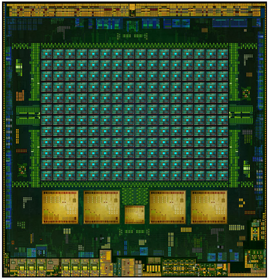
OpenGL ES



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Linköping University

- Introduction / Motivation
- OpenGL ES - Differences
- Good Practice

Introduction / Motivation

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- **PCs (incl. laptops) sales declining, smartphones/tablets fast rising**
  - Will smartphones/tablets replace PCs?

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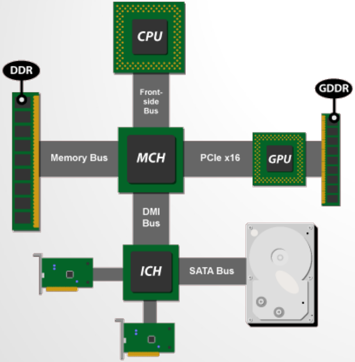
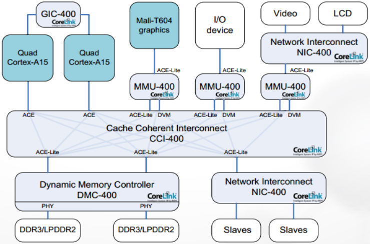
- **PCs (incl. laptops) sales declining, smartphones/tablets fast rising**
  - Will smartphones/tablets replace PCs?
- **Driving factors: cheaper, smaller, longer runtime**
  - due to different architecture (so called System-on-a-Chip (SOC))

Introduction / Motivation



PC



SOC

Introduction / Motivation

PC

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Introduction / Motivation

PC	SOC
▶ Distributed memory and caches	▶ Shared memory, small caches (if at all)
▶ Several broad, often star-organized busses	▶ One central bus, limited size
▶ Optimized for Performance	▶ Optimized for Efficiency

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    Cheap? Good for high resolution?
- **Imagination Technologies: PowerVR**
  - Traditionally best architecture
  - GPU used in the Dreamcast
  - Also licensing core, not selling chips

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  - Chip manufacturer
  - ARM CPUs, Own GPU: Adreno (former ATI)
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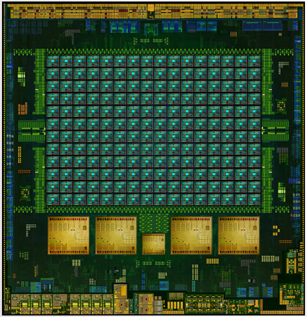
    - Currently fastest (due to fast memory access?)
- **NVIDIA: Tegra**
    - Chip including ARM CPUs and own GPU
    - good runtime, not so good performance
    - Until now: only non-unified architecture

Introduction / Motivation

K1



Introduction / Motivation

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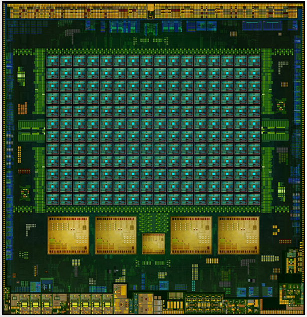

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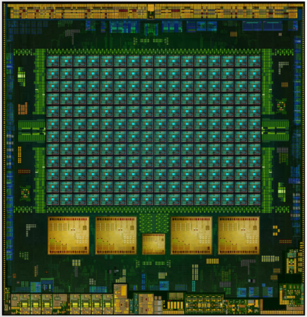
K1	365	17

Introduction / Motivation

K1



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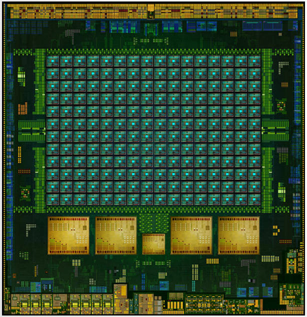

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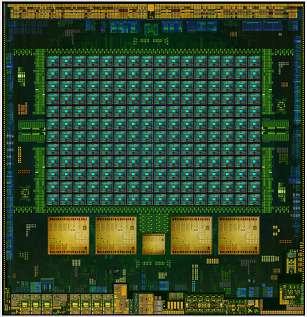

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Speedup (Graphics card)	x13.7	x19.8
Compares to graphic-card	6 years old	11 years old

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- Gap between performance and memory bandwidth will become larger

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  - Optimize existing methods for low pow performance hardware
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- **3.0: “Simple” Extension to 2.0**
  - more flexible than 2.0
  - fully compatible

Differences

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Differences

- **Only 2 shaders**
  - Vertex & Fragment
  - No Tesselation or Geometry Shaders
- **Removed memory-intensive operations and data structures**
  - Limited Anti-Aliasing
  - 2.0: Textures: only byte data types, only 2D
    3.0: also float data types, also 3D textures
  - Good support for texture compression

Differences

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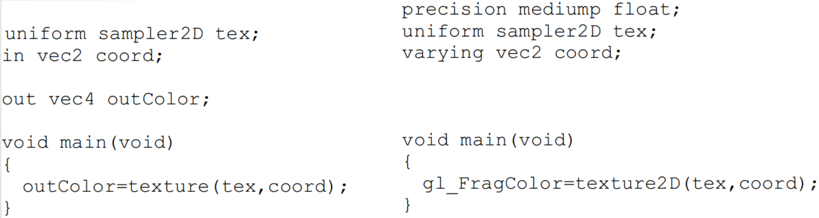
  - Vertex buffer: standard in 3.0, optional in 2.0 (available in older iOS)
  - Same memory: can pass pointers from CPU to GPU
- **Need to declare precision for shader variables**
  - Select lesser precision for better performance
  - Recommendation: high precision in vertex shader, medium in fragment shader
  - Caution: if the same uniform variable is used in both vertex and fragment shader it has to have the same precision in both

Differences

OpenGL 3.0

OpenGL ES



OpenGL 3.0

```
uniform sampler2D tex;
in vec2 coord;

out vec4 outColor;

void main(void)
{
  outColor=texture(tex,coord);
}
```

OpenGL ES

```
precision mediump float;
uniform sampler2D tex;
varying vec2 coord;


void main(void)
{
  gl_FragColor=texture2D(tex,coord);
}
```

Which version to use?

- **1.x:**
- **2.0:**
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  - Blackberry: since 10.2

Which version to use?

- **1.x: Too old, limited**
- **2.0: Best bet, should offer enough flexibility for most purposes**
- **3.0: Still too new?**
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- **Tesselation ?**

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- **Don't use memory intense data structures like framebuffers, 3D textures, etc. if not absolutely necessary**
- **Don't use double, reduce precision or use fix-point if possible**
- **Use ifs only to avoid memory accesses or heavy computations**
    - Might however be less useful when core count increases

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  - supported in hardware
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  - caution however if using textures for other things than images
- **Biggest bottlenecks: overdraw, texture accesses**

Conclusion

- **Smartphones/Tablets: big and still fast growing market**
  - Directly linked to SOC architecture
    => unlikely to change
  - Memory Access: expensive, will only get worse
- **OpenGL ES: streamlined OpenGL designed for these systems**
- **Biggest challenge: minimize memory footprint**
  - But be aware: you can break the rules...
  - ...just as long as you know what you are doing

Questions?

Thank you very much!

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