



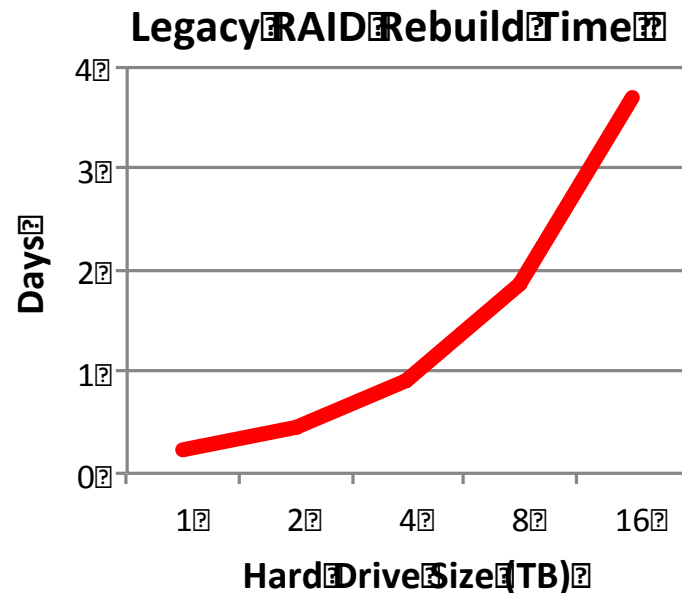
# Reliability and Availability at Scale

MAKING THE ODDS WORK IN YOUR FAVOR

PANASAS PRODUCT MARKETING

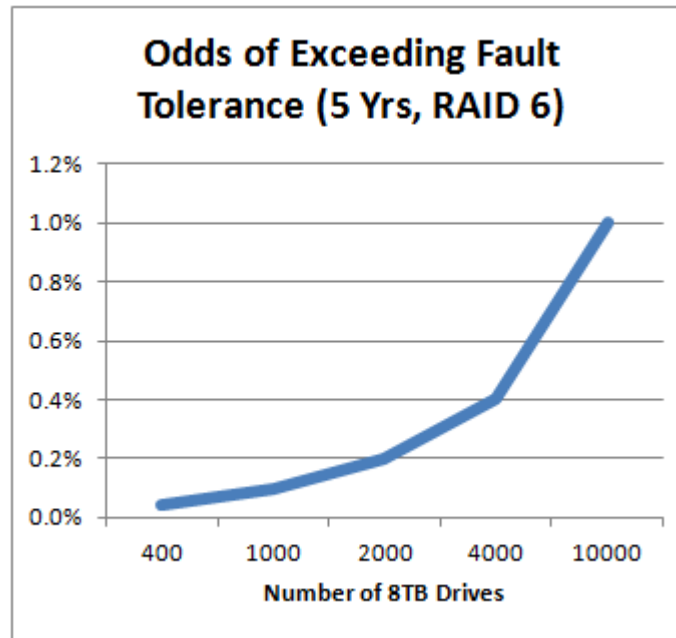
## ■ Large Deployments Exacerbate Existing Vulnerabilities in Traditional Data Protection Schemes

- Reliability gets worse with scale
- Slow rebuild times
- Lengthy disaster recovery
- Unnecessary availability outages



At 50MB/s RAID rebuild rate

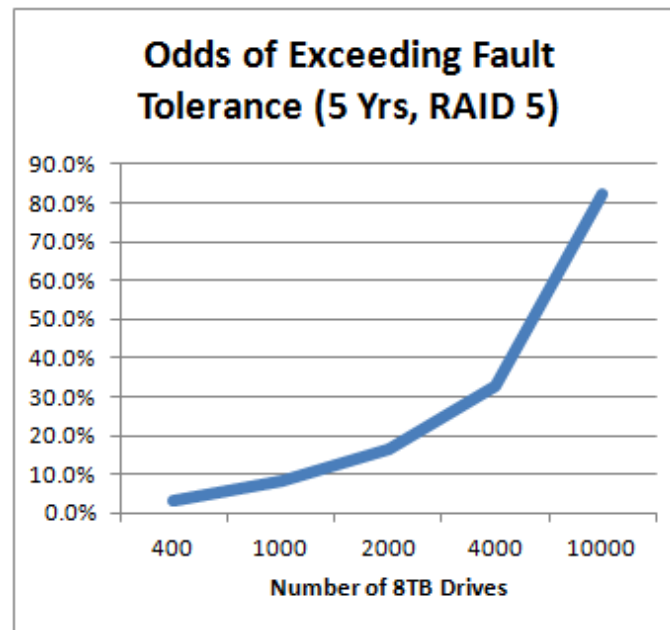
- All hardware RAID volumes risk exceeding fault tolerance
- 100 hardware RAID volumes = 100x the risk
- What are the odds for a typical hardware RAID 6 system (Lustre)



Assumptions:  
• 8TB drives  
• 10 drive RAID 6 stripes  
• 50MB/s rebuild rate  
• 3% drive AFR

- This may appear ok, but there's a problem here...

- **Previous graph assumes RAID rebuilds always complete**
- **Latent Sector Errors are becoming a big problem**
  - Hard drive vendors say: 1 in  $10^{15}$  sectors
  - Large-scale studies say they're much more common: 1.9% of enterprise drives had LSE's, even with background disk scrubbing – probably a higher % today...
- **LSE's typically count as a drive failure for hardware RAID, bringing actual RAID 6 reliability much closer to theoretical RAID 5 levels:**

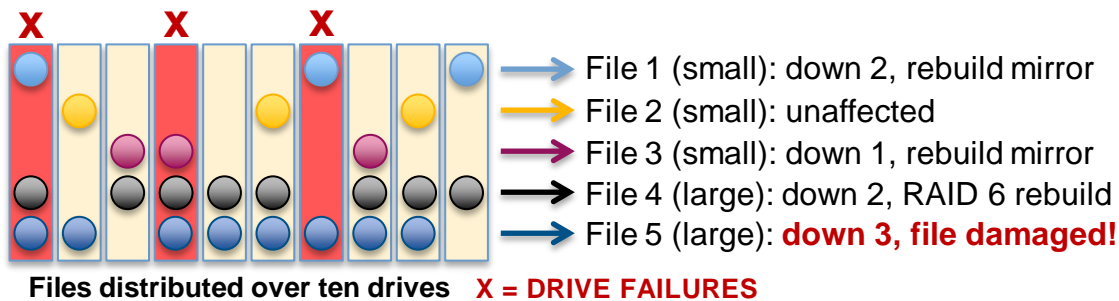


- **Replace hardware RAID with software-based per-file RAID using erasure coding**
- **Protect files, not entire block devices**
- **Limit rebuilds to affected files, not entire drives**
  - Don't rebuild portions of drives that are ok
  - Don't rebuild empty space
- **Provide additional parity protection to protect against Latent Sector Errors**
- **Distribute data on stripes selected from all drives in system**
  - RAID rebuild performance scales linearly
  - Data reliability can increase with system scale instead of decreasing

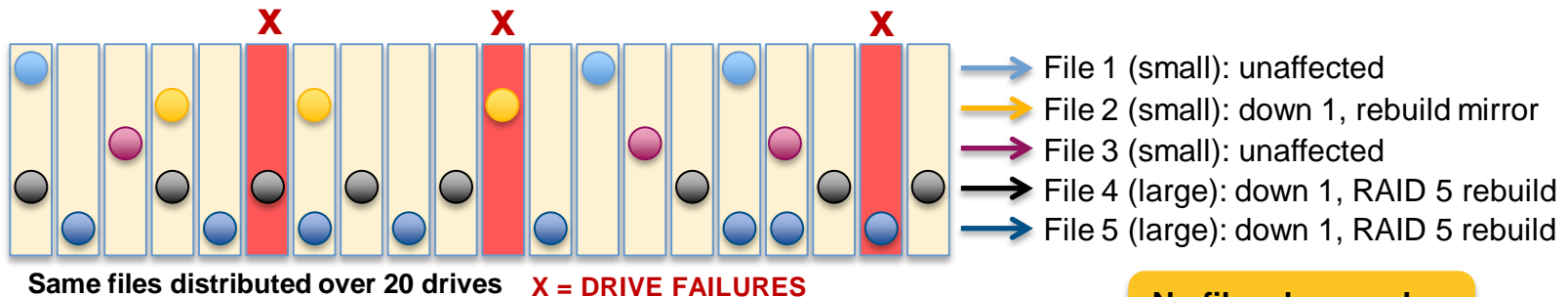
# UNDERSTANDING PER-FILE RAID

## ■ Per-file Distribution Reduces Risk at Scale

- Small files are triple mirrored, large files are striped
- With more and more drives, three drive failures (exceeding fault tolerance) are less and less likely to affect any given file

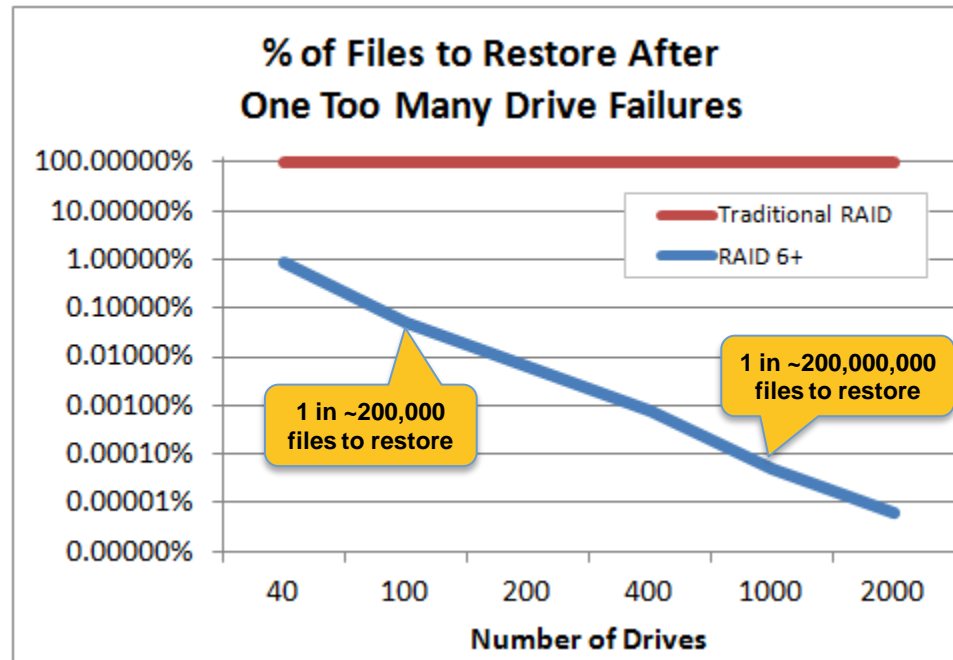


**One file damaged;  
Only need to restore File 5**



**No files damaged;  
Can rebuild all data**

- **Fast Time to Restore**
  - Restore specific files instead of entire file system
  - Made possible by extra protection of namespace (directory data) in RAID 6+
- **Percentage of Files to Restore Approaches Zero with Scale**
  - With RAID 6+ (66% small files), a triple simultaneous disk failure means:



Scaling by 10x increases reliability by 1000x!

- **Current availability model for storage is a problem at scale**
  - System goes offline upon exceeding fault tolerance anywhere in system
  - Availability needs to be more granular
  
- **Instead architect for “Always On”**
  - File system remains available even after exceeding fault tolerance
  - Protect directory structure deeper than data so directory structure stays navigable and all unaffected files can be accessed normally
  - Make it easy to quickly restore damaged files if possible



- **ActiveStor 16 with PanFS 6.0: no-compromise hybrid scale-out NAS**
- **Changes the game for reliability and availability at scale**
- **RAID 6+ triple parity protection based on erasure codes in software – 150x improvement over dual parity and no hardware RAID controllers**
- **Data reliability increases with scale instead of decreasing**
- **New availability model keeps file systems online, even after “one too many drive failures”**
- **For more information, please visit:**
  - <http://www.panasas.com>



ActiveStor 16




10 shelves, 1.2PB

**THANK YOU!**

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