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Understanding Embedded - Microprocessors

Embedded microprocessors are specialized computing chips designed to perform specific tasks within an embedded system. Unlike general-purpose microprocessors found in personal computers, embedded microprocessors are tailored for dedicated functions within larger systems, offering optimized performance, efficiency, and reliability. These microprocessors are integral to the operation of countless electronic devices, providing the computational power necessary for controlling processes, handling data, and managing communications.

Applications of Embedded - Microprocessors

Embedded microprocessors are utilized across a broad spectrum of applications, making them indispensable in

Details	
Product Status	Active
Core Processor	ARM® Cortex®-A9, ARM® Cortex®-M4
Number of Cores/Bus Width	2 Core, 32-Bit
Speed	200MHz, 800MHz
Co-Processors/DSP	Multimedia; NEON™ MPE
RAM Controllers	LPDDR2, LVDDR3, DDR3
Graphics Acceleration	No
Display & Interface Controllers	Keypad, LCD
Ethernet	10/100/1000Mbps (2)
SATA	-
USB	USB 2.0 + PHY (1), USB 2.0 OTG + PHY (2)
Voltage - I/O	1.8V, 2.5V, 2.8V, 3.15V
Operating Temperature	-40°C ~ 125°C (TJ)
Security Features	A-HAB, ARM TZ, CAAM, CSU, SNVS, System JTAG, TVDECODE
Package / Case	400-LFBGA
Supplier Device Package	400-MAPBGA (14x14)
Purchase URL	https://www.e-xfl.com/product-detail/nxp-semiconductors/mcimx6x1avk08ab

i.MX Smart Devices

Giant Waterproof Tablet – i.MX53

Honeywell Lynx Touch security panel with the i.MX25

Icephone, Medical Phone with i.MX31

Navico Marine Navigation i.MX51

Maxtrack tablet for Brazilian Police with i.MX51

Avaak Vue Personal Video Network With the i.MX25

Invoxia IP Phone - i.MX503

Gigaset DECT phone with i.MX233

Sophia systems' non-contact card Reader/Writer for DoCoMo with i.MX51

i.MX233 based i'mWatch

AMX 20.3" Modero X Series Panoramic Table Top Touch Panel with i.MX53

Televic in Belgium trams using MX51

Line6 "Stagescape" audio mixing system with i.MX51

Japanese Boarding Gate Pass Reader with i.MX27

Self service touch screen terminal

Sharp e-Dictionary with i.MX28

Harris military communication equipment with i.MX27

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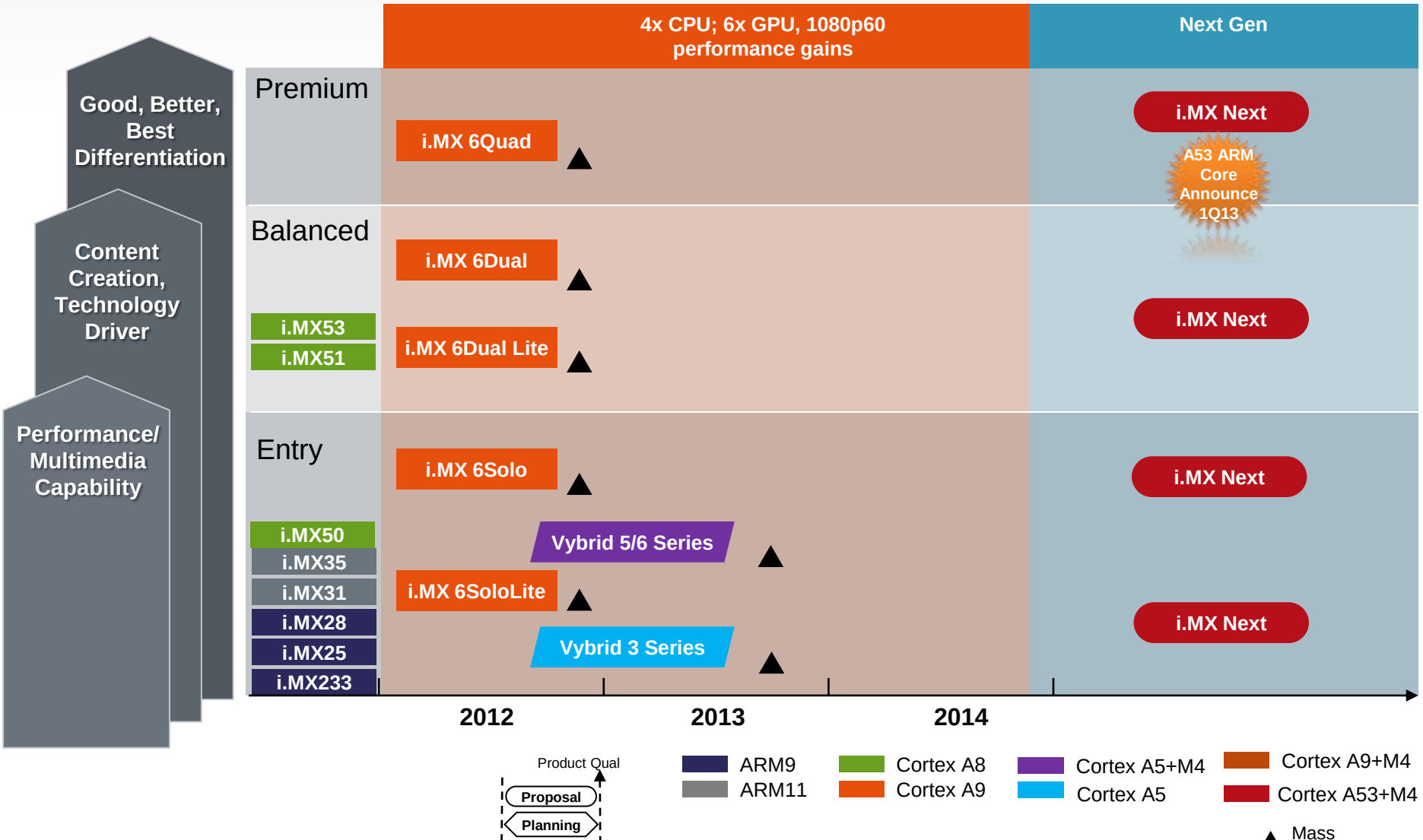
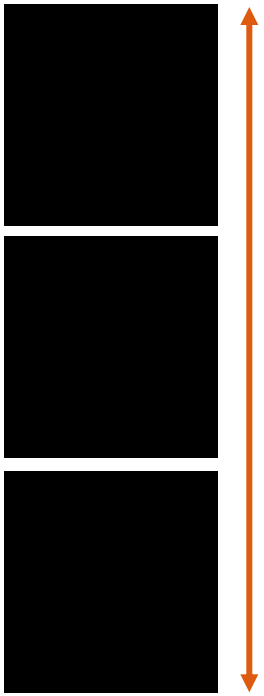
Applications Processor Family Roadmap



Freescale i.MX 6: unmatched pin-compatibility

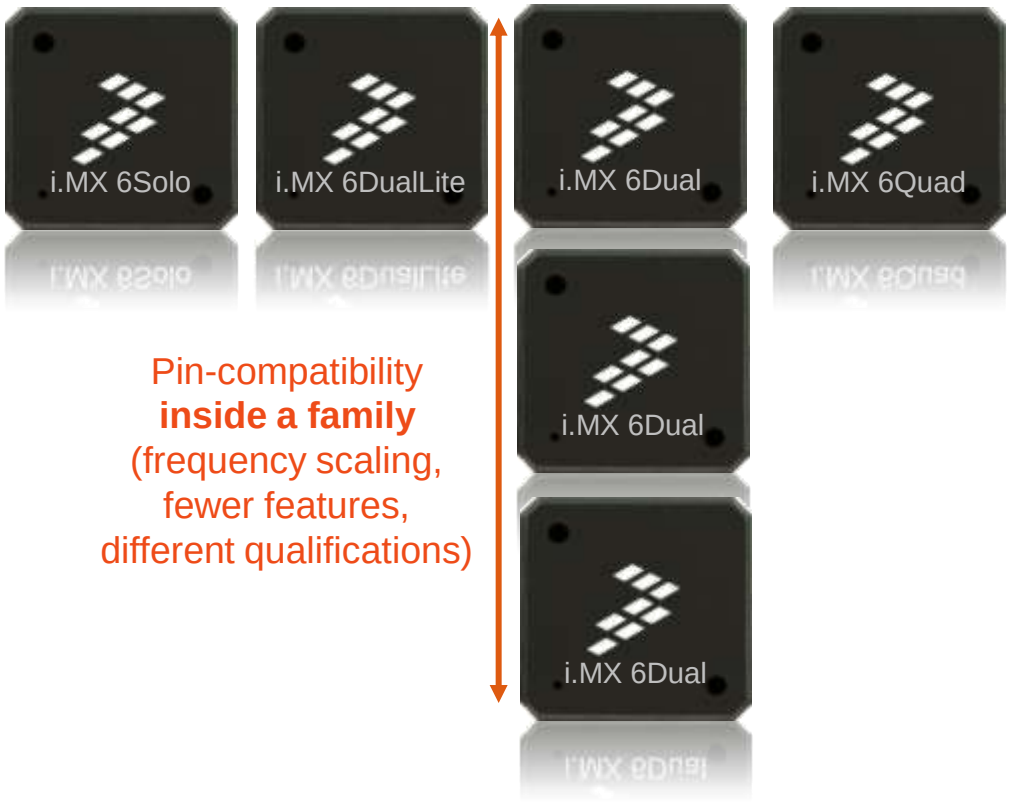
Competitors



Pin-compatibility
inside a family
(typically frequency scaling)

Freescale

Pin-compatibility
between families



Pin-compatibility
inside a family
(frequency scaling,
fewer features,
different qualifications)

Android Support Quad Core

The Good News: Heavy Lifting Already Done

The work required to go from 1 to 2 cores was much greater than to go from 2 to 4 (or more) cores… Android 3.0 (Honeycomb) natively supported Quad core out of the box in June 2011

If you have 4 threads and 4 cores, Android will schedule a thread per core

Intelligent Integration of Multi-Media

i.MX 6Dual/6Quad VPU

-H.264 MVC1080p60 decode
-H.264 MVC 720p60 encode
- 350mW power consumption for single video!

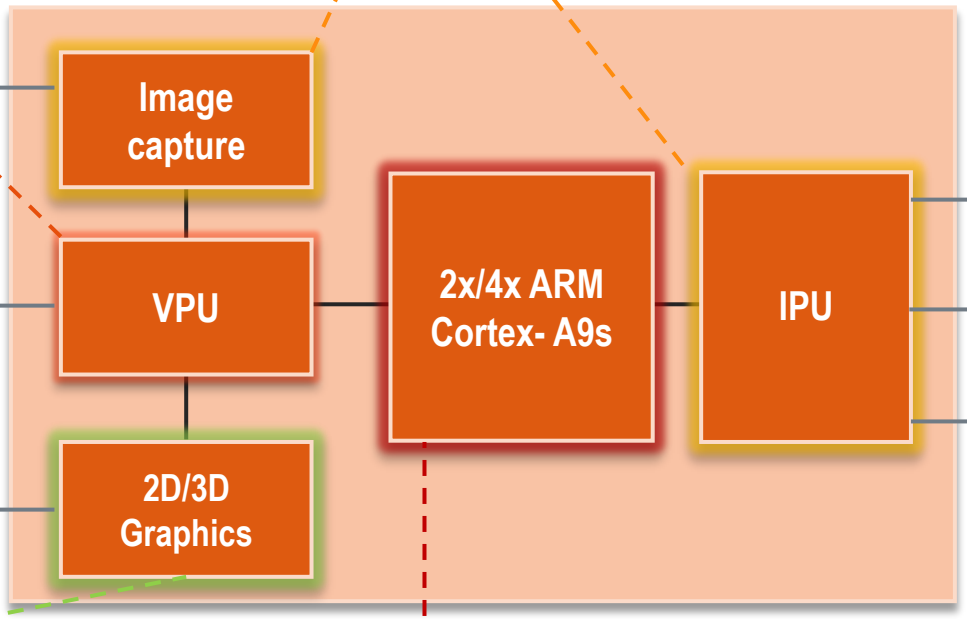
i.MX 6Dual/6Quad IPU

- Four Display support (2x MIPI-DSI, Parallel, HDMI v1.4a)
- Stereoscopic camera input
- Color adjustments and gamut mapping
- Gamma correction and contrast stretching
- Compensation for low-light conditions & backlight reduction

Recording Video

Movie Content

Game Content



3D LCD

Publish

3D Television

i.MX 6Dual/6Quad Triple-Play Graphics

- 3 engines: 3D, OpenVG and BLT
- 200 MT/s, 4 shaders, 3 separate engines
- High quality 3D games optimized for mobile
- Augmented reality views (real world + 3D objects)
- Advanced 3D video formats (source/depth format)

i.MX 6Dual/6Quad– 2x/4x cores

- Create, transform, enhance, & publish multimedia fast!
- Intuitive User Interfaces for content viewing
- Scalability for 'the next big use case'

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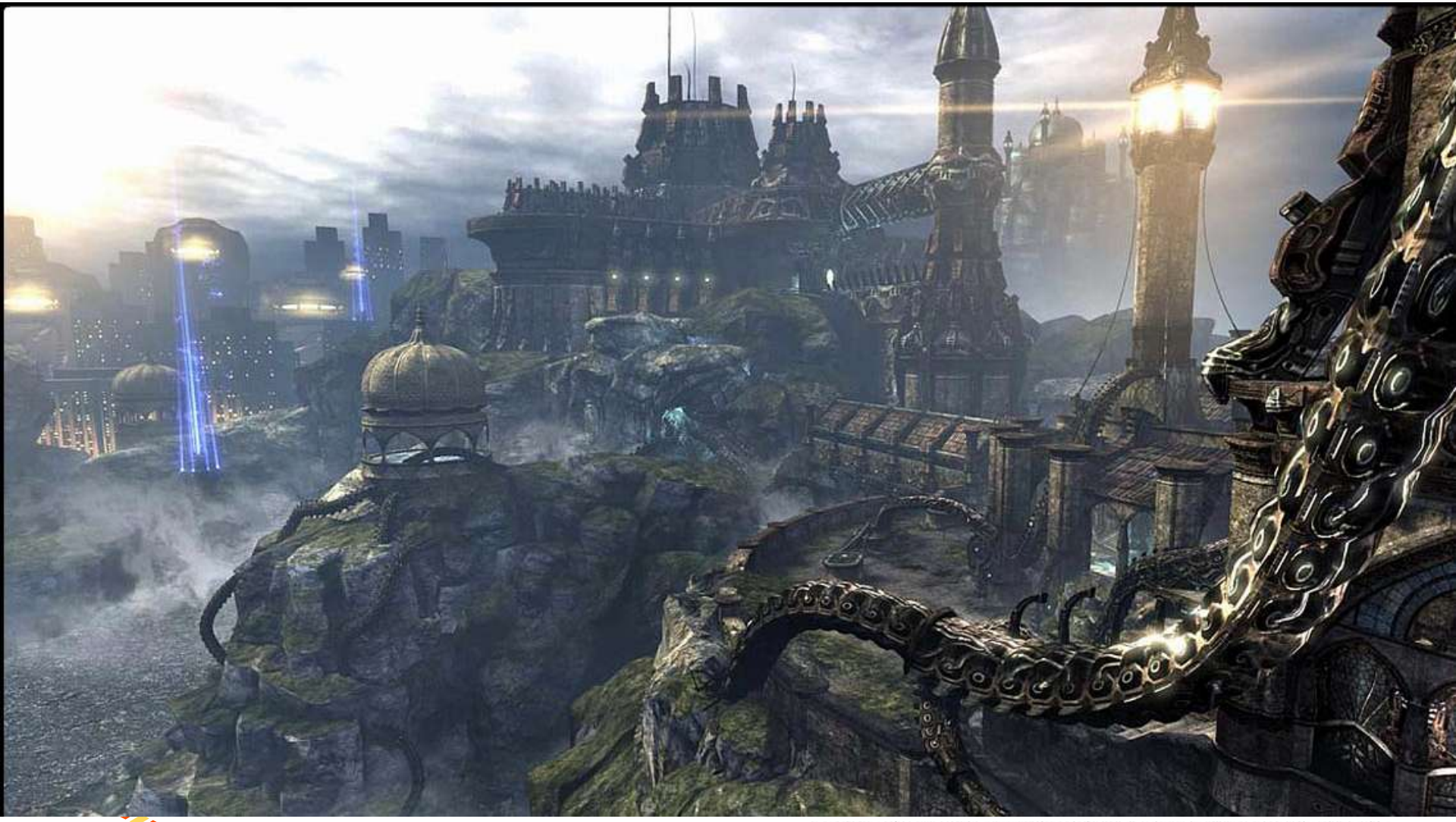
Vivante GC2000 Ultra-threaded GPU

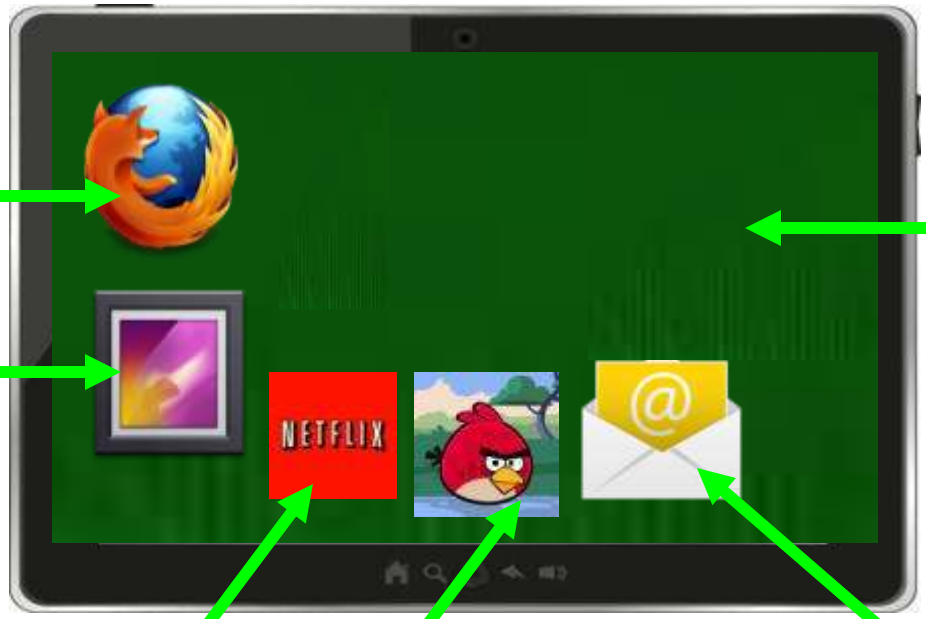


Good tablet application performance requires a balanced processor architecture (CPU speed, Memory BW, HW Accelerators)

Application
-HW Dependency #1
-HW Dependency #2
-HW Dependency #3
-**User satisfaction 'metric'**

Browsing
-CPU speed (rendering)
-Video HW unit
-Memory bandwidth
-**Fast page draw**

Imaging
-JPEG HW dec
-Memory bandwidth
-2D perf (swipe)
-**Fast image viewing**



User Interface
- CPU speed (geometry)
- 3D HW unit
- Memory BW
-**Responsiveness**

Video Playback/Streaming
-HW video unit
-Memory bandwidth
- **jitter-free video**

Games
-CPU speed (geometry)
-3D HW unit (TPS)
-Memory Bandwidth (complexity)
- **Richer graphics, no 'lag'**

Email/IM
- CPU speed
- Memory Bandwidth
-**Responsiveness**

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User Interfaces – Characteristics and Implications

- **UI content is inherently dynamic**
  - Unlike Games (which use pre-cached images/textures)
  - User content can/will change at any time
  - Therefore UI must refresh continuously in case new content emerges
  - Requires high speed (533Mhz) and wide (64-bit) memory bus to ensure high frame rates

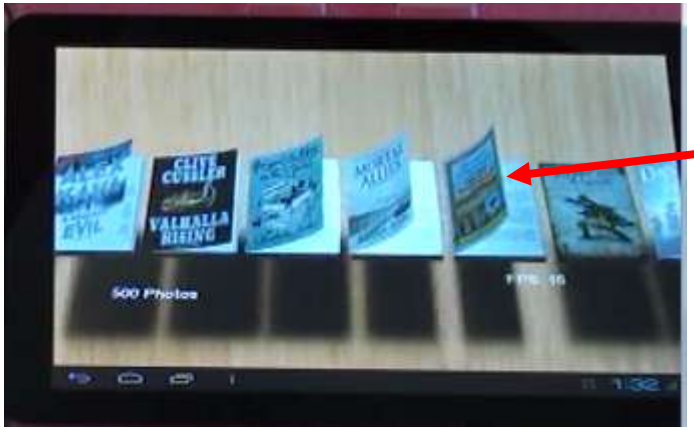
Recommend Dual Core + 64-bit Memory Bus

User Content is dynamic and (potentially) always changing. Especially true of streaming movies, YouTube, pictures, home moviews

User expects their 'latest' content to be instantly visible when scrolling (either touch or via remote with TV)
Thumbnails must be visible and smooth as they scroll left to right.

User Interfaces – Characteristics and Implications

- **UI requires high resolution support → 1080p TV or LCD is now the norm**
  - 1080p30 fps content is becoming a standard offering from websites and streaming
  - 1080p60 is around the corner
  - Must be able to decode h.264 High Profile 1080p at high bitrates (for user content decode as well as for video streaming over the net)
  - Must be able to support newer 1080p TVs. Consumer devices starting to hit >1080p LCDs (iPAD HD) Requires large memory space, fast display capabilities, in hardware rotation/scaling
  - Advantage Freescale i.MX 6: up to 4XGA, dual display engines, 64bit memory space @ 533Mhz
- **Access to fast CPU MIPS → used for complicated transforms to augment visual experience**
  - CPU cores useful to add in additional transforms that don't map well to 3D unit
  - Morphing effects and some fluid dynamics for innovative UI effects
  - CPU cores can also be used to augment 3D unit and act as a 'secondary' 3D unit
  - Advantage Freescale i.MX 6: up to Quad core Cortex A9 at 1.2Ghz → nearly 5Ghz of CPU horsepower



Book cover icon "blowing in the wind" when scrolling fast to visually indicate speed. Can use CPU power to calculate

Browsing and Image Viewing

Webkit Browser page rendering and scrolling

JPEG decode + encode 1024x768

- All workloads implemented on CPU
- Does not use HW accelerators at all
- Done in order to test CPU capabilities

App	1 Core	2 Core	Dual Core vs Single Core	4 Core	Quad Core vs Dual Core
JPEG	.2 fps	~1fps	5x faster	~4.5 fps	4x faster
Browser Scroll Time	289	36.25	>87% faster	15	>50% faster
Browser FPS	3.45	27.58	8x higher	64.4	>2x higher

Watch it live!
http://www.youtube.com/watch?v=JYFmBIk3itI#t=2m49s …

Gaming Performance

- **Benchmarking 3D game performance is tricky**
  - Dependent upon the 3D HW, the CPU speed and memory BW
  - Must balance all three to get best performance
- **Review websites use generally available benchmarks to rate tablets**
  - Example: Basemark, NenaMark, Antutu, Quadrant

Taiji Girl (Basemark ES2)

NenaMark2 3D Benchmark

AnTuTu Benchmark

Quadrant Benchmark

	6Quad	6DualLite	6Solo	Tegra2
Taiji Girl	25.65 fps	9.2 fps	7.67 fps	6 fps
NenaMark	49.2	30.5	27.2	21
AnTuTu	9605	5583	4531	4904
Quadrant	4011	3005	2414	2559

Video Playback and Streaming

- **Video Playback or Streaming performance is highly dependent upon screen resolution**
  - 1080p playback on a 1024x768 screen takes less bandwidth than 1080p on a 1920x1080 LCD
- **Available Memory bandwidth on 32bit DDR is ~1600MB/s**
  - 64bit memory is up to 3200MB/s
  - This assumes 50% utilization of the interface (generous)
- **Total Memory B/W required for 1080p playback**
  - On 1024x768 screen: ~800MB/s
  - On 1920x1080 screen: ~1100MB/s
  - If performing parallel tasks, will add to memory bandwidth needs
  - System activity+screen size Can vary memory bandwidth by up to 500MBs

Recommend Dual Core + 64-bit Memory Bus for 1080p Playback

User Interfaces – Characteristics and Implications

- Screenshots of Unreal Citadel Running on i.MX 6Quad

i.MX 6 Series VPU: *Transcoding & Full-duplex*

On-fly-*transcoding*

Source Resolution (decoded stream)	Max # Streams @ 30fps Target Resolution (encoded stream)		
	SD (720x480)	HD720p (1280x720)	HD1080p (1920x1080)
SD	4	--	--
HD720p	2	2 (24fps, TBD))	--
HD1080p	1	1	1 (24fps) 1 (**TBD** for 30fps)

Full-duplex

	Standard	**Profile**	**Performance**	
Full-duplex HW Codec	H.264	BP	720p@30fps, 1080p@24fps	20Mbps
			1080p@30fps (**TBD**) Dual 720p@30fps (**TBD**) (***TBD,*** *current VPU standalone testing shows 29fps for bitrate less than 5Mbps, but see room for encoder optimization*)	5Mbps
	MPEG4	Simple	720p@30fps	15Mbps
	H.263	P0/P3	720p@30fps	15Mbps

21x21 FCBGA Mechanical structure

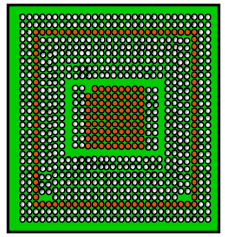
The IMX6Q/D Design

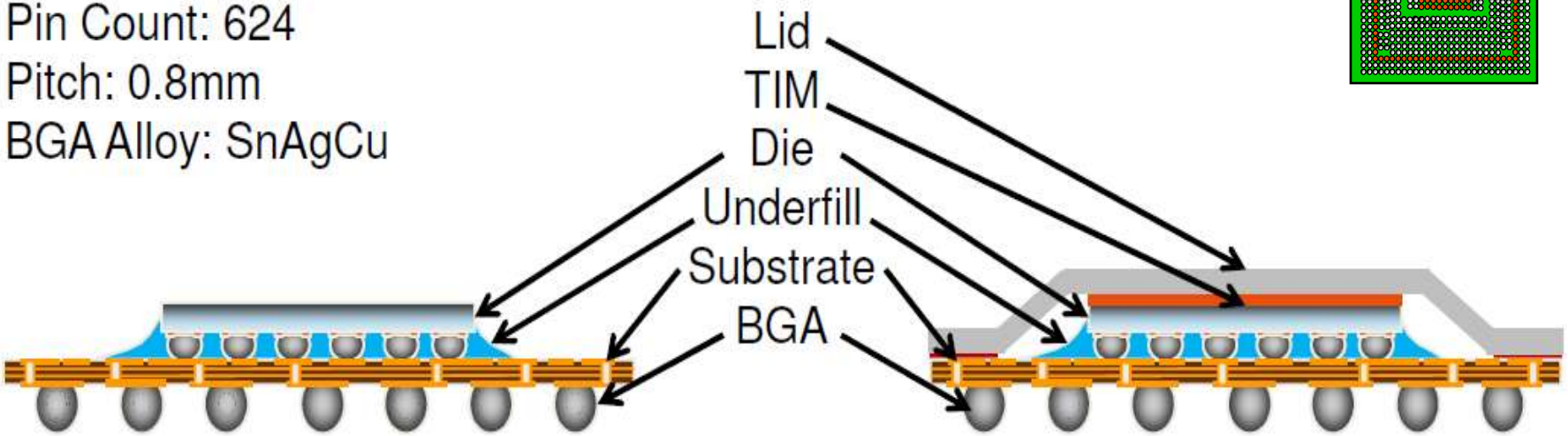
Package: 21x21mm FCPBGA

Pin Count: 624

Pitch: 0.8mm

BGA Alloy: SnAgCu





Stack-ups

Bare Die, 0.4mm core	Min	Nominal	Max
Device	0.280	0.305	0.330
Gap height (UF thickness)	0.070	0.080	0.090
Substrate (2/2/2 0.4mm core)	0.560	0.660	0.760
BGAs	0.300	0.400	0.500
TOTAL (sum of square tolerance)	1.301	1.445	1.589

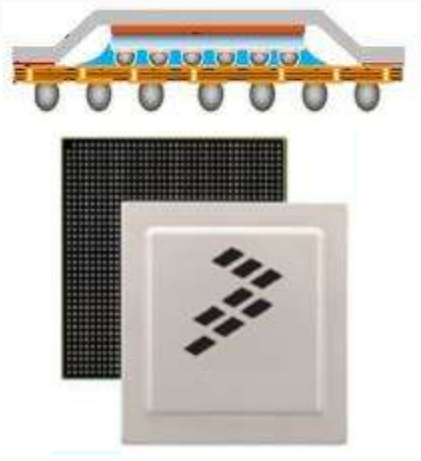
Lidded, 0.4mm core	Min	Nominal	Max
Lid	0.450	0.5	0.550
Thermal interface Material (TIM)	0.025	0.05	0.075
Device	0.280	0.305	0.330
Gap height (UF thickness)	0.070	0.080	0.090
Substrate (2/2/2 0.4mm core)	0.560	0.660	0.760
BGAs	0.300	0.400	0.500
TOTAL (sum of square tolerance)	1.841	1.995	2.149

Full dimensions available in the i.MX 6 Consumer and Automotive Datasheets on the i.MX 6Quad/6Dual Extranet

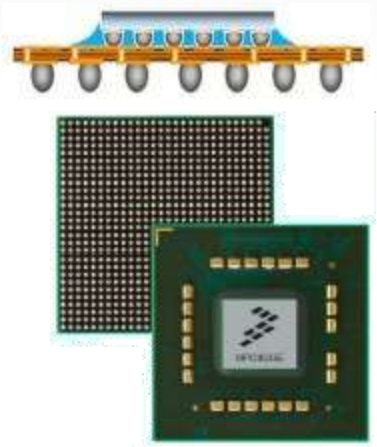
Packaging and Qual levels – 21x21 FCBGA Package

- **Lidded – Auto and Industrial**
  - Contains a metal lid covering the processor
  - More robust for industrial or automotive environments
- **Non-Lidded – Consumer**
  - Exposes the back side of the die (flipchip)
  - Lower Z-height for space constrained devices
  - Easier to attach custom heat spreaders
- **Three types of Qual for i.MX 6Series**
  - Consumer→ Highest Frequency
  - Automotive→ Maximum environmental support
  - Industrial→ Longest duration (“always on”)
- **Only Non-Lidded packaging will be available in Consumer Temp**

Lidded



Non Lidded



Type	Characteristics
Consumer	•-20 to 105Deg Tj •5 year life cycle @ 50% duty cycle •Max of 1.2Ghz CPU speed
Automotive	•-40 to 125Deg Tj •10 year life cycle @ 10% duty cycle •Max of 1Ghz CPU speed
Industrial	•-40 to 105Deg Tj •10 year life cycle @ 100% duty cycle •Max of 800Mhz CPU speed

FC-BGA Manufacturing App note (Lid and non-Lid) Available on freescale.com

...MX 6 Quad SABRE Lite Board (TO1.0 Silicon)

http://boundarydevices.com/products/sabre-lite-imx6-sbc/

Low Cost Community Board

- 1GByte of 64-bit wide DDR3 @ 532MHz
- Three display ports (24-bit RGB, LVDS, HDMI)
- Two camera ports (1xParallel, 1xMIPI)
- Serial ATA (SATA)
- Dual SDHC card slots (1 std, 1 micro)
- PCI express port
- Analog (headphone/mic) and Digital (HDMI) audio
- Compact size (3¼"x3¼")
- 10/100/1G Ethernet
- 10-pin JTAG interface
- 3 High speed USB ports (2xHost, 1xOTG)
- CAN port
- UART debug port
- I2C

- Purchase directly from Boundary Devices
  - PO, Credit Card or PayPal placed directly with Boundary Devices
  - Schematics and user manual available on Boundary website
- Additional supply partners available in Q3

SABRE-Lite will not be stocked, sold, or supported by Freescale
All support from Boundary Devices, partners or IMXCommunity.org

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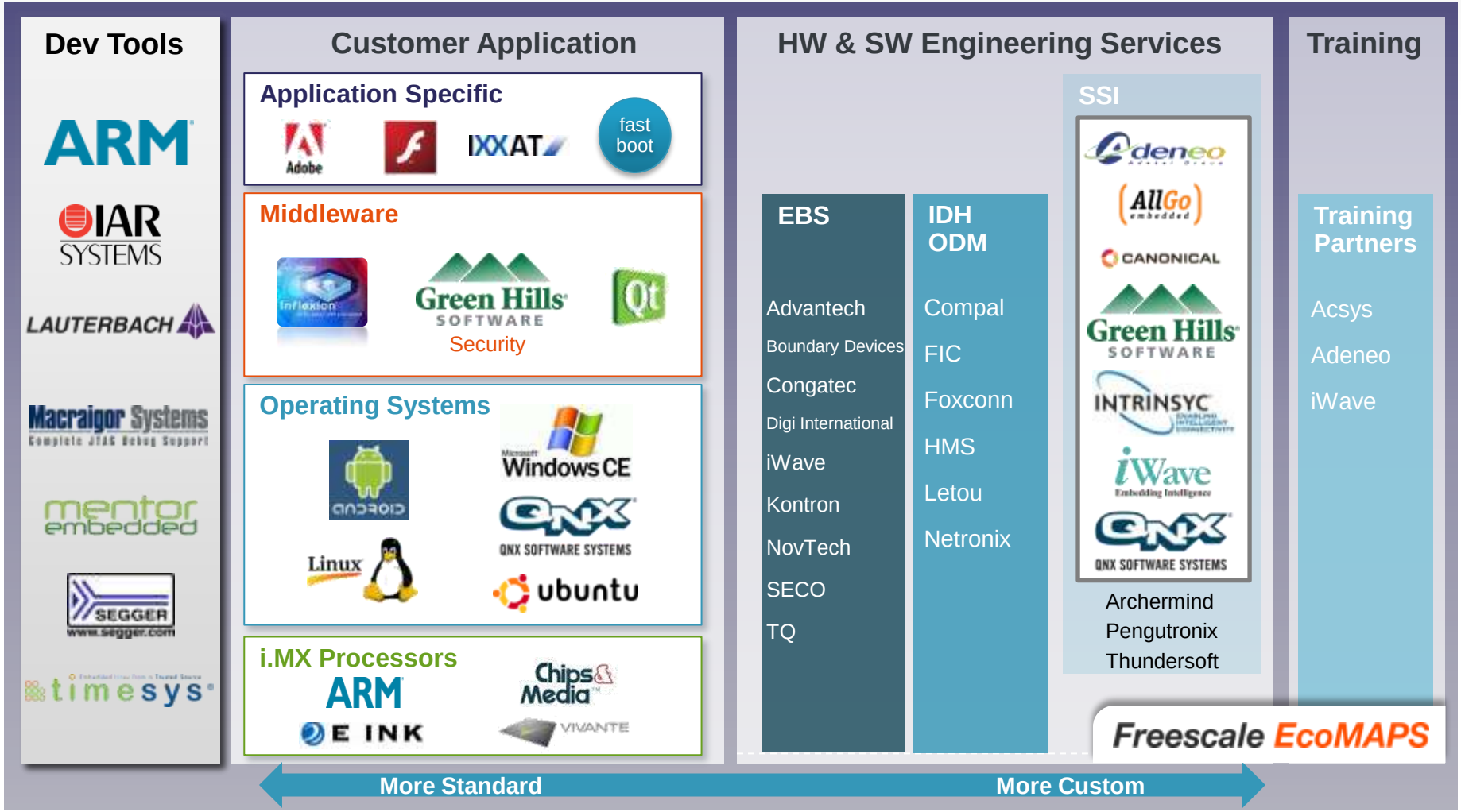
Freescale EcoMAPS for i.MX Architectures



IDE: Integrated Development Environment
BDM: Background Debug Module

EBS: Embedded Board Solutions

IDH: Independent Design House
ODM Original Design Manufacturer

SSI: Software & Solution Integrators

www.imxcommunity.org

A Freescale supported open web community of developers sharing common interest in transforming i.MX applications processors into practically anything imaginable.

Community Facts at a Glance

- Over 3,800 members and over 200 Freescale engineers and marketers interacting with you
- Support and enablement for i.MX processors and software
- Forums, Groups and Blogs Posts
- News, Photos and Videos
- Training, Events and Promotions

History of Android Development

Android	Google Release	First Freescale Release
Cupcake	Android 1.0 (September 2008) Android 1.1 (February 9, 2009) **Android 1.5 (April 2009)**	**R3 (June 2009)**
Donut	**Android 1.6 (September 2009)**	**R5 (September 2009)**
Eclair	Android 2.0 (October 2009) Android 2.0.1 (December 2009) **Android 2.1 (January 2010)**	**R7 (January 2010)**
Froyo	Android 2.2 (May 2010) Android 2.2.1 (January 2011) Android 2.2.2 (January 2011) Android 2.2.3 (November 2011)	**R9 (August 2010)**
Gingerbread	Android 2.3 (December 2010) **Android 2.3.3 (February 2011)** Android 2.3.4 (April 2011) Android 2.3.5 (July 2011) Android 2.3.6 (September 2011) Android 2.3.7 (September 2011)	**R10 (January 2011)**
Honeycomb	Android 3.2 (July 2011) **Android 3.2.1 (September 2011)** Android 3.2.2 (August 2011) Android 3.2.4 (December 2011) Android 3.2.6 (February 2012)	**R11 (September 2011 – i.MX53)** **R12 (September 2011 – i.MX 6D/Q)**
Ice Cream Sandwich	Android 4.0.1 (October 2011) Android 4.0.2 (November 2011) Android 4.0.3 (December 2011) **Android 4.0.4 (March 2012)**	R13 (December 2011) R13.1 (January 2012) R13.3 (June 2012) R13.4 GA (September 2012) *to align to 6Series launch
JellyBean	Android 4.1 (September 2012) Android 4.2 (December 2012)	JB 4.1 GA candidate – Dec 2012 JB 4.2 Beta Feb 2013 JB 4.2 GA – April 2013