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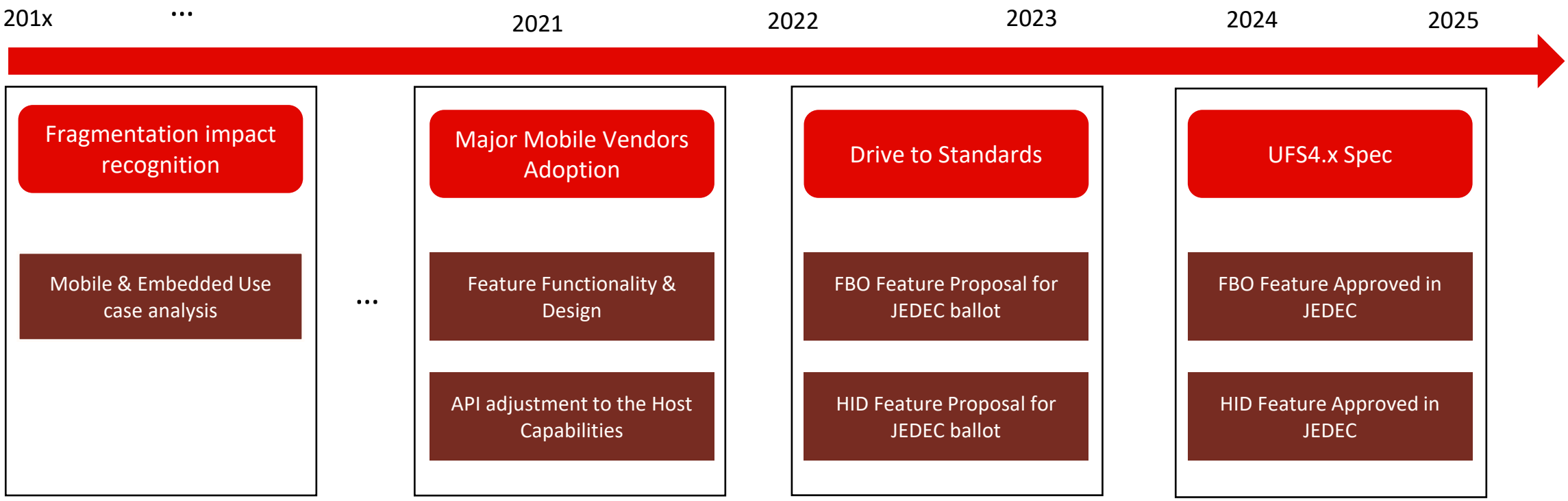
Configurable Host Initiated Defrag (HID) for Optimal Efficiency

Presenter:
Alex Lemberg, Senior Technologist System Design

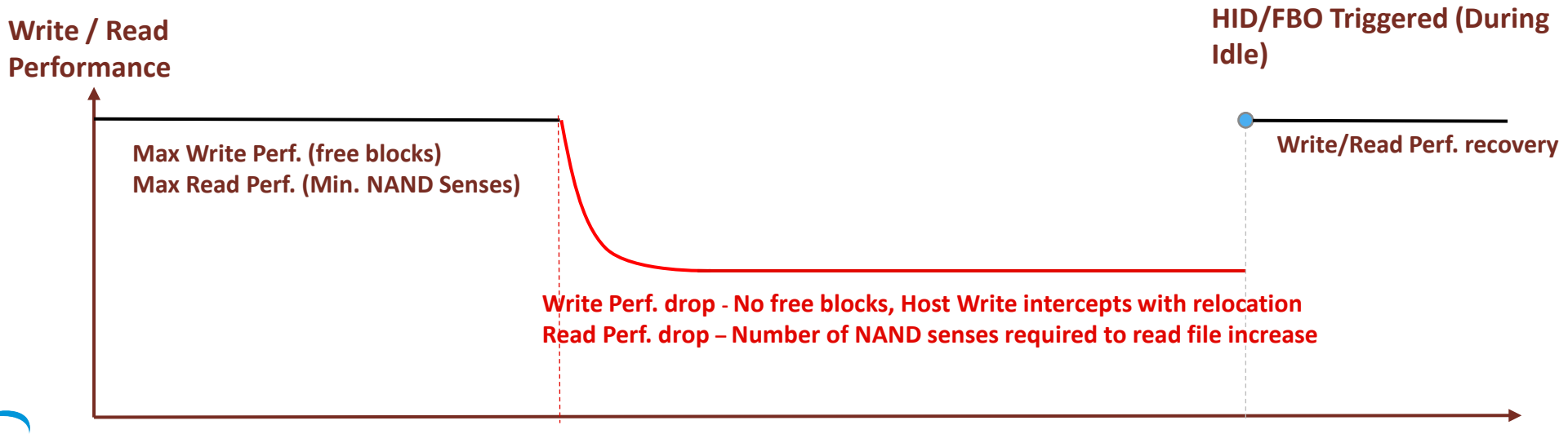
FMS the Future of Memory and Storage

UFS Memory Fragmentation Features - Evolution

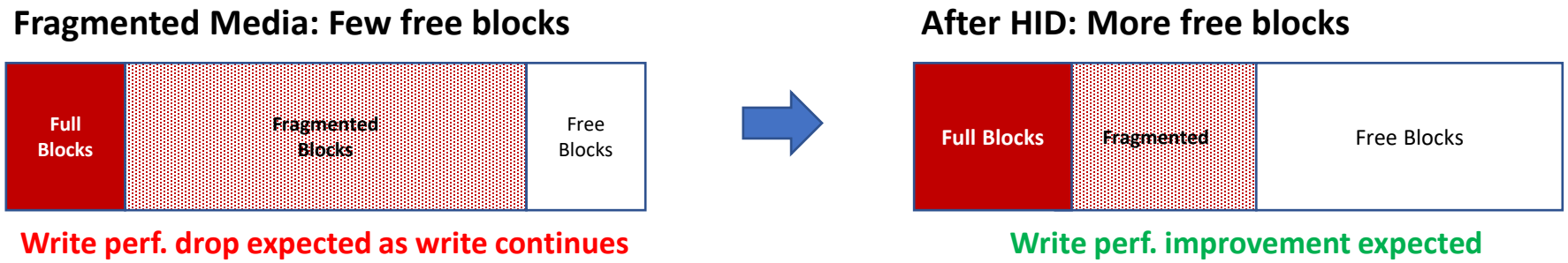


Fragmentation Features – HID & FBO

	Host Initiated Defrag (“HID”)	File Based Optimization (“FBO”)
Scenario	Over time files written & erased -> No free blocks (occupied by partial valid data)	File is getting random updates in-place File is still sequential on the host LBA
Problem	**Write** performance drop due to Storage relocation in foreground to free blocks	File **Read** performance drop due to increased number of NAND Senses
Solution	Proactive relocation (free up blocks in advance)	Defrag by relocation fragmented blocks on physical level
Benefit	Improve New file **Write** performance	Improve file **Read** performance



Host Initiated Defrag (HID) - Background

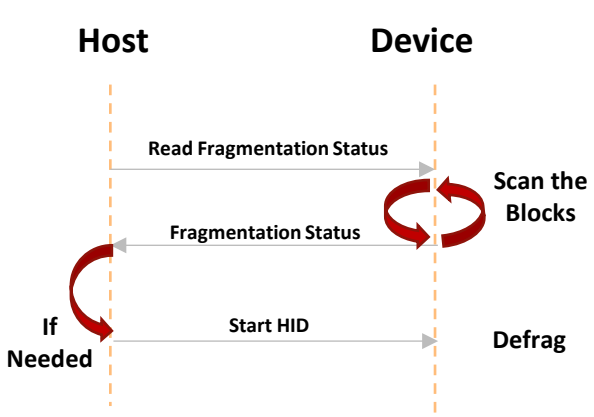


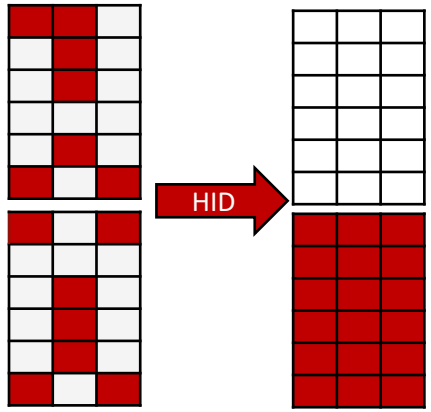
- The HID solution added to JEDEC UFSv4.1 standard
- The HID solution is coming to maintain Write performance over fragmented media
- The Host may check if the device is fragmented by using HID API
- If the device is fragmented, the Host may issue the HID operation
- **Desired outcomes – Free blocks for next host writes and better Write perf.**

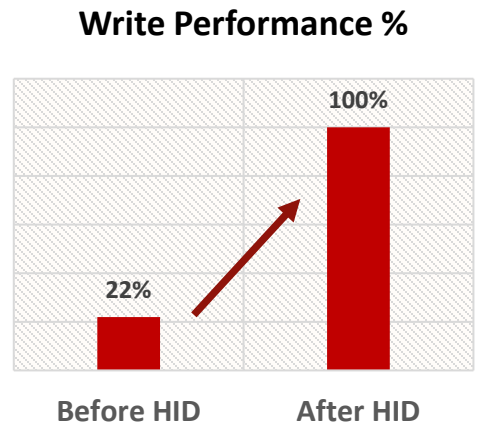
HID - Operation Flow

Host defines optimal timing for HID → • Check If Fragmented • Run Defrag → Storage performs physical defrag (in IDLE) → Free Blocks available to absorb Write operation

Optimal Time Example:
- During night/charging
- During Idle Time
- Initiated by User App







Running HID in Idle Time –> Get Ready for the Next Write

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HID Efficiency - User Control

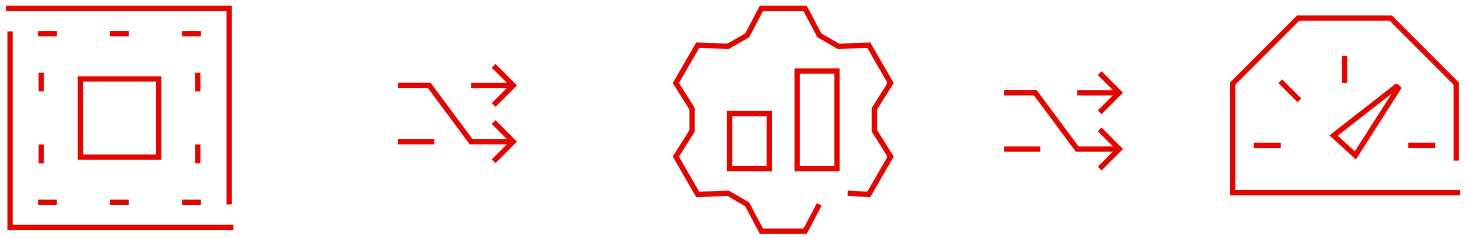
HID Operation – Vendor Specific Criteria

HID Defrag algorithm chooses Candidate Blocks based on a **Vendor-Specific** Criteria to achieve a Desired Outcome:

Vendor Specific
Criteria

HID Operation

Vendor Specific
Desired outcome



The same HID feature may produce completely different outcomes on products from different vendors

Proposed Solution –
Allow Calibration of HID Relocation Criteria

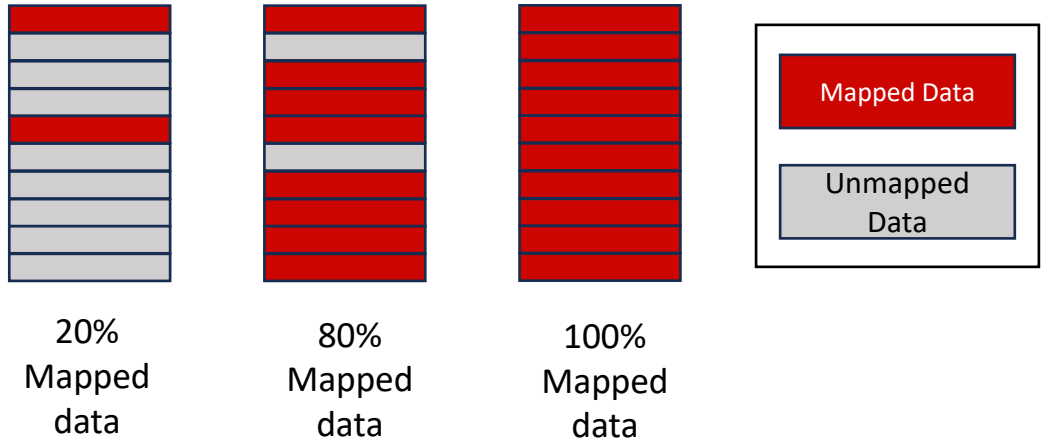
Criteria

- Mapped Data Rate (MDR) in %
- Relocation Data Size

Outcome

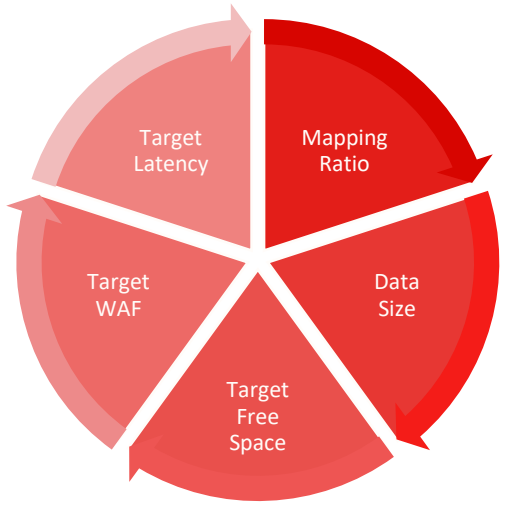
- Latency
- Free Space
- Write Amplification (WAF)

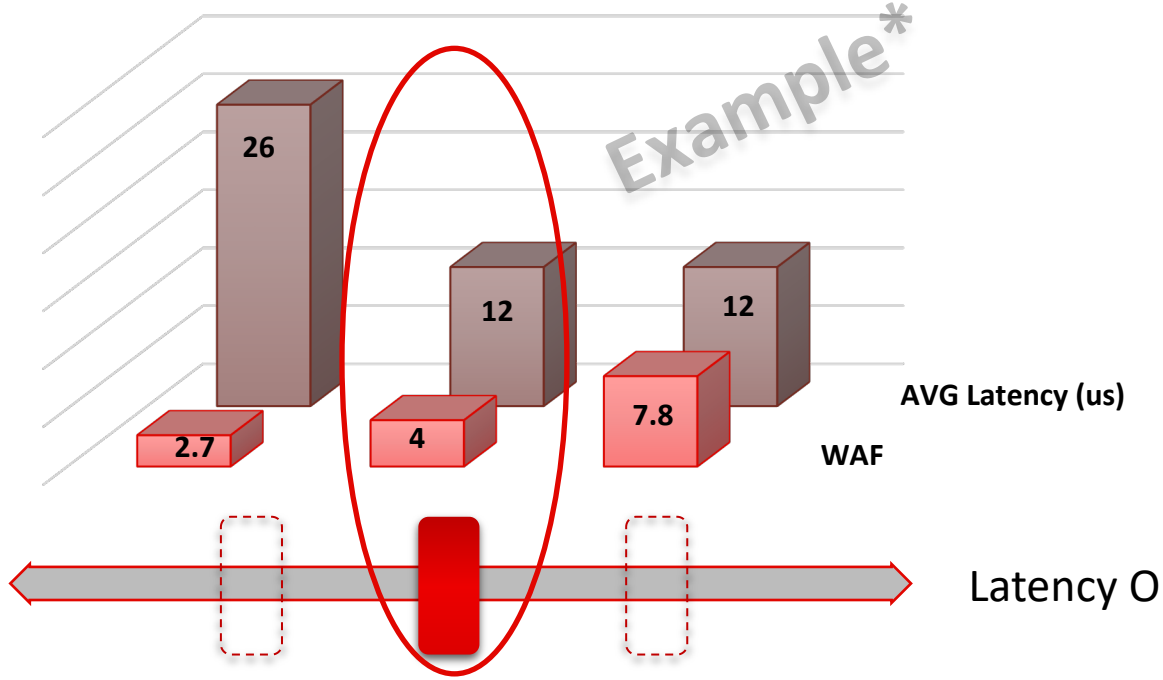
MDR – the % of valid mapped data within physical data block



The higher MDR % → The more data is relocated during Defrag → The higher WAF

Criteria Calibration -> HID Efficiency





WAF Optimization Driven

Latency Optimization Driven

Mapped Data Ratio (MDR): < 20% < 80% < 100%

* The example represents UFS storage device in a full and fragmented condition

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Thank You!

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