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the New Era of Storage

Design challenges in building an Advanced NAND Flash Array controller for 19/20 nm MLC

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Evolution of NAND Flash

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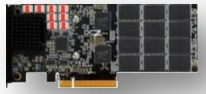
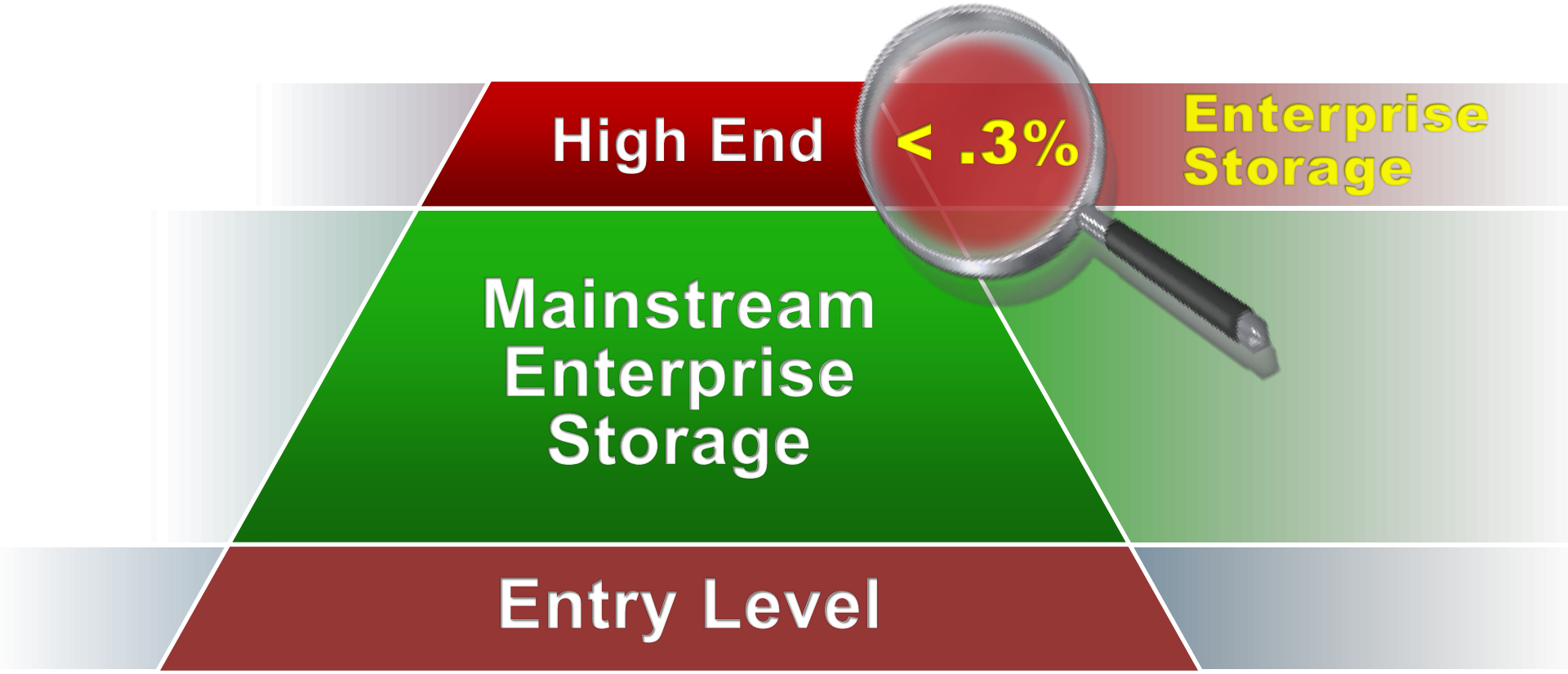
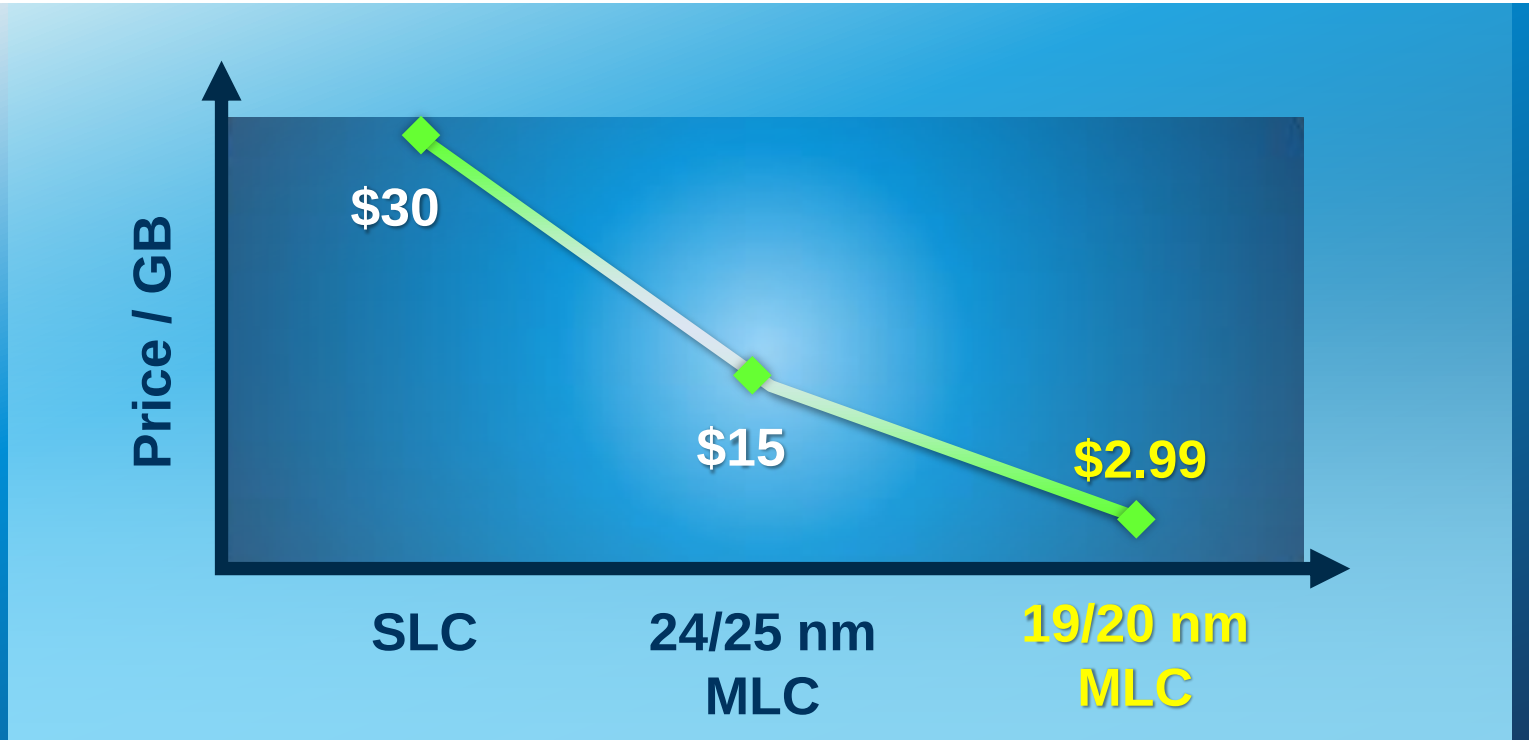


	SSD	Card	Appliance	Primary
Purpose	▪ HDD replacement ▪ Plug and play	▪ Server cache	▪ High performance ▪ Special uses	▪ Shareable ▪ Scalable ▪ Affordable
	▪ Encumbered by HDD protocols	▪ Direct Attached Storage	▪ Doesn't scale ▪ Expensive to manage	▪ Built from ground-up

Enterprise Adoption of Flash is Limited Because of High Cost



The High Cost of Older Technology



Latest Generation Flash Breaks the Cost Barrier

- **19/20 nm MLC Flash breaks the cost barrier**
  - Optimized for high density/low cost: < 60¢/GB
- **But what about endurance?**
  - Degrades rapidly with geometry
  - 19/20 nm MLC – few thousand writes
- **Enterprise requires 100x more write endurance**

100x Life Amplification of Latest Generation of Flash

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- Minimize writes to the Flash
- New RAID algorithm
- New DSP/ECC
- Adaptive reads and writes
- Device physics manipulation

Optimize the Storage Stack

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- **System**
  - Compression, de-duplication, encryption in hardware to minimize writes to the flash
- **RAID**
  - Must achieve better than RAID-6 reliability with much fewer writes to flash
- **Flash Controller**
  - Develop more sophisticated DSP and ECC algorithms
- **FTL**
  - Flash physics manipulation to optimize for system-wide wear-leveling
  - Adaptive reads and writes based on usage patterns

Create a *System-Level* Flash Controller

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- **Proprietary algorithms extend MLC life to 5 years**
  - No existing flash memory controller can achieve this
  - Life Amplification™ reduces damage to flash oxide layer

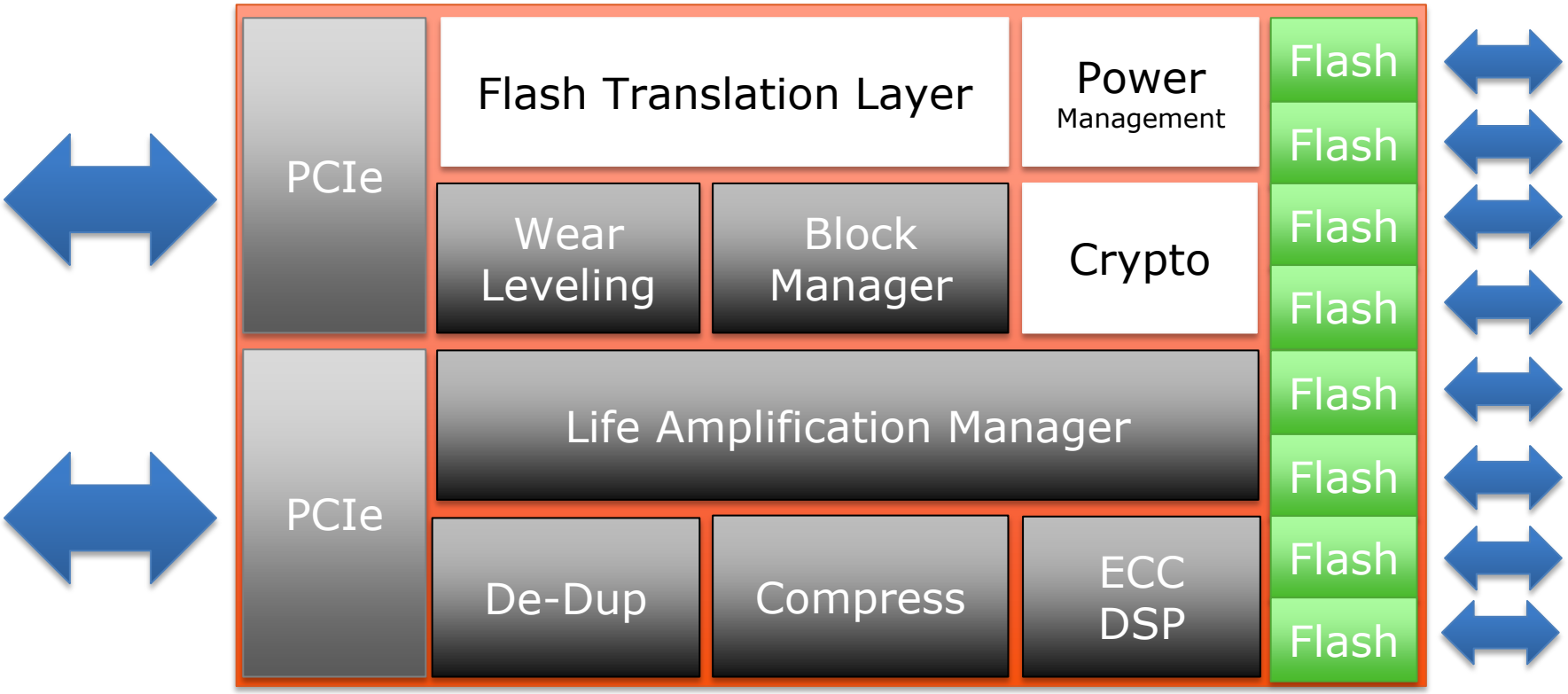
$$\text{SSD Lifetime} = \frac{\text{Endurance} * \text{Capacity}}{\text{Throughput} * \text{Duty Cycle} * \text{Write\%} * \text{Write Amplification}}$$

$$\text{Skyera SSD Lifetime} = \frac{3\text{K} * 1\text{TB}* (\text{Life Amplification}^{1})}{370\text{MBps}* 80\% * 30\%} = 5 \text{ years}$$

- **ASIC investment in Flash Memory Controller**

[1] Life amplification is equivalent to 100x lower than industry standard 5x write amplification

Flash Memory Controller



Flash Translation Layer

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- Page-based flash translation layer
- Power fail protection
- Multi-processor concurrency
- Designed to support read retry
- Extremely low write amplification
- Native support for in-line de-dup and compression

Flash Memory Management

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- Life Amplification Management
- Native support for snapshot & cloning
- 256-bit AES encryption
- Abstracted interface for advanced Flash operation

Questions…