



The Future of Wireless Flash

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Topics of Discussion

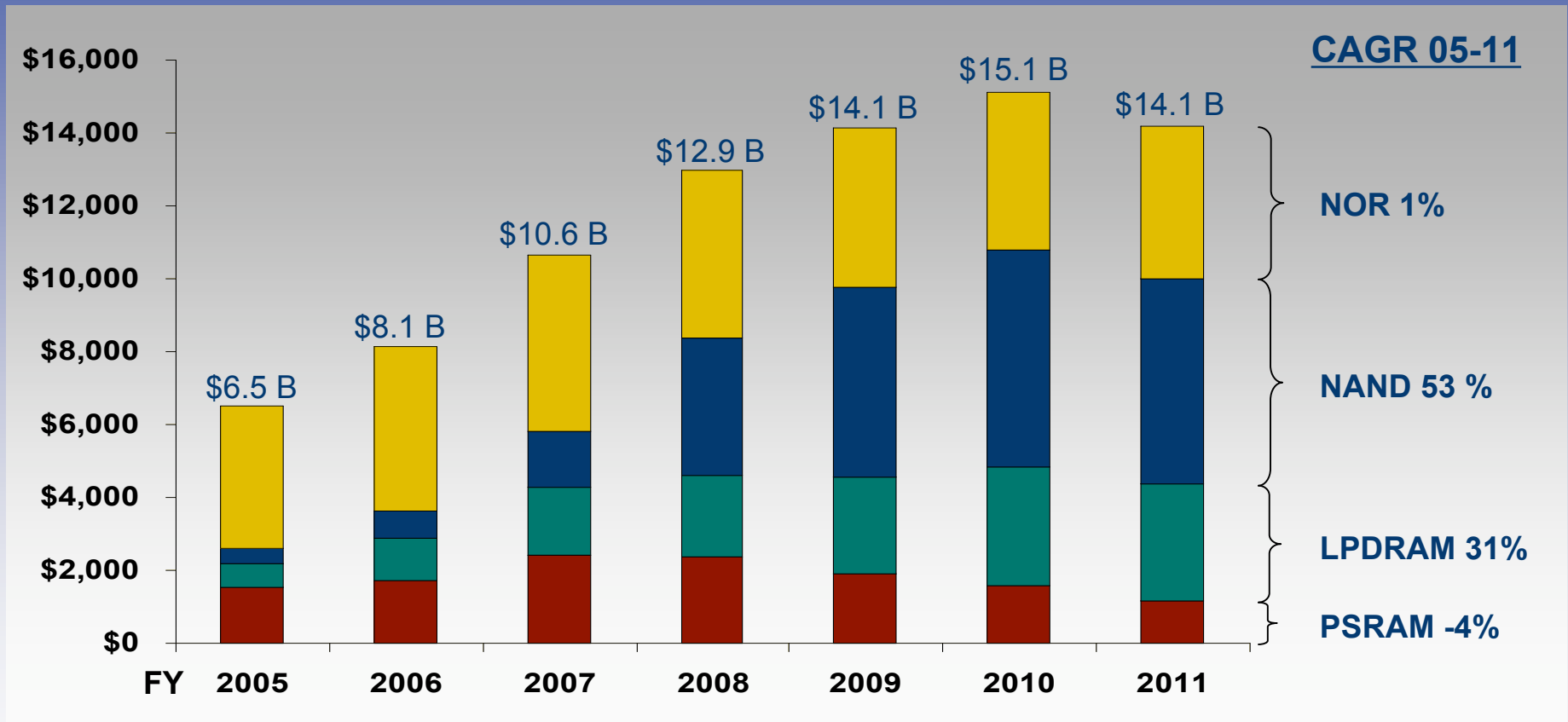
- **Mobile Market Evolution**
- **Flash Memory Solutions for Cell Phones**
- **Managed NAND**
- **Summary**



Mobile Market Evolution

Mobile Segment Growth

Mobile Memory Market
(Millions of US\$)



Source: MU MKTG

- The mobile segment shows strong growth over the next 5 years

Mobile Handset Market Segmentation

Basic



- Voice
- Prepaid/consumer
- Phonebook
- Polyphone ringer
- SMS/MMS

Feature



- Java support
- Downloadable games
- MMS
- WAP/XML browser
- Built-in camera
- Still picture
- MP3 download and replay
- Bluetooth

Smart



- 1.3–2-megapixel camera
- Video and audio streaming
- MPEG4 playback
- Interactive games
- Digital TV

High-End



- Organizer OS
- Digital TV
- Office applications
- Wireless sync to PC
- Video and audio streaming
- Navigation services
- 5–7-megapixel camera

2G (GSM)
14.4 Kb/s

2.5G (GPRS)
115 Kb/s

2.75G (EDGE)
384 Kb/s

3G (UMTS)
1.2 Mb/s

3.5G (HSDPA)
10 Mb/s

Bandwidth Requirements

Min 20MB/s

Min 60MB/s

Min 80MB/s

Min 200MB/s

Min 500MB/s

Application Drivers and Key Factors

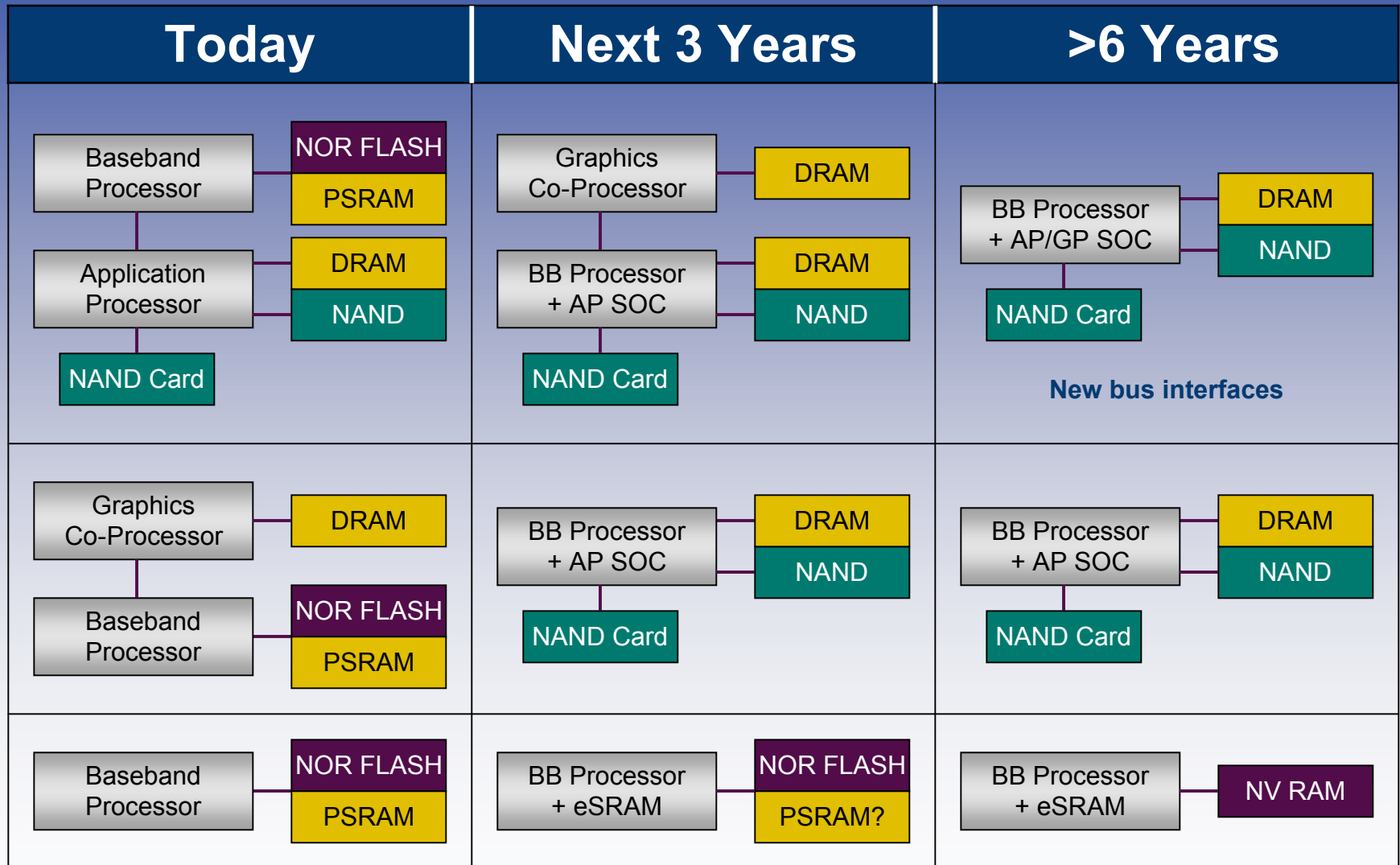
- **Multimedia, video, mobile DTV, Navigation, Networking**
 - ▶ **Memory density (application and storage)**
 - ▶ **Memory bandwidth and bus interfaces**
 - ▶ **Power consumption**
- **Form factor and BOM cost**
 - ▶ **Multichip packages (MCPs)**
 - ▶ **Unified memory subsystems**
- **Time to market**
 - ▶ **SW support**
 - ▶ **Standards**



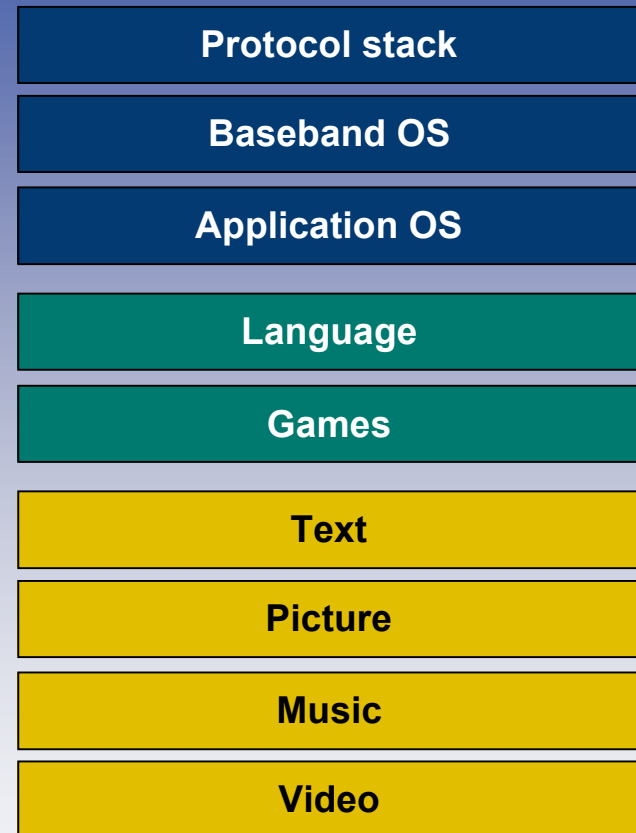
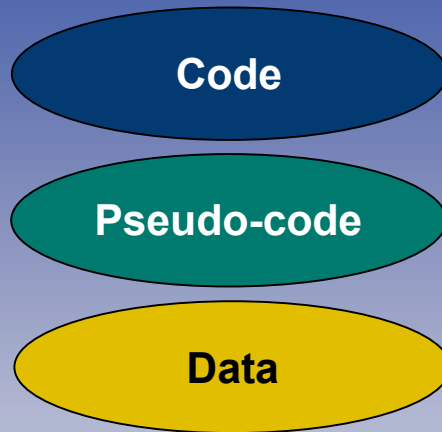
Flash Memory Solutions for Cell Phones

Mobile Handset Architecture Trends

High End
 Smart
 Feature
 Basic



Flash Memory Usage in Cell Phones



- NOR memory has always been used to store and execute (XIP) code
- NAND has typically been used to store data (memory cards)
- As memory density needs increase, NAND is being used as code/data storage device with NOR I/F (XIP) or raw NAND I/F (shadowing in LP DRAM) to keep the cost down

Flash Memory Usage in High-End Phones

Factor driving bit consumption	Total Mb
GSM protocol stack code	13-14
GSM/GPRS protocol stack code	40-48
GSM/GPRS/EDGE protocol stack code	90-96
UMTS protocol stack code	128-192
Baseband OS code	4-6
WAP (WEB support)	4
JAVA runtime environments	1-2
Phonebook (500 full contacts)	4
MSGs	2-4
Backgrounds	1-2
Calendar	1
100 x Polyphonic sounds (MIDI-WAW)	1
10 x MPEG3 sound	10
Languages	4-8

Factor driving bit consumption	Total Mb
Applications OS	256-1000
10 x 2D game	1-2
10 x 3D game	10-15
Bluetooth code	4-8
Up to 120 MP3 songs	2000
50 picture 3.0MPx (JPEG 90%)	396
50 picture 4.0MPx (JPEG 90%)	480
50 picture 5.0MPx (JPEG 90%)	600
50 x 30 sec video clip VGA (MPEG)	250

- Low end memory needs are dictated more by the protocol stack
- High-end cell phone memory needs are driven by multimedia applications and data storage
- Current Flash memory needs on mid- to high-end cell phones is 1-8Gb

Future High-End Phones

- **Play realistic games with 3D acceleration**
- **Store large volumes of MP3s and MPEG video**
- **Act as a media storage device, enabling transfer of music and video to PCs, car, and home entertainment**
- **Watch digital television real time over the air or through the network**

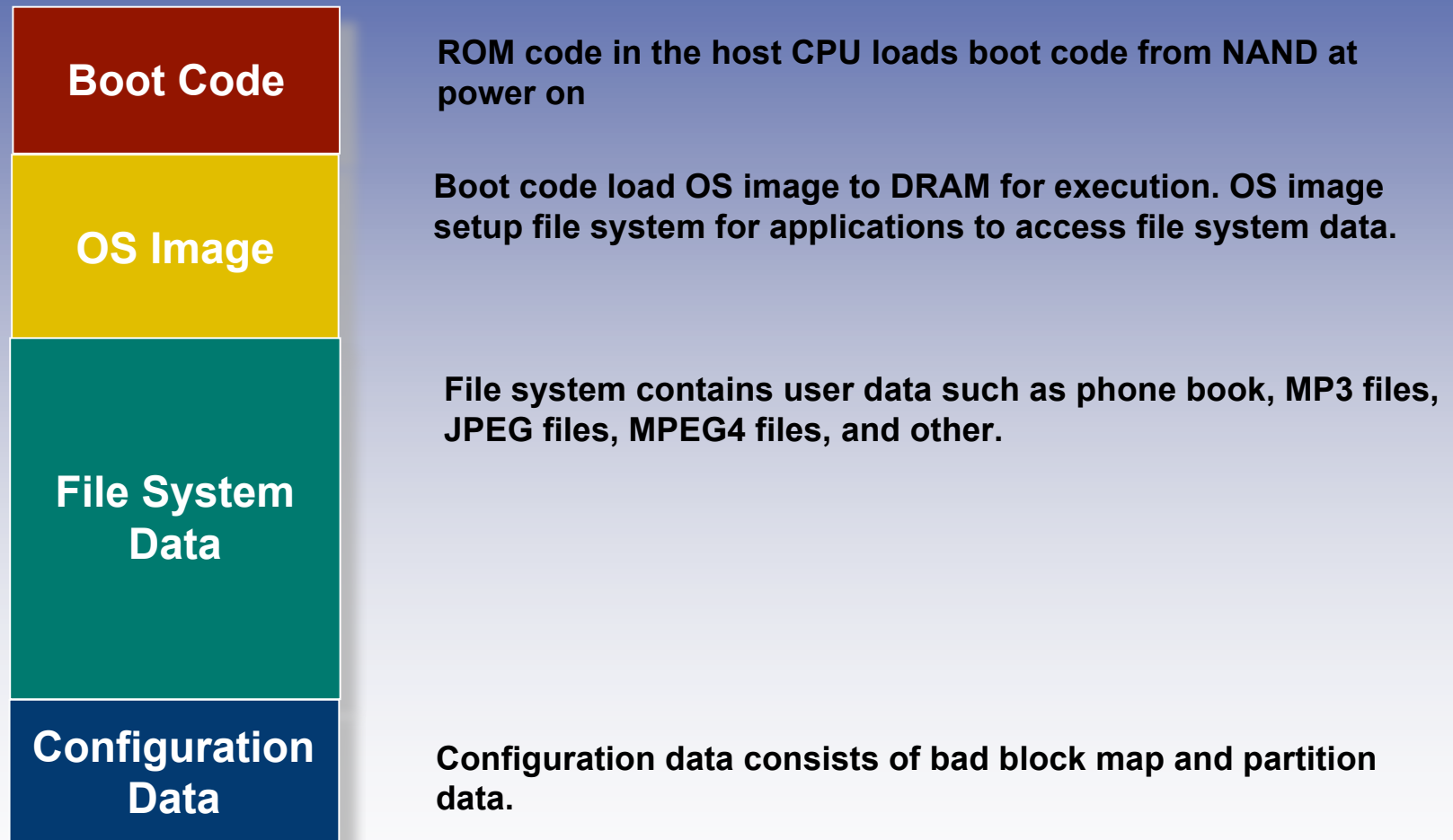
Cell Phone Design Concerns

- **Low cost/high density**
 - ▶ **NAND Flash is the answer**
- **Real estate**
 - ▶ **Multiple functionality/device integration**
 - **LP DRAM/NAND MCP**
- **Multiple sources**
 - ▶ **Need to support different Flash memory solutions for more flexibility**
 - ▶ **Unified NAND Flash standard would be desirable**

Cell Phone Design Concerns

- **Time to market: limited SW integration efforts**
 - **Easy transition from legacy systems (NOR I/F support)**
 - **Accommodate different vendor IDs and features for the same type of device**
 - **Accommodate different Flash memory technologies**
 - **SLC vs. MLC**
 - **MLC support is very complex due to ECC**
 - **Support boot capabilities**
 - **Accommodate different Flash Memory solutions**

Common NAND Flash Storage Use Case

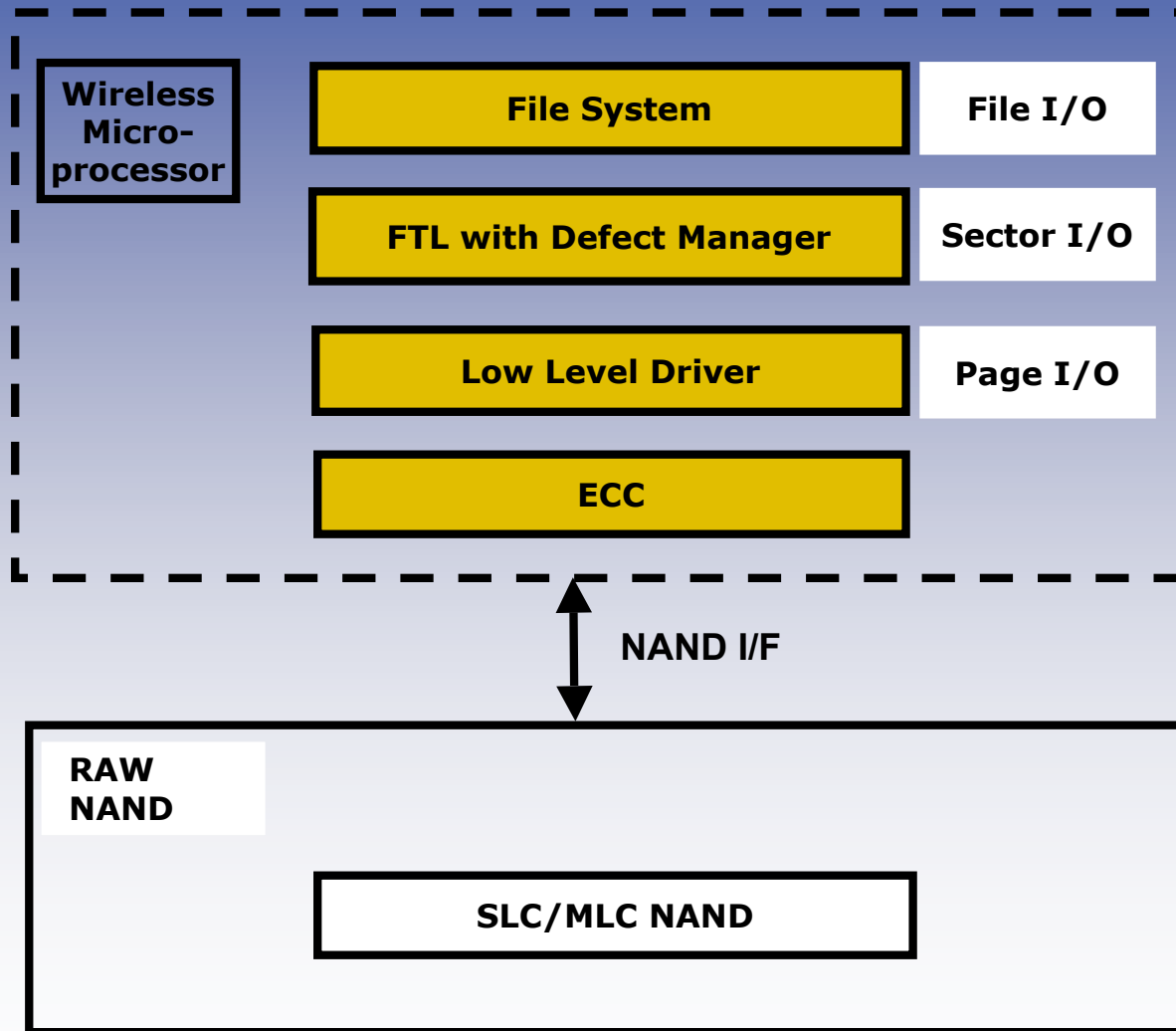




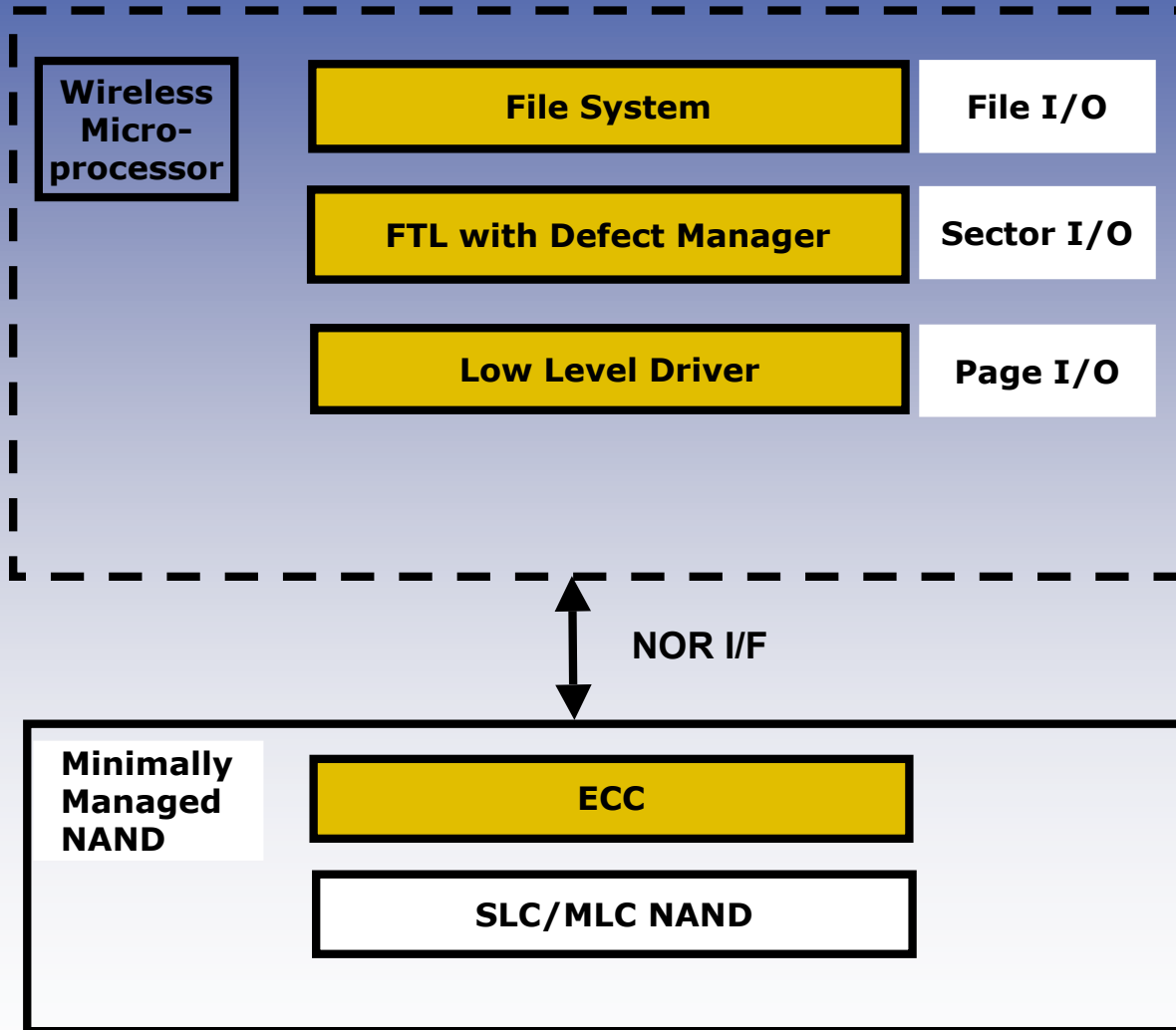
Wireless Flash Memory Solutions

- **Raw NAND**
 - ▶ Host needs to handle PROGRAM/ERASE/READ operation, bad bits, bad blocks
- **Minimally Managed NAND**
 - ▶ Solution based on Raw NAND
 - ▶ Embedded ECC
 - ▶ Host needs to handle PROGRAM/ERASE/READ operation and bad blocks
- **Embedded Flash Drives**
 - ▶ Solution based on Raw NAND
 - ▶ Embedded Flash controller (ECC and Flash management)
 - ▶ Host handles WRITE/READ operations

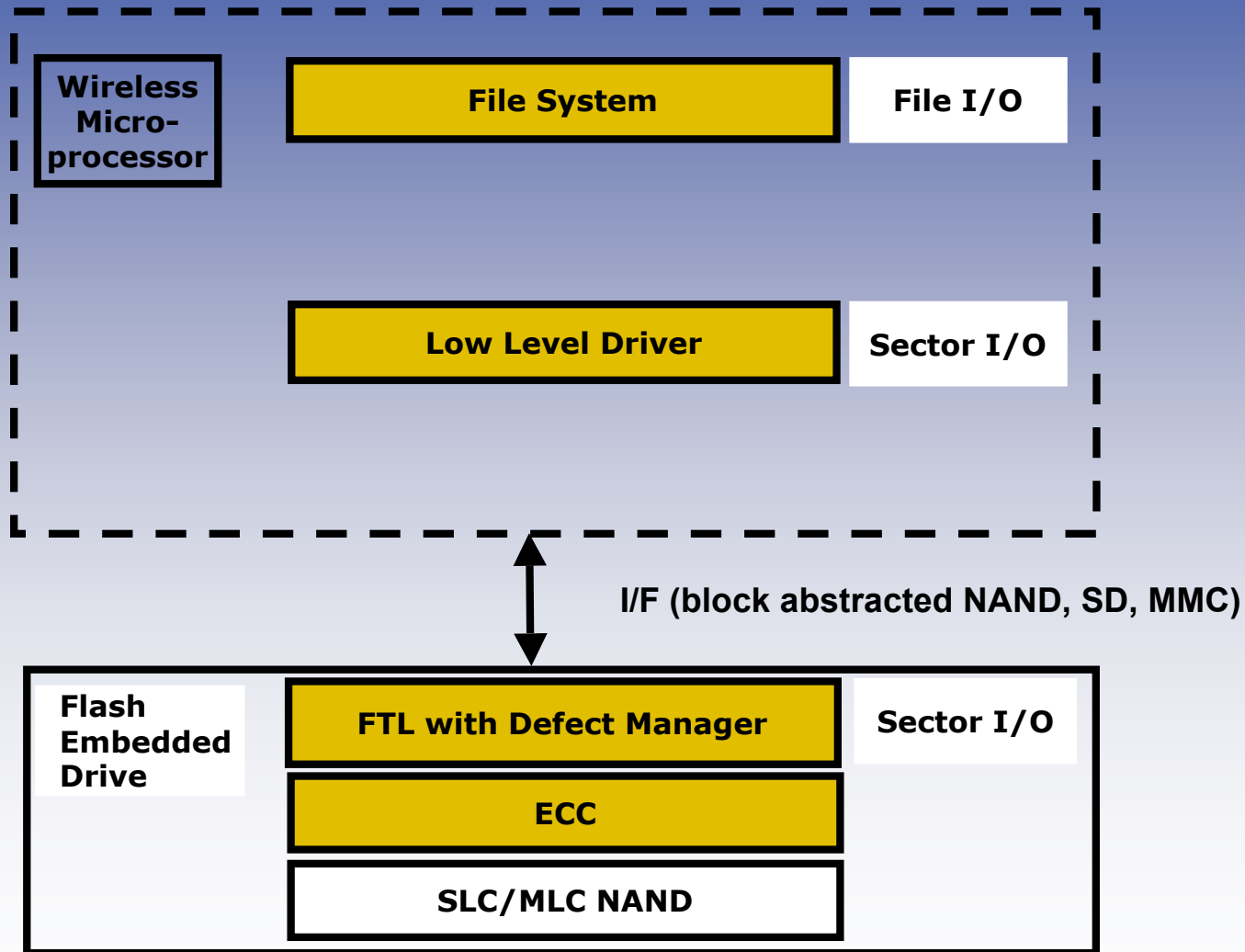
Wireless Flash Memory Solution – Raw NAND



Wireless Flash Memory Solution – Minimally Managed NAND



Wireless Flash Memory Solution – Flash Embedded Drive



Wireless Flash Memory Solution Pros and Cons

	Technology Independent	Royalty Free	JEDEC Standard	Major OEM Commitment
iNAND (SD)	Yes	No	No	?
MMC BGA	Yes	Yes	Yes	Yes
MDOC H3	Yes	No	No	?
Raw NAND	No	Yes	ONFI	Yes
OneNAND	No	No	No	Yes
MDOC H1	No	No	No	Yes

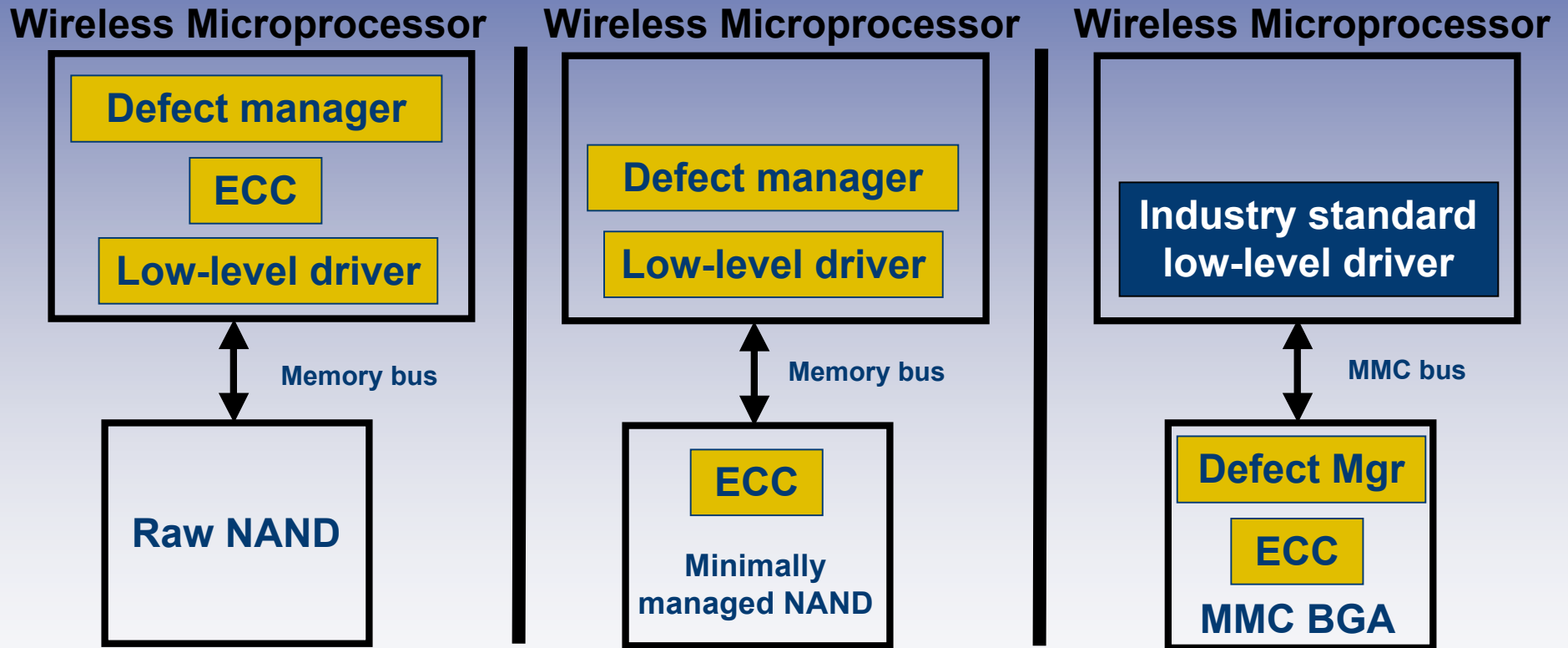
- **MMC I/F is the clear choice**
- **JEDEC standardization has begun for MMC and LPDRAM in BGA**



Micron's Managed NAND Solution

Interface Comparison

- MMC BGA hides all NAND technology details behind a high-level interface

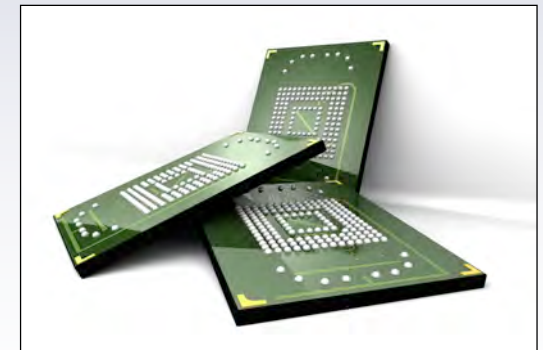
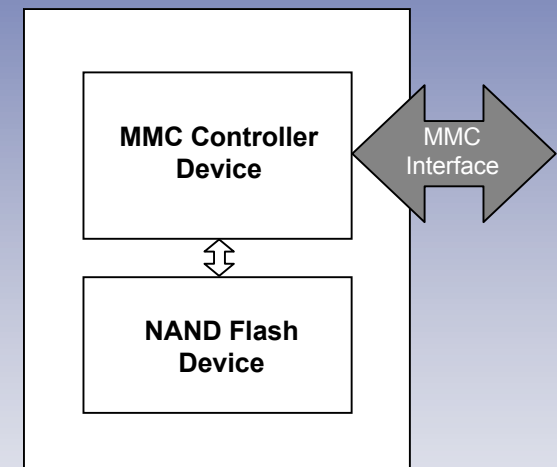


Technology and vendor dependent
 Technology and vendor independent

Micron “Managed NAND”

Managed NAND addresses the increased complexities of future MLC

- ▶ Integrates easily for faster development and time-to-market
- ▶ Provides a higher level of ECC and block management, yielding higher reliability
- ▶ Provides a consistent and standard MMC interface
 - Compliant with MMC system specification
 - Every mobile processor has an MMC I/F
- ▶ Bootable, requires only processor boot ROM (no NOR required)
- ▶ Same interface for various densities and technologies
- ▶ Password protection, permanent and temporary write protect
- ▶ 52 MHz clock speed (MAX), 416 Mb/s data rate (MAX)
- ▶ 12 x 16 x 1.3mm BGA package



Proposed New MMC BGA Features

Under Discussion at JEDEC (JC-64)

- **MMC 5.0 Specification**
- **Faster speed interface**
 - ▶ **Clock up to 104MHz**
 - ▶ **DDR signaling**
 - ▶ **Combined would provide 200MB/s**
- **Improved boot-up support**
 - ▶ **Boot code protection**
 - ▶ **Faster boot code procedure**
- **Multiple devices on a bus**
- **Programmable I/O**
- **Block lock**
- **Sleep mode**

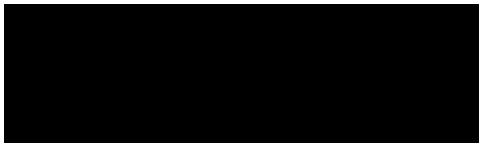


NAND Component Standardization Efforts

Open NAND Flash Interface (ONFI) Initiative

- Industry leaders formed ONFI initiative to define uniform NAND Flash component interface
- Avoids design pre-association with specific NAND devices to accelerate product cycles
- Reduces design/validation effort required to qualify/integrate new NAND Flash designs
- Provides consistency in existing NAND behavior, yet also allows innovation for new features

ONFI Promoters



SONY



hynix
Semiconductor

PHISON
Knows What You Need

**Other brands and names are the property of their respective owners.*

ONFI Goals

- **Develop a standardized NAND Flash interface that allows interoperability between NAND devices and hosts**
- **Accelerate time to market of NAND Flash-based products**

ONFI Participants

- ONFI seeks contributors from a variety of sources within the NAND Flash memory industry, including:
 - ▶ Host designers
 - ▶ Memory vendors
 - ▶ OEMs
- Goal: enable adoption of NAND Flash into existing and new markets

ONFI Contributors

•Cypress

•Data I/O

•Denali

•InComm

•Intelliprop

•Marvell

•Skymedi

•Spansion

ONFI Benefits

- **Standardization of:**
 - ▶ **Self-identification of device capabilities**
 - ▶ **Command set/protocol**
 - ▶ **Memory organization**
 - ▶ **Array addressing**
 - ▶ **Timing parameters**
 - ▶ **Electrical interface**
 - ▶ **Package pin definitions**

Summary

- **Low-end phones will continue using NOR Flash and PSRAM with XIP for optimal power consumption, performance, and cost**
- **Memory card support will expand to fulfill data storage for memory-hungry multimedia applications**
- **NOR I/F is no longer a must for new wireless processors. The MMC/SD ports available in any mobile system offers the right I/F for a low pin count, standardized, embedded MMC Flash solution**
- **Standardization activities thru ONFI for NAND components and through JEDEC for MMC Managed NAND are underway to ease adoption of NAND in Wireless applications.**
- **Embedded flash drives are being offered in different configurations: Managed NAND only or Managed NAND + LP DRAM for an integrated memory subsystem solution**

