



# Challenges and Advances in Data Recovery of SSDs

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# Recovery Market Comparison

Technology	~ Volume for 2011*	Failure Rate**	Recovery TAM (5%?)
SATA HDD	< 470M	~5%	~1.2M?
SATA SSD	< 20M	~0.7%	~7k?

**IT@Intel Brief**  
Intel IT  
IT Best Practices  
Solid-State Drives and Employee Productivity  
July 2011



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## Validating the Reliability of Intel® Solid-State Drives

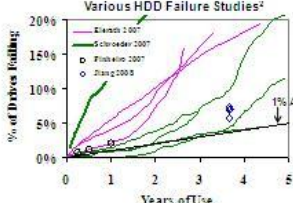
**Benefits of Intel® Solid-State Drives**

- 87 percent reduction in annualized failure rate decreases IT total cost of ownership.
- 4x faster I/O performance increases employee productivity.

To enhance employee productivity while reducing IT total cost of ownership (TCO), in 2009 Intel IT made a strategic decision to standardize on mobile business PCs equipped with Intel® Solid-State Drives (Intel® SSDs). Early TCO calculations using data from solid-state drive (SSD) manufacturers indicated that we could reduce TCO due to greater reliability compared to hard disk drives (HDDs).<sup>1</sup> In a yearlong study of more than 45,000 SSDs deployed in our mobile business PC fleet, we validated that Intel SSDs provide an 87 percent reduction in the annualized failure rate compared to HDDs—which supports our early TCO analysis. See Figure 1.

### Intel® SSD Reliability: Data Speaks Volumes

- Studies show HDDs fail at alarming rates!
- SSD reliability is THE key ingredient of TCO
- Independent study reported 0.59%<sup>1</sup> ARR




	Intel SSDs Deployed in 2010	Annual Return Rate (ARR)	Annual Failure Rate (AFR)
Intel - IT	>45K	1.06%	0.61%
ZT Systems	>100K	0.46%	0.26%
Resellers / Distributors	>>500K	0.77%	0.40%

**Intel SSD's exemplify reliability**

1. Source: [http://www.researchgate.net/publication/484444444\\_flash\\_drive\\_data\\_why\\_ssd\\_failure\\_rates](http://www.researchgate.net/publication/484444444_flash_drive_data_why_ssd_failure_rates)  
<http://www.fairplayforssd.com/2010/08/20/082010ssdreport.html>

2. Source: see slide 26



## Does the market need SSD recovery?

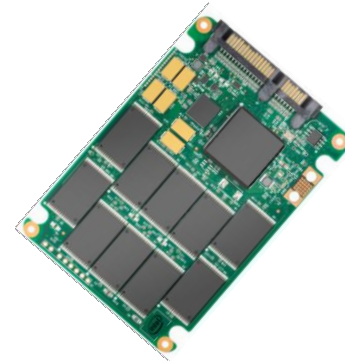
\* Source: Highest number from market analyst / Intel    \*\* Source: Intel@IT Brief, Elerath 2007, Jiang 2008, Pinheiro 2007, Schroeder 2007

# HDD vs. SSD Recovery: Paradigm Shift



## Evolution

- Fixed logical to physical
- No “erase” command
- Mechanical failure modes
- FW tuned to mechanics / ASICs
- “Swap components” approach
- Manufacturing special sauce



## Revolution

- Indirection aka FTL, many copies
- Proprietary data structures
- Trim, defrag, wear-level
- Scramble, encrypt, redundancy
- Random component or FW fails
- De-solder, read, reassemble data
- FW special sauce

***Firmware IP key to SSD design and recovery***

# SSD Recovery: Today and Tomorrow

- SSD market continues to grow
  - Recovery needs increasing some, solutions exist
- Recovery enablement requires trust
  - FW IP risk is significant
  - Recovery support costly for SSD company, revolution each generation, opportunity cost
- New NVM technologies on the horizon
- Investment required for cost effective recovery
  - Business models need to evolve – pay for tools?

***Rapid technology advancement requires mind shift***



**Thank You !**