Enjoy the Ultimate WQXGA Solution

with Exynos 5 Dual
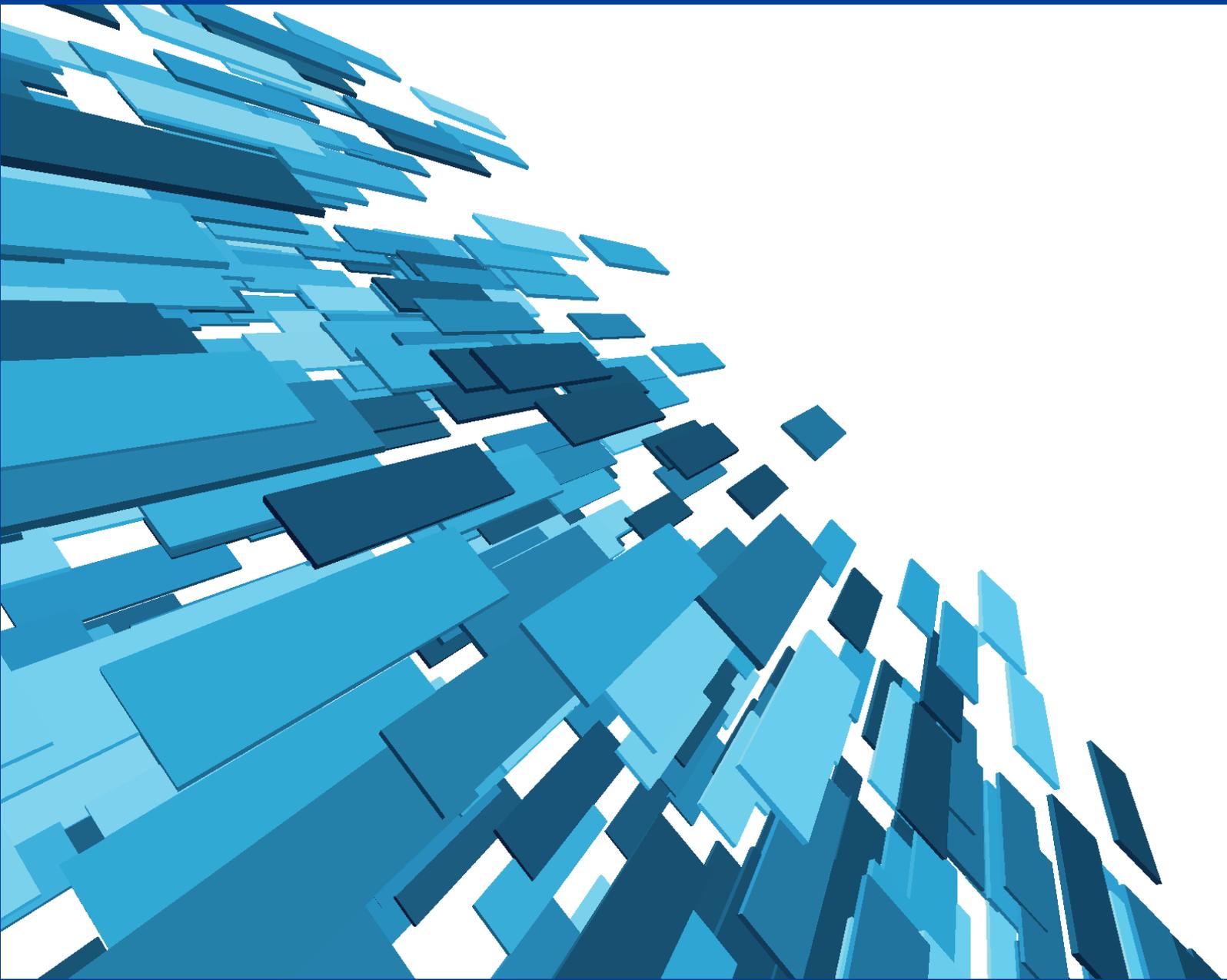
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Executive Summary

Since 2009, the mobile industry has experienced an unprecedented number of new trends. The current trend sees gadgets providing low-power mobility without compromising performance.

When users realized the advantages of browsing the web, watching HD video, and playing 3D games on a mobile device, they demanded displays with higher resolution and better multimedia performance.

Designed to keep up with these mega trends, Exynos 5 Dual supports a WQXGA solution.

Exynos 5 Dual key features:

- System-on-a-chip (SoC) based on the 32-bit RISC processor for tablet PCs. Designed with the 32nm low-power process, Exynos 5 Dual provides performance features such as dual core CPU, highest memory bandwidth, WQXGA display, 1080p 60fps video hardware, 3D graphics hardware, Image Signal Processor, and high-speed interfaces such as USB 3.0 and SATA3.

- Cortex-A15 dual core (with each core running at 1.7GHz speed), whose DMIPS is 40% higher than Cortex-A9 core.

- 12.8GB/s memory bandwidth with 2-port 800MHz LPDDR3 for heavy traffic operations such as 1080p video en/decoding, 3D graphics display, and high-resolution image signal processing with WQXGA display. Exynos 5 Dual supports dynamic virtual address mapping, which helps software engineers fully utilize memory resources.

- The best 3D graphics performance with a variety of APIs, such as openGL ES 2.0 and Halti, that can be used for GPUs with openCL full profile.

- 1080p 60fps video performance, which is critical for 3D stereoscopic playback/record and wireless display.

- WQXGA resolution of display subsystem, making it different from its competitors. For the first time in the mobile industry, Exynos 5 Dual integrates eDP controller and PHY transceiver to save power, space and bill of materials (BOM). Integrated eDP is specially designed with low-power circuit and features hardwired logic to support Panel-Self-Refresh (PSR) protocol.

- Image Signal Processor (ISP) of 8M pixel 30fps with add-on post processing units, such as 3-Dimensional Noise Reduction (3DNR), Vdeo Dgital Image Stabilization (VDIS), and Optical Distortion Compensation (ODC) integrated. Its ISP pipeline supports zero-shutter lag.

- BOM savings by integrating USB Host/Dev3.0, HSIC with PHY transceivers, and eight channels of I2C supporting a variety of sensors.

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Exynos 5 Dual Technical Values, Focusing on WQXGA Features

The following five key features are required to receive full support for WQXGA resolution: fast core performance, powerful 3D H/W engine performance, wide memory bandwidth, WQXGA display controller with proper interface, and low power consumption.
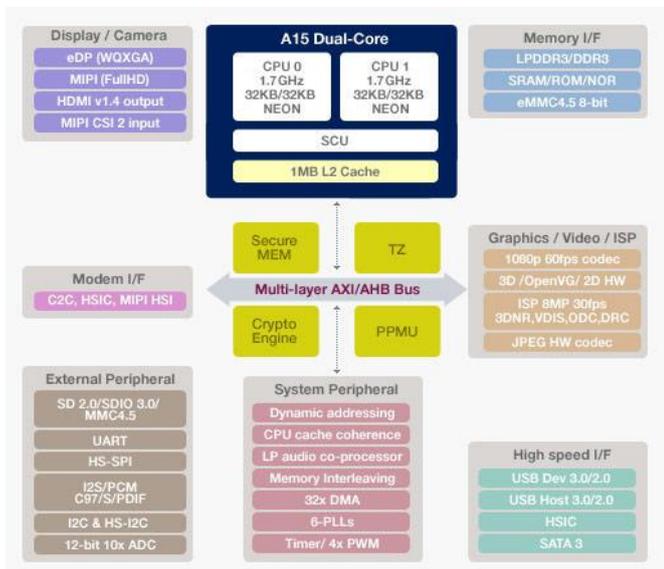
Figure 1 : Block Diagram of Exynos 5 Dual

World's First Cortex-A15 Dual Core

Exynos 5 Dual is designed for high-end tablets that require multi-window operations, full multitasking, and fast response while running applications. Exynos 5 Dual is the first chip in the market to integrate Cortex-A15 dual core.

The computing capability of Cortex-A15 dual core is similar to the CPU of a personal computer. The DMIPS/MHz of Cortex-A15 is 40% higher than the older generation Cortex-A9 core.

The 32nm process of Exynos 5 Dual can increase the Cortex-A15 speed up to 1.7GHz, while the older 45nm process Cortex-A9-based Exynos 4 Dual runs at 1.4GHz. 1.7GHz Cortex-A15 dual core is 2 times better performance than 1.4GHz Cortex-A9 dual core.

Cortex-A15 CPU core, with enhanced VFP and Neon coprocessor, is 1.5 times faster in integer performance and 2.0 times faster in floating-point performance than Cortex-A9 core.

In interconnection, it also supports 128-bit AMBA4 master and slave ports with upcoming cache coherent interconnect.

World's First 12.8 Gbytes/sec Memory Bandwidth with 2-port 800 MHz LPDDR3

In a worst case scenario, memory bandwidth can be very critical. 60 frames per second is the speed after which the after-image effect is no longer visible. The UI frame rate has been developed up to 60 frames per second, enabling users to experience a smooth transitioning motion. 60fps on WQXGA easily breaks the conventional requirement of memory bandwidth.

Displaying a 24bpp WQXGA screen at 60 frames per second consumes 1GB/s bandwidth. Because it is combined with partial images and UI icons, the final display out requires 8GB/s bandwidth. This is effective bandwidth that does not include memory utilization. If utilization is 80%, required real bandwidth becomes 10GB/s.
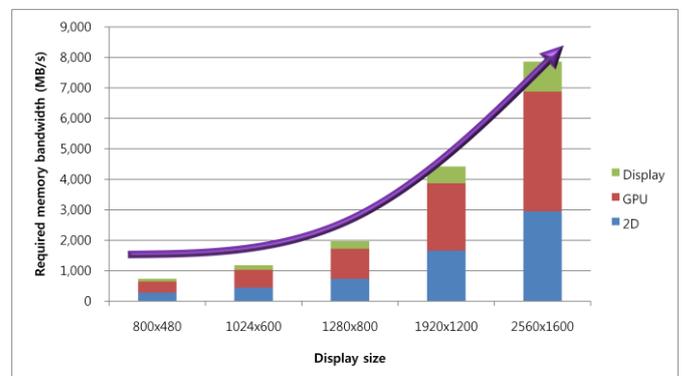
Figure 2 : Required effective memory bandwidth by display size

Furthermore, WQXGA display combined with worst case scenarios (such as UI with overlay types of 1080p video playback, camera preview, and encoding, and simultaneous HDMI out to HDTV) makes memory bandwidth management more difficult.

Exynos 5 Dual has been designed for WQXGA display, with effective bandwidth; therefore, it can support such worst case scenarios.

Exynos 5 Dual has adopted the mobile industry's first 2-port 800MHz LPDDR3 to support 12.8GB/s, which is two times wider than the bandwidth of Exynos 4 Dual 45nm as described in Figure 3. With 12.8GB/s memory bandwidth, Exynos 5 Dual

can make seamless UI motions and rich application operating momentum on a WQXGA resolution.
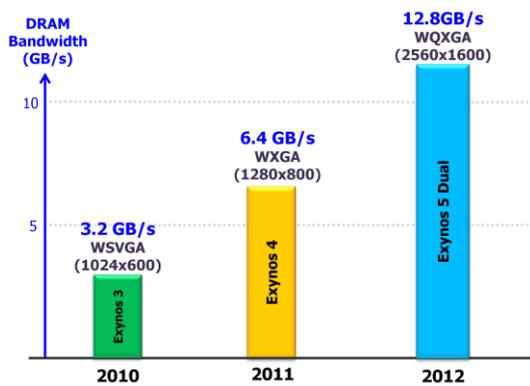
Figure 3 : Exynos memory bandwidth comparison

Ultimate WQXGA Display Solution with Low-Power eDP and PSR

Normally, the conventional MIPI interface has a maximum of 4 lanes, ideally running at 1Gbps. However, in most cases, when considering EMI and tuning issues, effective speed is less than 900Mbps. Therefore, using MIPI interface cannot guarantee more complex resolution higher than Full HD.

This is the first case in which a mobile AP has integrated eDP. Exynos 5 Dual does not require an external eDP converter to support WQXGA. Furthermore, conventional eDP is used for laptops and consumes much more power than the MIPI interface used in mobile devices. Thus, Samsung System LSI has specially designed eDP for Exynos 5 Dual, with power consumption at six times less than a conventional eDP interface.
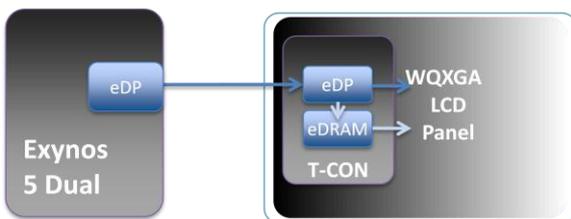
Figure 4 :eDP integration and associated Timing controller

The eDP in Exynos 5 Dual supports Panel-Self-Refresh (PSR) to save set power consumption. When Exynos 5 Dual detects an unchanged still image display, it sends a PSR command to T-con to operate PSR.

In PSR mode, the T-con stores Exynos 5 Dual's output image in its eDRAM and displays it on the panel. At the same time, Exynos 5 Dual can turn off display related blocks and frame buffer memory reading. This PSR mode consumes 20 times less power than active mode in AP. This reduction in power consumption is very effective, especially for a tablet application mainly used for reading content such as web pages, e-books, and magazines.
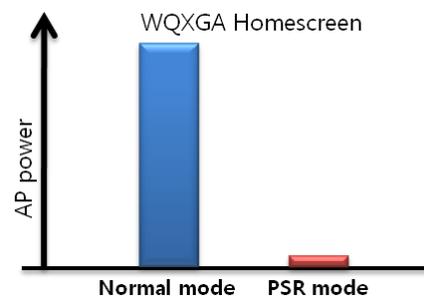
Figure 5 : WQXGA PSR mode power consumption

WQXGA display distinctly differentiates Exynos 5 Dual from other conventional products. Backed by memory bandwidth and eDP with PSR, Exynos 5 Dual is the only AP to make real true color (24bpp) WQXGA display with the lowest power consumption and a more flexible application scenario without the help of any external component.

World's Best 3D Performance

Currently, the 3D graphics engine in mobile operating systems is used for 3D rendering and for all basic graphic work on the screen. Because the 3D graphic engine operates UI overlay, homescreen, 3D games, and more, 3D performance has become a very important feature for measuring Mobile AP's overall performance. The 3D performance in the Exynos series has always been beyond compare; however, Exynos 5 Dual will raise the bar for mobile AP's 3D performance even higher.

Screen resolution is directly related to 3D performance. WQXGA resolution is four times better than WXGA, meaning that mobile APs must deliver 3D performance at least two times better than the previous generation. To meet the standard of WQXGA resolution, mobile AP requires a new 3D engine and architecture.

Samsung System LSI worked closely with ARM to achieve the quad core Mali-T604, the most advanced mobile 3D engine to

date. With Mali-T604, Exynos 5 Dual delivers two times better GPU performance than Exynos 4. Since Exynos 4 has more than enough 3D performance to satisfy WXGA resolution, Exynos 5 Dual is the only mobile AP that can handle WQXGA content with 60fps updates.
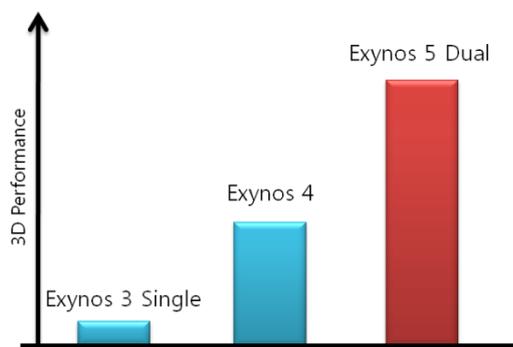
Figure 6 : 3D Performance comparison

In addition, the 3D feature of Exynos 5 Dual fully supports GPGPU, including openCL v1.1 full profile.

GPGPU is a solution that distributes the CPU's computation workload to the GPU. In GPGPU support, the floating point performance and precision of GPUs are the key factors. While CPUs can handle 64-bit floating point (double-precision), most mobile GPUs can only handle 32-bit floating point (single-precision). Exynos 5 Dual is the first mobile AP that can run double precision floating point and full precision with outstanding 72GFlops floating point performance. With this functionality, a developer can handle more precise and heavy computation works by simultaneously using Exynos 5 Dual's cortex-A15 dual cores and quad Mali-T604 cores performance.

World's First Cortex-A15 with HKMG Process

Seamless operations in Smartphones and tablets require peak performance, but the limitation in battery capacity and high power consumption restricts AP's overall peak performance. With the advanced 32nm High-K Metal Gate process, Exynos 5 Dual achieves 1.7GHz core speed with low power consumption.

In comparison to the conventional Poly-Si/SiON process, the HK/MG process enables 10% leakage or 40% delay improvement.
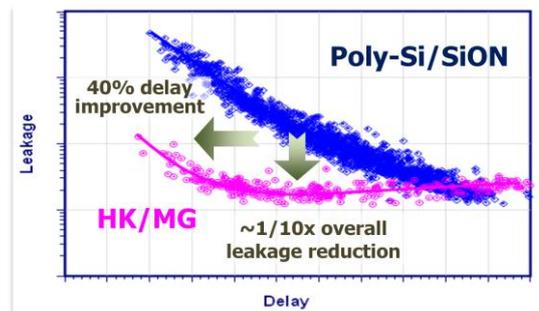
Figure 7 : High-K Metal gate process

Therefore, a 32nm LP processor displays 30% dynamic power reduction and 55% leakage power reduction when compared to the processor implemented at 45nm LP at the same frequency. With this process technology, Exynos 5 Dual can maintain a longer peak performance operating time.

1080p 60fps Video Performance and VP8 Decoder

After Exynos 4 Dual 45nm, support for full HD 30fps became the main functionality in high-end mobile APs. Also, the video decoding feature of Exynos 4 Dual 45nm enabled end users to play most existing video codecs without any additional encoding. Exynos is the best solution for playing and recording video; however, the demand for better quality video and Stereoscopic 3D content requires a more advanced video engine.

Exynos 5 Dual is first in the market to support full HD 60fps video encoding/decoding. It can display stereoscopic contents through integrated HDMI v1.4a; moreover, Exynos 5 Dual H/W video codec can decode VP8 codec for Web-M and Web-P to full HD 60fps.

With full HD 60fps encoding, the user can record video in full HD 60fps, and also transfer and display a full HD video on TV via WiFi display. When a user wants to watch a full HD video through WiFi display, the mobile AP must first decode the content and then re-encode and packetize later. For this activity, the mobile AP needs to simultaneously process at least 30fps decoding and encoding.

WiFi display requires a lot of memory bandwidth because not only does 1080p video need to be decoded and encoded at the same time, but also because basic UI and communication need to work. Thus, Exynos 5 Dual is the core of the perfect home entertainment solution and is the only option to make real WiFi display with more options for application scenarios.

USB 3.0 DRD Solution for Faster PC Sync UP and LTE

The size of WQXGA content, advanced 3D games, and 1080p 60fps video data is approximately three times larger than content made for previous generation mobile devices. To support this amount of data, Exynos 5 Dual provides USB 3.0 with 5Gbps SuperSpeed mode, which is 10 times faster than USB 2.0. Moreover, Exynos 5 Dual's USB 3.0 is a Dual-Role Device, meaning it can detect the status of a slave device by its connector's signal and then operate as either Host or Device. With DRD mode, Exynos 5 Dual supports keyboard, external storage as USB Host, PC sync as USB device, and LTE data modem.

Summary

Exynos 5 Dual provides multi-windows and multi-tasking with exceptional 3D performance. Its 32nm HKMG process, low-power eDP, and Panel Self Refresh combine to provide overall lower power consumption. Add in its 12.8GB/s memory bandwidth and its LPDDR3 800MHz RAM, and users will experience seamless UI & graphics for even longer.
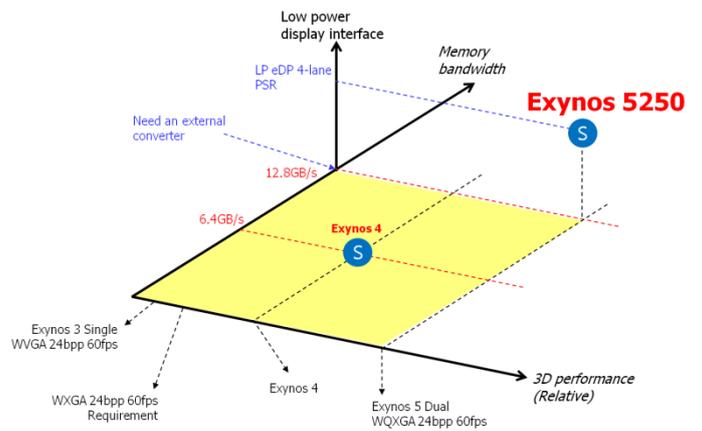
Figure 8 : Overall WQXGA solution comparison

Thanks to the world's first Cortex-A15 dual core and all the features it brings with it, Exynos 5 Dual is the complete solution for future WQXGA resolution devices.

About Samsung Electronics Co., Ltd.

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For more information

For more information about the Samsung Exynos 5 Dual, visit http://www.samsung.com/global/business/semiconductor/minisite/Exynos/products5dual.html

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