Bitboys G40
Embedded graphics processor

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Brief history of embedded graphics hardware

• The early contenders
  – Bitboys G10: SVG Tiny vector graphics acceleration
  – Other propriety, non-standard 3D graphics hardware

• The standards are ratified (OpenGL® ES 1.0)
  – ATI Imageon, NVIDIA GoForce
  – Bitboys G30
  – Imagination MBX
  – Mali series from Falanx
  – Sanshin’s G-Shark

• The standards mature (OpenGL® ES 1.1)
  – Bitboys G32 and G34

• Future standards
  – Targeting programmability, OpenGL® (ES) 2.0
  – Bitboys G40
Current graphics processors

- Targeting OpenGL® ES 1.1, typical features
  - OpenGL® ES 1.1 pixel pipeline in hardware
  - 32-bit color (8-8-8-8)
  - Some form of texture decompression (2bpp or 4bpp)
  - Full-screen anti-aliasing
  - 1 pixel / clock

- Optional: Hardware transformation and lighting
  - Fixed-function or limited programmability
  - Choice of integrating hardware T&L depends heavily on target system – not necessarily required if CPU has floating point processing capability

- Design sizes (typical for all contenders)
  - <400 Kgates without hardware T&L
  - Hardware T&L adds 150-400 Kgates

G40 - Introduction

- Graphics processor IP core designed and optimized for handheld devices
  - Integrates into an SoC, connects to the system memory bus
  - Supports OCP, AMBA AHB or customer specific buses

- Targeting consumer products in 2007-2010 timeframe
  - Mobile phones (feature and smart-phones)
  - Handheld gaming devices
  - Other embedded devices (PDAs, car navigation, set-top boxes)

- 2D, 3D and vector graphics acceleration
  - Programmable, floating-point vertex shader (32-bit IEEE)
  - Programmable, floating-point pixel shader (16-bit OpenEXR)
  - Complete OpenGL® ES 1.1 pipeline in hardware

- Target content
  - Device’s user interface, games, application graphics
G40 - Main development guidelines

• Target volume market mobile phones in 2007-2010 timeframe
  – We expect 3D graphics breakthrough in mobile phones in 2006 timeframe – Japan first, then Europe, followed by US

• Industry standard content creation tools and game art will be largely based on the use of shaders
  – Don’t want to stray from this path

• Scene complexity and performance target
  – 60 FPS
  – 20-30k polygons/frame
  – QVGA or VGA display resolution
  – Depth complexity 5
  – Relatively complex pixel shaders
  – High sustained pixel fillrate

G40 - Main development guidelines (continued)

• Power consumption
  – Careful selection of features to reduce hardware size
  – Programmable architecture instead of fixed-function
  – Intelligent power management

• Process technology
  – 90 or 65 nm are used for mobile phone SoCs in this timeframe
  – 200 MHz peak clock frequency

• “Feature-proof” architecture
  – Product cycles on the embedded side are long
    • Large number of IP blocks integrated into heavy SoCs
    • Standardization takes a lot of time
    • Mobile phones are all about standards
  – Need to make a bet for which features to support → programmability provides safety
G40 – Rendering features

- 2D graphics rendering
  - BitBlts, fills, ROPs (256)
  - Small separate core for rendering bitmap-based user interfaces

- Vector graphics rendering
  - SVG Basic level feature set, targeting OpenVG
  - Anti-aliased rendering of concave and convex polygons
  - Rasterization integrated into the 3D pipeline
  - Support for linear and radial gradients
  - Arbitrary clip paths
  - 10-50x performance over software rendering

- 3D graphics
  - Transformation and lighting in hardware
  - Floating-point vertex and pixel shaders
  - Multitexturing: Four textures per pixel
  - Fully programmable architecture, no fixed-function pipeline
  - FLIPQUAD full-screen anti-aliasing
  - PACKMAN hardware texture decompression

Why vector graphics

- Very suitable mobile and handheld devices
  - Resolution independent
  - Small content size
  - High-quality anti-aliased images

- Strong customer demand for hardware accelerated vector graphics rendering

- Usage:
  - User interfaces
  - Interactive applications
  - (Streaming) cartoons
  - Greeting cards
  - Procedural texture generation for 3D games

- Software APIs
  - OpenVG from Khronos
  - SVG (Scalable Vector Graphics)
Architecture

- Rendering pipeline based on OpenGL® 2.0 shader architecture
- Fully floating-point, programmable, well integrated architecture
- Fixed function fully emulated using the programmable pipeline
- Designed from ground up to power mobile phones and other handheld devices