Bitboys G40
Embedded graphics processor

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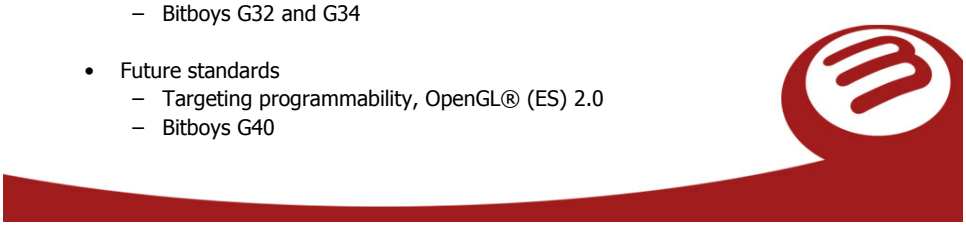
Brief history of embedded graphics hardware

- 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)

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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