebug, " (Discrete GPU)\n" );
	if( vpdp.deviceType == VK_PHYSICAL_DEVICE_TYPE_INTEGRATED_GPU )	fprintf( FpDebug, " (Integrated GPU)\n" );
	if( vpdp.deviceType == VK_PHYSICAL_DEVICE_TYPE_VIRTUAL_GPU )		fprintf( FpDebug, " (Virtual GPU)\n" );
	if( vpdp.deviceType == VK_PHYSICAL_DEVICE_TYPE_CPU )				fprintf( FpDebug, " (CPU)\n" );
	fprintf( FpDebug, "\tDevice Name: %s\n", vpdp.deviceName );
	fprintf( FpDebug, "\tPipeline Cache Size: %d\n", vpdp.pipelineCacheUUID[0] );
```

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Which Physical Device to Use, II


```
        // need some logical here to decide which physical device to select:

        if( vpdp.deviceType == VK_PHYSICAL_DEVICE_TYPE_DISCRETE_GPU )
            discreteSelect = i;

        if( vpdp.deviceType == VK_PHYSICAL_DEVICE_TYPE_INTEGRATED_GPU )
            integratedSelect = i;
    }

    int which = -1;
    if( discreteSelect >= 0 )
    {
        which = discreteSelect;
        PhysicalDevice = physicalDevices[which];
    }
    else if( integratedSelect >= 0 )
    {
        which = integratedSelect;
        PhysicalDevice = physicalDevices[which];
    }
    else
    {
        fprintf( FpDebug, "Could not select a Physical Device\n" );
        return VK_SHOULD_EXIT;
    }
```

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Asking About the Physical Device's Features


```
    VkPhysicalDeviceProperties  PhysicalDeviceFeatures;
    vkGetPhysicalDeviceFeatures( IN PhysicalDevice, OUT &PhysicalDeviceFeatures );

    fprintf( FpDebug, "\nPhysical Device Features:\n");
    fprintf( FpDebug, "geometryShader = %2d\n", PhysicalDeviceFeatures.geometryShader);
    fprintf( FpDebug, "tessellationShader = %2d\n", PhysicalDeviceFeatures.tessellationShader );
    fprintf( FpDebug, "multiDrawIndirect = %2d\n", PhysicalDeviceFeatures.multiDrawIndirect );
    fprintf( FpDebug, "wideLines = %2d\n", PhysicalDeviceFeatures.wideLines );
    fprintf( FpDebug, "largePoints = %2d\n", PhysicalDeviceFeatures.largePoints );
    fprintf( FpDebug, "multiViewport = %2d\n", PhysicalDeviceFeatures.multiViewport );
    fprintf( FpDebug, "occlusionQueryPrecise = %2d\n", PhysicalDeviceFeatures.occlusionQueryPrecise );
    fprintf( FpDebug, "pipelineStatisticsQuery = %2d\n", PhysicalDeviceFeatures.pipelineStatisticsQuery );
    fprintf( FpDebug, "shaderFloat64 = %2d\n", PhysicalDeviceFeatures.shaderFloat64 );
    fprintf( FpDebug, "shaderInt64 = %2d\n", PhysicalDeviceFeatures.shaderInt64 );
    fprintf( FpDebug, "shaderInt16 = %2d\n", PhysicalDeviceFeatures.shaderInt16 );
```

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Here's What the NVIDIA A6000 Produced


```
Init03PhysicalDeviceAndGetQueueFamilyProperties

Device  0:
        API version: 4206797
        Driver version: 4206797
        Vendor ID: 0x10de
        Device ID: 0x2230
        Physical Device Type: 2 = (Discrete GPU)
        Device Name: NVIDIA RTX A6000
        Pipeline Cache Size: 72
Device #0 selected ('NVIDIA RTX A6000')

Physical Device Features:
geometryShader =  1
tessellationShader =  1
multiDrawIndirect =  1
wideLines =  1
largePoints =  1
multiViewport =  1
occlusionQueryPrecise =  1
pipelineStatisticsQuery =  1
shaderFloat64 =  1
shaderInt64 =  1
shaderInt16 =  1
```

Here's What the Intel HD Graphics 520 Produced


```
Init03PhysicalDeviceAndGetQueueFamilyProperties

Device  0:
        API version: 4194360
        Driver version: 4194360
        Vendor ID: 0x8086
        Device ID: 0x1916
        Physical Device Type: 1 = (Integrated GPU)
        Device Name: Intel(R) HD Graphics 520
        Pipeline Cache Size: 213
Device #0 selected ('Intel(R) HD Graphics 520')

Physical Device Features:
geometryShader =  1
tessellationShader =  1
multiDrawIndirect =  1
wideLines =  1
largePoints =  1
multiViewport =  1
occlusionQueryPrecise =  1
pipelineStatisticsQuery =  1
shaderFloat64 =  1
shaderInt64 =  1
shaderInt16 =  1
```

Asking About the Physical Device's Different Memories


```
VkPhysicalDeviceMemoryProperties                vpdmp;
vkGetPhysicalDeviceMemoryProperties( PhysicalDevice, OUT &vpdmp );

fprintf( FpDebug, "\n%d Memory Types:\n", vpdmp.memoryTypeCount );
for( unsigned int i = 0; i < vpdmp.memoryTypeCount; i++ )
 {
      VkMemoryType vmt = vpdmp.memoryTypes[i];
      fprintf( FpDebug, "Memory %2d: ", i );
      if( ( vmt.propertyFlags & VK_MEMORY_PROPERTY_DEVICE_LOCAL_BIT      ) != 0 )   fprintf( FpDebug, " DeviceLocal" );
      if( ( vmt.propertyFlags & VK_MEMORY_PROPERTY_HOST_VISIBLE_BIT      ) != 0 )   fprintf( FpDebug, " HostVisible" );
      if( ( vmt.propertyFlags & VK_MEMORY_PROPERTY_HOST_COHERENT_BIT ) != 0 )   fprintf( FpDebug, " HostCoherent" );
      if( ( vmt.propertyFlags & VK_MEMORY_PROPERTY_HOST_CACHED_BIT       ) != 0 )   fprintf( FpDebug, " HostCached" );
      if( ( vmt.propertyFlags & VK_MEMORY_PROPERTY_LAZILY_ALLOCATED_BIT ) != 0 )   fprintf( FpDebug, " LazilyAllocated" );
      fprintf(FpDebug, "\n");
}

fprintf( FpDebug, "\n%d Memory Heaps:\n", vpdmp.memoryHeapCount );
for( unsigned int  i = 0; i < vpdmp.memoryHeapCount; i++ )
{
      fprintf(FpDebug, "Heap %d: ", i);
      VkMemoryHeap vmh = vpdmp.memoryHeaps[i];
      fprintf( FpDebug, " size = 0x%08lx", (unsigned long int)vmh.size );
      if( ( vmh.flags & VK_MEMORY_HEAP_DEVICE_LOCAL_BIT  ) != 0 )     fprintf( FpDebug, " DeviceLocal" );     // only one in use
      fprintf(FpDebug, "\n");
}
```

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Here's What I Got on the A6000's


```
6 Memory Types:
Memory  0:
Memory  1:  DeviceLocal
Memory  2:  HostVisible  HostCoherent
Memory  3:  HostVisible  HostCoherent HostCached
Memory  4:  DeviceLocal HostVisible HostCoherent
Memory  5:  DeviceLocal

4 Memory Heaps:
Heap 0:  size = 0xdbb00000 DeviceLocal
Heap 1:  size = 0xfd504000
Heap 2:  size = 0x0d600000 DeviceLocal
Heap 3:  size = 0x02000000 DeviceLocal
```

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Asking About the Physical Device's Queue Families


```
uint32_t count = -1;
vkGetPhysicalDeviceQueueFamilyProperties( IN PhysicalDevice, &count, OUT (VkQueueFamilyProperties *)nullptr );
fprintf( FpDebug, "\nFound %d Queue Families:\n", count );

VkQueueFamilyProperties *vqfp = new VkQueueFamilyProperties[ count ];
vkGetPhysicalDeviceQueueFamilyProperties( IN PhysicalDevice, &count, OUT vqfp );
for( unsigned int i = 0; i < count; i++ )
{
	fprintf( FpDebug, "\t%d: queueCount = %2d  ;  ", i, vqfp[i].queueCount );
	if( ( vqfp[i].queueFlags & VK_QUEUE_GRAPHICS_BIT ) != 0 )	fprintf( FpDebug, " Graphics" );
	if( ( vqfp[i].queueFlags & VK_QUEUE_COMPUTE_BIT  ) != 0 )	fprintf( FpDebug, " Compute " );
	if( ( vqfp[i].queueFlags & VK_QUEUE_TRANSFER_BIT ) != 0 )	fprintf( FpDebug, " Transfer" );
	fprintf(FpDebug, "\n");
}
```

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Here's What I Got on the A6000's


```
Found 3 Queue Families:
	0: Queue Family Count = 16  ;   Graphics Compute Transfer
	1: Queue Family Count =  2  ;   Transfer
	2: Queue Family Count =  8  ;   Compute Transfer
```

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