

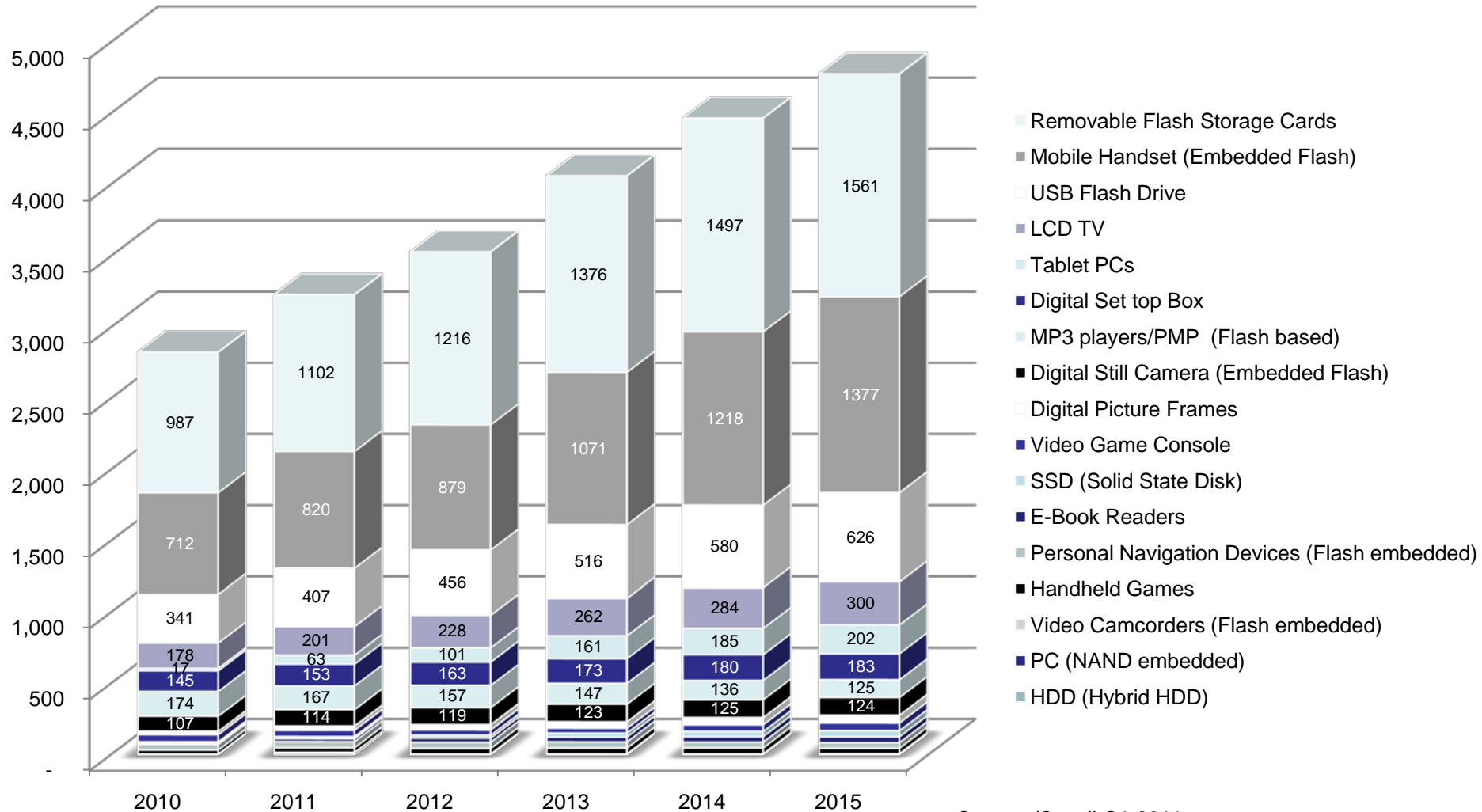


# **NAND Flash Comparisons for Mobile Consumer Products**

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# Number of Units (Millions) by Application



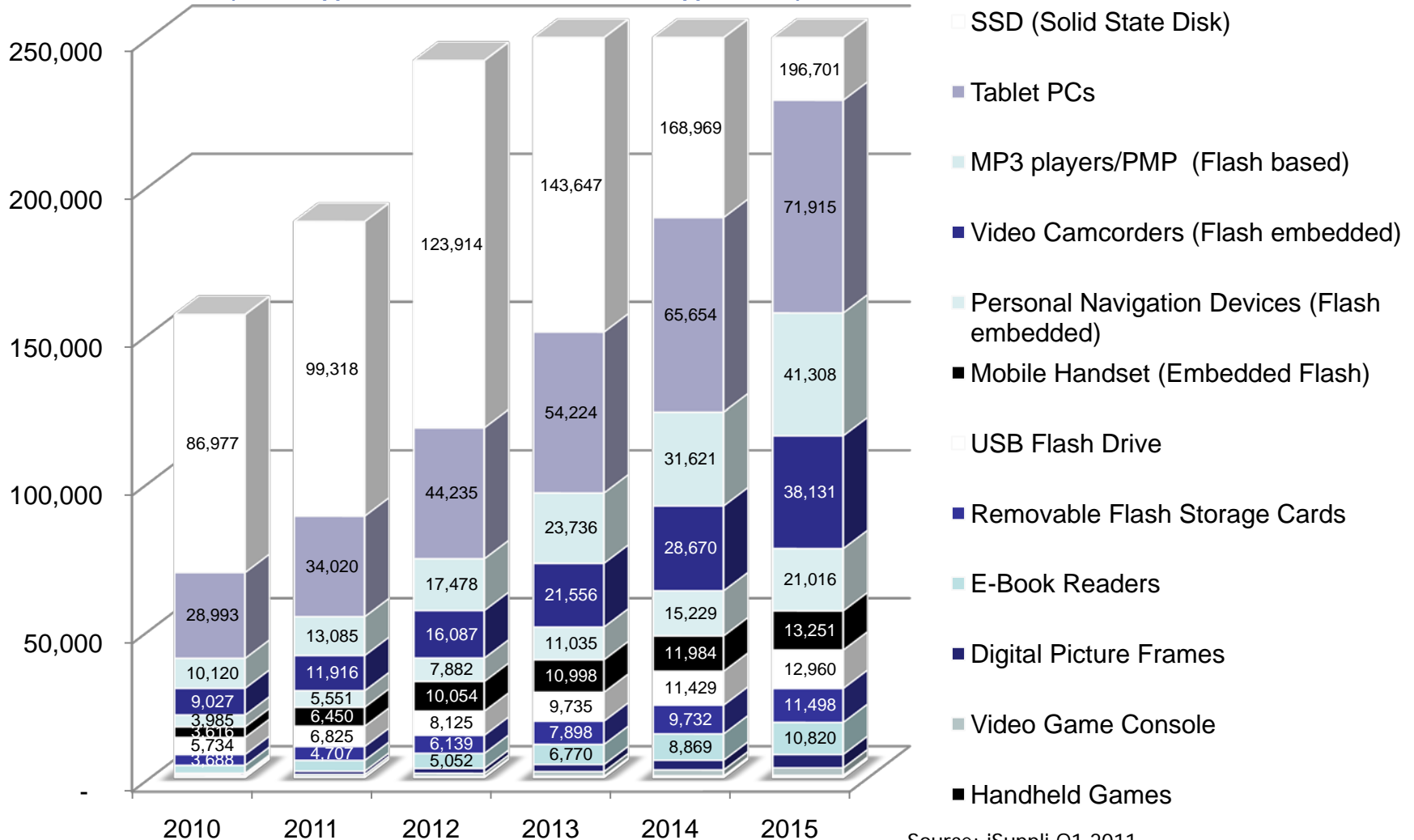
Source: iSuppli Q1 2011

Flash Memory Summit 2011  
Santa Clara, CA



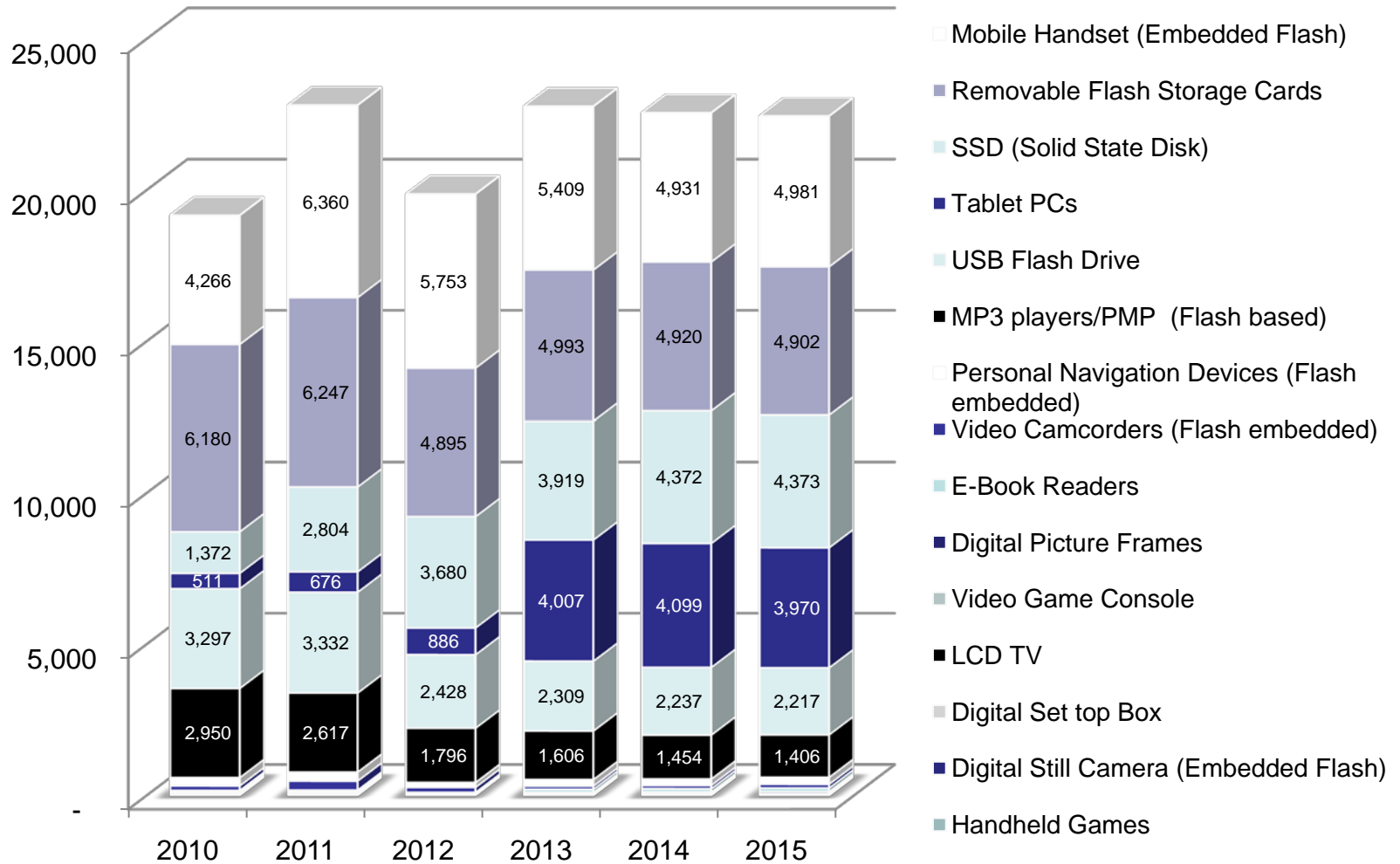
# Megabytes (MB) per Unit by Application

(Chart capped at 250,000 to better show all applications)



Source: iSuppli Q1 2011

# Millions of \$ by Application



Source: iSuppli Q1 2011

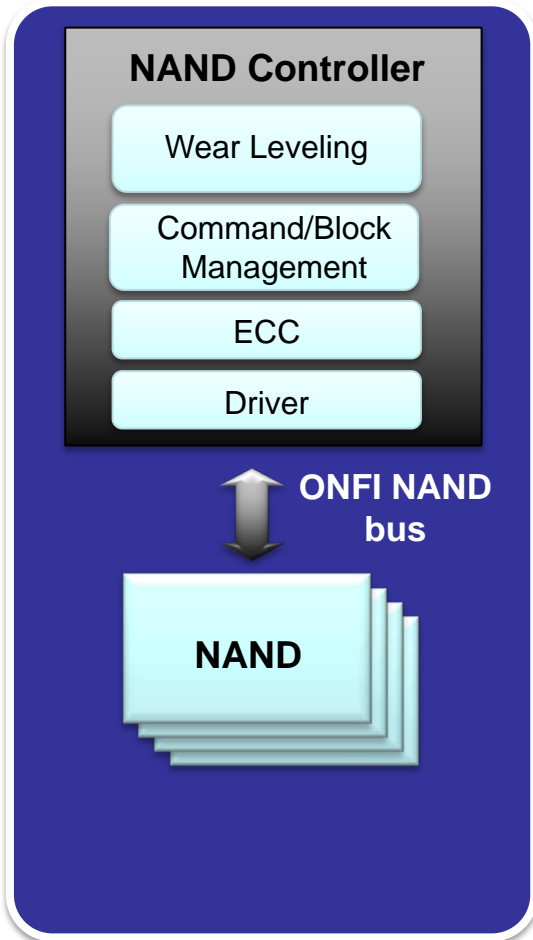


# Most Important Attributes for Mobile Products

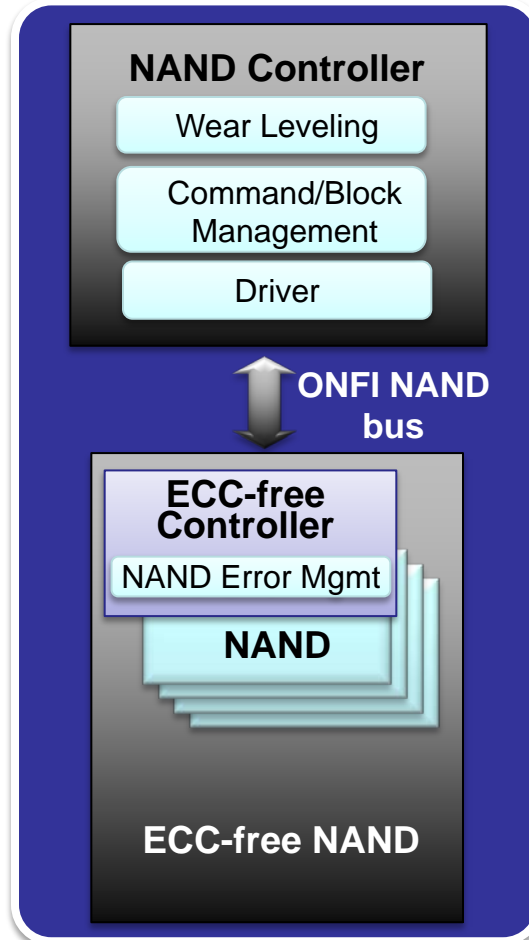
- Performance
- Power
- Price

# High-Level System Comparison

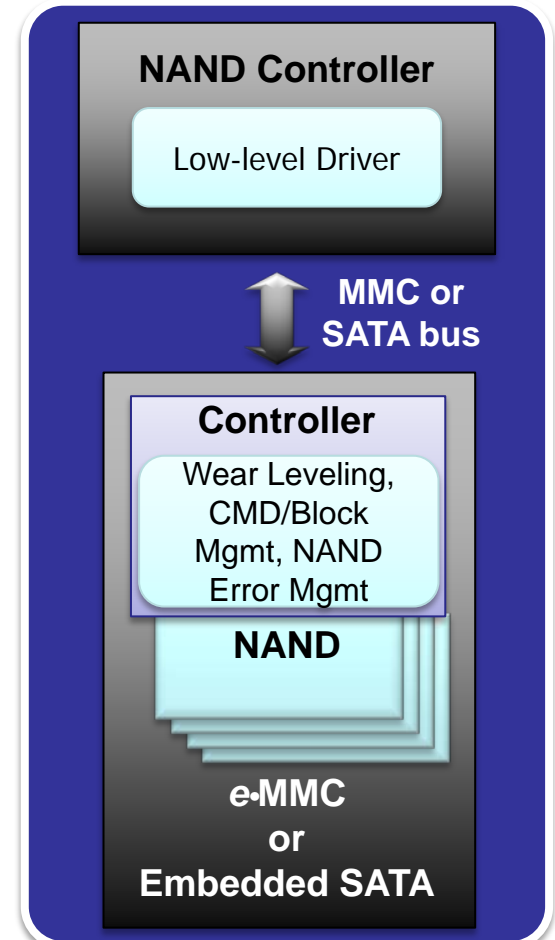
## Raw NAND



## ECC-free NAND



## Fully Managed NAND



# High-Level System Comparison

NVM Solution	Internal NAND Management	Internal Controller Architecture	Protocol	Performance	Power	Notes
Embedded SATA	<ul style="list-style-type: none"> <li>ECC</li> <li>CMD/Block management</li> <li>Error management</li> <li>Wear leveling</li> </ul>	<ul style="list-style-type: none"> <li>32-bit</li> <li>200KB SRAM</li> <li>4 channels</li> </ul>	SATA	★★★★★	★	CMD queuing: <ul style="list-style-type: none"> <li>No LP modes</li> <li>No DRAM</li> </ul>
ECC-free	<ul style="list-style-type: none"> <li>ECC</li> </ul>	<ul style="list-style-type: none"> <li>32-bit</li> <li>Large SRAM</li> <li>1 or 2 channels</li> </ul>	ONFI NAND, EZ-NAND	FTL-optimized ★★★★★	★★★★★	<ul style="list-style-type: none"> <li>CMD queuing</li> <li>Sync I/F</li> </ul>
Raw NAND	None (host required)	N/A	ONFI NAND	FTL-optimized ★★★★★	★★★★★	N/A
eMMC	<ul style="list-style-type: none"> <li>ECC</li> <li>CMD/Block management</li> <li>Error management</li> <li>Wear leveling</li> </ul>	<ul style="list-style-type: none"> <li>8-bit</li> <li>Small SRAM</li> <li>1 or 2 channels</li> </ul>	MMC	★★★	★★★	Usage model optimizations can improve performance

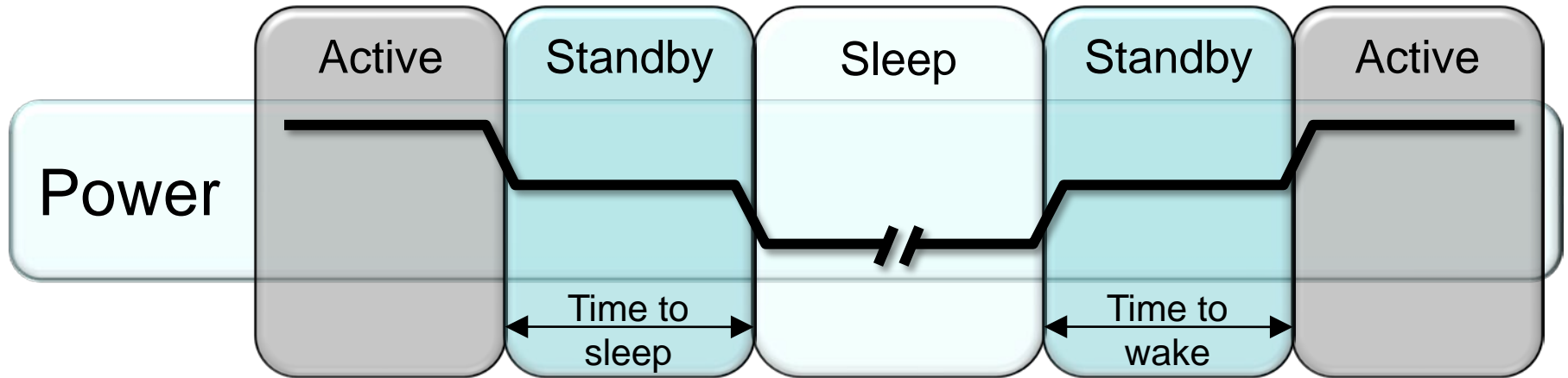


# Nonvolatile (NV) Storage Solution Estimates

Parameter	eMMC	Embedded SATA	ECC-free ClearNAND™ Flash
Sequential READ (MB/s)	60	160	150
Sequential WRITE (MB/s)	40	100	80
Random READ (4K IOPs)	2K–4K	2K–10K	40K
Random WRITE (4K IOPs)	0.2K–0.4K	0.5K–1.0K	3K
Active Power (W)	0.5	1.0	1.0
Standby Power (mW)	30	60	30
Sleep Power (mW)	1	1	1



# NV Power-State Management



	e-MMC	Embedded SATA	ECC-free ClearNAND™ Flash
Active Power (W)	0.5	1.0	1.0
Standby Power (mW)	30	60	30
Sleep Power (mW)	1	1	1
Time to Sleep (μs)	500	500,000	10
Time to Wake (μs)	1000	10,000	10

# Conclusions

- Micron offers a full portfolio of Flash-based storage solutions:
  - e•MMC
  - Raw NAND Flash
  - ClearNAND™ Flash
  - SSDs
  
- ClearNAND Flash provides a compelling combination of solid performance and low power consumption

*Revisit Micron's FMS 2011 presentations at:  
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