NAND Flash Considerations for Consumer Applications

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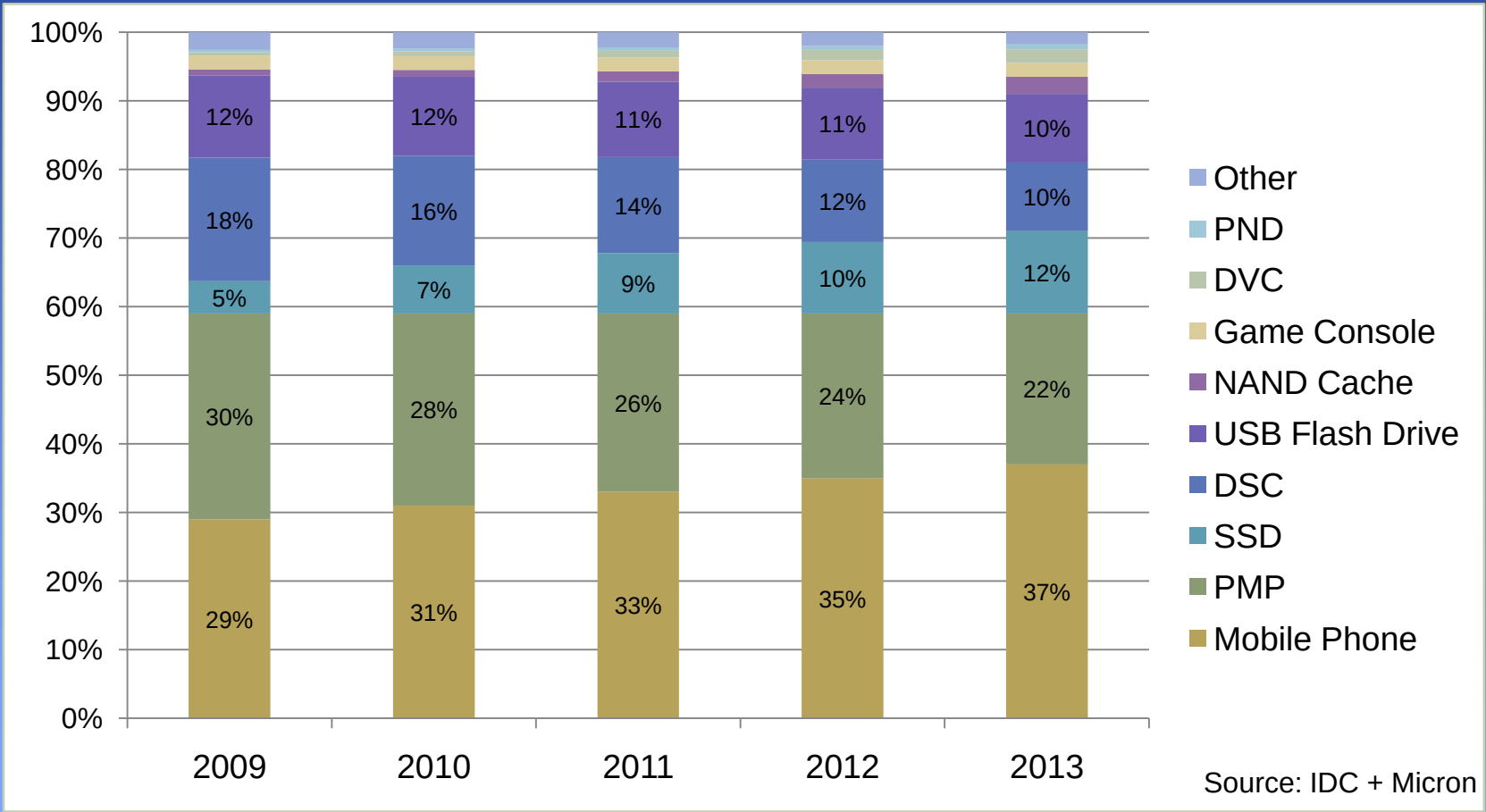
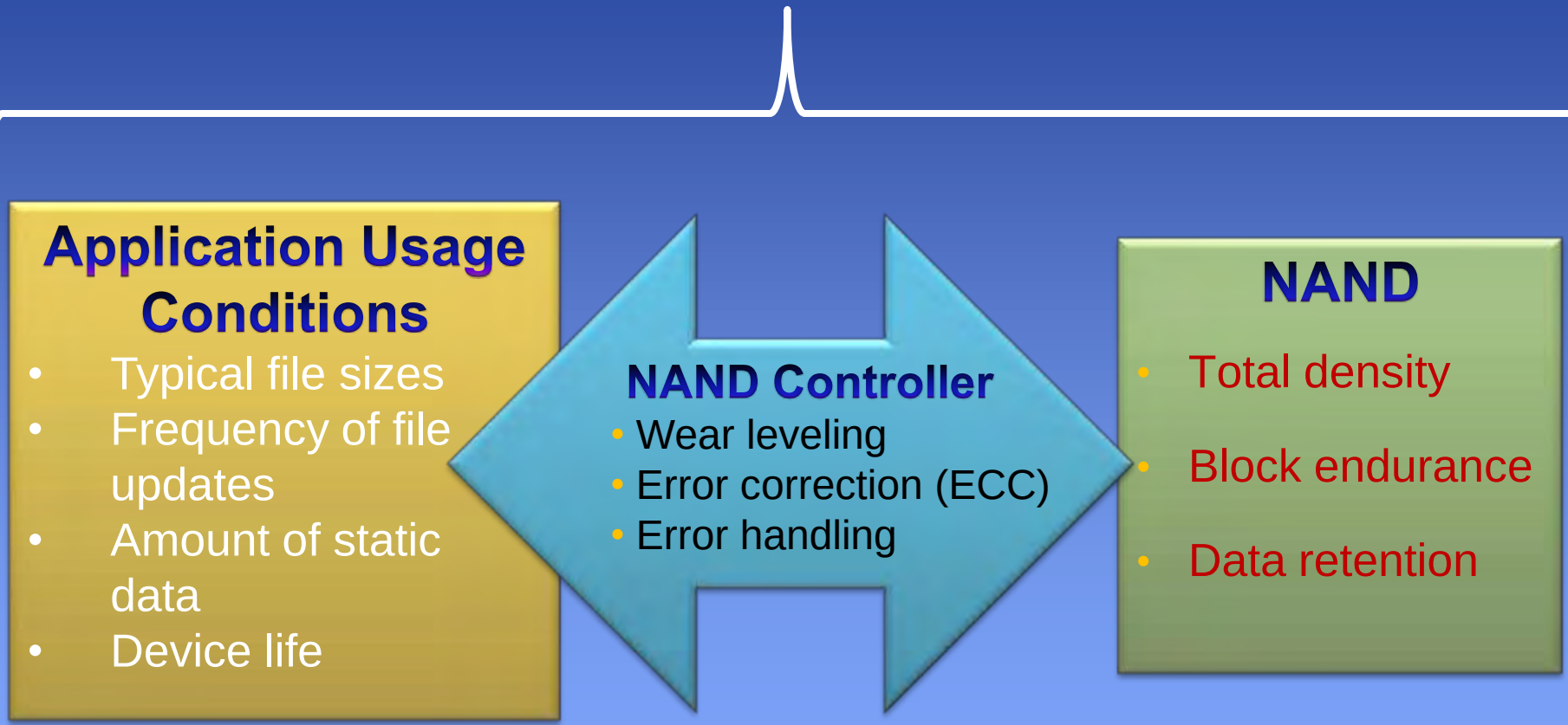
Agenda

- NAND in Consumer Applications
- Overall System Reliability
- NAND Requirements
- MP3/PMP Example
- Summary

NAND Bit Share by Application



Overall System Reliability



…NAND Plays a Limited Role

System Reliability: Application Usage Conditions

- *How* the system is used significantly impacts overall system reliability
- Primary contributor is frequency of file updates (workload)
  - Heavier workload requires more NAND endurance
- File sizes, required device life, amount of static data also contribute
- Consider *worst-case* usage

System Reliability: NAND Controller Factors

- Wear leveling
  - Improves device life
  - Reduces NAND endurance requirements
  - Static wear leveling is typically most effective (though rarely used!)
- Error correction code (ECC)
  - Reduces uncorrectable bit error rate
- Error handling
  - Bit errors should not result in system-level fails

System Reliability: NAND Flash

- NAND is adapting to meet application requirements
- Many consumer applications accept:
  - Low endurance
  - Consumer-level reliability
  - Moderate data retention
- What are adequate NAND requirements for consumer applications?

NAND in Consumer Apps

- Application requirements should *match* consumer expectations
- NAND controller provides the link
  - Allows lowest-cost NAND to be used in consumer applications
  - Compensates for reduced NAND capability
- Determine actual NAND requirements

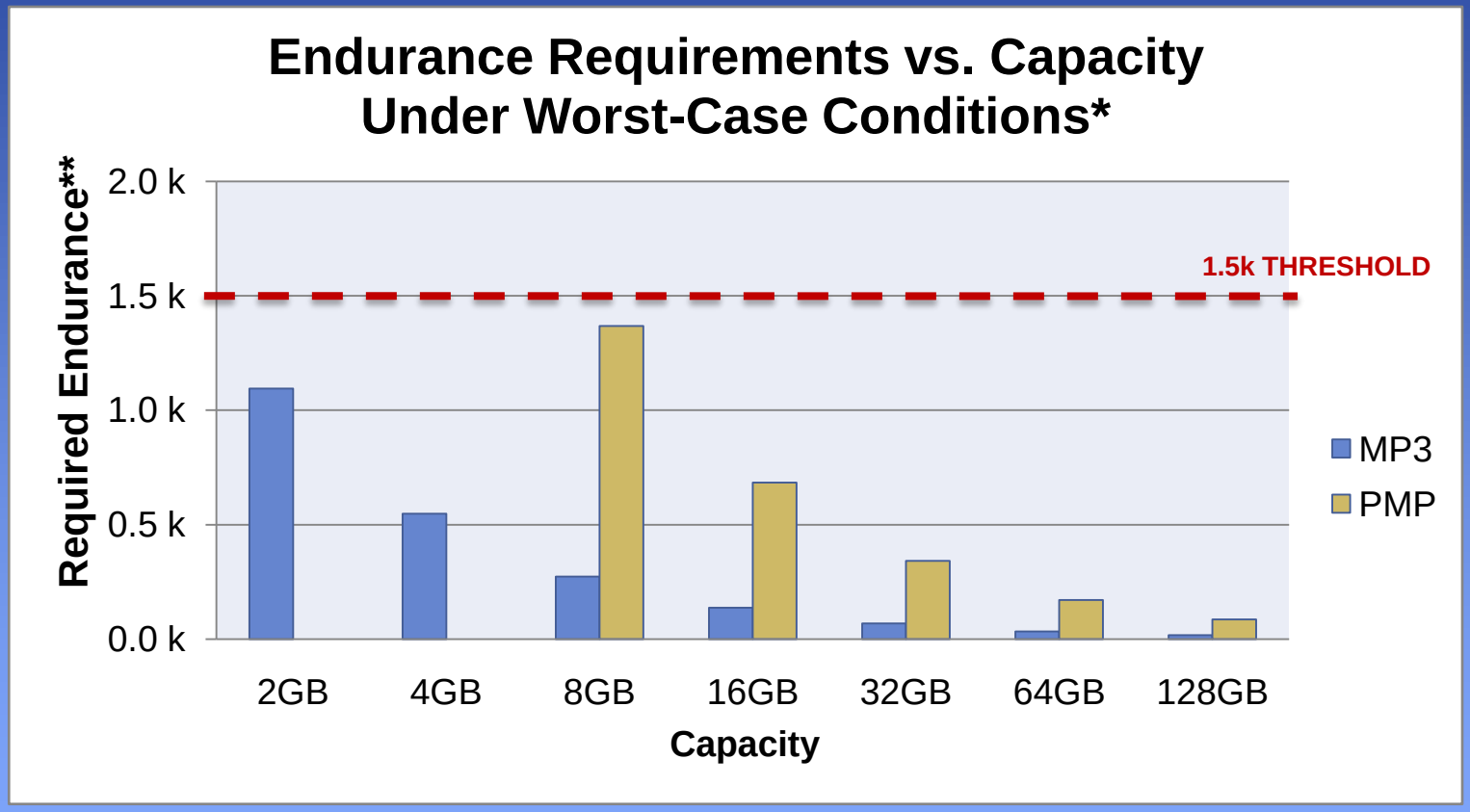
Consumer Application Example:
MP3/PMP Worst-Case Usage Condition

- 90% Static Data
  - Small amount of “free” capacity
- Dynamic Wear Leveling
  - Only “free” capacity is included in wear leveling
- “Very Heavy” daily workload
  - MP3: end user updates 30 songs (~2CDs) per day for 5 years
  - PMP: end user updates 35 songs per day + 7 movies per month for 5 years

MP3/PMP NAND Endurance

	Usage scenario (Static Data + Dynamic Data)	Capacity	Life	Daily workload (Dynamic Data: user data + FAT, etc.)	Required Endurance (with worst-case wear leveling)
MP3	**Static (90%):** 3.6GB (~950 songs, 4MB/song) **+** **Dynamic (10%):** 20/60/120 MB per day	4GB	5 year	20MB (moderate usage, 5 songs per day)	**91 cycles**
				60MB (heavy usage, 15 songs per day)	**274 cycles**
				120MB (very heavy usage, 30 songs per day)	**548 cycles**
PMP	**Static (90%):** 7.2GB (~500 songs, 4MB/song + 2 movies, 2GB/movie) **+** **Dynamic (10%):** 100/300/600 MB per day	8GB	5 year	100MB (moderate usage, 9 songs per day + 1 movie per month)	**228 cycles**
				300MB (heavy usage, 25 songs per day + 3 movies per month)	**684 cycles**
				600MB (very heavy usage, 35 songs per day + 7 movies per month)	**1,369 cycles**

MP3/PMP: Endurance vs. Capacity



* Conditions: 90% Static data, dynamic wear leveling, very heavy workload, 5-year life

** Calculation used: Endurance = (5 years x 365 days/year) ÷ ((Capacity x 10%) ÷Daily workload)

Summary

- Consumer applications drive NAND technology
- Controller helps compensate NAND capabilities
- NAND generally meets or exceeds requirements for consumer applications