June, 2010

eReader System Development

FTF-CON-F0778

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Session Introduction

- eReader Market is rapidly growing and segmenting. This session will introduce you to the features of the eReader system and how you can develop it with the help of Freescale.

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Session Objectives

- After completing this session you will be able to:
  - Understand the Freescale eReader processor roadmap
  - Briefly understand EPD technology
  - Recognize different Freescale solutions for different eReader Types

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Agenda

- Freescale MultiMedia Markets
- Processor Roadmap
- eReader Technology and Features
- System Comparison
- Fifth Item Covered in this Section

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Freescale Multimedia Markets

Automotive

- Historic leadership in Telematics
- Ramping in radio and infotainment
- Initial designs in advanced clusters

OnStar by GM SYNC Powered by Microsoft KIA

eReaders

- Dominant market share in emerging
- eReader market
- Aligned with market leaders

amazon SONY E·INK

Smart Mobile Devices

- Pioneer in portable media players
- Thought leader for smartbooks
- Focused investment in tablets

PHILIPS Google SHARP

Embedded Multimedia

- Broad traction in the embedded market
- Connected display based devices in
- consumer and industrial markets

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i.MX Roadmap for eReaders and Tablets

Tablet computing

i.MX51
- Cortex A8

- ► 800MHz ARM Cortex™-A8
- ► Smartbook and Tablet computing solution
- ► Supports soft EPD for E Ink® and AUO eReaders
- ► Supports dual screen eReaders

eReaders

i.MX35
- ARM 11

i.MX31

- ► Mainstream eReader product today
- ► Optimal mix of cost, low power, and performance
- ► Enables sub $199 eReader performance node

i.MX23
- ARM 9

- ► Low cost $99 eReader with LCD screen
- ► Optimal mix of cost, low power, and performance

Key:
Mass production

2009

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i.MX Roadmap for eReaders and Tablets

Tablet computing

eReaders

i.MX53
- Cortex-A8

- High performance tablet computing solution
- 1080p HD Video decode
- Will run soft EPD from AUO and E Ink
- eReaders that need high performance multimedia
- - PixelQi, Sharp®, Liquavista

i.MX51
- Cortex-A8

i.MX508
- Cortex-A8

- Cortex A8 with high performance E Ink EPD
- Cut system cost by 50% versus A8 + Epson™
- Retail cost down by over $30
- Support for high resolution, faster panels, and color
- Next gen dual scan panel support

i.MX35
- ARM 11

i.MX31

i.MX50x
- Cortex-A8

- Cortex-A8 with flexible LCD Interface
- Ideal eReader solution for non-E Ink solutions
- Works with AUO Soft TCON, AUO TCON ASIC
- Works with PixelQi, Mirasol®, Liquavista, Sharp, etc.

Key:
Mass production
Tape Out

i.MX23
- ARM 9

2009 2010

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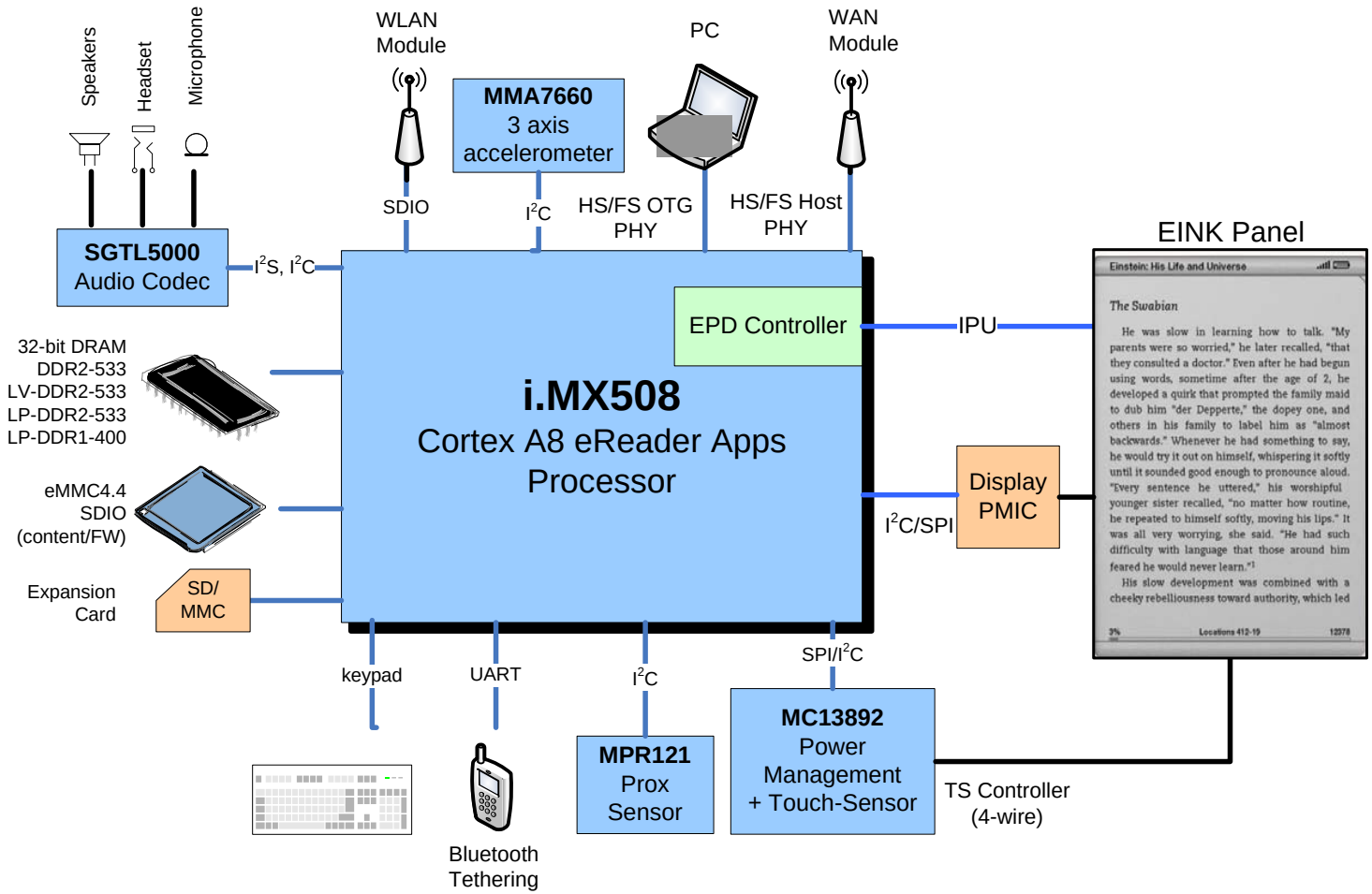
Next Gen eReader System



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What is Special about an eReader?

▶ A Microencapsulated Electrophoretic Display (EPD)

- Also known as Electronic Paper Display or bubbles
- E Ink Vizplex® is the leading panel solution

▶ Low Power

- Weeks v. hours

▶ Sunlight Readable

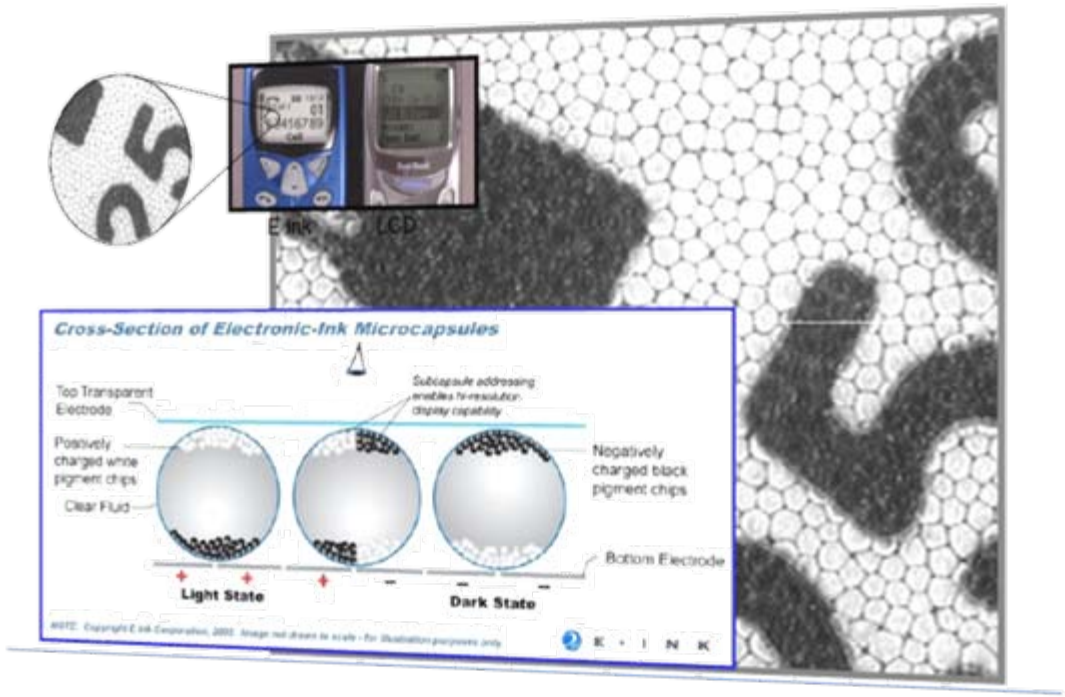
- Reflective v. backlight

▶ Thin and light

- Hold it in one hand

▶ Simple to use

- Some 3G enabled
- No monthly fee
- Easy to download new books



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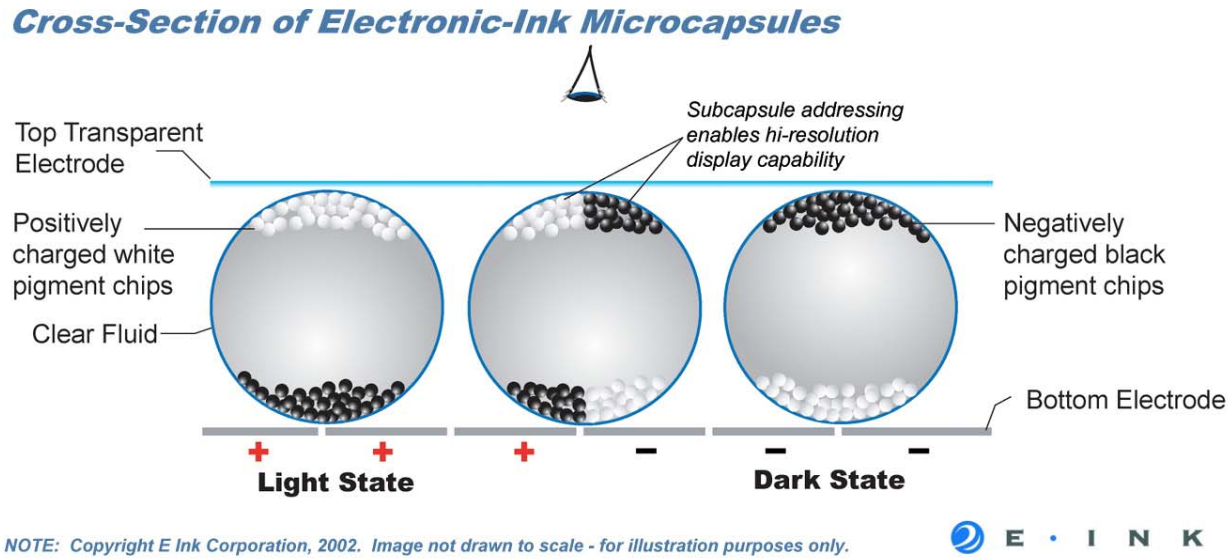
Display Requirements



- Panel PMIC: Must support bi-polar high voltage to move charged particles
- Temp Sensor: Movement of particles are temperture dependent so a temp sensor is required
- EPDC controller: Manipulating display requires special controller
  - This controller can be implemented in SW or hardware

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Software Implications

- Sub 10Hz display in a 60Hz world
- UI must be designed around display
  - Scrolling, quick movements, animation, video and the like are not supported
- Some systems support a smaller LCD screen for control

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Reference design methodology: 1 solution for 3 kinds of developers

- Development System
  - Used for early development of application software
  - Performance evaluation
- Hardware reference
  - Schematics and layout available as reference to all customers
- Reference System: Hardware + BSP + Middleware
  - BSP provided as software starting point for software
  - Middleware is constantly evolving: Power management, acceleration, etc
  - While demo is provided, application development is left to customer or third party
  - System is not meant to be turn-key

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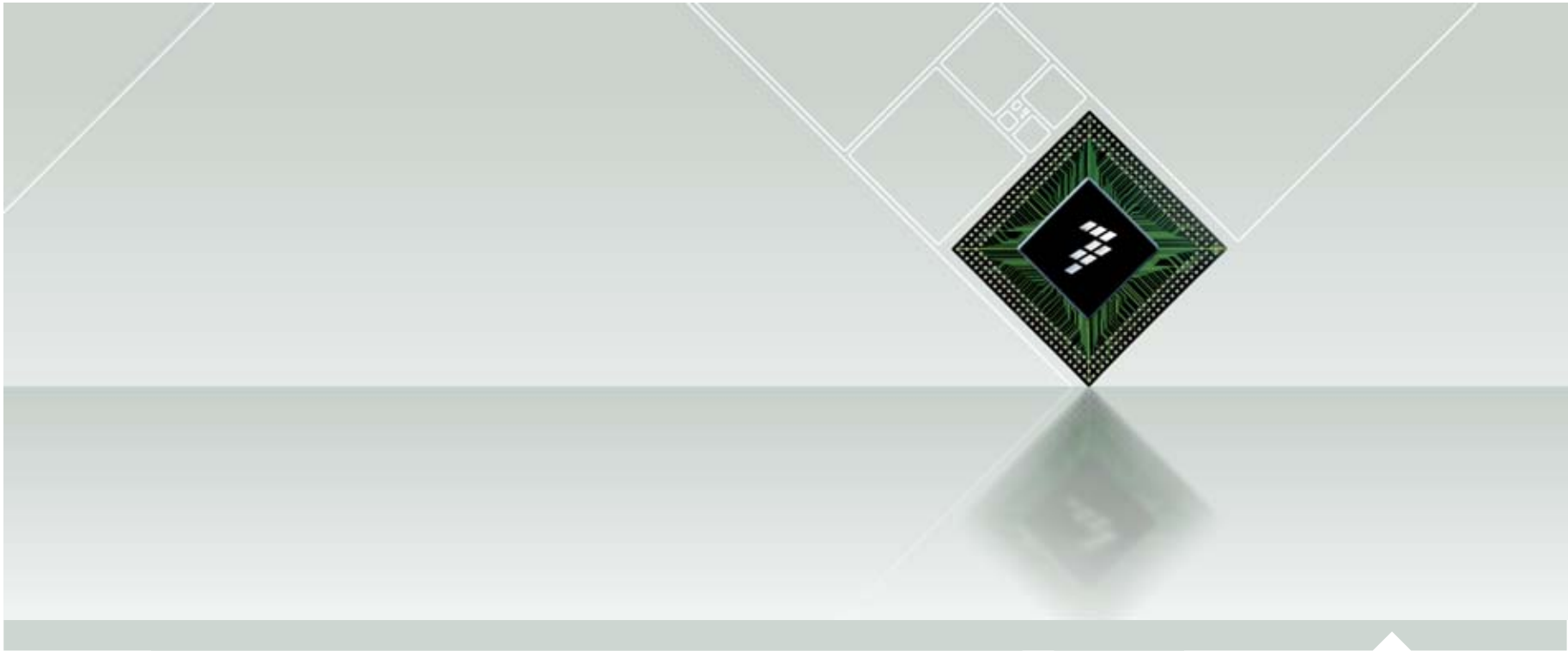

eReader System Comparisons

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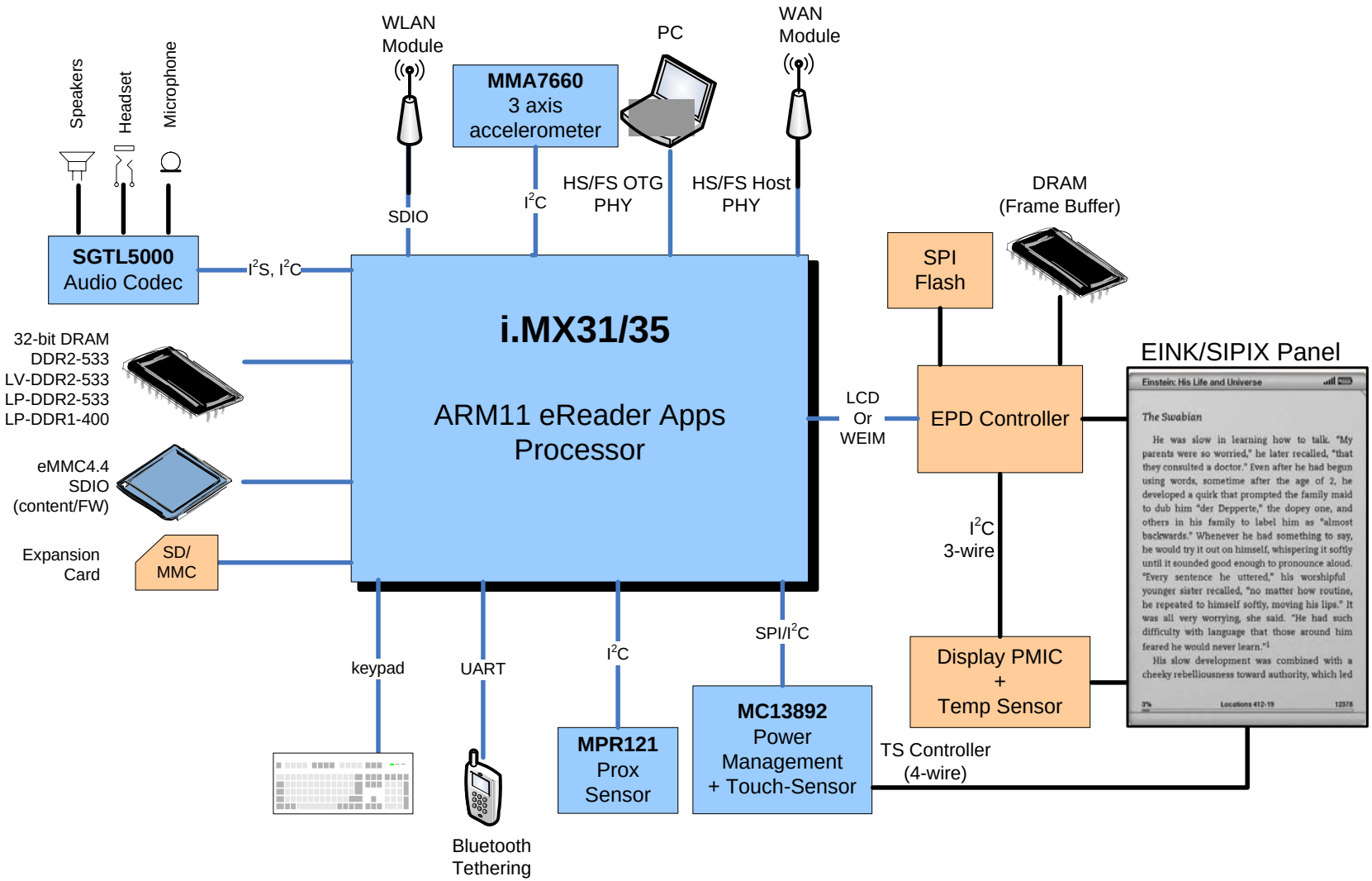
Current Generation eReader System



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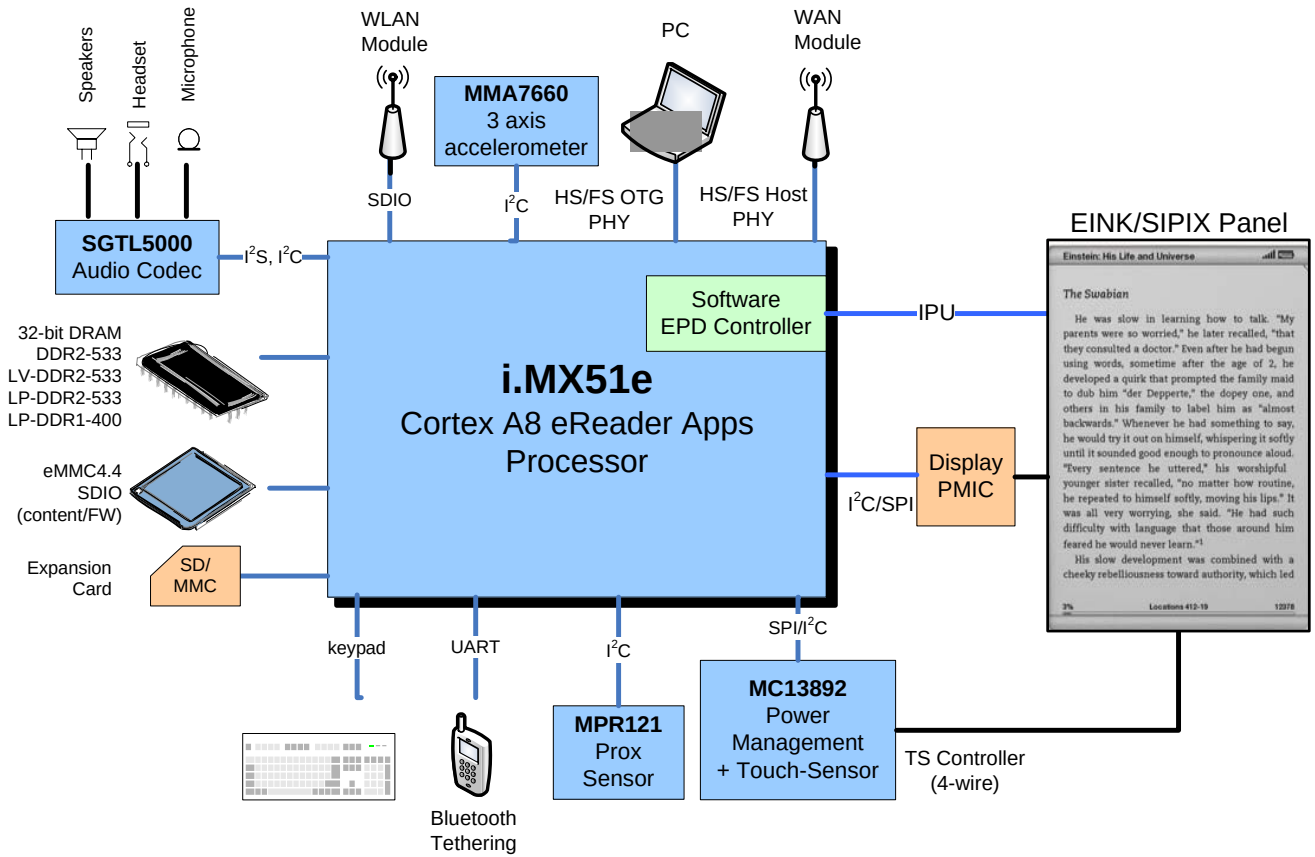
i.MX51e eReader Solution



- **Advantages**:
  - External EPD controller, DRAM, and associated flash not required
  - Cortex A8 decode performance
  - Scalable to i.MX508 or media centric eReader enabled tablet

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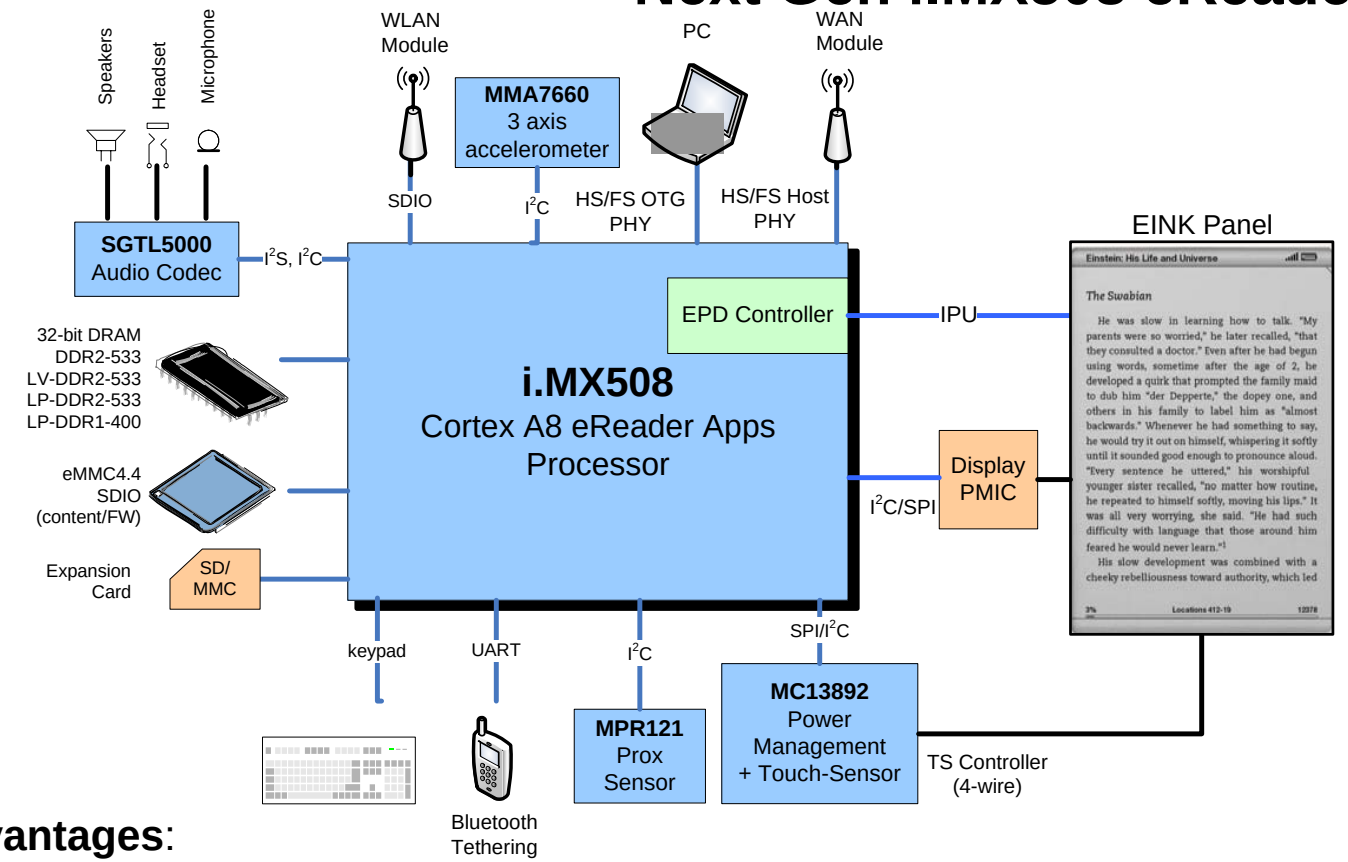
Next Gen i.MX508 eReader Solution



► **Advantages**:

- Best Performance: Cortex-A8 w/ dedicated internal controller
- Best Power: quickest to do work and turn off
- Lowest system cost:
  - No external controller
  - Targeted eReader apps processor with integration to lower system cost

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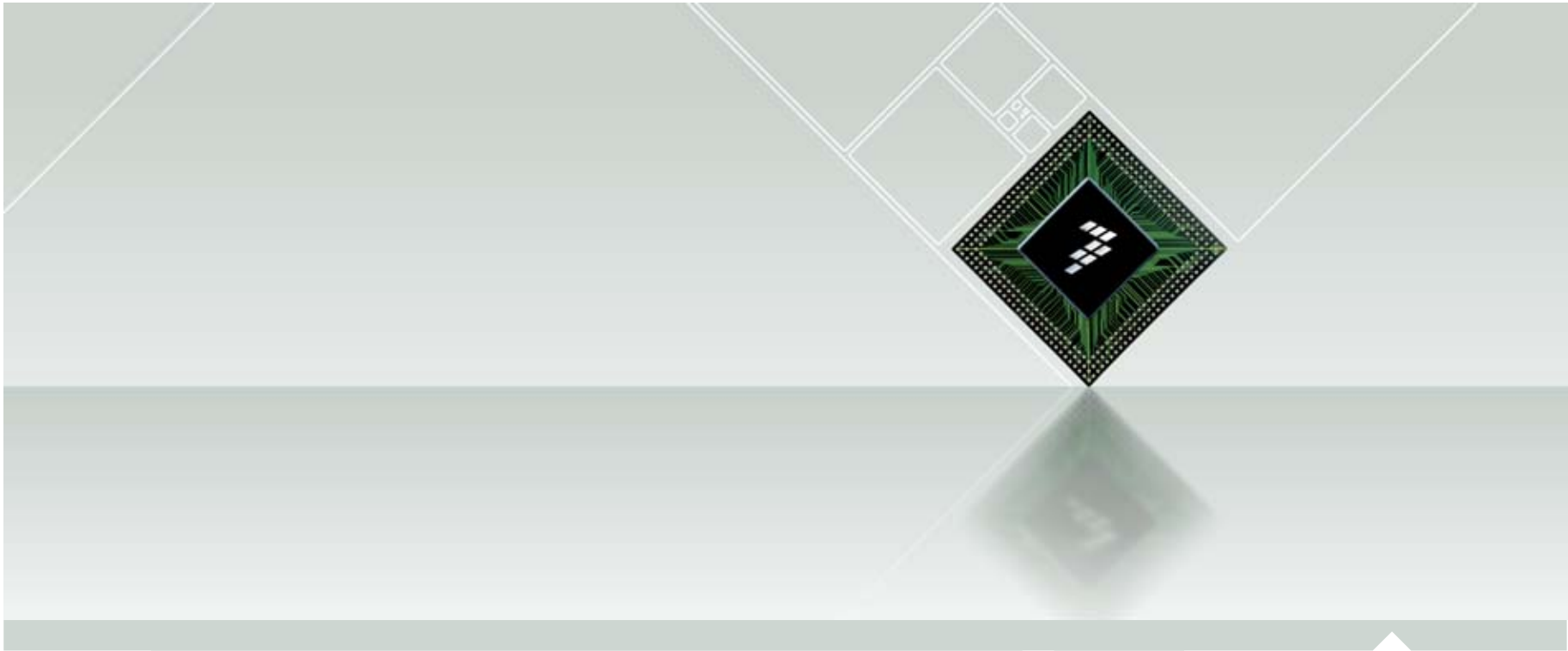

i.MX51e: Soft Controller Reference Design

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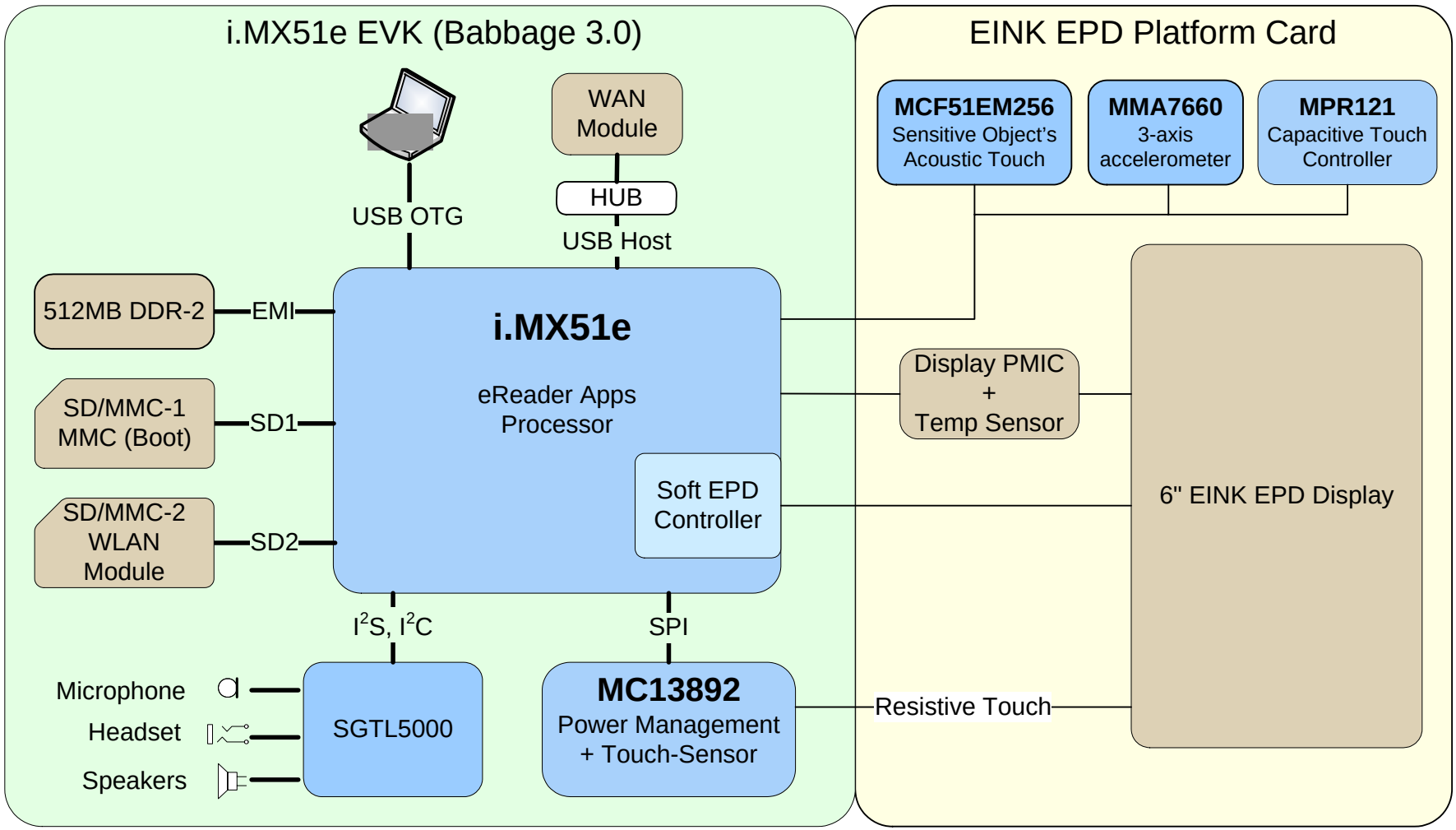
i.MX51e eBook Development Platform



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Soft EPD Overview

- Supported under Linux or Android
- Initial support for 6” panel 800x600 @ 50-Hz.
- Support for 4-bit pixel depth.
- Support for full or partial screen updates.
- Support for concurrent screen updates:
  - Max number of concurrent updates is configurable; Most EINK hardware display controllers support 12 to 16 concurrent updates.
  - A ProcessID will be returned to the caller to track progress of each update.
  - Notification provided when update completes.
- Support for collision detection:
  - Collisions will be detected on a per-pixel basis.
  - All pixels that do not collide will be updated.
  - All pixels that do collide will not be updated.
  - Application will be able to determine which update calls collided and will be responsible for resending the data.
- Support for the 4 update modes:
  - M0 = INIT (3000mS)
  - M1 = DU (320mS) – G->B or G->W (e.g. pen input)
  - M2 = GC16 (980mS) – High-Fidelity (Flashing)
  - M3 = GC4 (600mS) – Used for text (ghosting)

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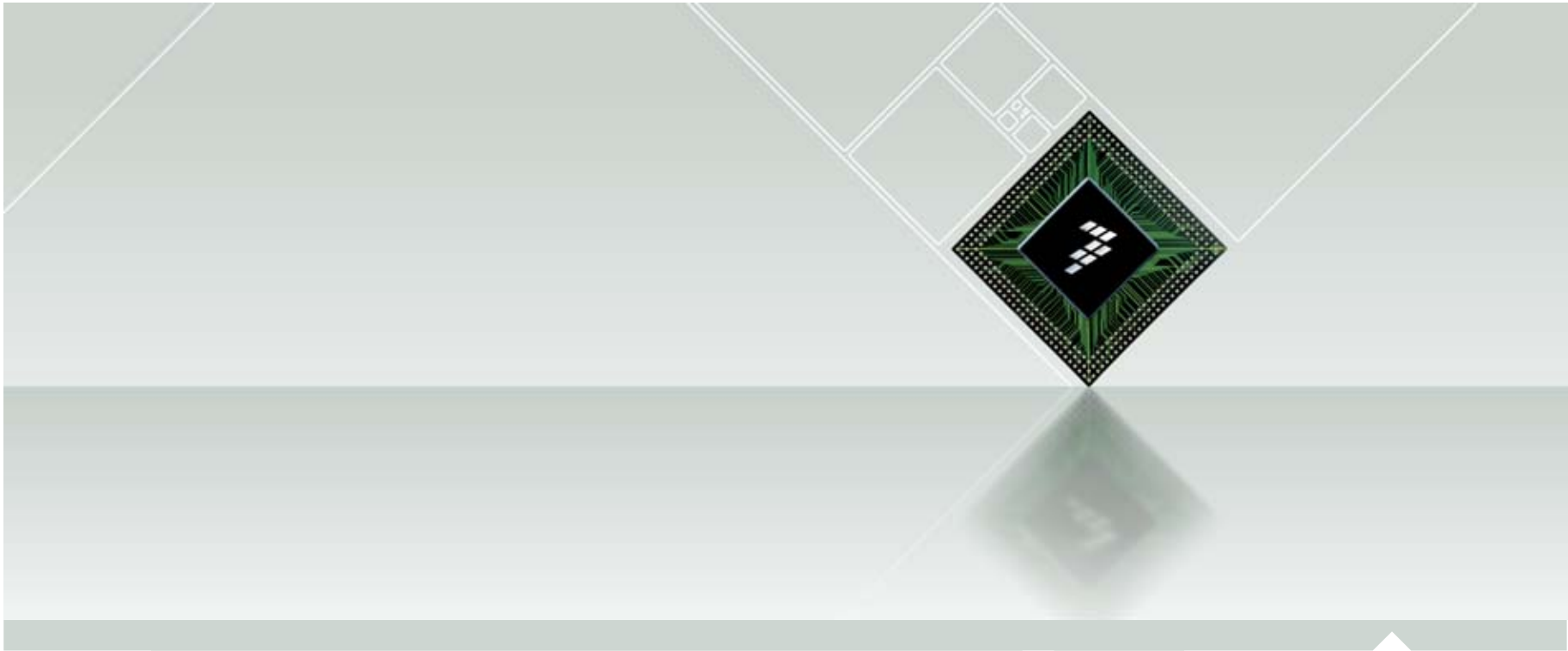

i.MX508

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Introducing the i.MX508 SOC for eReaders

The i.MX508 is the first system-on-a-chip (SOC) to combine the latest ARM Cortex-A8 processing core with the latest, integrated E Ink electronic paper display (EPD) controller

Lower Cost

- **50% less** than a similar processor with a standalone EPD controller, the i.MX508 facilitates new price points
- Other system level cost savings from use of RAW NAND, Dual USB PHY, DDR2 memory, etc.

Extended Battery Life

- Special **power-saving modes** designed for eReaders
- **Low power features** include the use of the new LP-DDR2 memory
- High performance CPU combined with large L2 cache memory reduces the amount of time processor is on, providing more power efficiency

Get Faster Page Flips

- Increased **performance** to flip pages faster
- Capability to drive next generation panels for **improved reading experience**
- Headroom to add new applications and capabilities

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i.MX508 Block Diagram

▶ Specifications:

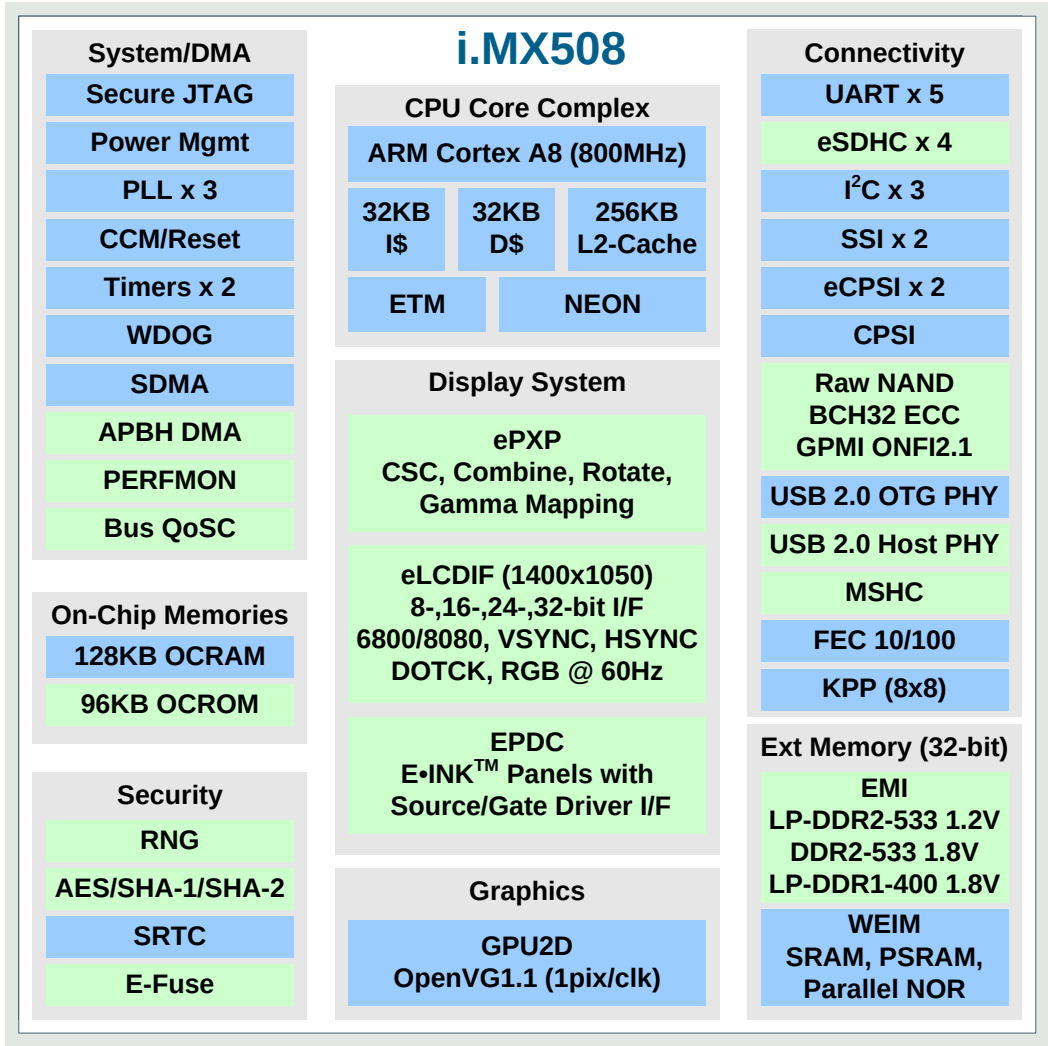
- **CPU:** ARM Cortex-A8 800MHz
- **Process**: 65nm, LP/GP
- **Core Voltage**: 0.7-1.1V
- **Temp Range:** 0 to 70C
- **Package**: 12x12 0.5mm

▶ Features and Advantages

- High Performance CPU : Cortex-A8
- Advanced power management features
- Integrated E-INK EPD Controller
- LP-DDR2 support for low-power applications
- Managed NAND Flash Support with eMMC 4.4/SDIO
- Raw NAND with up to 32-bit ECC and ONFI2.1/Toggle
- Dual USB PHY support (HS OTG, HS Host)
- Flexible LCD display support up to 1400x1050 @ 60Hz

▶ Schedule:

- Samples Q310
- Production Q410



Change from i.MX51x Unmodified from i.MX51x

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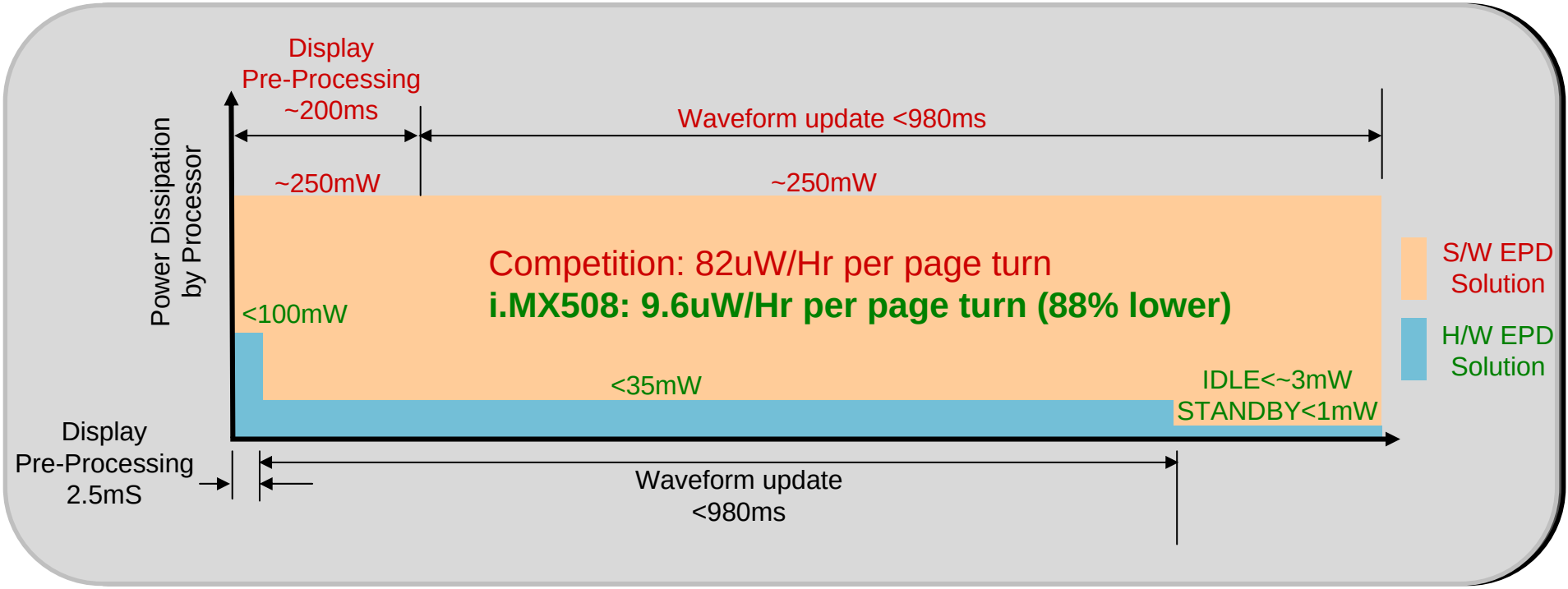
HW EPD: Ultra Low Power Consumption on Page Turn

i.MX508 **accelerates display pre-processing** steps resulting in lower power and lower latency between framebuffer update and final display



Freescale i.MX508 Assumptions:

- 800x600 Display
- GC16 full-screen operation
- i.MX50 running at max 400MHz
- ePXP running at 266MHz
- EPDC bus @ 266MHz with "autoslow" dynamic frequency scaling enabled
- PIXCLK at 17MHz (EPDC TFT I/F)

Competitive Assumptions:

- Cortex-A8 + DSP running at 400MHz
- Power consumption is fixed at 250mW during update as CPU/DSP must drive interface

Common Definitions:

- Power is SOC only for page turn
- Panel will be similar
- DRAM power will be the same for mDDR and will be less for LPDDR2 on i.MX508.
- Display pre-processing is CSC, gamma, rotation and updating working buffer
- 980ms is max time required for waveform GC16

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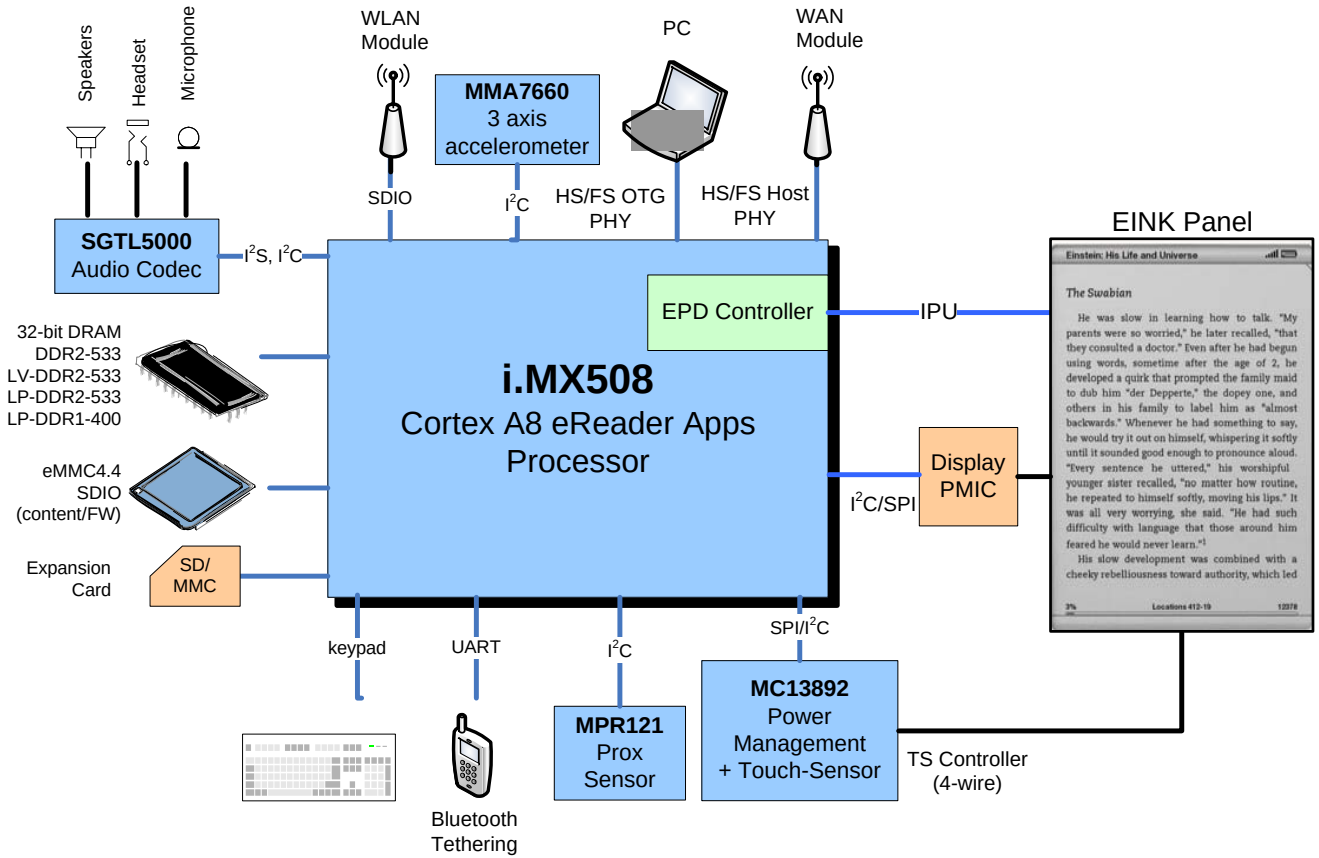
Next Gen i.MX508 eReader Solution

- **Advantages**:
- Best Performance: Cortex-A8 with dedicated Internal controller
- Best Power: quickest to do work and turn off
- Lowest system cost:
  - No external controller (EPDC) or EPDC memory
  - Targeted eReader apps processor with integration to lower system cost



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OS Support

- Windows® Embedded CE

- Linux®

- Android™

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Summary

- eReader System Development
  - The display adds challenges to both hardware and software
  - Outside display, very similar to a smartphone from a HW perspective

- Freescale has SW EPD controller solution available today or next gen HW solution in mid Q3

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For Further Information

- www.freescale.com/imx508
- www.freescale.com/eReaders
- www.smartmobiledevices.wordpress.com

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Session Closing

By now, you should be able to:

- Understand the Freescale eReader processor roadmap
- Briefly understand EPD technology
- Recognize different Freescale solutions for different eReader Types

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