

Hard Disk and Solid State Reliability Symposium

- *Pursuit of Excellence*

Determining The Reliability of Disk Drives

- *Current challenges*

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Determining The Reliability of Disk Drives

A User View of the current challenges...

- **Reliability Trends of Disk Drives**
- **Comments on validity, methodology and relevance of data**
- **Fitness for Use considerations**
- **Alignment with System Level Fault management**
- **Comments on the Prediction/ Demonstration methodology**

Determining The Reliability of Disk Drives

A Simple Introduction

Do the Math - (simplified for Marketing types)

- > Count all the drives shipped,
- > Count all the verified failures among the returns & *voila...*
- > You have an MTBF of 1.2 Million Hours- that is 136.89 years, *folks!!!*
- > Five years ago, it was only 800KHours (that is a measly 91.26 yrs..)
- > Now isn't that great???
- > *Wait! There is More!*
- > You 8x5 users will get Four Times more reliability !

Pursuit of Excellence – Mission Accomplished!

Now turning to a slightly more technical audience...

- > They do state the AFR % right next to MTBF...
- > What's more, disk drives have indeed gotten more reliable ...

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Reliability Trends of Disk Drives

- Sun Microsystems composite data on disk drives

	2003	2008
• Annualized verified failure rate (AFR)	1.1 %	0.5 %
• OEM AFR (reference info.)	1.5 %	0.8 %
• Sun AFR differs from OEM AFR , possibly because:		
> Sun screens returns and verifies failures.		
> NTFs are counted in some OEM numbers		
> Sun Product Introduction after product maturity demo.		
> Qualification regimen, Configuration control		
> System integration & Compatibility regimen		
> Close partnership with suppliers for proactive quality actions.		
• Drives are getting better!		

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Reliability Trends of Disk Drives

How about Actual Returns?

- Annualized Return Rate (ARR) is better too!
- Sun Microsystems composite data on disk drives

	2003	2008
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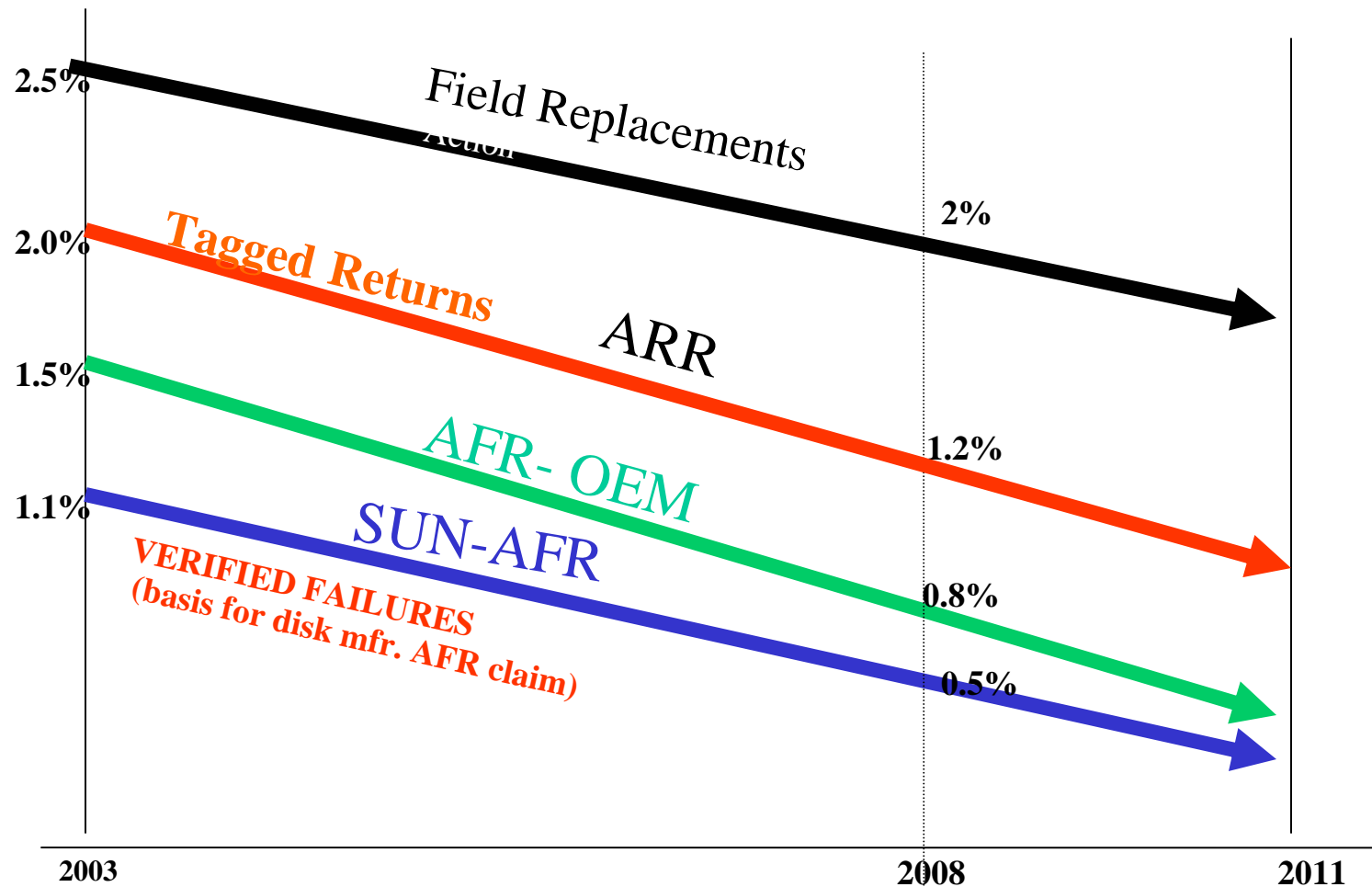
• Annualized Return Rate (ARR)	2.0 %	1.2 %
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• Field Replacement Action rate (annualized)	2.5 %	1.5 %
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- Sun ARR reflects a 60% average “NTF/CND rate”

- Field Replacement Action Rate reflects a 25% trouble shooting effectiveness and enterprise field downtime response factor

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Reliability Trends of Disk Drives

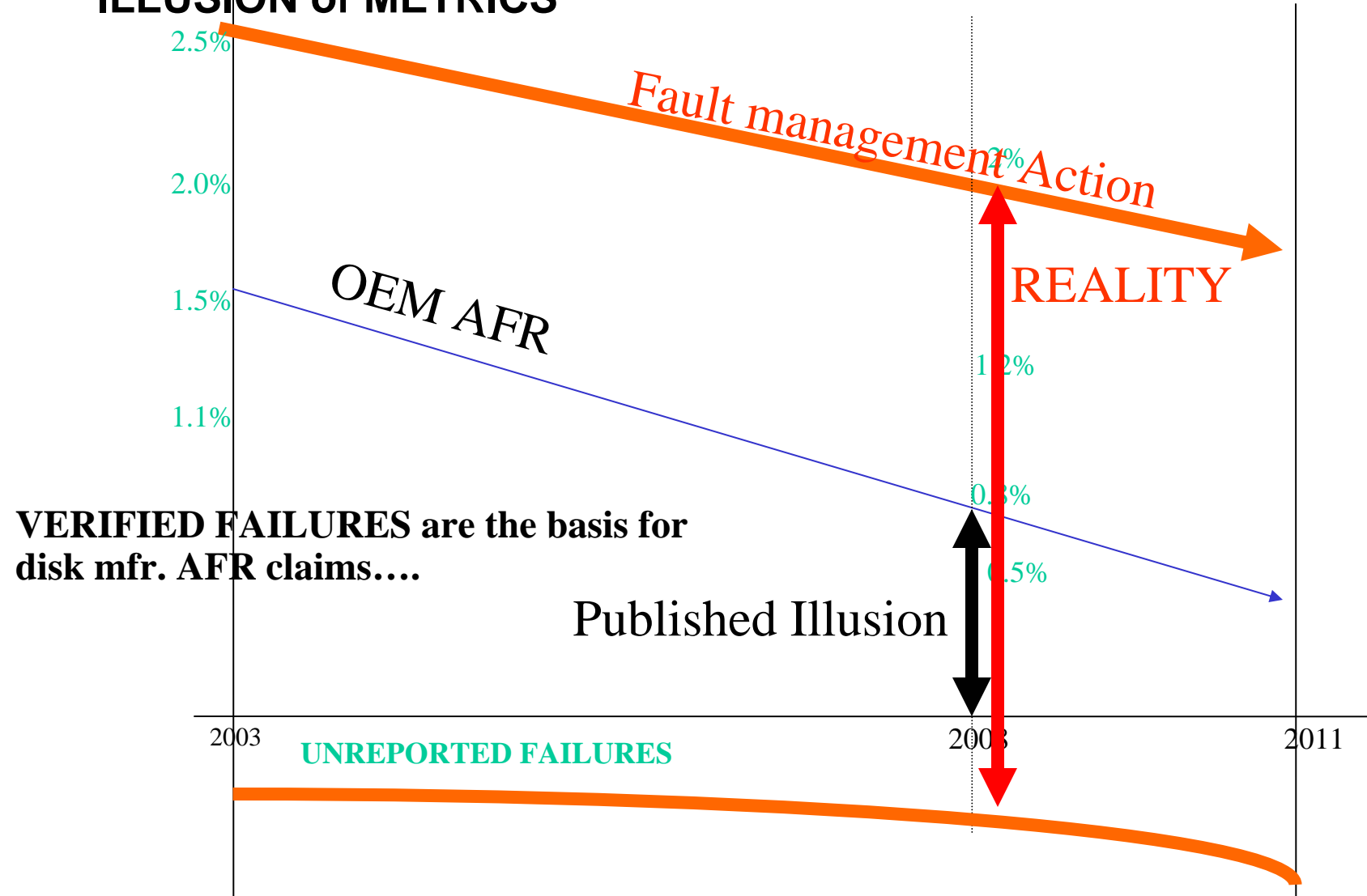
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Validity, Methodology, Relevance of Data

- How does Sun AFR fit in with drive mfrs. numbers?
 - > Disk drive manufacturers are happy to agree...
- Other user's experiences
 - > 4 to 6% AFR ?
 - > Failure Acceleration Factors assumptions questioned.
 - > Workload variability
- Unreported Failures
 - > Handling \$\$ - not worth it.
 - > Systems designed to heal/ignore/retry disk drive faults
 - > Upgrades well before end of useful life
- Relevance- In the context of the System
 - > Disk drives & SSDs are just one component in the system
 - > System Fault Management Alignment is the KEY challenge ahead

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ILLUSION of METRICS



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Fitness for Use Considerations

Criteria are changing...

- > Performance Loss,
- > Operating Conditions Changes-
 - Multi drive enclosures, Cooling Fan Vibrations
- > Intelligent Power Management
 - Hype vs. Reality
 - Time to Data
- > Super RAID, MAID, Disk Farms, Disk Forests...

What is a BETTER drive? Better AFR? Better user experience?
Is AFR below 0.5% important to the user?

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Fitness for Use

- **Affects ARR & Field Replacement rate**

(No useful framework currently for impact of those in assessing reliability of drives)

- **Performance Loss:**

Not a real AFR Criterion today at drive level.

Systems ARR & Field replacement are definitely impacted.

- **Operating Condition Changes:** 5- 500Hz is still the only spec.

(RV factor numbers are system guidelines, not drive spec.)

- **New “in” things:** Intelligent power management.

Design tradeoffs soft pedalled- Lower RPM means lower seq. perf. and time to data impact is glossed over

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Fitness for Use - A Perspective

Some Good Enhancements:

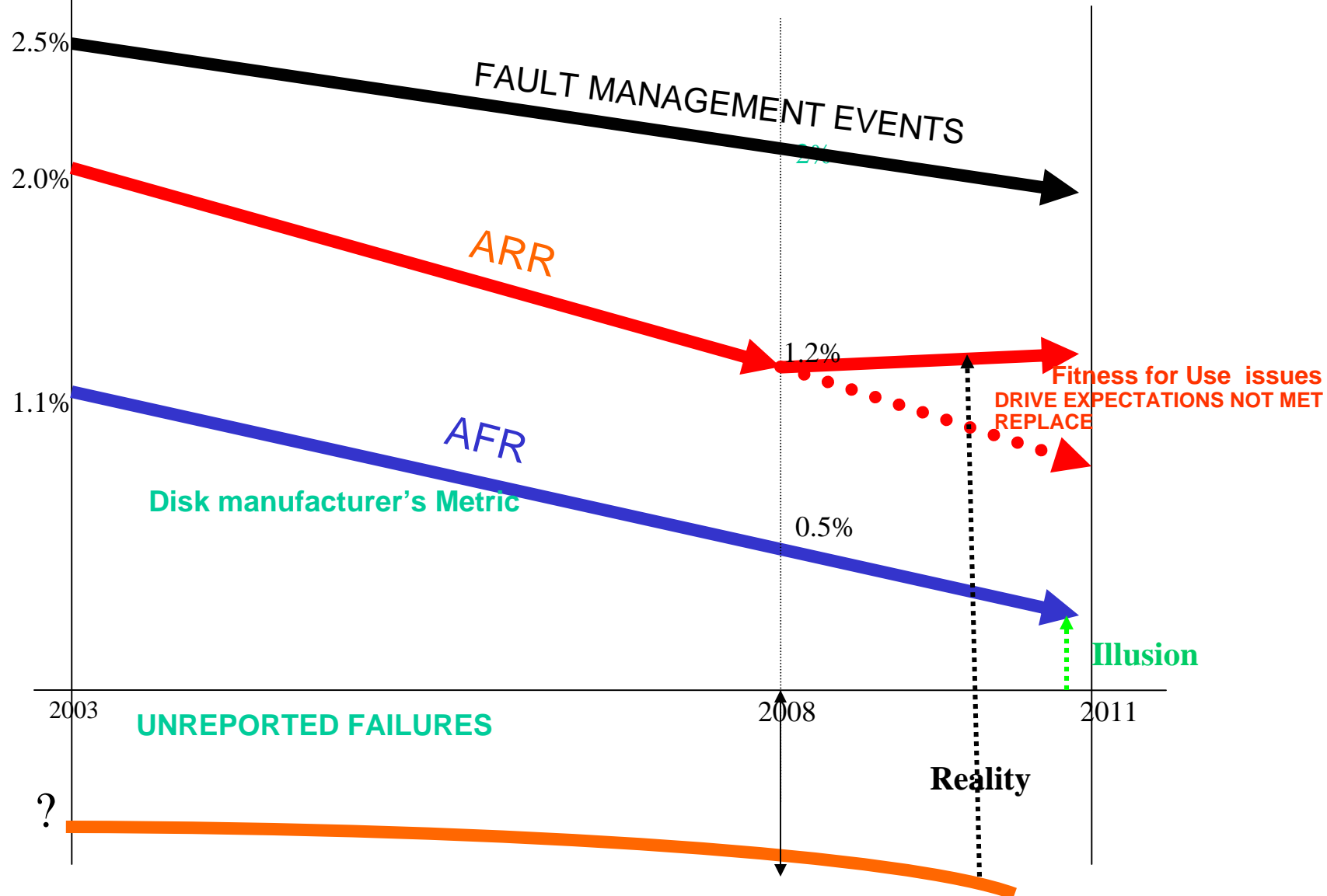
- . Data Integrity Technologies, Robust Drive Firmware download and Prediction of failures have affected perceived Reliability significantly.
- . Prediction of failures – SMART got more public attention & ironically, is the least effective. Great success in others taken for granted!)

Some Archaic/ Legacy Benchmarks: still being used...

- . Soft error rates : What does this indicate at System level? Is 0.1% performance loss a concern or distraction?
- . Performance Loss due to vibration – is poorly addressed
- . Designed in performance variation - such as variable BPI/TPI, are not even disclosed properly and impact is not well characterized
- . Heroic Retries : Unnecessary Perf. Impact when data loss has been factored into System Fault management

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What is a better drive? Better AFR, without Fitness To Use changes?



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- **System level Fault Management is advancing..**
 - > Predictability- Bed rock of Fault Management
 - > Dynamic fault management and healing
 - > Re-provisioning
 - > Cost of service, cost of support dynamics
 - > Trade offs – performance loss, time to data

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System Fault Management

“There are only two kinds of drives-

Those that have failed already and those that are about to fail!”

Systems have to be architected to handle drive failures- whatever the AFR is or will be. That is the core of System Fault Management.

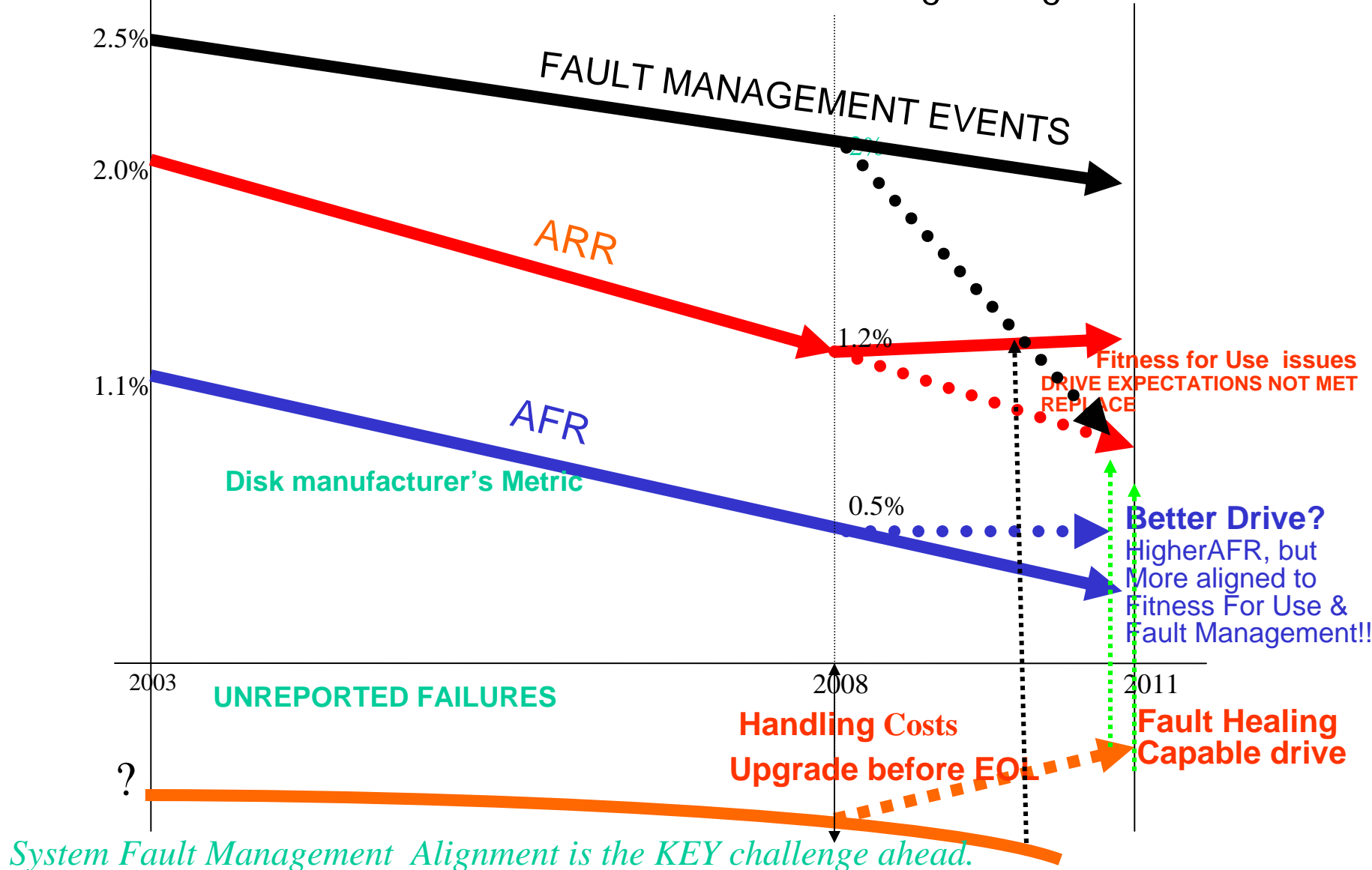
The huge RAID Storage Subsystems are proof of that.

Improving failure rate in the context of System Fault Management is LESS EFFECTIVE than Aligning Drive functions/features to strengthen System Fault Management

System Fault Management Alignment is the KEY challenge ahead.

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What is a better drive? Better AFR? Better Fault Mgmt Alignment?



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Predictability- Bed rock of Fault Management

- SMART remains an unfulfilled promise.
Percentage of Returns for SMART is in single digits.
- How many system designs use SMART to rebuild RAID?
- Disk drive suppliers do not like “False Positives” .
 - > So this is a stalemated situation
- But, with very low failure rates and large amounts of data to be backed up, improving prediction is more important than improving disk drive reliability

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Some Fault Management Alignment Steps ...

Dynamic fault management and healing

Policy based, reconfiguration of useful drives,
Auto Health checks & Monitoring, Accessible logs.

Re-provisioning

Auto-Repurposing drives
Controlled Offline Activities in Dynamic Provisioning

Cost of service, cost of support dynamics

The True Enterprise vs. Consumer Product differentiator.

Intelligent Trade offs of performance loss, time to data, power consumption. Need policy setting capabilities.

ADD YOUR IDEAS HERE....

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Implications of the System FM Alignment Approach... on Reliability Prediction/ Demonstration

- What constitutes a relevant Drive Failure?
- When is a proactive reconfiguration a drive failure?
- What is a statistically meaningful demonstration for 0.5% AFR levels?
- Should one use acceleration factors? Any valid data on the factors?
- With continuous Improvement, maturity growth and one year product manufacturing life, what does the data mean?

Time to re-examine the old assumptions...

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In Summary

DISK DRIVES ARE GETTING BETTER

CLASSICAL RELIABILITY BENCHMARKS ARE

- BEING QUESTIONED
- GETTING HARDER TO DEMONSTRATE
- DO NOT ADDRESS USER EXPERIENCE
- arguably, INCREASINGLY MEANINGLESS

DISK DRIVE INDUSTRY NEEDS TO ALIGN WITH

- USER RELEVANT RELIABILITY
- SYSTEM FAULT MANAGEMENT

THANK YOU