November 2007

i.MX Technology Overview
The Coolest Thing since the Ice Age

NC303

Rajesh Gopi
i.MX Applications Engineering

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i.MX: Everywhere in Digital Consumer Market

- Cellular phone, Smartphone
- IP Phone
- Portable Audio Player
- Portable Video Player
- Portable Navigation Device
- Web Tablet/Handheld PC
- Intelligent Remote Control
- Security & Surveillance
- Mobile Gaming
- MP3 Player
- Digital Still Camera
- Projectors
- POS Terminal
- Bar Code Scanner
- Biometrics
- ***Smart Speed™ Technology:***
  High Performance with Low Power Consumption

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i.MX Vision

Mobile & Home Consumer

- High Performance Silicon
- Flexible Multimedia
- Customization for market leaders followed by broad market roll-out
- Product Development Kits

- i.MX
- ColdFire®
- Symphony™ DSP & Digital Amplifier

Distribution/General Purpose

- Low cost development tools
- Board support packages
- Proven reference design solutions

Automotive Infotainment

- “Auto Harden” and design for zero defect
- High performance processing for software upgradeability
- Advanced multimedia for audio, video, & navigation
- Automotive channel leadership

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▶i.MX Applications Processor

Addressing multimedia intensive applications with low power solutions

*Performance:

- 35-61% better performance per MHz
- 2x faster MPEG4 Decode

Scale:

- Shipped more than 64 million processors
- Over two million i.MX31 in first 244 days

Breadth:

- Broad cross-industry appeal
- Design wins in cellular, PMP, IP telephony, remote controls, industrial, automotive, GPS…

Cellular

Entertainment

Enterprise

* = benchmarked to leading competition by 3rd party

Video | 3D Graphics | Security | Audio | Connectivity | Low Power

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i.MX Momentum in Automotive w/ Microsoft/Ford

Ford's new fully integrated, voice-activated in-car communications and entertainment system for mobile phones and digital music players

- Ford Sync powered by Microsoft Auto Software and Freescale i.MX31 processor
- Planned availability in 12 Ford, Lincoln and Mercury models in 2008 in U.S.
- Users can access their mobile phone or digital music player via voice commands.

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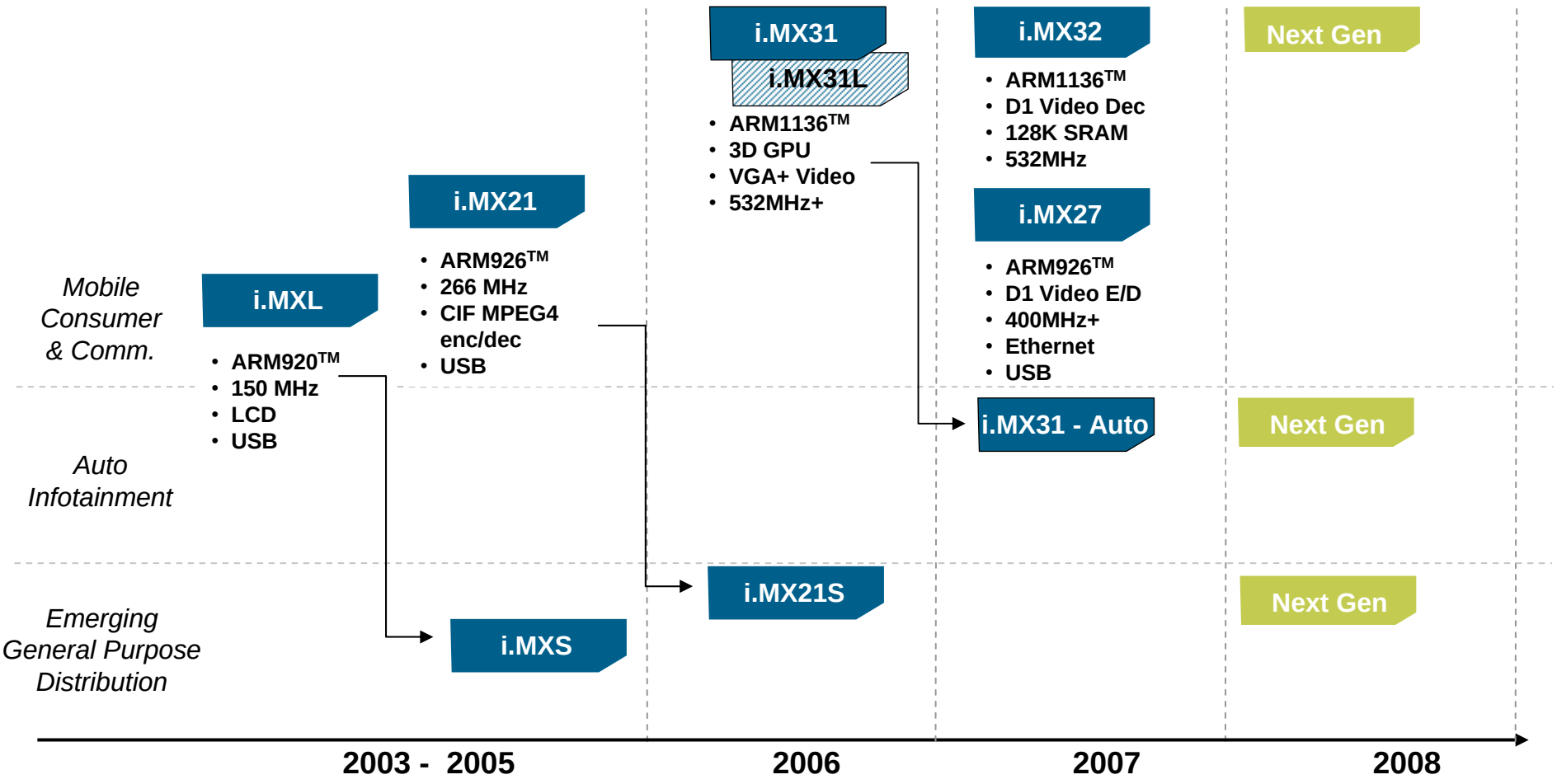
i.MX Applications Processor Roadmap



Right Edge = Production

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i.MX31 Applications Processor

Specifications:

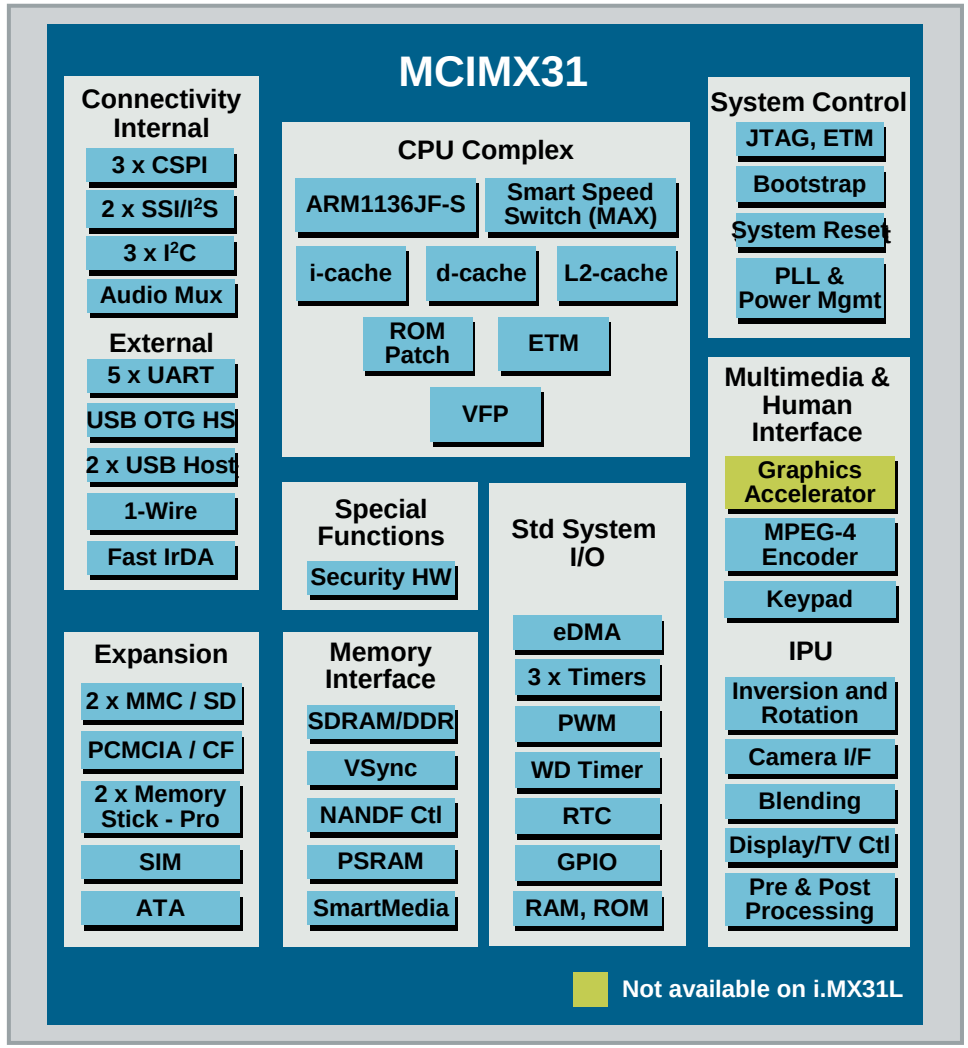
- CPU: ARM1136JF-S™, 532 MHz; 400 MHz Auto version
- Process: 90nm
- Core Voltage: 1.2-1.6V

Key i.MX31 Features and Advantages

- ARM1136JF-S with 128Kb L2 Cache
- Integrated 3D graphics processor
  - Eliminates 2 chip solution
  - Eliminates separate memory subsystem
- Integrated HW Image Processing Unit (IPU)
  - CMOS/CCD Interface
  - Resize, CSC, Deblock, Dering, Blending
- Vector Floating Point Co-Processor (VFP)
- Enhanced DMA RISC-based DMA controller
- Connectivity
  - WLAN, BT, GPS via external chipset
  - HS USB, ATA-6, MMC/SDIO, MS-Pro, Compact Flash
  - 266MHz Mobile DDR, NAND/NOR, Mobile SDRAM, SRAM
- Scale - shipped multi-million units
- Breadth – design wins in PMP, PND, Cellular, IP Telephony, POS terminals, automotive infotainment

Availability:

- Shipping Now



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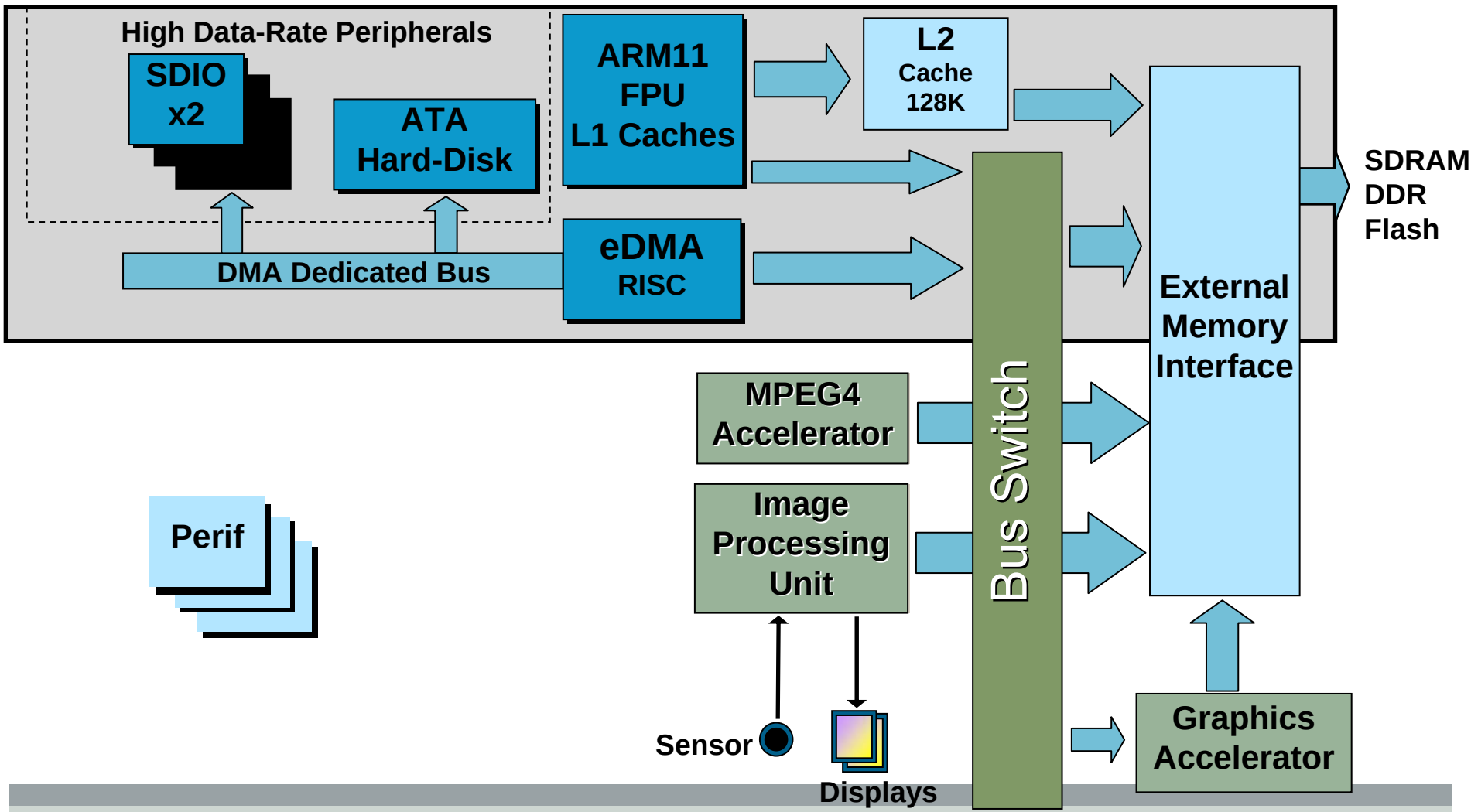
i.MX31 Detailed



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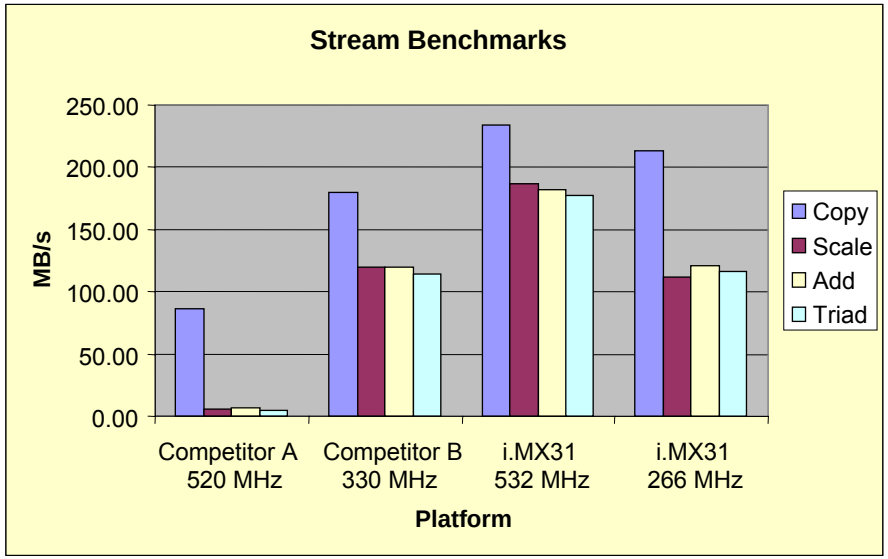
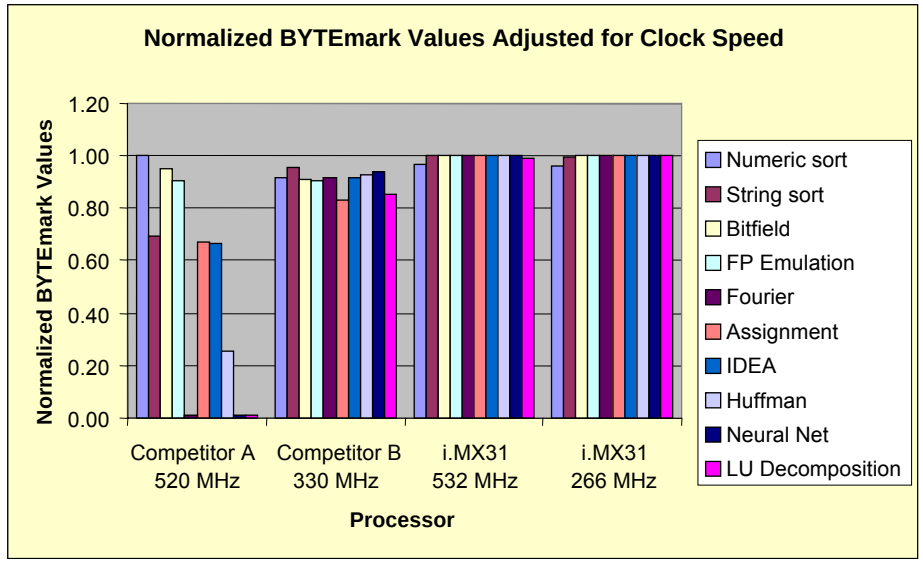
i.MX31 – Best In Class Apps Processor



Higher MB/s is better



Higher Normalized BYTEmark value is better

The i.MX31 architecture scales well with clock frequency and outperforms other architectures even at lower clock frequencies.

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i.MX32 Block Diagram

- **CPU Platform**
- ARM1136JF-S CPU , I-Cache, D-Cache, L2-Cache
- Jazzelle Java Acceleration
- VFP – Vector Floating Point Co-processor

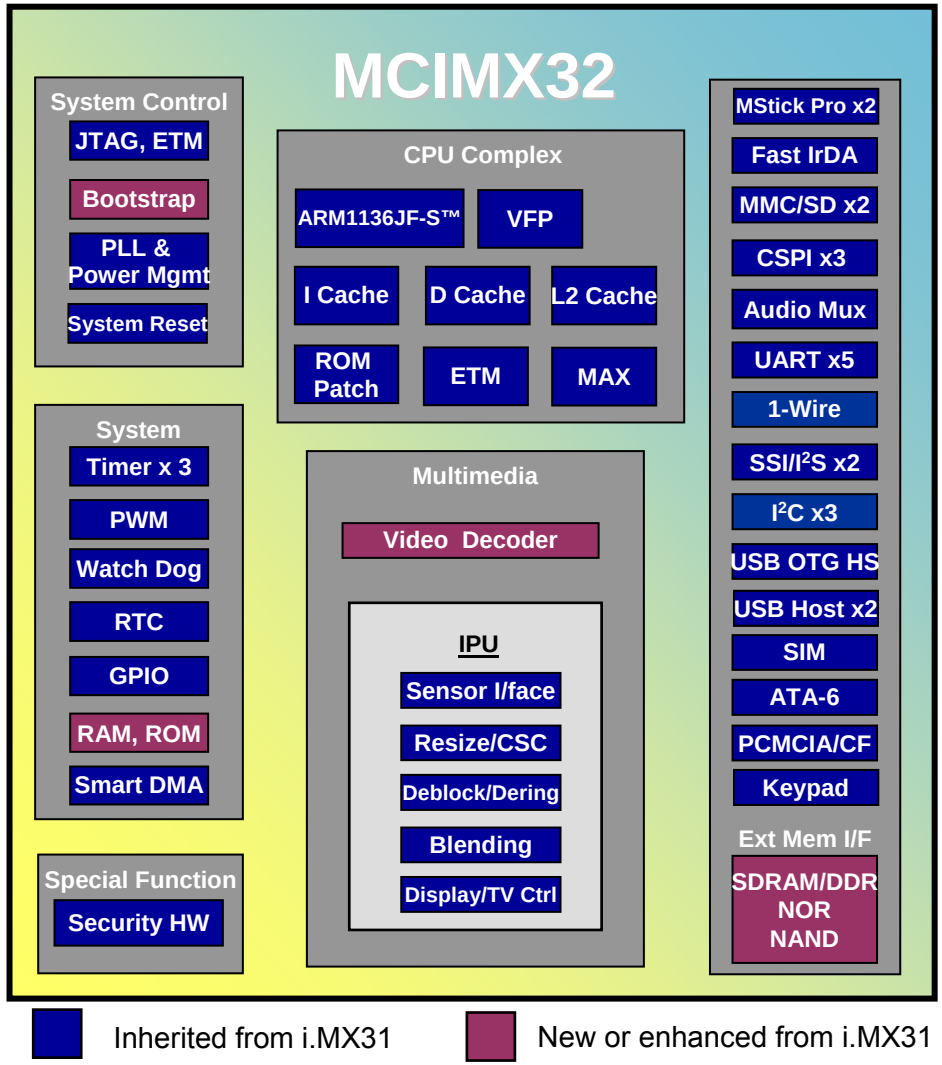
- **Multimedia**
- Multi-standard HW Decoder
- IPU - Image Processing Unit

EMI – External Memory Interface
- (mobile) SDRAM 16/32 bit, 133 MHz
- DDR 16/32 bit, 266 MHz
- SLC/MLC NAND Flash 8/16-bit

- **Connectivity**
- USB 2.0 High Speed
- ATA-6 (HDD) Interface, Audio MUX
- MMC/SDIO, Memory Stick

- **Power Management**
- Advanced Power Management (DVFS, DPTC)
- Active well-bias, Power Gating

- **Specs Summary**
- CPU Speed: starting at 532 MHz
- Core Voltage: 1.0 – 1.45 V
- Technology: 90 nm



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i.MX32 Applications Processor

Display
- WVGA Main Display
- Secondary Display Support

Camera
- Direct interface to CMOS/CCD sensors
- 5M pixel @ 6 fps

Security
- MMU (Memory Management Unit)
- High Assurance Boot (HAB)
- Security Controller (SCC), including Secure RAM and Security Monitor
- Run-Time Integrity Checker (RTIC), Including SHA-1 accelerator
- Random Number Generator Accelerator (RNGA)
- Secure JTAG Controller (with optional JTAG disabling)
- Universal Unique Identification
- Tamper Detection

Multimedia
- Multi Standard HW Video Decoder @ D1 30fps
  - MPEG4 SP, H.263 P3, H.264 BP, VC-1 MP
- Low Power Audio using 128KB embedded SRAM
- Image Processing Unit (IPU)

Connectivity
- SSI, i^2S, I^2C, UARTs
- HS USB, ATA-6, MMC/SDIO, MS-Pro, Compact Flash
- BT, WLAN, AGPS (all via external ICs)
- 266MHz Mobile DDR, NAND/NOR, Mobile SDRAM, SRAM
- SLC/MLC NAND Flash

Power Management
- Advanced power management (DVFS, DPTC)
- Active well-bias, power gating

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i.MX32: Audio Playback Mode Power

Major improvement achieved in software audio codec optimization:

-30% reduction for i.MX Power

-17% reduction for PMP Platform

Optimization List	
1V	yes
1 PLL	yes
Reduce PLL Vcc	yes
Run QPER on 33Mhz	yes
Use 13mW DAC+HP (new data)	yes
Automatic EMI clock gating	yes

Conditions:		
Battery	350	mAh
	3.7	V
	80	% down limit
	85	% efficiency
Buck converter	95	% efficiency

	Domain Name	MX32/System Power GSO codec [mW]	MX32/System Power MAD codec [mW]
MX32	*QARM*	**15.70**	**8.70**
	QPER	**10.40**	**9.40**
	QL2	**0.22**	**0.22**
	FVCC	**1.31**	**1.31**
System	*extMemDomain*	**3.60**	**2.70**
	extPeriphDomain	15.80	15.80
	iODomain	2.80	2.80
	NAND	2.00	2.00
	Total Power [mW]	51.83	42.93
	Play Time [h]	16.14	19.49
	MX32 Power:	***27.63***	***19.63***

i.MX32 running 133MHz Core and 33MHz Bus at 1.0V core voltage

SoC Video Decoder Power = ~140mW

(with associated audio and high level OS)

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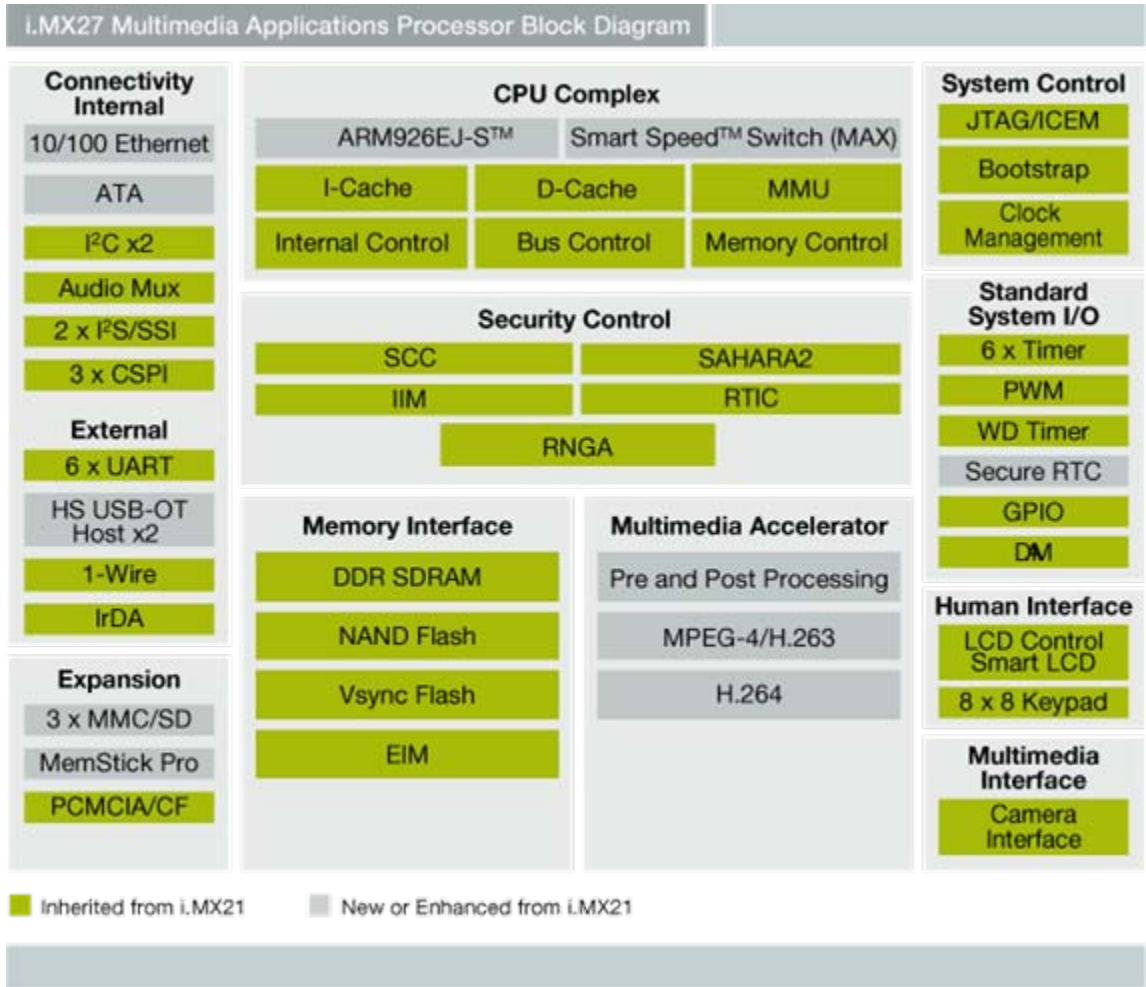
i.MX27 Application Processor

- **CPU Complex**
  - ARM926EJ-S™ 400 MHz @1.6V, 266 MHz @1.2V*
  - 16 Kb L1 I- and D-caches
  - 16 Channel DMA
  - Architecture compatible with i.MX21
  - ETM Real-Time Debug
- **Low Power**
  - Active Well-Bias
  - Dynamic Process and Temperature Compensation
  - Dynamic Voltage and Frequency Scaling
- **Security**
  - Sahara2 Crypto Accelerator (AES, 3DES)
  - Electronically-Blown Fuse Box for custom HW IDs
- **Connectivity**
  - Ethernet MAC
  - 6x UARTs, IrDA
  - 480 Mbps USBOTG + 2 Hosts
- **Expansion**
  - MemStick Pro, PCMCIA/CF, MMC & SD/SDIO Card Interface
  - ATA-6 HDD Interface
- **Multimedia**
  - MPEG 4/ H.263/H.264 D1 @30fps HW Codec w/ pre- & post- processing
  - High speed CMOS sensor I/F + I^2C
- **External Memory Interface**
  - 16/32-bit SDRAM @133 MHz
  - 16/32-bit DDR @266 MHz
  - 8/16-bit NAND Flash, PSRAM support
- **Technology**
  - Low power 90nm



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Changes from i.MX21

New Features

- 10/100baseT Ethernet MAC
- Memory Stick Pro
- 3 Additional General Purpose timer channels
- 2 Additional irDA capable UARTS for a total of 6
- ATA Host Controller
- 1 Additional I^2C for control of USB transceiver
- 1 Additional MMC/SD controller
- Symmetric / Asymmetric Hashing and Random Accelerator (SAHARA2)
- Secure RTC

Enhanced Features

- ARM926 at 400 MHz
- USB 2.0 OTG High Speed
- EMI updated with mobile DDR
- Video CODEC updated with D1 H264, H.263 P3
- Pre- and Post-Processing with added rotation, mirroring, zoom
- Updated LCDC with 24-bit panel support.
- SCC updated with isolated power supply for keeping secure information on standby power.
- JTAG boundary scan support added.

Removed Features

- FIRI
- BMI

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ARM926EJ-S Architectural Benefits

5 Stage Pipeline with Branch Prediction

- Harvard Architecture, with 16 KB Instruction and Data Caches
- Allows for greater CPU core parallelism (5 stages working at a time).

ARM v5TE ISA

- Single cycle MAC operations.
- 16-bit fixed point DSP instructions include support for saturated arithmetic to enhance signal processing algorithms.
- Memory Management Unit supports open operating systems.
- Greater Multiply capabilities with enhanced 16x32-bit multiplier.
- ISA can be extended via co-processors.

Thumb ISA

- Added 16-bit instructions for providing greater code density, usually 30-40%.
- Adds greater compiler capability to balance ARM and Thumb routines to balance code size and performance.

Java Capabilities

- Jazelle co-processor added to ARM core, adding a third ISA (ARM, Thumb, Java).

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Applications for the i.MX27

Video and Voice over IP Phone

Unit shown = *Quanta YV11*
Based on the i.MX27 processor

Video Surveillance

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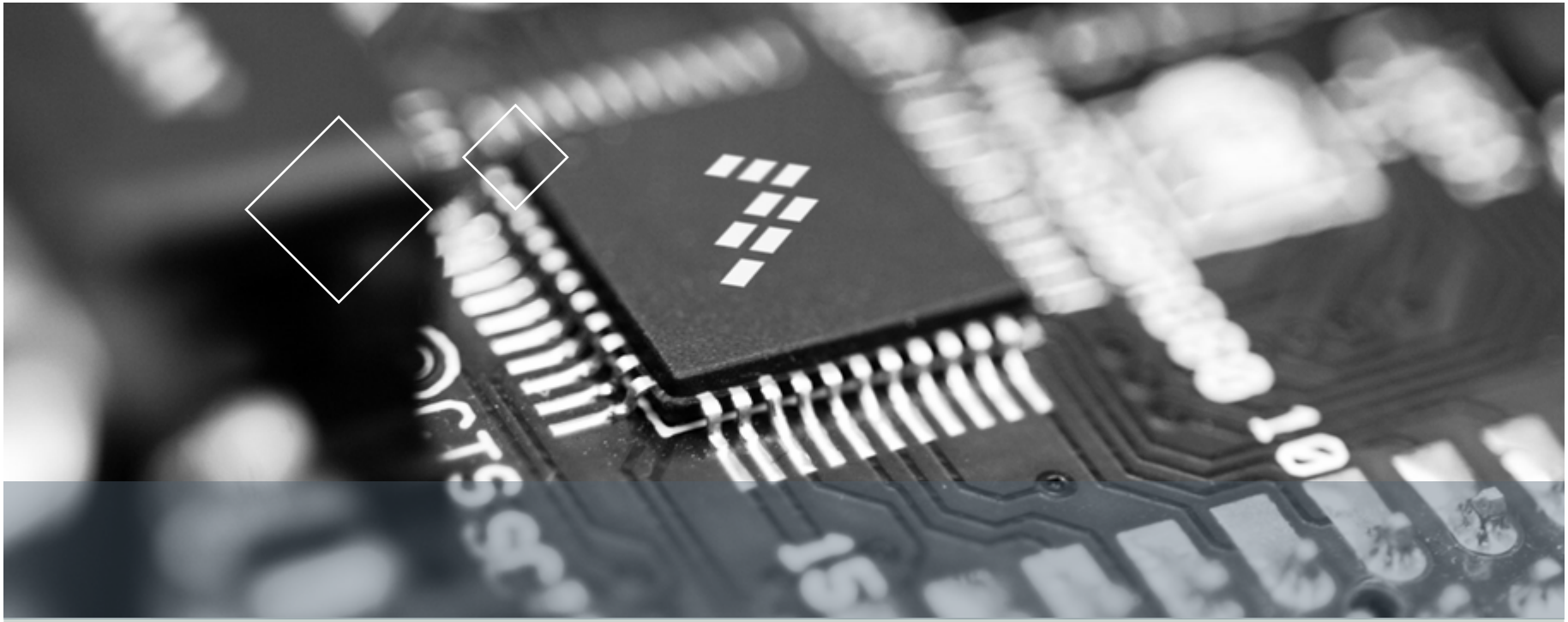

i.MX MAX **P**roduct **D**evelopment **K**it

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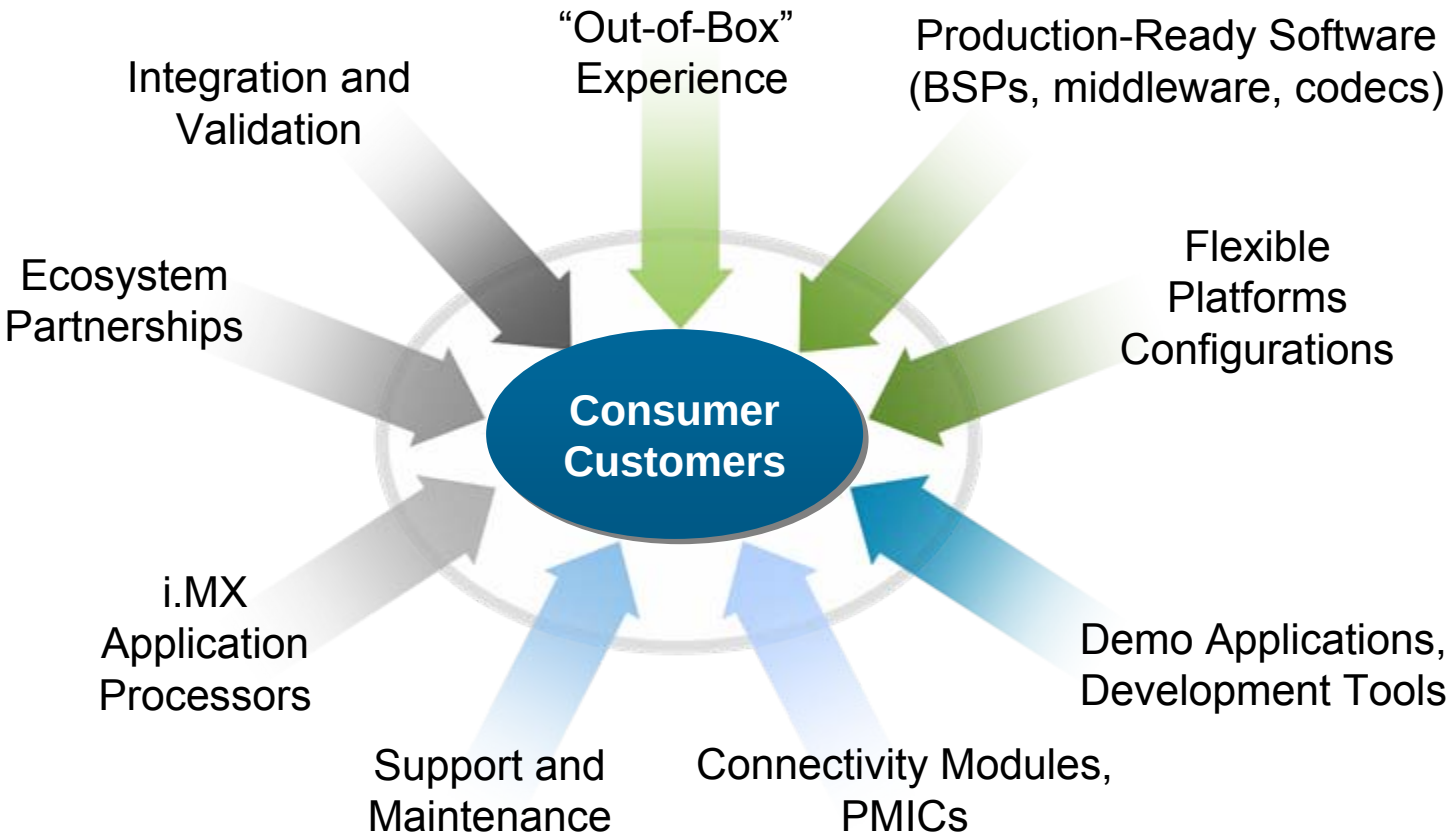
i.MX Consumer Platforms

Develop and market platform-level solutions that enable innovative consumer product development with i.MX processors



Platform thinking. Platform strategy. Platform execution.

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Product Development Kit (PDK)

- **P**roduct **D**evelopment **K**it (**PDK**) is a superset of several reference designs (Portable Media Player, Portable Navigation Devices, etc…)
  - Being developed to speed customers' Time To Market for i.MX based designs
  - Reduces FSL support effort for low touch opportunities

- PDK includes standard offering, and options as follows
  - Standard PDK
    - Hardware board (small & modular 3 stack solution)
    - Software SDK (Software development kit that includes Optimized BSP and minimal middleware and basic Codecs)
    - Associated documentation

  - Options (already integrated and tested with PDK)
    - Codecs not included in the standard offering
    - Additional middleware framework & components (MMF: Multimedia Framework, Security, *Power management XEC*)
    - Freescale GUI builder Power Parts

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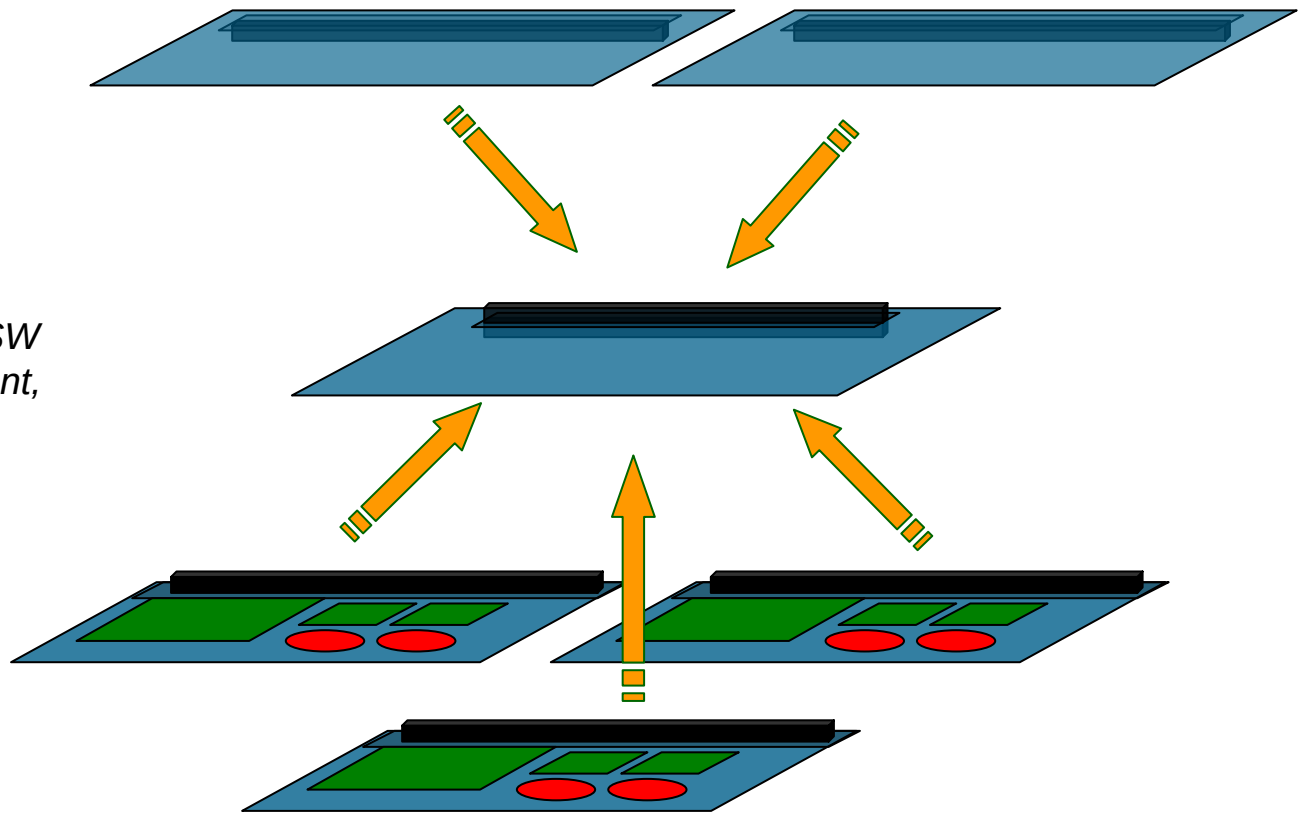
3-Stack Development & Demo Board

- 3 stackable boards that are near form-factor demonstration modules and working platforms
- Total cost (BOM and manufacturing) to be sub $1000

- **Personality Module**
  Peripherals board, 1 superset board or 1 for each application

- **Debug Board**
  All functions necessary for SW and Applications development, but do not reside on final consumer product hardware

- **CPU Engine**
  One board for each SoC (i.MX27, i.MX31, future generation i.MX)



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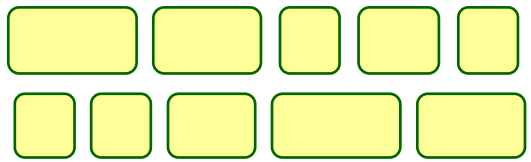
SDK (Software Development Kit)

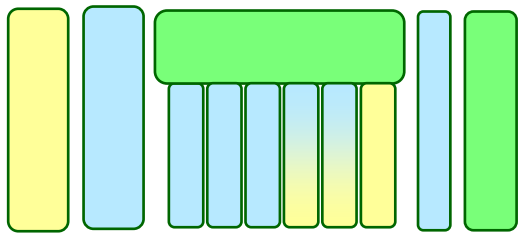
- All production ready Software components required to create a product. Components development source identified as GSO, DevTech, MAD R&D or 3rd party

- **Tool Set:** FSL supplied and list of 3rd party development tools

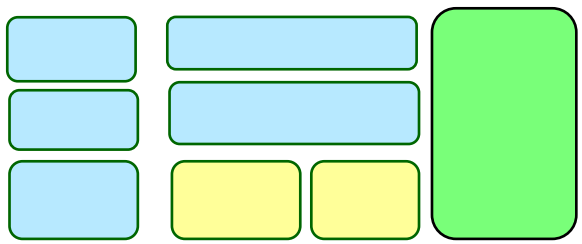
- **Applications sampler**, set of apps for demos or to serve as starting point for customers



- **Middleware:** open source Gstreamer + plug-ins and wrappers, or WinCE DLLs or MAD R&D MMF & PowerParts



- **O/S & Drivers,** from standard BSP with additional drivers to support Peripherals on Personality Module



MAD Platform Team | GSO/DTO Team | Third Party or Open Source

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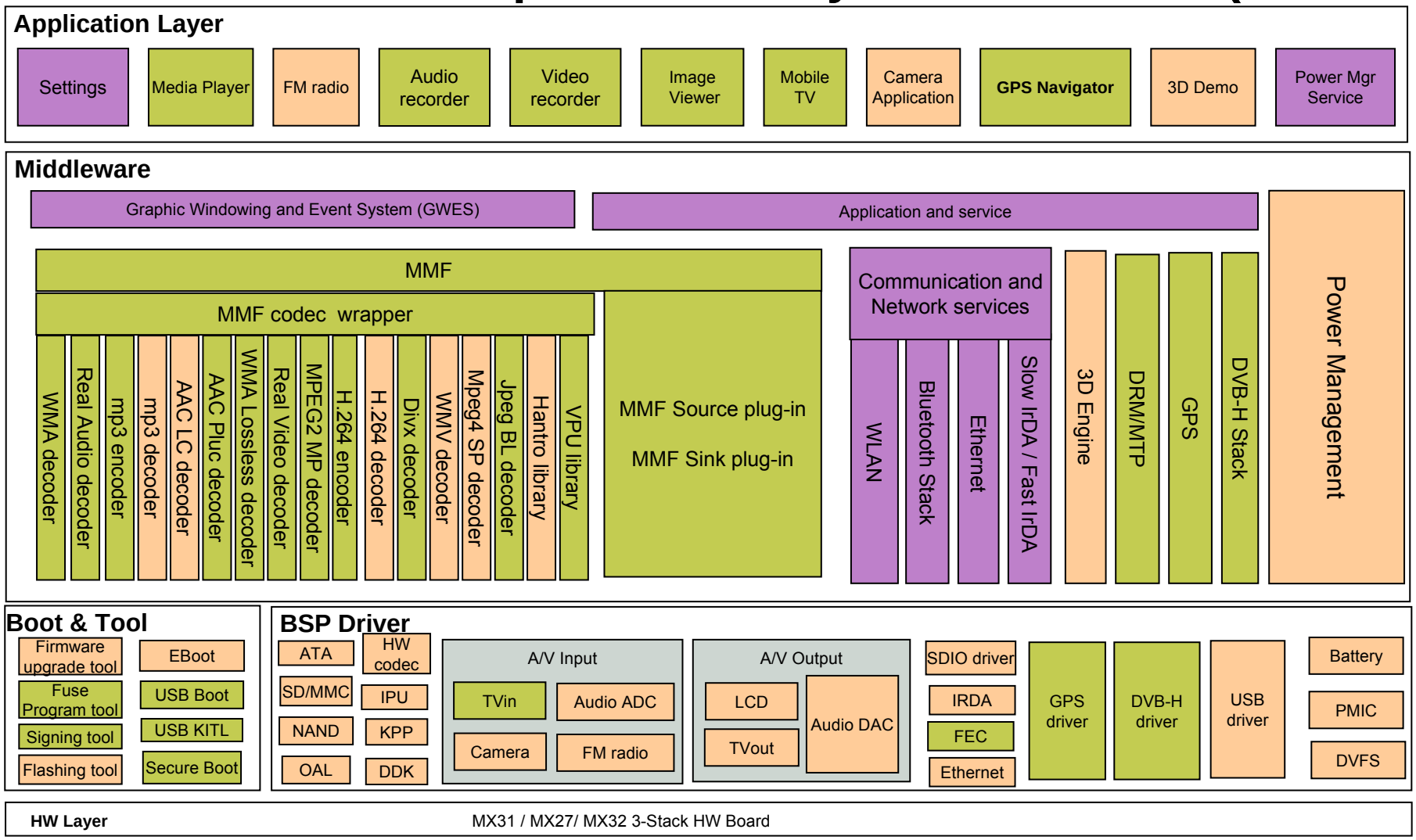
Components ready in W-PDK Inc4 (PDK 1.0)



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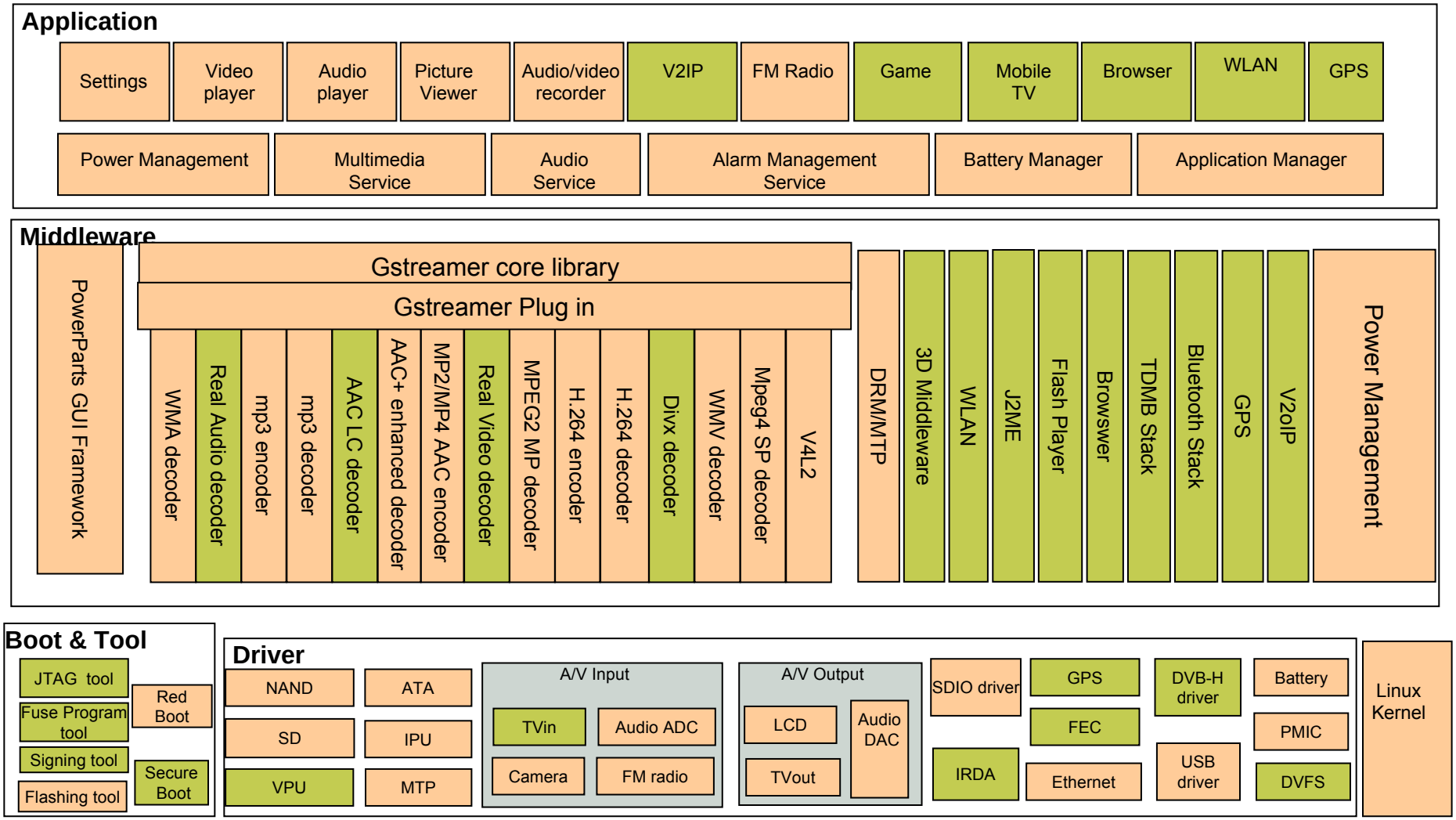
Components ready in L-PDK Inc4 (PDK 1.0)



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Related Session Resources

Sessions

Session ID	Title
NC303	i.MX Technology Overview
NC312	.Net MicroFramework on i.MXS
NC313	Developing Codec-Based Video Systems
NC305	Building an Embedded Linux System on an i.MX Processor
NC306	Efficient Power Management Techniques for devices Based on i.MX Applications Processors

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